

The breeding population of the Egyptian Goose *Alopochen aegyptiaca* in the city of Lisbon

A população nidificante de Ganso-do-Egipto *Alopochen aegyptiaca* na cidade de Lisboa

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ABSTRACT

The Egyptian Goose *Alopochen aegyptiaca* has been introduced in many European countries over the last decades. Despite being a recent introduction in Portugal and Spain, the species has been dramatically increasing in those countries, and breeding has been widely reported in large cities. Yet, little is known about the breeding biology and success of urban populations, particularly in southern Europe. This work aimed to estimate the size, distribution and breeding success of the current breeding population in the city of Lisbon, by prospecting 54 potential breeding sites and collecting information on presence and breeding evidence of the species. The current breeding population of Egyptian Geese in the city of Lisbon is estimated at 20-26 pairs. The majority of pairs breed in lakes in city parks and gardens, most of which with an islet that provides a safe nesting site. The breeding success of this urban population is of 62% and the productivity is 5.5 chicks per breeding pair, considering breeding pairs with hatching success. Only five pairs were found breeding outside parks and closer to the shoreline and most failed to raise chicks successfully. In city parks, during the period of this study, three pairs had a second clutch. The breeding in urban areas is affected by maintenance work at breeding sites during the breeding season (e.g., complete draining of lakes, cut of vegetation cover) which disrupted or delayed breeding attempts. The high breeding success of the Egyptian Goose in urban areas, compared to other European countries, alerts for the urgent need to monitor and study the dispersal of urban populations, and to implement specific control measures. The access to safe nesting sites in lakes of city parks (e.g., islets) and the feeding of goslings by humans are two key aspects to consider in the management of urban populations of the Egyptian Goose.

Keywords: Invasive species; Urban population; Breeding success, Monitoring.

RESUMO

O Ganso-do-Egipto *Alopochen aegyptiaca* foi introduzido em muitos países europeus ao longo das últimas décadas. Apesar de ser uma introdução recente em Portugal e Espanha, tem aumentado drasticamente e a sua nidificação tem sido frequentemente observada em grandes cidades. Apesar disso, pouco se sabe sobre a biologia reprodutiva e o sucesso das populações urbanas, particularmente no Sul da Europa. Este trabalho teve como objetivo estimar o tamanho, distribuição e sucesso reprodutor da população nidificante na cidade de Lisboa, através da prospeção de 54 locais de nidificação potenciais e recolha de informação sobre a sua presença e nidificação. A atual população nidificante de Ganso-do-Egipto na cidade de Lisboa é estimada entre 20-26 casais. A maioria dos casais nidifica em lagos de parques e jardins da cidade, com um local seguro para a nidificação. O sucesso reprodutor desta população urbana é de 62% e a produtividade é de 5,5 crias por casal, considerando os casais reprodutores que tiveram crias. Nos parques da cidade, durante o período deste estudo, três casais tiveram uma segunda ninhada. Apenas cinco casais foram encontrados a nidificar fora de parques com lagos e próximos das margens do Tejo e a maioria não conseguiu ter sucesso. A nidificação foi afetada por trabalhos de manutenção nos jardins durante a época de nidificação (por exemplo, drenagem completa de lagos, corte da cobertura vegetal), que interromperam ou atrasaram tentativas de nidificação. O sucesso reprodutor nas áreas urbanas foi elevado, comparando com valores reportados noutros países europeus, o que alerta para a necessidade urgente de monitorizar e estudar a dispersão das populações urbanas, assim como de implementar medidas específicas de controlo populacional. O acesso a locais de nidificação seguros nos grandes parques urbanos e a alimentação por humanos são dois aspetos fundamentais a considerar na gestão das populações urbanas.

Palavras-chave: Espécie invasora, Populações urbanas, Sucesso Reprodutor, Monitorização.

Introduction

Invasive species are one of the major threats to biodiversity (Duenas et al. 2021) and urban areas have been found to enhance their establishment and spread in non-native areas (Borden & Flory 2021). The Egyptian Goose *Alopochen aegyptiaca* occurs naturally in most of the subsaharian African region, but it has been introduced in many European countries, usually as a result of being a popular species in zoos and private collections. This invasive species occurs mainly in wetlands, including large estuaries and inland water bodies, but can also be found in urban areas. In the last 10 years, this invasive species has been dramatically increasing in Portugal and Spain (Keller et al. 2021) and currently, in Portugal, the species can be found in the main urban areas, large

estuaries and is widely spread in the Alentejo region (southern Portugal).

