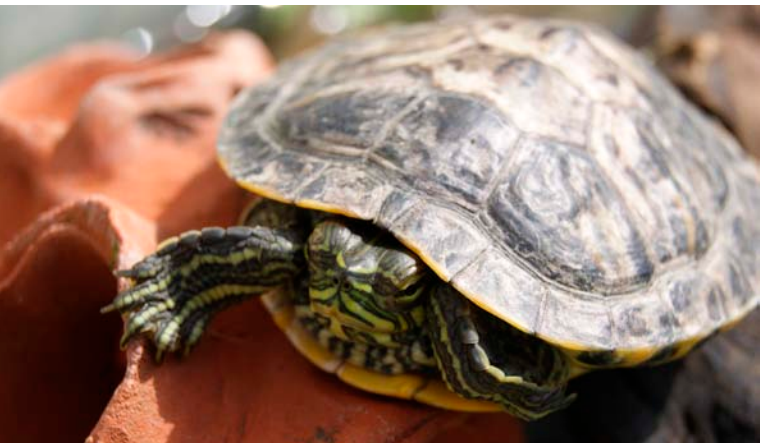


Trachemys scripta. © *Danny Steven S. CC BY-SA 3.0*

The management of pond slider (*Trachemys scripta*)

Measures and associated costs

Scientific name(s)	*Trachemys scripta* (Thunberg in Schoepff, 1792), with 3 subspecies *T. scripta scripta*, *T. scripta elegans* and *T. scripta troostii*
Common names (in English)	Pond slider (*Trachemys scripta*), red-eared slider (*T. scripta elegans*), yellow-bellied slider (*T. scripta scripta*), and Cumberland slider (*T. scripta troostii*)
Author(s)	Pieter 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 included on the Union list: *Trachemys scripta*. Technical note prepared by IUCN for the European Commission.

Table of contents

Common names

BG	Червенобуза костенурка
HR	Crvenouha kornjača, žutouha kornjača
CZ	Želva nádherná
DA	Rødøret terrapin, Cumberland terrapin, guløret terrapin
NL	Roodwangschildpad, geelbuikschildpad, geelwangschildpad
EN	Red-eared slider, yellow-bellied slider, Cumberland slider
ET	Punakõrv-ilukilpkonn
FI	Punakorvakilpikonna
FR	Tortue de Floride
DE	Buchstaben-Schmuckschildkröte
EL	Ερυθροκρόταφη νεροχελώνα
HU	Közönséges ékszerteknős
IE	–
IT	Testuggine palustre americana
LV	Sarkanausu bruņurupucis
LT	Raštuotasis vėžlys
MT	Il-fekruna tal-ilma ħelu, it-terapinn
PL	Żółw ozdobny
PT	Tartaruga de orelha amarela, tartaruga de orelha vermelha, tartaruga-da-Florida
RO	Țestoasă de Florida cu tâmple galbene
SK	Korytnačka písmenková
SL	Popisana sklednica
ES	Tortuga pintada
SV	Gulbukig vattensköldpadda

Summary of the measures, emphasizing the most cost-effective options.

Prevention of escape into the environment

Fencing of ponds can be undertaken to prevent escape of individuals from containment into the environment. However, the effectiveness of this measure is only reported for temporary fences used to support eradication campaigns and monitoring, but not for long term application (the species can live up to 40 years) for example for preventing the escape of individuals that are companion animals/pets purchased before the species was listed.

Prevention of reproduction in containment

Surgical sterilisation can be undertaken to prevent captive individuals reproducing.

Secondary spread

In order to prevent secondary spread of *Trachemys scripta* once they have been introduced, fencing can be used for small isolated waterbodies. However, fences may also prevent movement of native species and interfere with recreational or other activities and therefore may not be a feasible long term measure. In order to address human assisted secondary spread a public awareness campaign is required to make people aware of the dangers related to releasing *T. scripta* into the wild.

Early detection

For the early detection of *T. scripta*, the most promising tool is with the use of the environmental DNA (eDNA) methods as it allows a quick screening on the presence of *T. scripta* based on a water sample and can be applied across relatively large areas. Citizen-science platforms have also shown the potential to provide high chances of detecting the species at an early stage, although confusion with native species is likely among laypeople. The use of basking turtle traps (floating traps used by the *T. scripta* to sunbathe), basking surveys, or the use of sniffer dogs are measures which can support early detection for sites of conservation concern (where native turtles co-occur), or to confirm presence following from possible sightings, but are unlikely to be cost-effective for early detection at a large scale (for example, at the national level).

Rapid eradication

To eradicate the species at an early stage of invasion, several methods have been used, however their success is usually limited to a very local scale. Moreover it is often difficult to determine if a population is completely eradicated or if some small population remains. The drainage of ponds (coupled with fencing and traps) has been used in Australia to eradicate populations from isolated water bodies (such as agricultural dams). Other methods have also been used but are not known to have successfully led to eradications. This includes the use of basking turtle traps which have been shown to reduce population numbers, shooting, and angling. Additionally, sniffer dogs can be used to detect and destroy nests.

Management

For managing established populations, the measures are the same as described for rapid eradication, but are integrated and applied across different sites. The investment in time and personnel quickly increases with the number of locations being targeted, while the success of capturing the animals (and the effectiveness of management aim, such as population reduction) depends on geographic and environmental factors (for example, size of water body, connectivity with other waterbodies etc.) other than on the specific approach used, and the possibility of further releases in the area. The management of established *T. scripta* populations (either for eradication, population control or containment) should therefore focus on those locations where ecological damage is known (such as where competition with or predation on native turtle species occurs). This does not mean that at other locations no actions need to be undertaken, but given the restrictions in time and budget it is important to prioritize areas and to develop a feasible management strategy. In this respect, risk assessment models (GIS-based) can provide an added value to target those locations where the species is expected to have the highest impact.

Measures for preventing the species being introduced, intentionally and unintentionally.

This section assumes that the species is not currently present in a Member State, or part of a Member State's territory.

A ban on importing (pre-border measure), selling, breeding, growing, and cultivation, as required under Article 7 of the IAS Regulation, targeting intentional introduction of *T. scripta*.

MEASURE DESCRIPTION

As the species is listed as an invasive alien species of Union concern, the following measures will automatically apply, in accordance with Article 7 of the EU IAS Regulation 1143/2014:

Invasive alien species of Union concern shall not be intentionally:

(a) brought into the territory of the Union, including transit under customs supervision;

(b) kept, including in contained holding;

(c) bred, including in contained holding;

(d) transported to, from or within the Union, except for the transportation of species to facilities in the context of eradication;

(e) placed on the market;

(f) used or exchanged;

(g) permitted to reproduce, grown or cultivated, including in contained holding; or

(h) released into the environment.

Also note that, in accordance with Article 15(1) – As of 2 January 2016, Member States should have in place fully functioning structures to carry out the official controls necessary to prevent the intentional introduction into the Union of invasive alien species of Union concern. Those official controls shall apply to the categories of goods falling within the Combined Nomenclature codes to which a reference is made in the Union list, pursuant to Article 4(5).]

Therefore measures for the prevention of intentional introductions do not need to be discussed further in this technical note.

However, species covered by the restrictions set out under Article 7 of the EU IAS Regulation 1143/2014 may still be kept in containment under the condition that escape and reproduction are not possible, according to:

(1) Articles 8 (Permits) and 9 (Authorisations) which allow for permitted specimens to be kept (reproduction may also be permitted).

(2) Articles 17 (Rapid eradication) and 19 (Management) which allow for animals to be kept as part of non-lethal eradication/management measures.

(3) Article 31 (Transitional provisions for non-commercial owners) which allows non-commercial owners to keep their companion animals until the end of the animals' natural life, provided that these were kept before the inclusion on the Union list.

(4) Article 32 (Transitional provisions for commercial stocks) which allows commercial owners to keep specimens of invasive alien species of Union concern for up to two years after inclusion on the Union list.

Therefore, this note includes information on the appropriate measures to ensure that reproduction or escape from containment are not possible, please see *Prevention of escape into the environment* and *Prevention of reproduction of contained specimens* sections below.

Fencing of garden ponds.

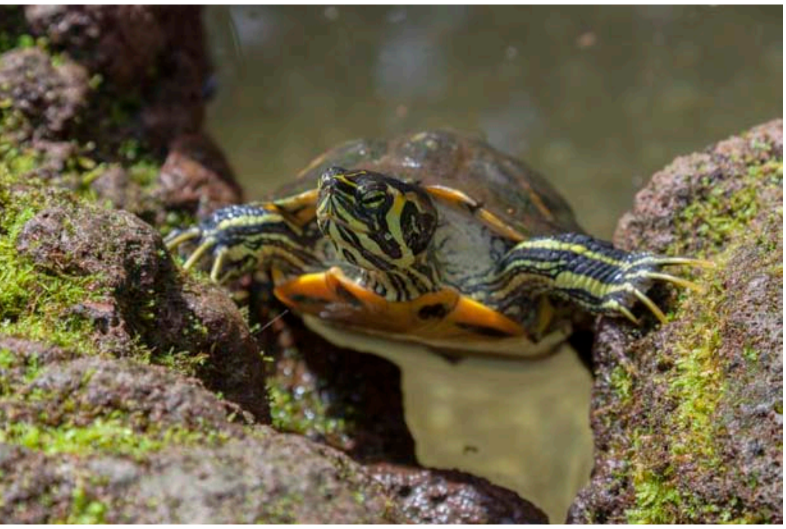
MEASURE DESCRIPTION

The species are usually kept as pets indoors but are also in outdoor garden ponds, from which they could escape into the wild.

The use of fences surrounding waterbodies have been used to contain populations of *T. scripta*, during surveys and also during eradication campaigns. As an example, in southern France Cadi *et al.*, (2004) used an enclosed 'T' shaped 50 cm high fence placed within 2 m of the edges of the ponds, whereas in the USA Bluett and Schauber (2014) used a welded wire fence (5.08 x 10.16 cm-mesh; height 1.83m) erected 3 to 6m from the shoreline, with wire extensions into the ground (trenches filled with soil) to prevent escape of larger individuals. The individuals use the available shoreline up to the fence for basking.

SCALE OF APPLICATION

Small individual ponds.



Trachemys scripta *is native to the south central and south eastern United States and northern Mexico. © Diego Delso. CC BY-SA 4.0*

EFFECTIVENESS OF MEASURE

Unknown.

The measure has been shown to be effective to prevent escape for research and eradication purposes (see references noted above), however in these cases fences were temporary and not permanent (or long-term), therefore the long-term (individuals can live for up to 40 years) effectiveness is unknown and will depend upon regular upkeep and maintenance.

EFFORT REQUIRED

Would need to be in place for the life span of the turtles (up to 40 years).

RESOURCES REQUIRED

Materials and tools for fence construction.

SIDE EFFECTS

Environmental: Negative
Social: Neutral or mixed
Economic: Neutral or mixed

Urban ponds including those in private gardens are known to be important for biodiversity (Hassall, 2014), and building fences around garden ponds will negatively impact native species by restricting access to water and food supplies, and preventing seasonal movement of amphibious species.

ACCEPTABILITY TO STAKEHOLDERS

Unacceptable.

Fences as required to prevent escape of *T. scripta* are likely to be considered an eyesore by owners.

ADDITIONAL COST INFORMATION

No information.

LEVEL OF CONFIDENCE*

Inconclusive.

There is little information on the effectiveness or use of fences to contain *T. scripta*, especially within private gardens.

* See Appendix

Surgical sterilisation.

MEASURE DESCRIPTION

Overall, there is little readily available information on the control of fertility of the species (IUCN, 2017). In addition to keeping males and females separate, and limiting the availability of nesting habitat (sandy soil), sterilisation of male individuals of the species is a known option. Innis *et al.*, (2013) report that orchiectomy (removal of testes) using coelisoscopicy (as opposed to shell osteotomy) was found to be a successful, practical and safe minimally invasive surgical technique for the sterilisation of male chelonians. A large number of *T. scripta* individuals were captured and relocated to the Pistoia Zoo in Italy, where 43 were surgically sterilised within LIFE Emys project (project LIFE12 NAT/IT/000395 LIFE Emys) – For the exact procedure undertaken see Costa Edutainment (2016).

SCALE OF APPLICATION

The application of measure will be to a limited number of individuals due to costs. Innis *et al.*, (2013) performed it on 25 individuals, whereas 43 individuals were surgically castrated as part of the LIFE Emys project (Costa Edutainment, 2016).

EFFECTIVENESS OF MEASURE

Effective.

Innes *et al.*, (2013) have shown that male surgical sterilisation can be effective and minimally invasive.

EFFORT REQUIRED

Individuals are held for 24 hours prior to surgery, and full access to water was provided 24 hours post surgery (Innes *et al.*, 2013). Additional follow up monitoring may be needed.

RESOURCES REQUIRED

Veterinary surgical expertise and facilities.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed
No side effects are expected.

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.

The measure should be seen as acceptable to those keeping *T. scripta* as pets, depending upon cost of procedure, and especially coelioscopic orchiectomy as the procedure avoids surgery to the shell (and therefore much longer healing times (Innes *et al.*, 2013).

ADDITIONAL COST INFORMATION

No information available, but it is likely to be a relatively expensive measure to undertake.

LEVEL OF CONFIDENCE*

Established but incomplete.

There is limited information available on surgical sterilisation for the species.

The species is not introduced unintentionally.

