Cartographic Perspectives

The Journal of nacis

Number 83, 2016

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The Journal of nacis

Number 83, 2016

IN THIS ISSUE

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The Journal of nacis

ISSN 1048-9053 | www.cartographicperspectives.org | @nacis_cp

ABOUT THE COVER: *Detail from a 1922 Sanborn map sheet for Hanover, New Hampshire. See Cartographic Collections, starting on page 22, for more.*

LETTER FROM THE EDITOR

Last year I joined Patrick Kennelly as the co-Editor of *Cartographic Perspectives* to "learn the ropes," as one might say. I have had the pleasure of watching and learning from Pat as he shepherded articles through the peer-review process, and coordinated the work of the Section Editors who source and edit content for the other sections of the journal. I'd like to thank him for breaking me in gently, and being available as a colleague with whom I could confer when trying to make decisions and communicate them to authors. I now feel ready to take the training wheels off and move the journal down the road.

In so doing, I am fortunate to have the continued support of many individuals including:

- Assistant Editor Daniel Huffman, without whom the production of the journal would simply not happen;
- *Practical Cartographer's Corner* Section Editor Alex Tait, a long time NACIS member and former President, who is a practical cartographer himself;
- Terri Robar, who does an excellent job in sourcing pieces profiling *Cartographic Collections* all around the world, including in my little, far-away corner in Australia, where I recently found her messages circulating;
- Matt Dooley, our *Visual Fields* Section Editor, works assiduously to bring us beautiful maps and some accompanying explanatory text, a highlight of the journal and unique to *Cartographic Perspectives*;
- Angie Cope, who works with readers to provide *Reviews* of the latest map-related books; and
- Fritz Kessler, who is leading the journal's newest section, *Views on Cartographic Education*, which communicates strategies that educators can use to improve the map-making skills of students and others who want to learn more about cartography.

I would like to thank Andy Woodruff, who has served as the Section Editor for *On the Horizon* for several years and is stepping down from that role. When this section was established, it was relatively rare for mapmakers to code, and a section that focused on that topic seemed both useful and novel. Now, if the NACIS Annual Meeting is any guide to what is happening in everyday mapmaking, most cartographers are coding in some way or another, whether they are automating steps in Photoshop through a macro, or scripting dynamic map behaviors for interactive maps using JavaScript. Thus, after some discussion and thought among members of the Editorial Team, we have decided to retire *On the Horizon*; the content we once published in this section now fits best in the *Practical Cartographer's Corner*, as it's what practical cartographers are frequently doing.

In 2010, CP became cartography's first (and still only!) fully open-access journal, and NACIS members no longer received a print edition of the journal by default. In 2011, CP moved to the Open Journal System platform, which has allowed us to distribute the journal digitally, and offer authors online publication of their work more quickly after acceptance. Since 2011, we have still had a number of print subscribers, mostly libraries, for whom we provided a printed volume at a higher cost than the normal NACIS dues.

Some libraries have dropped their print subscriptions in favor of pointing their patrons to our digital edition. This was an expected outcome of the decision to take *CP* open-access. It now no longer makes economic sense to print the journal for the small number of remaining print subscribers. Therefore, the NACIS Board recently decided to cease publication of the print edition beginning with *CP* 83 and offer the journal only in digital format.

This decision allows the society to invest in innovative projects, such as recording and streaming presentations at the NACIS annual meeting, which we trialled in 2016. As a result, we are also able to innovate in *CP*. *CP* 84 will feature a contribution that builds on one of these recorded presentations to both bring that content to audiences who were not able to attend in person, and to expand upon the content presented in Colorado Springs. I hope you look forward to engaging with this new format.

In *CP* 83, you will find a peer-reviewed article by Paolo Raposo, Cynthia Brewer, and Kevin Sparks, describing a method for designing impressionistic land cover base map layers in larger-scale topographic maps, providing a more legible base map than the orthoimages that are in common use at these scales. Their method can also be used in conjunction with orthoimages and terrain shading to draw upon the strengths of all three layers.

The Evans Map Room at Dartmouth College is the cartographic collection featured in *CP* 83. Read about Lucinda Hall's fantastic efforts to make the Map Room's heavily used New Hampshire Sanborn maps accessible to the world by digitizing them and distributing them via the Internet: the starting point for the Map Room's growing digital collection series, focused on maps of New Hampshire.

In *Visual Fields*, Matthew Picton presents a series of compelling, three-dimensional sculptures of cities from around the world, capturing aspects of their history, culture, and sense of place, using maps and images to transport you to these locations.

Three book reviews complete *CP* 83. The first is Mark Denil's review of Globes: 400 Years of Exploration, Navigation, and Power. The second is Lisa Sutton's review of the Historical Atlas of Maine, which features the maps of NACIS member Mike Hermann, and which received the American Association of Geographers' Globe Award for Public Understanding of Geography. Mark Denil is on double-duty in *CP* 83, also reviewing the Oxford Atlas of the World, Twenty-First Edition.

I hope that you will dive into the journal to get your cartographic fix of the day, and pass along what you learned to your carto-colleagues and friends.

Amy L. Griffin
Editor, Cartographic Perspectives

DOI: 10.14714/CP83.1351

PEER-REVIEWED ARTICLE

An Impressionistic Cartographic Solution for Base Map Land Cover with Coarse Pixel Data

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Several everyday cartography applications do not require sharply precise base maps, and in fact benefit from their generalization or deliberate obscuration, such as tourist or transit maps. Additionally, raster data fine enough for a given map scale are not always available. We present a method of creating an impressionistic land cover base map for topographic mapping in which the above two conditions are true, using the National Land Cover Database (NLCD) of the US Geological Survey (USGS). The method is based on reclassification, upsampling, constrained randomization at class boundary edges, and deliberate use of colors with very similar lightness values. The method spans both scientific geospatial data treatment and artistic cartographic design, and both generalizes and enhances the data. The processing, automated in ArcGIS™, is detailed, and examples of the product are provided.

KEYWORDS: land cover; topographic mapping; upsampling; raster generalization; enhancement; uncertainty

INTRODUCTION

Cartographers often regard the data processing and synthesis at the earlier stages of mapmaking as the most time-consuming part of the task. Frequently, data layers compiled in a geographic information system (GIS) start out with different levels of spatial, temporal, and attribute resolution, and resolving these differences involves careful analytical consideration. Simplification is typically the main approach to take at this point, bringing higher-resolution data down to appropriately comparable levels of detail as those in the coarser input data.

Occasionally data enhancement is appropriate, albeit challenging to achieve or justify in an analytical sense. Enhancement as an operation is usually considered to be among the set of all generalization *operators*, though it is not typically thought of as an increase in spatial detail. Operations such as displacing buildings away from roadways to ensure a visible gap (Neun, Burghardt, & Weibel 2009), exaggerations of portions of route networks (Reimer 2010), or terrain shading generalizations that enhance ridges (Marston & Jenny 2015) each enhance. These treatments typically sacrifice achievable planimetric accuracy in a small portion of the map (e.g., displacing a building by 1 mm at 1:25,000 makes its placement 25 m off of its real position), but are regularly considered acceptable in mapmaking. The readability (i.e., legibility, visual hierarchy, and symbol & shape resolution) and aesthetic benefits of making these enhancements outweigh the small losses of spatial accuracy they introduce.

We present an automated suite of data processing and map design techniques for enhancing raster land cover data for cartographic depiction in cases where some boundary accuracy can be sacrificed, such as in general-purpose topographic mapping. Our method is useful for treating data representing classed phenomena, but is particularly well suited to cartographic depictions of land cover, where the boundaries between classes are often naturally fuzzy (e.g., between a grassy field and a forested area). The product layer functions best as a translucent base map, and when combined with other topographic feature layers such as terrain shading and thematic vectors. Figure 1 illustrates the product land cover for the area around Hermitage, Missouri; the land cover is shown in combination with terrain shading, vector symbols, and an orthoimagery base.

Figure 1. *Hermitage, Missouri.*

We developed our method in the context of a redesign of the United States Geological Survey (USGS) US Topo topographic mapping series. The US Topo 1:24,000 topographic map series is now served freely online in the GeoPDF file format. Several new feature layers have been added to the updated map series to reflect user requirements gathered by the USGS (Sugarbaker, Coray, & Poore 2009), with most of the new themes illustrated with existing federal geospatial datasets. This paper reports on our efforts to use National Land Cover Database (NLCD) 2006 data in 1:24,000 US Topo map series, as well as in multi-scale USGS National Map Viewer map products.

Our method arose from the challenge inherent in using the 30 m NLCD data at 1:24,000, at which scale they appear heavily pixelated (Figure 2). Each pixel prints at a size of 1.25 mm, whereas they must be only 0.25 mm to ensure that they are barely discernible by the human eye at typical viewing distances. Aiming for this size suggests that NLCD data are only appropriate for use at 1:120,000

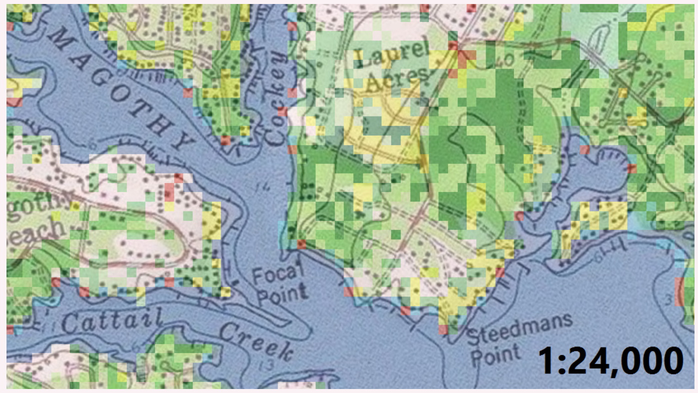

Figure 2. *Unchanged NLCD data shown with transparency over a USGS topographic map sheet at 1:24,000.*

and smaller cartographic scales. The method we developed here simultaneously upsamples classed data in a manner related to interpolation or super-resolution techniques (Atkinson 2005), as well as offers a set of graphic variable decisions for portraying the product raster that remains deliberately vague at class borders.

The treatments detailed here both cartographically generalize and enhance the input classed raster. The number of classes is reduced by means of simple reclassification, region shapes are simplified using constrained stochastic "airbrushing" (as explained below), colors are chosen to deliberately ambiguate region borders, and the product is at higher pixel resolution than the input. Our method is differentiated from other methods proposed for achieving higher-resolution raster land cover because it explicitly takes into account how the product will be depicted on a map. The processing is both science and art, in that achieving a higher resolution land cover base map is done with a stochastic process in precisely-constrained areas of the raster, and the symbolization is chosen to create an "impressionistic" visualization in the artistic sense.

THEORETICAL CONTEXT AND RELATED WORK

Cartographic generalization research has been considerably less common on raster than on vector datasets. Early work sought to establish frameworks and theory on the various kinds of raster generalization possible (McMaster & Monmonier 1989; Weibel 1992). Land cover and digital elevation models (DEMs) have been the focus of most cartographic work on raster generalization. Monmonier (1983) notes how land cover generalization is more naturally approached in the raster domain. He describes the process as involving several smoothing and aggregation-of-class-region operations, requiring a series of criteria choices for such things as region inclusion or exclusion, and hierarchical importances across aggregated classes, among others. He later (1987) details the need for areal displacement when generalizing class regions, comparing how continuity is more or less crucial to diverse land cover classes and region morphologies. Subsequent raster generalization work has focused on using combined vector and raster techniques in categorical generalization (Peter & Weibel 1999; Steiniger & Weibel 2005), often employing amalgamation techniques borrowed from vector polygon data treatments (Li & Su 1995; Regnauld & Revell 2007; Zhang et al. 2013). Such methods have typically been parameterized by cartographic constraints (Harrie & Weibel 2007). Researchers have often taken a morphological approach, selecting, aggregating, deforming and displacing polygonal raster regions to acceptable degrees for generalization (Li 1994; Su & Li 1995; Su et al. 1997; Cámara & López 2000). Morphological analysis of raster regions has been applied with direct reference to available thematic or geomorphological information about each region (Brassel & Weibel 1988; Mackaness & Edwards 2002; Gao, Gong, & Li 2004). Researchers have also explored the use of morphing techniques for static and animated products (Li & Wong 2008; Pantazis et al. 2009).

A promising approach to land cover mapping is texture synthesis, developed in computer graphics, and gaining attention in cartographic and geographic information science research (Mariethoz & Lefebvre 2014; Dumas et al. 2015). Jenny, Jenny, and Cron (2012) present an application of texture synthesis to cartography, seeking to create artistic, "pseudo-natural" maps of land cover by effecting gradual transitions between classes. They describe *texture sythesis by example*, a family of techniques in which pixel colors are chosen based on a comparison of other pixels in the scene in similar spatial arrangement to similarly-colored neighboring pixels. This method is proposed for making "transition textures" between classes in land cover cartography. They describe map design parameters dictating where such textures could be used (224):

> To avoid a technical look of the land cover category boundary, the subtextures could dissolve into subtexture islands. The number and size of these subtexture islands within the neighbouring subtexture should be arranged naturally; e.g., become smaller with increasing distance from the boundary. The width of this patchy transition zone should appear plausible. The boundary between the subtextures should vary naturally (e.g., undulate), but also must not diverge too much from the category boundary defined in the underlying land cover dataset.

Their experimental techniques have been applied to cartographic panorama views (Jenny & Jenny 2013). An approach with similar realism and creative license is taken by Patterson (2002), and applied to small-scale land cover in combination with terrain shading for the US National Atlas (2013). While these techniques are promising, they do not address increases in pixel resolution.

