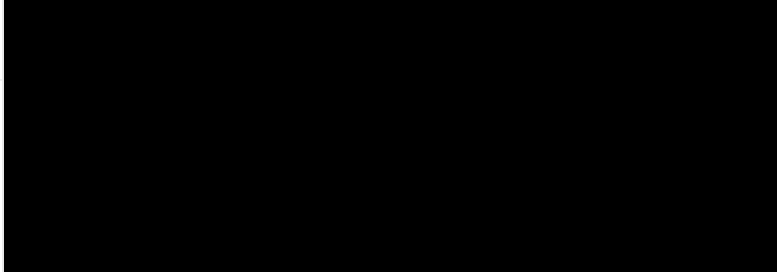

PRECISION CUT ARCHERY · WESTERN HUNTER

Arrow Ballistics Study.

2025 & 2026 Complete Field Guide

Vanes · Broadheads · Drag · Noise · FoC · Fletch Count · Helical

SHOTS FIRED **1,500** 2025 study	+ MORE **1,400+** 2026 study
DATA POINTS **9,800+** Combined	BROADHEADS **26+** Tested

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01

2025 Study Overview

Background, team, scope, and methodology — Precision Cut Archery

TOTAL SHOTS	RADAR READINGS	DATA POINTS	POINTS TESTED
1,500	**2,400**	**7,400+**	**26**
Shooting machine	Garmin Xero C1 Pro	Fully public	FP · Mech · Fixed

What was measured

Three core metrics: Aerodynamic Drag (resistive force slowing the arrow — lower means less wind drift, less drop, and more retained energy at distance), Restorative Lift (fixed-blade horizontal deviation at 70 yards from an out-of-tune bow on a shooting machine — lower means better broadhead steering), and Sound Signature (flight noise weighted for both human and whitetail deer hearing).

Reference build: 450gr arrow at 280fps. Speed captured at 0.5, 30, and 60 yards. All results shown with 95% confidence intervals.

The team

Contributor	Role
James Yates	Western Hunter editor — study architect, backcountry bowhunter
Tristan Litke / Precision Cut	Data collection, ballistics software, analysis
Easton Archery	Shafts, shooting machine, indoor facility, primary funding
Archery Sound Lab (J. McIntosh)	Controlled acoustic testing — all sound measurements
Black Ovis	Built all test arrows to spec; on-site repairs throughout
Hoyt Bowhunting	Provided Hoyt AX-2 test bows

Independence
No team member was paid or incentivized by any manufacturer. All components purchased independently. Raw data, methods, and full analysis are freely available to the public.

02

2025 — Vane Performance Overview

Drag constant, fixed-blade steering, and deer-weighted sound — all vanes at 3-fletch / 2° helical baseline

Vane	Drag	BH Steering	Deer Noise	Verdict
AAE Max Stealth 3f · 2° helical	Low	Best	Quietest	Top Pick
Flex Fletch Quad X 3f · 2° helical	Low	Excell.	V. Quiet	Top Pick
TAC Driver 2.25 3f · 2° helical	Low	Excell.	Quiet	Top Pick
AAE Max 23 3f · 2° helical	Low-Mid	V. Good	Quiet	Strong
Bohning Blazer 3f · 2° helical	Mid	Good	Moderate	Solid
Q2I Fusion X-II 2.5" 3f · 2° helical	Mid	Good	Moderate	Solid
AAE Hybrid HP 3f · 2° helical	Mid	Moderate	Moderate	Moderate
Flex Fletch FFP-300 3f · 2° helical	Mid-High	Moderate	Moderate	Moderate
Flex Fletch FFP-360 3f · 2° helical	High	Moderate	Loud	High Drag
Bohning X Vane 2" 3f · 2° helical	Mid	Moderate	Moderate	Moderate
Flex Fletch FFP-187 3f · 2° helical	Lowest	Weakest	V. Quiet	Low Lift

Key insight

The top three vanes (Max Stealth, Quad X, TAC Driver 2.25) hit all three metrics: low drag, strong broadhead steering, and quiet flight. The FFP-187 is the cautionary example — lowest drag of all but worst broadhead steering. Low drag alone does not make a good hunting vane.

03

2025 — Broadheads & Aerodynamic Drag

26 points across three categories — every broadhead adds drag over a field point

FIELD POINTS	MECHANICALS	FIXED BLADES
5	11	10
Baseline — lowest drag	Mid drag tier	Highest drag tier

Critical finding

No broadhead in this study hit with field points at distance. Every broadhead — including the lowest-drag mechanicals — added enough aerodynamic drag to shift point of impact meaningfully past 40 yards. You must have a dedicated broadhead sight tape.

