

# AB 2023 and Risk-Limiting Audits

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This document: [http://statistics.berkeley.edu/~stark/  
Seminars/caceo-legis10.pdf](http://statistics.berkeley.edu/~stark/Seminars/caceo-legis10.pdf)

## Risk-Limiting Audits

If the electoral outcome is wrong, there's a known minimum chance of a full hand count (which fixes it), *no matter what caused the outcome to be wrong.*

“Wrong” means the outcome isn't what a full hand count would show.

The *risk* is largest chance a wrong outcome won't be fixed.

Counts ballots by hand until there is strong evidence that the outcome is right (or until there has been a full hand count).

Role of statistics: Less counting when the outcome is right, but still a big chance of a full hand count when outcome is wrong.

Efficiency depends on batch sizes: Need data plumbing and vote tabulation systems (VTSs) designed for auditing.

Essential that voters create a durable audit trail that reflects the true outcome.

Essential that voting systems enable auditors to access reported results (total ballots, counts for each candidate) in auditable batches.

Essential to perform “ballot accounting” to ensure that no ballots appeared or disappeared.

Essential to select batches at random, *after* the results are posted or “committed.” (Can supplement with “targeted” samples.)

Need a plan for when to count more ballots, possibly leading to full hand count. “Explaining” or “resolving” isn’t enough. Plan must ensure that the chance of a full hand count is high whenever the outcome is wrong.

Compliance audits vs. materiality audits.

California AB 2023 (Saldaña, sponsored by SoS Bowen):  
[http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab\\_2001-2050/  
ab\\_2023\\_bill\\_20100325\\_amended\\_asm\\_v98.html](http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_2001-2050/ab_2023_bill_20100325_amended_asm_v98.html)

First proposed audit bill that limits risk!

(b)(3) “Risk-limiting audit” means a manual tally employing a statistical method that ensures a large, predetermined minimum chance of requiring a full manual tally whenever a full manual tally would show an electoral outcome that differs from the outcome reported by the vote tabulating device for the audited contest. A risk-limiting audit shall begin with a hand tally of the votes in one or more audit units and shall continue to hand tally votes in additional audit units until there is strong statistical evidence that the electoral outcome is correct. In the event that counting additional audit units does not provide strong statistical evidence that the electoral outcome is correct, the audit shall continue until there has been a full manual tally to determine the correct electoral outcome of the audited contest.

What do you need to do a risk-limiting audit?

Batch-level results.

Ability to retrieve ballots for each batch.

Way to select batches at random.

Procedures for hand counting.

Rules for “escalation” that limit the risk (statistics).

## Quantifying the Evidence the Audit Sample Gives

What is the biggest chance that—if the outcome is wrong—the audit would have found “as little” error as it did?

That chance depends on

- how the sample is drawn and its size
- batch sizes and reported votes in each batch
- the errors that are found

Chance can be big *even if no errors are found*—if the sample is small or the margin is small.

Don't stop counting until that chance is small!

Evidence is stronger when:

- Margin is bigger
- Sample is larger
- Batches are smaller
- Fewer differences are found

## The Calculations are Simple

For the most efficient method so far (the *Kaplan-Markov method*), only need ordinary arithmetic: addition, subtraction, multiplication, and division.

Nothing fancy.



## Pilot Audits in California

Marin County 2/08 (first ever); 11/08

Santa Cruz County 11/08

Yolo County 11/08, 11/09 (2, incl. 1st single-ballot audit)

Measures requiring super-majority, simple measures, multi-candidate contests, vote-for- $n$  contests.

Contests ranged from about 200 ballots to 121,000 ballots.

Counting burden ranged from 32 ballots to 7,000 ballots.

Cost per audited ballot ranged from nil to about \$0.55.

Had planned 11/2008 audits in Humboldt (hit by “deck zero” problem) and Monterey (hit by PEMT)

## Sampling plans

### Developed suite of methods to suit different counties

Simple random sample: “by lot,” same chance of picking each batch

Stratified simple random sample: stratify on mode of voting, machine, county, etc. Can help logistics.

PPEB sample: bigger chance of picking batches that can potentially hold more error. Less counting, generally.

**Watch out for bad random number generators!** Excel is actually *wrong*.

“Seed” random number generator with mechanically generated random number: dice, ping-pong balls, . . .

## Procedures

Important that batch totals stay constant during the audit.

Need to have final results for each group of batches before drawing sample from that group.

For instance, if provisionals haven't been resolved when the audit starts, don't add them to IP count for the purpose of auditing—keep them separate.

“Final” margin is the one that matters for the audit—not preliminary statement of vote.

Draw sample, hand count, apply rule to determine whether to stop or count more.

## Yolo County Measure P, November 2009

Reg. voters	ballots	precincts	batches	yes	no
38,247	12,675	31	62	3,201	9,465

VBM and in-person ballots were tabulated separately (62 batches).

For risk-limit 10%, initial sample size 6 batches; gave 4 distinct batches, 1,437 ballots.

Single-ballot auditing would save *lots* of work

Can determine the initial sample size for a single-ballot audit even though the cast vote records (CVRs) were not available.

For risk-limit 10%, would need to look at CVRs for 6 ballots. That's less than 0.05% of ballots cast—one twentieth of one percent.

For risk-limit 1%, would need to look at CVRs for 12 ballots. That's less than 0.1% of ballots cast—one tenth of one percent.

Cf., 1,437 ballots (11.33% of ballots cast) for actual batch sizes.

What do we need for efficient audits?

Reducing counting effort is mostly about reducing batch sizes.

Jellybean example.

Need structured, small batch data export from VTSs.

Ideally, a VTS that can report CVRs and a way to associate CVRs with physical ballots. Think about auditability when you buy new equipment!

Legal permission to subdivide precincts—IP vs. VBM, machine by machine, etc.

Faux sub-precincts for PCOS? What about L&A testing? printing?

Smaller ‘decks’ for VBM ballots—CCOS.

Interested in Participating in the AB 2023 Pilots?

My students and I would be thrilled to help you.

We'll even help you count.

