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ECOLOGY, BEHAVIOR, AND REPRODUCTION OF INVASIVE EGYPTIAN GEESE (*ALPOCHEN AEGYPTIACA*) IN TEXAS

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ABSTRACT.—Information on many aspects of Egyptian Goose (*Alopochen aegyptiaca*) life history in Texas and North America is lacking. We utilized a citizen science invasive bird project in order to collect biological data on Egyptian Geese throughout Texas. Lake/Pond was the most commonly recorded habitat (69.9%) followed by golf courses (15.6%), and rivers (9.2%), and geese were on land more often than in water. Resting (27.3%) and foraging (26.0%) were the most commonly recorded behaviors and aspects of thermoregulation are provided. The diet includes grass, aquatic vegetation, and a variety of items offered by humans. They commonly occur (24%) with other waterfowl species with few cases of agonistic behavior, and one case of hybridization with a domestic duck is documented. Mean flock size was 5.1 (range: 1-53). The geese are permanent residents, with short-distance movements common throughout the year. Breeding occurs from January to July, peaking March to May. Nesting was recorded on the ground (n = 3) and in trees (n = 2), and number of goslings ranged 2–11. Information is also provided for reproductive chronology and life cycle. Ultimately, the Texas geese appear to be generalist in nature, as they are throughout their native and nonnative ranges. The potential threats this species poses throughout its introduced range warrants further investigation.

Nonnative introduced species are generally considered to have potential negative effects on the environment (Simberloff 2000, 2003, Pyšek et al. 2012, Ricciardi et al. 2013, Blackburn et al. 2014), making nonnative species a critical component of the conservation of biodiversity worldwide. In addition to potential ecological impacts, economic (Pimentel et al. 2005, Charles and Dukes 2007, Holmes et al. 2009) and societal (Bomford 2003, Banks et al. 2008) impacts deserve attention. In avian ecology, a growing number of studies are providing anecdotal or correlative evidence of threats from introduced species to native species (Baker et al. 2014). At a minimum, proper management of nonnative introduced species relies on a basic understanding of the role they play in the novel ecosystem.

The Egyptian Goose (*Alopochen aegyptiaca*; hereafter ‘EGGO’) is native to Africa, particularly sub-Saharan Africa (Brown et al. 1982, Maclean 1988, Davies 2005) with a native population greater than 500,000 individuals (Banks et al. 2008). In addition to its native populations, EGGO have successfully established populations in Europe (Sutherland and Alport 1991, Delaney 1993, Lensink 1999, Rehfisch et al. 2010, Gyimesi and Lensink 2012) and are considered one of the most rapidly spreading invasive species in Europe (Gyimesi and Lensink 2012). In North America, EGGO occur regularly in Florida, Texas, and California, among other regions (Pranty and Garrett 2011, Pranty and Ponzio 2014, eBird 2016). Information on EGGO in North America is limited to status and distribution

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of populations in Arkansas (Smith and James 2012, Chesbro 2015) and Florida (Pranty and Ponzo 2014), as well as a first documented nesting event in Florida (Braun 2004).

In their native range, EGGO are considered a nuisance by the public (Stephen 1985, Little and Sutton 2013) due to their prevalence on golf courses. Additionally, in their native and nonnative ranges, concerns of eutrophication through excess defecation are often reported (Stephen 1985, Little and Sutton 2013, Gyimesi and Lensink 2010, Rehfish et al. 2010). Further, the invasive populations in Europe pose ecological and economic threats which include aggression towards native species, hybridization, eutrophication, agricultural damage, and aircraft strikes (Rehfish et al. 2010, Gyimesi and Lensink 2010). The potential threats that the EGGO pose in Texas and North America make this species an excellent candidate for further study.

In this study we use the Texas Invasive Bird Project (TIBP), a citizen-science study targeting six invasive species in Texas (Brooks 2013), to document life history aspects surrounding the EGGO in Texas. We summarize results of the citizen-science study with particular emphasis on aspects of ecology, behavior, and reproduction of the EGGO in Texas. We also compare this information with other EGGO populations and assess any potential threats the EGGO may pose to Texas's native wildlife. This is the first study to provide information on ecology and reproduction of the EGGO in North America.

