# TRUCK PARKING INFORMATION SYSTEMS: TRUCK DRIVER USE AND PERCEPTIONS

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## ACRONYMS

| | |
|---|---|
| AASHTO | American Association of State Highway & Transportation Officials |
| AMPO | Association of Metropolitan Planning Organizations |
| ATA | American Trucking Associations |
| ATRI | American Transportation Research Institute |
| CMS | Changeable Message Sign |
| DMS | Dynamic Message Sign |
| DOT | Department of Transportation |
| DSRC | Digital Short-Range Communications |
| ELD | Electronic Learning Device |
| FDOT | Florida Department of Transportation |
| FHWA | Federal Highway Administration |
| IVR | Interactive Voice Response |
| MAASTO | Mid-America Association of State Transportation Officials |
| MATS | Mid-American Trucking Show |
| MDOT | Michigan Department of Transportation |
| MNDOT | Minnesota Department of Transportation |
| MUTCD | Manual on Uniform Traffic Control |
| NATSO | National Association of Truck Stop Operations |
| NTSB | National Transportation Safety Board |
| OOIDA | Owner-Operator Independent Driver Association |
| RAC | Research Advisory Committee |
| TDOT | Tennessee Department of Transportation |
| USDOT | United States Department of Transportation |
| VDOT | Virginia Department of Transportation |
| VMS | Variable Message Signs |
| XML | Extensible Mark-up Language |

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## BACKGROUND

Since 2015, the lack of available truck parking has been consistently ranked as one of the top-five industry concerns among trucking stakeholders.[1] Among truck drivers, the issue ranks as the top concern.[2] Drivers frequently report parking on shoulders, ramps or other undesignated locations when there is no available truck parking.[3] Prior research also identified an economic impact from the lack of available parking. Drivers will often park earlier to ensure they find safe parking prior to running out of hours-of-service. The lost wages associated with early exit from revenue trips averages over $4,600 annually per driver.[4]

In 2012, Congress passed "Jason's Law," which recognized the safety risks truck drivers face from a lack of available parking and created a national priority for relieving the shortage.[5] However, nine years after enactment of Jason's Law, the lack of safe parking still plagues the industry.

## STATE-LEVEL TRUCK PARKING INITIATIVES

Passage of Jason's Law has led to more states initiating studies to identify solutions to the truck parking shortage. These studies consistently identify a need for real-time parking availability updates. The I-95 Corridor Coalition (now called the Eastern Transportation Coalition), comprised of 17 state Departments of Transportation (DOTs), has reported that when faced with no real-time parking information, drivers often miss legal opportunities to park.[6] In 2000, the National Transportation Safety Board (NTSB) recognized the need for real-time truck parking information to help alleviate the current truck parking shortage.[7] In 2010, a California survey found that over 70 percent of drivers surveyed would use updated truck parking information to make decisions about where to park, confirming the NTSB's finding more than a decade later.[8] Multiple states have begun to test new technologies to provide real-time parking updates through the use of weighted pads, cameras, and exit and entrance sensors.

There are a variety of current technologies used by states to monitor parking availability that can be broadly categorized into two types, sensing technologies and dissemination technologies. Sensing technologies are generally defined as systems that sense the presence of trucks in parking spaces or facilities, whereas dissemination technologies are generally defined as systems for distributing the gathered parking data to interested parties. In terms of sensing technologies, they can typically be differentiated by direct and indirect methodologies. Indirect parking methodologies are, "[…] detecting and classifying vehicles at all ingress and egress points of the parking facility and summing the difference over accumulated counts at specified

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[1] "Critical Issues in the Trucking Industry – 2020." American Transportation Research Institute. October 2020.
[2] Ibid.
[3] Boris, Caroline and Rebecca M. Brewster. "Managing Critical Truck Parking Case Study – Real World Insights from Truck Parking Diaries." American Transportation Research Institute. December 2016.
[4] Ibid.
[5] Smith, Summer. "Jason's Law Has Passed, Now What?" CDL Life. July 10, 2012. Available online: https://cdllife.com/2012/support-jasons-law/
[6] I-95 Corridor Coalition. "I-95 Corridor Coalition Truck Parking Initiative: Concept of Operations Version 4.0." November 24, 2010. Available online: https://i95coalition.org/wp-content/uploads/2015/02/I-95-CC-Truck-Parking-ConOps-Version-4.0-2010-11-24.pdf?x70560
[7] National Transportation Safety Board. "Highway Special Investigation Report: Truck Parking Areas." Report No. PB2000-917001. May 17, 2000. Available online: https://www.ntsb.gov/news/events/Documents/truck_bus-SIR0001.pdf
[8] Rodier, C. J., Shaheen, S. A., Allen, D. M., Dix, B. "Commercial Vehicle Parking in California: Exploratory Evaluation of the Problems and Solutions." California Path Program, Institute of Transportation Studies, University of California, Berkeley. March, 2010.

time intervals."[9] Direct parking methodologies detect the number of parking spaces available for each individual parking space. Table 1 provides information on various sensing technologies.[10]

**Table 1. Direct and Indirect Monitoring Technologies**

| Type of Technology | Direct/Indirect Monitoring | Technical Specifications |
|---|---|---|
| Magnetometers | Direct / Indirect | Magnetic "trip wire" monitors trucks at the entrance and exit of parking facility. |
| Entrance/Exit Cameras | Indirect | Different calibrated "trip wires" at the entrance and exit of a parking facility triggers a camera to capture truck counts. |
| In-Pavement Detection Grid | Direct | "Pucks" embedded at two points in each parking space, triggering when both are covered. |
| Parking Space Cameras | Direct | Cameras monitor pixels to "count" the truck spaces occupied by visual recognition; can be either 2-D or 3-D. |

Direct monitoring of parking spaces is preferred by industry over indirect parking monitoring, as it is more accurate over time. Dissemination technologies are equally diverse in the tools and approaches used. Table 2 provides information on the most common dissemination technologies.

**Table 2. Common Dissemination Technology**

| Type of Technology | Mode of Dissemination |
|---|---|
| In-Cab Systems | Telematics or other in-cab systems can provide "push" data on parking availability via multiple formats (e.g. XML feeds or DSRC). |
| Mobile Technologies | Smartphone applications or 511 services using Interactive Voice Response (IVR). |
| Website | State or private websites with XML feeds. |
| Variable Message Signage (VMS) | Variable message signage on roads. |

Table 3 provides a summary of public sector truck parking information projects undertaken throughout the U.S., including the Table 1 and Table 2 technologies utilized, and the scale of implementation across each state.[11]

[9] Morris, T., Morellas, V., Pananikolopolous, N., Cook, D., Murray, D., Fender, K., Weber, A. "A Comprehensive System for Assessing Truck Parking Availability." Center for Transportation Studies, University of Minnesota. January, 2017. Retrieved from https://www.dot.state.mn.us/ofrw/PDF/assessing-truck-parking.pdf

[10] Ibid.

[11] Original Chart: U.S. Department of Transportation, Federal Highway Administration. "National Coalition on Truck Parking: Technology and Data Working Group – Truck Parking Availability Detection and Information Dissemination." February,19.https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/workinggroups/technology_data/product/best_practices.htm

**Table 3. State and Multi-State Projects**

| Project | Caltrans | Minnesota DOT | Colorado DOT | Florida DOT | Michigan DOT | I-95 Corridor Coalition | Tennessee | Mid-America Association of State Transportation Officials |
|---|---|---|---|---|---|---|---|---|
| **Funding Agency** | FHWA and Caltrans | MNDOT and FHWA | Federal Funding and Colorado DOT | FHWA and FDOT | FHWA and MDOT | FHWA, MDOT, and VDOT | FMCSA and TDOT | USDOT through TIGER grants |
| **Location** | One privately owned site on I-5. | Three public rest areas along I-94. It will also integrate with the Wisconsin I-94 system. | Six locations during the first phase, with a final goal of deploying across the state on I-25, I-70 and I-76. | A total of 68 locations will be active by April 2019. Seven rest areas and weigh stations along I-4 and I-95 are scheduled for phase 1. | Seven private truck stops and five public rest areas. | The system is active at two rest areas in I-95 and two more on I-64 Virginia. Testing was done at rest areas on I-95. | Two rest areas. | Eight MAASTO states: Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Ohio, and Wisconsin |
| **Information Dissemination** | Website, mobile apps, and IVR | DMS, website, in-cab geolocation application device integrated with existing ELD and XML feeds for third-party use. | DMS with type "A" Inserts, website, mobile apps, and XML feeds for third-party use. | DMS, website, mobile apps, DSRC-enabled in-cab devices, and XML feeds for third-party use. | DMS with type "A" inserts, DSRC-enabled in-cab devices, websites, and mobile apps. | Website, IVR and XML feeds for third-party use. | Website, DMS with type "A" inserts, in-cab devices, mobile apps, and XML feeds for third-party use. | Website, DMS with type "A" inserts, mobile apps, and in-cab devices. |
| **Sensing Technology (Categorized)**[12] | In/Out and Space-by-Space | Space-by-Space | In/Out and Space-by-Space[13] | In/Out and Space-by-Space[14] | In/Out and Space-by-Space | In/Out and Space-by-Space | In/Out and Space-by-Space | In/Out and Space-by-Space |

[12] In/Out Detection is defined as, "[c]ounting vehicles as they come in and as they leave a facility", and Space-by-Space detection is defined as, "[s]ensing a vehicle parked in an assigned location."
[13] Colorado utilized different technology for Weigh Stations and Rest Areas.
[14] Florida utilized different technology for private parking areas and public parking areas.

