

## What Resolution Should Your Images Be?

The best way to determine the optimum resolution is to think about the final use of your images. For publication you'll need the highest resolution, for desktop printing lower, and for web or classroom use, lower still. The following table is a general guide; detailed explanations follow.

| Use                | Pixel Size   | Resolution | Preferred File Format | Approx. File Size |
|--------------------|--|------------|-----------------------|-------------------|
| Projected in class | About 1024 pixels wide for a horizontal image; or 768 pixels high for a vertical one | 102 DPI    | JPEG                  | 300–600 K         |

|          |  |        |      |          |
|----------|--|--------|------|----------|
| Web site | About 400–600 pixels wide for a large image; 100–200 for a thumbnail image | 72 DPI | JPEG | 20–200 K |
|----------|--|--------|------|----------|

|                                   |   |         |             |         |
|-----------------------------------|---|---------|-------------|---------|
| Printed in a book or art magazine | Multiply intended print size by resolution; e.g. an image to be printed as 6" W x 4" H would be 1800 x 1200 pixels. | 300 DPI | EPS or TIFF | 6–10 MB |
|-----------------------------------|---|---------|-------------|---------|

|                          |  |         |             |        |
|--------------------------|--|---------|-------------|--------|
| Printed on a laserwriter | Multiply intended print size by resolution; e.g. an image to be printed as 6" W x 4" H would be 1200 x 800 pixels. | 200 DPI | EPS or TIFF | 2-3 MB |
|--------------------------|--|---------|-------------|--------|

### Digital Camera Photos

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Digital cameras have a range of preset resolutions which vary from camera to camera.

| Designation  | Resolution         | Max. Image size at 300 DPI | Printable size on a color printer |
|--------------|--------------------|----------------------------|-----------------------------------|
| 4 Megapixels | 2272 x 1704 pixels | 7.5" x 5.7"                | 12" x 9"                          |
| 3 Megapixels | 2048 x 1536 pixels | 6.8" x 5"                  | 11" x 8.5"                        |
| 2 Megapixels | 1600 x 1200 pixels | 5.3" x 4"                  | 6" x 4"                           |
| 1 Megapixel  | 1024 x 768 pixels  | 3.5" x 2.5"                | 5" x 3"                           |

If you can, you generally want to shoot larger than you need, then sharpen the image and reduce its size in Photoshop.

## **For Screen: Classroom Use and Web sites.**

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For images that will exist only on screens, it's better to think in terms of pixel dimensions only.

For classroom use, the guiding factor is the presentation equipment. Your monitor might be able to show 1800 X 1440 pixels, but you won't be able to project that. The Hitachi CP-X430W projectors we have installed in the Schermerhorn classrooms project an image of 1024 X 768 pixels (what's known as XGA resolution). This is pretty standard for high-end digital projectors these days. Any image you're showing that's larger in pixel dimension will be resampled down by the projector. So **if you're saving an image for use in the classroom, there's no need to make it much larger than 1024 pixels wide.** (Of course if you're going to zoom in on a detail of the image, you'd need it that much larger.)

If you use PowerPoint to project your images, you might notice that a 1000 pixel wide image looks tiny on the PowerPoint workspace (or perhaps unexpectedly large). That's because PowerPoint measures its images according to the Document Size, not the Pixel Dimension as PowerPoint is made to work at the highest resolution possible for whatever device will ultimately display the slide show. (See below for more about Document Size and Pixel Dimensions.) The PowerPoint slide is 10" wide and 7.5" high. So an image with a Document Size of 10" X 7.5" and a resolution of 50 PPI will fill your PowerPoint screen, but when it's projected it'll look fuzzy (in pixel terms, that image is only 500 X 375 pixels). Conversely, if you have an image that's 4" X 3" at 300 PPI it will import into PowerPoint as rather a small image on the 10" X 7.5" field, but since the image is actually, 1200 X 900 pixels you could scale it up to the full width of the PowerPoint slide without any loss in image quality when it's projected. (You could think of it as the projector having an effective resolution of about 102.5 PPI.)

It's best to look at the pixel dimension of your images as you're making them. As long as they're at least about 1024 pixels wide (for a horizontal image) they should be fine for teaching.

