An Indian house crow (Corvus splendens) *prepares to ingest a chunk of wholemeal bread. © GerifalteDelSabana. CC BY-SA 4.0.*

The management of Indian house crow (*Corvus splendens*)

Measures and associated costs

Scientific name(s)	*Corvus splendens* (Vieillot, 1817)
Common names (in English)	Indian house crow
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Common names

BG	Индийска домашна врана
HR	Indijski gavran
CZ	Vrána domácí
DA	Indisk huskrage
NL	Huiskraai
EN	Indian house crow
ET	Õuevares
FI	Intianvaris
FR	Corbeau familier
DE	Glanzkrähe
EL	–
HU	Indiai varjú
IE	–
IT	Cornacchia delle case
LV	Indijas vārna
LT	Indinė varna
MT	–
PL	Wrona orientalna
PT	Corvo-indiano
RO	–
SK	Vrana lesklá
SL	Domača vrana
ES	Cuervo indio
SV	Huskråka

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

It is important to note that there are currently no established Indian house crow populations within the EU, at most there are only a few single birds spread over a large area in the Netherlands, together with one single individual recorded each in Ireland and (North) Cyprus. In addition, as the species is listed on the EU IAS Regulation, any new populations within EU Member States should be rapidly eradicated, and this should be the priority course of action. Therefore, any of the management measures applied to widespread or established populations discussed here are not currently needed, nor should be in the future within the EU context. While sole control measures as management have never led to a confirmed established Indian house crow population eradication or significant reduction, and often create costs without positive sustainable effects, the risk of taking a 'do nothing' approach that allows unrestricted Indian house crow population growth has led to catastrophic situations in some of the affected non-EU countries. The focus of any management of the species within the EU should always aim for an early eradication, and must be planned and funded in such a way that it can quickly succeed. Appropriate post-intervention monitoring should be applied to ensure no Indian house crow has survived.

Prevention: The Indian house crow is a very mobile and adaptable species. While its invasion in East Africa, the Arabian peninsula and Malaysia was a result of deliberate introduction for reasons of enhanced pest control, the main pathway of the species' introduction (aside from natural spread within countries where it is established) in the last 100 years has been through transport as a stowaway on ships. This is often cargo and container ships as they offer many possibilities for safe nesting or shelter, and are used by the crows while the ships are anchored in ports that have established, often large colonies of Indian house crow. Once reaching new coastlines or ports, birds leave the ship, disturbed by loading/unloading procedures or juveniles in the nest are immature (Cheke, 2008). Any prevention of unintentional introductions or secondary spread must therefore target the shipping as a pathway, either pre-embarking, or on route. From an EU perspective, increased bio-security at ports of origin (with Indian house crow populations), proactive elimination of Indian house crow populations in non-EU neighbouring countries or from countries with main shipping routes to the EU, would help address this risk. In addition, including Indian house crow as a public health risk in the system of International Health Regulations – Ship Sanitation Certificates (SSC) and Exemption Certificates (SSCEC) would support addressing the risk on route. Indian house crows have been recorded from three countries within the EU in the last five years, and any transport from such sites must be prevented.

Early detection: Indian house crows are highly mobile and vocally active birds, so the chance of their detection is high if observations are done at the right places and by knowledgeable persons. Once someone is familiar with the features of the Indian house crow, recognition will be straightforward, as the species has distinguishable habits and sound. However, in small numbers (i.e. in the earliest stage of a new invasion) and when invading new and hitherto unknown locations, Indian house crows tend to "lower their profile", contrary to the dominating behaviour they display over other birds when they are more numerous. Indian house crows mix with other *Corvid* species like native crows, ravens and rooks, making it easy to overlook a few Indian house crows among such groups of black birds, as size, colour and even some sounds are similar to those of Jackdaw, *Corvus monedula*, or Rook, *Corvus frugilegus*. The species tends to be restricted to ports and coastline settlements for a prolonged period of time after initial invasion, allowing for detection by simple bird observations. Improving detection capacity at ports and vulnerable sites could be achieved by training staff to identify Indian house crow and making it part of their regular routines. In addition, scanning databases and internet resources of bird-watching clubs, bird curiosity platforms and social media websites, will support detection across broader geographic areas at low cost and without specialised personnel.

Rapid eradication: As for any newly detected invasive alien species of Union concern, rapid eradication is critical, and this is particularly true for Indian house crows since, to date, no established populations are present in the EU. Possible introductions are likely to be limited to one or two individuals, though often a reported single bird has one or two undetected associated individuals, so immediate confirmation of population size needs to be done by skilled people. Due to the recognisable living patterns, vocal activity, usage of closest possible resources, communal roosting behaviour etc., the invasion situation can be assessed within a few days. Based on the findings, eradication must be initiated as soon as possible. Indian house crow have a nesting season with prolonged nesting activity leading to four juveniles maximum per breeding pair. Therefore the risk of sudden population explosion following on from a small Indian house crow invasion does not exist, which could provide an eradication management window of a few years, however it is strongly recommended that detection and eradication occurs within three months of confirmed detection, as beyond this (for example six months) costs will increase and public perceptions may begin to favour the presence of the species. In addition, as the Indian house crow is a species of Union concern, the EU IAS Regulation

requires that eradication measures are started within three months of an early detection (Art. 17).

In terms of the measures for rapid eradication, lethal removal by shooting Indian house crows on selected sites (making usage of their regular behaviour) is the most cost-effective way to proceed quickly. Due to the risks associated with firing live ammunition in urban or port areas, a highly skilled/trained person is required. Health and safety regulations, as well as all legal aspects of gun law and gun usage must be strictly followed in such operations. It is important to note that, with any eradication or management measure, Indian house crows learn to avoid perceived threats and can recognise individuals. Therefore, unless sufficient firearms can be deployed in the field to put all birds at risk of culling, no shooting upon groups of birds should be conducted as the shooter, as well as the overall threat of persecution, are very quickly recognised by the Indian house crows and will result in strong avoidance behaviour. This might lead to secondary spread of the remaining birds into different areas and the surrounding region. Trapping with live traps is another possible method for rapid eradication of a small new invasion, though this is less effective to achieve rapid eradication.

Management: The use of chemicals (poison or stupidants) to catch and then euthanise Indian house crow individuals has been widely applied to reduce established populations around the world (there are no confirmed eradications with this method). However, this measure has potential negative impacts upon other (native and perhaps protected) bird species, and there are legal restrictions that need to be considered. Poisoning by use of the USDA developed Avicide "Starlicide"® (DRC 1339) is target specific for crows and highly effective if large numbers of birds need to be tackled. Yet the use of Avicides is restricted within the European Union, so its use within an eradication operation will probably only be possible in a neighbouring country/region (as a method for prevention of ship transport into the EU, see above under *Prevention*).

Given the current situation of the species in Europe, eradication must be the goal of any management of the species in the EU. To achieve this a combination of measures is most likely necessary (for example, shooting and trapping). It is important to stress that Indian house crows are very clever, highly opportunistic and constantly adapting and learning about human actions. Hence one can manage the bulk of an established population, but also create a maximal educated group of birds. These 'experienced' birds will likely migrate into neighbouring areas and establish new populations. Given their experience, such new populations will then be even less susceptible to any management measure.

Additional deterrent measures (often combined) applied outside the EU are not discussed here, and include building proofing, landscape manipulation, scaring, sound or optical repelling including bird-laser use, scaring or hunting with trained falcons, garbage sanitation or similar control/social context measures. None of these will limit population growth significantly and Indian house crows will always find new resources and strategies to profit from. Here, we focused on methods that offer realistic prospects of prevention, eradication, or management of Indian house crow populations.

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.

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

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.

Public awareness and voluntary control.

MEASURE DESCRIPTION

The best way of safeguarding the EU coasts and ports would be to deny the access of Indian house crows onto ships that are destined for European ports. International ships are understood as the most important, if not the only pathway of introduction of Indian house crow from other invaded continents (or from native range countries) to Europe (Parrot, 2011; Ryall, 2008 in Woolnough *et al.*, 2008). To be effective, awareness raising activities and local controls (biosecurity checks and measures in ports and on ships) would be needed in those ports of origin identified to be potential sites for Indian house crow embarkation onto ships destined to EU ports.

SCALE OF APPLICATION

Due to the large area the Indian house crow has invaded and colonised so far in around 30 countries outside its natural range (Lever, 2006; Ryall, 2002; Meier and Ryall, 2008), and the immense quantities and types of ship traffic with permanently changing routes involving owners and companies from around the globe, this measure is likely to be impossible to be effectively applied at a global or even inter-continental scale. It could be applied at a smaller scale, such as choosing those ports in the Mediterranean which have Indian house crow populations established, especially the city of Port Said, Egypt and adjacent areas of the Suez Canal (Kamel, 2014). However, even this would still cover a very large area and number of shipping lines and authorities.

Therefore, it may be advisable to further reduce the scale of application (in regard to number of locations, not necessarily geographical extent) by concentrating on the development of action plans for unintentional introductions (including *Early detection* and *Rapid eradication* measures, see sections below) for those ports at risk within the EU. This will include all ports that receive ship traffic from the Atlantic side of Africa or via the Suez channel. Those ports, within the EU, known to have a record of Indian house crow in the recent past are Rotterdam/the Netherlands (Ottens and Ryall, 2003), Cork/Ireland (Moore, pers. comm.) and a peninsula in North-Cyprus on the island of Cyprus (Richardson, pers. comm.). Note that none of these sites have delivered proven records of eradication so far.

EFFECTIVENESS OF MEASURE

Unknown.

Such measures would require the involvement of many different actors, across a large geographic area, to provide educational and control measures at the required ports of origin. As there would be no practical way to supervising these areas, across the shipping connections and the different actors involved, it is highly unlikely that these measures would be effective.

EFFORT REQUIRED

These measures would need to be in place permanently.

