WITHIN RANGE / READABLE SAMPLE

Ballistics 101

Understand the numbers.
Know what you have actually proven.

Complete excerpts from the October 2026 illustrated edition.

The original guide page numbers remain on the excerpt pages.

Inside this sample:

Flight reference lines and forces

Bore line, sight line and trajectory

Wind drift and the limits of one reading

The complete fictional South Island notebook case

Full product: 69-page guide + 4-page fillable record pack.

NZ$12.99 including GST. One-off purchase.

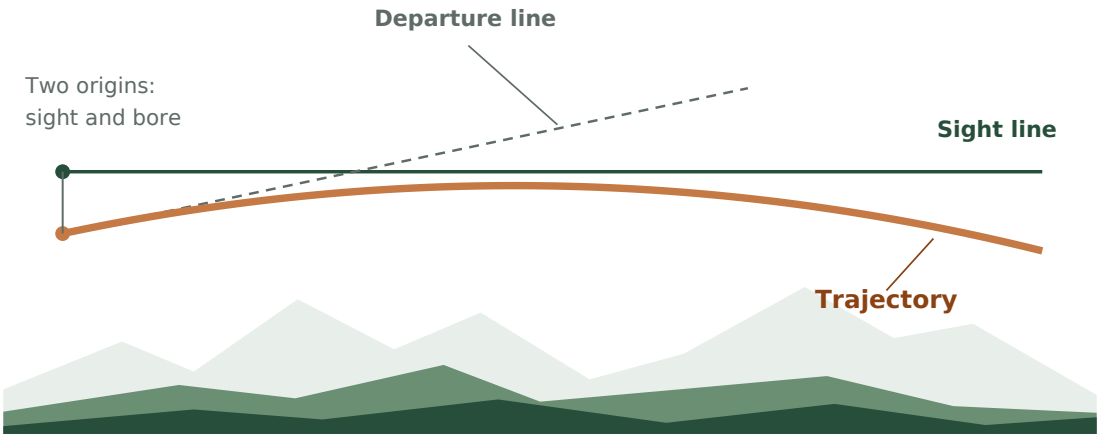
Explore the full guide at withinrange.nz/store/ballistics-101/

Educational material. Fictional observations are labelled; no hunting outcome is promised.

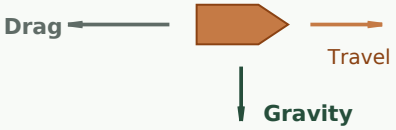
Visual study: the flight in context

FIGURE 02 / The flight has more than one reference

READ THE REFERENCES BEFORE THE CURVE



FORCES AFTER DEPARTURE



1 Choose a reference

The apparent rise belongs to the sight line. Gravity never stops.

2 Keep the forces distinct

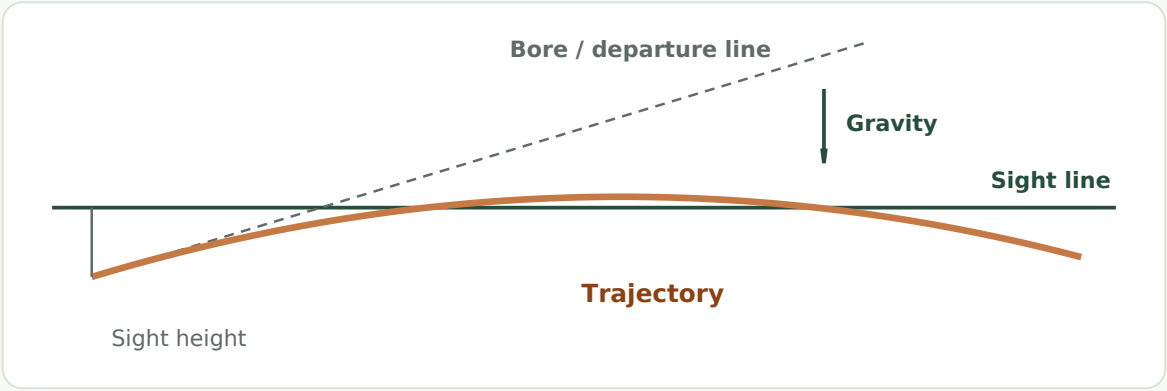
Drag opposes relative air motion. Gravity accelerates downward.

Invented landscape; not a measured flight or a field scenario.

Conceptual reference lines and forces, shown over an invented landscape. Curvature, heights and distances are exaggerated; no trajectory data or field suitability is represented.

