INTEGRATED WETLAND—DRY LAND FEATURES WITH ASTRONOMICAL ASSOCIATIONS

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Introduction

This article has several objectives:

- It describes a new class of man-made landscape features that to my knowledge have not previously been identified in New England.
- It suggests that the culture responsible for the features possessed an interest in and a knowledge of astronomy.
- It demonstrates the value of Ground Penetrating Radar (GPR) for studying wetland features.

Chronology of Discovery

These features first came to the author's attention when examining aerial photographs of the land adjacent to Spencer Brook in Carlisle, Massachusetts. This land belongs to the town and the town was considering construction of subsidized housing units on it. The property has Indian ceremonial features on it and the construction was cause for concern to the Narragansett and Wampanoag Tribes. An informal group consisting of a professional archaeologist, a tribal historic preservation officer from the Narragansett Tribe, an avocational archaeologist and the author surveyed the area and prepared a report for the town (Harris et. Al. 2005). It was in the course of this study that the aerial photographs of the area were examined. Most of the aerial photographs studied and those presented in this article are from the MassGIS collection (www.mass.gov/mgis/) and were taken in 2001.

These photos showed linear features in the wetlands which were probably man-made. Such features are fairly common and are commonly thought to be drainage ditches. As this article shows, these are not all ditches, and some are aligned with certain astronomically interesting directions. It was then realized that some of them were collinear with stone rows and other features on the adjacent dry land. This led to a closer investigation, which could only be done when the wetlands were frozen. It was found that some are low mounds, which were made visible in the aerial photographs by differences in vegetation. Other segments could not be identified on the ground although they are apparent from the air. Others are ditches but do not have any apparent drainage function. To develop more understanding of the mounds, several of them were studied using Ground Penetrating Radar (GPR).

Methods

As noted above, the first recognition of the linear wetland features was through examination of aerial photographs. The photographs were analyzed by the Terrain Navigator Pro software package sold by MyTopo, Billings, Montana. This software allows distance and directions to be determined from topographic maps and downloadable aerial photographs. With one exception, the annotated aerial photographs in this article were created in Terrain Navigator with some post processing in Adobe Photoshop. The processing involved controlling contrast and adding annotations.

Orientations of certain features by ground measurements were determined with a Brunton sighting compass (precision ~ ± 1 degree). Ground measurements of distance were carried out with surveyor's tapes and with a Leica Disto Model A5 precision laser distance meter (precision ~ ± 1 cm.). The locations of points on larger scale features were determined with a handheld Garmin GPS unit with a typical accuracy of 2-3 meters. Most of the GPS determined locations were refined by comparison with aerial photographs. The aerial photographs presented in this article are all looking vertically and are oriented with north at the top (with the exception of Figure 17 which is looking northwest on a slant).

Astronomical Concepts

As the title of the article suggests, these features are distinguished by associations with astronomical alignments. Careful inspection of the aerial photographs will reveal that there are linear features visible other than those discussed in this article. They are the subject of another investigation and will not be treated in this article.

Before discussing the details of the features, it seems appropriate to define the astronomical concepts associated with the features. All the features except one are aligned with the azimuths of the sunrise or sunset points on the horizon on significant days. The reciprocal directions of the solstice sunrises and sunsets are also solstice sunsets and sunrises. There are important astronomic events other than those listed here and there are also other constructions which may relate to astronomy. However, this article only considers the following directions:

- The winter solstice sunrise (azimuth approximately 123 degrees true)
- The summer solstice sunrise (azimuth approximately 58 degrees true)
- The sunrise and sunset on the equinox days (approximately 90 and 270 degrees)
- The sunset on August 12 (azimuth approximately 290 degrees true)
- The sunrise on August 13 (azimuth approximately 70 degrees true)
- A line parallel to the Milky Way when it is passing through the zenith at the time of the winter solstice (the line is along the 140-320 degree axis.)

The sunrise and sunset directions are accurate to approximately one degree depending on atmospheric conditions and terrain. The Sun appears to be ½ degree across. At this latitude the apparent direction of the Sun's contact with the horizon will be shifted about one degree for every degree of elevation of the horizon. For very low horizons atmospheric refraction plays a role in the apparent position of the Sun. The Milky Way is much less precisely defined. The winter Milky Way appears to be between 15 and 30 degrees wide depending on how ambient lighting conditions affect perceptions. The directions in this article refer to the center line which has an uncertainty of approximately ±5 degrees but is not dependent on horizon elevation.

The solstice and equinox alignments are well known and are important to cultures across most of North America (Aveni 2001, Williamson 1984). An example is the Nikkomo Celebration held in New England by the Narragansett and Nipmuc Tribes around the winter solstice. The other directions may require some elaboration. The sunset and sunrise around August 12 and also on May 1 are widely marked by alignments in Mesoamerica (Aveni 2001, Malmstrom 1996). The entire city of Teotihuacan, the greatest Mesoamerican ceremonial center, is aligned to the sunset at that time. The dates August 12 and May 1 are 260 days apart and are intimately involved in the 260-day calendar used by Mesoamericans for thousands of years and still in use in certain areas (Tedlock 1982). It is less well known that these are important dates north of Mesoamerica as well. An early 19th Century star chart in the Field Museum in Chicago is attributed to the Skidi Pawnee. It has been interpreted as showing the sky on the night of August 12-13 (Leonard 1987, Chamberlain 1982, Murie 1981). Important ceremonies are held near these dates by modern tribes in the Northeast and are part of an ancient tradition (www.narragansett-tribe.org). There are numerous structures aligned with both the sunrise and sunset on these days in New England (Fohl and Leonard 2006). It should be noted that areas in the vicinity of the wetlands discussed in this article have astronomically aligned features also (Harris et. al. 2005).

The directions of the Milky Way when it passes directly overhead form a cross which divides the sky into quadrants (not simultaneously but at two times of the year: winter and summer) according to South American beliefs (Sullivan 1996). In the winter, around the winter solstice, the line runs roughly 140-320 degrees. In the summer, around the middle of August, the line runs roughly 40-220 degrees. The Milky Way has been widely thought of as the pathway of souls by Indians all over the Americas (Lankford 2007). There are numerous features aligned with these directions in New England. An example is the Wampanoag Royal Cemetery in Lakeville, MA, whose boundaries are aligned with these two lines (Leonard 2009).

