

THE NEW YORK BOTANICAL GARDEN

Specimen Imaging: From photography basics to backing up an archive

Part 1 of 5

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17 January 2014

Data Capture Course – Accra, Ghana

Imaging Goals

For Access:

- Publication, print or web
- Remote study (e.g. eLoans)
- Reduce physical handling and 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 balanced
- Readable text
- Taxonomically informative



Overview

- Terminology
- Equipment
 - Hardware
 - Software
- Image capture process
 - Herbarium sheets, packets
 - Pinned objects (Christiane)
 - Spirit collections (Christiane)
- Image processing post-capture
- Image storage

TERMINOLOGY

Imaging Goals

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

- **In focus**
- Good exposure
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Focus

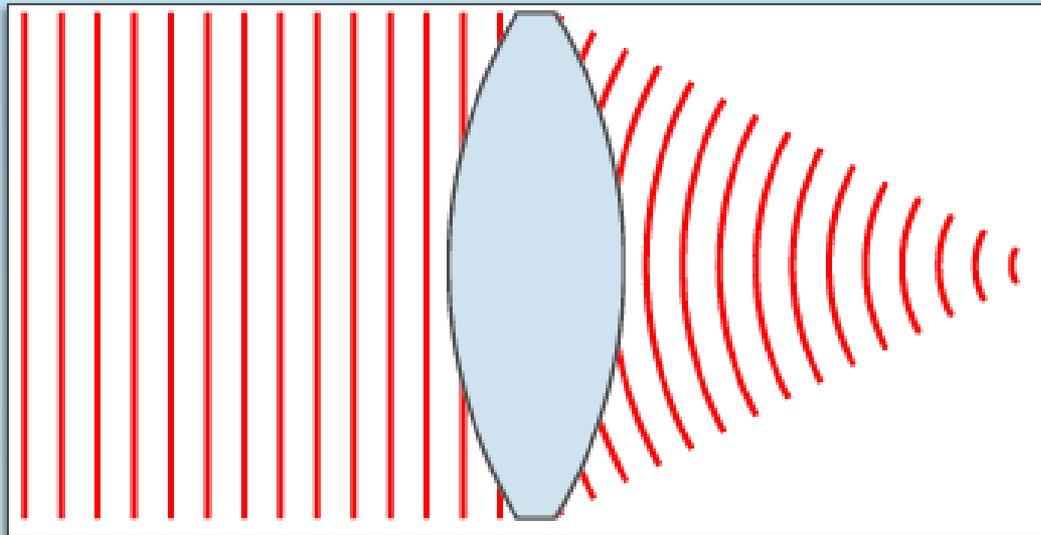
- a) The distinctness or clarity of an image
- b) The state of maximum distinctness or clarity of such an image.



Focus

The point at which rays of light converge, or the point from which they appear to diverge as after refraction or reflection in an optical system.

