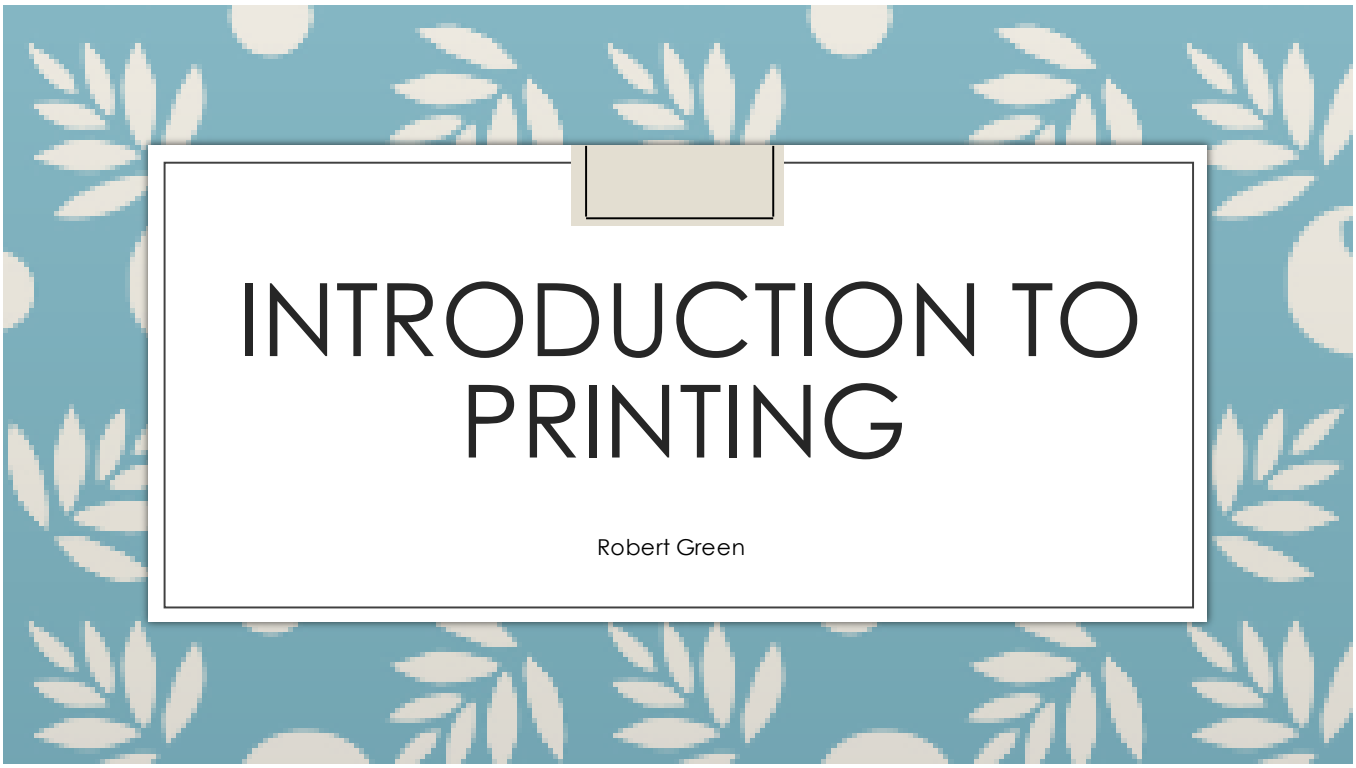


# Preface

Do you need to learn how to print?

If you just want a hard copy of your images that you can pop into a scrapbook or give to someone, and "close enough is good enough", then most of the information in this seminar is not needed. And this is not a bad thing, or poor photography. Modern printing services can produce a great print from a well-edited file.

So, who is this seminar for?

This introduction is for photographers who want to ensure the print fulfils their creative vision – whether through a print service or with their own printer.

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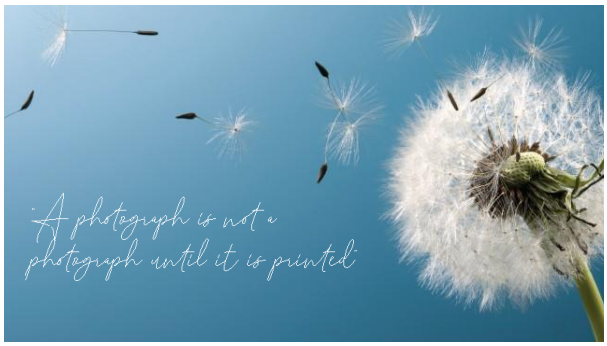
Before the modern age of ***screens***, a photograph was always a physical print. Now days, almost all images taken by amateur photographers (like us) are viewed on screens. We capture, edit and display our images for that medium. When we turn our attention to printing, some of our images, a whole new layer of complexity is introduced. For one – an image on a screen looks fine at 72 ppi, but a printer needs around 200 ppi to look OK. So, an image snapped on a phone can look good on the screen but terrible as a print.

That said, the "smarts" of modern editing programmes and printer software can often produce reasonable prints without us ever learning how to make a good print. So, this seminar is not arguing that you need to learn everything being covered today in order to print your images. If though, you have sought-out some training in printing, its likely you are interested in producing more than just "reasonable" prints. You want to make your images shine as tangible pieces of photographic art.

It's an easy trap to fall into – that the images stored in our devices constitute a collection of photographs. But the reality is … there are no photographs. Nor even images. Not even something permanent. What we have, are data files of ones and zeros recorded as magnetic states; that time, heat, vibration or decay will dissolve in little more than a decade.

To make things worse, these ones and zeros are not even recorded as a whole. They are written in chunks all over the storage media, relying on a master table to index their order. What we think of as "an image" is something constructed by software from the ones and zeros. The constructed image will look different on every device we view it on. The file format, colour standard, bit-depth, graphic card, display type, calibration standard, gamma and white point settings all affect how the image we see will look to us – as well as the colour temperature of the light in the room and the colours surrounding the screen.

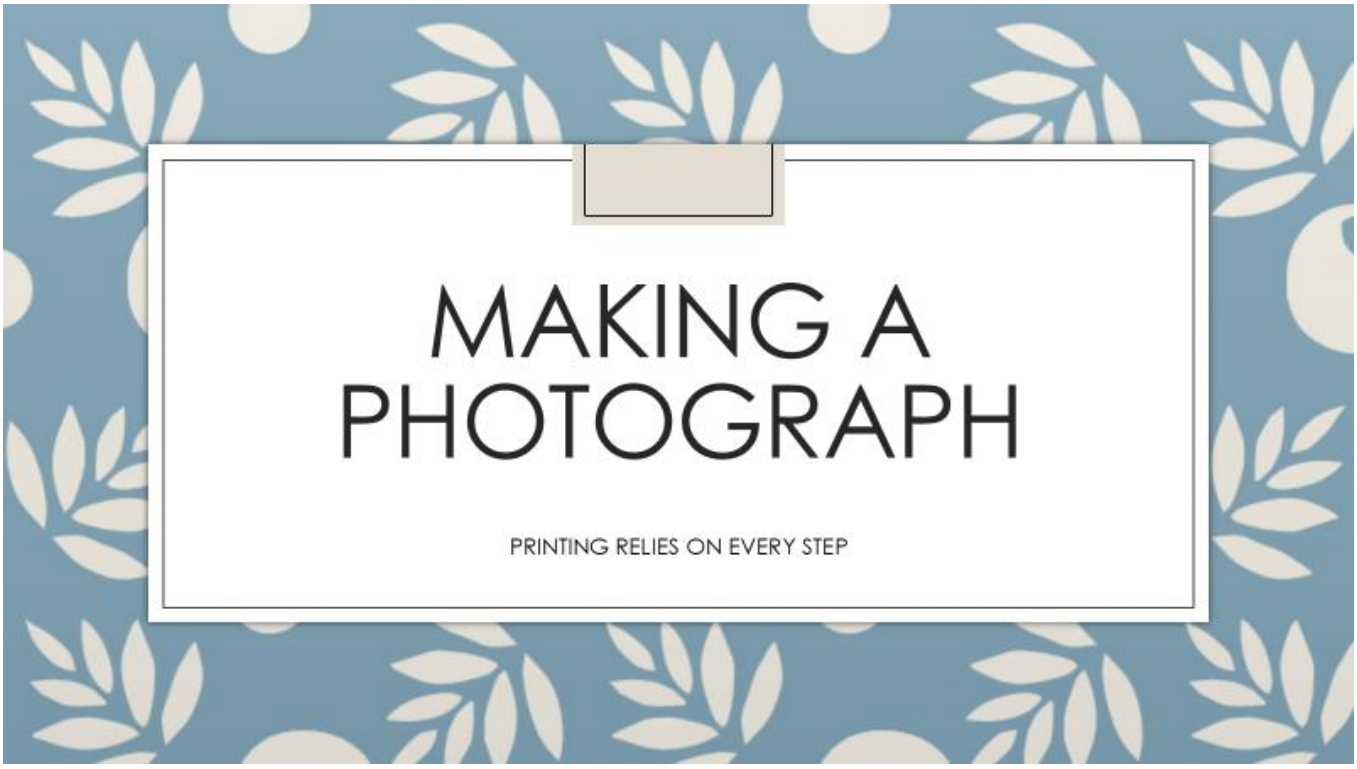
The final insult to our hard work as photographers is that the electronic image is ephemeral. It evaporates the instant we look at another image. So, when we think about our images, we are really talking about memories – not a tangible creation.




