Get Out The Audit (GOTA):
Risk-limiting ballot-polling audits are practical *now*!

Philip B. Stark

Department of Statistics, UC Berkeley

28 March 2012
EVN Annual Meeting
Santa Fe, NM

Risk-Limiting Audits

Risk-limiting Audit

To pass, need strong statistical evidence that full hand count would find the same outcome—or a full hand count.

Large, known chance of requiring a full hand count if the outcome is wrong, no matter why.

Risk is biggest chance of not correcting a wrong outcome.

Two main kinds of Risk-Limiting Audits

Comparison Audit

Check addition, then check what was added:

Export subtotals from VTS.

Check that subtotals sum to contest totals.

Spot-check subtotals by hand-counting the votes on the corresponding ballots.

Keep checking until have strong statistical evidence tabulation error didn't change the outcome—or until you've done a full hand count.

Ballot-Polling Audit

Directly check outcome:

No data export from VTS.

Like an exit poll, but the ballots have to talk to you!

Keep sampling until there's strong statistical evidence that a full hand count would show the same outcome—or until you've done a full hand count.

Ballot-polling audits: steampunk

Ballot-polling audits are less efficient than comparison audits at the ballot level (you have to inspect more ballots) but low-tech and *much* easier to implement.

Only need a *ballot manifest* and a way to select ballots at random (dice suffice).

Calculations can be done with a hand calculator (or slide rule, or pencil and paper).

Simple contest, where winner reportedly got a majority.
(Can modify for plurality winner.)

- Find reported winner and winner's share $s > 50\%$.

- Get ballot manifest: How many ballots in all & how organized.
  E.g., 200,129 ballots in 350 batches.
  Batch 1 has 196 ballots, batch 2 has 995, . . . , batch 350 has 502.
  Ballots need to stay in *some* fixed order within batches during the audit, but the order doesn't matter

- Pick "tolerance" t, small enough that $s - t > 50\%$.
  (Bigger t gives smaller chance of full hand count, but bigger expected number of ballots audited.)

A simple ballot-polling audit: step by step

1. Set $T = 1$.
2. Select a ballot at random from those cast in the contest.
3. If the ballot does not show a valid vote, return to step 2.
4. If the ballot shows a valid vote for the winner, multiply T by

$$(s - t)/50\%.$$

5. If the ballot shows a valid vote for anyone else, multiply T by

$$(1 - (s - t))/50\%.$$

6. If $T > 9.9$, stop.
7. If $T < 0.011$, perform a full hand count to determine who won. Otherwise, return to step 2.

Ballot-polling audit: properties

Each ballot that shows vote for winner increases T and our confidence that reported outcome is right.

Each ballot that shows vote for someone else decreases T and our confidence that reported outcome is right.

If the reported winner's true share of the vote is at least $s - t$, chance of a full hand count is $< 1\%$.

Ballot-polling audit: numbers

Suppose winner reported to get $s = 60\%$ of valid votes.

- Set $T = 1$.
- Draw ballot at random.
- If it does not show valid vote, ignore it.
- If it shows vote for winner, multiply T by

$$59\%/50\% = 1.18.$$

- If it shows vote for anyone else, multiply T by

$$41\%/50\% = 0.82.$$

- Keep drawing until $T > 9.9$ or $T < 0.011$.

At most a 1% chance the audit will require a full hand count if winner got at least 59% of the vote.
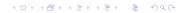
Workload estimates

Number to inspect is random but *expected* number is predictable.

For 10% risk limit, $t = 1\%$, two competitive candidates:

winner's true share	expected ballots to inspect
61%	97
60%	120
55%	480
52%	3,860

Doesn't depend on size of contest, so for big contests (president?), only a very small fraction of ballots.

Sample sizes can be smaller if there are more than 2 viable candidates.

Workload: California 2008

2008 presidential election, 13.7 million ballots cast in California.

61.1% reported for Obama.

If Obama really got over 61%, could confirm he won California at 10% risk by auditing about 97 ballots *statewide* (0.0007% of ballots).

Not onerous.

County workload

County workload proportional to the percentage of ballots cast there.

$\approx 25\%$ of ballots cast in Los Angeles county.
$> 75\%$ cast in largest 12 counties.
$< 1\%$ cast in smallest 14 counties.

For 61% winner share, expect to audit 97 ballots
≈ 24 ballots from LA
≈ 73 from the largest 12 (including LA)
≈ 1 total from smallest 14.

For 52% winner share, expect to audit 3,860 ($< 0.03\%$ of ballots)
≈ 946 from LA
≈ 2922 from largest 12 (including LA)
≈ 35 total from smallest 14.

Ballot-polling risk-limiting audits are practical, today.
No need to export data, modify voting systems, re-scan ballots . . .

Brainstorm

How to orchestrate BPA across, say, 59 counties?

Online video conference, webcast to the world?

Would work for 100 ballots; what about 4,000?