ACLAM/ASLAP

ECONOMIC REPORT

2017

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INTRODUCTION

In 1966, an extensive change in the use of specific warm-blooded animals for research and other purposes was witnessed with the enactment of the Animal Welfare Act and associated regulations by the Federal Government, as administered by the USDA (Alvarado and Dixon, 2014). Prior to that year there was no federal law in the United States specifically addressing humane care and treatment during the acquisition, commercial traffic and transportation of these subjects, or standards of care for these species when used in research or for exhibition or for use as pets. The legislation established a new social contract for the use of animals, devising a minimum acceptable set of standards of care by scientists, transporters, and commercial exhibitors and dealers. Since its ratification, the Act has been revised several times to address social undercurrents and to enhance the wellbeing of a substantial variety of animals (Alvarado and Dixon, 2014). The 1985 version of the law, for example, clarifies the notion of "humane care," to ensure that a proper environment is maintained for animals' physical and psychological development, and defines the practices considered painful for animals used in research, teaching or testing. Unannounced inspections of the animals and areas where they are housed and handled, as well as examination of records and other documents, are the primary methods by which USDA enforces these regulations. Noncompliance can result in monetary penalties, license suspensions and revocations, and confiscation of animals.

Since this legislation was enacted, several other federal laws with specific requirements regarding the use of animals in research with associated components of laboratory animal veterinary care have been promulgated, including the Health Research Extension Act of 1985 which mandates compliance with the Public Health Service (PHS) Policy on Humane Care and Use of Laboratory Animals (NIH, 2015), the Federal Food, Drug, and Cosmetic Act, and the Federal Insecticide, Fungicide, and Rodenticide Act, among others. Noncompliance with PHS Policy can jeopardize an entire institution's privilege to use live vertebrate animals for scientific study and teaching, and in obtaining grants awarded by the National Institutes of Health and the National Science Foundation. In fact, repayment to the federal government of funds awarded to an institution back for significant non-compliance regarding animal welfare requirements has been mandated many times, highlighting the importance of a fluent and effective implementation of the extensive animal care standards. Voluntary assessment and accreditation of laboratory animal care programs is available through the Association for Assessment and Acreditation of the Laboratory Ainmal Care (AAALAC) International, a private non-profit organization, which provides a

peer-review process that involves nearly 1,000 companies, universities, hospitals and government agencies around the world. Responsibilities for establishing and maintaining appropriate and compliant programs of animal care often fall upon the institution's laboratory animal veterinarians, which are called upon to utilize their advanced training and experience.

The Guide for the Care and Use of Laboratory Animals (National Research Council, 2011) and the *Guide for the Care and Use of Agricultural Animals in Research and Teaching* (Federation of Animal Science Societies, 2010) describe the primary standards for animal research, teaching and testing; and the role of the attending veterinarian with direct or delegated authority to provide medical care and relieve severe pain or distress, including euthanasia, to enable the highest standards of care is strongly emphasized in these guiding documents. In all cases, there must exist an Institutional Animal Care and Use Committee (IACUC) appointed by the chief executive officer to review all proposed uses of animals, to inspect the animal facilities and review the program of care, and to investigate any concerns involving the care and use of animals at the institution. Laboratory animal veterinarians provide a variety of essential roles in helping IACUCs to fulfill their mandates.

The American Society of Laboratory Animal Practitioners (ASLAP) was formed in 1967 subsequent to the enactment of the Animal Welfare Act into law. An allied member organization in the AVMA House of Delegates, ASLAP is guided by the mission to advance laboratory animal medicine and welfare through member development and representation in the greater professional community. The AVMA's Animal Welfare Committee and the Legislative Advisory Committee both have ongoing representation by ASLAP to help guide animal welfare related policies and to maintain inclusion of animal research needs as a component of animal welfare policy within the AVMA's legislative agenda. ASLAP membership is open to all veterinarians, veterinary residents and veterinary students with interest in this field, and requires endorsement by an existing member. The ASLAP Veterinary Student Liaison Committee is represented at all North American veterinary schools and helps bridge information and opportunities for students considering the pursuit of specialization in laboratory animal medicine.

The American College of Laboratory Animal Medicine (ACLAM) was founded in 1957 to encourage education, training and research in laboratory animal medicine and to recognize veterinary medical specialists through certification and ongoing continuing education. Becoming a Diplomate in this specialty requires completion of a recognized post-DVM training program in laboratory animal medicine

at least two years in duration, or six years of full-time experience in applicable laboratory animal medicine activities. Veterinarians must be graduates of an AVMA-accredited college or instead possess an ECFVG (Education Commission for Foreign Veterinary Graduates) or PAVE (Program for the Assessment of Veterinary Education) certificate. First-author publication of an original research article demonstrating knowledge of the scientific method in a peer-reviewed journal is another qualifying requirement before candidates are eligible to take the certifying examination. Through these requirements, ACLAM Diplomates must demonstrate their expertise in laboratory animal biology, laboratory animal resource management, clinical laboratory animal medicine and surgery, laboratory animal pathology, and animal experimentation. The ACLAM publishes a wide variety of position statements on key topics applicable to the animal care and use programs, such as the provision and evaluation of adequate veterinary care for laboratory animals, which provide essential guidance for high quality programs in addition to the requirements of federal regulations.

As defined by the International Association of Colleges of Laboratory Animal Medicine (http://www.iaclam.org/lav.html; retrieved April 2017), laboratory animals are distinguished from other animals by their intended use in research, teaching or testing and in some cases, because they possess specialized anatomic, genetic, physiologic or metabolic conditions that differ from other members of the same species. While the term "laboratory animals" could potentially include a wide range of wild and domestic species used for food or fiber production or kept as pets, in practice the term is generally applied to those animals with a defined health and genetic status and usually purpose-bred for their intended uses in research. Laboratory animal veterinarians (LAV) help oversee the proper use of animals in research, teaching and testing environments to ensure strict regard for their welfare, however, these veterinarians' role is not restricted to regulation. They are also engaged in a variety of tasks including animal model development, clinical medicine, surgery, anesthesia, disease prevention, individual and population-based health and genetic quality control screening, program and fiscal administration, instruction and training, research or research support, policy development and implementation, and animal welfare regulatory compliance. Larger institutions may employ veterinarians with only one of these roles as their primary responsibility, whereas smaller institutions may need all roles filled by one or two individuals. Consulting (i.e., self-employed) opportunities exist to enable the knowledge and skills of laboratory animal veterinarians to benefit smaller institutions, or to help provide professional guidance for larger institutions in the interests of providing the highest quality

of care. Thus, there are many position levels and sub-specializations within the broad field of laboratory animal medical practice to meet the various roles and responsibilities required for a fully functioning institutional program of animal care and use.

Non-compliance with the myriad laws, regulations and policies governing the use of animals in research, teaching and testing can result in the immediate suspension of the activity, the suspension or revocation of licenses allowing the use of animals, the issuing of monetary civil penalties, and the repayment of federal grants and contracts awarded to an institution, among other consequences. Citations of noncompliance with federal animal welfare standards can also become public information through the Freedom of Information Act, with the result of long-term negative effects on the institution and the risk of reduced future business activity, thereby causing economic harm to a research enterprise and its mission of scientific discovery. The animal welfare laws, regulations and policies give significant authority and place considerable responsibility on veterinarians to uphold animal use standards of care – a constantly evolving challenge, given the variety of species used and the expanding domains of investigative research. The legal requirement, according to the federal animal welfare laws and policies, to employ a qualified veterinarian with demonstrated training and/or experience in the care and management of the species being attended differentiates laboratory animal medicine from other sectors within the practice of veterinary medicine. Laboratory animal veterinarians are largely employed in the public sector, such as in research institutions, academia, and government civil or uniformed services, while some are employed by corporations and a few are self-employed professionals who provide consulting services on a full- or part-time basis as needed to meet an institution's level of need. Administrative leadership roles in large-scale, species-diverse animal research programs are commonly fulfilled by laboratory animal veterinarians; these can involve more than 100 animal caretakers, veterinary support staff, and administrative professionals in multiple facilities of large academic campuses or commercial companies, thus further distinguishing this field from many other employment sectors of veterinary medicine.

At the time of this writing, ASLAP had 822 members and ACLAM had 979 Diplomates in active status. Because some individuals are members of both organizations, the total population size of laboratory animal veterinarians is estimated to be approximately 1,400 people. To help these organizations in their strategic planning and efforts to provide managerial and predictive information to their members, the American Veterinary Medical Association (AVMA) conducted two major surveys during calendar year

2015, the employment and the compensation surveys, results of which are presented in this report. A combined ASLAP and ACLAM membership roster, with duplicates purged, was provided to the AVMA to enable survey data collection by e-mail invitation. Other supporting documents were also available for analysis.

The overall objective of this report is to provide valuable information to both ACLAM and ASLAP members and to prospective laboratory animal veterinarians, as well as to guide each organization in decision making. Essentially, this study report aims to:

Assess the national economic environment and make inferences about the market for laboratory animal veterinarians and veterinary services and the future of the profession;

- Provide a current overview of the laboratory animal veterinarian workforce;
- Discuss the level of underemployment among laboratory animal veterinarians;
- Present professional income figures and identify factors affecting income; and
- Discuss the educational debt of laboratory animal veterinarians.

Data used in this study were obtained from both primary sources (AVMA employment and compensation surveys) as noted above and secondary sources (macroeconomic data from the Bureau of Economic Analysis, AVMA Report on Veterinary Compensation, and ACLAM/ASLAP Salary Survey of Laboratory Animal Veterinarians).

The objective of the *AVMA Employment Survey* was to evaluate the conditions of employment and the positions of employees in the laboratory animal veterinary sector. The AVMA Compensation Survey was fielded to understand the difference in earnings within the industry and provide an overview of the debt level of veterinarians in this sector of the veterinary profession. This survey also collected information to evaluate the financial conditions of private practices and to determine the overall satisfaction of laboratory veterinary professionals with their level of compensation.

The Employment Survey was initially launched in March 2015 and was distributed to 1,184 members from the ACLAM/ASLAP membership list (sampling frame). The survey was open for three weeks with a

reminder sent at the end of each week to encourage greater participation. On March 23, 2015 the survey was officially closed, with a response rate of 39.7 percent reached. The Compensation Survey is more detailed in terms of information regarding veterinarians' level of compensation, the level of student loan debt, the duration of debt repayment, the mechanisms of repaying debt, and other factors useful in explaining economic conditions. The AVMA Compensation Survey was sent to 1,319 members. The response rate for the AVMA Compensation Survey was lower (20 percent) than that for the employment survey.

The AVMA Employment Survey is divided into three major sections, with a total of 65 questions. The three sections cover demographics, internship and residency participation, and current employment. The demographics section inquires as to the general characteristics of the respondents. The internship and residency section asks about program and species focus, as well as the primary focus of internships and residencies in which respondents participated, and respondents' satisfaction with these experiences. The last section gathers information regarding the employment status of respondents, the type of institutions that employ them, position types, income, the average number of hours worked per week, methods of compensation, types of benefits received, and satisfaction with current employment.

In addition to demographics queries and other general questions, the AVMA Compensation Survey, which was distributed to the broader AVMA membership, contains questions exclusive to veterinarians working in private practice and to private practice owners, distinguishing earnings data between laboratory animal veterinarians working in the public sector and those in private practice. Information collected from private practice owners primarily focuses on business management and financial aspects of practices.

EXECUTIVE SUMMARY

Surveying the landscape of the "field" is instrumental in any trade organization or professional association efforts to build a foundation for strategic decision-making. Professionals who are members of these kinds of groups, in turn, might seek information relative to industry employment and compensation trends that analysis through an objective industry study can provide. For the American College of Laboratory Animal Medicine and the American Society of Laboratory Animal Practitioners, and across the veterinary industry at large, AVMA survey findings on matters influencing career choices

for these professionals and discussion of opportunities and challenges for this sector of the profession are expected to be of interest.

Observing an improvement in the U.S. job market at least through calendar year 2015 when this study was conducted, the report that follows declares that study findings point to favorable economic conditions that are expected to continue for at least the eight to 12 months to follow. Further, the report notes that the high demand for laboratory animal veterinarians in the United States and an unusual combination of features for their responsibilities make them among the highest compensated professionals in the veterinary field, a situation likely to attract newcomers to the specialty – at least until the demand for such talent is fully met or exceeded. Until that time, however, professionals in this sector will command higher prices for their labor.

Age and Time

Supplying fresh talent to the market for veterinarians are the 28 U.S. colleges of veterinary medicine and the 19 foreign colleges that are U.S. accredited. Assuming existing suppliers of graduates maintain their production plans, an increase in the supply of veterinarians will likely emerge in 2018 when two new schools start to turn out graduates. And, even with an applicant-to-seat ratio post-recession decline, 2015 saw a ratio above 1, which translates into more applicants than spots at institutions of learning.

While younger veterinarians – i.e., age 40 and under – make up more than three quarters of the AVMA membership, less than a third of laboratory animal veterinarians fall into this age group – a phenomenon likely to do with the length of time necessary to achieve the specialization. Once they get there, according to survey respondents in 2015, more than half work in college/university environments, while nearly 15 percent are employed in pharmaceutical, biotech or other industries; slightly more than 10 percent are found in federal or state government, some 5 percent are self-employed, and the rest work in not-for-profit organizations or hospitals, other institutions, and contract research organizations.

Work patterns emerge among the group, with veterinarians employed in not-for-profit organizations or hospitals putting in the highest mean number of hours per week at nearly 48 hours worked. Veterinarians in academia clock in a slightly shorter work week at 46.4 hours, slightly higher than uniformed services veterinarians. Likewise, some differences are seen in the distribution of net underemployment across institution types. Those with higher net underemployment are academia with

-398.8 hours, followed by industry (-99.8 hours), and civil service (-57.0 hours). Uniformed services veterinarians have the lowest net underemployment with -18 hours.

Earnings and Debt

In addition to revealing that board certification and completion of a residency increase earnings, analysis shows that when only the type of employment is considered, veterinarians employed in industries or commercial organizations within the laboratory animal sector of the veterinary field earn 21 percent more than veterinarians in academia; uniformed service veterinarians earn an income that is about 13 percent lower than professionals in academia. Men in the sector earn on average 12.7 percent higher income than women. Regional variations in income are also seen, with veterinarians in ZIP Code Region 0 having the highest mean salary and veterinarians in Region 9 the lowest.

Educational debt comparisons across employment type show that veterinarians in contract research organizations have, at $61,400, the highest DVM debt, followed by veterinarians in not-for-profit institutions, who average $58,083 in debt. Where lab animal veterinarians are working showed distinctions in debt load, as well: Veterinarians in this sector who were employed in Region 1 reported the highest mean DVM debt, at $68,067.

Continuing study of the workforce issues pertinent to the laboratory animal veterinary sector, as for all other AVMA's Board of Veterinary Medical Specialties (ABVS)-recognized specialties, should be encouraged.

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This section covers three topics. The first part presents an overview of economic conditions in the United States and explains the link between selected macroeconomic variables and the performance of the veterinary profession. The second part presents a look at the market for veterinary education, that is, the demand for veterinary education and the supply of veterinarians. The last part of this report analyzes the market for laboratory animal veterinary services.

The cost of education has increased dramatically during the last decade, leading to a debate about the causes of this escalation. Some researchers have pointed out the nature of medical education as the main source of the increasing cost of education. The rapid technological changes in medicine make updating facilities and equipment and remaining competitive difficult for veterinary colleges, which may be reflected in the increasing cost per seat.

One of the consequences of the increasing costs of education is the high rate of indebtedness of many graduates. In 2016, the mean debt for all veterinary graduates was $143,758, and more than 11 percent had debt above $250,000 from veterinary education alone. For veterinary graduates, servicing that debt is a profound problem, considering that 56 percent of all graduates have a debt-to-income ratio (DIR) of 2 or higher and will likely require some assistance with their debt service obligations. The market for veterinary education, unlike the market for general education, is considerably restrictive, with entry to the market granted only through accreditation, which is provided by the AVMA Council on Education to institutions that meet certain standards of quality.

The market for laboratory animal veterinary services is restricted also: to specific buyers. End-users of laboratory animal veterinary services are primarily universities, industries, research institutions and government agencies. Because households do not purchase services from this sector of the veterinary services profession, factors affecting the performances of this market will differ markedly from those of the general market for veterinary services.

1.1 GENERAL ECONOMIC CONDITIONS AND THEIR IMPLICATIONS TO THE LAB ANIMAL VETERINARY INDUSTRY

Gross Domestic Product (GDP) is the most widely used metric to gauge the economic health of a country. The most commonly used method of computing GDP is to sum up the expenditures of all

individuals and businesses nationwide. The nominal GDP must then be converted into real GDP using a GDP deflator for year-to-year comparisons. When nominal GDP is standardized into real GDP, a conclusion can be drawn as to whether the economic performance has increased or decreased relative to a previous time period. The U.S. Bureau of Economic Analysis releases four quarterly reports annually to inform decision makers about the trend in GDP. A high GDP suggests an expansion in economic activity and, consequently, a lower unemployment rate and higher wages are expected. In contrast, when GDP is down, people might be experiencing job loss or a decrease in salaries, demand for goods and services might be declining, some businesses may close, and public spending might drop substantially.

Figure 1 presents U.S. real GDP and the change in percent it reflected from 2000 to 2015. Real GDP has increased every quarter except for the period December of 2007 to June of 2009, corresponding to the period of the last economic recession. As of the third quarter of 2016, the GDP for the United States was estimated at above $18.4 trillion. Goods and services production accounted for more than $12 trillion, with the remaining going to investment, government spending and net trade.

The portrayal of GDP offers insight into the state of the national economy and the direction the economy is expected to take. This information facilitates decision making to support strategic planning, based on a likely economic scenario. When economic activity is increasing and GDP is rising, the national economy is said to be in an economic expansion. During an expansion households demand more goods and services than during a recession. Veterinary businesses, like most other businesses, should benefit from this increase in demand. New jobs would be generated to meet the surge in demand and wages will improve to reflect the increased sales generated by clinical veterinary practices. New graduates would find a more favorable job market in this scenario, with a lower probability that they would be unemployed after graduation.

Examining the percentage change in real GDP enables a short-term comparison of trends and, more specifically, helps professionals in an industry prepare for adverse consequences of an economic downturn. A recession occurs when real GDP declines for two consecutive quarters, and information about an increasing probability of an economic contraction and expansion is available through the Conference Board's Leading Economic Index (LEI). By following this monthly LEI, business owners can anticipate contractions and expansions 12 to18 months in advance.

