STUDIES OF THE TIME BUDGET AND DAILY ACTIVITY OF COMMON EIDER *SOMATERIA MOLLISSIMA* DURING INCUBATION

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ABSTRACT

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In the Common Eider *Somateria mollissima*, only females incubate the clutch over a period of 25–28 days. Determining their schedule of nest absence, how long they are away, how often, and where they go can be problematic. They must also avoid nest predation while tending to their own needs. We used geolocators to investigate the behavior of incubating females on forested islands in Dolgaya Guba Bay (65°03′N, 035°47′E), White Sea, Russia. Data were obtained for 12 females: three in 2015 and 2016, four in 2017, and two in 2018. During the entire incubation period, females left their nests for the sea 12–28 times. The average duration at sea was 331.0 ± 53.8 min, including 261.1 ± 47.9 min during the darkest hours in otherwise 24-hour daylight. The patterns are similar to those of eiders nesting in lower, non-polar latitudes, where nights are dark.

Key words: Common Eider, Russia, White Sea, breeding behavior, incubation period, geolocator

INTRODUCTION

The Common Eider *Somateria mollissima* is a seaduck closely connected with Arctic seas and with northern regions of the Atlantic and Pacific oceans. The species typically nests on small islands, often in extremely inhospitable environments (Goudie *et al.* 2020). Males do not take part in incubation, so females cannot leave nests for long periods. The presence of the female during the incubation period maintains egg temperature and provides clutch protection against predators. Prolonged absence may lead to clutch supercooling and increased risk of nest destruction. Thus, successful nesting depends on nest-leave frequency, duration of absence, and timing. Considering that the species occurs from Arctic archipelagoes to islands in the temperate zone, female behavior during the incubation period may or may not be controlled by local environments and could vary by latitude.

In the present study, we obtained and analyzed information on the time budget of Common Eider females nesting on islands of the White Sea. A comparison was made between our data and data collected on the Spitsbergen archipelago, in Iceland, and on islands in the Baltic Sea (Mehlum 1991, Bolduc & Guillemette 2003, Kristjánsson & Jónsson 2011, Garbus *et al.* 2018).

There are several approaches to investigate bird behavior during the incubation period. Direct observation provides precise and detailed information but is very time-consuming, requiring continuous presence throughout the incubation period (Criscuolo *et al.* 2000, Kristjánsson & Jónsson 2015). Various types of recording devices have also been used to investigate female incubating activities during the day; the devices (e.g., automatic scales, temperature detectors) can be implanted under the nests, along with surveillance video cameras to continuously record behavior for several days or over the entire incubation period (Aldrich & Raveling 1983, Bolduc & Guillemette 2003, Schmidt *et al.* 2005, Kristjánsson & Jónsson 2011, Garbus *et al.* 2018). Such procedures record when the bird is out of the nest, but not where the female went while absent.

Another way to calculate the time budget of the incubating bird is to use geolocators or global location sensors (GLS loggers). A logger is fixed on a plastic leg ring, and recorded data allow calculation of the approximate latitude and longitude (accurate to ~100 km), which permits tracing bird movements over appreciable distances. Each logger also has a sensor that records illuminance at set intervals, which provides an indication of bird activity (Burger *et al.* 2012, Gosbell *et al.* 2012, Loktionov *et al.* 2015). Given that there is no dark period during the polar day, any fluctuations in recorded light intensity depends on female behavior. Besides shading the geolocator while legs are drawn beneath the body when on the nest, it is also possible to identify periods when the device is submerged in water.

METHODS

Study area

Our study was carried out on several small unnamed islands within Dolgaya Guba Bay, which is surrounded by Bolshoy Solovetsky Island in the White Sea ((65°03′N, 035°47′E; Fig. 1). Dolgaya Guba Bay freezes during the winter, forcing the eiders to winter elsewhere and return to the islands in the spring. The 49 islands of the group are scattered throughout the bay; 22 are forested (with European red pine *Pinus sylvestris*, European spruce *Picea abies*, European white birch *Betula pendula*), while 27 are treeless and dominated by meadow vegetation: lyme grass *Leymus arenarius* or crowberry

Empetrum nigrum, with occasional shrubs of common juniper *Juniperus communis*. On the forested islands, the nests occur in groups of 2–5, with no visual contact between occupants, and the distance from the nests to the sea does not exceed 100 meters. No terrestrial predators are present, but gulls (European Herring Gull *Larus argentatus*, Great Black-backed Gull *L. marinus*, Mew Gull *L. canus*), corvids (Hooded Crow *Corvus cornix*, Northern Raven *C. corax*), and White-tailed Eagle *Haliaeetus albicilla* are numerous. Eider nests are predated by all these species, except for the White-tailed Eagle, which catches adult eiders and ducklings. Chicks are also predated by European Herring and Great Black-backed gulls. The damage caused by gulls is insignificant on forested islands, but they are the main nest predators in treeless landscapes.