METHODS

For full details on the Texas Invasive Bird Project methodology see Brooks (2013). In brief, data were collected from a questionnaire that was designed to collect pertinent information on nonnative avian species in Texas. The questionnaire contained non-competitive questions that would elicit honest answers from competitive bird watchers. The questionnaire, available at: www.hmns.org/InvasiveBirds.doc, was distributed to birders via internet list-servs, birdwatching festivals, birdwatching clubs, and word-of-mouth.

Returned questionnaires ranged from mostly blank with many unanswered questions to fully complete with detailed information. Insufficiently completed questionnaires were not included in

analyses. Photographs were often sent in with questionnaires. In order to ensure accuracy of the results, the citizen science data were proofed through checking photographs and ground truthing. The data were tabularized to conduct analyses, and results represent data that were submitted from June 2008–March 2016.

The citizen science data were supplemented through detailed observation of a bonded adult pair of EGGO that produced and fledged two goslings in early 2015. Beginning in November 2010, DMB performed weekly aquatic bird counts and monitoring at McGovern Lake in Hermann Park (Houston, Harris Co., Tx). The EGGO were observed opportunistically for a little over two years (13 January 2014 - 10 February 2016). The lake is nestled within an urban park and contains two well-planted islands, a smaller west island where the EGGO nested, and a larger east island.

RESULTS

Habitat

The most commonly recorded habitat of the EGGO was a lake and/or pond setting (69.9%; Fig. 1), followed by golf courses (15.6%), and rivers (9.2%). Most situations involved an urban component such as subdivision parks or water retention ponds. EGGO were most often recorded on land (57.6%) as opposed to water (37.7%), although in many cases the EGGO were initially observed on land but went into water as the observer approached closer (Fig. 2).

Thermal Regulation

The EGGO were capable of withstanding a wide range of temperatures (4.5 C°–35 C°). On 12 February an EGGO in Lufkin thermo-regulated by standing on one leg on the bank of a pond with scattered snow on the ground. An EGGO from McGovern Lake (25 December) was observed roosting at dawn on the corner of a dock 1.5 m above water following a 4.5 C° night.

Behavior

The most frequently recorded behaviors of the EGGO (Fig. 3) were resting (27.3%), foraging (26.0%), vocalizing (12.6%), and swimming (10.0%).

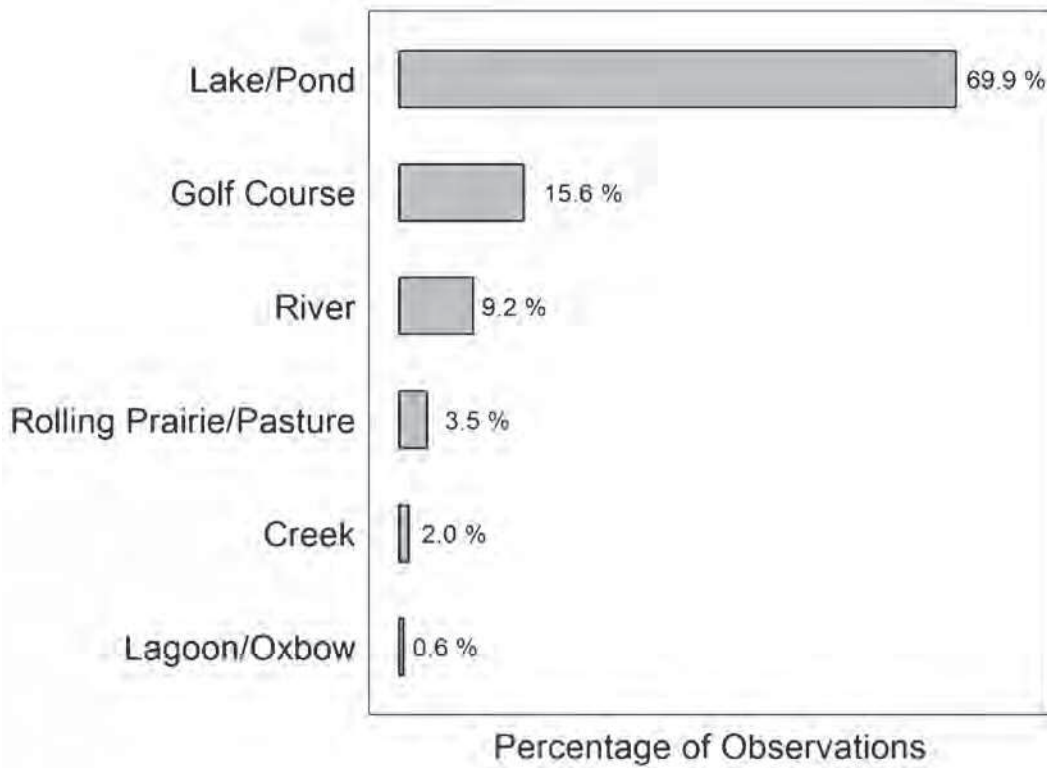


Figure 1. The percentage of habitats used by EGGO in Texas. Lake and pond were combined as the distinction was relative.

