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ORIGINAL ARTICLE

Taxonomy and Nomenclature for the Stone Domain in New England

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Abstract The European settlement of rural New England created an agro-ecosystem of fenced fields and pastures linked to human settlements and hydro-powered village industry. The most salient archaeological result was the "stone domain," a massive, sprawling constellation of stone features surviving as mainly undocumented ruins within reforested, closed-canopy woodlands. We present a rigorous taxonomy for this stone domain based on objective field criteria that is rendered user-friendly by correlating it to vernacular typologies and functional interpretations. The domain's most salient class of features are stone walls, here defined as objects meeting five inclusive criteria: material, granularity, elongation, continuity, and height. We also offer a nomenclature and descriptive protocol for archaeological field documentation of wall stones (size, shape, arrangement, lithology) and wall structures (courses, lines, tiers, segments, contacts, terminations, and junctions). Our methodological tools complement recent computationally intensive mapping tools of light ranging and detection (LiDAR), drone-imaging, and machine learning.

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Resumen El asentamiento europeo en la zona rural de Nueva Inglaterra creó un agroecosistema de campos cercados y pastos vinculados a los asentamientos humanos y la industria dependiente de energía hidráulica de las aldeas. El resultado arqueológico más destacado fue el "dominio de piedra", una constelación masiva y en expansión de características de piedra que sobrevivieron como ruinas principalmente indocumentadas dentro de bosques reforestados de dosel cerrado. Presentamos una taxonomía rigurosa para este dominio de piedra basada en criterios objetivos de campo que se vuelve fácil de usar al correlacionarla con tipologías vernáculas e interpretaciones funcionales. La clase de características más destacada del dominio son los muros de piedra, aquí definidos como objetos que cumplen cinco criterios inclusivos: material, granularidad, elongación, continuidad y altura. También ofrecemos una nomenclatura y un protocolo descriptivo para la documentación arqueológica de campo de piedras de pared (tamaño, forma, disposición, litología) y estructuras de pared (hiladas, líneas, niveles, segmentos, contactos, terminaciones y uniones). Nuestras herramientas metodológicas complementan las recientes herramientas de mapeo computacionalmente intensivas de detección y medición de luz (LiDAR), imágenes de drones y aprendizaje automático.

Résumé L'implantation européenne dans la Nouvelle Angleterre rurale a créé un écosystème agricole de champs et de pâturages clôturés, lié aux colonies humaines et à une industrie villageoise fondée sur l'énergie hydraulique. La conséquence archéologique la plus saillante fut le « domaine de pierres », une vaste constellation tentaculaire d'éléments de pierre traversant le temps comme des ruines essentiellement non documentées au sein de forêts reboisées à canopée fermée. Nous présentons une taxonomie rigoureuse de ce domaine de pierres sur la base de critères objectifs de terrain rendus faciles d'utilisation grâce à leur corrélation avec des typologies vernaculaires et des interprétations fonctionnelles. Les murets de pierre sont la catégorie la plus importante des caractéristiques du domaine, ils sont ici définis comme des objets correspondant à cinq critères inclusifs : matériau, granularité, allongement, continuité et hauteur. Nous proposons également une nomenclature et un protocole de description pour la documentation du champ archéologique des pierres des murets (taille, forme, disposition, lithologie) et des structures des murets (parcours, lignes, niveaux, segments, contacts, terminaisons et jonctions). Nos outils méthodologiques sont complémentaires avec les récents outils de mappage axés sur une informatique intensive tels que la détection de la lumière et de mesure à distance (LiDAR), l'imagerie par drone et l'apprentissage par machine.

Keywords stone walls · classification · historical archaeology · Anthropocene · New England

Purpose

The vast majority of abandoned fieldstone walls crisscrossing the now-forested landscape of rural New England appeared when waste stone from agricultural fields and pastures was scuttled outward to fence-lines (Fig. 1) (Dodge 1872; Bowles 1939; Allport 1990; Thorson 2002; Bickford 2003; Dincauze 2004; Johnson and Ouimet 2014). The resulting regional gridwork is estimated to have been ~400,000 km in length, ~0.8 m in average width, and ~1 m in height (Fig. 2) (Johnson and Ouimet 2016). Quoting stonemason Kevin Gardner (2001), most were built "by ordinary farmers and workers, children, women, indentured servants, Native Americans, and slaves," and range from "rambling collections of unsorted rubble thrown into loose mounds" to "the most finely assembled formal public projects."

Despite this great range in form and origin, mapping and inventory projects using remote-sensing imagery (i.e., light-ranging and detection [LiDAR]) and geographic-information systems (GIS) applications: treat the entire population of linear stone features (walls and lines) as a single undifferentiated entity (ArcGIS Online 2022) and ignore the abundance of related but nonlinear features. Though such investigations demonstrate quantitatively how the presence or absence of stone walls varies with specific landscape attributes (location, elevation, slope, land use, proximity, roads, soil type, etc.) they do not address the more interesting cultural research question of how different types of walls and related objects vary over the landscape (Garrison 1991). To facilitate this research objective, we[1] offer a field-based objective taxonomy for all stone features, a recommended nomenclature, and a protocol for routine description. Our methodological report draws no cultural conclusions. Rather, we offer a visual field tool analogous to a Munsell soil-color chart that can standardize the descriptions and classifications needed for comparative analysis. In our case, the concern is not whether a dish can also be a platter, plate, or saucer (Beaudry et al. 1983), but whether a stone wall can also be a fence or a cairn or a mere pile.

Objective classifications start with explicit definitions. The stone domain is defined as the subset of outdoor historical material culture composed of stone. The choice of the word "domain" follows mathematical usage as the full set of possible objects, rather than the range known at present. Though roughly equivalent to the term "stone landscape" in cultural resources management (CRM) practice, landscapes, by definition, must consist of multiple elements or components.

The other domains—"wood" (main structural element), "fiber" (rope, leather, fabric, netting, etc.), and "metal" (chiefly iron for bars, tools, hinges, nails, etc.)—are not explictly defined here, generally decompose at the century scale, and thus do not survive as aboveground archaeology. By definition, neither wood nor iron fencing is part of the stone domain. From historical statistics, it is known that

[1] My use of the pronoun "we" in this article reflects the contributions of hundreds of unnamed parrticipants who have offered feedback.

Fig. 1 This object is classified as a stone wall because it meets all five of the required defining criteria of: material (stone), granularity (population of stones), elongation (length/width >4), continuity (no breaks), and height (>knee-high or stone-on-stone). Taxonomically, it is the Fitted *Variant,* of the Panel *Subtype,* of the Single *Type*, of the Freestanding *Family*, of the Wall *Class*, within the Stone *Domain*. Descriptively, it is a chest-high, partially collapsed, well-stacked, paneled, single wall dominated by hefted fieldstone slabs of granite-gneiss. (Photo by author, 2008.)

most of New England's extant stone walls were once hybrid mixtures of stone and wood. Because the wood has decomposed, only what remains can be classified. Iron fencing and hybrids with stone were very rare in rural New England settings and are ignored.

Our classification concentrates on the primitive, unmortared, freestanding walls associated with abandoned rural farmsteads, but also includes the more complex walls associated with dwellings, barns, and mills. Walls constitute a class of objects within the stone domain that is distinct from its sister classes of "concentrations," "lines," and "notable stones."

More specifically, we offer a/an (1) objective, field-based definition of a stone wall as meeting all five criteria of material, granularity, elongation, continuity, and height; (2) standardized nomenclature for consistent field description of all objects, such as stone size, shape, and source and wall structure; (3) taxonomy, or rule-driven classification, based on a stepwise yes/no algorithm (decision tree) based on observed structure and location; and (4) protocol-rubric for rapid field description, naming, and data entry. Our structural taxonomy is independent and inclusive of Indigenous, or precontact, stone features.

Background

Archaeologically, the vast majority of New England's stone walls are "artifacts," being objects made by humans (Trigger 1989). They commonly aggregate into larger assemblages, features, or sites,

Fig. 2 Sample of stone linears (pink lines) from Hillsboro County, New Hampshire, mapped on aerial orthophotos bounded by longitudes 71.567–71.631 west and latitudes 42.921–42.951 north. Scale shown by yellow bar is 0.64 km (0.4 mi.); north is to the top of the image. These mapped linears do not distinguish five families of stone walls and two families of stone lines. (Image by author, 2022, from New Hampshire Stone Wall Mapper [ArcGIS Online 2022].)

such as lanes, enclosures, cellars, gridworks, and districts. Regardless of scale, the vast majority of walls are the tangible, durable residues of an agroecosystem that swept over the rural interior landscape in a temporal wave of deforestation and afforestation beginning in the late 18th century, peaking in the early to mid-19th century, and declining to the mid-20th century. Had these walls been older, buried, and smaller, or had they been demonstrably Indigenous in origin, early American archaeologists would likely have given them rigorous typological attention, as with projectile points, ceramic styles, and burials. Instead, stone walls were distinguished by vernacular folk typologies. This neglect of rigorous attention to walls derives from the close association between American archaeology and excavation, a precedent set by Thomas Jefferson's (1785) *Notes on Virginia* before the vast majority of New England's walls were built. The much later arrival of scholarly historical archaeology in the 20th century was also closely associated with excavation, as conveyed by the title of James Deetz's (1996) elegant 1977 summary, *In Small Things Forgotten*.

Geologically, the vast majority of walls are also "*landforms*" assigned to the human agency of the Anthropocene epoch. Thorson (2002) claimed them as the region's "signature landforms." The American Geological Institute supported this claim in a cover story of *Earth* magazine (Andriote 2014). The New Hampshire Geological Survey is overseeing their mapping as a statewide, citizen-science program. Had these landforms been seen earlier as "natural" as moraines, stream channels, sand dunes, or shorelines, geologists would have classified them carefully. Dow and Ouimet (2022) are beginning to upgrade attention to walls and soils as geological features.

Ecologically, walls are also "habitats," a gridwork of lines of dry, lichen-covered, porous stone within otherwise moist densely rooted soils. The material properties and microclimatologic and pedologic effects of walls offer novel habitats, corridors, boundaries, and barriers that impact flora and fauna at different scales (Sinclair et al. 1967; Thorson 2005; Stafford 2007). Though they are indeed local "anthromes" (anthropogenic biomes), and though they enrich biodiversity as "'exemplars' of novel ecosystems" (Collier 2013), little attention has been given to stone-wall ecology, perhaps because the stone residues of human activity are so poorly defined (Marshall and Moonen 2002).

Proper description and classification of stone walls in New England has largely fallen through the metaphorical cracks of these three scientific disciplines. Instead they were claimed with less rigor by the disciplines of history, art, architecture, and geography. In the context of the Anthropocene, historical archaeology should play the lead role in upgrading our scientific understanding of stone walls at the landscape scale.

Previous Work

Classification of New England's stone walls began shortly after 1607 when the term "old Walls" was used to describe the ruins of the Popham colony at the mouth of Maine's Kennebec River (Russell 1976). Here, the adjective "old," indicates that chronology, rather than structure, lithology, or purpose, was the attribute of interest.

Description and classification emerged slowly and informally, as farmers, travelers, and masons created informal, emic, vernacular categories, generally based on utility: sea wall, pasture wall, foundation wall, cemetery wall, cellar wall, etc. Because the vast majority of extant walls lack specific historical documentation, their purposes must be interpreted from tangible field evidence using the heuristic "form follows function." This approach works for intact walls in self-evident situations, like a mill dam built across a stream. It cannot work for the vast majority of abandoned fieldstone walls because a single form can serve multiple functions simultaneously (waste disposal, fencing, and boundary marking), while also providing an opportunity for creating folk art through local patterning of stone shape or composition, for example, concentrating quartz cobbles or slanting tabular stones. Nor can the heuristic work if the original forms have disintegrated, been rebuilt, or were kept to serve aesthetic, rather than utilitarian purposes.

The vernacular names used for stone walls and related features throughout the region are as idiosyncratic as local cultural idioms (Dodge 1872) (Table 2). For example, the "rock wall" of northern New England, the "stone wall" of southern New England, and the "stone row" of glaciated New Jersey refer to the same thing. Undefined synonyms are abundant. For example, the most common type in New England, the normal single wall of this classification, is also variously known as the farmer's wall, tossed wall, pasture wall, dyke, stone hedge, thrown wall, single-stack, or topped wall. Refuse piles of stone waste are synonymously called piles, heaps, mounds, and dumps if unordered, and stacks, cairns, monuments, corrals, rings, pyramids, and beehives if arranged in some way. This lack of consistency hinders interpretation. Our goal is not to replace these folk (internal, emic) typologies, which link to local cultural identities, but to include them within a scientific (external, etic) taxonomy that retains as much of the original language as possible.

Conflations of classification create confusion. The functional phrase "stone fence" is used interchangeably with the material phrase "stone wall." Walls distinguished by salient material say nothing direct about structure or function. Walls named by analogy, for example, "lace walls," deflect awareness from the wall's salient characteristic of excess porosity (the ratio of void space to stone). Ad hoc wall classifications are typically binaries created for the purpose of specific investigations. For example, Johnson and Ouimet (2016) differentiate loosely vs. tightly packed walls. Fields (1971) invoked aesthetic judgment to distinguish rubble vs. tailored walls. Gage and Gage (2006) find spiritual significance in some walls, but not others. Bowles (1939) classified them either as mineral resources or mineral reserves, based on the tonnage of stone.

Luckily, New England's wall typology is homegrown, being almost entirely independent of Old World antecedents (Rainsford-Hannay 1958; Given 2004; Land Use Consultants 2007; Chirikure and Pikirayi 2008; McAfee 2011; Agnoletti et al. 2015). Distinctive names for English, Scottish, Irish, Italian, and African styles, for example, were not imported, even though the vast majority of walls were built by descendants of these groups. Most New England walls were crudely utilitarian sites of waste disposal along fencelines and were thus stylistically independent of more intentional architectural wall traditions, for example, the sedimentary walls of the bluegrass country of the Appalachians (Murray-Wooley and Raitz 1992), the primitive stacks of the Ozarks (Hoard and Prawl 1998), and the ancient Indigenous ruins of the Great Basin (Hawley 1938). New England walls are so regionally distinctive that they merit a regional classification.

