Nesting behaviour and factors affecting reproductive success of Velvet Scoter *Melanitta fusca* breeding at Lake Tabatskuri, Georgia

SOPIO KIKNAVELIDZE[1], NATIA KOPALIANI[1], NIKA BUDAGASHVILI[2], NIKA MELIKISHVILI[1], ZURAB JAVAKHISHVILI[1], ALEXANDER GAVASHELISHVILI[1] & NIKA PAPOSHVILI[1,*]

[1]Institute of Ecology, Ilia State University, K. Cholokashvili Ave. 3/5, Tbilisi 0162, Georgia.
[2]SABUKO (Society for Nature Conservation), Vano Sarajishvili str. 3a, Tbilisi, Georgia.
*Correspondence author. E-mail: nika.paposhvili.1@iliauni.edu.ge

Abstract

The Velvet Scoter *Melanitta fusca* is declining globally and the species is classified as vulnerable (VU) on the International Union for Conservation of Nature (IUCN) Red List. Of particular concern is the tiny relict breeding population in the Caucasus, which has been classified as critically endangered. Information on this population remains scarce, and more knowledge of its ecology is required for its effective conservation at its last breeding site in the entire region, Lake Tabatskuri in Georgia. Here, we aim to determine the main drivers of nesting success for the scoters breeding at Lake Tabatskuri, which contribute to the birds' overall productivity. From 2019–2021, data were collected from all nests on the one breeding island in the lake, during visits made prior to and during incubation, and from camera traps installed by some nests. Results suggested that predator abundance and the frequency of predation attempts had a major impact on nesting success despite the scoters' defence of their nests. Deploying cameras close to (*c.* 1 m from) Velvet Scoter nests slightly affected their behaviour, but predation rates appeared to be lower at these nests. In the absence of mammalian predators, Armenian Gulls *Larus armenicus* (the most numerous breeding bird on the island) and Marsh Harriers *Circus aeruginosus* predated eggs, which had a significant impact on the outcome of the scoters' breeding attempts. Predation of nesting females by Marsh Harriers also added to adult mortality and potentially limited production of offspring at Lake Tabatskuri. Continued monitoring of Velvet Scoter abundance and production of offspring at this model site, as well as studying the abundance and impact of the gulls, is essential for determining whether predator control measures are needed to maintain the population.

Key words: hatching success, interspecific interaction, nesting behaviour, predation, reproductive output.

The Velvet Scoter *Melanitta fusca* is classed as Vulnerable (VU) on the International Union for Conservation of Nature Red List (IUCN 2023). The European breeding population has declined by about 32–46% over the past three generations (BirdLife International 2020). Well away from its stronghold breeding areas in the northern boreal forest region, the last known concentration of breeding birds in the Caucasus is close to extinction (Paposhvili 2018, 2021) and, based on the latest estimates from Georgia (where the last relict population still breeds), it is critically endangered (CR) in the region (Georgian Biodiversity Database 2021). Whilst historical information about numbers breeding in the Caucasus is poor, recent observations suggest that habitat degradation, hunting, egg collection, entanglement/drowning in fishing nets and predation pressure may all contribute to overall poor reproductive success, which is the most probable cause of the rapid population decline (Paposhvili 2021). Additionally, climate change potentially poses a major threat to the species now and into the future (Drever *et al.* 2011). Studies at Lake Tabatskuri, Georgia, during 2017–2020 indicated that the scoters' overall reproductive output was likely adversely affected by low nesting success, most likely caused by one or more factors in combination, including disturbance, predation, other inter- and intra-specific interactions (*e.g.* occupation of nesting sites by gulls *Larus* sp. and other scoters), the age and body condition of the females, and potentially other unknown factors. A better understanding of the ecological factors influencing the birds' nesting outcomes continues to be an urgent requirement, however, to support and develop effective conservation actions for increasing and maintaining overall breeding success, and potentially enabling the geographical dispersal of this last breeding population to formerly occupied areas elsewhere in the Caucasus.

In this study, we therefore combine our own direct observations of the nests with remote observation methods (*i.e.* using camera traps) which monitor nests continuously without causing undue disturbance to the nesting females, to identify the main factors affecting the nesting success of the Velvet Scoter at Lake Tabatskuri.

