2013 U.S. Veterinary Workforce Study: Modeling Capacity Utilization

Final Report

For:

American Veterinary Medical Association

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Acknowledgement

The study team received guidance and subject matter expertise from a Workforce Advisory Group (WAG). While WAG members provided insights and guidance to the study team, the views expressed in this report do not necessarily reflect the views of specific WAG members or the institutions that they represent.

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Executive Summary

The American Veterinary Medical Association (AVMA) contracted with IHS Healthcare & Pharma (IHS) and the Center for Health Workforce Studies (CHWS) to conduct a study on the current and future adequacy of supply of veterinary medical services and veterinarians. The purpose of this study is to help inform strategies to ensure the economic viability of veterinary medicine as the profession works to attract and retain highly qualified professionals. This study was designed to produce information regarding the number and employment sector mix of veterinarians the nation needs to train to ensure a balanced supply (both geographically and over time) as the profession works to fulfill its social mission. The primary goals of this study, therefore, were to:

1. Identify and quantify key trends and factors related to veterinary workforce decisions, demand for veterinary services, economic viability of practice, and care delivery;
2. Quantify the degree to which there is under- or- over capacity in veterinary services at the national, state, and employment sector levels
3. Identify gaps in the workforce research and areas requiring further research; and
4. Develop a Veterinarian Workforce Simulation Model that over time would be maintained and enhanced by AVMA's new Economics Division.

Methods used to collect information and produce the findings presented in this report include: (1) a review of the published and gray literature; (2) interviews with subject matter experts and key stakeholders; (3) empirical analysis of surveys and data collected by AVMA, the federal government, and other institutions; (4) fielding of a 2012 Veterinary Workforce Survey; and (5) development of the Veterinarian Workforce Simulation Model for projecting future supply and demand.

Key findings regarding the current state of the veterinary workforce include:

- Market indicators suggest excess capacity at the national level to supply veterinary services. Recent trends include falling incomes of veterinarians, falling rates of productivity (using various measures), and increased difficulty for new graduates to find employment.
- Respondents to the 2012 Veterinary Workforce Survey who indicated that they were engaged in clinical practice were asked to characterize their local market areas and their practices' capacity and productivity. Almost half of the respondents reported perceptions of too many veterinarians and too many veterinary practices. A similar percentage also reported perceptions of just the right number of both veterinarians and veterinary practices. Slightly more than half of the respondents indicated that their practices were not working at full capacity.

- Based on survey responses to the question of how much productivity could be increased if (a) there are no changes in the way the practice is organized, (b) there are no changes in the number of veterinarians or support staff, and (c) there is an unlimited supply of clients and patients, we calculate excess capacity for veterinary services were highest for equine practice (23% excess capacity), followed by small animal (18%), food animal (15%), and mixed practices (13%). These numbers reflected that 42% of veterinarians who reported on the capacity status of their practice (i.e., did not respond "don't know/not sure") reported that their practice was already working at full capacity. We assume that in 2012 the demand for veterinarians employed in government, academia, industry, and "other" (tax exempt and municipalities) sectors is equal to supply (i.e., there is no shortfall or surplus at the national level).

Key supply-related findings include:

- We estimate the current supply of active veterinarians at the beginning of 2012 is approximately 90,200. This estimate is roughly equivalent to the estimate in the recent National Academy of Sciences report that cites 92,000 professionals in 2010 based on AVMA data, but makes adjustments for what appears to be an overestimate of active veterinarians age 65 and older in the AVMA data.[1]
- The number of new college of veterinary medicine graduates entering the US over the next decade is unknown, but estimates based on North American Veterinary Licensing Exam (NAVLE) data are that approximately 3,457 graduates (from accredited and non-accredited) colleges of veterinary medicine completed their education in 2012. Enrollment data allows us to project the likely number of new CVM graduates through 2016, and we model alternative supply scenarios with different rates of growth assumptions ranging from no increases in graduates after 2016 to 4% annual growth in new graduates after 2016. These scenarios reflect announced growth in enrollment at existing CVMs, as well as the potential for continued expansion if historical rates continue.
- Supply projections are presented based on alternative assumptions regarding number of new graduates, hours worked patterns, and retirement patterns.
- We define a "2012 equivalent" veterinarian as someone who works 2,313 hours per year in professional activities—which is the national average across veterinarians of all age groups and gender. Under the Baseline Scenario with assumed 2% annual growth in number of CVM graduates, the national supply of 90,200 veterinarians in 2012 is projected to grow to approximately 95,400 by 2020, 100,400 by 2025, and 108,900 by 2030.

[1] National Academy of Sciences. Workforce Needs in Veterinary Medicine. 2012. http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/Vet-Med-Report-Brief-Final.pdf.

These future year projections are in terms of 2012 equivalents that take into consideration the changing age and gender composition of the veterinarian workforce.

- Women constitute approximately 50% of the current workforce, but will likely grow to 71% of the workforce by 2030. Women constitute 78% of new graduates, whereas the older workforce nearing traditional retirement age is predominantly male.

Key demand-related findings include:

- Based on estimates of excess capacity among veterinarians in clinical practice (calculated from the 2012 Veterinarian Workforce Survey) and the assumption of balance between supply and demand for veterinarians in non-clinical practice, we calculate national demand for veterinarians equals 78,950 in 2012. Comparison to supply suggests national excess capacity of 12.5% at current price levels for services (equivalent to the services of approximately 11,250 veterinarians).
- The Baseline Demand Scenario models current trends—accounting for changing household demographics, trends in livestock and food animal consumption patterns, and demand drivers in other employment sectors. Therefore, this scenario represents our best estimate of future demand under the status quo. Under this scenario, total demand is projected to grow to 88,100 in 2025 (or by 12% relative to 2012).

Future adequacy of supply findings include:

- Comparison of the Baseline supply and demand scenarios (with the Baseline scenario reflecting informed assumptions about the continuation of current trends) suggests that the magnitude of the surplus capacity will range from 11% and 14% between 2012 and 2025 (equivalent to approximately 9,300 to 12,300 veterinarians).
- We model the sensitivity of the supply projections to different assumptions regarding number of veterinarians trained, hours worked patterns, and retirement patterns. Under every scenario the supply projections exceed demand through 2025. Given the high debt load of new students and stagnating incomes seen in recent years among veterinarians, it is unlikely that veterinarians will reduce average hours worked or retire earlier than current and historical patterns. Consequently, there is greater potential for the supply projections to exceed the baseline estimates rather than fall short of the baseline estimates.

The report discusses research gaps that if filled could help inform strategies to ensure adequate access to veterinary services and the economic viability of veterinary practice:

- Develop more objective measures of demand for veterinary services.
- Develop early warning indicators of imbalances between supply and demand (similar to the Aggregate Demand Index developed by the Pharmacy Manpower Project).
- Conduct research on the price sensitivity of pet and animal owners.

- Monitor the careers of new veterinarians by selecting a sample each year for participation in a long term follow-up study that seeks to explore the career trajectories of individuals who become veterinarians in the current supply/demand environment.
- Acquire additional information on the average amount of time veterinarians spend providing specific types of services to simulate the demand implications of changing mix of services demanded and implementation of alternative care delivery models.

In summary, it appears that at the national level there is current excess capacity to provide direct animal care services. In percentage terms, the level of excess capacity appears to be largest for equine practices, followed by small animal practices, food production practices, and mixed animal practices. This excess capacity is likely to persist for the foreseeable future even if veterinary schools were to curtail expansion of enrollment. However, this excess capacity could potentially be reduced or eliminated if veterinarians were able to increase demand for veterinary services through outreach programs to educate pet owners or by removing access barriers or reducing the cost to purchase services to spur greater volume of services.

I. Background

The American Veterinary Medical Association contracted with IHS Healthcare & Pharma (IHS) and the Center for Health Workforce Studies (CHWS) to conduct a study on the current and future adequacy of supply of veterinary medical services and veterinarians. The purpose of this study was to help inform strategies to ensure the economic viability of veterinary medicine as the profession works to attract and retain highly qualified professionals. This study was designed to produce information regarding the number and employment sector mix of veterinarians the nation needs to train to ensure a balanced supply (both geographically and over time) as the profession strives to fulfill its social mission. The primary goals of this study, therefore, were:

1. To identify and quantify the implications of key trends and factors related to veterinary workforce decisions, demand for veterinary services, economic viability of practice, and care delivery;
2. To estimate the degree to which there is under- or- over capacity in veterinary services at the national and state level by employment sector; and
3. To identify gaps in the workforce research and identify areas requiring further research.

The information in this report was obtained using four data collection strategies:

1. **Empirical analysis of survey and other data**. We analyzed data collected by the American Veterinary Medical Association (AVMA), federal agencies, and other organizations. AVMA's database of veterinarians (which contains information on veterinarians who are not members of AVMA as well as members) was a primary source for the current supply of veterinarians. Multiple years of the Biennial Economic Survey, Pet Demographic Study, and Graduating Senior Survey were analyzed. We also analyzed the U.S. Census Bureau's American Community Survey (ACS). These sources are described later in more detail.
2. **Literature review**. We conducted a review of the peer-reviewed literature on the veterinary workforce, as well as industry and government reports. The review focused on the literature published since the KPMG (1999) veterinary workforce study.[1]
3. **Phone interviews with key stakeholders and subject matter experts**. Approximately two dozen phone interviews were conducted with members of the study Workforce Advisory Group, key stakeholder groups, and subject matter experts recommended by members of the advisory group.
4. **New workforce survey of veterinarians**. From September to October 2012, we conducted a survey with a sample of veterinarians to collect information on

retirement patterns and intentions, perceptions of local adequacy of veterinary supply capacity, and other workforce-related information. This survey is described later, with a detailed description provided in Appendix A.

A key component of this study was the development of a Veterinary Workforce Computer Simulation Model that over time will be refined, updated, and used by AVMA's new Veterinary Economics Division. The supply and demand components of this workforce model were designed to be flexible to simulate the implications of changes in trends affecting supply and demand for veterinary services. This report, therefore, is the first in a planned series of regular reports and analyses that will be sponsored or published by AVMA's economic analysis team.

A. Key Study Concepts and Definitions

Throughout this report we refer to the following economic, workforce-related, and other terms:

- **Employment sector**. Veterinarians work in a variety of settings, with a large majority in private clinical practice. Others work in industry/commercial, federal government, academia, or "other" settings (e.g., tax-exempt organizations and municipal governments). Veterinarians in clinical practice are often differentiated by whether they are predominantly small animal practices, small/large mixed animal practices, equine practices, or food animal practices.
- **Supply of veterinary services**. This term generally refers to the provision of veterinary services to animals—regardless of whether these services are provided by veterinarians, veterinary technicians or assistants, or other support staff.
- **Active supply of veterinarians**. Veterinarians were considered part of the active supply if they self-reported working in veterinary medicine.
- **Full-time equivalent (FTE) supply**. While most veterinarians work full time, some are employed part time. We defined one FTE based on the average annual hours (2,313) worked across all active veterinarians (part time and full time) in 2012. Supply was defined as the number of veterinary service hours veterinarians reported as being at work or working and thus, assumedly, available and able to supply services. The FTE concept allowed us to compare current supply to future supply, and compare supply to demand using a standardized unit.
- **Demand for veterinary services**. In this report, the technique for measuring demand varied across employment sectors. The main driver of demand for veterinarians in small animal, equine, and mixed animal practices reflected the willingness to pay for veterinary services as measured by national patterns of veterinary visits by animal owners. Demand for food animal veterinarians and many government veterinarians reflected changes in populations of livestock. The Baseline Demand Scenario that was modeled assumed that the ratio of livestock to veterinarians, with the ratio varying by type of livestock, remains constant over the projection horizon. Demand for veterinarians in academia reflected growth in schools and assumed the same

ratio of academic veterinarians to students. Demand for veterinarians in industry and other sectors reflected projected growth in a variety of sectors of the economy.

- **Need for veterinary services**. Whereas the term "demand" reflected consumers' willingness to pay for veterinary services given the price of services, the term "need" referred to an assessment of services that were warranted. Veterinarians may have expressed their clinical judgment that animals should receive certain services (e.g., preventive care), but if animal owners are unwilling to pay for such services at prevailing prices or are unaware of the need for such services, then the need goes unmet (for lack of demand). Need also referred to someone expressing a desire for veterinarians to serve in some geographic area or career path/niche. For example, in many rural areas animal owners desire improved access to veterinary services but the level of demand is insufficient to make veterinary practice financially viable. While there is an expressed need for veterinarians, there is insufficient demand. Likewise, in some career paths (e.g., public health) there may be unfilled positions. A group may have expressed that they "need" more veterinarians in public health or desire a "surge capacity" in the event of emergencies, but if government agencies cut positions, do not create jobs, or are unable to offer competitive salaries for such services, then this need does not translate to demand.
- **Supply capacity**. We defined capacity as the ability to provide services. Capacity generally referred to the ability of veterinarians to supply services in a specific geographic area and employment sector. On an individual level, capacity was the total amount of services a veterinarian was able to provide based on available resources.
- **Excess capacity**. This term referred to the ability to provide services in excess of the quantity demanded at a price that consumers are willing to pay. Excess capacity means that veterinarians in a particular geographic area and/or employment sector are underutilized. This underutilization can take the form of unemployment, but more often takes the form of reduced productivity because either (1) the veterinarian does not have sufficient demand for services to keep busy, or (2) the veterinarian is keeping busy by providing services that could be provided by a technician or other staff member with less training.

B. Theoretical Framework for Veterinary Workforce Assessment and Literature Review

Veterinary workforce planning is the process to help ensure that the nation has the right number and mix of veterinary service providers in the right places to provide access to services at affordable prices that support economically viable veterinary practices. Over the past several decades, numerous reports and articles have been published on the topic of whether the United States has the right number and mix of veterinarians to meet the country's current and future needs. Some of these studies found current and projected excess capacity within the veterinary workforce—including work by Arthur D. Little, Inc. in

1978[2], Wise and Kushman in 1985[3], Getz in 1997[4], and Brown and Silverman (KPMG) in 1999.[1]

Other studies suggested there is a shortfall of veterinarians in select careers (namely, food animal production and public health), in rural areas, or in research (i.e., receiving PhD training). These included studies by the AAVMC (2006)[5], Sterner (2006)[6], Andrus et al. (2006)[7], Funk and Bartlett (2008)[8], GAO (2009)[9], Jarman et al. (2011)[10], and National Academy of Sciences (2012)[11]. The National Academy of Sciences report stated that they found little evidence of workforce shortages in most fields of veterinary medicine and expressed concern that "an unsustainable economic future is confronting the profession (p. 207)" due to the large number of veterinarians being trained and the high debt levels of new graduates. [11]

Often, studies that reported a shortage confused the terms "need" and "demand." They found, for example, that the U.S. and the world might need more veterinarians in a public health capacity to improve social good (e.g., to help combat animal spread diseases such as West Nile fever and to help prevent outbreaks of SARS, monkey pox, bovine spongiform encephalopathy, and highly pathogenic avian influenza) or to help ensure the safety of food supply, if governments or other institutions were unable to fund positions or to pay competitive wages to attract and retain veterinarians, then the demand for veterinary services was not present. As defined previously, demand for services was based on a price point (in this case, compensation levels), and it would have been inefficient and a disservice to train people for positions that were unfunded or for which compensation levels were non-competitive.

Likewise, the nation might need more veterinarians to work in food production—especially in rural areas. However, if there is insufficient demand to make veterinary practices in these areas financially viable then these areas will have difficulty attracting and retaining veterinarians despite the abundance of veterinarians in the workforce. As noted by the National Academy of Sciences report: "Regions that formerly supported a veterinarian can no longer do so. This is not a sign of a shortfall in the supply of veterinarians but rather of a shortfall in employment opportunities (p. 204)."[11]

Effective planning, therefore, requires answers to the following questions:

1. What is the right number and mix of care providers?
2. What is considered "adequate" access to services?
3. What prices are affordable to purchasers of services while still supporting economically viable veterinary practices?

Answering these questions is made complicated by the dearth of research conducted on these topics.

What is the right number and mix of veterinary services providers?

From an economic perspective, the right number and mix of veterinary providers is the number of veterinarians and support staff (technicians, assistants, etc.) that allows for the most efficient delivery of services at prices that consumers are willing to pay. Efficient delivery of veterinary services starts with each occupation operating at the top of their license. That is, veterinarians do the work that only they are trained to do. Veterinary technicians, assistants, and other support staff do the work that they are trained to do. In an efficient system, veterinarians minimize the amount of work they do that can instead be done by a person with less training.

What is considered "adequate" access to services?

Having too few veterinary service providers means that some demand for services may go unmet—despite pet or animal owners' willingness to pay for services at prevailing prices. Perceived shortages have long existed in many medical fields. Some physician specialties have reported long, average wait times for new patients to obtain an appointment or for existing patients to obtain a return appointment. The American Academy of Neurology reported that in 2012 the average wait time was 35 business days for a new patient to see an adult neurologist and 30 days wait for existing patients to obtain follow-up visits.[12] A 2009 survey of physician appointment wait times by Merritt Hawkins and Associates found that the average wait time for new patients to see a neurosurgeon was 24 days, for family practice 20 days, for orthopedic surgery 17 days, and for cardiology 15 days.[13] The Children's Hospital Association also found long wait times to see a pediatric specialist were common, with an average wait time of 45 business days for patients to obtain a clinic visit with a pediatric neurologist.[14]

In contrast, the AVMA 2012 Pet Ownership Survey asked questions regarding wait time to obtain an appointment with a veterinarian.[15] The majority of pet owners reported that they were able to obtain a visit that same day or the next day with the veterinarian practice, with approximately 85% of owners able to obtain an appointment within three days of calling to schedule (Exhibit 1). These findings were relatively consistent across owners of dogs, cats, horses, and birds. For owners who waited longer than three days for an appointment, it was unclear if the length of time was due to the veterinarian practice being unable to accommodate the patient because the practice was booked, whether the visit fell on a holiday or weekend, or whether the wait time was to better accommodate the schedule of the pet owner.

Exhibit 1. Wait Time to Obtain Appointment for Last Veterinarian Visit for Pet (% distribution by wait time)

Wait Time	Dog	Cat	Horse	Bird
Same day	28%	27%	29%	29%
Next day	27%	27%	25%	29%
2-3 days	30%	30%	26%	25%
3-5 days	9%	10%	11%	10%
1-2 weeks	5%	5%	7%	5%
More than 2 weeks	1%	1%	2%	2%
Total	100%	100%	100%	100%

When there are too few providers, employers experience abnormally long wait times to fill vacant positions. A 2012 survey by the Children's Hospital Association, for example, reported that more than one-quarter of children's hospitals reported vacancies of 12 months or longer for pediatric providers in many pediatric specialties.[14] When there is excess capacity, then large numbers of applicants vie for available job openings and vacancies were filled quickly. GAO (2009) reported that over a five-year period the vacancy rate for veterinarian positions in slaughter plants varied by location and year, ranging from no vacancy to a high of 35% of positions vacant.[9]

A challenge for workforce planning is to better understand the extent to which high vacancy rates are local and/or associated with inadequate compensation, versus the degree to which high vacancy rates are widespread and associated with inadequate supply capacity. In the case of veterinary medicine, there were no widespread indicators of inability for consumers to access veterinary services and ample indicators that consumers are able to obtain access to veterinary services if they are willing to pay current prevailing market prices.

What prices are affordable to purchasers of services while still supporting economically viable veterinary practices?

While research on this topic falls outside the scope of this study, the "price" to purchase veterinary services can be thought of as the costs that consumers pay to obtain veterinary services for their pet or animal. For employment sectors where veterinarians are hired as employees, however, the price of services can be thought of as compensation levels required to attract and retain veterinarians.

Consider Exhibit 2, which illustrates the relationship between supply of veterinary services, demand for services, and price. As illustrated in Figure A, in a competitive market, supply and demand interact to produce what economists define as a "market clearing price." That is, in a competitive market the price (P*) is determined such that the quantity of veterinary services supplied will be equal to the quantity (Q*) of services demanded. If the supply of

services grows faster than demand, then supply shifts to the right—as illustrated by beginning supply (S1) and ending supply (S2) in Figures B and C. If prices adjust (Figure B), then the market clearing price will fall from P1 to P2 and the quantity of services demanded will increase from Q1 to Q2 such that supply and demand are again in equilibrium. If prices fail to adjust (as illustrated in Figure C), then at the prevailing price the quantity of services that veterinarians are willing to supply (Q2) exceeds the quantity that consumers are willing to purchase (Q1) creating excess capacity (Q2-Q1). When supply grows faster than demand, then average incomes of veterinarians will fall because either, (1) the prices they charge for their services will decline, or (2) the volume of services that they provide will decline because the same aggregate volume of services is being distributed over a larger number of providers.

If supply grows slower than demand, then the opposite phenomenon occurs with prices rising or the quantity of services demanded falling until supply and demand are again in equilibrium, and veterinarian incomes rise.

Exhibit 2. Supply, Demand, and Price

Figure A

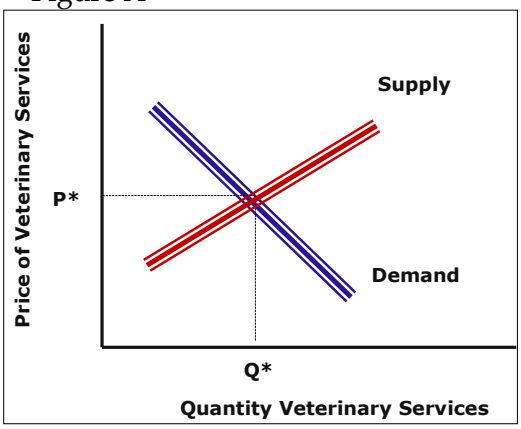


Figure B

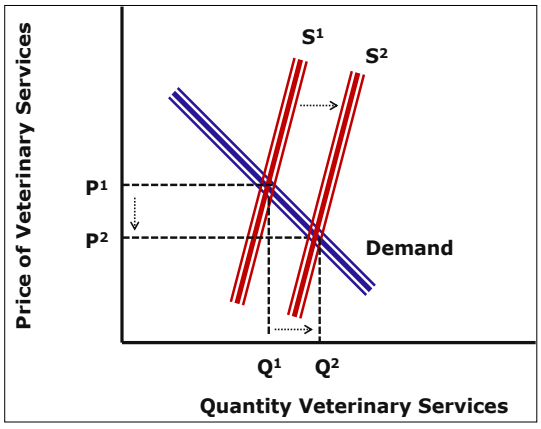
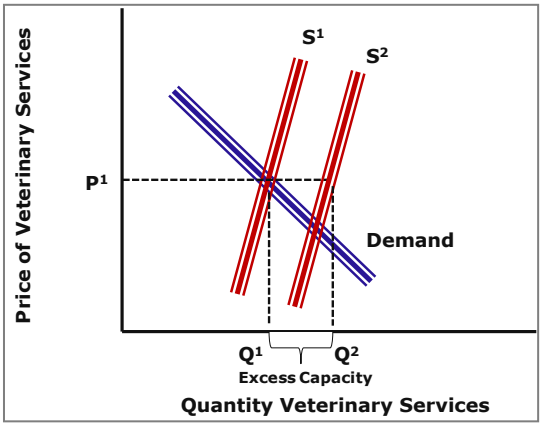


Figure C



C. Defining Current National Demand and Measuring Excess Capacity/Shortfall

Numerically, the national demand for veterinarians can be thought of as the current supply minus (plus) any current excess capacity (shortage). Mathematically,

$$Demand = Supply - Excess\ capacity$$

or

$$Demand = Supply + Shortfall\ capacity$$

In labor markets where workers are predominately employees (rather than self-employed), demand for workers is calculated as the number of positions that have been adequately funded (i.e., current employed workers plus the number of vacancies for which firms are actively recruiting and for which compensation should be adequate to attract applicants).[a] When vacancy rates are low (reflecting normal time delays to fill positions when people change employment or retire), then demand is largely filled and supply is equal to the number of workers currently employed plus those unemployed workers who are actively seeking employment in the field.

Results of our 2012 workforce survey (Appendix A) suggested that 41% of veterinarians were owners/partners, 43% were associates/employees, and 16% reported their status as "other." Estimating demand for workers is more complicated in professions such as veterinary medicine (or employment sectors within a profession) where a substantial number of workers are self-employed or are compensated in large part based on performance—e.g., compensated based on amount of revenues generated. The measurement challenge is that self-employed people, by definition, are not unemployed. Rather, they adjust their number of hours worked to meet workload (or demand) or their productivity per hour changes. When demand for services is low, these individuals work fewer hours and/or provide fewer services per hour worked, and when demand is high, they work more hours and/or provide more services per hour worked. A challenge with using hours worked as a metric for demand for services is that many factors influence the amount of hours worked—ranging from demand for services to personal issues (health and family) to economic considerations.

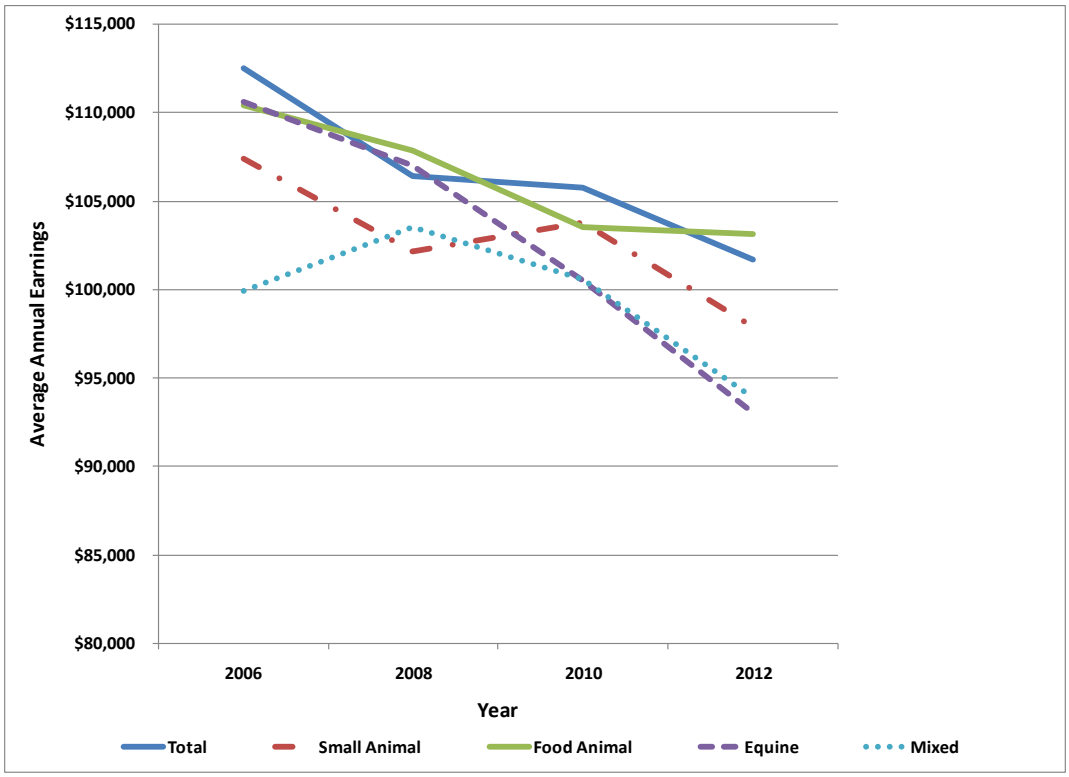
As discussed later, using AVMA data we were able to estimate current state and national supply of veterinarians by employment sector. While we could not directly measure demand for services, we could estimate the degree to which supply capacity exceeded or fell short of demand. To do so, we looked for indicators of a shortfall or excess of capacity. In

[a] As indicated previously, positions that remained vacant because the offered salary was below market rates was not considered part of demand.

many geographic areas, veterinarians in direct animal care were experiencing indicators consistent with excess capacity, such as short wait times for animal owners to obtain an appointment (Exhibit 1), declining or stagnating incomes (Exhibit 3), declining productivity[a], increased difficulty of new graduates to find employment (Exhibit 4), perceptions that supply exceeded demand (Exhibit 5), and the ability and willingness to provide more services if the demand was present (Exhibit 6).

Our analysis of the 2006 through 2012 AVMA Biennial Economic Surveys suggested declining average income (in 2012 dollars) of veterinarians in clinical practice, with the decline especially pronounced for veterinarians in equine practice.[17]

Exhibit 3. Average Annual Earnings of Veterinarians in Clinical Practice



Source: Analysis of the 2006 through 2012 Biennial Economic Survey.