Equipment

We used two types of loggers, either a Mk3006 (16×14×6 mm; 2.5 g) produced by Biotrack, Ltd. (now Lotek Wireless) or a C250 (17×18×6 mm, 2.6 g) produced by Migrate Technology, Ltd. Each was fixed to a plastic leg ring, and both models recorded date, time (Greenwich Mean Time, GMT), duration of the bird's stay on the ocean, and water temperature. The Mk3006 logger recorded illuminance (LUX index) every 10 minutes, saving the maximum value during the interval. The logger registered the illumination in scores of 0 to 64, which roughly corresponded to values of 0–100 lux; values greater than 100 lux were perceived by the device as the maximum illumination. Also recorded was immersion time in seawater (WET index). The immersion sensor is active every three seconds, and a value of 0–200 is recorded in the logger's memory every 10 minutes. This latter record indicates how many times the sensor registered immersion in water during this period. The C250 model had several modes available; we chose mode 6, which recorded illuminance at one-minute intervals and maximum illuminance every five minutes (within the interval 1.136–1163.994 lux). The logger fixed the state of immersion every 30 seconds, recording the number of immersions every 10 minutes (0–20). Thus, the duration of logger immersion was determined at higher accuracy than the duration of the bird's activities on land.

The loggers were limited in the quantity of recordable data. The device memory was sufficient to record immersion data over a shorter period: about 15–17 months, versus 36 months for the luxmeter. Here, we report data only from those nesting cycles that included both luxmeter and immersion data.

Logger attachment

Female eiders were captured and ringed during 07–19 June 2014–2018. Recapturing was performed at the same intervals in 2016–2019; some data used was from loggers that were in place for two years and longer. A coarse net was pulled across a target bird's path towards the sea, then the female was frightened away from the nest and towards the net. Some birds could be taken by hand from the nest, and a few were caught with a hand net.