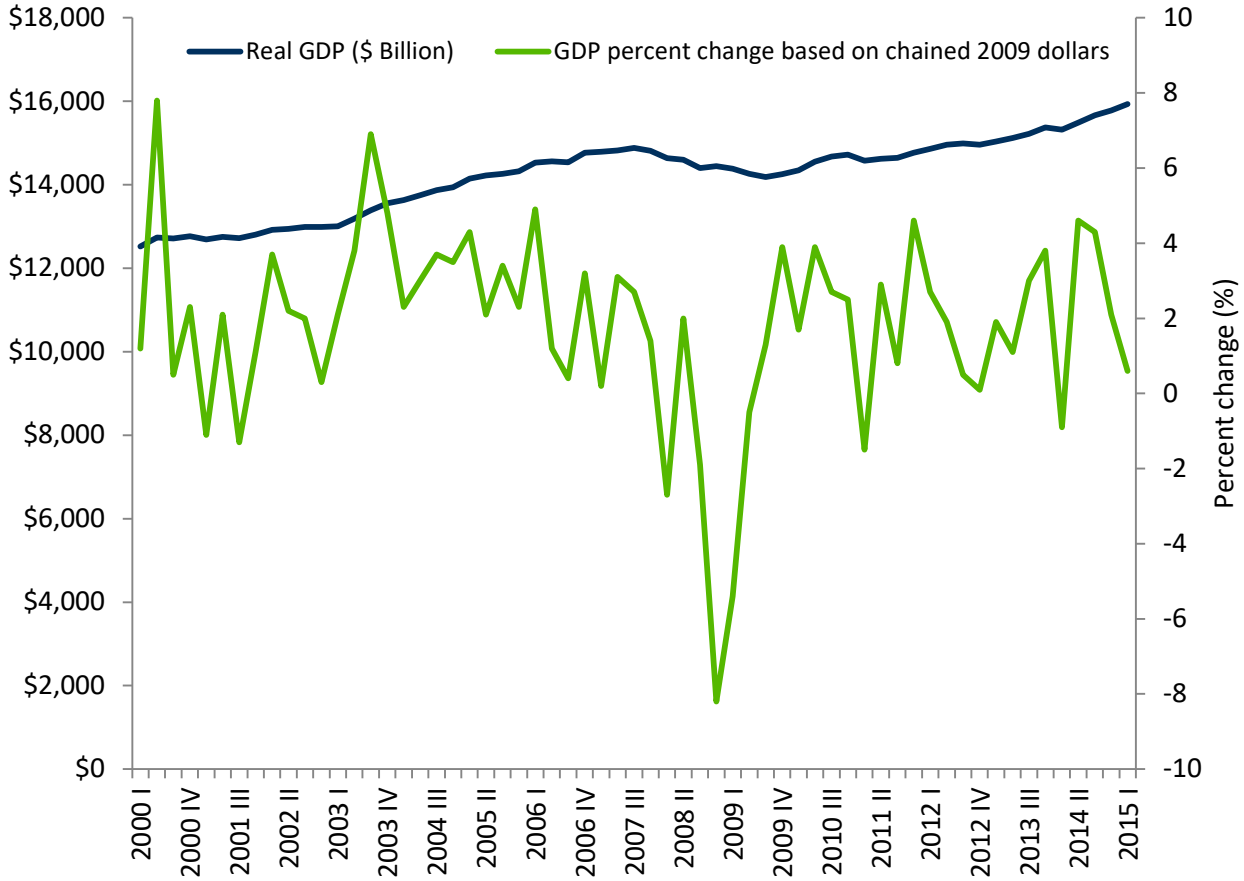


Figure 1*: Real GDP and Percent Change in Real GDP (Quarterly data 2000-2015)*

Source: U.S. Bureau of Economic Analysis

1.2 LINK BETWEEN GDP AND UNEMPLOYMENT

Economist Arthur Okun was the first to produce a scientific analysis of unemployment and economic growth. Okun's work yielded a concept now known as Okun's Law, which argues that a quantity of goods and services produced depends on the amount of labor used. That is, when the economy is growing rapidly, many jobs have to be created to meet the demand that exists in the growing economy. Although there has been much debate over the stability of this relationship and the extent to which the rate of increase in the economy affects unemployment, many economists agree that when GDP grows rapidly, the unemployment rate declines and slower or negative growth is associated with a rising unemployment rate. Figure 2 shows the real GDP and the unemployment rate in the last four decades. The unemployment rate was relatively high in the early 1980s when real GDP was below $8 trillion, then

falls off to 5.6 percent when real GDP reached $8.5 trillion. In 2000, the unemployment rate fell to its lowest level when the GDP stood at approximately $13 trillion. Due to the economic downturn in the late 2000s, the GDP growth was undermined and the unemployment rate increased drastically, reaching a level not seen since 1980.

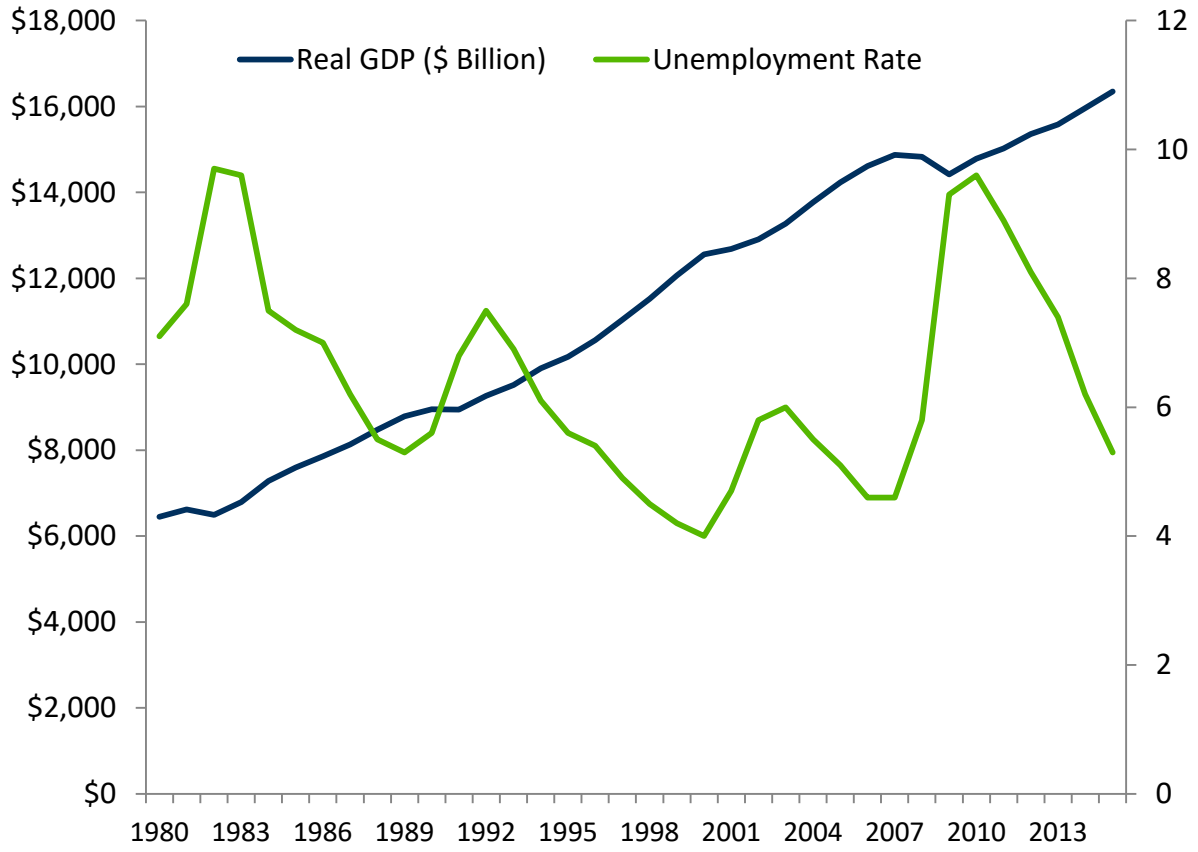


Figure 2*: Real GDP and Unemployment in the United States*

Source: U.S. Bureau of Economic Analysis

Figure 3 is more explicit in explaining the the relationship between variation in real GDP and the unemployment rate. They both move in the same direction but at a different rate of variation, with the variation in the GDP having a lagged effect on the unemployment rate. That is, when economic growth slows, the effect on unemployment will not be evident until some time later. As the downturn persists, employers will get rid of some employees to reduce inefficiencies in production.

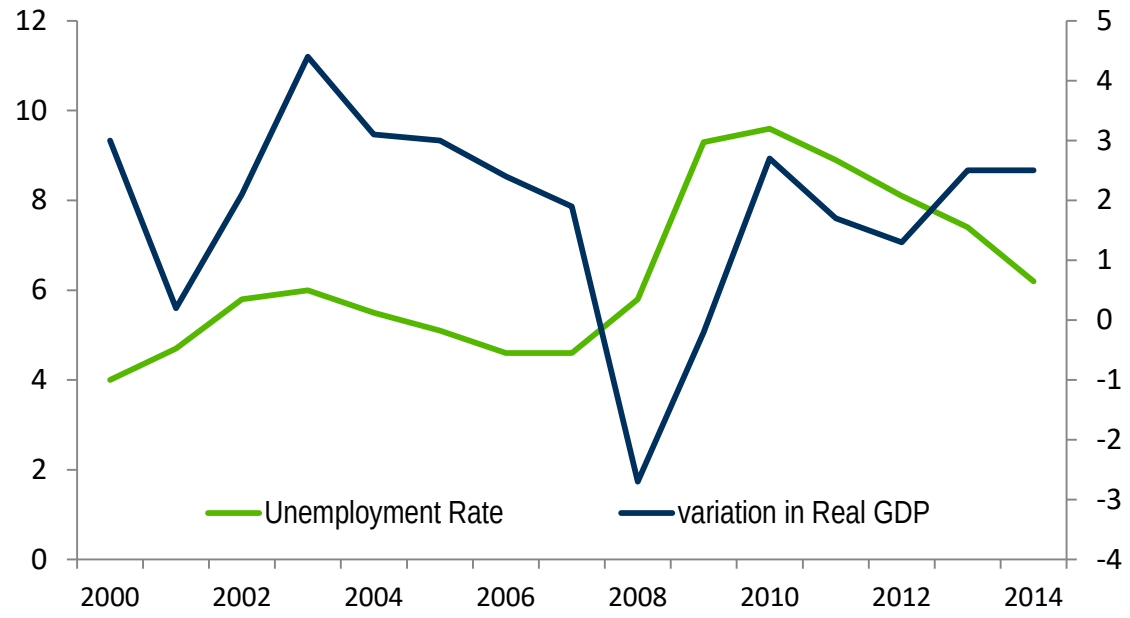


Figure 3*: Variation in Real GDP and the Unemployment Rate in the United States*

Source: U.S. Bureau of Labor Statistics

The employment-to-population ratio, the ratio of the total labor force currently employed to the total working age population, is also used to assess the health of the labor market. Figure 4 illustrates the employment-to-population ratio of the United States from 2000 to 2016. This ratio shows that each economic crisis led to a reduction in the employment-to-population ratio. The last recession, which was a deeper than average recession, had greater adverse effect on the ratio in that it fell from 63 percent in 2008 to 58.3 percent in 2010. Since then, the ratio has recovered, with a net improvement nearing 60 percent in March 2016.

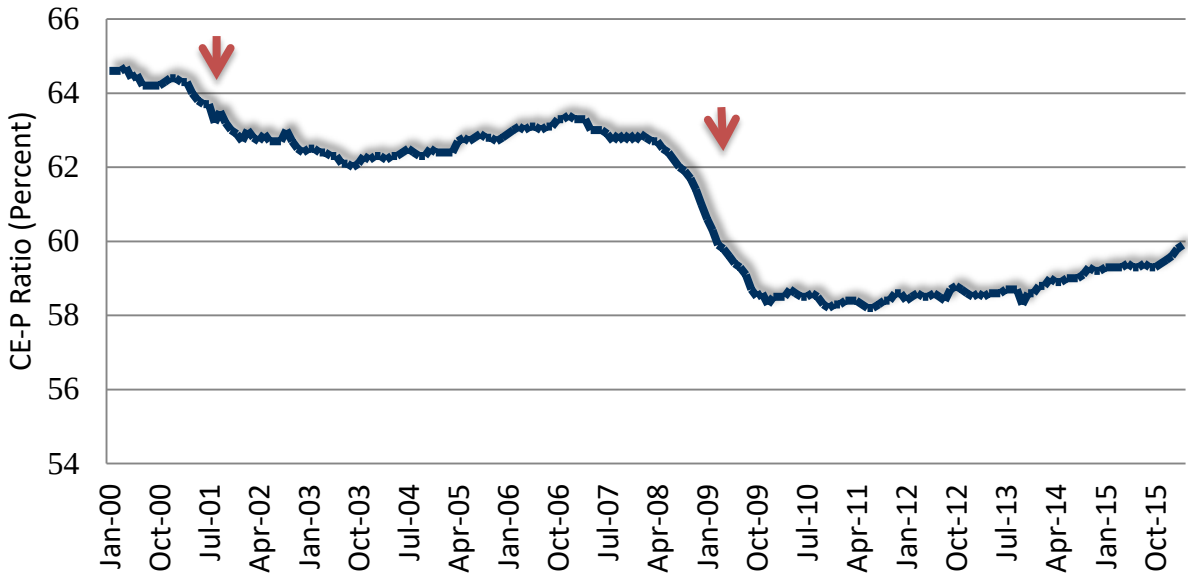


Figure 4*: Civilian Employment-Population Ratio in the United States (2000- 2016)*

Source: U.S. Bureau of Labor Statistics

In the light of the macroeconomic variables (real GDP and the unemployment rate) presented above, we can conclude that the general condition of the economy is improving and that unemployment is declining, which can be translated as an improvement in the job market. The expansion of economic activity should be reflected as an increase in the level of household income. The increase in households' disposable income will benefit all sectors of the economy including veterinary services, at least for clinical practitioners.

1.3 THE FUTURE OF THE VETERINARY PROFESSION

The ABVS first recognized laboratory animal veterinarians as the third veterinary specialty. The first known position officially created for a laboratory animal specialist was in 1915 (Alvarado and Dixon, 2014): a post occupied by Simon D. Brimhall at the Mayo Clinic. With Congress passing the Public Health Service Act in 1944, the nation saw a substantial increase in biomedical research fueled by tremendous federal support. A direct consequence of the approval of the Public Health Service Act was a substantial increase in demand for veterinarians in general, and specifically, for veterinarians who could help with the use of animals in biomedical laboratories. The ACLAM specialty certification was instituted by the AVMA ABVS in 1957.

In the past 100 years, the laboratory animal veterinary specialty has grown considerably. Today more than 1,400 laboratory animal veterinarians are practicing nationwide. Their ultimate goal is to ensure that animal health and welfare are maintained in scientific environments. The demand for laboratory animal veterinarians depends on the number of veterinary schools producing graduates interested in the LAV specialty and on the number of institutions engaged in biomedical research, which is the largest consumer of laboratory animal veterinary services needing these professionals. The expansion of these markets, in turn, depends on the economic conditions of the nation. Our analysis indicates that economic conditions will remain favorable at least for the next eight to 12 months. Given the alignment in party affiliation of the new administration and Congress, rapid changes in policy could prolong or shorten the current expansion. Also of potential significance to the market are the universities waiting for AVMA accreditation or considering launching a veterinary medical college, and the robust number of high-caliber veterinary medical school applicants.

Laboratory animal veterinarians are among the best paid veterinarians in the United States due to the high demand for their services. The average annual professional income of laboratory animal veterinarians is well above the average income of most veterinary practitioners. This state of affairs will continue to pull many students and practitioners toward the LAV specialty until the demand and supply of laboratory animal veterinary services is reached. With the continuous entry of new consumers into the market for LAV services, demand will shift up along the supply curve creating an upward trend for price. Each new business that requires research animals generates additional demand for LAVs that must be filled. The income for laboratory animal veterinarians has been consistently higher than all other veterinary professionals, indicating that the growth in the demand for LAV services has exceeded the growth in supply, especially compared to all other segments of the veterinary profession.

SECTION II: MARKET FOR VETERINARY EDUCATION

The market for veterinary education in the United States is characterized by a limited number of sellers (colleges of veterinary medicine) bringing a relatively homogeneous product, the DVM degree, to a well-restricted market (barriers to entry). As of December 2016, 30 U.S. colleges of veterinary medicine are in operation along with 19 foreign colleges that are U.S. accredited. The accreditation is conferred by the AVMA Council on Education and only accredited colleges are allowed to grant the doctoral degree in veterinary medicine. The 28 AVMA-accredited U.S. colleges of veterinary medicine currently graduating

students are supplying almost 3,000 veterinarians to the domestic market each year, while the foreign U.S.-accredited schools are producing an additional 500. Provided that existing suppliers have maintained their production plans, an increase in the supply of veterinarians might be seen in 2018 with the first graduates from Midwestern University and Lincoln Memorial University. Furthermore, the applicant-to-seat ratio has consistently increased since 2004, reaching a peak of 2.4 in 2008 then declining during the post-recession period to its lowest level in 2012 (Figure 5). In 2015, the ratio was still above 1, meaning that there were still fewer seats available than applicants willing to buy.

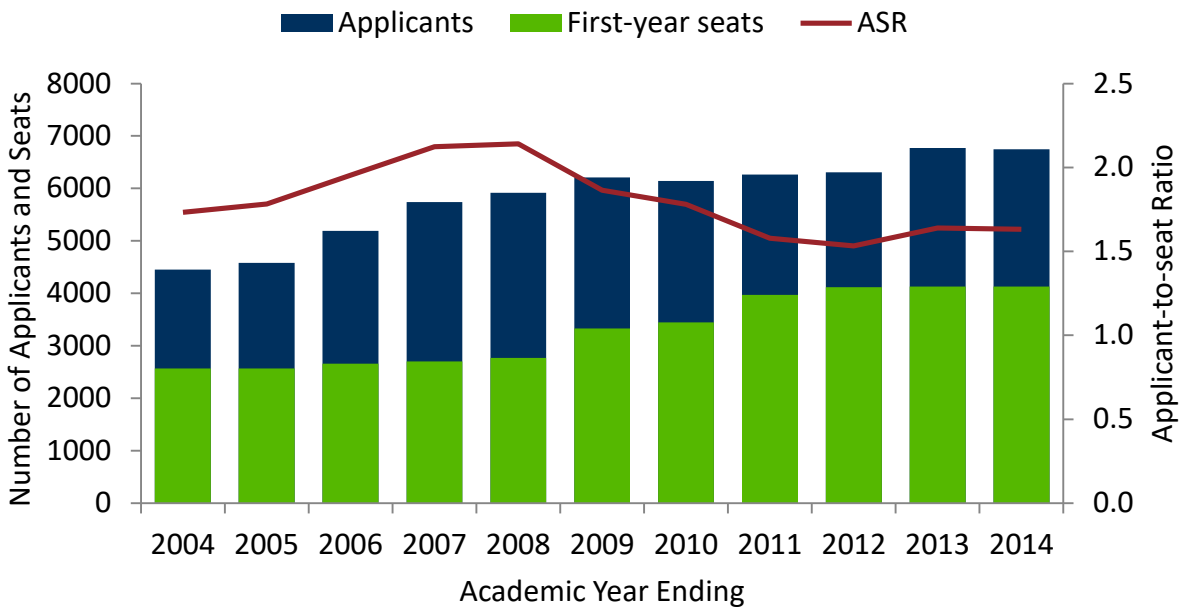


Figure 5*: Applicants, Seats Available, and the Applicant-to-seat Ratio, 2004-2014*

Source: AAVMC internal data reports (2004-2014)

Prices of veterinary college seats in general, and prices of non-discounted seats (out-of-state and private university) in particular, are now running more than $200,000, experiencing some of the highest price increases for the two last decades. The average tuition for discounted and for non-discounted seats in 2015 for U.S colleges of veterinary medicine was $103,327 and $191,710, respectively (AVMA, 2016). Figure 6 shows the tuition and fees by veterinary medical college in 2015 and the rate of increase in tuition and fees from 1999 to 2015. Midwestern University, Western University and Lincoln Memorial University (private, non-discounted seats) had the highest cost of tuition and fees in 2015 with $54,758, $49,595 and $42,275, respectively. In terms of percentage change in tuition and fees during the last 15 years, however, Tufts

University and the University of Wisconsin-Madison are among the colleges with the lowest cost changes. Among public schools with both discounted and non-discounted seats, North Carolina State University and Kansas State University have both increased their tuition and fees by more than 150 percent since 1999.

