The Measurement of Use of Web-based Information Resources: An Early Look at Vendor-supplied Data

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To manage Web-based resources effectively, librarians need to evaluate vendor-supplied data about their use. This article explores the types of data available, using as its starting point the elements defined by the International Coalition of Library Consortia's (ICOLC) "Guidelines for Statistical Measures of Usage of Web-based Indexed, Abstracted, and Full-text Resources." It discusses the problems and issues of comparing use data from different vendors. Then, illustrated with data from one library, the article addresses five measures that have implications for collection management: variability of ICOLC data elements over time, which demonstrated the need to examine data continually; ratios of queries per session, which showed more stability over time than individual ICOLC elements; use by hour, which documented remote use but confirmed that most use occurred during regular library hours; use of electronic journal collections, which was more scattered than the classic 80/20 distribution; and use of Web-based resources in relation to a disciplinary population, which provided an index of value for assessing use of a particular resource. This study identifies aspects of data collection that librarians need to pay special attention to, recommends that vendors report the maximum number of simultaneous users per day and data gaps in addition to ICOLC elements, and suggests per capita use as a comparative measure among libraries.

The proliferation of Web-based resources has greatly increased the information that libraries can deliver to their users' desktops. These resources have great power and promise but come with substantial cost—the price of licensing them. Electronic versions of products often cost more than the print copy, and in most cases, the license allows for only a year of access, whereas the library purchases the print copy outright and can keep it

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indefinitely. Librarians working with finite funds must evaluate the use of electronic resources to maximize the impact of their expenditures.

Fortunately, computers have remarkable abilities to track the way people use Web-based resources through software that captures the transactions of patrons. Although librarians can approximate the number of log-ins to a resource by counting the number of times patrons go through the library's Web gateway to that resource, this measure misses many other dimensions of use, such as number of queries, that only monitoring on the vendor's server can provide. Currently, the library community has proposed standards for reporting use statistics for electronic resources—the International Coalition of Library Consortia's "Guidelines for Statistical Measures of Usage of Web-based Indexed, Abstracted, and Full-text Resources" (hereafter called the ICOLC guidelines).[1] A few vendors fully meet these standards, some partially comply, and others supply none of the ICOLC elements. Although some vendors argue that they cannot afford to provide statistics, Tom Peters has expressed skepticism at their claims of excessive costs.[2] Judy Luther has taken an evolutionary view, reporting that "the industry is at the first stage of creating the capability to gather statistics, establish standards, and deliver comparable and reliable data."[3] The bottom line is that for good management, libraries must have the kinds of statistics called for by ICOLC and the additional data recommended by the present article.

To gather data, the investigators either drew on statistical reports sent regularly by vendors or retrieved data from password-protected Web sites provided by vendors.

Because Web-based resources are so new, the availability of data on their use is a recent phenomenon and there has been little time for data-intensive studies on use. The authors could find only a few studies that report analysis of data comparable to that discussed here. Of note is the investigation, reported in four articles, that Carol Tenopir and colleagues conducted about database use patterns in ninety-six (ninety-three in one study) academic and ninety-nine public libraries.[4–7] Charles T. Townley and Leigh Murray reported a case study on the use of networked (including CD-ROM, locally mounted, and Internet-based) resources at six academic libraries.[8] Rather than summarize the findings and conclusions of these authors, this article refers to their work at relevant places below.

The present authors examined data on the use of Web-based electronic resources in 1999 and in the first eight months of 2000 that vendors supplied to a library that serves a research university with 25,000 students, 1,750 teaching faculty; ninety-two bachelor's, eighty-five master's, and fifty-five doctoral programs; and a comprehensive health sciences center. The library had an electronic resources budget of $360,000 in FY1999 and $475,000 in FY2000. What follows describes current conditions and major issues—what kinds of statistics are available, additional measures derived from the statistics, and what improvements will help librarians better serve their users. Because Web-based resources are a relatively recent development, much will change as time passes. Regardless, because of the importance of analysis and interpretation of data on the use of Web-based resources, it is essential for the library profession that there be early exploration of the subject.

Study Design

The present study began by determining the use data available for Web-based resources from fifty-one vendors. The vendors included publishers, aggregators, and consortia that distribute electronic resources. The resources examined fall into four categories:

1. indexing and abstracting databases;
2. collections of full-text e-journals;
3. directory or reference databases with full-text records;

4. mixed databases with several segments, such as MD Consult, which includes full-text reference books, indexing and abstracts of journal articles, and full-text of selected journal articles.

A key concern was how vendors applied the proposed ICOLC guidelines. Essentially, the guidelines call for five "elements," or categories of data, that vendors should provide libraries about the use of a resource.[9] ICOLC has identified and defined, or in some way described, these elements as follows:

- *Queries* (searches) are "unique intellectual inquir[ies] … typically … recorded each time a search form is sent/submitted to the server."
- *Menu selections* occur when "display of data is accomplished by browsing (use of menus)." In such circumstances, "the number of alphabetic and subject menu selections should be tracked."
- *Sessions* (log-ins) "if relevant, must be provided as a measure of simultaneous use."
- *Turnaways* occur when "requests exceed simultaneous user limit."
- *Items examined* include data units "viewed, marked or selected, downloaded, emailed, printed [when this is recorded and] controlled by the server."

In the fall of 2000, of the fifty-one vendors studied, three reported all ICOLC elements relevant to their resources, twenty-eight supplied selected elements, and twenty offered none. To gather data, the investigators either drew on statistical reports sent regularly by vendors or retrieved data from password-protected Web sites provided by vendors. They then entered the data into spreadsheets for analysis. The investigators did not study use of resources whose vendors only supplied statistics on demand. With thirty-one vendors supplying data, often for multiple resources, the data-gathering process was labor-intensive.

The differences among vendor-supplied statistics were a central problem and will be the first one the present article addresses. From the data available, five measures emerged that have implications for collection management:

1. the variability of ICOLC data elements over time;
2. the ratios of queries per session for searchable databases;
3. hourly use;
4. uses of e-journal collections;
5. the ratio of uses of Web-based resources per FTE in the disciplinary population.

The application of each measure is discussed later in this article.

