Preservation Study at the Syracuse University Libraries

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In 1985, in conjunction with the development of a preservation program at Syracuse University Libraries, a survey of the non–rare book collections was undertaken. Utilizing methodology similar to that employed at Yale and Stanford, a stratified random sample of 2,548 books and periodicals was examined. Aspects of physical condition, including pH, brittleness, mutilation, and environmental damage were surveyed. A pilot study and full survey revealed that 25 percent of the collection is in need of repair, and 86 percent of the materials appear to be acidic, while only 12 percent showed a high degree of brittleness. Additional information on collection characteristics such as age and national makeup was also obtained from the study.

n fall 1984, the survey of collections subgroup of the Syracuse University Libraries Preservation Committee was charged with determining the best method of surveying the non-rare book collections of the Syracuse University Libraries in order to determine the nature and size of their preservation/conservation concerns. Checking the relevant literature and contacting individuals involved in preservation surveys at other institutions provided two types of information: criteria for judging book condition and methods of determining a valid statistical sample. This information was gathered to answer the following questions: (1) How many kinds of preservation problems exist? and (2) What percentage of the collection show these problems?

Utilizing this information, the survey subgroup developed a series of recommendations to the Preservation Committee. These recommendations covered sample size; the use of random numbers and mapping the collection prior to selecting volumes for examination; criteria to be checked; the value of a pilot study; and

personnel, training, and materials needed to carry out such a study. A timetable and cost estimates for these recommendations were also suggested.

The Preservation Committee accepted the recommendations and agreed that the survey should be carried out during summer 1985. The work would be done by members of the subgroup and work-study students.

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METHODOLOGY

The preservation surveys conducted by Yale University and Stanford University influenced the methodology adopted by the survey subgroup at Syracuse University.[1] Modifications were made to suit local needs and constraints. Factors of time and money played an important role. The survey could be neither as large nor as long as the one carried out at Yale.

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Sample

The book and periodical collections of the following libraries were studied using a stratified random sample: E. S. Bird (general reference, fine arts, humanities, social sciences, and area studies, excluding the rare book department), science and technology/Carnegie (general science, biology, chemistry, engineering, and mathematics), physics, and geology. Stratification ensured that a proportionate number of books from each subgroup was surveyed (see appendix A).

Random Numbers

A program generating random numbers to be used in selecting survey volumes was prepared by a computer science student at Syracuse University. Numbers were generated for each location of the library to be surveyed. The random numbers consisted of the following elements: floor or location (one or two digits), stack or range (one to three digits), section (one or two digits), shelf (one or two digits), and volume (one or two digits).

Mapping

Prior to the generation of random numbers, the library collections were mapped and labeled to indicate shelving arrangements and numbers. Each stack or range was labeled with a number, and a tally was made of the number of sections and shelves in each range. These data were used in the course of generating random numbers for each location.

Questionnaire

Development of the questionnaire was the most lengthy process in the preservation study. The subgroup was concerned that the questionnaire be easy to use and straightforward as well as recording all relevant data. This was essential, since the bulk of the survey was to be carried out by work-study students. Therefore, some of the more detailed and sophisticated analyses of book structure used in the Yale survey were eliminated. The following criteria were in the final revision of the questionnaire:
Date volume surveyed

Call Number (first two letters for LC)
Publication date
Random number
Country of publication (rather than where printed)
Surveyor identification (individual reporting data)
Volume and condition
  Type: monograph or periodical
  Circulation: circulating or noncirculating
  Has book (volume) circulated in last five years?
  Boards/cover type: leather, cloth, paper, boards, stiffened (reinforced paperbacks), pamphlet, box/portfolio, and mixed (e.g., leather and boards)
Boards and covers need repair?
Hinges need repair?
Spine needs repair?
Binding needs repair?
Leaf detached?
Fold test (to determine the brittleness of the paper)
Page corner breaks after:
  15+ folds
  5+ folds
  2–4 folds
  1 fold
  no test
pH (acidity of paper)
  Yellow = acidic
  Green = slightly acidic
  Blue = acid free
  No test
Damage—Mutilation
  Razored
  Torn
  Underlined/writing
  Scotch tape
  Food and drink
Damage—Environmental
  Fading
  Mold
  Insects
  Water
  Yellowing
  Foxing (yellowish-brown spots on paper caused by dampness)
  Burns

To make the recording and subsequent analysis of data as efficient and easy as possible, a machine-readable form was used.[2] The form was modified for the pur-

pose of this study by the use of a cardboard overlay that singled out certain spaces for data entry (see figure 1).

Staff

The subgroup proposed to have the staff work in pairs for both the selection and testing of volumes for the sample. In selecting materials, two staff members would go to the stacks, one with a list of random numbers and a book cart. The other member would retrieve the items from the shelves as the random numbers were called out. If there was no item for that number, the next number would be called out until a full cartload of books was obtained. These would then be taken to a study room, within the location being sampled, where they would be studied against the questionnaire. The two staff members would take turns making observations and recording data.