There are no known unintentional introductions of the species into the EU and therefore this section is left blank. We are treating the escape of individuals from zoos and private collections as intentional introductions (see above).

* See Appendix

Measures to prevent the species spreading once they have been introduced.

Fencing of waterbodies where the species is known to be established.

MEASURE DESCRIPTION

The species is known to be established in artificial water bodies, such as public ponds or fountains within an urban or semi-urban environment including parks etc., due to unwanted pets being released (for example, in Rome, see Di Santo *et al.*, (2017)). It is important to note that while *T. scripta* are faithful to home ranges even if the waterbodies lower during the summer, they will migrate to find better habitats if a waterbody completely dries and conditions become unfavourable (Ernst *et al.*, 1994; Wyneken *et al.*, 2008; O'Keeffe, 2009). These populations are a potential source of invasion into sub-urban and natural habitats where native biodiversity may be impacted (Di Santo *et al.*, 2017).

The most effective measure to prevent the secondary spread from these sites is to undertake an eradication (see below), however fencing can also be used to contain and prevent their spread. As noted in the *Fencing of garden ponds* section above, such fences are used during surveys of the species, see Cadi *et al.*, (2004) in southern France who used an enclosed 'T' shaped 50 cm high fence placed within 2m of the edges of the ponds. Also, Bluett and Schauber (2014) in the USA used a welded wire fence (5.08 x 10.16 cm-mesh; height 1.83m) erected 3 to 6m from the shoreline, with wire extensions into the ground (trenches filled with soil) to prevent escape of larger individuals. The individuals use the available shoreline up to the fence for basking.

Fences are also used to prevent escape during eradication measures, for example, see O'Keeffe (2009) in Australia.

SCALE OF APPLICATION

While the measure needs to be taken at the very local and small scale (for each individual waterbody) to be effective, all artificial water bodies that contain the species within the urban setting will need to be fenced. No evidence of this measure being used for this objective (to prevent spread from urban water bodies) has been found.

EFFECTIVENESS OF THE MEASURE

Unknown.

The measure has been shown to be effective to prevent escape for research and eradication purposes (see references noted above), however in these cases fences were temporary and not permanent (or long-term), contrary to what would be needed to prevent secondary spread. Therefore their effectiveness is unknown.

This would not prevent the species from spreading during flooding, or by people actively moving individuals etc.

EFFORT REQUIRED

Theoretically within the EU the fences would need to be in place for the life span of the turtles (up to 40 years). Fencing would ideally be combined with measures to capture/eradicate the species from the water bodies, and therefore the fencing could be removed once the eradication is confirmed. However, determining complete eradication seems to be very difficult (García-Díaz *et al.*, 2017).

RESOURCES REQUIRED

The cost to provide a proper fencing, depends on the size of the environment the species occurs. For example, it will be cheaper to fence small ponds or fountains, compared to larger lakes in public parks etc.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed

The effect on the environment can be negative as the fencing might hamper natural migration of species living in the wild (such as amphibians). It might also be effective to maintain other alien species (such as crayfish) and thus a positive side effect.

No socio-economic side effects are described in literature.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

It is unclear how this measure would be perceived by stakeholders as there is an economic cost, and may lead to negative public perception in relation to animal welfare (for both *T. scripta* and other species living in the fenced waterbodies) and people may therefore damage fences or even move individuals. The fences may also be seen as an 'eye-sore' by the public and lead to damages due to vandalism. On the other hand there could be potential public support if fencing is seen as a solution to contain the species without the need to remove them. This might allow the species to occur in public ponds minimising the danger of escape and thus increasing the acceptability.

ADDITIONAL COST INFORMATION

No additional information was found.

LEVEL OF CONFIDENCE*

Inconclusive.

There is no information available of the long-term use of this measure for preventing secondary spread.

* See Appendix

Communication and awareness campaigns.

MEASURE DESCRIPTION

Secondary spread between waterbodies, and most concerning from urban water bodies to those in natural environments, is also possible through individuals being intentionally moved by people. Therefore effective communication on the potential impacts related to the movement of the species into the wild is key to avoid this form of secondary dispersal. Recent research on the introduction and spread of *T. scripta* in Bulgaria (Kuzmanova *et al.*, 2018), in Italy (project LIFE12 NAT/IT/000395 LIFE Emys[1]), in Spain and Portugal (project LIFE09 NAT/E/0000529 LIFE *Trachemys*[2], LIFE *Trachemys*, 2013) and in France (Peinado *et al.*, 2011) has shown that there is generally little awareness and knowledge on the possible impacts of the species in the wild. Dedicated communication and awareness campaigns could help to increase the knowledge on the species and reduce the possible impacts from intentional introductions and human assisted secondary spread (see Peinado *et al.*, 2011). It is important to start awareness campaigns at the pet shop, educating pet sellers and informing them on the advice and specifics they need to give to customers buying sliders (this also applies to other species than the ones which are banned from sale in compliance to the EU Regulation on IAS, the EU Wildlife Trade Regulations and the EU Nature Directives). Several projects in France, Italy and Spain have combined the efforts of habitat restoration, eradication or population control of the species with communication campaigns to stakeholders (see for example Valdéon *et al.*, 2010; Carbone, 2011, but also the many reports made within the LIFE *Trachemys* project).

SCALE OF APPLICATION

Dedicated communication and awareness campaigns on the issue should be carried out at a relatively local/sub-national scale. The reason is that they would be more effective at reaching the target audience if they are organised at a small scale with specific examples for the region and in the local language (see LIFE *Trachemys*, 2013). Good example of this is the LIFE Emys project in Italy which included actions aimed at raising public awareness among students, veterinarians, pet sellers and the general public. For this purpose a booklet was disseminated (mainly in schools), along with a leaflet (for veterinarians, teachers, and pet shop owners). Additionally an educational path was made to invite people to get involved on the issue within a zoological garden, and this was considered an essential element of the project.

Another good example is an eradication project that was run in Corsica (Peinado *et al.*, 2011), which was accompanied by an awareness and communication campaign with the objective to inform citizens on the problems related to alien species.

Also, the LIFE *Trachemys* project implemented a communication campaign for several locations in Spain and Portugal (LIFE *Trachemys,* 2013), and there have also been similar campaigns in mainland France (Carbone, 2011), and Bulgaria (Kuzmanova *et al.*, 2018).

EFFECTIVENESS OF THE MEASURE

Unknown.

Teillac-Deschamps *et al.*, (2009) modelled the effect of management strategies (those that mixed direct action, such as turtle removal, with public education and those that did not) in urban green spaces and used the red-eared slider as an example. They found that direct actions (turtle removal) without public education only had a limited, short term effect on the abundance of feral turtles in green spaces and had no effect on the level of public concern about environmental questions. They showed that a mix of different communication strategies improved people's awareness and altered their behavior with respect to introduced species issues.

The LIFE Emys project in Italy obtained positive results on the dissemination of information with regard to the management of alien sliders. They also brought captured individuals to a zoological garden where an educational campaign was coupled to it.

The LIFE *Trachemys* project in Spain and Portugal was able to reach many people but especially scholars through organized activities.

However, the actual impact of such campaigns in changing the people behavior is not clear, and there are no elements to assess whether this had any impact on the number of animals released in the environment. In fact, to be successful, the campaign should address the appropriate audience (those responsible of the releases) and should be tailored accordingly. A monitoring action to follow the progress of the campaign should also be considered, so to implement corrective measures if the target of the campaign is not achieved. But there is no information in either of these projects to verify whether this was carried out.

1 LIFE Emys http://www.lifeemys.eu/en/objective/
2 LIFE *Trachemys* http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPageandn_proj_id=3821

EFFORT REQUIRED

Such awareness campaigns regarding invasive alien species in general need to be in place continually. The effort required may be high as research has indicated that it is not easy to make people aware of the dangers related to alien species in order to change their behaviour (Teillac-Deschamps *et al.*, 2009).

RESOURCES REQUIRED

It is difficult to assess the costs related to this measure as it depends on the scale and location that the measure is implemented. Generally the costs are expected to depend on the quality of the campaign, the involvement of communication professionals, the size of the communication and awareness campaign and the methods (and tools) used to communicate. The examples available in literature did not quantify the costs of content generation and dissemination, but rather gave an overall cost of the project including eradication, early detection, communication and awareness.

Peinado *et al.*, (2011) gives a description of the different steps that were taken. They made use of an information brochure, large information signs, and stickers, to inform people about the work going on through the project, on how to recognise the species, and what the impacts of IAS are. Other measures to reach the general public were implemented, such as the publication of a small educational book, and the development of an internet website. A similar approach was followed in the LIFE *Trachemys* project performed in Spain/Portugal where different measures were applied to raise awareness such as a theatre play, a leaflet and visitations of schools.

SIDE EFFECTS

Environmental: Positive
Social: Neutral or mixed
Economic: Neutral or mixed

The general awareness on the impact of other alien species might grow with a positive effect on the environment. A negative side effect from an economic point of view for pet dealers (for example), might be that less non-native species might be bought.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

A key stakeholder group to raise awareness with are the operators of pet shops and pet fairs (even though the species is now banned from sale), as it is possible that they will not actively support such a campaign as they may see it as negatively affecting their business.

ADDITIONAL COST INFORMATION

There is no detailed information available on the costs for this specific type of actions.

LEVEL OF CONFIDENCE*

Established but incomplete.

There is information available on the method in literature (for example, LIFE *Trachemys* and LIFE Emys project) but the overall effect of the method is not very well documented, therefore the method is considered established but incomplete.

* See Appendix

Trachemys scripta *life span ranges from 20–50 years. © Aleksander Niweliński*

Measures for early detection of the species and to run an effective surveillance system for an early detection of a new occurrence.

Basking surveys.

MEASURE DESCRIPTION

Trachemys scripta is known to bask for prolonged periods and compete with the native *Emys orbicularis* for basking sites (Cadi and Joli, 2003). Basking surveys can be conducted by experts using visual observation (aided with high-powered binoculars or spotting scopes). This method is described in Vogt (2012) and has been used mainly for *Graptemys* species but can be effectively applied to freshwater turtles that bask at certain times of day and season. This involved floating downstream in a boat or canoe between 09.00 and 11.00am when the turtles are most likely to be basking. A similar method, but shore based, has also been used by Thomson *et al.*, (2010) to identify and even make estimates on abundance of *Trachemys scripta*. They used X10 binoculars to survey all likely turtle habitat in a single 'pass' in order to avoid counting single turtles multiple times, and stopped the surveys when all habitat in the vicinity had been scanned.

Technology could also be used (for example, remote sensing using drones), to reduce costs and time spent undertaking the surveys, but this has not been tested.

SCALE OF APPLICATION

The scale of application depends on how the observation is performed, but in general is applied at a site scale, such as an individual wetland. Thomson *et al.*, (2010) used the method in the Sacramento river basin at two localities one of 4 ha and one of 5.2 ha.

EFFECTIVENESS OF MEASURE

Neutral.

It is unlikely to be an effective early detection measure at a national scale, but may be effective for areas of conservation concern, or for high risk areas that are hydrologically connected to known populations (such as up- or downstream in other countries). Vogt (2012) states that the method is most effective for assessing population densities of freshwater turtles.

EFFORT REQUIRED

Thomson *et al.*, (2010) mention that surveys were between one and several person-hours of effort depending on the extent of the habitat present at each locality, usually with two observers independently surveying for turtles. They surveyed all likely turtle habitat in a single pass in order to avoid counting single turtles multiple times and stopped the surveys when both surveyors scanned all habitat in the vicinity. They searched for basking turtles, heads of swimming turtles, and aquatic surface-basking individuals.

RESOURCES REQUIRED

It needs well trained personnel, boats and survey equipment. Vogt (2012) used the method from a boat and needed two persons (somebody steering the boat and an observer). If the observation is done from the shore, one single person should be sufficient. However, Thomson *et al.*, (2010) also made use of two persons to undertake shore-based surveys.

SIDE EFFECTS

Environmental: Positive
Social: Neutral or mixed
Economic: Neutral or mixed

Possibly other invasive alien species (and native species of conservation concern) can be detected which can yield a positive environmental effect. There are no social side effects described in literature.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

Visual observations are likely to be considered acceptable as it does not harm the individuals (Vogt, 2012; Thomson *et al.*, 2010). However there may be resistance to access and undertake surveys on private land.

ADDITIONAL COST INFORMATION

No additional information is available.

LEVEL OF CONFIDENCE*

Established but incomplete.

There is a description of the method and a few examples given in Vogt (2012). There is also a description of the method in Thomson *et al.*, (2010), but no specific details for the EU are available, therefore the method can be considered established but incomplete.

Sniffer dogs.

MEASURE DESCRIPTION

Dogs have been employed as the principal detection technique in population studies involving tortoises (Cablk and Heaton, 2006) and *T. scripta* nests (O'Keeffe, 2009; LIFE *Trachemys*, 2012b). As with basking surveys, this is not a measure that is suited to be used for early detection at a large scale (such as a national scale), but could be applied for detection within high risk sites of conservation concern, or as part of an eradication or management programme and is therefore discussed here. As part of an eradication campaign in south-east Queensland, Australia, detection dogs were used to identify nests, and eggs, and were used to verify terrestrial sightings when exact locations were unknown. In this way the method allowed the programme to reduce or eliminate breeding recruitment (O'Keeffe, 2009).

