Employment and Economic Impacts of Veterinary Medicine in Ohio: An Update

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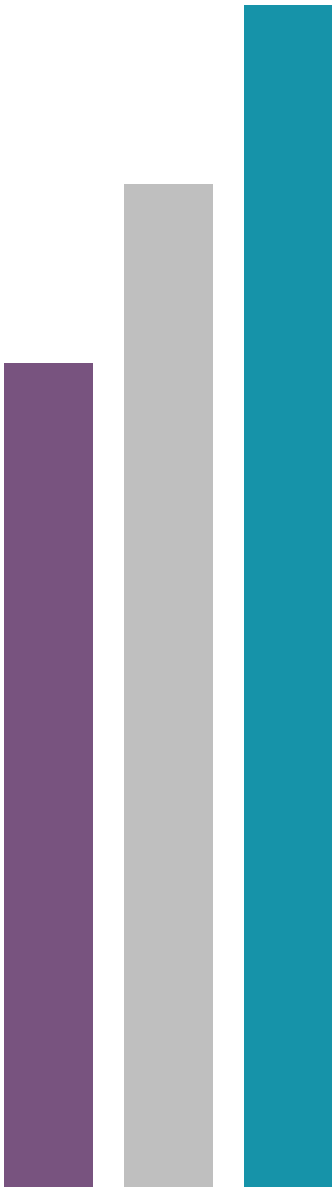
April 17, 2023



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Summary of Major Findings

This report assesses the scope and impact of veterinary medicine in Ohio. The report updates the 2017 study, "Economic and Social Impacts of Veterinary Medicine in Ohio" by Bill LaFayette and Stephen A. Buser. This update considers only the economic aspects of the earlier study. The study also projects the need for new workforce over the coming decade; this is a new feature in this update.

The work and practices of veterinarians give rise to thousands of jobs and billions of dollars in economic impact. In 2021 the veterinary services industry in Ohio employed 16,541 workers who received wages totaling $723 million and generated $1.1 billion in output. Including other relevant industries, total animal-related employment is 57,100 workers who received wages totaling $3.4 billion and created output of $8.8 billion.

This direct impact is multiplied to a veterinary services industry contribution of $2.5 billion in output annually to the Ohio economy and the sustaining of more than 26,000 Ohio jobs. When other supporting and animal-related industries are included, the economic contribution to Ohio's economy rises to $19.2 billion annually, including $7.4 billion in wages, salaries, and self-employment income, and more than 93,000 Ohio jobs sustained. If the animal-related impact did not exist, neither would these supplier and household impacts.

These broader animal-related industries include animal production (farming) and related industries, animal food manufacturing, farm and pet supplies wholesalers and retailers, biotechnology research, racetracks, zoos, and non-veterinary pet care. The impacts also include those of the Ohio State University College of Veterinary Medicine, including the Veterinary Medical Center (VMC). The contributions include the direct output and employment of the industries themselves, as well as the necessary contributions of suppliers, which are referred to as indirect impacts. It also includes the impact of the household spending of direct and indirect workers from their wages and salaries, which they spend on household goods of all kinds. The impact of this household spending is referred to as an induced impact.

Impacts of veterinary services, the College of Veterinary Medicine and the VMC, and the auxiliary animal care industries are shown in Table S-1 on the next page. These also include earnings impacts: the wages, salaries, and self-employment income earned through direct, indirect, and induced activity. Because these impacts do not include animal-related components of broader industries, high school and undergraduate programs, and visitor impacts, these impacts are more likely to be understated than overstated.

Table S-1: Economic Impacts on the Ohio Economy of Veterinary and Animal-Related Industries and Ohio State Institutions, 2021

	Direct	Indirect	Induced	Total
Output (thousands)				
Veterinary services	$ 1,105,862	$ 450,196	$ 976,918	$ 2,532,976
Ohio State (College and VMC)	88,989	4,664	53,783	147,435
Other industries	7,576,085	4,940,386	4,024,305	16,540,776
Total	**$ 8,770,935**	**$ 5,395,246**	**$ 5,055,006**	**$ 19,221,187**
Earnings (thousands)				
Veterinary services	$ 723,158	$ 106,955	$ 310,452	$ 1,140,565
Ohio State (College and VMC)	68,914	3,000	41,023	112,937
Other industries	2,599,358	1,868,530	1,670,621	6,138,509
Total	**$ 3,391,430**	**$ 1,978,485**	**$ 2,022,096**	**$ 7,392,011**
Employment				
Veterinary services	16,541	1,906	7,711	26,158
Ohio State (College and VMC)	822	34	424	1,280
Other industries	39,767	29,406	31,764	100,937
Total	**57,130**	**31,346**	**39,900**	**128,376**

Industry growth and the approaching retirement of veterinarians and other workers in the veterinary medical industry will create a need for more than 24,000 new workers in the industry between 2021 and 2031.

This need is 46% greater than total 2021 employment in the industry. More than half of the total need will be for veterinary assistants and technicians, who will take an increasing role in animal care. This mirrors the situation in human healthcare, which is increasingly relying on nurses and others without an M.D. or D.O. to help satisfy the rapidly increasing need for care.

Ohio veterinary services employment in 2021 was 46% higher than in 2010, immediately after the 2007-2009 recession. The veterinary auxiliary industries' employment was 34% higher. This compares favorably to the total Ohio employment growth across all sectors of 6.9%.

In contrast to total Ohio employment, whose growth was only 55% of the national average, veterinary services growth was only slightly less than the national average and growth of other animal-related industries was 23% greater. Thus, in a small way, these animal-related industries brought the employment growth of the Ohio economy closer to the much faster growth elsewhere in the U.S.

There are considerable differences in veterinary services employment growth among Ohio regions.

There is at least one veterinary office in 86 of Ohio's 88 counties. Local employment is analyzed by dividing the state into six large metropolitan regions and seven other regions including smaller metropolitan areas and rural counties. Employment in all of these 13 regions was higher in 2021 than in 2010. The Columbus area enjoyed the strongest net growth between 2010 and 2021 with a

gain of 60%. Columbus growth was followed closely by the East North Central region with a gain of 58.5% and the Cincinnati and Dayton MSAs with 55%. However, the Southeast gained only 5% over those 11 years.

There are 3,930 veterinarians practicing in Ohio. While this number is relatively small, the corresponding economic impact of the veterinary industry in Ohio is remarkably large.

This total from the Ohio Veterinary Medical Association includes both payroll employment and self-employed individuals. Many of these self-employed veterinarians are owners of their own practice. The majority of veterinarians in Ohio, 55%, are in private practices focusing on companion animals and another 10% treat farm animals or both pets and farm animals. Smaller numbers work in academics and research or are employed by corporations or government. The focus of 21% of Ohio veterinarians was not reported.

Ohio educational institutions offer an array of veterinary and animal care programs beginning as early as high school and continuing through Ohio State 's doctoral programs.

Of the 86 high school career and technical education centers throughout the state, 28 offer coursework in animal science or animal care, including five offering a specific program in equine science. At least 27 two-year and four-year colleges and universities in Ohio offer veterinary and animal-related programs and/or certificates, including 20 four-year pre-veterinary programs. Ohio State offers the only doctoral program in veterinary medicine in Ohio, Kentucky, and West Virginia. Additionally, Ohio State offers master's and doctoral degrees in comparative and veterinary medicine, and a master's program in veterinary public health. The veterinary medicine program is ranked fourth among all North American veterinary schools by *U.S. News and World Report*, the highest-ranked college at Ohio State.

Ohio State also accommodates a robust veterinary research program, some discoveries of which have been commercialized, and one of the largest veterinary medical centers in the U.S.

Researchers in the College of Veterinary Medicine developed the first feline leukemia vaccine and have developed technology used in tick-borne disease diagnostics. Faculty are leaders in the development of advanced animal orthopedic procedures, infectious diseases, food safety, and cancer. The VMC is one of the largest veterinary medical centers in the U.S. and is the only comprehensive referral veterinary medical center for companion animals, farm animals, and horses in Ohio, Kentucky, and West Virginia. The veterinary health system cares for more than 80,000 patients annually in six hospitals and on farms across Ohio. The college's Large Animal Services in Marysville, Ohio provides farm-based service to livestock operations across 17 counties.

The cost of the four-year DVM degree leads to levels of graduate debt averaging more than $160,000.

Despite large decreases in average burden in recent years, debt service on the average unsubsidized federal loan is $1,088 per month or $13,052 per year over 25 years. This negatively impacts graduates' ability to finance consumption, including adverse impacts on their credit score. A recent study has shown that this debt burden influences the career choice of new DVM graduates, steering them toward more lucrative private practice and clinical training, and away from the critical needs in public practice.

Introduction

This report is an update to the 2017 study, "Economic and Social Impacts of Veterinary Medicine in Ohio" by Bill LaFayette and Stephen A. Buser. This update considers only the economic aspects of the earlier study; the social impacts are still current.

The report begins with an analysis of economic and employment trends of the veterinary services industry and other animal-related industries and occupations within these industries. This includes a comparison of occupational wages in Ohio with national averages and the current age distribution of veterinarians. Following this is the distribution of occupations within industries and industries within which veterinarians and other animal-related workers are employed. This includes an analysis new to this update: a 10-year projection of the total and occupational need in Ohio's veterinary services industry. The next section discusses the distribution of veterinarians and animal ownership across Ohio. This is followed by a listing of the animal-related high school and college programs that supply these workers to the relevant industries and a discussion of the unique characteristics of The Ohio State University College of Veterinary Medicine. An update of the economic impact of Ohio's veterinary and animal-related industries follows. The report concludes with the impact of veterinary college debt on students and graduates.

Veterinary and Animal-Related Economic and Employment Trends

This section discusses trends in veterinary services and animal-related employment in Ohio and its regions, and compares those trends to U.S. averages. Employment can be measured in either of two ways: by industry (where people work regardless of what they do) or by occupation (what people do regardless of where they work). Both of these perspectives are relevant in assessing veterinary services and other animal-related employment. As discussed later in this section, a veterinary office includes the veterinarians but also technicians and other office and administrative staff. These support positions are included in the veterinary service industry and rightly so. If not for these support workers, office operations would be less efficient – if the office were able to function at all.

On the other hand, the veterinarian occupation includes veterinarians practicing in these offices as well as those in other industries such as research organizations, higher education, food inspection, and elsewhere in a broad array of employment opportunities. The insights revealed in that analysis can help those entering the profession get a better appreciation for the wide range of career opportunities open to them.

The section discusses industry employment, growth, and concentration first, followed by occupational employment.

Industries

Table 1 on the next page reports 2021 Ohio employment in veterinary services and auxiliary animal-related industries. Total Ohio payroll employment is shown on the last line for comparison. These industries are defined by the North American Industry Classification System (NAICS); the industry's NAICS code is shown with the industry's name. NAICS is a hierarchical system with codes between two and six digits. The first three digits of a six-digit code indicate the subsector to which a detailed industry belongs, while the fourth digit indicates the industry group. The code for dog and cat food

manufacturing is 311111. The first three digits, 311, indicate that the industry belongs to the food manufacturing subsector of the manufacturing sector (codes 31-33). An industry group within food manufacturing is animal food manufacturing (3111), which includes both dog and cat food manufacturing and other animal food manufacturing (311119). The employment in 311111 and 311119 sums to the employment in 3111. This is indicated by indenting those industries in Table 1.

The third and fourth columns of Table 1 display the Ohio and U.S. percentage change in employment since 2010, the employment trough following the 2007-2009 recession. The final column reports the location quotient (LQ), a measure of concentration of Ohio employment relative to the national average. This is calculated as the percentage of total Ohio employment in a specific industry divided by the percentage of total nationwide employment in that industry. Thus, an LQ greater than 1.0 implies an industry that is more concentrated in Ohio than average. Specifically, veterinary services' LQ of 1.032 indicates that the industry's employment is 3.2% greater than average, or 3.2% greater than would be expected in an economy Ohio's size. (Total payroll employment has a location quotient of 1.000 by definition.)

Several industries in Table 1 include animal-oriented activities and much more. Pharmaceutical preparation manufacturing (NAICS 325412), surgical and medical instrument manufacturing (NAICS 339112), and druggists' goods merchant wholesalers (NAICS 424210) include products for both animals and humans. Other professional equipment merchant wholesalers (NAICS 423490) is an even broader industry including wholesalers of veterinarians' equipment as well as wholesalers of non-medical laboratory equipment, engineers' supplies, and religious supplies. Consequently, these four industries are not considered in the analysis to follow. The relevant industry totals are highlighted in lavender in Table 1.

One significant modification of the employment totals is necessary. The Quarterly Census of Employment and Wages (QCEW) provides accurate counts of 95% of employment, but one of the few sectors substantially undercounted is farm employment. Ohio animal production and aquaculture employment according to the QCEW was 6,462 in 2021, and total crop and animal farm employment was 14,725. A comprehensive count of farm employment (but no detailed industries) is available from the Regional Economic Accounts of the Bureau of Economic Analysis. This shows total 2021 farm employment of 84,080. Assuming that crop production employment and animal production employment are equally understated in the QCEW, an estimate of Ohio animal production employment is 36,898. This is shown in Table 1 in lieu of the QCEW total.

Table 1: Ohio Payroll Employment in Veterinary and Animal-Related Industries

NAICS code and industry	Ohio employment, 2021	Change, 2010-2021		Location quotient
		Ohio	U.S.	
541940 Veterinary services	**16,541**	**46.4%**	**48.3%**	**1.032**
Auxiliary industries				
112 Animal production and aquaculture	36,898	25.6%	7.1%	1.212
115210 Support activities for animal production (including equine boarding)	1,230	66.9%	13.5%	1.097
3111 Animal food manufacturing*	2,750	2.4%	31.8%	1.108
311111 Dog and cat food manufacturing	862	-28.7%	59.2%	0.726
311119 Other animal food manufacturing	1,888	27.9%	13.8%	1.458
325412 Pharmaceutical preparation manufacturing (including veterinary medical preparations mfg.)	5,520	16.1%	2.8%	0.689
339112 Surgical and medical instrument manufacturing (including veterinarians' instruments)	2,094	7.2%	18.1%	0.421
423490 Other professional equip. merchant wholesalers (including veterinarians' equipment)	848	-21.9%	33.8%	0.683
424210 Druggists' goods merchant wholesalers (including veterinary medicines)	10,155	25.4%	28.1%	1.142
424910 Farm supplies merchant wholesalers	3,518	16.1%	8.1%	0.827
453910 Pet and pet supplies stores	4,436	0.2%	20.0%	1.019
711212 Racetracks	464	-66.8%	-37.0%	0.536
712130 Zoos and botanical gardens	2,124	18.5%	20.4%	1.513
812910 Pet care, except veterinary services	5,686	156.4%	129.5%	1.080
Total auxiliary industries	75,723	23.0%	15.5%	0.910
Veterinary services plus auxiliary industries	92,264	26.6%	19.8%	0.929
Excluding 325412, 339112, 423490, and 424210				
Auxiliary industries	**57,106**	**33.7%**	**27.3%**	**0.950**
Veterinary services plus auxiliary industries	**73,647**	**36.4%**	**31.2%**	**0.967**
Total payroll employment	**5,246,891**	**6.9%**	**12.5%**	**1.000**

** Indented industries are components of this industry.

Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics. Animal production employment and LQ estimated from Regional Economic Accounts, U.S. Bureau of Economic Analysis; see text.

