General approach to managing invasive alien species

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Introduction

Invasive alien species cause major problems for the affected human populations and particularly for the authorities in the invaded areas who must set up and launch the measures intended to solve the problem. Well before the notion of biodiversity emerged in the scientific literature on ecology, proliferations of introduced plant and animal species had caused damage to human uses of the environment. In general, efforts were made to mitigate the impacts of biological invasions in order to enable the continued use of the sites in question.

Advances in scientific knowledge have contributed significantly to better understanding invasions, to better assessing their impacts and to designing corrective measures. Concrete measures undertaken by managers (see Box 17) are generally in response to considerable social pressures. Until recently, due to a lack of access to scientific and technical information, measures were often launched without waiting for instructions or information from outside the immediate area. On the basis of the available knowledge and resources, and the existing regulatory instruments, managers put together local projects, occasionally under crisis conditions. Luckily, the situation has changed considerably since that time.

Box 17

Who are the managers and what does management consist of?

Managers

The term “manager” is derived from the term “management”, which is very vague and can be applied to a vast range of subjects and fields. A look in a dictionary indicates that management is the “act of managing”, generally the business of another person but also one’s own business. The verb “to manage” is synonymous with “to administer” or “to regulate”. However, what would seem to be important in these definitions is that management concerns the business of other people. The “other people” are the owners of the land on which interventions take place and, in many cases, the work is conducted by public organisations on private land. That is effectively the case in most situations and being a manager essentially means handling the business of others.

Managers can take on a number of roles, ranging from public or private owners to appointed administrators, spanning all geographic scales and administrative echelons. But their role always consists of administering a given area, according to the many objectives, rights and responsibilities arising from the applicable regulations, as well as the forms of organisation, development and maintenance of natural environments. Concerning invasive alien species, the group of managers effectively confronting the problem, from many different angles, ranges from the State to private property owners and can include just about anyone, to say nothing of the various public agencies and many forms of local government.

In this book, the term “manager” includes all the above, except as indicated otherwise.

Management

Concerning the issue at hand, the term “management” may be summed up in three very simple questions: 1) Is intervention a good idea?, 2) How can the problem be eliminated? or 3) How can we live with the problem? A more formal definition might be “administration of the concrete impacts of biological invasions directly confronting the authorities of the invaded area who must design and effectively implement a policy” (Dutartre, 2010).

What does the notion of management cover? What should it include?

- Management comprises all aspects of the possible interventions against IASs, ranging from a prior assessment of the situation to effective implementation of corrective measures and the subsequent consequences of intervention.
- It necessarily includes strategic and technical decisions, and should include information on the objectives and planned modes of operation, indispensable elements in preparing an intervention.
- It should also include an analysis of the situation as it pertains to the groups of people and their interests/needs in the concerned environments. Management is in fact the “site” where these groups of people can meet, discuss and debate issues.
- It always brings into play groups of participants other than the managers and the directly concerned public and must engage these other groups (researchers, funding entities, etc.) in dialogue concerning a number of aspects (regulations, life sciences, human and social sciences, etc.).

There are many difficulties involved in IAS management. Even if this opinion is increasingly shared by all stakeholders, but does not make matters any easier for those effectively confronted with the problems, this enhanced awareness is a reason to hope that there will be significant improvements in management techniques in the years to come.

The difficulties do not reside exclusively in the technical aspects of the interventions required to reduce or eradicate the plant and animal populations deemed harmful in a given context. On the scale of a single manager, it may be possible to take only the technical aspects into account for a given project because they ensure effective results, however the same approach is not possible when the assessment and the corresponding measures address larger geographic, administrative and time scales.

This is because IAS flows, their expansion dynamics and their impacts result from a wide array of social processes that are often inextricably mixed and part of greater globalisation processes that certainly do not make the situation any simpler. Among the factors contributing to the difficulties are international trade and its regulations, leisure travel and other activities enabling the intentional or unintentional transportation of species, work on aquatic environments, greater and more diverse needs concerning aquatic environments even though many are now degraded, etc.

That is why widely shared knowledge of the basic elements forming the context of IAS management, ranging far beyond the strictly technical and local aspects addressed by a given manager confronted with a given IAS, would appear necessary if IAS management is to improve.

Prerequisite information

Management deals with living organisms, with plants and animals, not inanimate objects. In short, organisms capable of reproduction, of colonising favourable biotopes, of travelling from one biotope to another in different manners, of adapting, etc. In addition, the means of dispersal of animals is generally the animals themselves, but for plants, the propagules can be entire plants or simply stalk fragments, which makes it more difficult to avoid their dispersal.

All management strategies must take this into account and make use of the available knowledge concerning the biology and ecology of these species. However, this knowledge is often incomplete, notably because certain species have undergone biological or ecological adaptations to the host area, for which no information is immediately available. Information from the areas where the species originated is useful and should be taken into account, but the possibility of adaptations should be kept in mind. In addition, it should be noted that many IASs do not cause any particular problems in their original ranges and consequently, any available information may be highly insufficient.

In many cases in the past, it turned out that it was necessary to acquire precise information on a species in the context of the host site (biotope or set of biotopes such as a lake, a river reach, a section in a network of ditches) or the host area in order to prepare better management strategies, improve the technical conditions of interventions and reduce the impact on species not targeted by the management work. The necessary information concerns in particular:

- the biological cycle in order to take action when it is most effective. For example, postnuptial moulting in birds means they cannot fly and may be more easily captured;
- reproductive and dispersal mechanisms in order to select the technical means capable of hindering or reducing dispersal following the intervention. Examples are setting up containment nets for plants with fragile stalks (see Figure 45a) or taking action prior to fruition and seed production in water primrose or various species growing along river banks to avoid contamination in situ and when the plant waste is processed. These measures may also be used to prevent the dispersal of animals (see Figures 45b and c).

