Vector Surveillance and Control at the Local Level

Findings from the 2020 Vector Control Assessment

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Introduction

Vector-borne diseases pose a substantial risk to human health. Mosquitoes and ticks are the two primary vectors of pathogens that cause disease in the United States. The most commonly reported mosquito-borne and tickborne disease in the U.S. are West Nile virus disease and Lyme disease respectively, with the latter being the most reported vector-borne disease overall. Cases of West Nile virus disease, dengue, and chikungunya are reported most years, with dengue and chikungunya — both mosquito-borne diseases — reported mainly in the U.S. territories. An estimated 476,000 cases of Lyme disease are diagnosed and treated in the U.S. every year. While a recent vaccine for dengue has been authorized, and a new vaccine for Lyme disease is in development, pharmaceutical options to prevent most vector-borne diseases are currently limited. Reducing overall contact with disease vectors remains the best available prevention strategy.

Local vector programs play a critical role in monitoring and managing disease-carrying species of mosquitoes and ticks. These programs may be housed in local health departments (LHDs), in mosquito control districts, or in other governmental structures such as tribal authorities. Local vector programs may conduct critical activities such as trapping and species identification, coordination with neighboring counties and state epidemiologists, and insecticide resistance testing. Using a combination of evidence-based strategies, local programs can help mitigate the risk of vector-borne disease within their communities.

Local vector programs also engage in outreach activities to help raise awareness of the risk of vector-borne diseases. They provide information to help their communities understand the best ways to minimize the risk of encountering local species of mosquitoes or ticks. The risk of vector-borne disease can vary widely depending on the local climate and ecology. For example, Lyme disease is commonly reported in the northeast and less likely to be reported in the southwest. While Lyme disease is less of a concern in the southwest, ticks in this region may carry other diseases such as Rocky Mountain spotted fever, a disease that has notably affected tribal communities in Arizona. The range of climates and habitats found throughout the U.S. also means that local communities have different seasonal patterns to account for as they try to minimize human contact with mosquitoes and ticks. Local vector programs are uniquely positioned to respond to issues that may arise in their communities.

It is essential to have a well-functioning local vector surveillance and control system across the country, not only to address routine community risks but also to monitor for new vector-borne pathogens and prevent vector-borne epidemics. The mosquito-borne Zika virus caused a cluster of cases in Brazil in 2015, leading the World Health Organization to declare a public health emergency in 2016. The disease was primarily reported in Latin America, but some locally-acquired cases as well as some travel-associated cases were reported in the United States. Pregnant women and newborn infants experienced severe consequences of the outbreak as the virus was found to cause serious fetal abnormalities. While the virus was last reported in the U.S. territories in 2019, the possibility of a vector-borne epidemic remains present. The predicted effects of climate change may also influence the risk of vector-borne disease. Warming temperatures may expand vector habitats and introduce the risk of some mosquito and tickborne diseases in areas where they have not historically been common. The U.S. Centers for Disease Control and Prevention (CDC) has observed that climate-related changes are already increasing the risk for infectious diseases, including vector-borne diseases.

2020 Vector Control Assessment

Purpose

To understand the range of activities and overall capacity of local vector programs, the National Association of County and City Health Officials (NACCHO), supported by a cooperative agreement from the CDC, conducted a nationwide assessment of local vector control programs in 2017. This initial assessment provided a baseline understanding of local mosquito surveillance and control capacity. In 2020, NACCHO conducted the second iteration of this national assessment, with an expanded questionnaire that included items related to tick surveillance and control.

The results of the 2020 Vector Control Assessment provide updated data on local mosquito surveillance and control capacity, as well as an opportunity to begin tracking changes in mosquito-related activities over time and provide baseline data on tick surveillance and control. This report provides a summary of the results from the assessment, highlighting results that may be most relevant to public health officials and policymakers.

Methods

The 2020 assessment was conducted through Qualtrics© survey software. It included 26 total items. The assessment was sent to 1,664 verified programs. These programs were drawn from NACCHO's database of 2,213 local vector programs. Verified programs were defined as those programs for which an active email address or phone number could be confirmed. After the survey was distributed via Qualtrics©, routine follow-up emails were sent, and NACCHO staff directly followed up with as many programs as possible via phone and email. A total of 483 programs responded accounting for a response rate of 29%. A total of 348 programs responded to both the 2017 and 2020 assessments.

Forty-eight states as well as D.C. are represented in the sample. Maine and Vermont had no respondents, but this does not necessarily reflect a lack of local vector control programs in those states. Responses were not distributed proportionately across all regions of the country. The three states with the highest number of responding programs accounted for 22% of the total sample (Illinois had 49 responding programs; Ohio had 39; and Indiana had 20).

Possible Effect of the COVID-19 Pandemic

It should be noted that this assessment was fielded during the coronavirus disease 2019 (COVID-19) pandemic. Responses were requested between November 2020 and January 2021, a period which coincided with a notable spike in COVID-19 cases across much of the United States. It is likely that the response rate was affected by this trend as many local health department staff were diverted from their usual programmatic areas to support the COVID-19 response. The response rate for the 2020 assessment was 29%, a notable decline from a response rate of 57% in 2017. When the response rate for the 2020 Vector Assessment is compared to other national surveys NACCHO fielded during the pandemic, it aligns with the overall trend NACCHO research staff observed. Survey response rates have declined during the COVID-19 pandemic.

Data Limitations

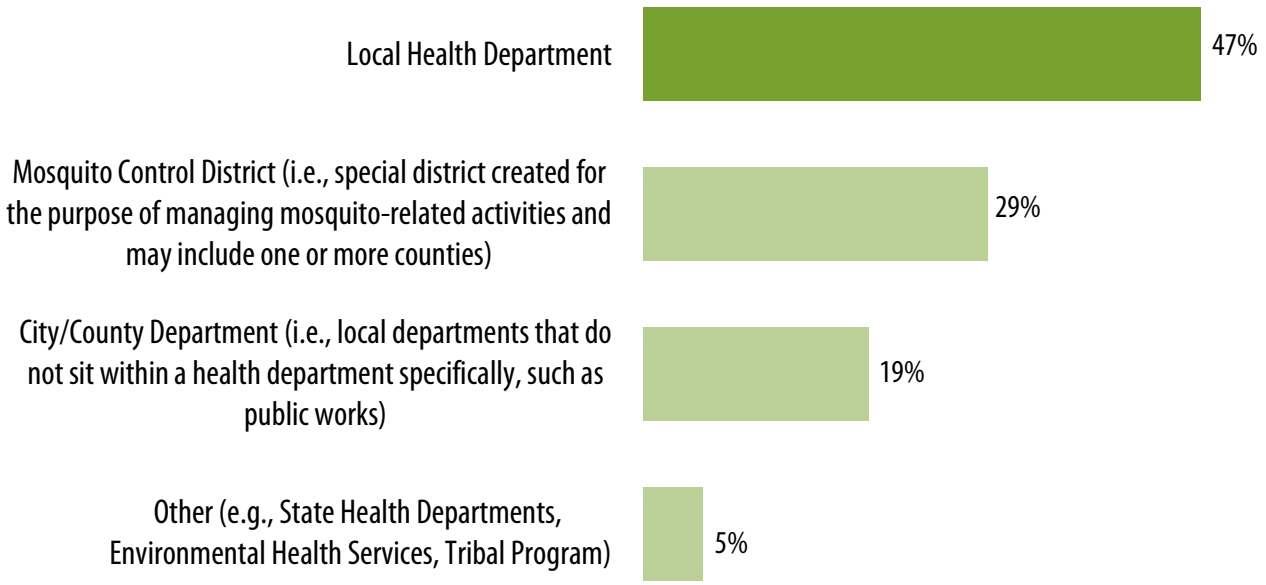
Several limitations should be considered when using the results of this study. All data were self-reported by respondents and were not independently verified. Respondents may have provided incomplete, imperfect, or inconsistent information for various reasons. Some of these reasons could include skipping questions due to time constraints, estimating responses to reduce burden, or interpreting undefined questions or response options differently. Second, the low response rate may be biased, such as toward respondents more engaged in this work, which could limit generalizability.