SCALE OF APPLICATION

The scale of application is suggested to be at the level of a waterbody, noting that the species can disperse up to 2km from the waterbody to lay eggs (Gibbons *et al.*, 1983 in O'Keeffe, 2009). According to the LIFE *Trachemys* project in Spain and Portugal (LIFE *Trachemys*, 2012b) the dogs can be used to search larger areas if it is done early in the morning and if it is not too hot (in terms of the dogs' welfare).

EFFECTIVENESS OF MEASURE

Neutral.

As a measure for early detection at a national level, the measure will not be effective due to the scale of potential application, but at a site scale level the measure can be used to detect the species and confirm possible sightings, especially in areas where the species is difficult to detect visually.

LIFE *Trachemys* (2012b) mentioned that the measure works for new laid nests or for hatchlings, but that older nests are missed by sniffer dogs which reduces the effectiveness of the measure.

EFFORT REQUIRED

There is no detailed information given on this in literature. In Europe *T. scripta* can successfully reproduce in several Mediterranean countries and lays its eggs between April to June in Spain (Perez-Santigosa *et al.*, 2008) and May to August in France (Cadi *et al.*, 2004). Therefore the use of this method is restricted to the period of eggs and nests being present.

RESOURCES REQUIRED

There is a need for a trained dog and a dog handler. Training such dogs requires investment in time and money, at least for training and maintenance (including feeding, housing, transport).

LIFE *Trachemys* (2012b) gives a description of the different steps that are taken to train such a dog (familiarization, searching for dummy nests and eggs, searching for real nests), which shows that the resources required can be high depending on the number of dogs trained.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed

There are no side effects mentioned in literature.

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.

Since the dog is specifically trained to find the alien *T. scripta* and does not harm or disturbs native species the measure can be considered acceptable. This is not specifically stated in literature but deducted by the author based on LIFE *Trachemys* (2012b).

ADDITIONAL COST INFORMATION

There is no information available on the costs in literature.

LEVEL OF CONFIDENCE*

Established but incomplete.

Specifically for the red-eared slider there is the study of O'Keeffe (2009) mentioning the use of a sniffer dog and the test described in Spain/Portugal (LIFE *Trachemys*, 2012b). There are other studies mentioning the use of sniffer dogs to search for nests of terrestrial or marine tortoises (for example see Witherington *et al.*, 2017).

* See Appendix

Environmental DNA (eDNA).

MEASURE DESCRIPTION

The currently established methods to detect *T. scripta* is based on visual observation, via (baited) trapping or the use of sniffer dogs (see other *Surveillance* sections). However, these often only yield results if the species is already well established missing the opportunity for early detection to support rapid eradication measures. Moreover, identification mistakes can be made when visual observations are performed. Environmental DNA (eDNA) can successfully be used to detect the occurrence of rare or alien species in aquatic environments, and also to support the confirmation of eradication (Rees *et al.*, 2014; Valentini *et al.*, 2016; Harper *et al.*, 2018; Hering *et al.*, 2018). Environmental DNA, is DNA that is shed by the organism (cellular or extracellular) and released into the environment, in this case water. Via a water sample the species can be detected based on the extraction of DNA coupled to DNA amplification and DNA matching with sequence information present in databases (such as Genbank[3]). The eDNA method has gained a lot of interest during the last years and has been proven to be a reliable and cost-effective method, especially to detect alien invasive species (Herder *et al.*, 2014). However, eDNA will not distinguish between alive and dead animals, and will also not locate the individuals of the species, and therefore follow up 'traditional' surveys may be needed to confirm the presence and exact location. There is currently a COST action specifically addressing the use of eDNA in biomonitoring (see DNAqua project[4]).

Recently, Davy *et al.*, (2015) developed primers to detect 8 native and 1 alien (*T. scripta*) freshwater turtle species to Canada based on eDNA. However, once the species-specific primers developed by Davy *et al.*, (2015) are tested in Europe and yield positive results, a collection of water samples and testing of the occurrence of *T. scripta* will be possible at a large scale across different water body types. Caution should be paid to the environmental conditions, since temperature, solar radiation, presence of organic material, and other environmental factors can influence the detection of the species using this method (Davy *et al.*, 2015). In addition, species-specific primers can sometimes vary across different continents and probably need optimisation. Therefore, at this stage future specific testing for *T. scripta* in Europe and a standard protocol are necessary to apply this tool on a large scale (personal experience of the author). Once this protocol is available the method can be applied at several locations at once.

SCALE OF APPLICATION

In their research Davy *et al.*, (2015) tested the method for *T. scripta* on a small natural pond (3.5 m diameter, 1 m deep) in Canada. However, eDNA monitoring programmes can be established at large scales, for example across whole watersheds as is currently being undertaken for alien Asian carp monitoring in the Upper Illinois River and Chicago area waterway system (AsianCarp US, 2018), or across multiple watersheds at a national scale as was done in the UK as part of a non-targeted macro-invertebrate sampling programme based on metabarcoding (Blackman *et al.*, 2017). While this measure could be applied in all EU Member States at risk of invasion from *T. scripta* it will be impossible to monitor all waterbodies for the species, therefore areas at high risk of introduction or sites sensitive to the impacts from *T. scripta* may need to be prioritised for monitoring.

EFFECTIVENESS OF MEASURE

Effective.

The approach can be considered effective as it has a higher efficiency compared to traditional visual observation or trapping (see Davy *et al.*, 2015). However, additional testing of the specific primers for use in Europe are still required, and some optimization is still needed with regard to the tools implementation in general biomonitoring programmes (see Herring *et al.*, 2018). In addition, as discussed above it will be impossible to apply to all waterbodies, and therefore the measure should be combined with other surveillance tools (such as citizen-science, traps, etc.) to be more effective.

The measure will also be an effective tool to support the confirmation of eradication success (see García-Díaz *et al.*, 2017).

EFFORT REQUIRED

As an early detection measure it will need to be applied while there is a risk of introduction.

RESOURCES REQUIRED

Davy *et al.*, (2015) assumed a sampling effort of 10 water samples for eDNA testing per site, resulting in an estimated cost of 500 Canadian dollar (ca. 330 Euro) to detect a single species at a single site using eDNA. A review by Herder *et al.*, (2014) on the possible applications of eDNA for the detection of IAS in Europe found that costs are associated with the sampling which vary depending upon multiple factors, and the analysis of the samples which has an average

3 GenBank https://www.ncbi.nlm.nih.gov/genbank/
4 DNAqua http://dnaqua.net/

cost of €150 per sample (for single species). However costs increase when additional factors are included that influence the reliability of the results (such as number of replicates, inclusion of positive and negative controls), and that investment is required in validation of the primers and measures to prevent contamination.

Specifics on the eDNA method as well as it potential can be found in Deiner *et al.*, (2017).

SIDE EFFECTS

Environmental: Positive
Social: Neutral or mixed
Economic: Positive

The environmental effects are expected to be positive as the application of this technique also allows the monitoring of native freshwater turtles at the same time and with the same method, therefore not only providing environmental, but also economic benefits (cost-effectiveness for conservation budgets).

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.

The method has an advantage compared to traditional methods with regard to animal welfare as it is considered non-invasive as it does not physically target the species itself (for example, as traps do). Therefore, the perception of the method, especially with the public, is positive (Geerts *et al.*, 2018). This method allows monitoring of the species at a larger scale compared to traditional survey methods, but the initial costs and expertise needed can be a hurdle to implement this directly at the large scale.

ADDITIONAL COST INFORMATION

According the review by Herder *et al.*, (2015) it is not possible to say that in general eDNA is more cost-efficient than traditional methods, as this depends on the target species. There are no detailed studies available of the costs of monitoring *T. scripta* based on eDNA in Europe. However, Davy *et al.*, (2015) found that the cost of detection through traditional surveys was 2 to 10 times higher than eDNA detection for freshwater turtles (incl. *T scripta*), and concluded that eDNA surveys could provide a cost-effective alternative to the variable outcomes of traditional detection methods for freshwater turtles.

In addition, Herder *et al.*, (2014) found that increasing the species being detected increases the costs of analysis of samples by €40 per extra species, though recommends that if more than three species are being detected next generation sequencing is needed and costs rise to around €350 per group of species (such as amphibians, or fish), with €100 to €200 for each additional group.

LEVEL OF CONFIDENCE*

Established but incomplete.

The method is established and has been tested in the field as well as in the lab (Davy *et al.*, 2015), but the application in the field (specifically for *T. scripta*), especially at the large scale, is not documented in literature. Therefore, some caution is needed with regard to field application. At the moment there is a need for standardisation of the eDNA method, and there is a specific workgroup as part of the EU COST Action DNAqua-Net project trying to streamline the use of this method. Nevertheless, the method has been used in several studies and has proven its reliability (see Geerts *et al.*, 2018; Deiner *et al.*, 2017; Herder *et al.*, 2014.)

* See Appendix

Citizen-science.

MEASURE DESCRIPTION

A surveillance measure to support early detection is an online platform where sightings of the species can be posted based on citizen-science. Citizen-science species occurrence datasets are increasingly recognized as a valid tool for monitoring the occurrence and spread of invasive alien species across large spatial and temporal scales (Roy *et al.*, 2015). A good example of this kind of platform is observation.org (and its country derivatives). This platform allows people to post visual observations of species including invasive alien species such as *T. scripta*. The objective of the measure is to have good observations, since based on these sightings the species can be detected at an early stage and thus targeted for control or eradication. Besides online platforms, many smartphone apps have been developed to record sightings of species. A COST action has been recently launched on "Increasing understanding of alien species through citizen-science" (COST Action Alien-CSI[5]). This COST action specifically aims to establish a European-wide citizen-science alien species network with the goal of fostering collaboration to increase data gathering capacity and exchange of information on alien species (Roy *et al.*, 2018).

However, these data-platforms are mainly dependent on citizen-scientists who collect and upload data, typically from 'opportunistic sampling' with no underlying scientific survey design (Boakes, 2010) which can limit the conclusions that can be drawn from these data (Isaac *et al.*, 2014) and may lead to a delay in detecting a new presence of the species. Most parts of north-west Europe have an extensive network of volunteer observers although this is less the case for southern and especially eastern Europe (Boakes *et al.*, 2010). Unstructured citizen-science data do not reliably allow to estimate species abundance or population trends (Kamp *et al.*, 2016), yet in an early-warning scenario it is likely sufficient to know where a species is establishing, and these data limitations are thus of a lesser concern.

SCALE OF APPLICATION

The measure can be applied at the European scale, but also at country scale. Observation International provides the site[6] with many regional aliases and apps for mobile devices: ObsMapp (Android), iObs (iOS) and WinObs (Windows). For example on Observation.org for Belgium, 150 observations are present for *T. scripta*. These data have been used to locate the occurrence of the species in the province of East-Flanders (Belgium) and to start management programs (author's experience).

EFFECTIVENESS OF MEASURE

Neutral.

In general, online citizen-science platforms can be used to set-up an early warning system to detect alien species (Gallo and Waitt, 2011). However, the species may be confused with a number of other freshwater turtles alien to Europe, particularly belonging to the closely related genera *Chrysemys* and *Pseudemys* (although there are morphological features which may provide good diagnostic hints). Therefore, the stakeholders engaged will need to be informed (for example, see GB Non-native Species Secretariat guide[7]) or trained on the observation and identification of the species. This may lead to problems of misidentification and misreporting. For example, in a recent study on the distribution and biogeography of amphibians and reptiles of Europe (Silliero *et al.*, 2014), the authors warn that the records of *T. scripta* might also include records of introduced specimens of other *Trachemys* species or even related genera (such as the alien *Chrysemys picta*). Also according to Kraus (2009) there are records of *T. scripta* in Germany which have been misreported as *Chrysemys picta*. It is important to have observations submitted to a quality control/validation process (for example based on pictures checked by experts) (Gallo and Waitt, 2011). Moreover, in some Member States (for example Belgium) only the invasive alien species occur (Belgium has no native turtle species) and consequently it is easier to identify *T. scripta*.

EFFORT REQUIRED

Different aspects need to be considered when implementing this measure: 1) educate/train people in order to reduce misidentifications, 2) provide an online platform where actual observations can be posted (which may already exist for other alien species), 3) have as many platforms connected in order to avoid scattered information (data management), 4) have a quality check by local experts on the data posted and 5) make it easy accessible and easy to retrieve data.

RESOURCES REQUIRED

The main cost is the cost needed to provide an online platform and to maintain the data (data management), however such systems may already exist for other alien species citizen-science programs within Member States.

5 Alien CSI https://alien-csi.eu/
6 Observation International https://observation.org/
7 GB NNSS http://www.nonnativespecies.org/downloadDocument.cfm?id=78

There is also a cost related to the educational aspect in order to inform or train observers.

SIDE EFFECTS

Environmental: Positive
Social: Neutral or mixed
Economic: Positive

The involvement of citizens into the observations of alien species can have a positive environmental effect as they increase awareness about the problems related to alien species and their impacts and may even contribute to the management of the species in general. However, Teillac-Deschamps *et al.*, (2009) found that the concern about general environmental questions is often limited even if there is a public awareness campaign organized. In addition, setting up such an online platform can also be useful to get data and thus information on other (alien) species (Roy *et al.*, 2018).

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.

The measure will be generally accepted by most stakeholders and is already being used for several species worldwide.

ADDITIONAL COST INFORMATION

A general COST action has been launched but does not provide specific details on the costs for this specific species.

