Greening Interlibrary Loan Practices

Dennis Massie

Program Officer
OCLC Research

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Dennis Massie, for OCLC Research

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OCLC Research
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Please direct correspondence to:
Dennis Massie
Program Officer
massied@oclc.org

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Executive Summary

In September 2009, OCLC Research commissioned a study of current Interlibrary Loan (ILL) practices by California Environmental Associates, a firm of environmental impact consultants. The study was completed in January 2010, with findings reviewed and amended in March 2010.

The largest environmental impacts directly associated with ILL operations are packaging, shipping, and paper use.

The single most important finding of the study is that an ILL unit can cut its greenhouse gas emissions in half simply by re-using packaging materials.

Perhaps the most surprising fact to emerge from the study is that padded mailers are much friendlier to the environment than cardboard boxes, based on the impact of their respective manufacturing processes.

The assumed effectiveness of common-sense practices to reduce ILL's impact on the environment is borne out by scientific analysis:

- Re-use is preferable to New
- Ground is preferable to Air
- Near is preferable to Far
- Aggregation is preferable to 1X1
- Nylon bags are preferable to Plastic bins (unless the bins are always shipped full)
- 30% recycled paper equals New ($-wise)

Libraries are already doing a lot to be green:

- Reusing packaging materials
- Bundling outgoing shipments
- Sourcing books from local institutions

Further greening activities may be constrained by budget limitations, operational constraints, and systemic barriers.

The biggest opportunity to improve the environmental profile of the ILL system is for libraries to adopt the best practices in packaging and shipping displayed by surveyed institutions.

The recommended practices are not always possible (or even appropriate for all situations). However, if most libraries routinely follow the recommendations, the impact across the global resource sharing community will be enormously positive for the environment.

Acknowledgements

This project was inspired by Karen Bucky, reference librarian at the Clark Art Institute Library, who brings her passion for protecting the environment to work with her every day.

Jim Michalko, Vice President of OCLC Research, signed off on the study and suggested California Environmental Associates for the consulting role.

Katie Birch, Director of OCLC Delivery Services, was extremely supportive and helped pay for the work out of her departmental budget.

Rose Harrington of Stanford University's Green Library arranged a brilliant walk-through of her interlibrary loan unit and mail room, and her staff graciously set aside illustrative examples and answered every imaginable question.

Twenty-nine experts at eighteen different institutions believed in the project and gave generously of their time and talent to provide the grist. (See page 11 for a complete list of names and institutions.)

Aarthi Ananthanarayanan and Laura Keller of California Environmental Associates proved to be quick studies on the topic of resource sharing, performed all the study's calculations and analysis, and, in the end, provided all the magic.

Introduction

In a world rapidly going digital, practitioners of the "ancient" art of interlibrary loan find themselves working in a growth industry. Business is booming. Advances in discovery technology, combined with shrinking library materials budgets, have sent the number of borrowing requests shooting through the Learning Commons roof. Within the global OCLC resource sharing network, representing only a fraction of worldwide interlending activity, 10,179 libraries in 46 countries fulfilled 10.3 million ILL transactions from July 2008 through June 2009, up 300,000 from the previous year (OCLC 2009). Two out of every three of those requests was for a book that had to be packaged and shipped to the borrowing library, then repackaged and shipped back again to the lending library.

With all that fuel being burned, and all that packaging being used, one can almost picture Mother Nature shopping online for a gas mask, or perhaps for a hermetically-sealed biodome in which to take up permanent residence.

In September 2009, OCLC Research hired a firm of environmental impact consultants, California Environmental Associates, to conduct a three-month study of interlibrary loan processes, with an eye toward lowering the carbon footprint of resource sharing operations worldwide. "Affordable best practices" was the goal. OCLC Research and OCLC Delivery Services co-sponsored the study. The primary consultants (Aarthi Ananthanarayanan and Laura Keller) visited two academic libraries in the San Francisco Bay Area and initiated telephone interviews with staff at a dozen other libraries of various types and sizes across the country.

For years ILL practitioners have been streamlining their processes for efficiency and sustainability. So, happily, the investigators found many amazing best practices already in place. These are listed in Appendix A as part one of the Library Greening Toolkit. The key contribution of the consultants was to determine the carbon emissions, per book loaned, per mile, for several of the libraries in the study. Then, by analyzing the processing, packaging and shipping practices of those libraries, Aarthi and Laura were able to determine which practices had a positive or negative effect on the emissions numbers. The result is a list of recommended "green" interlending practices that are finally as scientifically quantifiable as they are common-sensical.

The point of issuing these recommendations is that benefit accrues each time such practices can be utilized. The practices outlined in this report are not always possible to follow, or even appropriate in every situation. But if many libraries across the entire system conduct the bulk of their routine interlending business along the lines recommended by this study, Mother Nature will breathe a little easier. And that's always a good thing.

Study Methodology

CEA's task: California Environmental Associates was engaged to measure the environmental impacts associated with interlibrary loan processes and recommend improvement options

Methodology:

- Interviewed 12 representative research, art and public libraries within the OCLC system to identify best practices.
- Interviewed shipping, packaging, and library experts.
- Toured Stanford University's Green Library and Jackson Graduate School of Business Library to understand lending processes.
- Collected data from 10 libraries on consortia arrangements, shipping methods and guidelines, and packaging material composition and sourcing.
- Determined per book-mile greenhouse gas emissions and associated impacts from packaging, shipping, and paper use for 4 lending institutions.
- Recommended improvement options.

Study Consultants and Participants

Environmental Impact Consultants

- California Environmental Associates http://ceaconsulting.com/
    - Aarthi Ananthanarayanan, LEED AP, Research Associate
    - Laura Keller, Associate
    - Jill Kaufman Johnson, Principal

Interlibrary Loan Process and Data Interviewees

- Clark Art Institute
    - Karen Bucky
- Emory University
    - Margaret Ellingson
- Getty Research Institute
    - Aimee Lind
- New York University
    - Jennifer Salvo-Eaton
- Princeton University
    - Jennifer Block
- San Francisco Public Library
    - Michael Hudson

- Stanford University, Green Library
    - Rose Harrington, Vivian Gao, Olga Katz, Alex Rajeff, Michael Reyes
- Stanford University, Jackson Graduate School of Business Library
    - Lars Flatmo, Joyce Rages
- Swarthmore College
    - Sandra Vermeychuk
- University of Chicago
    - David Larsen, Sandra Apple gate, Joseph Gerdeman
- University of Miami
    - Scott Britton, Clarissa Arguello, Rodrigo Castro, Ronald Figueroa
- University of Minnesota
    - Elizabeth Ringwelski, Cherie Weston

Other Experts Consulted

- Maria Harris, Environmental Defense Fund
- Chris Sweet, Illinois Wesleyan University
- Steve Slightom, Lanter Delivery Services
- David Allaway, Oregon Department of Environmental Quality
- Cyril Oberlander and Tim Bowersox, SUNY IDS Project
- Tracy M. Luna, University of Tennessee at Knoxville

Findings and Recommendations

Before conducting any interviews or gathering any data, the consultants had a pretty good idea of which aspects of the interlibrary loan life cycle would lend themselves to investigation and improvement. Packaging, shipping, paper use, and waste disposal were the big four.

Environmental impacts: contributing factors

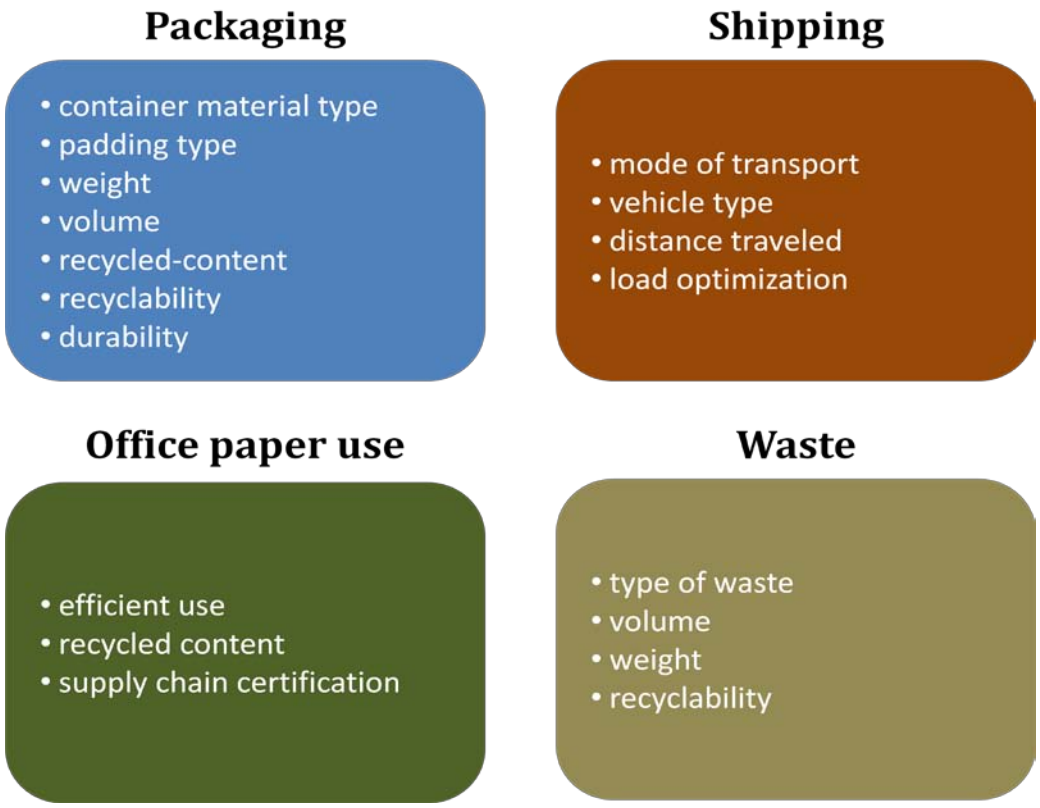


Figure 1: Key factors that contribute to the environmental impacts from packaging, shipping, waste, and paper use

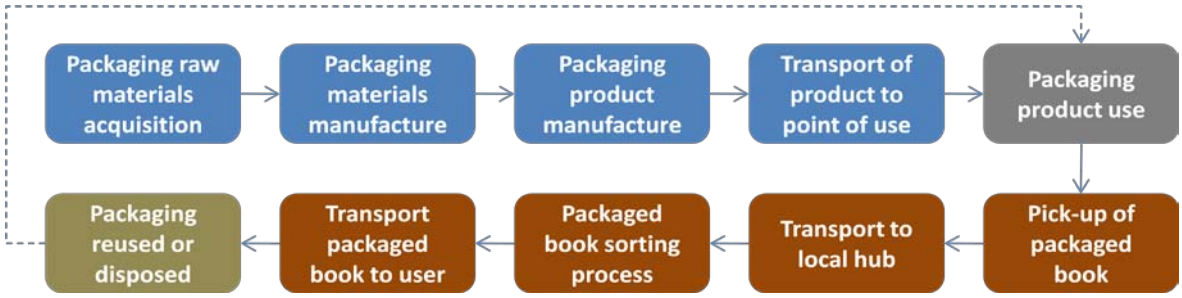
Setting aside paper use for a moment, the consultants knew from previous experience that packaging and shipping have an enormous impact on the environment. The manufacturing

processes of the packaging material account for the lion's share of emissions for each item shipped. Institutions that routinely use brand new boxes and padded mailers will see their packaging materials account for 51% of their greenhouse gas emissions for each item, more than half of the total emissions. Shipping accounts for 48%. The impact of waste disposal is pretty minimal.

