Nasua nasua. © *Aleksander Niweliński.*

The management of coati (*Nasua nasua*)

Measures and associated costs

Species (scientific name)	*Nasua nasua* (Linnaeus 1766)
Species (common name)	Coati
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Common names

BG	Южноамериканско носато мече (коати)
HR	Nosati rakun
CZ	Nosál červený
DA	Næsebjørn
NL	Rode neusbeer
EN	Coati
ET	Ninakaru
FI	Koati
FR	Coati roux
DE	Roter Nasenbär
EL	Κοάτι της νότιας Βραζιλίας
HU	Vörösorrú koáti (ormányosmedve)
IE	–
IT	Coati rosso
LV	Dienvidamerikas degunlācītis
LT	Paprastasis koatis
MT	–
PL	Koati
PT	Quati-de-cauda-anelada
RO	–
SK	Nosáľ červený
SL	Nosati medvedek
ES	Coatí
SV	Vanlig näsbjörn

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

The coati (*Nasua nasua*) is a small to medium sized social carnivore of the Procionidae family, of South American origin. For more information on the species ecology, particularly in relation to its invasive potential, please see the species EU risk assessment (Deputy Direction of Nature, 2015).

In terms of prevention, the species is readily identifiable and unlikely to be mistaken for other native species with the possible exception of the pine marten (*Martes martes*). Intentional introductions into the EU have been primarily for the pet trade, but are now banned, as the species is listed as Invasive Alien Species of Union concern according to Regulation 1143/2014 (EU IAS Reg.). However, compliance and enforcement, particularly for online trade, remains a challenge. The species is also widely kept in zoos, where it needs to be phased out. Before the regulation came into force, a total of 769 coatis were kept in 165 zoos in Europe (including non-EU states) (Lacueva, J. pers. comm., 2019), however this number should now be reduced. Escapes from zoos are rare but are more likely to be more frequent from private owners, given coati's propensity to escape (Standley, 1992). Surgical sterilisation is recommended for the prevention of reproduction in containment, and the use of enclosures on artificial ground with roofs is the most effective way of preventing escape into the environment. The production of identification materials for the species (and other IAS), for example, as produced during the Mallorca eradication by Alvarez *et al.,* (2006), should help raise awareness amongst those involved in the pet trade and the general public, which would also support the use of citizen-science to help with the early detection and rapid identification of any escapes. Sterilisation of any remaining captive animals, particularly those held by private owners (who may keep the animals until the end of their natural life) and on islands, provides a potential route to ensure they do not breed in captivity, or in the event that they escape.

Within the EU, individual escaped coatis have been reported in the UK, including animals recaptured by trapping, but with no evidence of breeding. A breeding population established in Mallorca and an eradication programme was undertaken between 2002 and 2013, with sporadic reports of individuals since. Overall, 44 animals were removed, primarily by live trapping, shooting by professionals and through the support of local hunters. Based on the limited information available on the management of the species as an IAS, the combined use of trapping and shooting is recommended as the basis for rapid eradication or control. In approximate terms, the four year active period of eradication on Mallorca involved more than 100 person-days of field work per year, and approximately 2,000 km of annual travel. In addition to the four years of eradication, subsequent monitoring and response has required 0.1 person-years of technical staff support. The average cost per animal captured was estimated at €1,500 (Deputy Direction of Nature, 2015). Apart from these examples, there is limited experience in the wider control of coati, but methods applied to similar species, such as raccoons, are likely to be appropriate; cage traps are the standard method for trapping (CABI, 2019) and shooting has also proved an efficient method for this species. The use of Judas animals may also be effective to help locate individuals in the later stages of an eradication programme, although more experience of the application on this species is required. More targeted survey methods, such as the use of camera traps, can be used to support control programmes.

We also recognise other control methods such as toxins, introduced diseases, immunocontraceptives, and gene drives as measures that could potentially be implemented in the future (see IUCN, 2017). However, these are not discussed below, as they have not been applied on the species, and are also not currently considered practical, acceptable or available for use in Europe.

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.

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.

Cages and fences.

MEASURE DESCRIPTION

According to IUCN (2017), fences and cages are used in zoos and fur farming to keep coati captive. However, coati are intelligent animals very capable of escaping containment, and according to the Association of Zoos and Aquariums Small Carnivore Taxon Advisory Working Group (AZA, 2010) are expert escape artists, and care needs to be taken to prevent them from digging, jumping, climbing, or swimming out of enclosures. Therefore, containment facilities need to be secure, well maintained, fully covered (roofed), and placed on artificial surfaces due to the climbing and digging capacity of the species (AZA, 2010).

