SWEDISH MUSEUM OF
NATURAL HISTORY

Intercalibration of eggshell thickness measurements at the Swedish Museum of Natural History

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Contents

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Photo by Eva Kylberg

Introduction

Eggshell thickness can be used as a biological indicator for the influence of contaminants in the environment [*Bignert and Helander*, 2015; *Helander et al.*, 2002]. At the Swedish Museum of Natural History, eggs have been collected and their shell thickness measured as part of various monitoring programs. Common guillemot, common tern and Eurasian oystercatcher egg are collected each year as part of the National Monitoring Program for Contaminants in Marine Biota, osprey eggs are collected within the monitoring program for osprey “Projekt Fiskgjuse” and white-tailed sea eagle eggs have historically been collected within “Projekt Havsörn” (project white-tailed sea eagle) and national monitoring. The thickness of eggshells has been recorded over different periods for the various bird species with the oldest systematic measurements starting in the 1960s. Eggshell thickness measurements are usually performed during the year of collection but have also been done as part of retrospective work on older eggs.

In 2015 there was a mechanical problem with the instrument that had been used for the shell thickness measurements until then (Starret). The instrument was repaired and measurements continued until 2018. A new instrument of a different type (Mitutoyo) was acquired as a replacement, which required an adjustment to the measurement methodology. The measurements obtained with the old instrument between 2015 and 2018 have not been evaluated and it is uncertain if the instrument was reliable during this period.

In this report we evaluate 1) the need for a correction factor between the measurements obtained with the old and new instrument (including a change in methodology), 2) the variability between measurements conducted by different laboratory staff with the new instrument and 3) the variability between repeated measurements on the same egg with the new instrument.

Methods

Eggshell thickness measurements

The old micrometer instrument is a modified Starret model 1010 micrometer and the new instrument is a Mitutoyo 293-240-30 External Micrometer (range 0-25 mm).

Starret micrometer

A hand drill was used to create a hole just above the equator of the eggshell (Figure 1) for the extraction of egg content. After the egg content was extracted, the shell was cleaned on both the inside and outside in lukewarm water. The shell was then placed to dry at room temperature. After the shells had dried for three months, the thickness of the eggshell was determined by inserting the micrometer through the whole in the intact egg and taking 3-5 measurements around the hole. The average measured thickness for the individual measurements was recorded together with information on whether the outer shell membrane was attached to the inside of the eggshell.

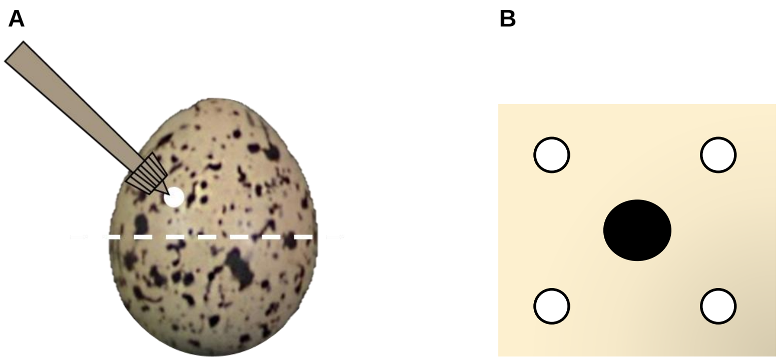

Figure 1. A) The procedure for the incision with the Starret micrometer; placement of a drill hole done with a hand drill just above the equator (the dashed line), B) black circle indicate the drill hole and white circles the 3-5 locations around the hole where the shell thickness was measured around the whole in the intact egg. Figure from *Palmheden* [2024]. The egg is from an Eurasian oystercatcher (*Haematopus ostralegus*).

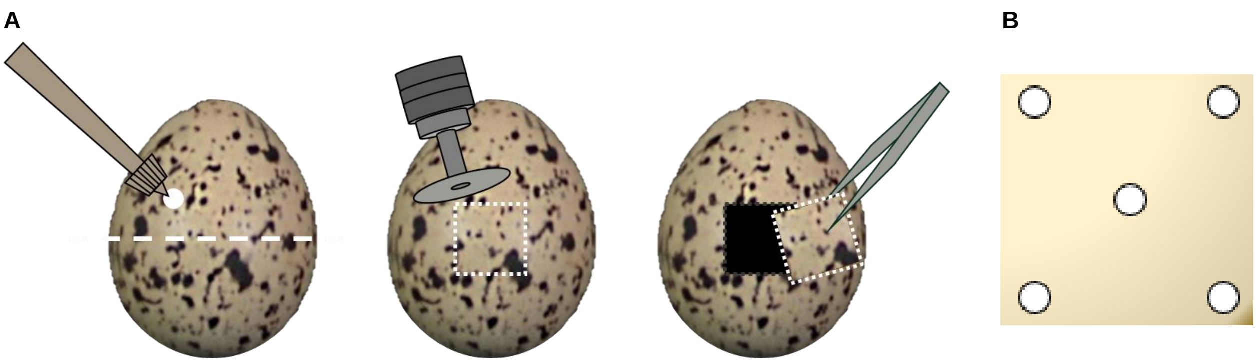

Figure 2. A) The procedure for the incision with the Mitutoyo micrometer (from left to right); placement of a drill hole done with a hand drill just above the equator (the dashed line), placement of incisions in the egg (the small dashed lines) with the multi-tool, removal of shell square with forceps. B) 1x1 cm square cut from the eggshells – the five circles indicate the locations where the shell thickness should be measured. Figure from *Palmheden* [2024]. The egg is from an Eurasian oystercatcher (*Haematopus ostralegus*).