Comparing Use Across Vendors: Problems and Issues

The ICOLC statistical categories have the virtues of being few in number and straightforward, but their simplicity belies the difficulty of applying them. Vendors or, in the case of locally loaded databases, the local systems administrators control what is reported. What they report depends in part on the computer-monitoring software they use and in part on how they label, define, and count activity. For example, in the present study, one vendor segmented its database into two parts and counted a single query twice when both segments were accessed. Other databases, even if similarly segmented, may count such searches as only one query. Thus, use statistics for the first database may appear higher than use statistics for the second database, even if they are arguably equal. Comparison of different vendors' resources also can be complicated by the ways that each statistical program counts repeated uses of a document within a session and linking to new documents from a chosen document. Further, if vendors get new monitoring software, this may change the statistics reported and/or their meaning, as was encountered twice in the present study. These examples demonstrate that librarians must use updated documentation and explanatory materials to properly interpret current numbers and must retain older documentation to make comparisons over time. The authors recommend an annual review of the way each vendor counts the elements it reports.

Another factor contributing to the difficulty in comparing and interpreting use statistics is that basic session or log-in information may be compromised at public workstations if several different users can search a database without logging out in turn. Alternatively, a resource timing-out due to lack of interaction with it may mean that some users need to log in more than once per sitting (arguably a single session) to complete their work. Librarians would benefit from research that could ascertain whether length of time between interactions with a resource while actively using it (e.g., reading a downloaded article onscreen) varies among different types of Web-based resources (e.g., longer gaps on humanities databases and shorter ones on medical databases). Such research would aid in setting time-out limits that minimize interruptions to users and maximize simultaneous use.

The avenue of access to a resource also may influence use statistics. Libraries in a consortium, for example, may have the option of subscribing to resources from particular vendors either directly or through the consortium. In one notable instance in the present study, the library subscribed to resources from the same vendor in two different ways: some resources were licensed directly, and others were negotiated through a consortium. The consortium loaded the latter resources on its computer and used monitoring software that was different from the vendor's software. As a result, the consortium reported only sessions, whereas the vendor offered complete ICOLC statistics.

Finally, upon examination of daily data for several resources, the present study discovered that some days were missing, yet monthly and yearly summaries gave no indication of the gaps. To inform librarians about the integrity of use statistics, vendors should report when data have been lost or compromised.

Measures of Use and Their Import

Currently, the basic measures of Web-based resources are the ICOLC elements. The present study analyzed ICOLC-compliant data supplied by vendors. In the course of the analysis, the authors identified additional measures that could prove valuable for libraries. These included variability of data over time; queries per session; hourly use; the number of titles providing a given proportion of use in e-journal collections; and use in relation to disciplinary and institutional populations.

Variability of Data over Time and Related Issues

Electronic resource use data provide very helpful information, but their collection must be efficient. Thus, an important issue is how often the library has to collect data. Most vendors included in this study provided monthly data. If use is stable from month to month, handling data twelve times a year is unnecessary and an annual report would do. In contrast, if use varies greatly from month to month, monthly data are necessary for a true understanding of how resources are used. In an academic library, one would expect some variability because of the changing need for information during the course of the academic year.

To determine the variability of elements over time, the study team calculated the coefficient of variation, which is the ratio of the standard deviation to the mean. The coefficient of variation normalizes data and allows for comparison among resources with widely different numerical ranges of use. A low coefficient signifies little data scatter compared to the mean over the time periods studied; the coefficient of variation increases as data scatter relative to the mean increases. A coefficient of 0.2 is relatively low, indicating that the data vary, on average, by 20 percent relative to the mean. A coefficient of 0.8 or above is relatively high, demonstrating that the data vary, on average, by a degree of 80 percent or more relative to the mean. The analysis of the variability of ICOLC elements and of queries per session (see discussion of this ratio in the next section) for the products studied can be found in table 1. There are some noteworthy patterns.

TABLE 1
Variance of Monthly Frequencies by ICOLC Elements

Resource	Time Span	Mean	Std. Dev.	Coef. Var.
		Sessions		
Linguistics & Language Behavior Abstracts	8/99–5/00	50.40	39.14	0.78
Art Abstracts	1999	228.83	176.88	0.77
Reader's Guide Abstracts	1999	470.17	359.76	0.77
Humanities Abstracts	1999	464.50	351.63	0.76
Social Work Abstracts	8/99–5/00	126.20	94.13	0.75
Predicasts PROMT	1999	62.33	46.12	0.74
America: History and Life	1999	136.67	95.42	0.70
PAIS International	1999	124.00	84.23	0.68
General Business File ASAP	1999	207.83	133.37	0.64
Historical Abstracts	1999	94.25	60.79	0.64
Social Sciences Abstracts	1999	1,065.58	680.59	0.64
PsycINFO	1999	3,080.92	1,817.11	0.59
Library Literature	1999	134.50	75.81	0.56
Biological and Agricultural Index	1999	238.67	129.77	0.54
General Science Abstracts	1999	294.58	156.39	0.53
Cambridge Scientific Abstracts	1999	174.75	84.27	0.48
ERIC	1999	1,168.08	520.19	0.45
Applied Science & Technology	1999	405.75	173.95	0.43
Ovid (health sciences databases)*	1999	2,372.25	887.37	0.38
Bowkers Books in Print	1999	143.83	45.90	0.32
Current Contents	1999	1,195.92	345.54	0.29
Ideal	12/98–11/99	1,026.64	289.43	0.28
Web of Science	1-6;8–12/99	1,358.36	367.82	0.27
Beilstein	1999	497.58	120.10	0.24
MDConsult	8/99–3/00	1,855.55	381.94	0.21
		Queries		
Cambridge Scientific Abstracts	1999	370.58	329.48	0.89
Peterson's UndergradSearch	1999	24.67	21.56	0.87
ABI/INFORM	1999	1,034.75	848.15	0.82
Gale Literature Databases	1999	104.40	77.48	0.74
Econlit	1999	246.75	172.14	0.70
Periodical Abstracts	1999	385.25	268.34	0.70
America: History and Life	1999	204.83	141.04	0.69
Historical Abstracts	1999	119.00	76.93	0.65
Wilson Select	1999	953.00	619.64	0.65
Contemporary Women's Issues	1999	112.00	71.99	0.64
NetFirst	1999	122.83	78.62	0.64
Dissertation Abstracts	1999	333.86	209.47	0.63
Peterson's GradSearch	1999	25.58	15.75	0.61
Biography and Genealogical Master Index	1999	73.75	44.28	0.60
MLA International Bibliography	1999	735.25	420.27	0.57
Associations Unlimited	1999	45.08	25.13	0.56
Health Reference Center	1999	548.08	291.12	0.53
Research Centers & Services Directories	1999	6.75	3.25	0.48
World Almanac	1999	25.58	11.89	0.47
PapersFirst	1999	70.58	31.34	0.44

