map library bulletin board

Estimating the Size of a Large Map Collection or How I "Lost" 200,000 Maps and Still Kept My Job

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"The Cartographic Information Center ('Map Library') in the Department of Geography & Anthropology, is the largest university map library in the nation. Its more than 500,000 maps and photographs rank LSU 10th among all U.S. map libraries." This statement from the pamphlet *Louisiana State University Facts '93*, was repeated in the community information section of the Baton Rouge telephone directory and was also repeated to this map librarian by his barber.

This article will briefly trace the growth in the number of maps reported as held in the LSU cartographic Information Center to illustrate how much these figures were inflated over the years. Next, this article will present the methodology used to establish a statistically sound estimate of the map holdings and will propose a set of standards for estimating the size of a large map collection.

The boastful statement that opened this article has been repeated often enough to be regarded as factual by people outside of the map library profession. Within the profession, it has been regarded with skepticism long before this librarian became associated with the LSU Cartographic Information Center. Although LSU has reported its holding statistics to the map library guides and directories since 1954, this statement does not appear in the professional map librarian literature. Interestingly, the "facts" reported in the opening statement were drawn from several sources that appeared over a span of nine years. The claim that Louisiana State University has "the largest university map library in the nation" appears to be derived from the second edition of the *Guide to U.S. Map Resources* published in 1990. In this source, LSU heads the list of the largest geoscience libraries with 400,000 maps (Cobb 1990, p. xii). Another table in the *Guide* lists LSU as fifth among all U.S. map libraries after the Library of Congress, the National Archives, Harvard, and the University of Wisconsin (Cobb 1990, p. xi). According to the *Guide,* LSU was the fifth largest map library in the nation and the third largest university map library. The "fact" in the original quote claiming that Louisiana State University is tenth among all U.S. map libraries dates from the Winter 1981 issue of *Library Trends* (Stevens 1981, p. 528). The figure of 500,000 maps and aerial photographs in the opening statement does not appear in either the 1990 *Guide* or the *Library Trends*, but it can be attributed to two 1986 publications (Cobb 1986, p. 61; Wolter 1986, p 349). The wild fluctuation in the number of maps reported between 1981 and 1990 raised doubts about their accuracy. This map librarian was suspicious of the conveniently round figure and began searching the Cartographic Information Center files for proof to substantiate the figure.

No such proof was found. In fact, the last recorded count of the map holdings is now over forty years old. Apparently, all reported figures since January 1958 were unsupported guesses. Thus, the following question arose: How significantly have the reported LSU map collection figures been inflated since 1958?

In Table 1, the rounded figures prior to and including 1958 are based on actual map counts. The large increase between 1954 and 1955 resulted from the transfer of the Army Map Service collection from storage in the main library to the map library and the acquisition of 5000 maps from the Library of Congress. The corresponding average annual acquisitions rates for these years are also based on actual counts. In contrast, the figures from 1968 to 1990 are unsupported guesses. The annual acquisition rates listed after 1968 are inferred from the increase between reports. As can be seen, once the figures ceased to have a statistically sound basis they began to soar to unrealistic levels. Further, the inferred annual acquisition rate for the years between 1981 and 1985 is an incredible 23,750 maps per year. This rate is two and a half times the number of maps acquired by the Cartographic Information Center in one unusual year, 1996, as the result of participation in the Library of Congress Geography & Map Division Summer Special Project.

Although the reported number of maps dropped inexplicably in 1990, by 1995 the most commonly quoted figure for the number of maps held in the Louisiana State University Cartographic Information Center was 500,000. Since this figure could not be substantiated, this map librarian resolved during the summer of 1996 to either confirm or refute its validity by conducting a systematic estimate of the map holdings.

Methodology

The Cartographic Information Center map collection is housed in 129 flat five-drawer cabinets, 39 vertical two-drawer cabinets, 830 pamphlet boxes, 13 large corrugated cardboard boxes, 10 classroom map carts as well as various other storage containers. All of the materials are stored in the 2414 square foot map room. Because only a small fraction of the map collection is cataloged, and counting each individual map would be impossible, a method had to be developed to produce a statistically sound estimate of the number of maps.