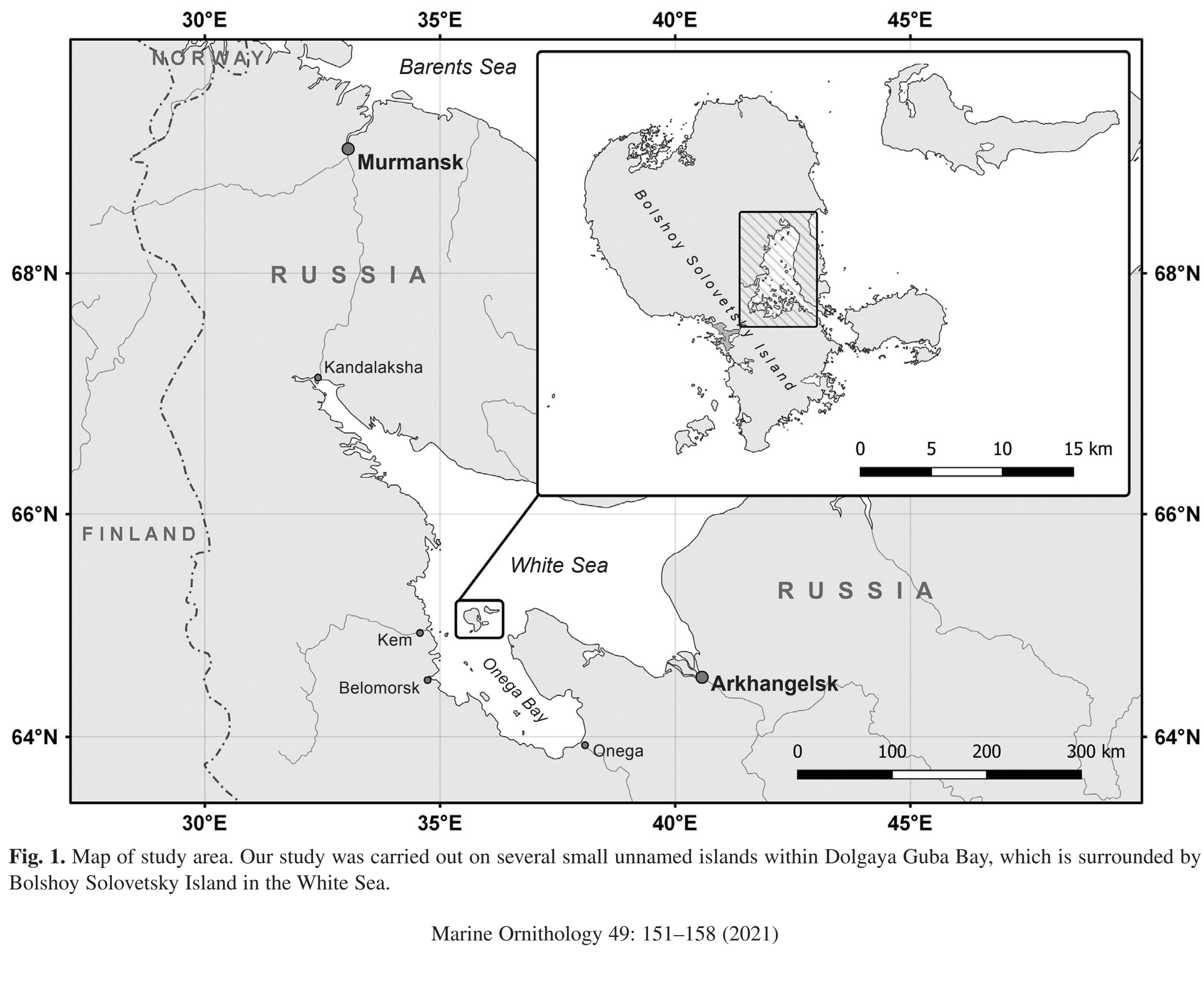

Fig. 1. Map of study area. Our study was carried out on several small unnamed islands within Dolgaya Guba Bay, which is surrounded by Bolshoy Solovetsky Island in the White Sea.

The data acquired covered the entire incubation cycle, ending with successful raising of nestlings. In total, 12 females were tracked: three in each of 2015 and 2016, four in 2017, and two in 2018. For two females (Q371 and B636), the incubation cycle was repeated, as the first clutch had been either predated (Q371) or abandoned after the logger was attached (B636). We reached these conclusions based on illumination intensity data.

Among birds that had been instrumented previously, if their loggers recorded a sharp transition from complete darkness to strong light and then submergence, we concluded that the female had left the nest temporarily (i.e., a few hours) as a result of our activities on the island, i.e. frightened. All data recorded during the day of our visit were excluded from analysis and replaced with daily average for each female.

Data analysis

For the daily activity analysis, the incubation period was subdivided into 10-minute intervals (1 day = 144 intervals). The minimum interval duration depended on logger recording frequency. The time of the recordings were converted from GMT to local time. The time of every record was rounded to the nearest 10 minute; instrument readings were transformed from absolute values to relative ones and expressed as a percentage.

Every series of logger readings for a complete and successful incubation cycle was combined into a single time scale. The count began from the first day of incubation; brooding begins after the second or third egg has been laid (Swennen *et al.* 1993, Bolduc & Guillemette 2003). Having only the data recorded by loggers without visual observations, we could not determine the precise time when the eggs were laid nor when incubation started. The geolocator data for all females showed that continuous incubation was preceded by a day when that was not the case. On this day, eiders tended to be on the water for less than 10 hours. The luxmeter would then be in the dark for about 12 hours, then record the maximum illumination for about two hours. We assumed that the female had begun to incubate on this day.

We used Google Sheets software to tabulate the data and performed statistical processing in STATISTICA 12.

Data interpretation

In the study region, eiders begin incubation during the last 10 days of May and continue to the middle of July, including nests of repeated egg-laying. Depending on the individual female, incubation in our study lasted 25–27 days. Using day-by-day data on the illuminance over several months, we could estimate breeding success for every female. A single period of decreased illumination for 25–27 days indicated full incubation with successful chick hatching. Two intervals of reduced illuminance were evident in cases of repeated egg-laying after the first clutch had been destroyed. A complete absence of periods of decreased illuminance means that the female skipped the breeding season (Fig. 2).

Analysis of data obtained for the entire incubation period allowed us to distinguish the following:

- the number of trips to the sea, the duration of absence from the nest, and the duration of intervals between trips;
- total time on the water; and
- preferred time of day for descending onto the water.

As indicated by visual observations of Common Eiders on the Spitsbergen archipelago, females spent 38.0% and 20.9% of time out of the nest engaged in preening and other physical activities, respectively (Criscuolo *et al.* 2000). This agreed with our observations. Because preening takes place both on the water and on the shore, we suggest that the duration of a female's presence on the water is the minimum time of its absence from the nest; the total time that a female was away from the clutch was certainly greater.

The duration of nest absence and the number of trips to the water were calculated separately for the "night" (22h00 to 03h00) and "day" (03h00 to 22h00). There is no dark time in our study area in June, but the sun goes below the horizon for 2.0–2.5 hours per day. Corvid predation on eider nests on the forested islands was usually lowest during that time of subdued light.

Data obtained from the luxmeters allowed us to determine what the female was doing when it was not on the water. We selected two parameters based on illumination data:

1. The number of 10-minute intervals when the luxmeter readings were <10 lux. Such readings could be recorded only if the bird was sitting and the logger was tucked underneath. The threshold at 10 lux allowed us to disregard smaller light intensity values that might appear because of light penetrating through the bird's feathers.

