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Physical Characteristics of Bald Eagle Eggs from Maine, 2000 to 2012

Fish and Wildlife Service

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Physical Characteristics of Bald Eagle Eggs from Maine, 2000 to 2012

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By:

Steven E. Mierzykowski
U.S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, Maine 04473

and

Charles S. Todd
Maine Department of Inland Fisheries and Wildlife
650 State Street
Bangor, Maine 04401

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EXECUTIVE SUMMARY

Between 2000 and 2012, 91 abandoned or non-viable bald eagle (*Haliaeetus leucocephalus*) eggs were collected from 55 nest territories in inland and coastal habitats in Maine. Several measurements were recorded from each egg including length, breadth, total mass, mass of egg contents, eggshell mass, and eggshell thickness. Egg volume was determined from length and breadth measurements. Desiccation factors were calculated to account for moisture loss following egg deposition.

- Basic egg measurements (length, breadth, total mass, eggshell mass) were similar to those reported in other bald eagle egg collections in the United States and Canada.
- There were no significant differences in egg characteristics between inland nest territories and coastal territories.
- Egg collections in Maine began as early as mid-April and ended at late as mid-July. Nearly 60% of eggs were collected in June, primarily during the first two weeks.
- Desiccation in eggs averaged 22% by the time they were collected. There was a weak negative correlation between egg collection date and the desiccation adjustment factor.
- The current average shell thickness of Maine bald eagle eggs indicates an increase in thickness of approximately 3% from eggs collected in the state during the 1970s and 1980s. Current thicknesses, however, also indicate that Maine eggs are still 10% thinner than reported pre-1946 levels (i.e., prior to the use of DDT). There was a weak negative correlation between shell thickness and egg content DDE concentration.
- The Ratcliffe Index, an indicator of eggshell thickness, was unremarkable and slightly higher than results from bald eagle eggs collected from 1986 – 2000 in the Great Lakes.

Keywords: bald eagle, *Haliaeetus leucocephalus*, eggshells, Maine

TABLE OF CONTENTS

Page

List of Figures and Tables

PREFACE

This report describes the physical characteristics of 91 abandoned or nonviable bald eagle eggs collected from 55 nest territories in Maine between 2000 and 2012.

Questions, comments, and suggestions related to this report are encouraged. Written inquiries should refer to Report Number FY13-MEFO-3-EC and be directed to:

Steve Mierzykowski
U.S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, Maine 04473

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This report complies with the peer review and certification provisions of the Information Quality Act (Public Law 106-554, Section 515).

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1. Introduction

Since 2000, the U.S. Fish and Wildlife Service (USFWS), Maine Department of Inland Fisheries and Wildlife (MEDIFW), and its conservation partners have been involved in numerous investigations of Maine's bald eagle population. Non-viable and abandoned eggs were often collected in these investigations and provided to the USFWS for processing and contaminant analysis. In this report, characteristics of 91 bald eagle eggs collected between 2000 and 2012 from 55 nest territories throughout the state are summarized and discussed.

2. Study Objective

Measure and report characteristics of abandoned or non-viable bald eagle eggs collected in Maine.

3. Study Area

All bald eagle nest territories located in inland (lacustrine and riverine) and coastal (estuarine and marine) habitats throughout Maine were included in this investigation (Figure 1). Bald eagle investigations in Maine between 2000 and 2008 focused on territories located in lacustrine and riverine habitats. Nest territories located in marine and estuarine habitat were the focus of eagle contaminant studies between 2009 and 2012.

4. Methods

4.1 Egg Collections. Only nonviable or abandoned eggs were collected for this investigation. Most eggs were observed during aerial surveys of nests and tree climbers were dispatched within 24 – 36 hours to recover eggs if they appeared abandoned or were well past their hatch date. In addition, several eggs were collected during nestling sampling operations associated with USFWS and other studies. After nestling bald eagles were lowered to the ground for processing, tree climbers would thoroughly inspect the depths of nest bowls to located buried nonviable eggs. Upon collection, eggs were transported from the field in coolers and stored in a refrigerator until processed. Most eggs were processed within 24 - 48 hours of collection.

Collection location information for each egg included MEDIFW nest territory number, descriptive location, township, county, coordinates (decimal degrees), territory habitat type (inland – lacustrine or riverine, coastal – estuarine or marine) and date of collection.