Overview of the Study Area

The wetland considered in this article surrounds Spencer Brook, a tributary of the Assabet River, on the border between the towns of Concord and Carlisle in eastern Massachusetts (Figure 1). Although not formally named it is referred to as Spencer Brook Swamp in this article. In colonial times it was called Fifty Acre Meadow (Lapham 1970, Donahue 2004, Shattuck 1835). It lies between South and West Streets in Carlisle to the west and a housing development on an esker to the east. There are four groups of wetland features outlined with white lines and designated as Features A, B, C, and D in Figure 1.

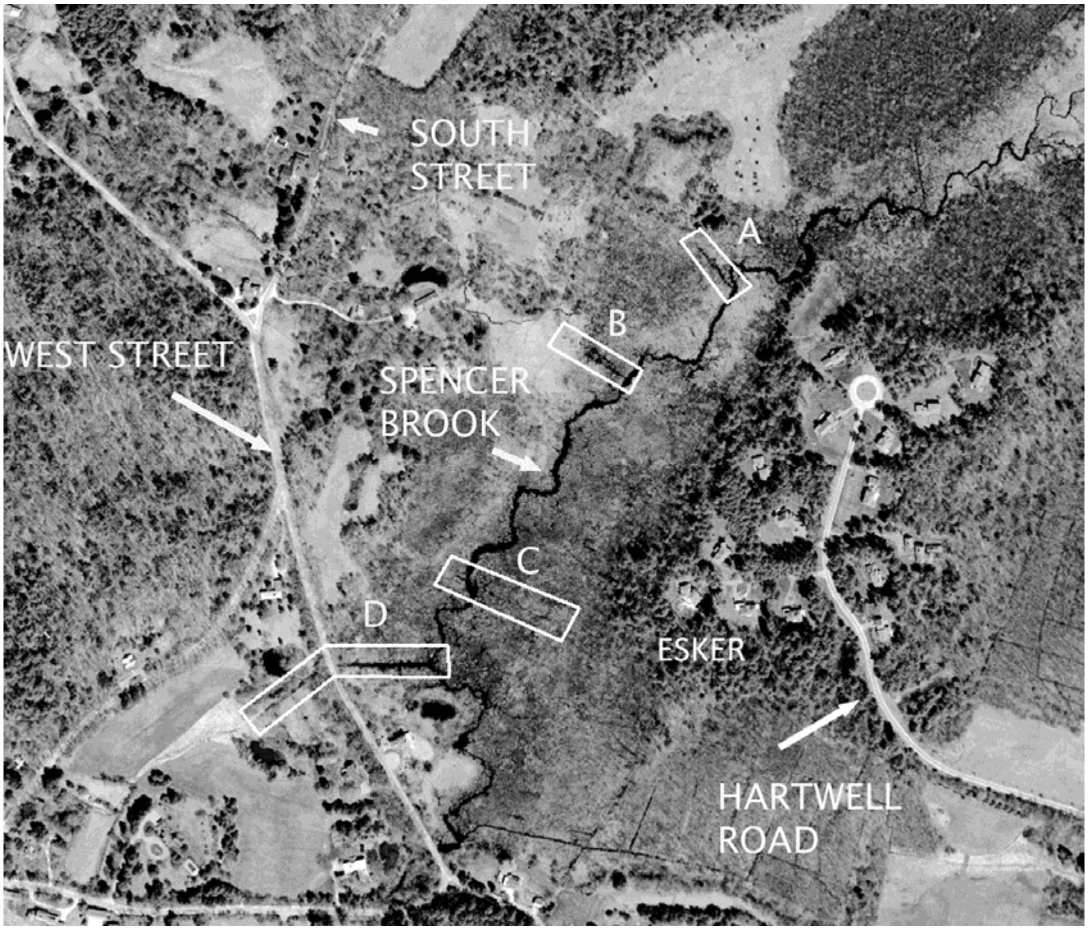

Figure 1. Aerial photograph of the study area in the Spencer Brook Swamp (Photograph from MassGIS via Terrain Navigator and annotated by T. Fohl)

The dry land features are shown as solid white lines in Figure 2. Lines in wetlands and between widely separated features on dry land are shown as dashed lines. Individual separated stones are indicated by white square dots. The dry land features are designated by numbers 1-7. These groups of features will be discussed in detail in the following sections.