In 2012, approximately 38.5% of veterinary medical school seniors did not have an offer for employment or further education (internship or residency) at the time of the survey (Exhibit 4). The proportion of seniors without an offer was relatively constant (between 10.4% and

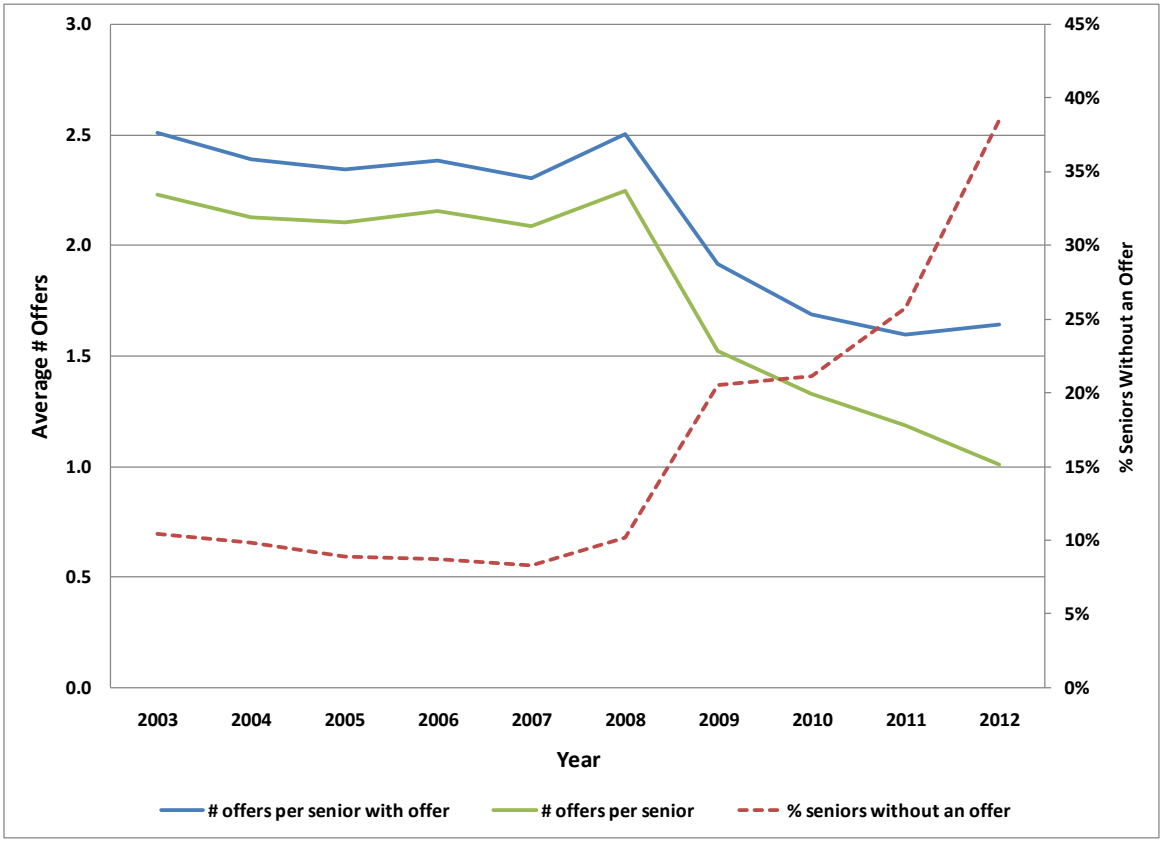
[a] A report by Bayer Healthcare LLC, indicated a consistent decline in median new clients/FTE veterinarian (slide 21), median active clients/FTE veterinarian between 2001 and 2009 (slide 22), declining in median transactions/FTE veterinarian (slide 23), and decline in patients/veterinarian/week (slide 24).[16]

8.3%) from 2003 to 2008, before there was a large increase to 20.5% in 2009 and to 38.5% in 2012. Survey results showed a consistent decline in the average number of offers (both overall and conditional on having at least one offer). While there was an uptick in 2008, in general there was a consistent decline in (1) average offers per senior, and (2) average offers per senior with at least one offer. In 2003, there were 2.23 offers per senior, and this number declined to 1.01 offers per senior by 2012. The large number of offers garnered by some seniors illustrated that regardless of the state of the economy or the state of the veterinary labor market, some seniors (presumably top seniors from highly respected schools) had little difficulty finding employment upon graduation. On the other hand, the survey indicated that a growing number of students had no offers in hand as they neared graduation.

Still, an AAVMC survey of recent DVM graduates of schools and colleges of veterinary medicine in the US finds that at six months post graduation only 2.1% of year 2012 graduates report being unemployed (with the remaining 97.9% employed in veterinary medicine, some other field, or enrolled in a graduate program).[a] Among year 2011 graduates, only 1.6% report being unemployed at six months post graduation.

[a] Survey of Recent DVM Graduates of Schools and Colleges of Veterinary Medicine in the United States [Internet]. Washington, DC: Association of American Veterinary Medical Colleges; 2013 Feb p. 1–9. Available from: http://www.aavmc.org/Public-Data/Survey-of-Recent-US-DVM-Graduates.aspx

Exhibit 4. Percent of Veterinary Medical School Seniors with at Least One Offer for Employment or Further Education, and Average Number of Offers

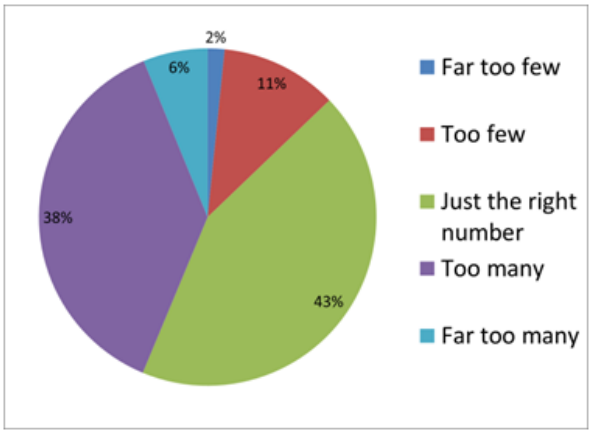


Source: Analysis of the 2003 through 2012 Graduating Senior Survey. Note: This survey was administered electronically to students in accredited schools of veterinary medicine, starting approximately one month prior to graduation and was open until time of graduation. Prior to 2008, the survey was distributed as a paper questionnaire that schools disseminated to seniors within a few weeks of graduation. Moving to an electronic format for data collection increased the response rate from approximately 70-75% per year to over 90% per year.

Respondents to the 2012 Veterinary Workforce Survey (see Appendix A) who indicated that they were engaged in clinical practice were asked to characterize their local market areas and their practices' capacity and productivity. Almost half of the respondents reported perceptions of too many veterinarians and too many veterinary practices (Exhibit 5). A similar percentage also reported perceptions of just the right number of both veterinarians and veterinary practices. Slightly more than half of the respondents indicated that their practices were not working at full capacity (Exhibit 6).

Exhibit 5. Perceptions of Local Market Areas

How would you characterize the number of *veterinarians* currently serving the same animal population?



How would you characterize the number of *veterinary practices* currently serving the same animal population?

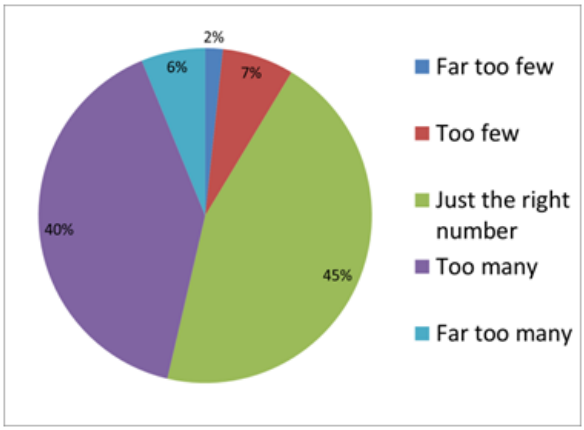
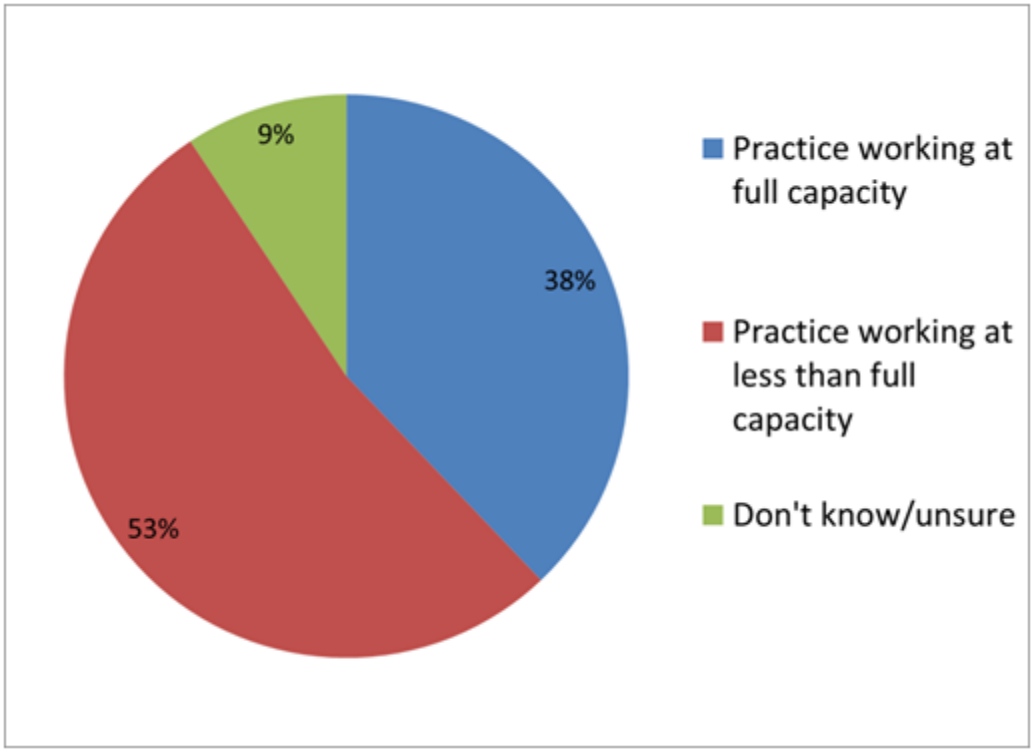


Exhibit 6. Assessment of Practice Productivity among Respondents Engaged in Individual or Group/Herd Animal Health Care



For those who reported their practice was working at less than full capacity, two follow-up questions were posed about the quantity of potential productivity available under two scenarios.

In the first scenario, respondents were asked to assume the following:

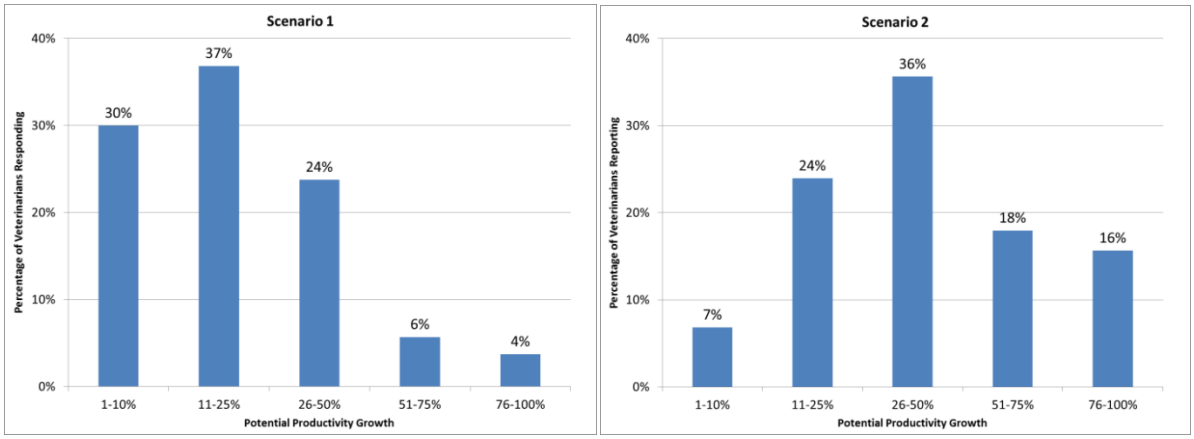
- There are no changes in the way the practice is organized.
- There are no changes in the number of veterinarians or support staff.
- There is an unlimited supply of clients and patients.

In the second scenario, respondents were asked to assume the following:

- There is an unlimited supply of clients and patients.
- This supply of clients and patients enables you to hire additional good technicians and support staff.
- The staff is well trained in providing great medical care.

About one-third of these respondents reported potential productivity gains of greater than 25% under the first scenario (Exhibit 7). Respondents reported greater potential for productivity increases under the second scenario—indicating the potential to expand the provision of veterinary services through greater use of support staff. Under the second scenario, about two-thirds of respondents reported potential productivity gains of greater than 25%.

Exhibit 7. Potential Productivity Growth



In the absence of objective metrics to define excess capacity, veterinarians themselves were called upon to judge (based on their perceptions) whether they had the ability and willingness to increase the level of services provided given their current practice resources and at prevailing prices for services. The survey sample size was sufficient to analyze responses to the excess capacity questions for more populous states and for each

employment sector, but was of insufficient size to jointly estimate responses by state and employment sector (especially for less populous states).

We used ordered logistic regression analysis—which imposes simplifying assumptions on the distribution of responses across states and employment sectors—to estimate the magnitude of current excess capacity by state and employment sector. The dependent variable was whether the respondent indicated their practice was (1) working at full capacity, or potential productivity increased (2) 1-10%, (3) 11-25%, (4) 26-50%, (5) 51-75%, or (6) >75%. The explanatory variables in the regression were employment sector and state. We applied the estimated ordered logistic prediction equations to each state and employment sector to calculate the probability veterinarians would indicate the above responses (1) through (6). For responses (2) through (6), we used the midpoint of each range (e.g., 5% is the midpoint of the 1-10% range) as an indicator of excess capacity. Using this information, we estimated that nationally there was 17% excess capacity for veterinary services in private clinical practice (under Scenario 1). National estimates of excess capacity for veterinary services were highest for equine practice (23% excess capacity), followed by small animal (18%), food animal (15%), and mixed practices (13%). These numbers reflected that 42% of veterinarians who reported on the capacity status of their practice (i.e., did not respond "don't know/not sure") reported that their practice was already working at full capacity.

A table of the estimated excess capacity in veterinary practices by state and practice is provided in Exhibit 8, and maps of the state estimates of excess capacity for small animal practice, equine practice, food animal practice and mixed animal practice is presented in Exhibit 9 through Exhibit 12, respectively.

For small animal practices, the Midwest and South regions of the U.S. appeared to have the largest average excess capacity (Exhibit 9). Estimates of excess capacity for individual states (especially less populous states) were subject to small sample size, and therefore were less precise estimates of the actual magnitude of excess capacity as compared to regional or national totals. In part because of the regression approach used, geographic variation in patterns of excess capacity was similar across practice types. Estimates were unavailable for South Dakota and Utah due to lack of survey respondents in those states.

Exhibit 8. Estimated Current Excess Capacity by State and Practice Type

State	Food Animal	Small Animal	Equine	Mixed
Alabama	21%	24%	31%	19%
Alaska	25%	28%	35%	22%
Arizona	18%	21%	28%	16%
Arkansas	6%	7%	10%	5%
California	12%	15%	20%	11%
Colorado	12%	14%	20%	11%
Connecticut	13%	15%	21%	11%
Delaware	10%	12%	17%	8%
Florida	15%	18%	24%	13%
Georgia	15%	17%	23%	13%
Hawaii	19%	23%	29%	17%
Idaho	18%	21%	27%	16%
Illinois	18%	21%	28%	16%
Indiana	25%	29%	36%	23%
Iowa	16%	19%	25%	14%
Kansas	22%	25%	32%	20%
Kentucky	23%	26%	33%	21%
Louisiana	11%	14%	19%	10%
Maine	11%	13%	18%	9%
Maryland	21%	25%	31%	19%
Massachusetts	11%	13%	18%	10%
Michigan	14%	16%	22%	12%
Minnesota	10%	12%	17%	9%
Mississippi	31%	35%	42%	28%
Missouri	21%	24%	31%	19%
Montana	11%	13%	18%	9%
Nebraska	34%	38%	45%	31%
Nevada	20%	24%	30%	18%
New Hampshire	28%	32%	39%	26%
New Jersey	17%	20%	26%	15%
New Mexico	30%	34%	41%	28%
New York	14%	16%	22%	12%
North Carolina	10%	12%	17%	9%
North Dakota	15%	18%	24%	13%
Ohio	12%	15%	20%	11%
Oklahoma	8%	10%	14%	7%
Oregon	15%	17%	23%	13%
Pennsylvania	10%	12%	17%	9%
Rhode Island	12%	15%	20%	11%
South Carolina	19%	22%	28%	17%
South Dakota	NA	NA	NA	NA
Tennessee	16%	19%	25%	15%
Texas	13%	15%	21%	11%
Utah	NA	NA	NA	NA
Vermont	9%	11%	16%	8%
Virginia	16%	19%	25%	14%
Washington	12%	15%	20%	11%
West Virginia	13%	16%	21%	12%
Wisconsin	16%	19%	25%	15%
Wyoming	20%	23%	30%	18%
U.S.	**15%**	**18%**	**23%**	**13%**

NA=estimate not available because no veterinary respondents in the state.

Exhibit 9. Estimated Current Excess Capacity of Veterinary Services: Small Animal Practice

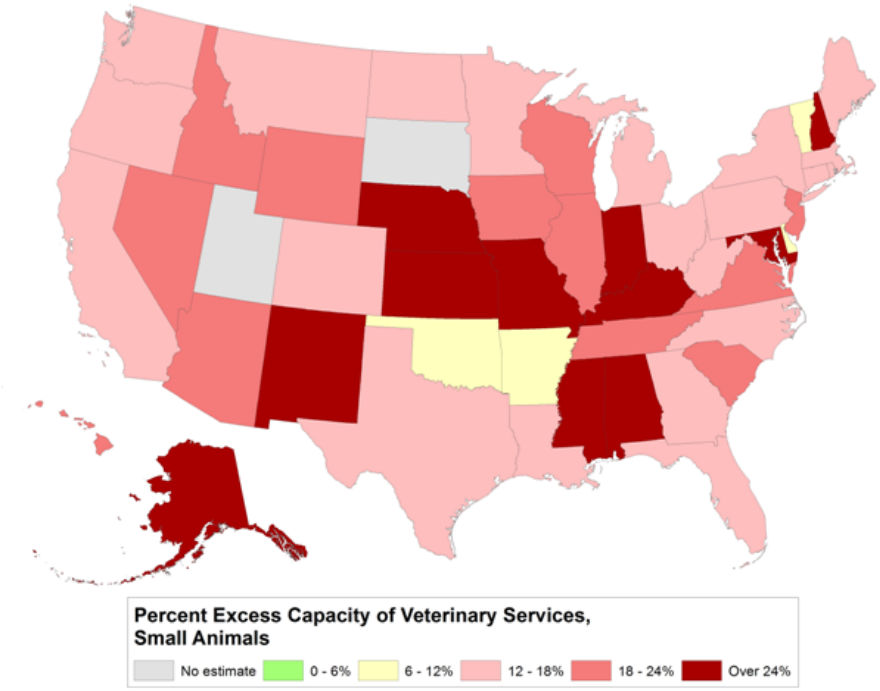


Exhibit 10. Estimated Current Excess Capacity of Veterinary Services: Equine Practice

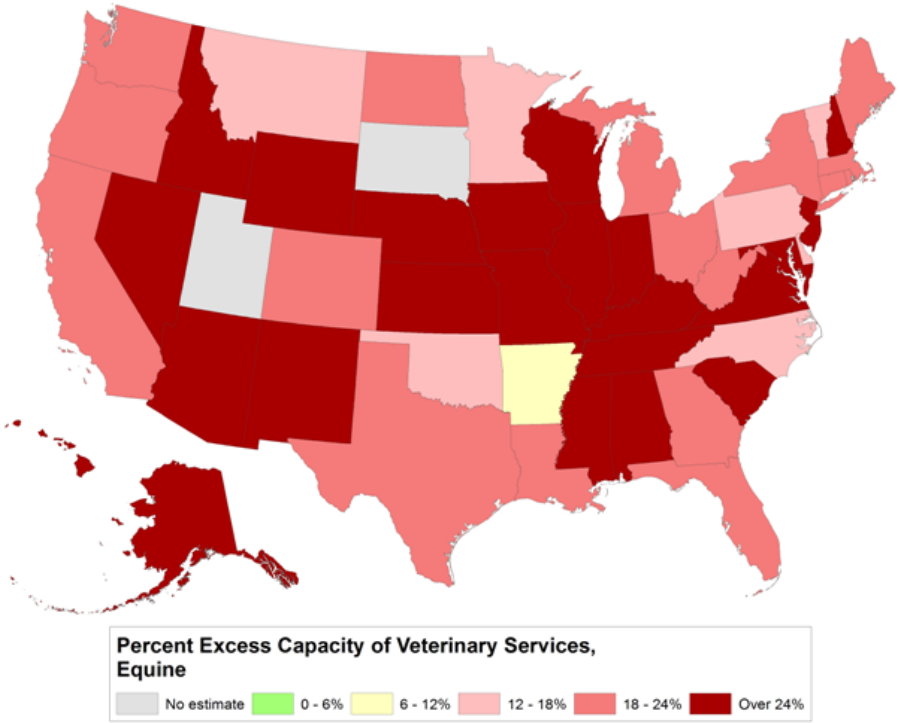


Exhibit 11. Estimated Current Excess Capacity of Veterinary Services: Food Animal Practice

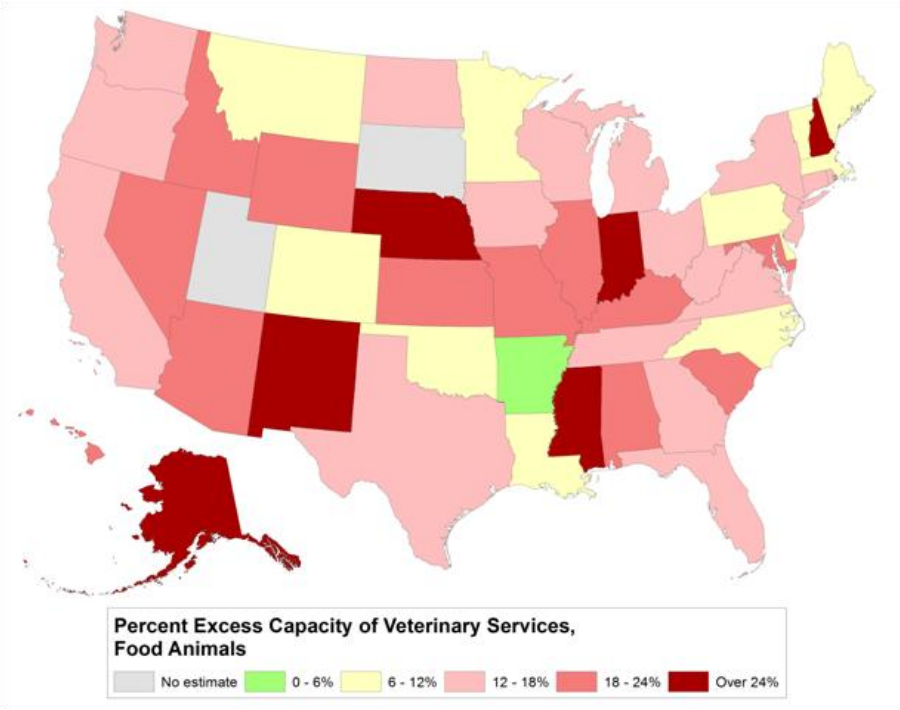
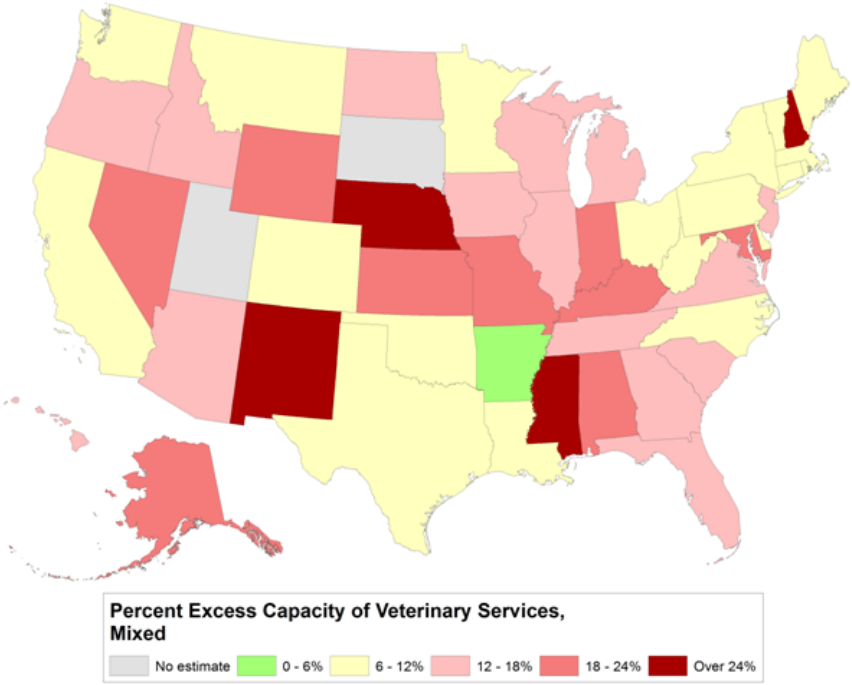


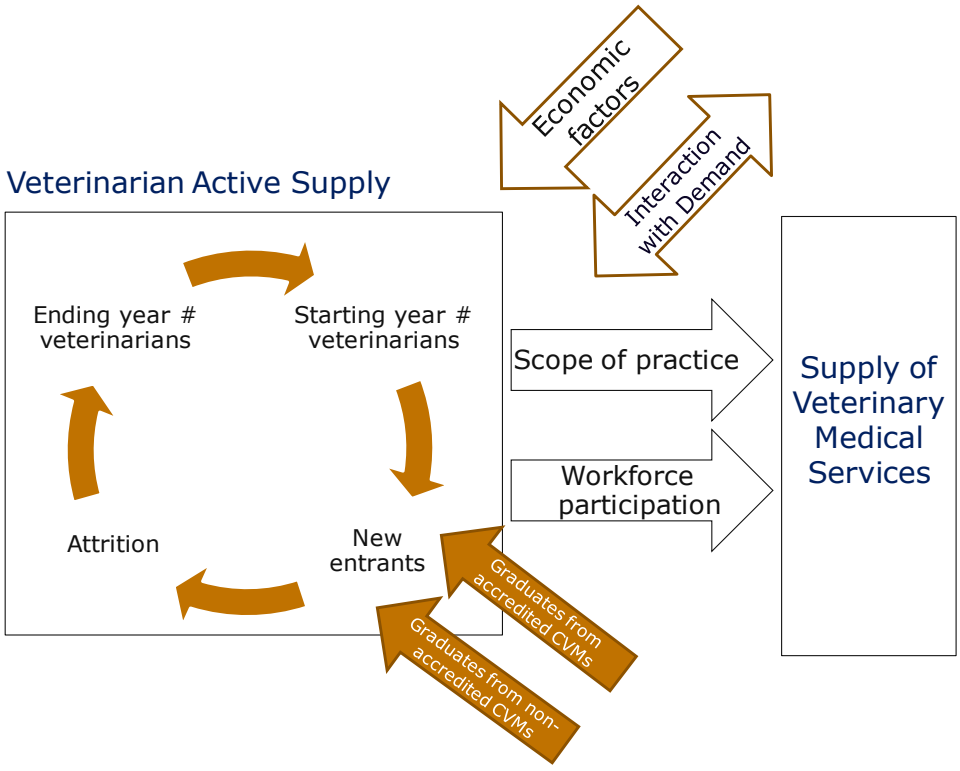
Exhibit 12. Estimated Current Excess Capacity of Veterinary Services: Mixed Animal Practice



II. Estimating and Projecting Veterinarian Supply

Projections of the future active supply of veterinarians were based on a microsimulation model that simulated career choices of individual veterinarians.[a] The projections started with a database that contained information on each veterinarian in the current workforce, added new graduates entering the veterinary workforce from accredited and non-accredited colleges of veterinary medicine (CVM), and subtracted veterinarians who left the workforce (Exhibit 13). Adjusting for patterns in hours worked allowed for calculating a "2012 equivalent" supply—where a 2012 equivalent was defined by the average hours worked by veterinarians in 2012 (2,313 hours) including veterinarians of all ages, gender, and full-time/part-time status. By definition, active supply and 2012 equivalent supply were identical in 2012, but could differ slightly by state and over time depending on the age and gender composition of the workforce and the expected work hours by age and gender. All the supply estimates and projections presented in this report are in terms of 2012 equivalents unless labeled as active.

Exhibit 13. Microsimulation Model of Veterinarian Supply



[a] Note: While microsimulation modeling has been used extensively by public and private organizations for forecasting and policy analysis, only recently has microsimulation modeling been used for health workforce modeling. The federal Bureau of Health Professions, Health Resources and Services Administration, recently adopted the use of microsimulation modeling for all its health profession supply and demand modeling.

Major data sources for modeling supply and career behavior included:

- **AVMA Veterinarian Database**. This file contains data on AVMA members and non-members as of January 1, 2012. It contains demographic and professional information on 124,876 individuals—including retired veterinarians and those likely practicing outside the U.S. This file served as the basis for estimates of the 2012 supply of veterinarians and also informed the analysis of new and recent graduates.
- **Biennial Economic Survey of Veterinarians**. Every two years AVMA conducts a survey of self-employed veterinarians who own their practice, and a survey of veterinarians who are employees. The file contained information on salary, hours worked, graduation year, employment sector, and other demographic information. While the number of veterinarians sampled in each survey differs, the 2012 survey contained records from 4,099 veterinarians.
- **AVMA Graduating Senior Survey**. Data for years 2003 to 2012 were analyzed to better understand availability of job offers and preferences for employment sector. The 2012 survey contained approximately 2,500 responses for key questions analyzed.
- **American Community Survey (ACS)**. This annual survey is conducted by the U.S. Census Bureau. Each year contains approximately 3 million individuals in 1 million households. We combined the 2006 through 2010 surveys to increase sample size, resulting in a file with 4,553 veterinarians of which 4,398 reported being active in the workforce. The file contained demographic, employment, location, income, household, and other information. These data were analyzed primarily to model workforce behavior (e.g., hours worked) as a function of demographic, economic, and other factors.
- **Veterinarian Workforce Survey.** An electronic survey conducted in September and October 2012 collected information on workforce behavior for 3,497 participants (adjusted response rate of 34.8%). Additional information from this survey and key findings are summarized in an Appendix. Pertinent information from the survey included information on retirement patterns and estimates of veterinarian perception of excess capacity in veterinary supply.

In subsequent sections, we summarize the data, methods, and assumptions used to estimate current supply, new entrants to the U.S. veterinarian workforce, attrition from the workforce, and patterns of hours worked. Subsequently, we present national and state projections of supply.

A. Estimated Current Supply

Current supply was estimated from AVMA files that contain information on both AVMA members and non-members. Approximately 98,900 veterinarians were listed as active in

their profession and located in the U.S. However, the large number of veterinarians older than age 65 listed as active likely over-represented the number actually working in veterinary medicine. For example, AVMA's files suggested that approximately 18% (n~17,400) of the active workforce was age 65 or older, with 7% (n~7,400) age 75 or older (Exhibit 14). Across all industries, the Bureau of Labor Statistics (BLS) reported that 5.4% of workers were age 65 or older in 2010.[a] For comparison, we combined the 2006 through 2010 waves of the ACS [b](n=4,398 veterinarians) to estimate the age distribution. Using the sample weights, we calculated that approximately 4% of active veterinarians in the ACS file were age 65 or older. As depicted in Exhibit 14, the number of veterinarians in the ACS sample was less than estimates from the AVMA veterinarian database. This reflected (1) the ACS data averaged across four years were a proxy for the size of the population in 2008 versus AVMA data, which estimated supply at the start of 2012, and (2) occupation in the ACS was self-reported so veterinarians might have reported themselves in a different occupation (e.g., reported as "teacher," if in academia).

In addition, we calculated the age distribution of veterinarians in the 2010 and 2012 (combined) Biennial Economic Survey who responded that they were active in the workforce. The survey contained few veterinarians older than age 70, so activity rates for those age 70 and older were unavailable from this survey.