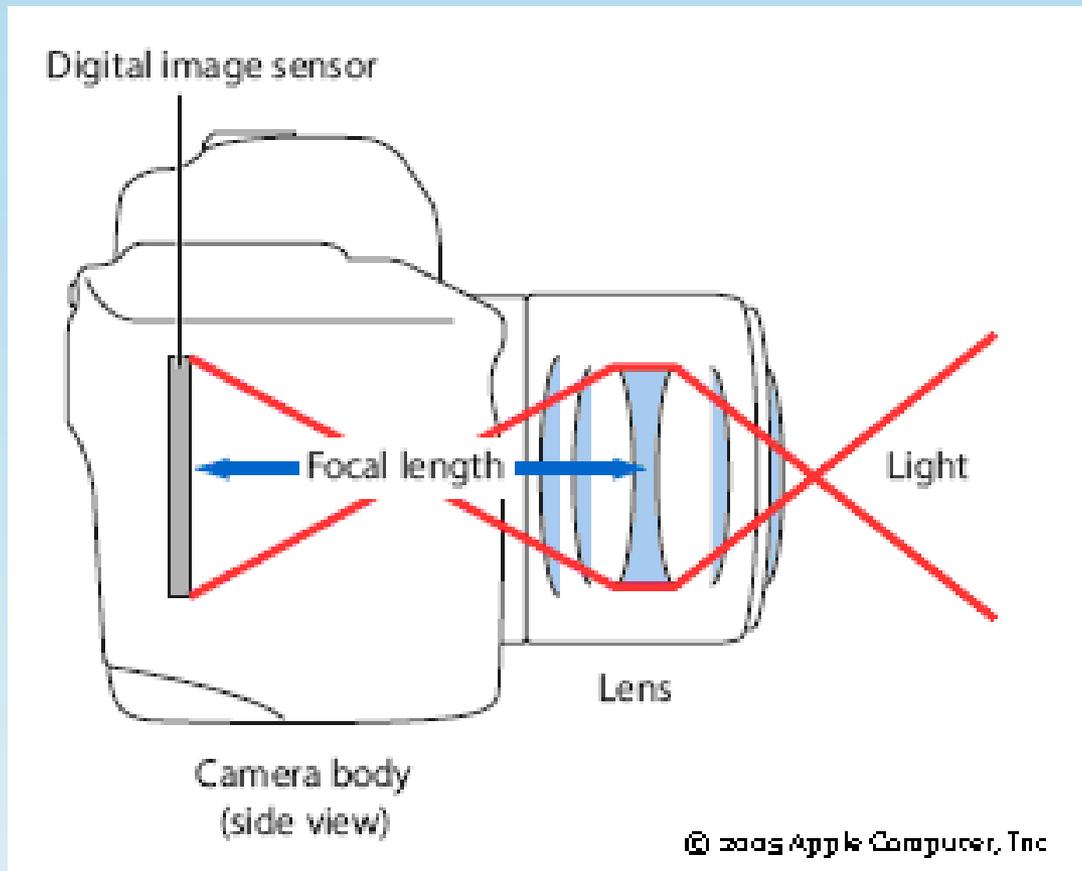
Lens



Focal Point

Focal Length

The distance from the lens to the point where the light rays converge to form a sharp image of an object on the image sensor.
Measured in millimeters.



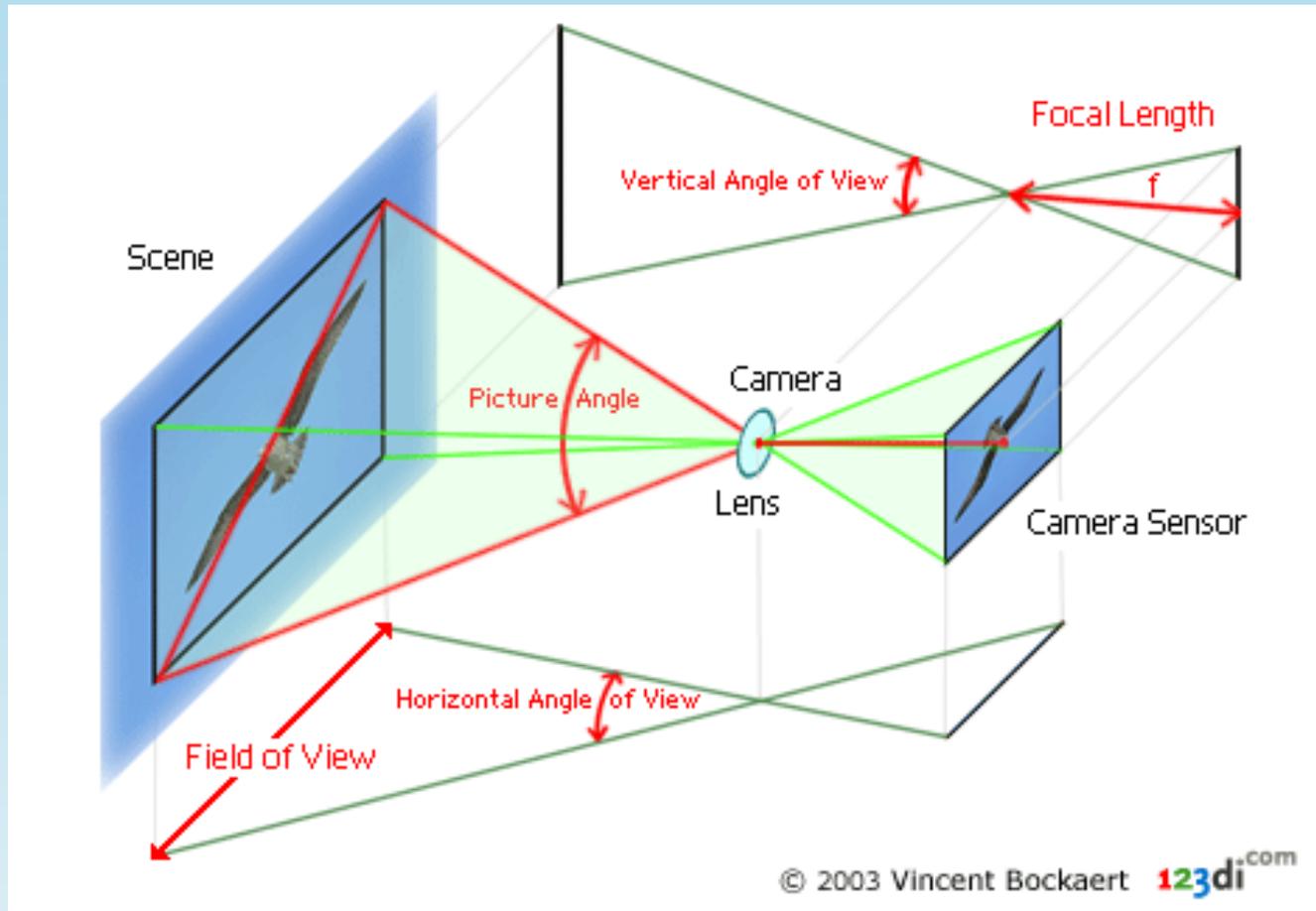
Camera Lenses and Focal Length

Focal length of a lens determines how much of the object will be captured and how large/magnified the objects will be in the image.



