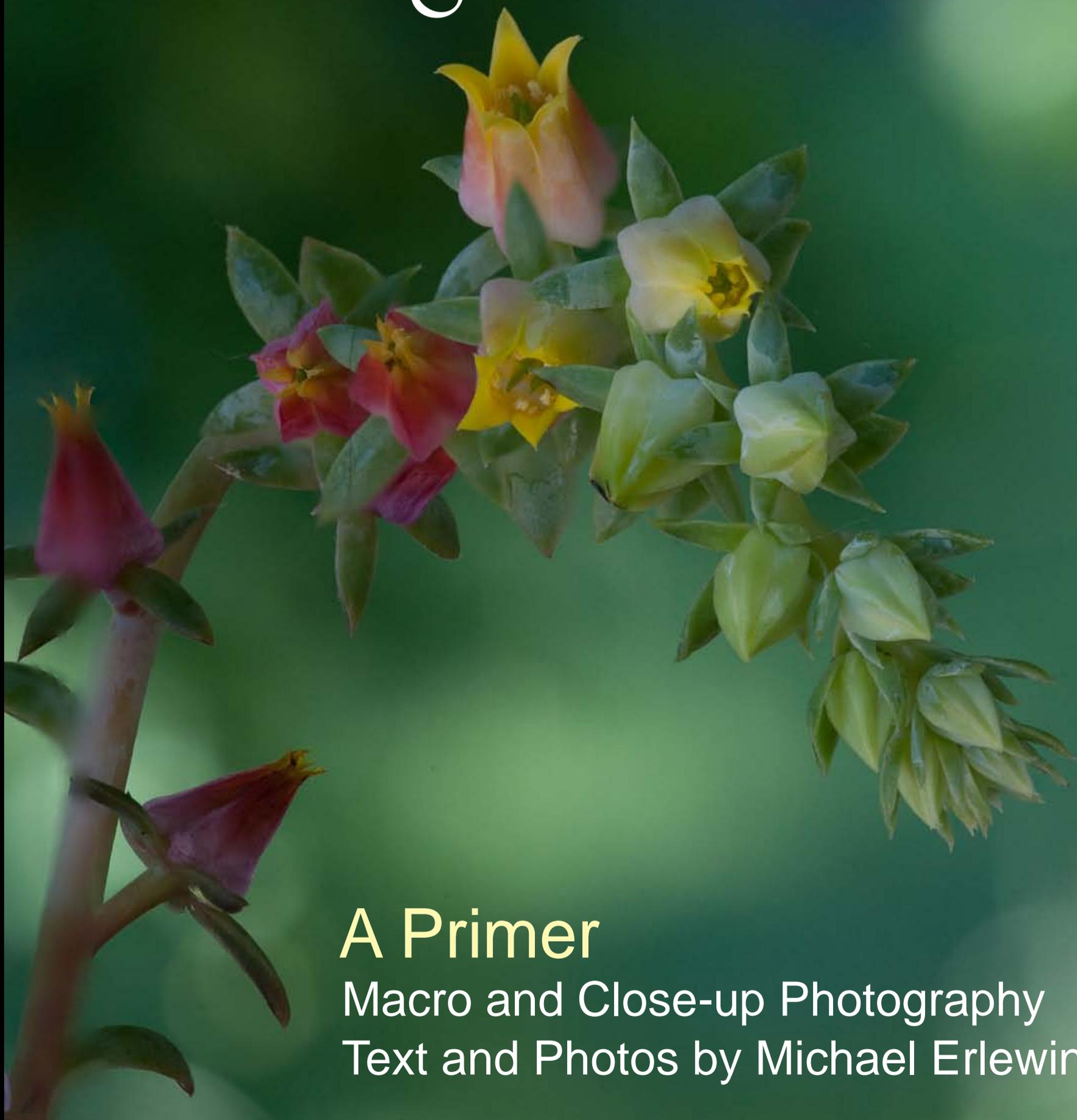


The Art of Focus Stacking



A Primer

Macro and Close-up Photography

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Photo: The Earthwork Farm in Lake City, Michigan

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Introduction

Focus Stacking

Interest in 'focus stacking' is increasing rapidly. In this short article, I would like to suggest some reasons why this might be. For those of you unfamiliar with focus stacking, let's make clear what it is.

Just as exposure bracketing and HDR (High Dynamic Range) techniques, where a number of photos are taken at different exposures and then seamlessly combined into a final photograph are popular, so focus stacking takes a series of single photos of an object each taken at a slightly different focus points and combines these photos seamlessly into a final photo that represents the object with everything in focus, as if it naturally had greater depth of field (DOF). This requires special software to align the series of photographs and merge them into a single resulting image.

Focus Stacking is essentially 'focus bracketing' and the result is a photo where everything (or more than you might expect) appears to be in focus as opposed to the traditional photograph where there is only a single plane of focus and anything not on the plane is to some degree out of focus, however slightly. The resulting stacked photo (from combining the images at different focal distances) can be remarkable, and advances in focus-stacking software like Zerene Stacker, Helicon Focus, Adobe's Photoshop CS4 are perfecting this technique.

Two Types of Focus Stacking

There are two general types of focus stacking being used today, with perhaps the most common idea of this technique including a camera mounted on a focusing rail (or a lens with bellows attached) and the photographer taking many dozens (sometimes up to 150-200) photographs, each one just a few millimeters apart from one another. This first technique is used mostly for scientific, product photography, and by a few naturalists who carefully create deep stacks, usually in a studio, like the one on the left, which is very lovely.

And while this more elaborate form of focus stacking is wonderful in its own way, it requires more specialized equipment and does not readily lend itself to being used outside in the fields and woods or at least is more difficult to take outside. There are many tutorials on the web for this type of more-technical style of focus stacking available, so I refer you to Google to find those. For myself, I am not much interested in that method because I don't want to haul all that equipment around and prefer being outside to being in a studio.

It is also possible to stack photos and get excellent results armed with just a camera and a tripod. This will be the method presented here. I will present some guidelines to what I call "Short-Stacking," where instead of 100 layers painstakingly shot to achieve perfect incremental focus (a science in itself), we shoot just a few (let's say from two to a dozen) photos and combine those to achieve the effect of seeming great-

er focus and depth of field (DOF). This less technical approach is (by definition) somewhat more impressionistic than the first method I described because no attempt is made to get every possible micro layer-step photographed. Focus stacking requires that nothing moves. In nature (as we know) this is very difficult due to wind, changing light, moving creatures, and so on.

With short-stacking we shoot fewer photos, choosing which layers in the scene we want to capture and have in focus that represent our impression of what is key or beautiful about the particular shot. To my mind, although less demanding, there is somewhat more art in this method, but that is just my opinion. I like it because I can be out in the wilds of nature without a lot of equipment and still produce photos with an apparent greater focus and depth of field, thus: focus stacking.

The Equipment Needed

While theoretically you can stack focus with any digital camera, in reality the process quickly sorts itself out in favor of better cameras and (for sure) sharp lenses. After all, the 'focus' in focus stacking means trying to get things sharply in focus and that requires a lens that is actually sharp and a camera that can process the light from the lens efficiently. In practice any decent digital camera with a sharp lens will work, but like everything else, it is easy to fall into the pattern of wanting a better camera and (in particular) better and sharper lenses. And let's not forget about tripods.

While some few photographers who focus stack make a virtue out of hand-holding their shots (Look mom, no tripod!), the rest of us will find that we want our camera and lens mounted on a stable tripod. With all of the other variables in this technique, trying to hand-hold the camera is not something I would choose to do. In this presentation good focus stacking requires a tripod. After all, we want the scene to hold perfectly still while we sample shots at different focal distances. Having the camera also shake and move around simply because I am holding it does not interest me. Therefore I suggest one needs a camera, a good lens, and both of those mounted on a sturdy tripod.

The Actual Technique

Given that you have the camera securely mounted on a tripod, the technique is pretty straight forward. You aim the camera at a scene you like (whether close-up as in macro photography or farther away as with landscape) and proceed to take several carefully-focused photos at various focal distances. You will need to decide what part of the scene you want to have in focus, which for a landscape shot may be the whole thing, but for a close-up shot it could be just a flower. Let's use a flower or a leaf as an example.

Starting at the very front-most part of the flower, carefully focus at that front edge and take a shot. Next, using the focusing ring on your camera, move it just enough to focus a little deeper into the subject and take a second shot, and so on, until your final shot is one of the far (rear) edge of the subject.

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You now have a series of photos each with a different focus point running from the front to the back of the object. In each shot, part of the flower is in perfect focus while the rest of the shot (to some degree) lacks focus. You might have as few photos as two or as many as you like or feel you need. As mentioned earlier: if you get into dozens or hundreds of shots you probably need to have special equipment, chiefly some kind of focusing rack to mount your camera on that allows tiny evenly-spaced incremental movements, etc. For reasons given above, I am not going there in this article. Here we will work with just a camera and tripods.

Once you have taken several layers of shots you are ready to process the layers into a single photograph. You do this back home on your computer using special software which you will need to have. Some brands of focus-stacking software include:

Adobe Photoshop CS4
CombineZM
Helicon Focus
Zerene Stacker

I have tried all of the above software and while they all seem to work, each has its quirks. CombineZM is free (GPL) so you might want to download a copy, but it lacks the polish and ease of use (IMO) that I look for in a program. The most well-known application that can process photo stacks is Adobe Photoshop CS4 (and higher), which is easy to use but it is not free and also runs very slowly when building stacks. There is a general review of focus-stacking software later in this article (including how to stack in Photoshop) but all of the above-listed software do more or less the same thing, which is to align your stack of photos and merge them. The program I use almost all the time is Zerene Stacker, but all of the above can do the job more or less well.

Software to Align and Merge

Using the focus-stacking software, each of the stack of photos that were taken needs to be lined up - aligned. Every time we turn the focus ring, the whole image is enlarged (or shrunk) depending on which way we turn it. While each layer is a photo of the same object, these photos are enough different that they don't just automatically line up. They have to be aligned, one with the other. Once the stack of photos are in the stacking software (each one in a different layer), the program has to do two things and in this order. First the program will align all of the different photos so they line up with one another internally. This can take a long while in Photoshop but Helicon Focus and Zerene Stacker are very fast.

Once the layers are aligned then the aligned layers are blended to merge the separate layers into a single photo which we then flatten and save to our hard drive. It is as simple as that although these operations can take a long time depending on the number of layers and the subject matter. Something with a lot

of contrast and detail is easier for the software to align than say a pile of sand where there are not many reference objects. It all depends. Some take seconds while others can take 30 minutes or more. Photo stacking, like macro photography itself, is a lesson in patience, so if you are in a hurry I don't suggest it. For me it has been good because I need to learn to have more patience and this is a fun way to do that.

The Result

So there you have the general technique which as you see is actually pretty simple. The tricky part is learning how to get the results you imagine rather than the results you actually get. Focus stacking is a natural teacher about expectations and real-world experience. You don't always or easily get what you want, at least I don't.

However focus stacking can deliver stunning results when all goes well. I find it worth the effort but don't imagine that focus stacking is the only kind of photography I do. There are subjects that lend themselves to stacking and those that do not. I already knew something about traditional depth-of-field photography and wanted to add this new technique to my skills. In this article I will try to illustrate (using photos) some of the ins and outs of focus stacking which hopefully can make your experience of this fascinating technique easier.

Before we get into some of the technique of focus stacking, I would like to present a possible reason why focus stacking is so appealing to the eye. Every person of my age has a natural right to have a theory or two.

A Possible Theory

Human vision can only focus on one area of a scene at a time. No matter how much we take in, no matter how much is going on around us, our eyes can only focus at one point at any given time. Everything but that point of focus is, to some degree, out of focus. Just try it now. Look across the room at an object and note how your peripheral vision on either side of the object is slightly out of focus. We are so used to this phenomenon that we are seldom even aware of it.

Although everything around us actually is not in focus except where we look, this does not affect us because wherever we look, things are in focus. The mind automatically behaves as if we live in a world where everything is always in focus, because as we look here or there things are always in focus, which brings me to my point:

The photos we take, at least at near distances, are seldom in complete focus. In fact we have no choice but to focus on one area of a scene or another and all other areas will be at least somewhat out of focus. This is why photographers make such a big deal out of depth of field (DOF). In particular macro photographers struggle to get this beetle or that butterfly (in its entirety) in focus. We push our f-stops so high that diffraction often destroys our resolution before we can

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get everything in focus. Enter focus stacking.

Focus Stacking creates a photo image where most everything is in focus, just like our mind assumes the world out there is, as well – in focus. While with most photos we are drawn to wherever the photographer happened to focus, given a stacked photo we are free to look anywhere we want. The photographer no longer dictates where our eye should go by his personal point of focus and we are at liberty to just kind of look around as we like, like little kids.

This newfound freedom brings a kind of spaciousness to the mind and stacked photos can have an almost 3D quality, when really the only thing new is that the whole picture (or at least the main subject) is more in focus than we are used to. Let's look at examples of stack photos and some of the things to keep in mind.



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Traditional Depth of Field

It would take a whole section to properly explain the main factors that make up a standard macro photo, which are Depth of Field, Aperture, Distance, and Focal Length, not to mention their interdependence. Wikipedia has a fair explanation and some very good external links that present this. Suffice it to say that there is no magic bullet or solution to the problem of wanting subjects to be in greater overall sharpness, DOF, or whatever we want to call it. There are only different approaches, each of which gets us part of the way there, and each of which has inherent problems.

The theory and practice of obtaining maximum depth-of-field in a photograph is complex and will not be discussed here. Often what macro and close-up photographers want is not so much more depth of field as simply more of the object they are photographing in focus. Call it what you want.

Let's say you have a lovely katydid close-up and the only thing in focus is its eye. The rest of the insect is in varying degrees of blur. What we want is more of that katydid in focus. How do we do that? There are several traditional ways.

One way would be to get in very close with a wide-angle lens. Wide-angle lenses tend to put more of everything in the frame and in greater focus. The problem is that wide-angle and macro are to some degree opposites because wide-angles lenses by their very nature try to step-back and cram more into the frame while macro lenses are just trying to get in closer. By getting very close with a wide-angle lens (with a very short minimum focus distance) you can get some good effects. When picking a wide-angle lens you want to ask: "What is the minimum focus distance for that lens?" If it is less than a foot, the lens may be helpful in macro and close-up photography.

A second way to get more in focus is to use a telephoto and get back far enough so that the whole object you are shooting is in focus at that distance by using a higher aperture (like f/11) to gain greater depth-of-field. Using a 300mm lens at f/11 from several yards and a camera body with enough megapixels, you can crop out the small part you want. This can sometimes do the trick. Again, when picking a telephoto lens for this kind of work you want to find one with a very short minimum focus distance. When using a long lens you will have to stop the aperture down to get everything in focus.

The problem with pushing the aperture to higher numbers like f/16 or f/22 is that at the high end of aperture we run into diffraction, which by definition destroys sharpness. I won't lecture about diffraction here, but do look it up on the Internet. In a word diffraction is about how rays of light bend around an object when coming through a very narrow aperture and manage to get in each other's way. The result (for our purposes here) is that with high apertures sharpness rapidly degrades and we lose what we tried to gain by going

to higher apertures.

Typically a lens is most sharp around f/4 or f/5.6. Better lenses can still resolve sharpness (despite the onset of diffraction) at f/8 and even f/11. Beyond that few lenses hold up. This does not mean that we don't use higher apertures, but just that we have to consider whether sharpness is absolutely important in any particular shot. With my best lenses I typically push the aperture to f/8 and f/11 to get greater sharpness and depth of field.

The modern digital SLR (DSLR) evolved from the 35mm format film camera and that format essentially covers a range from 35mm to 65mm, with 50mm being the center of that range. The 35mm format was designed around the fact that the 50mm lens is considered the "normal" lens because the human eye sees at a focal length of about 50mm. Any lens less than 35mm is considered wide-angle, and any lens larger than 65mm is considered a telephoto.

Sharpness

Sharpness is a topic that photographers endlessly discuss on Internet forums. To understand sharpness we only need to consider the term "acceptable sharpness," as in: what degree of sharpness is acceptable to you. Every analog (non-stacked) photo has one and only one plane in the photograph where things are exactly sharp. Every other plane in that photo (on either side) is gradually relatively less sharp until it becomes blurred. Even a wide-angle lens, where most everything may seem to be in focus, there still is only one plane that actually is in exact focus. All other parts of the photo are relatively blurred. It is a question of what you consider acceptable sharpness, sharpness good enough for you. Only in non-analog photos such as focus stacking do we find more than one plane sharp.

The plane of focus is always at right angles to the plane of the camera sensor unless we explore view cameras or tilt/shift lenses for DSLRs that let us twist and angle that one focal plane this way and that to achieve very interesting effects.

So we have one plane of focus in every photo and the areas in front of and behind that plane that are also in "acceptable focus" make up our depth-of-field, which may be very shallow or very deep. Obviously a lens set to infinity shooting a landscape has a very deep DOF while in general a lens focused close-up has a more shallow DOF.

And we don't always want everything in focus. In fact, aside from "sharpness," the other term often discussed by photographers is "bokeh," which refers to the lovely out-of-focus areas behind your subject. Lenses have a good or poor "bokeh" and the relative bokeh of various lenses is fiercely contested. Bokeh is like the difference between the harsh camera shots of a newscast and the soft feathery feel of many movies, where the subject is in focus against a wash of blurry and lovely pastels. Even when focus stack-

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ing, we learn to drop some of the back layers and just have a nice bokeh.

In taking a photo, we first select a focus point; we focus. Then, and only then, we decide on how much depth of field we need by adjusting the aperture. Of course, due to various light and other conditions we don't always have much choice in the real world. But theoretically we do.

If we go wide-angle, we have more depth of field and if we go telephoto we have a more narrow depth of field. That is why with wide-angle lenses there is often little to no bokeh because everything is too much in focus. And with telephoto lenses we can have the subject in exact focus against a nice blurry background – good bokeh.

When we are close up, we tend to have a very narrow DOF, while shooting at a distance with a narrow aperture gives us a wider depth of field ; more of the subject is in focus.

And while this topic is too complex to go into here in detail, there are three factors that help to determine your depth of field: aperture, focal length of the lens, and distance to subject. They can be summed up in this table.

Narrow DOF	Greater DOF
Large Aperture	Small Aperture
Telephoto	Wide-Angle
Close-up	Far Back

As you can see, we can get greater DOF by using a small aperture, a wide angle lens, and by standing far back. However these three factors don't all work together smoothly for close-up work. If we stand far back with a wide-angle lens set to a small aperture we get a great depth of field of whatever is at infinity but it won't help us in macro and close-up photography.

For close-up work we have to mix and match techniques to get any kind of depth of field and the history of photography is filled with attempts to push any of these approach as far as possible, which brings us to Focus Stacking.

Focus stacking is a non-analog (digital) approach to taking photos with increased sharpness and the appearance of greater depth-of-field. Actually, focus stacking is a sampling technique similar in approach to CDs and DVDS in that an analog (reality) source is sampled with enough to approximate a desired result. With CDs the desired result is music, with DVDs it is movies, and with focus stacking it is a composite photo with enough samples to give the impression of greater sharpness and depth of field.

Beginning

It has been several years now since I intensively began to work with focus stacking to achieve better all-around focus and at least the illusion of greater depth of field. For myself I have learned a lot about this apparently simple but demanding technique. Focus stacking originally arose as an in-studio technique where

bellows and incremental focusing rails were used to take hundreds of micro-stop photos that were combined to create a single ultra-close-up photo of something like the compound eye of a bee or dragonfly or whatever. Since I already spend enough time indoors, that approach was not all that appealing to me. Also, a couple of dozen images of various compound insect eyes were plenty for me. I got the idea.

I was more interested in how focus stacking might be applied to outdoor nature photography using a much smaller series of photos and doing away with the bellows, focusing rails, and what-not. I was not so interested in ultra-close-ups of anything as I was in getting a little more depth of field out of whatever I was photographing, whether it was an insect, a flower, plant, and so on. I wanted more of whatever I was photographing to be in focus. I like what I call "mini-landscapes," small worlds where everything is pristine and... in focus. That was the intention.

I use Nikon systems and back then I happened to have the Nikon 105mm f/2.8 macro lens and that is where I began. Any lens can be used to stack photos, but generally this technique excels at close-up and macro ranges. You can stack landscape photos (and to good effect) but of course at a distance even the tiniest of change in the focus has a huge effect. In other words, once you get out toward infinity the number of the stacked photo images that are effective are few to none. This is generally true of many wide-angle lenses as well.

Wide-angle lenses by their nature have greater depth of field, and turning the focus even a small amount changes the image greatly. Although I am learning to stack photos using wide-angle lenses, you really need a wide-angle lens with a long focus throw to do this easily or mount the lens on a focus rail and do it that way. Few wide-angle lenses have a long focus throw.

In general, the focal length range of lenses that works well for focus stacking in my experience are from 60mm to 200mm and then only if these lenses are dedicated macro lenses. Keep in mind that there are Nikon 105mm lenses that are not macro lenses and that do not get close enough to smaller subjects to make them worthwhile. So do be careful when purchasing a lens for macro work to make sure it is a true macro lens and not just a standard lens. Also some lenses claim to have a macro option, but I suggest you avoid these as well. If you love macro and close-up photography, just get a standard macro lens.

Investment

Macro lenses can be had on the cheap, so to speak, because in macro photography (and absolutely in focus stacking) only manual focusing is used. Auto focus is not needed or desired. Because most photographers today think only in terms of auto-focus lenses, a good Nikon 105mm f/2.8 lens can be found on Ebay for between \$200-\$300. Of course you can pay a lot more, but you can do fine macros with the Nikon 105mm macro lens or the Canon equivalent.