RESOURCES REQUIRED

Resources required are not known, but are likely to be very high.

SIDE EFFECTS

Environmental: Positive
Social: Neutral or mixed
Economic: Negative

Closer cooperation with the shipping and port actors would be beneficial and would raise the issue of Invasive Species prevention at large. However, costs would be borne by non-EU countries and the private sector, who may see it as unnecessary bureaucracy and expenses.

ACCEPTABILITY TO STAKEHOLDERS

Foreign (non-EU) port authorities, and shipping companies, may not be favourable to European agencies or governments examining/monitoring their work and routine, especially if only done to protect the European continent. Sharing data would be necessary, raising potential issues of data protection and storage. While some stakeholders may endorse such measures as it provides opportunities and work, others are likely to actively or passively oppose it and hence undermine the efficacy of the overall operation.

ADDITIONAL COST INFORMATION

The costs likely involve many unknown issues but, since the measure is judged ineffective, an attempt to gather or calculate costs is neither useful nor attempted here.

LEVEL OF CONFIDENCE[1]

Established but incomplete.

Examples from current trade disputes and customs challenges provide a view into the complexity of such a system and its vulnerabilities. It might be that positive examples of similar actions were missed or are not known, but the general information basis is judged as sufficient.

1 See Appendix

Removing populations of Indian house crows at port sites.

MEASURE DESCRIPTION

To reduce the risk that Indian house crow individuals embark onto ships (cargo or leisure) that are destined for European ports or coasts, the known Mediterranean port sites that have invasive Indian house crow populations established could be supported with funds and expertise to eradicate these populations (see *Eradication* and *Management* sections below). The aim would be to create a 'buffer' and allow for an early warning for the most vulnerable ports in Europe (such as those at the EU Mediterranean coastline). Known populations can be targeted and other sites should be investigated/monitored, as populations have been reported from other North African or East Mediterranean countries (Roll *et. al.*, 2008) but are not all confirmed.

SCALE OF APPLICATION

The measure needs to target the entire population of Indian house crows in the respective port and city, ideally eradicating all individuals from the area, or at least suppressing the population constantly by 40-60 %, as this has shown elsewhere, for example in Mauritius or Saudi Arabia (Gopal, 2016; Ruhoman, pers. comm.; Felamban, pers. comm., Woolnough *et al.*, 2008), to keep population development in check.). However, the risk with such permanent control is that educated birds will flee the area, creating an extension of the invasion to surrounding environments, or representing a bigger risk of getting onto departing ships (Meier and Haverson, 2016).

The areas that would require this measure are different in both geographic scale and population size of birds, ranging from a reported dozen Indian house crows in Çannakale, Turkey (Ryall, 2016; Annonym., 2017), covering a territory of probably still only some km², to ten thousands in Port Said/Egypt and surrounding coastal and Suez channel area, covering around 1,500 km² (Kamel, 2014).

Large-scale operations against Indian house crow have been implemented before elsewhere (for example, Ash, 1984) and can be successfully implemented if planned accordingly and funded until the eradication is confirmed.

EFFECTIVENESS OF MEASURE

Neutral.

The measure will likely be effective, as it addresses the major points in Northern Africa and the Mediterranean coast where the Indian house crow can embark onto ships and, given the speed of modern engines, comparably easily reach European coastline. These sites are likely responsible for the invasion existing in Çannakale, Turkey and Northern Cyprus.

While this measure will not completely rule out the risk of Indian house crow travelling on ships from other regions like the southern or western African coast (which have single records but may be underreported), it will reduce the probability of an introduction event, which is already relatively low, making this an effective measure. However, it has little implication for the EU's Atlantic ports, which are far away from the Egyptian sites, but still have had records, probably from unknown populations along the west coast of Africa (Portier, pers. comm.; Bergiera *et al.*, 2005). The removal of the currently few birds from the Dardanelles, Turkey will go a long way to secure that invasive Indian house crow makes no passage further into the Black Sea and thus helps to protect the EU Member States of Bulgaria, Greece and Romania against Indian house crow invasion at their coastlines.

EFFORT REQUIRED

The effort varies with the size of the populations, for example a few birds in Turkey will demand circa 2 weeks of onsite operations, but a large scale campaign, as would be required in Port Said, will need around two years of constant efforts due to the much larger size population (Meininger *et al.*, 1980). New measures need to be taken if/when new invasions are reported at these sites or once the population has built up – depending on the approach taken (eradication or permanent control) and funds available.

However, it needs to be stressed that the earlier in the stage of invasion the eradication is undertaken, the less funding is needed over time (Suliman *et al.*, 2011a).

RESOURCES REQUIRED

Exact costs are not known, but it is estimated that ca. €10,000 would fund the removal of less than a dozen isolated birds, to probably up to €500,000 needed for a large scale operation using poison and trapping as demanded for situations like in Port Said (see eradication and control tables below). Local cooperation will be crucial for knowledge of sites. Surveillance programmes are a prerequisite for success and must run much longer than the eradication programme itself. As such, local bird watching groups and specifically trained staff need to be on the ground for an additional six months to one year after project closure to confirm eradication success, but also to maintain longer term monitoring for potential re-invasion at the sites. A public awareness campaign at the sites of eradication on the impacts of Indian house crow and the need for its eradication would also be needed.

An Indian house crow (Corvus splendens). © *GerifalteDelSabana. CC BY-SA 4.0.*

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Positive
Economic: Positive

Besides the intended impacts of the measure aimed at protection of European sites, there will be also an immediate positive effect on the local (non-EU) sites and communities, including the halting of the impacts from the invasive Indian house crows on the environment, economy, and human health. Negative impacts to native non-target species may result from control activities, especially for large-scale programmes.

ACCEPTABILITY TO STAKEHOLDERS

If finances are provided from external parties, local communities and decision makers are likely to support the measure, as they will benefit from the relief of the impacts of the species, and at least temporarily create new jobs. As a small risk persists that some groups or individuals see such actions as intervention on their national issues, cooperation actions must be stressed and developed from the very beginning.

ADDITIONAL COST INFORMATION

The **cost of inaction** is not possible to calculate, but undoubtedly extending an Indian house crow invasion free zone in the Mediterranean will provide the whole Union the buffer area needed to safeguard its territory against an invasion of Indian house crow.

The **cost-effectiveness** is estimated to be high, at least where satellite populations of Indian house crow that are very close to the EU border (for example Çannakale/Turkey) are eradicated. Such measures could be jointly funded and co-ordinated between the EU and the country where the eradication is needed. Such measures undertaken to date have shown that providing funds only to organisations attempting to undertake Indian house crow eradication (or reduction) is no guarantee for success (Meier, 2013). The issue of re-invasion must be addressed too, in particular for the large Egyptian populations, where even isolated places at the Red Sea are reached (Kinnear, 1942; Shepherd, 2000; Jennings, 2004; Ryall and Meier, 2008), but their isolation also allows for targeted action.

Socio-economic aspects are seen as neutral since funding needs to be provided, but will minimise actions needed within EU Member States. The invaded countries will benefit through a reduction in future control or mitigation costs in the long term.

LEVEL OF CONFIDENCE[1]

Inconclusive.

The approach of buffering invasion-free zones has been applied at various other scenarios, when source populations of introductions are tackled to secure free or freed areas (Veitch and Clout, 2002; Veitch *et al.*, 2011; Veitch *et al.*, 2019). The situation with Indian house crow is easier to observe since the bird is more detectable than many IAS for example amphibians, invertebrates or weeds. Thus the data situation is robust enough to allow for the above conclusions here, even though it has not yet been applied to the species.

1 See Appendix

Integration of Indian house crow as a public health risk in the system of International Health – Regulations Ship Sanitation Certificates and Exemption Certificates.

MEASURE DESCRIPTION

Indian house crows are – besides their environmental impact – known vectors/carriers of various organisms detrimental to human health, for example Salmonella, Coli bacteria, West Nile Virus, New Castle Disease, Avian Influenza etc. (Al-Sallami, 1991; Jennings, 1992; Cooper, 1996; Roy, 1998; Nyari *et al.*, 2006).

The role of the SSC/SSCEC is to assess, document and mitigate public health risks on board ships on international voyages and document all risks to port authorities on the ships' route. Ships not possessing valid Ship Sanitation Certificate will be inspected regarding vectors which might carry diseases contagious to humans, upon arrival at port. Vectors are defined as "an insect or other animal that normally transports an infectious agent that constitutes a public health risk" (WHO, 2011). If there is evidence of public health risk, including presence of vectors, the inspection authority will detail and, if necessary, undertake the measures required. Then, a Ship Sanitation Control Certificate is issued detailing the control measures, and suggesting preventative measures for the ship. If no evidence of a public health risk is found on board, a Ship Sanitation Exemption Certificate is issued (valid for 6 months).

The required inspections are done under law of the WHO and regulated in the EU under the jurisdiction of the Health and Safety Commissioner, supported by the EU SHIPSAN ACT partnership (Mouchtouri *et al.*, 2018). Being an officially established process (since 2005, when it replaced the Deratting Certificates), the addition of Indian house crow to the issues to verify on board will allow for measures to be taken to remove Indian house crow stowaway birds while still being in the wider area of their origin, such as most likely not affecting not yet invaded countries. If no lethal control is technically possible, authorities in ports will be made aware of the presence of Indian house crow on board.

SCALE OF APPLICATION

The measure needs to be applied within the existing SSC framework, such as for all the WHO listed ports and sites under control, which are currently more than 2,000 ports (WHO, 2019), hundreds of which are under EU responsibility. If an endorsement of the action is not feasible at a global scale (for example countries within the native range of Indian house crow do not support this measure), an implementation within the EU area could be sought, if such process is legally possible within the existing WHO standards.

EFFECTIVENESS OF MEASURE

Unknown.

