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REPORT

An Inventory of Precontact Burial Mounds of Iowa

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A long-term project to map and catalog all precontact Native American burial mounds in Iowa provides information about the number, location, form, survivorship, and rate of loss of mounds. This analysis reveals previously undocumented mound manifestations, including a large cluster of 200 linear mounds along the central Des Moines River valley. Historical records reveal that at least 7,762 mounds were identified at 1,551 sites in Iowa between 1840 and the present. About 47% of the mounds from these sites can be possibly seen in lidar, with 33% of the total clearly seen in lidar. Data show that mound loss over time is linear. Extrapolation of data suggests that at least 15,000–17,000 mounds stood in Iowa in the nineteenth century, but the actual number was likely higher.

Un proyecto a largo plazo para mapear y catalogar todos los túmulos funerarios de los nativos americanos previos al contacto en Iowa que proporciona información sobre el número, la ubicación, la forma, la supervivencia y la tasa de pérdida de túmulos. Este análisis revela manifestaciones de túmulos previamente no documentados, incluyendo un gran conjunto de 200 túmulos lineales a lo largo del valle central del río Des Moines. Los registros históricos revelan que al menos 7,762 túmulos fueron identificados en 1,551 sitios en Iowa entre 1840 y el presente. El análisis del mapa lidar indica que aproximadamente el 47% de los túmulos de estos sitios se pueden ver posiblemente en lidar, y el 33% del total se ve claramente en lidar. Los datos muestran que la pérdida de túmulos con el tiempo es lineal. La extrapolación de los datos sugiere que al menos 15,000-17,000 túmulos existieron en Iowa en el siglo XIX, pero el número real probablemente era más alto.

Keywords: burial mounds; GIS; mound survivorship

Palabras clave: túmulos funerarios; GIS; pérdida de túmulos

Burial mounds were once widespread throughout eastern North America, but most were damaged or destroyed by postcontact settlement activities. Yet the number of mounds that originally existed or survive is largely unknown and untracked in most regions. Recent improvements in GIS data management and the greater ease of searching digitized archives yield more accurate estimates of the minimum number of mounds identified in Iowa since 1840 (Figure 1). This data, when compared with recent high-resolution lidar mapping, allows for estimation of mound survivorship, as well as the extrapolation of data to estimate the number of lost mounds.

In Iowa, precontact burial mounds typically date to the Woodland and Late Prehistoric periods, but some examples date to the terminal Late Archaic or the protohistoric periods (Alex 2000:79–129). Midwestern mounds are typically divided into categories by shape (Birmingham and Rosebrough 2017:6–12). Conical mounds—round or somewhat oval earthen rises—are the most common form. Linear mounds are generally straight with a length greater than twice their width. A compound mound comprises two or more connected mounds, usually alternating conical and linear mounds. An effigy mound is shaped like an animal or mythical creature. Other mound shapes are very rare;

