Artificial nesting platforms support population recovery of the Dalmatian pelican *Pelecanus crispus* along the Danube River in Bulgaria

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SUMMARY

The Dalmatian pelican *Pelecanus crispus* is a Near Threatened species of waterbird with populations in the wetlands of the Lower Danube River. Breeding populations declined due to habitat loss and wetland drainage and conservation efforts have focused on bringing breeding Dalmatian pelicans back to their former wetland sites in Bulgaria. Since 2008, conservation efforts have focused on building artificial nesting platforms at marshes along the Lower Danube River. These efforts resulted in considerable growth of the population in the country. Between 2011 and 2021, four wooden platforms were installed at the Belene Island wetland complex (Pechina and Martvo Marshes) and the Kalimok wetland complex. All four platforms were used successfully by pelicans, resulting in the formation of two new breeding colonies and a total of 91 pairs in 2021. The majority, 88 pairs, were recorded at the Belene Island marshes, with the remainder at the Kalimok colony. The average annual breeding success was 1.17 young per pair at Peschina Marsh (occupied from 2016-2021), 0.90 at Martvo Marsh (2020-2021), and 1.33 at Kalimok (2021). The average across all three colonies was 1.14 young per pair. By 2021, the breeding population of Dalmatian pelicans in Bulgaria had grown to 131-150 breeding pairs at three locations.

BACKGROUND

Habitat loss and human modification of natural conditions are two of the most critical threats leading to species population declines and extinction (Tilman *et al.* 1994, Fahrig 1997, Goudie 2013, European Environmental Agency 2020). In order to resolve these threats, conservation and restoration initiatives should aim to provide suitable habitats for species that are currently in decline due to lack of suitable habitat (Clarke *et al.* 2010).

The Lower Danube River is an internationally important wetland ecosystem that provides specific conditions for the survival of several threatened bird species during their annual cycle. Many waterbird species, including the Dalmatian pelican *Pelecanus crispus,* depend on the river and adjacent wetlands. The Dalmatian pelican is Near Threatened worldwide, according to the IUCN Red List, with a decreasing global population trend of between 11,400-13,400 mature individuals (BirdLife International 2018). In Europe, the species was recently downgraded to Least Concern (BirdLife International 2015) with stable or increasing breeding populations concentrated mainly in Greece, Romania, Turkey and Bulgaria totalling 2,831-3,094 pairs (Catsadorakis *et al.* 2015, Catsadorakis & Portolou 2018).

By the middle of the 19th century Dalmatian pelicans were recorded breeding at five locations in Bulgaria – one along the Black Sea coast, one in the south-east of the country, and three along the Lower Danube (Michev *et al.* 2012). Anthropogenic activities, including drainage of wetlands, resource extraction, and other land use changes, led to a significant decline in wetland habitat during the first half of the 20th century (Catsadorakis & Portolou 2018). As a result, only one breeding colony remained in Bulgaria, at Srebarna Lake Biosphere Reserve and in 2007, its population was estimated as 14-128 pairs (Iankov 2007). Restoration of the hydrological regime of two key wetlands for pelicans along the Danube River, Persina Nature Park and Kalimok Complex was accomplished from 2002 to 2008, financed by the Global Environmental Facility, as part of a World Bank-managed Wetlands Restoration and Pollution Reduction project (GEF 2009).

Artificial structures have been successfully used to support Dalmatian pelican breeding colonies in Russia, Romania, Greece, and Turkey (Vinogradov *et al.* 1982, Pyrovetsi 1990, Burgess & Hirons 1992). The use of artificial structures as a conservation action to support breeding colonies of different waterbirds has been effective in 60% of the 11 studies assessed on the Conservation Evidence website (https://www.conservationevidence.com/actions/480).

In 2000, artificial platforms were first used to support breeding Dalmatian pelicans in Bulgaria at the Srebarna reserve, the only natural colony remaining in the country at that time (Fig. 1). Pelicans occupied the 90 m^2 fixed wooden platform and 30 nests were recorded. During the following two years, the platform was refurbished several times and another two platforms were built in 2003 giving a total surface area of 310 m^2. The platforms were not maintained, however, and, although pelicans continued to successfully use the platforms, by 2011 the available surface was reduced to 75 m^2 and by 2021 to 45 m^2 (Michev & Kambourova 2012).

