Depth of Field

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Depth of Field

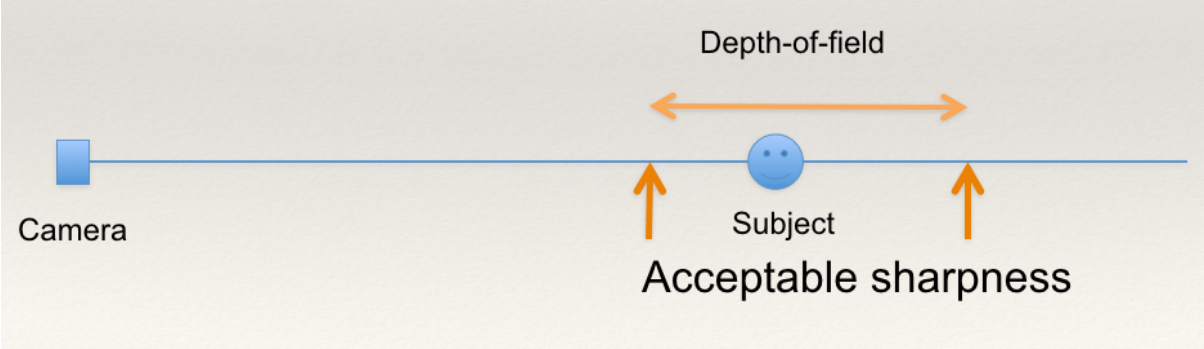
Regardless of what lens you are using, at any particular focus setting your camera can only focus precisely on objects that are a specific distance from the camera. Objects that are closer than this focus distance and objects that are further away will be out of focus - either by a small amount of by a large amount. Sometimes you will want as much as possible of your image to be in focus, as in this example:

Other times you will want the main subject to be in focus and the background to be out of focus, as in this example where we want viewers to pay attention to the bird and its nest without being distracted by whatever might happen to be in the background.

The distance between the closest and furthest points from the camera that are *acceptably sharp* (acceptably in focus) in the captured image is called the ***depth of field (DoF)***. There are various technical and mathematical ways of describing "acceptable sharpness"

but they are not a great help to most photographers and I will not explain them in this document. In practice, we are concerned with capturing images in which we can control what is and is not in suitable focus and that is what I will explain.

Depth of field can be represented diagrammatically like this:

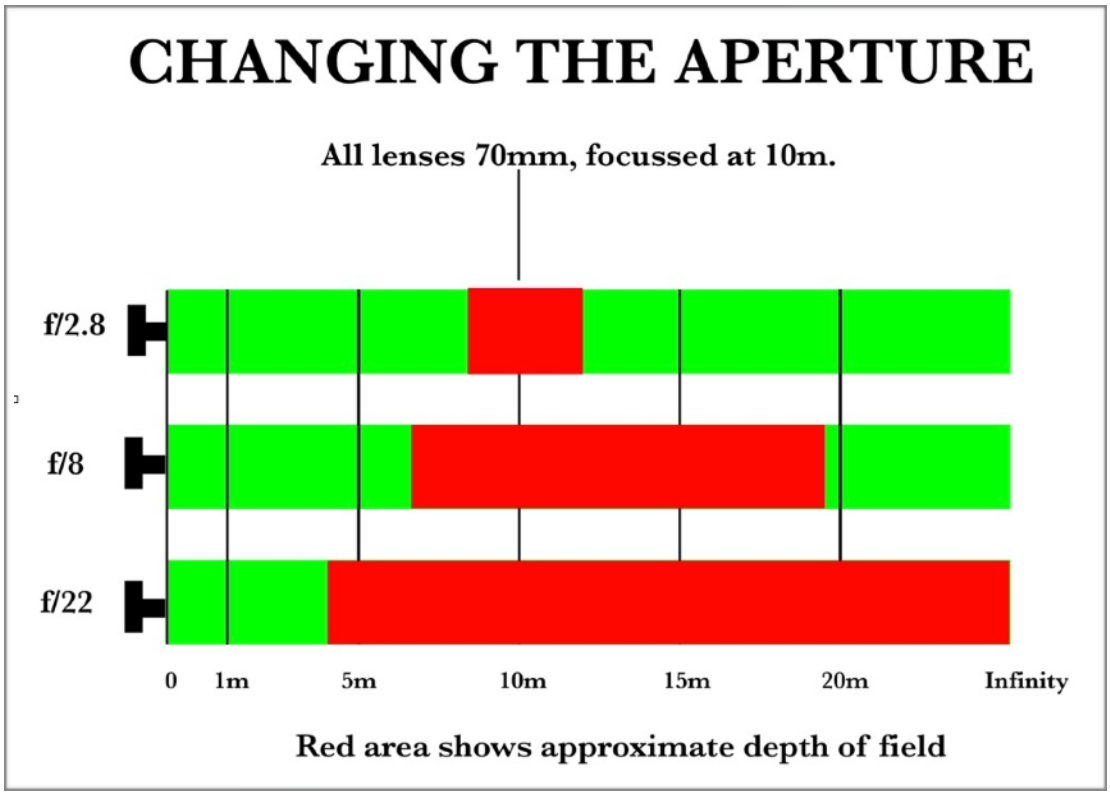


(Where the camera is focused on the 'subject'.)

Most photographers know that the aperture setting can influence the depth of field in an image, as shown in the following images that were all taken with the same lens/camera and at the same distance from the subject. They clearly show that as the size of the aperture is reduced the depth of field increases.

This knowledge can be used effectively to control depth of field in many situations - but it is not the full story. *Depth of field is determined by three basic factors, all of which are under the control of the photographer: the aperture of the lens, the focal length of the lens and the distance between the subject and the camera.*

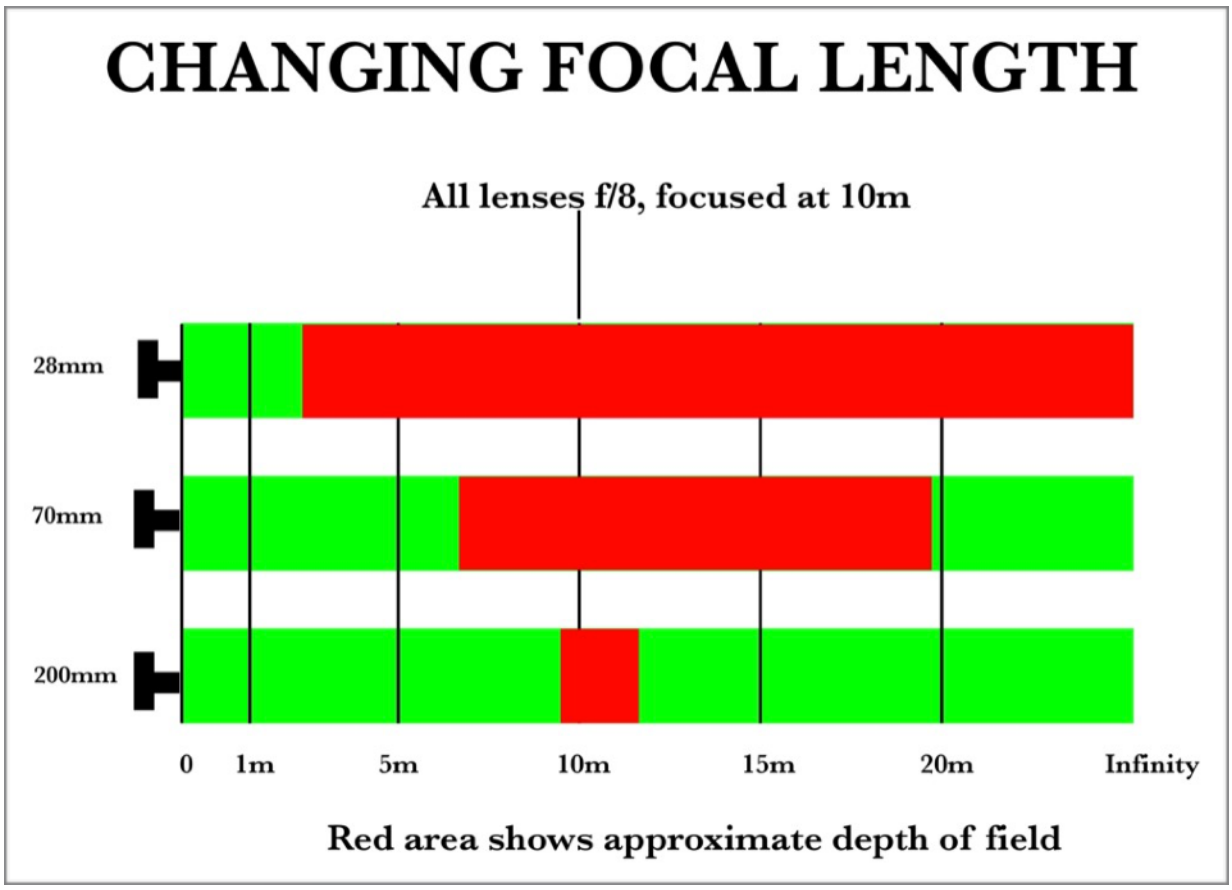
If the focal length remains constant and the distance from camera to subject remains constant the effect of **changing the lens aperture** will be similar to this:



It is obvious in this illustration that changing the aperture on a relatively short focal length lens (70mm on a full-frame camera in this example) can make a huge difference to what is acceptably sharp and what appears blurred in the captured image. In this illustration, the focus is at 10m and at f/2.8 the DoF extends from just 1.5m in front of the subject to just 2m behind the subject. However, if the aperture is reduced to f/22 the DoF extends from about 6m in front of the subject to infinity behind the subject.

You should notice in this diagram that in all cases the DoF extends further behind the subject than in front of the subject. It is often claimed that 1/3 of the DoF will be in front of the subject and 2/3 will be behind, but that only occurs for special combinations of aperture, focal length and subject distance. In the example above (a 70mm lens and subject at 10m) 1/3 of the DoF will be in front of the subject when the aperture is approximately at f/5.6.

If the lens aperture remains constant and the distance from camera to subject remains constant the effect of **changing the focal length of the lens** will be similar to this:



This diagram illustrates what most photographers know - shorter focal length lenses produce images with greater depth of field (when the aperture and subject distance are similar). What you may not have realised if you use a 28-70mm or a 70-200mm zoom lens is just how great the difference in DoF will be at the two ends of the zoom range on those lenses.

In the example above (aperture at f/8 and subject at 10m) the DoF in front of the subject is just 0.56m with the 200mm lens, whereas it is 3.27m for the 70mm lens and 7.5m for the 28mm lens. Behind the subject the DoF is just 0.62m with the 200mm lens, 9.47m with the 70mm lens and effectively infinite with the 28mm lens. Quite clearly this will make a big difference to the appearance of the image. But you also have to keep in mind that these three focal lengths have very different fields of view. When focused on a subject at 10m, the above lenses will have the following horizontal fields of view:

20mm lens will have 18.86m horizontal field of view

70mm lens will have 5.14m horizontal field of view

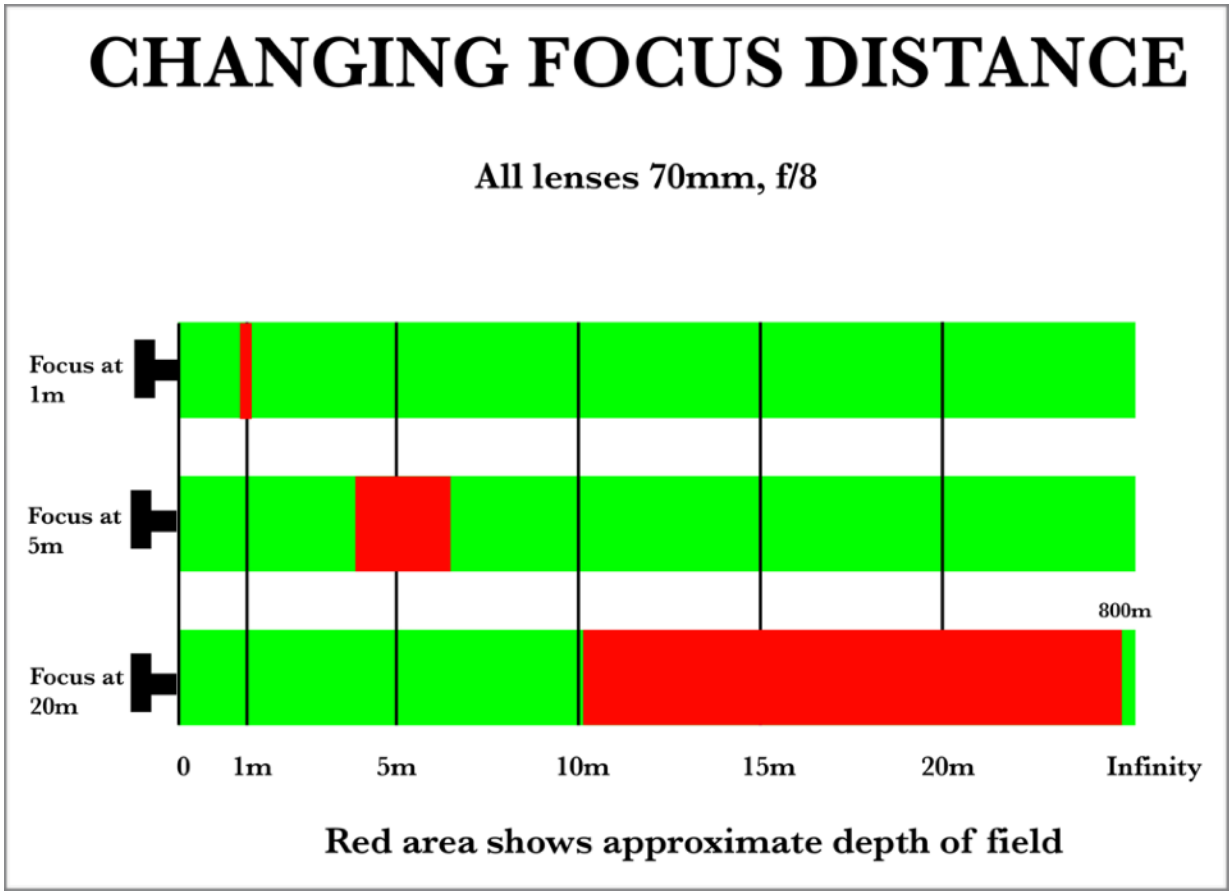
200mm lens will have 1.8m horizontal field of view.