Methods

Study area

Lake Tabatskuri (41°39'N, 43°38'E) is located on the Javakheti volcanic plateau at 2,000 m above sea level in Georgia, on the border of Borjomi and Akhalkalaki municipalities, in the northern part of the Samsari Mountain Range. The lake is included in the Ktsia-Tabatskuri protected area, which is managed by the Borjom-Kharagauli Protected Areas Administration and has two villages on its edge: Tabatskuri and Moliti. The surface area of the lake is 14.2 km^2, maximum depth is 45 m (average = 15 m), and the lake has a clean water column. The area is characterised by cold winters and snow cover that lasts up to 150 days. A small island (1 ha) in the northern part of the lake (Supporting Materials Fig. S1) is currently the only nesting area for the Velvet Scoter in Georgia and indeed in the entire Caucasus (Paposhvili 2021). This island in Lake Tabatskuri seems to be favourable for nesting scoters, probably because there are both deep and shallow waters around the island with clear, food-rich areas necessary for feeding adults and later ducklings. The island is covered in dense vegetation, providing safe nest sites for wildfowl, safe from land predators. Moreover, nesting Armenian Gulls *Larus armenicus* may have provided extra protection for the island from other predators (*e.g.* birds of prey) through defence of their own nests at the site.

Nest surveys

Each summer, from 2019 to 2021, two or three observers walking closely abreast searched the entire island for nests in June–July (Supporting Materials Figs. S2 & S3). The island was searched three times each year to locate nests missed during the earlier visits and we recorded the nests' location (latitude, longitude; Fig. 1), clutch size and the fate of the eggs. Camera traps were deployed at nests where there was no dense vegetation around the nest, to allow unrestricted visibility (Supporting Materials Fig. S4), and were placed at different nests on each occasion in different parts of the island: seven in 2019, four in 2020 and five in 2021 (Fig. 2). All camera traps using photo mode were deployed 70–90 cm from the nest. Only one, which used video mode, was installed < 35 cm away. All were triggered by motion and were not installed during the first search of the island but during subsequent visits. In total, 131,219 photos from the camera traps were recorded and analysed.

In the post-hatching period (August), we rechecked all nests and recorded the number of hatched, unhatched and/or predated eggs in each nest (Supporting Materials Figs. S5 & S6) to calculate the percentage of successfully hatched eggs and depredated eggs in each clutch, and thus the overall hatching and nesting success. All unhatched eggs in the nests were broken to determine whether they were addled or contained a dead embryo (Supporting Materials Fig. S7). From the nests where the camera trap was deployed, we collected information on birds visiting the nest, the scoters' daily warning displays (targeted bill-opening and hissing towards approaching danger – *i.e.* an "unwanted guest"), daily turning of the eggs and changes in position by the female, time when the nest is unattended during incubation, duration of the overall nesting period, egg predation and air temperatures extracted from the camera traps (Supporting Materials Figs. S8–S11).

Data analysis

We hypothesised that egg predation, year, the presence of camera traps and air temperature affected the percentage of successfully hatched eggs in a clutch (hereafter, hatching success). Presence of the camera was included because it could potentially disturb the nesting female, to the extent of causing her to abandon the nest. Data on these variables were obtained from our observations made in 2019, 2020 and 2021 (Supporting Materials Table S1a,b,c). To identify which variables might play a role, linear models (LMs) were used to fit the predictor variables (Table 1) using R version 4.3.2. (R Core Team 2023). All possible combinations of predictor variables and interaction terms were explored to