If accepted, it would be a binding process requiring the removal of stowaway Indian house crow individuals and nests before they pose a threat to human health (and to non-invaded areas). However, uninspected ships, poor inspection quality or the departure of birds prior to the inspection (flying to land) would limit the reliability and effectiveness of the measure. A risk of less comprehensive inspections poses risks that ships are declared free of Indian house crows, while in fact a bird (potentially with nests) is carried, and delay early detection and rapid response measures, as the inspection results are usually not questioned

EFFORT REQUIRED

The effort would need to be ongoing and be routinely applied.

RESOURCES REQUIRED

No extra resources are required, as the system is already in place and running, being paid for by the shipping industry/ship owners and partially international governments. The extension to include Indian house crow (as a carrier of diseases posing a human health risk) as a vector for Ship Sanitation Certificates inspections would need policy engagement and development through the WHO committee. However, keeping the WHO system up-to date is ongoing, so no extra costs will occur. The only additional resources required would be skills and equipment needed to remove Indian house crow when detected on board, though many of the competent authorities pest removal services would have these.

SIDE EFFECTS

Environmental: Positive
Social: Positive
Economic: Neutral or mixed

Depending on how the measure's primary intent is viewed, to either reduce impacts to human health or the environment, the side effects to the other sector will be positive. No economic side effects are envisaged.

ACCEPTABILITY TO STAKEHOLDERS

While it is expected that the measure will be acceptable by many stakeholders, it may not be accepted by some shipping operators and inspectors. Operators from the native range of the Indian house crow (Pakistan to Myanmar) may not see the sense behind such measure, and operators and inspectors might reject the need for it

based on the additional work, costs and bureaucracy etc. In addition, Indian house crows have spiritual and religious values in some Asian regions and are possibly welcomed by some sailors on long journeys and rather liked on board (Woolnough *et al.*, 2008). Hence, clear opposition of crews to the measure might exist.

ADDITIONAL COST INFORMATION

No major additional costs would arise, as the system is already in place. The only additional costs would be for the removal by the shipping operators if Indian house crows are detected, but these are not costs for the EU Member States or controlling agencies.

LEVEL OF CONFIDENCE[1]

Established but incomplete.

The exact procedures of the ship inspections are not known to the author, hence a detailed investigation of the appropriateness of the process in combination with the proposed measure is needed to give better verification of the aspects stated here. Such investigation might show that the issue is much more complex than detailed here.

1 See Appendix

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

Prevention of secondary spread within the EU via transport by ship.

MEASURE DESCRIPTION

The information provided regarding the prevention of ship-assisted transport of Indian house crow into EU territory (un-intentional introductions) also applies to the issue of avoiding secondary spread (via shipping) once Indian house crow has invaded a site within the EU. Please see the above section for details, as the aspects are identical and hence will not be repeated here. The aim behind the measures is to avoid Indian house crow spreading further via ship transport (as a hitchhiker) or into neighbouring areas, and to establish surveillance for inland spread.

The existing records of the species in the EU include (note: there are no confirmed eradications for these populations): Hoek of Holland, where a pair arrived in 1994 and grew to ca. 35 birds and where eradication was attempted; in the port of Cork, Ireland, an individual was reported in 2010, with the bird last seen in 2014, and may have originated from the Hoek of Holland population; North Cyprus, where one individual was recorded in 2011 (Ryall, 2016).

SCALE OF APPLICATION

The above mentioned details (please see above section under *Prevention of unintentional introductions and spread*) need to be applied in a concentrated manner around any site of invasion, but also in neighbouring countries, and sites/ports linked by shipping routes.

EFFECTIVENESS OF MEASURE

Please see above section under *Prevention of unintentional introductions and spread.* In case of the Ireland example, a "doing nothing" approach was chosen, so no example on effectiveness exists.

EFFORT REQUIRED

Please see above section under *Prevention of unintentional introductions and spread.*

RESOURCES REQUIRED

Please see above section under *Prevention of unintentional introductions and spread.*

SIDE EFFECTS

Environmental: Positive
Social: Neutral or mixed
Economic: Negative
Please see above section under *Prevention of unintentional introductions and spread.*

ACCEPTABILITY TO STAKEHOLDERS

Please see above section under *Prevention of unintentional introductions and spread.*

ADDITIONAL COST INFORMATION

Please see above section under *Prevention of unintentional introductions and spread.*

LEVEL OF CONFIDENCE[1]

Please see above section under *Prevention of unintentional introductions and spread.*

1 See Appendix

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

Improving detection capacity at vulnerable ports/ sites and adjacent coastal areas.

MEASURE DESCRIPTION

The species primary pathway of introduction into the EU is as a hitchhiker via shipping, therefore staff of selected administrational units (for example, customs), port authorities and perhaps local nature organisations/bird watching groups need to be made aware of the species and its possible introduction, along with its potential impacts and how to identify it (for example, GB NNSS, 2012). The chosen personnel needs to be trained, and ideally a government focal unit assigned (for example, existing invasive alien species units) as the authority to receive possible Indian house crow recordings for verification and follow up. Port staff would obviously be responsible for port sites, but NGOs or national wildlife authorities could also cover additional priority areas, including adjacent coastlines and islands.

Once aware/trained, observers should look at any suspicious *Corvid* species and provide a photographic/video evidence to send to experts for verification. Such a process can be efficient with use of smartphone apps (many already exist for IAS within Member States).

SCALE OF APPLICATION

There is no existing example of such a system for Indian house crow. While desirable for all ports in the Union's Member States, it is more realistic to establish such measure within priority areas, for example ports and adjacent coastal areas with regular international shipping traffic. It is realistic to ignore all entirely landlocked Member states for this measure.

EFFECTIVENESS OF MEASURE

Effective.

All Indian house crow birds that have been confirmed in the EU were reported initially by bird watchers scanning coasts for seasonal birds etc., therefore it is believed that by training staff at vulnerable areas they should be able to relatively easily and accurately detect Indian house crows if introduced. Also, it is important to note that there is at least some kind of detection capacity at some ports (by random monitoring by various professional and non-professional observers), as proven by the detection already taken place (though it is unknown how rapidly the detections occurred).

EFFORT REQUIRED

The identification capacity would need to be in place permanently at vulnerable sites (EU ports with major routes with areas where Indian house crows are present, both alien and native), and therefore training and resources would need to be provided at regular intervals. While the window in which rapid eradication measures are technically feasible is estimated to be a few years (such as before the population becomes too large or spreads to other areas), it is strongly recommended that detection and eradication occurs within three months of introduction, as beyond this (for example, six months) costs will increase and public perceptions may begin to favour the presence of the species. In addition, as the Indian house crow is a species of Union concern, the EU IAS Regulation requires that eradication measures are started within three months of an early detection (Art. 17).

RESOURCES REQUIRED

The production of training materials (which could be done at EU level and translated) and development of a smartphone application (or inclusion of Indian house crow in existing IAS apps) is required. No extra staff are needed to undertake the monitoring, but it needs to be part of the daily routine of those groups working in the relevant high risk areas/ports and coastline services.

A small degree of training needs to be given to selected staff, but this is simple to implement (for example, providing a poster and short video on the Indian house crow and its identification, with information on relevant points of contact). This system is already used in Australia with the coast guard and customs, successfully covering the large administration unit of Western Australia, where occasionally arriving Indian house crows have been detected, identified and shot (Woolnough *et al.*, 2008), and where the public have been asked to report any sightings immediately so they can be removed humanely (DAF, 2008).

For personnel working in the field of trade-control (customs, veterinarians) or security, such task will be just a small addition to their regular tasks, not demanding extra time, and thus can be followed up easily.

A local or national focal unit (many of which already exist within EU Member States) must be ready and equipped to receive suspicious notifications and have the capacity (or access to capacity) to verify records quickly. There needs to be enough surplus capacity to deal with well-intended, but wrongly identified records handed in (especially in the beginning of the measure), to ensure that interest and motivation remain for staff on the ground to further notify possible records.

SIDE EFFECTS

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

ACCEPTABILITY TO STAKEHOLDERS

The acceptability should be high among staff working in areas like customs, border security, biosecurity, veterinary, cargo safety and sanitation that are already dealing with similar issues. However, some individuals may reject such a measure, as it may be seen as additional (less important) work, which could result in an ineffective monitoring system. A well explained voluntary approach might be more useful, even if at the beginning it just covers some sites or areas. Birdwatchers and nature organisations are possible cooperative partners that would mostly support such a measure, but not automatically, since some enjoy seeing new birds and recording them. Further, some birdwatchers and other members of the general public may not report sightings or welcome such a system, as it may result in lethal action, which they may disagree with (Ottens, 2003; Meier, pers. obs.; Birdlife International, pers. comm.; Vane and Runhaar, 2016).

ADDITIONAL COST INFORMATION

No extra costs are expected to arise because of the described measure. **Costs of inaction** will therefore be potentially high, as any resulting invasion will consequently only be recognised at a later stage, when it will be much more problematic and costly to remove animals. To give a vague cost example, the difference between removing a newly arrived single bird, compared to removing for example ten established Indian house crows, will mean an approximate cost increase of 3,000% or more (Meier and Haverson, 2016.; Suliman, pers. comm.).

LEVEL OF CONFIDENCE[1]

Well established.
While the system is not established for Indian house crows, it already exists internationally in numerous ways, covering aspects of general quarantine procedures, customs, border control, coast security etc. Customs and veterinary officials deal successfully with much more difficult organisms to identify. The measure therefore is a proven method already in place, and the visual and acoustic presence of Indian house crow allows easily adding this species with priority for the Union to an existing, established work scheme.

1 See Appendix

Regular scanning of online bird sighting information sources.

