

# KEY BOW ATTRIBUTES

## EFFICIENCY, SPEED, NOISE & VIBRATION

### Dynamic Efficiency:

**Objective:** The objective of the Dynamic Efficiency test is to provide an assessment of the amount of energy output by a bow relative to the amount of energy expended by drawing the bow back.

**Rationale:** The purpose of the compound bow is to transfer the energy expended in drawing the bow back (Potential or Stored Energy) into the energy propelling the arrow downrange (Kinetic Energy). Unfortunately, not all of the Potential Energy is turned into Kinetic Energy. This could be due to various reasons, but regardless of the cause you are not getting all the energy out of the bow that you have put into it. The reason for testing dynamic efficiency is to determine which bows perform the best in

AS TESTED BY JON TEATER  
AND ANTHONY BARNUM  
OF ARCHERY EVOLUTION



transferring the energy that is “stored” into the energy in motion that is released through the arrow.

**Procedure:** The Easton Bow Force Mapper system is used to create Force – Draw curves for each bow. The plot information obtained from the Mapper is then analyzed to obtain the amount of energy expended in drawing the bow back (See Figure page 63). This value in pound-feet (lb-ft), considered “potential energy” (or stored energy) for this assessment, is then com-

pared with the Kinetic Energy output by the bow during shot execution with 300 grain, 360 grain, 420 grain and 540 grain arrows. The Kinetic Energy is calculated with the following formula:

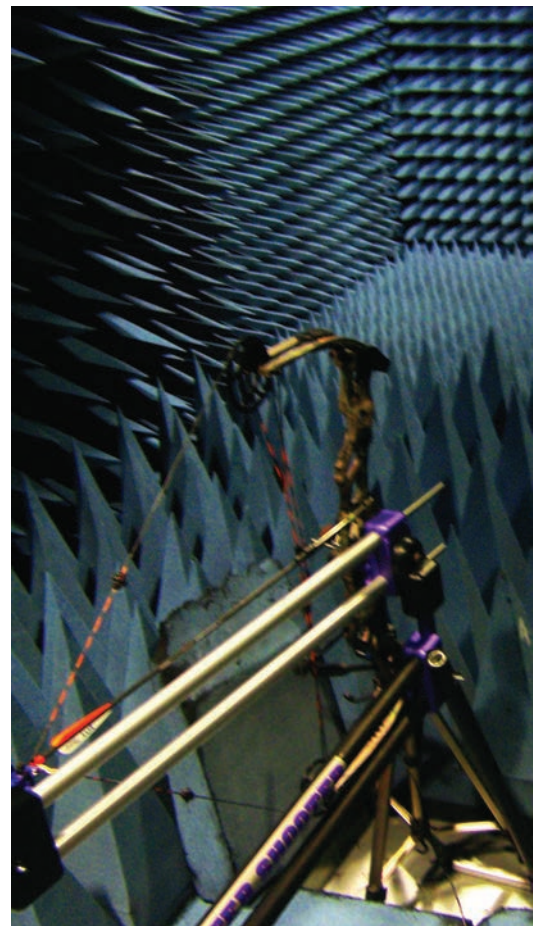
$$KE = \frac{\text{ARROW WEIGHT} \times \text{SPEED}^2}{450240}$$

Where “KE” is in pound-feet, “Arrow Weight” is in grains, “Speed” is in feet per second (fps) and 450240 is a conversion factor that accounts for unit changes between arrow weight (grains) and velocity



*Jonathan Teater (right) and Anthony Barnum formed Archery Evolution as a not-for-profit testing organization providing unbiased, objective test results to bowhunters and competitive archers. Their “day jobs” give them access to test equipment beyond what most manufacturers have available, such as the sound chamber at right. The test work has gained a wide following on the Internet, through archerytalk.com and their own archeryevolution.com. This article is part of the 2007 Compound Hunting Bow Face-Off copyrighted by the two men and available in its entirety on-line. Look for more bow and accessory test results in upcoming issues of ArrowTrade Magazine.*

*Portions of the test work were conducted at Lancaster Archery Supply. Other 2007 Face-Off sponsors include Brownell, Bass Pro Shops, Carbon Express, Victory Archery, Rinehart and Spot Hogg, which builds the Hooter Shooter and provided Premier rests for the test bows.*



## Dynamic Efficiency

Compound Bow	300 Grain Arrow Dynamic Efficiency	RANK
Mathews Drenalin	83.0%	1
High Country Iron Mace	81.5%	2
PSE X-Force	80.8%	3
APA Black MambaX2	80.0%	4
Diamond Black Ice	79.2%	5
Alpine Silverado	79.1%	6
Elite Synergy	79.1%	6
Bear Truth	78.1%	8
Hoyt Vectrix	77.9%	9

