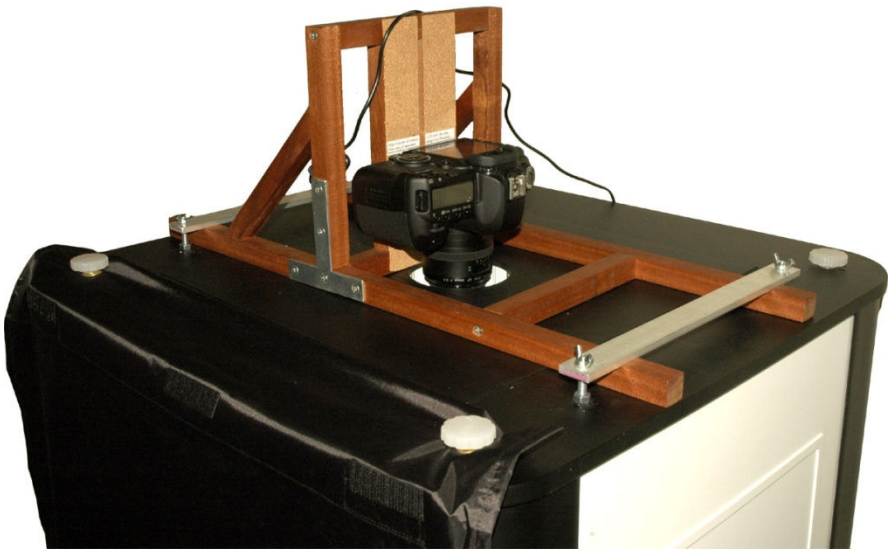
Assembling the Custom Components for Specimen Imaging

Consortium of Pacific Northwest Herbaria

Version 1.0
July 9, 2010



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1. Introduction

This document provides instructions for assembling the custom hardware components used for imaging specimens under the Consortium of Pacific Northwest Herbaria's 2010-2013 collaborative NSF Grant. It is intended as a guide for similar projects elsewhere. However, the components described here are specific to our choice of imaging equipment and may not be suitable for use elsewhere.

Also discussed here are the custom software scripts used for metadata capture, image processing, and image tiling. The tiling script creates a version of the image that can be viewed with the Gmap Image Viewer (http://www.rmh.uwyo.edu/gmapviewer/about.php), an online, open-source viewer created for use with herbarium specimens.

About the Consortium:

The Consortium of Pacific Northwest Herbaria is a regional partnership of herbaria from Pacific Northwestern North America, formed in 2007. Its primary objective is the formation of a network of collections data accessible through a single online search portal. The Consortium facilitates digitization of specimens at regional herbaria.

Funding for the Consortium has been provided primarily by the National Science Foundation, first with a supplement to the WTU Herbarium's 2004-2007 NSF grant (0346624), and currently with a collaborative NSF grant (0956414) between WTU, OSC, ID, and MONT. Administration and web site development occur at WTU.

2. Velcro tabs on lightbox curtain:

Additional velcro tabs on the fabric curtain will make it easier to quickly position the curtain out of the way while inserting and removing specimens from the lightbox during image capture. Use strips of self-adhesive velcro cut into pieces about 2 inches long. Place the hooked sides of the velcro along the top of the curtain in the positions indicated in Figure 1. Place the soft sides of the velcro along the bottom and sides of the curtain as indicated in Figure 1.