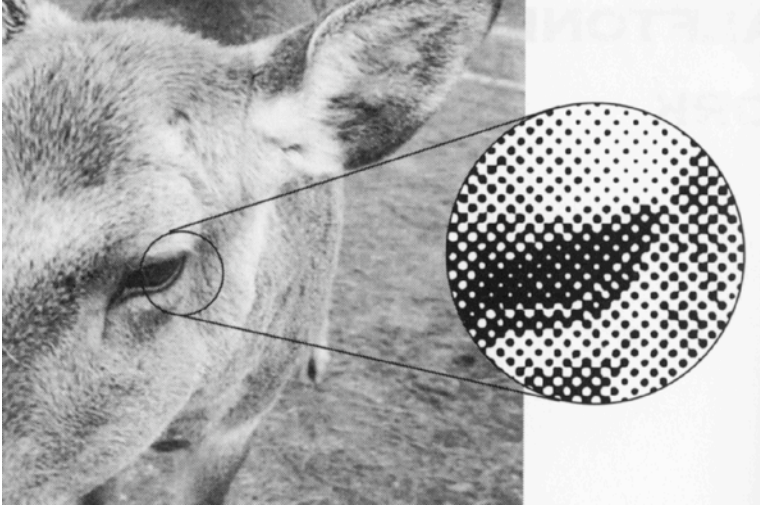
The standard resolution for web images is 72 PPI (often called "screen resolution"). At that size, the pixels you see on the screen are all the pixels there are; an image that's 4" long at 72 PPI will take up about 4" of your monitor. (Obviously there'll be a lot of variation here, as most monitors have a range of resolutions they can be set at.)

Most web sites are built to be visible on many different kinds of monitors. Usually a web site would be about 700-800 pixels wide. That means an image that's about **400 or 500 pixels wide** will take up a good chunk of the web page, and look pretty big on a monitor. You might want a bigger image on your site, but remember, some users might only have screens that show 800 X 600 pixels.

## **For Print: The dot and the line.**

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A bit about printing: images are printed using a halftone screen, made up of a mesh of tiny spots of varying sizes. In the old days, these patterns were formed by exposing a photograph through screens etched on glass, which were measured by counting the number of parallel lines to the inch. Thus the traditional measurement for the resolution of a printed image is still "lines per inch" or LPI.



A halftone image screen.

Newspaper images are generally printed with a very coarse screen, about 90 LPI. Magazines are usually printed with a 133-150 LPI screen, and book illustrations at least 150 LPI. Photo quality ink-jet printers print at the equivalent of about 133-150 LPI, and most laserwriters can handle about a 100 LPI screen.

Digital images are usually measured by counting the number of individual pixels (dots of image data) in an inch. Thus the resolution of digital images is often given in “Dots per Inch”(DPI) or, more precisely, “Pixels per Inch” (PPI).

[The terminology gets confusing as laserwriters are also measured in terms of Dots per Inch, referring to the spacing of individual dots of toner in making up solid forms, such as letters, or halftone spots. Since it takes a certain amount of laserwriter dots of toner to make up a halftone spot, and since the halftone spots vary in size while laserwriter dots are all the same size, a 600 DPI laserwriter can print a halftone screen of about 100 LPI.]

The higher the LPI resolution of the final image, the more image data a digital image requires. But the computer needs to create the halftone screen from the image before printing it, and it takes more than one pixel to make a halftone spot. The usual rule of thumb is: 2 pixels for every final halftone spot. That is, to print something at 150 LPI halftone resolution, you need an image of 300 PPI. However, most image processing software can get away with less. Anything within the range of 1.5 to 2 times the final LPI resolution should be OK. So, realistically, **to print an image at 150 LPI, you can use a digital image anywhere from 225 PPI to 300 PPI.** (You can, of course have more image data, but it doesn't give you any better a final result, and just takes up extra disk space and clogs your image processing software upon printing.)

### **Document Size and Pixel Dimensions**

Image editing software, such as Photoshop, can adjust many variables in your image. Some are relative variables, and some absolute. The absolute size of the image is the “Pixel Dimension.” This is the number of individual little dots of color in the image. The Document Size (in inches or cm) and the resolution (in PPI or pixels per cm) are relative to the Pixel Dimension. The Document Size tells you how big your image can print at the given resolution.

For example, if you have an image with a 6” X 4” document size at 300 PPI resolution, you can print that image comfortably up to 6” X 4” at 150 LPI. The absolute size of the image would be

1800 X 1200 pixels, that is the document size multiplied by the resolution (6 X 300 = 1800; 4 X 300 = 1200). You can also do the calculations in reverse. If you have an image of 1800 X 1200 pixels, and you know the magazine it'll be published in prints at 133 LPI, then you know you'll need a resolution of 2 X 133 or 266 PPI, then divide: 1800 / 266 = 6.77; 1200 / 266 = 4.51. So that same 1800 X 1200 pixel image could also be printed as a 133 LPI image at about 6.75" X 4.5".

That also means that if you have a scan at 72 DPI which is, say, 900 X 600 pixels, you could send that file to the printer as long as it was going to be reproduced as a 3" X 2" image or smaller (900 pixels / 300 PPI = 3"; 600/300 = 2).

If you scale the image down, Photoshop will decrease the number of pixels in the image by *resampling* them (averaging the values of neighboring pixels to make new pixels), if try to increase the number of pixels in your image Photoshop will *interpolate* new pixels (inventing new pixels based on surrounding ones) giving you a bigger, but fuzzier, image.

