DPI vs PPI

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DPI stands for dots per inch and refers to the output resolution of a printer. It describes the density of ink dots placed on a sheet of paper (or another photographic medium) by a printer to create a physical print.

DPI has nothing to do with anything displayed digitally.

Note: *This is not to be confused with the NPPC definition where DPI means a Digitally Projected Image.*

PPI stands for pixels per inch and describes the input resolution of a digital image, not a print.

PPI is used to resize images in preparation for printing. To understand this, we also need to understand what a pixel is.

A **Pixel**, or picture element, is the smallest building block used to create a digital image. Pixels are square and arranged on a grid. Each pixel is made up of red, green and blue sub-pixels which when blended together gives each pixel its different colour or hue.

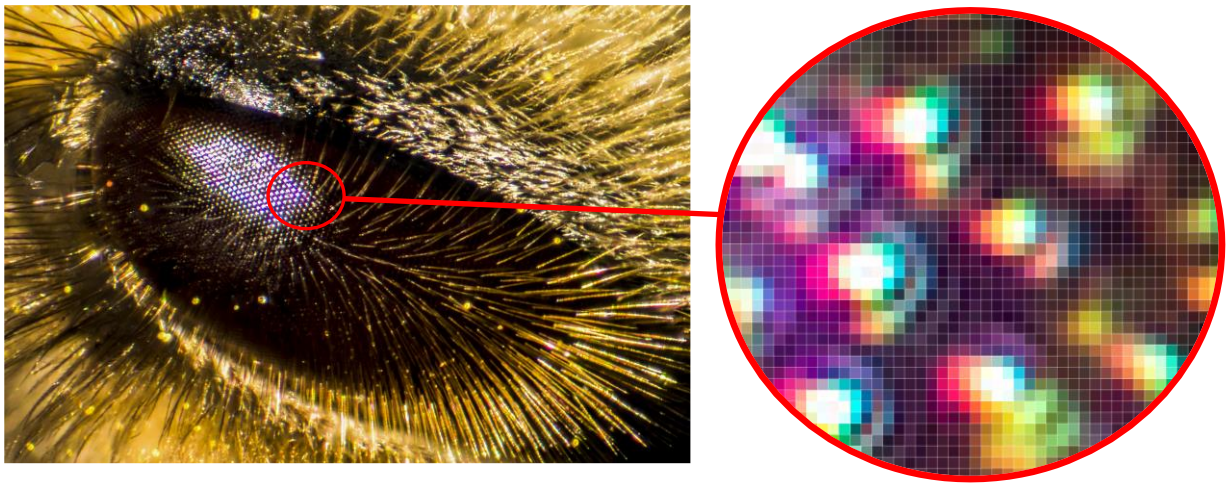

Image 1 – A Bees Eye *Image 2 - Magnified*

In the image above, one portion has been magnified many times over so that you can see its individual *composition in pixels.*

Digital Image Size

It is essential that you understand what digital image size means before we proceed with the comparison of DPI vs. PPI. The size of a digital photo is created in your camera. It depends on the model of camera you are using and how you have set up your camera. For example, my Nikon D500 captures a raw file that is 5,568 pixels wide by 3,712 pixels high.

If you do the math, 5,568 × 3,712 = 20,668,416 pixels, or 20.6 MP (million pixels or megapixels). When you hear someone say that they have a 20.6 MP camera, this is what they are referring to.

PPI and Screen Resolution

PPI is also used to describe screen resolution (not to be confused with digital image resolution). The resolution for any particular screen is a fixed quantity. Screen resolutions vary between devices and are continually getting better.

A 28” 4k monitor with a pixel count of 3840 x 2160 pixels has a screen resolution of 157.35 PPI. This compares to 108.79 PPI for a 27” monitor with a pixel count of 2560 x 1440 and 81.59 PPI for a 27” monitor with a pixel count of 1920 x 1080. While an iPhone 11 Pro Max has a 6.6” screen with a pixel count of 2688 x 1242 resulting in a screen resolution of 458 PPI.

Displays with higher resolutions have device pixels that are smaller and more closely packed together. Images on higher resolution screens appear sharper and crisper than those same images displayed on lower resolution devices. However, this is only true to a point. How far away from the device you view the image and how good your eyes are also affect how sharp a digital image looks on a screen.

Since the pixel count for any device is fixed the image resolution will not impact how a photo looks on that device. You can save an image at 72 PPI, 150 PPI, 300 PPI or even 5,000 PPI, but for a given device you will not see any difference in how the image looks. It is the image size – the actual number of pixels along its length and width – that changes how an image looks on any particular display screen, not the image resolution.

Below are two versions of the same photo. I exported them from Photoshop at two different resolutions. Image 3 has a resolution of 1 PPI while image 4 has a resolution of 3,000 PPI.

