

THE NEW YORK BOTANICAL GARDEN

# Herbarium Specimen Imaging: Standards and Suggestions

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iDigBio Small Herbarium Workshop – Botany 2014

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# Overview

- Imaging Goals and Standards
- Barcodes
- Equipment
  - Hardware
  - Software
- Image file types and archiving

# Imaging Goals

## For Access:

- Publication, print or web
- Remote study (e.g. eLoans)
- Reduce physical handling, potential for damage
- Species identification confirmation
- To facilitate specimen label data capture
- Public outreach, promote collection or institution

# Imaging Goals

## For Archive:

- Capture the highest quality digital image of a specimen with the best technology available; making a digital copy of the physical specimen
- Save, manage, and maintain an archive of specimen images as carefully and conscientiously as you maintain a collection of physical specimens
- Migrate these images from one file format and/or image management system to another as needed for as long as possible.

# Imaging Goals

## For image capture:

Capture highest quality images as digital copies of the physical specimens:

- In focus
- Good exposure
- White and color balanced
- Readable text
- Taxonomically informative
- File name unique and easily linked to the specimen record
- Accomplish all of the above as efficiently as possible



# Focus

- The distinctness or clarity of an image.
- The state of maximum distinctness or clarity of such an image.

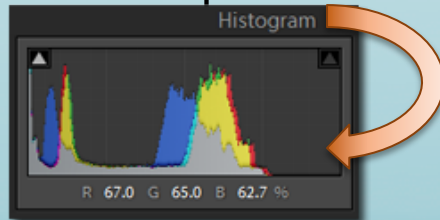


# Exposure

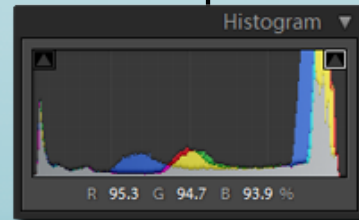
The act of exposing the image sensor to light.  
The quantity of light reaching an image sensor or film.



Under exposed



Well exposed



Over exposed



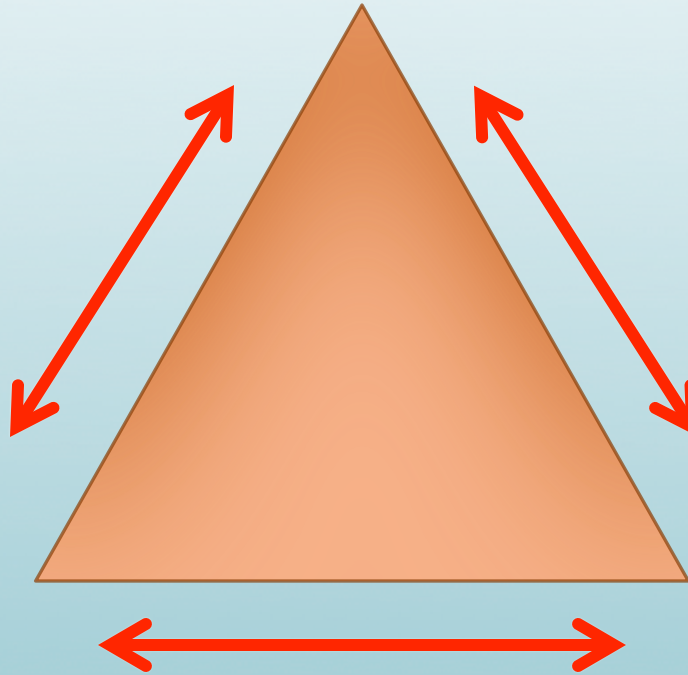
Use the histogram as a guide for good exposure

# Exposure

Determined by three factors: Aperture, Shutter Speed, and ISO

## Aperture (f-number):

Adjustable opening in the camera that limits the amount of light passing through the lens onto the image sensor.



## Shutter Speed:

Length of time a camera shutter is open, exposing the sensor to light.  
Measured in seconds.

## ISO:

Image sensor's sensitivity to light.



# White Balance & Color Balance

- Remove unrealistic color casts, so objects appearing white in person are rendered white in the image.
- The adjustment of the intensities of the colors (typically red, green, and blue primary colors).

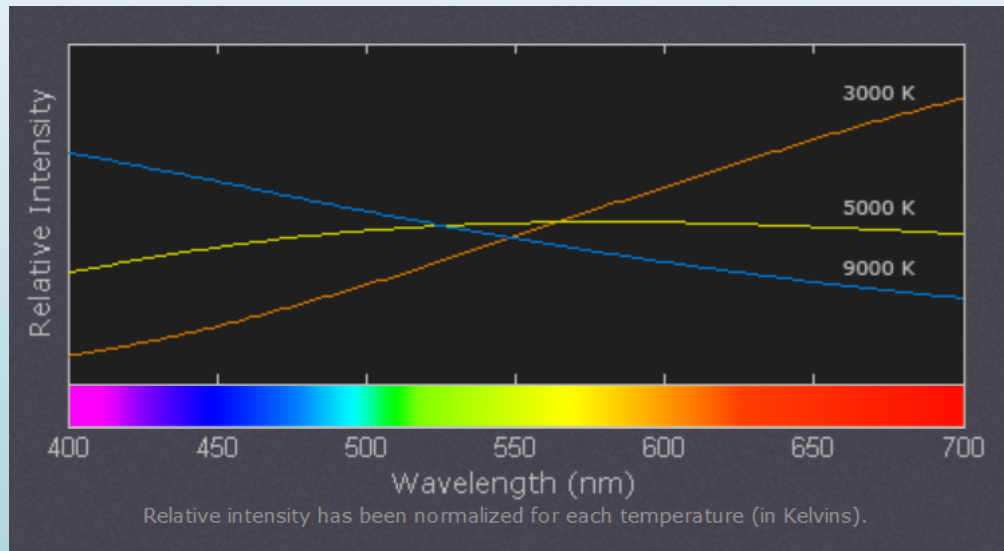


Sources: <http://www.cambridgeincolour.com/tutorials/white-balance.htm>; [http://en.wikipedia.org/wiki/Color\\_balance](http://en.wikipedia.org/wiki/Color_balance)

# Color Temperature

Describes the relative intensities of various wavelengths of white light

Measured in Kelvins (K)



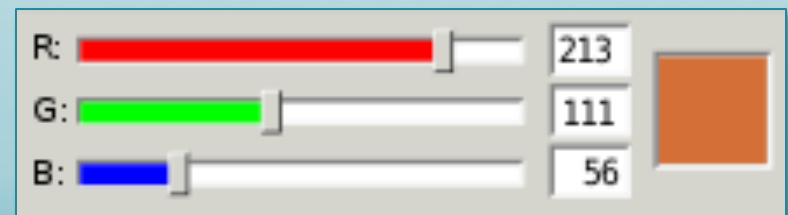
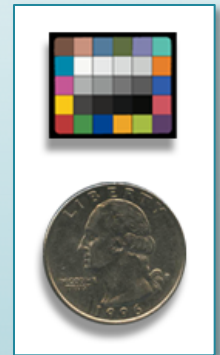
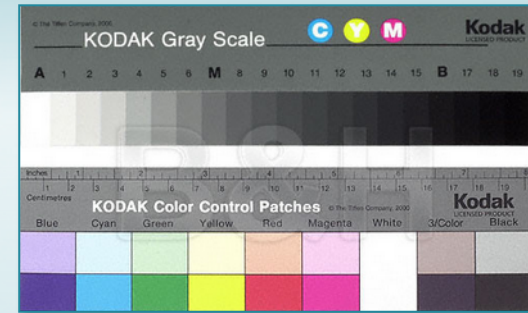
Intensity relative to light source

Temperature	Source
1,700 K	Match flame
1,850 K	Candle flame, sunset/sunrise
2,700–3,300 K	Incandescent lamps
3,000 K	Soft (or Warm) White compact fluorescent lamps
3,200 K	Studio lamps, photofloods, etc.
3,350 K	Studio "CP" light
4,100–4,150 K	Moonlight <sup>[2]</sup>
5,000 K	Horizon daylight
5,000 K	tubular fluorescent lamps or cool white/daylight compact fluorescent lamps (CFL)
5,500–6,000 K	Vertical daylight, electronic flash
6,200 K	Xenon short-arc lamp <sup>[3]</sup>
6,500 K	Daylight, overcast
6,500–10,500 K	LCD or CRT screen
15,000–27,000 K	Clear blue poleward sky

Sources: <http://www.cambridgeincolour.com/tutorials/white-balance.htm>; [http://en.wikipedia.org/wiki/Color\\_temperature](http://en.wikipedia.org/wiki/Color_temperature)

