Resources and techniques to improve management of invasive alien species

This chapter was drafted by:
Emmanuelle Sarat (IUCN French committee),
Alain Dutartre (independent expert, formerly at Irstea),
Emilie Mazaubert (Irstea).

With the collaboration of:
Benjamin Bottner (Development agency for the Vilaine River basin),
Anne-Laure Gourmand (MNHN),
David Happe (Auvergne regional environmental directorate),
Jacques Haury (AgroCampus Rennes),
Nicolas Poulet (Onema),
Yohann Soubeyran (IUCN French committee).

The need for an organised and coordinated approach

The available tools for managers
The need for an organised and coordinated approach

The different stakeholders and the value of a network

As noted in Chapters 4 and 5, IAS management is necessarily a collective effort with links between various categories of stakeholders, including researchers, managers and people active in natural environments. This means that it is necessary to designate the people best suited to set up an organisation and decide on the techniques employed, but also to determine how the many actions should be coordinated on the various geographic and administrative levels, i.e. the local, regional, national and European levels. Given the very wide range of stakeholders, the creation of an organisational structure for IAS management is not an easy task.

For example, on the local level, there is no one type of stakeholder that has been designated to take charge of IAS management. It can be any stakeholder in a position to have an effect on these species, i.e. environmental managers, the general public (hunters and anglers) in some cases, the technicians of local governments in others, the employees of State services or volunteers from non-profit groups (Menozzi and Pelligrini, 2012).

All these stakeholders differ in type, organisation, resources and objectives, as well as in the techniques they select to manage IASs. The legal status of each species is also an element in determining the applicable stakeholder. For example, for fauna, pests and game (see Chapter 2, page 67) are managed mainly by hunters, trappers and the personnel of the National agency for hunting and wildlife (ONCFS). The same is true for the environment where the disturbances and damage occur. The stakeholders involved are not the same for terrestrial and aquatic environments, nor for protected natural areas. Effective management of species throughout the country thus depends on the stakeholders involved and on their degree of participation, to the point of directly influencing the selection of the techniques employed (Menozzi and Pelligrini, 2012).

IAS management thus leads stakeholders to create new types of partnerships in order to succeed because it is widely acknowledged that a lack of coordination is a significant factor of failure. This interdependence may be observed on the local level, i.e. horizontally, but also between the various management levels, the local, national and international, with each level playing a different role (Menozzi and Pelligrini, 2012). Generally speaking, the national level provides funding for strategic coordination or for specific projects (notably via calls for projects). It can also institute a strategic framework (see Chapter 3). The regional level coordinates and funds management work, the local level actually does the work. The interactions between these levels are, however, very complex and require sharing of information, of knowledge and know-how, and collaborative preparation of projects.
Highly simplified diagram of the relations between the main stakeholders in IAS management, on the main management levels. According to Sarat, 2014.

- National level:
  - Research ministry
  - Agriculture ministry
  - Health ministry
  - Ecology ministry
  - MNHN
  - ONCFS
  - IRSTEA
  - INRA
  - CNRS
  - ANSES
  - IUCN
  - FCBN
  - FNPF
  - FNC
  - FNLON

- Regional level:
  - DREAL
  - Water agencies
  - Onema regional offices
  - ONCFS regional offices
  - ARS
  - Universities
  - Local governments
  - Botanical conservatories (CBN)
  - FCEN - CEN
  - FRC
  - FREDONS

- Site level:
  - Regional nature parks
  - Towns, municipal associations
  - River boards
  - Agricultural councils
  - Conservatories for natural areas (CEN)
  - Environmental protection groups
  - Fishing federations, ACCA
  - Fishing associations, FDPMA
  - FDGDOINS, trapper associations
  - Nature reserves
  - ONCFS local offices
  - Onema local offices

Data services and organisations:
- Public institutions and organisations
- Non-profit organisations
- Local governments and related public organisations

Note that the National botanical conservatories vary significantly in their legal status (non-profits, boards, section of the MNHN). Their status is not indicated in this diagram.

Figure 109

Figure 110
The diagram showing the relations between the stakeholders involved in IAS management in aquatic environments (see Figure 109) illustrates this complexity. Though far from complete and not attempting to provide a total picture, the diagram nonetheless reveals a certain number of points.

- A wide variety of stakeholders are involved on each level of IAS management. Though the stakeholders differ in type of organisation, resources and objectives, they all participate. Several categories of stakeholders exist:
  - the State and State services, active primarily on the national level. In conjunction with public agencies and local State services, they implement environmental policies, including those concerning IASs. The interministerial relations involve above all information exchange,
  - public agencies and local State services ensure the links between the national level and the management stakeholders on the site level. In this category, the research community is present on both the national and regional levels and can serve as a link with environmental managers,
  - environmental-protection groups/federations and non-profits are well represented on the national level and on the site level. Their more limited presence on the intermediate level reduces the links between the local and national levels, however the public agencies and research organisations can play the same role,
  - the local governments (regions, departments, towns) are involved in funding management projects and in disseminating information on IASs. The various forms of municipal cooperation (urban areas, municipal associations, boards), river boards and the regional nature parks play a more direct role in the actual management of IASs.

- There is a dense web of relations between organisations on the same level. Between levels, relations are not as numerous. Contacts between the site and national levels could be improved by better coordination on the regional level. On the site level, stakeholders are obviously in direct contact, however their roles and degree of involvement vary with each situation.

- The transmission of information and the development of know-how are often approached in a top-down manner, from the national to the local with little involvement of managers, whereas the formulation of projects and the actual management are organised from the bottom up. The stakeholders on the site level inform the upper level on the disturbances and damage caused by IASs and the needs for management intervention.

- Funding for projects and interventions is provided by a limited number of clearly identified sources, namely the Ecology ministry and its regional directorates, Onema, ONCFS, the Water agencies and local governments, all of which also bring European funds (ERDF, LEADER, LIFE, etc.) into play.