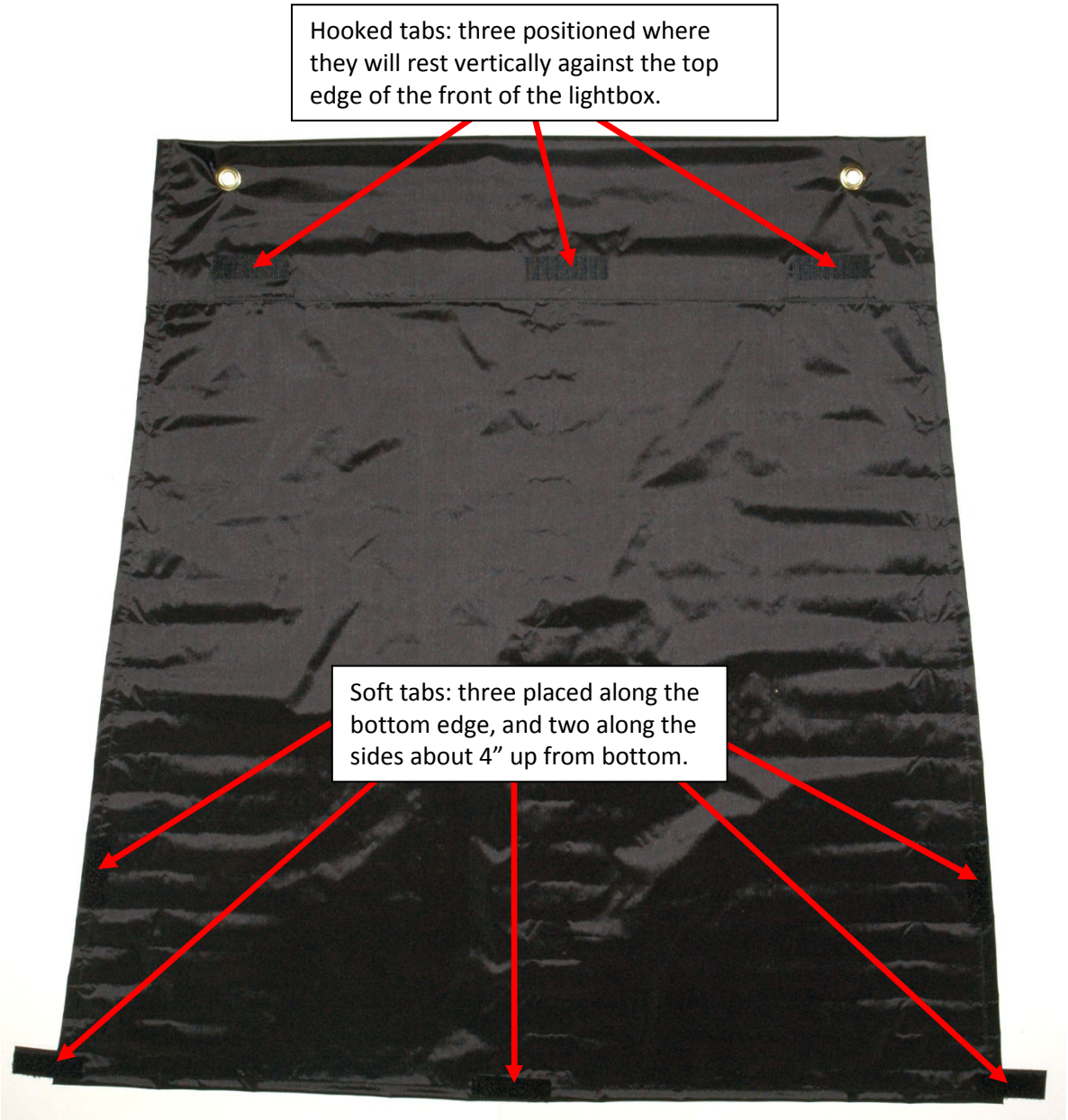


Figure 1. Placement of velcro tabs on lightbox curtain.

3. Custom camera mount:

Building the camera mount is a fairly time-consuming process. However, it is necessary to provide a stable position for the camera. The Ortery Lightboxes we use do not come with any suitable methods of positioning a dSLR in the appropriate position on the lightbox.

3.1. Hardware, supplies, and tools required:

Hardware and supplies for each mount (# of pieces in parentheses):

1) Lengths of hardwood ca. ¾" thick by ¾" wide. If you can't fine ¾" then use 1" and adjust subsequent measurements as needed. You will need the following lengths, for a total of 103.5 inches or 8 feet 7.5 inches:
    a. 24" (2)
    b. 8.5" (2)
    c. 8" (2)
    d. 7.5" (3)
2) Lengths of hardwood ¾" thick by 1-½" to 2" wide by 7-¾" long (2)
3) Metal T-braces with arms 2 to 3" long and widths less than ¾", including the ¾" screws that come with each brace (2)
4) 1-¾" wood screws, with inset phillips heads (14)
5) 1" wood screws, with inset phillips heads (4)
6) Wood finish. I'd suggest an oil-based finish that soaks into the wood.
7) Piece of thin cork padding at least 10" long by 4" wide with adhesive backing. If you can't get adhesive backing, then use spray-glue.
8) Large plastic thumb knob with a ¼" x 20 thread hole (1)
9) ¼" x 20 thread bolt blank (no head) at least 2" long (1)
10) 1" fender washer with a 3/16" diameter hole enlarged to slightly smaller than ¼" using a drill press. If you don't have a drill press, just get one with a ¼" hole (1)
11) Gorilla glue or something similar

Hardware for attaching the mount to the lightbox (# of pieces in parentheses):

1) ¼" x 20 thread bolts 1-¼" long, threaded all the way to the base (4). If you can't find a bolt of this size threaded to the base, then use 5/16" x 20 thread bolts 1-¼" long and adjust subsequent hardware and measurements.
2) ¼" x 20 thread nuts (4)
3) ¼" x 20 thread wing nuts (4)
4) Plastic caps for ¼" bolts (4)
5) Aluminum bars 1" wide by ¼" thick by 12" long (2)

Tools:

1) Chop saw for cutting wood into lengths. You can get by with a hand saw or skillsaw, but making nice end cuts and angle cuts will be more difficult.
2) Sandpaper or electric sander (60 grit and 120 grit will do)
3) Electric drill.
4) Drill press (for drilling holes in the aluminum bars)
5) Drill bits. Approximate sizes: __, __, 0.230, and __
6) Phillips-head screwdriver
7) Socket wrench and regular wrench, sized to fit the ¼" bolts that will attach to the lightbox
8) Metal grinder
9) Tape measure and pencil

3.2. Assembling the camera mount:

These instructions assume you are pre-drilling the holes for each screw. When pre-drilling a hole to attach two pieces of wood, hold the two pieces tightly in position (use a clamp if it helps) and drill the hole through both pieces at the same time, using a drill bit slightly smaller than the diameter of the screw. Then, use a drill bit slightly larger than the screw to enlarge the hole in the first piece of wood (the one into which the screw is inserted first) so the threads do not bind in this part of the hole. Last, use a large drill bit to create a shallow inset so the screw head sits flush against the wood surface.

When attaching the T-braces, position each brace into place against the wood, and use the holes in the brace as guides for pre-drilling the holes for the screws. Try to place the drill holes precisely in the center of the T-brace holes if possible.

1) Cut the hardwood into the lengths given above.
2) Sand these pieces until reasonably smooth (at least, no splinters or rough spots). Be careful to not round the corners or ends.
3) Take the two 8" lengths of ¾" x ¾" hardwood and cut the ends at 45° angles such that the faces of the angles are on the same side (Figure 2). These two pieces will form the diagonal braces for the upright portion of the camera mount.
4) Using the diagram in Figure 2 as a guide, asemble the two sides of the camera mount using the 24" and 8.5" pieces of hardwood, and the metal T-braces. Use the ¾" wood screws that came with the T-braces to attach the 8.5" upright to the 24" base, predrilling each hole, and being careful that the upright is at a right-angle to the base. Do not yet put a screw into the hole at the intersection of the T brace arms.
5) Using the diagram in Figure 2, assemble the vertical risers and associated cross-pieces using 1-¾" screws. Position the two risers (the 1-½" or 2" wide pieces) such that the gap between them is just barely large enough to accept a ¼" bolt. The bolt should slide feely

up and down this gap without binding. Use two of the 7.5" long pieces for the top and bottom of the mounting plate.