One reason for the increase in the price of seats at U.S. colleges of veterinary medicine is the rise in the cost of production. Veterinary education requires special types of facilities and equipment and accreditation is based on the quality of these. Poor quality facilities can cause a loss of accreditation. In addition, with the decline of federal and state support, keeping a research laboratory up to date with new technology is expensive. A large part of the costs borne by the colleges is transferred to students in the form of increased tuition and fees. Other reasons for escalating costs are common to other sectors of the economy, and include rapidly increasing health care costs and retirement benefits for employees, increased regulation and accountability, and rising maintenance and operations costs.

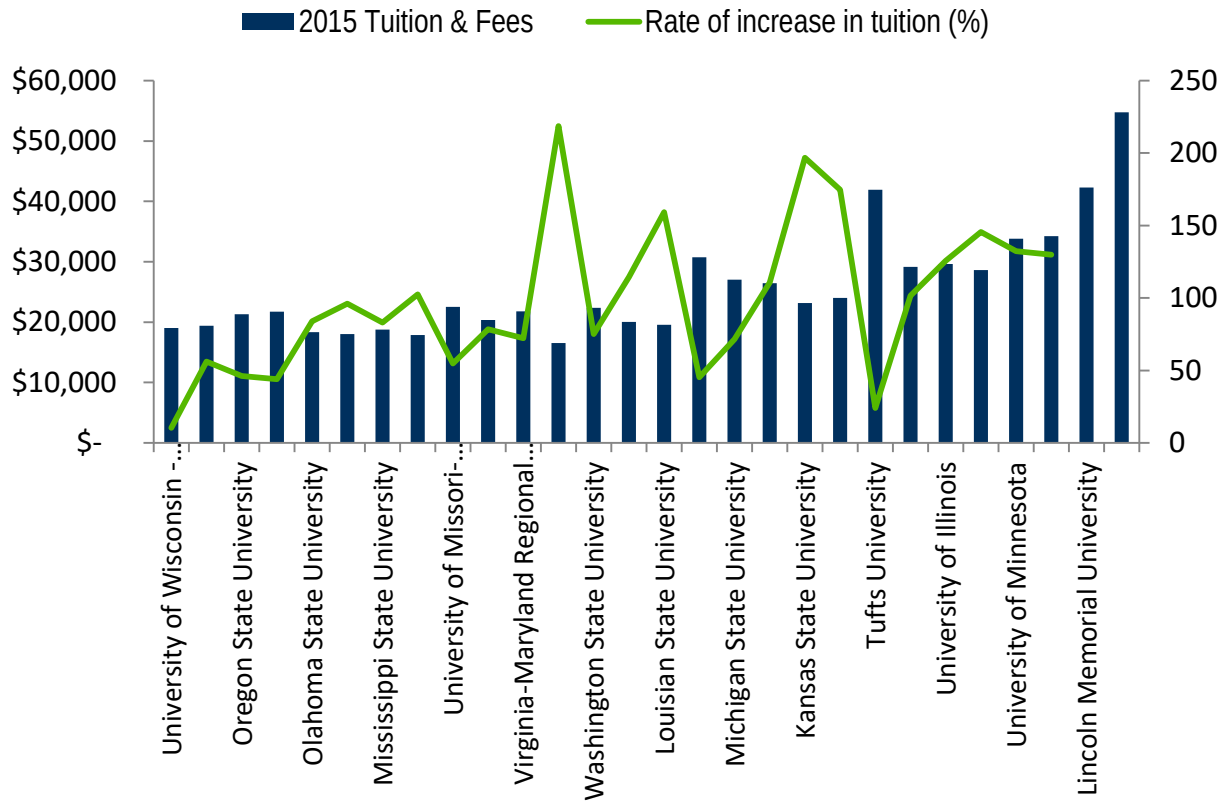


Figure 6*: 2015 College Tuition and Rate of Increase since 1999*

Between 2001 and 2015, approximately 34,000 new veterinarians graduated from the U.S. AVMA-accredited U.S. colleges of veterinary medicine. Figure 7 shows the number of new veterinarians by gender who graduated from the U.S. colleges of veterinary medicine since 2000. The number of female graduates is trending up while that of male veterinarians is almost flat with an annual average of around 590 individuals. The rate of change in the number of veterinarians for each gender is illustrated in *Figure 8*. Except for 2008 (during the recession) and 2013, the rate for female veterinarians has increased each year, while the percentage change in the number of male graduate veterinarians has increased and decreased in roughly the same number of years.

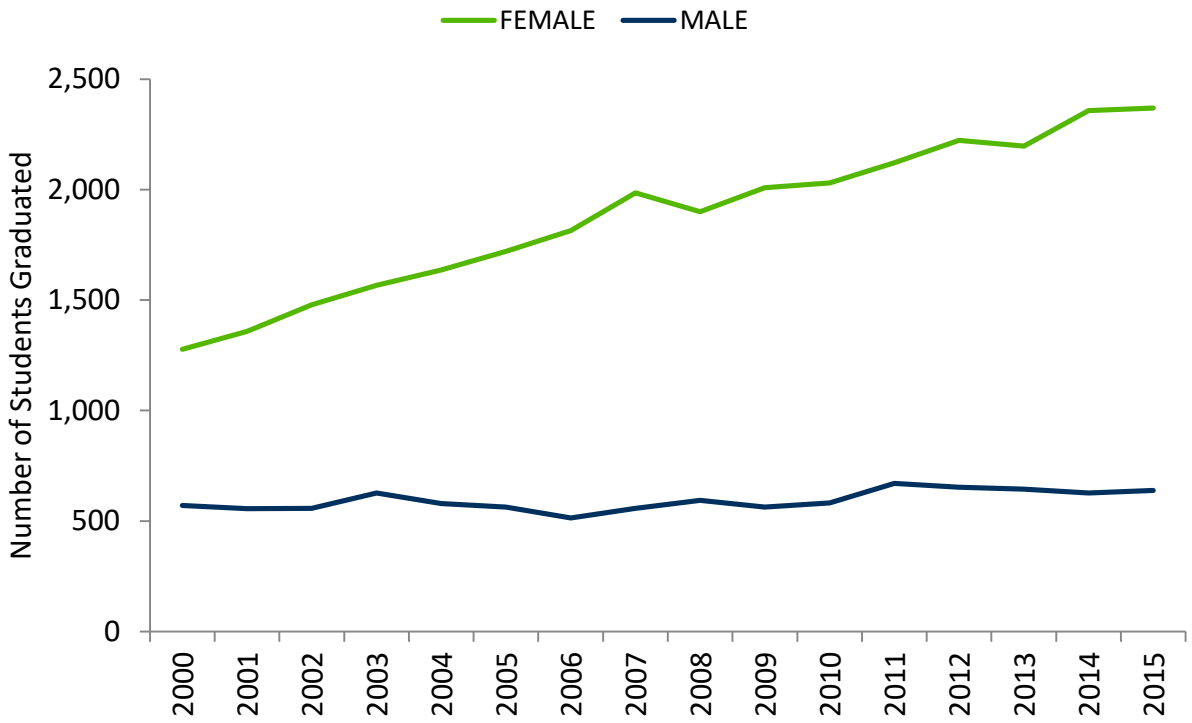


Figure 7*: Number of New Veterinarians by Gender and Year of Graduation*

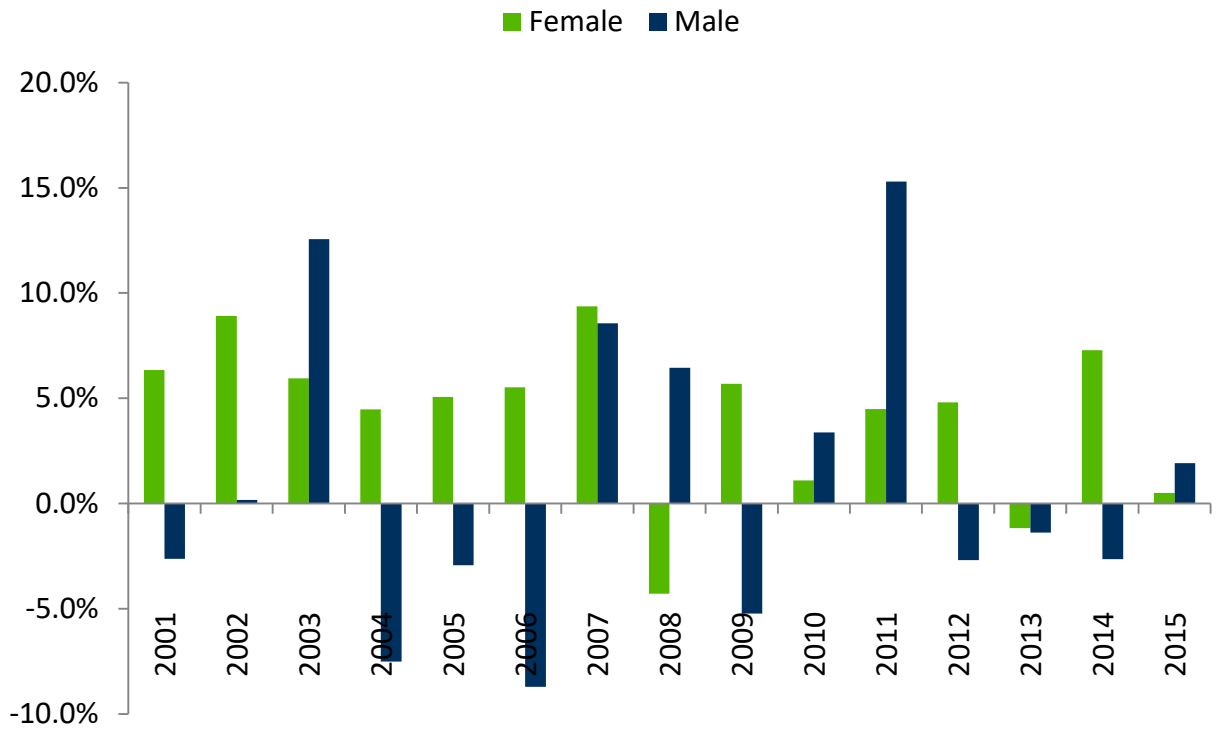


Figure 8*: Percent Change in the Number of New Veterinarians*

SECTION III: MARKET FOR LABORATORY ANIMAL VETERINARY SERVICES

Unlike companion animal or equine veterinarians, who provide services directly to households, laboratory animal veterinarians provide their services to pharmaceutical and biotechnology companies, diagnostic laboratories, animal feed and agrochemical companies, universities, research centers, and regulatory agencies. Pharmaceutical and biotechnological companies, for example, use animals for pre-clinical studies. In the United States, the use of animals in clinical studies is highly regulated, and requires the presence of a laboratory animal veterinarian to ensure that all standards related to animal use are met. Animal feed companies use animals to determine nutritional requirements for products. Diagnostic testing laboratories, commercial vendors of research animals, and contract research organizations, among others, all require the presence of laboratory animal veterinarians to provide their various services.

Demand for laboratory animal veterinary services depends on the performance of these institutions. As the general condition of the economy is continuing to improve, the government might decide to invest more money in research and development of health-related studies. Increasing research into health-related studies suggests an increase in the use of laboratory animals for testing new drugs, devices, vaccines, and other human health products. Research laboratories will increase demand for laboratory animal specialists to meet the increasing needs of these facilities. In the same way as with the increase in the pet population and the changing relationship between humans and their pets, an increase in pet health studies and therapeutic product development will ultimately increase the demand for laboratory animal veterinarians.

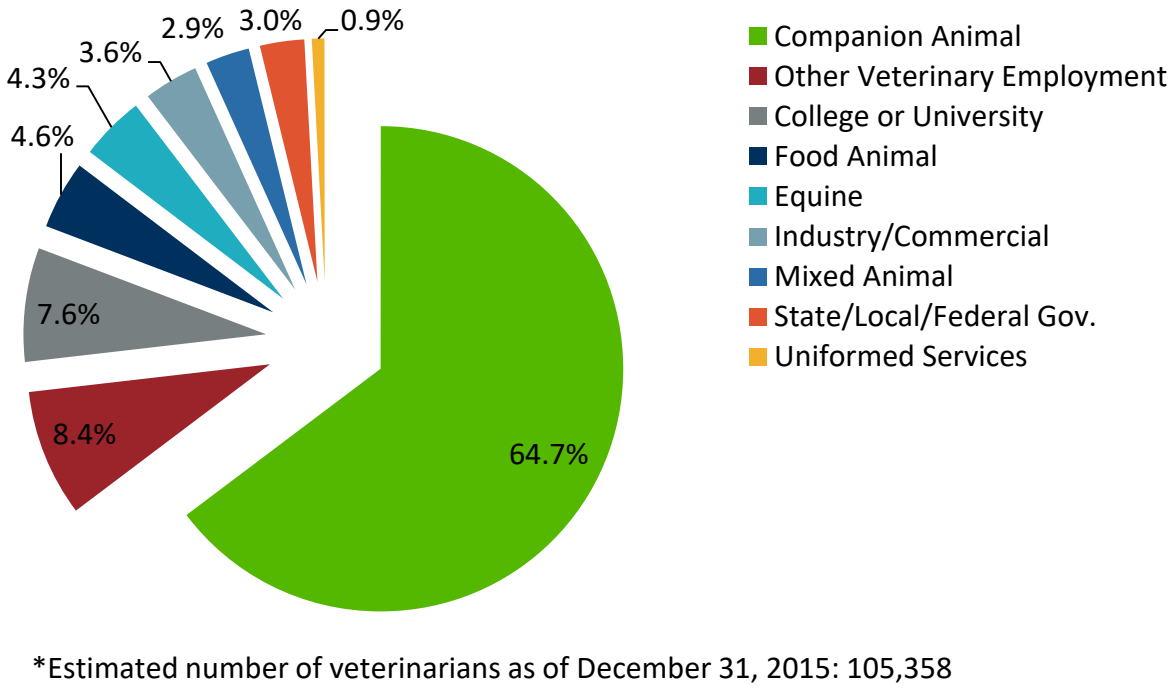
SECTION IV: THE LABORATORY ANIMAL VETERINARY WORKFORCE

The AVMA estimates that the total number of veterinarians in the United States is 105,000 as of December 2015. The private sector accounts for about 80 percent of veterinarians, and the remaining 20 percent are either in the public or the corporate sectors (Figure 9*)*. Laboratory animal veterinarians represent a small proportion of the general population of U.S. veterinarians. They are mostly employed in the public and corporate sectors, especially in pharmaceutical and biotechnology industries, diagnostic laboratories, animal feed and agrochemical industries, and universities or private research centers. Some of them are self-employed consultants working with government agencies or research centers. In 2003, it was estimated that there were between 1,000 and 1,200 laboratory animal veterinarians across the nation (Nolen, 2003).

In 1997, a lab animal veterinarian workforce study was published by Weigler et al. showing the supply and demand relationship for workers in the profession. This workforce study covered the period 1980 through 2005 and encompasses veterinarians in the laboratory animal veterinary industry in the United States. The objective of the study was to provide a comprehensive demographic profile of all veterinarians in the industry, estimate the total amount of public money invested in the industry, and estimate the supply and the demand for lab animal veterinary services. The main conclusion was that the market for laboratory animal veterinarians was near equilibrium, meaning that supply for and demand for lab animal veterinarians was almost equal. Nearly two decades after this workforce study, the 2015 Employment and Compensation Surveys provide a new look at the profession in terms of

demographics, employment, underemployment, professional income, and educational debt incurred by veterinarians in the LAV specialty.

For a better understanding of the laboratory animal veterinary industry, this section presents an analysis of LAV workforce. A typical workforce analysis starts with a comprehensive evaluation of the current resources, and proceeds with an assessment of future needs of the industry, and finally presents a comparison of supply and demand. Available Information does not allow such comprehensive analysis for this report. Some information pertaining to workforce analysis such as pay rate or hours worked per week have been reported in other sections of the report, but, some important components such as demographics, reasons to become a laboratory animal veterinarian, willingness to change career direction to another veterinary sector, and type of employment prior to become laboratory animal veterinarian are discussed here.



*Estimated number of veterinarians as of December 31, 2015: 105,358

Figure 9*: Distribution of U.S. Veterinarians by Type of Employment in 2015*

4.1 DEMOGRAPHICS OF LABORATORY ANIMAL VETERINARIANS

4.1.1 Gender Distribution of Veterinarians

The laboratory animal veterinary industry is one of only a few veterinary specialties represented by a majority of male veterinarians. Figure 10 presents the gender distribution of the survey respondents and of U.S. veterinary industry overall. Women represent the majority (63.0 percent) in the general veterinary population, but in the ACLAM/ASLAP sample, the majority of positions (57.1 percent) are occupied by men.