Any data available on these species in other parts of the world where they have become invasive are of great value. These data often include useful information on species dynamics, favourable biotopes, known impacts and on the conditions and results of management work already undertaken. Given however that each situation is unique, these data must be approached with some caution.

That being said, it is not necessary to know everything about a species before deciding to take action. Failing an approach based strictly on solid knowledge, an empirical[7] approach may be employed when data are insufficient or support from the scientific community is unavailable, but should be systematically accompanied by simultaneous analysis of the intervention conditions and consequences. Even though managers may not have a great deal of time to devote to this analysis, it is nonetheless important in that it can produce new knowledge on the species managed and can avoid the use of less effective techniques that limit intervention results. The objective of the analysis is to improve the technical conditions of interventions and reduce the uncertainties.

Figure 45

a © Syndicat de rivière Côte-Sud
b, c © M. Collas, Onema

The installation of barriers avoids disseminating the cuttings of plants with fragile stalks, e.g. a) water pennywort in the photo. For animals, physical barriers (trapping barriers and filtering systems) are required to avoid dispersal of the managed species. Examples are b) a barrier around a pond for the Louisiana crayfish and c) a filtering system for a fish farm in a pond.

7. An empirical method is based on past experience and available data, not on theoretical considerations.

Prevent

An attainable solution?

A wide-ranging analysis of the issues involved in biological invasions indicates that prevention is without any doubt the best of all solutions. A reduction or elimination of the unintentional transport of species and an assessment of the risks involved in introducing “useful” species prior to their transport would certainly be of great use in limiting the damage caused by biological invasions.

This approach is clearly a central component in the regulation recently voted by the European parliament (European parliament and Council, 2014, see page 56) in that a significant part deals with analysis of introduction paths, border controls and the creation of an assessment procedure on the risks of introduction.

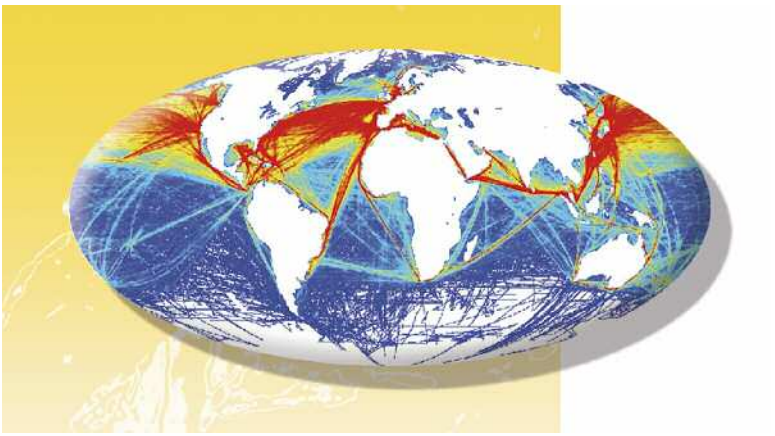
That being said, in the current situation, prevention remains an ideal solution that will be difficult to attain (Dutartre, 2010). Effective prevention of biological invasions would require:

- the means to identify alien species likely to have adverse effects on biodiversity and on human uses of ecosystems;
- identifying and controlling human activities that may be the direct or indirect causes of species introductions.

Though prevention is of course necessary at every possible organisational level (”from the planet to the plot”), it is clear that it will, at best, slow future flows of species, and even then on the condition that it be organised in a coordinated manner across all geographic scales.

International trade is without doubt one of the main causes of species dispersal on the planet (see Figure 46). The analysis carried out by Westphal et al (2008), using a database containing information on species ecology, biogeography, the socio-economics of the countries in question, etc., revealed that the importation of goods is

Figure 46



Map of world maritime activity in 2005. Source: Voluntary Observing Ship (VOS), World meteorological organisation.

the most important variable. The greater the volume of international trade, the greater the number of invasive alien species. Consequently, international trade and the intentional or unintentional transport of species must be severely regulated. That in itself is a major undertaking.

Organisational proposals

A number of proposals have been made over the past few years to increase preventive efforts. In 2000, Shine *et al.* listed the necessary characteristics of an institutional network designed to manage biological invasions. More recently, Genovesi and Shine (2004) discussed in detail the elements of a future European strategy for invasive alien species. The authors listed a number of sectors where unintentional introductions were likely to occur and proposed examples of "good practices" intended to reduce the risks. Those sectors covered a vast array of activities, ranging from agriculture to ornamental fish, horticulture and falconry.

Prevention on the national level must support the efforts on the international level. The fact that France has a number of territories spread all over the planet, in highly diverse biogeographic areas, adds a further degree of complexity. Implementation of the European regulation on the national level should accelerate the deployment of preventive efforts.

Local managers should implement in full the stipulated preventive measures. As local relays, they have an important role to play in disseminating information on prevention and in raising the awareness of the general public (see Box 18).

Box 18

Managers, participants in prevention

Managers can play an important role in raising awareness among the general public concerning the issues involved in biological invasions. They are familiar with the local area and the stakeholders, have the necessary scientific knowledge and can bring significant resources into play in disseminating information. They can also initiate preventive measures that should be better publicised, as is shown by the examples below.

Meetings with aquarists

The Sèvre-Niortaise basin interdepartmental institution (IIBSN) recently took part in an "aquarist market" in the Deux-Sèvres department. Via a conference, an exhibition, the distribution of informational documents and an anonymous questionnaire to learn how the aquarists operate, IIBSN informed the participants on the consequences of releasing alien species to the natural environment (see Figure 47).

The Onema NE regional office is currently preparing brochures to raise awareness among aquarists and pet shops and inform them on the problems caused by the introduction of alien species into the natural environment.