Comparison of active veterinarians across the three sources suggested the number of active veterinarians older than age 65 was overstated in AVMA's files. Consequently, we revised the 2012 supply estimate for veterinarians age 65 and older based on retirement patterns (discussed later). When projecting supply from 2012 to 2013 and beyond, the supply simulation model rapidly "retired" veterinarians in the older age groups because the older age distribution was inconsistent with expected retirement rates. For example, under a hypothetical scenario where all veterinarians were retired by age 85, one would not expect to see active veterinarians older than age 85 in AVMA's database. Under this hypothetical scenario, when projecting from 2012 to 2013, the simulation model would remove all veterinarians older than age 85 from the count of active supply when projecting from 2012 to 2013. Our adjustment to the estimated number of active veterinarians used the probability of retiring to remove a portion of the older workforce from the estimate of active supply to reflect what was more likely the actual age distribution of older veterinarians still practicing in the profession.

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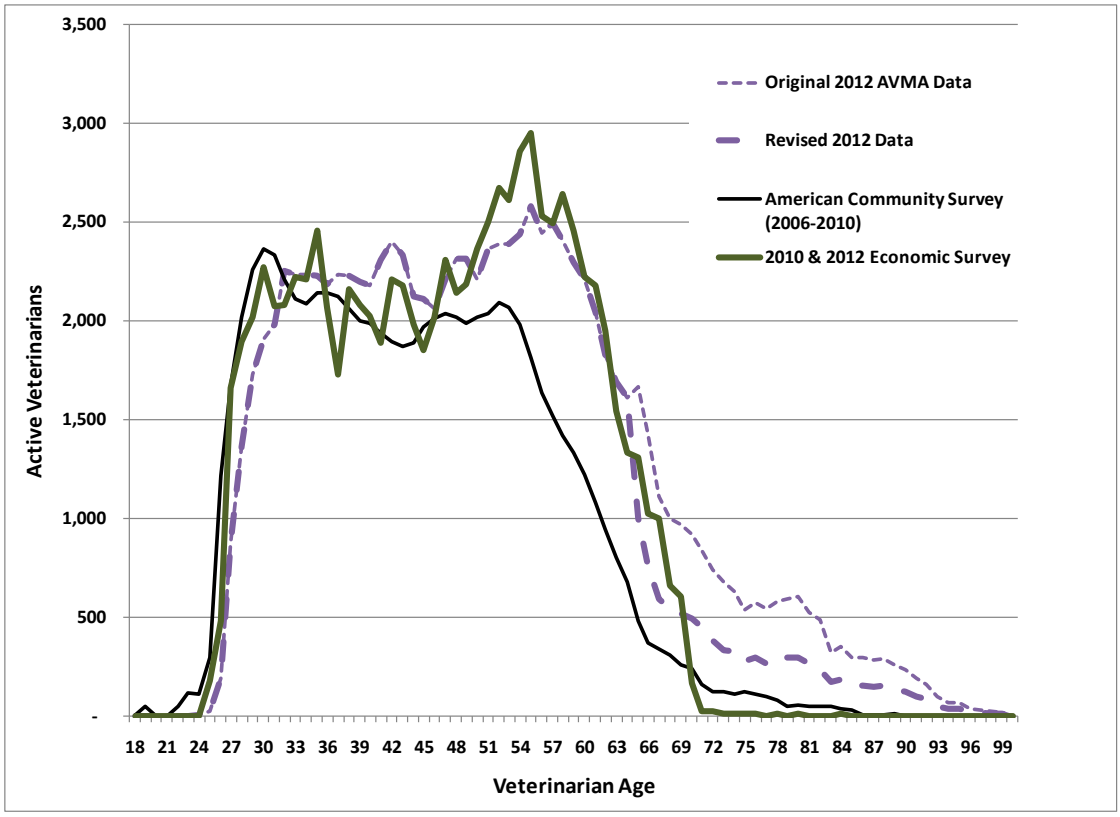
[a] Labor Force Statistics from the Current Population Survey. March 2012. http://www.bls.gov/cps/cpsaat03.htm

[b] The ACS is conducted annually by the U.S. Census Bureau. The ACS replaced the long form of the census. This survey collects detailed information on a representative sample individuals and households in the U.S. and each state—including information on demographics, household income, and characteristics about the house (e.g., single family home, apartment, farm, etc.).

This adjustment removed 8,195 individuals, and resulted in a current supply estimate of 90,705 active veterinarians. This supply estimate was slightly lower than the estimate of 92,000 professionals (in 2010) reported by the recent National Academy of Sciences which cited AVMA data based on workforce activity status in the AVMA database.[11] Of the active veterinarians, approximately 9,100 (10%) were age 65 or older— a number more consistent with other estimates and which suggested that veterinarians tend to retire later than the national average.

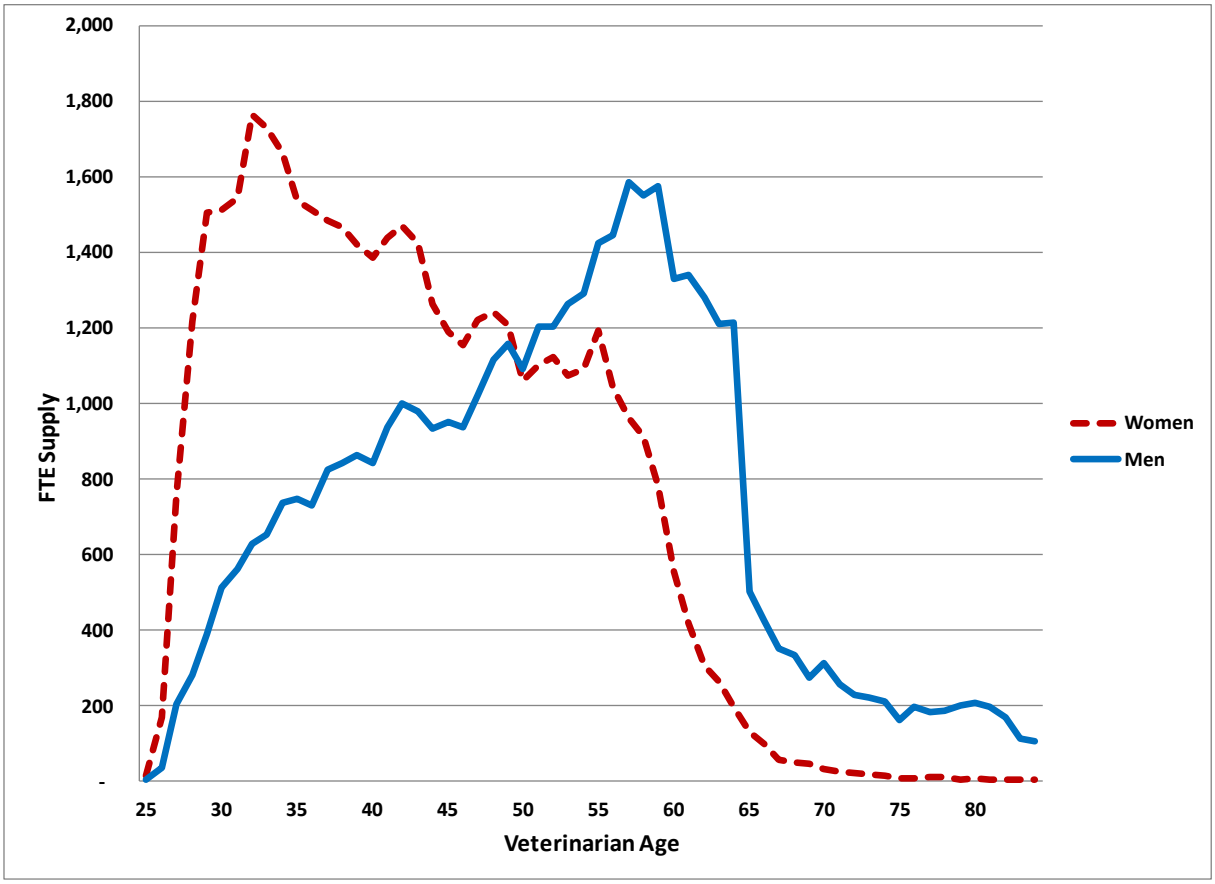
Exhibit 14. Veterinarian Age Distribution and Initial Supply Refinement



Source: Analysis of AVMA's Veterinarian Database, the ACS (2006 to 2010 combined files), and the Biennial Economic Survey of Veterinarians (2010 and 2012 combined files).

As illustrated in Exhibit 15, younger veterinarians were disproportionately women. Consequently, women will constitute a growing portion of the workforce as a substantial portion of the men are expected to retire in the next one to two decades.

Exhibit 15. Veterinarian Age and Gender Distribution



Source: Analysis of AVMA's Veterinarian Database.

The size and characteristics of the veterinary workforce varied by state (Exhibit 16). Massachusetts had the highest percentage of the workforce that was female (65%) compared to the national average (50%). Iowa, Idaho, and Montana were tied for largest percentage of the workforce age 55 or older (40%) compared to the national average (32%).

Exhibit 16. State Estimates of Veterinarian Supply: 2012

	Total			Employment sector				
State	Active	% Women	% Age 55+	Private Clinical Practice	Industry/ Commercial	Government	Academia	Other
AK	230	63	34	180	<10	20	10	10
AL	1,440	40	35	1,090	40	80	210	40
AR	710	33	39	600	30	60	20	20
AZ	1,680	52	32	1,470	50	50	60	40
CA	7,980	52	35	6,460	270	250	610	290
CO	2,730	53	31	2,150	80	140	250	100
CT	1,100	54	31	910	80	20	60	20
DC	140	54	33	70	<10	50	10	10
DE	210	59	30	160	20	10	10	10
FL	5,060	47	32	4,390	90	160	280	160
GA	2,780	51	26	2,170	120	170	280	60
HI	280	50	37	230	<10	20	<10	10
IA	1,700	34	40	1,260	90	130	180	40
ID	670	38	40	580	30	30	30	20
IL	3,310	52	28	2,810	100	80	220	120
IN	1,720	44	36	1,380	90	60	160	30
KS	1,480	38	39	1,110	120	70	150	50
KY	1,370	41	30	1,190	30	70	80	20
LA	1,200	47	29	1,000	20	40	120	30
MA	2,010	65	28	1,570	90	40	200	60
MD	2,170	56	31	1,520	80	370	120	70
ME	520	54	35	460	10	10	20	10
MI	2,800	53	34	2,230	150	100	220	80
MN	2,060	49	34	1,640	90	80	190	50
MO	2,000	43	34	1,620	100	70	170	50
MS	840	41	29	670	20	60	110	10
MT	580	40	40	510	10	20	10	10
NC	3,170	56	26	2,490	160	170	290	60
ND	240	46	31	210	<10	10	20	<10
NE	840	33	37	690	30	70	50	20
NH	550	61	28	490	10	10	30	10
NJ	1,950	52	30	1,600	160	40	90	50
NM	640	53	38	530	20	30	30	20
NV	630	46	27	570	20	20	30	10
NY	4,090	52	30	3,420	100	110	320	140
OH	3,230	51	30	2,700	110	110	240	70
OK	1,400	39	37	1,170	30	80	110	30
OR	1,670	56	31	1,390	40	50	110	60
PA	3,570	54	29	2,910	160	100	310	80
RI	250	61	26	220	<10	10	10	10
SC	1,090	52	26	930	30	50	60	40
SD	370	35	37	310	10	20	20	10
TN	1,860	50	27	1,580	40	70	150	40
TX	6,280	44	33	5,300	180	310	380	160
UT	520	33	34	450	10	30	30	10
VA	2,880	58	28	2,330	80	170	200	80
VT	370	55	35	320	10	10	20	<10
WA	2,600	56	33	2,120	70	100	200	90
WI	2,540	47	33	2,110	100	100	190	50
WV	400	50	29	350	10	30	20	10
WY	290	41	38	240	10	20	20	10
U.S.	90,230	50	32	73,860	3,200	4,000	6,690	2,480

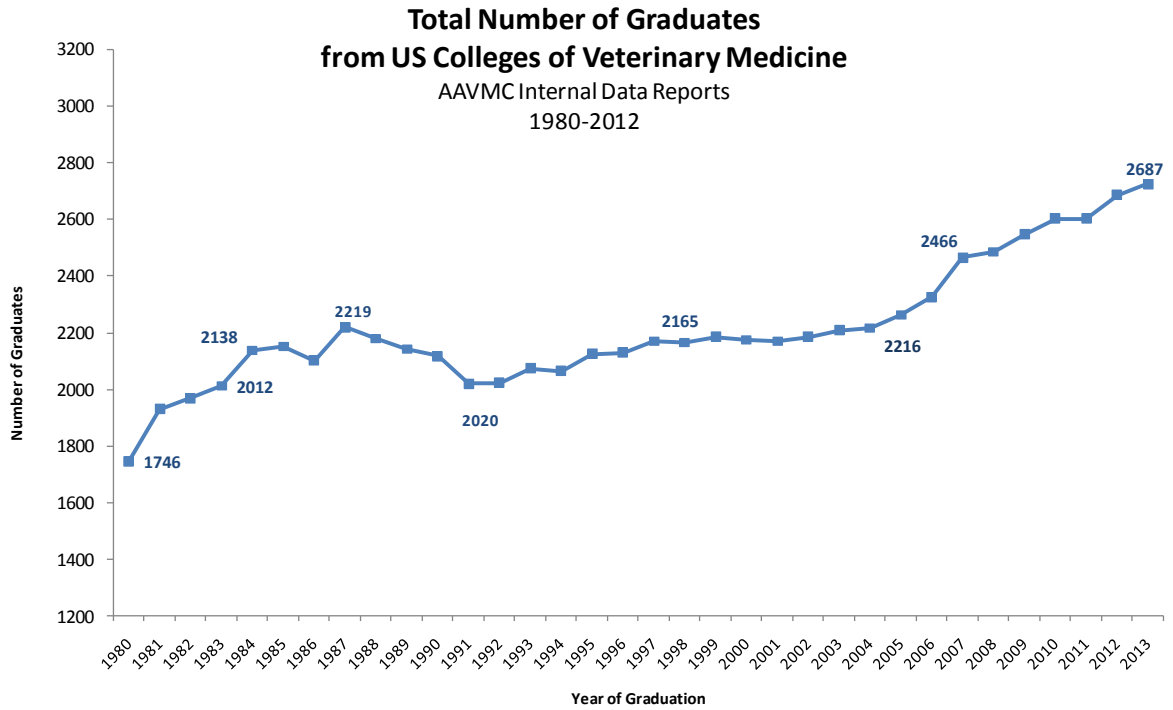
Notes: Numbers might not sum to totals because of rounding. Veterinarians whose employment sector was unknown were distributed across employment categories based on each state's distribution of veterinarians whose employment sector was known.

B. New Entrants to the U.S. Veterinarian Workforce

The career of veterinarians often spans 30 or 40 years, so the number and age distribution of new veterinarians trained each year has profound implications for the future supply with the impact compounding year after year.

The estimated number of new graduates entering the workforce in 2012 was taken from the number of candidates passing the North American Veterinary Licensing Exam (NAVLE) who applied through U.S. licensing boards in 2011/2012. Since the number of candidates passing the NAVLE in future years is unknown, the best available data were used to calculate the number of new entrants in the future. Data on enrollments in AVMA accredited schools in the U.S. were combined with data on enrollments of American students in AAVMC member (AVMA accredited and non-accredited) schools outside of the U.S. for the classes of 2013-2016. The growth rate of enrollment was then applied to the initial estimate from the NAVLE to get the number of new graduates through 2016 (reflecting that the new student class would experience some attrition during the first year). Scenarios estimating the impact of increased seats in current schools and in new schools are addressed later (page 33) under "Supply Projections." According to the AAVMC, overall growth in graduates from U.S. veterinary schools was flat from the mid-1980s through the 1990s, but increased markedly over the last decade and thus has averaged approximately 2% per year for the last 30 years (Exhibit 17).

Exhibit 17. Total Graduates from U.S. Colleges of Veterinary Medicine: 1980 to 2012



Source: American Association of Veterinary Medical Colleges

The recent period of expansion in enrollment among colleges of veterinary medicine was possibly fueled by declining state funding, especially during the steep economic downturn that occurred between 2008 and 2012. The increase in enrollment has likely reached the maximum capacity at these colleges as enrollments have begun to level off. As such, beyond the class of 2016, a 2% annual growth rate in new entrants to the veterinary workforce was assumed for the Baseline supply scenario. The number of new entrants in the baseline scenario is summarized in Exhibit 18. Alternative supply scenarios with different assumptions regarding the number of new entrants to the workforce were also modeled.

Exhibit 18. Estimates of New Veterinarians Entering the U.S. Workforce[a]

Year	New Veterinarians	Year	New Veterinarians	Year	New Veterinarians
2012	3457	2018	4230	2024	4764
2013	3595	2019	4315	2025	4859
2014	3775	2020	4401	2026	4956
2015	3986	2021	4489	2027	5055
2016	4066	2022	4579	2028	5156
2017	4147	2023	4671	2029	5259

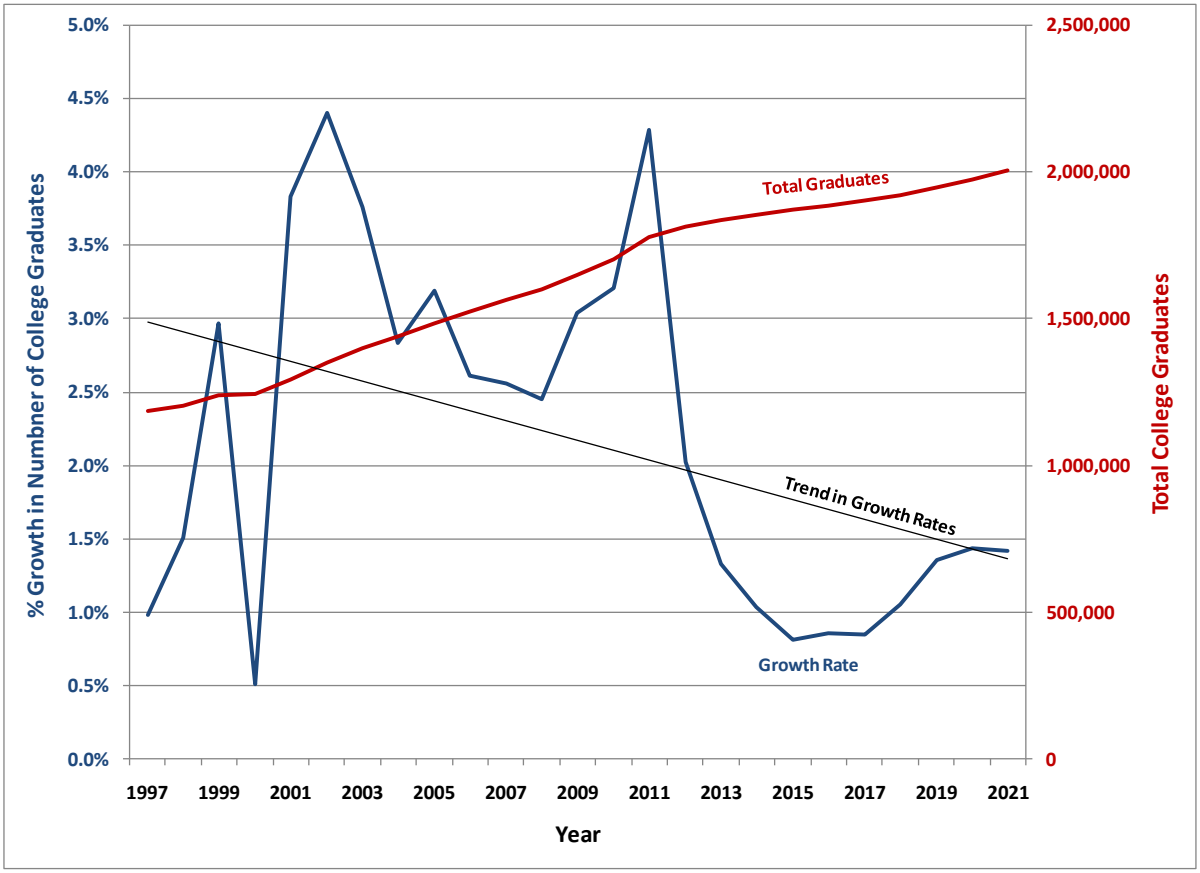
Sources: (1) NAVLE Technical Reports. https://www.nbvme.org/?id=82 ; (2) AAVMC estimates and projections (2012-2015) of American graduates of accredited colleges of veterinary medicine, as reported in Table 2-4 of National Academy of Sciences report.[11] (3) Assumed 2% annual growth in number of graduates new entrants in current Baseline supply projections, based on analysis of AVMA veterinarian database.

Historical trends have shown 2% annual growth in graduates from U.S. VMCs. The annual growth rate in recent years has been 4% when combining U.S. graduates from U.S. and international VMCs. However, it was unclear whether the recent 4%rate of growth (or even the 2% long term trend) is sustainable given U.S. demographic growth patterns and trends in educational attainment. As depicted in Exhibit 19, the number of U.S. college baccalaureate graduates (across all academic fields) was projected to increase through 2021, but the growth rate declined. Between 2001 and 2011, the number of college graduates increased each year by 2.5% to 4.5%. The Institute of Education Sciences projected much slower growth rates in the total number of baccalaureate graduates—with growth rates of

[a] These projections accounted for students in all U.S. CVMs and U.S. citizens that were students in the 20 AAVMC member (AVMA accredited and non-accredited) schools outside of the U.S. These baseline growth scenario numbers did not account for the planned expansions in the veterinary medicine pipeline of Utah State University in 2016, Lincoln Memorial University in 2017, or Midwestern University in 2018, or other potential new veterinary schools. A high-growth supply scenario assumed 4% annual growth in number of new graduates to illustrate the supply implications of training different numbers of new veterinarians.

1% to 2% between 2013 and 2021. The growth trend for master's degree and PhD graduates was slightly higher—with growth rates falling from 2.5% in 2013 to 1.5% by 2021.

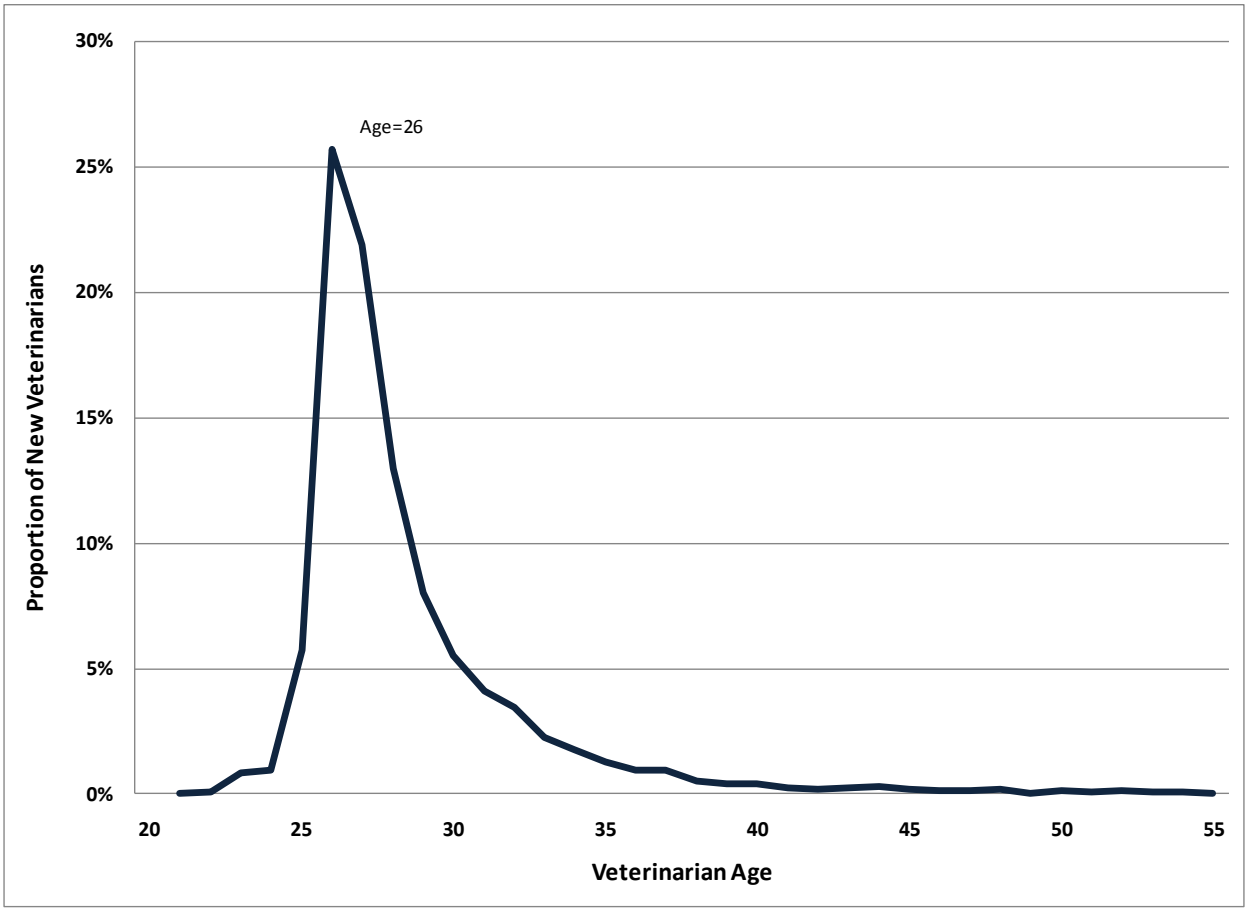
Exhibit 19. Past and Projected U.S. Baccalaureate Graduates (across all academic fields)



Source: Historical data and projections of future college graduates from the Institute of Education Sciences, National Center for Education Statistics, Table 33. Published January 2013.
http://nces.ed.gov/programs/projections/projections2021/tables.asp

Using AVMA data on the year of graduation, we identified veterinarians who graduated between 2008 and 2011 to calculate the gender and age distribution of new graduates. In recent years, the percentage of new female graduates has remained relatively stable at around 78%. Most new graduates were between age 26 and 30, and 25% of new graduates were age 26 (Exhibit 20).

Exhibit 20. Age Distribution of New Graduates from Veterinary Medical Schools



Source: Analysis of AVMA's Veterinarian Database.

The microsimulation approach used to model future supply created an artificial cohort of new graduates each year, with each new graduate assigned an age and gender based on the probability distributions observed among graduates during the past four years.

C. Workforce Attrition

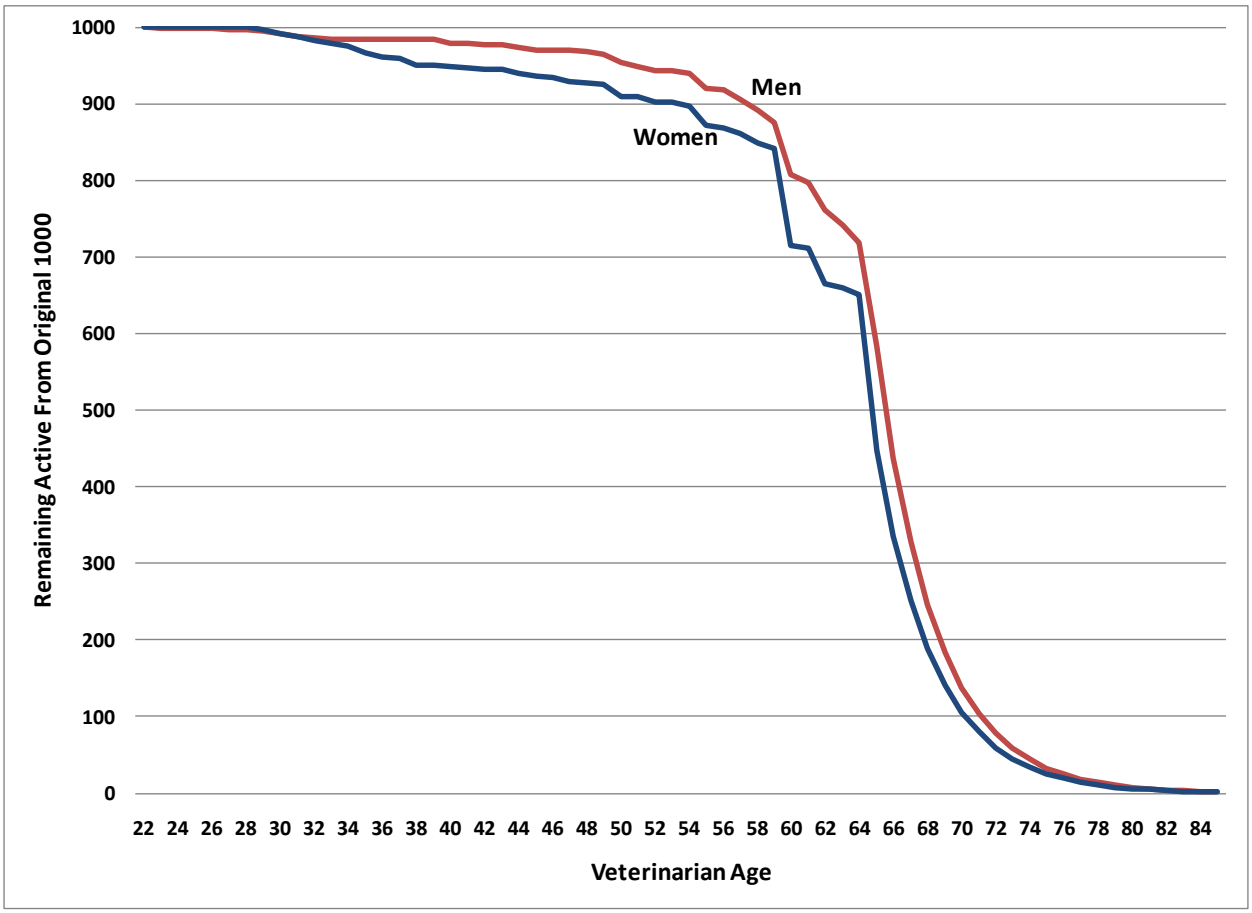
Our review of the literature and analysis of existing data sources found little information on the retirement patterns of veterinarians. While analysis of membership type in AVMA's database provided some indication of retirement patterns, the decision to survey the veterinary workforce (see Appendix A) was determined in part by the need to have better information about workforce attrition patterns.