It's not surprising then, that photographers say, "*A photograph is not a photograph until it is printed.*" Only by printing can an image be given permanent life. Only by printing can we complete the photographic journey - of pre-visualisation, composition, editing, printing – that creates a photograph.

We've probably all had the experience of carefully crafting the edit of an image to display the beauty of the scene as we saw it. But when we've sent it to a friend, displayed it on a website, or showed it on a projector, □ beauty becomes a beast! And that fleeting display becomes forever remembered as an "ugly duckling", rather than your "pride and joy". The image never became a *photograph* – a fixed, real product of our creativity that is seen exactly as we want it to be seen.

So, … your interest in printing your work is a way to take your photography seriously.




When we stop treating printing as an optional "add-on" reliant on the whim of automated machines, the making of a print becomes the last step in a journey of creating a photograph. And, in this journey, this last step relies on every step beforehand. It's not just what to do with a printer that matters. Its also what you do when capturing and editing an image that affects its success.

The full journey of creating a photograph involves many **artistic** issues –

- The motivation for the image
- The emotion we want to share
- The composition that best captures this
- Planning and opportunities
- The use of available light
- etc.

To give them expression, Photography also involves a range of **technical** issues -

Usually, when we capture an image, we're concerned with

- What to focus on
- What aperture to use
- What shutter speed suits the subject
- What ISO gives us this combination without too much noise

There are, though, many other settings that affect what we can achieve in editing and ultimately, in printing our image.

- which picture profile we use
- the colour temperature we have set
- the accuracy of our exposure
- which file format we store the image in
- the resolution of the sensor
- and the colour space we are using

The decisions we make about how we **CAPTURE** our images can greatly affect how well we can PRINT our images.

Some of these decisions have a cascading effect …

- The most fundamental is which file format you use.
  If you shoot in JPEG, the file you get will "bake-in" the effects of the Picture Profile and Colour Temperature you have set;
  And the limitations of JPEG's 8-bit data, that defaults to the narrower sRGB colour space, will limit adjustments to exposure and colour that you might need to make in editing.
- When you shoot in RAW, the larger 12- or 14- bit data files can store the maximum colour information and exposure gradation;
  and because there is no processing "in camera", whatever you choose about Picture Profile and Colour Temperature is not written to the file – leaving you free to make full changes in editing.
- Lastly, using the whole of the sensor (ie, not using *crop mode*) gives you more pixels to work with.

Similarly, to **EDIT** our images, there are multiple factors that affect how colours are seen …

- The first is the **screen** – every screen displays colours differently, and this changes over time.
  Hence the need to **calibrate** your screen so that it conforms to a standard. (more on that in a minute)
  Note - not every screen supports calibration and profiling.
- While mostly, different **software** delivers similar results, they all differ in how they interpret the 1's and 0's.

For really accurate, detailed prints, the engine that interprets the RAW file can make a significant difference. (such as DXO's Pure Raw engine)

- To ensure you can use all the colours in your image, its best to edit in the widest **colour space** possible – usually ProPhotoRGB
- And to ensure consistency, any unusual colour cast needs to be corrected by adjustments to the **colour temperature**.
- As well, the colours and light **around your monitor** affect how colours on the monitor are perceived.

And, when we **PRINT** our images, many more factors affect the result we get out of the printer –

- **Hardware** - while most of us will struggle to see the difference between brands, Canon and Epson printers do have differing strengths in different parts of the spectrum. Also, different models have different features – e.g., roll feeders; suction vs friction guides; paper sizes; photo black ink; etc.
- The **resolution of the print head** will determine how detailed the print will be and how smoothly colour gradients will print.
- The size of the **colour gamut** will determine how closely the printer can match the screen.
- Whether 4, 8 or 12 **inks** are used will affect how accurately and how diversely the printer can print.
- As you might expect, the **type of paper** greatly affects the look of a print.
- Different papers affect colour and contrast in different ways. To get an image to look as it does on the screen, you need to print with a **profile** that is specific to the paper being used.
- Which also means that the editing step also needs to know what paper you are preparing the print for – something called "Soft Proofing" (that we will look at later).
- And, if you are a perfectionist, you will go beyond using a generic ICC profile and have ICC profiles calibrated for your printer!


The usual reaction to this complexity is "That's overwhelming!" "Far too hard". But, most of this is only for the professionals - For the rest of us, there are some simple principles …

For everyday printing, only a few things are critical.


**CAPTURE**

1. Use the AdobeRGB colour space
2. Shoot in RAW
3. Expose correctly – i.e., avoid losing data in the shadows and highlights

*You're probably doing this already – so, nothing to worry about here.*

**EDITING**

1. Use ProPhotoRGB colour space and 16-bit mode – to capture the most colours
2. Control the environment
3. Calibrate your monitor
4. Soft proof with ICC profiles

*These might be new skills/steps for you – but none of them are hard.*

**PRINTING**

1. Select paper purposefully
2. Print with ICC profiles
3. Handle paper with care

*The final step involves almost no skill (particularly if you use a printing service). But there are some steps to learn about how to prepare a file for printing (whether on your printer or by a printing service)*

# CAPTURE

The first step – capturing an image – is straightforward and something most of us do already. So, we'll move straight on to what we need to do in editing to prepare an image for printing.

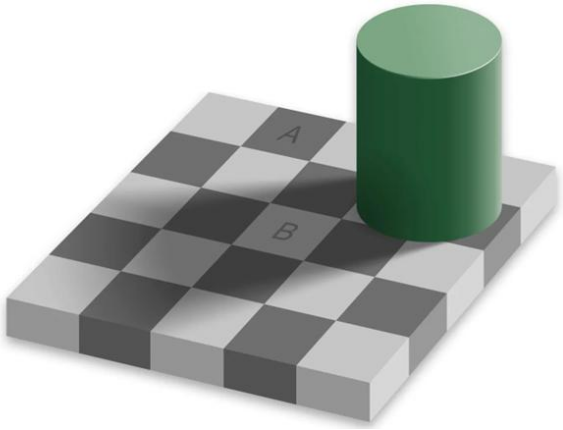
## EDITING

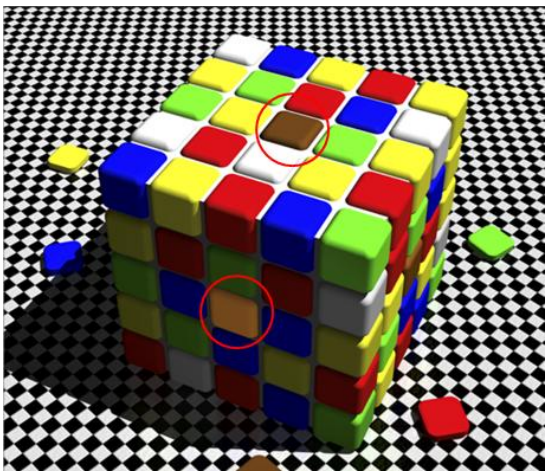
When we plan to print an image, there are a few additional actions we can add to our usual workflow that will ensure the image will print *at its best.*

# ❶ Control the Environment

Unless you know something about the human visual system, you will usually think, "what you see is what you get" – ie, things are just as we see them to be. However, what we see is a constructed reality that interprets raw sensory input to create an image. Because our visual system makes lots of assumptions below our awareness, what we "see" is not exactly what eye eyes are seeing. If we don't control the environment in which we edit and view our images, our visual systems will make lots of errors about what we see.

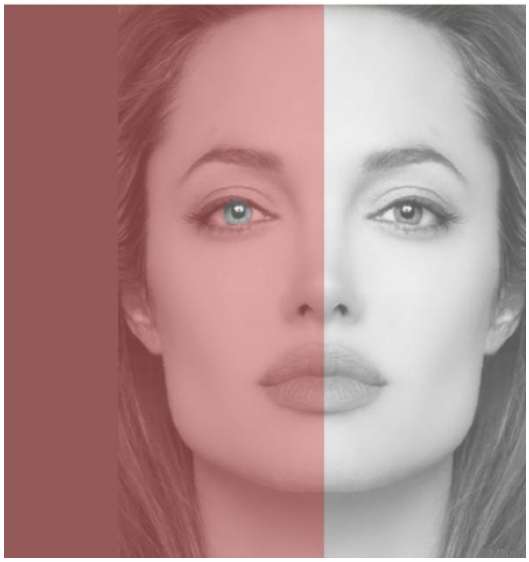
Here's an example of this - squares "A" and "B" are the same brightness/shade even though they look different. Our brain adjusts how they appear because one is in the shade.