Overcoming the limitations of fixed numbers and sizes of pixels—that is, getting more pixels and therefore higher-fidelity samples—in remote sensing equipment and data has been a focus of much research for the past three-or-so decades (Cracknell 1998; Campbell and Wynne 2011). Hardware solutions include the creation of smaller sensor elements or larger sensor arrays (along with appropriate optical lenses), but these solutions are either impractical, prone to noise, or expensive, for technical reasons beyond the scope of this article. Software image-processing methods have been favored due to the difficulties of hardware solutions, with algorithms proposed from diverse imaging fields such as medical microscopy, computer vision, and geospatial remote sensing. Much of the research on improving pixel-based land cover classification in recent decades has focused on *mixed pixels*, which are those pixels whose spectral profiles are produced by an aggregation of multiple land cover types present in that pixel's instantaneous field of view (IFOV). These are distinct from *pure pixels*, wherein the land cover types present in the IFOV are relatively uniform. Mixed pixels occur at any spatial resolution (i.e., pixel size), "often at the edges of large parcels or along long linear features, such as rivers or highways, where contrasting brightnesses are immediately adjacent to one another" (Campbell & Wynne 2011, 291). A greater proportion of mixed pixels in a scene leads to greater inaccuracies in classified products (Smith et al. 2003; Latifovich & Olthof 2004) because there is more uncertainty in the image (Congalton et al. 2014). Efforts to determine the contents of mixed pixels have typically sought to establish probabilities for the presence of each of a set of land cover types in a given pixel, with relative probabilities calculated using linear and non-linear mathematical models (Marsh et al. 1980; Ichoku & Karnieli 1996; Mather & Tso 2009; Roy et al. 2014; Chen et al. 2015; Imbiriba et al. 2016). Recent research has focused on machine learning techniques (e.g., active learning, neural networks, support vector machines), where algorithms are trained on curated datasets before being used on pre-classified data (Foody & Mather 2004; Tuia et al. 2011; Samat et al. 2014; 2016). Foody (1999) states that training sets emphasizing raster region border pixels (i.e., where mixed pixels typically occur) tend to give classification neural networks more generalizable knowledge.

In remote sensing and other imaging disciplines, methods that attempt to resolve variations smaller than the sensor pixel size are referred to as *super-resolution*. Super-resolution methods generally take advantage of aliasing in the captured image (i.e., distortion and mis-identification of signals in the image due to insufficient resolution), which is what causes mixed pixels. These are distinct from interpolation, which can increase resolution but does not recover fluctuations unresolved by the sensor. Super-resolution algorithms employ a wide diversity of approaches (see Tian & Ma [2011] and Nasrollahi & Moeslund [2014] for comprehensive reviews), but can generally be divided among those that function on single or multiple images, and then again on those that function in the spatial domain of the pixels (i.e., the pixel values in topological and metric relation to each other) and those that operate in the frequency domain (i.e., on the pixels after a suitable mathematical transform, such as the Fourier transform or wavelet analysis). Most algorithms in the literature and in imaging practice operate in the spatial domain (Nasrollahi & Moeslund 2014). The theoretical approach taken is generally to regard the given image(s) as a decimated product of either the higher- or infinitely-detailed, hypothetical original scene after some mathematical function, the function modeling the optical and/or sampling process that produced the existing, low-resolution image. Images at some higher target resolution are then derived by theoretical reconstruction of the original scene; much of the diversity of the methods developed over the years is in how reconstruction occurs.

One of the earliest super-resolution methods developed was applied to Landsat 4 data, which featured multiple translated views of the same areas of the Earth (Tsai & Huang 1984). Single-image methods typically take a more purely theoretical approach, often using machine-learning techniques applied to preprepared training data (Freeman et al. 2002; Yang et al. 2010; Kwon et al. 2015), using repetitive adjacency patterns within a single image (Glasner, Bagon, & Irani 2009), or taking advantage of repetitive texture elements in the image (Park et al. 2010). Such methods may also apply distortions and noise to the input image to generate hypothetical other images of the same scene (Nasrollahi & Moeslund 2014), in order to obtain a set from which to reconstruct a high-resolution scene. Reconstruction of the hypothetical high-resolution image, especially in the context of facial recognition applications, is sometimes termed "hallucination" (Baker & Kanade 2002). Super-resolution methods work with the ratio luminance pixel values, not nominal or ordinal data such as classed land cover images.

METHOD

We create a generalized land cover map layer, using constrained stochastic raster region edge enhancement and color symbolization to deliberately obfuscate and soften land cover class boundaries. The resulting map layer is produced at a finer resolution, and yields an impressionistic or painterly representation of generalized land cover. Since the resulting land cover layer is an image, it lends itself easily to standard image zooming and resampling as will happen in a multi-scale interactive mapping interface (i.e., scale-space theory transformations apply: see Lindeberg [2008; 2014]). Zooming is a certain context in which the land cover layer is meant to be used, since it would be served digitally in zoomable PDF media.

Our method involves several raster data operations, each of which is either a generalization or an enhancement of the data. First, a suitable target resolution of the raster data for use in the map product is calculated using the output map scale and the graphic resolution of the map medium (Tobler 1987). For mapping at 1:24,000, we use a target resolution of 2 meters. Classed land cover as well as percent canopy and impervious surface data layers from the 2006 NLCD are used. Because the first data layer is nominal and the latter two are ratio, their processing progresses in independent threads until the final stages of land cover layer production.

All processes are automated using a single Python script within ArcGIS™, making the method amenable to large map series production. All of the processes described here use various tools available in ArcMap™ and the Esri Spatial Analyst™ extension package.

NOMINAL DATA TREATMENT

The NLCD is maintained and made publicly available online by the USGS. Derived from unsupervised classification (Anderson et al. 1976) of Landsat Enhanced Thematic Mapper+ (ETM+) data, it provides nationally-consistent land cover for the entire conterminous United States at 30 m pixel resolution (Homer et al. 2007). The NLCD contains several distinct datasets, including a categorical classed land cover layer, and percent-coverage layers for tree canopy and impervious surface. While there exist sporadic coverages of authoritative land cover data at higher spatial resolutions throughout the United States, their lack of ubiquity makes them a problematic source for nationwide mapping.

Reclassification

One of the main generalization operations we undertake is simple reclassification, reducing the dozens of NLCD classes to four categorical classes and two magnitude classes. This is done to minimize thematic and visual complexity of the land cover presented to the reader, such that the product land cover serves as a generalized overview, rather than a high-resolution analytical data layer. The process is opposite to the aim of super-resolution, where smaller pixel sizes are sought in order to determine sub-input-pixel thematic variation. The aim here is to produce a general impression of land cover rather than provide precision cartometric analysis data.

The classed layer of the 2006 NLCD uses a scheme equivalent to the Anderson Land Cover Classification System (Anderson et al. 1976). We reclassify these to three classes, being agricultural, grassland, and barren land (Table 1). Agricultural land includes all types of land used to grow food or animal feed (i.e., row crops, orchards, pasture, etc.), and is aggregated to a single class to denote areas where topographic map users would presumably want to avoid trespassing. Our grasslands class includes all the classes from the "shrubland" and "herbaceous" supercategories of the NLCD, thereby denoting any lands principally bearing small shrubs, grasses, sedge and moss that hasn't been classed as pasture (i.e., isn't commercially used). The barren land class includes those areas classed in the NLCD as rocky, sandy, or made of clay, and generally devoid of vegetation (i.e., deserts, talus, bedrock, etc.). Grassland and barren land are given in our output base map as two general types of landscapes topographic map users may find passable. These three classes are given on the assumption they provide a general impression of land cover for macro-level navigation and natural resource management, rather than a detailed analysis supported by the original NLCD and other land cover data sources.

Generalized Land Cover Class	Input NLCD 2006 Classes
Agricultural land	*81,82*
Grasslands	*51, 52, 71, 72, 73, 74*
Barren Land	*31,32*

Table 1. *The input NLCD classes aggregated by reclassification into each of the three product classes.*

Our reduction of the many NLCD classes is a basic model generalization operation (Sester 2008), engineered to keep the land cover base map visually and thematically simple, rather than complex. Greater numbers of classes are obviously possible (e.g., sub-classes of the existing three), but having them would require a larger palette of graphic variables to symbolize them. Greater thematic granularity offered by higher numbers of classes comes at the expense of greater graphic complexity, and, thereby, greater difficulty in map reading, and greater dependency on legends. In the context of a US Topo redesign, these three classes constitute a significant increase over the previously non-existent land cover information, without introducing a great deal of visual complexity. We seek to keep the land cover thematically and visually simple on the rationale that other map layers overlaid should not have to overcome a complex land cover base map in the overall visual hierarchy.

Water bodies such as ocean, lakes, rivers, and reservoirs are the fourth categorical class in our land cover layer. This is produced using National Hydrography Dataset (NHD) High Resolution (Simley & Carswell Jr. 2009) polygons by simple rasterization at the output resolution, and included to denote areal bodies of water. Other hydrographic features such as glaciers and marshes are excluded; the rationale for this is that polygonal NHD data overlaid on our land cover base map can be used to symbolize these features more accurately than they are represented in the NLCD.

Canopy cover and impervious surface (i.e., built-up) areas, while present in the classed NLCD data, are instead represented in our method by their respective dedicated NLCD data layers, representing their percent coverage values with color saturation gradients. These pixels are prepared using a simple upsampling and thresholding technique described later.

Boundary Uncertainty Rationale for Class Edge Change

The next step in processing classed pixels for land cover is to introduce softer (i.e., less pixelated) edges between regions. We describe the technical rationale for our impressionistic, "airbrush" solution in this section.

The raster data model is intuitive and simple, being a collection of regularly-spaced samples or derived data points. The model is particularly useful and intuitive for continuous phenomena, since the topology of and distance between data points is implicit. Nonetheless, there exist certain conceptual ambiguities in the model, particularly with respect to pixel assignment and the fact that cell size is variable (Raposo & Samsonov 2014). Classed rasters contain cells whose category has to be defined by some statistical process, though the signal present in the cell area during data capture typically varies throughout, as is the case in mixed pixels. Also, the variable cell resolution in the model directly introduces the Modifiable Areal Unit Problem (Openshaw 1984).

The latter problem, arising from variable cell sizes, is particularly salient whenever raster resolution is changed, such as in resampling to a larger cell size for map generalization. Cell size is directly related to the spatial precision of the dataset, and changes to resolution drive error propagation through scale. In spatial data such as geographic rasters, the measure of space over which one sample is collected, being the cell size, is the spatial frequency of the dataset. The Nyquist-Shannon sampling theorem (Nyquist 1928; Shannon & Weaver 1949) describes the frequency range over which data of a given sampling frequency can be considered precise. In rasters, the cell size determines the distance over which the dataset is imprecise. According to the theorem, a dataset should have a frequency of one-half or smaller than the highest frequency (i.e., smallest variation) of the phenomenon it seeks to reliably sample or represent. By corollary, a dataset is imprecise over distances smaller than twice the model frequency resolution. For geographic rasters, this translates to twice the pixel size (Tobler 1987). This means that single pixels, in terms of their ability to differentiate geographic variable fluctuation across their extents, should be regarded with considerable uncertainty. Of course, the foregoing has not considered classification accuracy; for the purposes of this work, we assume no classification uncertainty or error.

With geographic phenomena such as land cover, raster pixel uncertainty is compounded by the naturally imprecise boundaries frequently encountered in the physical world. Grasslands, for example, regularly grade into their neighboring areas, such as forests or deserts. Certain land cover regions have more sharply-defined borders than others, such as roadways or mechanically-tended agricultural fields. In the case of fine-enough raster data, sharp boundaries are representable, but the location of these is not precisely represented if the data are coarse, and therefore the exact location of such boundaries must be regarded as uncertain in the absence of other, more precise data.

The Uncertainty Corridor

The two interacting factors of natural edge ambiguity and cell imprecision lead us to consider boundaries between raster land cover classes as lying along an *uncertainty corridor*, constituted of mixed pixels. Figure 3 illustrates the uncertainty corridor between two distinct land cover regions. According to the sampling theorem, we cannot be certain of precisely detecting or representing an object that is smaller than twice the pixel size. It follows that the precision of the location at which one land cover class ceases and another begins is no finer than the width of two cells

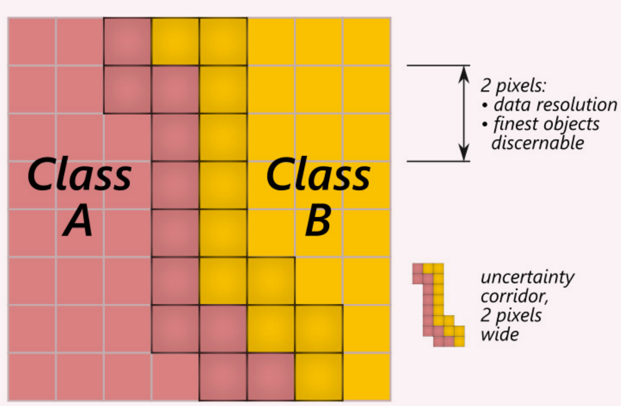

Figure 3. *The uncertainty corridor between two raster class regions.*

in our input data. We therefore regard the cell immediately on either side of a region border as inherently uncertain, and use the concept of a 2-cell uncertainty corridor to describe all such uncertain areas in the input raster.

