A LyX Accelerator

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1 Purpose

As in all creative endeavors, we are judged in science by what we produce. Our most important products are the things we write – journal articles, proposals, chapters, monographs, and books. It follows that the tools we use for writing are pretty important to our happiness. The purpose of this document is to enhance your pleasure with your work by accelerating mastery of a lovely tool for scientific writing.

LyX is delightful, open-source software for scientific writing—lean of purpose, flexible in execution, and, after a bit of learning, a genuine pleasure to use. Excellent documentation accompanies the download – actual .pdf *manuals* with tables of contents and indexes. Reading through these is necessary for using the software with skill and without frustration. That said, there are a few tricks that I have learned as I used LyX, bits of knowledge that will save you time and effort. That is why I am writing this "accelerator", to help you gain mastery of a wonderful tool more quickly than you would without my help. This document compliments the LyX manuals. It does not substitute for them. I have also added some material about submitting papers composed in LyX to journals, material that does not appear in the LyX manuals.

As an additional help to you, I have collected LyX files for four different types of documents: a manuscript formatted for the Journals of the Ecological Society of America, a proposal formatted for submission the Population and Community Ecology Program of the National Science Foundation, a curriculum vitae, and a letter. You may use these as templates for your own documents. The Ecological Applications manuscript is a draft prepared somewhat before the final published version (Hobbs et al., 2012).

2 What is LyX?

LyX provides an easy-to-use graphical interface to LaTeX. Which, of course, now begs the question, what is LaTeX? LaTeX is a document preparation system and markup language widely used by

academics, particularly mathematicians, statisticians, physicists, chemists, computer scientists, and engineers. Knowing the composition of its primary user-community, you may have guessed that LaTeX is particularly well-suited to preparing documents that include lots of math. You are right. If you are going to be scientist, then you must be able to write papers and proposals that describe models using properly formatted equations. Commercial word processors, particularly MS Word, are truly hopeless for this task, even if you gussy them up with add-ons like MathType. However, there are many other reasons to use LyX to produce academic documents besides its facility with mathematics.

3 Why bother with LyX?

Here are some reasons to take the time to learn LyX.

1. LyX produces stunningly attractive LaTeX documents as .pdf files, perfectly formatted, clean, and crisp. Comparing a .pdf produced by LyX with a Word document will make you wonder why you ever bothered with Word. LyX documents are noticeably sharper, with precision spacing between letters and words, and with fonts that are, well, beautiful.

2. It is free. Serious scientific writing with MS Word also requires that you separately purchase MathType and Endnote. Keeping up with Office products and these two (not-cheap) add-ons is an unnecessary expense. Spend the money you save using LyX on good wine and fast computers.

3. It is rock solid. This is the overwhelming reason I eventually gave up on Word and Pages etc. MS Word documents that contain more that a handful of equations, and particularly documents that contain MathType equations *and* an EndNote bibliography, become as unstable as jello. You will be typing along in Word, humming Bach, and when you try to save (or print) the document, MS Word will announce dismissively that you don't have enough disk space to save the document. *Not enough disk space? Grrrrr–there are >100 GB of disk space!* Doesn't matter. A days work is probably trashed. This happened to me with two separate manuscripts and hours of research on the web failed to produce a solution. I decided to learn LyX and I have never looked back[1].

4. It does the kinds of things that academics and scientists need—I have already mentioned math, but LyX also excels by putting referenced figures and tables in the proper place in the document with captions that stay with them. It allows you to create perfect literature cited sections in the correct journal format. It can automatically write out lists of figures and tables, tables of contents and indexes. It allows you to write exams where you can turn the answers on and off. (Ok, ok, this is just cute, but it *is* cute). Here is a great example of the power of LyX for scientists. Let's say you have a manuscript with eight figures A referee insists that you remove two of them. In LyX, all of the figures and all *references to them* in the text will automatically renumber themselves in the proper sequence if any figure is removed. Try that in Word. Keeping track of figure numbers manually is a serious source of errors in your final version.

5. It works with Sweave an knitr. Sweave is a LaTeX package that allows you to embed R code in your document, so that when data are updated, figures and tables update automatically. This is a fabulous tool for making unambiguous links between you manuscripts and the data they present. It encourages proper documentation of all results presented in manuscripts.

[1] A second irritation with MathType is that you cannot use bold font for Greek letters — $\boldsymbol{\beta}$ is impossible. This is a non-trivial limitation for serious work.

The package knitr is supposed to be even better, but I have not used it yet. Both are native to LyX.

6. The first two NSF proposal that I wrote in LyX were funded on the first try. I estimate that a document that looks better than the competitions' documents gives you a 10% edge, maybe 15%. Seriously.

7. It is perfect for writing structured documents with chapters, sections, sub-sections, boxes, figures, tables, algorithms and so on. You will make your living by producing these documents. Make your life easier. Learn LyX.

4 Learning LyX

4.1 Download

You can download LyX for Mac OS, Linux or Windows (my sympathies), from `http://www.lyx.org/Download`. You will also need to download a flavor of LaTeX, but not to worry, that task is explained as part of the download instructions for LyX. At some point you will want to get a LyX compatible reference manager like BibDesk for Mac or Mendeley for Mac, Linux, or Windows. Both are free and open source.

4.2 The manuals

I recommend that you start by reading the Introduction and Tutorial, which clearly explain some philosophical differences between the LyX approach to document preparation (what you see is what you mean) and the conventional approach (what you see is what you get). To read a manual, click on it and a LyX document opens. Compile the .pdf for better reading. This is done by clicking the little eyes in the upper left of the toolbar. Next read through the Users Guide and the Math Manual. You don't need to read these for mastery, but rather to become familiar with what they contain, so that you can go to the proper sections as questions arise. The Embedded Objects manual is good preparation for writing proposals where figures, boxes, etc. need to be placed within the flow of text. Later, on a slow Sunday afternoon, when you need something exciting to do, take a look at Additional Features.

4.3 The LyX wiki

There is a terrific LyX wiki—`http://wiki.lyx.org/`

4.4 Learning from the Web

LyX will do most things that you need to produce lovely documents, but to really use its full potential, you need to know a bit of LaTeX, which can be embedded in your LyX document using ERT boxes, described below (see section 12). There is nothing I have needed to do in LyX that I couldn't figure out quickly by searching on "LaTeX and....." or "LyX and....." For example, I needed to know how to format NSF proposals compactly so that they were compliant with margins and fonts and fit within 15 pages. This required judicious condensing of white space, smaller fonts for section headings and so on. A search on "LaTeX and NSF proposal" provided exactly what I needed at the top of the search results.