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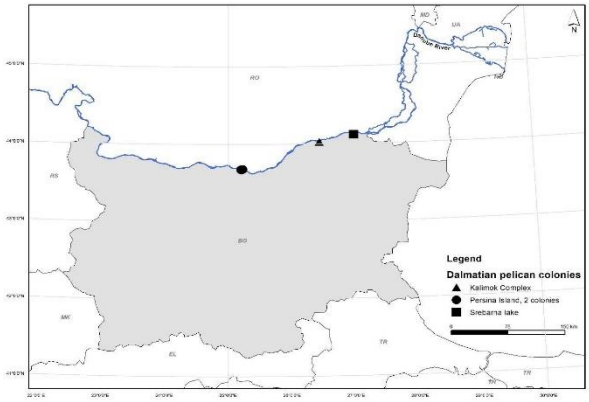

Figure 1. Distribution of Dalmatian pelican (*Pelecanus crispus*) breeding colonies along the Danube River in Bulgaria.

The Burgas wetlands is a group of freshwater and saltwater coastal lakes with a total surface of 95 km^2. The freshwater lakes (Burgas and Mandra) are rich in fish, and thus preferred foraging grounds for pelicans, while Atanasovsko Lake is a well-known roost for both great white (*Pelecanus onocrotalus*) and Dalmatian pelicans (Kostadinova & Gramatikov 2007). Unsuccessful attempts, using artificial platforms, were made to bring back Dalmatian pelicans at Mandra Lake, where pelicans had not been recorded since 1960 (Michev & Kambourova 2012). At the end of 1999, two floating rafts were anchored in the overflow basins of the lake, but pelicans only used the platforms for resting and there were no breeding attempts. During the same period, two platforms were built in the western part of Burgas Lake, but soon after that the platforms were vandalised (Petar Iankov pers. comm.). In 2017, one wooden fixed platform (144 m^2) with two pelican decoys was built on Atanasovsko Lake but there were no signs of breeding attempts (Bulgarian Biodiversity Foundation 2017).

Attempts to establish a new Dalmatian pelican breeding colony or to strengthen existing ones were also made in Greece and Romania. In Greece, a study found that two rafts and one artificial island were occupied by pelicans but, shortly after egg laying, the platforms were abandoned (Pyrovesti 1997). In 2007, at Sinoe Lake, Romania, a platform was built to support an existing Dalmatian pelican colony and used by pelicans for several years. However, without maintenance the 350 m^2 platform was destroyed by ice blocks formed during winter (Sebastian Bugariu, pers. comm.).

In this paper we test whether artificial platforms can be used to restore breeding populations of Dalmatian pelicans along the Lower Danube River in Bulgaria.

ACTION

The study focused on two sites, the Belene Islands Complex (43° 40’21” N, 25° 11’16” E) and the Kalimok Complex (44° 01’31” N, 26° 25’42” E). Both were historically important areas for many waterbirds, however, due to changes in the hydrological regime by the end of the 1990s, both sites lost their permanent connection to the Danube River. The Belene Island Complex (7,009 ha) is a Special Protection Area and internationally important wetland under the Ramsar Convention (Fig. 2). The area forms part of the Persina Nature Park and is one of the most important freshwater wetlands along the Bulgarian-Romanian part of the Lower Danube. This area includes the Peschina, Martvo and Dyulova Bara marshes, which are surrounded by old riverine willow and poplar forests (Todorov *et al.* 2007). The Kalimok Complex (9,429 ha) is also a Special Protection Area and includes a former Danube marsh, which was turned into a network of fishponds (Fig. 3) and then abandoned in 1997 (Kutzarov *et al.* 2007). The distance between both project sites is 115 km (Fig. 1).

