

ELECTION AUDITING

BEST PRACTICES AND NEW AREAS FOR RESEARCH

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SUMMARY

Election auditing is the process of independently reviewing a process or system to ensure compliance with election laws, policies, and standards. Election audits help ensure the election outcome is reliable and valid by providing evidence that the election is conducted properly, that only eligible voters participated, and that the outcomes are accurate. The foundation of a functioning democracy rests on the trust citizens place in the electoral process. Any perceived or actual vulnerabilities, manipulation, or interference can undermine public confidence in the fairness and accuracy of elections. Therefore, audits and auditing should be considered a cornerstone in the complex system of election administration. Audits promote transparency and security and help promote voter and stakeholder confidence in the election administration process and consequently the legitimacy in the outcomes of elections and is something we consider here.

The best-known type of election audit is the post-election tabulation audit that confirms the accuracy of electoral contests by ensuring that the votes were interpreted and tabulated correctly by the tabulation equipment. However, election auditing can be broader than just a check on the tabulation system and can include audits of key systems and processes within the election ecosystem. From this perspective election auditing is meant to demonstrate that ballots were correctly created, issued, and accounted for, that only eligible voters participated in the election, voting systems count votes accurately, that election officials

comply with federal and state laws as well as internal regulations and policies, and that any discrepancies that are found during these audits are resolved. Broader auditing involves the evaluation of the entire election ecosystem that contributes to a fair election including an evaluation of processes, procedures, training, and other systems that helped to produce the election outcome.

Although post-election tabulation auditing has been widely discussed, the amount of research into this area is surprisingly thin. Almost no research has been done into traditional “fixed percentage audits” and state laws and practices do not seem to be based on rigorously defended criteria. Risk-limiting audits are a new development with a lot of reformist support, but there is no consensus on the trade-offs among parameters, such as sample size and administrative tractability. Research into other types of audits, such as process audits and registration systems, are even more limited. There are no standards about the reporting of audit results and data concerning audit results are surprisingly difficult to find. Finally, despite claims made that audits increase confidence in elections, very little research has been done to confirm this claim or to understand when or how this claim might be true. Therefore, there is much research to do.

1. INTRODUCTION

Election auditing is the process of independently reviewing a process or system to ensure compliance with election laws, policies, and standards. Election audits help ensure the election outcome is reliable and valid by providing evidence that the election is conducted properly, that only eligible voters participated, and that the outcomes are accurate. The foundation of a functioning democracy rests on the trust citizens place in the electoral process. Any perceived or actual vulnerabilities, manipulation, or interference can undermine public confidence in the fairness and accuracy of elections.

Audits should be considered a cornerstone in the complex system of election administration. Audits promote transparency and security and help promote voter and stakeholder confidence in the election administration process and consequently the legitimacy in the outcomes of elections (Election Assistance Commission 2021). While research so far has not provided strong evidence that post-election tabulation auditing or other process audits filter down and improve voter confidence, the paucity of research in this area suggests that more research is needed to determine whether, and if so, when, and how voter confidence can be enhanced by distributing auditing information to voters. At the very least, election audits provide evidence to election officials and perhaps some stakeholders that the election was “trustworthy,” meaning that it is worthy of confidence based upon an impartial observer’s assessment that it determined the correct winners (Stewart 2022).

If audits are to ensure trustworthy elections, they must be based on rigorously defended standards and reported clearly. Surprisingly, despite the great attention to post-election tabulation audits among the reform community over the past two decades, overall, the research literature into audits is still thin. Standards are still in their infancy and being developed. Implementation has been slow and little of it is documented.¹ There is a great need for collaborative research between election officials and academics to codify best practices along

mundane parameters such as sample sizes, record-retention practices, and data presentation.

Beyond tabulation audits, research to develop and improve methods to audit other areas of election administration, such as voter registration systems, ballot management systems and election processes, are even more in their infancy. As with post-election tabulation audits, much work needs to be done with academics and administrators working together to discover best practices that increase trustworthiness and minimize administrative burdens. Finally, despite claims made that auditing would increase trust among voters in the accuracy of election results, almost no research has been done to verify that this is true or, more importantly, to understand which features of audits might be more important to the public.

The widest known type of election audit is the post-election tabulation audit that confirms the accuracy of electoral contests by ensuring that the votes were interpreted and tabulated correctly by the tabulation equipment. All but five states have a law or administrative rule that requires some type of post-election review of the tabulation system, which we will refer to as simply a tabulation audit, although the methods and timing vary along with who performs the audit and how discrepancies discovered during the audit are handled.²

However, election auditing can be much broader than just an examination of tabulation systems. Election administration has three phases, the pre-election phase, the election phase, and the post-election phase, all of which provide opportunities to conduct audits to verify the work is done correctly, which is part of our broad definition of election auditing. In particular, these phases provide unique opportunities to audit key systems and processes within the election ecosystem:

- » Pre-election phase: audits of voter registration records
- » Election phase: logic and accuracy testing, in-person voting process audits, mail ballot validation audits
- » Post-election phase: tabulation audits including a review of cast vote records and ballot images, ballot management audits

From this perspective election auditing is meant to demonstrate that ballots were correctly created, issued,

1 The only published reports we are aware of documenting implementation are from New Jersey and Rhode Island RLA pilot projects (<https://electionline.org/resources/new-jersey-rla-case-study/> and <https://www.commoncause.org/wp-content/uploads/2019/09/RI-Report-Design-FINAL-WEB5.pdf>)

2 See NCSL, Post-Election Audits, Table 1 (<https://www.ncsl.org/elections-and-campaigns/post-election-audits>).

and accounted for, that only eligible voters participated in the election, that voting systems count votes accurately, that election officials comply with federal and state laws as well as internal regulations and policies, and that any discrepancies that are found during these audits are researched and resolved. Broader auditing involves the evaluation of the entire election ecosystem that contributes to a fair election including an evaluation of processes, procedures, trainings, and other systems that helped to produce the election outcome. Therefore, auditing is meant to also measure system level performance including detecting and fixing errors in the vote counting and other facets of the election system (e.g. polling place operations, worker performance, chain of custody procedures, voter registration systems, etc.), create accountability in election administration to voters, deter fraudulent activity (e.g. machine hacking, voter impersonation, voter fraud), limit the risk of certifying an incorrect election outcome, and provide feedback to the election official for process improvement. These processes are also meant to promote the confidence of election officials, stakeholders, and the public in the administration of elections and the legitimacy of the outcomes they produce.

Given this backdrop, in this essay we cover some of the election processes where election audits and research either does or should take place. Therefore, we consider all the stages of the election ecosystem and where data are generated either explicitly for auditing or as a byproduct of election security, such as chain of custody documentation. We recognize the complex data ecosystem of anonymity, privacy, access, and security that election administrators must traverse while also recognizing the need for transparency and openness to the most foundational collective activity of our society—voting and elections.

We begin with tabulation audits since much of the research that does exist has been there and consider the importance of sample size across different types of audits. We also consider issues around ballot images, voter privacy, and data access that help to make election data more complicated and sometimes difficult to access. Other issues we consider include the different audiences in the field of election administration and how that influences what to audit and how to communicate that information with others and whether or not such actions increase citizen trust or confidence. Finally, we focus on what we know from academic studies and reports about election auditing that show large gaps in our knowledge and consider voter registration systems, the newer field of election forensics, process audits and how they can be expanded.

2. WHAT DO WE KNOW ABOUT POST-ELECTION TABULATION AUDITS?

Post-election tabulation audits are the best-known type of election audit. Begun in the 1960s in California, they are now required in most states. However, tabulation audits take different basic forms. Within each form, they are conducted using different standards that vary across the states. The most basic classification of tabulation audits as reported by the Election Assistance Commission divides them into three types:³

1. Traditional tabulation audits, which examine a fixed percentage of voting machines or precincts and compare the results from the sampled ballots with the results reported in the original count.
2. Risk-limiting audits, (RLAs) which also examines a sample of ballots and compares them with the original count. Unlike traditional audits, the number of ballots sampled in an RLA depends on how close the race is and how certain one wants to be that the original count named the correct winner.
3. Machine assisted audits including some transitive audits.

