

Two of the most essential tools for most bird watchers are their binoculars and a good field guide to identify the birds they see with them. After they become serious "Birders" they often leave the field guides at home, but not their binoculars. Instead, the second essential tool will be a spotting telescope for viewing more distant birds, mainly waterfowl and sandpipers, and the occasional rare sparrow perched across a field.

Most binoculars come in either of two types: porro and roof prism binoculars.

## Porro prism binoculars



## Roof prism binoculars



**Porro prism binoculars** offer more optical quality for the same amount of money, but are bulkier and heavier. These are the ones with the familiar shape, with the eye piece lenses closer together and the larger objective lenses, away from the observer's eyes, further apart. A second variation seen in miniatures places the two objectives closer together than the eyepieces. They both also, due to the way they're built, are more vulnerable to getting knocked out of alignment, causing the person to see double when trying to look through them. Just the normal shocks and bounces of shipping from manufacturer to the store will often knock some of these binoculars out of alignment, especially the cheaper ones. You shouldn't buy these at the store without checking them first for alignment ("collimation").

But **porro prism binoculars offer the best optical quality for the money.**

**Roof prism binoculars** are lighter in weight, more visually pleasing with the straight-through shape, and **cost more to get good optical quality.** They also are easier to make waterproof, important for keeping foreign material from getting inside and fogging up the view. They also are less prone to getting knocked out of alignment. Most of the mid-grade and premium binoculars offered for sale for over a hundred dollars are sealed, waterproof roof prism binoculars. This offers better protection for the investment in costly low-dispersion glass in the lenses, fancy multi-element lenses, and fancy multi-layered anti-reflective coatings on the lens and prism surfaces.

There is a third form of binoculars - Galilean type, a pair of simple "Galilean" telescopes. These don't use prisms to get the image right-side up, because they don't need them. They have just two lenses, one objective lens, and an ocular (eye piece) lens which is concave, thinner in the center, instead of convex. These are the oldest and simplest working telescope type, which work well at low magnification, but not at the higher magnification used for bird watching.

Note that with spotting telescopes, the alignment problem noted above for porro prism binoculars doesn't apply; there's only one telescope, not a pair. You can't see double through only one eye.

A recent innovation in spotting telescopes has been the introduction of the angled eyepiece. This is mostly useful for having a 'scope set up on a tripod when observers of varying heights want to look through the 'scope. Taller observers can simply bend a little lower to view through the angled eyepiece, while shorter observers stand up straight and look through. With a straight-through 'scope, taller observers have to hunch down to look through a 'scope if it's low enough for the shorter observers to see through. But the straight 'scope is handy for peering over the tops of reeds or other obstacles between you and the bird – you can have the 'scope as high as your eyes, without looking down and needing the 'scope to be lower than your eyes.



Straight –through and angled spotting telescopes

What about those mini-sized binoculars?

Some ultra-cheap binoculars are available with objective lenses about an inch in diameter (21 to 28mm diameter - an inch is 25.4mm). They are very small and easy to stuff in a pocket and weigh next to nothing. But they have a problem - they are tiny and weigh next to nothing. In your hands they don't hold steady. Larger, heavier binoculars tend to hold steadier in your hands, so the image doesn't jump around as much. This jumpy image is also a problem with higher magnification even in the larger, heavier binoculars. Another thing to consider - cheap roof prism binoculars won't offer the optical quality of porro prism binoculars. At that price range, they won't have the "fixes" needed to deliver the bright, clear, detailed image of porro prism binoculars. But it's not cheap or easy to waterproof porro prism binoculars.

What does "7x35" or "8x42" mean?

The number before the "X" is the magnification.

The number after the "X" is the size, in millimeters, of the objective lens.

**Magnification** means how many times as large or "close" the image will be compared to what you see with your eyes without the binoculars. As noted, it also magnifies minor motions in your hands, causing the image to jump around while you're trying to get a look. The more you magnify the image, the jumpier it will get, and the smaller the piece of the world you will see in the image. But that's also how much larger the image of your bird will be if you can find it.

I recently compared and found that a high quality 8x42 binocular made it slightly easier to read a book text 15 feet away than my standard, medium quality 10x42 binoculars.

The **size of the objective lens** determines how much light the binoculars can "pull" in for your image. Popular belief is that this determines how bright and how well defined your image will be. The reality is a bit more complicated - it has to do with the size of the opening in the pupils of your eyes, the magnification, and the objective lens size. The diameter of the objective lens divided by the magnification yields the actual diameter of the shaft of light coming out of the eye piece of the binoculars to your eyes. This is called "Exit Pupil". If the pupil in your eye is smaller, then a portion of that shaft of light will bounce off the opaque part of your eye's iris and won't go into your eye. That light is "wasted" and won't make your image brighter. But the wider shaft makes it easier to "find" it and get your eyes to take in a full image. Also, if you use the binoculars for star gazing at night, the wider lens and exit pupil will let your eye's pupil get wider and still take it all in. In daytime use, your eye's pupil is normally about 2-3 mm wide, and any binoculars with an exit pupil that wide will produce an image about equally bright, popular belief to the contrary. At night, a young person's iris might open up as much as 7 to 9mm wide, while a middle aged person's iris usually won't open up more than about 5mm. So a 5mm exit pupil will give you all you can use even at night if your pupil doesn't open beyond 5mm. Brightness can also vary with lens coatings and prism glass formula. I'll get to that later.

There's another thing about the size of the objective lens - larger objective lens also means bigger, heavier binoculars. As with magnification, there's a "sweet spot" in there that's best for you. Larger and heavier does make the binoculars steadier in your hand, and the image doesn't jump around

quite as much. See note earlier on those mini binoculars. But too big and heavy can make them tiring to lug around and fatigue your arms and hands when you're trying to hold them and look through them.

It's best to try different sizes and weights for feel, comfort, how jumpy the image is, and find your own "sweet spot" for the right weight and easiest viewing. The most popular "sizes" are about 32mm objective lens size, often called "mid-sized", and the most popular 42mm objective lens size which most "birders" choose for their own use.

**I generally recommend 7x35 porro prism binoculars, for about \$30, for people who are beginners or only use them occasionally.** This includes "extra" binoculars intended for visitors to use. The extra price for more expensive binoculars would be **wasted** on them, because the 7x35's are much **easier for them to use**. Hard-core heavy users generally "graduate", when they have the skill, to 8x42 roof prism binoculars costing anywhere from \$100 to \$3,000, depending on how much they can afford and want to spend. I personally use a good mid-priced model of 10x42 binoculars which cost me about \$300 new.

### **Field of View**

For a lot of people, this can be **VERY IMPORTANT**. For my first few years, I used 7x35 porro prism binoculars with a very good field of view and was still often frustrated when I wanted to look at a bird in a tree. I'd bring up the binoculars and focus, and find myself looking at leaves, twigs and branches. But **which** leaves and twigs and branches? Where was the **bird**? Which **tree** was I looking into? It took years to gain the skill to reliably find my bird. And that was with a very good field of view. Many binoculars have higher magnification, which means they zoom in more on their target, filling your image with a smaller piece of the real world, a smaller Field of View. This is typically measured in how many feet across you can see at 1,000 yards distance. With lower magnification, you can see more real estate, more feet across at 1,000 yards. That makes it easier to find your bird, even though it will look smaller. With higher magnification, that chunk of real estate is smaller but your bird looks larger, if you can find it. It's a trade-off and depends on your level of skill at finding your bird in the binoculars. For beginners or people who only occasionally use binoculars, I recommend 7x or lower magnification to get the wider field of view and improve the odds of getting to see what you're looking for. Even highly skilled, all-pro level birders usually won't choose magnification higher than 8x, although some birders with above average coordination and skill at getting the bird into view might opt for 10x binoculars, - addicted, like I am, with the larger image of the bird.

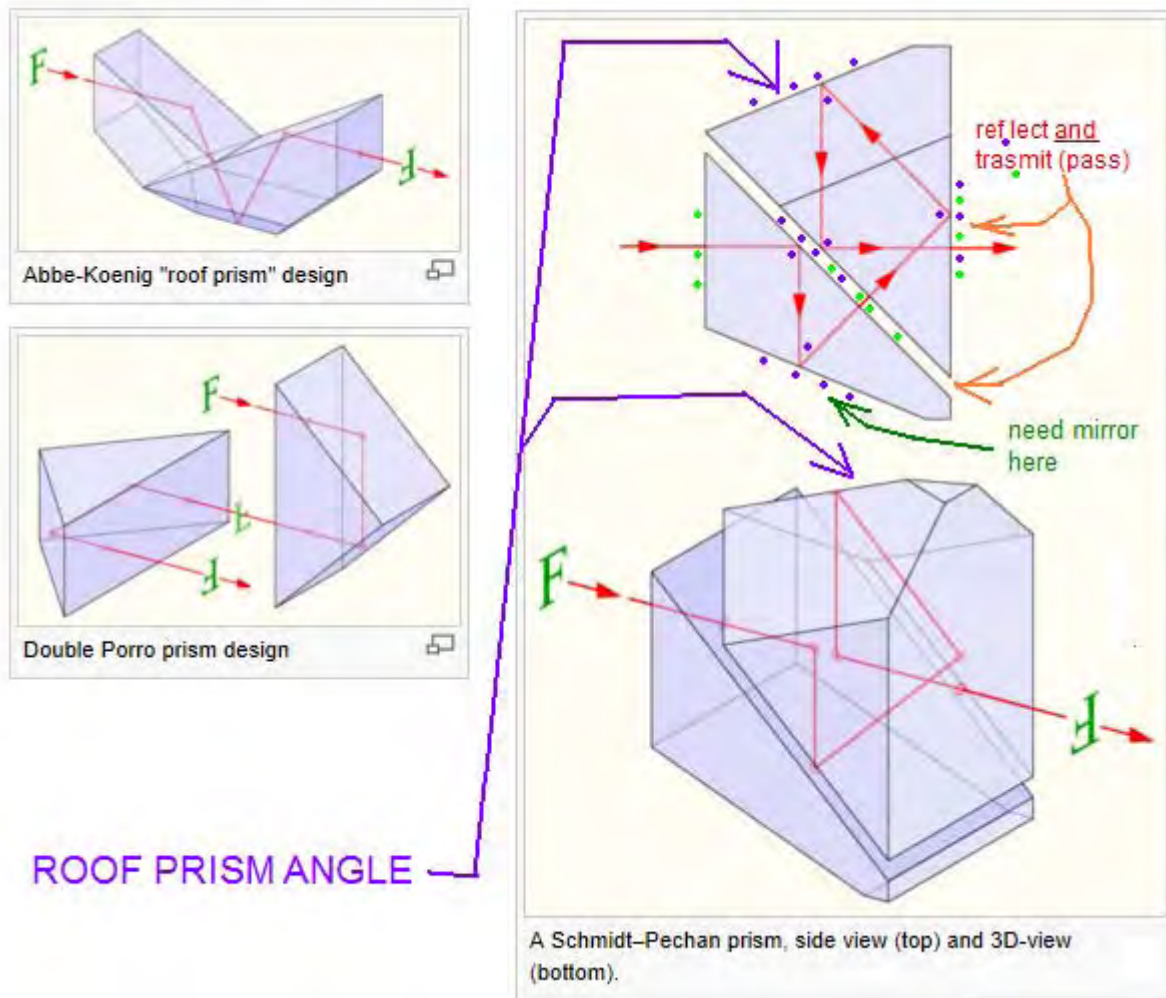
Note - field of view does correspond with magnification, but not **EXACTLY**. Always note the specifications of the binoculars and the advertised field of view in the literature from the manufacturer or seller. Some 8x binoculars don't have more field of view than some other 10x binoculars. They do vary somewhat depending on details of design.