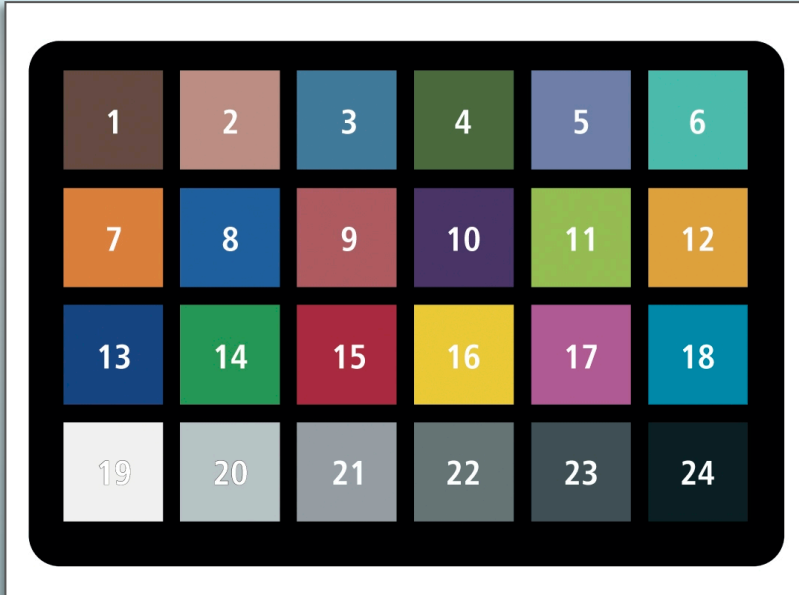
# Exposure and Color Balance

- Visual confirmation:
  - If the picture is too dark...
  - If the picture is too bright...
- Use aim points:
  - X-Rite Color Checker ([\\$86](#))
  - ColorGauge Nano Target ([\\$195](#))
  - Kodak Q-13 ([\\$40](#))
- RGB Color Model:
  - Combinations of red, green, and blue light = 16.7 million color combinations



# Color Aim Points

## Example: X-Rite ColorChecker Mini



**R G B**

No.	Number	sRGB			CIE L*a*b*			Munsell Notation	
		R	G	B	L*	a*	b*	Hue Value / Chroma	
1.	dark skin	115	82	68	37.986	13.555	14.059	3 YR	3.7 / 3.2
2.	light skin	194	150	130	65.711	18.13	17.81	2.2 YR	6.47 / 4.1
3.	blue sky	98	122	157	49.927	-4.88	-21.925	4.3 PB	4.95 / 5.5
4.	foliage	87	108	67	43.139	-13.095	21.905	6.7 GY	4.2 / 4.1
5.	blue flower	133	128	177	55.112	8.844	-25.399	9.7 PB	5.47 / 6.7
6.	bluish green	103	189	170	70.719	-33.397	-0.199	2.5 BG	7 / 6
7.	orange	214	126	44	62.661	36.067	57.096	5 YR	6 / 11
8.	purplish blue	80	91	166	40.02	10.41	-45.964	7.5 PB	4 / 10.7
9.	moderate red	193	90	99	51.124	48.239	16.248	2.5 R	5 / 10
10.	purple	94	60	108	30.325	22.976	-21.587	5 P	3 / 7
11.	yellow green	157	188	64	72.532	-23.709	57.255	5 GY	7.1 / 9.1
12.	orange yellow	224	163	46	71.941	19.363	67.857	10 YR	7.1 / 10.5
13.	blue	56	61	150	28.778	14.179	-50.297	7.5 PB	2.9 / 12.7
14.	green	70	148	73	55.261	-38.342	31.37	0.25 G	5.4 / 8.65
15.	red	175	54	60	42.101	53.378	28.19	5 R	4 / 12
16.	yellow	231	199	31	81.733	4.039	79.819	5 Y	8 / 11.1
17.	magenta	187	86	149	51.935	49.986	-14.574	2.5 RP	5 / 12
18.	cyan	8	133	161	51.038	-28.631	-28.638	5 B	5 / 8

19.	white (.05*)	243	243	242	96.539	-0.425	1.186	N	9.5 /
20.	neutral 8 (.23*)	200	200	200	81.257	-0.638	-0.335	N	8 /
21.	neutral 6.5 (.44*)	160	160	160	66.766	-0.734	-0.504	N	6.5 /
22.	neutral 5 (.70*)	122	122	121	50.867	-0.153	-0.27	N	5 /
23.	neutral 3.5 (1.05*)	85	85	85	35.656	-0.421	-1.231	N	3.5 /
24.	black (1.50*)	52	52	52	20.461	-0.079	-0.973	N	2 /

\*50 2 degree observer sRGB values for Illuminate D65.

[http://xritephoto.com/ph\\_product\\_overview.aspx?catid=28](http://xritephoto.com/ph_product_overview.aspx?catid=28); [http://xritephoto.com/ph\\_product\\_overview.aspx?ID=824&action=support](http://xritephoto.com/ph_product_overview.aspx?ID=824&action=support)

# Exposure and Color Balance

Using the camera's Manual Mode, adjust the aperture, shutter speed, color temperature, and WB shift until white values are acceptable.

The image displays a workflow for color calibration. On the left, Digital Photo Professional (DPP) shows a folder view with a selected image. A green arrow points from the DPP interface to the camera's LCD screen. The camera screen shows the Manual Mode (M) settings: 1/60 shutter speed, F8.0 aperture, 5200 ISO, and 100 exposure compensation. The WB SHIFT menu is open, showing a color calibration chart with a white patch (M) selected. A green arrow points from the camera screen to the right, where a table of color values is shown. A red arrow points from the DPP interface to the table.

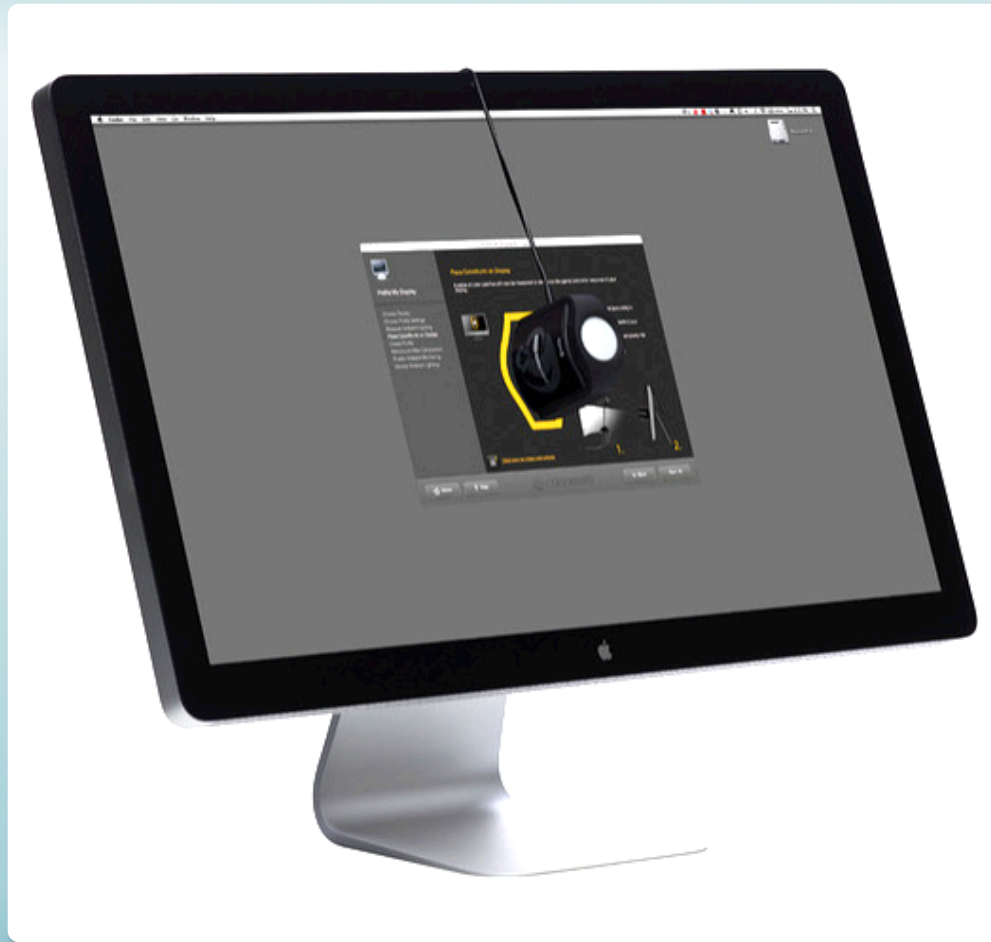
R	G	B
19	white (.05*)	
243	243	242

Additional information from the DPP interface:

- Color bars and a ruler are visible at the top of the DPP window.
- The DPP status bar shows: sRGB / sRGB, High quality, and a circled value of 239,245,238 R / S, High quality.

# Monitor Calibration

Ensure consistent image representation/standardization between any calibrated monitor and other devices, such as printers.