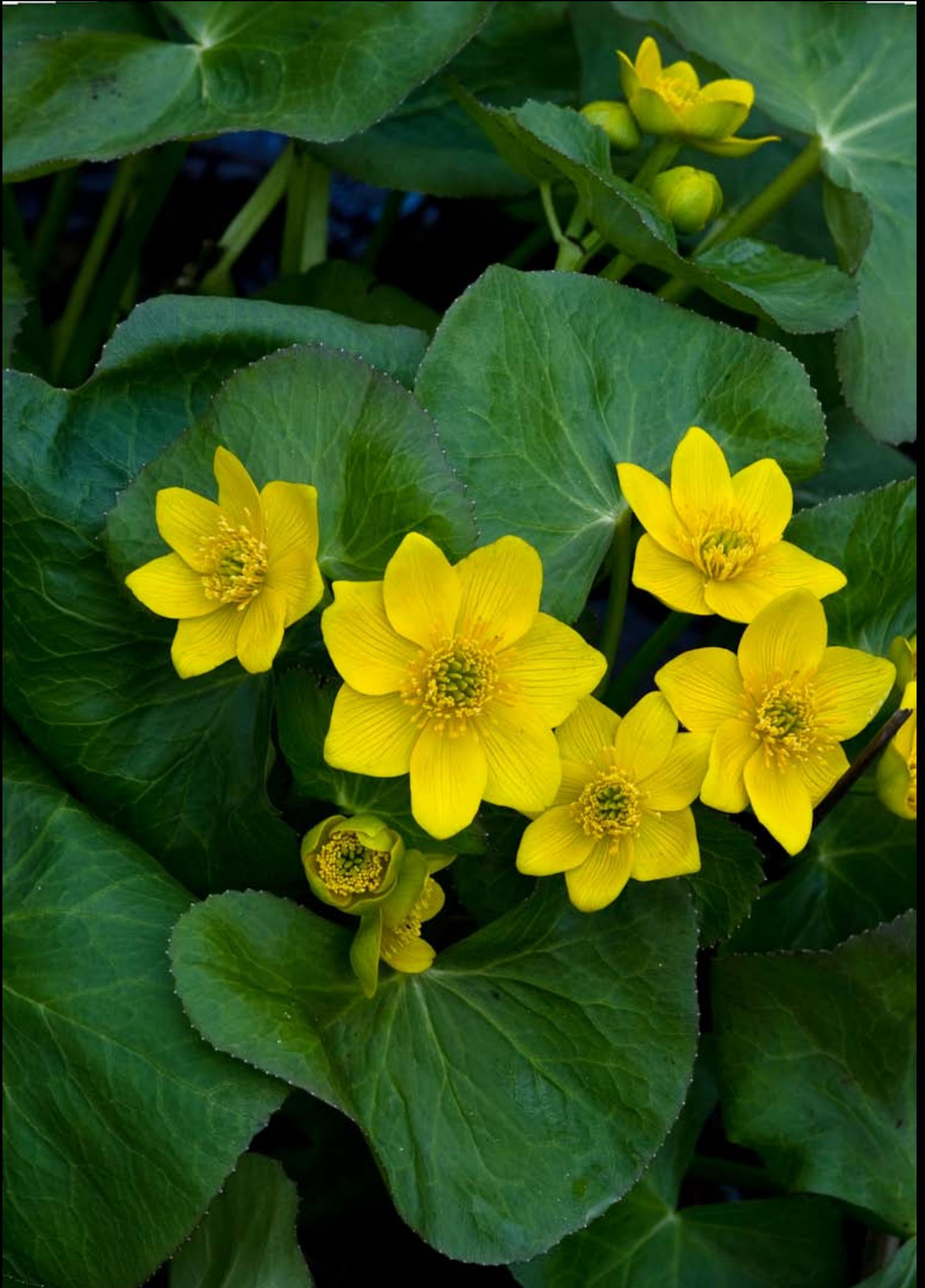
Example of “Deep Stack” Focus Stacking

A Deep Stack Using a Focus Rail by Ed French

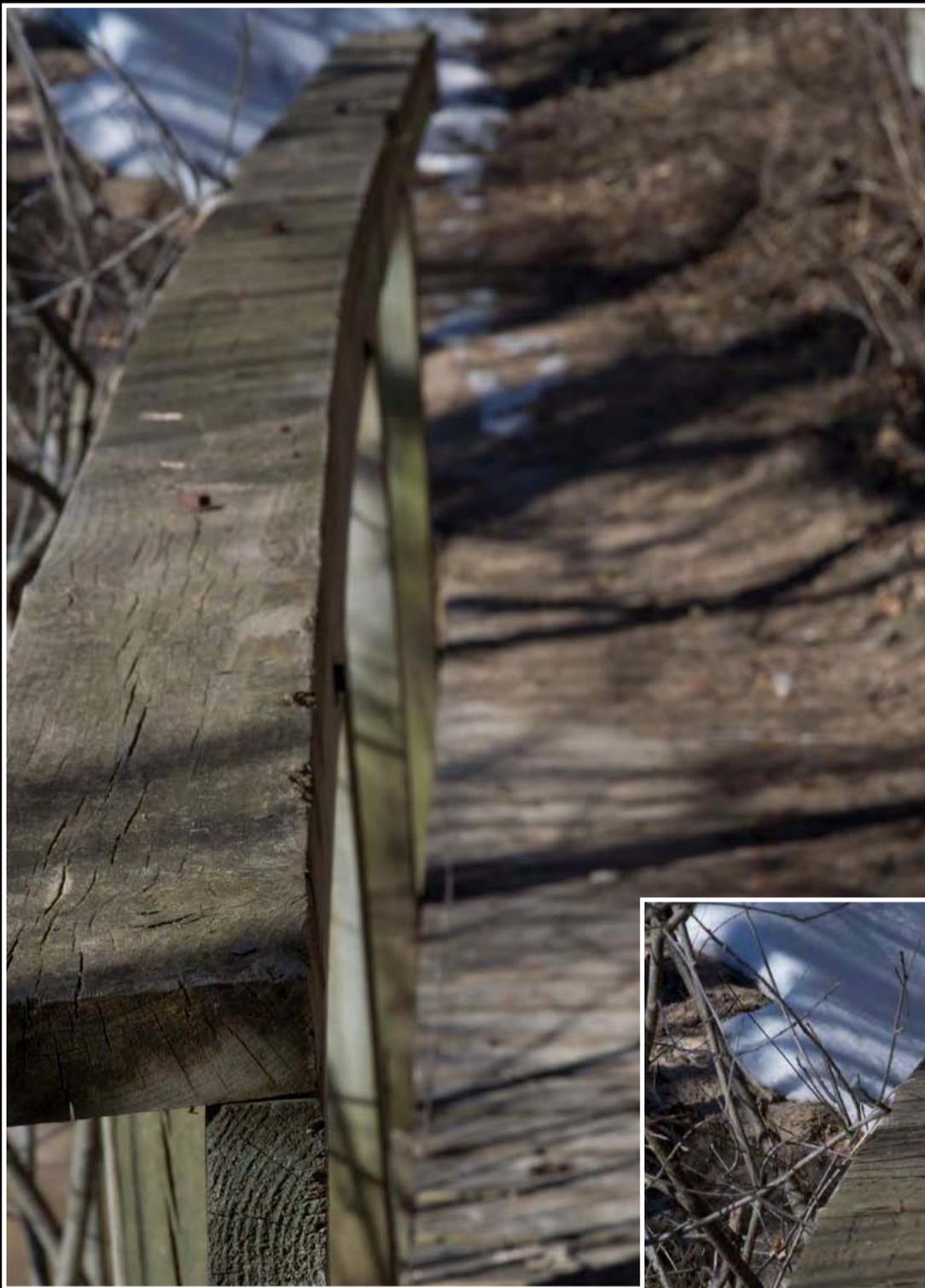
This is a 67 image pano where each image had a generous overlap > 50%. The center was shot at f/5.6 and focus stacked from another 55 images. After the center images were taken, the artist switched to f/22 and shot the 66 individual frame for the rest of the pano. See more at: <http://www.efrench.members.winisp.net/> Used with permission.

Stacked Photo with Good Bokeh (Bow-Kah)





Focus Stacking: An Example



Above: Near Shot

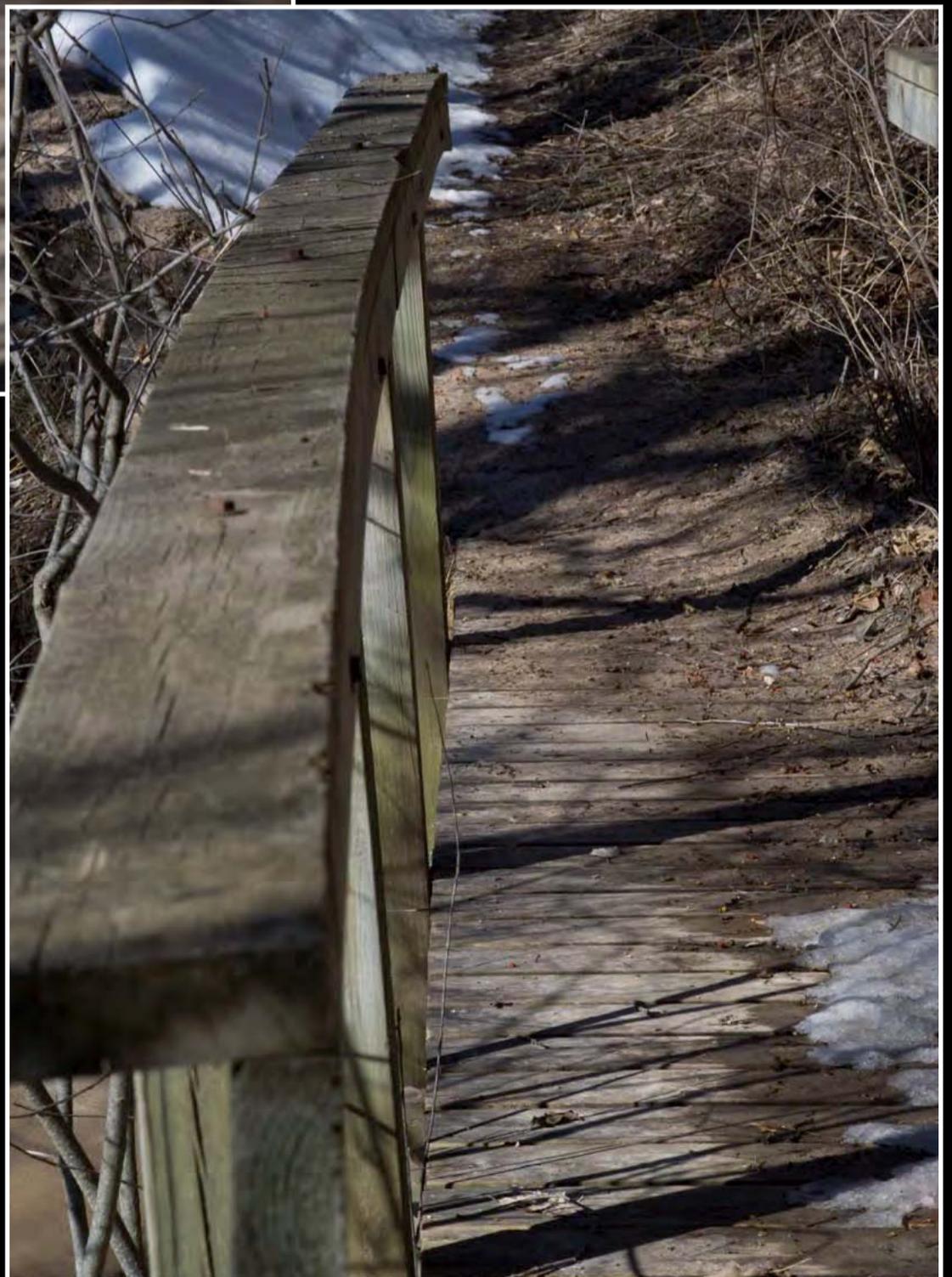
The Simplest Stack

Here is a stack of two photos, a near shot (above) and a far shot (below). Stack the two together, blend them, and we get the finished shot on the right side of the page. Pretty simple: two quick shots combined to give you a depth of field it would be very difficult to get otherwise.

The result composite photo puts the railing, the board walk, and even the background in decent focus. This lends a sense of space and clarity to the shot.

Note: With a good 60mm lens you might be able to get this depth of field without stacking.

Below: Far Shot



Result: The Two Shots Combined in a Single Photo



A two-Stack Example



Here is a photo of a little spring diorama of some Michigan ferns emerging. Notice how the ferns in the front are in focus on the left but those in the back are not. In the right photo the ferns in the rear are in focus but those in front are not. Our eye is drawn to the area in the photo where everything is in focus. Trying to get the whole scene into focus through manipulating the DOF would be difficult if only because the woods where these ferns grow is quite dark.

Now let's look at a stacked photograph that is a blending of four different photos, each focused on different areas of the scene. As you can see, at least the main subject (the various ferns) are in focus. But notice the ferns midway between the front and back ferns are somewhat out of focus. In stacked focus, unless you shoot hundreds of photos, not everything will be in focus, but you can choose what is and what is not in focus. Here the two groups of ferns (front and back) are in focus, which makes for a nice effect.

As you look at this photo, see how appealing it is to have things in focus and to be able to look around the scene as opposed to being denied that freedom by having some areas of the photo out of focus.



I point this out because I believe that focus stacking or focus bracketing will (in time) become at least as important to us as HDR or exposure bracketing have up to this point.

Camera makers may eventually even include focus bracketing as a feature where, perhaps, we focus on the front and back areas of any scene or object and the camera produces a series of bracketed photos with the focus at different layers between the two points we set. We would tell the camera how many layers or photos we want. This could be very useful because one of the problems of focus stacking is taking the photos fast enough to capture the images before changes in lighting, etc. set in. This would be a poor man's focus stacking because in reality many of the best macro lenses do not autofocus, and so on.

So far the results I am getting are pleasing to me. The example used here gives you some idea of what a stacked photo can look like. In fact, farther on we will look at a bunch of stacked photos so that you can get an idea of what they look like and what subjects lend themselves to focus stacking.

Result: The Two Shots Combined in a Single Photo



Focus-Stacking Software and Pricing

Focus Stacking Software

There are a number of software applications that do focus stacking and probably more will be coming along. I don't have time to learn them all but I would like to know which ones work the best for my purposes which are small to mid-sized stacks of close-up and macro subjects. I only need one good software application but to find that I have had to experiment. That being said, here is a brief summary of three of the main contenders, Adobe Photoshop, Zerene Stacker, and Helicon Focus. Perhaps this will save you some time and expense.

Let me start right off by popping one big bubble: the idea that you can do quality focus stacking without any ever retouching. No software I have tried will do that and here is the main reason why. Focus stacking (short of an infinite-numbered stack) by definition leaves out of perfect focus whatever areas are between the focus layers. If you have layers, you have something between them that is not in perfect focus, theoretically at least.

If you want a perfectly smooth image, one with nothing left out, well, that is your standard traditional photo. However, the traditional photo has a single plane of focus. Even a very wide-angle lens, while having everything more in focus than longer lenses, still has areas of focus and areas out-of-focus. That is the reality.

Focus stacking by definition is a form of sampling, just like we sample sound or movie frames. Streaming them together (digitally) produces the effect of seamless music or motion pictures but in reality they are still a series of samples that only give us the impression of seamlessness. We live in a world of sampled impressions.

Therefore no focus-stacking software will be without artifacts however small or difficult to detect they might be. Even if you string 200 layers of images together, there will be minute discrepancies, although we may not be able to detect them with the unaided eye. Few of us may want to do 200-layer stacks as they generally require a studio, a focus rail, special lighting, etc. Many of us want to be out in the meadows and woods and not in the studio.

My point is that to stack focus and expect no flaws is an oxymoron, conceptually. The question is what software gives me what I need with the least amount of compromise. With that in mind let's look at three of the major focus-stacking applications:

Adobe Photoshop CS5 (CS5)
Zerene Stacker 1.2 (ZS)
Helicon Focus 5.1 (HF)

Note the acronyms which I will be using in this article. All three of these applications are capable of producing acceptable stacked images that range in quality from moderate to exceptional. As mentioned, none of this stacking software is equivalent to a point-and-shoot camera in that you press a button and can count

on a perfect or even a good stacked photo every time. In other words, some operator judgment and experience will be required. How much depends upon how perfect a stack will satisfy you.

I can testify that any search for perfection will lead to a greater expenditure of time, learning, and experience. And stacked photos that we find satisfying today probably will not satisfy us a little farther down the road. There is both a learning and a perception curve to focus stacking in my experience.

The Time it Takes

Let's start with time. How long does it take to align and blend a stack of images in these three programs? Both Zerene Stacker and Helicon Focus are fast, really, really fast compared to Adobe Photoshop CS4/CS5. If anything, Photoshop CS5 takes longer than CS4. For example, a stack of 8 images took between 30-40 seconds in both ZS and HF but took over 28 minutes in CS5. Folks, that is a big difference!

And a stack of 36 photos in CS5 sent me to bed and in the morning it was still chugging away. I finally just gave up and shut down the program. So if you want real-time results in this lifetime, Photoshop CS5 is probably not the program to use.

Processing stacked photos at the end of the day is time consuming and requires a certain amount of care and awareness. If you already own Photoshop, play around with short stacks to see the results, but if you are serious about focus stacking, you will be old before your stacks process. At my age I don't have that kind of time.

Pricing (in U.S. dollars)

Adobe Photoshop CS5 (Mac and PC)

Well, at a cost of some \$660 Photoshop CS5 once again brings up the rear. You can photo stack in both Photoshop CS4 and CS5, but the results in CS4 really are poor. In CS5 Adobe has finally gotten into the ballpark with ZS and HF but still is listed third in my book due to its tendency to warp the image somewhat. At \$660 few of us will spring for Photoshop just to stack focus. Of course, if we already have CS5, check it out.

As for pricing for Zerene Stacker and Helicon Focus, they are less expensive than Photoshop, but have caveats of their own.

For example, Zerene Focus offers the following:

Professional Edition \$289
Personal Edition \$89
Student Edition \$39

For Helicon Focus, it is a little more complicated:

Helicon Focus Lite (1-year license) \$30
Helicon Focus Lite (Unlimited license) \$115
Helicon Focus Pro (1-year license) \$55
Helicon Focus Pro (Unlimited license) \$200
Helicon Focus Pro X64 (Unlimited license) \$250



Focus-Stacking Software and Pricing

The Fine Print: Zerene Stacker (PC only)

With Zerene Stacker (ZS) any version gets you unlimited use for that version in perpetuity and its upgrades free. If a new version comes up, ZS says “When version 2.0 becomes available, new licenses will be made available at attractive upgrade pricing.”

As far as I can tell all versions are identical. There are no differences between levels. They state that the professional version is for those who use it to make money, the personal for those who use it for satisfaction, and the student version is for individuals enrolled in a degree or certificate program. You can use ZS on more than one computer as far as I understand.

The Fine Print: Helicon Focus (PC Only)

With HF, it is more complicated. You can buy in cheaper than ZS, but the license only lasts a year. I doubt any of us like that idea. So the HF Pro version at \$200 gets you into the game and provides the retouching functions, batch mode, and some other feature which are not in the “Lite” version. Well, I already stated that all of these stacking software require some retouching from time to time, so (IMO) that option does not work for me.

So I had to buy the \$250 version for the reasons just given AND because that is the only version that takes advantage of the 64-bit chip on my PC and for those of you with 32-bit PCs, to overcome the 3 GB address space for Windows 32-bit applications. HF does allow you to use it on up to four computers as long as you only use one computer at a time.

The Software Results

This is the section that is most important but also where it gets more complicated. All three programs can produce acceptable results, with Photoshop coming in third every time and Zerene Stacker and Helicon Focus vying for top dog, depending on the attributes of a particular stack.

Adobe Photoshop CS5

I previously said that unlike Photoshop CS4, which did not produce acceptable results much of the time, that CS5 is very much better. It is better aside from a tendency to actually warp the entire photo, changing the shape of whatever flower, bug, etc. you are working with at times. For many wild things, the amount of change is not enough to totally reject the photo, but for product photography the ‘warping’ is definitely not acceptable. And the cost of the software is something to consider, but most of all CS5’s inability to process stacks in a timely manner makes it not usable for me, at least for stacks of any size. Therefore I cannot recommend this software at this time for focus stacking, although Adobe has made improvements between CS4 and CS5.

Helicon Focus

HF is the fastest of the applications I have tested, if only because it accepts RAW (native) format which shaves some time off the process and simplifies it a bit for me. Also, a lot of time and consideration has gone into creating Helicon Focus and this software is of professional quality and feel. It is easy to use.

You can drag and drop your files into HF or just point to a folder and have them loaded. I have not found an easy way to select all the files in a folder in a flash, so if you know how to do that, let me know. Right now I have to select the first, hold down the shift key, and select the last, but it should be much easier to select the whole group.

HF offers two stacking methods, Method-A and Method-B, but Method-B seems to be the only one I am using so far that works as I like it, since it produces the sharpest results. Method-A is said to work with contrast only, but I have not found it useful yet. And HF is fast, which is wonderful.

The results are very professional, but like all focus stacking software often need touching up. HF does provide retouching software, but only in the more expensive versions. The retouch feature in HF is (for me) awkward and not nearly as intuitive to use as Zerene Stacker, so that is a disappointment. It does work, but I find myself never looking forward to using it with any joy.

HF focus supports ProPhotoRGB and the color seems to be good. Helicon Focus is a solid program of professional quality and I can highly recommend it, although I find myself preferring Zerene Stacker most of the time, for reasons to be presented now.

Zerene Stacker

Zerene Stacker, like Helicon Focus, is fast, easy-to-use, and of a professional build. And Zerene Stacker accepts whatever color space you send it (like ProPhotoRGB) and returns the result in the same space. Like HF, Zerene Stacker offers two stacking methods, both of which I find very useful.

The first, PMax, does an incredible job of stacking photos that have fine detail. The bristles and hairs on insects and plants are intelligently handled by PMax, better than either CS5 or HF. That is the good news. The bad news is that this greater definition comes at the price of some added noise in the photo and some loss of more subtle color.

For many photos, this noise is not significant, but for some it is. The loss of subtle color is also not important unless you are looking at something like the tiniest color shift, in which case something is lost. I want to state this but, in practice, I tend to not mind these problems as they are minimal for most of my work.



Focus-Stacking Software and Pricing

Therefore I find that I use PMax most of the time now because it gives me the kind of stacked look I want, very much in line with my idea of what a stacked photo should look like. When there is too much noise then I run the second method, DMap.

DMap does not introduce noise and holds the colors perfectly. It has the downside of (at times) having more artifacts than does PMax, so photos done in DMap may require some retouching. As mentioned, I tend to use PMax unless I am unhappy with the result, in which case I send it to DMap.

The retouching feature in Zerene Stacker is a brilliant achievement, so easy to use and intuitive that my first thought was "Why in the world has Adobe not bought this technology, sent its author Rik Littlefield to the Bahamas for life, and included it in Photoshop". With ZS, you just move through your stack, find the frame with the part of the image as you want it and just paint with a brush over the original. In a second, it's perfect.

With Zerene Stacker, you can drag and drop files into the program and just run the stacker.

Summary

As mentioned I am dumbfounded at the lack of attention Photoshop has given focus stacking in terms of speed and results. That being said, both Helicon Focus and Zerene Focus do an excellent job at stacking photos. Either one will give you good results.

Personally I tend to use Zerene Stacker for the following reasons: It is much less expensive for the full version. It provides two methods that I actually use (with HF, I use only one) and the PMax method in ZS (although not perfect) is unique to this kind of software, as far as I know. No one else offers it. No one gets every hair on the insect, sort-of-thing.

The retouching feature in ZS is worth the price of admission by itself. I can fix a finished photo that has a couple of artifacts in seconds and have a perfect image. And last, the support from ZS has been flawless.

Let me end by reiterating my opening caution that no focus-stacking software is as simple as point-and-shoot or press-a-button. If you are serious about focus stacking, you will have to do some retouching and fiddling with stacks. Luckily both Helicon Focus and Zerene Stacker allow you to do this. ZS and HF have taken some of the adventure out of focus stacking. With Adobe Photoshop CS4, getting a good stacked photo was like looking for 4-leaf clovers. ZS and HF let us get one almost every time.

Six Examples

In the following pages are six comparison images using Helicon Focus (Method B) and Zerene Stacker (PMax). Hopefully, you can see for yourselves the good, bad, and ugly in the various photos. For each photo, the Zerene Stacker is shown first, followed by the same image in Helicon Focus. No retouching was done, although some minimal exposure adjustments and some sharpening were added to all.





Result: Details good, but posterization in background



Result: Looks pretty good.



Result: Details good, but upper-right is not-so-good



Result: Looks good



Result: Looks good



Result: Looks pretty good



Result: Details good, but posterization in the upper background

The Good, the Bad, and the Ugly

The following six two-page spreads will really let you know whether you want to play around with focus stacking or not. Going in, you should know upfront what the advantages and disadvantages of focus stacking are.

Any stacked photo, in particular a short stack, is at best a compromise, an attempt to blend the sharper parts of a series of photos into a single photo. As with all compromises, the complete truth by definition is violated, hopefully in as few ways as possible, but some information is lost because we are selecting layers of the photo rather than a single shot.

