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How-to Understand Binocular Performance
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The information discussed in this article began as portions of a binocular comparison article. Last year I wrote an article, a 4 way binocular comparison. Since then I've recorded notes on a dozen different binoculars and have written a 2nd binocular comparison article. These sections of the binocular article took on a life of their own and I elected to pull them out and publish these separately. Information included in this article is relative to Magnification, Contrast and Resolution and has been greatly expanded upon beyond my original remarks in the binocular comparison article. Several aspects discussed here, relative to magnification and contrast, were not discussed in the binocular comparison article. Here I have tried to be more thorough in my coverage of the topics. (The binocular comparison article Fujinon 16x70 vs Pentax and Oberwerk" is the reference for other relevant information related to this article).

I've been thinking for some time about how simple binocular indices fail to measure the relative performance quality of binoculars. Several indices exist, and some result in a better rank of binocular sizes than others. But in my opinion, none that I have seen completely index the performance of binoculars. As I reviewed the results of my findings I realized that I wanted to make an attempt at devising a performance index that represented not only the magnification versus aperture relation but also the quality of performance.

The information collected and presented here relates to the development of a Binocular Performance Index based on the conclusions I reached in the recent testing of my binoculars. Even if you don't agree with the final outcome of the index, the information collected here, as it relates to the optical performance of binoculars, should be beneficial to everyone, seasoned amateur and novice alike. I hope you find it useful, and I'd accept any comments or discussion. Any errors or omissions in this article are mine. Clear Skies, and if not Cloudy Nights.
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MAGNIFICATION

Importance of Magnification

I wanted to determine how much magnification was contributing to the overall gain in seeing. Based on my experiences at the telescope, I expected power to have a significant benefit on faint objects. When at the telescope and you want to see deeper into a cluster you can't always go looking for a larger aperture scope, you simply put in a higher power eyepiece. With a given telescope aperture, I have noted many times at higher powers that I can see more and fainter stars in clusters. I have noted the same experience with binoculars. To test this I tried various binocular magnifications all at the same aperture.

The Mask Test

The mask test is simple, although tedious. Use various sizes of binoculars on numerous star fields and deep sky objects at full aperture and again at masked aperture. A cardboard mask 50mm in diameter was placed over the objectives of the larger binoculars. I have included views thru various 70s and 80s at full aperture and then masked at 50mm. I've also used 3 different 50mm binoculars in the comparison. The primary requirement is keep to the same star field boundaries for every binocular and record exactly what is seen. Nearly all of the comparisons were done side by side under the same conditions by the same observer.

For this 2nd binocular mask test I started with 10x50s and 12x50s. Cardboard masks 50mm in diameter were placed over the objectives of the 15x70s, 16x70s and the 20x80s so a comparison could be made to the 50s. Two of the binoculars that were used in the 1st test, the Orion Ultraview 10x50 and the Oberwerk LER 15x70, are again used in the 2nd round of tests. Previously, I did this test with 10x50s, 15x70s and 16x80s at full aperture and then again with the 70s and 80s masked down to 50mm.

The aperture mask results show the # of stars in a given field increases considerably with a magnification jump from 10x to 12x to 15x, 16x or 20x. In one case, at masked aperture, there was an increase from 25 to 40 stars within the same field. At 15x the number of stars in the given fields increased by about 40% over 10x50. At 16x and 20x the number of stars increased by about 50-60% over the 10x views. (Refer to binocular comparison article "Fujinon 16x70 vs…" for table of data on star fields measured).

With the mask, the sky background at 15x, 16x and 20x was slightly darker. The binoculars, which at full aperture operate at f4.7 to f4.8, with a mask were operating at f6.8 except the 20x80s. The 20x80s are normally f5.6 and masked they were operating at f9. Seven out of twelve binoculars I tested are operating within the narrow range of f4.6 to f4.8. (Refer to binocular comparison article "Fujinon 16x70 vs…" for discussion on measuring focal length)

The objects seen in the 10x50s were easily surpassed by every higher magnification. Stars that were at the limit of vision in the 12x50s or 15x70s would readily pop into view at higher magnifications. There were some results that showed more stars at 16x than at 20x. However, the mask test began to show the relative weight of magnification vs. aperture. I'm sure aperture will have a benefit when it comes to diffuse objects, but for most binocular viewing, magnification may be the primary contributor to improved performance.