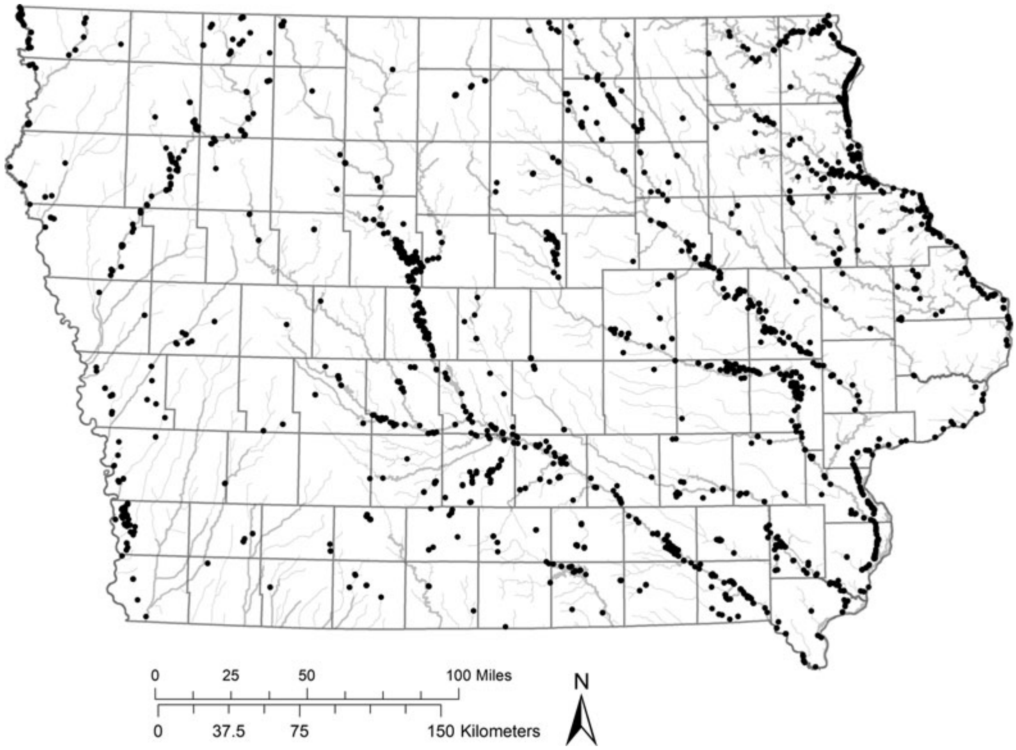

Figure 1. All recorded mound sites in Iowa.

in Iowa there is one cruciform mound and one ring mound (13HA30 and 13AM321, respectively, in Office of the State Archaeologist [OSA] 1961–2003). Other earthworks such as village or ceremonial enclosures are known in Iowa (Whittaker and Green 2010), but they are not included in this analysis because they typically did not contain burials. There are no Mississippian platform or rectangular mounds documented in Iowa, but they are recorded in adjacent states (e.g., Birmingham and Rosebrough 2017:10–13).

Archival Research

For this project, I collected data from a wide range of sources about the location, number, and types of mounds, as well as the year of first recordation (Supplemental Appendix I). The Iowa Site File paper forms of the Iowa Office of the State Archaeologist (OSA 1961–2003), the OSA digital site forms after 2002, and the archives of significant early Iowa mound researchers were consulted (for the full list of sources, see OSA 2011–2023); a full discussion of historic mound evaluation is included in Whittaker (2023). The limitations of collecting and analyzing large volumes of historical mound data were discussed in detail by Arzigian and Stevenson (2003:47–56) in their analysis of Minnesota sites. Their observations hold true for the Iowa data: the quality of historical data ranges widely, from detailed survey maps of individual mounds to passing mentions of vaguely recalled possible mound groups made decades after their destruction.

Historical records can provide data both about the shape of mounds expected at a site and their number. For records in which mound shape was not specified, I coded the mound as conical, by far the most common mound shape—with the expectation that if the mounds were unusual they would be noted as such. I tallied sites that are recorded only as “mounds” or “mound group” as two conical mounds, the minimum number of mounds and the most likely mound shape. When a range of mound counts was given, the highest number was counted.

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Because of the low numbers of mounds noted between 1840 and 1869, those were combined with the 1870s in my analysis of the decades in which mounds were reported. In the 1840s, 57 mounds were recorded from three sites; in the 1850s, three mounds from two sites; and in the 1860s, 20 mounds from two sites. In contrast, in the 1870s, 355 mounds were recorded from 43 sites.