6) Attach the mounting plate to the two sides of the camera mount using 1-¾" screws (Figure 2).
7) Use the last 7.5" long piece to create a brace on the front of the camera mount using 1-¾" screws (Figure 2).
8) Attach the two 8" long diagonals to the back of the upright portion of the camera mount (Figure 2). Use the 1" long wood screws for these.
9) Apply a coat of wood finish to the mount, and let dry overnight.
10) Cut the cork padding into two pieces each measuring 9 ¼" long by 1-½" to 2" wide (depending on the width of the mounting plate verticals). Attach these to the mounting plate verticals using the self-adhesive or spray glue (Figure 3).

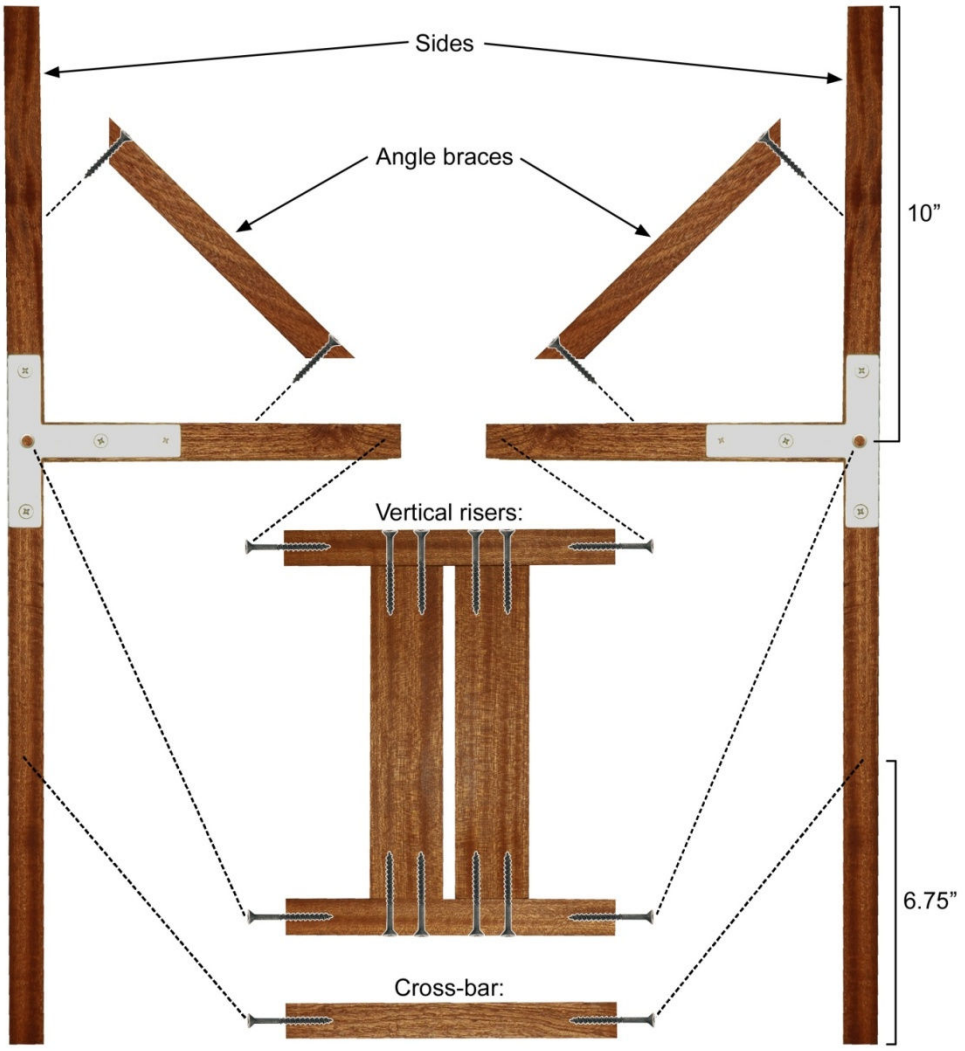


Figure 2. Partially assembled components of the custom camera mount.

Figure 3. Vertical risers of camera mount, with cork pads attached and camera alignment guide taped into place..

3.3. Creating the thumb knob:

The thumb knob holds the camera to the mount. It is positioned through the vertical gap between the mounting plates verticals, and into the tripid socket on the bottom of the camera. The length of the bolt must be precise or it will either not be deep enough to fit the socket, or it will be too deep and prevent the camera from tightening down against the cork.

1) Insert the bolt blank into the thumb knob bolt hole, and screw it all the way down.
2) Put a mark on the bolt exactly 1-⅛" from where it meets the base of the thumb knob (this assumes you are using ¾" thick wood for the mounting plate).
3) Remove the bolt blank from the thumb knob and use a metal grinder to grind off the bolt past the mark. Be sure to clean up the threads on the ground end.
4) Re-insert the bolt blank into the thumb knob, this time with the cut end in. Place a washer over the bolt, place it through the vertical groove on the camera mount, and thread it into the camera to check that the length is correct.
5) If correct, remove the bolt blank from the knob, apply a little gorilla glue, re-insert into the knob and tighten firmly. Let dry.

3.4. Attaching the camera mount to the lightbox:

The camera mount is attached to the top of the lightbox by clamping it down under two aluminum bars positioned over the ends of the mount. These aluminum bars are clamped into place using wing-nuts threaded over two bolts on each side of the lightbox.