What the Mask Does and Doesn't Do

The mask has the effect of modifying the performance attributes of each binocular system, exclusive of magnification. Obviously, the mask reduces the aperture, in turn increasing the focal length of the binocular, but other very important effects are imparted by the use of the mask. As an example, the 16x80 used in the first test, when used at full aperture, exhibited poor sharpness at 60% out from center to the edge. The 50mm mask placed over the 80mm objective is blocking down the objective to 62% of the full diameter. All the light from the poorly sharp outer area of the field of view of the lens is now effectively

blocked out. This would improve edge distortion and resolution.

Masking is a well-known technique used to improve some of the performance characteristics of refractor telescopes. Masking reduces the aperture, increases the focal length of the system and reduces exit pupil, potentially improving several performance characteristics, especially chromatic aberration, atmospheric seeing and contrast.

What masking does not do is isolate magnification from the affect of exit pupil. So, this mask test is really a measurement of increased benefit of higher magnification, added benefit of increased contrast due to smaller exit pupil, reduction in chromatic aberration and lens edge distortion and also it includes potential benefits from improved atmospheric seeing due to smaller aperture.

Exit Pupil

Magnification and Aperture in any optical system determines the exit pupil, the diameter of the circle of light rays exiting the eyepiece and entering the eye. Exit pupil = aperture / magnification. As either one of these varies, exit pupil varies. In a test for the benefits of aperture by increasing aperture and holding magnification constant, exit pupil would increase. As an example, a test for aperture using 10x50, 10x60, 10x70, and 10x80 binoculars would result in exit pupils of 5mm, 6mm, 7mm and 8mm. In a test for the benefits of aperture while holding exit pupil constant, magnification would need to increase as aperture increases. In this case the test would need to be based on 10x50, 12x60, 14x70 and 16x80 binoculars, each case resulting in a 5mm exit pupil. In this instance, there would be some influence on the results caused by the increase in magnification.

If magnification is held constant and aperture is increased, the influence of the larger aperture increases the potential limiting magnitude and the maximum resolution. Also, exit pupil grows larger, the image becomes brighter, but contrast decreases.

If aperture is held constant and magnification is increased, the system slowly but surely approaches the magnification needed for optimum resolution and limiting magnitude. Exit pupil decreases, contrast improves and resolution is gained.

I was not able to isolate the influence of exit pupil from magnification.

Although it would not isolate exit pupil from magnification, a more telling test for magnification would be to put various eyepiece configurations into the same binocular body, using only one objective lens to test all the magnifications. This would at least keep the influence of the objectives and the prisms constant. This is not practical.

It should be evident that it was not possible for me divorce the relationship of magnification and aperture. Exit pupil is imparting its own influence on the results of these tests. The four primary binoculars in this test 12x50, 15x70, 16x70 and 20x80, have exit pupils of 4.2, 4.7, 4.4 and 4.0. However, with the 50mm mask in place these same binoculars have exit pupils of 4.2, 3.3, 3.1 and 2.5.

Magnification vs Aperture

In open clusters, the difference in the number of stars seen at full aperture versus masked to 50mm was only a few stars, generally on the order of only 1 to 3 stars more. About 80%+ of all the additional stars beyond what the 10x50s could see were viewed with the apertures masked at 50mm, indicating it is magnification and the accompanying affects of exit pupil and not aperture that is responsible for the added seeing. The conclusion reached here is that most of the additional stars seen in a field are a result of the increase in magnification and only a marginal increase is due to aperture.

It should soon become apparent, the primary benefit aperture may be contributing is maximum brightness for the viewing of all objects but especially for extended objects, and maximum brightness is achieved at the lowest magnification. For all other purposes, the maximum potential ability of aperture is not fully utilized and any increase in magnification provides significantly greater ability to utilize that potential, giving greater steps up in performance.