Mapping and Checking Mound Data

The 2020 statewide lidar survey conformed to then-current US Geological Survey (USGS) 3DEP specifications, with typical vertical accuracy better than 6 cm $RMSD_z$ and typically more than two measurements per m^2 (US Geological Survey 2019). This level of accuracy and thoroughness exceeds what can be practically done with in-field EDM survey systems (e.g., Whittaker and Tiffany 2021), and these data far exceeded the quality of the earlier lidar data and even field maps, showing more mounds at far higher resolution and accuracy (Figure 2; Iowa State University Geographic Information Systems Support and Research Facility [ISUGISSRF] 2023; Office of the Chief Information Officer 2023). In addition to hillshade maps, ISUGISSRF (2023) also provides interactive digital elevation models (DEMs), in which any view is shaded by the relative elevation of all 1 m DEM grid points. This means that, as one gets closer to a possible mound, it is possible to see whether the model projects it as a true rise with slopes on all sides. If a rise had discernible slopes on all sides that clearly break with surrounding topography, it was coded as a clear mound. If it was ambiguous, it was coded as a possible mound. Examples of ambiguity include rises with slight slopes in all directions from a center point, which gradually fade into surrounding topography; rises that look badly distorted but occurred where historical records suggested a mound should be; or rises on slopes in which the summit is not clearly discernible from the natural upslope. Clear mounds were also coded by apparent damage: no observed damage, less than half the mound damaged or distorted, or more than half damaged or distorted. Mounds were coded by shape, including conical, linear, effigy, compound, and other. Aboveground earthworks, such as village enclosures, were placed in the "other" category and so were not included in this study. Possible mounds near existing mound site boundaries were considered part of the existing site if they were on the same landform. The results are shown in Supplemental Appendix I.

Occasionally, lidar imagery revealed more mounds than were originally recorded (Figure 2). Experiments with using raw LAS data to create better DEM maps of sites, following the method discussed by Whittaker (2020), proved fruitless, because the quality of USGS 3DEP processing and filtering performed on the 2020 hillshade and DEM defaults was superior to the processing available in common GIS programs like ArcMap and ArcScene.

Mound Distribution

This study identified previously unknown aspects of mound distribution in Iowa (Supplemental Figures 1–5). For example, by mapping all effigy mounds, it detected a geographic break in their forms: all effigy mounds north of Guttenberg were shaped like a bear or raptor, and all those to the south were a mix of other effigy forms (Whittaker and Collins 2022).

A second, newly discovered mound distribution pattern emerged in central Iowa. Two clusters of linear mounds were identified: a large cluster of approximately 200 linear mounds along 40 km of the Des Moines River and a smaller cluster of about 65 in seven sites in Hardin County along 11 km of the Iowa River (Whittaker 2022). Neither of these clusters had been fully recognized in the archaeological literature. Limited archaeological evidence suggests that the Des Moines River linear cluster is associated with the Late Woodland transition to Great Oasis, a regional manifestation of large-scale Plains–Midwest shifts to village life occurring around 1000 BP (Whittaker 2022).

Calculating Mound Survivorship

Table 1 presents a summary of all the mounds expected based on historical research and how they are seen in lidar. In Iowa, 7,762 mounds were historically recorded, or 0.138 mounds identified per square mile; this figure is nearly identical to the 0.137 mounds identified per square mile in Minnesota, where Arzigian and Stevenson (2003:63–64) noted 11,868 mounds. Conical mounds make up the vast

