Prioritization of Potential Invasive Alien Plants in France

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Abstract.
Given the number of alien species already present in France and the time needed to conduct a full pest risk analysis (PRA), a prioritization process appears to be a useful tool for a preliminary selection step. Existing screening processes often lack considerations about the technical feasibility of control and the current distribution of the species which are necessary to make a decision concerning eradication. The author therefore applied the latest version of the Prioritization Process developed by the European and Mediterranean Plant Protection Organization (EPPO PP) on a selection of 303 alien species occurring in France or already invasive in neighbouring countries. In a first step, this process classifies species into four categories: species not considered invasive, species on an observation list, potential invasive species and invasive species. A second step was to select those which are priority for a PRA from those already identified as potential and invasive species.
This paper compares the results with those provided by the risk assessment system developed by Weber & Gut (Journal for Nature Conservation 12 (2004) 171-179). This latter identifies three risk classes according to species scores based on their attributes and their environmental impact : low (3-20), intermediate (21-27) and high risk (28-39). Overall both methods yield similar results except for agricultural weeds which are not taken into account by Webber & Gut. *Solidago canadensis* (38), *Acacia dealbata* (36), *Baccharis halimifolia* (31) or *Reynoutria japonica* (34) were identified among the species with the highest risk. These species are also considered invasive by the EPPO PP but they are already too widespread for the outcomes of the PRA to be worthwhile. The advantage of the EPPO PP is that it makes it possible to identify among species with high impact, emergent invasive (or potential invasive) species for which preventive action will be most profitable in France, e.g. *Alternanthera philoxeroides*, *Eriochloa villosa*, *Humulus japonicus*, *Myriophyllum heterophyllum*.

Introduction

The management of invasive alien plant species usually focuses on species already widely distributed, with negative impacts on ecosystems (e.g. in France: *Ludwigia grandiflora*, *Reynoutria japonica*, *Ambrosia artemisiifolia*). This is of course necessary, but not sufficient since new plant species are regularly introduced with the globalization of trade. In order to tackle the fraction of the new introduced species that have a high probability to become widely established and invasive, we need to develop a more global strategy including early detections and preventive eradications in parallel to regular management actions.

One important part of such preventive strategies includes Weed Risk Assessments (WRA) which are science-based risk analysis tools for determining the weed potential of new species introduced or detected on the territory. To develop an effective WRA-based strategy, we should first have a clear understanding of all alien species established on the national territory and be able to rapidly detect new arrivals on this territory. This means developing a national inventory of alien species that should be regularly updated (Genovesi & Shine, 2002) as well as an early detection system.

Lists of alien plant species in France

To date, despite a lot of existing information on invasive alien species e.g., the review of the current state of knowledge by Muller (2004), there is no comprehensive list of alien plants in France. Yet, these national inventories are widely recognized as providing a crucial source of information and are an important tool for invasion research and management (Cadotte *et al*. 2006; Richardson & Pysek 2006).

Lists focusing on the most relevant species have nonetheless already been compiled at the national level (Aboucaya, 1999) or for several French administrative regions (see the full list in Table 1). More recently, the DAISIE project has identified nearly 1,300 introduced and 700 established plant species in France (Lambdon *et al*., 2008). These various lists define several categories of alien species: casual *versus* established species, major invasive species, potential invasive species or species only requiring monitoring (observation list), with sometimes finer subdivisions within these broad categories (Lacroix *et al*., 2007). As a consequence, the current criteria used to define invasiveness are far from homogeneous. This situation clearly shows the need to build a standardized approach, to be used as a basis for producing reference lists of non-native plants in order to highlight the species that need priority actions.

Risk analysis as tools for preventive actions

In Europe, plant protection services in line with the European and Mediterranean Plant Protection Organization (EPPO) activities, have historically used Pest Risk Analysis (PRA) to identify the probability of introduction, establishment and impact of pest species (insects, diseases) in a defined area, and if necessary, PRA defines what are the most appropriate measures of preventive control. Since 2002, EPPO has extended the use of the PRA scheme to study invasive plants (Schrader *et al*., 2010). However, regarding the number of potentially invasive species already present on the European continent (or absent but with a high probability of being introduced), it is not possible to perform a full PRA for all these species as the scheme is long and very detailed. For this reason, EPPO is currently developing a tool for quick and transparent prioritization (*EPPO Prioritization Process* for Invasive Alien Plants, abbreviated EPPO PP in the following text) in order to i) provide a clear overview of

invasive and potentially invasive alien plants present in 50 European and Mediterranean countries in the EPPO region, ii) establish priorities among the species requiring a PRA.

Table 1 Numbers of alien, established and invasive species reported in the recently published regional floristic atlases, regional floras or other available publications about invasive species in France.

Regions	**Alien taxa**[1]	**Established taxa**	**Invasive taxa**	**Total number of taxa**[2]	**References**
Auvergne	~ 614 (24%)	~ 205 (8%)	12 * (0.5%) 56** (2%)	2560	Antonnetti *et al*. (2006)
Basse-Normandie	287 (18%)		11* (0.7%) 16** (1%)	1620	Provost (1993) ; Zambettakis & Magnanon (2008)
Bourgogne	-	125 (7%)	36 (2%)	1847	Bardet *et al*. (2008)
Bretagne	-	-	17* 21**	-	Magnanon *et al*. (2007)
- Côte-d'Armor	-	-	8* (0.7%) 12** (1%)	1150	Philippon *et al*. (2006)
- Finistère	380 (34%)		13* (1%) 21** (2%)	1129	Quéré *et al*. (2008)
- Ille-et-Vilaine	200 (15%)		9* (0.7%) 16** (1%)	1373	Diard (2005)
- Morbihan	344 (20%)	191 (11%)	9* (0.7%) 18** (1%)	1694	Rivière (2007)
Centre	-	-	-	-	
- Loiret	-	103 (9%)	7* (0.5%) 15** (1%)	1382	Pujol *et al*. (2007)
Corse	404 (17%)	153 (6%)	30 (1%)	2397	Jeanmonod & Gamisans (2007)
Drôme	72 (3%)	74 (3%)	16 (0.7%)	2385	Garraud (2003)
Franche-Comté	-	-	38* 49**	-	Ferrez (2006)
Île-de-France	-	-	-	-	
- Essonne			23 (2%)	1215	Arnal & Guittet (2004)
- Eure-et-Loir	129 (9%)	65 (5%)	8* (0.6%) 45** (3%)	1366	Dupré *et al*. (2009)
- Seine-Saint-Denis	269 (25%)	127 (12%)	10* (0.9%) 12** (1%)	1089	Filoche *et al*. (2006)
Mediterranean area	1253	351	60	-	Brunel & Tison (2005)
Pays de la Loire	-	-	-	-	Lacroix *et al*. (2007)
- Loire-Atlantique et Vendée	360 (19%)	204 (11%)	-	1850	Dupont (2001)
- Sarthe	364 (24%)	173 (11%)	10* (0.7%) 12** (0.8%)	1525	Hunault & Moret (2009)
- Mayenne	105 (7%)		-	1441	David *et al*. (2009)

[1]Alien species gathers all introduced species including established species, casual aliens and subspontaneous species,

[2] the total number of taxa includes both introduced and native taxa

* : invasive species, ** : potential invasive species, -: no data available.

During the last 15 years, other risk assessment tools have been more specifically developed for invasive plants :

- The Australian Weed Risk Assessment (Phelloung, 1995), one of the first and still the most acknowledged and used throughout the world (Gordon *et al*., 2008). The assessment of a species is probably shorter than with a PRA but still relatively long to be used as a quick assessment tool.
- In the United States, precise tools for assessing environmental impacts have been developed during the 2000s (Warner *et al*., 2003, Morse *et al*., 2004, Randall *et al*.,

2008). Conducting such an analysis however needs a lot of information about the impact on ecosystem processes or about recent population dynamic which are often not available for emergent species.

- For Central Europe, Weber & Gut (2004) have developed a much shorter assessment (twelve questions). Andreu & Vila (2009) have tested it for Spain and found very similar results compared to the Australian WRA.

In France, a specific risk assessment or an adaptation of an existing tools is still lacking. To date, the Plant Health Laboratory (LNPV) is involved in the development of the EPPO PP while the Federation of National Botanical Conservatories (FCBN) has tested the Weber & Gut risk assessment in order to update the list of species regulated by the Environmental Code (prohibition of sale and introduction into the wild). Currently this list only contains two species : *Ludwigia grandiflora* and *Ludwigia peploides*. Seventy-three species have been assessed and could potentially be added in the next years after negotiations with the different stakeholders.