### **Coatings**

All binoculars, even the cheapest, offer at least some anti-reflective coatings on at least some of the lenses to reduce light loss through reflecting when the light should be passing through the lenses and prisms. More expensive binoculars have fancier, more effective multiple layer coatings

that let more of the light through. Most mid-price and high-price binoculars boast "FMC" meaning Fully Multi-Coated on all air-to-glass surfaces of lenses and prisms, letting the most light through.

Roof prism binoculars also need additional coatings on certain surfaces of their prisms to keep the light going through properly. The "roof" surfaces that give roof prisms their name need phase correction to keep light reflecting through those surfaces from interfering and getting darker and smudgy. The cheapest roof prism binoculars probably don't have this needed "Phase Correction" or "P-coating" on those surfaces. Their image will lack the detail and "definition" of better optics.



Another surface on the Schmidt prism, in the commonly used Schmidt-Pechan roof prism set, needs a reflective coating, similar to the reflective coating on the mirrors in your house, to keep the light going along the path. The mirrors in your house probably use aluminum, which reflects about 82% of the light. Stepping up in price, one can get a special oxygen-free "HR" process to put the metal on the glass surface, increasing the reflection to about 88 – 90% for the aluminum. Stepping up again, a more expensive silver coating can reflect 87% - 92% of the light. An free "HR" process silver coating can reflect or 97 – 98% of incoming light. Stepping up yet again, one can get a still more expensive di-electric chemical multi-coating, with alternating layers of material of high and low refractive index, up to 64 or 70 carefully placed layers. This can reflect over 99% of light across the visible spectrum. For a price. Note that all these mirror coatings are for roof prism binoculars

only; porro prisms already reflect 100% of the light at all reflecting surfaces and don't need either a mirror coating or a phase correction coating. They can still benefit from anti-reflective multi-coatings on air-to-glass surfaces where the light goes into and comes out of the prisms and lenses.

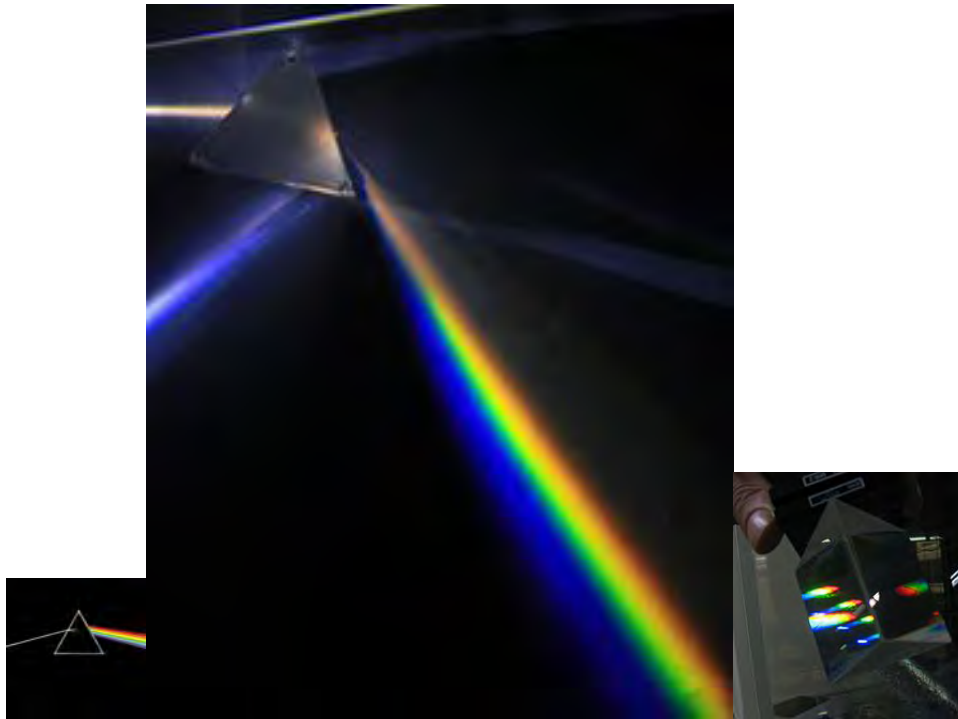
All of these various coatings are used to increase the light transmission efficiency of the binoculars, to yield a brighter, clearer image with less light getting lost along the way. More money will usually get better coatings and more light getting through the binoculars to your eyes with a brighter image with higher contrast.

Prism glass - BK7 glass versus BaK-4 formula glass, and clear optical plastic

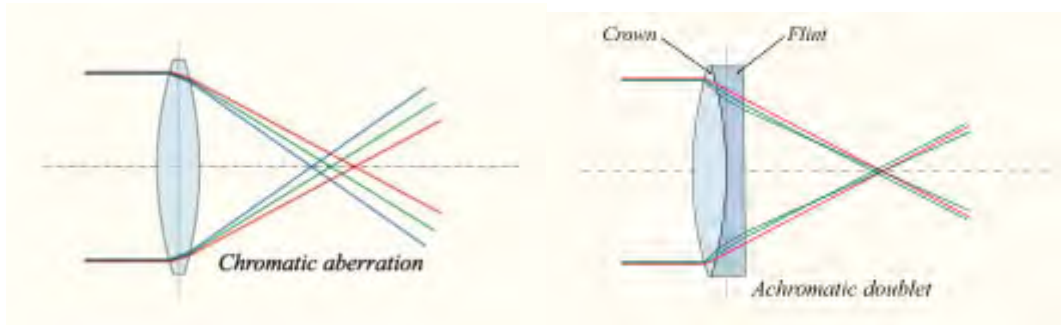
Another factor that affects how much light comes through the binoculars is the formula of glass used in the prisms. BaK-4 glass (Barium Crown formula no. 4) is more transparent (99+% in the prisms), but more expensive, than is BK-7 (Boron Crown formula no. 7) glass in the prisms (85 - 90%). So the more expensive BaK-4 glass in the prisms will yield a slightly brighter image. This is true for both porro prism and roof prism binoculars. Due to the shorter light path in the lenses, BaK-4 glass generally won't be used there, just in the prisms, which have a longer distance of travel for the light going through them. Except for special low-dispersion formulas, most high grade lenses used in quality optical equipment are made with BK-7 glass. Eye glasses, due to the very short distance going through the single lens to the eye, can even use clear plastic, which absorbs more light than glass but weighs less. With the much shorter distance of travel through a single thin lens, plastic eyeglass lenses still absorb only a negligible amount, detectable only by special measuring instruments. For the longer light path through binocular prisms and lenses, the amount of light absorbed by clear plastic would be much more significant, making it impractical for use in telescopes or binoculars.

Chromatic Dispersion

Most of you have, in school or elsewhere, seen the example of the visible light spectrum of colors as produced by rainbows and also with glass prisms which break up white light into the colors that it contains, spread out by the prism or rain droplets to show the colors therein. This is fine for prisms used for that purpose, but all clear surfaces where light comes in at an angle do the same thing, to variable amounts, with their incoming light. This includes the lenses in the binoculars. It causes light of different colors to fail to come to a focus at the same place, a problem for telescopes, microscopes and binoculars, where you want a full color, clear, sharp image.



Images of prism and “rainbow” of colors – and on right, lights seen through a prism with colors smeared by the dispersion.

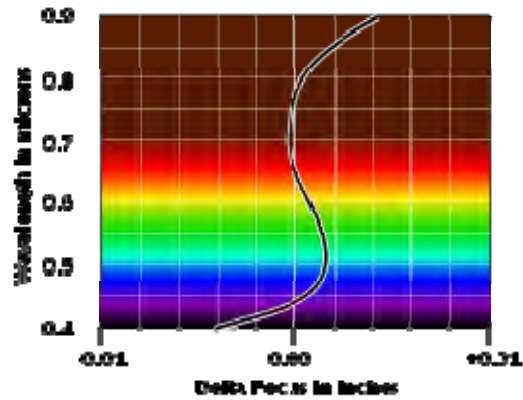
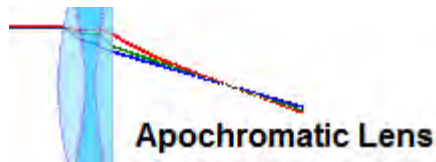


With a “regular” lens without correction, colors don’t focus at the same point.