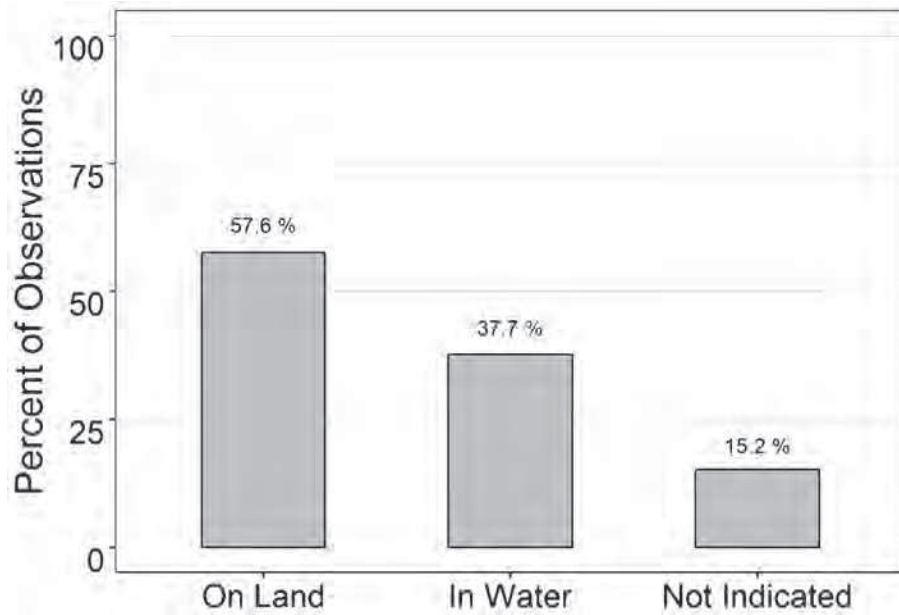


Figure 2. The percentage of EGGO in Texas using land, water, or no indication given.