<http://www.wexphotographic.com/?/charts/monitor-calibration-comparison-chart.html>

<http://www.digitalcameraworld.com/2014/02/25/best-monitor-calibrator-for-photographers-6-top-models-tested-and-rated/>

# Imaging Goals

## For image capture:

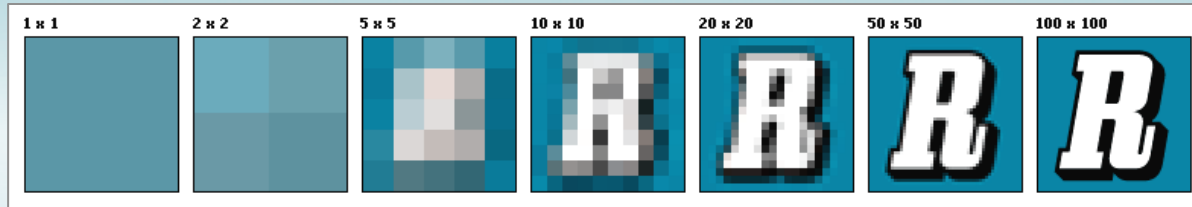
Capture highest quality images as digital copies of the physical specimens:

- In focus
- Good exposure
- White and color balanced
- **Readable text**
- **Taxonomically informative**
- File name unique and easily linked to the specimen record
- Accomplish all of the above as efficiently as possible



# Resolution, Image Size, & Megapixels

The fineness in detail in an image, measured in pixels per inch (ppi)



More pixels per inch = greater resolution = better printed image quality

Smaller pixel size = greater resolution = larger image file size

1 Megapixel = 1,000,000 Pixels

3744 x 5616 pixels



Monitor resolution = 72 ppi

Image Size =  $\frac{\text{Pixel dimension of Image}}{\text{Display resolution in ppi}}$

= 52 x 78 inches or 4.5 times bigger than original 11 x 17 inch sheet

[http://help.adobe.com/en\\_US/photoshop/cs/using/WSfd1234e1c4b69f30ea53e41001031ab64-7945a.html#WS75D24624-A761-40b6-832E-8AB0E2383C90a](http://help.adobe.com/en_US/photoshop/cs/using/WSfd1234e1c4b69f30ea53e41001031ab64-7945a.html#WS75D24624-A761-40b6-832E-8AB0E2383C90a)

<http://www.digital-slr-guide.com/define-megapixels.html>

[http://en.wikipedia.org/wiki/Image\\_resolution#mediaviewer/File:Resolution\\_illustration.png](http://en.wikipedia.org/wiki/Image_resolution#mediaviewer/File:Resolution_illustration.png)



# Resolution, Image Size, & Megapixels

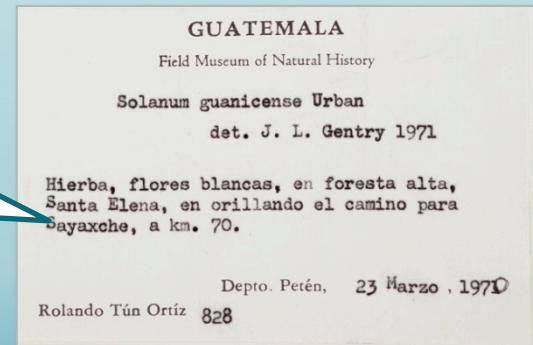
Mega pixels	Image Dimensions (pixels)	Print Size (inches) at 300 dpi	Image size (inches) on 96 ppi monitor	Raw File (MB) (uncompressed 12 bits/pixel)	TIFF File (MB) (uncompressed 48 bit/pixel)
2	1740 x 1160	4 x 6	18 x 12	3	12
3	2160 x 1440	5 x 7	22.5 x 15	4.7	18.7
10	3872 x 2592	8 x 12	40.3 x 27	15.1	60.2
12	4256 x 2832	9 x 14	44.3 x 29.5	18.1	72.3
14	4608 x 3072	10 x 15	48 x 32	21.2	84.9
18	5184 x 3456	11x 17	54 x 36	26.9	107.5
24	6016 x 4000	13 x 20	62.6 x 41.7	36.1	144.4
36	7360 x 4912	16 x 24	76.7 x 51.2	54.2	216.9

## OCR Accuracy:

minimum text size =

**x-height  $\geq$  20 pixels**

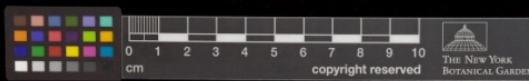
Sayaxche



<http://www.digital-slr-guide.com/define-megapixels.html>; <http://www.atiz.com/resources/DPI-PPI-Megapixels-and-Resolution.pdf>

<http://pixeldensitycalculator.com/>; <http://web.forret.com/tools/megapixel.asp>

Color Checker & Scale Bar  
secured in place



NY IMAGED

Stamp as Imaged

Specimen fills the frame,  
straight



Unique ID number



All text visible  
and in focus

34  
65

WISCONSIN  
DADE CO.

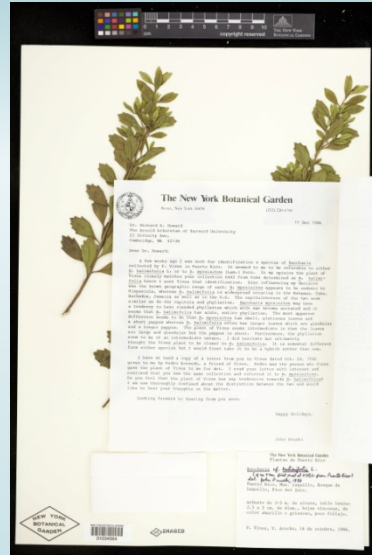
*Sorghum*  
*halepense*  
(L.) Pers.  
(or X S.  
bicolor?  
or S.  
sudansense?)

Probably not truly escaped.  
Robust (Germania?)  
culms to 2.5 m tall. Weed; pri-  
marily local on edges of but also sparsely  
scattered throughout cult. field of corn.  
(T 5 N; R 8 E; Sec. 10. E side Gp. Hwy. PB,  
S of jct. with Hwy. 69, 4½ mi. S of VERONA.  
Date: Sept. 6, 1981 No.:  
Coll.: T. S. and S. A. Cochrane 9668

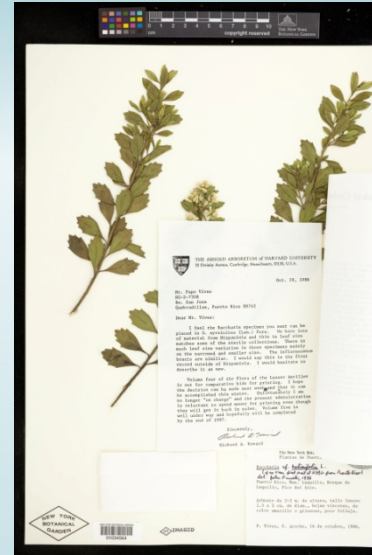
# Unique Image File Names



01034564-01.jpg



01034564-02.jpg



01034564-03.jpg



01034564-04.jpg

Multiple images of one specimen may be necessary

- Fragment packets, large labels, separate fruits, boxed specimens, etc.
- Can add sequential numbers as suffix to file name (e.g. -01.jpg, \_A.jpg)

Benefit to using barcode number to name image file:

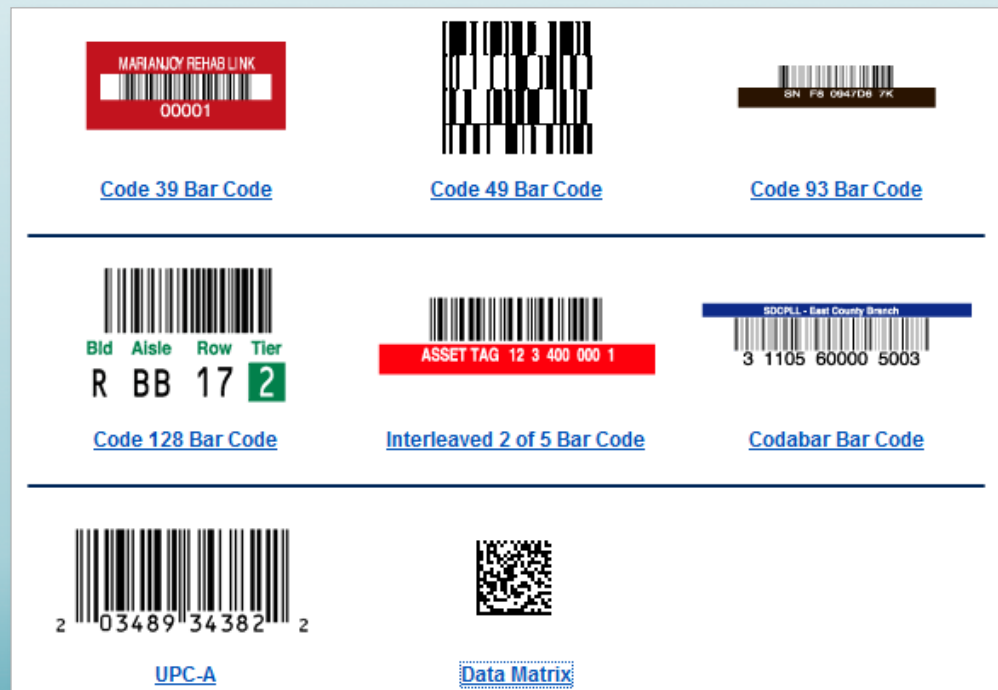
- Can rename image using a barcode scanner at moment of image capture
- Can use software that reads/searches batches of images and renames the files as the barcode (e.g. BardecodeFiler Application)

# Barcodes

Can be used as the primary unique identifier for each specimen

- Unique within the physical collection
- Unique within the database (ie. avoid/prevent duplication)
- Can be used to generate unique image file names
- Easily link specimen image with database record

Machine readable, reduce transcription error when entering data in the database and when naming associated image files