2.1 TRADITIONAL TABULATION AUDITS

Traditional, or fixed-percentage, tabulation audits generally use a predetermined percentage or number of ballots or paper records across ballot types (mail ballot, early, and Election Day), precincts or tabulators where a sample of ballots are hand counted and compared to the reported results from those systems (Norden et al. 2007).⁴

3 For a good overview of types of audit see <https://www.ncsl.org/elections-and-campaigns/post-election-audits>, the Election Assistance Commission's *Election Audits Across the United States*, available at: <https://www.eac.gov/election-officials/election-audits-across-united-states>, and https://www.brennancenter.org/sites/default/files/legacy/d/download_file_50227.pdf.

4 Some states allow for other electronic audits within this framework. For example, Hawaii allows the election official to retabulate 10% of ballots on their own voting systems. These types of audits are problematic because they use the same voting system for the re-tabulation, which may not reveal programming errors or issues in the adjudication of marginal marks.

There is a great deal of variation and nuance across the states in terms of sample sizes. For example, states with fixed percentage audits that are defined in statute will require a minimum percentage of ballots, devices, or precincts, while some states used a fixed number of precincts instead of percentage. In some states, the audit size is determined by the state election official. In still other states, the sample size varies based upon the margin of victory.

As far as we can tell, these differences are not based on a rigorous set of standards about what constitutes a necessary sample size. Instead, it appears that policy diffusion in this area has followed from what other states do and what seems “reasonable” to be accomplished in a state. Because traditional tabulation audits first began a half a century ago and statistical science (and the auditing techniques that depend on them) has advanced considerably, research into the optimal auditing regime for fixed-percentage audits is important.

There are other differences across the states other than sample size, such as which ballots are scrutinized (Election Day, mail, provisional, etc.), which offices are examined (rarely the entire ballot), when the audit occurs (pre- or post-canvass) and what happens when an audit discrepancy occurs. Again, we are unaware that any research in this area identifies best practices among these different choices or research that helps to align traditional audit procedures with audit goals including transparency, integrity (accuracy), trust, and efficiency.

2.2 RISK-LIMITING TABULATION AUDITS

A risk-limiting audit (RLA) is a post-election tabulation auditing procedure that provides statistical assurance that voting hardware and software produced the correct winners.⁵ RLAs developed from acceptance sampling, which was used for quality assurance in munitions factories during WWII. From this perspective, RLA is not a new idea, just an old idea repackaged and comes more from business than statistics as it is about statistical process control. From this perspective, this might be an area of study where scholars in business administration might have important contributions to make.

RLAs involve reviewing portions of the audit trail—voter-verified paper records—to identify and correct any erroneous electoral outcomes.⁶ RLAs first require an accounting of ballots to ensure that the correct number of ballots have been cast based upon the records in the audit trail.

Because recounting all cast ballots is time-consuming and costly, RLAs assess a random sample of all ballots cast. The number of reviewed ballots increases incrementally until a predetermined “risk limit”—the highest statistical probability that the audit will not correct an incorrect outcome—is met or election administrators conduct a full recount.⁷ The risk limit is a number between 0 and 1 that limits the risk of certifying an incorrect winner. For example, if the election outcome is incorrect and there is a 5% risk limit, there is at most a 5% chance that the audit will not identify an incorrect outcome, and at least a 95% chance the audit will correct it. Therefore, RLAs do not check whether each ballot was counted properly, unless a full

5 For a good overview of risk-limiting audits see Jennifer Morrell, *Knowing It's Right Parts one through Four: A Practical Guide to Risk Limiting Audits*, available at: https://democracyfund.org/wp-content/uploads/2020/06/2019_DF_KnowingItsRight_Part1.pdf, https://democracyfund.org/wp-content/uploads/2020/06/2019_DF_KnowingItsRight_Part2.pdf; https://democracyfund.org/wp-content/uploads/2020/06/2020_DF_KnowingItsRight_Part3.pdf; https://electionline.org/wp-content/uploads/2021/02/2021_DF_KnowingItsRight_Part4.pdf; NCSL <https://www.ncsl.org/elections-and-campaigns/risk-limiting-audits>; and Lindeman, and Stark. 2012, *A Gentle introduction to Risk-limiting Audits*.

6 Paper records may include paper ballots themselves, paper audit trails produced by direct-recording electronic voting machines, or paper ballot records produced by ballot-marking devices.

7 RLAs only amend the original outcome if they lead to a full hand recount that contradicts the original outcome.

hand recount is necessary. The number of ballots that must be hand-counted is a function of risk limit, vote margin, RLA method and (weakly) contest size. Lower risk limits entail examining more ballots, as do closer elections (Lindeman & Stark 2012; Stark 2012; 2018). RLAs by design escalate to a full hand count to review the election if the risk limit is not met ensuring the accuracy of the machine count.

The most common types of RLAs are *ballot comparison* or *batch-comparison* and *ballot-polling* audits (Lindeman and Stark; Appel and Stark 2022). In a *ballot-comparison* audit, voting machine results are compared to hand counts of randomly selected “clusters” of ballots. Cluster sizes equal one in ballot-level comparison audit, while *batch comparison* audits select clusters at higher levels such as a precinct or tabulator. Auditors first check whether every cluster’s subtotals sum to contest totals for each candidate (National Conference of State Legislatures 2022). If the two are consistent, specific ballots are identified and retrieved. The audit team examines the ballot and enters the voter marking for the audited contest(s) exactly the way they appear on the ballot. If these comparisons cannot determine the winner with a sufficient degree of confidence, administrators must escalate the audit and require more ballots to examine.

Alternatively, in a *ballot-polling* audit, auditors recount a random sample of ballots from the entire population of ballots without the extra steps of clustering ballots and performing subtotal comparisons. In a ballot polling audit, individual ballots are retrieved. The audit team examines and records the voter markings for the audited contest(s) on a tally sheet. The votes are then totaled and the margin of victory for the winner(s) is compared to the margin of victory originally reported. The audit is looking for a similar or larger margin of victory. The audit stops when the vote shares in the sample provide sufficiently strong evidence that the election was decided correctly. This threshold is set by the pre-set risk limit.

Polling audits require examining more ballots than ballot-level comparison audits, especially for close contests but are the best option when vote tabulation systems cannot export counts for individual ballots and contests. Both ballot-polling and ballot-level comparison audits are more efficient than batch-level comparison audits (Lindeman & Stark 2012).⁸

8 For comparison audits, the number of ballots grows like the reciprocal of the margin, while polling audits use the square of the reciprocal. At a 10% risk limit and with the winning candidate receiving 52% of the vote, a comparison

Regardless of the RLA method used, auditors escalate the audit if the risk limit is not met, requiring an additional sample of ballots to be selected. This continues until either the risk limit is met, or a full recount has been performed.

Colorado implemented its statewide RLA in 2017. The procedure took almost ten years to develop and was supported by Colorado’s Secretary of State, who believed it would improve election integrity while reducing the number of ballots that had to be hand-counted (Awad 2017). The National Academies of Sciences, Engineering, and Medicine, the Presidential Commission on Election Administration, the American Statistical Association, the League of Women Voters, Common Cause, Verified Voting Foundation, The Carter Center, and The Brennan Center for Justice also supports risk-limiting audits (Verified Voting 2019; The Carter Center 2020; Deluzlo 2018; Appel & Stark 2020). They argue that RLAs increase voters’ confidence that election results are accurate and reduce the burden placed on local election officials by standard post-election audits. RLAs, therefore, present an efficient and cost-effective way to ensure proper ballot tabulation and potentially reduce election skepticism (Deluzlo 2018). State governments have also used RLAs to boost voter confidence. The Georgia Secretary of State’s Office, for example, has used their risk-limiting audit to tout election integrity in the state (Georgia Secretary of State 2022). However, the fact is that we have no consistent evidence that RLAs, or any type of tabulation for that matter, increased, decreased, or had no effect on the public’s confidence in the election result. This is an important and critical research question.