Magnification vs Limiting Magnitude and Maximum Resolution

In telescopes, the most important component is aperture, the size of the objective lens or primary mirror. Along with determining the maximum amount of light that can be gathered, aperture controls the limiting magnitude and maximum resolution. No amount of magnification will enable you to resolve a double star that is beyond your aperture's limit. It is the ability of raising the telescope to optimum magnification that allows maximum resolution to be achieved. At greater magnification increased contrast allows limiting magnitude to be achieved. In a telescope used at lower magnifications, maximum light may be gathered, but limiting magnitude or maximum resolution may not be achieved. Magnification really helps us to see.

If we use the general rule that the best eyes unaided under the best conditions can resolve stars as close as 4 arcmin, or 240" apart, then we can simply divide 240 by the separation of a close double to determine what magnification might be needed to resolve the components. Based on this, an equal magnitude double with a separation of 2.4 arc-seconds would need a magnification of 100x to resolve. It will vary according to the acuity of the observer, the atmospheric seeing and the quality of the optics. To test this assumption, I pressed my 76mm reflector and 78mm refractor into service to determine the lowest possible magnifications at which I could clearly see the separation of the two components of e1, e2 Lyra, the Double-Double.

Based on Dawes limit for maximum resolution, 4.56/D" or 116/Dmm, binocular lenses of 70mm to 80mm have a potential maximum resolution of between 1.5 to 2.0 arc-seconds. On that basis, both the 76mm and 78mm telescopes have maximum resolution that will permit resolving these two doubles of 2.3" and 2.6"even under average conditions, and both these scopes would be close to their limits and nearly equal in aperture to my large binoculars.

I was able to achieve resolution of both components at magnifications between 70x and 90x, but not at all below 70x. These results agree fairly well with what would be expected based on the above general rule,

and in fact results were just slightly better. This gives a pretty good indication of the magnification necessary to achieve maximum resolution.

The formula 1300D is given, where D is the aperture in meters, for determining minimum magnification needed to realize the potential maximum resolution. This formula agrees closely with the results I obtained using the 76mm scope on e1, e2 Lyra. The calculation for 70mm binoculars is 91x, for 80mm it is 104x. Even a 35mm binocular needs a minimum of 45x magnification to achieve maximum resolution. Limiting magnitude, 11th mag for 70mm to 12th mag for 80mm, and maximum resolution may not be reached because magnification is so low the system doesn't take full advantage of the aperture. People with the most acute vision may achieve maximum results at lower magnifications, however these values hold true for most people.

All of the above assumes the optical system is made to diffraction-limited specifications. Although they may exist, I have not seen any binoculars specified as diffraction limited. Therefore, it might be expected that most if not all binoculars would never be able to reach these limits. It is reasonable to expect that the scopes used for comparison would be able to achieve slightly better results, and they did.

As I stated earlier, no amount of magnification will enable you to resolve a double star that is beyond your aperture's limit. Likewise, no objective lens will reach the limits of its maximum resolution unless sufficient magnification is employed. I have recorded views of many double stars under excellent seeing conditions with various 35mm, 50mm, 70mm and 80mm binoculars ranging from 7x power up to 20x power and results I get indicate maximum resolution by the best binoculars is in the 7" to 10" range. Magnification is generally so low in binoculars that limiting magnitude and maximum resolution abilities of the objective lens are not achieved.

This helps explain why we get so much significant improvement in binoculars by increasing magnification. Along with increased image scale, higher magnification utilizes more of the ability of the available aperture. As an example, on an exceptionally still clear night, the AB component of the Trapezium at 8.7" was resolved in the 20x80s at full aperture and was seen also masked at 20x50, but was not seen in any other binocular of lesser magnification. It was the magnification of 20x, not the aperture of 80mm that provided just a bit more ability to see allowing easier splitting of this close double than could be seen with the 16x70s or the 15x70s.

Baseline Index – Magnification vs. Aperture

There are a number of references out there to 'Binocular Indexes', some of which simply multiply magnification x aperture to arrive at an Index Value. Based on the test results noted above, I emphatically agree with Alan Adler that magnification holds much greater importance than aperture and that indexes should account for this importance. Alan uses an index based on magnification x square root of aperture. This seems definitely headed in the right direction.

