Digital Image Guide

for Media Production
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National Park Service
U.S. Department of the Interior
Harpers Ferry Center

Introduction

This document gives guidelines for selecting or preparing digital image files for use by Harpers Ferry Center or by parks for media production. This information is technology and application dependent, so it will change over time. Also, it does not cover all possible situations. This guide assumes that files are being supplied to HFC for use in our projects. If you are working with a vendor who will be providing services to you, seek their advice. Be sure to review the *Definitions and Important Details* section that follows *Guidelines* for more information.

Content

Digital Photography

The file type produced by a digital camera is determined by the capability of the camera and the settings chosen by the photographer. The type of file significantly influences the quality possible in media production. All high-end cameras can make ***camera raw*** and ***JPEG*** file formats. Many also have ***TIFF*** file capability. Because data compression is inherent in JPEG files and it always results in the unrecoverable loss of information, **JPEG files are not acceptable for quality reproduction**.

File Types

Digital Negative (***DNG***)
A universal camera raw format that is gaining widespread acceptance. A DNG file is our first choice in file types for digital photography. Files converted from a proprietary camera raw format to DNG files are still camera raw files and preserve all the raw attributes. Hasselblad, Leica (M8), and Pentax cameras and backs use DNG as their native raw format. There is more information under *File Types* in *Definitions and Important Details* section.

Camera Raw (*NEF, CRW, CR2, ORF,* etc.)
The actual name and file extension varies between camera manufacturers. See *File Types* in *Definitions and Important Details* section for more information on camera raw files.

Adobe DNG files (preferred) or proprietary camera raw formats automatically provide the highest resolution and bit depth for the camera, with the most flexibility, and ultimately the highest possible quality for reproduction. If your camera does not make camera raw files it is not up to the task of making files for reproduction.

The quality of the media is dramatically influenced by the nature of the files. **Digital Negative or Camera Raw format is highly recommended.** Harpers Ferry Center will scale and refine raw files for their final use.

Sensor and File Sizes

A digital camera sensor's native resolution is referred to in ***megapixels***. One megapixel is one million pixels. The number of pixels produced by a sensor is determined by multiplying the vertical axis resolution by the horizontal axis resolution.

For example 3888 pixels x 2592 pixels = 10,077,696 pixels or 10 megapixels.

Digital Photography (continued)

The maximum physical image size that can be made at a cameras native resolution for a specific use (output resolution) can be determined by dividing the resolution of each axis by the required final output resolution.

For example the same 10 megapixel camera produces a file that is 3888 x 2592 pixels. If we are printing high quality offset we might want a resolution of 350 ppi. 3888 / 350 = 11.1 inches; 2592 / 350 = 7.4 inches. So we can produce an 11.1 x 7.4 image at 350 ppi using the native resolution of the camera.

If a larger than native file is needed interpolation of the file in conversion from camera raw to the working TIF or PSD file is necessary. How successful this will be depends on the quality of the image (lens, camera, conditions, photographer) and the ability of the software plus the skill of the individual working with the file. There are many “ifs” involved.

Scans

To ensure a usable scan, two variables must be known: resolution requirements and final image size. Size must also consider cropping—do not assume the full image is being used. These variables are linked and must be known before the scan is made to assure adequate resolution for the use.

Resolution

Resolution is the measure of the density of information in a digital image. It is the number of pixels in a given physical space. The more pixels per inch the higher the resolution. Resolution is usually expressed in ***dots per inch (DPI), pixels per inch (PPI)***—which is the same thing, or ***pixels per millimeter***. See pages 6 and 7 for more information.

Final Image Size

The final image size is the physical size of the individual image when it is output. A usable scan cannot be ensured without including the final image size when calculating the resolution. Also check a graphic print-out (comp) for cropping.

Scale Calculation for Percent Enlargement or Reduction

Use this method if your scanner software calculates the scan resolution from the required final resolution and the size change:
• Measure the distance between two points within the image in an actual size comp. Then measure the same distance in the original transparency. Divide the comp dimension (final size) by the transparency dimension (original) to get the enlargement or reduction factor (you can add two zeros to this number if you need a percent). It does not matter what unit of measure you use as long as it is the same for both measurements. Millimeters are good because they are small increments and you can avoid converting odd fractions to decimal.