5 Getting started

The templates that I provide will allow a very quick start, but there are some things that you can do to set-up LyX that allow you to produce documents of widely useful formats without using the templates. So, once you have LyX up an running, go to the toolbar at the top of the screen, click on Document, Settings, Fonts and choose 11 or 12 point. Then click on Page Margins and fill in

the fields to set margins at 1" all around. Next, click on Text Layout and choose single or double space, whichever you will use most often. You can always change it later. Then, before you leave the Settings menu click the button that says Save as Document Defaults.

6 The document class

The underpinning philosophy of LyX differs from most other word processors. LyX is "wysiwym" – what you see is what you *mean.* So, if you mean to write a scientific article, then you choose a *document class* that is appropriate for scientific articles. Once that choice is made, formatting is pretty strictly controlled by LyX, which results in a beautiful, consistently formatted document. Choosing document classes is accomplished by going to Document, Settings, Document class. To the right you will see a drop down list that lists all of the classes available.

There are many types of document classes (letters, reports, books, slide presentations) and some journals have their own class with specific formatting – many of these special classes are included here. The default class is "article" which has worked fine for me for journal submissions and proposals. Princeton University Press is happy with the "book" class for the manuscript I will soon submit.

As an exercise, keep the document class set on article and go back to your document. Look in the upper left hand corner of the screen – there will be a drop down list with Standard at the top. Open it and look at the types of structures (LyX calls them environments) that are available for the article class. These are what you use to structure and format your document. Now change the document class to book and look at the list again. Change to letter, etc.

7 The document preamble

Click on Document, Settings, LaTeX preamble. A window will open up where you can place LaTeX code that is executed whenever you compile a .pdf. This is extremely useful. It allows you to include commands to customize your document and to use packages that are full of cool hacks. The advantage of open-source software like LyX and LaTeX (and R for that matter) is that thousands of clever people contribute useful code when they are bored on Sundays. In the case of LaTeX, these are often produced in Packages (as in R) that are part and parcel of the standard LaTeX distribution that you downloaded. However, you must tell LyX (in the preamble) that you want to use them. Otherwise, they simply sleep peacefully on your hard disk. My preamble is shown in Algorithm 1. After you enter a preamble you want, clicking Save as Document Defaults will apply your preamble to all new documents.

8 Math

Math is why we are going to al this trouble, so we perhaps we should start with some tips on entering equations a LyX document. The details are well covered in the Math manual, but I will emphasize a few points here.

8.1 Equation types

There are three equation types that you will use most often. Inline equations appear within the sentence, i.e., $\mu_i = g(\theta, x_i)$. Display equations are a single line of math with white space on either side, for example,

$$\log(\lambda_{i,t}) = (B_0 + B_1 D_{i,t-1} + B_2 L_{i,t} + B_3 W_{i,t} + B_4 G_i + B_5 O_t)\,\Delta t. \quad (1)$$

Multiple equations are handled by equation arrays (and other formats described in the manual), which look like this:

$$\begin{aligned}
\log\left(\lambda_{i,t}\right) &= \left(B_0 + B_1 D_{i,t-1} + B_2 L_{i,t} + B_3 W_{i,t} + B_4 G_i + B_5 O_t\right) \Delta t && (2)\\
\eta_{i,t} &= \lambda_{i,t} N_{i,t-1} - h_{i,t} && (3)\\
\Pr\left(\mathbf{N}, \mathbf{B}, \sigma \mid \mathbf{y}, \mathbf{h}, \mathbf{X}\right) &\propto \prod_{i=1}^{41}\prod_{t=1}^{13} \text{Poisson}\left(y_{i,t} \mid N_{i,t}\right) \times && (4)\\
&\quad \prod_{t=2}^{13} \text{lognormal}\left[N_{i,t} \mid \log\left(\eta_{i,t}\right), \sigma\right] \times\\
&\quad \text{gamma}(N_{i,1} \mid .001, .001) \prod_{j=0}^{5} \text{normal}\left(B_j \mid 0, 10^{-6}\right) \times \text{gamma}\left(\sigma^{-2} | .001, .001\right).
\end{aligned}$$

There are handy keyboard shortcuts for deftly entering inline equations (cmd-m for Mac OS and cntrl-m for Windows) and display equations (shift-cmd-m for Mac, shift-cntrl-m for Windows). For equation arrays, click on Insert, Math, Eqnarray environment.

8.2 Entering equations

When you a open a display or inline formula using shortcuts or the mouse, a pinkish shaded box with a blue border opens to accept math input–LyX is now in math mode. LyX offers some very nice tools for mathematical composition, training wheels for bare knuckles LaTeX.

Go to View and click on Toolbars. You want to open two of them, Math (auto) and a couple of lines down, Math Panels (auto). LyX responds by displaying two toolbars of common mathematical symbols, operations etc. You should explore these by clicking on them in math mode. Note that whenever you cursor over an element of a pull down math menu, LyX will show the LaTeX code for it. This is a great way to lean LaTeX commands, which eventually will vastly accelerate your ability to write mathematical expressions–writing is much faster than pointing and clicking.

For example, open the lower case Greek letters pull down by clicking on the α on the math panels toolbar, which you just opened. Now cursor over the β. Notice that a little tan box shows beta [^M G B]. Forget the second part, the [^M G B]. The first part is the LaTeX code you would use to enter a β. Try this. Open an inline or display equation. In the pink box with the blue border, enter \beta. Voila. This illustrates that all LaTeX expressions begin with \.

Note that there are three boxes for equation arrays. The leftmost box is for the left hand side of the equation; the center box is for the = (or $\propto$ etc.), and the the right box is for the righthand side.

Equations can be numbered by right clicking on them. However, because I usually want all of my equations numbered by default, I have assigned a keystroke sequence to insert a numbered equation.

9 Figures

Figures and other graphics are critical components of scientific articles and proposals. LyX does a lovely job of incorporating them directly into these documents. To fully understand this topic, you should read the Embedded Objects manual, but I will get you started. There three ways to display figures in LyX:

1. Collected sequentially at the end of the document.

2. Within the document without allowing text to wrap around the figure, that is, with white space on each side.

3. Within the document allowing text wrapping, that is, with text on one side and the margin on the other.

I will briefly cover the first two topics here. For the third one, read the Embedded Objects manual and see the examples in the NSF proposal template.