Archaeologists distinguish between emic and etic classifications. Emic refers to those emerging from within the behavioral system, i.e., the local folk typologies and regional idioms. Etic refers to those imported to field settings from outside. Our goal is to create a purely descriptive, etic, “scientific” taxonomy that can be applied anywhere in the world (as with a Munsell color chart), but which is tailored for New England.

Key research questions that could be addressed by our etic taxonomy are both spatial and temporal. Most importantly, researchers could map out the distribution of wall type on the cultural landscape at any scale, perhaps discovering that stone bands (low, unstructured): are increasingly common at greater distance from cellar holes; are more common over some bedrock lithologies than others; or were more common earlier than later. More generally: the relative proportion of taxa—piles to bands to single, double, broad, and capstone walls, etc.—may indicate progressive stages from the management of stone refuse on pioneeering farmsteads to the use of stone for architectural purpose. For ecologists, the differences between taxa correlate with aerial connectivity of habitat from patches, to barriers, to corridors. Questions that cannot be answered directly involve the actual mass of moved stone or the culural groups involved. One key value of our etic classification is that it will allow local-to-global comparisons of emic typologies.

Loosely speaking, there is general agreement and consistent usage for four distinct New England wall types during the mid-19th-century interval of peak construction. In *Thoreau’s Country*, ecologist David Foster comingles structure and function:

> Broadly speaking, there are two predominant types of stone walls. “*Single*” walls consist of simple lines of typically large stones that usually enclosed pasture land. ... A second, much broader “*double*” stone wall often consists of well-formed parallel lines. ... These massive walls surround cultivated fields. (Foster 1999)

This fundamental structural distinction dates back to Roman and medieval times, and is retained in this taxonomy. A second, longstanding distinction is also structural. A freestanding wall, typically built on fairly level agricultural upland, has two faces. In contrast, a “bank” wall is typically built on sloping land, with one face being embedded against the slope to help stabilize the soil. Stonemasons sometimes insert verbs of technique into structural labels, for example, a single-stack wall, a double-faced wall, and a retaining wall.

Methods

Taxonomies are not typologies. The latter are bin-sorting, pigeon-holing classifications that segregate things into overlapping subjective categories, like the genres of music or literature. In contrast, taxonomies are objective, rule-driven, hierarchical, dichotomous decision trees based on the presence-absence of diagnostic criteria. Most familiar is the modernized Linnaean classification of living organisms used in biological systematics that nest species into genera, families, orders, classes, and phyla at progressively higher taxonomic ranks.

After publishing a geoarchaeological narrative history of New England’s stone walls using vernacular typologies (Thorson 2002), I initiated focused conversations with hundreds of wall aficionados—archaeologists, historians, ecologists, historians, land-managers, and others—about the nomenclature and classifications they applied to stone walls. All of those I encountered were either informal or simple. After failing to convert existing regional typologies into broader and more rigorous classifictions based on known wall attributes (chronology, geometry, magnitude, location, function, structure, source, material, and builders), and, after failing to find a regionally workable precedent in the international literature, I created, sui generis, a series of trial-and-error taxonomies based on structure and solicited professional archaeological critiques at regional meetings. Initial attempts to use multivariate statistics (notably cluster analysis and principle-components analysis) were abandoned, and we are now exploring the use of machine learning algorithms.

During the summer of 2004, I traveled thousands of miles of back roads in greater New England to obtain a synoptic, uniform, grounded overview of stone walls as a regional phenomenon. My study area was cornered in the southwest by Westchester County, New York, in the northwest by Burlington, Vermont, in the northeast by Machias, Maine, and in the southeast by Chatham, Massachusetts. A preliminary classification was published as the final chapter of a field guide (Thorson 2005) to stimulate public feedback prior to eventual publication in the peer-reviewed literature. In 2009 I sought feedback on an an improved version via the website of the Stone Wall Initiative (2019). Multiple iterations of the taxonomy followed, based on external reviews and by field tests during CRM investigations and forensic expert-witness projects. Following more than a decade of improvements within New England, the classification had finally stabilized to the point where I asked archaeological colleagues to review it prior to journal submission.

All taxonomies reflect the compromise between the lumping and splitting of categories, the sequence of stepwise decisions used to sort them, and the tradeoff between using familiar names for taxa vs. technically precise ones. This taxonomy is based entirely on wall structure, presents the minimum number of categories needed to parse the whole stone domain, and adopts several functional verbs ("enclosing," "supporting," "flanking," and "blocking") as stand-ins for observed criteria. As with biological taxonomy, taxa can only be defined as outgroups from something larger. This required identifying a stone domain, from which stone walls could be extracted.

Stone Walls

Definition

A stone wall is an object composed of a population of stones aggregated into one or more segments that is more than four times longer than wide, continuous along its length, and is either (approximately) knee-high or composed of stones resting in contact with one another (Fig. 3) (Table 1) This definition includes five diagnostic criteria: material, granularity, elongation, continuity, and height, as explained below. Two of the five criteria, elongation and height, required arbitrary numerical thresholds of 4:1 and ~0.5 m, respectively, based on qualitative field trials and expert interviews (Fig. 4).

MATERIAL: The vast majority of the stone in historical New England walls consists of glacially quarried, transport-modified, and weathered fragments of nearby bedrock deposited by the Laurentide ice sheet (Fig. 5) and are unmarked by human tools. Only a small portion of wall stone was quarried from bedrock and (or) shaped by humans (Figs. 6, 7). Rare walls are built exclusively of manufactured stone. Many roadside walls contain fragments of synthetic stone (brick, concrete, bituminous pavement, broken mortar) or are built entirely of it. Some walls of natural conglomerates (puddingstone) closely resemble synthetic conglomerates (concrete).

GRANULARITY: A stone (Latin, *lapis*) is an object composed of the material rock (Latin, *roca*), a particle broken from the larger mass. A stone wall is thus a granular object composed of a population of rock particles, generally cobble-sized or larger. This granularity requirement excludes the rare exceptions of a single quarried slab that, when laid on edge, would otherwise qualify as a stone wall.

ELONGATION: By definition, a wall is a linear (or broadly curved) feature that is considerably longer than it is wide. Based on length/width ratios from historical illustrations and reports, informal surveys, and questionnaires from experts, we adopt an arbitrary length/width integer ratio of 4:1. Objects with a lower ratio are concentrations.

CONTINUITY: Regardless of height, a wall (segment) is continuous along its length, forming a solid line of stone, rather than a gapped line. This criteria excludes gaps created by collapse.

HEIGHT: This requirement is met by one of two criteria: the default categorical case of having stones occur one above another, or the rare case in which large stones (arbitrarily knee-high (~0.5 m) to an average adult human) abut one another to create a continuous barrier. The categorical case of negligible elevation is needed for the thousands of nondescript fenceline bands of waste stone that are only slightly above soil grade and those that have tumbled or collapsed from their original heights. The overwhelming majority of single and double walls easily meet both height criteria.

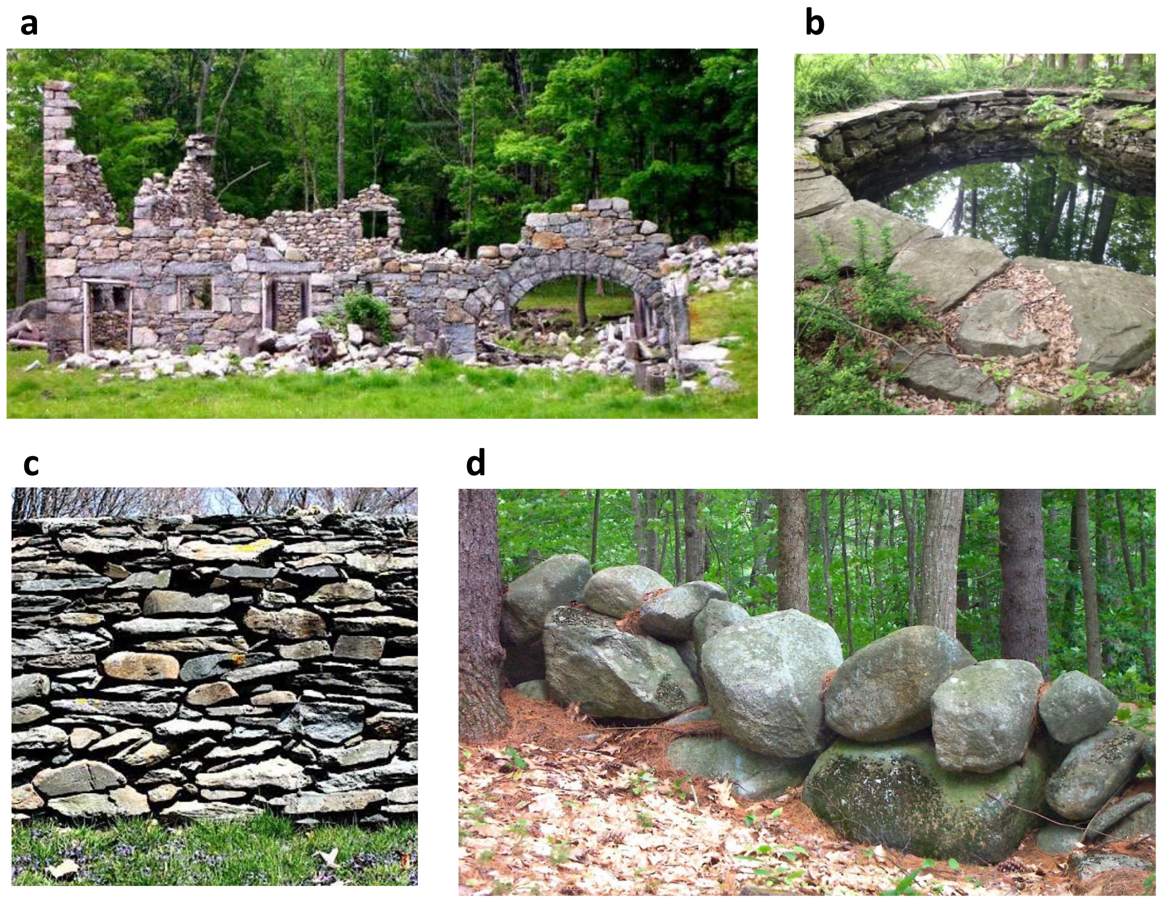

Fig. 3 The class *Stone Wall* within the *Stone Domain* includes many taxa of lower rank exhibiting great variety of structure and material. In the descriptions below the taxonomic rank ***Family*** is boldfaced italic, the *Type* within that family is lowercase italic, and descriptive terms defined in Table 1 are underlined. (*a*) *Squared* ***Enclosing*** walls of Shaker barn in Harvard, Massachusetts, contains a mix of fieldstone and quarrystone. (*b*) Two-tiered *Circular* ***Enclosing*** walls of large cistern in Mansfield, Connecticut, with a one-course capstone tier of quarried slabs above fieldstone. (*c*) One-tiered, uncoursed face of *Double* ***Freestanding*** wall in Middletown, Rhode Island, with laid degree of order. (*d*) Hefted- and Assisted-sized, equant-shaped, milled granite boulders dominate *Single* ***Freestanding*** wall in Bow, New Hampshire. (Photos by author; *a*, *c*, and *d*, 2004–2010; *b*, 2018.)

Walls repurposed or "robbed" down to granular soil no longer exist, so cannot be classified. Walls "robbed" down to foundation stones fail the height criteria, becoming lines or scatters.

This field-based definition of a stone wall means that LiDAR hillshade and slope images, even with a ~1 m resolution, will either fail to detect or misidentify many stone walls. Stone lines built with large stones will be misidentified as freestanding walls in a Type 1 error (false positive). Undetected low walls, like bands, will be excluded as a Type 2 error (false negative).

Nomenclature

Making meaningful comparisions between sites and regions requires use of standardized terms with clear definitions. This section offers a common language.

SEGMENTS: The fundamental unit in stone-wall science is the *segment*, defined as any portion of a wall of any length having consistent characteristics, such as height, width, structure, lithology, or direction (Fig. 8). Any significant change in any one of these characteristics, based on discretion by the field investigator, requires defining a new segment.

