SETTING UP YOUR COMPUTER

Color management

The need for color management starts to become obvious once you consider the number of devices that need to work together in an imaging system. The input might come from a digital camera, or perhaps a film scanner if our starting point is a negative or transparency, while a flatbed scanner would be needed for scanning in other artwork. Each has its own way of recording color as digital data.

TURNING TO OUTPUT devices, you may work on an image using an LCD or CRT screen whose colors differ, subtly or more, from the factory-defined specifications; someone may just have pressed the monitor's little buttons and the little shift to red went unnoticed. We're also dealing with light being emitted from the device. Equally two printers of the same model may remain within manufacturing tolerance yet output color different enough to be visible—and that's before we add to the mix the huge range of third party paper, even inks, which you might be using in your printer. Again, the printer has to process color data in its own way, and the final print will have its own color characteristics.

An imaging system almost inevitably includes a number of devices with differing technologies, different ways of assessing and managing color. So a Canon digital camera needs to sample the scene's colors and record them in red, green, and blue values, and in the format required by the camera's own operating system. The Epson inkjet printer also has its own proprietary operating system and ultimately needs to break down color information until it is able to send appropriate instructions to the ink nozzles. In other words, color is "device dependent."

Stuck in the middle of all these devices, somehow your computer needs to reconcile all this device dependant color. As if it wasn't challenging enough to carry the original scene's colors all the way through to the final print, the computer needs to deal with many permutations of input and output. The final image may consist of a digital photograph plus artwork that has been scanned or created in a drawing package such as Adobe Illustrator. As well as merging multiple inputs, the output may well be destined for multiple devices. You might want to print using more than one printer, or perhaps display it on an electronic picture frame, not to mention the web and PDF.

What is needed is a way to move the color information through the various devices in an accurate, predictable, and efficient way—a Color Management System. This can be broken down into two key requirements; the first of which is a color space that is device-independent—the "Working color space." The second is a way to accurately describe the color characteristics of each camera, printer, scanner, monitor, and so on—the ICC profiles. The third is a means of exploiting profiles so that each device's color information (the device-dependant color) can be translated through the system.

Many have already offered varies analogies for color management—that it's like a chain, or perhaps building blocks. Personally I prefer to think of it as stepping stones, all of which are necessary to place your foot on accurately to make it across.

You can shoot and store a picture on an Epson camera and output it onto an Epson printer using Epson inks and paper, yet such closed systems are better in theory than in practice.

Epson digital camera

P7000 portable hard drive

Outside the loop

Stepping away from the closed loop, there are even more opportunities for color confusion, If you have a camera from one manufacturer and a printer from another (not to mention a computer graphics card and a computer display somewhere along the line) then there are certain to be further difficulties.

Typical digital SLR

A scanner

Color spaces and gamuts

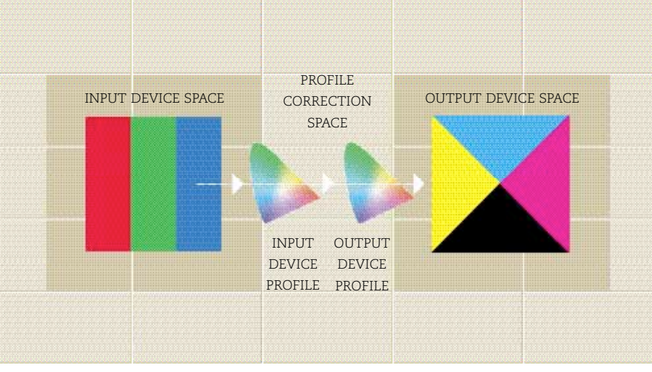
An ICC color profile is a file that describes a particular device's color characteristics and how it captures or outputs color values. They are often known as ICC profiles after the International Color Consortium (http://www.color.org/), the industry body that creates, promotes, and standardizes the vendor-neutral, cross-platform, color management architecture and components.

THERE ARE THREE main types of ICC profile: input, display, and output.

Input profiles are for input devices such as cameras or scanners, which capture color, the first step in the process. To produce an input device profile requires accurate information about the real color of the original object—this means the use of a reference target of known colors against which the capture's RGB values can be modeled. Profiles for scanners are common, as they are self-contained units with their own light sources, but it's less common to profile cameras because lighting conditions vary. The profile would only tell you what the camera's color characteristics are in those lighting conditions. Unless you can repeat them, for instance in a studio, camera profiles have little value.

Display profiles are for computer monitors or TV screens, while output profiles are for printers, from desktop inkjets to commercial offset and digital presses. As we will see on the following pages, these profiles are created by measuring the device's output—the monitor or the print—against known values. Monitor profiling has been a do-it-yourself task for a few years, while printer profiling is still on a twin track. Custom color profiles are available from vendors or remote profiling services, or you can make your own if you can justify the cost of the equipment needed.

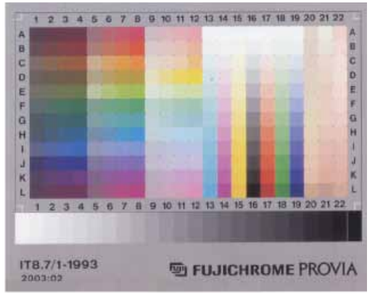
With each device having a profile, things take shape. Photoshop or other ICC-aware imaging software can control colors by reading any profile already embedded in the image. It can read the monitor profile and understand what colors you are seeing on screen. When you tell it you are going to print the image on your Epson 2880 using Premium Luster 260, the printer profile gives it the information to convert the image's color data into the instructions needed by the printer.



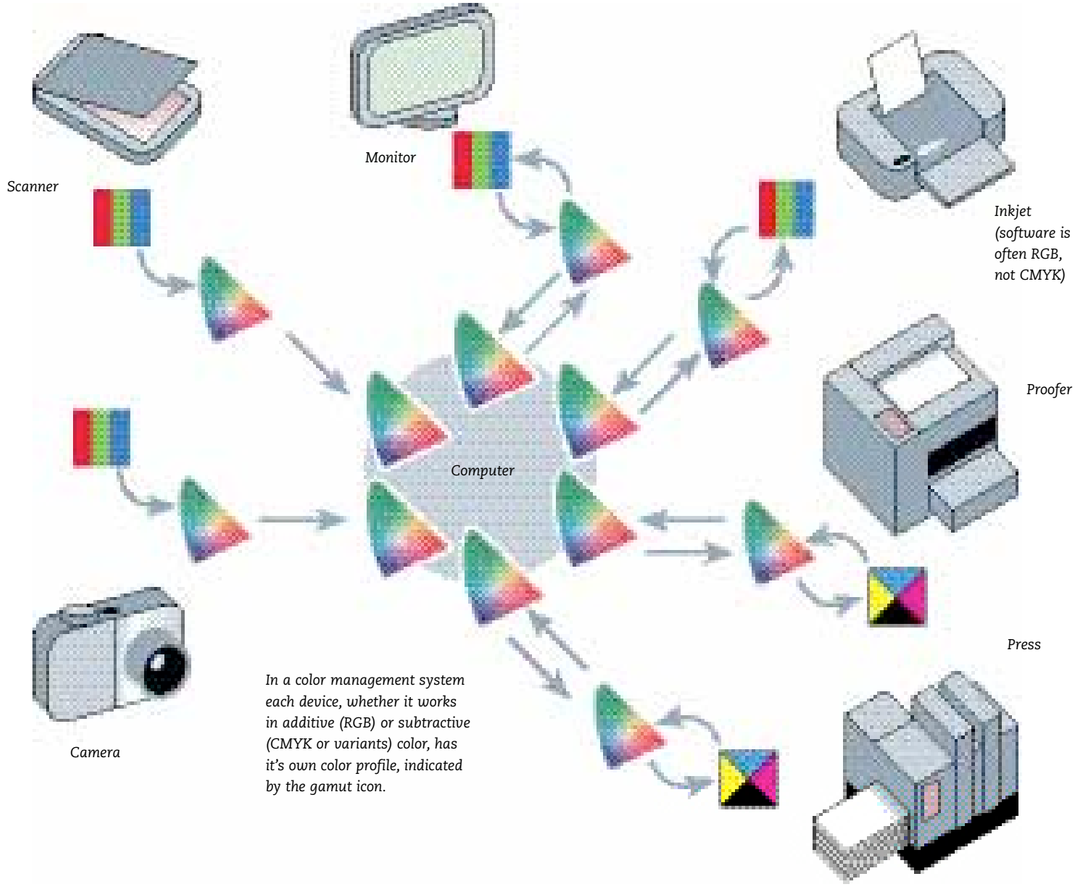
Color management is about taking color data from one device to another—from an RGB capture to an inkjet printer with any number of inks.

Management approach

Remember my stepping stones analogy? With color management you're jumping between irregular objects and can easily slip. But you can see where you're going and with a bit of care you can get there.



A color chart, printed so devices can be tested against its purity.

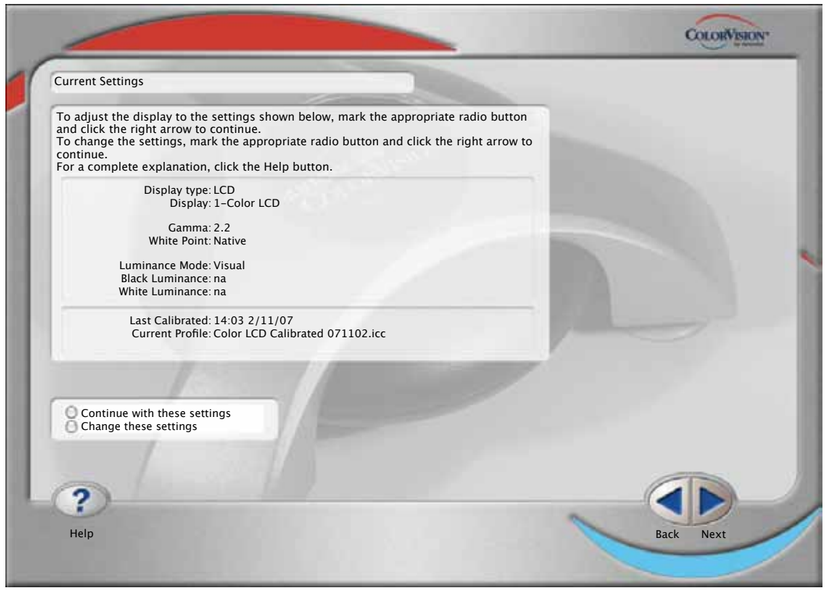


In a color management system each device, whether it works in additive (RGB) or subtractive (CMYK or variants) color, has it's own color profile, indicated by the gamut icon.