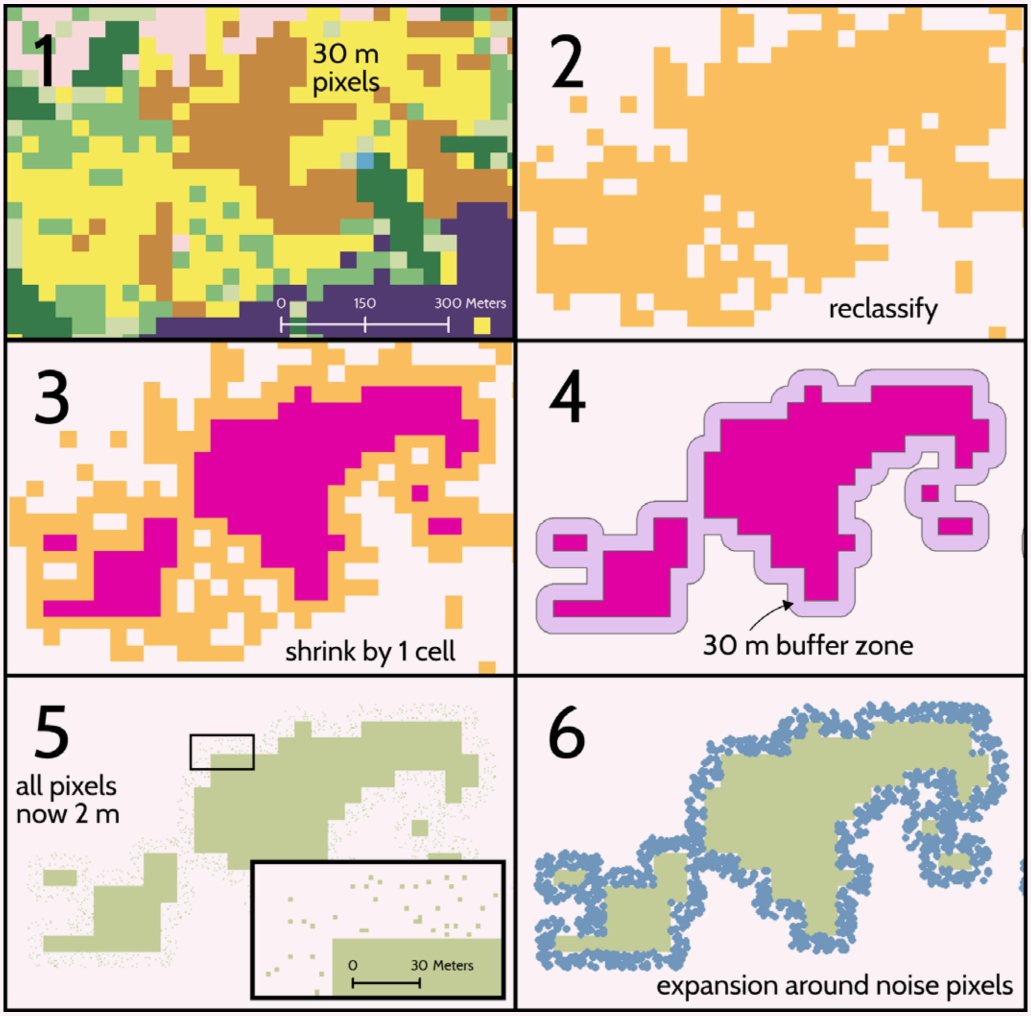

Figure 4. *The process of categorical land cover class generalization (part 1 of 2).*

We do not attempt an interpolation or super-resolution in the uncertainty corridor for several reasons. First, since the data are nominal, interpolation and super-resolution are not arithmetically possible. Interpolation lacks theoretical basis, since the operation does not recover thematic variation not captured in the input data; in the absence of this we cannot be certain any interpolated pixel is accurate. Interpolation, super-resolution, or mixed-pixel analysis could be attempted on raw, multi-band sensor data and used to create a classed land cover raster at an appropriate resolution; such a process would involve computation costs that may make it impractical for map series production.

"AIRBRUSH" REGION EDGE TREATMENT

The process of categorical land cover class generalization is illustrated in Figures 4 and 5 over a small agricultural region; the same processing is applied to grassland and barren land regions. The reclassification described earlier is illustrated across numbers 1 and 2 in Figure 4.

Following reclassification, the raster regions are shrunk by 2 cells and expanded back by 1. This process, common in morphological analysis, has several purposes. First, it eliminates single cells or areas where a class is only 1 or 2 cells wide (i.e., below the width that can be safely regarded as precise), thereby simplifying the shapes and spatial distribution of land cover patches, and removing imprecise, isolated cells. This leaves regions one cell thinner than they are in the input data (see Figure 4, number 3). Removing isolated or thin regions of cells in this manner reduces the analytical precision of the data, but this is by design, since the product being developed is a generalized land cover base map and not a precise analytical dataset.

The shrink-and-expand process creates the 2-cell, 60 m wide uncertainty corridor between any two adjacent regions (see Figure 3). The shrunk regions are polygonized, and buffers are calculated around them (Figure 4, number 4). Buffer regions are 30 m wide, corresponding to the input cell size and one-half the width of the uncertainty corridor.

The shrunk class regions are now upsampled to 2 m resolution. A random-assignment raster is calculated in the buffered regions around these, also at 2 m resolution (Figure 4, number 5). This raster is generated such that one out of every five pixels contain a binary flag, with all other pixels being null. The raster containing the regions and that containing the randomly-placed pixels are mosaicked into one. Each of the isolated, randomly-placed pixels is used as a seed around which the edge of the raster class is expanded by seveb, 2 m cells (Figure 4, number 6). This process creates a meandering, ragged edge around each land cover raster region, with a dispersed appearance similar to airbrush painting. We remove most small gaps remaining in the uncertainty corridor, as well as simplify the boundary edge, by expanding and shrinking the class pixel regions by 3 pixels (see Figure 5 numbers 7 and 8). At this point, the final class boundary "airbrush" edges have been geometrically defined.

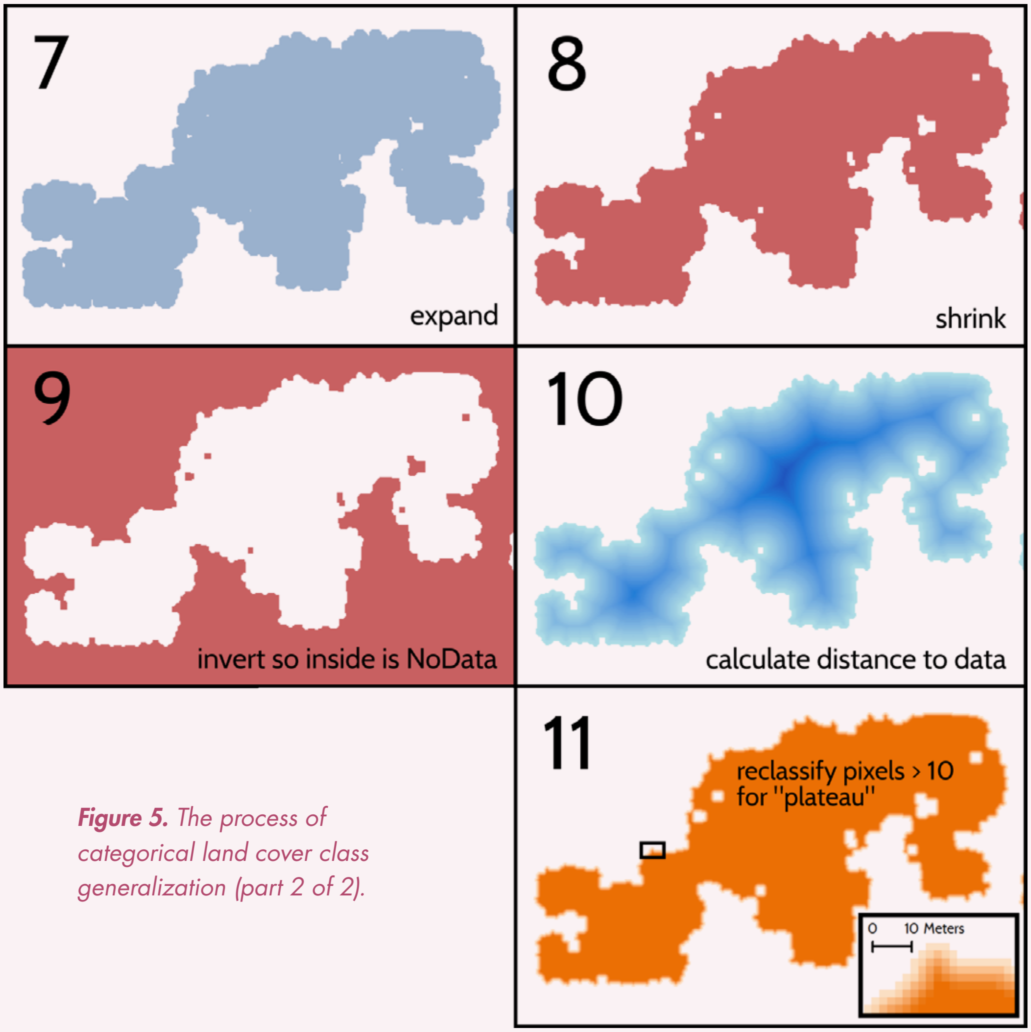

Figure 5. The process of categorical land cover class generalization (part 2 of 2).

The final product uses a color gradient effect at class edges to produce a feathered appearance. In order to provide for pixel values at the margins of class regions that will drive color gradients, two more transformations occur. First, the class regions are inverted such that their areas become null cells, while other areas contain a binary flag (Figure 5, number 9). The Euclidean distance for each null-value cell to the closest data-containing cell is calculated, yielding a distance raster inside the land cover class regions (see Figure 5, number 10). To isolate only those cells near the margins of these regions, we apply a threshold to the distance raster such that all pixels with values greater than 10 (i.e., all pixels further than 10 m from the margin) are given the value of 10; this produces "plateaus" in each land cover class region (Figure 5, number 11). Class regions now have cell values between 0 and 10, with values increasing inward in the area within 10 m of the region edge. These distance numbers are later used to drive color gradient application to create the feathered, "airbrushed" appearance desired; internal areas of regions take on a full classification color, while the edges feather to allow class colors to gradually modulate into each other. The culmination of this edge gradient with the meandering, randomized edges each class is given is the basis of the "airbrushing" name we give the process.

TREATMENT OF RATIO LAND COVER CLASSES

Interpolation and thresholding constitute the data processing procedures for percent canopy and impervious surface data. For each, the raster is upsampled using bilinear interpolation three times, from 30 m cells to 15 m, then to 5m, and finally to the target resolution of 2 m. The objective of this repeated resampling is to ensure a smooth interpolation. The interpolated raster is then thresholded at 20%, so that areas below 20% are removed. Figure 6 illustrates the results of this procedure on percent impervious surface and canopy rasters. The top row shows the original 30 m NLCD cells, while the bottom row shows our generalized, higher-resolution product. Impervious

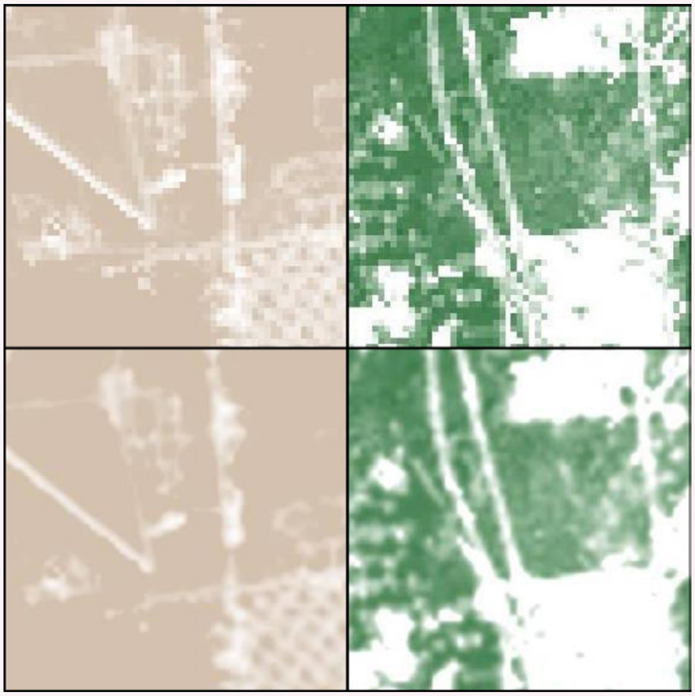

Figure 6. Percent impervious surface (left) and percent canopy coverage (right) rasters before (top, 30 m cells) and after (bottom, 2 m cells) resampling and thresholding.

surface shows as increasingly white, while canopy shows as increasingly green.

CANVAS "PATCHING"

Once the categorical and ratio classes have been processed, their spatial union is calculated. Any isolated areas of the map where no class is assigned are identified. This is necessary since the airbrushed classed regions have stochastic edges and the thresholded regions have thresholded ones, making it likely that small unclassed patches, a few pixels in width, occur between classed regions. Some of these areas will correspond to small classed areas in the classed NLCD input that were deliberately removed at the earlier shrink and expand operations. These regions occur within the uncertainty corridor and are by definition less than 2 input pixels (60 m) in width; they are typically much thinner still. At the margins of the impervious surface and canopy rasters, visual inspection over multiple examples determined that empty class areas created by the 20% thresholding were virtually equivalent in size to those defined between classed regions. We term these areas "patches," and resolve the issue of their presence in the design phase of our process by giving these pixels a neutral "canvas" color. The selection of this color reflects those we make for our classes so that all colors blend together, both in the design and perceptual senses; further discussion of the use of color in our solution is given below. Once colored appropriately, these areas serve as small, gradual transitions between classes in the manner described by Jenny, Jenny, and Cron (2012).

As mentioned before, areas containing certain hydrographic features such as glaciers and marshes are not included in our output land cover classification. As with "patches," these areas are classed to also carry the neutral canvas color. This reflects our design decision to use vector NHD data to represent these features, above the generalized land cover base map (i.e., glaciers shown with polygons, marshes shown with texture and pattern fills).

