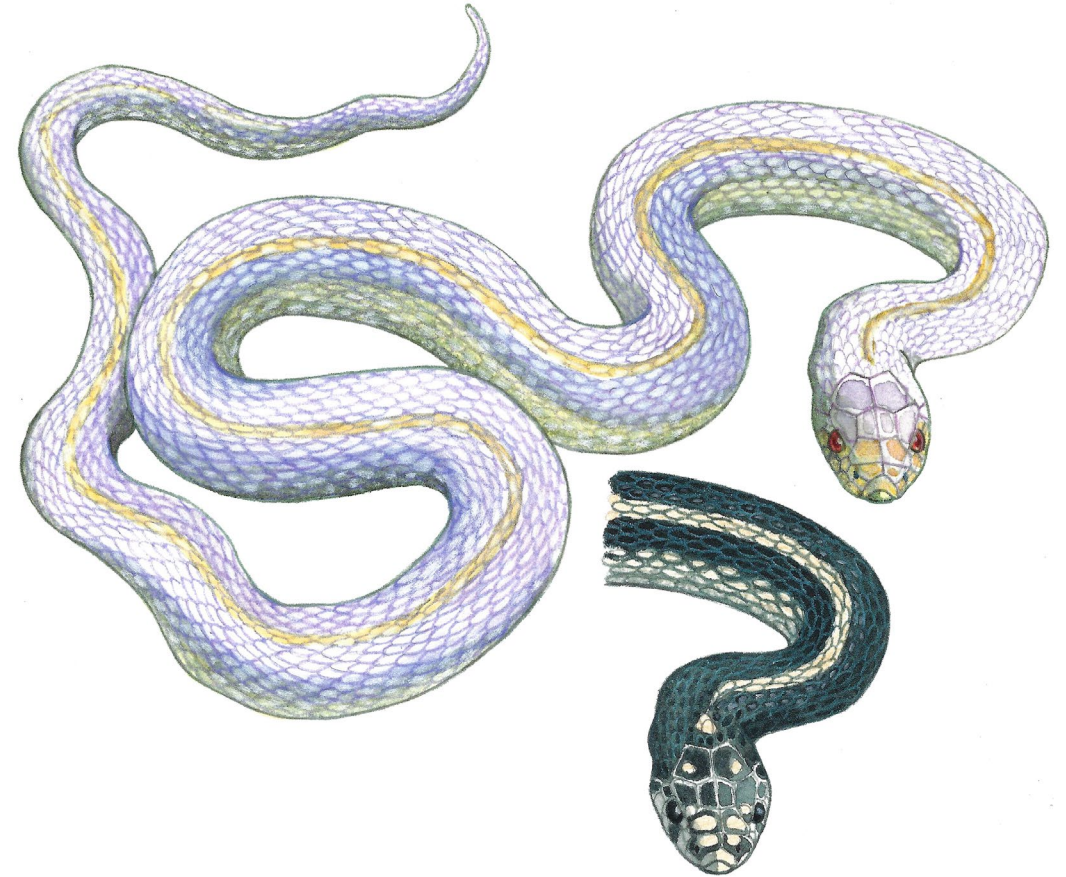


Working group II: ARC and Invasive Species

Managing IAS: invasive alien snakes as a case study

Riccardo Scalera

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LIFE Platform Meeting: Amphibian and Reptile Conservation (ARC)

Challenges and Opportunities in Europe

Santander, Spain - 22-24 May 2024



California kingsnake. © Julien C. Piquet.

