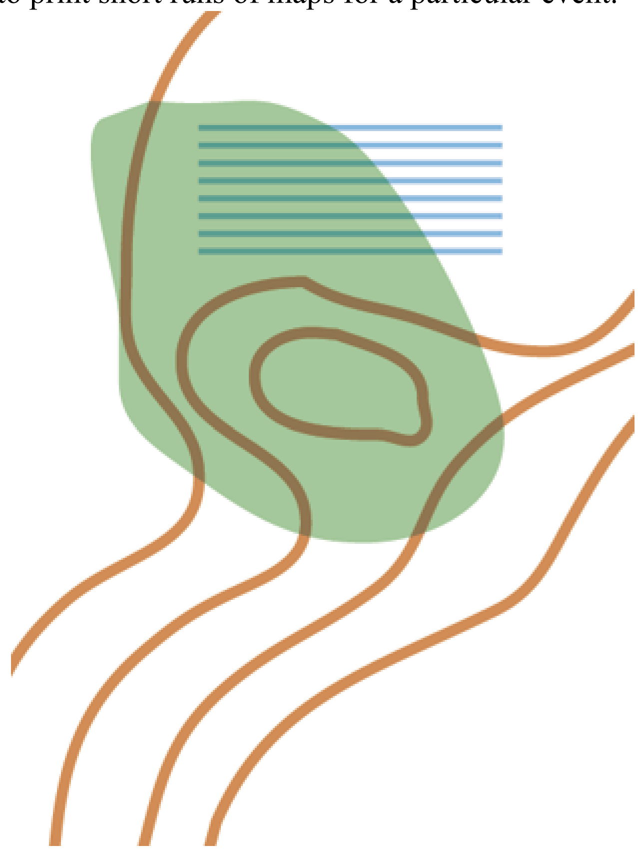
Printing Orienteering Maps with a 4-color (CMYK) printing process

By Pat Dunlavey

Many orienteering mappers have discovered advantages to foregoing the traditional approach to printing maps which requires that a commercial offset printer use five, six or seven Pantone Matching System ink colors (spot colors) which are mixed especially for orienteering maps (Process Black, PMS471[Brown], PMS429[Blue], PMS 361[Green], PMS136[Yellow], PMS428[Gray], and PMSPurple[Purple]). The greatest problem with spot color offset printing is the cost, especially when a club wishes to print short runs of maps for a particular event.

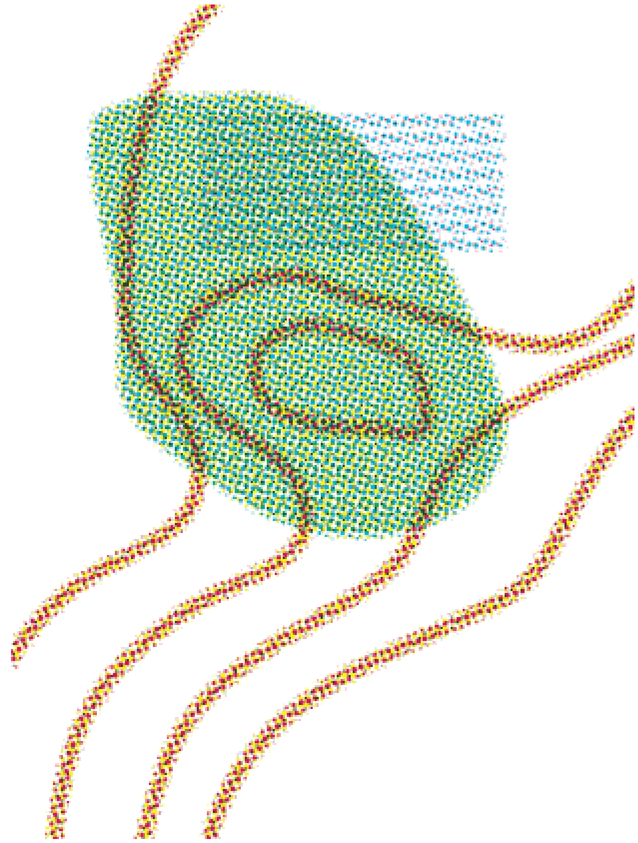
In spot color printing, the map image is built up very deliberately from discreet colored inks: black for culture and rock, brown for landforms, blue for water, etc. Where one color interacts with another on a spot color printed map, the two inks simply add together to produce a darker color. Therefore, when for example a contour (brown line) passes through an area of thick vegetation (green), the result looks something like this:



At this point, we need to understand a new term: *composite color*. When an image is converted into composite color, all the colors in the image are simulated in some standard color model, by combining varying amounts of the component colors for that model. At this moment, you are looking at a composite color rendering in the RGB, or red, green, blue (additive) color model – the color model used for computer screens. A printed image, such as a color photograph in a magazine, would typically be rendered into the CMYK color model. That is, printing with a combination of Cyan, Magenta, Yellow and Black inks. It's also known as process color. In the CMYK color model, the colors interact subtractively – that is, the more color you lay down, the darker the image gets.