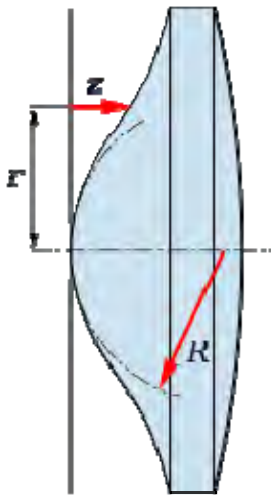
A partial fix is the use of "Achromatic" lenses, which have glass of two different formulas in them, compensating for this color "dispersion" and bringing at least red and blue light into the same focus, leaving a problem with the yellow and greens, which will remain a little bit off.

I believe all binoculars and telescopes offered for sale at all prices use achromatic (or better) objective lenses, and mid-priced and high-priced 'scopes and binoculars have achromatic or better (see below) lenses throughout.

Another step up in cost and refinement is the “Apochromatic” lens, with three elements, each with differing dispersion properties, used to focus three colors of light onto the same focal point. Premium-class telescopes and binoculars generally have apochromatic objective lenses and "aspheric"-shaped (see below) eyepieces.



### "Aspheric" lens elements



Another problem with refractive lenses is a geometric aberration in the way the light is bent, due to the varying thickness of the lens at different parts, thicker in the center and thinner out towards the edges. Some optical manufacturers make special "aspheric" lenses of complicated shapes to try to compensate for these effects and bring the outer part of the field of view into clearer, sharper focus, for a more uniform clarity across the field of view. They try to make the image "flatter", more accurately focused across the full width of the image, not just in the center. Premium-class binoculars and telescopes incorporate these aspheric lenses, also referred to as “field flattener” lenses, for the eyepiece lenses. This does introduce a “coke bottle” effect, which bends the sides of the image a bit, more noticeable at lower magnifications than at high magnifications. I’ve seen this with the premium Zeiss binoculars I used to have, and in a pair of Swarovski premium-class



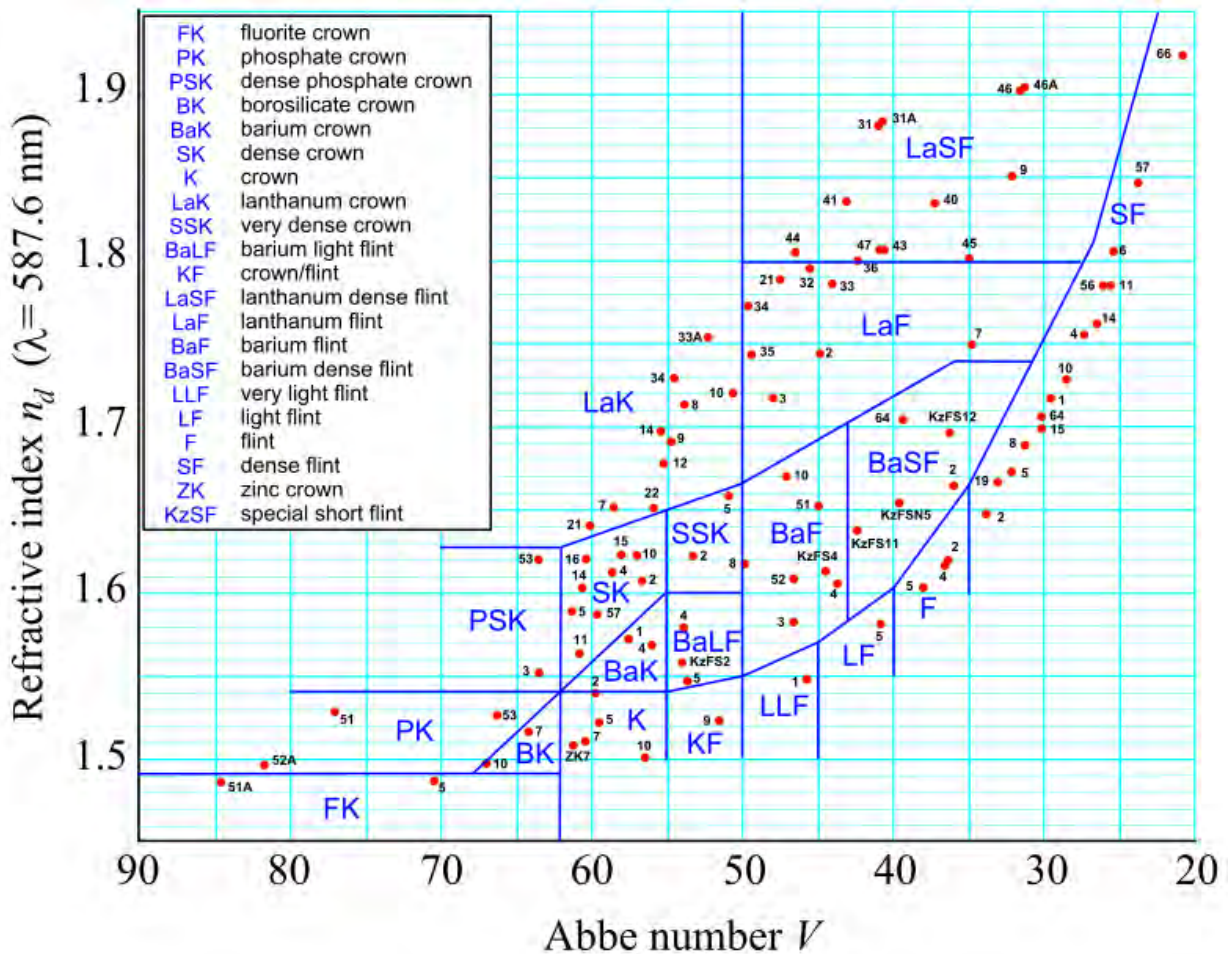
binoculars someone had. I consider it a fully acceptable trade-off for the clarity of the image presented.

So, premium-class binoculars and telescopes (“groups four and five”) use a three-element “Apochromatic” objective lens, and “aspheric”/ “field flattener” eyepiece lenses, to address both color dispersion and focus uniformity across the field of view. This produces a noticeably better image with more clarity, edge-to-edge sharp detail, and less eye strain for the observer when using the optics for extended periods of time, as compared to the lower optic classes.

### Special extra-low dispersion glass formulas

Another additional partial solution is to use a more expensive formula of glass called “low dispersion” glass, or XP, HD, ED, or FL glass. The various low-dispersion formulas differ in cost and effectiveness in reducing this color dispersion, or chromatic aberration. (These lenses use the low-dispersion formula glass in the main part of the lens. They still are achromatic lenses, with a second high-dispersion formula in the compensating part.) Fluoride (FL) glass, the highest-performing formula, has been with us in apochromatic and superachromatic lenses (see above) since 1963, and is still very expensive. This fluoride ion glass formula steps premium class binoculars up to the top elite class. The benefit is an image with slightly more intense colors.

Here is a chart showing different properties of refractive index and chromatic dispersion in different formulas of glass. Higher Abbe numbers mean LESS chromatic dispersion.



Higher Refractive Index means the lenses can be thinner (with less geometric distortion) and still bend the light as much as thicker lenses with a lower refractive index. Note that this chart does not show a third, important variable: Transmission, or how much light the glass absorbs as it passes through the glass.

Most of these aberration problems, and some of their partial solutions, have been with us for centuries, addressed by astronomers wanting to get wide-field photos of the night sky without distortion or loss of focus across their photographic films. Some of the low-dispersion glass formulas have been around at least since the 1930's, while others, especially the new top-of-the-line FL formulas with fluorine ions in the glass, are newer. The introduction of ED and FL glass into binoculars and spotting telescopes for bird watching is relatively new and still very expensive.

## So what's out there now?

Binoculars and telescopes seem to come in five general classes with successively better optics and higher prices. Most of this also applies to spotting telescopes, but I'll start with binoculars:

### **GROUP ONE – cheap roof prism binoculars – under \$100**

Cheap miniature roof prism (under \$100), probably without phase correction coatings - These models probably have one 2-element “Achromatic” objective lens, and single element lenses elsewhere in the binoculars. Inexpensive roof prism binoculars (and telescopes) under \$80 probably won't have the phase-correction coating on the roof prisms, needed to correct smudging of the image. I did find one model in this group which is a waterproof roof prism model, and should be more durable than most of the others in groups 1 and 2. It could serve as an inexpensive backup mini-spare or as a “starter” for kids until they get more reliable in caring for their binoculars.

### **GROUP TWO – economy porro prism binoculars – up to \$80**

(both miniature and "normal" size)

These outperform all entries in group 1, because they have porro prisms. But inexpensive porro prism binoculars aren't waterproof or shock proof. Handle with care. Like group 1, one achromatic objective lens and single element lenses in the binoculars otherwise. Two models in particular, offered for about \$30, are of special value. **These are the best choice for casual users, beginners, and “visitor” loaner binoculars.**

**These economic porro prism binoculars are the best value for the money.**

### **GROUP THREE – mid-grade binoculars (mostly roof prism) – \$80 - \$300**

Most of these are sealed, waterproof binoculars, with metallic mirror coating on the Schmidt surface and phase correction on the “roof” surfaces (roof prism models), and two-element achromatic lenses throughout, with anti-reflective multi-coatings. Differences among the models in this group are relatively small, since the basic design is the same for all. All of them do produce nicer images than either of the two preceding groups, as demonstrated at the bird club lecture demo table last September (2013). However, differences are there, hence the need for the ratings from the comparison studies. Some of those differences come from differing mirror types (roof prism models), quality of the lens coatings, or even the formula of glass used in the lenses, resulting in slight variations in brightness of the image and intensity of the colors.