# Barcodes

## Most common = Code 39

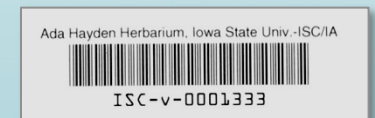
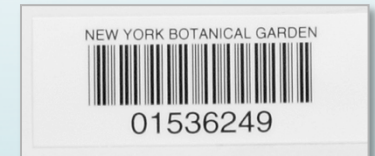
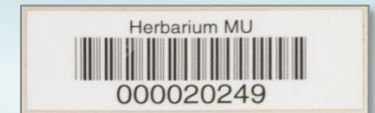
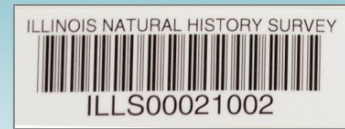
- Alphanumeric
- Variability in length
- Most scanners can read by default (always confirm)

## Things to consider:

- Archival quality and permanence
- Consistency (e.g. 8 digit number, padded with 0's)
- Include human readable text
- Include Index Herbariorum code, Institution
- Size/footprint: smaller might be harder to handle, smaller human readable text
- Roll vs. sheet

## Suggested reading:

- [Macrofungi Collections Consortium reference manual](#) (pg. 16-17)
- [Improving Collection Maintenance Through Innovation: Bar-Code Labeling to Track Specimens in the Processing Stream](#) (G. R. Rácz & W. L. Gannon, 2005).
- [BarCode Technology for Herbarium and Museum Biological Collections](#)
- [University of Florida Herbarium, Herbarium Management](#)
- [Utility of QR codes in biological collections](#) (M. Diazgranados & V. Funk, 2013).
- <http://www.silverbiology.com/products/herbariumbarcodes/>



# Barcodes

Pre-printed barcodes purchased from vendor:

- No need to buy/maintain archival printer, archival ink, archival blank barcodes, etc.
- Ensure uniqueness
- Suggested vendors:
  - Watson Label Products: <http://web.wlp.com/index.html>
  - Computype: <http://www.computype.com>

Print your own barcodes:

- Easier to encode existing accession numbers in new barcodes
- Can print a range of label sizes, if needed
- Easier to print 3 barcodes of the same number for specimens with 3 objects (e.g. sheets)

# Imaging Equipment: Hardware

- Camera, scanner
- Lens
- Structural support for camera
- Light source
- Computer
- Cables (AC adapter, USB)
- Image storage space



# Camera

## Recommended:

- Digital single lens reflex (DSLR) camera
- At least 18 megapixels
- Full frame image sensor
- Capture RAW image file format
- Live view shooting mode (remote shooting)





# Camera Lens

For photographing herbarium specimens using a camera with a full frame image sensor, you will need:

50 – 60 mm Macro Lens

Goal: size of the object on the sensor  $\geq$  the size of the actual object

Reproduction ratio  $\geq$  1:1

Example



**Canon EF 50mm  
f/2.5 Compact Macro**

Example



**Sigma 50mm f/2.8 EX DG Macro Lens  
for Nikon DSLR Cameras**

[www.nikonusa.com/en/Learn-And-Explore/Article/gnhy8b3m/macro-lenses.html](http://www.nikonusa.com/en/Learn-And-Explore/Article/gnhy8b3m/macro-lenses.html)

# Recommended Nikon Camera = \$3900



**Nikon D800E Digital SLR Camera**  
36 MP, Full Frame Image Sensor  
[B&H = \\$3296.95](#)



**Sigma 50mm f/2.8 EX DG Macro Lens**  
for Nikon SLR Cameras  
[B&H = \\$329](#)



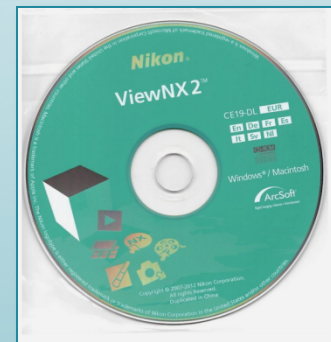
**USB Cable**  
(included)



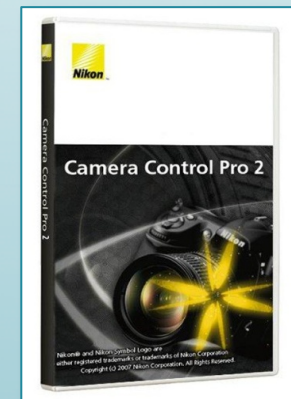
**EP-5B Power**  
**Supply Connector**  
[B&H = \\$49.95](#)



**EH-5b AC Adapter**  
[B&H = \\$84.89](#)



**ViewNX 2**  
**Image Viewing**  
(included)



**Camera Control Pro**  
**2**  
**Remote shooting**  
[B&H = \\$139](#)

# Recommended Canon Camera = \$3817



**Canon EOS 5D Mark III**  
22 Megapixel Full Frame Sensor  
**B&H = \$3399**



**Canon EF 50mm f/2.5 Compact Macro**  
**B&H = \$299**



**USB Cable**  
**(included)**



**Canon AC Adapter Kit ACK-E6**  
**B&H = \$119**



**EOS Utility = Remote Shooting Software**  
**Digital Photo Professional = Viewing**  
**(Both included)**

# Image Sensor

Converts optical image to an electronic signal



**Recommend full frame sensor**

Blue box = Full Frame (35 mm)



APS-H (Canon)  
28.7 × 19 mm  
548 mm<sup>2</sup>



APS-C (Nikon DX,  
Pentax, Sony)  
~23.6 × 15.7 mm  
~370 mm<sup>2</sup>



APS-C (Canon)  
22.2 × 14.8 mm  
329 mm<sup>2</sup>



Foveon (Sigma)  
20.7 × 13.8 mm  
286 mm<sup>2</sup>



Four Thirds System  
17.3 × 13 mm  
225 mm<sup>2</sup>



Nikon 1/CX  
13.2 × 8.8 mm  
116 mm<sup>2</sup>



1/1.7"  
7.6 × 5.7 mm  
43 mm<sup>2</sup>



1/1.8"  
7.18 × 5.32 mm  
38 mm<sup>2</sup>



1/2.5"  
5.76 × 4.29 mm  
25 mm<sup>2</sup>

# Full Frame vs. Cropped sensor

(36 × 24 mm)

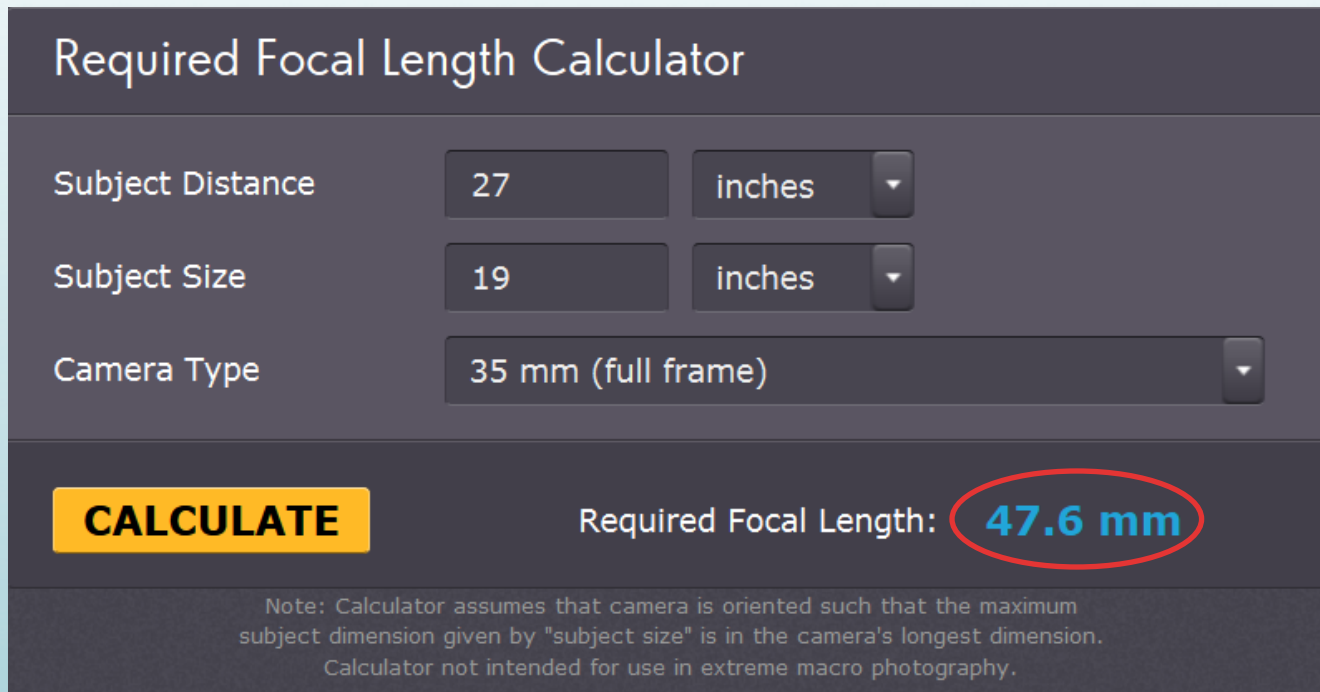
(25.1 × 16.7 mm)

Same lens, same distance from specimen, different sensor size



# Calculate Focal Length

Be sure the combination of camera image sensor and lens focal length will capture the entire specimen in the image.