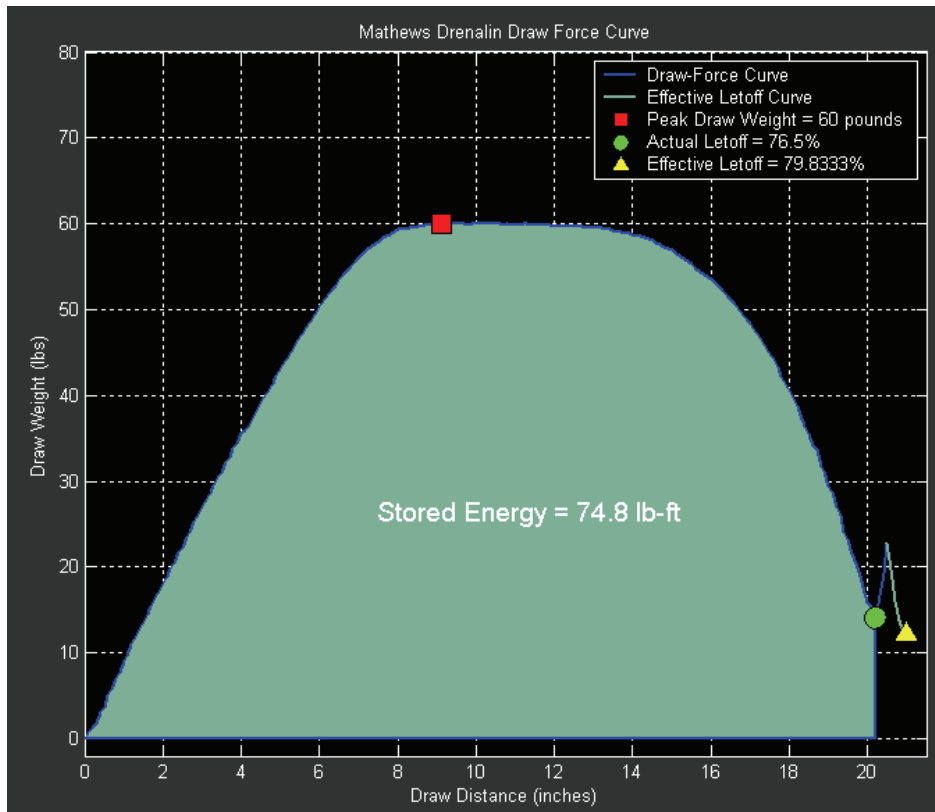
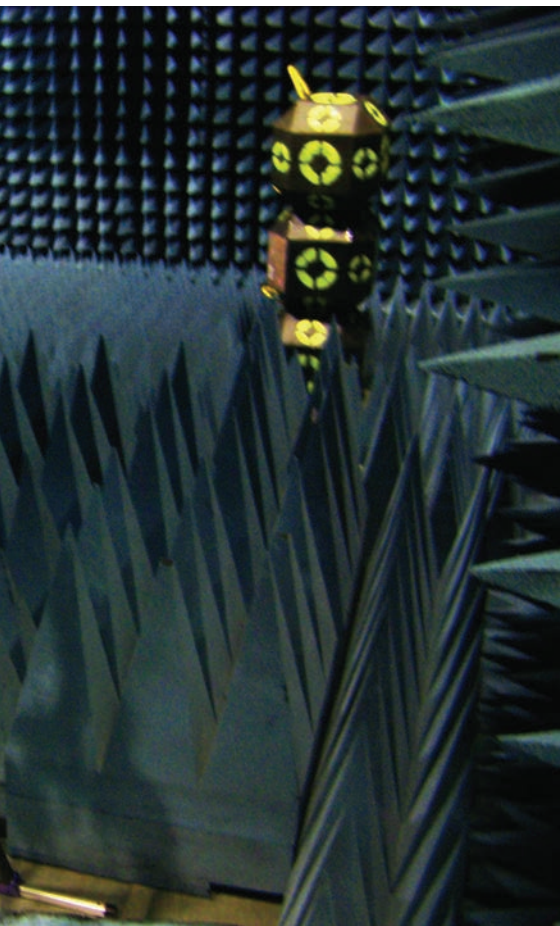
Compound Bow	360 Grain Arrow Dynamic Efficiency	RANK
Mathews Drenalin	85.1%	1
High Country Iron Mace	83.8%	2
PSE X-Force	82.4%	3
APA Black MambaX2	82.2%	4
Alpine Silverado	81.6%	5
Elite Synergy	81.0%	6
Diamond Black Ice	80.9%	7
Bear Truth	80.2%	8
Hoyt Vectrix	80.0%	9

Compound Bow	420 Grain Arrow Dynamic Efficiency	RANK
Mathews Drenalin	86.3%	1
High Country Iron Mace	85.4%	2
PSE X-Force	84.1%	3
Alpine Silverado	83.5%	4
APA Black MambaX2	83.2%	5
Diamond Black Ice	82.3%	6
Elite Synergy	82.1%	7
Reflex Ridgeline 34	81.9%	8
Hoyt Vectrix	81.8%	9

Compound Bow	540 Grain Arrow Dynamic Efficiency	RANK
Mathews Drenalin	87.2%	1
High Country Iron Mace	87.0%	2
Alpine Silverado	85.8%	3
APA Black MambaX2	85.8%	3
PSE X-Force	85.7%	5
Diamond Black Ice	84.2%	6
Ross Cardiac	84.1%	7
Reflex Ridgeline 34	83.9%	8
Elite Synergy	83.8%	9
Hoyt Vectrix	83.8%	9

(fps). The ratio of the Kinetic Energy to the Potential Energy for all four arrow weights is assessed.