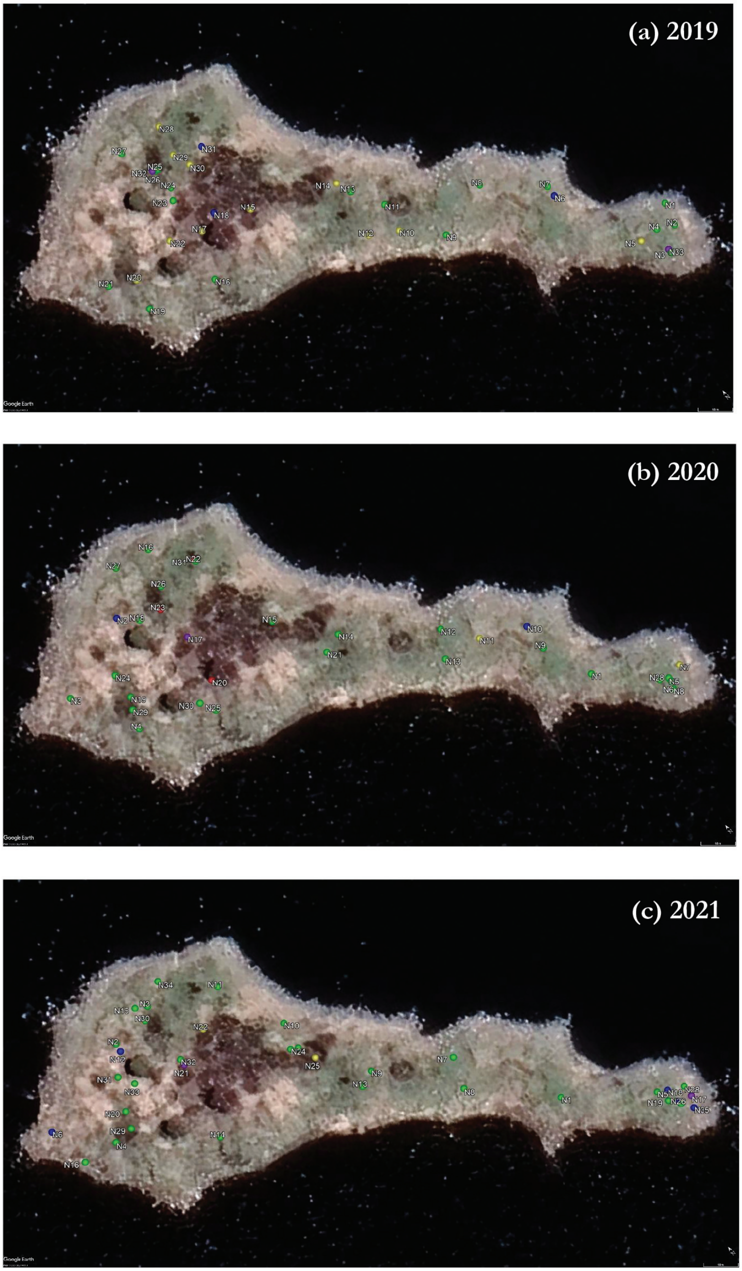

Figure 1. Aerial survey images showing the location of individual Velvet Scoter nests on the island in Lake Tabatskuri during: (a) 2019, (b) 2020 and (c) 2021. Green points = successful nests; yellow = predated nests; blue = abandoned nests; violet = dump nests; red = nests with predated females.

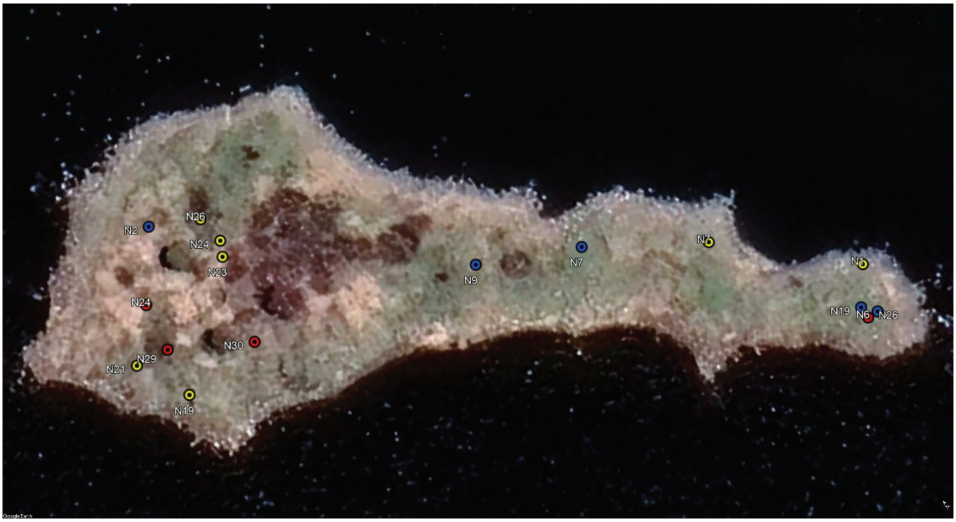

Figure 2. Location of individual Velvet Scoter nests on the island in Lake Tabatskuri where camera traps were deployed in summers 2019–2021. Yellow points = 2019 (at 7 nests); red = 2020 (4 nests); blue = 2021 (5 nests).

determine the best model. Models were evaluated using the Akaike information criterion (AIC). The same procedure was used to determine which of the predictor variables appeared to influence the percentage of predated eggs in a clutch.