The image shows a web-based calculator titled "Required Focal Length Calculator". It has three input fields: "Subject Distance" set to 27 inches, "Subject Size" set to 19 inches, and "Camera Type" set to "35 mm (full frame)". A yellow "CALCULATE" button is on the left. To the right, the result is displayed as "Required Focal Length: 47.6 mm", with "47.6 mm" circled in red. Below the calculator is a note: "Note: Calculator assumes that camera is oriented such that the maximum subject dimension given by 'subject size' is in the camera's longest dimension. Calculator not intended for use in extreme macro photography."

Input	Value
Subject Distance	27 inches
Subject Size	19 inches
Camera Type	35 mm (full frame)

**CALCULATE** Required Focal Length: **47.6 mm**

Note: Calculator assumes that camera is oriented such that the maximum subject dimension given by "subject size" is in the camera's longest dimension. Calculator not intended for use in extreme macro photography.

A camera with full frame sensor raised 27 inches above an herbarium specimen with a long edge of 19 inches requires a focal length of 48 mm.

<http://www.cambridgeincolour.com/tutorials/camera-lenses.htm>

# Camera

## Less expensive alternatives



**Nikon D5200 DSLR Camera**  
24 MP DX CMOS Sensor  
(1.5x Crop Factor)  
[B&H = \\$597](#)



**Canon EOS Rebel T3i DSLR Camera**  
18MP APS-C CMOS Sensor  
(1.6x Crop Factor)  
[B&H = \\$499](#)



**Nikon 40mm f/2.8G AF-S DX Micro-Nikkor**  
(Mac Repro ratio 1:1)  
[B&H = \\$277](#)



**Sigma Normal 50mm f/2.8 EX DG Macro**  
Autofocus Lens (Max Repro 1:1)  
[B&H = \\$349](#)

# Camera

## Less expensive alternatives

### **Mirrorless interchangeable-lens camera:**

- Highest number of megapixels possible
- With full frame image sensor
- Captures RAW image file format
- Macro lens

### **Point and shoot camera:**




- Highest number of megapixels possible
- Largest image sensor possible
- RAW image file format, if possible



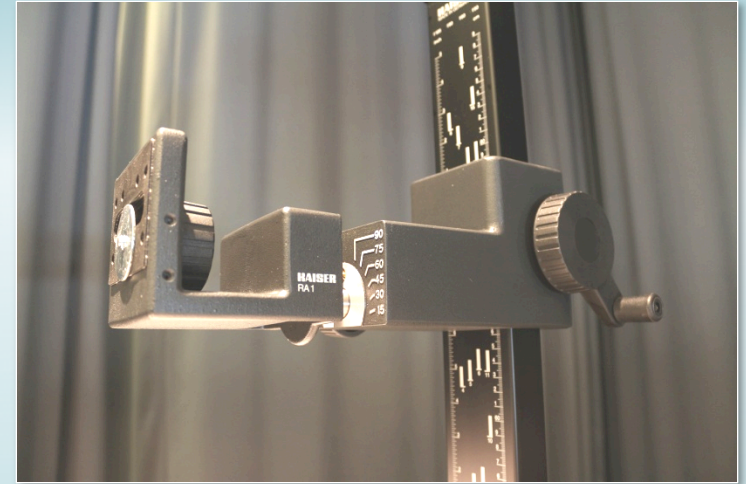
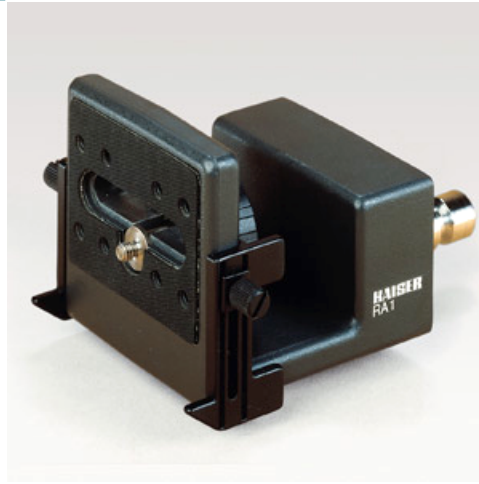
# Compare Camera Specifications

Digital Photography Review: search for and compare cameras

<http://www.dpreview.com/products/compare/cameras>

<p>Side by side 3 cameras compared</p> <p>ADD CAMERA ...</p>	 <p>Nikon D800E</p> <p>◀ move left   move right ▶</p>	 <p>Canon EOS 5D Mark II</p> <p>◀ move left   move right ▶</p>	 <p>Fujifilm X-M1</p> <p>◀ move left   move right ▶</p>
<b>Basic Information</b>			
Buying options	<a href="#">Check prices</a>	\$2,900 - \$3,630	<a href="#">Check prices</a>
Review / Preview	<p><b>84%</b></p> <p><a href="#">Read review...</a> Jun 11, 2012</p>	<p><b>79%</b></p> <p><a href="#">Read review...</a> Feb 13, 2009</p>	<p><b>77%</b></p> <p><a href="#">Read review...</a> Sep 17, 2013</p>
Announced	Feb 7, 2012	Sep 17, 2008	Jun 25, 2013
<b>Price</b>			
MSRP	US: \$3,299.95 UK: £2689.99 EU: €3171		\$699 body only, \$799/£679.99 with 16-50mm
<b>Body type</b>			
Body type	Mid-size SLR	Mid-size SLR	Rangefinder-style mirrorless
Body material	Magnesium alloy		
<b>Sensor</b>			
Max resolution	7360 x 4912	5616 x 3744	4896 x 3264
Other resolutions	6144 x 4912, 6144 x	4080 x 2720, 2784 x	S: (3:2) 2496 x 1664 /

# Kaiser RS 1 Tabletop Copy Stand



- **RA-1 Arm**
- 40" counterbalanced, "low vibration" column
- 18 x 20 inch baseboard
- Can place MK Photo eBox on baseboard or use other light source
- **[B&H = \\$575.74](#)**

# Bencher Copymate II Tabletop Copy Stand

- Fluorescent lights included
- Color temperature 5200K
- Working Area 20"W x 16"D
- Column 36" or 48" long
- [B&H = \\$1041.95](#)



[http://www.bencher.com/photo/copymate2\\_90061.php](http://www.bencher.com/photo/copymate2_90061.php)

# Copy Stand

## Advantages:

- Easy to assemble
- Adjustable
- Lights may be included

## Disadvantages:

- Lights may not be included
- Environmental illumination
- Shadows



Example: imaging workstation with Bencher Copymate II copystand, lights included

# MK Photo-eBox™

“NYBG Modified Version – Model 777000”

## Advantages:

- Even illumination
  - 8 Fluorescent lights, 2 per side  
28W, 6500K (“flicker-free”)
  - 1.5 ft. strip LEDs, 5500K
- Self-contained, easy to operate
- No need to crop image
- Small footprint: 2 ft. x 4 ft.



<http://mkdigitaldirect.com/products/lighting-systems/mk-photo-ebox.html>

# MK Photo-eBox™

“NYBG Modified Version – Model 777000”

## Disadvantages:

- Limited size of subject
- Shipping lead time: 3-5 weeks
- Price: [B&H = \\$1536.50](#) + S/H
- Replace bulb, fan, ballast
- No door knobs
- Remove center feet



# Photo e-Box vs. Copy stand



**MK Photo e-Box 1419**  
1/50 of a second at f11



**Copy stand**  
1/80 of a second at f20

Both photographed using Canon EOS -1Ds Mark III with a 50mm Macro lens

Image from e-Box shows more detail, due in part to the wider aperture, but also to the wrap-around lighting.

<http://digitalphotorepro.blogspot.com/2011/06/mk-direct-photo-e-box-1419-v-copystand.html>

# Consortium of Pacific Northwest Herbaria

## Specimen imaging Documentation

[www.pnwherbaria.org/documentation/imaging-documentation-v4.pdf](http://www.pnwherbaria.org/documentation/imaging-documentation-v4.pdf)

<http://pnwherbaria.org/documentation/custom-components-v1.pdf>

# Ortery

Celebrating 13 years of Photography Automation and Leadership

Company   Products   Examples   Applications   Where to Buy

### Professional Studio Lighting

Color accurate & shadow free results everytime - Regardless of experience

### Compatible Camera\*

Choose from a long list of Canon & Nikon DSLR cameras

\*Sold Separately

### Top & Side Shot Capability

Camera housing unit mount for straight down shooting



JPG/RAW/TIFF

### Automatic Image Transfer

JPG/RAW images are instantly transferred to computer during capture

### Image Capture & Processing Software

Compose, Capture & Process Images in one simple program



**Figure 2.** Front side of the Lightbox with the front panel removed, a custom specimen holder inside, and a custom camera mount.