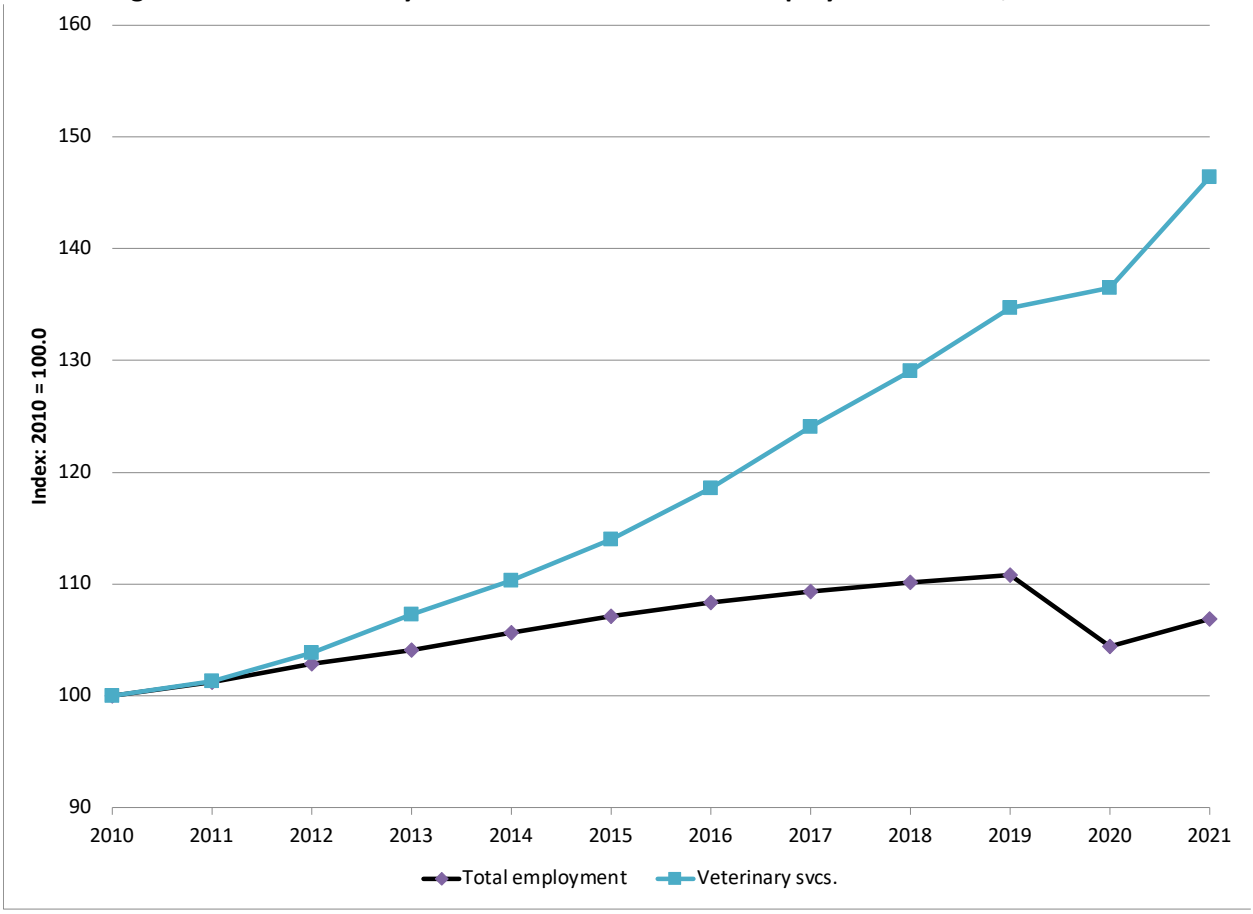
The principal conclusion of Table 1 is that veterinary services and animal-related industries have outperformed other industries in Ohio. **Ohio employment in veterinary and animal-related industries, excluding the broad animal-related industries, was up more than 36% (19,643 jobs), compared to the 31% national average. Veterinary services employment increased by nearly half. In contrast, total Ohio employment across all sectors increased less than 7% between 2010 and 2021 versus the 12.5% national average growth. Without the growth of animal-related industries, the state's employment performance would have been even weaker than average.**

Industry-level results are mixed, but some industries performed substantially better than average. These include animal production and related support industries, other animal food manufacturing, pharmaceutical manufacturing, farm supplies wholesaling, and non-veterinary pet care. On the other hand, dog and cat food manufacturing employment has declined steadily since 2010. Losses amounted to nearly 29% (347 jobs). Employment at these manufacturers nationwide in 2021 was more than half again its 2010 level. Other significantly underperforming industries primarily focus on animals include pet and pet supplies stores and racetracks.

The LQ column gives insight into animal-related industries that are more concentrated in Ohio than elsewhere. Ohio employment in veterinary offices and clinics was 3.2% greater than average. Employment in other animal food manufacturing factories was 41.8% greater – a very high concentration that makes this industry a key driver of the Ohio economy. Zoo employment had an even greater concentration, with Ohio employment 51.3% above average. Farming is 21.2% above average and druggists' goods wholesalers' employment is 14.2% greater – but recall that this industry supports humans as well as animals.

Figure 1 contrasts the robust employment gains of Ohio veterinary services with the much weaker employment growth of the total statewide economy. Worth noting is the fact that the onset of the pandemic in 2020 caused veterinary gains to slow but not reverse, while total employment in 2020 fell 5.8%.

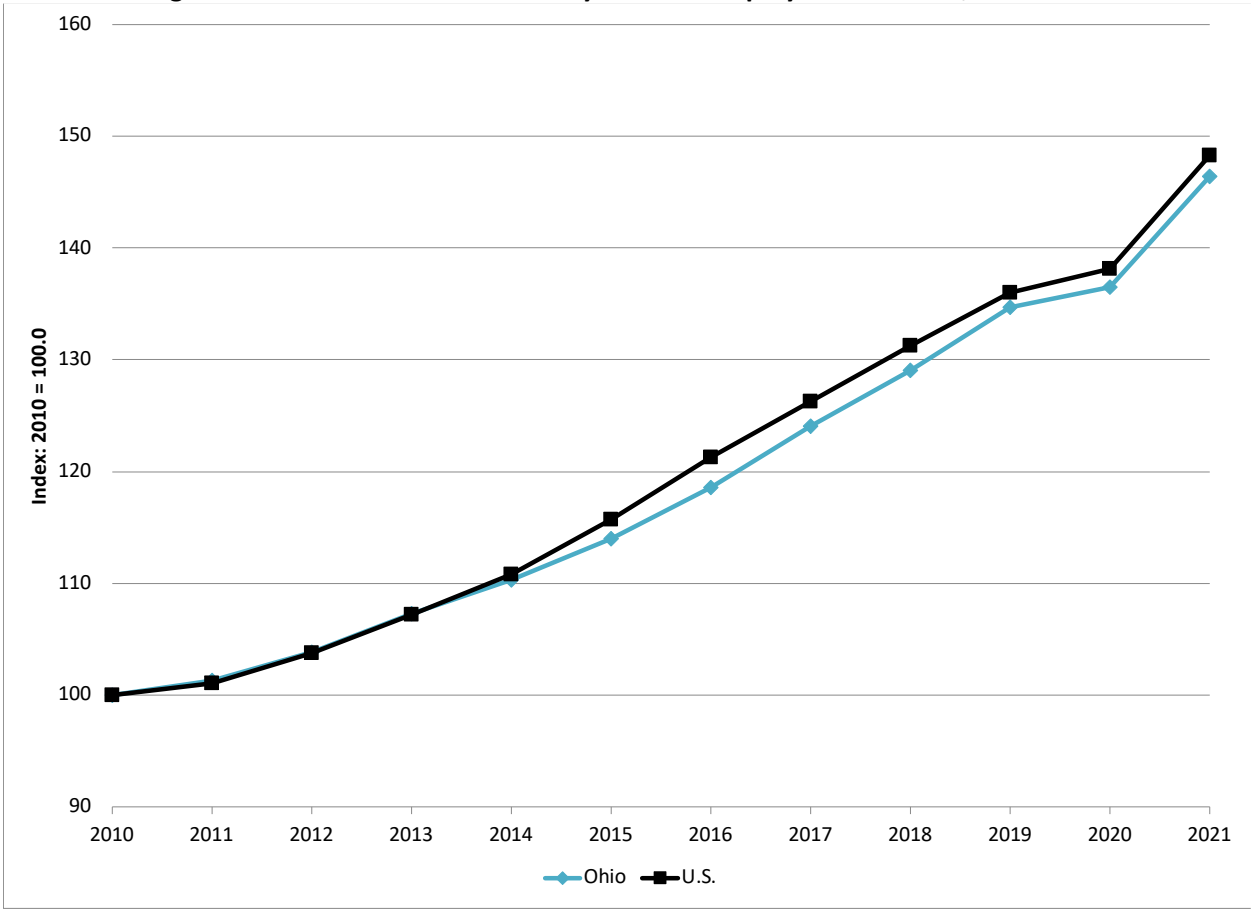
Figure 1: Ohio Veterinary Services versus Ohio Total Employment Growth, 2010-2021



Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Figure 2 compares growth of veterinary services employment in Ohio and nationally. The trends have been very similar, with Ohio employment increases only slightly slower than the national average. Because a significant percentage of veterinary services establishments focus partly or exclusively on companion animals and most function in a primarily local market, one might expect the industry's growth to mirror the very slow growth of Ohio population and households. **For that reason, it can be argued that the fact that the veterinary services industry's employment growth is only slightly less than the national average is a sign of strength.**

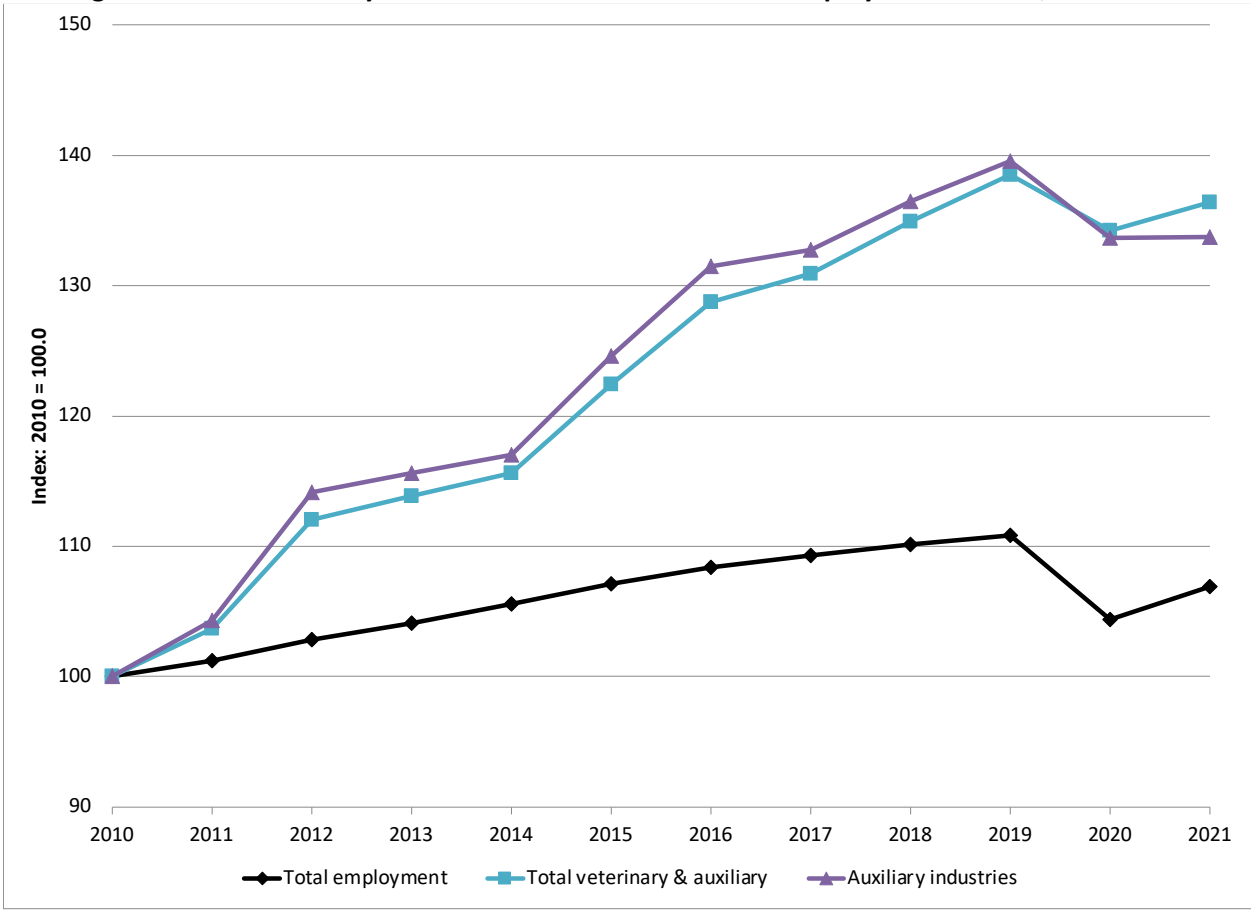
Figure 2: Ohio versus U.S. Veterinary Services Employment Growth, 2010-2021



Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Figure 3 spotlights the performance of auxiliary industries – omitting those that are less animal related – and these industries plus veterinary services. These trends are also compared to the trend for all sectors. Unlike veterinary services, these industries were affected by the pandemic. Total 2020 average employment in animal-related industries was down 4.2% from 2019, less than the 5.8% total Ohio employment loss and the 6.1% U.S. loss. The worst losses were suffered by racetracks and zoos, where employment fell 44.2% and 29.4%, respectively. The same was true of the broad sector including these two industries, arts, entertainment, and recreation, where employment fell 26% in Ohio and 29% nationwide. **Nevertheless, in a small way, the strength of veterinary services and auxiliary industries improved the below-average growth of Ohio employment over the past 11 years.**

Figure 3: Ohio Veterinary and Animal-Related versus Total Employment Growth, 2010-2021



Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Table 2 includes total and average payroll earnings of the workers in these industries. The average (mean) wages must be interpreted with caution. For statistical reasons, average wages usually overstate the earnings of the typical worker and do so by differing degrees. A different measure of the average wage, the median, is a better reflection of workers' wages. This is the wage that is at the midpoint of the wage distribution, so that 50% of workers in the industry earn less and 50% earn more. Thus, it represents the earnings of the typical worker. The median wage is unavailable in this data set, however.

The $43,719 average wage of veterinary services and the $26,404 average wage of the combined veterinary and relevant auxiliary industries are both less than the average Ohio wage and less than the corresponding national average wage of these industries. As will be discussed later, the veterinary services industry includes both veterinarians and lower-paid support occupations that bring down the industry average wage. However, the 17.5% wage growth of Ohio veterinary services employment between 2010 and 2021 exceeded the 12.4% growth of all employment statewide. (The same was true at the national level.) The relevant auxiliary industries' wage growth was weighed down in both cases by the decline in inflation-adjusted farm wages. Ohio auxiliary wage growth also suffered from the loss of relatively well-paying dog and cat food manufacturing jobs, and the lack of growth in racetrack wages.

Table 2: Wages in Veterinary and Animal-Related Industries

NAICS code and industry	Ohio total wage, 2021 ($000)	Average wage, 2021		Average wage change 2010-2021*	
		Ohio	U.S.	Ohio	U.S.
541940 Veterinary services	**$ 723,158**	**$ 43,719**	**$ 48,018**	**17.5%**	**20.2%**
Auxiliary industries					
112 Animal production and aquaculture	272,459	11,285	29,689	-11.7%	-7.3%
115210 Support activities for animal production (including equine boarding)	52,214	42,450	42,784	-0.3%	8.2%
31111 Animal food manufacturing**	185,941	67,615	68,787	-2.1%	8.1%
311111 Dog and cat food manufacturing	66,702	77,381	71,717	-7.2%	-2.4%
311119 Other animal food manufacturing	119,239	63,156	66,100	10.3%	15.6%
325412 Pharmaceutical preparation mfg. (incl. veterinary medical preparations mfg.)	526,563	95,392	133,241	13.8%	2.1%
339112 Surgical and medical instrument mfg. (including veterinarians' instruments)	153,050	73,090	94,455	5.4%	6.4%
423490 Other professional equip. merchant wholesalers (incl. veterinarians' equipment)	66,795	78,768	104,103	-4.1%	24.4%
424210 Druggists' goods merchant wholesalers (including veterinary medicines)	1,302,041	128,217	143,802	31.7%	21.7%
424910 Farm supplies merchant wholesalers	237,883	67,619	72,632	18.3%	20.4%
453910 Pet and pet supplies stores	115,116	25,950	31,142	19.2%	24.8%
711212 Racetracks	9,098	19,608	42,853	0.1%	36.3%
712130 Zoos and botanical gardens	76,447	35,992	38,897	7.3%	7.6%
812910 Pet care, except veterinary services	128,314	22,567	26,795	22.3%	21.3%
Total auxiliary industries	3,269,843	43,182	64,575	10.7%	7.6%
Veterinary services plus auxiliary industries	3,993,001	43,278	61,616	11.7%	7.9%
Excluding 325412, 339112, 423490, and 424210					
Auxiliary industries	$ 1,221,394	$ 21,388	$ 35,822	-1.4%	2.1%
Veterinary services plus auxiliary industries	$ 1,944,552	$ 26,404	$ 38,759	6.6%	7.5%
Total payroll	$ 306,154,393	$ 58,350	$ 67,610	12.4%	16.4%

*Adjusted for inflation. ** Indented industries are components of this industry.
Source: Quarterly Census of Employment and Wages and Consumer Price Index for All Urban Consumers, U.S. Bureau of Labor Statistics.