TABLE 1 (CONT)
Variance of Monthly Frequencies by ICOLC Elements

Resource	Timespan	Mean	Std Dev	Coef Var
		Queries (cont.)		
GPO	1999	71.08	30.20	0.43
Proceedings First	1999	32.17	13.35	0.42
Medline (through OCLC)	1999	363.58	133.92	0.37
Ovid (health sciences databases)*	1999	11,278.65	4,118.84	0.37
ArticleFirst	1999	1,811.25	649.47	0.35
Contents First	1999	147.67	51.93	0.35
Union Lists	1999	43.75	13.45	0.31
Britannica Online	6/99–5/00	1,431.75	401.19	0.28
Web of Science	1–6;8–12/99	6,049.09	1,443.60	0.24
WorldCat	1999	3,886.25	653.48	0.17
		Queries per Session		
Cambridge Scientific Abstracts	1999	2.05	1.13	0.55
Historical Abstracts	1999	1.32	0.30	0.22
America: History and Life	1999	1.55	0.26	0.17
Ovid (health sciences databases)*	1999	4.80	0.36	0.08
Web of Science	1–6;8–12/99	4.50	0.37	0.08
		Items		
Research Centers & Services Directories	1999	2.25	3.44	1.53
Historical Abstracts	1999	175.00	246.92	1.41
Peterson's UndergradSearch	1999	16.67	21.01	1.26
America: History and Life	1999	282.00	334.30	1.19
Predicasts PROMT	1999	220.08	214.61	0.98
ABI/INFORM	1999	1,115.70	1,040.27	0.93
Gale Literature Databases	1999	59.42	54.83	0.92
Peterson's GradSearch	1999	52.42	40.72	0.78
Wilson Select	1999	1,022.50	728.24	0.71
Periodical Abstracts	1999	397.00	260.17	0.66
General Business File ASAP	1999	856.50	549.57	0.64
Health Reference Center	1999	545.00	332.87	0.61
Ovid (health sciences databases)*	1999	6,888.12	4,232.02	0.61
Associations Unlimited	1999	30.08	17.94	0.60
Contemporary Women's Issues	1999	140.33	79.98	0.57
Biography and Genealogy Master Index	1999	80.92	45.48	0.56
Ideal	1/99–11/99	764.00	243.00	0.32
Britannica Online	6/99–5/00	1,779.25	427.30	0.24
		Turnaways		
Harrison's Online	7/99–5/00	95.91	272.45	2.84
Web of Science	1–6;8–12/99	10.55	16.81	1.59
Ovid (health sciences databases)*	1999	248.58	252.72	1.02
MDConsult	7/99–3/00	0	0	0

* Weekly frequencies

For sessions data, the range of coefficients of variance among databases was large, 0.21 to 0.78. The average coefficient of variation was 0.54; in other words, the average standard deviation was 54 percent of the mean over the course of the year. Use of health sciences resources such as the Ovid health sciences database collection and MDConsult was below average in variance and may show greater stability because the campus clinics and hospital never close and health sciences students attend classes throughout the year more so than students in other fields. All of the databases or database collections with a physical or biological science component (Beilstein, Web of Science, Applied Science and Technology, Cambridge Scientific Abstracts [among the databases offered by Cambridge Scientific Abstracts, the study library licensed Conference Papers Index, Environmental Sciences & Pollution Management, ERIC, Sociological Abstracts, TOXLINE, Environmental RouteNet, and Water Resources RouteNet], and Biological and Agricultural Index) were at or below the average coefficient of variance. Humanities (Historical Abstracts, America: History and Life, Humanities Abstracts, Art Abstracts) and social sciences databases (Social Sciences Abstracts, General Business File ASAP, PAIS International, Predicasts PROMT, and Social Work Abstracts) were above average in variance, with the exception of ERIC. The authors speculate that these groupings reflect literature and database use patterns of disciplines. Scientific disciplines have higher frequencies of publication, resulting in the need for scientists to check databases more often to keep up to date with the literature. Further, William C. Baum et al. offered evidence that the less paradigmatic (i.e., less scientific) a discipline, the longer its publications.[10] This also may contribute to scholars in the social sciences—and even more in the humanities—being more episodic in searching databases than physical or biological scientists because it would take the first two longer than the last to read through publications identified by their searches. Speculation about reasons for variability aside, the amount of variability found in analyzing session patterns demonstrates the need to examine monthly statistics over the course of a year rather than for one or two selected months or only the annual totals.

Queries showed a range of coefficients of variation as well, from 0.17 to 0.89, somewhat greater than for sessions. The average coefficient of variation was 0.54, the same average as sessions. Like data for sessions, scientific resources are below average in variation, whereas social sciences and humanities resources are above average, with the exception of Cambridge Scientific Abstracts which has a science component but showed the highest variation of all resources in the queries category. However, Cambridge Scientific Abstracts' mix of science and social sciences databases may have contributed to results unlike other resources with only scientific components. As with sessions, the variation of queries is great enough that librarians need to analyze monthly rather than annual data.

A count of items displayed may be the best measure of the value of a resource.

The items-examined category showed a higher degree of variability over time compared to sessions and queries. The range of the coefficients of variation was 0.24 to 1.53, with a mean of 0.81. Higher variability is understandable because searches may have vastly different results depending on topic; some retrieve hundreds of items and others retrieve only a few. Once again, continual analysis enables librarians to better understand the variation and patterns in the data, rather than relying on an annual summary.

The item category as proposed by ICOLC does raise a significant question about its meaning. The ICOLC guidelines describe the category as "examined" items, but without tracking users' eye movements, a librarian cannot be certain that users actually looked at the items. But

computer-monitoring software can record what items users display (i.e., view, mark, select, download, e-mail, or print). Indeed, the ICOLC guidelines enumerate these. This argues for renaming the category "items displayed."

A count of items displayed may be the best measure of the value of a resource. Although one cannot be certain that searchers read what they display, they likely do read shorter entries such as citations and at least scan full text. Whether items are citations or full text, they are what a user ultimately seeks. There are occasions, usually at the start of a project, when scholars may want to determine that no one else has worked on their topics. But, generally, users do not seek zero results. They want to find citations or full text that will tell them something about their topics. More than any other ICOLC element, the items element measures this.