9.1 File formats

LyX supports a variety of graphics files. I tend to use .pdf's for figures, but .jpg and .eps work as well.

9.2 Creating a figure with a caption

1. At the approximate place in the document where the figure should appear, click on Insert, Float, Figure. This step applies to the first two ways to display figures, above. If you want option 1, do *not* place the figure at the end of the document. Put it close to the first place it will be referenced. Trust me.

2. A box will open up with a nested box for the figure caption.

3. Write out the figure caption.

4. Put the cursor above the caption within the outer box and click on Insert, Graphics. A dialog box will open asking for the path to the figure file. In many cases, it will probably be best to simply put in the name of the file, for example `regression_plot.pdf`, rather than the full path. (To understand this, see the section 13.1.1, below.) However, for now, go ahead and click on browse, then the file, and the full path will be displayed in the dialog box. You will probably want to adjust the size of the graphic using the check boxes etc. Experiment with this. It is also possible to paste a graphic into the box, copied from the R plot window, for example. If you do so, LyX will ask you for a file name. If you don't specify a full path, the file will be store in LyX's working directory. (More about that later).

5. After the graphic appears in the box[2], click to the left of it and click on Insert, TeX code and enter `\center` in the red box. See section 12 to understand this operation.

6. If you want to put the figures at the end of the document, you may skip the next step.

7. If you want to embed the figure in the text (without wrapping), click somewhere outside the figure box. You will see a shaded box with Figure: on it. Right click on it and click on Settings. There are a few of these that I use frequently: Default Placement, Top of page and Here if possible, and Here definitely. Sometimes you need to experiment with these to see what works best. They are explained in the manual on Embedded Objects.

8. If you want the figures at the end of the document, simply uncomment the line `\usepackage{endfloat}` in your preamble. It will gather up all of the figures and tables, generate lists of them, place them in the correct order at the end of your document, and insert "Place figure __ approximately here" in the text with proper whitespace. However, it will not wash you socks.

9. You are almost done. Cursor over the caption and click on Insert, Label. A box will open up containing a name for the figure. You can rename it if you like.

[2]When you use .pdf files for graphics, you will probably get an error message that the graphic cannot display. This only refers to display in LyX. It will show up perfectly in your compiled .pdf.

10. When you want to refer to the figure, something like (Figure __), click on Insert, Cross-Reference. You will see the label of the figure in the drop down list. Click on the figure name to insert a number in the proper spot in your text. Now the figure is referenced. If you remove add another figure in front of this one, or remove any figures in the document, the numbering for figures will update automatically.

10 Tables

The steps for creating a referenced table resemble those for creating a figure. Again, there are three ways to include tables:

1. Collected sequentially at the end of the document.
2. Within the document without allowing text to wrap around the figure, that is, with white space on each side.
3. Within the document allowing text wrapping, that is, with text on one side and the margin on the other.

Here is what you do:

1. At the approximate place in the document where the table should appear, click on Insert, Float, Table. This step applies to the first two ways to display table, above. If you want option 1, do *not* place the table at the end of the document. Put it close to the first place it will be referenced. Trust me.
2. A box will open up with a nested box for the table legend.
3. Write out the table legend.
4. Put the cursor under the caption within the outer box. You now have three options.
   (a) If you created your table using R's `xtable` package, then you should open a ERT box directly beneath the legend and paste the LaTeX code output by `xtable` into it. If you like, you can automate this with Sweave, as described in section 15.
   (b) If you created a .csv or .xls file containing the table, open it in Excel or Numbers and return to your .lyx document. Click on Insert, Table and enter the proper number of rows and column. Now go back to your spreadsheet and copy the table. Return to LyX and put the cursor in the upper left cell of the table. Now the key trick. Click on Edit, Paste Special and choose Plain text.
   (c) You can also import the table directly using File, Import table (CSV). This will create a separate document. Select all and paste it into your table box below the legend.
5. Format the table by clicking on View, Toolbars, Table (auto). This will produce a set of intuitive graphical tools for resizing cells, adding rows and columns, changing borders, etc.
6. If you want to put the table at the end of the document, you may skip the next step.
7. If you want to embed the table in the text (without wrapping), click somewhere outside the table box. You will see a shaded box with Table: on it. Right click on it and click on Settings. There are a few of these that I use frequently: Default Placement, Top of page and Here if possible, and Here definitely. Sometimes you need to experiment with these to see what works best. They are explained in the manual on Embedded Objects.

8. If you want the table at the end of the document, simply uncomment the line `\usepackage{endfloat}` in your preamble. It will gather up all of the figures and tables, generate lists of them, place them in the correct order at the end of your document, and insert "Place Table __ approximately here" in the text with proper whitespace.

9. You are almost done. Cursor over the caption and click on Insert, Label. A box will open up containing a name for the table. You can rename it if you like.

10. When you want to refer to the table in the text, something like (Table 9), click on Insert, Cross-Reference. You will see the label of the table in the drop down list. Click on the table label to insert a number in the proper spot in your text. Now the table is referenced. If you remove add another table in front of this one, or remove any tables in the document, the numbering for tables will update automatically.

11 Bibliographies

This is a somewhat deep topic, but I will get you started.

11.1 The BibTeX database

LaTeX and LyX have a standard approach to automating bibliographies, an approach that substantially predates software like EndNote. LaTeX bibliographies are based on a special database format know as BibTeX. These are plain text files with a format for each entry (in this case, the R manual) that looks like this:

```
@manual{R_mannual,
Address = {Vienna, Austria},
Author = {{R Development Core Team}},
Date-Added = {2011-12-05 15:12:05 -0700},
Date-Modified = {2011-12-05 15:12:05 -0700},
Note = {{ISBN} 3-900051-07-0},
Organization = {R Foundation for Statistical Computing},
Title = {R: A Language and Environment for Statistical Computing},
Url = {http://www.R-project.org/},
Year = {2011},
Bdsk-Url-1 = {http://www.R-project.org/}}
```

Now, the heroic among you may want to build a BibTex database like this by hand using `vi`[3], but for the rest of us, there is are easier ways.