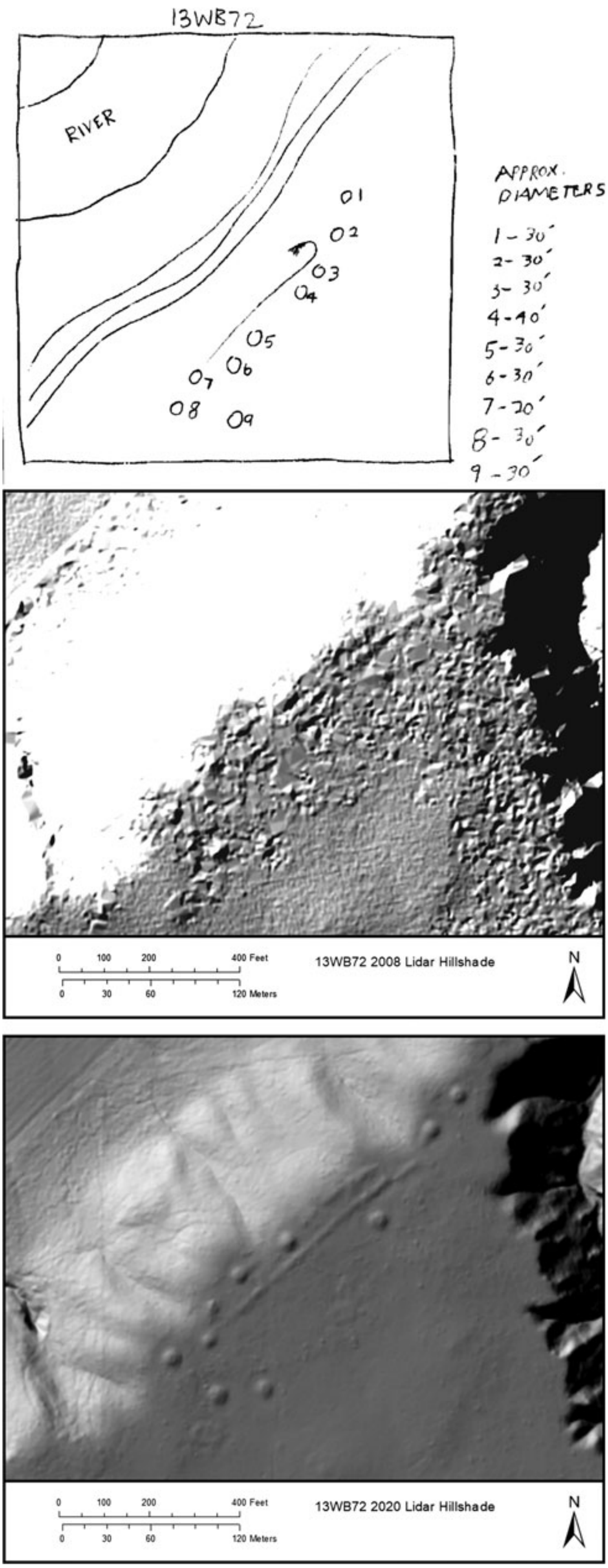

Figure 2. Example site 13WB72. Upper: Richard Flanders's 1962 sketch map in the Iowa Site File (OSA 1961–2003); middle: site area in 2008 lidar hillshade; lower: site seen in 2020 lidar hillshade (ISUGISSRF 2023).

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Table 1. Summary of Mounds of Iowa.

Shape	Historically Identified	%	Possibly in Lidar	%	Clear in Lidar	%	Undamaged	%
Conical	6,567	84.6	3,085	47.0	2,103	32.0	1,406	21.4
Linear	790	10.2	455	57.6	370	46.8	302	38.2
Effigy	373	4.8	56	15.0	56	15.0	51	13.7
Compound	32	0.4	26	81.3	26	81.3	16	50.0
Total	7,762	100.0	3,622	46.7	2,555	32.9	1,775	22.9

majority of mounds in Iowa, both in historically identified (85%) records and as observed in lidar. Although there are significantly fewer linear and compound mounds, they have higher rates of survivorship. Effigy mounds have the lowest rates of survivorship.

I wanted to use mound survivorship to determine the rate at which mounds were lost and then to project this data backward to estimate the number of mounds lost before they had even been noted. Of crucial interest is the rates at which mounds are lost over time. I assumed that survivorship would be exponential, with the rate of loss being rapid during the early decades of non-Native settlement and then decreasing in recent years.

At first, I looked at survivorship by decade (Figure 3; Table 2). Figure 4 presents all possible mounds seen in 2020 lidar by each decade. These data show a trend of increased survivorship over time. However, neither linear ($R^2 = 0.61$) nor exponential ($R^2 = 0.64$) trendlines are statistically significant. The two trendlines were close to each other, both visually and statistically, suggesting that survivorship is not exponential over time.

The lack of R^2 significance is due to the idiosyncrasies of survivorship. Although mound loss is necessarily cumulative over time, within each decade large sites can skew survivorship. For example, the Sny Magill Mound Group (13CT18) was first mapped in 1885 and contains 95 mounds, now preserved as part of Effigy Mounds National Monument. In contrast, the Harpers Ferry Great Mound Group (13AM79) was first noted in 1892 and contained 922 mounds, now largely destroyed. Such cases play havoc with decade-based survivorship trendline significance.

