Kodak Professional

Systems & Solutions

Application Note

June 26, 2000

Using the ProPhoto RGB Profile in Adobe Photoshop v5.0

This document introduces the KODAK ProPhoto RGB profile and describes how to use the ProPhoto RGB profile within Photoshop v5.0 to:

- Provide full-gamut, device-independent editing of color images.
- Minimize unnecessary gamut compression.
- Increase productivity and reliability in imaging workflows.

This document reccommends some best practices for digital image reproduction.

Introduction

The objective of the ProPhoto RGB working space is to let you maintain and edit an image in a device-independent color space while displaying it in the device-specific color space of a monitor.

The Kodak ProPhoto RGB working space and Photoshop v5.0

The color management within Photoshop v5.0 lets you accurately display the same image on multiple systems with different monitor gamuts without the need to convert the color data from the gamut of one monitor to another. Adobe Photoshop has two color management features that help you accomplish this goal with device-independent editing methods:

- The separation of the device-specific monitor RGB color space from a device-independent RGB working space
- ICC profile embedding to help automate digital imaging processes and help minimize the gamut compression that occurs when an image is inappropriately converted

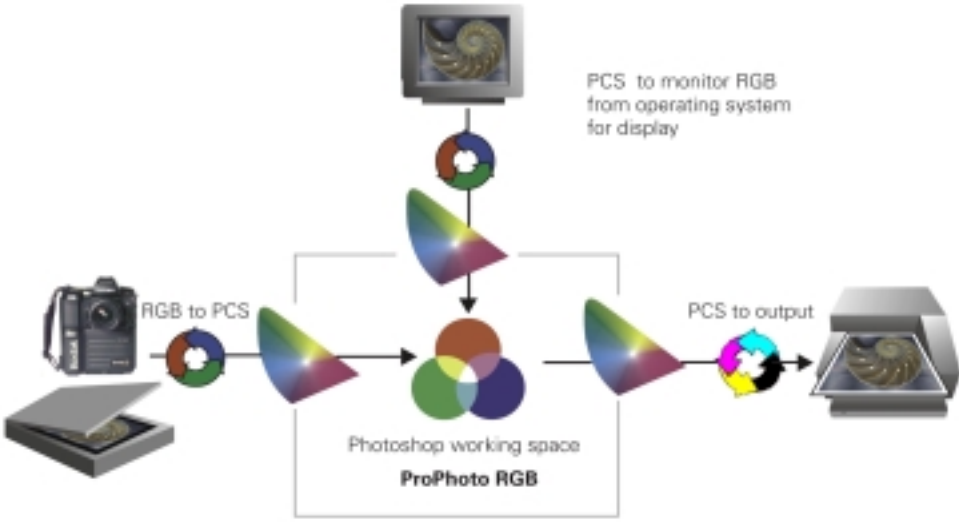
To maximize the potential of these Photoshop color management features, Eastman Kodak Company has created the ProPhoto RGB color space for use as a Photoshop working space that is independent of the workstation-specific, device-dependent, monitor color definitions. The parameters of this working space have been encapsulated in an ICC-compliant profile you can download from: www.Kodak.com/go/colorflow.

What is the ProPhoto RGB working space?

The ProPhoto RGB working space is an idealized color space defined in terms of gamma, white point, and phosphor settings. The compatibility of ProPhoto RGB parameters with Photoshop working space requirements lets you use the ProPhoto RGB working space as an intermediate and convenient color space in which to store, edit, archive, and transfer color data for imaging applications that use ICC-compliant profiles (for example, QuarkXPress 4, PageMaker 6.5, InDesign, OPI servers, and ICC compliant RIPs).

In Photoshop, the ProPhoto RGB working space becomes the key to a color management methodology:

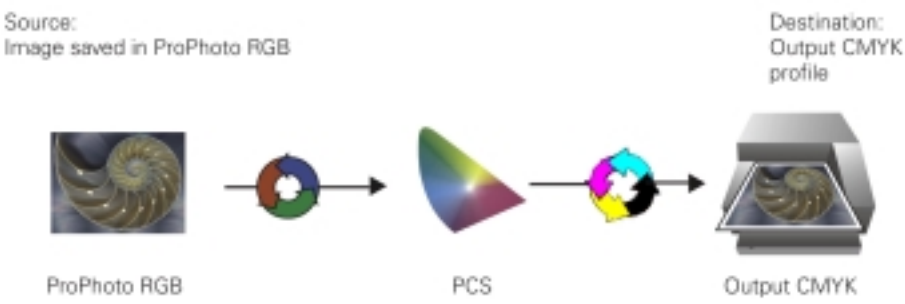
ProPhoto RGB working space



When you use the ProPhoto RGB color space in Photoshop, you can display an image in monitor RGB while the image is maintained and edited in the larger gamut of the ProPhoto RGB working space. You use the monitor profile only to display the ProPhoto RGB image correctly during real-time conversion of the image working space to monitor RGB values that are corrected for display on a specific monitor.

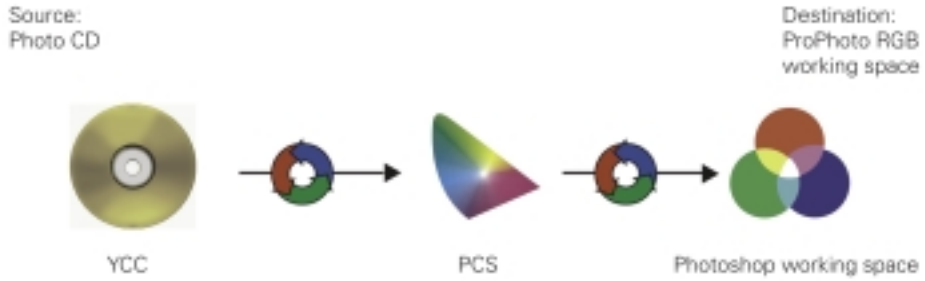
The ProPhoto RGB working space comes as an ICC-compliant profile you can use as a source or destination profile. You can use the ProPhoto RGB profile as a source profile in programs, such as page layout applications (QuarkXPress, PageMaker, InDesign, OPI servers, and ICC-compliant RIPs) to bring the color data from the working space into the monitor color space. For example:

ProPhoto RGB as a source profile



You can also use the ProPhoto RGB profile as a destination profile to move images into a working space for archiving.

ProPhoto RGB as a destination profile



Why edit in the ProPhoto RGB working space?

What's the advantage of editing in the ProPhoto RGB working space over editing in other RGB working spaces? You can:

- Convert images into and out of the ProPhoto RGB working space without causing gamut compression or loss of color data.
- Create an image appearance once and preserve the appearance when you output the image to multiple output devices.
- Edit an image with significant tonal or color balance moves using a tool in PhotoShop's Image Adjust menu without creating unanticipated results. (For example, a tonal adjustment to darken yellows is not as likely to acquire a reddish or greenish hue.)

Preparing to use the ProPhoto RGB color space

To use the ProPhoto RGB profile in Photoshop, you'll need to:

- Select the monitor profile you want your operating system to use so you can see how an image appears on your specific monitor.
- Set up the ProPhoto RGB profile as a Photoshop working space in which you can edit.
- Select a profile for your output device, typically a device-dependent CMYK color space.

We suggest you follow the recommendations in this document to set up Photoshop for use with the ProPhoto RGB working space.

Selecting a monitor profile for your system

Before you begin to use the ProPhoto RGB working space in Photoshop, you should calibrate your monitor, create a custom profile for your monitor, and select the monitor profile you want your system to use.

The monitor system profile lets you see the image in the monitor color space when you check Display Using Monitor Compensation on Photoshop's RGB Setup window. In the meantime, the image is maintained in the ProPhoto RGB color space where you can edit it.

When Photoshop opens, it looks to the operating system for a monitor profile and sets that profile as the default monitor profile within Photoshop.

To select a monitor profile using Colorsync v3.0:

1 Select Apple → Control Panels → Monitors.

This window appears:

2 Select the monitor profile you want.

Do not click Calibrate in this window if you have already used a monitor calibration utility.

To ensure that those settings from the utility are in effect, re-run the monitor calibration utility after closing this Control Panel.

Setting up the ProPhoto RGB working space

You can get the ProPhoto RGB working space either by downloading the profile that encapsulates the working space or by entering the parameters of the working space in Photoshop and making a profile based on the values. After you have the profile, you can load it as the working space profile.