3. Bore line, sight line and the apparent rise

FIGURE 05 / Three different reference lines



Exaggerated geometry. Gravity acts throughout; the trajectory falls below the departure line.

The line of bore is the direction the barrel points. The line of sight is the straight reference line from your eye through the optic to the target. They are separated by the sight height, so a scoped rifle is normally zeroed with the bore angled slightly upward relative to the sight line.

THE IMPORTANT BIT

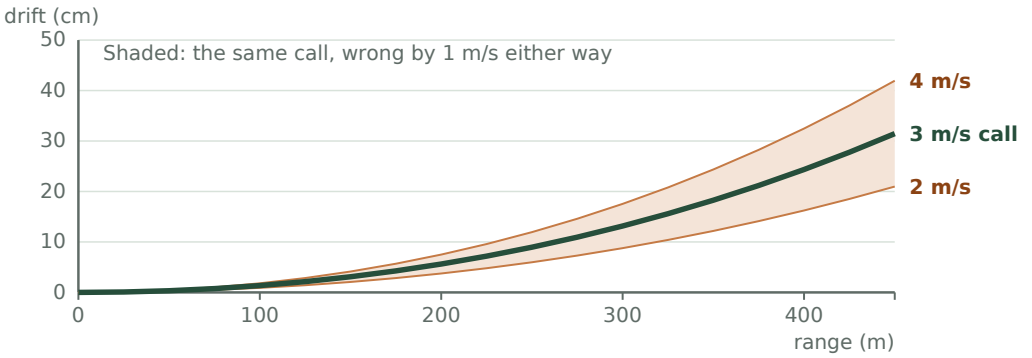
“Up” needs a reference. A bullet can climb relative to the ground and cross the sight line, yet fall below the straight continuation of its departure direction. Gravity has not switched off or reversed. In ordinary zeroing diagrams, the apparent rise is measured relative to the sight line.

THE NERDY BIT

At muzzle exit, velocity points along the departure direction. Gravity changes its vertical component from the start. In the simplified, level-ground picture, the path bends below the departure line, crossing the sight line on the way up and again on the way down. The bore line is a useful geometric reference; barrel movement can make the actual departure direction slightly different (Hornady Manufacturing, Inc., n.d.-b).

9. Wind drift

FIGURE 11 / A wind call has uncertainty



Model output for an illustrative 10 g, 850 m/s, G7 0.250 load. Not a firing table.

Within Range model output: illustrative 10 g, 850 m/s, G7 BC 0.250 load; sea level, 15 °C, level fire. Not a firing table.

Crosswind gives air-relative drag a sideways component. Full-value crosswind is perpendicular to the flight path. In the chart, the same 1 m/s error in a wind call moves impact under 1 cm at 100 m but about 8 cm at 400 m.

THE IMPORTANT BIT

A calculator turns entered wind speed and direction into a predicted correction. It cannot observe a gust, a sheltered valley or the wind halfway to the target.

THE NERDY BIT

Drift is not simply wind speed multiplied by flight time: a bullet does not instantly adopt the wind's sideways speed. Drag and flight time both matter. Under comparable conditions, a higher-BC projectile generally drifts less.

WHY WITHIN RANGE ASKS FOR THIS

Wind uncertainty matters because a small error in wind estimation produces progressively larger horizontal uncertainty as distance increases. Enter the wind you actually observe, and treat a forecast as a reference rather than a field measurement.

A closer look: wind correction and wind uncertainty

A correction asks, “What does the model predict for the wind I entered?” Uncertainty asks, “How different might the actual wind be?”

Those are separate questions. Two people can enter the same wind speed and obtain the same predicted drift while having very different reasons for trusting that input.

Completed example — two descriptions of the same entry

Description A	Description B
“The wind is light.”	“My observation is local; I cannot observe the entire path.”
Source and time omitted	Source and observation time retained
No account of variation	Changes and uncertainty recorded
Output treated as settled	Output treated as conditional on the entry

Description B supplies more context. It does not turn an observation at one location into a measurement everywhere.

A useful learning experiment

In the calculator, keep the setup and other inputs fixed and compare two wind-uncertainty assumptions. Write down which result changed and which assumptions remained fixed. Treat the comparison as an exploration of the model, not evidence about today's actual conditions.

If the numerical result changes, explain why in words before treating the new number as useful.