Scale Calculation for Required Scan Resolution

Some scanner software requires the calculated scan resolution to be entered by the user. Use this method for them:
• Make the same measurements as above. Multiply the comp dimension (final size) by the required resolution and divide the result by the transparency dimension (original size) to get the required scanning resolution.

300–400 DPI (120–160 pixels per centimeter) at the final output size is required for high quality printing on coated paper. 160 pixels per centimeter (res 16 or ~406 ppi) is the preferred resolution for publications at HFC.
Be sure you understand the relationship between physical size and resolution —see *definitions and important details* starting on page 6.

All resolution requirements stated in this document are at the final output size for the media being produced. Please refer to a supplied cropping guide when calculating the size and resolution of a scan. Scans are often used at less than full frame. If this is not taken into account the resulting resolution will be lower than required.

Scans (continued)

Be aware that a quality scan involves more than having adequate resolution and that a good scanner must meet several additional criteria.

Bit Depth

Save 16 bit per channel files if your scanning software allows it. This provides dramatically more tonal data. Most image editing is destructive, so having a data cushion is helpful.

Color Mode

All scanners scan in RGB. If you are scanning a black-and-white original, please scan and save an RGB file to send to us. This gives us more to work with even if we eventually convert it to grayscale.

Color Management

Convert files other than camera raw to the Adobe RGB (1998) color space and save with this same profile embedded. Review a companion document called *Color Management for Harpers Ferry Center Designers and Cartographers* for more information on how the Center uses color management: http://www.nps.gov/hfc/products/imi/imi-docs.htm

File Types

Tagged Image File Format (TIFF or .tif)
This is the catch-all file format for uncompressed ***raster*** data (see definitions) and is preferred. PSD or uncompressed PDF are also acceptable. **JPEG files are not acceptable for quality reproduction.**

Sharpening

Do not sharpen the files. We can always sharpen more but we can not remove excessive or inappropriate sharpening.

Guidelines for Specific Media

Commercial Offset Printing

For offset printing, the rule of thumb is that resolution should be 1.5 to 2 times the ***screen ruling (LPI)*** being used.

Please see **Definitions and Other Important Information** beginning on page 6 if there are terms or acronyms here you are not familiar with.

Coated paper (gloss or dull), 150-200 LPI screens

Resolution:	300–400* ppi (120–160 pixels per centimeter)
Color Space:	RGB preferred if coming to HFC
File Type:	TIFF, PSD, or PDF with no compression
Profile:	Adobe RGB (1998), US Web Coated (SWOP) v2, or Gray 20% Dot Gain **

Uncoated paper (offset paper), 100—150 LPI screens

Resolution:	200–300* ppi
Color Space:	RGB, CMYK, or grayscale —talk to your service provider
File Type:	TIFF, PSD, or PDF with no compression
Profile:	Adobe RGB (1998), US Web Uncoated v2, or Gray 25% Dot Gain **

Newsprint, 60—120 LPI screens

Resolution:	150–200* ppi
Color Space:	RGB, CMYK, or grayscale — talk to your service provider
File Type:	TIFF, PSD, PDF with low compression, JPEG high quality (low compression)
Profile:	Adobe RGB (1998), US Web Uncoated v2, or Gray 30% Dot Gain **

Inkjet Printing

Park wayside displays or other large inkjet exhibits

Resolution:	200* ppi
Color Space:	RGB preferred by HFC, CMYK or grayscale OK
File Type:	TIFF, PSD, or PDF with no compression
Profile:	Adobe RGB (1998), US Web Coated (SWOP) v2, or Gray 20% Dot Gain **

Making highest quality photographic inkjet prints, printing on a high quality, photo grade or museum grade paper, and the <u>printer has a Postscript RIP</u> (you are doing the printing)

Resolution:	240–720* ppi (device dependent)
Color Space:	RGB, CMYK, or grayscale
File Type:	TIFF or PSD
Profile:	Adobe RGB (1998), US Web Coated (SWOP) v2, or Gray 20% Dot Gain **

Making highest quality photographic inkjet prints, printing on a high quality, photo grade or museum grade paper, and the <u>printer does not have a Postscript RIP</u> (you are doing the printing)

Resolution:	240–720* ppi (use the native resolution of the print engine for best quality)
Color Space:	RGB
File Type:	TIFF or PSD
Profile:	Adobe RGB (1998) **

Notes:

• Even though inkjet printers are CMYK devices they seem to work best when RGB files are sent and the printer does the conversion. This is especially true with six-color (or more) printers (CMYK + light C, light M, light K, R, G, B, etc.).