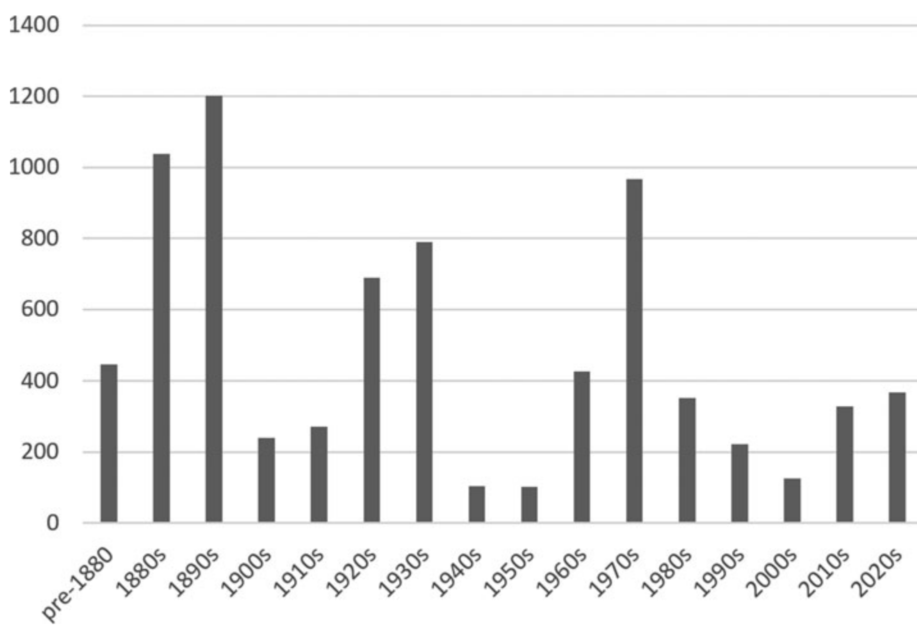

Figure 3. Mounds identified per decade.

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Table 2. Mounds Identified by Decade.

Decade	Sites	Mounds Identified	Mounds per Site	Possibly in Lidar	%	Clear in Lidar	%
Pre-1880	50	446	8.9	74	16.6	50	11.2
1880s	78	1,038	13.3	460	44.3	277	26.7
1890s	50	1,201	24.0	102	8.5	77	6.4
1900s	48	239	5.0	112	46.9	64	26.8
1910s	46	272	5.9	169	62.1	146	53.7
1920s	121	689	5.7	237	34.4	123	17.9
1930s	138	789	5.7	378	47.9	261	33.1
1940s	21	104	5.0	62	59.6	51	49.0
1950s	24	101	4.2	34	33.7	24	23.8
1960s	136	426	3.1	179	42.0	124	29.1
1970s	278	966	3.5	648	67.1	479	49.6
1980s	146	351	2.4	189	53.8	141	40.2
1990s	113	221	2.0	194	87.8	142	64.3
2000s	58	125	2.2	73	58.4	54	43.2
2010s	110	328	3.0	267	81.4	215	65.5
2020s	98	368	3.8	370	100.5	308	83.7
Keyes-Orr[a]	36	98	2.7	74	75.5	19	19.4
Total	1,551	7,762	5.0	3,622	46.7	2,555	32.9

[a]Charles Keyes and Ellison Orr did not clearly date their discovery of 36 mound sites, but their work was conducted between 1900 and 1945.