Information for fishermen and canoeists

One part of the LIFE + CAISIE programme in Ireland to prevent species introductions (www.caisie.ie, see the management report, volume 2, page 27) developed a wide range of tools including biosecurity guidelines for people active in aquatic environments (fishermen, canoeists, divers). Five key steps (inspect, remove, clean, throw away and inform) are presented in detail to encourage people to disinfect their equipment and avoid the unintentional dispersal of IASs in Ireland.

New types of pets

Trade in red-eared slider turtles, a new pet species, was authorised in France until 1997. It has been estimated that over four million turtles were imported between 1985 and 1994. After having outgrown their welcome, notably because they were considered dangerous for children (bites), a large number was released to the natural environment by the owners. To reduce the number of released red-eared slider turtles, the Conservatory for natural areas on Corsica created several informative tools (cartoon, teaching kits, games) to inform a wide public on the problems created by the new types of pets (see the management report, volume 2, page 171). A special internet page informs owners where they can find turtle reception centres and reminds them that it is prohibited to release the animals to the environment.
(http://www.cen-corse.org/conservatoire-espace-naturel/corse.php?menunac=10).

Figure 47

Information session organised by the Sèvre-Niortaise basin interdepartmental institution (IIBSN).

Monitor

The discovery of a new species on a site may occur fortuitously, however the acceleration in the number of introductions and the increase in the harm and damage done have made it necessary to develop a specific monitoring system. The various types of species likely to be introduced are now fairly well known, as are the most favourable host biotopes for permanent installation, the step prior to dispersal and invasion.

This knowledge can serve in setting priorities for the sites requiring monitoring. For example, stagnant environments are the best for aquatic plants. For helophytes on the other hand, the physical configuration and local disturbances play an important role. For animals that can move more easily and often much faster over greater distances, the presence of food and a biotope/environment offering sites where they can rest in safety can constitute criteria determining where they settle.

However, an effective monitoring system must cover all types of biotopes, including those that might seem less favourable for species. For example, certain submergent plants with fragile stalks that can be easily broken by water currents or waves may nonetheless be found in areas exposed to river currents or to the wind along lake edges that are far from the best for their installation and continued development. An effective system must also be permanent, which does not mean continuous throughout the year, but rather according to a schedule based on the knowledge acquired on the biology and ecology of known introduced species, both in their original range and in the host areas. It must be efficient, given the limited resources (funding, human and technical resources, time, etc.) that can be allocated for IAS management. Finally, it is necessary to encourage synergies among the diverse stakeholders by bringing into play the work groups and monitoring networks that already exist.

Even if the groups of plant and animal species likely to be introduced are now better identified (biological types, groups with particular capabilities, introduction paths conducive to certain species, etc.), it is virtually impossible to know all the species capable of being introduced. That is why particular attention must be paid to all living plants and animals that appear in a monitored biotope. Once the new plant or animal has been observed, an alert must be issued in view of identifying the species. The “newly arrived” species may turn out to be native. This occasionally occurs when submergent plants return to biotopes that have been modified by human activities.

Given that in a particular area, the species capable of establishing a long-term presence have relatively similar ecologies and fairly comparable development rates, it should be possible to identify times during the year when their presence becomes more easily detectable, e.g., flowering of plants, rutting periods of mammals and winter groupings of birds.

The establishment of a monitoring network is confronted with major constraints, notably in terms of limited resources, which can lead to setting intervention priorities for the field operators, and with social obstacles having to do with the implementation of public policies and with the perceptions of the public and managers concerning biological invasions.

In the book that they coordinated, Genovesi and Shine (2004) listed the necessary components of a monitoring system in terms of “information collection, management and sharing”:

- colonisation dynamics, including the arrival of new species;
- trends in the problems and/or adverse impacts caused by the colonisation dynamics, in order to better assess the full range of damage to the environment and to human activities;
- intervention dynamics in view of reducing or eliminating the problems and impacts;
- impacts caused by an intervention in order to determine whether the intervention is harmless, whether the risks are "acceptable" or whether risk management is required when an intervention, seen as indispensable, is itself a source of damages.

Similarly, the European commission working document, that accompanied the proposal for the regulation of the European parliament and Council on "the prevention and management of the introduction and spread of invasive alien species" (section on "Member States actions", subsection "Strengthening surveillance and control"), contained the following instructions: *"Organise cooperation with the public or specific groups of citizens (nature reserve managers, hunters, anglers, farmers, birdwatchers, etc.) to mobilise expertise and deploy "eyes and ears" on the ground to facilitate detection of IASs".*

What available forces could be organised for environmental monitoring? A number of different organisations and institutions have operators or employees that work at least part of the time in natural environments. They include Onema, ONCFS, different types of groups such as the Regional federations against pests (FREDON) and the Departmental federations of pest-control groups (FDGDON), associations such as fishing and hunting federations, environmental-protection groups, etc.

The same is true for many local governments that manage rivers and natural environments (river boards, municipal associations, etc.) and have hired technicians in charge of organising the management of their area. Some have already set up work teams for various projects ("green teams", see the management report, volume 2, page 67). During their work in the field, these technicians and teams could, without too much effort if adequate training is provided, reinforce the available observational capacities and produce data for the monitoring network.

Precise numbers are not yet available, but several hundred people could no doubt be mobilised in continental France and even several thousand if the members of the associations mentioned above were also requested to open their eyes and ears.

These operators and employees of course already have jobs to do and this monitoring activity would come on top of that work. That is why it is important that national negotiations be undertaken under the authority of the State, via the Ecology, Agriculture and Health ministries, in view of progressively creating a large network, thus ensuring that this activity is undertaken in the most efficient manner to limit the time spent by each participant.

This "official" network could also receive support from voluntary observers and citizen groups, thanks in particular to the recent development of citizen-science programmes that make it possible to collect highly diverse types of information (see page 229). This would be a means to fill out the network with decentralised sources of monitoring.