Greater interaction between these stakeholders and levels is required to improve the implementation and the results of IAS management. Improved knowledge and its dissemination depend to a large degree on collaborative efforts between managers, technicians, researchers and experts active in the various networks. For example, new information on IAS distribution can result for the collaboration between:

- the managers of natural areas (whether protected or not) who monitor the species and the colonised areas;
- the coordinating structures on the departmental and regional levels that participate in producing collective distribution maps to inform the upper level and the research organisations;
- local people and land owners who can inform on the past history of the intervention site, on the introduction and colonisation of species and on the results of management techniques employed previously.

On the basis of this initial diagnosis, what can be done to improve the production, dissemination and sharing of this “hybrid” knowledge, combining science and observations in the field, held by the various stakeholders? How can coordination, a decisive factor in better IAS management, be encouraged and improved, what steps can be taken to optimise the work done and the funds invested?
Coordination groups

The emergence of the work groups

Difficulties in managing invasive alien aquatic plants arose in France in the 1970s (Dutartre et al., 2014), primarily in the South-west, but they then spread along most of the Atlantic coast up to Brittany. Limited interventions on a few, heavily colonised sites were carried out as early as the late 1970s. The results demonstrated the full extent of the difficulties that remained to be overcome, notably the need to coordinate the work and the participants.

Starting shortly after the year 2000, work groups were progressively established to improve coordination of the management work against invasive aquatic plants. Their launch was often spontaneous in response to repeated requests on the part of stakeholders involved in managing invasive species and the objective was to provide scientific and technical answers to the problems encountered by environmental managers.

The administrative boundaries of the areas covered by these groups vary considerably. Those boundaries depend on the history of past management work, on the structures in charge of coordinating the work and on the participants. Work groups are active on all levels, e.g. from the national level with the Biological invasions in aquatic environments (IBMA) work group down to the departmental with the Charente observatory on invasive plants (OPE), as well as in large river basins, e.g. the Loire-Bretagne work group on invasive plants, and on the regional level with the Pays-de-la-Loire committee. Their operations are specific to each group and depend on the situation in each area.

These groups offer management stakeholders a chance to participate in generating new knowledge on IASs. A number of them have existed for over ten years and have contributed, in proportion to the areas covered, to producing significant amounts of information on the distribution of invasive plants, to drafting distribution maps, to disseminating information on past management projects and to increasing awareness of the problems involved. They also made possible a number of interventions by finding the necessary funding and ensuring its availability over time, by bringing together a wide range of participants to jointly develop management techniques designed to maintain human activities on the sites while limiting the impacts caused by invasive alien species.

By mobilising many different stakeholders (non-profits, public agencies, State services, local governments, managers of natural areas, local people, etc.), these groups serve as information clearing houses and contribute to disseminating throughout the country data on the species and on the technical and organisational aspects of their management. Building on this experience, the work groups have progressively expanded their scope to include invasive plants outside of aquatic environments and, currently, invasive alien fauna, thus taking advantage of the existing networks and the available know-how, and continuously reaching out to new stakeholders.

Figure 110 shows the position of these regional groups within the web of interactions between the stakeholders involved in IAS management in aquatic environments. The regional and national work groups reinforce the links within each level and between levels. They facilitate the launch of many projects in conjunction with the stakeholders on both the site level and higher levels, e.g. research organisations and public agencies. Finally, they are all interconnected and serve as relays between managers and decision-makers.
Indispensable strategies

That being said and the existence of the work groups notwithstanding, there remain many needs in terms of network building and information sharing, particularly in areas where coordination groups do not yet exist.

A national strategy for IAS management

The formulation of a national strategy is an indispensable step in order to:
- reinforce links, both horizontal (between organisations and stakeholders) and vertical (between the national, regional and site levels);
- ensure that IASs are seen as a priority issue for environmental management;
- support local projects and improve information exchanges between organisations.

The upcoming implementation of the European regulation will improve coordination on the national level and information exchanges between the various stakeholders. The regulation requires that the Member States set up a surveillance, monitoring and research system for IASs and it also laid the foundation for information exchange on the species in the Union list in order to coordinate management work on the European level (Le Botlan and Deschamps, 2014).

Regional strategies

In the absence of a national strategy, local strategies have been progressively proposed by a number of coordination groups (see Box 28). They are the product of the organisational efforts by these groups (consolidation and sharing of knowledge and information, creation of decision-aid tools, coordination of management work, etc.). They also exist thanks to the collective dynamism shown by many of the stakeholders dealing with IAS management and to the helpful and supportive ambiance that has come into being over time within the work groups. The main objective of these strategies is to provide answers in terms of the necessary knowledge and management of IASs in the geographic and/or administrative area specific to each group, while providing a general framework for the work on these species by the main stakeholders involved. They are intended as a means to coordinate and ensure the consistency of the various projects implemented in the given region.

These strategies are often accompanied by definitions of terms and highlight the national and regional context of IAS management (main species encountered, projects and stakeholders active in the region). They list the general objectives and a number of guidelines. Finally, lines of work are presented and filled out with a detailed programme of prioritised operational projects.

These strategies initially focussed on plants, but they now increasingly include animals. Though they are often established for regions, they can also target other types of geographic areas such as river basins. That is the case of the recently published strategy on IAS management in the Loire-Bretagne basin (Hudin et al., 2014).
Examples of regional strategies for invasive alien species

- Regional management strategy for invasive alien plants in the Pays-de-la-Loire region (Matrat et al., 2012)
  This regional strategy is the product of the discussions held over the past five years in the Pays-de-la-Loire committee for the management of invasive alien species. The strategy is divided into two sections dealing with general policy and with management recommendations. It focuses on aquatic plants and highlights the need for urgent action and for better organisation of public policies.