Image 3 - Saved at 1 PPI

Image 4 - Saved at 3000 PPI

You can’t tell, because they are *not* different. On a screen, pixels are pixels and the pixels don’t change size unless you change the resolution setting of your monitor. Both these images have the same pixel dimensions (1600 x 1200) so they take up the same number of pixels on a screen regardless of the pixel per inch setting.

This is where most of the confusion exists because PPI and DPI are often used interchangeably to mean the same thing, which is wrong! *DPI does not apply to digital images!* As stated above, DPI is a physical property of a printer, not the digital image.

PPI and the Projected Image

The presentation of the digital image using the club projector is set up to show all images at the same ratio using a limit of 1,600 pixels wide by 1,200 pixels high.

When preparing an image to be projected by the clubs projector, it is important that the image is as close as possible to 1600 x 1200 pixels to ensure it is shown at its best. If an image is less than the maximum size it will scaled up to the 'apparent' size so that it will completely fill the screen.

The more pixels in the same space mean greater levels of detail and crisper images

To maximise the size being projected it is important to use up to the allowable pixel count. The following two images (image 5 & image 6) were taken of the same subject.

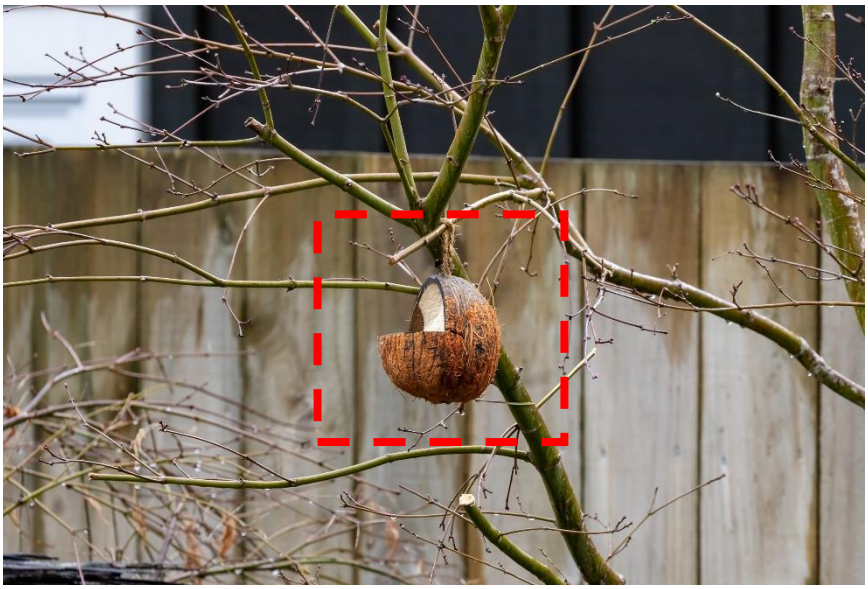

Image 5

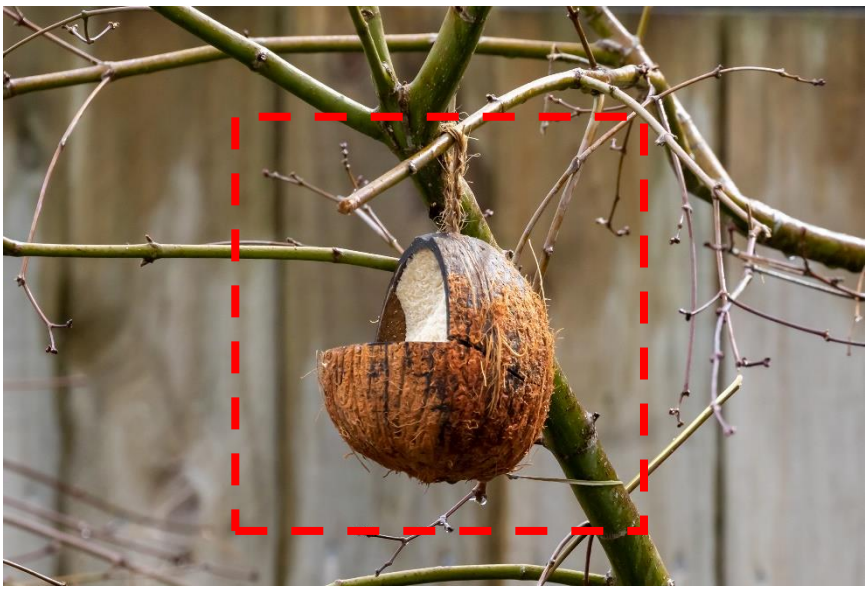

Image 6

If you were to then crop each image so that the coconut was the centre of attention and the image was within the allowable pixel count for the club projector (1600 x 1,200) then you may end up with the loss of detail.

