

Mapping the Literature of GIS

Edith A. Scarletto

This study analyzed citations in four journals, *Annals of the Association of American Geographers*, *Cartography and Geographic Information Science*, *International Journal of Geographical Information Science*, and *Cartographic Journal*, using Bradford's Law of Scattering to identify three influence zones indicating core and peripheral titles in the study areas of GIS. Journals were ranked resulting in twenty-three core journals and 187 secondary journals. Scores for relevant indexing/abstracting services are also given to describe access points and coverage. The results can assist librarians and collection managers to support research in their institutions where GIS is both used and studied.



Academic librarians have traditionally fit emerging disciplines into their existing structure, and Geography and Map Librarians (among others) have integrated Geographic Information Science (GIS) into their duties as quickly as faculty and students have adopted them. The ARL (Association of Research Libraries) GIS Literacy Project began during the early 1990s to recognize the increasing interest in GIS, and several SPEC KITS have been issued about its support including Davie¹ and Salem.² Using a working definition from the *Encyclopedia of GIS*, GIS is "knowledge acquired through processing geographically referenced data. Geographic Information Services are... provisions of information generated from geospatial data."³ As GIS has evolved into a discipline of its own, the challenge of supporting this research area has become more acute. Practitioners and researchers at many ends of the technical and theoretical spectrum need literature

to support research and to contribute additional knowledge to their discipline. Academic libraries support research by collecting and providing access to journal literature in their institutions. The challenge of selecting journals is exacerbated as budgets shrink and is especially difficult for a multidisciplinary research area like GIS.

This article examines and creates a list of the GIS journals in three ranked zones of influence using Bradford's Law of Scattering.⁴ Analyzing citations in four source journals, *Annals of the Association of American Geographers*, *Cartography and Geographic Information Science*, *International Journal of Geographical Information Science*, and *Cartographic Journal*, the resulting three influence zones can assist librarians in identifying core and peripheral titles in the study areas of GIS. Comparing these results with other bibliometric studies of GIS and geography journals cited in this paper, in addition to using Impact Factors and metrics, can

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help librarians determine where funding should be spent to cover the most ground for GIS literature support.

Literature Review

The discipline of Geographic Information Science (GIS or GIScience) has its history in both technical and theoretical disciplines. The development includes geographic information systems, computer science, remote sensing, geography, and statistics, making it nearly impossible to isolate where GIS begins and ends. Together with the technical and theoretical aspects of acquiring geographically referenced data (remote sensing and others), tools and knowledge contribute to the growing research area. This is sometimes referred to as GIScience,

a scholarly discipline that addresses fundamental issues surrounding the use of a variety of digital technologies to handle geographic information, namely information about places, activities and phenomena on and near the surface of the Earth that is stored in maps or images. GIScience includes the existing technologies and research areas.⁵

The interdisciplinarity of GIS has been documented by Robert Allen,⁶ who identified the topics in the following areas: Biology/Ecology, Urban/Regional Planning, Technology, Natural Resources, Hydrology, Geography, Library Science, Atmospheric Science, Education, Transportation, Archeology, Criminology, and Medicine. He found that these disciplines both use and write about GIS. Other interdisciplinary studies of geography have included Anne Buchanan and Jean-Pierre Herubel.⁷ Buchanan and Herubel used citation analysis to identify the interdisciplinary nature of Historical Geography, finding that the subdisciplines draw deeply from the related subject area, historical geography from history, economic geography from economics. As GIS is also expected to draw from

the subdisciplines noted by Allen and Buchanan and Herubel above, many of the subdisciplines are likely to be present in the results of this study.

Geography and GIS have also been studied using citation analysis to examine the characteristics of literature use in the disciplines. William Robinson and Paul Poston⁸ used citation analysis to investigate this idea, looking at how authors used literature and the nature of what they cited. They found that authors in different journals used different percentages of literature formats depending on the journal in which they published. The proportion of books cited compared to periodicals and report literature differed between publications. They also found a similar difference in the age of the literature used and the country where it was published. Each journal in turn exhibited different author characteristics. The proportional use of different source formats is one aspect of the literature that will be examined in the Results section of this study.

Additional studies have used the core journal approach with bibliometrics and citation analysis in geography to represent the discipline, identifying most cited authors, classic authors over time, and the network of geography journals. These studies attempt to find the most influential or "classic" authors of the field. They include: Andrew Bodman;⁹ J.W. Whitehand;¹⁰ Neil Wrigley and Stephen Matthews;¹¹ Robinson and Poston;¹² and David Lee and Arthur Evans.¹³ Because the choice of source journals was a critical issue in the development of this study, a review of their methodologies follows.

Bodman used the journals in the geography category listed in the *Social Science Citation Index* to generate his core journal list. He suggests that using a core journal list in affiliated disciplines could contribute to the breadth of the geography core for future studies.¹⁴ Wrigley and Matthews¹⁵ examined the geography journals *Area*, *Transactions of the Institute of British Geographers*, *Annals of the American Association of Geographers (AAAG)*, and *Pro-*

Professional Geographer for the articles cited most often in a ten-year period. Their list of most cited articles features four of the articles they deem as potential classics in geography. These classics were found in the journals *Transactions of the Institute of the British Geographers*, *Progress in Human Geography*, *Geographical Analysis*, and *Environment and Planning A*. Wrigley and Matthews are looking specifically at the field of geography.

Robinson and Poston also looked at literature use, implementing what they considered to be "leading periodicals," studying the titles *AAAG*, *Applied Geography*, *CJ*, *Economic Geography*, and *Geographical Analysis*.¹⁶ Sampling these titles and examining citation patterns, they found that the authors in each of these journals differed in how they used geographic literature. Gatrell and Smith¹⁷ looked at journal citation networks using a set of twenty-two journals in geography to determine how journals were represented in the citations of others on the list. They specifically excluded cartography journals making their resulting core list of literature less applicable to GIS, a cartographic tool. The journals *AAAG*, *Antipode*, *Environment and Planning A*, *Geoforum*, *Geographical Analysis*, *Professional Geographer*, and *Transactions of the Institute of British Geographer*¹⁸ were high on their list in the citation networks.