The number of turnaways demonstrated the most variability, with a variation coefficient over 1 for three resources and zero for one resource that had low demand relative to the number of licenses purchased. The number of turnaways depends on the number of simultaneous users licensed. A library could reduce the number of turnaways to a very small number by licensing a large number of simultaneous users, but the variation coefficients indicate that use is widely variable and that, for much of the time, licensing a greater number of simultaneous users would be a waste of library money.

Examining turnaways is crucial in determining the number of simultaneous users needed for a product. When the number of turnaways is consistently zero, perhaps too many users have been licensed. In such cases, the number of simultaneous users needs to be examined to estimate demand. In a study at ninety-three academic libraries of the use of databases supplied by one vendor, Tenopir and Read found that simultaneous use was relatively uncommon: "providing access to only one user for a general research database… would be satisfactory 82.8 percent of the time in research libraries and 95.2 percent of the time in baccalaureate colleges"[11] The present study did not examine simultaneous use the same way that Tenopir and Read did, who sampled the number of simultaneous users logged on once an hour, sixteen hours a day, for six months. Instead, the present study relied on daily reports from Web of Science and MDConsult of the maximum number of simultaneous users who logged on. The data for Web of Science show that simultaneous use occurred daily and increased. In February 1999, use reached the maximum of ten simultaneous users on only one day and in February 2000, on seventeen days. For MDConsult, in the first year of the license, users never exceeded the simultaneous user limit and a broad range of simultaneous use occurred. With this information, in the second year, the librarians at the present study's library reduced the number of simultaneous users licensed. The second-year limit was chosen to maximize value while limiting turnaways.

These cases illustrate how simultaneous user data are crucial in determining the number of licensed simultaneous users needed to meet most of demand. Therefore, the authors recommend that ICOLC add a sixth element—the maximum number of simultaneous users per day. As with turnaways, if vendors report only the highest number of simultaneous users in a month, librarians do not know whether the maximum was reached just once, every day, or somewhere in between. To preclude such ambiguity, vendors should report turnaways and simultaneous users on a daily basis.

Besides variability within a year discussed above, there is also variability from year to year. Data from January to August 2000 at the study library demonstrated various differences from the same period in 1999, as summarized in table 2. Beilstein, a database available since 1995, showed a 13.39 percent increase in sessions from 1999 to 2000, whereas Web of Science, a database available since 1999, showed an increase in sessions of 71.80

TABLE 2
Comparison of 1999 and 2000 Use Frequencies by ICOLC Elements

Resource	UIC Subscription Began	1999–2000 Months Studied	1999 Data	2000 Data	Difference	% Change	Other % Changes		
			Sessions				Queries	Queries per Session	Items
Current Contents	1993	Jan–Aug	3,001	5,482	2,481	82.67			
Web of Science	1999	Jan–May, Aug	6,914	11,878	4,964	71.80	61.74	–5.83	
America: History and Life	1999	Jan–Aug	853	1,162	309	36.23	63.75	20.21	
Cambridge Scientific Abstracts	1999	Jan–Aug	1,283	1,685	402	31.33	230.12	151.36	
PAIS International	1999	Jan–Aug	879	1,035	156	17.75			
Beilstein	1995	Jan–July	3,338	3,785	447	13.39			
Predicasts PROMT	1999	Jan–Aug	385	419	34	8.83			32.53
Business Abstracts	1993	Jan–Aug	1,948	2,095	147	7.55			
Bowkers Books in Print	1996	Jan–Aug	1,094	1,122	28	2.56			
Social Sciences Abstracts	1993	Jan–Aug	7,437	7,540	103	1.38			
Readers Guide Abstracts	1993	Jan–Aug	3,168	3,155	–13	–0.41			
Humanities Abstracts	1993	Jan–Aug	3,617	3,542	–75	–2.07			
Biological and Agricultural Index	1994	Jan–Aug	1,705	1,601	–104	–6.10			
Historical Abstracts	1999	Jan–Aug	679	637	–42	–6.19	35.08	43.98	
Library Literature	1994	Jan–Aug	1,058	982	–76	–7.18			
General Science Abstracts	1993	Jan–Aug	2,306	2,093	–213	–9.24			
PsycINFO	1994	Jan–Aug	22,277	18,688	–3,589	–16.11			
General Business File ASAP	1999	Jan–Aug	1,309	1,054	–255	–19.48			–20.80
ERIC	1993	Jan–Aug	8,863	6,830	–2,033	–22.94			
Art Abstracts	1995	Jan–Aug	1,704	1,229	–475	–27.88			
Applied Science and Technology	1994	Jan–Aug	3,210	2,291	–919	–28.63			

TABLE 2 (CONT)
Comparison of 1999 and 2000 Use Frequencies by ICOLC Elements

Resource	UIC Subscription Began	1999–2000 Months Studied	1999 Data	2000 Data	Difference	% Change	Other % Changes		
			Queries				Sessions	Queries per Session	Items
ECO	1998	April–Aug	5,131	20,519	15,388	299.90			
Associations Unlimited	1996	Jan–Aug	360	1,267	907	251.94			61.02
Cambridge Scientific Abstracts	1999	Jan–Aug	1,690	5,579	3,889	230.12	31.33	151.36	
Biography and Genealogy Master Index	n.a.	Jan–Aug	629	1,419	790	125.60			96.89
Econlit	1999	Jan–Aug	1,225	2,623	1,398	114.12			
MEDLINE	n.a.	Jan–Aug	2,483	4,530	2,047	82.44			
Gale Literary Databases	n.a.	Jan–Aug	837	1,410	573	68.46			134.83
NetFirst	n.a.	Jan–Aug	697	1,151	454	65.14			
America: History and Life	1999	Jan–Aug	1,316	2,155	839	63.75	36.23	20.21	
Web of Science	1999	Jan–May, Aug	32,033	51,809	19,776	61.74	71.8	–5.83	
ABI/INFORM	1996	Jan–Aug	5,191	8,047	2,856	55.02			40.39
Historical Abstracts	1999	Jan–Aug	918	1,240	322	35.08	–6.19	43.98	
MLA International Bibliography	1995	Jan–June	4,646	6,205	1,559	33.56			
WilsonSelect	n.a.	Jan–Aug	6,141	8,065	1,924	31.33			24.62
Periodical Abstracts	n.a.	Jan–Aug	2,532	3,159	627	24.76			15.44
Health Reference Center	n.a.	Jan–Aug	3,399	3,874	475	13.97			7.82
Research Centers & Services Directories	2000	Jan–Aug	52	59	7	13.46			20.83