In Portugal, the first observation of the species in the wild was made in 1989, when two birds were detected in a city park in Lisbon (Reino 1989). Despite this early observation, more records of the species are only known for the XXI century, when 1-3 individuals were reported in 2002-2003 in disperse locations in Portugal mainland (Caminha – Viana do Castelo; Esposende - Braga) but also in a city park in Porto (Matias 2010). The first evidence of breeding occurred in the following years (2004-2007), when fledged birds or clutches were observed in Benavente (Santarém), Ponte de Lima (Viana do Castelo), Biscaia (Cascais) and Arraiolos (Évora) (Matias 2010). Despite

these first breeding records, those were scarce and the Egyptian Goose was not detected as a breeding species during the field work of the II National Breeding Bird Atlas, that covered the years 1998 to 2005 (Equipa Atlas 2008). The breeding of this species may have been overlooked in the first decade of this century, particularly in cities, as the species was often looked as a captivity or ornamental bird species. In 2010, breeding was reported in a city park in Porto, Parque da Cidade (Matias 2012) while the first breeding reported in the city of Lisbon (Jardins da Gulbenkian) was in 2013 (de Lima 2013). Since then, breeding become frequently reported in both cities. The species usually breeds close to water bodies, nesting on the ground (e.g., islands) but also in trees (Eltringham 1974, Sutherland & Allport 1991, Callaghan & Brooks 2016). In urban areas, breeding is frequent in city parks with a lake or pond (Sutherland & Allport 1991, Weirich et al. 2021). Despite this noticeable increase in the number of clutches reported in the city of Lisbon, there are no figures of the current breeding population in this urban area. Additionally, little is known about the breeding biology and success of urban populations (but see Weirich et al. 2021), particularly in southern Europe. Using the opportunity of

a study focused on the breeding phenology of the species, this work was implemented to estimate the size and distribution of the breeding population in the city of Lisbon, collecting also information on their breeding success.

Methods

This study was held in the city of Lisbon, from 1 February to 30 July of 2022. There is no published information on the breeding biology and phenology of the species in Portugal. For that reason, prospection visits were done during a long period (six months), encompassing late winter, spring and early summer, knowing that hatching occurs mainly between april and july in the Netherlands (Lensink 1999). Using the available information of known breeding sites from previous years (collected from Biodiversity4all and PortugalAves), recent presence records of the species (from the same sources) and potential breeding sites (parks and gardens with lakes, tanks or ponds; marinas and docks) we visited 54 sites in the city of Lisbon (see Table 1 and Figure 1). Some sites were visited once (19), but all sites with geese (1 or 2 adults) were visited at least twice, as