Work has already been put into designing this network (Thévenot and Leblay, 2014) and the local groups that coordinate data collection in their area (for over a decade in some cases) already participate in this monitoring system. However, coordination remains a major concern, for example:
- training network members on how to identify species (see Figure 48);
- progressive widening of the network to include the observation of all plant and animal species. The current specialisation (often plants, more rarely animals) must be overcome by coordinating the members of the pre-existing networks on the local and regional levels;
- validation, transmission techniques and storage of the information produced by the observations;
- dissemination of the information to the entire network;
- the decision-making process for management interventions.

The establishment of such a network will require a cultural shift in that it will oblige the various partners to negotiate and to agree on common objectives, given that each partner has its own specific operating objectives that are not necessarily convergent with those of the other partners. Above and beyond the official requests by the State, funding will certainly have to be provided to assist some partners in effectively taking part in the network.

Figure 48

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One necessary step in establishing monitoring networks is a series of informational and training sessions for the people working in the field.

Schedules for monitoring work must be adapted to each species, for example by shifting observation dates during the spring to ensure that plant development is sufficiently visible and easily detectable (development of beds, flowering, etc.) and, for fauna, during periods when the behaviour of each species makes it more visible. Study has already been put into this aspect, but adaptation to local situations will probably be required, notably to the climatic conditions.

In general, identification of plant, vertebrate and some invertebrate species (e.g. crayfish) does not present any particular difficulties thanks to an array of books, guides and internet sites, however, the same may not be said for a majority of invertebrate species. These species are less easy to observe given their small size and are, to date, less commonly indicated in easily accessible documents, however, many remain very rapid and effective invaders, for example certain molluscs and crustaceans from Eastern Europe arriving via shipping canals (e.g. see Devin et al., 2005).

In general, species identification takes place using the naked eye, stereo microscopes or even compound microscopes for the smallest specimens, however these tools, similar to all others, have physical limits and require special knowledge and/or documentation. Molecular tools are now being developed, e.g. detection of environmental DNA (for example, see Dejean et al., 2012 on American bullfrogs and the management report, vol. 2, page 158), that will progressively fill out the range of currently available tools.

Major needs in terms of training for the personnel participating in this monitoring network will manifest themselves, on network objectives, issues and functioning, on observation and drawing samples in the field, and the transmission of samples and information, etc.

Among the points that require further study are a reduction in lead times between the initial observation, analysis of the situation, definition of a local strategy and effective intervention, taking into account the many regulatory aspects, in particular those dealing with private property.

Monitoring must of course be pursued on sites or in areas where management work on a given species has taken place. It should include assessments tailored to the species in question and be carried out regularly to keep close tabs on the situation.

Finally, to ensure that the “monitoring / early detection / rapid response” system is fully functional, its organisation must span the geographic and administrative levels required to structure the transfer and storage of the information produced by monitoring, as well as the technical, regulatory and financial conditions governing interventions and the fate of the “products” drawn from the intervention sites.

Intervene?

Prevention looks to the future and to the species that will not be allowed to enter a new area. But what of the present, of the alien species having just arrived and the many IAS already well established? A solution might by to intervene rapidly on the former, as soon as they are identified to avoid problems and damage, and to intervene regularly on the latter in order to "regulate" them, i.e. maintain them at a level where the problems are tolerable and the damage remains within limits.

But in all cases, it is necessary to set the intervention conditions following a complete analysis of the situation in view of determining whether an intervention is indeed necessary.

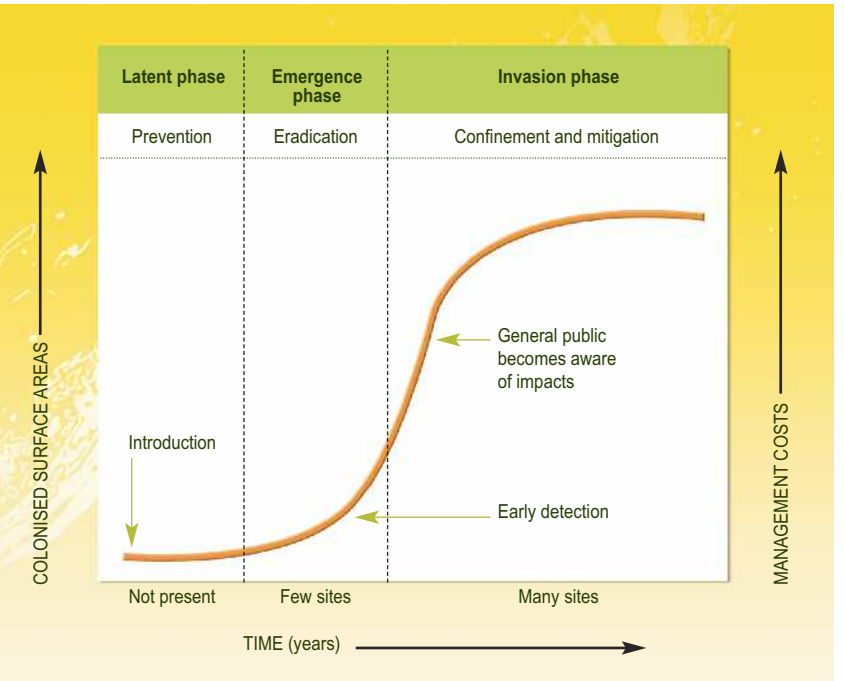
The degree of colonisation, the indispensable criterion in deciding to intervene

One of the criteria determining whether it is necessary to intervene is the degree of IAS colonisation in the given area (continental France, overseas territories).

Three main stages of colonisation have been identified (Dutartre, 2010 and Figure 49).

■ **Invasion not yet under way.** This may be the case for an alien species observed occasionally or on a single site, or where the species does not maintain its presence on the sites where it was introduced. However, the capability of the species to invade has been observed in other parts of the world.