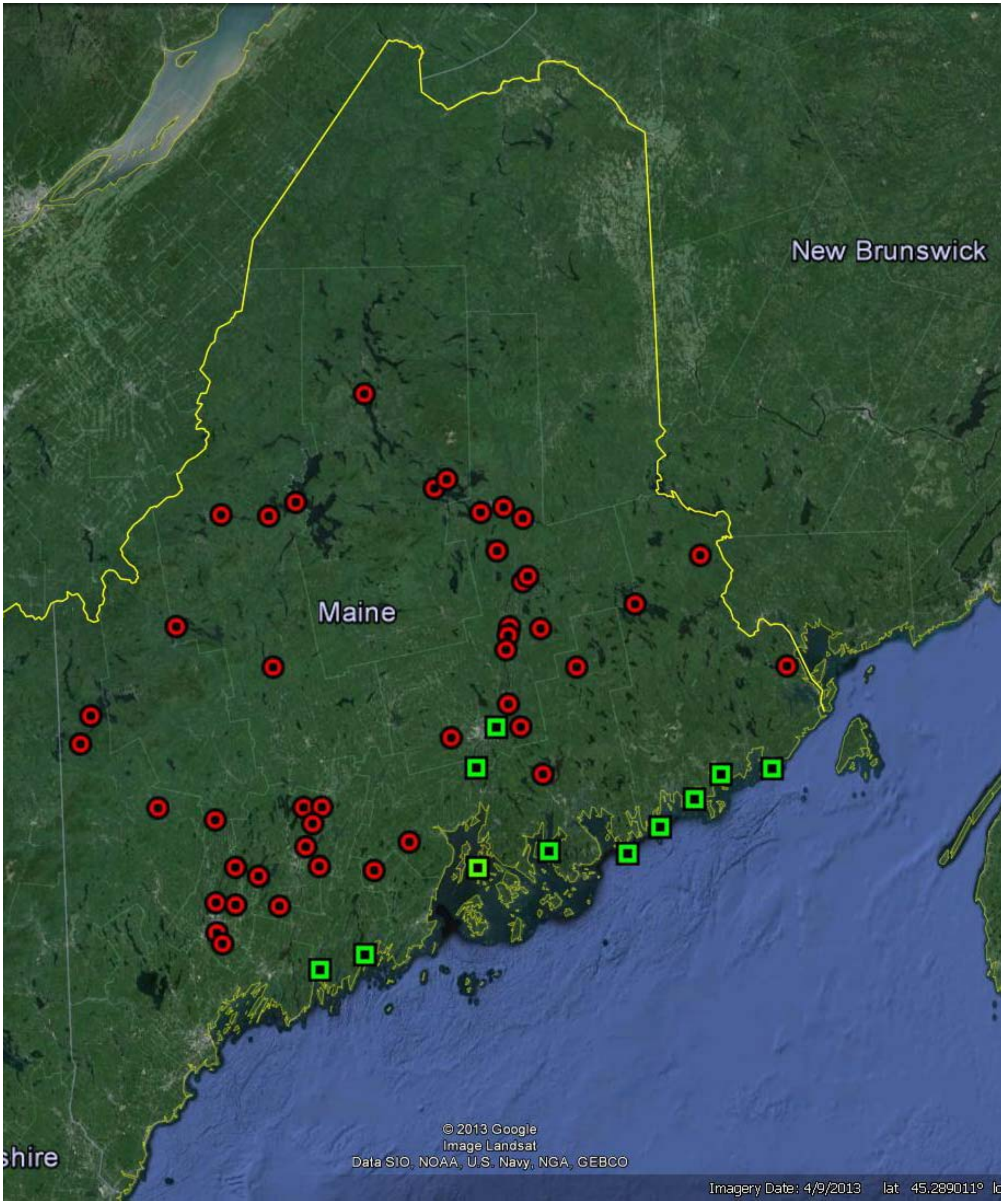


Figure 1. Maine bald eagle egg collection locations. Red circles = inland nest territories (lacustrine and riverine habitat). Green squares = coastal nest territories (estuarine and marine habitat).

4.2 Egg Processing. Prior to processing, whole eggs were thoroughly cleaned of surface debris using a paper towel soaked with de-ionized water. Slightly cracked and intact eggs that were not leaking were also cleaned, but the amount of cleaning depended on the size of the crack and the amount of surface debris. Surfaces of cracked eggs that were leaking were not cleaned, since most egg contents were destined for contaminant analysis.

4.2.1 Dimensions and Mass - Dial calipers precise to ± 0.1 millimeters (mm) were used to measure length and breadth. Two breadth measurements were taken to derive a mean value. An electronic balance precise to ± 0.1 gram was used to measure total egg mass, egg content mass and eggshell mass.

4.2.2 Volume - Egg volume in milliliters (mL) was determined from length and breadth measurements using the formula in Stickel *et al*. (1973):

$$\text{Volume} = 3.73 * \text{Mean Breadth} * \text{Length} - 35.3$$

4.2.3 Egg Contents - To extract egg contents, a 20 gauge needle attached to a 10 cubic centimeter syringe was inserted into the apex of the egg to relieve pressure prior to opening. After scoring several rotations around the egg equator with a stainless steel scalpel, eggs were pried open and the contents placed in chemically clean jars. The egg contents were then weighed and frozen.

4.2.4 Desiccation Correction Factor - Since most eggs in the Maine collections would be used in contaminant analyses, a Desiccation Correction Factor was calculated for each egg to account for moisture loss following egg deposition, according to the formula adapted from Best *et al*. (2010):

$$\text{Desiccation Correction Factor} = \text{Weight} * \text{Volume}^{-1}$$

The correction factor is often applied to the organic and methylmercury wet weight contaminant concentrations reported by analytical laboratories to derive a corrected wet weight concentration - referred to as the fresh wet weight concentration.

4.2.5 Eggshell Thickness - After a 10-day drying period, eggshell thickness with membranes attached was measured with a digital micrometer precise to ± 0.001 mm. Four thickness measurements were taken from each eggshell half and the mean determined from the eight measurements. Eggshell mass was recorded after thickness measurements.

4.2.6 Ratcliffe Index - Egg length, breadth, and eggshell mass were used to calculate the Ratcliffe Index (Ratcliffe 1970). The Ratcliffe Index is considered a reliable indicator of shell thickness (Burnham *et al*. 1984) when thickness measurements are lacking. The index value was calculated using the following formula:

Ratcliffe Index = Eggshell Mass (mg) / Egg Length (mm) * Egg Breadth (mm)

4.3 Data Summations and Statistical Analyses. Egg data were summarized by arithmetic mean ± standard deviation, and range (Table 1). One egg with outlier values, ME199-0001, was not included in the calculations of desiccation correction factor, total mass, and egg content mass. Mass of this egg was extremely low compared to other eggs processed and the egg contents were dissimilar to any other egg. The contents of this whole, intact egg were a coarse grey material similar in texture to river sediment. The dimensions of this egg (i.e., length and breadth) and the eggshell thickness were unremarkable and included in calculations of the mean and standard deviation for those particular metrics.

The Mann-Whitney U Test was used to determine if there were significant differences in physical characteristics of eggs collected from inland and coastal habitats (Figure 4). The acceptable level of significance was $\alpha = 0.05$. Pearson's Correlation was used to examine possible relationships between desiccation correction factor versus egg collection date (Figure 5) and egg content DDE concentration versus eggshell thickness (Figure 6). Statistical tests were performed with Systat 12® (Systat Software).

5. Results and Discussion

5.1 Collection information. Depending on the weather, Maine bald eagles begin laying eggs in late March or early April. Nearly 60% of the eggs in this study were collected in June (Figure 2), primarily before the third week (Figure 3). The earliest collection was April 11 and the latest was July 15 (Figure 3).

5.2 Egg Dimensions, Mass, and Volume. Bald eagle egg size varies with latitude. As the average body size of bald eagles increases from south to north (e.g., Florida to Maine), so do egg dimensions (Stalmaster 1987). In the current study of Maine bald eagle eggs, the average length was 73.6 ± 2.9 mm (range: 65.4 – 81.8 mm) and the average breadth was 56.6 ± 2.0 mm (range: 50.7 – 62.0 mm). Average eggs across the entire North American bald eagle range were 70.0 – 76.0 mm in length and 53.0 – 58.0 mm in breadth (Stalmaster 1987).