However, as the following images illustrate, if you use different focal lengths (e.g with a zoom lens) and then crop the images to give approximately the same image content the difference in depth of field will be obvious.

f/8 200mm

f/8 70mm

If the lens aperture and the focal length remain constant, the effect of **changing the distance between the camera and the subject** will be similar to this:



As you might expect, the further away the subject is from the camera the greater the depth of field.

If we focus any lens at infinity, the distance at which the closest object in the frame still looks acceptably sharp is called the ***hyperfocal distance***. If we focus the lens at the hyperlocal distance, the depth of field will extend from approximately *half* the hyperfocal distance to *infinity*, giving the maximum possible depth of field for the given focal length and aperture combination. One of the reasons that the DoF is so great when the lens in the above example is focused at 20m is that at f/8 the hyperfocal distance for a 70mm lens on a full frame camera is approximately 20m (so everything from about 10m to almost infinity will be in focus when the lens is focused at 20m).

Keep in mind that hyperfocal distances and depth of field are simply approximations because there is never an absolute boundary between what is or is not acceptably in focus in an image. That's why different tables of DoF values that you mind find on the internet or in an app might show slightly different numbers - they may be based on different mathematical assumptions about what is "acceptably sharp". If you want to explore this in mathematical depth, Google "circle of confusion".

Effect of sensor size.

The examples above were all based on a full-frame camera. If your camera has a cropped sensor the same basic principles apply but the numbers i the examples will be different. If you search the internet for information about depth of field you will find conflicting claims about how sensor size effects depth of field. The bottom line is this: the depth of field for your particular camera sensor and lens combination will be determined by just three things that you can control - aperture, focal length and distance from camera to subject. Whether or not the depth of field is different for some other camera (with a different sensor) set to the same aperture, focal length and subject distance is basically not relevant unless you are trying to compare cameras. The important thing is to become familiar with whatever camera you have so that you can control aperture, focal length and subject distance to achieve the depth of field that you need or want for a particular image.

A final word

Very often, you cannot change the distance between you and the subject you are photographing (particularly in Nature photography). Further, if you are using a prime lens you cannot change the focal length. So, you are left with aperture as your primary tool for controlling depth of field.

However, you have to keep in mind that aperture is one of the three camera settings that controls exposure - the other two being shutter speed and ISO setting. If factors such as available light and the high-ISO performance of your camera dictate that you need to use a large aperture (which will reduce depth of field) you might have to consider the orientation of the subject to the camera so that you can obtain an acceptable image with only a shallow depth of field. This is particularly important with macro photography but it can also be important in general photography, as illustrated by the following images. Each of these images was taken at f/5.6 with a 600mm lens, a shutter speed of 1/1250 sec (because of the fast movement if the subject) and ISO 1600 because of the low light. For each image the focal point was on the grasshopper.

The depth of field is the same in both images (because aperture, focal length and subject distance were the same) but by waiting for the heron to turn side on to the camera I could achieve an acceptable focus on all the bird.

If you find any errors in these notes, or you want to make any comments on them, please email me.

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