wikiSearch – From Access to Use

Elaine G. Toms, Lori McCay-Peet, and R. Tayze Mackenzie

Centre for Management Informatics
Dalhousie University
6100 University Ave
Halifax, Nova Scotia, Canada
etoms@dal.ca, mccay@dal.ca, mackenziert@dal.ca

Abstract. A digital library (DL) facilitates a search workflow process. Yet many DLs hide much of the user activity involved in the process from the user. In this research we developed an interface, wikiSearch, to support that process. This interface flattened the typical multi-page implementation into a single layer that provided multiple memory aids. The interface was tested by 96 people who used the system in a laboratory to resolve multiple tasks. Assessment was through use, usability testing and closed and open perception questions. In general participants found that the interface enabled them to stay on track with their task providing a bird's eye view of the events – queries entered, pages viewed, and pertinent pages identified.

Keywords: Digital libraries; user interface; information task; search; BookBag; interactivity tools; search workflow.

1 Introduction

The design of interfaces to digital libraries (DLs) is strongly embedded in information retrieval (IR) traditions. Like the early IR systems, the first generation of DLs provided a simple search box to receive user queries, and had more limited functionality than a 1970s command-driven search system; help was nonexistent, and any special features (e.g., syntax) were hidden from the user. Systems resources were focused on extracting documents from huge repositories.

But DLs support a larger task – a work process – that may have multiple interrelated sub-tasks. For a student, that larger task may be writing a term paper for a course. For the shopper, this may mean understanding the nuances of mp3 players and comparing possible options to make a purchase. For the citizen, it may be separating fact from fiction during elections in order to decide how to vote. Rarely has the full spectrum of tasks been delineated such that the work flow and the information flow(s) within the larger work task are operationalized, and systems constructed to support the entire process (although efforts are emerging, [e.g., 3, 17]). Regardless of the type of work task or domain, multiple information sub-tasks are invoked during that workflow process to extract and manipulate the raw material required to complete that work task. In this research, we focused specifically on one aspect of that workflow, articulating how one type of information task – search – may be integrated into the workflow. We describe our design and its subsequent evaluation.

M. Agosti et al. (Eds.): ECDL 2009, LNCS 5714, pp. 27–38, 2009.

2 Previous Work

Embedding search within applications has been widely promoted [5, 10, 17]. But the research underlying support for users of DLs and the design of that support is founded partially in information seeking and retrieval (IS&R) research, partially in human computer interaction (HCI), and partially in the application domain.

While the stand-alone DL started with a simple search interface, these have evolved to aid the user: techniques for searching/scanning/examining information objects [e.g., 10, 2, 11], enabling social engagement [6] and personalizing the user's experience [14]. But many of these initiatives have not considered the "information journey" [1], and the overall workflow that underpins that process.

One of the earliest implementations to integrate search into the work process was perhaps the first mathematics digital library [12] which from an interface perspective is not unlike those that followed, providing targeted and integrated support tools such as automatic query reformulation. An interesting contrast in design is a comparison of [17] and [13]'s prototypes to aid student writing. Twidale *et al* [17] deployed multiple intelligent agents to suggest keywords and related documents. Reimer *et al*'s [13] prototype worked with already found documents. Twidale *et al* automated much of the search process leaving the user no longer in control while Reimer *et al* dealt only with "information assimilation." In both cases, the job is incomplete – knowing the *what* does not necessarily indicate the *how*.

For the past 20 years, HCI has been developing best practices and principles for interface design [15]. Notably core principles include maximizing visibility and minimizing search time while not overloading the user's working memory, providing logically structured displays while at the same time providing only relevant information, and enabling the reversal of actions. The user needs to feel "in charge of the interface" which challenges our basic instinct to simplify the task of the user by automating as much as possible. Yet most search systems and indeed many digital libraries fail on these basic principles. Consider the classic IS&R system, Google, which hides much of the search workflow process from the user. As a result the user has to keep track of that process as well as keep track of the original work task progression. Typically, a labyrinth of pages must be navigated while the user hunts for the needed information requiring the user to remember the core landmarks that had previously been visited, the information acquired, as well as what is completed and still left to do. The usual solution for information found is to bookmark the page, print the page or produce endless lists of post-it notes. DLs do much the same.