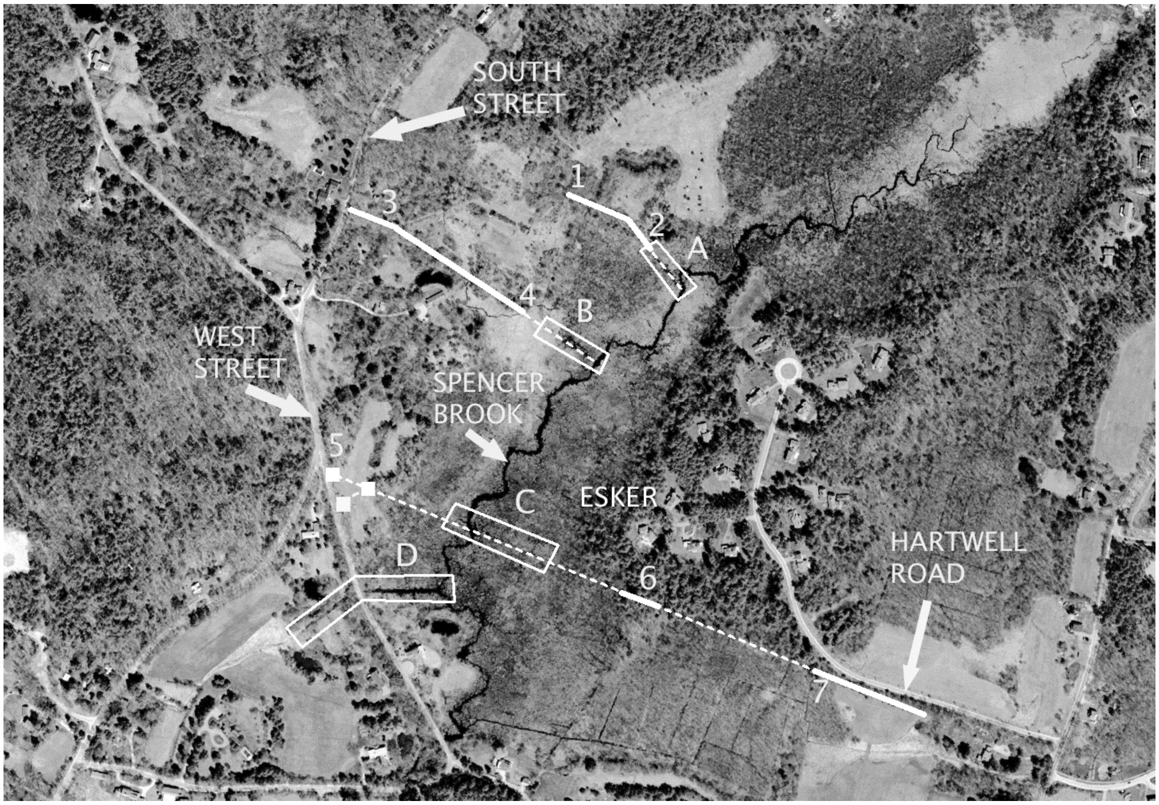

Figure 2. Overview of study area with features on dry land shown as solid white lines and square dots. (Photograph from MassGIS via Terrain Navigator and annotated by T. Fohl)

Wetland Features A and B

Details of the two northernmost wetland features, designated as A and B, are shown in Figure 3. The linear features are visible in the aerial photographs because of variations in vegetation on top of them. These variations are probably caused by the disturbance of the wetlands when the features were built. They appear to be lines of low mounds of earth with signs of ditching on either side. When covered by snow, the mounds of Feature B are seen to be about 30 centimeters high (Figure 4). The snow in the figure is of fairly uniform depth (approximately 15 centimeters) and it is assumed that the shape of the snow covered surface is similar to the shape of the surface of the snow.

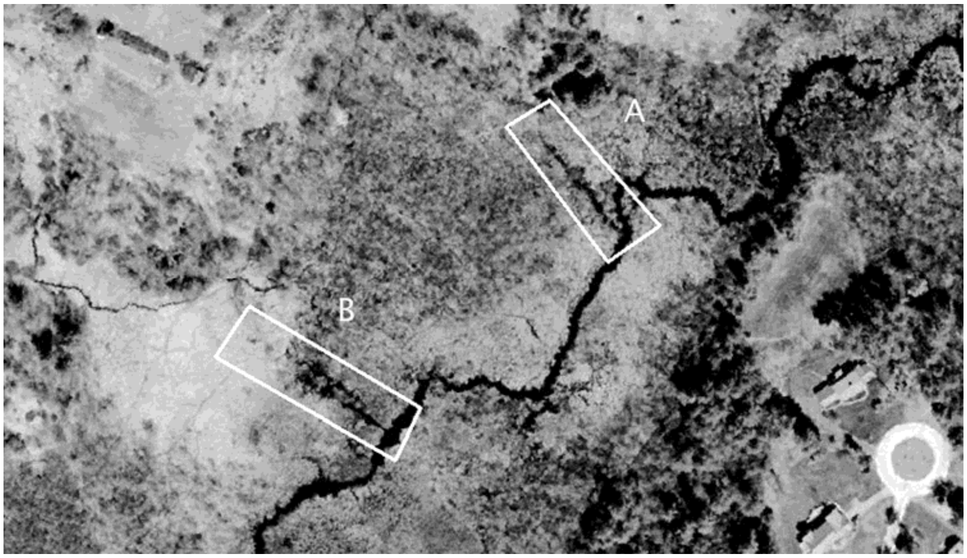

Figure 3. Detailed aerial photograph of features A and B (Photograph from MassGIS via Terrain Navigator and modified by T. Fohl)

Figure 4. Section of the row of mounds forming feature B. Arrows designate tops of mounds. (photograph by T. Fohl)

Wetland Feature A

Wetland Feature A is more or less continuous from Spencer Brook to near the edge of the wetland where it meets a collinear stone row that extends onto dry land (Figure 5), a distance of 79 meters. The row of mounds and the stone row are aligned with the winter Milky Way (140-320 degrees). The stone row continues in this direction for 35 meters to the top of a small knoll. At the top of the knoll the row meets another row that aligns with the August 12 sunset. This row continues for approximately 84 meters to a small wet area where it thins out and stops. The locations of these rows can be seen as solid lines in Figure 2 and are labeled as dry land Features 1 and 2, with Feature 2 being the stone row touching the Spencer Brook wetland.

Figure 5. Stone row (dry land Feature 2) ending in the wetland and connecting to wetland Feature A (photograph by T. Fohl)

Wetland Feature B

Wetland Feature B is apparently not continuous from Spencer Brook to the edge of the wetlands. It is a row of mounds which runs about 70 meters from Spencer Brook toward the edge of the wetlands leaving a clear distance between the mounds and the edge of the wetland of about 53 meters. It is, however, collinear with a stone row that ends in the wetland (Figure 6). This stone row (dry land Feature 4) runs along the edge of the wetland, through a stream and along a peninsula between two wet areas for 195 meters. This section of the stone row and the row of mounds in the wetland are aligned with the winter solstice sunrise (approximately 123 degrees). As can be seen in Figure 2, the row connects with another row (dry land Feature 3) that runs to the edge of South Street. This row is aligned with the August 12 sunset (approximately 290 degrees). It is 71 meters long.

Figure 6. End of stone row (dry land Feature 4) in wetland. It is collinear with wetland feature B. (photograph by T. Fohl)

Wetland Features C and D

There are two wetland features found in the southern section of Spencer Brook Swamp. They are labeled C and D in Figures 1, 2 and 7.