11.1.1 Software for managing BibTeX databases

There are excellent, open source programs for managing BibTeX databases. I use a Mac and am very happy with a program called BibDesk (`http://bibdesk.sourceforge.net/`), but it doesn't run on Windows. Windows and Mac can use a cool looking program called JabRef (`http://jabref.sourceforge.net/`), and I understand that the latest cool thing is Mendely `http://www.mendeley.com/` and I may eventually investigate these later ones to facilitate teaching the poor souls who insist on using Windows machines. In any case, I urge you to download one of these. In the case of JabRef and Mendeley, you are a bit on your own because I haven't used them. Mac users, I recommend that you use BibDesk.

[3]The UNIX, line-oriented text editor. No mouse. No GUI. Only those of you with grey hair are likely to know what this is, but Mevin Hooten writes *all* of his papers using LaTeX in vi. Heroic. Wicked fast.

11.1.2 Creating a BibTEX database

There are two easy ways to create your database of references.

1. If you are staring from scratch, that is, you don't have an existing database of articles etc., then the easiest way is to build your database is by exporting references in BibTEX format from Web of Science or other online databases . You may need to snoop around on the export part of the site, but all of these will have the option to export a BibTEX file. Import the file into your BibTex database. How you do that depends on the software you use. For BibDesk, it is as simple as pasting into the list of records[4].

2. If you have built up a EndNote, Ref Manager, or other commercial database with thousands of entries (like mine), do not despair, they will also export references in BibTex format. Here is what you do for EndNote.

   (a) Select the records you want to bring over to BibTex.

   (b) Select the bibliography style BibTEX export[5].

   (c) Right click on a selected entry and choose Copy Formatted. Paste into your BibTex bibliography manager. Voila.

Actually, I use a blend of these approaches. Some of my references come from the web, others from my aging EndNote database. I have never needed to bring all of my EndNote reference across. I just build the BibTEX database as I need new references. I have a master database for all references. I also build separate databases for individual papers, proposals, book projects, etc. This is easy enough to do and facilitates portability of documents as described in the section on organizing files.

11.2 Creating a literature cited section in a LyX document

Once your database is set up, creating a literature cited section is a snap. Here is what you need to do.

11.2.1 Telling LyX where to find files

1. Go to the end of your document. Click on Insert, List / TOC, BibTEX Bibliography. A dialog box will open. You will need to tell LyX where to find your BibTEX database and the proper style file.

   (a) Click Add. A new dialog box will open. Click on browse, find you database, and click on the file name. You may want to set only the file name, not the complete path for reasons that are described below (see section 13.1.1). However, for now, use the full path.

   (b) You now need to fill in the lower Style field. This requires some explanation. Virtually all top-tier scientific journals support LATEX and provide a style file for formatting references in the Journal's format. These files will have the extensions `.bst` or `.sty`. You can search

[4]

(a) If you are asked if you want unique keys generated you can say yes or no. If you say yes, the software is likely to generate something that is not very informative. If you say yes, then you must fill in the key fields of each record. The advantage is that you can give keys that are recognizable–something like Wolf_2004_willows rather than isi0099r5.

[5] I have modified mine to eliminate the Notes field, but it will work unmodified. However, the notes field can cause some formatting problems in you references that need to be edited by hand if it is not removed. The EndNote help describes how to modify style files.

for style files for your target journal using a utility found at `http://bst.maururu.net/index.php` I included style files for ESA journals and for Science in the LyX material on the class web site. Enter the path (or the file name) in the Style field.

(c) If you are going to use ESA style, you must go to Document, Settings, Bibliography and check the Nat Bib button and the Author-Year option for Nat Bib Style

(d) When you are done, you will see a shaded box that says BibTex generated bibliography. The citations will not appear until you compile the document.

(e) I have started making small database for each paper I write by cutting and pasting references from the master database to a database specifically for the paper, which lives in a subfolder of the folder holding the manuscript. This is much easier than it sounds. It is a good thing to do because it keeps all of your stuff for a manuscript in one place.

11.2.2 Editing records to preserve proper names, italics etc.

There are a couple of things you need to do to edit records so that they appear properly in you literature cited. The first in proper nouns. The style files for journals often specify that all words in the title except the first one begin with lower case letters. This will produce something like: Are wolves saving yellowstone's aspen? A landscape-level test of a behaviorally mediated trophic cascade. Undesirable. To fix this, you need to edit the title field of you BibTex database and put { } around anything you want to remain capitalized. So, in your database the title should be Are wolves saving {Yellowstone's} aspen? A landscape-level test of a behaviorally mediated trophic cascade. This will preserve the capital Y in Yellowstone.

Sometimes scientific names appear in titles, requiring italics. Italics can be put into titles in your database using something like Distance rules for minimum counts of {Eurasian} lynx \emph{Lynx lynx} family groups under different ecological conditions. This preserves the capitalization of Eurasian and makes *Lynx lynx* italic.

11.2.3 Entering citations

There are two ways to place citations in your document.

1. Click on Insert, Citation. LyX will open a simple dialog box that shows the entries in your database. Select the references you want to cite and click add. These must be in the proper order, i.e. oldest first. There are up and down buttons to allow you to adjust their order. There is a citation style pull down that allows you to choose among the styles, for example Hobbs (2012), (Hobbs 2012), (2012) etc. This works without any fuss and bother.

2. Open your BibTeX database manager (e.g., BibDesk or JabRef) and select the references you want to cite. In LyX, place the cursor at the spot in the text where you want the citation to appear. In BibDesk, you right click on a selected reference, then click on Send to LyX. In JabRef you go to Tools, Push entries to external application (LyX, Kile) (shortcut cmd-L or cntrl-L). Getting this to work for JabRef requires changing the paths to some "pipes." (Not as interesting as it might sound).

   (a) For Macs this is easy. Go to LyX Preferences, Paths, and copy the path to the lyxpipe. Then, paste the path into the JabRef preferences for external programs. For Windows, this is covered on the LyX wiki (`http://wiki.lyx.org/LyX/LyXServer`).

   (b) The key on Windows is to copy the following into the lyxServer path box under LyX preferences: lyx: \\.\pipe\lyxpipe . In JabRef, copy this into the path to lyxpipe box: \\.\pipe\lyxpipe.in. The .bib file you're working with has to be in the same directory

as your .lyx file for this to work and you have to close both programs and restart them in order for the changes to take effect.