Aims of the study

The first aim of this work was to use a first check-list of the most relevant alien plant species in France, in order to identify emergent invasive species which are priority species for several kinds of actions according to the threat they represent to natural and semi-natural ecosystems or to agricultural activities. At the national level, the present study is a part of a longer-term project which intends to i) inventory the comprehensive list of all non-indigenous plants recorded in France and ii) build a transparent and standardized protocol that can be used to decide which species of this list are invasive and which should be subject to management measures. With this end in mind, the present study has the objective to test and to compare the two methods of prioritisation already in use, i.e. the EPPO PP and the risk assessment of Weber & Gut (2004) for central Europe. Finally, at the European level, this study aims to validate the EPPO PP by applying it to a large list of alien species which has been, at least partially, previously classified by expert judgement (Aboucaya, 1999).

Material & Methods

Species assessed

A plant data set gathering 370 species of various statuses was pre-selected to be tested through the 2 prioritization methods:

- The initial list included 217 alien species present in France and identified by Aboucaya (1999) as major invasive species (61 taxa), as potential invasive species to monitor (65 taxa) or as presenting less risk (91 taxa part of an observation list).
- this initial list has been updated with a data set containing 91 species reported in more recent check-lists published at the regional scale (see Table 1).
- species acknowledged as invasive at the European scale by EPPO have been added : 15 species out of the 21 of the EPPO Alert List, 2 out of the 9 species of the EPPO A2 list (species of serious phytosanitary concern which are recommended for regulation by EPPO) and 1 out of the 38 species of the EPPO List of invasive alien plants.
- species which are already invasive in neighbouring countries but not yet present in France were also added, based on the following published lists:
    - Italy : Celesti-Grapow *et al*. (2009),
    - Spain : Dana *et al*. (2004),

- Belgium : Invasive Species in Belgium (2010),
- Switzerland : Swiss Commission for Wild Plant Conservation CPS/SKEW (2006)

Description of the risk assessment methods used
All the 370 species were assessed using the *EPPO Prioritization process* (Brunel *et al*., 2010) while 288 species for which sufficient information is available were also evaluated with the risk assessment developed by Weber & Gut (2004) for Central Europe (abbreviated W-G WRA in the remainder of the document). It contains twelve questions dealing with : the area of origin, range size in the risk area, invasiveness elsewhere, mode of reproduction and dispersal, plant height and life form, population size and type of habitat invaded. As the W-G WRA was developed for continental areas, question 11: "*Habitats of species. Allocate species to one of the following. If more than one statement applies, take the one with the highest score. Riparian habitats (3), Bogs/swamps (3), Wet grasslands (3), Dry (xeromorphic) grasslands (3), Closed forests (3), Lakes, lakeshores, and rivers (3), Other (0)"* was adapted to the French conditions, adding "Dunes and coastal cliffs" as a relevant habitat. For more details on the latter protocol, please refer to the corresponding publication.

The EPPO PP consists in eleven questions including key aspects as invasiveness elsewhere in the world, climate match, spread capacity, impact on agriculture and environment. The first part of the process aims at classifying plants into several categories. According to the possible combination of scores for spread potential and adverse impact, three outcomes are possible (Figure 1).

		Spread potential		
		Low	**Medium**	**High**
Adverse impacts	**Low**	Minor concern	Minor concern	Observation list
	Medium	Minor concern	Observation list	Observation list
	High	Observation list	**List of (potential) invasive plants**[1]	**List of (potential) invasive plants**

Fig. 1 Matrix of spread potential and adverse impacts of assessed species with the corresponding outputs.

If the species qualifies as an invasive alien plant of major concern through this first set of questions, the second section of the process then investigates the efficiency of international measures (to be justified through a pest risk analysis) to prevent the entry and spread of the species and whether the species still has a significant suitable area for further spread (in order to exclude species which are already too widespread and can no more be controlled at low cost).

[1] In the latest version of the EPPO PP (Brunel et al., 2010), species with medium spread and high impact are on the observation list, in order to select only the most invasive species.

For the most important questions (climate matching, spread potential and impacts), a level of uncertainties is defined. This relativizes the risk and identifies points where research efforts must be driven.

Source of data

The necessary information for the species were obtained from various sources. The status of the species in France (only cultivated, casual, established) was obtained from Kerguélen (1993) updated by Bock (2005) and from various recent floristic atlases (Table 1).
Geographical distribution data for Europe was obtained from the DAISIE website. I only considered the number of countries where the species are clearly established (excluding casual and unknown occurrences). Native areas of alien species were checked with the online database from the Germplasm Resources Information Network (GRIN), National Germplasm Resources Laboratory, Beltsville, Maryland (http:// www.ars-grin.gov/npgs/tax/index.html), as well as from recent standard European floras (e.g. Flora Iberica, Flora d'Italia, Flora Helvetica, Nouvelle Flore de Belgique, …).
Climatic match was determined by considering the origin of the species, its current distribution and the World Map of the Köppen-Geiger climate classification (Kottek *et al*., 2006). The potential area for further spread was determined according to current distribution in France or elsewhere in the world and the extent of the remaining suitable climates and habitats in the area under consideration.
Status of the species as a weed elsewhere was taken from the Global Compendium of Weeds (GCW) (Randall, 2007). As the GCW probably exacerbates invasiveness, the author decided that to be considered as invasive elsewhere, a species has to combine at least three of the following qualifiers: "agricultural weed", "environmental weed", "noxious weed", "sleeper weed" and "weed".
Species traits (life form, seed number and viability, vegetative reproduction, dispersal mode) were extracted from various publications (species fact sheets, previous weed risk assessments in other countries). Data on habitats and the ecology of the species and local abundance were taken from recent regional floristic atlases (Table 1) and other botanical publications. Frequency and impact in cultivated fields was taken from Jauzein (1995) and Mamarot (2002) while herbicide resistance was checked with Heap (2010).

Concerning the population density in natural and semi-natural habitats as well as the impact in agricultural lands, if the species under assessment is not present in France, I used data within the European range or within another area where the species has been introduced with a similar climate to France. The uncertainty associated to these questions was ranked as medium if data was taken from another European country, or as high if data was taken from a country with similar climate elsewhere in the world. This also introduces a distinction between invasive species (with observed impacts in France) and potential invasive species (not yet present in France but already invasive under similar ecological conditions).

Results & Discussion

Global results

The list of invasive species resulting from the *EPPO Prioritization Process* and the scores from the W-G WRA are given in Appendix 1. Out of the 370 species assessed with the EPPO Prioritization Process, 127 were classified as invasive or potentially invasive species, of

which 32 were identified as priorities for PRA, 232 species were of minor concern and placed on the observation list and 8 species were not considered as invasive or potentially invasive. The scores of the 288 species assessed by the W-G WRA ranged from 12 to 38, with 95 species presenting a high risk, 147 species presenting an intermediate risk (further observation needed) and 30 species having only a low risk.

Comparison of the two methods of prioritization

Comparing the previous classification of alien species based on expert judgments (Aboucaya, 1999), a substantial agreement with EPPO Prioritization Process (Cohen's Kappa = 0.75) and the Weber & Gut Protocol (Cohen's Kappa = 0.73)was found. Table 2 shows that the agreement between the EPPO Prioritization Process and the Weber & Gut Protocol is also good (Cohen's Kappa = 0.75). For example, among the 32 species which are priority for a PRA according to EPPO PP, 24 have also a high risk and 8 an intermediate risk according to the W-G WRA.

Table 2 Comparison of the classification of the 280 alien species as either invasive or not by the EPPO Prioritization Process and by the Weber & Gut Risk assessment.

	Weber & Gut WRA			
EPPO PP Lists	**High Risk**	**Intermediate risk**	**Low Risk**	**Total**
Priority for a PRA	24	8		**32**
Invasive Species	59	32		**91**
Observation List	18	107	24	**149**
Not Invasive		3	5	**8**
Total	**101**	**150**	**29**	**280**

The differences between the two methods can be explained in two ways. Most of the 40 species that were only identified as invasive by the EPPO PP (Table 2), are agricultural weeds with economical impact on crop production (e.g., *Abutilon theophrasti*, *Bidens subalternans*, *Conyza* spp., *Panicum* spp., *Xanthium* spp.). The W-G WRA (and the previous national and regional check-lists, Table 1) only aims at identifying species at risk for biodiversity: the scores of agricultural weeds are therefore low because they are mostly annuals and species restricted to man-made habitats (on average, these traits lead to - 5 points). This is also true for small annual species whose impacts are probably less than perennial or woody invasives but can nevertheless be reported as forming dense monospecific stands threatening native vegetation like *Eragrostis pectinacea* in sandy areas of the Loire valley (Dupont, 2001) or *Claytonia perfoliata* in coastal sand dunes (Quéré *et al*., 2008).