These articles present several methodologies for examining citations to illustrate user behavior with different perspectives, all with the idea that choosing core journals in an area of study can help to define the literature through the window of the study sample. Some could argue that GIS has moved beyond geography, making this background not as relevant. Often, the reputation of journals builds over time, and many titles have merged, split, or changed the focus of their publication to meet the changing direction of the discipline. As experienced in the course of this study, they both move away from traditional geography and move with it to include GIS.

Studies have also been done looking at perceptions of quality and the impact status of journals in geography and GIS. Caron et al. (2008) comes closest to the purpose of this study by using a combination of subjective journal ranking (Delphi method) and objective Impact Factor analysis¹⁹ to determine an overall journal ranking in the field of GIS, using an international focus. The final ranking of GIScience journals²⁰ by Caron et al. included forty-six titles. Their list contains a majority of international titles, including quite a few from remote sensing.

Methodology

The "Protocol for Mapping the Literature for Nursing and Allied Health Professions"²¹ was followed as a model for this study. This protocol has been used primarily in the nursing and allied health professions²² and has been a well-respected methodology of the Medical Library Association for eighteen years. The protocol consists of choosing several source journals in a field and examining the citations to articles in those journals over a period of time to determine the most cited journals, or core literature. These journals are ranked into three zones of influence by the number of times they are cited by the articles included in the study: Zone 1, highest influence journals; Zone 2, moderate influence journals; Zone 3, lesser influence journals. GIS is a synthesis and applied methodology for remote sensing, surveying, mapping (cartography), computer engineering, statistical analysis, and (of course) geography. This makes it similar to the nursing and allied health fields, which are also based on several "sister" disciplines that contribute to and share resources. These similarities in how the fields relate to one another presented a unique application of the "protocol" to GIS literature.

Selecting Source Journals

The methodology of this study can be divided into the selection of source journals, data collection, and Bradford's Law.

The first step in “mapping the literature of GIS” was the selection of source journals. Source journals are the journals from which the articles and subsequent citations listed in those articles are studied. All of the citation data collected was drawn from articles published in the source journals during the time of analysis (2008–2010). This is arguably the most important step in the analysis process and subject to the most debate. When trying to determine the core literature of the discipline based on ranking, which source journals are chosen for analysis can create a source of bias in the results.

Several criteria were applied to the selection of source journals for this study. Using English language titles, the first criterion was the association with a professional organization, the second was the presence of a Thompson Reuters Journal Impact Factor from the *Journal Citation Reports*, the third was focus on the topic of Geographic Information Science, and the fourth was broad circulation. While professional associations are not the only source of scholarly journals, they do indicate a level of responsibility to the profes-

sion. All four source journals had some affiliation with a professional association. Also, three of the four journals selected are listed in the Thompson Reuters *Journal Citation Reports* (JCR), which calculates the Journal Impact Factor. *Cartography and Geographic Information Science* (CGIS) was the exception. Impact Factors are defined as the “average number of times articles from the journal published in the past two years have been cited in the JCR year.”²³ Many studies have noted the flaws of the Journal Impact Factor;²⁴ however, it is a recognizable and repeatable metric. A broad circulation provides evidence of interest in the publication and the opportunity for professionals to be exposed to its content. The professional affiliations, publishers, and one-year/five-year Impact Factor and *Journal Citation Reports* half-life for each source journal are listed in table 1. As CGIS is not indexed in the *Journal Citation Reports* and does not have an Impact Factor, the metrics from *Scopus*, SJR for prestige, and SNIP for normalized impact are also listed.²⁵

Starting with the *Magazines for Libraries* (2010) list of journals in “Cartography,

TABLE 1
Source Journal Details

Journal	Professional Association	Publisher	Impact Factor (2010) 1yr/5yr ^a	Scopus Metrics (2010) SJR/ SNIP ^b	Half Life (2010)
<i>AAAG</i>	Association of American Geographers	Routledge	1.889/2.986	.045/1.985	>10.0
<i>IJGIS</i>	Association of American Geographers/ Royal Geographical Society	Taylor & Francis	1.489/2.162	.061/2.854	8.9
<i>CGIS</i>	Cartography & Geographic Information Society	American Congress on Surveying and Mapping		.036/1.056	
<i>CJ</i>	British Cartographic Society	Maney Publishing	0.607/0.644	.032/.822	7.7

a. Institute for Scientific Information, *Journal Citation Reports*, 2010.

b. Elsevier Science Publishers, *Scopus*.

GIS and Imagery,"²⁶ the *Annals of the Association of American Geographers (AAAG)*, *International Journal of Geographical Information Science (IJGIS)*, *Cartography and Geographic Information Science (CGIS)*, and *Cartographic Journal (CJ)* were chosen based on the above criteria. Exclusions in the choice of source journals were inevitable in the scope of the present analysis. While both remote sensing and engineering of GIS systems are critical to the GIS endeavor, journals focused primarily on those topics were excluded for this analysis. Two titles that were considered and then excluded were *Cartographica* and *Transactions in GIS*. *Transactions in GIS* was excluded because it lacked a professional association affiliation and Journal Impact Factor at the time of analysis, while *Cartographica* was excluded because of its very small circulation (433 according to *Magazines for Libraries*)²⁷ and a lack of Journal Impact Factor. In the Results section, both of these journals are represented as influence Zone 1, indicating that their exclusion as source journals did not adversely affect their standing, though it may have affected the position within the zone rankings.

Data Collection

Using the source journals, the sample comprised all articles published in a three-year period (2008 through 2010) excluding editorials and book reviews. The references for the study articles were downloaded from the Thompson Reuters *Science Citation Index*, *Social Sciences Citation Index*, and Elsevier *Scopus* and then entered into a Microsoft Excel spreadsheet for the first stage of analysis. Each entry contained the source journal title, source article title, source article author, and source article publication year. Each cited reference was then associated with a source article, cited author, title, volume, issue, and year of publication where appropriate. The published reference list of each source article was used to verify each of the citations listed in the resulting database.