The implication here is that an institution can cut its per-package emissions almost in half simply by reusing the packaging material.

The graphic in Figure 2 clearly demonstrates the advantage of reusing boxes and padded mailers.

1. **Packaging material production—51%** of total GHG emissions per package
2. **Shipping operations—48%** of GHG emissions per package
3. **Waste disposal—1%** of GHG emissions per package* (Franklin Associates 2004)



*These results corroborated by internal CEA analysis. Waste disposal impacts do not include methane emissions from decomposition in landfill.

Figure 2. The three major Environmental impacts from ILL material distribution logistics

While waste disposal is only 1% of GHG emissions, deciding to reuse packaging material rather than dispose and procure new material allows for the first four packaging steps to be eliminated, significantly reducing overall packaging impacts.

Environmental impacts: office paper use

The consultants learned some best practices from the study participants that reduce the use of paper within ILL processes down to the bare minimum. (See Appendix A.) ILL management systems such as ILLiad and WCRS, and document transmission systems such as Odyssey and Ariel, have been reducing the amount of paper used within ILL for years. So interlending operations are already rather tree-friendly. Some of the best practices noted by the consultants can reduce paper use even more—down to zero sheets for a typical copy request, and to 1.16 sheets for a typical lending request. The point is that little improvements added up over thousands of iterations amount to a substantial benefit.

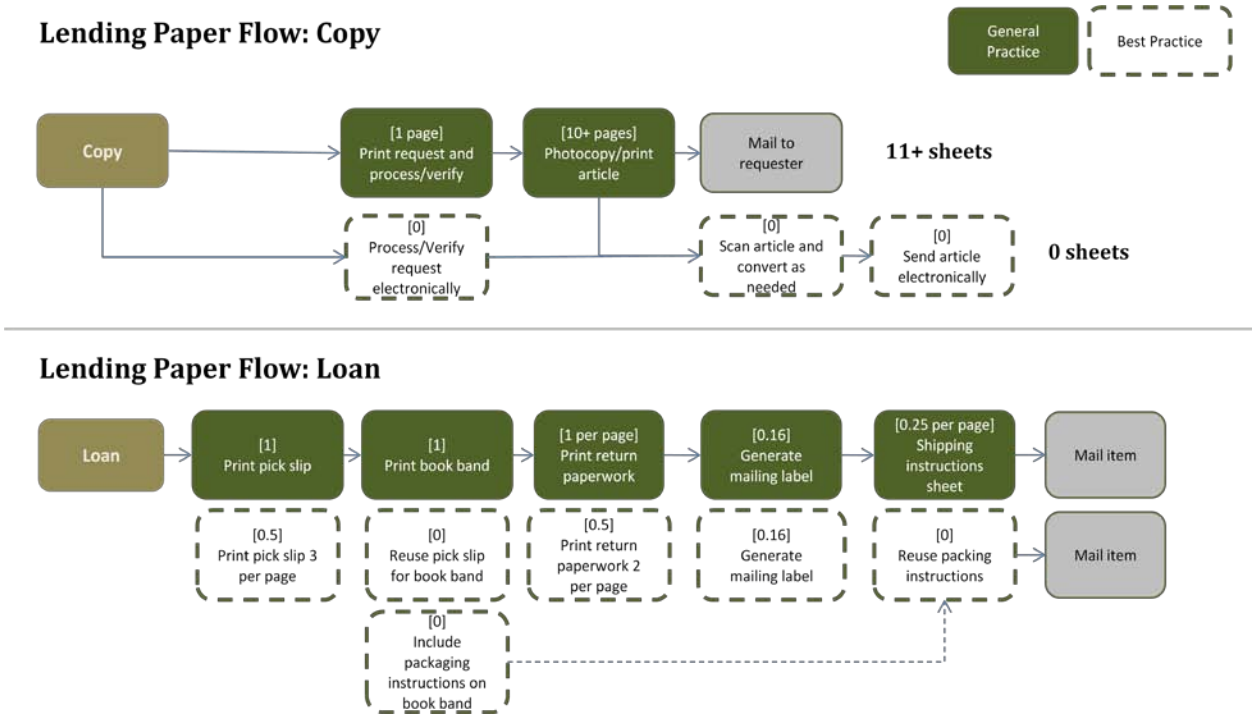


Figure 3. Lending paper flow for copies and loans

Check out the ILLiad Workflow Toolkit for time-saving tips on automating workflow, templates, and eliminating paper processes: http://toolkit.idsproject.org

By reducing loan paperwork from 3.5 to 1.16 pieces of paper, a mid-size library with a volume of 10,000 loans per year would reduce paper use by 234 lbs per year, and

- Save 3 million BTUs of energy
- Stop 688 lbs CO_2e from being emitted
- Reduce 2,600 gallons of wastewater
- Prevent the creation of 223 lbs of solid waste (Paper Task Force 2010)

By reducing article loan paper use from 11 (or more) to 0 pieces of paper, a mid-size library with a volume of 5,000 requests would reduce paper use by 550 lbs per year, and

- Eliminate about 1 ton of wood use or 7 trees
- Save 8 million BTUs of energy
- Stop 1,618 lbs CO_2e from being emitted
- Reduce 6,110 gallons of wastewater
- Prevent the creation of 525 lbs of solid waste

Best Practice: University of Tennessee at Knoxville's ILL staff saves paper and staff time using a unique loan request template that doubles as a pick slip and return paperwork. They print it on special sheets that are half label, half copy paper, so outgoing and incoming mailing labels are also printed in one step, using only one piece of paper total. Book bands are printed 2 to a page, resulting in 1.5 pieces of paper per transaction. (See Appendix B for details.)

Environmental impact analysis: overview

Table 1 shows a comparison across the four libraries of the overall environmental impact of their ILL lending activities.

Notice that the highest volume lender here, the University of Chicago with almost 35,000 loans annually, sees greenhouse gas emissions from its lending operations each year that are about one and a half times what a single family home would produce.

The lowest volume lender, the Clark Art Institute, puts out about twice as much emissions in a year as a single ten gallon tank of gasoline.

Remember to reuse and recycle office paper: Recycling 1 ton of paper saves 17 mature trees, 7,000 gallons of water, 3 cubic yards of landfill space, 2 barrels of oil, and 4,100 kilowatt-hours of electricity — enough energy to power the average American home for five months. *Source: EPA, 2008*

Table 1. Comparison of overall environmental impact of ILL lending

	University of Miami	Clark Art Institute	Stanford University (Green Library)	University of Chicago
Loan volume (returnables)	10,143	471	6,445	34,559
Book Miles Traveled (000s)	13,849	767	11,756	38,702
Total Emissions (lb CO_2e)	6,297	439	10,009	37,931
Shipping Emissions (lb CO_2)	6,095	383	6,735	20,851
Packaging Emissions (lb CO_2e*)	203	56	3,274	17,080

*Packaging impacts are calculated in carbon dioxide equivalents (CO_2e), incorporating the impacts of methane and nitrous oxide (greenhouse gases significant in the production of packaging materials); CO_2e information was not available for the shipping impact calculation; therefore CO_2 impacts alone were calculated.

- **24,000 lb CO_2**: Emissions from the energy use of a single family home in one year
- **11,013 lb CO_2**: Emissions from the average car
- **196 lb CO_2**: Emissions from a ten gallon tank of gasoline (US EPA 2009)
- **16.44 lb CO_2** : Approximate emissions from the manufacture and distribution of a new book (Sibley 2009)

Note: This analysis covers the roundtrip impact of ILL lending operations at each institution. Borrowing was excluded from this calculation to avoid double-counting of emissions. Shipping and some of the packaging impacts listed here would be considered within an organization's Scope 3 emissions. See Appendix A, Library Greening Toolkit, for background on the different scopes of greenhouse gas emissions.

See Appendix C for Additional Environmental Impact Data and Appendix D for Institution Profiles. See Appendix E, Data Methodology, for assumptions and calculation methodology.

Observations: Packaging

Choices in procedure and in the type of packaging material used can have massive impacts on greenhouse gas emissions per item sent.

Table 2. Comparison of packaging emissions

	University of Miami	Clark Art Institute	Stanford University (Green Library)	University of Chicago
Packaging Emissions (lbs CO_2e)	203	56	3,274	17,080
Packaging Emissions (lbs CO_2e per 100 books)	2	12	51	49
Packaging % of total emissions	3%	13%	33%	45%

- **Reusing materials is key**. Stanford University and the University of Chicago have highest packaging-per-book emissions because they reuse minimal amounts of packaging materials compared to Clark and Miami.
- **Reusable courier bags and bins help to reduce packaging emissions.** Clark's per-book-mile emissions from packaging are higher than Miami's because Clark is not a member of a resource-sharing consortium, while Miami's courier provides reusable packaging.
- **For new materials, choose less energy intensive products.** Miami, which has the lowest per-book-mile emissions, reuses a large quantity of packaging materials, especially boxes. For new materials, it purchases jiffy mailers which require less energy to produce than boxes.
- **Recycled content boxes reduce resource use.** The University of Chicago uses boxes which contain 90% post-consumer recycled content, significantly reducing resources required to produce packaging materials, which is around 80 trees per year (Paper Task Force 2010). See Special Case in Appendix E (p.61) for additional information on resource use and GHG emissions from production of recycled content materials.

Emissions intensity of packaging choices

Arguably the single most surprising fact to emerge from this investigation is the relative impact on the environment of the manufacturing processes associated with padded mailers when compared with those of cardboard. Cardboard has long been considered a safe and responsible choice as a container for interlibrary loan materials in transit, as it protects the contents, is reusable, and can be recycled.