**GROUP FOUR – premium binoculars - \$900 to \$1,500, all roof prism models).** These have the three-element “Apochromatic” objective lens, to correct the focus for three colors, and achromatic (2-element) aspheric (“field flattener”) eyepiece lenses. The mirror coating in the prism is a 60 to 80 layer iridescent dielectric coating. These refinements produce a noticeably brighter, clearer, sharper image with less eye strain, but are more of a strain on the budget. After using one of these for any length of time, you won't want to settle for anything less.

**GROUP FIVE – elite binoculars with FL glass - \$1,500 to \$2,500 –** a small step up for optical quality, but a “giant leap”, about \$1,000 more, in price, to get the very best optics money can buy. A new Cornell review came out this fall, concluding that most of the top elite models were so close in score that they couldn't pick an overall best of group. They also held the opinion that the small improvement with the FL glass in the elite group might not justify the extra thousand dollar cost over the non FL premium models (which they called “the new Mid-Price Group” – I call them the

premium class). This reinforces my view that the three-element “Apochromatic” objective lens and the “Aspheric”/“Field Flatteners” eyepiece lenses really make the largest improvement over the mid-grade group with two-element “Achromatic” lenses.

With each step up from one major class to another, the image will get clearer, sharper (more detailed), and brighter, with less eye strain for the observer over long periods of viewing. Within each class, there is some variation in optical and mechanical or handling quality, which generally but not exactly follows with the price. But each class will outperform anything in the next class down in image brightness, contrast, and clarity.

A specialty product of interest – there are some Image-Stabilized models of binoculars (and even one expensive spotting telescope) available for sale. Notably, Canon offers 8x25 and 10x30 models for about \$400 or \$500. If you have trouble holding your image steady enough, even with the heavier full-size binoculars, these might be of interest to you. I tried one of the Canon models some years back, and concluded that I wasn’t missing much with my regular binoculars and that for me the extra money would be better spent upgrading to the next level up in optical quality of regular binoculars. But for some folks, these could be a real blessing and well worth the price. There also is one \$6,000 image-stabilized spotting scope, a Nikon Fieldscope, which might hold more steady when wind is shaking the ‘scope and tripod. I haven’t seen one of these in the field.

When the birds are nearby and well illuminated with a dark background behind them, most binoculars of all classes will produce a very similar image. The most expensive classes of binoculars will show more clarity, color, contrast and detail on birds in poor lighting, either in deep shade or backlit against a bright sky. Spotting telescopes of the higher classes will also get more range – able to resolve smaller details on birds farther away, that lesser optics can’t resolve. And that’s what a ‘scope is for.

One problem is that there's very little information on the quality and performance of the low and mid-priced binoculars, to know which ones to buy and which to avoid. The \$30 porro prism 7x35 binoculars can be well worth buying and using, while some more expensive ones might be headache-makers not worth owning, even for free. Only the very top-of-the-line binoculars have reliable information on their actual optical quality, along with a select few of the mid-grade models. That information comes from comparison review studies where observers compared multiple binocular models by various makers and rated them for optical quality and comfort of use. The manufacturers’ websites don’t have this information. One can go to most manufacturer's websites and get some specifications, such as field of view, close focus, and exit pupil, but light transmission (published in only two models), resolution, contrast, uniformity of resolution, and geometric distortion information is not published, even with the most expensive premium models. And the critical lens types can be determined only by the overall optic scores in the comparison reviews or implied by price. The comparison studies feature subjective reviews by testers trying out each model and scoring them on performance in various categories. No scientific measurements are presented.

There have been some comparison reviews every few years, with a selection of mid-priced and top-of-the-line models, which give a good idea of how worthwhile those selected models are, and that's where I get most of my information. There also are customer reviews, one to five stars, at Eagle Optics and at Amazon.com, which are much less reliable but better than no information at all. The most reliable information comes from Bird Watchers Digest and Birders World magazines,

both bird watcher oriented publications, and Cornell University's Living Bird Quarterly magazine. These studies compared a selection of mid-priced and premium models, but there are many, many additional economy and mid-grade models out there for which I have no actual quality information. Some other sites appear to be much less trustworthy and I don't put as much faith in their evaluations, but as with all of this, the selections of models reviewed don't overlap much for comparison, except for the most popular of the elite-class models.

My only information on the important 7x35 porro prism binoculars is that the Maryland Ornithological Society has chosen one model to award to promising kids, and that Amazon has a similar model by another maker with even more field of view and about the same Amazon customer ratings and price. I recommend those two, based on this information alone, which is all I know about them. But quality 7x35 porro prism binoculars, hard to find otherwise, are a far better choice for the occasional or casual user than any of the other binoculars out there. The more expensive binoculars would actually be a waste of money; the \$30 7x35's are easier and less frustrating to use. They're lighter to carry and lighter on the pocketbook as well. Roof prism binoculars can be had for less than \$80, but they won't match the image quality of the \$30 porro prism 7x35's.

For the seasoned and skilled heavy users, who want more, I recommend sealed 8x42 roof prism binoculars, and after that it's more a matter of how much you want to spend. Generally, the more you spend, the better the image quality the binoculars deliver. This is where the extra price for more durable, waterproof roof prism binoculars protects the investment in expensive, high quality optics. Mid-priced and premium class roof prism binoculars all now have this protection, including the two models of binoculars I currently use.

So, with the disclaimer that I just don't really know enough about the quality of most of the binoculars being offered for sale, I present below a sample listing of a few models which I believe, based on the reviews of those particular models in the articles I have been able to find, should be a good value for the price. Other models are either more expensive for the same quality, according to the reviews I've read, or are of quality unknown to me. Within the mid-grade group, I doubt any will be really disappointing compared to others; the most obvious difference I've found is subtle variations in image brightness or color intensity. That probably comes mostly from the type of mirror coating used, or from the glass formula in the lenses.

My listings, which follow, work upwards in price, with a few mini's leading off with the lowest price, working up to about \$400, with the premium top-of-the-line models thrown in at the end for contrast. There are some other models worthy of consideration in the intermediate range between \$400 and \$900, but I don't know enough about their quality or design to include them here. I do believe they generally will feature silver or di-electric mirror coatings and more expensive anti-reflective coatings for a brighter image but still use exclusively two-element achromatic lenses. Some of the more expensive ones might possibly have "aspheric"/"field flattener" eyepiece lenses.

## GROUP ONE – CHEAP ROOF PRISM BINOCULARS

Two ultra cheap roof prism mini's which are NOT waterproof and one that is.  
(The funny-looking "Lucida sans Typ" font appearing below is used to keep columns straight; the "Garamond" font used through most of this article won't line up the columns neatly.)

### \*Tasco Essentials 165RB

size	price	FoV	relief	focus	weight	
8x21	\$11	383'			6.6 oz	\$11 Adorama
4 stars 121 reviews, a best seller at Adorama						

### \*Bushnell Powerview

size	price	FoV	relief	focus	weight	
8x21	\$16	378'	10mm	21 ft	6.9 oz	\$12.52 Adorama
4 stars 291(!) reviews, best seller at Adorama						

### Tasco Sierra TS825D

size	price	FoV	relief	focus	weight	
8x25	\$17	350'	15mm	6.5 ft	11.7 oz	\$17.31 Adorama
4 stars, only 3 Amazon reviews - this one is waterproof.						

Amazon buyers overlook that the Sierra is waterproof, but it does have the 2nd lowest field of view of all 8x binoculars in this list. None of these can match the image of the 7x35 porro's below.

One club member reports that the best-selling Bushnell Powerview listed above did not deliver the "definition", i.e. fine focused details, of his new \$250 Nikon Monarch DCF binoculars (a recommended model).

These cheap mini's might, however, be somewhat useful as pocket-size spares, and as starters for kids who can play with them and possibly learn to be more responsible, and "graduate" as they get older, to better binoculars, like the \$30 models below.

Sort of example: as a kid, I owned a very poor quality "Space Telescope" gotten through a cereal box offer - a Galilean type telescope, 12x19mm, no sharp focus, couldn't resolve moon craters, but I thought it was the most wonderful possession I ever had as a kid. The color fringes (chromatic aberration) around the edges were a big bonus. For me, it was the most "Wonderful Toy" I ever had. (I actually still have it as a sentimental relic from my childhood.)

## GROUP TWO – ECONOMY PORRO PRISM BINOCULARS

The two models following are **\*\*porro prism, not waterproof\*\*** but probably the best choice of the bunch, especially for beginners and casual users – note that cheap roof prism binoculars will not match these in optical quality, unless they cost \$90 or more, which is entry price into the next Mid-Priced group with significantly better optics and image.

### **\*\*Bushnell Falcon**

size	price	FoV	relief	focus	weight	
7x35	\$23	420'	12mm	20 ft	21 oz	\$23 Amazon

4.5 out of 5 stars, 82 Amazon customer reviews

### **\*\*Tasco Essentials Zip**

size	price	FoV	relief	focus	weight	
7x35	\$30	500'			22.4 oz	\$30.42 Amazon

4.5 out of 5 stars, 21 Amazon customer reviews  
 - widest field of view of any binoculars in this listing

It may be possible to upgrade from these economy porro prism binoculars and go to waterproof models with BaK-4 glass in the prisms, producing a brighter image. There are some more expensive porro binoculars which are advertised as shock resistant and waterproof. I couldn't find any information on the glass formula used in the Leupold BX-1's prisms, and must assume it's still the cheaper BK7, not the clearer BaK4. (BK7 is Boron Crown formula #7, BaK4 is Barium Crown formula #4). I would otherwise expect binoculars costing \$90 or more to have the clearer BaK4 glass in the prisms; all of the "Mid-Grade" Group (\$90-\$500) binoculars in my listings do have BaK4 glass prisms and achromat lenses throughout; these porro's apparently don't.

**NOTE THAT MANY OF THE FOLLOWING “ECONOMY” MODELS ACTUALLY COST MORE THAN \$90.00, AND FOR THAT PRICE ONE CAN STEP UP TO THE NEXT, “MID-GRADE” GROUP WITH BETTER QUALITY OPTICS AND IMAGES.**

At this price range, some of these, especially the Nikon action models, **should**, but apparently **don't**, have 2-element achromat lenses throughout. The mid-grade group which follows does. Without achromat eye lenses, these models will belong in the "economy" class despite the price, and they just won't be able to compete with the mid-grade group in image quality.