TABLE 2 (CONT)
Comparison of 1999 and 2000 Use Frequencies by ICOLC Elements

Resource	UIC Subscription Began	1999–2000 Months Studied	1999 Data	2000 Data	Difference	% Change	Other % Changes		
				Queries (cont.)			**Sessions**	**Queries per Session**	**Items**
Union Lists	n.a.	Jan–Aug	364	409	45	12.36			
Contemporary Women's Issues	1999	Jan–Aug	908	999	91	10.02			10.85
PapersFirst	n.a.	Jan–Aug	581	626	45	7.75			
WorldCat	n.a.	Jan–Aug	30,379	32,282	1903	6.26			
ArticleFirst	n.a.	Jan–Aug	12,907	13,544	637	4.94			
Peterson's GradSearch	2000	Jan–July	169	174	5	2.96			0.27
Britannica Online	1996	Jan–Aug*	12,253	10,229	–2,024	–16.52			–32.82
Peterson's UndergradSearch	2000	Jan–July	184	142	–42	–22.83			11.28
WorldAlmanac	n.a.	Jan–Aug	217	159	–58	–26.73			
Proceedings First	n.a.	Jan–Aug	306	216	–90	–29.41			
ContentsFirst	n.a.	Jan–Aug	1,188	800	–388	–32.66			
GPO	n.a.	Jan–Aug	539	256	–283	–52.50			
				Queries per Session			**Sessions**	**Queries**	**Items**
Cambridge Scientific Abstracts	1999	Jan–Aug	1.32	3.31	1.99	151.36	31.33	230.12	
Historical Abstracts	1999	Jan–Aug	1.35	1.95	0.6	44.44	–6.19	35.08	
America: History and Life	1999	Jan–Aug	1.54	1.85	0.31	20.21	36.23	63.75	
Web of Science	1999	Jan–May, Aug	4.63	4.36	–0.27	–5.83	71.80	61.74	

TABLE 2 (CONT)
Comparison of 1999 and 2000 Use Frequencies by ICOLC Elements

Resource	UIC Subscription Began	1999–2000 Months Studied	1999 Data	2000 Data	Difference	% Change	Other % Changes		
			Items				Sessions	Queries	Queries per Session
Gale Literary Databases	2000	Jan–Aug	491	1,153	662	134.83		68.46	
Biography & Genealogy Master Index	n.a.	Jan–Aug	676	1,331	655	96.89		125.60	
Associations Unlimited	1996	Jan–Aug	236	380	144	61.02		251.94	
ABI/INFORM	1996	Jan–Aug	5,311	7,456	2,145	40.39		55.02	
Predicasts PROMT	1999	Jan–Aug	1,162	1,540	378	32.53	8.83		
WilsonSelect	n.a.	Jan–Aug	6,638	8,272	1,634	24.62		31.33	
Research Centers & Services Directories	2000	Jan–Aug	24	29	5	20.83		13.46	
Periodical Abstracts	n.a.	Jan–Aug	2,533	2,924	391	15.44		24.76	
Peterson's UndergradSearch	2000	Jan–July	133	148	15	11.28		–22.83	
Contemporary Women's Issues	1999	Jan–Aug	1,023	1,134	111	10.85		10.02	
Health Reference Center	n.a.	Jan–Aug	3,336	3,597	261	7.82		13.97	
Peterson's GradSearch	2000	Jan–July	369	370	1	0.27		2.96	
General Business File ASAP	1999	Jan–Aug	5,842	4,627	–1215	–20.80	–19.48		
Britannica Online	1996	Jan–Aug*	16,672	11,201	–5,471	–32.82		–16.52	

* Britannica Online did not capture remote data for 2/15–5/3/99

percent. Perhaps because Web of Science was newer, people had not discovered it or become accustomed to using it in 1999. As table 2 shows, other resources had varied patterns, with some showing a decrease in use and others an increase.

As tables 1 and 2 show, the coefficient of variation in 1999 was not a predictor of the amount of change between 1999 and 2000 (January through August for most resources) for sessions, queries, and items. For example, for sessions, both Reader's Guide Abstracts and Art Abstracts had coefficients of variation of 0.77 in 1999, but the absolute percentages of change were 0.41 percent and 27.88 percent, respectively, from 1999 to 2000. Beilstein and Web of Science had coefficients of variation for sessions of 0.24 and 0.27, respectively, but one changed 13.39 percent and the other changed 71.80 percent from 1999 to 2000.

Although consistent trends in growth or decline would help librarians in planning, this is too much to expect in the early years of Web-based resources. Ann Peterson Bishop, in comparing the results from studies at several libraries, found that e-journal systems are not used in their first year of implementation by most of their target audiences, so perhaps use patterns take a long time to become established.[12] Townley and Murray found that twelve to eighteen months of access are needed before heavy use of a database will be observed. They also found that the number of alternative electronic information resources available affects use.[13] Even if the resource mix stays constant, perhaps at some point growth in use will cease. As years pass and research on the use of Web-based resources progresses, librarians will learn more about what influences growth and decline in use.

Queries per Session

The two ICOLC elements most often reported by vendors in the present study were sessions and queries. These are important measures in themselves, and also noteworthy is the ratio between them. Townley and Murray studied the use of networked databases at six academic libraries. Based on a formula developed by the Texshare consortium from experience with OCLC FirstSearch databases, they estimated that users made three queries per session when the computer-monitoring software did not report queries.[14] In the present study, the authors calculated queries per session for three individual databases and two database collections that supplied both elements. In 1999, none of these coincided with three queries per session, but their overall mean was close at 2.84. The three databases had the following ratios: Historical Abstracts, 1.32 queries per session; America: History and Life, 1.55; and Web of Science, 4.50. For the database collections, Ovid health sciences databases had a ratio of 4.80 queries per session and Cambridge Scientific Abstracts, 2.05 queries per session.

A month-by-month examination of the data revealed that sessions alone can occasionally provide a misleading indicator of productive database use. Although the average for the year was greater than one, for some months the ratio of queries per session was less than one, indicating that some sessions did not result in use of the resource. For example, in the data for Historical Abstracts and Cambridge Scientific Abstracts, there were months during which users logged in more than they searched, suggesting that they either could not operate the search engine or decided not to conduct a search, or that a librarian was showing a patron how to access the database but nothing else.