MEASURE DESCRIPTION

Active searches of relevant internet sites and print information sources like bird club journals or online discussion forums, bird lists etc. would support the detection of new Indian house crow invasions in the EU, as they have done for other regions or countries (for example, Linders and Langrand, 2014). One vital source are online bird forums; routine searches on bird forums specialised in new or exotic records have often provided the very first information on newly arrived Indian house crows (Meier, pers. obs.). Online sources have the advantage of (potentially) showing records much faster when compared to printed sources, and are more commonly accessed and used among birdwatchers. In addition, online sources can be accessed from anywhere, so investigations are relatively straightforward. Key additional information to collect would include how many birds were seen, and the location and environment of the sighting(s). Increased awareness across the birdwatching community can also be created by incorporating the species in national bird days (nationwide census etc.), which may increase the likelihood of the species being reported. As not all Member States have the same level of invasion risk, a possible priority would be for the measure to be applied in Member States where the species has already been recorded, or have major shipping routes with countries that have established populations. None of the past known invasions have been in landlocked countries, and in those non-European countries having larger inland populations of Indian house crow, invasion dates back over 100 years, with associated significant population growth and inland invasion from the coast (Meier, 2013; GISD, 2018).

If an Indian house crow is recorded within a Member State, it would need to be verified, therefore access to staff of wildlife agencies or other professional units who could be sent to verify the record would also be needed.

Computer modelling for predicting possible spread of Indian house crow has been attempted in the past (Nyari *et al.*, 2006; Fraser *et al.*, 2015), but so far failed to help predict later invasion scenarios.

A beautiful female Indian house crow (Corvus splendens) *perched on top of a bike. © GerifalteDelSabana. CC BY-SA 4.0.*

SCALE OF APPLICATION

The area of focus can be just local, nationwide or even wider, including EU-wide or Europe-wide. Necessary effort would evidently rise drastically with every scale increase, in relation to the number of forums and data sources that had to be searched. It may be more cost-effective to focus on Member States and EU bordering countries in which the species has already been recorded (for example, Ireland/Cyprus/the Netherlands/Greece/Bulgaria).

EFFECTIVENESS OF MEASURE

Effective.

This measure has proven to be effective, as online searches on bird forums have often provided the very first information on newly arrived Indian house crows (Meier, pers. obs.; Linders and Langrand, 2014). Experience in the Netherlands, however, has also shown that despite regular Indian house crow reports on online platforms by birders, these data were insufficient to provide accurate and reliable counts of the number of birds present, hence a dedicated survey effort (roost count + count in the total surrounding area) was needed (de Baerdemaeker and Klaassen, 2012).

If the initial recording person can be contacted, more information can often be gained. However, not everyone is sympathetic for the needed eradication of invasive Indian house crow and therefore such contact could lead to hesitation in information provision (incl. posting future recordings online). While a single person or group might be able to lower the effectiveness of the measure, birdwatchers are a very large community and so any negative effect would be negligible since it is likely that others will report additional sightings.

Using these information sources coupled with site investigations by trained staff, would greatly increase the likelihood that new incursions will be identified in time to support rapid eradication measures.

EFFORT REQUIRED

The measure would need to be in place indefinitely, or while the Indian house crow is an invasion risk to the EU.

RESOURCES REQUIRED

Staff time would be needed in regular intervals (ca. half working day every three months) to review relevant bird forums, other online resources and social media. In addition, access to expertise (and their time/transport) to investigate and verify sightings on site is required. Costs will increase with larger geographic coverage, or increased frequency of searches.

SIDE EFFECTS

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

This work may provide opportunities to detect additional invasive alien bird species. There are no economic or social side effects expected.

ACCEPTABILITY TO STAKEHOLDERS

Most stakeholders would be supportive, however some birdwatchers may not like that management authorities use their data (Meier, pers. obs.) to inform eradications (but their numbers are small).

ADDITIONAL COST INFORMATION

It might be possible to combine efforts through bi/multi-lateral coordination, for example along the Adriatic coast or the Atlantic and Mediterranean regions of Spain, France and Italy etc.

Cost of inaction is discussed above in the first *Early detection* section.

LEVEL OF CONFIDENCE[1]

Well established.

This system is already used by the author efficiently for Indian house crow invasion records and surveillance since a decade ago. It is also used by others to detect invasive plants, insects etc. (STDF, 2013; IPPC, 2017). The increasing use of online and real-time recording makes this measure crucial for the early detection of Indian house crow.

1 See Appendix

Detailed monitoring of areas close to established Indian house crow invasion sites.

MEASURE DESCRIPTION

This measure consists of undertaking onsite surveys, by skilled staff (or volunteers), at areas that surround established Indian house crow infestations and that can potentially become invaded. While technically this is not a measure for detecting new occurrences in Member States, it is a measure for detecting new occurrences via secondary spread which could occur if the species became established within an EU Member State (or a non-EU Member State close to the border with another EU Member State), and therefore would be critical support for any rapid eradication or management measure.

Note that established populations of Indian house crow do not currently exist in EU Member States (or close to the EU border), and are limited to individual birds. The situation in the Netherlands is unclear (Meier, pers. obs.) but the birdwatching network in that country is very large and individual birds are likely to be detected (Huysentryt, pers. comm.). In 2018, two adults were reported (in Staphorst), and in 2019 so far (to 17/05/19) there have been two sightings of one adult (in The Hague) and these were the first birds reported since 01/01/2015 (waarneming.nl). The history of the once established Dutch Indian house crow population showed that large periods of non-attention existed, despite Indian house crows being seen spreading or travelling in increasing wider areas, even across the Dutch-Belgian border (Ottens and Ryall, 2003; Meier, pers. obs.).

The surveys need to be undertaken regularly, ca. every month all year round, if there are no permanent staff present. This measure aims to detect any new satellite populations (via secondary spread) in previously non-invaded neighbouring areas.

Such movements of Indian house crows can be due to:

A make use of seasonal or newly discovered resources;
B escape threats or persecution, for example from starting control efforts;
C need to find new or additional roosting or breeding sites, because of lack of space or inter-population competition within the existing colony.

Such a measure needs to be taken into account for eradication planning, so that the chosen removal scenario matches the potential spread of (and can adapt accordingly to) the Indian house crow invasion.

SCALE OF APPLICATION

The scale of the measure is defined by the extent of the current invasion and potential spread etc. Such relocations seldom result in settlements more than 10 km away from the former location. However, monitoring (and managing) populations near international borders, or even national jurisdictions, can be challenging, as the birds might move back and forth or the invasion could spread from one site to the other. Such movements existed when Indian house crows from the Netherlands moved close to the Belgian border (Ottens and Ryall, 2003) and toward the port of Antwerp (Ryall, pers. comm.) This has also occurred outside the EU, for example in the case of Indian house crow invasion in Eilat, Israel and Aqaba, Jordan, where control efforts on one site were positive for the other, but unrestricted population growth at the non-managed site compromised the control efforts on the active management site (Hatzofe, pers. comm.). Therefore, a wider geographic area must be monitored, especially when the invasion crosses borders. Such cross border co-operation needs to be developed with countries with Indian house crow that border Member States, for example Turkey.

Geographic features also need to be considered when identifying areas to monitor, for example inhospitable places might force the invasive birds into a certain direction. The spread of Indian house crow in the Muskat area, Oman, is only possible along the coast (preferred habitat anyway), as the vast desert inland is a barrier to invasion (Meier ,pers. obs.).

EFFECTIVENESS OF MEASURE

Neutral.

The measure is necessary (including for eradication programmes), but its effectiveness very much depends on the capacity of responsible authorities (including skills and motivation of the personnel, their time, and available resources) and the environmental terrain that needs to be surveyed. In addition, surveyors must be careful not to affect the Indian house crows behaviour (potentially leading to dispersal) due to their repeated appearance and observations, which Indian house crows are very sensitive to (they are known to be able to recognise people they have previously encountered).

Because of the amount of uncertainties, there is no guarantee that the measure will be effective as an early detection measure (such as “neutral”).

EFFORT REQUIRED

The measure needs to be applied (surveys ca. every month) for as long as the Indian house crows are still present, otherwise a secondary invasion can take place and be missed.

RESOURCES REQUIRED

The costs are largely dependent upon the area covered by the surveys. A regular visit at least every month is advisable, if no permanent staff exists on the ground. All staff need to be skilled/trained and time and resources for unplanned emergencies must be incorporated. Staff will also need to be mobile (by car) and have optics and navigation equipment to mark/record points and re-find locations. Accommodation and communication costs need to be covered. If the surveys cover more than one country, the relevant entry permissions will need to be sought.

While costs will vary between Member States, it is estimated that it currently costs ca. 2,000 Euro for a single reconnaissance trip of two people for one week, with equipment and transport to survey the remotest of sites (based on author's experience).

SIDE EFFECTS

Environmental: Positive
Social: Positive
Economic: Neutral or mixed

The environmental side effects are judged as positive, as monitoring the surveyed areas provides the opportunity to survey for other invasive species, and species of conservation concern.

ACCEPTABILITY TO STAKEHOLDERS

A risk is that the repeated presence of the surveyors may start to raise public opposition against a lethal removal of Indian house crows, although their presence also provides an opportunity to highlight the problem caused by the species with local communities. Access to private lands may also be an issue, especially if repeated access is required.

ADDITIONAL COST INFORMATION

A cost of inaction of this measure could be an eradication failure, because information on the spread of the species was missing, which would lead to increased costs, perhaps halting another eradication attempt.

In addition, if a Member State in a border region with an established infestation does not work effectively on such monitoring, the results will be negative (both environmentally and economically) for the neighbouring states as well, or even the whole Union.

LEVEL OF CONFIDENCE[1]

Established but incomplete.

The information is drawn from projects and situation developments in mostly non-EU countries and on other continents. Therefore the transfer to the Union situation is not directly possible. Lack of close monitoring, and the unclear outcome of the eradication undertaken in the Netherlands in 2014/15, are EU examples of how information gathering must be enhanced in future Indian house crow invasions.

1 See Appendix

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

Shooting by use of firearms or air gun.