On the other hand, the 18 species that were only identified as invasive by the W-G WRA are species that do not yet have an invasive behaviour in France. If a species is already present in France, the EPPO PP mainly relies on its effective impact in natural or semi-natural habitats and pays less attention to its behaviour elsewhere. For example *Eupatorium adenophorum* is established in riparian habitats in Corsica without forming dense populations (Jeanmonod & Gamisans, 2007). According to the intrinsic biological traits of this species (vegetative reproduction, life form, plant height and seed dispersal), the W-G WRA has identified it as presenting a high risk, which is consistent with the invasive behaviour of this plant in Spain (however, if the EPPO PP was applied at the EPPO region scale, it would also have ranked this species as invasive). This illustrates the greater predictive power of the W-G WRA more suitable for species that are not yet present. So, the W-G WRA appears as a good complement to the EPPO PP, particularly in order to identify future potential weeds.

The observation list obtained through the EPPO PP

The observation list contains 232 species. The mean score of the species on the observation list with the W-G WRA was 24.2 but it ranged from 12 to 32, with 18 species recognised as being potentially invasive (score>28), meaning that some species have intrinsic traits that confer them the ability to spread and invade. Lag phase can sometimes last several decades before an introduced species suddenly occupies a wider range of habitats and/or become invasive (Kowarik, 1995).

Two broad groups of species can be distinguished: those which are confined to ruderal and man-made habitats environments (*epoecophytes*) and those that are already established in natural or semi-natural habitats (*hemi- and holo-agriophytes*). The first group contains a significant proportion of annuals typically found in disturbed areas: *Bidens bipinnata*, *Eleusine indica*, *Eragrostis mexicana*, *Euphorbia maculata*, *Veronica persica*. They are of minor concern as they are well controlled in cultivated crops. For some species considered as invasive in previous lists, like *Nicotiana glauca* (Jeanmonod & Gamisans, 2007) or *Araujia sericifera* (Brunel & Tison, 2006), there are some uncertainties: they are forming dense stands but the naturalness of the invaded habitats is not certain. I have taken the decision to downgrade such species to the observation list, paying closer attention to the nature of the invaded habitats. Special attention must also be given to *Conyza floribunda*, which is reported as a ruderal species over most of the territory but seems able to penetrate into natural habitats in areas where it is currently expanding, e.g., in Normandy (Zambetakkis & Magnanon, 2008) and in the Côtes-d'Armor (Philippon *et al*., 2006).

The second group gathers species that have already crossed the environmental barriers. Among these species, some have been eliminated because of their low dispersal ability, due for example to few or no production of viable seeds, coupled with a lack of long-distance dispersal mechanisms (*Elaeagnus* x *submacrophylla*, *Spiraea* spp.). Other species have not (yet) been observed to form dense monospecific populations: *Amelanchier spicata*, established in oak forests on acid soils in Burgundy (Bardet *et al*., 2008), *Arctotheca calendula*, *Aptenia cordifolia* or *Tetragonia tetragonoides*, which are established in coastal sand dunes. Finally some species are considered as well integrated in their new habitat, e.g., *Juncus tenuis* or *Eleocharis bonariensis* (Dupont, 2001).

Some of the 18 species on the observation list that should be put under particular surveillance are highlighted here as they are already serious plant invaders in neighbouring countries and as their score with the W-G WRA was superior to 27, meaning that they present a high risk :

Ageratina adenophora (Spreng.) King & H. Rob. [syn : *Eupatorium adenophorum* Spreng.] (WG-WRA Score: 32) : established along rivers in Corsica (Jeanmonod & Gamisans, 2007) and in the Alpes-Maritimes department (Carles & Thébaut, 2010). In the South of Spain and in the Canary Islands, this species is spreading and forms dense stands along rivers and in riverine forests (Dana *et al*., 2004). It has a prolific asexual seed production (apomixis) which can reach 60 000 seeds/m² (Weber, 2003).

Asclepias syriaca L. (WG-WRA Score: 34), established since at least the mid 19th century (Garraud, 2003) in the Center and the South of France. Most of the time the species is only reported as escaped from gardens where it is cultivated. In the South of the Rhone Valley, it can however exhibit an invasive behaviour in riparian habitats, without forming populations exceeding 80% coverage, the stands can however reach high densities.

Hakea sericea Schrad. & J.C.Wendl. (WG-WRA Score: 30), established in the Esterel mountains both in the Var and the Alpes-Maritimes departments. It is invasive in Portugal, mainly in disturbed habitats (roadsides) but also in undisturbed shrublands. It is cold, drought

and wind resistant. It is adapted to fires which lead to mass release of seeds and stimulates germination. This is why *Hakea sericea* could rapidly become dominant in the Pine forests of the Esterel mountains which are prone to regular fires during summer.

Delairea odorata Lem. [syn.: *Senecio mikanioides* Otto ex Walp.] (WG-WRA Score: 29). It is cultivated and sometimes escapes from gardens in Bretagne, locally in the Finistère department, it can form dense stands several meters high, smothering trees and shrubs (Quéré *et al*., 2008). It is also established on the coastal areas of Provence. The plant spreads by vegetative growth, the stolons fragment easily and can quickly produce new plants.

Mahonia aquifolium (Pursh) Nutt. (WG-WRA Score: 29) is considered invasive in dunes, rock outcrops, grasslands and woodlands in Belgium where its clonal growth could lead to dense populations that are likely to overgrow and outcompete native species and accelerate the colonisation of open habitats by woody vegetation. In France, this species is largely cultivated and well established in different kind of habitats: dunes in the North of France (Toussaint *et al*., 2008), hedges and cool temperate forests in Burgundy (Bardet *et al*., 2008), edges of grasslands (Antonnetti *et al*., 2006); however no dense stands have been yet reported in these habitats.

The List of Invasive Species obtained through the EPPO PP

One hundred and twenty seven (127) species have been identified as invasive or potential invasive species by the EPPO PP. This list can be subdivided according to the extent of the invaded territory and according to the type of impact (environmental or economical).

Forty widespread invaders are already widely dispersed in all or several biogeographical regions of France (e.g., *Reynoutria japonica, Acer nedundo, Senecio inaequidens*) while 77 regional invasive species that are still restricted to only one biogeographical region, in either atlantic (*Polygonum polystachyum, Rhododendron ponticum, Spartina alternifolia*), continental (*Cotoneaster horizontalis*, *Rudbeckia laciniata*) or Mediterranean climates (*Acacia dealbata*, *Lonicera japonica*).

Ninety-six species are environmental weeds exhibiting, at least in one locality, large, dense and persistent populations in natural or semi-natural habitats with can have a cover at least 80 %. 30 species represent a major concern for agricultural activities (6 species are both agricultural and environmental weeds: *Artemisia verlotiorum, Galega officinalis, Lindernia dubia, Phyla filiformis, Phytolacca americana* and *Sicyos angulatus?*).

The mean score with the W-G WRA was 29.8, ranging from 21 to 38. The species with the highest score was *Solidago gigantea* (38) which combines high dispersal capacity, efficient vegetative reproduction and dense stands in wet meadows. Other environmental weeds with high scores include some aquatic invasive species that fragment easily and can rapidly cover entire water bodies: *Azolla filiculoides* Lam. (34), *Elodea nuttalii* (Planch.) H.St.John (34), *Ludwigia grandiflora* (Michx.) Greuter & Burdet (33), *Ludwigia peploides* (Kunth) P.H.Raven (36) and *Myriophyllum aquaticum* (Vell.) Verdc (34). Some trees like *Acacia dealbata* (36), *Prunus serotina* (35), *Ailanthus altissima* (33) or *Acer negundo* (32) also achieve high scores.