### **Nikon Aculon porro**

rubber armored, BaK4 glass, NOT WATERPROOF, but claims to have “aspheric field flattener eyepiece lens elements???” (maybe an aspheric achromat objective lens?) does this "Aculon" model have achromat eyepiece lenses? No, the Cornell review clearly shows the optics of these to be typical for the economy class, not up to mid-grade class optics. The “field flattener elements” must be in the objective lens only.

size	FoV	relief	focus	weight	price	
7x35	488	11.8 mm	16.4 ft	24.2 oz	\$61.95 Adorama,	\$61.54 Amazon
8x42	420	12 mm	16.4 ft	26.6 oz	\$99.95 Adorama	\$67.98 Amazon
10x42	315	11.6 mm	16.4 ft	26.8 oz	\$99.95 Adorama	\$79.95 Amazon

Leupold BX-1 Yosemite waterproof Porro                      price

size	FoV	relief	focus	weight	Adorama	Amazon	Eagle Optics
6x30	420'	18.5 mm	15.7 ft	17.0 oz	\$79.95	\$87.99	\$89.99
8x30	389'	15.5 mm	10.0 ft	17.0 oz	\$102.95	\$102.89	\$99.00
10x30			11.0 ft	17.0 oz	\$ -	\$104.99	\$94.00

Leupold BX-1 Rogue waterproof porro					price		
size	FoV	relief	focus	weight	Adorama	Amazon	Eagle Optics
8x42	341'	16.5 mm	24.0 ft	18.5 oz	\$139.95	\$ -	\$149.00
10x42			21.0 ft	24.2 oz	\$134.95	\$ -	\$ -

Vortex Fury 6.5 x 32 - apparently discontinued; not on Eagle site.

Closest equivalent is:

Vortex Raptor - O-ring sealed, nitrogen filled, fog proof, waterproof, BaK-4 glass porro prisms, rubber armored.

					price		
size	FoV	relief	focus	weight	Adorama	Amazon	Eagle Optics
6.5x32	410'	20 mm	15 ft	17.3 oz	\$ -	\$119.00	\$120
8.5 x 32					\$ -	\$129.00	\$ -

Literature doesn't specify, but at that price, some of these models ought to have full achromatic lens sets (not just the objectives). Achromats would probably bring these into the mid-price group. But the Nikon Action below evidently doesn't. Probably these don't either. The older Vortex Fury model was recommended by Wayne Mones on the Audubon website, from personal use.

\*\* The following Nikon Action Extreme EX porro prism series is nitrogen-purged & sealed waterproof, and claims to be shock resistant.

These Nikon's have BaK-4 glass in the porro prisms.

They PROBABLY DO NOT have 2-element achromat lenses throughout; optic scores for this model, from the comparison study in 2005, are well below those of the mid-grade group below. And as Porro's, they are bulkier and heavier than roof prism binoculars of the same objective lens size. The prices should place them with the mid-grade group, but optics scores aren't up to the mid-grade group.

Nikon Action EX					price		
size	FoV	relief	focus	weight	Adorama	Amazon	Eagle Optics
7x35	489'	17.3 mm	16.4 ft	28.2 oz	\$106.99	\$123.96	\$ -
8x40	429'	17.2 mm	16.4 ft	30.2 oz	\$134.95	\$215?? (why?)	
10x50	341'	17.2 mm	23 ft	35.8 oz	\$169.99	\$178.95	\$ -



### **GROUP THREE, MID-GRADE BINOCULARS, \$80 - \$450**

mostly sealed roof prism binoculars, a couple of porro prism models also

This class of binoculars features 2-element achromat lenses throughout, BaK-4 glass in the prisms, phase corrective coating on the "roof" surfaces and a mirror coating on the Schmidt prism mirror surface (roof prism models). All of these are (or should be) sealed, waterproof and fog proof.

I personally recommend that anyone contemplating spending \$80 or more should consider purchasing a model from this group (or higher), due to the higher optical performance and the more durable construction, protecting your investment in the optics.

Most roof prism models in this group use an aluminum mirror on the surface of the Schmidt prism, same as in the mirrors in your home. The Swift Ultras, Alpen, and some others enhance the aluminum coating with an "HR process" keeping oxygen out, for a brighter surface. Older Eagle Optics Rangers and the Atlas Intrepid ED models use a more expensive silver coating for a still brighter surface. The newest Eagle Optics Rangers and Monarch models step up to a di-electric mirror coating for 99% plus reflectivity, brightest available, previously only found in premium-grade or elite-grade binoculars. These models previously used silver coatings; probably the increasing market price of the precious metal made the upgrade to the di-electric coating feasible.

In the Baltimore Bird Club demo and talk at Cyburn last September (2013), the mid-grade roof prism binoculars on the table clearly did out-perform economy porro prism binoculars in image quality, according to the people who tried them out and compared them.

In my tryout, I also noticed a similar step up in image quality and clarity from the mid-grade to the premium-class Zeiss binoculars on the table, despite the fact that they were older than most of the other binoculars and didn't have any of the fancy ultra-low dispersion glass formula in the lenses as used in today's premium and elite class binoculars.

Considering what I've seen in several models, I suspect that most of the mid-grade binoculars actually are very similar in optical quality, probably because they are all of the same basic design, with Schmidt-Pechan roof prisms, phase correction coatings, and 2-element achromatic lenses throughout, differing slightly in brightness of the image, due to the type of mirror coating or in some cases an improved glass formula with lower color dispersion in the lenses. According to actual comparison reviews, the lens glass formula doesn't guarantee better optical performance.

There are also some sealed, waterproof **porro** prism binoculars with BaK-4 glass in the prisms, including the Swift Audubon series (with one roof prism model added among them). Swift Ultra previously included some porro models. (I bought one and subsequently broke it.)

The waterproof porro's are bulkier and heavier than roof prism models of the same objective lens size. None of the porro's need or use a mirror coating or a phase correction coating on the prisms.

The three following models are about the cheapest in mid-grade roof prism, but have major endorsing recommendations and are known as true quality waterproof binoculars.

The Shrike (\$100) was rated least expensive waterproof, quality binoculars by a couple who write for Bird Watchers Digest, who also conducted one of the major comparison studies and ratings of

binoculars in medium and high-price categories - but this model does have a lower field of view than most of the 8x binoculars shown in this list. They did score below average for the mid-grade group in optical quality (at a lower-than-average price) in the Cornell study (fall 2013).

**Eagle Optics Shrike**

size	price	FoV	relief	focus	weight	
8x42	\$100	341'	17.6mm	13.1 ft	23.2 oz	\$100 Eagle Optics
10x42	\$110	304'	13.6mm	13.1 ft	22.4 oz	\$110 Eagle Optics

The Atlas Optics Radian (\$130) was rated least expensive binoculars recommended for bird watching by the staff at Eagle Optics internet store, overlooking their own store-brand Shrike recommended above by Bird Watchers Digest, and the Radian does have closer focus and a slightly wider field of view than the Shrike has, for an extra \$30. Rated average for the mid-price group in optical quality in the newest Cornell review. And a bargain at the price.

**Atlas Optics Radian**

size	price	FoV	relief	focus	weight	
8x42	\$130	375'	17.5mm	6.5 ft	23.0 oz	\$130 Eagle Optics
10x42	\$140	305'	15.5 mm	6.5 ft	23.0 oz	\$140 Eagle Optics

**Bushnell Nature View** - most Nature View models are unsealed porro, but the three below are sealed roof prism models with rubber armor. The 8x32 mid-size model is the lowest-priced mid-grade binocular model I know of, and probably of very good quality, making it quite the bargain, as all three of these models are. There's some room for confusion; the Amazon models offered for sale feature light earth-tone khaki color, and appear to be a discontinued line, but the models sold by Eagle Optics are green with ribbed design on the rubber armor, for a better grip in wet or slippery conditions. I'm not sure if the field-of-view, eye relief, close focus, etc. are the same for both lines; I show the Eagle Optics spec's and prices below.

**Bushnell Natureview roof prism binoculars  
Eagle Optics prices 02/27/2014**

size	price	FoV	eye	focus	weight
8x32	89.95	393'	16.6 mm	5 ft	16 oz
8x42	119.99	435'	16 mm	12 ft	27 oz
10x42	119.95	325'	15.2 mm	13 ft	23.1 oz

Here are some more models of mid-grade roof prism binoculars, working up in price:

**Leupold BX-2 Acadia**

size	price	FoV	relief	focus	weight	best price and where
8x42	\$193	394'	15.5mm	7.5 ft	23.1 oz	\$192.48 Amazon
10x42	\$175	368'	15.5mm	9.0 ft	23.5 oz	\$174.99 Amazon

Leupold has their own brand names for the coatings, including "L-Coat (TM)" for the phase coating. I have some confusion with "Cascades" and "Acadia" model lines. The Leupold website implies that the more expensive "Cascades" have rubber armor and the "Acadia" does not, but sites like Amazon and Adorama put some question to that. The website does not otherwise specify any obvious difference between "Acadia" and "Cascades" models, but the spec's and prices differ, and the Acadia models have closer focus than the more expensive Cascades.