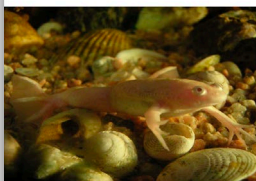
Invasive alien snakes

Information on measures and related costs in relation to species considered for inclusion on the Union list

Scientific name(s)	<i>N.a.</i>
Common names (in English)	Invasive alien snakes
Author(s)	Riccardo Scalera and Tim Adriaens
Reviewer(s)	Chloi Adampoulou, Miguel A. Carretero, Victor Colomar, Josh Fisher, Robert Fisher, Ramón Gallo-Barneto, Patricia Hernández, Mary Jo Mazurek, Hubert Laufer, Sigrid Lenz, Marta L. Darias, Sofía L. Plaza, Alicia M. Alonso, John Measey, Gianpaolo Montinaro, Julien C. Piquet, Shane R. Siers, McKayla Spencer, Richard Struijk, Rémon ter Harmsel, Sylvain Ursenbacher, Loïc van Doorn, Joseph Wasilewski, Katie E. Costello, Ana Nunes, Jose L. Postigo
Illustrations	Massimiliano Lipperi, Studio Wildart (<i>Reproduction is authorized provided the source is acknowledged.</i>)
Date of completion	02/10/2023



The management of African clawed frog (*Xenopus laevis*)
Measures and associated costs



Scientific name(s)	<i>Xenopus laevis</i> (Daudin, 1803)
Common names (in English)	African clawed frog
Authors	Pete Robertson and Riccardo Scalera
Date of completion	22/09/2018

Table of contents	
Summary of the measures	2
Prevention	3
Managing pathways	3
Effective reporting of new incursions	3
Raising awareness	3
Preparation of contingency plans	4
Rapid eradication	4
Aquatic funnel traps and fyke nets	5
Hand dip-net and seine net	5
Pond draining	5
Pond destruction	6
Electro-fishing	7
Addition of fish as predators or competitors	7
Biocides	7
Chemicals (oils)	8
Sterile males	8
Sterile females	8
Surveillance	8
Management	10
Fencing and barriers	10
Addition of fish as predators to unoccupied waterbodies to limit colonisation	10
Bibliography	11
Appendix	12

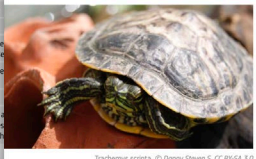
The management of American bullfrog (*Lithobates catesbeianus*)
Measures and associated costs



Scientific name(s)	<i>Lithobates catesbeianus</i> (Shaw, 1802)
Common names (in English)	American bullfrog
Authors	Tim Adriams, INBO (Research Institute for Nature and Dierprotection), David Halfmaarten (INBO, Belgium), and Riccardo Scalera (IUCN Invasive Species Specialist Group, Italy)
Reviewers	Riccardo Scalera, IUCN Invasive Species Specialist Group, Italy
Date of completion	30/05/2019
Citation	Adriams, T., Byns, R., Halfmaarten, D., and Scalera, R. 2019. Information on measures and related costs in relation to species introduced from the United States to the European Union. Technical note prepared by IUCN for the European Commission.

Table of contents	
Summary of the measures	2
Prevention	4
Managing pathways	4
Effective reporting of new incursions	4
Raising awareness	4
Preparation of contingency plans	4
Rapid eradication	4
Aquatic funnel traps and fyke nets	5
Hand dip-net and seine net	5
Pond draining	5
Pond destruction	6
Electro-fishing	7
Addition of fish as predators or competitors	7
Biocides	7
Chemicals (oils)	8
Sterile males	8
Sterile females	8
Surveillance	8
Management	10
Fencing and barriers	10
Addition of fish as predators to unoccupied waterbodies to limit colonisation	10
Bibliography	11
Appendix	12

The management of pond slider (*Trachemys scripta*)
Measures and associated costs



Scientific name(s)	<i>Trachemys scripta</i> (Thunberg in Schoepff, 1792), with 3 subspecies: <i>T. scripta elegans</i> , <i>T. scripta troostii</i> , and <i>T. scripta troostii</i>
Common names (in English)	Pond slider (<i>Trachemys scripta</i>), red-eared slider (<i>T. scripta elegans</i>), yellow-bellied slider (<i>T. scripta troostii</i>), and Cumberland slider (<i>T. scripta troostii</i>)
Author(s)	Peter Boets (Provincial Centre of Environmental Research, Belgium)
Reviewer(s)	Riccardo Scalera
Date of completion	29/08/2019
Citation	Boets, P. 2019. Information on measures and related costs in relation to species introduced from the United States to the European Union. Technical note prepared by IUCN for the European Commission.