Average total mass of Maine bald eagle eggs was 112.4 ± 15.0 grams (range: 76.1 – 157.7 grams, one egg with an outlier value was excluded from the calculations). Mass of egg contents averaged 95.7 ± 13.9 grams (range: 66.1 – 136.4 grams, one egg with an outlier value was excluded from the mean and standard deviation calculations).

Figure 2. Distribution of bald eagle egg collections in Maine by month.

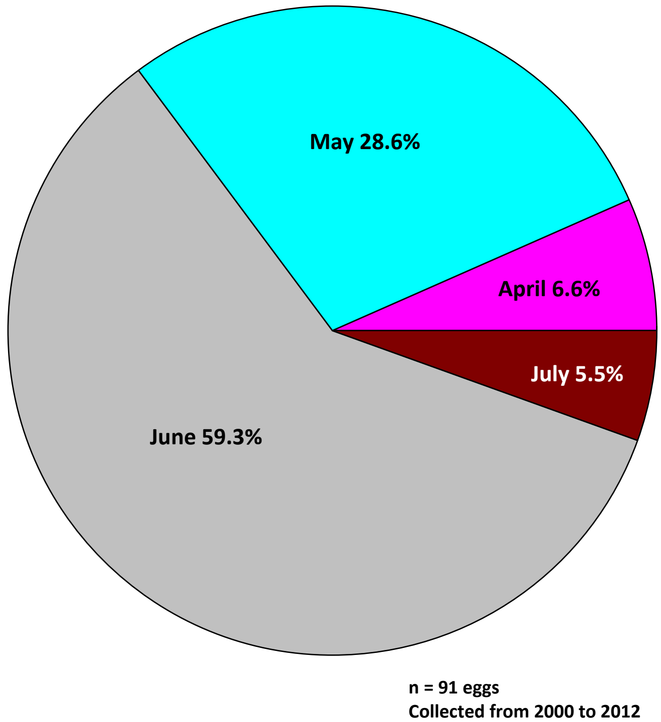
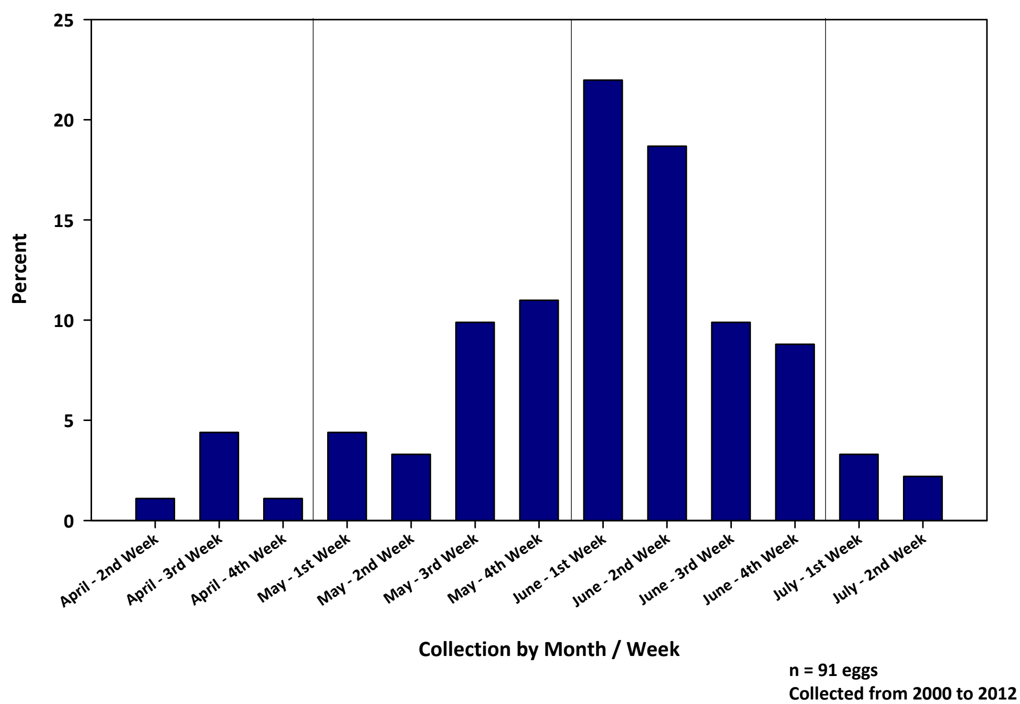


Figure 3. Distribution of bald eagle egg collections in Maine by month and week.



Average volume in Maine bald eagle eggs was 120.2 ± 10.1 mL (range: 88.3 – 153.9 mL).

There was no significant difference in any of the egg variables on a habitat basis. Physical characteristics of eggs collected from inland territories were not significantly different from eggs collected from coastal territories (Mann-Whitney U Test, all $p > 0.05$, Figure 4).

5.3 Desiccation Correction Factor. Avian eggs typically lose approximately 16% of their mass by the end of incubation (Heinz *et al*. 2009), while raptor eggs subjected to drying and decay prior to collection may lose as much as eight times their mass (Stickel *et al*. 1965). Abandoned and non-viable bald eagle eggs, particularly those in exposed nest bowls, may be subjected to direct sunlight and heat for some time before being collected. Consequently, contaminant residue concentrations in partially dried eggs may be exaggerated (Stickel *et al*. 1973).

The average desiccation correction factor for Maine bald eagle eggs was 0.794 ± 0.081 (range: 0.543 – 0.936, one egg with outlier values was excluded from the calculations). There was a weak negative correlation between egg collection date and the desiccation adjustment factor ($n = 90$, Pearson's correlation coefficient $r = -0.258$, Figure 5).

5.4 Thickness. Reproductive impairment and eggshell thinning in birds has been linked to DDE contamination (Longcore and Stendell 1977). Since the 1972 North American ban on DDT (1970 in Canada, 1972 in the United States), the parent compound of DDE, bald eagle eggshell thickness has increased and productivity has improved (Grier 1982).