The *Federal Depository Manual* provides a list of conversion factors to translate linear measurements of collections to numbers of items (GPO 1993, p. 93). The map conversion factor is given as 200 flat sheets per two inch deep drawer. A quick calculation using the supplied conversion factor yielded 1000 flat maps per five-drawer cabinet or 129,000 maps in the Cartographic Information Center's flat map cabinets. Since this rough estimate yielded a number significantly less than the reported 500,000 figure, it was realized that there were either 371,000 maps in the remaining storage containers, the conversion factor was too generalized, the 500,000 map figure was completely fanciful, there must be many unaccounted maps checked out to the faculty, or a combination of all of these factors was at work. Obviously, a more reliable estimate could be made.

Year	Number of Maps	Annual Acquisition Rate
1954[1]	15,700	not reported
1955[2]	59,040	2,010
1958[3]	68,757	3,015
1968[4]	180,000	11,000
1976[5]	300,000	15,000
1981[6]	325,000	5,000
1985[7]	420,000	23,750
1986[8]	500,000	80,000
1990[9]	400,000	-25,000

[1]Goodman 1954
[2]West 1955
[3]West 1958
[4]Carrington 1970
[5]Carrington and Stephenson 1978
[6]Stevens 1981
[7]Carrington and Stephenson 1985
[8]Cobb 1986
[9]Cobb 1990

Table 1. Reported Cartographic Information Center Collection Size.

The collection estimation project consisted of four parts: the Preliminary Survey, the Characterization Survey, the Measurement Phase, and the Estimation Phase. Prior to starting the project, a map room floor plan was drawn to facilitate the work and to chart the project's progress.

The Preliminary Survey's goals were to identify the storage areas that contained maps and to identify which map storage areas would have to be manually counted. Each drawer, box, or other type of storage container was opened for inspection. As a result of the Preliminary Survey it was realized that using the Government Printing Office conversion factor would produce an inaccurate estimate since the collection contains many diverse material formats which are housed in many different storage container types. Although the GPO conversion factor would not suffice for the whole flat drawer collection, the Preliminary Survey indicated that the collection could be broken down into more specific homogeneous storage areas, each with its own conversion factor (Allen 1996, p. 14). The generalized areas of homogeneous map collections, such as a topographic series, in a similar storage method were grouped together and plotted on the floor plan. The term "density groups" was coined to reflect the assumption that a uniform density of maps per linear measurement existed throughout the group of storage containers. The density groups would be more precisely defined and delineated during the Characterization Survey. Areas of heterogeneous collections, such as city plans, were designated for manual counting. Further, it was found that 53 of the 645 flat map drawers did not contain maps and were excluded from the next survey. One hundred and sixteen drawers contained heterogeneous collections that required manual counting.

The Characterization Survey's goals were to determine the number and nature of the density groups and to determine the appropriate conversion factor for each density group. In order to achieve these goals, the remaining 466 flat map drawers and the other storage areas were again inspected to determine a more accurate spatial extent of each density group. Further, the general density group descriptions from the Preliminary Survey were refined to be more precise. A total of forty-one density groups were characterized including the following examples: flat historic nautical charts, folded current nautical charts, captured foreign maps from the World War II era, recent 1:50,000 scale topographic maps of Mexico, 8x11-inch film negatives, full sized coastal survey chart film negatives, folded U.S. Geologic Survey topographic quadrangle maps stored horizontally, folded U.S. Geologic Survey topographic quadrangle maps stored vertically, and plat maps. Making the density groups as specific as possible would be essential to achieving an accurate final estimate, thus collections of maps that might have easily been grouped together if the storage areas had not been inspected were further refined into separate groups. For example, within the Army Map Service collection the following more specific density groups applied:

Maps stored flat, one stack per drawer
Maps stored flat, two stacks per drawer
Maps stored folded, one stack per drawer

It can easily be seen that the difference in the number of maps per linear unit in the last two groups would be roughly a factor of two while the difference in storage method in the first two groups could be addressed by measuring both stacks.