This is why I say that short-stacked photos are the photographer's 'impression' of the subject. They combine a series of desirable photo layer/highlights into a single photo. As focus stackers, we choose to create an artfully-flawed photo that gives a more desirable impression than any single-focus photo. That is the theory and this is where the art comes in. The art of focus stacking is to sample focus effectively so that the finished photo provides more information than any single-layer photo might.

And by 'information', I don't mean just the pixels in the photo. A single-shot traditional photo offers that. Focus stacking (short-stack) attempts to sample the subject selectively, bringing different areas of the photo into higher focus, and ignoring the rest.

Beginning focus stackers naturally try to get everything they can into focus, because it is a relief from traditional photos that dictate one main focus area. It is fun to finally see all that focus clarity. But as time goes by, just pure focus (like with a rack) is not only very time consuming, but is not always satisfying. In addition, the existence of artifacts at close inspection can be discouraging. In the end, focus stacking is impressionistic, a creative effort on our part to present a subject as we experience it.

In the following pages one stacked photo is compared at different stacking rates to an un-stacked traditional photo. For this example I am using a 12-stacked photo taken in the wild, but with the help of a light tent to make sure that no wind was moving the subject, which in this case is the Dogtooth Violet (also called "Trout Lily"), one of our most lovely spring flowers. This one is getting ready to open. The forest floors are literally covered with the mottled leaves of this plant in spring-time, and from all those leaves some smaller number of flowers bloom each year.

Twelve stacks is a bunch, enough to embrace quite a wide range, from the front leaf tips in the close foreground, the flower itself, to the back leaf leaning the other way – quite a reach.

At first glance, things are in focus, from the front to the back. Note the tips of the leaves, the top of the flower, the stems, and even some of the dry tree leaves making up the background which I purposely did not drill down on, preferring some out-of-focus areas.

The photo looks pretty good. I have not color corrected it or anything else, other than a little bit of sharpening. I will be showing you three separate photos. The first will be the 12-stack photo, the next will be a shorter stack of four of the photos from the 12-stack shot, selected based on getting as much of the photo in focus as a 4-stack will allow, and the last photo is a traditional non-stacked photo for comparison.

For each photo, there will be two-page spread, with the entire photo on the right, and close-up photos of the flower head and stem on the left side.

There are six two-page spreads to look at, so take your time and look closely for this is the kind of compromise you will have to get used to if you are interested in focus stacking using a short stack.

The Impression

Looking at the photo on the right, the impression is of a woodland flower remarkably in focus, from the tip of the front leaves (reaching out toward you), to the tip of the back leaf, leaning quite away from the flower. And the flower itself is sharp, or so is the impression. And impression is what short stacking is all about.

Now work through the next twelve pages and photos, noting that in reality parts of the photo suffer blurring from the focus-stacking process itself. As mentioned, this is no wind here, at least that I could see. I am using Adobe Photoshop CS4 to align and blend the stack, so there may be other software that can do a better job of avoiding artifacts. But no software can avoid generating artifacts, unless you want to use a rack mounted camera and shoot 100+ photos for each stacked photo. Even then there will be problems.

If your resulting stacked photo has too many artifacts, try playing with the stack, stacking different combinations, choosing layers which have the things you most want in focus. This takes time, so take the time to explore. You will be surprised at how you can pull a good stacked photo out of what appeared as a throw-away. And if there are still pesky blurred areas of a photo you really love, take it into Photoshop and use the Clone Stamp tool to carefully repair the blur. For those special shots, it is worth the effort.

The Good, the Bad, and the Ugly

The Three People to Impress

They are, of course, “Me, Myself, and I,” the ones who really care about my photos. My wife, kids, and friends only want to see a very few photographs. After maybe ten or twelve, they start to look around. And I have 100,000 plus. Other photographers like this, but want to change that, etc. This leaves just me as the one who sees it all, takes the photos, stacks them, and enjoys them. If I am happy with a photo, warts and all, that is enough.

The following six two-page spreads will really let you know whether you want to play around with focus stacking or not. Going in, you should know upfront what the advantages and disadvantages of focus stacking are.

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At first glance it looks pretty good, but let's look at the details.



12-stack Photo Artifacts

Look carefully along both the right and left sides of the flower stem. See the fuzzy out-of-focus areas. These were not caused by movement but are artifacts of the artificial aligning and blending of so many stacks.



12-stack Photo Artifacts

Look carefully on both sides where the flower joins the top of the stem. See the blurry areas on both sides. Also notice the blurred tip of the right end of the flower at the bottom.

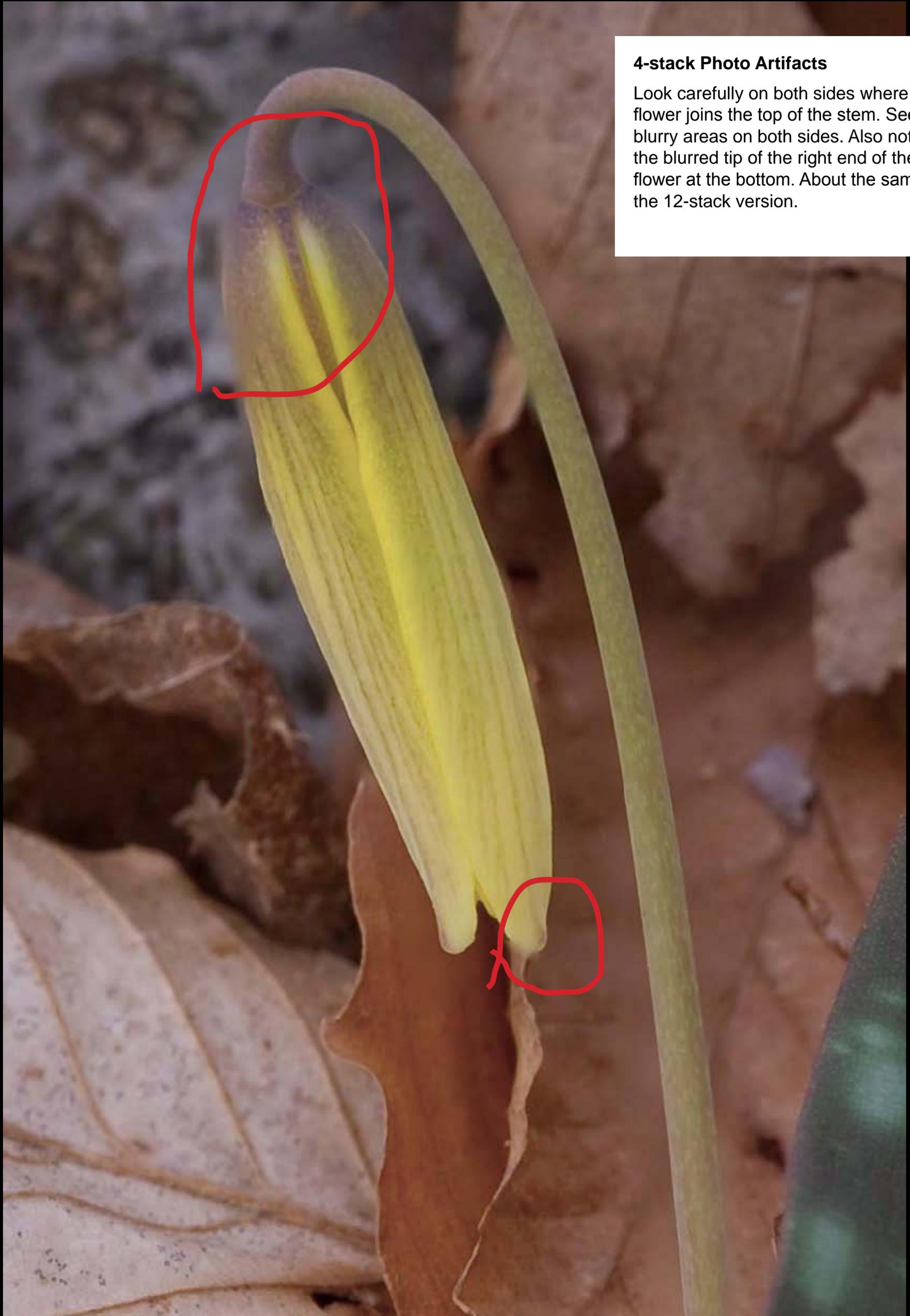


4-stack Photo Artifacts

Look carefully along both the right and left sides of the flower stem. See the fuzzy out-of-focus areas, although less than the 12-stack version. These were not caused by movement, but are artifacts of the artificial aligning and blending of so many stacks.

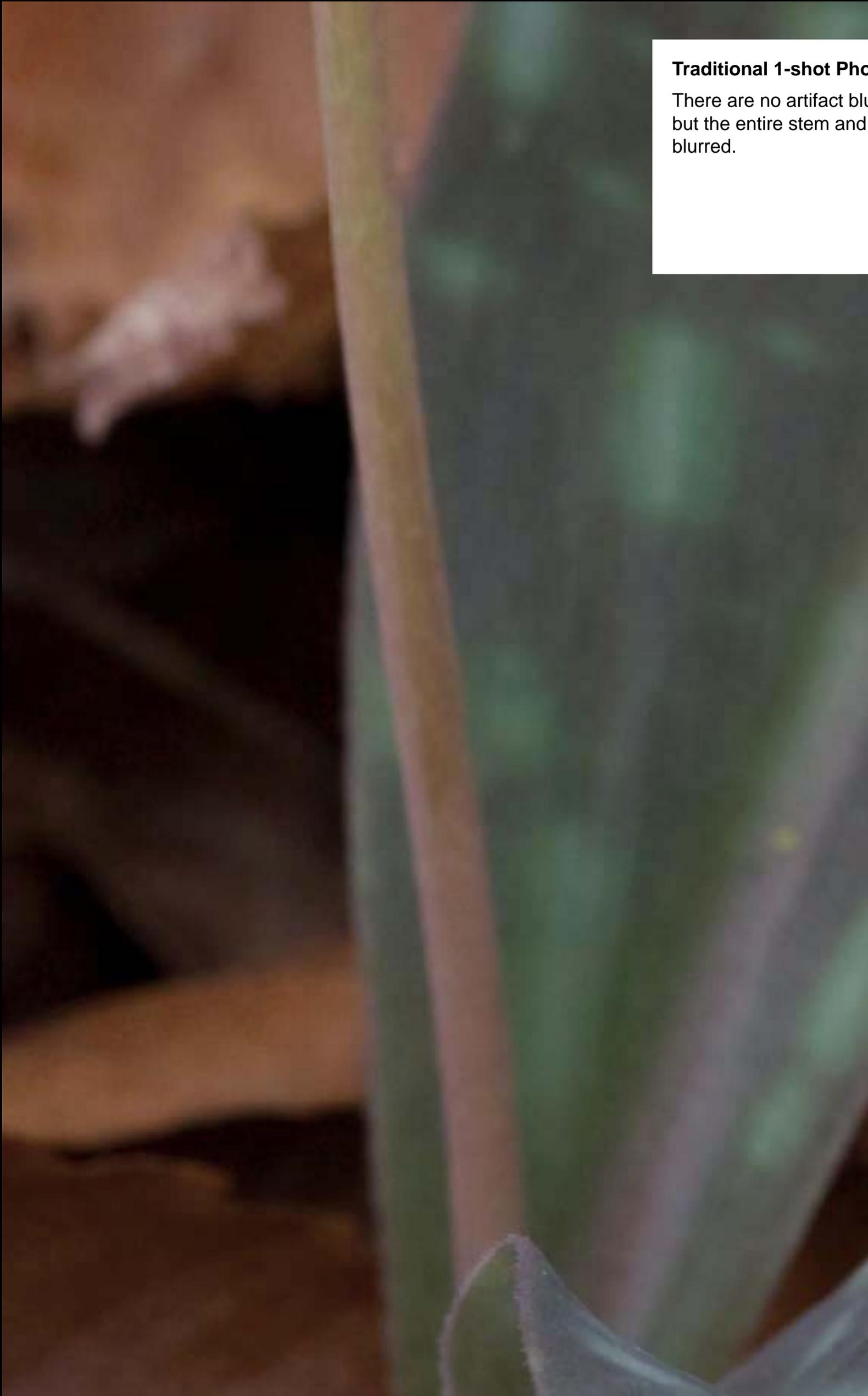


A photo using only four stacks



4-stack Photo Artifacts

Look carefully on both sides where the flower joins the top of the stem. See the blurry areas on both sides. Also notice the blurred tip of the right end of the flower at the bottom. About the same as the 12-stack version.



Traditional 1-shot Photo

There are no artifact blurs in this photo, but the entire stem and leaf behind it is blurred.

Traditional One-Stack Photo



Analog Photo





Whatever It Takes

Don't ask me why Photoshop decided to bend over backward to align this stack like this, causing this odd-shaped pattern to emerge. The program has a mind of its own and this kind of result is common using the "Align" command. In some cases the twisted shape actually affects the entire photo, widening or shortening the image.

However, just crop the finished photo and it looks pretty normal. This photo has not been retouched.





Twisted

Here is another example of the gyrations that the Photoshop "Align" process sometimes goes through to line up all the layers of the stack.

Just crop the finished photo and it looks pretty normal. This photo has not been retouched.



Crop it and it looks normal again



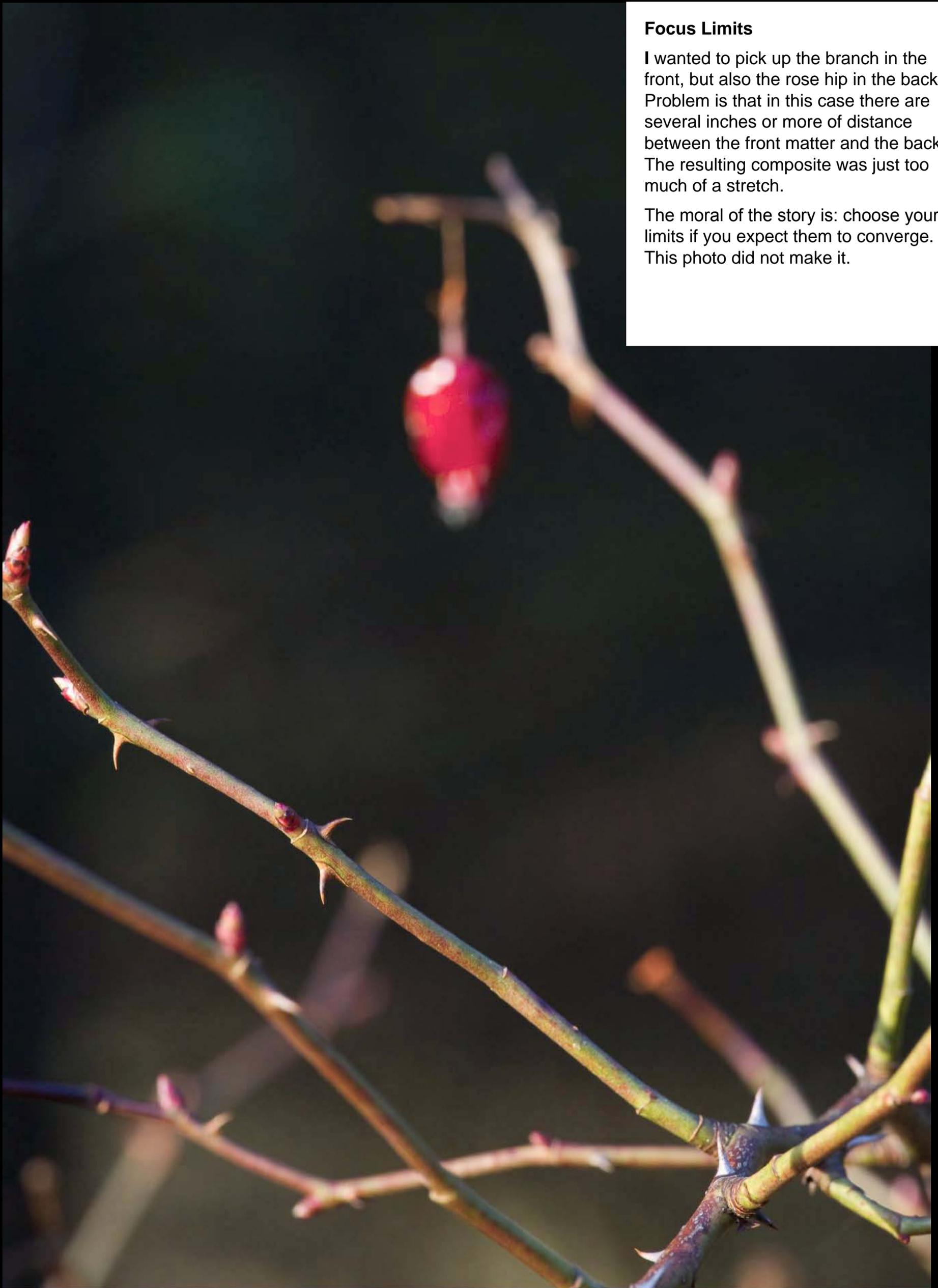
Normal Align Marks

Notice the marks on all four edges of this photo. They look like indentations. You will find these on almost every stacked photo from Photoshop and they are the result of the program's aligning function as it positions layer over layer and forces them to line up.

They can take many forms and aside from the indentation-like marks, you often will also have blurred or out-of-focus areas running along the border. Totally normal. You just have to crop them out.



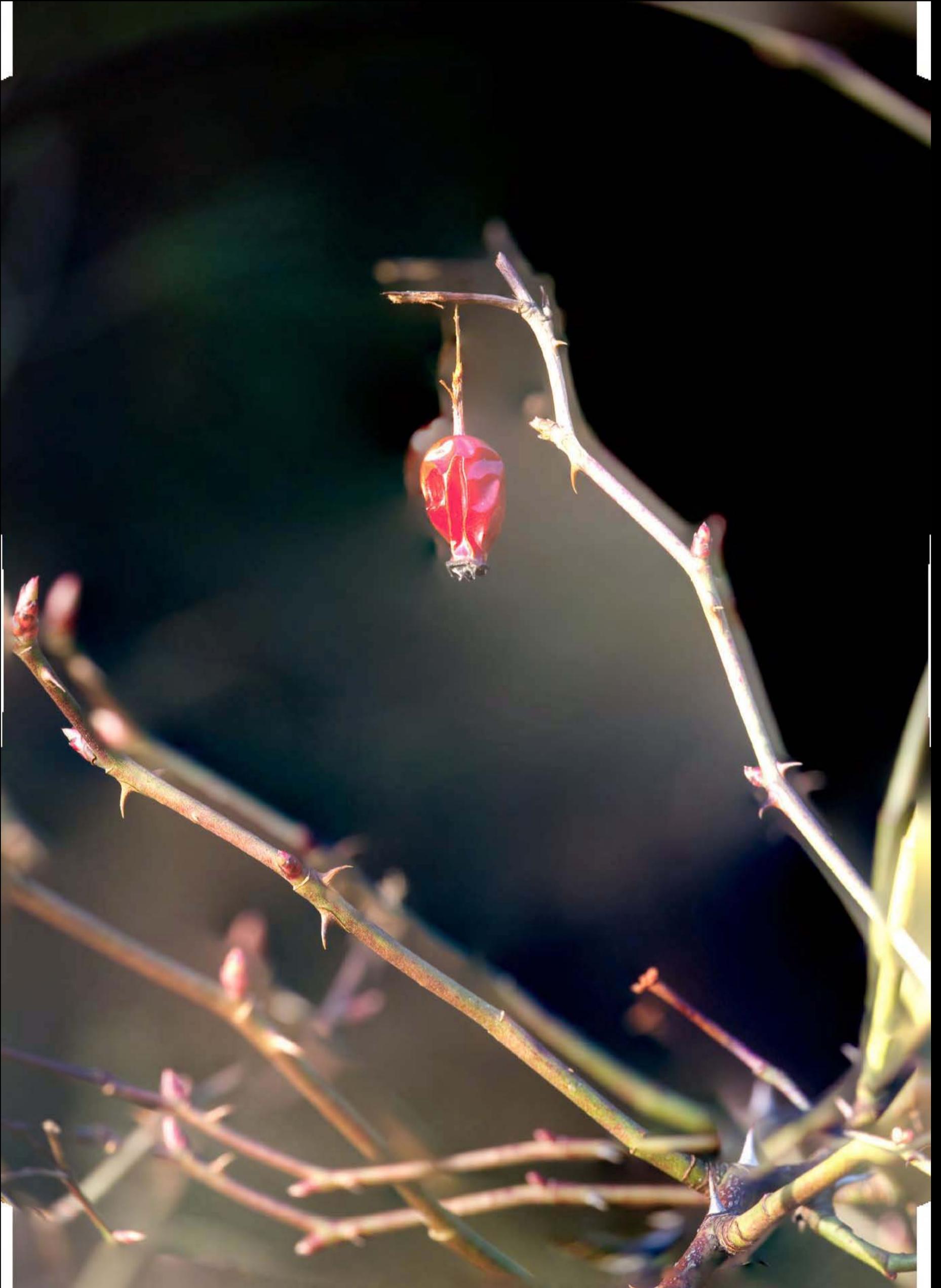
Same photo with the marks cropped out



Focus Limits

I wanted to pick up the branch in the front, but also the rose hip in the back. Problem is that in this case there are several inches or more of distance between the front matter and the back. The resulting composite was just too much of a stretch.

The moral of the story is: choose your limits if you expect them to converge. This photo did not make it.



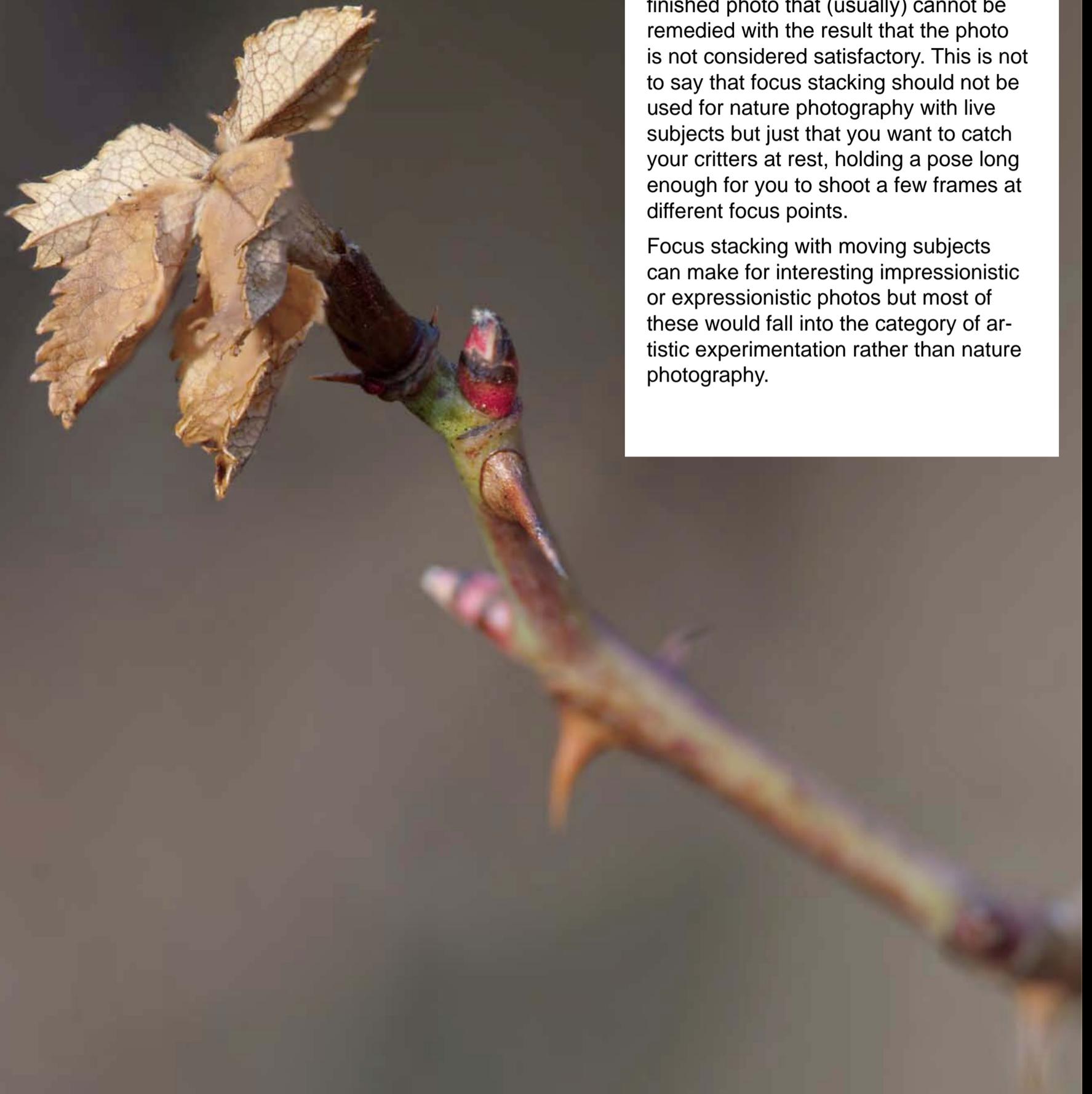
“A Stack Too Far”



Use a Shorter Stack

Just because you took six photos does not mean you have to put all six in the stack. In this case I ran the full stack, but look at the halos around the upper leaves. No good. There was obviously either wind or too much perspective change in focusing.