Eggshell thickness was measured to determine if eggshell thickness had increased since previous collections in Maine. Thickness measurements of Maine bald eagle eggs collected prior to the use of DDT were not located. Buehler (2000, citing Anderson and Hickey 1972) presented a pre-1947 thickness average of 0.584 mm from a large sample of bald eagle eggs from Florida. Grubb *et al*. (1990) used a pre-1947 thickness of 0.591 mm based on bald eagle eggshells from southern California and Baja California, Mexico. Best *et al*. (2010) used a pre-1946 eggshell thickness value of 0.610 mm from the Great Lakes and Alaska. Clark *et al*. (1998) used a pre-DDT thickness value of 0.6165 mm for New Jersey bald eagle eggs.

In our comparison of eggshell thickness to historical levels, we selected the value of 0.610 mm as the pre-1947 thickness; the same value used by Best *et al*. (2010) for a northern bald eagle population. Average eggshell thickness in Maine bald eagle eggs collected between 2000 and 2012 was 0.544 ± 0.053 mm (range: 0.410 – 0.680 mm). The current average eggshell thickness indicates an increase by approximately 3% from Maine bald eagle collections in 1970s (Wiemeyer *et al*. 1984) and 1980s (Wiemeyer *et al*. 1993). Current thicknesses, however, also indicate that Maine eggs are still 10% thinner than reported pre-1947 levels (i.e., prior to the use of DDT). DDE levels in Maine bald eagle eggs have decreased 17-fold since levels were reported in the 1960s (Krantz *et al*. 1970, Wiemeyer *et al*. 1972, Mierzykowski *et al*. 2008), and current concentrations (0.97 µg/g, USFWS unpublished data) are well below the estimated threshold associated with 15% reductions in shell thickness (16 µg/g, Henny and Elliott 2007).

There was a weak negative correlation between shell thickness and egg content DDE concentration (n = 80, Pearson's correlation coefficient r = - 0.247, Figure 6).

5.5 Eggshell Mass. As noted above, eggshell mass was recorded after a 10-day drying period and after eggshell thickness measurements were taken. Average eggshell mass in 91 Maine bald eagle eggs was 12.9 ± 1.5 grams (range: 7.6 – 16.1 grams).

5.6 Ratcliff Index. The average Ratcliffe Index was 3.08 ± 0.28 (range: 2.29 – 3.91). Index values for Maine bald eagle eggs in earlier collections were not located. In the Great Lakes, Ratcliffe Index values for bald eagle eggs collected between 1986 and 2000 were 2.92 at Great Lakes shoreline territories and 3.04 at inland territories (Best *et al*. 2010). In the present study of Maine eggs, the average Ratcliffe Index value was slightly higher than the Great Lakes investigation.

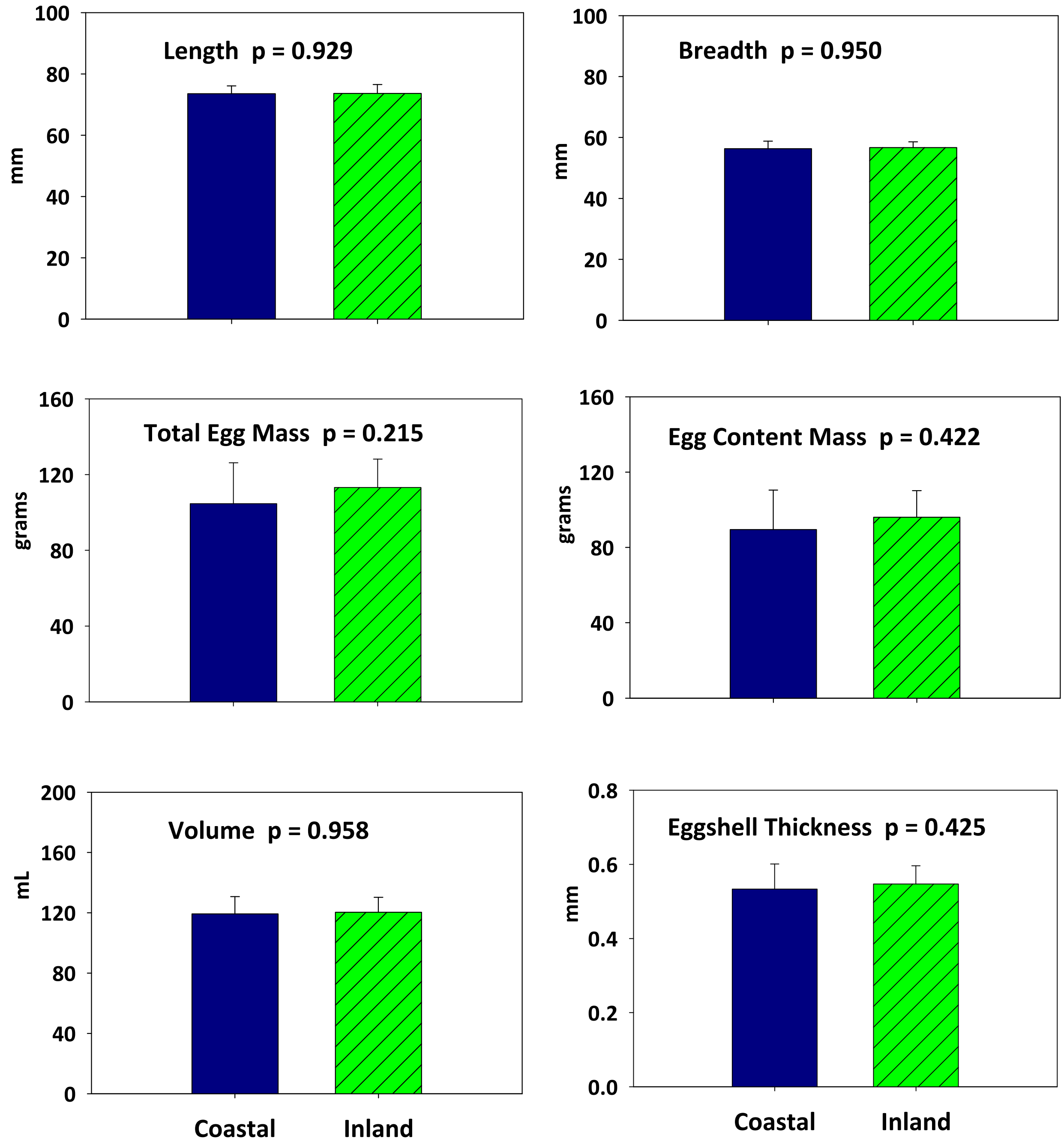
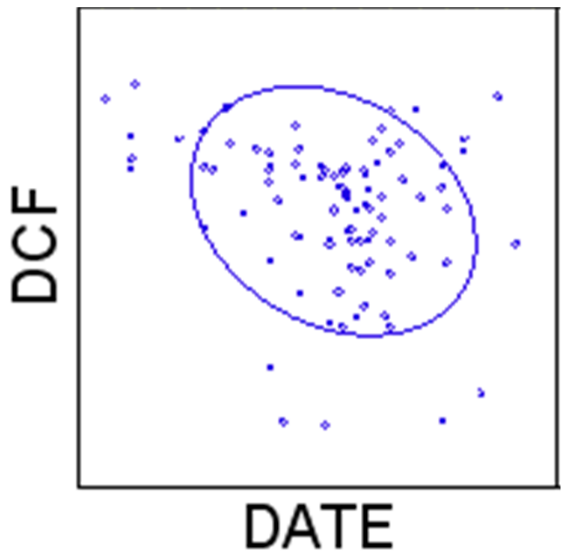