As shown in Table 3, there are differences in programs with respect to how the information is collected and disseminated to truck drivers. These disparities can create confusion for truck drivers who may not know where or how to access truck parking information state to state, or how to interpret different availability scales.

## RESARCH OBJECTIVE

The need for more consistency in disseminating truck parking availability information to drivers led the American Transportation Research Institute (ATRI) Research Advisory Committee (RAC)[15] to rank "Standardizing Truck Parking Information Systems" as a top research priority for 2019. The goal of the research was to identify how drivers are currently receiving truck parking availability information and driver preferences for how that information is disseminated.

## METHODOLOGY

In 2019, ATRI developed and conducted a truck driver survey at the Mid-America Trucking Show (MATS). Following MATS, ATRI posted the survey on its website (www.TruckingResearch.org) from March 28, 2019 through May 27, 2019. The survey was advertised through industry trade press and through interviews on Sirius XM Radio. A copy of the survey can be found in Appendix A.

## RESPONDENT DEMOGRAPHICS

A total of 1,103 drivers completed the survey. While a majority of the respondents were male (83%), 17 percent were female, representing a much higher percentage than the industry overall where women represent just 6.7 percent of the driver population.[16] A majority of respondents (90.3%) were between 25 and 64 years of age, with drivers 45 to 64 representing 66.2 percent of the respondents. Additionally, a majority of respondents (68%) have 11 or more years of experience as a commercial driver. The respondent demographics are shown in Table 4.

**Table 4. Survey Respondent Demographics**

| Gender | Percent |
|---|---|
| Male | 83% |
| Female | 17% |
| **Age** | |
| Under 25 | 2% |
| 25-44 | 24% |
| 45-64 | 66% |
| 65+ | 8% |

[15] ATRI's Research Advisory Committee is comprised of industry stakeholders representing motor carriers, trucking industry suppliers, labor and driver groups, law enforcement, federal government, and academics. The RAC is charged with annually recommending a research agenda for the Institute.
[16] "Trucking Trends 2019." American Trucking Associations. 2020.

| Years of Driving Experience | Percent |
|---|---|
| Less than 1 Year | 5% |
| 1-5 Years | 15% |
| 6-10 Years | 12% |
| 11+ Years | 68% |
| **Industry Segment** | |
| For-Hire | 70% |
| Private | 24% |
| Don't Know | 6% |
| **For-Hire Sector** | |
| Truckload | 67% |
| Specialized/Flatbed | 12% |
| Less-than-Truckload | 9% |
| Other | 11% |
| **Employment Type** | |
| Company Driver | 65% |
| Owner-Operator | 33% |
| **Average Length of Haul** | |
| Local (< 100 miles per trip) | 8% |
| Regional (100 – 499 miles per trip) | 26% |
| Inter-Regional (500 – 999 miles per trip) | 35% |
| Long-Haul (1,000+ miles per trip) | 31% |
| **Fleet Size** | |
| < 5 power units | 18% |
| 6-50 power units | 19% |
| 51-500 power units | 26% |
| 501- 1,000 power units | 14% |
| 1,001+ power units | 23% |
| **Vehicle Configuration** | |
| 5-axle Dry Van | 39% |
| 5-axle Refrigerated Trailer | 19% |
| 5-axle Tanker | 15% |
| 5-axle Flatbed | 14% |
| Longer Combination Vehicles | 4% |
| Other | 8% |

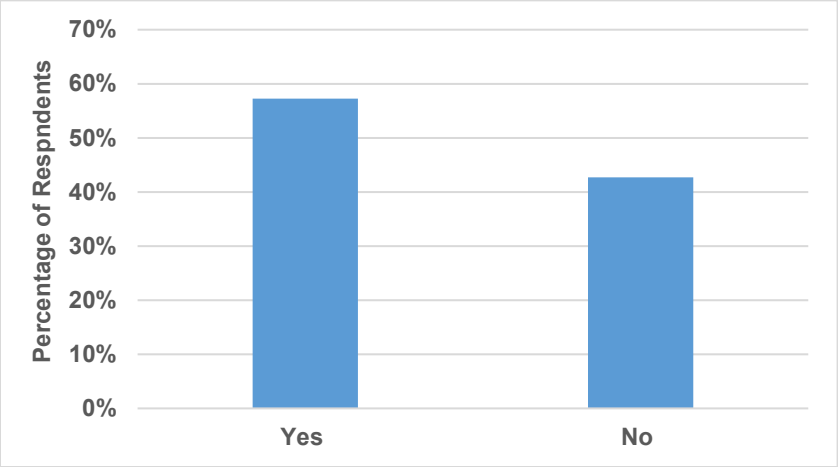
## RESULTS

*Smartphone-Based Truck Parking Apps*

In recognition of the need for real-time truck parking availability information, a number of providers have launched smartphone-based apps for drivers over the last several years. These apps provide information on the number of available spaces, amenities offered, and other useful information. One challenge for drivers using the parking availability apps is the federal "one button press" restriction on handheld mobile devices while driving a commercial vehicle,[17] which generally means a driver must already be parked somewhere to utilize the truck parking availability app for parking needs down the road.

Drivers were asked about their use of truck parking apps over the last 12 months. As shown in Figure 1, 57.3 percent of drivers indicated that they had utilized a truck parking app in the past year. This is similar to research from 2016 where 55.5 percent of drivers reported using websites and smartphone-based apps to find available truck parking.[18]

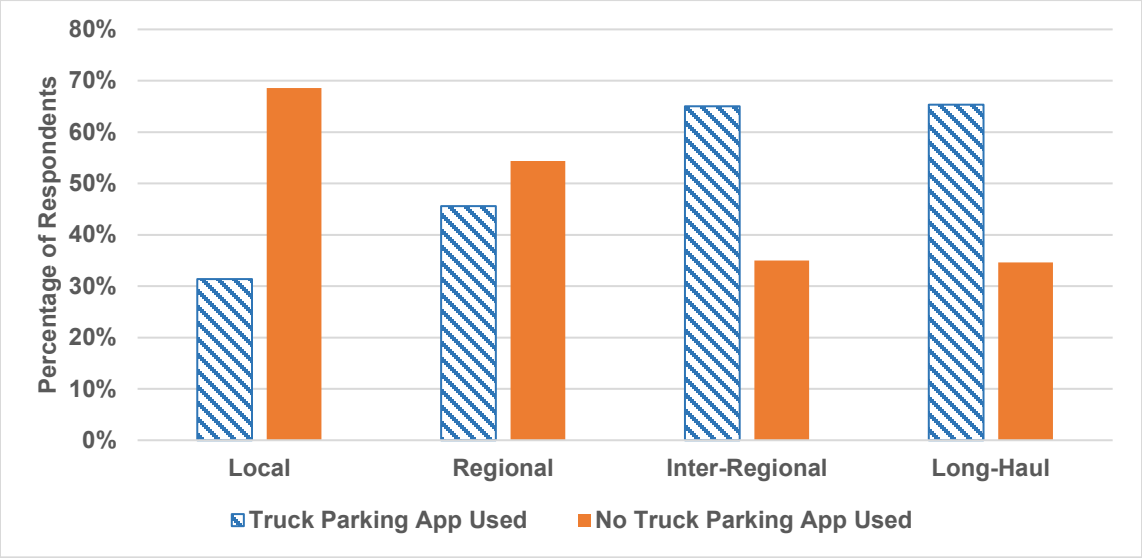
**Figure 1. Respondent Use of Smartphone-Based Truck Parking Apps in the Previous 12 Months**




As would be expected, drivers with longer average trip lengths were more likely to report using a truck parking app than local or regional drivers whose average trips do not typically require them to locate truck parking (Figure 2).