However, RLAs can place additional administrative burdens on local election officials. The procedure is impossible without an audit trail of either paper ballots or voter-validated paper records generated by electronic voting machines. Local election officials must ensure that the audit trail remains complete and accurate and develop procedures to properly store and catalog paper ballots before the audit (Lindeman & Stark 2012). For example, Georgia had to perform its 2022 RLA while conducting its senatorial runoff election, adding to the already burdensome task of running a second election (Johnson 2022).

Despite these limitations, RLAs are less contentious than other election policies, likely because they have the potential to improve election integrity without im-

audit would examine 120 ballots, while a polling audit would need 3,860 (Lindeman & Stark 2012).

pacting access.⁹ On the other hand, the most controversial election reform policies, such as voter identification laws and convenience voting, often pit access against integrity. RLAs also do not appear to have garnered sustained opposition from either political party. The procedure has recently surged in popularity and has been implemented by both Republican and Democratic states (National Conference of State Legislatures 2022).

2.3 MACHINE ASSISTED TABULATION AUDITS

According to the EAC (2022:13) transitive audits are re-tabulation audits that digitally rescan ballots on a different voting system or tabulator and the results of the two systems are compared. A transitive election audit, also known as a double-count audit, runs all the ballots through two independent tabulating systems. The ballots are first tabulated on the official tabulator used to record final votes and then run through a second tabulator from a different manufacturer with different hardware and software to confirm the vote totals. The EAC suggests that if both systems report the same election outcomes it provides evidence the outcomes are correct, even if it finds some discrepancies across systems. In this case, the post-election audit relies on the independence of the tabulation system's software and hardware to demonstrate the veracity of the outcomes, not human confirmation.

Transitive audits of this type have several advantages over traditional and RLA audits. Perhaps the biggest advantage is that they retabulate 100% of the ballots **and** 100% of the contests on the ballot, while traditional and risk-limiting audits focus on examining a smaller number of ballots overall and only audit a few contests. Relatively speaking RLAs are more complicated to explain to voters (especially a method like ballot-polling) and one of the draws to the machine assisted audit is that it is simple to perform and simple to explain. In Florida, for example, county Supervisor of Elections have the option to do an automated independent audit on the entire ballot in at least 20%

of precincts chosen randomly.¹⁰ But several counties have expanded this to a 100% ballot re-tabulation audit using independent software and hardware. Another twist on this theme is Maryland's 100% automated tabulation audit using scanned images from the official vote tabulators.^{11 12}

However, scholars have argued that only a human review of physical ballots is a reliable method to identify tabulation errors and voters have increasingly become concerned about tabulation machine counts. For these reasons, Lindeman and Stark (2012; 2013a, 2013b) identify a transitive audit as an audit that uses a second tabulation count only to obtain a cast vote record that can then be used as the sample frame for the RLA. In addition, other scholars and the EAC have noted that relying on scanned images has some undesirable properties as image data are manipulatable (Bernhard, et al 2019, EAC 2022).

Whether 100% re-tabulation audits using independent software and hardware, but without confirmation through a manual audit of the paper trail, provide the necessary evidence-based confirmation of the election outcomes is an important question for research as more states and localities opt in to these tabulation audit methodologies.

2.4 SUMMARY OF PREVIOUS POST-ELECTION TABULATION AUDIT RESEARCH

In terms of quantity, much of the other academic research in election auditing is in the areas of implementation, intricacies, efficiencies, value, and accuracy of RLAs (Stark and Wagner 2012; Stark 2008; Garland et al 2018; Lindeman et al 2018). For example, research focuses on different mathematical formulas for conducting the audit (Lindeman et al 2012; Zagórski, McClearn, and Morin 2021; Rivest 2017; Rivest and Shen 2012). Recently, research has expanded RLAs to Instant Run Offs (Blom et al 2020) and have been considering procedures to ensure voter privacy (Ryan et al 2021).

9 Fifteen states currently utilize RLA procedures, either as the official method, as an optional method, or as part of a pilot program for tabulation audits. There are two main clusters of RLA states, one in the Midwest (Michigan, Pennsylvania, Ohio, Virginia, Kentucky, and Indiana) and another in the west (California, Oregon, Washington, and Nevada, Colorado). Only Texas, and Georgia fall outside these clusters. These patterns may indicate some level of policy diffusion, with states more likely to adopt RLAs if nearby states have already done so (DellaVigna & Kim 2022).

10 <https://www.flrules.org/gateway/ruleNo.asp?id=1S-5.026>.

11 Maryland also conducts a manual, fixed percentage audit.

12 To review Maryland's re-tabulation audit reports go to https://elections.maryland.gov/press_room/documents/Post%20Election%20Tabulation%20Audit%20Pilot%20Program%20Report.pdf and https://www.elections.maryland.gov/voting_system/documents/2018%20Post%20Election%20Tabulation%20Audit%20Legislative%20Report.pdf.

There has been very little research on traditional audits. A book entitled *Confirming Elections* (Alvarez, Atkeson and Hall 2012) describes research on a pilot project in New Mexico that was meant to assist policy makers in promulgating rules and guidelines for audits (Toulouse Oliver and Adams 2012). The research tested various hand counting methods (Kerevel and Atkeson 2012), chain of custody procedures, how long the audit took (Bryant and Atkeson 2012), and how much it cost (Bryant and Atkeson 2012). Another study (Goggin et al 2010) also examined different hand counting procedures and their efficacy. There is also a book chapter that summarizes election audits in California and the history of auditing in California (Logan 2012). We also found one recent manuscript that looked at the performance of traditional audit from a RLA perspective (Jaffee 2023), and research that looked at recounts as audits of tabulation machines (Ansolabehere 2012). These studies are limited in number and topics studied.

In terms of the impact of tabulation audits on voter confidence, the extremely small literature is mixed with Traugott and Conrad's (2012) and Jaffee et al (forthcoming) both suggesting that information about post-election audit results improved confidence, while Dalela, Kulyk, and Schurmann (2021) showed that when voters in an experimental setting learned the number of ballots examined in a RLA their confidence was reduced. Another study used public opinion data in 2020 on voter confidence and examined how those attitudes related to the state post-election audit regime and found that voters in states with post-election audits were less likely to be confident in vote counting at the state level (Stillerman 2022).

2.5 RESEARCH QUESTIONS IN POST-ELECTION TABULATION AUDITING

As we described above, research on the implementation, performance, and impact of tabulation audits is scant. Because we have only sporadic and unsustainable research in this area it is ripe for further investigation and investment. Therefore, there are many research questions left to address in the broader area of tabulation auditing.

Regarding implementation, we also need to take some very basic steps to describe the processes election jurisdictions use in post-election audits. There is a great deal of variation across and within states in how they conduct tabulation audits and there are many ways to present the collected data. There is no standardized format across jurisdictions to present and inform voters of the outcome. Moreover, despite the theoretical-

ly public nature of tabulation audits, recent research suggests that only twenty percent of states and jurisdictions make data from the audits available in usable form for the public or researchers to examine (Jaffe et al 2023). In the remaining states, nearly all of them, the data quality varies with some having substantial data, but not in a format that is easily accessible, while other states have missing or incomplete data. If data are not available for review, or easy for voters to interpret, it cannot impact public confidence. Unless the results of audits are made as available as the election results they verify, they can provide neither the public assurance that is claimed nor support research in this field. Therefore, research on how to report and increase public information around audits is critical.