# HerbScan: Inverted Flatbed Scanner

## Advantages:

- Very large images
- Consistent results
- Easy to operate

## Disadvantages:

- Slow (5-6 min./scan)
- Limited subject matter
- May be discontinued



# Camera vs. HerbScan

100% Magnification

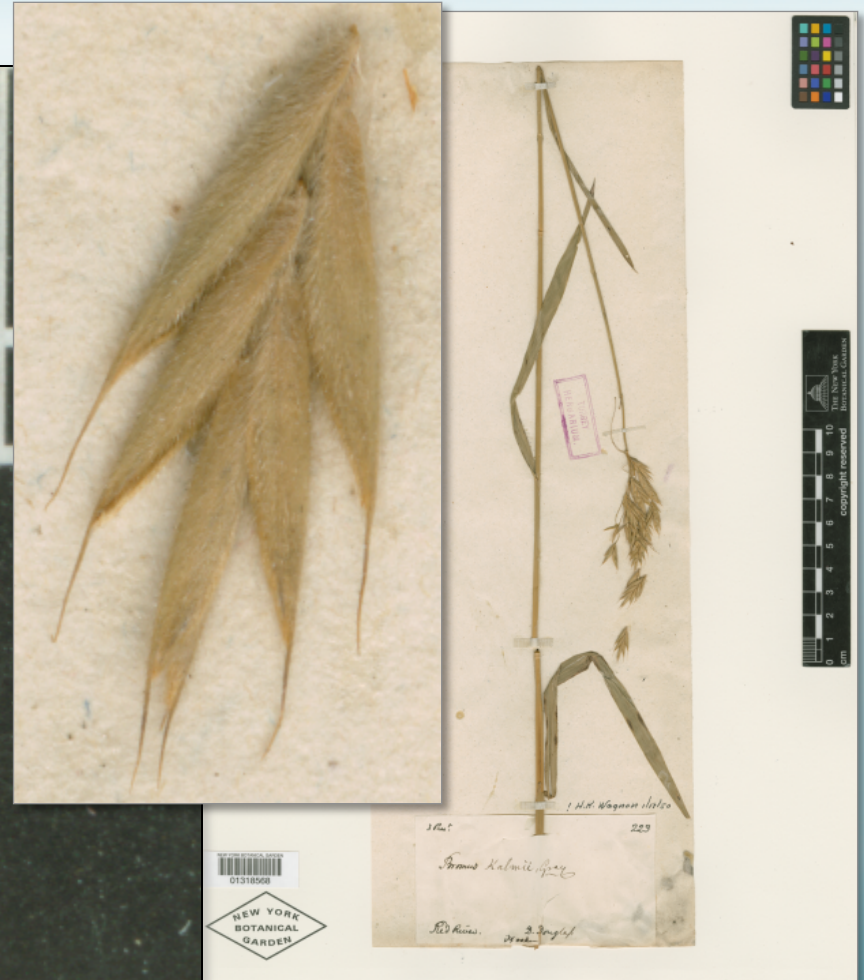
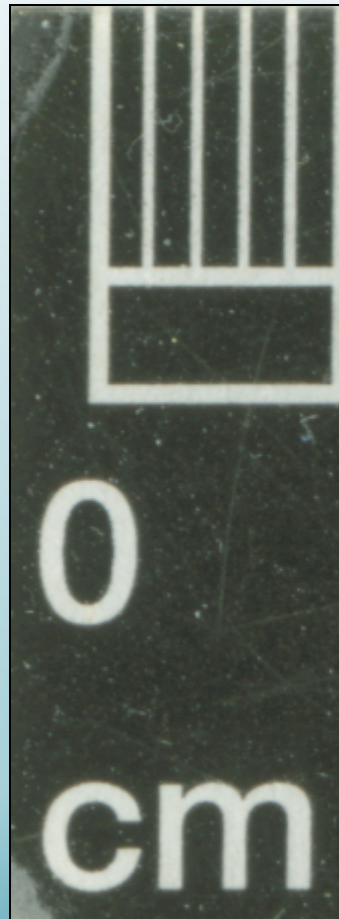
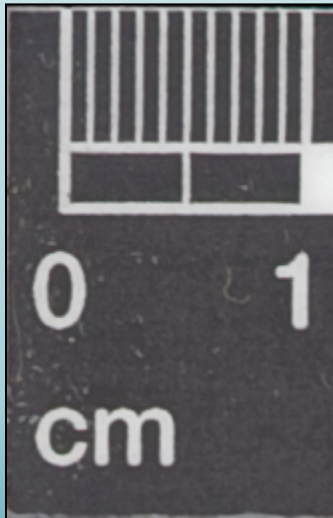
**HerbScan**

7158 x 10144 pixels, 600 dpi

**Canon EOS 5D Mark II**

50 mm lens,  
f/9, 1/40 sec

3744 x 5616 pixels  
300 dpi



# Computer

- Laptop or Desktop computer
  - Recommended minimum:
    - i5 processor
    - 4GB RAM (preferably more if plan to run image editing/processing software)
    - 500GB hard drive
  - Laptop: 17.3” display, USB mouse

# SilverBiology

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[www.silverbiology.com](http://www.silverbiology.com)

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## Purchase & Rental Options

[Learn More](#)



Mobile Copy Station for Herbaria now available

**Starting Price: \$8200** (not including cost of labor or RAID storage).

“If you are interested in renting a copy station please contact us so we can keep you informed of any changes to this service.”

- Biodiversity Image Server
- Herbarium Barcodes
- Mobile Copy Station
- Web Portal

# Imaging Equipment: Software

- Remote image capture software
- Image viewing software
- Image editing software
- Image cataloging software

# Remote Image Capture Software

Utilize Live View Shooting Mode

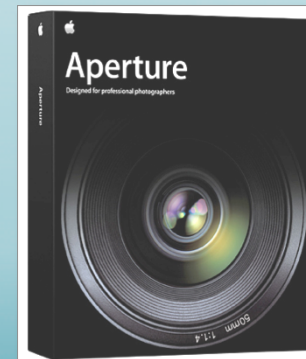
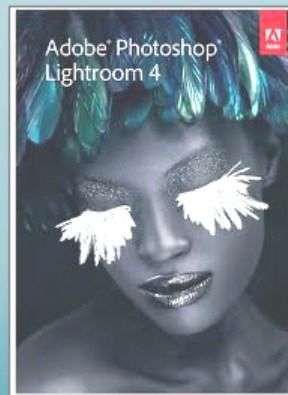
<http://www.tethertools.com/plugging-in/software>

Software	Camera	Price	OS
EOS Utility	Canon	Free with camera	Win, Mac
Camera Control Pro 2	Nikon	<a href="#">\$139</a>	Win, Mac
Adobe Lightroom	Canon, Nikon, Leica	<a href="#">\$135</a> (Students & Educators: <a href="#">\$77</a> )	Win, Mac
Aperture	Canon, Nikon	<a href="#">\$80</a>	Mac
SofortBild	Nikon	Free	Mac
ControlMyNikon5	Nikon	Standard <a href="#">\$30</a> ; Pro <a href="#">\$50</a>	Win
PK_Tether	Pentax	Free	Win
Smart Shooter	Canon, Nikon	<a href="#">\$50</a>	Win, Mac
digiCamControl	Nikon	Free	Win

# Image Viewing Software

Software	Camera	Price	OS
<a href="#">Digital Photo Professional</a>	Canon	Free with camera	Win, Mac
<a href="#">ViewNX 2</a>	Nikon	Free with camera	Win, Mac
<a href="#">Adobe Lightroom</a>		<a href="#">\$135</a> (Students & Educators <a href="#">\$77</a> )	Win, Mac
<a href="#">Aperture</a>	Canon, Nikon	<a href="#">\$80</a>	Mac
<a href="#">Free Picture Viewer</a>		Free	Win
<a href="#">Free Photo Viewer</a>		Free	Win

Select Software of interest in table above and link to website.



# Image Editing & Cataloging Software

Software	Image Editor	Non-destructive image editing	Image Catalog	Cost	Operating System
<a href="#">Lightroom</a>	X	X	X	\$135	Win/Mac
<a href="#">Photoshop</a>	X			\$20/month, \$220/yr (DVD discont'd)	Win/Mac
<a href="#">Aperture</a>	X	X	X	\$80	Mac
<a href="#">Capture 1 Pro 7</a>	X	X	X	\$300	Win/Mac
<a href="#">GIMP</a>	X			Free	Win/Mac/Linux
<a href="#">AfterShot Pro</a>	X	X	X	\$50	Win/Mac/Linux

Select Software of interest in table above and link to website.

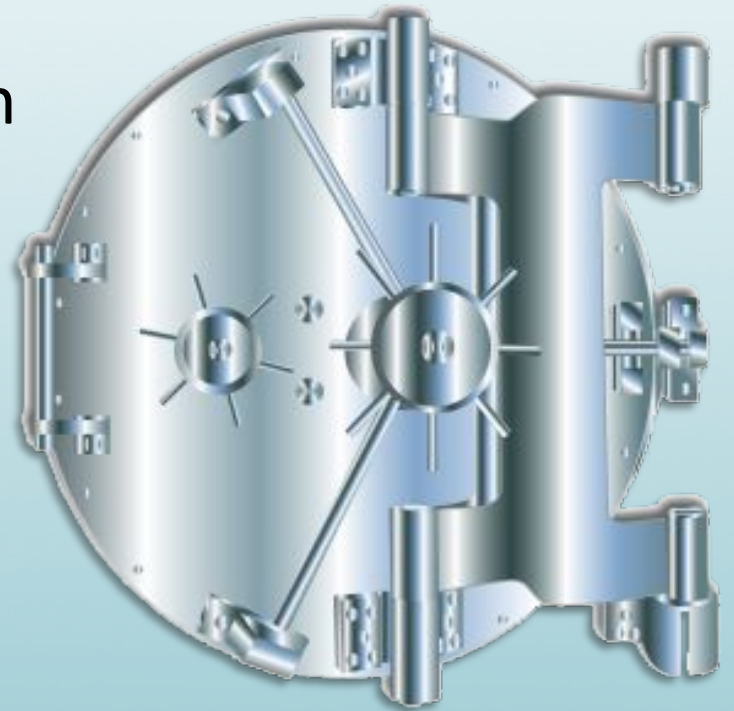


# Imaging Goals: Archiving

- Capture the highest quality digital image of a specimen with the best technology available; making a digital copy of the physical specimen.
- Save, manage, and maintain an archive of specimen images as carefully and conscientiously as you maintain a collection of physical specimens.
- Migrate these images from one file format and/or image management system to another as needed for as long as possible.