Figure 4. Physical characteristics of Maine bald eagle eggs – coastal (n = 16) vs. inland (n = 75) territories. Bars represent means and whiskers represent standard deviations. p values from Mann-Whitney U Test.

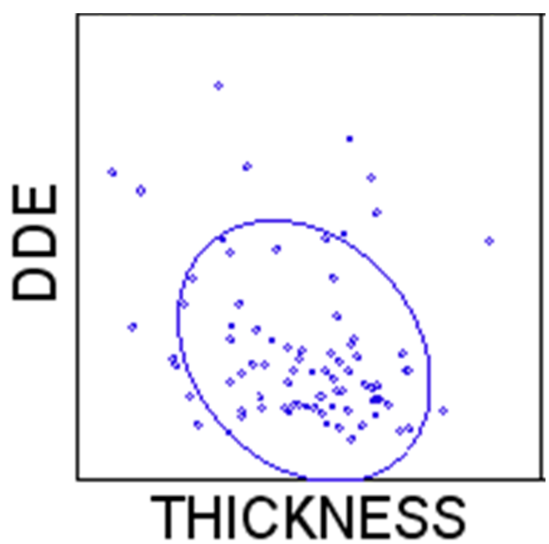
Table 1. Summary of metrics in 91 bald eagle eggs from Maine, 2000 - 2012. One egg with outlier values, ME199-0001, was excluded from the mean and standard deviation calculations for total mass, mass of egg contents, and desiccation factor. Its values are listed separately after Range.

Metric (units)	Mean	±	Standard Deviation	Range			
Length (mm)	73.6	±	2.9	65.4	-	81.8	
Breadth (mm)	56.6	±	2.0	50.7	-	62.0	
Total Mass (g)	112.4	±	15.0	76.1	-	157.7	(Outlier 44.0)
Mass of Egg Contents (g)	95.7	±	13.9	66.1	-	136.4	(Outlier 28.0)
Volume (mL)	120.2	±	10.1	88.3	-	153.9	
Desiccation Correction Factor	0.794	±	0.081	0.543	-	0.936	(Outlier 0.256)
Eggshell Thickness (mm)	0.544	±	0.053	0.410	-	0.680	
Eggshell Mass (g)	12.9	±	1.5	7.6	-	16.1	
Ratcliff Index	3.08	±	0.28	2.29	-	3.91	



Pearson's Correlation Coefficient
r = - 0.258

Figure 5. Relationship between egg collection Julian date (Date) and desiccation correction factor (DCF).



Pearson's Correlation Coefficient
r = - 0.247

Figure 6. Relationship between eggshell thickness (Thickness, mm) and egg content DDE (DDE, µg/g fresh wet weight).

6. Summary

Between 2000 and 2012, 91 abandoned or non-viable bald eagle (*Haliaeetus leucocephalus*) eggs were collected from 55 nest territories in inland and coastal habitats in Maine. Length, breadth, total mass, mass of egg contents, eggshell mass, volume, desiccation factor, eggshell thickness, and the Ratcliffe Index were measured or calculated for each egg.

There was no significant difference in egg characteristics between inland and coastal habitats (Mann-Whitney U Test, $p > 0.05$, Figure 4). Basic egg measurements (length, breadth, total mass, eggshell mass) were similar to those reported in other bald eagle egg collections in the United States and Canada (Stalmaster 1987, Bortolotti 1984).

Egg collections began as early as mid-April and ended as late as mid-July. Nearly 60% of the eggs were collected in June, primarily during the first two weeks.

Desiccation in eggs averaged 22% by the time they were collected. There was a weak negative correlation between egg collection date and the desiccation adjustment factor ($n = 90$, Pearson's correlation coefficient $r = -0.258$, Figure 5).

The current average shell thickness of Maine bald eagle eggs indicates an increase in thickness of approximately 3% from egg collections in the state during the 1970s (Wiemeyer *et al*. 1984) and 1980s (Wiemeyer *et al*. 1993), but still 10% thinner than reported pre-1946 levels (i.e., prior to the use of DDT). DDE levels in Maine bald eagle eggs have decreased 17-fold since levels were reported in the 1960s (Krantz *et al*. 1970, Wiemeyer *et al*. 1972, Mierzykowski *et al*. 2008) and current concentrations (0.97 µg/g, USFWS unpublished data) are well below the estimated threshold associated with 15% reductions in shell thickness (16 µg/g, Henny and Elliott 2007). There was a weak negative correlation between shell thickness and egg content DDE concentration ($n = 80$, Pearson's correlation coefficient $r = -0.247$, Figure 6).

Ratcliffe Index measurements, an indicator of eggshell thickness, were slightly higher compared to Ratcliffe Index values from the Great Lakes for eggs collected from 1986 – 2000.