Format types were assigned to each citation according to its publication type in the electronic version of *Ulrich's Periodicals Directory*:²⁸ journal (scholarly journal), book (monograph), proceeding, and other (including Internet sources, software programs, government documents, unknown). *Ulrich's Periodical Directory* was chosen as a valid, repeatable, and independent determiner for assigning the format of "journal" or "book" to a title and to verify journal title changes. All previous titles were listed under the current title when possible. Some exceptions are noted in the Discussion section of the study. The resulting information was tabulated in a Microsoft Access database so that queries by format type, source journal, and publication date could be analyzed. The dataset was examined to determine how many citations of each format were found for each source journal. Percentages were calculated to illustrate how much of the citation activity was attributed to journals, as journals were the primary focus of the study.

Bradford's Law

Bradford's Law of Scattering was then applied to the resulting data from the source journals. Bradford's Law states that, when you divide the total number of citations in a list of literature by three, the top third of the accumulated citations constitute the most influential journals in the field; the second group constitutes the broader influence in the field. This influence drops considerably with the third grouping of citations, which made up the majority of the database.²⁹ For this study, the total number of citations ($n=12,081$) was divided into thirds. Then, journals were listed in descending order by total number of citations. Using a cumulative count of the number of citations, when the number of citations reached one third of the total, the cluster for Zone 1 was drawn. When the count was made with the remaining journals and again reached one third of the total, this cluster was labeled Zone 2. The remainder of the list was clustered into

Zone 3. When Zone 1 was divided from Zone 2, the difference in the numbers of citations on each side of the zone was very distinctive. Zone 1 contained journals with a minimum of seventy-seven citations and Zone 2 a maximum of sixty-eight citations. However, the division between Zone 2 and Zone 3 was less distinct. The Zone 3 grouping occurred in the middle of the list of journals all with nine citations. The journals having been listed alphabetically within their citation counts, all journals cited nine or fewer times were reassigned to Zone 3.

The journals in Zones 1 and 2 were examined for indexing coverage using the bibliographic databases *Social Sciences Citation Index (SSCI)*, *Science Citation Index Expanded (SCIE)*, *GEOBASE*, *GeoRef*, and *Scopus*. *Scopus* is a citation indexing tool similar to *Science* and *Social Science Citation Index* is a multidisciplinary indexing source. *GEOBASE* was chosen for its concentration on Geographic literature and *GeoRef* as a complement to physical geography coverage. Using the protocol method provided by Delwiche, Schloman, and Allen,³⁰ each journal was searched in the indexing source to identify the total number of entries for the three years of the study. The largest number of entries for each title was determined to be the 100 percent coverage level and assigned a score of five. The remainders were compared against it using the percentage method and assigned a coverage score based on the point system below:

- 5 point= 95–100% coverage
- 4 points= 75–94% coverage
- 3 points= 50–74% coverage
- 2 points= 25–49% coverage
- 1 point= 1–24% coverage
- 0 point= <1% coverage

(Delwiche, Schloman, and Allen, *Mapping the Literature of Allied Health: Project Protocol*, 21)³¹

Results

A total of 12,081 citations in 486 articles were published during the study period 2008–2010. The results of the format assignments for citations in each of the source journals are listed in table 2. The data give an indication of the level of citation activity in the source journals for each format type. It also shows the variety of citations per journal and the variety of citation activity (number of citations) per journal. The citations were also divided based on year of publication to examine the currency of each citation format. The *Annals of the Association of American Geographers (AAAG)* and *International Journal of Geographical Information Science (IJGIS)* by far contributed the most journal articles to this dataset, AAAG being the largest contributor at 5,987 journal articles and IJGIS contributing 4,390. Together they represent more than double the number of journal articles in either of the remaining journals. These two journals also contributed the largest number of citations to the overall database by more than half. The average number of citations

TABLE 2
Format Types by Source Journal and Citation Frequency

Cited Format Type	Number of Citations in Source Journals									
	AAAG		IJGIS		CGISC		CJ		Totals	
	No.	%	No.	%	No.	%	No.	%	No.	%
Journal Articles	5,987	47.2%	4,390	52.3%	1,191	50.9%	513	31.6%	12,081	48.2%
Books	4,246	33.4%	1,870	22.3%	510	21.8%	627	38.7%	7,253	28.9%
Other	2,346	18.5%	1,312	15.6%	468	20.0%	361	22.3%	4,487	17.9%
Proceedings	118	0.9%	827	9.8%	170	7.3%	121	7.5%	1,236	4.9%
Total	12,697	100.0%	8,399	100.0%	2,339	100.0%	1,622	100.0%	25,057	100.0%

per article differs by journal, showing that *AAAG* had an average of thirty-six citations per article ($n=163$ articles), while *IJGIS* had an average of twenty citations per article ($n=213$ articles). *Cartography and Geographic Information Science (CAGIS)* had nineteen citations per article ($n=62$ articles), and *Cartographic Journal (CJ)* had an average of ten citations per article ($n=48$ articles). Overall, the average number of citations per article was twenty-four.

Except in *CJ*, journal articles comprised nearly half of the citations in the source articles. Journal articles comprised one third of the citations in *CJ*, with another third composed of books. Books constituted 28 percent of the total citations compared to the 48 percent for journal articles and 17 and 4 percent for other and proceedings formats respectively. Making up a third of the citations, books constituted a significant part of the cited literature in the study and are indicating a significant component in GIS research. Conference proceedings were also a significant portion. Many conferences could have been examined on their own for levels of influence in the profession as several of them made multiple appearances (such as AutoCarto).

The age of citations is always a topic of discussion in citation analysis, especially regarding the half-life³² of book, journal use, and impact.³³ As seen in table 3, over

50 percent of the journal articles in the dataset were published between 2001 and 2011, 30 percent from 1991 to 2000, and the remainder distributed through the remaining years examined. For books, 40 percent of the citations were from 2001 to 2011 and a third from 1991 to 2000. Current literature from both books and journals are the primary citations for the studied literature. The remaining formats, "other" and "proceedings," exhibited over 50 percent representation in 2001–2011. Conferences are often a source of new developments in the field, especially with applied tools such as GIS. Websites and trade journals may also be more impactful in recent years detailing newer procedures and activity. Overall, the most recent two decades comprise more than 90 percent of the total citations. This lends to support the half-life theory of currency as a large measure of usefulness for the studied literature. GIS is also a relatively new discipline, and this fact has no doubt contributed to the currency represented in the citations.