This is a colour example of the same problem -

The centre tiles on top and the side (circled in red) are the same colour.



And if that doesn't convince you how important the context is when seeing colour, here's a pure B&W image but part of the image has some shading.

NOTE: The red shading does not cover the iris (there is a hole over the iris). Both eyes actually are without colour but one iris appears blue!

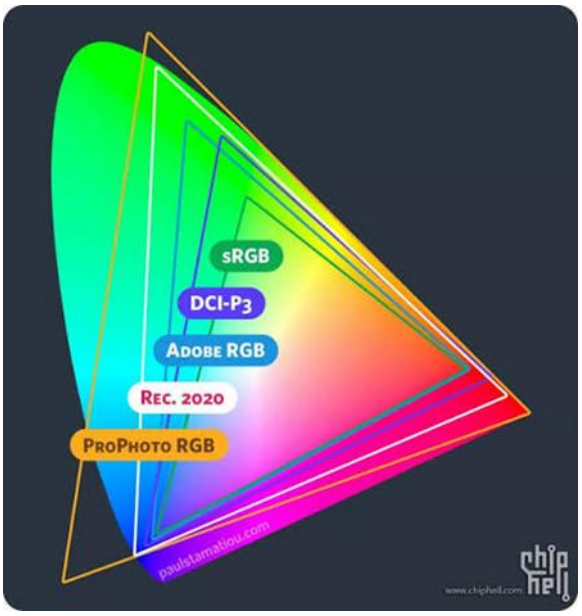
Because we make adjustments when editing based on what we "see", but "what we see" is affected by everything around what we are looking at, we can make more reliable judgements about editing decisions if we control the environment in which we do our editing.

- Edit in the same lighting; use *Daylight* lamps
- Avoid too bright or too dark; the monitor should be the brightest object in front of your eyes
- Avoid direct sunlight; esp. behind the screen
- Avoid reflections on the screen; use a screen shade
- Avoid strong, bright colours around the display; keep colours neutral

## ❷ Edit with the widest colour space

Editing with the widest colour space means using a monitor that can display all the colours of one or other of the industry standards, and setting your editing software to use in a colour space that preserves all the colours recorded by your camera.

The different gamuts are shown in this diagram –




- sRGB covers the smallest range of colours, with limited range in blues and greens that mostly concern landscape photographers. DCI-P3 and AdobeRGB cover a wider spread of colours and are similar enough that it usually doesn't matter. Technically, DCI-P3 monitors are more suited to when images are primarily intended for digital screens. While AdobeRGB monitors more closely match the colour gamut of printers. Mac products are DCI-P3 compliant and mostly, don't affect how images are prepared for printing. That said, printing on high-end printers might require care about out-of-gamut colours. (covered later)
- Don't worry about Rec. 2020 - it's a global video standard that defines the wide colour gamut, of 4K and 8K Ultra HD and deep bit depths used for modern television and digital video production.
- ProPhotoRGB covers almost all known colours and is far wider than even the best displays or printers can represent. (See: sRGB vs. Prophoto RGB vs. Adobe RGB: Which one is better?)

Budget office displays mostly only display the sRGB standard; sometimes, less than this. Choose a quality monitor with the widest colour space you can afford. e.g., 100% Adobe RGB (or close). That said, don't fret if your monitor is only 100% sRGB compliant. If you keep your workflow to the sRGB colour space, you can still make fabulous prints. (You'll just have to be careful to not push saturation too far and watch-out for colour banding in shading).

Set the colour space of your editing software to ProPhotoRGB. Although this is wider than your monitor can display or a printer can print, this setting uses 16-bit depth which ensures that you will not lose colour information, and no colours in your edits will be outside what the programme can handle. It also future-proofs your images for when you upgrade your system.

Lastly, matt or reflection-controlled screens are best for editing. Colours do display brighter on a glossy screen – so they are fine if all you want to do is view your images on a screen, as a glossy screen will show them at their best. But, for print editing, glossy screens can be problematic as a print will never look like a glossy screen.

## ❸ Calibrate the monitor

Having invested in a suitable monitor, we have to keep it in top condition.

The reproduction of colours on our monitors happens through the combination of three colored lights (Red, Green, and Blue—RGB). Different monitors reproduce colours differently. This is due to the five main factors:

- Differences in the hardware components of the monitors
- Variations in manufacturing and quality control
- Differences in graphics cards and drivers
- Color management settings of the operating system
- Aging of the components

Monitor calibration adjusts a monitor to match predetermined standards This ensures that the colours you see will look the same on any other calibrated device – monitor or printer. Calibration sets the monitors brightness, contrast, gamma, and white point to known standards. This eliminates variation between how your image appears to you and how it will appear on any other calibrated device – monitor or printer. Although you might like to edit with a bright screen to make your images appear fantastic, but paper doesn't emit light, the false boost on the screen means that the image, on paper will be darker than you expect.

Calibration uses an ICC profile unique to the monitor to correctly translate colours . This ensures that different devices, printers and other screens, maintain colour consistency. ie, while the monitor you use will display RGB values for a particular colour in its own unique way, the profile adjusts what is displayed to accurately align with industry standards for how those RGB values should be seen.

A reputable brand of monitor (one that claims % compliance with a particular standard – sRGB, DCI-P3 or AdobeRGB) - will be calibrated at the factory. However, regular use of the monitor will result in drift from this standard. It's good practice to recalibrate every 3 months. Practically speaking, though, once calibrated, you may not notice (or care) about minor variations while editing. However, when you print, small variations in colour might bother you.

The calibration of a monitor requires a colorimeter and special software. There are several devices available, at different price-points. Many club members will have one that you might be able to borrow. *It might be a good idea for the club to purchase one or two that people can borrow a few times each year.*


Calibration is an automated process. The device sits against the screen and measures colours and tones displayed by the calibration software. The software then calculates how much the

screen profile needs to be adjusted, and records this information into your computer. (See Why Calibrate and Profile a Monitor | Francesco Gola and Ultimate Monitor Calibration Guide)

Having said all this, do you need to calibrate your monitor?

- If creating Fine Art images is your goal – YES
- If it matters to you that prints closely resemble your creative vision on the screen – YES
- If you have a relatively new high-end computer system (Mac, or Windows system claiming close coverage of AdobeRGB or DCI-P#) – PROBABLY NOT
- If you have a basic or older system that doesn't allow display changes – NO (you need a new system!)
- If using a consumer-level print service (eg, Warehouse Stationary), their machines often automatically correct images to a generic standard – so calibration doesn't add anything.

Print some test prints and compare them to your screen. If close, don't fret about calibration. If prints are too dark, lower you screen brightness and/or boost the exposure of your image before printing; and retest.

# PRINTING

## ❶ Working with ICC profiles

Hopefully, it's not too frustrating that we are half-way through this seminar and we have yet to talk about printing! What we have covered up to this point is important because when our aim is to PRINT an image, not just look at it on a screen, so many things affect how a print will turn-out. This can seem overwhelming, but most of the issues related to the capture of images are already "good practice" that you are probably already doing.

And you probably already have an editing workflow well-suited to making prints. eg, many people invest in a adequate computing equipment, have their software set-up to maximise their options, and edit in a neutral environment. The only change might be finding a way to calibrate your screen so that you will know that the colours you see can be matched by a printer.

In the section on Calibration, we said that monitors had to be *calibrated* so that they displayed an expected colour for the RGB values of a pixel, and not their own version of those values. And it was explained that there are agreed international standards for colour that allow profiles to be created for each individual monitor so that they correctly display colour. If you "*put 2 and 2 together*", you will have realised that its only half the solution to calibrate the monitor … the printer also needs to match the international standard if you are going to get correct colours.

This is where it gets complicated. (Not for us, but for the manufacturers). Not only do the different printers differ in how they represent colours, but every different paper changes how colours look in unique ways! So what is needed is a profile for every type of paper for every type of printer – which is exactly what ICC paper profiles are.

Fortunately, you don't need to understand a lot about ICC profiles to know how to use them – but it's helpful to understand a few things. Particularly, in addition to ICC profiles being important for how we manage the *actual printing of the image, the profile also* affects what we do as the *last step of editing an image*. And both of these actions are dependent on our **choice of paper**.

Let's look at each of these steps …

## Selecting Paper

We edit an image to create a particular "look and feel" that conveys what we want that image to convey. When that is mage is to be displayed as a physical print, the choice of paper is another part of deciding the "look and feel" of the finished print.

If you've ever searched for inkjet papers online, you'll be aware that there is a bewildering array of options for paper. Paper varies in all the ways listed here. And, paper with of the same material, coating, finish, texture, etc., can come from different manufacturers. Different papers create a different look for your image. So the first issue to be answered is – "how do you want your image to look?"