- Strategy against invasive species threatening biodiversity in the Basse-Normandie region (Mercier (coord.), 2013)
  The Basse-Normandie regional “Invasive species” committee was set up in 2007 to set priorities for IAS management work. The strategy has resulted in a consistent programme of operational projects for IAS management on the regional level (fauna and flora), according to priorities targeting three components, new knowledge, management and communication.
  (http://www.gt-ibma.eu/wp-content/uploads/2014/04/Strat%C3%A9gie-de-lutte-contre-les-EI-menant%C3%A7anta-biodiversit%C3%A9-de-BN.pdf)

- Regional strategy for invasive alien species in the Languedoc-Roussillon region (CBNMD and CEN-LR, 2010)
  The purpose of the strategy against invasive species (fauna and flora) is to establish and coordinate a strategic management framework. The objective is to reduce to a minimum the risks represented by IASs for the environment, the economy and society, and to protect the aquatic and terrestrial ecosystems in the Languedoc-Roussillon region. To reduce ecosystem exposure to those risks, the strategy is divided into three sections, 1) assess the threats, 2) manage species, habitats and landscapes, and 3) exchange information, communicate and coordinate.

- 2014-2020 strategy for IAS management in the Loire-Bretagne basin (Hudin et al. (coord.), 2014)
  This strategy deals with knowledge, prevention and the restoration of ecosystems, in an effort to coordinate the work between the different administrative levels in the Loire-Bretagne basin, in conjunction with other, larger areas (France and Europe). It recommends focussing on the most relevant projects within the framework of a large river basin. Common objectives and major guidelines are set to optimise the human and financial resources required on the different levels (river basin, region, department, sub-basin, river board, etc.). The document is accompanied by an operational set of projects.
  (http://www.centrederessourcesloirenature.com/mediatheque/espces_inva/StrategieGestionEEE_BassinLoireBretagne_FCEN.pdf)
The available tools for managers

Lists of species

Before it is possible to set up effective management strategies, it is necessary to obtain more information on IASs and to rank them according to their invasive potential. Many studies on alien species have already been conducted, on different geographic scales, on different taxa and using different methods depending on the objectives of the study (Mandon-Dalger et al., 2014).

Lists to raise awareness

IAS lists presented to non-experts in biodiversity are often intended to raise awareness and inform on the adverse impacts of species with which people are occasionally familiar in other circumstances. That is the case for managers of parks and gardens who, in some cases, eliminate certain species after learning that they are invasive in natural and semi-natural environments. In most cases, the official lists for plants are drafted on the regional level by the national botanical conservatories and occasionally approved by the regional scientific council for natural heritage (CSRPN) (see Figure 111).

In Belgium, an effort was made to limit the sources introducing IASs. The novel approach consisted of negotiating with plant producers to draw up a list in view of a voluntary agreement not to market the listed species (Halford, 2011). This initiative may be used in France in the near future to limit the sources of IAS introductions.
**Lists to provide knowledge**

These lists are intended by their authors either to provide information in addition to various guides and identification sheets, which present the risks raised by these species, or as recommendations for management work in natural areas. In some cases, these management recommendations suggest limiting the sources of IAS introductions and the authors hope to reach certain professions (horticulturists, growers, merchants). However, the lists do not take into account the economic situation of the professions and do not specifically target them, which explains why the lists rarely achieve their objective.

**Lists for surveillance, early detection and rapid response**

Given that it is often difficult to monitor an entire region and all species, a solution is to draw up lists of priority species. The lists may contain both species already present in the region in view of avoiding their dispersal and species that are not yet present, but for which the risks of introduction are deemed high. Alerts may be issued for species known to be invasive and that require a rapid response following early detection (Mandon and Fried, 2013). The alert documents are sent to the naturalist networks and the plant-protection services, two groups highly competent in taxonomy because that is needed in some cases to distinguish between relatively similar plants. A recent example concerned Japanese knotweed in Corsica, a fairly easy species to identify, but occasionally difficult to distinguish from the hybrid *Reynoutria x bohemica*. Alerts have already been issued by the Agency for food, environmental and occupational health & safety (ANSES) and by the national botanical conservatories.

**Regulatory lists**

The regulation prohibiting trade in IASs or their introduction in the natural environment (article L411-3, see Chapter 2), with the appended lists of invasive alien species drawn up by Muller (2004), was included in the document on Good agro-environmental conditions (BCAE, decree dated 13 July 2010 on the rules for good agro-environmental conditions). The lists prepared by the European plant protection organisation (EPPO) were mentioned in the decree dated 31 July 2000 listing the organisms harmful to plants, plant products and other objects, that are subject to mandatory countermeasures. The decree dated 25 August 2011 (French official bulletin dated 27 August 2011), modifying the decree dated 31 July 2000), lists the organisms harmful to plants, plant products and other objects, that are subject to mandatory countermeasures (see Chapter 2 and Figure 112).
The problems with lists of species

The drafting of lists of species is confronted with an array of difficulties. The lists are produced by numerous stakeholders or groups of stakeholders, they cover different geographic scales and implement methods that vary, to the point that there is no real organisation between them. The result is a large number of species lists, of different types and having different objectives. The work to produce them may result in conflict, particularly when the objective is to set up regulations on the introduction and sale of certain species. The above is particularly true for plants, whereas for animals, to date there is only a small number of lists containing few species or only certain groups of species, mainly vertebrates not including fish, and they rarely cover entire regions.

A second problem with lists of species is that they generally include only the invasive alien species already known in the given area, i.e. they do not mention the new arrivals, the so-called “door knockers” already near the area, but not yet introduced. Finally, there is still no national list, for either plants or animals, because the method of preparing the list and its objectives have not been defined.

A number of recommendations have however been made (Mandon-Dalger et al., 2014). Drawn up using scientific criteria, “general” lists for plants and animals could serve as the starting point for other lists. They could be used as lists for monitoring, comprise multiple criteria and cover the country as a whole. “Operational” lists could then be derived from the general lists, adapted to the specific stakeholders and conditions (objectives, local area). These operational lists would include the regulatory lists or topical lists, adapted to the applicable geographic scale. In addition, by listing entire taxonomic groups (e.g. families and genera) comprising the invasive species, it would be possible to include a larger number of species whose ecology is not well known and thus contribute to prevention. A general requirement is that the lists remain open and easy to update for new species arriving in a given region. Information on how they should be used and on their territorial validity must systematically accompany the disseminated lists in order to avoid incorrect use.