In Table 3 are the number and percentage change in establishments in veterinary services and animal-related industries. According to the Bureau of Labor Statistics (BLS): "An establishment is an economic unit, such as a factory, mine, store, or office that produces goods or services. It generally is at a single location and is engaged predominantly in one type of economic activity."[1] A firm with three locations is a single "enterprise" but three establishments. The establishment is the unit by which BLS measures activity; the industry in which the establishment's employment is classified is based on the primary activity within the establishment. Thus, a pet food manufacturer with a factory and a separate research laboratory would be classified both in dog and cat food manufacturing and in research and development in biotechnology. If, however, the lab is inside of the factory, all employment in the facility is classified in manufacturing.

[1] United States Bureau of Labor Statistics. (2011). Chapter 2: Employment, Hours, and Earnings from the Establishment Survey, in *Handbook of Methods*, p. 1. Retrieved from https://www.bls.gov/opub/hom/pdf/homch2.pdf

Table 3: Establishments in Veterinary and Animal-Related Industries

NAICS code and industry	Ohio establishments 2021	Change, 2010-2021	
		Ohio	U.S.
541940 Veterinary services	**1,178**	**13.3%**	**17.1%**
Auxiliary industries			
112 Animal production and aquaculture	n/a	n/a	n/a
115210 Support activities for animal production (including equine boarding)	163	71.6%	17.6%
31111 Animal food manufacturing*	87	6.1%	24.2%
311111 Dog and cat food manufacturing	13	0.0%	100.3%
311119 Other animal food manufacturing	74	7.2%	7.7%
325412 Pharmaceutical preparation mfg. (incl. veterinary medical preparations mfg.)	65	160.0%	118.4%
339112 Surgical and medical instrument mfg. (including veterinarians' instruments)	47	20.5%	81.8%
423490 Other professional equip. merchant wholesalers (incl. veterinarians' equipment)	115	23.7%	48.4%
424210 Druggists' goods merchant wholesalers (including veterinary medicines)	871	116.7%	96.6%
424910 Farm supplies merchant wholesalers	402	18.9%	16.3%
453910 Pet and pet supplies stores	347	5.5%	15.4%
711212 Racetracks	29	-25.6%	-20.1%
712130 Zoos and botanical gardens	30	30.4%	31.4%
812910 Pet care, except veterinary services	817	77.2%	79.3%
Total auxiliary industries excluding 112	2,973	54.4%	51.5%
Veterinary services plus auxiliary industries	4,151	40.0%	40.2%
Excluding 112, 325412, 339112, 423490, and 424210			
Auxiliary industries	**1,875**	**58.0%**	**58.5%**
Veterinary services plus auxiliary industries	**3,053**	**37.1%**	**39.9%**
Total Ohio establishments	**315,104**	**10.2%**	**21.3%**

* Indented industries are components of this industry.

Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Table 3 omits an establishment count for animal farms because the Regional Economic Accounts do not include establishment totals. Although these totals are included in the QCEW, it is virtually certain that establishments are undercounted just as employment is undercounted. While the growth in veterinary offices and clinics was less in Ohio than at the national level, it was greater than the growth of all establishments in Ohio. The number of nonfarm auxiliary industry establishments increased by more than half.

Table 4 combines the information in Tables 1 and 4 to yield the average establishment size for these industries. Ohio veterinary services establishments are on average slightly larger than their counterparts elsewhere, and the average size increased from just under 11 positions on average in 2010 to 14 in 2021. In contrast, average employment in the auxiliary industries declined in nearly all cases, with the average Ohio racetrack losing more than half their employment.

Table 4: Average Establishment Size in Veterinary and Animal-Related Industries

NAICS code and industry	Ohio		United States	
	2010	2021	2010	2021
541940 Veterinary services	**10.9**	**14.0**	**10.4**	**13.2**
Auxiliary industries				
112 Animal production and aquaculture	n/a	n/a	n/a	n/a
115210 Support activities for animal production (including equine boarding)	7.8	7.5	5.3	5.1
31111 Animal food manufacturing*	32.7	31.6	25.5	27.0
311111 Dog and cat food manufacturing	93.0	66.3	56.6	45.0
311119 Other animal food manufacturing	21.4	25.5	18.7	19.8
325412 Pharmaceutical preparation manufacturing (including veterinary medical preparations manufacturing)	190.1	84.9	122.6	57.7
339112 Surgical and medical instrument manufacturing (including veterinarians' instruments)	50.1	44.6	70.1	45.5
423490 Other professional equip. merchant wholesalers (including veterinarians' equipment)	11.7	7.4	8.8	7.9
424210 Druggists' goods merchant wholesalers (including veterinary medicines)	20.1	11.7	17.0	11.1
424910 Farm supplies merchant wholesalers	9.0	8.8	10.0	9.3
453910 Pet and pet supplies stores	13.5	12.8	11.4	11.9
711212 Racetracks	35.8	16.0	38.8	30.6
712130 Zoos and botanical gardens	78.0	70.8	49.6	45.5
812910 Pet care, except veterinary services	4.8	7.0	5.1	6.5
Total auxiliary industries excluding 112	32.0	25.5	30.1	22.9
Veterinary services plus auxiliary industries	24.6	22.2	23.6	20.2
Excluding 112, 325412, 339112, 423490, and 424210				
Auxiliary industries	**36.0**	**30.5**	**30.8**	**25.1**
Veterinary services plus auxiliary industries	**24.2**	**24.1**	**21.6**	**20.6**
All establishments	**17.2**	**16.7**	**14.2**	**13.2**

* Indented industries are components of this industry.
Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Occupations

As discussed earlier, employment can be measured by occupation as well as by industry, allowing the same analysis of employment and wage changes as presented above for industries. Unlike the industry statistics, however, these occupational statistics are based on a limited sample and include nearly 800 individual occupations. For this reason, employment levels and wages are reported with a margin of error, which in some cases is quite large. Occupations are defined and classified by the Standard Occupational Classification (SOC) system, a scheme analogous to NAICS. Unlike NAICS codes, which can be two to six digits, SOC codes are always six digits – two digits, a dash, and four digits. The two digits before the dash identify the occupational group, the broadest category. The four digits after the dash denote successively more specific occupational classifications.

Table 5 shows May 2021 payroll employment of the relevant veterinary and animal care occupations. These are grouped into two categories: primary occupations, which are directly associated with veterinary services and animal science activities, and secondary occupations, which provide less-direct animal care and support. The table also shows the range within which the unobservable true

employment level is likely to fall (with a 90% likelihood) and changes from May 2010, as employment was beginning to increase after the recession.

Table 5: Payroll Employment in Veterinary and Animal-Related Occupations

Occupation	Employmt., 5/2021		Chng. 5/2010-5/2021	
	Est.	Range*	Ohio	U.S.
Primary occupations				
29-1131 Veterinarians	3,330	3,207-3,453	64.9%	41.8%
29-2056 Veterinary technologists and technicians	4,740	4,498-4,982	104.3%	48.6%
31-9096 Veterinary assistants and laboratory animal caretakers	3,170	2,840-3,500	1.3%	40.3%
25-1071 Health specialties teachers, postsecondary (incl. veterinary medicine teachers, postsecondary)	7,500	7,403-7,598	36.4%	32.5%
19-1011 Animal scientists**	30	28-32	-72.7%	14.3%
19-1023 Zoologists and wildlife biologists	170	155-185	n/a	-8.7%
Secondary occupations				
39-2011 Animal trainers	530	443-617	103.8%	62.6%
39-2021 Nonfarm animal caretakers	8,170	7,892-8,448	83.2%	67.1%
45-2093 Farmworkers, farm, ranch, and aquacultural animals	940	763-1,117	n/a	7.1%
45-2021 Animal breeders***	n/a	n/a	n/a	-31.2%

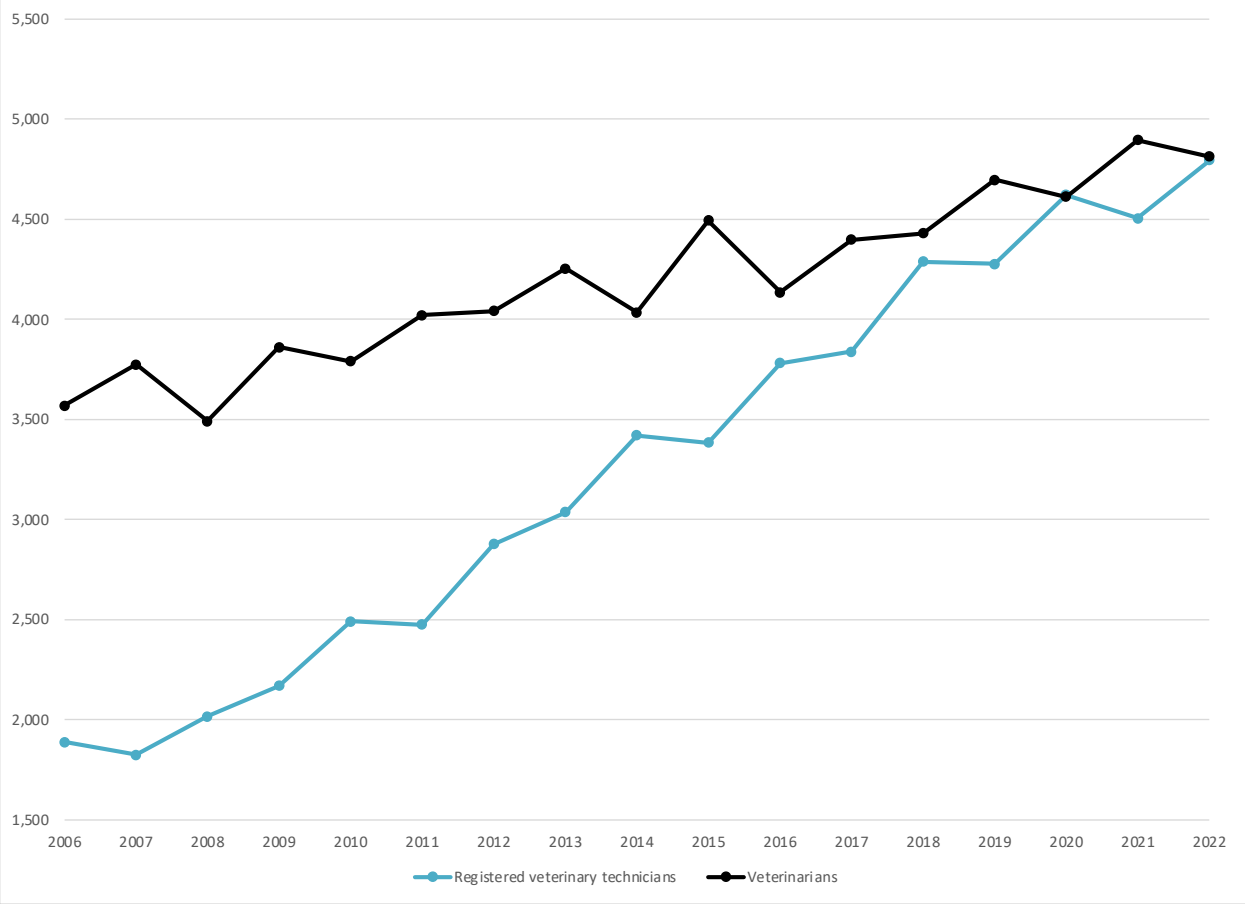
*90 percent confidence level. **2021 data not reported; levels and changes use 2020 data. ***Recent data not reported.
Source: Occupational Employment Statistics, U.S. Bureau of Labor Statistics.

The estimates in Table 5, like the industry estimates, refer to payroll employment only and do not include business owners. **As discussed later in this section, 7.9% of veterinarians nationally are self-employed (down from 16.2% in 2016).** Applying this percentage to the 3,330 wage and salary-earning veterinarians yields a total estimate of approximately 3,570. In addition to being subject to the measurement error shown in Table 5, the percentage of self-employed veterinarians in Ohio may differ from the U.S. average.

The Ohio Veterinary Medical Licensing Board (OVMLB) is responsible for the licensure of veterinarians and registered veterinary technicians. As of the end of fiscal year 2022, there were 4,795 active veterinary technician licenses and 4,813 veterinarian licenses. As Figure 4 reveals, the number of licensed technicians has been increasing faster that the number of licensed veterinarians. The number of technician licenses was slightly more than 2.5 times as great than in 2006, while the number of veterinarian licenses increased only 35% during that period. Moreover, the number of Ohio veterinarian licenses overstates the number of veterinarians resident in Ohio. Some veterinarians holding Ohio licenses are located outside of Ohio – mostly in adjacent states – but sometimes treat animals in Ohio. This requires a state-issued license. According to the OVMLB, these non-Ohio veterinarians licensed by the state are 18.3% of the total. **Thus, the total number of licensed Ohio resident veterinarians is 3,930.**[2] It is much less common for veterinary technicians to be licensed outside their home state, so the actual total is much closer to the 4,795 who are licensed. (Note that 4,795 is well within the margin of error in Table 5.)

[2] Email from Jack Advent, executive director, Ohio Veterinary Medical Association, February 24, 2023.

Figure 4: Veterinarians and Veterinary Technicians Licensed in Ohio, 2006-2021



Source: Ohio Veterinary Medical Licensing Board annual reports, fiscal years 2013, 2018, and 2022.

Median annual Ohio and U.S. wages and salaries for these occupations are reported in Table 6. As discussed above, the median is the preferable statistic because it represents the wage of the typical worker. As in the case of employment, wages are reported with error so 90% ranges are also reported. In cases in which the ranges overlap, we cannot be confident that the true Ohio wage is actually different from the true national average. Ohio wages of veterinary assistants, zoologists, animal trainers, and nonfarm animal caretakers are significantly less than the national average; those of animal breeders are significantly greater.

Again, however, these estimates refer to payroll earnings (wages and salaries) and do not include self-employment income. **This is a material consideration for veterinarians: the 7.9% of self-employed veterinarians are not represented in this sample and may be earning far more than the $98,010 Ohio median and the $109,920 U.S. median reported in Table 6.** Surveys reporting veterinarian earnings including self-employment income seem not to be available. In any case, the personal income of a practice owner is conceptually different from the salary of an employed veterinarian. Unlike an employee, the practice owner's take-home income is under his or her control. Personal income will vary based on the decision of how much to convert to personal income and how much to reinvest in the business – essentially, the owner's preference for current consumption. Consequently, any survey including self-employment income would have to be approached carefully.

Table 6: Median Wages and Salaries in Veterinary and Animal-Related Occupations, May 2021

Occupation	Ohio		U.S.	Chng. 5/10-5/21	
	Wage*	Range**	Wage	Ohio	U.S.
All occupations	**53,170**	**53,064-53,276**	**58,260**	**2.2%**	**12.0%**
Primary occupations					
29-1131 Veterinarians	98,010	93,796-102,224	109,920	3.2%	1.3%
29-2056 Veterinary technologists and technicians	36,510	35,926-37,094	38,250	4.5%	2.7%
31-9096 Veterinary assistants and laboratory animal caretakers	29,420	29,038-29,802	31,780	24.0%	11.9%
25-1071 Health specialties teachers, postsec. (incl. Veterinary medicine teachers, postsec.)	141,260	140,412-142,108	133,310	48.3%	-0.2%
19-1011 Animal scientists***	55,707	52,420-58,993	66,047	-4.6%	-6.1%
19-1023 Zoologists and wildlife biologists	61,760	60,463-63,057	70,300	-1.4%	-6.8%
Secondary occupations					
39-2011 Animal trainers	38,480	35,556-41,404	38,230	-10.4%	-2.5%
39-2021 Nonfarm animal caretakers	26,840	26,411-27,269	29,520	2.1%	21.1%
45-2093 Farmworkers, farm, ranch, and aquacultural animals	30,640	29,261-32,019	32,150	16.6%	11.7%
45-2021 Animal breeders****	n/a	n/a	43,270	n/a	5.9%

*Amounts in red: Ohio pay significantly less than U.S. average. Amount in green: Ohio pay significantly greater than U.S. average. **90 percent confidence level. ***2021 data not reported; levels and changes use 2020 data. ****Recent data not reported.