It is important to note that research on these three themes, 1) implementation, 2) performance (results), and 3) impact on public confidence and trust of tabulation audits can take many forms. Some of these research questions might best be studied quantitatively, testing best ways to do hand counting, relating different implementation procedures to results, efficiency, and security, or using experimental designs to test different methods for efficiency and security. Other important questions include how discrepancies discovered during the tabulation audit are handled and how ballots are adjudicated in close contests in places where voter intent laws are strong? We also need to know what we learn about the quality of our election processes and the legitimacy of the vote tabulation systems that determines winners and losers from tabulation audits.

Finally, we need to understand how audit practices impact voters. The research is small and inconsistent as described above and we do not even know if voters are aware of post-election audits or their findings. Certainly, awareness of such facts is important to their impact. Therefore, we need to know more about voter awareness, how and if this information is transmitted, and if not, how best to communicate this information to voters. These should include in-depth quantitative studies that use detailed surveys within and across jurisdictions. In-depth, quantitative studies can help provide great insight about the implementation and performance of post-election audits, whether they take advantage of the strengths of a single- or multiple-jurisdiction research design.

In addition to quantitative studies, it is also important currently for post-election tabulation audit research to also include detailed qualitative case studies of imple-

mentations in specific jurisdictions.¹³ We have no consistent data describing the process of counting votes for audited contests including how long hand counting takes, what methods for hand-counting are used, how ballots or batches are randomly selected, how much tabulation audits cost in terms of labor and time, how ballots or other data are organized in anticipation of the audit, what data are collected formally or informally, and how, or even if, it is reported.

RLAs are a good example as several jurisdictions have implemented RLAs to varying degrees of success. It is important for research to collect information on the details of these implementations in these jurisdictions now, before important information and data are lost, to use this information to assess RLA implementations. Examples of studies like this exist in the academic research literature (Alvarez, Atkeson and Hall 2012), but more are needed. For example, Colorado spent an enormous amount of time working to implement its tabulation audit, a detailed case study of Colorado and its jurisdictions and other states and their jurisdictions would provide basic and valuable knowledge on the process and the data it produces.

Importantly, all these types of projects can lead to evidence-based best practices.

2.6 BALLOT IMAGES, CAST VOTE RECORDS, AND BALLOT PRIVACY

Ballot images and the cast vote record (CVR) data can provide great value for independent and third-party auditing and are types of data that are generated as a by-product of the election. From these data types, researchers can reconstruct many important quantities associated with election outcomes including the number of ballots cast, vote totals for candidates and ballot measures, and undervotes and overvotes, *etc.* The ability to use data to independently reconstruct or reproduce the reported election results could become a foundational tabulation auditing process nationwide if such data are made available routinely and quickly after an election has been certified. This takes tabulation auditing to the next level allowing voters, candidates, and other stakeholders to access images or electronic data that tell the election story from the ballot level.¹⁴ Ballot images, for example, can provide

information about voter intent and help researchers and election administrators understand how voters interact with their ballot to improve the voting process.

However, releasing ballot images and CVRs also has potential downside especially around ballot privacy, which is a fundamental value in a democracy and is a feature of election integrity. Ballot privacy protects the voter from undue influence and the system from vote-buying, a form of election fraud, and corruption. Prior to the introduction of the Australian ballot many instances of vote buying schemes were recorded (Kuo and Teorell 2017; Aidt and Jensen 2017).

To maintain the secrecy of a voter's identity, ballots should be anonymous. However, ballots can give clues to their owner at the system and voter level. At the system level a variety of pieces of information from different sources such as the voter file, county and state level post-election reports by precinct and vote mode, or precinct, vote mode, and party in the case of a primary can be combined with CVR or ballot image data to potentially identify specific voter's ballots (Atkeson et al 2023). Precinct identification and vote mode information (e.g., mail ballot, Election Day, provisional, or in-person) are often available at the individual ballot level from ballot images or from the CVR.

At the voter level a voter can put stray marks, specific marks, or even sign their name that would either allow the voter or others to identify a voter's ballot. In a recent evaluation of primary ballots in Leon County, Florida, Atkeson et al found that 16 voters out of 66,871 voters signed a name to a ballot (Atkeson et al 2023). They found significantly more ballots with stray marks, interesting notes, and other markings that could be used for voter identification. If ballot images are going to be released, we need to come up with cheap and easy methodologies to remove ballot marks that could be voter identifying and allow for vote-buying. Alternatively, states could reject ballots with identifying marks as does Nevada, but how would this administrative rule change perceptions of voter access and voter integrity?

Clearly, more research needs to be done on questions about ballot privacy. For example, when is voter privacy affected through the release of CVR records or precinct-level results reports and what are the best practices necessary to ensure voter privacy? Currently

13 A good example of this is the Rhode Island Report available at: <https://www.commoncause.org/wp-content/uploads/2019/09/RI-Report-Design-FINAL-WEB5.pdf>.

14 For example, Dane County, Wisconsin places their CVR online and call the program a "Do it Yourself Audit,"

available at: <https://elections.countyofdane.com>. Other jurisdictions in California and Colorado have also put CVRs or ballot images online for public review.

states rely on arbitrary rules that do not protect ballot privacy. Better rules need to be developed that are evidence based. How can voter records, such as voting history and information from the canvass be combined with other information such as CVRs or ballot images to limit voter privacy? What percentage of ballots are marked with stray marks that could allow for voters to identify their ballot to others if released? What technologies would we need to develop to make ballots both accessible to voters for review and maintain voter privacy?¹⁵ Do we find that voters interact with their ballot differently when their ballots are available for review then when they are not? Certainly, some experimental evidence suggests as much.

3. DETERMINING SUFFICIENT SAMPLE SIZES IN ELECTION AUDITS

Determining an appropriate sample size has been a longstanding issue as it relates to election audits. Traditional tabulation audits primarily use a predetermined number of ballots to compare against result reports from the voting system. But these tend to be arbitrary, appear to be related what election administrators think is doable, and what other state states are doing. Therefore, studies need to ask and answer important questions about sample size for these and other types of audits we discuss.

These questions become even more challenging when we begin to think about other types of pre- and post-election process audits beyond tabulation audits. For example, auditing the voter registration file may have a very different sample size from auditing provisional ballot applications. How can election administrators determine a sample size that is appropriate for the type of audit being conducted? How can they ensure the sample size is robust enough to meet the purpose of the audit but reasonable enough to assess in a limited amount of time and with limited resources?

Because there are so many different processes to audit and examine in election administration, some large, such as the voter registration file, and some much smaller, such as provisional voters, it may be helpful to have an audit manual developed for election administrators. For example, the GAO has a document, *Using Statistical Sampling*, that addresses sampling issues.¹⁶ It may be helpful for researchers to build a similar guide for election administrators that is targeted to their audit system.

Outside of election administration, many federal, state, and local programs are audited using the Government Auditing Standards, commonly referred to as the generally accepted government auditing standards (GAGAS), implemented by the U.S. Government Accountability Office.¹⁷ While many election officials are looking for an exact number or formula, the most recent version of these auditing standards indicate sufficient, appropriate evidence is more nuanced. GAGAS suggests auditors may use statistical methods to

15 The Ballot Image Audit Tool used in Weld County, Colorado is a good example.

<https://www.weld.gov/Government/Departments/Clerk-and-Recorder/Elections-Department>. Also a recent pilot project in Leon County Florida has developed an audit and ballot image website: <https://2022voterdata.lci.fsu.edu/>

16 <https://www.gao.gov/assets/pemd-10.1.6.pdf>

17 <https://gaoinnovations.gov/yellowbook/>

interpret and assess the sufficiency of evidence but leaves the decision of what constitutes sufficiency to the auditor's professional judgment by stipulating that "the greater the audit risk, the greater the quantity and quality of evidence required."¹⁸ Of course, that would require that auditors have discretion, but since jurisdictions have different types of systems and different numbers of voters it makes sense for many audits across jurisdictions to have different sampling sizes.