A number of methods for drawing up lists based on an assessment of the invasion risks (EPPO, ISEIA, Weber and Gut, see Box 3, page 31, and Box 13, page 93) already exist and it is necessary to consult them, in order either to select one and use it, thus making possible comparisons with other known lists, or to adapt them in view of producing the various “general” and “operational” lists. When drawing up the future national lists, it will also be necessary to take into account the requirements contained in the European regulation. These lists should be prepared in a very open manner, involving the environmental managers and economic stakeholders (horticulturists, breeders, farmers, etc.), including when the lists are intended for regulatory purposes. Approval by the various stakeholders of the method employed and the results produced is a factor in ensuring the success of regulations.

The results for aquatic environments

A double issue of the Bulletin français de pêche et de pisciculture (no. 344-345) was published in 1997 following the symposium titled “Species introductions in continental aquatic environments in continental France”. It contained an initial list of aquatic plants with almost 50 species (Dutartre et al., 1997).

A national survey by Aboucaya (1999) also proposed a list of alien plants including 61 known invasive species, 65 potential invasive species and 91 species requiring monitoring, of which over 20% were aquatic species. In 2004, Muller coordinated a review on invasive plants and proposed a list of the main invasive alien plants in continental France, among which were a number of species from aquatic environments.

Since that time, the disturbances caused by biological invasions have increased significantly and an array of lists, often focussing on plants, have been drafted for a wide range of geographic areas, but rarely for continental France as a whole. The fact that lists of plants were composed earlier and in greater number than lists of animals is primarily due to the existence of regional stakeholders working essentially on plants.
One of the projects launched by the Biological invasions in aquatic environments (IBMA) work group right from its founding was a list of introduced plant and animal species in aquatic environments in continental France. Designed as an open-ended project to assist in reviewing the overall situation in these environments in continental France, the objective of the list was to serve as a knowledge base used in setting up strategies for the management of introduced species.

The available data was first compiled to produce a general list of introduced species. From this first list, a second was drawn up containing only the species seen as invasive by various experts and/or organisations. For each plant and animal species, a proposal concerning its status (degree of invasive potential) was made. The two lists are updated, to the extent possible, in step with the arrival of new information (Mazaubert et al., 2012).

The proposed status for each species is subject to debate because the criteria used by the experts may differ from those of the environmental managers and other stakeholders (see Figures 113 and 114). In addition, the diversity of the available information, of environments and species, the different dynamics of certain species in different parts of continental France and the difficulty in measuring impacts all contribute to the difficulties of drawing up a single list.
The proposed list (Dutartre and Mazaubert, 2012) is designed to be upgradeable and should be seen as indicative of current knowledge at a given point in time on the alien species considered invasive. The list and the method used to compile it may be consulted via the link below: http://www.set-revue.fr/bilan-des-especes-exotiques-envahissantes-en-milieux-aquatiques-sur-le-territoire-francais-essai-de/illustrations.

**Distribution maps of species**

The increasing numbers of invasive species arriving in an area and the limited funds available for management projects often mean that managers and decision-makers must set priorities and fund those management operations promising the best results with respect to the set objectives. Without a precise list of IASs and data on their geographic distribution, it is difficult to set up an effective management strategy. Early detection and a rapid response also require regular monitoring of species distribution over the given area.
Species mapping is a means to obtain precise information on their distribution and by updating the maps over time, it is possible to monitor their colonisation dynamics and to identify any specific local conditions that may facilitate their dispersal (see Figure 115). This information on species distribution and dynamics can also be used to establish an “invasibility scale” and consequently to prioritise species (for example, see the scale proposed by Lavergne\(^\text{13}\)).

![Cartes de répartition](http://flore.cbnm.org/index.php?option=com_florereunion&view=listes&layout=listeinvasif&Itemid=16)

Distribution of box elder in the Centre region.

It would be an excellent idea, if only to have on hand the means to convince funding entities of the need to undertake management interventions, to precisely define the data-collection, -storage and -analysis strategy before launching monitoring programmes on the distribution of a species.

For plants, a number of organisations and work groups already coordinate data collection according to strategies adapted to their area (botanical conservatories, conservatories for natural areas, local governments, etc.) and serve as the liaison to national databases. Standardised monitoring protocols (species, colonised environments, priority research areas, types of monitoring points, etc.) have been proposed and training sessions are available to learn to identify and monitor IASs. Maps are then drawn up and made available to stakeholders.
Internet sites for on-line entry of IAS-distribution data have been developed specifically by and for the managers of natural areas (see Figure 116). That is notably the case for the botanical conservatories, the Regional observatory on invasive alien plants in aquatic ecosystems (ORENVA) and the Board for balanced management of the Gardons basin (SMAGE), that all propose sites offering the possibility to input observation data and view distribution maps (see Box 30). These sites are not necessarily open to the general public, contrary to sites for citizen science.

Figure 116

The Plant observatory for South-west France (OFSA), an example of an internet site for data input and access to distribution maps.

Box 30

**Internet sites for data input and access to distribution maps**

- **OFSA.** The Plant observatory for South-west France was created by the National botanical conservatory for South-west France (CBNSA) to assist the observation of wild plants (http://www.ofsa.fr). It offers:
  - data produced by the naturalist network, inventories managed by the conservatory botanists, resource documents and a herbarium;
  - data management and validation services;
  - a platform for knowledge analysis and dissemination.

The mapping section on the site provides access to distribution maps for many species present in the area covered by the conservatory.
Local monitoring of invasive alien animal species must still be set up in large parts of continental France. On the national level, efforts to monitor vertebrates have been launched by ONCFS, in partnerships with the hunting federations and environmental-protection groups, and by Onema. Surveys on specific taxa, for example those carried out by the League for the protection of birds (LPO) on alien species (Dubois, 2007 and 2013) or by the National museum of natural history (MNHN) on the Asian hornet, fill out the available information.

Geomatic tools (GIS, remote sensing, etc.) are increasingly used to acquire knowledge and to manage the data on IASs. These operational tools serve to store and analyse data on the issues surrounding biodiversity conservation and the pressures weighing on it, using a common reference dataset (Soubeyran, 2010). Remote sensing is also a means to lift the constraints involved in monitoring species distribution over vast territories, e.g. the long distances on rivers, and when access to private property and wetlands is difficult.