• When using an inkjet printer as a comping device in preparing files for other media, work according to the requirements of your final product.

Guidelines for Specific Media (continued)

Digital Photographic Printing (Lambda, Light Jet, etc.)

Resolution:	200–400* ppi (lower resolution for very large prints)
Color Space:	RGB
File Type:	TIFF if the output is only an image PDF if the image is placed in a page layout
Profile:	Adobe RGB (1998) **

Screen Printing and Porcelain Enamel

Resolution:	200* ppi
Color Space:	RGB or grayscale
File Type:	PSD, TIFF, PDF with no compression
Profile:	Adobe RGB (1998) or Gray 20% Dot Gain **

Color Laser Printer

(with a Postscript RIP and you are doing the printing)

Resolution:	150–200* ppi
Color Space:	CMYK or grayscale You can use RGB, but the RIP will do the conversion to CMYK, and the resulting image quality may not be satisfactory.
File Type:	TIFF or JPEG medium quality (medium compression) PDF is OK if the printer has a Postscript RIP
Profile:	Color management recommended but not necessary **

Display Screen or Internet Publishing

Resolution:	72–100* ppi
Color Space:	RGB or grayscale
File Type:	TIFF, PSD, PDF, GIF, or JPEG medium to low quality (medium to high compression)
Profile:	sRGB **

*For all processes the specified resolution is at the final imaged size. For more information see *resolution* below.

** For information on the color management process at Harpers Ferry Center, download the companion document: *Color Management for Harpers Ferry Center Designers and Cartographers* from: http://www.nps.gov/hfc/products/imi/imi-docs.htm

Copyright Information

Be sure that use rights from the photographer and model releases from people appearing in the image have been secured as required for any photograph, digital image, or other graphic you might publish. Please supply this information to Harpers Ferry Center with the image. You can add this information to the image metadata using any of several Adobe applications. For copyright requirements information contact HFC Graphics Research office, (304) 535-6714.

More Information

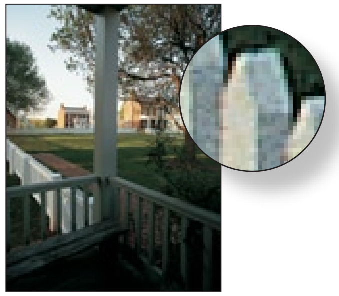
This is an overview. The designer for your Harpers Ferry Center project can discuss specifics of the job with you.

See the color management document at:
http://www.nps.gov/hfc/products/imi/imi-docs.htm.
It details the use of ICC color management (ColorSync) at HFC.

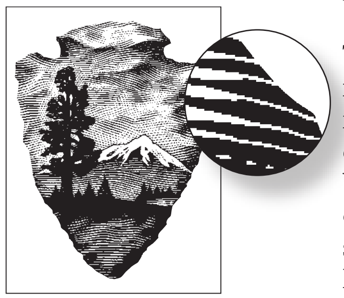
For more information go to the Harpers Ferry Center website:
http://www.nps.gov/hfc.

Definitions and Important Details

A *digital photographic image*, as used here, is a raster file. A raster file can result from a scan, a digital photograph, or have been created with software. It is a continuous tone image, meaning that it has shades of gray (or color). From this raster file, by various means, we produce a visual representation—a picture or an image.



__Raster__—A digital photographic image above, and a bitmap image below, and enlargements of each showing the pixels.



Several attributes determine how well a digital photographic image suits a specific use. Resolution, color space, and file type are primary. Others—contrast, color balance, and sharpening—deal more with crafting visually satisfying images regardless of intended use and are not addressed here.

An image might be used in a commercially printed publication, a small circulation publication printed on a desktop printer, a large format display like a wayside or banner, or it might be viewed in its final form on a computer monitor. Each of these categories might have subcategories with their own requirements.