Alignment

Keep sensor parallel to subject



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Exposure

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



Under exposed



Well exposed

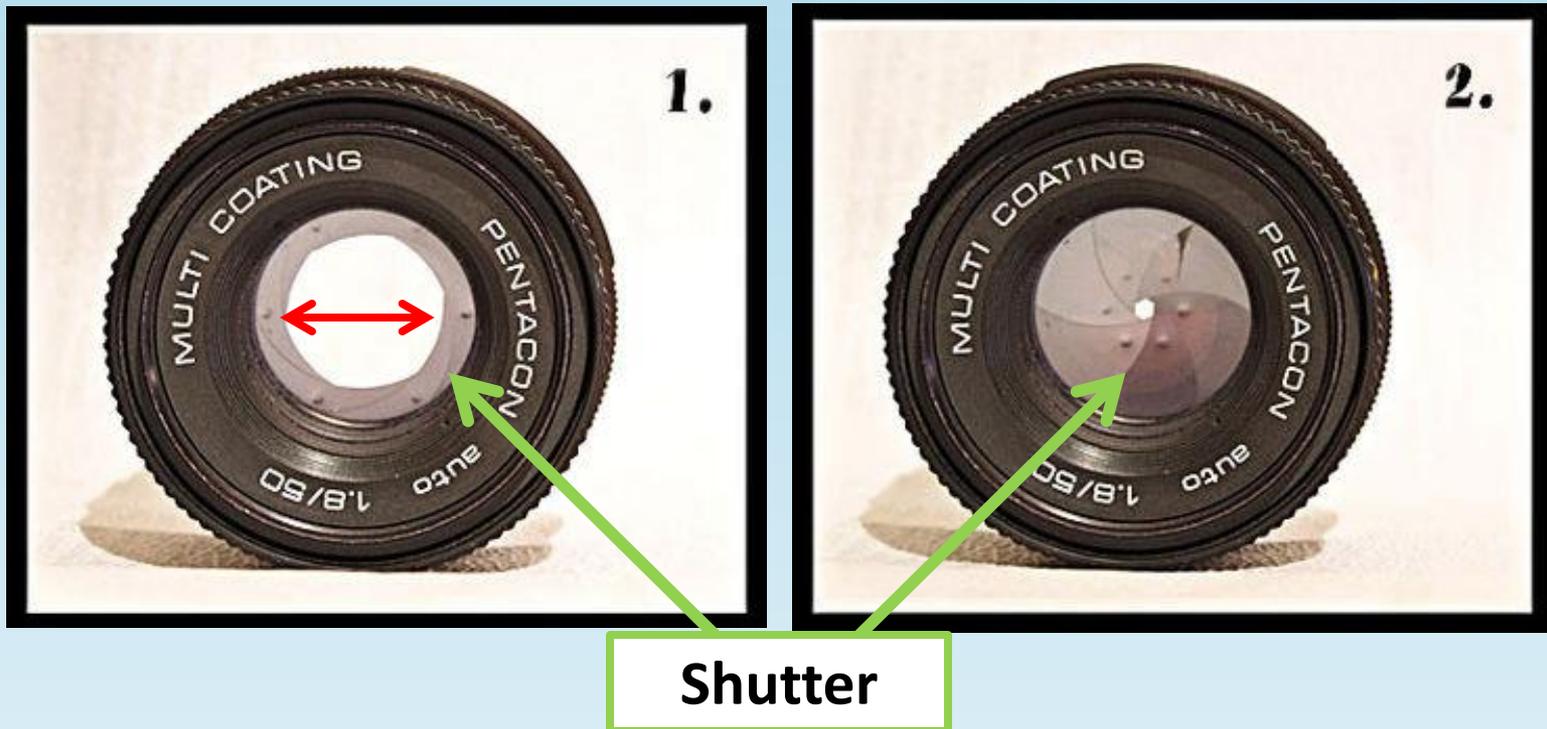


Over exposed

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

Aperture

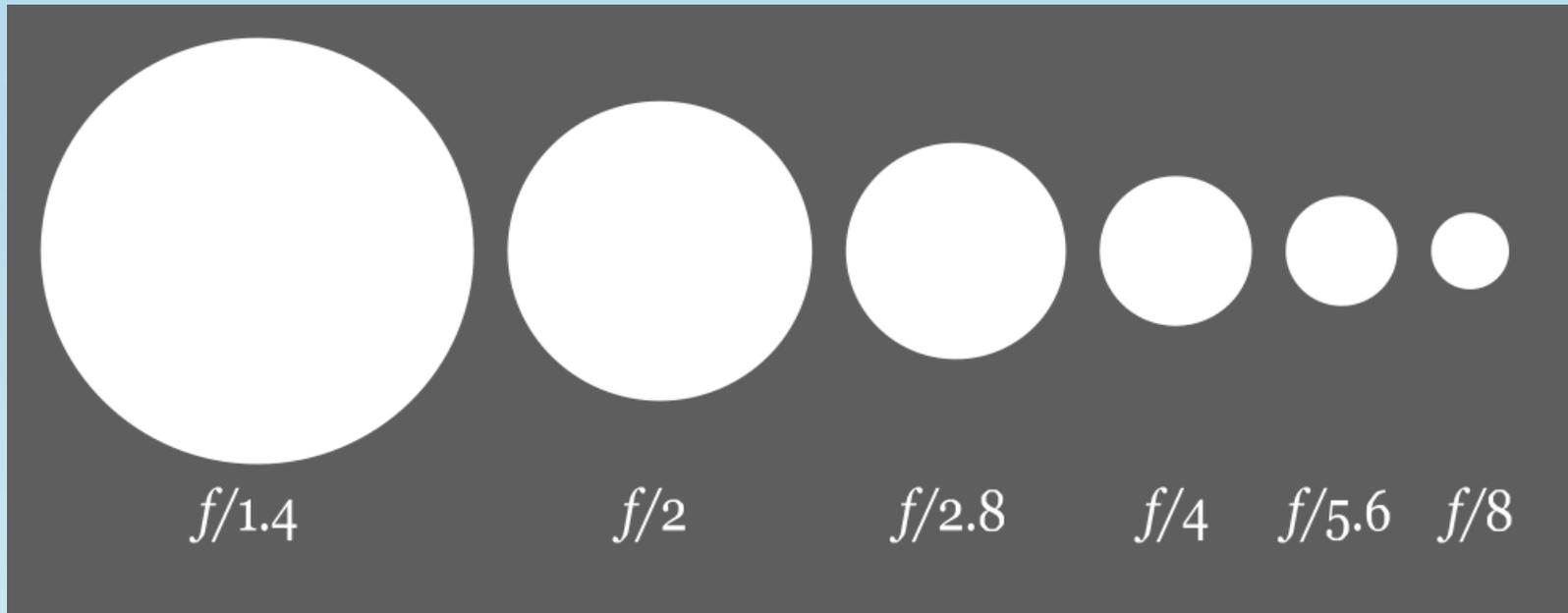
The adjustable opening in the camera that limits the amount of light passing through the lens onto the image sensor. Aperture size is controlled by the camera shutter.



- The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company. Updated in 2009. Published by [Houghton Mifflin Company](http://www.houghtonmifflin.com/).
- Image source: <http://en.wikipedia.org/wiki/File:Apertures.jpg>