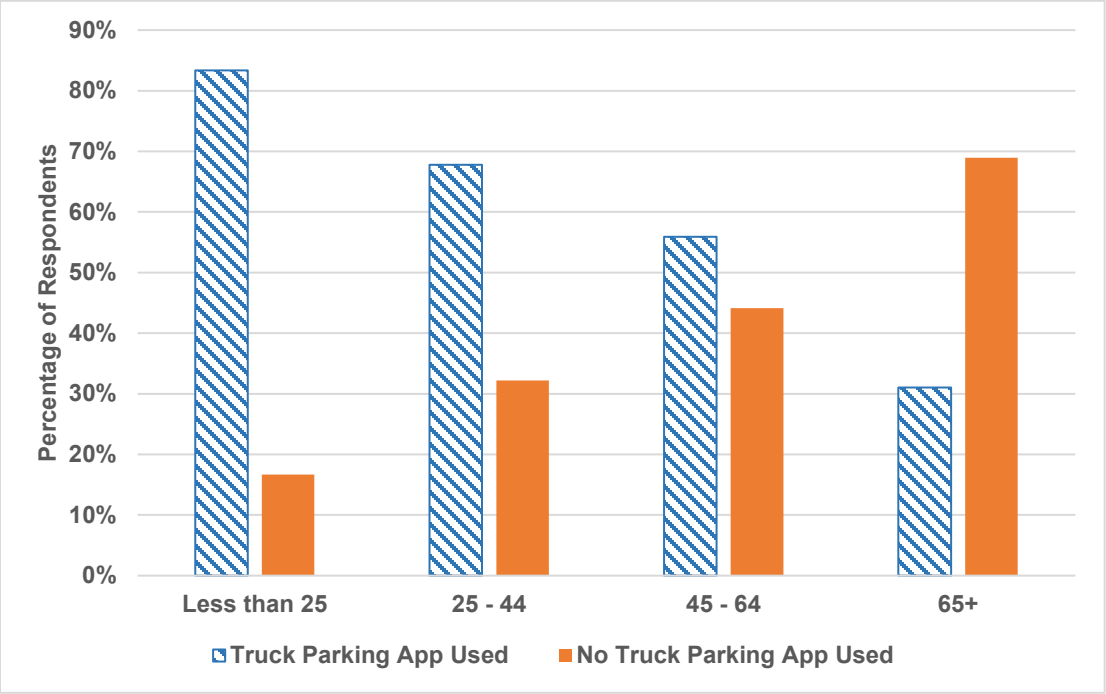
[17] "Mobile Phones Restrictions Fact Sheet." Federal Motor Carrier Safety Administration. Available online: https://cms8.fmcsa.dot.gov/driver-safety/distracted-driving/mobile-phone-restrictions-fact-sheet.
[18] Boris, Caroline and Rebecca M. Brewster. "Managing Critical Truck Parking Case Study – Real World Insights from Truck Parking Diaries." American Transportation Research Institute. December 2016.

**Figure 2. Smartphone-Based Truck Parking App Use by Average Length of Haul**



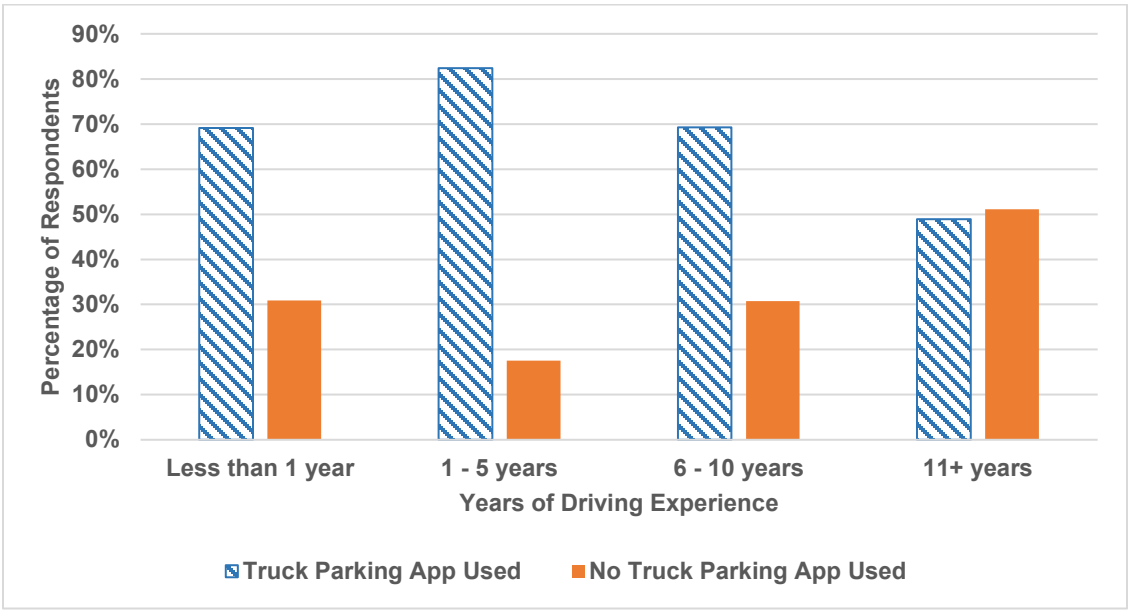

Use of truck parking apps was also more prevalent among younger drivers, with 68.7 percent of drivers under 45 years of age reporting use (Figure 3). It is unknown if this is a function of veteran drivers already knowing when and where they plan to park, or younger drivers being more tech-savvy.

**Figure 3. Smartphone-Based Truck Parking App Use by Age**




Similarly, use of apps was higher among new entrant drivers; drivers with five years of experience or less were almost two times more likely to use a truck parking availability app than drivers with 11 or more years of experience (Figure 4).

**Figure 4. Smartphone-Based Truck Parking App Use by Years of Driving Experience**



In addition, a slightly higher percentage of female drivers reported using truck parking apps than male drivers (66.2% for females, 56.2% for males).

Other notable findings on the use of smartphone-based apps for truck parking availability include the following:

- Drivers paid by the mile were approximately two times more likely to use a truck parking app than drivers paid by the hour.
- Use of truck parking apps was highest among drivers working for larger fleets, with 65 percent of drivers working for fleets of 1000+ trucks using truck parking apps, compared to 51 percent of drivers at fleets with 20 or fewer trucks.

In order to gauge driver loyalty with truck parking apps, respondents were asked to indicate if they were still using the same truck parking app(s) as they had used in the past 12 months. Seventy-one percent of respondents indicated that they were still using the same apps to identify available truck parking. Among the reasons that drivers listed for why they continued or discontinued use of truck parking apps are listed below.

Continued Use

- Up-to-date, accurate information
- Ability to reserve parking spaces in advance
- Convenience

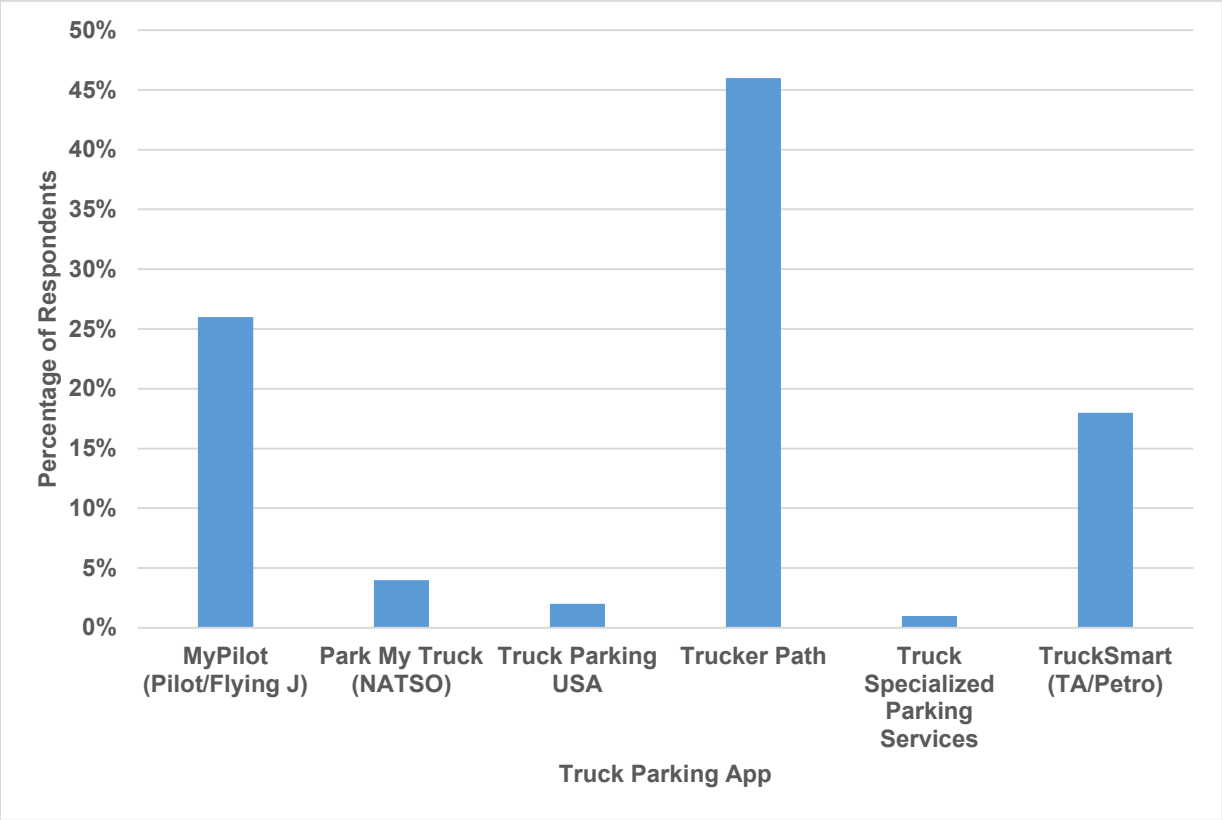
Discontinued Use

- Lack of Accuracy
- Need for multiple applications
- Difficult-to-navigate technology

Interestingly, drivers indicated that accuracy was both a reason for continued use and discontinued use, but in both cases “accuracy” was both important and influential. The perception of accuracy differs from individual to individual, with some citing their respective truck parking app as accurate, whereas others found truck parking apps to be inaccurate. This could be a result of either differences in technology designs or individual levels of patience, as many of the positive responses to accuracy were caveated. Drivers were also asked which truck parking apps they currently use. Figure 5 shows the percentage of respondents mentioning each of the apps referenced by drivers.[19]

[19] Percentages do not add up to 100 percent, as some drivers used multiple applications. Each time an application was mentioned, it was included in the total sum.