One original component of the EPPO PP is to take into account species which threaten agricultural activities. Most alien weeds are just considered as one more weed, without particular difficulties in managing them in a context of intensive practices based on the use of herbicide. Agricultural weeds included in the present list of Invasive species are those that are reported to form dense stands within fields despite a classical weed control program. These species generally require specific measures due to a lack of control of the available herbicides and/or due to other weedy traits like an effective vegetative reproduction. Most of these species occur in maize fields (*Amaranthus* spp., *Panicum* spp., *Sicyos angulatus*) or in

Mediterranean vineyards (*Bidens subalternans*, *Conyza* spp.). Some species are of concern in pastures due to their toxicity for cattle (*Galega officinalis*) or because they are not grazed and thus decrease the quality of forage (*Phyla filiformis*).

Table 3. List of invasive and potential invasive plants with high priorities for a PRA in France ranked according to their score with the W-G WRA.

Species	**Origin[2]**	**Area[3]**	**Habitat**	**I[4]**	**Score**
Hydrocotyle ranunculoides L.f.	Am.	[M]AC	Static or slow-flowing freshwater bodies	E	34
Rosa rugosa Thunb.	E. As.	A	Coastal dunes and sandy shores	E	33
Senecio angulatus L.f.	S. Afr.	M	Coastal shrublands, roadsides, wastelands	E	32
Acacia saligna (Labill.) H.L.Wendl.	Aust.	M	Heathlands, coastal scrub and beaches, forests	E	31
Crassula helmsii (Kirk) Cockayne	Aust.	A[C?]	Static or slow-flowing freshwater bodies, edges of ponds, lakes.	E	31
Gomphocarpus fruticosus (L.) R.Br.	Afr., Arab.	M	Wastelands, roadsides, torrents of river	[E]	31
Eichhornia crassipes (Mart.) Solms	S.Am.	MA	Static or slow-flowing freshwater bodies	[E]	30
Elide asparagoides (L.) KerguŽlen	S. & E. Afr.	M	Roadsides, wastelands, riversides, edges of scrublands	E	30
Pistia stratioides L.	S. Am.	MA	Static or slow-flowing freshwater bodies	E	30
Sesbania punicea Benth.	S. Am.	M	Riparian habitats, wetlands, ruderal habitats	E	30
Acacia longifolia (Andrews) Willd.	Aust.	M	Riparian habitats, woodlands, grasslands, coastal dunes and scrub	E	29
Alternanthera philoxeroides (Mart.) Griseb.	S. Am.	[M]A	Rivers, lakes, ponds, and irrigation canals	[EA]	29
Cyperus esculentus var. *leptostachyus* Böck.[1]	Am.	AC	Maize fields, riparian habitats	AE	29
Humulus japonicus Siebold & Zucc.	E. As.	M[AC]	Riverbeds, alluvial deposits rich in nutrients	E[A]	29
Periploca graeca L.	E. Med.	M	Riparian habitats, *Populus alba* forests, sand dunes	E	29
Salpichroa origanifolia (Lam.) Baill.	S. Am.	MA	Coastal dunes, ruderal habitats	E	29
Senecio deltoideus Less.	S. Afr.	M	Wet areas	E	29
Sicyos angulatus L.	N. Am.	MA	Maize fields, riparian habitats	AE	29
Solanum elaeagnifolium Cav.	Am.	M	Wastelands [potentially in all cultivated fields]	[A]	28
Acacia retinodes Schltr.	Aust.	M	Mediterranean woods, ruderal habitats, coastal sands	E	27
Cabomba caroliniana A.Gray	Am.	[M]AC	Static or slow-flowing freshwater bodies	E	27
Phyla filiformis (Schreider) Meikle	S. Am.	M	Damp meadows, edges of ponds	E	26
Akebia quinata Decne.	T. As.	[M]A	Riparian habitats	[E]	25
Setaria faberi F.Herm.	T. As.	[M]A[C]	Roadsides, highways, potentially maize fields	[A]	25
Hypericum majus (A. Gray) Britton	N. Am.	C	Wetlands, edges of ponds	E	23
Alert List (species not yet established in France)					
Salvinia molesta D.S. Mitch.	S. Am.	[MA]	Static or slow-flowing freshwater bodies	[E]	33
Pueraria lobata (Willd.) Ohwi	As.	[M]	Riparian habitats, forest edges, woodlands	[E]	32
Spartina densiflora Brongn.	S. Am.	[A]	Estuaries, interdital marine habitats	[E]	30
Myriophyllum heterophyllum Michx.	N. Am.	[MAC]	Static or slow-flowing freshwater bodies	[E]	29
Apios americana Medik.	N. Am.	[MAC]	Riparian habitats, maize fields	[AE]	28
Echinocystis lobata (Michx.) Torr. & A.Gray	N. Am.	[C]	Forest fringes, riparian habitats in floodplains	[E]	26
Eriochloa villosa (Thunb.) Kunth	E. As.	[C]	Maize fields, hedgerows, riversides	[A]	24

[1]*Cyperus esculentus* var. *esculentus* is native at least in the mediterranean part of France. The variety *leptostachyus* Boeck is native from America and naturalized in the South-West ; the variety *sativus* Boeck is naturalized around horticultural farms.

[2]Abbreviations used for area of origin : Afr.=Africa, Am.=America, Arab.=Arabic Peninsula, As.=Asia,

Aust.=Australia, E.=East, N.=North, S.=South, W.=West, Med.=Mediterranean, [3]Three main biogeographical areas have been distinguished : M. for Mediterranean, A. for Atlantic (oceanic) and C. for continental. Letters between brackets means that the species is not (yet) recorded in the corresponding area but this area is however at risk.
[4]Impact of the species : A.=Agricultural impact, E.=Environmental impact. Letters between brackets mean that the species has not yet had an impact.

Invasive Species requiring a PRA

Among the list of Invasive species, 25 species that still have a limited distribution compatible with a possible eradication or containment at low cost were identified. Seven species not yet established in France but invasive in neighbouring countries were also identified as potentially invasive in France. These 32 species have therefore the highest priority for a national PRA in France. Table 3 shows that aquatic and riparian habitats as well as the Mediterranean area are the most threatened.

Aquatic species

Wet biotopes are considered as more vulnerable to invasions than dry biotopes. Two third of the species with high priority (Table 3) are affecting riparian habitats, damp meadows or aquatic habitats. PRAs at the EPPO scale have already been performed for three out of the six species invading static or slow-flowing water bodies: *Crassula helmsii*, *Eichhornia crassipes* and *Hydrocotyle ranunculoides*. All three species are now on the EPPO A2 List (regulation as quarantine pests is recommended). *Crassula helmsii* invades edges of ponds in less than 20 locations in Bretagne and Normandie. Eradication is still possible and is under development at least in Finistère (Quéré *et al*., 2008). *Eichhornia crassipes* and *Pistia stratioides* are only casual aliens in France. Episodic blooms of *Pistia stratioides* have already been recorded in the South-West (Jalle de Blanquefort) during the 2003 summer (Dutartre, pers., comm., 2010). In the South and the South-West of France, *Eichhornia crassipes* has no stable populations. The monitoring of habitats at risk should continue for these two species. In Corsica, an invasive stand of *E. crassipes* had been detected in lagoon basins, near the Figari airport, and is currently under eradication (Jeanmonod & Schlüssel, 2008). *Cabomba caroliniana* A.Gray. was first observed in France in 2005 invading 15 km along the Burgundy canal near Dijon (Dutartre *et al*., 2006). More recently, it was also recorded in two locations in the « Canal du Midi » near Toulouse (Enjalbal, 2009). However, the EPPO PRA does not conclude that there is a clear risk. *Alternanthera philoxeroides* (Mart.) Griseb. is localized along the Garonne and Tarn rivers in the South-West without yet exhibiting an invasive behaviour (Georges, 2004). It should be closely monitored because it has recently been observed spreading on the Arno River in Italy (Brunel *et al*., 2010).

Mediterranean region

The impact of *Acacia dealbata* is well known (even if this species is still widely sold and planted in areas at risk). Some other *Acacia* sp. (*A. longifolia*, *A. retinodes*, *A. saligna*) are still of limited distribution in the Var department and in Corsica. According to their impact in other Mediterranean areas (e.g. Portugal), *Acacia* sp. should be eradicated where and when possible and should be used anymore in plantations. Several *Senecio* sp. also represent a risk, particularly *Senecio angulatus* which already forms dense stands in coastal scrublands or in wet habitats.