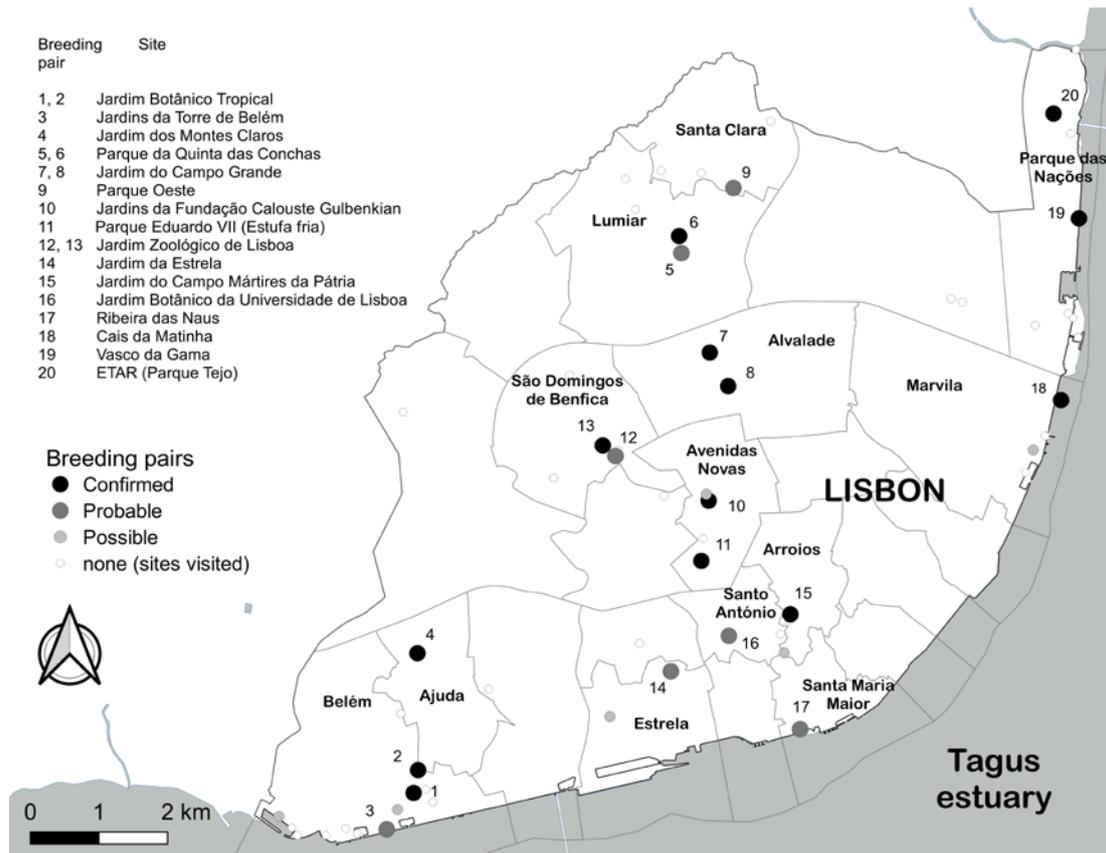
Table 1- Sites visited during the census of the Egyptian Goose breeding population in Lisbon

Tabela 1 - Locais visitados durante o censo de população nidificante do Ganso-do-Egipto em Lisboa

WATER BODIES PROSPECTED				
City Area	Sites Visited	Lakes	Tanks/Fountains	Marinas/Docks
West	14	7	8	3
North	8	11	3	0
Centre	17	18	11	2
East	15	3	4	7

Figure 1- Map showing the breeding population of the Egyptian Goose and the potential breeding sites visited in the city of Lisbon in 2022

Figura 1 - Mapa ilustrando a distribuição da população nidificante de Ganso-do-Egipto e os locais potenciais de nidificação visitados na cidade de Lisboa em 2022



well as sites that were under maintenance work, being the visits intercalated in at least three weeks. Five sites were visited frequently (Quinta das Conchas, Campo Grande, Jardim Zoológico, Parque Eduardo VII and Calouste Gulbenkian), with eight or more visits during the period referred above, due to the collection of data for other study. This difference in the number of visits conducted to some sites was not expected to influence our results, as the assessment of productivity only required a single visit in the late chick-rearing period (see below).

The breeding of the species in each potential nesting site was classified as either possi-

ble, probable or confirmed, using a simplified list of the national breeding atlas criteria: the presence of chicks (confirmed breeding), the territorial behaviour of an adult Goose or the regular observation of a pair or an individual in adequate nesting habitat (probable breeding) and the occasional observation of an individual in adequate habitat (possible breeding). To estimate the breeding population in the city of Lisbon, we considered confirmed and probable breeding pairs as the minimum number of breeding pairs. The maximum threshold was calculated by adding the number of possible breeding pairs.

In order to have a figure of breeding suc-

cess, we collected information of productivity (number of chicks alive per clutch) in every visit to the breeding sites. Despite not knowing the exact hatching date and age of clutches, we photographed every clutch in all visits for a study focused on the breeding phenology of the species, in order to estimate their age. These photographs, crossed with the information of the dates of visits, were used to crudely estimate their ages considering a classification of 6 age-classes (<15; 15-30; 30-45; 45-60; 60-75; 75-90 days) (see Supporting information, Figure S1). In a similar context to ours, where Egyptian Gooses were breeding in city parks in a non-native country, Weirich et al. (2021) found that 89% of all mortality of goslings occurred in the two first weeks of life. Considering that most mortality of Egyptian Goose chicks occurs in the first month of life (Eltringham 1974, Weirich et al. 2021), we assumed that the number of goslings alive with more than 45 days would be a good proxy of the productivity for each pair. Measuring complete fledging success is extremely difficult and the estimation of exact hatching dates requires a very large monitoring effort, for which we consider that our methodology was effective to assess the productivity. For the calculation of success and productivity, we considered all breeding pairs (confirmed and probable pairs) but also only the breeding pairs with chicks (i.e., with hatching success). Whenever possible, we collected information on the causes (or potential causes) of mortality or disturbance.