Source: Occupational Employment Statistics, U.S. Bureau of Labor Statistics.

The decline in the percentage of self-employed veterinarians in the U.S. from 16.2% in 2016 to 7.9% in 2021 is statistically significant. It is consistent with the increase in the average size of veterinary offices reported in Table 4, and suggests that veterinarians are selling their practices and these are being consolidated into larger offices. While the individuals leaving self-employment are presumably being rewarded, the overall decline in veterinarian self-employment is a negative development. In addition to the greater potential income discussed above, a recent American Veterinary Medical Association study of the satisfaction of practice owners found that veterinarians who owned their own practice had significantly higher levels of compassion satisfaction and significantly lower levels of burnout.[3]

The slow growth rate of veterinary establishments in Ohio coupled with the larger average establishment size suggests that the share of Ohio veterinarians who are self-employed has declined as well. However, the total number of Ohio resident veterinarians combined with the estimated number of veterinarian employees in Table 5 suggests that self-employment rates are higher than average in Ohio. The employment range in that table suggests that **the share of self-employed veterinarians in Ohio could be anywhere from 12% to 18%**.

The Ohio Veterinary Medical Association periodically collects data from its members regarding the focus of their practice. Table 7 applies the percentages reported by the most recent survey to the 3,930 Ohio resident veterinarians. As shown, more than half of Ohio veterinarians concentrate on pets or companion animals. Some veterinarians treat a variety of species (mixed) and others practice predominately on horses or food/farm animals

[3] F.B. Ouedraogo and S.L. Lefebvre. (2022). Benefits of practice ownership among US private practice veterinarians extend to professional quality of life. *Journal of the American Veterinary Medical Association*, *260*(15) 1971-1978. https://doi.org/10.2460/javma.22.05.0218

Table 7: Practice Discipline of Veterinarians in Ohio

Practice discipline	Survey percentage	Inferred number of veterinarians
Pet animal	55%	2,162
Mixed animal	3%	118
Equine	5%	197
Food animal	4%	157
Academic	5%	197
Animal shelter	4%	157
Government/military	2%	79
Research	1%	39
Not reported	21%	825
Total	**100%**	**3,930**

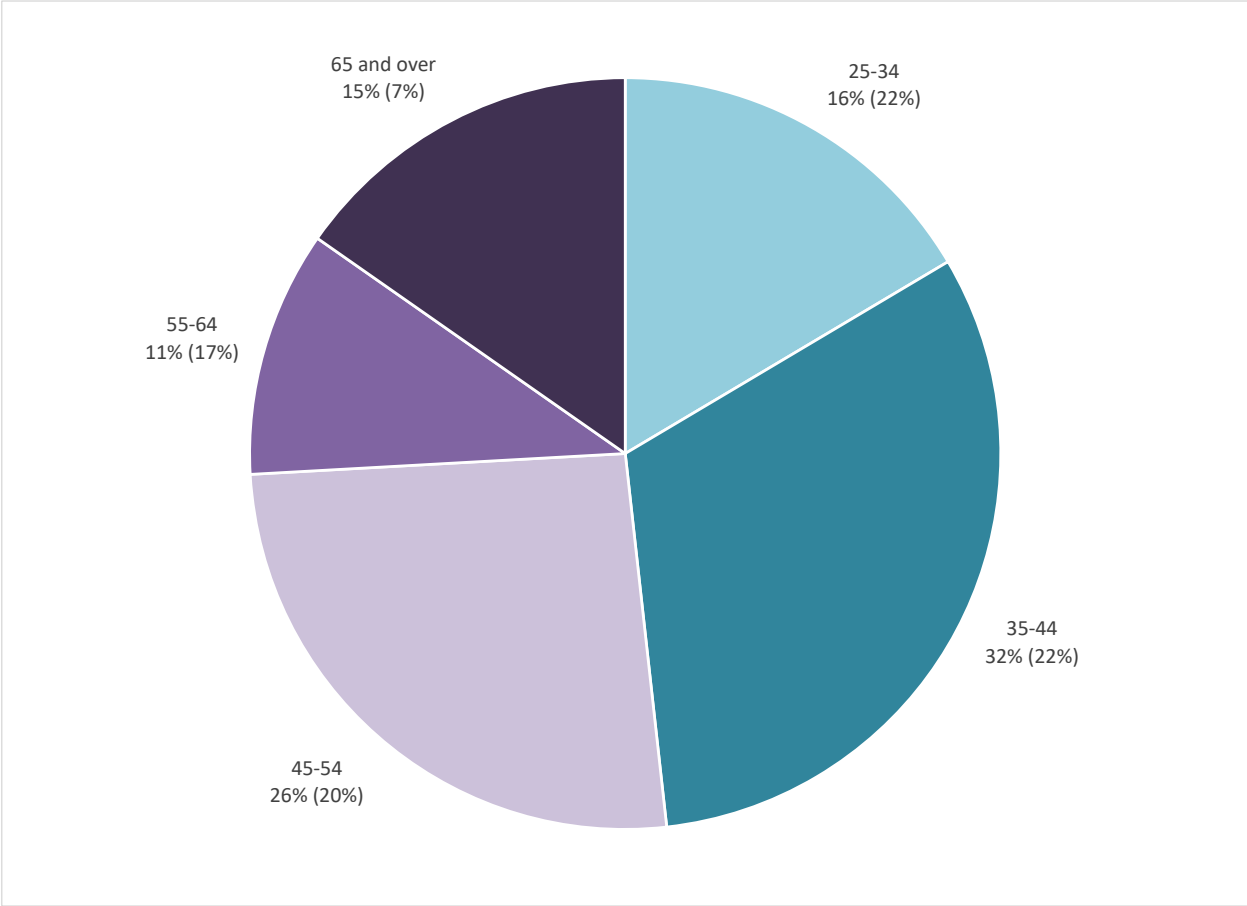
Source: Ohio Veterinary Medical Association member survey.

Age Distribution of Veterinarians

The increasing age of the workforce is a growing concern among employers and workforce professionals. The existing trend of retirements among aging Baby Boomers was drastically accelerated by the pandemic, and Bureau of Labor Statistics projections suggest little chance that the share of adults participating in the labor force will return to its pre-pandemic level in the foreseeable future. These projections are that the percentage of adults in the labor force in 2031 will be at what will then be a 60-year low. Not reflected in the statistics is the talent and experience that retiring workers are taking with them.

The age distribution of veterinarians in Ohio is not available, but the national distribution is reported. This distribution is graphed in Figure 5. The share of all workers in the specific age group is shown in parentheses. The Ohio distribution, if it were available, might show a slightly larger share in older age groups: the median age of the Ohio population in July 2021 was 39.6 versus the 38.8 U.S. average. Primarily because veterinarians start their career later than those in many professions, veterinarians are typically older than average: the median age of veterinarians in 2022 was 46.6, compared to 42.3 for the entire workforce. The lack of young workers leads primarily to a larger share of veterinarians in their prime working years, though. The share of veterinarians aged between 25 and 54 is 74% versus 64% for all workers. Those older than 55 account for 26% of veterinarians versus 24% of all workers. Applying the percentages to the 3,930 employed veterinarians in Ohio, **around 1,020 of veterinarians are 55 years or older and 590 are 65 or older. Virtually all of these are likely to retire within the next 15 to 20 years.** The implications of these retirements are analyzed in the next section.

Figure 5: Age Distribution of Employed Veterinarians, United States, 2022



Percentage of all workers by age in parentheses. Chart omits the 16-24 age group (0% of veterinarians, 12% of all workers).
Source: Labor Force Statistics from the Current Population Survey, U.S. Bureau of Labor Statistics.

Intersecting Industries and Occupations

This section uses national-level statistics for 2021 from the Bureau of Labor Statistics to derive estimates of the number of individuals in each occupation employed within individual industries, as well as the industries employing those in specific occupations and the number employed. This analysis focuses on three of the veterinary and animal-related industries in Ohio in 2021: animal production, animal food manufacturing, and veterinary services. The following section takes the analysis one step further for the veterinary services industry by deriving projections of 10-year worker needs in the Ohio veterinary offices, clinics, and hospitals that comprise the industry.

These analyses require the assumption that the employment patterns of these industries within Ohio are equivalent to those elsewhere. Differences in the size distribution of Ohio businesses versus the national distribution could give rise to differences in the occupational distribution of industry employment in Ohio. Most of the Ohio average establishment sizes in Table 4 are close to the national averages, but Ohio animal food manufacturing establishments are much larger than those elsewhere. Animal production establishment sizes are unavailable. There could also be some difference in the occupational makeup because of differences in establishment focus and customers – the share of large-animal veterinarians, for example. Still, the relationship between industry employment and occupational

employment is useful in suggesting the range of occupations needed by animal-related industries and the industries within which veterinary and animal-related workers can find employment.

The estimates of the number of Ohio workers by occupation in animal production is shown in Appendix Table A-1, and occupational estimates in animal food manufacturing are in Table A-2. As Table A-1 reveals, nearly half of the payroll employment in animal production consists of farmworkers, and one-quarter is composed of agricultural managers. Animal breeders, animal trainers, and veterinary assistants are also represented among the occupations employed by these farming operations.

Employment in animal food manufacturing, as shown in Table A-2, is focused on production-oriented occupations, with food scientists and technologists and agricultural and food science technicians – presumably with training in animal nutrition – accounting for approximately 19 positions, or 0.7% of the total industry employment. This may not include all the animal science-related support required by this industry, however. Some of the work needed by animal food and veterinary drug manufacturers is performed by outside academic and non-academic research facilities on a contract basis. For example, researchers at The Ohio State University's College of Veterinary Medicine developed the first feline leukemia vaccine. The vaccine was licensed to Zoetis Inc. and is now used worldwide. Battelle in Columbus has a practice area dedicated to the study of animal metabolism and other animal-related research activities. The use of these services by private industry lessens the need to employ scientists directly.

Appendix Tables A-3 through A-6 provide national-level estimates of employment by industry for four veterinary and animal-related occupations: veterinarians, veterinary technologists and technicians, veterinary assistants and laboratory animal caretakers, and nonfarm animal caretakers. These estimates cannot be as easily localized to Ohio as those for occupations within industries. In addition to the potential problem of industries in which the employment distribution differs from the national average, there is a much greater problem of industries with greater or less concentration in Ohio than average. If an industry has greater-than-average employment in Ohio, such as animal food manufacturing or zoos and botanical gardens, that industry should also account for a greater-than-average share of total employment within the relevant industries. Still, the national-level employment shares provide a general sense of the industries within which Ohio workers are employed.

Table A-3 reveals that **92.4% of veterinarians are either employed in veterinary offices or are self-employed**. While some of these self-employed individuals may be consultants, the vast majority are likely owners of their own practice. As discussed earlier, **the 7.9% of veterinarians who are self-employed is a greater share than the 6.3% of all workers who are self-employed, but less than the 16.2% of veterinarians who were self-employed in 2016.** This implies that a veterinary career offers opportunities for business development and entrepreneurship. Those pursuing a veterinary career would be well-served to develop the skills needed to start and operate a business. Recognizing this need, the College of Veterinary Medicine offers a graduate business minor in cooperation with the Fisher College of Business. Other veterinarians are employed primarily by federal, state, and local governments (2.8%), social advocacy organizations such as animal welfare organizations (1.5%), and public and private colleges and universities (0.9%).

According to Table A-4, 91% of veterinary technologists and technicians nationwide are employed in veterinary offices. Colleges and universities employ 2.9%, social advocacy organizations employ 1.6% and research and development enterprises employ 0.8%. The employment pattern of veterinary assistants and animal caretakers, shown in Table A-5, is roughly similar, with a somewhat larger

percentage of workers employed by postsecondary institutions (3.7%) and research organizations (1.8%).

The employment of nonfarm animal caretakers in Table A-6 is more dispersed among industries than the other occupations, with the share of self-employed workers (19.1%) far higher than among any of the other occupations. One-third of these workers nationwide are employed in the other personal services industry, which includes the non-veterinary pet care services included in Table 1 – services such as animal grooming, animal shelters, and pet boarding. Other miscellaneous store retailers (pet stores) account for 13.9% of these positions, with veterinary services employing 12.8%.

Projecting Workforce Needs in Veterinary Services

The Bureau of Labor Statistics database analyzed above also includes 2031 projections of the number of workers employed in specific occupations. The following paragraphs discuss 2031 projections of Ohio occupational employment in the core veterinary services industry.

The Ohio Labor Market Information Bureau provides 10-year industry growth projections for Ohio, but the most recent projections cover 2018-2028, and only for other professional services, veterinary services' industry group. These projections are related to the 2018-2028 and 2021-2031 U.S. projections for other professional services and veterinary services to produce a rough projection of 2021-2031 Ohio growth in veterinary services. Combining this with the national occupational projections generates occupation-level employment projections for the state. These incorporate both industry growth and anticipated shifts in demand for specific occupations by the veterinary services industry.

The net employment growth derived from these calculations represent only a portion of the projected total need for new employees, however. A much greater need is created through turnover in existing positions. The U.S. employment projections provide annual average openings for all occupations across all industries. Multiplying each occupation's annual openings by 10, subtracting the 10-year net change, and dividing the result by the 2021 employment total yields the 10-year turnover percentage for each occupation. This percentage multiplied by the derived 2021 occupational total gives the 10-year replacement need. (This assumes that the turnover rate in a specific occupation in Ohio veterinary services statewide is equal to the national rate for that occupation across all industries.) The turnover need plus the growth need equals the total need.

Appendix Table A-7 presents results of this analysis for the 25 occupations with the greatest total need. These occupations represent more than 98% of the total need for all occupations. Replacement needs over the next 10 years total 21,700, more than current total employment. Turnover can result from retirements, which as discussed above will be larger than they have been, as well as workers being promoted, changing occupations or careers, moving out of state, or passing away. These are net needs in the sense that they do not reflect a worker filling an equivalent job opening in a veterinary office elsewhere in Ohio. This fills a need of the new employer and creates a need for the old employer, but these two impacts net out.

The key finding of this analysis is that veterinary services in Ohio have a 10-year growth and replacement need of more than 24,000 new workers. It should be remembered that this is a projection, not a forecast, and assumes a continuation of the status quo. It does not reflect economic changes, unanticipated technological changes, or workforce dynamics that could impact needs in total or in individual occupations. But the ultimate message of this analysis is that the upcoming workforce needs

of Ohio veterinary offices will be substantial. Failing to satisfy these needs will challenge the ability of veterinarians to serve their patients effectively.

The two occupations with the greatest need, veterinary assistants and veterinary technicians, account for more than half of the total need. Employment in these two occupations is expected to increase 19%, compared to the 15.3% net increase in total veterinary services employment. This is analogous to the situation in human healthcare, which is increasingly relying on nurses and others without an M.D. or D.O. to help satisfy the increasing need for care. Veterinary assistants face higher turnover than veterinary technicians, creating a larger total need. The occupation with the third-greatest need, receptionists, emphasizes that **the profession must work as diligently to attract support staff as it works to attract those providing direct animal care**. Without receptionists, clerks, and accountants, veterinary practices could not easily function.