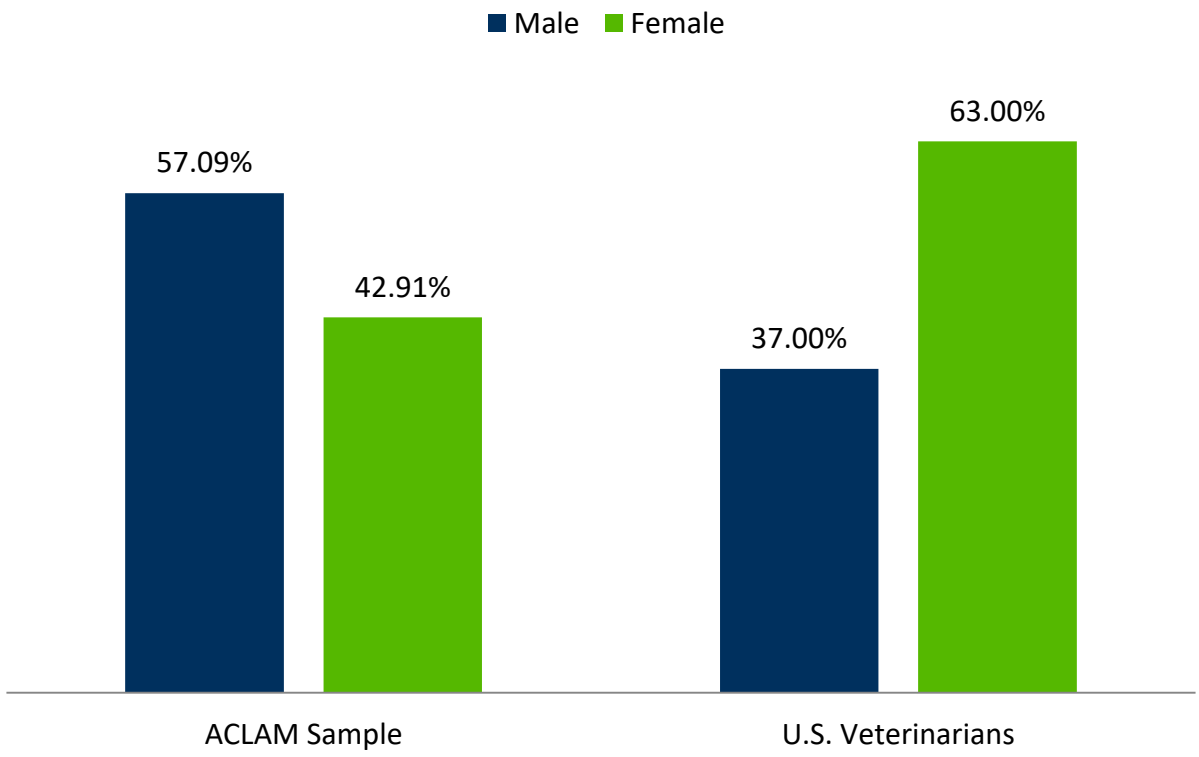


Figure 10*: Gender Distribution – ACLAM/ASLAP and U.S. Veterinarians*

4.1.2 Age and Gender Shift

Historically, the veterinary profession has been a male-dominated one. In 2009, for the first time, AVMA female members outnumbered their male counterparts (NRC, 2011). The gender shift in the industry, started in the mid-1970s with a steady increase in the number of female candidates admitted to U.S.

colleges of veterinary medicine (University of California, 2015). In the United States in 2001, 69 percent of new graduates were female, and in 2015, 79 percent were female. This is a 15 percent increase in the percentage of female graduates over the 15-year period. Younger veterinarians are mostly women whereas the majority of older veterinarians are men. Figure 12 illustrates the gender shift among the respondents. The ACLAM/ASLAP population is relatively older than the general population of veterinarians (Figure 11). Veterinarians age 40 and under represent 76.0 percent of the AVMA membership and only 30.4 percent of the laboratory animal veterinarians. This might be due to the fact that the specialization typically takes extra years to complete and younger veterinarians have not yet attained that level of proficiency.

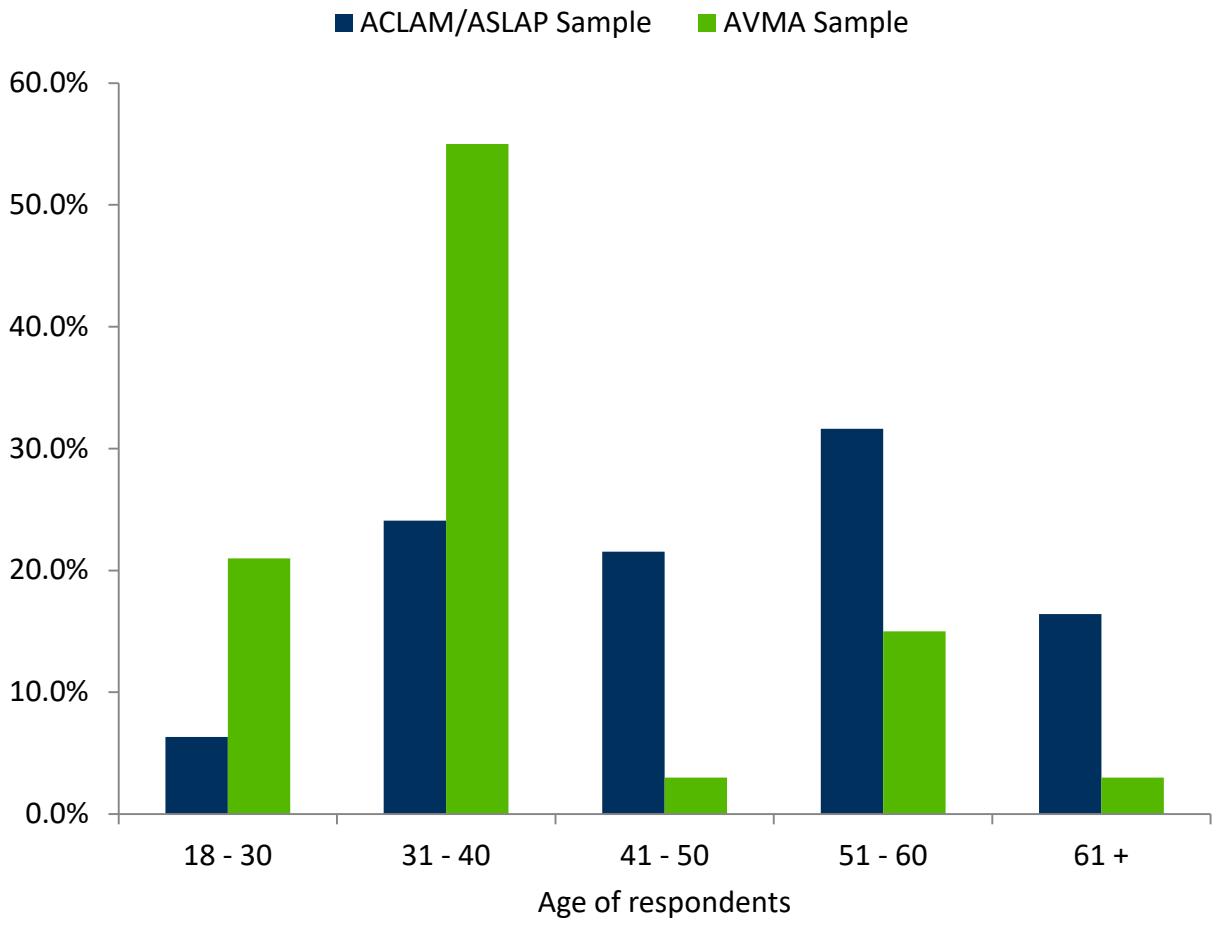


Figure 11*: Distribution of ACLAM/ASLAP Sample Respondents by Age Category*

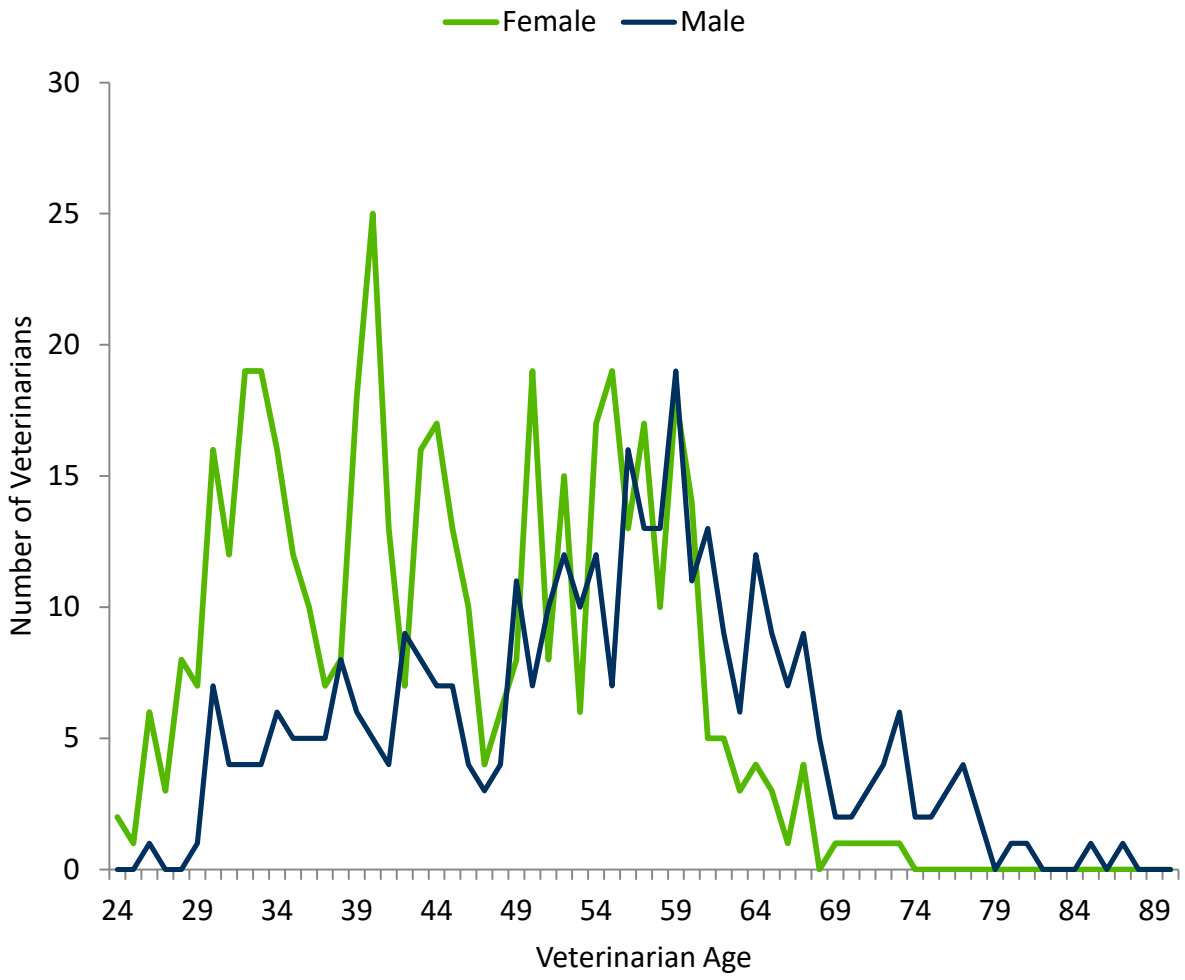


Figure 12*: Survey Respondent Age and Gender Distribution*

4.1.3 Race/Ethnicity of Veterinarians

The distribution of veterinarians by ethnicity is presented in Figure 13. All ethnic groups are represented, but the majority (85.1 percent) of respondents are white, a distribution consistent with that of the U.S. veterinary population. (Percentages for the national distribution do not total 100 percent since some survey respondents identified as more than one race.)

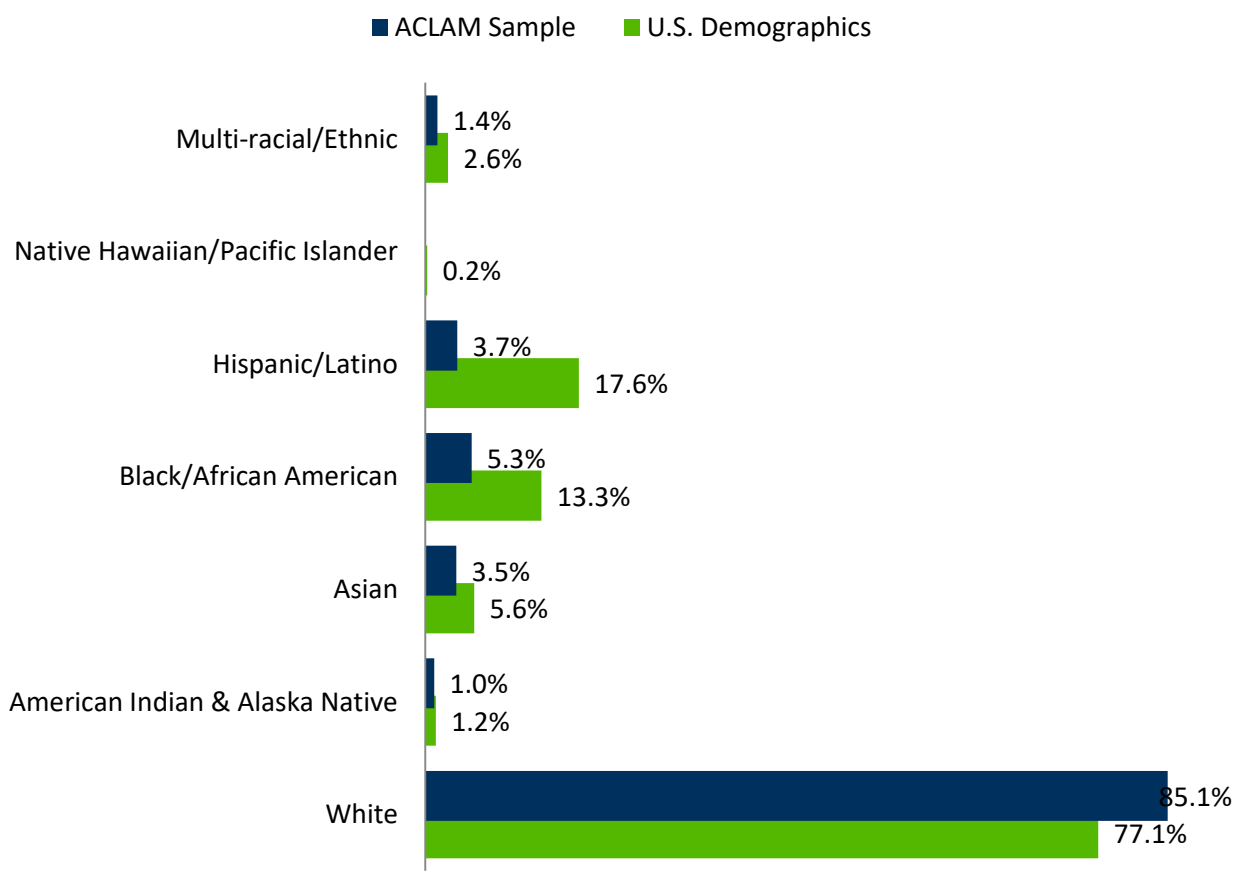


Figure 13*: Distribution of Veterinarians by Ethnic Group*

4.2 LABORATORY ANIMAL VETERINARIANS IN THE UNITED STATES

The geographic distribution of laboratory animal veterinarians is based on information provided by survey respondents. The numbering of the regions is constructed using the two first digits of each respondent's ZIP code. An illustration delineating the 10 regions is presented in Appendix 1. Laboratory animal veterinarians are more concentrated in regions with a higher number of veterinary colleges and industry laboratories (Regions 2, 9, 1 and 7).

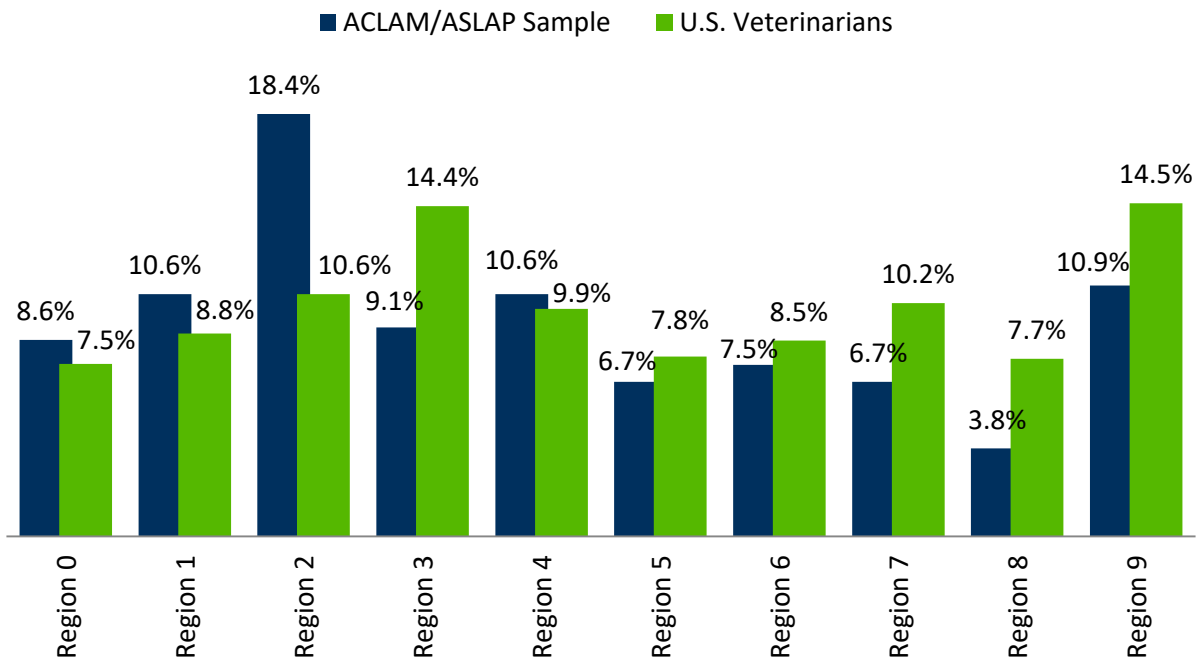


Figure 14*: Distribution of Survey Respondents and the U.S. Veterinarians by Region*

4.3 LABORATORY ANIMAL VETERINARIANS BY VETERINARY COLLEGE ATTENDED

A comparison of U.S. colleges of veterinary medicine attended for laboratory animal veterinarians and the U.S veterinary population is presented in Figure 15. The largest suppliers of veterinarians in the United States are The Ohio State University, Texas A&M University and Colorado State University. Among laboratory animal veterinarians, however, the largest portion of the respondents graduated from North Carolina State University, the University of Missouri, and the University of Florida.