Figure 49



Different stages of invasion and management objectives. Adapted from Branquart, 2010, according to Tu, 2009.

■ **Invasion initiated, but limited geographic extension.** The species has been clearly identified as invasive in other areas where it has been introduced, however it is present on only one or on a very small number of sites where it does not expand noticeably.
■ **Invasion has already spread widely.** In this case, the species is present on numerous sites spread over a vast area. It can cause considerable problems, either on certain sites or on all the colonised sites.

The issue of eradication

Eradication of a species, i.e. an intervention resulting in its total (and permanent) disappearance, is possible during the first stage of colonisation, when the alien population is located on very few sites. But once the invasion has begun to spread, efforts to regulate the situation are generally all that remain possible. In this case, it is necessary to "live with it" and to regularly manage the IAS over time. Ideally, this management work should address all colonised sites, be sized to handle the observed colonisations and be undertaken regularly in order to maintain the "managed" situation.

In their article titled *A pound of prevention, plus a pound of cure, Early detection and eradication of invasive species in the Laurentian Great Lakes*, Vander Zanden *et al.* (2010) drew up a list of questions that should be answered before attempting to eradicate a species.

The list is divided into three main topics.
■ **The cost of the intervention** (in terms of time and money). What is the probability that it will be necessary to repeat the eradication effort? What is the cost of the potential collateral damage for ecosystems and humans? What is the cost of subsequent ecological-restoration work?
■ **How probable is the success of the eradication effort?**
- *Biological factors.* How early in the invasion sequence was the species detected? What is the current status of the invader (density, area colonised, speed of expansion)? Is the eradication likely to be successful, given the species in question and the habitat? What is the probability that a new invasion will occur?
- *Social and institutional factors.* Are the available resources sufficient and do institutions exist that are capable of carrying out an eradication effort (authority, funding, clearly defined organisation, cooperation between institutions)?
Does the public support the initiative and is it willing to participate? Are there legal or institutional obstacles that may counteract or delay the eradication?
■ **The cost of not taking action.** What impacts and what economic and ecological costs may be expected from the invasion? What is the probability that the IAS will cause adverse impacts?

The above list comprises the questions deemed indispensable in preparing an intervention, however its actual execution may encounter many assessment difficulties because a number of elements are very difficult to predict and/or to quantify. The list nonetheless remains a useful starting point in a general approach to the issue.

In their review of eradication efforts for various plant species, Mack and Lonsdale (2000) noted that the available information revealed a small number of clear victories, a few stalemates and many defeats. They drew a number of conclusions for eradication efforts:
■ eradication of invasive alien plants is successful only when they are eliminated immediately following their arrival (which is rarely possible);
■ if eradication is not possible, maximum effort should be put into treating small, isolated areas of introduction;
■ continuous monitoring is required to enhance the chances of early detection and eradication;
■ eradication may led to adverse consequences, e.g. invasion of the site by another invasive species.

A clear definition of the term eradication would also be useful. In common, general usage, it means the complete elimination of the species from the site where it recently settled. This definition was adopted in part by Myers *et al.* (2000) when they wrote "*Eradication is the elimination of all individuals and propagules of an invasive species that have the potential to reproduce",* but they then added a second section that expands the definition and renders it less clear for communication purposes *("or a reduction in species populations to acceptable density levels*").

In order to expand the range of terms, rather than adopting “control” directly from English, it is preferable to use the term “regulation” to designate a reduction in populations (the second part of the definition proposed by Myers et al.) to abundance or density levels that do not cause serious problems in terms of either biodiversity or pest control. The term “eradication” can then be reserved for the total elimination of individuals and propagules (Dutartre, 2010).

Early detection and rapid response

This operational approach is included in most proposals concerning management strategies. It essentially deals with the effort required to identify each newly arrived alien species before it has become permanently established on a site or, failing that, before it can disperse from the initial site to favourable, nearby sites. Early detection enables a rapid response in the effort to manage the newly arrived species, which may include a decision to eradicate.

This approach is based in part on the available knowledge concerning the origins and introduction paths of species (i.e. information on where to focus detection efforts) and on the effective operation of a permanent monitoring network for natural environments, which makes it possible first to detect a species, i.e. precisely identify it with confirmation by an expert, and secondly to make a management decision after consulting a stakeholder network. Each situation must be examined in detail before making a decision which must be based on:

- the available information on the species in question (particularly its invasion capabilities), obtained from the scientific literature or from experts in the network;
- site characteristics (the ecological issues in particular) and its connectivity with other favourable sites for the species.

The decision must be preceded by discussions with the site manager and the site owner (see Box 19). It may also be a good idea to inform the users of the site in order to explain the decision and avoid excessive reactions.

The management decision may opt either for direct intervention on the species (eradication or regulation), with monitoring to determine intervention effectiveness, or, if not much is known on the species, notably its invasion capabilities, for reinforced monitoring of the species, the site and favourable, nearby sites in order to determine the biological and ecological characteristics of the species. It would not be reasonable to adopt a general principle that “each new species must be eradicated” when it is clear that our knowledge base on many species is insufficient. Monitoring based on regular observation campaigns to quantify species dynamics may result at some point in a decision in favour of direct intervention, but in all cases the monitoring reports must be disseminated to the entire network.

The management decision may be taken following rapid discussions among a group comprising the State services, experts and local stakeholders, including a review of the available knowledge concerning the species, the colonisation issues on the host site and the available intervention resources depending on the species and the site. Existing organisations, e.g. certain national or regional work groups (see the IBMA group, page 98), can provide expert knowledge and their highly reactive networks to assist in making the decision.