The pH and fold tests were to be carried out simultaneously. A page toward the middle of each volume would be marked near the margin gutter with a Light Impressions pH Testing Pen #2396. While the pH chemical was reacting, the upper corner of the page would be folded back and forth and creased up to 16 times, or less if the corner broke off earlier. These two tests would indicate the acidity and brittleness of the paper used in the volume. Staff for the pilot surveys would consist of members of the survey subgroup. For the full survey, work-study students supervised by members of the subgroup would be utilized.

Data Analysis

The primary analysis of data from the survey was accomplished by Syracuse University Testing Services using the machine-readable answer sheets that they had provided for the survey. Consultation between members of the survey subgroup and Testing Services staff led to the establishment of format and correlations to be produced from the raw data (see Appendix B).

PILOT SURVEY

In order to test the questionnaire, the random number sample, and the procedures to be followed, a pilot survey utilizing the collections of the fifth floor (area studies) of Bird Library was carried out from June 10 through 14, 1985. Two teams composed of the four members of the subgroup carried this out in about forty hours of work (i.e., twenty hours per team). Additional help was provided by the preservation coordinator and her assistant.

The random numbers tables presented the main problem during the pilot survey. Many of the random numbers did not yield items to be checked, resulting in a sample size that was too small. Analysis resulted in the discovery of two problems: (1) the programmer had input incorrect data relating the mapping of the collections and the random numbers to be produced, and (2) the range of numbers for selecting an individual volume from a shelf was found to be too high. It was changed from one to forty to one to twenty. These modifications in data input and the volume range produced a new set of random numbers that yielded an adequate sample of material. When the survey was completed, the data sheets were given to Testing Services to be tabulated and analyzed for a variety of correlations. The success of the pilot study thus provided the final impetus for the subsequent full survey of the collection.

FULL SURVEY

The full survey of the Syracuse University Library Collections was carried out between July 16 and August 7, 1985. Eight work-study students put in a total of 315 hours on the project. A training workshop for the student surveyors was held on July 16 to acquaint them with the goals and procedures of the study. Each student was given a packet that included the names, offices, and phone numbers of the supervisors, a list of surveyor codes for identification purposes, a list of country of publication codes, a list of materials and supplies, instructions for finding books to evaluate and for filling out the test forms. The orientation workshop included a step-by-step presentation of how the survey was to be done. There were samples of book types and problems that might be encountered. The students were divided

DATE

○○ CALL NUMBER
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SURVEYOR
IDENTIFICATION

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○⑭

TYPE
1 ①②
1=monograph
2=periodical

CIRCULATION
5 ①②
1=circulating
2=noncirculating

**HAS BOOK CIRCULATED
IN LAST 5 YEARS?**
9 ①②
1=yes
2=no

DAMAGE

31 ①② razored

32 ①② torn

33 ①② underlined/
writing

34 ①② scotch tape

35 ①② food/drink

36 ①② fading

37 ①② mold

38 ①② insects

39 ①② water

40 ①② yellowing

41 ①② foxing

42 ①② burns

1=yes
2=no

BOARDS/COVERS-TYPE
11 ①②③④⑤⑥⑦⑧
1=leather 5=stiffened
2=cloth   6=pamphlet
3=paper   7=box/portfolio
4=boards   8=mixed

BOARDS/COVERS NEED REPAIR
15 ①② 1=yes
2=no

HINGES NEED REPAIR
17 ①② 1=yes
2=no

SPINE NEEDS REPAIR
19 ①② 1=yes
2=no

BINDING NEEDS REPAIR
21 ①②   1=yes
2=no

LEAF DETACHED
23 ①②   1=yes
2=no

FOLD TEST
25 ①②③④⑤
1=15+
2=5+
3=2-4
4=1
5=no test

pH TEST
29 ①②③④
1=yellow
2=green
3=blue
4=no test

PUBL. DATE			RANDOM NUMBER										COUNTRY	
MO.	DAY	YR.	A	B	C	D	E	F	G	H	I	J	K	L
Jan. ○														
Feb. ○														
Mar. ○	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪
Apr. ○	①	①	①	①	①	①	①	①	①	①	①	①	①	①
May ○	②	②	②	②	②	②	②	②	②	②	②	②	②	②
Jun. ○	③	③	③	③	③	③	③	③	③	③	③	③	③	③
Jul ○	④	④	④	④	④	④	④	④	④	④	④	④		
Aug ○	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤		
Sep. ○	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥		
Oct ○	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦		
Nov ○	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧		
Dec. ○	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨		

FIGURE 1

into pairs for a practice session and each pair was given about twenty books to practice on. After ten books, the students traded activities so that the observer became the data recorder and vice versa. When the full survey began, students were at first scheduled to work in pairs. Due to classes and other scheduling conflicts, some of the study was carried out by students working on their own. This did not seem to pose any problems, and the survey was carried out accurately and efficiently. On two floors there were not enough random numbers to provide a full sample, so additional numbers were generated to bring the sample up to the required size. The results of the survey and

the information and correlations they provided make up the remainder of this report.