By dropping the last few layers I lose focus in the lower stem but mostly get rid of the halos on the leaves. I can always say that the lower stem is good bokeh! Result is on the next page.



Movement Causes Artifacts

Focus Stacking is primarily for still life photography where nothing is moving. Movement causes artifacts in the finished photo that (usually) cannot be remedied with the result that the photo is not considered satisfactory. This is not to say that focus stacking should not be used for nature photography with live subjects but just that you want to catch your critters at rest, holding a pose long enough for you to shoot a few frames at different focus points.

Focus stacking with moving subjects can make for interesting impressionistic or expressionistic photos but most of these would fall into the category of artistic experimentation rather than nature photography.



Small Gains

On this page is a photo with no focus stacking. Nice, but I want to add just a little more depth of field, so I make a short stack.

On the next page is the result, with increased focus up top but still some nice out-of-focus area in the lower stem. Focus stacking need not be at terminator force but can be use gently for enhancement.



Problems with Focus Stacking



Layer One



Layer Two

Intervening Matter

There are two problems here, and only further cropping will correct them. In the red boxes is a branch in the foreground, and this branch moves dramatically between the two layers, which suggests it is too far out front of the wild leek shoots that are just coming up.

In the resulting composite, the two branches don't align but blur and smear on the photo. Also note that in the front lower-left corner is a stick that I failed to get in focus. Not good.

One solution is to crop out the bad parts, but some forethought on my part would have avoided this.

Front Matter

I have learned to inspect my shot carefully before I begin shooting to see if there is any intervening matter. If there is something between the camera and the subject:

- (1) Move the camera.
- (2) If not destructive, carefully remove whatever is obstructing the view.
- (3) Often I gently bend back branches (withouth breaking them) until they are just out of the shot.
- (4) I don't do invasive removal, like uprooting plants, bulldozing, or detonations.



POSSIBLE CROP

Two-Shot Reflection Stack



Photo of Stream Bed

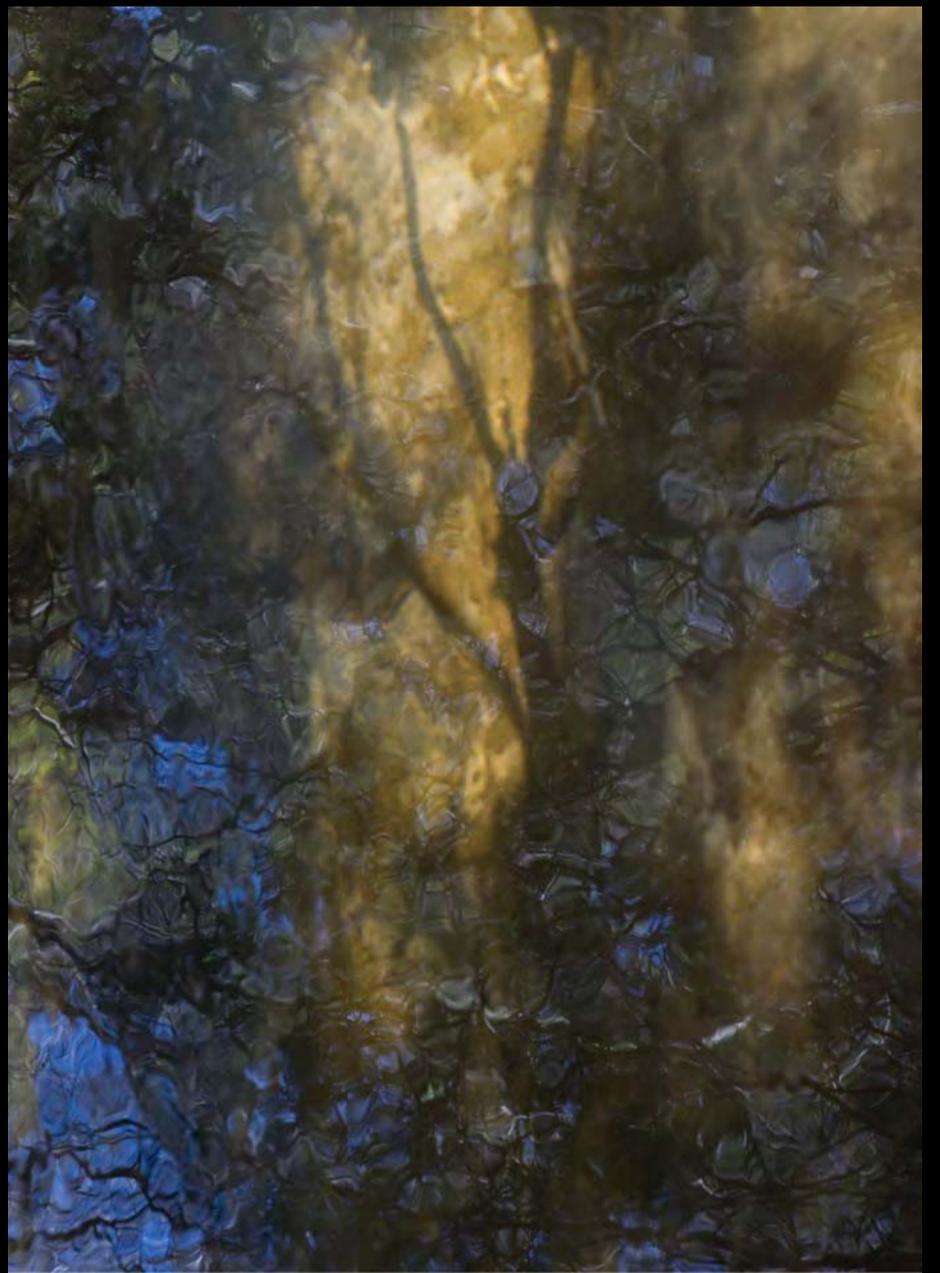


Photo of Stream Surface

Two Layers

Clear water makes a great 2-layer stack. Simply shoot one layer with the bottom of the stream in focus and another with whatever is reflected on the top surface, and combine them.

Here there is a sunlit stream bed with overhead trees and blue sky reflected on the surface. The combination allows you to focus on the bottom or the top reflection, making for a creative and interesting effect. No need to align this type of shot; just merge.

Resulting Two-Shot Reflection Stack



Many possible variants of this

Another Reflection Example



Photo of Stream Bed

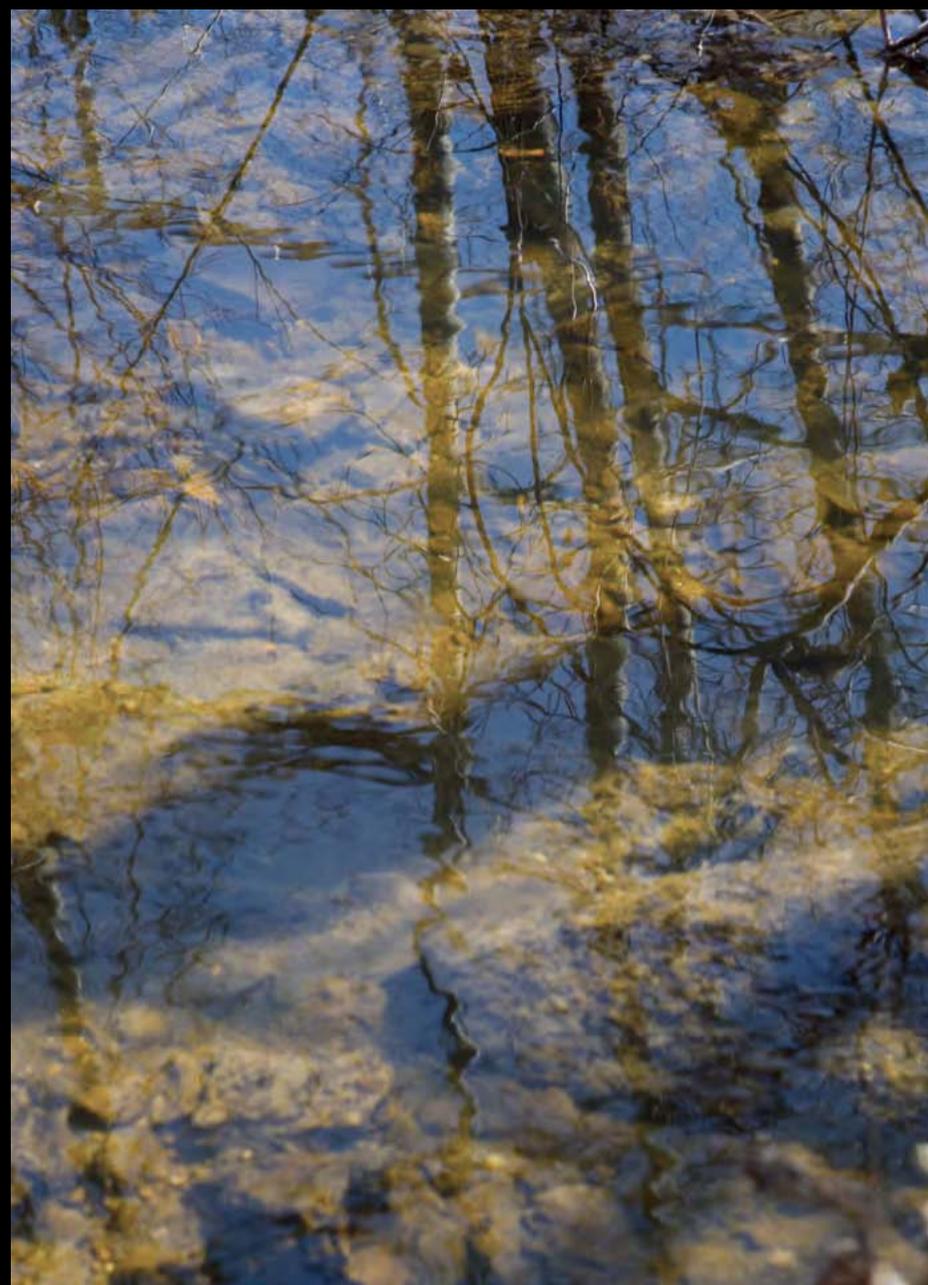


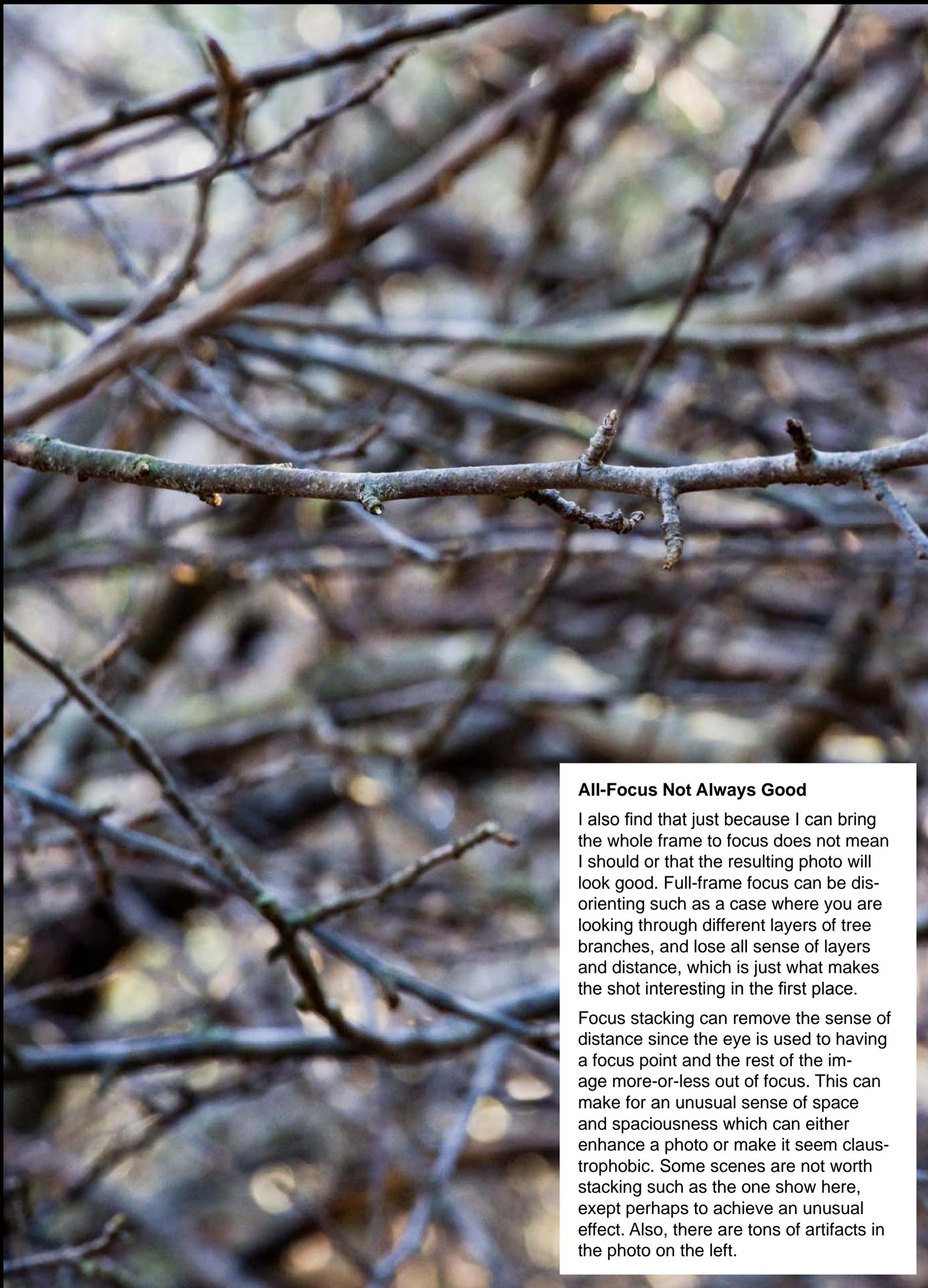
Photo of Stream Surface

Merge Two Photos

Here is another example of two photos merged, by with no aligning, since we want to keep the surface image separate from the image of the bottom of the stream.





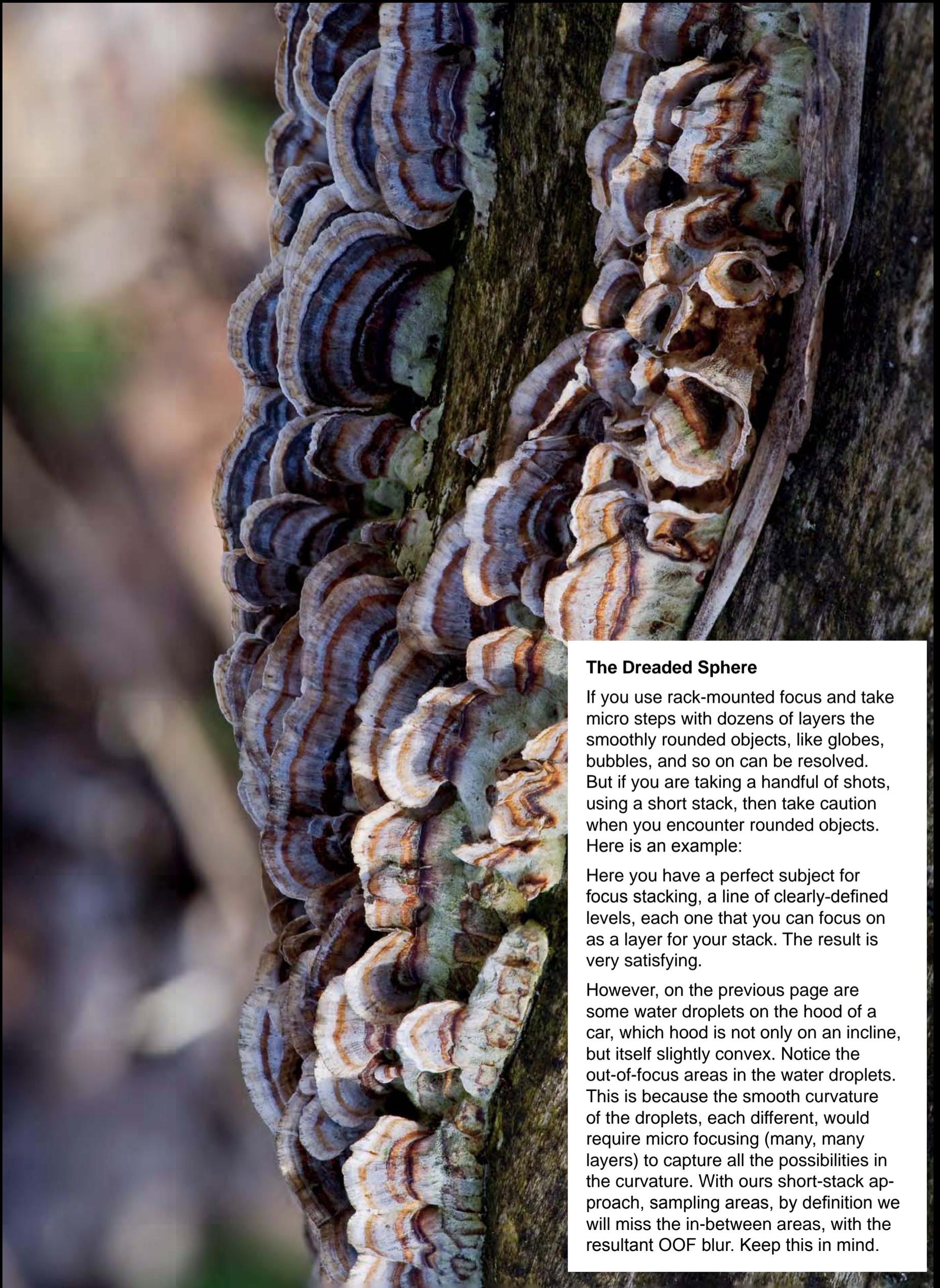


All-Focus Not Always Good

I also find that just because I can bring the whole frame to focus does not mean I should or that the resulting photo will look good. Full-frame focus can be disorienting such as a case where you are looking through different layers of tree branches, and lose all sense of layers and distance, which is just what makes the shot interesting in the first place.

Focus stacking can remove the sense of distance since the eye is used to having a focus point and the rest of the image more-or-less out of focus. This can make for an unusual sense of space and spaciousness which can either enhance a photo or make it seem claustrophobic. Some scenes are not worth stacking such as the one show here, except perhaps to achieve an unusual effect. Also, there are tons of artifacts in the photo on the left.





The Dreaded Sphere

If you use rack-mounted focus and take micro steps with dozens of layers the smoothly rounded objects, like globes, bubbles, and so on can be resolved. But if you are taking a handful of shots, using a short stack, then take caution when you encounter rounded objects. Here is an example:

Here you have a perfect subject for focus stacking, a line of clearly-defined levels, each one that you can focus on as a layer for your stack. The result is very satisfying.

However, on the previous page are some water droplets on the hood of a car, which hood is not only on an incline, but itself slightly convex. Notice the out-of-focus areas in the water droplets. This is because the smooth curvature of the droplets, each different, would require micro focusing (many, many layers) to capture all the possibilities in the curvature. With our short-stack approach, sampling areas, by definition we will miss the in-between areas, with the resultant OOF blur. Keep this in mind.



Another Example

The pine cone on the previous page has a round shape, but there is plenty to focus on and highlight.

However, the Michigan orchid below has a large round-shaped flower, so this shot required MORE than average layers in order not to have blurred spots on the curvature.



Additional Considerations

Playing With Stacks

Back on the computer, after a day's shoot, you process a stack in Photoshop and look at the results. Some stacks work and some have too many artifacts, motion that you didn't see at the time, areas that Photoshop could not distinguish properly, etc.

Some stacks are simply beyond use or repair, but most are not, so don't just give up on a stack because at first glance it has problems. Try to see what is causing the problem. Here are some things you should check out before giving up on a stack.

Inherently Flawed

Don't forget that unless you are on a focus rack and taking a huge number of photos under essentially laboratory conditions that photostacking, by definition, is flawed. Focusing using a short-stack means you are sampling the focus here and there rather than seamlessly photographing and merging the entire frame. By design, you are leaving out many areas of the photo which are not treated as a focus point. This is a choice you make.

An Art, Not a Science

There will be areas that are (how ever so slightly) out of focus. The art of focus stacking is to make these areas as unobtrusive as possible, selecting what you feel are the key areas in the photo that tell the story as you see it, areas that you want to be in sharp focus.

Focus stacking, at least in my experience, is more of an art rather than a science. Slavishly using a focus rack to obtain perfect focus through a stack of hundred or so photos simply is not interesting to me, and way too time consuming. I am happy to look at the deep stack photos that others make. Most of all, rack-focusing is more suited to the studio and not the woods and fields. I need to be out there in nature and without too much gear.

The art in focus stacking is learning how to give your impression of a subject in a few carefully-chosen frames, merging them into a single unified photo that expresses that impression. That is why focus stacking is an art and not a science.

The Bad Frame

Did you include a frame that does not belong in the series by mistake? I am surprised at how often I manage to do this and, of course, a frame from a different series will seriously screw up a stack and make it appear unusable.

Too Many Frames

Just because you took ten frames of the subject does not mean you need all ten or that all ten will resolve, especially when the result shows problems. Try dropping layers, usually from the back where they matter least and can serve as bokah (nicely out of focus). Shorten the stack and run it again. Often the result can be different enough to save the shot.

Minimal Frames

Forget about the whole sequence. Go into the layers and find just the layers that best put the subject into focus. Use those, often just two or three. You end up with a more normal photograph, but one with the essential subject remarkably in focus. This is still better than just the one area in focus of a traditional DOF photo.