The idea of statistical sampling in election audits has only been explored in research around risk-limiting tabulation audits (Lindeman & Stark 2012). This creates a very narrow scope for both determining a sufficient sample size and methods of auditing. There is a desire from election officials that the methods for conducting tabulation audits and audits of other key election processes, including how the sample size is calculated, be as simple and as transparent as possible. The appropriate sample size should consider the time and resources it will take to conduct the audit. In determining the sufficiency of evidence, the auditor should determine whether enough appropriate evidence exists to address the audit objectives and support the findings and conclusions to the extent that it would persuade a knowledgeable person that the findings are reasonable.

Relatedly, knowing when to expand an audit after the sample data has been examined may also be important. For example, errors in provisional ballots may show a training problem that was identified within a sample of provisional ballots. But the findings may generate a need for more analysis and may require additional samples to clarify problems or find solutions. Having rules of thumb to help make the decisions based upon principles of auditing and statistics is important to make state and local election officials feel like they are on track.

4. VOTER REGISTRATION FILES

Voter registration databases and their accuracies is another area where we have seen a small amount of research. Voter registration systems are dynamic and always changing as people move, die, have a change of status (e.g., become convicted felons), or enter the system as a new voter. Voter registration serves to record general eligibility to vote in the jurisdiction's elections and for what races a particular registered voter is qualified to vote in. Voter registration information is used to determine election geography (like precinct boundaries) and for the allocation of voting equipment and materials. Registration information is used in the mail ballot process and is used to confirm the identity of individuals voting in person. It can also be used to confirm the integrity of an election, thus serving as an important component of election security.

However, the dynamic nature of these files is also problematic because there is no administrative record documenting each election, the eligible voters, and the electors who voted in the election. Only Florida, Ohio, and North Carolina provide time stamped public files for each election. For greater transparency in the conduct of elections, states should be encouraged to create and maintain a time stamped voter file for every election documenting who was a qualified elector and who voted.

Given the many roles that administrative data, especially voter registration data, play in the administration of elections, it is mission critical that these data be as accurate as possible. These files have been audited in a variety of ways. Unfortunately, a series of recent studies has shown that inaccuracies exist in voter registration datasets (Alvarez et al. 2020; Kim, Schneider, and Alvarez 2020; Ansolabehere and Hersh 2010).

As in other areas some important descriptive work is necessary to identify what auditable documents are available for review and for research? Voter registration systems also need to be audited for their accuracy, is the voter's information correct? Is the voter in the correct district for purposes of representation? Are certain groups of voters more likely to have their information correct than other groups of voters (for example, race, gender, age, address, or party)? Other questions should ask what state factors correlate with higher quality voter registration databases? For example, do mail ballot or predominantly mail ballot states have higher quality registration databases? How can we know? How can these audits inform the election

¹⁸ <https://gaoinnovations.gov/yellowbook/evidence.html>

integrity process including increasing trust and confidence.

4.1. AUDITS OF VOTER REGISTRATION FILE, ABSENTEE REGISTRATION FILE, AND ELECTION DAY FILES

We know virtually nothing about the relationship between different election files and the systems used to keep track of in-person and mail voters. These systems should be audited for consistency and accuracy. Do the files agree with each other in terms of who voted and how? What do these files tell us about the voter experience? For example, work sponsored by the Bipartisan Policy Center, examined Election Day files to understand line lengths (Atkeson and Stewart 2017). The data from the Election Day files included the name of the voter along with their check-in-time which allowed inferences to be made about both the speed of check-in and resulting lines.

5. PROCESS AUDITS

In addition to tabulation audits, the election process generates an abundance of system level data throughout the election from logic and accuracy testing of the tabulator to candidate certification (Alvarez et al 2013). Process audits review election procedures and allow election administrators or third parties (e.g., academics, auditing firms, canvass boards) to examine equipment and procedures to ensure the rules, policies, procedures, and laws are applied correctly and efficiently.

Process audits should also help to ensure trustworthy elections and we see these audits as essential and something that should be researched. In general, we know little about these processes or the administrative documents they produce.¹⁹ So, as with the study of tabulation audits, some very basic information needs to be collected including information about the current scope of process audits as well as the development of new auditing tools and methods. What processes are audited, how are they conducted, and what data are generated from these types of audits that could be provided to researchers? What paper and digital trails are collected during the election from different processes such as logic and accuracy testing, mail ballot processing, in person voting and ballot management, etc.? In addition, auditing of ballot security and voter access, especially in in-person voting is important. What are election forensics and how does it differ from or is like current audit tabulation and process audits in place?

5.1 PRE-ELECTION LOGIC AND ACCURACY TESTING

Every election jurisdiction in the nation conducts what are termed “Logic and Accuracy” or “L&A” tests, essentially, these tests are used to ensure that ballot tabulating equipment is functioning as expected and counts votes accurately *before* it is used in a live election. Two states, Wyoming and North Dakota, repeat their L&A test after the election to ensure tabulators counted correctly.

If a tabulator malfunctions during the test, or produces inaccurate results, it is either subject to maintenance and/or reprogramming, or completely removed

¹⁹ The Elections Group outline some of those administrative documents that are produced and needed for various process audits in the Part Two series of guides. <https://www.electionsgroup.com/exploring-audits-series>

from use for that election. Once the tests are concluded, tabulators are zeroed out, produce what are called “zero tapes,” or “zero reports” to ensure there are no residual votes remaining in the memory card(s) of the tabulator, sealed and prepped for distribution to a polling location or for use counting mail ballots.

Many jurisdictions (i.e., New Mexico) also utilize logic and accuracy test results to further test the function and accuracy of Election Night Reporting (ENR) systems. If the data are found to be inaccurately reported via the ENR, procedures to identify and rectify the issue before the tabulators are deployed – and results are reported on election night – are implemented.

While L&A testing is a well-embraced best practice of election jurisdictions around the country, current research does not delve much into the use of this practice (though see Walker et al 2022 for a good start). Importantly, we do not know how often L&A tests find flaws in either the overall function or accuracy of test results, and we do not know much about whether practices utilized to remedy malfunctions are used consistently across states. We also do not know how much this process affects the confidence of external stakeholders and/or the public. Research into this process and what – if anything – can be done to improve it further would be particularly useful to election officials.

5.2 BALLOT MANAGEMENT AUDITS

Ballot management ensures end-to-end accountability for ballots during every phase of the election. It is the way in which election administrators ensure the proper handling of ballots during the pre-election, election, and post-election periods. This is done through a systematic process of ballot accounting and ballot reconciliation along with establishing an unbroken chain of custody for ballots and the equipment used to process them. While there are examples of election offices failing to upload memory cards or scan batches of ballots, these are most often honest, but preventable, mistakes. Unfortunately, ballot management has also played a role in disinformation surrounding mail ballots with claims that significant numbers of mail ballots were added into the official vote count.

The principles of good ballot management apply to all types of ballots; mail ballots, ballots cast in-person (early and on Election Day), ballots sent or returned electronically by UOCAVA or disabled voters, provisional ballots, and ballots requiring replication due to damage or identifying voter marks. An audit of ballot management records validates that election officials had appropriate security and accounting mechanisms

related to the possession and movement of ballots, enhancing the integrity and security of the election. It can also identify and remedy rare instances where validly submitted ballots have not yet been tabulated or correctly counted toward the election result or were counted more than once. It also ensures that any discrepancies between submitted and counted ballots are adequately researched and resolved. Importantly, such audits might help confirm that an election had integrity (by showing that important election artifacts were subject to a strong chain-of-custody), they might also help locate places in the process where the chain-of-custody could be improved, enhancing the integrity and security of future elections.