Results

Nest surveys

A total of 99 nests with clutches were found during the 3-year study: 33 in 2019, 31 in 2020 and 35 in 2021. In these three years, birds tended to use the same places for nesting, but not always the same nest bowl (most were within 2–3 m of the previous year's nest). In 2019, of the 33 clutches, 52% were successful (*i.e.* at least one egg hatched), 33% were totally predated, 9% were abandoned (eggs found to be addled), and 6% were dump nests, *i.e.* without an incubating female which therefore failed to hatch (Table 2; see also Paposhvili 2021). Of the 280 eggs found in these 33 nests, only 36% hatched successfully, 32% were addled, 3% contained dead embryos, and 29% were predated (Table 3). The average number of eggs in a nest (± s.d.), calculated for successful nests (where at least one egg hatched), was 8.47 ± 1.37, and the average number of eggs that hatched in these nests was 5.88 ± 2.20 (Table 3). In 2020, from the 31 nests, 74% clutches were successful, 16% predated (including three nests where the females were killed on their nests), 6% were abandoned and 3% were laid in a dump nest containing 22 eggs that, surprisingly, was briefly incubated, but by 5 August all these eggs had failed to hatch (Paposhvili 2021 and Table 2). In total 296 eggs were found in these 31 nests, of which 49% hatched successfully, 41% were addled, 5% were

Table 1. Variables included on modelling the hatching success of Velvet Scoters breeding at Tabatskuri Lake, Georgia.

Variable	**Description**
Nest success	The proportion of nests in which ≥ 1 egg hatched
Hatching success	Percentage of hatched eggs in a successful clutch
Predation occurrence	Presence or absence of predated eggs in a clutch
Predation rate (%)	Percentage of predated eggs in a clutch
Year	Year of the study
Camera trap	Presence or absence of a camera trap deployed to observe the nest
Air temperature	Mean air temperature (°C) over the nesting period, extracted from camera traps

suffocated and 5% were predated (Table 3). The average clutch size in successful nests was 9.26 ± 2.09, and the average number of these that hatched was 6.34 ± 1.92 (Table 3). In 2021, of the 35 nests, 74% were successful, 6% were predated, 14% were abandoned and 6% were dump nests (without incubating females) which ultimately all failed to hatch (Table 2). In total, 325 eggs were found in these 35 nests, of which 55% hatched, 31% were addled, 5% were suffocated and 9% were predated (Table 3). The average clutch size recorded for successful nests was 8.88 ± 1.03 eggs, and the average number of eggs that hatched in these nests was 6.80 ± 1.86 (Table 3).

Table 2. Colony size and fate of Velvet Scoter nests found at Tabatskuri Lake, Georgia in summers 2019–2021.

	Year		
Nests	**2019**	**2020**	**2021**
Initiated	33	31	35
Successful	17	23	26
Predated	11	2	2
Nests with predated females	0	3	0
Abandoned	3	2	5
Dump	2	1	2

Camera trap data

Clutches in the nests where camera traps were located all hatched successfully in each year of the study (Supporting Materials Table S1a,b,c). Data from one of the 16 camera traps, the one using video *vs.* picture mode, was not used in analysis of the factors affecting the scoters' hatching success because it was placed within 35 cm of nests (compared to 70–90 cm for all others), and was not camouflaged, so was likely to

Table 3. Clutch size and nest success for all Velvet Scoter nests found at Tabatskuri Lake, Georgia in 2019–2021, together with the average number of hatched, depredated, addled and suffocated eggs in the nests. Sample sizes for all nests and successful nests each year are in Table 2, with detailed information in Supporting Materials Table S1a,b,c.

Reproductive parameter	**Year**		
	2019	**2020**	**2021**
All nests			
Clutch size (mean ± s.d.)	8.5 ± 2.9	9.6 ± 3.2	9.3 ± 4.0
Nest success (mean ± 95% CI)	0.52 (0.34–0.67)	0.74 (0.59–0.90)	0.74 (0.60–0.89)
Successful nests			
Clutch size (mean ± s.d.)	8.5 ± 1.4	9.3 ±2.1	8.9 ± 1.0
Eggs hatched (mean ± s.d.)	5.9 ± 2.2	6.4 ± 2.0	6.8 ± 1.9
Eggs depredated (mean ± s.d.)	0.2 ± 0.5	0	0.2 ± 0.2
Eggs addled (mean ± s.d.)	1.8 ± 1.6	2.6 ± 1.1	1.4 ± 1.9
Eggs suffocated (mean ± s.d.)	0.6 ± 0.5	0.3 ± 0.5	0.5 ± 1.1