The two survey questions used to provide information on attrition patterns asked currently active veterinarians at what age they planned to become permanently inactive in the workforce and asked currently inactive veterinarians at what age they became permanently inactive. These responses were combined to create estimates of workforce attrition for males and females by

age. Estimates of retirement patterns were combined with mortality rates from the Centers for Disease Control and Prevention to estimate overall workforce attrition rates, and mortality rates took into consideration that people in professional occupations tend to have lower mortality rates through age 65 as compared to national average mortality rates for men and women. Johnson et al. found that age-adjusted mortality rates for professional and technical occupations were approximately 25% lower than national rates for men and 15% lower for women. [18]

Applying these rates to veterinarians suggested that for every 1,000 men and 1,000 women who entered the veterinary workforce, approximately 437 men and 335 women were active past age 65 (Exhibit 21). Approximately 104 men and 80 women remained active past age 70.

Exhibit 21. Veterinarian Workforce Attrition Patterns



Source: Analysis of AVMA 2012 Veterinary Workforce Survey.

The approach we used to model future supply of veterinarians differed from the approach used in the recent National Academy of Sciences (NAS) study.[11] The NAS estimated annual number

of retirements by dividing (1) size of the current workforce by (2) length of veterinarians' career span (which was assumed to be 35 years for most veterinarians but only 30 years for veterinarians in food-animal practice because of the physical and strenuous nature of the work).[a] The approach used by NAS, however, failed to reflect the current and projected future age distribution of the workforce. Furthermore, retirement patterns can change over time based on social norms and policies (e.g., increasing the eligibility age for Social Security and Medicare), economic conditions and their impact on retirement assets, ability to sell one's veterinary practice, and work-life balance decisions. The BLS, for example, reported that many older workers were delaying retirement and this pattern of delayed retirements was expected to continue even after the economy recovers.[19] Among the population age 65 and older, labor force participation rates grew slightly from 11.8% in 1990 to 12.9% in 2000. There was a substantial increase to 17.4% in 2010, and in 2020, the BLS projected that 22.6% of individuals age 65 and older would be part of the labor force.

The NAS reported "anecdotal evidence from practitioners suggests that a high percentage of new graduates leave equine practice within 5 to 10 years" for reasons including long hours and limited time for personal life (p. 49).[11] The large majority of these younger veterinarians leaving equine practice (as well as those leaving mixed animal practices) were likely to transition to other employment sectors—such as small animal practice, academia, government, or industry.

Alternative supply scenarios presented in this report include whether older veterinarians accelerated or delayed retirement compared to historic patterns.

D. Hours Worked

Projections of the future supply of veterinary services took into consideration trends and factors that may influence future levels of effort as defined by work hours. Trends with implications for total hours worked included: (1) the growing portion of the workforce that is female, (2) shifts in the age distribution of the workforce, (3) generational shifts in work-life balance expectations, (4) industry consolidation that could lead to a growing proportion of the workforce that is employed rather than self-employed, (5) imbalances between supply and demand for veterinary services, (6) changes in the economics of veterinary practice, and (7) changes in technology and care delivery patterns that could affect office and on-call hours for veterinarians who provide animal care.

Our analyses were designed to address many of the above trends. Findings from our analysis of AVMA's Biennial Economic Survey (2002 to 2012) and the Census Bureau's 2010

[a] During the interviews, informants suggested that there might be some validity to the belief that veterinarians in food animal practice departed practice a few years earlier than companion animal veterinarians, but that it might not be such an issue going forward. The nature of food animal practice has changed and the physical effort required of the veterinarian might not be as constant as in the past. Some of that work is now being accomplished by other technical personnel in food animal production facilities and feed lots.

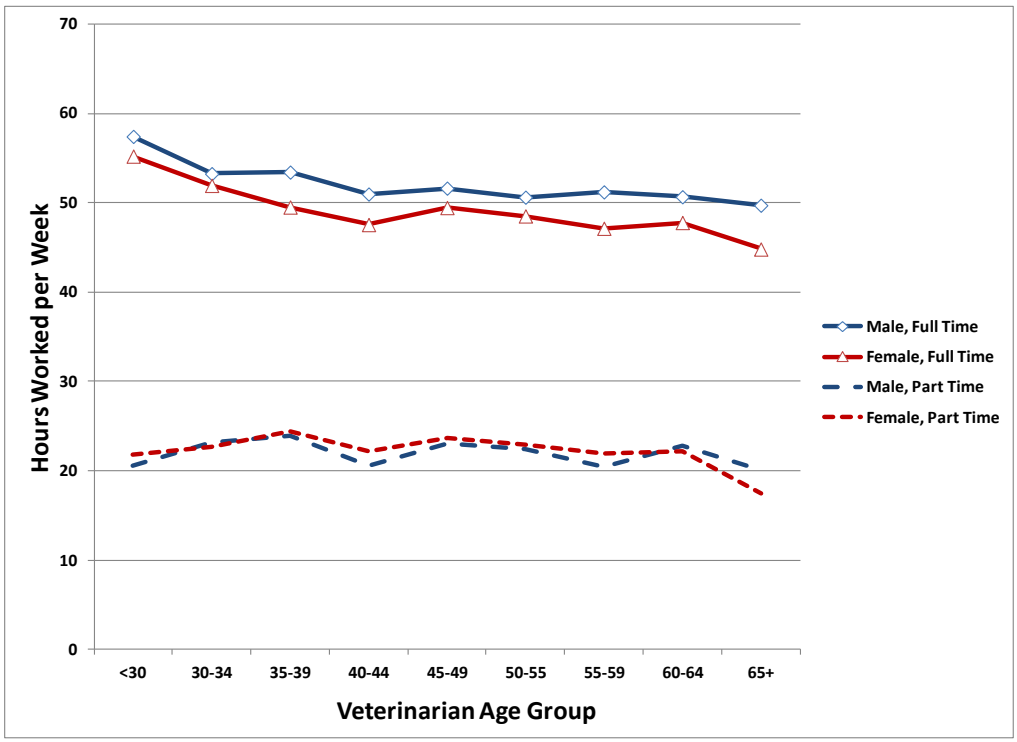
ACS provided insights and were incorporated into the supply projections presented later. To generate a complete sample of veterinarians in the Biennial Economic Survey, we combined the Owners and Non-owners components of the survey. As illustrated in Exhibit 22, in 2012 the average number of hours worked for both men and women tended to decline with age. This was true for both part-time and full-time workers. Among the 1,989 men in the survey, the average hours worked per week was 48.2, while for the 1,905 women in the survey the average was 45.1 hours. Veterinarians younger than age 30 worked the most hours per week, with men working 55.2 hours and women working 52.8 hours. Conversely, veterinarians age 65 and older worked the fewest hours, with men working 41.1 hours and women working 33.1 hours.

While there was little gender difference in average hours worked when controlling for self-reported full-time versus part-time status, 18% of women reported working part time versus 11% for men. There were also differences by age and gender in average weeks worked per year (47.5 weeks for men and 46.0 weeks for women) and temporary departures from the workforce (3% for men and 4% for women). Taken together, we observed that men age 30 to 39 tended to work approximately 15% more hours than the industry average, while women age 60 to 64 tended to work the fewest hours at approximately 37% less than the average (Exhibit 23). Using this information, we calculated FTE scalars which we applied to the projections of future active supply to account for the impact of demographic shifts on average hours worked. Under a Baseline supply scenario, where future workforce participation patterns were similar to today's patterns, we counted men age 30 to 39 as 1.15 FTE, and women age 60 to 64 as 0.63 FTE.

Combining the 2002 through 2012 waves of the Biennial Economic Survey, we investigated whether there was evidence of generational shifts in average hours worked. We found no evidence of a generational shift. Among men, we did observe an increase in hours for those age 30-45 versus those younger than age 30, and a slight downward shift in hours across most age groups over time (Exhibit 24). Hours worked in 2012 were slightly below the average from 2002 to 2012, while hours for 2004 were near the lowest across years and hours for 2008 and similar to 2006. We observed similar patterns of hours worked by women between 2002 and 2012, with downward shifts over time (Exhibit 25). These shifts toward lower average hours worked appeared to affect all the age groups, so this could be indicative of market conditions rather than generational shifts. High levels of student debt[a] made it unlikely that younger veterinarians would work fewer hours than historical patterns suggested, and hours worked would likely rise if there was sufficient demand.

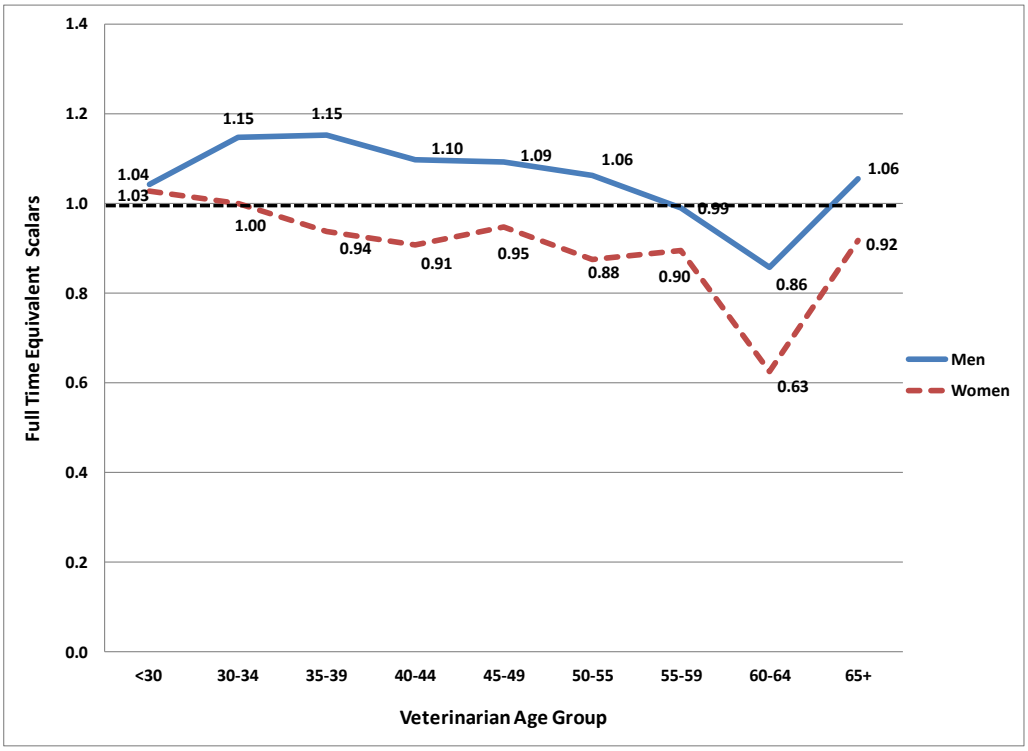
[a] Shepherd and Pikel (2011) reported that the average student debt of new veterinarian graduates was $142,613 in 2011, a 6.5% increase from 2010 levels.[20]

Exhibit 22. Average Hours Worked per Week



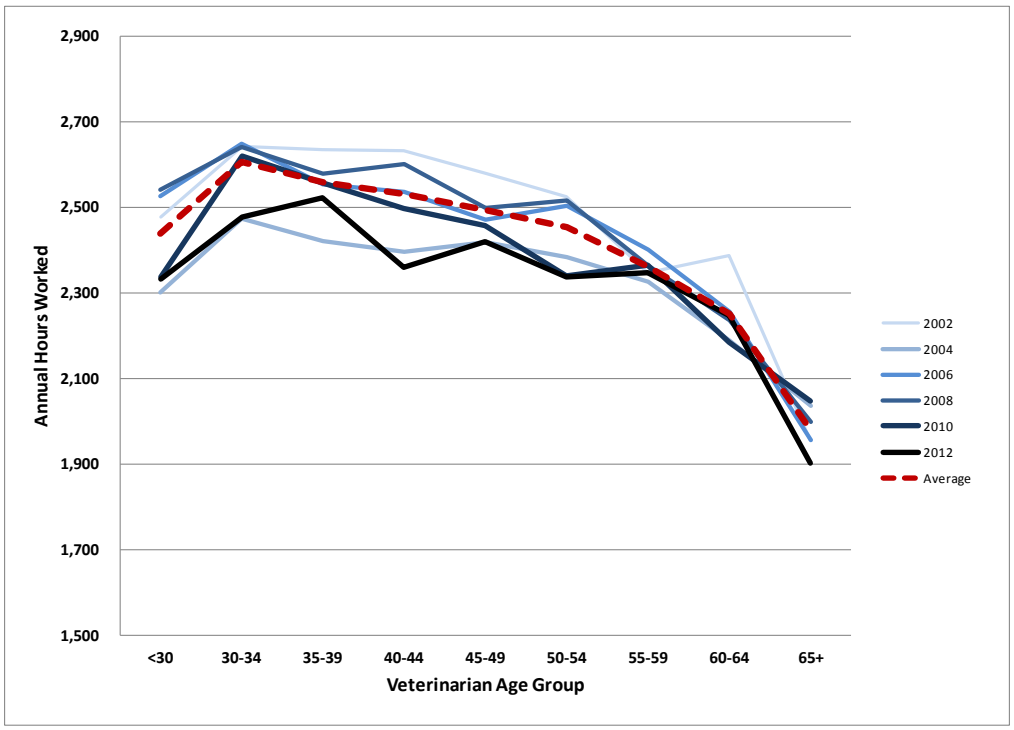
Source: Analysis of the Biennial Economic Survey, 2012.

Exhibit 23. Full-Time Equivalent Scalars



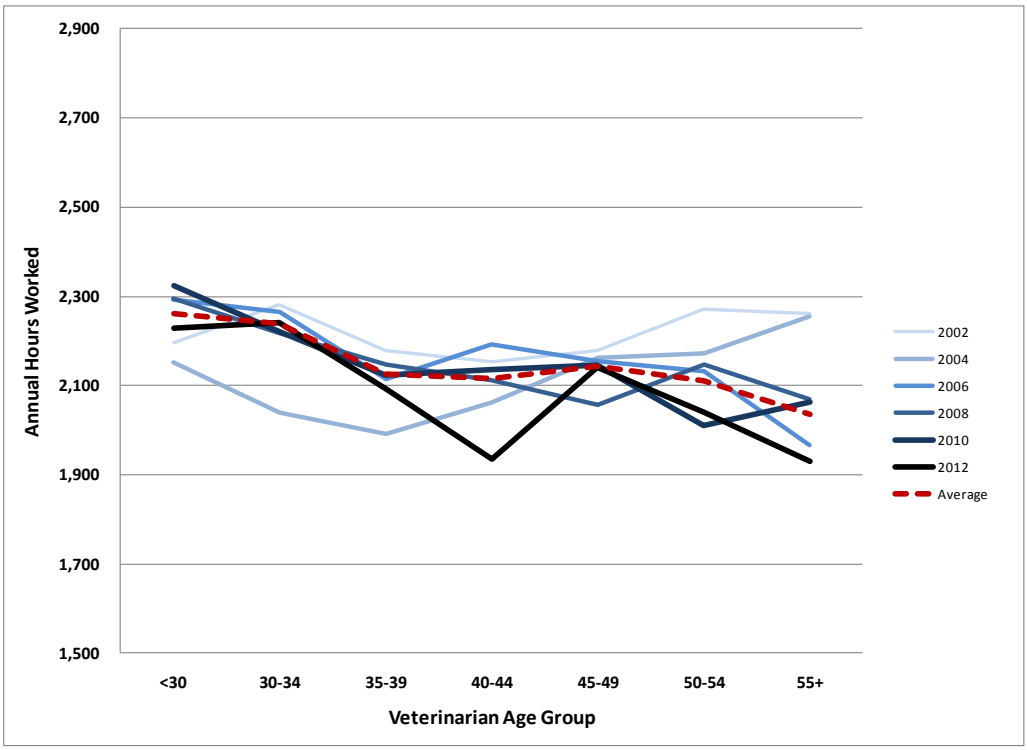
Source: Analysis of the Biennial Economic Survey, 2010- 2012.

Exhibit 24. Average Annual Hours Worked for Men: 2002-2012



Source: Analysis of the Biennial Economic Survey, 2002-2012.

Exhibit 25. Average Annual Hours Worked for Women: 2002-2012



Source: Analysis of the Biennial Economic Survey, 2002-2012.

E. Supply Projections

The Baseline Scenario projects future supply under the assumption that current patterns of retirement and hours worked remain unchanged within a demographic group defined by age and gender. Also, the scenario assumes that the number of new veterinarians entering the U.S. workforce each year grows at approximately 2 percent annually (as presented in Exhibit 18). The Baseline Scenario, therefore, represented our best estimate of future supply under the status quo. Under this scenario, FTE supply rose steadily from approximately 90,200 in 2012 to 91,000 by 2015, 95,400 by 2020, 100,400 by 2025, and 108,900 by 2030 (Exhibit 26).

Because an increasing proportion of veterinarians are women and current patterns revealed that women were more likely than men to work part time, the FTE supply projections grew more slowly than active supply (or number of veterinarians in the workforce). Currently, half (~50%) of veterinarians are women, but we found that by 2030 women were likely to constitute nearly three-fourths (~71%) of the workforce. However, the impact on total veterinarian hours supplied from the increasing proportion of women in the workforce was partially offset by an increasing proportion of veterinarians who were younger (and who typically worked full time). Thus, active and 2012 FTE supplies were growing at approximately the same rate. In the remainder of this report, we present only estimates of 2012 equivalent supply (as this measure was defined to be comparable to FTE demand).

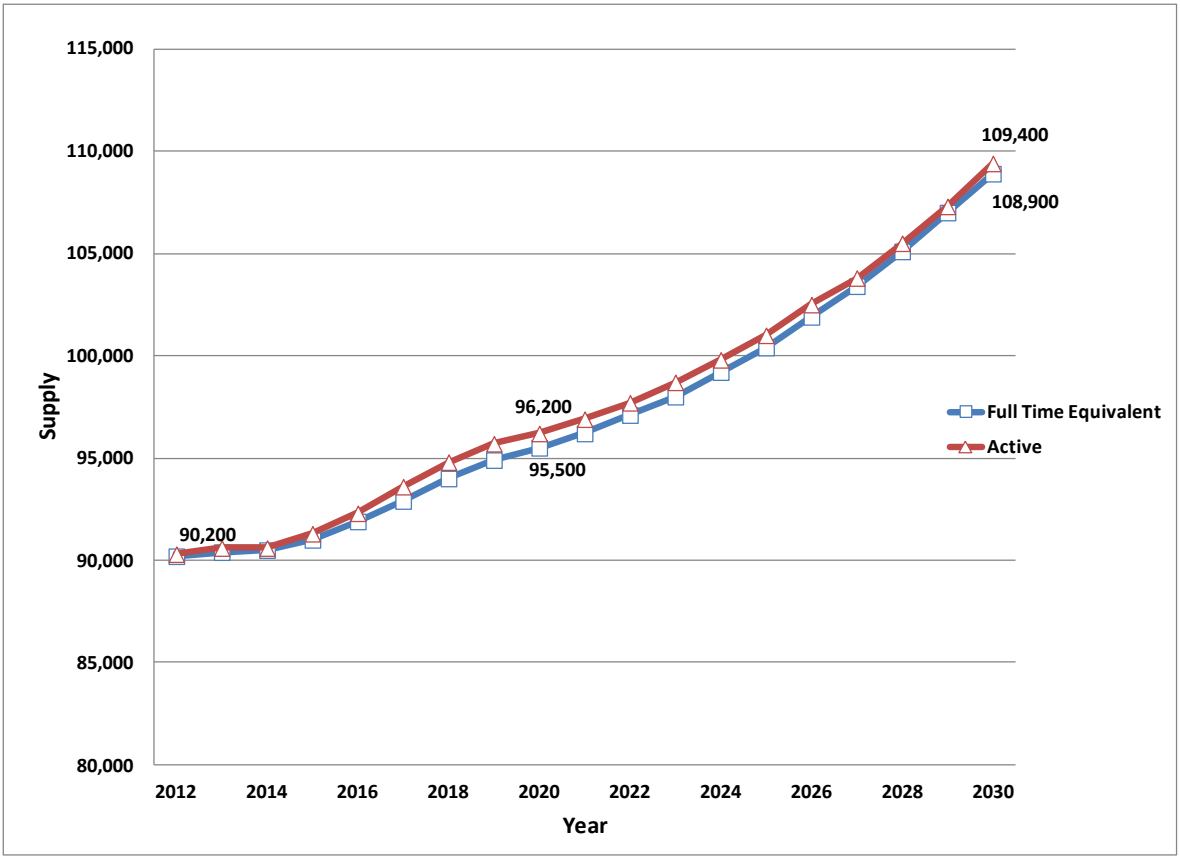
Over time, though, supply-related inputs will shift due to (1) changes in national norms, policies, and economic factors affecting hours worked and retirement patterns; and (2) changes in the number of new graduates from accredited and non-accredited colleges of veterinary medicine. Alternative assumptions of key supply inputs illustrate the sensitivity of supply projections (Exhibit 27).

- **Flat Growth of Graduates Scenario**. This scenario models the implications of keeping the number of new entrants to the U.S. workforce constant starting in 2016 (the last class for which enrollment data are available). By 2030, the difference in supply relative to Baseline was 9,537 fewer FTEs (-8.8%).
- **Flat Growth Scenario Plus Known Expansions**. This scenario models the implications of keeping the number of new entrants to the U.S. workforce constant starting in 2016 (the last class for which enrollment data are available), while accounting for known expansions to Utah State University (25 additional students starting in 2016), Lincoln Memorial University (100 additional students starting in 2017), and Midwestern University (100 additional students starting in 2018). By 2030, the difference in supply relative to Baseline was 6,400 fewer FTEs (-6%). While plans for potential veterinary schools at the University of Arizona and in Buffalo, New York have been publicly announced, since numbers of potential entrants into the U.S. workforce and the first year of graduation were unknown, these potential programs could not be considered for this

scenario. Likewise, additional enrollment growth in international schools such as Ross University was unknown and therefore not included in this scenario.

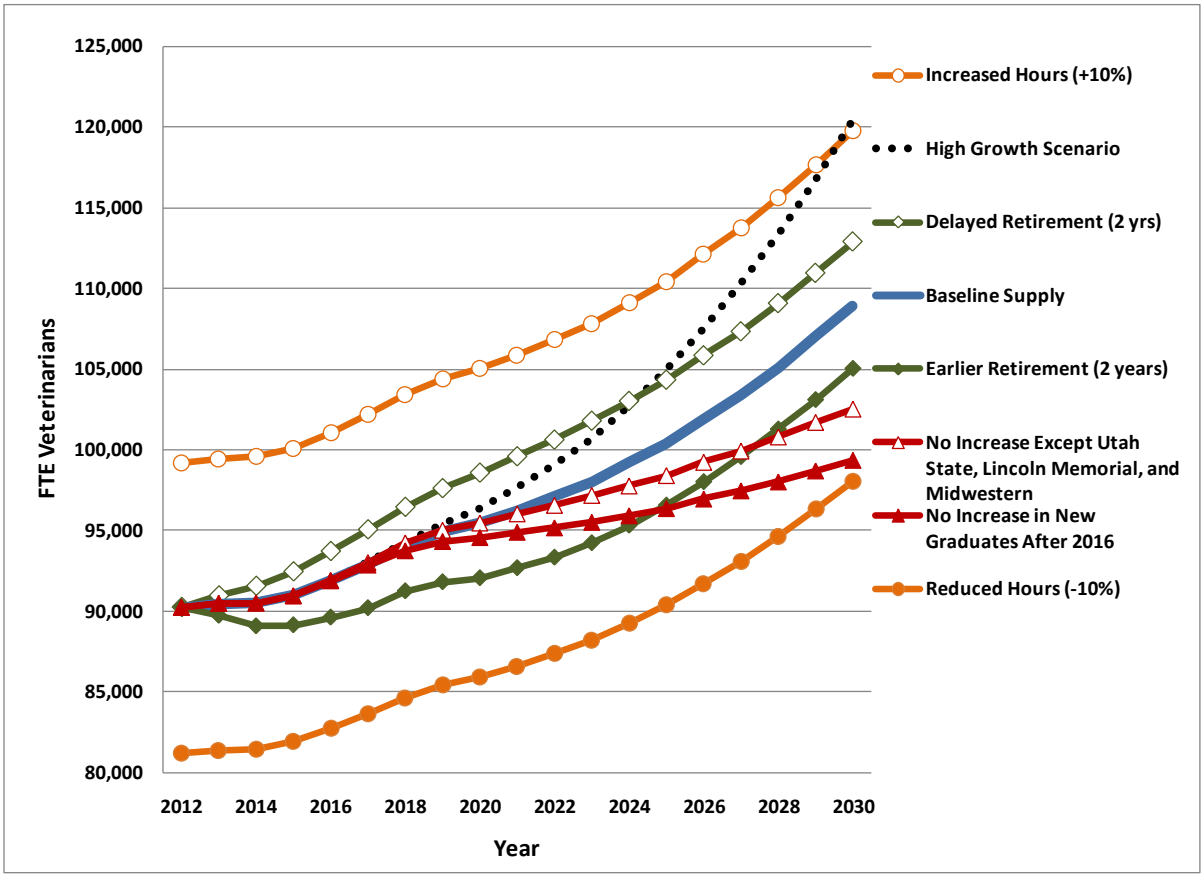
- **High Growth Rate Scenario (4% annual growth).** The growth rate in number of U.S. citizens graduating from U.S. and international schools combined has been approximately 4% average annual growth in recent years. This hypothetical scenario illustrated the implications if recent growth trends continued. Whereas the baseline scenario assumed that each year the number of graduates grows by 80-95 between 2016 and 2025, this high growth scenario assumed that the number of new graduates grows by 160 to 220 each year between 2016 and 2025. Under this scenario with 4% annual growth in new graduates, by 2030 the supply was 11,500 FTEs higher than under the Baseline scenario which assumed 2% annual growth in number of new graduates.
- **Delayed or Earlier Retirement Scenarios**. Over time, veterinarians could delay retirement to reflect, for example, changes in Medicare eligibility age or improved health that prolongs careers. Or, veterinarians might decide to retire earlier because of work-life balance choices. These scenarios model retirement patterns that shift to reflect (1) retiring two years earlier, and (2) retiring two years later, on average, relative to current retirement patterns. By 2030, the difference in supply relative to Baseline was roughly ±4,000 FTEs (±4%).
- **Change in Total Hours Worked Scenarios**. The Baseline projections reflect the changing demographics of the veterinarian workforce. However, total average hours worked could change to reflect changes in desired work-life balance and a need to work more hours due to high educational debt. If average hours decreased by 10% (from approximately 47.8 hours/week to 43.0 hours/week), for example, then there would be an immediate 10% shift down in FTE supply. Likewise, if average hours worked increased by 10% (rising to 52.6 hours/week) then there would be an immediate 10% shift up in FTE supply. By 2030, the difference in supply relative to Baseline was ±10,900 FTEs (±10%).

Exhibit 26. Projections of Active and "2012 Equivalent" Supply: 2012-2030 (Baseline Scenario)



Note: "2012 Equivalent" supply adjusted for the changing age and gender distribution of the workforce, where each veterinarian was assumed to work 2,313 hours in professional activities (the national average hours worked in 2012).

Exhibit 27. Alternative Supply Scenarios: 2012-2030



The downward shift in average hours worked during the past decade (across all age groups and controlling for gender) could be the result of insufficient demand for services among veterinarians in private clinical practice. If so, this suggests that the potential supply of veterinarian services was greater than actual supply, and that average hours worked would rise if there was a better balance between market supply and demand.

Changes to retirement patterns could increase or decrease supply, with a two-year swing in retirement patterns changing future supply by approximately the same impact as one graduating class of new veterinarians. If, as anticipated by the BLS, many older workers delay retirement even after the current economic downturn recovers, then the future supply of veterinarians will likely be higher than the baseline projections. [19]

Changing the number of new veterinarians trained has significant long-term implications on supply, with the impact accumulating over time. FTE supply has flexibility to shift up or down quickly to accommodate short-term fluctuations in demand (although economic pressures and the need to pay off educational debt could prevent hours from falling).

III. Estimating and Projecting Demand for Veterinarians

The demand component of the *Veterinary Workforce Model* was designed to forecast pet ownership and food animal populations, demand for veterinary services, and the derived demand for veterinarians through 2025 by employment sector. Demand was projected at the state level for the small animal, equine, and food animal sectors, but calculated at the national level for industry, academia, government, and the "other" employment due to lack of state-level data and the regional nature of these employment sectors.

A. Data and Methods

Major data sources for modeling demand and animal populations include:

- **2012 Veterinary Workforce Survey**. A sample drawn from the AVMA database of veterinarians (including active and retired, and AVMA members and non-members) collected information on perceptions of the adequacy of veterinarian supply in one's local geographic area and employment sector, and perception of level of excess capacity within one's own veterinary practice. An appendix provides more detail on this survey and findings.
- **AVMA Pet Demographic Survey (PDS)**.[15] Data from the 2007 and 2012 surveys were used to analyze the number and type of pets owned in a household. Additionally, the survey measured the number of visits to a veterinarian in the past year and the type of service performed during a visit.
- **Biennial Economic Survey of Veterinarians**.[17] Every two years AVMA conducts a survey of self-employed veterinarians who own their practice and a survey of veterinarians who are employees. Information on the proportion of time worked by animal type and employment sector was used in the demand analysis. The 2012 survey contained records from 4,099 veterinarians.
- **American Community Survey (ACS)**.[21] This annual survey conducted by the U.S. Census Bureau contains information on approximately 3 million individuals in 1 million households representative of the population in each state in 2010. The file contains demographic, employment, location, income, household, and other information. These data were combined with the PDS data to model the estimated number of pets and veterinary services provided to pets in each state as a function of demographic, economic, and other household characteristics.
- **Census Bureau Population Projections**.[22, 23] We used state and national projections of the population to forecast change in the number and characteristics of households through 2030.
- **IHS Food Animal Projection Model**. This model, developed by IHS's Agricultural team, predicts the U.S. population of food animals, including beef and dairy cows, swine, poultry, and sheep.

In subsequent sections, we summarize the data, methods, and assumptions used to estimate current demand, and changes in employment sector. Then, we present projections of the national demand for veterinary services and veterinarians.

Small Animal Practice and Household-Owned Equine

Projecting demand for small animal veterinarians at the state level and into the future starts with projecting pet ownership, from which we calculated the demand for veterinary services and veterinarians. Demand for services was defined as the number and mix of veterinary services that households were anticipating to use as a function of pet needs, price of services, and households' ability and willingness to pay for services.

To forecast demand for small animals (separately for dogs, cats, birds, and "all other") and household equine (i.e., excluding horses not owned by individual households), we first developed forecasting equations that related propensity to own pets as a function of household characteristics. (Demand for equine veterinarians is discussed in more detail in a later section). These forecasting equations were then applied to a database containing characteristics of a representative sample of households in each state for 2010 through 2025. The 2010 ACS contains approximately 1,283,700 households that are representative of the approximately 100 million households in the U.S., with household sample weights developed for 2011 through 2025 to reflect Census Bureau population projections.