Run It Again

Sometimes if I just run the whole stack again I will get a good result. I have no idea why this is so, but it is worth a try if you love the subject.

Don't Forget the Traditional Photo

And as a last result, use a single frame. Forget about stacking. One virtue of taking bracketed focus shots is that, more often than not, at least one of the frames will be the shot you would have taken if you only had one shot – the traditional photo with one point of focus. When all else does not work, usually there may be a single photo that will do the job.

In summary, it is well worth it to spend some time tinkering with the stack before you abandon the shot, especially if it is a photo you really like.

Short Stacks for Macro, Not Micro

How close is too close? That is a question you will find yourself answering as you get into focus stacking. Of course, it depends a lot on what lens you are using, but I have found that trying to focus on too tiny a part or flower generally shows poor results. Let's take some examples.

The advantage of traditional one-shot photography is that you don't have artifacts, but unless you are photographing a two dimensional subject (like a page from the newspaper) and even then, unless that newspaper is flat and exactly parallel to the plane of the camera's sensor, you automatically have distortion from perspective. That perspective puts one area of the photo in focus and throws another out of focus to some degree.

Of course the eternal quest for the holy grail of depth-of-field by photographers meets with disappointment as diffraction exacts its toll of resolution at smaller apertures, thus the main reason for focus stacking. Yet focus stacking, as we have pointed out, cannot but fail to capture every bit of the subject, but it can manage to fail successfully if we are careful, resulting in a photo that has the appearance of real depth of field.

Additional Considerations

Landscapes

Focus stacking is probably more successful in enhancing focus in non-close-up shots like mid-range and distant subjects such as landscapes, where adding even a little more depth of field dramatically enhances the shot. Look at the landscape shots elsewhere in this book for an example of this

Close-up, Macro, and Micro

Where focus stacking breaks down most visibly is in extreme close-up shots, what we would call micro, rather than macro shots. When you get this close, you really do need a focusing rail, studio, lights, and all of that. You can get great shots using a rail and micro-stepping the focus, but for me this is a whole other kind of photography than that being presented here. It really is a science and not so much an art, although art is involved there too.

Not for Micro Work

For example, shooting a very tiny flower: Being so close to a subject shows not only any weakness in the lens but also weakness in the technique of short-stack focus photography. By not covering every millimeter of that scene we are opening ourselves up to tiny movements of wind and simply extremes of perspective within the subject matter itself. The result is that artifacts are more visible up close than when we stand back, just like some of the French Impressionist painters like Monet or Pissarro, which are best viewed from a few feet back, rather than right up close. The artifacts or artifice is absorbed at a distance but obvious when you get too close. The same goes for focus stacking that is not rail mounted and studio bound.

I find this out by trial and error. Sometimes I can get away with a lot and at other times, the technique itself shows its flaws. The take away is there are limits to what short-stack focusing will allow. As you get closer and closer, going from close-up photography to macro photography, or even closer to micro photography, you need more precise control, preferably in exact micro increments to get results. Impressionist focus sampling as we are discussing here doesn't cut it. We would need to be more exact than that.

As mentioned, the science of stepped-rail focusing does not interest me, so I refer you to Google, where you can find any number of tutorials on rail stacks – requiring both science and art. Striking photographs, yes, but sometimes a little too 'clinical' for my taste.

Looking Close

If you look very closely at any stacked photo, you can find its flaws, however minute. This is the nature of the beast and just part of the deal when you use short stacks. Most such flaws are usually embraced by the overall enhanced sharpness of the stacked photo and don't stand out. Some are glaring and cause the photo to be rejected. Still others can be fixed in Photoshop easily, if they are few. If they are legion, there is not much you can do but enjoy it in the abstract, flaws and all. Then you really are really an impressionist! Frankly I am continually amazed at how well most stacked photos work out if you take some care with the original shots.



Traditional Analog Shot (note distance is blurry)



Stacked Photo (note more clarity throughout)





Partial Stack (note clarity achieved by fewer photos)



Stacked Photo of Small Flower (note artifacts)



Traditional Analog Shot (note more clarity)



Traditional Analog Shot (note distance is blurry)



Stacked Photo (much more clarity throughout)





Macro and Close-up Equipment

This section will be a painful read for many of you. Equipment is expensive, and it seems that all beginners start out trying to cut corners and end up paying more for their stuff than professionals because they buy the cheap stuff, are unhappy with it, and end up getting the good stuff too, thus buying twice. I certainly did this and regret it to this day.

All the pros advised me to just buy the good stuff right off, but I did not listen. After all, I knew best, and was not sure that this more detailed photography stuff was something I would really get into, so I bought cheap, and then bought it all again. The smart money buys the good stuff and, if you don't like photography, you can actually sell the good brands and get some money back.

I cringe when I come across some of my early tripods that I bought trying to save a dime and then ultimately found clumsy, heavy, and ugly. They are worth nothing and sit unused (and unsalable!), taking up storage space. Therefore, I am only going to tell you about the good stuff and why it is worth the money. You make up your own mind and follow your own budget. As mentioned, I didn't listen, and it cost me plenty, not to mention the suffering and discouragement of using poor equipment, which is priceless.

Tripods Are Key

The long and the short of it is that you need a tripod to do accurate focus stacking. I know there are a few photographers out there who claim to focus stack handheld, but that is why there are few of them. Personally I would not (could not) do focus stacking without a good tripod. You not only need a tripod, you need a GOOD tripod. I bought three cheap ones before I had the common sense to get one good one. The cheap ones are in storage. As mentioned, I can't even sell them, so do yourself a favor and get a decent tripod.

And, if you are a hiker or woods-walker, get a light tripod, preferable one made with carbon-fiber legs on it. A good tripod becomes like a third arm to a macro shooter. I seldom hit the fields without one.

These Photographs

Pictured here is the primary Nikon equipment I use most of the time: Nikon D3s and Nikon D3x bodies, each shown here with a Voigtlander 125mm f/2.5 APO-Lanthar lens, a Markins Q3 Ball-Head, MC-30 Remote Release, and setting on Gitzo carbon-fiber tripods GT2531 (3-leg) and FT1228 (4-legs and center column). These tripods and ball heads are as light as possible, yet sturdy enough to hold the quite-heavy Nikon cameras and lenses.

Equipment for Macro and Close-up Photography



Equipment for Macro and Close-up Photography

Ball Head

Another item that you don't want to cheap-out on is a good ball head for the tripod on which your camera sits. I should know; I have a whole shelf of lousy ball heads that I bought trying to avoid buying one good one. I have ones with a pistol-grip handle, ones with two handles, etc., a total waste of time and money. Ball heads are expensive and the good ones are brands like Really Right Stuff (RSS), Kirk, Arca-Swiss, and Markins.

I use the Markins Q-Ball Q3 (shown on right), which sells on Ebay for about \$260 and I feel that are every bit as good as the much more expensive kinds.

L-Bracket

I hate to keep laying these essentials on you, because it can be very discouraging to the pocket-book, but it is best to know the truth sooner, than later:

You need an L-bracket on your camera!

An L-Bracket mounts on your camera body and allows you to quickly change from the standard horizontal position to vertical position. The ones shown here are on the lower-left-hand side (and base) of each camera.

For me, the L-bracket is essential because I like to shoot vertically most of the time but have to switch in a moment to horizontal for a wider shot. I use Kirk Enterprise L-Bracket and plates. They are excellent.

Quick-release Clamps

It is not enough to have a ball head on your tripod. You also have to be able to get your camera on and off the tripod. You can screw it on and off but that takes a lot of time and sooner or later you are gonna' mess up the threads in the base of your camera and have a real problem on your hands. You need to be able to get that camera on and off the tripod in seconds, not minutes of fumbling with thumb screws.

My quick-release of choice is the Swiss-Arca style, as used by Kirk Enterprises, Really-Right Stuff, and of course Swiss-Arca-style plates. You need one. The quick release shown here are built into the Markins ball head and receive the L-brackets, which are thumb-tightened on.

Remote Shutter Release

Another (for me) essential accessory is the remote shutter release, which attaches to the camera and allows me to release the camera without having to touch the camera's shutter-release button and potentially cause vibrations. Remote shutter release cords for Nikon are available on Ebay for very little and are more than a little helpful. They can be seen here dangling from the right side of the cameras. Some of the newer camera bodies like the Nikon D7000 have infrared remotes, so there are not cords involved.



Camera Bodies

There actually are many cameras that will do a good job. Ultimately, after you find you like photography, you want a DSLR (Digital Single Lens Reflex) camera, with a 100% viewfinder (shows the whole image, not just most of it) with a large LCD preview window and preferably with mirror lockup (will explain in a moment). Another feature I could NOT do without is the ability to see a histogram of the RGB levels on the LCD at the rear of the camera body. Let me go over all of this in more detail.

For myself, I love Nikon cameras, but Canon, Panasonic, Sony, and others also make fine DSLRs. It is just that Nikon cameras are better looking and, well, just better. <G> Suit yourself.

Viewfinders

DSLR cameras offer viewfinders that are larger and smaller, meaning that some cameras show most (but not all of the frame), while better ones do show all of it. If you can, get a camera that will show ALL of the frame, a viewfinder that also is as clear and bright as possible. I would not consider trying to do focus stacking using a camera with only an LCD preview window, as in: a camera without a real viewfinder. You will be doing all of your work looking through the viewfinder, so get a camera with a large clear viewfinder. That is my point.



Depth of Field Preview

How wide open or not your lens diaphragm is determines your depth of field. If the lens is wide open (smallest aperture number, like F/2.8), you have the most light-gathering ability for that particular lens, but your Depth-of-Field (DOF) will be razor thin. In other words, aside from the one plane that is in focus, everything else is out-of-focus. When your lens is closed down to the smallest apertures (highest aperture number, like f/22), you have the least light coming into the lens, but the greatest DOF.

When you look through the viewfinder of your camera for a preview of a shot, the lens is always forced wide open, so you get a very bright image, which is needed to focus properly. However, when you actually take the photo, your lens will be automatically stopped down to the actual aperture you set and the photo taken. That actual aperture may be so small (and dark) to your eye that you could not see well to focus, which is why the viewfinder always shows the lens wide open.

However, especially in focus stacking, you can need to know how much DOF field you already have. If you already have enough DOF, perhaps you don't need to focus stack for this photo. Some of the better cameras have a Depth-of-Field (DOF) Preview button which can be a great help, especially in close-up and macro photography where you want to know how much of that bug or flower actually is already in focus.

When you look through the viewfinder of the camera and focus on your subject, you can see where your focus is, of course, but not how much more (the DOF) of the object is also on focus. Pressing the DOF Preview button on a camera stops the lens down to whatever aperture you have set and allows you to see (although often in dim light) exactly how much of the total object is in focus – your depth of field. So while not a show-stopper, a DOF Preview button is VERY helpful to the close-up photographer.

Mirror-Lock-Up

Cameras with a mirror-lock up are to be preferred because it allows you to lock the mirror up before the shot. Otherwise the slap of the mirror can cause vibrations that resonate through the camera body and blur the image you are trying to take.

Ready to Rock

Given all the above equipment, you have what you need to hit the trails and stack photos. You might also want to decide how much 'stuff' you want to carry with you through the woods and over hill and dale. Things get really heavy fast after a mile or so. And I am talking about what you want to carry ASIDE from your camera, ball head, lens, and tripod, which you will probably want to have with you at all times.

Equipment for Macro and Close-up Photography



Common Macro Lenses

In the above photo are ten lenses commonly used for macro and close-up work. Most, but not all, are Nikon lenses. The one marked "J" consists of two lenses stacked together to make higher magnification, as listed below. For my work, the most-used lens is (I), the Voigtlander 125mm f/2.5 APO-Lanthar, a marvel of a lens. The other incredible lens (IMO) is (C), the 60mm f/4 APO lens from Coastal Optics. Any of the lenses listed above would be good for macro and close-up photography.

- A. Micro-Nikkor 105mm F/2.8 VR Lens
- B. Kiron (Lester A. Dine) 100mm f/2.8 Macro
- C. Coastal Optics 60mm f/4.0 APO
- D. Micro-Nikkor 55mm P Auto f/3.5
- E. Micro-Nikkor 60mm f/2.8 D Lens
- F. Micro-Nikkor 85mm f/2.8 PC Tilt/Shift Lens
- G. Micro-Nikkor 70mm-180mm AF f/5-5.6 D
- H. Micro-Nikkor 200mm AF F/4 ED-IF Macro
- I. Micro Voigtlander 125 F/2.5 Macro APO-Lanthar
- J-1. Micro-Nikkor 105mm P F/4 Macro Lens
- J-2. Micro-Nikkor 105mm P F/4 Macro Bellows Lens

Most close-up and macro photographers use lenses in the short telephoto range, from 60mm to 200mm.

The Lens Is the Thing

Lenses are the heart of photography, IMO, and certainly a good sharp lens is required for decent focus stacking. And lenses can be expensive, to say the least. Fortunately for macro and close-up photography, where we must focus manually anyway, we can use older lenses which are readily available at reasonable prices.

The kind of lens you need depends on the kind of photographing you intend to do. And while focus stacking can be used for landscape and intermediate distance photography, much of it tends to be done in close-up and macro photography.

Speaking very generally, most macro and close-up work is done with short telephoto lenses, rather than wide angle lenses. Traditionally, the 50mm lens has been set as the standard and any lenses smaller than that (24mm, 35mm, etc.) are considered wide angle lenses, while any lenses longer (105mm, 200mm) are considered telephoto lenses.

You can do focus stacking with almost any kind of lens (including wide angle lenses) with the exception perhaps of fisheye lenses. And we should differentiate between standard lenses and macro lenses. A macro lens allows you to focus down to very short distances from your subject, providing you greater magnification and thus huge images of tiny critters like ants, as well as flowers, leaves, etc. Standard lenses don't usually have a focus distance close enough to do macro photography, so take note.

Equipment for Macro and Close-up Photography

The Quest for Depth of Field

As long as there have been cameras and lenses, photographers have struggled to achieve greater depth of field (DOF). When a lens is wide open the DOF is very shallow, which means that, at best, you can expect to have sharp focus only in one plane of the photo. The rest of the frame will be more or less out of focus.

As we close down the lens (smaller openings), we achieve greater and greater DOF until a point is reached where the effects of diffraction set in and begin to destroy the overall sharpness of the photo. So photographers are caught between the devil and the deep blue sea, trapped by almost no DOF at wide apertures or loss of sharpness when stopped down too far. That has been the traditional problem.

We all seem to like to see photos that embrace greater DOF and with the advent of focus stacking this is becoming increasingly possible. Focus stacking has been going on for a long time, but limited to those photographers with enough technical expertise in Photoshop (or other software) to painstakingly stack layers of photos and then gradually erase part of different layers to reveal those areas of greatest sharpness. Each photo becomes a real labor of love and is very time intensive.

Now that Photoshop CS4 (and other software) can do this more automatically, focus stacking is increasing coming into its own. Today (using Photoshop as an example), all that is necessary is to place the stack of photos (at different focus points) as individual layers and apply two commands to that stack, Align and Blend.

The “Align” command automatically works through the layers and aligns the subject in each layer so they line up. Once that is done, the “Blend” command blends the aligned layers into a single photo, automatically doing what previous photographers laboriously did by hand. The resulting image is a stacked photo, where the stack of individual photos has been aligned, blended, and reduced to a single photo that appears to have a greater depth of field or overall sharpness, if all has been done correctly.

Users of Adobe Lightroom 2.0 (and higher) can select a series of photos in Lightroom and send them to Photoshop where they can be aligned, blended, and automatically saved back into Lightroom, including any adjustments made to the photos in Lightroom. What this means is that focus stacking is now available to a much wider group of users than in the past. Just as HDR-stitched photos have become very popular and have their own special “look,” we can expect to see focus stacking following on the same path to more common usage. Focus stacking also has a certain look that differentiates it from standard photos.

Perhaps camera makers like Nikon may include focus stacking (focus bracketing) in future camera bodies just like they did with aperture bracketing, which is now available. The user would focus at the front and the rear of a subject, indicate how many photos should be stacked, and the camera would do the rest. Of course, this sounds like a job that would require a tripod. For shots of live subjects, in-camera focus stacking would further open up this technique, since the stacked series would happen at maximum speed. Later in this text, we will walk through how to use Adobe Photoshop to stack photos.

Diffraction

When your camera lens is wide open like F/2.8, there is plenty of room for light to enter and the parallel rays of light more or less stay parallel, with minimal divergence. However when you narrow the lens to a tiny opening, like f/22, not only does less light come through, but after passing through a small aperture, parallel light rays begin to diverge, spread out, and interfere with one another.

At small apertures the light waves get out of phase with one another, pile up in some areas, and cancel each other out in other areas. The net result is that they create a pattern of bands called the “diffraction pattern,” and this pattern impacts the photo image we are trying to create, causing it to deteriorate.

The long and the short of it is that no matter how fine a lens you have or how many megapixels your camera sensor has, diffraction imposes an absolute resolution limit for photo detail that cannot be gone beyond. Diffraction automatically smoothes or blurs detail that we have resolved with the higher f/stop of the lens.

Web Sites for Lenses

The best web sites to learn the qualities of lenses (in my opinion) are:

Bjørn Rørslett (<http://www.naturfotograf.com>)

Thom Hogan (<http://www.bythom.com>)

Challenges in Focus Stacking

Challenges in Focus Stacking

Focus stacking has a number of distinct challenges, things to keep in mind when you are learning to use this technique, so let's go over some of them.

Near Focus

A continual problem I have is not having the nearest objects in focus. It is an easy mistake to make. Of course, if there is a single object I don't miss that. But let's say I am photographing a bunch of moss or foliage. Many times after the shoot when I am back on the computer I find that I did not get the very most front matter. It could just be the tip of the top of a few blades of grass but it more-or-less ruins the shot. So it pays to back off until the entire field is out of focus, and then start in until the first something appears and shoot that. Some focus stackers make a rule of starting with an out-of-focus shot.

With rear focus, it usually does not matter. We can just call a missed layer in the rear... bokeh.

A Focus Too Far

Often we try to get too much of the entire frame in focus and it can be just too far of a reach. I have learned to let the rear part of the frame remain somewhat out of focus so that it either is or resembles bokah. This brings out the subject in the foreground that is in focus all the better, which amounts to traditional photography with just a wee bit more in focus.

You will get a feel for how much you can strong-arm the entire frame into focus. I find it is better to pick my battles carefully.

“All-Focus” Not Always Good

I also find that just because I can bring the whole frame to focus does not mean I should or that the resulting photo will look good. Full-frame focus can be disorienting, such as a case where you are looking through different layers of tree branches and lose all sense of layers and distance which is just what makes the shot interesting in the first place.

Focus stacking can remove the sense of distance, since the eye is used to having a focus point and the rest of the image more-or-less out of focus. This can make for an unusual sense of space and spaciousness which can either enhance a photo or make it seem claustrophobic. Some scenes are not worth stacking.

Movement

Focus Stacking is primarily for still life photography, where nothing is moving. Movement causes artifacts in the finished photo that (usually) cannot be remedied, with the result that the photo is not considered satisfactory. This is not say that focus stacking should not be used for nature photography with live subjects, but just that you want to catch your critters at rest, holding a pose long enough for you to shoot a few frames at different focus points.

Focus stacking with moving subjects can make for interesting impressionistic or expressionistic photos, but most of these would fall into the category of artistic experimentation rather than nature photography.

What's Missing?

Usually you won't know until you are home on the computer processing the shots, but here is the rule of thumb: unless you are shooting 30-40 shots on a focusing rack setup or shooting traditional (one plane of focus), something will be left out, somewhere. The skill comes in choosing what you want in focus and what if left out will never be missed.

Just about every stacked photo I have made has weak or missing spots, if not outright blatant artifacts. I generally ignore those who insist every speck has to be in focus or you are a lousy photographer. That's asking too much and is by definition impossible without shooting hundreds of photos. Every other possibility has one kind of flaw or another. With focus stacking, you just have to pick your battles.

And as I like to say, focus stacking (at least the kind I do) is at heart impressionistic, meaning that I as the photographer choose what to have in focus and what to ignore. The result (like all photographs) is my impression of the subject, the sense of it as I see it. Like HDR and other newer techniques, focus stacking is just another way to present an impression of what you see, in this case by playing with focus. Further on I will illustrate these various problems.

Camera Modes

Most cameras nowadays offer you the option of several shooting modes, typically:

Program Mode

The camera does everything for you and decides what is your best shot.

Shutter Priority Mode

You set the shutter to what you need, and the camera does the rest. For example, in sports events, you need a high (fast) shutter speed to capture the action, while in still life photography, you can use a much lower shutter speed.

Aperture Priority Mode

Here you set the aperture yourself to gather more or less light, and let the camera do the rest.

Manual Mode

In this mode, the photographer sets everything, the shutter speed, the aperture, and the focus. THIS is the mode I generally use and recommend, although you can use any of the above with the exception of auto-focus. Setting aperture, shutter speed, and ISO limits becomes natural very quickly.

Challenges in Focus Stacking

Histograms

I have been photographing since around 1954 when my father loaned me his Kodak Retina 2A camera for a summer trip. Of course I was shooting film and dad paid for that and the developing. But the expense of film and the fact that you had to wait days to find out if your photo even came out were great inhibitors to my photography experimentation. Back then I used a light meter to determine how to set my exposure but even that device (or my ineptitude) did not guarantee me a decent photo.

In general I wouldn't spend the money for film/ developing and I hated the guesswork involved in having no immediate visible feedback from each shot I took. With the advent of digital cameras all that changed.

Now I can afford to shoot as much as I like and the LCD preview screen gives me instant feedback as to whether I am in or out of focus, whether I have too much or too little light, and so on. There is one feature in these new cameras that is VERY important to have, and that is visible histograms that evaluate exposure. The RGB histograms amount to a 21st century light meter, one built into the camera itself.

Using RGB histograms allows us to tell at a glance whether the photo we just shot is exposed properly for our purposes or whether it is too dark or too light. Histograms make it clear whether we have a lot of clipping going on, which means we have lost photo information that can't be retrieved later in Photoshop. This is something we really need to know, because if I spend an hour shooting an important subject only to find out later that all images were severely overexposed, it is a heartbreaker if I can't repeat the shoot due to circumstances, etc.

This is not the place to explain how best to use histograms. There are dozens of good tutorials on using histograms on the web. Just note: when shopping for a camera, get one that does show you an RGB histogram. Since I don't use automatic focus, shutter, or aperture, I would be lost without histograms.

Focus

In Focus Stacking, auto-focusing is not used since auto focusing lets the camera decide on one and only one focus point, and that is that. In focus stacking we need many points of focus, and want to set each one ourselves, since the camera does not have an eye for beauty... yet. So you will be using manual focus for close-up and focus stacking.

Camera Bodies

The two leading makers of fine camera bodies are Canon and Nikon. Both companies make good cameras. I happen to like the Nikon workmanship and right now they are the best low-light cameras on the market, meaning they can work at relatively high ISO levels, i.e. work in low light with less graininess. Nikon also has (even according to Canon users) the best auto-focus system and best flash system available. It is too bad that there is not a universal lens mount for DSLRs because once you start buying lenses for one brand, Nikon or Canon, it is very difficult to switch camera bodies since they are not interchangeable.

Normal Lenses

On 35mm format cameras (like many DSLRs) the 50mm lens is "normal" and anything longer (60mm, 90mm, 200mm, 500mm) is considered a telephoto lens and anything shorter (35mm, 24mm, 14mm) is considered as wide angle. Almost every photographer has a 50mm lens and preferably a fast one... f/2.8 or better. Most photographers' kits also have at least one wide-angle lens and one telephoto lens. I mentioned earlier that the most popular macro lenses typically range from 60mm to 200mm, with 105mm being traditionally a popular length for macro photography. My favorite macro lens is 125mm.