Downloading the KODAK ProPhoto RGB profile

You can download the ProPhoto RGB profile from www.Kodak.com/go/colorflow.

The name of the profile is:

- ProPhoto RGB.pf (for Macintosh computers)
- ProPhoto RGB.icm (for Windows systems)

Important: *Do not edit the ProPhoto RGB profile or you will make it ineffective.*

While you are at the Kodak web site, you may want to download a technical paper that has additional information about the ProPhoto RGB working space. The name of the paper is *Reference Output Medium Metric RGB (ROMM RGB) White Paper*. The name of the PDF file is ROMM_RGB_White_Paper.pdf.

Creating a ProPhoto RGB profile by entering parameters

If you don't have the KODAK ProPhoto RGB profile, you can make the profile by entering the profile's parameters in Photoshop's RGB Setup window and saving the parameters as an ICC-compliant profile. You can then load the profile in the RGB Setup window.

To enter the ProPhoto RGB parameters:

1. Select File → Color Settings → RGB Setup.
2. Set Gamma to 1.80.
3. Set White Point to 5000K (D50).
4. Select Custom and set x and y values for red, green, and blue to:

Primary	x	y
Red	.7347	. 2653
Green	.1596	.8404
Blue	.0366	.0001

5. Click Save to create an ICC-compliant profile and store the profile in the default profiles directory.

You can now load the profile as a working space.

Loading the KODAK ProPhoto RGB profile

Set up an RGB wide-gamut working space by selecting the KODAK ProPhoto RGB profile as the RGB working space.

To load the ProPhoto RGB profile:

1. Select File → Color Settings → RGB Setup.
2. Click Load and select the ProPhoto RGB profile.
3. Check Display Using Monitor Compensation.
4. Click OK.

Defining a device-dependent CMYK color space

By selecting a CMYK ICC profile, you can define a device-dependent CMYK color space (typically, that of your printer) that Photoshop uses to convert images from the working space for output.

If you've checked Embed Profiles in the File → Color Settings → Profile Setup window, Photoshop uses the settings in the CMYK Setup window to tag all CMYK images, regardless of the CMYK color space the image is in.

The settings in the CMYK Setup window replace the Photoshop v4.0 separation tables. A CMYK image will display as it will be printed on the device selected in the CMYK Setup window.

To set up the CMYK space with an ICC profile:

1. Choose File → Color Settings → CMYK Setup.
2. Make these selections in the CMYK Setup window and click OK:
   - **CMYK Model.** Click ICC.
   - **Profile.** Select a profile for your output device.
   - **Engine.** Select Kodak CMM. If you do not have the latest Kodak engine, go to Kodak.com, and download the latest Kodak CMM for Colorsync.
   - **Intent.** Select Perceptual.
3. Click OK.

Verifying the ProPhoto RGB working space setup

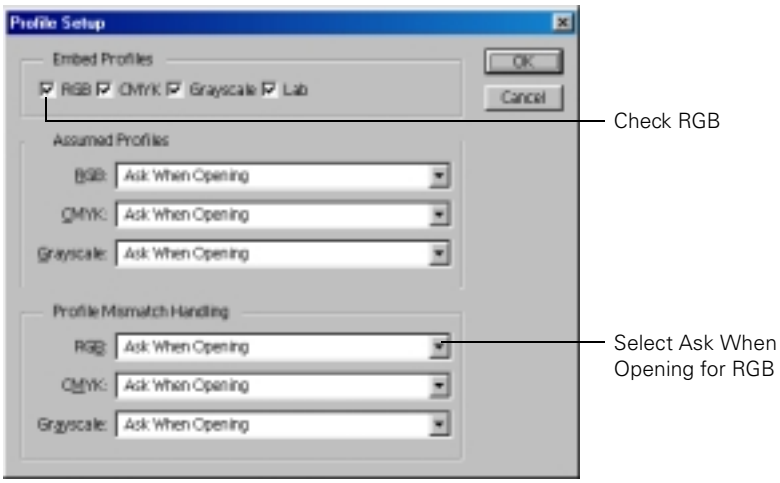
You verify the setup of the ProPhoto RGB working space by testing whether the profile embedded in an image and the working space are consistent.

Embedding RGB images with the ProPhoto RGB profile

To embed the ProPhoto RGB profile in an image:

1. Set the ProPhoto RGB profile as the working space in RGB Setup. (See "Setting up the ProPhoto RGB working space" on page 6.)
2. Open the image you want.