- If you want punchy colours, you will likely choose a glossy paper, or at lease a semi-gloss.
- If you want a softer, dreamy mood, you will likely choose a matt paper.
- And depending on whether or not you want to convey depth, you will choose textured or non-textured.
- If you want archival quality, you might not choose papers with brightening agents.

(See: Types of Photo Paper: A Complete Guide)

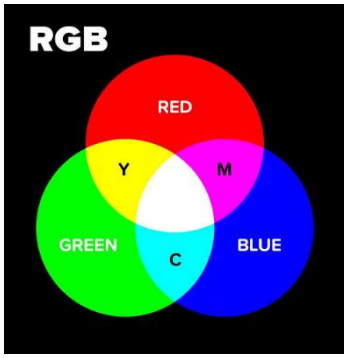
*REMEMBER: There's no right or wrong. A photo can have many different "looks". It's up to you to think about what suits your intentions.*

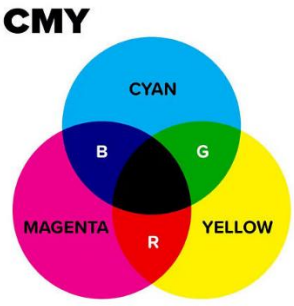
Your answer to the question of which look you want raises some issues –

- Different papers need different print settings.
- Different printers print differently on the same paper
- And, more fundamentally, paper is an entirely different medium to a screen; so you have to understand/accept that you are not mirroring the screen.
  (a bit like how a book and a movie story are the same story but convey it differently)

## Printer Profiles

The decision of which paper to use affects **how to set-up the printer** to use that choice of paper, and, we have to **prepare the image** for printing with those settings. Fiest, let's look at the problem of setting-up the printer to correctly lay-down ink on the paper we have chosen …

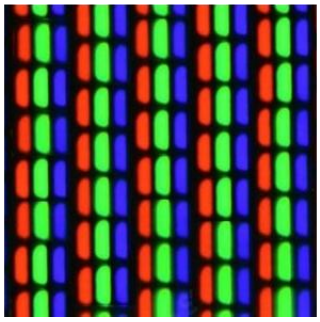


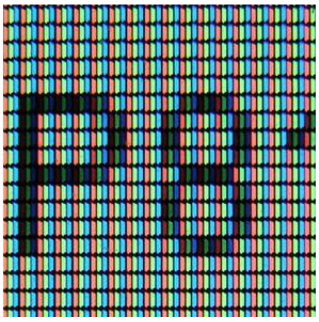

Obviously, screens and printers create an image in different ways, and its this difference that we have to manage in order to produce a print that is like the image we edited. The first difference is that screens use an ADDITIVE colour model – adding difference mixes of Red, Green and Blue to create colours; while printers use a SUBTRACTIVE colour model to subtract reflectivity away from pure white (the paper). This creates the second, and most major difference – a screen is shining light towards your eyes, while a print doesn't have light behind it; it reflects the light falling on the print (so is duller). (See: The Fundamental Differences of Screen to Print… | Image Science)

The third difference is that the image on a screen is made-up of **pixels** – each pixel comprising the 3 colours, Red, Green, & Blue, that shine at different strengths to produce a specific colour and a specific intensity.

Pixels on a Screen



Letters created by pixels



Whereas the image created by a printer is made-up of much smaller **dots.** The printer clusters dozens or hundreds of tiny ink dots (Cyan, Magenta, Yellow, and Black) together across different patterns to trick the human eye into seeing shades and gradients. This technique is known as halftoning or dithering.

Inkjet printer

The printer doesn't just print the pixels as different coloured dots – as if the print is just a paper version of the screen. It translates the differently coloured pixels into patterns of even smaller dots of the available coloured inks of the printer. These tiny dots can be of different sizes and can overlap each other to different degrees

As we noted earlier, each of the scores of different papers available for printing differs in how they accept the colours put on them. And, on top of all this variation, printers vary in their ability to lay-down the ink and also in the range of colours they use.

Printer software does a fantastic job of translating the colours of pixels into patterns of coloured dots. But, the combination of dozens of different printers, across hundreds of different papers yields endless variation in colour and tone. You wouldn't know how an image would print until is was printed. That's a lot of paper and ink to waste; which is ultimately a lot of money!

Earlier, we looked at how the variability of monitors can be managed by calibrating your monitor to a known standard. Calibration brings your monitor into line with how it displays colour according to internationally agreed values.

In a similar way, there are specific profiles for each type of paper, when used with a particular model of printer. These profiles ensure the standardised colour you see on your calibrated monitor is translated to give the closest match when printed. We say, "closest", because (as we just discovered) a printer cannot exactly match a display. And, for some papers, the difference is quite noticeable. So, when we choose the paper, we then tell the printer which ICC profile to use so that it understands how to print on that paper.

ICC profiles are available on each paper manufacturer's website:

| | |
|---|---|
| Epson | Ilford |
| Canon | Hahnemühle |
| Canson | Red River |
| etc. | |

### Soft proofing with ICC profiles

*Soft proofing* is an *editing* step. But it relies on decisions made in relation to printing – principally, what paper (and printer) are to be used). When you soft proof an image, you adjust the image to account for the changes that will occur in the translation to printed form, in order to retain as much similarity to the screen version as you can. Usually, the biggest difference is when you print on matt paper. The level of contrast, or the depth of the blacks, is noticeably less. Unless you specifically want a "washed-out" look, the level of contrast in the image has to be adjusted to account for more ink being absorbed into matt paper.

An ICC profile allows the computer to simulate how the image will look when printed on the paper you selected – on the screen, before you print it. This provides you a "soft" (ie, not hard-copy) proof of the final output. If we just ***press Print*** without the step of soft-proofing, we won't know what we will get out of the printer until its done its job. And what then? Compare the print to the screen, make some changes based on guessed about what might improve things; and try again … most likely, only approximating what you want. Meanwhile, at about $4 per A3 sheet and $2 for ink, the costs mount-up!

Soft-proofing avoids all this by allowing us to make the necessary adjustments before sending the job to the printer.


## ❷ Ensure adequate resolution

Image resolution is another concern that spans both the use of a printer and our editing of the image. Earlier, we saw that ppi is the critical measure of how much detail we have in an image. While dpi is a measure of how finely pixels can be represented on paper. You can send an image to the printer to print at 600 or 1200 dpi or even higher. But if the number of ppi of the image is too low, all you will get is a very detailed pixelated image – ie, the too few pixels will be printed very exactly but will not be close enough to produce a pleasing image.

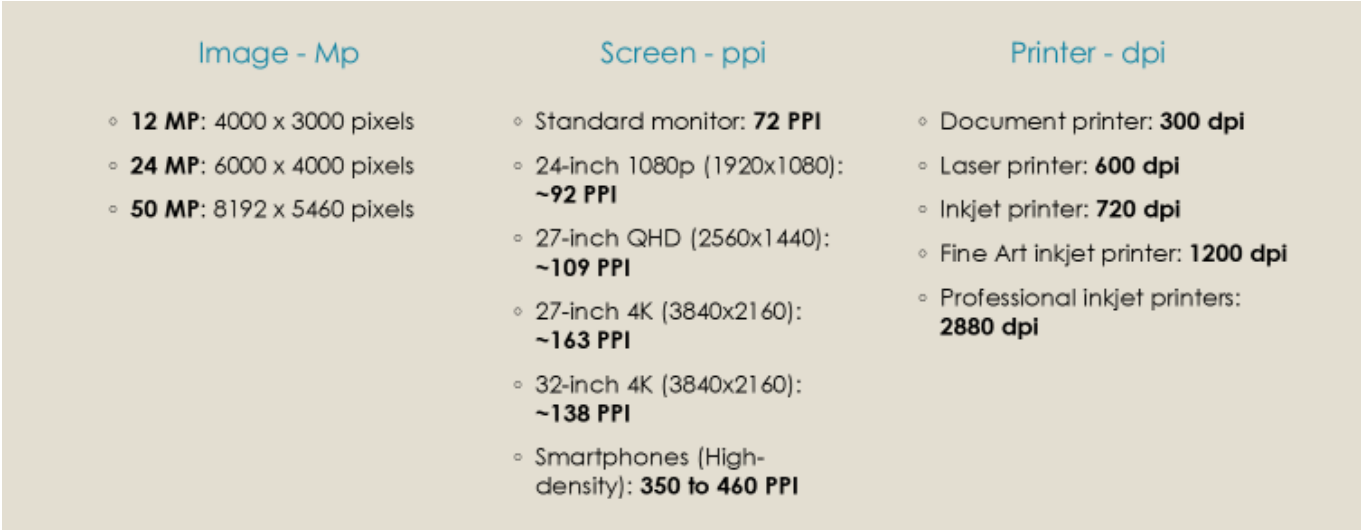
While the dpi of a printer affects how crisp and detailed the image can be displayed, it is the number of pixels in the source image that determines how large we can make an image appear before it breaks-down. A 600 pixel wide image will be sharp if only 2" wide (ie, 300ppi), but would be pixelated and blurry if printed 6" wide (having then only 100ppi).