RESULTS
Presentation of the Data

Results are compiled in tables 1 through 7. The total holdings for each location, the sample size, and the standard error are given at the head of each table. Findings for each question in the survey are expressed as the number of volumes in the sample over the percentage in the sample. The last column in each table gives the overall characteristics of the sample. Characteristics of the collection for each library building are presented in tables 1 through

TABLE 1
COLLECTION CHARACTERISTICS

Standard error %	1.127	1.686	1.960	1.960	1.3297
Total holdings	909,970	222,645	22,961	25,979	1,181,555
Sample size	1723	703	57	50	2533
Library	Bird	Carnegie	Physics	Geology	Overall
Monographs	1300	313	28	37	1678
	75.45	44.52	49.12	74.00	65.86
Periodicals	423	390	29	13	855
	24.55	55.48	50.87	26.0	33.56
Circulating	1113	305	33	39	1490
	64.59	43.39	57.89	78.0	58.48
Noncirculating	610	348	24	11	993
	35.40	56.61	42.10	22.0	38.97
If circulating, number	393	130	18	9	550
circulating in last 5 years	22.81	18.49	31.58	18.00	21.56
Board and Cover Type					
Leather	6	7	0	1	14
	0.35	1.0	0	2.0	0.56
Cloth	393	42	12	6	453
	22.90	6.0	21.05	12.0	17.79
Paper	90	24	2	8	124
	5.24	3.43	4.76	16.0	4.94
Boards	1005	495	41	32	1573
	58.57	70.71	71.93	64.0	61.73
Stiffened	43	81	0	2	126
	2.51	11.57	0	4.0	5.02
Pamphlet	87	16	0	0	103
	5.07	2.29	0	0	4.11
Box/Portfolio	4	8	0	0	12
	0.23	1.14	0	0	0.48
Mixed	88	27	2	1	118
	5.13	3.86	3.51	2.0	4.63

Key: 1300
    75.45%
1300 = frequency. Number of sample volumes in Bird that are monographs.
75.45% = column percent. Sample percentage of volumes in Bird that are monographs.

3. These are followed by data describing the condition of the collection for each library location in tables 4 through 6. Table 7 displays variable intersection frequencies and proportions. Intersecting variable frequencies show the combined effect of two variables on a single volume, for instance, brittle books that also have an acidic pH value.

Tables 1 through 6 were constructed by combining the data for locations basement through fifth floor of Bird Library and labeling it "Bird"; combining data for levels one through seven of the Science & Technology Library and labeling it "Carnegie"; and combining the physics collection with physics storage, located in Carnegie, and labeling it "Physics." Geology remained a separate location. In addition, statistics were computed for the totals for all locations and labeled "Overall."

Tabular data are stated in a frequency/column percent format for each cell, where frequency is the number of volumes having a given characteristic and in the specified location. Column percent is the percentage of books in the stated location with the given characteristic.

For example, in table 1 the first cell under the "Bird" column describes the monographic collection in Bird. The numbers given are 1300/75.45. This means that from the sample of books examined at Bird Library, 1300 were monographs. The second number shows that 75.45 percent of the sampled books in Bird were monographs.

Characteristics of the Collection

Details of the characteristics of the collection revealed by the survey are found in tables 1 through 4. Two-thirds of the sample were monographs, and one-third peri-

TABLE 2
AGE OF COLLECTION

Standard error %	1.127	1.686	1.960	1.960	1.3297
Total holdings	909,970	222,645	22,961	25,979	1,181,555
Sample size	1723	703	57	50	2533
Library	Bird	Carnegie	Physics	Geology	Overall
Age					
	173	104	7	10	294
1980–1985	10.24	14.86	16.67	20.41	11.54
	952	332	38	21	1343
1960–1979	56.33	47.43	67.00	42.86	52.70
	243	117	9	6	375
1940–1959	14.38	16.71	15.79	12.24	14.72
	151	47	3	8	209
1920–1939	8.93	6.71	5.26	16.33	8.20
	85	51	0	1	137
1900–1919	5.03	7.29	0	2.04	5.51
	41	29	0	0	71
1880–1899	2.43	4.14	0	0	2.85
	28	13	0	1	42
1860–1879	1.66	1.86	0	2.04	1.69
	14	6	0	2	22
1840–1859	0.83	0.86	0	4.08	0.86
	2	1	0	0	3
1820–1839	0.12	0.14	0	0	0.12
	0	0	0	0	0
1800–1819	0	0	0	0	0.0

Key: 173
    10.24%
173 = frequency. Number of samples in Bird published in 1980–1985.
10.24% = column percent. The sample percentage of volumes in Bird published in 1980–1985.

TABLE 3
COUNTRY OF PUBLICATION

	Bird	Carnegie	Physics	Geology	Overall
Standard error %	1.127	1.686	1.960	1.960	1.3297
Total holdings	909,970	222,645	22,961	25,979	1,181,555
Sample size	1723	703	57	50	2533
Library	Bird	Carnegie	Physics	Geology	Overall
Country					
United States	923	399	25	34	1381
	54.10	57.08	43.86	69.39	54.2
Great Britain	177	108	16	3	304
	10.38	15.45	28.07	6.12	11.93
France	77	21	0	3	101
	4.51	3.0	0	6.12	3.96
USSR	67	10	1	0	78
	3.93	1.43	1.75	0	3.02
India	84	6	2	1	93
	4.92	0.86	3.51	2.04	3.70
Germany, East	8	24	1	1	34
	0.47	3.43	2.44	2.04	1.35
Germany, West	85	29	1	5	120
	4.98	4.15	2.44	10.20	4.78
Others	302	106	11	3	422
	17.53	15.08	19.29	6.00	16.56

Key: 923
    54.10%

923 = frequency. Number of sample volumes in Bird that were published in the United States.
54.0% = column percent. The sample percentage of volumes in Bird that were published in the United States.

odicals. Sixty percent of the total sample were circulating items, and of these 22% had circulated in the last five years (table 1).