3 Select File → Color Settings → Profile Setup. The Profile Setup window appears:



4 In the Embed Profiles section, check RGB.

When you save the image, the profile you selected for a working space under RGB in the File → Color Settings → RGB Setup window is embedded in the image.

5 In the Profile Mismatch Handling section, under RGB, select Ask When Opening.

This setting causes a warning to appear when you open an image that has an embedded profile that is different from the profile for the current working space. (See the next section, "Checking whether an embedded profile and the working space are consistent.")

6 Click OK.

Checking whether an embedded profile and the working space are consistent

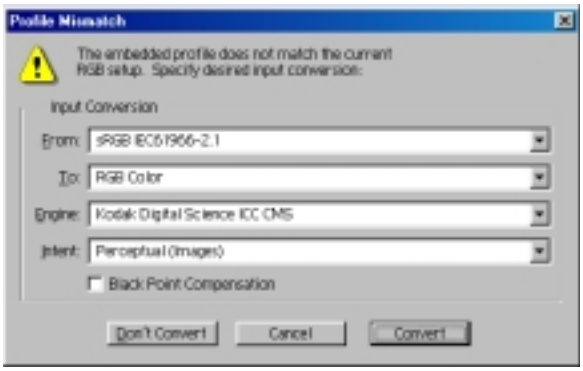
Selecting the Mismatch Handling setting for RGB to Ask When Opening, in the File → Color Settings → Profile Setup window causes a warning to appear when you open an image embedded with a profile that is different from the profile for the current working space.

This example of the verification process lets you see what happens when an embedded profile and the working space are inconsistent and how to correct an inconsistency:

1. Set the ProPhoto RGB profile as the working space in RGB Setup. (See "Setting up the ProPhoto RGB working space" on page 6.)

2. In Photoshop, open the Bottles image in the Photoshop application folder → Goodies → Samples.

   The Bottles image is embedded with an sRGB profile. Because the sRGB profile and the ProPhoto RGB working space are not the same, this message appears when you open the image:



3. Click Convert to convert the Bottles image from sRGB to ProPhoto RGB.

4. Save the image as Bottles.mrgb. The ProPhoto RGB profile is embedded in the Bottles.mrgb image.

5. Close and re-open the Bottles.mrgb image. No profile mismatch message appears because the embedded profile is the now same as the profile for the working space (ProPhoto RGB).

6. Close the Bottles.mrgb image.

7. Re-open the original Bottles image embedded with the sRGB profile. The Profile Mismatch warning appears because the embedded profile is not ProPhoto RGB.

   Click Don't Convert. The image retains its data in sRGB, but it displays as if it is ProPhoto RGB and appears over-saturated.

8. Select File → Color Settings → RGB Setup.

9 Uncheck Display Using Monitor Compensation. The image now appears less saturated, closer to proper display, because sRGB is the monitor definition.

10 Close the RGB Setup window. Leave the original Bottles image open.

11 Open the Bottles.mrgb image.

The ProPhoto RGB profile compresses colors at the edge of the gamut to prevent clipping. As a result, the image looks very desaturated, unlike the sRGB image when Display using Monitor Compensation is unchecked.

12 Select the original Bottles image and check Display Using Monitor Compensation to display the image correctly. Notice that the original Bottles image is now over-saturated compared to the correctly displayed Bottles.mrgb image.

13 Close the Bottles image without saving it. If you save it, the ProPhoto RGB profile will replace the sRGB profile.

Here are some tips to help you determine whether an image is being displayed with the correct profile in the correct working space:

If the image looks	A possible reason is	So do this
Over-saturated on the monitor	An image was not converted to ProPhoto RGB when you opened the image.	Reopen the original image and make sure it is in the ProPhoto RGB color space. before continuing to edit.
Desaturated on the monitor	Display Using Monitor Compensation is unchecked.	Check Display Using Monitor Compensation.
Desaturated on output	The ProPhoto RGB image was not converted to the output-specific color space.	Convert the image to the color space of the output device before outputting the image.