Broadhead	Type	Drag	Wind Drift	Notes
Field Point (avg of 5)	Field Pt	Lowest	Least	Drag baseline. Every broadhead exceeds this floor.
Sevr 1.5 / 2.0 100gr mechanical	Mech	Low-Mid	Low	Closest to FP drag of any broadhead tested.
G5 T2 / Montec CS 100gr mechanical	Mech	Mid	Moderate	Solid mid-tier mechanical performers.
Large-cut mechanicals Rage-style, 100gr+	Mech	Mid-High	High	Larger blade profiles add significant drag at distance.
Iron Will Vented / S100 100gr fixed	Fixed	Low-Mid	Low	Best fixed blades for drag efficiency in this study.
Slick Trick / G5 Montec M3 100gr fixed	Fixed	Mid	Moderate	Reliable mid-pack fixed blade performers.
Large-blade fixed blades Wide-cut, 100gr+	Fixed	High	Most	Highest drag penalty. Wind drift becomes critical at 80–120yds.

Wind drift compounds with the square of distance

The drag gap between a field point and a fixed blade looks small at 40yds but multiplies fast. At 120yds in a 10mph crosswind, the difference between the lowest and highest drag broadheads is several inches. Western hunters shooting past 60 yards feel this most acutely.

04

2025 — Fletch Count: 3-Fletch vs. 4-Fletch

Four vanes in both configs: AAE Max 23, AAE Max Stealth, Flex Fletch Quad X, TAC Driver 2.25

AVG DRAG INCREASE
+7.3%
Going from 3 to 4 fletch

BH STEERING GAIN
–0.9"
Less deviation at 70 yds

SOUND INCREASE
<+1 dB
Barely perceptible to deer

Vane	Drag Change (3→4f)	BH Deviation @ 70yds	Deer Noise
AAE Max 23	+5.8% more drag	**–10.2% less deviation**	+1.1 dB louder
Flex Fletch Quad X	+6.3% more drag	+3.0% MORE deviation	+1.3 dB louder
AAE Max Stealth	+8.9% more drag	**–3.9% less deviation**	+0.3 dB louder
TAC Driver 2.25	+8.3% more drag	**–4.0% less deviation**	+0.9 dB louder
Average	**+7.3% more drag**	**–3.8% / ~0.9" less**	**<+1 dB louder**

3-fletch is correct for most hunters
The 4th fletch costs ~7% more drag for under 1" of broadhead steering improvement on average. At hunting distances, that gain is negligible. The Quad X was the exception — 4-fletch made it steer worse, not better. Default to 3-fletch.

Sound: a non-issue
Under 1 dB difference in every case tested. A 10 dB increase represents a doubling of perceived loudness — so the fletch count noise difference is effectively inaudible to a deer.

05

2025 — Helical Angle: 0°, 2°, and 4°

Three vanes: Bohning Blazer, Q2I Fusion X-II 2.5", AAE Max Stealth (0° not tested)

Vane	Helical	Drag	BH Steering	Noise	Summary
Bohning Blazer	0° straight	Lowest	Weakest	Quietest	Low drag, poor steer
Bohning Blazer	2° helical	Mid	Best	Moderate	Sweet spot
Bohning Blazer	4° helical	Highest	Excell.	Loudest	Best steer, max drag
Q2I Fusion X-II	0° straight	Lowest	Weakest	Quietest	Low drag, poor steer
Q2I Fusion X-II	2° helical	Mid	Best	Moderate	Sweet spot
Q2I Fusion X-II	4° helical	Highest	Excell.	Loudest	Best steer, max drag
AAE Max Stealth	2° helical	Low	Best	Quiet	Top tier at 2°
AAE Max Stealth	4° helical	Mid	Excell.	Moderate	Still strong at 4°

2° helical is the sweet spot

2° helical delivered the best broadhead steering relative to its drag cost in every vane tested. Measurably better than 0° for fixed-blade control, and quieter and lower-drag than 4°. For any hunting setup, 2° helical is the correct default.

Never run 0° straight fletching with fixed blades

Confirmed in both 2025 and 2026 studies: zero-degree straight produced the worst broadhead steering of any configuration in every vane tested. The drag savings do not justify losing broadhead control.