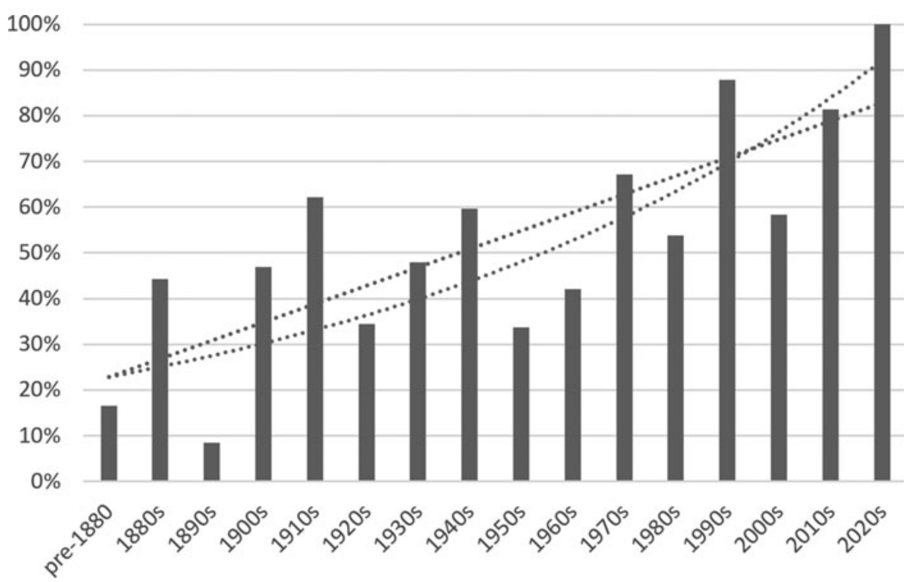

Figure 4. Percent of mounds possibly seen in lidar by decade identified. Linear trendline $R^2 = 0.6102$; exponential trendline $R^2 = 0.6359$.

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Table 3. Mounds Identified by Era.

Era	Mound Sites	Mounds Identified	Mounds per Site	Possibly in Lidar	%	Clear in Lidar	%
Pre-1900	178	2,685	15.1	636	23.7	404	15.0
1900–1959[a]	434	2,292	5.3	1,019	44.5	688	30.0
1960–2023	939	2,785	3.0	1,920	68.9	1,463	52.5
Total	1,551	7,762	5.0	3,575	46.1	2,555	32.9

[a]Includes Keyes-Orr sites from Table 2.

I decided to further combine data to obtain a statistically significant trendline and so determine whether loss was logarithmic. At least three data groupings are needed to determine whether a trendline is an exponential curve or a straight line, and grouping data would presumably even out the decade-to-decade idiosyncrasies. Indeed, there appeared to be natural breaks in the data that allow it to be divided into three roughly even eras (Table 3). Era 1, 1840–1900, is dominated by Lewis's surveys and early mound accounts. Era 2, 1900–1959, was dominated by Keyes and Orr's surveys. Era 3, 1960 to the present, is dominated by modern cultural resource management and lidar investigations. Each group contained roughly equal counts of mounds, and each era spanned about 60 years. This division also allowed the inclusion of 98 undated mounds recorded by Orr and Keyes at uncertain times during Era 2.

Grouping by era proved to be highly significant, as revealed by both linear ($R^2 = 0.9978$) and exponential ($R^2 = 0.9896$) trendlines (Figure 5). The trendlines disconfirm my initial assumption regarding survivorship and support the counterintuitive idea that survivorship is linear.

How Many Mounds Existed in Iowa?

Because survivorship is linear, it is reasonable to use survivorship to project backward and estimate how many mounds may have existed in the late nineteenth century. This can be done by comparing survivorship of those mounds possibly seen in lidar to those mounds clearly seen in lidar. If only 23.7% of mounds noted in the nineteenth century are possibly seen in 2020 lidar, and 3,575 total mounds