Start by drilling holes in the aluminum bars (Figure 4):

1) Use a drill bit slightly larger than ¼" (the bolts must fit easily through these holes) to drill one hole in each end of one of the bars (not both bars). The exact position of the holes doesn't matter, but try to make them the same distance from each edge and about ¼" from the ends of the bar. Drilling should be done on a drill press to ensure a clean, vertical hole.
2) Use the holes in this first bar as a guide for drilling the holes in the second bar. Simply place the first bar on top of the second, position them both under the drill press, and drill down through the second bar.
3) Clean the holes to remove any burs and sharp edges. A metal grinder works, or use a larger drill bit in the drill press to round the edges of each hole.

Then, drill four holes in the top of the lightbox and attach the four bolts (Figure 5). The holes for these bolts will be on the left and right sides of the box top (as viewed from the front where the door is). The mount should end up positioned as shown in Figure 6.

1) Remove the top of panel of the lightbox.
2) From the left and right edges of this panel, mark a guideline 2 inches in from the edge.
3) Mark the midpoint on each guideline, as measured from the front and back edges of the panel.
4) Mark the midpoint on each aluminum bar.
5) For each guideline, align the midpoint mark of an aluminum bar with the midpoint mark on the guideline, and center the holes on each end of the bar over guideline.
6) Fix the aluminum bar in place (either hold it firmly, or tape it down).
7) Drill through the panel using the holes in the aluminum bar as guides for the drill bit. Make absolutely sure the drill stays vertical. Use a drill bit around 0.230 inches in diameter.
8) Run a ¼" x 20 thread by 1 ¼" long bolt up through each hole in the top panel. You'll need a socket wrench and a hand wrench, and will need to use some force to get the bolts to go through the slightly smaller holes (they should fit very snugly in the hole). Make sure the bolts go through perpendicular to the panel and not askew.
9) Run a nut down each bolt, and snug it down against the plastic enough to keep the bolt from being able to turn (but not too hard – you don't want to crack the plastic).

Figure 4. Aluminum bars with holes drilled through each end.

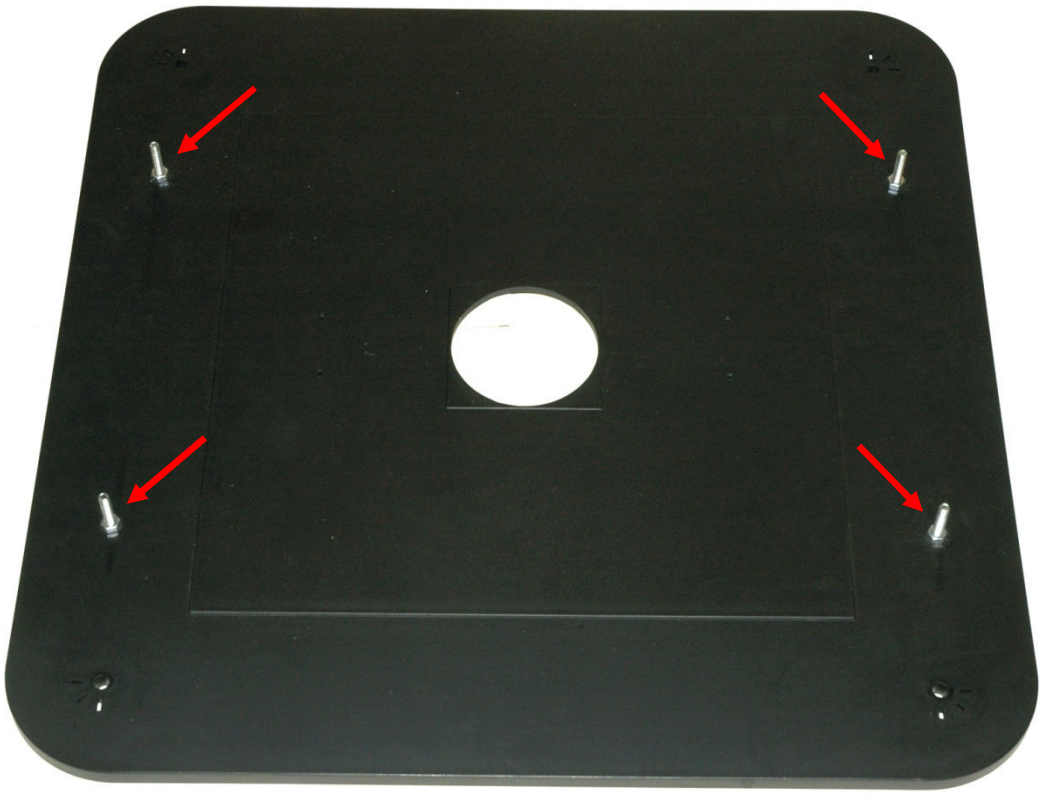


Figure 5. Position of the four bolts through the top panel of the lightox 2" in from the edge and positioned to align with the holes in each aluminum bar.

Figure 6 shows the completed and assembled camera mount. If you did it right, the aluminum bars should fit snugly but easily over the bolts. When you tighten the bars down over the camera mount be sure not to go too tight. It doesn't take much pressure to hold the mount in place, and too much tightening could weaken or crack the plastic of the top panel. If you see any bend in the aluminum bars then you are much too tight.

The plastic caps can be placed over the bolts when the camera mount is removed. This reduces the chances someone will be injured by the projecting bolts.