Index	Minolta	Orion	Pentax	Oberwerk	Fujinon	Orion	Oberwerk
	Activa	Ultraview	PCF III	LER	FMT SX	Giant	LER
Binocular	**7 x 35**	**10 x 50**	**12 x 50**	**15 x 70**	**16 x 70**	**16 x 80**	**20 x 80**
Magnification	7	10	12	15	16	16	20
Objective Dia mm	35	50	50	70	70	80	80
Sq Root Obj Dia	5.9	7.1	7.1	8.4	8.4	8.9	8.9
Adler Index	**41**	**71**	**85**	**125**	**134**	**143**	**179**

The Adler Index is important in that it provides a magnification/aperture baseline across all makes and models that show the size performance order of binoculars. We need this to begin a comparison that includes other attributes. It shouldn't be difficult to agree that not all models in a given size are built with the same quality attributes. Therefore, due to variations in quality, they may not hold the same rank in a performance index.

CONTRAST AND RESOLUTION

There are many additional binocular performance attributes that can be considered when trying to rank performance. However, I think the two things that contribute most to improved performance are contrast and resolution. These two attributes are affected by the quality of the glass in the optical system, the coatings on all glass surfaces and baffles built into the binocular. The following method is directed towards accounting for coatings and baffles that impart greater benefit to better binoculars.

Quality of Optical Components

The quality of the glass and the polish used in the lenses is the primary contributor to contrast in the system. Limiting magnitude and maximum resolution are a function of contrast and contrast is directly related to the optical quality of the lenses. Not only must the objectives be of premium quality for best contrast but also the prisms and eyepieces must complement the quality of the objectives. The manufacturer can save considerable cost by using a lower grade of glass.

Wide-angle binoculars take in a much larger area of sky in the view. Since the sky acts like an extended object, as we include more sky in the fov, contrast decreases over the entire area. The True field of view (Tfov) is usually given for the binocular. Although better binoculars may not suffer from lower contrast, generally a wider field of view will lower the overall contrast.

Wide-angle eyepieces with Apparent field of view (Afov) greater than 60°, used to provide a wide field of view desired by most users, can be imparting lower performance characteristics or aberrations of their own to the binocular system. All but the better wide-angle eyepieces impart some aberrations in optical systems, often noticed as edge distortion. The Afov of the eyepieces in a binocular is easily determined as binocular Tfov x magnification. If a narrow Afov eyepiece is contributing to an overall narrower binocular field of view, it is helping to improve contrast and it may be helping to improve edge distortions.

The size, the cut, the glass the coatings and the alignment of the prisms all have an affect on the performance. Prisms cannot be designed to improve the performance of the system. You can't get more out of the other components than their potential. Prisms can only be designed to support the performance potential of the other components in the binocular. Unless the prisms are of the highest quality, they are reducing the performance of the system. Only the best prisms can provide the maximum potential of the system. Phase corrected prisms available only in premium binoculars provide the highest level of performance of prisms in a binocular.

Coatings

Uncoated lenses may pass only 93% to 96% of the entering light through each lens element. A binocular with four uncoated surfaces is passing only about 75% to 85% of the available light. The rest is reflected back off the glass surfaces. The remaining light that does not pass thru the lens can scatter off the insides of the barrel and cause glare in the image. A single coating of Magnesium Fluoride on each optical surface can increase light transmission up to 97% or 98+%. The best modern coatings and multi-coated lenses can increase light transmission up to 99+% for each surface, almost negating light loss due to reflections.

Single coated Mg F lenses can look blue. Multi-coated lenses can look blue, green or purple, depending on the coating used, the thickness of the coating or the number of layers of coating. Trying to judge the quality of coatings by looking at the color is like trying to judge the performance of a vehicle by looking at the paintjob. A green car is not always faster than a blue car. A higher quality applied single coating could be providing greater benefit than a poorly applied multi-coating.