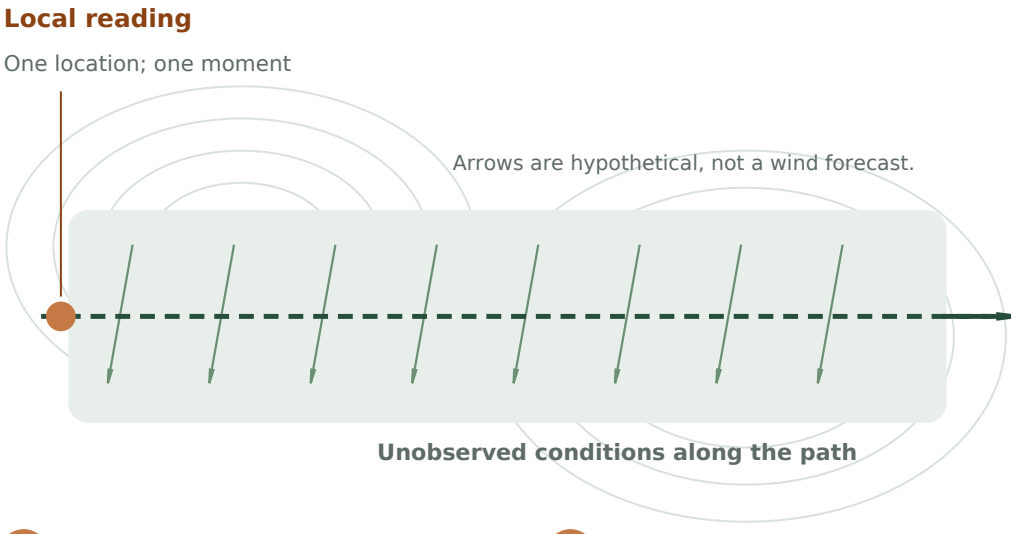
THE IMPORTANT BIT

A forecast, a local observation and uncertainty about the whole path have different roles. Record which one you have.

Visual study: what the wind reading leaves open

FIGURE 12 / One wind reading is not the whole path

PLAN VIEW / WHAT ONE READING LEAVES OPEN



1 Observation
Write where, when and how the local value was obtained.

2 Assumption
A single value used for the path is a modelling assumption.

3 Uncertainty
Variation and gaps still matter. A precise input can be uncertain.

4 Conditional output
Retain the wind call and its uncertainty with the result.

No terrain airflow or drift amount is calculated in this illustration.

Conceptual plan view with invented contour lines and hypothetical crosswind arrows. No airflow simulation, spatial measurements or drift values are shown.

Worked case: from a South Island notebook to a corrected input

This is one continuous **fictional learning case**. The people, setup and observations are invented. The arithmetic is real. It illustrates a record error; it is not a firing solution or a hunting outcome.

1. Give the record an identity

Mere is preparing her notebook after three visits to a South Island range. She keeps the same rifle, factory-load lot, optic, prone position and support in this example. Her labels are Rifle A / Load A / Prone. She uses metres for distance and millimetres for group measurements. Her reason for practising is to understand her records before considering a field application.

The load catalogue is a published starting source. Her actual muzzle velocity is unmeasured. The notebook says so. Changing a group-size entry will not improve that velocity evidence.

2. Keep the whole notebook

At a recorded 100 m she retains five five-shot, centre-to-centre extreme spreads: **28, 41, 35, 47 and 39 mm**. These are the same fictional samples used in the earlier notebook lesson. The arithmetic mean of the five spreads is 38 mm; the smallest is 28 mm.

She does not delete the 47 mm group. Nor does she treat the mean as a hit probability or substitute it for a particular recent group without checking the app's input meaning.

3. Make a conditional prediction

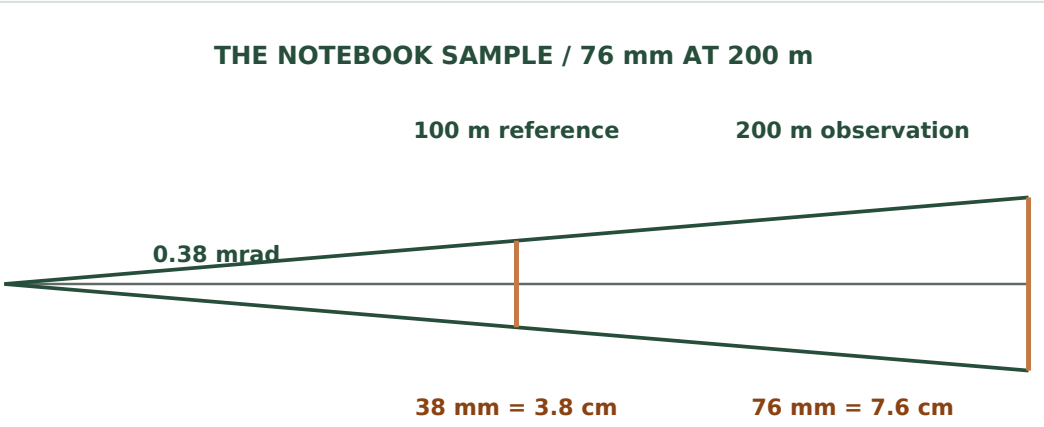
Her ballistic table is labelled **model output**. It retains the exact load identity, original velocity source, BC model, zero, atmosphere and date. This lets a later observation be compared with the calculation that actually existed, rather than a retrospectively edited table.