The division of journals into three influence zones based on Bradford's Law of Scattering is displayed in table 4. Zone 1 contains twenty-three journals, or 1 percent of the cited journals. The second Zone comprises only 10 percent of the cited journals and 190 moderate influence journals. The last influence zone,

TABLE 3
Cited Format Types by Publication Year Periods

Publication Year (Range)	Cited Format Type								
	Journal Articles		Books		Other		Proceedings		Total
	No.	%	No.	%	No.	%	No.	%	
2001–2010*	6,644	55.0%	2,896	39.9%	2,876	64.1%	747	60.4%	13,163
1991–2000	3,734	30.9%	2,579	35.6%	962	21.4%	362	29.3%	7,637
1981–1990	886	7.3%	911	12.6%	228	5.1%	90	7.3%	2,115
1971–1980	420	3.5%	424	5.8%	116	2.6%	12	1.0%	972
pre-1971	397	3.3%	443	6.1%	239	5.3%	25	2.0%	1,104
unknown	0	0.0%	0	0.0%	66	1.5%	0	0.0%	66
	12,081	100.0%	7,253	100.0%	4,487	100.0%	1,236	100.0%	25,057

TABLE 4
Distribution by Influence Zone of Cited Journals and References

Zone	Cited Journals		Cited Journal References		
	No.	%	No.	%	Cumulative Total
1	23	1.1%	4,027	33.3%	4,027
2	190	9.1%	4,028	33.3%	8,030
3	1,857	89.7%	4,051	33.5%	12,081
Total	2,070	99.9%^a	12,106	100.0%	
a. Totals may not add to 100 due to rounding.					

Zone 3, contained 1,857 cited journals. These comprised 89 percent of the cited journals. These results are consistent with the numbers for other core literature studies using this protocol³⁴ where similar percentages of journals make up the three influence zones. Of the journals in Zone 1, fifteen titles were found with more than 100 citations. These include major titles in geography, remote sensing, computer systems and GIS, cartography,

The journals in Zone 1 and Zone 2 are listed in table 5 with their relevant indexing coverage. Indexing coverage was determined using Delwiche, Schloman and Allen's methodology.³⁵ *Scopus*, *GEOBASE*, *Science Citation Index Expanded (SCIE)*, and *Social Science Citation Index (SSCI)* provided the most complete coverage of the source journals, with both high average and cumulative indexing scores. This is not surprising, since *Scopus* and the *SSCI/SCIE* seek to provide broad subject as well as scholarly coverage. These provide the bulk of the indexing coverage for Zone 1 titles. Surprisingly, *GeoRef* provided less indexing coverage than was expected based on the perceived applied uses for GIS in earth sciences. It may be that the methodology (number of citations in the index based on the study timeline) did not indicate as much use as was expected. *GEOBASE* provided good indexing coverage in Zone 1 titles on par with *SSCI/SCIE* and *Scopus*. Zone 2 titles had less indexing coverage overall, but especially from *GEOBASE*, perhaps

due to the interdisciplinarity of the titles from outside the geography scope. *Scopus* maintained coverage throughout the listing and seems to cover with more consistency even than *SSCI/SCIE*.

Discussion

Many of the core journals listed in Zone 1 of this study have also appeared in other core journal lists providing validation for the first zone of influence. Four of these, *Transactions of the Institute of British Geographers*, *Progress in Human Geography*, *Geographical Analysis*, and *Environment and Planning A*, were noted as containing "classics in geography" by Wrigley and Matthews.³⁶ Robinson and Poston³⁷ also identified important titles: *AAAG*, *Applied Geography*, *Cartographic Journal*, *Economic Geography*, and *Geographical Analysis*, which appear in Zone 1, except for *Economic Geography*, which is near the top of Zone 2. From Gattrell and Smith, seven of their selections appear in Zone 1, including: *AAAG*, *Antipode*, *Environment and Planning A*, *Geoforum*, *Geographical Analysis*, *Professional Geographer*, and *Transactions of the Institute of British Geographers*.

In the final ranking of GIScience journals by Caron et al.,³⁸ sixteen titles are listed in Zone 1 and eleven of the journals are listed in Zone 2. His final rankings contain more international titles and remote sensing titles than this study. This study specifically excluded remote sensing titles as source journals in favor of the more

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>International Journal of Geographical Information Science</i>	838	4	0	4	5	5
<i>Annals of the Association of American Geographers</i>	458	3	0	3	0	5
<i>Cartography and Geographic Information Science</i>	262	4	0	5	0	4
<i>Environment and Planning A</i>	216	4	0	4	0	5
<i>Computers Environment and Urban Systems</i>	162	4	0	5	0	5
<i>Photogrammetric Engineering and Remote Sensing</i>	162	4	0	4	5	1
<i>Geographical Analysis</i>	161	4	1	4	0	5
<i>Cartographica</i>	144	4	0	5	0	1
<i>Transactions in GIS</i>	141	4	0	5	0	3
<i>Progress in Human Geography</i>	139	2	0	2	0	5
<i>Professional Geographer</i>	136	2	1	2	5	0
<i>Science</i>	129	3	0	4	5	1
<i>Environment and Planning B</i>	126	3	0	3	0	5
<i>Computers and Geosciences</i>	113	5	0	5	0	0
<i>Political Geography</i>	112	3	0	4	0	5
<i>Environment and Planning D</i>	101	3	0	4	0	1
<i>International Journal of Remote Sensing</i>	97	4	1	5	5	1
<i>Cartographic Journal</i>	94	3	0	4	0	5
<i>Geoinformatica</i>	87	4	0	5	5	1
<i>Institute of the British Geographers Transactions</i>	86	4	0	5	0	5
<i>Nature</i>	81	3	1	4	1	5