Mitutoyo micrometer

A hand drill is used to create a small hole (to reduce pressure in the egg) just above the equator of the eggshell (Figure 2A). A multi-tool (Dremel) equipped with a thin saw blade (0.6 mm thick and 22 mm in diameter) is used to cut out a square from the egg for the egg extraction. The first incision starts at the small whole and 1×1 cm square is removed (Figure 2).

The eggshells (including the square that was cut out) is cleaned carefully on both the inside and outside in lukewarm water. The outer membrane on the shells inside should not be removed (the inner membrane can be lost). The shells, including the cut out squares, are placed to dry at room temperature. The thickness of the eggshell is measured in mm with the Mitutoyo micrometer on the cut-out square after the eggshells have dried for three months. The measured thickness is recorded together with information on whether the outer shell membrane is attached with the inside of the eggshell. The thickness (in mm) of the eggshell is based on the average value of five measurement points (Figure 2B) with an accuracy of two decimal places. The sum of the combined width of the shell and outer membrane has to be recorded. If the outer membrane is not attached to the shell, the outer membrane is measured separately in the same way as the shell.

A thorough description of the current methodology used for the collection, preparation and storage of eggs can be found in *Palmheden* [2024].

Data

The analysis was based on measurements of eggs from three monitoring programs. The data was combined from various sources and measuring events (Table 1). *Database*: data extracted from the database (ESBase) where eggshell measurements have historically been stored. *Intercomparison data*: a smaller number of eggshells were re-measured with the new instrument and results paired with the observations from the old instrument. *Mixed laboratory staff measurements*: retrospective measurements with the new instrument of a subset of eggs collected during the period 2016-2019 for the marine program (eggs measured only by one of 3 staff) and 2019-2021 for white-tailed sea eagle program (the same 10 eggs measured by 5 staff) by a mix of laboratory staff. *Measurements during year of collection*: eggs measured during collection year within the marine monitoring program 2020-2023. *Re-measurements:* re-measurements off eggs already measured with the new instrument within the marine program from 2015 to 2021. The re-measurements were performed during a one-year period by one individual (staff_4) to minimize variability. Measurements where the outer membrane had been separated from the eggshell and the outer membrane not separately measured were excluded from the data.

The data provided two types of overlap with paired observations between the old and new instruments: a) For the marine monitoring and white-tailed sea eagle programs, there were periods of overlap after the instrument broke the first time in 2015 and until it was completely phased out (marine data overlap 2015-2018; white-tailed sea eagle data overlap 2015-2016), b) Two intercomparison studies provided paired data. One where 15 old white-tailed sea eagle eggs were re-measured using the new instrument (2012-2014) and one where 13 old osprey eggs were re-measured using the new instrument (1965-1973). Further, paired measurements for the new instrument but with different personal performing the measurements were obtained by combining data from staff_4 and "Mixed laboratory staff measurement" (2016-2021) within the marine program.

For white-tailed sea eagle, we discarded the old data during the overlapping 2015-2016 period from further analysis. This was done as the comparison between the measurements from the old and new instruments showed large inconsistencies, which we did not find for the other years of white-tailed sea eagle measurements nor for the marine data. In addition to the potential problem with the old instrument, inexperienced staff was conducting the measurements with the old instrument for white-tailed sea eagle during this period, which could be responsible for the problems with these two years of measurements.

The thickness of the eggshells for the five bird species increases from common tern (~0.2 mm), to Eurasian Oystercatcher (~0.3 mm), to osprey (~0.4 mm) and to guillemot and white-tailed sea eagle (~0.6 mm; Table 2). Especially for the tern and Eurasian oystercatcher that have the thinnest shell (<0.5 mm), a large number of shells were broken into smaller or larger pieces (~60% and 30%, respectively), and sometimes the shell break as the measurement is conducted. This made a comparison between measurements conducted at different times more difficult as it cannot be guaranteed that the thickness is measured on the same egg piece. Information on the state of the shell is part of the data.

The switch from the old to new instrument required a switch in the methodology as described in the section on “Eggshell thickness measurements”. When we in the analysis refer to differences between the old and new instrument, this combines the difference in the precision of the instruments and the effect of the adjustment in methodology when the new instrument was introduced.

Table 1. Data used for the intercomparison of the two micrometer instruments. The Mitutoyo osprey measurements for the intercomparison data were measured by *Ingdahl* [2025].