Alert List

An awareness campaign could be implemented in order to prevent the introduction of species not yet established in France. Among species used in aquaria, *Myriophyllum*

heterophyllum and *Salvinia molesta* should be prohibited or at least, a warning label should alert people not to discard these species in natural areas. Both species can invade static or slow flowing waters and can rapidly reach high coverage. *Salvinia molesta* is a free floating perennial fern, probably of hybrid origin. It is sterile and spreads by vegetative growth and fragmentation. It is one of the most invasive aquatic plants in tropical and southern Africa, in tropical Asia and Australasia (Weber, 2003). In Europe, it is already invasive in Italy: it has covered the entire water surface (around 1.7 ha) of a lake in less than three months (Giardini, 2004). *Myriophyllum heterophyllum* has been recorded in Germany and Austria and has shown invasive behaviour where it has been introduced in western North America (Washington State Noxious Weed Control Board Website, 2010).

Several species used as ornamentals should also be subject to preventive measures (these species should no longer be available for purchase in garden centers or nurseries, or at least advices on their proper use and disposal should be provided). This is the case for two vine species not yet established in natural areas in France: *Echinocystis lobata* and *Pueraria lobata*. *Echinocystis lobata* is an annual fast-growing species, covering large areas in floodplains, riparian habitats and forest fringes in a large part of Central Europe (Germany, Poland). Its spatial occupation competes with native species (Klotz, 2007). *Pueraria lobata* is a perennial native from eastern Asia. It is invasive in Italy and in the south of Switzerland. It has negative effects on crop production, forestry production and the natural environment, as it smothers existing flora. The severity of its impact has justified its addition to the EPPO A2 List in 2006.

Several *Spartina* sp. are already serious invaders in estuaries all along the French Atlantic coast. Another species, *Spartina densiflora* is invasive in Portugal and Spain but is not yet recorded in France. As for other invasive *Spartina*, invasions by *S. densiflora* may deeply change the structure of foreshores previously occupied by annuals *Salicornia* sp. These dense clones may also slow the flow of water, and thus increase the rate of sedimentation.

Introduction of contaminated seeds is harder to prevent. Maize fields are the most at risk for the establishment of new alien weeds due to several favourable conditions (empty ecological niche for summer annuals, irrigation, Etc.). Therefore, the national arable weed monitoring implemented in France (*Biovigilance Flore* network, see Fried *et al*., 2007) should particularly look after *Apios americana*, already invasive in Italy and *Eriochloa villosa*, invasive in North America and spreading rapidly in Central Europe.

Conclusions & Perspectives

The first aim of this work was to identify priority species to perform national PRAs on and to raise awareness on those species that can still be subject to early detections and preventive eradications. As a secondary outcome, this study provided an observation list and a list of invasive species which are both ranked according to spread potential and effective impact reported in France. Such lists can have many possible uses. I propose some examples here and the LNPV strongly encourages their development.

<u>Actions to develop on the ranked lists of invasive species</u>

Prioritized lists of invasive species can provide information for the development of appropriate regulations and voluntary restrictions on intentional plantings. To date, only two species are regulated in France: the sale, purchase, use and introduction into the wild of *Ludwigia grandiflora* and *Ludwigia peploides* is forbidden by the Order of May 2, 2007 (Articles L. 411-3 and R. 411-1 to R. 411-5 of the Environmental Code). Many other invasive species have the same level of impact and should also be added to the list of regulated species.

With this end in mind, the French national botanical conservatories have used the W-G WRA to assess and to rank a list of 73 species (*unpubl. doc.*). Nurseries and garden centers that want to develop environmental-friendly actions can use this list to remove invasive plants from their catalogues (for more details, see the *EPPO Code of conduct on horticulture and invasive alien plants*).

Unlike other countries such as Belgium or Switzerland, France has no Black List of invasive species. Even if such a list has no regulatory or legal value, it can have an authoritative value and provide useful information for people in nearby countries or in more distant areas with similar climates who want to identify species with a high likelihood of spread and impacts. Thus, prioritized lists of alien species can be a useful tool to exchange information with other countries in the framework of an early detection system at the European scale.

Land managers facing numerous invasive species in nature reserves can also use such categorized lists to determine priorities for control programs. Last but not least, this work also highlights species for which further research is needed to determine their spread capacity and the exact nature of their impact.

Toward an invasive plant risk assessment council

This list is still a working document that will need to be validated by a committee gathering other partners such as, regional experts from national botanical conservatories and scientists working on plant invasion in France. Moreover, it is important to note that prioritisation of alien plants is not a static process. When new information becomes available, species will be re-evaluated especially if new data could influence the ranking of the species. This *invasive plant risk assessment committee* that could be established, could also validate a specific risk assessment method for identifying invasive species in France and oversee the future work on the inventory of non-native plants in France.

References

Aboucaya A (1999) Premier bilan d'une enquête nationale destinée à identifier les xénophytes invasifs sur le territoire métropolitain français (Corse comprise), in Les Actes du colloque « Les plantes menacées de France », Brest, 15-17 octobre 1997. *Numéro special de la Société Botanique du Centre-Ouest* **19**, 463-482.

Andreu J, Vilà M (2009) Risk analysis of potential invasive plants in Spain. *Journal for Nature Conservation* **18**, 34-44

Antonetti P, Brugel E, Kessler F, Barbe JP & Tort M (2006) *Atlas De La Flore D'Auvergne*. Conservatoire botanique national du Massif central, Chavaniac-Lafayette (FR).

Arnal G, Guittet J (2004) Atlas de la flore sauvage du département de l'Essonne. Biotope, Mèze (Collection Parthénope) ; Muséeum national d'Histoire naturelle, Paris (FR).

Bardet O, Féderoff E, Causse G, & Moret J (2008) *Atlas de la flore sauvage de Bourgogne* Biotope, Mèze (Coll. Parthénope) ; Muséum national d'Histoire naturelle, Paris (FR).

Bock B (2005) Base de Données Nomenclatural de la Flore de France v4.02: http://www.tela-botanica.org/page:eflore [Accessed on March 2010]

Brunel S & Tison JM (2005) A method of selection and hierarchization of the invasive and potentially invasive plants in continental Mediterranean France. In: Invasive Plants in Mediterranean Type Regions of the World. Proceedings of the International Workshop, 25–27 May 2005 (Ed. Brunel S). pp. 27–36. Council of Europe Publishing, Mèze, France.

Brunel S, Schrader G, Brundu G, Fried G (2010) Emerging invasive alien plants for the Mediterranean Basin *EPPO Bulletin* **40**, 219-238.

Cadotte MW, Murray BR, Lovett-Doust L (2006). Ecological patterns and biological invasions: Using regional species inventories in macroecology. *Biological Invasions* **8**, 809–821.

Carles L & Thébault L (2010) *Guide de la flore des Alpes-Maritimes du Mercantour à la Méditerranée*, Editions Gilleta Nice Matin, Nice (FR).

Celesti-Grapow L, Alessandrini A, Arrigoni PV, Banfi E, Bernardo L, Bovio M, Brundu G, Cagiotti MR, Camarda I, Carli E, Conti F, Fascetti S, Galasso G, Gubellini L, La Valva V, Lucchese F, Marchiori S, Mazzola P, Peccenini S, Poldini L, Pretto F, Prosser F, Siniscalco C, Villani M, Viegi L, Wilhalm T & Blasi C (2009) Inventory of the non-native flora of Italy. *Plant Biosystems* **143**, 386–430.

DAISIE European Invasive Alien Species Gateway: http://www.europe-aliens.org [Accessed on May 2010]

Dana ED, Sobrino E, & Sanz-Elorza M (2004) *Plantas invasoras en España: un nuevo problema en las estrategias de conservación*. In: *Atlas y Libro Rojo de la flora vascular amenazada*. (ed. Aeal Banares Baudet), pp. 1010-1029. Madrid (SP).

David C, Gérard M, Hubert H, Jarri B, de Labarre Y, Ravet M (2009) Atlas de la flore de la Mayenne. Editions Siloë, Nantes (FR).

Diard L (2005) *Atlas de la flore de l'Ille-et-Vilain*e. Editions Siloë, Nantes (FR)

Dupont P (2001) Atlas floristique de la Loire-Atlantique et de la Vendée. Etat et avenir d'un patrimoine. Tome 2 Cartes et commentaires, Editions Siloë, Nantes (FR).

Dupré R, Boudier P, Delahaye P, Joly M, Cordier J & Moret J (2009) *Atlas de la flore sauvage du département de l'Eure-et-Loir*. Biotope, Mèze (Collection Parthénope) ; Muséeum national d'Histoire naturelle, Paris (FR).