Aperture

Often expressed as an f-number

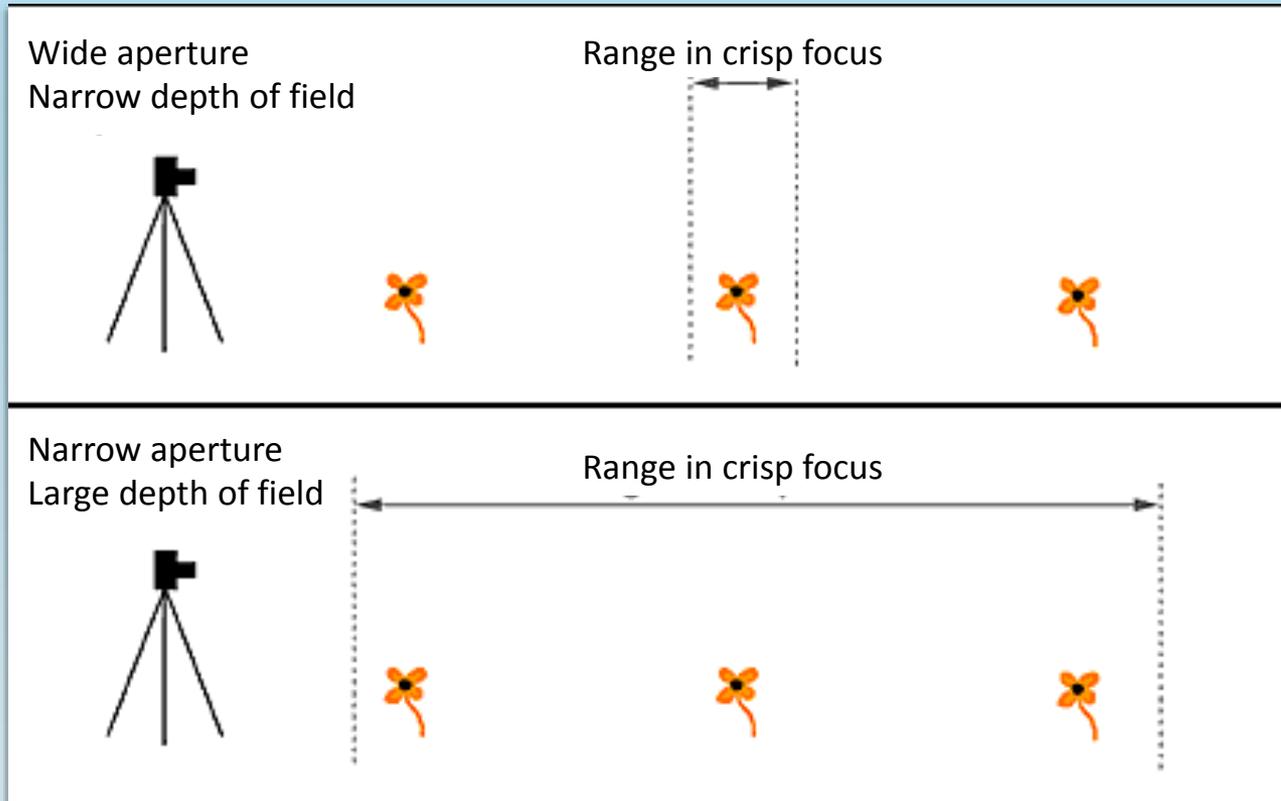


Wider aperture = More light = Lower f-stop number
Narrow aperture = Less light = Higher f-stop number

- The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company. Updated in 2009. Published by [Houghton Mifflin Company](http://www.houghtonmifflin.com/).
- Image source: http://en.wikipedia.org/wiki/File:Aperture_diagram.svg

Depth of Field

The range of distance in front of and behind an object focused by the camera lens, within which other objects also appear clear and sharply defined in the resulting image.



f/5.6



f/32



Shutter Speed

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

... 1/200 s... 1/60 s... 1/30 s... 1/8 s... 1 s... 10 s... 30 s...

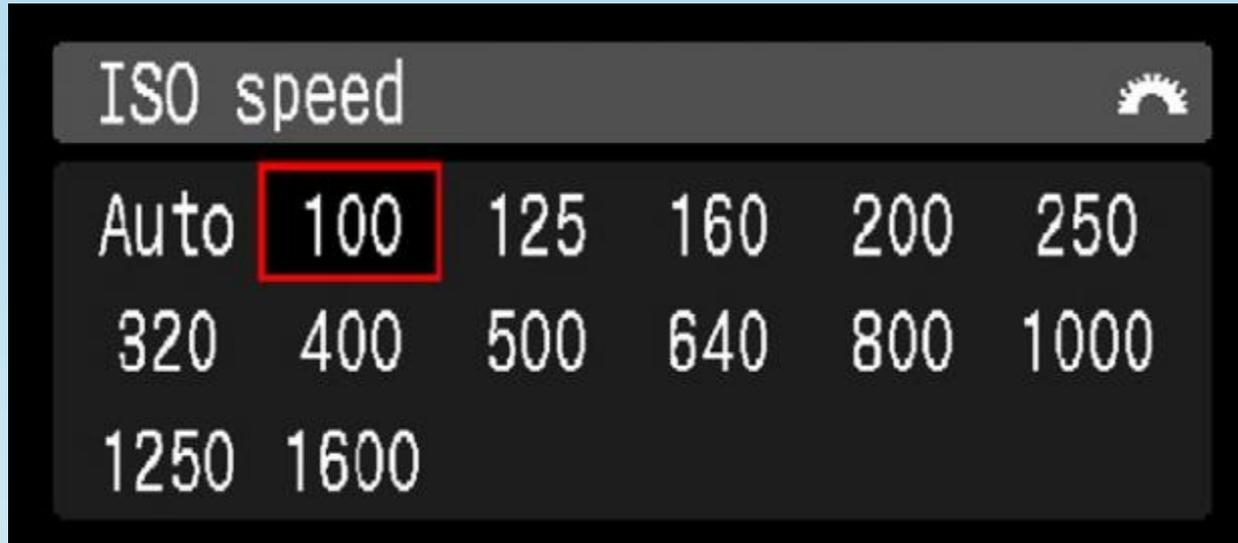


More time = More light = Smaller denominator
Less time = Less light = Larger denominator

http://en.wikipedia.org/wiki/Shutter_speed

ISO = Film speed?

Photographic film's sensitivity to light.
Digital camera image sensor's sensitivity to light.