Since 2008 in continental France, a technique to monitor and precisely locate water primrose using satellite images has been experimented by Agrocampus-Ouest and the Development agency for the Vilaine River basin (see Box 31).

Molecular tools can also be of great help in mapping IAS distributions. For example, the “environmental DNA” technique is based on detecting specific DNA traces left by organisms in water, via their epidermic cells, urine or scat. In the framework of the management work on American bullfrogs in the Centre region, comparisons between the standard survey technique (daytime searches and nighttime listening) and environmental DNA showed that the latter succeeded in detecting the species even when population densities were low and often no visual observations had been made. In addition, the environmental DNA technique turned out to be less expensive (Michelin et al., 2011). The technique is now operational for various taxa (amphibians, fish) and is undergoing development work and tests for other species (crayfish, bivalve molluscs, etc.).

- Orenva. The Poitou-Charentes regional observatory on invasive alien plants in aquatic ecosystems (ORENVA) was created by the region Poitou-Charentes (http://www.orenva.org/). It consists of a network of local managers drawing up inventories and nine coordinators of departmental or river-basin organisations. Its steering committee in charge of regional coordination includes the region, the regional environmental observatory and the Forum of Atlantic marshes. Following registration on the site, it is possible to directly enter observations (http://sigore.observatoire-environnement.org/orenva/). See also: http://www.gt-ibma.eu/strategies-ou-en-sont-les-institutions/strategies-infranationales/observatoire-regional-desplantes-exotiques-envahissantes-des-ecosystemes-aquatiques-orenva/

- Smage des Gardons. The Board for balanced management of the Gardons basin (SMAGE) is a public river-basin territorial agency uniting 118 towns in the Gardons river basin and the Departmental council of the Gard department. Management work on a number of invasive plants, including water primrose and knotweed, started in 2009. The work included experiments on several species, interventions to regulate the spread of species and, since 2013, efforts to raise the awareness of elected officials and residents. In 2014, an internet site (http://invasives.les-gardons.com/) was set up to provide access to fact sheets on species and photos, to consult existing observations for approximately 15 species present in the river basin and to enter new observations indicating the location of species, with the possibility of adding photos. (http://www.gt-ibma.eu/strategies-ou-en-sont-les-institutions/strategies-infranationales/smage-et-114gardons/)
From mapping to management using remote sensing for invasive plants.  
Water primrose in the Vilaine River basin

The spread of invasive aquatic plants such as large-flower water primrose (*Ludwiga grandiflora*) in many rivers, lakes and ditches in the Vilaine basin and the corresponding need to map the plants led the Vilaine development agency (IAV) to set up a research programme on how to locate the plants using satellite and/or aerial photos. Over a period of six years (2008 to 2013), in a close partnership with Agrocampus Ouest Rennes, the many necessary components were gathered, notably field data (GPS locations, measurements of plant spectral reflectance, botanical inventories, etc.) and satellite/aerial images (using multispectral and hyperspectral sensors across bandwidths ranging from the visible to mid infrared). Following a great amount of work involving statistical processing and image classification, the operational results listed below were obtained:
- proven differentiation of water primrose with respect to other species due to statistical differentiation of the spectra;
- production of basin-wide maps for water primrose with a high degree of precision;
- assistance for field surveys by producing alert maps and identifying the sectors to investigate;
- drafting of maps showing dissemination risks, in conjunction with GIS processing;
- multi-year monitoring of colonisation on control sites (see Figure 117);
- location to the metre on sites using aerial photos to complement the field data.

This approach is promising, but is confronted with the availability and high cost of satellite and aerial images. Improvements are expected in the near future and should facilitate the use of remote sensing for gathering information and managing certain invasive plants.

Benjamin Bottner (Development agency for the Vilaine River basin), Jacques Haury and Hervé Nicolas (AgroCampus Rennes)

**Figure 117**

Monitoring of water primrose, native aquatic plants and free water surface over time in the Mortier de Glénac marshes (Morbihan department). According to Bottner and Noël, 2014.
Citizen science and invasive alien species

Over the past few years, citizen science (defined as “programmes to collect information involving the public in the framework of a scientific project” by the French initiative for citizen science, 2012) has made great strides. From newbies to experts, with everyone in between, but always on a voluntary basis, citizen science allows people to participate in research projects on biodiversity and to supply information for scientific databases (see Box 32).

Key points in setting up a citizen-science project

When setting up a citizen-science project, a certain number of “ingredients” are required (Gourmand, 2015), but the quantities and proportions vary for each project:

- coordinators, i.e. a research lab, a management structure, local relays, etc.;
- a research topic and educational objectives offering sufficient interest and variation over time to maintain the commitment of the observers;
- a sufficient number of existing or potential observers. They must feel involved and care about the research topic and monitored species. They must also have the impression that their observations are unique, while belonging to a large group. In general, people learn rapidly, but they lose interest just as rapidly if novel aspects are not regularly injected into the project;
- a collaborative spirit and social bonding are central components, with each person providing their experience and know-how, going beyond prejudices and learning to know one another;
- a project protocol with carefully balanced compromises, e.g. required level of competence and number of persons, either few, highly standardised data or a large quantity of more heterogeneous data, activity limited to a precise area or wide open, etc.

Currently, there are over 200 citizen-science projects in France, basing their work on a number of different methods depending on their scientific and educational objectives (IFREE, 2011). Some of these projects aim to set up and maintain a network of observers in order to collect a maximum amount of data without first defining a collection method, followed by ex post exploratory research. The purpose of other projects is to share naturalist information within a network of observers in order to improve their collective knowledge, but without publishing it. Finally, other projects are directly derived from academic research where an ecological question requiring an answer is first raised. A protocol for data collection is then drafted and the educational objectives are built up around the research topic (IFREE, 2011).