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Table A-1. Collection information and metrics of Maine bald eagle eggs

USFWS Sample #	Territory Location, Township	Habitat/ Sub-habitat	Collection Date	Total Egg Mass (g)	Length (mm)	Mean Breadth (mm)	Egg Content Mass (g)	Calculated Volume (mL)	Desiccation Factor	Eggshell Thickness (mm)	Eggshell Mass (g)	Ratcliffe Index
ME002-0301	Androscoggin Lake, Leeds	Inland/Lacustrine	6/5/2003	115.0	77.6	55.0	101.0	123.9	0.815	0.506	11.6	2.72
ME002-0701	Androscoggin Lake, Leeds	Inland/Lacustrine	6/19/2007	123.3	75.4	58.1	105.6	128.0	0.825	0.465	11.8	2.70
ME027-0901	Bartlett Island, Mount Desert	Coastal/Marine	6/16/2009	115.8	72.9	56.3	100.9	117.7	0.858	0.495	11.9	2.90
ME043-0901	Schoodic Island, Winter Harbor	Coastal/Marine	6/14/2009	120.6	76.0	58.8	102.6	131.4	0.781	0.570	14.6	3.27
ME052-1001	Inner Goose Island, Addison	Coastal/Marine	6/2/2010	98.0	72.3	53.3	82.1	108.4	0.757	0.575	12.8	3.32
ME052-1002	Inner Goose Island, Addison	Coastal/Marine	6/2/2010	99.3	74.0	53.2	83.8	111.5	0.751	0.562	12.8	3.25
ME056-1001	Little Ram Island, Roque Bluffs	Coastal/Marine	6/2/2010	96.1	75.2	56.1	80.5	121.9	0.660	0.510	12.5	2.97
ME075-0301	Brandy Pond, T39 MD	Inland/Lacustrine	6/6/2003	106.1	70.6	56.4	86.7	113.1	0.766	0.588	13.9	3.49
ME075-0302	Brandy Pond, T39 MD	Inland/Lacustrine	6/6/2003	114.4	70.9	56.5	95.7	114.1	0.839	0.616	13.0	3.25
ME075-0401	Brandy Pond, T39 MD	Inland/Lacustrine	5/10/2004	110.3	68.8	56.0	94.2	108.5	0.868	0.471	12.4	3.22
ME075-0501	Brandy Pond, T39 MD	Inland/Lacustrine	6/14/2005	121.7	74.7	58.4	102.4	127.3	0.805	0.598	15.3	3.51
ME081-0501	West Grand Lake, Pukakon TWP	Inland/Lacustrine	7/11/2005	141.7	75.4	60.3	123.6	134.1	0.921	0.566	14.4	3.17
ME083-0401	Tomah Stream, Codyville Plt	Inland/Riverine	6/23/2004	121.1	74.1	58.9	102.5	127.5	0.804	0.461	11.4	2.61
ME083-0501	Tomah Stream, Codyville Plt	Inland/Riverine	6/8/2005	115.8	77.1	56.7	100.8	127.6	0.790	0.424	10.7	2.45
ME089-0201	Debsconeag Deadwater, T1 R9 WELS	Inland/Lacustrine	7/3/2002	123.0	73.3	57.8	107.0	122.6	0.873	0.563	13.5	3.19
ME089-0202	Debsconeag Deadwater, T1 R9 WELS	Inland/Lacustrine	7/3/2002	125.0	73.7	58.6	108.0	125.8	0.859	0.572	13.9	3.22
ME095-0401	Penobscot River, Passadumkeag	Inland/Riverine	5/19/2004	120.3	74.4	57.4	102.0	124.0	0.823	0.543	13.5	3.16
ME095-0402	Penobscot River, Passadumkeag	Inland/Riverine	5/19/2004	122.8	76.0	57.0	105.5	126.1	0.837	0.536	13.2	3.05
ME141-0601	Quakish Lake, T3 Indian Purchase	Inland/Lacustrine	6/6/2006	104.0	70.6	55.6	89.3	111.0	0.805	0.515	11.8	3.01
ME141-0602	Quakish Lake, T3 Indian Purchase	Inland/Lacustrine	6/6/2006	100.7	68.8	55.4	86.5	106.9	0.809	0.494	11.2	2.94
ME141-0701	Quakish Lake, T3 Indian Purchase	Inland/Lacustrine	6/11/2007	107.3	71.2	56.0	92.3	113.4	0.814	0.536	11.9	2.98
ME141-0702	Quakish Lake, T3 Indian Purchase	Inland/Lacustrine	6/11/2007	102.9	69.8	56.1	87.6	110.6	0.792	0.509	11.7	2.99
ME149-0401	Penobscot River, Chester	Inland/Riverine	6/16/2004	93.4	71.0	54.3	77.9	108.5	0.718	0.578	12.4	3.22
ME149-0701	Penobscot River, Chester	Inland/Riverine	5/4/2007	106.7	74.5	55.3	90.9	118.2	0.769	0.559	12.9	3.13
ME149-0702	Penobscot River, Chester	Inland/Riverine	5/4/2007	116.7	75.3	55.1	100.3	119.5	0.840	0.484	11.1	2.68
ME154-0701	Penobscot River, Mattamiscontis	Inland/Riverine	5/4/2007	120.4	71.0	58.1	104.4	118.6	0.881	0.568	13.4	3.25
ME155-0901	Hog Island, Bremen	Coastal/Marine	4/11/2009	122.5	72.8	57.1	109.9	119.6	0.919	0.430	10.3	2.48
ME156-0701	Flagstaff Lake, Flagstaff TWP	Inland/Lacustrine	5/31/2007	114.9	71.7	57.6	99.8	118.6	0.841	0.493	11.6	2.81
ME161-0401	Boyden Lake, Perry	Inland/Lacustrine	6/4/2004	120.0	75.3	57.3	102.6	125.5	0.818	0.622	13.3	3.09
ME172-0801	Passadumkeag River, Lowell	Inland/Riverine	7/15/2008	108.7	76.0	56.0	92.7	123.3	0.752	0.554	13.0	3.06
ME176-0501	Mattamiscontis Lake, T3 R9 NWP	Inland/Lacustrine	6/13/2005	124.3	78.3	56.4	109.2	129.4	0.844	0.503	12.3	2.79