Process color has been the standard technique for most color printing for the last 40 years or so, and printers are very accustomed to dealing with it. With different combinations of cyan, magenta, yellow and black, they can simulate a huge variety of colors, though there are significant portions of the visible color spectrum that CMYK cannot reach.

Process color relies on combining carefully adjusted amounts of the four different colors. However, offset printing cannot print a tint of a color (say 50% cyan) as a continuous tone. Instead, it simulates the tint by printing a screen of small dots, known as a halftone screen. (The frequency of the screen is typically 150 lines per inch or so.) Therefore, except where portions of the image which are solid cyan, magenta, yellow or black, or a combination of solid colors (e.g. solid yellow plus solid cyan makes green), the image will be built of overlapping patterns of colored dots. For continuous tone images, this is not generally too noticeable. However, orienteering maps are not continuous tone, and in fact rely heavily upon fine lines and sharp edges, where halftone screens are at their weakest. Not only do the clarity of lines and edges suffer under ideal circumstances, as can be seen here, but in the real world, the registration or alignment of the four colors, is not going to be as good as simulated in these drawings. The result is fuzzier edges,



Composite color is also used in inkjet and laser printers, and digital offset printers. They don't all use the same halftone screen method for regulating the density of the four composite colors. Ink jet printers, for example, modulate the frequency of very small dots of ink, rather than building different sized dots of ink. This is sometimes called FM screening, or stochastic screening. It also happens to be significantly better at resolving fine edges, because it is using a larger number of smaller dots.

Composite Color and PostScript

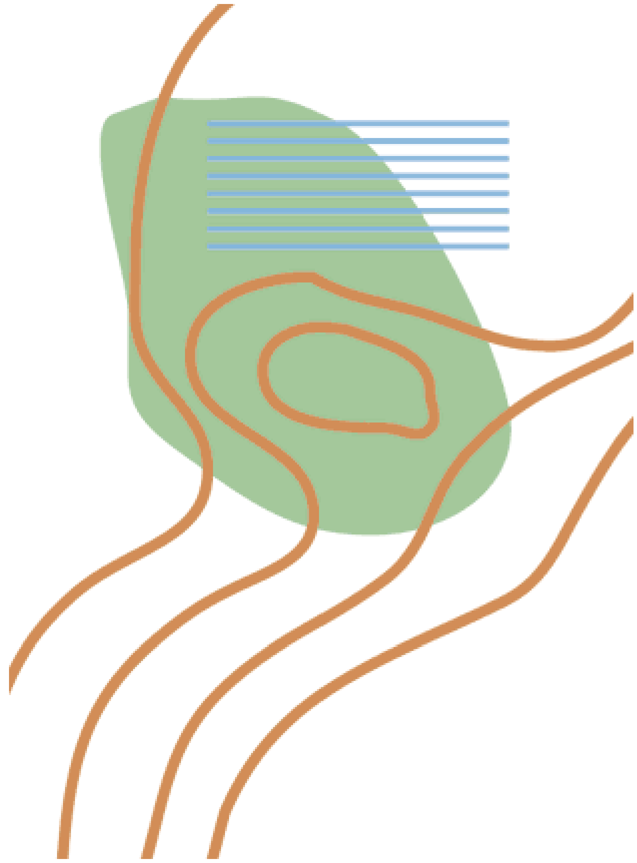
OCAD and other drawing programs use the PostScript page description language to send the map to a printer. Traditionally, as I have said, orienteering maps have been printed using spot colors – that is, each ink color is printed separately, and combined on the paper. We printed separations, five or more individual images, each representing a single ink color. Each of these images is actually a black and white or grayscale image, and the color is created by using the colored inks in the printing press, one color per separation or plate.

Composite color is a whole different kettle of fish. Instead of sending several different images, the program just sends a single image that is rendered into a color model that the output device understands. It need not be the actual color model that the printer prints in (e.g. CMYK), but it does need to be understood by the printer. For example, most ink jet printers use CMYK for output, yet require their input to be in the form of RGB color. A translation occurs internally in the printer.