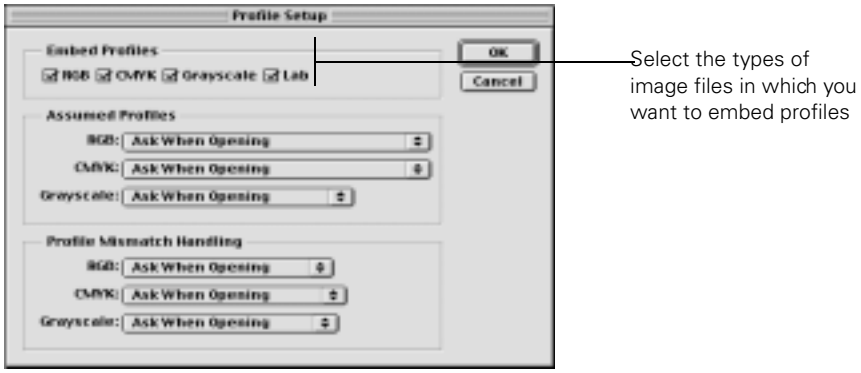
Using ICC profiles in Photoshop

In the Profile Setup window (File → Color Settings → Profile Setup), you can control how Photoshop uses and applies profiles to an image. You can specify:

- The types of files that will have embedded profiles when they are saved (Embed Profiles)
- How to handle a file that does not have an embedded profile – such as raw or pre-v5.0 Photoshop files (Assumed Profiles)
- How to handle an image file that contain an embedded profile that does not match the current working color space setup (Profile Mismatch Handling)

Specifying image types for embedded profiles

Under the Embed Profiles section of the Profile Setup window, you can specify what kinds of image files that can be embedded with profiles when you save. Check RGB to embed the ProPhoto RGB profile in an image.



Embedding a profile lets you transport a digital image across different applications and platforms without ambiguity about its origin. Embedding ICC profiles also helps automate digital imaging processes.

Currently, you can embed profiles in image files with these formats:

- Adobe Photoshop (*.psd)
- Tagged Image File Format, or TIFF (*.tif)
- Encapsulated PostScript, or EPS (*.eps)

- Joint Photographic Experts Group, or JPEG (*.jpg)
- PICT (*.pct)

The embedded profile becomes the source profile that converts from the device-independent ProPhoto RGB color space to the profile connection space (PCS) Images in the ProPhoto RGB color space that are embedded with the ProPhoto RGB profile are interpreted unambiguously when they are read through an ICC-compliant, color-managed application. Embedding a profile adds slightly to the size of the file.

For most color-managed work, you'll want to embed profiles. In some instances, however, you should chose not to embed profiles. For example:

- For images that have been converted to RGB color spaces, such as LVT or Durst Lambda images, you cannot embed the correct profile with the Photoshop v5.0 setups. You can convert the images via Photoshop's Profile to Profile feature, but you do not want to tag these images with an incorrect working space profile. The best option in this case is to uncheck RGB under Embed Profiles.
- When you work with a CMYK or RGB test file for calibration purposes whose color values must be maintained for reproduction and measurement, you also deselect the associated Embed Profiles checkbox.

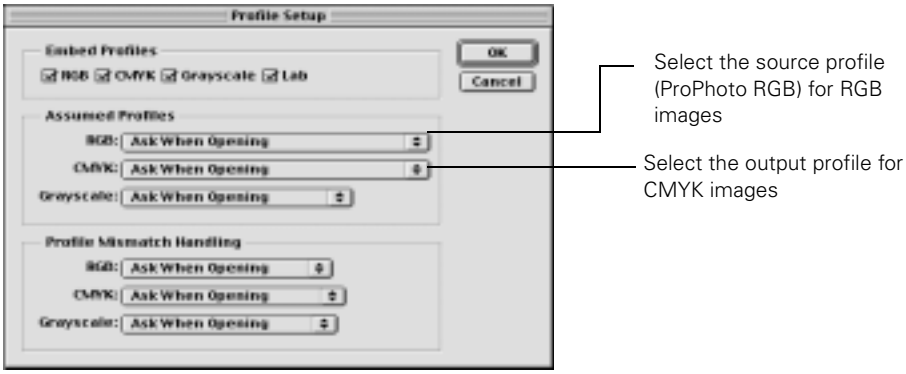
Opening an image that does not have an embedded profile

When you open an image in Photoshop that does not have an embedded profile, you can:

- Convert the color information to a specific color space – if you know the color space of the file.
- Decide on a case-by-case basis (Ask When Opening).
- Do no conversion (None).