# Benefits to Archiving

- Can create new derivatives as technology evolves
  - (Example: Higher resolution images online)
- Avoid repeat digitization efforts



# Recommended Storage Configuration

- **Working File Storage:**
  - Images being processed, not ready for archive
- **Primary Archive Storage:**
  - Permanent home for images.
  - Main copy (not a backup), onsite
  - Important that it be stable and be able to grow
- **Backup media:**
  - 1 or several hard drives that can be taken offsite
  - Best practice to also save to other media, e.g. optical disk or digital tape

Source: Krogh, P. *The DAM Book, 2<sup>nd</sup> Edition*. O'Reilly Media, Inc. 2009. 160.

# Image Storage Space

- Multiple external hard drives
- Optical Disks (CDs, DVDs, Blu-Ray)
- Network server space
- Consider using backup storage space online:
  - Article: *“40 Online Backup Services Reviewed”*  
[http://pcsupport.about.com/od/maintenance/tp/online\\_backup\\_services.htm](http://pcsupport.about.com/od/maintenance/tp/online_backup_services.htm)
  - Google Drive Storage 100 GB for \$5/month or 200 GB for \$10/month  
<http://www.google.com/drive/storage.html>

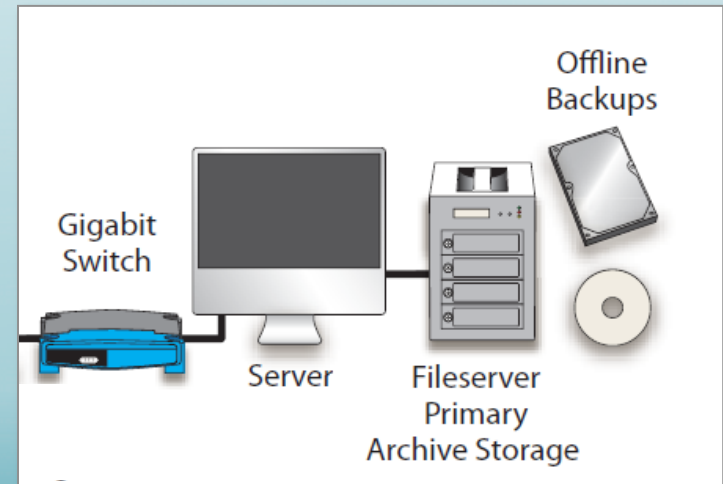


Image Source: Krogh, P. *The DAM Book, 2<sup>nd</sup> Edition*. O'Reilly Media, Inc. 2009. 196.

# Basic Image Storage Configuration

Computer + Dedicated Image Drive  
+ External Backup Drive + Optical Disk Backup

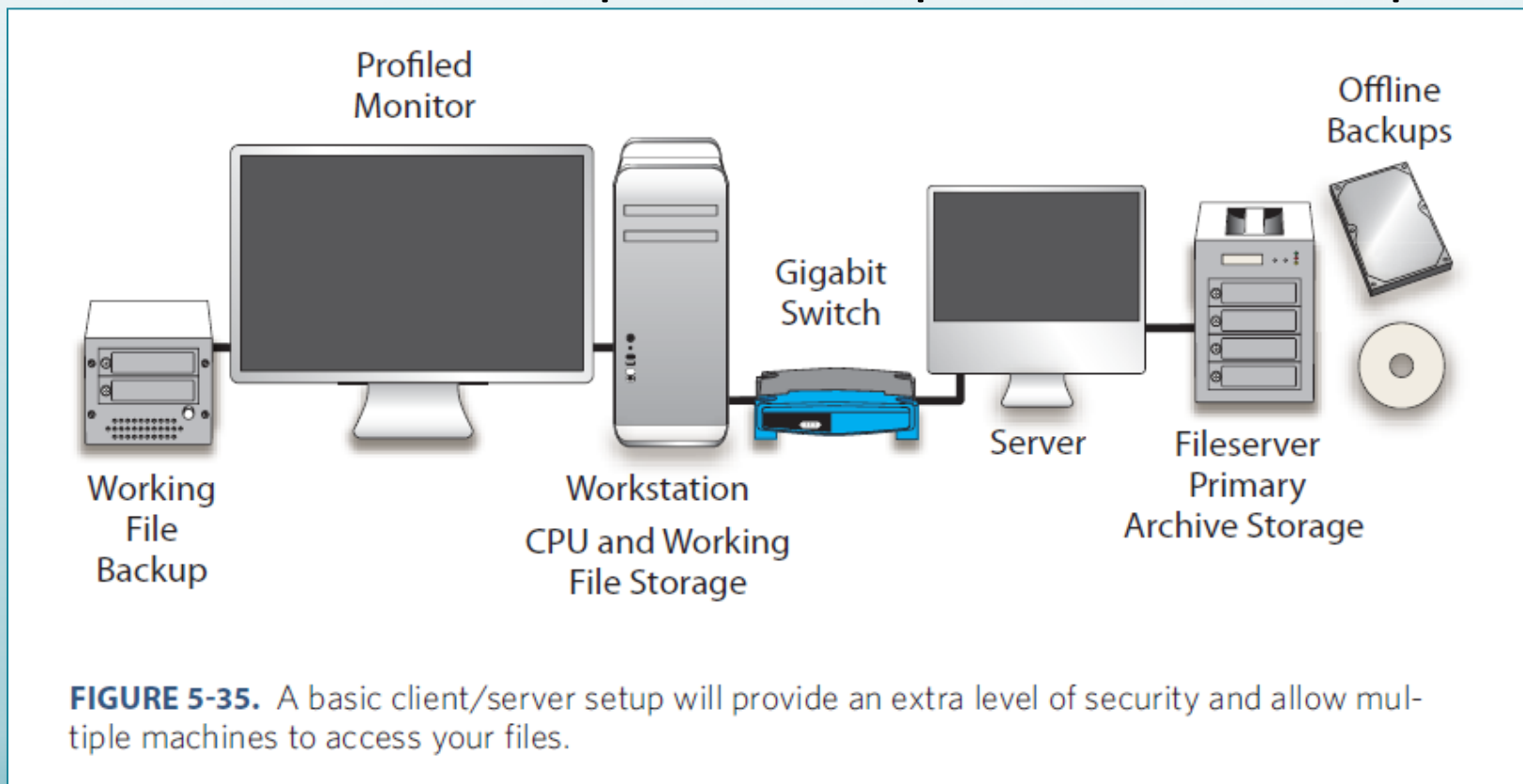


**FIGURE 5-34.** This is the basic starter system.

Source: Krogh, P. *The DAM Book, 2<sup>nd</sup> Edition*. O'Reilly Media, Inc. 2009. 194-195.

# Client/Server Storage Configuration

Computer + Gigabit Ethernet Switch + Server +  
External Backup Drive + Optical Disk Backup



**FIGURE 5-35.** A basic client/server setup will provide an extra level of security and allow multiple machines to access your files.

Source: Krogh, P. *The DAM Book, 2<sup>nd</sup> Edition*. O'Reilly Media, Inc. 2009. 196.

# Archival Image File Formats

**Recommend saving the original capture  
(raw format, no loss of data)**

## Proprietary camera raw formats

Canon = CR2, Nikon = NEF, Pentax = PEF

Do not support embedded metadata

- XMP sidecar file for metadata and editing instructions
- Easily separated from the image file



# Archival Image File Formats

Recommend saving the original capture  
(raw format, no loss of data)

**DNG = Digital Negative is the preferred choice**

Open license RAW format

Small file size, full bit depth

Supports embedded metadata

- XML data in header

- No sidecar file



**The Advantages of the DNG File Format:** <https://www.youtube.com/watch?v=7Ljbo6aL3Jc>



# Archival Image File Formats

**TIFF = Tagged image file format**

Highest bit-depth feasible

Lossless compression

Un-edited

Supports embedded metadata

Large file size

Often used for archiving

# Resolution, Image Size, & Megapixels

<b>Mega pixels</b>	<b>Image Dimensions (pixels)</b>	<b>Print Size (inches) at 300 dpi</b>	<b>Image size (inches) on 96 ppi monitor</b>	<b>Raw File (MB) (uncompressed 12 bits/pixel)</b>	<b>TIFF File (MB) (uncompressed 48 bit/pixel)</b>
<b>2</b>	1740 x 1160	4 x 6	18 x 12	3	12
<b>3</b>	2160 x 1440	5 x 7	22.5 x 15	4.7	18.7
<b>10</b>	3872 x 2592	8 x 12	40.3 x 27	15.1	60.2
<b>12</b>	4256 x 2832	9 x 14	44.3 x 29.5	18.1	72.3
<b>14</b>	4608 x 3072	10 x 15	48 x 32	21.2	84.9
<b>18</b>	5184 x 3456	11x 17	54 x 36	26.9	107.5
<b>24</b>	6016 x 4000	13 x 20	62.6 x 41.7	36.1	144.4
<b>36</b>	7360 x 4912	16 x 24	76.7 x 51.2	54.2	216.9