LEVEL OF CONFIDENCE*

Established but incomplete.

The method is described in general in literature, but not specifically for alien sliders. It is not clear (there are no exact numbers) to what extent citizen-science and these online platforms help in terms of early detection. It is shown (see Gallo and Waitt, 2011) that this measure can help, but it is not quantified.

* See Appendix

Trachemys scripta *is a cosmopolitan invasive species. © Aleksander Niweliński.*

Use of passive trapping methods.

MEASURE DESCRIPTION

An additional surveillance method is the use of basking turtle traps or nets (for more details see also physical removal under *Rapid eradication for new introductions* below). Basking turtle traps (Scalera, 2006; Valdéon *et al.*, 2010; LIFE *Trachemys* 2012a,b) have been mainly used to capture *T. scripta* and have been found to be more effective compared to nets (García-Díaz *et al.*, 2017), though the effort needed to set up and control basking traps or nets is quite high (LIFE *Trachemys*, 2012 a,b).

The objective of this measure is to set up a monitoring system at sites at high risk to introductions within Member States that are known to be vulnerable. These sites could include (semi-)urban water bodies, natural water bodies close to urban, or water bodies connected to sites with known populations in other countries. The identification of high risk sites can be supported by distribution models to predict the potential range expansion, or identify areas where the species might reproduce in the wild (in the future). Ficetola *et al.*, (2009) found that bioclimatic differences can determine the areas where aliens become invaders. Early detection could be focused to these source areas. However, climate change can increase fitness in the future, and therefore the interactions between climate change and fitness can boost the invasiveness of this alien species (Ficetola *et al.*, 2009).

In practice the use of the traps is often started when observations have been made to find out how big a population is (see LIFE *Trachemys* project in Spain and Italy). Therefore, in terms of early detection, this measure may be more suited to surveying priority sites (for example, of conservation value) in response to secondary spread of the species once it has established. The measure can also be used to confirm possible sightings of the species, for example, through citizen-science.

The establishment of a monitoring system based on traps would be less feasible compared to existing monitoring systems such as the one used for crayfish (such as a citizen-science project in the Netherlands monitoring crayfish, see Koese and Evers (2011)) as traps used for crayfish are small, cheap and can be easily transported. The crayfish monitoring project in the Netherlands is an example of how the two methods, active trapping and citizen-science, can be combined.

SCALE OF APPLICATION

Applying these turtle traps for observational purposes is a relatively large investment (see for detail on costs for applying basking turtle traps under *Rapid eradication* below; Bugter *et al.*, 2011). Although basking turtle traps and nets can provide reliable evidence of the species being present, it is not feasible to apply this at the large scale (personal experience of the author). If the method is applied it will be likely at the scale of a catchment, nature reserve or a single water body, like a lake or pond. Several projects in Spain, Italy, France and Portugal mention the use of a range of trapping methods (see for example LIFE *Trachemys*, 2012b).

EFFECTIVENESS OF MEASURE

Neutral.

For an objective of early detection within a Member State, the measure is not really feasible to be applied across a large geographic scale, however it could be applied to high risk sites, especially if they are connected to areas that have populations of the species in other Member States.

A possible method to increase the effectiveness of the measure is to install camera traps on the basking turtle traps. This provides extra evidence of the species being present or not, even if the species is not caught (this has been tested in Belgium, personal experience of the author). Camera traps have also been tested in the LIFE *Trachemys* project with varying success (see LIFE *Trachemys* 2012b, c). Basking traps are frequently used to provide a platform for *T. scripta* to bask and facilitate direct observations. Vogt (2012) states that basking turtle traps are not adequate for routine sampling, because the turtles must become accustomed to the newly offered basking areas.

EFFORT REQUIRED

The effort can be considered quite large as the cost for placing and controlling such a basking turtle trap (Bugter *et al.*, 2011; LIFE Emys project and many more projects) is high. The best time to trap is during spring and summer when individuals are more likely to be found basking. Traps have to be checked at least once a day (potentially more often) depending on several factors, including presence of (other) predators, heat etc. which may kill the bycatch.

Below is the cost given for constructing, placing and checking as well as removing basking turtle traps (Bugter *et al.*, 2011). The costs are given in the framework of a project aiming at the removal of the species, but certain steps of the action are similar with using basking turtle traps for observation.

- Estimated price per trap = € 150 (Sundeck traps are available for purchase from €152)
- Labour per hour including placing, checking as well as removing the traps = € 70 (depended on the country)

See for details on cost *Rapid eradications for new introductions* where the measure is explained in detail. There is no detailed cost of the implementation of this measure, as the overall project cost only is mentioned.

RESOURCES REQUIRED

The large trapping efforts reported by García-Díaz *et al.*, (2017) imply a large investment is required. Bugter *et al.*, (2011), the LIFE Emys project and other researchers (see Valdeón *et al.*, 2010) made an evaluation of the cost (see *Rapid eradication for new introductions*) when using such traps for the capture and physical removal of the species.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed

The use of basking turtle traps has no side-effect on other species as the turtle traps are selective but will capture native turtles. For fyke nets this is somewhat different as these often have by-catch (fish, crayfish, frogs, salamanders, sliders, birds, mammals etc. which may predate each other into the net or drawn). Floating devices to ensure that a part of the net is above water level and allow for species with lungs to breath the air are needed, so to prevent by catch mortality.

There are no socio-economic side effects reported in literature.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

The cost is high (for details see rapid eradication for new introductions) and the perception of the species being present in the wild is not always negative (Kuzmanova *et al.*, 2018). The use of traps and especially nets may lead to negative perceptions from fishermen, and general public.

ADDITIONAL COST INFORMATION

No additional costs are reported in literature.

LEVEL OF CONFIDENCE*

Well established.

The information on the use of turtle traps has been well studied (see Scalera, 2006; Valdéon *et al.*, 2010; LIFE *Trachemys*, 2012b and many other projects). In addition, a cost calculation (Bugter *et al.*, 2011) and model on removal has been made by García-Díaz *et al.*, (2017). The methods to catch the species are well described. However, in the context of surveillance to support early detection the method is not reported as such in literature.

* See Appendix

Measures to achieve rapid eradication after an early detection of a new occurrence.

Physical removal via draining of the pond.

MEASURE DESCRIPTION

The objective is to drain the waterbody where *T. scripta* is present, making individuals easier to be manually removed. The measure can be combined with seine nets to remove individuals before the water body is drained.

This measure can only practically be done in relatively small isolated habitats of rather low ecological status (O'Keeffe, 2006; O'Keeffe, 2009; Bugter *et al.*, 2011). This is due to the fact that interconnected habitats cannot be drained easily and the draining of natural habitats with a high ecological status may negatively impact many local species. Following drainage *T. scripta* will burrow into the silt (up to 2 m deep) and therefore the silt needs to be removed, such as by mechanical excavation, spread out in a secure area and the sliders need to be removed by hand (O'Keeffe, 2009). When a water body is drained rapidly, up to 75% of the sliders will try to emigrate (O'Keeffe, 2009). Therefore, before draining water bodies, sites need to be secured with barrier fences and pitfall traps to prevent emigration (O'Keeffe, 2009; Vogt, 2012). In addition O'Keeffe (2009) recovered and relocated native fauna, and filled in and then compacted the drained waterbody. The measure has been applied in Australia, but is not reported for Europe.

SCALE OF APPLICATION

This method is reported in literature to be applied at the local scale (one specific pond or waterbody) because it is labour intensive and because of the practicalities with regard to organising such physical removal actions. The measure has been described by O'Keeffe (2009) and is applied on the local scale, such as small irrigation dams. No exact details are given on the size of the pond the measure was applied.

EFFECTIVENESS OF MEASURE

Neutral.

O'Keeffe (2009) state that water body drainage is their preferred method (to eradicate the species from Queensland). However, this comes with a number of caveats, in that it can only be effectively undertaken on isolated water bodies with low conservation value, note that the measure undertaken by O'Keeffe (2009) resulted in the filling in of the drained water body.

EFFORT REQUIRED

O'Keeffe (2009) reported that the approach could be completed in 1–5 days, depending on the size and complexity of the waterbody. Much depends on the local environmental conditions, the size of the waterbody, the density of *T. scripta* occurring, the accessibility to the site, etc. Before draining water bodies, it is important to first secure sites with barrier fences and pitfall traps (O'Keeffe, 2009). Pitfall traps are in fact large buckets that are placed in the soil similar to traps used for amphibians. When sliders migrate they will fall into the pits and cannot climb out of it. It is also important to provide good communication on why the species are caught, how they are caught and what is done with the animals once they are actually caught (this applies in fact to all eradication or control measures). The LIFE Emys project and several other projects provide a good qualitative estimate of the effort required to run such eradication campaigns, but do not focus on the draining of ponds.

A range of local and environmental permissions would be required before such method could be used.

RESOURCES REQUIRED

The cost would vary depending mainly on the size of the waterbody, and whether (native) fish need to be removed to rescue them beforehand (capture the fish and translocate them). However, (personal communication with Peter Paul van Dijk mentioned in the report on *Chrysemys picta*, see Scalera *et al.*, 2017) other techniques, such as those which foresee a combination of baited fyke traps and basking traps, may be more cost-efficient than draining a pond.

SIDE EFFECTS

Environmental: Negative
Social: Neutral or mixed
Economic: Negative

Draining of a pond can have major negative effect on the local species (plants, macroinvertebrates, fish etc.) and should be assessed on beforehand if it outweighs the positive effects of removing *T. scripta*.

If it is a commercially important site, such as a fish farm, the effect of draining can have a negative economic side effect.

No social side effects are reported in literature.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

Experience in the northern and western European countries (Belgium, Flanders) has shown that the opinion of the public towards removal of the species is mixed (personal experience of the author but see also Kuzmanova *et al.*, 2018). The general perception of the species presence is often neutral or even positive and therefore public support for any type of eradication or management is low (Ficetola *et al.*, 2012; personal experience of the author).

Teillac-Deschamps *et al.*, (2008) state that upon asking the general public about their feelings on turtles, many people who spent time hiking commented that they liked seeing turtles during their walks. For some urban people, this exotic species is one of the few representations of nature to which they are exposed in urban parks.

Many nature organisations are still in favour of removing alien species from nature reserves and are generally more positive towards the actions done to eradicate the species (Ficetola *et al.*, 2012).

ADDITIONAL COST INFORMATION

No specific information on details of costs is available in literature.

LEVEL OF CONFIDENCE*

Unresolved.

The measure has not been applied regularly or at a large scale according to literature. Therefore it is difficult to assess the level of confidence.

Pond sliders are often bully native species out of basking sites.
© *Aleksander Niweliński.*

* See Appendix

Physical removal using traps and nets.

MEASURE DESCRIPTION

There are several methods used to capture *T. scripta* which are mentioned in several LIFE projects. For an overview of all methods that have been tested and used to capture *T. scripta*, refer to Sancho Alcayde *et al.*, (2015). One popular (passive) method is the use of basking turtle traps (see also *Surveillance* section above). These are floating traps (with or without bait) that are often used for the sliders to bask (sunbathe) and that have been proven to be effective in capturing the species (Scalera, 2006; Valdéon *et al.*, 2010; Vogt, 2012, LIFE *Trachemys*, 2012b; Foglini and Salvi, 2017). Essentially, this trap is comprised of a floating 'cage' with a slippery inside frame from which turtles cannot climb out.

The sundeck turtle trap is a floating wire cage submerged and anchored (Vogt, 1980). The target turtle is attracted by a bait in the centre of the cage which can be reached by climbing a mesh vinyl coated wired ramp. The modified "Bolue" trap is a floating trap consisting of a round platform, made of wood or cork. The turtles can be caught in a net as they attempt to climb over the platform. The "Bolue" trap was developed for capturing individuals for research (Valdeón *et al.*, 2010), but has also been used to control *Trachemys scripta*, for example in Spain since 2010 (Valdeón *et al.*, 2010). Another type of trap is the Aranzadi Turtle Trap (ATT), which is a modification of the "Sun Deck Turtle Trap" (Heinsohns Country Store, 2009). In this case the metal grille ramp is replaced with cork plates on both sides of the trap. Cork plates have proven to be effective to census pond slider populations as turtles are attracted to this kind of substrate to bask (Valdéon *et al.*, 2010).

With regard to the use of bait, research by Mali *et al.*, (2014) has indicated that bait (fresh chicken entrails for red-eared sliders) can be used but that frequent replacement is necessary. In addition, they found that the success of capturing the species increased when they used dry dog food and dry cat food compared to traditional canned sardine bait. Trials in Flanders have indicated that there was no increased catching success when using canned cat food (personal observation of the author). However, Drost *et al.*, (2011) found that ground or shredded cat food did not hold together and was more difficult to handle than whole sardines, and that (limited trials) canned sardines worked better than alternative baits.

Vogt (1979) found that painted turtles *Chrysemys picta* were enticed to enter traps baited with conspecifics in the early spring when these turtles were copulating but not yet feeding. This could be used for *T. scripta* as well, although it has not yet been tested according to literature.