The table below should be cause for careful consideration of when it is appropriate to use cardboard packaging. It shows that the greenhouse gas emissions resulting from the production, transport, and disposal of **mailing bags** (on the left) are **significantly lower than cardboard boxes** (on the right, Franklin Associates 2004)

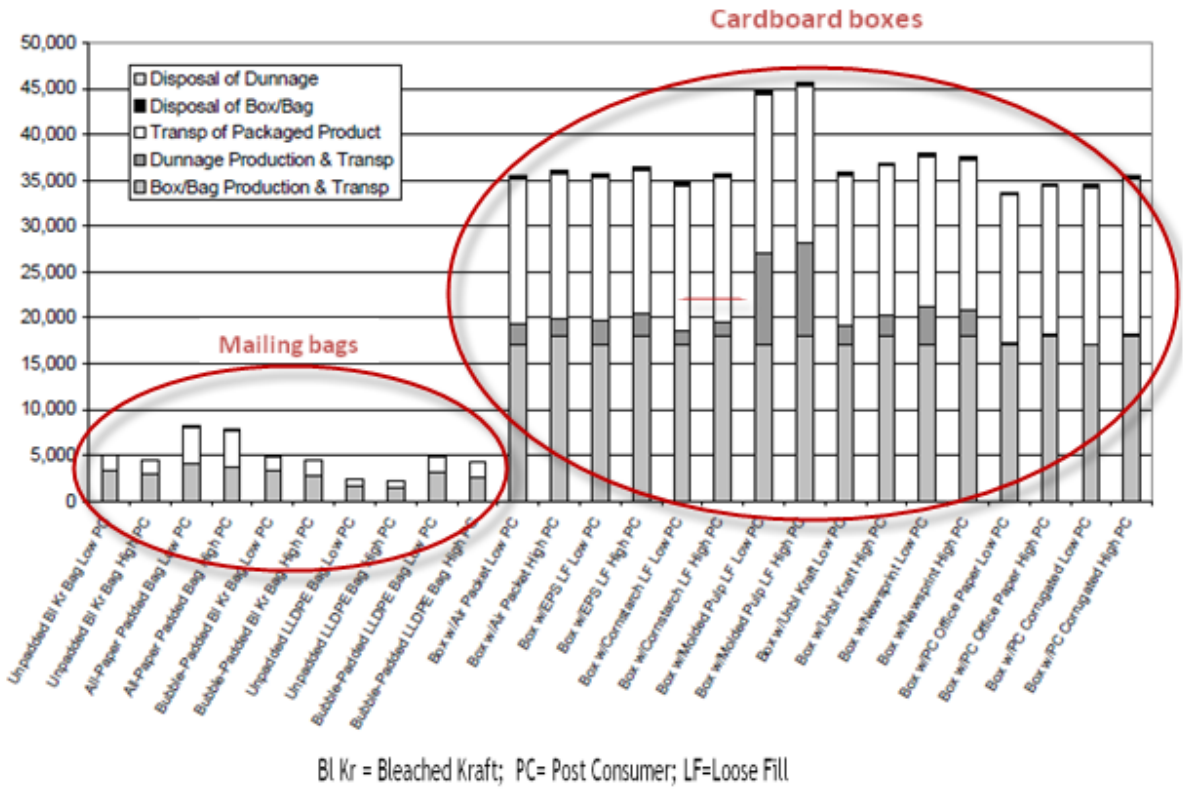


Figure 4. Total greenhouse gas emissions for 10,000 packages—pounds CO_2 equivalents
(Franklin Associates 2004)

Should one avoid using a cardboard box for packaging interlibrary loan materials at all cost? Does using cardboard packaging make one a bad person? The answer is no, of course not. This is a perfect time to make a point about all the recommendations coming out of this study, and their potential application in daily interlibrary lending operations out in the real world. ILL practitioners as a whole are an extremely capable group. They know what needs to be done in order to do the job correctly—getting materials safely, efficiently, and cost-effectively to those who need them, and, in the case of a returnable item, back home again. Sometimes a cardboard box is precisely what is needed, to ship an oversized or valuable or fragile item to an ILL partner. Interlibrary loan practitioners must use their professional judgment when deciding what sort of packaging is needed to accomplish the task at hand.

However, knowing what we now know about the relative impact on the environment of a padded mailer and a cardboard box, there are likely to be times—many times—when a padded mailer is perfectly adequate.

Bottom line: if practitioners can find a way to follow this report's recommendations most of the time, for most routine ILL activity, benefit will accrue. Do it when possible. Don't when impossible or inappropriate. Use professional judgment. Act decisively and guilt-free according to your informed professional opinion.

Observations: Shipping

A few key shipping decisions can make a huge difference in emissions numbers.

Table 3. Comparison of shipping emissions

	University of Miami	Clark Art Institute	Stanford University (Green Library	University of Chicago
Shipping Emissions (lbs CO_2)	6,095	383	6,735	20,851
Shipping Emissions (lbs CO_2 per 100 Book-Miles*)	0.044	0.050	0.057	0.054
Shipping % of total emissions	97%	87%	67%	55%

*This represents the emissions from moving 1 book 100 miles to normalize for loan volume and distance.

- **Aggregate materials to minimize shipments.** Clark and Chicago primarily use boxes to ship loans; however, Clark's per-book-mile emissions for ground shipments are higher because it aggregates shipments less frequently than Chicago (due to Clark's smaller volume of loans).
- **Minimize package size.** University of Miami has the lowest ground shipping emissions per book-mile. It uses 60% bags to ship materials, compared to other schools that use primarily boxes. Bags take up less space on the truck and can therefore help reduce carbon emissions and shipping costs.
- **Packaging size matters for courier shipments.** Totes occupy approximately 4.5 times as much space as nylon bags. For example, Miami's courier uses nylon bags while Chicago's uses totes.
- **Ground transportation produces fewer emissions that air.** While shipments traveling by air make up less than 10% of Miami's total book-miles, they account for 35% of its emissions.
- **Source materials locally if possible.** While Stanford and Chicago use similar shipment methods, the average Stanford loan travels around 700 miles further—in part because of the school's geographic location. By comparison, the average loan within Stanford's local consortium travels just one-third the distance of its Chicago counterpart.

Implications

What have we learned from correlating the data with the various packaging and shipping practices? Nothing that common sense wouldn't have marked as a good idea in the first place. But now we have some numbers we can point to that illustrate the actual difference in environmental impact among the various procedural alternatives.

What the data tells us . . .

Packaging impacts will be minimized by:

- Reusing packaging materials (cuts footprint nearly in half!).
- Joining local consortia that use reusable totes and nylon or canvas envelopes and require no additional packaging.
- Promoting reusability by using durable materials and handling them carefully to help others reduce their footprints.

Shipping impacts will be minimized by:

- Using the smallest size packaging possible (right-sizing to loan materials).
- Sourcing books/materials from the nearest lenders.
- Aggregating shipments (loans and returns) to the same destination.
- Using a low-impact mode of transportation (ground, not air).
- Choosing fuel-efficient vehicles.

Remember: CO_2e is just one tool to gauge environmental impacts—shipping and packaging operations also have implication for resource use, toxics, and waste production that should be considered, as well.

Barriers to greening

Kermit the Frog was correct when he lamented that it's not easy being green. The obstacles thrown into the path of those who would strive to protect the environment are numerous and formidable. We've listed some of these obstacles below.

Green interlibrary loan practices aren't always practical. But benefit accrues each time an ILL practitioner is in a position to make a green choice.

Cost barriers:

- Cost of greener (durable, recyclable, compostable) packaging materials limits their use.
- Cost of overhead scanners limits ability to send articles electronically without printing.
- Cost of recycled-content paper limits its use.

Operational barriers:

- While return items are not time-sensitive and may be held and then bundled with loan items, loan items must be sent immediately, limiting their aggregation and requiring more shipments.
- Fragile items require additional padding.
- Lack of communication between mailroom and library makes reuse of packaging difficult.
- Lack of storage space for used packaging materials discourages reuse.
- The time it takes to preserve and reuse old packaging materials may outweigh the avoided costs of new packaging materials.

Systemic barriers:

- Licensing agreements require that articles be printed prior to scanning electronically, resulting in unnecessary paper use.
- Lack of system for sharing best practices.
- Lack of incentives to improve environmental friendliness of activities.

Recommendations

The consultants' recommendations go beyond making process-oriented improvements to include strategies for better communication and for banding together to influence entities from which libraries buy services.

1. **Implement the current best practices** of libraries surveyed (see Appendix A).
    - Reuse packaging materials.
    - Promote reusability of packaging to help others reduce their footprints.
    - Use the smallest size packaging possible (form-fitting).
    - Source books/materials from the nearest lenders.
    - Aggregate shipments (loans and returns) to same destination.
    - Ship via ground, not air.
    - Use office paper with 30% recycled content, which costs about the same as virgin paper and works just as well in copiers.
2. **Communicate:** set-up portal/listserv for sharing greening and best practice information.
3. **Consider launching a purchasing consortium** to lower costs of packaging materials, office copy paper, and overhead scanners.
4. **Team together to influence**
    - article subscription licensing agreements to allow e-sending without print copying.
    - UPS/FedEx to use hybrid vehicles for shipments.
    - courier services to implement logistics best practices.

Appendix A. Library Greening Toolkit

Best practices observed: packaging

GOAL: Reuse packaging materials, minimize their size and weight, and utilize materials with maximum post-consumer recycled content.

1. Reuse materials:

- Sort materials that are received into "reuse", "recycle", and "trash" bins. [Chicago, Emory, Stanford]
- Collect used boxes and shipping materials from staff and other departments at the university (not just the library) for reuse. [NYU]
- Used shredded paper can serve as padding. [Emory, Princeton]. Reuse messy loose fill materials such as packing peanuts or shredded paper by placing them in plastic bags and then using as padding material. [NYU]
- If waterproofing is necessary, use plastic bags. They are lightweight and can be reused and recycled. [Stanford]
- Bubble and jiffy mailers can be used as box padding if no longer mailable. [Chicago, Emory, Stanford]
- The following materials can be reused: cardboard boxes, paper-filled jiffy bags (if not stapled), bubble mailers, bubble wrap, Kraft paper, shredded paper filler, Styrofoam peanuts, archival ribbon. [Emory]

2. Procure materials that are durable, contain recycled content, and are recyclable:

- If it becomes necessary to purchase new materials, try to source materials that are durable, contain recycled-content, and are recyclable.

- Cardboard mailers (e.g. U-Line Easy Fold) are recommended because they are durable, can be reused several times, contain 20-30% recycled content, and can be folded to the size of the item which reduces the volume of the package and the need for additional padding material. [Emory, Getty]

3. Recycle materials at end of life:

- If material can no longer be reused, recycle whenever possible. [Stanford]

4. Other innovative practices:

- If mailroom is separate from the library, ensure that there is communication so that library materials received can be reused by the mailroom in outgoing shipments. [Chicago, Stanford]
- If bundling books for shipments in bins/totes, use archival ribbon rather than additional packaging. [Emory]
- If eliminating paper files from automating workflow, use freed-up space to store packaging materials. [Stanford Business]
- Canvas bags are extremely durable and reusable (note that stickers placed on canvas bags can leave goo behind). [Swarthmore] Choose bags with clear plastic windows for shipping labels. [Chicago, Stanford]
- Participate in a local delivery consortia; they are often cheaper, reduce book-miles traveled, and do not require packaging other than a canvas bag or a paper routing slip tied to the books with archival ribbon and placed in reusable totes [Chicago, Emory, Stanford]

5. Practices to avoid:

- Avoid Styrofoam peanuts; they are not recyclable. [Stanford]
- Do not staple or rip open paper jiffy bags (they explode and can't be reused).

Best practices observed: shipping

GOAL: Reduce book-miles traveled and encourage fuel-efficient modes of transport.