Monitor calibration

The single most important step in color management is calibrating your monitor. If the computer doesn't know how it is displaying the colors that you are seeing, it's going to have a hard job translating them into accurate instructions for the printer. Both the Mac and Windows operating systems now include color calibration utilities that allow you to calibrate the display with your own eyes, but for a more dependable scientific approach you really need to consider a colorimeter.

Monitor calibration devices like this one need to be rested against the screen. Once in place, the software will commence showing it a series of colors.



A screen from the ColorVision calibration software. As you can see, the device keeps you informed about the settings you're using.

Calibration

Serious photographers budget for devices such as the Eye-One Display from Gretag Macbeth, the Spyder, or the more recent ColorMunki. These combine a colorimeter with dedicated software. Whichever model you choose, the color consistency of your prints will show a marked improvement.

Before beginning calibration, allow the display to warm up. A screen's color characteristics are not always the same when it is cold, and it should be allowed to settle at its working temperature.

Another preparatory step is to disable any screen savers or energy management settings on the computer, because you don't want them to kick in while the colorimeter is doing its calibration work. It is equally important to keep the screen away from lamps or windows, and it's a good idea to switch off lights and perhaps close the blinds.

In general, all these devices give you a series of on-screen instructions, that need to be followed. Usually you are told to place the colorimeter on your monitor and then the software sends a series of test colors to the screen. The device measures how the monitor is outputting these colors and, after 5-10 minutes, creates a color profile.

Next steps

Most calibration devices automatically save the new monitor profile in the correct folder for Mac or Windows and also set it as the current profile. The next step is to use the profile in Photoshop or other imaging software. Your photos should already look more accurate on screen.

Post-calibration

After you have calibrated the monitor the first time, it's a process that should be repeated every so often. Each time you change the monitor's settings, you will probably remember to recalibrate, but you may not be aware if someone else alters the brightness when you are absent. The monitor's performance characteristics may also change over a period of time, or occasionally a color-managed program may suddenly start displaying weird colors—a sign of a corrupt monitor profile. To deal with such eventualities, some photographers recalibrate their monitors every month. You can ask your computer to remind you to do so. It's a quick job and soon becomes a habit.

Printer profiles

With your monitor calibrated, the color management chain is nearly complete. Your computer has the right information to assess the image's on-screen appearance, and it is ready to translate it into instructions to send on to your inkjet printer. It just needs to know a little bit more about the intended output. While the computer usually detects the printer model and the cartridges, printers aren't smart enough to establish what type of paper you are using, and in any case, both printer and ink may vary from factory settings. What it needs is a definition of the characteristics of your combination of printer, ink, and paper—a printer profile.

ESSENTIALLY YOU HAVE a couple of choices. One is to obtain printer profiles from Epson, a third party ink or paper vendor, or from a remote profiling service. The other is to build your own custom profiles.

Epson profiles

At first, it is sensible to keep things simple and stick to Epson inks and paper. The printer's setup disc will install Epson's ready-created profiles on your system, and updated profiles can also be found on Epson's support web site. These are usually a good starting point.

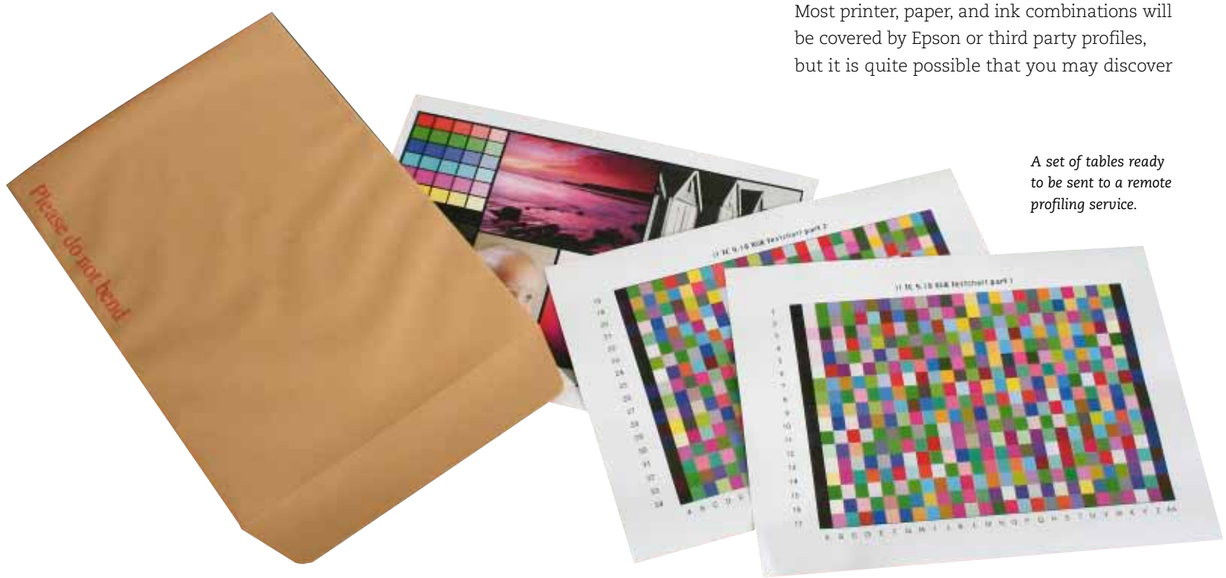
Third party papers and inks

Third party vendors obviously want to make using their papers and inks as easy as using Epson's own products, so the manufacturers or distributors usually supply printer profiles at no extra cost, typically as downloads. Again, these generic profiles are often all you need to start getting great results.

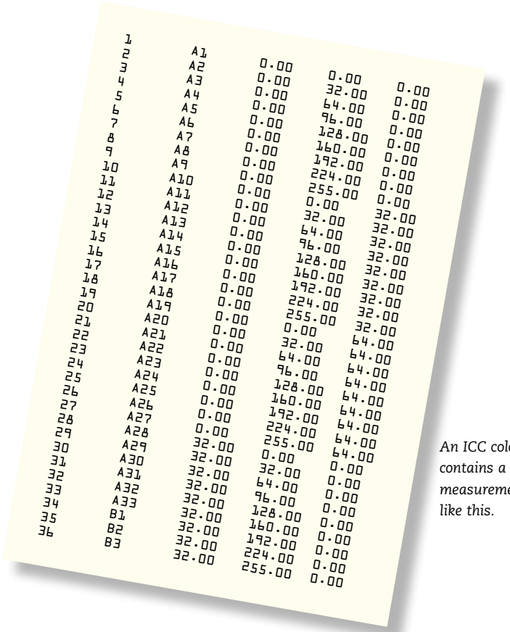
Custom profiling services

Most printer, paper, and ink combinations will be covered by Epson or third party profiles, but it is quite possible that you may discover an exception, or perhaps be dissatisfied with a supplied profile's results. One course of action is to buy your own spectrometer (see "Colorimeter profiling" on page 66) and make your own printer profiles. Often, however, a more economical solution is to find a remote profiling service, which will create a profile just for you.

The process is quick and simple. Some third party paper or ink suppliers offer custom profiles for free, or you can consult a professional printing and color management specialist. In each case, you are generally given instructions and a target file that you put through your printer with the ink and paper combination that you want to profile. You then mail the print to the vendor or profiler, and they use a high quality spectrometer to create a unique ICC profile for your printing environment. This is normally emailed back to you with installation instructions.



A set of tables ready to be sent to a remote profiling service.



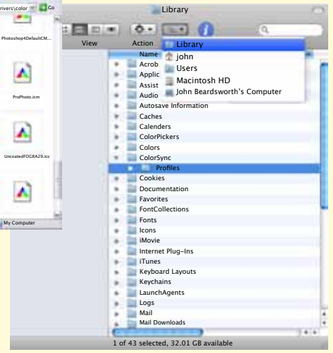
An ICC color profile contains a series of measurement tables like this.

Where to install printer profiles

Mac OSX - HD › User › Library › ColorSync › Profiles

Windows XP and Vista - C:/windows/system32/spool/driver/color

On Windows XP and Vista, monitor and printer profiles go in C:/windows/system32/spool/driver/color.



On the Macintosh, the profiles are installed into the Library, within the Profiles folder of the ColorSync area.

On Windows or Mac computers you can get information about any profile by simply right clicking it (if you're using a one button mouse with a Mac, Ctrl-click). This is a paper profile supplied by the paper supplier Permajet for one of its inkjet papers.

Colorimeter profiling

Making your own printer profile is not difficult, but until recently the cost has been a big deterrent. While a monitor calibration device can cost less than a hard drive, the equipment for creating your own printer profiles has cost four or five times as much. However, the success of the ColorMunki, a dual device combining monitor and printer profiling, has been as much due to its lower price as to its features, and this seems to indicate that printer profiling will soon become almost as common as monitor calibration—which will be no bad thing.

This spectrophotometer is a dual purpose device for monitor and printer profiling. It measures the full visible spectrum of light reflected from color prints or screens.

A WIDE RANGE of products is available from color management specialists like Color Confidence, who make the ColorMunki, Gretag-Macbeth, Pantone, or Chromix. Some products are very expensive, partly because they are pitched at press and other commercial-scale printing environments, but even those suitable to home or small office inkjet printers will set you back enough to merit a cost-benefit comparison.

Unfortunately, before making the investment, such an analysis can only be approximate. You may be able, for instance, to cost the time you save getting prints that match your quality standards, and paper and ink wastage may well come down dramatically, especially if you use a variety of third party paper and ink combinations. Yet precise numbers, if ever possible or truly accurate, will only be available in retrospect, and in any case it can be difficult to place a value on greater dependability of output. How do you ever evaluate the psychological benefits of printing becoming a more reliable experience? All one can say is that you need to go through this thought process for yourself and for your individual circumstances. While making your own printer profiles can, for some, amount to a question of whether you can afford it, others would ask how a professional setup can afford not to do so?

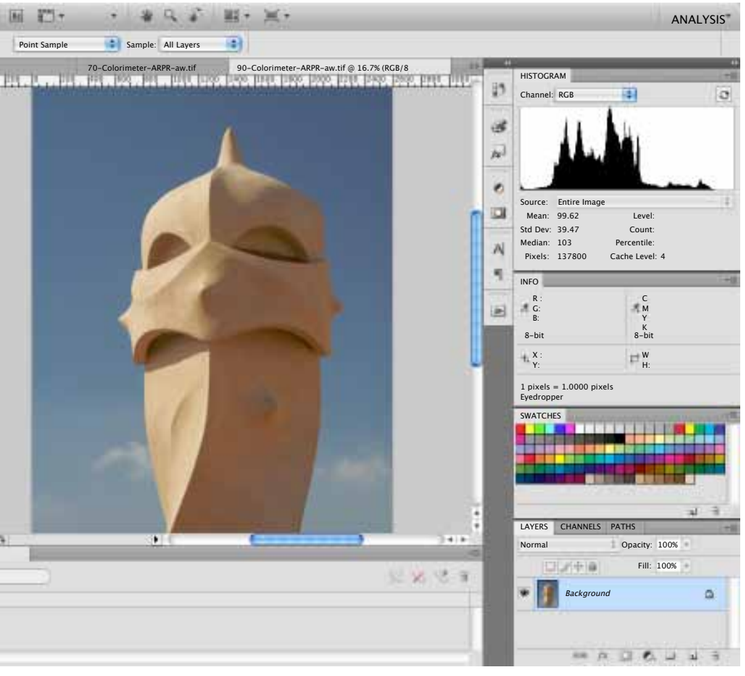
While individual profiling products differ in many ways, in general they all come with hardware devices and supporting software for both Mac OS and Windows. You are then guided through the process with on-screen instructions, and this usually means printing a sample page using your chosen combination of printer, ink, and paper.