Results

Breeding population

The total breeding population of Egyptian Goose in the city of Lisbon was estimated at 20-26 pairs (see Table 2 and Figure 1). It was possible to confirm the breeding of thirteen breeding pairs by the direct observation of clutches during the period of this study,

while the breeding of other seven pairs was considered probable due to their aggressive/territorial behaviour ($n = 3$) or regular presence in a site with suitable nesting habitat ($n = 4$). The sum of confirmed and probable breeding pairs was considered the minimum estimate of the breeding population. The six cases classified as possible breeding were: three observations of pairs in potential breeding sites close to other breeding pairs/sites (not seen simultaneously); a pair previously observed in a site not accessible during the study due to long-term maintenance work; and two online observations of birds with young (PortugalAves 2022) which could not be verified (to exclude the hypothesis of being a pair already recorded).

Most of the breeding sites of the Egyptian Goose were located in city parks with lakes (75%, $n=20$). In the majority of those sites there was an islet in the lake (57%, $n=16$), which was the most probable location of the nest. The five breeding pairs that were not observed in city parks with large lakes, mostly in the eastern area of Lisbon city, were observed in marinas, coastal gardened areas and other shoreline locations. In three city parks, more than one breeding pair were able to establish successfully (see Table 2), but always in a different lake or tank, not close to the other pair. There were no observations of different pairs breeding in the same lake or tank. Only in two visits/sites more than two adult birds were seen together. At Parque Oeste, in mid-april, twenty birds with adult plumage were seen resting together in the same lake (where no breeding pairs were established). These birds were most likely non-breeding birds, either young individuals or adults without established territories or between breeding attempts. In late July, sixteen birds with adult plumage were also seen at Quinta das Conchas, in the large lake were a breeding pair defended a territory earlier in the season (in february/march), but apparently abandoned the site.

Table 2 - Breeding pairs of the Egyptian Goose in the city of Lisbon (confirmed and probable breeding pairs)

Tabela 2 - Casais reprodutores de Ganso-do-Egipto na cidade de Lisboa (casais confirmados e prováveis)

BREEDING PAIR	SITE	COMMUNITY AREA	BREEDING SITE	HATCHING DATE (Month)	BREEDING	EVIDENCE
1	Jardim Botânico Tropical	Belém	Large lake (with islet)	January and May	Confirmed	With chicks
2	Jardim Botânico Tropical	Belém	Large tank	January	Confirmed	With chicks
3	Jardins da Torre de Belém	Belém	Several tanks		Probable	Pair
4	Jardim dos Montes Claros	Ajuda	Large lake (with islet)	February	Confirmed	juveniles
5	Parque da Quinta das Conchas	Lumiar	Large lake		Probable	Pair defending territory
6	Parque da Quinta das Conchas	Lumiar	Large lake (with islet)	January and May	Confirmed	With chicks
7	Jardim do Campo Grande	Alvalade	Large lake (with islet)	February and June	Confirmed	With chicks
8	Jardim do Campo Grande	Alvalade	Other Large lake (with islet)	March	Confirmed	With chicks
9	Parque Oeste	Santa Clara	Small lake		Probable	Pair defending territory
10	Jardins da Fundação Calouste Gulbenkian	Avenidas Novas	Large lake (with islet)	April	Confirmed	With chicks
11	Parque Eduardo VII (Estufa Fria)	Avenidas Novas	Large lake (with islet)	March	Confirmed	With chicks
12	Jardim Zoológico de Lisboa	São Domingos de Benfica	Large lake (with islet)		Probable	Pair defending territory
13	Jardim Zoológico de Lisboa	São Domingos de Benfica	Tank (with islet)	April	Confirmed	With chicks
14	Jardim da Estrela	Estrela	Small lake		Probable	Pair
15	Campo dos Mártires da Pátria	Arroios	Large lake	April	Confirmed	With chicks
16	Jardim Botânico Universidade de Lisboa	Santo António	Fountain		Probable	Pair
17	Ribeira das Naus	Santa Maria Maior	Pond		Probable	Pair
18	Cais da Matinha	Marvila	Marina/Shoreline	April	Confirmed*	With chicks
19	Vasco da Gama	Parque das Nações	Marina/Shoreline	April	Confirmed*	With chicks
20	ETAR (Parque Tejo)	Parque das Nações	Tanks (fenced area)	May	Confirmed	With chicks