Table of contents	
Summary of the measures	2
Prevention	3
Managing pathways	3
Effective reporting of new incursions	3
Raising awareness	3
Preparation of contingency plans	4
Rapid eradication	4
Aquatic funnel traps and fyke nets	5
Hand dip-net and seine net	5
Pond draining	5
Pond destruction	6
Electro-fishing	7
Addition of fish as predators or competitors	7
Biocides	7
Chemicals (oils)	8
Sterile males	8
Sterile females	8
Surveillance	8
Management	10
Fencing and barriers	10
Addition of fish as predators to unoccupied waterbodies to limit colonisation	10
Bibliography	11
Appendix	12



Invasive Alien Species native to parts of the EU: The Italian wall lizard (*Podarcis siculus*)



Scientific name(s)	<i>Podarcis siculus</i> Rafinesque-Schmaltz, 1810
Common names (in English)	Italian wall lizard
Authors	Riccardo Scalera (IUCN, SSC, Invasive Species Specialist Group, Italy)
Reviewers	Roberto Sindaco (Istituto per le Piante da Legno e l'Ambiente, Italy)
Date of completion	28/10/2019
Citation	Scalera, R. 2019. Invasive alien species native to parts of the EU: The Italian wall lizard (<i>Podarcis siculus</i>). Technical note prepared by IUCN for the European Commission.

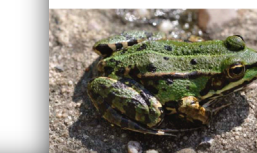
1.1. Native range within the EU

The species is native to the Italian Peninsula, Sicily, and the north Adriatic coast, i.e. Slovenia and Croatia (including many east Adriatic islands) (Sindaco et al., 2006).

1.2. Alien distribution within the EU

Introduced populations of the species are present in several locations in countries where native populations of the species also occur, for example in Sardinia, Italy (Lanza, 1982; Podnar et al., 2005) and in some east Adriatic places (i.e. Dubrovnik – Dalmatia; Podnar et al., 2005). Around Garda Lake (northern Italy), both autochthonous and introduced populations are present (Nardelli et al., 2018). Alien populations are also present in France, including in Corsica (Podnar et al., 2005; Pascual et al., 2006), Toulon, Hyères, and the island of Corsica (Podnar et al., 2005; Pascual et al., 2006). In Spain, in both mainland and the Balearic islands (Valdeon et al., 2010; Pigueton et al., 2002; Portugal (Valdeon et al., 2010; Capula and Ceccarelli, 2003), and Greece (Adamopoulou et al., 2009; CAB, 2016).

Invasive Alien Species native to parts of the EU: The Eurasian marsh frog (*Pelophylax ridibundus*)



Scientific name(s)	<i>Pelophylax ridibundus</i> (Peters, 1844)
Common names (in English)	Eurasian marsh frog
Authors	Riccardo Scalera (IUCN, SSC, Invasive Species Specialist Group, Italy)
Reviewers	Roberto Sindaco (Istituto per le Piante da Legno e l'Ambiente, Italy)
Date of completion	28/10/2019
Citation	Scalera, R. 2019. Invasive alien species native to parts of the EU: The Eurasian marsh frog (<i>Pelophylax ridibundus</i>). Technical note prepared by IUCN for the European Commission.

report this species as native throughout France, where it is introduced except in the extreme north-east (Lescure et al. Massary, 2012), as well as in Iran, where *P. ridibundus* most likely should be excluded (Petrakakis et al., 2016). Also the map of the new European Atlas (Sillero et al., 2014) merges the ranges of *P. ridibundus*, *P. bedfordiae* and *P. kurtmulleri*.

introductions may lead to complex patterns of water frog assemblages and distributions, including situations of hybridisation and introgression between the different taxa of the genus *Pelophylax* (Dufresnes et al., 2018). The various species belonging to the *Pelophylax* genus may be difficult to distinguish morphologically and this, together with the difficulties related to the taxonomic attribution of the relevant taxa (whose group has also been subject to recent revisions), may affect the precise definition of the alien and native range of the species.