Table 1 Nomenclature and definitions used for the "Stone Domain"

Term	Definition[a]
	General
Rock	Material: a strong, brittle, aggregate of minerals or particles (natural or human)
Stone	Object: a fragment of rock not attached to earth's crust
Boulder	Large stone lacking angular corners. Not a slab or block (see below). Size >0.256 m ID[b]
Erratic	Statistical outlier: usually by stone size, but also by composition and/or shape
Soil	Mixture of mineral and (or) organic material above "parent" material (rock or sediment)
Till	Unconsolidated sediment deposited directly by glacier ice with minimal reworking
Grade	The land surface at top of soil, sediment, or rock, exclusive of large boulders and slabs
	Stones
SHAPE	
Block	Equant (a = b = c), sharp[c] edges
Ball	Rounded block
Slab	Elongate (a > b > c), sharp edges
Pillow	Rounded slab
Tablet	Thin and broad (a > or = b >> c), sharp edges
Disk	Rounded tablet
Prism	Elongate (a >> b = c), sharp edges
Column	Rounded prism
Blade	Thin and narrow (a >> b >> c), sharp edges
Dull blade	Rounded blade
SIZE	
Rubble	Cobble to granule grain size, sharp edges (2-256 mm)
Gravel	Boulder to granule grain size, rounded edges (2-1000 mm)
One-hander	Can be lifted with one adult human hand
Hefted	Can be lifted by human muscle with at least 2 hands.
Assisted	Can be lifted and (or) moved only with assistance (pry-bar, livestock, ramp, tripod, etc.)
Residual	Was not moved, left in place
SOURCE	
Field	In situ or adjacent land
Pit	Taken from excavation into unconsolidated sediment (also removal from natural face)
Quarry	Taken from bedrock face or excavation, usually by cutting (and) or blasting
DEGREE OF ORDER	
Dumped	Randomly nested against one another by gravity (a.k.a. tossed, thrown, or pitched)
Stacked	Lifted and placed, but not fitted with care, leaving much void space
Laid	Lifted and carefully fitted by size and shape, leaving limited void space

Table 1 (continued)

Patterned	Embellished by geometric pattern(s) such as lines, slants, mosaics, or figures
Built	Not dumped degree of order: stacked, laid, or patterned
Dumped	Dumped degree of order
Walls & Features	
ORIENTATION	
Local Datum	Datum = 0 = center of wall at grade from some initial point (tip, termination)
Coordinates	X is line of wall (+ away, - back), Y is across (+ right, - left), Z is height (+ height, - depth)
Map view	Top view (XY)
Profile view	Side view (XZ)
Cross view	End or section (YZ)
MAP-VIEW HIERARCHY	
Project datum	Point of origin for project mapping or description (GPS coordinate or benchmark)
Segment	Fundamental linear unit in XZ or XY with similar characteristics between contacts
Wall	Total of one or more segments between terminations
Parcel	Land surface area adjacent to walls, usually partial or full enclosure of 2–4 walls
SEGMENT CONTACTS	
Contact	Boundaries between segments in XZ or XY excluding terminations
Woven	Segment contact is woven with overlapping stones extending +/- X from vertical Z
Abutting	Segment contact is NOT interwoven. Stones abut in X, usually with straight line in Z
Gradational	Contact neither woven nor abutting. Gradation in X on either side of arbitrary Z
Bend	Contact is bend in X (rather than gradual curve) with obtuse angle (< 45 degrees off-line)
Gap	Contact is beginning or end of open space within a continuous wall
WALL TERMINATIONS	
Termination	Wall beginning or end in XY (coincides with first and last segments)
Junction	Termination junctions with another wall, usually in T, L (left/right) or X junctions
Tip	Wall terminates without junctioning. Freestanding. Built or unbuilt
STRUCTURE	
Freestanding	Wall has two faces on opposite sides, not necessarily same height
Flanking	Wall has one face only, the other abutting some other material
Face	Profile view of wall in XZ at any Y
End	Cross view of wall at termination in YZ
Line	Map view of wall in XY at any Z
Tier	Unit of one or more related courses in XZ or YZ
Course	Single layer of stones in XZ or YZ
Cap	Top course and/or tier in XZ or YZ
Foundation	Basal course and/or tier in XZ or YZ

Table 1 (continued)

CROSS-SECTION SHAPE (YZ)	
Mound	Irregular but continuous curve convex skyward (default for stone band)
Triangular	Bottom is base of isosceles triangle (default for single wall)
Trapezoid	Flat top less wide than flat bottom, but parallel to it (default for double wall)
Panel	Vertical stacking one stone wide, usually of similar width (creates "lace" walls)
Asymmetric	Any consistent departure from symmetrical shape
MATRIX	
Drystone	No mortar or fill in void space
Mortared	Mortar, usually cement or lime in any portion of void space (sometimes called a wet wall)
Hearting	Small stones, often rubble, in core of double wall
Filled	Matrix occupied by soil or standing water (allows for submerged or buried)
WALL TERRAIN	
Upland	Freely drained and firm upland soils
Lowland	Poorly drained and soft soils of lowlands and valleys
Rocky	Outcrops of the earth's crust
Streambed	Flowing or intermittent streams

[a] Definitions used for this project.

[b] "ID" abbreviates intermediate diameter of three-dimensional stone.

[c] The term "sharp" is used over "jagged" or "angular" because a perfect cube is sharp, but not angular.

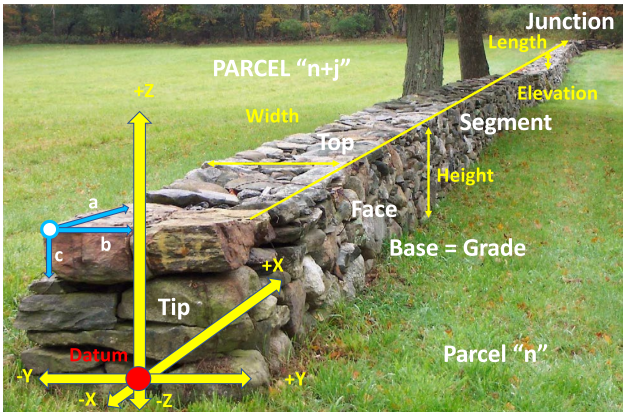

Fig. 4 Coordinate system and terminology for mapping and describing stone walls. Local datum (red dot; X, Y, Z = 0 , 0, 0) is center of base of wall at soil grade at an arbitrary start. Coordinates (yellow arrows) are +X in the forward direction and -X in the reverse direction. Y and Z are orthogonal to X. Elevation anywhere is +/- Z. Wall height at any X is top minus base in Z, specified for right (+Y; adjacent to parcel "n") and left (-Y; opposite face). Wall width at any X is span in Y for any Z. This single-segment wall terminates in a Built Tip with no junctions. Stone dimensions (blue arrows; a = length, b = width, c = thickness) convert to named shapes (this one is a > b > c = slab). (Image by author, 2022.)

a b c d

Fig. 5 Examples of stone shapes and sizes. (*a*) Stone Cairn resembling human form (a detached, upright, built concentration) in Milford, Connecticut, shows stone shapes from the top down: *ball* (equant, rounded a = b = c), *slab* (a > b > c), *prism* (a >> b = c) and *block* (equant, unrounded a = b = c). (*b*) Segment of two-tiered single wall in Hebron, Connecticut, is dominated by *hefted* stones with *assisted* stones in basal tier and *one-handers* generally near top. By definition, *residual* stones were not moved to the wall. (*c*) Lichen-covered stone in wall in Mansfield, Connecticut, is hefted in size and disk-shaped (rounded a = b >> c). (*d*) Naturally occurring tablets (unrounded a = b >> c) at Grindstone Point, Maine, will round into disks during breakdown by losing the corners. (Photos by author, 2004–2010.)

Statistical methods for segmentation, for example, involving stone size, shape or pattern, are encouraged. A gap in the wall also requires defining a new segment. Individual segments have dimensions in X, Y, Z (Fig. 4) (Table 1), with length (X) parallel to the line of the wall, and with width (Y) and height (Z), orthogonal to X. Width exceeds height when Y>Z. The default direction is +X in the forward direction (relative to datum) and -X in the backward direction. "Map view" (wall top) of an

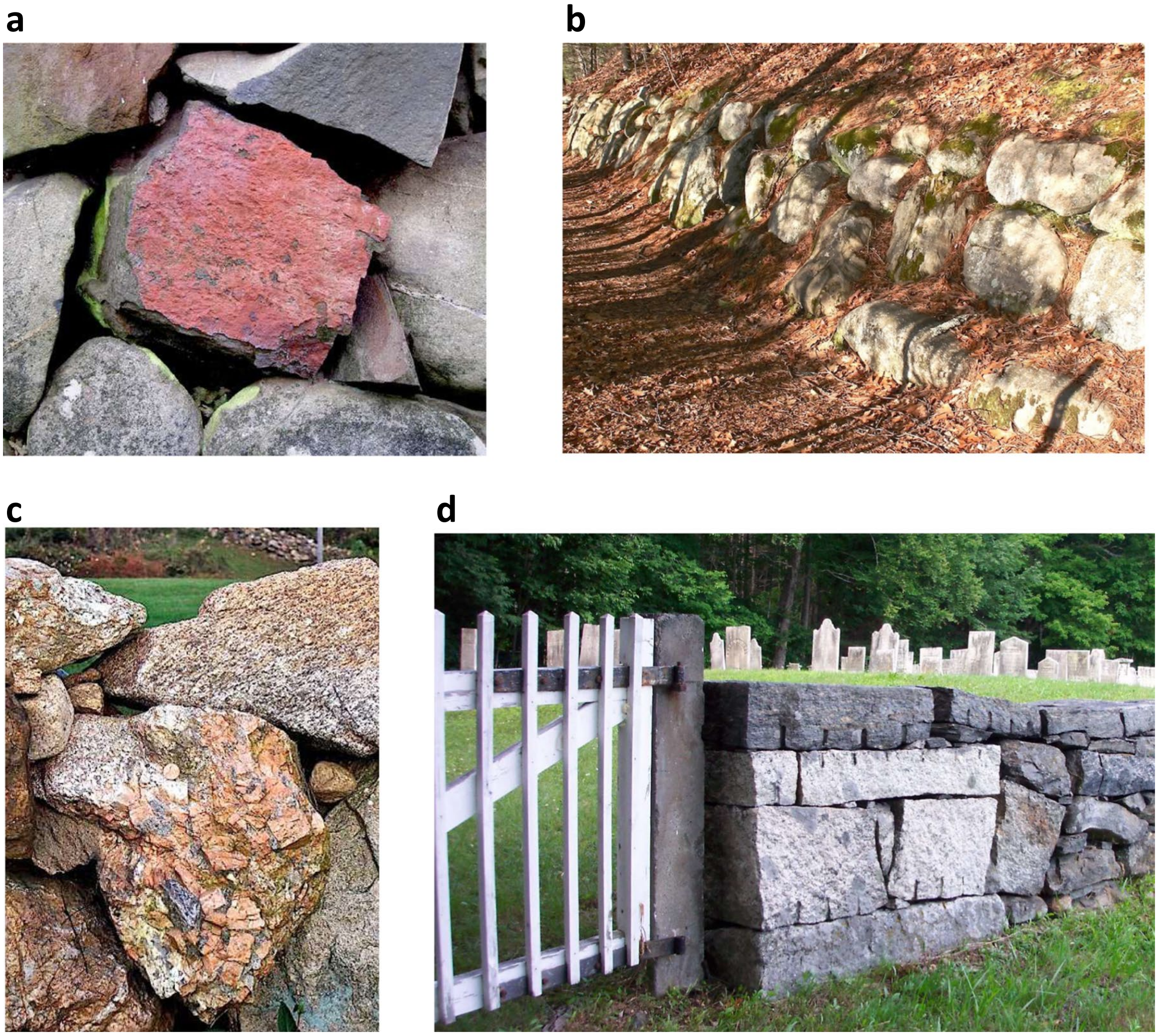

Fig. 6 Examples of contrasting of materials and sources. (*a*) Laid single wall in Farmington, Connecticut, built of angular basalt traprock talus at top and rounded gneiss boulders at base. The central stone is coated with red jasper as a hydrothermal precipitate. (*b*) Pitstone (from gravel pit) of granite laid in normal (*Subtype),* retaining *(Type),* flanking *(Family)* wall *(Class)* in Concord, Massachusetts. (*c*) Coarse (pegamatite) pink granite in stacked single wall in Block Island, Rhode Island. (*d*) Laid cemetery wall in central New England showing gate post of imported bluestone sawn into shape, two lithologies of quarried slabs showing drillholes, and gravestones consisting of imported marble. (Photos by author; *a*, *c*, and *d*, 2004–2012; *b*, 2017.)

individual segment is the XY plane seen from above (+Z). "Profile view" (wall face) is the XZ plane on either the left (-Y) or right (+Y) sides. "End view" (wall tip) is the YZ plane seen in the look direction (+X) or back-look direction (-X). When wall segments are incorportated as GIS shapefiles, the XY field coordinates typically refer only to the wall's midline and migrate to the geoidal reference frame of latitude, longitude, and azimuths.