Approximately 98,200 households were sampled in the combined 2007 and 2012 Pet Demographic Study to gauge pet ownership. Of these households, approximately 58,900 owned at least one pet. In these pet-owning homes there are 62,623 dogs, 71,283 cats, 9,322 birds, 5,541 horses, and 13,566 other pets.

For households with dogs, the mean was 1.7 dogs/household, but the number ranged from 1 to 100. We used Poisson regression to quantify the likely number of dogs in each household as a function of household characteristics (Exhibit 59). Factors used to predict dog ownership include household demographics, such as number of children and the age, race, and marital status of the head of household; household socioeconomic characteristics, including job status and highest educational attainment of head of household and total household income; home type (e.g., single family home, apartment); region of the country; and whether the head of household reported their occupation as farmer. Selection of explanatory variables was based on hypothesized factors related to pet ownership, but restricted to variables presented in both the Pet Demographic Study and the ACS. Separate but similar Poisson regressions were estimated to model household demand for cats, birds, horses, and "all other" pets. We used logistic regression (with the same explanatory variables) to estimate households' probability of pet ownership.

The regression results for dogs and cats are presented in Appendix B and are reported as rate ratios that reflect the rate of pet ownership for a household with a particular characteristic relative to the "comparison" group. A household whose head was age 65 or

older, for example, owned dogs at 1.52 times the rate of ownership for households headed by a person younger than age 25. Dog, cat, and bird ownership was most likely in households with a head age 45-54, whereas horse ownership was more likely for households with a head age 55-64 (all else being equal). Pet ownership tended to rise with age of head of household through age mid-40s and 50s, before declining among the elderly. Other findings showed the impact of specific characteristics, controlling for other characteristics:

- There were significant regional differences in rates of pet ownership
- Propensity to own a pet varied significantly by race
- Having more children was associated with increased rates of pet ownership
- Higher educational attainment (which was correlated with household income) was associated with lower rates of pet ownership
- Being unmarried was associated with higher ownership of dogs and cats
- Cat and bird ownership tended to decline with higher household income, while horse ownership tended to rise with household income
- Living in a mobile home was associated with the highest rate of pet ownership, while living in an apartment, condominium, or duplex was associated with lower rates of pet ownership
- Farmers were significantly more likely to own dogs, cats, and horses, but less likely to own birds as pets relative to non-farmers.

Using PDS data, we used Poisson regression to quantify the relationship between dog owners' number of visits to a veterinarian during the year and household characteristics (including number of dogs). We modeled annual visits to the veterinarian for 10 categories of services (with some groupings in the PDS combined because of small sample size). The 10 categories are 1) general exam, 2) vaccines, 3) emergency care, 4) laboratory tests, 5) drugs, 6) flea/worm medication, 7) surgery, 8) behavior, 9) euthanization, and 10) "other."[a] Each of the 10 regressions was calculated separately for dogs, cats, birds, horses, and "other" animals.

The household characteristics included in these regressions were the same characteristics used to model demand for pets (Appendix B). In general, higher household income was associated with greater propensity to obtain veterinary services, while having more children in the household was associated with lower propensity to obtain veterinary services. There was substantial regional variation in propensity to seek services, with pet owners in the New England region often more likely to obtain veterinary services compared to pet owners in other regions. Many of these findings were consistent with previous work, such as Wolf

[a] Emergency care combined the survey categories of emergency, hospitalization, and x-ray. The number of services provided will exceed the number of visits to a veterinarian, as multiple services might be provided during one visit.

et al, who reported that income had a significant positive association with the likelihood of pet-related and veterinary service expenditures.[24]

Applying the pet ownership equations to the ACS and using the ACS sample weights allowed us to aggregate across households to predict the number of pets owned in each state. Using Alabama as an example, the analysis estimated that 794,200 households had a dog, the average number of dogs was 2.0 per household, and the total of pet dogs in the state was almost 1.6 million (Exhibit 28). Aggregating across the states and the District of Columbia suggested there were 76.0 million pet dogs in the U.S. in 2010, a number slightly above the 72.1 million estimate reported by AVMA from the 2007 Pet Demographic Study.[15] U.S. cat ownership in 2010 (81.1 million) was slightly lower than the AVMA estimate for 2007 (81.7 million). Bird ownership in 2010 (13.5 million) was higher than the AVMA estimate for 2007 (11.2 million). The 2010 estimate for horse ownership (8.1 million) was also above AVMA's 7.3 million estimate for 2007. At the national level, our estimates were similar to those of Daneshvary and Schwer (2012), who reported that about half of households had at least one companion animal.[25]

Pet ownership per household varied substantially by state. Among households with a dog, for example, the estimates ranged from 1.4 dogs/household in Maryland to 2.1 dogs/household in several states. South Dakota had the highest rate of cat ownership; Alaska had the highest rate of bird ownership; and South Dakota had the highest rate of horse ownership.

After calculating the estimated number of services, we applied these relationships to households in the 2010 ACS that contained household sample weights to provide state-level estimates for 2010. Each household had a sample weight that, when applied, produced estimates for the size of the population consistent with the Census Bureau's population projections through 2025. Using this approach, we estimated that approximately 155.8 million total veterinary services were provided to dogs, 125.3 million to cats, 3.9 to birds, 10.1 million to horses, and 34.9 million to other non-food animals in 2012.

Exhibit 28. State Projections of Total Small Animals and Household-Owned Equine, 2012

	Dogs			Cats			Birds			Horses		
State	Households[1]	# Dogs[2]	Ave/ HH[3]	Households[1]	# Cats[2]	Ave/ HH[3]	Households[1]	# Birds[2]	Ave/ HH[3]	Households[1]	# Horses[2]	Ave/ HH[3]
AK	106,900	188,700	1.8	99,100	218,700	2.3	15,700	59,800	3.4	6,100	28,100	9.0
AL	802,500	1,603,200	2.1	531,100	1,326,800	2.6	63,800	143,100	2.6	47,800	178,800	7.2
AR	529,500	1,103,400	2.2	346,300	877,500	2.7	49,400	124,300	2.8	32,000	121,600	5.9
AZ	1,075,400	2,025,900	2.0	815,900	1,812,800	2.4	118,900	389,200	3.5	71,100	316,700	6.7
CA	4,585,500	7,883,700	1.7	4,315,500	9,229,100	2.2	730,500	2,362,700	3.5	246,100	1,010,800	7.2
CO	853,500	1,553,200	1.9	664,800	1,437,300	2.3	90,200	275,300	3.3	56,000	239,400	5.9
CT	384,200	558,200	1.5	492,900	971,500	2.1	54,600	162,500	3.8	12,300	29,100	2.0
DC	47,100	65,000	1.5	47,100	82,600	1.9	5,200	11,500	2.4	1,100	2,600	2.8
DE	124,800	216,500	1.8	94,700	213,200	2.4	13,600	35,400	3.0	4,700	17,900	4.9
FL	2,687,400	4,645,700	1.8	2,184,600	4,882,100	2.3	307,000	787,600	2.9	98,100	350,700	4.6
GA	1,347,200	2,365,900	1.8	968,900	2,204,800	2.4	145,500	386,200	3.1	50,700	187,200	4.8
HI	136,200	227,500	1.7	118,900	239,900	2.1	23,100	70,400	4.2	6,400	21,200	6.2
IA	508,800	877,900	1.8	414,400	1,042,800	2.8	44,600	126,000	2.8	35,300	173,400	5.8
ID	281,700	548,700	2.1	211,200	490,100	2.5	30,800	98,500	3.6	21,500	109,800	7.7
IL	1,633,800	2,643,300	1.7	1,410,000	3,184,800	2.4	172,200	431,200	2.7	62,000	211,900	5.0
IN	963,700	1,621,100	1.8	802,700	1,902,500	2.5	100,200	256,800	2.8	39,000	138,600	5.2
KS	449,700	769,400	1.8	363,500	900,500	2.7	39,100	112,300	2.8	29,000	137,500	5.7
KY	803,100	1,646,300	2.2	569,300	1,446,200	2.7	68,000	152,500	2.6	51,000	194,300	7.4
LA	740,600	1,488,200	2.1	459,100	1,123,600	2.6	65,300	161,100	2.8	41,300	159,500	6.5
MA	681,700	984,600	1.5	922,100	1,789,800	2.0	100,400	297,200	3.7	21,500	50,100	2.0
MD	701,500	1,147,400	1.7	537,800	1,146,600	2.3	74,200	184,600	2.9	24,200	85,900	4.4
ME	180,200	275,100	1.6	226,200	476,800	2.2	25,500	78,200	4.0	6,300	15,500	2.2
MI	1,416,000	2,354,700	1.7	1,183,600	2,771,900	2.5	147,000	377,600	2.8	54,300	187,600	4.9
MN	844,800	1,419,500	1.7	699,500	1,691,900	2.7	73,600	208,300	2.8	53,700	251,300	5.5
MO	941,000	1,605,100	1.8	756,200	1,858,400	2.7	83,000	235,100	2.8	56,700	255,900	5.2
MS	467,200	929,000	2.1	296,400	739,400	2.6	36,800	83,900	2.7	27,200	105,100	7.6
MT	190,000	360,200	2.0	147,200	341,500	2.5	19,800	64,300	3.3	15,000	76,900	7.8
NC	1,488,400	2,679,900	1.9	1,113,000	2,577,700	2.4	164,100	443,300	3.1	58,900	217,800	5.2
ND	110,900	190,300	1.8	94,800	238,700	2.8	9,700	28,700	2.7	8,900	48,300	7.6
NE	296,400	506,500	1.8	242,300	605,100	2.8	25,700	72,800	2.8	20,400	99,500	5.8
NH	164,900	244,100	1.6	210,200	426,800	2.1	22,900	69,200	3.8	5,600	13,600	2.1
NJ	925,000	1,381,600	1.6	899,800	1,864,600	2.2	118,800	283,900	2.3	27,600	78,000	2.6
NM	360,800	708,500	2.1	270,000	619,600	2.4	40,700	138,800	3.4	25,700	115,900	7.7
NV	432,000	786,200	1.9	324,500	698,600	2.3	48,700	149,700	3.5	26,700	114,500	6.2

	Dogs			Cats			Birds			Horses		
State	**Households[1]**	**# Dogs[2]**	**Ave/ HH[3]**	**Households[1]**	**# Cats[2]**	**Ave/ HH[3]**	**Households[1]**	**# Birds[2]**	**Ave/ HH[3]**	**Households[1]**	**# Horses[2]**	**Ave/ HH[3]**
NY	1,893,900	2,818,300	1.6	1,992,600	4,050,400	2.1	262,000	624,400	2.3	56,100	154,300	2.6
OH	1,665,800	2,745,400	1.7	1,409,900	3,272,900	2.5	172,300	432,800	2.8	63,100	219,400	4.9
OK	706,000	1,508,000	2.2	464,700	1,189,100	2.7	65,800	178,900	2.7	44,300	168,200	6.8
OR	610,100	1,064,200	1.8	595,700	1,319,200	2.3	91,000	289,800	3.3	34,800	152,000	7.0
PA	1,512,700	2,317,000	1.6	1,503,700	3,205,400	2.2	191,300	453,500	2.3	47,500	141,000	2.8
RI	115,400	169,600	1.6	152,000	302,800	2.1	17,200	51,500	3.7	3,600	8,300	2.0
SC	691,300	1,234,200	1.9	510,000	1,173,500	2.4	75,200	198,800	3.1	26,600	100,500	5.2
SD	135,600	238,500	1.8	113,300	296,100	2.9	11,900	36,900	2.8	11,300	62,100	7.7
TN	1,115,900	2,235,600	2.1	773,800	1,934,300	2.6	91,400	204,400	2.6	66,600	242,100	6.7
TX	4,152,800	8,604,900	2.2	2,730,600	6,759,300	2.7	399,300	1,022,500	2.9	248,900	915,400	6.1
UT	421,100	807,000	2.0	312,800	703,400	2.4	46,100	150,000	3.7	30,300	146,400	6.8
VA	1,122,300	1,920,900	1.8	858,100	1,905,900	2.3	119,600	307,800	2.9	42,200	153,800	4.6
VT	82,600	125,100	1.6	105,800	221,400	2.2	11,500	35,000	4.0	3,000	7,700	2.4
WA	1,041,000	1,807,000	1.7	995,400	2,172,200	2.3	152,800	487,900	3.4	59,000	254,900	7.1
WI	861,800	1,412,400	1.7	752,500	1,747,900	2.5	88,400	220,300	2.7	35,300	128,700	5.5
WV	324,900	599,700	1.9	252,800	601,800	2.5	37,300	98,400	3.0	13,100	48,300	4.6
WY	105,500	201,700	2.0	79,300	180,900	2.4	10,900	34,300	3.4	8,200	41,600	7.9
U.S. Total (2012)	**43,821,100**	**77,414,000**	**1.8**	**36,436,900**	**82,470,800**	**2.4**	**4,972,500**	**13,689,000**	**3.0**	**2,137,800**	**8,289,700**	**5.8**
AVMA[4] (2007)	**43,021,000**	**72,114,000**	**1.7**	**37,460,000**	**81,721,000**	**2.2**	**4,453,000**	**11,199,000**	**2.5**	**2,087,000**	**7,295,000**	**3.5**

[1] Estimated households with a pet, based on logistic regression. [2] Estimated number of pets, based on Poisson regression. [3] Average number of pets of that type per household with a pet. [4]American Veterinary Medical Association. 2007. U.S. Pet Ownership & Demographics Sourcebook. https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx

After calculating current and projected future use of veterinary services associated with different types of pets, we calculated the proportion of time that veterinarians spent providing care to different types of animals to calculate ratios of FTE veterinarian demand per animal. Using self-reported estimates from the 2012 Biennial Economic Survey of the amount of time spent providing care to different types of animals, we calculated the proportion of total private clinical practice veterinarian time spent with different animals by practice type (Exhibit 29). Responses from the Biennial Economic Survey were weighted such that the number of respondents reporting their clinical practice type was consistent with the number by practice type in AVMA's database.

An estimated 47% of total private clinical practice veterinarian time was spent providing care to dogs. The majority of this time was provided by veterinarians in small animal practice, followed by mixed large/small animal practices. A tiny proportion of time spent caring for dogs was provided by veterinarians in food animal or equine practices. Likewise, approximately 28% of veterinarian time was spent providing care to cats, with the majority of this time provided by veterinarians in small animal practices. Summing along the columns of Exhibit 29, approximately 77% of clinical veterinarian time was provided by veterinarians who reported themselves as primarily in small animal practice, 11% in food animal practice, and 6% each in equine and mixed animal practice.

Exhibit 29. Distribution of Time Spent By Practice Type

	Practice Type				
Animal	**Small Animal**	**Food Animal**	**Equine**	**Mixed**	**Total**
Dogs	43.97%	0.62%	0.11%	1.91%	46.61%
Cats	26.30%	0.33%	0.06%	1.05%	27.74%
Birds	0.58%	0.01%	0.00%	0.02%	0.60%
Other Pets	1.13%	0.02%	0.00%	0.04%	1.19%
Dairy Cows	0.65%	5.41%	0.07%	0.51%	6.64%
Beef Cows	1.39%	3.01%	0.07%	0.88%	5.35%
Swine	0.22%	0.88%	0.01%	0.09%	1.20%
Poultry	0.05%	0.06%	0.00%	0.01%	0.12%
Horses	2.06%	0.51%	5.42%	1.23%	9.22%
Sheep and other livestock (including small ruminants)	0.64%	0.37%	0.07%	0.25%	1.33%
Total	**77%**	**11%**	**6%**	**6%**	**100%**

Based on these estimates of the proportion of veterinarian time spent providing care to different animal types, estimates of the current national supply of veterinarians by practice type, and the assumptions of a current national excess capacity in the ability of veterinarians to provide services (Scenario 1 discussed previously), we calculated that in 2012:

- 4,449 services for dogs= 1 FTE veterinarian
- 6,013 services for cats= 1 FTE veterinarian
- 8,648 services for birds= 1 FTE veterinarian
- 38,854 services for other pets= 1 FTE veterinarian

Note that very few services were provided to pets in the "other" category, so while there was less reliability in this estimate of services per FTE veterinarian, this category of pets had little impact on the overall demand for veterinary services. Also, as discussed previously, services were not equivalent to visits as multiple services might be provided during one visit. This analysis did not take into consideration that some services were more veterinarian-time intensive than other services. Additional information on the relative time resource intensity of each service could improve the projections of future veterinarian demand to the extent that growth in demand for services differs slightly for the different types of services. Better information on the amount of time spent providing specific types of services could improve the ability to simulate the demand implications of alternative models of care delivery (e.g., greater use of non-veterinarian staff).

Overall, this translated into 2012 FTE demand for 35,029 dog veterinarians, 20,846 cat veterinarians, 454 bird veterinarians, and 897 "other" animal veterinarians—recognizing that each FTE was actually made up of multiple veterinarians providing care to a variety of pet types.

Equine Practice

The American Horse Council reported 9.2 million horses in the U.S. including:[a]

- 845,000 for racing
- 2.7 million for showing
- 3.9 million for recreation
- 1.75 million for other activities

Based on the proportion of private clinical practice veterinarian time spent with different types of animals (Exhibit 29), and taking into account estimates of the current excess capacity in the ability of veterinarians to provide services (Exhibit 7), we calculated demand for equine veterinarians at 5,640 in 2012. This translated to approximately 1,630 horses cared for per FTE veterinarian (with the majority of this care provided by equine veterinarians). From Exhibit 29 we estimated that 59% of care provided to horses was provided by veterinarians in equine practice, 22% of care was provided by veterinarians who described their practice as predominantly small

[a] AHC defines "other" activities to include: farm and ranch work, rodeo, carriage horses, polo, police work, informal competitions, etc. http://www.horsecouncil.org/national-economic-impact-us-horse-industry

animal practice[a], 13% of care was provided by veterinarians in mixed practices, and the remaining care was provided by veterinarians in food animal (3%) practices. For veterinarians in equine practice, approximately 94% of their time was spent caring for horses, with the remaining 6% caring for a variety of small and large animals.

The Pet Demographic Study included households that captured a portion of horse ownership. Based on the survey sample weights, the households in this survey accounted for close to 8.3 million horses in 2012 (or 90% of horses in the U.S.). The demand projections included in this report modeled growth in demand for horses overall as a function of the projected growth in demand for horses by households.

Food Animal Practice

The demand for non-government food animal veterinarians was linked to the U.S. population of food animals. To estimate the demand for food animal veterinarians, we used the food animal population projections generated by the IHS Agricultural Forecasting Model. A summary of this model is provided in Appendix C. This model does not forecast aquaculture stocks, so growth in aquaculture veterinary services was an omitted component of this analysis.

Using the clinical time distribution reported in Exhibit 29 for food animals, we first estimated the number of FTE veterinarians caring for food animals by animal type: dairy cows, beef cattle, swine, broilers and layers, sheep, and other livestock (Exhibit 30). The other livestock category included turkeys, "other swine," and less common food animals. We compared these FTE estimates against current food animal production estimates to calculate FTE-to-animal ratios. Using the surplus estimates discussed earlier (Exhibit 7), we calculated what the FTE-to-animal ratios would be if food animal veterinarians were working at full capacity. Compared to current supply of 11,060 FTEs, we calculated demand for 9,550 FTEs, if food animal veterinarians were all working at full capacity.

Exhibit 30. Food Animal Veterinarian Workforce, 2012

Animal Type	Total Food Animal Supply (millions)	FTE Veterinarian		Animals per FTE Veterinarian	
		Supply	Demand	Current	Removing Excess Capacity
Dairy cows	9.2	4,990	4,330	1,800	2,100
Beef cattle	81.5	4,020	3,490	20,300	23,400
Swine	64.8	900	780	72,000	83,100
Broilers and layers	7,896.4	90	80	87,738,000	98,705,300
Sheep	5.4	780	680	6,900	7,900
Other livestock	310.6	220	190	1,411,800	1,634,700
Total	NA	11,060	9,550	NA	NA

[a] Analysis of the 2012 Biennial Economic Survey (weighted using information in AVMA's database of veterinarians) found that veterinarians who reported their work as predominantly small animal practice reported spending approximately 2.7% of their time, on average, providing equine care.

From the forecasting model, between 2012 and 2025 we projected growth in the supply of broilers and layers (22%), turkeys (14%), swine (10%), and beef cattle (3%) (Exhibit 31). We projected a small decline in supply of dairy cattle (-2%) and sheep (-6%).

Exhibit 31. Projected Growth in Food Animal Supply

	2012		2015		2018		2021		2025	
	FTE Veterinarians	Food Animal % Change (relative to 2012)	FTE Veterinarians	Food Animal % Change (relative to 2012)	FTE Veterinarians	Food Animal % Change (relative to 2012)	FTE Veterinarians	Food Animal % Change (relative to 2012)	FTE Veterinarians	Food Animal % Change (relative to 2012)
Dairy Cows	4,991	0.00%	4,950	-0.83%	4,970	-0.42%	4,936	-1.11%	4,906	-1.70%
Beef Cattle	4,019	0.00%	3,943	-1.87%	4,005	-0.34%	4,044	0.63%	4,134	2.87%
Swine	901	0.00%	923	2.45%	935	3.73%	960	6.58%	990	9.93%
Poultry	89	0.00%	98	9.73%	102	13.82%	104	16.69%	108	20.89%
Sheep and all other ruminants	780	0.00%	770	-1.25%	759	-2.60%	747	-4.13%	730	-6.40%
Turkeys	221	0.00%	232	4.56%	236	6.78%	244	10.43%	249	12.57%

Industry/Commercial

Veterinarians working in industry conduct a wide variety of services. Some of the major areas of focus include pharmaceutical and biotechnology companies that work on drug discovery for human health; animal health companies that produce veterinary pharmaceuticals, biotechnology, and diagnostics; and animal feed companies that define nutritional requirements.[a] Due to limited information on the current demand for veterinarians working in industry, we used the assumption that the current supply (FTE=3,210) and demand for 2012 were in equilibrium.

To project future demand for veterinarians working in industry, we used information from a recent survey conducted by the National Academy of Sciences. The survey contacted 118 companies from around the industry sector that were known to employ veterinarians. Of the 118 companies contacted, there were 59 respondents that collectively employed 1,527 veterinarians in 2007 (which represented approximately 49% of the 3,125 AVMA reported industry veterinarians for the same year).[b] Of these respondents, companies anticipated a total of 463 new positions opening between 2008 and 2016, representing a 30% growth. This equated to a 3.75% average annual growth rate between 2008 and 2016. Additionally, the 59 respondents

[a] http://www.nap.edu/openbook.php?record_id=13413&page=90

[b] http://www.nap.edu/openbook.php?record_id=13413&page=92

reported that 15.7% of currently employed veterinarians would reach or exceed age 65 by the year 2016. This equated to an additional 240 vacancies in anticipated hiring needs. It was important to note that at the time of the survey, the industry sector, like other areas of veterinary medicine, had been affected by the economic recession and it was likely that many veterinarians would delay retirement and therefore weaken the demand for replacements.[a] For modeling, we assumed that 3.75% annual growth in industry veterinary positions would continue through 2016, but then the growth in demand would slow to approximately half this rate (or 1.9%annually) from 2017 through 2025. Cumulatively, these annual growth rates amounted to a 37% increase in demand between 2012 and 2025.

Government Veterinarians

To accurately measure the demand for veterinarians working in government in both clinical and non-clinical roles, we separated the population into two distinct groups: (1) veterinarians working with the Department of Defense, and (2) veterinarians working for all other government agencies. The second group was the largest of the two, and included veterinarians working for the Department of Agriculture and Department of Health and Human Services (Exhibit 32).

Exhibit 32. Veterinary Workforce in Federal Employment, 2012

Employer	# Employed Veterinarians
Department of Defense	987
Department of Homeland Security	15
Department of Agriculture	1,753
Department of Interior	37
Department of Health and Human Services	328
Food and Drug Administration	113
Centers for Disease Control and Prevention	93
National Institutes of Health	92
U.S. Public Health Service Commissioned Corps	22
Other	8
Total	3,120

Veterinarians working for these agencies provided many services centered around, but not limited to, the U.S. food animal population. This included enforcing meat and poultry inspection procedures, regulating animal medications, and researching animal diseases. As many of these veterinarians provided services related to food supply animals, we linked demand for veterinarians in these agencies to the projected growth in supply of food animals.

[a] http://www.nap.edu/openbook.php?record_id=13413&page=98

There were approximately 5.8 veterinarians in food animal production for every veterinarian working for the government in either the Department of Agriculture or the Department of Health and Human Services. Under the Baseline demand scenario, we assumed that this ratio would continue over time.

The other major group of government veterinarians works in the armed forces. These veterinarians are involved in research; providing training and care to military working dogs, ceremonial horses, and working animals of many Department of Homeland Security organizations; and ensuring a safe food supply for the military. For modeling purposes, we assumed that future demand for veterinarians in the military would grow (or decline) at the same rate as the projected size of the military. To estimate the demand for veterinarians working in the armed forces, we used information provided in interviews with key stakeholders and trends in growth of the armed forces as reported by the Congressional Budget Office (CBO).[26] For veterinarians working in the armed forces, the CBO projects the size of the armed forces to decrease by approximately 1.3% per year between 2012 and 2017. Between 2012 and 2025, we assumed that the size of the armed forces would decline by 17%, and that demand for veterinarians in this employment sector would fall accordingly.

Academia

We modeled demand for veterinarians working in academia as a function of the number of new graduates entering veterinary medicine. Based on the current number of veterinarians working in academia and the estimated number of new graduates in 2012, we estimated there to be 6,800 veterinarians working in academia, or approximately 2.08 veterinarians for every new graduate. Assuming that the amount of time devoted to teaching, research, and administration remains relatively constant over time, we assumed that this ratio of veterinarians-to-graduates would remain constant. With states and the federal government facing increasing costs pressures, and universities under pressure to control costs, it is unknown whether current faculty-to-student ratios are sustainable.

B. Projections of State and National Demand for Veterinarians

We projected supply of animals, demand for veterinary services, and demand for veterinarians through 2025 at the state level for small animals, equine, and food animals. For all other employment sectors we made projections at the national level. Using the assumptions of excess capacity in direct animal care, we calculated that 2012 national demand for veterinarians was 78,950. Demand for small animal veterinarians (48,800) constituted 62% of estimated total demand, with food animal (9,550), academia (6,800), and equine (5,640) the three next largest sectors (Exhibit 33). By 2025, demand for small animal veterinarians was projected to grow to 54,640 (remaining at 62% of total veterinarian demand) (Exhibit 34).

Our estimate of 2012 demand for 48,800 veterinarians in small animal practice was lower than the estimate reported by The National Academy of Sciences.[11] That study estimated that in 2006,

a total of 48,158 FTE veterinarians were providing companion animal care (with companion care equivalent to our small animal sector—which included the portion of time spent providing small animal care by veterinarians in other employment sectors such as mixed animal practices). The National Academy of Sciences predicted demand in 2016 would be between 50,805 and 65,950 FTEs (depending on productivity levels of veterinarians). To reach the midpoint of these estimates (58,378) suggested demand was increasing by about 1,022 veterinarians per year between 2006 and 2016—reaching 54,300 FTEs in 2012 (or 11% higher than our estimate of current demand). The National Academy of Sciences demand estimate (interpolated to estimate demand for 2012) was approximately equivalent to current supply and would approximate demand under the assumption of no current excess capacity in the companion animal sector.

We projected that the demand for small animal veterinarians would grow by 12% (approximately 450 FTEs per year) between 2012 and 2025 as a function of population growth and changing household characteristics (including modest growth in average household income). This projected growth rate over a 13-year period (about 0.9% average, annual growth) was substantially lower than the 1.3% average annual growth rate projected by KPMG (1999) for the period 1997 to 2015.[1]

Demand for food animal veterinarians was projected to grow only 1% between 2012 and 2025—reflecting very little growth in supply of dairy cows and beef cattle that together accounted for 83% of veterinarians involved in food production. Furthermore, industry consolidation and improved productivity could contribute to an actual decline in demand for food animal veterinarians. These findings were similar to the KPMG study, which estimated a 1.7% decline (between 1997 and 2015) in FTE veterinarians working in large animal practice.[1] State level estimates of the total FTE demand for small animal veterinarians, equine veterinarians, and food animal veterinarians are provided in Exhibits 35, 36, and 37 respectively.