Our development considered the basic HCI design principles in concert with IS&R conceptual models (e.g., Kuhlthau's [7, 8] modified by Vakkari [18,19], and Marchionini's [9]) to represent search as a workflow process.

3 Design of wikiSearch

The design process involved brainstorming sessions to identify possible approaches while being mindful of design principles. These sessions included eight lab personnel: undergraduate and graduate students and researchers. A series of prototypes emerged and the result of this iterative process was the interface illustrated in Figure 1.

Our implementation, which we call wikiSearch, accesses the Wikipedia at present, although the design is generic and applicable to other types of information resources/repositories. The interface was driven by the principle to "structure and sequence the display" so that the grouping and ordering was logical to the user's task. As a result we ordered the interface into three core components. The first column reflects task-based activities, the second relates to the search itself, and the third is at a high level of granularity – detailed viewing of documents.

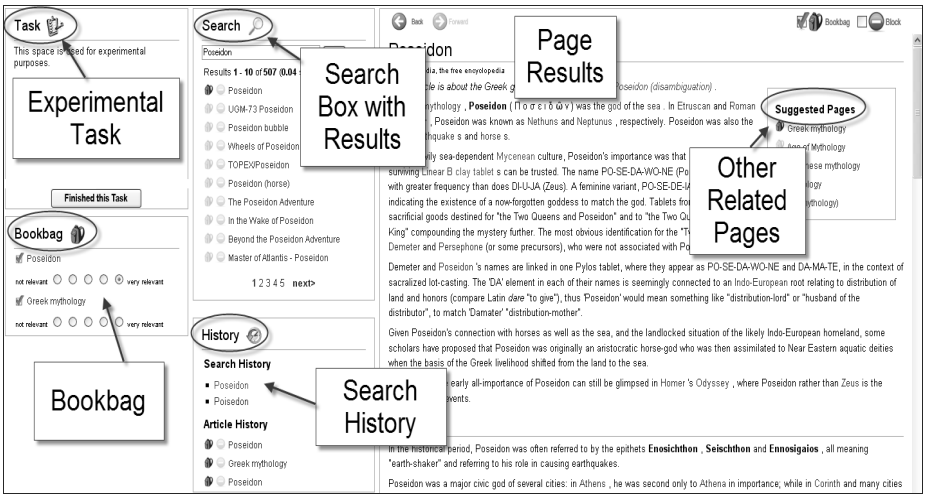

Fig. 1. wikiSearch

The **Task** (extreme left) section contains the contents of the experimental task that participants are assigned. However, we envision this as workspace for task completion. Below the task description is a BookBag, akin to the shopping cart in online shopping environments, which is used to collect information objects deemed useful to the task. Pages can be removed from the BookBag, and to assist our experimental process, pages can be rated for likely relevance to the task. Pages can be added to the BookBag from several places in the interface. While browser bookmarks enable the identification of useful websites, they do not support the principle of maximized visibility provided by the BookBag.

The second column, the **Search** section, contains three sub sections: one devoted to entering a query, one to displaying results and a third to displaying history of search activities. The search box remains unchanged from other systems at this point. Remaining attentive to our principles meant a compromise in displaying search results (both the current and historic). While most systems provide a single independent page that is part of a multi-page labyrinth, we wanted to avoid overloading the user's memory so that results and their use are always visible. To conserve space, the results section contains a list of ten titles with the option to display others by selecting a button forward (or backward). Given user prevalence for looking only at the first page of results, displaying ten simultaneously seems sufficient. "Mousing" over each title invokes a pop-up window that displays a search word-in-context summary of each

information object. The third, the history sub section, keeps track of all queries issued and all information objects viewed. Both can easily be used by a mouse click. As a result we have made visible to users all prior actions – a useful memory aid.

The third column displays the **information object**, a scrollable wiki page. Each page contains ordinary hypertext links and links to search within the wiki. A page may be loaded from a link in the Search results or History section, or from links stored in the BookBag. In addition to the page display, a text box provides a further list of Suggested Pages. This set of page links is created by entering the first paragraph of that page as a search string, and displaying the top five results. This list had the potential to provide more specific pages about the topic, or be distracting (much like the Suggestions provided by Toms [16]).

In addition, pages may also be blocked so that they never need to be viewed again for this particular task. This is much like a Boolean negative, ensuring that the workspace is not cluttered with unneeded, irrelevant information objects.