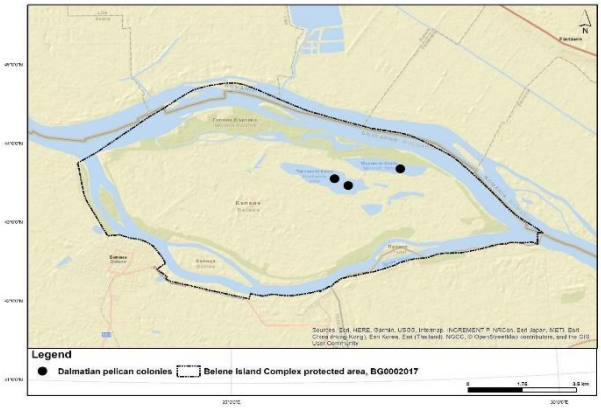

Figure 2. Location of the Dalmatian pelican (*Pelecanus crispus*) breeding colony within the BG0002017 Belene Island Complex protected area. The distance between the platforms at Peschina Marsh is 470 m.

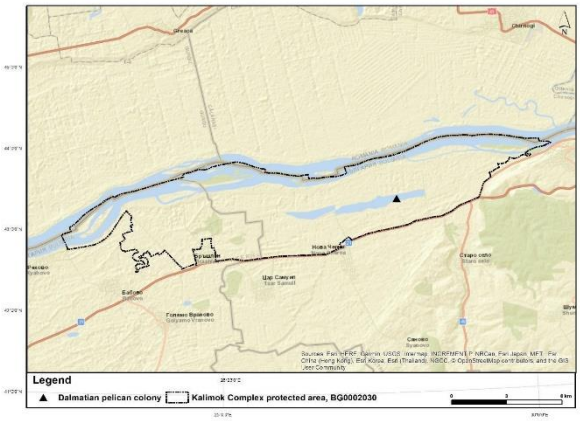

Figure 3. Location of the Dalmatian pelican (*Pelecanus crispus*) breeding colony within the BG0002030 Kalimok Complex protected area.

In December 2011, when the marshes were dry, we installed one fixed wooden artificial nesting platform to encourage breeding pelicans at Peschina Marsh (Figs. 4, 5). The platform was based on a design by Catsadorakis (2017), with support poles sunk 1 m into the ground and the platform itself 2.5 m above the substrate – high enough to ensure it did not get flooded once water returned to the marsh. The initial surface of this platform

was 12 m^2 (4 x 3 m), but it was extended to 16 m^2 (4 x 4 m) in 2016 and then to 32 m^2 (8 x 4 m) in 2018. This ensured sufficient space for numerous great white pelicans that had been recorded using the platform as a resting area during the spring migration (April-May). In subsequent years, the platform size was gradually increased to 64 m^2 by 2021 (Table 1). In 2012-2013 we built a second platform in Peschina Marsh and one in Martvo Marsh (each 8 x 4 m). The platform at Kalimok Complex was built in December 2020 using the same design (8 x 4 m). All platforms were covered with common reed *Phragmites australis* stems, to be used as nesting material.

Figure 4. The artificial wooden platforms built in Peschina marsh, part of the Belene Island Complex, March, 2020. Photo: Svilen Cheshmedzhiev

On completion of the platform at the Kalimok Complex, we also deployed three life-size Dalmatian pelican decoys, two birds in a laying position and one standing up (Fig. 5). The decoys were custom manufactured from a fiberglass composite and painted to resemble adult pelicans. The first platform at Belene Island Complex had not been occupied until 5 years after it was built, and our goal was to test whether decoys would attract breeding pelicans faster than during the previous experience.