**Example:** The speed of a 300 grain arrow out of the Mathews Drenalin used in this evaluation

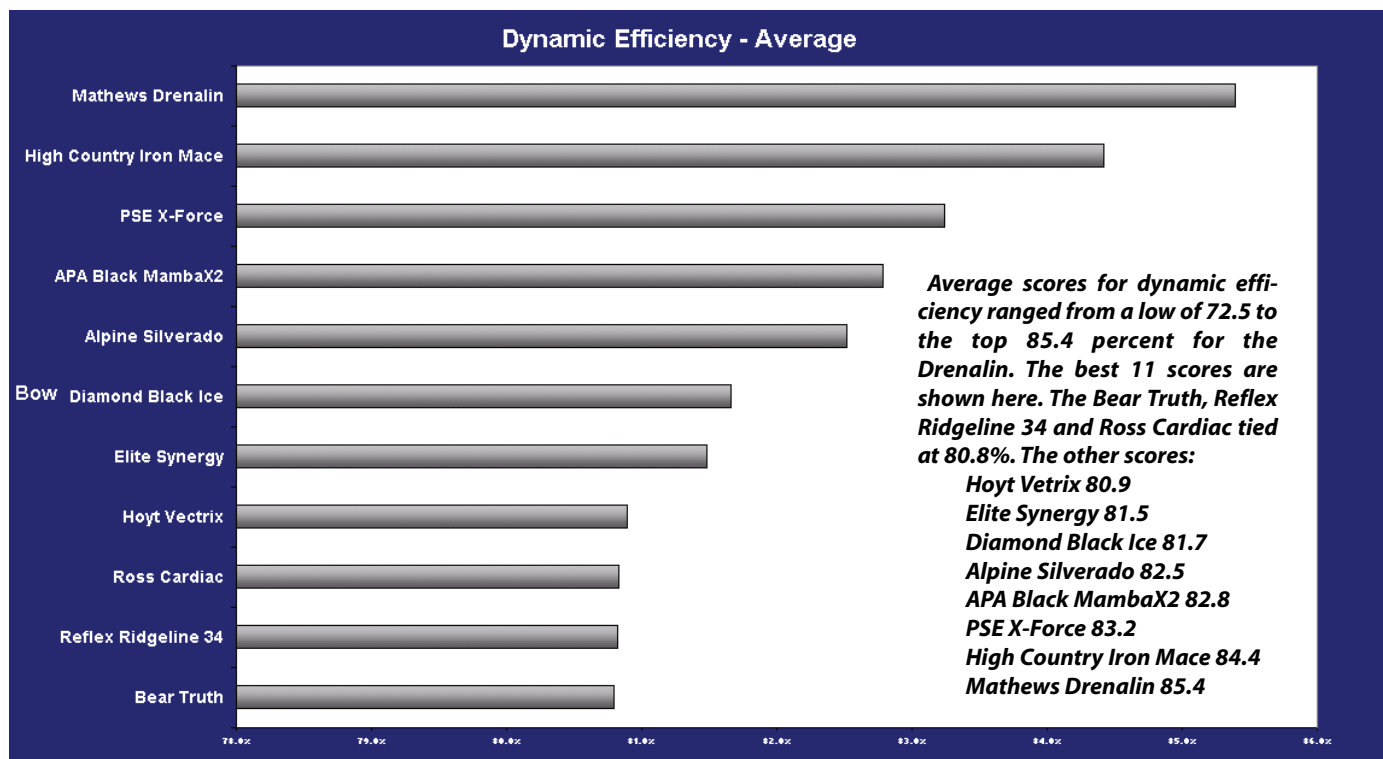


**Force-Draw Curve and Calculated Potential Energy for the Mathews Drenalin.**

was measured to be 305.4 feet per second (fps). The speed of a 540 grain arrow out of the same bow was measured to be 233.3 fps.

Using the formula for KE on page 62, we can show that the Kinetic Energy of the 300 grain arrow is 62.1 lb-ft, while the Kinetic Energy of





the 540 grain arrow is 65.2 lb-ft. Dividing these two KE values by the Potential Energy (74.8 lb-ft), a dynamic efficiency of 83.0% and 87.2% is achieved, respectively.

### Speed per Inch of Power Stroke

**Objective:** The objective of this section is to determine the speed properties of a bow based on power stroke at point blank range with varying arrow weights.

**Rationale:** Because there are so many varying configurations in today's compound bows (e.g. low or high brace height, reflex / deflex riser geometry), the amount of speed output by each bow per the inch of its power stroke is a reason-

able way to put each bow on more of an equal playing field.

**Procedure:** Each bow is mounted to the Hooter Shooter. A series of three speed measurements are taken with an Easton Professional Chronograph at a distance of 3 feet from the bow with 300, 360, 420, and 540 grain arrows. These measurements are confirmed with an Oehler Research M35 Chronograph and then averaged per arrow weight. The brace height of each bow is then measured and 1.75 inches is added to this measurement. This value is subtracted from 29 inches (all bows setup to 29 inches AMO draw-length) to determine the length of the power stroke. The power stroke

value is then divided into the average speed for each of the arrow weights. The average speed per inch of power stroke over all arrow weights is then calculated for use in the overall results.