These elements and the collapsed/flattened design removes and limits the number of mouse clicks required to do a task, eliminates the 'labyrinth' effect, introduces space for tracking useful items, makes visible as many actions as possible, enables a low level Boolean negative, and introduces the concept of serendipity while searching/scanning. Reversal of actions was deemed irrelevant as it is impossible for any action to interfere with the process; all actions are visible. Enabling page blocking meant that irrelevant and/or unneeded pages never need be viewed a second time.

Our first design challenge – managing the search process – was rendered by column 1 and 2, and the second challenge by our History and BookBag functions. As a result, the simplified interface condensed what normally would have appeared in four interface windows or browser web pages into a single-layer display that reflected the search process while adhering to standard design principles. At the same time, it introduced a natural workflow: task is contained to the right as well as the work associated with that task, and the actions associated with active searching are contained in the centre with the view of items to the extreme right. Previous activities – queries entered, pages viewed, and pertinent items to retain – are always visible to the user, requiring less time to traverse a labyrinth of pages. Other than the magical black box – the retrieval engine – all actions are also controlled by the user.

4 Evaluation of wikiSearch

To test our design, initially we ran basic usability studies with 22 participants and then used the resulting design for the conduct of other research studies. In these studies the interface accessed a locally-stored version of Wikipedia using a retrieval system based on Lucene 2.2, an open source search engine. In one of these studies (N=96) we additionally assessed the wikiSearch interface by adding post session questions which enabled participants to reflect on their experience with the system and to assess their perception of its features. In this section, we describe the experiment used to collect the data.

4.1 Participants

The 96 participants (M=49, F=47) were primarily (90%) students from the university community, and from mixed disciplines. 25% held undergraduate degrees and

12% graduate or other degrees. 84.4% were under 27. They were an experienced search group with 86.5% searching for something one or more times a day, and also relatively frequent users of the Wikipedia (54% use it at least weekly).

4.2 Tasks

Prior to assessing the system, participants completed three tasks from a set of 12 tasks that were developed according to a set of principles: 1) no task could be completed using a single page; 2) the task required searchers to actively make a decision about what information was truly relevant in order to complete a task. The tasks were used in the INEX 2006 Interactive Track. Each task required that pages used to respond to the task be added to the BookBag and rated. Task topics varied from environmental issues surrounding logging and mining to the hazards of red ants and the impressionism movement. One example is:

> "As a tourist in Paris, you have time to make a single day-trip outside the city to see one of the attractions in the region. Your friend would prefer to stay in Paris, but you are trying to decide between visiting the cathedral in Chartres or the palace in Versailles, since you have heard that both are spectacular. What information will you use to make an informed decision and convince your friend to join you? You should consider the history and architecture, the distance and different options for travelling there."

Three tasks were assigned to each participant, such that all tasks were performed by 24 people. Order of task was counterbalanced to control for learning effects.

4.3 Metrics

The assessment used the System Usability Scale (SUS) [4] to assess user perception of usability. User events were logged to assess whether and how the features were used, and finally users responded to a series of closed and open-ended questions concerning their perception of the system.

4.4 Procedure

Data collection took place in a laboratory setting where 5 to 7 people were processed simultaneously. A research assistant was always present. Participants were simply told that we were assessing how people search. They were presented with the following steps in a series of self-directed webpages: 1) Introduction which introduced the study, 2) Consent Form that outlined the details of participation, 3) Demographics and Use Questionnaire to identify prior knowledge and experience, 4) Tutorial and practice time using the wikiSearch system, 5) Pre-Task Questionnaire, 6) Assigned task to be completed using wikiSearch integrated into the interface as illustrated in Figure 1, 7) Post-Task Questionnaire, 8) Steps 5 to 7 were repeated for the other two tasks, 9) Post-Session Questionnaire to identify user perception of the system, 10) SUS Questionnaire, and 11) Thank-you for participating page.

5 Results

After completing the three tasks and working with the system for 21 minutes, on average (and not including the tutorial or completion of experimental questionnaires), the 96 participants responded to sets of questions that dealt specifically with the interface and selected tools, as well as the 10 item SUS questionnaire. All questionnaires used the same seven point scale with the left side labeled "Strongly Disagree" and the right side, "Strongly Agree."

SUS Questionnaire: This questionnaire [4] is composed of five positively worded statements and five negatively worded statements. Participants indicated the degree to which each agreed with the statements about the wikiSearch system.