WALLS: Walls consist of one or more segments aligned (or broadly curved) in map view (XY). Walls extend across stone-free gaps (built gates, never-built portions, collapse, removal), including abandoned road or cartway (~4–6 m) passages, called "barways." The beginnings and ends of walls are "terminations." Though a wall can have one or many segments, there are only two terminations: the beginning of the

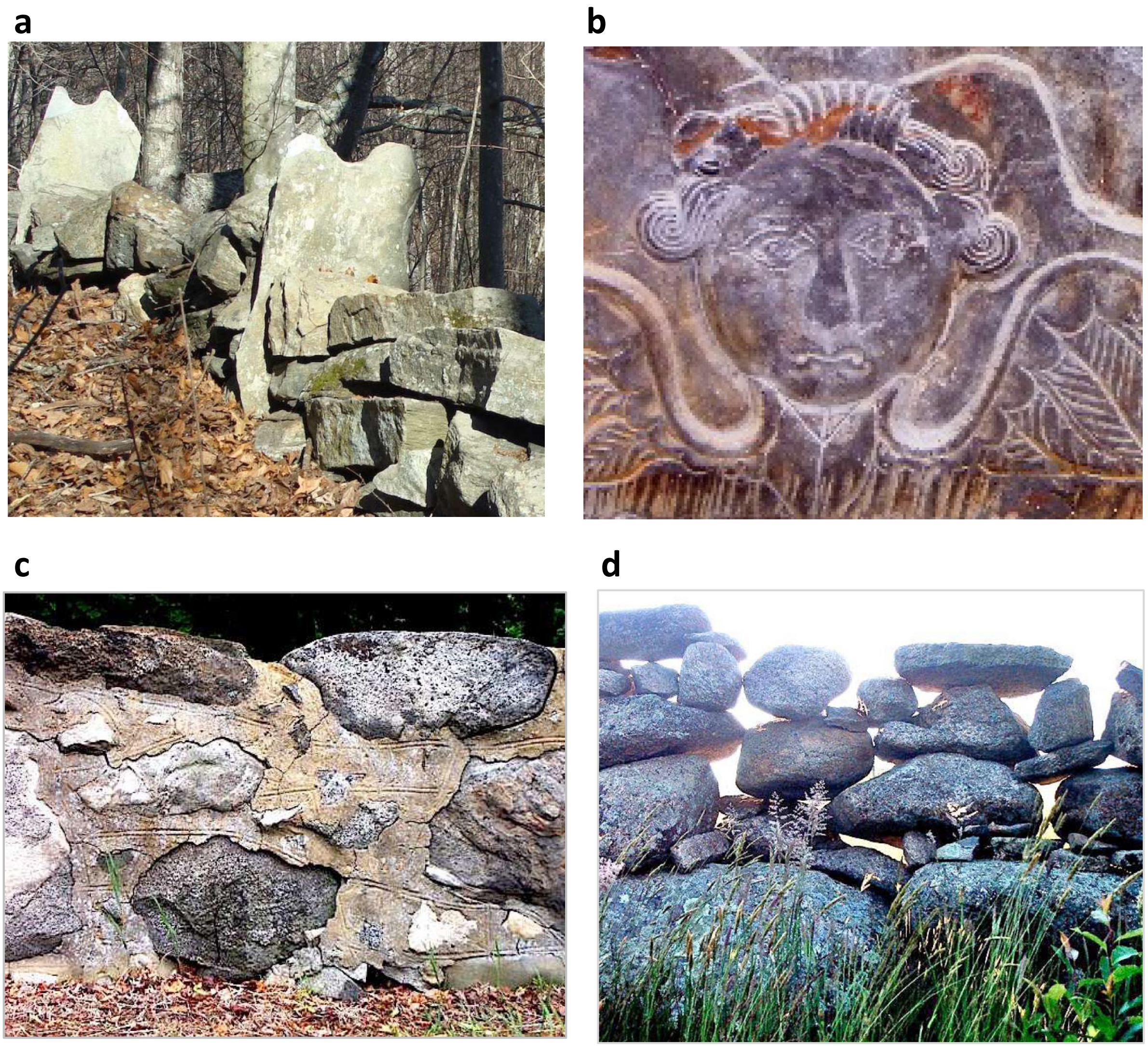

Fig. 7 Examples of contrasting tool marks and wall form. (*a*) Tablet-shaped "saddle stones" notched to hold wooden poles for an alleged sheep fence in Canterbury, Connecticut. Slabs of single wall abut vertical tablets. (*b*) Inscribed 17th-century Puritan "slate" gravestone in Concord, Massachusetts, a notable stone. (*c*) Surface smear of concrete mortar (wet wall) on face of otherwise drystone single wall in western New England. (*d*) Lace Wall in Chilmark, Martha's Vineyard, Massachusetts, is an Open (*Variant*) Paneled (*Subtype*) Single (*Type*) Freestanding (*Family*) wall (*Class*). (Photos by author; *a*, *c*, and *d*, 2004–2012; *b*, 1989.)

first segment and end of the last. Within walls, segments meet at "contacts." At "abutting" contacts, the segments are built against one another, rather than being interwoven, making the contact between them an actual (often vertical) line. At woven contacts, the segments junction with the stones overlapping each other at the contact, making the contact between them an arbitrary (usually vertical) line. At "gradational" contacts, segments grade into one another at or exceeding the meter scale, making the contact between them an arbitrary line at the midpoint between the transition. A "gap" contact between two segments is used when there's a stone-free space within the line of the wall. Gap contacts may be "built" or "unbuilt." If built, they are usually more carefully built than the bulk of the segment being considered because the segment

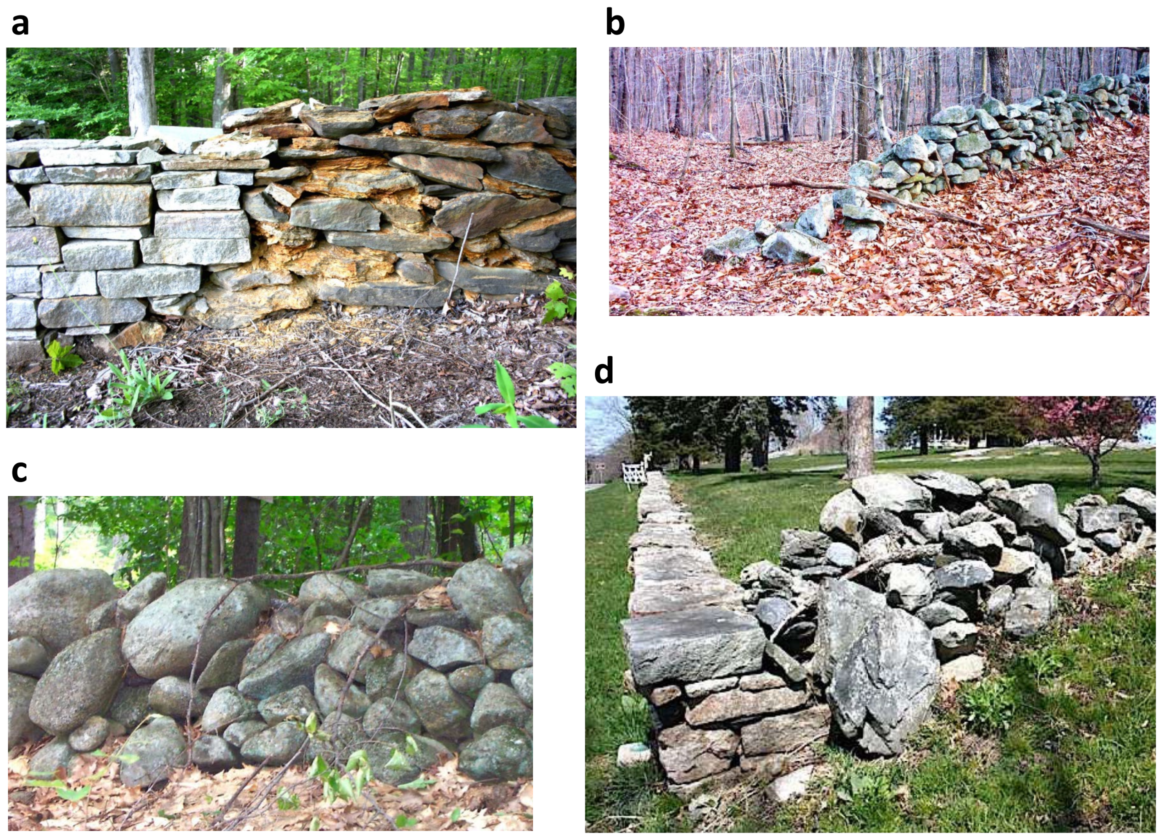

Fig. 8 Examples of contrasting terminations (ends of walls) and contacts (ends of wall segments). (*a*) Segment of laid double wall of quarried granite slabs was built against a disintegrating segment of single wall dominated by quarried (pyrrhotite-bearing) schist. By definition, this one wall has two abutting segments with a non-vertical contact. (*b*) Unbuilt tip of final segment of single wall is a termination. (*c*) Wall in southern New Hampshire shows steeply inclined gradational contact between a segment of assisted boulders to left and segment of hefted stones to right. (*d*) Older stacked fieldstone single wall (to right) terminates with younger laid quarried wall to left with an abutting, "L" junction to right, in Tiverton, Rhode Island. The older wall was locally rebuilt. (Photos by author; *a*, 2018; *b* and *c*, 2004; and *d*, 2008.)

requires support in the -X or +X directions in addition to those of the the -Y and +Y directions. A "bend" contact is noted when the forward line of the wall changes abruptly at an angle <45°, either in a kink or sharp curve, but the wall continues. "Terminations" are either "tips" or "junctions." At tips, walls end without meeting another wall. Built tips are stacked or laid in the cross-sectional direction (YZ) plane for extra strength. Unbuilt tips usually the result of a wall not being completed all the way to a junction, or the stones being later removed for use elsewhere. At junctions, walls intersect other walls, typically with abutting or woven terminations, usually in the shapes of the letters L, T, X (which involve roughly perpendicular junctions), and Y (which involve obtuse angles). Walls may also junction with sharp curves, essentially rounded corners.

PARCELS: Walls can be, but seldom are, isolated or singular. Normally, two or more walls junction to outline "parcels" of land that, in New England, are usually four-sided rectangular or rhomboidal areas. Parcels most commonly adjoin one another on opposite sides of a shared wall with distinct faces. For the case of isolated farmsteads, the outermost parcels often define the edge of land conversion.

MATERIAL: Stone is an "object" composed of the "material" rock. Rock is an aggregate of one or more minerals. In decreasing order, the most common rock lithologies in New England wall stone are probably gneiss, schist, granite, quartzite, slate, marble, and basalt. Locally there are walls of sandstone, limestone, conglomerate (puddingstone), and others. Stone can also be synthetic, especially since the 20th century. Some originally mortared (wet) walls have disintegrated and been rebuilt as unmortared (drystone) walls.

STONE SOURCE: Most stone in walls is "fieldstone," the residues of adjacent agricultural fields and pastures, and other sources (Fig. 6). The bulk of this residue stone came from a loose, irregular stratum of glacial meltout till (basal and supraglacial), with smaller amounts coming from lodgement till and coarse glaciofluvial sediment. Virtually all stone was broken (quarried) from jointed bedrock, entrained by moving ice, and shaped by subglacial processes, most significantly by milling (rounding through crushing) the sharp corners. Though the stones in walls are often broadly similar to those from nearby glacial till, there are notable discrepancies between these populations due to human fractionation for size and shape preferences, particularly for laid foundations. "Quarrystone" refers to any stone extracted from bedrock quarries, a source usually indicated by: cutting, drilling, and hammering marks; rough, generally flat surfaces; and limited weathering. "Pitstone" refers to stone from excavated pits in unconsolidated sediment, the barrow pits of gravel mining operations. This source is usually indicated by abrasion (scrape), crushing, or percussion marks on rounded stone.

STONE SIZE: Stone size follows a continuum from small cobbles (fist-sized) to that of the Madision Boulder, the largest glacial erratic known in New England (25 × 11 × 7 m), weighing upwards of 5,000 tons (Figs. 4, 5). Stones of pebble size or smaller are seldom present in walls. "One-handers" are fragments that can be lifted with one adult human hand, usually cobbles; "Hefted" are those lifted directly into the wall, usually with two or more human hands; "Assisted" are larger stones whose placement required some form of assistance unseen by the observer, perhaps dragging by livestock and/or lifted by gantrys, tripods, pulleys, ramps, mechanical lifters, etc. "Residual stones" are those that were too big to be moved. Boulders are large rounded stones, technically anything larger than head sized, but, by convention, anything at least twice that size. Large glacial erratics are boulders in size, but most often not in shape.

STONE SHAPE: Though the vast majority of stones have an irregular shape, they can be approximated by assigning them lengths, widths, and thicknesses (see Figure 4*a*, *b*, and *c*, respectively). This lowercase designation for clasts from sedimentology is used instead of X, Y, Z for segments. The b axis (width) is also known as the intermediate diameter (ID). There are two fundamental distinctions involving stone shape: Most important is the degree to which the three axes, a, b, and c, approximate each other. In the extremes, a cube has a = b = c and a blade has a >> b >> c. The second distinction is the degree to which an originally sharp-angled fragment quarried along bedrock joints was milled into a rounded shape, usually within the glacial shear zone during transport. The conversion from sharp-edged to rounded members of this continuum, respectively, are: blocks to balls (a = b = c), slabs to pillows (a > b > c), tablets to disks (a = b >> c), prisms to columns (a >> b = c), and blades to dull blades (a >> b >> c). During glacial transport, the continuum of strength/survivibility of the original shapes goes from blocks and balls (strongest) to slabs and pillows, to tablets and disks, to prisms and columns, to and blades and dull blades. Other shape names are not described here.

DEGREE OF ORDER: The arrangement of stone within a wall ranges from highly ordered to merely dumped (Fig. 9). Completely unordered is the degree called "dumped," with no investment of stacking or fitting the stone. This term is used regardless of whether the stone was dumped as a population or tossed individually. Next is "stacked," in which the stones are merely placed or stacked above one another, with a minimum of forethought. Next is "laid," the work of masonry, in which large and small stones are carefully fitted and placed to obtain minimum surface porosities and maximum strength. Finally, there is "patterned," a design of some sort, a degree of order distinct from laid, and usually beyond it. Any degree of order above dumped is considered "built."

MATRIX: Matrix refers to material within the void spaces of larger stones. The vast majority of New

Fig. 9 Examples of degree of order in wall construction. (*a*) Single wall at Nathan Hale Homestead in Coventry, Connecticut, shows three segments defined by different degrees of order: dumped, stacked, and laid. (*b*) Wall in Weld, Maine, near the northern end of the common occurrence of New England walls is dumped, a characteristic of pioneering farmsteads. (*c*) Blocks and slabs of granite near Lake Sebago, Maine, show hefted blocks and slabs above assisted stones, a common pattern in the stacked degree of order. (*d*) Mortared stones at Newport, Rhode Island, show a mosaic of large and small stones indicating a patterned degree of order. (Photos by author, 2004.)

England walls are "dry" stone walls, which lack a matrix other than air. Most were built on strong soil and are composed of stones resting on one another, giving rise to considerable internal void space (porosity). Mortared walls, known as "wet" walls, have a mortar matrix, usually concrete with sand aggregate (Fig. 7*c*). Many mortared walls are only partially mortared, typically on the capstone course, the face, or as a bead below the capstone course. Double walls contain an interior core of smaller stones (heartstones, or "hearting"), usually consisting of rubble, occasionally with some granular sand. Walls low to the ground or sunk into it often have a soil matrix composed of decomposed organic matter. Submerged walls have a water matrix. Walls buried by sediment have a sediment matrix.