06

2026 Study Overview

Expanded methodology adding accuracy, deer-weighted noise, FoC analysis, and high-speed protocols

VANE BUILDS
24 std / 12 hi
Both speed protocols

BROADHEADS
25 std / 9 hi
Fixed · Mech · FP

FOC BUILDS
50+
Easton 5.0 & FMJ Max

TEST RIGS
2
~280fps & ~325fps

What's new in 2026

New Element	What It Tells Us
Deer-weighted noise	Sound scored against whitetail hearing frequency response. Deer hear differently than humans — rankings shift meaningfully.
Broadhead accuracy	Group size (extreme spread) and mean radius at 70yds, torqued and untorqued, measuring real-world fixed-blade flight.
Torque-induced BH drift	Lateral distance between torqued field-point and torqued fixed-blade groups — the 2026 restorative lift measure.
Arrow clocking	Matching vane helical direction to bow's natural torque direction. Free accuracy improvement with no gear change.
Front-of-Center analysis	Regression-based isolation of FoC effects controlling for weight, spine, and speed. Most rigorous FoC analysis to date.
Early flight yaw	Frame-by-frame yaw measurements from slow-motion cameras per build, torqued vs. untorqued.
High-speed protocol	Second rig at 29"/80#/~325fps to verify whether component rankings hold at higher velocity.

07

2026 — Standard Speed Vanes (24 Builds)

~280fps / 28" / 70# · Metrics: drag, torque-induced BH drift, deer-weighted noise (50–61 dB), accuracy

Vane	Cfg	Drag	BH Drift	Deer Noise	Verdict
Flex Fletch SK2 3f helical	3f	Lowest	Low	Quietest	Top Pick
AAE Max Stealth 3f right helical	3f	Low	Low	Quiet	Top Pick
AAE Max Stealth (Left) 3f LEFT — clocked	3f	Low	Lower	Quiet	Best clocked
True Flight F22 Raptor 2" 3f right offset	3f	Low	Low	Quiet	Strong
DCA Mini Sabre 3f helical	3f	Mid	Low	Quiet	Strong
AAE AIRAZR Talon 3.0 3f helical	3f	Mid	Low	Moderate	Strong
Flex Fletch FFP-225 3f helical	3f	Mid	Mid	Quiet	Moderate
AAE Hybrid HP 3f helical	3f	Mid	Mid	Moderate	Moderate
AAE AIRRZR 23 3f helical	3f	Mid	Mid	Moderate	Moderate
AAE AIRRZR 23 4f helical	4f	Mid-Hi	Low	Moderate	Moderate
DCA Mini Sabre 4f helical	4f	Mid-Hi	Low	Moderate	Moderate
Bohning Heat 3f helical	3f	Mid	Mid	Moderate	Moderate
Q2i Rapt-X 3f helical	3f	Mid	Mid	Moderate	Moderate
TAC Driver HP 2.25 3f helical	3f	Mid	Mid	Moderate	Moderate
UV Vane 3f helical	3f	Mid	Mid	Moderate	Moderate
DCA Super Sabre 3f helical	3f	Mid-Hi	Mid	Moderate	Moderate

Firenock AeroVane II 3f STRAIGHT 0°	3f	Low	Highest	Quiet	Poor Steer
Bohning Heat 4f helical	4f	Mid-Hi	Low	Loud	Tradeoff
Flex Fletch FFP-300 4f helical	4f	High	Low	Loud	Tradeoffs
AAE AIRRZR 23 5f helical	5f	Highest	Low	Loud	Tradeoffs
AAE Max Stealth 2f helical	2f	Lowest	Mid	Quiet	Situational
Flex Fletch FFP-360 3f helical	3f	Highest	Mid	Loudest	Worst

Vane geometry
Taller vanes steer broadheads better (r = –0.38 correlation with height). Longer vanes are quieter to deer (r = –0.59 with length). SK2 and Max Stealth hit both: tall enough to steer, long enough to be quiet.

Clock your vanes — free accuracy gain
Matching helical direction to your bow's natural torque direction reduced broadhead drift and tightened groups measurably. Test which direction your bow naturally torques under a bad release, then fletch to match.