Exhibit 33. Total FTE Demand for Veterinarians in the U.S., 2012

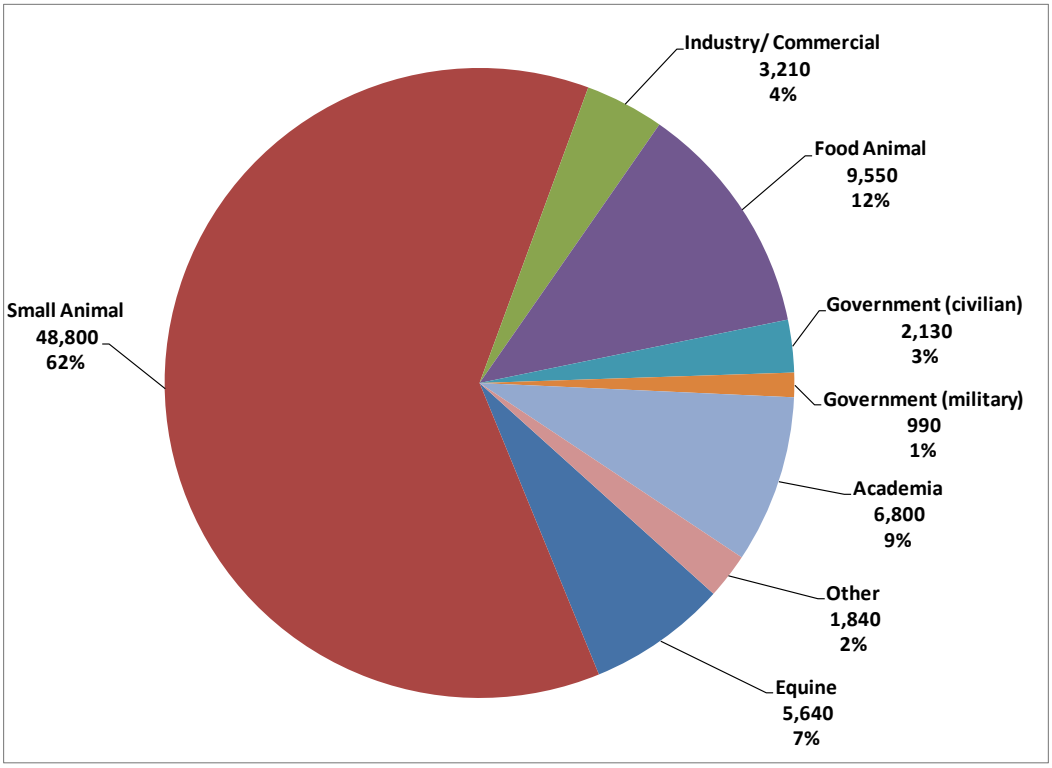


Exhibit 34. Total FTE Demand for Veterinarians in the U.S., 2025

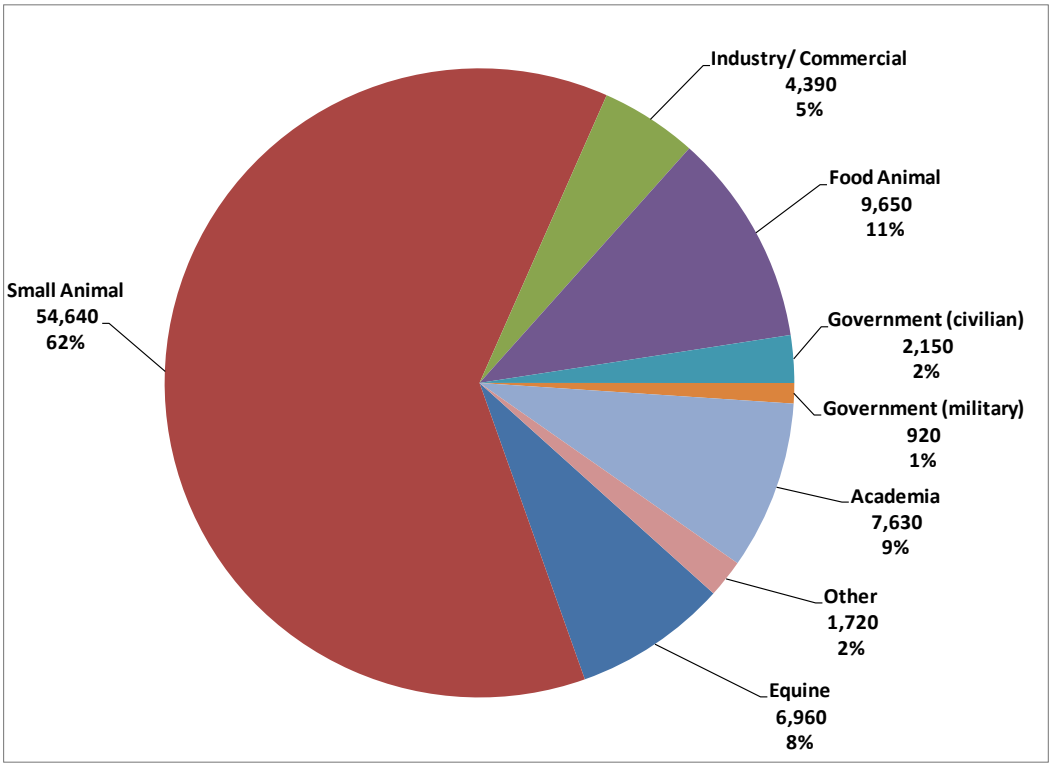


Exhibit 35. State Estimates of Total FTE Demand for Small Animal Veterinarians

State	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
AK	105	105	105	105	110	110	110	110	110	110	110	115	115	115
AL	845	850	855	860	865	865	870	875	875	880	880	885	890	890
AR	655	660	665	670	675	680	680	685	690	695	695	700	705	710
AZ	1,080	1,110	1,140	1,170	1,200	1,230	1,260	1,290	1,325	1,355	1,385	1,420	1,455	1,490
CA	4,880	4,945	5,010	5,065	5,130	5,195	5,255	5,320	5,380	5,440	5,490	5,560	5,615	5,670
CO	920	930	935	940	950	955	965	970	975	980	985	995	1,000	1,005
CT	510	510	510	515	515	515	520	520	520	520	520	520	520	520
DC	55	55	55	50	50	50	50	50	50	50	50	45	45	45
DE	150	150	150	155	155	155	160	160	160	160	160	165	165	165
FL	3,090	3,155	3,225	3,290	3,365	3,435	3,505	3,580	3,660	3,735	3,805	3,890	3,970	4,050
GA	1,465	1,490	1,510	1,530	1,550	1,570	1,590	1,610	1,630	1,645	1,660	1,680	1,695	1,715
HI	130	130	130	135	135	135	135	135	135	135	135	135	135	135
IA	555	560	560	560	560	560	560	560	560	560	555	555	555	555
ID	290	295	300	305	310	315	320	325	330	335	335	340	345	350
IL	1,745	1,750	1,760	1,765	1,770	1,775	1,780	1,785	1,785	1,790	1,785	1,795	1,795	1,795
IN	965	970	975	980	985	985	990	990	995	1,000	995	1,000	1,000	1,005
KS	465	470	470	475	475	475	475	480	480	480	480	480	480	480
KY	860	865	870	875	880	885	890	895	895	900	900	905	905	910
LA	820	825	825	830	835	840	840	845	845	850	850	855	855	855
MA	935	940	945	945	950	955	955	960	960	965	965	965	965	965
MD	725	730	740	745	755	760	765	770	780	785	790	795	800	805
ME	245	245	250	250	250	250	255	255	255	255	255	255	255	255
MI	1,590	1,595	1,605	1,615	1,620	1,630	1,635	1,640	1,645	1,645	1,645	1,650	1,650	1,650
MN	985	995	1,005	1,010	1,020	1,030	1,035	1,045	1,050	1,060	1,065	1,070	1,080	1,085
MO	970	975	980	985	990	995	1,000	1,005	1,010	1,010	1,010	1,015	1,020	1,020
MS	440	440	445	445	450	455	455	460	460	465	460	465	470	470
MT	215	215	215	220	220	220	220	225	225	225	225	225	225	230
NC	1,760	1,785	1,810	1,835	1,860	1,885	1,905	1,930	1,955	1,980	1,995	2,025	2,045	2,070
ND	125	125	125	125	125	125	125	125	125	125	120	120	120	120
NE	280	280	280	280	280	280	280	280	280	280	280	280	280	280
NH	195	195	200	200	205	205	205	210	210	210	215	215	215	220
NJ	1,030	1,035	1,045	1,050	1,055	1,060	1,065	1,075	1,080	1,085	1,085	1,090	1,095	1,100
NM	340	345	345	350	350	355	355	360	360	365	365	365	365	365
NV	415	425	435	445	460	470	480	495	505	515	525	540	550	560
NY	2,210	2,215	2,225	2,230	2,235	2,240	2,240	2,245	2,245	2,245	2,240	2,245	2,240	2,235
OH	1,875	1,880	1,885	1,885	1,895	1,895	1,895	1,900	1,900	1,900	1,890	1,895	1,890	1,890
OK	880	885	890	890	895	900	900	905	905	910	910	915	915	920
OR	665	675	685	690	700	710	715	725	735	740	750	760	770	775
PA	1,820	1,825	1,830	1,835	1,840	1,845	1,845	1,845	1,850	1,850	1,845	1,845	1,845	1,845
RI	155	155	155	155	160	160	160	160	160	160	160	160	160	160
SC	740	750	760	765	775	780	790	795	805	810	815	820	825	830
SD	185	185	185	185	185	185	185	185	185	185	185	185	185	185
TN	1,245	1,260	1,270	1,280	1,290	1,305	1,315	1,325	1,335	1,345	1,350	1,365	1,370	1,380
TX	4,745	4,825	4,905	4,975	5,060	5,135	5,210	5,290	5,370	5,450	5,510	5,600	5,680	5,760
UT	505	510	520	525	535	540	550	560	565	575	585	595	600	610
VA	1,250	1,260	1,275	1,290	1,305	1,320	1,330	1,345	1,355	1,370	1,380	1,390	1,405	1,415
VT	115	115	115	120	120	120	120	120	120	120	120	120	125	125
WA	1,145	1,160	1,180	1,195	1,210	1,225	1,245	1,260	1,275	1,295	1,310	1,330	1,345	1,365
WI	955	960	970	975	980	985	990	990	995	995	1,000	1,000	1,005	1,005
WV	385	385	385	385	385	385	385	385	385	385	385	385	385	380
WY	110	110	110	110	110	110	110	110	110	110	110	110	110	110
U.S.	48,800	49,295	49,810	50,250	50,780	51,245	51,685	52,130	52,585	53,035	53,325	53,850	54,250	54,640

Note: State projections might not sum to national totals due to rounding.

Exhibit 36. State Estimates of Total FTE Demand for Equine Veterinarians

State	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
AK	15	15	15	15	15	20	20	20	20	20	20	20	20	20
AL	105	105	105	110	110	110	110	115	115	115	115	120	120	120
AR	75	80	80	80	80	85	85	85	85	85	85	90	90	90
AZ	205	210	215	220	230	240	250	255	265	270	275	290	300	310
CA	675	690	695	710	725	745	755	770	785	790	800	825	840	850
CO	180	180	180	185	190	190	195	195	200	200	200	205	210	210
CT	30	30	30	30	30	30	30	30	30	30	30	30	30	30
DC	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
DE	15	15	15	15	15	15	15	15	15	15	15	15	15	15
FL	265	275	280	285	295	310	315	325	335	340	345	365	375	385
GA	140	140	140	145	150	155	155	160	160	165	165	170	175	175
HI	15	15	15	15	15	15	15	15	15	15	15	15	15	15
IA	110	110	110	110	115	115	115	115	120	120	115	120	120	120
ID	60	65	65	65	70	70	75	75	75	75	80	80	85	85
IL	160	160	160	165	165	170	170	170	170	170	170	175	180	180
IN	90	90	95	95	95	95	100	100	100	100	100	105	105	105
KS	85	85	85	85	90	90	90	90	90	90	90	95	95	95
KY	110	110	110	110	115	115	115	115	120	120	120	120	125	125
LA	95	95	100	100	100	105	105	105	105	105	105	110	110	110
MA	50	50	50	50	50	50	50	50	50	50	50	55	55	55
MD	65	65	70	70	70	70	70	75	75	75	75	75	80	80
ME	15	15	15	15	15	15	15	15	15	15	15	15	15	15
MI	145	145	145	150	150	155	155	155	160	160	160	160	165	165
MN	180	180	185	185	190	195	195	200	205	205	205	210	215	215
MO	160	160	160	160	165	170	170	170	175	175	175	180	180	185
MS	55	55	55	55	60	60	60	60	60	60	60	65	65	65
MT	50	50	50	50	55	55	55	55	55	55	55	60	60	60
NC	165	170	170	175	180	185	185	190	195	195	195	205	210	215
ND	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NE	55	55	55	55	55	55	55	60	60	60	60	60	60	60
NH	10	10	10	10	10	10	10	15	15	15	15	15	15	15
NJ	70	70	70	70	75	75	75	75	75	75	75	80	80	80
NM	65	65	65	65	70	70	70	70	75	75	75	75	75	75
NV	75	75	80	80	85	90	90	95	95	100	100	105	110	110
NY	140	140	140	140	140	145	145	145	145	145	145	150	150	150
OH	170	170	170	175	175	180	180	180	185	180	180	185	185	190
OK	105	110	110	110	110	115	115	115	120	120	115	120	125	125
OR	100	100	105	105	110	110	115	115	120	120	120	125	125	130
PA	125	125	125	125	130	130	130	135	135	135	135	135	140	140
RI	10	10	10	10	10	10	10	10	10	10	10	10	10	10
SC	70	70	70	70	75	75	75	80	80	80	80	80	85	85
SD	45	45	45	45	45	50	50	50	50	50	50	50	50	50
TN	150	150	150	155	160	160	165	165	170	170	170	175	180	180
TX	555	565	575	585	605	625	635	650	665	670	680	705	725	735
UT	115	115	120	120	125	130	130	135	135	140	140	145	150	150
VA	120	120	120	125	125	130	130	135	135	135	135	140	145	145
VT	5	5	5	5	5	5	10	10	10	10	10	10	10	10
WA	175	180	185	185	190	195	200	205	210	210	215	220	225	230
WI	95	95	95	95	100	100	100	100	105	105	105	105	110	110
WV	35	35	35	35	35	35	35	35	35	35	35	35	40	40
WY	25	25	25	25	25	30	30	30	30	30	30	30	30	30
U.S.	5,645	5,730	5,790	5,885	6,030	6,185	6,270	6,370	6,480	6,520	6,550	6,750	6,880	6,965

Note: State projections might not sum to national totals due to rounding.

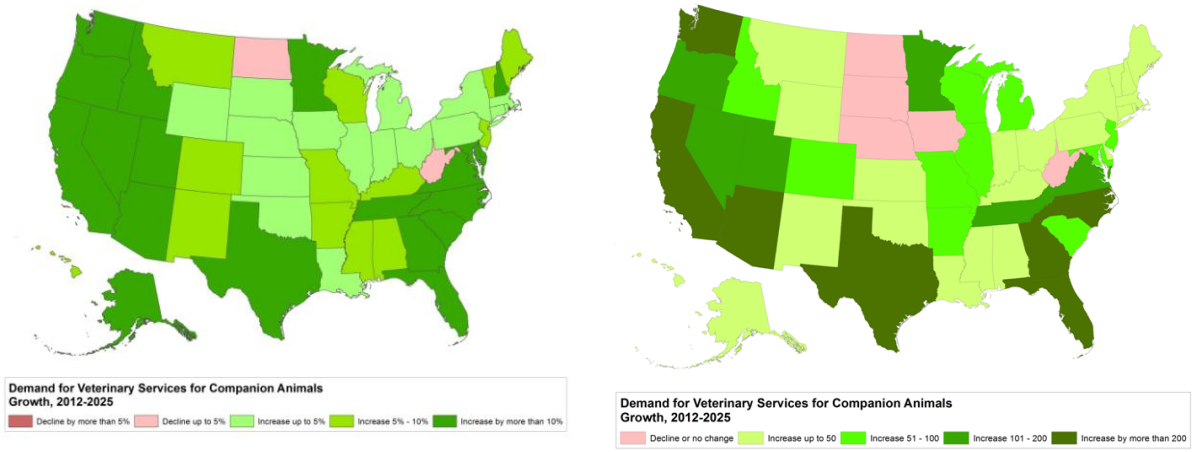
Exhibit 37. State Estimates of Total FTE Demand for Food Animal Veterinarians

State	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
AK	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
AL	430	430	435	435	435	435	435	430	425	425	420	420	415	415
AR	510	505	500	495	485	475	465	455	440	430	415	405	395	380
AZ	50	50	50	50	50	50	50	50	55	55	55	55	55	55
CA	245	240	240	235	235	235	235	235	235	235	235	235	235	235
CO	130	125	120	115	115	115	115	115	110	110	110	105	105	105
CT	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
DC	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
DE	90	85	85	85	80	80	75	75	70	70	65	65	60	60
FL	80	75	70	65	65	65	65	65	60	60	60	60	60	60
GA	575	580	590	595	595	595	590	585	580	575	570	570	565	560
HI	5	5	5	5	5	5	5	5	5	5	5	5	5	5
IA	940	940	940	955	975	985	995	1,005	1,020	1,035	1,055	1,065	1,080	1,095
ID	95	95	95	95	95	100	100	100	100	100	105	105	105	105
IL	220	215	210	205	205	200	200	195	195	190	190	185	185	180
IN	160	155	155	155	155	150	150	145	145	145	145	145	140	140
KS	305	300	295	290	290	290	290	290	290	290	290	290	290	290
KY	250	260	275	285	300	310	325	335	345	355	370	380	395	405
LA	125	130	140	145	155	160	170	180	185	195	200	210	220	225
MA	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
MD	115	115	115	115	115	115	115	115	110	110	110	110	105	105
ME	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
MI	90	85	85	85	85	85	85	85	85	85	85	85	85	85
MN	435	435	435	440	445	450	455	460	465	475	485	490	495	500
MO	365	360	355	355	355	350	350	350	345	345	340	340	340	335
MS	320	320	325	330	330	330	330	330	330	325	325	325	325	325
MT	120	115	115	115	115	115	115	115	115	115	115	115	115	115
NC	730	720	715	715	715	710	700	695	685	680	675	670	665	655
ND	75	75	70	70	70	70	70	65	65	65	65	65	65	65
NE	330	320	310	305	305	305	300	300	300	295	295	295	295	290
NH	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
NJ	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
NM	55	55	55	55	50	50	50	50	50	50	50	50	50	50
NV	20	20	20	20	20	20	20	20	20	20	20	20	20	20
NY	65	60	60	60	60	60	60	60	60	55	55	55	55	55
OH	140	135	135	135	140	140	140	140	145	145	145	150	150	150
OK	430	450	455	465	480	490	500	510	525	535	545	555	565	580
OR	60	60	60	55	55	55	55	55	55	55	55	55	55	55
PA	185	185	185	185	185	185	185	185	185	185	185	185	190	190
RI	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
SC	115	115	115	115	120	120	120	120	120	120	120	125	125	125
SD	240	235	230	225	225	225	220	220	220	220	215	215	215	215
TN	85	80	80	75	75	75	75	75	75	75	75	75	75	75
TX	820	830	825	820	825	830	835	840	840	840	845	845	850	855
UT	85	85	85	85	85	85	85	85	85	85	90	90	90	90
VA	165	160	160	160	155	155	150	150	145	145	145	140	140	135
VT	10	10	10	10	10	10	10	10	10	10	10	10	10	10
WA	50	45	45	45	45	45	45	45	45	45	45	45	45	45
WI	150	145	140	140	135	135	135	135	135	130	130	130	130	130
WV	15	15	15	15	15	15	15	15	15	15	15	15	15	15
WY	70	65	65	60	60	60	60	60	55	55	55	55	55	55
U.S.	9,550	9,510	9,480	9,475	9,515	9,540	9,555	9,570	9,570	9,580	9,595	9,610	9,630	9,650

Note: State projections might not sum to national totals due to rounding.

Exhibit 38 depicts the percent change in demand for small animal and equine veterinarians. Two regions that saw the largest increase in demand for veterinarians were the Southeast and the Western U.S. Unsurprisingly, the two states with the largest growth, Arizona and Florida, fell within these geographic regions. Conversely, both North Dakota and West Virginia would experience a minor reduction in demand for veterinarians between 2012 and 2025. The projected growth for North Dakota was low, possibly, given the economic growth seen in the state in recent years as a result of the oil industry (this growth was not captured in the latest state-level population projections produced by the U.S. Census Bureau).[a]

Exhibit 38. State Projections of % and FTE Demand Growth for Small Animal Veterinarians: 2012-2025



Demand for food animal veterinarians was concentrated in the Midwest and Southern states (Exhibit 39). Between 2012 and 2025, demand was projected to decline in the New England region and in many states, while demand was projected to increase (in percentage terms) across many of the southern states (Exhibit 40).

The Baseline Scenario projects future demand under the assumption that current patterns of pet ownership will remain largely unchanged but will reflect changing household demographics (e.g., age, race/ethnicity); the supply of food animals will grow as projected by IHS's Agricultural Forecasting Model; that patterns of care delivery for pets, horses, and food animals will remain largely unchanged; and that demand for veterinarians in academia, government, and industry will reflect recent trends in their respective demand drivers. The baseline scenario also assumes a current national 17% excess capacity of veterinarians in small animal, equine,

[a] While the oil boom has increased the population in North Dakota, much of that increase has been from unaccompanied male workers who are living in man camps. It is extremely difficult to find housing for families in the Bakken oil reserve. It is unknown how long this boom period will persist.

and food animal practice veterinarians. The Baseline Scenario, therefore, represented our best estimate of future demand under the status quo. Under this scenario, total demand grew 12% — from approximately 78,950 in 2012 to 88,070 in 2025 (Exhibit 41). Veterinarians in small animal and equine care constituted the largest portion of total demand, with food animal and academia reflecting the second and third largest employment sectors, respectively.

Exhibit 39. State Estimates of Demand for Food Animal Veterinarians: 2012

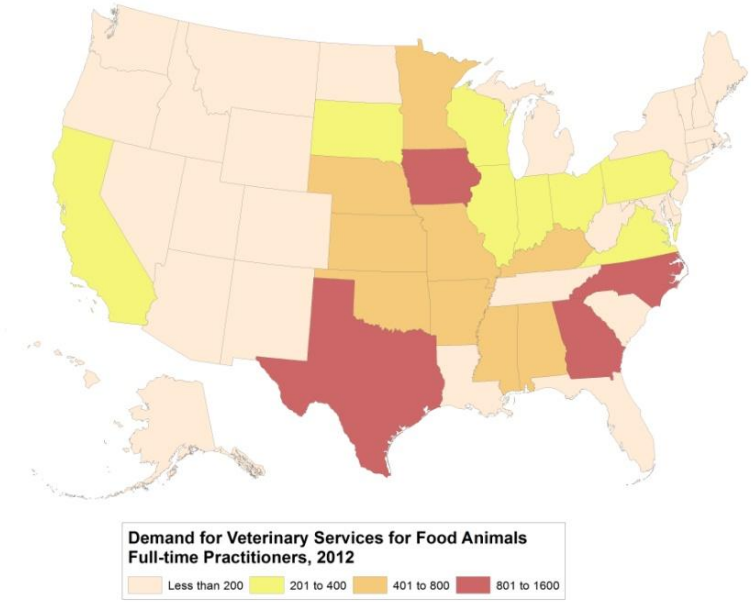
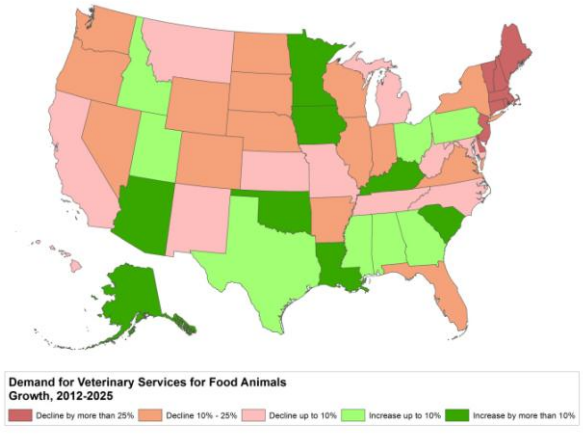


Exhibit 40. State Projections of % and FTE Demand Growth for Food Animal Veterinarians: 2012-2025



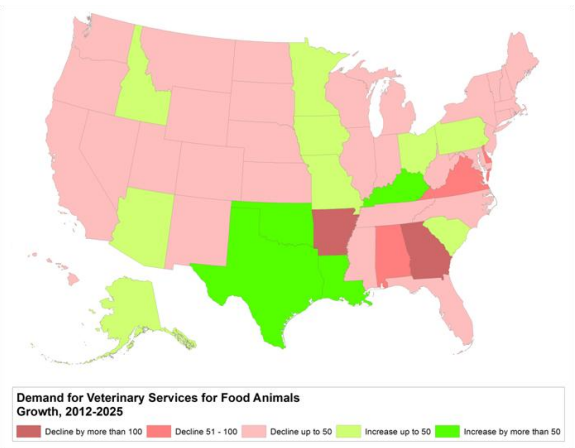


Exhibit 41. Baseline Demand Projections: 2012-2025

Practice	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Equine	5,640	5,730	5,790	5,880	6,030	6,180	6,270	6,370	6,480	6,520	6,550	6,750	6,880	6,960
Small Animal	48,800	49,300	49,810	50,250	50,780	51,250	51,690	52,130	52,590	53,040	53,320	53,850	54,250	54,640
Industry/ Commercial	3,210	3,330	3,450	3,580	3,720	3,790	3,860	3,930	4,000	4,080	4,150	4,230	4,310	4,390
Food Animal	9,550	9,510	9,480	9,480	9,520	9,540	9,560	9,570	9,570	9,580	9,600	9,610	9,630	9,650
Government (civilian)	2,130	2,120	2,110	2,120	2,130	2,130	2,130	2,130	2,130	2,140	2,140	2,150	2,150	2,150
Government (military)	990	970	960	950	940	920	920	920	920	920	920	920	920	920
Academia	6,800	7,190	7,340	7,480	7,630	7,630	7,630	7,630	7,630	7,630	7,630	7,630	7,630	7,630
Other	1,840	1,830	1,820	1,810	1,800	1,790	1,780	1,770	1,770	1,760	1,750	1,740	1,730	1,720
Total	78,950	79,970	80,760	81,560	82,540	83,240	83,840	84,460	85,100	85,660	86,070	86,880	87,500	88,070

Note: Totals may not add to the sum of column values due to rounding.

The Baseline Scenario suggested that at the national level demand for veterinarians would grow by 11-12% between 2012 and 2025. The growth in demand was driven primarily by demand for small animal practice (which would continue to constitute approximately 62% of FTE veterinarian demand). Study projections suggested higher than average percentage growth in demand in the industry/commercial, equine, and academia employment sectors—although projections for each of these sectors had important caveats. For industry, there was little information on which to base trends in demand and the demand growth assumptions relied heavily on an industry survey conducted during the middle of the economic downturn. The equine sector has experienced turbulent times during the economic downturn and diminished demand in the racing sector. The projected growth in this sector reflected (in part) the observed relationship that older people have a greater propensity to own horses. To the extent that this relationship was generational rather than an age relationship, then the rising elderly population might not own horses at the same level as the current elderly. While we projected modest growth in demand for veterinarians in academia, university and government, budget pressures and vagueness regarding the number of new veterinarians who would be trained, created some uncertainty in these projections. Slow growth in the government and other (tax-exempt institutions and municipalities) sectors reflected anticipated budget pressures that would restrain hiring. Slow growth in the food animal sector reflected projections of slow or negative growth in the nation's stocks of beef cattle, dairy cattle, sheep, and swine, despite substantial growth in demand for poultry (which requires a relatively small veterinary workforce to oversee the large volumes of poultry produced).

IV. Conclusion

This section reviews the main findings of this study, discusses study strengths and limitations, identifies potential areas for future research, and provides summary conclusions.

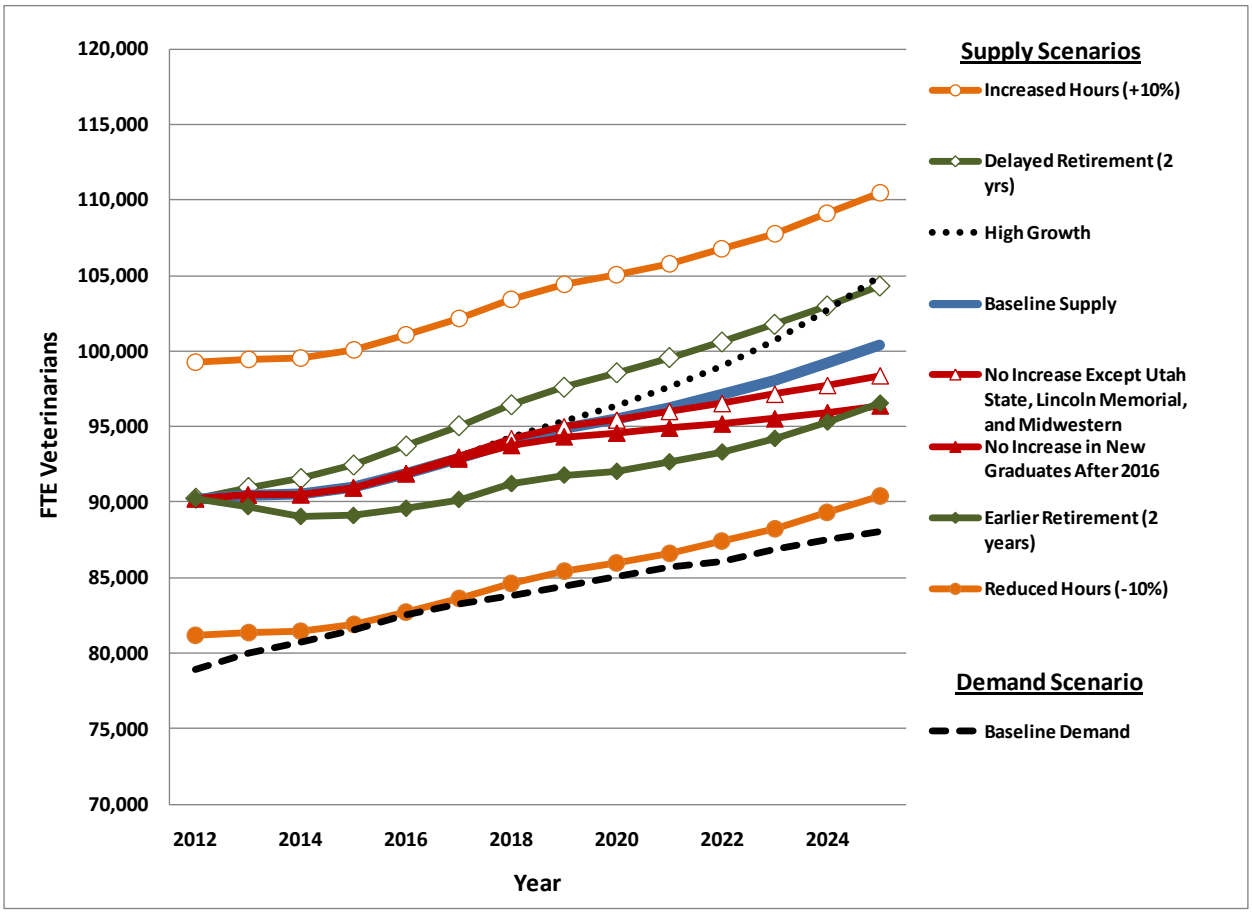
A. National Projections of Adequacy of Supply and Discussion

We estimated that the supply for veterinarians (90,200) in the U.S. in 2012 exceeded demand for veterinarians (78,950) by approximately 11,250 (or excess capacity of 12.5%) at the current levels of prices for services. Because a large proportion of veterinarians were self-employed and unemployment rates for veterinarians were low, this excess capacity took the form of under-employment rather than unemployment. Between 2012 and 2025, under a baseline scenario we projected that both supply and demand would grow by about 11% (reaching demand of 88,100 and supply of 100,400 by 2025). Comparison of the baseline supply and demand scenarios suggest that the magnitude of the excess capacity ranges from 11% to 14% between 2012 and 2025 (ranging from 9,300 to 12,300 FTEs each year between 2012 and 2025). If veterinary practices were to staff using a greater proportion of veterinary technicians and other supply staff, then the excess capacity among the veterinarian workforce could be even higher.