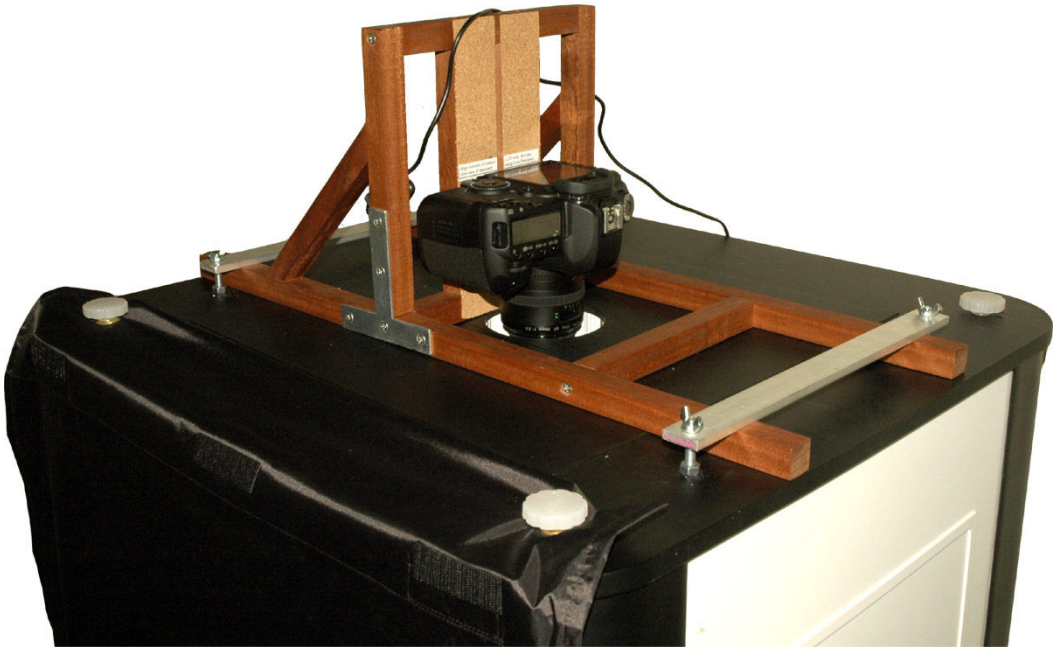


Figure 6. Finished camera mount attached to top of lightbox using aluminum bars and wingnuts.

3.5. Placing a camera positioning guide on the camera mount:

Print out the Word document "camera positioning tags.doc" and cut out one of the tags. Cut this tag in half so each side fits the width of the mounting plage verticals. Tape the tag over the cork padding at the precise position where the camera should go (Figure 3). However, this will need to wait until after you've made the custom specimen holder and have all the components assembled for use.

4. Specimen backdrop and holder:

4.1. Supplies and tools required:

1) Two thick pieces of posterboard or fiberboard 15” x 20” by about ⅛” thick (if you can’t find this size, get 16” x 20” or cut a larger one down to size). Get the deepest, dullest black surface you can. If you can't find deep black, then get a dark neutral color along with a thin black sheet of poster paper, and use spray glue to attach this to the board.
2) Double-sided tap, removable.
3) Razor blade (exacto knife).
4) Metal ruler or bar, long enough to act as a straight-edge for cutting.

4.2. Assembly:

1) Use one of the sheets to cut two strips as follows:
    a. One strip 15” long by 1.5” wide. Use a metal ruler and razor blade to make the cut as straight and clean as possible, or make sure one of the long edges is an outside edge of the sheet (and thus already straight).
    b. One strip 18.5” long by 1.75” wide. Again, make sure you get a clean, straight edge or use an outside edge.
2) Use removable, double-sided tape to attach the 15” x 1.5” strip to one of the 15” ends of the un-cut sheet. Aling the outside edges of the scrip with the outside edges of the un-cut sheet. This edge will form the top of the holder.
3) Use removable, double-sided tape to attach the 18.5” by 1.75” strip to the left side of the sheet (with the 15” strip at the top). This strip should tightly abut the previously attached strip, and its outside edge should aling with the outside edge of the uncut sheet.

If done right, the two strips will form an upside-down "L" with the inside corner being where the top left corner of each specimen sheet will be placed (Figure 7). This inside corner should form a perfect right-angle.

4.3. Positioning the holder inside the lightbox:

Use the double-sided tape to attach the holder to the inside of the lightbox as shown in Figure 7. Push the top edge of the holder right up against the tan power plug that sticks up in the back of the box, and center the left and right sides evenly between the left and right sides of the box. This position should put the center of each specimen sheet very close to the center of the light box. Then, the camera mount’s position can be fine-tuned from there to get the proper framing of the specimen through the viewfinder.