08

2026 — Standard Speed Broadheads (25 Builds)

~280fps / 450gr · Drag predicts deer noise strongly (r = +0.83)

Broadhead	Type	Drag	Accuracy	Deer Noise	Verdict
Iron Will Vented 100gr	Fixed	Low	Tight	Quiet	Top Fixed
Iron Will S100 100gr	Fixed	Low	Tight	Quiet	Top Fixed
Iron Will Wide 100gr	Fixed	Mid	Tight	Moderate	Strong
G5 Montec M3 100gr	Fixed	Mid	Tight	Moderate	Strong
QAD Exodus Full Blade 100gr	Fixed	Mid	Tight	Moderate	Strong
Slick Trick Std 4-Blade 100gr	Fixed	Mid	Moderate	Moderate	Solid
Magnus Stinger 2-Blade 100gr	Fixed	Low	Moderate	Quiet	Solid
Muzzy Trocar 3-Blade 100gr	Fixed	Mid	Moderate	Moderate	Solid
Toulou 100gr	Fixed	Highest	Wide	Loudest	Avoid
Sevr 1.5 100gr	Mech	Low	Tight	Quiet	Top Mech
Sevr Hybrid 1.5 100gr	Mech	Low	Tight	Quiet	Top Mech
Sevr 2.0 100gr	Mech	Low	Tight	Quiet	Top Mech
Sevr Hybrid 2.0 100gr	Mech	Low-Mid	Tight	Quiet	Strong
G5 T2 100gr	Mech	Mid	Tight	Moderate	Solid
G5 Megameat 100gr	Mech	Mid	Moderate	Moderate	Solid
Grim Reaper Fatal Steel 100gr	Mech	Mid	Moderate	Moderate	Solid
Beast Aluminum 2.3 100gr	Mech	High	Moderate	Loud	Tradeoff
Gold Tip EZ Pull 100gr	FP	Baseline	Baseline	Baseline	Reference

Mechanicals grouped tighter on average than fixed blades. Field point = quietest and tightest baseline by a significant margin.

09

2026 — High Speed Testing

12 vane builds + 9 broadheads re-tested at 29" / 80# / ~325fps

VANE BUILDS	BROADHEADS	TEST SPEED
12	**9**	**~325fps**
Subset of std speed	Subset of std speed	vs. ~280fps baseline

Vanes — most groups tightened at high speed
The majority of vane builds fell below the parity line for mean radius and group size. Higher velocity actually improved accuracy for most configurations.

Vane rankings remained consistent across speeds
Top vanes at 280fps stayed top at 325fps. Rankings were stable — best performers are speed-agnostic.

Marginal vanes got worse at high speed
Vane builds that were borderline at 280fps became measurably worse at 325fps. Higher velocity amplifies instability — it does not correct it.

Good broadheads remained consistent at high speed
Fixed blades that flew clean at standard speed continued performing well. Strong performers are consistent across both protocols.

Problem broadheads got worse at high speed
Fixed blades with wide groups at 280fps opened up further at 325fps. Speed amplified instability rather than correcting it.

10

2026 — Standard vs. High Speed Comparison

Parity scatter: x = standard speed value, y = high speed. Above the line = worse at speed.

Metric	What Happened at High Speed	Takeaway
Vanes — mean radius	Most improved (fell below parity line)	**Speed tightens most vane setups**
Vanes — BH drift	Rankings held — top stayed top	**Vane rankings are speed-stable**
Broadheads — mean radius	Mixed: good BH better, bad BH worse	**Quality setups rewarded, bad ones penalized**
Broadheads — group size	More spread for high-drag fixed blades at speed	**High drag + high speed = bigger groups**

Speed does not fix a bad setup

If your broadhead or vane combo is marginal at 280fps, going to a faster bow will make it worse. Build the setup correctly first — then optimize for speed if you want it.

11

2026 — Front-of-Center (FoC) Analysis

Regression isolation · scatter correlations · slow-motion early flight yaw · Broadhead: QAD Exodus 100gr

What is FoC?

Front-of-Center is the percentage of arrow weight located forward of the arrow's midpoint. Higher FoC places more mass at the tip, which stabilizes the arrow in flight — especially with a fixed-blade broadhead creating aerodynamic lift at the front. The 2026 study used regression modeling to isolate FoC's effect while holding arrow weight, spine, and speed constant. This is the most rigorous FoC analysis in archery to date.

