Do Shotguns and Muzzleloaders Pose Less Risk than Centerfire Rifles for Hunting Deer in Pennsylvania?

Mountain Top Technologies, Inc.

Todd S. Bacastow, Ph.D.
Quiz

- **True or False:** "There is no way a 12 ga slug can travel one mile when fired level at [3 feet]."
  - Logic
    - The amount of time it takes a slug to hit the ground while in flight is the same as one dropping from the tip of the barrel which is \( t = \sqrt{\frac{2x}{g}} \) at 3 feet.
    - A bullet must be airborne 3.07 seconds to travel 1 mile at a velocity of 1700 fps.

- **True or False:** "It wouldn’t surprise me at all if Sarah Brady [Brady Center to Prevent Gun Violence] herself paid this Todd Bacastow."
An Incident – An Implication

Casey Burns Survived a Stray Bullet While Pregnant

Casey Burns was sitting in her car in the driveway of her North Whitehall Township home, laughing with her sister, brother and fiancé when somewhere nearby, a gun went off. The bullet penetrated the car window, cracking the glass. Burns' head began to bleed. She was shaking as her family quickly called for help.

Within minutes, emergency crews arrived and began advanced life support. When they learned that Burns not only had a severe head injury but was 7 ½ months pregnant, they called University MedEvac. The helicopter rushed her to Lehigh Valley Hospital.

Mom and daughter vow to keep up fight

Thursday, October 26, 2006

By JIM DEEGAN
The Express-Times

A report that finds hunting with shotguns isn't any safer than hunting with high-powered rifles won't signal the end of a campaign to expand hunting restrictions into parts of Lehigh and Northampton counties, a leading advocate said Wednesday.

Allie Dickinson, whose 18-year-old daughter Casey Kantner was shot in the head by a hunter's stray bullet in 2004, said Pennsylvania hunting rules haven't kept pace with the growth in areas such as the Lehigh Valley.
Conventional Wisdom: Shotguns as a Safety Mgt Tool

SPECIAL REGULATIONS AREAS
Special Regulations Areas include: In western Pennsylvania, all of Allegheny County. In southeastern Pennsylvania, all of Bucks, Chester, Delaware, Montgomery and Philadelphia counties.

Deer: All Special Regulations Area counties are now contained within the Wildlife Management Unit system. Seasons and antler restriction requirements are based on these units and general deer seasons. However, certain laws and regulations in regards to arms and ammunition still apply to specific counties in Special Regulations Areas. It is now lawful to hunt or take deer on private lands in the southeast special regulations areas through the use of or taking advantage of bait. (See baiting section on General Hunting Regulations page elsewhere in this Digest for more information.)

Arms & Ammunition: Muzzleloading long guns .44 caliber or larger, bows and arrows, manual or auto-loading shotguns. 410 or larger using slugs and 20-gauge or larger using buckshot. Buckshot is not permitted in Allegheny County. Only bows and arrows, including crossbows, are permitted in Philadelphia County. Crossbows may be used during any firearm deer season statewide, and during any established deer season in Wildlife Management Units 2B, 5C and 5D. In WMUs 2B, 5C and 5D, hunters using a crossbow during the archery season must purchase an archery stamp in addition to their general hunting license and appropriate WMU antlerless deer license. Hunters using crossbows during the muzzleloader season must have a muzzleloader stamp in addition to their general hunting license and appropriate WMU antlerless deer license. Crossbows must have a minimum draw weight of 125 pounds and a maximum draw weight not to exceed 200 pounds.

Small Game, Hunttable Furbearers & Crows: Manually operated or auto-loading shotguns plugged to a 3-shell capacity, manually operated .22 caliber or less rimfire rifles and handguns, and bows and arrows.

Lawful While Trapping: Manually operated .22 caliber or less rimfire rifles and handguns, except as noted under specific "Furtaking" regulations elsewhere in the Digest.

PGC, 2007 - 2008 Hunting Digest
Incidents

464 incidents, 98 incidents not associated with hunting deer; of the 366 remaining incidents:
- No rifle incidents in Special Regulations Areas
- 19% of the incidents occurred in Special Regulations Areas
- 75% of the incidents involved rifles
- 21% of the incidents involved shotguns
- 4% of the incidents involved muzzleloaders
Study's Purpose and Objective

- **Purpose:** To answer the question “Do shotguns and muzzleloaders pose less risk than centerfire rifles for hunting deer in Pennsylvania?”

- **Objective:** To provide a scientific basis for policy pertaining to the mandatory use of shotguns and muzzleloaders for deer hunting in designated areas of Pennsylvania.
Maximum Range as Represented in the 1998 Report

**Affected Area by Sporting Arm**
SAAMI (Sporting Arms and Ammunition Manufacturers Institute)

- 259 ac: '00' Buckshot
- 1,030 ac: 12ga Slug
- 5,880 ac: 30-30 Winchester
- 14,913 ac: .270 Winchester
- 24,454 ac: .30-06 Springfield
- 28,274 ac: 7mm Remington Magnum
Important Assumptions

- The average hunter exercises reasonable care.
- Hunters will tend to use the best available legal firearm-ammunition combination.
- The typical hunter will discharge the firearm at a height of 3 feet to impact a standing deer at approximately 3 feet height.
- The projectile’s trajectory will most frequently be approximately level with the earth’s surface.
# Firing Conditions (Errors)