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>Antipode</i>	80	4	0	4	0	5
<i>Geoforum</i>	77	4	0	5	0	5
<i>Total Indexing Coverage for Zone 1</i>		83	1	95	31	80
<i>Average Score</i>		3.6	0.04	4.1	1.3	3.4
ZONE 2						
<i>Water Resources Research</i>	68	4	3	4	5	0
<i>Journal of Geographical Systems</i>	66	4	0	5	0	4
<i>Journal of Hydrology</i>	66	4	4	5	5	0
<i>Ecological Modeling</i>	65	0	5	5	1	4
<i>Economic Geography</i>	65	0	3	0	5	3
<i>Remote Sensing of Environment</i>	63	5	1	5	5	1
<i>Geomorphology</i>	61	5	4	5	5	0
<i>World Development</i>	60	5	0	5	5	0
<i>Geographical Review</i>	59	3	0	3	0	5
<i>Landscape Ecology</i>	58	5	0	5	5	1
<i>Urban Studies</i>	57	3	0	3	0	5
<i>Journal of Climate</i>	56	4	1	5	5	0
<i>IEEE Transactions on Visualization and Computer Graphics</i>	52	0	0	5	5	1
<i>URISA Journal</i>	51	0	0	5	0	0
<i>Urban Geography</i>	50	3	0	4	0	5
<i>Climatic Change</i>	46	2	1	5	5	1
<i>Landscape and Urban Planning</i>	46	4	0	5	5	5
<i>Hydrological Processes</i>	45	4	3	5	5	0
<i>Conservation Biology</i>	41	4	0	5	5	1
<i>Geoderma</i>	40	5	4	5	5	0
<i>Statistics in Medicine</i>	39	0	0	5	5	1

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Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>International Journal of Health Geographics</i>	37	4	0	5	0	5
<i>Social Science and Medicine</i>	36	4	0	5	0	0
<i>Area</i>	35	3	0	3	0	5
<i>Global Environmental Change</i>	35	4	0	5	5	5
<i>Agriculture Ecosystems and Environment</i>	34	5	0	5	5	1
<i>Human Ecology</i>	34	3	0	4	0	5
<i>Papers in Regional Science</i>	34	3	0	3	0	5
<i>Monthly Weather Review</i>	31	4	0	5	2	5
<i>Social & Cultural Geography</i>	31	3	0	3	0	1
<i>American Planning Association Journal</i>	30	2	2	0	5	5
<i>American Statistical Association Journal</i>	30	0	0	5	5	1
<i>Ecology</i>	30	4	0	5	5	1
<i>Geopolitics</i>	30	4	0	4	0	5
<i>International Journal of Urban and Regional Research</i>	30	3	0	3	0	5
<i>Geographical Journal</i>	29	5	2	2	0	5
<i>Information Visualization</i>	28	0	2	0	5	2
<i>Biosciences</i>	26	0	4	5	1	0
<i>Geografiska Annaler B</i>	26	0	0	0	0	0
<i>Geojournal</i>	26	0	3	5	5	3
<i>Geophysical Research Letters</i>	26	0	5	0	0	3
<i>ISPRS Journal of Photogrammetry and Remote Sensing</i>	26	2	5	5	0	4
<i>Society and Natural Resources</i>	26	0	0	5	0	4

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>Environmental Management</i>	25	0	4	5	5	4
<i>Geological Society of America Bulletin</i>	25	0	5	4	2	0
<i>International Journal of Human Computer Studies</i>	25	0	5	5	0	4
<i>Journal of Biogeography</i>	25	4	0	5	5	0
<i>Mathematical Geosciences</i>	25	4	1	3	5	0
<i>Parallel Computing</i>	25	0	0	2	5	1
<i>Quaternary Research</i>	25	5	5	5	5	1
<i>Ecological Applications</i>	24	4	0	5	5	1
<i>Emerging Infectious Diseases</i>	24	0	0	5	5	0
<i>IEEE Transactions on Pattern Analysis and Machine Intelligence</i>	24	0	0	5	5	1
<i>International Journal of Climatology</i>	24	5	1	5	5	0
<i>Progress in Physical Geography</i>	24	4	5	5	5	0
<i>Earth Surface Processes and Landforms</i>	23	4	0	5	0	0
<i>Environmental Modeling and Software</i>	23	4	0	5	5	0
<i>Cartographic Perspectives</i>	22	4	0	5	0	0
<i>Ecological Economics</i>	22	0	3	0	5	4
<i>IEEE Transactions on Geoscience and Remote Sensing</i>	22	3	1	5	5	0
<i>Journal of Geography</i>	22	3	0	3	0	5
<i>Soil Science Society of America Journal</i>	22	5	1	5	5	0
<i>American Journal of Public Health</i>	21	0	0	5	5	5

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>American Meteorological Society Bulletin</i>	21	0	1	3	5	1
<i>Computers & Operations Research</i>	21	0	0	5	5	1
<i>European Journal of Operational Research</i>	21	0	0	5	5	2
<i>Journal of Applied Meteorology and Climatology</i>	21	4	0	4	5	0
<i>Journal of Environmental Management</i>	21	4	0	5	5	1
<i>Journal of Geophysical Research</i>	20	3	2	4	5	1
<i>Spatial Cognition and Computation</i>	20	0	0	2	0	5
<i>American Economic Review</i>	19	0	0	5	0	4
<i>Cultural Geographies</i>	19	2	0	2	0	5
<i>Gender Place and Culture</i>	19	3	0	3	0	5
<i>Graphical Models</i>	19	4	0	5	5	0
<i>IEEE Transactions on Knowledge and Data Engineering</i>	19	0	0	5	5	1
<i>Journal of Economic Geography</i>	19	3	0	3	0	5
<i>Regional Studies</i>	19	4	0	4	0	5
<i>American Journal of Sociology</i>	18	0	0	1	0	5
<i>American Sociological Review</i>	18	5	0	5	0	5
<i>Atmospheric Environment</i>	18	5	0	5	5	0
<i>Biological Conservation</i>	18	5	0	5	5	0
<i>Canadian Geographer</i>	18	3	0	3	0	5
<i>Journal of Historical Geography</i>	18	2	0	2	0	5