As illustrated in Table 1, the level of agreement with the positively worded statements varied from 5.5 to 6.23 on a seven point scale. In general participants found the system easy to use and easy to learn, and expressed an interest in using it more frequently and felt confident in using the system.

Table 1. Positively expressed statement on the SUS questionnaire

#	*Positive Statements*	Mean	SD
1	I think that I would like to use wikiSearch frequently	5.50	1.47
3	I thought wikiSearch was easy to use	6.11	1.09
5	I found the various functions in wikiSearch were well integrated	5.66	1.00
7	I think most people would learn to use wikiSearch very quickly	6.23	0.86
9	I felt very confident using wikiSearch	5.70	1.27

Similarly, the level of disagreement with negative statements varied from 1.44 to 2.93 on the same scale indicating general disagreement with the statements. Participants tended not to find the system complex, or to require technical support, or difficult to learn or cumbersome to use (see Table 2).

Table 2. Negatively expressed statement on the SUS questionnaire

#	*Negative Statements*	Mean	SD
2	I found wikiSearch unnecessarily complex	2.22	1.04
4	I think that I would need the support of a technical person to be able to use wikiSearch	1.44	0.86
6	I thought there was too much inconsistency in wikiSearch	2.93	1.43
8	I found wikiSearch very cumbersome to use	2.50	1.34
10	I needed to learn a lot of things before I could get going with wikiSearch	1.83	1.19

Overall, results indicate positive response on the System Usability Scale indicating that the system meets at least a level of usability.

Use of the System. Customized logging software logged all user activity. Among the possible actions recorded per task were issuing queries (mean = 6.7), viewing pages (mean = 11), reviewing pages from history (mean = 1.5), viewing results pages (mean = 7.7) and reviewing results pages two or higher (mean = 7.8), accessing pages via an

internal page link (mean=2.1), adding pages to the BookBag and rating their relevance (mean=4.5), and blocking pages (mean=0.5). Overall, participants executed 38 actions per task (which does not including scrolling forward and backward within a single page view or using any other scrolling action). As a result, we concluded that their level of activity was sufficient for them to assess a novel interface.

Perception of the BookBag. The BookBag, much like the shopping cart in e-commerce, is particularly pertinent to digital libraries. As illustrated in Table 3, participants found the BookBag useful in gathering pertinent pages and keeping track of those pages. In addition, participants speculated on their potential future use, indicating 6.38 on average agreement in using it again if it were available.

Table 3. Responses concerning the BookBag

Statements	Mean	SD
I found the BookBag useful in helping me collect the pages that I needed.	6.47	0.75
I found the BookBag helped me keep track of the pages that I found useful.	6.50	0.71
If presented with the opportunity, I would use the BookBag feature again.	6.38	0.92

After the closed questions, participants responded to two open-ended questions asking when they found the BookBag the most useful and when they found it not useful.

Table 4. When the BookBag was most useful and when particpants would not use it

Most useful for:	N=86	Would not use:	N=71
Organization of search	45	For certain task or search types	59
Task completion	32	When not planning to return/irrelevant or insufficient content	12
Navigation of web pages	32	When other tools are available to perform the same function	2
Substitution of other tools	31	When privacy is a concern	1

Participants found the BookBag usefully served several functions (Table 4):

***1. Organization of search*:** Participants indicated that the BookBag was useful for helping keep track of, save and organize their search results. The BookBag allowed participants to search and collect web pages and then move on to task completion.
***2. Task completion*:** The BookBag's value with regard to task completion included reviewing, analysing, clarifying, cross-referencing, synthesizing, determining relevancy, and comparing web content. "When I had read everything through, I could look at my results, and weigh them with the information provided, and change my mind as I went along" (P596).
***3. Navigation of web pages*:** The organizational and task completion functionality of the BookBag were closely related to navigation. The BookBag was useful when "comparing and contrasting information. It was easy to have the web pages in front of

me instead of click back and forth from the favorites page" (P619). The BookBag also prevented participants from getting "lost" while exploring other pages.
***4. Substitution of other tools or techniques*:** Participants made direct comparisons between the BookBag and other tools and techniques they currently use. These included the use of the BookBag as a "memory aid" (P605). The BookBag eliminated the need for pen and paper, an email to self, copying and pasting, and printing results. The BookBag also replaced browser functions such as history, favourites, bookmarks, back-and-forth navigation, as well as right clicking, the use of drop-down menus, the need to keep multiple windows open, and repeating searches.