Composite Color Pitfalls for Orienteering Maps

Overprinting colors

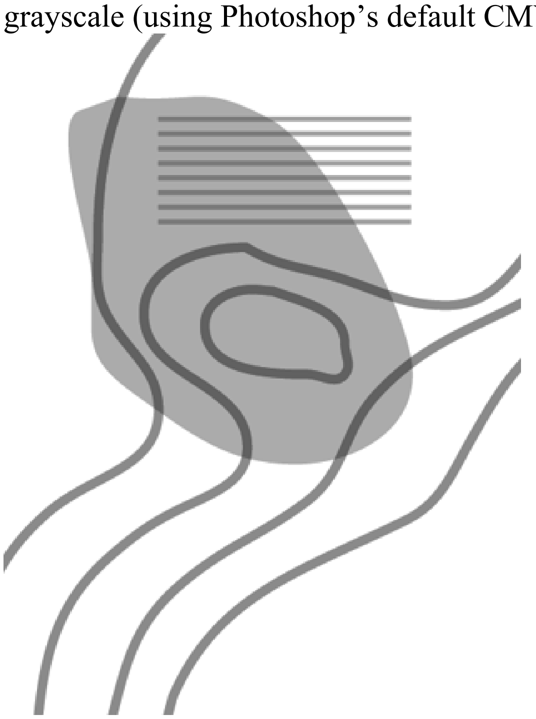
Now if you think about what happens when you print spot colors, especially when spot colors overlap, you might begin to realize that composite color is going to behave a little differently. As there is no universal behavior for what happens when one object lies atop another, composite color does not even try to address the issue. The top object simply obliterates whatever is printed before. PostScript has no command to tell it to draw one object on top of another as if the object were being made with transparent ink.

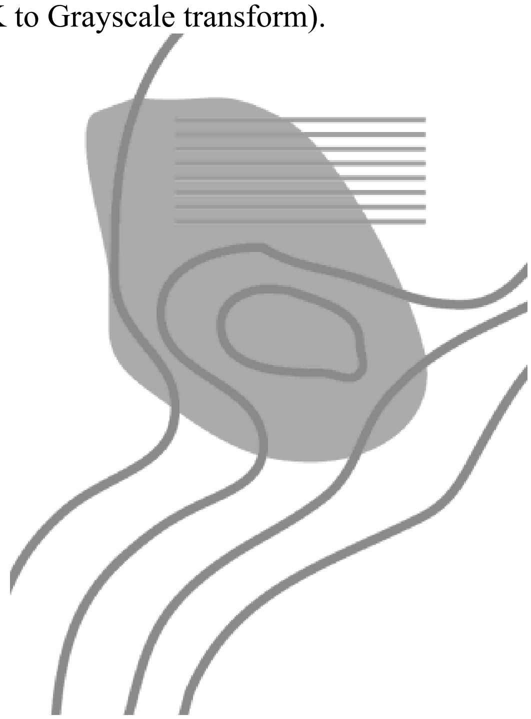


This is a very large pitfall for orienteering map printing in composite color, since orienteering maps rely heavily upon the build up of layers of color. Here is the same image as above as it might appear when printed from OCAD using the composite color option:

Notice how where the contours and marsh lines overlap the green they do not get darker. Indeed these lines may even appear to get lighter. There is also a shimmer effect at the transition between green and the brown and blue lines. These effects are largely the result of the way the light receptors in our retina are hard-wired together to enhance contrast.

One of my rules of thumb in cartographic design is that a map should remain legible when converted to grayscale. This forces me to give preference to the symbolic variables of brightness, line weight/symbol size, texture, etc., over color. Color is used to enhance symbolic differences, and to group symbol classes thematically, but is not the primary symbolic variable. Here are the two examples from above, rendered as grayscale (using Photoshop's default CMYK to Grayscale transform).