My sister-in-law has the Leupold BX-2 Acadia 10x42's (\$175) and they seemed OK to me when I looked through them. My Swift Ultra's were slightly brighter; I believe the Ultras have HR process aluminum mirror coating; perhaps the Leupold has standard aluminum mirror without the extra HR process brightening. I did notice one awkward feature in the Leupold Acadia model - instead of a stiff rotating eyepiece for bringing both eyes to focus together, this uses a lever next to the regular focus knob for bringing both eyes to focus, and it's easily dislodged, requiring more frequent adjustment to get proper focus alignment. Both models have BaK-4 glass roof prisms. Either one would do fine for birding, no complaint. This is very probably true for almost any of the mid-grade roof prism models offered for sale by all makers; the basic design is the same, even though slight differences show up in the field of view, eye relief, close focus and weight spec's. Optics score differences in the studies may have been due to the brighter image with models with brighter mirrors or type of glass in the lenses. Four models in this mid-grade class feature ED glass lenses, which produce more intense colors in subdued lighting.

continuing with more -

Bushnell Legend Ultra HD series - rubber armored, "extra-low dispersion", "ED Prime Glass" objective lenses (similar to Alpen Apex XP?). Year 2009 upgrades to objective lens glass formula, more Field of View at cost of less eye relief. Magnesium body, and improved antireflective lens multi-coatings.

Rated bottom of the group optically in the Bird Watchers Digest comparison review in 2011. That despite the improved glass formula and improved antireflective coatings. Still recommended by Wayne Mones on the Audubon website; this reinforces my impression that virtually all mid-grade roof prism binoculars should be good for bird watching and meet with his (and my) approval.

Bushnell Legend Ultra HD series							
	size	price	FoV	eye	close	weight	price & where
only comes in camo	8x32	\$220	426'	15.4 mm	6.2 ft	20.7 oz	\$219.50 Adorama,
camo or black	10x36	\$210	341'	15.4 mm	6.2 ft	20.7 oz	\$209.99 Adorama,
	8x42	\$218	420'	17 mm	6.5 ft	22.4 oz	\$218.34 Adorama
	10x42	\$250	340'	15.2 mm	6.5 ft	24.7 oz	\$249.95 Adorama

continuing with more models:

Vortex Diamondback							
	size	price	FoV	relief	focus	weight	best price and where
	8x32	\$190	420'	10 mm	5.3 ft	18.4 oz	\$190 Eagle Optics
	8x42	\$220	420'	18.0 mm	4.5 ft	25.2 oz	\$220 eagle optics ,
	10x42	\$140	345'	16 mm	5 ft	24.4 oz	\$140 e-bay, \$150 Hayneedle

"Wild Bird Centers" (store brand, manufacturer unknown)  
 size price FoV relief focus weight best price and where  
 8x42 no specs \$240 at the Wild Bird Center store  
 10x42 no specs \$250 Kevin Graff loves his 10x WBC's.

These store-brand models can be bought at Wild Bird Centers stores.

- - - NIKON MONARCHS - - -

these are the standard to compare with other mid-grade binoculars.

**The Nikon Monarch 5 ED models are top-rated in the mid-grade group, at about \$300**, in the Cornell study dated fall, 2013. No reason to spend more unless you're going up to the premium class for \$900 & up.

Nikon Monarch 3

size	FoV	relief	focus	weight	best price 11/27/13
8x42	330'	24.1	9.8 ft	24.7 oz	\$227

Nikon Monarch 5 - best in class, see the ED group, below

Nikon Monarch ATB

size	FoV	relief	focus	weight	best price 11/27/13
8x42	330'	19.6	8.2 ft	21.5 oz	\$297
10x42	299'	17.4	9.8 ft	24.7 oz	\$247

Nikon Monarch ATB (WA)

size	FoV	relief	focus	weight	best price 11/27/13
10x42	314'	15.5	8.2 ft	21.1 oz	\$327

Nikon Monarchs come in a confusing collection of models of various vintages and prices. Models include:

Monarch 3, -DCF, (silver mirror), (discontinued models still in stock)

Monarch 5, -ATB, and -7 models (dielectric mirror)

Monarch ATB has wide angle and extra light weight, no ED glass mentioned in the advertising literature.

Monarch 7 has ED glass, rubber-armored, "super" lens and prism antireflective coatings.

\$477 at Adorama. No mention in the 7's advertising blurb about "apochromat" or "field flattener" lenses. I believe those features are reserved for the premier class (and premier priced) Nikon EDG models.

One club member tried several models including the \$300 Eagle Optics Ranger SRT (see below) and decided his favorite was the Monarch, which he currently uses. I need to check which Monarch model line he has; I suspect it's the Monarch 5 with ED glass and the dielectric mirror, \$297 at Adorama, see the ED grouping coming later in this list.

Alpen Apex XP (model numbers in the 600's series)

size	FoV	relief	focus	weight	best price 11/27/13
8x32	340'	16mm	4 ft	19 oz	\$269.10 Amazon
10x32	314'	16mm	4 ft	19 oz	\$279 Amazon , \$310 Adorama
8x42	341'	20mm	5.0 ft	22 oz	\$287.10 Amazon , \$319 Adorama
10x42	315'	16mm	5.0 ft	22 oz	\$315 Amazon , \$350 Adorama

The Alpen Apex earlier model 493 (8x42) was rated slightly below average optically in the Bird Watchers Digest comparison in 2007, but the newer XP model 693 (8x42) scored near the top, well above most others, including Monarch, in the 2011 reviews.

I suspect a higher-performing grade of low-dispersion glass may be in the lenses, or perhaps a better mirror coating made the difference. The published field of view, eye relief, and close focus spec's remain the same as for the older model 493 (8x42).

Eagle Optics Ranger - now uses di-electric coating (99% reflectivity), not aluminum or silver (92 - 98% reflectivity), for the mirror. The older Ranger SRT used a silver mirror.

**Eagle Optics Ranger**

size	FoV	relief	focus	weight	best price
8x42	341'	19.5mm	5.2 ft	22 oz	\$300 at Eagle Optics
-	5 stars	202 reviews	by Eagle customers		
10x42	314'	16 mm	5.2 ft	21.6 oz	\$309.99 Eagle Optics
-	5 stars	102 reviews	by Eagle customers		

- The older Ranger SRT (silver mirror) is the high quality 8x binocular that beat my Swift Ultra 10x in fine details seen reading fine print at 15 ft distance, mainly due to slightly brighter image with higher contrast. They now use a di-electric mirror coating, significantly brighter than the aluminum mirror most models use.

Swift Ultra is my "standard" pair of binoculars (I have the 10x42.)

Swift Ultra 8x42	\$301	341'	19.5mm	6 ft	24 oz	\$301.30	Adorama
Swift Ultra 10x42	\$302	314'	16 mm	6 ft	25 oz	\$302.34	Adorama

- These 10x are my standard binoculars.

Note the smaller field of view with the higher magnification of 10x, compared to 8x binoculars.

Swift also made an Ultra in porro prism, weighing 28 oz, "Ultra Lite", with waterproofing. I actually bought those first, but they broke at the eyepiece, so I went for the more durable roof prism binoculars which are now my standard, and proved themselves by surviving the "dog wars" - chewed up by the family dog but still working just fine. For comparison, the discontinued waterproof Ultra porro models are listed below, but are no longer in stock or available for purchase; I believe they might be better optically than my roof prism standard, and better than the current Swift Audubon series binoculars offered for sale at a higher price. But they failed the durability test. Note their longer close-focus spec compared to my current standard roof prism binoculars. (Spec's for the roof prism above.)

**Swift Ultra porro 8x42	approx. \$300*	341'	18 mm	13 ft	28 oz
**Swift Ultra porro 10x42	approx. \$300*	288'	18 mm	13 ft	28 oz
** (discontinued models no longer available)					

The Swift Audubon binoculars (below) show what one can do with putting money into porro prism binoculars, making them more durable and waterproof and putting in the optical coatings. One roof prism "twin" matches the "regular" porro model, and one ED porro model is offered. The ED model costs more and has better optical quality due to the glass formula. All three are 8.5 x 44.

Swift Audubon porro								
size	price	FoV	relief	focus	weight			
8.5x44	\$329	430'	16 mm	10 ft	29 oz	4 stars	7 reviews	
Swift Audubon roof								
size	price	FoV	relief	focus	weight			
8.5x44	\$388	336'	19 mm	9 ft	23 oz	5 stars	5 reviews	
twin to the porro prism model, but with different spec's, lighter weight								
Swift Audubon porro ED								
size	price	FoV	relief	focus	weight			
8.5x44	\$430	430'	16 mm	10 ft	29 oz	4 stars	7 reviews	

I looked through the Audubon roof prism model, and found my Swift Ultra's were brighter. (Probably HR vs non-HR aluminum mirrors.) The Vanguards (in the ED group following) have still brighter colors, especially in subdued lighting.

Leupold Wind River Katmai - discontinued and high price for the one model Amazon still has in stock, about \$450

What about those Vortex models - ?

- Crossfire (about \$160), Diamondback (about \$220), Viper (about \$590), Razor (\$1,180)? What makes those models different? I think the Razor is a premium-class model, but what about the differences among these other three models of roof prism binoculars, if all mid-grade roof prism models are about equal? Mirror coatings? More? Does the Viper have aspheric/field flattener lenses?

Also note the significantly lower optic score for the Bushnell Legend Ultra HD with the special grade glass, contrasting with the significant upgrade in optic score for the Alpen Apex XP vs the older non XP Apex in the 2009 comparison tests. The two Apex models used the same configuration, lens focal lengths, etc for the same FoV, close focus, eye relief etc , yet differ significantly in their optic scores. Must be either lens glass formula or mirror coating difference or both. Better glass didn't lift the Bushnell Legends up to the top at all, according to the reviewers.

= = special grouping-within-the-grouping: mid-grade binoculars with ED glass = =

here are the new mid-grade ED binoculars, four models, \$290 - \$400. With the ED glass, they will have images with brighter colors. I found that, as with the premium and elite classes, most of these appear at the same price at Amazon, Adorama, and Eagle Optics. In this case, I suspect 2 of the 4 are distributed THROUGH Eagle Optics. Like most of the other mid-grade binoculars, these will have BaK-4 glass in the Schmidt-Pechan roof prisms with phase corrective coatings. All lenses (including objective) will be 2-element achromats. They are O-ring sealed, waterproof, nitrogen-purged roof prism binoculars. They differ in their mirror coatings and reviewer ratings.