11.3 Making the proper heading (Literature Cited)

The default heading for the literature cited section of your document is Bibliography. Most journals want Literature Cited instead. This is easily done, offering a nice illustration of the use of LaTeX commands within LyX (see section 12). Go to the line immediately above the bibliography, a shaded box reading BibTex generated bibliography. Click on Insert, Tex Code or use the keyboard shortcut (cmd-L on the Mac, cntrl-L on Windows, the L is lower case). Enter the text \renewcommand\refname{Literature Cited} into the red box.

12 Using Evil Red Text (ERT's)

Recall that LyX is simply a front-end for LaTeX, obviating the need to enter LaTeX commands directly. However, there are many times when the ability to embed LaTeX code in your document will be necessary to get your document to appear as you want it. In the templates I provided, you will see many of these ERT's, as they are called, that show up as red text in a box. You can enter this text by a keyboard shortcut, cmd-l (the l is a lower case L) on the Mac or cntl-l on Windows, or by using the toolbar, Insert, TeX code. So, for example, to insert a page break, you put `\newline` in an ERT box. ERT's are *really useful,* so you should be sure you understand them. One warning, if you fail to put a space between the end of the ERT box and the text, you will get an error Undefined control sequence when you try to compile the document into a .pdf. What all this really means is that you need to know a bit about LaTeX to use LyX effectively. A very nice Crash Course can be found at `http://www.haptonstahl.org/latex/index.php` and I included a LaTeX cheat sheet summarizing many command in the LyX files on the class web site.

13 Collaborating

13.1 With LyX and LaTeX users

13.1.1 Files needed to compile a LyX document to .pdf

Unlike MS Word, LyX keeps files for graphics and your bibliography distinct from the main `.lyx` document file–this is one of the reasons LyX is so stable. If you are working with modern colleagues who use LyX or LaTeX, they can edit the `.lyx` or `.tex` file without the other ones. But if they want to compile a `.pdf,` then they need the whole set including:

1. BibTex bibliography (`.bib` file)
2. Style file for bibliography (`.bst` or `.sty` file)
3. Files for all graphics (`.pdf, .jpg, .ps`, etc)

This is easily accomplished by bundling the files into a folder or zip file and sending the whole lot to your collaborators. However, there is a trick that makes this easy to deal with at the other end described in the section on organizing your work (section , below)

13.1.2 Exporting .tex files

When you work with mathematicians or statisticians, they will want a `.tex` file to edit. These are easily exported from LyX. Use File, Export, LaTeX (plain) or LaTex (pdflatex). Reverse the process using File, Import to bring a `.tex` file produced by LaTeX in to LyX.

13.2 With Word users

You are bound to have colleagues who soldier on with a word processor that tries to do everything for everyone and ends up doing nothing well. (I won't mention brands this time.) One of those colleague just might be your major professor or your lab leader. What now? How do you give her / him a document that can be edited and marked up? There are three solutions to this problem.

1. Adobe Acrobat has great editing tools. Comments on your stunning dissertation chapter can be made directly on the .pdf using Adobe. This is the simplest route.

2. It is possible to export `.rtf` files from LyX that can be brought into Word[6]. This is not a terribly happy solution, however, because try as it might, the export utility rarely formats the equations properly. This might not matter much, but the point of using LyX in the first place is to produce a beautiful document and .rtf's exported from LyX are ugly.

3. The *best* route is to convince your colleagues (read major professor, lab leader, etc.) to download LyX. There is no learning curve, none, zero, for *editing* a LyX document. Track changes and notes work just as they do in any other word processor. This saves time for everyone–your colleague can easily modify and annotate the document and you won't need to transcribe the changes that he or she makes. My group has used this route very successfully.

14 Organizing your work

I have a standard organization for files needed to produce a complete proposal, paper, or book. The current drat of the manuscript lives in a folder with a subfolder. The main folder contains the LyX file (.lyx, the bibliography file (.tex) and style file (.sty) Files for figures, pdf's, jpegs, etc. are found in `./figures`, that is a subfolder of the folder containing the document.

When you organize your work this way it is important you be sure that your working directory is the one where the document is stored. If you start your session by opening the document from its directory, this will occur automatically. This is important because you need a simple pathname to the needed files to make sure your document can be easily transported to a different computer. If you follow these steps, the paths to your files for figures, your bibliography, and style files, will not have a long path that is specific to your computer. This will allow you to send collaborators the document folder so that he or she has all the needed files and will not need to tediously edit path names.

15 `Sweave`

`Sweave` is a dramatically useful way to link your data to your papers. It allows you to embed R code in your documents so that your manuscript *automatically updates* whenever you change results in R. So, for example, imagine that you have a table built from some analysis in R. Moreover there are parenthetical expressions in the text that reference cells of the table (means, medians, credible intervals, etc). You decide to make a change in your analysis. In the old way of doing things, you need to output the table, probably to a `.csv` file, hunt through the text to find all of the references to the table in the text and change them by hand. This is error prone and tedious. With `Sweave`, you simply update your analysis and recompile your paper. Voila. Everything is revised. This is non-trivial–it assures that the results you report are exactly as they are produced in you analysis. It avoids the sinking feeling that you might have two years after publishing a paper and you are called on to reproduce the analysis. If the document is attached to the code, it is a snap. If it is

[6] If you *must* go this route, you may need to download a utility called latex2rtf from `http://latex2rtf.sourceforge.net/`.

not, well, you might have some anxious problems if you did not thoroughly document your work flow, file locations and R programs.

A brief caveat is needed here. There is a new, improved version of `Sweave` called `knitr`. There is a lot of material on the web about how to use (see, for example, `http://yihui.name/knitr/demo/lyx/`, `http://yihui.name/knitr/`, `https://bitbucket.org/stat/knitr/downloads/knitr-manual.pdf`). I plan to spend an afternoon figuring out how to use `knitr`, but I haven't done it yet. You have two options. Skip over all of the subsections below that are `Sweave` specific and learn that stuff from the `knitr` documentation. That way you won't need to relearn syntax which is similar, but not identical. The other option is to learn what I know about `Sweave` at this point, which works well, and then build on that knowledge to move to `knitr`.

15.1 First steps with `Sweave`

There is great documentation on using `Sweave` in the LyX help. Go to `Help` on the LyX menu bar and look under `Specific Manuals`. You should read this. Also see `http://wiki.lyx.org/LyX/LyxWithRThroughSweave`

Start by installing the `Sweave` package in R. Open a new document in LyX. Next go to the Document tab on the LyX menubar and click on Settings. Scroll down to modules and choose Sweave. Click OK. You are now ready to write your first `Sweave` document.