The view through binoculars with higher quality coatings provides the eyes with a noticeable increase in the ease of seeing. One of the finest coated binoculars I own, by outward appearances and by image fidelity, is the Fujinon FMT-SX 16x70. The Fujinon coatings have a green/purple/blue color and show nearly no reflections. Orion Ultraview 10x50s, another fine performer, have similar color and show nearly no reflections. The Pentax 12x50s have purple coatings that show little reflection.

Both Oberwerk 15x70 and 20x80 binoculars have green/blue coatings and at least one very bright reflection shows when looking into the objective end. In fact, the reflections off the Oberwerk lenses shows bright detail and color of the object reflected, more so in the 20x80s. By comparison, looking for a reflection in the Fujinon, all you see is a muted dark outline of the object being reflected, no detail and no color what-so-ever.

Reflections off the objectives at any particular angle may not be an accurate indication of the ability of the coatings to perform on-axis thru the lens system. Probably the best test is to view the brightest objects and look for reflections or haze thru the eyepiece. Reflections or glare through the eyepiece is a fairly good indication of poorly coated or uncoated optics. The 20x80s showed ghost reflections of Jupiter and Venus.

Internal Barrel Reflections – Baffles

Baffles help block stray light that is scattered towards the internal sides of the barrels. It is desirable to control light scatter on the inside of the barrel by using non-reflective coating, baffle rings and baffle ridges. Reflected light inside the barrel will reduce the overall contrast of the object viewed.

If the image of a bright object is moved towards the edge of the binocular fov, the Oberwerk 15x70s and the Oberwerk 20x80s show bright reflections down the inside of the barrel. The Oberwerk 15x70s have baffle ridges cut into the inside of the barrel, however every cut leaves a bit of shiny metal showing and this may be acting like a reflective surface lining the insides of the barrel. The Oberwerk 20x80s barrel interior is covered with a black coating that seems to be completely impregnated with a silvery white reflective powder. The insides of the barrels reflect light almost like a mirror. By far the Oberwerks had the most internal reflections of any binoculars in this group tested. Minolta Standard XL12x50s and Orion Ultraview 10x50s showed minor reflection off the inside of the barrel. No other binocular that I've tested shows any light reflection off the inside of the barrel.

Fujinon 16x70 barrels are matte finished half way down the barrel. At that point there is a baffle ring. Beyond that the barrel has fine matte black ridges. No other binocular had this high degree of baffling. Orion Vista 8x42s had a similar barrel, half matte, half ridged, but there is no baffle ring. Pentax 12x50s have a matte finish in the barrel with two baffle rings. Minolta Activa 7x35s have a matte black barrel with a baffle ring.

The combination of high quality optical glass, proper baffling and improved coatings provides increased light to the eye, less scatter, higher contrast and an overall more pleasing view. Comparing binoculars side by side, it becomes readily apparent the improvement afforded by those with better qualities. Faintest objects, not seen in binoculars of lesser quality, more readily stand out from a darker sky background in higher quality binoculars.

Impact of Optics, Coatings and Baffles

The better performance of the Fujinon 16x70s, due to the improved qualities of the optics, coatings and baffles seems to skew the magnification mask data. Whether the Fujinons were masked to 50mm or not, as compared to 16x80s and 20x80s, they were picking up more stars in wide-open clusters and in tight clusters they were resolving more stars. Likewise, I think the 10x50 Ultraview vs. the Nikon 10x50s and the 12x50 Pentax vs. the Oberwerk 15x70s both showed improved performance due to a higher quality optical system. There must be some benefit of higher quality lenses, coatings and baffles.

The introduction of these examples into the mix shows the need to modify the base index. We have no

outward method of assessing the quality of the glass used for the objectives or the prisms. Unless literature informs us of high quality components, we can only judge optical quality once we view thru the lens. We can assess the quality of coatings and baffles. Although certainly not conclusive, I think it is fair to say that more expensive binoculars usually incorporate higher quality components and the results are generally apparent in use.

Image scale can be deceiving. Higher magnification, at first look, can give you the impression that you are seeing more. You are seeing it bigger, and indeed you may be seeing more, but not always. In some cases, higher magnification provides greater ability to see, for instance when splitting close doubles. But better contrast and resolution, provided by higher quality optics, coatings and baffles, at a slightly lower magnification may result in seeing more.