The resulting pixel count for the cropped image 7 is 620 x 620 and when compared to image 8 which has a pixel count of 1,200 x 1,200 you can start to see that the first image has started to loose detail, this is especially noticeable around the top of the coconut.

Image 7

Cropped down to enlarge subject.

Resulting image is: 620 pixels x 620 pixels

Image 8

Cropped down to enlarge subject.

Resulting image is: 1200 pixels x 1200 pixels

To ensure the highest quality of an image when projected it is recommended that where possible you fill your camera viewfinder with the subject and thereby minimising the amount of cropping and/or resizing required, and therefore minimising any lose, to fit the clubs size criteria.

Resizing an Image

When you take a photograph using a digital camera, the camera must convert the scene in front of the lens into a discrete grid of pixels. The same is true for images acquired onto a computer from other physical sources, such as a scanner. This process is called "sampling."

Once an image is in a digital format, you no longer have access to any other information about the scene from which it originated beyond the pixels in the image. This means that when you resize an image, the editing software cannot fill in gaps in the data with information from the actual scene; instead, it must "resample" the image to construct an approximation to the original scene.

Upsampling

Upsampling is the type of resampling that the editing software performs when you enlarge an image. When the image is enlarged, the original pixels will then be spaced further apart, and the application must "make up" the new pixels between them, using an appropriate approximation of the original scene.

Downsampling

Downsampling is the opposite of upsampling, used when an image is made smaller. Although shrinking an image does not require filling in new space as in the case of upsampling, your editing software may still use an approximation in order to preserve as much information about the image as possible.

For example, consider the following image of alternating black and white pixels (31 pixels wide x 31 pixels high).

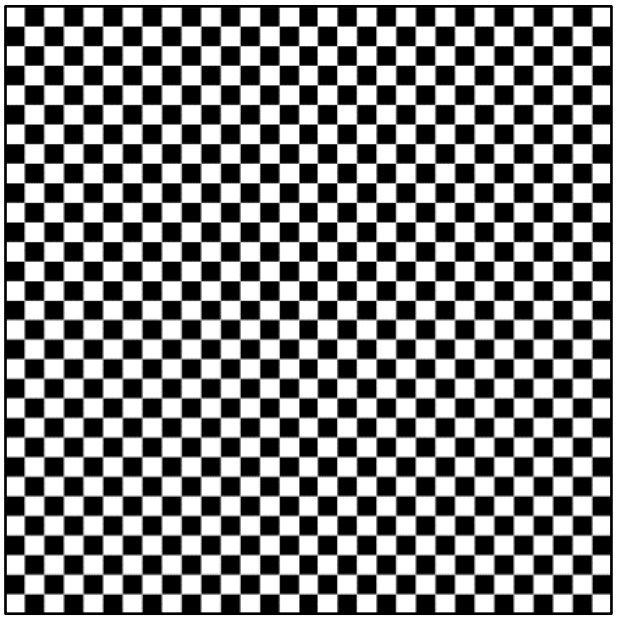

Image 9

If you reduce this image to half its size (16 x 16) by directly sampling the values of every other pixel, you would end up with the following, a white or blank image or it could be a completely black image.

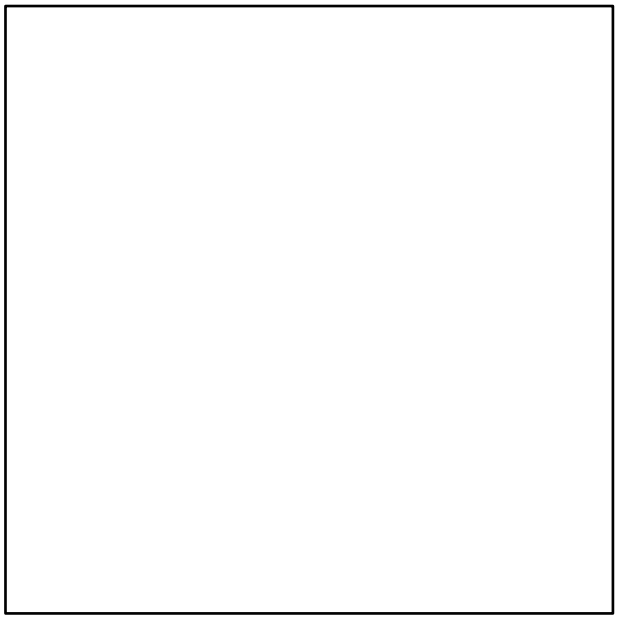

Image 10

A better approximation method is needed to ensure that such details are not lost.

As a comparison the following is the result of upsampling the image to 50 x 50 pixels.