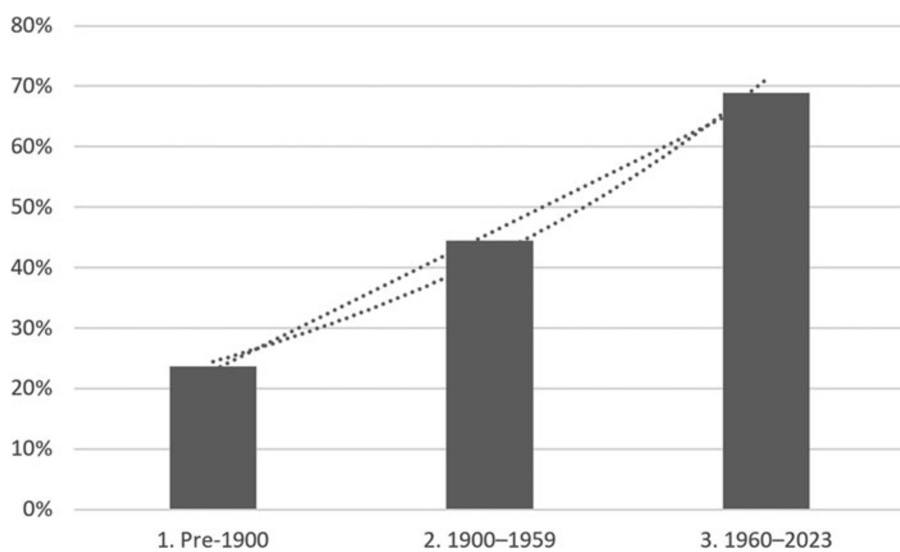

Figure 5. Percent of mounds possibly seen in lidar by era. Linear trendline $R^2 = 0.9978$; exponential trendline $R^2 = 0.9896$.

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were possibly seen in 2020 lidar (Table 1), this suggests that 15,084 mounds were present in the late nineteenth century. If only 15% of mounds noted in the nineteenth century are seen clearly in 2020 lidar, and 2,555 mounds are seen clearly in 2020 lidar, this suggests that 17,033 mounds were present in the nineteenth century.

The suggested range of 15,000–17,000 total mounds in Iowa seems highly plausible, given the historical evidence for 7,762 mounds; it is not a stretch to assume that only half the mounds that existed at the time of US settlement were ever historically noted.

These conservative Iowa tallies do not reflect the mounds lost to early settlement plowing. The total number of mounds in the nineteenth century was probably higher than 15,000–17,000, based on comparisons of mounds mapped by T. H. Lewis in modern agricultural fields in Iowa and those he mapped in Minnesota (Whittaker 2020). Using the Lewis data to further explore the possible numbers of mounds in Iowa, we can exit the realm of the statistically plausible and enter that of the educated guess. Comparisons of Lewis's Minnesota's data, collected when US settlement was still underway, and the Iowa data, collected when settlement was largely complete, suggest that about 50% of the mounds constructed in what are now agricultural fields in Iowa survived to be mapped by Lewis. Lewis mapped 21.9% of his mounds in Iowa in what are now agricultural fields (Whittaker 2020:17–18). If we extrapolate from the weak, nonrepresentative Lewis data that another 22% should be added to the high-end 17,000 estimate of mounds for Iowa, this suggests 20,700 mounds might have stood in Iowa.

Conclusion

This analysis is based on (1) high-volume data of variable quality, collected from hundreds of historical sources, and subject to multiple layers of interpretation and (2) lidar analysis, which can be subjective. It should not be used to make definitive proclamations about the precise number of burial mounds in Iowa or precontact population levels, but it does provide some estimations of the enormity of what was lost. Of the mounds that stood in Iowa in the mid-nineteenth century, whether it was 15,000 or 17,000 or even 20,700, only 1,775 of them appear clear and undamaged in the 2020 lidar: just 9%–12% of the total.

The most alarming conclusion of this analysis is that mound loss is linear over time. The apparent rate of mound destruction in Iowa is not slowing, despite their cultural and historical significance being appreciated for more than 150 years and their being legally protected in Iowa for 50 years (Pearson 2000). As high-resolution lidar data become widely available, I would recommend that similar projects be undertaken in other regions of North America. Sorting and compiling historically collected data on mounds and comparisons with lidar data can be arduous, but this tally, however imperfect, is edifying.

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Data Availability Statement. All data used in this report are available at the Iowa Office of the State Archaeologist.

Competing Interests. The author declares none.

Supplemental Material. For supplemental material accompanying this article, visit https://doi.org/10.1017/aaq.2023.49.

Supplemental Appendix I. Summary of All Mounds Sites.
Supplemental Figure 1. Distribution of conical mounds.
Supplemental Figure 2. Distribution of linear mounds.
Supplemental Figure 3. Distribution of linear mounds in central Iowa.
Supplemental Figure 4. Distribution of effigy mounds.
Supplemental Figure 5. Distribution of compound mounds.

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