The number of pixels we start with is determined by our camera's sensor. The number of pixels we have available to print is determined by the cropping and resizing we undertake during editing. How detailed we can print those pixels is determined by the dpi of the printer.

This can be confusing, because the term *resolution* is used for all three devices – camera, screen and printer. But they refer to different things – (examples below)

- The images you take with your camera have a certain number of pixels. That number is determined by the pixel density of your camera's sensor.
    - If you have an older camera, it might have 12 Mp resolution, even though it might be a Full Frame sensor.
    - Whereas others might have a smaller sensor, say APS-C, but have more megapixel (eg, 24 Mp).
    - Some might have a high-resolution Canon 5DS with 50.6 Mp.
- When you view your images on a screen, how detailed and how sharp the image appears depends on how many pixels the screen has in each inch.
    - It thus makes sense that screens with higher numbers of pixels per inch will show more detail (at the same viewing distance)
    - When you zoom in or out on an image, the computer uses an algorithm to map image pixels against screen pixels to give you the image size you want.
    - At a certain point though, trying to display too few image pixels for the screen's resolution will result in a "pixelated" (fuzzy) screen image.
- Printers, on the other hand, vary in how many micro-dots they can print per inch. The more ink dots per inch, the more detailed it can render the pixels of your image through its halftoning and dithering algorithms.
    - Printers can print any ppi you send it. If your image is more detailed than 300ppi, a low-resolution printer will most likely "throw away" pixels; but a high-resolution printer would create finer detail because it can print more finely.

***Note:*** *While it is appealing that "more = better", you will struggle to see the difference between an image printed at 300dpi and the same image printed at 1200dpi, even if the image is 600ppi or even 1200ppi. The eye cannot resolve that level of detail.*

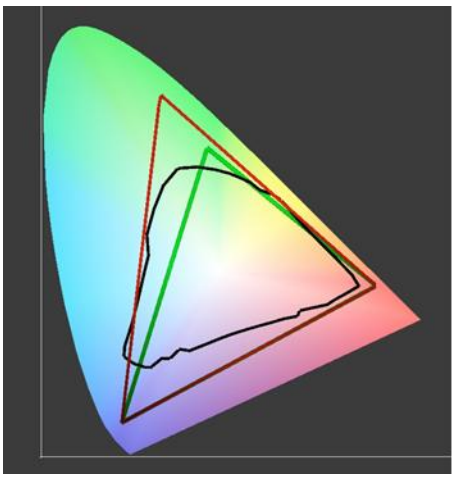


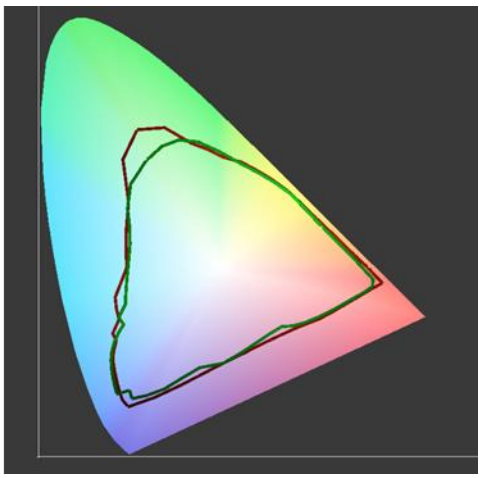
In addition to the level of physical detail in an image, measured as linear space, an additional aspect of resolution is how finely small differences in colour can be represented. This is called the **colour depth** of a monitor or printer.

As we saw earlier, mixing three base colours creates a wide variety of colours. Each colour is represented by a number. An 8-bit code, as used in JPEG files, can only represent 256 colours. A 16-bit code can represent 16m colours! Most modern computer screens can display 16.7 million different colors. For editing, a monitor that can display all these colours, using a colour-space that can accommodate this range of colour, with files that can store all these colours, is important. (Which is why editing in JPEG is limiting).

When it comes to printing,to properly translate the enormous variation of colour captured by raw files, particularly intense colours at the outer reaches of the visible colour spectrum, a printer needs **extended ink colours** – which is why professional-level printers use up to a dozen inks.

These graphs show the performance of two leading 12-ink printers.





In the left image, the red triangle is the range of colours in the AdobeRGB colour space. While the green triangle is that of the sRGB colour space. You can see that limiting yourself to sRGB restricts the colours you can both see on a screen as well as print with a printer. (If you send an sRGB image to one or other of these printers, you're not going to see all the shades of green (in particular) that were captured by your camera). The black line, in the image on the left, is the average boundary of these printers. As you can see, they can't print many of the greens and magenta-reds in a raw image; even though you will see them on an AdobeRGB compliant screen. (the image on the right shows how the two printer models differ in their colour depth)

This means that the image you edit on the screen, is likely to have colours that cannot be printed with the printer. These colours are called **out-of-gamut.** As you might expect, the printer doesn't just 'not print' these colours; nor does it just print the same colour for these shades that can't be represented. Rather, the printer uses an algorithm to adjust all colours so that colour differences simulate "the real world". But – this can cause problems: which is why soft-proofing is so valuable because we can catch these before sending the job to the printer.

Returning to physical resolution. *How many ppi, then, do you need to make a print?*

Well, … it depends. As you might expect, the detail we can resolve with our eyes depends on the viewing distance. So, the amount of detail we need in a print, for it to look acceptable, varies with the viewing distance. If you are printing photo books, you'll need to ensure your images have around 300 ppi. For prints displayed on wall, you can go a bit lower; though mostly its best to stick around 300 ppi.

# Adequate resolution

- 2 Megapixels (1200 x 1600 px): Best for 4 x 6 inch prints.
- 6 Megapixels (2000 x 3000 px): Best for 5 x 7 or 8 x 10 inch prints.
- 12 Megapixels (3000 x 4000 px): Best for up to 11 x 14 or 12 x 18 inch prints.
- 24 Megapixels (4000 x 6000 px): Best for up to 16 x 24 inch prints.
- 45+ Megapixels (6000 x 8000+ px): Best for massive 24 x 36 inch prints and beyond

What if you don't have enough pixels to give you the size print you require?

There are several options –

1. Lightroom offers **Super Resolution** in the Details panel that will double the size of your image (up to a point).
   Or you can use **Generative Upscale** for larger sizes (but uses credits).
2. Photoshop offers **Super Resolution** in the Camera Raw filter.
   Or, **Generative Upscale** for larger sizes (but again uses credits).
   Alternatively, you can use **Image Resampling** to upscale (non AI)
3. Programmes like Topaz **Gigapixel** and **Photo AI** will upscale your image to even larger sizes.

Lastly, a side-note …

When calculating the number of pixels you need to print at a certain size, it is considered best practice to match the **native print-head resolution**. This differs for Epson and Canon. Epson's native print resolution is 360ppi, while Canon's is 300ppi. Ie, if printing a 10x8 image on an Epson printer, you would size the image to 3600 pixels wide. But for printing on a Canon printer, you would size it to 3000 pixels wide. Does it really matter whether you use 360 or 300? Most people can't tell the difference! But there are some fine details that come out best following these guidelines.


360 ppi


300 ppi

# Photographic workflow for perfect prints

## Capture

- **File format** — RAW has advantages throughout the workflow
- **Colour space** — AdobeRGB colour space
- **Resolution** — use the whole sensor
- **Picture profile** — doesn't matter for RAW (affects the JPEG screen image)
  affects JPEG files
- **Colour temperature** — doesn't matter for RAW; AUTO mostly fine; select as needed
  affects JPEG files
- **Exposure** — avoid crushing shadows or blowing-out highlights
  adjust aperture, focus, ISO as needed (don't fear high ISO)

## Editing

- **Control the environment** — neutral colours, adequate light, eliminate reflections,
  avoid backlight, "cool-ish" light, keep the same
- **Software** — supports 16-bit workflow & soft-proofing
  ? Specialist RAW processing (DxO PureRAW 6)
- **Colour space** — ProPhotoRGB or AdobeRGB colour space
- **Colour cast** — correct colour casts
- **Calibration** — set Gamma (2.2) and White Point (D-65)
  profile the monitor
- **Soft-proof** — use the relevant ICC profile to soft-proof the image

## Printing

- **Paper** — Select paper purposefully
- **ICC profiles** — Install and use ICC profiles for the printer/paper
- **Resolution** — ensure the ppi is appropriate
  (generally 300 or 360 ppi; not less than 200 ppi)
- **Paper handling** — store in original box; keep print side up
  clean hands (or gloves)
  use the correct feed tray
  allow time to dry/de-gas
  keep flat; allow curled paper to lie flat
  roll prints with the printed side facing outward;
  protected by glassine paper
  use acid-free (archival) materials
- **Print file** — export JPEG, TIFF or PNG if using print service

# HOW TO …

Practical Steps involved in Printing

To finish-up, let's look at how to do some of the steps mentioned in the printing workflow …

## SET THE COLOUR SPACE

One of the steps mentioned earlier is that of setting the colour space of your editing software to the widest possible. Lightroom automatically uses the ProPhotoRGB colour space but you need to ensure it passes files to other editors (including Photoshop) using the ProPhotoRGB colour space. In Photoshop, the working colour space is a choice for each user.