**Figure 5. Truck Parking Apps Used by Drivers**

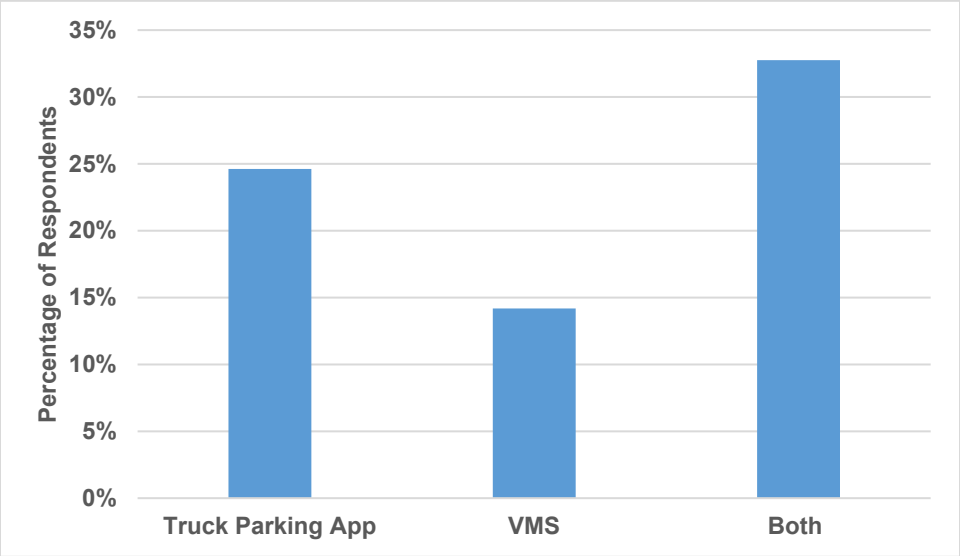



The top three most frequently cited truck parking apps were Trucker Path (46.4%), MyPilot[20] (26.3%) and TruckSmart (18.0%). As previously noted, truck driver demographics correlate with different degrees of usage: use of truck parking apps varied by respondents, with older drivers less likely to use a truck parking app than younger drivers. Given that 54.3 percent of the industry's driver workforce is 45+ years of age, truck parking apps may not represent a ubiquitous solution for all truck parking needs.[21] Additionally, more experienced drivers were less likely to utilize a truck parking app than newer drivers. This may be a function of more experienced drivers being more familiar with their routes and available parking locations than newer drivers. Thus, providing parking information needs to be multi-functional.

Respondents reported using both variable message signs (VMS) and third-party truck parking apps to identify available parking. This relationship is illustrated Figure 6.

[20] MyPilot became MyRewards Plus as of 3/30/21.
[21] Current Population Survey (CPS) 2019. U.S. Census Bureau and Bureau of Labor Statistics.

**Figure 6. Technology Utilized by Respondents**




Approximately 25 percent of respondents indicated that they use truck parking apps exclusively for identifying available parking, while 14.2 percent of respondents indicated relying exclusively on variable message signs. A plurality of respondents (32.8%) indicated that they used both truck parking apps and variable message signs, which further supports a solution to the parking shortage that incorporates multiple functionalities.

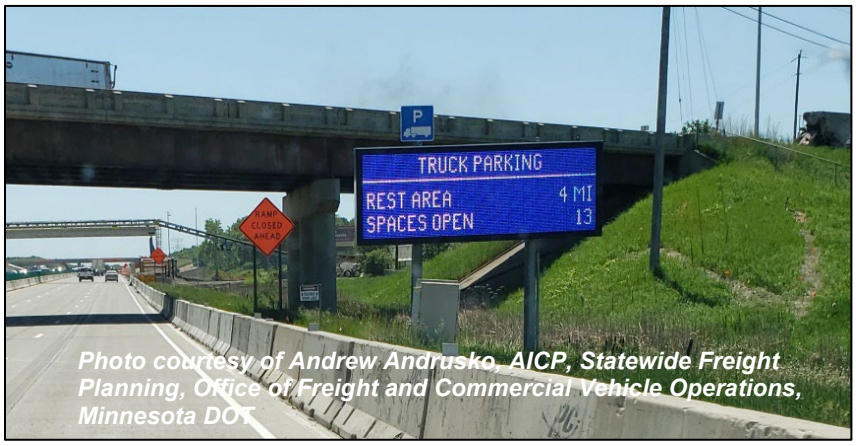



*Photo courtesy of Andrew Andrusko, AICP, Statewide Freight Planning, Office of Freight and Commercial Vehicle Operations, Minnesota DOT*

*Variable Message Signs*

Respondents were asked about their exposure to variable message signs, a solution to the parking problem used by a number of state and multi-state groups. Respondents were asked if they had seen signs, and if the information provided was helpful and accurate. These VMS questions provided information on drivers' level of exposure and level of trust in VMS. As shown in Figure 7, over 70 percent of respondents indicated that they had seen VMS with truck parking information.

**Figure 7. Percentage of Drivers Who Have Seen Variable Message Signs with Truck Parking Information**

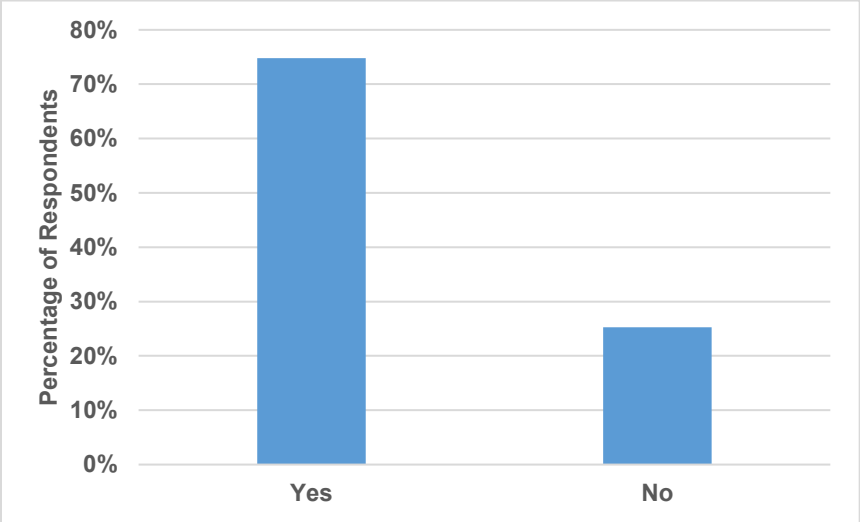
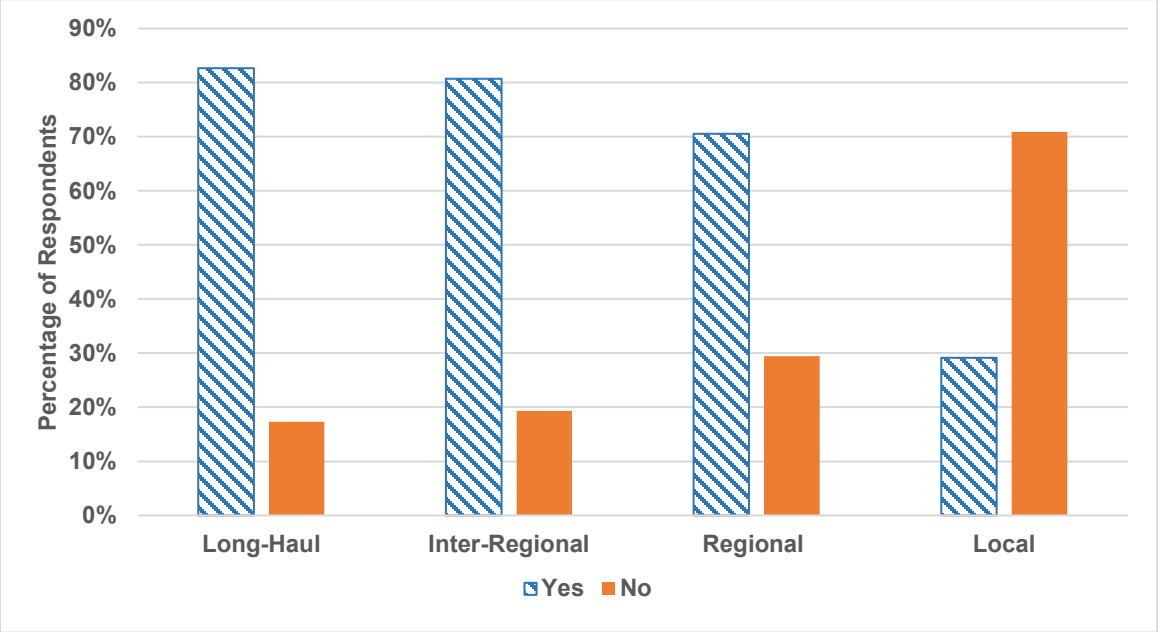



Figure 8 shows that the likelihood that drivers would see VMS with truck parking information increased with their average length of haul. This likely reflects that potential exposure to the VMS signs increases with time and distance.