Camera Body Features

Close-up and macro photography require a stable support such as a tripod and with focus stacking it is pretty much mandatory. An added feature that you might want to look for when buying a camera body is the ability lock the mirror up before a shot. With DSLR bodies typically, in order to see through the viewfinder to focus one has to have a mirror so that you can see out of the front of the lens. Yet when a picture is taken that mirror has to first be raised up out of the way, the photo taken, and the mirror lowered for the next shot. When the mirror is raised it slams into the top of the camera body and causes vibration which very often affects the photo being taken. The shock of the mirror being raised reverberates through the camera while the shot is taken and causes the photo to be very slightly out of focus.

This is especially important in close-up and macro photography, in particular when focus stacking. Higher-end cameras have a setting that allows you to raise the mirror when you take a photo, wait for a second while the mirror is raised and the vibration vanishes, and then press the release button a second time to take the actual photo. This of course only works for still life or shots where action is not what you are after. This is a very important feature to have, if you can.

Challenges in Focus Stacking

Wind and Focus Stacking

I live in Michigan which is for the most part just flat, since the glaciers moved across it like a snow plow (way back then) and scraped it flat. With nothing to stop it, like mountains and valleys, we have wind and more often than not.

Wind is a problem for any macro photographer, but a much greater problem if you are trying to stack photos, since even a tiny movement results in halos and other artifacts. The proverbial advice for shooting in wind is either don't shoot at all or be patient and wait for a lull.

This is good advice except where you need to shoot five or ten photos each at a different focal point. What happens is that you get two or three shots off and the wind moves the subject (or parts of the subject) a tiny bit. You don't even see it because you have your eye to the viewfinder, your hand focusing, and your mind busy coordinating it all.

It actually is worse than this. The wind doesn't usually just move one blade of grass or whatever. It moves all kinds of things ever so slightly, often too subtle for you to even catch, but not too subtle for your lens to catch. The result is that all kinds of stuff moves around.

Where you figure this out is back home on the computer while processing the stacks. Photo after photo has some movement flaw or all kinds of little wind-generated artifacts. Some can be fixed in Photoshop, but a lot are not worth fixing unless you like being a photo-touchup artist for hours at a time.

To make things worse, if you are shooting seasonal flowers the season does not wait for the wind to die down. Many flowers are in and gone in a few days. We can schedule time for shooting, but we can't control the wind which sometimes is strong enough to keep all of the plants dancing for days at a time. What to do?

One thing we can do (although not focus stacking) is just use a higher shutter speed (one that stops motion) and just shoot traditional one-shot photos with as much depth of field as we can push the aperture. There is always that. Or, if you are shooting something like an entire flower that moves slowly in the wind and can push the shutter speed up so that the whole flower is caught, SOME stacks will work because Photoshop will align the whole flower, shot by shot. Although this approach sometimes works, it seldom works well and is hardly worth the effort.

Another thing I have tried is to make little stakes and string little panels of cloth on them in an attempt to stop the wind from coming in. I even bought some small collapsible car antennae so the whole thing could be portable but the wind came in from above or from anywhere that was not covered and did its thing, so this was not a satisfying solution. For really good stacked photos of very small flowers wind is pretty much a deal breaker.

There is an inexpensive way out of this, although it is

a real PITA to haul around and that is: a Light Tent. Light Tents are expandable cubes of translucent material that are used for product photography.

They diffuse light over whatever is inside the cube AND they stop wind. These light tents are all over Ebay, and you can get a 24" or 30" Light Tent for around \$30. You will have to cut the bottom of one of the flat sides out of the tent for it to be used outdoors, and resign to dedicate the tent for field work since it is going to get dinged and smudge no matter how careful you are.

Simply place the tent over the area on the ground where the flowers are and start shooting. The tents even come with a Velcro cover for the front (with a slit for the camera lens) if the wind is trying to get in the front direction, so you have five sides that are closed and one side (the bottom) that is open. These light tents work great for ground work provided you resign yourself to carting them around in the woods, in addition to your tripod, camera, lenses, and what-not. But this is a real solution worth trying if you really want those good stacked photos.

I even had my daughter sew a skirt on the bottom of the light tent so that I could feather it out to further stop wind from coming in from the bottom.

PHOTO

On the next page is an inexpensive Light Tent that I have cut the bottom (cut on one of the flat sides) out of. I then place the light tent over the subject, as you can see. Here the subject is the Mullein plant. In this photo I have partially bent the detachable (velcro) front panel back, so that you can see into the tent. I usually just poke the camera lens through the slit in the front or pull back the velcro from the top and shoot downward from there. This is my smaller tent. I also have a 48" tent that kids could play in. I use it to place over whole sections of plants, like in a field so that I can stop the wind and concentrate on the flowers or the insects on the flowers, etc. This approach is a little extreme and cumbersome but it does work well.

Here you see a Nikon D3s on a Gitzo GT2531 tripod, with a Markins Q3 ballhead, and a Nikon MC-30 remote shutter release. These and the following shots are kind of sloppy, because I was fighting rain that was only minutes away.

Challenges in Focus Stacking



Light Tent setup

Challenges in Focus Stacking



Light Tent closer-up



Light Tent when the wind is really bad

Challenges in Focus Stacking

Light Tents in the Field

Light Tents fold up flat or can be twisted into a small round package but as you get to the larger sizes it becomes more difficult to twist them into their smallest form. Lets face it, light tents are a hassle to drag around, but if you live in an area where wind is the default and not the exception, like Michigan, your choice is either waiting a long time for the chance to make a stacked photo or using a light tent. And I mean a long time.

As mentioned earlier, taking a traditional one-shot photo is not too much of a problem in wind. Just push up the shutter speed or the aperture, or both. Forget about getting a stacked photo that day. However, if you stack photos then wind will seldom let you get more than a couple of shots off before it starts to move things around within the frame.

Even with a light tent, you have wind. It creeps in through the bottom of the tent, although using a couple of rocks or large sticks to weigh down the sides can lessen it a bit. Still, if the wind is up and the flower (or whatever) is delicate and on an attenuated stem, you are going to find movement and still be waiting for the wind to die down, although light tents greatly can speed up an outing, allowing you to get many more photos on a windy day.

I have 24" and 48" light cubes and usually always have the smaller one in my car. Using light tents can mean that I range in a smaller radius from my car than I otherwise might, but the results are more than worth it. With care and setup (weighting the sides if the wind is up), I can shoot fairly large stacks most of the time.

Of course, to avoid getting the white sides of the tent in the photo you will have to shoot at some angle, either from the slit in the front of the tent or by pulling back the Velcro strips along the top of the front. If you can blur the white tent as background, it works well for some subjects. Larger light tents give you more freedom in this regard, but are even more awkward to move around.

I find that using light tents is well worth the extra effort and hassle involved. And the larger (48") tent can be used in a field of flowers or plants, placed over an entire section, allowing you not only to work with plants, but to remove the wind factor on the top of plants (like Queen Anne's Lace) and concentrate on the many interesting insects that are wandering around on the flower heads. Moving insects AND moving flowers due to wind usually manage to make any stacked photo almost impossible, but remove the wind and the insects may pause long enough to get some depth from stacking a few shots.

Light Diffusers

Diffusers and reflectors are readily available on Ebay, B&H, Adorama, and other providers of photography accessories and there are many tutorials on the Internet as to how to use them. There are gold, silver, and white reflectors, and usually one type of opaque diffuser.

My problem is with the diffusers currently on the market. While they may be useful in full sun, I find that for any more delicate sun-shade condition, they block too much light. For example, in a woods situation, where some streaming sunlight is coming through the forest canopy (that is too harsh and needs to be toned down) the standard diffuser more or less creates more shade rather than diffuses the light. Here is a solution:

I bought one of the regular diffusers. I use the 22" round diffuser because I can collapse it and (with effort) jam it into my coat pocket, which pocket acts like a carrying case.

I then went to WalMart and picked out a somewhat-sheer fabric that lets a lot more of light through than the original panel. Silk screen material also is perfect. I stretched this new fabric over the open diffuser and (temporarily) clamped it in place and then had my daughter (I can't sew) sew around the rim, fixing the new fabric. Then, with the new fabric firmly sewed on, I carefully cut out the original translucent panel. The result is a diffusing panel that is actually helpful in many situations.

It folds up and fits in my coat pocket or the little round bag it came in. I also stuff it in a holster-type camera bag which holds it without any additional sleeve and pop it out whenever I need it. It screens and softens the light so I don't have glaring patches of sun that blow out the highlights. I prop it up somehow, by any means I can - sticks, holding it, hanging it from its one loop from my tripod, etc. This diffuser acts as a filter to bring down the light to a manageable level.



Processing Focus Stacks

Lightroom and Photoshop

I don't want to get too technical here, but it might be useful for you to get a visual idea of how your stack of photos is processed, so here is a quick run through.

I use adobe Lightroom 2.6 to not only catalog all my photos but also to develop and touch up photos. It really is a great program, a comfort to use. But to stack photos I use Adobe Photoshop CS4. Luckily Adobe has seen to it that these two programs work seamlessly together so that I can send two or more photos from Lightroom to Photoshop and back with no trouble. I will show you how I do it, but you, of course, will come up with your own favorite methods.

After I input my photos to the Lightroom catalog I go through them to find the stacks and mark them, so that I don't mistake a stacked series of photos from just a standard shot or two. So I go through my new photos and mark the beginning of each stack with a green border which tells me this is a stack that runs from the green photo until the next different shot. Here is a screen shot from lightroom on the next page.

As you can see, near the upper left-hand corner, I have marked a photo with a green border as the first in a series of four photos. In this case the photo is of a dying tree trunk that has been drilled out by one of Michigan's Pileated Woodpecker, a bird with a body about a foot and a half long!

You can see the stack of photos both in the main grid view and in the loupe view running along the bottom of the screen as well. There are some other stacks following this one that are visible.

Lightroom and Photoshop are the trademarks of Adobe Software, Inc.

Archiving Photos

I take lots of photos and their individual size keeps getting larger, what with sensors with more megapixels, like the Nikon D3x, etc. What to do with them? How do I protect them from... whatever?

It is good to have as many copies of your photos as you can manage, and stored in different places at that. I have my computer set up so that when I copy a new set of photos from a flashcard they are written simultaneously to two separate hard drives. This is accomplished through RAID formatting which always keeps two copies of all files, separately. Therefore, if one disk goes down, the other (hopefully) is intact. In addition, I also copy all the files to a third disk for even more protection.

I use Adobe Lightroom to keep track of my photos, as well as to do most developing tasks, like light-balance, tone, sharpening, and so on. I store each day's photo shoot in a separate folder by date, in the format "YYYY-MM-DD" so that they can appear sequentially and be sorted by date.

Lightroom has strong keyword capability and attributes you can tag a photo with, such as "Keep," "Reject," plus five colors and five star ratings. As for keywords, you can enter almost anything and find it later. I use the color, five-star rating, keep & reject attributes all the time, but tend to fall behind on writing out all the keywords. I do tag my "Keepers" in red, so a search for all red-bordered photos let's me find the most important ones quickly.

I like to browse through my entire collection from time to time, just because I often find photos I have overlooked for one reason or another that now I have a use for or can touch up to make them useful.

PC or Mac Computer

I have both a Mac and PC and work with images on both machines, although I do more video work on my MacPro and still-photo work on the windows-7 PC. Both computers can handle 64-bit applications. As for monitors, I have used two monitors for years and find the extra room indispensable. Lately, I have switched to a single 30" monitor.

Processing Focus Stacks

The screenshot displays the Adobe Lightroom 2 Library grid. The interface includes a menu bar at the top (File, Edit, Library, Photo, Metadata, View, Window, Help) and a main title bar with the Adobe Photoshop Lightroom 2 logo and navigation tabs (Library, Develop, Slideshow, Print, Web). The grid shows a series of 20 images arranged in a 5x4 grid, representing a focus stack of tree trunks. The images are labeled with their respective numbers and file names (e.g., BB1_4793, BB1_4794, BB1_4795, BB1_4796, BB1_4797, BB1_4800, BB1_4801, BB1_4802, BB1_4805, BB1_4806, BB1_4807, BB1_4808, BB1_4809, BB1_4810, BB1_4811, BB1_4812). The images show a progression of focus from the foreground to the background. The grid is filtered to show only the selected images, and the status bar at the bottom indicates that 4 images are selected out of 256 photos in the folder '2010-03-28'. The bottom right corner shows the 'Filters Off' status.

Processing Focus Stacks

Lightroom, Step 2

I have selected these four photos to be stacked. Next, I select the PHOTO tab at the top of the screen, scroll down to the EDIT IN option, and within that option I select the “Open as Layers in Photoshop” option. This will automatically send all four photos to Photoshop where they will appear as consecutive layers, ready to be processed as a focus stack. Instructions continued on next two-page spread.

Note: Color Space

Color Space (in a camera or in software) sets the practical limits on how much color can be handled. There are three main types of color space commonly encountered in cameras and their software, sRGB, AdobeRGB, and ProPhotoRGB. The AdobeRGB color space is wider than the sRGB color space, and the ProPhotoRGB color space is much wider than the AdobeRGB color space.

Which color space to use depends on a number of considerations including how are you going to use your finished photos? Most DSLR Cameras offer you the choice of two color spaces, sRGB (web output) and AdobeRGB (printed color). AdobeRGB has a broader range of color coverage than sRGB, so many folks use that. However, please note:

If you are going to shoot JPEG in the camera then you want to set your color space to sRGB. The same goes if you are shooting JPEG and outputting to the web or a computer; use sRGB. Otherwise, you will have to convert to sRGB later in the process.

HOWEVER, if you shoot camera-RAW images, you don't have to worry or choose a color space ahead of time or be concerned what your camera color space is set to BECAUSE raw images are independent of color space and their color space is automatically assigned by whichever raw converter (software) you use, that is: whatever color space you set your raw-image converter to. Repeat: raw images are color-space independent.

As mentioned above, if you are shooting raw then it does not matter how you set your color space in the camera BECAUSE your software/converter can be set to whatever color space you want. Right now, the broadest color space is ProPhotoRGB. Adobe Lightroom defaults to the ProPhotoRGB color space and Adobe Photoshop can be set to ProPhotoRGB.

I use ProPhoto RGB and convert to whatever other color space (sRGB, etc.) when I output images from the above programs. I set both Adobe Lightroom and Adobe Photoshop to ProPhotoRGB.

The ProPhotoRGB color space is said to resolve 90% of all possible surface colors in the CIE Lab color space and 100% of likely real-world surface colors, which is saying a lot. Therefore a combination of the RAW format from the camera and ProPhotoRGB color space in your software is the best available at the moment and a good argument for not using JPEG compression.

Note: JPEG or Raw Format

Most sophisticated DSLRs offer two output formats, Raw (native) or .JPG compressed, although almost all professionals that I am familiar with shoot their important photos using the Raw format. The reason for Raw is that by using the raw format there is much greater flexibility to adjust your light balance and other important factors later (like years!) back in the studio, while with a compressed bit-map format like .JPG, you lose most of that flexibility and may live to regret it. With .JPG, light-balance factors are fixed forever in that format, and can only be tweaked a little, so you better be a skilled photographer and get the shot right in the first place.

I shoot in raw (native) format at the highest bit rate, which is 14-bit Raw in the Nikon cameras that I use. Yes, it uses more space, slows down the computer, etc., but you get a better photo as a result AND can dicker with the photo years from now, when some new development will allow us to pull more from the raw format than we can now. All the bits and bytes that the camera saw are there.

If you are a macro or close-up photographer, I would very sincerely suggest you shoot RAW, because if you get any good at it, years from now you may really regret using the .JPG format which loses some of your precious data.

Processing Focus Stacks

The screenshot displays the Adobe Lightroom Library grid. The 'Edit In' menu is open, showing options for opening photos in Photoshop. The 'Open as Layers in Photoshop...' option is highlighted. The grid contains 20 photos, with the 196th photo selected. The photos show a focus stack of tree trunks, with the selected photo showing a close-up of a tree trunk with a hole.

Lightroom Library Grid View

Library | Develop | Slideshow | Print | Web

Text | Attribute | Metadata | None

Filters Off

193 8872 x 4256 BB1_4794 NEF

194 8872 x 4256 BB1_4795 NEF

195 8872 x 4256 BB1_4796 NEF

196 2032 x 4256 BB1_4795 NEF

197 8872 x 4256 BB1_4797 NEF

198 2032 x 4256 BB1_4800 NEF

199 2032 x 4256 BB1_4801 NEF

200 2032 x 4256 BB1_4802 NEF

201 2032 x 4256 BB1_4805 NEF

202 2032 x 4256 BB1_4806 NEF

203 2032 x 4256 BB1_4807 NEF

204 8872 x 4256 BB1_4808 NEF

205 2032 x 4256 BB1_4809 NEF

206 2032 x 4256 BB1_4810 NEF

207 2032 x 4256 BB1_4811 NEF

208 2032 x 4256 BB1_4812 NEF

Sort: User Order

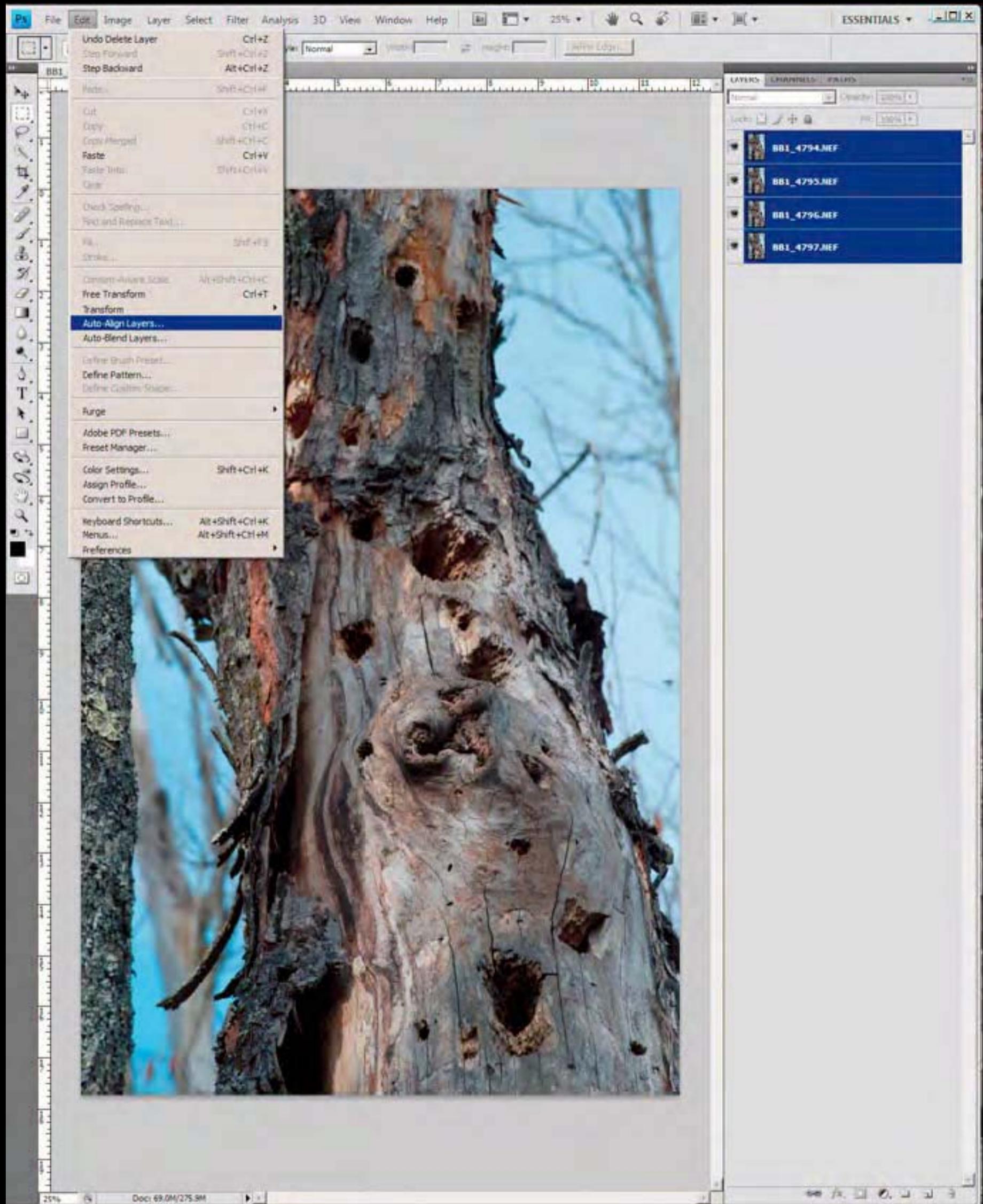
Thumbnail

Folders / 2010-03-28 / 256 photos / 4 selected / BB1_4794.NEF

Filter

Filters Off

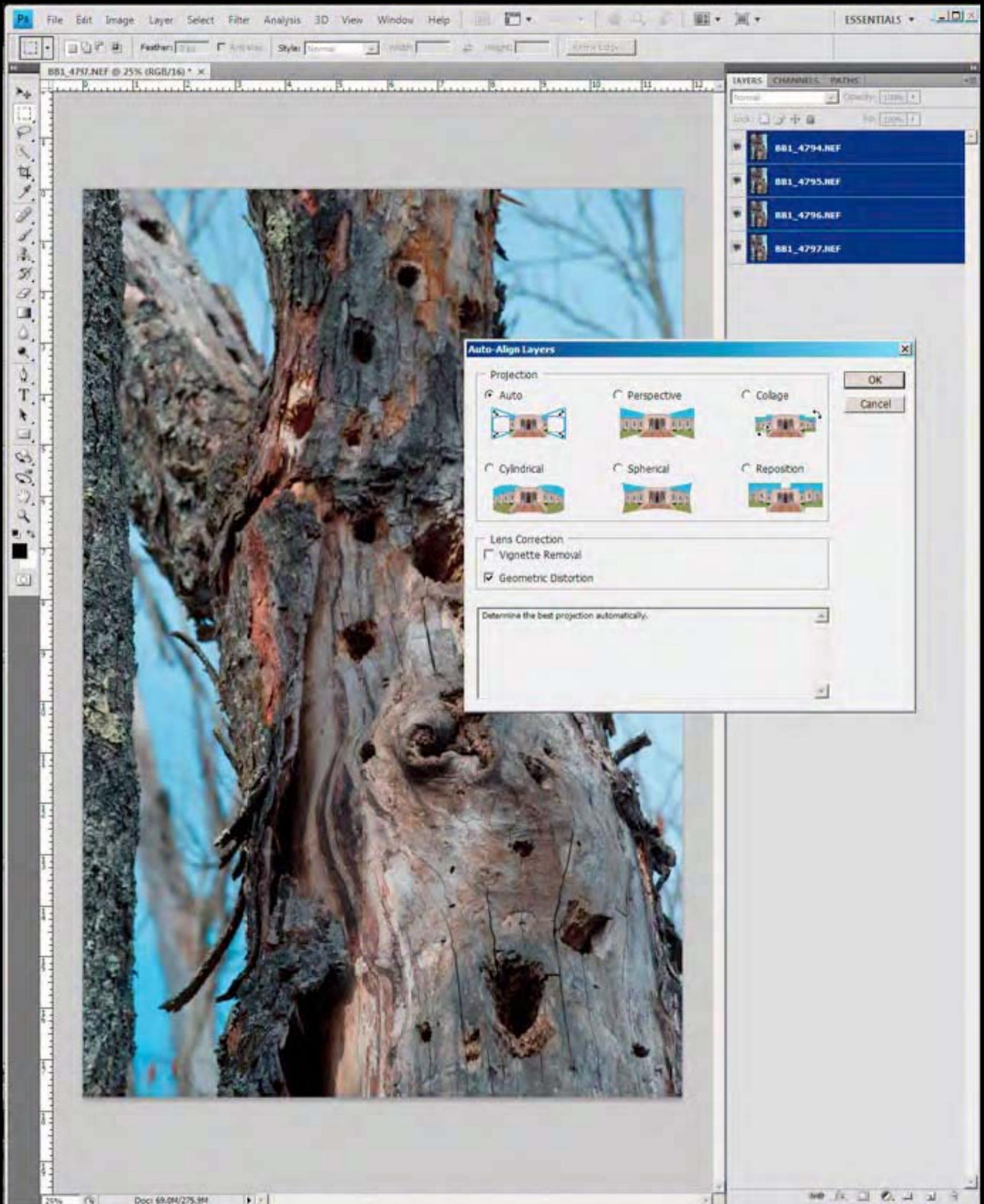
Processing Focus Stacks



Photoshop Launches Automatically

Photoshop will automatically open and the four photos I selected appear, one above the other, as layers. I then select all four, and from the EDIT menu, I select "AUTO-ALIGN Layers, which brings up the Auto-Align Layers dialog box, as you can see on the left.