In addition to the above mentioned traps, turtles can be trapped with a variety of nets and funnel-traps: minnow, seine, fyke, Cathedral, and crayfish traps (Fowler and Avery, 1994; Bennett, 1999; Gamble, 2006; Sterrett *et al.*, 2010; Brown *et al.*, 2011; Vogt, 2012; Polo-Cavia *et al.*, 2012; Lascève, 2014; LIFE *Trachemys,* 2012b, d). The latter three devices are all funnel-type traps and as such should be set partially-submerged to avoid the captured animals drowning. In Australia, Cathedral traps are used in preference to basking traps which are difficult to transport and unsuitable for use in public or high visibility locations. Bait used in funnel traps can be placed either suspended near the funnel entrance or placed in bait containers deeper inside the trap (Vogt, 2012). The disadvantage of these nets is that other species especially fish are caught as by catch and that they require very frequent checks (at least every 24 hours) which is very labour intensive (personal experience of the author, but see also Bugter *et al.*, (2011) and Vogt (2012). However, any species of fish, crayfish, frogs, salamanders, sliders, birds, mammals etc., which may predate each other into the net or drawn, may be captured.

It is recommended to place the basking turtle traps early in the season (or during summer) for more northern European countries with distinct seasons (personal observation of the author). During winter, the species hibernate and are not active, but in spring they are very fond of basking. The spring and early summer are the periods when the highest catching success is obtained (personal observation of the author). Vogt (2012) states that they are not adequate for routine sampling, because the turtles must become accustomed to the newly offered basking areas. In addition, it is important when placing these basking turtle traps that no other possible basking areas are in the neighborhood of the trap (for example fallen trees or branches) as these reduce the chance of catching the species via the trap. If possible and acceptable small basking areas can be made inaccessible or fallen trees can be removed (temporarily).

SCALE OF APPLICATION

This method is often applied at the local scale (one specific pond or waterbody or one specific nature reserve) as it is labour intensive and due to the practicalities with regard to organising such physical removal actions and regular checks. For example, Drost *et al.*, (2011) undertook a trapping campaign of *T. scripta* at Montezuma Well, a 112m diameter and 17m deep spring in Arizona, USA.

Examples of the application can be found in France (Maurer, 2015; Lescéve, 2015; Carbone, 2011) in Spain (Valdéon *et al.*, 2010; LIFE *Trachemys* project) and in Corsica (Peinado *et al.*, 2011). The scale of application ranges in size (from 17ha to 2,960 ha).

EFFECTIVENESS OF MEASURE

Neutral.

As a measure by itself, it is unlikely to eradicate a population. A vast amount of literature is available on the use of traps to capture the species, with many studies mentioning the mixed success of using the traps to reduce numbers of *T. scripta*.

The results of a project in Corsica (Peinado *et al.*, 2011) in an area of 168 ha indicated that fyke nets provided the best results irrespective of the type of environment and that the use of oil of Sardines (as bait) had a positive effect on the capture success. A high success rate of up to 80% of the individuals that were spotted, were caught. However they also mention that the success rate and effort required depends on the number of fykes used, the environmental conditions, etc.

Drost *et al.*, (2011) used trapping over two years (2007 and 2008) to remove *T. scripta* from a spring 112m diameter in Arizona, USA, however they only managed to remove most of the population over a two-year period. They estimated that 3 individuals were remaining after the removal effort (from ca. 20 before hand), and recommended a continued trapping campaign (using basking traps) to be implemented to remove the remainder of the individuals. It is unknown if this was undertaken and therefore if eradication was successful, the species is still listed as 'present' on the US National Parks Service species lists for Montezuma Castle National Park but this is a much larger park than just Montezuma Well. They found that hoop nets (out of hoop nest, basking traps, hand, and dip net), were the most effecting at capturing *T. scripta* (71% of captures were through this method), followed by basking traps (21% of captures), during a removal campaign in Montezuma Well ecosystem, USA. However they also found that an advantage of the basking traps is that they are much less time intensive than the hoop nets.

According to the LIFE Emys (Gili, 2016) project prior to the start of the "eradication phase", a complete feasibility study should include:

- Estimation of abundance of alien animals
- Thorough physiography and sites accessibility analysis
- Identification of threats in order to reach or to target a complete removal (eradication).

Where the above conditions are not met Gili (2016) suggests to:

- avoid captures from locations where eradication is not possible
- prevent further releases with strong education plans and communication strategies.

EFFORT REQUIRED

The effort required depends on the size of the area that is targeted, the density of occurrence of the species, the accessibility and therefore it is difficult to give an overall estimate of the effort that is required.

In terms of effort needed for individual trap types, Drost *et al.*, (2011) state that hoop nets require two separate trips and several hours to set them one day, and then check them the next. In contrast to basking traps, which are set out at the beginning of the season and operate continuously until they are retrieved in autumn, and only require a quick check to see of any turtles are captured. They also found that setting out hoop nets over 48 hours (rather than 24) did not increase capture total of *T. scripta* individuals.

In terms of effort for eradication campaigns, below is an overview of different studies that mention the effort required.

Vogt (2012) describes the use of a baited hoop trap and generally states that for this type of trap bait should be changed daily and traps checked at 4 to 8 hour intervals.

The use of fyke nets has been tested in France in 3 different projects (Lascève, 2014; Maurer, 2015; Peinado *et al.*, 2011).

- Lascève (2014) gives an estimate of the time and effort required based on their project performed in France. For the action performed in 2015 a total of 146 days effort was needed (2 people employed 73 days each). This resulted in a capture of 159 *Trachemys* individuals from a waterbody that was 350 ha. The action started in 2003 and still continued in 2018, indicating that long-term eradication or population control is needed.
- Carbone (2011) also performed an action in France in the Mauguio basin (2,960 ha), where 133 alien turtles were caught over a period of 4 years (2010–2013), but it is unknown if this achieved eradication.
- A study performed by Lambert *et al.*, (2018) in the USA reported the capture of 180 individuals over 900 trapping nights using nets and supplemented with hand trapping without further details.
- Within the LIFE *Trachemys* project (LIFE *Trachemys*, 2012b) several methods to capture the turtles were tested including basking turtle traps. In total over two years 214 individuals were caught in Portugal (across 4 separate areas), whereas 13,870 individuals were caught in Valencia (25 areas). 18% of the individuals were caught using basking turtle traps.
- Drost *et al.*, (2011) undertook a two-year removal campaign (that removed most *T. scripta*) of *T. scripta* from Montezuma Well, a single spring 112m in diameter in Arizona USA. They had over 500 trap-days of effort using hoop nets and nearly 600 trap-days of effort with basking traps. Trapping effort with hoop nets averaged about 40 trap-days per month, ranging from 8 trap-days in March 2008 (a short, partial month) to 74 trap-days in July 2008.

RESOURCES REQUIRED

Cost estimate of a turtle removal attempt for one particular Dutch wetland location (size not given) (Bugter *et al.*, 2011):

- Estimated price per trap = € 150 (Sundeck traps are available for purchase from €152)
- Number of traps/action 5 = € 750 (Traps total)
- Labour per hour = € 70
- Trap placement 4 hours = € 280
- Trap checking 28 hours = € 1,960 (Two hours every day for two weeks)
- Organization 8 hours = € 560
- Transport 8 hours = € 560
- Trap removal 4 hours = € 280
- Trap cleaning and storage 4 hours = € 280
- Total labour: 56 hours = € 3,920
- Total = € 4,670

In addition to the above, the cost for euthanizing the species (on average 90 euro per species in Belgium, for one individual, probably cheaper if more than one is euthanized), if it cannot be brought to a refuge centre for wild animals, is needed.

Another project targeting the removal of alien *T. scripta* in France (Étang de Mauguio) estimated the average cost of removal per individual at 184 euros (including one technician, trapping devices and transportation cost). They caught 133 individuals over a period of 3 years using mainly fyke nets and not basking turtle traps (Carbonne, 2011).

The project LIFE EMYS estimated the eradication cost at 55/euro per individual (Gili, 2016).

Luiselli *et al.*, (1997) mentioned that before such eradication campaign is considered a feasibility study should be performed. This obviously also comes with a cost, but can probably reduce the expenses on the long run.

SIDE EFFECTS

Environmental: Negative
Social: Neutral or mixed
Economic: Negative

The environmental side effects can be negative as the traps and nets will also capture non-target native species (bycatch, such as any species of fish, crayfish, frogs, salamanders, sliders, birds, mammals etc. when using fykes for example). Negative side effects on the economic activities can exist if this is applied in a commercially important fish pond for example or if the nets/basking cages are destroyed/stolen. Social side effects are not reported in literature.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

See the *Physical removal via draining of the pond* section (*Rapid Eradication*) above.

ADDITIONAL COST INFORMATION

The idea has been given in a risk assessment survey in the Netherlands to include the removal of the species in the ongoing muskrat eradication programme (see Bugter *et al.*, 2011) or other ongoing eradication programmes. This could reduce the costs considerably and allow to increase the scale of application.

LEVEL OF CONFIDENCE*

Well established.

There is a lot of literature available on the use of traps to catch *T. scripta* (see for example Valdéon *et al.*, 2010, O'Keeffe, 2009; Scalera, 2006, Vogt, 2012; LIFE Emys project and many other projects). There is a lot of information available on which trapping method yields the best results, how they should be placed and when and what is the effectiveness.

* See Appendix

Shooting.

MEASURE DESCRIPTION

Shooting has been used as a means of reducing *Trachemys* populations in ponds and lakes. This technique, however, has not been very effective in the USA (see http://icwdm.org/handbook/reptiles/Turtles.asp). According to a risk assessment study done in the Netherlands (Bugter *et al.*, 2011) although turtles are quite shy and will easily flee, they do have to warm up in the sun making them quite visible and therefore, a potential target for shooting. However, shooting one will cause the others to flee and thus the efficiency in an area with many turtles is very low. Therefore, shooting could be an option if just one or only a few turtles have to be removed urgently (Bugter *et al.*, 2011).

The measure has been tested on *T. scripta* in France (with mixed success) within the two projects “Tests de méthodes de gestion d’une population de Trachémyde à tempes rouges sur le plan d’eau du site de Courpain (Loiret)” (Maurer, 2015) and “Opération de régulation d’une population de Trachémyde à tempes rouges sur le site des Vieux Salins d’Hyères (Var) (Lascève, 2014).

This method has also been tested within the LIFE *Trachemys* project (LIFE *Trachemys*, 2012b). Within this project ammunition was selected in order to be able to shoot *T. scripta* within a distance between 20 to 120m. The turtles can be mainly target when sunbathing although they can also be shot when being present at the water surface to breathe.

SCALE OF APPLICATION

This method can be applied at the local scale (one specific pond or waterbody) because it is labour intensive and because of the practicalities with regard to organising such physical removal actions. Maurer (2015) mentions that the measure was applied at the site “Courpain” (17 ha) during a test to eradicate *T. scripta* in this area.

EFFECTIVENESS OF MEASURE

Ineffective.

Shooting has shown to have a limited success mainly because turtles are easily disturbed and only one individual at the time can be caught (Bugter *et al.*, 2011). There has been some success with the measure in France (Maurer, 2015) but the total number of individuals shot was low, therefore it was considered ineffective as an eradication measure.

Within the LIFE *Trachemys* project (Sancho Alcayde *et al.*, 2015) the method was considered effective only for removing larger (adult) individuals at low density, provided that the shooter is well-experienced.

EFFORT REQUIRED

There are no detailed quantitative data available on the effort that is required. There is a description made in Maurer (2015) mentioning that two people tried to shoot alien terrapins occurring at the Courpain site (17ha) and that 2 *T. scripta* individuals were shot in 2 hours. However, visiting a site several times and ambushing the species will require significant time and effort.

RESOURCES REQUIRED

A risk assessment study made in Belgium (Verwaijen, 2016) gave a cost calculation for the weapon that is needed (300–4,000 euro) and the cost for ammunition (40–140 euro for 250 bullets) but no further details on the cost calculation were given in this study.

Sancho Alcayde *et al.*, (2015) mention that the equipment used in the project has had a cost of 2,549 euros (rifle, holster, mount, visor and ammunition - 200 projectiles). Bullets are relatively expensive, at around 70 euros for a box of 20 units.

SIDE EFFECTS

Environmental: Negative
Social: Negative
Economic: Neutral or mixed

The use of firearms can have negative environmental effects through the disturbance of local fauna (such as breeding water birds) and can also disturb or restrict human activities during operations (Sancho Alcayde *et al.*, 2015).

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

In addition to stakeholder perceptions to eradication measures in general (see *Physical removal via draining of the pond* section (*Rapid Eradication*) above), shooting can raise additional ethical questions and would require special permits along with a strictly regulated access to the site (Sancho Alcayde *et al.*, 2015).

ADDITIONAL COST INFORMATION

No detailed extra information on the cost for this specific measure is available in literature.

LEVEL OF CONFIDENCE*

Established but incomplete

As mentioned in literature the method exists but it is not widely used for this species.

* See Appendix

Physical removal via angling.

MEASURE DESCRIPTION

Turtles can be captured by hook and line (see Fowler and Avery, 1994; Davis, 1976, LIFE *Trachemys* project, 2012b; Sancho Alcayde *et al.*, 2015).

According to Davis (1976) turtles can be captured through a fish line equipped with cans. Any size small cans can be used, but soft drink cans work best. The author suggests to remove the entire top of the can and punch a small hole in the bottom. Thread the fishing line through the can with the open end down. Tie a treble hook on the line and bait it with pieces of fish or other meat. Drop the hook into the water and fasten the other end of the line to a pole, tree or stout root. Adjust the length of the string so that the hook will be just below the water surface for catching slider turtles. The can will slip down over the bait and protect it from fish. Turtles will stick their heads up into the can and get the bait and the hook.