15.2 Chunks

The best way to understand this is material is to open the LyX document, `Hobbs first Sweave docII.LyX` and have it open on the screen as you read this. Open another blank document to try things out.

LyX communicates with `Sweave` using `Chunk` environments. This is not a complicated as it sounds. To illustrate, we will set up some options for Sweave. Go to the environment drop down list (the one with Standard at the top in the upper left of the LyX menu bar). At the very bottom of the list, click on Chunk. You are now ready to write your first bit of `Sweave` code. Enter the following at the top of your document:

\SweaveOpts{echo=TRUE} %turns off (FALSE) or on (TRUE) R code in output

\SweaveOpts{keep.source=TRUE} %leaves comments in r code

This block of code sets up some options. In particular, it allows the R code to be included printed in your document, which is not what you will usually want to do in a manuscript (you would choose `FALSE`), but for teaching I want you to see what is going on in this document.[7]

Start your document with lots of impressive scholarship and hand waving about the transformative nature of your research until you finally need to show some actual data. Set the environment to chunk (in the drop down box at the far left end of the tool bar) and enter

```
> library(xtable)
> #load("path to data/filename.Rdata")  # do this if you need to get data etc. needed by later
> data ( airquality )
> names(airquality)[4]="Temp"
> k=kruskal.test ( Ozone ~ Month , data = airquality )
```

Understand that "`path to data/`" is a stand-in for the path on your computer. You probably want to keep the data it a sub folder of the document folder to make the document portable, but there are many logical ways to do this.

[7] If you get an error about Babel not being loaded, go to Documents, Settings, Language, and choose Language Package, Always Babel.

```
> boxplot ( Ozone ~ Month , data = airquality )
>
```

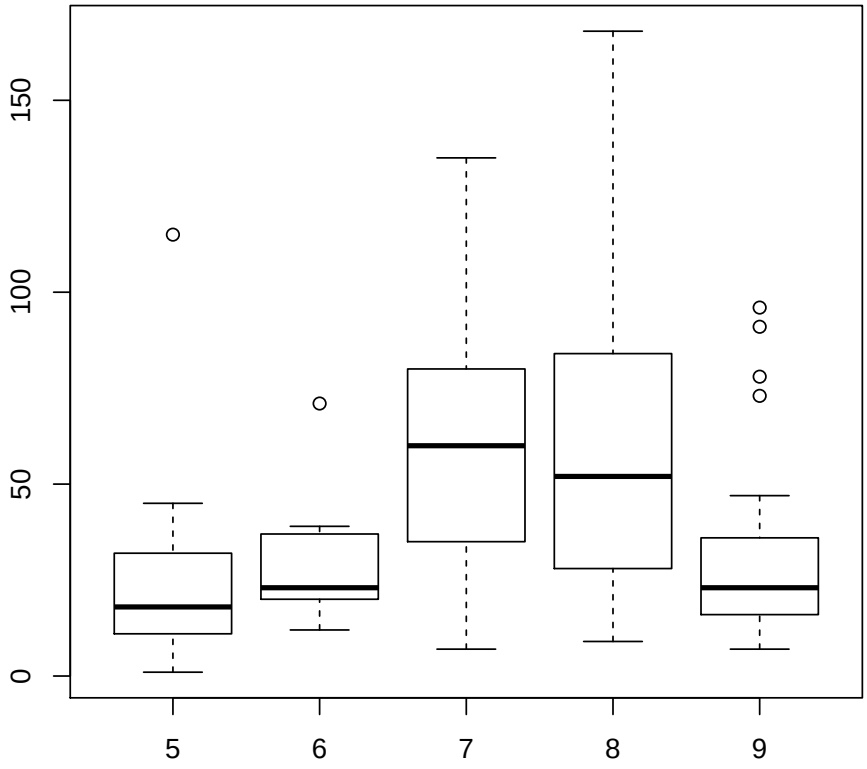

Figure 1: Example plot produced by Sweave

Now switch back to the standard environment and continue your text.) And you are typing along in your Nature paper and want to add a P value produced by the Kruskal Wallace test, P = 6.9e-06. To produce this, you entered P = ERT \Sexpr{signif(k[[3]],3)} in an ERT box after P =. Remember what an ERT box is, a place to enter a LaTeX command written in a little red box invoked by Insert, Tex Code or by cmd-L.

Notice that you entered plane-Jane R code between the `<<a>>=` and the `@`. This is a code block named `a`. It must be a `Chunk`. It would be instructive to copy and paste the `Chunk` between the `<<a>>=` and the `@` into R and run it. Notice that the P value appeared seamlessly in the text.

Now we are ready to do some more R stuff. Enter a figure float (remember figure floats?) and add the `Chunk`:

```
<<fig =TRUE , echo = TRUE >>=
boxplot ( Ozone ~ Month , data = airquality )
```

Truth be told, I never use Sweave for figures. Instead, I write the figures as .eps or .pdf files directly from my R script. Any time these files are updated by the script, they automatically update in the document.

The best part of Sweave is the ability to link complicated tables to your document using the xtable package in R. Take a look at this:

Table 1: Example table

```
> library(xtable) #the xtable package must be installed in R.
> data ( airquality )
> names(airquality)[4]="Temp"
> k=kruskal.test ( Ozone ~ Month , data = airquality )
```

```
> print(xtable(airquality[1:8,],  digits=c(0,0,1,5,2,1,2)),   display=c("s","s","f","f","f","f"
+ NA.string="NA",
+ include.rownames=FALSE, floating=FALSE)
```

Ozone	Solar.R	Wind	Temp	Month	Day
41	190	7.40000	67	5	1
36	118	8.00000	72	5	2
12	149	12.60000	74	5	3
18	313	11.50000	62	5	4
NA	NA	14.30000	56	5	5
28	NA	14.90000	66	5	6
23	299	8.60000	65	5	7
19	99	13.80000	59	5	8

```
> #remember that column 1 is rownumber
> #floating = FALSE is mandatory
```

15.3 Using `xtable`

15.3.1 Components of an `xtable` statement

The most challenging part of using Sweave is using `xtable`, a R package that produces LaTeX code for publication quality tables. It is a reasonably deep topic, that deserves its own study, but I will cover some highlights here.