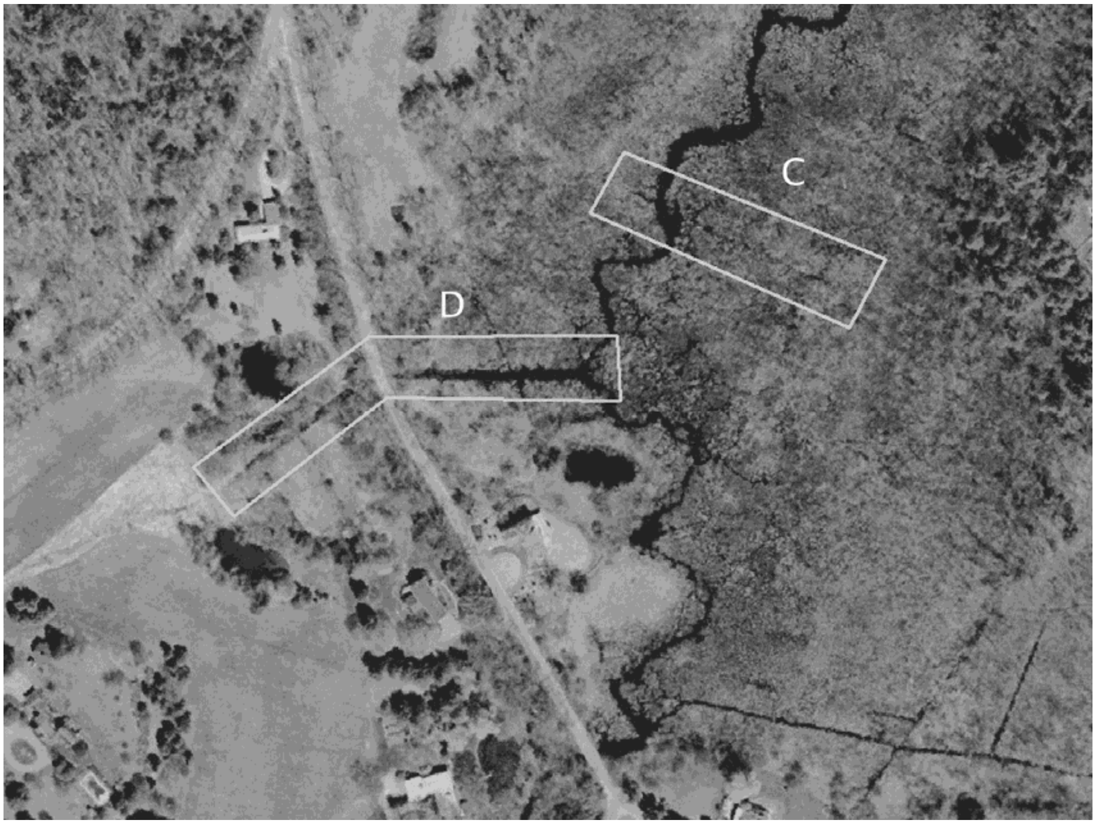

Figure 7. Detail view of aerial photograph showing linear features C and D. (Photograph from MassGIS via Terrain Navigator and annotated by T. Fohl)

Wetland Feature C

The first of two wetland features found in the southern section of Spencer Brook Swamp is labeled Feature C in Figures 1 and 2. Feature C is part of a rather complex set of features arrayed along a line that points toward the August 12 sunset. The following components of this line are discussed below, starting at the eastern end of the line:

- stone row ending in a two-rock pile: dry land Feature 7 in Figure 2 (length: 168 meters)
- earthen mound (length: 20 meters)
- ditch (length: 20 meters)
- stone row including horseshoe shaped array of stones: dryland Feature 6 in Figure 2 (length: 25 meters)
- ditch (length: 15 meters)
- wetland Feature C itself (length: 130 meters), and
- triangular array of large rocks: dry land Feature 5 in Figure 2

With the exception of the triangular array of rocks, these components of the line are obviously manmade.

Beginning at the southeastern end and following the line northwest toward the sunset, the line is defined by a stone row 168 meters long running nearly parallel to Hartwell Road in Concord, MA. It ends near the edge of the wetland (Figure 8). This feature is designated as dry land Feature 7 in Figure 2 and is shown as a solid white line.

Figure 8. End of the stone row (dry land Feature 7) adjacent to Hartwell Road. (photograph by T. Fohl)

Starting approximately 3 meters from the end of the stone row (Figure 8), a low earthen mound continues on the line for approximately 20 meters into the wetland (Figure 9).

Figure 9. Earthen mound that extends the line into the wetland. View is looking southeast toward the end of the stone row adjacent to Hartwell Road . (photograph by T. Fohl)

The earthen mound connects to a ditch which is approximately on the line but is also part of a network of ditches (Figure 10). The channel formed by the ditch touches the mound from the right and runs parallel to it for about 15 meters. At the end of the mound the channel widens and continues along the line.

Figure 10. Earthen mound connecting to the ditch looking northwest. (photograph by T. Fohl)

Continuing along the line to the northwest, the ditch ends after approximately 20 meters and there are no apparent features on the line in the wetland for approximately 190 meters. At this point the line contacts the southern end of the esker shown in Figures 1 and 2. A row of stones starts at the water's edge and crosses the esker to the water on the other side, a distance of approximately 25 meters. The row is shown as a solid white line in Figure 2 and is designated as dry land Feature 6.

At the approximate midpoint of the row of stones that crosses the esker, there is a loose, horseshoe-shaped array of stones which is bisected by the row (Figure 11). The horseshoe opens to the northwest facing the August 12 sunset. In the photograph, Figure 11, the stones do not stand out well from the surrounding forest debris, and so are designated by red dots. The red arrow shows the location of the line and direction to the sunset.