The angling method has been tested in Spain within the LIFE *Trachemys* project (LIFE09 NAT/E/0000529) (Sancho Alcayde *et al.*, 2015). The authors first tried to lure the species with bait (meat) and then placed an angling hook in front of the turtles to try and catch them. This method required trial and corrective measures to address error, and it is mainly considered to be useful in urban environments. Specific details (such as the type of wire and the type of hook) on the angling gear used can be found in the document "Ensayos de efectividad de medios de captura. Año 2012" of the LIFE *Trachemys* project (LIFE *Trachemys*, 2012b; Sancho Alcayde *et al.*, 2015). In the study they used a Savagear rod Salt 8" and 10–30 g of action, with a small reel Tubertini Vertigo (size 2,500) with 100 m of line braided fused Stren Microfuse of "0.08" mm, to which a piece of heavy monofilament bass is knotted (60 cm "0.40" mm) yellow, for easy viewing.

SCALE OF APPLICATION

This can be done at the scale of a small local pond as described in literature (see LIFE *Trachemys* website, Sancho Alcayde *et al.*, 2015).

EFFECTIVENESS OF MEASURE

Ineffective.

There is a description in Davis (1976) mentioning that the method is effective at catching individuals, but it is time consuming. The LIFE *Trachemys* project mentions that the method could work mainly in an urban environment but that it requires several trials to capture the species. Therefore, they score the measure as medium effectiveness since it mainly targets individuals that are accustomed to people passing and mainly larger individuals (Sancho Alcayde *et al.*, 2015). Complete eradication using this method is unlikely and the method can mainly be used for population reduction.

EFFORT REQUIRED

The LIFE *Trachemys* project mentions that the skills needed are high, therefore it is expected that the effort needed is high as well and that the time needed can quickly increase depending on the skills of the angler, the access to the site. In 2013 a single person captured 851 exotic turtles in all kinds of environments in 103 hours of dedicated effort (Sancho Alcayde *et al.*, 2015), which is still acceptable in terms of invested cost per captured individual. However, no details are given on the skills of the person, the density of the turtles occurring, the accessibility of the site, etc.

RESOURCES REQUIRED

A breakdown of costs of the equipment required is provided by Sancho Alcayde *et al.*, (2015). The total budget needed for the equipment used is about 169 euros per season (with a useful life of 4 years for the fishing equipment (rod and reel), and a fixed annual cost in replacement of threads, ballasts and hooks).

- Cane: 100 euros (useful life for at least 4 campaigns if the handling is adequate).
- Reel: 40 euros (useful life 4 campaigns if the handling is appropriate).
- Braided line "0.08 - 0.10" mm (at least 300 m for one season): 50 euros.
- Triples (about 5 packages of 20–25 units per season): 50 euros.
- Low 0.40 mm (yellow monofilament line, 100 meters for 4 seasons): 3 euros.
- Ballasts 5 g (20 per season): 12 euros (lead), 50 euros (tungsten).
- TOTAL SEASON (calculation to 4 years): ca. 169 euros.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed

No information is given on the side effects in literature; however, it is possible that native turtle species could also be caught.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

In addition to stakeholder perceptions to eradication measures in general (see *Physical removal via draining of the pond* section (*Rapid Eradication*) above, this measure raises welfare concerns (such as ingested fish hooks) which would reduce its acceptability and may raise concern from the public (Davis, 1976).

ADDITIONAL COST INFORMATION

No additional information was found.

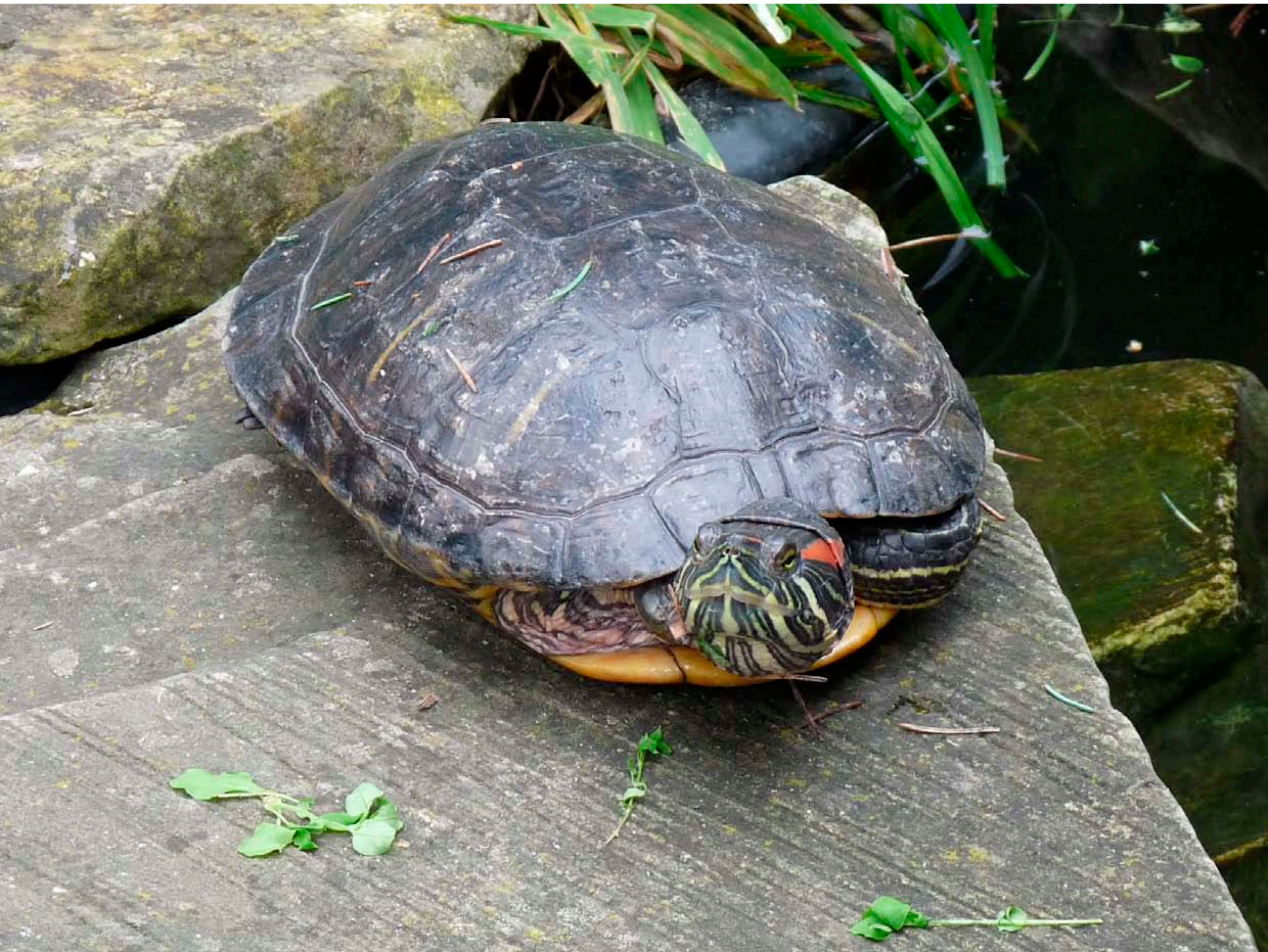
LEVEL OF CONFIDENCE*

Established but incomplete

Besides a short notice by Fowler and Avery (1994) and the description in Davis (1976) there is a short description available in the document "Ensayos de efectividad de medios de captura. Año 2012" of the LIFE *Trachemys* project and a description in Sancho Alcayde *et al.*, (2015).

* See Appendix

Trachemys scripta *are often unfortunately released by pet owners into the wild . © Aleksander Niweliński*



Physical removal via hand (dip-net or snorkeling).

MEASURE DESCRIPTION

Vogt (2012) describes that basking aquatic turtles can often be captured by hand or dipnet if approached underwater or from the rear. Investigators traveling by boat can rush basking turtles at full speed and often pluck them off a log or sweep them into a dipnet. Another way of catching them by hand is by diving or snorkelling. Muddling or noodling for turtles in shallow water involves feeling for them in the mud, the nooks and crannies below logs, snags, rocks, and under overhanging banks. Such haphazard methods of capturing turtles suffice for locality documentation but are generally inappropriate for eradication (or quantitative sampling). Investigators working in a closed system, such as a small pond, can perhaps capture all of the turtles present by muddling (Vogt, 2012).

The method using a hand-net has been briefly described in the LIFE *Trachemys* project (LIFE09 NAT/E/0000529) (Sancho Alcayde *et al.*, 2015) where they mention that a hand-net could be used to capture juveniles which cannot dive yet or even adults if you are able to surprise them.

SCALE OF APPLICATION

The capture by hand is described for some species of turtles by Vogt (2012) mainly in tropical regions and is shortly mentioned from the LIFE *Trachemys* project in Spain. There are no specific details available in literature on the scale of this method.

EFFECTIVENESS OF MEASURE

Neutral.

As described in Vogt (2012) the method can be effective at capturing individuals but depends on the species, the location, the training of the person trying to catch the species. The document "Guía metodológica para la captura y manejo de galápagos" briefly mentions the use of this method (LIFE *Trachemys*, 2012a), as do Sancho Alcayde *et al.*, (2015).

The skills needed are, according to the test within the LIFE *Trachemys* project performed in Spain, rather low, but the effectiveness is scored as 'neutral' (Sancho Alcayde *et al.*, 2015). It is likely to be more effective in situations where animals have difficulty to escape (during droughts, or in suddenly emptied ponds and pools) or when turtles show some confidence and tolerance in human presence (such as in peri-urban environments) (Sancho Alcayde *et al.*, 2015).

EFFORT REQUIRED

Vogt (2012) describes the technique as "not very efficient" as it can take, for certain species under certain circumstances between 20 and 30 minutes to catch an individual. In a project in the Pego-Oliva marsh, a maximum catchability was obtained with an average of up to 25 individuals/person, with up to 180 specimens removed in one morning in a portion of ditch (Sancho Alcayde *et al.*, 2015).

RESOURCES REQUIRED

Sancho Alcayde *et al.*, (2015) mention that the cost for a hand-net is low, 30–60 Euros.

SIDE EFFECTS

Environmental: Negative
Social: Neutral or mixed
Economic: Neutral or mixed

There are side effects related to this measure, for example disturbance of native species, but also wading through the mud can have an effect on the water quality and thus on other species occurring in the habitat.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

See the *Physical removal via draining of the pond* section (*Rapid Eradication*) above. However, hand capture is likely to be seen as more acceptable in terms of animal welfare than trapping or shooting by the public (personal experience of the author).

ADDITIONAL COST INFORMATION

No detailed extra information could be found for this method.

LEVEL OF CONFIDENCE*

Established but incomplete

There is a description of the method and a few examples given for turtles (not for *T. scripta* specifically) in Vogt (2012). The method has been tested within the LIFE *Trachemys* project (LIFE09 NAT/E/0000529) and is assessed on its effectiveness, but it is not clear at how many locations this was tested (LIFE *Trachemys* website; Sancho Alcayde *et al.*, 2015).

* See Appendix

Integrated control management.

MEASURE DESCRIPTION

In order to manage established populations of the species, a combination of the rapid eradication measures described above can be used depending on the specific circumstances. The choice of management aim, eradication, control or containment, depends upon the size of the water body, the number of individuals, the connectivity with other water bodies, etc. See the above *Rapid eradication* sections for details on the separate measures. For containment of small populations within a specified area fencing seems to be the most appropriate approach (see the *Fencing of public waterbodies* section (*Prevention of secondary spread*) above).

Several projects provide examples of how to manage populations in the wild. For example the LIFE Emys project, the LIFE *Trachemys* project (LIFE *Trachemys* 2012a, b, c, 2013; Sancho Alcayde *et al.*, 2015) and several other projects performed in France (Lascève, 2014; Maurer, 2015), Corsica (Peinado *et al.*, 2012), but also Spain (Valdéon *et al.*, 2010) and Italy (Zanetti, 2018).

The LIFE Emys project (Gili, 2016) stated that a good evaluation on the feasibility of the project before the start needs to be performed. In addition, mathematical models (for example, habitat suitability models or ecological niche models) can be applied to prioritize areas where management actions need to be focused on (Ficetola *et al.*, 2009).

There are several options to deal with the individuals captured and removed from the wild. One of the methods is to euthanize the animals. Another option is to place the animals within rescue centres or zoos or to release them in semi-natural environments such as quarries. The disposal of live specimens at rescue centres and zoological gardens, as reported for Italy, Spain, and France (Scalera, 2006) is a measure that could provide a solution which prevents to euthanizing the animals. Also, the LIFE Emys project (Gili, 2016) implemented this kind of measure and coupled an educational aspect to this. This is also implemented in Flanders (Belgium) where an agreement has been made between the province of East-Flanders and several rescue centres to take care of the live specimens that are caught (personal experience of the author). In some cases private pet owners can also take care of the specimens if an official agreement with them is made and if the proper measures are taken to avoid secondary dispersal.

SCALE OF APPLICATION

The scale of application depends on the resources available, and the management aims across the sites identified for management. Some sites may be suitable for eradication, and others for control or containment. In terms of effectiveness, measures with the aim of control will be more likely to be applied across a larger area than eradication.