FINAL RASTER FLATTENING

The final spatial processing step in the method is to mosaic the nominal rasters, ratio rasters, and patches into a single, flattened raster layer. Since there will be small overlaps between classes for the same reasons there were patches between them, classes are mosaicked together using a hierarchy of decreasing importance:

1. rasterized hydrography (the most precise layer)
2. percent impervious surface
3. percent tree canopy coverage
4. agricultural areas
5. grassland areas
6. barren areas
7. patches

The rationale behind this hierarchy is that the location of anthropogenic land cover class boundaries will be of greater importance to most US Topo users than will the boundaries of natural classes. This reflects findings from a USGS National Map User survey, where respondents indicated a desire to have access to data that would exhibit changes over time (Sugarbaker et al. 2009). Rasterized hydrographic features are given top priority because they are the most precise of all the datasets going into the land cover raster. Impervious surface, most frequently representing concrete, asphalt, and other human-created land cover, is then the next most prioritized land cover type. Tree canopy is next, since this is a long-standing feature type relevant to topographic maps, and present in some historical and recent versions of USGS topographic series.

Land Cover Class	Original Value Range	Remapped Range in 0–231
Water Bodies	*1*	*0*
Percent Impervious Surface	*20–100 (percentages)*	*20–100*
Percent Canopy Cover	*20–100 (percentages)*	*120-200*
Agricultural Lands	*0–10 (airbrush edge distances)*	*201–210*
Grasslands	*0–10 (airbrush edge distances)*	*211–220*
Barren Lands	*0–10 (airbrush edge distances)*	*221–230*
Patches	*1*	*231*

Table 2. *The classes used in the land cover implementation, their input values at the end of geoprocessing, and their remapped cell values in a single 8-bit integer raster for symbolization using a color map.*

Class	Color	RGB	Lightness x/255	Notes
Agricultural		*(214, 209, 148)*	*170*	
Grassland		*(181, 196, 171)*	*173*	
Barren		*(227, 179, 148)*	*176*	
Canvas		*(212, 193, 174)*	*182*	*Constant*
Water		*(179, 189, 196)*	*176*	*Constant*
Forested		*(0, 112, 0)*	*53*	*Color at 100%*
Built-Up		*(255, 255, 255)*	*255*	*Color at 100%*

Table 3. *Color specifications.*

Percent impervious and canopy coverage are also given greater priority over the three categorical land cover types since their upsampling represents a true spatial interpolation (rather than a stochastic edge derivation), and because these layers are more informative in that they represent continuous magnitudes rather than nominal classes. The three remaining nominal classes follow, in order of presumed usefulness for navigation or natural resource management. Finally, canvas patches fill any space not claimed by at least one of the preceding classes, including areas more precisely mapped with NHD vector symbols such as glaciers or wetlands.

The output land cover base map is created as an 8-bit raster, to which a color map is applied. An 8-bit raster is chosen because it keeps file sizes small, relative to deeper bit depths. Before flattening, pixel values among the nominal land cover classes are 0 through 10 m, and 20% through 100% for the ratio classes, after each class has been thresholded. Cell values are remapped for each class using simple offsets such that each populates a predefined integer range between 0 and 255 (Table 2).

COLORS

In addition to the airbrushed edge, the deliberately vague, “impressionistic” edges rely heavily on class colors whose lightness values are very similar. Color lightness, also called “value” or “luminosity,” is a parameter distinct from hue and saturation. When colors of similar lightness are presented in adjacent areas, the human eye has little ability to differentiate between them, even across different hues and saturation levels (Livingstone and Hubel 1988; Brewer 1994; 1996). We use this effect in our color selections to make the location of where one land cover class ends and another begins deliberately unclear. When the final land cover layer is translucent and used with an underlying orthoimage, these locations are made somewhat sharper by lightness differences in the imagery.

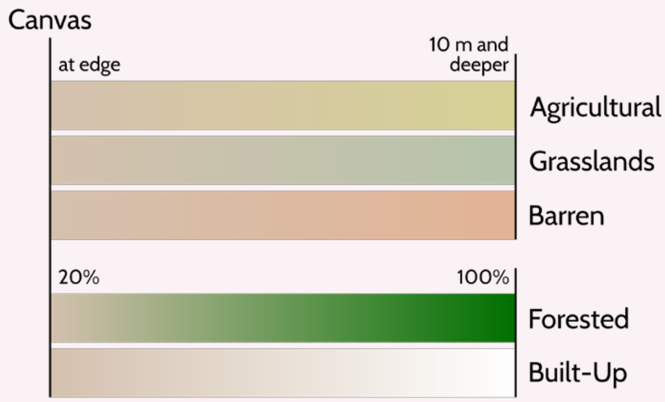

Figure 7. The palette of color gradients used.

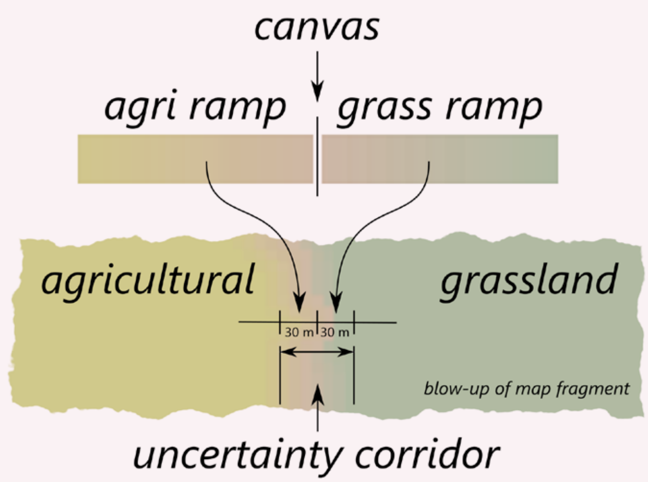

Figure 8. The "airbrush" edge effect for region border ambiguation, using stochastically-generated edges and colors of very similar lightness.

The color palette used in our final land cover map layer is given in Table 3. Lightness values for agricultural areas, grasslands, barren areas, water bodies and canvas areas are kept similar at approximately 69% (using HSV in the RGB color model). Forested and built-up categories grade in lightness according to the percent coverage in the given pixel, and thereby do not maintain a similar lightness value. However, because these two classes naturally fluctuate from low to high lightness values throughout the mapped area, they too have an airbrush-like, painterly effect.

Linear color ramps are used for all nominal raster classes (Figure 7). A linear color ramp is defined for each class, starting at the common, neutral canvas color, and ramping up to the palette color for the class. In the case of agricultural, grassland, and barren classes, canvas is used at the very outer class edge (i.e., at the center of the uncertainty corridor) and the class color is used at the inside end of the feathered-edge gradient (at 10 m into the region), as well as throughout the region's inner area. In the case of percent canopy and impervious surface classes, canvas is used at the lowest value (20%), and the palette class color is used at full coverage (100%). These color choices allow adjacent, differently-colored regions to visually fade into each other; the sum effect of these color choices along with the randomized edge generation described before constitute the "airbrushed" land cover base map effect (Figure 8).

To implement automatic color assignment, we created a color map file (i.e., an Esri .lyr file) containing our color ramps defined over the integer ranges to which we algebraically shifted our raster classes. An RGB value is specified for each integer value in the final, algebraically-shifted raster (see Table 2). ArcMap™ uses this color map file to define the symbology for any land cover raster produced by our method, producing consistent symbology across any number of maps in series.

DEMONSTRATION: LAND COVER AT 1:24,000

Figures 1, 9, 10, and 11 provide examples of our land cover map layer in conjunction with other typical map layers: road and hydrographic vectors, terrain shading, and orthoimagery. The land cover layer is particularly effective as a translucent overlay on orthoimagery because it recolors the imagery, providing ancillary visual cues to suggest what is present at any location. This recoloring also applies some degree of standardization of color to the base map when an orthoimage is present, unifying the overall appearance. The use of white for built-up areas helps to accentuate roadways in particular, especially when these are symbolized with white or pale vector lines. This "ghosting" or "glow" effect is particularly helpful where roads are apparent in the orthoimagery but absent in the vector data, as is sometimes the case for The National Map.

Figure 9. *St. Louis, Missouri.*

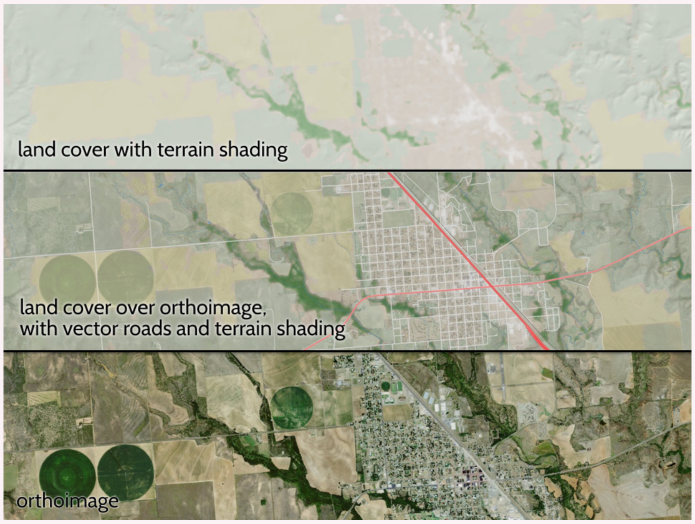

Figure 10. *Memphis, Texas.*

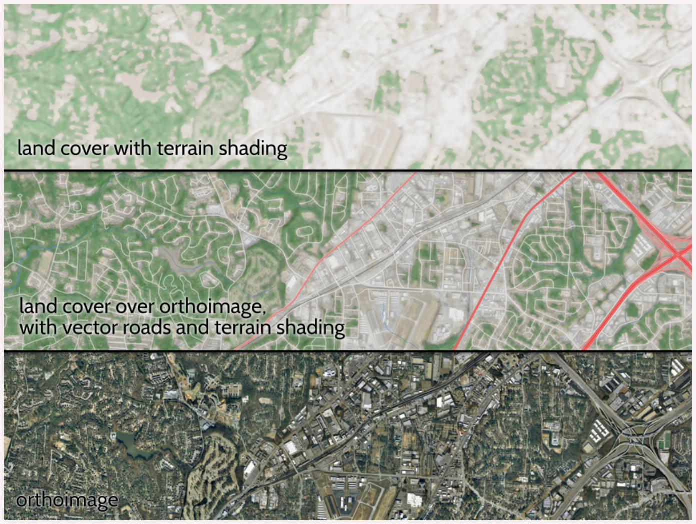

Figure 11. *Atlanta, Georgia.*

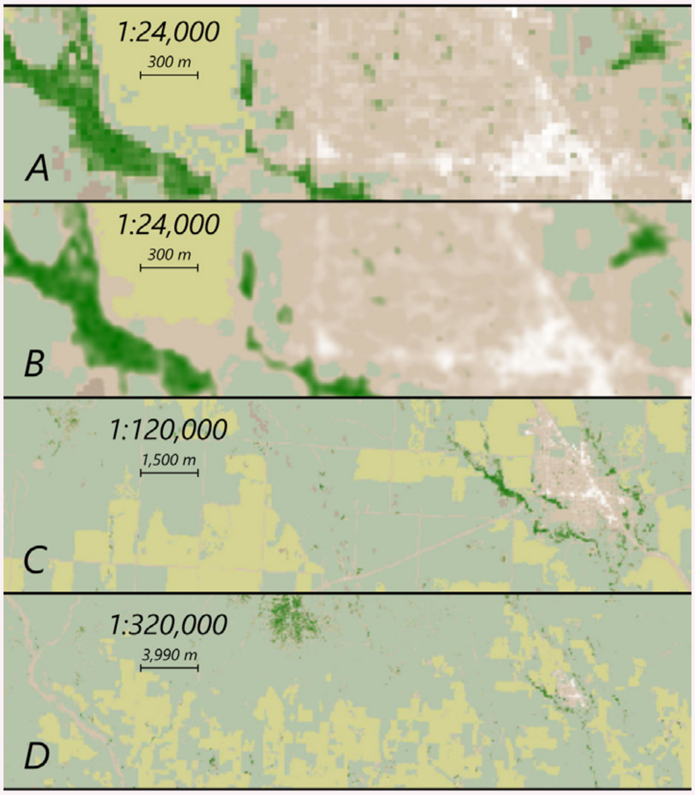

Figure 12. *Multi-scale land cover products.*

TREATMENTS FOR SMALLER MAP SCALES

The same design concept is applied to small-scale land cover. Processing is similar but simpler, since only generalization and not edge enhancement is required at coarser map resolutions; i.e., there is no need to derive sub-pixel classes. The product land cover consists of the same five land cover classes, plus water bodies; "canvas" patches are unnecessary, because no stochastic airbrushing is used. The three input rasters are first reclassified, following exactly as in the large-scale land cover (see Table 1). NLCD data are resampled to a resolution equal to 0.00025 times the target scale, using nearest neighbor resampling for the classed NLCD data, and cubic convolution for both the percent impervious and percent canopy rasters. The percent impervious surface and canopy rasters are thresholded for values 20% and higher, as in the 1:24,000 case. Water body polygons are rasterized at the calculated resolution. The land cover class rasters are mosaicked with the same priority order as used in the large-scale processing (minus canvas patches). The same color specifications are used, with the exception that agricultural lands, grasslands, and barren lands are represented without color ramps at their edges. The product land cover still exhibits a painterly quality, despite no longer using the "airbrush" effect at class edges, because the similar color lightness values continue to effectively blur edges.

Figure 12 illustrates the product of this processing at various scales in the area around Memphis, Texas. The original-resolution NLCD data are reclassified and colored according to our specifications in *A*, the product of our large-scale processing is shown in *B*, and land cover for two sample smaller scales are shown in *C* and *D*, respectively.

CONCLUSIONS

Our cartographic solution achieves an informative land cover base map layer for use at 1:24,000 or similarly large topographic map scales from NLCD data which have been both generalized (i.e., reclassified into fewer classes and geometrically simplified) and enhanced (i.e., produced at higher resolution with randomized class edges). The goal of the resulting land cover base map is not to improve the analytical usefulness of NLCD data or to present a map layer for precise cartometric analysis; rather, it is a solution for making use of coarse land cover data at larger map scales when an imprecise general impression of land cover constitutes an acceptable base map.