Data	Starret (old) micrometer	Mitutoyo (new) micrometer
Marine (guillemot, European oystercatcher, common tern)		
Database	1968-2018	
Mixed laboratory staff measurement		2016-2019
Measurements during year of collection		2020-2023
Re-measurement (staff_4)		2015-2021
White-tailed sea eagle		
Database	1956-2014*	2015-2022
Mixed laboratory staff measurement		2019-2021
Intercomparison data	2012-2014	2012-2014
Osprey		
Intercomparison data	1965-1973	1965-1973

*the 2015-2016 white-tailed sea eagle data was removed after an evaluation of the data.

Correction factor

We primarily used data on paired samples between the old and new instrument for estimation of average correction factors between the two instruments (paired data is found in the Appendix). We followed the methodology presented in *Soerensen et al.* [2023], which assume proportionality between the measurements with the two instruments. We therefore derived a multiplicative correction factor (percent of the measured thickness) rather than an additive correction factor (a constant addition of thickness across all measurements). Intuitively, it would make sense, that a difference between the two instruments would manifest itself as a constant difference across all measurements but the mean arithmetic difference between the two instruments as a function of general eggshell thickness for the five bird species, suggest that the difference between the two instrument increases with eggshell thickness (Table 2). However, there could be arguments for the use of either methods.

We cast the problem as a simple pair-wise comparison of log-concentrations,

$$ln(C_{old-instrument}) - ln(C_{new-instrument}) = ln(k)$$

We calculated the correction factors between instruments by taking the geometric mean on the natural logarithm of the individual instrument factors using the equation:

$$k = e^{-d}$$

where *k* is the mean correction factor (instruments ratio), d is the arithmetic mean difference of $\ln(C_{old-instrument})$ minus $\ln(C_{new-instrument})$ for each eggshell thickness.

To calculate corrected values for the old starret instrument based on the correction factors derived in the "Results and discussion" section the following equation can be used:

$$C_{old-recalculated} = \frac{C_{old}}{k_{old/new}}$$

Table 2. Arithmetic mean difference (and standard deviation) between the old and new measurements of the paired observations collected (2015-2018). For the marine program, the staff_4 re-measurements were used to pair with the measurements from the old instrument.

Species	Eggshell thickness (mm, approximated)	Difference$_{old/new}$ (mm)	n
Common tern	~0.2	0.013±0.026	37
Eurasian oystercatcher	~0.3	0.022±0.035	33
Osprey	~0.4	0.019±0.027	13
White-tailed sea eagle	~0.6	0.026±0.055	15
Guillemot	~0.6	0.046±0.025	53

Linear regression model

For guillemot, where a long time series (1968-2023) and overlapping year of measurements with the old and new instrument exists, an additional method was used to estimate an alternative correction factor. We fitted a linear regression model with the eggshell thickness as the response variable and both measurement year and instrument type as explanatory variables taking into account that the egg pairs are not statistically independent. The "year" variable was centered at 2015 to facilitate interpretation as this marks the period during which both the old and new instruments were concurrently used. By including data from 2015 to 2018 where both instruments were applied to independent samples, the model estimate the effect of the instrument independently of the temporal trend. The instrument was treated as a categorical variable (old vs. new), and the model assumed a constant difference between instruments across years. This approach allowed us to quantify the systematic shift between instruments while adjusting for long-term trends in eggshell thickness. The guillemot data used was from the database (1968-2018), from the "Re-measurement" data (2015-2021) and from the "Measurements during year of collection" data (2022-2023; Table 1).

Results and discussion

Variability within and between egg-shells measurements

The recorded eggshell thickness is based on the average of five measurements within the 1x1 cm square. The standard deviation between the five measurements provides information on the combined variability in shell thickness within the 1x1 cm square and the uncertainty of the new Mitutoyo micrometer (Table 3). This can be held up against the variability across eggs collected in a given year, which represent the variability between individual bird eggs in an area.

We found the average standard deviation between the five measurements on the eggshell square ranged between 0.007-0.015 mm (CV: 1.8-3.5%) and the inter-egg standard deviation within years ranged between 0.015-0.049 mm (CV: 7.5-9.3%). In both cases, the standard deviation increased with increasing average eggshell thickness at the species level. This result confirm, as would be expected, that the intra-egg variability was smaller than the inter-egg variability within each year for the new instrument.

Impact of personnel on eggshell thickness measurements

To evaluate the difference in measurements between staff members, we use data from the marine program (Figure *3*). We found that the difference between the data from the re-measurements of eggs by staff_4 and the “Mixed laboratory staff measurement” and “Measurements during year of collection”, all conducted with the new instruments, decrease over the period 2016 to 2021. We therefore only include the most recent years in the comparison (2020-2021), where clear routines for the use of the new instrument had been introduced and the new methodology tested by the laboratory staff.