2. The number of 10-minute intervals with the luxmeter readings ≥100 lux, while the bird was off the water. Such readings appeared when the logger-bearing leg was in the light at least once in a 10-minute interval. It is noteworthy that a part of a bird's actual activities outside the nest may proceed at lesser illuminance values, for example, the bird moving through a thick undergrowth during a sunless night. A part of the maximum readings recorded could refer to the intervals when the bird was on the nest and slightly raised itself in order to turn the eggs or change its position. That is why the considered parameter gives no way of concluding with confidence whether the bird was on the nest or what activities it was engaged in at a given moment. The parameter, however, depends directly on the bird's behavior and may be interpreted as some "general (unspecified) activity".

In the absence of visual observations, we could not define the bird's behavior during intervals having maximum illuminance values of ≥10 lux and <100 lux. To avoid false interpretations, such intervals were excluded from analysis. As an example, Fig. 3 displays changes of WET and LUX indices over two days of incubation. The female left the nest and traveled to the water for 30–40 minutes around midnight, representing "time spent on water." During full daylight, intervals with a heightened illuminance were recorded repeatedly and corresponded to moments when the female changed position or turned eggs in the nest. Those intervals were recorded as *illumination ≥ 100 lux ~"activity"*. During remaining time, the luxmeter recorded values of 0–10 lux (*illumination < 10 lux ~"inactivity"*).