Figure 5. Real-sized Dalmatian pelican decoys, placed at the platform of Kalimok Complex, December 2021. Photo: Svilen Cheshmedzhiev

After the hydrological regime of the two wetland areas was improved in 2008, an ongoing monitoring programme was established mainly covering the waterbird breeding season from March to July. Occasional visits were also carried out from August to December to collect data about the waterbird congregations during the non-breeding season. Direct counts, from predefined observation locations (Bibby *et al*. 2000), were carried out by ornithologists from the Bulgarian Society for the Protection of Birds (BSPB) and Persina Nature Parks rangers. Each adult sitting at the well visible nest was considered as an apparently occupied nest, therefore a pair. Data are available from the BSPB bird database (www.smartbirds.org). To obtain more precise data about the platform occupancy in the project sites during the breeding period 2020-2021 we used a small quadcopter drone. The model used was DJI Mavic Pro 2 (https://www.dji.com/mavic-2). Considering all precautions for safe flight and existing ethical guides for using drones while surveying birds (Vas *et al.* 2014) we launched the drone at a minimum distance of 500-700 m and flying over the platforms at > 70 m altitude. To minimise the disturbance, we conducted a single flight in favourable weather conditions. This was sufficient time to collect data about the breeding pairs. Once the drone reached the platform, several images were taken and used to identify the pelicans sitting on their nests (Fig. 6).

Breeding success was measured as the average of the number of young produced per pair in each colony across the study period. All calculations were carried out using Excel (Microsoft Office Professional Plus 2013). Maps were drawn using ArcMap 10 (ESRI, CA, USA, 2013).

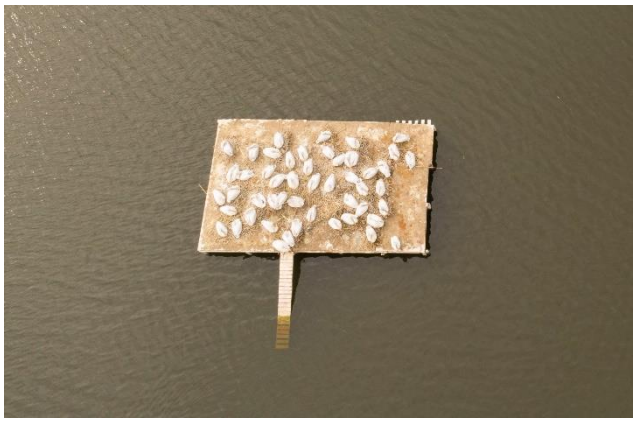

Figure 6. Apparently occupied nests of Dalmatian pelican at platform B of Peschina marsh, March 13th 2021. Photo: Svilen Cheshmedzhiev

Costs

The construction and installation of one 32m^2 platform cost between €1500 and €2000 in 2011. This included the cost of materials (support poles, wooden platform) and labour for installation. Construction took approximately 1 week for a team of 4-5 people. The pelican decoys added to some platforms cost an extra €400 each.

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CONSEQUENCES

The first artificial nesting platform was installed in 2012 at Peschina Marsh and was used by small groups of 10-20 immature pelicans during spring and autumn of that year. From 2012 – 2016, pelicans were observed mainly resting on the platforms. Table 1 shows the results from breeding successes across the study sites. The first breeding pair was recorded in May 2016 on platform B at Peschina Marsh, and the first chick was observed on 1st June. In 2020, breeding was confirmed on the Martvo Marsh platform, located 2 km away from Peschina Marsh. Pelicans occupied the platform at the Kalimok Complex in March 2021 with breeding confirmed by April. The number of breeding pairs at Belene Island Complex rose from seven in 2016, when the colony was established, to 88 in 2021. Another three pairs were recorded at the colony in Kalimok Complex in the first year of the colony. The most successful year was 2021 when all four platforms were occupied, and 91 breeding pairs produced 109 fledged chicks. The average breeding success across the colonies established in the study period was 1.14 young per pair.

Table 1. Dynamics of the breeding performance of the Dalmatian pelicans (*Pelecanus crispus*) using artificial platforms at Belene Islands Complex and Kalimok Complex in the period 2016-2021. n/a indicates that the Kalimok Complex platform was not built until December 2020. The totals represent the maximum numbers of pairs registered during the breeding season.
Breeding success is defined as the average number of young produced per pair in each colony.