MEASURE DESCRIPTION

The measure involves shooting all Indian house crows in a stage of early invasion, or alternatively those that were not caught or killed by a larger management campaign (for example, through poisoning, see relevant section below). Shooting is a standard method for control and eradication of invasive birds, and Sharp (2004) has produced a standard operating procedure for the shooting of pest birds.

Newly arrived Indian house crows do not travel far and start to establish a territory and daily routine. If not disturbed (so that they disperse), this phase gives a good opportunity to organise a rapid eradication response, as this situation will not change for a while. However, there is a risk that a third party tries to persecute or protect the birds for personal motivations (Varne and Runhaar, 2016), which could result in their dispersal (see *Prevention of secondary spread* section above).

It is important to note that Indian house crows learn quickly and can often recognise the threat posed by a shooter, or learn to avoid certain locations where shots are fired from. This will result in avoidance or even fleeing from the area, therefore this measure needs to be combined with the early detection measure *Detailed monitoring of areas close to established Indian house crow invasion sites* detailed above to monitor for secondary spread of the species in response to the disturbance caused by shooting.

Shooting requires thorough planning, which incorporates precise knowledge on the Indian house crow population and its habitat use, including information on habits, movements, pair bonding, feeding grounds, roosting sites, and nest locations. Likewise, characteristics of the area, and threats to the operation and mitigation measures, such as engagement activities to increase public awareness of the eradication etc., must be reflected in the plan. Safety underpins all decisions of the shooting operation, including choice of rifle and ammunition, where and when to shoot and the choice of skilled personnel.

The strategy should avoid shooting a single bird in a group. In order to be effective for eradication, lone birds or pairs must be targeted, or even a whole group, which will need to be ambushed and assaulted by more than one shooter. Suliman *et al.* (2011b) noted that during an eradication campaign on Socotra, Yemen, it became apparent that the crows would attack any human within the proximity of their nest and so the project team used this method to attract a bird to the site. The avoidance of early detection of the shooter by the Indian house crows being targeted is a priority. Often the invasion will be in rather densely populated areas, sometimes security relevant sites like ports, bridges, near an airport and so on. Therefore, in such situations, extra precautions are needed, and unavoidable public attention will require more safety precautions and operational protocols.

The use of an air rifle as an alternative to a fire arm is an option; it follows the same strategy and safety issues, but is of less danger to surrounding public and goods due to its lower power. The limited noise that air rifles produce when fired has the additional advantage of not disturbing nearby birds, and draws less public attention. On the negative side, the air rifles light projectiles are easier to fail with, for example in strong winds that often occur at coastal areas. Hence it is important to have shooters with a proven track record.

Depending on these practical limitations, it might be that high density Indian house crow populations cannot be eradicated by shooting alone. However, shooting will always be part of eradication programmes, for example for populations in early invasion stages, to eliminate the last birds present, to trap-shy birds etc.

Any national or local legislation on the use of firearms needs to be respected.

SCALE OF APPLICATION

The measure can only be successfully used to eradicate small numbers of Indian house crow (such as small invasions, early detected invasion, or remnant individuals after a poison operation), as the population will learn very rapidly about this threat and move to different areas. On the islands of Socotra, shooting was used to remove the remaining 13 birds in 2009, following on from a ten year control campaign (Suliman *et al.*, 2011b). Small populations

usually stay close together (Ottens and Ryall, 2003; Linders and Langrand, 2014; Meier, pers. obs.), making the scale of application relatively small. However, the need to preferably shoot single roaming birds or isolated pairs requires shooters to be mobile and quickly move between different sites, for example the outer edges of the invaded territory and its centre. Therefore, the technique can be used successfully over areas of up to 50 km^2, not only within 1 km^2 or less. Single Indian house crows are best shot on a predefined spot of their territory that they regularly visit. This also allows to plan a safety procedure with fixed duties and responsibilities, experience that makes any following shooting at the same site a routine operation (DAF, 2008; Rocamora and Henriette, 2015).

EFFECTIVENESS OF MEASURE

Effective.

There is no better and direct removal option for a single Indian house crow (or a small number) than shooting them (Suliman *et al.*, 2011a). Shooting has been used successfully for the eradication and removal of Indian house crow in other projects and countries (Meier, pers. obs.; Suliman *et al.*, 2011b; Rocamora and Henriette, 2015). Generally it is known to be a useful method for bird control and eradication of early invasions or those with small numbers (Feare *et al.*, 2016; Haverson, pers. comm.).

Shooting must be performed by experienced persons that are not only skilled shooters, but who have knowledge and understanding about the target species, especially given the known rapid adaptive behaviour of Indian house crow in response to human threats (Meier, pers. obs.). If a single shooter is used, the birds will very rapidly identify this person. On Socotra, the guider/assistant of the shooter became clearly identified by the Indian house crow (which kept a distance) by day four of an eradication campaign (Suliman *et al.*, 2011b). This can drastically reduce the efficiency of the measure within a few days of constantly imprinting the negative effect in the Indian house crows.

EFFORT REQUIRED

In an ideal scenario, the use of this measure for one to two weeks should be enough to eradicate a small, or remnant population. On Socotra, the eradication of 13 birds took 1 shooter (and a small team of local staff, including a guider) 15 days (Suliman *et al.*, 2011b). However, after approximately two-three weeks of implementation, a break is advised. The use of reconnaissance observations would then be needed to understand the behaviour of the remaining Indian house crows that have become influenced by the shooting. With an updated picture and adapted plan, a second round of shooting can be undertaken.

Post shooting monitoring needs to be put in place to confirm eradication. On Socotra, more than 300 person-hours were deployed, along with a reward, for information of sightings by local communities (Suliman *et al.*, 2011b).

RESOURCES REQUIRED

Beside a skilled shooter(s), additional technical staff are needed (including those with knowledge of local landscape and communities – especially if the shooter is not local) to support safety issues, guiding the shooter to new locations, communicate with local communities, and provide support in documenting/reporting. Appropriate mobility and communication gear are needed (car, mobiles, headsets, radios), as well as other technical material (binoculars, spotting scope, laser distance measure, GPS), to allow constant observation of operational situations and marking of locations etc. The team needs to be in place all day and be flexible, as an operation is possible at any time (with suitable light conditions), and needs to be able to respond to sightings immediately. Accommodation and travel costs are also required for all team members.

Weapons with different ammunition are required (for example, .17, .22, or .22 win mag calibre, with silencer, lead free ammunition to shoot at water sites, magnum shot gun ammunition demanding a 12/76 or larger calibre etc.), and must be in good condition. Good (expensive) optics are also needed. It is therefore advisable to hire a shooter that already has these weapons in possession. This is also beneficial as the weapons would need to be safely stored and maintained after the eradication campaign, raising ownership and safety questions. However, it is likely that the shooter will want to use their own weapons and ammunition.

Additional government officials are potentially required to accompany the shooting operation, either at the beginning or throughout the campaign. If they are not paid by their administration, their additional costs (travel, per-diems and accommodation, etc.) need to be included in the budget. Costs/fees for permissions, weapon transport or import and safe deposition etc. need to be planned and budgeted for. Insurance is also needed and must be specific, fully adequate and in place before any operational activities have begun. The shooter will likely have their own shooting/hunting insurance, which will need to be validated.

Overall, while shooting as a rapid eradication measure can be a complex and costly activity, it can lead to quick and immediate results, so a cost-benefit analysis should be quickly undertaken before deciding on this as an option.

As an example, the costs for the removal of the 13 Indian house crows on Socotra, Yemen in 2009, were in total around 550,-- US $ per bird (Suliman *et al.*, 2011a), including long distance travel, hotel and 15 days of work for two foreign staff (but also supported by 200 hours of volunteer help of local staff). The total expenditure of 7,153,-- US $ saved the island from further investments of hundreds to thousands of US $ each year, otherwise used for paying bounties to local communities for collected chicks and eggs (removing over 550 in 10 years, Suliman *et al.*, 2011b), achieving population reduction, although

not eradication. The threatening of the abandonment of this bounty system was the reason that a decision for eradication by shooting was made, demanding a one-time 'high' investment, followed by longer term surveillance costs. In the Netherlands, the eradication campaign of an established population (<30 birds) executed by a private contractor has cost €23,600. This involved an initial trial and error phase of several capturing methods, eventually resorting to shooting as the principal method. Simulations showed that alternative strategies using capturing would incur a much higher cost of about €40,000 (TweedeKamer der Staten-Generaal, 2015).

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Negative
Economic: Negative

Possible environmental side effects are judged as mixed since, while non-target impacts are highly unlikely, there is sound disturbance, even if only over a short time frame – but especially relevant if operations are undertaken in sensitive areas (for example protected areas, bird breeding or resting areas) –, and lead ammunition can negatively impact the environment (ECHA, 2018). If the measure is not done professionally, there is a real risk of actively driving individual Indian house crows to neighbouring environments (secondary spread), enlarging the area of invasion. This might have been the case in the attempt of eradicating Indian house crow from Hoek van Holland, the Netherlands in 2014/15 (Meier, pers. obs.). Even trained professional shooters can, at a distance of over 50 m, still confuse Indian house crow with native corvids, although the probability of this is low. For example, non-target casualty of jackdaw *C. monedula* was reported during the Dutch eradication campaign (Adriaens, pers. comm.). Impact of disturbance on native breeding birds can be mitigated by planning actions outside the breeding season.

Social and economic side effects are judged as potentially negative, depending upon the areas that the operation needs to be undertaken in. For example, it may require the (temporary) cessation of activities (for example, closing of a bridge, or closure of recreation facilities) for safety reasons. Human safety issues are also a concern, but these can be mitigated if the correct safety procedures are followed.