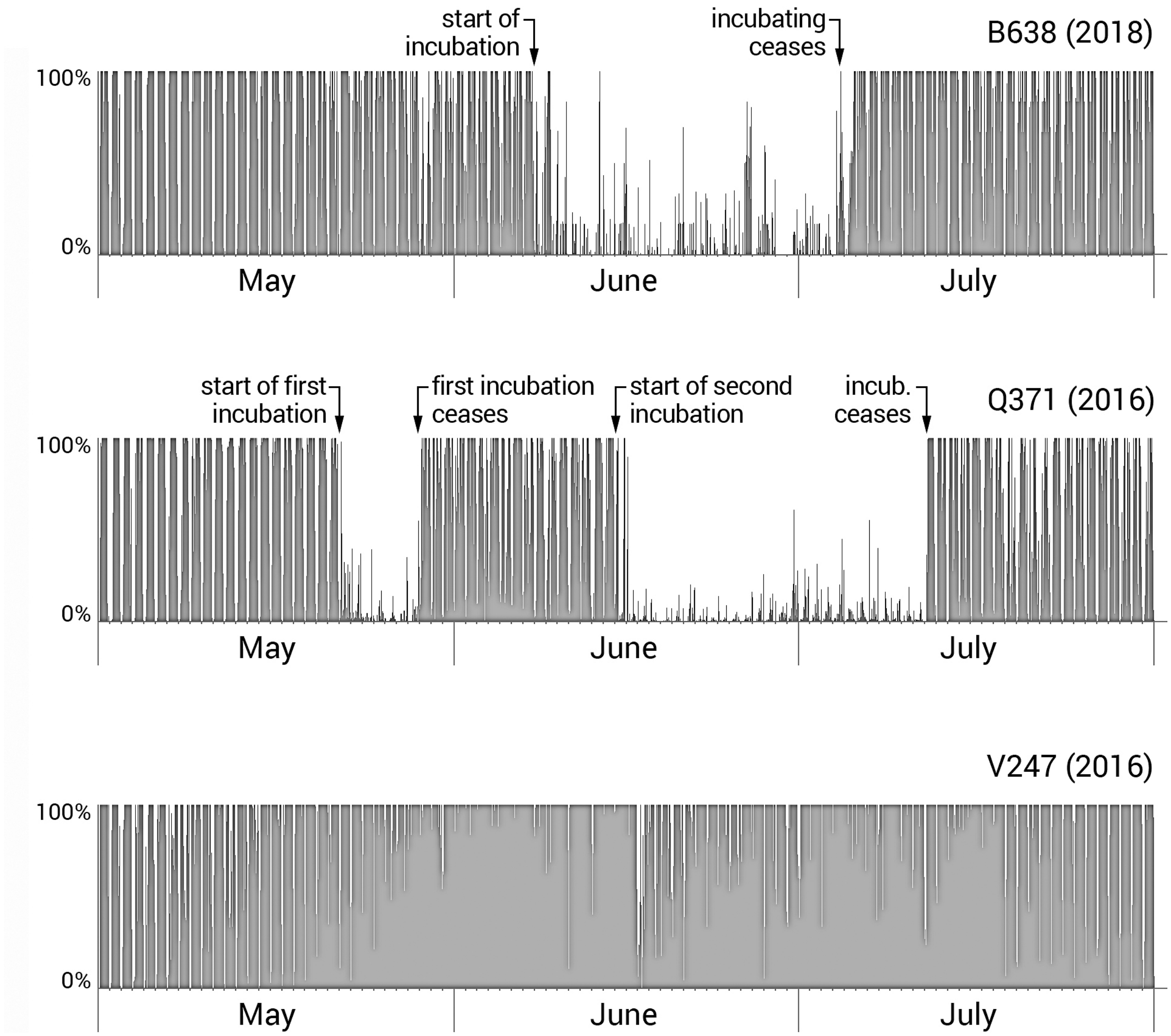

Fig. 2. The illuminance level dynamics during the Common Eider *Somateria mollissima* breeding season (based on records of GLS loggers): (B638) a successful incubation; (Q371) first clutch lost, second nesting successful; (V247) a skipped nesting season. The vertical axis displays the mean maximum illuminance averaged over six 10-min intervals, in %.

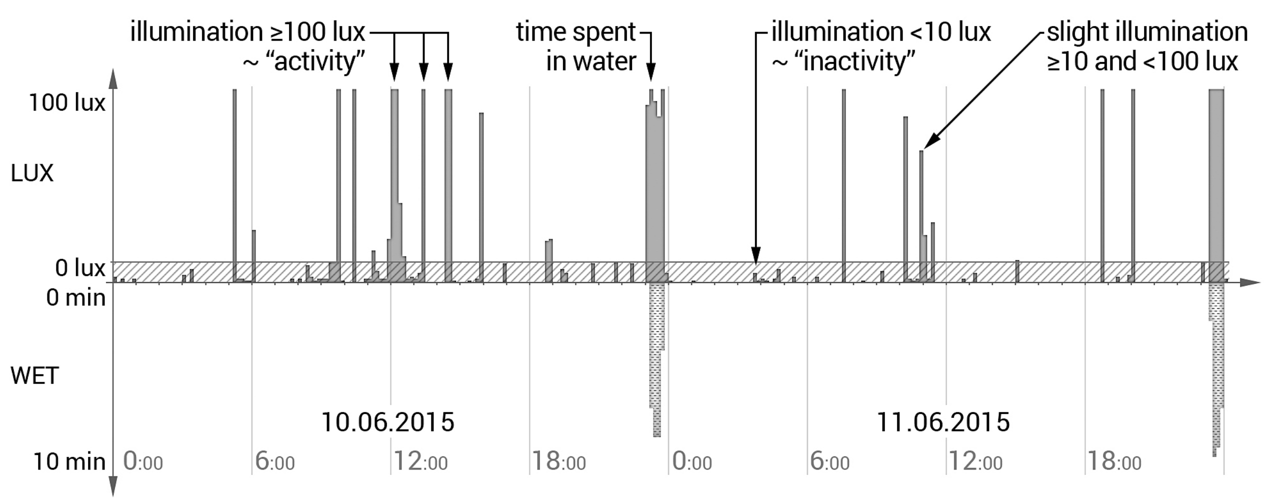

Fig. 3. Integrated data from the LUX and WET recorders of logger L599, 10–11 June 2015. The LUX value is the maximum value recorded by the luxmeter during each 10-minute interval (upper limit = 100 lux); the WET value is the time spent (in minutes) on the water during each 10-minute interval.

RESULTS

On the first day of logger attachment with the bird incubating, the average time that females spent on the water was 244.9 ± 45.0 min (standard deviation (SD) = 155.7 min). On the second day, the females spent 62.9 ± 20.9 min (SD = 72.4 min) on the water, and 13.7 ± 1.0 min (SD = 17.5 min; Fig. 4). During the first day of incubation, illuminance of ≥ 100 lux averaged 380.0 ± 68.4 min (SD = 237.0 min), which differs significantly from all the other days, i.e. 127.7 ± 5.0 min (SD = 85.2 min). It is noteworthy that the second day of incubation did not differ from all the remaining days in terms of amount of time where illuminance > 100 lux. To make the processed data more uniform, the logger values for the two first days were not used in the subsequent calculations.