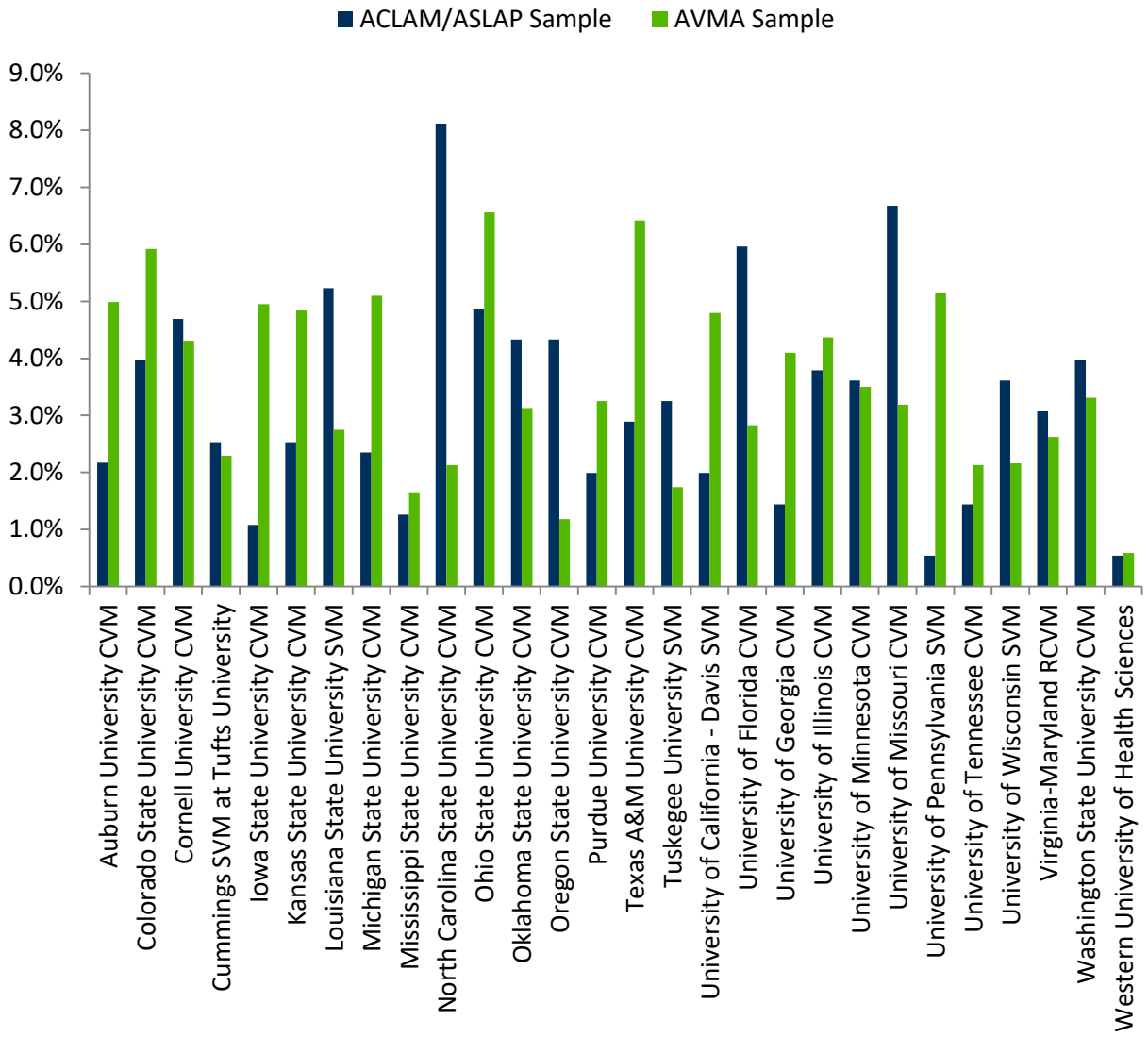


Figure 15*: Distribution of Survey Respondents and the U.S. Veterinarians by VMC Attended*

4.4 LABORATORY ANIMAL VETERINARIANS BY TYPE OF EMPLOYMENT

The distribution of the 2015 AVMA-ACLAM/ASLAP compensation and employment survey respondents (Figure 16) shows that 397 (52.5 percent) respondents are college and university employees, 14.8 percent of respondents are employed in pharmaceutical, biotech or other industries, 10.4 percent are in federal or state government, 5.2 percent are self-employed, and the remaining 17.1 percent are in not-for-profit organizations or hospitals, other institutions, and contract research organizations. The

distribution of laboratory animal veterinarians by type of employment and by region is reported in Appendix 2.

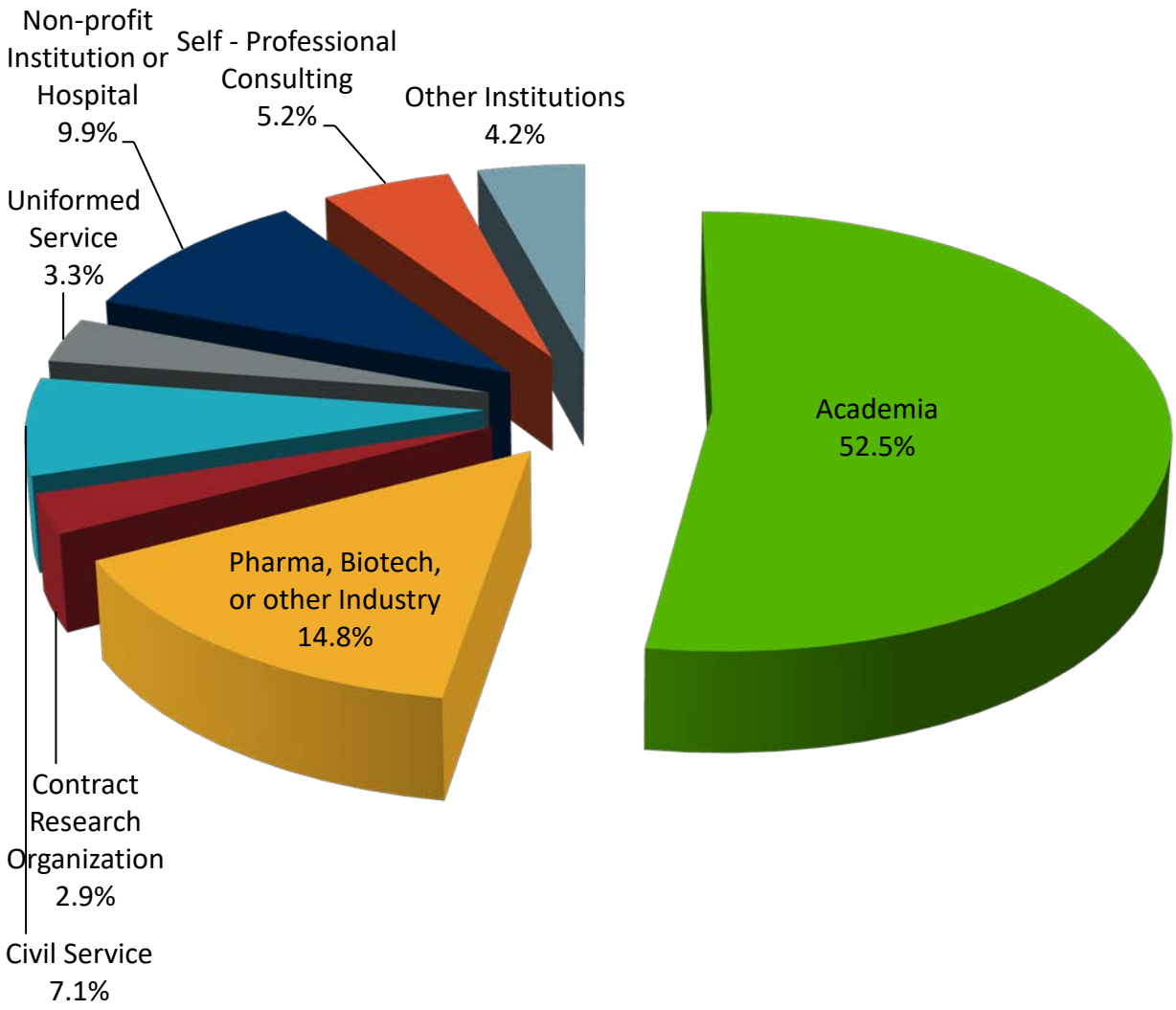


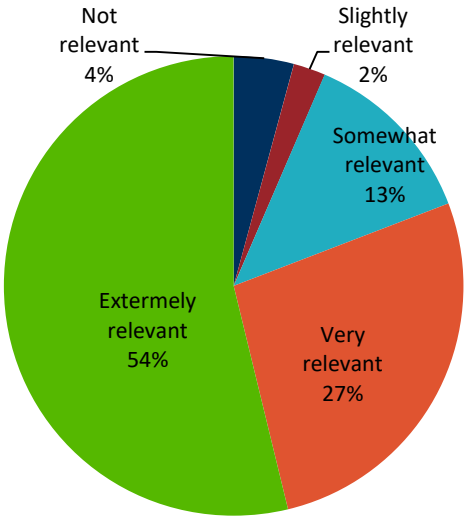
Figure 16*: Distribution of Survey Respondents by Type of Employment*

4.5 REASON FOR BECOMING LABORATORY ANIMAL VETERINARIAN

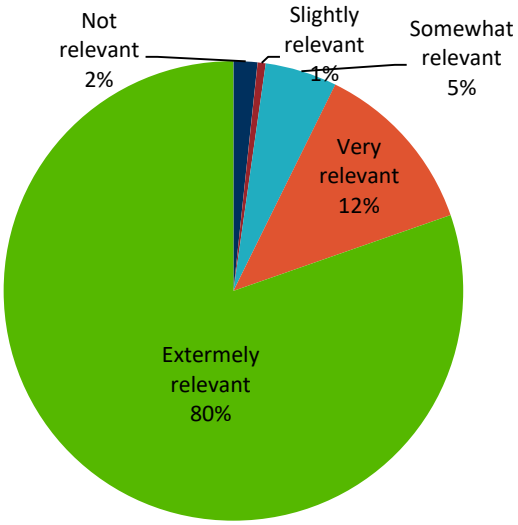
It is important to have a clear understanding about what motivates workers and prevents them from migrating to other activity sectors. To that end, survey respondents were asked to indicate the reasons

they decided to become laboratory animal veterinarians. The viability of the industry depends on the level of motivation and enthusiasm of the personnel. With the veterinary profession being highly segmented and the substantial level of competition to attract high-quality staff, decision makers need to know what they must do to not only maintain existing human resources, but also to attract potential candidates.

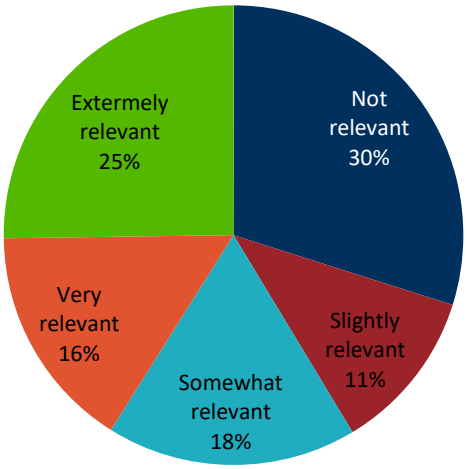
The four reasons given for choosing to work in the lab animal veterinary field are: income, increased opportunities, employer requirement, and personal goal. Each respondent was asked to rate how relevant each of these reasons was in his/her decision to become laboratory animal veterinarian. A desire to increase opportunities and personal goal were the reasons rated most highly (Figure 17). Anticipated higher income comes in third place, with 54 percent of respondents acknowledging that higher income expected in laboratory animal profession was the reason they chose this career.



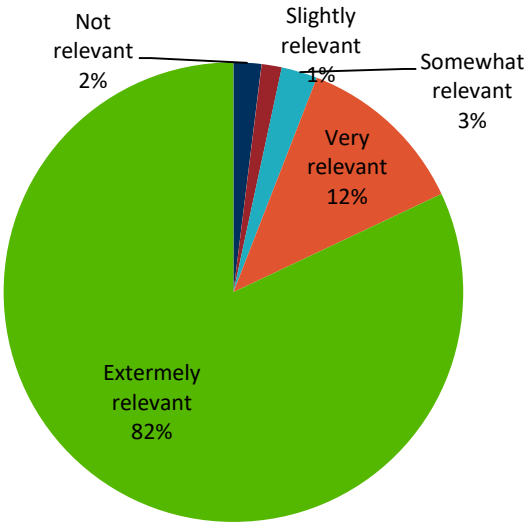
Reason 1: anticipated higher income



Reason 2: desired to increase opportunities



Reason 3: required/recommended by employer



Reason 4: a personal goal

Figure 17*: Reasons for Becoming Laboratory Animal Veterinarian*

4.6 INTRA-INDUSTRY MOBILITY

Of all the respondents, 50.3 percent started their career as laboratory animal veterinarians and the remaining 49.7 percent later joined the sector after spending some time in other sectors. Those who started their professional career in other sectors prior to joining the laboratory animal veterinary sector were asked to specify their previous sector. Approximately 84 percent came from private practices, 6.7 percent from universities or research institutions, and 9.5 percent from the public sector.

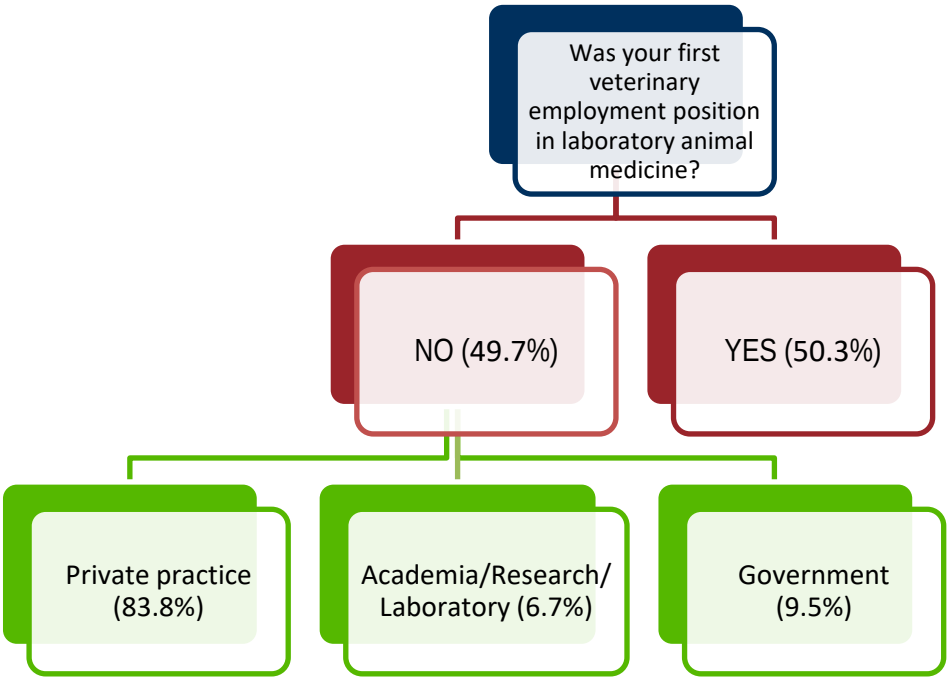


Figure 18*: Employment Type Prior to Laboratory Animal Veterinary Profession*

Respondents were asked also to indicate whether they would like to move from their current veterinary sector to another. In response, about 92 percent said they prefer to stay in their current sector against only 7.9 percent who would like to shift elsewhere, though mostly other than into private practice. Only 3.2 percent would like to move to a private practice, 25.8 percent want to join academia or research institutions, 25.8 percent seek industry employment, 12.9 percent prefer to go to not-for-profit institutions or hospitals, and 32.2 percent prefer a government job.

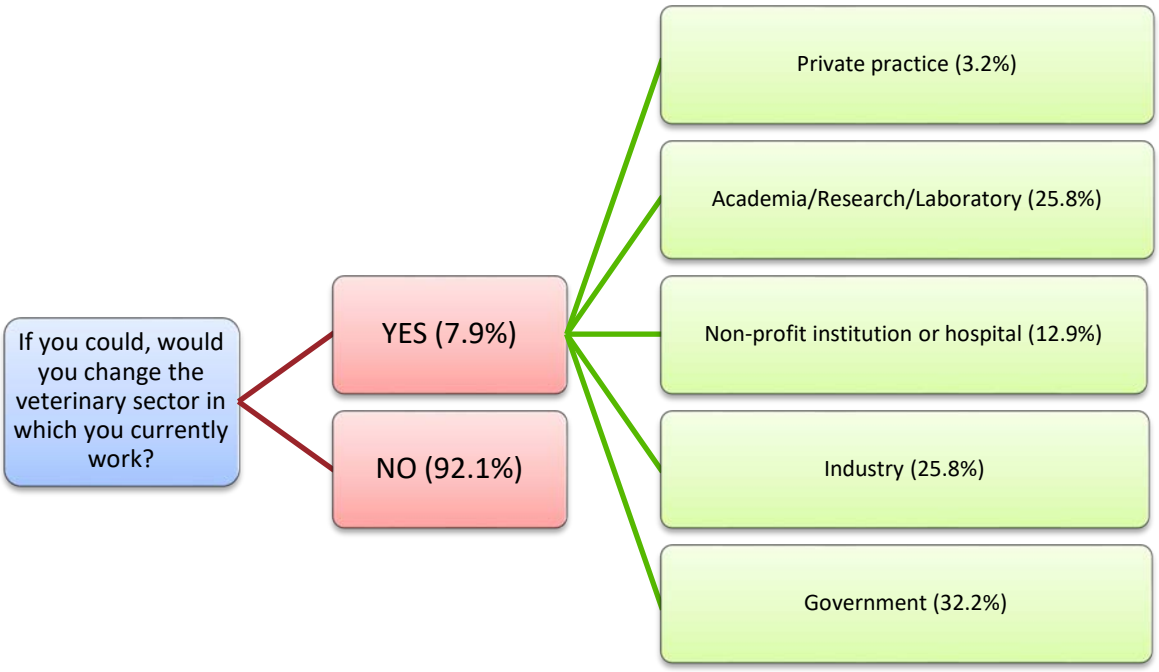


Figure 19*: Willingness to Change Sector and Preferred Sector*

SECTION V: UNDEREMPLOYMENT

An extensive body of literature on unemployment rates provides the demographics of people who are not currently employed but are actively searching for a job. That literature shows the proportion of unemployed people within the entire labor force of a country during a certain period of time. This piece of information constitutes an important macroeconomic variable that could be used to assess the performance of the national economy. This is important because an upward trend in the unemployment rates indicates that the economy is contracting, whereas a downward trend implies an expansion in economic activities. One of the limitations of using the unemployment rate as an economic indicator is that it does not account for people who are not employed at their full capacity. Professional associations such as ASLAP or ACLAM are made up of active professionals, retired members, or veterinarians still enrolled in advanced education. In trying to understand the economic condition of such populations, the unemployment rate might not be an appropriate gauge to assess the health of the industry's job market.

An alternative way to investigate the employment conditions of an industry is to determine the level of underemployment. Underemployment occurs when jobs becomes insufficient for skilled workers. To

determine the level of underemployment in the LAV industry, we computed the number of hours that laboratory animal veterinarians desire to work above what they are currently working. In the employment survey, two questions were added to help us elucidate this situation. First, respondents were asked to give an approximation of the average number of hours they work per week within veterinary medicine. Second, they were asked to choose between three options if they could change the number of hours/week. The options are:

- Work fewer hours per week for a lower level of total compensation
- Work more hours per week for a higher level of total compensation
- Work the same number hours per week with no change to the current level of total compensation

The first part of this section presents the summary statistics of the number of hours per week for specific groups, and the second part investigates the level of underemployment for each selected group.