When interpreting these results, the overrepresentation of respondents located in the Midwest should be taken into account. In addition, it should be noted that population size did not have any notable relationship with the number of programs responding by state. For example, three programs responded from Pennsylvania, the fifth largest state by population per the 2020 U.S. Census, while six responded from Wyoming, the least populated state.

Comparisons with data from the prior assessment are provided. However, it should be noted that both the study population and the respondents are different for each assessment. In addition, comparisons are not tested for statistical significance.

Program Characteristics

Organization Type of Responding Programs



n=483

Nearly half of respondents (47%) were from programs managed by LHDs.

Population Size Served

A majority of respondents (55%) reported that their program serves a population of less than 100,000 people.

Twenty-six percent serve populations of less than 25,000 people, and 9% serve populations of 1 million people or more.

Funding

Sixty-seven percent of programs reported having dedicated funding (these are funds appropriated for specific purposes), and 83% reported that at least part of their funding was from local sources (e.g., taxes).

Dedicated funding ranged from just $500 for some programs to approximately $35,000,000 – the highest funding reported by a program.

Mosquito Surveillance and Control Capacity

A scoring matrix was created to prioritize and weight questions based on the necessary capacities of a comprehensive, evidence-based vector control program. Using the CDC framework for vector control capacity as guidance, five core capacities and five supplemental capacities were used to rank each organization as **fully capable**, **competent**, or **needs improvement**.

Core Capacities

1. Routine mosquito surveillance through standardized trapping and species identification
2. Treatment decisions using surveillance data
3. Larviciding, adulticiding, or both
4. Routine vector control activities (e.g., chemical, biological, source reduction, or environmental management)
5. Pesticide resistance testing

Supplemental Capacities

6. Licensed pesticide application
7. Vector control activities other than chemical control (e.g., biological, source reduction, or water management)
8. Community outreach and education campaigns regarding mosquito-borne diseases, how they spread, and how to prevent infection
9. Regular communication with LHDs regarding surveillance and epidemiology
10. Outreach (e.g., communication and/or cooperation) with nearby vector control programs

Definitions

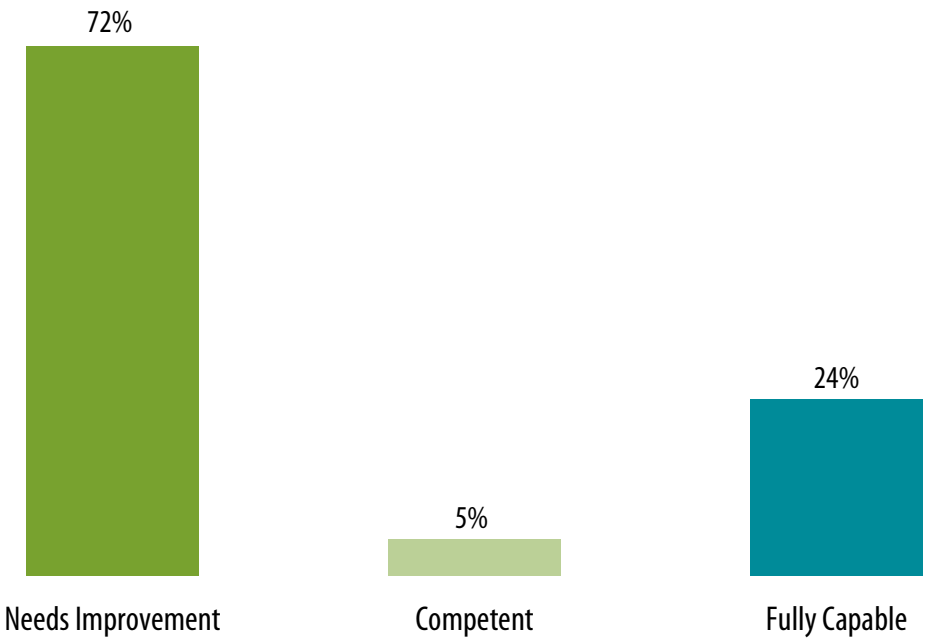
Fully Capable: Vector control organization performs all core and supplemental capacities

Competent: Vector control organization performs all core capacities

Needs Improvement: Vector control organization fails to perform one or more core capacities