This is a social, wild species, to maintain the welfare of captive animals it will be important to consider their social needs, appropriate environmental enrichment and space requirements (Kleiman *et al.,* 2010). According to AZA enclosure complexity is as important as enclosure size in meeting locomotory requirements of the species.

SCALE OF APPLICATION

On-line resources describe cages measuring 3 m × 3 m × 3 m to hold coati as a pet enclosure[1], however, animals held in such conditions for extended periods will have compromised welfare. Larger enclosures are needed to promote animal welfare for a social, wild species such as the coati. AZA recommend a minimum floor space of 16.4 m^2 for two individuals with between 3.05–3.66 m of usable vertical space (AZA, 2010).

EFFECTIVENESS OF THE MEASURE

Effective.

Coati can be kept captive through the use of appropriate cages and enclosures.

EFFORT REQUIRED

Animals would need to be kept captive for the remainder of their lifespan.

RESOURCES REQUIRED

Maintaining captive animals in suitable enclosures requires a commitment to appropriate secure construction and maintenance, feeding and veterinary care for the remainder of the animal's lifespan.

SIDE EFFECTS

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

Maintaining animals in captivity has a low environmental impact. It may be more socially acceptable than euthanising animals, but carries welfare costs for the animals concerned.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

While keeping animals in secure captivity will be acceptable to some current owners and the general public, building cages and maintaining animals in suitable conditions is likely to be costly if the welfare of the animals is not to be compromised.

ADDITIONAL COST INFORMATION

No information.

LEVEL OF CONFIDENCE*

Established but incomplete.

Maintaining animals securely in captivity is widely used in zoos.

Surgical sterilisation.

MEASURE DESCRIPTION

In addition to keeping male and females separate, surgical sterilisation (castration and spaying/hysterectomy) is be used to prevent reproduction of individuals in containment, and is often recommended for coati that are kept as pets to reduce aggression[2]. Minto *et al.,* (2017) describe a minimally invasive hysterectomy in *Nasua nasua,* using the hook technique, which is commonly used for dogs and cats.

There are alternatives to surgical sterilisation, but these are only recommended for use on wild animals (for example, those captured and released) and include immunocontraception with products such as injectable GonaCon or the use of contraceptive implants such as GnRH agonists, which have also been used on zoo specimens (see IUCN, 2017). These methods have shortcomings for use on captive animals including a lack of 100% effectiveness, the need for repeat applications, together with side effects such as adverse injection-site reactions. There is also limited information available on their use with this species, although non-vaccine contraceptive implants, Melengestrol acetate (MGA) have been found to cause uterine pathology in captive *Nasua nasua* (Chittick *et al.,* 2001).

SCALE OF APPLICATION

Surgical sterilisation needs to be applied to each animal individually, requiring veterinary expertise and specialised facilities.

EFFECTIVENESS OF THE MEASURE

Effective.

Castration and hysterectomy are successfully used to prevent reproduction in *N. nasua* (see Minto *et al.,* 2017).

EFFORT REQUIRED

Needs to be undertaken once.

RESOURCES REQUIRED

Access to veterinary skills with clinical experience of exotic animals.

SIDE EFFECTS

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

1 AnimalWised Coatis as pets – https://www.animalwised.com/coatis-as-pets-guidelines-and-tips-935.html
2 See https://www.thesprucepets.com/pet-coatimundi-1239553
* See Appendix

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.

The method should be acceptable to most stakeholders, as it appears to be common practice for those individuals kept as pets. In addition, the minimally invasive hysterectomy as presented by Minto *et al.,* (2017) has potential advantages to conventional techniques, including reduced pain, lower risk of dehiscence of the stitches and haemorrhage, shorter and better recovery time (wound completely healed in 10 days) and lower physiological stress response. In addition, as it is a non-laparoscopic technique it does not require expensive equipment (Minto *et al.,* 2017). The authors also believe there are no long-term health risks to the coatis due to the hysterectomy.

ADDITIONAL COST INFORMATION

Castration or spaying are widely applied to similarly sized species such as domestic cats and dogs. This approach is also commonly applied to captive coati. However, no specific costs for use on this species were identified.

LEVEL OF CONFIDENCE*

Established but incomplete.

This is a widely used method, but the level of published information on its use on this species is limited.

The species is not introduced unintentionally.

MEASURE DESCRIPTION

The only known pathway of introduction for the species is through the pet trade (Deputy Direction of Nature, 2015). We are treating the escape of individuals from zoos and private collections as intentional introductions.