<http://www.digital-slr-guide.com/define-megapixels.html>; <http://www.atiz.com/resources/DPI-PPI-Megapixels-and-Resolution.pdf>

<http://pixeldensitycalculator.com>; <http://web.forret.com/tools/megapixel.asp>

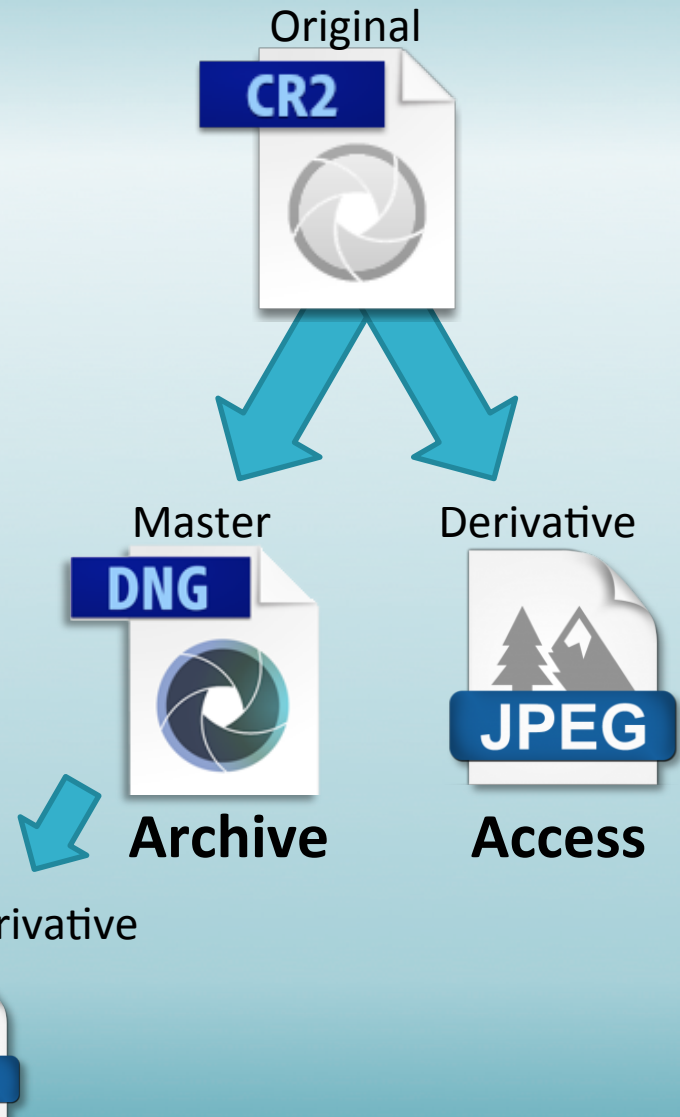
# Export Derivatives From Master

## Export DNG for archive

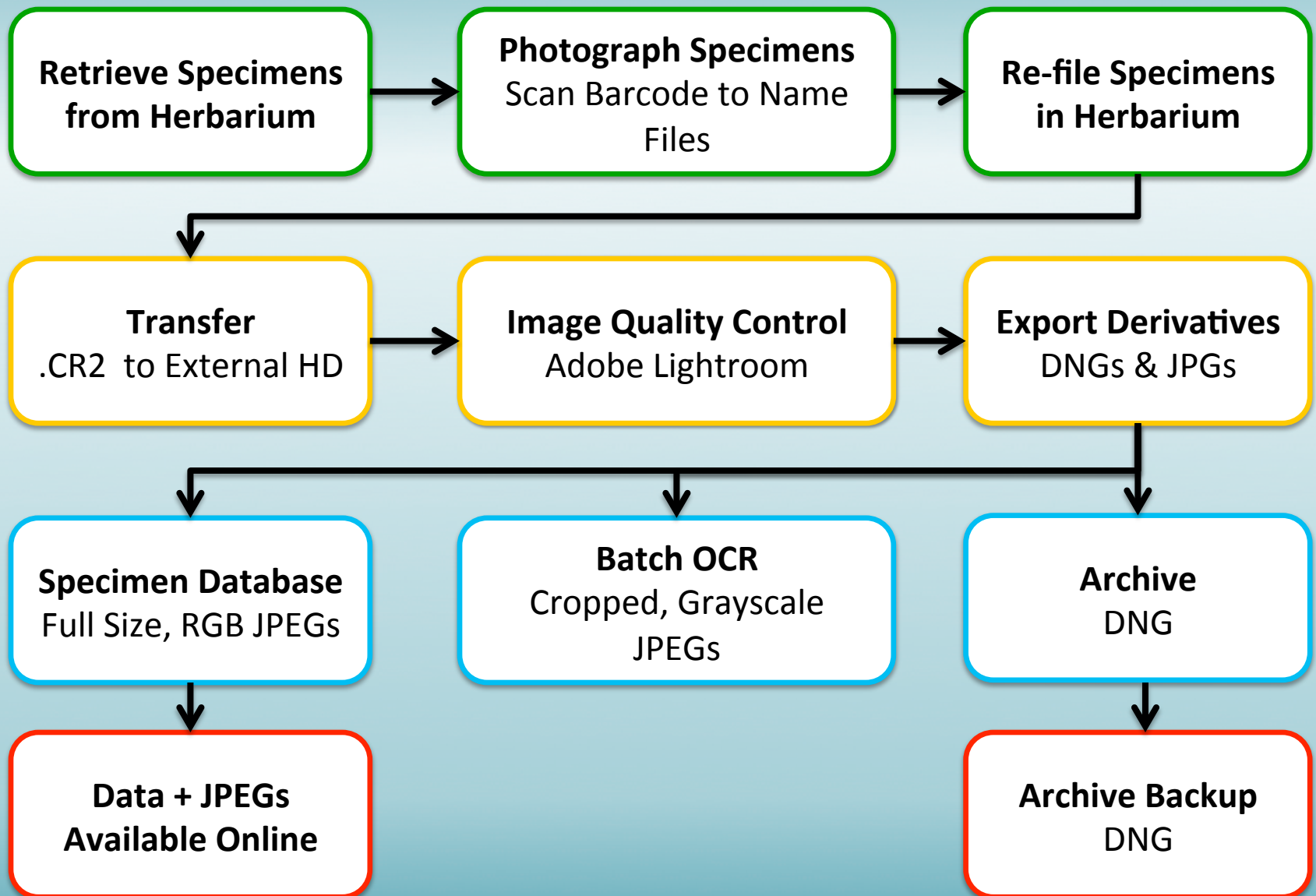
- Master copy DNG from which can make new derivatives
- Saving the CR2 optional

## Export JPEG for access (web, print)

- Full resolution
- sRGB color space
- Lossy compression, cannot be edited without generating image artifacts



# Imaging Workflow





# Online Resources

## **Tri-Trophic Digitization TCN Project Documents:**

<http://tcn.amnh.org/documents>

## **iDigBio Digitization Resources:**

[https://www.idigbio.org/wiki/index.php/Digitization\\_Resources](https://www.idigbio.org/wiki/index.php/Digitization_Resources)

## **iDigBio Imaging Equipment Recommendations:**

<https://www.idigbio.org/content/idigbio-imaging-equipment-recommendations>

## **iDigBio Workflow Modules and Task Lists:**

<https://www.idigbio.org/content/workflow-modules-and-task-lists>

## **iDigBio Imaging Processing Task List:**

[https://www.idigbio.org/sites/default/files/sites/default/files/Module\\_5\\_Image\\_Processing\\_Tasks\\_%28Rev2012-11-07%29.pdf](https://www.idigbio.org/sites/default/files/sites/default/files/Module_5_Image_Processing_Tasks_%28Rev2012-11-07%29.pdf)

## **Policy on Acceptable Formats for iDigBio-hosted Images:**

<https://www.idigbio.org/sites/default/files/Image%20File%20Format%20Recommendations%20and%20Standards.pdf>

## **iDigBio Beginner's Guide to Digital Imaging – Glossary:**

<https://www.idigbio.org/sites/default/files/sites/default/files/BeginnersGuideToImagingGlossary.pdf>

## **Blog by Michael Bevans, former NYBG Herbarium Information Manager for Digitization:**

<http://digitalphotorepro.blogspot.com/2011/02/welcome-to-digital-photo-repro.html>

## **Audubon Core Multimedia Resources Metadata Standard:**

<http://www.tdwg.org/homepage-news-item/article/audubon-core-public-review/>



# THE NEW YORK BOTANICAL GARDEN

## Thank you

Special thanks to Gil Nelson, Michael Bevens, Melissa Tulig, Barbara Thiers, iDigBio, NSF and the ADBC program, and all The New York Botanical Garden Herbarium staff past and present who help maintain the physical collections along with their digital counterparts.