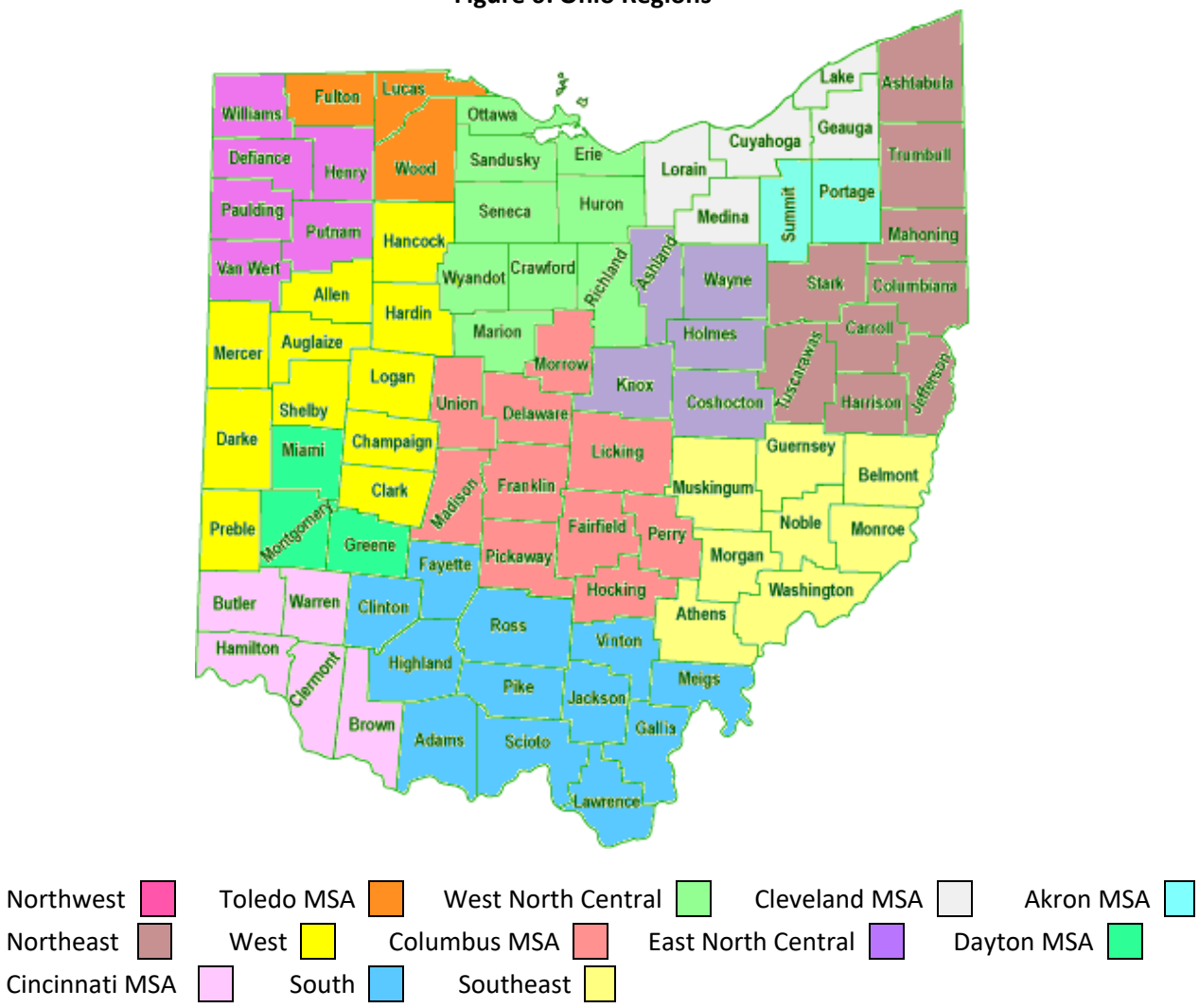
However, the Bureau of Labor Statistics warns that all industries will confront large worker needs in coming years for the same reason as the veterinary services industry: the aging workforce and the retirement of experienced workers. Competition for workers and workforce shortages will continue and worsen over the coming decade.

Spatial Characteristics of Veterinary Medicine and Animal Ownership

The number and growth of veterinary services practices and their employment varies widely across the state. However, **there is at least one veterinary office in 86 of Ohio's 88 counties** – all but Monroe and Noble Counties in Southeast Ohio. Appendix Table A-8 provides county-level employment totals in these practices in 2010 and 2021, the net percentage change in employment, and the number of establishments in each of the two years.

While county-level analyses can be worthwhile, it is often preferable to examine trends in a broader regional context. This is especially important in the analysis of the availability of veterinary services considered later in this section. While there may be no veterinary offices in a specific county, those in adjoining counties may (or may not) adequately meet the needs of both the county without offices and their home county. Figure 6 proposes a regional grouping of Ohio's counties. These 13 regions consist of the state's six largest metropolitan statistical areas (MSAs) – Akron, Cincinnati, Cleveland, Columbus, Dayton, and Toledo – and seven other regions including smaller MSAs and rural counties. Counties were grouped together based on economic commonality, primarily in agriculture and manufacturing. These regions were regularly used for analyses in the bimonthly *On the Money* articles on the Ohio economy formerly written by the author for Hannah News Service.

Figure 6: Ohio Regions



Northwest | Toledo MSA | West North Central | Cleveland MSA | Akron MSA
Northeast | West | Columbus MSA | East North Central | Dayton MSA
Cincinnati MSA | South | Southeast

Table 8 shows the veterinary services employment and establishment totals for these 13 regions. As is true of the state, employment in all regions was higher in 2021 than in 2010. The Columbus MSA enjoyed the strongest net growth with a gain of 60%. Columbus growth was followed closely by the East North Central region with a gain of 58.5% and the Cincinnati and Dayton MSAs with 55%. On the other end of the scale, the Southeast gained only 5%.

Table 8: Veterinary Services Employment Growth and Establishment Counts by Region, 2010 and 2021

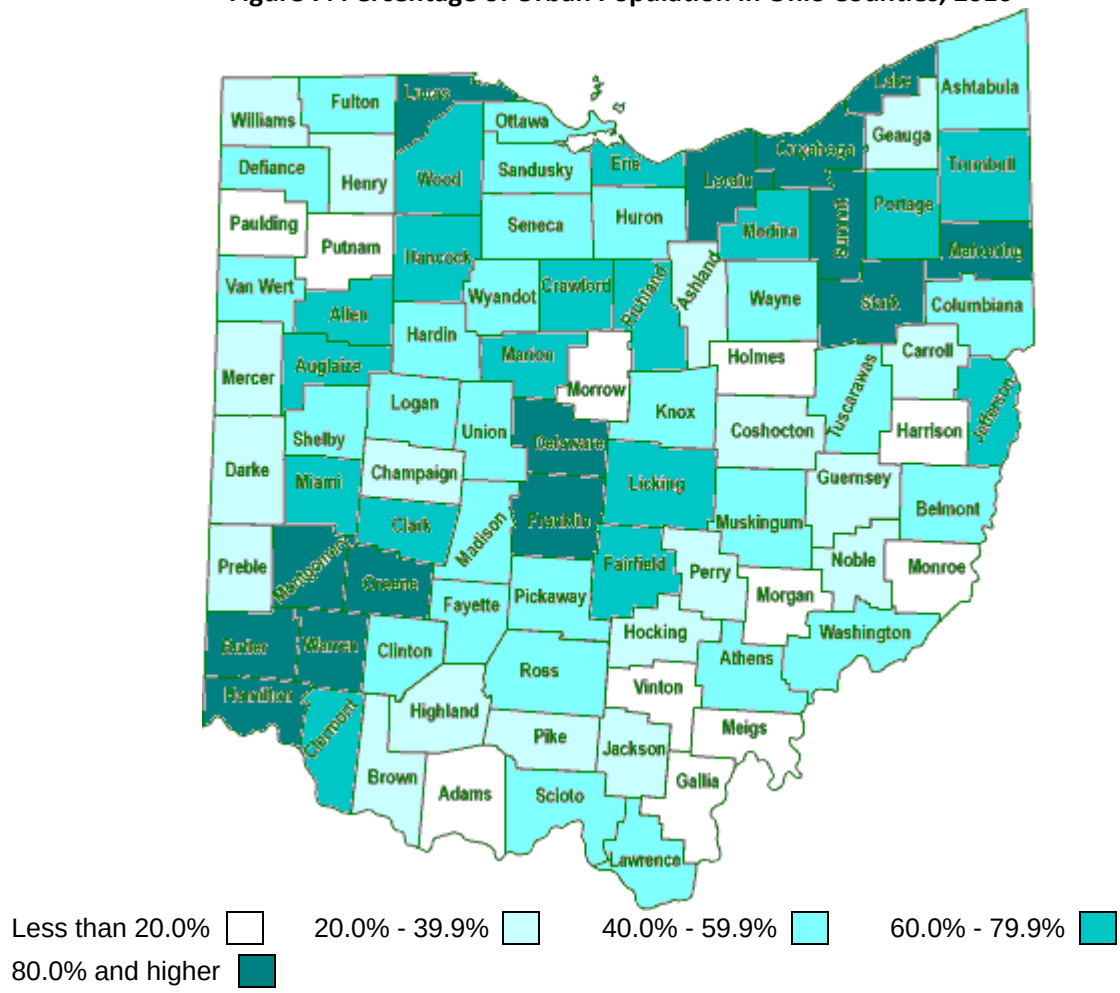
Region	Employment			Number of establishments	
	2010	2021	Net change	2010	2021
Ohio	11,298	16,541	46.4%	1,040	1,178
Akron	785	1,145	45.9%	65	74
Cincinnati	1,729	2,685	55.3%	153	173
Cleveland	1,948	2,734	40.3%	176	183
Columbus	2,417	3,874	60.3%	183	244
Dayton	743	1,150	54.8%	60	67
Toledo	522	750	43.7%	45	52
Northeast	1,010	1,294	28.1%	105	114
Southeast	341	358	5.0%	32	33
South	323	460	42.4%	38	43
West	601	786	30.8%	69	70
Northwest	116	171	47.4%	14	14
West North Central	409	570	39.4%	60	58
East North Central	335	531	58.5%	38	38

Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Population density also varies widely across Ohio. This is an important issue for veterinary service demand because higher concentrations of population lead to more pets and higher demand for companion animal veterinary services. The Census Bureau classifies areas as urban or rural based on the density of development, both residential and non-residential. These areas are built up from census blocks (which in an urban area correspond to city blocks) and do not correspond to corporation limits. A developed area with a population of at least 50,000 is called an “urbanized area,” and one with a population between 2,500 and 50,000 is called an “urban cluster.“ Population, housing, and territory outside of urbanized areas and urban clusters are classified as rural. Figure 7 maps the percentage of each county’s population in urbanized areas and urban clusters in 2010.[4] Ohio is a fairly urbanized state, with urban population accounting for at least half the total in 45 of the 88 counties.

[4] This 12-year-old analysis remains the most current. The 2020 census will supply the data for an update, but these data have not yet been released.

Figure 7: Percentage of Urban Population in Ohio Counties, 2010

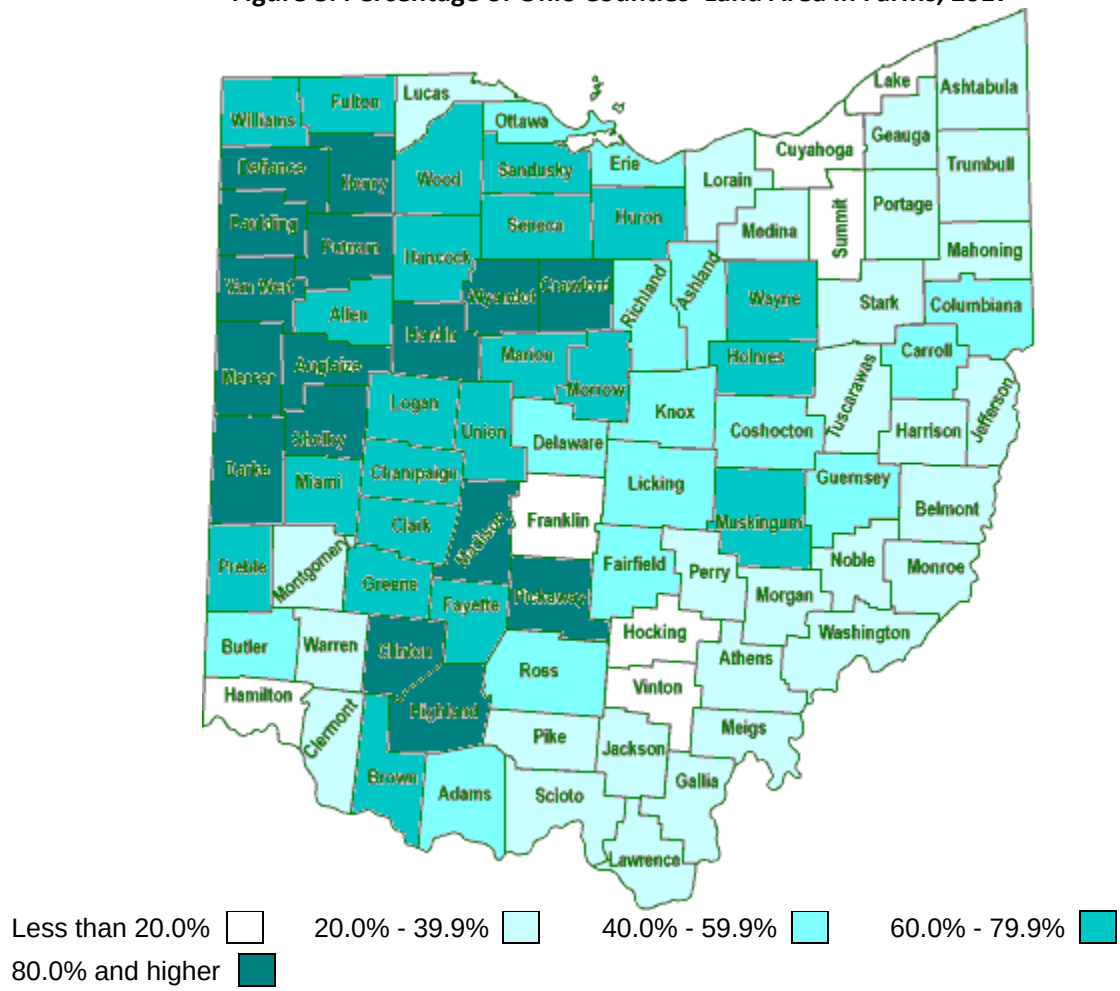


Source: Census 2010, Table P2, U.S. Census Bureau.

Farm animals are an important focus of veterinary services. By tending to the health of farm animals, veterinarians help to protect the financial well-being and productivity of farms, the safety of the food supply, and Ohio's agribusiness sector, which employs one in seven Ohioans.[5] Figure 7 shows the concentration of farming activity by mapping the percentage of each county's total land area in farms. Ohio's primary farming areas are in western and northwestern Ohio. Note that some counties with a high proportion of farming land are also at least moderately urbanized, such as the counties surrounding Franklin County in central Ohio and Lucas County in the northwest. This is not necessarily inconsistent: the urbanization data in Figure 7 refer to population shares while the farm data in Figure 8 refer to land shares. A county with one or two urbanized areas surrounded by large tracts of lightly populated farmland would rank as both relatively urbanized and relatively heavily farmed.

[5] See B. LaFayette (2019). Ohio agribusiness industries and workforce needs.

Figure 8: Percentage of Ohio Counties' Land Area in Farms, 2017



Source: 2017 Agricultural Census, U.S. Department of Agriculture; Population land area from population density data, U.S. Census Bureau.

Statewide farm animal totals from the past three agricultural censuses are shown in Table 9. The number of cattle has increased only modestly over the past decade. In contrast, the number of broiler chickens, turkeys, and hogs have increased between 40% and 66%. On the other hand, the number of goats and geese have declined by double digits, but the population of these animals was small to begin with. The number of horses and ponies is larger but fell 18.5% over the decade.

Table 9: Farm Animal Population, Ohio Totals, 2007-2017

Breed	Total			Change	
	2007	2012	2017	2007-2017	2012-2017
Cattle excluding cows	706,707	696,487	714,500	1.1%	2.6%
Cows	565,695	545,806	569,750	0.7%	4.4%
Goats	69,505	51,558	59,612	-14.2%	15.6%
Hogs	1,831,084	2,058,503	2,561,252	39.9%	24.4%
Sheep and lambs	123,161	111,972	127,501	3.5%	13.9%
Chickens: broilers	10,021,948	12,194,024	16,604,195	65.7%	36.2%
Chickens: layers	27,070,109	28,312,692	28,868,147	6.6%	2.0%
Geese	4,215	2,757	2,677	-36.5%	-2.9%
Roosters	n/a	43,609	32,571	n/a	-25.3%
Turkeys	2,074,750	2,096,395	3,131,824	50.9%	49.4%
Equine	119,198	114,127	97,181	-18.5%	-14.8%

n/a = Not available.
Source: Agricultural Census, U.S. Department of Agriculture.