Mosquito Surveillance and Control Capacity

Mosquito Program Capacity

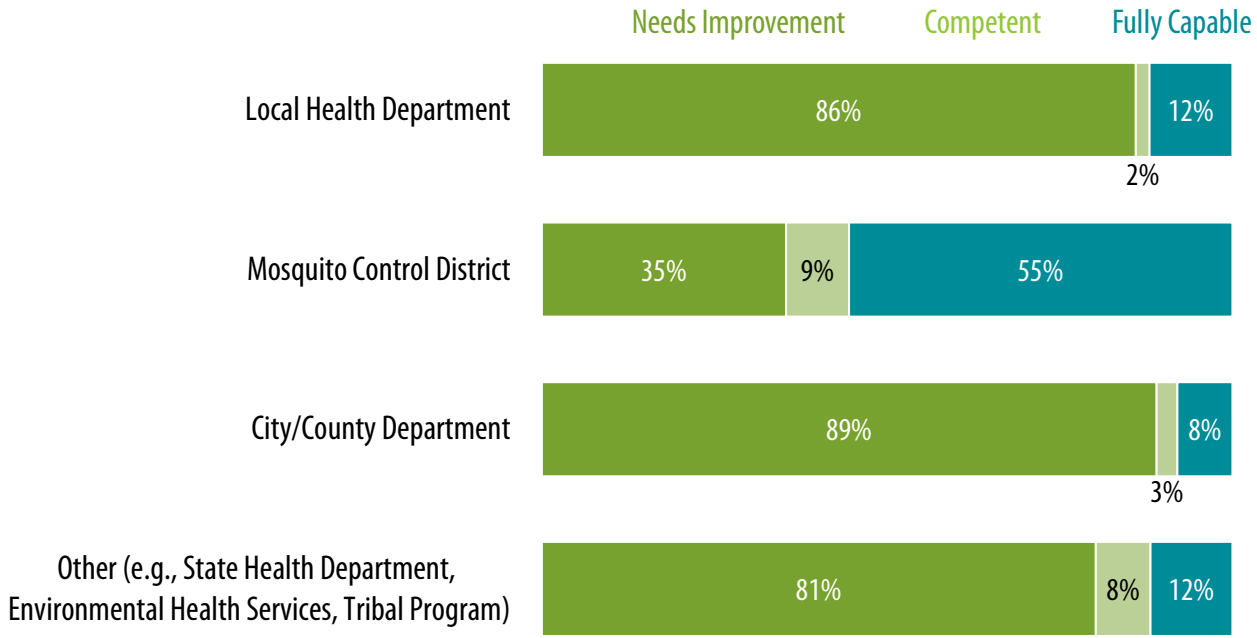


n=483

A majority of programs (72%) fell into the needs improvement category. This trend appeared to be driven mostly by limited capacity for pesticide resistance testing.

Mosquito Surveillance and Control Capacity

Mosquito Program Capacity, by Organization Type

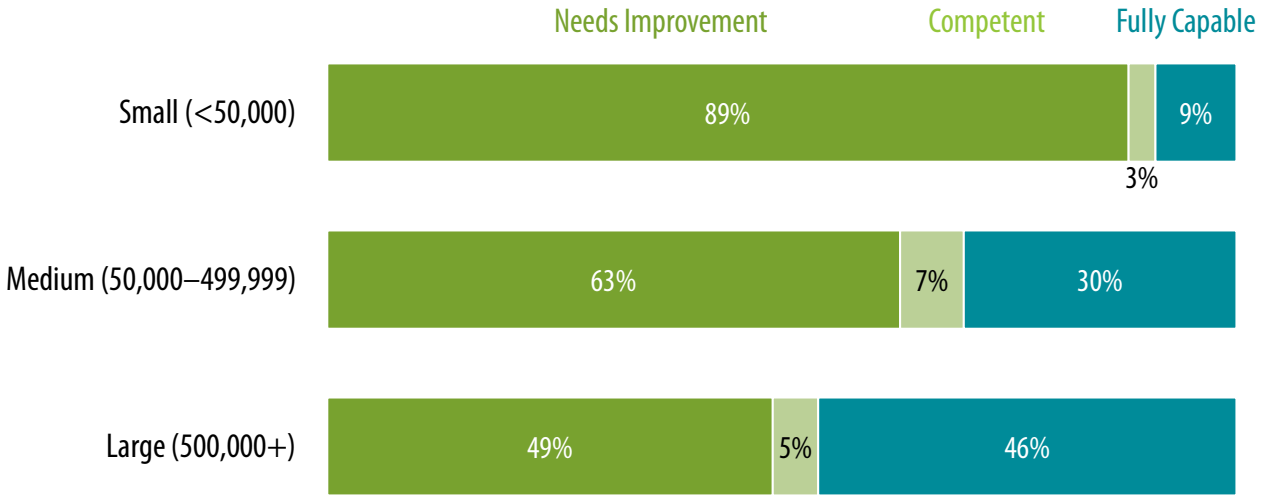


n(LHD)=226
n(MCD)=139
n(city/county)=92
n(other)=26

More than half of programs managed by mosquito control districts (55%) were fully capable, while 12% or fewer of those in other organization types were characterized as such.

Mosquito Surveillance and Control Capacity

Mosquito Program Capacity, by Size of Population Served

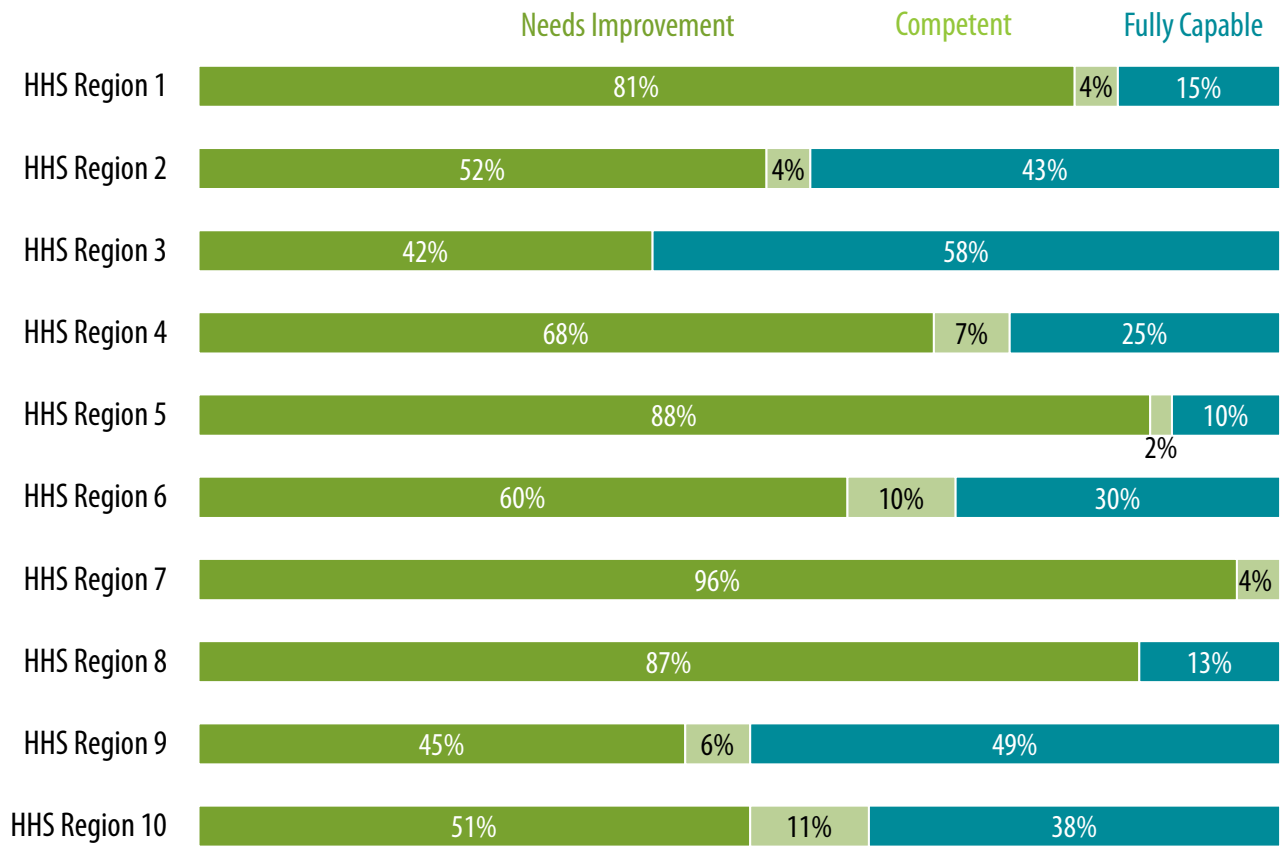


n(small)=200
n(medium)=198
n(large)=79

Programs serving larger populations (i.e., more than 500,000 people) were **more likely** to be fully capable compared to those serving smaller populations (i.e., less than 50,000 people).