INTERNAL STRUCTURE: In the vertical direction (XZ and YZ), walls consist of "tiers" and "courses" (Fig. 10) A tier is any vertical section of the wall that is similar in stone size, shape, and placement, for example, a "foundation" tier of larger boulders or a cap tier of quarried slabs different from those in the bulk of the wall. A tier may consist of one or more courses or horizontal layers of stone. Tiers and courses create a

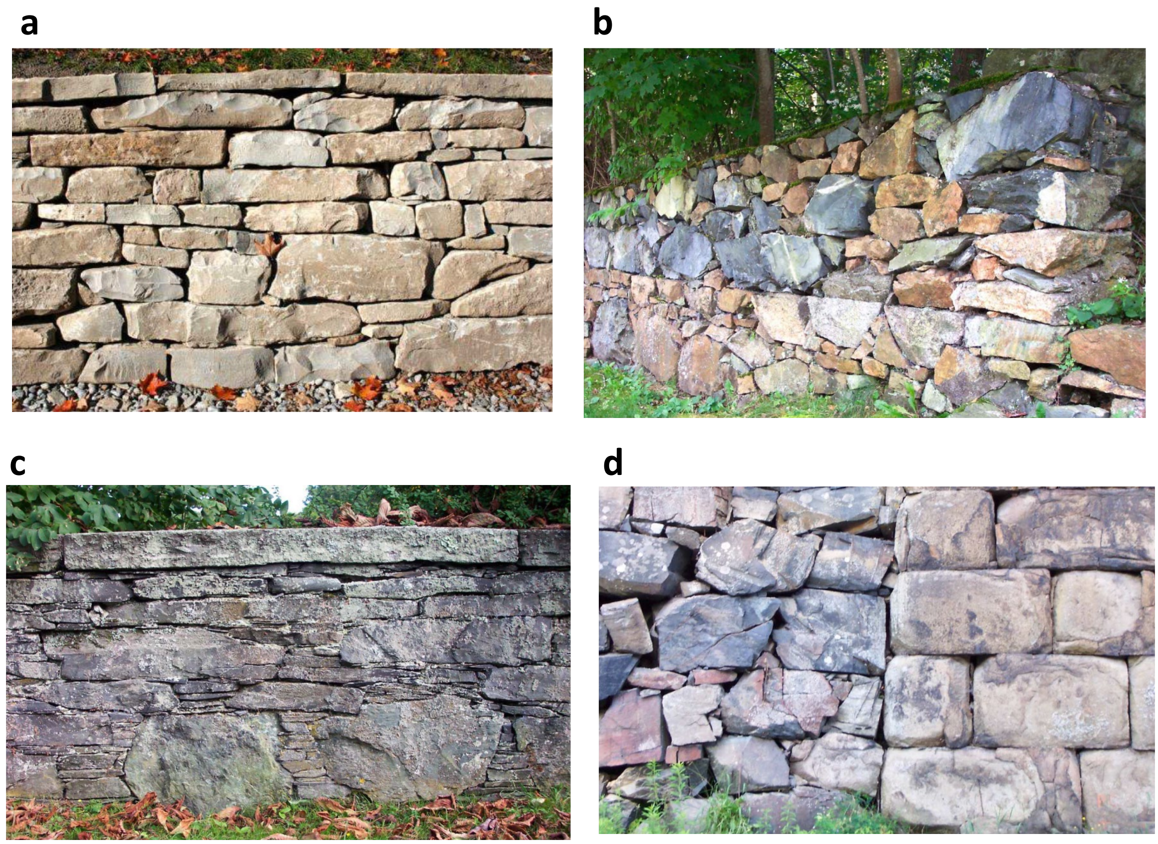

Fig. 10 Examples of tiers, lines, and courses in stone walls. (*a*) Two tiers in a laid wall in Hope, Ontario, with well-defined courses composed entirely of quarried dolomite. The top tier is defined by a single course of longer, thinner, more tablet-shaped stones relative to the underlying slabs. (*b*) Two well-defined tiers of angular quarried rubble in laid wall without courses in Newport, Rhode Island (note carefully laid corner). (*c*) Three-tiered, coursed, complex, patterned, carefully laid wall in Newport, Rhode Island, with almost no visual porosity. From the top down are capstone, main, and blocky tiers. (*d*) Detail of two large walls laid for a railroad trestle in central Vermont. The X direction is into the page, indicating these are separate lines laid parallel to one another to form an Aligned Hybrid Wall. To the right is the original, built of quarried blocks. To the left is rubble built against it to support another track. (Photos by author, 2000–2004.)

horizontal grain analogous to strata in geology. In map view (XY), only the best built walls are symmetrical. Most are asymmetrical, with one side (face) being more or less well-built than the other. Extra lines of stone are often dumped or stacked against preexisting walls, creating hybrid walls. In cross section (YZ) the shape of walls varies from: "mounded," a broad convexity; "triangular," the common shape of a single wall; "trapezoidal," the common shape of a battered double wall (width at top is shorter), and rectangular, a "panel" of stacked single stones. Rare, but conspicuous, is a hybrid wall in which a double wall provides a foundation tier for a single wall above it, a form known as a Galway Dyke in Scotland.

Taxonomy

The "stone domain" is the total set of all cultural stone objects in outdoor settings. This taxonomy deals only with the visible, above-grade portion of that domain. It defines, distinguishes, and illustrates the taxa. Figures 11, 12, 13, 14, 15, and 16 provide a gallery of photographs arranged by taxonomic rank and linked to specific taxa. For clarity, each nested level of subdivision (five taxonomic ranks) is described using a consistently different text style: CLASS, **Family**, *Type*, *+Subtype*, and **Variant*. Table 1 summarizes the terminology previously discussed and used as criteria. Table 2 identifies the hierarchical

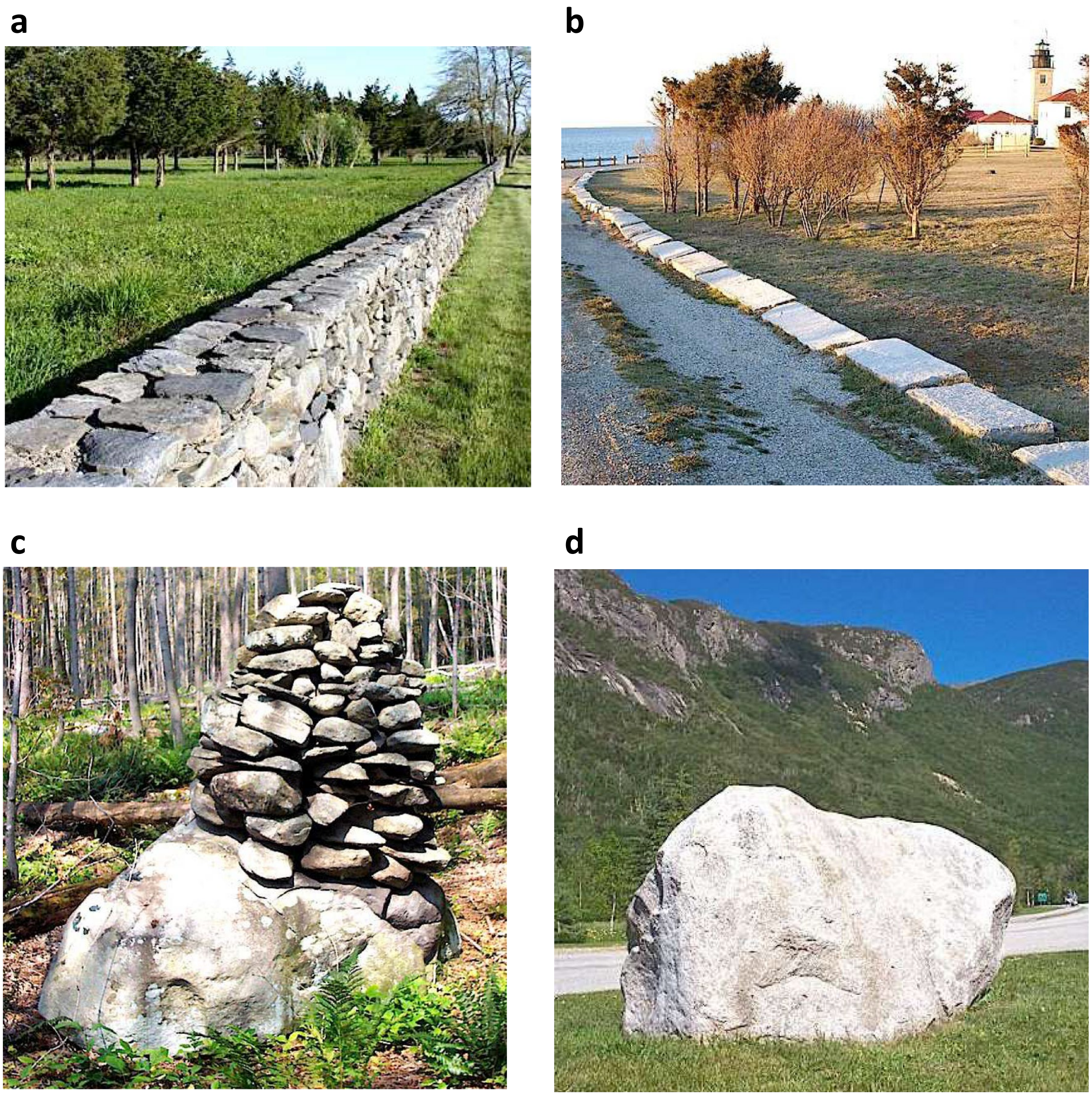

Fig. 11 Examples of all four classes within the stone domain. (*a*) Walls meet the material, granularity, elongation, continuity, and height criteria. This is a recently built Normal (*Subtype)*, Double (*Type*), Freestanding (*Family*) wall *(Class).* (*b*) Lines fail either the continuity or height criteria. Low (*Family*), Border (*Type*), Line *(Class)* of quarried granite, Beavertail, Rhode Island. (*c*) Concentrations fail the elongation criterion. Detached (*Type*), Upright (*Family*), concentration (*Class)* of fieldstone above a boulder in Berkshires, Massachusetts. (*d*) Notable stones fail the granularity criterion. Outsized (*Family*) Erratic (*Type*) notable stone *(Class*), a glacial boulder of granite in Franconia Notch, New Hampshire. (Photos by author, 2004–2009.)

list of all taxa; the diagnostic criteria used to isolate each uniquely; the vernacular or folk names commonly applied to that taxa; and the unique common names for each unique taxa at the level of *Type* or lower. Appendix 1 (Supplementary Materials) is a "dichotomous key," a.k.a. decision tree, based on the presence/absence of diagnostic criteria, a.k.a. a stepwise algorithm of yes/no choices to define all taxa. The following text is a more intuitive narrative than the stepwise algorithm.

The first class to emerge from the "stone domain" (because it is easiest to isolate) is NOTABLE STONE

Fig. 12 Examples of all four types within the class Notable Stone. (*a*) Outsized (*Family*) Erratic (*Type*), unmarked, unshaped, boulder of granite in Mansfield, Connecticut, in original position. (*b*) Outsized (*Family*), Placed (*Type*), unmarked, unshaped stone of weathered marble in Litchfield Hills, Connecticut, was moved for landscape ornamentation. (*c*) Modified (*Family),* Shaped (*Type),* gravestone in Mansfield, Connecticut, was shaped and marked. (*d*) Modified *(Family)*, Unshaped (*Type),* Marked (*Subtype),* granite boulder (Settler's Rock, Block Island, Rhode Island) was only slightly shaped. (Photos by author, 2001–2012.)

(Fig. 12), differentiated from the other three classes because the object being classified is a singular object, rather than part of a granular population. They cannot be parts of larger structures. The family **Modified** stones are those significantly shaped and/or marked by humans, usually bearing tool marks, inscriptions, or decorations. This excludes scrapes and scratches caused by human movement. Modified stones divide into types that are *Shaped* (as with posts and gravestones) or *Unshaped* (as with boulders bearing plaques).