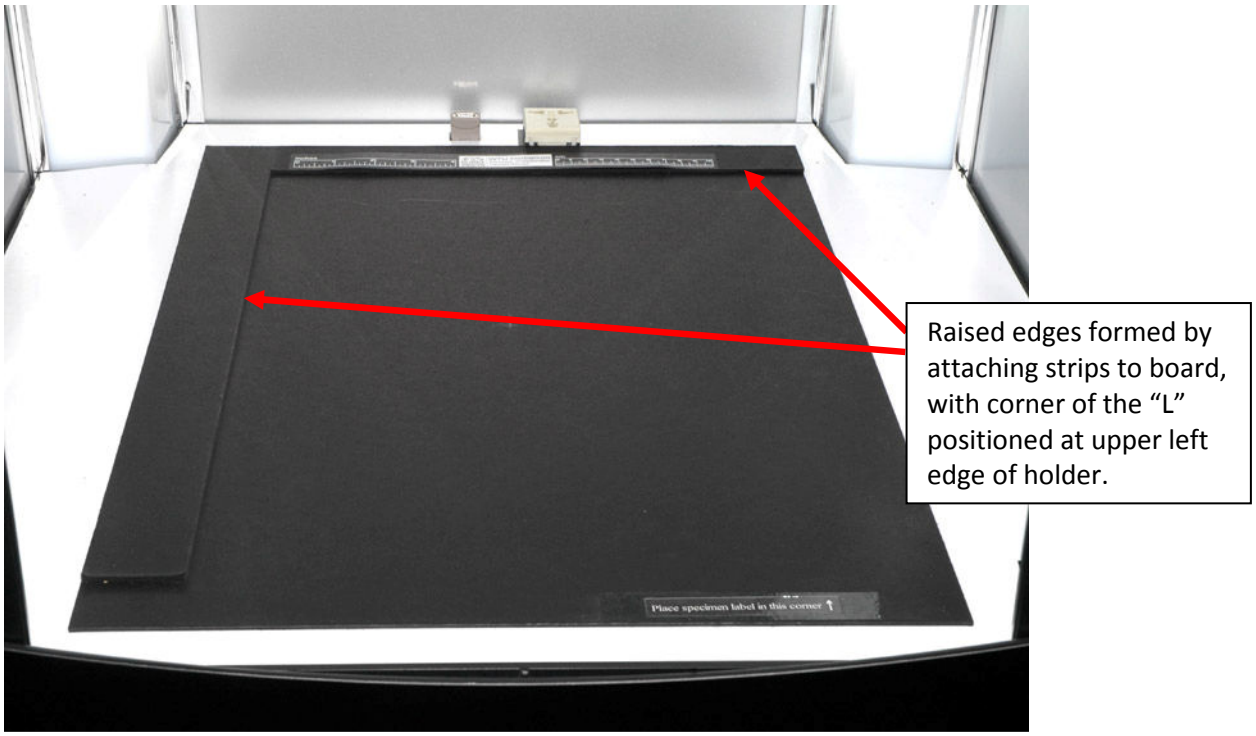


Figure 7. Specimen backdrop and holder, placed inside the lightbox.

4.4. Custom ruler and other tags attached to holder:

The custom ruler is simply a TIFF image printed out at a specific size, to create a ruler 10.75" long by 1" wide (Figure 8) that can be attached to the top of the specimen holder using removable, double-sided tape. Several templates are provided which can serve as a basis for creating a ruler specific to the collection being imaged:

1) Ruler Template.psd: This Photoshop image contains separate layers for each part of the ruler, including the insitutions logo and/or name. If you have a copy of Photoshop, then modify this image to remove the existing logo and name, and replace them with new ones. Then save the image as a TIFF file for printing.
2) Ruler Template.tif: This TIFF image can be used as the starting point if you do not have Photoshop.
3) Ruler Template.doc: This file can be used for printing copies of the ruler. The document contains the TIFF image of the ruler template sized to exactly 10.75" by 1". Replace this TIFF image with your own ruler image.

If desired, tape a small tag to the lower right corner of the holder that indicates the proper position of the specimen label, as shown in Figure 10.

Figure 8. Example of a custom ruler.

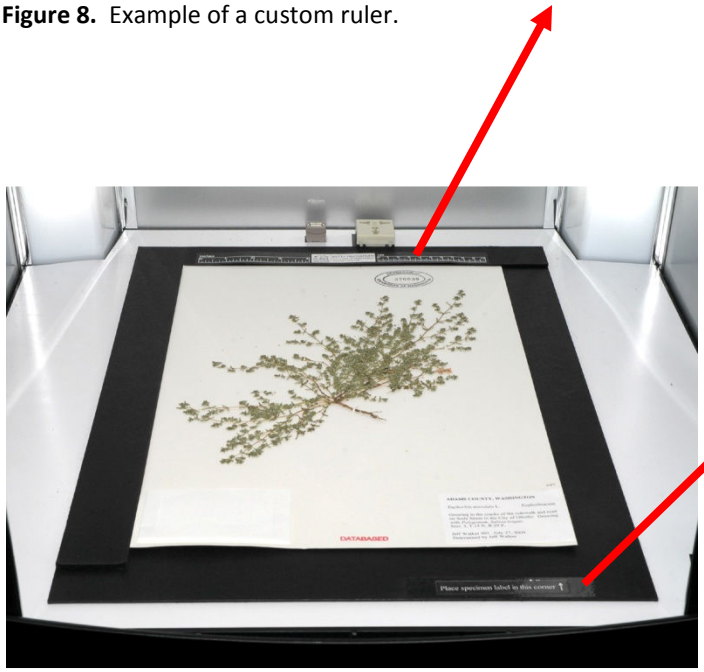


Figure 9. Proper placement of custom ruler and specimen label tag.

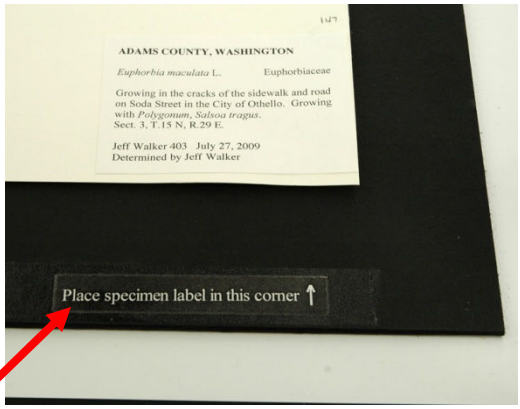


Figure 10. Tag indicating proper position of specimen label.

5. Paperweights:

These paperweights are used to hold down the corners of specimen sheets that do not lie flat. Here is one way to make suitable paper weights. However, other materials could be used or it might be possible to find pre-made weights that will do the job.

Materials and tools:

4 foot long steel bar 1" wide by 3/16" thick.
Flat black enamel spray paint
flat white enamel spray paint
Metal grinder (a hacksaw can be used but it will be more difficult)
Pair of vice-grip pliers (to hold the metal while grinding – it gets really hot!)

Assembly:

Use the metal grinder to cut the steel bar into lengths as follows:

1) four pieces 6" long
2) one piece 3" long
3) five pieces 1" long

You'll have bar left over, so make extras if you like. Then use the grinder to slightly round the corners of the bars just enough to remove any sharp edges or burs. Let cool. Paint the 6" and 3" long bars flat black, and the 1" long bars flat white. The finished bars are shown in Figure 11.