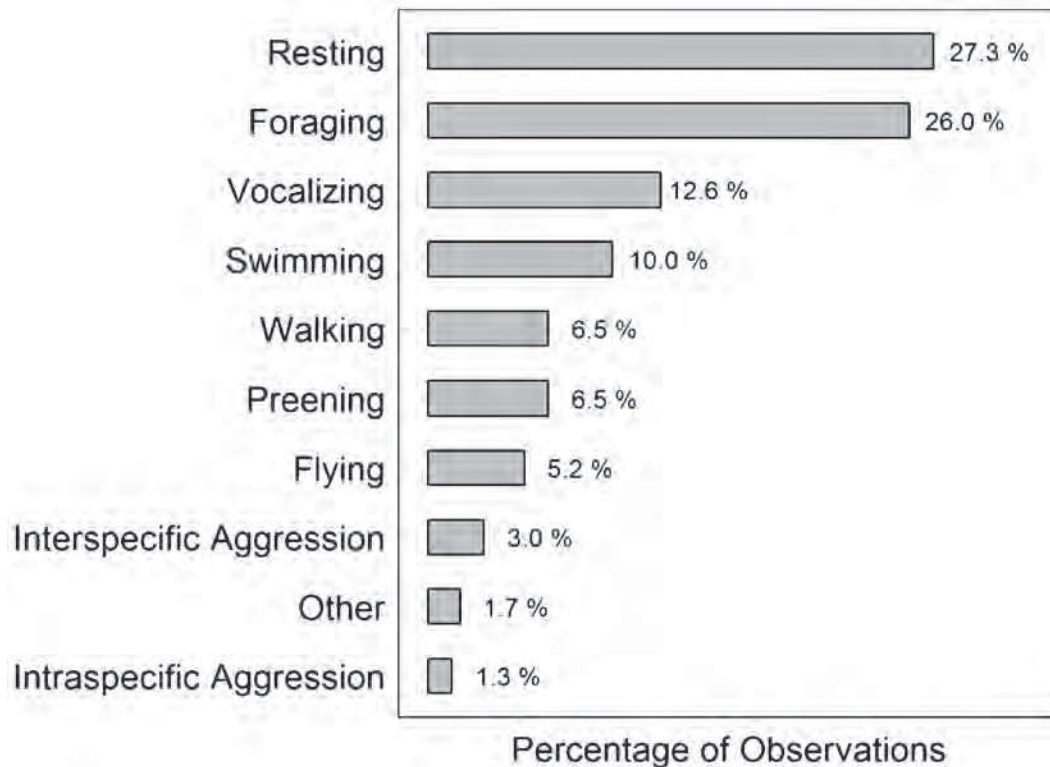


Figure 3. The most common behaviors of Egyptian Geese in Texas.

Although information on EGGO diet was rarely recorded, they utilized some type of supplemental feeding in 12% of the reports. This included: bread (n = 4), corn (n = 4), bird seed (n = 3), hen scratch (n = 2), acorns (n = 1), and dry cat food (n = 1). They were also recorded eating grass (n = 3), aquatic vegetation (n = 1), and an Almond Verbena (*Verbena virgate*) tree's spent seeds (n = 1).

EGGO were highly capable of adroit maneuverability in flight. For example, on one occasion the McGovern Lake pair parted in flight as one flew over and one under a bridge with 2 m clearance without colliding (DMB personal observation).

Interspecific interactions

EGGO were recorded with other waterfowl species 24% of the time. Commonly recorded waterfowl in association of the EGGO include: Black-bellied Whistling Duck (*Dendrocygna autumnalis*; n = 11), various domestic waterfowl species (n = 11),

Muscovy Duck (*Cairina moschata domesticus*; n = 10), Mallard (*Anas platyrhynchos*; n = 8), and Ring-necked Duck (*Aythya collaris*; n = 4). Interspecific aggression was only observed on four occasions, to (n = 1 each) a Canada Goose (*Branta canadensis*), a squirrel (*Sciurus* sp.), a house cat (*Felis catus*), and a domestic duck (*A. p. domesticus*).

There was one instance of documented hybridization of an EGGO with a domestic White Pekin duck. Offspring successfully hatched and both parents aggressively protected the young. In another instance, the bonded male EGGO at McGovern Lake forced copulation with a feral female Muscovy Duck, vehemently dunking her head underwater.

Flock Dynamics

The overall mean flock size was 5.1 (mode = 2, range = 1-53, standard deviation = 7.8). The highest observed flock sizes occurred in May, June, and September, while the lowest occurred in April and August (Fig. 4). Although the most frequently

recorded group size was 2, followed by solo EGGO (Fig. 5), large flocks (up to 53) were observed. There appears to be no temporal correlation of large flocks, as flocks of 10-19 were observed in March, June, September, and November; flocks of 20-49 were observed in January, June, and December; and flocks > 50 were observed in May and September.

Seasonality and movements

EGGO are non-migratory, permanent residents in Texas as they were observed throughout the calendar year (Fig. 4). Short-distant movements are typical however, as EGGO were encountered at McGovern Lake during only 45% (N = 108) of the surveys. For example, the adult pair was observed at a large concrete reflection pond ~250 m northeast of McGovern Lake on 24 August 2014, and the pair with their two grown offspring were observed at the zoo duck pond ~375 m south of the lake on 5 July 2015. The longest continuous duration the EGGO occupied McGovern Lake was during breeding (n = 18 continuous weeks).

Reproduction

In Texas, EGGO breed from January–July as goslings (2-11/brood) were recorded during these

months, peaking March–May. Nesting was recorded on the ground (n = 3) and in trees (n = 2). One detailed nesting was given by an observer which documented an EGGO nest in a large Sycamore tree (*Plantanus occidentalis*) with a natural hollow at the junction of two main branches about 10 m above the ground. Both parents attended the nest, individually and simultaneously. Goslings jumped from the nest in mid-late March. A second detailed nesting event involved a parent attending a clutch of 16 eggs while being followed by a brood of 6. A third nesting event listed a man-made island in a golf course pond as the nesting location.