Often a specially-defined grid of colored cells or tiles, you allow the sheet 10-15 minutes' drying time and then follow the instructions and roll the spectrophotometer over each row in turn. Sometimes a further sample page is needed, so the device can measure other hues. As soon as that's done, the software generates the printer profile and places it in the correct folder for your operating system.

Photoshop color settings

Now we turn to setting up your image editing software for a color-managed workflow. With your monitor properly calibrated, and printer profiles representing possible combinations of printer, ink, and paper, your computer now has the key information about the hardware you're using. Image editing software can get the monitor's profile from the operating system, and translate the on-screen image into a print. It just needs you to choose a printer profile and tell it which printer, ink, and paper you're using.

PHOTOSHOP



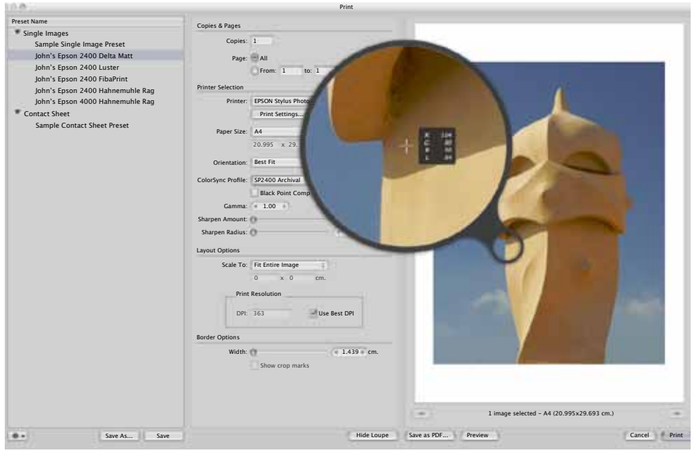
NOT SO LONG ago, a book such as this would have shown Adobe Photoshop's color management and only mentioned other image editing programs in passing. But Photoshop's status as most photographers' main printing application has been challenged—or rather complemented—by Adobe's own Lightroom and Apple's Aperture. I say "complemented" because many photographers do more complex image editing in Photoshop but use Lightroom or Aperture to manage their pictures. If you do manage images with these programs it makes sense to print directly from them when you need another copy of an image.

Whichever program you are using, it's important to understand where its color management settings are and how to use them. So we will look first at Photoshop which—given it's broader user base and legacy—has many more options, and then we'll examine the more streamlined color management features of Lightroom and Aperture.

Photoshop's color settings

Under Photoshop's Edit menu is the Color Settings command. This very important dialog box is where you set the working color space—the profile Photoshop will use to manage color—and in particular the Working RGB (the theoretical color space that you are using while editing). You need to choose a setting that provides the best image quality for inkjet printing. It is also where you decide how Photoshop should handle any differences between your chosen color space and whatever profile may already be embedded in an image.

The Color Settings dialog box caters to Photoshop's very wide range of users, not just inkjet photo printers. Web designers often work in the sRGB color space, while commercial press operations focus more on CMYK settings—to mention just two groups of users. So rather than explaining all Photoshop's settings, the following pages will concentrate on getting the color settings right for inkjet photo printing.



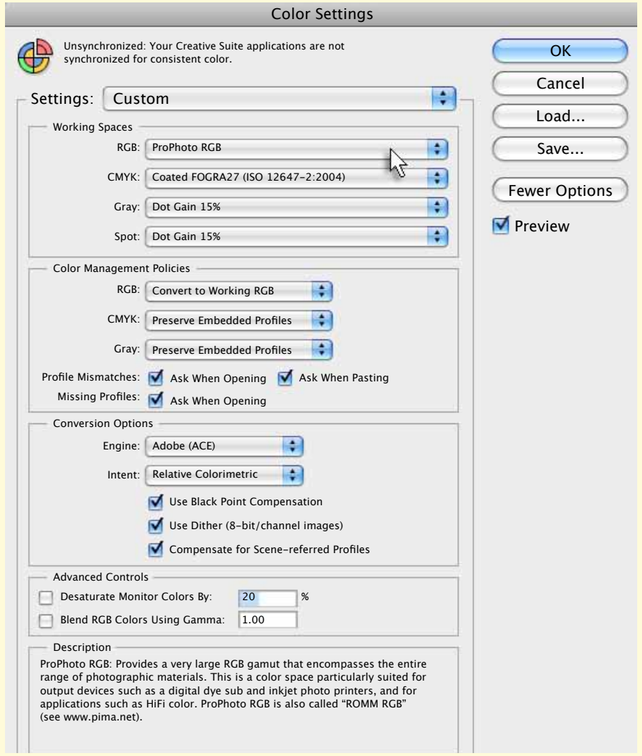
APERTURE

Settings

Depending on your location, the default setting is either North America General Purpose 2 or Europe General Purpose 2. For inkjet printing it's better to change this to US or Europe Prepress Defaults, but that is only a starting point.

Adobe Photoshop, Adobe Lightroom, and Apple's Aperture are three of the most popular choices for editing and printing photographs, with the latter two handling image management too.

LIGHTROOM



Working Spaces

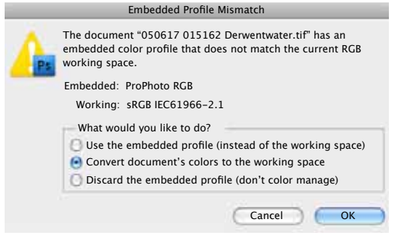
Working Spaces is a key group of settings, and you have separate drop-down boxes for RGB, CMYK, Grayscale, and Spot. These correspond to the color modes used in Photoshop's *Image › Mode* menu. We only really need to set the RGB color setting:

• **Adobe RGB** is a general purpose color space and has a wide gamut (range of colors). It may appear the obvious choice, but it's not really the best.

• **sRGB** This is a very common color space because of its use for the web and for JPEGs. It also has the narrowest gamut of color, so you shouldn't choose it if you want the best print quality.

Notice the Description area at the bottom of the Color Settings dialog. As you move the mouse over drop-down menus and other parts of the dialog there's a short, but often helpful, explanation of the settings. Here the More Options button in the top-right group is selected.

• **ProPhotoRGB** is another, more modern general purpose color space, and it has the widest gamut of colors. For this reason it's now generally acknowledged as the best color space to choose for inkjet photo printing. Unless you have a specific reason to the contrary, choose ProPhotoRGB.



Photoshop detects when an image's embedded profile doesn't match your chosen color space.

Color Management Policies

Color Management Policies comes next and this is where you tell Photoshop how it should deal with any clash between its settings and those that may already be embedded in an image. Perhaps you have files "tagged" with different profiles, before you started a color-managed workflow, or a picture may have come from another computer with different color settings.

For example, imagine Color Settings shows the Working RGB is set to the sRGB. What should Photoshop do if you then open an image whose profile was the much wider ProPhotoRGB working space? Should it convert the colors to sRGB? Equally, consider a second case where Photoshop has been set to work in ProPhotoRGB and the image is a JPEG straight from the camera and tagged as the narrow sRGB. Should Photoshop convert the image data to the wider working space, or works with it as it is?

The drop-down box's choices are quite straightforward:

• Off
• Convert to Working RGB
• Preserve Embedded Profiles

Off turns off color management for new Photoshop documents and for files whose profile differs from the Photoshop's working space. It's not a good choice if you are trying to establish a color-managed workflow.

Convert to Working RGB assumes that the working RGB should take priority over any profile that may already be in the image. In the first example above, this choice would convert my wide gamut ProPhotoRGB file into the narrower gamut sRGB. That might suit someone producing images for a internet site, because sRGB is the lowest common denominator, which ensures that images look OK in whatever browser is being used to view them. For the inkjet printer, however, the conversion would effectively discard a lot of subtle colors and image quality. So it's not the ideal choice.

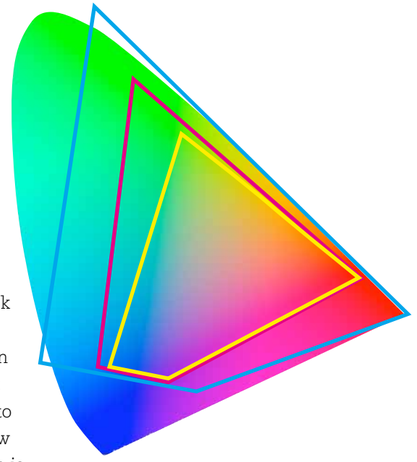
But, in the second case, where Photoshop is set to ProPhotoRGB, converting an sRGB-tagged JPEG to the wider gamut Working RGB would not do the image any harm and would potentially allow you to do more work on it without posterization or other damage. If you are routinely working with JPEGs or images with a narrower profile than ProPhotoRGB, the choice of Convert to Working RGB may be appropriate.

Preserve Embedded Profiles means that Photoshop respects any profile embedded in the image. When you open an image whose profile differs from the Working RGB, Photoshop does not convert the colors but leaves things how they are.

So the ProPhotoRGB image would be opened as ProPhotoRGB, even if Photoshop's Working RGB were sRGB. Equally, the JPEG is opened as an sRGB image and not converted to the wider gamut Working RGB.

While this seems a somewhat passive approach, it's actually the choice that leaves you the most flexibility, does no damage, and doesn't stop you changing the color space afterwards. That is why, on balance, it is the best choice here.

Also in Color Management Policies is a small group of check boxes called Color Mismatches. These settings are less critical in terms of getting color right, but are valuable as they allow you to balance smoothness of workflow against knowing how Photoshop is handling mismatches.