5.1 MEAN HOURS WORKED PER WEEK

The mean hours worked per week for survey respondents is 46.1. The 2016 AVMA Census of Veterinarians shows that a typical AVMA member spends, on average, 43 hours per week on veterinary-related activities. Thus, in terms of workload, laboratory animal veterinarians are on average working more hours per week than are their peers in other types of veterinary practice. An average female veterinarian in the LAV industry works 45.6 hours a week while her male counterpart typically works 46.6 hours per week. The difference in mean hours, however, is not statistically significant. In other words, we do not have enough evidence to assert that male veterinarians work on average more hours a week than their female colleagues.

5.1.1 Mean Hours Worked per Week by Type of Employer

The average number of hours worked per week by type of employment is illustrated in Figure 20. The horizontal dashed line shows the average hours per week for the entire LAV profession. Veterinarians working in not-for-profit organizations or hospitals work the highest mean number of hours per week (47.6 hours/week) followed by veterinarians in academia (46.4 hours/week) and the uniformed service (46.1 hours/week). The average for almost all types of employment except that for self-employed veterinarians is around the industry mean.

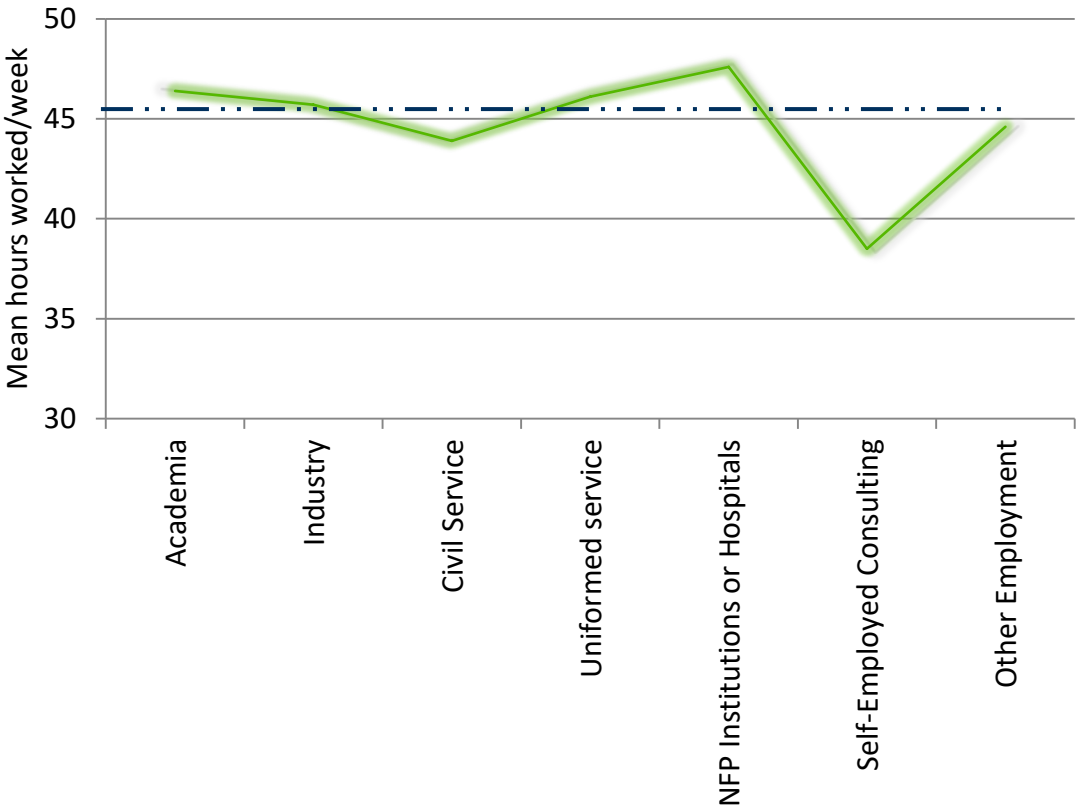


Figure 20*: Mean Hours Worked per Week by Type of Employment*

5.1.2 Mean Hours Worked per Week by Region

Mean hours per week varies substantially by region. Region 6 has the lowest mean hours per week (41.6 hours) while Region 8 reports the highest average hours per week (49.5 hours). In total, only three regions (Regions 2, 4 and 6) are below the industry average. The variation around the average annual hours worked per week by region may reflect the mix of enterprises in the region as well as the supply and demand for lab animal veterinarians in the region. A tighter supply-demand balance would suggest a higher mean number of hours worked per week, while a less tight supply-demand balance would suggest a lower mean number of hours worked per week.

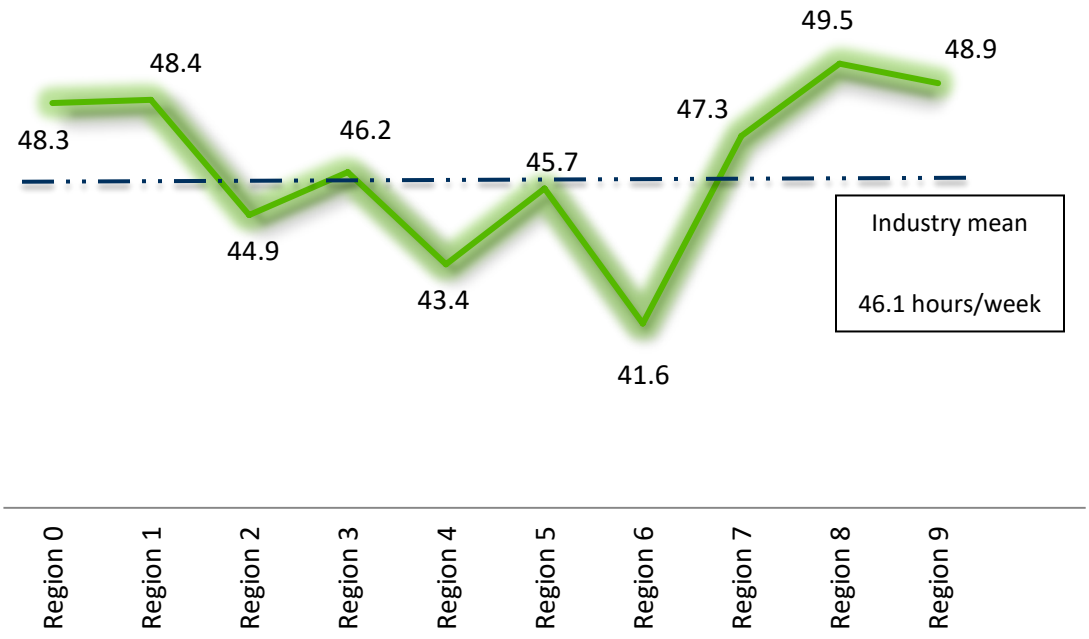


Figure 21*: Mean Hours Worked per Week by Region*

5.2 MEASURING UNDEREMPLOYMENT IN THE LABORATORY ANIMAL VETERINARY INDUSTRY

Figures 22, 23 and 24 illustrate the proportion of respondents who are underemployed by gender, type of employment and region, respectively. There are 13.3 percent of female respondents and 14.9 percent of male respondents who are not working at their full capacity and would like to add more hours to what they currently work. The *2015 AVMA-Report on Veterinary Employment* indicates that the underemployment prevalence is 13.9 percent for women and 16.6 percent for their male colleagues. In both cases, the underemployment rate is lower for female veterinarians.

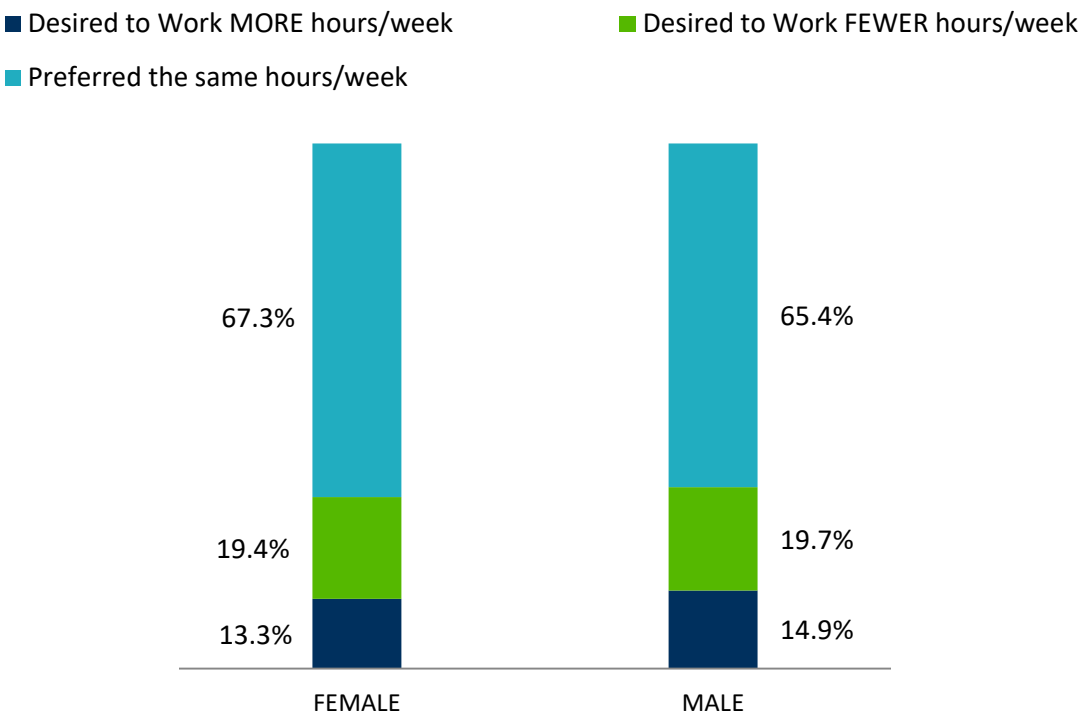


Figure 22*: Underemployment by Gender*

In terms of underemployment by type of employment, the distribution indicates that half of self-employed veterinarians (50 percent) are underemployed, because they desire to work more hours per week. As for the rest of the employment types, not-for-profit organizations have the lowest rate of underemployment; only 5.6 percent of respondents fall in the category of underemployed. For the AVMA sample, the rate of unemployment for veterinarians in the public and corporate employment varies from 0.0 percent (uniformed service) to 16.7 percent (industry/commercial organizations). Besides the self-employed veterinarians, the industry sector of the lab animal specialty has a higher rate of underemployment compared to other sectors of the lab animal profession.

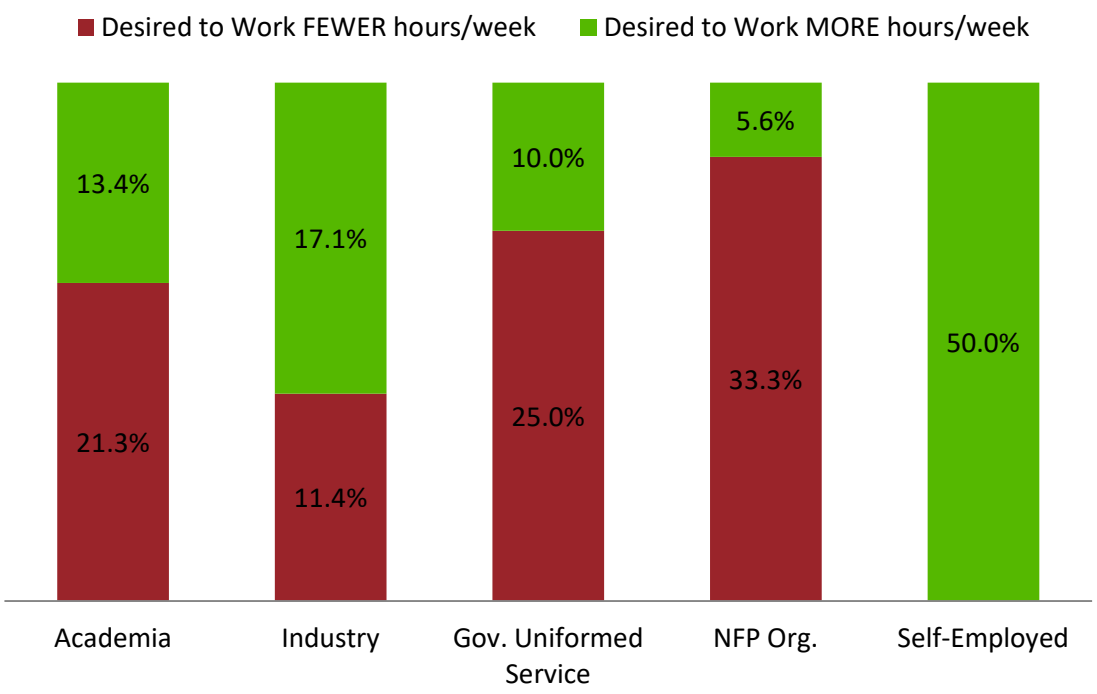


Figure 23*: Underemployment by Type of Employment*

Level of underemployment differs across regions. The proportion of respondents who desired to work more hours per week is higher in Region 8 (18.2 percent) and Region 2 (17.8 percent), but relatively low in Region 3 (9.8 percent) and Region 4 (8.3 percent).

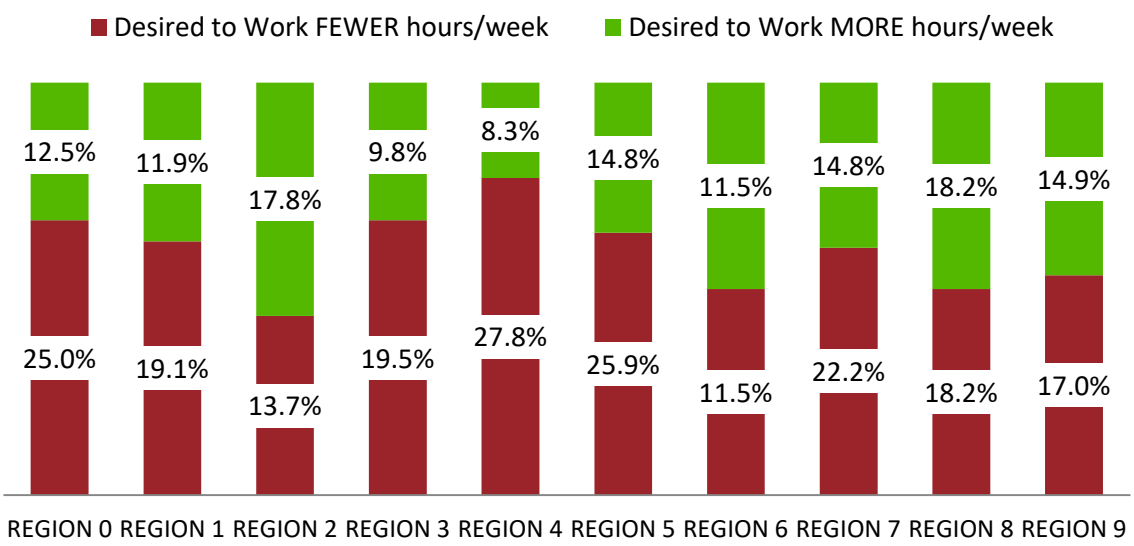


Figure 24*: Underemployment by Region*

Figure 25 presents the proportion of veterinarians who consider themselves underemployed for the two mutually exclusive samples (ACLAM/ASLAP survey respondents and AVMA sample respondents). For both samples, the rate of underemployment is high in regions 8 and 2 and lower for regions 3 and 4. This indicates that the problem of underemployment is real in both Region 8 and Region 2 and needs to be addressed.

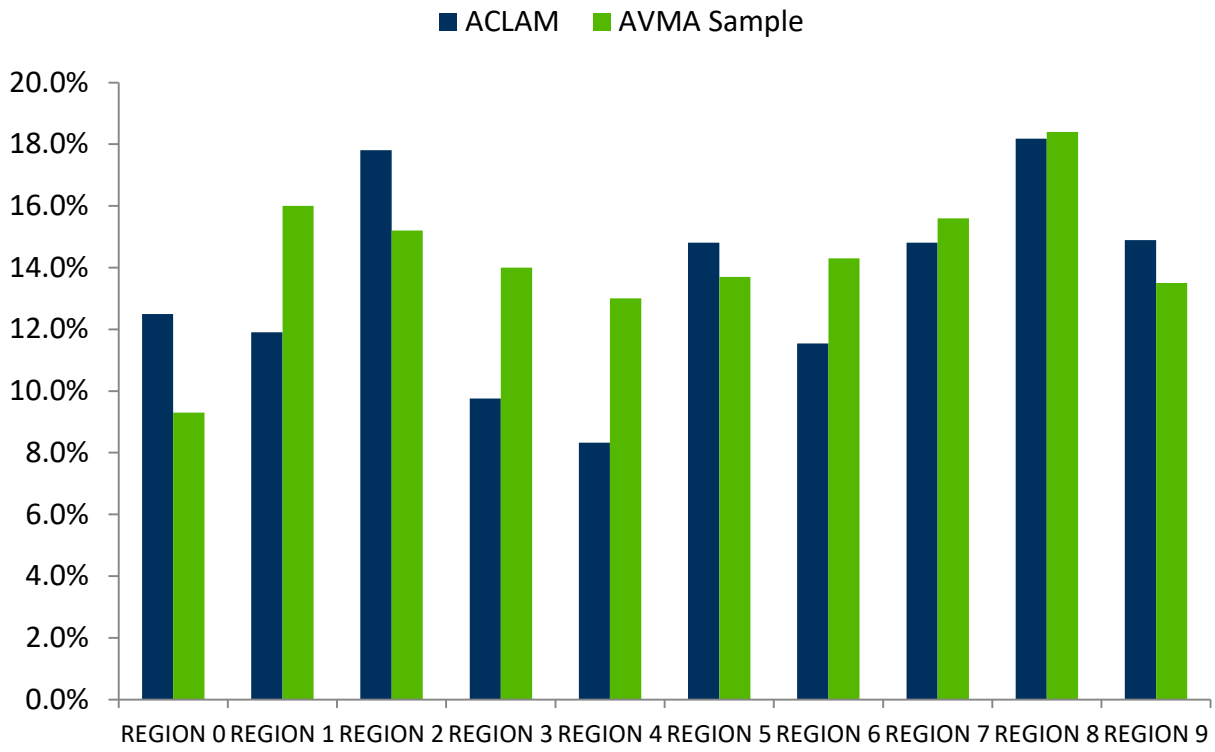


Figure 25*: Proportion of Underemployed Veterinarians – ACLAM Respondents vs. AVMA Respondents*

Current mean work hours per week for respondents in each hour preference group are presented in Figure 26. Desire to change hours worked per week is a function of the current number of hours per week. Of those respondents who desire to have fewer hours per week, the majority (64.1 percent) are veterinarians who are currently working more than 40 hours per week. Unsurprisingly, 52.8 percent of those who desired to work more hours per week are currently working 40 hours per week or less. In the category of respondents who prefer to keep their current work schedule, 57.9 percent are currently working more than 40 hours a week and only 9.2 percent are working fewer than 31 hours a week.