Observations of invasive alien species are occasionally included in citizen-science projects, in programmes addressing specific topics or in more general projects monitoring biodiversity. In most cases, the data provided by the observers are of use in monitoring the spread of known populations, in noting the installation of new populations and in detecting the arrival of new invasive alien species. Distribution maps, using the information supplied by the observers, can be drawn up and regularly updated.
For plants in general, the association Tela Botanica was founded in December 1999 in view of creating a network of French-speaking botanists. The site www.tela-botanica.org was launched in July 2000 and its main purpose is to serve as a platform for botanists using French as their main language. There are now over 24,000 registered participants, including over 20,000 French nationals. It serves as the home for and it links over 100 projects and discussion forums addressing different topics, geographic areas, types of plants, etc. The site also publishes a weekly information bulletin.

The “Invasive plants” forum deals with naturalised plants that are known to be invasive or are potentially invasive. The objective is to list and map invasive plants, as well as exchange advice on how to manage them. Another project, titled “Invasive plants in LR and PACA”, is for stakeholders working on gathering knowledge and managing invasive plants in the Languedoc-Roussillon and the Provence-Alpes-Côte d’Azur regions (Southern and South-eastern France).

Concerning animals, it is possible to provide information on Asian hornets, squirrels (http://ecureuils.mnhn.fr/) (see Figure 118) and alien flatworms (http://bit.ly/Plathelminthe) via the INPN site or special sites used for programmes coordinated by the National museum of natural history (MNHN).

For plants, a site is available to report common ragweed in the Rhône-Alpes region (www.signalement-ambroisie.fr).

Reports on other species should be made to the more local observation networks (CBN, ONCFS, Onema, local governments and environmental-protection groups) that manage their own database, check the information and transmit it to the national level (see Box 33).

The site for squirrels in France (http://ecureuils.mnhn.fr/) is coordinated by the MNHN. It informs the public on the presence of invasive alien squirrels and can be used to report observations.
Feedback on a participatory survey on invasive alien species in the Auvergne region

The Auvergne regional environmental directorate became aware of the introduction and spread of many invasive animal species in the region and decided in 2013 to launch two participatory surveys to update the available information on the distribution of several taxa in Auvergne. A year and a half after the start of the surveys, an initial progress report was drafted.

The first survey, addressing red-eared slider turtles and northern raccoons, became operational in the beginning of 2013. Those two species were selected in an effort to attract as many stakeholders as possible (naturalists, hunters, anglers, ONCFS, the general public, etc.) to the project. The survey was managed jointly by the Regional environmental directorate and by the Auvergne conservatory for natural areas. It succeeded in collecting isolated observation data and in consolidating data sets scattered among various stakeholders (e.g. certified trappers for northern raccoons). As a result, the amount of available data increased significantly (see Figure 119). For the northern raccoon, the quantity of observation data tripled and the presence of the species was detected in 90 towns throughout the region, whereas in 2011, only 42 towns had been identified. The survey contributed to identifying a new dispersal locus in France, in addition to the long-standing presence in the Picardie region.

Building on this initial success, in the beginning of 2014 the Regional environmental directorate started a new participatory survey targeting two types of aquatic species, bivalve molluscs and crayfish. Thanks to a major communication effort by the partners (naturalist reviews, sub-basin management plan, fishing federations, etc.), the new survey could call on a regional network of over 110 potential observers of which 70% have gone through a half-day training session. When the survey ended in October 2014, 980 observation data points (90% for crayfish, 10% for bivalve molluscs) had been collected. This regional project looked at both native and invasive species. In addition to providing information on the distribution of the species, it also served to raise the awareness of a large group of stakeholders concerning two relatively unknown species.

David Happe, Auvergne regional environmental directorate

Figure 119

Map locating observations of northern raccoons in the Auvergne region thanks to a participatory survey launched by the Regional environmental directorate and the Auvergne conservatory for natural areas.

Source: Auvergne regional environmental directorate and the Auvergne conservatory for natural areas.
Other observations may be reported in collaborative naturalist databases that centralise data on biodiversity in general and can include data on certain IASs. These databases are also growing rapidly. In some cases, they are open only to trained observers, in others to the general public. The collected data do not necessarily comply with a set collection method and are often relatively limited in scope (e.g. species observed, date, place, name of observer). For example, the databases managed by the League for the protection of birds (LPO) can be used to report observations of “escaped” animal species, of which some are invasive. The information contained in these databases can be of use in alerting to the presence of IASs and be transmitted to the national and local monitoring networks.

The citizen-science programmes and the collaborative naturalist databases often include the means to input data on-line. A number of smartphone applications to identify and report IASs are now being developed and made available to the general public, including the ones listed below.

- **The AGIIR application** developed by INRA. This application can be used to report observations on introduced insects and invasive species such as the pine processionary and the Asian hornet. (http://www.inra.fr/Grand-public/Dossiers/Lesagricultures-du-futur/AGIIR-contre-les-insectes-invasifs);

- **The Th@t’s invasive application**, developed as part of the Reducing the impacts of non-native species in Europe programme (RINSE - Interreg IV des Deux-Mers). This application uses a library of photos and biological characteristics to identify an IAS, photograph it and geolocate it. (http://www.rinse-europe.eu/smartphone-apps);

- **Pl@ntnet**, an application developed by INRA, CIRAD, INRIA and Tela-Botanica, serves to identify and geolocate over 4,000 species of plants in France, including some invasive alien species. (www.plantnet-project.org);

- **Signalement ambroisie** is an application with an on-line data-input system that can be used to report the presence of common ragweed (ambroisie) and transmit the information to the concerned towns and ragweed manager who will take the necessary action. (www.signalement-ambroisie.fr);

- **iMoustique** is used to photograph and report the presence of the Asian tiger mosquito, a vector for dengue fever and Chikungunya fever. (http://www.eidatlantique.eu/page.php?P=155).

Data supplied by non-experts in species identification should be used with caution in order to reduce error rates when setting up protocols, and during the validation and analysis phases (Gourmand, 2012). It is important to estimate the error rate in species identification and to check observation data when there is any doubt. Error rates can be calculated by checking observation photos and any clearly abnormal data. These rates are useful in determining data quality.