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>ACME: An International E-Journal for Critical Geographies</i>	17	0	0	5	0	0
<i>Ambio</i>	17	4	1	5	4	1
<i>American Journal of Epidemiology</i>	17	2	0	2	5	1
<i>Annual Review of Environment and Resources</i>	17	0	1	5	5	5
<i>Annual Review of Sociology</i>	17	0	0	5	0	5
<i>Artificial Intelligence</i>	17	0	0	5	5	1
<i>Concurrency and Computation Practice and Experience</i>	17	0	0	5	0	0
<i>Geology</i>	17	4	0	5	5	0
<i>ACM Computing Surveys</i>	16	0	0	5	5	0
<i>Annals of Regional Science</i>	16	3	0	5	0	3
<i>Canadian Journal of Forest Research</i>	16	5	0	5	5	1
<i>Cognitive Science</i>	16	0	0	4	0	5
<i>Development and Change</i>	16	2	0	2	0	5
<i>Global Ecology and Biogeography</i>	16	5	0	5	5	0
<i>Information Sciences</i>	16	0	0	5	5	1
<i>International Journal of Applied Earth Observation and Geoinformation</i>	16	4	0	4	5	1
<i>Journal of Transport Geography</i>	16	4	0	4	0	5
<i>Royal Statistical Society Journal A</i>	16	0	0	2	5	5
<i>Social Forces</i>	16	0	0	3	0	5
<i>Tijdschrift voor Economische en Sociale Geografie</i>	16	0	0	3	0	5

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>Climate Research</i>	15	4	0	4	5	1
<i>Ecology and Society</i>	15	4	0	5	5	3
<i>Forest Ecology and Management</i>	15	4	0	5	5	1
<i>Fuzzy Sets and Systems</i>	15	0	0	5	5	1
<i>Health and Place</i>	15	5	0	5	0	0
<i>Journal of Coastal Research</i>	15	2	1	2	5	1
<i>Operations Research</i>	15	0	0	5	5	4
<i>AIDS Care</i>	14	4	0	4	0	5
<i>Applied Geography</i>	14	0	0	5	0	5
<i>Cognitive Psychology</i>	14	5	0	5	0	5
<i>Environmental Health Perspectives</i>	14	0	0	5	5	5
<i>Geografiska Annaler A</i>	14	0	0	4	5	1
<i>Geography Compass</i>	14	4	4	5	5	1
<i>IEEE Transactions on Systems Man and Cybernetics</i>	14	5	0	5	0	0
<i>Journal of Urban Affairs</i>	13	0	0	5	5	1
<i>ACM Transactions on Graphics</i>	13	2	0	3	0	5
<i>Biometrika</i>	13	0	0	5	5	1
<i>Catena</i>	13	0	0	5	5	1
<i>D Lib Magazine</i>	13	3	5	5	5	1
<i>Demography</i>	13	0	0	5	0	0
<i>Economic and Political Weekly</i>	13	0	0	5	0	0
<i>Eurasian Geography and Economics</i>	13	5	0	4	0	5
<i>Historical Geography</i>	13	5	0	5	0	0
<i>Journal of Visual Languages and Computing</i>	13	0	0	5	5	1

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>Management Science</i>	13	0	0	4	5	5
<i>Numerische Mathematik</i>	13	0	0	5	5	0
<i>Population, Space and Place</i>	13	4	0	4	0	5
<i>Sociologia Ruralis</i>	13	4	0	5	0	5
<i>Epidemiology</i>	12	0	0	1	5	1
<i>International Regional Science Review</i>	12	5	0	5	0	5
<i>Pattern Recognition</i>	12	0	0	5	5	0
<i>Risk Analysis</i>	12	4	0	5	5	5
<i>Social Science Quarterly</i>	12	0	0	5	0	5
<i>Surveying and Land Information Science</i>	12	4	0	5	0	0
<i>Theory Culture and Society</i>	12	0	0	5	0	0
<i>Third World Quarterly</i>	12	5	0	5	0	5
<i>Transportation</i>	12	4	0	5	5	5
<i>Transportation Research A</i>	12	5	0	5	5	5
<i>Accident Analysis and Prevention</i>	11	0	0	5	0	5
<i>Algorithmica</i>	11	0	0	5	4	1
<i>Annals of Mathematics and Artificial Intelligence</i>	11	0	0	5	5	1
<i>Biometrics</i>	11	4	0	5	5	1
<i>Computational Statistics & Data Analysis</i>	11	0	0	5	5	0
<i>Ecosystems</i>	11	5	0	5	5	1
<i>Environmental Conservation</i>	11	4	0	5	5	1
<i>Environmental Science and Policy</i>	11	0	0	5	5	2
<i>GIScience and Remote Sensing</i>	11	5	5	5	0	0
<i>Global Biogeochemical Cycles</i>	11	4	2	4	5	0

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>International Migration Review</i>	11	2	0	2	0	5
<i>Journal of Conflict Resolution</i>	11	0	0	5	0	5
<i>Journal of Geophysical Research Atmospheres*</i> (Georef includes all parts)	11	4	5*	1	0	0
<i>Journal of Peace Research</i>	11	0	0	2	0	5
<i>Journal of Soil & Water Conservation</i>	11	4	0	5	5	1
<i>Lancet</i>	11	0	0	5	5	2
<i>Psychological Review</i>	11	0	0	5	5	5
<i>Review of African Political Economy</i>	11	4	0	5	0	5
<i>Royal Statistical Society Journal B</i>	11	0	0	4	5	1
<i>Stochastic Environmental Research and Risk Assessment</i>	11	5	1	5	5	1
<i>Transportation Research B</i>	11	4	0	5	5	5
<i>Transportation Research C</i>	11	4	0	5	4	2
<i>Urban Affairs Review</i>	11	3	0	3	0	5
<i>Agricultural and Forest Meteorology</i>	10	4	0	5	5	1
<i>Annals of Operations Research</i>	10	0	0	5	4	2
<i>Annual Review of Anthropology</i>	10	5	0	5	0	5
<i>Boundary Layer Meteorology</i>	10	5	0	5	5	0
<i>British Medical Journal</i>	10	0	0	0	5	1
<i>Climate Dynamics</i>	10	5	1	5	5	0
<i>Computer Graphics Forum</i>	10	0	0	5	5	0
<i>Computer Journal</i>	10	0	0	5	5	1