Participants would *not* use the BookBag for the following reasons (Table 4):

***1. For certain task and search types*:** Participants indicated that the usefulness of the BookBag was dependent on the length and complexity of the task or search. The BookBag's usefulness would be low if conducting short or simple tasks while "this feature is most useful when completing searches or research on a complex, multi-part task" (P564). Others indicated it would not be useful for general interest searching or browsing, and particularly for non-school/research related searching.
***2. Content*:** Some responses related to the functionality of the BookBag feature, with several suggesting it would not be useful if the web page content was insufficient or "if I did not think the information was useful for me in the future" (P689).
***3. Competing tools*:** Two participants expressed their preference for other browser features they currently use including tabs and search history.
***4. Privacy*:** One participant indicated that the BookBag function would not be useful "when privacy is an issue" (P576).

Perception of the Interface. A core design element of this interface was the integration of search box, results and page display as well as history and BookBag on a single display. Participants responded to three questions regarding this element. In general, participants found the side-by-side display useful, saved time and kept them on topic as illustrated in Table 5.

Table 5. Response about the interface display

#	Statement	Mean	SD
1	I found the presentation of search results side-by-side with the display of a single page useful	6.13	1.00
2	I found the presentation of search results side-by-side with the display of a single page saved time	6.09	1.21
3	I found the presentation of search results side-by-side with the display of a single page kept me on topic	5.77	1.29

Perception of the Mouse-over Summaries. The compromise in design was the implementation of search result summaries, or snippets, as 'mouse-over' elements. This is a significant change from typical practice where a page of result summaries is the norm. The two questions asked slightly different versions of the same question (see Table 6). Participants found the 'mouse-over' easy to use, but at the same time were not as strong in their agreement about the mouse-over feature.

Table 6. Response to the Mouse-over Summaries

#	Statement	Mean	SD
1	I found the 'mouse over' summaries easy to use	5.82	1.50
2	I would prefer to see each summary displayed at the same time on a single page	3.46	1.89

Interface preference: As a final question participants chose between the wikiSearch style and Google-style of search interface. As illustrated in Table 7, 74% preferred the single, collapsed interface to the multiple page solution.

Table 7. Preference for interface style

Items	N (96)	%
wikiSearch interface: search box, search results and the display of a single web page on a single screen or page; the search summaries are not all visible at the same time	71	74
Google-style interface: search box and search results are on the same page; you need to click backward and forward to select and display a new webpage; search results are all visible on a single page	20	21
Neither	5	5

In addition, participants identified their reason(s) for their preferences which are identified in Table 8. The 96 responses were coded using one or more of the codes.

Table 8. Number of participants who identified reasons for preference for a wikiSearch or Google-style interface

Code	Wikisearch (N)	Google-like (N)
Ease, speed, efficiency	43	2
Results display	39	5
Navigation	26	2
Task focus/ organization	29	0
More accustomed to Google	n/a	7

While the overall preference was for the wikiSearch interface, participants had difficulty separating content from interface. Eleven participants perceived a reduction in the quantity of results and the quality and reliability of results content. Comments included “Wiki info is not credible” (P721) and “the amount of useful information I found was not the same as google” (P579). The remainder of this analysis is limited to the usefulness of the interface rather than content.

1. Ease, speed, efficiency: Almost half (43) participants made positive comments specifically relating to the ease, speed, and efficiency of the wikiSearch, preferring the collapsed interface “because it was so easy to stay on task and there was little distraction. It was much more time efficient” (P548). Two participants preferred the Google-like interface for its “simpler interface” (P598) and because “it's easy to use” (P630).

2. Results display: Forty-three participants who preferred the wikiSearch interface commented that they liked the search results display. Most of these comments related to the single page display of the wikiSearch making it "easier and quicker to always see search results on the same page instead of having to go back and forth" (P547).
3. Navigation: Participants indicate that they preferred the navigational functions of wikiSearch "because everything I needed was on one page, I didn't need to go back and forward between different search results" (P592). Two participants, however, indicated that they preferred the Google-like search interface because it is easier to locate specific pages (for which they have forgotten the URL) through Google and due to a preference for opening links in new tabs.
4. Task focus/organization: twenty-nine participants made comments regarding the usefulness of the Wikisearch to help them organize their search and maintain their focus on the task at hand. WikiSearch showed participants "alot of what you want not what you don't want" (P709), helped them to avoid getting "lost in many google pages" (P684) and "definitely kept me focused on my task" (P661).
5. More accustomed to Google: Seven participants indicated their preference for the Google-style interface by qualifying it with a statement that they were more accustomed to Google. "The format was new so it didn't seem as instinctive as Google" (P571).