For details and examples, see the separate *Rapid eradication* sections. The scale of application ranges from a small urban pond through large nature areas.

EFFECTIVENESS OF MEASURE

Neutral.

In terms of population control there is evidence that physical removal measures can be effective at individual sites or isolated waterbodies. However the effectiveness across a large geographic scale is currently unknown, and is likely to be much harder to achieve, and potentially impossible. The same can be said also for eradication and containment. The local environmental conditions and the size of the population determine the effectiveness of the measure.

Examples of effectiveness described for different methods applied within different projects can be found in the *Rapid eradication* sections above. A good overview on the different physical passive and active removal methods and their effectiveness can be found in Sancho Alcayde *et al.*, (2015).

A good example of a project trying to manage the reduction or control of *Trachemys* and at the same time restore the native populations is the LIFE project *Trachemys*. A significant amount of progress was achieved and evidence from the project's seven locations showed that at:

- Peñíscola marshes – a reduction in the number of captures of exotic turtles was observed, while catches of native species (especially *Mauremys*) increased;
- Almenara marshlands – continued efforts to remove *T. scripta* specimens and to destroy nests of this species was reflected in the low number of juveniles present and, therefore, in a reduction in the capture of exotic turtles;
- Marjal dels Moros – numbers of catches of exotic species stabilized or fell. A mixed nesting area of *Emys*, *Mauremys* and *T. scripta* was detected which is under surveillance and control. The populations of native turtles were found to be in good condition with signs of recovery (increase of nests and juveniles);

- Marsh of Rafalell i Vistabella – monitoring work successfully verified the reproduction of *Emys* that had been reintroduced;
- P. N. L'Albufera – biodiversity has increased in the Natural Park thanks to reintroduction works by action C8 (Provision of Services to participate in the implementation of the captive breeding program of Cyprus grass snake *Natrix natrix cypriaca*, *Cypriot dendrogalias*, *Hierophis cypriensis* and freshwater turtle *Mauremys rivulata*) (Tancat de la Pipa and Tancat de Milia);
- Albufera Gaianes – the population of exotic turtles (mainly *T. scripta*) has been reduced and the reintroduction of *Mauremys* has started;
- Portugal – four sites were expected to benefit in the medium term from eradication work targeting exotic turtles. Problems still existed with *T. scripta* reproduction, but the number of nests, juveniles and adults was low.

EFFORT REQUIRED

See the *Rapid eradication* sections above in relation to effort for individual measures, but in summary, the effort required depends again on the aims that are set, and on the area, size of the waterbody, number of individuals that are targeted. It is expected that the effort required to manage established populations (such as population control, eradication, or containment across many sites) will be relatively high due to human resources needed (for example, for setting and checking traps) and the fact that the measures will need to be in place permanently (or repeated on a regular basis).

RESOURCES REQUIRED

See the Rapid eradication sections above in relation to effort for individual measures with the aim of eradication at small isolated sites. If the aim of management is the control across a larger landscape, a combination of the methods could be used, selected based on individual site conditions, including fencing of ponds to keep them in a contained environment.

Although there are no detailed cost calculations available in literature on the costs of each type of approach there are general numbers on the budget available for different projects.

For the LIFE Emys project (Italy) , the total project cost was € 1,053,472 (Gili, 2016). The project ran for 3 years and included slider removal from two sites, establishment of a reproduction and reintroduction programme for the native turtle *Emys orbicularis*, and public outreach.

For the LIFE *Trachemys* project the total budget was 1,200,754 €. The project ran 3 years and focused on eradicating slider populations from 17 wetland sites in Valencia and Portugal and public outreach activities (see *Effectiveness* section above)[9].

Regarding the keeping of the animals within rescue centres or zoos the LIFE Emys project (After LIFE Conservation Plan) gives an estimate of 30,000 Euro for keeping all captured individuals for a period of 3 years.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed

Several side effects can occur depending on the management action that was chosen. For details please see previous *Rapid eradication* sections.

Regarding the keeping of the animals within rescue centres or zoos a side effect could be that less resources are available for other animals at these rescue centres thus affecting also other (native) species that could be housed and treated at these centres (Ficetola *et al.*, 2012). In addition there is a risk that individuals might end up in the wild again due to flooding, or theft.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

The acceptability often depends on the stakeholder group. As mentioned above, local citizens may not see the need of eradication, whereas nature conservationists probably are more in favour of control measures especially if the species threatens native species (Ficetola *et al.*, 2012; LIFE *Trachemys*, 2013).

Regarding the keeping of the animals within rescue centres or zoos it is expected that this could be more easily accepted by the general public since this measure could provide a good alternative to keep them in a contained environment without having to eradicate them (Scalera *et al.*, 2016).

ADDITIONAL COST INFORMATION

There are no further detailed data available on the cost of the management measures specifically applicable for *T. scripta* than the ones already reported above.

LEVEL OF CONFIDENCE*

Established but incomplete.

There have been almost a dozen projects such as the LIFE Emys and LIFE *Trachemys* projects setting up an entire management action for established populations including removal of the species, introduction of native species and setting up a communication campaign. However, the number of projects, especially in more northern or eastern EU member states with regard to alien *T. scripta* seems to be limited. One study was found on measures to limit *Trachemys scripta elegans* invasion in Latvia (Pupins and Čeirāns, 2019).

9 LIFE Trachemys http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPageandn_proj_id=3821

* See Appendix

Bibliography

Adrados, L.C. and Briggs, L. 2002. Study of application of EU Wildlife Trade regulations in relation to species which form an ecological threat to the EU fauna and flora, with case studies of American bullfrog (*Rana catesbeiana*) and red-eared slider (*Trachemys scripta elegans*). Study report to the European Commission. Amphi Consult, Denmark.

AsianCarp US. 2018. Asian carp monitoring and response plan 2018. http://asiancarp.us/Documents/MRP2018.pdf

Bennett, D. 1999. Reptiles and Amphibians – Expedition Field Techniques. Royal Geographical Society, London.

Blackman, R.C., Constable, D., Han, C., Sheard, A.M., Durkota, J., Hanfling, B. and Handley, L.L. 2017. Detection of a new non-native freshwater species by DNA metabarcoding of environmental samples – first record of *Gammarus fossarum* in the UK. *Aquatic Invasions*, 12(2): 177–189

Bluett, R.D. and Schauber, E.M. 2014. Estimating Abundance of Adult *Trachemys scripta* with Camera Traps: Accuracy, Precision and Probabilities of Capture for a Closed Population. *Transactions of the Illinois State Academy of Science*, 107: 19–24.

Boakes, E.H., McGowan, P.J., Fuller, R.A., Chang-qing, D., Clark, N.E., O'Connor, K. and Mace, G.M. 2010. Distorted views of biodiversity: spatial and temporal bias in species occurrence data. *PLoS Biology*, 8(6), p.e1000385.

Brown, D.J., Farallo, V.R., Dixon, J.R., Baccus, J.T., Simpson, T.R. and Forstner, M.R.J. 2011. Freshwater turtle conservation in Texas: harvest effects and efficacy of the current management regime. *The Journal of Wildlife Management*, 75: 486–494.

Bugter, R.J.F., Ottburg, F.G.W.A., Roessink, I., Jansman, H.A.H., van der Grift, E.A. and Griffioen, A.J. 2011. Exotic turtles in the Netherlands: a risk assessment. Alterra report 2186.

Cablk, M.E. and Heaton, J.S. 2006. Accuracy and reliability of dogs in surveying for desert tortoise (*Gopherus agassizii*). *Ecological Applications* 16: 1926–1935.

Cadi, A., Delmas, V., Prevot-Julliard, A–C., Joly, P., Pieau, C. and Girondot, M. 2004. Successful reproduction of the introduced slider turtle (*Trachemys scripta elegans*) in the South of France. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 14: 237–247.

Cadi, A. and Joli, P. 2003. Competition for basking places between the endangered European pond turtle (*Emys orbicularis galloitalica*) and the introduced redeared slider (*Trachemys scripta elegans*). *Canadian Journal of Zoology*, 81:1392–1398.

Carbone H. 2011. Campagne de lutte à grande échelle contre les tortues de Floride *Trachemys scripta elegans* et autres tortues exotiques sur le site Natura 2000 « étang de Mauguio » dans le cadre d'un programme européen : LIFE + LAG'Nature, 46p. Rapport de stage.

Costa Edutainment. 2016. LIFE EMYS Final Report. LIFE12 NAT /IT/000395-Lifeemys.

Davis, J.T. 1976. Turtle control in farm ponds. Texas Agricultural Extension Service, Texas A and M University. College Station, Texas.

Davy, C.M., Kidd, A.G. and Wilson, C.C. 2015. Development and Validation of Environmental DNA (eDNA) Markers for Detection of Freshwater Turtles. *PLoS ONE* 10(7): e0130965. doi:10.1371/journal. pone.0130965.

Deiner, K., Bik, H. M., Machler, E., Seymour, M., Lacoursiere-Roussel, A., Altermatt, F. and Lodge, D. M. 2017. Environmental DNA metabarcoding: transforming how we survey animal and plant communities. *Molecular Ecology Resources*, 26(21): 5872–5895.

Di Santo, M.P., Vigoli, L., Carpaneto, G.M. and Battisti, C. 2017. Occurrence patterns of alien freshwater turtles in a large urban pond 'Archipelago' (Rome, Italy): Suggesting hypotheses on root causes. *Lakes and Reservoirs: Research and Management*, 22: 56–64.

Drost, C.A., Lovich, J.E., Madrak, S.V., and Monatesti, A.J., 2011. Removal of nonnative slider turtles (*Trachemys scripta*) and effects on native Sonora mud turtles (*Kinosternon sonoriense*) at Montezuma Well, Yavapai County, Arizona: U.S. *Geological Survey Open-File Report 2010–1177*, 48 p.

Ernst, C.H., Jeffrey E.L. and Barbour, R.W. 1994. Turtles of the United States and Canada. Washington, D.C. Smithsonian Institution Press.

Fernandez, S., Sandin, M.M., Beaulieu, P.G., Clusa, L., Martinez, J.L, Ardura, A. and García-Vázquez, E. 2018. Environmental DNA for freshwater fish monitoring: insights for conservation within a protected area. Peer J, 6, e4486.

Ficetola, G.F., Thuiller, W. and Padoa-Schioppa, E. 2009. From introduction to the establishment of alien species: bioclimatic differences between presence and reproduction localities in the slider turtle. *Diversity and Distributions*, 15: 108–116.

Ficetola G.F., Rödder D., Padoa-Schioppa E. 2012. *Trachemys scripta* (Slider terrapin). In: Francis R (ed) Handbook of global freshwater invasive species. *Earthscan, Taylor and Francis Group, Abingdon*, pp 331–339.

Foglini C. and Salvi R. 2017. Non-native turtles in a peri-urban park in northern Milan (Lombardy, Italy): species diversity and population structure. *Acta Herpetologica, v. 12, n. 2*, p. 151–156. ISSN 1827–9643.

Fowler, J.F. and Avery, J.L. 1994. Turtles. Prevention and control of wildlife damage (Eds SE Hygnstrom and RM Timm), pp. F-27–F31. University of Nebraska, Lincoln, Nebraska.

Gallo, T. and Waitt, D. 2011. Creating a Successful Citizen Science Model to Detect and Report Invasive Species. *BioScience*, 616 (1): 459–465, https://doi.org/10.1525/bio.2011.61.6.8.

Gamble, T., 2006). The relative efficiency of basking and hoop traps for painted turtles (*Chrysemys picta*). *Herpetological Review* 37: 308–312.

García-Díaz, P., Ramsey, D. S. L., Woolnough, A. P., Franch, M., Llorente, G. A., Montori, A., Buenetxea, X., Larrinaga, A. R., Lasceve, M., Álvarez, A., Traverso, J. M., Valdeón, A., Crespo, A., Rada, V., Ayllón, E., Sancho, V., Lacomba, J. I., Bataller, J. V. and Lizana, M. 2017. Challenges in confirming eradication success of invasive red-eared sliders. *Biological Invasions* 2750 (19): 9.

Geerts A., Boets P., van den Heede S., Goetshals PLM. and van der Heyden C. 2018. A search for standardized protocols to detect alien invasive crayfish based on environmental DNA (eDNA): A lab and field evaluation. *Ecological Indicators*, 84:564–572.

Gili G. 2016. Ligurian Invasive Fauna Eradication pro-indigenous *Emys orbicularis* restocking. LIFEEMYS – LIFE 12 NAT/IT/000395. 21p.

Harper, L.R., Buxton, A.S., Rees, H.C., Bruce, K., Brys, R., Halfmaerten, D. and Hanfling, B. 2019. Prospects and challenges of environmental DNA (eDNA) monitoring in freshwater ponds. *Hydrobiologia*, 826, 25–41.

Hassell, C. 2014. The ecology and biodiversity of urban ponds. *Wiley Interdisciplinary Reviews: Water*, 1(2).

Herder, J.E., Valentini A., Bellemain E., Dejean T., van Delft J.J.C.W., Thomsen P.F. and Taberlet P. 2014. Environmental DNA – a review of the possible applications for the detection of (invasive) species. Stichting RAVON, Nijmegen. Report 2013–104.