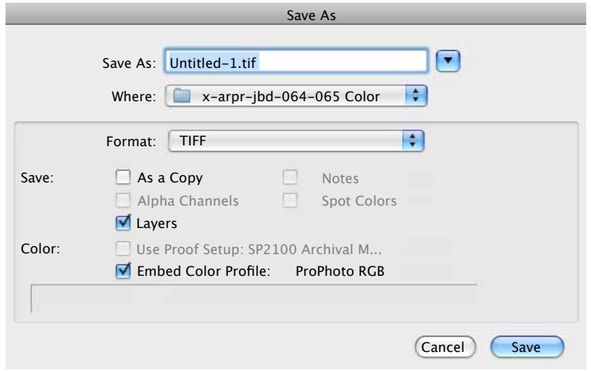
This gamut comparison shows the ProPhotoRGB space in cyan, the sRGB space in magenta and the Adobe RGB space in yellow.

Essentially the check boxes tell Photoshop whether to prompt you for a decision when you open a file whose profile differs from Photoshop's Working RGB.

When you're first getting used to a color-managed workflow, it can be a good idea to leave all these settings checked. Each time Photoshop finds a mismatch, it will ask you what to do—use the embedded profile, convert it to the Working RGB, or switch off color management. The great thing is that it forces you to go through the thought process each time.

However, it can be tiresome if Photoshop has already been set to respect any embedded profiles. Also, after a short while, you'll be confident of what Photoshop is doing. So once you reach that point, uncheck them.

There is a serious risk of a clash between printer and printer-software managing the colors and Photoshop trying to do so. As the reminder shows here, only one device should do so at at time.

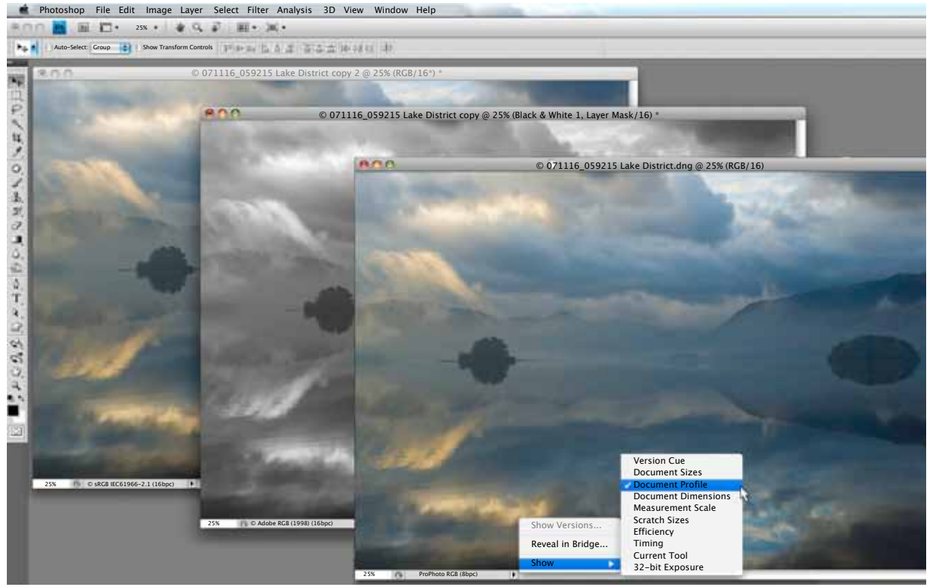


Saving Files

One important concept is that Photoshop has document-specific color settings. The Working Space chosen in the Color Settings dialog is for Photoshop's overall environment. It will be used for:

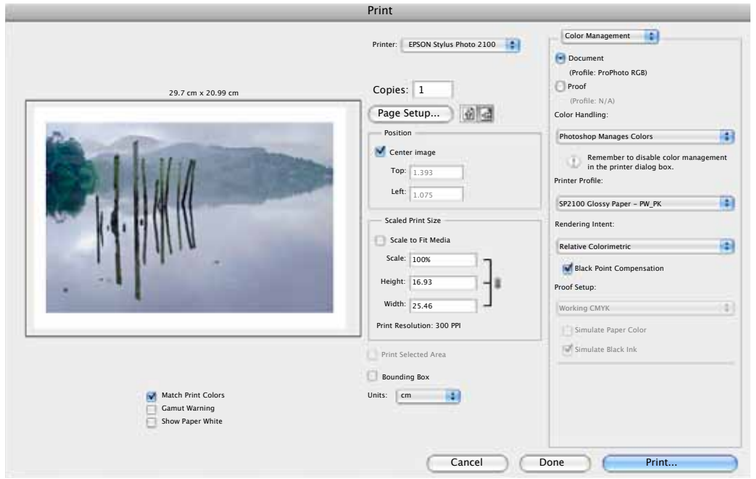
- New documents
- Existing images with no embedded ICC profile
- Imported untagged images such as those from digital cameras.

When you save a file, the color space is embedded inside it.



Here one image is ProPhotoRGB, another Adobe RGB (a mono one, at that) and another uses sRGB—this is document-specific color at work; all three can be open at once.

Document specific color means that each individual file has its own ICC profile embedded within the document. While Photoshop itself has an overall color space, it can have open a number of images, each using its own color settings.



Photoshop's File > Print dialog box is where all the color management work comes together. The preview can be in soft proofing mode, via the Match Print Colors check box, and other settings control print scaling and color handling.

Printing

The *File > Print* dialog box is another critically-important area of color management in Photoshop. This is where everything comes together—the calibration of our screen, the printer profiles that describe the characteristics of the printer, ink, and paper that you are using, not to mention the original image's aesthetic quality and post processing work.

Assuming you have got everything right so far, this is about the last point where it's possible to take a wrong turn.

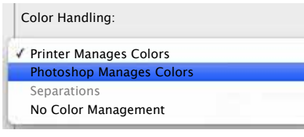
Fortunately, a lot of work has gone into making the choices as obvious as possible, and—since Photoshop CS3—the Print Preview dialog box has been color managed and even has soft-proofing built-in.

The color management section is on the right-hand side of the window where there is a drop-down box with two choices. One is Output, but for now choose Color Management, and you get a number of settings which, not surprisingly, are best understood by working from top to bottom.

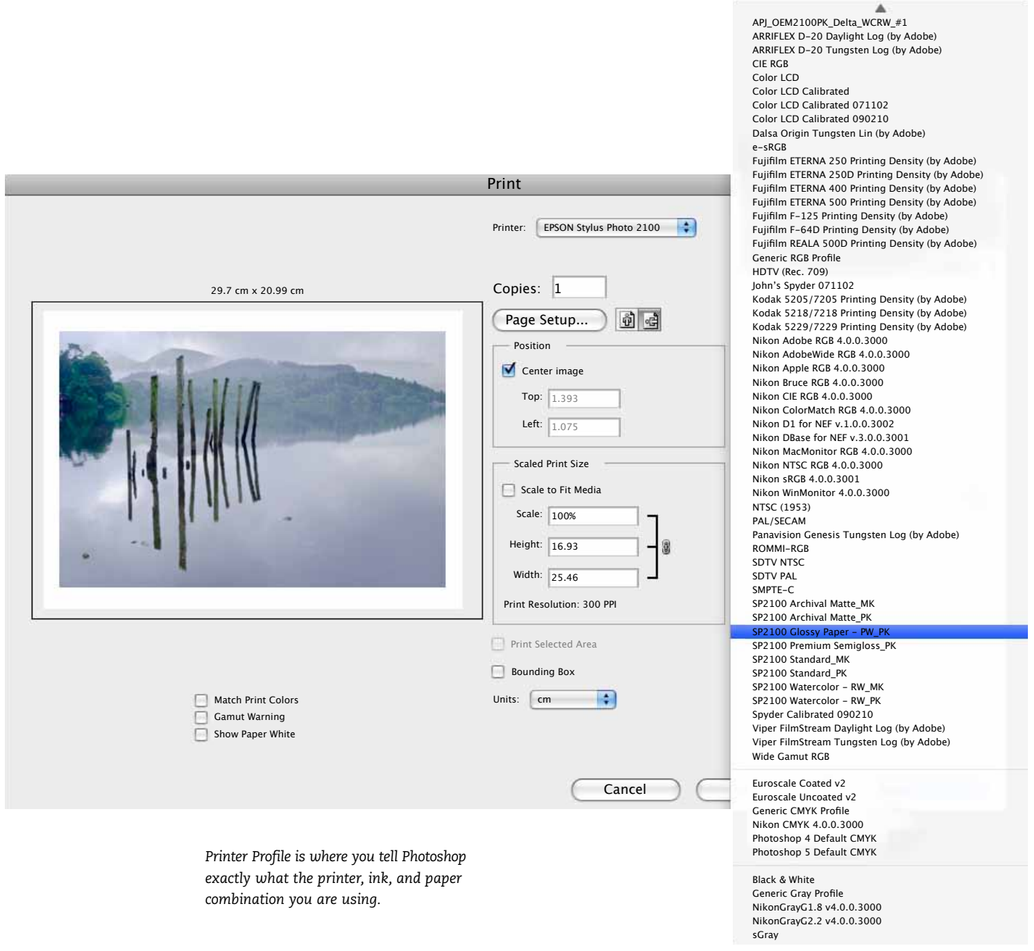
By default, Photoshop assumes we want to print using the image or "document" profile. The next setting, Color Handling, is much more critical and gives us four choices:

- **Printer Manages Colors** Photoshop lets the printer convert colors from the document to the printer's internal color space. Choose this option when you don't have profiles for your printer, paper, and ink combination.
- **Photoshop Manages Colors** Photoshop converts the colors and sends them to the printer. This is the choice you must use when you are printing profile tests.
- **Separations** is for printing CMYK separated colors, unimportant here.
- **No Color Management** is not recommended when printing pictures.

The first two are the important ones for our needs, so let's look at each in turn.



The Color Handling drop-down box lets you decide whether Photoshop or the printer should manage the colors.



Printer Profile is where you tell Photoshop exactly what the printer, ink, and paper combination you are using.

Photoshop Manages Colors

For our purposes, the most likely choice is Photoshop Manages Colors. Also known as application color management, this method is designed for the color-managed workflow where the user wants complete control of how document colors are rendered. Photoshop converts the colors and sends the instructions to the printer driver.

Notice that choosing Photoshop Manages Colors immediately makes available the Printer Profile drop-down box. This is because Photoshop Manages Colors means that you are telling Photoshop to convert the image colors and to do so using the profile selected in the Printer Profile drop-down box.

Remember I mentioned wrong turns? Well, one is here. It is very easy—even for experienced inkjet printer users—to overlook that the Printer Profile drop-down box defaults to the current Working RGB. At this point Photoshop has no real idea what paper the printer is using. Almost always, the Printer Profile needs to be changed to the profile that represents the printer, paper, and ink combination you are using. Even if you haven't changed anything, always review the Printer Profile setting before you click the Print button.