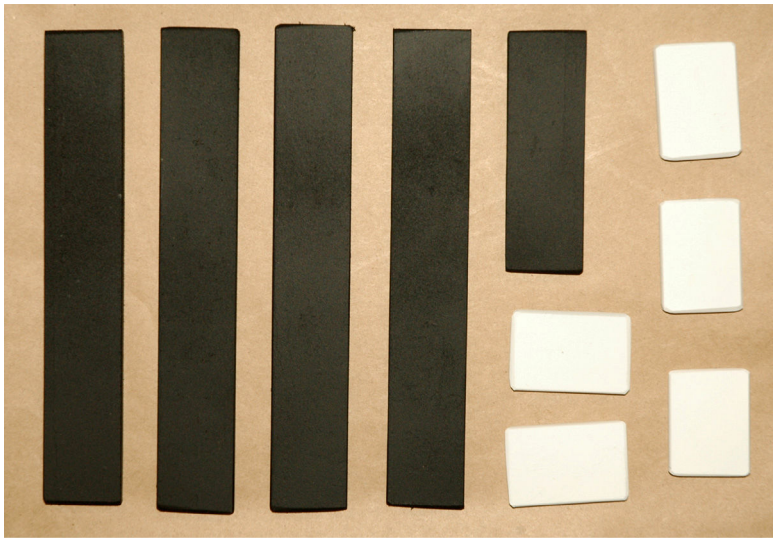


Figure 11. Completed paperweights, including four 6" black bars, one 3" black bar, and five 1" to 1.5" white bars.

6. Tub to hold imaging equipment during transport:

We use a plastic storage tub lined with foam. The inside tub dimensions should be approximately 17" long, 14" wide, and 10" deep. The minimum length and width are determined by the length and width of the laptop. Foam can be used to line the inside of the tub and create cubbies for storing items, as shown in Figure 12. The cubbies shown here can be adjusted as desired. The depth of the cubbies should be just greater than the camera height. On top of the cubbies, place a firm foam piece the same width and length as the tub. The laptop can be placed on this foam piece, and another large piece placed over top of the laptop. Use small foam shims along the sides of the laptop to keep the laptop from sliding around.

Figure 12. Storage tub with foam liners and cubbies. Measurements shown are guidelines, and should be adjusted to fit the size of your tub and equipment.

7. Software scripts:

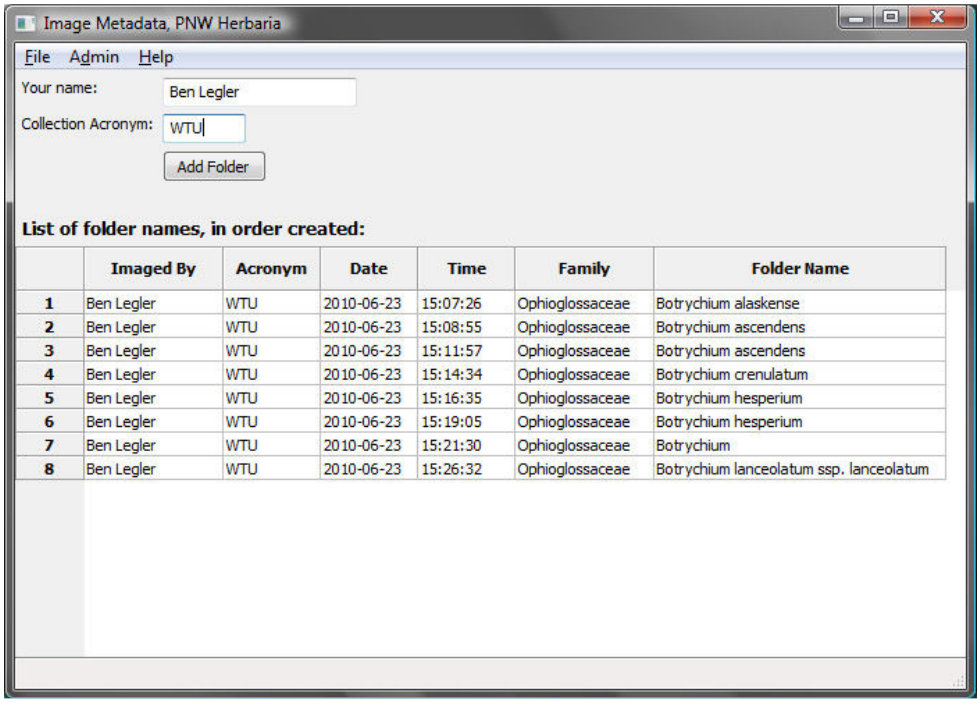
7.1. Image metadata form:

Requirements:

1) Python (http://www.python.org/). Tested with verison 2.6.4. The script is not compatible with versions 3.x.
2) wxPython (http://www.wxpython.org/). Tested with version 2.8.

The metadata form (Figures 13, 14) is a standalone script written in Python. It is used during the image capture process to record contextual information for each folder of specimens, including who is doing the imaging, the herbarium acronym, and the name on the folder (scientific name, genus, etc.). The metadata is stored in an SQLite database on the computer being used for imaging.

This metadata is then transferred periodically to the PNW Herbaria server along with the images. Then, during image processing on the server, the meta is linked to each imaged specimen image using a timestamp associated with the metadata and the image. This match occurs by comparing the image timestamp against the metadata timestamps, and finding the folder metadata entry whose timestamp immediately preceeds the image's timestamp.