We calculated a correction factor between staff_4 and other staff (Table *4*) and found that the differences were mostly significant (the confidence interval does not contain 1.0), the exceptions being two cases ($k_{staff\_4/staff\_2\text{-}guillemot}$ and $k_{staff\_4/staff\_3\text{-}common\ tern}$) with only two observations in each. Correction factors for groups with at least four paired observations indicate a difference of 1-3% between staff. This suggests that continuous intercalibration exercises should be held in the laboratory to ensure that everyone uses the same methodology such that the variability between staff does not increase beyond the current level, and hopefully can be brought down further.

Table 3. Arithmetic means of the standard deviations and coefficient of variations of repeated measurements done on each shell square (n=5 per egg) and the eggshell thickness for the new instrument. For the between egg variability, eggs from the marine program were collected in the same year (n=10 per year, except for a few cases where less than 10 eggs were collected, 2015-2021) by staff_4 using the new instrument and for white-tailed sea eagle 10 egg between 2019-2021 were used.

Species	Standard deviation (mm)		Coefficient of Variation (%)	
	Intra-egg variability	Inter-egg variability	Intra-egg variability	Inter-egg variability
Common tern	0.007	0.015	3.5	7.5
Eurasian oystercatcher	0.009	0.028	3.1	9.3
White-tailed sea eagle	0.010	0.048	1.8	8.8
Guillemot	0.015	0.049	2.5	8.2

Table 4. Correction factors (confidence intervals in parenthesis) between staff for the new instrument. Measurements with the new instrument were done continuously each year as part of the monitoring program (mixed lab and staff numbered 1, 2, 3) and evaluated against re-measurements by staff_4. Data used in the comparison: 2020-2021. Instances where the outer membrane has been separated from the eggshell and only the shell therefore has been measured has been removed.

Species	$k_{staff\_4/mixed\ lab}$	*n*	$k_{staff\_4/staff\_1}$	*n*	$k_{staff\_4/staff\_2}$	*n*	$k_{staff\_4/staff\_3}$	*n*
Common tern	1.018 (1.000-1.037)	20	1.026 (1.009-1.043)	18			0.953 (0.790-1.156)	2
Eurasian oystercatcher	1.028 (1.014-1.043)	16	1.028 (1.014-1.043)	16				
Guillemot	1.027 (1.017-1.038)	60	1.030 (1.018-1.041)	54	0.994 (0.979-1.009)	2	1.012 (1.004-1.020)	4
Combined	1.025 (1.102-1.033)	96						

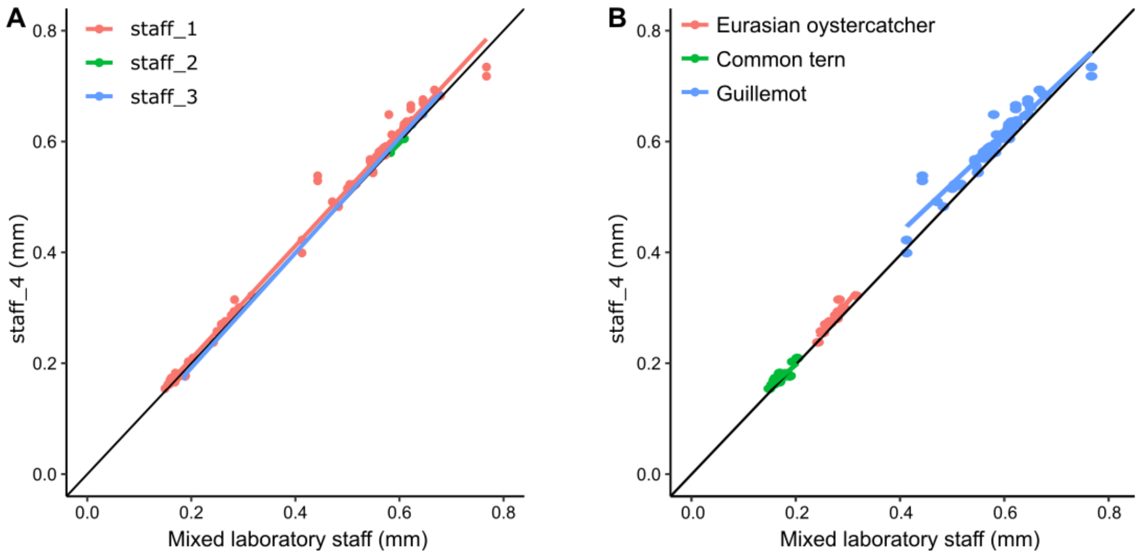

Figure 3. Correlation of measurements with the Mitutoyo micrometer as part of the "mixed laboratory staff" measurements (2020-2021) and as part of the re-measurements conducted by staff_4. Colors represents the A) different laboratory staff and B) different bird species.

Eggshell thickness correction factor between instruments

The correction factor for all species combined is 1.067 but it varies between 1.046 and 1.076 (Table 5). This corresponds to a difference of 6.7 % (4.6-7.6 %). The correction factors for the birds within the marine monitoring (common tern, Eurasian oystercatcher and guillemot) is higher than for osprey and white-tailed sea eagle. This could be a result of the uncertainty between different staff, which in the previous section was shown to be 2-3% but it could also be a result of bias in the marine data, which rely on the overlapping measurements with the old and new instrument during the 2015-2018 period, where we cannot validate the measurements with the old instrument.