Mosquito Surveillance and Control Capacity

Mosquito Program Capacity, by HHS Region



n(Region 1)=27
n(Region 2)=23
n(Region 3)=19
n(Region 4)=84
n(Region 5)=135
n(Region 6)=40
n(Region 7)=26
n(Region 8)=45
n(Region 9)=47
n(Region 10)=37

Program capacity was analyzed across the U.S. Department of Health and Human Services (HHS) Regions.

When analyzed by HHS Region, programs located in Region 3 (Pennsylvania, West Virginia, Maryland, Delaware) and Region 9 (Hawaii, California, Nevada, Arizona) were **most likely** to be fully capable.

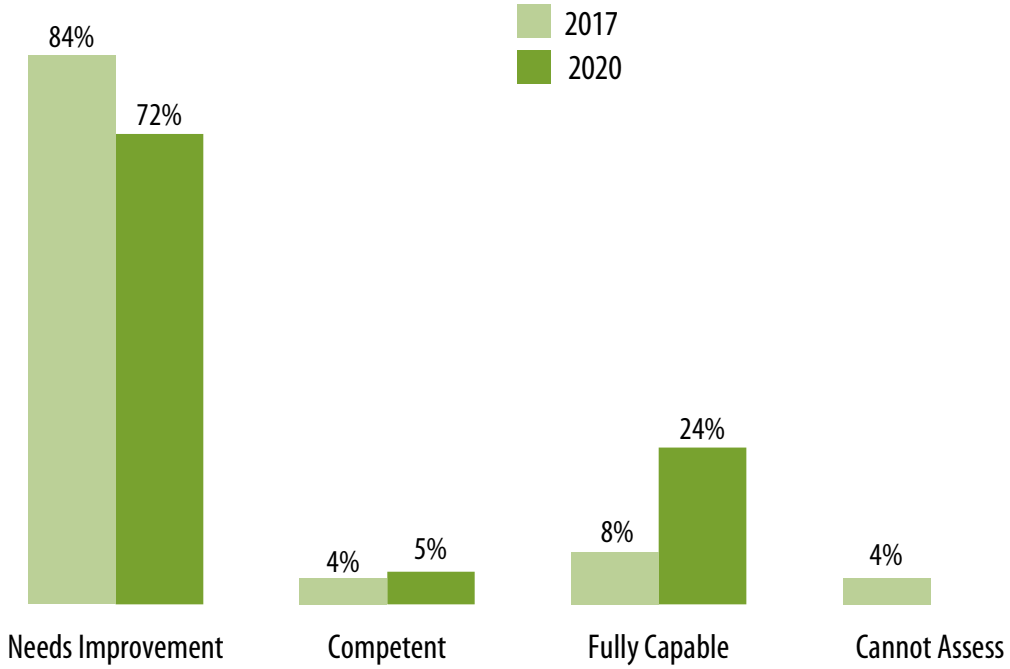
Notably, no programs in Region 7 (Nebraska, Iowa, Kansas, Missouri) reported being fully capable.

Programs in Region 5 (Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota) were **less likely** to be fully capable than those in many other regions. However, it should be considered that this region had a higher response rate than other regions; therefore, Region 5 did have a larger number but lower proportion of programs that were fully capable.

Note: Totals may not sum to 100% due to rounding.

Mosquito Surveillance and Control Capacity

Mosquito Program Capacity, Over Time



n(2017)=1,083
n(2020)=483

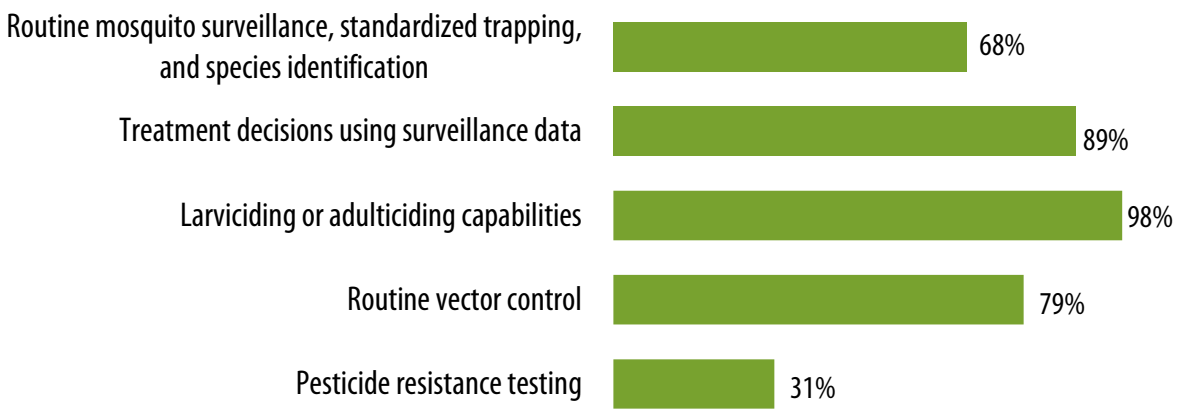
When compared to 2017, there was an overall trend of improvement. In particular, the proportion of programs categorized as needs improvement decreased by 12 percentage points. Meanwhile, the proportion of programs categorized as fully capable tripled.

Out of 483 responses in 2020, 348 were from programs that had also completed the assessment in 2017. Seventeen percent of these programs showed measurable improvement, with 11% moving from needs improvement to fully capable.

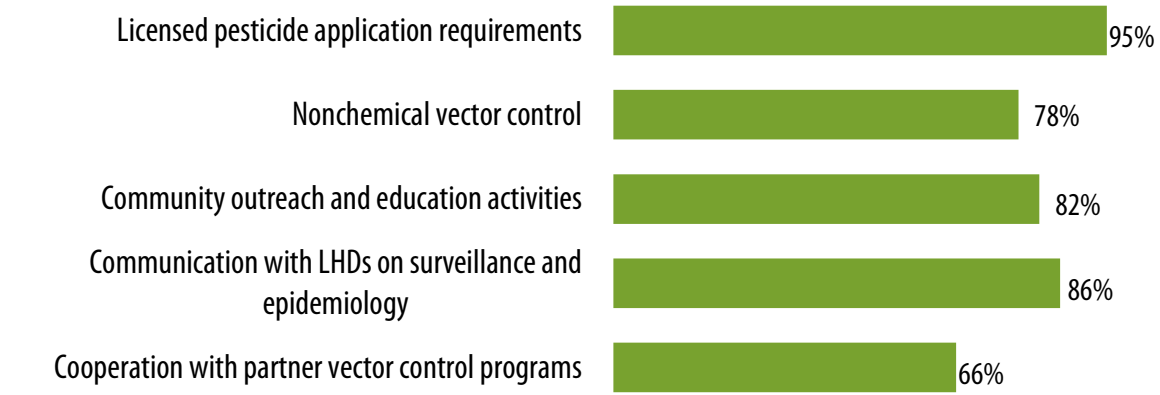
Mosquito Surveillance and Control Capacity