Ballot accounting, along with establishing a chain of custody, ensures the number of ballots in an election officials’ possession are consistently and accurately confirmed throughout each phase of the election. Ballot reconciliation compares the number of voters who received credit for voting to the number of ballots tabulated.²⁰ Reconciliation is conducted in early voting, and on election night, to ensure that the number of ballots issued equals the sum of the number of ballots cast plus provisional ballots cast plus ballots spoiled. Reconciliation also takes place as mail ballots are processed. This basic procedure ensures that there are no inaccuracies in the number of ballots voted, which could lead to questions of “ballot box stuffing” or abnormalities.

Before election results can be certified, all jurisdictions conduct a canvass of the results to ensure their accuracy before they are official. Though this process looks different depending upon the state and jurisdiction, in general, the canvass of results is the process of re-evaluating (and even reconciling once again) the results from each polling location and tabulator, qualifying and counting (or rejecting) provisional ballots, adding in any hand-tallied ballot results, qualifying and counting votes for write-in candidates, and, finally, adding in any additional results pursuant to either ballot curing or provisional ballot appeals.

Because there is such a wide variety of both laws and procedures, as well as the internal checks and balanc-

²⁰ This can be problematic because some states give voting credit to mail voters after a voter is qualified and the ballot is separated from the qualification process. When the ballot envelope is opened if there is no ballot there the election official does not know whose vote is missing and consequently the number of ballots and number of voters will be different.

es used to ensure those procedures are functioning as expected, there is a huge gap in our current understanding about these processes, their success at identifying and being used to rectify any existing errors in process, and whether or not there are universal best practices that could be applied across jurisdictions to improve the overall performance of election administration.

Therefore, we need to understand the overall impact of these processes on the accuracy and reliability of election processes and results. There are no studies on ballot accounting and reconciliation, and we do not know whether and how many early vote centers, Election Day vote centers, and precincts balance. For example, after the 2016 election, presidential candidate Jill Stein attempted a recount in three states. While her recount in Michigan stopped due to a judge's order, what she did accomplish in Wayne County showed significant discrepancies between the number of voters and ballots (Eder 2016). A post-election analysis by the Detroit Free Press found in 248 precincts a total of 782 more votes tabulated than voters who signed the poll books (Wisely and Reindl 2016). These discrepancies led the Michigan Bureau of Elections to audit 136 problematic precincts. While their analysis showed no signs of fraud per se, they were unable to balance over half of the precincts they audited (Oosting and Gerstein 2017). In another example, the Carter Center (2020) observed Georgia's 2020 audit and found that election officials had difficulty documenting the chain of ballot custody and developing consistent procedures for storing and organizing paper ballots. These observations suggest that this is a ripe area for greater transparency, auditing, and auditing research.

5.3 AUDITING IN IN-PERSON VOTING EXPERIENCE

The voting process today for many Americans involves some type of in-person experience. In some jurisdictions, the traditional precinct-based election-day in-person voting process is used. Other jurisdictions use vote centers, which are typically available for all voters in the entire jurisdiction. Some jurisdictions use vote centers for both early and Election Day voting (e.g., New Mexico), while other jurisdictions use vote centers for only early voting and precincts for Election Day (e.g., Florida).

There are many aspects of the in-person voting process where auditing can improve the voting experience, ranging from audits of voting locations, to process audits, and audits of the technologies used in the in-person voting system. Also, the personnel who provide support and services to voters and the in-person

voting locations can and should be audited for knowledge and performance.

First, the locations that are used for in-person voting, regardless of whether the process is the traditional precinct-based election-day voting system or a system based on vote centers, should be audited. Some specific issues that require systematic research are how to audit locations to insure their accessibility and their compliance with state and federal regulations for accessibility. These accessibility issues include physical access to the location for all voters and how suited the in-person voting location is for easy movement for all voters through the voting process. Other issues that research could consider for auditing include lighting, auditory distractions, and assistance when long lines form during peak voting times. In-person voting locations will require electricity, parking, and other amenities (for voters and staff), and research should consider how to audit these aspects of in-person voting locations. Studies have examined the quality of vote centers and precincts and have related those characteristics to questions about turnout, voter confidence, and voter identification, vote choice, and line length (Stein et al 2020; Barreto et al 2009; Pettigrew 2017).

Second, the procedures used to process in-person voters need research. The typical in-person voting process includes authentication, ballot access, ballot marking, ballot confirmation, and vote casting states. Each of these stages in the process involves different procedures that vary by jurisdiction. However, each of these stages can and should be audited --- to detect problems in the processes and to find places where the processes can be improved. Research needs to focus on how to develop auditing procedures for these processes that can be implemented jurisdiction-wide, in ways that do not interfere with the election operations. Election observers might be one possible means to systematically audit polling operations in real time.²¹

Third, all technologies used in the in-person voting process require auditing. While the exact technological profile of an in-person voting setting will vary widely by jurisdiction, it is often the case there may be some technological devices used for authentication, ballot marking, as well as ballot confirmation and vote casting. Each of these technologies should be audited in various ways, before, during and after their use in the in-person voting process. Research is needed to determine the optimal ways to audit these different

21 See for example Atkeson et al 2009, Atkeson et al 2010, Atkeson et al 2015.

technologies, focusing on analyzing their accuracy, usability, reliability, accessibility, and security.

Fourth, an integral component of the in-person voting process are the people who staff the polling places or voting centers. Sometimes these staff are essentially volunteers who are paid a nominal sum for their service on Election Day. In other situations, especially in jurisdictions where the vote center model is used, the staff may be employees of the jurisdiction. Regardless, research needs to focus on auditing the training used for staff, auditing their recruitment and their experience, and studying their performance before, during and after election operations. Such auditing studies can help find places where in-person staff may be underperforming, where they can be more efficient, and can help improve their experience as well as the experience they provide for voters. For example, several academic studies have examined poll worker knowledge and implementation of voting rules (Atkeson et al 2014; Suttman-Lea 2020; Kimball et al 2010; Atkeson et al 2010; Cobb et al 2012) and have found serious deficits. Other studies have focused on characteristics, recruitment, and training (Burden and Milyo 2015).

There are also issues that intersect procedures, technology, and personnel that may require auditing, and which need detailed research. One of these issues regards the general security of the voting experience and the voting location. We recommend that researchers develop sound procedures to conduct security audits of in-person voting, including detailed information and data security audits, auditing the physical security of the voting location and all technology used in the in-person voting process. Research might also study the security of voting locations themselves, and whether some types of voting locations are subject to more or different types of security problems.

5.4 MAIL BALLOT VALIDATION AUDITS

States use a variety of methods to validate that the individual who receives an absentee or mail-in ballot is the same individual who completes that ballot. This can include requiring specific personally identifying information such as a drivers' license number (Georgia) or the last four digits of the voter's social security number (New Mexico); requiring a returned ballot envelope signed by one or more witnesses, or a notary (North Carolina); or ensuring a fully completed and signed affidavit (Pennsylvania).²² The most common method of mail ballot validation is comparing the signature on a voter's returned ballot envelope to a reference signature(s) for that voter, usually a signature from the department of motor vehicles, the voter registration database, or other government records. Some localities have numerous images of signatures from different government resources that provide more possible matches for the voter. The ballot is considered validated if the ballot signature and the reference signature match.

Signature validation is conducted by staff or bipartisan poll workers. Training requirements are not uniform. Training focuses on approving anything that is a match. Mail ballot validation audits can improve trust by showing that the auditors and signature verifiers generally reach the same decisions about whether signatures match. This is done by drawing a sample of signatures that have been reviewed, both those that have been accepted and those that have been challenged. Independent auditors use the same reference signature and compare to determine if they would reach the same outcome as the original verifiers. This can be done as mail ballots are being processed, which helps spot concerns and allow for additional training, or post-election.

Research questions about signature verification involve the quality of training and different signature matching methodologies (Alexander and Mills 2014; Janover and Wetpahl 2020), the application of training to correct decision-making (Sita et al 2002), the accuracy of signature validation audits, the factors that might affect that accuracy, and the use of databases and technology to assist in signature identification (Hussain et al 2015). Do different mail ballot identification schemes across states (driver's license numbers vs social security numbers vs signatures) impact acceptance and rejection rates?