As a side note, several introductions have also been carried out in countries outside the EU (for example in Switzerland (Dufresnes et al., 2018) and in Asia, e.g. in the Russian Federation and Kazakhstan (Borkin et al., 2002; Holtsbeek et al., 2008; Kuzmin et al., 2009).

has never been confirmed (Fons et al., 1991; Lescure and de Massary, 2012). The status of the species is also unclear in Sardinia (Italy). It either naturally colonised the island during the Messinian salinity crisis, or was introduced by man, as genetic evidence seems to suggest, possibly by the Romans or Carthaginians. Thus considering that negative impacts are reported from Sardinia (Schilli, 1999; Luselli, 2006; Scali, 2011), the most appropriate status of the species in IT should be "both native and cryptogenic invasive", as this category is not applicable, "both native and alien invasive" was selected. One record of one individual, most likely escaped from a terrarium, is known from Belgium.

Information on management measures and associated costs in relation to species:

- on the Union list
- considered for inclusion on the Union list



Notes drafted by IUCN within the framework of contract “Technical and Scientific support in relation to the Implementation of Regulation 1143/2014 on Invasive Alien Species”



Often build on, and expand from, information present in the species Risk Assessment (brief Risk Management note)



Disseminated as much as possible among various stakeholders

Structure



Table of contents

	Prevention 2		
	Management of key pathways..... 2		
	A ban on importing (pre-border measure), selling, breeding, growing, and cultivation, targeting intentional introduction of invasive alien snakes.. 4		
	Managing captive animals 9		
	Biosecurity measures and pathway action plans.... 10		
	Prevention once introduced 16		
	Physical and electrical barriers 16		
	Public awareness 19		
	Surveillance for early detection 21		
	Use of passive trapping methods..... 21		
	Environmental DNA (eDNA) 23		
	Sniffer dogs..... 25		
	Citizen science..... 27		
	Visual surveys 29		
	Rapid eradication 33		
	Contingency planning and emergency measures.... 33		
	Management 36		
	Active searching and hand capture..... 36		
	Trapping methods and devices..... 39		
	Chemical control..... 44		
	Biological control..... 45		
	Habitat restoration vs. habitat alteration..... 46		
	Shooting..... 48		
	Integrated management strategies 48		
	Bibliography 50		
	Appendix		

Vai alla pagina 50

Contents

Prevention of <u>intentional</u> introductions - measures for preventing the species being introduced intentionally into the territory of a Member State. This table is for a single measure, and the table is repeated for each separate prevention measure identified.									
Measure name									
Measure description									
Scale of application									
Effectiveness of the measure	Effectiveness of measure	Effective		Neutral		Ineffective		Unknown or not yet applied	
	Rationale:								
Effort required									
Resources required									
Additional cost information									
Side effects (incl. potential) – both positive and negative	Environmental effects	Positive		Mixed		Negative		None	
	Social effects	Positive		Mixed		Negative		None	
	Economic effects	Positive		Mixed		Negative		None	
	Rationale:								
Acceptability to stakeholders	Acceptability to stakeholders	Acceptable		Mixed		Unacceptable		Unknown	
	Rationale:								
Level of confidence on the information provided	Inconclusive		Unresolved		Established but incomplete		Well established		
	Rationale:								

- Prevention
- Surveillance measures (to support early detection)
- Rapid eradication (for new introductions)
- Management