Despite some months with anomalous ratios, the most stable measure found in this study was queries per session. Although the coefficients of variation for sessions ranged from 0.21 to 0.78, with an average of .54, and those for queries ranged from 0.17 to 0.89, also with an average of .54, the range for queries per session was 0.08 to 0.55 for the five resources for which both sessions and queries were available. The average for the five was 0.22. For both Web of Science and the Ovid health sciences database collection, the coefficient of variation was 0.08. Humani-

ties databases showed slightly higher figures. America: History and Life had a coefficient of variation of 0.17, and Historical Abstracts had one of 0.22. The database collection Cambridge Scientific Abstracts had a coefficient of variation of 0.55. Except for Cambridge Scientific Abstracts, the coefficients of variation of ratios of queries to sessions were low, in two cases very low. Furthermore, tables 1 and 2 show that the coefficients of variation of queries per session, unlike coefficients of variation for sessions and queries, showed a positive correlation with the percent change between 1999 and 2000. A lower coefficient of variation corresponded with a lower percent change; and as one rose, so did the other.

In general, use was highest between 10 a.m. and 5 p.m., peaking sometime in the afternoon.

Finally, because the ratio of queries per session is more stable than the individual ICOLC elements, it has potential for being an indicator of changes in the way vendors gather data on use or of differences between resources in the same or similar disciplines. Thus, if a ratio suddenly increases, it may mean a vendor has segmented a resource and now, by previous standards, counts each search twice, as occurred in the present study. Or if one resource's ratio of queries to sessions differs greatly from the ratios for similar resources in the same or similar disciplines, the meaning of the data from the outlier may be suspect.

Hourly Use

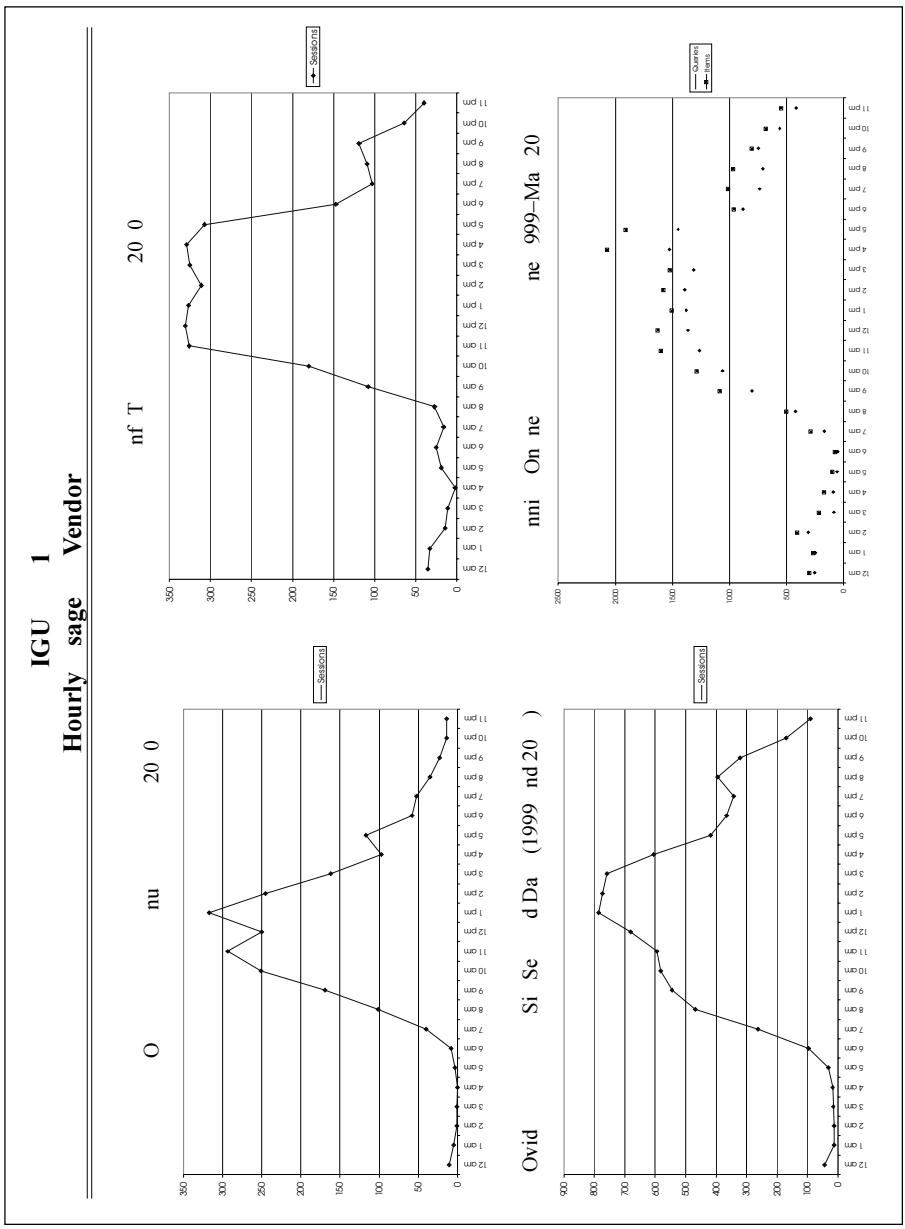
Some vendors provide statistical information on use by hour of day for selected ICOLC elements. The authors found that vendors may record use by time of day in the library's local time, the server's local time, or Greenwich Mean Time and may or may not adjust for daylight savings time. To compare hourly use patterns and to understand their meaning, librarians must ascertain what time of day a resource's monitoring software uses and then, if necessary, adjust the data to local time, as was done in the present study.

In the present study, four vendors provided data on use by the hour. Infotrac and ABC-CLIO reported sessions per hour; Britannica Online reported the number of queries and documents per hour; and Ovid's statistics module allows librarians to extract the number of sessions for any given hour (although this takes so long that it limits data collection). Use by hour across these resources was very similar. In 1999, use of the two Infotrac databases, General Business File ASAP and Predicasts PROMT, was highest between 11 a.m. and 6 p.m., peaked between noon and 1 p.m., with evening use tapering off about midnight. For January through August 2000, use of the two ABC-CLIO databases, Historical Abstracts and America: History and Life, was highest between 10 a.m. and 3 p.m., peaked between 1 p.m. and 2 p.m., and tapered off steadily throughout the afternoon with few uses between midnight and 6 a.m. From June 1999 to May 2000, Britannica Online showed the heaviest use between 9 a.m. and 6 p.m., peaking between 4 p.m. and 5 p.m., with some use at every hour of the day.