The Vanguard entry is the only one appearing in the BWD article of 2012. In their mid-grade group it bested all of the other mid-grade models. But they scored slightly BELOW average for mid-grade binoculars in the newer Cornell review (fall 2013). Probably the truth is somewhere in the middle. I bought the Vanguard model on sale, and found that the ED glass does give their image brighter colors than those seen through my standard Swift Ultra binoculars. I also found

focus to be more critical, due to less depth of field in the image, useful for photographers but not advantageous for viewing birds through binoculars. They appear to have standard or “HR” aluminum mirrors.

The Cornell review (newest available review) placed the Monarch 5 (an ED model) at the top of the group. This model has di-electric mirrors and the ED formula in the lenses, giving them the brightest image in the mid-grade group, with the ED-enhanced color intensity.

The cheapest of the four, Atlas Intrepid ED, not only has the ED glass but also a silver mirror coating, brighter than the standard aluminum. It also offers a 7x36 model, an upgrade alternative to the \$30 7x35 porro prism binoculars.

FoV = Field of View, in feet wide at 1,000 yards distance  
 eye = eye relief, in millimeters (mm)  
 close = close focus, in feet from the objective lens  
 weight = in ounces

**Atlas Intrepid ED - silver mirror coating (brighter than aluminum)**

size	FoV	eye	close	weight	price
7x36	477'	16.8mm	5.1 ft	22.8 oz	\$300
8x42	420'	17 mm	6.5 ft	26.6 oz	\$290
10x42	342'	15.0mm	6.5 ft	26.6 oz	\$300

**Vanguard Endeavor ED**

size	FoV	eye	close	weight	price
8x42	400'	19.0mm	8.2 ft	26 oz	\$350 before \$50 mail-in rebate, \$300 net.
10x42	340'	16.5mm	8.2 ft	26 oz	\$350 before \$50 mail-in rebate, \$300 net.

**Nikon Monarch 5 (ED, with dielectric mirrors, top-rated in group)**

size	FoV	eye	close	weight	price
8x42	300'	19.6mm	8.2 ft	21.5 oz	\$297 Adorama 11/27/13
10x42	288'	18.4mm	7.8 ft	21.6 oz	\$326 Adorama 11/27/13

\*\* rated best-in-class in latest Cornell review, fall 2013 \*\*

**Zeiss Terra ED - mid-grade ED, not premiums, best close focus in this group**

size	FoV	eye	close	weight	price
8x42	375'	18mm	5.25 ft	25.4 oz	\$350
10x42	330'	14mm	5.25 ft	25.4 oz	\$400

## GROUP FOUR, PREMIUM BINOCULARS, \$900 - \$1,500

Binoculars in this class gain their superiority from a three-element "Apochromatic" objective lens (which can focus three colors to the same exact point) and "aspheric"/"field flattener", eye piece (ocular) lenses. This combination yields a significantly clearer image, with sharp focus across the full field of view, with less eye strain. Anyone trying one of these models out for any length of time probably won't want to settle for anything less. Most of these will also have the di-electric iridescent mirror coatings and first-rate anti-reflective lens coatings

Prices are generally about the same for Amazon, Adorama and Eagle Optics with these premium products.

**Leica Trinovid** (not the super low dispersion Fluorite lens models, a more economical alternative, still premium class). These models also uniquely sport THREE eyepiece lenses, plus focus lens and objective lens. (all of the other mid-grade, premium and elite models have two ocular lenses, a focus lens and an objective lens)

size	FoV	eye	close	wt	price
8x42	378'	15.5mm	11.5 ft	28.6 oz	\$1,449.00 Amazon
10x42	324'	16 mm	11.5 ft	28.0 oz	\$1,499.00 Amazon

**Nikon Premier** - field flattener eyepiece design, high-reflection "HR" silver coating (not the superior dielectric iridescent mirror)

size	FoV	eye	close	wt	price
8x32					\$1,196.95 Amazon
8x42	367'	20mm	9.8 ft	28 oz	\$1,449.00 Amazon
10x42	314'	18.5mm	9.8 ft	27.9 oz	\$1,599.95 Amazon

**Zeiss Conquest HD** transmission 90% + , T\* coatings , **best in class**, per Cornell 2013

"mid-sized" , 32 mm (less glass, lower weight and prices)					
size	FoV	eye	close	wt	price
8x32	420'	16 mm	4.9 ft	22.2 oz	\$900 Amazon
10x32	354'	16 mm	4.9 ft	22.2 oz	\$910 Amazon
"full sized", 42 mm					
8x42	384'	18 mm	6.5 ft	28 oz	\$950 new, Amazon
10x42	345'	17 mm	6.5 ft	28 oz	\$924 new, 849 used Amazon

Zeiss is one of only two manufacturers to publish transmission figures for their binoculars, the other being Swarovski. Zeiss does so for both their Conquest model above, and for their new Victory HT series in the elite class which follows. **The Zeiss Conquest rated best-in-class for the premium group in the Cornell study** (which called the group "The New Mid-Priced Group"). They were not only best in class in performance, but also less expensive than any of their competitors as well!

**Swarovski Companion CL** - mid-size 30 mm offerings in green, tan or black

size	FoV	eye	close	weight	price
8x30	372	15 mm	9.8 ft	17.6 oz	\$ 949.00 Adorama 11/27/13
10x30	300	14 mm	9.8 ft	18.2 oz	\$1019.00 Adorama 11/27/13



## GROUP FIVE, ELITE BINOCULARS, \$1,500 - \$2,500

The expensive FL (fluoride ion) glass pushes Premiums up to the Elite state-of-the-art class, best optics that money can buy. But note that the Nikon EDG included here **by price** don't advertise FL glass and rated significantly lower in optics score than the others in this grouping.

Leica and Nikon offer 7x binoculars which could serve as an ultra-premium alternative to the economy \$30 porro prism 7x35's in group 2, or the \$300 Atlas Intrepid 7x36 in the mid-grade ED group. With the better grade glass and the apochromatic objective and aspherics in the eyepiece lenses, they would offer the world's best view in a 7x binocular. At a price.

Leica Ultravid HD - with the fluoride (FL) lenses (elite class)

Mid-size 32mm

Size	FoV	eye	close	weight	
8x32	404'	13.2mm	6.6 ft	18.9 oz	\$1,949.00
10x32	352'	13.3mm	6.9 ft	19.9 oz	\$2,049.00

(3 eyepiece lenses in the 10x32 only, like the Trinovids)

Full-size 42mm

7x42	420'	17 mm	10.8 ft	27.2 oz	\$2,149.00
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Only 8 lens elements each side per Leica website - ??

8x42	390'	15.5 mm	9.8 ft	27.9 oz	\$2,199.00
10x42	336'	16 mm	9.5 ft	26.4 oz	\$2,299.00

Nikon EDG - actually an upscale Premium model, not quite up to Elite -  
Nikon EDG - ED glass, not FL;

size	FoV	eye	close	wt	price range
7x42	420	22.1	9.8 ft	27.7 oz	\$2,296.95
8x42	405	19.3	9.8 ft	27.7 oz	\$2,296.65 - 2,399.95
10x42	342	18.0	9.8 ft	27.9 oz	\$2,496.95 - 2,499.95

Zeiss Victory FL - Zeiss has moved the 42mm models from the Victory FL line to the HT line. With Victory FL, choose 32mm or 56 mm objective size. The Zeiss website says these have the normal Schmidt-Pechan roof prisms, not the Abbe-Koenig roof prisms used in the HT binoculars.

I list only the "mid-sized" 32mm binoculars below.

These 32mm binoculars will weigh less, for people who don't want the regular full weight binoculars. This 32mm size is currently considered "mid-sized" and is growing in popularity.

These smaller Zeiss FL 32mm models weigh less and cost less than 42mm "full size".

But the lower weight in the hands might cause more image jitter for some users.

The recent Cornell study gave these the highest (by a tiny fraction) optic score of all.

All prices as of 5/15/13 Zeiss Victory FL with 32mm objective lens:

size	FoV	eye	close	weight	Adorama - Amazon prices
8x32	420'	15.5	6.56 ft	19.75 oz	\$1,489.00 - \$1,679.99
10x32	360'	15.2	6.56 ft	19.75 oz	\$1,899.99

The new HT models by Zeiss feature a new, proprietary Schotz HT high-transparency FL glass formula, and produce the brightest image of any binoculars on the market, with a published transmittance performance of 95%. (Swarovski has 90% transmittance, the only other manufacturer to publish a figure.) Most of the comparison reviewers hadn't seen the HT's yet when they did their reviews. Comments on the internet suggest these may possibly be overtaking the Swarovski models as the most popular elite class binoculars. The Cornell reviewers, who DID see these, rated them about the same as the three others in this group, a virtual three-way tie among Zeiss (both flavors), Leica, and Swarovski.

#### Zeiss Victory HT

(Swarovski has 90% transmittance, the only other manufacturer to publish a figure.)

Size	FoV	eye	close	weight	Amazon	Adorama	Eagle Optics	prices
8x42	408'	16mm	6.2 ft	27.7 oz	\$2,200	\$2,200	\$2,200	
10x42	330'	16mm	6.2 ft	28.4 oz	\$2,140	\$2,250	\$2,250	

prices as of 10/18/13

Swarovski EL SwaroVision - FL lenses, 90% transmittance (only other transmittance data I have is the Zeiss). These seemed to be the best-sellers and highest-priced among the elite binoculars as of spring 2013. Mid-size and full size available.

#### Swarovski EL SwaroVision

size	FoV	eye	close	weight	price range
8x32	423'	20mm	6.2 ft	20.5 oz	\$2,159.00 Adorama 11/27/13
10x32	360'	20mm	6.2 ft	20.5 oz	\$2,239.00 Adorama 11/27/13
8.5x42	399'	20mm	4.9 ft	29.4 oz	\$2,459.00 Adorama 11/27/13
10x42	336'	20mm	4.9 ft	29.6 oz	\$2,499.00 Adorama 11/27/13

Reviews seemed to indicate the Leica, Zeiss and Swarovski were tied at the very top for optical quality. The Swarovski's seem to be the best sellers of the bunch, with the Zeiss HT's possibly catching up to take the lead in sales. I'm not sure which of those two is currently best-selling. Reviews generally show a three-way tie among Leica, Zeiss and Swarovski for top performance honors.