The great majority (85%) of the books in the collection are in rigid covers, i.e., leather, cloth, mixed, boards, or boxed. Only 15% are bound in less durable covers such as limp paper, stiffened (i.e., reinforced) paper, or pamphlet binding (table 1).

In general, the collection sampled is recent in age: more than half falls into the 1960 to 1979 period. Seventy-nine percent of the volumes date from 1940 to 1985 (table 2). More than half were published in the United States, followed by England, West Germany, and France (table 3). The countries represent the major collecting areas of the library.

The sample was highly acidic (table 4). By use of the indicator bromocresol green, it was found that approximately 62% of the books were very acidic (the indicator turned yellow at a pH of lower than 5.4), 25% were acidic (the indicator stayed green as applied), and only 12% were non-acidic (the indicator turned blue).

A correlation of acidic paper is eventual embrittlement. However, a folding endurance test on the sample showed a surprising result. Seventy-seven percent of the books sampled passed 15 or more folds, 8% fell into the 5–14 fold category, 10% were fairly brittle at 2–4 folds, and just 3% were very brittle at one fold. One percent of the books were not tested because of their value or because they contained large numbers of plates.

This result is perhaps less surprising when the comparatively recent age of the collection is considered, but the acidity of most of the volumes in the collection (86%) does not augur well for the future.

Volumes Needing Repair

The number of deteriorated volumes (i.e., those needing repair for covers, spines, bindings, hinges, or leaves that are broken, torn, or detached) was surprisingly low at 25% (see table 4). Since several of these characteristics may be found in a single volume, the number of volumes or items needing repair is smaller than the total number of repairs needed. Therefore in the ''Overall'' column, 1207

TABLE 4

CONDITION OF COLLECTION

	Bird	Carnegie	Physics	Geology	Overall	
Standard error %	1.127	1.686	1.960	1.960	1.3297	SE (p) = 1.3297%
Total holdings	909,970	222,645	22,961	25,979	1,181,555	Z = 0.5 = 1.96
Sample size	1723	703	57	50	2548	p 1.96(1.3297) =
						p ± 2.6062
						Confidence interval
						on proportions
Library	Bird	Carnegie	Physics	Geology	Overall	p ± 2.6062
Need repair						
	218	87	9	5	319	
Boards and Covers	12.71	12.38	15.79	10.0	12.52	(9.914, 15.126)
	264	58	4	8	334	
Hinges	15.38	8.26	7.02	16.0	13.11	(10.504, 15.716)
	223	85	9	7	324	
Spine	13.0	12.13	21.43	14.0	12.72	(10.113, 15.326)
	120	23	0	3	146	
Binding	6.98	3.28	0	6.0	5.73	(3.124, 8.336)
	64	13	0	2	79	
Leaves	3.73	1.85	0	4.08	3.10	(.494, 5.706)
Number items	474	134	11	9	628	
needing repair	27.51	19.06	19.29	18.00	24.65	(22.044, 27.256)
pH						
	1124	409	14	26	1573	
Yellow, acidic	65.77	58.26	33.33	52.0	61.73	(60.128, 64.336)
	410	185	20	12	627	
Green	23.99	26.35	47.62	24.0	24.61	(22.004, 27.216)
	167	108	8	12	295	
Blue, nonacidic	9.77	15.38	19.05	24.0	11.58	(8.974, 14.186)
Brittleness						
	46	23	0	0	69	
1 fold, breaks	2.69	33.33	0	0	2.727	(.1207, 5.333)
	186	52	0	4	242	
2–4 folds	10.89	7.43	0	.16	9.50	(6.894, 12.106)
	163	29	0	7	199	
5–14 folds	9.54	4.14	0	14.0	7.81	(5.204, 10.416)
	1293	592	42	36	1963	
15 + folds	68.59	84.57	1.00	72.0	77.04	(74.434, 79.646)

Key: 218
  12.71%

218 = frequency. Number of sample volumes in Bird with covers in need of repair.
12.71% = column percent. The sample percentage of volumes in Bird with covers in need of repair.

repairs are indicated but this only involved 628 actual volumes. The most frequent damage in all locations is to boards and covers, hinges, and spines. Thus, if embrittled paper is not a factor, most of these volumes are candidates for rebinding. Extrapolated to the entire collection of 1,181,555, the number of volumes needing repair is 291,254.

User Damage

User damage or mutilation, whether intentional or inadvertent, was in evidence (see table 5). Of the books sampled, only 20% appeared to have been razored or torn, or had writing or underlining.

Scotch tape, or traces of food and drink. Of these, most common was damage due to writing and underlining (12%), and next was torn pages (8%).