If direct intervention on the species is deemed necessary, it must be carried out as soon as possible, taking into account any known confinement measures and precautions required for the species or type of species. For example, an intervention on submergent plants with fragile stalks must recognise the risks and adopt precautionary measures such as confinement nets, systematic collection of fragments, etc. The subsequent disposal of the plant or animal biomass drawn from the site should be included in the management strategy. Special monitoring to assess the effectiveness of the intervention should be set up. The monitoring reports, a source of useful feedback, should be disseminated to the entire network.

Cases of early detection and subsequent management

New Zealand pigmyweed (*Crassula helmsii*) :

- Initial observation at the end of 2011 in the Deux-Sèvres department, identification confirmed, significant colonisation of a pond (http://sevre-niortaise.fr/wp-content/uploads/19_347_fichecrassula7_288.pdf).
- The IIBSN intervention protocol was drafted rapidly (mechanical removal and manual maintenance) because the species was well known for its colonisation capabilities and management difficulties (EPPO list http://www.eppo.int/INVASIVE_PLANTS/ias_lists.htm#A1A2Lists and information from the U.K.).
- Data sheet drafted by Nicolas Pipet (IIBSN technician), warning notice drafted and disseminated by CBNSA (November 2011).
- Mechanical removal carried out in April 2012 with regular manual interventions on the site since.
- Intervention reports disseminated by IISBN (see the management report, vol. 2, page 47) and information on the IIBSN site.

(http://www.sevre-niortaise.fr/accueil/des-thematiques-du-bassin-versant/les-plantes-exotiquesenvahissantes/).

Cape pondweed (*Aponogeton distachyos*) :

- Initial observation in 2014 in a pond in the Deux-Sèvres department (see Figure 50).
- A CBNSA warning notice existed for the species, indicating that "the species should be monitored to detect any possible invasion dynamics".
- Discussions via email in April and May 2014 among several members of the network (including the naturalists who discovered the species) on the appropriate management strategy.
- An observation report was drafted.

(http://www.orenva.org/IMG/pdf/fiche_vanille_d_eau_-_version_iibsnsmbb.pdf).

- Two proposals were discussed, namely 1) eradicate the species on the site (there were worries about subsequent colonisation of the site and nearby sites) and 2) monitor species dynamics on the site and check that it did not yet exist in nearby environments (the species was not known to have high invasive potential and very few plants had been observed). It was decided to run several monitoring campaigns over two years to assess its colonisation capabilities and then reassess the strategy.
- Reinforced monitoring was planned, but the few plants observed were uprooted, apparently in the beginning of the summer, by an unknown person.

Figure 50

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*Cape pondweed (*Aponogeton distachyos*).*

American bullfrog (*Lithobates catesbeianus*):

- Initial observation of a frog found dead in June 2013 in a private lake in the Indre-et-Loire department.
- Information transmitted via internet forums to the French herpetological society.
- Species identified by the French herpetological society on the basis of photos supplied by the private owner.
- Information transmitted to local stakeholders, including ONCFS, Onema, Beuvron river board, Loir-et-Cher Departmental committee for the protection of nature and the environment (CDPNE).
- Site visited in July 2013, but no American bullfrogs observed.
- Samples of environmental DNA drawn the lake and neighbouring lakes. DNA analysis results were negative. Monitoring protocol (listening at night) set up for the year 2014. Monitoring carried out regularly by the Indre-et-Loire ONCFS, in conjunction with local stakeholders (employment agency, local governments).

Regulation

Regulation consists of regular interventions on IASs already established over large areas, in order to restrain them on the managed sites to levels where the disturbances and damage caused remain minor with respect to the uses and ecological functioning of the environments. This type of intervention has already been carried out for over 20 years on some sites in continental France.

The technical aspects of interventions depend in part on the type of species (uprooting of amphibious plants, harvesting of submergent plants, shooting or trapping of animals, etc.), but the practical implementation conditions must be adapted to the site or area and to any specific needs of the managers.

If the species has already been regulated in France or abroad, the feedback from the interventions constitute an excellent starting point for the prior study on how to conduct the future intervention, taking care, however, to check the compatibility of the different situations (characteristics of the site and type of manager, organisational and regulatory aspects). On the other hand, if no information is available on the species or type of species, a more wide ranging analysis of the technical aspects is required, taking into account primarily the known biological and/or ecological characteristics of the species or type of species.

Knowledge and integration of the contextual aspects of the intervention are a key factor in ensuring optimal execution. Knowledge on the biology and ecology of species and on the technical possibilities is now widely available thanks to the increased numbers of studies and better dissemination of information from various sources, however the contextual aspects are not sufficiently taken into account. Neglecting them runs the risk of unexpected results or more or less serious failure of the intervention. This analysis approach, by avoiding the indiscriminate use of a “technical cure-all” implemented by another manager in a completely different context, reduces the risk of attempting to employ a solution not suited to the site in question.

Potential approaches

An approach that begins with the observation of a new species (or the analysis of IAS expansion where the disturbances and damage have begun to be noticed) and ends with effective intervention against the species is one that starts and comes to an end in the field. In the final analysis, management always takes place locally, where the managed species are found.

Some management approaches over the past two or three decades in some parts of continental France were undertaken by managers directly confronted with local difficulties that were often severely criticised by residents and visitors to the sites. Lacking a formal organisational framework, they were obliged in some cases to work under crisis conditions, in the process developing their own local approach based essentially on the available resources and equipment.

Given that the vast diversity of situations (site, IAS, management needs) requiring management obviates any possibility of a one-size-fits-all approach, even for a given species, the local approach mentioned above cannot be directly transferred to other sites, but can nonetheless be very effective on the given geographic and organisational levels.

Over the past several years, particularly in the regional and local groups, considerable thought has been put into IAS management approaches on higher territorial and administrative levels (see Chapter 3), in an attempt to integrate both the effective management done by local managers and more wide-ranging organisational forms. Particular attention was paid to the issues of prevention and the need to coordinate research and management.