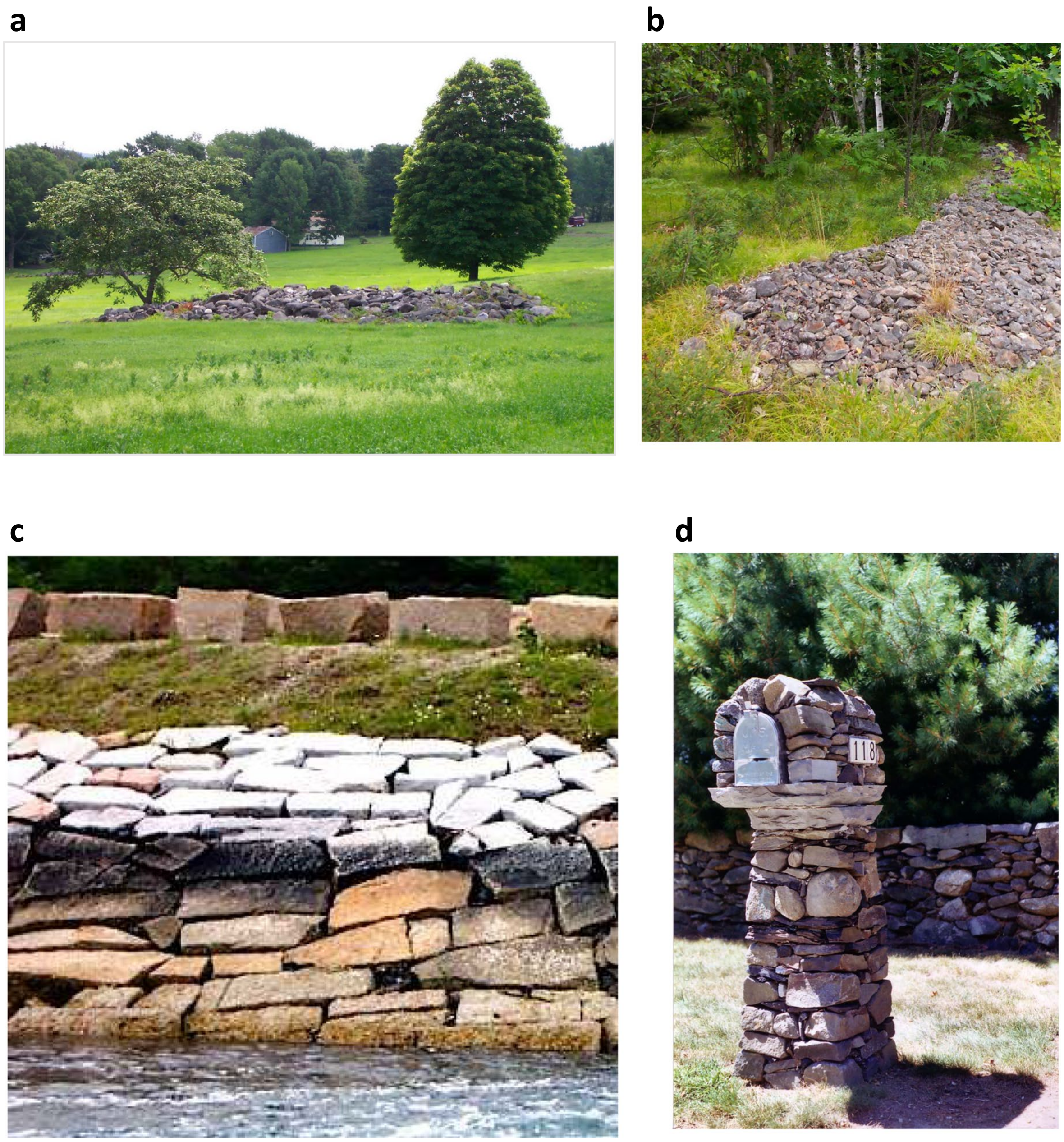

Fig. 13 Examples of both families within the class Stone Concentration. (*a*) Normal (*Subtype)* Pile *(Type)* in southern Maine is diagnostically isolated, above grade, crudely circular, and unusually large. (*b*) Normal (*Subtype)* Pile *(Type)* in Acadia National Park, Maine, consists entirely of the size one-handers. (*c*) Built (*Family*), Surface (*Type*), Veneer *(Subtype)* in Acadia National Park, Maine, is sloped for erosion control. Above the veneer is a dashed (*Type*), high (*Family*) line (*Class)* of quarried slabs of pink granite. (*d*) Detached (*Subtype*), Upright *(Type),* Built *(Family),* Concentration (*Class)* with three tiers built to the laid degree of order for mailbox in Jamestown, Rhode Island. (Photos by author, 2004.)

The unshaped subtype *+Standing* stones (dolmens) are elongated with the a axis normal to the earth's surface, yielding a high center of gravity, an unstable and unlikely natural arrangement. Others belong to the subtype *+Stable*, idenfified by markings only. The family **Outsized** stones are anomalously large outliers

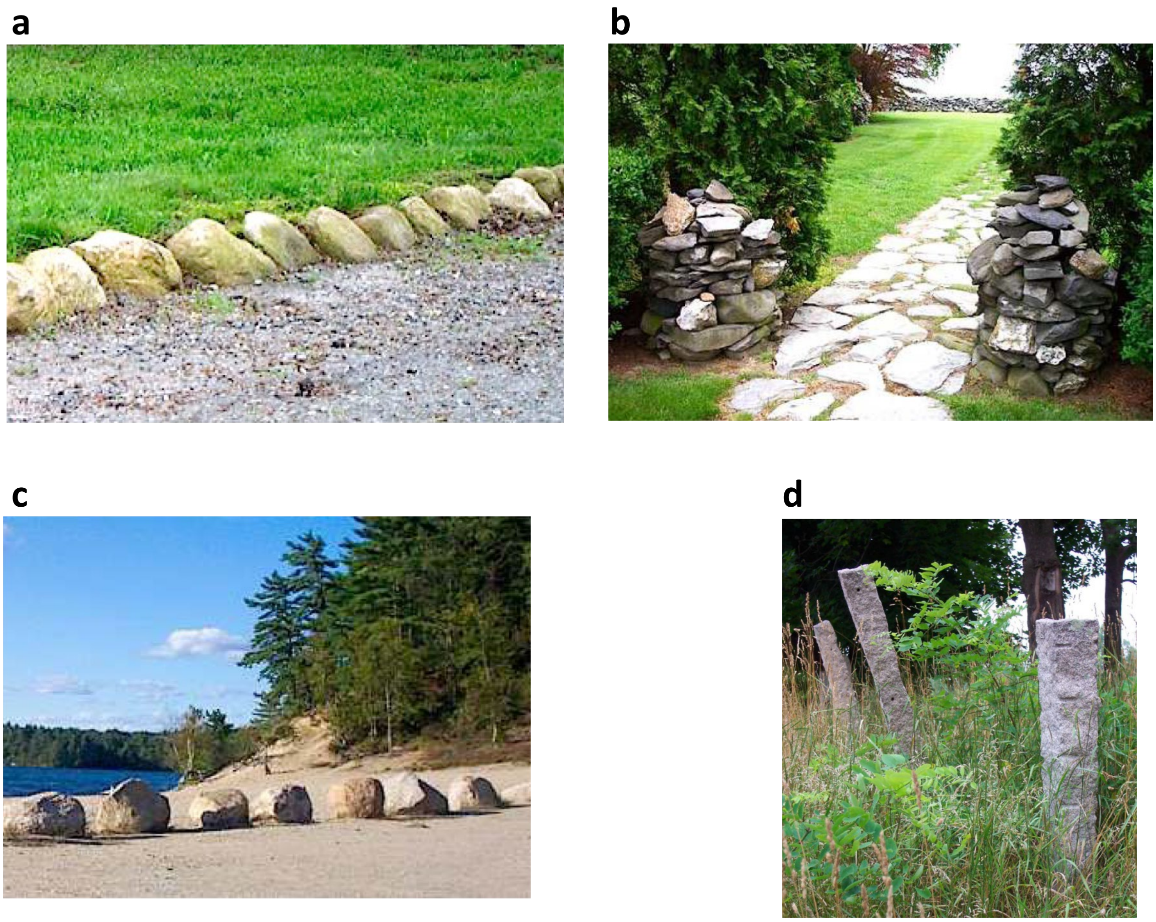

Fig. 14 Examples of all four families within the class Stone Line. (*a*) Low (*Family)* Border (*Type*) is one-stone-thick line of abutting small boulders marking boundary between two surfaces in Jamestown, Rhode Island. (*b*) Low (*Family)* Divider (*Type*) is walkway in Jamestown, Rhode Island, between two detached upright concentrations. (*c*) Dashed (*Type*) High (*Family*) line in Exeter, Rhode Island, has boulder spacings less than the diameters. (*d*) Dotted *(Type)* High (*Family*) line is Limerick, Maine, has widely spaced posts of cut granite. (Photos by author, 2004–2009.)

of the nearby stone population, but are otherwise not intentionally modified by humans. Field evidence of human movement, usually conisting of scrape marks or crushing damage, differentiates this family into *Placed* stones, which are stones used for landscaping that bear those marks, and *Erratics*, which show no evidence of human movement, but are often designed around.

Having isolated and partitioned the class NOTABLE STONE, the remaining three classes are all granular; made of populations of stones. The simplest outgroup to isolate are nonlinear CONCENTRATIONS whose L/W ratios are <4 and usually have small surface areas (<100 m^2). The simplest are discrete masses with a dumped degree of order, suggesting they are sites for disposal of stone waste. These belong to the family **Dumped** concentrations. If the bulk of the concentration is on soil grade and the stones are not touching (usually quasi-linear clusters of boulders), it is the type *Scatter.* If the bulk of touching stones occur in a topographic depression at or below adjacent soil grade, it is assigned to the type *Fill.* If the bulk rises above soil grade as an eminence, it is assigned to the type *Pile.* Piles above or adjacent to stone walls are grouped into the subtype *+Attached*, which may be further differentiated into variants **Corner* or **Segment* attached piles. The vast majority of piles are randomly distibuted and lack hollow centers.

Fig. 15 Examples of all five families within the class Stone Wall. (*a*) Normal *(Subtype)* Single (*Type)* Freestanding (*Family)* wall in Storrs, Connecticut, has two faces. This is by far the most common type of wall in New England. (*b*) Armoring (*Type)* Flanking (*Family)* wall supports and prevents erosion of preexisting stream bank in interior Maine. Flanking walls have only one face. Note that stones support one another. (*c*) Small (*Type)* Supporting (*Family)* wall of cellar in southern New Hampshire supported a small house. The top tier is laid (degree of order) and horizontal. (*d*) Square (*Type)* Enclosing (*Family)* walls surround the town pound in Harvard, Massachusetts. The walls are similar, high, strong, and not horizontal. (*e*) Faced (*Variant)* Dam *(Subtype)* of Perpendicuar (*Type)* Blocking (*Family)* wall supports impervious fill to block the flow of water to impound a now-drained millpond in Mansfield, Connecticut. (Photos by author, 2004–2012.)

They are assigned to the subtype *+Normal*. These have a broad range of shapes, typically sprawling oblongs that are convex skyward, that are higher on one side, presumably the side from which it was built. Piles are also commonly dumped in places preempted from other uses, such as on tree stumps, large rocks, or in streams. If distinct but widely spaced piles are aligned in a row, they are assigned to the subtype *+Aligned*. These occur most commonly when loads of stone have not yet coalesced into a

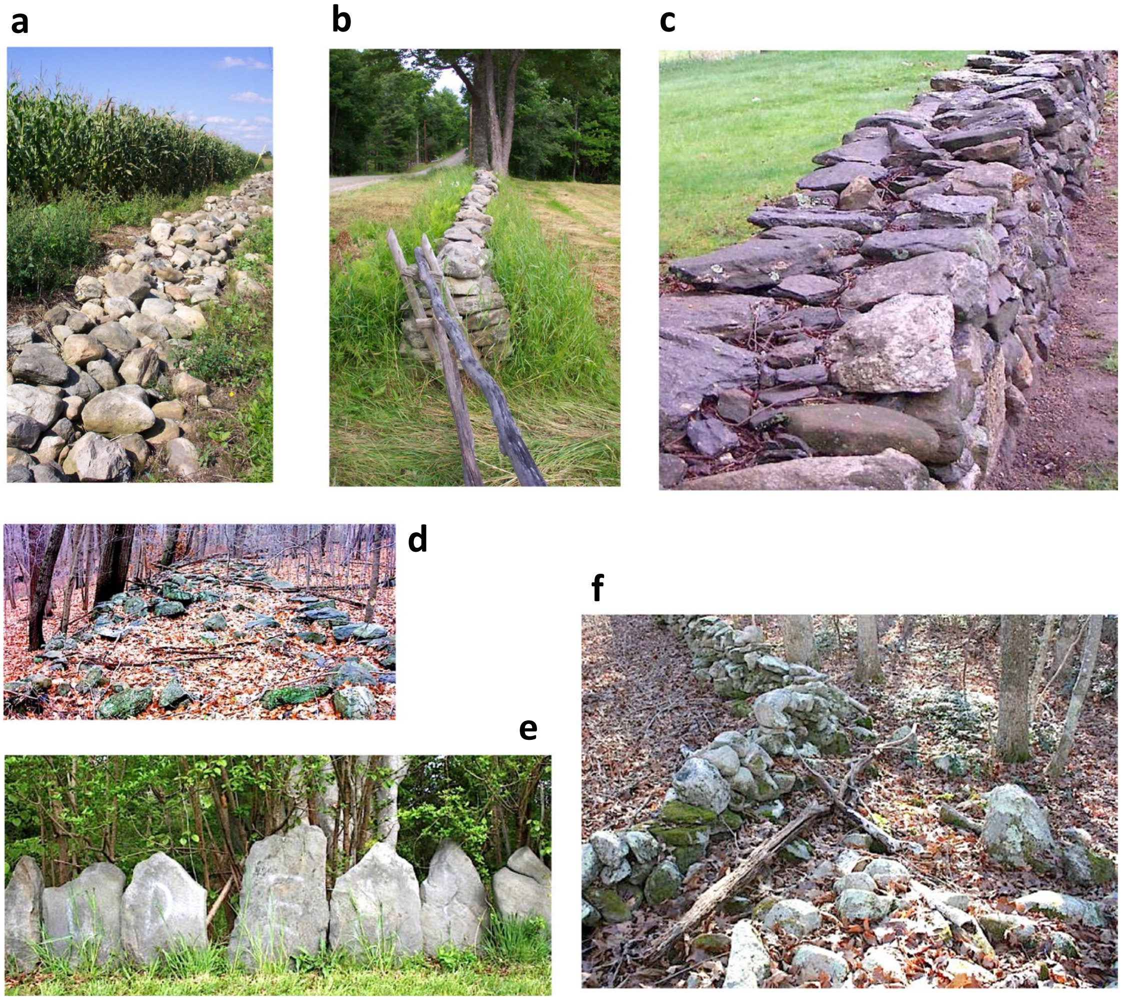

Fig. 16 Examples of all six types within the family Freestanding in the class Wall. (*a*) Normal (*Variant*) of Upland *(Subtype)* Band (*Type)* in Voluntown, Connecticut, defined by dumped (unbuilt) structure. (*b*) Fitted (*Variant*) of Normal *(Subtype)* Single (*Type)* wall in southern Vermont defined by uppermost course being single stone thick. (*c*) Normal *(Subtype)* Double (*Type)* wall in Storrs, Connecticut, defined by having two separately built faces. (*d*) Normal (*Subtype*) of Broad (*Type)* wall in Mansfield, Connecticut, defined by extra width between separately built faces. (*e*) Pale (*Variant*) of Inequant *(Subtype)* Abutting (*Type)* wall of unknown location defined by tablet-shaped stones abutting one another. (*f*) Aligned *(Subtype)* Hybrid (*Type)* wall in Ashaway, Rhode Island, defined by alignment of two types, a single wall to *left* (with a bend) and a band (*right*) to create a single asymmetrical wall. (Photos by author, 2004–2012.)

primitive freestanding wall type (stone band). Piles with hollow centers are the subtype +*Ring* piles. The ring variant *Large (approximately >1 m) develop most commonly above trees or stumps that have since rotted away, making them particularly common in former orchards. They also develop around charcoal pits and firepits. The ring variant *Small are typically associated with wooden posts and small orchard trees, and can be aligned.