We modeled the sensitivity of the supply projections to different assumptions regarding the number of veterinarians trained, patterns of hours worked, and retirement patterns. Under

every scenario the supply projections exceeded demand through 2025 (Exhibit 42). Given the high debt load of new students and stagnating incomes seen in recent years among veterinarians, it was deemed unlikely that veterinarians would reduce average hours worked or retire earlier than current and historical patterns. If veterinarians worked more hours, fewer veterinarians would be required to provide the same level of services. Consequently, there was a greater potential for the supply projections to exceed the baseline estimates rather than to fall short of the baseline estimates. It was unlikely that veterinarians would reduce hours worked because of economic pressures to maintain practice and household income. Likewise, it was unlikely that veterinarians would retire earlier than historical patterns because of a combination of economic pressures, changes in federal policies such as delaying eligibility age for Medicare, and the general overall improvement in population health that allows people to live longer and remain healthier.

Exhibit 42. Alternative Supply Scenarios vs. Baseline Demand Projections 2012-2025



B. Study Strengths and Limitations

The supply and demand projections presented in this report were based on microsimulation models that took into consideration many factors shown to be associated with supply and demand for veterinary services. Most of the data used were from the most recent AVMA surveys, Census Bureau population estimates and projections, and other key data sources. Where data were lacking, assumptions were necessitated. For this reason, the projection models were designed to be updated as new information or data sources become available.

Whereas traditional workforce models often start with the assumption that supply and demand are in equilibrium in the base year, this study relied on a survey with 3,497 respondents who provided their assessment of the adequacy of veterinary supply in their local geographic area and employment sector. These veterinarians also provided insight on the amount of excess capacity (if any) in their practices. This information allowed us to quantify a measure of excess capacity by state and employment sector (for those sectors providing direct animal care where a substantial portion of veterinarians are self-employed or owners of veterinary practices).

Data limitations contributed to several study limitations that were potential areas for future research.

1. The estimates of excess capacity in 2012 were based on the self-reported perceptions of veterinarians as to whether their local supply of veterinarians was adequate, and the degree of excess capacity within their practice. Development of more objective measures of both physical and human excess capacity in veterinary practices would improve the accuracy of the results. Still, the perceptions of excess capacity were consistent with other evidence, such as stagnating or falling incomes of veterinarians, increased difficulty of new graduates finding employment, and trends in declining productivity.
2. The modeling of demand for veterinary services was made complicated by the large variation in types of work provided by veterinarians. This was true especially in food animal production where veterinary services differed substantially by animal type. A more detailed analysis of how much time was spent providing specific veterinary services would improve the estimates of the demand for veterinary FTEs—especially as the mix of services would likely change over time.
3. Our analysis covered the major food animal types with the exception of aquaculture veterinary practice. Future research might model the growth in aquaculture and also separate out animal types included in the "all other" category used in this analysis.
4. There was little information to model growth trends in demand for veterinarians in industry. Our analysis relied on survey data collected during the middle of an economic downturn that asked industry representatives their plans for hiring.
5. Additional research is needed to better understand trends in horse ownership by type of owner and horse use (households owning horses for leisure, racing horses, etc.). Our analysis found a correlation between age of head of household and propensity to own horses, but additional research is required to better understand if this is an age effect or

a generational effect (with the future elderly owning fewer horses per capita than the current elderly).

6. The supply projections assumed that new graduates from veterinary medical colleges would locate in states and employment sectors with the least excess capacity. That is, new veterinarians would gravitate to geographic areas and employment sectors where there are the greatest career and employment opportunities. The current supply projection model did not take into account that some veterinarians would move geographically or change employment sectors during their career (e.g., switching from equine or food animal to government or research). Consequently, projections of imbalances between veterinary supply and demand would be less accurate for specific states or employment sectors as compared to the national projections.
7. The demand analysis took into consideration changes in the racial/ethnic composition of the U.S. population. However, there may be additional diversity or cultural differences that warrant additional research. For example, within the non-Hispanic "other" demographic group, there were people from Asia, the Middle East, and many other regions where different cultural norms exist as to providing veterinary care for companion animals.

C. Areas for Future Research

The data limitations and research gaps described above highlight potential areas where additional research could improve understanding of trends affecting the veterinary workforce. The workforce simulation models developed for this study were built to be updated and refined as research gaps are filled, and an important component of this study was identification of unanswered questions. We suggest the following as areas where additional research is needed or where data collection efforts might be implemented.

1. *Develop more objective measures of demand for veterinary services*. For this analysis, current demand was estimated by adding current supply plus estimates of current excess capacity. Another approach is benchmarking. For this approach one would identify communities where there appears to be a good balance between supply and demand for services. That is, consumers in that area do not experience abnormally long wait times or difficulty to access veterinary services, veterinarians are able to earn compensation levels consistent with their expectations, and veterinary practices are efficient in terms of how workload is divided between veterinarians and support staff. Findings from these case studies could then be extrapolated to other communities to assess adequacy of supply.
2. *Develop early warning indicators of imbalances between supply and demand*. AVMA might consider developing a measurement system similar to the Aggregate Demand Index developed by the Pharmacy Manpower Project.[a] This index was based on monthly input

[a] http://www.pharmacymanpower.com/

collected across different geographic areas on the assessment of balance between supply and demand and levels of difficulty hiring new pharmacists. Consistent and frequent collection of metrics could provide baseline trends and early indicators of changes in the balance between supply and demand. Potential indicators include:

- Indicators regarding availability of veterinarian jobs
    - Number of job openings for veterinarians advertised
    - Number of vacancies for veterinarians
    - Ratio of applicants per veterinarian job opening
    - Average length of time to fill a veterinarian job opening
- Indicators regarding veterinary practices
    - Practice profitability
    - Frequency of organizational changes in practices (selling/merging/consolidating)
    - Numbers of services provided and ratio of revenue per service provided
    - Perceptions of the extent to which practice works at peak efficiency/productivity
    - Perceptions of adequacy of supply in an area
    - Average wait times for non-emergency appointments
- Indicators regarding veterinarians' income and workforce behavior
    - Veterinarian income and per hour equivalent
    - Plans to leave veterinary medicine for another career and reasons why
    - Age when a veterinarian becomes permanently inactive

Indicators such as those above can be collected through existing data collection efforts at the AVMA. Periodic collection of these data and monitoring of changes in these indicators would help AVMA recognize when shifts in the relationship between supply and demand for veterinarians occur. Moreover, as these indicators are collected over time, AVMA could begin to analyze the relationship between these indicators and the results of the supply and demand projection model.

3. *Conduct research on the price sensitivity of pet and animal owners*. The current excess capacity among veterinary practices providing direct animal care could be influenced through efforts to increase the volume of services used. Research is needed to better understand the degree to which reducing the price of services will increase volume of such services. If services are "price elastic," then small reductions in price of some services could translate to substantially higher volume. On the other hand, if services are "price inelastic," then changes in price will have little effect on volume of services.
4. *Monitor the careers of new veterinarians*. With the estimation that a current surplus of more than 11,000 veterinarians exists and is projected to persist into the future, it is important to understand what the ramifications of this imbalance will be for new veterinarians. New veterinarians could be identified as they successfully complete the NAVLE examination each year. From that group, a sample could be selected each year for participation in a long-term, follow-up study that seeks to explore the career trajectories of individuals who

become veterinarians in the current supply/demand environment. Of importance would be observing:

- how do these new professionals fare in the job market?
- is there a threshold of how long they will unsatisfactorily pursue a career as a veterinarian and will there develop a large exodus of new veterinarians at some point in the future?
- will there be effects on their willingness to start new practices or buy existing practices from retiring veterinarians?

While, some have already speculated about these questions, it will be important to collect the data to confirm or dispute these speculations and understand how the new veterinarians' careers play out over time.

5. *Acquire additional information on the average amount of time veterinarians spend providing specific types of services*. Such information could improve the ability to simulate the demand implications of the changing mix of services demanded, and implementation of alternative care delivery models such as greater use of non-veterinarian staff.
6. *Continue to update model inputs and refine model components, parameters, and assumptions*. The model developed for this project is sophisticated and contains a large number of data inputs, parameters, and assumptions. As the future unfolds, the underlying data inputs of the models will become outdated and need to be recompiled for the models to remain useful over time. Related to this is periodic updating of the model parameters. Periodically, the model parameters should be revisited and changed as necessary as additional research is conducted and our understanding of the drivers of supply and demand for veterinarians changes. Moreover, as has been pointed out in the previous section, there are a number of refinements that will improve the granularity of the model's projections, including improving the equine demand module of the model and improved understanding of the drivers of new veterinarian geographic distribution. Supply inputs that could be updated periodically in the model include current supply, number of new graduates, hours worked patterns, and retirement patterns. Demand inputs that would require periodic updating include new Census Bureau population estimates/projections for each state, and evolving patterns of pet ownership and use of veterinary services.
7. *Evaluate demand projection assumptions*. The demand projections presented here assumed that care delivery patterns would remain comparatively unchanged relative to current patterns. If veterinarians make greater use of veterinary technicians or other staff, then all else being equal, there would be fewer veterinarians needed to supply the same level of services.

D. Summary

In summary, it appears that at the national level there is current excess capacity to provide direct animal care services. In percentage terms, the level of excess capacity appeared to be largest for equine practices, followed by small animal practices, food production practices, and mixed animal practices. This excess capacity is projected to persist for the foreseeable future in the absence of reduced growth in the number of new veterinarians trained and/or efforts to expand the use of veterinary services.

While at the national level there appears to be excess capacity in veterinary clinical practice, in certain geographic areas and for certain skill sets (e.g., research) there may be pockets where there is insufficient capacity to meet demand for services. Despite the increased difficulty that new veterinarian graduates are having finding employment, the large number of employment offers made to some new graduates demonstrates that top students at well regarded CVMs may have little difficulty finding employment.

Why is it important to have supply and demand in balance? From a societal perspective the nation's resources should be put to their most efficient use. Training too many veterinarians uses educational and financial resources that might be put to other uses, but more important, it reduces the average productivity of veterinarians over the course of their 30- to 40-year career. Excess capacity reduces the financial viability of veterinary medicine, placing a financial burden on veterinarians and their families—especially new veterinarians entering practice with high levels of educational debt. As articulated by Getz (1997): "As long as the excess supply continues…a number of persons trained to be veterinarians seem likely to be disappointed in their economic circumstance."[4]

Training too few veterinarians also has costs. If that were to be the case, then services needed by animals may not be provided—even if the owners of these pets and animals were able and willing to pay prevailing prices for services. National shortages tend to exacerbate geographic inadequacies in supply, with the available workforce gravitating towards metropolitan and higher income areas. However, while there may be a rationale to refocus the training of some veterinarians (e.g., away from animal practice and towards research), the indicators are that the nation is producing more veterinarians than are required to meet the demand for veterinary services at prevailing prices for all types of veterinary services.

Also, data collection systems might be put in place to provide early warning signals of changes in veterinary workforce supply and demand imbalances. Projections of future supply and demand for veterinary services and veterinarians should be periodically updated to incorporate the latest trends in supply and demand determinants.

Market forces create "signals" regarding whether the nation is producing too many or too few veterinarians. The signals being broadcast by the market for veterinary services are declining veterinarian productivity, stagnating and declining incomes, and increasing difficulty of new graduates to find employment. These signals are consistent with veterinarian perceptions that there is excess capacity in clinical practice and that veterinarians are under-employed and could increase productivity if there were more demand for services. The supply and demand projections presented here using the most recent trends in supply and demand determinants suggest that the excess capacity is likely to persist for the foreseeable future.

Appendix A: Results from the 2012 Workforce Survey

In July 2012, upon submission of the first draft report to the Work Advisory Group (WAG) and subsequent discussion of gaps and uncertainties in several of the supply model parameters, it was decided that a primary data collection effort be undertaken to fill the data gaps. The identified gaps included data on the perceived degree of excess capacity in providing veterinary services; current professional activity status of veterinarians; work effort across gender, age, and employment sector distribution; likelihood and timing of moving across employment sectors; and likelihood and timing of permanently leaving veterinary medicine. The data were to be collected from veterinarians in all employment sectors, those actively working in the profession, as well as those who had already become permanently inactive in the profession.

A. Survey Design

During the month of August, project staff worked with the WAG to develop a survey capable of collecting the desired data. The survey questions were drawn from a number of sources, including previously conducted surveys of human medicine physicians, the AVMA biennial economic survey, and a survey conducted earlier in 2012 by the Veterinary Information Network. In September, WAG members pilot tested the survey instrument. Upon gathering their feedback, the survey was finalized. The final survey instrument comprised 17 numbered questions. The number of questions posed and answered by respondents, however, was conditional on the responses to certain questions on the survey. For example, respondents who reported that they were permanently inactive in veterinary medicine were not asked questions about their current veterinary medical practice, but rather were asked questions regarding their decision to become permanently inactive.

Population Data Source, Sampling Frame, and Sample

In September 2012, the Center for Health Workforce Studies (CHWS) worked with AVMA's membership department to select a sample of veterinarians from the AVMA's database of veterinarians. This sampling frame numbered 104,235 veterinarians and included veterinarians who were not members of the AVMA and retired veterinarians. Because the survey was to be conducted online with email solicitations as the only means of requesting participation in the effort, only veterinarians for whom the AVMA database had valid emails were eligible to be part of the sampling frame.

The sampling frame was characterized across four dimensions: age, gender, employment sector, and professional status. Age was distinguished across two groups (age 50 and older/younger than age 50), employment sector across five groups (see Exhibit 43), and professional status across two groups (active in veterinary medicine/not active). The cross-classification of these dimensions yielded 30 subgroups (see Exhibit 44).

Exhibit 43. Employment Sector Groups

Employment Sector	*AVMA Employment Type Classification (AVMA database code)*
Private Clinical Practice	General Medicine/Surgery (1), Production Medicine (2), Referral/Specialty Medicine (3), Emergency/Critical Care Medicine (4), Other Private Clinical Practice (5)
Academia	Veterinary Medical College/School (6), Veterinary Science Department (7), Veterinary Technician Program (8), Animal Science Department (9), Other Academia (10)
Government	U.S. Federal (11), State (12), Local (13), Army (15), Air Force (16), Public Health Commission Corps (17)
Industry/Commercial	Pharmaceutical/Biological (19), Feeds/Nutrition (20), Laboratory (21), Agriculture/Livestock Production (22), Business/Consulting Services (23), Other Industry/Commercial (24)
Other	Humane Organization (25), Membership Assn/Professional Society (26), Foundation/Charitable Organization (27), Missionary/Service (28), Zoo/Aquarium (29), Wildlife (30), Temporarily Not Employed in Veterinary Field (32), Non-Veterinary Employment (33), Not Employed (34), Not Listed Above (35), No Information Provided (36), Foreign (14), Other Government (18)

Exhibit 44. Population Cross-Classification and Subgroup Counts

Active Veterinarians Age 50 and Older

Employment Sector	*Female*	*Male*
Private Clinical Practice	11,129	25,757
Academia	1,272	2,892
Government	708	2,380
Industry/Commercial	626	1,827
Other	6,006	7,685
Total	19,741	40,541

Active Veterinarians Younger than Age 50

Employment Sector	*Female*	*Male*
Private Clinical Practice	20,444	9,520
Academia	1,641	830
Government	517	254
Industry/Commercial	418	304
Other	6,438	2,527
Total	29,458	13,435

Retired Veterinarians

Employment Sector	*Female*	*Male*
Private Clinical Practice	53	699
Academia	10	69
Government	4	42
Industry/Commercial	7	55
Other	17	103
Total	91	968

Within each of the subgroups, veterinarians were randomly selected for inclusion in the sample in sufficient number to achieve a target margin of error rate of +/-3% for each of the subgroups. This target yielded a total sample size of 11,443 veterinarians. The subgroup distributions are shown in Exhibit 45.

Exhibit 45. Sample Subgroup Counts

Active Veterinarians Age 50 and Older

Employment Sector	*Female*	*Male*
Private Clinical Practice	747	776
Academia	491	627
Government	380	595
Industry/Commercial	386	523
Other	706	725
Total	2,710	3,246

Active Veterinarians Younger than Age 50

Employment Sector	*Female*	*Male*
Private Clinical Practice	770	738
Academia	538	408
Government	314	193
Industry/Commercial	275	221
Other	712	608
Total	2,609	2,168

Retired Veterinarians

Employment Sector	*Female*	*Male*
Private Clinical Practice	38	437
Academia	12	48
Government	3	33
Industry/Commercial	4	46
Other	13	76
Total	70	640

Survey Distribution Details

Data collection began on September 11, 2012 with an email sent to each veterinarian selected into the sample. Reminder emails were sent to non-respondent veterinarians on September 17 September 30, October 11, and October 28. The online survey remained open through November 2, 2012, at which point data collection was closed.

Response Rate Analysis

In all, 3,497 responses were collected from the 11,443 veterinarians sampled, for an unadjusted response rate of 30.6% (3,497 ÷ 11,443). The unadjusted response rate was a biased indicator of the actual level of response to the survey because it did not take into account that some portion of the sampled veterinarians never received the invitation or follow-up emails due to outdated or incorrect email address information from the AVMA database or because the emails were rejected by a spam filter or other software system that blocks potentially unwanted email automatically. Among the 11,443 veterinarians sampled, 1,138 of the email addresses in the database were undeliverable and 264 yielded a response that the email could not be delivered because it was considered spam. Taking these responses into account, the adjusted sample size was 10,041. The adjusted response rate, then, was 34.8% (3,497 ÷ 10,041).

Exhibit 46 through Exhibit 50 present the findings of an analysis of the response rates for select sample subgroups. The tables include the response rate, the figures used to calculate the rate, as well as statistics to determine whether the rates were different.

Exhibit 46. Survey Response by Gender

Gender	*Rate*	*N*	*Responses*	*F*	*p*
Male	33.7%	5,224	1,761	*4.234*	*< 0.040*
Female	35.7%	4,817	1,718		

In terms of gender, response levels among male and female veterinarians varied statistically ($F = 4.234$; $p < 0.040$). Female veterinarians were slightly more likely to respond (35.7%) than male veterinarians (33.7%).

In terms of employment sector, response levels in the five categories varied statistically ($F = 50.035$; $p < 0.001$). Veterinarians in the government employment sector were the most likely to respond to the survey (44.1%), followed closely by those in academia (41.8%) and in the industry/commercial sector (40.8%). Veterinarians in the private clinical practice and other employment sectors were least likely to respond to the survey (29.0% and 28.7%, respectively).

Exhibit 47. Survey Response by Employment Sector

Employment Sector	*Rate*	*N*	*Responses*	*F*	*p*
Private clinical practice	29.0%	3,275	949		
Academia	41.8%	1,845	772		
Government	44.1%	1,259	555	*50.035*	*< 0.001*
Industry/Commercial	40.8%	1,253	511		
Other	28.7%	2,409	692		

The final sample subgroup variable was age and AVMA professional activity status. The three categories were non-retired, age 50 and older; non-retired, younger than age 50; and retired, all ages. Veterinarians who were not retired and age 50 and older were more likely to respond to the survey, with a response rate of 37.6%, than their non-retired counterparts younger than age 50 and also retired veterinarians (31.2% and 34.6%, respectively). The response rate differences between the groups were statistically significant ($F = 21.080$; $p < 0.001$).

Exhibit 48. Survey Response by Age and AVMA Professional Activity Status

Age and AVMA Status	*Rate*	*N*	*Responses*	*F*	*p*
Non-retired, Age 50 and Older	37.6%	5,089	1,912		
Non-retired, Younger than 50	31.2%	4,276	1,333	*21.080*	*< 0.001*
Retired, all ages	34.6%	676	234		

Another important variable was available in the sampling frame: geographic location. Veterinarians in the Northeast were the most likely to respond to the survey (38.4%), while veterinarians in the West were the least likely (32.1%). Although the differences in response rates observed across the geographic regions were small, the variation did reach statistical significance ($F = 6.055$; $p < 0.001$).

Exhibit 49. Survey Response by Geographic Location

Census Region	*Rate*	*N*	*Responses*	*F*	*p*
Northeast	38.4%	1,624	624		
Midwest	35.4%	2,360	836	*6.055*	*< 0.001*
South	34.2%	3,730	1,274		
West	32.1%	2,324	745		

So far, the response rate analysis has been limited to the response rate differences across groups within a single variable. To complete this review of response rate differences, it is important to consider all of the variables simultaneously. To do so, a logistic regression equation was estimated with the likelihood of response as the dependent variable and the other five variables (described above) as regressors. The results of this analysis (Exhibit 50) confirmed the single variable findings and indicated some additional nuanced findings as well. While response rates did vary across categories of employment, veterinarians in private clinical practice did not respond at a different rate than veterinarians in the reference category (other employment sector). Moreover, veterinarians in the Northeast were more likely to respond to the survey than veterinarians in the reference geographic category (West census region), but veterinarians in the Midwest and South regions were not more or less likely to respond to the survey than veterinarians in the reference geographic category. Similarly, non-retired veterinarians age 50

and older were equally likely to respond to the survey than their retired counterparts in the sample. However, non-retired veterinarians who were younger than age 50 were less likely than retired veterinarians and non-retired veterinarians age 50 and older.

In conclusion, response rates were observed to vary across a number of veterinarian characteristics, and several of the observed variations yielded statistically significant differences in an analysis that considered all of the variables simultaneously. The level of variation, however, tended to be relatively minor with the exception of employment sector. The findings of the multivariate logistic analysis informed the development of sample weight to ensure that the results of the survey accurately represented the responses of the targeted population of veterinarians in the U.S.

Exhibit 50. Survey Response by Employment Sector, Geographic Location, Professional Activity Status, Age, and Gender

				95% CI for Odds Ratio	
Variable	*Coefficient*	*p*	*Odds Ratio*	*Lower*	*Upper*
Emp Sector - Private Clinical Practice	-0.0082	< 0.892	0.9918	0.8814	1.1161
Emp Sector - Academia	0.5735	< 0.001	1.7744	1.5604	2.0178
Emp Sector - Government	0.6675	< 0.001	1.9494	1.6884	2.2507
Emp Sector - Industry/Commercial	0.4924	< 0.001	1.6363	1.4162	1.8905
Census Region - Northeast	0.2886	< 0.001	1.3346	1.1665	1.5268
Census Region - Midwest	0.1098	< 0.080	1.1161	0.9868	1.2623
Census Region - South	0.0420	< 0.463	1.0429	0.9322	1.1668
Sample Grp – Non-retired 50 and Older	-0.0998	< 0.268	0.9051	0.7585	1.0799
Sample Grp – Non-retired > 50	-0.3500	< 0.001	0.7047	0.5885	0.8439
Male	-0.1158	< 0.008	0.8906	0.8175	0.9703

Response Weighting Procedures

To ensure that the results of the survey accurately reflected the responses of the population of veterinarians targeted for study, the survey responses were weighted using information from the response rate analysis described above. The weighting process consisted of developing two sets of weights. The first set was generated to correct for differences in rates of response that reached statistical significance between veterinarians across the variables considered in the analysis. This set of weights (*weight_r in the dataset*) was generated by taking the reciprocal of the response rate for members of each respondent group, and then adjusting the reciprocal to account for the overall response rate to the survey. Following the response rate analysis described above, responses were distributed into 32 respondent groups defined by the simultaneous cross-classification of employment sector, geographic location, age/AVMA

professional status, and gender (Exhibit 51). The specific weights and calculations used to develop them are presented in Exhibit 52.

Exhibit 51. Respondent Group Cross-Classification

Group ID	*Gender*	*Region*	*Sample Group*	*Employment Sector*
1	Male	Northeast	Non-Retired 50 and Older & Retired	Private Clinical & Other
2	Male	Northeast	Non-Retired 50 and Older & Retired	Academia
3	Male	Northeast	Non-Retired 50 and Older & Retired	Government
4	Male	Northeast	Non-Retired 50 and Older & Retired	Industry/Commercial
5	Male	Midwest & South & West	Non-Retired 50 and Older & Retired	Private Clinical & Other
6	Male	Midwest & South & West	Non-Retired 50 and Older & Retired	Academia
7	Male	Midwest & South & West	Non-Retired 50 and Older & Retired	Government
8	Male	Midwest & South & West	Non-Retired 50 and Older & Retired	Industry/Commercial
9	Male	Northeast	Non-Retired Younger than 50	Private Clinical & Other
10	Male	Northeast	Non-Retired Younger than 50	Academia
11	Male	Northeast	Non-Retired Younger than 50	Government
12	Male	Northeast	Non-Retired Younger than 50	Industry/Commercial
13	Male	Midwest & South & West	Non-Retired Younger than 50	Private Clinical & Other
14	Male	Midwest & South & West	Non-Retired Younger than 50	Academia
15	Male	Midwest & South & West	Non-Retired Younger than 50	Government
16	Male	Midwest & South & West	Non-Retired Younger than 50	Industry/Commercial
17	Female	Northeast	Non-Retired 50 and Older & Retired	Private Clinical & Other
18	Female	Northeast	Non-Retired 50 and Older & Retired	Academia
19	Female	Northeast	Non-Retired 50 and Older & Retired	Government
20	Female	Northeast	Non-Retired 50 and Older & Retired	Industry/Commercial
21	Female	Midwest & South & West	Non-Retired 50 and Older & Retired	Private Clinical & Other
22	Female	Midwest & South & West	Non-Retired 50 and Older & Retired	Academia
23	Female	Midwest & South & West	Non-Retired 50 and Older & Retired	Government
24	Female	Midwest & South & West	Non-Retired 50 and Older & Retired	Industry/Commercial
25	Female	Northeast	Non-Retired Younger than 50	Private Clinical & Other
26	Female	Northeast	Non-Retired Younger than 50	Academia
27	Female	Northeast	Non-Retired Younger than 50	Government
28	Female	Northeast	Non-Retired Younger than 50	Industry/Commercial
29	Female	Midwest & South & West	Non-Retired Younger than 50	Private Clinical & Other
30	Female	Midwest & South & West	Non-Retired Younger than 50	Academia
31	Female	Midwest & South & West	Non-Retired Younger than 50	Government
32	Female	Midwest & South & West	Non-Retired Younger than 50	Industry/Commercial

Exhibit 52. Survey Response Rate Difference Weights

			A	B = 1 / A	C = 3,497 / 10,038[a]	D = B * C
Group ID	*N*	*n*	*Response Rate*	*1 / Response Rate*	*Overall Response Rate Adjustment*	*Weight*
1	262	91	34.7%	2.87912	0.34658	0.99785
2	74	36	48.6%	2.05556	0.34658	0.71242
3	38	16	42.1%	2.37500	0.34658	0.82313
4	82	43	52.4%	1.90698	0.34658	0.66093
5	1,514	444	29.3%	3.40991	0.34658	1.18182
6	503	211	41.9%	2.38389	0.34658	0.82621
7	431	199	46.2%	2.16583	0.34658	0.75064
8	401	158	39.4%	2.53797	0.34658	0.87962
9	186	46	24.7%	4.04348	0.34658	1.40140
10	57	31	54.4%	1.83871	0.34658	0.63727
11	19	7	36.8%	2.71429	0.34658	0.94073
12	40	20	50.0%	2.00000	0.34658	0.69317
13	1,027	251	24.4%	4.09163	0.34658	1.41809
14	292	104	35.6%	2.80769	0.34658	0.97310
15	151	51	33.8%	2.96078	0.34658	1.02616
16	146	53	36.3%	2.75472	0.34658	0.95474
17	240	90	37.5%	2.66667	0.34658	0.92422
18	71	35	49.3%	2.02857	0.34658	0.70307
19	26	14	53.8%	1.85714	0.34658	0.64365
20	86	39	45.3%	2.20513	0.34658	0.76426
21	1,102	350	31.8%	3.14857	0.34658	1.09124
22	371	171	46.1%	2.16959	0.34658	0.75194
23	306	151	49.3%	2.02649	0.34658	0.70235
24	256	98	38.3%	2.61224	0.34658	0.90536
25	285	83	29.1%	3.43373	0.34658	1.19007
26	87	37	42.5%	2.35135	0.34658	0.81494
27	22	10	45.5%	2.20000	0.34658	0.76248
28	49	26	53.1%	1.88462	0.34658	0.65318
29	1,067	286	26.8%	3.73077	0.34658	1.29302
30	389	147	37.8%	2.64626	0.34658	0.91715
31	266	107	40.2%	2.48598	0.34658	0.86160
32	192	74	38.5%	2.59459	0.34658	0.89924

[a] 10,038 was used as a denominator for the response rate adjustment rather than 10,041 because three individuals in the sample did not have adequate address information in order to be classified in terms of geography.

The second set of weights was generated to allow for a national-level benchmark to be developed for each question on the survey. Because the sample was selected in a disproportionate manner in order to produce accurate estimates within subgroups defined by the strata variables of the population of veterinarians targeted for use in developing supply and demand model parameters, the strata characteristics in the sample were not distributed in the same manner as they were in the targeted population of veterinarians in the U.S. Thus, in the aggregate, they did not represent the targeted population of veterinarians. To correct for the differences in the distribution of these characteristics, the reciprocal of the sampling fraction (adjusted for the total response rate) was used as the basis for the sampling design adjustment factor (Exhibit 53).

The final step in creating the national-level benchmark weight was to correct for the identified response rate differences identified in Exhibit 50. The adjustment was made by multiplying the sampling design adjustment factor values (*weightb*) by the weights presented in Exhibit 51 (*weight_r*). This second set of weights was labeled *weight_bmark_final* in the dataset. This set of weights should only be used to generate national-level population benchmarks.