²² See <https://www.ncsl.org/elections-and-campaigns/table-14-how-states-verify-voted-absentee-mail-ballots> for a delineation of how states verify vote-by-mail ballots.

5.5 WHAT DO WE KNOW ABOUT ELECTION FORENSICS?

The concept of a “forensic audit” on election processes has been recently circulated by a subset of election integrity activists, primarily those who disbelieve the outcome of the 2020 presidential election. Firms and ad-hoc organizations - such as the Cyber Ninjas in Maricopa County (2021) - have successfully convinced certain election jurisdictions around the country to conduct “forensic” audits and have released subsequent audit reports. There is little consensus around what a “forensic” audit consists of in the election administration world. While the concept of a forensic audit - that is, an audit that is geared toward uncovering unethical or illegal activity - is well documented and utilized in the financial audit world (Bolgna and Robert 1985; Messier 2000; Singleton and Singleton 2004; American Institute of Certified Public Accountants 2002), there is not a consensus-accepted parallel in the election administration world. Indeed, it seems as though in some ways the public concept of a “forensic audit” is in line with already-existing RLAs or other post-election audit processes and/or that the concept includes process audits along with post-election vote verification procedures.

Words and definitions matter to public debate. As such, if the concept of a “forensic audit” in the election administration context has staying power, which is its own research question, it needs definition and consensus. It would be important to explore questions around what the concept means to those advocating it, what it means to the public, and what it means to election administration professionals, as well as other stakeholders including academics. Academics, in particular, have a subfield related to the study of election anomalies which is an attempt to measure election frauds using statistical methods to determine whether the election results are accurate or a distortion of electors’ intentions (Mebane 2023).²³

Important questions include how do academic election forensics intersect with stakeholder and election administrator election forensics? What advancements in academic forensics could we make from greater access to process data? Do certain specific types of audit processes and procedures relate to the concept of a “forensic audit” vs. other types of audit processes? For example, the post-election audit run by Pro V&V on the Dominion Voting Systems Democracy Suite

hardware and software sponsored by the Maricopa County Commission following the 2020 election may represent a type of forensic audit (Cobb 2021). Another important question pertaining to the topic of “forensic audits” is whether it is necessary, useful, and/or ultimately harmful for forensic audits” to include the interviewing of voters and public citizens about their voting habits?

For example, in Otero County, New Mexico in 2022, the “New Mexico Audit Force,” an ad-hoc group touting voter integrity efforts, secured access to a list of registered voters and their 2022 Primary Election vote history. The group proceeded to canvass the homes of some voters in the jurisdiction, asking questions targeted at the veracity of their documented voting practices (vis a vis public records), party affiliation, marriage status, etc. Research should attempt to demonstrate whether such post-hoc voter interviews - especially when conducted in an in-person, unsolicited and arguably investigatory format, especially by non-governmental entities, are ultimately helpful to the accuracy of post-election vote verification procedures, and whether they are harmful to voter confidence or discourage turnout.²⁴

The problem here is that in the financial world, financial forensic audits happen routinely to ensure that, for example, bank records and corporate records match. However, in these instances someone can write a check and that check deposit can be audited in the system. In the election world, this is much more complicated because ballot privacy is essential and therefore ballots are anonymous and not connected to their electors. Voter and ballot privacy norms make typical financial forensic audit formats impossible. That does not necessarily mean that there cannot be voter audits that have similar characteristics as those in financial forensic audits but careful attention to formats that protect the voter privacy and voting rights will be essential. Election officials and researchers will need to explore what financial auditing rules can apply and when.

Lastly, many voter integrity groups seeking to conduct “forensic audits” have also sought access to highly sensitive documentation and/or election systems themselves to verify whether those systems could have been hacked, tampered with, etc. With few exceptions,

23 Also see Beber and Scacco 2012; Deckert, Myagkov, Ordershook 2011; Jiménez and Hidalgo, 2014; Cantu 2019.

24 The Department of Justice has in particular raised questions about this practice see p. 8 of the Department of Justice Audit Guidance, available at: <https://www.documentcloud.org/documents/21018516-doj-audit-guidance>.

jurisdictions across the country have limited or completely restricted access to systems and documents that provide information about security protocols, database infrastructure, etc. to limit the security risk to those systems.

Access to voting tabulators, whose internal workings are largely proprietary in nature, is highly discouraged and usually completely restricted outside of authorized personnel (election officials and certified vendors). Whether or not a forensic audit of such systems is complete without such access is an important question. And whether the benefit of restricting access to keep such systems secure and limit tampering and risk, vs. making their inner workings available for “forensic audit,” is an important normative question as well.

6. AUDIENCES

The study of election administration is a multidisciplinary and interdisciplinary field and includes scholars from political science, statistics, accounting, engineering, computer science, public policy, and public administration. It is also a very applied field for an academic enterprise with strong connections to the election community. Election administrators, election officials, non-governmental organizations, and academics often work together to advance the field.²⁵

Given this backdrop, it is important to understand that there are multiple audiences to consider especially when research is focused on broader processes and compliance audits. Who are the consumers of the information an election audit produces? If audits are essential to the accountability and transparency of the election process, this is an important research question to be addressed.

To set the stage, it is most important to identify what, or who, are the audiences that want to receive this information, and for what purpose? The recent increase in public interest in the tabulation audit process necessarily drives this primary question. When the initial question has been addressed, the logical next question is, what is the best process to produce information relevant to that audience?

In the vein of exploring how to communicate relevant information to relevant audiences, a further research question could address how auditing processes and results can be most easily communicated and disseminated to interested audiences?

Further, it is useful to understand who might help to validate the results of the audit? In other words, who are the trusted officials or figures that can vouch for the accuracy and integrity of the process?

25 A good example of this is a collaborative research design between academics across the country, MEDSL, and election officials sponsored by the Bipartisan Policy Center on election lines during in-person voting. The resulting paper was Stein, Robert M et al. 2020. “Waiting to Vote in the 2016 Presidential Election: Evidence from a Multi-County Study,” *Political Research Quarterly* 73(2):439-453, available online: <https://doi.org/10.1177/1065912919832374>

There are both internal and external stakeholders' audiences and they have different needs. Internal stakeholders are election administrators, election staff, election boards, canvas boards; state government officials (e.g., fiscal/financial bureaucrats, human resources managers, county/municipal administrators, election vendors, IT teams). External stakeholders include "The Public," legislators/policymakers, candidates, political parties, poll watchers, poll observers, election observers, activists/advocates, good government groups, media, voters and academic researchers.

For example, in contemplating tabulation audits, the likely answer to the question of audience is wide-ranging, to include both internal and external stakeholders. Both media coverage since 2020, and the existing academic research, suggest that the questions answered by tabulation audits (specifically those focused on the accuracy of vote counting systems) are not only useful to improve internal functions and election processes, but also to demonstrate through audit systems the accuracy and legitimacy of the election process to the public and other stakeholders. This also helps to improve internal functions as audits produce information about successes and failures and the efficacy of policy implementation. It would seem critical, therefore, to design tabulation audits to build trust among stakeholders by making the results transparent, digestible, and analyzable.

In contemplating process audits, the question has multiple dimensions. Process audits – such as those which check the accuracy of the voter rolls, the accuracy of precinct maps, audit the chains of custody and ballot accounting and reconciliation, and the integrity of the voter check-in process, while important to validating the accuracy of the election especially when things go wrong are also very useful to the election administrators and other internal stakeholders that would use such audit-produced information to improve the efficiency and overall quality of the election process and improve the experience of voters.

However, it is arguable that with the rise of election integrity activists, in addition to those stakeholders in the public sphere who have become interested in the inner workings of the election process, these types of audits should also be relevant to these external stakeholders as well to ensure the internal security of the process as it relates to determining the correct outcome. Therefore, it may be important in these process audits to construct the processes guiding such audits, as well as the reports and information produced by them.