Additionally, the Characterization Survey identified two density groups that covered large storage areas that would present special problems when determining their conversion factors: the U.S.G.S. topographic quadrangle maps and the U.S.G.S. thematic maps. Although these two groups were heterogeneous, they were too large to consider manually counting the maps. Further, since they comprised a large percentage of the collection, they warranted the extra effort to accurately estimate their contents. A standard linear conversion factor could not be determined for the U.S.G.S. topographic quadrangle maps for two reasons. First, the maps were stored vertically which would have required removing 1,997 folders from the drawers and placing them on a flat surface for measuring. Second, the folders contained a mix of flat 15-minute quadrangle sheets and folded 7.5-minute quadrangle sheets. In order to avoid removing the folders and to account for the presence of flat and folded maps, it was decided to use the vertical map folder as the conversion factor unit.

Since the number of maps in each folder varied depending on the alphabetic range assigned to the folder, the number of editions of each sheet, and the number of copies of each edition, it was best to calculate the average number of maps per folder. The maps in a random sample of five percent of the folders (100 folders) were counted. The resulting conversion factor for this density group was 19.5 maps per folder applicable to 75 vertical map drawers. Two vertical map drawers contained historic Louisiana quadrangle sheets with a higher percentage of 15-minute quadrangle sheets while one drawer contained a set of unfolded 7.5-minute planimetric maps. The maps in these three drawers were counted manually in order to have accurate figures for later requests for preservation funds.

The density group containing the U.S.G.S. thematic maps in manila sleeves was a smaller problem than anticipated. The thematic maps are stored vertically in 619 pamphlet boxes. Since the pamphlet boxes were all the same type with a uniform interior width (7.5 centimeters), the pamphlet box was used as the conversion factor unit. Again, five percent of the boxes (32 boxes) were sampled and the average number of maps per box calculated.

While calculating the average number of thematic maps per box it became evident that standards defining what would be counted as one map had to be established. These standards were later expanded and applied to the counting of the heterogeneous collections. Since many of the manila map sleeves contained multiple thematic map sheets and text parts, the contents of each sleeve in the sampled box were removed and examined. A four sheets series that fit together to form one map image was counted as a single map. Sheets that depicted the same area but with different themes were each counted as one map. A single sheet that contained multiple smaller maps was counted as one map. The accompanying text was not counted. The conversion factor for the U.S.G.S. thematic map density group was 19.3 maps per pamphlet box.

Since the remaining density groups contained maps that were stored horizontally, determining the appropriate conversion factor was a simple process. A standard method of determining a linear conversion factor is to measure a given unit, such as a centimeter, against a homogeneous stack of map sheets and then count the number of sheets per centimeter (Allen 1996, p. 14). Samples from several stacks or from different heights of the same stack may be taken and averaged together for a more accurate conversion factor. This method introduces possible error due to differential compression of folded maps at various heights in the stack, an inaccurate ruler reading, or if the stack is compressed by the sampler.

Determining an accurate conversion factor would be crucial to achieving an accurate final estimate. In an effort to eliminate these inaccuracies, a micrometer was used to measure the one-centimeter sample. The micrometer was set to the English unit equivalent of one centimeter (.3937 inch) and its thimble was secured with tape in order to ensure the same measurement on all samples. A representative stack of maps was removed from the drawer, placed flat and adjusted until the sheets were flush on one edge of the stack. The flush stack edge was moved until about one centimeter of the stack protruded from the edge of the cabinet top. The instrument was held vertically as its anvil was aligned on the bottom map sheet. As the micrometer was slid towards center of the map stack, the spindle forced out any sheets that did not fit within the one-centimeter opening. The sheets that remained in the micrometer were counted to provide a conversion factor unbiased by compression or by an inaccurate ruler reading. When sampling folded maps, the maps were sampled from the double edge opposite the fold. Some representative conversion factors for the different map types in the density groups are listed in Table 2.

As can be seen from the list, there is a wide range of conversion factors for maps stored horizontally. Further, the conversion factor is influenced not only by the sheet thickness, but also by map condition due to use, applied backings, and folding methods.