Increasing the resolution of spatial data by interpolation is a dubious task when there is no further information by which to be certain about the interpolation accuracy. Usually, when two or more layers at different spatial resolutions need to be used together in cartographic representation or analysis, the finer-resolved ones are coarsened to match the coarsest one. This paper has presented work that has attempted to do the opposite for the sake of solving a practical map design problem posed by the USGS. We have based our methods on scientific principles, but there is undoubtedly also a great deal of art and subjective creativity in our approach.

Our cartographic product successfully provides a generalized and painterly representation of land cover. The same methods might be useful for other kinds of classed phenomena, with the proviso that uncertain, ambiguous boundary edges are appropriate or acceptable. The representation produced by this method is abstract, and does not achieve greater precision than the input pixels. Indeed, while the pixels in the output have been made finer, this has deliberately happened at the expense of precision. As discussed above, this loss of certainty remains constrained to boundary edges.

We believe this generalized representation is useful for several reasons, especially when applied to land cover. First, imprecise region borders often reflect reality, such as might be seen between forests and grasslands, where types of land cover grade into each other. Also, the product land cover layer is an image, much like a photograph, meaning that it readily lends itself to scaling and zooming as a reader explores a topographic map in any "slippy" map digital context where pan and zoom functionality is available (e.g., a US Topo GeoPDF file). We hope our product land cover base map conveys our intention: that general impressions of the land cover can be identified for the sake of map viewing and visualization, but that borders, given the data at hand, need not be precisely delineated.

NOTE

Python source code for the scripts developed and used here is available by contacting the authors.

ACKNOWLEDGEMENT

This research was financially supported by a USGS Center of Excellence for Geospatial Information Science (CEGIS) grant awarded by Dr. E. Lynn Usery through the Cooperative Ecosystem Studies Units (CESU).

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DOI: 10.14714/CP83.1379

Digital Projects from the Evans Map Room at Dartmouth College

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Dartmouth College Library's dedicated map collection originated during the tenure of Nathaniel L. Goodrich, who served as the Librarian of the College from 1912 to 1950. Housed in the bright and sunny Evans Map Room, it provides cartographic coverage for the entire world, and has grown over the years from 31,000 items in 1946 to almost 200,000 by 2014. Additionally, atlases of all subjects and sizes are scattered throughout the Library's other collections.

When I arrived at Dartmouth and began working with the map collection, I saw how many people used our collection of New Hampshire Sanborn maps, which is unique to Dartmouth College within the state: the Library of Congress deposited a duplicate set here many years ago. When I previously worked at the John R. Borchert Map Library at the University of Minnesota, patrons weren't allowed to touch the actual maps—they instead had to use microfilm versions.

Because the New Hampshire Sanborn collection was so heavily used, I wondered if there was a way to make the maps more available digitally, and decided that we should digitize them all. Scanning the maps was not a problem, as we have a large-format roll-type scanner. But the decision to digitize them left us with more decisions to make: what format or formats would we offer, at what resolution we would scan the maps, how would we store them, and how would we advertise the availability of these new digital files? This project happened before the Library had a digital collection infrastructure, and so we didn't have any pre-existing guidelines to use.

We eventually decided to offer two different image formats: JPEG and TIFF. We scanned the maps at 300 dpi for both formats, which we felt was a good resolution because it could provide lots of detail without creating files

***Figure 1.** Entrance to the Evans Map Room in Baker/Berry Library.*

that would be too big to manipulate. We stored the files on compact discs, creating separate discs for each town's maps; this gave us a portable format that also made it easier for us to copy and distribute maps based on geographic location. We didn't have an organized method of advertising these new digital files outside of a Library News item. However, as we received new questions about the Sanborn collection, we told potential users about the scanned images.

It took several months of dedicated work from Peter Allen and several of our student workers to scan all of our Sanborn maps and write the files to multiple discs. These discs made it very easy for us to supply users with the new digital images of the maps, while also protecting the paper maps from the previously heavy use they had received.

Once our Library eventually created a more formal digital infrastructure, we used the scanned Sanborn maps as our first digital map collection. Because we had decided on certain criteria for originally scanning those maps, they helped define what was acceptable for use within the

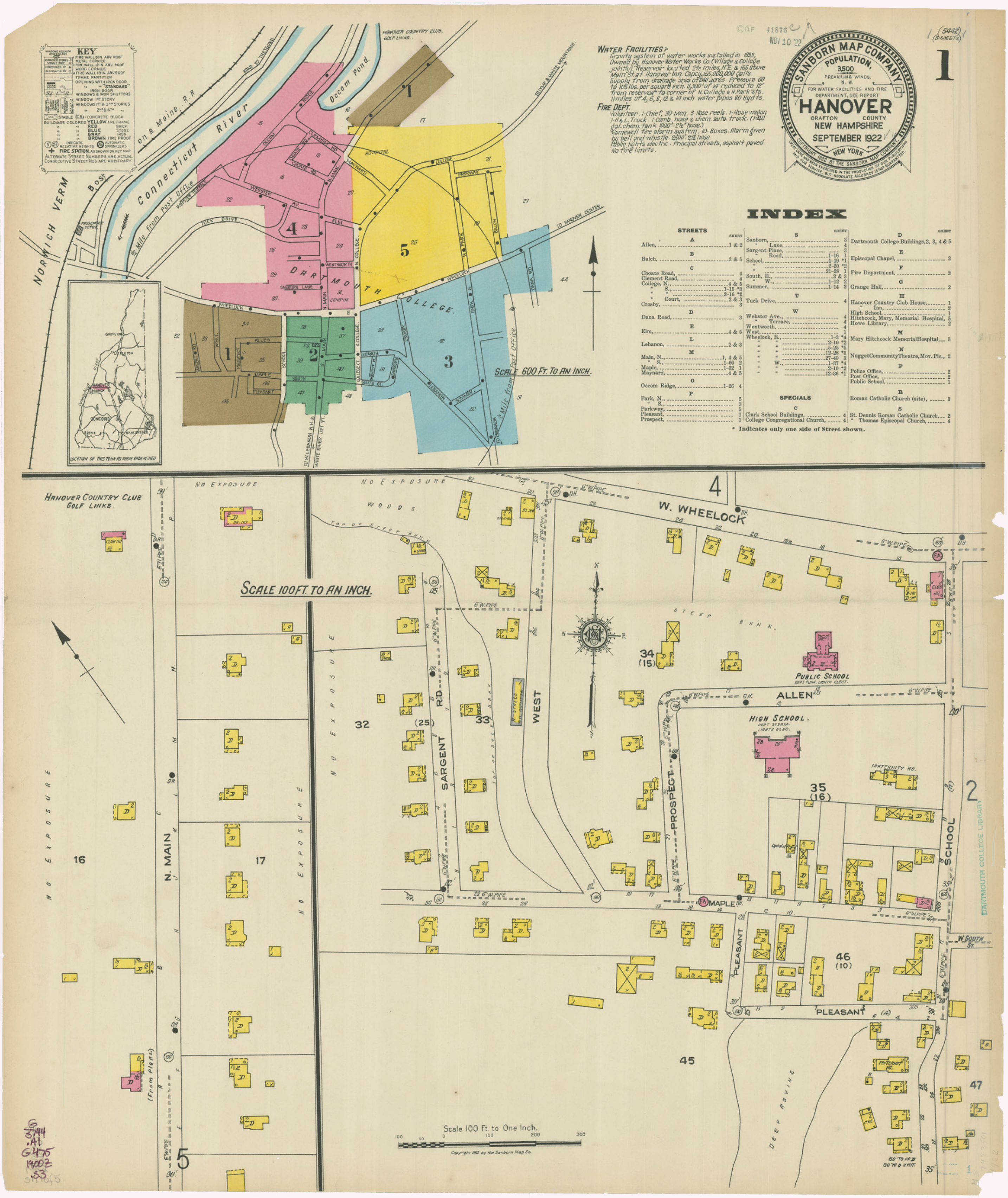

Figure 2. Sanborn sheet for Hanover, NH (1922).

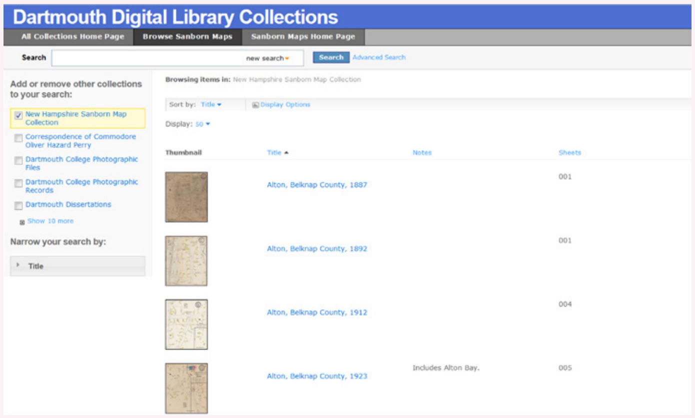

Figure 3. *The New Hampshire Sanborn Collection web page.*

new infrastructure. All the digital projects team needed to do was upload our scans into our new system, CONTENTdm. Once loaded and verified, I created an opening page to explain the collection and also provided examples of how researchers used Sanborn maps.

Once we finished the Sanborn collection, we looked at our other maps to find more unique, small collections we could digitize. Our set of maps of Dartmouth College itself and the Town of Hanover receive heavy use. As the College sits within the town boundaries, most maps of one contain the other—both are permanently linked.

Figure 4. *Early map of Hanover, New Hampshire (ca. 1700).*

Figure 5. Map of the Second College Grant (1880).

Figure 6. Map of New Hampshire (1770).

This time, because we now had a digital infrastructure within which to work, we had a more formal set of procedures for creating new collections. I created a proposal for the Dartmouth College/Hanover map collection. Once the digital projects group approved the proposal, we formed a group to oversee this new project, including members from the Evans Map Room, the Preservation Department, and the Cataloging & Metadata Department. The Cataloging & Metadata Department created a list of maps from both the online catalog and our card catalog. Using that list, I looked at each map to determine whether it should be included in the digital collection. I also added missed maps to the list. Missed maps are those we found while physically handling each map.

Once a week, the Preservation Department picked up 15 to 20 maps and looked them over to see if they needed preservation. While they were in Preservation, Cataloging & Metadata also looked over the maps to include missing information on the list, and also steadily worked on creating individual catalog records for each digital item, as well as a record for the entire set. Once those two departments finished, Preservation returned the maps to the map room for scanning. Once a month, the group convened to chart our progress and resolve any outstanding issues. In about one year, we examined over 200 maps, and eventually the digital Hanover/Dartmouth College collection contained 178 of them.

Following this project, I next submitted a proposal to create a collection for the state of New Hampshire. This was a much larger collection, and eventually contained 615 maps. One reason for the collection's size is that it included several different maps sets, including a geologic set, flood plain and flood prone sets, and various USGS sets at different scales. We did not, however, include the individual cities and towns in the state; that is the latest digital map collection we are working on.

All of these new digital collections are unique to Dartmouth and to the state of New Hampshire. I felt these were important artifacts and that they needed to be made available digitally. Hanover and Dartmouth may be in the middle of the state, but we're not exactly close to anything, and it's a trek for many people to get here. Making these collections digital opens them up to everyone, everywhere.

Many thanks to Peter Allen, Danada Dinsmore, William Ghezzi, Deborah Howe, Christina McCarthy, Barbara Sagraves, and Stephanie Wolff who helped make these collections digital.

WEB SITES

The Sanborn Map Collection: www.dartmouth.edu/~library/digital/collections/maps/sanbornmaps/index.html

The Hanover, NH Map Collection: libarchive.dartmouth.edu/cdm/landingpage/collection/hanmaps

The Granite State Map Collection: www.dartmouth.edu/~library/digital/collections/maps/granitemaps/index.html