**Figure 8. Percentage of Variable Message Sightings by Length of Haul**

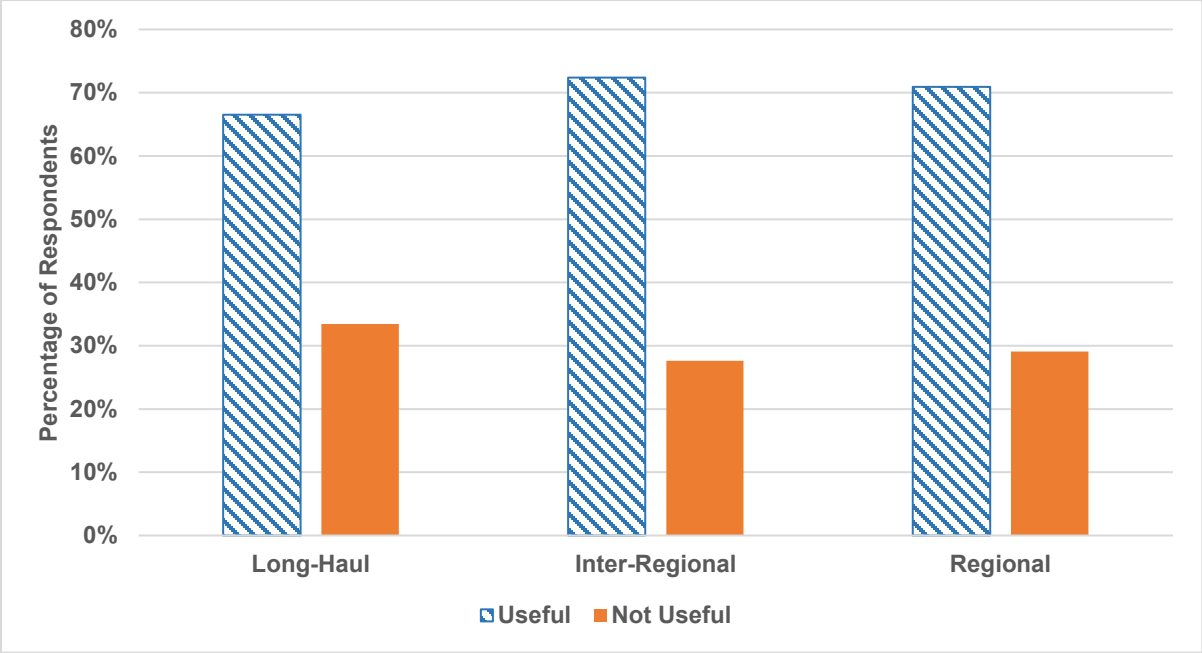



As expected, local drivers represented the smallest percentage of those who had seen variable message signage, with just 29 percent of respondents indicating they had seen VMS for truck

parking information. Truck divers were asked the frequency of VMS sightings by state, and among the states mentioned most frequently were Ohio, Kentucky, Florida and Michigan. The complete listing of VMS sightings by state can be found in Appendix B.

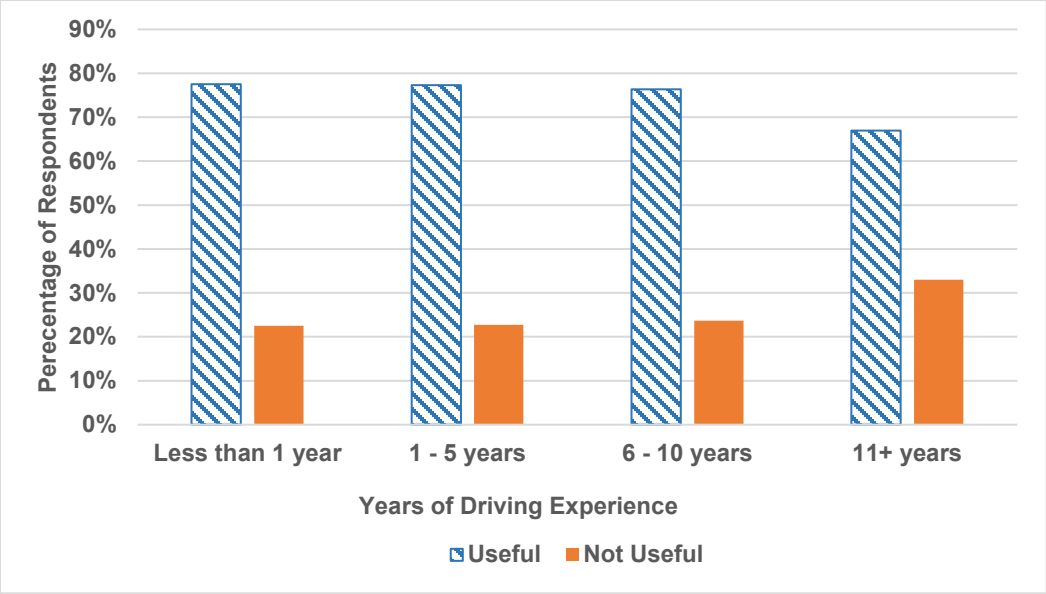
Drivers were asked to rate the usefulness of VMS for identifying available truck parking and as shown in Figure 9, most drivers (in total, 70.1%) indicated that truck parking VMS were useful.

**Figure 9. Usefulness of Variable Message Signage by Length of Haul**



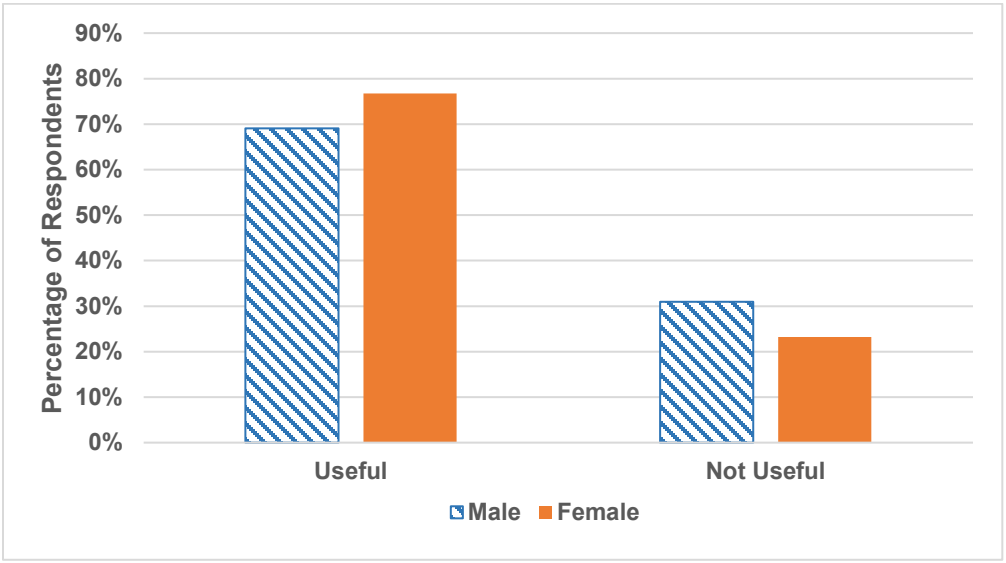

While truck drivers were generally positive about the usefulness of truck parking VMS, long-haul drivers – those whose average length of haul was over 1,000 miles – had the lowest percentage of respondents (66.5%) reporting that the truck parking VMS were useful. This may indicate their need and desire to plan truck parking much farther out than VMS makes practical or their experience and familiarity with regular route parking locations. Figure 10 shows that newer drivers found truck parking VMS more useful than those drivers with 11 or more years of driving experience. Anecdotally, the degree of usefulness of the data likely relates to the degree of perceived accuracy of the technology.

**Figure 10. Usefulness of Variable Message Signage by Years of Experience**




The useful nature of truck parking VMS was viewed differently by male and female respondents, with a higher percentage of female drivers (76.7%) reporting that the information was useful while just 69 percent of male drivers found the information useful (Figure 11).