Environmental Damage

Environmental damage to a book results from its location conditions or from the book's internal chemistry (see table 6). Kinds of damage considered in the survey were fading of the cover, mold, insects, water damage, yellowing, foxing (yellowish-brown spots caused by dampness), and burns. Of the volumes sampled in the survey, 42% showed environmental

TABLE 5

MUTILATION DAMAGE

Standard error %	1.127	1.686	1.960	1.960	1.3297
Total holdings	909,970	222,645	22,961	25,979	1,181,555
Sample size	1723	703	57	50	2533
Library	Bird	Carnegie	Physics	Geology	Overall
	426	56	4	2	488
Number volumes mutilated	24.72	7.97	9.52	4.00	19.15
	17	5	0	0	22
Razored	0.99	0.71	0	0	0.88
	170	31	2	1	204
Torn	9.89	4.42	4.76	2.0	8.12
	272	24	2	2	300
Writing/Underlining	15.83	3.42	4.76	4.0	11.94
	30	9	0	0	39
Scotch tape	1.75	1.29	0	0	1.55
	46	3	1	0	50
Food/drink	2.68	0.43	2.38	0	1.99

Key: 426
    24.72%
426 = frequency. Number of sample volumes in Bird that have mutilation damage.
24.72% = column percent. The sample percentage of volumes in Bird that have mutilation damage.

damage, primarily yellowing (37%) and fading (13%).

Since environmental damage encountered in a collection can be related to its age and location, it is noteworthy that the collections in the Carnegie building have, at 49%, the highest percentage of this kind of damage. Carnegie, which houses the science and technology and mathematics library collection, is an antiquated structure with a problematic heating system and no air conditioning.

Intersections

Calculating intersections between two variables produced useful statistics. For instance, How many of the books with nonintact leaves have very brittle paper? Table 7 summarizes the data showing variable intersections. The numbers given in table 7 are frequency/row percent/column percent. An example will serve as explanation.

The first cell under the column, "Needs repair," also corresponds to yellow (acidic) pH readings. We find the numbers:

    481
    30.21
    75.63

Thus, 481 volumes in need of repair have a yellow or acidic pH reading. This repre-

sents 30.21% of all volumes. (See table 4). The final number indicates that 75.63% of all books that need repair have a yellow pH reading. The statistics given are compiled from the overall library data except in the last two columns labeled "Bird" and "Carnegie." Therefore, the intersection data reflects the condition of the overall library collection. Although the analysis of intersecting variables yielded many results that were expected, the data also showed that some variables may not influence damage as much as has been assumed.

As expected, most of the extremely brittle books have a yellow pH reading. Of the books with pages that broke after one fold, 97% had a yellow pH reading, while none had a blue (acid free) pH reading. In the 2–4 and 5–14 fold breakage groups, the percentage of yellow pH readings were 98% and 89%, respectively. These statistics correspond to Yale's findings that "more than 99 percent of the brittle books were acidic."[3] In addition, Yale found that approximately 80% of the nonbrittle books were acidic, while our survey results showed 68%. Most of the books with an acid-free (blue) pH reading had pages that did not break even after 15 folds. None of the acid-free books had pages that broke in 5–14 folds.

TABLE 6
ENVIRONMENTAL DAMAGE

	Bird	Carnegie	Physics	Geology	Overall
Standard error %	1.127	1.686	1.960	1.960	1.3297
Total holdings	909,970	222,645	22,961	25,979	1,181,555
Sample size	1723	703	57	50	2533
Library	Bird	Carnegie	Physics	Geology	Overall
Number volumes with	681	347	21	22	1071
environmental damage	39.52	49.36	36.84	44.00	42.03
	196	113	12	5	326
Fading	11.40	16.14	21.05	10.0	12.79
	13	4	0	0	17
Mold	0.76	0.57	0	0	0.68
	3	2	0	0	5
Insects	0.18	0.29	0	0	0.20
	41	17	4	2	64
Water	2.40	2.43	9.52	4.0	2.56
	570	310	16	19	915
Yellowing	33.33	44.41	38.10	38.00	36.60
	40	17	0	2	59
Foxing	2.33	2.43	0	4.0	2.35
	2	0	0	0	2
Burns	0.12	0	0	0	0.08

Key: 681
    39.52%

681 = frequency. Number of sample volumes in Bird with environmental damage.
39.52% = column percent. The sample percentage of volumes in Bird with environmental damage.

Acidity was strongly correlated with need for repair. Approximately 30% of the very acidic books required repair, while only 13% of the acid-free books needed repair. Of the volumes needing repair, 76% had a yellow (high) acidity reading, while only 6% of the volumes with a blue (acid free) reading needed repair.

As expected, it was demonstrated that leaf brittleness has a direct relationship with need of repair. Approximately 60% of the volumes that had leaves brittle enough to break in one fold and 53% of those that broke in 2–4 folds required repair. However, 58% of the books needing repair did not have brittle pages (i.e., had leaves that did not break in 15 folds of the fold test). Thus, other factors, such as age or usage, may also be contributing to book damage.

The need for repair was determined for various types of book covers. Not surprisingly, volumes with a sturdy cover, such as boards or stiffened paper, showed a lower incidence of repair need. Approximately 33% of the pamphlet-bound volumes needed repair, while the percentage of volumes bound in paper or cloth requiring repair was 37% and 39%, respectively.