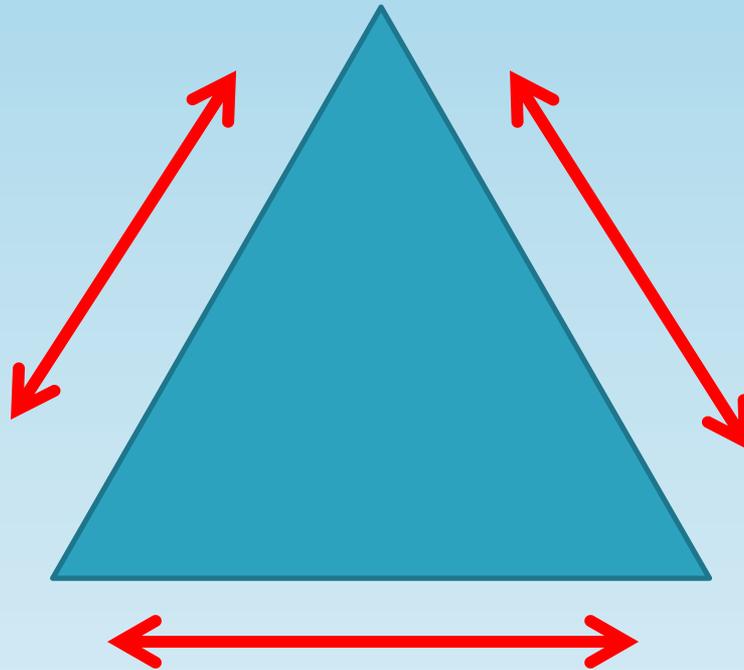
Lower number = Less sensitive to light = Finer grain/Less noise
Higher number = More sensitive to light = Bigger grain/More noise

Exposure

Aperture

Shutter
Speed

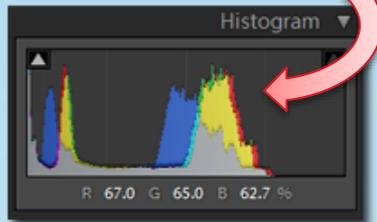
ISO



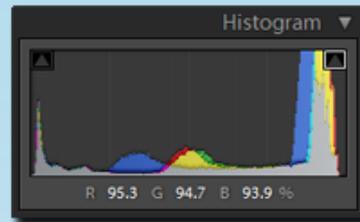
Exposure

Use the histogram as a guide for good exposure

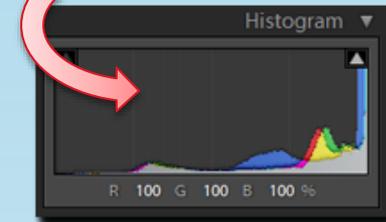
Dark



Ideal



Light



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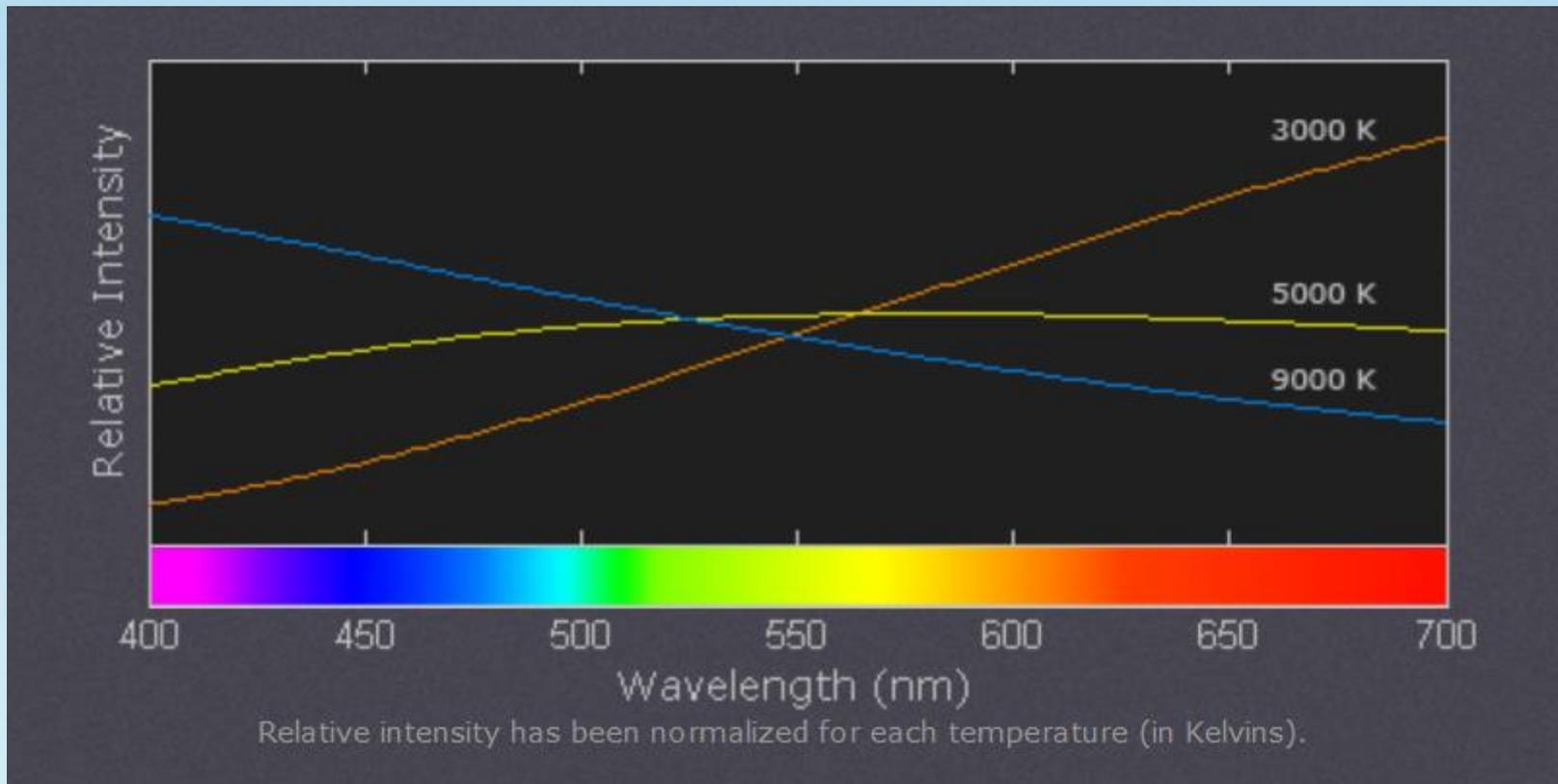
White Balance