Only the confidence interval for the white-tailed sea eagle crosses the 1:1 line with a lower confidence limit of 0.995, indicating that there is no significant difference between the two instruments within the sample set. However, as the two other independent results from the marine monitoring data and the osprey data, as well as the combined data, indicates that the difference is significant, this is most likely a result of the small number of observations for white-tailed sea eagle (n=15).

Table 5. Correction factors, $k_{old/new}$, with confidence interval in parenthesis for paired observations (data available in the Appendix).

Bird species	$k_{old/new}$	n
Common tern	1.064 (1.014-1.117)	37
Eurasian oystercatcher	1.073 (1.029-1.119)	33
Osprey	1.046 (1.008-1.084)	13
White-tailed sea eagle	1.047 (0.995-1.102)	15
Guillemot	1.076 (1.064-1.088)	53
All	1.067 (1.050-1.084)	151

Figure 4B show the variability of single correction factors around the average. The spread is larger for the thinner eggshells of common tern and Eurasian oystercatcher. These shells are more britle than the thicker eggshells and often break into smaller pieces. While work was done to exclude measurements done on fragmented eggshells, some might still be present in the data. In general, work with these thinner shells is more difficult and could explain a higher variability in the results.

Figure 5 presents the time series for uncorrected (A, B, D, E) and corrected (C, F) time series for guillemot and white-tailed sea eagle. For the uncorrected measurements, time series for both bird species show a decrease since the change of instrument. The same decrease is observed for the common tern and Eurasian oystercatcher (shorter time series, data not shown). It is highly unlikely that four different bird species with widely different geographical distribution and feeding strategies, should have such a synchronized and sudden decrease.

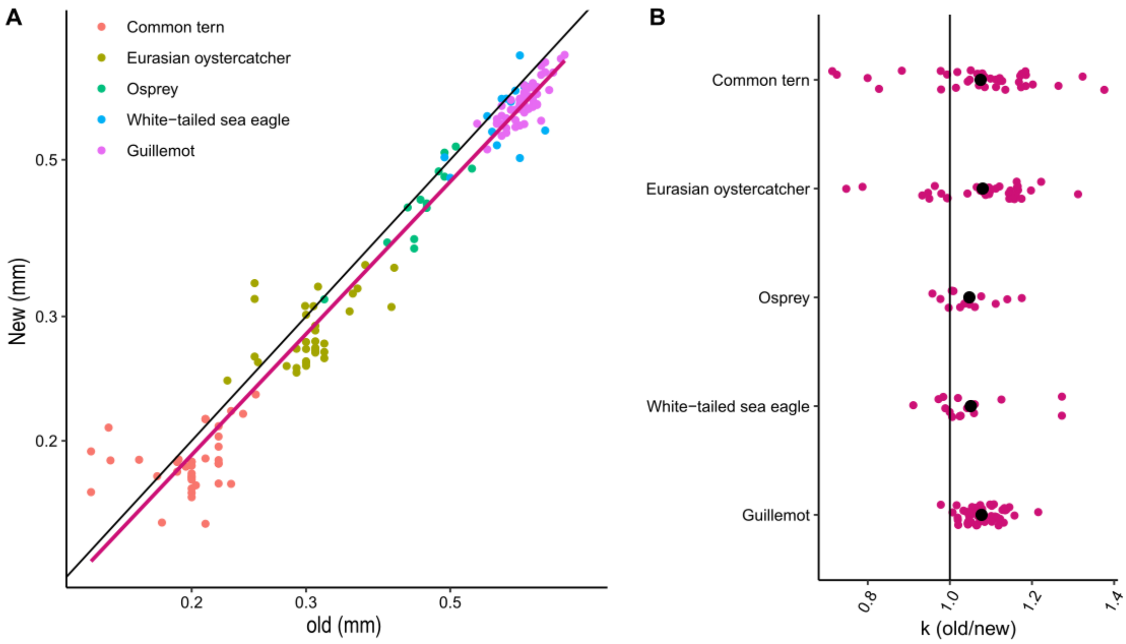

Figure 4. A) Correlation of Starret (old) and Mitutoyo (new) micrometers measurements for the five bird species and B) individual and average correction factors for $k_{old/new}$.