Concentrations that are arranged by stacking belong to the family **Built.** The next distinction is whether they are of the type *Surfaces* or *Uprights*. In *Surfaces*, stone replaces soil on grade. If grade is subhorizontal, they are the subtype +*Pavement*. Included are familiar cobblestone pavements and patios that are less than four times long than wide. The rare sister subtype of +*Veneers* are built on sloping surfaces, usually to prevent erosion. Veneers grade into the armoring subype of the family

Table 2 Taxa of the stone domain with diagnostic criteria and common names

Taxon Names by Rank					Common Names		Diagnostic Criteria for Taxa at Specified Rank				
CLASS	***Family***	*Type*	*+Subtype*	**Variant*	This study	Vernacular, informal typology	Class	*Fam*	*Type*	*+Subt*	**Variant*
WALL					**STONE WALL**	Fence, row, dyke, line	MEETS ALL CRITERIA: MATERIAL, GRANULARITY, ELONGATION, CONTINUITY, HEIGHT				
	Freestanding					Two-faced, double-sided		*Two faces from base up*			
		Band				Dump, fenceline stone			*Dumped degree of order*		
			Upland							*Above drained soil of upland terrain*	
				Normal	Stone Band	Tumbled, heaped, tossed, robbed					Ribbon-shaped in width
				Patterned	Patterned Band	Zigzag, beaded, aligned piles					Variation in direction, width, etc.
			Lowland		Causeway Band	Causeway, fords, road, path				*Within poorly drained soils of lowland terrain*	
		Single							*Top tier has single stack*		
			Normal		Single Wall	Fence, pasture, farm, tossed				*Broader bases, triangular cross section*	
			Panel							*Single stone wide, bottom to top*	
				Fitted	Panel Wall	Cordwood, chinked, tight					Visual porosity is low
				Open	Lace Wall	Lace, cannnonball, sheep					Visual porosity is high
		Double							*Two built faces from base up. Width for structural support*		
			Normal		Double Wall	Double, two-faced, farmstead				*No capstone course*	
			Capped							*Top course spans both faces*	
				Capstone	Capped Double Wall	Estate, fancy, architectural					ab planes of upper course horizontal
				Copestone	Coped Double Wall	Coped					ab planes of upper tier vertical or angled
		Broad							*Two built faces from base up. Width greater than structural support*		
			Normal		Broad Wall	Consumption, disposal, walking				*Above well drained soils of upland terrain*	
			Lowland		Crossing Wall	Causeway, culvert, bridge				*Above poorly drained or unstable soils, or streams*	
		Abutting							*Large, unstacked, stones placed end to end*		
			Equant							*Equant to sub-equant stones (a~b~c)*	
				Block	Block Wall	Stone line					Angular stones
				Boulder	Boulder Wall	Stone line					Rounded stones
			Inequant							*Non-equant stones: slab, tablular, and prism*	
				Pale	Pale Wall	Pale, picket, edging					High center of gravity. B axis parallel to line of wall
				Rail	Rail Wall	Cut stone foundations					Intermediate center of gravity. B axis vertical.
				Slab	Slab Wall						Stable center of gravity. B axis parallel to grade.
		Hybrid							*Two or more wall types merged*		
			Tiered		Upright Hybrid Wall	Superimposed				*Merger is vertical (in Z) with one taxon built on another*	
			Aligned		Aligned Hybrid Wall	Parallel				*Merger is horizontal (in X) with on taxon built against another*	
	Flanking							*Single face perpendicular to break in slope (scarp) between levels (treads)*			
		Retaining							*Near-vertical wall supports and(or) protects adjacent treads.*		

Flanking Walls when the stones rest one above another for support, as with many sea walls on sloping banks.

In contrast, the *Upright* type of the Built family of concentrations are stacked, laid, or patterned structures more than one stone thick that range in height up to many meters, for example, the Bunker Hill Monument near Boston. Most uprights are *+Detached* and isolated, as with marker cairns, and the nearly ubiquitous, one-on-one stacks of stone sometimes called meditation stacks. Also common are less transient cairns and monuments marking trails and vistas of many sizes and shapes, and stacks built merely to hold waste stone efficiently. In contrast the subtype *+Support* uprights usually come in multiples and were created to support something from below. This category includes: the pillars that once supported bridges from below; built corners for farmstead outbuildings; and the foundations within cellars to support chimneys.

At this point there are only two classes left, STONE LINES and STONE WALLS. By definition, these, are significantly elongated, usually with L/W ratios of 10:1 or greater, well above the threshold ratio of 4:1. Stone walls are continuous and elevated, whereas stone lines fail to meet one or both of these criteria. The family ***Low*** lines fails the height criteria (knee-high or stone-on-stone), and are usually abutting, but need not be. If the line separates two different areas or soils, for example, garden on one side and yard on the other, it belongs to the type *Border.* If it divides a single uniform area, it is the type *Divider.* Stone walkways through a yard, stepping stones across a swampy brook, or a cobbled roadbed are dividers. Differentiating borders from dividers on ancient farmsteads requires examining the soils on both sides.

The family **High** lines are high enough to qualify as walls, but fail the continuity requirement. They are very common today, mostly as large boulders and slabs in open areas aligned to allow pedestrian access but block vehicles. Had the stones been pushed together to abut, they would have become a stone wall. High stone lines can be of the type *Dashed* if the gaps between the stones are smaller than the average diameter, or the type *Dotted,* if the gaps are usually wider than the average stone diameters. Stone

Table 2 (continued)

			Normal		Retaining Wall	Retaining, cut or fill					Supports an upslope cut and(or) downslope fill
			Regolith		False-retaining Wall	Half-buried					Colluvial sediment is banked upslope
		Armoring			Riprap Wall	Riprap, roadcuts, sea			*Sloping wall protects scarp of slope between treads*		
	Supporting					Building foundations		*Top course horizontal and level with laid degree of order*			
		Small			Cellar Wall	Cellar holes			*House-sized, large, top tier at or just above grade.*		
		Large			Foundation Wall	Barn, building foundations			*Barn-sized, top tier at or above grade*		
	Enclosing							*Continuous, uniform, simultaneous structure, waist+ high (need not be level)*			
		Square			Squared Enclosure	Pound, corral, pen, yard, cistern, stone building			*Two or more woven squared segments around small enclosure*		
		Circular			Circular Enclosure	Silo, cistern, kiln, charcoal ring			*Circular single segment*		
	Blocking							*Stone holds back (blocks) flowing water or supports earth that does*			
		Perpendicular							*Blockage perpendicular to stream*		
			Dam			Mill dam, reservoir dams				*Continuous at or above bank*	
				Faced	Stone-faced Dam	Traditional mill dam					Supports low permeability material that blocks water
				Stone	Stone Dam	Tightly built dam, dimension stone					Cut blocks of dimension stone block water directly
			Check dam		Check Dam	Flood control, in-stream pools.				*Below bank within channel, locally large stones*	
		Parallel				Dikes			*Blockage parallel to stream*		
			Levee		Levee Wall	Levee (holds stream in)				*Adjacent to flood channel, impervious*	
			Dike		Dike Wall	Dike (prevents stream access)				*Adjacent to potentially flooded lowland,impervious*	
LINE					**STONE LINE**		FAILS CRITERIA OF HEIGHT OR CONTINUITY				
	Low							*Fails height criterion but meets continuity criterion*			
		Border			Border Line	Borders, raised beds, walkway			*Line between two areas*		
		Divider			Divider Line	Borders, raised beds, walkway			*Line through a single area*		
	High							*Fails continuity criterion but meets height criterion*			
		Dotted			Dotted Line	Stone Posts, rock dots			*Average space lengths > average stone diameter*		
		Dashed			Dashed Line	Walkways, borders			*Average space lengths < average stone diameter*		
CONCENTRATION					**STONE CONCENTRATION**		FAILS CRITERION OF ELONGATION				
	Built							*Stacked, laid, or patterned degree of order*			
		Surface							*Touching or abutting fails height*		
			Pavements		Stone Pavement	Patio, cobblestone street				*Subhorizontal aerial surface*	
			Veneers		Stone Veneer	Sloping pavements				*Sloping surface.*	
		Upright							*Built (>dumped)*		
			Detached		Stone Cairn	Cairn, monument, survey mark, beehive, chimney				*Built above soil grade and(or) on large stone*	
			Support		Stone Pillar	Pillars, piers,				*Top tier equal to nearby others or to supporting wall*	

posts for a fence or border provide an example of a high dotted stone line. A cut stone post detached from anything else would be a shaped notable stone. An unshaped natural prism or blade of stone of comparable shape would be a standing stone.

At this point in the narrative, the class STONE WALL remains as the only one satisfying all five of the defining requirements. The next step is to isolate the most common and important family of **Freestanding** walls by carving out the other four families—**Supporting, Enclosing**, **Blocking**, and **Flanking.** Though each of these families are named by function, they are defined by observable, objective criteria.

As with supporting uprights, the family **Supporting** walls were built to support a structure from below. Objectively, these have two features required for good foundations: a laid (strongest) degree of order (i.e., masonry) in the top tier and a top course defining a flat, horizontal surface. Usually there are two or more nearly identical segments with a seamed corner. These are the common foundation walls for now-absent wood-frame houses and barns, most of which top out just above grade on land with little slope. Owing to the architectural complexity of farmstead centers, we differentiate supporting walls into only two arbitrary types, *Large* and *Small*, roughly equivalent to the footprints of barns and houses. The small type are usually cellar holes that simultaneously provided a foundation for the house above and the lateral support needed to prevent inward collapse of earth. The large type of supporting walls exhibits more variety and often tops out significantly above grade on steep to moderate slopes. Adjacent supporting walls (i.e., those in the same cellar or for the same foundation) are usually similar to each other in material and structure because they were usually built simultaneously from the same source. Though there is great variety in stone size and source, supporting walls are unified by their laid and horizontal top tiers.

The most thoretically challenging family of walls to classify are **Enclosing** walls. As with supporting

Table 2 (continued)

	Dumped						*Dumped degree of order, discrete masses*
		Scatter			Stone Scatter	Concentration, fence dumps	*On soil grade, majority of stones not touching (one stone thick)*
		Pile					*Above soil grade, stones touching (mounded)*
			Normal		Stone Pile	Pile, heap, dump	*Detached, above grade (soil, boulder, rock), most crudely circular*
			Attached			Corner, tumor, surmounting.	*Attached to wall*
				Corner	Corner Pile	Rubble, cobble	*Fills wall corner (usually smaller stone)*
				Segment	Attached Pile	Pile	*Adjacent to and(or) above wall segment*
			Aligned		Beaded Piles	Beaded, pile	*Discrete piles aligned*
			Ring				*Circular arrangement with empty center*
				Large	Ring Pile	Tree pile, fire pit	*Meter scale, Larger than fencepost*
				Small	Post Pile	Post pile	*Decimeter scale, equal to fencepost*
		Fill			Stone Fill	Stone dump	Below soil grade, stones touching (filled depression)
NOTABLE STONE					**NOTABLE STONE**		FAILS CRITERION OF GRANULARITY (focus is on individual stones)
	Outsized						*Size outlier relative to population, not deliberately modified*
		Erratic			Glacial Erratic	Erratic	*No evidence of human movement*
		Placed			Placed Stone	Landscaping boulder	*Evidence of human movement (scraping, lifting, crushing marks)*
	Modified						*Deliberately shaped and (or) marked by humans*
		Shaped			Shaped Stone	Post, obelisk, gravestone	*Evidence of shaping, quarrying, marking, etc.*
		Unshaped					*Stone appears uncut or unshaped*
			Standing		Standing Stone	Dolmen, Obelisk	*Unstable (high) center of gravity and geometry*
			Stable		Marked Stone	Boulder with marks, plaques	*Stable center of gravity*
Notes:	*For the class wall, add the name "wall" at the end of each taxon, for example "freestanding wall."*						
	Diagnostic criteria are carried downward through lower taxa, for example, the criteria for "pile" also apply to "normal" pile.						
	See also the dichotomous key (decision tree) and list of terms.						

walls (foundations) the focus is on a group of 2 or more walls built as a single architectural entity to enclose something. The most easily identified type is the *Squared* enclosure, most often used to confine animals, variously called pens, stockades, corrals on farms, and pounds in town centers, which typically are no larger than 40 ft. on a side. The label "squared" refers to nearly perpendicular corners, making rectangles and rhomboids part of this family. The specifications that such features be "sheep high, hog tight, and bull strong" translate into key diagnostic criteria of fence-height, a stacked or laid degree of strength, and a top course parallel to soil grade. Enclosure walls usually have, for added strength, large stones in a single tier. Enclosures with horizontal top courses are differentiated from supporting walls by context. Though large parcels, such as fields, pastures, orchards distant from the cultural centers, and family homes, are often enclosed by the family freestanding walls, their much larger scale and heterogenity preclude them from this family.

Enclosure walls can also have been built to hold material, as with cisterns, tanks, kilns, and the external walls of stone buildings. The type *Circular* enclosures include curved, rather than linear, walls. Stone silos, well guards, the ring walls around industrial-scale charcoal hearths, cisterns, and circular guides for livestock-powered "walking" mills all meet the criteria for a circular enclosure.