ACCEPTABILITY TO STAKEHOLDERS

Almost everyone will oppose the use of firearms in their local surroundings, at least against the often charismatic Indian house crows (Vane and Runhaar, 2016). In addition, local hunters may see a stranger shooting in their area as an unwelcome intruder and not agree with the operation, even if they agree with the reason for it. Therefore, active engagement with local communities and authorities to mitigate these objections as much as possible is required before any eradication operation is put in place. In the eradication attempt of 2014/15 in Hoek van Holland, local people were actively attempting to hide Indian house crows in their houses so they couldn't be trapped or shot by the project (Vane and Runhaar, 2016).

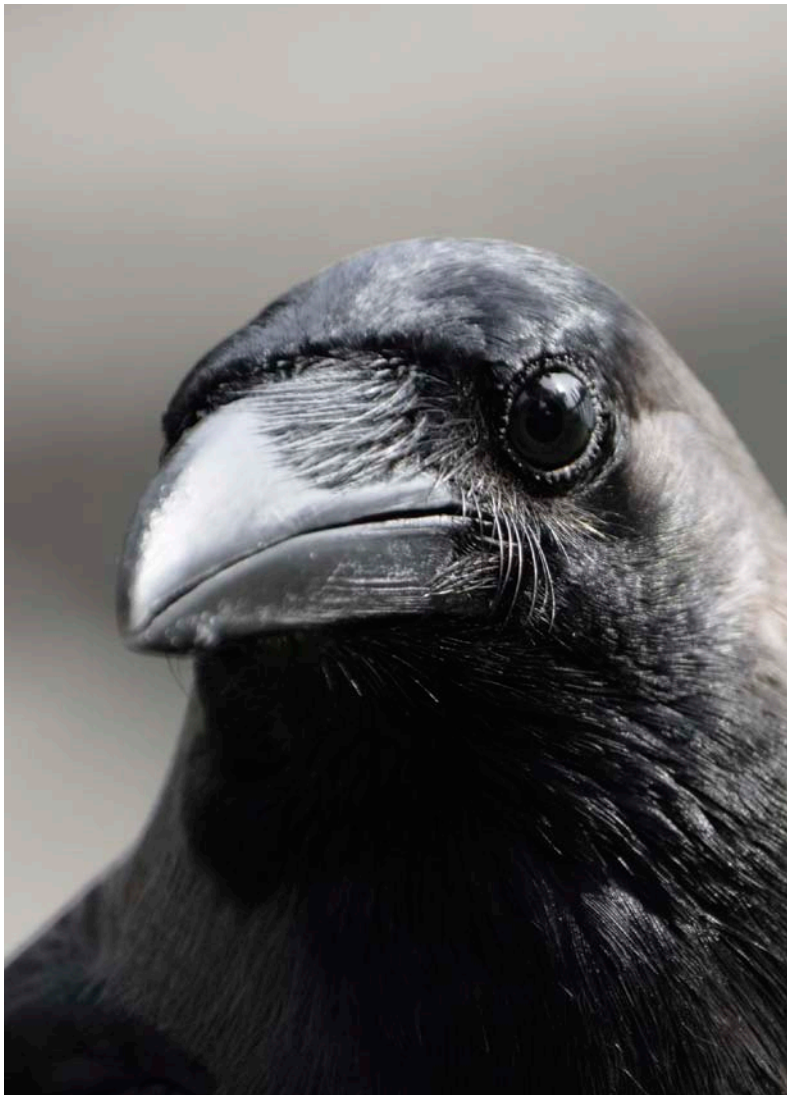
ADDITIONAL COST INFORMATION

Initial short term costs are high compared to more passive operations like trapping, but the operational phase of shooting is much shorter. The same is true when compared to management measures that aim to control the species; while initial costs of shooting to eradicate will be high, the long term costs will be much lower, as only monitoring will be required post eradication (Weiss, pers. comm.; Suliman *et al.*, 2011b; Meier, pers. obs.).

LEVEL OF CONFIDENCE[1]

Well established.

Shooting as a tool to control or eradicate invasive species is an internationally applied and recognised successful technique, even if applied on a large scale against terrestrial vertebrate mammals (Campbell *et al.*, 2004).



Indian house crow (Corvus splendens). © *GerifalteDelSabana. CC BY-SA 4.0*

1 See Appendix

Trapping by use of live traps.

MEASURE DESCRIPTION

For this measure, multiple live traps are installed in the area of Indian house crow invasion at different sites. The aim of the measure is to catch the maximum number of birds in the live traps, although this is a challenging operation when targeting Indian house crows (Leo and Manley, 2018). If not all birds are caught, the remaining few birds would need to be removed by other methods to achieve complete eradication (for example shooting, see above table). Live traps capture birds unharmed, so if non-target species are caught, they can be released (Tracey *et al.*, 2007).

The types of live traps used are often a 'drop in' trap, such as the bird is allowed to move into the trap, but cannot leave. Trade names are 'Larsen trap', 'Australian Crow trap' or 'Ladder trap' to name a few, but additional types and self-constructed devices exist on the market. All of them allow the catching of multiple birds in one setting, partially using the effect that the caught birds attract others from the same population.

The traps to use are sometimes defined by legal aspects, for example overall size, or times of the year they are allowed to be operated, etc. An installation that allows (either manually or automatically) the release of non-target species is useful, or often legally required in order to receive permission for trap usage.

Indian house crows are lured in either by food or a decoy bird of the same species (which is often difficult to attain initially). A juvenile can be taken out of a nest and hand-raised for this purpose, as they become tamed very quickly and make an ideal decoy bird. The decoy bird should be 'feather-clipped', to prevent any flying, if this individual does escape from its housings. Keeping and transporting such decoy bird for the purposes of facilitating an eradication is allowed under EU Regulation 1143/2014 on invasive alien species (Article 7, 1(d)). Any bird in the trap must be protected from people, other animals, sun/weather and needs to be fed and watered regularly and adequately. This is necessary due to animal welfare aspects, but also to maintain the efficiency of the trap. Poorly kept birds that are giving distress signals and warning calls will quickly lead to a learned trap shyness, resulting in irreversible trap avoidance of the rest of the still free ranging Indian house crow population. That would compromise the measure effectiveness for a long time (Feare and Mungroo, 1990; Feare *et al.*, 2016; Omar Al-Saghier, pers. comm.; Felamban, pers. comm.). Birds are caught alive, so in theory the option of removing and keeping the caught Indian house crow in captivity exists. However, beside the legal aspects (keeping species of Union concern is prohibited under the EU IAS Regulation 1143/2014), this is strongly not advised to do with Indian house crow, because they are a high risk species for successful escape from captivity. Indian house crows, like other *Corvids*, are very intelligent and, if they escape from captivity (especially if held in a different location from the original population), could lead to an invasion in a new area, triggered by a trap-shy 'educated' bird. Therefore, appropriate euthanasia must be prepared for and performed, according to national or regional euthanasia standards (Sharp and Saunders, 2004, 2011; EAZA, 2011; AVMA, 2013).

The removal of caught birds must be done at night and as quickly as possible, to avoid any stress to the birds and risking them sending warning signs to the rest of the population. Indian house crows, therefore, should not be killed within the trap, but by pre-prepared technical tools and techniques (Sharp and Saunders, 2011; AVMA, 2013). Traps must be cleaned after removal so not to repel any uncaught bird by feathers laying around etc. The decoy bird shall be taken out before removing the other trapped birds, if further use of this tamed Indian house crow for decoy aspects is planned. After the end of the trapping programme (and achieved eradication), the decoy bird(s) must also be euthanised.

Technicians working in direct contact with Indian house crow must be provided with appropriate safety equipment against injuries from attacking Indian house crows (eye protection, skin protection, strong gloves, helmet, etc.). In addition, infections by Indian house crow carried pathogens must be prevented, therefore breathing protection needs to be worn and all tools need to be cleaned and disinfected after being in contact with live or dead Indian house crows (or their body liquids, feathers etc.), following established health and safety protocols.

Kill traps do not work well with Indian house crow, as once the first individual from the population is killed, no other Indian house crow will go close to the trap, or a similar device. Such traps, or a drop net technique, can be used to capture a single Indian house crow – when early detected. For single birds, any measure is possible to apply without the learning effect to other crows, but the individual itself will still learn from any misapplication. Kill traps may be applied to a group of birds, but the risk of creating a trap shy population is very high if birds escape or witness such trapping attempt.

Note that this measure can also be used to reduce established populations (as a management measure, rather

than rapid eradication of new introduction), but see the Scale of application below regarding geographic limitations of its effective use.

SCALE OF APPLICATION

The key in using live trapping as an eradication measure is that enough effective traps are set within the daily used area of the Indian house crow population. The number of traps used (and scale) is limited by the capacity to maintain the traps (see above in Measure description), so that they remain effective and do not risk the success of the overall operation. Human disturbance (including sole curious by-standers watching, filming etc.) must be avoided, which is challenging in sites in urban environments, and on private properties.

Installing live traps can be done across the total area Indian house crows are actively roaming in, up to ca. 50 km^2, which would equate to around ten traps. All traps must be visible to Indian house crows, ideally set on the most lucrative places for feeding, near the most frequented watch out posts, on the way to nocturnal roost sites, etc., therefore suitable locations can become scarce quickly. However, not every place can be chosen, for example trapping right next to a roost is likely to lead to the failure of the whole trapping programme.

EFFECTIVENESS OF MEASURE

Neutral.

In terms of rapid eradication of a very small new infestation, for example one or two birds, the measure should be effective, but will be more costly than shooting. However, trapping on its own is very unlikely to eradicate a population (especially a larger, or more established one), as shown in a number of projects, as the chances of making mistakes are multiple, creating trap shyness quickly and preventing any further catches. For example, trapping was attempted to control the species on Mauritius with cage traps, but this did not provide effective results due to difficulty in monitoring the cages (Puttoo and Archer, 2003). However, there are now camera traps that can allow for remote monitoring, which under certain conditions can improve procedures. However, setting up camera devices in urban surroundings might need permissions, and raise issues of data protection. Also, in 1999 and 2000, two trapping attempts were made to eradicate Indian house crow on Socotra (using Larsen traps and a funnel trap), but they failed to capture any birds (costing US$ 1,500 and UD$ 700 for the traps and shipping) (Suliman and Taleb, 2010).