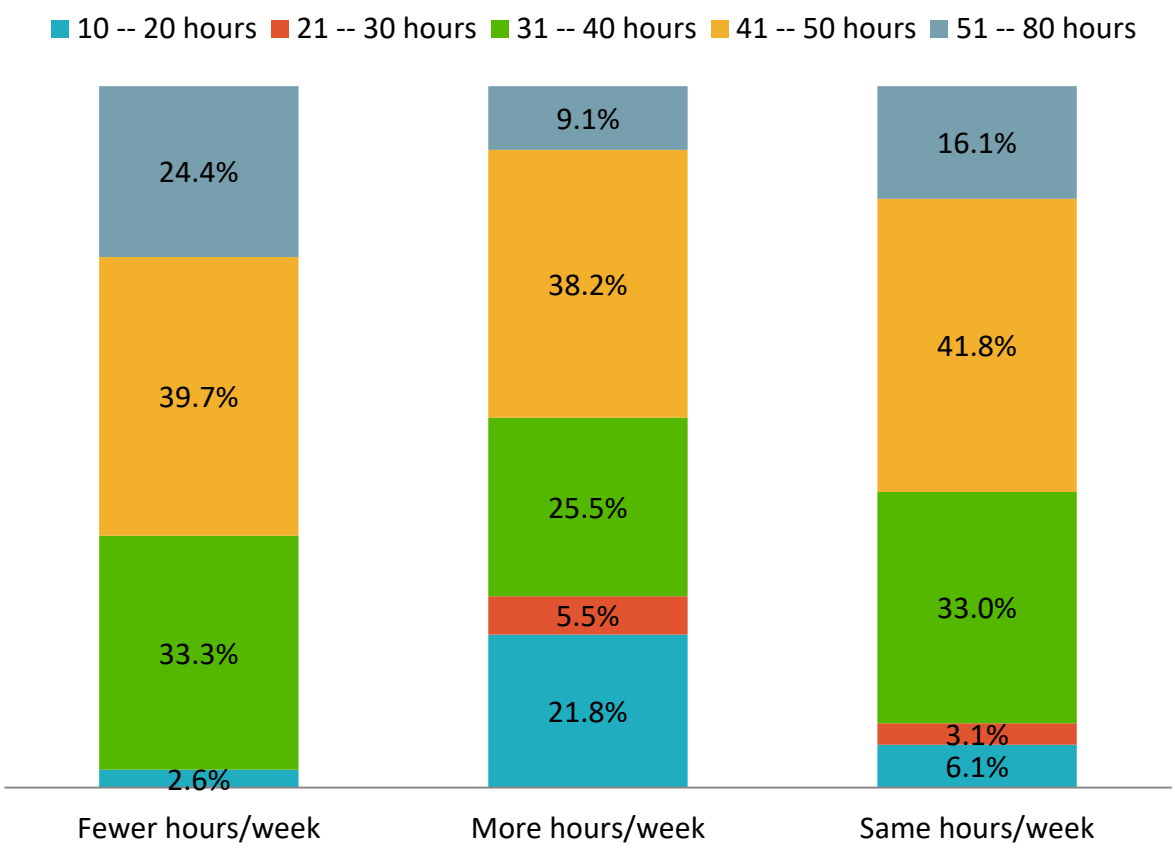


Figure 26*: Hour Preferences and Mean Hours per Week*

The net hours of underemployment are obtained by taking the difference between the number of individuals who want to work more for more compensation multiplied by the number of hours they want to work more and the number of individuals who want to work less for less compensation multiplied by the number of hours they want to work less. In total, 19.6 percent of respondents indicated they wish to reduce the hours they work by a mean 14.9 hours, while 13.9 percent of respondents wish to increase the hours they work by a mean 12.6 additional hours per week. The net hours of underemployment are therefore -471.5 hours and assuming that a typical laboratory animal veterinarian works on average 40 hours per week, a total of 12 veterinarians will be needed to offset the net total hours of those veterinarians who wish to work less and those who wish to work additional hours during their work week.

The net hours of underemployment was computed with respect to the gender of respondents. The results show that the net hours of underemployment is -227.3 hours for female veterinarians and -250 net hours for their male counterparts.

The distribution of net underemployment varies across type of institution. Those with higher net underemployment are academia with -398.8 hours, followed by industry (-99.8 hours), and civil service (-57.0 hours). Uniformed service has the lowest net underemployment with -18 hours. At the rate of 40 hours per veterinarian per week, the academic sector will need nine additional veterinarians; industry two veterinarians; and civil services about one veterinarian to offset the net total hours between those veterinarians who wish to work less and those who wish to work additional hours during their work week.

In the same way, the net underemployment was calculated for each region, with results varying substantially from region to region. Some regions (Region 2 and Region 6) show positive net underemployment, indicating that residents currently work more than their actual desired hours. Among the remaining regions, Region 4 has the highest net hours of underemployment (Figure 27).

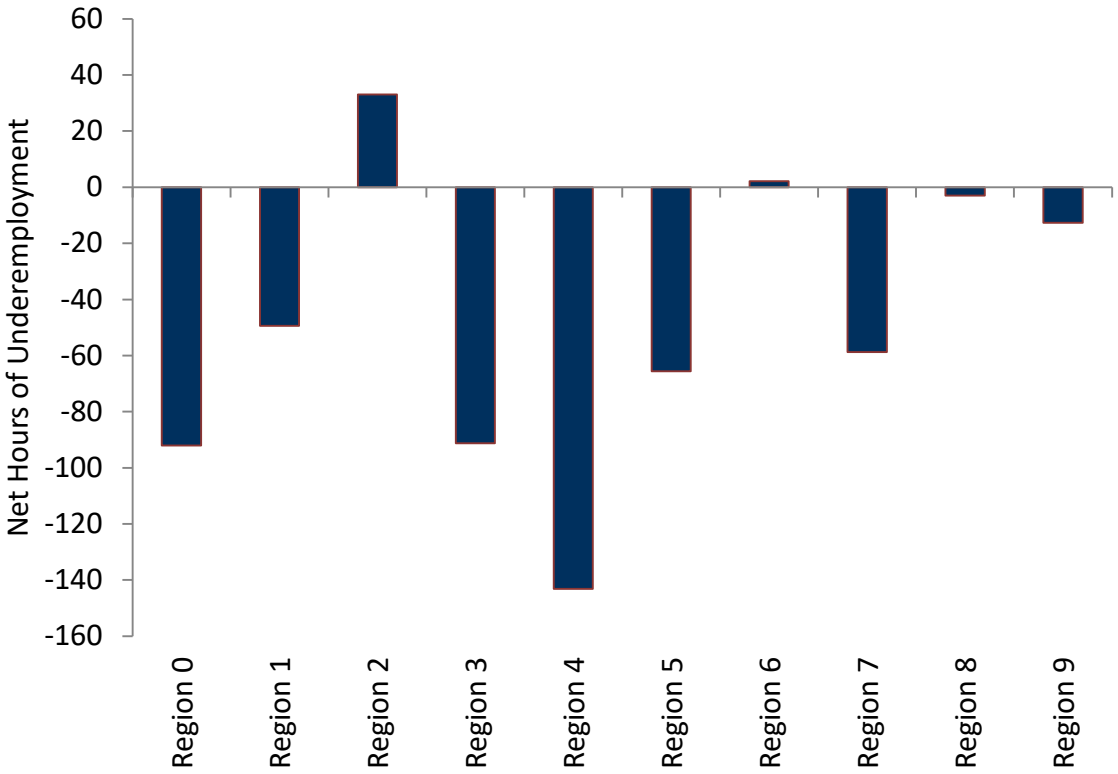


Figure 27*: Net Hours of Underemployment by Region*

5.3 FACTORS AFFECTING DESIRED HOURS

An ordinary least squares (OLS) regression was used to determine factors affecting desired hours in the lab animal veterinary industry. An OLS regression is an equation in which unknown parameters are estimated such that the difference between observed and predicted variables is minimized. The resulting model can be expressed in a formula such that controlled variations in the independent variables are used to predict the dependent variable (the variable being explained). In this case, the dependent variable is desired change in hours worked (underemployment) and the independent variables used to explain this variation were health condition (each respondent was asked to provide a general appreciation of his/her health condition using five scores: poor =1, fair = 2, good = 3, very good = 4, and excellent = 5), gender, type of institution, board certification, income and location.

In total, 119 observations with sufficient responses were considered in the analysis. The results are presented in Table 1. According to our model, only actual number of hours was found to be significant (*P*

< .05) in explaining desired hours. A one-hour increase in the actual number of hours decreases the desired hours by 0.5 hours, once all other factors were simultaneously included. The coefficient of multiple determination (R-squared) in this model was relatively poor, suggesting that other unmeasured factors may also be involved in this relationship.

Table 1*: Parameter Estimate of Factors Affecting Net Underemployment*

Variable	Parameter Estimate	Standard Error	*P* > | t |
Intercept	14.261	12.458	0.255
Number of years since DVM graduation	-0.245	0.196	0.216
Board certified	2.716	3.534	0.444
Number of years to retirement	0.239	0.156	0.127
Regular hours worked per week	-0.439	0.111	0.000
Academia	Omitted		
Industry	-0.720	4.069	0.860
Civil services	-4.437	5.366	0.410
Uniformed services			
Not-for-profit organization	5.137	4.683	0.275
Self-Professional consulting	8.986	5.567	0.110
Satisfaction with current employment	-0.373	1.455	0.799
Total personal income	0.000	0.000	0.369
Gender (1 = Male)	3.503	2.896	0.230
Health condition	-0.644	1.756	0.715
Region 0	Omitted		
Region 1	0.653	5.865	0.912
Region 2	6.958	5.356	0.197
Region 3	-3.098	6.154	0.616
Region 4	-1.847	5.685	0.746
Region 5	-5.076	6.478	0.435
Region 6	5.078	7.110	0.477
Region 7	1.748	6.225	0.780
Region 8	5.578	8.320	0.504
Region 9	2.597	5.679	0.649
R - Squared	0.3401		
Number of obs. included	119		

5.4 FACTORS CONSIDERED TO EXPLAIN EXPECTED AGE OF RETIREMENT

This analysis used an OLS linear regression to determine the optimal age of retirement using some demographic and professional factors measured in the surveys. Factors hypothesized to have impact on age of retirement are number of years since graduation, board certification, actual number of hours worked, type of institution, satisfaction with current job, gender, total income, health condition, and location. The parameter estimates from this regression are presented in Table 2, based upon the 361 observations with sufficient responses used in the analysis.

According to the model, the factors found to be significant ($P < .01$) in explaining optimal age of retirement are: number of years since graduation, board certification, and actual number of hours worked (approaching significance). The overall expected age of retirement is 68 years. The expected age of retirement for people with board certification, when all other factors are kept constant, is two years below the overall average for laboratory animal veterinarians. This indicates that board-certified professionals retire sooner than their colleagues who are not board certified. This might be due to the income gap, since board certification typically improves professional income. Expected year of retirement necessarily increases with number of years since graduation, and veterinarians in Region 6 have an expected age of retirement two years earlier than those in Region 0. An increase in the actual hours worked per week reduces the expected age of retirement. Though it was anticipated that, given the difference of income across institution types, type of employer would have an impact on the expected age of retirement, the results show otherwise. The R-squared for this OLS model was also only moderate, again suggesting that this issue needs further study.

Table 2*: Factors Considered Explaining Expected Age of Retirement*

Variable	Parameter Estimate	Standard Error	*P* > | t |
Intercept	68.112	2.878	0.000
Number of years since DVM graduation	0.114	0.034	0.001
Board certified	-2.533	0.912	0.006
Regular hours worked per week	-0.052	0.029	0.074
Academia	Omitted		
Industry	-0.445	1.045	0.670
Civil Services	1.841	1.371	0.180
Not-for-profit organization	1.409	1.085	0.195
Self-Professional consulting	0.925	1.756	0.599
Satisfaction with current employment	0.548	0.380	0.150
Total personal income	0.000	0.000	0.808
Gender (1 = Male)	-0.276	0.737	0.708
Health condition	-0.400	0.454	0.380
Region 0	Omitted		
Region 1	-0.791	1.482	0.594
Region 2	-1.129	1.412	0.425
Region 3	0.915	1.562	0.558
Region 4	-1.564	1.536	0.309
Region 5	-2.303	1.712	0.180
Region 6	-2.954	1.708	0.085
Region 7	0.136	1.683	0.936
Region 8	3.062	2.211	0.167
Region 9	0.319	1.473	0.829
R-Squared	0.1112		
Number of Obs. included	361		

SECTION VI: PROFESSIONAL INCOME AND FRINGE BENEFITS

The income of employees is a major component of any workforce analysis. In an industry such as veterinary services, which is highly segmented, it is important to have a clear view of the differences in employee compensation between different segments to better understand certain dynamics such as intra-industry mobility (moving from one segment to another within the industry), rates of replacement (age distribution in some segments is severely skewed, indicating an aging population), rates of

underemployment, and excess capacity. This section presents the trend in professional income, factors affecting income, and fringe benefits provided to laboratory animal veterinarians by type of employment.

6.1 TRENDS IN PROFESSIONAL INCOME OF LABORATORY ANIMAL VETERINARIANS

The trend in professional income was determined based on the information collected from the historical salary surveys of laboratory animal veterinarians (2014 Report) and the 2015 ACLAM/ASLAP Compensation Survey. The salary survey of laboratory animal veterinarians is conducted every three years by a subcommittee representing both ACLAM and ASLAP, and aims to assess the annual professional income of laboratory animal veterinarians working in the United States. Summary statistics from previous years' findings are included in these reports. For the purpose of comparison, we converted the nominal incomes into real dollar incomes, with 2010 used as the base year.

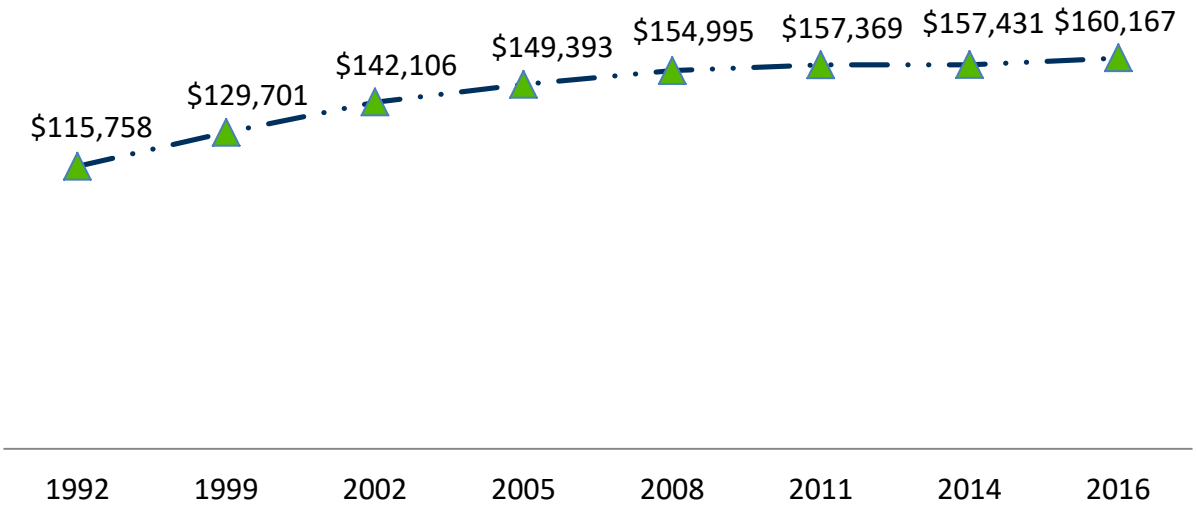


Figure 28*: Mean Annual Income of Laboratory Animal Veterinarians, 1992-2016*

6.2 PROFESSIONAL INCOME OF LABORATORY ANIMAL VETERINARIANS

6.2.1 Professional Income by Years of Experience

Descriptive statistics of income for laboratory animal veterinarians by number of years since DVM graduation are presented in Table 3. Both the mean and the median income are reported. Only respondents with annual professional income between $20,000 and $500,000 are included in the analysis to avoid the effect of extreme values.

The mean annual income increases with the number of years since graduation. A laboratory animal veterinarian with at least 50 years of experience earns on average $216,800, equivalent to almost twice the mean annual earnings of his or her peer who graduated during the last 10 years. The second quartile corresponds to the median income and represents the level of income that divides the distribution in half. That is, 50 percent earn professional income below the median and the other 50 percent receive a professional income above the median. In the same way, the first quartile of income reflects that 25 percent of respondents earn professional income below this value and the third quartile reflects that 25 percent of the respondents receive a professional income greater than that value.

Compared to the veterinary profession in general, laboratory animal veterinarians have a relatively higher professional income than their colleagues from other sub-sectors of the industry. In 2015, the mean annual wage for U.S. veterinarians was $112,350 (AVMA Census of Veterinarian, 2016). The first quartile of income from ACLAM/ASLAP survey respondents with less than 10 years of professional experience indicates that 75 percent of this group of respondents has professional income above $98,000.

Table 3*: Professional Income of LAVs by Number of Years since DVM Graduation*

		Mean	Std. Dev	1st Quartile	Median	3rd Quartile
1 -- 9 years	$	113,297	30,578	98,000	112,000	126,000
10 -- 19 years	$	135,957	38,071	107,000	130,000	160,000
20 -- 29 years	$	181,786	73,428	128,000	170,096	210,000
30 -- 39 years	$	198,121	60,009	163,000	190,000	228,638
40 -- 49 years	$	209,175	51,658	171,000	210,000	227,000
50 years +	$	216,800	94,906	188,000	230,000	230,000

6.2.2 Professional Income by Advanced Education

Advanced education refers to board certification and residency participation. The National Research Council reported that in 2009 the difference in mean income between practice owners with board certification and those without was $39,860. For the sample respondents (Table 4), the mean salary for board certified LAV members is $52,827 higher than the $119,815 received by their non-boarded colleagues. The difference in median income is $60,000 between boarded and non-boarded LAV members.

Table 4*: Professional Income and Board Certification*

	Mean	Std. Dev	1 Quartile	Median	3 Quartile
DVM	$ 119,815	53,088	94,000	105,000	130,000
DVM + Board Certificate	$ 172,642	63,550	125,000	165,000	200,000

The effect of residency participation on professional income is captured in Table 5. Veterinarians with residency experience earn a mean $167,579, whereas those who did not participate in a residency program earn a mean annual salary of $152,986. Residency provides important specialized training to new veterinarians that can be attractive to employers and improve earnings, as well as is an important mechanism to enable LAVs to qualify to sit for their ACLAM board examinations.