Dutartre A, Chauvin C, Grange J (2006) Colonisation végétale du canal de Bourgogne à Dijon. Bilan 2006 – Prospection de gestion. Voies Navigables de France, Cemagref. 87pp.

Ferrez Y (2006) Définition d'une stratégie de lutte contre les espèces invasives de Franche-Comté - Proposition d'une liste hiérarchisée. Conservatoire Botanique de Franche-Comté, DIREN Franche-Comté, Union Européenne, 71 pp.

Filoche S, Arnal G, Moret J (2006) *La biodiversité du département de la Seine-Saint-Denis. Atlas de la flore sauvage*. Biotope, Mèze (Collection Parthénope) ; Muséeum national d'Histoire naturelle, Paris (FR).

Fried G, Reboud X, Gasquez J, & Delos M (2007) 'Biovigilance Flore', a Long-Term French Weed Survey. *20eme Conference du COLUMA.Journees Internationales sur la Lutte contre les Mauvaises Herbes, Dijon, France, 11-12 decembre, 2007*.

Garraud L (2003) *Flore De La Drôme. Atlas Écologique Et Floristique* CBN alpin de Gap-Charance, Gap (FR).

Genovesi P & Shine C (2002) European Strategy on Invasive Alien Species. Convention on the Conservation of European wildlife and natural habitats. T-PVS (2003) 7 revised. 50 p. http://www.coe.int/t/e/Cultural_Cooperation/Environment/Nature_and_biological_diversity/Nature_protection/sc23_tpvs07erev.pdf?L=E [Accessed on March 2010].

Georges N (2004) L'Herbe à Alligator (*Alternanthera Philoxeroides* (Martius) Grisebach) atteint le département du Tarn-Et-Garonne. *Le Monde des Plantes* **484**, 1-3.

Giardini M (2004) *Salvinia molesta* D.S. Mitchell (*Salviniaceae*): the second record for Italy (Latium) and consideration about the control of this invasive species. *Webbia* **59**.

Gordon DR, Onderdonk DA, Fox AM & Stocker RK (2008) Consistent accuracy of the Australian weed risk assessment system across varied geographies. *Diversity and Distributions* **14**, 234–242.

Heap I (2010) The International Survey of Herbicide Resistant Weeds. Online Internet: www.weedscience.com [Accessed on May 2010].

Hunault G, Moret J (2009) *Atlas de la flore sauvage du département de la Sarthe*. Biotope, Mèze (Collection Parthénope) ; Muséeum national d'Histoire naturelle, Paris (FR).

Invasive Species in Belgium (2010): http://ias.biodiversity.be/species/all [Accessed on March 2010]

Jauzein P (1995) *Flore Des Champs Cultivés* Sopra-INRA, Paris (FR).

Jeanmonod D & Gamisans J (2007) *Flora Corsica*. Edisud, Aix-en-Provence (FR).

Jeanmonod D & Schlussel A (2008) Notes and Contributions on Corsican Flora, XXII. *Candollea* **63**, 131-151.

Kerguélen M (1993) *Index synonymique de la flore de France*. Museum national d'histoire naturelle, Paris (FR).

Klotz S (2007) *Echinocystis lobata*: http://www.europe-aliens.org/pdf/Echinocystis_lobata.pdf [Accessed on March 2010].

Kottek M, Grieser J, Beck C, Rudolf B & Rubel F (2006) World Map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift 15, 259-263. DOI: 10.1127/0941-2948/2006/0130.

Kowarik I (1995) Time lags in biological invasions with regard to the success and failure of alien species. In: Pysek, P. *et al*. (eds), *Plant invasions, general aspects and special problems*. SPB Academic Publishers, pp. 15-38.

Lacroix P, Magnanon S, Geslin J, Hardegen M, Le Bail J & Zambettakis C (2007) *Les plantes invasives des régions Basse-Normandie, Bretagne et Pays de la Loire 1. Définitions et clé pour l'élaboration de listes de plantes « invasives avérées », « potentiellement invasives », ou « à surveiller » Version 1*. Conservatoire Botanique National de Brest, Brest (FR).

Lambdon PW, Pysek P, Basnou C, Arianoutsou M, Essl F, Hejda F, Jarosik V, Pergl J, Winter M, Anastasiu P, Andriopoulos P, Bazos I, Brundu G, Celesti-Grapow L, Chassot P, Delipetrou P, Josefsson M, Kark S, Klotz S, KokkorisY, Kühn I, Marchante H, Perglova I, Pino J, Vilà M, Zikos A, Roy D & Hulme PE (2008) Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. *Preslia* **80**, 101–149.

Magnanon S, Haury J, Diard L, Pelloté F (2007) Liste des plantes introduites envahissantes (plantes invasives) de Bretagne. Conseil scientifique régional du patrimoine naturel de Bretagne, 24 pp.

Mamarot J (2002) *Mauvaises Herbes Des Cultures* ACTA Editions, Paris (FR).

Morse LE, Randall JM, Benton N, Hiebert R & Lu S (2004) *An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1*. NatureServe, Arlington, VI.

Muller S (2004) *Plantes invasives en France*. Muséum national d'Histoire naturelle. Paris (FR), 168pp. (Patrimoines naturels, 62).

Phelloung P (1995) Determining the weed potential of new plant introductions to Australia Report. Australian Weeds Committee and the Plant industries Committee, Perth (AU).

Philippon D, Prelli R & Poux L (2006) *La Flore Des Côtes-d'Armor* Editions Siloë, Nantes (FR).

Provost M (1993) Atlas de la répartition des plantes vasculaires de Basse-Normandie. Presses Universitaires de Caen, Caen (FR)

Pujol D, Cordier J, Moret J (2007) *Atlas de la flore sauvage du département du Loiret*. Biotope, Mèze (Collection Parthénope) ; Muséeum national d'Histoire naturelle, Paris (FR).

Quéré E, Magnanon S, Ragot R, Gager L & Hardy F (2008) *Atlas De La Flore Du Finistère* Editions Siloë, Nantes (FR).

Randall JM, Morse LE, Benton N, Hiebert R, Lu S & Killeffer T (2008) The Invasive Species Assessment Protocol: A Tool for Creating Regional and National Lists of Invasive Nonnative Plants that Negatively Impact Biodiversity. *Invasive Plant Science and Management* **1**, 36–49.

Randall RP (2007) Global Compendium of Weed: http://www.hear.org/gcw/ . [Assessed on May 2010]

Richardson DM, Pysek P (2006) Plant invasions: Merging the concepts of species invasiveness and community invisibility. Progress in Physical Geography **30**, 409–431.

Rivière G (2007) *Atlas de la Flore du Morbihan* Siloë Editions, Nantes (FR).

Schrader G, Unger JG & Starfinger U (2010) Invasive alien plants in plant health: a review of the past ten years. *EPPO Bulletin* **40**, 239-247.

Swiss Commission for Wild Plant Conservation CPS/SKEW (2006) http://www.cps-skew.ch/plantes_exotiques/information_sur_les_plantes_exotiques_envahissantes.html [Accessed on May 2010]

Toussaint B, Mercier D, Bedouet F, Hendoux F, Duhamel F (2008) Flore de la Flandre française. Centre régional de phytosociologie agréé, Conservatoire Botanique national de Bailleul, Bailleul (FR).

Warner PJ, Bossard CC, Brooks ML, DiTomaso JM, Hall JA, Howald AM, Johnson DW, Randall JM, Roye CL, Ryan MM & Stanton AE (2003) Criteria for categorizing invasive nonnative plants that threaten wildlands. http://www.cal-ipc.org/ip/ inventory/pdf/Criteria.pdf. [Accessed on October 2007].

Washington State Noxious Weed Control Board Website. http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/Myriophyllum-heterophyllum.pdf [Accessed on May 2010].

Weber E (2003) Invasive Plant Species of the World – A Reference Guided to Environmental Weeds. CABI Publishing, Wallingford, UK, 548 p.

Weber E, Gut D (2004) Assessing the risk of potentially invasive plant species in central Europe. *Journal for Nature Conservation* **3**, 171-179.

Zambettakis C & Magnanon S (2008) *Liste des plantes vasculaires invasives, potentiellement invasives et à surveiller en région Basse-Normandie*. Conservatoire Botanique National de Brest, Brest (FR).

Appendix : Prioritized list of invasive and potentially invasive species in France

Species in bold are species which have been identified as priority for a national PRA

[1]Indicates the region at risk : M=mediterranean, A=atlantic, C=continental. Letters between brackets means that the corresponding regions is not yet invaded but is at risk.