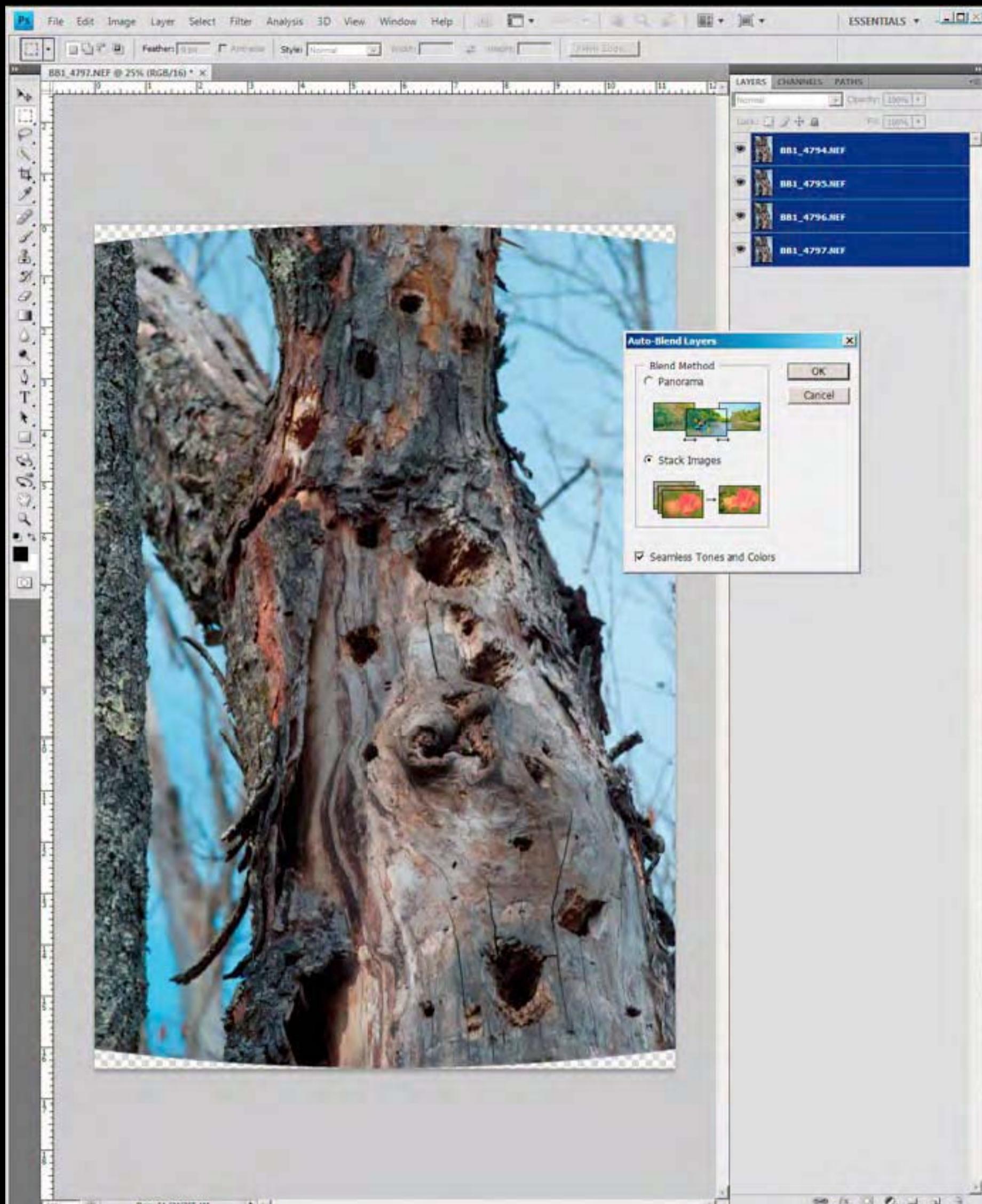
Processing Focus Stacks



Auto-Align Dialog Box

Once the dialog box is up, you want to check the AUTO radio button and the GEOMETRIC DISTORTION check box, as shown here, and hit OK. The program will then proceed to align the images in all the layers with one another. Depending on various considerations, this can take less than a minute to thirty minutes or more. In fact, the program will even say "Not Responding," but have patience, wait, and it will return.

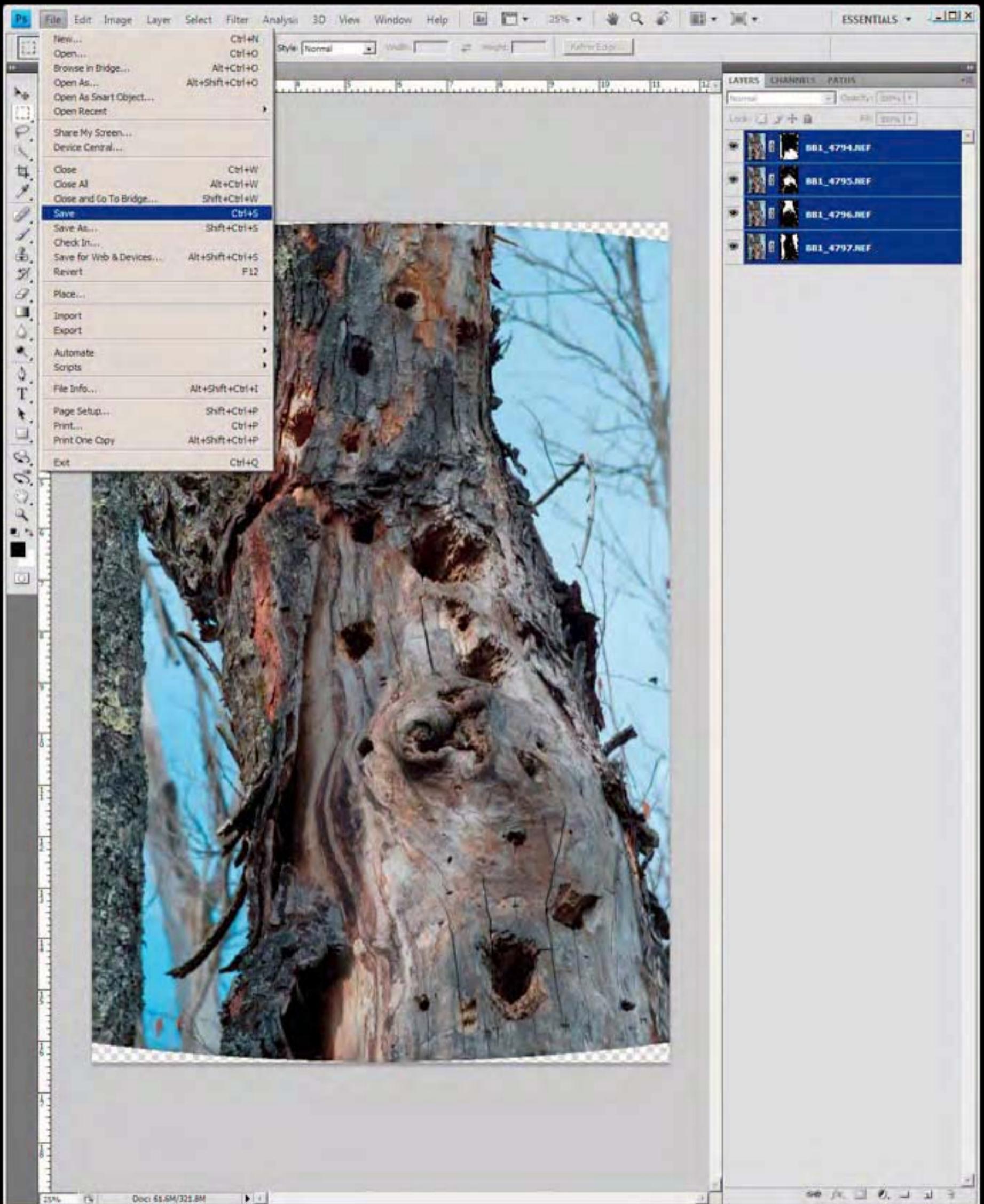
Processing Focus Stacks



Auto-Blend Dialog Box

When the images have been aligned, you will see that the image may be shaped differently than before. Next, go back to the EDIT tab at the top of the screen and this time select the AUTO-BLEND LAYERS option and make sure you have checked the STACK LAYERS option and the SEAMLESS TONES AND COLORS option. Press OK. The program will now blend all the stacks into a single image. This takes less time than alignment.

Processing Focus Stacks



Save The Stacked Photo

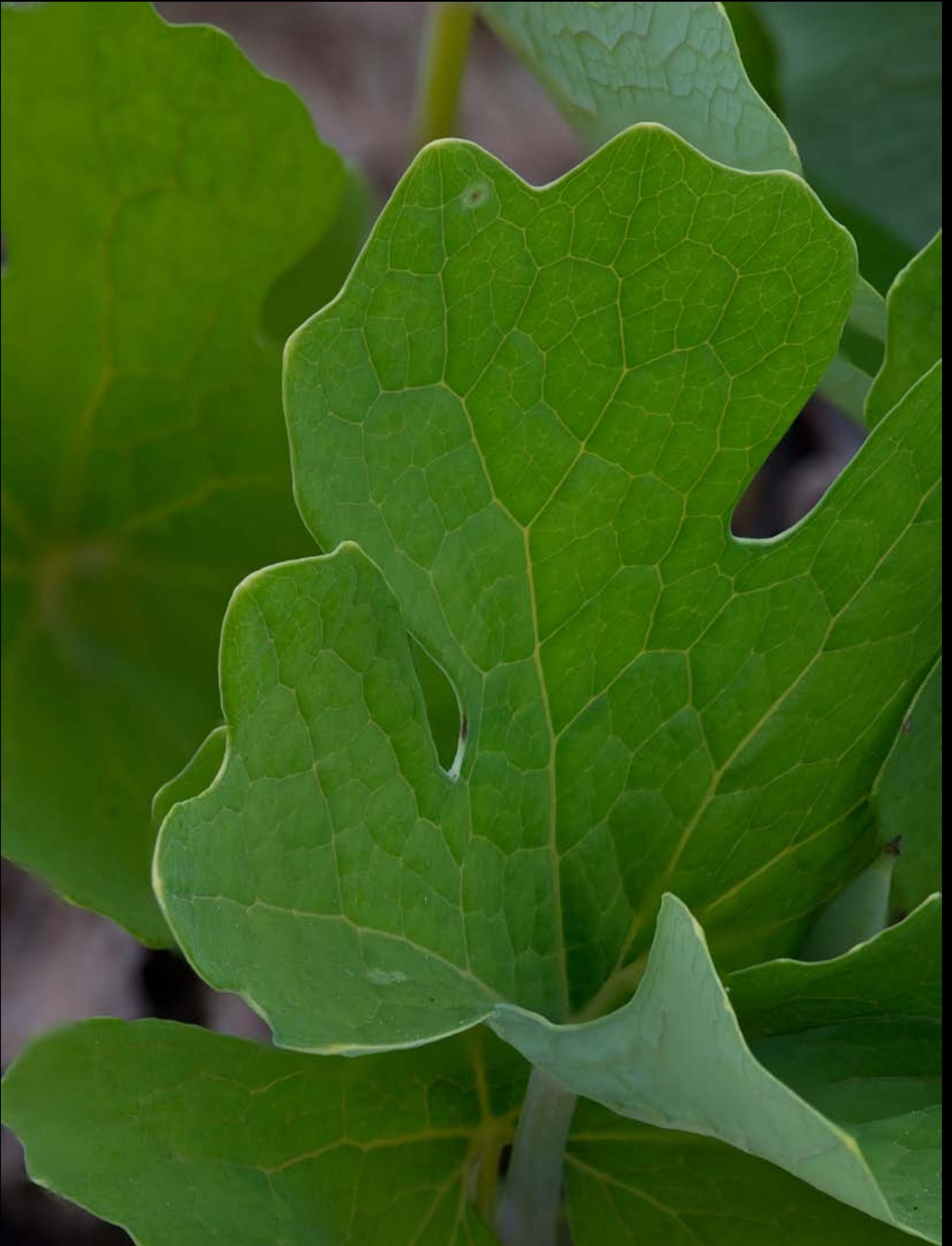
When the layers have been blended and the stacked image is displayed, you want to **FLATTEN THE IMAGE**, by choosing that option in the pull-down menu in the upper-right-hand corner of the layers palette.

Then, from the **FILE** menu at the top of the page, select **SAVE** and the finished stacked photo will be automatically saved as a .TIFF image on your hard drive and that image will be added to your Lightroom collection. I tag all stacked photos in red.











Examples of Focus Stacking















Examples of Focus Stacking







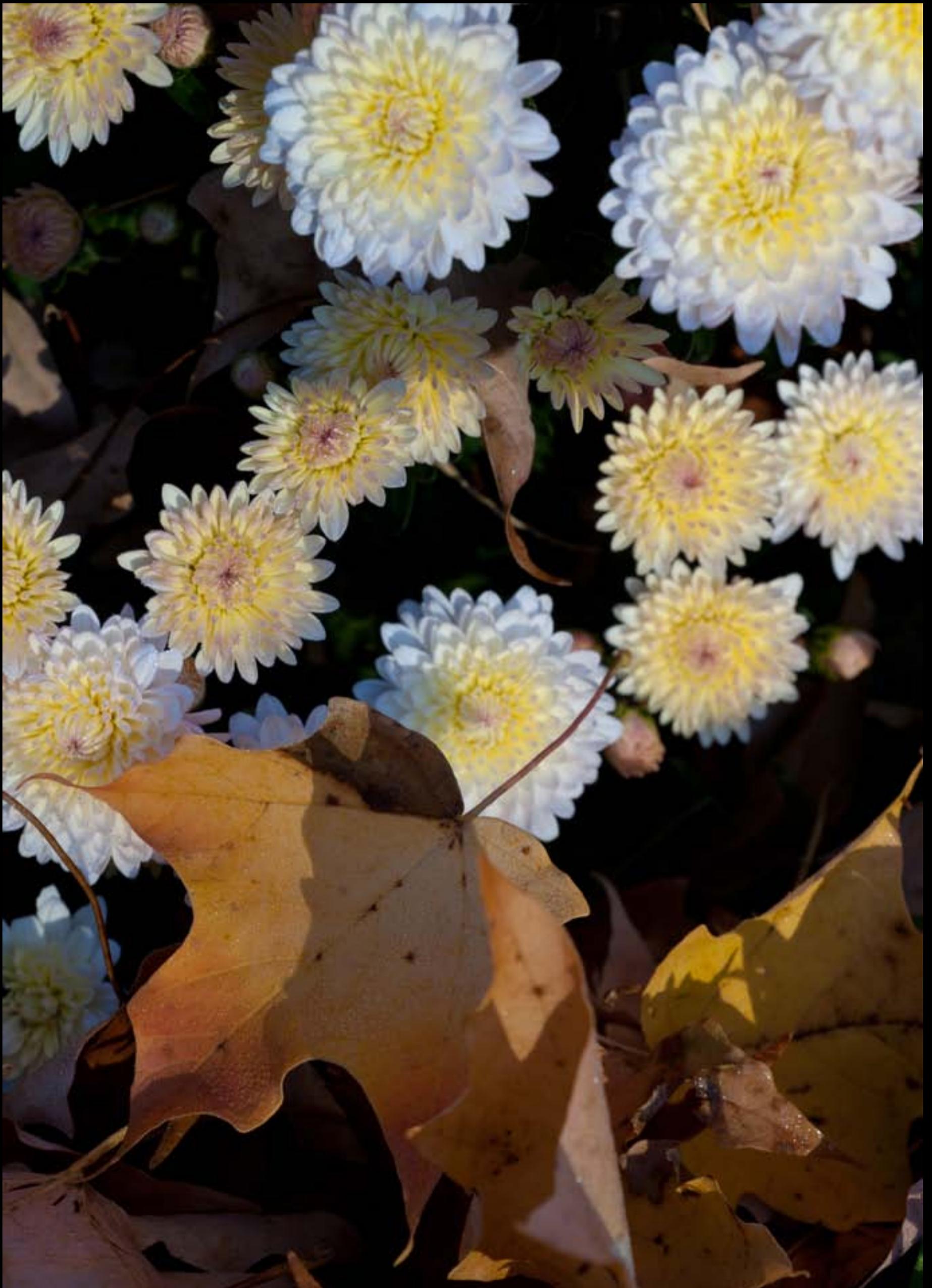
Examples of Focus Stacking



Examples of Focus Stacking



Examples of Focus Stacking



Examples of Focus Stacking



Examples of Focus Stacking



How I Got Into Nature Photography

BY Michael Erlewine

What motivates me in nature photography is probably a little unusual and I will sketch it out so that you know where I am coming from. I was a naturalist from the time I was six-years old until I discovered how beautiful women are at the age of say sixteen. So I kind of segued out of nature study when I was around seventeen. We can perhaps all agree that nature is serene and beautiful but I am not as sure that all of us are aware that nature is also fierce, a very harsh mistress.

I find it hard to look nature in the eye. And I usually blink first, because she never blinks. There is some tough love there. And while I loved nature, as I grew older, I also gradually shied away from looking directly at the harder parts. I find the same problem with Billie Holiday recordings, my favorite woman singer. Even though I love her singing, I am not always willing to put myself through the emotions she brings out in her voice. I can't go there without paying the price of my full attention and all that entails.

It is the same thing with nature. Nature is so absolutely direct and not all of her story is happy. There is an enormous amount of suffering to be witnessed in nature, creatures living in fear their entire lives of being eaten and at the same time struggling to find something to eat, and so on. Nature tells a touching story and I did not always want to be touched. I was not willing at times to go there and over the years I kind of opted out of that kind of directness. I was out of shape in that department and like exercise I found it hard to get back into the rhythm of it.

Then some years ago I had a very tough personal time, one that kind of popped me out of whatever groove or bubble I was in and I found myself kind of waking up in the middle of this personal crisis. Some part of me was back from wherever it had gone to years before. At that time I was somewhat inconsolable and soon wandered outside of whatever box I normally was happy in.

One of the places I went was out into nature once again. Whatever pain I didn't want to face in nature all those years was nothing compared to how I was feeling at that time and before I knew it I was out in the fields and meadows watching the sun come up every morning. Unless it rained or something, I believe I saw the sun come up every morning from late May until it was too cold to go out that early, sometime in October. And here is what is interesting.

When I went back out into nature, this time I took a camera. I just happened to. I had been photographing since the late 1950s, but not as intensely as I was about to. Perhaps the camera was my excuse to get out there, a better reason than the truth which was that I was desperate at some level. And I took pictures. Looking at nature real close up was a good antidote for what I was suffering from. Perhaps it was the pristine mini worlds that I could see into through a macro lens, worlds untouched by all in the world that had recently touched me so painfully.

Anyway the fact of the matter is that here I was out in nature with my eye glued to a lens peering at her truths and lessons after many years of not being able to really look. Somehow my mind was calmed by what I was seeing and before long I found myself searching for and learning to use better and better macro lenses. Yes, it was therapy.

The story is actually a bit more complex than I have described it here and I wrote it all out in two free e-books for those inquiring minds who really want to know more. The books are "The Lama of Appearances: Learning Dharma through Nature" and "Experiences with Mahamudra: The Dharma of Meditation." They can be found at MacroStop.com. I don't need to go into those details now.

I retell this story here to explain to readers why the resulting nature photographs from my photography were never the reason I did photography. Some photographers find this hard to understand, so I present it here.

It was not the resulting photos (stacked or unstacked) that interested me, but rather the process, the mental therapy I got out of being out there in the meadows and peering through my lenses at whatever was there. It was not what I was seeing through the lenses that was important, but rather the act of "seeing" itself. It was all about the "seeing." It was about getting my mind right and about ever-so-carefully setting up and taking these close-up photographs, holding ever so still for ever so long until the wind died down or the critter stopped moving, and then taking one, two, or ten photos without anything moving whatsoever. This elaborate and slow process did something to my mind, something clarifying and bright.

So over quite some period of time I healed myself not with pills and potions but with the ritual of taking precise photographs and the mental clarity that came out of that process. It was the "process" not the product that was important and it has remained so to this day. For the longest time I hardly (sometimes never) looked at the resulting photos or, if so, just long enough to get some bearings on how I might perfect the process. Again, it was the process and the "seeing" that was satisfying.

Over the years the resulting photos also happened to get better but it is only recently that I have even begun or bothered finishing these photos so that I might show them to others. After all, there are probably more than 125,000 of them at this point.

I did become a better photographer through the process and the patience required in macro photography but most of all I became a much clearer person in the mind. And all of this time I was more and more aware of what nature is all about. And as the Buddhists say, the laws of nature accurately reflect the dharma, the path to clarity and awareness set out by the Buddha. So, I was learning dharma during all this time as well. This is a synopsis of my story and what macro photography for me is all about.

Unsolicited Advice

What follows are comments, notes, suggestions, warnings, etc. related to photography, macro and close-up photography, and focus stacking. They are roughly organized and are intended to give you some information on commonly asked questions and areas where that I feel should be pointed out.

Good Lenses – When I was just starting out and did not want to spend any money on a hobby that I might not stick with I was ingenious at rationalizing why I should buy cheap lenses. All I did was waste money because I ended up getting the expensive lenses anyway. The lens is "the thing" my friends, so get a good one. Good lenses are worth their weight in money.

Tripod – You need one for focus stacking and a good one at that. I have a whole bunch of lousy, cheap tripods I can't even sell that I bought trying to avoid buying one good tripod. A light and strong carbon-fiber tripod is a treasure. I use Gitzo carbon-fiber tripods, three-section (not four), and the model I use is the GT2531 and it weighs 3 lbs. and costs around \$500. Wirth every penny.

Ball Heads – Between your tripod and your camera you need some kind of connecting head. A good ball head with Arca-style quick-release clamp is superior to anything else I have tried. Markins make an inexpensive and good one (Q3) for about \$260 on Ebay. The BH-40 by Really Right Stuff is a more expensive ball head.