Mosquito Surveillance and Control Capacity, in 2020

Core Capacities



Supplemental Capacities



n=330–483

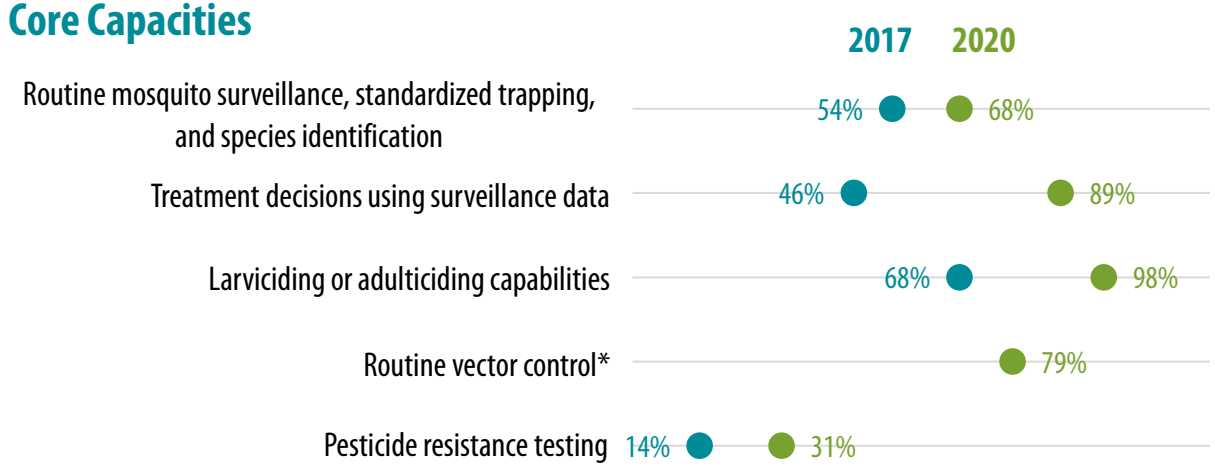
Most programs had the capacity to perform four out of five core activities and all supplemental activities.

Only 31% of respondents reported capacity to conducting pesticide resistance testing—the primary driver for programs characterized as needs improvement.

Mosquito Surveillance and Control Capacity

Changes in Mosquito Control and Surveillance Capacity, Over Time

Core Capacities



Supplemental Capacities

n(2017)=541–1,083, n(2020)=330–483

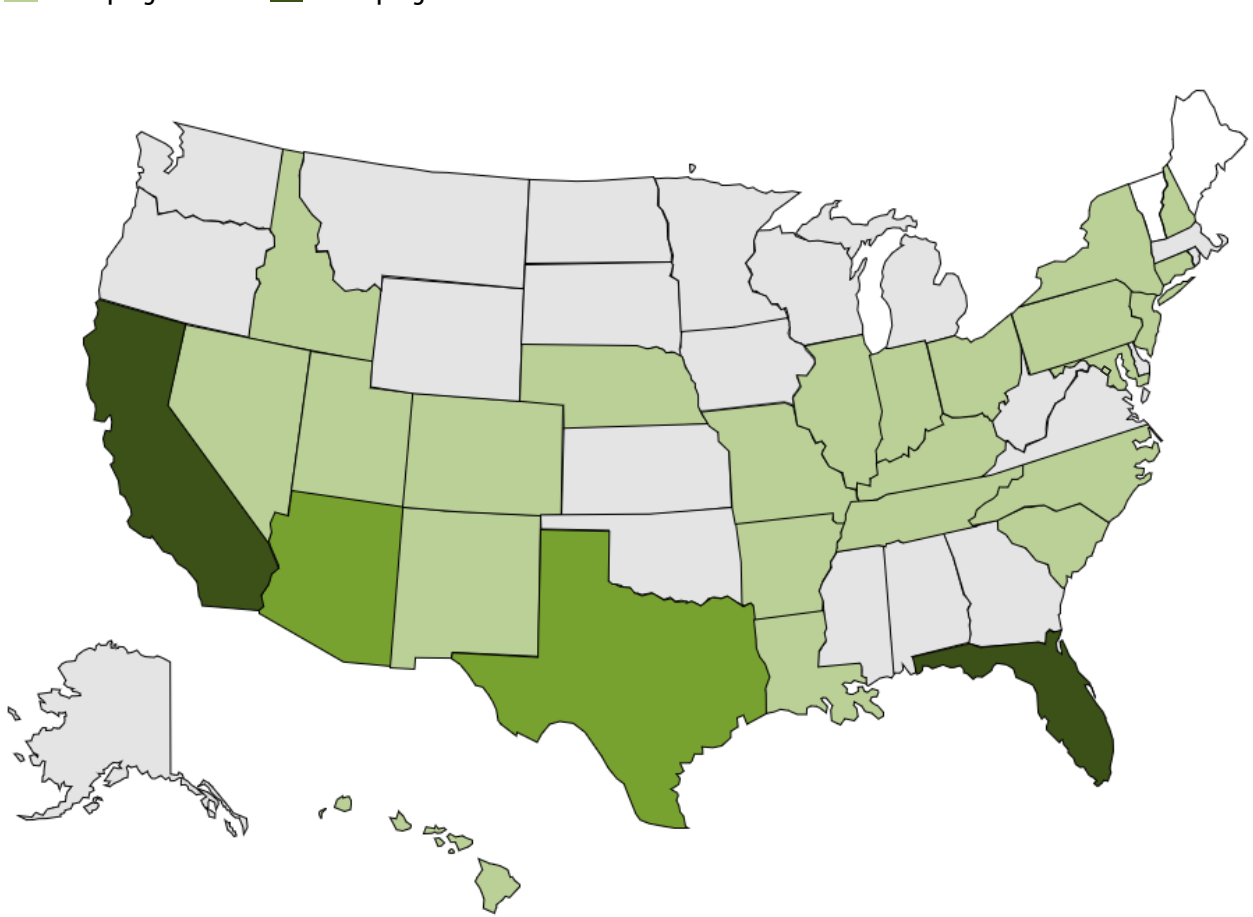
A higher proportion of programs were able to perform activities across the core and supplemental capacities in 2020 as compared to 2017. In particular, treatment decisions using surveillance data increased by 43 percentage points.

**In 2017, the assessment asked only about routine control for Aedes aegypti and Aedes albopictus, as Zika was of specific concern at this time. This item is not directly comparable to the 2020 assessment, which asked about routine control without regard to a specific species.*

***In 2020, this item was changed, but the results remain comparable.*

Mosquito Surveillance and Control Capacity

Aedes aegypti Targeted Control, by State



n=380

Programs in California and Florida were **most likely** to conduct control activities targeting *Aedes aegypti*.