For Ovid's health sciences databases, including full-text journals, six days were studied: November 9 and 10, 1999, and February 25, March 30, April 24, and July 11, 2000. These days were chosen because they occurred during a semester and represented the full spectrum of weekday use, Monday through Friday. After data collection, it was discovered that the data were reported in Greenwich Mean Time; and as use was shifted to local time, some of the use was actually for the prior calendar day, but six twenty-four hour periods were examined. Use was highest between 9 a.m. and 5 p.m. and peaked between 1 p.m. and 2 p.m. There were 136 sessions between midnight and 6 a.m., or an average of 22.7 sessions per day during that time period. Infotrac averaged 0.3 sessions per day between midnight and 6 a.m., and ABC-CLIO databases averaged 0.08 sessions. Britannica Online did

not offer sessions but averaged 2.8 queries per day between midnight and 6 a.m.

As seen in figure 1, all the databases studied showed similar use patterns. The hour number on the x-axis represents the entire hour-long period, so that 5 p.m. equates to 5 p.m. to 6 p.m. Differing length of time studied and widely different absolute amounts of use resulted in differences in scale, but the hourly use patterns are very similar. In general, use was highest between 10 a.m. and 5 p.m., peaking sometime in the afternoon. Tenopir and Read found a similar pattern in their study of the number of simultaneous users of a set of online databases in academic libraries—highest use from 10 a.m. to 6 p.m., with a peak for several



types of academic libraries around 2 p.m.[15] Libraries have sought Web-based resources to increase access to information outside the library building, and around-the-clock use shows this has happened, although use remains highest during the hours the library is open. However, determining the percentage of use that occurs in the library and the percentage that originates outside the library is currently impossible given the statistics provided. It would be valuable for libraries to work with vendors to obtain such data while preserving the privacy of individual users. Should statistics document increased remote use over time, libraries will have reason to provide additional online help or perhaps a phone help line.

Use of E-journal Collections

E-journal collections are an important type of Web-based resource. When librarians can select and change the mix of journals they license within a collection, data on the use of individual titles are important. One approach to evaluating such data falls under the rubric of the 80/20 rule. In the management literature in 1954, J. M. Juran discussed the phenomenon by which a small percentage of elements (the vital few) accounted for a large portion of an effect.[16] Juran's Vital Few principle was introduced to the library literature by Richard L. Trueswell in 1969, who demonstrated that often 80 percent of library use is satisfied by 20 percent of materials.[17] The so-called 80/20 rule has been tested over the years in journal collections in various libraries. Tina E. Chrzastowski found that 26 percent of the journal collection accounted for 80 percent of use in an academic chemistry library.[18] Robert J. Veenstra found an almost perfect match with the 80/20 rule in an academic veterinary medical library: 80.1 percent of use was accounted for by 19.8 percent of journal titles held.[19] However, not all studies have fit the 80/20 pattern: the University of Minnesota Biomedical Library found that 47 percent of titles were needed to satisfy 77 percent of the total use.[20]

Methods of study of the use of print collections are unable to capture every use.[21] Reshelving studies depend on patron compliance, whereas citation studies miss current-awareness uses and use for instructional and clinical purposes. Circulation studies miss in-house use. In contrast, with an e-journal collection, it is possible to record every time a journal article is accessed as long as the only route of access is through the software that monitors use of the supplying server.

The study team gathered data for four e-journal collections to determine what percentage of the titles accounted for 80 percent of use. Three of the collections were studied from October 1999 to March 2000: American Chemical Society (ACS), Karger, and Project Muse. A fourth, Ovid, was studied from October 1999 to April 2000, with data unavailable for some dates. ACS supplies chemistry journals (no surprise); the Karger collection is composed of health sciences journals; Project Muse is made up of humanities, social sciences, and mathematics journals; the Ovid e-journal collection contains health sciences journals. All four showed a ratio lower than 80/20; that is, more than 20 percent of the collection was needed to satisfy 80 percent of use. The ACS e-journal collection was the closest, with 28 percent of titles accounting for 80 percent of use. In a collection of health sciences journals subscribed to through Ovid, the ratio was 80/43. With the Karger collection, 44 percent of titles provided 80 percent of use. With Project Muse titles, the use data were reported in the categories of articles, images, table of contents, other (use that did not fall into one of the three previous categories), and total (all four combined). Mathematics journal articles that contained many graphics were counted as images rather than articles for this database. Each category resulted in a different ratio. For articles, 80 percent of use was supplied by 38 percent of titles, images had a ratio of 80/29, and other had a ratio of 80/52. For the total category, 80 percent of use was supplied by 48 percent of titles.

Noteworthy, then, are at least two observations. First, although the pure science collection (ACS) is closest to the 80/20 distribution, the health sciences collections from OVID and Karger fit closely with what was obtained at the University of Minnesota Biomedical Library. This suggests that health sciences journal collections have greater scatter of use. Second, most of the measures of the use of Project Muse are equally scattered, except for images that largely describe use of mathematics journals. This and the data for use of ACS journals suggest that the 80/20 rule comes closest for paradigmatic science but does not apply elsewhere.

When e-journal collections can be purchased on a title-by-title basis, ratios of percentage of use to percentage of titles have collection development implications. If a library cannot afford to keep all titles, the question becomes, What percentage of use does the library want to meet? It may set 90 percent or 80 percent as its target goal. It then can ascertain the least expensive mix of titles that meets its goal and cancel the others. Onsite print collections or document delivery could supply articles from titles canceled in electronic format. During the present study, the authors found that for several e-journal collections, title-by-title use data were not available. Because such data are very helpful, libraries should require them when negotiating contracts with vendors.

Use in Relation to Disciplinary and Institutional Populations

Although the use of several resources in the same discipline can be compared in a somewhat straightforward manner, the size of the disciplinary population deserves consideration when comparing resources in different disciplines. To examine the relationship of the disciplinary population and a resource, the authors compared the use of resources that could be mapped to a particular program, department, or college to the population of that unit. The clearest indication of the likely disciplinary population for a resource is commonality of name of an academic unit and the resource (e.g., PsychINFO mapped to the psychology department, Social Work Abstracts to the school of social work). Per capita use, as discussed here, equals the frequency of an ICOLC element reported for a resource divided by the population of its corresponding academic unit. Population equals full-time equivalency (FTE) faculty (including graduate assistants) plus FTE instructional enrollments—that is, the number of students enrolled in classes of a unit, calculated on the basis of course enrollment credit hours (fifteen per undergraduate FTE, twelve per graduate).[22] Table 3 lists the resources, use data for ICOLC elements, the academic units that correspond to the resources, the population of those units in the fall of 1999, and the per capita use for the resource.