* See Appendix

Nasua nasua, *also known as the coati, is a member of the racoon family from tropical and subtropical South America. © Archive of Institute Symbiosis.*

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

None known.

MEASURE DESCRIPTION

Should animals establish in an area, the only method to prevent their spread is to undertake rapid eradication or management measures, as described below.

Measures for early detection of the species and to run an effective surveillance system to detect efficiently new occurrences.

Citizen-science and awareness campaigns.

MEASURE DESCRIPTION

Citizen-science is a very popular tool on data collection on species occurrence (see Roy *et al.,* 2012 for a review of citizen-science projects). In terms of their use on IAS, they can be used to identify and track the spread of already established IAS, such as the spread of Harlequin ladybird, *Harmonia axyridis* in the UK (Brown *et al.,* 2018), or to detect early incursions, such as the introduction of Asian Hornet in Great Britain (see the GB NNSS page on Asian Hornet with links to the 'Asian hornet watch App' http://www.nonnativespecies.org/alerts/index.cfm?id=4).

Nasua nasua is a suitable candidate for incorporating into citizen-science programmes that will support the early detection of an introduction of the species. It is a conspicuous species, diurnal (so active during daylight), relatively easy to identify, and is unlikely to be confused with any native species within the EU, apart from possibly the pine marten (*Martes martes*). The probability of introductions of the species is low, as keeping it is now banned under the EU IAS Regulation, and additional Members States regulations, however there is still a risk of escape from animals that were purchased before the ban, and those that may continue to be bought illegally. Incorporating the species into existing IAS awareness campaigns and reporting tools targeting the public would benefit early detection of the species across the EU. For areas at high risk, for example, where suspected introductions have occurred, targeted engagement with key stakeholder groups such as farmers, hunters, naturalist groups (as was done in Mallorca) would support rapid eradication programmes.

The GB Non-native Species Secretariat have produced a coati identification guide (see ID factsheet found here http://www.nonnativespecies.org/factsheet/factsheet.cfm?speciesId=2324 accessed 22/05/19), as have the Govern De Les Illes Balears (pdf is accessible on http://www.caib.es/sites/proteccioespecies/ca/n/el_coati-21489/ accessed 22/05/19).

SCALE OF APPLICATION

The citizen-science processes within each EU country, especially those related to vertebrates, should be encouraged to support early detection for the species. The scale of application is therefore at a national or insular level.

An example at the national level is the UK, where an escaped pair of this species were first detected via a volunteer's camera trap that was part of the Mammal-web citizen-science platform (www.mammalweb.org) (Julia Coats, pers. comm.). This project aims to collate, validate and curate camera trap data to document the distribution and ecology of mammals, and has a description of the *Nasua nasua* in their 'learn about animals' section.

At an insular level, in the case of Mallorca, citizen-science and engagement with key stakeholders supported the eradication campaign. This included engagement with birdwatchers and other naturalist groups (Societat d'Història Natural de les Balears (http://www.shnb.org/), Grup Balear d'Ornitologia i Defensa de la Naturalesa (https://www.gobmallorca.com/), Sociedad Española de Ornitología (https://www.seo.org/), Sociedad Española para la Conservación y Estudio de los Mamíferos (http://www.secem.es/)), as well as biology students in the Balearics University.

EFFECTIVENESS OF THE MEASURE

Effective.

This species is diurnal, gregarious and quite noisy, raising its visibility if present in an area. Reports by the general public proved a useful source of information to assist in the eradication on Mallorca; the first coati detection in Mallorca was provided by a farmer (Mayol *et al.,* 2009). Also, as proved in the UK, citizen-science can be effective at providing early detection of the species to support rapid response.

EFFORT REQUIRED

The measure needs to be in place while there is a risk of new introductions of the species. In the maturation period of certain fruits (such as figs and plums in Mallorca), the possibility of detection in environments close to rural homes is higher (personal experience of the author).

If the awareness-raising campaign is to support a rapid eradication programme, the effort must be maintained for

at least five years from the last sign of presence, since individual animals can adopt very different behaviours.

RESOURCES REQUIRED

Brochures/identification guides need to be produced and distributed to relevant citizen-science and other naturalist groups (see GB Non-native Species Secretariat and Govern De Les Illes Balears links above). In the Mallorca case, with minimal cost, an official phone number was established to collect notifications from individuals of the presence of the species and transmit them to the fauna control team.