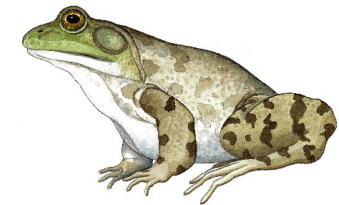


Table repeated for each of the measures identified

Prevention

Prevention of intentional and unintentional introductions

Phase	Measure
Prevention of intentional and unintentional introductions	• Management of key pathways • A ban on importing (pre-border measure), selling, breeding, growing, and cultivation, targeting intentional introduction of invasive alien snakes. • Managing captive animals • Biosecurity measures and pathway action plans
Prevention of secondary spread	• Physical and electrical barriers • Public awareness

Invasive alien snakes are animals usually kept as pets or for display in private or public zoological collections, from where they are known to escape or occasionally be released into the wild.

Management of key pathways (pathway management plans, codes of conduct, and voluntary measures)

- Implementation of **awareness raising campaigns**
- Adoption and enforcement of appropriate management plans and **codes of best practice, e.g.**
 - ✓ *European Code of Conduct on Pets and Invasive Alien Species*
 - ✓ *European code of conduct on zoological gardens and aquaria and invasive alien species*
 - ✓ *Guidance document on e-commerce and IAS*
- Pathways action plans -> see EU Regulation on IAS

Information on effectiveness, resources needed not available, but acceptable and without side effect

Invasive alien snakes are animals usually kept as pets or for display in private or public zoological collections, from where they are known to escape or occasionally be released into the wild.

A ban on importing (pre-border measure), selling, breeding, growing, and cultivation, targeting intentional introduction of invasive alien snakes

- EU Regulation 1143/2014 - In accordance to Article 7 only one species of snake is included in the Union list so far, *Lampropeltis getula*, but other amphibians and reptiles are also regulated (*Lithobates catesbeianus*, *Xenopus laevis*, *Trachemys scripta*)
- National legislation

Usually effective in the long term (but not all agree), but acceptability and side effects questionable

Points for discussion

Experience on effectiveness of codes of best practices and bans and relevant implications

The reproduction of snakes kept in captivity may be achieved through different methods

Managing captive animals

- **Isolation** of sexes in separate environments
- Application of surgical **sterilisation** of specimens
- Application of **immunocontraception**
- Limitation of **nesting habitat** availability
- Replacement of **eggs**.
- Implant of passive integrated transponders (**PIT**)

Limited information on effectiveness and resources required, side effects and acceptability questionable

Points for discussion

Are there any useful example of actual implementation of the measures above in invasive alien snakes?
Or any other reptile/amphibian? Any valid standards for keeping animals in captivity?

Invasive alien snakes may be introduced to new areas unintentionally through a variety of pathways, e.g.:

- As “contaminants” via airports, seaports, roads, railways, canals, pipelines, etc.
- As stowaway in air and sea cargo

Biosecurity measures and pathway action plans

Control for pathways of unintentional introduction and spread can be performed through:

- increased **biosecurity measures**
- implementation of **pathway action plans** (as foreseen by Article 13 of the EU Regulation on IAS).
- transported goods to be checked for stowaways: see measures under the “**Surveillance measures to support early detection**” and “**Management**” sections, e.g. visual checks, eDNA, quarantine measures, physical and electrical barriers, use of sentinel traps, detection dogs or fumigants, chemicals or bright lights, reducing prey availability awareness raising, etc.

Points for discussion

Any example of successful implementation of biosecurity measures in preventing unintentional introductions? Any life stage that normally results undetected?

Prevention of secondary spread of the species. Need to prevent further dispersal of invasive alien snakes from already existing populations into new suitable reproduction habitats, protect vulnerable sites to alien snake invasion, and also to limit movement in sites undergoing control or eradications

Physical and electrical barriers

- fences may be combined with trapping, e.g. terrestrial drift fences with funnel and pitfall traps
- fences may be complemented with electrified wire or poly tape to increase overall effectiveness

Effectiveness, side effects and acceptability depends on the species and environmental conditions.

Points for discussion

- Are there actual examples of barriers used for invasive alien snakes? For other reptiles and amphibians?
- Are there other interventions used to prevent secondary spread?