Note: NACCHO does not have data for Maine and Vermont.

Mosquito Surveillance and Control Capacity

Remaining Gaps in Capacity

- Pesticide resistance testing remains the biggest gap in mosquito surveillance and control capacity.
- Routine mosquito surveillance has increased but continues to lag behind mosquito control capacity.
- Non-chemical vector control has increased but trails behind chemical control activities.
- Some programs may be applying pesticides without accompanying surveillance data to help guide those decisions.

Species-Specific Activities

- While not routine, of the programs that reported species-specific control activities, the most reported target species was *Culex pipiens*.
- *Culex pipiens* is a known vector for West Nile virus and is found across the northern continental United States.
- In 2021, an outbreak of West Nile virus disease was documented in Arizona, primarily around Maricopa County. With over 1,600 cases estimated, and over 1,100 of those cases classified as neuroinvasive, this outbreak is one of the largest in U.S. history. While West Nile virus disease outbreaks can be difficult to predict given the confluence of factors leading up to them, this latest outbreak emphasizes the need for continued investment in vector control and surveillance. As of now, West Nile virus disease has no specific medical treatment options, so minimizing contact with mosquitoes remains the best available strategy for lowering the risk of serious or potentially fatal disease.

Tick Surveillance and Control Activity

This assessment marks the first comprehensive national assessment of tick-related activity focused on program capacity at the local level. A survey of tick activity published in 2020[†] included some local or county public health professionals, as well as state-level professionals. The 2020 survey found that inconsistent funding, as well as limited infrastructure, guidance, and institutional capacity prevented local and state programs from expanding their tick surveillance and control activities. In addition, a 2019 report by NACCHO detailed similar findings regarding tick-related activity. LHDs reported insufficient staffing and lack of direct funding as barriers to conducting tick-related activities. The 2019 report also noted that a lack of uniform training for tick-related activities posed a challenge for LHDs.

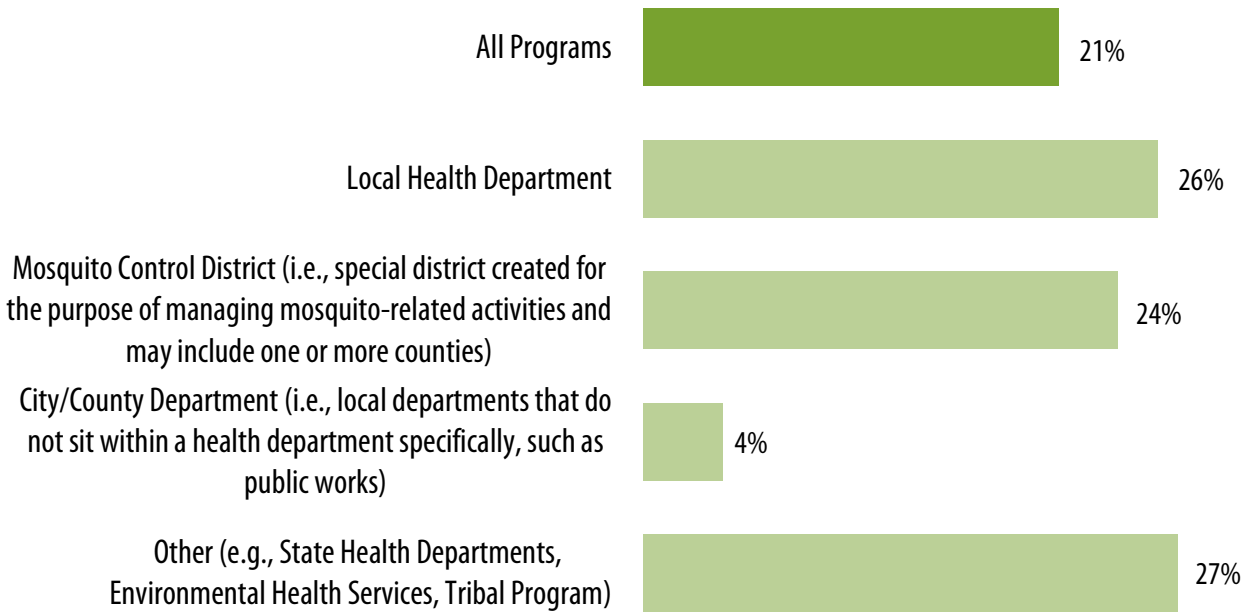
In the 2020 Vector Control Assessment, a much lower number of programs reported tick-related activities than mosquito-related activities. (A total of 483 programs responded to the mosquito assessment items. This number dropped down to 103 for the tick portion of the assessment.) Most programs reported some mosquito surveillance or control activities, but most programs were not engaged in tick surveillance or control. It should be noted that tick surveillance and control does not have the same structured set of best practices and core activities as mosquito surveillance and control.

The data from the 2020 Vector Control Assessment provides a baseline measure of local capacity for tick-related activity, and this information may be used to help inform future interventions in the field, which could include best practice guidance for tick control programs.

[†] *Emily M Mader, Claudia Ganser, Annie Geiger, Laura C Harrington, Janet Foley, Rebecca L Smith, Nohra Mateus-Pinilla, Pete D Teel, Rebecca J Eisen, A Survey of Tick Surveillance and Control Practices in the United States, Journal of Medical Entomology, Volume 58, Issue 4, July 2021, Pages 1503–1512, https://doi.org/10.1093/jme/tjaa094*

Tick Surveillance and Control Activity

Tick Surveillance, by Organization Type



n(all)=483
n(LHD)=226
n(MCD)=139
n(city/county)=92
n(other)=26

There were no significant trends observed among the organization types engaged in tick surveillance. While mosquito control districts notably outperformed for mosquito-related activities, LHDs and mosquito control districts reported conducting tick surveillance activities at similar rates.