The process of removing unrealistic color casts, so that objects which appear white in person are rendered white in the image



Color Temperature

Describes the relative intensities of various wavelengths of white light
Measured in Kelvins (K)



Color temperature 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 ^[2]
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 ^[3]
6,500 K	Daylight, overcast
6,500–10,500 K	LCD or CRT screen
15,000–27,000 K	Clear blue poleward sky

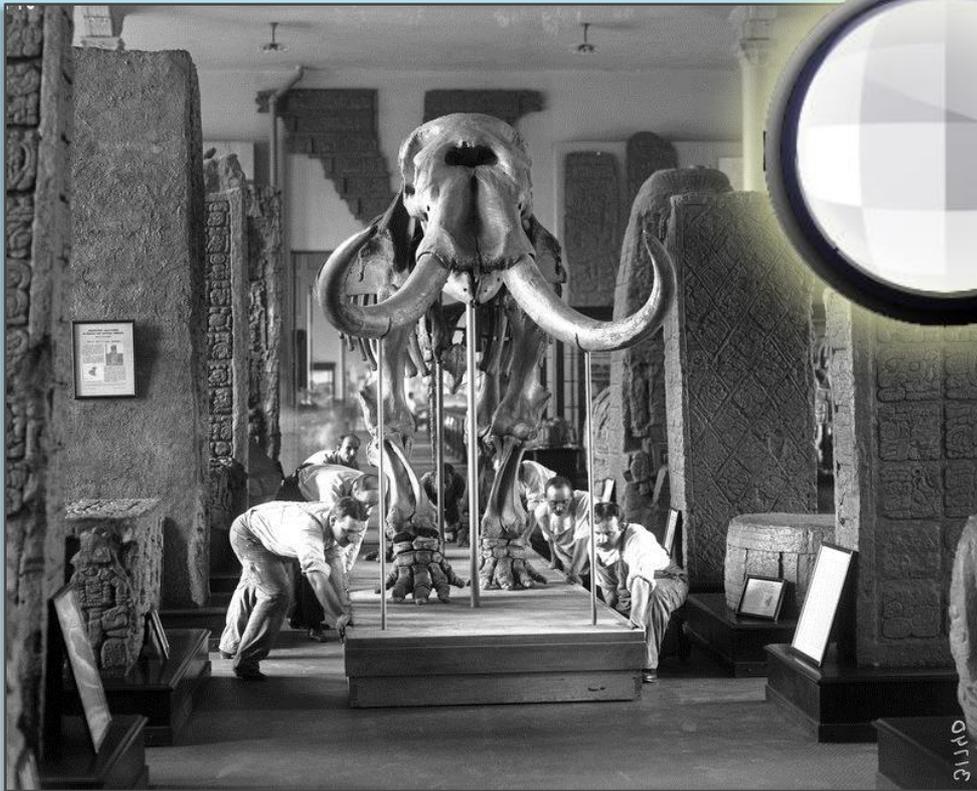
Color Balance

The adjustment of the intensities of the colors (typically red, green, and blue primary colors).



Pixel (Picture Element)

The most basic unit of an image displayed on a computer, television screen, or printer. A given combination among the pixels of various brightness and color values forms an image.



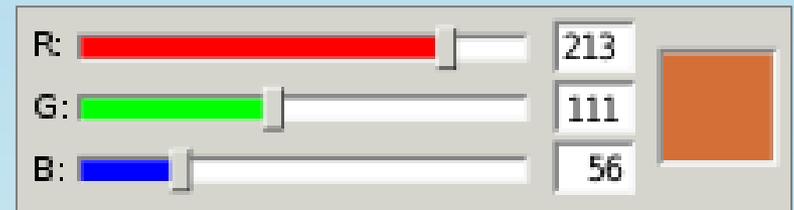
In an 8 bit grayscale image, each pixel can be any one of 256 brightness values.