**PHOTO BELOW:** A series of three Speed Measurements is taken at a distance of 3 feet from the chronometer entrance. This is repeated until four different arrow weights have been measured. Results of the tests by weight appear in the chart at the top of page 65, while each bows average score for the 12 arrows fired through is represented in the bar chart at right.



## BOWSHIELD™

### BOW CARRIER

4 GEAR POCKETS!

**POLE MOUNTAIN**  
OUTDOORS, INC.  
866-632-5711  
polemountainoutdoors.com

Do you really want a backpack cluttering your treestand?

**Bowshield** drapes over the back of your seat, saddlebag style, allowing instant access to the gear pockets!

## Speed per Inch of Power Stroke

Compound Bow	Power Stroke (in.)	300 Grain Arrow (fps / in)	RANK
High Country Iron Mace	19 7/8	15.6	1
Alpine Silverado	20	15.5	2
APA Black MambaX2	20 3/16	15.4	3
Elite Synergy	20 1/4	15.4	3
PSE X-Force	21 1/4	15.3	5
Mathews Drenalin	20 1/4	15.1	6
Bowtech Guardian	20 1/8	15.0	7
Hoyt Vectrix	20 1/4	15.0	7
Reflex Ridgeline 34	20	14.9	9

Compound Bow	Power Stroke (in.)	360 Grain Arrow (fps / in)	RANK
High Country Iron Mace	19 7/8	14.4	1
Alpine Silverado	20	14.3	2
APA Black MambaX2	20 3/16	14.3	2
Elite Synergy	20 1/4	14.2	4
PSE X-Force	21 1/4	14.1	5
Mathews Drenalin	20 1/4	13.9	6
Bowtech Guardian	20 1/8	13.8	7
Hoyt Vectrix	20 1/4	13.8	7
Reflex Ridgeline 34	20	13.8	7

Compound Bow	Power Stroke (in.)	420 Grain Arrow (fps / in)	RANK
High Country Iron Mace	19 7/8	13.5	1
Alpine Silverado	20	13.4	2
APA Black MambaX2	20 3/16	13.3	3
Elite Synergy	21 1/2	13.2	4
PSE X-Force	21 1/4	13.2	4
Hoyt Vectrix	20 1/4	13.0	6
Mathews Drenalin	20 1/4	13.0	6
Reflex Ridgeline 34	20	13.0	6
Bowtech Guardian	20 1/8	12.9	9

Compound Bow	Power Stroke (in.)	540 Grain Arrow (fps / in)	RANK
Alpine Silverado	20	12.0	1
High Country Iron Mace	19 7/8	12.0	1
APA Black MambaX2	20 3/16	11.9	3
Elite Synergy	21 1/2	11.8	4
PSE X-Force	21 1/4	11.8	4
Bowtech Guardian	20 1/8	11.6	6
Hoyt Vectrix	20 1/4	11.6	6
Mathews Drenalin	20 1/4	11.6	6
Reflex Ridgeline 34	20	11.5	9

**Assumptions:** An assumption is made that the speed per inch of power stroke more accurately characterizes the speed performance of a given bow. Another assumption is made that the string travel past the brace position during shot execution does not impart any energy on the arrow.

### Noise Output

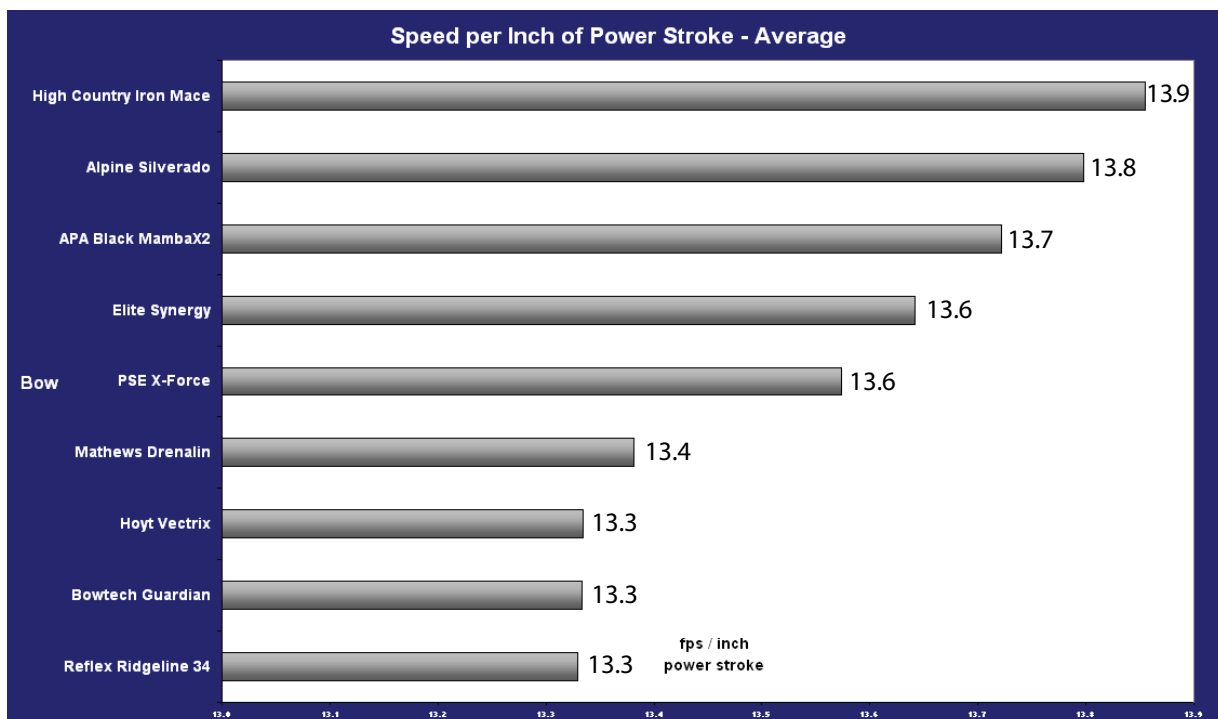
**Objective:** The objective of this section is to determine the noise output properties for each bow at point blank range.