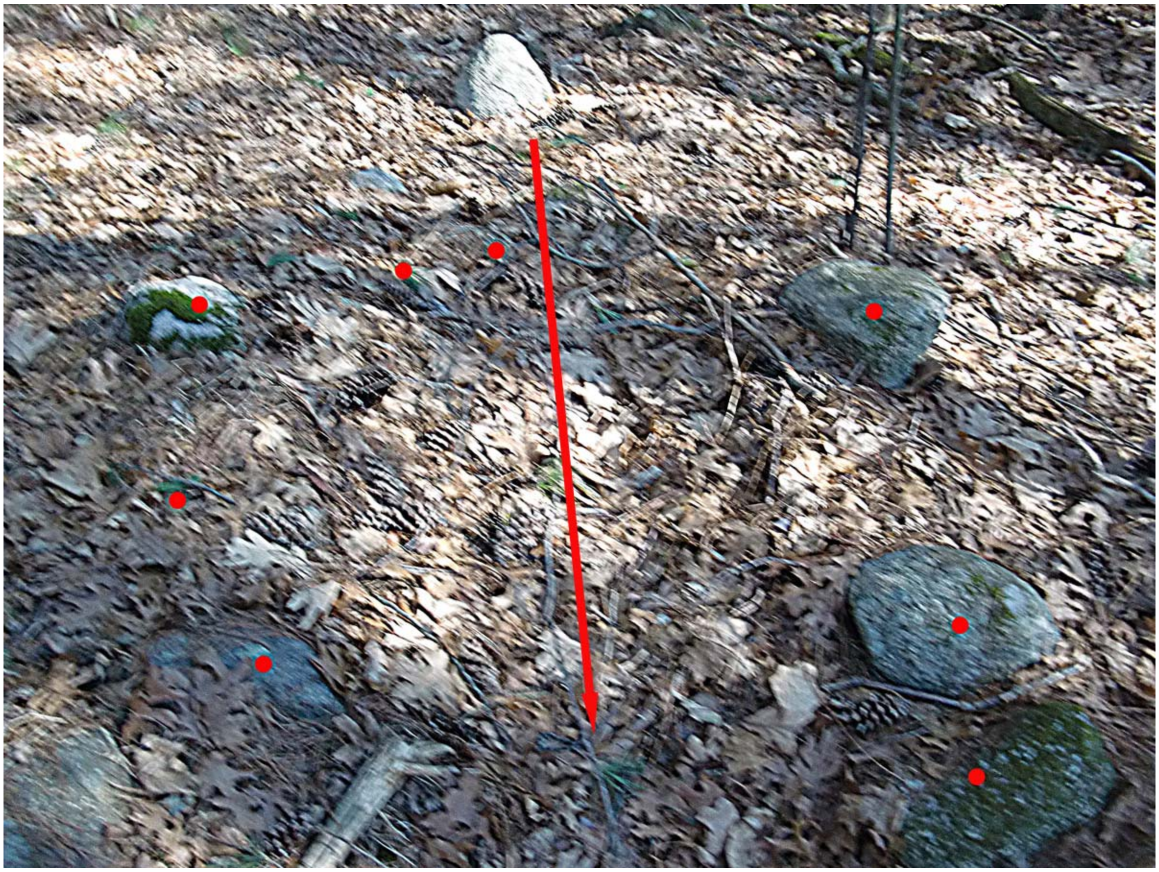

Figure 11. Horseshoe shaped array of stones designated by red dots. Distance between foreground rocks is approximately 0.75 meters. (photograph by T. Fohl)

The stone row going northwest ends at the water's edge (Figure 12).
There is a ditch continuing the line in the wetland to the northwest beginning where the stone row ends. It disappears in the wetland growth after approximately 15 meters.

Figure 12. Section of stone row (dry land Feature 6) crossing the esker and contacting the water looking northwest. (photograph by T. Fohl)

It is worth noting that this part of the esker at least is otherwise completely free of stones. This suggests that the stones forming the row and the horseshoe array were transported from a considerable distance away. A walking survey of this section of the esker found no stones on the surface within at least 100 meters. Most of the esker is now in private yards which were inaccessible and it is possible that there were stones in these areas. Some of the stones are estimated to weigh hundreds of kilograms and would require a lot of effort to move.

Starting at the end of the ditch which runs northwest from the esker, there are no visible features until the line meets the linear wetland Feature C, a distance of approximately 110 meters (Figures 2 and 7). Feature C extends to the bank of Spencer Brook and a feature on the other side of the brook is in line with it and is included as part of wetland Feature C. Feature C is roughly 130 meters long.

The line extending from wetland Feature C has no visible features as it crosses the wetland to the northwest from Spencer Brook until it reaches a very large rock on dry land near the edge of the wetland (Figure 13). This rock is part of a triangular array of very large rocks indicated by the square white dots in Figure 2 in the vicinity of West Street in Carlisle. This array is designated as dry land Feature 5. The line connects the rock near the wetland and the northern rock of the triangle while passing over another large rock in the open field (not marked in Figure 2 but noted in Figure 16). The final rock in this line is about one meter high and two meters across (Figure 14). It has an array of smaller stones distributed over its top surface. A line connecting the third, southern rock (Figure 15) and the first rock near the wetland is aligned with the sunrise on August 13. A schematic diagram of the triangular array and these relationships is shown in Figure 16. The triangular array is at the southern edge of group of approximately ten ceremonial structures covering an area of approximately 2,000 square meters adjacent to West Street.

Figure 13. Rock on dry land near wetland in line with wetland Feature C. Rock is approximately 2.5 meters long. (photograph by T. Fohl)

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Figure 14. The final rock in the line of features connected with linear wetland feature C. Note smaller rocks distributed on top. (photograph by T. Fohl)

Figure 15. Third rock of triangular array. It is approximately 1.5 meters high. (photograph by T. Fohl)

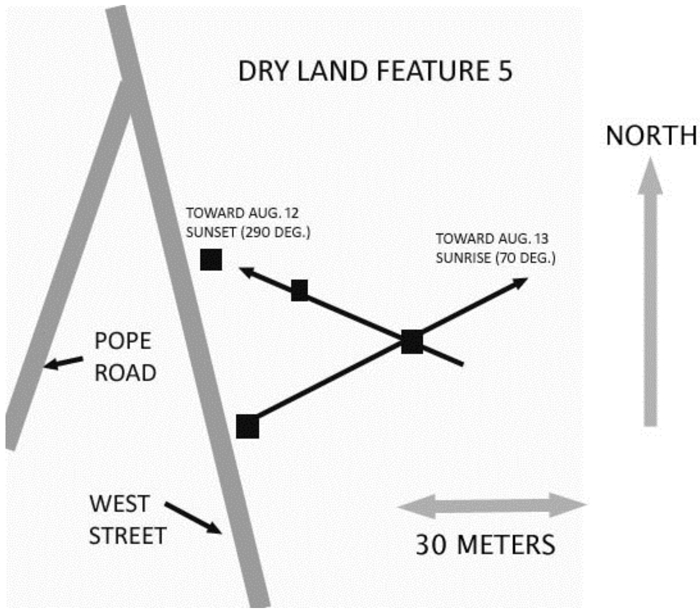

Figure 16. Schematic of triangular dry land Feature 5.

Wetland Feature D

Wetland Feature D consists of a pair of ditches which converge at an angle of 168 degrees. They are shown in the aerial photograph of Figure 7 and in a closer view in a photograph downloaded from Bing Maps (Figure 17) (www.bing.com/maps/). The western branch, labeled Channel 1, is aligned with the sunrise on the summer solstice and with the sunset on the winter solstice, at azimuths of 58 and 238 degrees, respectively. Channel 2 is oriented along an east-west line and is aligned with the sunrise and sunset at the equinoxes.