TABLE 5
Distribution and Indexing of Coverage 2008–2010 of Cited Journals
in Zones 1 and 2^a

Cited Journal	# of Citations	GEOBASE	GeoRef	Scopus	Science Citation Index Expanded	Social Science Citation Index
ZONE 1						
<i>Computers and Graphics</i>	10	0	0	5	5	1
<i>Environment and Behavior</i>	10	4	0	4	0	5
<i>Estuarine Coastal and Shelf Science</i>	10	5	0	5	5	0
<i>Hydrology and Earth System Sciences</i>	10	4	1	5	5	1
<i>Journal of Political Economy</i>	10	5	0	5	0	5
<i>Journal of Rural Studies</i>	10	3	0	4	0	5
<i>Journal of Wildlife Management</i>	10	4	0	5	5	1
<i>Land Economics</i>	10	4	0	5	0	5
<i>Natural Hazards</i>	10	4	1	5	5	1
<i>Pattern Recognition Letters</i>	10	0	0	5	5	0
<i>Physical Geography</i>	10	2	1	5	2	1
<i>Population Research and Policy Review</i>	10	4	0	5	0	5
<i>Public Administration Review</i>	10	0	0	3	0	5
<i>Quarterly Journal of Engineering Geology and Hydrogeology</i>	10	4	4	5	5	1
<i>Quaternary Science Reviews</i>	10	4	2	5	5	1
<i>Technometrics</i>	10	0	0	5	5	0
<i>Transportation Research Record</i>	10	0	0	5	5	2
<i>Water International</i>	10	0	1	5	5	1
<i>Total Indexing Coverage for Zone 2</i>		443	113	805	559	432
<i>Average Score</i>		2.33	0.59	4.23	2.94	2.27

a. Adapted from Burtis and Taylor, Mapping the Literature of Health Education: 2006-2008, 210.

general GIS titles, while remote sensing remained an important part of the Caron et al. listings. Caron et al. also focused on international coverage, while the study discussed here focused only on English language titles. Sixteen of the titles ranked by the Caron et al. study are not included in this study's Zone 1 or Zone 2 rankings. These variations could be due to the methodologies employed. The Delphi method was a series of rankings based on perceived prestige and Journal Impact Factor rankings. Second, *Journal Citation Reports* does not index all of the journals listed in Zones 1 and 2. This would specifically exclude them from the Caron et al. rankings. Third, quite a few of the titles noted by Caron et al. are foreign language publications, which could limit their accessibility for North American and British researchers.

The results of this citation analysis can be applied in academic libraries as noted in other core journal studies.³⁹ They can be used as a core journal list by which to measure journal coverage of a discipline by a library. Determining a usable core list of GIS journals is a difficult endeavor and depends heavily on intended purpose of the final list. Several of the studies cited above corroborate the significance of journals selected in Zone 1 to the field of GIS. These journals represent the most reliable finding of the study and can be used as a strong measure of core literature. Since the purpose of this research was to support academic librarians and their efforts to provide collection and research support, librarians can be fairly confident in using the core journal lists as a benchmark for their own collections. The journals in Zone 2 present a moderate influence in the field based on Bradford's Law of Scattering and a corresponding moderate corroboration in other similar research. The journals in this secondary list provide a supplement to a GIS core journal collection. A secondary journal list can be used to build the interdisciplinarity of a GIS journal collection at an institution.

Core journal lists can also be used to measure the influence of journals where

faculty have published and to identify influential journals where they could potentially publish. Paynter⁴⁰ has noted that supporting faculty research using core lists and impact factors is an important role for librarians. Librarians can provide core journal lists with several metrics to faculty who are expected to publish so that they can indicate the value of their work. While Impact Factors are an important metric, GIS is an interdisciplinary field, and interdisciplinary lists may be more difficult to identify for faculty.⁴¹ The subject categories used by the Journal Citation Reports Impact Factors do not provide a category that cleanly represents GIS. Because it is so interdisciplinary, journals may fall into several categories that are more difficult to identify in the rankings. Librarians who work with faculty who need to publish can point them to Zone 1 and Zone 2 journal listings as a metric for their publications and for publishing opportunities.

A multitiered core journal list can be used to identify related disciplines and applied areas for GIS. Both traditional and related areas of geography are represented in the study results including remote sensing, computer science, computer engineering, applied geography, physical and human geography, as well as related fields such as psychology. The titles in Zone 2 can help fill in less popular or lesser known titles and supplement a journal collection in GIS. This is often the most difficult part of collections as noted in Corby (2003).⁴² The Zone 2 titles trail off considerably from most to least cited. A variety of disciplines is represented throughout Zone 2 and it seems to expand beyond Geography the further down the list it goes. Depending on the reach of GIS into other disciplines at a particular institution, librarians may use that variety to build the case for promotion of GIS into other disciplines as both a research area and as an applied tool. At my own institution, I have used such a list to work with the Health Sciences librarian to locate a variety of journals related to

health informatics and health geography publications. As the Public Health College on campus becomes more interested in GIS, their interest has reflected back to the GIS professionals on campus. While it was not originally one of the concentrations of the Geography department, they have also become more interested as a result of their colleagues on campus. Now these journals can support several groups of researchers with similar interests. Other GIS librarians might use this example to expand or market services to researchers, providing examples of applied research from the journals noted in those fields.

The characteristics of the source journals studied here can also be extrapolated to some extent to the researchers themselves. The authors in the journals studied tend to use literature (both book and journal literature) published in the last ten years, indicating a preference for recent information. Whether this is because GIS is technology based and researchers are closely watching new developments in their field, or just that technology moves so quickly that it begs discussion, is not clear. GIS researchers also use journal literature more than any other format, closely followed by books. Journals are clearly an important source for GIS researchers, and the collection development implications should be closely monitored. Librarians can use this information when making weeding issues or when deciding what materials should be kept in close reach on campus and which might be candidates for storage or off-campus relocations. Other decisions such as funding issues between serial and monographic collections can also be examined by looking at the characteristics of the literature the authors cite. These authors are continuing to use both books and journal articles rather evenly, while other disciplines may move in one direction or the other. Using this information, librarians may be less likely to generalize GIS researchers with other disciplines who have changed this type of literature usage.