Only 10% of the stiffened and 18% of the board-covered volumes were in need of treatment. The only cover types requiring repair in percentages higher than the cloth covered were mixed, e.g., leather or cloth and boards (60%) and leather (50%). However, it is likely that age and environment are the major contributing factors in these categories.

Of the cloth and paperbound books that need repair, most demonstrated spine, hinge, or cover damage. Among the pamphlet-bound books, cover and spine damage were most common. Damage to the leather and mixed bound books was found in all areas checked, but was most apparent in the spine and covers.

Surprisingly, the percentage of volumes that have circulated in the last five years and need repair (36%) against the percentage of volumes that have not circulated in the last five years and need repair (22%) is not significantly different at the .05 confidence level. Thus, we can conclude that factors other than circulation usage are also contributing to the need for repair. The computer analysis does not provide the relative percentages of repairs needed for periodicals versus monographs.

TABLE 7

INTERSECTIONS

	Needs repair	Leaves not intact	Binding not intact	Spine not intact	Hinges not intact	Board not intact	Yellow	pH Green	Blue	1	2-4	Brittleness 5-14	15+	Bird	Building Carnegie
pH															
	481	69								67	243	178	1088	*	*
	30.21	4.35	–	–	–	–	–	–	–	4.21	15.28	11.19	68.43		
Yellow	75.63	85.19								97.10	98.38	88.56	54.87		
	114	11								2	4	19	603	*	*
	17.95	1.74	–	–	–	–	–	–	–	.32	.63	3.01	95.41		
Green	17.92	13.58								2.90	1.62	9.45	30.41		
	40	1								0	0	4	2292	*	*
	13.42	.34	–	–	–	–	–	–	–	0	0	1.34	97.99		
Blue	6.29	1.23								0	0	1.99	14.73		
Brittleness															
	41	13	15	29	31	25								*	*
	59.42	18.84	21.74	42.03	44.93	36.23	–	–	–	–	–	–	–		
1	6.45	16.05	10.07	8.95	9.23	7.76									
	130	14	37	78	72	69								*	*
	52.63	5.67	15.04	31.84	29.39	28.16	–	–	–	–	–	–	–		
2-4	20.44	17.28	24.83	24.07	21.43	21.43									
	84	12	31	40	46	45								*	*
	41.58	6.00	15.42	19.80	22.77	22.28	–	–	–	–	–	–	–		
5-14	13.21	14.81	20.81	12.35	13.69	13.98									
	372	40	63	170	181	176								*	*
	18.75	2.02	3.18	8.60	9.15	8.90	–	–	–	–	–	–	–		
15+	58.49	49.38	42.28	52.47	53.87	54.66									
Boards and Covers															
	7	4	3	6	5	6	*	*	*	*	*	*	*	*	*
	50.00	28.57	21.43	42.86	35.71	42.86									
Leather	1.10	5.00	2.03	1.84	1.47	1.86									
	174	19	51	90	94	82	*	*	*	*	*	*	*	*	*
	38.67	4.23	11.33	20.04	20.98	18.26									
Cloth	27.32	23.75	34.46	27.61	27.73	25.39									
	46	5	10	23	29	26	*	*	*	*	*	*	*	*	*
	36.80	4.00	8.00	18.40	23.2	20.80									
Paper	7.22	6.25	6.76	7.06	8.55	8.05									
	288	40	59	150	156	127	*	*	*	*	*	*	*	*	*
	18.15	2.53	3.73	9.48	9.85	8.02									

TABLE 7 *Continued*

	Needs repair	Leaves not intact	Binding not intact	Spine not intact	Hinges not intact	Board not intact	Yellow (pH)	Green	Blue	1 (Brittleness)	2–4	5–14	15+	Bird (Building)	Carnegie
Boards	45.21	50.00	39.86	46.01	46.02	39.32									
	12	2	3	2	9	6									
	9.52	1.60	2.40	1.60	7.20	4.80	*	*	*	*	*	*	*	*	*
Stiffened	1.88	2.50	2.03	.61	2.65	1.86									
	34	4	9	13	9	23									
	33.01	3.88	8.74	12.62	8.74	22.33	*	*	*	*	*	*	*	*	*
Pamphlet	5.34	5.00	6.08	3.99	2.65	7.12									
	3	2	2	1	1	1									
	25.00	16.67	16.67	8.33	8.33	8.33	*	*	*	*	*	*	*	*	*
Box/portfolio	.47	2.50	1.35	.31	.29	.31									
	73	4	11	41	36	52									
	60.33	3.33	9.09	34.17	30.00	43.70	*	*	*	*	*	*	*	*	*
Mixed	11.46	5.00	7.43	12.58	10.62	16.10									
	202	22	46	105	102	111								393	130
	36.27	3.96	8.27	18.95	18.38	20.11	*	*	*	*	*	*	*	75.14	24.86
Circulated in last 5 years? Yes	31.61	27.16	30.87	32.11	30.09	34.26								22.81	18.49
	437	59	103	222	237	213								1330	573
Circulated in last 5 years? No	21.95	2.98	5.19	11.18	11.94	10.71	*	*	*	*	*	*	*	69.89	30.11
	68.39	72.84	69.13	67.89	69.91	65.74								77.19	81.31
														681	347
Environmental damage	–	–	–	–	–	–	–				–	–	–	66.25	33.75
														39.52	49.36
														426	56
Mutilation	–	–	–	–	–	–	–				–	–	–	88.38	11.62
														24.72	7.97
		58	121	265	285	271	1052	411	204	38	165	134	1317	*	*
Monograph	–	3.42	7.12	15.61	16.78	16.00	61.96	24.20	12.01	2.23	9.71	7.89	77.56		
		71.60	81.76	81.54	85.59	83.90	66.37	65.13	68.92	55.07	66.80	66.67	66.78		
		23	27	60	48	52	533	220	92	31	82	67	655	*	*
Periodical	–	2.71	3.18	7.06	5.65	6.12	62.70	25.88	10.82	3.65	9.65	7.88	77.06		
		28.40	18.24	18.46	14.41	16.10	33.63	34.87	31.08	44.93	33.20	33.33	33.22		