Of course, you need to install the `xtable` package. Most of the actual work is done with the `xtable()` function. Consider the following R code that is used to generate a table through Sweave. The first part (print xtable....) specifies a matrix, dataframe, or table that you want included in your paper. The next part (digits = ...) gives the number of significant digits that you want for each column. Note that there are *seven* columns even though you only want six quantities tabulated. The extra column is need to accommodate the row names even if you have told R that you don't want them (`include.rownames = FALSE`). The `dispaly = c(...` bit shows the type of quantity you want in each column, "s" for string and "f" for floating point. Again, you need an entry for row names even if you don't want them. Don't whine. Get used to it. This is the guts of `xtable,` but be warned, it is a deep topic.

15.3.2 An error to avoid

It is really easy to get the parentheses wrong in printing xtables. When you run a print(xtable(....)....) in R you must have output that looks like:

```
% latex table generated in R 2.13.1 by xtable 1.6-0 package
% Tue May 15 10:11:37 2012
\begin{tabular}{lrrr}  #diagnostic of correct!
\hline
& 2.5\% & 50\% & 97.5\% \\
\hline
\$b\_\{1\}\$ & 0.691 & 0.781 & 0.858 \\
\$b\_\{2\}\$ & 0.473 & 0.599 & 0.721 \\
\$b\_\{3\}\$ & 0.0572 & 0.21 & 0.452 \\
\$\backslash$beta\_1\$ & 0.00161 & 0.00286 & 0.00439 \\
\$\backslash$beta\_2\$ & 0.000843 & 0.00111 & 0.00141 \\
m & 0.43 & 0.514 & 0.597 \\
\$s\_1\$ & 0.554 & 0.839 & 0.946 \\
\$s\_2\$ & 0.877 & 0.925 & 0.979 \\
\$\backslash$psi\$ & 0.0274 & 0.0721 & 0.146 \\
deviance & 722 & 753 & 788 \\
\hline
\end{tabular}
```

If instead you get:

```
% latex table generated in R 2.13.1 by xtable 1.6-0 package
\begin{table}[ht]  #diagnostic of an error!
\begin{center}
\begin{tabular}{rrrr}
\hline
& 2.5\% & 50\% & 97.5\% \\
\hline
$b_{1}$ & 0.69 & 0.78 & 0.86 \\
$b_{2}$ & 0.47 & 0.60 & 0.72 \\
$b_{3}$ & 0.06 & 0.21 & 0.45 \\
$\beta_1$ & 0.00 & 0.00 & 0.00 \\
$\beta_2$ & 0.00 & 0.00 & 0.00 \\
m & 0.43 & 0.51 & 0.60 \\
$s_1$ & 0.55 & 0.84 & 0.95 \\
$s_2$ & 0.88 & 0.93 & 0.98 \\
$\psi$ & 0.03 & 0.07 & 0.15 \\
deviance & 722.08 & 752.96 & 788.31 \\
\hline
\end{tabular}
\end{center}
\end{table}
```

Then you have mismatched parentheses. The first bit (the correct way) was done using

```
print(xtable(table,digits=0,align=c("l",rep("r",7)),display=c("s","fg",rep("fg",6))),NA.st
ing=FALSE,sanitize.rownames.function = function(x) {x})
```

Note that there is only one parenthesis at the end of the statement because there are three before `NA.string = "NA"`. Also note where `display( )` is. It is within parens that match the (to the right of `xtable(` . The incorrect output was produced using:

```
print(xtable(table,digits=0,align=c("l",rep("r",7)),display=c("s","fg",rep("fg",6)),NA.str
ing=FALSE,sanitize.rownames.function = function(x) {x}))
```

16 Debugging Sweave errors

I usually write a separate R script that includes all of the Sweave code to allow me to test each chunk before I include it in the document. This code may be much more compact that the code I wrote to produce the analysis. The code for the document simply accesses the data objects produced by the full analysis script(s). So, I make sure the compact version of the code runs properly *before* I include it in the document. I also add chunks one at a time, compiling after each addition to be sure I know where errors occur if they occur.

Errors show up like this. You get the message, "`An error occurred running R-scrip, no verbose, no restore, etc...`■ meaning there is a problem with a chunk of R code *somewhere in your document.* I have a monograph that I am about to submit that is 80 pages long with > 30 chunks. This message raises the hair on my neck.

However, if you get this message and have no idea what produced it Go to View and choose View Messages. Then push Set... on far rhs. Check Statusbar messages as none. Then check Selected and check the No to the right of User commands (you will need to scroll down) to change it to Yes. Sweave error messages will appear here and will describe what the problem was and give you hints where it occurred.

17 Preparing LyX files for journals

Most journals will accept .pdf files for review, but you will probably need to submit the LaTeX code for the final manuscript. There are three ways to create these files.

17.1 Creating simple .pdf and .tex file

The easiest way is to simply compile your .pdf as usual and export a .tex file. Exporting is done using File, Export, LaTeX (pdflatex) as describe below. When you submit your paper, remember that the LaTex version is really a folder that contains your manuscript as well as subfolders for your BibTeX file and your figures. So here is what you do:

1. Prepare a folder that contains your LyX document and *in the same folder* the BibTex database and style file for literature cited. Figures can be in the same folder or in a sub folder. Be sure the path to the data base and style file have no more than the file name. If you have the `Sweave` module selected under Document, Settings, Module and your document does not use `Sweave` then unselect it. If it does use `Sweave` see the steps below.

2. Export the document using File, Export, LaTeX (pdflatex). This will produce a document of the same name as you LyX file with a `.tex` extension. So, if your document name is `foo.lyx` then the exported file will be named `foo.tex`.

3. Open the `.tex` file in TEXworks or other LaTeX compiler.

4. Set the compiler to pdfLaTeX and compile.

5. Set compiler to BibTex and compile.

6. Set the compiler to pdfLaTeX and recompile.Voila – a .pdf file will appear in the viewer window of Texworks and a file will be produced. You now have all of the files you need to submit your document in LaTeX to a journal.

Truth be told, this often takes a bit of tinkering to get right. Persevere.