6 Analysis and Discussion

The goal of our work is to develop an interface that emulates the flow of activities within the search process, while speculating on the further integration of that search process within the larger workflow. Our collapsed interface supports both the user's right to be in control and to have visible and available all the tools of the trade. Much like the desktop metaphor used to reference the Apple and Windows environments, this interface creates a "desktop" to support the search process. The evaluation completed by 96 potential users of the technology gave the design high usability scores. In addition, they made significant use of all of the features so as to gain some exposure to the system, and they did this for three tasks. Some of the features were used more than others as would be expected, but that use provided them with sufficient experience to assess its effectiveness.

As part of their assessment, we asked participants to contrast this interface with a Google-like interface. Some responses related both to the content as well as to the interface. Three-quarters preferred wikiSearch and this was for the navigational and organizational functions that it provided. Google-like interfaces tended to be preferred for the detailed search results and quality of the content; students seem trained to perceive Wikipedia content as sub-standard at our University.

Overall wikiSearch enabled people to stay on course with their task by providing a bird's eye view of the events – queries entered, pages viewed, and pertinent pages identified. This relatively simple, two-dimensional interface simplified navigation, and prevented people from getting lost in the labyrinth of pages. As a result, it demonstrated the value of providing visibility to the activities required in the search workflow process, and this visibility additionally support the core cognitive abilities, e.g., Recall and Summarize, noted by Kuhlthau [8] in the seeking and use of information.

The BookBag and Query History – mere lists – challenge the current superiority of tabbed-based browsers. Which one is the most effective remains to be seen. A limitation of our design was the inability to examine two pages in parallel, although participants noted the capability to quickly re-load pages from the BookBag and history. The BookBag was perceived the least useful for short, simple searches or when participants simply wanted to scan; it was perceived the most useful for more complex tasks that would involve multiple queries – the types of tasks performed by students. The BookBag replaced less reliable or cumbersome techniques they normally employed including memory, favourites, search history, copy and paste, clicking back and forward, and keeping multiple windows open.

The design decision to enable mouse-over summaries rather than full presentation met with mixed responses. While the presentation did not actually interfere with use, the user perception was not as positive. Whether this format is novel and thus has a learning curve, or whether it is truly a barrier to assessing results needs further research. Presumably, as search engines improve precision, results can be more reliably assumed to be relevant.

Although the interface was successful, it was used with a limited resource – the Wikipedia. However we believe the technology to be scalable to larger, e.g., the Web, or multiple, e.g., scholarly journal publishers,' repositories.

While this is a first attempt at delineating and supporting the search workflow, we see the potential for augmentation and improvements. For example, our history display separates queries and page views; would an integration of the two be more valuable, allowing the user to discern which queries were the most useful? The Bookbag, as noted by participants, is particularly useful for school projects and research. But how might it be enhanced? For example, adding note-taking capability (not unlike Twidale et al [17]) would at the same time support those significant cognitive activities noted by Kuhlthau [8]. In addition, what other functions does the student, in particular, need while using a digital library to complete a term paper? How much control is left to the user, and how much can be assumed by the system before the user feels out of control? Perhaps we need a stronger requirements specification that is both seated in what is ostensibly the user's work task process as well as in our information models and frameworks.

7 Conclusion

Our research is working toward an improved search interface with appropriate support for search workflow and its integration with the larger work task. We found strong support for enabling better visibility of basic activities within the search workflow while leaving the user in control of the process which are fundamental design guidelines. While much of DL interface development has followed implementations in information retrieval systems, it is time to consider how search is connected to the larger work process.

Acknowledgments. Chris Jordan implemented the search engine. Alexandra MacNutt, Emilie Dawe, Heather O'Brien, and Sandra Toze participated in the design and implementation of the study in which the data was collected. Research was supported by the Canada Foundation for Innovation, Natural Science and Engineering Research Council Canada (NSERC), and the Canada Research Chairs Program.

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