Isolated effect of +5 percentage points of FoC (weight held equal)

Metric	Effect	Confidence Level
BH group tightness — tuned bow	Better	Moderate confidence — benefit present on clean, well-tuned shots
BH group tightness — torqued bow	Better	HIGH confidence — strongest effect under a bad release
BH drift past field point — torqued	Less drift	HIGH confidence — FoC helps BH track closer to field point zero
BH drift from aim point — torqued	Less drift	HIGH confidence — consistent across all model variants tested

Key correlation data from scatter plots

Variable Pair	Pearson r	Interpretation
Torqued BH mean radius vs. FoC%	r = –0.80	Strong — higher FoC = much tighter torqued groups
Torqued BH group size vs. FoC%	r = –0.61	Strong — tighter extreme spread under torque
Untorqued BH group size vs. FoC%	r = –0.53	Moderate — benefit on clean shots too, less dramatic
BH drift vs. total arrow weight	r = –0.56	Heavier arrows reduce BH drift independently of FoC
BH drift vs. shaft spine (# = weaker)	r = +0.60	Higher (weaker) spine number = more drift — go stiffer
BH drift vs. launch velocity	r = +0.57	Faster arrows = more drift — speed alone is not a cure
BH drift vs. FoC% (scatter only)	r = –0.17	Weak raw scatter — use the regression model above

FoC matters most under torque — real hunting insurance

r = –0.80 between FoC% and torqued broadhead mean radius is one of the strongest findings across both studies. Under a high-pressure hunting shot — elevated heart rate, awkward position, hurried release — FoC provides measurable protection. Target 15–20%+ FoC for fixed-blade hunting setups.

Dynamic spine matters independently of FoC

Going from 300-spine to 200-spine (or dropping 50gr of point weight) reduces broadhead drift independently of FoC. Stiffer dynamic spine + higher FoC together are more powerful than either alone.

Early flight yaw — what the slow-motion showed

High-FoC builds damped yaw oscillation faster after launch. Heavy-insert builds (150–250gr on 340 spine) had lower peak yaw and faster decay on torqued shots. Shaft stiffness governs oscillation amplitude; FoC governs how quickly the arrow settles into clean flight.

CONCLUSIONS

Master Takeaways

The most actionable findings distilled from 1,500+ shots and 9,800+ data points across both studies.

Best vanes for hunting
AAE Max Stealth and Flex Fletch SK2 led the 2026 study. Flex Fletch Quad X and TAC Driver 2.25 topped 2025. All four deliver the trifecta: low drag, strong broadhead steering, and quiet flight in one package.

Best helical angle — 2° is the sweet spot
2° helical delivers the best broadhead steering per unit of drag in every vane tested across both years. Better than 0° for fixed-blade control; quieter and lower-drag than 4°. Default to 2°.

Never run 0° straight fletching with fixed blades
Confirmed in both 2025 and 2026: zero-degree straight produced the worst broadhead steering in every single test. Spin is non-negotiable for fixed-blade hunting. No exceptions.

3-fletch is correct for most hunters
The 4th fletch adds ~7% drag for less than 1" of broadhead-steering improvement on average. The Quad X outlier got worse. Default to 3-fletch.

You must have a dedicated broadhead sight tape
No broadhead in either study hit with field points at distance. Zero. Every broadhead adds meaningful drag. Even the most aerodynamic mechanicals shift point of impact past 40 yards.

Best fixed blades — Iron Will Vented and S100
Led the 2026 fixed-blade category: low drag, tight groups, and quiet flight. G5 Montec M3 and QAD Exodus Full Blade are strong alternatives.

Best mechanicals — Sevr series
Sevr 1.5, Sevr Hybrid 1.5, and Sevr 2.0 topped the 2026 mechanical category: quietest mechanicals tested and tightest groups at both speeds.

FoC — target 15–20%+ for fixed-blade hunting
r = –0.80 between FoC% and torqued broadhead mean radius is the strongest finding in either study. FoC is real insurance for the imperfect shots that happen in real hunting situations.

Arrow weight reduces BH drift independently of FoC
Heavier arrows reduce broadhead drift (r = –0.56) separate from FoC. Weight and FoC together are more powerful than either alone. Don't chase FoC while ignoring total arrow weight.

Speed amplifies instability — it does not cure bad setups
Marginal vanes and problem broadheads got worse at 325fps vs. 280fps. Build the setup correctly first. Then optimize for speed if you want it.

Clock your vanes to your bow — zero cost, real gains
Matching vane helical direction to your bow's natural torque direction reduced BH drift and tightened groups in 2026. Test your bow's natural clock. Fletch to match.

Wind drag compounds past 60 yards
Wind drift scales with the square of distance. Drag differences that look small at 40yds become serious at 80–120yds. Western hunters shooting across canyons and basins feel this most.

Source: Precision Cut Archery Arrow Ballistics Study 2025 & 2026 — precisioncutarchery.com/research