**Rationale:** A great deal of emphasis is placed on the amount of

noise output by compound bows. Today's hunting bows have different noise output characteristics with varying arrow weights. Many hunters use heavier arrows for increased down range kinetic energy, while others use lighter arrows for increased

## Speed per Inch of Power Stroke

Results chart: Average scores ranged from 12.3 to 13.9 fps/ inch power stroke. The top performing 9 bows are shown here.





speed. Because of these issues, noise output readings are measured at point blank range for 300, 360, 420 and 540 grain arrows.

**Procedure:** Each bow is mounted to the Hooter Shooter inside an Anechoic Chamber. A Larson Davis model 831 digital sound level meter (SLM) is mounted on a tripod and positioned 8 inches in front of a standard measuring point on the Hooter Shooter with the microphone set at a height of 36 inches. The digital sound meter frequency weighting is set to 'A' (which allows the meter to respond as the human ear would) with the maximum sound out-

*Noise Output Measurements were taken in an Anechoic Chamber designed for such testing. The spikes eliminate extraneous noise.*



## Noise Output

Compound Bow	300 Grain Arrow Point Blank (dBa)	RANK
Bowtech Guardian	84.8	1
Diamond Black Ice	86.4	2
Whisper Creek Innovator Pro	86.4	2
Ross Cardiac	86.6	4
Bear Instinct	87.3	5
RedHead XSC-33	87.5	6
PSE X-Force	88.0	7
Pearson Z-34	88.4	8
Darton Pro3000	88.5	9

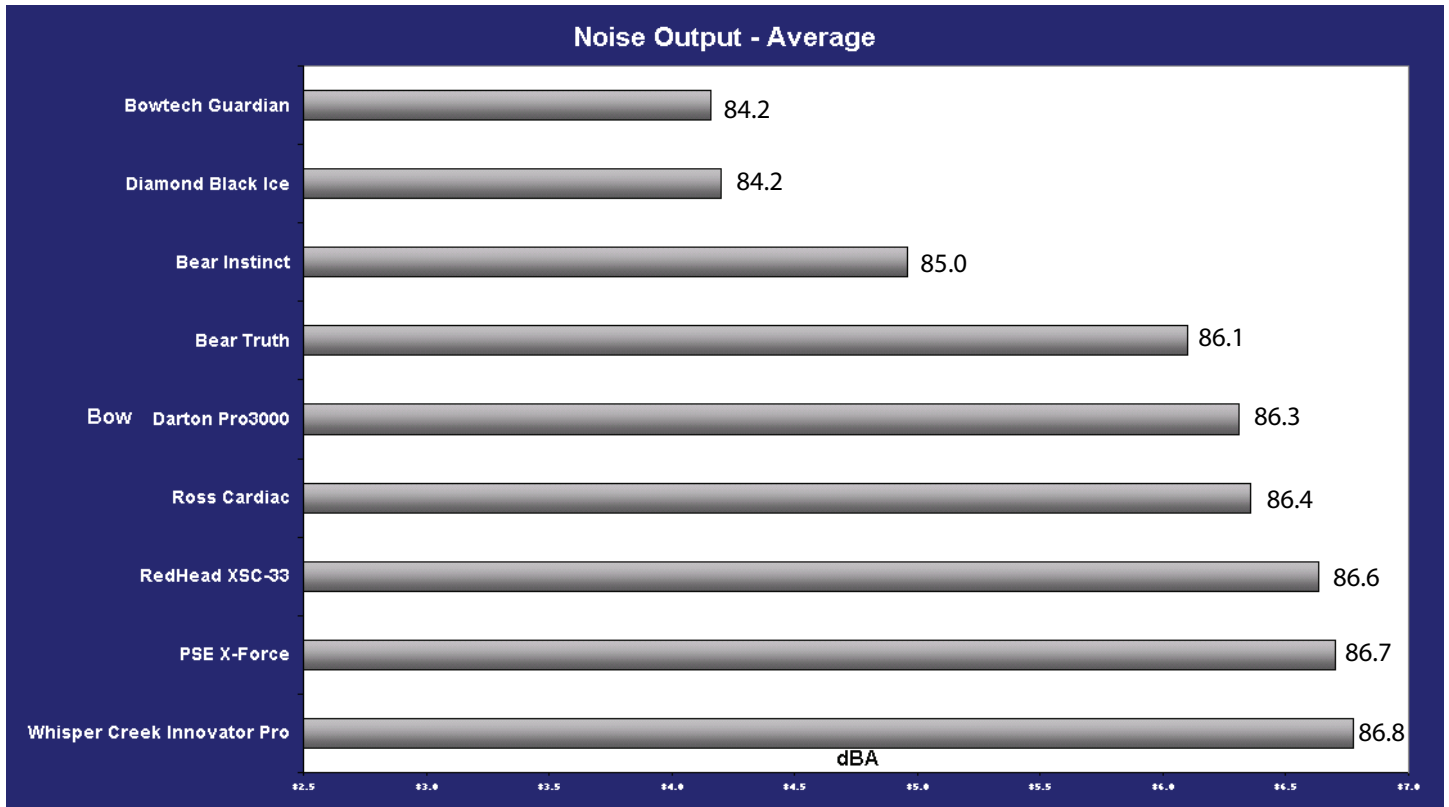
Compound Bow	360 Grain Arrow Point Blank (dBa)	RANK
Bear Instinct	85.0	1
Diamond Black Ice	85.1	2
Bowtech Guardian	85.7	3
RedHead XSC-33	86.3	4
Bear Truth	86.6	5
PSE X-Force	87.0	6
Darton Pro3000	87.3	7
Pearson Z-34	87.4	8
Reflex Ridgeline 34	87.9	9