Resolution of Fine Detail

In addition to maximum resolution, the ability to split close objects that we discussed earlier, we need to discuss resolution of fine detail. Fred W. Price, in 'The Planet Observer's Handbook', has this to say. "… the separation of two almost touching bright diffraction disks on a black background is different from the resolution of fine irregular detail of varying contrast and brightness…" on planets. "Although usually defined as ability to resolve fine detail, the resolving power and aperture of a telescope are alone not sufficient to determine a telescope's ability to resolve detail. Of greater importance is contrast and this has nothing to do with resolving power." "…the contrast between fine detail and its immediate neighborhood…affects the resolvability of the detail." These statements have equal or greater significance for binoculars since we have already established due to low magnification we cannot utilize the maximum ability of the aperture. We must rely on superior contrast to provide us with the optimum utilization of the system being used for viewing.

Brightness Gradients

A correspondence from Inge Shauvik explains brightness gradients in extended objects as the difference, sometimes almost imperceptible, in the light from one area to the immediately adjacent area. I understand this concept easier when I think of it as he describes the steepness of contour lines on a map. As the lines get closer together, the steepness is greater. It's easier to see drastically changing features, represented by steeper contour lines, than it is to see slightly changing features. If the light gradient is gradual, not perceptibly different from the adjacent area, it is more difficult to see the features in the object. The ability to resolve these differences to any extent is primarily dependant on contrast. There needs to be a sufficient amount of contrast between the adjacent areas within the object, or between the object and the background, in order to see it. Although this discussion was developed on extended objects, the same concept is applicable to all objects that no longer appear as point sources.

Globular clusters, as seen in telescopes, are a perfect example of that class of objects that require contrast to begin to resolve. They appear to glow because the size is so small and the large number of stars is so closely packed they sometimes cannot be resolved fully. In binoculars there are a great many small open clusters that take on a like appearance. In some ways these objects are similar to fine planetary detail.

Contrast is required to differentiate the fine detail from the nearly equal light in the immediate vicinity. Although the object may be bright, the light gradient across the object may be low. This makes it more difficult to pick out or resolve any detail. The ability of the binocular system to resolve is already limited by overlap of the broader diffraction fringes because it operates at magnification well below potential resolution. So contrast is needed to resolve the small differences in light gradients.

Need for Contrast

A good example is M36. Read what Stephen O'Meara wrote about M36. "Its 15 brightest members (between 9th and 11th magnitude) shimmer against a tight, hazy background caused by the feeble light of dozens of 13th and 14th magnitude stars." And about M37 he writes, "At 23x this cluster looks like a finely resolved globular cluster – a marvelous illusion. Indeed, Luginbuhl and Skiff likened it to a "broken down view" of M22…" " About 500 of these suns are brighter than 15th magnitude, and they are spread across 15'…"

Sky Catalogue 2000 lists M36 as 60* within 12' diameter, the brightest star being 8.8mag. Luginbuhl and Skiff states it is more concentrated towards the center. Burnham's Celestial Handbook states that M36 has 15* ranging from 8.8mag to 10.6mag. On one occasion, I noted seeing 6* in the 15x70s, 8* in the 20x80s, but I counted 13* in the dense core with the Fujinon 16x70s. The results here indicate stars resolved in dense open clusters increased as contrast and resolution improved. (Refer to the binocular comparison article "Fujinon 16x70 vs…" for table of starfield data).

Contrast Allows You to See More

Increased magnification improves the ability to resolve because objects are seen at a larger image scale and because it helps increase contrast. The qualities of contrast and resolution in an optical system are best observed when you have side by side comparisons and the smaller optics are seeing equal to or more than the larger optics. This most definitely cannot be due to magnification and I believe it is attributed to the result of better optics, coatings and baffles.

In a perfect system, a larger diameter objective imparts a smaller diffraction fringe around every point of light in an image and the result is we can see finer detail. What qualities of the lens allow the smaller objectives to see more? It is not resolution but contrast, the quality that allows seeing more in the detail provided by the rest of the system.