Owing to the importance of streams and hydropower in New England history, there exists a natural category of common walls used to create mill ponds and reservoirs, channel that water, and to control flooding with dikes and levees. These we isolate using diagnostic criteria into the family **Blocking** walls because they block or slow water movements. The *Perpendicular* type of blocking walls is built across the stream or valley. The majority are a subtype called *+Dam*, designed to impound ponds and reservoirs. Because natural fieldstone walls are porous, the vast majority of historical mill dams fall under the variant **Faced,* because the stones define an erosion-resistant face (like an armoring wall) strong enough to support a backfill of of low-permeability soil on the upstream side (like a retaining wall). An "industrial strength" dam composed entirely of dimension stone cut into blocks and fitted tightly is assigned to the variant **Stone* dam. These water-impounding dams contrast with much smaller and permeable subtype *+Check* dams, usually built as a stack of hefted stones within flowing-stream channels to create pools and (or) to attenuate the flood wave by creating added resistance. The *Parallel* type of Blocking Walls are built parallel to stream flow to block the flow of water moving away from the channel, rather than through it, generally during floods. These are the subtypes +*Levee* and +*Dike*. The former is built adjacent to the stream to keep it within the channel. The latter is built distant from the channel to prevent floods from reaching protected ground.

The family **Flanking** walls are restricted to significant breaks in slope. The type *Retaining* walls are built against and support near-vertical preexisting or excavated slopes. Retaining walls divide into two subtypes, +*Normal* vs. +*Regolith*. Normal occurs where the retaining wall supports a human-created near-vertical face, either on the uphill excavated side, or the downhill filled side. Regolith retaining walls occur when the slow downhill flux of regolith (colluvium) via soil creep or accumulates on the upslope side of a wall and (or) is eroded on the downslope side. These are informally called false retaining walls. The other type of flanking walls are *Armoring* walls. Though uncommon, they occur when a sloping bank is faced with a mass of stone where the upper stones are supported by the lower. This type includes the majority of riprap sea walls.

Thus far, the taxonomy has treated only a small proportion of New England stone walls, the specialized walls used to support buildings, enclose material, block the flow of water, and stabilize slopes. We now move to the vast majority of walls, the family **Freestanding** walls, defined by having two visible faces. There are six types: *Band, Single, Double, Broad, Abutting,* and *Hybrid.*

The most easily distinguished type are *Abutting* walls. Though only one-stone high, the stones are large enough to meet the knee-high height criteria. If the stones are +*Equant* (subtype) in shape, they create either the **Boulder* or **Block* variants, depending on whether the large stones are rounded or sharp-edged. More rarely, large stones are of the subtype +*Inequant*, with a length much greater than thickness (blades, tablets, prisms). When the b axis is parallel to wall, they are the variant **Pale* walls, as with a paled or picket fence. When the b axis is vertical, the result is the variant **Rail.* The **Normal* variant occurs when the b axis is parallel to soil grade.

The very common freestanding type, stone *Bands,* are essentially stone piles that exceed the 4:1 elongation ratio, thereby qualifying them as walls. They consist of stone that was merely heaped, mounded, tossed, or dumped in a line. Many of New England's so-called "tumbled" walls are instead stone bands. The two band subtypes +*Upland* vs. +*Lowland* are defined by local drainage. +*Upland* bands occur on broad slopes with aerated, usually agriculturally productive soils. The **Normal* upland variant is the linear ribbon of stone that thins and thickens along a former fenceline. The **Patterned* variant often takes one of two forms, the zigzag wall, in which the band follows the former base of a zigzag fence, or the beaded wall, which pinches and swells in thickness along a continuous line. The subtype +*Lowland* bands occur in settings where transportation was challenged by wet soils, brooks, and wetlands. This subtype incorporates a host of elongated stone features across low spots, such as primitive causeways, bridges, cattle fords, jetties, causeways, and pedestrian pathways.

Stone bands grade into the type *Single Wall* when the stone concentration is built upward beyond the dumped degree of order. This is New England's most common wall, defined as being only one stone wide in the top course. The +*Normal* subtype is roughly triangular, with larger stones at the base often pushed together to create a poorly defined foundation tier. The basal tier often resembles a crude double wall because stones were pushed in from opposite sides to provide a platform for the remaining stones. If stones of uniform size and shape are stacked above one another in the top tier the result is a +*Panel* subtype. If the stones in this panel are fitted, nested, or chinked closely together, the variant **Fitted* applies. A common example, the cordwood wall, consists of elongated stones (blades and prisms) stacked end to end. Normally, however, the panel stones are visually porous, creating the **Open* variant, often called a lace wall or cannonball wall.

Two types within the family freestanding walls have two faces built from opposite sides. If the two faces span the approximate minimum basal width needed for structural support (~1 m) they are the common type *Double Wall*. This is the classic, well-built, often carefully laid, often ornamental wall of well-established farmsteads and estates. Almost always they indicate an upgrade of wall stone already present as stone bands, crude single walls, or aligned piles. The default double wall is the subtype +*Normal*, which lacks a top course of capstones. Typically there is a scatter of small stone between the top course, sometimes called a "rubble cap." This does not constitute a capping layer because it merely fills void spaces and is centered between the faces. The subtype *+Capped* has a discrete upper course/tier of stones used to finish the wall. In the **Capstone* variant, large, generally tablet-shaped stones are laid with the a-b planes horizontal to span both faces, thereby binding both sides of the wall for structural support. Such capstone courses are commonly built of quarried stone and (or) bear the tool marks of drilling and shaping. In the **Copestone* variant, the a-b planes of the stones of the upper course are laid vertically (or at a steep angle) to span both faces. This practice, though common in Britain, is exceptionally rare in historical New England.

If the two faces of a freestanding wall are further apart than necessary for structural support, the type *Broad Wall* is assigned. Between the widely separated faces is a fill of smaller stone and rubble that is usually left uncapped. There are two main subtypes differentiated by local geographic setting. On the generally broad slopes and well-drained soils of uplands, the *+Normal* subtype of broad wall dominates. There, the extra width was used to dispose of stone derived from field clearing, usually during a capital improvement upgrade of adjacent parcels. In Britain, these are called "consumption" walls. In the *+Lowland* subtype, short sections of broad walls were often built across small- to medium-sized streams, often with a culvert or low arch near the base. In this case, waste stone was converted to primitive bridges.

Hybrid Walls are the sixth, final, and most complex type of freestanding wall. Two or more discrete types of wall occur in direct contact with one another. The subtype *+Tiered* is used when the hybridization is vertical (+Z). Examples include a single wall (stacked) or stone band (mound) above a preexisting double wall, perhaps to increase the height of a fence, or to hold extra stone. The subtype *+Aligned* is used when the hybridization is parallel to the line of the wall (X) on either side (+/-Y). Most common is when a stone band is pitched against a preexisting single or double wall to create a single asymmetrical landform. Alternatively, a single wall can be built at some distance away from a double wall and the intervening space filled with rubble to produce a hybrid wall that superficially resembles a broad wall. All five nonhybrid types of freestanding walls can occur in some combination either above or against a preexisting wall, giving rise to many combinations. A hybrid wall may also be both aligned and tiered, and may be merged with stone lines, though these are not differentiated in the taxonomy.

Common Names

A total of 86 individual taxa are uniquely and objectively defined by the end points of the stepwise decision tree, whether class, family type, subtype, or variant. To enhance utility, most are given unique common names of three words or less that align with existing regional typologies. We capitalize each word to signify a taxon, rather than a noun or adjective. Of the four classes in the STONE DOMAIN, all are common: Walls, Lines, Concentrations, and Notable Stone. Of the 30 named WALLS, only 5 are common: Single Wall, Double Wall, Stone Band, Broad Wall, and Retaining Wall, in decreasing order. The four named LINES are all common, usually at the scale of garden and yard rather than field: Border Line, Divider Line, Dotted Line, and Dashed Line. Of the 12 named CONCENTRATIONS, only 4 are common: Stone Pile, Stone Cairn, Stone Pavement, and Stone Scatter. Of the five named NOTABLE STONES, four are common: Glacial Erratic, Placed Stone, Shaped Stone, and Marked Stone.

Protocol-Rubric

The purpose of this taxonomy is to create specific, objective names that, when properly and consistently applied, provide a quick and objective standard method for identifying all features within the stone domain. Unique common names for each endpoint taxon carry not only the diagnostic criteria for that rank, but also the criteria carried forward from all higher ranks. For example, the common name Capped Double Wall (Fig. 8*d, left*) is taxonomically the **Capstone* (rather than copestone) variant of the subtype *+Capped* (rather than uncapped) of the type *Double* (rather than abutting, single, band, or broad) within the family ***Freestanding*** (rather than flanking, supporting, enclosing, or blocking) within the class WALL (rather than line, concentration or notable stone) within the domain *STONE* (rather than others, i.e., wood, fiber, or metal). Descriptively, the common name Capped Double Wall is shorthand for a two-faced wall built above grade from both sides composed of an elongated, continuous, and sufficiently high group of stones that has an ornamental single course of a top tier laid flat across both wall faces.

Though this discrete classification of the Capped Double Wall of our example conveys lots of information, it is based entirely on form and structure. It could be tall or low, long or short, made from fieldstone or quarrystone, mortared (wet) or unmortared (dry), composed of basalt or granite, be old or new, or be intact or greatly collapsed. To incorporate this infinite variability, we have developed a suggested nomenclature for incorporating attributes other than wall structure (Table 1) (Figs. 5, 6, 7, 8, 9, 10).

We also suggest a protocol or rubric for description based on a sequence of adjectives in this order: Condition (damaged or undamaged etc.) ➔ Magnitude (height, width, etc.) ➔Degree of order (stacked, dumped, or laid, etc.) ➔ Common Name ➔ Stone topography (size and shape, etc.) ➔ Stone lithology (granite, basalt, etc.) ➔ Stone source (fieldstone vs. quarrystone vs. pitstone). Different investigations will, of course, emphasize different attributes in different orders.

Consider this article's opening illustration (Fig. 1). Taxonomically, it is a **Fitted*, *+Paneled*, *Single*, ***Freestanding*** WALL (variant, subtype, type, family, class), based on its structure. Nominally, it is a Panel Wall. Descriptively, it is a partially collapsed, chest-high, carefully stacked, one-paneled single wall dominated by hefted slabs of granite-gneiss fieldstone. These adjectives specify present condition, height, degree of order, particle size, particle shape, composition, and source, none of which were mandated by the structural taxonomy.

Discussion

This article offers a conceptual tool for on-the-ground field work designed to parallel the above-ground mapping tools of aerial remote sensing, notably drone imaging, LiDAR, and GIS. Our tool is analogous to a Munsell soil-color chart with respect to standardization of description and classification. Though designed for New England, the taxonomy can be applied anywhere because it is based entirely on observable, easily distinguished criteria that make no assumptions about culture history.

We designed our taxonomy to provide an independent test of the documented historical sequence from the original forest to pioneeering farmsteads to successful multigenerational farms to farm-abandonment to reclamation for rural estates following the automobile. Each step in this sequence is mirrored by recognizable changes in discrete taxa within the stone domain, beginning with the stone piles from which cellar walls and foundation walls were built. Moving forward in time and outward in space are the freestanding walls of stone bands beneath wooden fences, to the stacked single walls of early farms, to the laid double walls, broad walls, and hybrid walls of established farms, to the capped double wall of country estates. At hydropower sites and village centers are the blocking and flanking walls of stone-faced dams, levee walls, and facing walls, and the enclosing walls of square enclosures surrounding cemeteries and pounds. The association between wall form and historical stage suggests that a true cladistic taxonomy based on wall phylogeny is possible in ideal settings. A pilot field test of our taxonomy done in conjunction with LiDAR mapping successfully demonstrated how wall taxa in three field areas changed spatially as a function of land use (Manandhar et al. 2021)

Beyond archaeology, the taxonomy also contributes to ecology because different walls create different habitats, corridors, and barriers. Every freestanding wall has a solar azimuth of sun and shade, a windward and leeward microclimate, and a moist and dry side as a function of regolith accumulation. Every wall family and type also has a different arrangement of the stones that ties directly to habitat. Geologically, the aboveground human artifacts are Anthropocene landforms that inform about the landscape that was developed.

The complexity of our taxonomy (1 domain, 4 classes, 11 families, 27 types, 28 subtypes, 17 variaints) was an unavoidable consequence of how taxonomies must be created. A good answer to the seemingly simple question: "What is a stone wall?" requires that they be extracted as a taxon (class) from a higher-ranked taxon (domain), and that they be distinguished from sister taxa of equal rank (concentrations, lines, and notable stones). This requirement forced us to create a classification of non-walls in order to deal with walls because the three sister classes all have arbitary thresholds with walls. Second, our highly granular, holistic classification allows users to simplify or generalize it as warranted by their research questions and scopes of work.

LiDAR-GIS studies of stone walls are a very exiting and important recent development. Our careful look at the phenomenon being mapped reveals limitations of the method. For example, the current ~1 m resolution of airborne imagery does not allow the distinction between lines and walls, and likely fails to resolve bands because they are often too low. Future field studies of stone-wall segments will be improved using tools we are now working to develop, notably photo-assisted apps. Quantitative analysis of those data will be assisted by pattern-recognition software and decision algorithms created through machine learning. All of this must be based on the sort of standardized terminology and taxonomic granularity we offer here.

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Declarations

Conflict of Interest There was no funding for this project aside from institutional support, small book advances on the general topic, and a related NSF grant on stone-wall education. Though I have received honoraria for many talks, none of them were for the rigorous taxonomy. Though I have served as a consultant when mapping walls, this is not specifically related to the taxonomy. I know of no conflict of interest for this purely methodological work.

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