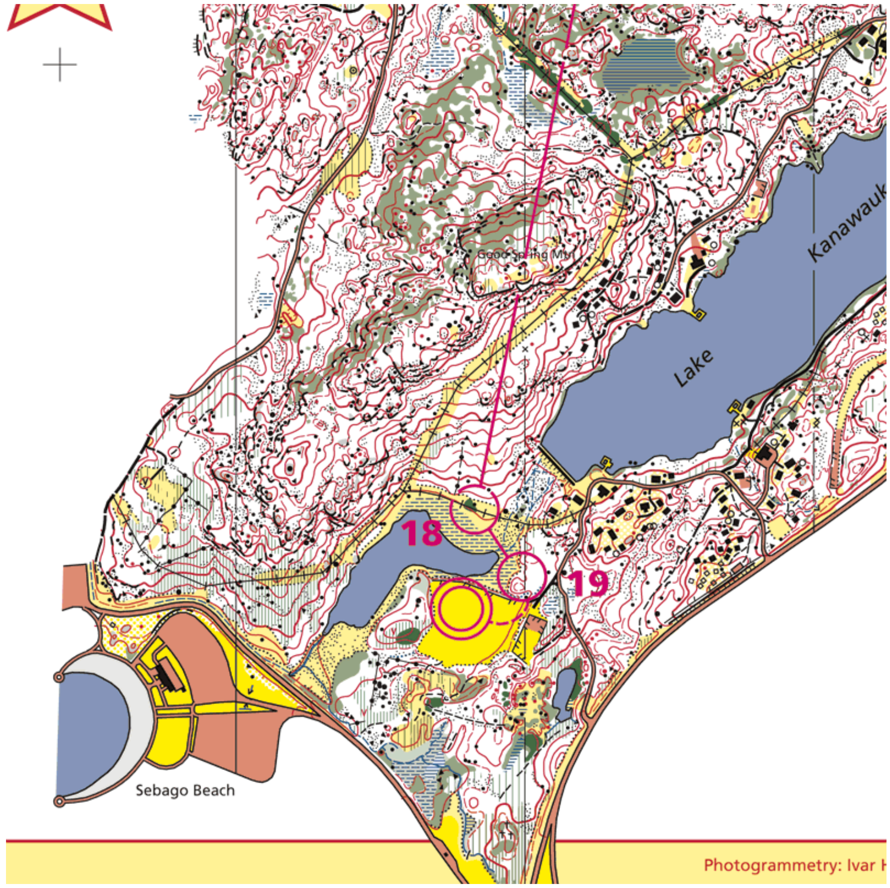


Objects Obliterating Other Objects

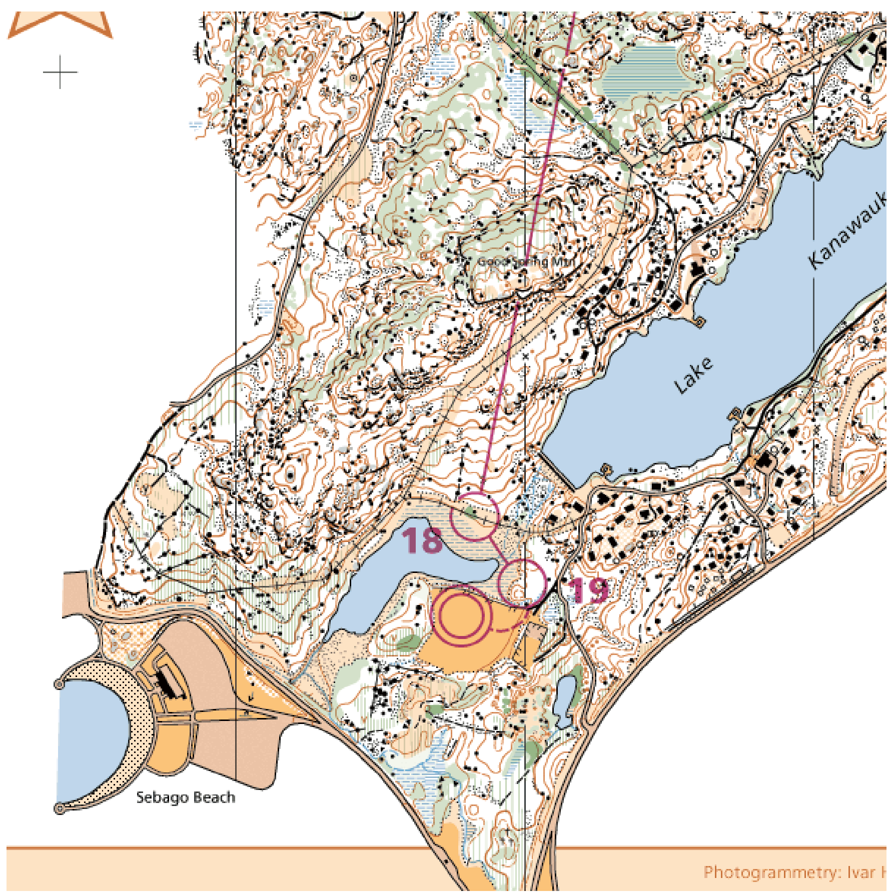
As mentioned above, in composite PostScript output, when an object is drawn, it obliterates whatever happened to be there before. The object being obliterated could actually be very important to the map reader. In this example, an uncrossable fence disappears under the purple line. Several people found themselves on the wrong side of this fence because of difficulties they had understanding the map.

Color Control

When you ask your software to produce CMYK output from spot color objects, you are at the mercy of that software's color conversion. The fidelity of this conversion is affected by a large number of variables. In practice, it takes a good amount of tweaking to produce accurate or even acceptable output colors. Here's a piece of the Surebridge Mountain map that I printed as composite CMYK color from FreeHand 9. I did not do any tweaking, although in theory, this is a color-managed workflow, mediated by the Kodak Digital Science system.