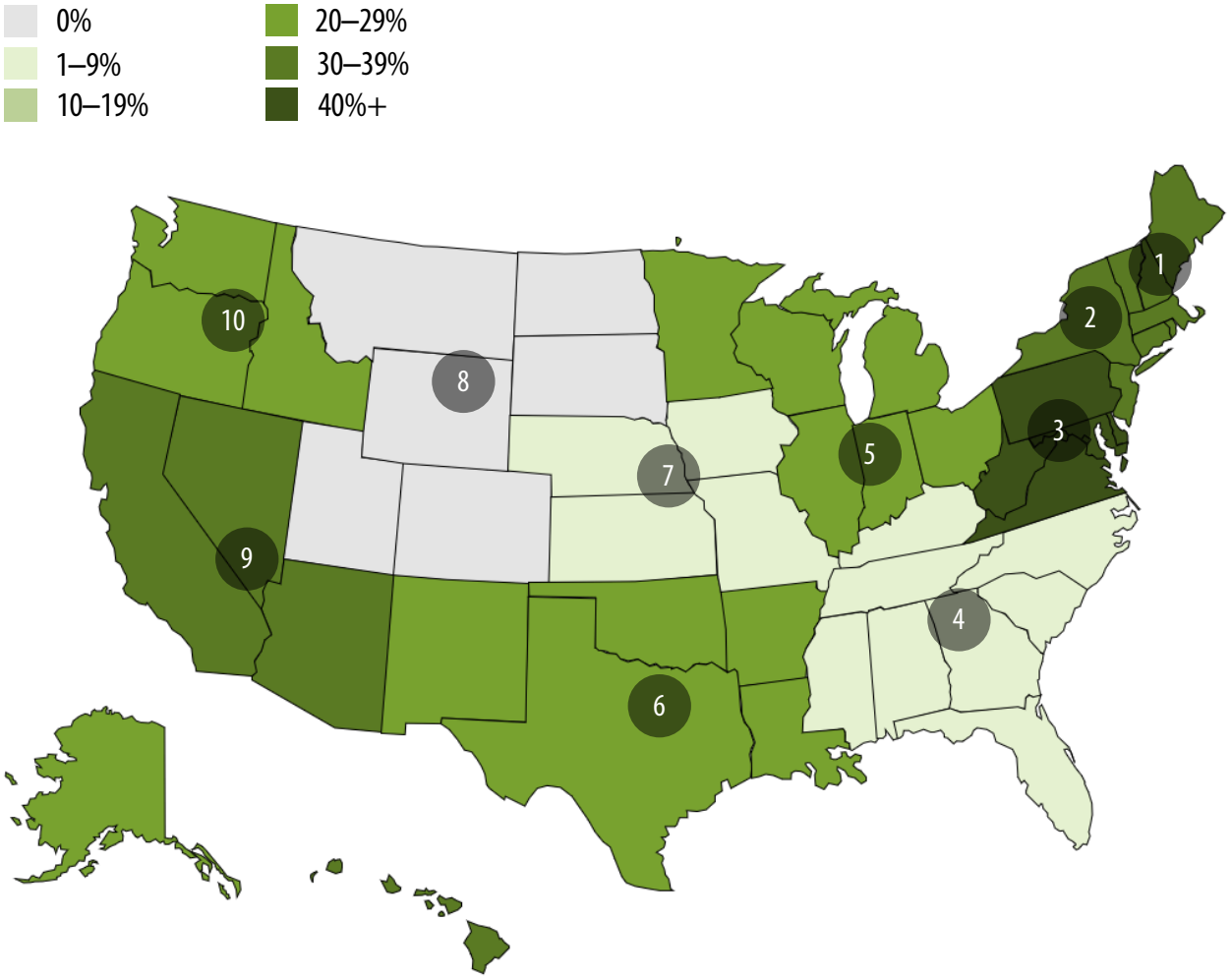
Of the programs engaged in tick surveillance, most (73%) reported dedicated funding.

Fifty-five percent of programs that were engaged in tick surveillance target *Ixodes scapularis*, the predominant vector for Lyme disease, and 50% target *Dermacentor variabilis*, a vector for Rocky Mountain spotted fever.

Nearly half of programs (45%) engaged in tick surveillance reported that they summarize and share this data with the public.

Tick Surveillance and Control Activity

Percent of Programs Conducting Tick Surveillance, by HHS Regions 1 through 10



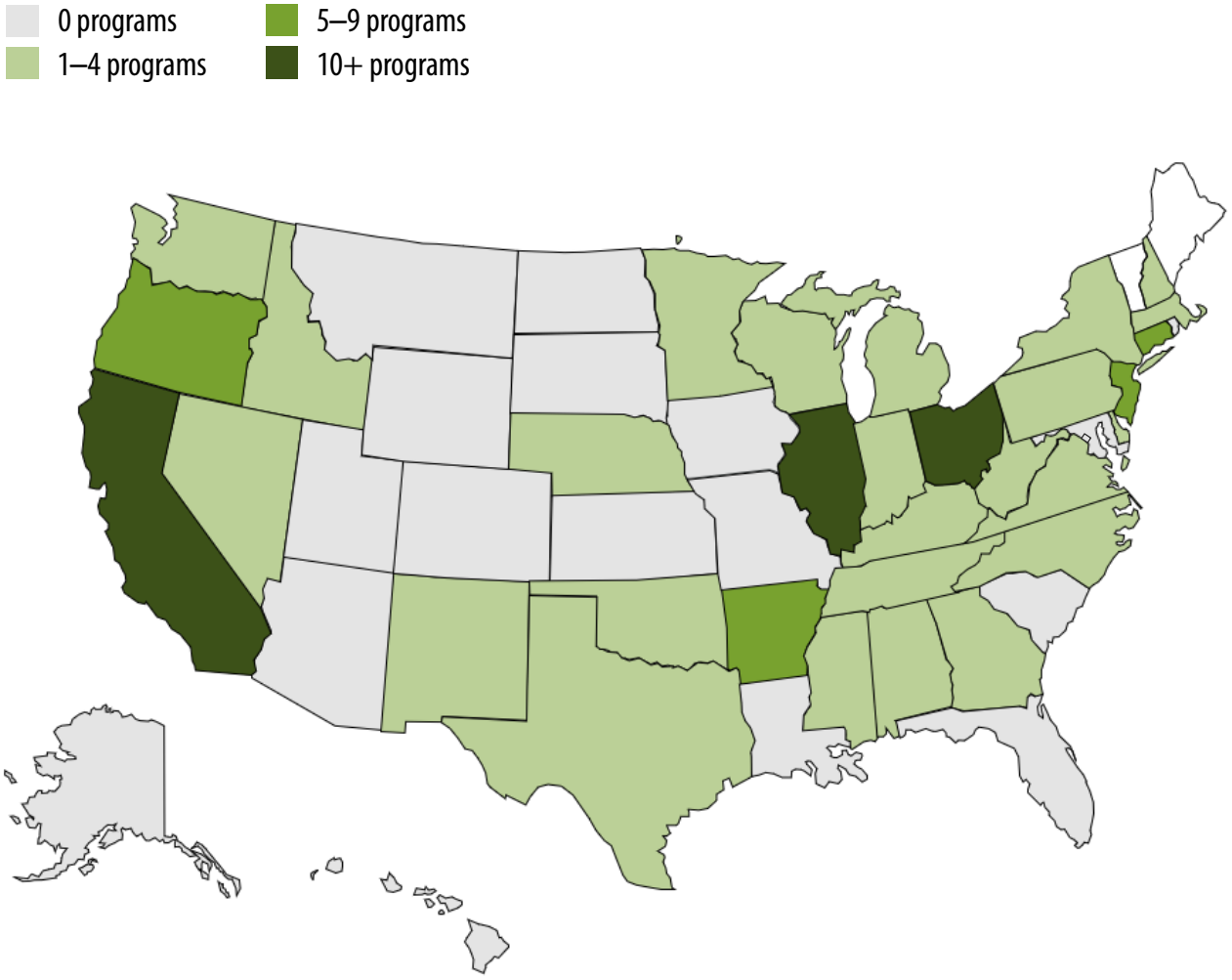
n=103

Of the 103 programs that were engaged in tick surveillance activities, those located in HHS Region 3 (Pennsylvania, Delaware, Maryland, West Virginia, Virginia) were **most likely** to conduct tick surveillance activities. Forty-seven percent of programs within this region reported tick surveillance activity.