Table A-1 (continued). Collection information and metrics of Maine bald eagle eggs

USFWS Sample #	Territory Location, Township	Habitat/ Sub-habitat	Collection Date	Total Egg Mass (g)	Length (mm)	Mean Breadth (mm)	Egg Content Mass (g)	Calculated Volume (mL)	Desiccation Factor	Eggshell Thickness (mm)	Eggshell Mass (g)	Ratcliffe Index
ME184-0001	Penobscot River, Argyle	Inland/Riverine	6/28/2000	113.0	72.5	56.1	95.0	116.4	0.816	0.574	13.0	3.20
ME184-0002	Penobscot River, Argyle	Inland/Riverine	6/28/2000	123.0	75.2	57.5	106.0	126.0	0.841	0.596	14.2	3.28
ME184-0401	Penobscot River, Argyle	Inland/Riverine	5/19/2004	120.4	72.0	57.3	99.8	118.7	0.841	0.607	14.5	3.51
ME184-0402	Penobscot River, Argyle	Inland/Riverine	5/19/2004	93.2	74.0	56.9	74.0	121.6	0.608	0.581	14.8	3.52
ME185-1101	Brassua Lake, Sandwich Academy Grant	Inland/Lacustrine	6/5/2011	85.2	71.5	54.8	72.6	110.7	0.656	0.479	11.0	2.81
ME186-0601	Gero Island, Chesuncook TWP	Inland/Lacustrine	6/29/2006	99.6	70.7	53.8	84.3	106.4	0.792	0.570	11.5	3.03
ME199-0001	Penobscot River, Brewer	Coastal/Estuarine	6/28/2000	44.0	71.9	53.9	28.0	109.3	0.256	0.595	13.3	3.43
ME224-1001	Cape Wash Island, Cutler	Coastal/Marine	6/16/2010	109.6	77.5	59.9	90.3	137.7	0.656	0.583	15.2	3.28
ME224-1002	Cape Wash Island, Cutler	Coastal/Marine	6/16/2010	126.7	73.4	56.6	108.0	119.5	0.904	0.501	11.8	2.84
ME240-1101	Tibbet Island, Boothbay	Coastal/Marine	6/9/2011	103.8	73.5	56.7	86.6	120.1	0.721	0.585	12.2	2.93
ME252-0501	Richardson Lake, Richardsontown TWP	Inland/Lacustrine	6/10/2005	104.7	72.1	53.6	90.5	108.8	0.831	0.502	10.4	2.69
ME262-0701	Kennebec River, Sidney	Inland/Riverine	6/18/2007	114.0	70.6	56.4	98.0	113.1	0.867	0.543	12.4	3.12
ME262-0801	Kennebec River, Sidney	Inland/Riverine	5/19/2008	105.2	71.6	56.5	84.7	115.7	0.732	0.579	12.7	3.14
ME267-0901	Bois Bubert Island, Milbridge	Coastal/Marine	5/13/2009	78.5	65.4	50.7	69.4	88.3	0.786	0.410	7.6	2.29
ME274-0201	Gulf Island Pond, Greene	Inland/Lacustrine	4/18/2002	128.0	73.3	57.9	115.0	122.9	0.936	0.494	11.6	2.74
ME277-0501	Penobscot River, Old Town	Inland/Riverine	6/9/2005	98.4	74.9	51.8	82.7	109.5	0.755	0.601	12.9	3.32
ME277-0901	Penobscot River, Old Town	Inland/Riverine	5/6/2009	110.8	75.0	53.2	95.0	113.5	0.837	0.596	13.1	3.28
ME280-1101	Moosehead Lake, T1 R1 NBKP	Inland/Lacustrine	6/7/2011	119.3	77.7	56.8	99.3	129.2	0.769	0.622	15.5	3.52
ME289-0001	Dolby Pond, Millinocket	Inland/Lacustrine	6/28/2000	118.0	75.2	55.6	100.5	120.7	0.825	0.562	13.3	3.18
ME289-0401	Dolby Pond, Millinocket	Inland/Lacustrine	6/14/2004	117.5	70.9	57.2	102.4	116.0	0.883	0.494	11.9	2.93
ME289-0701	Dolby Pond, Millinocket	Inland/Lacustrine	6/11/2007	110.5	74.7	58.7	93.6	128.3	0.730	0.548	13.2	3.01
ME304-0601	Penobscot River, Edinburgh	Inland/Riverine	4/28/2006	112.2	71.8	55.2	98.2	112.5	0.873	0.568	12.4	3.13
ME305-1001	Chemo Pond, Eddington	Inland/Lacustrine	5/27/2010	135.6	79.6	60.0	118.1	142.7	0.828	0.492	13.9	2.91
ME317-0701	Lower Togus Pond, Augusta	Inland/Lacustrine	5/25/2004	157.7	81.8	62.0	136.4	153.9	0.886	0.489	14.2	2.80
ME325-0501	Penobscot River, Winterport	Coastal/Estuarine	6/15/2005	91.0	73.2	56.3	79.0	118.3	0.668	0.680	16.1	3.91
ME325-1201	Penobscot River, Winterport	Coastal/Estuarine	4/17/2012	126.7	74.2	59.0	112.1	128.0	0.876	0.544	13.5	3.08
ME325-1202	Penobscot River, Winterport	Coastal/Estuarine	4/17/2012	119.4	73.8	57.5	103.1	123.0	0.838	0.518	12.3	2.90
ME325-1203	Penobscot River, Winterport	Coastal/Estuarine	4/17/2012	122.2	74.5	58.1	107.1	126.2	0.849	0.510	12.4	2.86
ME333-0801	Annabessacook Lake, Monmouth	Inland/Lacustrine	5/16/2008	124.9	74.2	58.4	108.6	126.2	0.861	0.527	13.1	3.03
ME336-0401	Quantabacook Lake, Searsmont	Inland/Lacustrine	5/26/2004	93.0	69.3	56.2	76.2	109.8	0.694	0.617	13.4	3.44
ME336-0402	Quantabacook Lake, Searsmont	Inland/Lacustrine	5/26/2004	106.8	73.4	56.2	90.0	118.4	0.760	0.600	13.3	3.23

Table A-1 (continued). Collection information and metrics of Maine bald eagle eggs