Trapping can also reduce a medium population of Indian house crows (Meier, 2013; Tsachalidis *et al.*, 2006; Meier, pers. obs.; Lee, pers. comm.), bringing their initial numbers down to a few individuals, which then need to be removed by different measures (for example, shooting).

EFFORT REQUIRED

The effort is required as long as Indian house crows are present, importantly, as long as birds are still being caught, and ideally until eradication is achieved. Once observations show that trapping has lost its effectiveness, traps should be removed to avoid further development of trap shyness by the remaining Indian house crows.

RESOURCES REQUIRED

Traps that are commercially available cost up to €500, as large and stable models are needed. If reliable brands are used, the risk of having an ineffective trap is limited. If traps are self-made, costs for material, building time, space rental, transport etc. must be budgeted for. Likely, the costs will be similar to a commercial bought trap, and mistakes in construction could occur. However, a self-constructed trap could be built to better suit the location conditions allowing for easier operation.

Once a trap(s) is set up, it needs daily maintenance and monitoring, which becomes intense if birds are caught and are used to attract others into the trap. One or two technicians are needed for supervising traps daily (which can be supported by cameras sending images at time intervals) and providing sustenance to trapped birds. The technicians must be mobile if the area to cover is large, because all trapped birds must be supplied early in the morning and again in the evening. Trained helpers are enough for this work, and no specialist caretakers are needed. The keeping of a decoy bird before a trapping season is a daily work that needs to be done by an assigned person if no local zoo or animal park with safe enclosures exists. This person needs to be found and paid, and the operation needs to have legal permission due to the species' listing on the Union list may incur costs, and the facilities to house the bird needs to be secure (to prevent escape).

Additional expertise is needed to empty and clean the trap(s), and euthanise and dispose of the birds safely. Staff require protection equipment and clothes, transport and accommodation, if not living on/near the trapping site.

Staff are also required for monitoring to verify movements, and changes in behaviour of the population, so that trapping strategies can be altered adaptively. They can be the same staff as the technicians caring for the traps and trapped birds, if such additional task does not create repelling reactions by the still freely moving Indian house crows. Like other *Corvids*, Indian house crows recognise individuals, and acquired information about humans' positive or negative interactions is shared and imprinted across the whole crow population. Experiences with people and traps can very quickly lead to long lasting changes in the behaviour of all surrounding crows (Marzluff *et al.*, 2010).

Records about traps, trapping success, trapping hours and experiences are needed in order to document the eradication and allow enhancement of operations elsewhere. Therefore, staff time and resources (office space or accommodation) for this work needs to be budgeted in. If cadavers of caught birds are used for further scientific

research (for example on diseases), the costs for a follow up storage and use must also be planned for.

If shooting is required to remove remaining individuals, see the relevant section above.

SIDE EFFECTS

Environmental: Neutral or mixed
Social: Neutral or mixed
Economic: Neutral or mixed
The risk that non-target birds are caught exists, but they can/must be resolved by an appropriate technical installation (this also helps to reduce the time staff presence is needed near the traps). There are no known social or economic side effects from trapping, apart from the potential human health risks from diseases carried by the birds, which is why adequate safety equipment and training is needed for those coming into contact with the birds.

ACCEPTABILITY TO STAKEHOLDERS

There may be some public objection to the killing of the trapped birds, or even to the trapping, as some people may enjoy the animals' presence (and will not grasp the implications or the impacts a larger established Indian house crow population would have). Some birdwatchers may oppose the trapping, as they might dislike bird trapping in general (except for ringing purposes), and some may be attracted to the presence of the exotic crows and would dislike if they are removed. The loss of possible income of local hotels/businesses when people cannot see the birds as an attraction may further make the removal a disliked operation by the local community.

ADDITIONAL COST INFORMATION

Apart from using a kill trap for a single bird (or possibly a few individuals), shooting may be a more **cost-effective** option in the long term.

Allowing service providers (for example, local pest control operators) or volunteers to perform trapping will perhaps reduce costs (Archer, 2001), but transfers the implementation of the measure to third parties with their own skills, and perhaps, a personal agenda. This can make the technique very quickly ineffective, and could reverse the positive cost effects by delaying the eradication of the species and therefore increasing the cost of any additional measures required due to population increase and potential spread.

LEVEL OF CONFIDENCE[1]

Well established.
A few live trapping programmes for Indian house crow are reported (Feare, pers. comm.; Omar Al-Sagier, pers. comm.; Suliman *et al.*, 2011b), showing that it cannot be entirely relied upon to be effective, as there is much space for error, and failed application will immediately lead to negative consequences on the Indian house crow population (becoming trap shy and potentially spreading).

1 See Appendix

Measures for the species' management.

Poisoning by use of chemicals like Avicides or Stupidents.

MEASURE DESCRIPTION

This measure is the most frequently used to control and eliminate large numbers of Indian house crow populations across the world. Millions of Indian house crow individuals have been killed by use of poison (Ash, 1984; Feare and Mungroo, 1990; Jennings, 1992; Archer, 2001); however, not a single eradication has been achieved by using only poisoning, although it is believed that this could be possible (Meier and Ryall, 2008; Meier, 2013). Years of successful poisoning operations implemented in South Africa (Durban and Cape Town) indicate that eradication is possible, even with an established population of ten-thousand Indian house crows (Stafford in Woolnough *et al.*, 2008; Stafford ,pers. comm.), although no eradication has yet been declared from the South African sites for unknown reasons.

The poison most often used is the US designed specific bird poison/avicide called DRC 1339, with USDA administrated trade name Starlicide® (EPA, 1995; USDA/APHIS, 2001). It was originally developed for use against invasive pest birds like European starlings in the USA and Australia, where it is still used for these purposes (Lapidge *et al.*, 2003), as well as other invasive starlings elsewhere (Feare, 2010). It was also applied to urban and problematic native crows in the USA. DRC 1339 is costly comparably to other avicides, as large amounts are needed because the powder is not stable once solved in water and mixed with bait/food. The mixing with food as bait for application at pre-baited sites known to Indian house crows is the only effective way to target Indian house crow using DRC 1339.

The use of DRC 1339 in urban or populated areas demands detailed safety protocols. Such protocols and experience already exist (Stafford in Woolnough *et al.*, 2008; Feare, 2010; Felamban, 2011; Peebles and Conover, 2016; Hatzofe, pers. comm.; NPCS-Mauritius, pers. comm.), but require constant actualisation. All human health and environmental risks must be investigated and mitigated before proceeding with a poison operation against Indian house crows. It is important to note that most EU Member States do not permit the use of poison against birds and avicides are not registered, or the active agents within USA or Australian products might not be permitted to be used within the EU. EU/national/local legislation on the use of avicides needs to be respected, and receiving relevant legal permissions would be needed. Due to these limitations, but also as no large populations of Indian house crow currently exist in Europe (and are not likely to establish due to the species being listed on the EU IAS Regulation), it is very unlikely that a scenario will arise where a poison operation with avicides like DRC 1339 should be considered as measure to control or eradicate Indian house crows in the EU.

The only practical alternative, still involving the application of a chemical and toxin, might be using stupefying substances, namely alpha-chloralose (Nelson, 1994). This is a registered active ingredient permitted for use in some rodenticides in Europe, and is also used occasionally in special situations demanding bird control (usually feral pigeons). Birds are fed it through baited food, getting stupefied by the substances, which allows them to be caught, for example in warehouses, food storage areas, airports etc. (Nelson, 1994; Tracey *et al.*, 2007; Meier ,pers. obs.). The application of the chemical at a dose and concentration of a narcotic stupefying which targets the live capture of birds, instead of killing them directly (requiring a larger dose), could be a scenario allowing for successful application, while reducing non-target and safety issues. Toxin doses are partially related to body mass, partially to the species' general susceptibility to the toxin, and abiotic factors like temperature also play a role. It may be possible to receive relevant legal permissions based on active agent and ingredients already registered in the EU market. Ideal situations for application would be as per the former Indian house crow population in Hoek van Holland/Rotterdam, where 70% of the circa 30 Indian house crows were used to being fed by a single person each weekend, approaching the persons car and taking food nearly from his hand without hesitation (Meier, pers. obs.). An initial approach to such a population could be done by accustoming the bird population to a trustworthy person that feeds them regularly and, at the start of the eradication, applies food mixed with a stupefying agent like alpha-chloralose. If dosed correctly and enough quantity of baited food is provided to the birds in the quickest possible time, a significant percentage of a small, but established, Indian house crow population can be stunned and collected for euthanasia. The remaining birds of such a one-time activity will need to be shot or caught by other means (and other persons), as they will have witnessed the fate of the other birds and likely become distressed and wary of any human contact. Their removal will be more difficult

than for the afore naive population. Therefore, even a very specific application of such method in unique situations is not guaranteed to affect 100% of the Indian house crows in one application. *Corvids* always have some birds watching while others are actively feeding, and issues like interspecific competition do prevent all crows from feeding jointly together.

Non-target species need to be driven away as much as possible before the application, and partially this is done by the Indian house crows themselves, especially with respect to raptors or other larger bird species. However, in lower numbers, as expected for a new invasion, Indian house crow will not be so dominant and aggressive.

SCALE OF APPLICATION

Any use of chemicals against Indian house crow must be applied in such way that a maximum number of birds have the potential to be poisoned.

Poison must be applied in the safest way. Ideally, this takes place at a location inaccessible to people or domestic animals, regardless of the scale of application. With regards to large scale application, the measure can be applied over areas of circa 1,000 km^2, choosing existing, but safe, feeding spots like waste dumps outside the city, etc. This would be the case for possible operations like for the population in Port Said, Egypt, where multiple sites would be needed to be pre–baited simultaneously and finally poisoned with DRC 1339, targeting thousands of Indian house crows at the same moment to maximally avoid learning effects.