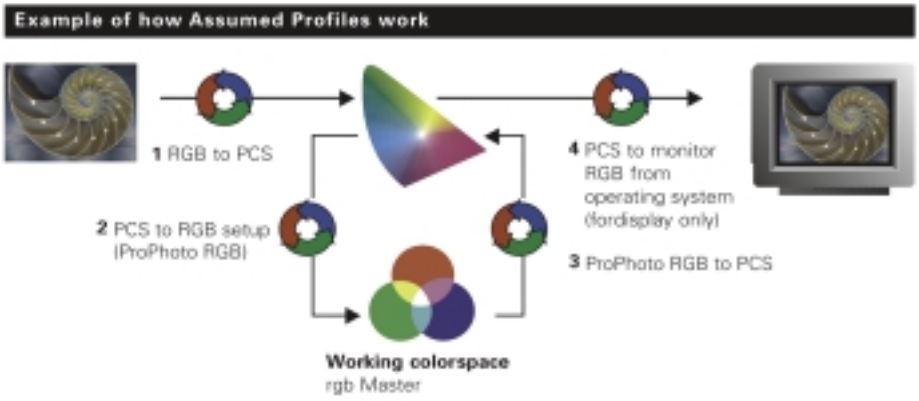
Converting color data to a specific color space

When you know the color space an image is in, you can select a profile in the same color space to use as an input profile. This conversion is useful when you are processing many images that are in the same color space.



You can select sRGB if you know you are getting RGB files of unknown origin from a Windows system, or select ColorMatchRGB for images of unknown origin from a Macintosh computer.

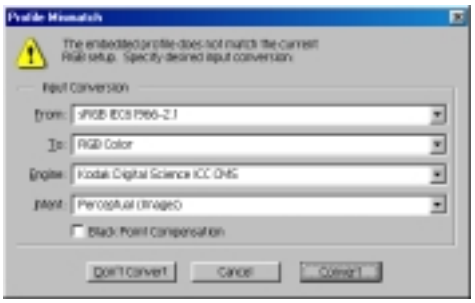
A closer look at the Assumed Profiles. The Assumed Profiles options work with the RGB and CMYK Setups. Here's an RBG example followed by an explanation of each step:



1. When you open an RGB file without an embedded profile, the Missing Profile dialog box prompts you to select an input profile.
2. Selecting a profile lets Photoshop bring the image color data into the PCS. Photoshop then looks to the RGB Setup.
3. Photoshop uses the RGB settings to bring the image's color data from the PCS the into the working color space (ProPhoto RGB).
4. Photoshop displays the image with the operating system monitor profile (ProPhoto RGB output to PCS and PCS to monitor RGB).

Decide on a case by case basis

If you select Ask When Opening in the Assumed Profiles section of the Profile Setup dialog box, a Missing Profile or Profile Mismatch window appears with a message that describes the color space of the image and the type of profile you need to select.



Make these selections in the window:

- **From.** Choose the profile for what you think the image's current color space is.
- **To.** Choose RGB Color. (By default, selecting RGB selects your ProPhoto RGB setting).
- **Engine.** Select Kodak CMM.
- **Intent.** Leave as Perceptual.
- **Black Point Compensation.** Leave unchecked.

If you click Convert, Photoshop makes a color conversion from the assumed color space to the selected working color space (ProPhoto RGB).

Leaving an image unconverted

Click Don't Convert to leave the image as it is. Beware that if you save your unconverted image with the recommended setting (Embed Profiles selected in the Profile Setup), Photoshop embeds the ProPhoto RGB profile, but does not alter the color information of the image.

Converting image color data – special cases

This section describes ways to convert images that require special handling, including YCC images from Photo CD, CMYK legacy files, and images of unknown origins.

Photo-YCC images

The KODAK ICC Photo CD File Plug-in is ICC-aware and lets you open a Photo CD image and apply an ICC-compliant profile to change the Photo-YCC data to RGB or CMYK data. The source profile is always a Photo CD input profile, while the destination can be Lab, CMYK, monitor RGB, or output RGB.