The Cornell reviewers came to the opinion that the Premium class group, costing a thousand dollars less, are close enough in quality that the extra money might not be justified for the improvement going up to the FL glass Elite group. (That would leave the Zeiss Conquest in the Premium group as the high-end binoculars of choice.)

internet binocular best price sellers:

Adorama <http://www.adorama.com/>

- often has the best price, but always compare price with Amazon

Amazon <http://www.amazon.com/>

- often has the best price, but always compare price with Adorama

Eagle Optics <http://www.eagleoptics.com/> - generally not as deeply discounted, but several models come at Eagle prices exclusively, and exclusively through Eagle.

Best-Price (a price comparison website) <http://www.best-price.com/>

Three local stores (or chains) carrying good optical quality binoculars and/or telescopes:

The Wildlife Authority, off Route 40 west of Route 29, look them up in internet for directions

Wild Birds Unlimited – a chain, two or three stores in the Baltimore metro area

Wild Bird Center – a chain, at least one store in our area, off Padonia Road off I-83 north of the Beltway

## SPOTTING TELESCOPES

Spotting 'scopes aren't as easily identified into their classes. I do recommend finding one with waterproofing, same with binoculars. None of my earlier, non-waterproof telescopes or premium binoculars work any more. Both of my current binoculars are waterproof, as is my telescope, and I will no longer buy any that isn't. Fortunately, most of the mid-grade and premium-grade binoculars and spotting telescopes sold today are sealed and waterproof, protecting the investment in the expensive optics.

There is another feature prominently and productively featured in most spotting 'scopes – zoom magnification (typically about 20 – 60x with the 80mm size 'scopes). Some binoculars also offer this (but not the premium or elite models), but it's not as useful with binoculars, since it tends to compromise optical quality a bit, and adds to the weight and price. With the 'scopes, the ability to zoom out to 20x to scan through groups of birds, then zoom in to 40x or even 60x as need arises, is valuable enough to more than make up for any slight loss in resolution or slight increase in price. Some purists insist on using fixed-power eyepiece lenses (typically 30x) for the slight improvement in resolution, but most users (including myself) prefer the flexibility of the zoom eyepiece.

I've mainly concentrated on the 'scopes with roughly 80mm objective lens size. 'Scopes with smaller objective lenses, about 50-65mm, are also popular, but they come with lower magnifications and won't be able to show the smallest details in far-away birds.

As mentioned previously, there are 'scopes with straight-through eyepieces and 'scopes with eyepieces mounted at an angle. The angled feature makes it a little harder to sight along the 'scope to get your target into the field of view, but it is much easier to place the tripod for people of varying heights – taller people simply bend down a bit more to look through the eyepiece without having to hunker down awkwardly to do so, while shorter people bend down just a bit less. This is very useful for trip leaders or those wishing to share their view with people of varying heights. It's also easier to set the height of the tripod with the 'scope on it, since it doesn't have to exactly match the height of the observer's eyes above the ground. There's more leeway here. But if you're looking over intervening grass or reeds, it's easier to just poke over the tops of the reeds with a straight-through 'scope, which will be higher up when it matches the position of your eyes.

The basic design features, including coatings and fancier lenses, influence spotting telescope price and optical performance the same way they do with binoculars. The prices are a higher than with the binoculars, but not by a huge amount. A **cheap** telescope will be similar to a cheap pair of binoculars, only **much worse** – with the higher magnification, the **optical flaws** stand out more clearly and it's harder to make out the finer details on more distant birds; you won't be able to see much through a cheap 'scope. It gets more important to invest in a costlier 'scope which will reveal more details on distant birds, since that's what the 'scope is for.

My Alpen 788 'scope currently goes for about \$450 to \$550 at Amazon. I can't recommend anything cheaper than this one. As it is, the Alpen will resolve details at a greater distance than I can make out with binoculars alone. I recently viewed my life bird Pink-footed Geese using both binoculars (Vanguard Endeavor ED) and telescope (Alpen 788) using two-element lenses, placing them both in my "Mid-Grade" class. With these optics, I got what seemed to be just as good a look at the geese as I could get with premium-grade optics (three-element Achromat objective lens and Aspherically shaped "field flattener" eye piece lenses). These views were of geese about 20 - 50

yards away; I saw no loss of detail compared to views through premium optical instruments. But the Alpen fails to resolve fine details in more extremely distant birds, remaining just a tiny bit blurry, no matter how I focus. Only a more expensive telescope, costing well over \$1,000, will resolve fine details of very distant birds.

The Bird Watchers Digest article in 2009 recommended the Alpen 788 ‘scope (which I have) as best under \$500 in price, then working upwards, two models by Vortex (sold by Eagle Optics) – the Vortex Viper (\$900 in Feb ’14) and then the Vortex Razor (\$1,600 Feb ’14). The Viper was said to show everything the same as the Razor except for the very most extremely distant birds, where the more expensive Razor revealed some details the Viper couldn’t show. The best-selling elite-premium ‘scopes run anywhere from \$2,500 to \$4,000, made by Kowa, Nikon, Swarovski, Zeiss and Leica. Reviews seem to generally favor all of these as nearly equal; there MIGHT be a very slight optical advantage to the Kowa and Swarovski models, per reviewer scores. But that’s within the margin of uncertainty and opinion.

Each major group step up here brings a little more detail visible a little bit further away.

In the field, I’ve seen people with Swarovski, Leica, Nikon (Fieldscope) and Kowa telescopes, and one or two other people with my mid-grade Alpen 788 model. While I haven’t seen the Zeiss, it’s rated up there, by reviewers, with the premium models I have seen.

For spotting ‘scopes, I’ve found three studies dated 2007, 2009 and 2010, with almost no overlap for models of mid-priced ‘scopes covered. I found the Bird Watchers Digest article from 2009 to be most helpful, and used it to choose the ‘scope I’m currently using.

See next page for a comparison of optic quality scores from those three studies, along with current prices (as of February, 2014) of the telescopes featured. Note that some models have already been discontinued.

Here is a listing of scopes and test scores of optical quality from those articles :

Prices were mostly sportoptics.com ; hard to find otherwise, some may be at Eagle Optics

model	Optics scores			internet price, 2/11/14
	BW 10	BWD09	Cornell08	
Swarowski ATM 80 HD	4.7	4.9P	4.8	\$3728
Kowa TSN-883 Prominar	4.6	4.9P	4.9	\$3050
Leica APO-Televid 82	4.3	4.9P	4.2	\$3899
Zeiss Victory Diascope 85T FL	4.3	4.7P	4.1	\$3000
Nikon Fieldscope EDG 85	4.1	4.1P	4.2	\$3997 Adorama
Nikon Fieldscope EDG VR 20-60x85				4500 - 6000
Amazon - WITH IMAGE STABILIZATION; might be useful in windy conditions				
Questar Birder (40, 60 x 88)			4.3	\$4500 from
Company 7 (Questar-dedicated DC-area outlet store)				
> Vortex Razor HD 85	3.9	4.6P		\$1600
Vixen Geoma II ED 82-A	3.8		3.4	
now Geoma 5892 ED 82-A , \$999				
Pentax PF-80 ED-A	3.8	3.8P		
Tele Vue-85	3.9		5.0	
> Vortex Viper				\$900
Brunton Eterna 80 angled ED	3.6	2.9P	3.8	
Celestron Regal 80 F-ED	3.5	3.3P		discontinued,
now selling Regal M2 80ED \$609				
Swift Sport Optics NightHawk 92 ED	3.4			
> Alpen 788		4.1M		\$450 - 500
Amazon				
Bushnell Elite ED 80	3.4	3.7M 2.9P	3.5	
"Elite" discontinued, now selling Legend Ultra HD 20-60x80 \$425				
Tele Vue-76	3.4			
Leupold Kenai 80 HD	3.2			

- note BWD09 mid-grade (M) and premium scores (P) are on different scales

BW 10 = Birders World 2010

BWD09 = Bird Watchers Digest 2009  
Cornell08 = Cornell Living Bird Quarterly 2008

note also that there were many more models tested without overlap from one study to the next, or of smaller or larger models.

I'm concentrating mainly on the approximately 80mm size with zoom roughly 20-60x. Note also that many of these models have been discontinued; newer models might be similar. There are also many people using 'scopes of 60 - 65mm size, but those models have lower magnification, zoom up to about 45x rather than the 60x offered by the 80mm sized models.

While the Vortex Razor was rated highly by the BWD '09 study, I'm not so sure that it would really be better than the Nikon Fieldscope, which was itself very highly rated (with the top group) in other written reviews, including one placing it above the Leica and Swarovski models in resolving ear tufts on a very distant Great Horned Owl. Most other reviewers put the Nikon Fieldscope slightly lower than the other best-of-the-best models, but the differences among the leaders (including Nikon Fieldscope) are small enough to leave it a matter of the reviewers' personal opinions and not a clear difference. Scores suggest the very best might possibly be the Kowa and Swarovski models by a small margin.

I just wish I had more comparisons in the different studies scoring the Alpen 788, the Vortex Viper, and possibly a couple of the other "mid-grade" 'scopes for a better comparison within that group.

In the field, I mostly see the top brands - Swarovski, Leica, Kowa and Nikon (fieldscope). Two or three thousand-dollar instruments all. While I haven't seen the Zeiss, it's up there with the leaders in reviewers' test scores. Once or twice I've seen someone else with another Alpen 'scope like mine.

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Stay tuned; I'll continue to update this article on the club web page. I can also be reached at [pete\\_webb@juno.com](mailto:pete_webb@juno.com) with any comments, questions, or corrections you might like to make.

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