If a more pro-active public awareness campaign is needed to support rapid eradication, activities may include media engagement, and advertising in newspapers, TV and radio.

SIDE EFFECTS

Environmental effects: Positive
Social effects: Neutral or mixed
Economic effects: Neutral or mixed
Raising public awareness of *Nasua nasua* and its potential impacts may benefit the reporting of additional invasive aliens species and raise awareness in general.

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.
No public opposition is expected in response to this activity, provided that the approach is positive, and ethical aspects are considered in its presentation. It is a measure that is likely to be well received by citizen-science volunteers, and acceptable to the rural population, farmers, hunters and others interested in natural heritage.

ADDITIONAL COST INFORMATION

The cost of this type of campaign can be very variable depending upon the scale of engagement and awareness raising activities chosen. A cost-effective approach is to engage with existing and established citizen-science programmes, and other relevant stakeholder groups.

In Mallorca, to support the eradication campaign, the cost was between €20 and €50 per poster, depending on the size and material (plastic or metallic), with on average one poster placed every 25 km^2, which ensured sufficient coverage of the territory; this cost was much less in sparsely populated areas (based on authors experience).

LEVEL OF CONFIDENCE*

Established but incomplete.
Citizen-science programmes are widely used to report on the introductions, and ranges of alien species, however active awareness raising activities on the species for this purpose are only known to have occurred in Mallorca and possibly the UK.

Professional monitoring.

MEASURE DESCRIPTION

This is not a measure that can be used as early detection for identifying a new occurrence of the species, however it is a tool for supporting detection of individuals as part of a rapid response to an incursion (for example, an eradication programme), and is therefore discussed here. It can also be used in conjunction with citizen-science, and photo-trapping, as discussed in the other two *Surveillance Measures* sections (above and below).

Once the presence of the species in an area is suspected or confirmed, a range of more targeted surveillance methods may be adopted, including field surveys and the collection of materials (such as faeces or hair) for genetic analysis, which can be used to identify the species and, in some circumstances, the sex of animals present in an area (see Berry *et al.,* 2007, Bohmann *et al.,* 2014, Comtet *et al.,* 2015, Ramon-Laca *et al.,* 2015, Thomsen and Willerslev, 2015, Ushio *et al.,* 2017). This approach requires training of field staff, for example environmental professionals, protected areas staff, forestry staff, hunting guards, and environmental technicians of the local (and national) governments.

SCALE OF APPLICATION

This measure can be implemented over large geographic areas (Berry *et al.,* (2007) undertook fox (*Vulpes vulpes*) scat collection for DNA analysis following public sightings across Tasmania).

EFFECTIVENESS OF THE MEASURE

Effective.
Berry *et al.,* (2007) have demonstrated the utility of faecal DNA analysis for the detection of an elusive invasive species (foxes in Tasmania), with a highly accurate and reliable DNA-based PCR-multiplex test that identified foxes from field-collected faeces. They also developed a sexing test, reliable for faeces less than three weeks old. The species identification test formed a key component of a Tasmania-wide detection and eradication programme. The

* See Appendix

accuracy, reliability, and cost-effectiveness of non-invasive tests makes them a critical adjunct to traditional tools for monitoring cryptic invasive species that are at low density in the early stages of invasion, and when eradication is still an option. Today, this method is widely used for many species (Bohmann *et al.,* 2014, Comtet *et al.,* 2015). Similar approaches can be used to collect hairs, for example from the use of hair-traps.

EFFORT REQUIRED

The measure needs to be in place from the initial sighting of the species until the eradication has been confirmed as successful.

RESOURCES REQUIRED

Trained staff to collect faeces, and access to a genetic laboratory for analysis. The collection of faeces can form part of the duties of staff undertaking control operations, which can reduce the manpower costs, but dedicated staff may be required if the method is widely used. The training costs for this method are low. The genetic analysis costs are widely variable, according to the technique chosen and number of samples. For analysing 50 samples, costs can be between €4,500 and €5,000 (Terrassa, personal communication). These costs are likely to be lower if large numbers of samples are to be analysed.

SIDE EFFECTS

Environmental effects: Neutral or mixed
Social effects: Neutral or mixed
Economic effects: Neutral or mixed
No environmental, social, or economic side effects expected.

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.
The measure is unlikely to raise objections from stakeholders. Access to private land may need to be negotiated.

ADDITIONAL COST INFORMATION

No information available.

LEVEL OF CONFIDENCE*

Established but incomplete.
The method has been applied to a wide variety of invasive alien mammals, but not yet to *Nasua nasua*.

Camera (photographic) trapping.