1. Source books locally by utilizing local borrowing group consortia agreements. [Chicago, Emory, NYU]
2. Set up "custom holdings" system to automate a lender string based geography. [Chicago, Emory]
3. Ship via "ground" mode rather than "air". [Chicago, Emory]
4. Request hybrid electric vehicles at FedEx and UPS.
5. Encourage use of/campus testing of fuel-efficient or hybrid vehicles for deliveries from offsite storage facilities.
6. Avoid multiple shipments to same destination by bundling returns with outgoing loans. [Chicago, Emory]
7. Scan and send articles and book chapters electronically to avoid physical transportation of materials. [Chicago, Emory]
8. Use staff at offsite storage facilities to scan and send articles electronically. [NYU, Princeton]

Best practices observed: office paper use

GOAL: Reduce, reuse, recycle, and procure sustainably

1. Minimize use of paper
    - Verify availability of lending materials before printing any pick slips. [Emory, NYU, Princeton, Stanford]
    - Use electronic automation tools (such as Rapid Manager or BSCAN ILL) for article lending requests and tracking. [Chicago, Minnesota, NYU]

- If borrowers do not use ILLIAD or Odyssey, send articles by email or remote URL. [Emory, Princeton, Stanford]
- Use paperless billing and record-keeping. [Clark]
- When printing pick slips, book bands, and mailing labels, fit multiple to a page. [Chicago, Clark, Emory, Miami]
- Scan articles and send electronically via Odyssey or Ariel. [Chicago, Emory, Stanford]
- Ask article vendors to allow, on a trial basis, sending e-versions of articles without printing first. [Minnesota]
- If overhead scanners are not available, explore campus options for photocopiers with scanning function. [Chicago]
- Save microfilm/microfiche images to USB drives rather than printing. [Chicago, Emory, Stanford]
- Scanning equipment is expensive and can be fussy—take the time to develop a user manual to speed up staff training. [Illinois Wesleyan]
- Engage an ILL mentor to help maximize use of workflow automation tools. [NYU, SUNY Geneseo]

2. Reuse paper

- Make photocopies on the back sides of scratch paper. [Minnesota, NYU]
- Reuse back side of scratch paper for notes (cut sheets in halves or quarters). [Stanford]
- Reuse pick slip as mailing record, book band, or return paperwork. [Clark, Stanford]

3. Procure paper from sustainable sources

- Maximize recycled content of paper purchased (30% post-consumer recycled content is often cost-neutral).
- Purchase FSC-certified paper when possible.

Greening checklist for library workplace

(Bay Area Green Business Program 2007)

Reduce solid waste, and recycle

- Buy products shipped with less packaging and/or which have easily recyclable packaging.
- Buy products in returnable, reusable, or recyclable containers.
- Work with vendors to minimize packaging (ask vendors to take back packaging, or choose vendors who offer this service).
- Centralize purchasing to eliminate unnecessary purchases and ensure all waste reduction purchasing polices are followed.
- Arrange for cooperative buying through government, association, co-located business group, etc.
- Maintain proper storage conditions (e.g. temperature, humidity, etc.) to reduce material degradation.
- Arrange storage area/access to reduce potential for damaging stock.
- In the lunch room, replace disposables with permanent items (mugs, dishes, utensils, towels/rags, coffee filters, etc) and use refillable containers for sugar, salt, pepper, etc. to avoid individual condiment packets.
- Purchase reusable rather than disposable office items (refillable pens, erasable white boards and wall calendars).
- Replace several similar products with one or two that do the same job.
- If you use catering services, negotiate a discount for using your own dishes (encourage caterers to serve "family style" in reusable serving dishes").
- Lease, rather than purchase computers and printers.
- Recycle cardboard, newspapers, office paper, mixed paper, junk mail, glass and metal containers, plastics, carpeting, wood, scrap metal.
- Compost food waste and landscape trimmings.

Reduce solid waste, and recycle—continued

- Donate or exchange unwanted but usable items (furniture, supplies, scrap materials, computer disks, etc) to schools churches, hospitals, nonprofit organizations, museums, etc.).
- Reuse garbage bag liners; reuse paper for packaging instead of Styrofoam pellets, bubble wrap or other packaging materials; have your customers return packaging to you for reuse.
- Reuse office paper by keeping previously used paper near printers.
- Use computer fax modems that allow faxing directly from computers without printing.
- Eliminate fax cover sheets by using "sticky" fax directory notes.
- Set copier and printer defaults to double sided.
- Set word processing defaults for smaller fonts and margins that minimize paper use.
- Use the size reduction feature when copying—two pages of a book can often be printed on one page.
- Reuse office paper as scratch paper.
- Use a bulletin board for memos, etc. to minimize the number of people receiving individual copies.
- Replace memos with email messages and discourage the printing of messages.
- Use electronic files, or eliminate unnecessary paper forms, or redesign forms to use less paper.
- Reuse envelopes: cover up old addresses and postage, affix new.
- Design marketing materials that require no envelope—simply fold and mail.

Reduce solid waste, and recycle—continued

- Reduce all unwanted mailings:
    - For duplicate mailings, return labels requesting all but one be removed.
    - Removed your name/company from junk mail lists at http://stopjunkmail.org.
    - Purge your own mailing lists to eliminate duplication.
- Use central or master hard copy files, not multiple personal files.
- For new software, order only the number of manuals needed. Do the same with phone books. Encourage employees to share.
- Purchase recycled-content or used products:
    - Dumpster lids, utility bins, drums or recycling bins and containers; refuse pails and bags (recycled HDPE trash liners).
    - Boxes or bags for shipping.
    - Toilet paper, tissues, towels, toilet seat covers
    - Copy, computer or fax paper. Folders or other paper products. Letterhead, envelopes or cards (35-100% PCW).
    - Recycled or remanufactured laser and copier toner cartridges.
    - Carpet, carpet under-cushion, floor mats. Construction materials when building/remodeling.

Conserve energy

- Have a professional energy assessment of your library done. Complete regularly scheduled maintenance on your HVAC.
- Use computer hardware programs that save energy by automatically turning off idle monitors and printers.
- Use energy efficient equipment.
    - Use electrical equipment with energy-saving features (e.g. Energy Star) and ensure proper settings are enabled.
    - Use computer hardware programs that save energy by automatically turning off idle monitors and printers.
    - Use a time switch to automatically turn off office equipment after working hours.
    - Use sensors on vending and ice machines, and place machines in shaded areas.
    - Use weather stripping to seal air gaps around doors and windows. Insulate hot water pipes, heaters, and tanks.
    - Replace refrigerators over 10 years old with new Energy Star ones.
- Use energy-efficient lighting.
    - Replace incandescent bulbs with more efficient compact fluorescent lamps (e.g. T-8s or T-5s).
    - Use lighting controls such as occupancy sensors, photocells, or time clocks, especially in low occupancy areas.
    - Use dimmable ballasts to dim lights to take advantage of daylight.
    - Use daylight dimmers that turn off automatically when light is sufficient.

- Other conservation tips
    - HVAC: use programmable thermostat to control heating and air conditioning. Set to 78F for cooling, 68F for heating. Use the thermostat's night setback. Use bypass timers and/or time clocks. Use occupancy sensors. Use small fans or space heaters during off hours rather than conditioning entire office. Apply window film to reduce solar heat gain. Shade sun-exposed windows and walls using awnings, sunscreens, shade trees, or shrubbery.
    - Lighting: clean light figures so they light as effectively as possible (dirt can reduce efficiency up to 50%). Use task lighting rather than lighting the entire area. Use light switch reminders to remind staff to turn off lights.
    - General: institute a formal policy that all electronic devices and lighting be turned off when not in use. Use the standby mode on equipment (e.g. energy-saving buttons on copiers). Rearrange workspace to take advantage of areas with natural light and design for increased natural lighting when remodeling.

Conserve water

- Have a professional water assessment of your library done. Review it annually for new measures to implement.
- Understand and monitor each water bill for indications of problems. Call your utility if you notice unusual increases in use.
- Regularly check for and repair all leaks. Train staff to monitor and respond immediately to leaking equipment.
- Use low-flow aerators (1.5 gpm or lower for sinks, 2.5 gpm or lower for showerheads).
- If irrigation system is in place, check sprinkler heads regularly to be sure they are watering the lawn, not the sidewalk. Test system quarterly to ensure proper coverage and repair all broken or defective sprinkler heads, etc. Water during early morning hours to reduce water loss from evaporation.

Conserve water—continued

- Landscape with drought-resistant plants. Group plants by hydrozone (how much water they need). Use low-volume irrigation such as drip systems. Use ground cover or mulch around plants to prevent evaporation. Use reclaimed water for irrigation. Install rain shut-off devices as part of irrigation/landscape control measures.
- Replace toilets with 1.6 gpf toilets, dual flush, or ultra low flush toilets. Replace urinal flush mechanism with 1.0 gpf diaphragms, or waterless varieties. Provide additional urinals in men's restroom and reduce the number of toilets (urinals use less water than toilets).
- Use signs in restrooms and kitchens to encourage water conservation.
- Educate staff about the benefits of efficient water use.
- Change window-cleaning schedule from "periodic" to "as required".

Prevent pollution

- Clean parking lots by sweeping or using equipment that collects dirty water.
- Label all storm water drains with "No Dumping, Drains to Bay" message (or similar).
- Keep a spill kit handy to catch/collect spills from leaking employee and visitor vehicles.
- Have an outdoor ashtray or cigarette butt can for smokers.
- Buy cleaners, batteries and other supplies in optimally sized containers to avoid unnecessary packaging.
- Replace standard fluorescent lights with low- or no-mercury fluorescent lights.
- Use rechargeable batteries and appliances (e.g. hand-held vacuum cleaners, flashlights).
- Use unbleached and/or chlorine-free paper products (copy paper, paper towels, napkins, coffee filters, etc.).

Prevent pollution—continued

- Replace toxic permanent ink markers/pens with water-based ones.
- Print promotional materials with soy or other low-VOC inks.
- Ask janitorial, maintenance, and grounds staff to use safer/less-toxic cleaning products, maintenance materials, pesticides and fertilizers. Eliminate use of chemical pesticides by implementing an integrated pest management (IPM) program.
- Call your local household hazardous waste disposal program for disposal of hazardous substances not in use.
- Implement a "just-in-time" purchasing policy and a "first-in/first-out" chemical usage policy.
- Routinely check storage areas, pipes, and equipment for leaks, spills, and emissions of chemicals, paints, and cleaners.
- Store any potentially hazardous materials securely. Store deliveries and supplies under a roof.
- Keep dumpsters covered when not in use.
- Recycle used copier toner cartridges and ink jet cartridges.
- Reduce vehicle emissions.
    - Offer electric vehicle recharge ports for visitors and staff using electric vehicles.
    - When possible, arrange for a single vendor who makes deliveries for several items.
    - Patronize services close to your library (e.g. food, copy center, etc.) and encourage employees to do the same.
    - Offer lockers and showers for staff who walk, jog or bike to work. Offer secure bike storage. Offer employee incentives for carpooling or using mass transit. Set aside car/van pool parking spaces.