Exhibit 53. Sampling Design Adjustment

Gender *Sample Group* *Employment Sector*	**A** *Population*	**B** *Sample*	**C = B / A** *Sampling fraction*	**D = 1 / C** *1 / Sampling fraction*	**E = 10,041 / 104,234** *Total Sampling Fraction Adjustment*	**F = D * E** *Sampling Design Adjustment*
Male						
Non-retired, Age 50 and Older						
Private Clinical Practice	25,757	714	0.0277	36.0742	0.0963	3.4750
Academia	2,892	532	0.1840	5.4361	0.0963	0.5237
Government	2,380	438	0.1840	5.4338	0.0963	0.5234
Industry/Commercial	1,827	442	0.2419	4.1335	0.0963	0.3982
Other	7,685	570	0.0742	13.4825	0.0963	1.2988
Non-retired, Younger than Age 50						
Private Clinical Practice	9,520	684	0.0718	13.9181	0.0963	1.3407
Academia	830	349	0.4205	2.3782	0.0963	0.2291
Government	254	170	0.6693	1.4941	0.0963	0.1439
Industry/Commercial	304	186	0.6118	1.6344	0.0963	0.1574
Other	2,527	529	0.2093	4.7769	0.0963	0.4602
Retired, All ages						
Private Clinical Practice	699	419	0.5994	1.6683	0.0963	0.1607
Academia	69	46	0.6667	1.5000	0.0963	0.1445
Government	42	31	0.7381	1.3548	0.0963	0.1305
Industry/Commercial	55	41	0.7455	1.3415	0.0963	0.1292
Other	103	73	0.7087	1.4110	0.0963	0.1359
Female						
Non-retired, Age 50 and Older						
Private Clinical Practice	11,129	694	0.0624	16.0360	0.0963	1.5448
Academia	1,272	431	0.3388	2.9513	0.0963	0.2843
Government	708	329	0.4647	2.1520	0.0963	0.2073
Industry/Commercial	626	338	0.5399	1.8521	0.0963	0.1784
Other	6,006	601	0.1001	9.9933	0.0963	0.9627
Non-retired, Younger than Age 50						
Private Clinical Practice	20,444	728	0.0356	28.0824	0.0963	2.7052
Academia	1,641	476	0.2901	3.4475	0.0963	0.3321
Government	517	288	0.5571	1.7951	0.0963	0.1729
Industry/Commercial	418	242	0.5789	1.7273	0.0963	0.1664
Other	6,438	624	0.0969	10.3173	0.0963	0.9939
Retired						
Private Clinical Practice	53	36	0.6792	1.4722	0.0963	0.1418
Academia	11	11	1.0000	1.0000	0.0963	0.0963
Government	4	3	0.7500	1.3333	0.0963	0.1284
Industry/Commercial	7	4	0.5714	1.7500	0.0963	0.1686
Other	17	12	0.7059	1.4167	0.0963	0.1365

B. Survey Results

The survey responses presented in this section have been weighted to account for the response rate variations and sampling design. Survey respondents were distributed relatively evenly by gender, with women making up 48% of the respondents and men making up 52% (Exhibit 54). The median age of a respondent was 54 years of age. Among women, the median age was 45 years of age, and among men, the median age was 60 years of age.

Exhibit 54. Respondent Demographics: Gender and Age

Gender	Number of Respondents	Percentage of Respondents
Female	1,671	48%
Male	1,808	52%

Age Category	Number of Respondents	Percentage of Respondents
Younger than 30 years of age	176	5%
30 to 39 years of age	646	19%
40 to 49 years of age	642	18%
50 to 59 years of age	900	26%
60 to 69 years of age	718	21%
70 years of age and older	398	11%

Age Category	Female	Percentage	Male	Percentage
Younger than 30 years of age	159	10%	17	1%
30 to 39 years of age	438	26%	208	12%
40 to 49 years of age	411	25%	231	13%
50 to 59 years of age	492	29%	408	23%
60 to 69 years of age	147	9%	571	32%
70 years of age and older	25	1%	372	21%

Nearly two-thirds (65%) of the respondents were associated with the private clinical practice employment sector (Exhibit 55). Respondents from the "other" sector made up the next largest group of respondents at slightly less than one-quarter (22%) of the total respondents. Respondents from the academia, government, and industry/commercial sector made up about 6%, 4%, and 3%, respectively, of respondents.

The youngest respondents were found in the private clinical practice sector with a median age of 53 years of age. Respondents from the academic, government, and industry/commercial sectors had a median age of 57 years of age.

Exhibit 55. Respondent Demographics: Employment Sector

Employment Sector	Number of Respondents	Percentage of Respondents	Median Age
Private Clinical Practice	2,250	65%	53
Academia	226	6%	57
Government	132	4%	57
Industry/Commercial	110	3%	57
Other	762	22%	56

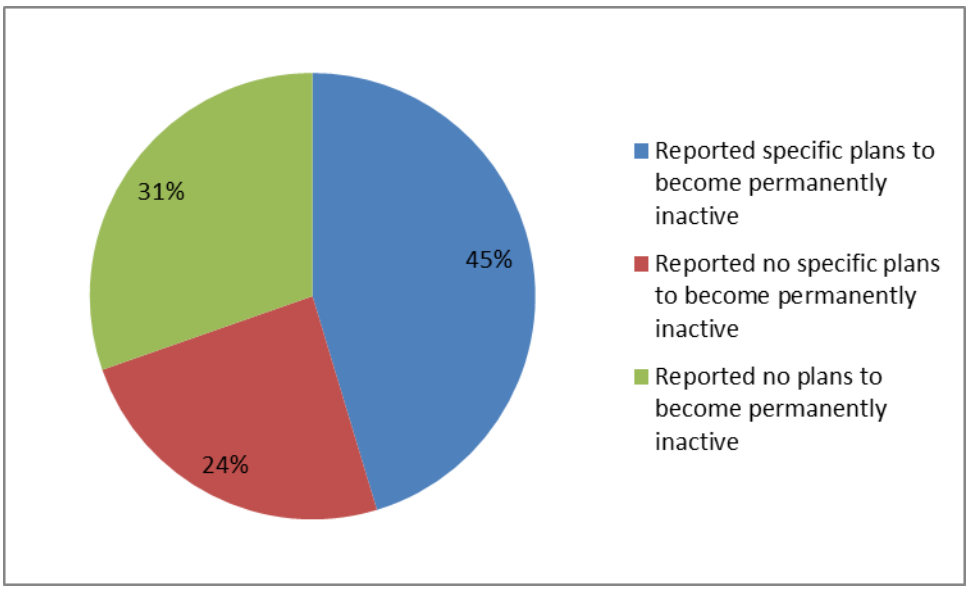
A total of 381 respondents reported being permanently inactive in veterinary medicine (Exhibit 56). Among them, the median age at which respondents become permanently inactive was 62 years of age. Looking at the distribution of the reported age at the time of becoming permanently inactive revealed that there was a rate of attrition among young veterinarians. Of the veterinarians who reported being permanently inactive in veterinary medicine, just over one-quarter (26%) left the workforce before age 60. This did not imply, however, that one-quarter of veterinarians would retire by age 60. For example, if older veterinarians had died then their ages at leaving the workforce were unknown.

Exhibit 56. Age when Became Permanently Inactive in Veterinary Medicine

Age Category (Age when became permanently inactive)	Number of Respondents	Percentage of Respondents
Younger than 30 years of age	3	1%
30 to 39 years of age	14	4%
40 to 49 years of age	20	6%
50 to 59 years of age	53	15%
60 to 64 years of age	113	32%
65 to 69 years of age	76	22%
70 to 74 years of age	35	10%
75 years of age and older	37	11%

Of the respondents who reported being active in veterinary medicine or being temporarily inactive, 45% reported an age at which they planned to become permanently inactive, 24% reported that they had no specific plans to become permanently inactive, but indicated plans to reduce the amount of time they spend in veterinary medicine at a specified age, and 31% reported that they had no plans to become permanently inactive (Exhibit 57).

Exhibit 57. Reported Plans for Becoming Permanently Inactive in Veterinary Medicine



Among those respondents who reported an age at which they planned to become permanently inactive in veterinary medicine, the median age reported was 65 years of age. Exhibit 58 presents the distribution of responses across age categories. More than one-third (34%) of respondents reported plans to remain active in veterinary medicine until at least 70 years of age. Note that findings from Exhibit 58 (anticipated age at retirement) are not directly comparable to findings from Exhibit 56 (age distribution of those who have retired). Some departures from the workforce are unplanned (e.g., departure for health problems, or departure for unanticipated career change influenced by job opportunities). Also, the large influx of new graduates over the past two decades means that a large portion of veterinarians have not reached traditional retirement age so the data on inactive veterinarians has a disproportion number of people who have left the workforce before traditional retirement age.

Exhibit 58. Age when Plan to Become Permanently Inactive in Veterinary Medicine

Age Category (Age when plan to become perm. inactive)	Number of Respondents	Percentage of Respondents
Younger than 50 years of age	12	1%
50 to 59 years of age	83	7%
60 to 64 years of age	235	19%
65 to 69 years of age	503	40%
70 to 74 years of age	275	22%
75 years of age and older	146	12%

Appendix B: Regression Results

Exhibit 59. Rate Ratios from Poisson Regression for Pet Ownership

Demand Determinants	# Dogs	# Cats	# Birds	# Horses
Age of head of household				
Age 65+	1.52*	2.61*	1.54*	1.82*
Age 55-64	2.34*	3.71*	3.38*	2.04*
Age 45-54	2.66*	4.02*	3.99*	1.78*
Age 35-44	2.62*	3.78*	3.01*	1.51*
Age 25-34	2.52*	3.29*	1.70*	1.75*
Age < 25[t]	1.00	1.00	1.00	1.00
Not Married	1.04*	1.09*	1.07*	.84*
Household income				
$85,000 or more	0.97	0.74*	0.76*	1.29*
$55,000 to $84,999	1.00	0.84*	0.68*	1.06
$35,000 to $54,999	1.03	0.90*	0.92*	0.92
$20,000 to $34,999	1.06*	0.99	1.01	0.89*
Less than $20,000[t]	1.00	1.00	1.00	1.00
Race				
Other	1.19*	0.91*	1.36*	0.75
American Indian, Aleut Eskimo	1.33*	1.34*	2.64*	2.25*
Asian or Pacific Islander	0.69*	0.46*	0.97	0.40*
Black/African-American	0.44*	0.25*	0.39*	0.31*
White	1.04	1.13*	1.12	1.22*
Did not specify[t]	1.00	1.00	1.00	1.00
Hispanic	0.997	1.10*	0.97	1.01
Employment status				
Not employed	1.17*	1.38*	1.47*	0.64*
Retired	1.07*	1.09*	1.26*	0.54*
Part-time	1.15*	1.35*	1.12	0.79*
Full-time	1.14*	1.29*	1.23*	0.92
Did not specify[t]	1.00	1.00	1.00	1.00
Is a Farmer	1.42*	2.31*	.48*	10.90*
Household type				
Other	0.75*	1.04	0.78	1.11
Twinplex/Duplex	0.64*	1.01	0.53*	0.17*
Condominium	0.50*	0.82*	0.50*	0.12*
Mobile Home	1.37*	1.46*	1.38*	1.63*
Apartment	0.43*	0.83*	0.79*	0.19*
House	1.13*	1.23*	1.10	0.85
Did not specify[t]	1.00	1.04	1.00	1.00
Region				
Pacific	1.44*	1.04*	1.31*	3.55*
Mountain	1.67*	0.91*	1.00	4.58*
West South Central	1.96*	0.98	0.76*	3.55*
East South Central	1.90*	1.02	0.61*	3.73*
South Atlantic	1.52*	0.93*	0.87*	2.21*
West North Central	1.40*	0.99	0.72*	3.61*
East North Central	1.29*	0.94*	0.71*	1.86*
Middle Atlantic	1.10*	0.88*	0.76*	1.21
New England[t]	1.00	1.00	1.00	1.00
Highest educational attainment				
Advanced degree	0.74*	0.85*	0.51*	0.55*
College graduate	0.84*	0.86*	0.58*	0.67*
Attended college	0.98	0.88*	0.72*	0.88
High school or less	0.99	0.87*	0.80*	0.86
Did not specify[t]	1.00	1.00	1.00	1.00
Number of children in household				
5+ children	1.80*	1.48*	4.04*	4.69*
4 children	1.36*	1.29*	1.65*	1.71*
3 children	1.25*	1.08*	1.52*	1.30*
2 children	1.20*	0.95*	0.94	1.02
1 child	1.20*	1.05*	1.03	1.08
No children[t]	1.00	1.00	1.00	1.00

* Denotes statistical significance at a 5% level. [t] denotes comparison group.

Exhibit 60. Rate Ratios from Poisson Regression for Dog Services

	Exams	Vaccines	Emergency Care	Lab Work	Drugs	Flea/Worm	Surgery	Behavior	Euthanized	Other
Age of head of household										
Age 65+	0.96	0.99	1.00	1.30*	1.18*	1.35*	0.95	0.73	2.13*	0.99
Age 55-64	0.95	1.02	0.92	1.27*	1.19*	1.15	0.87	0.59	2.07*	0.90
Age 45-54	0.96	1.03	0.91	1.16	1.13	1.15	0.85	0.58	1.56	0.84*
Age 35-44	0.96	1.01	0.90	1.10	1.07	1.06	0.80	0.41*	1.66*	0.79*
Age 25-34	0.98	1.05	0.83	1.02	0.99	1.14	0.80	0.76	0.98	0.85*
Age < 25ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Not Married	1.01	0.98	0.98	1.02	0.99	0.97	1.02	1.05	0.92	1.05
Household income										
$85,000 or more	1.27*	1.11*	1.04	1.65*	1.22*	1.01	1.13	1.01	0.91	1.57*
$55,000 to $84,999	1.26*	1.14*	1.05	1.59*	1.20*	1.01	1.00	0.75	0.93	1.28*
$35,000 to $54,999	1.23*	1.14*	0.97	1.42*	1.20*	1.00	1.00	0.76	0.95	1.15*
$20,000 to $34,999	1.14*	1.10*	1.02	1.16*	1.09	1.02	0.97	0.90	0.97	1.12
Less than $20,000 ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Race										
Other	1.06	0.95	1.19	1.29	0.99	0.92	1.07	1.86	1.11	1.25
American Indian, Aleut Eskimo	1.06	1.05	1.09	0.91*	0.98	1.23	1.10	0.00	0.37	1.07
Asian or Pacific Islander	1.03	0.96	0.97	1.13	0.84	1.07	1.11	4.80*	1.72	1.12
Black/African-American	0.97	0.95	0.96	0.77	0.74	1.04	0.87	2.07	0.55	1.38*
White	1.08	0.98	0.93	1.21	1.10*	0.94	1.04	2.18	1.05	0.99
Did not specify ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hispanic	1.00	0.99	0.91*	0.98	1.00	1.02	0.90	0.90	1.03	0.90*
Employment status										
Not employed	1.10*	1.07	0.91	1.14	1.26*	1.01	0.56*	0.32*	0.67*	0.96
Retired	1.09*	1.05	1.00	1.19	1.31*	1.05	0.73*	0.48*	0.89	1.10
Part-time	1.08	1.03	0.84	1.03	1.20*	0.99	0.70*	0.47*	0.81	1.05
Full-time	1.06	1.04	0.88	1.07	1.18*	0.99	0.71*	0.58*	0.83	0.92
Did not specify ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Is a Farmer	0.56*	0.77*	1.21*	0.79*	0.68*	1.31	1.09	0.00	0.92	0.73
Household type										
Other	1.01	0.96	1.19	1.11	1.00	0.80	1.79	1.61	1.13	1.13
Twinplex/Duplex	1.06	0.86	0.93	1.04	1.03	0.76	1.45	0.76	0.99	1.06
Condominium	1.09	0.96	1.06	1.11	1.04	0.73*	1.32	1.48	1.02	1.18

	Exams	Vaccines	Emergency Care	Lab Work	Drugs	Flea/Worm	Surgery	Behavior	Euthanized	Other
Mobile Home	0.98	0.94	0.94	0.85	0.99	0.92	0.82	0.51	0.79	0.74*
Apartment	1.11	1.00	0.90	0.90	1.05	0.84	1.00	1.57	0.87	1.03
House	1.03	0.96	0.97	0.91	1.06	0.83	1.18	1.13	1.23	0.86
Did not specify [t]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Region										
Pacific	0.82*	0.92	0.87	0.65*	0.78*	0.56*	1.51*	1.01	0.71*	0.99
Mountain	0.94	0.99	0.82*	0.65*	0.80*	0.28*	1.41*	0.99	0.67*	1.05
West South Central	0.86*	1.03	0.68*	0.65*	0.92	1.00	1.11	0.72	0.54*	1.18
East South Central	0.87*	0.99	0.67*	0.74*	0.95	1.13	0.99	0.40*	0.50*	1.27*
South Atlantic	0.95	1.02	0.67*	0.86*	0.98	1.07	1.09	0.81	0.59*	1.09
West North Central	0.89*	1.01	0.66*	0.75*	0.89	0.84*	1.20	0.57	0.73*	1.24*
East North Central	0.98	1.01	0.71*	0.84*	0.96	0.90	1.20	0.53	0.77	1.06
Middle Atlantic	1.03	1.00	0.84*	0.80*	0.94	0.81*	1.11	1.01	0.70*	0.92
New England [t]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Highest educational attainment										
Advanced degree	1.09	0.97	1.06	1.06	1.14	1.04	1.52	0.71	1.16	1.08
College graduate	1.09	1.01	1.03	0.96	1.07	0.99	1.41	0.64	1.16	0.97
Attended college	1.05	1.00	1.04	0.94	1.03	0.99	1.40	0.59	1.20	0.90
High school or less	0.95	0.96	0.94	0.74*	0.90	0.98	1.31	0.38*	0.91	0.75*
Did not specify [t]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Number of children in household										
5+ children	0.62*	0.80	0.77	0.43*	0.47*	0.87	0.95	0.00	0.00	0.38*
4 children	0.97	1.05	1.11	0.78*	0.74*	1.02	0.91	0.92	0.65	0.94
3 children	0.94	1.01	0.87	0.74*	0.70*	1.00	0.75*	0.39*	0.65*	0.78*
2 children	0.98	1.05	0.83*	0.79*	0.77*	1.05	0.74*	0.66	0.90	0.86*
1 child	1.01	1.01	0.94	0.91*	0.94*	1.01	0.93	1.19	0.91	0.93
No children [t]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Number of dogs	0.99	0.99	1.04*	1.01	1.02*	1.00	1.04*	1.05*	1.04*	0.99

* Denotes statistical significance at a 5% level. [t] denotes comparison group.

Exhibit 61. Rate Ratios from Poisson Regression for Cat Services

	Exams	Vaccines	Emergency Care	Lab Work	Drugs	Flea/Worm	Surgery	Behavior	Euthanized	Other
Age of head of household										
Age 65+	0.87*	0.83*	1.18	0.95	1.04	1.00	0.99	0.61	1.32	1.53*
Age 55-64	0.91	0.89*	1.07	0.92	1.07	0.99	0.80	0.59	1.15	1.60*
Age 45-54	0.90	0.90	1.12	0.91	0.98	1.02	0.90	0.54	1.16	1.25
Age 35-44	0.91	0.89	1.06	0.95	0.94	0.97	0.81	0.84	1.10	1.04
Age 25-34	0.95	0.91	1.07	0.92	0.98	0.94	1.01	0.86	0.96	0.63
Age < 25ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Not Married	1.00	0.95*	1.00	1.04	1.06	0.97	0.92	0.92	1.03	1.05
Household income										
$85,000 or more	1.36*	1.20*	1.20*	1.69*	1.28*	0.75*	1.06	1.57	1.45	1.02
$55,000 to $84,999	1.36*	1.22*	1.19*	1.60*	1.36*	0.80*	1.21	1.09	1.22	1.16*
$35,000 to $54,999	1.32*	1.18*	1.08	1.47*	1.35*	0.89	0.94	1.02	1.15	1.05
$20,000 to $34,999	1.19*	1.10*	1.07	1.22*	1.21*	0.95	0.93	1.47	1.02	0.92
Less than $20,000 ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Race										
Other	1.17	1.18	0.88	1.16	1.18	1.12	1.63	0.50	1.33*	0.37
American Indian, Aleut Eskimo	1.11	1.17	0.91	1.36	1.43	1.19	1.65	0.79	1.12	0.28
Asian or Pacific Islander	1.12	1.02	0.94	1.28	1.15	0.97	0.84	0.78	1.43	0.75
Black/African-American	1.01	1.01	0.94	0.79	0.85	1.07	1.30	0.48	1.22	0.66
White	1.15	1.11	0.86	1.22	1.21	1.10	1.54	0.42*	0.93	0.91
Did not specify ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hispanic	0.83*	0.85*	1.04*	0.82*	0.74	1.15	0.86	1.32	0.98	1.49*
Employment status										
Not employed	1.18*	1.19*	0.92	1.29*	1.32*	0.97	0.73	0.73	0.91*	1.70
Retired	1.17*	1.20*	0.91	1.15	1.15	1.17	0.71	1.05	0.97	1.71
Part-time	1.14*	1.13	1.03	1.17	1.28*	1.12	0.78	1.26	0.93	1.45
Full-time	1.10-	1.12	0.86	1.10	1.09	1.04	0.79	0.82	0.94	1.89
Did not specify ŧ	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Is a Farmer	0.49*	0.60*	0.52	0.59	0.53*	1.08	0.25	1.59	0.69	0.00
Household type										
Other	1.10	1.25	1.00	1.17	1.18	0.63	0.78	0.40	0.77	1.43
Twinplex/Duplex	1.06	1.18	1.45	0.96	1.30	0.79	0.87	0.79	0.90	1.57
Condominium	1.10	1.16	1.33	1.18	1.19	0.52*	1.14	0.87	1.00	1.70
Mobile Home	0.94	1.14	1.33	0.75	1.05	0.86	1.06	0.35	0.54	1.19

	Exams	Vaccines	Emergency Care	Lab Work	Drugs	Flea/Worm	Surgery	Behavior	Euthanized	Other
Apartment	1.10	1.19	1.27	1.02	1.25	0.87	1.23	0.93	0.87	1.40
House	1.01	1.18	1.26	0.87	1.07	0.85	0.86	0.69	0.68	1.39
Did not specify ‡	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Region										
Pacific	0.81*	0.75*	0.94	0.95	1.02	0.85	1.52*	1.24	0.80	1.04*
Mountain	0.87*	0.85*	0.76*	0.81*	0.85	0.34*	1.30	0.74	0.74	1.04*
West South Central	0.81*	0.87*	0.79*	0.87	1.03	0.89	1.04	0.94	0.67	1.00
East South Central	0.86*	0.93	0.66*	0.76*	1.03	1.14	1.09	0.50	0.64*	0.62*
South Atlantic	0.94	0.96	0.82*	1.02	1.17*	1.17*	1.15	0.98	0.85	0.82*
West North Central	0.87*	0.93	0.76*	0.81*	0.95	0.83	1.08	0.87	0.79	0.98
East North Central	0.94	0.87*	0.80*	0.97	1.21*	0.80*	1.23	1.42	0.74	1.08*
Middle Atlantic	1.03	0.96	1.01	1.02	1.14	0.92	0.99	1.45	0.87	1.04
New England ‡	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Highest educational attainment										
Advanced degree	1.05	1.10	1.13	0.94	0.89	0.84	0.50*	1.10	1.02	2.19
College graduate	1.03	1.10	1.04	0.83	0.85	0.78	0.46*	0.70	0.82	2.15
Attended college	0.96	1.05	1.04	0.76	0.87	0.73*	0.46*	0.65	0.73*	2.28*
High school or less	0.83*	0.95	0.94	0.62*	0.70*	0.72*	0.43*	0.62	0.61*	1.46*
Did not specify ‡	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Number of children in household										
5+ children	0.47*	0.66*	0.96	0.43*	0.26*	0.53	0.30	0.00	0.12	0.93*
4 children	0.82*	0.92	0.74*	0.63*	0.70*	1.27	0.98	0.68	0.55	0.63*
3 children	0.82*	0.88*	0.78*	0.57*	0.71*	1.15	0.84	0.12*	0.60	0.65*
2 children	0.88*	0.98	0.79*	0.74*	0.77	0.99	0.86	0.72	0.58	0.76*
1 child	0.94*	0.97	0.96	0.92	0.94	0.97	0.98	1.28	0.85	0.85*
No children ‡	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Number of cats	0.99*	0.98*	1.04*	1.03*	1.04*	1.02*	1.04*	1.03*	1.02*	1.04*

* Denotes statistical significance at a 5% level. ‡ denotes comparison group.

Appendix C: Modeling Approach Used to Forecast Future U.S. Production of Food Animals

The U.S. state-level inventory forecast produced by the IHS Agricultural Services group utilizes a global agricultural modeling complex incorporating a dynamic simultaneous structural partial equilibrium modeling methodology similar to methods used by the University of Missouri Food and Agricultural Policy Research Institute (FAPRI), the United States Department of Agriculture (USDA), and the Food and Agriculture Organization of the United Nations (FAO). The modeling complex consists of 10 partial equilibrium models covering the following sectors (Exhibit 62):

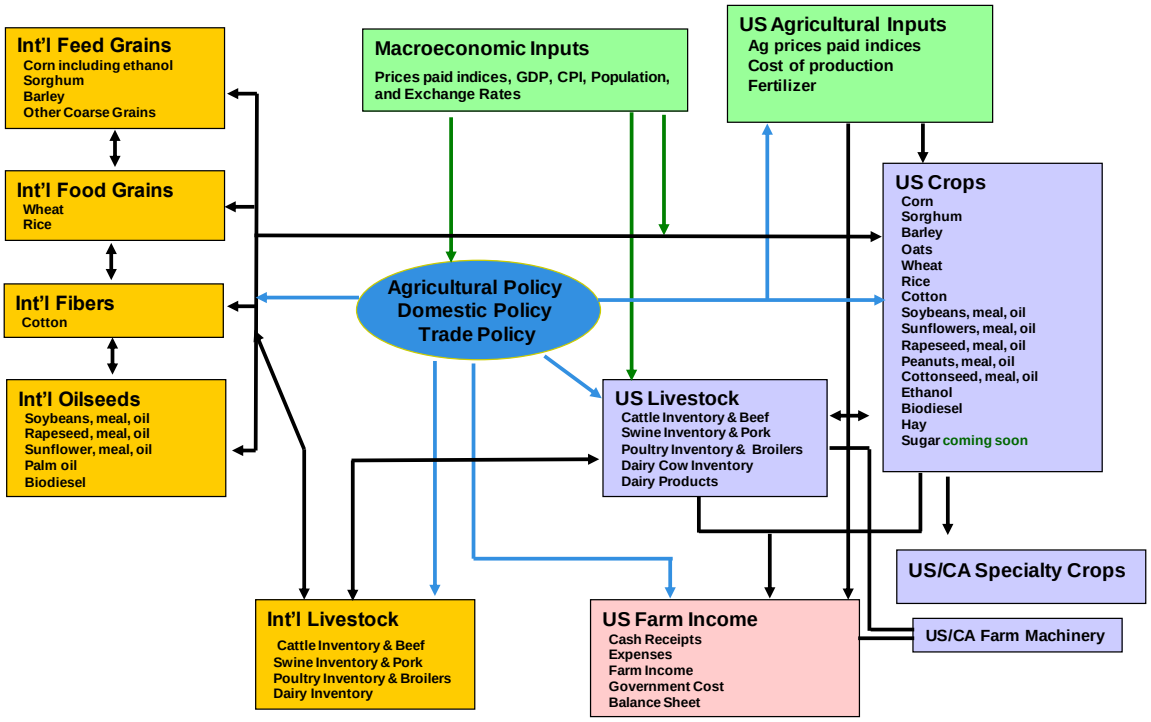
- U.S. Crops and Biofuels
- U.S. Livestock
- U.S. Dairy
- International Livestock
- International Grains
- International Oilseeds
- Oils and Meals, International Cotton
- International Sugar
- International Rice
- International Biofuels

The above were used in conjunction with other independent and more recursive models covering Global Cost of Production, Farm Income (for select countries), and Global Caloric Consumption. Each model leveraged sector-relevant macroeconomic, energy, and exogenous cost variable forecasts produced by other IHS groups in addition to industry-relevant exogenous variable forecasts produced from other forecast models developed and maintained by IHS Agricultural Services.

Each of the partial equilibrium models that made up the global agricultural modeling complex consisted of linear structural equations, which simulated specific behaviors at the country and global region level for both the supply and demand sides of various agricultural markets. The equations applied elasticity-based slope coefficients to behavior specific independent variables in order to solve for the optimal pricing solution for the market. Optimization from the livestock and meat industry perspective was achieved by maximizing current year net returns based on the returns from meat production relative to the cost of producing additional animals in a given year. Demand side optimization was achieved by simulating utility maximization given the utility derived from the relative cost incurred in acquiring an additional unit of a commodity. This was done by applying elasticity slope coefficients to the price of the given commodity, the prices of its relevant substitutes, and average per capita income. The elasticity slope coefficients simulated the average consumer's rate of substitution between two goods given relative price

changes in commodities as well as the consumer's marginal propensity to consume, given changes in income.

Exhibit 62. IHS Global Insight Agricultural Forecasting Model



The global agricultural modeling complex solves for country- and global region-level supply and demand data, as well as animal inventory numbers on country- and global region-levels on an annual basis. The U.S. state- and U.S. regional-level data utilized in this study were produced by applying the U.S.-level inventory data (produced from the larger modeling complex) to a secondary state-level livestock inventory model. This was done by utilizing historic state-level data provided by the USDA's National Agricultural Statistics Services (NASS). The historic state-level data provided by NASS are summed to produce historic regional aggregates for the North Eastern, Midwestern, Southern, and Western sections of the U.S. The annual regional share of the nation total was then calculated and used to forecast the regional share estimate into the future, with quantitative adjustments made to the data as was required by the forecast output.

A similar methodology was used to produce the state-level data. The annual state share of the related regional total was calculated and used to forecast the state share estimate into the future, with quantitative adjustments made to the data as required. The summation of the regional values was then compared to the national total to insure output consistency. Likewise, the state-level data were summed for comparison to the relevant regional data.

The modeling framework produced annual estimates of national-, regional-, and state-level inventories of cattle (including specific breakouts for beef and dairy cows), hogs (including a specific breakout for hogs used for breeding purposes), the number of broiler-type chicks placed, total sheep and lamb inventories, and the total inventory of turkeys raised for slaughter. The cattle inventory forecast was for January first-spot inventory values. This was due to the annual dynamics of the cattle inventory. The actual number of cattle that live within a given year was neither available nor necessary for measuring the U.S. beef and dairy industry. As cattle go through predictable gestational and life cycles, an annual spot inventory number was sufficient for determining the likely path of either expansion or retraction for the herd during a given year.

December first-inventory numbers were used as an appropriate proxy for the hog industry, for reasons similar to those stated above for the cattle industry. Although hogs have a shorter gestational period, as well as a shorter time span from farrowing to slaughter, the period was long enough and predictable enough that the annual inventory numbers could sufficiently determine the industry's path of expansion or retraction during a given time period. The same was true for the sheep and lamb inventories, which were recorded as the January first number, similar to cattle.

The inventory data for the turkey and broiler industries were different from the other three categories, as these industries were able to move at a faster pace than the other industries. The greater flexibility of the poultry industry rendered spot inventory forecast less accurate, as inventory numbers could be quickly retracted and then repopulated within a calendar year. Thus, in order to determine the size and direction of the two poultry industry sectors, annual livestock production figures were used. The broiler industry was measured by the number of broiler type chicks placed on feed during a given year, while the turkey industry was measured by the number of turkeys raised for slaughter in a given year. The two metrics were similar in that both measure the volume of animals that moved through the industry during a given year. The significant difference between the two data types was that the broiler inventory was measured at the beginning of the production process, while the turkey inventory was measured at the end of the production process.

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