The Evans Map Room: www.dartmouth.edu/~library/maproom

Dartmouth College Library: library.dartmouth.edu

The Dartmouth Digital Library Program: www.dartmouth.edu/~library/digital

Dartmouth College: dartmouth.edu

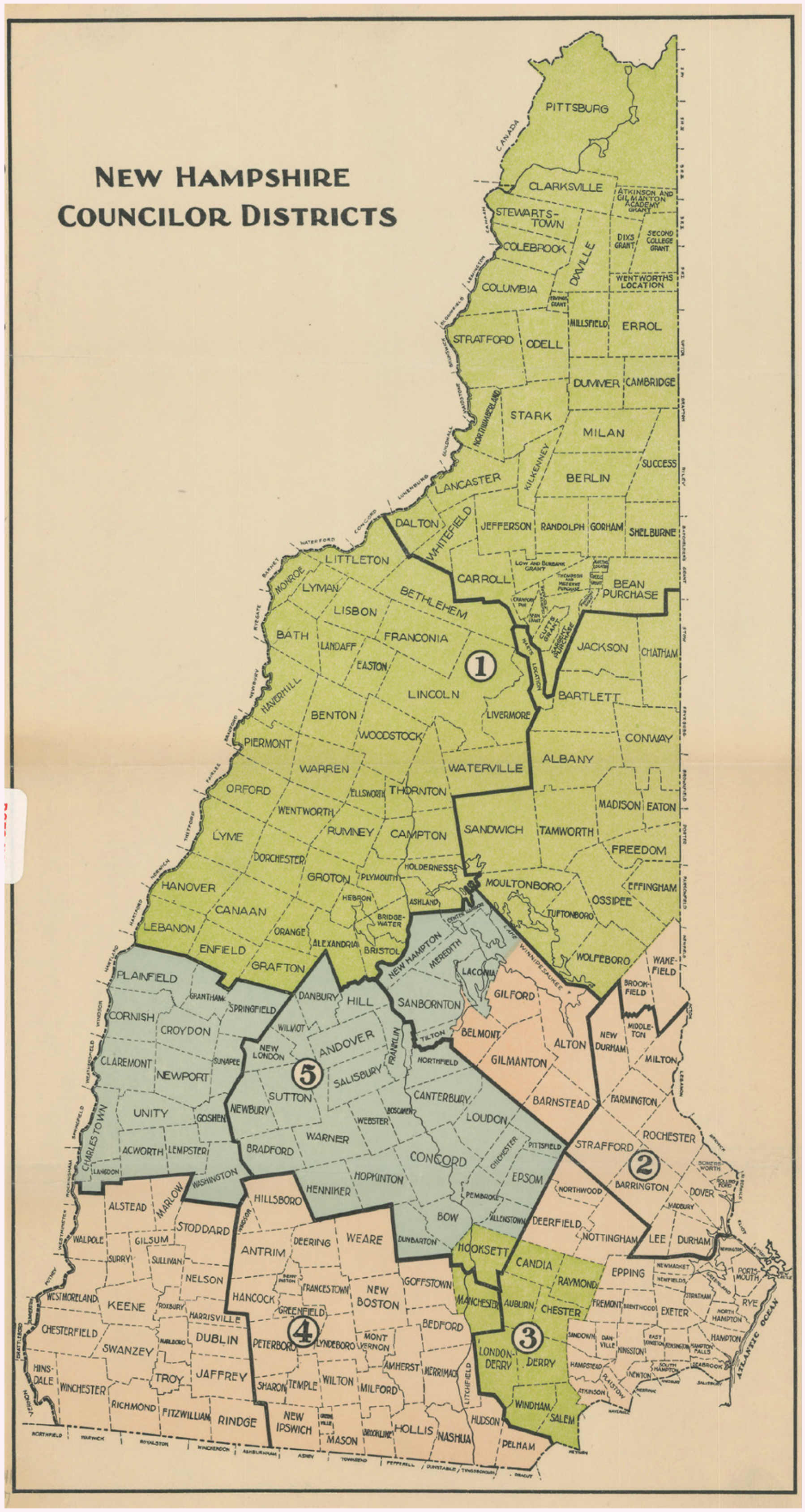

Figure 7. Map of New Hampshire (1900).

Figure 8. *Map of the White Mountains, New Hampshire.*

DOI: 10.14714/CP83.1364

Exploring the History of Cities through Sculpture

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"Boston," by Matthew Picton.

Maps have almost always been a feature in my work; to me, they function in a transportive manner, allowing for the imagination of place, landscape, and history. Maps are often objects of great beauty, intricate diagrams of the forms and patterns of the organisms that constitute the city. My works map the physical terrain and the historical and cultural landscape that reflects each city's evolving individuality and idiosyncrasy, interweaving the narratives of personal and public history.

I am less concerned with creating a factual and objective record than I am with presenting an emotional and cultural history of the city, a non-objective mirror of that history seen through the lens of film, music, literature, and the visual art of a given period. I am particularly interested in the intersection between history and art, the blurred line between the myth, the narrative, and the historical truth. Some works view a city specifically through its literary heritage; others will have defined periods of cinematography associated with them. Many cities will have undergone some cataclysmic change, through the effects of war or natural disaster, and some of the sculptures I have made have been specifically about this.

In my practice, a great deal of time is spent researching the city in question; I like to immerse myself in the history, reading the significant novels and films set in and about that particular city. I am slowly working toward a parallel history of all the major cities of the world, realized as sculptures.

I present four examples of my works here.

MEXICO CITY #2

To spend time exploring the Zocalo—the vast square in the heart of the oldest part of Mexico City—is to become aware of the layers of history in the city, the remnants of which are all visible here. High above the square is a huge Mexican flag, in its center is the emblem depicting the myth of the founding of the city: the eagle devouring the snake upon the cactus. The original city of Tenochtitlan was built on an island in Lake Texaco, the drained lake upon which Mexico city currently sits. The surrounding Spanish palaces and the Catholic cathedrals were built on top of the leveled Aztec pyramids of Tenochtitlan, the bases of which can be seen partially unearthed beneath the great flagstones of the square. It was here during excavations that the great stone wheel of the Sun Stone, the Aztec calendar, was discovered. The form of this can be seen in the background of the sculpture. In the palaces surrounding the Zocalo are some of the famous murals by Diego Riviera and Siqueiros, most of which are a visual representation of the history of Mexico. Images from these murals are suspended beneath the main street network inside the sculpture. These murals have been cut through with text from Octavio Paz's poem "La Piedra del Sol," based upon the Aztec calendar and the Sun Stone.

"Mexico City #2."

"Mexico City #2," detail.

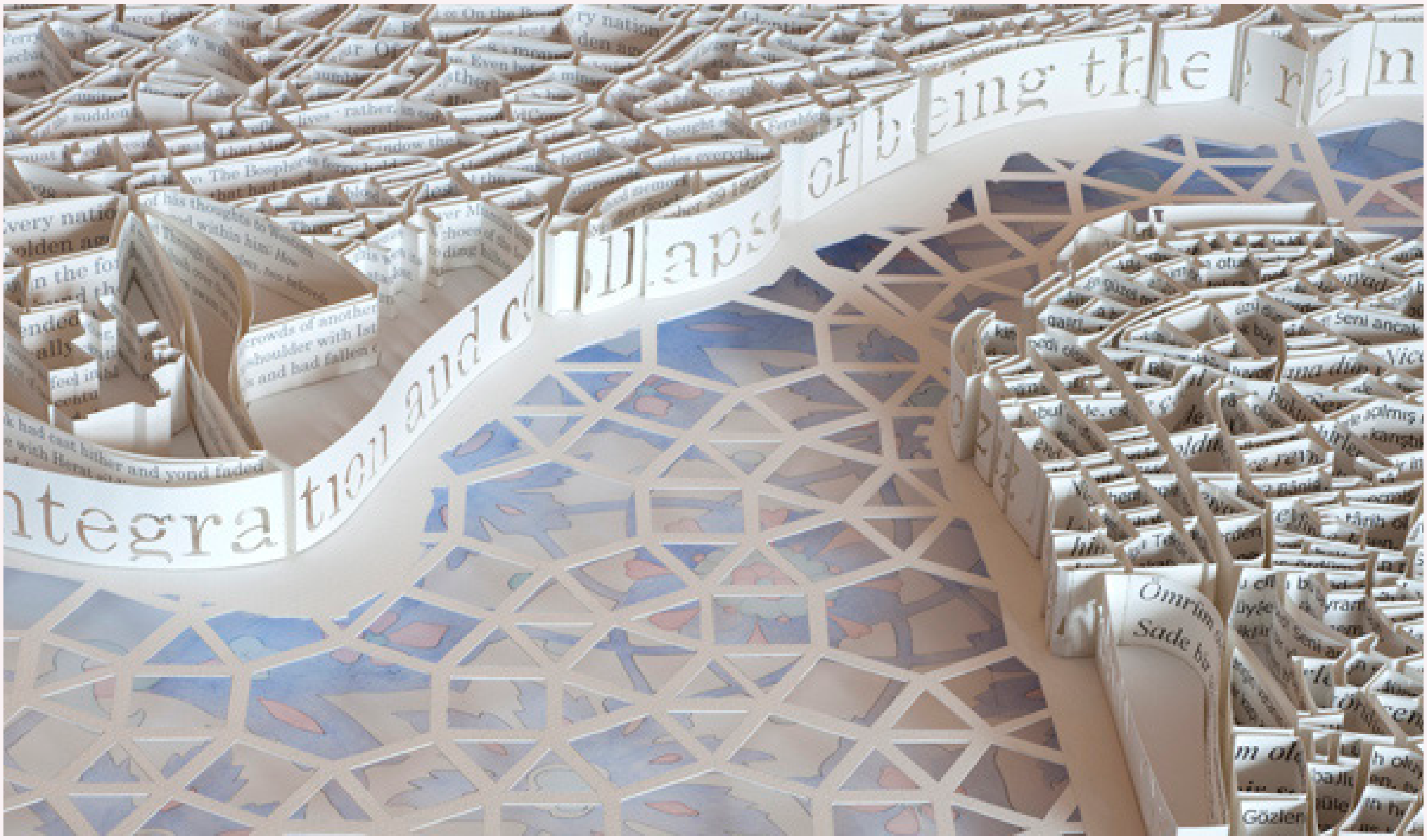
BOSTON

The sculpture "Boston" in part documents the history of the landfill that became Boston. The darker raised forms of the sculpture show the small peninsula that was the original scale of Boston in the 17th century. The Great Boston Fire of 1872 is depicted in the burnt and singed area in the sculpture. The sculpture also contains the words and thoughts of leading intellectual and cultural figures to have emerged from Boston. In many ways this sculpture illuminates the idealism in American culture, whether from the figures of the establishment or from those of the counter-culture.

"Istanbul."

ISTANBUL

Human societies are intrinsically dualistic by nature; few cities illustrate this more than Istanbul, which, particularly throughout the 20th century, has often been caught between competing polarities. Its unique geographic position, divided between the continents of Europe and Asia, mirrors the competing directions that its society and culture are pulled in. The sculpture incorporates texts from A Mind at Peace by Ahmet Tanpinar—this 1949 novel



"Istanbul," detail.

poetically depicts and expounds upon the difficult transitional years of the midcentury. The section across the Golden Horn is comprised of the poetry of Yahya Kemal (1884–1958), whose works reflected and reworked the Ottoman poetic heritage into the period in which he lived. The language used is the modern Turkish that became the official language in 1928. Across the Bosphorus on the Asian side are poems in the original Ottoman Arabic texts, by Esrar Dede and Sheyh Galib. The space that is the Bosphorus in the sculpture is filled by a watercolor painting; this painting is taken from the tiles on the wall revetments in the Mosque of Rustem Pasha in Istanbul.

BERLIN 1928–1989

This sculpture is comprised of three layers. The surface layer has a street form of West Berlin cut from the film poster of The Wings of Desire by Wim Wenders. The sunken portion of East Berlin is cut from the film poster of The Lives of Others by Florian Henckel von Donnersmarck. Underneath and visible in a fragmented form are images from the posters and covers of the film Berlin Alexanderplatz by Rainer Fassbinder. The three films address three very specific periods and localities: Berlin Alexanderplatz is set in the Berlin of 1928; The Lives of Others and The Wings of Desire take place in pre-1989 East and West Berlin, respectively.

The map used for the sculpture is from the pre-war era, 1932. The images along the wall are of the murals and graffiti that covered the Berlin Wall before its demolition in 1989.

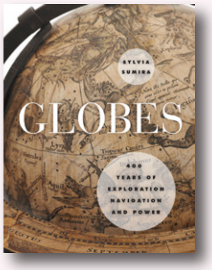
Matthew Picton creates fine art sculptures from a variety of media. He is based in Ashland, Oregon, and his work can be found in galleries and locations worldwide. For additional information, please see: matthewpicton.com

"Berlin 1928–1989."

"Berlin 1928–1989," detail.

Visual Fields focuses on the appreciation of cartographic aesthetics and design, featuring examples of inspirational, beautiful, and intriguing work. Suggestions of works that will help enhance the appreciation and understanding of the cartographic arts are welcomed, and should be directed to the incoming section editor, Matt Dooley: mathew.dooley@uwrf.edu.

GLOBES: 400 YEARS OF EXPLORATION, NAVIGATION, AND POWER



By Sylvia Sumira.

The University of Chicago Press, 2014.

224 pages, 120 color plates. $45.00, cloth.

ISBN: 978-0-226-13900-5

Review by: Mark Denil

Globes: *400 Years of Exploration, Navigation, and Power*, by the respected professional globe-conservator Sylvia Sumira, is a fairly comprehensive and concise overview of globes and their makers from the late-15th through the late-19th centuries. It is touted as a brief history of globe making, and, within its declared limits, it delivers on that promise. *Globes* is built around a museum-quality photo parade of scarce, fragile, precious, delightful, and wondrous artifacts supported by succinct gallery-wall-label-like texts, and it wraps that exhibition with equally succinct essays and glossaries to provide context and accessibility.

Globes are seductive objects: every one, from the newest and cheapest (say, an inflatable beach ball) to the rarest and most costly (many examples of which populate the pages of *Globes*), carries a special *je ne sais quoi*; rather like a cross between a map and a Ukrainian pysanka. Globes tend to be difficult to make, awkward to store, and a bit of a bother to use; they are usually too small to show the detail one wants or too large to handle conveniently. Most are absurdly delicate, and those that are not tend to annoyingly trade away precision for ruggedness. Still, their seductiveness is undeniable (at a quick count, I, myself, have at least twenty here in my apartment as I write), and the examples displayed in *Globes* attests to a long history of their siren-like appeal.

This University of Chicago Press book has a decent heft, with firm board covers in dark blue cloth, and reasonably opaque, Permanence of Paper standards mark pages of a good weight. A full bleed detail photo of a globe graces each dust jacket face: a celestial globe on the front and a terrestrial on the back.

The body of the book is divided into two main sections, plus a preface and four end-matter sections. The first main section is composed of three chapters: "The Parts of a Globe," "A Brief History of Globes," and "The Making of Globes."

The two-page spread entitled "The Parts of a Globe" displays unattributed engravings of a celestial/terrestrial globe pair, with the major features labeled with call-outs. As it happens, the labeled parts of the two are identical, save that the celestial sports an Equinoctial Line in lieu of the terrestrial's Equator, and a Colure, which the other lacks. It is not entirely clear why this chapter is so far separated from the useful two-page Glossary that is tucked away near the volume's end, in a sort of betwixt and between place after the main body but before the Bibliography, Picture Credits, and Index.

"A Brief History of Globes" fills eighteen pages with two-column text and twenty-two illustrations, six of which are full page. This chapter is the core historical narrative; it is sprinkled with frequent references to individual globes that appear in the second main section of the book ("The Globes"). One is at first tempted to read the narrative in parallel with reading the blurbs on the individual globes, but after a few pages of the narration the references start to bunch up and the connections become less specific, making that plan unworkable.