Compound Bow	420 Grain Arrow Point Blank (dBa)	RANK
Diamond Black Ice	83.6	1
Bowtech Guardian	84.3	2
Bear Instinct	84.5	3
RedHead XSC-33	84.5	3
Bear Truth	84.8	5
Ross Cardiac	85.5	6
Darton Pro3000	85.8	7
PSE X-Force	85.8	7
Pearson Z-34	86.0	9

Compound Bow	540 Grain Arrow Point Blank (dBa)	RANK
Bowtech Guardian	81.8	1
Diamond Black Ice	81.8	2
Bear Instinct	83.0	3
Darton Pro3000	83.6	4
Bear Truth	84.2	5
Ross Cardiac	84.5	6
Whisper Creek Innovator Pro	85.2	7
PSE X-Force	86.0	8
Whisper Creek Stealth LX	86.4	9

## Noise Output

Results chart: Average scores ranged from 90.9 to 84.2 dBA. Quietest bows are ranked below.



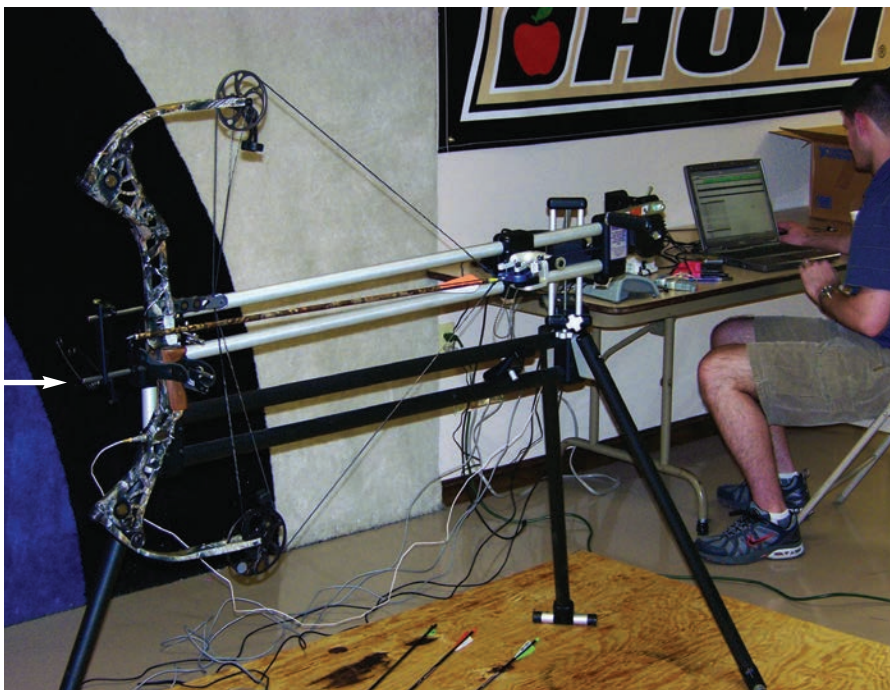
put measurements taken from shot to shot. A series of three (3) shots is executed for 300, 360, 420 and 540 grain arrows from each bow, during

which the peak sound measurements (dBA) are recorded. From these measurements, the average noise output is calculated for each

bow.

**Assumptions:** An assumption associated with this test is that the sample size of three firings per arrow weight is sufficient to correctly characterize the noise output of the bow at point blank range.

**Vibration Data Collection is accomplished through an accelerometer (white arrow) connected to the stabilizer bushing mounting hole of each bow and wired to a computer.**



### Vibration

**Objective:** The objective of the Vibration Test is to provide an indication of the amount of hand shock each bow produces under shot execution with four different arrow weights. For consistency, the vibration data is collected at the stabilizer bushing on each bow.

**Rationale:** The less vibration output by a bow and felt by the archer during and after shot execution, the more enjoyable a bow is to shoot, especially during long practice sessions. Our test equipment is highly sensitive; an archer may not be able to distinguish between some of the calculated vibration outputs of given bows.