Quick Release – When you buy a ball head, make sure to get one that has a built-in quick release clamp compatible with the dovetail style plates (Arca). This is important because you need to be able to attach or detach the camera in a second. Otherwise you will be thumb-screwing the camera to the head and sooner than later the threads will get ruined on the camera and you will be in for a big expense. Also: I would avoid the Bogen/Manfrotto type quick release system.

L-Bracket -- A quick-release L-Bracket for the camera body for macro shooting is essential. Otherwise you are stuck with just one view. I shoot most of my photos with the camera rotated so that the long side of the photo is the vertical but I need the ability to change to the horizontal view at a moment's notice. I use Kirk Enterprises for all my plates.

My Standard Kit – I travel light. Aside from my camera and tripod, I usually take only one extra lens in a very small case hung over my shoulder, if that. Mostly I only take the lens on the camera. I might stuff a collapsible diffuser in my pocket. That's it.

Outside

Direct Sun - Direct sun is very difficult to photograph in. Once the sun is up high in the sky, head for the shade or get out the diffusers because your photos will just not work out. Some part of your subject will catch or reflect the light and blow out that area leaving you with a photo that is both too dark and too light – one or the other. The hot spots will be hard to manage.

High-Haze Sky – Slightly overcast (hazy) skies are probably the best for photographing you can get. Grab your camera and head outside. With no direct sun, the whole sky is your diffuser. You can't beat it because there are no hot spots. I am not talking here about really cloudy days, but just bright hazy skies.

Sun and Shade -- Shadows mottled with sun rays make for difficult photography, like a forest canopy with rays of sunlight. It can be very attractive, but those rays of sun blow out easily and conflict with all that shade. Better to have a fine diffuser at these times to filter the sun a bit and bring it down to being less stark.

Flash – I tried it (and a lot) and didn't like what it did to the photos and the subjects. I know it is the way to go for certain kinds of definition, but I don't need it at the expense of the alien-flash look. If you must use flash, use a tiny flash like the Nikon SB-400 and on top of that use a snap-on diffuser and even then rotate the flash upward and not straight at the subject. This can work. Natural light is better

than any flash device. So I avoid flash if at all possible and if not possible, I soften it by using a diffuser.

When You Buy a Camera Be Sure it Has:

Histograms – Since most macro work requires manual focusing and many of the really good lenses don't synch with your in-camera light metering, it is essential to purchase a camera with a built-in histogram. I consider this essential. Read more about histograms here:

<http://www.bythom.com/histogram.htm>

Mirror Lock-Up – I have detailed this elsewhere, but I would not buy a camera without the ability to lock-up the mirror and thus remove the excess vibrations when the mirror snaps up out of the way of the lens viewfinder. It means I have to click the shutter, the mirror goes up, wait for the vibrations to die out, and click it again, but it makes a real difference. Stacking focus means: everything has to be motionless.

Remote Release Trigger – Absolutely essential. You can't touch the release button on the camera without affecting the shot, however slightly. Make sure your camera can take a remote release, either tethered (cord) or untethered (infrared). Don't leave home without it.

Depth-of-Field Preview – Not available on all cameras, but I would not buy one without it. Otherwise you have no idea of how much depth of field you have. The best Nikon and Canon cameras have this.

Lens Focus Throw - A lens with a focus throw greater than 360-degrees is preferred. With focus stacking you want to take many photos incrementally. If the focus throw (turn of the focus ring) is too short, it is difficult to micro-inch forward. My favorite lens has a 720-degree focus throw (two turns of the focus ring) and that is a real pleasure to use. For action-sports it would be a liability – take too long. For macro it is perfection.

APO Lenses - APO (apochromatic) lens are rare and expensive, but they provide better color by not having chromatic aberration and other anomalies. The best APO lenses I know for macro use are the Voigtlander 125mm f/2.5 APO-Lanthar macro, the Leica 100mm f/2.8 Elmarit-R APO macro, and the Coastal Optics 60 mm f/4 APO macro lens. All of these are very expensive but very nice

Accessories

UV Filters – I use clear or UV filters to protect my lenses although I know they must degrade the quality of the lenses, however minutely.

Lens Hoods – Most lenses come with a hood and you need them to keep extraneous light out, so by all means use them and if you have a lens without one, track the appropriate lens hood down and buy it. They are there for a purpose.

Extra Batteries – I am a little obsessive about having extra batteries for my camera or whatever. I try to carry an extra one in the car but seldom on my person when I photograph. I seldom shoot more than several hundred photos at one shooting so the new Lithium batteries are enough for one outing.

Close-up Adaptors – These are little lenses that screw on the front of macro lenses to give them even more close-up magnification. I have them but don't use them.

They may give you added magnification but for the most part they mess with your good glass. If you do get them get only diopters which have two elements (not one). There are scads of inexpensive one-element diopters on the market and they are not worth anything. The make your good lenses look crappy. I have all the good diopters and never use them. Almost never. Occasionally I fool myself into experimenting just to remind myself why I don't use them.

Polarizing Filter – Useful for darkening skies, reflections on water or leaves, etc. I have them but seldom if ever use them because I am doing close-up and macro, so not sky, shiny tree leaves, open water, etc.

Graduated Filter – I use the graduated filter in Adobe Lightroom for this instead of a filter you screw into the front of your lens. For my purposes that is good enough.

Memory Cards – I like to have lots of these and big ones. I mostly use Lexar and SanDisk, although I have some Delkin (because they were inexpensive). All work well. My little Nikon D7000 has two 64GB SD cards in it at all times. That's a lot of photos.

Extension Tubes – I have scads of them but seldom use them. They are used to give you greater magnification for a given lens but they always suck light out of your shot anytime you use them and I seldom feel it is worth it. In other words, if you have a f/2.8 lens and add an extension tube between the lens and the camera body, you will get greater magnification but lose one or more f-stops. Suddenly you have an f/2.8 lens that now is a f/3.5 lens or whatever f-stop. I seldom use them and am not happy with the results when I do.

Teleconverters – You can get a teleconverter lens that is placed between your lens and the camera body that will give you 1x or even 2x magnification. If you put a 2x teleconverter on a 200mm lens, you instantly have a 400mm lens. However, you lose light, meaning suddenly your widest aperture for that lens jumps from f/2.8 to f/3.5 or higher. I have these, but every time I use them I swear I will never use them again. It is very, very difficult to improve on a lens just as it is, which is why the lens was made just that way in the first place – optimum. Put anything on the front or back of it and you are (IMO) just taking a good or great lens and turning it into an average (or worse) a poor lens. I seldom ever, ever use one and don't suggest them. Of course, they are not for macro work but for distance photography. If I was shooting birds I would probably have to use them.

Neutral Density Filters – These are used for a variety of reason like adding blur or being able to use a wider aperture and still lesson diffraction. I don't use them and/or know much about them.

Gray Card – Can be useful for setting white balance on site but I seldom bring one along. Instead I do this in Adobe Lightroom. However, for very exact color work in the studio a Gretag Macbeth ColorChecker Passport system is what I use. In the field I seldom bring one along. I sometimes do.

Focusing Rail – Many macro photographers prefer to stack photos working with a focusing rail rather than turn the focus ring on the lens. Either way can produce good stacked photos. Using a focusing rail you mount your camera on the rail, the rail on your tripod, and by turning little geared wheels incrementally move your camera closer or farther from your subject, taking photos as you move along.

Bellows – Lenses can be mounted on a bellows which in turn is mounted on a focusing rail for very close macro work, usually in the studio. Special bellow lenses are often (and usually) used. They are similar to the old lenses used in enlargers back in the days of film. I am not going into this here, but some of you may want to learn about them. Bellows are used mostly for ultra-close macro work. I seldom use them.

Diffusers - A simple light diffuser can be very useful. Most on the market are too opaque for my taste, so I buy a cheap one, tear out the center, and sew in something that lets more light through. I go to walmart and pick some gauzy white fabric. All I want to do is cut back the strong sunlight a bit not block all of it.

Reflectors - In addition to diffusers, there are reflectors that reflect light onto your subject. Diffusers allow light to pass through them and you hold them in between the subject and the light source. Reflectors are held off at some angle to reflect light on the subject. I have tons of them but I mostly use them for video studio work. They can be helpful outdoors in taking macro shots where you are in the shade and trying to get more light on whatever you are photographing.

Other Stuff

Stacking Live Critters - Live critters do sometimes hold still long enough for stacking. Spiders, bees in the early morning, you would be surprised. Ants? Not likely. Butterflies yes and definitely dragonflies. Try for it. You will be surprised what even a two-shot stack will produce in terms of greater focus depth.

Dust Bunnies – Particles of dust, sticky pollen, and whatnot somewhere worm their way inside your camera and cling to your sensor. The results are little persistent spots on each and every photo you take. This is particularly bad when focus stacking because as you focus closer in that little dust-bunny spot becomes a long line on the finished stack photo or a bunch of lines which can be hard to remove. You must keep your sensor clean for focus stacking.

Sensor Cleaning – This is the ugliest part of digital camera work but you have to do it. There are different levels of cleaning the sensor. On my Nikon cameras I have to lock the mirror up, take off the lens, and look inside. Behind where the mirror was (before it was locked up) is the sensor actually covered by a Lithium Niobate filter which is pretty tough and does not scratch easily. Still doing anything with the sensor requires care and can be nerve wracking.

For beginners (and occasionally for any of us) cleaning the sensor is not only difficult but often fraught with worry about damaging the camera's sensor. It is no fun at all. The single most-important tool for cleaning the sensor is some way to know if you have it clean. The traditional way is to go outside, point the camera/lens at the sky and take a photo. Then get the photo off the card, put it in Photoshop (or somewhere), expand the photo, and minutely inspect it for dust, what are called "dust bunnies." This is a horrible method and can take a very long time, going outside and in, etc. It is easy to spend an hour doing this if you fail to remove the dust you can't see in any way except as describe above.

The best money I EVER SPENT was to buy a BriteVue

Quasar Sensor Loupe which costs a whopping \$88. You can get them from VisibleDust. This is a 7x round magnifier that fits over your open lens hole (when the lens is off) and is lit by six bright LED lights. By looking through it you can easily see every speck of dust on the sensor. No more taking photos endlessly. If you value peace of mind and don't want to be ritually humiliated by the previously-mentioned process, just buy one. I know it is expensive, but you won't regret it. That said, here in general is what has to be done to clean a sensor. Please refer to your camera manual for exact details.

The first step is to place the LED sensor loupe on the camera and look inside. What is there? Is it a piece of hair, tiny dust bunnies, or a gooey piece of pollen? With the LED loupe you can see it all.

The next step is to take a special hand blower and blow air on the sensor to remove any dust particles that can be removed. Be sure to hold the camera with the lens-hole pointing to the ground so the dust stirred up by the blower will float down and out of the camera. Then look again at the sensor.

After blowing a few times, if there is still something there then try a special sensor brush (I use the one by VisibleDust, called the Artic Butterfly). These battery-operated brushes whirl around and become charged so they pick up dust. Very carefully brush the sensor WITHOUT going beyond the sensor and touching the sides, which can have grease. If you pick up the grease and wipe it on the sensor you are in for real problems. Using the loupe, see if this did the trick.

And the last and most scary resort is to use a special fluid and a special swab to actually clean the sensor manually. Again, I use swabs and fluid by Visible Dust made for my Nikon cameras. This may have to be done repeatedly and it is very tricky. Too little fluid and you don't get it all, too much and it leaves a residue. No fun at all folks.

If all of the above do not work, you will have to send the camera to the manufacturer. The above is a very general description of the process and is not definitive. You must refer to your camera manual for precise instructions. I cannot be responsible for errors you might make in attempts to clean your sensor. Use the procedures listed above at your own risk. Before doing anything please read this excellent article on sensor cleaning by expert photographer Thom Hogan:

<http://www.bythom.com/cleaning.htm>

Shower Cap – Buy one of those inexpensive plastic shower caps with an elastic band in them for rain protection for your camera. They take up almost no space and are totally useful if your camera and lenses get caught in a rainstorm. Just put them over the camera and lens while you get wet. You do not want to get your camera and lenses soaked. Period.

Camera Vests – I have them but don't use them. If I need that many pockets I am taking too much stuff with me. Walking around with a zillion pockets full of stuff is something I have done plenty of in third-world countries where if you don't carry everything, it gets stolen. Pocket-loaded vests are no fun and I really like to travel ultra-light.

Photo Software - We could write a book about photography software and many people have. All I am going to do here is briefly tell you what I use. There are many simple programs

for processing digital photos and Adobe Elements is one that will do quite a lot and is inexpensive. However, most photographers use Adobe Photoshop and/or Adobe Lightroom.

I use Adobe Lightroom 3.0 and it is far easier to use than Photoshop plus it also allows me to catalog and keep track of all my photos. Compared to Lightroom Photoshop is a lot more expensive and difficult to learn, so I suggest you get Lightroom. However, and I am sure Adobe planned it this way, there are some tasks that you can't do in Lightroom and for which you need Photoshop or at least Adobe Elements. If you are on a budget, just get Lightroom and Elements. That will do you. And: you will love Adobe Lightroom. It is intuitive and adjusting photos in various ways is easy.

Focusing Rails - I do use focus rails in the studio but seldom outside because they are just one more thing to drag along and the focus ring works well enough for me. If you do buy a rail, get a good one. Read about them. Most of them IMO suck. Novoflex Focusing Rail Mini is a good one and Minolta (if you can find an old one) made a solid and really well-made rail.

Tripod Cleaning – I have several tripods but I primarily use one for dry work and one for wet work (ponds, swamps, etc.). The wet tripod has to be taken apart and carefully cleaned and dried every so often, and at the end of the season.

Manual Photography – I don't do close-up or macro on any other setting other than "Manual." It takes only a short time to adjust to doing everything manually and after that adjustment I would never go back. I use "Program Mode" for parties and anywhere I need quick, auto-focus results. Otherwise, I use only manual. I set my own aperture and shutter speed and get better results, the results I want. Turn the dial to manual and leave it there. Manual Mode requires setting aperture and shutter speed (and ISO), taking a photo, looking at the histogram, and either keeping that photo or deleting it, adjusting the settings further, and taking another photo. This is the way to go.

ISO – ISO dictates how your camera behaves in low light – how grainy things look. I keep my ISO as low as possible even though I have cameras that can handle very-low light levels like the Nikon D3s. If possible I have my ISO setting at 100 or 200 ISO. This means I have to sometimes use long shutter speeds but if I am doing still life, so who cares. If I am shooting moving critters, I adjust the ISO upward as needed.

Be Ready To:

Get Wet - Be ready to get wet and not worry about it. Especially if you are out in the dew and fields early in the morning, you are going to get really wet or you are not doing your job. Sometimes I wear hip boots in the field to stay dry. Most macro work requires being on your knees or lower, so just accept it. I routinely get soaked out there in the dew.

Get Dirty - Be ready to get dirty. It is nearly impossible to assume all the positions a macro photographer has to take on and not get anything on you. You are going to get dirty. So what? My family is used to seeing me walking around with dirt residue on my knees from kneeling here and there.

Get Exercise – Macro photography is some of the best

exercise possible because you are kneeling down, getting up, kneeling down, dozens or hundreds of times and it is all great exercise for your midsection especially. Best way to lose weight I know and still have fun. As I come across great subjects I am willing to get down again and again and hardly notice it, something an exercise program could not get you to do.

Get Cold - Be ready to get cold. Even summer mornings can be cold. Spring and fall mornings in the field can be very chilly. If the sun is out I start out cold and gradually warm up. The warmth of the rising sun is most welcome.

Things to Wear

Waterproof Boots - I need them and the Canadians make the best kind. Up in Canada they are serious about zipper ankle boots and they make them warm and waterproof.

Hip Boots – I use hip boots for streams, ponds, and swamps and also sometimes for wet grass in the early morning meadows. I can kneel in them and still not get wet. They are kind of cumbersome but sometimes it is just too cold to get soaked.

Running Shoes – In warm weather I use a pair of the lightest and most-breathable running shoes I can find and sometimes just let them get soaked. They dry quickly.

Pants – I find the ExOfficio superlight pants can get soaking wet and be almost dry twenty minutes later. I get wet a lot in the summer.

Clothes - Wear old comfortable clothes, just slightly less than what you need because you warm up. Include a floppy hat to protect the ears if in full sun. And footwear to season, but light, and waterproof. I usually wear a light synthetic down vest that I can take off if necessary.

Hats – In winter I use the old wool Navy Watch hats so that I can get my eye to the viewfinder. In summer I either use a baseball cap which I wear backward when photographing or a big (ventilated) loose floppy hat that protects my ears from too much sun.

Mosquito Netting - As the season grows longer and I still want to get into the deeper danker woods, I carry mosquito netting that goes under my hat and covers my face and neck. Any sports store has them for almost nothing.

Travel Light - Pack the car with stuff, but outside the car, travel very light: a camera, ball head, tripod, lens and maybe one extra lens and on too-bright days a small collapsible diffuser. That's it. I don't carry food, water, etc. Sometimes a cell phone if I am going to some strange place. I seldom get more than half a mile from the car. I have my water in the car.



In a Few Words.... the Key.

My Key to Taking Good Photos

The poet Gerard Manley Hopkins came up with a concept that struck me as true. He even made up his own word to describe it, "inscape." Inscape was to Hopkins an insight or path into the eternal or beautiful, literally the way or sign of the beautiful in the world around us. Let me explain.

I look forward to my trips out into the fields and woods. They offer me a chance to get my head together, to relax from the day-to-day grind of running a business, and generally to relax a bit. This is not to say that just going outside and walking in nature means that I am instantly relaxed. That usually takes time.

It is the same with taking photos. In the first ten minutes of a photo shoot I often don't see all that much to photograph. This too takes time, time for me to slow down, open up, and 'see', and let the natural beauty all around me in. It could be that I am still filled with all the workaday-world thoughts, the things I have to do, problems, and what-have-you. It takes time for my mind to relax and let go of its constant chatter. This day-to-day endless worry and thinking affects my photography. And here is where the word 'inscape' comes in.

As I get out there and wander through the fields or wherever, I gradually start to slow down and begin to see things that are beautiful, scenes that I might actually want to photograph. Slowly my view of the natural world around me starts to open up again, and I begin to experience things differently. I begin to 'see'. It takes time and usually does not happen all at once.

This little pattern of leaves over here or the way the light comes through the forest canopy grabs me just a little bit and the chatter of my mind pauses and begins to slow down. As I walk along, some little thing or scene appears beautiful to me; I am touched by it, however lightly at first. I gradually get distracted from my daily distractions and begin to center.

These little moments are 'inscapes', ways out of my mundane world and into the beauty of nature or, more accurately, back into the state of my own mind or being. As I take my time, I am able to see the beauty in things once again, and what I am seeing suddenly seems worth photographing. Like most of us, I photograph what catches my interest, what I find beautiful or worthy in the world around me.

These inscapes are signals that catch my attention, and they flag me down on my busy way forward to nowhere-in-particular. These moments and signs are how I stop going nowhere and manage to almost miraculously arrive somewhere once again, perhaps only at my own peace of mind. This is one of the functions of the beautiful, to catch us in the turmoil of life, flag us down, and induce us to pull over and take a

moment of rest - some time out. These moments of inscape are different on different days and different for different people. They represent the clues or signs that catch our attention and show us the way into the beauty of the natural world, actually the beauty of our own mind. Another way of saying this might be: what is beauty actually? What happens when we see something beautiful?

Beauty is not simply somewhere out there in nature waiting to be found, but always here within us, locked within us, we who are seeing this nature. Only we can see the beautiful. Beauty breaks down the rush of the everyday world and opens our heart a wee bit, making us vulnerable once again, more open to experience and input.

Through the natural beauty outside we go inside and experience the inner beauty of things, which is none other than our own inner beauty. That is what beauty is for, to be touched on, seen, so that we find once again the beauty within our own hearts that we may have lost through the distractions of our daily life. We forgot. We look outside in nature to see in here, to see into our own heart once again.

We can be sensitive to beauty in our photography. I would hate to tell you how many photographs I have of this or that butterfly or critter that are perfectly good photographs, but are empty of magic or meaning. They are well lit, well composed, and have everything that makes a good photograph except that 'magic' that keys or excites me. Instead, they are 'pictures' of a butterfly, but they have not captured any essence of anything. They might as well be in a field guide – snapshots in time with no meaning.

The reason for this (so I tell myself) is because they just happened to be there, photographic opportunities. I saw them and I took a photograph, but at the time they did not instill or strike any particular beauty in me. This, to me, is "gotcha" photography, taking a photo because I can, not because I saw beauty in it or was moved to do so. There was no inscape moment, no moment of vision – snapshots only.

I find that it really worth paying attention to what strikes me as beautiful or meaningful and photograph that, rather than just photographing the Grand Canyon because it is there or I am there. A lasting photograph, in my opinion, requires more of me than that, by definition. It has to mean something to me and for that to happen I need to actually be moved or inspired. Photographs that have special meaning for me usually have some form of inscape into a special moment that inspires me to capture the scene in a photo.

We can wander for miles looking for something to photograph, chasing down this or that butterfly or animal... searching. Or, we can slow down and let nature herself show us the signs, the inscapes through which

In a Few Words.... the Key.

we can relax and begin to 'see' photographically once again. We can listen to our own intuition. This process of inscape, of insight into the sublime in nature (the sublime within us) I find to be the key to good photographs and to creating photographs that are real keepers, at least in my mind. If we don't touch our own inner self in our work, we touch no one at all, but when we are touched by a moment, I find that others also feel this. Touch one, touch all.

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About the Author

Michael Erlewine

Archivist of Popular Culture Michael Erlewine is a well-known entrepreneur, the founder and creator of many large web sites including the All-Music Guide (allmusic.com), All-Movie Guide (allmovie.com), All-Game Guide (allgame.com), Matrix Software (AstrologySoftware.com), AstrologyLand.com, MacroStop, ACTastrology.com, StarTypes.com, Classic-Posters.com, MichaelErlewine.com, and others.

Erlewine was very active in the folk scene in the late 1950s and 1960s, especially in the Ann Arbor area, which included traveling with Bob Dylan (hitchhiking) in 1961. Later, as leader of the influential Prime Movers Blues Band (Iggy Pop was the drummer), Erlewine played a wide variety of venues, including the Fillmore Auditorium in San Francisco (during the "Summer of Love" in 1967) where his band opened for "Cream" during their first U.S. tour.

Erlewine was instrumental in the landmark Ann Arbor Blues Festivals of 1969 and 1970 as well as the Ann Arbor Blues & Jazz Festivals in 1972 and 1973, where he did audio and video interviews of almost all performers. This led to his becoming interested in archiving popular culture and founding the All-Music Guide (AMG), which today is the largest must review site on the planet. He did the same for film, video games, and rock and roll posters. Next to Microsoft, Matrix Astrological Software (founded by Erlewine) is the oldest software company on the Internet.

Erlewine still owns and runs the company today, which is located in Big Rapids, Michigan. Erlewine is also very active in Tibetan Buddhism and Macro Photography.

Photo Equipment In my work, I generally use the Nikon D3x, D3s, and D7000 cameras, with the Voigtlander 125mm 2.5 APO-Lanthar, the Coastal Optics 60mm f/4 APO lenses, and a Gitzo T2531 carbon-fiber tripod, with a Markins Q2 ball head. As for camera settings, I tend to shoot around f/11 at whatever shutter speed will bring down the ISO to 200 or so. -- Michael Erlewine



Questions and comments can be addressed to Michael@Erlewine.net and there are other free books and PDF downloads at: <http://www.MacroStop.com>.

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