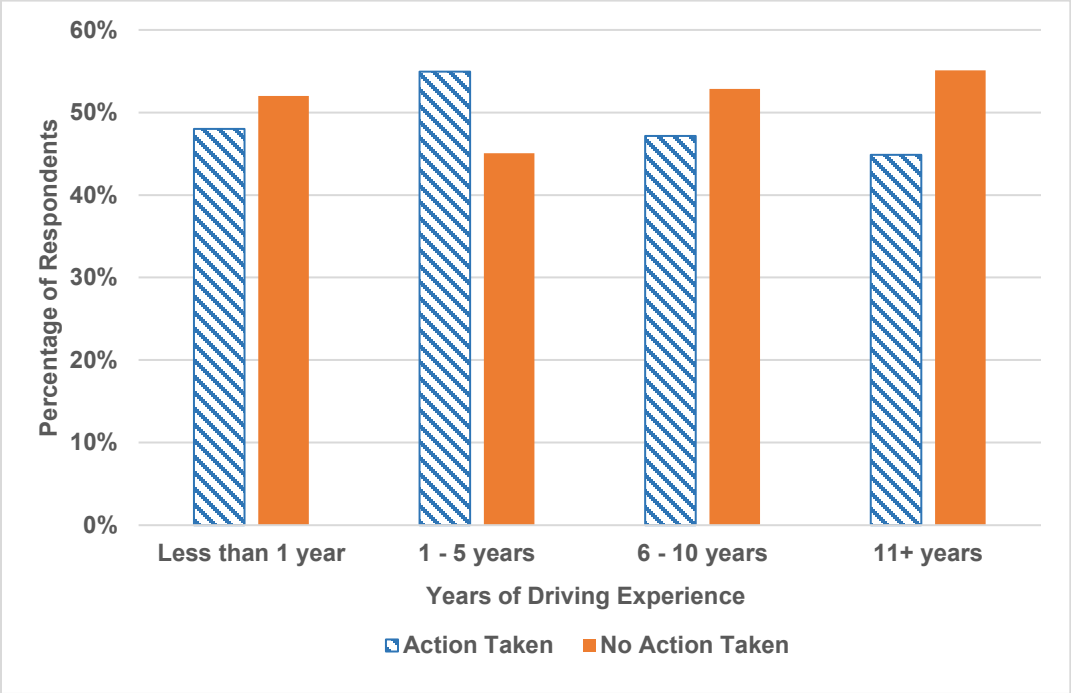
**Figure 11. Perception of Usefulness of Variable Message Signs by Gender**




Drivers were asked if they had ever taken action based on the information that was presented to them through variable message signage. Almost 47 percent of respondents reported taking action based on variable message signs, while 53.1 percent of respondents reported not taking action based on the information presented in these signs. Further broken down, drivers with 1 –

5 years of experience were the only group where a majority of respondents indicated that they had taken action utilizing the information from VMS. This relationship is detailed in Figure 12.

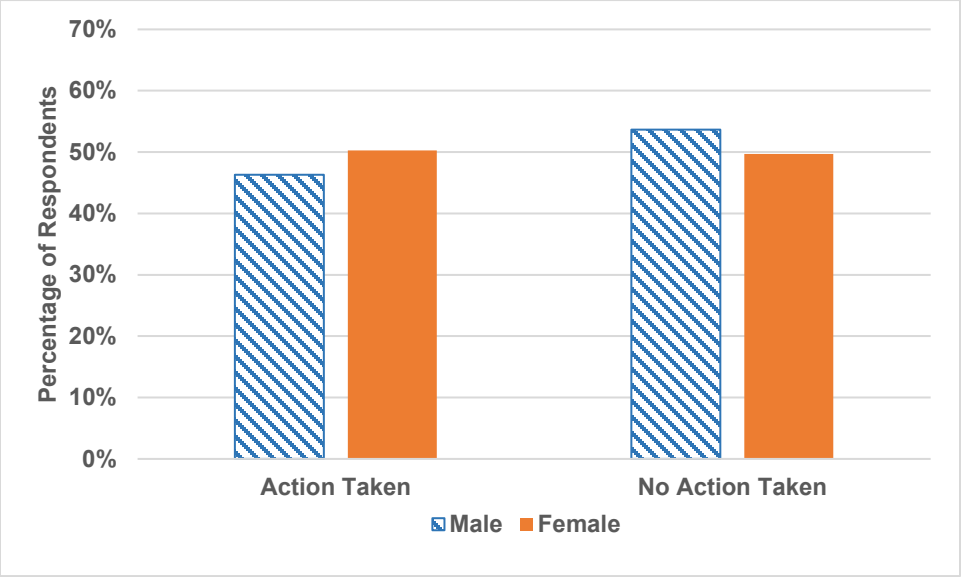
**Figure 12. Action Taken Based on VMS by Years of Driving Experience**




For three of the experience brackets, the majority of truck drivers have not taken action based on variable message signs. Drivers not taking action based on the VMS information appears to result from concerns over the accuracy of signage information, as improved accuracy is a top concern for drivers in the survey.

Gender may play a role in the action taken by truck drivers when confronted with VMS information. Figure 13 documents the relationship between gender and action taken as a result of variable message signs.

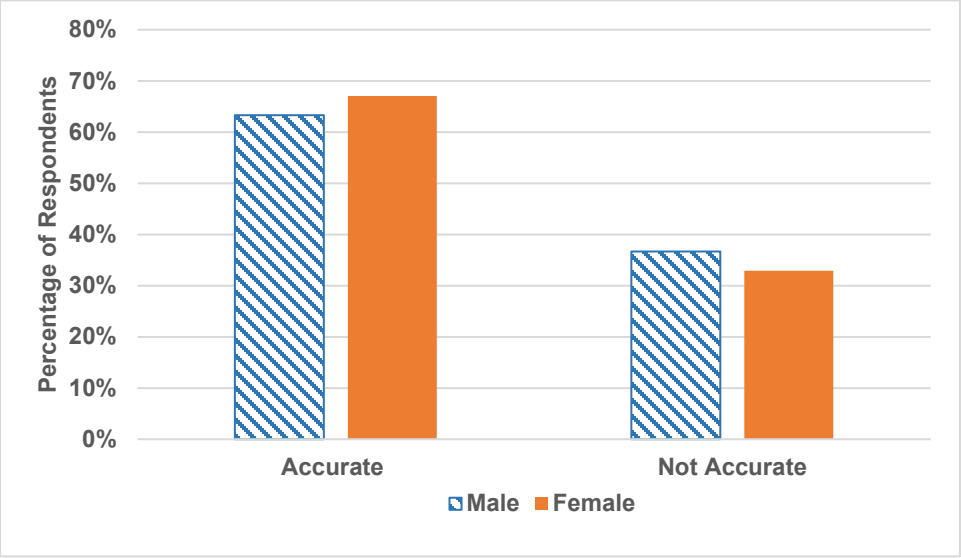
**Figure 13. Action Taken by Variable Message Signs by Gender**




As noted above, action taken in response to variable message signs varies slightly depending on the gender of the respondent. For female respondents, 50.3 percent of respondents took action as a result of a variable message sign. For male drivers, 46.3 percent of respondents had taken action based on a variable message sign.

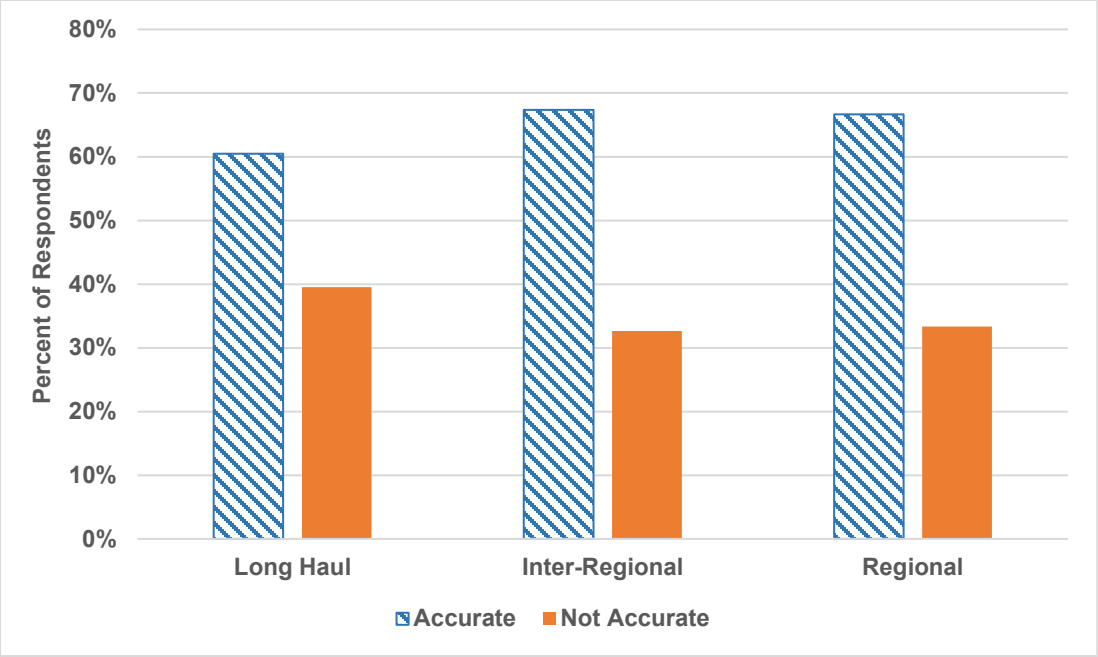
In addition, women believed VMS to be slightly more accurate than did men, with 67.1 percent of women reporting the information they acted on to be accurate, while 63.3 percent of men reported their information as accurate (Figure 14).