During the Characterization Survey it was observed that the map folders within the drawers ranged from thin brown wrapping paper to thicker kraft paper to tagboard folders. Further, these housing materials would contribute to the linear measurement of the map stacks. In order to eliminate both inflating the measurement and the need to remove all of the maps from the folders during the Estimation Phase, the housing material conversion factor, devised to account for folder thickness, would be subtracted from the linear measurement of the maps during the Estimation Phase. Again, the micrometer was used to determine the number of folders per centimeter by measuring the double edge opposite the fold. Since the thin paper folders were closer in thickness to an individual map sheet, it was decided to treat them as map sheet in the 60 to 70 sheets per centimeter range. The housing material conversion factors for the most common folders were:

- tagboard folders - 4 per centimeter
- kraft paper - 4 map sheets per folder
- brown wrapping paper - 2 map sheets per folder

Measurement Phase

The linear measure of the map stacks within the density groups, whether the maps were stored in drawers or boxes, was a simple task. All measurements were taken by one staff member to ensure consistency. The maps that were stacked were measured by placing a thin metal strip in the center of the top of the stack. The metal strip was than adjusted on the stack until it protruded from the edge of the stack and rested parallel to the bottom of the storage container. Next, a ruler was placed with its edge flat on the storage container bottom while the ruler's graduated edge was lined up perpendicular to the metal strip. The measurement was read from the bottom edge of the metal strip to the nearest millimeter. In the drawers where the map folders were spread out horizontally and overlapping, the folders were temporarily gathered into a single stack for measuring. Folded maps were measured from the edge opposite the fold to correspond with the micrometer's position during the conversion factor measurement. After the linear measurements were taken and recorded, the number and nature of the folders in the drawer were also recorded. The linear measurements from all storage containers in the density group were totaled, as was the number of folders.

Estimation Phase

The project's Estimation Phase was a simple math exercise. The formula for calculating the estimate for each density group depended on the nature of the map folders. If the density group contained tagboard folders, the product of the housing material conversion factor and number of folders modified the linear measurement. If the density group contained paper folders, the product of the appropriate housing material conversion factor and number of folders modified the number of sheets (see Appendix A).

Topographic Series	Condition	Conversion Factor
Denmark 1:20,000 scale	Pristine	67 per centimeter
Germany 1:25,000 scale	Worn	43 per centimeter
Korea 1:50,000 AMS series L751	Pristine	57 per centimeter
Java 1:25,000	Linen backing	24 per centimeter
Mexico 1:50,000	Slightly used	64 per centimeter
U.S.G.S. quadrangle maps	Folded once	34 per centimeter
U.S.G.S. quadrangle maps	Flat	77 per centimeter
Navigation Chart Series	**Condition**	**Conversion Factor**
NIMA aeronautical	Folded as shipped	3 per centimeter
NOAA nautical	Folded once	33 per centimeter
NOAA intracoastal	Folded as shipped	1 per centimeter

Table 2. Representative Conversion Factors for Different Map Types.

Validity checks on the estimation method were performed on estimates from a large and a small density group. The Java 1:25,000 scale topographic series served as the small group validity check. The Java map series that was housed in tagboard folders totaled 7.8 cm., and contained five folders. When these values and the appropriate conversion factors were inserted into the formula, an estimate of 181 maps resulted (see Appendix B). By actual count, the group contained 200 maps, illustrating that the estimate was almost ten percent short of the actual number.

The Mexico 1:50,000 scale topographic series served as the large group validity check. Coincidental with the collection estimation project, a sheet-level database of the maps in the collection depicting Mexico was completed. A database search returned 2674 map records in the series. Measuring the maps in their paper folders resulted in 42.1 cm. of maps and materials. The measurement included the 89 brown wrapping paper folders. When these values and the appropriate conversion factors were inserted into the formula, the result was an estimate of 2642 maps (see Appendix C). The low margin of error, 1.1 percent, is heartening, but is equally as suspicious as the conveniently round collection size estimate.

Standards

The standards established to guide the collection estimation project were intended to ensure consistency in what maps were included in the estimate and how the included sheets were counted as a single map. Thus, the standards can be divided into those defining maps within the project's scope and those defining a single map for estimation purposes.