Once a printer profile is selected, both Rendering Intent and Black Point Compensation (BPC) are activated. Generally you'll want to use Perceptual or Relative Colorimetric and have BPC checked. It's worth noting that with many of the newer models from Epson it is probable that choosing Relative Colorimetric will produce the more pleasing prints.

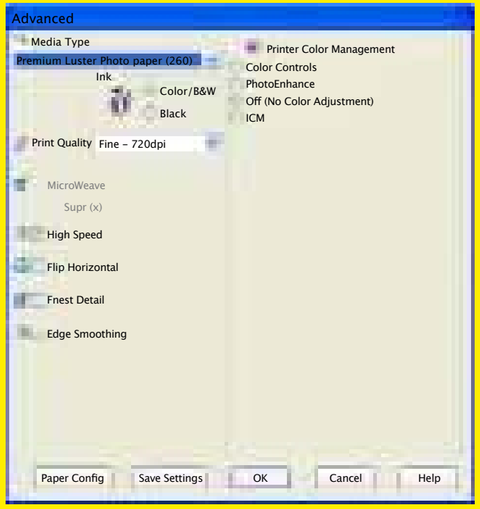
Printer Manages Colors

The other important Color Handling choice to try is Printer Manages Colors. This makes Photoshop leave the document color management entirely to the printer driver, so Photoshop does not convert the document colors or pay attention to whatever paper and ink settings may be in the printer driver. The document is sent directly to the printer driver with tags on how to convert its colors, but it is the printer driver that attempts to obtain accurate print color.

Experienced inkjet printer users who have their own print profiling equipment are often able to get better results by creating their own print profiles for Epson papers. So they, like authors of Photoshop books and tutorials, tend to prefer the Photoshop Manages Colors route.

Too many cooks spoil the broth

Another very important point is that the printer's own color management must be switched off in the printer driver. You don't want the printer fighting Photoshop.



When Photoshop's managing the colors, switch OFF the printer driver's color management.

However, Printer Manages Colors is certainly worth trying. You would usually choose it in two circumstances:

- You are using Epson paper and Epson ink and get good results.
- If you don't have a profile for the printer, ink, and paper combination.

While Epson's own profiles can be bettered, it's clearly in Epson's interests to support its printers with profiles that let the user get the most out of Epson papers and inks. So Epson continues to improve the accuracy of its supplied profiles and drivers, and updates are available on Epson's web site (www.epson.com). Printer Manages Colors can produce great results.

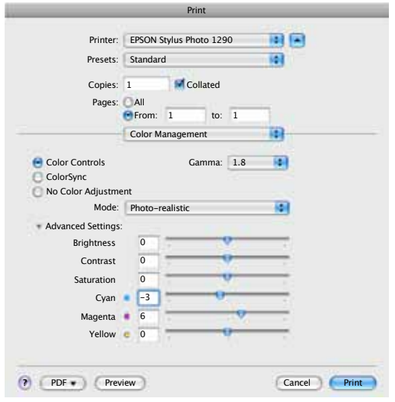
Sometimes you don't have a profile for a third party paper, and pretending it is another paper hasn't produced results quite as beautiful as you had hoped. In this case Printer Manages Colors allows you to access the printer driver and, using an existing Epson paper as a starting point, adjust how the printer outputs colors.

Getting into the printer driver is a bit awkward and varies a little depending on software version and operating system. On Windows the easiest way is to click the Page Setup button in Photoshop's *File > Print* dialog. That should take you to your printer's properties dialog box, which is actually the driver. Enter Custom mode, and click the Advanced button.

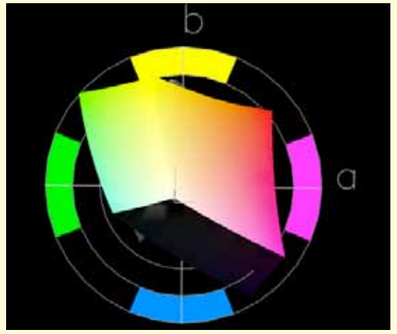
Under Color Management, the No Color Adjustment option should not be set—doing so would turn off the printer driver's color handling and is exactly the opposite of what Printer Manages Colors is supposed to do. Instead, choose Color Controls.

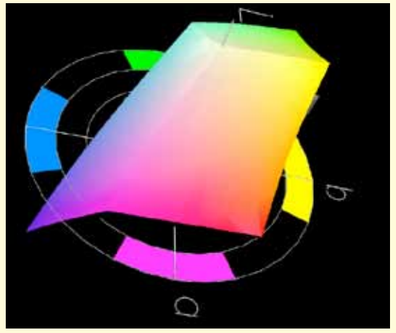
On a Mac, I find the easiest way is to click the Print button in Photoshop's *File > Print* dialog. Choose Color Management from the drop-down box, click the little triangle next to Advanced, and the dialog box reveals a series of sliders.

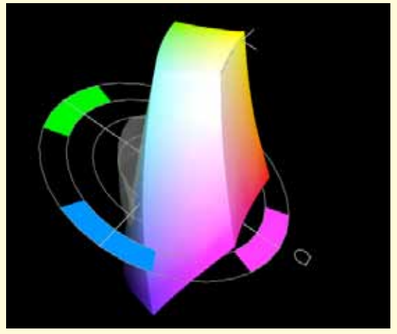
Both Windows and Mac users can then adjust these sliders to tweak the color output and run a test print. If your eyes tell you that your paper needs less magenta or more green, drag the corresponding slider and then run another a test print. You're moving boldly into the realm of guesswork and experimentation.

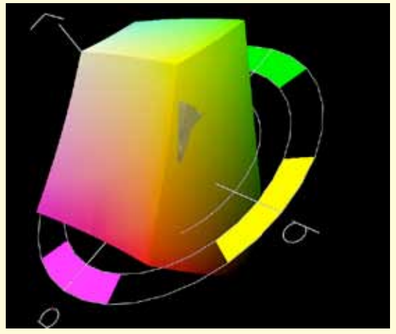


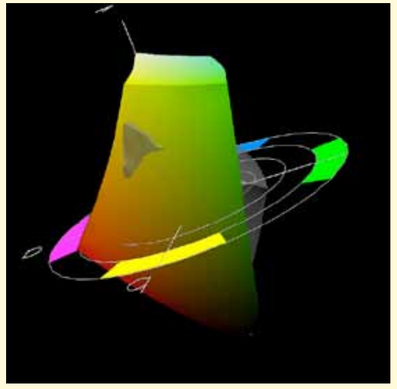
Epson's printer driver lets you start from a supplied paper profile and tweak the color output. On Windows the printer driver looks different, but has similar controls.











Visualizing Color spaces

Because the scientific L*a*b color system used to describe color spaces has three axes, it can be hard to visualize. In this book there are traditional illustrations (see page 71) since these clearly indicate the scope of different spaces, but to get the full picture you will need to use a program like ProfileEditor, which can produce 2D and 3D comparisons of color spaces. You can move the view in three dimensions by dragging with your mouse, and the free demo mode will allow you to try the experience (www.xrite.com).

Rendering intent

While a color management system can accurately describe input and output device's color reproduction, that isn't the whole story. The reason these systems exist is because every device is different and one cannot display the same range of colors as another. In digital printing, the issue is that the printer's gamut—even that of modern multi-ink printers—is generally significantly narrower than an RGB monitor. There are a number of options when compensating for this.

THESE OPTIONS ARE known as the "Rendering intent," a concept encountered on page 75, and they allow you to specify whether your computer should attempt to compensate for the printer's gamut automatically, or simply print the colors that work as best it can and ignore the fact that some fall out of gamut.

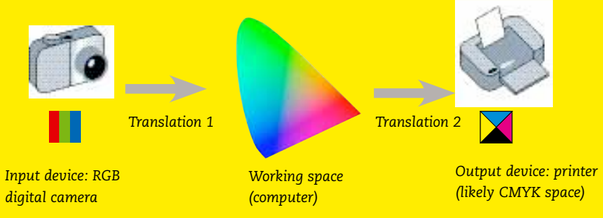
Rendering intent, however, can also be part of the color workflow when you import your pictures from your camera or other device to your computer, especially if you have them set up in different color spaces. You can set Photoshop's default rendering intent in the Color Preferences dialog introduced on page 70, the same dialog where you set up your working profile.

As you might imagine, the best results when printing photographs are achieved by using a rendering intent designed to achieve continuous graduation of tones in the resulting prints. This is what the Perceptual option is for. The compromise is that not only the colors out of gamut need to shift, but all shades are also adjusted proportionally so that detail can be rendered in out-of-gamut areas. This is a compromise, but one well suited to photographic prints. Indeed it can be fairly likened to chemical processes since these too were proportionate rather than 100% accurate.

That said, it is not always a compromise you need to make. If your image consists only of in-gamut shades, then there is no need to sacrifice the accuracy of Relative Colorimetric, and you can safely select this. Using the soft proofing tools to make a decsion will help you decide whether you should go for the accuracy of the Relative Colorimetric mode or the safety of Perceptual.

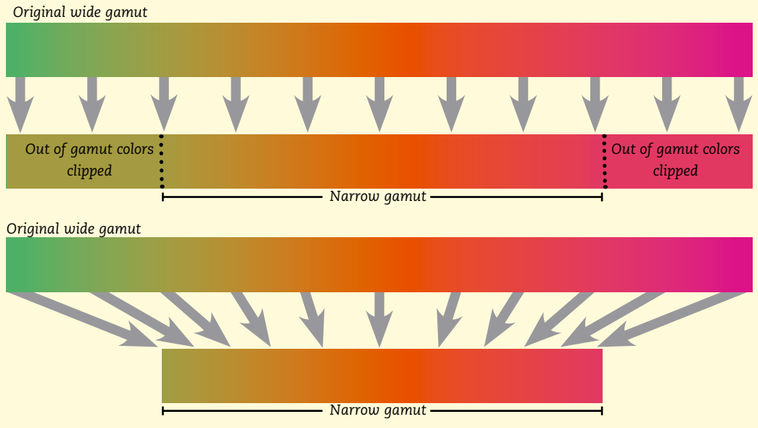
Where rendering intent happens

The rendering intent choice is applied both when a file is converted into the working space, and when it is output to your printer. It is this latter occasion which garners more attention, since the printer's gamut is likely the smallest of those involved so there is more potential for loss in the translation.

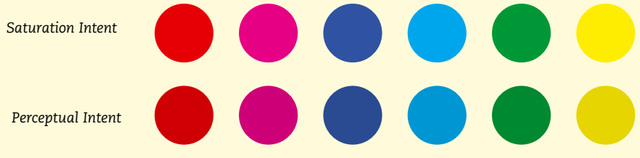


In a Relative Colorimetric conversion, the shades that are outside the gamut area are clipped and, rendered as the nearest in-gamut color. The result is areas of continuous tone in the print where there were areas of detail in the source.