Key: 481
    30.21%
    75.63%
481 = frequency. The sample number of volumes that need repair that had a yellow pH reading.
30.21% = row percent. The sample percentage of volumes with yellow pH reading that need repair.
75.63% = column percent. The sample percentage of volumes that need repair with yellow pH reading.
[–] Data not available. [*] Data available on printout.

Damage from environmental conditions represented about the same percentage of the sampled collection in both Bird and Carnegie. In Bird, 40% of the volumes had some environmental damage, while in Carnegie, 49% of the sample showed damage. Of all books having environmental damage, 66% are now located in Bird and 34% are in Carnegie. It should be mentioned that Bird Library was built in 1973, and much of its present collection was transferred from Carnegie at that time.

Approximately 8% of the collection sampled in Carnegie had mutilation damage, and in Bird, 25%. Of all volumes displaying mutilation damage, 88% were in Bird.

Although these statistics yield valuable data concerning the interactions of variables describing the condition of the col-

lection, they must be interpreted with care. Rarely does one variable account for all effects noted. Usage and environmental changes, as well as other factors, may need to be taken into consideration.

CONCLUSION

The preservation survey provided comprehensive information on the present condition of the collection and the number of items needing repairs. Each floor of Bird and Carnegie as well as the physics and geology branch libraries now has detailed information on the nature and types of damage discovered. The analysis includes damage assessments by the type of repairs needed so that a detailed cost figure can be developed and a conservation strategy implemented.

REFERENCES AND NOTES

1. Gay Walker and others, "The Yale Survey: A Large-Scale Study of Book Deterioration in the Yale University Library," *College & Research Libraries* 46:111–32 (Mar. 1985); Sally Buchanan and Sandra Coleman, "Deterioration Survey of the Stanford University Libraries Green Library Stack Collection," in *Preservation Planning Program Resource Handbook* comp. Pamela W. Darling (Washington, D.C.: Association of Research Libraries, Office of Management Studies, 1982), p.159–230.
2. Syracuse University Testing Services was consulted and several such forms were suggested. National Computer Trans-Optic form 08–6703:3029282726 was selected. The unaltered sheet had spaces for more than 100 questions and additional data.
3. Walker, "The Yale Survey," p.122.

APPENDIX A: SAMPLE SIZE DETERMINATION

Carl Drott gives a table for determining overall sample size, n, based on confidence level and tolerance.* A confidence level of 95% (99%) with a 1% tolerance is selected and n is determined to be 9604 (16590). If we can make an estimate of the number of volumes in need of repair we can use a correction factor to lower the sample size.

Assuming that 35% of the books need repair then the sample size would be

$$n = 9604 \cdot (.35) \cdot (.65) = 2185 \text{ (for 95\% confidence level)}$$
$$\text{or}$$
$$(n = 16590 \cdot (.35) \cdot (.65) = 3775) \text{ (for 99\% confidence level)}.$$

It should be noted that a sample size of 2185 (3775) is the minimum sample size necessary to achieve the desired confidence and tolerance levels. This number will be used to deter-

*Drott, Carl M. "Random Sampling: A Tool for Library Research," *College & Research Libraries* 28:119–25 (Mar. 1967).

mine a proportional sample size for each stratum. However, due to a rounding error the sum of the stratum sample sizes will be greater than the suggested overall sample size. Hence, we shall base all cost estimates on the larger sample size of 2184 (3780) that will be the actual number of items surveyed.

Then the sample size per stratum, n_s, is proportional to the overall sample size and is calculated by

$$n_s = \frac{N_s}{N_p} (n)$$

where

n = overall sample size
N_s = number of volumes in a given stratum
N_p = total number of volumes under investigation
 (N_p does not include the books from the sixth level)

The sample size for the fifth level would be computed as

$$n_5 = \frac{218,587}{1,181,555} (2185) = 408$$

Stratum sample sizes are given for several choices of confidence level in the following table.