Hering, D., Borja, A., Jones, J.I., Pont, D., Boets, P., Bouchez, A., Bruce, K., Drakare, S., Hänfling, B., Kahlert, M., Leese, F., Meissner, K., Mergen, P., Reyjol, Y., Segurado, P., Vogler, A. and Kelly, M., 2018. Implementation options for DNA-based identification into ecological status assessment under the European Water Framework Directive. *Water Research*, 138:192–205. https://doi.org/10.1016/j.watres.2018.03.003

Innes, C.J., Feinsod, R., Hanlon, J., Stahl., S. Oguni, J., Boone, S., Schnellbacher, R., Cavin, J. and Divers, S.J. 2013. Coelioscopic orchiectomy can be effectively and safely accomplished in chelonians. *Vet Record,* 172(20):526.

Isaac, N.J., Strien, A.J., August, T.A., Zeeuw, M.P. and Roy, D.B., 2014. Statistics for citizen science: extracting signals of change from noisy ecological data. *Methods in Ecology and Evolution*, 5(10), pp.1052–1060.

IUCN. 2017. Information on non-lethal measures to eradicate or manage vertebrates included on the Union list. Technical note prepared by IUCN for the European Commission.

Kamp, J., Oppel, S., Heldbjerg, H., Nyegaard, T. and Donald, P.F., 2016. Unstructured citizen science data fail to detect long-term population declines of common birds in Denmark. *Diversity and Distributions*, 22(10): 1024–1035.

Koese, B. and Evers, N. 2011. A National Inventory of invasive Freshwater crayfish in The Netherlands in 2010. EIS-Nederland.

Kuzmanova, Y., Natcheva, I., Koleva,V., Popgeorgiev, G., Slavchev, M. and Natchev, N. 2018. Public awareness of risks and recent marketing dynamics of Pond sliders (*Trachemys scripta*, Schoepff, 1792) in NE Bulgaria. *Zoology and Ecology*, 28 (4): 329–336.

Lambert, M. R., Screen, R., McKenzie, J., Clause, A., Johnson, B., Mount, G., Rollins, H., Pauly, G. and Shaffer H.B. 2018. Large-scale experimental removal of non-native slider turtles has unexpected consequences on basking behavior for both conspecifics and a native, threatened turtle. *Biorxiv.* https://doi.org/10.1101/312173.

Lascève, M. 2014. Premiers résultats de l'opération de limitation de la population de Tortue de Floride sur le site des Vieux Salins, Hyères (Var, France). Sci. Rep. *Port-Cros natl. Park.* 28: 195–201.

LIFE Emys project. http://www.lifeemys.eu/. Accessed on 13/04/2019.

LIFE *Trachemys* project. http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPageandn_proj_id=3821. Website accessed on 19/04/2019.

LIFE-*Trachemys* 2012a. Guía metodológica para la captura y manejo de galápagos. Informes LIFE*Trachemys* nº 8. *Conselleria d'Infraestructures, Territori i Medi Ambient*. 31 pp (in Spanish).

LIFE-*Trachemys* 2012b. Memoria intermedia de actuaciones. Años 2011–2012. Informes LIFE*Trachemys* nº 14. *Conselleria d'Infraestructures, Territori i Medi Ambient*. 26 pp.

LIFE-*Trachemys* 2012c. Uso de cámaras fotográficas para el estudio de puestas de galápago europeo (Emys orbicularis) en condiciones de semi-cautividad. Informes LIFE*Trachemys* nº 7. *Conselleria d'Infraestructures, Territori i Medi Ambient.* 11pp.

LIFE-*Trachemys* 2012d. Ensayos de efectividad de medios de captura. Año 2012. Informes LIFE*Trachemys* nº 11. *Conselleria d'Infraestructures, Territori i Medi Ambient.* 20pp.

LIFE-*Trachemys* 2013. Dossier divulgativo sobre el proyecto LIFE-*Trachemys*. Informes LIFE *Trachemys* nº 17. *Conselleria d'Infraestructures, Territori i Medi Ambient.* 13 pp.

Luiselli L., Capula M., Capizzi D., Filippi E., Trujillo Jesus V. and Anibaldi C. 1997. Problems for conservation of pond turtles (*Emys orbicularis*) in central Italy: is the introduced red-eared turtle (*Trachemys scripta*) a serious threat? *Chelonian Conservation and Biology* 2: 417–419.

Mali, I., Haynes, D. and Forstner, M.R.J. 2014.Effects of Bait Type, Bait Age, and Trap Hours on Capture Success of Freshwater Turtles. *Southeastern Naturalist*, 13(3): 619–625.

Maurer, C. 2015. Projet experimental de capture et d'étude d'une population de « Tortues de Floride » – Trachémydes à tempes rouges. *Maison de Loire du Loiret*, 13 pp.

O'Keeffe, M.S. 2006. Red-eared Slider Turtles in Australia and New Zealand: Status, impacts, management. Brisbane, Queensland 3–7 April, 2006. https://www.pestsmart.org.au/wp-content/uploads/2010/11/REST_Workshop_April2006.pdf

O'Keeffe, S. 2009. The practicalities of eradicating red-eared Slider turtles (*Trachemys scripta elegans*). *Aliens: The invasive Species bulletin*, 28: 19–25.

Peinado J., Bosc V., Destandau R. and Fleuriau R. 2011. Programme de gestion d'une tortue exotique *Trachemys scripta elegans* en région Corse « Tentative d'éradication et de sensibilisation du public aux problématiques liées aux espèces exotiques » – Synthèse de trois années : 2009/2011. CEN Corse. 15 pp.

Perez-Santigosa, N., Diaz-Paniagua, C and Hidalgo-Vila, J. 2008. The reproductive ecology of exotic *Trachemys scripta elegans* in an invaded area of southern Europe. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 18: 1302–131

Polo-Cavia N., López P. and Martín, J., 2012. Feeding status and basking requirements of freshwater turtles in an invasion context. *Physiological Behaviour* 105(5): 1208–13.

Pupins M., Ceirans A. 2019. Report on measures to limit *Trachemys scripta elegans* invasion in Latvia. [Atskaite par *Trachemys scripta elegans* invāzijas ierobežošanas pasākumiem Latvijā]. – Daugavpils, Latgales ekoloģiska biedriba: 8 pp. (In Latvian).

Rees, H., Maddison, B.C., Middleditch, D.J., Patmore, J.R.M. and Gough, K.C. 2014. The detection of aquatic animal species using environmental DNA – a review of eDNA as a survey tool in ecology. *Journal of Applied Ecology*, 51: 1450–1459

Roy, H.E., Rorke, S.L., Beckmann, B., Booy, O., Botham, M.S., Brown, P.M., Harrower, C., Noble, D., Sewell, J. and Walker, K., 2015. The contribution of volunteer recorders to our understanding of biological invasions. *Biological Journal of the Linnean Society*, 115(3): 678–689.

Roy, H., Groom, Q., Adriaens, T., Agnello, G., Antic, M., Archambeau, A., Bacher, S., Bonn, A., Brown, P., Brundu, G., López, B., Cleary, M., Cogălniceanu, D., de Groot M., De Sousa, T., Deidun, A., Essl, F., Fišer Pečnikar, Ž., Gazda A, Gervasini, E., Glavendekic, M., Gigot, G., Jelaska, S., Jeschke, J., Kaminski, D., Karachle, P., Komives, T., Lapin, K., Lucy, F., Marchante, E., Marisavljevic, D., Marja, R., Martín Torrijos, L., Martinou, A., Matosevic, D., Mifsud, C., Motiejūnaitė, J., Ojaveer, H., Pasalic, N., Pekárik, L., Per, E., Pergl, J., Pesic, V., Pocock, M., Reino, L., Ries, C., Rozylowicz, L., Schade, S., Sigurdsson, S., Sancho Alcayde, V., Lacomba Andueza, J.I., Bataller Gimeno, J.V. and Pradillo Carrasco, A. 2015. Manual para el Control y Erradicación de Galápagos Invasores. Colección Manuales Técnicos de Biodiversidad, 6. Conselleria d'Agricultura, Medi Ambient, Canvi Climàtic i Desenvolupament Rural. Generalitat Valenciana. Valencia.

Steinitz, O., Stern, N., Teofilovski, A., Thorsson, J., Tomov, R., Tricarico, E., Trichkova, T., Tsiamis, K., van Valkenburg, J., Vella, N., Verbrugge, L., Vétek, G., Villaverde, C., Witzell, J., Zenetos, A. and Cardoso, A. 2018. Increasing understanding of alien species through citizen science (Alien-CSI). *Research Ideas and Outcomes*, 4: e31412. https://doi.org/10.3897/rio.4.e31412.

Sterrett, S.C., Smith, L.L., Schweitzer, S.H. and Maerz, J.C. 2010. An assessment of two methods for sampling river turtle assemblages. *Herpetology Conservation and Biology* 5:490–497.

Scalera, R. 2006. *Trachemys scripta*. Delivering Alien Invasive Species Inventories for Europe.

Scalera, R., Genovesi, P., de Man, D., Klausen, B. and Dickie, L. 2016. European code of conduct on zoological gardens and aquaria and invasive alien species. 40 pages.

Scalera *et al.*, 2017. Study on Invasive Alien Species – Development of risk assessments to tackle priority species and enhance prevention. Contract No 07.0202/2016/740982/ETU/ENV.D2-Final Report. Annex 2: Risk Assessment for *Chrysemys picta* (Schneider, 1783).

Teillac-Deschamps P., Delmas V., Lorrillière R., Servais V., Prévot-Julliard A.C. 2008). Red-eared Slider Turtles *Trachemys scripta elegans* Introduced to French Urban Wetlands: an Integrated Research and Conservation Program. *Herpetological conservation*, 3: 535–537.

Teillac-Deschamps, P., Lorrillière, R., Servais, V., Delmas, V., Cadi, A. and Prevot-Julliard, A.–C. 2009. Management strategies in urban green spaces: Models based on an introduced exotic pet turtle. *Biological Conservation* 142(10): 2258–2269.

Thomson, R.C., P.Q. Spinks, and H.B. Shaffer. 2010. Distribution and Abundance of Invasive Red-eared Sliders (*Trachemys scripta elegans*) in California's Sacramento River Basin and Possible Impacts on Native Western Pond Turtles (*Emys marmorata*). *Chelonian Conservation and Biology* 9(2): 297–302.

Valdeón, A., Crespo-Diaz, A., Egaña-Callejo, A. and Gosá, A. 2010. Update of the pond slider *Trachemys scripta* (Schoepff, 1792) records in Navarre (Northern Spain), and presentation of the Aranzadi Turtle Trap for its population control. *Aquatic Invasions* 5 (3): 297–302.

Valentini, A., Taberlet, P., Miaud, C., Civade, R., Herder, J., Thomsen, P.F., Bellemain, E., Besnard, A., Coissac, E., Boyer, F., Gaboriaud, C., Jean, P., Poulet, N., Roset, N., Copp, G.H., Geniez, P., Pont, D., Argillier, C., Baudoin, J.–M., Peroux, T., Crivelli, A.J., Olivier, A., Acqueberge, .M, Le Brun, M., Møller, P.R., Willerslev, E. and Dejean, T. 2016. Next generation monitoring of aquatic biodiversity using environmental DNA metabarcoding. *Molecular Ecology*, 25: 929–942.

Verwaijen D. 2016. Code van goede praktijk voor het bestrijden en beheersen van de roodwangschildpad (*Trachemys scripta elegans*) in Vlaanderen. Studie in opdracht van het Agentschap voor Natuur en bos. (in Dutch).

Vogt, R.C. 1979. Spring aggregating behavior of painted turtles, *Chrysemys picta* (Reptilia,Testudines,Testudinidae). *Journal of Herpetology* 13: 363–365.

Vogt, R.C., 1980. New methods for trapping aquatic turtles. *Copeia*, (2): 368–371.

Vogt, R.C. 2012. Detecting and capturing turtles in freshwater habitats. Pp. 181–187, In: McDiarmid, RW, Foster, MS, Guyer, C, Gibbons, JW and Chernoff, N. (Eds) Reptile biodiversity: standard methods for inventory and monitoring. University of California Press, Berkeley.

Witherington, B., Peruyero, P., Smith, J.R., MacPhee, M., Lindborg, R., Neidhart, E. and Savage, A. 2017. Detection dogs for sea turtle nesting beach monitoring, management, and conservation outreach. *Marine Turtle Newsletter*, 152: 1–4.

Wyneken, J., Bels, V. and Godfrey, M.H. 2008. Biology of turtles. CRC Press.

Zanetti M. 2018. LIFE14 NAT/IT/000809 River functionality index as planning instrument for a good governance of Sile's ecosystem Azione C7 Controllo e eradicazione della specie *Trachemys scripta* spp. e altre testuggini palustri esotiche Relazione annuale e conclusiva. *Anno* 2018. 31p.

Appendix

Level of confidence provides an overall assessment of the confidence that can be applied to the information provided for the measure.

- **Well established:** comprehensive meta-analysis[1] or other synthesis or multiple independent studies that agree.
- **Established but incomplete:** general agreement although only a limited number of studies exist but no comprehensive synthesis and/or the studies that exist imprecisely address the question.
- **Unresolved:** multiple independent studies exist but conclusions do not agree.
- **Inconclusive:** limited evidence, recognising major knowledge gaps.

1 A statistical method for combining results from different studies which aims to identify patterns among study results, sources of disagreement among those results, or other relationships that may come to light in the context of multiple studies.

Your feedback is important. Any comments that could help improve this document can be sent to ENV-IAS@ec.europa.eu