The American Veterinary Medical Association undertakes periodic surveys of pet ownership; the most recent was conducted in 2017-2018. The number of pets in Ohio can be roughly inferred based on these national statistics and the total number of households nationwide and in Ohio. However, pet ownership rates are likely to vary based on demographics, income, and the homeownership rate (many landlords prohibit pets). These rough pet ownership and population estimates are presented in Table 10. These estimates suggest that there may be nearly 10 million companion animals in Ohio. (Household counts are not totaled because some households own more than one type of pet.)

Table 10: Companion Animal Ownership and Population, U.S. and Ohio, 2017-2018
Totals in Thousands

Animal	United States			Ohio	
	Total/owning households	Average number per household	Animal population	Total/owning households	Animal population
Total hhlds.*	120,791			4,676	
Pet ownership					
Dogs	48,255	1.59	76,811	1,868	2,974
Cats	31,896	1.83	58,386	1,235	2,260
Birds	3,509	2.15	7,538	136	292
Horses	893	2.14	1,914	35	74
Fish	10,475	7.29	76,323	406	2,955
Ferrets	326	1.54	501	13	19
Rabbits	1,534	1.46	2,244	59	87
Reptiles	3,669	1.64	6,032	142	234
Pet livestock	494	3.62	1,786	19	69
Pet poultry	1,397	11.00	15,367	54	595
Other mammals	1,978	1.78	3,521	77	136
All others	322	2.98	961	12	37
Totals	---	---	**251,384**	---	**9,732**

*2017-2018 average
Source: U.S. Pet Ownership Statistics, American Veterinary Medical Association; American Community Survey, One-Year Estimates, 2017 and 2018, U.S. Census Bureau.

The national pet ownership statistics also provide the average number of veterinary visits per year for dogs, cats, birds, and horses. Again assuming that Ohio is comparable to the U.S., the total number of visits to treat these animals can be estimated. As shown in Table 11, owners of these pets generated about **6.2 million veterinary visits in Ohio in 2017-2018 and spent slightly more than $1 billion**. The number of visits was 7.1 million in the previous survey conducted in 2012, but without margins of error, it cannot be concluded that this difference is significant.

Table 11: Estimated Annual Veterinary Visits for Companion Animals and Expenditures, Ohio, 2017-2018

	Dogs	Cats	Birds	Horses	Total
Visits per household per year	2.4	1.3	0.3	1.6	
Total visits (thousands)	4,484	1,605	41	119	**6,248**
Veterinary expenditure per household per year	$410	$182	$40	$614	
Total expenditure (thousands)	$765,945	$224,738	$11,673	$34,577	**$1,036,934**

Source: Calculated from U.S. Pet Ownership Statistics, American Veterinary Medical Association.

Although the pet population is unavailable at the county level, the total number of households can be used to approximate the availability of veterinary services. Table 12 relates the number of households to veterinary services employment for the 13 regions and compares the 2021 results to those in the previous version of this study, which were for 2012. The availability of veterinary services increased in all regions. As was true in 2012, **the large MSAs are generally better served than the small MSA and rural regions**, although the employee-household ratios in Cleveland, Dayton, and Toledo are lower than in the other large MSAs. **The East North Central region's ratio has remained the highest among the rural regions, and the updated estimates place it the highest of all regions**. One reason for this distinction is the large number of farms in that region, but there is no information available on small animal versus large animal specialization at a regional level.

Table 12: Veterinary Services Employment per 10,000 Households, 2021

Region	Households	Veterinary services employment, 2021	Employees per 10,000 households	
			2012	2021
Ohio	**4,832,922**	**16,541**	**29.3**	**34.2**
Akron	292,622	1,145	36.7	39.1
Cincinnati	690,302	2,685	31.9	38.9
Cleveland	890,105	2,734	24.6	30.7
Columbus	854,250	3,874	45.1	45.3
Dayton	338,505	1,150	24.4	34.0
Toledo	254,988	750	27.7	29.4
Northeast	502,946	1,294	21.5	25.7
Southeast	138,766	358	21.3	25.8
South	182,540	460	19.9	25.2
West	266,367	786	25.2	29.5
Northwest	73,280	171	18.8	23.3
West North Central	220,448	570	20.2	25.9
East North Central	115,451	531	36.5	46.0

Note: Regional households are estimated and do not sum exactly to the statewide total.

Source: American Community Survey, U.S. Census Bureau, County Business Patterns, U.S. Census Bureau (2012 employment ratios), Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Veterinary and Animal Care Education in Ohio

High-quality, convenient educational offerings are necessary to attract students and keep the veterinary and animal care workforce pipeline well stocked and prepared for continuing growth needs. A student's path to a veterinary career in Ohio often begins in elementary school. Surveys have shown that many veterinary students first considered becoming a veterinarian when they were six to eight years of age. This interest can be satisfied more formally when the student reaches high school. There are 86 career and technical education centers throughout the state, serving primarily high school students. Of these, 26 offer coursework in animal science or animal care, including seven offering a specific program in equine science. Two other centers offer at least one animal science course as part of a larger agricultural career program. These programs are listed in Table 13.

Table 13: Animal-Related Programs in Ohio High School Career Centers

School	County	Course(s), no program	Program		
			Animal/ vet sci.	Equine science	Animal care
Ashland County-West Holmes Career Center	Ashland		x		
Ashtabula County Technical and Career Center	Ashtabula				x
Butler Technology & Career Development Schools	Butler		x	x	
Springfield-Clark Career Technology Center	Clark		x		
Grant Career Center	Clermont		x	x	
Columbiana County Career and Technical Center	Columbiana		x		
Delaware Area Career Center	Delaware		x	x	
Four County Career Center	Fulton		x		
Greene County Career Center	Greene		x		
Great Oaks Career Campuses	Hamilton		x	x	x
Millstream Career Center (Findlay City Schools)	Hancock		x	x	x
Collins Career Technical Center	Lawrence		x		
Ohio Hi-Point Career Center	Logan		x		
Toledo Public Schools	Lucas		x		
Tolles Career and Technical Center	Madison		x		x
Tri-Rivers Career Center	Marion		x		
Medina County Career Center	Medina				x
Tri Star Career Compact	Mercer		x		
Mid-East Career and Technology Centers	Muskingum		x	x	x
Maplewood Career Center	Portage		x		
Pioneer Career and Technology Center	Richland		x		
Vanguard-Sentinel Career and Technical Centers	Sandusky	x			
South Stark Career Academy	Stark		x		
R.G. Drage Career Center	Stark		x		
Summit Career Center	Summit	x			
Trumbull Career & Technical Center	Trumbull		x	x	
Warren County Career Center	Warren		x		
Wayne County Schools Career Center	Wayne		x		x

Source: Individual school websites.

At least 25 two-year and four-year colleges and universities in Ohio offer veterinary and animal-related programs and/or certificates, including 19 four-year pre-veterinary programs. These are listed in Table 14.

Table 14: Animal-Related Programs in Ohio Two-Year and Four-Year Colleges and Universities

Institution	Pre-vet track/program	Animal science	Vet assistant	Vet technology	Equine vet tech
Ashland University	x				
Bowling Green State University	x				
Capital University	x				
Clark State Community College			x		
Cleveland State University	x				
Columbus State Community College				x	
Cuyahoga Community College				x	
Hocking College					x
Kent State University	x			x	
Malone University	x				
Miami University	x				
Muskingum University	x				
The Ohio State University	x	x		x	
Ohio University	x				
Otterbein University	x			x	x
Shawnee State University	x				
Sinclair Community College				x	
University of Akron	x				
University of Cincinnati				x	
University of Findlay	x	x			
University of Mount Union	x				
University of Toledo	x				
Walsh University	x				
Wright State University	x				
Xavier University	x				

Source: Individual institution websites.

The Ohio State University, through the College of Veterinary Medicine, offers the state's only Doctor of Veterinary Medicine (DVM) degree program. The College of Veterinary Medicine also offers master's and doctoral degrees in comparative and veterinary medicine, and a master's program in veterinary public health in collaboration with the College of Public Health. These graduate degree programs can be completed as dual degree programs with the DVM degree. Ohio State also offers a pre-professional track in veterinary medicine and bachelor's and master's programs in animal sciences. As mentioned previously, veterinary students at the Ohio State College of Veterinary Medicine can earn a combined business minor degree in association with the Fisher College of Business. This is designed to help these individuals gain the knowledge, experience, and skills to be successful practice and small business owners. As discussed earlier, practice ownership opens the door to greater financial rewards than salaried employment and higher levels of career satisfaction.

The Ohio State College of Veterinary Medicine, founded in 1885, is one of only 34 veterinary colleges in the U.S., and one of the oldest and largest. It is the only college of veterinary medicine in Ohio, Kentucky, and West Virginia. Its doctoral program has graduated almost 10,000 veterinarians who

practice in all 50 states and 40 countries and account for almost 80% of the practicing veterinarians in Ohio. **The veterinary medicine program is ranked fourth among all North American veterinary schools by *U.S. News and World Report*, the highest-ranked college at Ohio State.** The DVM program admits 165 students per year and takes four years to complete.
The College has a robust and respected research program. The college's Veterinary and Professional Skills Center provides students early and frequent hands-on skills building. As noted previously, College researchers developed the first feline leukemia vaccine and developed research-based technology used in commercial tick-borne disease diagnostics. The College is the lead institution in the interdisciplinary Center for Retrovirus Research. The College is also a leader in Ohio State's Global One Health Initiative and the Infectious Disease Institute, including zoonotic diseases (those transmitted from animals to people), antimicrobial resistance, the host response to infectious disease including immunology and microbiome, and much more. The College also plays an integral role through its Comparative and Translational Oncology Program by collaborating with the Ohio State Comprehensive Cancer Center, The James Cancer Hospital, and Nationwide Children's Hospital. Other faculty are leaders in the development of advanced animal orthopedic procedures, regenerative medicine, and related areas.

The Veterinary Medical Center (VMC) is one of the largest academic veterinary medical centers in the U.S. It is the only comprehensive referral veterinary hospital for companion animals, farm animals, and horses in Ohio, Kentucky, and West Virginia. The veterinary health system cares for more than 80,000 patients annually in six hospitals and on farms across Ohio. The VMC includes the Hummel & Trueman Hospital for Companion Animals, the Hospital for Farm Animals, and the Daniel M. Galbreath Equine Trauma, Intensive Care and Research Center, the Frank Stanton Veterinary Spectrum of Care Clinic, and the Large Animal Services Ambulatory Clinic in Marysville, Ohio. The Marysville clinic provides veterinary services to individual and large livestock facilities, including dairies, beef cattle cow-calf operations, feedlots, and much more across 17 counties. The Alice Lloyd Finley Memorial Veterinary Research Farm in Madison County, Ohio, serves as a teaching and research facility.

Economic Impacts of Veterinary and Animal-Related Industries in Ohio

This section presents the results of an analysis quantifying the impacts on the Ohio economy of veterinary services and other animal-related industries. The section begins with a general discussion of the theory and methods of economic impact analysis. The results of the analysis are then presented and discussed.

Theory and Derivation of Economic Impacts

Economic impact studies measure the increase in **output** in a specific geographical area – in this case, Ohio – resulting from defined economic activities. The activities here are the operations of veterinary services and the auxiliary animal-related industries identified in Tables 1 through 4, as well as the Ohio State College of Veterinary Medicine, including the VMC. Output – production and spending – is the value of goods and services that these industries produce annually in Ohio. The process of producing output generates wages, salaries, and self-employment income (earnings) for workers and business owners. Economic impact analysis estimates these earnings as well as the number of jobs that are created or sustained as a result of these activities. The activities of the other veterinary educational programs summarized in Tables 13 and 14 are part of these activities as well, but information necessary to quantify these programs' impacts would be similar to that needed for the College of Veterinary

Medicine and the VMC. This information was not available, and in any case, the resulting impacts would be small relative to those that can be more easily quantified.

The output, earnings, and employment generated by the industries themselves is referred to as **direct** impacts. However, direct impacts are only part of the total economic impact. The suppliers of goods and services to support the direct activities generate output of their own. To sustain this output, suppliers increase their own purchases of goods and services to accommodate the direct activities, pay wages, and may hire additional workers. These supplier activities are referred to as **indirect** impacts. In addition, direct and indirect business owners earn profits, and their employees earn salaries, wages, and tips. These owners and workers use their earnings to purchase household goods of all kinds. To the extent that these payments for purchases and wages and salaries are made to suppliers and employees within Ohio, the state's economic activity and output is increased further. The impact of this household spending is referred to as an **induced** impact. It is important to emphasize that the direct activities *cause* the indirect and induced activities, which would never have occurred had the direct activities not generated economic activity in the first place. For this reason, the indirect and induced impacts are as much a part of the total economic impact as are the direct impacts. This is the point that makes economic impact analysis legitimate.

The indirect and induced impacts arising from a given direct impact are specific both to a given industry and to a given geographical area. Any specific activity of the same type and scale is likely to require essentially the same goods and services from its suppliers regardless of where it is located. But if the structure of the area's economy is such that the program is forced to make most of its purchases from vendors outside the area, then most of the impact will leak from the area's economy. Conversely, a broad economy with many local suppliers – such as that of Ohio – will keep more of the impact of the output increase circulating within the economy, and the indirect and induced impacts will be greater. The indirect and induced impacts are measured through a set of economic impact multipliers that quantify these impacts in general terms. This study uses RIMS II (Regional Impact Modeling System) multipliers for Ohio from the U.S. Bureau of Economic Analysis. These multipliers are incorporated into an economic impact model developed by Regionomics.

Two general points regarding economic impact estimates must be emphasized. The first point is that the results of even the most carefully constructed economic impact estimation are only rough approximations of the actual impacts, which are unobservable. The second point relates to the meaning of the indirect and induced employment estimates. Employment is measured as headcount, the sum of full-time and part-time employment.[6] The implication of the employment impacts is that additional work exists to provide employment for the calculated number of full-time and part-time positions. The model cannot determine how much of the employment is filled by new headcount, and how much by increased hours on the part of existing workers. For this reason, it is appropriate to call these indirect and induced jobs "sustained" and not "created." However, even if no new workers are hired, the income of existing workers should increase because their hours increase. This will give rise to additional induced activity.

Additionally, some operational functions of the College of Veterinary Medicine, such as clerical, financial, and enrollment support, are carried out elsewhere at Ohio State. These university workers' employment and pay are supported in part by the existence of the College, along with all other enrollment and support units. Their pay and employment are not included among direct impacts

[6] The RIMS II results reflect the mix of full-time jobs and part-time jobs typical for the industries in question.

because they are outside the College and are essentially suppliers. But, unless the College is explicitly charged fair market value for these services, they are not captured in the economic impacts. Consequently, the economic impacts reported here understate the overall economic impact of the College.

Economic Impact Estimation and Results

Estimating economic impacts requires at least one of sales or revenue, earnings, or headcount. The industry economic impacts are based on total annual pay for 2021 from the QCEW as given in Table 2.[7] The College and VMC impacts are calculated from detailed financial records supplied by the College. Indirect and induced impacts were derived by applying to each expenditure item the multiplier for the industry affected by the expenditure. These line-item impacts are summed to calculate a total. This "bill-of-goods" approach generates more reliable results that are specific to the operations of the College and the VMC. This approach is particularly important in this case. The operations and purchase patterns of the College of Veterinary Medicine, which are likely to be significantly different from those of a typical university department as reflected in the multipliers for colleges and universities. Likewise, the wide-ranging operations of the VMC suggest that the multiplier for veterinary services – which reflects the operations of a veterinary office – is likely to misstate the VMC's impact.

Table 15 summarizes the results of the economic impact calculations. This table shows the output, earnings, and employment of the veterinary services industry, the College of Veterinary Medicine (including the VMC) and the remaining animal-related industries discussed earlier. Even though the VMC is in the veterinary services industry, adding its impacts to those of the industry does not lead to double counting because the industry totals only count earnings and employment in the private sector. Because VMC employment is included in employment of The Ohio State University, which is in the public sector.