USFWS Sample #	Territory Location, Township	Habitat/ Sub-habitat	Collection Date	Total Egg Mass (g)	Length (mm)	Mean Breadth (mm)	Egg Content Mass (g)	Calculated Volume (mL)	Desiccation Factor	Eggshell Thickness (mm)	Eggshell Mass (g)	Ratcliffe Index
ME336-0701	Quantabacook Lake, Searsmont	Inland/Lacustrine	6/7/2007	104.7	72.3	56.7	88.7	117.5	0.755	0.579	13.2	3.22
ME336-0702	Quantabacook Lake, Searsmont	Inland/Lacustrine	6/7/2007	89.5	67.5	54.8	74.3	102.7	0.724	0.572	11.8	3.19
ME365-0801	Pond in the River, Township C	Inland/Lacustrine	6/11/2008	118.6	78.2	57.6	100.2	132.6	0.756	0.599	15.4	3.42
ME369-0201	Green Lake, Ellsworth	Inland/Lacustrine	6/10/2002	126.0	72.9	57.3	96.0	120.5	0.797	0.486	11.8	2.82
ME369-0801	Green Lake, Ellsworth	Inland/Lacustrine	5/19/2008	113.3	70.3	56.5	96.6	112.9	0.856	0.534	12.1	3.05
ME371-0201	Western Island, Deer Isle	Coastal/Marine	6/4/2002	101.0	75.4	58.1	89.0	128.0	0.696	0.467	11.0	2.51
ME392-0601	Hermon Pond, Hermon	Inland/Lacustrine	6/5/2006	129.6	76.8	58.1	109.4	131.1	0.834	0.647	14.9	3.34
ME397-0601	Pleasant Pond, Litchfield	Inland/Lacustrine	5/22/2006	87.0	72.8	58.7	67.7	124.0	0.546	0.567	13.3	3.11
ME404-0601	Washington Pond, Washington	Inland/Lacustrine	5/25/2006	110.2	77.9	55.3	95.2	125.2	0.760	0.517	12.4	2.88
ME407-0701	Sabattus Pond, Greene	Inland/Lacustrine	5/9/2007	139.8	75.3	60.5	122.3	134.5	0.909	0.535	14.3	3.14
ME407-0801	Sabattus Pond, Greene	Inland/Lacustrine	5/21/2008	123.3	76.5	58.2	104.6	130.6	0.801	0.552	13.7	3.08
ME407-0802	Sabattus Pond, Greene	Inland/Lacustrine	5/21/2008	126.0	75.0	59.6	105.5	131.4	0.803	0.622	15.6	3.49
ME412-0501	Androscoggin River, Jay	Inland/Riverine	6/10/2005	106.8	69.1	56.5	92.1	110.2	0.836	0.502	11.1	2.85
ME412-0502	Androscoggin River, Jay	Inland/Riverine	6/10/2005	86.0	71.7	55.4	76.6	112.7	0.680	0.540	11.6	2.92
ME412-0701	Androscoggin River, Jay	Inland/Riverine	6/12/2007	126.5	75.5	57.6	110.4	126.9	0.870	0.545	13.1	3.01
ME412-0702	Androscoggin River, Jay	Inland/Riverine	6/12/2007	94.1	68.7	54.5	79.7	104.4	0.764	0.524	11.2	2.99
ME436-0501	Long Pond, Jackman	Inland/Lacustrine	6/21/2005	76.1	66.1	50.9	66.4	90.2	0.736	0.455	9.6	2.85
ME439-0401	Pemadumcook Lake, T1 R10 WELS	Inland/Lacustrine	7/7/2004	86.0	74.0	55.3	67.8	117.2	0.578	0.621	13.4	3.28
ME443-0601	Seven Mile Island, Vassalboro	Inland/Riverine	5/31/2006	126.5	74.7	58.1	105.1	126.7	0.829	0.581	14.8	3.41
ME443-0701	Seven Mile Island, Vassalboro	Inland/Riverine	6/8/2007	115.8	73.9	57.4	82.0	122.9	0.667	0.572	15.5	3.66
ME443-0901	Seven Mile Island, Vassalboro	Inland/Riverine	5/26/2009	132.7	78.2	57.6	114.3	132.7	0.861	0.513	14.2	3.15
ME491-0601	Kennebec River, Winslow	Inland/Riverine	6/1/2006	120.3	75.5	57.2	105.2	125.8	0.836	0.518	12.2	2.82
ME491-0701	Kennebec River, Winslow	Inland/Riverine	5/25/2007	130.8	76.0	58.8	110.6	131.4	0.842	0.453	13.1	2.94
ME498-0701	Penobscot River, Medway	Inland/Riverine	6/22/2007	135.3	76.3	58.0	117.5	129.8	0.905	0.559	13.6	3.07
ME509-0901	Kennebec River, Bingham	Inland/Riverine	6/16/2009	113.4	75.1	57.5	94.7	125.6	0.754	0.605	15.2	3.52
ME510-1201	Androscoggin River, Lewiston	Inland/Riverine	6/1/2012	82.7	75.5	55.8	66.1	121.7	0.543	0.599	13.7	3.25
ME562-1101	Androscoggin River, Durham	Inland/Riverine	6/29/2011	98.3	71.9	55.8	83.4	114.3	0.729	0.519	11.4	2.84
ME586-0901	Androscoggin River, Mexico	Inland/Riverine	6/3/2009	110.3	72.3	55.5	94.8	114.2	0.830	0.539	12.8	3.19
ME591-0901	Messalonskee Lake, Oakland	Inland/Lacustrine	6/3/2009	105.2	71.8	55.0	88.5	112.0	0.790	0.591	13.4	3.39

Notes:

Volume = 3.73*Mean Breadth*Length – 35.3 (Stickel *et al* . 1973)
Desiccation Correction Factor = Weight * Volume $^{-1}$ (adapted from Best *et al* . 2010).
Ratcliffe Index = Eggshell Mass (mg) / Egg Length (mm) * Egg Breadth (mm) (Ratcliffe 1970)
ME199-0001 was not included in the calculation of the mean for total egg mass, egg content mass, and desiccation factor.
ME289-0001 exploded and lost material during processing. Most of the material was recovered, but the egg content mass and desiccation factor should be considered estimates.