And the same map simulated as spot colors (using the technique described in the tutorial below):

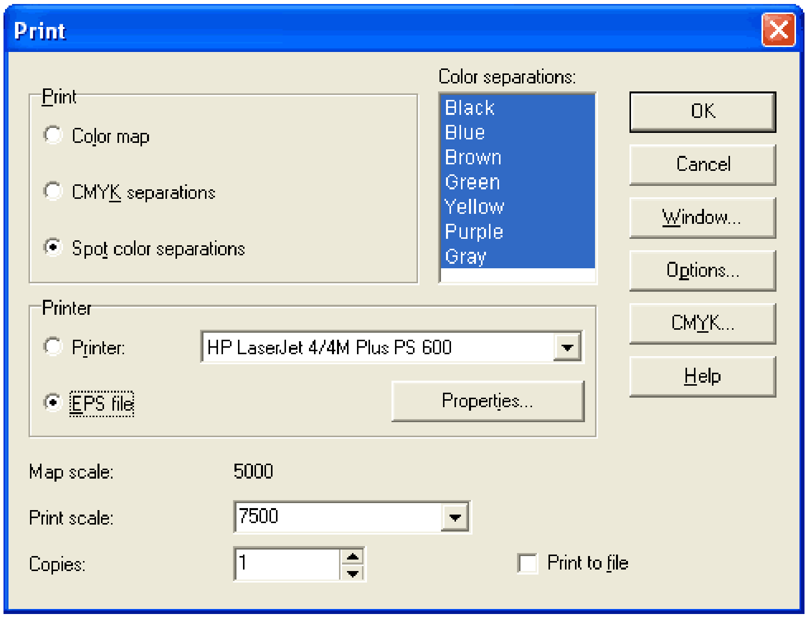


A Tutorial: Turning Spot Colors into Process Colors in Photoshop

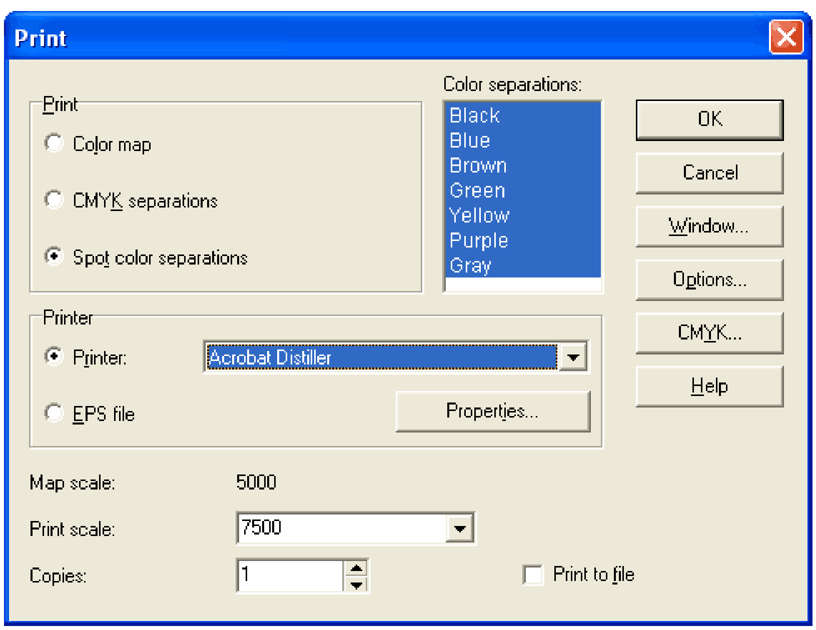
The process is identical to how a spot color map is created on a printing press, except that we are doing it in software. The originating software is commanded to produce PostScript separations, just as we would do for sending to an offset printer. Instead of sending those files to the printer, we render each one in Photoshop. We color each separation according to the ink color that it represents. And finally, we merge the separations into a single image. Once that is done, we can use it as a basemap upon which to overprint courses.