To use the ProPhoto RGB profile as a destination profile:

1. In Photoshop, select the ProPhoto RGB profile as the RGB working space. (See "Setting up the ProPhoto RGB working space" on page 6.)
2. In the ICC Photo CD File Plug-in, select the Photo CD input profile as the source profile.
3. Select the ProPhoto RGB profile as the destination profile.
4. Edit the image, if necessary.
5. Save the image. The ProPhoto RGB profile is embedded.

Depending on your Photoshop RGB setup, a Missing Profile dialog box my appar. If it does, click Don't Convert to close the Missing Prifile dialog box. Do not close the Missing Profile dialog box any other way. You have already selected your image and profiles. Doing so a decond time will produce an unacceptable outcome.

CMYK legacy files

When you open CMYK legacy files or pre-Photoshop v5.0 CMYK files, you are asked to convert the files into the color space of your output device as defined in the CMYK Setup.

You can do one of two things:

- Leave the file as is and not convert it for other uses.
- Convert the file.

If your CMYK legacy files still match your printer or press, you probably do not want to convert the files.

If the image does not have a profile, but you are printing it to a CMYK device, select the profile of the device you are printing to.

If you convert legacy CMYK files, the conversion process uses the CMYK Setup profiles.

Converting in non-ICC-aware Acquire modules

Input devices such as Kodak Digital Cameras and RFS 2035 and 3570 film scanners ship with Photoshop Acquire plug-ins that are not ICC-aware. The most effective way of using the ProPhoto RGB working space is to convert an image from scanner or camera RGB to the ProPhoto RGB working space when you open the image in Photoshop:

1. In Photoshop, select the ProPhoto RGB profile as the RGB working space. (See "Setting up the ProPhoto RGB working space" on page 6.)
2. Select Image → Mode → Profile to Profile.
3. Select the custom input profile as the source profile.
4. Select the ProPhoto RGB profile as the destination profile.

An alternative method is to set the custom input profile as the Assumed Profile for RGB images. This setup is convenient because the Profile Setup window can be set to apply the Assumed Profile when you open the image when the image does not have an embedded profile. With this method, the conversion uses the custom input profile as the source profile and the ProPhoto RGB working space as the destination. However, if you open an image from another source, such as a different scanner or digital camera, this image will be incorrectly converted. This method works well for single source work-stations, but is not recommended for general use.

Images of unknown origins

If you don't know the origin of an RGB image, determine whether it came from a Windows or Macintosh platform:

- If the image is from a Windows system, you can convert the image from sRGB to ProPhoto RGB.

- If the image is from a Macintosh computer, you can convert the image from ColorMatch to ProPhoto RGB.

In either case, you will not lose color data by converting to the ProPhoto RGB working space.

If the image was stored in a monitor RGB color space such as ColorMatch, some saturated colors in the image will already be clipped to fit within the monitor gamut. Converting the color data to ProPhoto RGB will not expand the gamut of the original image, but you will not lose additional color data in subsequent conversions into and out of the ProPhoto RGB working space.

Likewise, when you convert a ProPhoto RGB image to the CMYK color space of the output device, some gamut compression may occur.

Other ways to manage color using profiles

Additional ways for color managing Photoshop files include:

- Executing a mode change (Mode Change)
- Applying input and output profiles (Profile to Profile)
- Previewing CMYK images on the monitor (CMYK Preview)

Executing a mode change

Mode Change uses the RGB and CMYK Setup profiles, but it does not tell you what each setup is. You will have to check, especially if you are working on a computer that others work on.

Mode Change gives you these benefits provides a one step operation. If you save an image that has been mode changed, Photoshop embeds the profile chosen from the RGB or CMYK setup, whichever matches the image color space.

Applying input and output profiles

The Photoshop Profile to Profile feature lets you apply any input and output profile to an image file. Unfortunately, when you save the image, Photoshop embeds the setup profiles. It will not embed the profiles you have selected in the Profile to Profile dialog box.

To convert the color space of an open image:

1. Open the image you want to convert.
2. Choose Image → Mode → Profile to Profile.
3. Choose the source color space in the From pull-down menu. (You want to select the color space the image is in.)
4. Choose the destination color space in the To pull-down menu. (You want to select the color space to convert the image data to.)
5. For Engine, select the Kodak CMM. (On Macintosh computers, make sure Kodak CMM is selected in the ColorSync Control Panel v2.5+.)
6. Select Perceptual (Images) as the rendering intent.
7. Make sure Black Point Compensation is unchecked.
8. Click OK.