The maps excluded from the survey were:

- Electronic products
- Class sets
- Maps owned by the faculty but stored in the library
- Maps bound in folios
- Maps intended for distribution
- Index maps
- Photographic copies of maps if the original map was also present

Examples of maps included in the survey were:

- *U.S. National Atlas* separate sheets
- Drafts of original cartographic work by the faculty
- Duplicate sheets of the same edition

The standards for the definition of a single map sheet were:

- Multiple sheets that fit together to form one map image counted as one map
- Maps printed on both sides counted as one map
- Overlays to transparencies counted as one map
- A single sheet that contained multiple smaller maps counted as one map
- Sheets that depicted the same area but with different themes each counted as one map

Results

When the estimating and counting was completed and the subtotals were added, the estimate stood at 277,971 maps in the Cartographic Information Center on September 1, 1996. This statistically sound estimate became a benchmark that could be adjusted by all subsequent acquisitions and deselections. Thus, the estimated current holdings after three years of adjustments is approximately 289,000 maps.

At the project's conclusion, this map librarian reported the revised collection holdings estimate to the Geography & Anthropology Department Chair and emphasized that the new estimate contradicted the figure touted by the university. Further, that unless the department faculty had established individual map library annexes in their offices that accounted for the missing maps, the Cartographic Information Center had just "lost" 200,000 maps. Without hesitation, the Department Chair accepted the new estimate and endorsed reporting the revised estimate. Additionally, this map librarian kept his job. Currently, the Department Chair no longer boasts to prospective students and faculty that the Cartographic Information Center is the largest university map library in the nation. Instead, he is pleased that the Geography & Anthropology Department readily accepted losing its claim to being the largest university map library in the spirit of academic and professional honesty.

Conclusion

In general, the collection estimation project proved that it is possible to produce a statistically sound estimate of a large map collection size. Further, the project illustrated that the estimate's validity depended on consistent and accurate measuring and sampling as well as faithful adherence to the standards and definitions. Specifically, the validity check performed on the large and small density group estimates revealed that the estimation method worked well for large homogeneous map groups, but it was probably more efficient and accurate to simply count a very small homogeneous map group.

In reality, the age of electronic map images and geographic information systems capable of generating many permutations of maps and displayed data in response to a patron request, has rendered the collection holdings statistic obsolete. For example, any attempt to estimate how many maps can be created from the maps and data in a GIS package is similar to trying to estimate how many poems can be generated from the words in a dictionary.

There will be paper map collections until the day that all maps are stored electronically and all patron requests can be served by generating a map on request from a GIS station. As long as there are map librarians and library administrators, they will want to know the size of their paper map collections, and until all map collections are cataloged to the piece level, estimates will be used to determine the size of map collections. This article has presented one method to estimate the size of a large map collection. It can be used to establish a statistically sound estimate to serve as a benchmark that can be modified by future changes in the collection. The adjusted estimates can serve as reliable estimates of a collection's size until a collection is completely cataloged. It may be another forty years before the Cartographic Information Center's collection is retrospectively catalogued. Until then, this map librarian can honestly say with pride, "The Cartographic Information Center ('Map Library') in the Department of Geography and Anthropology, is the largest map library in the state with more than 289,000 maps."

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Appendix A
Estimation Formulas

Tagboard folders:
Linear Measure - (Total Folders X Housing Material Conversion Factor) X Density Group Conversion Factor = Total Maps

Paper folders:
(Linear Measure X Density Group Conversion Factor) - (Total Folders X Housing Material Conversion Factor) = Total Maps

Appendix B
Calculating the Number of Java 1:50,000 Scale Maps

$$8.8\text{ cm} - 5\text{ folders} \times \frac{1\text{ cm.}}{4\text{ folders}} \times \frac{24\text{ maps}}{1\text{ cm}} = \text{Total Maps}$$