1. Producing PostScript separations

You can either save as EPS files from your originating application, e.g. (OCAD 6)…

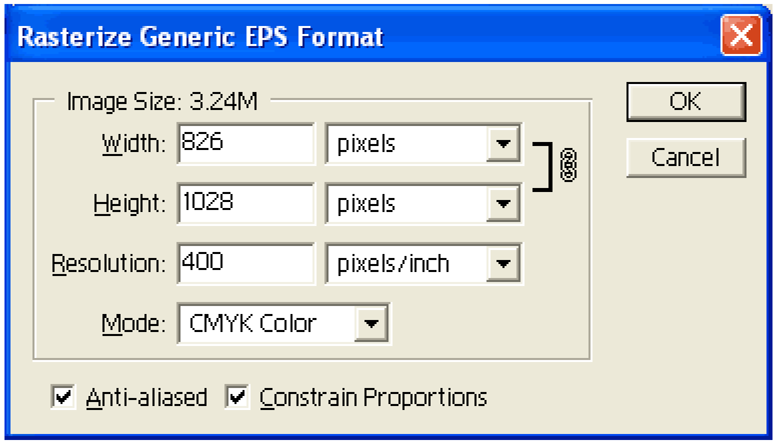


… or if you have Acrobat Distiller…



2. Rasterizing the Separations in Photoshop

In Photoshop, File>Open, and choose one of the *.eps files.
If you used Distiller, you can rasterized all the separations at once using File>Automate>Multi-Page PDF to PSD…

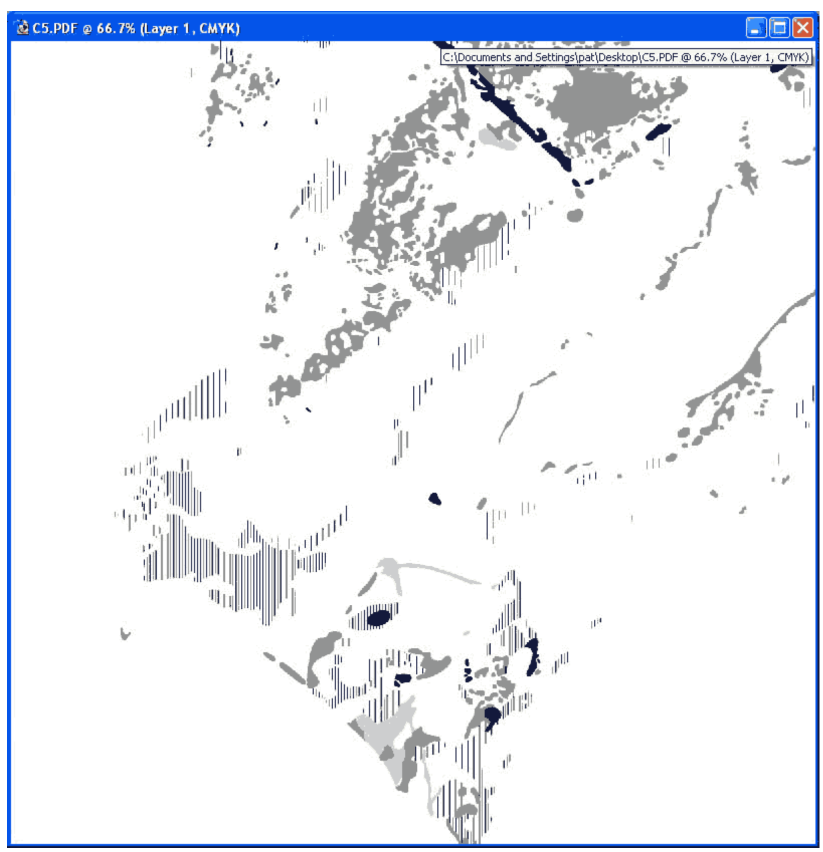


Choose a resolution that is sufficiently high so that fine black linework will be rendered accurately when printed. I would recommend a minimum of 300 pixels/inch. Choose Anti-aliased. Be sure to use the same settings for each file!

Note that if you are rasterizing EPS files, there are a couple things to watch for:

1. EPS files often to not contain, or correctly encode the fonts that are required, and Photoshop will refuse to rasterize.
2. Since EPS files are not full page descriptions, the width and height of each separation will vary somewhat. This will make it necessary to register the separations by-eye.