[2]Score obtained with the W-G WRA: 3-21: low risk, 21-27: intermediate risk, 28-39: high risk

[3]Type of impact : A=agriculture, E=environment. Letters between brackets means that the impact is only potential.

[4]Agriophyte are species which occur in natural or semi-natural habitats while epocophytes are species restricted to disturbed habitats.

Species name	Reg.[1]	Main habitats	Score[2]	I[3]	Status[4]
Widespread invasive species (impact are reported in all three biogeographical regions of France)					
Ludwigia peploides (Kunth) P.H.Raven	*MAC*	Static or slow-flowing freshwater bodies	36	E	*Agriophyte*
Reynoutria japonica Houtt.	*MAC*	Riparian habitats, roadsides, wastelands	34	E	*Agriophyte*
Ludwigia grandiflora (Michx.) Greuter & Burdet	*MAC*	Static or slow-flowing freshwater bodies	33	E	*Agriophyte*
Ailanthus altissima (Mill.) Swingle	*MAC*	Ruderal habitats, riparian habitats	33	E	*Hemiagriophyte*
Acer negundo L.	*MAC*	Alluvial forests	32	E	*Agriophyte*
Elodea canadensis Michx.	*MAC*	Static or slow-flowing freshwater bodies	32	E	*Agriophyte*
Elodea nuttalii (Planch.) H.St.John	*MAC*	Static or slow-flowing freshwater bodies	32	E	*Agriophyte*
Paspalum distichum L.	*MAC*	Wetlands : riversides, riverbeds	32	AE	*Agriophyte*
Senecio inaequidens DC.	*MAC*	Ruderal habitats, pastures, dunes, rocks	31	E	*Hemiagriophyte*
Buddleja davidii Franch.	*MAC*	Ruderal habitats, riversides, forests	31	E	*Hemiagriophyte*
Reynoutria x bohemica Chrtek & Chrtkova	*MAC*	Riparian habitats, roadsides, wastelands	31	E	*Agriophyte*
Robinia pseudoacacia L.	*MAC*	Ruderal habitats, forest, calcareous or sandy grassland	31	E	*Agriophyte*
Ambrosia artemisiifolia L.	*MAC*	Arable fields, ruderal habitats, riverbeds	30	A(E)	*Epoecophyte*
Bidens frondosa L.	*MAC*	Riverbeds	30	E	*Agriophyte*
Phytolacca americana L.	*MAC*	Ruderal habitats, maize fields, riparian habitats, forest logging	29	AE	*Hemiagriophyte*
Impatiens glandulifera Royle	*MAC*	Riparian habitats, forest edges	29	E	*Agriophyte*
Lemna minuta Kunth	*MAC*	Static or slow-flowing freshwater bodies	29	E	*Agriophyte*
Conyza canadensis (L.) Cronquist	*MAC*	Arable fields, ruderal habitats, riverbeds	27	A	*Epoecophyte*
Abutilon theophrasti Medik.	*MAC*	Maize fields, wet wastelands, sandy river banks	25	A	*Epoecophyte*
Panicum capillare L.	*MAC*	Maize fields, ruderal habitats, riverbeds	25	A	*Epoecophyte*
Panicum dichotomiflorum Michx.	*MAC*	Maize fields, ruderal habitats, riverbeds	25	A	*Epoecophyte*
Panicum miliaceum L.	*MAC*	Maize fields, ruderal habitats	25	A	*Epoecophyte*
Amaranthus retroflexus L.	*MAC*	Cultivated fields, wastelands, ruderal habitats	25	A	*Epoecophyte*
Amaranthus hybridus L.	*MAC*	Cultivated fields, wastelands, ruderal habitats	23	A	*Epoecophyte*

Invasive species with impacts in one or two biogeographical regions in France (widespread species but still lacking in a large area of the country)					
Solidago gigantea Aiton	*MC*	Ruderal habitats, damp meadows, disturbed forest	38	E	*Agriophyte*
Solidago canadensis L.	*MC*	Ruderal habitats, damp meadows, disturbed forest	36	E	*Agriophyte*
Azolla filiculoides Lam.	*MA(C)*	Aquatic habitats : stagnant rivers, ponds, waterways	34	E	*Agriophyte*
Helianthus tuberosus L.	*M(A)C*	Alluvial floodplain, riverbed and riparian habitats	34	E	*Agriophyte*
Myriophyllum aquaticum (Vell.) Verdc.	*(M)AC*	Static or slow-flowing freshwater bodies	34	E	*Agriophyte*
Reynoutria sachalinensis (F.Schmidt) Nakai	*(M)AC*	Riparian habitats, roadsides, wastelands	34	E	*Agriophyte*
***Hydrocotyle ranunculoides* L.f.**	***[M]AC***	**Static or slow-flowing freshwater bodies**	**34**	E	***Agriophyte***
Aster x salignus Willd.	*M(A)C*	Wetlands	33	E	*Agriophyte*
Cortaderia selloana (Schult. & Schult.f.) Asch. & Graebn.	*MA*	Wetlands, sandy soils, dunes	32	E	*Agriophyte*
Baccharis halimifolia L.	*MA*	Ruderal habitats, wetlands, saltmarshes	31	E	*Agriophyte*
Carpobrotus edulis (L.) N.E.Br.	*MA*	Coastal sand dunes and cliffs, salt marshes	31	E	*Agriophyte*
Lagarosiphon major (Ridl.) Moss	*(M)AC*	Static or slow-flowing freshwater bodies	31	E	*Agriophyte*
***Pistia stratioides* L.**	***MA***	Static or slow-flowing freshwater bodies	**30**	E	***Agriophyte***
***Cyperus esculentus* var. *leptostachyus* Böck.**	***AC***	**Maize fields, riparian habitats**	**29**	A	***Hemiagriophyte***
***Sicyos angulata* L.**	***MA***	**Maize fields, Riparian habitats**	**29**	AE	***Agriophyte***
Egeria densa Planch.	*(M)AC*	Static or slow-flowing freshwater bodies	28	E	*Agriophyte*
Amorpha fruticosa L.	*MC*	Riparian habitats, alluvial forests, coastal estuaries, dunes	27	E	*Agriophyte*
Conyza sumatrensis (Retz.) E.Walker	*MA(C)*	Wastelands, Roadsides, ruderal habitats, riversides	27	A	*Epoecophyte*
***Cabomba caroliniana* A.Gray**	***[M]AC***	Static or slow-flowing freshwater bodies	**27**	E	***Agriophyte***
Lindernia dubia (L.) Pennell	*(M)AC*	Edges of ponds, sandy riverbanks	26	E(A)	*Agriophyte*
Conyza bonariensis (L.) Cronquist	*MA(C)*	Arable fields, ruderal habitats, riverbeds	25	A	*Epoecophyte*
Regional invasive species (whose impacts are restricted to one biogeographical area) : more or less widespread in one region or very localized					
Artemisia verlotiorum Lamotte	*M(AC)*	Ruderal habitats, riparian habitats	36	E(A)	*Agriophyte*
Acacia dealbata Link	*M(A)*	Riparian habitats, wastelands, open forests	36	E	*Agriophyte*
Rudbeckia laciniata L.	*C*	Damp meadows, riparian habitats	36	E	*Agriophyte*
Aster lanceolatus Willd.	*(A)C*	Ruderal habitats, wetlands	35	E	*Agriophyte*
Prunus serotina Ehrh.	*(A)C*	Forests on acid soils	35	E	*Agriophyte*
Paspalum dilatatum Poir.	*M(AC)*	Riversides, wet meadows, ruderal habitats	34	E	*Agriophyte*
Prunus laurocerasus L.	*A(C)*	Wastelands, forests, human-modified forests, riparian habitats	33	E	*Agriophyte*
Lemna turionifera Landolt	*A(C)*	Aquatic habitats (eutrophic quite and warm waters)	33	E	*Agriophyte*
Spartina x townsendii n-var. *anglica* (C.E.Hubb.) Lambinon & Maquet	*A*	Coastal (intertidal zone)	33	E	*Agriophyte*
***Rosa rugosa* Thunb.**	***A***	**Coastal dunes and sandy shores**	**33**	E	***Agriophyte***
Spartina alterniflora Loisel.	*A*	Coastal (intertidal zone)	33	E	*Agriophyte*