The channels would drain water from the spring area to the west of Channel 1 into Spencer Brook through Channel 2 if they were connected. However, there is no direct connection between the two channels at present. The roadway which divides them may have been built after the channels were dug. A road was built from Concord to Fifty Acre Meadow, which was the old name for Spencer Brook Swamp, in 1666. It was extended to the north soon thereafter and called the Groton Road. It is now called West Street. A road was built from Groton Road to connect with a road to Chelmsford before 1671. It is now South Street. Simon Davis Jr. built a house on the corner of South and West Streets in 1685 (Lapham 1970). While it isn't certain where the Groton Road crossed the wetland it seems plausible that the connection between the two ditches was blocked by 1670.

Figure 17. A Bing Maps Bird's Eye View of the channels that form wetland Feature D (annotated by T. Fohl)

Ground Penetrating Radar (GPR) Studies

GPR was used to obtain information about the interior structure of wetland Features A and B and their surroundings without disturbing the wetland. GPR works by sending an electromagnetic pulse into the ground and recording its reflection from discontinuities in the ground underneath. The antenna unit of the GPR system has two antennas. One sends the pulse down into the ground and the other detects the reflected pulse. The detected pulse is recorded and analyzed in the data logger part of the GPR system.

GPR is widely used in construction work and more recently in archaeology. For a complete treatment of the use of GPR in archaeology see Conyers (2004). The scans reported in this article were carried out by Steven Arcone of the U. S. Army Cold Regions Research and Engineering Laboratory in Hanover, NH. He has extensive experience using GPR in Antarctica and in frozen wetlands in New England.

The GPR scans were done with a SIR 3000 data logger using a 400 megahertz antenna manufactured by GSSI, Salem, NH. The scans were taken by flagging 50 foot long paths that crossed the linear features, roughly perpendicular to their axes. The traverses were made at selected sections of the mounds and the data shown represent the results of single traverses over separate mounds. The radar antenna was mounted on a sled and dragged across the snow-covered mounds. One person dragged the sled and the GPR operator followed while monitoring the data logger. A photograph of the antenna on the sled is shown in Figure 18. Distances were determined by manually inserting tick marks in the recorded traces as the end flags were passed. A constant drag speed was assumed.

Figure 18. Ground Penetrating Radar 400 megahertz antenna on sled. (photograph by T. Fohl)

Selected portions of the traces obtained from traverses over the mounds of wetland Features A and B are shown in Figures 19 and 20.

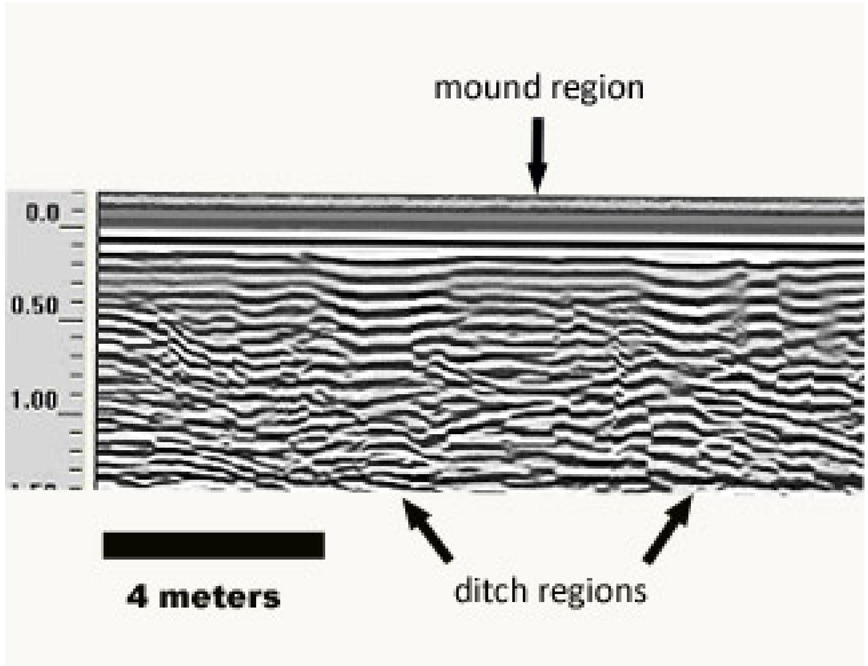

Figure 19. Ground Penetrating Radar (GPR) trace on wetland Feature A (Courtesy S. Arcone annotated by T. Fohl)

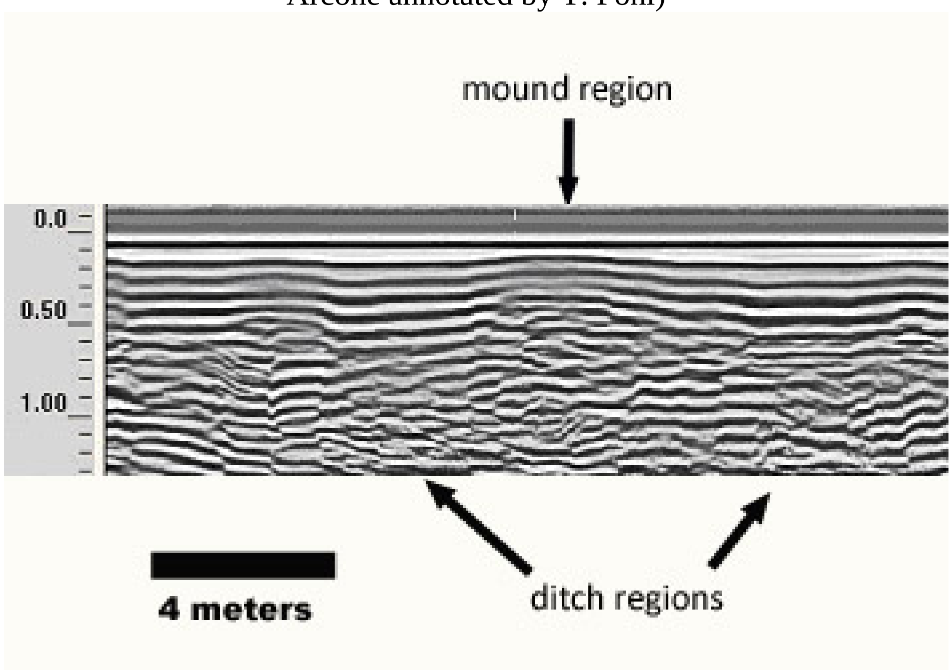

Figure 20. Ground Penetrating Radar (GPR) trace on wetland Feature B (Courtesy S. Arcone annotated by T. Fohl)

Figures 19 and 20 show relatively unprocessed data from GPR traces across selected parts of wetland Features A and B. The data logger applies proprietary corrections for such factors as attenuation of the signal and effects at the ground surface. The data of Figure 19 and 20 are not processed further.