MEASURE DESCRIPTION

This tool can be used both by professional teams (mostly in response to incursions), and by volunteers as part of citizen-science programmes (see sections above).

In the UK, a pair of escaped coatis were detected using camera traps (and subsequently captured). These camera traps were not set up to specifically be a surveillance measure to support early detection for the species, but were a volunteer's camera trap that was part of the Mammalweb citizen-science platform (www.mammalweb.org) (Julia Coats, pers. comm., see also Ashcroft (2019)).

Camera trapping is a very useful tool in response to possible incursions (such as reports from public, or citizen-science) to confirm the presence, possible individual or group identification, and determine population size, and also a tool to confirm the success of an eradication campaign. Automatic cameras with motion sensors can be set where there are possible sightings or suspicious traces (such as excrement or signs of presence); it is the author's opinion that many of the models available on the market can be effective. Due to the biology of the species (diurnal), it can be a daylight trap based on motion detection.

In Mallorca, camera-trapping was used to confirm presence, in some cases, as observations of individuals were not always reliable (confusion with pine marten) (Parpal and Colomar, pers. comm.).

SCALE OF APPLICATION

The scale of use depends on the local circumstances; to confirm local reports of presence, only a small number of cameras may be required for use on an ad hoc basis. If relying on this tool to assess progress of an eradication over a large area, then a considerable number of cameras deployed throughout the species alien range may be required.

EFFECTIVENESS OF THE MEASURE

Effective.
There is growing evidence of the successful use of camera traps for monitoring and detecting the presence of alien invasive mammals (such as arboreal species in Italy (Di Cerbo and Biancardi, 2013), on islands (Rendall *et al.,* 2014), multiple species in New Zealand (Anton *et al.,* 2018)). An additional example is in Sweden, where almost half of the racoon dog (*Nyctereutes procyonoides*) captures are assisted by photo-trapping by professional hunters (Dahl and Åhlén, 2017).

* See Appendix

Scent lures (fruits or other food) can attract animals, improving likelihood of capture. In Mallorca, where camera traps were used to confirm the presence and/or characteristics of the species, melon proved an effective bait (for camera traps, and capture cages), especially in hot weather (smell and high water content) (Parpal and Colomar, personal communication).

EFFORT REQUIRED

The effort to deploy and service camera traps is relatively low. However, checking the photographs can prove time-consuming, particularly if they regularly record moving vegetation or non-target species in the area.

RESOURCES REQUIRED

There are commercially available camera traps ranging from €100 to €800, depending on characteristics. Camera trapping technology is improving and becoming increasingly affordable. In the case of *Nasua nasua*, a large diurnal species, it is not necessary to have a sophisticated device. The technical staff must have some experience in its management (or be trained). The most effective are the MMS cameras (Multimedia Messaging), sending pictures via MMS or e-mail to the recipient (Dahl and Åhlén, 2017).

SIDE EFFECTS

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

There are no negative environmental impacts in the use of this system, and it can provide information on other species of conservation interest (both invasive and native).

ACCEPTABILITY TO STAKEHOLDERS

Acceptable.

The measure should be acceptable to most stakeholders. If placed in publically accessible areas, there is a risk of vandalism or theft.

ADDITIONAL COST INFORMATION

No information available.

LEVEL OF CONFIDENCE*

Established but incomplete.

Different modalities of photo-trapping are used throughout the world, both for the control of invasive species and other conservation biology work.

* See Appendix

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

Shooting.

MEASURE DESCRIPTION

If an animal or a group is located, one or several professional shooters can remove the animals with relatively little effort. In general, it is not a distrustful species and will take refuge in trees, where the use of an automatic or semi-automatic weapon of caliber .222 rem provided with telescopic sight is recommended. Normally, the animals climb trees, which allows them to be shot sequentially, without the risk of dispersion. If an animal of a group is caught in a trap (see below), it is common for the rest of the social group to remain in the vicinity, when shooting can be effective.

In Mallorca, where an eradication programme was undertaken between 2002 and 2013, this measure was used in conjunction with trapping, and in collaboration with hunters (see sections below).

SCALE OF APPLICATION

In Mallorca, the social groups, which include breeding females, had a range of approximately 4 km^2. Solitary males have a much larger range, so the method may not be as cost-effective for their removal.

EFFECTIVENESS OF THE MEASURE

Effective.