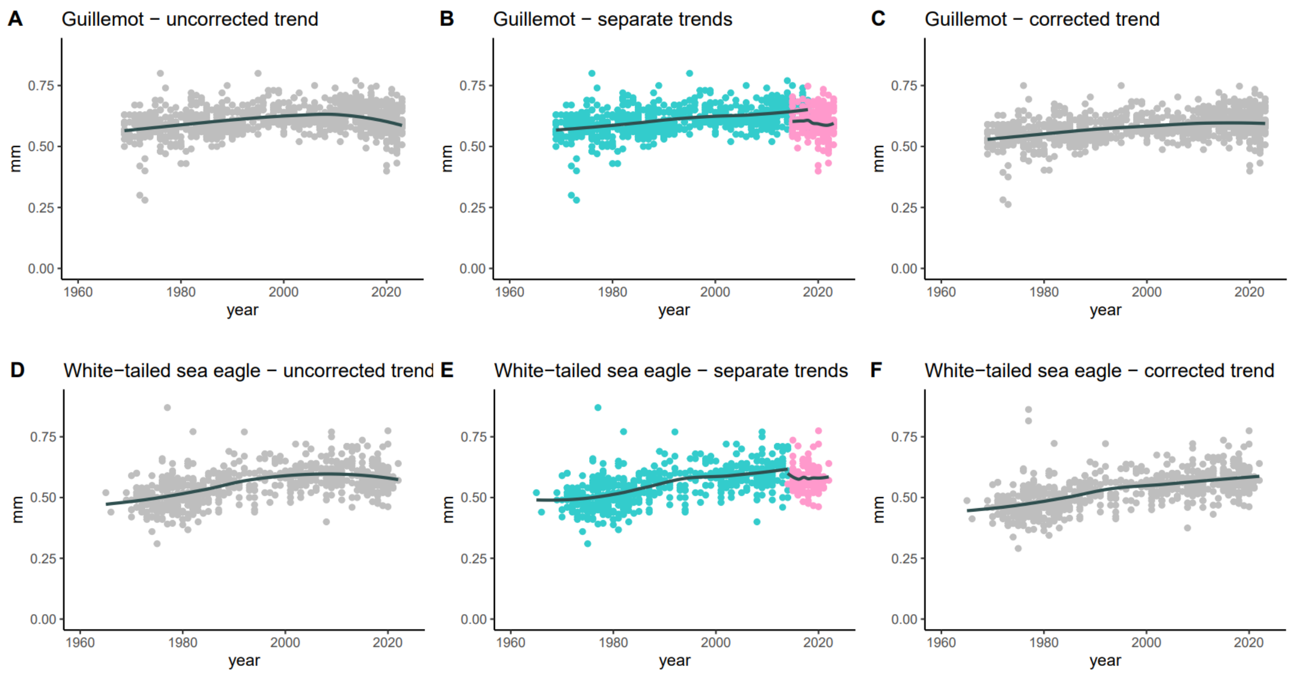

Figure 5. Time series and loess smoother lines (using ggplot2) for A+D) uncorrected data, B+E) measurement with the old (turquoise) and new (pink) instrument and method and C+F) measurements where old data is corrected using the overall correction factor $k_{old/new}$ of 1.067.

Using the guillemot time series as an example, the correction factor of 1.076 indicate that the difference between the old and new instrument (~0.046 mm if the shell is ~0.6 mm) is equivalent to ~60% of the increase in eggshell thickness that has been recorded over the last 50 years (a linear increase of 0.00158 mm y^{-1} over 50 years: 0.079 mm).

In addition to the calculation of correction factors calculated based on paired samples of old and new observations, we also conducted a linear regression for guillemot with the eggshell thickness as the response variable and measurement year and instrument type as explanatory variables. The linear regression for guillemot time series predicted a correction factor of 1.082 (or 8.2%) between instruments, similar to what was predicted using the paired data (1.076 or 7.6%).

These results combined support a significant systematic difference between instruments and emphasize the importance of a correction of the measurements with the old instrument in order to correctly interpret time trends in the full data series.

Uncertainty associated with decimal precision

An additional uncertainty factor, which we are not evaluating, is the importance of the number of decimal spaces that is used when recording the measurements. The measurements saved in the "ESBase" database has historically been stored with either two or three decimal spaces (unit in mm). Neglecting the third decimal space can result in a difference of up to 2% for the thin shells (example: two decimals 0.20 mm, three decimals 0.204 mm, difference 2%). While this should not result in a bias of the average across a times series (as each measurement should have equal change of being rounded up (>0.005) or down (<0.005)) it underlines the need for consistent recording of three digits for the eggshell thickness moving forward.

Conclusion

We find a significant effect on measured eggshell thickness due to the change in instrument (including methodology change). This effect is seen across five different bird species, with measurements conducted by different staff and across a longer time period. For guillemot, two different statistical approaches were used, both of which indicated a significant difference. We also tested the variability in the five measurements performed on each shell (intra-egg variability) and the variability in measurements due to different staff conducting the measurements (this can both be within year and between years). In both cases we saw that variability were present but smaller (<3.5%) than the effect of the change in instrument (>4.5%). While intra-egg and staff dependent differences can help explain some of the variability between instrument, especially in paired old and new measurements conducted by different staff, it is unlikely to explain the larger systematic difference we see between instruments. Thus, we conclude that the change in instrument has had a significant effect on the measurements and that corrections should be used when evaluating time trends of eggshell thickness. This is especially important as the trend in the eggshell thickness for all species are small over the period of observations (for guillemot 0.00158 mm y^{-1}).