Image source: The American Museum of Natural History Research Library

pixel. (n.d.). *The American Heritage® Science Dictionary*. Dictionary.com website: <http://dictionary.reference.com/browse/pixel>

RGB Color Model

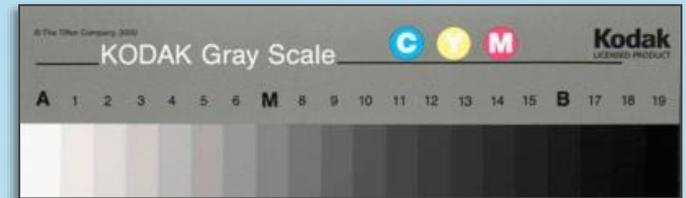
Red, green, and blue light are added together in various combinations to reproduce a broad array of colors.



256 values for Red x 256 values for Green x 256 values for Blue
= 16.7 million color combinations

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
 - Kodak Q-13



Color Aim Points



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 / 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 /

243	243	242	96.539	-0.425	1.186	N	9.5 /
200	200	200	81.257	-0.638	-0.335	N	8 /
160	160	160	66.766	-0.734	-0.504	N	6.5 /
122	122	121	50.867	-0.153	-0.27	N	5 /
85	85	85	35.656	-0.421	-1.231	N	3.5 /
52	52	52	20.461	-0.079	-0.973	N	2 /

ISO 2 degree observer sRGB values for Illuminate D65.

Monitor Calibration



FIGURE 5-32. A monitor being profiled with a colorimeter. It reads the color signature of the monitor, and computes a color profile that compensates for the imperfections in the monitor's color. The computer's OS uses this profile to correct the color of the signal being delivered to the monitor.

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

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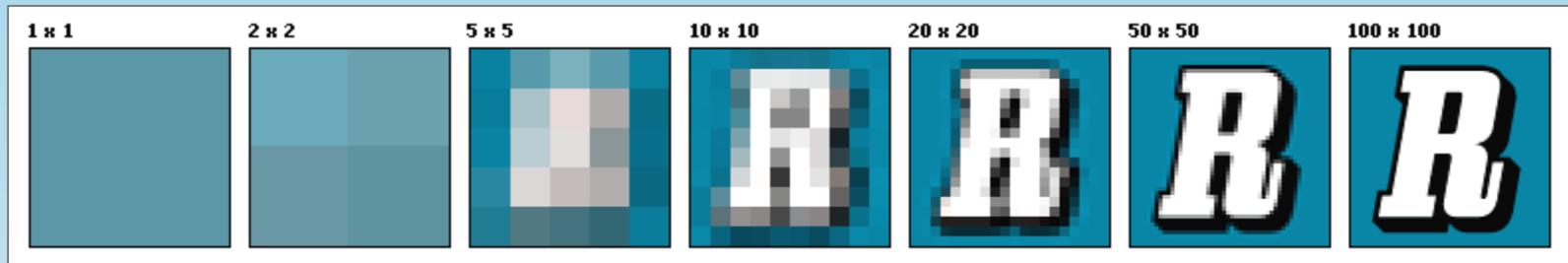
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Spatial Resolution

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



Pixel dimension = number of pixels in length x number pixels in width

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

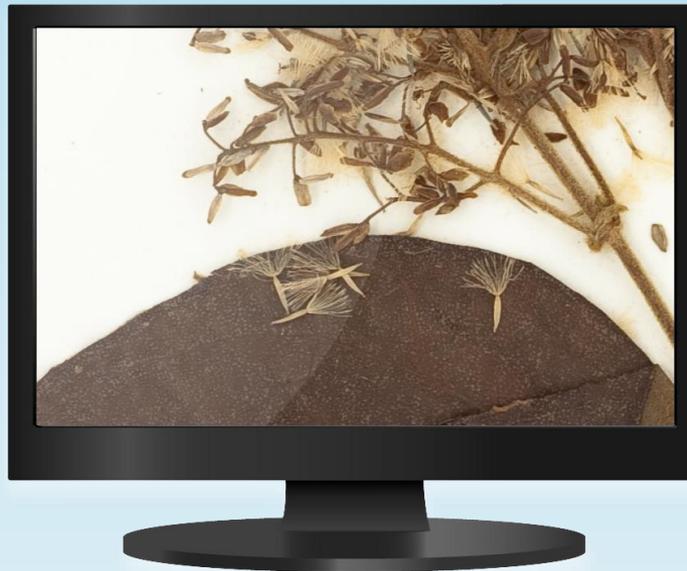
Image Size

$$\text{Image size in inches} = \frac{\text{Pixel dimension of image}}{\text{Display resolution in ppi}}$$

3744 x 5616 pixels



11x17" specimen sheet



Monitor resolution is 72 pixels per inch

= 52 x 78 inches

= 4.5 times
bigger than
original sheet

Overview

- ✓ Terminology
- Equipment
 - Hardware
 - Software
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 - Herbarium sheets, packets
 - Pinned objects (Christiane)
 - Spirit collections (Christiane)
- Image processing post-capture
- Image storage