STRATUM SAMPLE SIZE DETERMINATION

Confidence and Tolerance Levels		95% ± 1%	95% ± 1% no cf*	99% ± 1%
Overall Sample Size, n		2,185	2,401	3,775
	Total Volumes			
Basement	10,361	19	21	34
Reference	28,333	52	58	91
Second floor	100,331	186	204	321
Third floor	279,066	516	567	892
Fourth floor	273,292	505	555	873
Fifth floor	218,587	404	444	699
Science & Technology	182,645	338	372	584
Mathematics	40,000	74	82	128
Physics	22,961	42	47	74
Geology	25,979	48	53	84
Total	1,181,555	2,184	2,406	3,780
Actual number to be sampled		2,184	2,406	3,780

*cf = correction factor

APPENDIX B: STATISTICAL ANALYSIS

The data recorded on the testing forms were electronically read onto magnetic tape. Using Statistical Analysis Systems (SAS), Testing Services provided an analysis of the data. The analysis included frequency tables for each of the twenty-three survey questions by library location and intersections between variables. In addition, location data was grouped into five categories: Bird, Carnegie, Physics, Geology, and Overall. The last included all locations. Frequency tables were constructed using these combined location variables with the twenty-three questions. This included tables by country of publication and year of publication by location. Years of publication were grouped in twenty-year categories for ease of analysis. Finally, three new variables were created to give an assessment of damage and repairs needed.

"Needs Repair" became a new variable by combining the following condition variables: boards and covers, hinges, spine, binding, and leaves. "Environmental Damage" was made by combining fading, mold, insects, water, yellowing, foxing, and burns. "Mutilation" was constructed by combining razored, torn, writing, Scotch tape, and food/drink. These overall damage variables give a summary of the condition of the collection by location, as well as an overall assessment.

For each broad library location, frequencies and percentages were tabulated. Attaching standard errors to these location categories allows us to compute confidence intervals for the proportion of volumes in each location category with the characteristic of interest, e.g., environmental damage.

The standard error calculation gives an estimate of the accuracy of the sample data for making inferences about the total collection. The standard error of the sample proportion for large sample sizes is

$$SE\bar{p} = \sqrt{\frac{\bar{p}\,(1-\bar{p}p)}{n-1}},$$

where p = the sample proportion and n = the sample size.*

Using the standard error, confidence intervals can be constructed for the population proportion, p. That is, we can establish a 95% confidence interval for which we can be certain that the true population proportion will lie within 95% of the time. We calculate a confidence interval for p as

$$\bar{p} \pm Z_{\alpha/2}\, SE\,(\bar{p}).$$

For example, in table 6, the standard error for $\bar{p}$ for the Bird location is 1.127. (i.e., SE $(\bar{p})$ = 1.127). Looking at the data for the number of volumes mutilated we find that in Bird 426 volumes had mutilation and that is 24.72% of the sample collected. Thus, our estimate of the true proportion of books with mutilation damage at Bird is

$$\bar{p} = 24.72.$$

To construct a 95% confidence interval about the true proportion of mutilated volumes at Bird we use the formula,

$$\bar{p} \pm 1.96\, SE(p).$$

For our example, $\bar{p}$ = 24.72; 1.96 = $Z_{\alpha/2}$ = the Z value from a standard normal table corresponding to the .025 percentile. For a 95% confidence interval $\alpha/2$ = .025 and $Z_{\alpha/2}$ = 1.96. SE$(\bar{p})$ = 1.127. Thus, a 95% confidence interval for the proportion of mutilated books in Bird, p, is

$$24.72 \pm 1.96\,(1.127)$$
$$(22.51, 26.93).$$

We can be certain that the true proportion of mutilated volumes at Bird will lie within these limits 95% of the time with a 1% error rate.

The Overall data came from combining the data over all locations. Thus, in computing the overall standard error we needed to weight each location according to its contribution to the whole. The formula used for computing the standard error for proportions from stratified samples was

$$SE(\bar{p}) = \sqrt{Var(\bar{p})} = \sqrt{\frac{W_i^2 \cdot P_i Q_i}{n_i}},$$

*John Neter, William Wasserman, and G. A. Whitmore, *Applied Statistics* (Boston: Allyn and Bacon, 1978), p.298.

where

$W_i = \dfrac{N_i}{N} = \dfrac{\text{Population in the i}^{\text{th}} \text{ location}}{\text{Total Population}}$

W_i is the stratum weight for the i$^{\text{th}}$ location.

P_i = Sample proportion in the i$^{\text{th}}$ location

$Q_i = 1 - P_i$

n_i = Number of items in i$^{\text{th}}$ sample*

Then the Overall standard error is

$$SE(\tilde{p}_o) = \sqrt{[W_B^2 \, \text{Var}\,(\tilde{p}_B) + W_c^2 \, \text{Var}\,(\tilde{p}_c) + W_p^2 \, \text{Var}(\tilde{p}_p) + W_g^2 \, \text{Var}(\tilde{p}_g)]}$$

where B, c, p, and g represent Bird, Carnegie, Physics, and Geology location, respectively, and W is the stratum weight.

Confidence intervals have been computed for the Overall data for all variables indicating needed repairs, pH, and brittleness.

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*William G. Cochran, *Sampling Techniques*, 2d ed. (New York: Wiley, 1963), p.87–107.