have been more disruptive (see Supporting Materials Annex S1 for an account of observations from this device). The best model of hatching success identified by AIC included two categorical predictors: the presence or absence of depredation and camera traps (Table 4, Fig. 3). Nests with no predation were more successful, and the negative effect of depredation was reduced by the presence of a camera trap; *i.e.* the presence of a camera trap near a nest somehow seemed to mitigate the adverse effects of predation. The model explained 26.4% of the variation in the hatching success ($P < 0.001$, Table 4). The percentage of eggs that were depredated in each clutch was best explained by two categorical variables: the year and absence of camera traps (Table 5, Fig. 4), there being lower predation rates at nests where camera traps were installed. However more clutches were depredated in 2019 than in 2020 and 2021.

All the females returning to their nests showed some reaction to the presence of the camera trap, usually by exhibiting curiosity towards this new object. Only four females (27%) were sufficiently stimulated to make threat displays towards the cameras. Despite this, the females quickly habituated to the camera, showing no further response towards it by the day following deployment. On the rare occasions a threat display was made towards the camera, we cannot exclude the possibility that it was directed at another, unseen threat behind the camera

Table 4. Summary of the best linear model of the relationship between the hatching success and predictor variables (see Table 1 for a description of the variables). Reference models used in the analysis were "Depredation: No" and "Camera trap: No".

Model item	Coefficient	*P* value
Depredation: Yes	–0.449	< 0.001
Camera trap: Yes	0.110	0.302
Depredation: Yes * Camera trap: Yes	0.467	0.017
Intercept	0.561	< 0.001
Adjusted R^2	0.264	< 0.001

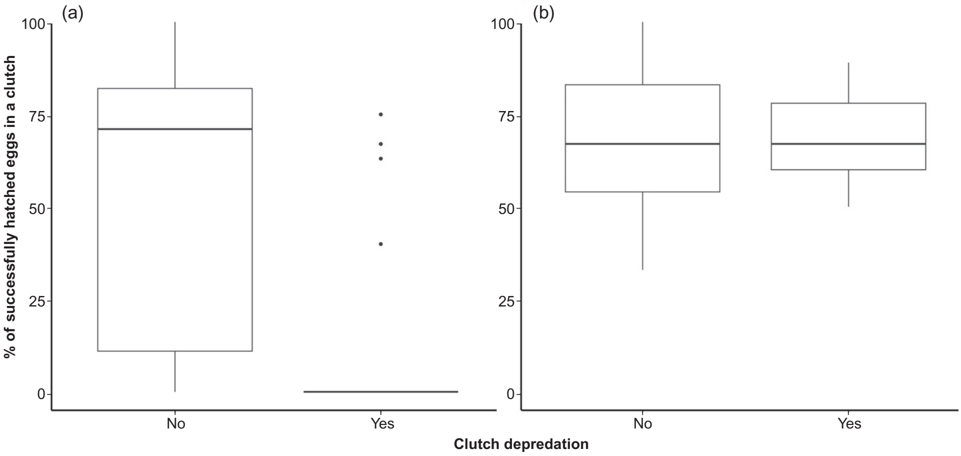

Figure 3. Box plots showing the relationship between the most important predictor variables (listed in Table 1) and hatching success for Velvet Scoters at Tabatskuri Lake, Georgia: (a) with no camera traps installed by the nests, and (b) with camera traps installed.

(*i.e.* out of view of the camera). Given this ambiguity, we ignored all threat displays aimed towards the camera in case they were at the camera rather than another source of threat. In total, we registered 2,534 threat displays (data from 15 cameras) that were not directed to the camera and were likely directed to repel an "unwanted guest" approaching the nest. Unfortunately, in only 13 cases out of 2,534 threat displays have the images captured the "unwanted guest" (all Armenian Gulls, Fig. S11).

Data collected over the 3-year study (both direct observations and from the camera traps), indicated that there were no land-based predators on the island. The

Table 5. Summary of the best linear model of the relationship between the depredation percentage and predictor variables (see Table 1 for a description of the variables). "Year 2021" and "Camera trap: No" are the categories used for model references.