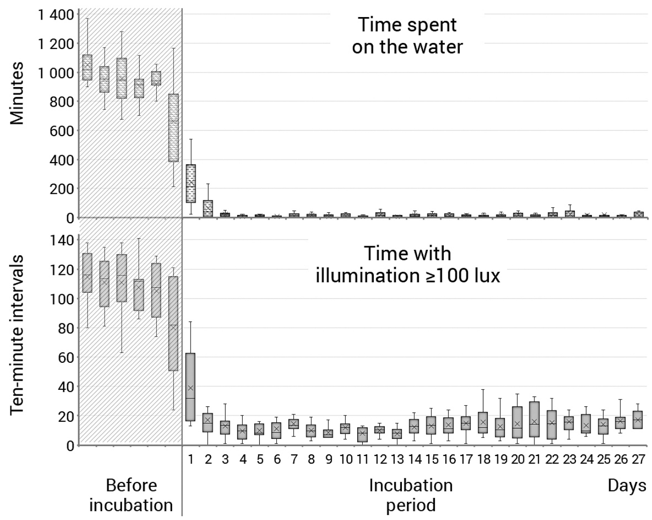

Fig. 4. Mean daily time Common Eider *Somateria mollissima* females (n = 12) spent on the water and the number of 10-minute intervals when the illuminance was ≥ 100 lux (indicating when monitored individuals were active), relative to the day of incubation.

The end of the Common Eider incubation cycle is much shorter than its beginning: the eggs hatch within 4–24 h of each other, depending on the clutch size (Goudie *et al.* 2020). That time is sufficient for all healthy nestlings to hatch and dry. Subsequently, the female takes them to the water. We considered incubation to be finished on the first day when the logger was immersed for over 120 minutes and in complete darkness for less than 90 ten-minute intervals. The last day of incubation was not used in subsequent calculations (Fig. 4).

Some "activity" periods lasted more than one 10-minute interval, occasionally up to several hours. In the absence of visual observations, we cannot say whether the female left the nest and what she was doing during that time; we can, however, determine the amount of time that the female was sitting quietly and incubating without changing its position. In that case, the recorded illuminance was < 10 lux. The value varied for different females, ranging from 66% to 82% (averaging 76.8% ± 0.15%; SD = 4.7%) of the total incubation time. The average length of time spent at sea for all females (n = 12) was 331.0 ± 53.8 min (SD = 186.5 min), or 0.95% ± 0.15% of the entire incubation period. The value varied more than nine-fold (69–649 min) for different females, regardless of the incubation duration and the year of observation (Table 1).

TABLE 1
Time budget of female Common Eiders *Somateria mollissima* over the entire incubation period except for the first two days

Female ID	Start of incubation	Incubation length (days)	Time spent in water		Time spent on land with illumination values of	
			Total (minutes)	Relative proportion to incubation time	≥ 100 lux (number of ten-minute periods)	< 10 lux (number of ten-minute periods)
V254	23 May 2015	27	254	0.7%	282	3071
L599	04 Jun 2015	26	462	1.3%	281	2753
V247	05 Jun 2015	25	520	1.6%	278	2786
R577	24 May 2016	27	177	0.5%	206	3003
R578[a]	25 May 2016	26	88	0.3%	173	3040
Q371[a,b]	15 Jun 2016	27	558	1.5%	362	2565
B350	30 May 2017	25	199	0.6%	280	2883
B803	01 Jun 2017	27	69	0.2%	292	3120
B835	01 Jun 2017	27	649	1.8%	211	3101
B801	05 Jun 2017	26	357	1.0%	251	2778
B636[a,b]	27 Jun 2017	25	293	0.9%	372	2566
B638	09 Jun 2018	26	346	1.0%	131	3056
Average		26.2 ± 0.2 SD = 0.8	331.0 ± 53.8 SD = 186.5	0.95% ± 0.15% SD = 0.52%	259.9 ± 20.5 SD = 70.9	2920.2 ± 54.6 SD = 189.0

[a] Females that were not startled from their nests while researchers visited the islands
[b] Females that were in their second incubation cycle during the considered year

Female activities and the length of time spent on the water showed no regular changes as the incubation period progressed. Other studies showed that the behavior of female eiders significantly changed during incubation. On islands in the southwestern Baltic Sea, some females left their nests for progressively shorter periods as incubation proceeded (Garbus *et al.* 2018). In Iceland, the length of female absences was shown to increase during late incubation (Kristjánsson & Jónsson 2011). However, in some studies at Baltic Sea islands (Bolduc & Guillemette 2003), no change in behavior during the incubation cycle was observed. On the Solovetsky archipelago, five of the 12 studied birds showed a statistically reliable tendency to decrease the number of intervals with illuminance below 10 lux as the incubation proceeded (Spearman's correlation coefficients: –0.5443 (V254), –0.5479 (L599), –0.6236 (V247), –0.7018 (Q371), and –0.7198 (B803) at a level of $P < 0.05$). As for the remaining Solovetsky females, the number of intervals with illuminance below 10 lux did not depend on the day of incubation.

Eider females prefer to leave their nests at night. From 22h00 to 03h00, every female was on the water 12.5 ± 1.5 times on average (n = 12). Among individual birds, the value varied from six to 23 times. The average time spent on the water at night during the entire incubation period was 261.1 ± 47.9 min (range: 65–577 min).