Prevention of secondary spread of the species. Need to prevent further dispersal of invasive alien snakes from already existing populations into new suitable reproduction habitats, protect vulnerable sites to alien snake invasion, and also to limit movement in sites undergoing control or eradications

Awareness raising

Raising public awareness of the risks posed by invasive alien species in general is a key management tool to deal with invasive alien snakes (see sections “**Rapid eradication for new introductions**” and “**Management**” below), and to prevent their introduction and spread (see also section “**Surveillance measures to support early detection**”). It includes citizen science.

Points for discussion

Are there any concrete examples of successful impact of awareness raising campaign specifically dedicated to invasive alien amphibians and reptiles?

Surveillance

measures to support early detection

Measure

- Use of passive trapping methods (in high risk areas)
- Environmental DNA
- Sniffer/detection dogs
- Citizen-science
- Visual surveys
- Surveillance at points of introduction
- Remote sensing and near-infrared cameras

→ see “Prevention”

Use of passive trapping methods (in high risk areas)

For details on the various techniques and tools, see "**Trapping methods and devices**" under the section "**Management**"

- Specific trap systems adopted for snakes in both terrestrial and aquatic environments are **Artificial Cover Objects (ACOs)**, also known as **artificial coverboard arrays**

Points for discussion

Are there any examples of (successful) implementation of use of traps to identify invasive herps populations specifically for surveillance purposes?

eDNA

- mainly used to detect **aquatic species** of snakes from water samples
- for **semi aquatic snakes** or **terrestrial species** occasionally occurring in pools
- rare examples for **terrestrial species** of snakes
- to collect eDNA in terrestrial environments -> use of Artificial Cover Objects (ACOs)

Usually effective and acceptable, with no or limited side effects, limited information on costs

Points for discussion

Are there other examples of eDNA being used to identify invasive alien snake populations, particularly in terrestrial environments?

Sniffer/detection dogs

- Used to locate snakes or areas where snakes are active
- Applied for detection within high risk sites of conservation concern, or as part of an eradication or management program, as well as in survey at inspection points
- To be used in association to other methods to capture the snakes
- Not suited for early detection at a large scale

Points for discussion

Are there any examples of (successful) surveillance activities targeting invasive alien amphibians and reptiles through this method?

Citizen-science

- Monitoring with citizen science can offer great support to both general and risk oriented-surveillance and is crucial for early detection
- Smartphone applications can be a helpful tool
- Specific and generic reporting platforms exist (EASIN, iNaturalist, Natusfera, Observation.org, Artsdatabanken, Faune de France ...)

Points for discussion

Are you aware of (successful) surveillance activities targeting invasive alien herps through citizen-science?

Are you aware of any other methods including bounties and challenges?

Visual surveys (incl. radio-tagged scout snakes)

- Visual surveys are a useful management component in relation to the application of several methods
- Lures can also be used to increase visual encounter probabilities
- Scout snakes (or Judas animals) can be also used

Effectiveness very variable, but usually acceptable and with no side effect, but results are not always satisfactory and need to be assessed species by species

Points for discussion

Are there any examples of successful surveillance activities targeting invasive alien snakes through the method above?

Remote sensing and near-infrared cameras

- use of GPS-based techniques for the study of animal movement have greatly advanced in recent years
- use of drone images coupled to a type of machine learning called deep neural network
- use of drones or vehicles mounted with near-infrared cameras implementing artificial intelligence

No information on effectiveness, resources, etc. but usually considered acceptable and with no side effects

Points for discussion

Very innovative techniques: any examples?