Additional resources

General:

- Sustainable Packaging Coalition: http://sustainablepackaging.org
- Environmental Defense Fund Innovation Exchange: http://innovation.edf.org

Tools:

- COMPASS: comparable packaging assessment: http://design-compass.org
- Green Shipping: carbon calculator: http://greenshipping.com
- Paper calculator: http://edf.org/papercalculator
- Greenhouse Gas Protocol: http://www.ghgprotocol.org
- ILLiad Workflow Toolkit: http://toolkit.idsproject.org

Example of packaging products:

- Green Packaging Inc.: http://greenpackaginginc.com/products.htm
- Green Planet Packaging: http://greenplanetpackaging.com

What is a "Carbon Footprint"?

A **carbon footprint** is a measure of the impact that human activities have on the environment in terms of the amount of greenhouse gases (GHG) produced, measured in units of carbon dioxide (CO_2).

Defining the "footprint"

Not all footprints are created the same—there is tremendous range in the scope of what companies decide to include in their footprint:

- Company owned and operated facilities
- Business and employee commuting
- Supply Chain operations

"Carbon equivalent" used as a standard measurement

Five gases in addition to CO_2 are considered major greenhouse gas (GHG) emissions:

- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

These have different global warming potentials (GWP), so to institute a common unit of measure, these other GHGs are converted into a "CO_2 equivalent" (CO_2e) unit via the following formula:

[x tons of a gas] * [GWP of the gas] = y tons CO_2e

Example: The GWP of methane is 23. What does 10 tons of methane translate to in terms of its carbon equivalent?

10 tons CH4 * 23 = 230 tons CO_2e

Role of transportation in carbon loading

For most companies, up to 75% of their GHG emissions come from transportation and logistics. (Sowinski 2007)

Greenhouse gas (GHG) emissions from transportation in California (California Air Resources Board 2007):

- 38% of carbon in CA is emitted from transportation sources
    - CO_2 emissions from transportation include:
    - ships, trains, and airplanes (2% each)
    - heavy duty vehicles/trucks (20%)
    - light and medium duty cars and trucks (74%)

CO_2 emissions per ton-mile compared to road transportation (Crouch 2008):

- Air by 8x
- Rail by 4x
- Sea by 8x

Should you consider more than your carbon footprint?

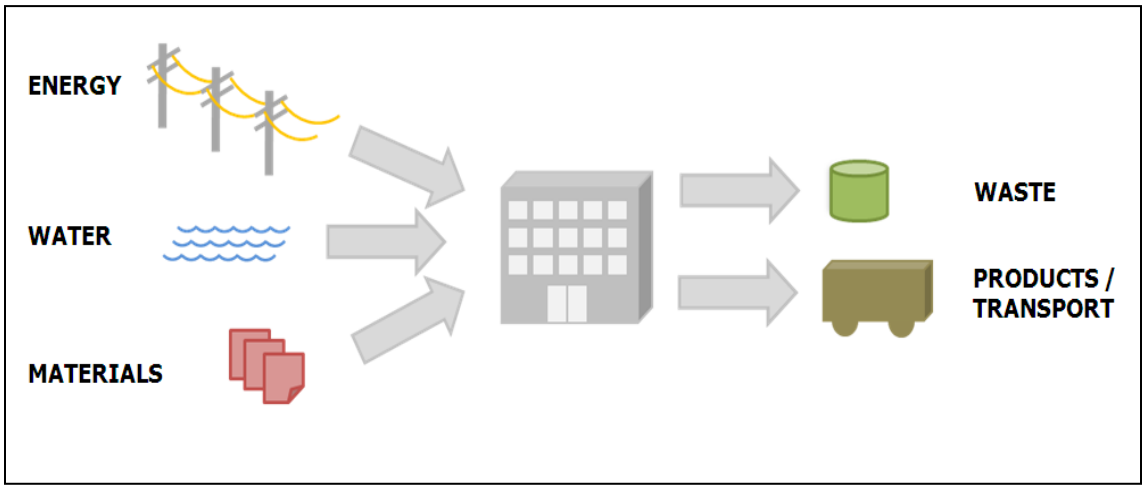


Figure 5. The entire "environmental footprint"

Many organizations are going beyond a "carbon footprint" to capture their full "environmental footprint," from energy, water and materials to physical plant to waste disposal and transportation of products.

Determining your scope (Ranganathan, et al 2004)

- **Scope 1:** Direct GHG emissions
  Occur from sources that are owned or controlled by the company (e.g. emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.).
- **Scope 2:** Electricity indirect GHG emissions
  Occur from the generation of purchased electricity consumed by the company.
- **Scope 3:** Other indirect GHG emissions
  Occur as a consequence of the activities of the company, but occur from sources not owned or controlled by the company (e.g. extraction and production of purchased materials; transportation of purchased fuels; use of sold products and services).

Appendix B. ILLiad Half Paper/Half Label Template

In an inspired effort to save paper, Tracy Luna, Head of Interlibrary Loan at the University of Tennessee in Knoxville, developed a template which lets the ILLiad resource sharing system print a mailing label and pick slip/book strap at the same time. Then she worked with a local printer to come up with a sheet that is half paper, half self-adhering label stock.

(See an example of the template on the next page.)

We came across the innovation when touring the ILL unit at Stanford University's Green Library. Tracy had shared her template and the secret of the paper/label stock with Stanford's Rose Harrington, who wanted to make sure this paper-saving idea reached a wider audience (and that Tracy received a well-deserved round of applause).

Tracy has graciously agreed to share her template with anyone who is interested; her contact information can be found at https://www.lib.utk.edu/ils/LendingIndex.html.

The source for the half paper/half label sheets is:

King Business Solutions
P.O. Box 1467 | New Tazewell, TN 37824
531 Straight Creek Road | New Tazewell, TN 37825
Phone: 423-626-7700 | 800-251-9236
Fax: 423-526-5225
http://www.kbfcorp.com/

As of July 2009, a box of 15,000 cost $1,979.00, including shipping.

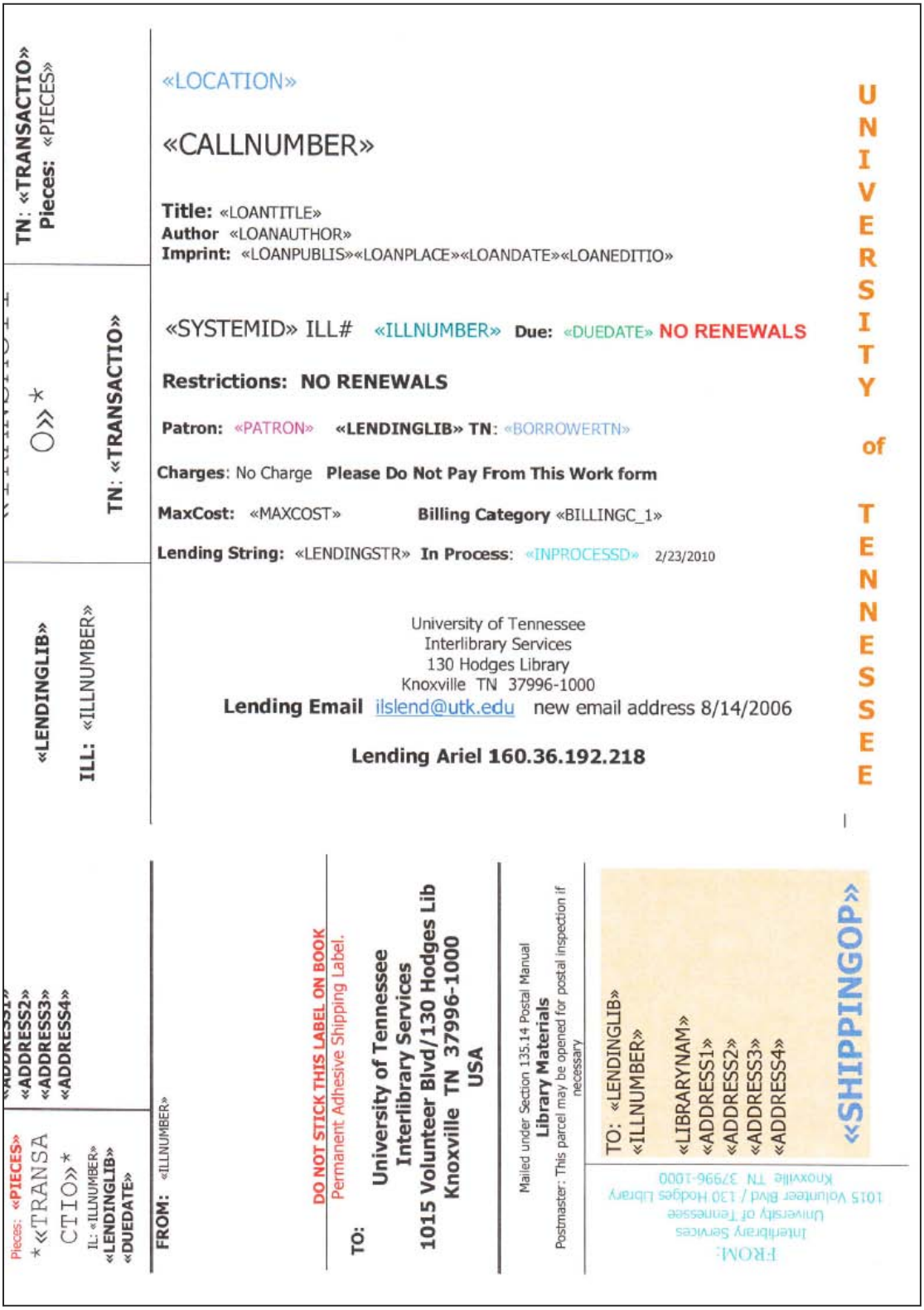


Figure 6. ILLiad "half paper/half label" template

Appendix C. Additional Environmental Impact Data

Environmental impact analysis—shipping

Table 4. Detailed shipping emissions data

	University of Miami	Clark Art Institute	Stanford University (Green Library)	University of Chicago
Courier Van Shipments	**3,476**	**N/A**	**371**	**8,017**
Total Items	5,975		2,532	20,261
Total Book Miles (000s)	3,393		196	8,550
Total CO_2 (lb)	1,189		117	6,164
% Aggregated Shipments	70%		95%	58%
Average Items/Shipment	1.72		6.82	2.53
Average Miles/Shipment	593		92	320
lb $CO_{2/}$Shipment	0.34		0.31	0.77
lb CO_2/100 Book-Miles	0.035		.060	0.072

Table 4. Detailed shipping emissions data—*continued*

	University of Miami	Clark Art Institute	Stanford University (Green Library)	University of Chicago
Ground Shipments	**3,036**	**346**	**1,800**	**8,842**
Total Items	3,599	470	2,416	13,170
Total Book Miles (000s)	9,165	766	10,337	26,413
Total CO_2 (lb)	2,776	383	4,600	8,518
% Aggregated Shipments	12%	24%	23%	33%
Average Items/Shipment	1.19	1.36	1.34	1.49
Average Miles/Shipment	2,919	1,690	4,477	2,106
lb CO_2/Shipment	0.91	1.10	2.56	0.96
lb CO_2/100 Book-Miles	0.030	0.050	0.045	0.032
Air Shipments	**329**	**1**	**601**	**655**
Total Items	569	1	1,497	1,128
Total Book Miles (000s)	1,291	0.423	1,223	3,739
Total CO_2 (lb)	2,130	1	2,019	6,169
% Aggregated Shipments	49%	0%	99%	48%
Average Items/Shipment	1.73	1.00	2.49	1.72
Average Miles/Shipment	2,263	370	760	2,797
lb CO_2/Shipment	6.48	0.70	3.36	9.42
lb CO_2/100 Book-Miles	0.17	0.17	0.17	0.17

Table 5. Detailed impact of material production and disposal

	University of Miami	Clark Art Institute	Stanford University (Green Library)	University of Chicago
Material Production				
Production of virgin non-courier packaging (no reuse) (lb CO_2e)	3,354	729	3,864	21,221*
Production of virgin non-courier packaging (including reuse) (lb CO_2e)	183	53	3,255	16,977
% Reduction through reuse	95%	93%	16%	20%
End of Life Disposal				
Disposal of all Packaging Materials (lb CO_2e)	20	3	19	103
Solid Waste				
Landfill Weight (lb)	593	102	581	3062
Landfill Volume (cu ft)	22	4	21	110

*The University of Chicago uses boxes which contain 90% post-consumer recycled cardboard—which significantly reduces resource use to produce packaging, but increases GHG emissions. See Appendix E, Special Case (p. 61), for background.