The results are that firms in the veterinary services industry, along with their suppliers and employees of the firms and their suppliers, created in 2021 $2.5 billion in output in Ohio, $1.14 billion in wages, salaries and self-employment income, and sustained more than 26,000 jobs in Ohio. The VMC and College of Veterinary Medicine together contributed an additional $147 million in output, $113 million in earnings, and sustained nearly 1,300 jobs. Other animal-related industries added $16.5 billion in output, $6.1 billion in earnings, and 101,000 jobs. **Together, these animal-related activities increased the output of the Ohio economy by $19.2 billion, the earnings of Ohio workers by $7.4 billion, and sustained 128,400 Ohio jobs.**

[7] Because self-employment income is not included in Table 2 and not otherwise available, the industry economic impacts are somewhat understated.

Table 15: Economic Impacts on the Ohio Economy of Veterinary and Animal-Related Industries and Ohio State Institutions, 2021

	Direct	Indirect	Induced	Total
Output (thousands)				
Veterinary services	$ 1,105,862	$ 450,196	$ 976,918	$ 2,532,976
Ohio State (College and VMC)	88,989	4,664	53,783	147,435
Other industries	7,576,085	4,940,386	4,024,305	16,540,776
Total	**$ 8,770,935**	**$ 5,395,246**	**$ 5,055,006**	**$ 19,221,187**
Earnings (thousands)				
Veterinary services	$ 723,158	$ 106,955	$ 310,452	$ 1,140,565
Ohio State (College and VMC)	68,914	3,000	41,023	112,937
Other industries	2,599,358	1,868,530	1,670,621	6,138,509
Total	**$ 3,391,430**	**$ 1,978,485**	**$ 2,022,096**	**$ 7,392,011**
Employment				
Veterinary services	16,541	1,906	7,711	26,158
Ohio State (College and VMC)	822	34	424	1,280
Other industries	39,767	29,406	31,764	100,937
Total	**57,130**	**31,346**	**39,900**	**128,376**

Although these economic impacts are reasonably comprehensive, they are more likely to be understated than overstated. As mentioned above, the impacts do not include those of the animal-related educational programs other than Ohio State. The impacts also omit broad industries that have a veterinary component. Four of these were discussed earlier: pharmaceutical preparation manufacturing (including veterinary pharmaceuticals); surgical and medical instrument manufacturing (including veterinary instruments); other professional equipment merchant wholesalers (including veterinary equipment); and druggists' goods merchant wholesalers (including veterinary medicines). Examples of other omitted activities and industries include:

- Transportation of livestock, which is part of general freight trucking.
- Pet food and supplies sold in supermarkets and discount stores.
- The Ohio Agricultural Council, the Ohio Veterinary Medical Association (OVMA), and meat and livestock development and marketing associations, which are part of an industry including all professional organizations.
- The animal-related work of the Ohio Department of Agriculture and state boards and commissions.

Another impact that is not considered is the visitor spending of out-of-state professionals and scholars who come into the state for conferences, seminars, and meetings with researchers in Ohio. One key example is the Midwest Veterinary Conference hosted by the OVMA. This is the fifth largest veterinary conference in the U.S. and the largest that is state-run.

In contrast to previous conferences, the 2022 conference was both in-person and virtual. Conference revenue totaled $1,342,460, including $880,000 from registration fees, $303,000 from exhibits, and $117,000 in sponsorships. Direct expenses incurred by the OVMA totaled $541,792, not including staff time or overhead. Experience Columbus estimates that the conference brought $1,892,200 into the

central Ohio economy. However, because this analysis is at the state level, relevant expenditures are only those that come in from out of state. In-state versus out-of-state attendance is only tracked for veterinarians. Generally, there are attendees from 25 to 30 states. The OVMA estimates that total non-Ohio attendance for the 2022 conference was approximately 40% to 50%, somewhat depressed by the lingering effects of the pandemic. The share of OVMA's expenditures applying to out-of-state attendees would constitute indirect impacts.[8]

The Midwest Veterinary Conference is only part of a much larger animal-related visitor impact, however. An even larger animal-focused event, the All-American Quarter Horse Congress, has been held annually at the Ohio State Fairgrounds since 1967. The 27-day event, the world's largest single-breed horse show, also includes lectures, demonstrations, and exhibits. It attracts more than 650,000 people and 28,000 entries to Columbus and generates $409 million annually for the central Ohio economy.[9]

Another equine event attracting out-of-state visitors, the Equine Affaire, is sponsored by Equine Affaire, Inc. The organization was founded in 1993 to create an education-oriented exposition, "in which horse people representing all breeds of horses and all equestrian disciplines would convene in a non-competitive environment and share their passion for horses."[10] The event was held at Dayton's Hara Arena in 1994, 1995, and 1996, and relocated to the Ohio State Fairgrounds since 1997. This four-day event also attracts enthusiasts from a wide area, and features educational programs, exhibitions, equestrian sports, and a trade show.

The Ohio State Fair and the state's 94 county and independent fairs also allow people to experience and learn about farm animals. Prior to the pandemic, the State Fair drew more than 900,000 visitors annually during its 12-day run. The county and independent fairs, held annually from mid-June through mid-October, are major summertime community events. Many visitors to these fairs, especially the county fairs, are in-state residents, so their spending primarily relocates economic impacts rather than creating them. Similarly, the State Fair's in-state visitors and out-of-state vendors and exhibitors generate little or no net Ohio impact. However, the key value of these fairs is deepening understanding of the importance of animals and Ohio agriculture among people who may never otherwise have such close encounters with these animals. Also, it may indirectly inspire individuals to consider a career in animal-related fields or other aspects of agribusiness.

Impacts of Veterinary College Tuition and Debt on Students and Graduates

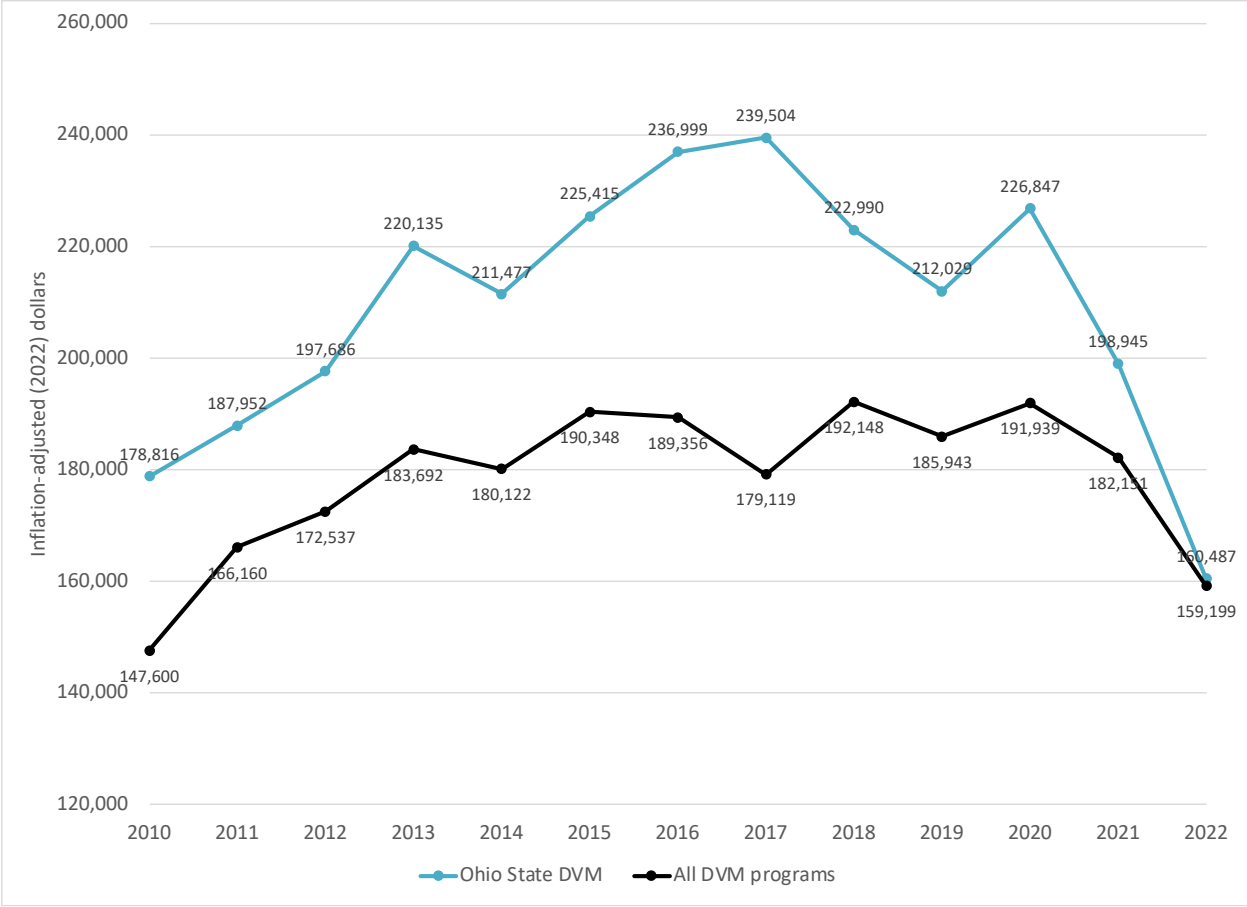
A veterinary doctoral degree is an expensive commitment. The Ohio State DVM program takes four years to complete. The in-state tuition for each of the first three years is $33,456 and increases by 50% to $49,871 for the final year due to an additional required semester. Total tuition is thus $150,239, not including books, supplies, clinical and university fees, room, and board. Including these additional costs, the cost of the DVM program for an Ohio resident is $56,646 in the first year, $53,354 in the second,

[8] Emails from Jack Advent, Ohio Veterinary Medical Association, March 8 and 9, 2023.
[9] The All-American Quarter Horse Congress. (n.d.). General information. https://www.quarterhorsecongress.com/general-information. Because the approach to arrive at this impact may have been different from that generating the impacts in this study, the $409 million should not be added to the measured impacts.
[10] Equine Affaire, Inc. (n.d.) Equine Affaire's history and mission. https://equineaffaire.com/about/historymission/

$53,326 in the third, and $78,776 in the fourth, for a total of $242,102. Tuition for out-of-state residents includes a $40,924 surcharge in the first year and $10 to $15 subsequently.[11]

Despite recent decreases, the debt of DVM graduates upon graduation is substantial. Figure 9 graphs the initial debt burden of graduates by year, adjusted for inflation. The debt burden for all programs rose sharply for graduation years through 2013. While the burden for other programs leveled off, the burden of Ohio State graduates continued increasing, albeit at a slower pace, through 2017. At that point, the burden of Ohio State graduates was one-third higher than average. The inflation-adjusted initial debt decreased across the board in 2021 and 2022, partly because of higher inflation. But because of an Ohio State tuition freeze, the initial debt fell to the national average in 2022, making the program much more competitive.

Figure 9: Initial Debt Burden of DVM Program Graduates, 2010-2022 Graduation Years



Source: The Ohio State University College of Veterinary Medicine. Inflation adjustment by the Consumer Price Index for All Urban Consumers, U.S. Bureau of Labor statistics.

Despite the improving financial picture for DVM graduates and despite starting salaries far higher than those in other fields, **the debt service on a six-figure loan impacts graduates' ability to finance household consumption.** High levels of debt adversely impact graduates' credit score. This increases the cost of borrowing to finance large purchases, compounding the financial impact of the debt service.

[11] The Ohio State University College of Veterinary Medicine. (n.d.). Cost of attendance. https://vet.osu.edu/education/tuition-fees-and-payment-information

Loan rates for federal student loans for graduate study are currently 6.54% for direct unsubsidized loans and 7.54% for direct PLUS loans (a loan is taken out by a parent or guardian). Perkins loans with a rate of 5% are available to students with exceptional financial need, but there is a lifetime borrowing limit of $60,000 for these loans, including amounts borrowed as an undergraduate. This makes Perkins loans of limited benefit at best to a DVM student. Direct unsubsidized loans have a maximum borrowing limit of $20,500 per year, and a lifetime limit of $138,500. The only annual limit for PLUS loans is the cost of attendance as determined by the school less any other financial assistance received. The loan term is at least 10 years and may be as long as 25 years for loans greater than $30,000. Assuming the average 2022 OSU loan principal of $160,487 and a 25-year term, **debt service on an unsubsidized loan is $1,088 per month or $13,052 per year**.

A separate point is that these are loans made by the U.S. government, and debt service payments are thus sent ultimately to Washington, DC. The earlier discussion of economic impact makes clear that expenditures made to entities outside the state provide no indirect or induced benefits to the Ohio economy. Consequently, as debt obligations increase, the favorable impacts of veterinary medicine on the Ohio economy – and the state tax revenues resulting from these activities – decline.

The debt burden of new DVM graduates also influences their career choice. A recent AVMA study found that DVM graduates with higher debt burdens more often seek jobs in private practice or obtain internships and residencies, where current or prospective starting salaries are higher than those in public practice. Even those choosing public practice may have done so because of obligations to their funders, e.g., branches of the military. These choices result in a reduced supply of veterinarians for critical needs in public practice.[12]

Conclusion

In several ways, this study has emphasized the crucial contribution of veterinary medicine and other animal-related industries to Ohio's economic growth. The employment analysis concludes that the employment growth of these industries in Ohio has been substantially greater than the state's relatively weak employment growth in total. These industries' total economic impact of $19.2 billion in output, $7.4 billion in earnings, and more 93,000 jobs enriches Ohio businesses and households.

But the occupational employment projections call out a threat to the veterinary services industry. The need for new workers to fill open positions resulting from industry growth and vacancies in existing positions totals more than 24,000 – 46% greater than the 2021 employment in the industry. If this need is not met, the industry will face growing challenges in meeting the needs of patients and their owners.

The occupational projections reveal a continued strong demand for veterinarians, with a growing need for veterinary assistants and technicians. These professionals will be called upon to provide an increasing share of total care. As noted earlier, this shift is analogous to that occurring in human healthcare and emphasizes the need both for the outstanding veterinary degree programs at The Ohio State University and the animal care certificate and degree programs elsewhere in the state.

This study has focused on the economic aspects of veterinary medicine and other animal related industries in Ohio, but this is not to negate the importance of the social aspects that were an emphasis of the earlier

[12] B. Bain and S.L. Lefebvre. (2022). Associations between career choice and educational debt for fourth-year students of US veterinary schools and colleges, 2001–2021. *Journal of the American Veterinary Medical Association 260*(9) 1063-1068. https://doi.org/10.2460/javma.21.12.0533

study. Pets make substantial contributions to the health and well-being of their owners. The study of ailments common to animals and humans was important at the time that the previous study was released but has taken added importance with the possible role of animals in transmitting COVID-19 and future pandemics that are worrying public health officials.

Appendix

Table A-1: Occupational Employment in Animal Production and Aquaculture, 2021

Occupation	SOC	Employment	Percentage
Total, all occupations	00-0000	6,462	100.0%
Farmworkers, farm, ranch, and aquacultural animals	45-2093	3,082	47.7%
Farmers, ranchers, and other agricultural managers	11-9013	1,548	24.0%
Farmworkers and laborers, crop, nursery, and greenhouse	45-2092	220	3.4%
First-line supervisors of farming, fishing, and forestry workers	45-1011	140	2.2%
Heavy and tractor-trailer truck drivers	53-3032	132	2.0%
Agricultural equipment operators	45-2091	107	1.7%
Animal breeders	45-2021	106	1.6%
Animal trainers	39-2011	94	1.5%
Farm equipment mechanics and service technicians	49-3041	83	1.3%
Chief executives	11-1011	77	1.2%
Bookkeeping, accounting, and auditing clerks	43-3031	69	1.1%
Animal caretakers	39-2021	65	1.0%
General and operations managers	11-1021	54	0.8%
Agricultural workers, all other	45-2099	49	0.8%
Meat, poultry, and fish cutters and trimmers	51-3022	41	0.6%
Managers, all other	11-9199	38	0.6%
Social and human service assistants	21-1093	35	0.5%
Light truck drivers	53-3033	35	0.5%
Landscaping and groundskeeping workers	37-3011	33	0.5%
Janitors and cleaners, except maids and housekeeping cleaners	37-2011	31	0.5%
Food science technicians	19-4013	28	0.4%
Agricultural technicians	19-4012	25	0.4%
Office clerks, general	43-9061	25	0.4%
Coaches and scouts	27-2022	22	0.3%
Maintenance and repair workers, general	49-9071	22	0.3%
Pesticide handlers, sprayers, and applicators, vegetation	37-3012	20	0.3%
Dispatchers, except police, fire, and ambulance	43-5032	20	0.3%
Secretaries and administrative assistants, except legal, medical, and executive	43-6014	20	0.3%
Veterinary assistants and laboratory animal caretakers	31-9096	17	0.3%
Food processing workers, all other	51-3099	13	0.2%
Sales and related workers, all other	41-9099	13	0.2%
First-line supervisors of production and operating workers	51-1011	11	0.2%
Separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders	51-9012	9	0.1%
Industrial truck and tractor operators	53-7051	9	0.1%
Packers and packagers, hand	53-7064	9	0.1%
Other		156	2.4%

Source: Industry-Occupation Employment Matrix, Employment Projections, U.S. Bureau of Labor Statistics.