The development of the National biodiversity strategy since 2010 and the recent vote by the European parliament of the regulation on IAS management (and its implementation on the national level) have encouraged and will continue to promote these coordination efforts.

These two approaches, the “local” very pragmatic approach and the “general” more theoretical approach, do not oppose each other given that:

- practical aspects are often a topic of study and, conversely, theoretical considerations can provide all stakeholders with general indications on how to approach the practical aspects;
- practical aspects are part of the theoretical process, but remain clearly delineated;
- practical aspects represent the last step in any approach.

Table 7 presents a breakdown of the roles played by the two approaches, indicating their respective positions in each part of the process (either leader or contributor).

Table 7 *Breakdown of roles between the general approach and the local approach.*

	General approach	Local approach
Knowledge	L - Review/compilation	C - Contribution
Prevent	L - Organisation/coordination	C - Information
Monitor	L - Coordination	L - Implementation
Intervene	C - Support	L - Implementation

L: Leader
C: Contributor

A "local" approach

Due to a lack of available knowledge and existing analyses on management situations, local approaches encountered various practical difficulties that have slowly faded over the years, in step with the lessons learned by managers. It would nonetheless appear useful to note here a basic procedure applicable to local IAS management (Dutartre, 2002), divided into three steps.

■ Define

- Site characteristics, e.g. types of environments, surface area, water depths, hydrological regimes, levels, connexity with other environments, types of bank, of riparian vegetation, plant and animal communities, etc.
- Uses and users, i.e. a complete listing of site uses (description of those uses, consumption of natural resources, etc.).
- Existing regulations for the site.
- Disturbances and their causes, a list of the expressed problems.
- The IASs causing the disturbances, including precise identification, their distribution in the environment, a review of the available knowledge on their biology and ecology, etc.
- Management issues and objectives (see Box 20).

■ Select

- One or more intervention techniques, taking into account the side effects of the techniques and the fate of the plants and/or animals taken from the site. "Mixed" interventions, comprising several complementary techniques, are a possibility in certain cases, however precise scheduling of the work is indispensable.
- An intervention strategy (organisation, funding, etc.), including from the start a programme of regular maintenance (a multi-year programme is a means to facilitate the work).

■ Assess

- The effectiveness of the intervention (duration, satisfaction of stakeholders, etc.).
- The ecological impact of the intervention.

Box 20

Intervene?

After defining the issues and analysing the context, it must be decided whether it is necessary to intervene. This question must be raised to ensure that any subsequent intervention is the result of a rational analysis and not simply the consequence of a desire to take action. A decision not to intervene is also a management decision.

It may be that the reported disturbances are overstated. In this case, the prior analyses can provide a more objective and comprehensive assessment of the situation, and possibly come to the conclusion that an intervention is not immediately necessary. A decision not to intervene must of course be explained to the stakeholders and does not mean that an intervention cannot take place in the future. A situation that, at a given moment, is deemed not to need immediate attention can evolve very rapidly to a more serious situation. That is why some monitoring of the site is useful in order to react to the changes within a time frame that allows for adequate management. The knowledge gained on the environment and species can be of assistance in estimating the future evolution and subsequent management needs. At certain points in time, a lack of technical means and tools suited to the precise context can also make it temporarily impossible to intervene effectively. However, it is better to avoid work poorly suited to the situation because it can often result further problems.

In some cases, interventions may not be repeated if their effectiveness is not evident or if they create side effects serious enough to durably disturb the treated site. An assessment of the issues at hand is always necessary.

Concerning this last point, local political considerations may prevail and result in interventions that certain partners, other than the managers themselves, see as not particularly useful or even harmful, but the only way to avoid such excesses is through continuous dialogue among all stakeholders.

A "general" approach

A general approach includes the local approach. It is possible to identify a number of key steps in the general approach that apply to different geographic and organisational levels (site, department, region, river basin, etc.). They correspond to the aspects discussed in this chapter (knowledge, prevent, monitor, intervene) and serve to inform managers on the practical components involved in the general approach.

Table 8 on the next page, drawn extensively from Soubeyran (2010), presents for each step in the general management approach the distribution of the roles played by the participants between the general and local approaches. It also attempts to list the interaction between the two approaches to analysing management situations.

The objective here is not to rigidly define roles or to codify the relations between stakeholders, but rather to describe how the relations might be organised.

The table is in any case incomplete because it is impossible to foresee the many possible situations, stakeholders and potential relations between professionals, institutions and people in general.

Table 8 *Breakdown of roles between the general approach and the local approach.*

	General approach	Local approach (manager)
Develop a strategy **Propose an organisational framework to improve IAS management** **Clearly define management objectives** **Assist implementation of coordinated measures and cooperative efforts among all stakeholders**	■ Review existing projects and data exchanges ■ Identify the roles and responsibilities of stakeholders ■ Include existing management work and coordination efforts ■ Mobilise local know-how ■ Comply with national and European strategies and in general with public policies on the management of water and biodiversity	■ Contribute to formulating strategy by providing information on needs and current measures ■ Learn about the strategy and participate in its implementation ■ Develop local management strategies adapted to the area
Inform the public and raise awareness	■ Formulate communication strategies, create and provide the tools ■ Inform financial partners and policy makers ■ Develop the priority measures to inform the public and raise awareness ■ Develop training courses	■ Inform local elected officials, property owners and people active in natural environments ■ Raise awareness of the general public ■ Inform higher levels on communication needs
Prevent the introduction and spread of alien species	■ Contribute to designing regulations suited to the local and national levels ■ Identify the concerned sectors ■ Propose codes of conduct ■ Formulate communication strategies ■ Organise meetings to share technical data, workshops, symposia ■ Provide training on species identification	■ Participate in drafting and implementing codes of conduct ■ Assist in identifying regulatory problems ■ Raise awareness of the general public ■ Provide training on species identification
Inventories, monitoring and surveillance	■ Mobilise experts and available knowledge ■ Propose and draft monitoring and inventory protocols ■ Centralise information and disseminate it (databases, GIS) ■ Keep technical and scientific watch to discover new monitoring options ■ Organise GIS training	■ Participate in drafting protocols ■ Constitute inventories, participate in collecting information on species ■ Map distribution ranges and establish local databases ■ Test innovative monitoring methods and contribute to improvements
Develop early detection and rapid response	■ Identify and set priorities for species not yet established ■ Assess risks ■ Identify the main introduction paths ■ Design action plans and assist in finding emergency funds ■ Serve as an information relay on the national level, contact taxonomic experts ■ Lead the monitoring network and organise discussions on management decisions ■ Draft and provide protocols for reporting and centralising information	■ Organise general surveillance in the field ■ Detect species and alert local networks ■ Organise surveillance of areas at high risk of invasion ■ Participate in the monitoring network ■ Execute rapid interventions
Set priorities for action	■ Set management priorities by defining criteria and drafting lists	■ Provide data on population dynamics ■ Manage priorities taking into account local demands and available funding