The way to control this is with the "Resample Image" option in Photoshop's Image Size dialogue box. If "Resample Image" is on, and you change a document Size measurement (Width, Height or Resolution), it will adjust the number of pixels accordingly, either scaling down the image, or resampling it up (decreasing image quality). If "Resample Image" is turned off, you cannot change the Pixel dimension, and changing the Resolution will affect only the Document Size and vice-versa.

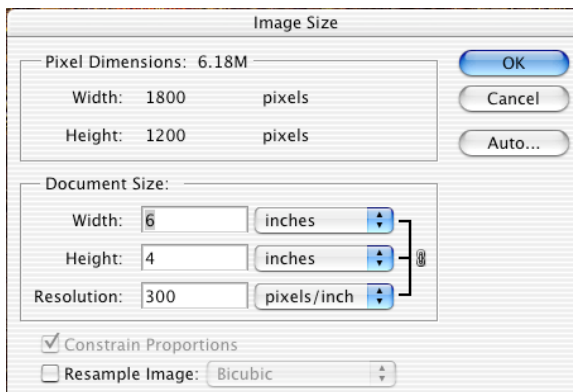


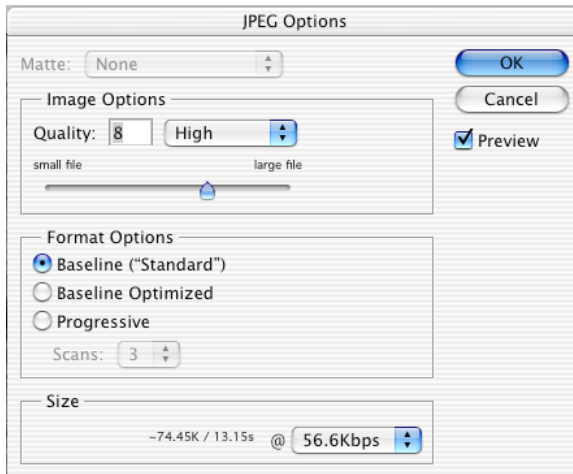
Image Size dialogue box in Photoshop

## Saving Images

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There are a multitude of image file formats, but the most common, and most cross-platform are JPEG, TIFF, EPS and GIF.

**JPEG** (or .jpg) is named after the Joint Photographic Experts Group which established the file format. It's one of the most portable formats, which means that Macs and PCs, both read JPEGs. Most image processing applications can handle them, and all web browsers can display them. JPEG, however, is a compression scheme, which means that saving images as JPEGs will result in some loss of image quality. You can often compress an image to about 1/10 of its original size by saving it as JPEG.



Save As JPEG dialogue box in Photoshop

JPEG is the best format for images you want to use in a PowerPoint presentation, and for most web site images.

When you save an image as a JPEG you'll usually see a dialogue box asking what quality image you want. More compressed images are smaller, less compressed images are better quality. Usually an image compressed at high quality looks perfectly fine. On extremely compressed JPEG images you can sometimes see boxy shapes known as "artifacts."



JPEG artifacts in a very highly compressed image, magnified 200%

A digital camera will usually record its pictures in JPEG format. You will have the option of how compressed you want your images ("Normal," "Fine," or "Superfine"). The trick is to find the amount of compression that records enough data, but doesn't take up too much room on your CF card.

When editing a JPEG image in Photoshop the program has to decompress the image and recompress it again upon saving. Thus every time you open, edit and close a JPEG image in Photoshop the image quality degrades a bit more. Therefore it's best to work with you images in a lossless format which editing, then convert to JPEG only once you're sure you don't need to edit anymore.

**TIFF** (Tagged Image File Format) (or .tif) is a lossless image description standard. Hence TIFF files tend to be much larger than JPEGs, Most scanners will automatically produce TIFF images. You can save TIFF images with LZW compression in Photoshop which is a lossless compression scheme. In TIFF images are written slightly differently for Macs and windows, but in most cases, either system can recognize TIFFs written on the other.

**EPS** (Encapsulated Postscript Format) (or .eps) is generally considered the standard for printing. It's a lossless image format, written the language laserwriters speak (postscript). EPS images are slightly larger than TIFF images, and each application that can create EPS images writes the code in a slightly different way (which can sometimes lead to problems). Still it gives the output device the most control over the image. If you have to send a file to a printer, EPS is usually the best format to use.

Photoshop gives you several options when saving an EPS image. One is the encoding (which can be ASCII or Binary). Binary gives you a smaller file size. Another is the preview. Since EPS images are literally a set of text commands to the printer, it needs to have another smaller file embedded in the file too that a text layout program like Quark XPress can see (hence the larger file size). You can usually save the preview image as a JPEG.

**GIF** (Graphics Interchange Format) (or .gif) images are used exclusively on web sites. A GIF image can only have up to 256 colors, though you can specify a unique color table for each image as you save it based on the colors used in that image. As a result, it's not very useful for images with lots of colors, and smooth transitions from color to color (like photographs and artwork). GIF images are useful for images with flat areas of color, like a logo on a website. GIF images can have transparent areas, and can also contain multiple images so that on a web site they become an animation.