**Tools to assist in identification and management**

An array of tools to assist in identifying and managing invasive alien species has been developed over the past few years. The tools are intended primarily for the managers of natural areas and consist of identification guides, management manuals, standard protocols on species monitoring and site management, etc. They are often developed and intended for regional applications. Table 13 presents a selection of the available types of tools and provides examples of each.
<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Objectives</th>
<th>Taxon</th>
<th>Examples (partial list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification guides and species sheets</td>
<td>Identification</td>
<td>Flora</td>
<td>- Descriptive sheets prepared by the Federation of national botanical conservatories</td>
</tr>
<tr>
<td></td>
<td>Species detection</td>
<td>Fauna</td>
<td>- Sheets prepared by the Sèvre-Niortaise basin interdepartmental institution (IIBSN) and the Development agency for the Vilaine River basin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(vertebrates, fish and a few invertebrates)</td>
<td>- Sheets on invasive species in the Lorraine region - Invabio</td>
</tr>
<tr>
<td>Management manuals and</td>
<td>Management advice and recommendations</td>
<td>Mainly flora, a few vertebrates</td>
<td>- Management manual for invasive alien plants in the Loire-Bretagne basin, by the Federation of conservatories for natural areas</td>
</tr>
<tr>
<td>recommendation sheets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategies</td>
<td>Proposals, organisation and coordination of projects</td>
<td>Fauna and flora</td>
<td>- Strategy of the Pays-de-la-Loire committee for the management of invasive alien plants, 2012, by the Pays-de-la-Loire environmental directorate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Strategy against invasive species threatening biodiversity in the Basse-Normandie region</td>
</tr>
<tr>
<td>Lists of species</td>
<td>Identification and prioritisation of projects</td>
<td>Fauna and flora</td>
<td>- List of invasive alien plant species along the French Mediterranean coast, CBNM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- List of invasive alien plants in the Centre region, CBNBP and Centre CEN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- List of invasive fauna in the Auvergne region, Auvergne environmental directorate</td>
</tr>
<tr>
<td>Methods to prioritise species and projects</td>
<td>Identification and prioritisation of projects</td>
<td>Fauna and flora</td>
<td>- EPPO prioritisation process for invasive alien plants, Lag*Nature</td>
</tr>
<tr>
<td>Protocols and sheets for field surveys</td>
<td>Species monitoring, standardisation of protocols and data</td>
<td>Flora</td>
<td>- Field-survey sheet indicating the presence/absence of invasive alien plants for rivers and wetlands, Work group on invasive species in the Loire basin</td>
</tr>
<tr>
<td>Protocols and sheets for site management</td>
<td>Standardisation of protocols and data, post-intervention monitoring</td>
<td>Flora</td>
<td>- Protocol for monitoring management sites for invasive alien plants in North-west France, CBNL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Site-monitoring sheets, Pays-de-la-Loire environmental directorate and FCEN</td>
</tr>
<tr>
<td>Sheets for waste management</td>
<td>Post-intervention monitoring, regulations</td>
<td>Flora</td>
<td>- Proposal for recycling and agricultural use of water primrose extracted from aquatic environments, Pipet and Dutartre (2011)</td>
</tr>
<tr>
<td>Assistance in drafting the special</td>
<td>Monitoring of work and compliance with</td>
<td>Flora</td>
<td>- Guide on drafting the special technical specifications for work on alien plants, Pays-de-la-Loire environmental directorate</td>
</tr>
<tr>
<td>technical specifications for projects</td>
<td>recommendations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bibliographical reviews</td>
<td>Summary of knowledge and provision of bibliographical references</td>
<td>Fauna and flora</td>
<td>- Invasive alien plants, Lambert E., 2009, Pays-de-la-Loire committee for the management of invasive alien species</td>
</tr>
<tr>
<td>Regulatory reviews</td>
<td>Summary and provision of legal references</td>
<td>Fauna and flora</td>
<td>- Summary of regulations on invasive vertebrates, ONCFS, Regulatory aspects of invasive plants, Pays-de-la-Loire environmental directorate</td>
</tr>
<tr>
<td>Distribution maps</td>
<td>Information on species distribution, identification of invasion fronts</td>
<td>Fauna and flora</td>
<td>- Distribution maps of the Pays-de-la-Loire work group on invasive plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Plant observatory for South-west France, SILORE, FCBN</td>
</tr>
<tr>
<td>Data-collection strategies</td>
<td>Standardisation of data collection and centralisation</td>
<td>Flora</td>
<td>- Distribution of invasive plants in the Centre region, CBNBP and Centre CEN</td>
</tr>
<tr>
<td>Techniques to raise awareness</td>
<td>Information for the general public</td>
<td>Fauna and flora</td>
<td>- Data-collection strategy of the Centre region, Centre CEN and CBNBP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Mobile exhibition of the Work group on invasive species in the Loire basin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- IIBSN exhibition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Information sheets, posters</td>
</tr>
</tbody>
</table>
Training sessions and informational meetings are regularly organised on the regional level. They serve to improve the knowledge base of stakeholders and consequently IAS management, to create collaborative links between stakeholders and to facilitate the exchange of information and feedback (see Figure 120).

Recently, the training sessions set up by various organisations have encountered difficulties in finding enough trainees. That is particularly the case for sessions lasting more than two consecutive days. For example, the Invasive plants training course organised by the CNFPT in Poitiers in 2014 was originally planned for four days, but had to be reduced to two. The same is true for the Invasive species course organised by the University of Metz in 2014, that was reduced from three to two days. Finally, the session proposed by the University of Strasbourg was cancelled given the lack of interest. To our knowledge, the four-day training course organised by the Technical workshop for natural areas (ATEN) is the only course in 2014 that went as planned.

It is difficult to pinpoint the reasons for this apparent lack on interest in standard training courses, though they probably include the easy access to the growing IAS knowledge base and the difficult financial conditions that reduce the available funds for training in the organisations likely to send people for training. One of the major disadvantages of this virtual disappearance of multi-day sessions is that it reduces or even eliminates any possibility of in-depth discussions between trainers and trainees, turning sessions into strictly one-way informational encounters. That is unfortunate because multi-day courses can easily become an occasion for discussions between all participants, whatever their job sectors, thus capitalising on all the know-how present and contributing to enhancing the overall quality of IAS networks.