Table 8 (cont.)

Interventions	■ Provide regulatory support ■ Contribute to analysis of technical decisions ■ Assist in finding funds for the proposed strategy	■ Define objectives ■ Select the management technique ■ Implement the project ■ Assess the results ■ See Chapter 5
Develop synergies between research and management	■ Develop ties between researchers and managers (common language and objectives) ■ Conduct comprehensive analysis of situations requiring management ■ Draft specific requests for research, focussing on the species in the given area, in view of improving their management, particularly as concerns the dissemination of the results	■ Inform higher levels on needs in terms of improving management and monitoring species ■ Provide field data ■ Participate in research experiments and support them in the field
Reinforce regional cooperation	■ Participate in regional monitoring and intervention programmes, in collection and dissemination of information publicising the measures taken ■ Make proposals to harmonise management protocols and methods	■ Develop contacts between managers, share information on interventions and their results

It will take time to develop these approaches, to set objectives and to determine how to achieve them. Time is also required for the various participants to come to know and understand each other, though it is also clear that the time to design and organise a general approach may be perceived as wasted by managers confronted with urgent requests for intervention.

It is not easy to reduce the time required to develop approaches. Most of the work groups created since 2000 and operating below the national level required at least three years before becoming fully operational. Developing effective relations between experts and managers will also take time. That is why the national network for surveillance, early detection and rapid intervention (as per the European regulation) should be set up as quickly as possible. The network should also be deployed over the entire country, including areas where IAS pressures are currently low or negligible, in order not to be surprised by new invasions or by the rapid spreading of IASs already widely present in certain areas.

This network will be of great use in harmonising the analyses and approaches of the many stakeholders involved in IAS management. It is clear that the various stakeholders operate according to very different time frames, e.g. managers need to react and launch projects quickly (”we need to act now”) whereas scientists need time for their research (”we need to understand before we take action”). To ensure optimum execution of a joint approach, these needs must be met and solutions may, initially, encounter difficulties due precisely to the different time frames. However, given that in most cases, management work initiated in compliance with regulations must be repeated over time, these difficulties should fade. It is nonetheless true that to maintain an operational situation and confident relations between the management and scientific sectors, it is necessary, similar to all human relations, to strive together to achieve the jointly approved objectives.

Other difficulties caused by differences in time frames may arise when certain persons, stakeholders or even elected officials suddenly discover, occasionally very late in the game, the implications of IASs management for their own needs and interests. This sudden “discovery” of the situation and the direct IAS-related risks can produce strong reactions on the part of these new stakeholders. The situation overnight becomes a major

problem because they are directly concerned, whereas before they were unaware of the situation. These reactions often reveal a degree of irrationality, ignorance or even dishonesty, which makes it more difficult to dialogue with these new stakeholders in the management work.

This “late discovery” occurs fairly regularly in cases where the only information disseminated concerns situations that may require IAS management in the future or, in extreme cases, situations where interventions have already been regularly organised in the area. It is clearly the consequence of insufficient communication and awareness raising targeting the stakeholders in question.

It must be said that though regular efforts have been made over many years by a majority of managers, they nonetheless remain insufficient in some cases. For example, a few years ago, a town made an urgent request for equipment to harvest aquatic plants because the exceptional weather conditions (it was the hot summer of 2003) had caused a massive proliferation of a new invasive plant in its lake. The same town had for several years received a series of reports warning about the progression of the species and the growing need to manage it. Similarly, during the July 2013 symposium organised in the Brière region (see Figure 51 a and b) with the participation of the regional nature park to discuss local management of primrose8, a number of farmers, who had recently discovered the problems involved with terrestrial primrose in wet meadows, criticised the participants from the regional nature park, Agrocampus Ouest and Irstea (and public authorities in general) for not having taken any action. They were unaware of the joint management of primrose by those organisations (involving both research and concrete interventions) for over a decade in that particular area.

Figure 51

a, b © A. Dutartre, Irstea

The symposium held in 2013 to discuss primrose in the Brière region was an occasion for researchers, managers and the general public to meet.

Group excursion in the Brière region to observe the colonisation of meadows by terrestrial primrose.

8. http://www.gt-ibma.eu/activites-du-gt-ibma/analyse-des-aspects-de-la-gestion-sur-un-site-pilote-application-a-la-gestion-des-jussies-par-le-parc-naturel-regional-de-briere/

Unfortunately, this “social inertia” is not limited to certain people or groups of people. It may be observed everywhere and anywhere, even in State representatives. It remains one of the main difficulties confronting the “management-science” partnership in this field and explains the need to improve the relevance and intensity of communication and awareness-raising efforts targeting all segments of the public, in order to overcome or at least reduce this inertia.