Rapid eradication

for new introductions

Measure

- Contingency planning and emergency funds

Contingency planning and emergency funds

- Techniques for monitoring, capturing and removing snakes -> see under the sections on **prevention and management**
- The rapid eradication of new introduction can be achieved thanks to a sound implementation of **surveillance measures** for early detection
- Requires a **contingency plan (rapid-response protocol)** with clear lines of responsibility, dedicated budgets, political and stakeholder support, risk communication, scientific follow-up.
- **Awareness campaign** and **training courses** are also needed
- Establishment of a **Rapid Response Team**

Points for discussion

Are you aware of any interesting case study of rapid eradications on amphibians and reptiles? They are usually underreported

Management

once a species has become widely spread

Measure

- Active searching and hand capture
- Trapping methods and devices
- Chemical control (toxins, fumigant, repellents, attractants)
- Biological control (Raptors/falconry, pathogens, parasites)
- Habitat restoration vs. habitat alteration
- Shooting
- Integrated management strategies

Active searching and hand capture

- It is the most popular and effective methods to capture snake for management purpose
- It include the use of tools such as snake bags, snake hooks, and snake tongs
- This method can be equally implemented for any management purpose, from eradication to control, to containment

Effectiveness depends on invasion extent and detectability of animals

Points for discussion

- Any data on detectability of different life stage, sex, etc.?
- Any information on methods applied for (humane) disposal and dispatch, including for euthanasia?

Trapping methods and devices

Traps can be equally implemented for any management purpose, from eradication to control, to containment (and for surveillance and prevention as well). Several types of trap design exists:

- Funnel traps, minnow traps and pitfalls
- Multi-capture traps and trap-drift fence combinations
- Net traps
- Electrical netting
- Glue traps

Supported by visual searches and dog searches, use of chemicals, baits and lures, artificial barriers, bounty systems, awareness raising campaigns

Points for discussion

Are you aware of study comparing effectiveness of different methods? Any experience with the use of poison baits?

Trapping methods and devices

Weakenesses:

- snake traps are most effective for adult snakes, while usually fail to catch smaller snakes
- snake traps (particularly with live baits) are less effective in environments with high prey abundance, at the end of the feeding season, or if different feeding habits exist between different life stages
- snake traps may not be effective at low density of the target snake population
- snake traps may produce bycatch, leading to unintended impacts on non-target species
- snake traps may be not effective in low numbers
- snake traps may lead to the genetic selection of animals that are reluctant to entering traps

Points for discussion

Any data on impact on different life stages, seasons, habitats, etc.?

Habitat restoration vs. habitat alteration

- design of structural alterations
- supply of refugia
- reduction of prey abundance
- limitation of nesting sites? (see “prevention of reproduction in captivity”)
- improve the conservation status of the threatened native species (by planting of trees and shrubs, placing nest boxes, using bright lights to deter snakes)

Points for discussion

Are you aware of any specific examples to discuss in terms of pros and cons?

Chemical control (toxins, fumigant, repellents, attractants)

It foresees the use of toxicants, attractants and pheromones, repellents and irritant products , contraceptive methods, sterile male release technique

Biological control (pathogens, parasites)

Shooting

Effectiveness inconclusive, little information and very limited to no experience in Europe

Points for discussion

Are you aware of any specific examples to discuss in terms of pros and cons?

Integrated management strategies

Use of a combination of all the measures above

Points for discussion

Are you aware of any specific examples?

Specific points for discussion

- Availability of effective management measures and of documented evidence on effectiveness
- Availability and accessibility of data on management actions in general
- Innovative techniques
- Side effects of management measures (environmental, social and economic)
- Obstacles, including conflicting legislation (e.g. regarding the use of chemicals, and euthanasia), access to private lands, species protection.
- Acceptability of management measures by stakeholders, particularly in relation to animal welfare considerations (but also in relation to denialism towards the problem of IAS in general)
- Scale of application, efforts required, resources required (including cost information)

General points for discussion

- What action is needed the most to improve effectiveness of management measures for invasive alien species of amphibians and reptiles?
- What are the biggest obstacles to implementing effective management measures for invasive alien species of amphibians and reptiles in your country?
- Which initiatives would you like to see on European level?
- What tools would be mostly needed (e.g. toolkits, workshops, training, webinars, platforms for networking...)