A brief chronology was recorded for the McGovern Lake birds. The pair appeared on 30 October 2014 after an absence of 4.5 months. Beginning 17 December 2014 only the male was seen on the south bank of the west island, serving as a sentinel, as the female incubated the clutch towards the interior of the island hidden by vegetation. The pair was first encountered with two goslings on 28 January 2015. The goslings grew quickly, attaining 50% adult size after the first month and nearly full grown at two months. The goslings dispersed from the natal site with their parents at a little more than two months of age on 1 April 2015. All four birds

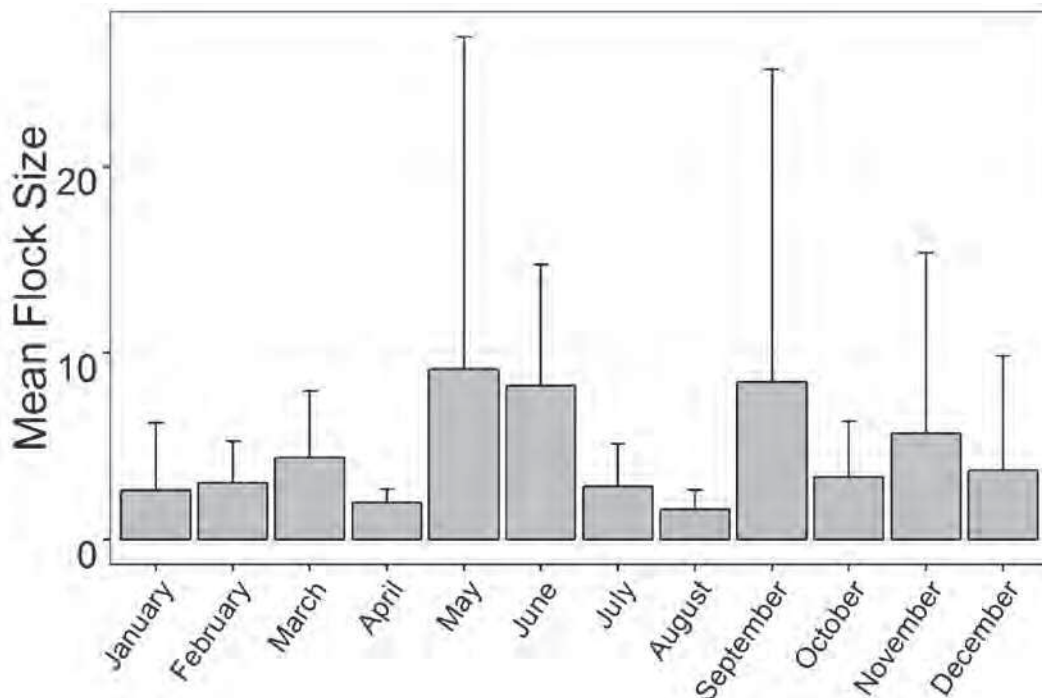


Figure 4. Mean flock size of Egyptian Geese in Texas per month, pooled across all years. Error bars represent standard deviation.