Research should examine the efficacy of the audit process as it pertains to the intended (and unintended) sets of stakeholders who will utilize the information produced by such a report. Not only should questions of the efficacy of the audit *process* be focused on the specific data to be analyzed, but also *how* that data should be analyzed. For example, is the initiation of the audit automatic or discretionary? Are the processes set forth in statute? Are the processes publicly observable and, if so, what mechanism(s) for making those processes public are most efficacious?

Considering a diversity of potential audit report consumers, we return to the discussion above regarding the audiences for auditing analyses. Important research questions regard who are the audiences for audit reports and information, how do the needs of each audience differ (for example, voters or stakeholders or election officials), and how can auditing information best be communicated to each audience? Of these, much thought needs to go into *how* auditing reports are constructed. As such reports are importantly addressed to both internal and external stakeholders – groups with widely varied knowledge and experience of the subject matter inherent within – it would be useful for future research to explore the best ways to present such information in a manner that is useful to a wide variety of audiences.

The research can and should explore, most importantly, how detailed should an audit report be? Should such reports include detailed primers for understanding the election and/or audit process(es) included in the report? Can the wide variety of experience and knowledge of potential stakeholders be simply addressed by an executive summary, content of the report, and indices/subsections?

Research can also explore what information makes for a digestible audit to the public, election officials, and legislators? Are there, and what kind of data standards could be considered for efficiency across states and localities? And, due to privacy concerns, what data are available through FOIA requests and what data is not available?

7. AUDIT REPORTING AND CURATION AND DATA REQUIREMENTS

To fulfill the expectations of audits, audit results need to be reported clearly and made widely available. Greater transparency of audit results and data will require a multi-pronged approach. Research on best practices for reporting across jurisdictions within a state, producing greater intrastate uniformity is a start, but the goal should also be some sort of interstate uniformity at least in terms of key variables or key data available for review. Second, to the degree that audit results are a local-government function, local election officials need the capacity to report those results—again, just as readily as they report the official election results themselves. Beyond the more established tabulation audits, data release and availability for other areas of concern may implicate voter privacy and security. In these cases, data sharing agreements may need to be developed for third-party auditing.

Therefore, we suggest that it is worthwhile to consider providing the resources necessary for election officials and academics to iron out the issues related to sharing and using auditing data. Additionally, resources might be needed to engineer secure data pipelines, storage, and computational infrastructures for the development of fast, reliable, and actionable auditing of large administrative datasets. How to maintain operational security and voter privacy, while providing the necessary information and reporting it out to the public, is going to be an important but sensitive discussion. Funding a committee or multiple state or local-academic partnerships to work on considering the problems and solutions for data sharing may be important. The National Association of Secretaries of State (NASS) or the National Association of State Election Directors (NASED) might be good pathways to form a committee to work on this question. The committee should consist of local election officials, election directors, and academics. This should be funded by nonpartisan 3rd party groups like the Bipartisan Policy Center or other demonstrably nonpartisan organizations.

One related research problem regards the development of appropriate means for retention and long-term storage of both auditing reports as well as the materials and data that are behind them. Determining the best practices for how jurisdictions and states can retain and use the materials and data from each audit that

they conduct to inform future behavior is another significant research topic. What materials need to be retained? How can they be stored, but made accessible for future use, in an efficient and cost-effective manner? What types of methodologies need to be used to compare the results from a contemporary audit with past historical audits? Auditing within-jurisdiction can spot important issues, but as social scientists know it often requires a comparison between jurisdictions for analysts to spot specific patterns in particular jurisdictions that are not obvious unless comparative cross-jurisdiction analyses of auditing materials and results is conducted. Research into which auditing domains might be best suited for comparative analyses, how those analyses should be conducted, what methods should be used, and who might be best suited to conduct such comparative studies, is necessary.

Finally, many of the material that form the basis for election auditing may be confidential. This is particularly true for election artifacts like ballot images and voter registration data. As we have noted the need for auditing materials like these to be retained, and in some cases possibly shared across jurisdictions and with outside parties and partners, there is a pressing need to research how election data and materials can be retained and shared in ways that protect the privacy of voters, and which can preserve the security of these materials. There is a vibrant and growing research literature on information and data security (Jarmul 2023). We recommend that research into how to secure election auditing materials and make them available for sharing in ways that do not violate privacy and confidentiality be initiated.

8. CONCLUSION

Our essay is meant to map out (1) the state of the field, (2) important empirical claims about election auditing where there is consensus about best practices, and (3) where future research in the field should be directed. The fact is that we know little about election auditing except as it relates to tabulation audits and even then, from a research standpoint there are still many questions to answer, much of the research is still in its infancy with developing standards, and best practices have not been widely established. Election audits are important because they provide evidence for a well-run and legitimate elections. Yet, voters, stakeholders, researchers and even election officials may not have looked at many of these processes to determine how they help ensure a trustworthy election.²⁶

Therefore, when we consider the entire election ecosystem, there are many opportunities for election administrators and academics to work together to create broader transparency around election audits, define how they contribute to the evidence for a trustworthy election, and how this information can successfully be transferred to the public, candidates, and other stakeholders. Therefore, our essay presents a variety of research questions around tabulation audits, voter registration systems, process audits, data curation and reporting, tests on how audits do or do not increase public confidence in election outcomes, questions about sample size, data issues in election audits, and potential data standardization across jurisdictions within states, and even better ways to create standardization in audit reporting across states.

In sum, we believe that documenting and learning more about tabulation audits and expanding election auditing into other areas is critical and have outlined particularly useful research questions that will improve election processes and advance the field of election science.

²⁶ Though see <https://www.electionsgroup.com/exploring-audits-series>.

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Jennifer Morrell (jennifer@electionsgroup.com) is the CEO and co-founder of The Elections Group, where she creates professional resources for elections officials and consults on election administration and auditing. She is a nationally recognized expert on election audits – specifically, Risk-Limiting Audits (RLA) – Morrell has successfully overseen RLA pilot programs in several states and authored a series on election audits, titled “Knowing It’s Right.” She serves as a subject matter expert for the U.S. Department of Homeland Security’s Cybersecurity and Infrastructure Security Agency (CISA) and is a member of the National Task Force on Election Crises. Since co-founding The Elections Group in 2020, she has focused her work on providing direct support to elections jurisdictions and states. She has consulted and provided guidance on all aspects of elections administration, including mail/

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Maggie Toulouse Oliver (magtoulouse@gmail.com) is the 26th Secretary of State of the state of New Mexico. She was first appointed to public office in 2007 when she became County Clerk in New Mexico’s largest county, Bernalillo County. Elected to her first full term in 2008, Secretary Toulouse Oliver served 2 1/2 terms as County Clerk until she was elected as Secretary of State in 2016. Overseeing elections in the state’s largest county gave Secretary Toulouse Oliver detailed, on-the-ground expertise in election administration that has helped to guide her current work overseeing elections statewide. Since becoming Secretary of State she has implemented increased transparency rules for financial disclosure and campaign finance reporting, modernized the online campaign finance system, helped craft and pass good government legislation like same-day voter registration, automated voter registration, and the state’s newly-formed Ethics Commission. In addition to her elected position, Secretary Toulouse Oliver is currently serving a third term as the elections-committee co-chair and is a former President of the National Association of Secretaries of State (NASS). She has also previously served NASS as President-Elect, Treasurer, and co-chair of the elections committee. She is currently a member of the University of Southern California Annenberg Center’s Voter Communication task force, an advisory board member for the Election Official Legal Defense Network co-founded by national election law experts Benjamin Ginsburg and Bob Bauer, and a founding and current member of the DHS-CISA Government Coordinating Council for the Election Infrastructure Subsector (EIS-GCC).

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