**Procedure:** An accelerometer (Dytran, model 3030A4) is attached

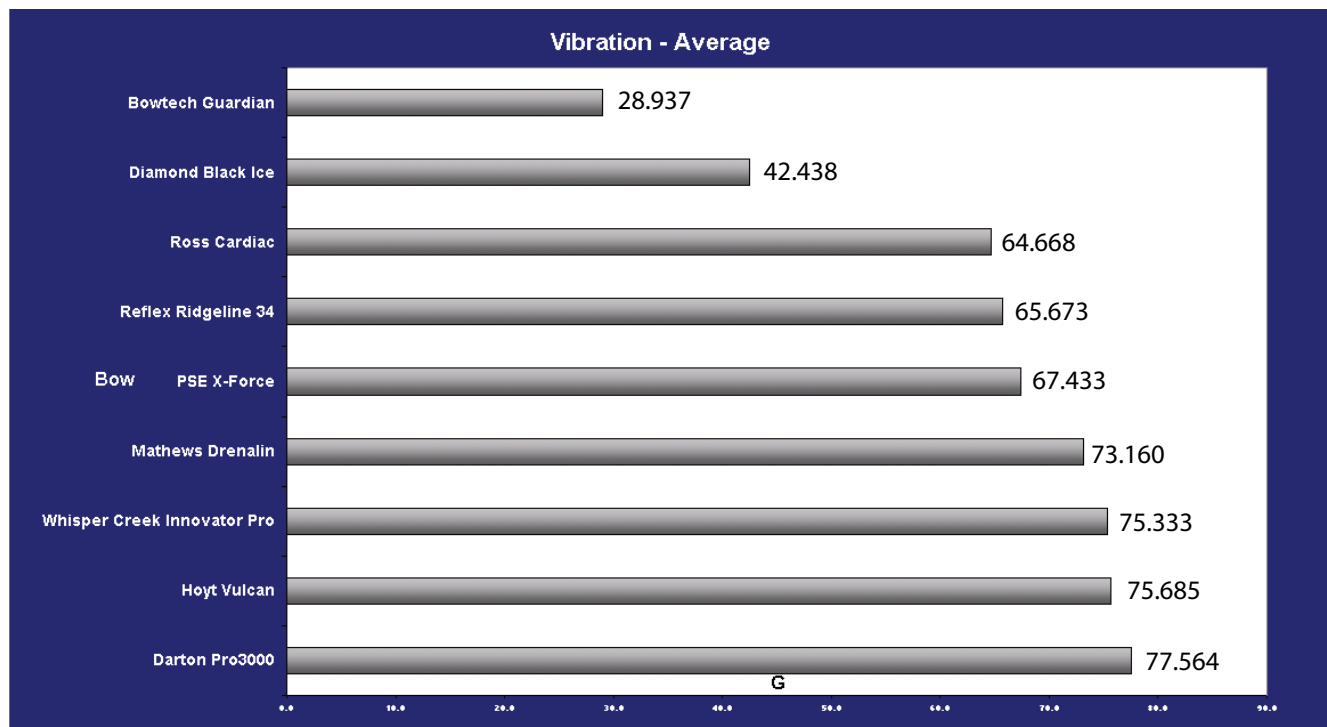
to each at the stabilizer bushing. A series of 3 shots is taken with 300, 360, 420 and 540 grain arrows, during which vibration data is collected. After data collection is completed,

each raw data set is analyzed to determine the average maximum vibration amplitude of the three shots for each arrow weight.

**Assumptions:** An assumption is

made that the stabilizer bushing area of each bow is an area that is representative of the amount of vibration an archer can expect to experience.

Vibration Results Chart: Average scores ranged from 190.074 to 28.937 Gs for all bows tested. Nine with least vibration are ranked in the chart below.



## Vibration

Compound Bow	300 Grain Arrow Vibration (G)	RANK
Bowtech Guardian	33.193	1
Diamond Black Ice	58.844	2
Mathews Drenalin	64.570	3
Reflex Ridgeline 34	65.191	4
Ross Cardiac	68.712	5
Doc's Sweet Demise	75.497	6
PSE X-Force	76.383	7
Whisper Creek Innovator Pro	88.448	8
Bear Instinct	90.372	9

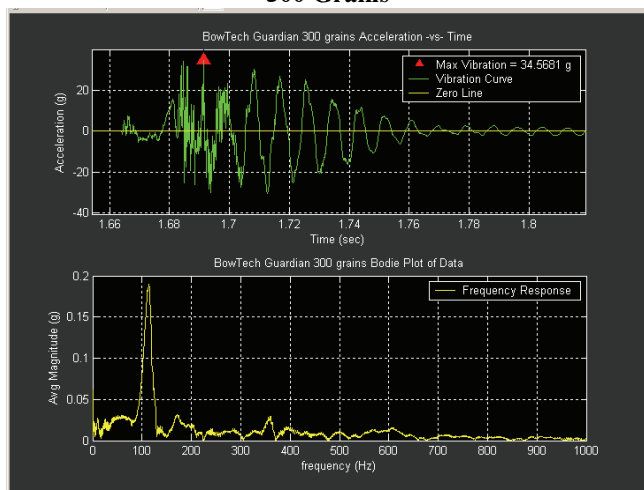
Compound Bow	360 Grain Arrow Vibration (G)	RANK
Bowtech Guardian	30.523	1
Diamond Black Ice	43.872	2
Reflex Ridgeline 34	59.376	3
PSE X-Force	67.968	4
Ross Cardiac	71.876	5
Mathews Drenalin	75.282	6
Whisper Creek Stealth LX	79.058	7
Hoyt Vulcan	79.687	8
Darton Pro3000	81.610	9