17.2 Creating edited LaTeX file

Occasionally there are some minor edits needed to meet journal formatting requirements that must be done on the .tex file (i.e., the LaTeX version of your document. For example, Ecological Society of America journals will allow captions beneath the figures for review, but insist on a list of figures with caption-less figures for final submission. I couldn't figure out how to do this in LyX, but it was a snap in LaTeX. You simply add `{\label{fig:_____}}` to each figure caption. For example, I changed

```
\caption{\label{fig:Posteriors_regression}Posterior distributions of pa-
rameters in the harvest regression model using indices of predator abun-
dance as independent variables. }
```

to

```
\caption[Posterior (solid line) and prior (dashed line) distribu-
tions of parameters in the population model using estimates of in-
dices of predator abundance as independent vari-
ables.]{\label{fig:Posteriors_state_space}}.
```

for each of the captions. Because the caption text is contained within the { } it shows up empty, but the text with the [ ] shows up in the list of figures required by the journal.

Once you have made the edits in you .tex file, you need to compile the .pdf using

using Texworks or other LaTeX compiler as described above (section 17.1). Set the compiler to pdfLaTeX

17.3 Creating LaTeX and .pdf with Sweave

Going from LyX with Sweave to .pdf via LaTeX:

1. Make a copy of the Sweave.sty file in the working directory of your document. To find the Sweave.sty file, enter `file.path(R.home(), "share", "textmf", "Sweave.sty")` in R.

2. Export the LyX file as a Sweave document (File, Export, Sweave). This will appear in your working directory as `documentname.Rnw`.

3. In R, execute something like:

```
setwd("/Users/Tom/Documents/lyx/Sweave example docs/") #set working di-
rectory to directory containing LyX document
Sweave(file="Hobbs first Sweave doc.Rnw",syntax="SweaveSyntaxNoweb")
```

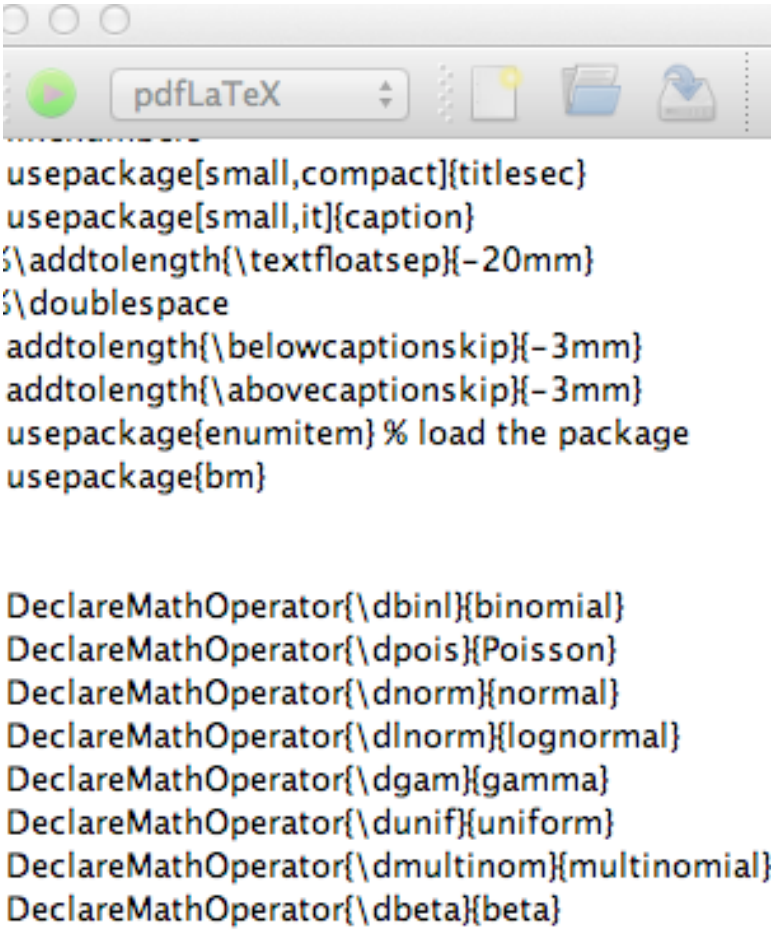

Figure 2: Illustration of setting compiler in Texworks. Note that the box in the upper right is set to pdflaTex.

R will write a `.tex` file which is what you will need to submit your manuscript. This file can be then be compiled to pdf file using Tex Works or other LaTeX compiler . You must set the compiler to pdfLaTeX, e.g.:

After compiling as pdfLaTex, then compile as BibTex. Compile again as pdfLaTeX as described above (section **??**). Voila. You are done.

Literature Cited

Hobbs, N. T., H. Andrén, J. Persson, M. Aronsson, and G. Chapron, 2012. Native predators reduce harvest of reindeer by Sámi pastoralists. *Ecological Applications* **22**:1640–1654.

Algorithm 1 An example LaTeX preamble for the Article document class. The % indicates a comment that can be used to turn commands on and off. There are .pdf files on the web describing packages shown here For example, do a web search on "endfloat package and LaTeX" or "fancy headings package and LaTeX." If you put this code (cut and paste) in the LaTeX Preamble box under Documents, Settings and then Save as Class Defaults it will appear whenever you start a document of class Article.

```
% For adding line numbers.  Remove % comments below when you want them
%\usepackage{lineno,setspace}
%\linenumbers
%Makes headings and captions more compact
\usepackage[small,compact]{titlesec}
\usepackage[small,it]{caption}
%reduces white space around figures, tables, and algorithms
%\addtolength{\textfloatsep}{-20mm}
%\addtolength{\belowcaptionskip}{-3mm}
%\addtolength{\abovecaptionskip}{-3mm}
%\addtolength{\intextsep}{-3mm}
%allows bold greek letters in LaTex math entered as ERT
\usepackage{bm}
% code for shortcuts for writing out distribution names.  Follows JAGS syntax.
\DeclareMathOperator{\dbinl}{binomial}
\DeclareMathOperator{\dpois}{Poisson}
\DeclareMathOperator{\dnorm}{normal}
\DeclareMathOperator{\dlnorm}{lognormal}
\DeclareMathOperator{\dgam}{gamma}
\DeclareMathOperator{\dunif}{uniform}
\DeclareMathOperator{\dmultinom}{multinomial}
\DeclareMathOperator{\dbeta}{beta}
%Creates spiffy headers and footers
\usepackage{fancyheadings}
\lhead{NR 575 Systems Ecology}
\chead{}
\rhead{A Lyx Accelerator}
%allows use of urls
\usepackage{url}
%Marvelous package for handling tables and figures in manuscripts.  Uncomment to
use.
%\usepackage{endfloat}
```