On the other hand, short training sessions as well as conferences, symposia and other meetings designed for the rapid transmission of information over a single day have grown sharply in number. Given the large number of people involved, these events can contribute to enhanced awareness of the problems involved in biological invasions and their management, to the formation of stakeholder networks in areas where they do not yet exist and to improving early detection of species.

Platforms for information exchange

The information on IASs is already widely available via various internet sites targeting different geographical levels (see Table 14). The sites propose an array of tools, ranging from documentation to mapping applications. More information is available on specific pages of larger, non-specialised internet sites, such as those of the Ecology ministry, the Conservatories for natural areas (CEN), the regional environmental directorates and various resource centres.
<table>
<thead>
<tr>
<th>Internet site</th>
<th>Geographic sector</th>
<th>Documentation</th>
<th>Database</th>
<th>Data-input possibility</th>
<th>Regulations</th>
<th>Species-identification sheets</th>
<th>Lists of species</th>
<th>Protocols for site monitoring</th>
<th>Strategies</th>
<th>Maps</th>
<th>Photo library</th>
<th>Management advice</th>
<th>Management feedback</th>
<th>News</th>
<th>Training</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>GISIN</td>
<td>International</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.gisin.org">www.gisin.org</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISSG</td>
<td>International</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.issg.org">www.issg.org</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CABI</td>
<td>International</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.cabi.org">www.cabi.org</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EASIN</td>
<td>Europe</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://easin.jrc.ec.europa.eu/">http://easin.jrc.ec.europa.eu/</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAISIE</td>
<td>Europe</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.europe-aliens.org">www.europe-aliens.org</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPPO</td>
<td>Europe</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="https://www.eppo.int/ABOUT_EPPO/about_eppo_fr.htm">https://www.eppo.int/ABOUT_EPPO/about_eppo_fr.htm</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBMA</td>
<td>National</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.gt-ibma.eu">www.gt-ibma.eu</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INVABIO</td>
<td>Lorraine region</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.invaibio.fr">www.invaibio.fr</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORENVA</td>
<td>Poitou-Charentes region</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.orenva.org">www.orenva.org</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUCN France, overseas IAS initiative</td>
<td>Overseas territories</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.especes-envahissantes-outremer.fr/">http://www.especes-envahissantes-outremer.fr/</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecology ministry</td>
<td>France</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.developpement-durable.gouv.fr/La-strategie-nationale-du-11793.html">http://www.developpement-durable.gouv.fr/La-strategie-nationale-du-11793.html</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DREAL</td>
<td>Regional</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INPN – MNHN</td>
<td>France</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://inpn.mnhn.fr">http://inpn.mnhn.fr</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCBN</td>
<td>France</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.fcbn.fr">www.fcbn.fr</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botanical conservatories (CBN)</td>
<td>Regional</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loire Nature resource centre</td>
<td>Loire basin</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://loirenature.com/">http://loirenature.com/</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservatories for natural areas (CEN)</td>
<td>Regional</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity Bretagne</td>
<td>Bretagne region</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.bretagne-biodiversite.org/">http://www.bretagne-biodiversite.org/</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Collections of management feedback

The stakeholders in biological invasions in aquatic environments have been virtually unanimous in noting a lack of information sharing and management feedback concerning IASs. There are many projects, conducted independently by different organisations or in partnerships with other groups confronted with the same problems or proposing suitable methods and tools. Each intervention site is managed according to the local context, to the local social issues, the specific characteristics of the site, the targeted objectives and the implemented protocols.

In response to the need for information sharing and to encourage contacts between stakeholders, regional collections of management feedback have been published (see Box 34). These collections illustrate the diversity of projects and stakeholders, and present the main results achieved. The objective is to pool the experience and make it available to other stakeholders confronted with the same problems. These documents can make a major contribution to the collective learning process now under way concerning the management of invasive alien species in aquatic environments.

**Collections of feedback reports on management of invasive alien species**

- Invasive alien species in aquatic environments, Practical knowledge and management insights (Sarat et al. (editors), 2015)
  The second volume of this book published in the Onema Knowledge for action series is a collection of fact sheets on invasive alien species and management projects carried out in continental France and Europe. A total of 26 fauna and flora species are covered in 52 examples presenting management projects, drafted in conjunction with the managers. (www.gt-ibma.eu)

- Management of invasive species in the Bretagne region (Quemmerais-Amice and Magnier, 2012)
  This document describes management projects for eight invasive species (both plant and animal), of which five are found more or less exclusively in aquatic environments (groundsel bushes, pampa grass, water primrose, Asian knotweed, American mink) and one in coastal marine environments (smooth cordgrass). Following a presentation of each species (origin and distribution, description and ecology, management recommendations), the document reviews a total of 15 management interventions for the six species. The information for each example includes a description of the site, the methods and resources employed, and the results obtained. The contact information for the managers of each intervention is listed at the end of the document. (http://www.bretagnevivante.org/images/stories/Reserves/Forum_gestionnaires/recueil%20esp%C3%A8ces%20invasives_2012.pdf)

- Management feedback from the Loire basin (Loire Nature resource centre)
  A database on the management of natural environments in the Loire basin presents management projects targeting IASs. The database provides detailed information on the projects, habitats, project context, costs involved and the contact information of the managers. (http://centrederesources-loirenature.com/home.php?num_niv_1=1&num_niv_2=5&num_niv_3=21)

- Invasive alien vertebrates in the Loire basin (not including fish), Knowledge gained and management feedback (Sarat (editor), 2012)
  This book, the product of a collective project coordinated by the National agency for hunting and wildlife (ONCFS) in the framework of the Loire Grandeur Nature plan with funding from the Loire-Bretagne environmental directorate and ERDF, describes the invasive alien vertebrate species present in the Loire basin and presents feedback from management projects. (http://centrederesources-loirenature.com/mediatheque/Faune_inva/Vertebres_exotiques_envahissants.pdf)