*Observation collected from online resources (PortugalAves or Biodiversity4all), no evidence of success was found during the prospection visits to the site

Breeding success

During this census, the breeding success of the Egyptian Goose in the city of Lisbon was of 60% (n=20) considering all breeding pairs (confirmed and probable breeders). When including second clutches (n=3), the success was slightly higher (65%). During our visits to breeding sites, although there was no intensive monitoring (e.g., daily visits), it was possible to collect valuable information of some causes of breeding disturbance or disruption. Substantial maintenance work was observed in several breeding sites (n=8, 39%) during the breeding period, which in all cases included complete draining of the lake, but also the cut of vegetation cover. At least in six cases that maintenance work occurred early in the breeding calendar, when pairs were establishing a territory or incubating, which led to a delay of the onset of breeding (n=3, hatching occurred 2 or 3 months after) but also disruption of breeding (n=2, pairs abandoned the breeding site).

The productivity of breeding pairs was of 6 chicks per breeding pair (5.5 chicks/pair) and 5 chicks per clutch (4.5 ± 3.5 chicks/clutch) considering only the pairs with chicks (n=13) and the period of this study (february-june). When considering all the breeding pairs (confirmed and probable pairs), the productivity was of 3.6 chicks/pair (n=20).

No direct observations of gosling mortality events were made, however, several attacks by Yellow-legged Gulls *Larus michahellis* on small chicks were observed in one particular breeding site, and only four of eleven goslings survived the first two weeks of life. In another breeding site, none of the chicks of the first clutch survived. The inexperience of the breeding pair and low food availability close to the nesting site, were the most likely reasons for the failure, as chicks were growing slowly and the inexperienced pair was not able to take them to a nearby lake with food. Despite the failed breeding attempt, the pair was able to produce a second clutch with only

a three-month interval between the hatching of both clutches. Noteworthy, the success of birds breeding near the city shoreline, in opposition to the lakes of city parks, was considerable low (0.6 chicks/pair, n=5 of 20).

Discussion

This work provides the first estimate of the size and distribution of the breeding population of Egyptian Geese in the city of Lisbon. We estimate a population of 20-26 breeding pairs within the limits of the city, most of them breeding in public city parks (75%) with a large lake and suitable nesting habitat.

Twenty years ago, this invasive species was not even breeding in Portugal (Equipa Atlas 2008) but it has been spreading and increasing in numbers over the Iberian Peninsula, especially in the last 10 years (Keller et al. 2020, Prietra Díaz 2022). While the species can already be found nesting in many non-urban areas in Portugal (e.g., Tejo estuary, most of the Alentejo region) breeding records in cities have also been increasing, particularly in Porto and Lisbon. The Egyptian Goose was classified as an invasive species in Portugal in 2019 under the national decree n° 92/2019 which established the legal regime applicable to the control, detention, introduction into nature and repopulation of invasive species, in agreement with the EU regulation n° 1143/2014. The current legislation and classification of the Egyptian Goose as an invasive species predicts the implementation of monitoring, early detection and rapid reaction mechanisms. Nevertheless, those mechanisms have not been implemented yet, including the monitoring of the species, which would be the baseline for the management of this invasive species. Little is also known about its breeding biology and ecology in south European countries, where environmental conditions are very different from other European countries where the species has been introduced decades ago (e.g. United Kingdom, Netherlands).