In terms of targeting smaller populations (or even as a rapid eradication measure), as is likely to occur within the EU, areas such as an inner yard compound of a closed storage facility, or a single open container in a port etc., should be used for toxin application. Automatically, the scale of the application will be within a few m^2, shared among one or two locations only. This is also the case for hand feeding. All other larger scale applications will likely be considered too risky, and will render non-poisoning alternatives more feasible.

EFFECTIVENESS OF MEASURE

Effective.

In itself, poisoning is a highly effective method to quickly reduce large numbers of Indian house crow cost-effectively, therefore the measure was estimated to be 'effective'. In addition, eradication using poison should have been possible in some programmes, but projects were abandoned too early or funding was lost. While these projects noted large numbers of Indian house crow killed, none or very few were documented sufficiently to allow verification of, and learn from, such operations (Meier and Ryall, 2008; Meier, 2013).

Poisoning is highly unlikely to be adopted as a feasible measure at larger scales in the European Union, but currently this is not an issue, given that there are no large established populations in the EU. In addition, securing the legal permissions to undertake poisoning operations within the EU would be needed before any operation could be undertaken. This makes the measure potentially ineffective as a rapid eradication tool (the most likely scenario of application within the EU) and costs will be very high for the preparation phase alone, making other options more cost-effective.

EFFORT REQUIRED

In general, the measure needs to be applied until all birds are killed, or until bait shyness has established in the surviving Indian house crows. Once bait shyness occurs, the measure needs to be halted (at least for a while) and other measures should be considered.

The targeting of birds that can be hand fed with an anaesthetic at certain sites is ideally done across the whole area (city, coast), in one to several days, to achieve the highest catch/mortality rate while the chance of learning is minimised.

Securing the prior necessary legal permissions, covering human and environmental health and safety issues within the EU would be demanding, so a lot of funding and time is needed to prepare the legal basis before potentially applying this measure.

RESOURCES REQUIRED

The avicide DRC 1339 is relatively expensive, with approximate costs of around €40/100g. An anaesthetic like alpha-chloralose is less costly (€ 7/100g). The direct comparison is, however, misleading, since the effects of these products are different and so are the doses needed (Seamans and Belant, 1999). DRC 1339 is primarily distributed commercially by the USDA itself, but also available by registered franchise sellers like private companies in New Zealand. Uncertified, it is also sold from Asian sources, but neither effect nor toxicity to the target animals, the environment, or human health, is known if using these products from unknown sources, which is strongly advised against.

Enough stock needs to be acquired for the whole operation, bearing in mind that there should be no risk of running out of chemicals in case of unexpected spoilage etc. Costs for the safe disposal of any surplus chemicals also needs to be budgeted. The operation itself needs weeks of pre-baiting. The short application period therefore demands a comprehensive technical preparation, including the involvement of many experienced or even certified people.

Additional costs include securing relevant legal permissions, custom fees, health and safety issues, including safe storage, medical supervision etc. The preparatory costs could therefore be large, before the operation can begin.

SIDE EFFECTS

Social: Negative

Environmental: Negative

Economic: Neutral or mixed

While DRC 1339 photo degrades in water, which is the primary route of dissipation in the environment, it is highly toxic to birds and freshwater invertebrates, and moderately toxic to freshwater fishes, and mammals, making the risk to non-target bird populations high (USDA, 1995). However, according to Feare (2010), the toxicity of DRC 1339 is lower for raptors, and low for mammals. Non-target side effects can also be reduced by selecting species specific (or targeted) baits, or using feeding areas where there are fewer non-target species (Feare, 2010). The use of DRC 1339 to attempt to eradicate Indian house crow from the island of Socotra was rejected due to the potential impacts to two non-target vulture species (Suliman *et al.*, 2011b). As reported from poisoning operations in South Africa, Djibouti, Tanzania, Kenia and Saudi Arabia, large numbers of Indian house crows at the baiting sites will have usually driven away most non-target species, so risks are reduced. In application like hand feeding single birds this is not the case, and the feeder cannot chase away other birds while trying to feed an Indian house crow. A stupefying dosage for crows may be lethal for other animals with smaller body mass for example passerines, so non-target losses must be expected. Furthermore, DRC 1339 has different effects on different species, being very effective against European starlings, which are also an invasive species in the USA and Australia, but native to Europe and under strong risk if this chemical is used in their presence. A target specific bait for Indian house crows which is not attractive to other birds does not exist.

There are no known economic side effects of the measure, and the only potential social risks are public health concerns, which should be easily mitigated for at the potential scale of use within the EU in the future.

ACCEPTABILITY TO STAKEHOLDERS

Killing Indian house crows or non-target individuals is likely to create public hostility, which can undermine the entire management scheme. It is important to note that Indian house crows affected by DRC 1339 will die in between the feeding site and their roost within a few hours, making it likely that uncontrolled dead birds are found in an urban setting by the public. This is not the case when using alpha-chloralose as a stupefying agent, which allows the collection of Indian house crows on site.

Alongside other objections including human health and safety aspects, environmental opposition and opposition against use of pesticides in general, the measure is likely seen as unacceptable for most European public stakeholders.

If poisoning was to be used, an appropriate information and engagement campaign would need to be undertaken to explain the reasons for the operation, risks of Indian house crow invasion, and explain possible non-target losses, to mitigate any negative public opposition.

ADDITIONAL COST INFORMATION

Based on the current and future context of the species invasion within the EU, and the EU situation in regard to poison use, this is not perceived to be a **cost-effective** option.

LEVEL OF CONFIDENCE[1]

Well established.

There are many projects (none in the EU) that have experience with extensive use of poison, namely DRC 1339, against Indian house crow, but not many using a stupefying agent like alpha-chloralose.

1 See Appendix

Fertility reduction, egg collection, egg coating, and nest destruction.

MEASURE DESCRIPTION

On the island of Socotra, which at the population peak held 26 breeding birds, a bounty system was established for 10 years between 1998 and 2008, which saw 550 chicks and eggs collected from nests (Suliman *et al.*, 2011b). This measure's aim was to control the population and restrict its expansion, and was adopted due to previously failed trapping and shooting attempts to eradicate the species (Suliman and Taleb, 2010; Suliman *et al.*, 2011b). The programme encouraged school children to search for nests and rewarded them for bringing nests and young birds to staff to be humanely dispatched.

Egg coating/oiling and nest destruction are also potential measures that could be used, and which are more widely practiced for managing ground nesting birds, such as invasive geese populations (Adriaens, pers. comm.). There are several examples, mostly in the USA (see IUCN, 2017, and references therein), where the method has been used successfully to manage gulls and water birds. However, Indian house crows nest off the ground in trees or human infrastructure such as pylons and therefore accessing nests would require costly specialist skills and equipment (IUCN, 2017). These measures are not discussed in detail as they have not yet been used, nor are they likely to be used within the EU as there are no established populations, and any introductions should be eradicated as per the requirements of the EU IAS Regulation.

SCALE OF APPLICATION

On Socotra, this measure was applied across the species distribution area in the main valley, WadiHadibu, and adjacent areas.

EFFECTIVENESS OF MEASURE

Neutral.

Over ten years, more than 550 chicks and eggs were removed in Socotra, making this an effective method of control that kept the numbers very low (Suliman *et al.*, 2011b). The programme successfully reduced the numbers

Indian house crows show two-toned appearance with paler nape, neck and breast (Corvus splendens). *© Anton Croos. CC BY-SA 4.0.*

of breeding birds to 13 (from as high as 26), which were then eradicated by shooting (see the relevant section above) (Suliman and Taleb, 2010).

Although there is no information available for Indian house crow, long-lived *Corvid* species with sufficient reproductive output are often not very vulnerable to fertility control, as adult survival is often the key driver in population development (Huysentruyt, pers. comm.). As such, this measure might be effective when populations are at low density, for example in early invasion stages, but not so much in established populations (for example, for Canada geese, fertility control can merely stabilise numbers locally; Adriaens, pers. comm.).

Egg oiling is unlikely to be suitable for this species due to the costs of locating and accessing nests (IUCN, 2017).

However, it is important to note that this measure is not required within the EU as the species is not established, nor is it likely to become so if new invasions are eradicated, as is required due to their listing on the EU IAS Regulation.

EFFORT REQUIRED

Needs to be in place permanently.

RESOURCES REQUIRED

On Socotra, the overall bounty costs were US $ 2,500 over 10 years. For bringing these young birds/eggs (550 in total) to the local environmental authority (SCDP), the children were given 1,000-1,500 Yemeni Riyals (circa $ 6-9) for each crow, depending on its age, and 2000 Riyals (circa $ 12) for an adult (Suliman and Taleb, 2010). There are also staff and other costs associated with running the scheme.

SIDE EFFECTS

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

Risks are to those people capturing the eggs/chicks in both accessing the nests, but also due to potential disease transfer. Disturbances may occur to non-target species nesting nearby, or where eggs or chicks are mistakenly collected by a person. Funding for bounty systems needs to be ongoing and therefore enough resources need to be available. This economic incentive may lead to attempts to keep the species present, and therefore as source of income, creating attempts of breeding it in captivity. Opposition can arise if such income source is finally attempted to be removed by an eradication.

ACCEPTABILITY TO STAKEHOLDERS

Egg removal and chick collecting for invasive species control is likely to be seen as controversial or unacceptable by the public. However, as noted above, egg oiling and nest destruction are seen as more acceptable alternatives (than for example shooting) used for population control.

ADDITIONAL COST OF INFORMATION

No information available.

LEVEL OF CONFIDENCE[1]

Well established.

Examples are few and all from outside the EU. For example on Socotra, Yemen, but also in Hong-Kong and Jeddah, Saudi Arabia, similar schemes were used temporarily (Meier, pers. obs.).

1 See Appendix

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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 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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