Twenty-one (from a total of 44) of the animals removed in Mallorca were killed with this method, some of them around a trap where a female of the group was caught. The method was effective if the shooter could rapidly respond to reports of the presence of animals. This approach was particularly effective on groups of females and juveniles, due to their diurnal and noisy behaviour, which makes them easy to locate. It may be possible to increase the effectiveness of this method through the use of dogs to help locate social groups.

EFFORT REQUIRED

Experienced staff must be available to move quickly in response to sightings. In Mallorca, this required a team specialised in the control of invasive vertebrate species (Parpal and Colomar, pers. comm).

RESOURCES REQUIRED

Hunting rifle (cost between €300 and €600) and staff (qualified shooters) costs. The effectiveness can be much greater if dogs are trained to track the species and, in this case, there will be additional costs of training, handling, and housing dogs.

SIDE EFFECTS

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

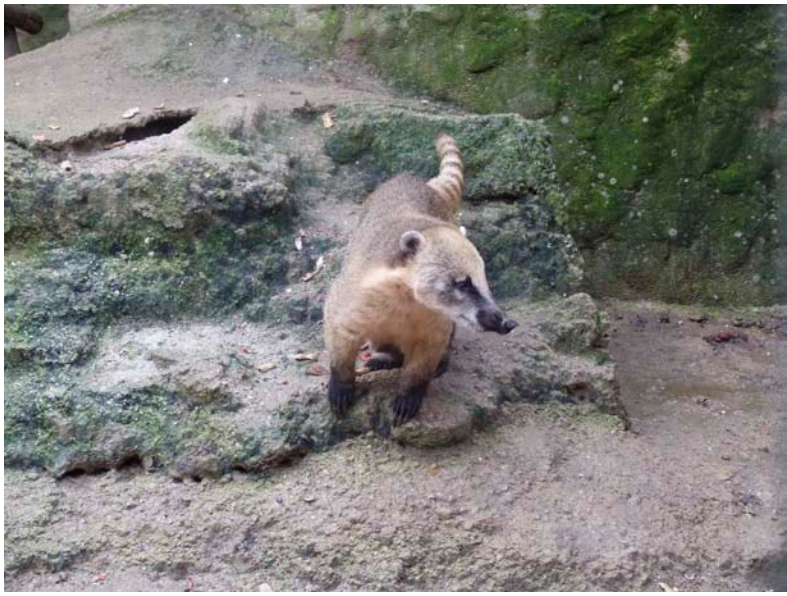
Professional shooters were used effectively in Mallorca, with a very low risk of non-target shooting of other species, due to the knowledge of the professionals undertaking the culling. The nature of the species and the use of experienced staff reduce the risks to animal welfare. The use of firearms close to human habitation raises safety concerns, and additional measures may be needed to mitigate these risks.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

Shooting of vertebrates can raise opposition from some sections of society, especially from animal welfare groups. However, this approach is widely used to control other species without widespread opposition, provided care is taken to ensure a quick and humane kill.

Adult coati's can weigh between 2 and 7.2 kg and grow between 85 and 113 cm long, with half of that length being its tail. © Archive of Institute Symbiosis



ADDITIONAL COST INFORMATION

The use of dogs similar to those trained to locate other species (such as foxes or badgers) should be considered.

LEVEL OF CONFIDENCE*

Well established.

This method has been successfully applied to the species in Mallorca (based on direct personal experience of the author) and is widely used around the world for the control of other invasive vertebrate species (see Orueta, 2003, 2007).

Trapping using live traps.

MEASURE DESCRIPTION

Tomahawk traps (see https://www.livetrap.com/index.php), or similar live traps, are effective to capture *Nasua nasua*, with dimensions of 1.0 m × 0.4 m × 0.4 m or more. The traps must be equipped with a door retention system to prevent reopening by the animal. Descriptions of suitable designs are given in Orueta (2007). The bait that has been shown to be most effective in summer is watery fruit such as melon, although meat and cat food can also be useful (author's personal experience). Traps should be provided with water and shade to protect the welfare of captured animals and should be checked at least daily. Remote (MMS) cameras that send pictures to a phone or email address once the trap has been triggered can also be used. This measure can be applied in conjunction with shooting, as was undertaken in Mallorca, in order to achieve eradication.

In the recent UK case, once the pair of coatis were detected (see Ashcroft 2019), the individuals were lured to the ground using fruit (grapes), and a fox trap with a string trigger was used to capture the first individual. The second individual was more timid, and was captured using a fox trap with a treadle trigger (Julia Coats, pers. comm.).

SCALE OF APPLICATION

Regional: The traps should be located where the presence of the species has previously been indicated. If there is suspicion of a group of animals, several traps may be needed.