For the separate placement model, she uses a recent group from the intended position. She checks the group-size field's selected unit before entering a value. The current calculator defaults to **cm @ 100 m**. That means a distance-normalised group span, not the physical span at every distance.

4. Preserve an observation that appears to disagree

At a later recorded 200 m session, an invented group measures **76 mm** centre to centre. Her quick note says “7.6 cm.” She copies **7.6** into a field still labelled **cm @ 100 m**. Now the model is being told about twice the angular spread represented by that observation.

FIGURE 26 / Correct the reference, preserve the sample



Invented 76 mm sample at 200 m. Small-angle arithmetic gives approximately 0.38 mrad or 3.8 cm @ 100 m. No containment probability is implied.

The 76 mm group is an observation; 7.6 cm is a valid unit conversion. The error occurs at the next step: entering the physical span at 200 m as if it were already normalised to 100 m.

5. Resolve the record error with independent evidence

Mere returns to the original target note: distance 200 m, span 76 mm. Both values were written before she saw the model result. She also checks the field label. The normalised input is:

7.6 cm × (100 m / 200 m) = 3.8 cm @ 100 m.

Equivalently, 0.076 m / 200 m = 0.00038 rad, approximately **0.38 mrad**. That is a geometric conversion of this sample, not a statistical estimate of all future shots.

She retains the original entry and corrects the input to 3.8. The group now has the proper angular scale. BC and velocity remain unchanged.

6. Write a conclusion with a boundary

The case establishes	The case leaves open
A factor-of-two distance-normalisation error in one copied group input	Whether the ballistic trajectory is correct
The corrected angular scale of the 76 mm sample at 200 m	Actual muzzle velocity and its variability
A traceable reason for changing 7.6 to 3.8	How representative these samples are over time
A record that preserves both the observation and correction	Any safe, ethical or humane hunting distance

Her conclusion is specific: “I corrected a units/reference error. My original 200 m group remains 76 mm. The revised model uses 3.8 cm @ 100 m. This does not resolve the unmeasured velocity or establish a field outcome.”

THE IMPORTANT BIT

A satisfying explanation comes from evidence that distinguishes causes. If the original distance or measurement method were missing, this case would remain unresolved. Do not force a trajectory mismatch into this explanation merely because the arithmetic is convenient.

Visual study: keep the observation, correct the input

FIGURE 27 / From target paper to an auditable input

ONE OBSERVATION / TWO WAYS TO WRITE ITS SCALE

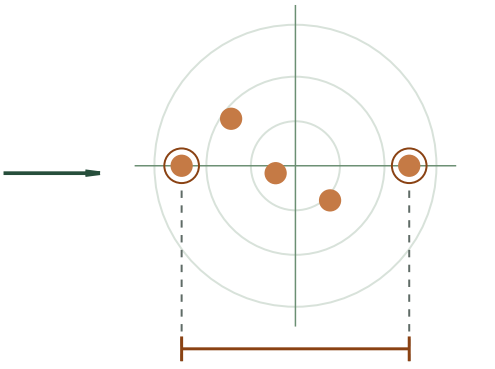
SESSION
Fictional teaching record

DISTANCE
200 m

EXTREME SPREAD
76 mm, centre to centre

ORIGINAL NOTE
7.6 cm at 200 m

The target is an invented sample.



DISTANCE-NORMALISED INPUT

7.6 cm x (100 / 200) = 3.8 cm @ 100 m

Preserve the 76 mm observation. Correct the copied input.

A unit/reference correction does not validate a ballistic trajectory.

Target layout and notebook are invented; measurement geometry is schematic.

Fictional case illustration. Five shot marks are invented. The highlighted pair defines centre-to-centre extreme spread; 76 mm at 200 m converts to 3.8 cm @ 100 m.