Compound Bow	420 Grain Arrow Vibration (G)	RANK
Bowtech Guardian	27.370	1
Diamond Black Ice	37.593	2
Reflex Ridgeline 34	69.362	3
PSE X-Force	65.054	4
Ross Cardiac	62.502	5
Mathews Drenalin	78.145	6
Whisper Creek Stealth LX	75.626	7
Hoyt Vulcan	73.912	8
Darton Pro3000	69.330	9

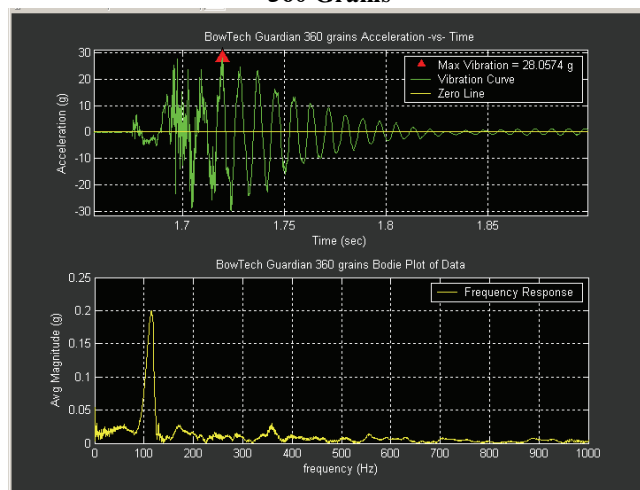
Compound Bow	540 Grain Arrow Vibration (G)	RANK
Bowtech Guardian	24.662	1
Diamond Black Ice	29.443	2
Ross Cardiac	55.583	3
Hoyt Vulcan	57.195	3
Whisper Creek Innovator Pro	57.839	5
Elite Synergy	58.621	6
PSE X-Force	60.326	7
Darton Pro3000	60.375	8
Hoyt Vectrix	61.266	9



### 300 Grains



### 360 Grains



**Two of the acceleration curves generated for the BowTech Guardian, a center pivot limb model that had the least vibration of all the bows tested by Archery Evolution for the 2007 Face Off.**

### Overall Performance Best Picks:

The "Overall Performance Best Picks" are provided in the following table. The percentage of points each bow received with respect to the highest scoring bow in each of the test categories (excluding adaptability / adjustability) was used to determine the total number of percentage points (highest scoring bow for a test category receives 100 percentage points for that category). This provides a truly comparative analysis of how each bow placed relative to its competitors based solely on the criteria outlined in this test with no additional weighting added. For personalized rankings of each bow, please see the Hunting Bow Results spreadsheet on line at [archeryevolution.com](http://archeryevolution.com).

### "Bang for the Buck" Best Picks:

The "Bang for the Buck" Best Picks are provided in the following table. The percentage of points each bow received with respect to the highest scoring bow in each of the test categories (excluding Adaptability / Adjustability) was used to determine the total number of percentage points (see "Overall Performance" Best Picks to the left). The MSRP for each bow was then divided into the total percentage points, providing a "percentage points per dollar" assessment. This assessment is based solely on the criteria outlined in this test and no additional weighting is added. For personalized rankings of each bow, please see the Hunting Bow Results spreadsheet.

Compound Bow	MSRP	Total Percentage Points	RANK
Bowtech Guardian	\$799	387.3%	1
Diamond Black Ice	\$699	358.4%	2
PSE X-Force	\$799.99	335.4%	3
Mathews Drenalin	\$799	331.4%	4
Reflex Ridgeline 34	\$599	330.6%	5
Ross Cardiac	\$730	327.6%	6
Elite Synergy	\$659	322.4%	7
Hoyt Vulcan	\$789	322.4%	7
Alpine Silverado	\$689	321.8%	8
High Country Iron Mace	\$699	321.2%	9

Compound Bow	MSRP	Total Percentage Points per Dollar	RANK
Martin Bengal	\$399	0.78036%	1
Bear Instinct	\$399.99	0.77371%	2
Whisper Creek Stealth LX	\$449	0.69281%	3
RedHead XP-32	\$499.99	0.61310%	4
Lakota Thunder	\$495	0.58901%	5
Bear Truth	\$549.99	0.56556%	6
Doc's Sweet Demise	\$549	0.56217%	7
RedHead XSC-33	\$549.99	0.55953%	8
Reflex Ridgeline 34	\$599	0.55185%	9

**BowTech's Guardian came out on top in overall performance (left) but Martin's economical Bengal leads the Bang for the Bucks Best Picks chart above.**

**What's the most efficient stabilizer for some of today's top models?**

**Archery Evolution will have the answers in the November issue.**

**ArrowTrade Magazine delivers more of the information that matters.**