EFFECTIVENESS OF THE MEASURE

Effective.

The Mallorca experience indicates that the system is effective, but not sufficient to ensure eradication on its own. However, in the UK, the two individuals were both removed through trapping.

Based on the author's experience, traps were used effectively (in conjunction with shooting and camera traps) to eradicate the species in Mallorca. In particular, traps allowed the capture of solitary animals, as well as some females with their young (12 animals in total). There were three captures of the same female (a 'Judas' animal, see below), which shows that the method is effective and does not generate learned avoidance by the animals. If a female is captured, often the young and/or other females remain in the vicinity, where it is easier to capture or shoot them. To be effective, trap sites should be selected by expert personnel with a knowledge of the species habits.

In Mallorca, the best results were obtained with large traps measuring 1 m on their largest axis, made of metal (electro-welded grid), with a wooden box for the bait. Handling precautions must be taken to avoid human odours on the trap.

In the UK, the critical aspect was using the correct trap, as if the trap is too small (for example, a badger trap), the animals will not fully commit, which risks the individuals not being captured, or being injured (especially as the species has a long tail that can be damaged by the closing mechanism) (Julia Coats, pers. comm.).

EFFORT REQUIRED

In Mallorca, the trapping programme required 6 to 12 man-days of effort per capture (location and checking of traps), and the traps were in the field between ten to fifty days.

RESOURCES REQUIRED

The commercial cost of the trap can be as high as € 1,000 for the larger ones, but it can be reduced considerably (ca. by half) if they are built by hand (locally). However, it must be totally metallic and strong enough to prevent the escape of captured animals. Vehicles to transport the trap, and expert personnel in its handling/checking, are also required. Euthanasia of the captured animals needs to be undertaken in the most humane way possible, and by a skilled professional. A shot to the skull is recommended, or injection of a lethal product (Euthacol) by veterinary supervision.

SIDE EFFECTS

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

* See Appendix

While non-target species can be caught, the traps allow these species to be released unharmed (again, it is recommended that traps are checked at least once a day). The use of an explanatory sign to avoid vandalism should be considered.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

Traps carry the risk of interference or vandalism. Although the traps are non-kill traps, they may be seen as unethical by sections of society.

ADDITIONAL COST INFORMATION

No information available.

LEVEL OF CONFIDENCE*

Established but incomplete.

There is evidence from its application in Mallorca and the UK.

Include the species among those that can be legally taken by hunters.

MEASURE DESCRIPTION

This measure should be applied across the entire area where species presence has been confirmed. It may require, according to the regulations of each state, an individual permit for each hunter, or the inclusion of the species within general hunting regulations (as was done in Mallorca). In the case of an official eradication plan, it is important to include this measure in the regulations, so that the species can be taken at any time and any place, opportunistically by hunters.

A European code of conduct on hunting and invasive alien species has been published by the Council of Europe (Monaco *et al.,* 2016), which aims to provide a set of voluntary principles for hunters and hunting managers to be adopted in order to, amongst other issues, strengthen the contribution of hunters to the management and conservation of biodiversity.

SCALE OF APPLICATION

National or sub-national (depending on the regulations).

EFFECTIVENESS OF THE MEASURE

Effective.

Shooting is an effective control technique for eradication of carnivores (Orueta, 2003). While the use of voluntary hunters is unlikely to be effective to eradicate a population, it is an effective (and cost-efficient) part of an eradication programme (as was done in Mallorca). While adding a species to the list of species that can be hunted carries a risk that hunters may want to maintain the species in the longer-term, for coati there is no sport or gastronomic value from hunting, so this risk is considered small. In addition, hunters will not want the species to establish, due to its possible impact on game species, and they can be very effective collaborators for their control (based on the author's experience in Mallorca). However, hunters may not be good at reporting all kills, which may underestimate the size of the population in an area and complicate monitoring towards eradication if this is based on declines in catch per unit effort.

This measure was adopted in the Mallorca eradication programme, where at least one third of the animals killed were shot by private hunters, who could respond quickly if an animal was found, without calling on permission or support from the authorities.

In addition, voluntary hunters are effectively used to support official control programmes of raccoon dog in Sweden, Denmark, and Finland. While it is unlikely they will be able to eradicate a racoon dog population totally by themselves, they are a cost efficient measure to control species numbers (Dahl and Åhlén, 2017).

EFFORT REQUIRED

Relatively little effort is required, only by the authorities to make and communicate the administrative changes and engage with the hunters (through associations etc.) to inform them of the species characteristics (identification, behaviour etc.).