See Appendix E, Data Methodology, for assumptions and calculation methodology.

Appendix D. Library Profiles

Library profile: University of Miami

Location: Miami, Florida

Consortia arrangements (lending):

- 52% Tampa Bay Library Consortium (uses DLLI carrier)
- 35% Kudzu / ASERL (Association of Southeast University Research Libraries)
- 5% RLG SHARES
- 8% non-consortia

Packaging types:

- 40% cardboard boxes (reused)
- 30% paper envelopes (some purchased new)
- 30% bubble envelopes (reused)
- Reusable nylon bags for couriers; some are lined with bubble mailers

Padding materials: primarily newsprint, also bubble wrap and Styrofoam peanuts

Packaging methods: packaging done in ILL area (not mailroom)

Shipping methods: FedEx Ground (3x/wk), DLII and Lanter (1x/day) for consortia

Best practices: electronic requests and article transfers; does not print articles prior to sending; minimizes paper use; tries not to rip envelopes so can reuse

Table 6. University of Miami emissions data

University of Miami	
Loan volume (returnables)	**10,143**
Book Miles Traveled (000s)	13,849
Total Emissions (lbs CO_2)	6,297
Shipping Emissions (lbs CO_2)	6,095
Shipping Emissions (lbs CO_2 per 100 Book-Miles)	**0.044**
Shipping % of total emissions	97%
Packaging Emissions (lbs CO_2e)	203
Packaging Emissions (lbs CO_2e per 100 books)	**2**
Packaging % of total emissions	3%

Library profile: Clark Art Institute

Location: Williamstown, MA

Consortia arrangements (lending):

- 50% RLG SHARES (art museum libraries is a subset)
- 50% non-consortia

Packaging types:

- 98% cardboard boxes (reused)
- 2% bubble envelopes

Padding materials: each book wrapped in bubble wrap (new and used); used shredded paper as needed

Packaging methods: Clark library does its own mailing in-house

Shipping methods: UPS Ground (1x/day); USPS for Canada (only 1% of shipments)

Best practices: doesn't buy any new boxes; ships only ground, not air; spends only $150/yr on packaging

Table 7. Clark Art Institute emissions data

Clark Art Institute	
Loan volume (returnables)	**471**
Book Miles Traveled (000s)	767
Total Emissions (lbs CO_2)	439
Shipping Emissions (lbs CO_2)	383
Shipping Emissions (lbs CO_2 per 100 Book-Miles)	**0.050**
Shipping % of total emissions	87%
Packaging Emissions (lbs CO_2e)	56
Packaging Emissions (lbs CO_2e per 100 books)	**12**
Packaging % of total emissions	13%

Library profile: Stanford University

Location: Stanford, CA

Consortia arrangements (lending):

- 32% UC System
- 30% RLCP
- 20% RLG SHARES
- 18% non-consortia

Packaging types:

- 85% cardboard boxes
- 5% cardboard mailers
- 5% bubble mailers
- Nylon bags and plastic bins (For Tricor and RLCP)

Padding materials:

- Tricor: wrap in recycled bubble mailers and place in nylon pouch (or plastic bin if DVDs, VHS, etc.)
- RLCP: plastic bins lined with plastic bags; occasionally pad with reused materials (e.g. envelopes)
- UC Berkeley (ILB, RLCP, and ILL): items shipped together in a bin, stacked inside a large plastic bag

Packaging methods: packaging done in mailroom, separate from ILL area

Shipping methods: Tricor courier for UC system, UPS for SHARES, USPS for non-resource sharing

Best practices: electronic requests and article transfers; minimal packaging for courier shipments; reuse of padding materials

Table 8. Stanford University emissions data

Stanford University	
Loan volume (returnables)	**6,445**
Book Miles Traveled (000s)	11,756
Total Emissions (lbs CO_2)	10,009
Shipping Emissions (lbs CO_2)	6,735
Shipping Emissions (lbs CO_2 per 100 Book-Miles)	**0.057**
Shipping % of total emissions	67%
Packaging Emissions (lbs CO_2e)	3,274
Packaging Emissions (lbs CO_2e per 100 books)	**51**
Packaging % of total emissions	33%

Library profile: University of Chicago

Location: Chicago, Illinois

Consortia arrangements (lending):

- 41% CIC
- 24% Illinet (ILDS)
- 14% RLG SHARES
- 2% Center for Research Libraries (CRL)
- 19% non-consortia

Packaging types:

- Reusable canvas bags and gray totes (for CIC, ILDS)
- 100% cardboard boxes containing 90% post-consumer recycled content (80% are new, 20% are reused)

Padding materials: newsprint and bubble wrap used in every box, 20% is reused

Packaging methods: students help pack for UPS

Shipping methods: Lanter (1x/day) for CIC and ILDS, USPS for international, UPS for all other

Best practices: tracks and monitors shipping data closely; electronic requests and article transfers; uses custom holdings to source materials; ships UPS ground not air; reuses newsprint and some bubble bags; prints bookbands 2/pg and shipping labels 3/pg; shipping boxes contain 90% post-consumer recycled content

Table 9. University of Chicago emissions data

University of Chicago	
Loan volume (returnables)	**34,559**
Book Miles Traveled (000s)	38,702
Total Emissions (lbs CO_2)	37,931
Shipping Emissions (lbs CO_2)	20,851
Shipping Emissions (lbs CO_2 per 100 Book-Miles)	**0.054**
Shipping % of total emissions	55%
Packaging Emissions (lbs CO_2e)	17,080
Packaging Emissions (lbs CO_2e per 100 books)	**49**
Packaging % of total emissions	45%

Appendix E. Data Methodology

1. **Scope**

   - Loans of returnable items requested via WorldCat Resource Sharing (WCRS) servers (Stanford data also includes ISO ILL requests sent peer-to-peer to University of California partners)
   - Data covered one year, July 2008 –June 2009 for all libraries surveyed.
   - OCLC provided data on loans from each of the 12 lending libraries to all of their borrowing libraries in the WorldCat system. Data included library codes, number of loans, and destination city/state/zip.

2. **Data Sources**

   - CEA conducted two phone interviews with each lending library; interviewees provided information on consortia lending volumes, packaging and shipping requirements, estimated packaging material usage frequency and reuse, item aggregation, and shipping methods.
   - The 2004 Franklin Associates study, "Life Cycle Inventory of Packaging Options for Shipment of Retail Mail-Order Soft Goods" was used as a starting point to develop the framework for calculating shipping and packaging lifecycle emissions and to make basic assumptions around parcel carrier operations. Where possible, the 2004 assumptions (such as fleet fuel efficiency) were updated for 2009.
   - Emissions factors and methodology from the Greenhouse Gas Protocol Mobile Source Tool were used to calculate transportation emissions.

3. **Data Limitations and Basic Assumptions**
   - The weight of each item loaned was assumed to be 1.5 lbs. Estimated packaging weights used in this study are listed in Table 10 on the next page.
   - Loan volume data was only available for requests made via OCLC WCRS servers. However, because the large majority of loans for Stanford University did not go through

the OCLC servers, this data was provided by Stanford's ILL staff and includes transactions from ISO ILL and OCLC systems.

- It is assumed that each library is responsible for the shipping and packaging impacts associated with its lending operations. To avoid double counting of impacts, data for borrowed returnables was not included in this calculation.
- For the purposes of this evaluation, it was not practical to quantify the total of environmental hazard for all areas of concern. We have therefore limited the calculations to greenhouse gas emissions (CO_2, or CO_2e, where data was available) due to the availability of a uniform metric and reputable data. Discussion on other environmental impacts has been included in the qualitative sections of this report.

Table 10. Definition of packaging systems

Packaging System	Dimensions	Weight (lb)	Notes
Padded Mailing Envelope (single item)	9.5" x 14.5" x .5"	0.15	#4 mailer; weight is average of #4 paper-padded and bubble mailers
Padded Mailing Envelope (2.5 items*)	9.5" x 14.5" x 1.25"	0.15	Assumes 250% increase in height
Cardboard box	UPS: 18" x 13" x 3"		
FedEx: 17.88" x 12.38" x 3"	0.91	Average volume of FedEx and UPS large express mail boxes; weight provided on company websites	
Cardboard Book Mailer (single item)	12" x 10.5" x .5"	0.37	Weight and dimensions based on U-line S-3655 Kraft easy-fold mailer
Cardboard Book Mailer (2.5 items)	12" x 10.5" x 1.25"	0.37	Assumes 250% increase in height
Plastic Courier Bin	19.8" x 13.8" x 11.8"	7	Size chosen based on dimensions provided by Steve Slightom, Lanter Systems. Weight and dimensions based on U-line S-9744 attached lid shipping tote.
Nylon Courier Bag	22" x 16"x2"	0.63	Nylon Round -Trip Mail Pouch, chosen based on cost estimate given by Rose Harrington at Stanford.

* Based upon conversations with the surveyed libraries, in cases where multiple items were shipped to the same destination, it was assumed that 2-3 items were bundled in the same package (2.5 on average).

Methodology: Shipping Impacts

1. Shipping Distance Calculation

- One-way straight line distances between lending libraries and borrowers were calculated based on lender addresses and borrower postal codes using the Batch Geocode Tool (www.batchgeocode.com).
- Distances were doubled to account for roundtrip travel.
- Actual road distances between lenders and borrowers were calculated for 50 randomly selected routes using Google Maps (www.maps.google.com). For the 50 sample routes, road distance was 23% higher, on average, that straight line distance. Accordingly, distances for all materials traveling by ground transportation were increased by 23% to account for the difference between straight line and road distances.
- Total road distance was multiplied by an additional 25% to account for under-filled vehicle loads and backhauling (e.g. increased mileage due to the fact that a sorting/distribution center may not be located directly en route from the lender to the borrower). This assumption is taken from the 2004 Franklin study.
- Straight line distance for materials traveling by air was increased by 9% to take into account non-direct routes (i.e. not along the straight line great circle distances between destinations) and delays/circling. The uplift factor comes from the IPCC Aviation and the global Atmosphere 8.2.2.3 , which states that 9-10% should be added (Defra, 2007).