The slide below describes the steps to set-up the ProPhotoRGB colour space in each application.

### Lightroom

- Lightroom automatically uses a large ProPhoto RGB variant (Melissa RGB) internally for all raw file processing in the Develop module
- To ensure ProPhoto is used when passing files to Photoshop or other applications, you must adjust your external editing preferences

1. Go to Edit > Preferences (Windows) or Lightroom Classic > Preferences (Mac).
2. Click the *External Editing* tab.
3. Locate the *Edit in Adobe Photoshop* section.
4. Change the Color Space dropdown menu to ProPhoto RGB.
5. Set the Bit Depth to 16-bit/component to preserve maximum color data

While in the External Editing tab, check that the *Presets* for Additional External Editors are all set-up to use ProPhoto and 16-bit editing. (most external editors, eg. Topaz, will be set-up this way)

### Photoshop

- Set-up Photoshop to use the ProPhoto RGB color space as your default working environment

1. Go to the top menu and select Edit > Color Settings.
2. Locate the Working Spaces section at the top of the window.
3. Click the RGB dropdown menu and choose ProPhoto RGB (or ROMM PP).
4. Under Color Management Policies, check the boxes for *Ask When Opening* and *Ask When Pasting* under profile mismatches.
5. Click OK to save your new default settings.

## CALIBRATE A MONITOR

If you have access to a colorimeter, it's an easy task to calibrate your monitor.

You will though, have to first install the calibration software that comes with the colorimeter, or download a free application like DisplayCAL - [DisplayCAL—Display Calibration and Characterization powered by ArgyllCMS]

**Preparation**

| | |
|---|---|
| **Warm up:** | Leave the display on for at least 30 minutes so colors stabilize |
| **Control the light:** | Block direct sunlight and stop room lights from changing; keep as for when editing |
| **Disable extras:** | Turn off night modes, auto-brightness, or energy savers on your computer and monitor |

**Calibration and Profiling**

- Plug the colorimeter device into a USB port
- Open the sensor software and mount the device flat against the center of the screen
- Set options for gamma (usually 2.2) and a standard white point (usually 6500K).
- Run the software to measure test patches, adjust values, and save a custom ICC color profile

## LOAD ICC PROFILES

Lightroom and Photoshop come with a number of pre-installed ICC profiles but they are very generic. Once you know what printer you will be using and the specific type of paper you will print on, you need to go to the paper manufacturer's website and download the specific ICC profile for that combination of printer and paper.

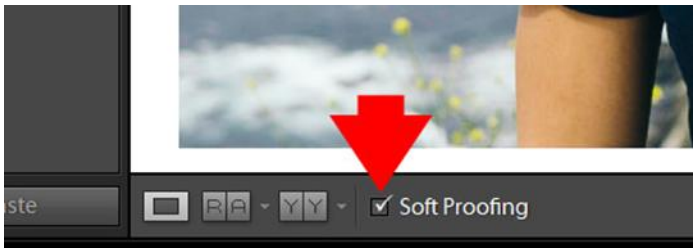
- This first step requires only a Google search for the manufacturer's website where ICC profiles are stored. eg, (for Ilford) "*Ilford ICC profile download*" will get you to the relevant page.
- On the download page, select your printer manufacturer, printer model and then look for the profile for the paper you are using. **Download** it.
- Once downloaded, extract the files from the Zip download
- Extract the files from the zipped download.
- Install the .ICC file –
    - for Windows: Right-click the .icc file and select **Install profile**
    - for Mac: Copy the file into the **Library/ColorSync/Profiles** folder
- The download will usually also contain a document detailing recommended printer driver settings (like media type and quality modes)

# SOFT-PROOF AN IMAGE

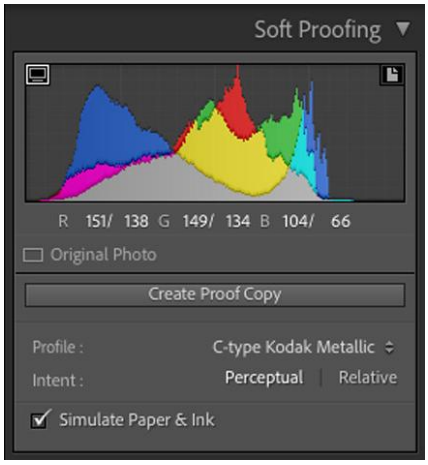
Soft-proofing is nothing more than a simple additional step after completing your edit of an image. Although slightly different in Lightroom and Photoshop, the end-result is a copy of your image modified so that when it prints, it will look close to the edits you see on the screen.

## *In Lightroom*

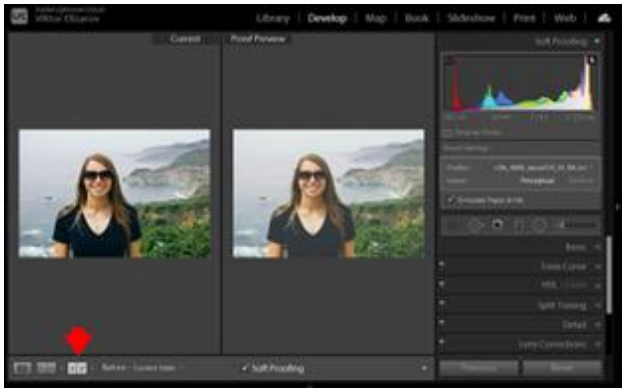
1. Open your photo in the **Develop** module
2. Turn on the **Soft Proofing checkbox** in the toolbar below the image (or press S).
   The check-box is at the bottom of the Develop window, next to the options for display mode.




3. Choose the profile for your specific paper and printer combination from the Profile dropdown menu (select *Other* to load downloaded ICC profiles).
4. Click **Create Proof Copy** on the right panel to make a virtual copy for your edits.
5. Set the **Intent** to *Relative Colorimetric* or *Perceptual* – as suits.
   Whichever looks best is the "right" one.
6. Check the **Simulate Paper & Ink** box to preview the dynamic range limits and paper whiteness.

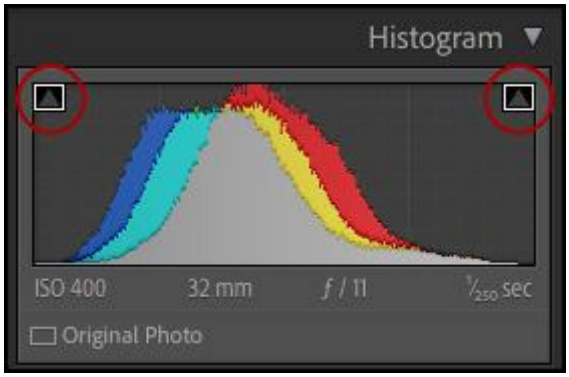



7. Activate the **Before and After** view
   This displays the edited image on the left and the Soft Proof virtual copy on the right where you will make the adjustments.



- Fine-tune exposure, contrast, or saturation on your proof copy so it closely mimics the appearance of the master image
  This is the difficult step – what changes to make that will bring the soft-proof copy closer to the edit you created
  Most likely, contrast and saturation will be the core issues.
  - Start by putting-in a slight S-curve in Curves
  - Possibly, adjust White and Black points to give more tonal separation.
  - Experiment with small changes to Vibrance and/or Saturation to lift the colours
  *NOTE: If printing on matt paper, the image will <u>never</u> have the dynamic range, contrast or vibrance of the edited image.*

8. Lastly, turn on the **Gamut Warning** icons in the top corners of the histogram to highlight colors that your printer cannot reproduce.
   Lightroom automatically shifts out-of-gamut colors into the printable range using your chosen rendering intent.
   You only need to edit the image if the preview looks harsh, or lacks detail in saturated areas.
   *REMEMBER: Even the best printer will not be able to print all colours your display can show. So, its nothing to fret about.*




*Dealing with out-of-gamut colours:*

Subtle clipping on minor highlights often looks fine in print. If the soft proof preview looks smooth and detailed (with the warning off), Lightroom will usually handle the adjustment well

*Make adjustments when:*

- Textures or gradients in the preview look blocky, muddy, or unnaturally flat
- Highly saturated neon or bright reds/blues lose their distinction

*Fix out-of-gamut areas by:*

- Using the HSL panel to dial back the specific color channel causing the warning
- Darkening bright saturated colors slightly to bring them back inside the printable color space

## *In Photoshop*

*For completeness, here are the instructions for soft-proofing in Photoshop. Because it's much more straight-forward in Lightroom, I recommend sticking with soft-proofing in Lightroom.*

1. Open your photo in Photoshop
2. With your image open, go to **Image > Duplicate**.
3. Name the new file with a distinct suffix like " - Proof Copy" and click **OK**.
4. Go to **Window > Arrange > 2-Up Vertical** to display both files side-by-side.
5. Click on your duplicate window and navigate to **View > Proof Setup > Custom**
6. In the window that opens, find **Device to Simulate** and choose your specific printer and paper ICC profile.
7. Leave **Preserve RGB Numbers** unchecked.
8. Choose a **Rendering Intent** that suits.
9. Check **Black Point Compensation** to keep shadow details.
10. Check **Simulate Paper Color** to mimic the paper's specific white base shade.
11. Click **OK** to save the setup.
12. Use adjustment layers (eg, Curves, Hue/Saturation) on the duplicate file to visually match it to your original master copy.