Meanwhile, no programs located in HHS Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming) reported conducting tick surveillance activities.

Tick Surveillance and Control Activity

Tick Surveillance, by State



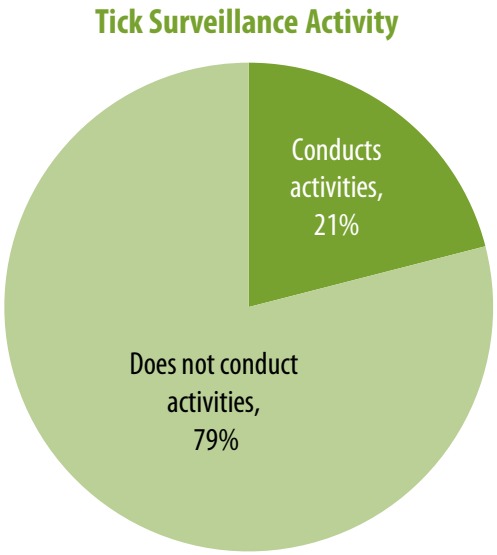
n=483

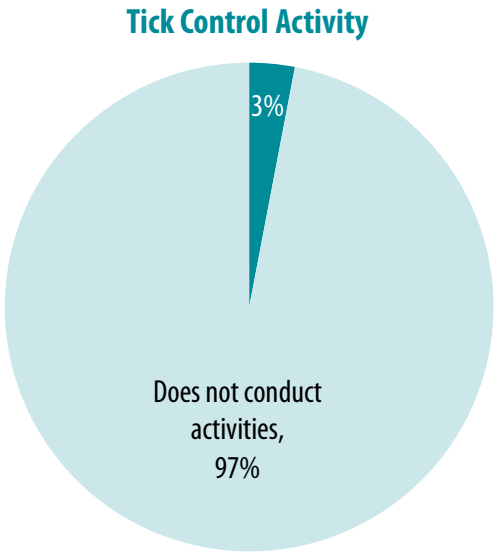
Of the 103 programs that were engaged in tick surveillance activities, those located in California, Illinois, and Ohio were **most likely** to conduct tick surveillance—with 16, 14, and 12 programs in each state doing so, respectively.

Note: NACCHO does not have data for Maine and Vermont.

Tick Surveillance and Control Activity

Tick Surveillance Compared to Tick Control Activity





n(surveillance)=483
n(control)=483

While reported rates of both tick surveillance and tick control were low, control activities lagged notably behind surveillance.

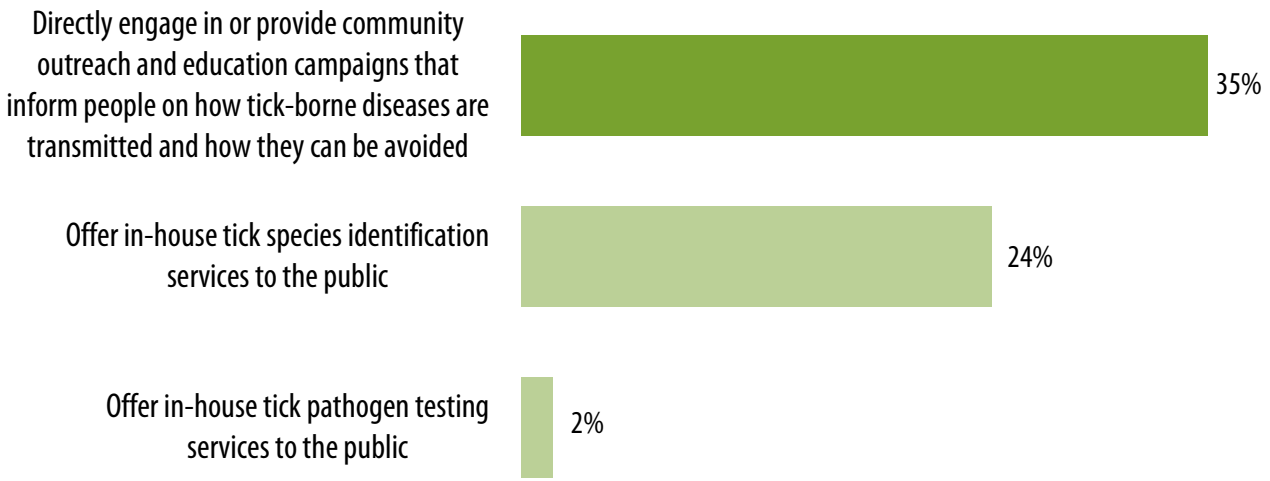
Approximately one in five respondents reported conducting tick surveillance activities. Only 3% of programs reported any type of tick control activity.

Tick surveillance activities may include tick collection and species identification.

Tick control activities may include application of synthetic chemical acaricide to kill host-seeking ticks or vegetation management (i.e., mowing or brush removal).

Tick Surveillance and Control Activity

Other Tick Activity



n=483

Thirty-five percent of programs provided community outreach and education that inform people on how tickborne diseases are transmitted and can be avoided.

In addition, 24% offered in-house tick species identification to the public. Only 2% offered in-house tick pathogen testing.

Conclusions and Recommendations

Mosquito surveillance and control capacity improved between 2017 and 2020. Most vector programs reported engaging in activities across the core and supplemental capacities.

However, most programs still need additional support to build capacity for pesticide resistance testing.

Many programs may benefit from additional support to build capacity for non-chemical vector control.

Some programs may be applying pesticides without accompanying surveillance data to help guide those decisions. Additional support may be needed to help bolster surveillance and evidence-based pesticide application efforts.

Across the 2017 and 2020 assessments, mosquito control districts continued to outperform LHDs in terms of mosquito control capacity.

Most programs were not engaged in tick surveillance or tick control activities. Tick control activities were notably lagging, with a vast majority of programs reporting no tick control activity at all. Given the prevalence of Lyme disease, urgent action may be needed to better understand the kind of obstacles local programs encounter around tick-related activities.

Most programs did not engage in education and outreach around preventing tickborne diseases. Increased resources or support may be needed to help bolster community engagement and education in this area.

Helpful Resource

Whether you are a local program establishing a mosquito surveillance and control program for the first time or considering building on current capacity, NACCHO's 'Practical Guide to Building Local Mosquito Control Capacity' can help. This resource educates, supports, and encourages local programs to be better prepared for future mosquito-borne disease outbreaks.

NACCHO
National Association of County & City Health Officials
The National Connection for Local Public Health

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The mission of the National Association of County and City Health Officials (NACCHO) is to improve the health of communities by strengthening and advocating for local health departments.

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