Aster novi-belgii L.	*(A)C*	Ruderal habitats, wetlands	32	E	*Agriophyte*
Cotula coronopifolia L.	*M(A)*	Saline and freshwater marshes, swampedges, streambanks	32	E	*Agriophyte*
Helianthus x laetiflorus Pers.	*M*	Riverbeds, wastelands.	32	E	*Agriophyte*
***Senecio angulatus* L.f.**	***M***	**Coastal shrublands, ruderal habitats**	**32**	E	***Agriophyte***
Cotoneaster dammeri C.K. Schenid.	*C*	Dry calcareaous grasslands	32	E	*Agriophyte*
Cotoneaster horizontalis Decne.	*C*	Dry calcareaous grasslands	32	E	*Agriophyte*
***Gomphocarpus fruticosus* (L.) R.Br.**	***M***	**Ruderal habitats, torrents of rivers, wetlands**	**31**	E	***Agriophyte***
Carpobrotus aff. acinaciformis (L.) L.Bolus	*(M)*	Coastal sand dunes and cliffs, salt marshes	31	E	*Agriophyte*
Fallopia baldschuanica (Regel) Holub + F. aubertii	*M(AC)*	Riparian forests, riverbeds, dunes, ruderal habitats	31	E	*Agriophyte*
Lonicera japonica Thunb. ex Murray	*M(A)*	Wet forests, riparian habitats	31	E	*Agriophyte*
Sorghum halepense (L.) Pers.	*M(AC)*	Arable fields, ruderal habitats	31	A	*Epoecophyte*
***Acacia saligna* (Labill.) H.L.Wendl.**	***M***	**Grassland, coastal scrub and beaches, forests**	**31**	E	***Agriophyte***
Opuntia ficus-indica (L.) Mill.	*m*	Dry grasslands, garrigue, rocks, ruderal habitats, dunes	31	E	*Agriophyte*
***Crassula helmsii* (Kirk) Cockayne**	***A(C)***	Static or slow-flowing freshwater bodies, edges of ponds, lakes	**31**	E	***Agriophyte***
Parthenocissus inserta (A.Kern.) Fritsch	*M(AC)*	Riparian habitats, ruderal habitats, hedges	30	E	*Agriophyte*
Opuntia stricta (Haw.) Haw.	*M*	Dry grasslands, garrigue, rocks, ruderal habitats, dunes	30	E	*Agriophyte*
Aster squamatus (Spreng.) Hieron.	*M(AC)*	(Damp) wastelands, riparian habitats, (damp) cultivated fields	30	E	*Agriophyte*
Vitis riparia Michx.	*M*	Riparian habitats, alluvial forests	30	E	*Agriophyte*
***Sesbania punicea* Benth.**	***M***	**Riparian habitats, wetlands, ruderal habitats**	**30**	E	***Agriophyte***
***Eichhornia crassipes* (Mart.) Solms**	***M(A)***	**Static or slow-flowing freshwater bodies**	**30**	E	***Agriophyte***
***Elide asparagoides* (L.) KerguŽlen**	***M***	**Ruderal habitats, riparian habitats, edges of scrublands**	**30**	E	***Agriophyte***
Oenothera glazioviana Micheli	*m*	Wastelands	30	E	*Hemiagriophyte*
***Periploca graeca* L.**	***M***	**Riparian habitats (*Populus alba* forest), dunes**	**29**	E	***Agriophyte***
***Humulus japonicus* Siebold & Zucc.**	***M[AC]***	**Riverbeds, alluvial deposits rich in nutrients**	**29**	E	***Agriophyte***
Cyperus eragrostis Lam.	*M(A)*	Riparian habitats and wetlands	29	E	*Agriophyte*
Heteranthera reniformis Ruiz & Pav.	*M*	Rice fields	29	A	*Epoecophyte*
Yucca filamentosa L.	*M*	Sand dunes, rocky shorelines	29	E	*Agriophyte*
***Acacia longifolia* (Andrews) Willd.**	***M***	**Riparian habitats, coastal dunes and shrubland**	**29**	E	***Agriophyte***
***Salpichroa origanifolia* (Lam.) Baill.**	***M(A)***	**Coastal dunes, ruderal habitats**	**29**	E	***Agriophyte***
***Senecio deltoideus* Less.**	***M***	**Wetlands**	**29**	E	***Agriophyte***
Pyracantha pauciflora (Poir.) M.Roem.	*M*	Wastelands, human-modified forests	29	E	*Agriophyte*
***Alternanthera philoxeroides* (Mart.) Griseb.**	***[M]A***	**Rivers, lakes, ponds irrigation canals, riparian habitats**	**29**	E	***Agriophyte***
Elaeagnus angustifolia L.	*M(A)*	Ditches, sand dunes, salt meadows	29	E	*Agriophyte*
Yucca gloriosa L.	*M*	Dunes	29	E	*Agriophyte*

Tradescantia fluminensis Vell.	*M*	Riverbeds, fresh rocks.	28	E	*Agriophyte*
Rhus typhina L.	*C*	Riparian habitats, forests clearings, dry grasslands	28	E	*Agriophyte*
***Solanum elaeagnifolium* Cav.**	***M***	**Wastelands, potentially arable fields**	**28**	A	***Epoecophyte***
Impatiens parviflora DC.	*(MA)C*	Moist to wet forests from floodplains to beech forests	27	E	*Agriophyte*
Xanthium italicum Moretti	*M(AC)*	Cultivated fields, riparian habitats, beaches	27	A	*Epoecophyte*
***Acacia retinodes* Schltr.**	***M***	**Forests, ruderal habitats, coastal sand dunes**	**27**	E	***Agriophyte***
Heracleum mantegazzianum Sommier & Levier	*(MA)C*	Wastelands, riparian habitats, damp meadows, forest margins	27	E	*Agriophyte*
Bidens subalternans DC.	*M*	Cultivated fields, ruderal habitats	26	A	*Epoecophyte*
Bunias orientalis L.	*(A)C*	Ruderal habitats, crop edges, pastures and damp meadows	26	A	*Hemiagriophyte*
Cytisus striatus (Hill) Rothm.	*M(A)*	Scrublands, roadsides	26	E	*Agriophyte*
Oxalis pes-caprae L.	*M*	Ruderal habitats, riverbeds, dunes, shrublands	26	E	*Agriophyte*
***Phyla filiformis* (Schreider) Meikle**	***M***	**Damp meadows**	**26**	E	***Agriophyte***
Rhododendron ponticum L.	*A*	Deciduous forests	26	E	*Agriophyte*
Eragrostis pectinacea (Michx.) Nees	*A*	Sandy soils in wastelands, along riverbeds, arable fields	26	E	*Agriophyte*
Medicago arborea L.	*M*	Coastal shrublands	25	E	*Agriophyte*
Setaria viridis (L.) P. Beauv. subsp. *pycnocoma* (Steud.)	*M(C)*	Arable fields, ruderal habitats	25	A	*Epoecophyte*
***Akebia quinata* Decne.**	***[M]A***	**Riparian habitats**	**25**	E	***Agriophyte***
***Setaria faberi* F.Herm.**	***[M]A[C]***	**Roadsides, highways, potentially maize fields**	**25**	A	***Epoecophyte***
Agave americana L.	*M*	Coastal cliffs, dunes, rocky places, distubed sites.	25	E	*Agriophyte*
Galega officinalis L.	*(MA)C*	Fresh grassland & pastures, ruderal habitats, river alluvium	25	AE	*Hemiagriophyte*
Echinochloa oryzoides (Ard.) Fritsch	*M*	Rice fields	25	A	*Epoecophyte*
Echinochloa phyllopogon (Stapf) Koso-Pol.	*M*	Rice fields	25	A	*Epoecophyte*
Heteranthera limosa (Sw.) Willd.	*M*	Rice fields	24	A	*Epoecophyte*
***Hypericum majus* (A. Gray) Britton**	***C***	**Etanges exondés**	**25**	E	***Agriophyte***
Impatiens balfouri Hook.f.	*M(AC)*	Riparian habitats, alluvial forest, ruderal habitats	24	E	*Agriophyte*
Aristolochia sempervirens L.	*M*	Riparian woods	24	E	*Agriophyte*
Bothriochloa barbinodis (Lag.) Herter	*M*	Vineyards, ruderal habitats	24	A	*Epoecophyte*
Rumex cristatus DC.	*M*	Riparian habitats, damp arable fields	21	E	*Agriophyte*
Crocosmia x crocosmiiflora (Lemoine) N.E.Br.	*A*	Dunes, heathlands, grasslands, riparian habitats, ...	21	E	*Agriophyte*