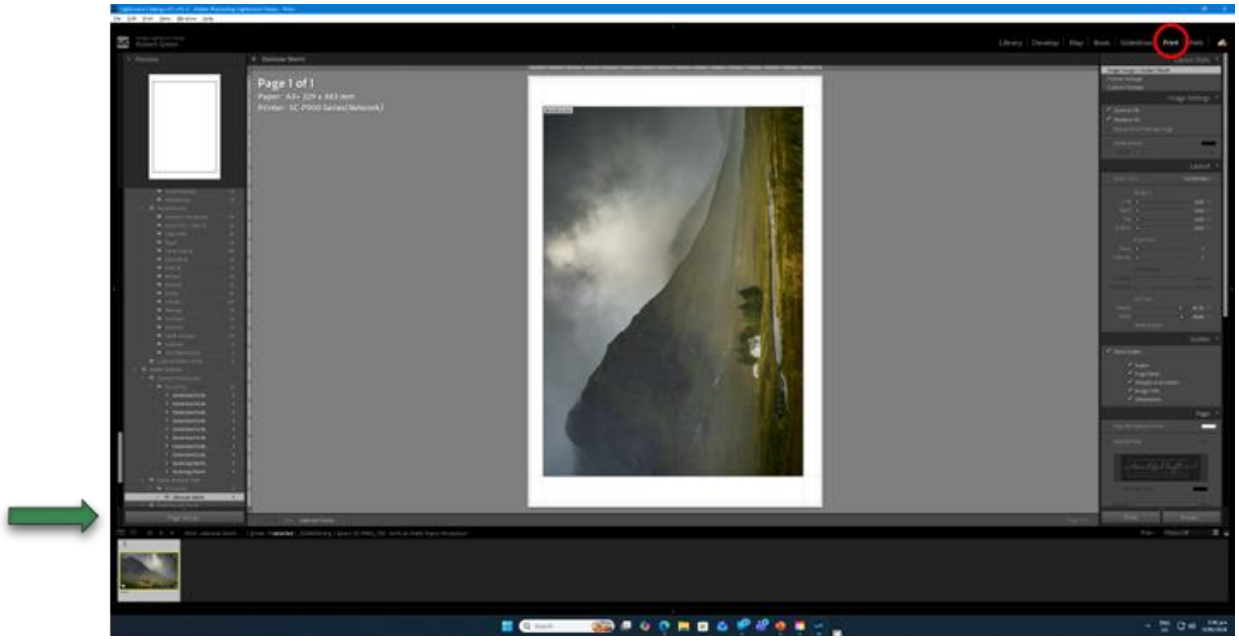

There are several ways to send a file to the printer. Lightroom provides a PRINT module to control all aspects of printing, so it is probably what most people will use. You can, of course, print from Photoshop. And both Canon and Epson provide specialist printing packages to simplify the process (though the way they do things is not always simple!)

*NOTE: These steps only apply if you are using your own printer, rather than sending a file to a print service.*

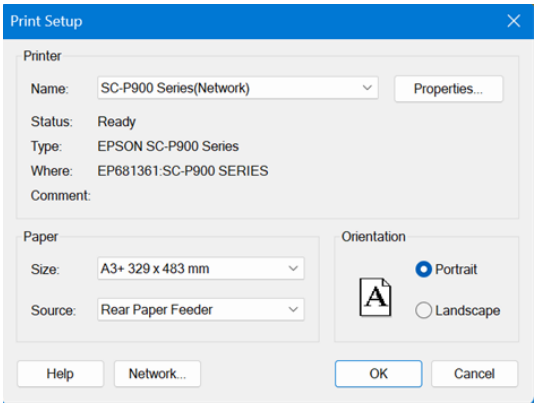
The Lightroom PRINT module allows you to control almost everything about printing from the one interface. It is accessed by clicking it's name in the list of modules at the top right of the Lightroom interface.

There are too many options for us to explore in this workshop. We'll focus just on the basic steps of printing an image. (For more information about the PRINT module, see Print module basics for Photoshop Lightroom Classic | Lightroom Classic)

Before selecting the PRINT module, have the image you want to print selected in the LIBRARY or DEVELOP module. Usually, this will be the virtual image version created in the soft-proofing process.

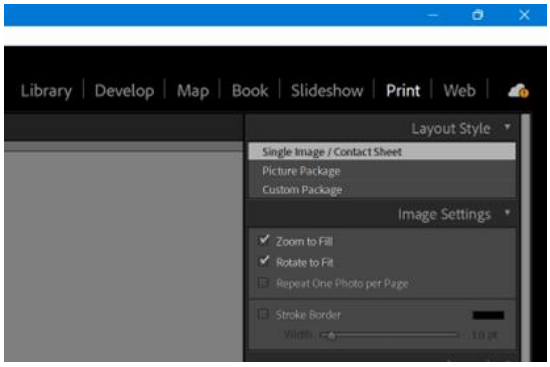


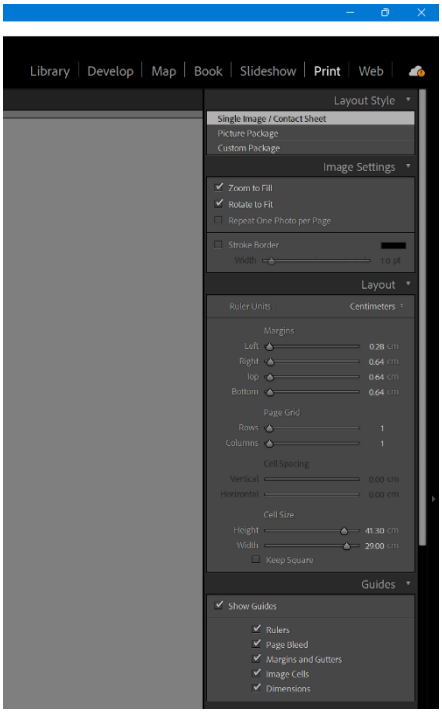
Firstly, click the button on the lower left of the screen to access the PAGE SETUP dialog box




This will open the Print Setup dialog box, you will tell the printer what size paper you are using and which feeder you will use. Any thickness up to 170gsm is generally fine through the rear feeder. But because paper loaded this way has to turn a corner, anything thicker is best loaded via the front feeder that keeps the paper flat. Also, indicate the orientation of the paper. *NOTE: this is not the orientation of the image. (In the image the image is a Landscape image but it is printed on the paper in a Portrait orientation.*

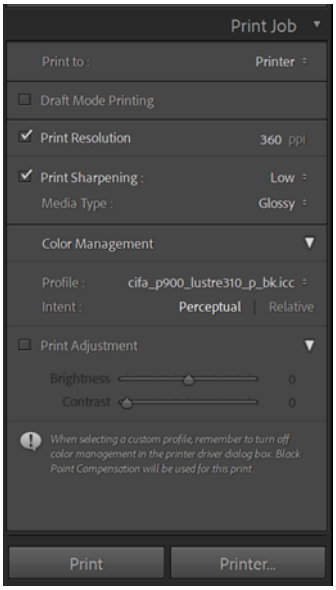
The panel on the right of the PRINT module screen has a number of sections to control various aspects of the print job. At the top of the panel on the right, you can pick a package of layouts to print several images on the one sheet, Mostly, as in the example above, select **Single Image/Contact Sheet**. Also check **Rotate to Fit** so that the image aligns with the shape of the paper (rather than prints across the page). (In the example, **Zoom to Fill** is selected so that the image exactly fills the matt dimensions of a specific frame. (If you don't want this automated cropping, just turn it off).




The next section, **Layout**, allows you to specify the width of the margins and the size of the image cell. These are, of course, linked. Changes to one affects the other. As, in this example, only one image is being printed, so there is only 1 row and 1 column. But this would change if you were printing several images on the same page.