Table A-2: Occupational Employment in Animal Food Manufacturing, 2021

Occupation	SOC	Employment	Percentage
Total, all occupations	00-0000	2,750	100.0%
Packaging and filling machine operators and tenders	51-9111	297	10.8%
Mixing and blending machine setters, operators, and tenders	51-9023	289	10.5%
Food batchmakers	51-3092	184	6.7%
Heavy and tractor-trailer truck drivers	53-3032	182	6.6%
Laborers and freight, stock, and material movers, hand	53-7062	149	5.4%
First-line supervisors of production and operating workers	51-1011	116	4.2%
Industrial truck and tractor operators	53-7051	102	3.7%
Maintenance and repair workers, general	49-9071	94	3.4%
Sales representatives, wholesale and manufacturing, except technical and scientific products	41-4012	88	3.2%
General and operations managers	11-1021	74	2.7%
Office clerks, general	43-9061	61	2.2%
Shipping, receiving, and inventory clerks	43-5071	55	2.0%
Helpers--production workers	51-9198	55	2.0%
Packers and packagers, hand	53-7064	55	2.0%
Inspectors, testers, sorters, samplers, and weighers	51-9061	52	1.9%
Industrial machinery mechanics	49-9041	50	1.8%
Industrial production managers	11-3051	41	1.5%
Extruding, forming, pressing, and compacting machine setters, operators, and tenders	51-9041	39	1.4%
Secretaries and administrative assistants, except legal, medical, and executive	43-6014	36	1.3%
Food and tobacco roasting, baking, and drying machine operators and tenders	51-3091	36	1.3%
Bookkeeping, accounting, and auditing clerks	43-3031	33	1.2%
Light truck drivers	53-3033	33	1.2%
Customer service representatives	43-4051	30	1.1%
Crushing, grinding, and polishing machine setters, operators, and tenders	51-9021	30	1.1%
Janitors and cleaners, except maids and housekeeping cleaners	37-2011	25	0.9%
First-line supervisors of transportation and material moving workers, except aircraft cargo handling supervisors	53-1047	22	0.8%
Accountants and auditors	13-2011	22	0.8%
Buyers and purchasing agents	13-1020	19	0.7%
Stockers and order fillers	53-7065	19	0.7%
First-line supervisors of office and administrative support workers	43-1011	17	0.6%
First-line supervisors of mechanics, installers, and repairers	49-1011	17	0.6%
Retail salespersons	41-2031	14	0.5%
Production, planning, and expediting clerks	43-5061	14	0.5%
Logisticians	13-1081	11	0.4%
Food scientists and technologists	19-1012	11	0.4%
Bus and truck mechanics and diesel engine specialists	49-3031	11	0.4%
Human resources specialists	13-1071	11	0.4%
Animal scientists	19-1011	11	0.4%
Maintenance workers, machinery	49-9043	11	0.4%

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Table A-2: Occupational Employment in Animal Food Manufacturing, 2021 (continued)

Occupation	SOC	Employment	Percentage
Sales managers	11-2022	8	0.3%
Financial managers	11-3031	8	0.3%
Market research analysts and marketing specialists	13-1161	8	0.3%
Industrial engineers	17-2112	8	0.3%
Agricultural technicians	19-4012	8	0.3%
Food science technicians	19-4013	8	0.3%
Order clerks	43-4151	8	0.3%
Executive secretaries and executive administrative assistants	43-6011	8	0.3%
Agricultural equipment operators	45-2091	8	0.3%
Miscellaneous assemblers and fabricators	51-2090	8	0.3%
Sales representatives, wholesale and manufacturing, technical and scientific products	41-4011	6	0.2%
Other		250	9.1%

Source: Industry-Occupation Employment Matrix, Employment Projections, U.S. Bureau of Labor Statistics.

Table A-3: Industries Employing Veterinarians, United States, 2021

Industry	NAICS	Employment (000)	Percentage
Total employment	TE1000	86.3	100.0%
Veterinary services	541940	72.9	84.5%
Self-employed workers	TE1100	6.8	7.9%
Federal government, excluding postal service	999100	1.3	1.5%
Social advocacy organizations	813300	1.0	1.2%
Colleges, universities, and professional schools; state	611302	0.7	0.8%
Other personal services	812900	0.7	0.8%
State government, excluding education and hospitals	999200	0.7	0.8%
Research and development in the physical, engineering, and life sciences	541710	0.4	0.5%
Local government, excluding education and hospitals	999300	0.4	0.5%
Animal production and aquaculture	112000	0.3	0.3%
Museums, historical sites, and similar institutions	712000	0.2	0.2%
Merchant wholesalers, nondurable goods (4242,6)	4240A2	0.1	0.1%
Colleges, universities, and professional schools; private	611305	0.1	0.1%
General medical and surgical hospitals; private	622105	0.1	0.1%
Other		0.6	0.7%

Source: Industry-Occupation Employment Matrix, Employment Projections, U.S. Bureau of Labor Statistics.

Table A-4: Industries Employing Veterinary Technologists and Technicians, United States, 2021

Industry	NAICS	Employment (000)	Percentage
Total employment	TE1000	122.8	100.0%
Veterinary services	541940	111.9	91.1%
Colleges, universities, and professional schools; state	611302	3.2	2.6%
Social advocacy organizations	813300	2.0	1.6%
Other personal services	812900	1.1	0.9%
Research and development in the physical, engineering, and life sciences	541710	1.0	0.8%
Colleges, universities, and professional schools; private	611305	0.6	0.5%
Local government, excluding education and hospitals	999300	0.6	0.5%
Federal government, excluding postal service	999100	0.5	0.4%
General medical and surgical hospitals; private	622105	0.3	0.2%
Museums, historical sites, and similar institutions	712000	0.2	0.2%
Pharmaceutical and medicine manufacturing	325400	0.1	0.1%
Other miscellaneous store retailers	453900	0.1	0.1%
Temporary help services	561320	0.1	0.1%
Colleges, universities, and professional schools; local	611303	0.1	0.1%
State government, excluding education and hospitals	999200	0.1	0.1%
Other		0.9	0.7%

Source: Industry-Occupation Employment Matrix, Employment Projections, U.S. Bureau of Labor Statistics.

Table A-5: Industries Employing Veterinary Assistants and Laboratory Animal Caretakers, United States, 2021

Industry	NAICS	Employment (000)	Percentage
Total employment	TE1000	103.5	100.0%
Veterinary services	541940	92.5	89.4%
Colleges, universities, and professional schools; state	611302	2.0	1.9%
Research and development in the physical, engineering, and life sciences	541710	1.9	1.8%
Colleges, universities, and professional schools; private	611305	1.8	1.7%
Social advocacy organizations	813300	1.4	1.4%
Animal production and aquaculture	112000	1.1	1.1%
Other personal services	812900	0.7	0.7%
Local government, excluding education and hospitals	999300	0.4	0.4%
Pharmaceutical and medicine manufacturing	325400	0.3	0.3%
Self-employed workers	TE1100	0.2	0.2%
Temporary help services	561320	0.2	0.2%
General medical and surgical hospitals; private	622105	0.2	0.2%
Colleges, universities, and professional schools; local	611303	0.1	0.1%
Museums, historical sites, and similar institutions	712000	0.1	0.1%
State government, excluding education and hospitals	999200	0.1	0.1%
Other		0.5	0.5%

Source: Industry-Occupation Employment Matrix, Employment Projections, U.S. Bureau of Labor Statistics.

Table A-6: Industries Employing Nonfarm Animal Caretakers, United States, 2021

Industry	NAICS	Employment (000)	Percentage
Total employment	TE1000	290.7	100.0%
Other personal services	812900	110.4	33.1%
Self-employed workers	TE1100	48.5	19.1%
Other miscellaneous store retailers	453900	39.4	13.9%
Veterinary services	541940	35.2	12.8%
Social advocacy organizations	813300	11.5	5.4%
Spectator sports	711200	8.2	4.2%
Local government, excluding education and hospitals	999300	7.1	2.9%
Museums, historical sites, and similar institutions	712000	6.9	2.0%
Support activities for agriculture and forestry	115000	6.4	1.1%
Animal production and aquaculture	112000	4.1	0.6%
Colleges, universities, and professional schools; state	611302	1.8	0.5%
Research and development in the physical, engineering, and life sciences	541710	1.4	0.5%
Colleges, universities, and professional schools; private	611305	0.8	0.3%
Other schools and instruction; private	611605	0.6	0.3%
Amusement parks and arcades	713100	0.5	0.1%
Federal government, excluding postal service	999100	0.5	0.1%
Merchant wholesalers, nondurable goods (4241,7,9)	4240A3	0.4	0.1%
Temporary help services	561320	0.4	0.1%
Promoters of performing arts, sports, and similar events	711300	0.3	0.1%
Other		6.3	2.8%

Source: Industry-Occupation Employment Matrix, Employment Projections, U.S. Bureau of Labor Statistics.

Table A-7: Occupational Growth and Replacement Needs, Veterinary Services, by Total Need, 2021-2031

Occupation	2021	2031	Growth	Turnover	Total need	Pct. of 2021
Total, all occupations	**16,541**	**19,080**	**2,539**	**21,707**	**24,245**	**146.6%**
Veterinary assistants and laboratory animal caretakers	3,489	4,153	664	7,383	8,047	230.6%
Veterinary technologists and technicians	4,221	5,020	799	4,499	5,299	125.5%
Receptionists and information clerks	2,327	2,352	24	3,184	3,208	137.8%
Animal caretakers	1,328	1,578	250	2,819	3,069	231.1%
Veterinarians	2,750	3,271	521	994	1,515	55.1%
Customer service representatives	362	387	25	500	524	144.8%
Office clerks, general	396	424	28	487	515	130.1%
First-line supervisors of office and administrative support workers	347	383	36	370	407	117.2%
Bookkeeping, accounting, and auditing clerks	192	205	12	231	244	126.6%
General and operations managers	189	223	35	169	204	108.0%
Janitors and cleaners, except maids and housekeeping cleaners	94	112	17	134	151	160.6%
Medical secretaries and administrative assistants	117	127	10	140	150	127.9%
Secretaries and administrative assistants, except legal, medical, and executive	132	134	2	148	149	113.2%
Medical and health services managers	64	93	29	57	86	134.5%
Maintenance and repair workers, general	49	56	7	49	55	112.9%
First-line supervisors of personal service workers	26	30	3	34	38	142.3%
Sales representatives, wholesale and manufacturing, technical and scientific products	23	26	3	23	27	118.3%
Human resources specialists	23	26	3	22	25	112.2%
Stockers and order fillers	11	15	4	20	23	207.3%
Clinical laboratory technologists and technicians	26	30	3	19	22	83.9%
Business operations specialists, all other	19	22	3	18	22	114.1%
Accountants and auditors	19	22	3	17	20	106.8%
Landscaping and groundskeeping workers	11	15	4	15	19	164.8%
Pharmacy technicians	15	19	4	14	17	115.6%
Animal trainers	8	11	4	13	17	221.3%

Table A-8: Veterinary Services Employment and Number of Establishments by County, 2010 and 2021

County	Employment			Number of establishments	
	2010	2021	Net change	2010	2021
Ohio	**11,298**	**16,541**	**46.4%**	**1,040**	**1,178**
Adams	0	6	n/a	0	2
Allen	63	118	87.3%	9	8
Ashland	49	85	73.5%	7	7
Ashtabula	74	90	21.6%	8	11
Athens	48	57	18.8%	5	6
Auglaize	18	42	133.3%	4	6
Belmont	67	96	43.3%	7	8
Brown	34	37	8.8%	4	4
Butler	314	456	45.2%	28	31
Carroll	22	30	36.4%	3	3
Champaign	12	33	175.0%	3	5
Clark	116	157	35.3%	15	14
Clermont	275	427	55.3%	28	34
Clinton	30	75	150.0%	6	9
Columbiana	87	136	56.3%	11	16
Coshocton	50	56	12.0%	5	4
Crawford	30	41	36.7%	4	5
Cuyahoga	928	1,393	50.1%	92	93
Darke	49	63	28.6%	7	7
Defiance	13	35	169.2%	3	5
Delaware	229	427	86.5%	18	32
Erie	41	69	68.3%	9	5
Fairfield	186	336	80.6%	14	21
Fayette	20	13	-35.0%	2	1
Franklin	1,693	2,542	50.1%	108	135
Fulton	48	53	10.4%	5	6
Gallia	40	26	-35.0%	4	2
Geauga	167	185	10.8%	19	21
Greene	166	251	51.2%	13	13
Guernsey	29	39	34.5%	3	3
Hamilton	789	1,302	65.0%	66	72
Hancock	95	93	-2.1%	7	6
Hardin	32	39	21.9%	4	3
Harrison	10	3	-70.0%	1	1
Henry	10	13	30.0%	1	1
Highland	32	34	6.3%	8	8
Hocking	15	18	20.0%	3	3
Holmes	15	90	500.0%	3	5
Huron	67	70	4.5%	12	11
Jackson	15	28	86.7%	3	4
Jefferson	33	33	0.0%	6	6
Knox	50	94	88.0%	7	7
Lake	252	328	30.2%	21	23
Lawrence	20	28	40.0%	2	2
Licking	158	265	67.7%	22	25

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Table A-8: Veterinary Services Employment and Number of Establishments by County, 2010 and 2021 (continued)

County	Employment			Number of establishments	
	2010	2021	Net change	2010	2021
Logan	32	34	6.3%	3	3
Lorain	388	539	38.9%	22	22
Lucas	371	540	45.6%	31	32
Madison	50	100	100.0%	5	8
Mahoning	146	213	45.9%	13	12
Marion	48	84	75.0%	6	6
Medina	213	289	35.7%	22	24
Meigs	10	30	200.0%	1	2
Mercer	96	106	10.4%	7	9
Miami	115	205	78.3%	11	12
Monroe	0	0	n/a	0	0
Montgomery	462	694	50.2%	36	42
Morgan	20	28	40.0%	2	2
Morrow	18	40	122.2%	3	5
Muskingum	36	67	86.1%	6	7
Noble	0	0	n/a	0	0
Ottawa	38	46	21.1%	4	4
Paulding	10	13	30.0%	1	1
Perry	10	28	180.0%	1	2
Pickaway	33	41	24.2%	5	4
Pike	10	13	30.0%	1	1
Portage	123	137	11.4%	11	10
Preble	39	45	15.4%	6	5
Putnam	23	46	100.0%	2	2
Richland	77	103	33.8%	10	10
Ross	76	93	22.4%	8	8
Sandusky	45	89	97.8%	5	8
Scioto	70	106	51.4%	3	3
Seneca	48	44	-8.3%	6	6
Shelby	49	56	14.3%	4	4
Stark	321	480	49.5%	37	38
Summit	662	1,008	52.3%	54	64
Trumbull	212	178	-16.0%	18	17
Tuscarawas	105	131	24.8%	8	10
Union	25	77	208.0%	4	9
Van Wert	30	28	-6.7%	3	2
Vinton	0	8	n/a	0	1
Warren	317	463	46.1%	27	32
Washington	141	71	-49.6%	9	7
Wayne	171	206	20.5%	16	15
Williams	30	36	20.0%	4	3
Wood	103	157	52.4%	9	14
Wyandot	15	24	60.0%	4	3

Note: Totals in red italics are estimates; see text. Because of inexact employment estimates, county employments do not add to the state total.

Source: County Business Patterns, U.S. Census Bureau.