The individual or overall corrections factors produced here (Table 5) should be used as a guideline. As the number of years with observations from the new instrument increases, regression analysis with eggshell thickness as a response variable can give more precise estimates on the effect of shift in instrument (including change in methodology) for all bird species as shown for guillemot in this report. We therefore recommend that the type and level of correction should be re-evaluated for individual studies for which the time series are needed in the future.

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Appendix

Dataset for the paired observations used to calculate the eggshell thickness correction factors.

year	bird species	specimen_ID	starret (mm)	mitutoyo (mm)
2015	Common tern	C2015/00579	0.200	0.187
2015	Common tern	C2015/00580	0.220	0.203
2015	Common tern	C2015/00581	0.220	0.186
2015	Common tern	C2015/00582	0.240	0.218
2015	Common tern	C2015/00583	0.220	0.210
2015	Common tern	C2015/00584	0.210	0.215
2015	Common tern	C2015/00585	0.210	0.215
2015	Common tern	C2015/00586	0.200	0.177
2015	Common tern	C2015/00587	0.210	0.153
2015	Common tern	C2015/00588	0.200	0.180
2016	Common tern	C2016/00519	0.220	0.188
2016	Common tern	C2016/00520	0.200	0.169
2016	Common tern	C2016/00521	0.220	0.186
2016	Common tern	C2016/00522	0.200	0.187
2016	Common tern	C2016/00523	0.230	0.174
2016	Common tern	C2016/00524	0.200	0.178
2016	Common tern	C2016/00525	0.190	0.181
2016	Common tern	C2016/00526	0.200	0.171
2016	Common tern	C2016/00527	0.190	0.187
2016	Common tern	C2016/00528	0.200	0.166
2017	Common tern	C2017/00975	0.180	0.153
2017	Common tern	C2017/00976	0.140	0.193
2017	Common tern	C2017/00977	0.140	0.169
2017	Common tern	C2017/00978	0.230	0.220
2017	Common tern	C2017/00979	0.200	0.184
2017	Common tern	C2017/00980	0.150	0.188
2017	Common tern	C2017/00981	0.200	0.176
2017	Common tern	C2017/00982	0.210	0.189
2017	Common tern	C2017/00983	0.220	0.196
2017	Common tern	C2017/00984	0.220	0.174
2018	Common tern	C2018/00115	0.177	0.178
2018	Common tern	C2018/00116	0.191	0.188
2018	Common tern	C2018/00117	0.196	0.184
2018	Common tern	C2018/00118	0.251	0.233
2018	Common tern	C2018/00120	0.149	0.209
2018	Common tern	C2018/00121	0.203	0.173
2018	Common tern	C2018/00122	0.166	0.188
2015	Eurasian oystercatcher	C2015/00571	0.250	0.318
2015	Eurasian oystercatcher	C2015/00572	0.250	0.334
2015	Eurasian oystercatcher	C2015/00573	0.280	0.255
2015	Eurasian oystercatcher	C2015/00574	0.227	0.243

2015	Eurasian oystercatcher	C2015/00575	0.300	0.302
2015	Eurasian oystercatcher	C2015/00576	0.300	0.258
2015	Eurasian oystercatcher	C2015/00577	0.310	0.291
2015	Eurasian oystercatcher	C2015/00578	0.290	0.250
2016	Eurasian oystercatcher	C2016/00509	0.300	0.255
2016	Eurasian oystercatcher	C2016/00510	0.410	0.352
2016	Eurasian oystercatcher	C2016/00511	0.320	0.267
2016	Eurasian oystercatcher	C2016/00512	0.310	0.267
2016	Eurasian oystercatcher	C2016/00513	0.320	0.275
2016	Eurasian oystercatcher	C2016/00514	0.360	0.329
2016	Eurasian oystercatcher	C2016/00515	0.300	0.259
2016	Eurasian oystercatcher	C2016/00516	0.310	0.269
2016	Eurasian oystercatcher	C2016/00517	0.290	0.270
2016	Eurasian oystercatcher	C2016/00518	0.310	0.271
2017	Eurasian oystercatcher	C2017/00967	0.350	0.305
2017	Eurasian oystercatcher	C2017/00968	0.320	0.262
2017	Eurasian oystercatcher	C2017/00969	0.370	0.355
2017	Eurasian oystercatcher	C2017/00970	0.310	0.287
2017	Eurasian oystercatcher	C2017/00971	0.300	0.270
2017	Eurasian oystercatcher	C2017/00972	0.310	0.277
2017	Eurasian oystercatcher	C2017/00973	0.300	0.276
2017	Eurasian oystercatcher	C2017/00974	0.290	0.254
2018	Eurasian oystercatcher	C2018/00107	0.299	0.310
2018	Eurasian oystercatcher	C2018/00108	0.253	0.258
2018	Eurasian oystercatcher	C2018/00109	0.250	0.263
2018	Eurasian oystercatcher	C2018/00110	0.406	0.309
2018	Eurasian oystercatcher	C2018/00111	0.354	0.323
2018	Eurasian oystercatcher	C2018/00112	0.313	0.331
2018	Eurasian oystercatcher	C2018/00114	0.308	0.310
2015	Guillemot	C2015/00260	0.650	0.638
2015	Guillemot	C2015/00261	0.640	0.607
2015	Guillemot	C2015/00262	0.690	0.679
2015	Guillemot	C2015/00263	0.610	0.546
2015	Guillemot	C2015/00264	0.600	0.596
2015	Guillemot	C2015/00265	0.600	0.541
2015	Guillemot	C2015/00266	0.660	0.632
2015	Guillemot	C2015/00267	0.700	0.687
2015	Guillemot	C2015/00268	0.630	0.569
2015	Guillemot	C2015/00269	0.590	0.562
2015	Guillemot	C2015/00270	0.650	0.611
2015	Guillemot	C2015/00271	0.670	0.594
2015	Guillemot	C2015/00272	0.650	0.583
2015	Guillemot	C2015/00273	0.550	0.562
2015	Guillemot	C2015/00274	0.750	0.704
2015	Guillemot	C2015/00275	0.660	0.590
2015	Guillemot	C2015/00276	0.670	0.642