It is possible to look at the data in table 3 in a variety of ways, but perhaps the most interesting result is which databases show high use per capita. Unquestionably, PsycINFO, ERIC, and Contemporary Women's Issues are the most heavily used per capita. The absolute frequencies of use of PsycINFO and ERIC are also the highest, so obviously these are extraordinarily important sources. But Contemporary Women's Issues has low absolute use, such that its cost may be questioned until one sees how high the use is per capita for such a small program. Of course, high use per capita also may be an indicator that a database is of value to other disciplines besides the primary population: in other words, use per capita may be an index of the multidisciplinarity of a database. For example, in addition to people from the psychology department, PsychINFO users may include people in medicine, nursing, education, social work, and public health. In contrast, business resources show lower use per capita, which may be attributed in part to a narrow focus that is not relevant to students and faculty in other fields. Moreover, relatively low per capita use for business resources may reflect that there are several of them to meet the demands of users, whereas PsychINFO is the only database licensed in psychology.

TABLE 3
Ratio of Use to Primary User Population, 1999

Database	Totals	Dept/College	Population	Per capita
	Sessions			**Sessions per Capita**
PsycINFO	36,971	Psychology	909.65	40.64
ERIC	14,017	Education	807.62	17.36
Beilstein	5,971	Chemistry	1,227.99	4.86
America: History & Life	1,640	History	635.88	2.58
Social Work Abstracts*	1,358	Social Work	552.47	2.46
Historical Abstracts	1,131	History	635.88	1.79
Business Abstracts	3,568	Business	2,560.14	1.39
General Business File ASAP	2,494	Business	2,560.14	0.97
Predicasts PROMT	748	Business	2,560.14	0.29
	Queries			**Queries per Capita**
Contemporary Women's Issues	1,344	Women's Studies	34.66	38.78
Econlit	2,961	Economics	578.70	5.12
ABI/INFORM	12,417	Business	2,560.14	4.85
America: History & Life	2,458	History	635.88	3.86
MLA International Bibliography	8,823	English & Languages	2,294.09	3.85
Historical Abstracts	1,428	History	635.88	2.25
	Items			**Items per Capita**
Contemporary Women's Issues	1,684	Women's Studies	34.66	48.59
ABI/INFORM	13,388	Business	2,560.14	5.23
General Business File ASAP	10,278	Business	2,560.14	4.02
Predicasts PROMT	2,641	Business	2,560.14	1.03

* 8/1999–7/2000

Calculations of per capita use provide an index of value. In a library where a specific subject fund may pay for a resource identified with that subject, high per capita use may suggest that the resource is supporting multiple subject areas and the subject fund deserves compensation. If per capita use suggests that a database is multidisciplinary, it also may deserve greater consideration in library instruction than other databases, especially in discussions of relevant resources.

Finally, the authors suggest that per capita use not by academic unit but, instead, by educational institution should be considered for national statistical reporting. To compare raw use data across libraries has limited meaning because of differences in institutional population sizes. It would be more telling to report use per capita, which normalizes the data. Although, ideally, all ICOLC elements should be normalized, in these early years of Web-based resource use, sessions are probably the easiest statistic for all vendors to capture. As more vendors become ICOLC compliant, queries, items, menu selections, and turnaways should be added to sessions. It could be argued that in national reporting, a library should include statistics on the use of free, unlicensed resources such as the National Li-

brary of Medicine's PubMed. The argument would be that when a library organizes and indexes its Web site to facilitate access and makes networked computers available to those who lack them, it should assess use of free resources reached through its site and equipment to have a full picture of the effectiveness of its efforts. Nevertheless, free resources normally do not offer statistics on use by a particular institution. A library can approximate the number of sessions for a resource by measuring how often the Web gateway to a resource is accessed. But this would yield only a weak estimate of sessions because there is no way to be sure that a user logged onto the resource after looking at it. Thus, the best national measures are vendor-supplied, ICOLC-compliant statistics, including sessions, queries, items, menu selections, and turnaways, normalized by institutional population.

Conclusions

Electronic resource use exhibited a great deal of variance over time. This suggests that, in general, monthly data analyzed continually are necessary for an accurate picture of the scope of use. One or two selected months of statistics will not provide a true picture of use. Indeed, this study found that in-depth understanding is aided by some analysis of daily data, especially of turnaways and simultaneous use. Extreme highs on a few days can create an appearance of heavy use in monthly or yearly summaries. A handful of extreme lows can be equally misleading. But an examination of a greater number of data points prevents misapprehensions. Furthermore, over time, use of a resource is likely to change. Comparison of data from 1999 and 2000 suggests that changes do occur in varying degrees over time, perhaps influenced by the length of time a resource has been available and the ever-changing resource mix. It will take a careful analysis of statistics of use over many years and at many different libraries before it is possible to make meaningful generalizations about change in use of Web-based resources over time.

As a result of this study, the authors make the following recommendations:

For vendors:

- Supply all relevant ICOLC elements.
- Supply documentation explaining how the data are counted and reported, and notify librarians if there is a change in data reporting and the date the change goes into effect.
- Report the maximum number of simultaneous users per day.
- Indicate in summary data for a given period how many days are missing data.
- For database or e-journal collections, supply use data for each title in the collection.

For libraries:

- Review the way vendors count the elements reported annually so that changes in definition may be noted and considered during interpretation.
- Examine data at least monthly and occasionally daily to have a true understanding of variations in use.
- Ascertain changes in use patterns from year to year.
- Calculate queries per session for insight into the level of use and to monitor stability of data.
- Be aware that data may not be reported in local time but may need to be converted from some other standard.
- Examine use of individual titles in e-journal collections.
- Evaluate use in terms of the primary user population of a Web-based resource for additional interpretation of value.

For comparison among libraries, initially report the number of sessions per institutional population (students, faculty) for all Web-based resources. As more vendors become ICOLC compliant, queries, items, menu selections, and turnaways should be added to per population comparisons.

Sound interpretation of data about use of Web-based resources is crucial to good library management. The data and issues surrounding them are new and complex,

and they require continued discussion in the library literature. The authors of the present study hope that it will stimulate further investigation and look forward to the reports and reflections of their colleagues.

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