With Perceptual rendering intent, all of the shades are adjusted so that they fit proportionally inside the narrower gamut, meaning that all the detail is preserved, but at the expense of color accuracy.

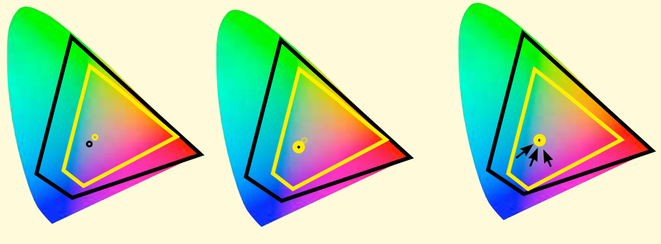


Saturation Intent preserves the strongest possible conversions of fully saturated colors. It's most useful when converting to a wider color space (the opposite of the scenario in the perceptual intent conversion) than the starting one, so those bright shades will be brighter still. This has more to do with display graphics than printed ones; for example converting from a web graphic to a known monitor. It's not really suited to photos.



In a color space there is a line between black and white known as the white point. This gamut chart, which is a section half way from the brightest and the darkest points shows the two different mid grays, but it's important to remember that this is merely one layer of a 3D-structure, with darker shades lower and lighter shades higher (see page 77). At the top is the white point.

In an Absoloute Colorimetric conversion, the white point is preserved, while in a Relative Colorimetric conversion the other colors are adjusted to compensate. Absoloute can lead to color shifts similar to the effects of incorrect white balance settings, while Relative compensates for characteristics of the target (off-white paper, for example).



The original color space is in black, the target in yellow, and their white points marked.

In Absoloute Colorimetric, the white point is preserved in the same location in the new space.

In Relative Colorimetric, the colors are proportionately shifted to the new space's white point.

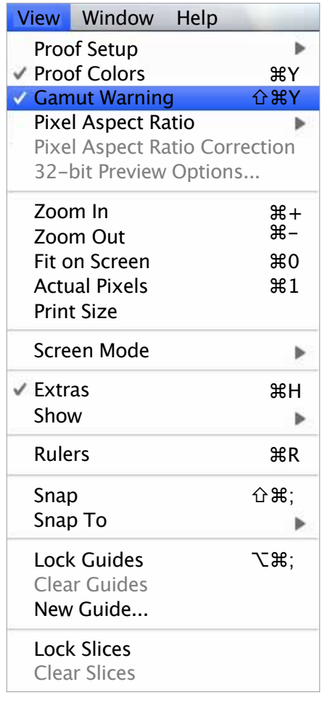
Soft proofing

In an ideal world, the print would come out of the printer looking just like it does on your computer screen. Unfortunately, it is not quite so easy because we are dealing with a series of devices and materials, and the monitor may have non-standard settings, as may the printer, the ink, or the paper. As we have seen, calibrating the monitor is the essential first step, and then a good profile for the printer, paper, and ink combination should get us close to good, predictable results.

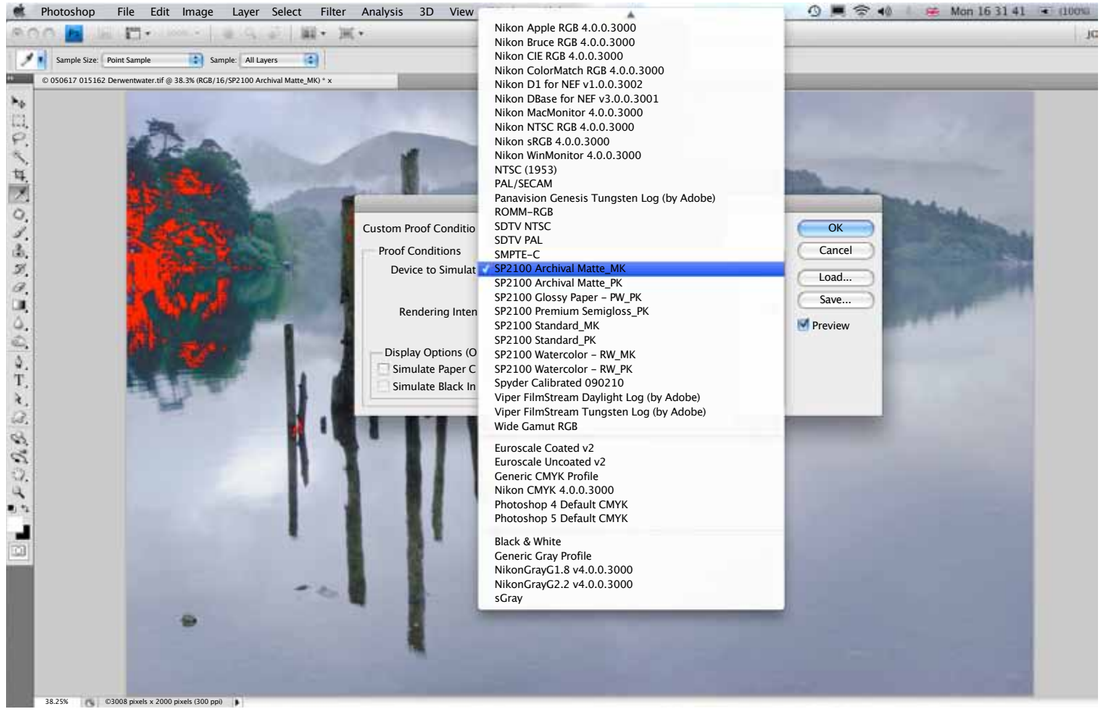
EVEN THEN, THE print may still not match the screen. It may then be tempting to apply a bit of guesswork and adjust the image so that although it looks wrong on screen, you're pretty sure the print will now come out right. For instance, if the prints are generally too dark, you might lighten the picture in Photoshop so that the end result is acceptable. But it's not a very satisfying method, and a rather hit or miss affair. That's where "soft proofing" comes into its own.

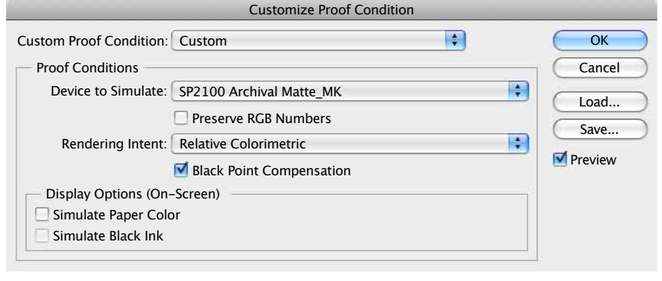
Soft proofing is a feature of Photoshop and other imaging software where the picture is displayed as it should appear on the print. By choosing the printer profile, the user tells Photoshop the exact combination of printer, paper, and ink that will be used to output the print. When the user then enters soft proofing mode, the software then applies the profile's information and adjusts the image's on-screen appearance. In other words, it's a clever kind of "print preview."

It should be said that for the soft proofed image to be of use, there must be accurate profiles for both the monitor and the printer. If the screen is not properly calibrated, or the output device's profile is inaccurate, Photoshop will not be able to make the on-screen preview look like the print.



Ctrl/⌘+Y switches soft proofing on and off. Switch on Gamut Warning with Shift+Ctrl/⌘+Y.





Proof Setup allows you to choose the profile representing the printer, paper, and ink combination you want Photoshop's soft proofing to simulate.

I like my Gamut Warning to be nice and brutal, but you can adjust it in Photoshop's Preferences—it's under Transparency and Gamut.

When you switch on the Gamut Warning, Photoshop highlights out-of-gamut areas. Notice that the document's title area also shows the printer profile that it is currently being simulated—in this case a third party paper type.

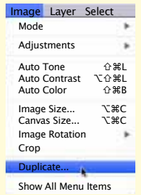
What to do about it

What soft proofing often reveals is that the paper and ink cannot reproduce as wide a range or gamut of colors as the monitor can display. You then have to decide what, if anything, to do about it.

Once you know you have a problem, one approach is to adjust the image until the on-screen colors lie within the printer's gamut. Switch on Photoshop's Gamut Warning with Shift+Ctrl/⌘+Y and any colors that lie outside the printer's gamut will be highlighted. You can then adjust the picture with a Saturation or Curves adjustment layer and bring its colors back within gamut. Unfortunately, while this gamut-based method tells you whether the colors will be printable, it doesn't tell you how they will appear and can still lead to wasted prints.

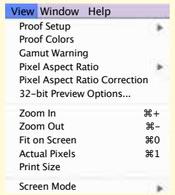
The other method is to create a copy of the image file and arrange both copies on screen. One, the master file, is left untouched and shows how the picture should ideally appear.

Let's look at the steps

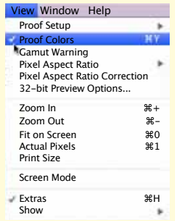


1 Choose *Image › Duplicate*. It can be a good idea to give the copy a name such as "Soft Proof Copy."

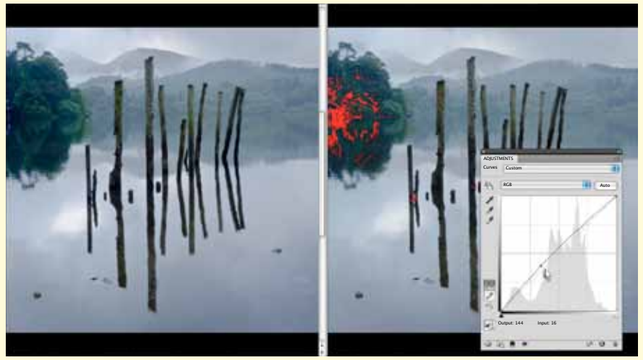
2 Select *Window › Arrange › Tile* so that the two copies are side by side.



3 Click on the original image's name to activate it, and make sure Proof Colors is off.



4 Activate "Soft Proof Copy" and switch Proof Colors on.



5 Add adjustment layers, either via the icon in the Layers palette or via *Layer › New Adjustment Layer*, and adjust the "Soft Proof Copy" until its appearance matches the reference image. The most likely adjustments are Hue/Saturation, Levels, and Curves. Also pay attention to the adjustment layer's blending mode—setting it to Color will ensure that the adjustment only affects the image color and not brightness.

The copy is viewed in soft proofing mode, and you add adjustments until it looks as close to the master reference image as it can.

The process is not exact, but generally the print will be a much better image with the adjustments made while soft proofing. As a final step, I like to bundle all the Adjustment Layers into a Layer Set named so I can remember the adjustments' purpose. I then drag it over to the master image and switch off its visibility, saving the master file and discarding the copy.