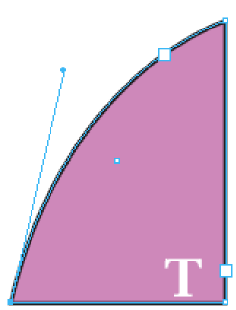
These standards primarily concern photographic images, but another type of raster image file must be mentioned because its requirements are so different. This is a ***bitmap*** or ***line*** scan. Examples might be a signature or logo. Such images have no shades of gray, only black or white. Because the edges of such images, where they go from black to white, have no transitional area of gray to smooth diagonal or curved edges, they require much higher resolution—four to eight times higher—than do digital photographic images.

Raster

The data for both types of image are recorded as raster data. Raster is a data structure, like a grid. Any point in an image falls in a discrete spot of information or picture element, called a *pixel*. A pixel describes the luminance and color of that spot. The image is made of row after row of pixels. This is clearly visible in the illustrations above. The density of pixels is the ***resolution***. The resolution is established at the origination of the file. Digital photographic images are always described by raster data. They are never described by vector data.

Vector

By contrast ***vector*** data are geometric instructions. A circle, for example, would be described by the x and y coordinates of its center, its radius dimension, and fill and stroke information. Because only objects are described, there is no data required for vacant areas. The amount of data required by these two different data types differs dramatically. Vector files are—except in extreme circumstances—substantially smaller than raster files. Text, line illustrations, flat tints, and blends are usually represented by vector data. The text in this document is an example of vector data.



__Vector__—There are no pixels until it is RIPed.

Vector files, unlike raster files, are resolution independent: you can scale vector files to whatever size you want and the image quality does not degrade. Why? Because the resolution is determined at the point of printing when the file is converted to raster (RIPed).

Definitions and Important Details (continued)

Resolution

Resolution is the measure of the density of information in a digital image. It is the number of pixels in a given physical space. The more pixels per inch the higher the resolution. Resolution is usually expressed in dots per inch (DPI), pixels per inch (PPI)—which is the same thing, or pixels per millimeter.

An inverse proportional relationship exists between the physical size of an image and its resolution. As you make an image larger, the resulting resolution is lower. As you make an image smaller, the resulting resolution is higher.

For example, a 200 dpi image at 4 x 5 inches doubled to 8 x 10 inches will be 100 ppi. Or, change the resolution to 400 ppi and the physical size shrinks to 2 x 2.5 inches.

Image editing applications provide the option to set the resolution and size independently, but the software interpolates the data as it is scaled up. This has limited usefulness. See interpolation, below.

Bit Depth

Information in a raster file also has a third dimension. This is bit depth—the amount of information contained in each pixel. It is the number of discrete values (shades) each pixel can use to represent a spot in the original scene or transparency. The higher the bit depth the more values are available and the more subtlety can be employed for each spot. Bit depth is independent of resolution.

• Bitmap files are 1 bit, and that bit is either on or off, black or white.
• Continuous tone files usually require 8 bits per pixel (and per color channel) to successfully create the illusion of photographic continuous tone. Eight bits (per color channel) allows for 256 discreet values (per color channel). An 8 bit RGB file is sometimes referred to as a 24 bit file.
• Each pixel of a 16 bit file can be one of roughly 64,000 theoretical discreet values in each color channel. Image editing software now fully supports 16 bit files, which includes 12 and 14 bit sources like digital cameras shooting raw files and many scanners.

The impact of 16 bit data is significant both for file size and for potential image quality. File size for 16 bit is double that for 8 bit. Because most image editing destroys data, image editing affects image quality. An 8 bit file has just enough data to present smooth tonal transitions in a reproduction. But if the image is edited some of that data will be discarded and tonal banding might be visible. We don't experience this more often only because dithering is applied to 8 bit files when they are edited. With the vast amount of additional data available in a 16 bit file, it becomes unlikely that abrupt steps in smooth tonal transitions will result.

Interpolation

Interpolation is what software does to increase the resolution of a raster file or to increase its physical size while maintaining the resolution. The software essentially makes up the missing information. Interpolation produces a larger file size, but the amount of useful information does not increase by much. Interpolation is not recommended if there are other options.

Color Type or Color Space

There are several ways to portray the hue, saturation, and luminance of a full-color image. We regularly use two specific methods, or processes (hence *process color)*:

RGB stands for Red, Green, Blue. This is an additive color process, meaning that as equal amounts of each color are added we approach white. RGB is used where light itself forms the image we view. Computer monitors and projectors are RGB devices.