2. Book-Miles Calculation

- In order to compare shipping impacts across schools, impacts were converted using the metric: pounds of CO_2 per book-mile travelled. This metric allowed us to normalize for differences in shipment volume and distances travelled.
- To calculate book miles, the distance between the lending and borrowing libraries was multiplied by the number of items going from the lender to the borrower.
- This distance was doubled to account for the roundtrip distance that the book travels.

3. Shipping Method Choice

- Based on interview responses, it was determined that materials travelled by the following modes: courier ground transportation, ground parcel post (FedEx, UPS, or USPS), or air transportation (courier air, FedEx, UPS, or USPS).

- Transportation mode for each shipment was selected based on the following factors (in this order):

    - **For shipments made to consortia members, where the consortia provide courier services:** Shipments were assigned the travel mode of courier van or air based on survey responses.

    - **For transcontinental/international shipments:** Air transport was assumed.

    - **2-day air delivery requirement:** For shipping agreements where shipments were guaranteed within 2 days by commercial parcel carriers (U. Miami – Kudzu), a straight line distance threshold of 800 miles was applied for ground transport, based on estimates from the UPS shipping time estimate tool (http://www.ups.com/maps).

    - **Courier air shipments:** Due to lack of data on courier air shipments, the impacts of materials traveling by courier air transport and commercial carrier air transport were assumed to be the same.

- **Loan Aggregation and Return Shipments**

    - Survey responses indicated that loaned volumes are aggregated for shipments, particularly for the largest borrowers. Aggregation for outgoing shipments was calculated based on reported behavior for consortium and parcel shipments.

    - Interviewees uniformly reported that return shipments were aggregated more frequently than outgoing shipments, given the lack to time pressure on receipt of return materials. Therefore, the number of return shipments was estimated to be 25% less that the number of outgoing shipments.

- **Estimating the Number of Outgoing Shipments**

    - **Consortia:** All consortium courier services included in this evaluation provide daily pick-up services for the lending institutions they serve. It is assumed that the courier service comes to each school approximately 245 days per year. (5 days/week for 52 weeks, less 15 days for holidays and closures).

- If the number of items going to a certain borrower was greater than or equal to 245 for the year, it was assumed that the courier services picked up items on every trip, resulting in 245 shipments from the lender to the borrower; the number of items per shipment was the total number of items loaned divided by 245.
- If the number of items going to a certain borrower was less than 245 and greater than or equal to 48 (approximate number of weeks in a year, accounting for holidays and school closures), it was assumed that the courier services picked up items at least once per week resulting in 48 shipments from the lender to the borrower; the number of items per shipment was the total number of items loaned divided by 48.
- If the number of items going to a certain borrower was less than 48, it was assumed that aggregation did not occur and that the number of shipments was equal to the number items loaned, with 1 item per shipment.

- **Parcel Shipments:** All of the lending institutions surveyed in this study use commercial parcel carriers for pick-up and drop-off of loaned materials.
  - For borrowers receiving at least 48 items (or 1 shipment per week), it was assumed that some shipments were aggregated. Interviewees reported aggregating 2-3 items at once for larger borrowers, so aggregated shipments were assumed to contain 2.5 items/shipment. The number of shipments was assumed to be the number of items loaned divided by 48.
  - If the number of items going to a certain borrower was less than 48, it was assumed that aggregation did not occur and that the number of shipments was equal to the number items loaned, with 1 item per shipment.

4. Calculating Impacts from Ground Transportation

Through research on previous shipping studies that surveyed UPS and FedEx, and conversations with representatives of the Lanter courier service, it was determined that materials that ship by ground transportation travel by delivery van and by tractor trailer truck. Materials are picked-up in a delivery van and transferred to a sorting center. They travel from sorting center to sorting center by tractor trailer, and then from the final sorting center to the delivery location by delivery van. Assumptions for vehicle mileage, fuel mix and efficiency, capacity, etc. are modeled after the 2004 Franklin Associates study. Assumptions taken from this study are listed below:

- **Vehicle types:**
    - P70 Delivery Van: Model Year: 1999; Fuel Efficiency: 7.5 mpg, based on Oak Ridge National Laboratory Transportation Data Book Edition 28; gross vehicle weight: 15,000 lb, unladen wt 9,400 lb, 700 cu ft; Max vehicle load: 5,600 lb or 700 cu ft
    - T28 trailer: Model Year: 1999; Fuel Efficiency: 5.4 mpg, based on Oak Ridge National Laboratory Transportation Data Book Edition 28; gross vehicle weight: 40,000 lb, unladen wt 9,560 lb, 2013 cu ft; Max vehicle load: 30,440 lb or 2013 cu ft
- **Distance by vehicle type:** Based on assumptions made in the 2004 Franklin study, it was assumed that the distance traveled by delivery van was 25 miles. This mileage includes the distance from the lending library to a sorting/distribution center and from a final sorting/distribution center to the borrowing library. The remainder of the trip was allocated to travel by tractor trailer truck.
- **Fuel mix:** Assumptions on fuel mix were borrowed from the 2004 Franklin study. It was assumed that 80.6% of freight vehicles run on diesel fuel and 19.4% utilize gasoline.
- **Calculating Fuel Use:** Emissions for ground shipping were calculated based on the fuel usage required for transport activities. As demonstrated by Equation 1, fuel usage was calculated by multiplying the road distance travelled by each type of vehicle between lender and borrower by the number of shipments going from the lender to the borrower. These totals were then multiplied by the fuel efficiency of each vehicle type to obtain the total gallons of fuel used. This amount was then multiplied by the fuel percentages of gasoline and diesel to determine the gallons of each fuel required for transport.

  Equation 1: Fuel Usage for Delivery Van (this calculation was repeated for tractor trailer distances and fuel use)

  (Distance Lender to Borrower by Delivery Van[mi])*(# of shipments)

  (Fuel Efficiency of Delivery Van [mpg])

  (Delivery van fuel use[gal])*(Percentage gasoline use[19.4%]) = Delivery van gasoline use [gal]

  (Delivery van fuel use[gal])*(Percentage diesel use[80.6%]) = Delivery van diesel use [gal]

- **Calculating Carbon Dioxide Emissions:** Carbon dioxide emissions were calculated based on fuel usage and using emissions factors and methodology laid out in the Greenhouse Gas Protocol. Equation 2 shows the calculation to convert fuel use to pounds of CO_2 emitted.

  Equation 2: Calculating CO_2 Emissions for fuel use

  2a: CO_2 Emissions from Total Gasoline Use = (Delivery Van Gasoline Use + Truck Gasoline Use)*Gasoline Heating Value* Gasoline Emissions factor

  2b: CO_2 Emissions from Total Diesel Use = (Delivery Van Diesel Use + Truck Diesel Use)*Diesel Heating Value* Diesel Emissions factor

- **Allocating CO_2 Emissions from Ground Transportation to Lending Institutions:** Equation 2 yields the CO_2 emissions of the entire vehicle traveling between the lender and the borrower. Emissions were assigned to each individual shipment of books by multiplying the emissions of the vehicle by the percentage of the truck volume the shipment occupied.

- Emissions were allocated based on the volume capacity of the vehicle rather than the weight capacity of the vehicle based on several sources which indicated that parcel carriers are more likely to fill loads based on volume rather than weight capacity.

- This calculation assumes that the truck is filled to capacity for each shipment. Under-filled loads were accounted for in the shipping distance calculation (Slide 44) by a 25% increase in mileage.

- Lending libraries indicated that they were shipping in cardboard boxes, padded mailing envelopes, cardboard book mailers, courier bins, and courier nylon bags. A uniform size for each of these packaging materials was assumed for this calculation. Padded mailing envelopes and cardboard book mailers were assumed to expand based on the number of items per shipment. The size and volume of each of these packaging systems is listed in Table 1.

- For example, if Lender A sent 30% of its single item shipments in padded mailing envelopes, emissions for those shipments would be allocated as follows in Equation 3:

Equation 3: Sample Emissions Allocation Calculation

(Delivery van emissions from single item shipments [lbs CO_2])*(Percentage shipments sent by mailing envelopes)*

(Volume of Padded mailing envelope with single item[cu. in.]/Volume-filled load capacity of delivery van[cu. in])

- This calculation was repeated for each configuration of packaging system and delivery vehicle to obtain the CO_2 emissions for each lender's shipments.

5. Calculating Impacts from Air Transportation

- Emissions for air transportation were calculated based on air operations emissions factors published by UPS and FedEx in their 2008 sustainability reports. It is assumed that published emissions factors include both the emissions from air transport and short hauls between airports and pick-up/delivery locations.
- Emissions factors are published using the metric: pounds of CO_2 emitted per available ton-mile (ATM). Emissions factors for FedEx and UPS are listed below.

  UPS: 1.23 lbs CO_2/ATM[1]

  FedEx: 2.2 lbsCO_2/ATM[2]

- Emissions factors for USPS air operations were not available. Because international shipments were assumed to use air transport and USPS was the carrier most cited for international shipments, the FedEx estimate of 2.2 lbs CO_2/ATM was used as the more conservative factor for this calculation.
- Total freight weight was calculated based on the percentage use reported of each packaging system in the data surveys. The assumed weight of each packaging system is listed in Table 1. Equation 4 below details the calculation used to determine total air freight.

Equation 4: Calculation of Air Freight

(standard book weight)*(# of items per shipment)*(# of shipments)+(percentage use of packaging system x*# shipments* weight of packaging system x)+(percentage use of packaging system y*# shipments* weight of packaging system y)* +(percentage use of packaging system z*# shipments* weight of packaging system z)

Equation 5: Calculation of Air Transport Emissions

lb CO_2 Emissions = (air freight [tons])*(total air miles)*2.2lbs CO_2/available ton-mile

6. Per-book-mile Emissions

Per-book-mile emissions estimates for each mode of transport were determined by dividing the total lbs of CO_2 emissions for each mode by the total book-miles for that mode. Per-book-mile emissions estimates for the entire lending institution were calculated by dividing its total emissions by its total book miles traveled.

Methodology: Packaging Impacts

1. Lifecycle Packaging Data

- Packaging lifecycle impacts were pulled primarily from the previously cited 2004 Franklin Associates study, "Life Cycle Inventory of Packaging Options for Shipment of Retail Mail-Order Soft Goods."
- Data provided in the Franklin study covers the lifecycle impacts of several types of packaging systems observed in the lender libraries. These lifecycle phases include material extraction, product fabrication, transportation to distribution center, transportation to end user, and disposal. For this ILL impact study, transportation to the end user is calculated separately per the methodology described in the previous section as the parameters set in the Franklin study are not appropriate for the question at hand.
- The Franklin study provides packaging lifecycle data for 2000 lb units of packaging material produced. Standard packaging sizes are used across the study. Impacts per package are based on the unit weight of each packaging material. However, the size of packaging units in the Franklin study was not appropriate for the ILL impact calculation; packaging units were scaled to sizes more appropriate for the materials being shipped by the lending libraries. Impacts were then adjusted according to the weight of the new packaging units. Assumptions on the size weight, and padding for each of the packaging systems considered are listed in Table 11.