During the day (03h00 to 22h00), 10 of the 12 females seldom left the nest and stayed on the water for a considerably shorter periods (1–70 min) than at night (59.5 ± 23.9 min on average). Only two females were absent from the nest by day (14 and 19 times, respectively) and stayed on water longer than at night (Table 2).

The average time interval between descents onto the sea for all females was 33.7 ± 3.0 h (SD = 10.4 h). Maximum intervals recorded for different females varied two-fold. One female did not leave the nest for almost four days (90.7 h), while two birds did not stay on the clutch for more than 50 hours.

The mean duration of female presence on the water was 17.2 ± 2.2 min (SD = 7.5 min), though the values were highly variable among females. The maximum length of a single stay on the water varied from 13 to 68 min, averaging 39.5 ± 4.4 min (SD = 15.4 min) (Table 3). There have been occasions recorded in Iceland when a female was absent from the nest for 24 hours, but the eggs died from exposure during that time (Kristjánsson & Jónsson 2011).

DISCUSSION

We were able to determine time budgets of Common Eider females during incubation. For the most part, the birds stayed quietly on the nest. The duration of such behavior did not depend on breeding season conditions or on the length of incubation, but it was controlled by individual female's specific behavior. The shortest durations were recorded for females nesting on a second clutch (2565 and 2566 10-minute periods with illumination values below 10 lux for Q371 and B636, respectively; Table 1). It is possible that, having lost their eggs, the birds became more restless; the sample volume, however, is insufficient for unambiguous conclusion. The total time that females spend on the nest may be longer, as illuminance over 100 lux can be recorded when the female turns eggs or changes position during the daytime. Without direct observation, we could not estimate a particular type of bird activity.

The proportion of time spent on the water varied from 0.2% to 1.8% (0.95% ± 0.15%; SD = 0.52%) of the total incubation period. This parameter is equivalent to the minimum time away from the nest.

TABLE 2
The relationship between female Common Eider *Somateria mollissima* activity on the sea by day and by night

Female ID	No. of descents onto the sea		Length of stay on water (minutes)	
	Day	Night	Day	Night
V254	3	9	33	211
L599	2	18	29	414
V247	14	6	303	195
R577	3	14	11	159
R578	4	7	9	79
Q371	4	17	70	488
B350	19	9	112	78
B803	2	10	1	65
B835	4	23	46	577
B801	5	9	48	294
B636	4	12	45	248
B638	2	16	7	325
Average[a]	5.5 ± 1.5 SD = 5.3	12.5 ± 1.5 SD = 5.1	59.5 ± 23.9 SD = 82.8	261.1 ± 47.9 SD = 165.8

[a] SD = standard deviation

TABLE 3
Duration of time spent on water and uninterrupted stays on land for female Common Eiders *Somateria mollissima*[a]

Female ID	Total descents onto the sea	Time on water (minutes)		Time between descents (hours)	
		Max	Avg (± SE)	Max	Avg (± SE)
V254	12	40.6	20.3 ± 3.2	75.8	49.1 ± 5.9
L599	20	49.5	20.0 ± 2.5	70.7	26.8 ± 3.8
V247	20	50.6	24.9 ± 2.2	90.7	27.5 ± 4.9
R577	17	24.0	10.0 ± 1.6	49.7	35.2 ± 3.0
R578	11	19.5	8.0 ± 2.0	73.5	50.7 ± 4.1
Q371	21	46.0	26.5 ± 2.4	70.2	28.6 ± 2.9
B803	12	13.0	5.8 ± 1.2	72.0	45.9 ± 5.1
B835	27	48.7	23.1 ± 2.4	71.3	22.1 ± 3.7
B801	14	67.9	23.9 ± 4.2	49.3	36.2 ± 3.5
B636	16	45.6	18.3 ± 2.7	87.3	33.6 ± 4.6
B638	18	35.7	18.8 ± 2.4	73.3	30.6 ± 4.7
Average	18.0 ± 1.6 SD = 5.6	39.5 ± 4.4 SD = 15.4	17.2 ± 2.2 SD = 7.5	73.4 ± 4.1 SD = 14.3	33.7 ± 3.0 SD = 10.4

[a] SD = standard deviation; SE = standard error

Female behavior during incubation largely determines the success of nesting. On one hand, it must stay on the nest for as long as possible to lessen the likelihood of clutch loss due to predators or exposure (hypothermia). On the other hand, it needs to preen and lubricate its feathers and (more importantly) rehydrate (Swennen *et al.* 1993, Criscuolo *et al.* 2000, Bottitta *et al.* 2003). During the incubation period of 26–28 days, eider females lose up to 46% of their weight (Gabrielsen *et al.* 1991, Garbus *et al.* 2018). Whether birds must compensate for the losses, at least in part by feeding, is a question yet to be answered. Some indirect evidence, such as increases of female weight after its return to the nest, indicates food consumption in small amounts (Garbus *et al.* 2018). Gerasimova & Baranova (1960) reported paunch openings performed on five female eiders in the White Sea (N. Pertsev unpubl. data) and 12 in the Barents Sea regions. The paunches appeared to contain mainly terrestrial plants, along with remains of algae and mollusks *Littorina* spp. It is conceivable that the birds needed food in small amounts, not so much to replenish energy as to stimulate the stomach which shrinks during incubation (Swennen *et al.* 1993).