Previewing CMYK images

Select View → Preview → CMYK to see how an RGB image will look in CMY(K). This preview is based on your CMYK Setup settings.

Recommended method for saving files

Saving in ProPhoto RGB as your destination is an intermediate step to archiving the ProPhoto RGB files after you make edits, but just before you convert them to their final destination. Generally you can convert the image to 8 bits after you make the initial color management – that is, after you have established the basic look of the of the image.

We recommend you save in the ProPhoto RGB working space because:

- Archiving RGB corrected images with the same source improves production.
- Repurposing RGB images to various devices is easier than starting from scratch.
- Saving in ProPhoto RGB preserves the color integrity of the image so it can be used for multiple output devices, for the Web, or for presentations.
- Editing in RGB gives you more options than editing in CMYK.

Exchanging ProPhoto RGB images

To exchange image files among workstations, set up each workstation with the same Photoshop Profile Preferences. Specifically:

- Set the ProPhoto RGB color space as the working space (See "Setting up the ProPhoto RGB working space" on page 6.)
- Check Embedding On when you save an RGB image.

These practices prevent excessive and inappropriate conversions that may result in loss of color data. If the embedded profile is the same as the working space, no conversion occurs. Avoid exchanging images with a workstation that does not have ProPhoto RGB as a working space because the image will be needlessly converted at that work-station, and gamut compression may occur.

Editing ProPhoto RGB images

You can edit a 16-bit image in the ProPhoto RGB working space with minimal artifacts. If the image you are editing has 8-bit color data of unknown origin, you can convert the 8-bit data to 16-bit data to apply Image Adjust moves. Then, you can change the 16-bit image back to 8-bit for final adjustments and output. Observe the effect on the image data by comparing histograms of an image adjusted in 8-bit data with an image adjusted in 16-bit data. Generally, you should see a smoother histogram in the 16-bit image.

You can edit while viewing the image in full gamut or as an output simulation. While you view and edit in the full-gamut ProPhoto RGB working space, you can make edits without regard to the specific output process – this is, you can establish the color appearance you want.

When you view an image as an output simulation, you can impart reproduction characteristics to the image that take into account the color gamut available for the chosen output process.

When you must store or edit an image in a device-dependent color space, be sure to archive the image in the device-independent ProPhoto RGB color space before you convert the image.

Viewing ProPhoto RGB images with KODAK COLORFLOW Soft Proof Filter Plug-in

Filters for viewing images correctly within Photoshop on a monitor are in place for most image reproduction scenarios, except RGB simulations. With the Soft Proof filter, you can correctly view an image that is in the ProPhoto RGB color space but is intended for an RGB output process (such as Durst Lambda) or an image that has already been converted to an output RGB.

Although most filters do not accomodate16-bit images, ICC Soft Proof is an exception. The Soft Proof filter operates on the contents of the graphics display buffer, so it remains active for 16-bit images that are displayed.

The KODAK COLORFLOW ICC Soft Proof Filter Plug-in is available for Macintosh computers only.

Printing ProPhoto RGB images from Photoshop

Maintaining a single image file in ProPhoto RGB and converting the data while printing to different output devices would be ideal. However, conversion at print time is risky, although you can do so successfully in closed-loop systems. Always contact the printer vendor to establish the degree of Photoshop and ICC/CRD compliance for the printer model you are using.

When you convert color at print time, you may lose the flexibility of controlling the rendering intent and selecting the color matching engine. The printer color management checkbox doesn't control whether your printer uses color management. It controls only whether the printer embeds color information that describes your RGB work space in the stream of data sent to the print driver.

Whether ICC profiles are being directly stored or are being converted to CRDs for use with PostScript Level 2 RIPs or higher is unclear. In any case, an ICC non-compliant printer might show no conversion or supersede a conversion with the printer's default conventions.

To convert color data to an output device color space through a Profile to Profile command:

1. Open the image you want to convert.
2. Select Image → Mode → Profile to Profile to convert the image from the ProPhoto RGB working space to output device color space (for example, XLS 8650 RGB).
3. Print the image.
4. Close the image without saving it to maintain the image in the ProPhoto RGB color space.