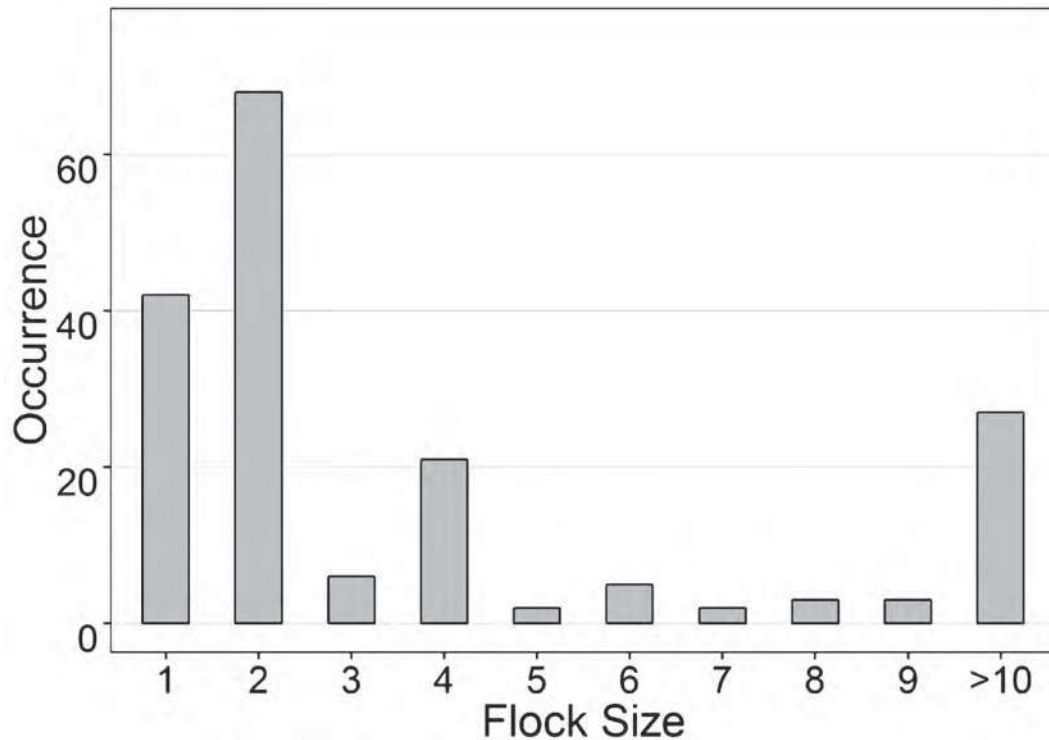


Figure 5. Frequency of flock size for Egyptian Goose in Texas.

returned once, after a three month absence, on 2 July 2015 and three days later were seen nearby on the zoo duck lake. Although the parents returned for the rest of summer and fall on 30 July 2015, the goslings were not seen again.

Predation and Mortality

There were two records of EGGO mortality by a vehicle. Another record of an unidentified species of hawk attacking goslings, which the parents defended. A photograph documented an adult EGGO predated by a Red-tailed Hawk (*Buteo jamaicensis*) as the EGGO's mate (still alive) was in the background. Raptors were present at the Herman Park site on three occasions but each time did not appear to cause distress to a single EGGO roosting alone on the corner of a dock after a chilly (4-8 C°) evening. On two of these occasions Red-tailed Hawks were seen perching in the tree tops nearby, ~20 m from the EGGO on 31 December 2014, and ~35 m away on 8 January 2015.

DISCUSSION

EGGO in Texas spend the majority of their time resting and foraging primarily near lakes/ponds, able to persist in temperatures ranging 4.5-35 C°. While most groups are comprised of only one or two birds, mean flock size is 5.1, but may occur in flocks exceeding 50 birds. They are permanent residents, breeding from January through July with a peak from March to May, and short local movements possible throughout the year. Currently, ecological impacts appear to be minimal, as they are amicably syntopic with a variety of other waterfowl, with agonistic behavior recorded on only four occasions to other vertebrates (n = 2 each for waterfowl and mammals), and hybridization was only documented in a single instance and reported in another.

Comparisons with Egyptian Geese in their Native Range

Throughout their native range EGGO are generalists in many aspects of their life history.

Habitat requirements are minimal as a water body is the main requisite. Rivers, lakes, ponds, marshes, reservoirs, estuaries, and pans are all utilized in their native range (Maclean 1993, Harrison et al. 1997). Diet consists of grain, crop seedlings, shoots, leaves, aquatic plants, seeds, grasses, and even insects (Brown et al. 1982, Maclean 1988, 1993). Breeding year round (Davies 2005), they are catholic in their nesting sites as they use tree cavities, cliffs, ledges, vegetation, caves, and buildings (Brown et al. 1982, Maclean 1993, Davies 2005). Predation is rarely reported, but is restricted mainly to large species of eagles (Lensink 1998), as an African Fish-Eagle (*Haliaeetus vocifer*) has been recorded pursuing an EGGO (DMB, unpublished data).

The generalist life history reported in Africa closely matches the results of this study. Habitats ranged from small subdivision ponds to large expansive lakes but generally required some water feature. Diet included grass, aquatic vegetation, Almond Verbena seeds, and a wide range of human offerings. Although nesting was rarely reported, nests were found both on the ground and in trees. EGGO are commonly found coinciding with humans and human development given that 12% of reports mentioned some form of supplemental feeding by humans. Furthermore, EGGO were commonly recorded perching on buildings, railings, docks, and other man-made structures. Lastly, while predation by Red-tailed Hawk was documented, this may be uncommon because on two different occasions a single EGGO did not seem distressed from the presence of a Red-tailed Hawk.

Throughout their native range, most potential negative effects from EGGO are of an economic nature. EGGO are considered a 'serious pest' (Mangnall and Crowe 2002) as their preference for cereal crops causes conflict with farmers (Maclean 1988, Mangnall and Crowe 2001, van Niekerk 2010). Further, they are considered a nuisance on many golf courses throughout South Africa (Mackay et al. 2014). Although these impacts went undocumented in our study, we highlight the potential of such conflicts given further population increase.