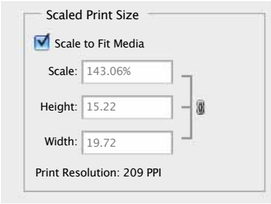
A couple of other settings are worth mentioning. Simulate Black Ink is usually left checked so the soft proof display lets you evaluate the print's color gamut.

Simulate Paper Color can be left on or off. Switched on, and you can assess the print's dynamic range on-screen, but it will look washed out because the whites will no longer be as bright as your monitor can display. At first, this can be misleading, and leaving Simulate Paper Color turned off will usually be easier until you have experience of how the on-screen appearance translates into the results on paper.

Soft proofing can simulate the paper's color. The left half is how the picture is supposed to look (aside from the gamut warning), while on the right the whites are subdued, indicating that they won't look as bright when printed as on screen. You may want to apply a brightness adjustment layer to compensate for subdued whites on paper.

Software setup and resolution

Before we can make a print of the size we want, we need to translate the digital image's pixels to paper's inches or centimeters. The image's height and width may be 3872 × 2592 pixels, 4208 × 2800, and so on, but the same pixels could be squeezed into a 5 × 7-inch print or stretched out to poster size. The resolution—how many dots are printed per inch—is the missing link. Put it another way: printed size (inches) × resolution (dpi) = image pixels.

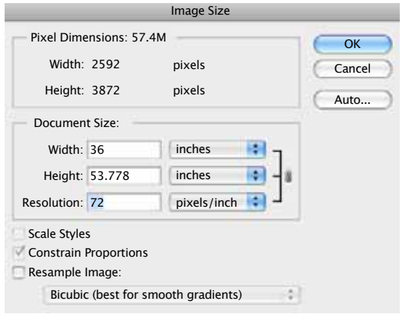


Photoshop's Print dialog has a setting that's useful for quick resizing but not if you are seeking the finest quality.

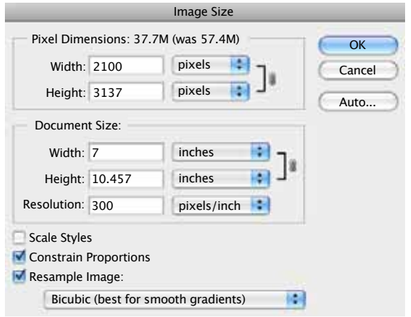
OVER THE YEARS Photoshop's Print dialog has developed into a powerful tool and has combined into a single interface with other functions such as a soft proofed preview, borders, and resizing the image to fit the chosen paper size. Handy though this is, it doesn't offer the same level of control as resizing the image before entering the Print dialog. If you use advanced sharpening methods, for instance, resizing through the Print dialog reduces the size of any sharpening haloes and so softens the image. It's much better to set the print size through *Image > Image Size* and then set the appropriate sharpening.

Photoshop users who also use Lightroom or Aperture have another option—printing their PSD and TIFF files through those programs. This can save lots of time printing batches of images or printing different sizes from the same master file, and avoids any risk of flattening complex, multi-layer Photoshop files and losing the original data.

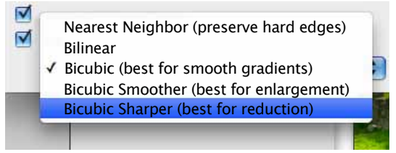
The *Image > Image Size* dialog is not that difficult to master. Look first at the Resample Image setting. If this is ticked, changing the pixels dimensions, document size, or resolution will mean that the actual image pixels will be changed or "resampled." If it is not checked, changes to the document dimensions or resolution will not affect the image pixels. The option to choose depends on what you are doing.



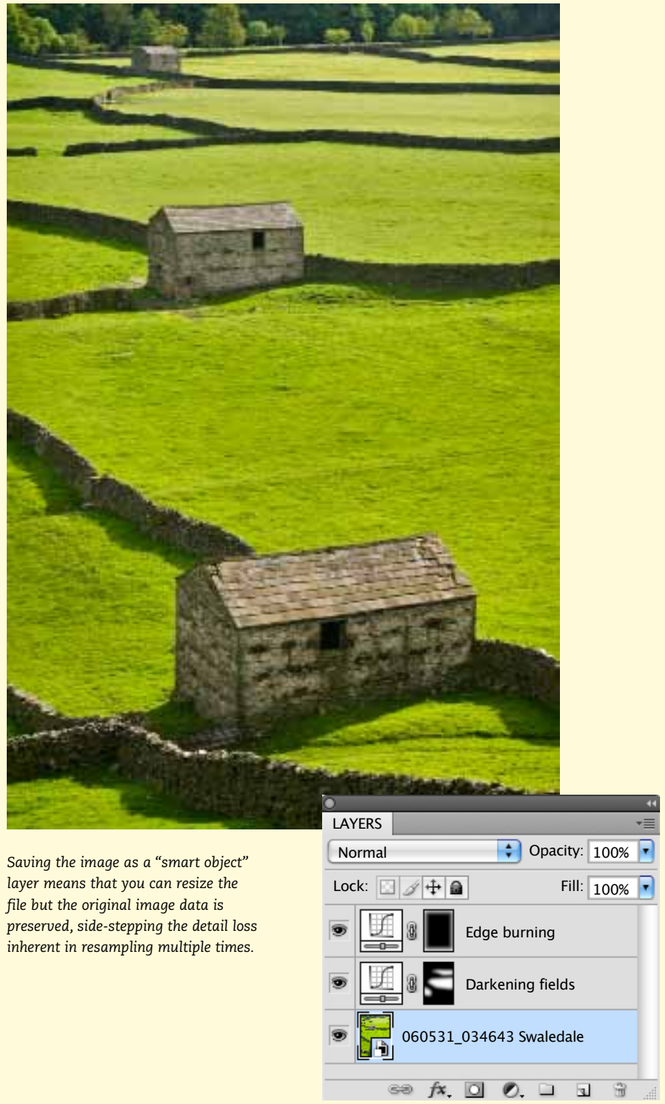
For example, if you are printing a JPEG it may well have a resolution of 72dpi. That's fine for viewing on screen, but not at all suitable for quality printing—it would be a big, low resolution image. A 36 × 53 inch (91 × 135 cm) print would look fine if viewed from a distance, but not if you expect it to be viewed from close up. 300dpi would be a better choice for a normal size print, but you wouldn't want to change the actual pixels—you're only correcting the resolution at which they are output. So in this case you would uncheck Resample.



On the other hand, let's say you want to print a 3872 × 2592 pixel image and the resolution is already set at 300dpi for a normal print quality. With these settings as they are, the picture would print out at 12.9 × 8.6 inches (36 × 22 cm). But if you wanted a 10.5 × 7 inch (27 × 18 cm) print, for instance, you would get better results by resampling the pixels and then applying the appropriate level of print or output sharpening. So leave Resample checked, set the dimensions in the Document Size, and then click OK.



Resampling means Photoshop has to recalculate and interpolate the pixel data, and you can choose from alternative methods at the bottom of the Image Size dialog. If you are making the image bigger, choose Bicubic Smoother. If you are reducing the image size, pick Bicubic Sharper and the resized image will keep more detail and appear sharper.



Saving the image as a "smart object" layer means that you can resize the file but the original image data is preserved, side-stepping the detail loss inherent in resampling multiple times.

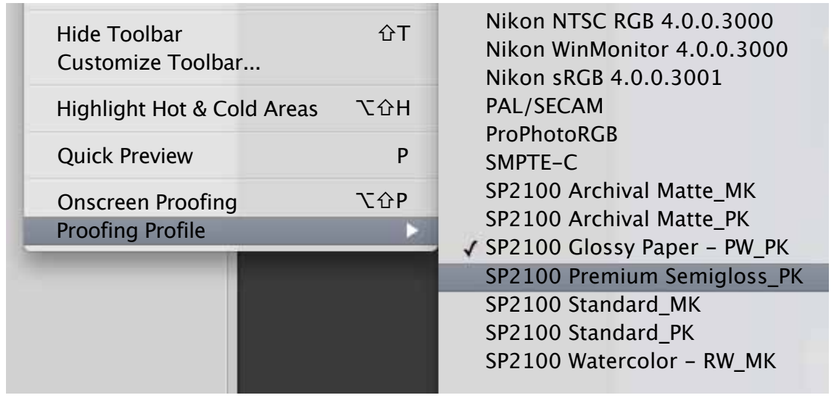
Printing with Aperture

Apple's Aperture was the first of that new wave of database-powered image editing programs that combined catalog functions with the ability to make most of the image adjustments photographers need to make. The goal is a more streamlined workflow, so Aperture can take pictures off the camera, adjust them, and print them. Even if a picture needs a quick trip to Photoshop for extra adjustments, you can then come back to Aperture for printing.

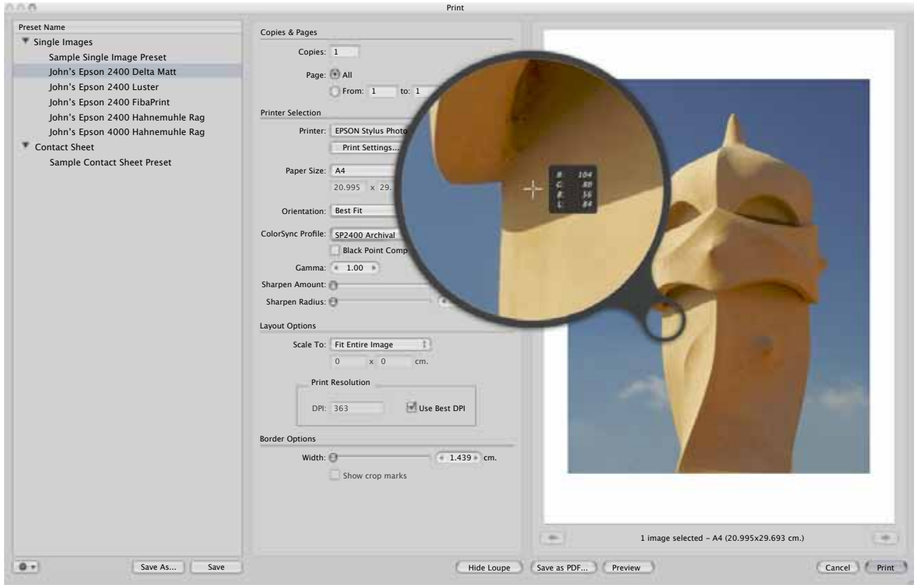
AS A NEW program for photographers, Aperture doesn't offer all the different color management and printing choices that Photoshop provides. Like Adobe's Lightroom, it doesn't need to allow for old ways of working or for an enormously wide range of users. So there is no equivalent to Photoshop's Color Settings dialog, no choice of Working RGB. The Mac operating system provides the color management, Aperture uses its own internal profile, and soft proofing is built into the *File > Print* dialog box. Some may regard this lack of choice as dumbing-down, but when all you want to do is print your photos, you don't need irrelevant, confusing choices. It's all about best practice, and including only those features that a photographer actually needs.