The wavy bands of light and dark areas indicate the varying strength of reflected pulses of electromagnetic energy from strata in the material beneath the antenna. As the antenna is moved along the surface, the traces are extended in time to the right. Assuming the antenna is moved at a constant speed, distance along the horizontal traverse line is proportional to distance along the horizontal time axis. The vertical axis is a time axis as well. Assuming a constant vertical propagation velocity for the electromagnetic energy, distance along the vertical time axis is proportional to depth. Thus the images are maps of subsurface structure as a function of depth and distance along the line of the traverse. In these examples, a typical propagation velocity for wetland material was used to set the vertical depth scale and it is shown in meters. The nominal velocity setting was 7.5 centimeters per nanosecond which was chosen on the basis of standard tabulated values. The horizontal scale was set by using manually set tick marks as described above.

Both data sets show relatively even bands of alternately black and white lines on either side and over the center of the mounds near the surface (approximately 0 to 50 centimeters deep). These probably indicate that these strata were laid down smoothly over a stable structure. The bands bow downward alongside the mounds and bow upward at the center of the mounds. The actual upward bowing is more pronounced than the traces indicate because the surface over the mound bulges upward and the traces are not corrected for this effect. The shapes of the strata suggest that material was dug from the area beside the mounds (indicated as ditches in the figures) and piled up to form the mounds. After the mounds were built, some processes probably deposited material over them and the ditches beside them to form the smooth strata. Also note that the deeper strata under the continuous bands are more disorderly, which may be an indication of the disturbance caused by earth moving.

More research using GPR and possibly coring techniques should be done before any conclusive statements about these wetland features are made. However, it is possible to make some observations about the probable history of the mounds. The continuous undisturbed character of the strata near the surface (less than ~ 0.5 meter) show that these strata were deposited under relative gentle conditions. The fact that they overlay more disturbed strata and are continuous over the dug out areas and the mounded up areas indicates that they were deposited after the mounds were built.

Another GPR scan was obtained almost by accident while leaving the wetland. It is not shown here because neither the exact location nor the horizontal distance were recorded. It detected what is most likely a succession of pond bottoms that slope upward to the present shoreline. These show successive episodes of filling in of the pond until it finally became a wetland. The deepest bottom seemed to be more than 3 meters below the present surface near the center of the pond. Although we did not get this data in the immediate vicinity of the mounds, it probably was originally quite deep near their location at one time. It would be difficult to raise the mounds if their surroundings were in deep water. This suggests that the date of construction was after the pond had filled in to the point where it was shallow enough for digging, but before the upper strata were deposited.

This hypothesis suggests that methods such as pollen analysis done in strata somewhat removed from the mounds could provide dates for the construction of the mounds without disturbing the mounds themselves. Geological analysis of the filling in episodes could also yield chronological information. Once this is established, it would be plausible to estimate dates for the stone features by association with the wetland features with which they are collinear.

Discussion and Conclusions

The evidence presented in this article makes a strong case for the human construction of the linear features in the Spencer Brook Swamp. It also makes a case for the wetland structures being conceptually connected to the dry land stone structures, even if they were not built by the same group of individuals. The fact that these structures have strong astronomical associations implies that astronomical concepts were at least part of the motivation for their construction.

Although the dry land structures resemble familiar New England stone fences in some instances, they differ in numerous details. Some differences are the following.

- Astronomical orientations are not thought to have been a factor in construction of farm walls.
- The connection with wetland structures does not follow farm practice.
- Many of the structures do not serve any farm-related purpose. They do not enclose anything, nor are they repositories of locally excavated stones.
- Parts of these structures simply are not walls. They are rows of loosely spaced stones.
- The apparent connections between widely separated features argue for a large scale design that doesn't seem to have an agricultural function.

The wetland structures are also difficult to connect to an agricultural function. Conceivably the mounds could have been supports for catwalks to the stream. But simpler access points are abundant. An example is the area where the road crosses the brook as shown in Figures 1 and 2. Such functions are also not consistent with alignments to stone structures on land and to astronomically important directions.

None of these factors tells us who built these structures or when. It is a fascinating puzzle. Regardless of who built these features, they do, in fact, exist as part of the built environment. Since the answers to the questions of by whom, when and why they were built are not known, this is a valid archaeological question which has received little or no previous attention. Moreover, the wetland structures offer a tantalizing possibility for dating both the wetland structures and the dry land structures non-destructively by dating pollen from the relatively undisturbed strata adjacent to the mounds.

Although the observations in this article may suggest that Indian cultures were responsible for these features, there is no direct evidence as to who actually did build them. While I have discussed these features with tribal members, there has been no input from them on the subject. The observations and conclusions are all based on work done over the past three years by the author and his collaborator, Steven Arcone.

Acknowledgements

The author extends thanks to Steven Arcone who suffered in the wintry swamps and obtained fascinating GPR data. Thanks to Kenneth Leonard and William Sullivan for reading the draft and making useful suggestions. Extra thanks to Curtiss Hoffman whose numerous comments and suggestions have greatly improved this article.