Comparisons with Egyptian Geese in their Invasive Range

The EGGO has successfully established populations throughout Europe (cf., Kampe-Persson 2010). Compared to the sparsely studied

North American populations (Braun 2004, Smith and James 2012, Pranty and Ponzo 2014), European populations have been well studied and documented (cf., Gyimesi and Lensink 2012). The most studied EGGO population in Europe is from the Netherlands (Lensink 1996, 2002, Gyimesi and Lensink 2010, 2012). From 1967 (the first year breeding was reported) to 1999 the mean annual growth rate was 28.2% (Lensink 1996, 2002, Gyimesi and Lensink 2012). Gyimesi and Lensink (2012) most recently estimated the breeding population of EGGO in the Netherlands at 10,000 pairs, and total population at 45,000 individuals.

Sutherland and Allport (1991) report general characteristics of the species' biology in Britain, part of its introduced range. They found EGGO had poor breeding success with an average of 1.06 young per pair. Their main habitats included parkland and rivers but in general were adjacent to water during molting. Flock size was greatest during molting where flocks of up to 50 birds were often seen. They fed on permanent grassland as well as stubble, crops, and pasture, and prefer breeding sites with short grass and open water nearby. Like in Africa, they are considered a cereal crop pest and therefore are in direct conflict with farmers in certain regions of Europe (Gyimesi and Lensink 2010).

Biology of the EGGO in Britain closely matches that reported in this study. Parkland habitat which generally included 'ornamental lakes' (Sutherland and Allport 1991) in Britain, is similar to parkland (i.e., golf courses, residential and suburban parks) commonly used by EGGO in Texas. Although our study documented few food items, they appear to be generalist in Texas which is similar to British populations, where they demonstrate an ability to switch from grasslands to pastures, stubble, and crops (Sutherland and Allport 1991). Flock dynamics are also similar in Texas and Britain, as the maximum flock size in our study was 53, and flock sizes of up to 50 are often seen in Britain (Sutherland and Allport 1991).

Are Invasive Egyptian Geese a Threat to the Environment in Texas?

Many potential and realized ecological, economic, and societal concerns garner attention with the feral population of EGGO in Europe (Gyimesi and Lensink 2010). These include eutrophication caused by defecation of large flocks of EGGO, defecation

in public areas, fierce aggression during breeding season, and hybridization with other native species (Gyimesi and Lensink 2010, 2012).

Flock size of EGGO is a major cause for concern as flocks can consist of hundreds to thousands of birds (Gyimesi and Lensink 2010), which can lead to large defecation inputs in the environment. The highest reported observation count was 53 in our study, but this could increase given further population growth.

Curtis et al. (2007) documented a negative effect on Black Sparrowhawk (*Accipiter melanoleucus*) nest success due to EGGO. Although we did not document any negative effects on native species from EGGO, interspecific aggression occurred on only four occasions, and only two of these involved waterfowl. EGGO are known to be aggressive and territorial (Johnsguard 1978) and regarded by Beazley (1964) as the most vicious of all waterfowl when nesting. The lack of aggression observed is likely due to lack of nests found. It is also possible that there is no strain on the EGGO due to abundant resources, thereby diminishing aggression.

Hybridization of EGGO has been documented with other introduced goose and duck species (Lensink 1996, Harrop 1998, Banks et al. 2008). We received one detailed report of an EGGO hybridizing with a domestic duck. We also directly observed a male EGGO forcefully copulating with a female domestic Muscovy Duck. This was around the same time that nesting commenced. Whether this behavior was promiscuity, territoriality, or a combination of the two is unknown. Given that 24% of the time geese were reported with other waterfowl species, we acknowledge the possibility of further hybridization.

CONCLUSION

We provide a general overview of the EGGO's natural history in Texas. Given their generalist nature and abundance of habitat, nesting, and diet choices, we find it possible that the population in Texas will continue to increase and subsequently thrive. More importantly, we feel the above, combined with the ecological and economic threats the species poses throughout its natural and invaded range warrants further study. We contribute initial information on aspects of ecology, reproduction, and behavior for nonnative EGGO on which it is our fervent hopes future studies will build. Although we do not explicitly document any negative ecological or economic impacts at this time, the potential for such impacts is

a cause for concern in Texas and North America.

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