2015	Guillemot	C2015/00277	0.590	0.564
2015	Guillemot	C2015/00278	0.680	0.598
2015	Guillemot	C2015/00279	0.640	0.600
2015	Guillemot	C2015/00280	0.700	0.665
2015	Guillemot	C2015/00281	0.590	0.571
2017	Guillemot	C2017/00714	0.600	0.577
2017	Guillemot	C2017/00715	0.650	0.562
2017	Guillemot	C2017/00716	0.600	0.562
2017	Guillemot	C2017/00717	0.670	0.633
2017	Guillemot	C2017/00718	0.640	0.590
2017	Guillemot	C2017/00719	0.710	0.628
2017	Guillemot	C2017/00720	0.620	0.608
2017	Guillemot	C2017/00721	0.680	0.599
2017	Guillemot	C2017/00722	0.690	0.568
2017	Guillemot	C2017/00723	0.640	0.596
2017	Guillemot	C2017/00724	0.650	0.623
2017	Guillemot	C2017/00725	0.640	0.559
2017	Guillemot	C2017/00726	0.720	0.664
2017	Guillemot	C2017/00727	0.740	0.695
2017	Guillemot	C2017/00728	0.610	0.572
2017	Guillemot	C2017/00729	0.640	0.593
2017	Guillemot	C2017/00730	0.670	0.597
2017	Guillemot	C2017/00731	0.670	0.608
2017	Guillemot	C2017/00732	0.680	0.634
2017	Guillemot	C2017/00733	0.630	0.556
2018	Guillemot	C2018/00021	0.660	0.615
2018	Guillemot	C2018/00022	0.660	0.615
2018	Guillemot	C2018/00023	0.650	0.599
2018	Guillemot	C2018/00024	0.610	0.554
2018	Guillemot	C2018/00025	0.630	0.589
2018	Guillemot	C2018/00026	0.570	0.517
2018	Guillemot	C2018/00027	0.690	0.659
2018	Guillemot	C2018/00028	0.620	0.588
2018	Guillemot	C2018/00029	0.680	0.619
2018	Guillemot	C2018/00030	0.650	0.618
2018	Guillemot	C2018/00031	0.640	0.610
1965	Osprey	C1965/07019	0.460	0.427
1965	Osprey	C1965/07024	0.440	0.386
1973	Osprey	C1973/07151	0.510	0.522
1973	Osprey	C1973/07156	0.400	0.382
1973	Osprey	C1973/07161	0.540	0.486
1973	Osprey	C1973/07165	0.430	0.428
1973	Osprey	C1973/07166	0.490	0.473
1973	Osprey	C1973/07172	0.490	0.512
1973	Osprey	C1973/07176	0.320	0.317
1973	Osprey	C1973/07179	0.460	0.434

1973	Osprey	C1973/07181	0.480	0.481
1973	Osprey	C1973/07193	0.440	0.374
1973	Osprey	C1973/07194	0.450	0.439
2010	White-tailed sea eagle	C2010/11320	0.600	0.610
2010	White-tailed sea eagle	C2010/11325	0.580	0.548
2010	White-tailed sea eagle	C2010/11331	0.590	0.524
2011	White-tailed sea eagle	C2011/06022	0.640	0.703
2011	White-tailed sea eagle	C2011/06027	0.610	0.610
2011	White-tailed sea eagle	C2011/06034	0.490	0.504
2012	White-tailed sea eagle	C2012/05333	0.570	0.576
2012	White-tailed sea eagle	C2012/05338	0.640	0.503
2012	White-tailed sea eagle	C2012/05344	0.650	0.637
2013	White-tailed sea eagle	C2013/02266	0.660	0.633
2013	White-tailed sea eagle	C2013/02271	0.630	0.626
2013	White-tailed sea eagle	C2013/02277	0.650	0.635
2014	White-tailed sea eagle	C2014/04434	0.700	0.550
2014	White-tailed sea eagle	C2014/04438	0.500	0.471
2014	White-tailed sea eagle	C2014/04445	0.620	0.604