At the bottom of the View menu, you have two commands—Onscreen Proofing, which switches soft proofing on, and *View > Proofing Profile*, which is where you tell Aperture what kind of paper you want it to simulate. As you choose different papers, Aperture updates full screen images (not the thumbnails) to give you an idea of how the image will appear on paper.

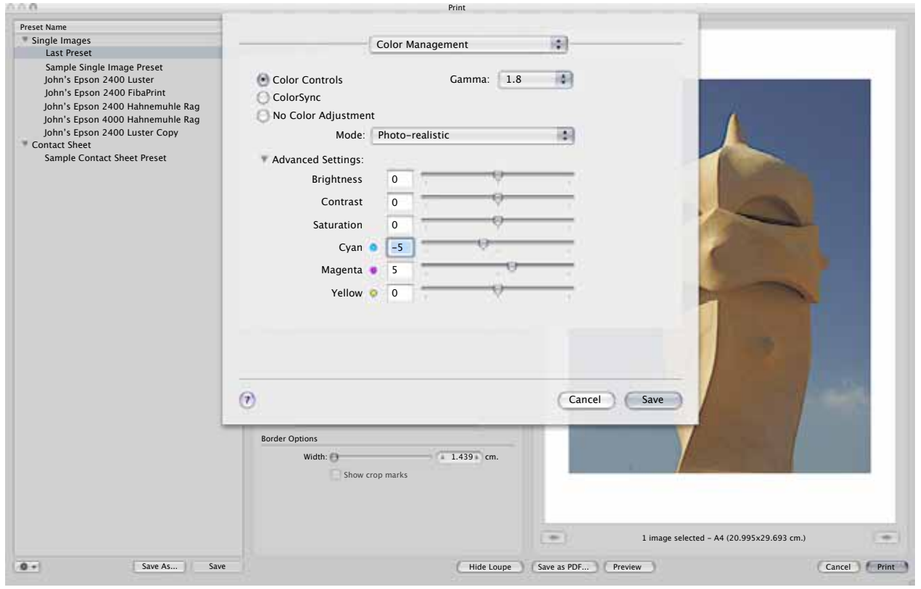
File > Print initiates Aperture's printing process and displays a three-column dialog box. The first column, Presets, lets you store frequently-used settings and recall them with a single click. So you can instantly switch to your settings for printing with



You can switch on Aperture's soft proofing by selecting Onscreen Proofing at the bottom of the View menu, and change the profile via the Proofing Profile option beneath it.



Aperture's File > Print dialog has three columns; presets for your favorite print setups, the middle column with the various print options, and on the right a soft proofed preview.



Click the Print Settings button and you can get to your printer's driver settings if you want advanced control over its color output.

The Print dialog's ColorSync Profiles drop-down box lets you tell Aperture which paper you're using and which profile it should use.

a certain sharpening level, a 1.57 inch (4 cm) white border on Epson Premium Luster, on an Epson 2400. It's a good idea to name your presets systematically so it's easy to recognize what they do; I use printer model then paper name.

The middle column is where you choose how to print. Some of the settings are self-explanatory, but one of the important ones is found just under where you choose the printer. It's a button called Print Settings and provides access to the Epson printer driver. Switch it to Color Management and click the triangle next to the word Advanced, and you are given access color sliders so you can tweak the output. This can be useful if you don't have a good profile for the paper you are using.

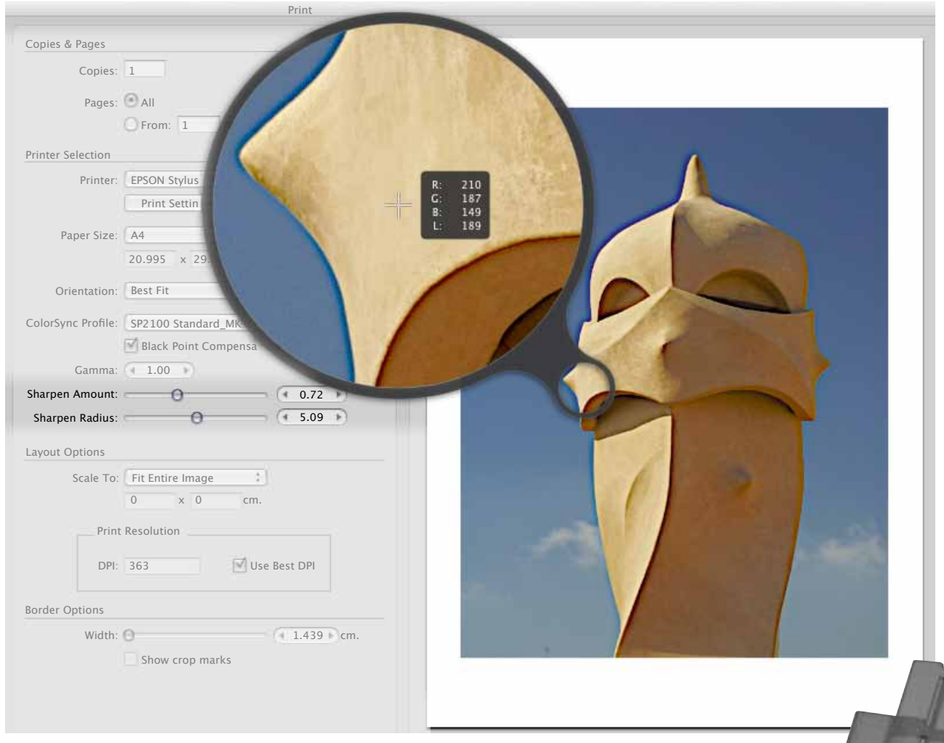
A little further down, the really important setting is ColorSync Profiles. This is where you choose the printer profile appropriate for the printer, paper, and ink combination you are using. Especially interesting is that when you choose a profile, Aperture updates the print preview at the right—the Print dialog box is effectively soft proofing.

There are also settings for print orientation, size, and borders, but the last controls I want to highlight are the two sliders for print sharpening. These are what is often called "output sharpening," which is purely applied while printing to tweak the image for the chosen size of print.

Aperture shows the results of sharpening in the Print dialog's preview. Handy though this is, it is worth making the point that this preview is only an on-screen simulation, and the monitor has a much lower resolution than the print. It is not the same as examining the print itself and then considering whether just enough sharpening has been applied—but not so much that it is noticeable. In other words, regardless of the on-screen preview, it is something of a leap of faith.

I like to use Aperture's Loupe to zoom in on the Print dialog box's preview and see the results of sharpening in greater detail. Activate the Loupe using the Show Loupe button or by using the keyboard shortcut ~ (tilde). Then move the cursor to a critical area of the image—eyes for example—and fix the Loupe to that spot by using the keyboard shortcut Shift + ~ (tilde). You can now adjust the sharpening sliders and see their effect on key details.

Finally, let's return to the Presets in the Print dialog's left hand column. When you've just spent a few minutes getting the settings just



The Loupe previews the results of Aperture's output sharpening, but always base your sharpening on the final printed output.

right, it makes sense to save a preset so that next time you print it'll be a breeze to repeat those settings. The more efficient you are with routine tasks, the more time and energy you have for the much more interesting artistic ones!

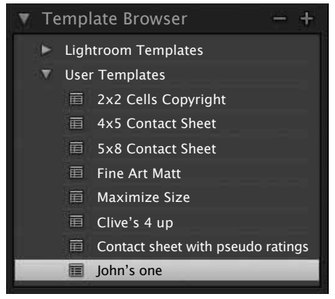
Printing with Lightroom

Shortly after Aperture was released, Adobe responded with Lightroom and offered versions for both Mac OS *and* Windows. It shares Aperture's objective of streamlining the image editing process and eliminating unnecessary options, so Lightroom uses its own wide gamut color space and gives the user no control over it. At the time of writing, Lightroom 2 does not have any soft proofing features. This omission, perhaps a tacit acknowledgement that only a small "elite" soft proof, means that printing in Lightroom is very straightforward indeed.

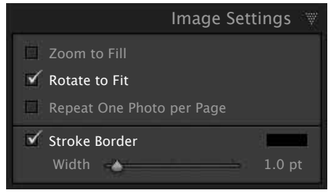
YOU INITIATE PRINTING by going into Lightroom's Print workspace. On the left are templates where you save favorite print settings and recall them when needed. You also have direct access to Lightroom's "collections," which serve as virtual folders and help you organize your pictures.

To the right are a number of panels such as borders, orientation, or add a title. These options are pretty self-explanatory, so let's go straight to those important for accurate, consistent color.

Many photographers begin editing pictures in Lightroom, do additional detailed work in Photoshop, and then return to Lightroom for its slick printing interface.



Save your settings as templates—you'll save yourself a lot of time if you do so.



The Image Settings panel contains a range of helpful layout settings.

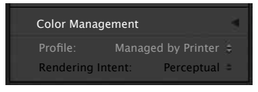
At the bottom of the left panel are two buttons. Page Setup is where you can choose paper size, while Print Settings accesses the printer driver. However, the really important settings are in the Print Job panel at the bottom of the right panel. Print Sharpening gives you three straight choices of output sharpening—Low, Standard, or High—and does not output a potentially misleading preview. You should examine the print, not the monitor's preview, and then decide if the sharpening level is suitable to the image. Generally, the setting should be left at Standard, while Low and High are best reserved for images with special requirements. For instance, a portrait of a child may well look best with only a small amount of sharpening.

There's also a setting for 16-bit output. If your printer has 16-bit printing, it's worth trying and placing 8-bit and 16-bit prints side by side. In theory there should be smoother tones, but it will be interesting—impressive, even—if you can spot the difference.

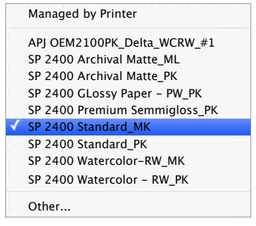
Next is the critically-important Color Management setting, and Lightroom defaults to Managed by Printer. Leaving it set to this option will mean that the printer driver controls the output, so you have to make sure you set the correct paper choice either in Print Settings or after you press Print.

However, Lightroom was born in the era of ICC profiles, and the Color Management drop-down box also lists all the print profiles on your computer. Choose one of these, hit Print, and switch off the printer driver's Color Management in the Printer's own dialog.

Until Lightroom includes soft proofing, there's not a lot more to be said about setting it up for printing. But that's the idea—it's intended to be that straightforward and it certainly manages it.



Managed by Printer is a good choice when you're using Epson's own paper.



The Color Management drop-down box also lists all the print profiles on your computer.