Urban areas as kinder gardens for the Egyptian Goose

The success and productivity of the Egyptian Goose reported in this study is considerable high (65%, 5.5 chicks/pair), when compared to the values reported in other non-native areas, namely in central European countries (1.1 chicks/pair, England, Sutherland & Allport 1991; 35-41%, 4.5 chicks/pair, Netherlands, Lensink 1999, Gyimesi & Lensink 2012; 4.7 chicks/pair, Germany, Schropp et al. 2016; 4.98 chicks/pair, France, Dubois 2016). This is meaningful, because urban areas may be providing safe nesting sites, when compared to natural areas, which emphasizes the necessity of knowing more about post-fledging dispersal movements of urban populations. Besides that, in only six months of monitoring, there were three breeding pairs with second clutches, all successful. The conditions in urban areas, together with the mild winter in southern Europe and the flexibility of the breeding phenology of the species, may enhance the productivity in these areas. Indeed, there are reports in citizen science biodiversity databases (such as the Biodiversity4all web portal, www.biodiversity4all.com) of Egyptian Geese clutches from August to December in Lisbon in recent years, which indicates that the annual productivity of this population is likely higher than 5.5 chicks/pair.

Monitoring and research

In complement to the monitoring of breeding numbers in urban and natural areas, it would be recommendable to run a monitoring program that included the colour-ringing of chicks from urban populations. This type of monitoring would be useful for a better understanding of the post-fledging dispersal of this species in urban areas and assess the potential dispersal to natural habitats, where the impact on native species can be more severe. Additionally, a colour-ring program could be the first step to implement

a citizen-science based monitoring of the species in city parks, a cost-effective monitoring strategy for invasive species (Strubbe 2017). The fast replacement of clutches and the occurrence of consecutive and successful breeding attempts along the annual cycle observed in this study strongly point out for the need of more research for a better understanding of the breeding phenology of the species in southern Europe for the assessment of the annual productivity of breeding populations.

Control measures in urban areas

Successful pairs were dependent on a safe nesting site (usually an islet) in a lake, which may be the key for the implementation of population control measures in urban areas. Urban areas have high levels of human disturbance and predators (e.g., feral and domestic cats, gulls), for which limiting the access of the species to nesting islets (or other safe nest site) in large lakes of city parks is likely the most cost-effective preventive measure to implement in cities. The control of eggs is also an option, considering that managers would have an “easy” access to islets, but requires close and continuous monitoring of breeding pairs along the year. Egyptian geese are currently hunted in other countries (e.g., Denmark, Netherlands) with some success in controlling the species (Strubbe 2017). Nevertheless, hunting is not a measure recommendable in urban or suburban areas. An alternative would be the trapping of territorial birds with decoy birds, which recently has been successfully tested in Flanders (Huysentruyt et al. 2022) or using falconry, particularly in large areas with suitable habitat, such as golf courses (Little 2020). It should also be noted that reports of the species have been increasing in city parks, ponds and marshes in the surroundings of Lisbon (e.g., Parque Urbano do Jamor, Jardim da Quinta da Alagoa, Paul das Caniceiras), as well as in other cities (e.g., Porto, Almada) which emphasizes the need

of monitoring and control these urban populations, and prevent their spread to “new” breeding sites. Considering the high breeding success in urban areas and the current size of the breeding population in Lisbon, it is predictable that this urban population will continue to expand in the Lisbon region, being limited only by the available suitable nesting habitat in the surrounding urban and natural areas.

Public awareness and education on invasive species

During the monitoring visits conducted to study the breeding population in the city of Lisbon, it was possible to observe the active and passive feeding of Egyptian geese by humans, namely by managers and workers of city parks. These were casual (but frequent) observations and several clutches (in at least three different breeding sites) were seen feeding directly from bowls or eating the food scraps during the feeding of other captivity ducks of the parks. This enhances the urgent necessity of educational actions directed to managers and workers of city parks (but also zoos and other private gardens) to inform them about the risks associated to invasive species, but also about the best practices to implement during the feeding of captive birds. In parks where the species has been recorded would be also recommendable to install informative panels, explaining the risks and potential impacts associated with this invasive species and alerting for the prohibition of feeding an invasive species.

Final Considerations

The monitoring and control of the Egyptian Goose, an invasive species which has been increasing in their distribution and numbers in south Iberia, is yet to be in place in Portugal. A well-defined and structured national eradication plan is clearly overdue, and considering the current status and distri-

bution of the species in Iberia, international cooperation with Spain would be indispensable for the proper management of the species. Besides that, the monitoring of “natural” and urban populations, including their breeding success and natal dispersion is also an urgent requirement for a better understanding of the demographic evolution of the species in southern European countries and to better define the most effective control measures to be implemented at a national level, both in urban and natural areas.

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