**Figure 14. Perception of VMS Accuracy by Gender**



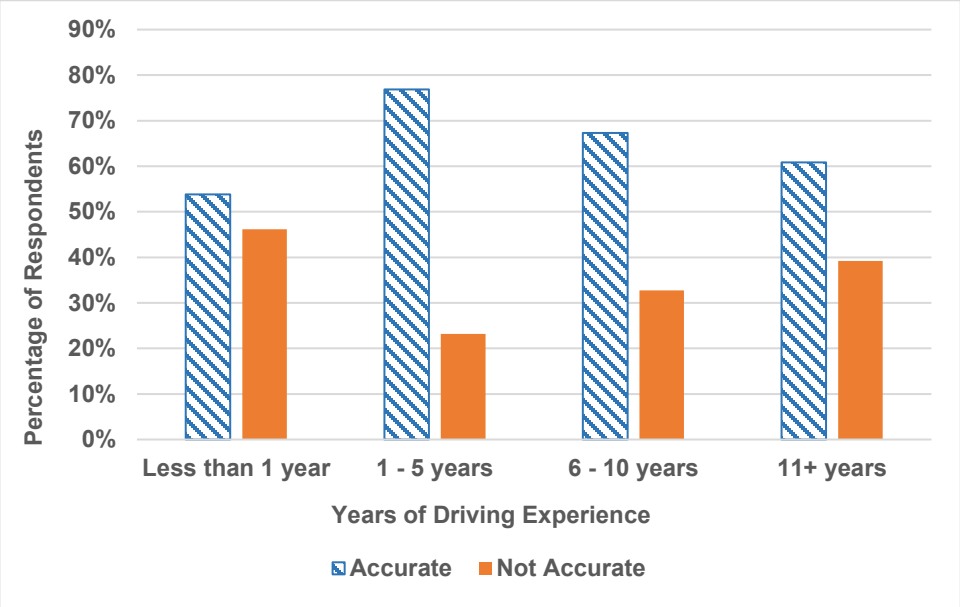
As is the case with app accuracy, VMS accuracy, across all respondents, is extremely important for truck parking information system utilization. Figure 15 illustrates the perceived accuracy of the current adaptive variable signage system, an important predicating factor on its use.

**Figure 15. Percentage of Respondents Who Find VMS Accurate by Length of Haul**




The perceived accuracy of variable message signs is also dependent on experience in the trucking industry, as indicated in Figure 16.

**Figure 16. Perceived Accuracy of Variable Message Signs by Years of Driving Experience**




For drivers with less than one year of experience, the perceived accuracy of variable message signs is mixed; 53.4 percent of respondents in this category find these signs accurate, whereas 46.2 percent of individuals found the signs to be inaccurate. The perceived accuracy by truck drivers increases up to five years of driving experience – with almost 80 percent of all individuals in this category finding the VMS information to be accurate. However, beyond five years of experience, the perceived accuracy of variable message signs decreases, with drivers of 11 or more years of experience finding the signs to be the least accurate. This perception of accuracy is important, as those who do not find the signs accurate will not use them. While the relationship between accuracy and driving experience may have its genesis in experienced drivers having direct familiarity with the parking facilities and space availability (and hence less tolerance for technology inaccuracy), open-ended comments indicate that experienced drivers simply have had more observations and encounters with space availability inaccuracies.

Given that most drivers find VMS to be accurate, they should be considered a core tool for information dissemination, at least until a more standardized and sophisticated information push system is available in the cab. However, these signs are not the only information solution to the truck parking crisis. Other methods are commonly used by truck drivers to monitor truck parking availability including truck parking apps.

Respondents were asked how they would address the current parking shortage. These responses were open-ended, but were binned by general subject matter. Due to the nature of the issues, some of the responses covered multiple subjects and were counted in multiple categories. The results are shown in Table 5.

*"Electronic-display CMS, when used judiciously, provide important, real-time information to travelers for improving the safe and effective utilization of the highways. Their messages help road users navigate congestion and prepare for other unexpected roadway conditions. As official traffic control devices, it is important that all the allowable types of messages displayed on these signs adhere to the most fundamental principles of effective traffic control devices, among which are relevance and timeliness, simplicity and familiarity of message, minimization of legend elements and complexity, and consistency with other types of signs. To maintain the integrity and effectiveness of CMS, prudent judgment should be employed in the determination of the use of CMS as well as the content and syntax of messages displayed thereupon. The adoption by agencies of sound policies governing the judicious use of these official traffic signs is expected to benefit the motorist by preserving their primary use of relevant and timely messages that help the motorist navigate unexpected or unusual traffic and travel conditions."* [22]

**Table 5. Respondent Recommendations for Addressing Truck Parking**

| Recommendation | Percent of Respondents |
|---|---|
| Increase parking capacity | 72.0% |
| Improve placement of the signs and how data is presented (e.g. actual number of spaces available vs. high/low or color-coded availability) | 15.9% |
| Improve accuracy of parking information | 11.8% |
| Improve relevance of parking information (e.g. update more frequently) | 6.3% |

Improving the number of available truck parking spaces was the most frequently cited response. However, due to restrictive zoning rules and land costs, this solution may not be a viable option in all locations. Other solutions proposed include improving the sign placement and how the

[22] Memorandum: U.S. Department of Transportation, Federal Highway Administration. "Official Ruling No. 2(09)-174 (I) — Uses of and Nonstandard Syntax on Changeable Message Signs." January, 2021. Available online: https://mutcd.fhwa.dot.gov/resources/interpretations/2_09_174.htm

parking availability data is presented, improving the accuracy of the information presented, and improving the frequency of information updates.

Accuracy is an important factor in the implementation of a space monitoring system. When asked in a survey, 89.2 percent of drivers responded that they wanted a system to be accurate more than 85 percent of the time.[23] In terms of motor carriers, 86.6 percent of respondents also wanted a system which maintained accuracy over 85 percent of the time. This level of accuracy is met by space monitoring through automated imaging technologies.

The dissemination architecture for this space availability information should consider two primary methods of sharing information, those being variable message signs and smartphone applications. A third ultimate approach is an automated push notification to the driver, through an embedded telematics solution. This was successfully tested in the Minnesota DOT- / FHWA-sponsored "Smart Park 4 Trucks" Field Test, which developed a suite of information distribution tools, and then assessed which were most effective and preferred by truck drivers. The push notification approach minimizes driver distraction and avoids conflicts with FMCSA's smartphone usage ban.

[23] Morris, T., Morellas, V., Pananikolopolous, N., Cook, D., Murray, D., Fender, K., Weber, A. "A Comprehensive System for Assessing Truck Parking Availability." Center for Transportation Studies, University of Minnesota. January, 2017. Retrieved from https://www.dot.state.mn.us/ofrw/PDF/assessing-truck-parking.pdf

## CONCLUSIONS

This ATRI truck parking survey confirms the important role that truck parking information systems can play in better managing existing truck parking capacity, but also identifies opportunities for improvement.

**Parking Monitoring Technologies.** Per the Minnesota field test, the ideal parking information system would utilize highly accurate, automated cameras to count available truck parking spaces. Digital imaging using cameras is highly accurate but relatively expensive; the Minnesota project's costs increased due to the use of 3D cameras. Most importantly, video systems do not impact the pavement and substructure of the parking surface – which is important to government agencies when freeze/thaw cycles exist. In total, these factors make this technology implementable across the United States, particularly when lower cost 2D solutions are developed.

**Variable Message Signs.** A majority of drivers, especially long-haul and inter-regional drivers, found that variable message signs were both useful and accurate. Being both useful and accurate indicates the necessity of variable message signs in any technological implementation, and should be standardized for all rest stops, both public and private, on major thoroughfares.

**Smartphone Applications.** Applications are a popular way of receiving parking information, but different tools and information are provided by different applications. The varied truck parking information can lead drivers to install multiple applications – as evident in the 212 driver respondents to this survey with more than one application on their phone. This alone demonstrates a need for more comprehensive information, and improved standards for collecting and disseminating core truck parking information.

**Embedded "Information Push" Systems**. Driver distraction is a legitimate safety concern, and state and federal laws ban almost all texting while vehicles are in motion. Yet, it is costly and inefficient for truck drivers to exit roadway systems to search for truck parking. The most efficient and effective solution is to automatically push truck parking availability data to the truck driver only when it is geographically relevant to know where truck parking availability exists. This concept was tested in the Smart Park 4 Trucks project, whereby the location of moving trucks was geo-fenced and monitored, and when the truck approached geo-coded locations, the real-time space availability information was "pushed" to the truck driver's embedded telematics device. The concept received extremely favorable reviews from truck drivers involved in the field test.

**Expanded Outreach**. A next important outreach phase in ATRI's truck parking research is to work directly with the National Association of Truck Stop Operators (NATSO), state DOT staff and state legislatures, truck driver groups and technology vendors in an attempt to implement a standardized truck parking information framework across the U.S. The technologies used in these systems are quite ubiquitous, and industry expectations and preferences have been clearly identified – so standardization of information and dissemination tools becomes a critical next step. A coalition of stakeholders could be convened to first validate and conceptualize a national truck parking information system architecture, or an expanded version of the U.S. DOT National Truck Parking Coalition could be tasked with setting up the framework. This initial development step is critical to creating the foundation for an efficient and accurate truck parking information program, providing great value to millions of truck drivers throughout the country.