	Imaged By	Acronym	Date	Time	Family	Folder Name
1	Ben Legler	WTU	2010-06-23	15:07:26	Ophioglossaceae	Botrychium alaskense
2	Ben Legler	WTU	2010-06-23	15:08:55	Ophioglossaceae	Botrychium ascendens
3	Ben Legler	WTU	2010-06-23	15:11:57	Ophioglossaceae	Botrychium ascendens
4	Ben Legler	WTU	2010-06-23	15:14:34	Ophioglossaceae	Botrychium crenulatum
5	Ben Legler	WTU	2010-06-23	15:16:35	Ophioglossaceae	Botrychium hesperium
6	Ben Legler	WTU	2010-06-23	15:19:05	Ophioglossaceae	Botrychium hesperium
7	Ben Legler	WTU	2010-06-23	15:21:30	Ophioglossaceae	Botrychium
8	Ben Legler	WTU	2010-06-23	15:26:32	Ophioglossaceae	Botrychium lanceolatum ssp. lanceolatum

Figure 13. Metadata entry form used for capturing folder names and other basic contextual information for each folder of specimens imaged.

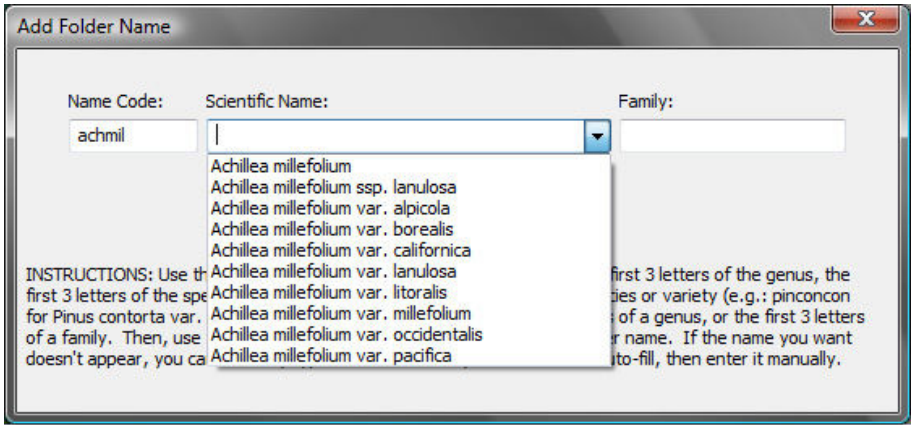


Figure 14. Clicking the "Add Folder" button on the metadata entry form brings up a dialog box where the folder name can be entered by typing a code for the name and selecting the desired name from a drop-down list.

A copy of the metadata script is provided with this documentation, or can be obtained from Ben Legler (blegler@u.washington.edu).

7.2. Image renaming form:

Requirements:

1) Python (http://www.python.org/). Tested with verison 2.6.4. The script is not compatible with versions 3.x.
2) wxPython (http://www.wxpython.org/). Tested with version 2.8.

The image renaming form (Figure 15) is a standalone script written in Python. It is used during the image capture process to rename images to the barcode using a barcode reader, for those collections being barcoded. The script is triggered by the "Software to Link" option in the Canon EOS Utility's Preferences dialog. The script simply displays a window with a text field for entering the new name and a button that triggers the rename and closes the window.

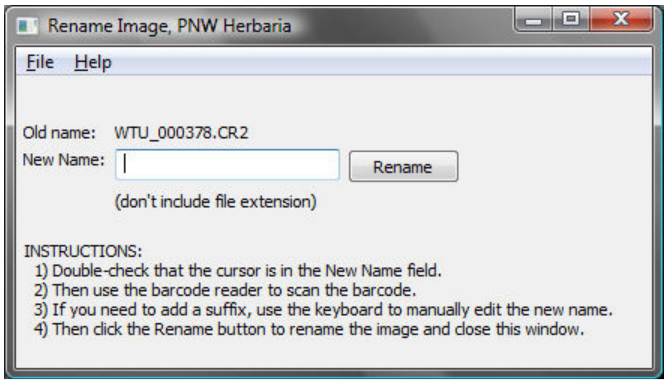


Figure 15. Image renaming utility used during image capture to rename each image to the barcode.

7.3. Image processing and tiling script:

Requirements:

1) Python (http://www.python.org/). Tested with version 2.6.4.
2) Python Image Library (http://www.pythonware.com/products/pil/). Tested with 1.1.6.
3) Adobe DNG Converter (http://www.adobe.com/products/dng/). Used to convert .CR2 images to .DNG for archiving. Note: "Adobe DNG Converter.exe" must be renamed to remove the spaces, and moved to a path that has no spaces.
4) MySQL-Python (http://www.codegood.com/archives/4, http://mysql-python.sourceforge.net/). Used to link images to the database. Tested with 1.2.2.win32-py2.6.

This script handles nearly all image processing on the PNW Herbaria server. It is run on a nightly schedule to process any new images received during the day. The script can process each image in about __ seconds on our server. By running multiple copies of the script on subsets of the images, it is possible to achieve an effective rate of __ seconds per image.

Before the script is run, new images are sent through Canon's batch conversion program to convert the .CR2 images from the camera into high quality JPEG images. Canon's utility is used because it provides the highest quality conversion results of any program I have tested. It is slightly better than Photoshop, and much better than DCRAW (used by ImageMagick).

The script performs the following steps:

1) Loop through a folder of new, unprocessed CR2 and JPEG images.
2) Rotate the JPEG if necessary.
3) Tile the JPEG and save the tiles in a location accessible to the online image viewer.
4) Move the JPEG to an archival location accessible to the web server.
5) Convert the CR2 image to DNG and copy the DNG to a permanent archival location.
6) Add a reference to this image in the MySQL database for the collection represented by this image. Data entry will occur later from the image.

This is it for image processing. There is no need to crop the images, change color balance, sharpen, etc. The camera settings we use provide us with images that need no subsequent processing except for rotation.

We are using a 21 MP Canon dSLR that produces 26 MB CR2 files. These are converted to DNG (22 MB) for archiving, JPEG (ca. 7 MB) for general access, and tiles (ca. 3.5 MB) for the image viewer. Total space required is about 32.5 MB per image (3.1 TB per 100,000 images).

A copy of the image processing script is provided with this documentation, or can be obtained from Ben Legler (blegler@u.washington.edu).