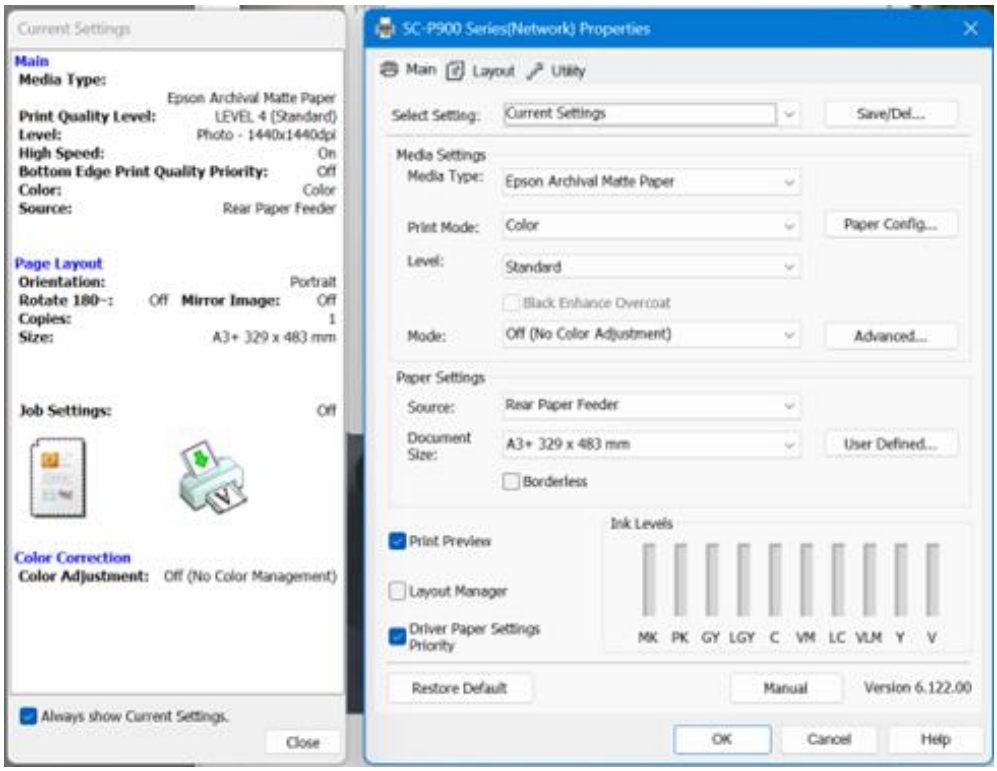
We'll skip the section on **Page** because this is for some advanced features.




The bottom section of the panel is where you specify some critical information. In the above example, printing is to an Epson printer, so resolution is set to 360 ppi. If you do your own sharpening, you might not want the printer to add much sharpening. *NOTE: Prints need a bit more sharpening than looks good on screen. Often, getting it how you want it and then allowing the printer to add a little bit more sharpening works well.*

It's also in this section where you tell the printer if the paper is glossy or matt – this affects how it lays down the ink. And you specify the same ICC profile as you used for the soft-proofing; and the same **Intent**. Because printing is to be controlled by the profile, don't put in any adjustment values.

To prepare for printing, click the **PRINTER** button at the bottom right of the screen, and then click the **Properties** button. This will bring you to a screen where you specify how the printer will manage itself. *NOTE: this will look slightly different for a Canon printer, and also if you are using the Mac environment.*




The first Dropbox allows you to select some specific options that might apply – eg, monochrome – if needed.

The **Media Type** Dropbox tells the printer what thickness to expect and whether Black Overlay ink is required. The documentation with the ICC profile will tell you what setting to use.

If a colour print, leave **Print Mode** as "Color".

Most printers will have an option to specify the quality level of the print job. For this Epson printer, it's possible to tell it to run faster by using bi-directional printing. Its quicker but print rows can be misaligned. (But I've never seen that). Or you can specify a higher density of printing. This uses more ink and takes longer. And generally, doesn't look that different (if at all!)

The most important option in this dialog is the **Mode**. Colour management must be **OFF**. This is because colour is managed by the profile. We don't want the printer putting its nose into the work.

The last settings come from the earlier dialog where we told the printer what paper and feeder we will be using.

If you have an option to see a **Print Preview**, I suggest selecting it. It gives you a "last chance" look at what will be printed where you can pick-up mistakes.

*NOTE: If your monitor displays the Adobe RGB gamut, be aware that the preview is an sRGB snapshot and so the colours won't look right on the monitor. But you can see if things are oriented correctly. If you do use the Print Preview option, you will have to click another **PRINT** button when it appears in order to start the job.*

If your printer is turned-on (as it should be), the ink levels will show here.

*(A word about inks: don't change them until the printer stops printing. The warning to change comes a long time before a cartridge is actually empty. And, there is all the ink in the tube to the print-head. When the cartridge actually stops flowing ink into the tube, printing will stop and you can change the cartridge. It is theoretically possible that stopping the print head mid task might create a very small discrepancy in the printed image. So far, no-one has seen this happen – at least with Epson printers)*

Lastly, ensure that the **Driver Paper Settings Priority** is checked because you want the printer driver you are controlling here to override any residual settings about paper, etc. stored in the printer from the last job.

The press **OK**.

The print job is now ready to print, so be sure to load the paper in the printer!

- Store paper in a cool, dark place, away from dust.
- Keep in its bag until required.
- Print surface UP.
- Handle with clean hands. Don't touch the print surface.
- Don't scuff the edges or crease the paper.

Then, back in the Lightroom PRINT module, click the **PRINT** button. (If using Print Preview, a dialog box will open; check the image looks correct and if so, click PRINT).


If you are not printing on your own printer, but are sending the image file to a print service, it's important to send them a file that contains all the information needed to produce the highest quality image. Before preparing he file, talk to the print service and check whether they need you to include a border or whether they will print the image with a border (and how wide you want the border to be). Keep the total size of the print to standard sizes to avoid extra charges – ie, A3, A3+, A2, A2+, etc.

## For exporting from Lightroom:

1. Select your image and click Export (Ctrl+Shift+E or Cmd+Shift+E).
2. Scroll to **File Settings**:

   Set **Image Format** to TIFF.

   Set **Compression** to None.

   Set **Color Space** to AdobeRGB (1998).

   Set **Bit Depth** to 16 bits/component.
3. Scroll to Image Sizing:

   Check **Resize to Fit** and select Dimensions.

   Input your exact target print size (e.g., 8x10 inches) and set **Resolution** to 300 pixels per inch.
4. Scroll to Output Sharpening:

   Uncheck this box, or set it to **Sharpen For**: *Matte Paper* or *Glossy Paper* (as suits) and choose **Amount**: Low.
5. Click **Export**.

## For exporting from Photoshop:

1. Go to **Image > Image Size** to set your physical dimensions:

   Ensure **Resample** is checked (use Preserve Details 2.0 if upscaling).

   Change units to Inches or Centimeters and input your exact print size.

   Set **Resolution** to 300 Pixels/Inch and click OK.
2. Go to **Image > Mode**:

   Ensure **RGB Color** is selected.

   Ensure **16 Bits/Channel** is checked.
3. Go to **File > Save As** (or **Save a Copy**):

Set the **Format** dropdown to TIFF.

Under Save Options, check the box for Embed Color Profile: Adobe RGB (1998). Click **Save**.

4. A TIFF Options window will pop up:

   Set **Image Compression** to NONE.

   Set **Pixel Order** to Interleaved.

   Leave everything else default and click **OK**.

# Further Information

*YouTube videos:*

**HOW TO PRINT - The ULTIMATE Guide to Achieving the PERFECT PRINT**
https://www.youtube.com/watch?v=IqOKWzLSKyg&list=PLpx5FA_OoaadT1oGNgpHa-mM66POt-eZu&index=14

**I Sucked at Printing Photos… Until I Tried This**
https://www.youtube.com/watch?v=UaG-Ik3dyAM&list=PLpx5FA_OoaadT1oGNgpHa-mM66POt-eZu&index=23

**Getting Started with Fine Art Printing—Full Guide**
https://www.youtube.com/watch?v=DsUEBnmETYo&list=PLpx5FA_OoaadT1oGNgpHa-mM66POt-eZu&index=40

**Soft Proofing In Lightroom**
https://www.youtube.com/watch?v=CPfuakd1x68

**ICC Profile Installation & Printer Settings In Lightroom**
https://www.youtube.com/watch?v=OisBJ2aldes

**Lightroom 5: Print the Perfect Image**
https://www.youtube.com/watch?v=1svDvqBwpPI&t=13s

*Resources:*

**First Man Photography Printing Masterclass**
https://firstmanphotography.com/series/printing/

**How to Print Photos: A Photographer's Guide**
https://www.naturettl.com/how-to-prepare-photos-for-print/

**Fotospeed's Art of Printing eBook**
https://fotospeed.com/ebook/artofprinting

**Start Printing Your Photos Today!**
https://medium.com/@AdamKarnacz/how-to-print-your-photos-304c8f2dd780

**Northlight Images Printing Resources** (very technical!)
Keith Cooper - top printing & paper reviews articles videos