RESOURCES REQUIRED

No special resources are required for this administrative measure. Hunters need to be communicated with, but they will have all the required equipment and skills.

SIDE EFFECTS

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

Negative impacts may include a desire from some hunters to maintain the species in the longer term (considered a low risk for coati, see 'effectiveness' above), though the engagement with hunters should increase their awareness of the impacts of the species and IAS in general so they may

* See Appendix

be more likely to report additional IAS sightings. In addition under-reporting of the numbers removed and possible non-target shooting of other species.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

Hunting can be opposed by sections of society and, if not implemented responsibly, can raise animal welfare issues. As such, it is advisable to adopt this measure with care, and ensure that the despatch of animals is quick and efficient, avoiding unnecessary suffering.

ADDITIONAL COST INFORMATION

No information available.

LEVEL OF CONFIDENCE*

Established but incomplete.

This approach was used with success in Mallorca.

Judas animals.

MEASURE DESCRIPTION

This method has not yet been conclusively used on this species, but the coati is a social species (Hirsch, 2011), supporting its possible effectiveness. It requires the capture of an animal, sterilising it (not neutering), fitting it with a terrestrial or satellite radio transmitter, and then releasing it back into the wild. The animal is then tracked as it searches for and joins other free-living social groups, which can then be removed using conventional eradication methods as described above (Campbell and Donlan, 2005).

In other species (goats), this method has typically involved the use of females; forced oestrus females have also been used to specifically attract adult males, which is known as the *Matahari Technique* (Hall, 2017).

SCALE OF APPLICATION

Local, where the species presence is confirmed. Judas animals are also used in Nordic countries to find racoon dogs; once an animal stays in the same area (100–2,000 ha depending on habitat) for several days, it is located to see if it has found a partner (see Dahl and Åhlén, 2017).

EFFECTIVENESS OF THE MEASURE

Effective.

The principle of the method is well established in other mammal species, and the social nature of coati suggests it may also be effective for this species. However, the only trial done in Mallorca was inconclusive due to problems with the radio transmitter fitted to the animal. The use of this method significantly reduced the cost and time taken to eradicate goats from islands (Campbell and Donlan, 2005). According to Dahl and Åhlén (2017), Judas animals are most effective when deployed in low density populations.

EFFORT REQUIRED

It is not possible to evaluate the effort (number of work days for each catch), since it depends on several variables: total number and density of animals present, characteristics of the area, skills of the operators, etc.

RESOURCES REQUIRED

The initial capture of the Judas animal by trap, veterinary intervention, radio tracking transmitter and expert personnel for its application, in combination with the professional shooter or trapper (detailed above). The Judas animal(s) will also need to be housed in a secure location when not deployed in the field.

GMS Satellite collar, which costs ca. €2,000–2,500, plus €500 for the battery. In the racoon dog situation on Nordic countries, one person can manage 20–25 Judas animals (Dahl and Åhlén, 2017).

SIDE EFFECTS

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

No side effects are expected, as long as the Judas animal is sterilised.

ACCEPTABILITY TO STAKEHOLDERS

Neutral or mixed.

This method may raise concerns from some sections of society, particularly animal welfare groups. Careful consideration of local conditions and handling of communications is needed to reduce the risk of opposition.

ADDITIONAL COST INFORMATION

The cost of this technique is relatively high, including initial effort for capture, surgical sterilisation, purchase of radio-transmitters, expert staff, time, etc. However, these must be balanced against the likely savings in time and effort required to achieve eradication, particularly in the later stages when population density is low.

LEVEL OF CONFIDENCE*

Established but incomplete.

There is limited experience using this measure with coati, but there are established cases of its use on other species.

* See Appendix

Measures for the species' management.

See all procedures described for *Rapid eradications*.

MEASURE DESCRIPTION

Based on the author's knowledge, there are no additional measures currently suitable for the management of this species other than the reduction (leading to eradication) of population numbers through the use of the techniques described above (photo-trapping, removal by shooting, or capture in traps etc.). Other control methods such as toxins, introduced diseases, immunocontraceptives, and gene drives are measures that could potentially be implemented in the future (see IUCN, 2017). However, these are not discussed in detail, as they have not been applied on the species, and are also not currently considered practical, acceptable or available for use in Europe.

Nasua nasua *can be found in the lowland forests east of the Andes.*
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Appendix

- **Well established:** comprehensive meta-analysis or other synthesis or multiple independent studies that agree. *Note:* a meta-analysis is 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.
- **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.

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