Model item	Coefficient	*P* value
Year: 2020	–0.2988	0.0005
Year: 2021	–0.2619	0.0017
Camera trap: Yes	–0.1884	0.0416
Intercept	0.3876	< 0.0001
Adjusted R^2	0.136	0.0007

main predators present were Armenian Gulls which bred on the island, and Marsh Harriers *Circus aeruginosus* bred in wetlands in the northeast and southwest parts of the lake. In most cases, no active predation of scoters' eggs by Armenian Gulls and Marsh Harriers was observed at active nests monitored by camera traps during incubation in 2019–2021. Only one camera trap recorded egg predation on two occasions by Marsh Harriers but both cases were on the same nest (21/2019). However, despite this egg predation, this female surprisingly did not abandon the nest and was even successful in subsequently hatching four ducklings; the Marsh Harrier only visited the nest for about 10–15 min after midday (12:40 h; 14:50 h) on two days (24 and 25 August 2021) and ate only one egg on each visit; both times the female managed to leave the nest safely and returned to the nest 3 h and 5 h later (Fig. S10). Armenian Gulls (both adults and juveniles) were recorded taking addled eggs remaining in a scoter nest where the other eggs had already hatched on only five occasions (Fig. S11). Scoter egg predation

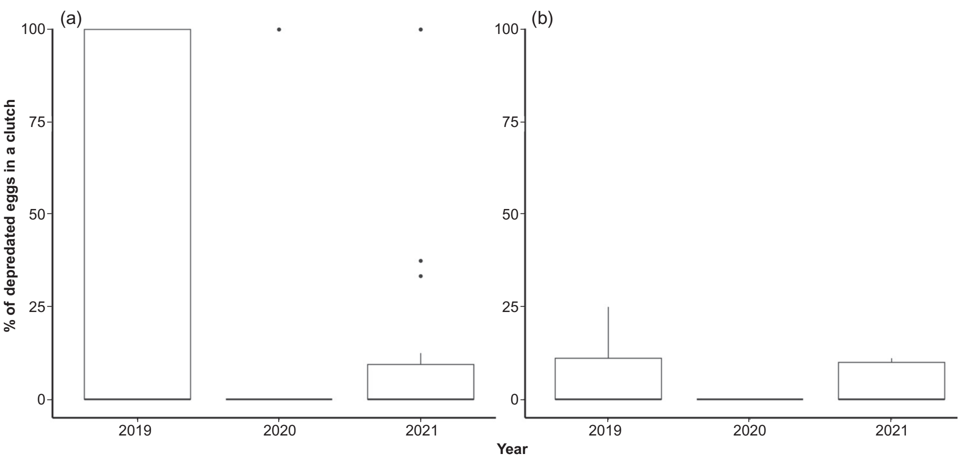

Figure 4. Box plots showing annual variation the percentage of predated eggs in a Velvet Scoter clutch at Tabatskuri Lake, Georgia: (a) with no camera traps installed by the nests, and (b) with camera traps installed, on including other significant predictor variables (listed in Table 1) in the model.

was observed each year during visits to all the nests on the island. In most cases, these were likely Armenian Gulls given their abundance on the island and their visits to the nests being monitored. Unfortunately, none of the three nests in 2020 where the sitting female was predated directly on the nest (Supporting Materials Fig. S12) had a camera trap. Nonetheless, we assume that the predator in all three cases was a Marsh Harrier because there is no other sufficiently strong avian predator at the lake in the summer to achieve this. In addition to gulls and harriers, camera traps revealed visits from other scoters on two occasions (see Supporting Materials Annex 2 for detailed accounts).

After successful hatching and leading the ducklings to water, camera traps revealed females returning to their nests alone on four occasions. In three cases, they returned within 1 h of departure; on the fourth occasion it was the following day. In all cases, the females (which had probably lost their ducklings) remained on the nest for the next 2–3 days, presumably in the hope of some of the remaining eggs hatching, although this was never witnessed.

Camera trap data confirmed that the total incubation period was 28 or 29 days for nests with known start dates (n = 11). Onset of incubation was considered to be when the female put down in the nest and spent most of the day on the nest, which was generally at the end of June. Incubation ended when the ducklings hatched, mostly during 20–25 July. Based on the all-camera data, females rolled their eggs on average 7.07 ± 5.16 times (n = 155; maximum daily rolling of the eggs = 24) and changed position on the nest on average 17.87 ± 12.47 times per day (n = 164; maximum daily changes in position = 60). In some cases, it was difficult to see whether the female was rolling her eggs or simply changing her position on the nest; ambiguous cases were assigned to a change of position. The actual frequency of egg rolling therefore was likely to be higher than described here.