Platform name	Colony	2016	2017	2018	2019	2020	2021
Peschina Marsh within Belene Island Complex							
Peschina marsh A	Platform size (sq.m.)	16	16	32	32	32	32
	Breeding pairs	0	0	0	3	0	16
	Fledged pelican chicks	0	0	0	3	0	17
	Breeding success	0	0	0	1	0	1.06
	Mean breeding success	1.03					
Peschina marsh B	Platform size (sq.m.)	32	64	64	64	64	64
	Breeding pairs	7	4	9	21	22	48
	Fledged pelican chicks	10	5	9	27	34	63
	Breeding success	1.43	1.25	1	1.29	1.55	1.31
	Mean breeding success	1.3					
Martvo Marsh within Belene Island Complex							
Martvo marsh	Platform size (sq.m.)	32	32	32	32	32	32
	Breeding pairs	0	0	0	0	8	24
	Fledged pelican chicks	0	0	0	0	6	25
	Breeding success	0	0	0	0	0.75	1.04
	Mean breeding success	0.9					
Kalimok Complex							
Kalimok	Platform size (sq.m.)	n/a	n/a	n/a	n/a	n/a	32
	Breeding pairs	n/a	n/a	n/a	n/a	n/a	3
	Fledged pelican chicks	n/a	n/a	n/a	n/a	n/a	4
	Breeding success	n/a	n/a	n/a	n/a	n/a	1.33
	Mean breeding success	1.33					

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DISCUSSION

The results in this paper suggest that artificial wooden platforms are effective in offering secure nesting conditions for Dalmatian pelicans and this is the first successful record of restoring a locally extinct population of the species in Bulgaria. The breeding population of the Dalmatian pelican has shown a noticeable increase in the study area during the period 2008-2021. In the Belene Islands Complex, a breeding population was established in 2016 after 60 years of absence, and the number of breeding pairs and fledged chicks has almost doubled since 2019. Breeding was confirmed for the first time at the Kalimok Complex. The newly established colonies added another 91 pairs to the approximately 40 pairs already breeding at Srebarna Lake, thus increasing the population size in Bulgaria to 131-150 pairs in 2021. The most recent data available (2006-2011) for Srebarna Lake show there were 1.11 young per pair, which is similar to our results (1.14).

The situation at Srebarna Lake, which was the main Dalmatian pelican colony in Bulgaria until 2021, seems to be complicated in recent years due to insufficient resources available to manage this biosphere reserve. There are several general pressures, such as poaching, which might create significant disturbance and reduce food sources for the pelicans. In addition, sedimentation and water pollution needs to receive urgent attention by management authorities. Natural predators that attack pelican clutches, such as wild boar *Sus scrofa* and raccoon dogs *Nyctereutes procyonoides,* have been recorded several times in the area a (Momchil Petrov, pers. comm.). A number of other conservation actions may also have contributed to the successful population recovery in both study sites. These include additional habitat restoration, including the construction of several channels and water gates to facilitate connection with the Danube River, and a reduction in human access. It is not yet clear why the pelicans colonised the platform at the Kalimok Complex so quickly, but the presence of decoys may have helped. At the Belene Islands Complex, without decoys, breeding was not confirmed until 5 years after the first platform was built.

The platforms offer a suitable artificial nesting site for pelicans but are limited in durability – lasting up to five years before needing refurbishment. Maintenance work on the platforms has been carried out annually since 2011, including covering the platforms with reed stems, and undertaking minor repairs. In future, building artificial islands from stones and gravel, covered by sand and soil might be a more sustainable, albeit more expensive, solution. Similar artificial islands were built for pelicans at Kerkini Lake, Greece (Crivelli 1996, Pyrovetsi 1997). Another solution under consideration is to tramp down natural vegetation along the margins of the lake in winter to create suitable natural space for the pelicans. This method has proved to be effective in Lake Prespa National Park, Greece (Catsadorakis 2017).

In conclusion, we consider that the recent building of artificial platforms following wetland restoration along the Lower Danube River has been crucial for the population growth of Dalmatian pelicans in Bulgaria. We recommend that similar actions be implemented at former breeding sites or other suitable locations in the country to ensure the long-term survival of the species.

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