Table 11. Definition of packaging configurations

Packaging Configuration	Component % Weight (As specified in Franklin Associates study)	Unit Packaging wt (lb)	Durability (Number of times item can be reused, based on survey responses)
Cardboard Mailer		**0.37**	**3.5**
Box		**0.91**	**4.5**
Bubble wrap		0.042	5
Corrugated Cardboard		0.16	5
Kraft paper		0.09	3
Newsprint		0.085	2
Peanuts		0.024	2
Bubble Padded Mailer		**0.078**	**3**
Bleached Kraft Bag (% wt)	66%	0.052	
LDPE and LLDPE Bubble Padding (% wt)	37%	0.029	
Paper Padded Mailer		0.22	2
Bleached Kraft Outer (% wt)	26%	0.058	
Unbleached Kraft Inner (% wt)	24%	0.052	
Macerated 100% PC Newspaper Padding	50%	0.11	

2. Packaging Choices for this Calculation

- **Size:** Because uniform packaging type was assumed for single and aggregated shipments, the packaging sizes selected represent sizes that are reasonable for shipping 1-3 items of variable size. Cardboard box size chosen is slightly larger than padded mailer and book mailer sizes due to the observation that cardboard boxes often contain more padding material than other packaging containers.

- **Padding material:** packaging padding needs in the Franklin Associates study represent approximately 50% void space in the package requiring padding material. Based on tour observations, it is estimated that the void space in library packaging operations is less than this amount. Therefore, it is estimated that the void space is approximately 25% of the volume of the package. To adapt the weight of padding material per package to the

packaging containers used in the library calculation, we followed the following calculation steps:

- Determine the weight ratio of Franklin study padding materials to Franklin study packaging containers.
- Find the weight of padding materials used by ILL departments relative to the packaging containers modeled in the ILL calculation.
- Divide this amount by half to account for reduced void space.

- **Additional adjustments to study data:**
  - **Cardboard Mailers:** The Franklin study did not cover the use of cardboard book mailers. In order to estimate the lifecycle impacts of cardboard mailers, production impacts for cardboard boxes were scaled for the unit weight of the cardboard mailer.
  - **Corrugated cardboard padding:** The Franklin study did not cover the use of corrugated cardboard sheets as padding material. The lifecycle impacts of this material were assumed to be 75% of the impacts of corrugated cardboard production, as it does not include the Kraft linerboard outer shell.
  - **Bubble wrap padding:** The Franklin study did not cover the use of bubble wrap as padding material. It does provide production data for the bubble padding used in padded mailing envelopes. These impacts were scaled based on the weight of bubble wrap padding modeled in the library calculation.
  - **Courier packaging**: No production impacts were attributed to courier packaging systems because of the length of time those materials remain in circulation (for example, one interviewee mentioned seeing plastic bins in circulation for 12 years). Reused padded mailing envelopes were most commonly used as padding material in courier bins and bags. For the ILL impact study, it was assumed that, if padded, bins contained 3 bubble padded mailing envelopes and canvas bags contained 1.

3. Transportation to Distribution Center and Disposal Impacts

- The Franklin study estimates impacts for transport from packaging production center to the point of use and from end user to disposal based on the locations of the distribution center and end use customer modeled in the study. As both of these impacts represented a very small percentage of the total lifecycle footprint, they were modeled

in the ILL impact study based on the percentage of production impacts they represented in the Franklin study.

- For packaging materials that were not modeled in the Franklin study, transportation to distribution center and disposal impacts were estimated as follows:
    - Cardboard Mailer: Same as cardboard box
    - Corrugated Cardboard padding: Same as cardboard box
    - Bubble Wrap: Same as packing peanuts (based on similar weight to volume ratio)

4. Allocations of Packaging Impacts:

- Packaging production and transport to distribution center impacts were attributed to the lending library for those new materials purchased by the lending library. No impacts were assumed for materials being reused.
- Disposal impacts represent the emissions required to transport waste packaging materials from the end use customer to the landfill or recycling center. This calculation made assumptions on reuse of materials based on survey responses. Disposal impacts were scaled to represent this behavior. For example, if bubble wrap padding can be used 5 times, it was estimated that 20% of the bubble wrap used at a school will be thrown away or recycled.
- Due to limited data on the decomposition emissions of waste once it reaches the landfill and recycling process emissions, disposal emissions include primarily emissions for transport to processing centers.

Special Case: Calculating packaging impacts from 90% post-consumer recycled content cardboard boxes

Multiple methods exist to estimate the GHG emissions impact from the production of cardboard boxes containing post consumer recycled content. For the sake of consistency within this calculation, we have adhered to the lifecycle scope as defined in the Franklin Associates study, which does not include emissions from decomposition at the landfill or those occurring as result of long term changes in land use or market forces. This method shows in an increase in GHG emissions as a result of the University Chicago's use of cardboard boxes containing 90% post-consumer recycled content. We recognize that this is a limitation of the study parameters and does not capture the full picture of impacts, which are detailed below.

Although **higher recycled content cardboard boxes require less energy to produce than lower recycled content options**, increasing the recycled content for these products shifts GHG emissions from the combustion of pulping liquors, a waste product of the manufacturing process, to fossil fuel-derived emissions. According to the methodology used by both U.S. EPA and the Franklin Associates study reviewed in this calculation, wood-derived emissions (from the pulping liquors) are not considered a net contributor to global warming, while fossil fuel-derived emissions are counted (Franklin Associates 2004).

The reason carbon dioxide emissions from wood or paper are not counted towards the total greenhouse gas emissions is as follows: as a tree grows, it removes carbon dioxide from the air. Once the carbon is trapped in the wood it can be released in a number of ways. Parts of the wood can be burned for energy while making pulp; paper that is thrown away can be burned in a municipal waste incinerator; or methane that is produced when the paper decomposes in a landfill can be transformed into carbon dioxide through oxidation or incineration. Because the CO_2 was taken out of the air by the tree during its growth, the release back into the air does not result in a net increase of greenhouse gas emissions (Environmental Defense Fund 2007)

Both energy sources have significant—if different-environmental impacts.

Extraction and use of fossil fuels for energy depletes a non-renewable resource and releases air pollutants and greenhouse gases. But there are analogous impacts associated with extracting and using wood for energy. First, growing and harvesting trees can deplete a non-renewable resource–natural forests. As noted above, intensive management practices used to grow trees for paper–including both the part of those trees that goes into the paper itself and the part that is burned for energy–can adversely affect water quality, biodiversity, habitat for endangered plants and animals, and the integrity of natural forest ecosystems. Thus, while intensive management can arguably regenerate the quantity of wood, it cannot renew many of the ecological values of natural forests.

Second, burning wood for energy creates air pollution just as burning fossil fuels does. On a lifecycle basis, when all energy sources are considered, releases of air pollutants are generally much lower for recycled than for virgin paper.

Even when recycled paper production uses more fossil fuel than its virgin counterpart, on a lifecycle basis the recycled system generates fewer greenhouse gas emissions.

In the landfill, where 80% of discarded paper ends up, the decomposition of paper produces methane, a greenhouse gas with 21 times the heat-trapping power of carbon dioxide. Paper recycling recovers used paper from the waste stream, directly reducing the amount of paper landfilled. Thus for recycled papers, any increase in greenhouse gas emissions during manufacturing is more than outweighed by reductions in emissions from landfills.

Appendix F. Bibliography

Bay Area Green Business Program. "Resource Conservation & Pollution Prevention Checklist for Office/Retail." January 1, 2007. http://www.jlsf.org/content/sf/files/In_Action_Docs_2008/SF_Green_Business_Program.pdf.

California Air Resources Board. "Sector-based Workshop: Transportation Sector." Presented at the California Air Resources Board Sector-Based Workshop, Sacramento, CA, December 14, 2007.

Crouch, Jason. "Materials Management, Recycling & Waste Reduction: Method Home Products" Presented at the Green Transportation and Logistics Summit, San Francisco, CA, October 16-18, 2008.

Davis, Stance C., Susan W. Diegel, Robert G. Boundy. *Transportation Data Energy Book, Edition 28.* Oak Ridge, TN: Oak Ridge National Laboratory, 2009.

Environmental Defense Fund and the Alliance for Environmental Innovation. "FAQs: Environmental Benefits of Recycled Paper."Environmental Defense Fund. July 2007. http://www.edf.org/page.cfm?tagid=24437 (accessed March 4, 2010).

Facanha, Christiano and Arpad Horvath. "Evaluation of Life-Cycle Air Emission Factors of Freight Transportation." Environmental Science and Technology 41 (2007) 7138-7144.

Franklin Associates. "Life Cycle Inventory of Packaging Operations for Shipment of Retail Mail-Order Soft Goods." Oregon Department of Environmental Quality and U.S. EPA Environmentally Preferable Purchasing Program, April 2004. http://www.deq.state.or.us/lq/pubs/docs/sw/packaging/LifeCycleInventory.pdf.

"Freight terms." www.solistics.com/Documents/Freight%20Terms.pdf (accessed December 18, 2009).

"GHG Emissions from transport or mobile sources calculation tool and guidance worksheet." Greenhouse Gas Protocol Initiative, June, 2009. http://www.ghgprotocol.org/downloads/calcs/WRI_Transport_Tool.xls.

"Global Citizenship Report 2008." Memphis, TN: FedEx Corporation, 2008. http://citizenshipblog.fedex.designcdt.com/fedex_citizenship_2008.pdf.

Horton, Valerie and Bruce Smith, eds. *Moving materials: physical delivery in libraries*. American Library Association. United States. 2010.

"Map multiple locations by address." Phillip Holmstrand. 2009. http://www.batchgeocode.com/.

OCLC. *OCLC Annual Report 2008/2009*. 2009. http://www.oclc.org/news/publications/annualreports/2009/2009.pdf, p.13. (accessed April 13, 2010).

Paper Task Force. "Paper Calculator." Environmental Defense Fund. http://www.edf.org/papercalculator (accessed January 5, 2010).

Ranganathan, Janet et al.,"The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard." World Resources Institute and the World Business Council for Sustainable Development, March 2004. http://www.ghgprotocol.org/files/ghg-protocol-revised.pdf.

Sibley, Lisa. "Cleantech Group report: E-readers a win for carbon emissions." CleanTech Group, August 19, 2009. http://cleantech.com/news/4867/cleantech-group-finds-positive-envi.

Sowinski, Lara. "Green Is Going Mainstream." *World Trade Magazine*, October 1, 2007.

United States Environmental Protection Agency. "Greenhouse Gas Equivalency Calculator.". http://www.epa.gov/cleanenergy/energy-resources/calculator.html (accessed January 6, 2010).