By performing the calculation, the conversion factors cancel out the units until only the desired unit remains:

$$8.8\text{ cm} - 5\text{ folders} \times \frac{1\text{ cm}}{4\text{ folders}} \times \frac{24\text{ maps}}{1\text{ cm}} = \text{Total Maps}$$

$$(8.8\text{ cm} - 1.25\text{ cm}) \times \frac{24\text{ maps}}{1\text{ cm}} = \text{Total Maps}$$

$$7.55\text{ cm} \times \frac{24\text{ maps}}{1\text{ cm}} = 181\text{ Maps}$$

Appendix C
Calculating the Number of Mexico 1:50,000 Scale Maps

$$42.1\text{ cm} \times \frac{67\text{ maps}}{1\text{ cm}} - 89\text{ folders} \times \frac{2\text{ maps}}{1\text{ folder}} = \text{Total Maps}$$

By performing the calculation, the conversion factors cancel out the units until only the desired unit remains:

$$42.1\text{ cm} \times \frac{67\text{ maps}}{1\text{ cm}} - 89\text{ folders} \times \frac{2\text{ maps}}{1\text{ folder}} = \text{Total Maps}$$

$$2821\text{ maps} - 89\text{ folders} - \frac{2\text{ maps}}{1\text{ folder}} = \text{Total Maps}$$

$$2821\text{ maps} - 178\text{ maps} = 2642\text{ Maps}$$

The Bodleian Library, Oxford, United Kingdom

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November 2000

Introduction

The Bodleian Library is the largest university library in Britain, holding in excess of six million books and housing one of the World's principal cartographic collections, amounting to around 1,200,000 maps and 20,000 atlases, along with rapidly growing numbers of CD-ROMs, digital datasets and cartographic software.

The Library, named after its founder, Sir Thomas Bodley, opened in 1602, and has been serving its readers from all over the World ever since. http://www.bodley.ox.ac.uk/mh/facts/facts20.htm

The map collection consists of maps from all parts of the globe, with topographic and thematic maps dating from medieval times to the present day. In addition to maps and atlases, the Map Room holds a comprehensive collection of gazetteers and guide books, which accompany around 6,000 books and 220 journal titles immediately accessible to readers on the Map Room bookshelves, with subject matter concentrating on geography, cartography and travel. Mapping produced by overseas national surveys worldwide can be consulted in the Map Room, ranging from commonly available Western European and North American output to more recently accessible Eastern European material.

As a library of legal deposit, the Bodleian assumes not only a university-wide role, but also a national and international one as a result of the wealth of its holdings. Deposit of Ordnance Survey (OS) material has resulted in an almost complete collection of OS mapping being held in the Library (Ordnance Survey itself was bombed in the Second World War, so their own collection is far from complete). Current British legislation requires a full environmental audit for any new building development being undertaken anywhere in the country, so the Library's virtually complete geographical *and* historical record of landscape change has enabled the Bodleian to provide a commercial service to land use consultants. Full details can be found in the 'Site Surveyors' section at: http://www.bodley.ox.ac.uk/guides/maps/

Brief history

Sir Thomas Bodley founded the Library to serve "the republic of the learned," and encouraged his contemporaries to enrich it with gifts of money and books. His agreement with the Stationers' Company of London in 1610 was a fore-runner of legal deposit legislation, as a result of which the Bodleian came to acquire British publications in ever-increasing quantities. The result of almost four centuries of building the collections is a veritable treasure trove of library materials.

Further major cartographic acquisitions included the arrivals of Richard Gough's collection of maps in 1809, and more recently the Todhunter Allen collection in 1987. During the late eighteenth century, most of the county maps then being published in Britain were claimed by the Library, while the nineteenth century saw the commencement of the unbroken deposit of Ordnance Survey mapping.

A purpose-built Map Room was opened in the New Bodleian Library in 1946, prior to which the Library had no special provision for the consultation of maps. There is accommodation for fifty readers, in addition to the card catalogue of maps, which currently contains around 250,000 entries, while map records are steadily being made available on-line in OLIS, the Oxford Libraries Information System.

The Map Room has an established staff of five, together responsible for its day-to-day running, including all aspects of reader service, acquisitions and cataloguing. In addition there are at present three staff dedicated to the commercial land use consultancy service and another two working