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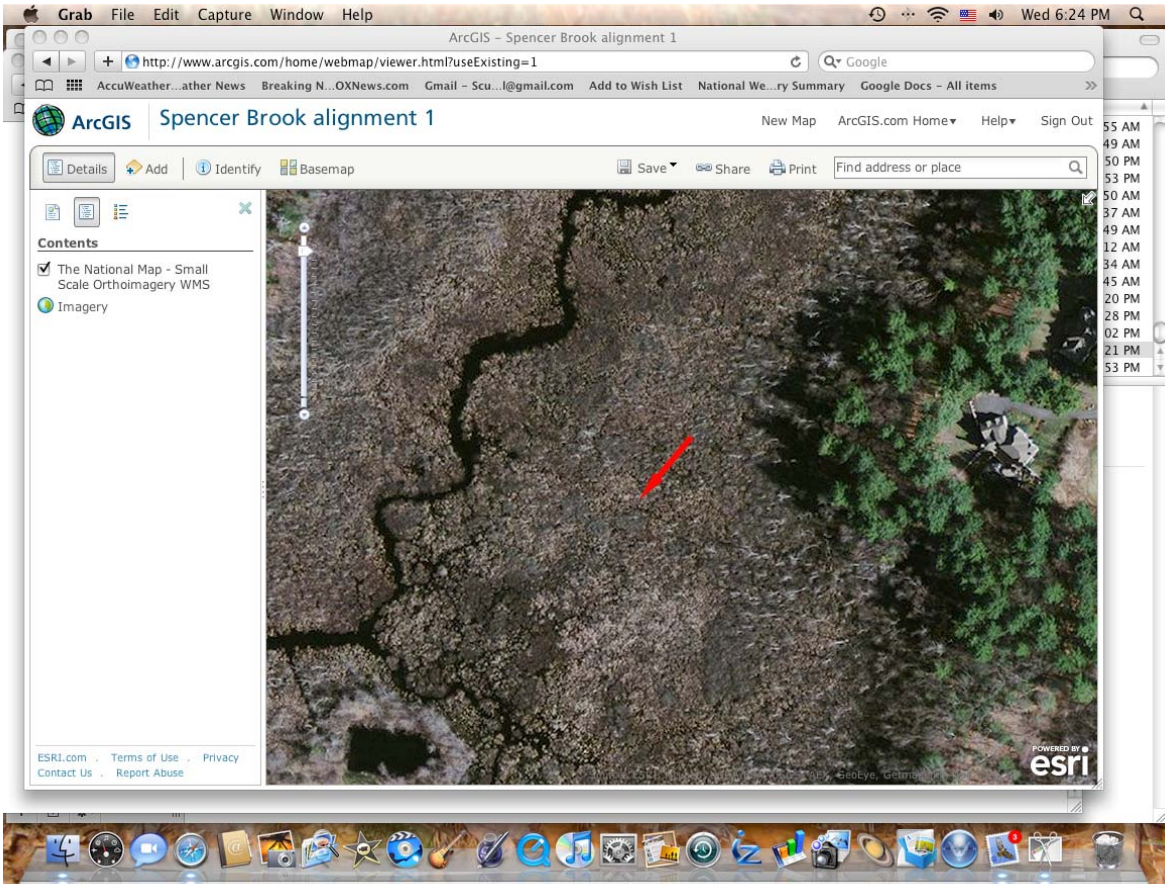
Post Publication Notes

The above text is substantially identical to an article that was published in the *Bulletin of the Massachusetts Archaeological Society*, Vol. 71, No. 1 (2010). The photographs of the features are in color in this electronic version whereas the images in the printed version are all in black and white. Hopefully this makes details easier to see. Some of the annotations have been changed as well.

I have added a few images with comments in this addendum with the hope that they will be of additional interest.

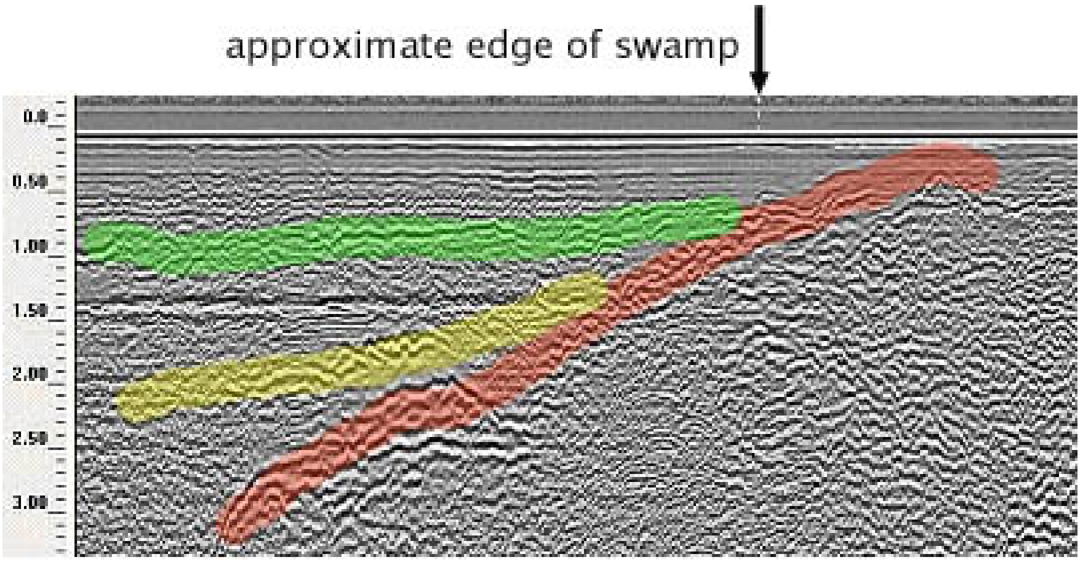
This is a photograph of another part of the stone row that passes over the esker. It is on the southeastern side of the esker. It connects with the horseshoe structure and the northwestern section of the row shown in Figures 11 and 12 in the body of the article. This section of the row touches the wetland southeast of the esker.



This recently obtained aerial photo shows a longer length of wetland Feature C than is shown in the images in the body of the article. It is designated by a red arrow. Although ground inspection of the area of Feature C did not reveal a ditch, this image suggests that the linear feature, wetland Feature C, is a continuation of the ditch shown in Figure 12 of the article. Of course ground inspection was only possible when the area had snow cover.

This is a picture of the rock in the triangular array of rocks described on page 15 and Figure 15 of the article. It is on the line running toward the August 12 sunset and is part of the multi-component line containing wetland Feature C.

Here is Steven Arcone recording GPR data in the swamp. Thanks!



The article mentions a GPR trace which was taken while returning from the mound areas. It was not included in the article because the location was not recorded exactly. The path of the traverse was approximately a line running west from wetland Feature B to the wooded area as shown in Figures 1 and 2 of the article. The annotated trace, shown above, reveals interesting aspects of the history of the wetland.

Apparently, the wetland was once a body of open water. This is suggested by the fact that there is a definite bank at its edge which may be a result of wave erosion. The GPR trace tends to confirm this. It shows strata that look like pond bottoms which were buried by successive flooding events. Three distinct bottoms are highlighted in color with red being the deepest and thus the oldest. All these bottoms converge at the present edge of the swamp which is probably the old shore of a pond. It would be interesting to get dates for the various strata.

Timothy Fohl
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