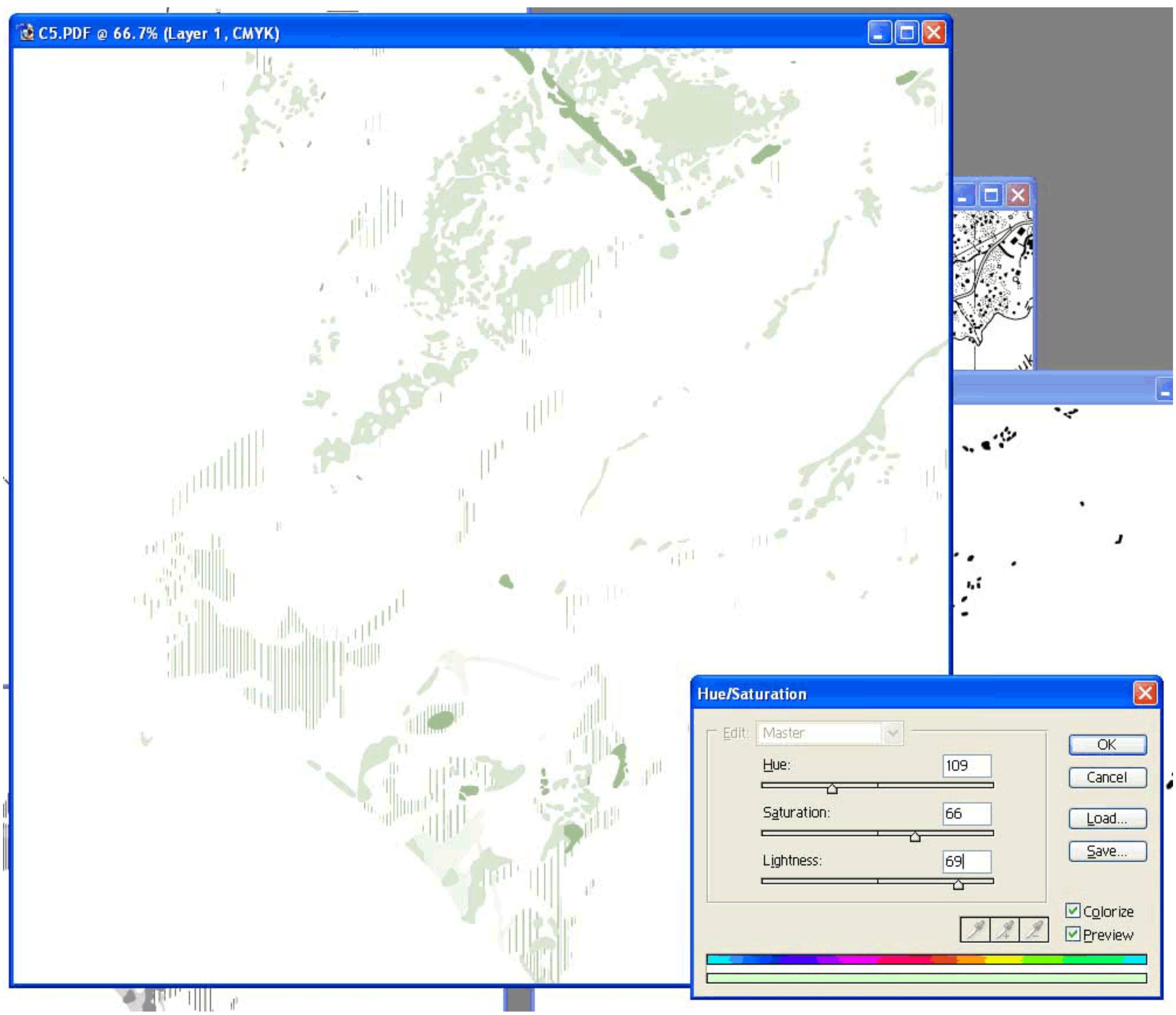
You should now have one grayscale image for each separation (color mode is CMYK however), as below:



3. Colorizing the Separations in Photoshop

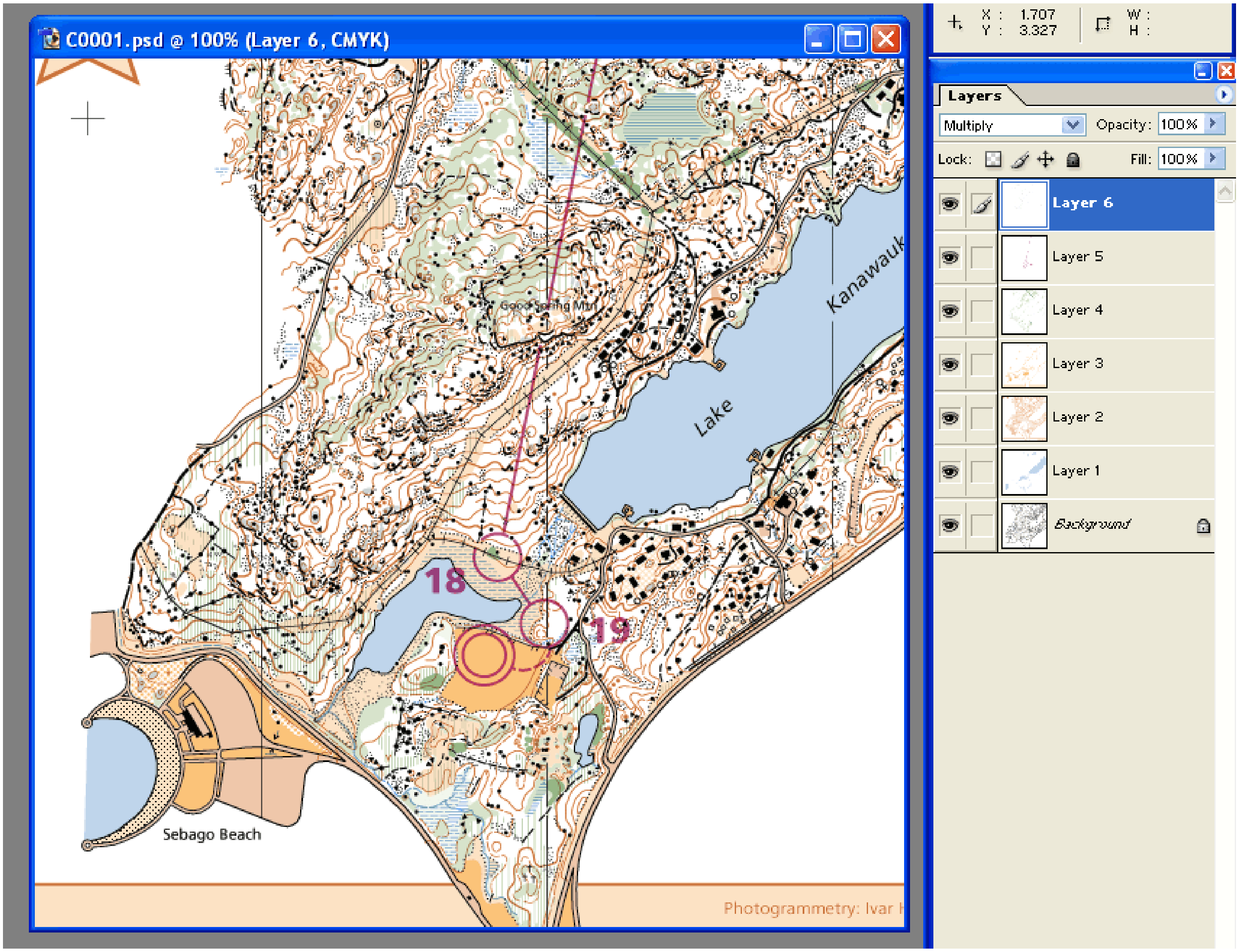
The separations are colorized using the Hue & Saturation dialog. Click on the "Colorize" checkbox. I use the following settings, depending on which color I'm trying to create. The separation names in the table are links to Photoshop Hue&Settings files, which you can download and Load, rather than having to key in the values.

Separation	Hue	Saturation	Lightness
PMS Process Black	NA	NA	NA
PMS 136 (Yellow)	37	100	72
PMS 299 (Blue)	196	100	70
PMS 361 (Green)	109	66	65
PMS 428 (Gray)	203	4	70
PMS 471 (Brown)	20	70	50
PMS Purple	292	100	55

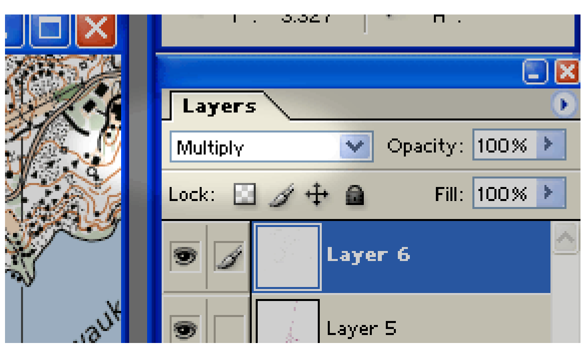


4. Merging the Separations in Photoshop

This is very straightforward if you batch-rendered a PDF file. If you are assembling EPS renderings, you will need to pay attention to registration between the separations. The basic idea is that you copy all of the rendered and colorized separations into a single multi-layer document.



The only other trick is to set the blending mode to “Multiply” on each layer.



5. Flattening the Separations in Photoshop

Flattening the layers is optional at this point. It will save you some memory, but if you need to tweak something, it will be much harder once the separations have been flattened into a single CMYK image.

Printing and Course Overprinting

To print the map, create a flattened copy (you might want to hang onto the layered copy though). Save a copy in a CMYK-aware format (the best is probably. TIFF - JPEG and GIF do not support CMYK). Now just print it as you would any document from Photoshop, or place the image into another program (e.g. Quark Express) and print from there.

To print courses, I would recommend using the same method as above, except that courses should be kept on their own layers. You can do limited editing on the course if necessary, e.g. move numbers. When you want to print a particular course:

1. Make the map layer(s) and that course layer visible
2. Save-As a TIFF: check “As a Copy”; uncheck “Layers”
3. Give it a name, e.g. “SurebridgeDay1Blue.tif”

Last modified: 11/18/2002

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