During incubation, sitting females left the nest for an average of 2.38 ± 2.18 h each day (n = 153). However, there were three cases when females left the nest for unusually long periods (15–24 h; once during the first days of incubation and twice during the last days of incubation). There were four cases where the females did not leave the nest at all for 24 h (twice during mid-incubation; twice on the hatching day). Before leaving the nest, females almost always covered the eggs with down, although there were five cases when they did not do so. In two cases, a Marsh Harrier visited the nest (the same nest in both cases) almost immediately after the female departed from the nest; in one case, 40 min after the nesting female had left another female scoter with five ducklings visited the nest and occupied it for < 2 h (see Supporting Materials Annex 2); in another two cases, there were no other visits to the nest during her absence (all occurred 2–3 days before hatching).

We recorded a female leaving four newly hatched ducklings alone in the nest, returning to the nest 3 h later, but 90 min later she left again, returning 2 h later. The unattended ducklings huddled and did not leave the nest during her absences. The female then incubated the ducklings for the next 14 h, after which she led them away.

Discussion

Observations from 2019–2021 revealed that the average clutch size in Velvet Scoter nests on Lake Tabatskuri varied between 8–9 eggs over these three years (means = 8.47, 9.26, 8.88, respectively) for successful nests (*i.e.* where at least one egg hatched), with modal clutch sizes of eight eggs in 2019 and nine eggs in 2020 and 2021. In 2019, overall clutch size ranged from 4–13 eggs (average = 7.94, on excluding eggs from dump nests), in 2020 from 3–15 eggs (average = 9.13, on the same basis), and in 2021 from 2–12 eggs (average = 8.48, as before). A few eggs (2–6 eggs) were found in predated and abandoned nests each year. Only twice were incubating females associated with nests with small clutch sizes: six eggs from which two hatched in 2019 and three eggs from which one hatched in 2020. Both were probably second nesting attempts, given the small clutch sizes and incubation persisting into early August. On this basis, the normal clutch size of scoters breeding at Lake Tabatskuri was 8–9 eggs (as described for taiga- and arctic-breeding Velvet Scoter in Cramp & Simmons in 1977), which likely gave rise to a normal brood size of 6–7 newly-hatched ducklings.

Self-evidently, hatching success increased significantly with a reduction in predation, which was substantially lower in 2020 and 2021 than in 2019, most likely due to the nesting failure of Armenian Gulls in these years (N. Paposhvili, pers. obs.). In 2020, many Armenian Gulls left the lake prematurely because they no longer had chicks to feed on the island, and in 2021 only a few dozen nested successfully.

Positioning camera traps near nests, within sight of incubating birds, had no adverse effects on hatching/nesting success during the study, although they stimulated enhanced threat posturing in the first days following deployment. This gave initial cause for concern, because increased undue stress may elevate energy expenditure, potentially affecting body condition, which could jeopardise the female's ability to successfully conclude incubation and protect newly hatched ducklings from Armenian Gull attacks when they move onto water (as described previously by Paposhvili 2021). There were however no clear adverse effects on females, and the use of camera traps was invaluable for determining the factors affecting nesting success/nesting female behaviour. From the camera evidence, nesting Velvet Scoters were effective at protecting their nests from Armenian Gulls when they were attended nests, rebutting gulls using threat displays (we witnessed only one case when the nesting female directly attacked the approaching gull). Threat displays were witnessed daily at every monitored nest, but only in 13 cases out of 2,534 images with threat displays did pictures catch and identify the "unwanted guests" as Armenian Gulls. In all other cases, the recipient of the threat posture was not visible in the picture, making it impossible to distinguish between the genuine approach of some source of danger or a response to the presence of the camera trap. At the same time, interestingly, the presence of camera traps near nests appeared to counter the negative impact of egg predation on the scoters' breeding success. It seems that the scoters may be less deterred by the presence of a camera trap than the gulls hunting for eggs, but the reason for this finding remains unclear. The cameras were mainly placed by nests where the vegetation was less dense, to provide clearer images, so theoretically should have been easier for predators to find.