<table>
<thead>
<tr>
<th>Firing Condition (Errors)</th>
<th>Firing elevation simulated (d)</th>
<th>Firing condition</th>
<th>Feet above a standing deer at 300 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35°</td>
<td>Errant Shot</td>
<td>210 ft.</td>
</tr>
<tr>
<td></td>
<td>10°</td>
<td>High Error in aiming</td>
<td>53 ft.</td>
</tr>
<tr>
<td></td>
<td>5°</td>
<td>Moderate error in aiming</td>
<td>26 ft.</td>
</tr>
<tr>
<td></td>
<td>~0</td>
<td>Aiming at target</td>
<td>0 ft.</td>
</tr>
</tbody>
</table>
Rifle Firearm-Ammunition

30-06 Springfield soft point
Mass = 150 grains, MV = 2910 fps

12 gauge sabot .50 caliber HP semi-spitzer
Mass = 385 grains, MV = 1900 fps

.50 caliber CVA Powerbelt
Mass = 348 grains, MV = 1595 fps
Ricochet Distance

- Initial trajectories and ricochet trajectories were computed at the Armaments Engineering and Technology Center (AETC), Picatinny Arsenal, NJ.
- Maximum ricochet distances (initial + ricochet) were compared.
Ricochet Distance as it relates to angle of elevation and angle of impact

Firing Angle of Elevation & Probability of Ricochet

<table>
<thead>
<tr>
<th>Firing Angle of Elevation (d)</th>
<th>Probability of Ricochet</th>
<th>Shotgun/ Muzzleloader</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>10</td>
<td>&lt;.6%</td>
<td>&lt;7.3%</td>
</tr>
<tr>
<td>5</td>
<td>&lt;38.0%</td>
<td>91%</td>
</tr>
<tr>
<td>0</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Trajectories for 35° Firing Elevation

Rifle vs Shotgun/Muzzleloader Analysis
35 Degree Firing Distance

- RF - .30-06 150 grains
- SG - .50 cal 385 grains
- ML - .50 Cal 348 grains

No ricochets after impact
Trajectories for 10° Firing Elevation

Rifle vs Shotgun/Muzzleloader Analysis
10 Degree Firing Elevation Distance

- RF - .30-06 150 grains
- SG - .50 cal 385 grains
- ML - .50 Cal 348 grains
Trajectories for 5° Firing Elevation

Rifle vs Shotgun/Muzzleloader Analysis
5 Degree Firing Elevation Distance

- RF - .30-06 150 grains
- SG - .50 cal 385 grains
- ML - .50 Cal 348 grains
Trajectories for 0° Firing Elevation

Rifle vs Shotgun/Muzzleloader Analysis
0 Degree Firing Elevation Distance
0° Elevation with Ricochet

<table>
<thead>
<tr>
<th>Ammunition</th>
<th>Initial Impact Distance (ft)</th>
<th>Ricochet Distance (ft)</th>
<th>Difference Distance (ft)</th>
<th>% Less than Rifle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rifle (.30-06 150 grains)</td>
<td>1408</td>
<td>4835</td>
<td>3427</td>
<td>Initial</td>
</tr>
<tr>
<td>Shotgun (.50 cal 385 grains)</td>
<td>840</td>
<td>5205</td>
<td>4365</td>
<td>40%</td>
</tr>
<tr>
<td>Muzzleloader (.50 cal 348 grains)</td>
<td>686</td>
<td>4498</td>
<td>3812</td>
<td>51%</td>
</tr>
</tbody>
</table>

Band Thickness is the Ricochet
Affected Area
as a
Percent of the Rifle Danger Area

<table>
<thead>
<tr>
<th>Firearm-Ammunition Combination</th>
<th>Percent of Rifle Danger Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35 deg. Firing Elevation</td>
</tr>
<tr>
<td>Rifle (.30-06 150 grain)</td>
<td>100.0%</td>
</tr>
<tr>
<td>Shotgun (.50 cal 385 grain)</td>
<td>55.5%</td>
</tr>
<tr>
<td>Muzzleloader (.50 cal 348 grain)</td>
<td>43.6%</td>
</tr>
</tbody>
</table>
Conclusions

- Conventional wisdom is sometimes wrong

- When considering extreme, high, and moderate firing errors the shotgun and muzzleloader were less risky than the centerfire rifle

- When firing with smaller or no aiming error, which is probably the most likely circumstance, the shotgun proved to be riskier than a centerfire rifle

- The muzzleloader was always less risky than both the rifle and shotgun

- Eliminating or controlling the ricochet seems essential if the shotgun is to be used as an effective risk management option
Answers to the Quiz

- **False:** “There is no way a 12 ga slug can travel one mile when fired level at [3 feet].”
  - The blogger did not account for the projectile retaining 95% of its energy and excellent ballistic characteristics after initially hitting the ground.

- **False:** “It wouldn’t surprise me at all if Sarah Brady herself paid this Todd Bacastow.”
  - The study was funded by the PA Legislature and completed in cooperation with the PA Game Commission.
  - As a firearms owner, I’m concerned by a policy that can in some circumstances achieve the opposite of the intended result.