Using the study results related to indexing, librarians can have a better idea of which databases are best at discovering the core journals in GIS. Traditional subject-based databases are not necessarily the only products covering the interdisciplinarity of the field. *GEOBASE* is not the only strong indexer of this literature. Librarians should be aware of this when directing GIS-focused researchers. They would be wise to direct them to *Scopus* and the *SSCI/SCIE* for comprehensive literature coverage as well as traditional sources. Especially in the case of Zone 2 titles, the aggregate indexing sources *Scopus* and *SSCI/SCIE* are more useful to researchers. Undergraduate students, who are less likely to be familiar with peripheral databases, or those in subject areas other than their own, may not realize that GIS is covered in many other places. They would also benefit from the broad coverage of *Scopus* and *SSCI/SCIE* for both technique and application resources in GIS.

Careful citation analysis with both sampling and nonsampling methodologies can bring into focus the literature used by scholars, providing librarians and researchers with insight into the information usage patterns in a discipline. While the information can be parsed into the many variables described above, it is the goal of this study to determine a ranked list of influential journals for the academic GIS discipline. These findings contribute to the body of knowledge that informs what literature is important to the growing discipline and provides librarians with behavioral data about GIS researchers and their literature needs.

Limitations of Study

There were several challenges to compiling the data for this study. Unknown citations, incomplete information in the citation databases used to download references, foreign language titles, theme journal issues, and the selection of core journals could possibly contribute to different results. While the Thompson

Reuters *SSIE/SSCI* are extensive databases of knowledge for analysis, the data presented several challenges for this study. Many nonjournal citations were excluded from the data, and many citations were misattributed in both the author and title fields in the *SSIE/SSCI*. The published manuscript was used to verify a complete citation list for each article, but this also created some problems. The authors of the journal articles also misattributed sources in their bibliographies and reference lists. If the information provided by the source author was not sufficient to verify a citation and assign it to a unique journal title, the citations were assigned an "other" format. Some foreign language titles were also difficult to locate in the *Ulrich's Periodical Directory* using either the title or the ISBN number or because the author chose to use a romanized title. A translated or romanized title was not always the formal name of the non-English language journal. Journals with common titles were investigated to confirm that the assigned article was attributed to the correct journal, as many journals share similar titles. Again, if this was not verifiable, the title was assigned to the "other" format.

A second data challenge was a theme issue in *AAAG* that examined the coverage of core topics over the course of the journal's history (Volume 100, Issue 5, 2010 Centennial Issue). These articles specifically examined other articles from the *AAAG* and traced all of the articles on a specific topic over the course of the journal's publications. Consequently, these articles often cited over 100 articles in the review, increasing the self-citation of *AAAG*. Many journals compile theme issues throughout publication; while one theme issue in a three-year span might not skew the data, in this case, the sheer volume of self-citations was determined to be a significant variable in the analysis. Therefore, all statistics and counts were calculated without the theme issue data. While the source journals are well represented, any study of this type could

find that self-citation could influence the results.

Two of the journals excluded from this study were represented highly in Zone 1. These exclusions are a potential limitation; but their positions in the final ranking (*Cartographica* and *Transactions* occupy positions 8 and 9 respectively in the descending list of total citations) affirm their influential role in the discipline. In a follow-up study, *Transactions* would be included as a source journal as it was recently added to the *Journal Citation Reports*. Other limitations are the cited journals themselves. Many of them have changed titles and split titles over the course of publication. If possible, these were collated under the current title name. For others, where the reference was made to the previous title, which was split into more than one journal, determining the final journal attribution was difficult. In the case in which the current title could not be determined, the citation was listed under the older title. The result was that some journals are represented in the zone listings multiple times under different iterations of the title name (*Journal of Geophysical Research*; *IEEE Transactions on Systems Man and Cybernetics* are examples). This does skew the zone listing, but attributing the citations to newer titles that may or may not have been the destination journal when the article was written seemed like a less subjective research decision.

Another limitation was the split between Zones 2 and 3. The calculated one third number of cumulative citations occurred between the lists of journals with the same number of citations. In the list, Zone 2 divided the group of journals cited nine times. Zone 2 was moved up to incorporate only the journals with ten citations. Another researcher may have included all nine citation titles and therefore changed the makeup of the zone. As these journals make up the end of a last zone, the listing seemed less compromised by moving the zone up instead of down.

Conclusion

The importance of this study can be found in the Zone 1 journal listings. These twenty-three journals represent significant bodies of literature influential in the GIS disciplines. Librarians can use this list to cross-check their literature support for GIS in the variety of subject areas around a campus and as a core title list when building a collection. The rate of use for older journal literature, particularly in these influential journals, can influence decisions for retention, relocation, and back-file purchases to support GIS researchers. Collaboration in collection development is a must in a discipline with such breadth and reach. Creating a core list of journals for an emerging discipline, or one that crosses many disciplinary lines can be a great asset for librarians especially as they focus on user behavior to tailor services and instruction. Indexing and abstracting tools are another area of collection development that is always under review and another area for collaboration. Using the levels of coverage for Zone 1 and Zone 2 journals, a librarian can identify the best tools to either purchase or point to when GIS researchers are looking for journal literature.

While several other core lists, *Magazines for Libraries* and the Caron et al. Delphi study provide additional lists, this study provides one based on citation data from core journals in the field. The Zone 2 listings are particularly important at the top of the list and reflect current trends in the application of GIS as well as its directions. Using this list, and referring to an institution's research areas, GIS can be more supported in the academic library. Librarians try to choose the best research for their patrons and often make those decisions based on journal package deals as well as recommendations from faculty. It is important to provide data to back up those decisions when approaching budget officers and selection managers for purchasing and deaccessioning. These data can supplement researchers' recommendations and provide a solid basis for consideration. Future researchers could repeat this study using additional source journals and compare the results to those in this study to check for self-citation bias and new areas of research. Examining changing formats and especially the use of eBooks as well as the influence of specific conference proceedings as scenes of innovation are insights that could inform the literature.

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