In contrast to the gulls, the nesting females were generally unable to rebuff Marsh Harriers when they visited the nest. In some cases, the females fled the nest returning a few hours later, to check the contents and continue incubating if the nest was not completely destroyed by the Marsh Harrier. In 2020, three sitting females were discovered preyed upon by Marsh Harriers while incubating on their nests. This could be because many Armenian Gulls left the lake prematurely that year, forcing Velvet Scoter to incubate without the "umbrella" of predator protection provided by nesting Armenian Gulls nearby, which normally chase away any raptor approaching the island.

The existence of dump nests also contributed to reductions in overall numbers of hatched eggs. Egg dumping is well described in waterfowl, mainly in the context of nest parasitism (Weller 1959), or because of nest site limitations in high nesting densities (Morse & Wight 1969; Kruckenberg 2019). Other hypotheses predict that females may lay eggs in another's nest due to early loss of its own nest from predation, or that a bird is trying to increase the number of hatchings from its own eggs by laying eggs in the nest of others (Pienkowski & Evans 1982). Although it is impossible to determine the true cause in our study, dump nests occurred in almost the same area (that with the highest density of nesting scoters) in all three years. Furthermore, in 2021, when the most eggs occurred in dump nests (19 and 26) this coincided with a year with the highest number of nests ever recorded on the island (Supporting Materials Fig. S13). For these reasons, it seems likely that high female densities, suffering from limited numbers of suitable nest sites, could contribute to the response of females laying in dump nests as observed.

Why a female with five hatched ducklings should need to incubate at another nest is perhaps difficult to explain. The stimulus of a nest of uncovered eggs could be strong enough to initiate a sitting response (especially if the nest was close to hatching and eggs were pipping), because this would present an opportunity for her to contribute to her fitness by increasing her own brood size. Creching or brood amalgamation would reduce the probability of her own offspring being depredated once on the water. However, the cost of her returning to do so without her ducklings increased the chance of her own ducklings being predated (if they were not already predated by then), especially because the returning owner ultimately displaced her, effectively denying her either opportunity. Females returning to the nest 10–30 min later without ducklings were observed in other nests, which may be the result of high duckling predation rates on the first day they enter the water (known to be the case from our direct observations). Hence, females who have lost all their ducklings return to the nest in the hope that the remaining unhatched eggs have subsequently hatched, to rescue her reproductive investment that year. This may also explain why some females cover the remaining unhatched eggs with down after successful hatching before leading the brood away from the nest.

Scoter nesting success seems therefore to be affected by an interaction between gull presence and predation, all of which in disparate ways are affected by human disturbance. Human presence on or near the island causes females to leave nests, and they are less likely to cover the eggs on departure. This adversely affects the thermal environment of the nest and eggs (potentially increasing rates of addling and embryo death), flushes gulls into the air above the island, and enhances nest predation rates. The local awareness-raising programme, involving engagement and collaboration with the members of the community, including protected area staff and key local fisherman, have seemingly helped to reduce adverse human effects on nesting success because the hatching success rate rose from 52% (2019) to 74% (2021), which approached the levels reported from North American studies for the con-specific White-winged Scoter *Melanitta deglandi*, of 67–92% (Brown & Brown 1981) and 72–89% (Traylor *et al.* 2004). While the Armenian Gulls are the main predator of scoter eggs and subsequently on small ducklings at Lake Tabatskuri (N. Paposhvili, pers. obs.), and may have a significant impact on the scoters' reproductive output, they may also play an important role in excluding Marsh Harriers from the gull colony. Despite gulls being an important predator of eggs and ducklings, many females can defend their eggs from gulls, whilst Marsh Harriers also take sitting adult females, although we only observed them killing females in the absence of gulls. Armenian Gulls therefore may have an important role to play, because female mortality would have a more profound effect on population growth than the loss of eggs or ducklings. Gulls take eggs (from nests) and ducklings (from water) mainly when human disturbance distracts females from sitting on nests or keeping their brood together and protected. For this reason, human disturbance needs to be managed, and maybe gull numbers kept to a level that minimises their predation of scoters whilst providing umbrella protection from their colonies to keep Marsh Harriers away from sitting females.

It seems more important than ever to maintain or improve current habitat conditions at the lake (Paposhvili *et al.* 2023), to elevate the duckling survival rate (which still remains low at Lake Tabatskuri; Paposhvili 2021) and to build further upon the successes of management interventions. Maintaining restrictions on human movement on or close to the island, likewise keeping current fishing/recreational boating restrictions across the northern part of the lake, controlling the use of the lake water for irrigation, minimising pollution and continuing to protect this important site is vital for conserving its precarious Velvet Scoter population into the future.

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