Contrast and resolution are enhanced with the introduction of improved multi-coatings and effective baffling. Binoculars that do not incorporate the best of these features do not measure up to the performance of similar sized or sometimes even smaller binoculars that do. That's why models such as The Pentax 12x50s or the Fujinon 16x70s, with better coatings and baffling, perform at a much higher relative position on the index than do higher magnification binoculars with a larger aperture.

Performance Index

Coatings and baffling have been proven to impart significant impact to the performance ability of binoculars and must be accounted for in any comparative performance indices. In this index I account for the various qualities or absence of quality in coatings and baffles by modifying the base index value with these adjustments:

+ 10% for best coatings 0% coated – 10% some lack of coatings

+ 10% for best baffles 0% baffled – 10% some lack of baffles

Index	Minolta	Orion	Pentax	Oberwerk	Fujinon	Oberwerk
	Activa	Ultraview	PCF III	LER	FMT SX	LER
Binocular	**7 x 35**	**10 x 50**	**12 x 50**	**15 x 70**	**16 x 70**	**20 x 80**
Magnification	7	10	12	15	16	20
Objective Dia mm	35	50	50	70	70	80
Sq Root Obj Dia	5.9	7.1	7.1	8.4	8.4	8.9
Adler Index	**41**	**71**	**85**	**125**	**134**	**179**
Coatings	10%	10%	10%	-10%	10%	-10%
Baffles	0%	0%	10%	-10%	10%	-10%
Performance	**46**	**78**	**103**	**102**	**162**	**145**

Index	Minolta	Orion	Nikon	Minolta	Orion	Bear
	Standard XL	Vista	Kestrel	Standard XL	Giant	Custom
Binocular	**7 x 35**	**8 x 42**	**10 x 50**	**12 x 50**	**16 x 80**	**25 x 70**
Magnification	7	8	10	12	16	25
Objective Dia mm	35	42	50	50	80	70

Sq Root Obj Dia	5.9	6.5	7.1	7.1	8.9	8.4
Adler Index	**41**	**52**	**71**	**85**	**143**	**209**
Coatings	0%	10%	0%	0%	0%	0%
Baffles	0%	10%	0%	0%	10%	0%
Performance	**41**	**63**	**71**	**85**	**157**	**209**

I have assigned a value to Coatings and Baffles based on the notes in the Quality of Build table. (Quality of Build notes published in binocular review article). I was tempted to start using % values in single increments all the way from –10% to +10%. I don't think that is necessary, especially for a relative index. Instead I simply moved the rank up or down in this way. If there are any reflections off the objective – 10%, if the coatings seem average then 0% change, if there is little or no reflections at all +10%. Likewise if the barrel has anything bright or shiny inside or has no baffle –10%, if the barrel is baffled or has a dull finish 0% change, if the barrel is effectively ribbed, or has an effective matte finish with a baffle +10%.

I am surprised at how closely I think these values represent the performance rank of all these binoculars based on actual use, except maybe for the 25x70s. Even though they had larger image scale, I don't recall the increased magnification being enough to outweigh the performance of the Fujinons. The 25x70s may be showing that this index puts slightly to much emphasis on magnification and not enough on quality. In fact, if quality were given more weight, the Fujinon should top the list. My opinion is that the Fujinons were the best performers. Just as any other index would, I believe this index is only a good indication of relative performance.

For any binoculars you want to compare, you can apply this index and get a pretty good indication of their relative performance. Information on coatings and baffles is usually available. Off the shelf, with only a quick outward inspection and without much testing, the expected values for these features can be assessed. Certainly, the opportunity to look through the binocular and down the barrel at the glass, the coatings and insides has a tremendous benefit in determining ranking. Generally, the quality level of binoculars is fairly well known and it seems the values for coatings and baffles follows pretty closely in line.

Simple binocular indices that do not account for all of these features are leaving out qualities that have a significant influence on performance. Applying this info to an index gave me a much better numerical rank of the relative performance of all my binoculars.

CREDITS

providing the forum where we all have the opportunity to share valuable information.