The eight pages of "The Making of Globes" are very informative. This is a topic on which one would expect the author's expertise to shine, and she does not disappoint. This is not a how-to manual on globe building, nor is it a treatise on globe restoration, but it is a general discussion of what is going on inside the ball by someone who has looked inside more than a few of them, and of the situation on the outside by someone who has often had to fix the ravages of more time than the maker probably ever expected the artifact to survive.

We now come to the main event: the section entitled simply, "The Globes." The primary focus of the collection is on printed globes, but there is a smattering of manuscript and engraved-metal globes to round out the overview.

The author enjoyed a long association with the British Museum, and the lion's share (forty-one) of the globes on display resides in that institution. A further eleven are from other British collections, with seven more held by museums in other countries.

The photography is excellent. Each globe is displayed in a full-page, full-length portrait, including its stand (where one exists), and more than half of the globes also have at least one full-bleed, two-page-spread detail photo as well.

The page layout in this section is formal, and rather old-fashioned; quite in keeping with the dates of the artifacts. There are generous, symmetrical side margins, with a clear inch and three-quarters deep space across the top. The five-line exhibit identification heading is center justified, and below it is a five-inch wide, centered and fully justified text block that starts just an inch and a half above the page center. Each page in this section has this good, solid, formally balanced 18th century page architecture: elegant, refined, and self-assured.

Contrast this formality to the (very nice) two-column, flush left/ragged right text in the first section, or the way the Preface has a justified text block similar to "The Globes" section, but with its heading and text placed flush, well over to the left. There is a clear sectional differentiation and hierarchy expressed in the page layouts, and we are left in little confusion as to what the author expects us to see as the serious work. I think a tip of the hat to Maggi Smith, the designer, is in order—and while we are at it, to the photographer, Elizabeth Hunter, as well.

Globes: *400 Years of Exploration, Navigation, and Power*, is a sumptuous work providing excellent views of a large number of exquisite artifacts, and secondarily offering a historical horizon into which each globe can be placed. If you want to have a good look at globes that you, in all probability, would never otherwise have ever seen, then this is the book for you. Unfortunately, Ms. Sumira's writing on history does not do justice to the globes and their photographs (and, I assume, in many cases, her own restoration work). No editor is mentioned in the credits or preface, and she is sorely missed.

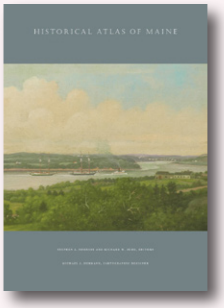
The problem lies, in part, with what one might call some rather peculiar grammatical constructs the author employs, constructs which make sorting out things like pronouns something of a puzzle and making for a somewhat staccato narrative flow. Most individual instances are just niggling, but far too often I found myself halting in mid-sentence to try to worry out just who "he" might be, or to find myself running full tilt into a new topic in the middle of a sentence.

The author especially seems to have a bit of a rocky time with interjected explanations: her discussion of rhumb lines on a Mercator globe is a case in point. First, she launches, without warning, into the topic of loxodromes in the second half of a mid-paragraph sentence that started off being about new discoveries in Asia. She then quickly (and not too clearly) tells us what rhumb lines are, and mentions their use, before she then brings up portolan charts. After observing that portolans were not constructed on a geometrical base, but that the rhumbs on them were shown as straight, she then says that they spiral to the poles on a globe. (Really? A rhumb on a Mercator projection does, but who knows where a straight line on a map with no geometric base actually goes? It could wander just about anywhere.) After this ten-line aside, the paragraph then abruptly drops the topic and closes with the line: "In 1551 Mercator published a companion celestial globe." What a wild ride through a cobbled-up paragraph!

The majority of this grammatical fluffiness is in "A Brief History of Globes," although some examples creep into the text in "The Globes" as well. Clearly the author is on much firmer ground in the chapter "The Making of Globes," which is, as already mentioned, well written.

All in all, *Globes*: *400 Years of Exploration, Navigation, and Power* is an interesting and worthwhile book. Delectable photos of exquisite artifacts are its main strength, but the information contained (and especially the globe-making chapter) raises it out of the dread coffee table book league. The book is about *globes*: don't expect much about exploration, navigation, or power. One suspects that the subtitle was just tacked on by the publishers, because, hey, everything has a subtitle these days. List price for the hard copy book is $45, but I have seen new hardcover copies online for as little as $24. Even at list, though, it seems a good value.

HISTORICAL ATLAS OF MAINE



Edited by Stephen J. Hornsby and Richard W. Judd, cartographic design by Michael J. Hermann.

The University of Maine Press, 2015.

208 pages, with 76 two-page illustrated color plates. $75.00, hardcover.

ISBN 978-0-89101-125-5

Review by: Lisa Sutton

The *Historical Atlas of Maine* is a solid book, weighing in at over five pounds. It is handsome and well made, printed on heavyweight paper that feels good in the hand. It would make a gorgeous coffee-table book, but it has much more to offer as well.

The *Historical Atlas of Maine* is divided into four parts: From Ice Age to Borderland, 13,000 BP–1790; Shaping Maine, 1790–1850; Industrial Maine, 1850–1910; and Maine in the Modern Era, 1910–2000. Each part begins with an essay summarizing the period, and continues with 14–24 plates that illustrate specific slices of the history of each era. Each plate is a two-page spread offering information in many forms: details of historical maps, photographs, charts, and multiple maps showing a variety of information, as well as a few paragraphs of text.

Part I (From Ice Age to Borderland, 13,000 BP–1790) begins with several plates covering the glaciation and prehistoric periods of Maine, including tools and archeological sites from early human settlement. Early European exploration of Maine is next, as well as contact between Europeans and native groups, with maps and charts showing the drastic changes in native populations. Early trading and European settlement, charting and interior exploration, and the Revolutionary period are all covered as well.

Part II (Shaping Maine, 1790–1850) examines the War of 1812, Maine's new statehood, disputes over Maine's international (northeast) border, and surveys of the interior. This section also takes a look at human migration, with plates covering native spaces and treaty areas, migration from within New England, Irish migration, Shaker communities, and the expansion of settled areas. Plates covering the economic development of the time period include the development of agriculture, farming the salt marsh, lumbering, wooden shipbuilding, deep-sea fisheries, maritime trade, port towns, and the mercantile area of Portland. The final plate covers Maine in 1850.

Part III (Industrial Maine, 1850–1910) begins with plates on bird's-eye view maps, county atlases, and maps created by the native Wabanaki people, and then moves on to scientific surveys, population changes, and French-Canadian immigration. Most of the plates in this section deal with various forms of industrialization: railroads, electrification, mills, textiles, leather goods, pulp and paper, granite and ice, and sardine canneries. Plates looking at agricultural issues include agricultural specialization, potatoes, connected farm buildings, and rural decline. This section winds down with plates on Maine's natural areas: Thoreau's travels in Maine, artists in the mountains and coasts, summer cottages, hunting and fishing, and changing native homelands. The section concludes with a plate on Maine in 1910.

Part IV (Maine in the Modern Era, 1910–2000) looks at changes in Maine over most of the last century. Beginning with a plate on the shift to a more urban population, it then moves on to state highways, metropolitan Portland, changes in manufacturing, specialization in agriculture, canning corn, the shift from moving logs on rivers to moving them on roads, and lobster fisheries. Plates on tourist maps, the promotion of Maine as a tourist destination, and public lands examine recreational activities in Maine. The section ends with plates on environmental problems, native land claims, and Maine in 2000.

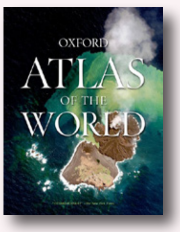
This atlas does a fine job of exploring many details of Maine's history. The essays which introduce each part are well written and concise, neatly summarizing the main events and changes taking place over the given time period. Within each essay are references to each plate in that section, so that while reading the essay, the reader can easily flip to a plate that explores a given topic in greater detail. The inclusion in each part of a final plate showing the population and a map of the state at the end of that time period offers the reader a nice time-lapse view of Maine.

The data visualization is exquisite, with visually simple maps and graphics that convey the needed information gracefully. The color choices are excellent, with graphs and charts that use colors that coordinate beautifully with other images on each plate. This kind of attention to detail is a large part of the reason that this atlas is such a pleasure to read. Despite the abundance of information on each plate, the layout allows the eye to move easily across the page, and it never feels cluttered or busy.

The nature of the layout is such that some of the historic maps and photographs are reproduced at a rather small scale. One gets a good overview of the image, but can't always look closely at details. Though the reader might like to look more closely at some of these images, that is not really the purpose of this book, and the images are used appropriately to illustrate the points being made. Besides, the atlas includes an extensive list of sources at the end, so that if one really wanted to track down a particular map or image, one could do so.

Overall, the *Historical Atlas of Maine* is an excellent work, providing a graceful historic tour of Maine. The liberal use of historical maps gives the book an authentic historic flavor, which enhances the reader's experience of this trip into Maine history. The atlas's format of plates on various topics makes it easy to flip through and find topics of interest, and the combination of historical maps and documents with modern mapping to illustrate some of the points being made is quite masterful. This book is well constructed and well conceived, both informative and engaging. It would be a fine addition to the collection of anyone who has an interest in Maine history.

OXFORD ATLAS OF THE WORLD, TWENTY-FIRST EDITION



Oxford University Press USA, 2014.

448 pages. $89.95, hardcover.

ISBN 978-0-19-939472-2

Review by: Mark Denil

How does one review a general reference tome like the *Oxford Atlas of the World*? A thematic atlas has a declared focus addressing an identified need, and one can evaluate its successes and failures in serving that need. A general reference atlas, by contrast, must support a wide range of *ad-hoc* consultations, so there is no sharply defined *need* against which one can measure it. One might compare statistics with other atlases (reporting map counts in much the same way dictionaries tout word counts); one could comment on map clarity (a highly subjective measure at the best of times, and one really only definable in the light of a defined map need; something that in this case we know we don't have defined); or one might examine the explicit and implicit assumptions and arguments framing the presentation (why are some opinions given as fact and other facts ignored as opinion?). This review will attempt to touch on all these approaches, and if it occasionally seems that the reviewer gags on a gnat while swallowing a camel and ignoring an elephant, just remember that, above all, a general reference atlas is supposed to be accommodating.

Promotional material for the *Oxford Atlas of the World* might strike the reader as a tad bombastic. Take a statement like: "Providing the finest global coverage available, the *Atlas of the World* is not only the best-selling volume of its size and price, but also the benchmark by which all other atlases are measured." Whether true or not, this leaves unexamined what is meant by "available," how strictly one is defining the limits of "size and price," and what value an "Oxford Atlas" unit of measure might have. Being "the only atlas to be updated annually" is easier to see as a strength in these days of potentially constantly updated online map resources, but how does the update schedule help purchasers of this Twenty-First edition after October 2015, when the Twenty-Second is due to be released?

Publisher's blurbs and inevitable outdated-ness aside, we have before us the current (at writing) *Oxford Atlas of the World*. It is a solid volume of respectable size and weight, 14¾ by 11¼ inches and 7½ pounds (by my bathroom scale). It is not the largest atlas available, by either page size or count, but it both pulls its weight and fits on a bookshelf. Nicely bound in heavy, smooth, semi-gloss boards, it sports a DigitalGlobe image of the new island that recently appeared and joined itself to Nishinoshima in the Volcano Island group. The general presentation exudes gravitas, and the photo boasts currency: the two touchstones of the ethos of an atlas.

Inside, the atlas is divided into several sections:

- Table of Contents
- Foreword
- User Guide
- World Statistics
- The Future of the Oceans and Seas
- Images of Earth
- Gazetteer of Nations
- World Geography
- World Cities
- World Maps
- Geographical Glossary
- Index to World Maps

In addition, symbol keys and map extent indices can be found on the endpapers: information pertaining to World maps in the front and to European maps in the back.

The "Foreword" lays out some basic conventions followed throughout the atlas. For example, we learn that the names used are "in conventional English form and are those that are in common usage. They are the forms used by publications such as *Newsweek*, and the *Washington Post*, and by the BBC and the Foreign Office." Now, I've not done more than glance at *Newsweek* or the *Post* since sometime in the Ford administration, but keyword searches of their respective websites do not show "Hawai'i" being the standard spelling in either of these publications. Still, this tells us we needn't expect names like Peiping or Zaïre.

Among the "User Guide" material is a map sequence key: a small world map with a sinuous red arrow showing the order in which the maps appear. This is a very handy affordance that makes explicit what in most atlases must be tediously pieced together mentally.

The "Table of Contents" is a two-page spread of all the contents, including all the maps and all the insets, with mention of each map's representative fraction. The listing of insets is especially nice to see. In both this section and the next, the headings (section names and continents in the "Table of Contents;" country/city names and column heads in "World Statistics") are set off from the list bybeing not only boldface and larger type, but also in a dark blue lettering that makes the headings stand out clearly but quite subtly from the list.

"World Statistics" has one page each for lists of countries (alphabetically) and cities (alphabetically by country). The country list details area (in square kilometers & miles), population, capitol cities, and income, while the city list gives populations.

The section titled "The Future of the Oceans and Seas" is a bit of a grab bag of short descriptions of various marine issues supported by maps and photos. This four-page section is divided in half into "Overview" and "Issues" subsections, and each has a short list of page references to the "World Geography" section. The pages are made up as tessellated mosaics of small blocks of text addressing each theme, but it is not clear why some blocks sit on colored boxes and some do not. There are colored heading bars backing the title for each theme with the color fading left to right: some bars are orange and some are blue. The blue-headed themes have light blue boxes behind their text blocks, and some of the themes headed with orange have orange boxes, but other orange-headed themes have no color behind the body text. It is very busy looking, and seems to have been done for no other reason than decoration. The same sort of layout graces the "World Geography" section, but the subtle titling in the "Table of Contents" and "World Statistics" sections would have worked better and been less garish.