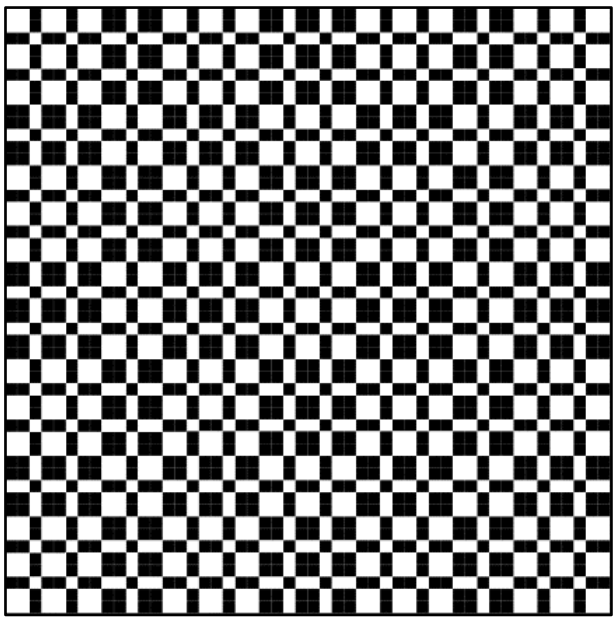

Image 11

Both upsampling and downsampling of images will always results in some degradation to a certain extent (certainly not as bad as the samples above). But by using different tools, such as Adobe Photoshop or Topaz Gigapixel AI you can generally do a pretty good job at resizing an image without losing quality. A lot depends on the algorithm used by the software and the options chosen by the user. At some point it is definitely up to the user and how much quality they require vs file size.

Adobe Photoshop - https://www.adobe.com/nz/products/photoshop.html

Topaz Gigapixel AI - https://topazlabs.com/gigapixel-ai/

DPI and the Printed Image

When talking about print size, PPI refers to the number of image pixels from the digital file that will be used to create one inch on the printed medium. The math is quite simple to determine the size of the print that can be made from a digital file. Take the pixel dimensions of your image and divide those values by the resolution (PPI value). For example, if I print one of the 5,568 × 3,712 pixel image files from my D500 at 200 PPI, the photograph would be 5,568/200 = 27.84" long and 3,712/200 = 18.56" high.

However, pixels do not exist on paper. Taking the most common consumers printing device, the inkjet printer, to examine how an image from the screen (in PPI) is produced on paper:

An inkjet printer makes millions of small droplets of ink and places each drop carefully in near perfect rows to recreate the digital picture. Because there are many more possible colours than there are shades of ink, three or four basic colours can usually be combined to reproduce practically all possible colours.

Often these ink droplets are also called dots and over an area of the print, the term for resolution DPI is used again just like pixels. But ink drops are different than pixels, because where your computer only needs one pixel to produce any shade of colour, an inkjet printer needs three or four (or even many more) dots of different coloured ink to reproduce one pixel that looks like the combination of the dots' colours. The typical colours for basic printers are either Red, Green and Blue or Cyan, Magenta, Yellow and Black. For this reason, you may hear some printer manufacturers making wild claims of thousands of DPI in resolution that they can produce.

For example, if your home printer is using a three colour system of Red, Green and Blue (RGB) and printing out a digital file of 300 PPI, it will need to put down up to 900 dots per inch (3 colours x 300 pixels per inch) in order to recreate the original 300 PPI digital file.

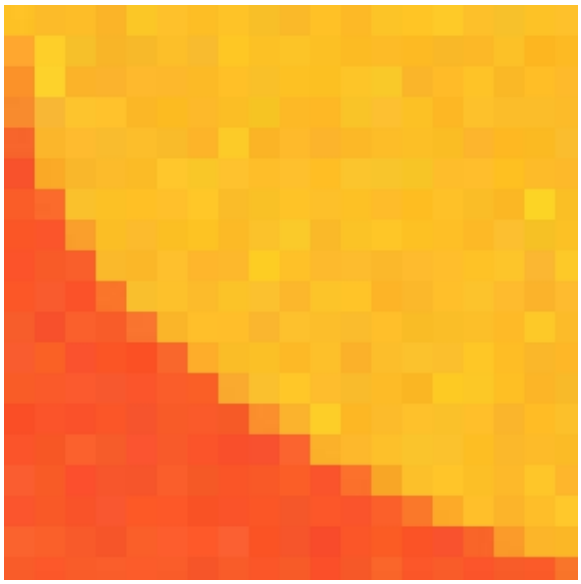

Image 12

Example of Digital Image Pixel Pattern

Image 13

Example of Inkjet Ink Drop Pattern

So 300 PPI on your computer screen is not the same thing as 300 DPI on a printer.