**Formalizing Truck Parking Information System Standards**. There are numerous methods for moving towards a simplified and standardized truck parking information system. All

approaches will require substantial outreach and collaboration with truck parking stakeholders. Critical support will be needed by:

- Federal Highway Administration. The FHWA is the leading agency within the U.S. Department of Transportation for surface transportation planning, management and funding in the U.S. The FHWA produces, among many other planning documents, the Manual on Uniform Traffic Control Devices (MUTCD)[24] which would form the foundation for many aspects of a national standard on truck parking information system communications.
- American Association of State Highway & Transportation Officials (AASHTO). AASHTO represents the 50 state departments of transportation, among other agencies. AASHTO is organized to discuss, create and formalize standard communications protocols and messaging; the AASHTO process provides substantial input into the FHWA MUTCD.
- American Trucking Associations (ATA). The ATA is the largest national trade organization for the trucking industry. The ATA, composed of thousands of motor carriers, is a member of the U.S. DOT's National Truck Parking Coalition, and has strongly advocated for increased attention on, and funding for truck parking initiatives.
- Owner-Operator Independent Driver Association (OOIDA). OOIDA is the largest association representing truck drivers. The OOIDA Foundation has conducted numerous truck driver surveys on a range of relevant truck parking topics, and sits on the U.S. DOT's National Truck Parking Coalition. OOIDA's membership has consistently ranked "truck parking" as a top concern among truck drivers.
- National Association of Truck Stop Operators (NATSO). NATSO is the national association representing private truck stop operators. With private truck stop operators representing the large majority of all truck parking in the U.S., NATSO's participation in future truck parking information system standards is critical. NATSO also is a member of the U.S. DOT's National Truck Parking Coalition.
- Association of Metropolitan Planning Organizations (AMPO). AMPO represents more than 400 urban areas in the U.S. While AMPO has not been a regular, active participant in truck parking initiatives, the truck parking issues – including zoning and planning – that arise in and around metropolitan areas requires that AMPO and relevant municipal agencies become actively involved.

[24] U.S. Department of Transportation. Federal Highway Administration. "Manual on Uniform Traffic Control Devices." Available online: https://mutcd.fhwa.dot.gov/

## SYNOPSIS OF MODEL SYSTEM

The survey conducted by ATRI confirms strong support for the implementation of new information technologies to assist truck drivers in finding critical truck parking. Most drivers find variable message signs to be helpful and accurate, but the perceived accuracy can be improved. With the advent of many new technology tools, there is a need for standardization in parking assessment technology and information dissemination methods. This can be seen in the sheer number of counting technologies used; the information formats used (e.g. space counts versus color-coding), and the number of available truck parking apps used by truck drivers. Therefore, the four criteria necessary for any widely implemented parking system are accuracy, ease of installation (and maintenance), user-friendliness, and multi-channel distribution. A fifth criteria, cost-effectiveness, is less well defined and understood.

These four criteria formed the basis for the system developed and field-tested in Minnesota by ATRI and the University of Minnesota (U of MN). This field test took place on segments of Interstate 94, a truck-intensive corridor connecting Wisconsin, Minnesota, and North Dakota.[25] In three public rest areas, a system of automated cameras were installed to monitor the number of available truck parking spaces. The MN system had to adhere to certain state DOT criteria:

- It could not disturb the pavement or any substructures – as freeze/thaw cycles would exacerbate the damage;
- It should not require human recalibration;
- It must automate real-time parking *space* occupancy; and
- It must disseminate information over multiple wireless channels.

These criteria were met by a system of cameras using automated imaging software, developed by the U of MN. According to the final report, truck driver survey data indicated that truck drivers prefer specific space availability information over other approaches. It also commented on the technical benefits of space counting: "direct methods (defined as counting availability of specific spaces) will not be subject to any accumulation error over time and therefore in theory should provide more reliable information without any manual intervention to correct errors." [26] The study found that the system averaged a one-spot discrepancy between the projected number of spots and the actual number of spots 95 percent of the time. For this reason, a highly accurate, automated system for counting space availability is preferred.

[25] Morris, T., Morellas, V., Pananikolopolous, N., Cook, D., Murray, D., Fender, K., Weber, A. "A Comprehensive System for Assessing Truck Parking Availability." Center for Transportation Studies, University of Minnesota. January, 2017. Retrieved from https://www.dot.state.mn.us/ofrw/PDF/assessing-truck-parking.pdf
[26] Ibid.

## APPENDIX A

### Commercial Driver Perspectives on Truck Parking Information Systems

The American Transportation Research Institute (ATRI), the trucking industry's not-for-profit research organization, is interested in commercial driver perspectives on the truck parking information systems that many states are developing to address truck parking issues.

All responses on this survey will be kept **strictly confidential** and will only be reported in aggregate form. Due to the sensitivity of this research, under NO circumstances will we release any of your personal or organizational information.

1. What is your gender?

   ❑ Male
   ❑ Female

2. What is your age?

   ❑ Younger than 25
   ❑ 25 – 44
   ❑ 45 – 64
   ❑ 65+

3. How many years of professional truck driving experience do you have?

   ❑ Less than 1 year
   ❑ 1 – 5 years
   ❑ 6 – 10 years
   ❑ 11+ years

4. In what segment of the trucking industry do you primarily operate? (check one)

   ❑ For-hire
   ❑ Private
   ❑ Don't Know

5. If for-hire, which sector best describes your operation? (check one)

   ❑ Truckload
   ❑ Less-than-truckload
   ❑ Specialized, flatbed
   ❑ Specialized, tanker
   ❑ Express / Parcel Service
   ❑ Intermodal Drayage
   ❑ Other (please specify): _____
   ❑ Don't Know

6. Which of the following best describes your employment: (check one)

   ❑ Employee driver
   ❑ Owner-operator (O-O) with own authority
   ❑ O-O/Independent Contractor leased to a motor carrier
   ❑ Don't Know

7. What is your average length of haul? (check one)

   ❑ Local (less than 100 miles per trip)
   ❑ Regional (100-499 miles per trip)
   ❑ Inter-Regional (500-999 miles per trip)
   ❑ Long-Haul (1,000+ miles per trip)
   ❑ Don't Know

8. What is the primary vehicle configuration that you typically operate? (check one)

   ❑ 5-axle Dry Van
   ❑ 5-axle Refrigerated Trailer
   ❑ 5-axle Flatbed
   ❑ 5-axle Tanker
   ❑ Straight Truck
   ❑ Longer Combination Vehicles (Doubles, Triples, etc.)
   ❑ Other (please specify) :_____
   ❑ Don't Know

9. If you are an employee or leased driver, how many total tractors does your fleet operate? (check one)

   ❑ ≤ 5
   ❑ 6 – 20
   ❑ 21 – 50
   ❑ 51 – 500
   ❑ 501 – 1,000
   ❑ 1,001 – 5,000
   ❑ 5,001+
   ❑ Don't Know

10. How are you primarily paid? (check one)

   ❑ Per hour
   ❑ Per load
   ❑ Per mile
   ❑ % of Freight Bill
   ❑ Other (please specify):_____
   ❑ Don't Know

11. In the last year, have you used any type of smart phone-based truck parking app?

   ❑ Yes
   ❑ No
   ❑ Don't Know

12. If yes, do you still use the same truck parking app?

   ❑ Yes
   ❑ No

   a. Why or why not?

| |
|---|
| |

13. What smartphone app(s) do you currently use to find available parking?

   ❑ myPilot
   ❑ Park My Truck
   ❑ Truck Parking USA
   ❑ Trucker Path
   ❑ Truck Specialized Parking Services
   ❑ TruckSmart (TA/Petro)
   ❑ Other (please specify): _____
   ❑ I do not use smartphone apps to locate available parking.

14. In the last two years, have you seen any roadside signs showing real-time truck parking availability information?

   ❑ Yes
   ❑ No
   ❑ Don't Know

   a. If yes, where?

| State | Road |
|---|---|
| | |

   b. Did you find the information useful?

   ❑ Yes
   ❑ No
   ❑ Don't Know

   c. Why or why not?

| |
|---|
| |

15. Have you ever pulled off and parked based on the information from a roadside truck parking information system?

   ❑ Yes
   ❑ No
   ❑ Don't Know

   a. If yes – was the parking availability information accurate?

      ❑ Yes
      ❑ No
      ❑ Don't Know

16. Can you think of any way to improve truck parking information systems?

| |
|---|
| |

## APPENDIX B

### Frequency of VMS Sightings by State

| State | Frequency |
|---|---|
| OH | 112 |
| KY | 92 |
| FL | 91 |
| IN | 91 |
| MI | 90 |
| WI | 66 |
| TN | 59 |
| KS | 47 |
| MN | 36 |
| VA | 34 |
| IL | 31 |
| IA | 17 |
| CO | 15 |
| MO | 15 |
| TX | 15 |
| GA | 11 |
| PA | 10 |
| MD | 8 |
| NC | 6 |
| SC | 6 |
| CA | 5 |
| AL | 3 |
| MS | 3 |
| MT | 3 |
| NE | 3 |
| NY | 3 |

| State | Frequency |
|---|---|
| UT | 3 |
| AR | 2 |
| LA | 2 |
| NV | 2 |
| NM | 2 |
| OK | 2 |
| OR | 2 |
| WY | 2 |
| AZ | 1 |
| CT | 1 |
| ID | 1 |
| NJ | 1 |
| SD | 1 |
| WV | 1 |
| AK | 0 |
| DC | 0 |
| DE | 0 |
| HI | 0 |
| ME | 0 |
| MA | 0 |
| NH | 0 |
| ND | 0 |
| RI | 0 |
| VT | 0 |
| WA | 0 |