It is almost obligatory these days for an atlas to include a selection of satellite images. In the *Oxford Atlas of the World*, these are of cities. For the most part the images are well chosen; they serve to convey the geographic character of the city layout, situation, and environs. Of the seventeen images, ten are Landsat, six are RapidEye, and one is GeoEye. All were sourced through NPA Satellite Mapping, who also provided the composite "cloud-free" image views used for the section title page spreads.

The "Gazetteer of Nations," filling 31 three-column pages, displays flags, a thumbnail location map, a selection of hard and statistical facts, and a short blurb about each country. The blurbs usually include a geographic/climatic description and a short, potted history, although some countries (particularly the smaller Caribbean islands) have very abbreviated write-ups.

The 40 pages of the "World Geography" section provide short, two-page introductions to some salient issues in physical, social, economic, and biodiversity geography. Supported with charts, maps, photos, and texts, the discussions are necessarily brief, but seem reasonably succinct. Each spread has a general discussion, set in a clear, serifed face with reasonable stroke contrasts, while other texts are in either a smaller-sized sans-serif or an even yet smaller condensed sans-serif. One gets the impression the type size and style (normal or condensed) was chosen more for copy-fitting than for purposes of a coherent textural hierarchy.

The graphs seem mostly well designed, but there is an inconsistent use of unnecessary drop shadows on the graph bars: some have shadows and some don't. A very few, like the Gender Parity Index graph on page 109, have things that look like shadows, but upon close examination we see that what looked like shadows are actually bars for the same data categories for a different year!

This section is the atlas's main collection of thematic mapping. Matters of Cosmological, Physical, Meteorological, Floral, Faunal, Human, and Economic Geography are touched upon, briefly, but for the most part clearly and usefully. However, the two six-inch diameter hemispherical star charts, authored by Wil Tirion, are disappointingly small.

This section also contains, as would be expected, a large number of small-scale rectangular world maps. At least, the graphic boxes around the maps are rectangular, but one notices that most of the maps themselves are not. They are, in fact, on some pseudo-cylindrical projection (that looks like Eckert IV), but the maps have no line indicating the limb: there is just plain white or blue space that fills in the whole rectangle. The weird illusion is compounded by the absence of most graticule lines: there is only the Prime Meridian and the Equator. These two straight lines intersect (of course) orthogonally, slightly off center to the west, and do very little except reinforce the mistaken impression that the projection itself is rectangular (which it quite obviously is not). When I say obviously, I mean of course to you or me: to a general reader it will just be misleading. The inclusion of these maps is indicative of a rather shocking and cavalier disregard by the atlas's publishers for both their users' interpretation and for their own reputation.

The next section is that of "World Cities." Seventy cities are covered in thirty-one pages, some with both regional and city center maps. There are generally four maps to a page, with an occasional double-wide or -tall map. The maps are identified on a header bar; blue for most maps and yellow for city details. The land colors of light brown for built-up areas, light yellow for less dense areas, and green for vegetated lands works well, as do the red-cased dropout main roads and the double line blue highways with blue outlined interchanges. Less consistently happy is the way that city detail map extents are shown on city regional maps by means of a white (drop out) background; the detail extents can be hard to pick out on some of the smaller-scale maps.

"World Cities" is followed by "World Maps," which constitutes the great bulk of the atlas and is divided into seven sub-sections: The World, Europe, Asia, Africa, Australia and Oceania, North America, and South America. These 190 pages of maps (including the seven sub-section double page title images), are arguably the main reason the atlas exists, and it is on these maps that the atlas will stand or fall. The extents of the individual maps seem reasonably well chosen, with many maps enjoying strategic excursions beyond strictly rectangular neatlines to supply important context. The selection of included insets is soundly logical as well.

The "World Maps / The World" sub-section opens with a pair of two-page world maps (physical and political) on a Winkel III projection. Across the spread underneath the physical map is a 40° north latitude around-the-world transect profile, with additional mountain peaks not on the line itself shadowed in; a very nice feature. That page space beneath the political map is filled with eight Azimuthal Equidistant maps centered on various cities with distance circles at 5,000-kilometer intervals. This is also quite interesting and engaging. One notes that this projection is called Azimuthal on this page, but is referred to as Zenithial where it appears elsewhere in the atlas.

The polar maps, each a single page, are disappointingly small. In the south, the many ice shelves are well labeled, as are the Antarctic stations, which are picked out with red points. The shallowest level of the bathymetry in the Arctic Ocean is a bit hard to distinguish from the Greenland ice cap and Ellesmere glaciers, due mostly to the blue form-shading on the ice caps.

The sub-section wraps up with a one-page map of the Atlantic, and a page of major Atlantic islands, plus one page for Greenland (with Iceland and Svalbard) and a page for Iceland by itself. This is good coverage for Iceland; in most atlases since Ortelius, it has had to make do with an inset at best.

Islands, on the whole, do pretty well in the *Oxford Atlas of the World*. The two pages of Mediterranean islands, for example, show most of the major islands at 1:800,000, excepting Crete and Cyprus at 1:1 million and Malta/ Gozo at 1:400,000.

A "Geographical Glossary" follows the last map. Geographical terms and abbreviations in thirteen languages found on the maps are identified and defined in English. The glossary is followed by a 109-page "Index to World Maps," listing "the names of all principal places and features shown on the World and City Maps." Each entry lists the name, country or region, geographical coordinates, atlas page, and Cartesian map location coordinates for that feature, plus symbols indicating confluences (for rivers), administrative rank, and legal status where appropriate. This is a most useful resource sorely lacking in too many atlases.

It would be a formidable task to comprehensively compare the 21st edition of the *Oxford Atlas of the World* to atlases from other publishers and/or mapping houses. Atlases appropriate for one audience may be less useful or usable by another, so even identifying appropriate pairings would require analysis beyond the scope of this review. The atlas business has always been one with fierce competition and thin financial margins, leading publishers to establish and stick with house practices and to find innovative ways to assemble and reassemble the same basic components into a range of atlases targeted at niche audiences. For example, Octopus Publishing Company, which owns Philip's, the mapping house responsible for the maps in this atlas, themselves publish a range of atlases under the Philip's name. These include: *Philip's World Atlas* (£15; 96 world map pages, "recommended for students [and] general home reference"), *Philip's Atlas of the World* (£75; 193 world map pages, which sounds a lot like the *Oxford Atlas of the World*), *Philip's The Royal Geographical Society Atlas of the World* (£100; 277 world map pages, "Positioned at the top of the Philip's world atlas range"), and the lavish *Philip's Universal Atlas of the World* (£150; 290 world map pages, "Positioned at the very top of the Philip's world atlas range"). One wonders what gem would be positioned, after the top and very top, at the very tippy-top of the range.

I would have liked to compare the cartography in a Philip's-branded atlas with the maps in this Oxford product, but was unable to locate one for perusal. I do, however, happen to own eight other Oxford atlases of various sorts, ranging in vintage from 1951 to 1973, so we can compare this new edition to some of its older siblings.

Over the time period of the samples, the Oxford University Press atlases used maps "Prepared by the Cartographic Division of the Clarendon Press" (Clarendon being the name used for academic publications of the Press), and the strong family resemblance amongst these maps is echoed in the maps from Philip's. Taking the two-page map of Southern Europe from the Twenty-first edition of the *Oxford Atlas* as an example, and the similar Mediterranean map from both the 1951 *Oxford Atlas* and the 1951 (1958 reprint) *American Oxford Atlas* for comparison, we can observe both broad similarities and minor but significant differences.

The maps in the two older atlases are substantially identical, save that the hypsometric colors in the American Oxford Atlas are noticeably more saturated, and, by comparison, more garish than its sister aimed at a British audience. In the newer atlas, the colors are also quite saturated, but are supplemented by a black overprint hill shade that varies the color value. As well, the hypsometric class breaks are shifted upwards on the new map, with additional high elevation classes, giving better definition to the high ground. The bathymetric classes are also multiplied; from two to nine, which seems rather a lot. It is unclear just why so much detail of the depths is wanted, and, with the hues running very quickly to dark and purplish blues, there seems to be an awful lot of ink on the page.

The projection note on the new map is ridiculously brief: simply "Conical with two standard parallels." The notes on the older maps manage to tell us we are looking at a "Conical Orthomorphic Projection, Origin 42° N., Standard parallels 35° and 49°, Scale reduction 0.7%" before directing us to a scale errors note on page 7. Someone seems to have a low opinion of our ability to understand such matters, which is somewhat annoying.

The annotation text on the new map is considerably larger than had been used in the 1950s, as is obvious when comparing some labels appearing on both maps. The characters in the country name TURKEY, for example, are 4mm tall on this new map and only 3mm on the old. Other capital letter comparisons (new/old) are the city Bucharest (3mm/2mm), the region Cyrenaica (2.5mm/1.5), and the city Tubruq (Tobruk) (2mm/1mm). The old maps, in fact, abound with very clear annotations with characters 1mm tall; the new map has only a very few minor names in crowded places as small as 1.35mm, and as a result has lost a very large number of place and feature names. The new map is, in fact, quite crowded with type: it forms a heavy overprint of black ink that is only partially relieved by the liberal use of a serifed typeface with dramatic stroke variation. The older maps are subsequently much more open and clear than the new version, but the heavy text on the new map is likely in part dictated by the heavy ink of the saturated bathymetry/hypsometry and the black hill shading overprint on land. The annotation on new map, however, seems much in line with current contemporary commercial cartographic practice. Clearly, as with all map making, one is always trading off on something; choosing an atlas is largely recognizing and judging the trade-offs.

In a final comparison, we should look at the way national borders are depicted in the 1950s editions and in 2015. In both the line is a combination of a less-than 1mm wide red line with a black dot-dash overprint. In the 1950s the black line was about 0.25mm, and in 2015 it is about 0.5mm wide. In the 1950s, the two components were not particularly well registered, and the alignment of the red with border rivers was similarly casual. In 2015 the line component registration was much better (except where the red part runs over red roads of exactly the same color, which causes an appearance of a problem), but the much higher saturation on the red line makes it hard to differentiate the line components. I needed a magnifying glass to confirm that there are two components in that line, and a linen tester to see the parts clearly. The new map also uses the same symbol for boundaries on land and at sea, where the old map used a much finer (half-width) dashed red line with no overprint to divide, say, the Greek Dodecanese from the Turkish mainland. The heavy 2015 border symbolization, though, is in line with the overall heavy-handed symbolization the newer map employs everywhere.

One of most annoying aspects of this atlas lies in the endpaper map keys. Both the key base maps (the World in the front and Europe in the back) are on rectangular, cylindrical projections, and the map extent rectangles (for maps in the atlas) are all orthogonal rectangles. It just so happens, however, that there are *no* cylindrical maps amongst the maps listed on the keys: the extents shown on the key simply do not match the extents of the maps in the atlas! Did the publishers think no one would notice? Do the publishers care if anyone notices?

As mentioned earlier, selecting an atlas is largely a choice amongst trade-offs. This *Oxford Atlas of the World* offers a selection of maps with useful and coherent extents, with reasonably good (if somewhat exuberant) hill-shaded hypsometry and large annotation with an easily understood multi-dimensional hierarchy. Other atlases differ in details, the significance of which is up to the purchaser to decide. Both the *Times Atlas of the World*, and the *National Geographic Atlas of the World* have maps with roughly the same extents and scales (albeit for more money and on pages considerably larger than the *Oxford Atlas of the World*), but the *Times* uses a subtle, but often difficult to visualize, hypsometry with no hill shading, while the *National Geographic* uses hill shading alone, with no elevation color (but it does have honking dark and wide national boundary vignettes). The Gazetteer in the *Times* atlas, like the *Oxford*, lists geographic coordinates for each entry, but the *National Geographic* makes do with alphanumeric page coordinates.

No one should pick an atlas based on a review (or on any number of reviews); there are just too many factors to consider and the factors are too individually specific. The Twenty-First edition of the *Oxford Atlas of the World* is a reasonably good, reasonably sized atlas that has a reasonably good chance of fulfilling the reasonable needs of most users. It is not without shortcomings, some of which are discussed here, but how seriously these shortcomings affect its usability is for you to decide.

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REFERENCES: References should be cited parenthetically in the text, following the author-date system found in *The Chicago Manual of Style*, 16th ed. (**chicagomanualofstyle.org**). When making a direct quote, include the page number. Examples: (Doe 2001) and (Doe 2001, 38).

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Robinson, A. H., J. L. Morrison, P. C. Muehrcke, A. J. Kimerling, and S. C. Guptill. 1995. *Elements of Cartography, 6th Edition.* New York: John Wiley & Sons.

Articles in Periodicals: Author's or authors' names as in *Books,* above. Year. "Title of Article." *Title of Periodical,* volume number, page numbers, DOI if available. Follow punctuation and spacing shown in the following example.

Peterson, M. 2008. "Choropleth Google Maps." *Cartographic Perspectives* 60: 80–83. doi: 10.14714/CP60.237.

Articles in edited volumes: Name of author(s). Year. "Title of Article." In *Title of Edited Volume*, edited by [Editor's or Editors' names, not inverted], page numbers. City of Publication: Publisher's Name.

Danzer, Gerald. 1990. "Bird's-Eye Views of Towns and Cities." In *From Sea Charts to Satellite Images: Interpreting North American History through Maps*, edited by David Buisseret, 143–163. Chicago: University of Chicago Press.

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Cartography Associates. 2009. "David Rumsey Donates 150,000 Maps to Stanford University." *David Rumsey Map Collection*. Accessed January 3, 2011. http://www.davidrumsey.com/blog/2009/8/29/david-rumsey-donates-150-000-maps-to-stanford.

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Cartographic Perspectives

The Journal of **nacis**

Number 83, 2016