Definitions and Important Details (continued)

Color Type or Color Space

CMYK stands for Cyan, Magenta, Yellow, and Black. This is a subtractive color process. As color is subtracted we approach white, and as equal amounts of CMY are added we approach black (theoretically). The black ink normally is used to add density. Subtractive color is used to form images where light is reflected from a reflective surface (like paper) and, in the process, is filtered by the ink layers deposited on that surface. CMYK is used in commercial offset printing, inkjet printing, and color laser printing.

All scans and digital camera images begin life in the RGB color space. Even large commercial drum scanners create RGB data, which might or might not be converted to CMYK as part of its internal process. The RGB color space has a gamut (range of colors and luminance) that can approach the range that the human eye can perceive. But the possible gamut of CMYK is sharply limited by the physics of the process and includes only a portion of the possible RGB gamut.

Color Profile

A color profile is a set of instructions that provide a color reference for other software and devices that might use the file. Profiles are embedded in image and layout files. The proper use of profiles in a color managed workflow can dramatically improve the predictability and consistency of the final result. Profiles are based on standards established by the International Color Consortium (ICC).

Camera Raw and Raw File Types

Camera raw formats automatically provide the highest resolution and bit depth for a camera and allow the most flexibility—and ultimately the highest possible reproduction quality. This is true in part because the data has not been processed with the capture parameters (white balance, sharpening, curves, etc.). All of these are limiting once applied and destructive to change later. And some are dependent of the size of use. So the ability to postpone “baking” the file until the specific use is known has advantages. Also, since processing the raw file does not change it, the raw file can be used again and again, much like a negative.

Most camera manufacturers have at least one proprietary raw format. These are not universally compatible and support for them will not exist forever. There will be too many for software manufacturers to support. When this happens what will happen to the unsupported camera raw files that photographers have archived? You can see the need for a standard raw format.

DNG

DNG (.dng), or Digital Negative file, began as a proposal from Adobe for a common camera raw format. Adobe developed the DNG format and a software utility to create DNG files from proprietary camera raw and released them and the code for anyone to use freely. Hasselblad, Leica (M8), and Pentax among others, have adopted DNG as their native camera raw format.

Proprietary Camera Raw

NEF—Nikon, *CRW* and *CR2*—Canon, *ORF*—Olympus, etc., etc., etc.
The name, file extension, and software required is different for each camera manufacturer. These and the DNG raw format all have the same capabilities.

Other Raster File Formats

PSD (.psd), or Photoshop document, is Photoshop’s native file format. It can preserve all layers, additional channels, and paths in their editable form. Few other applications can accept images in PSD format. So, don’t send an image.psd to someone who doesn't have Photoshop.

TIFF (.tif), or Tagged Image File Format is a good, all-around, basic format that preserves all of the raster data. TIFF can be used without conversion in all popular page layout programs, and it can be converted to any other common file type with no loss of data unless compression is applied.

Definitions and Important Details
(continued)
Other Raster File Formats

EPS (.eps), or Encapsulated PostScript is no longer recommended, because it does not work well with color management and the files are significantly larger for the same amount of data.

JPEG (.jpg) is both a method of data compression for images and a file type. Because image files are raster data they tend to be large. This can be a problem for some uses of images like on-line viewing. Therefore, for these applications the use of data compression is appropriate. BUT BEWARE: the term *data compression* can be misleading in image editing. It amounts to intelligently *throwing away information*. The more compression, the more visible is the deterioration. The lost data cannot be recovered. Never use lossy compression—JPEG or other methods—for images meant for high quality reproduction. For uses of this format that are appropriate, save only the final completed file as JPEG. Always keep the parent file as a TIFF or Photoshop format file to return to. Do not resave a JPEG file because each time you throw away more data. If you are forwarding a file that might require more work, always play it safe and send a TIFF made from the parent, not from the JPEG.

PDF (.pdf), or Portable Document Format, is a newer file format recommended to replace EPS. Images saved from Photoshop as PDF files can then be viewed using Acrobat Reader. JPEG compression can also be applied in the process of saving a file as PDF. The same cautions mentioned under JPEG should be observed. Most page layout programs now accept PDF files for images. PDF will preserve vector data in a raster file (an image with a clipping path).