Observations on islands of the Baltic and North seas show that eider females prefer to leave their nests after sunset. Darkness lasts about seven hours in the region, and the danger of nest predation is much lower at night (Swennen *et al.* 1993, Garbus *et al.* 2018). In the central Baltic, on Christiansø Island, only three of 50 incubation intermissions (6%) occurred in the daytime (notably, it was only one bird that left the nest in daylight; Garbus *et al.* 2018). Observations on Saltholm Island in Øresund Sound (Bolduc & Guillemette 2003) showed slightly more frequent intermissions during the day: eight of 61 (13%). As in the previous case, all departures were made by the same bird; the Saltholm Island individual, however, did not leave the nest after 06h20. Eiders nesting in Iceland or Spitsbergen showed no difference in activity at different times of day (Mehlum 1991, Kristjánsson & Jónsson 2011). On Spitsbergen, the sun is above the horizon during the entire breeding season, but in Iceland it sets partially for 2.0–2.5 hours per day. The principal nest predators in those regions are large gulls, and their activity decreases slightly during the dark hours. As in Iceland, it is also light around the clock on the Solovetsky Islands (White Sea) in June. However, gulls are absent from those islands and corvids display minimal activity from 22h00 to 03h00. Thus, eider females leave their nests at night 2.3 times more often than during the day (Table 4). So, the diurnal rhythm of eiders on the Solovetsky Islands is close to that of the nesting birds on the Baltic Sea, although the nocturnal activity is slightly diminished.

One more factor that indirectly influences the duration of incubation intermissions is seawater salinity and the availability of freshwater. Saltwater consumption increases the rate of metabolic processes (Nehls 1996), accelerates female weight loss, and reduces the energy reserves needed for successful incubation. The salinity is 26‰–27‰ in Dolgaya Guba Bay (Khaitov *et al.* 2013), 7‰–8‰ in the Baltic Sea near Bornholm Island (Rak & Wieczorek 2012), and 34‰–35‰ at Spitsbergen (Kongsford; Promińska *et al.* 2017). The low salinity in the Baltic Sea makes it possible for eiders to not spend time searching for freshwater; they can drink the seawater without harm. Among the abovementioned localities, seawater near Spitsbergen is the most saline; there are, however, numerous nearby freshwater basins in early summer and the snow cover persists until the middle of the incubation period. Thus, females may consume snow in their immediate vicinity (Criscuolo *et al.* 2000). In Dolgaya Guba Bay, the small islands where we conducted our studies were practically devoid of freshwater basins. There are no rivers on the Solovetsky archipelago, though there are many lakes and small streams; however, we have not recorded an eider female on the lakes of Bolshoy Solovetsky Island during our 30 years of observations. At the same time, marine duck flocks, including eiders, were regularly recorded in the bays near the stream mouths. It is possible that eiders on the Solovetsky Islands must spend more time in search of freshwater than those nesting in other regions. Therefore, the increased absences raise the risk of clutch loss; the number and duration of female absences directly affects incubation success (Mehlum 1991, Swennen *et al.* 1993). However, if the eiders nesting on forested islands leave their nests at night when the predators are less active, they minimize the risk of clutch predation and/or loss of eggs. Therefore, it may be safely concluded that the eider populations nesting on islands in the White Sea incubate successfully by shifting periods of increased activity to the darkest times of day, as is the case for eiders inhabiting lower latitudes.

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TABLE 4
The diurnal rhythm of Common Eiders *Somateria mollissima* in the different regions

Study area (latitude)	Duration of recesses (minutes)			Number of recesses			Share of daytime recesses (%)	Source
	Average	Min	Max	Average	Min	Max		
Denmark (55°N)	14.2 ± 6.1	3	42	—	9	19	13	Bolduc & Guillemette 2003
Denmark (55°N)	34	7	70	13	7	17	6	Garbus *et al*. 2018
Iceland (65°N)	45 ± 2.1	10	110	—	—	—	—	Kristjánsson & Jónsson 2011
Solovetsky archipelago (65°N)	17.2[a]	0.2[a]	90.8[a]	18	11	27	30	Present study
Spitsbergen (78°N)	4.2	—	—	13	—	—	42	Mehlum 1991

[a] Length of stay at the sea

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