Table 5*: Professional Income and Residency Participation*

	Mean	Std. Dev	1st Quartile	Median	3rd Quartile
DVM	$ 152,986	63,754	104,000	139,000	190,000
DVM + Residency	$ 167,579	64,958	120,000	158,000	198,000

6.2.3 Professional Income by Gender

A gender gap in income occurs with laboratory animal veterinarians as it does with the general veterinary profession. Female respondents have an average income of $149,098 while the mean professional income for male respondents is $182,090 per year. The median income is $133,500 for women and $175,000 for men (Table 6).

Table 6: *Professional Income and Gender*

	Mean	Std. Dev	1st Quartile	Median	3rd Quartile
Female	$ 149,097	60,011	109,000	133,500	175,000
Male	$ 182,090	65,976	130,000	175,000	215,000

6.2.4 Professional Income by Type of Employment

Professional income for laboratory animal veterinarians also varies by type of employment (Table 7*).* Veterinarians in industry or commercial organizations receive the highest mean annual income ($203,884) and those in uniformed services have the lowest mean annual income ($140,460).

Table 7*: Professional Income and Type of Employment*

	Mean	Std. Dev	1st Quartile	Median	3rd Quartile
Academia	$ 158,179	60,815	110,000	150,000	195,000
Industry	$ 203,884	85,323	141,500	180,000	260,000
Gov.- Civil service	$ 151,525	34,435	122,000	158,000	176,000
Gov. - Uniformed service	$ 140,460	25,034	120,000	144,650	165,000
Not-for-profit org.	$ 165,312	68,390	120,500	146,000	203,500
Self-employed consultant	$ 189,871	81,217	114,487	215,000	260,000
Other employment	$ 150,092	44,590	117,000	152,000	170,000

6.2.5 Professional Income by Region

Mean professional income of respondents by region varies between $132,649 and $210,228 *(*Table 8*)*. Region 0 has the highest average income ($210,228) followed by Region 1 ($185,862) and Region 8 ($176,266). Region 5 is at the bottom of the scale with an average professional income of $132,649.

Table 8: Professional Income and Geographic Location

	Mean	Std. Dev	1st Quartile	Median	3rd Quartile
Region 0	$ 210,228	92,735	128,000	180,000	300,000
Region 1	$ 185,862	75,552	140,000	165,000	220,000
Region 2	$ 168,650	48,128	130,000	173,000	188,000
Region 3	$ 143,917	42,440	109,000	127,000	180,000
Region 4	$ 162,979	70,041	109,000	152,500	219,000
Region 5	$ 132,649	46,193	97,017	118,463	153,000
Region 6	$ 174,408	71,904	128,000	164,000	200,000
Region 7	$ 146,426	49,565	107,000	145,000	180,000
Region 8	$ 176,266	41,248	150,000	175,000	192,000
Region 9	$ 138,500	53,036	104,500	130,000	166,807

6.3 FACTORS AFFECTING PROFESSIONAL INCOME

In total, 549 respondents were included in this section of the analysis. An OLS linear regression model was used to fit the income data. The results are presented in Table 9.

The results indicate that one more year of experience increases professional income by $2,616, holding all other factors constant. In terms of the returns on education, the results show that board certification and residency increase earnings by $38,301 and $9,906, respectively. When only the type of employment is considered and designating income of veterinarians in academia as the benchmark, the results indicate that veterinarians employed by industry or in commercial organizations earn $35,006 more than academia veterinarians, whereas uniformed service veterinarians and civil service veterinarians receive, respectively, $26,565 and $19,254 less income than those in academia.

The results also show that men receive on average $17,145 more than women. Possible reasons for the income gap between female and male veterinarians have been extensively discussed. The effect of location on income is also reported. Veterinarians in Region 0 receive the highest mean salary and veterinarians in Region 9 receive the lowest mean salary. All of the regions are statistically different from Region 0.

Table 9: Factors Affecting Earnings of Laboratory Animal Veterinarians

Variable	Parameter Estimate	Std. Error	*P* > |t|
Number of Years since DVM	2,616.01	225.15	0.0001
DVM (base dummy)			
DVM + Board Certification	38,301.00	6,761.43	0.0001
DVM + Residency	9,905.82	5,528.57	0.0737
DVM + Graduate Degree	-9,650.63	6,912.64	0.1633
DVM + Other Degree	-2,309.95	7,166.97	0.7473
Academia (base)			
Industry	35,006.00	6,705.91	0.0001
Government - Civil Service	-19,257.00	9,442.07	0.0419
Government - Uniformed Service	-26,565.00	11,870.00	0.0256
Not-for-Profit Organization	6,622.52	7,396.09	0.3710
Self-Employed Professional	-2,786.29	18,093.00	0.8777
Other Employment	-8,124.39	10,445.00	0.4370
Male Veterinarian	17,145.00	4,650.33	0.0003
Region 0 (base)			
Region 1	-19,067.00	9,725.01	0.0504
Region 2	-38,645.00	9,535.56	0.0001
Region 3	-46,981.00	10,282.00	0.0001
Region 4	-32,373.00	9,730.05	0.0009
Region 5	-45,608.00	11,115.00	0.0001
Region 6	-41,066.00	10,628.00	0.0001
Region 7	-49,089.00	11,186.00	0.0001
Region 8	-45,009.00	13,132.00	0.0005
Region 9	-52,309.00	9,685.04	0.0001
Constant	97,577.00	11,451.00	0.0001
R-Square	0.444		
Number of Observations	549		

6.4 FRINGE BENEFITS AVAILABLE FOR LABORATORY ANIMAL VETERINARIANS

Veterinarians, in addition to their professional income, might be accorded various types of fringe benefits. These benefits differ across practice types and are viewed as incentives to hire and motivate workers, which in turn can stimulate higher productivity. Benefits can be categorized by three major

groups: health care and other insurance, compensation and professional development, and other benefits. In the first group, incentives such as medical, dental, life and disability insurance are considered. The second group is composed of tax-deferred retirement plans (e.g., 401(k), IRS-qualified profit sharing plan), employer contribution/match to a tax-deferred retirement plan, continuing education expenses, license fees and association dues. The last category, time-off benefits, includes paid vacation, sick, legal, and continuing education leave.

These incentives may influence veterinarians' career decisions. Comparing laboratory animal veterinarians and the general population of veterinarians, the availability of each of these benefits was evaluated. Next, the combination of fringe benefits provided by type of employment within the LAV sector was studied, grouping the benefit offerings into three categories to help highlight possible differences.

6.4.1 Benefits Received – ACLAM/ASLAP vs. AVMA General Population

The types of fringe benefits typically provided by employers are reported on the Y-axis of Figure 29. The histogram shows the percentage of people in each sample who are provided the corresponding benefit. It is important, however, to point out that benefits might vary by type of practice. Companion animal veterinarians will be more likely granted a discount on pet care, for example, while large animal veterinarians will likely benefit from personal use of a vehicle. Nevertheless, the length of the bars conveys that in almost all types of benefits categories, laboratory animal veterinarians have more advantages over their colleagues in other types of practices. More than 90 percent of ACLAM/ASLAP respondents are covered by a medical plan while only 70 percent of the general veterinarian population has access to this benefit. Life insurance covers 80 percent of laboratory animal veterinarians but only 35 percent of all other veterinarians. More than 80 percent of ACLAM/ASLAP members receive paid sick leave and paid legal holidays whereas among the general veterinary profession, the share of those receiving these benefits is only about half.

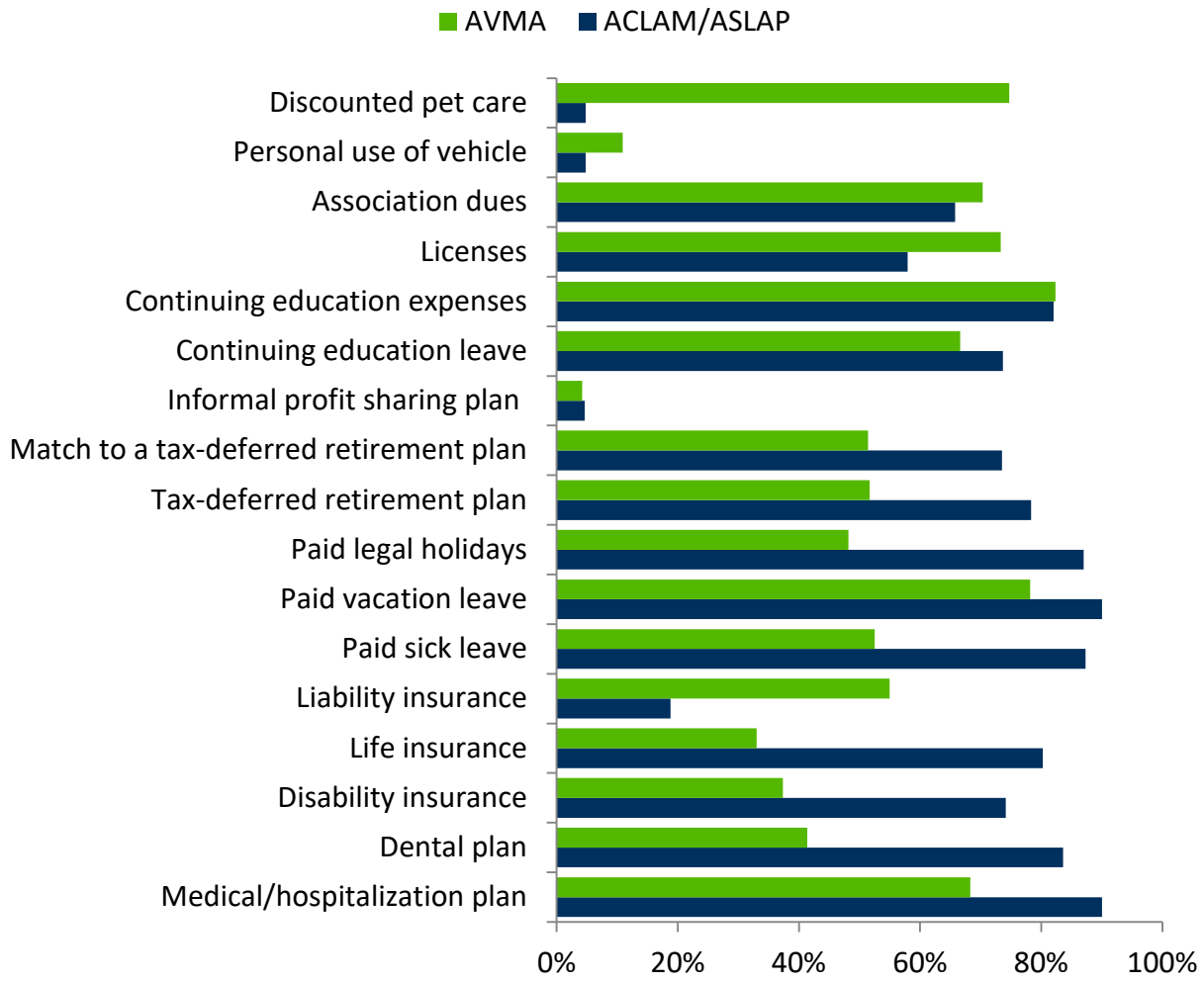


Figure 29*: Fringe Benefits Received for ACLAM/ASLAP Members vs. AVMA Respondents*

6.4.2 Benefit by Type of Employment within the Laboratory Animal Veterinary Industry

- *Health Care and Insurance*

Academia, industry, and not-for-profit organizations provide greater opportunities for coverage in terms of medical plans, dental plans, disability insurance and life insurance (Figure 30).

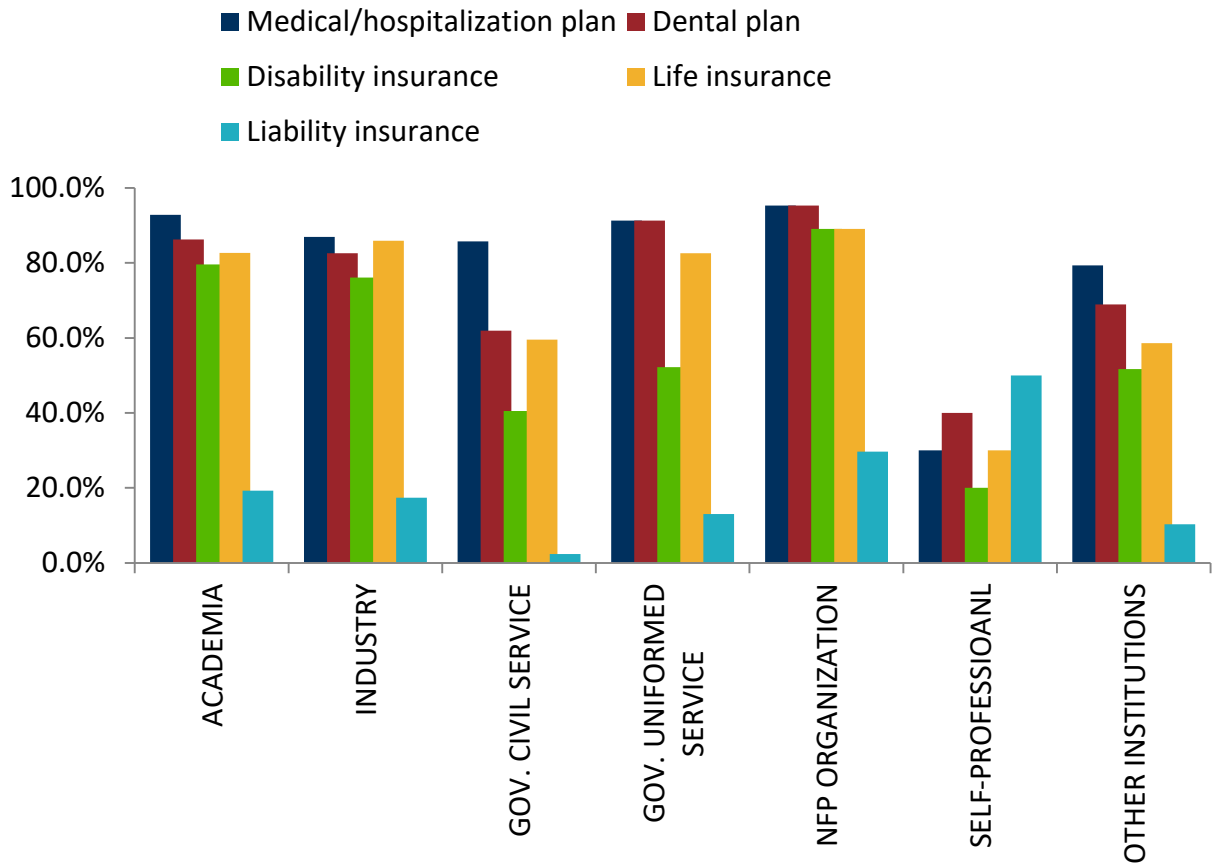


Figure 30*: Health care and Insurance Plan Provided by Type of Employer*

- *Retirement and Professional Development*

Roughly 80 percent of veterinarians in each of these three entities: academia, industry and not-for-profit organizations, receive access to a tax-deferred retirement plan or matching funds to a tax-deferred retirement plan, association dues, and continuing education expenses (Figure 31).

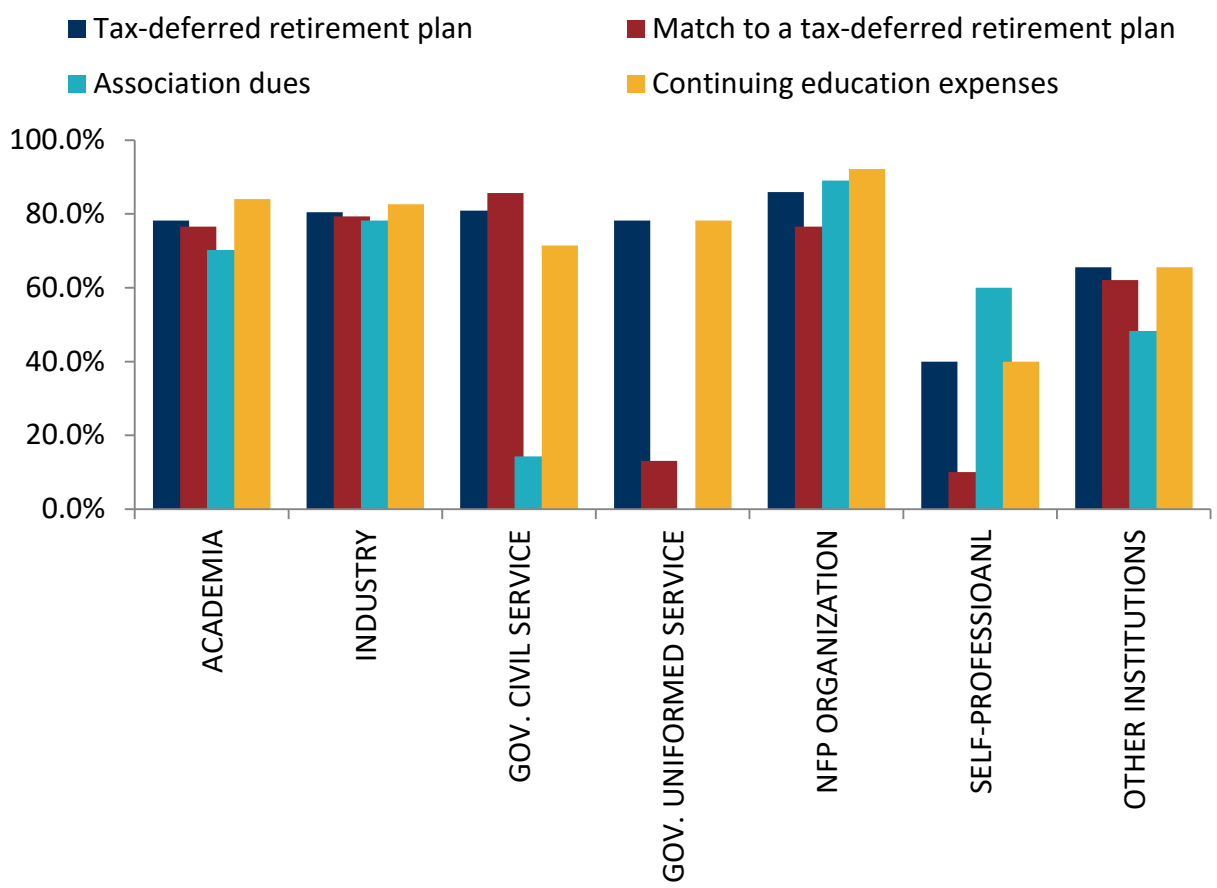


Figure 31*: Professional Development and Compensation Plans Provided by Type of Employer*

- *Other Benefits Received*

Most institutions provide additional benefits such as paid sick or vacation leave, paid legal holidays, and continuing education leave (Figure 32).

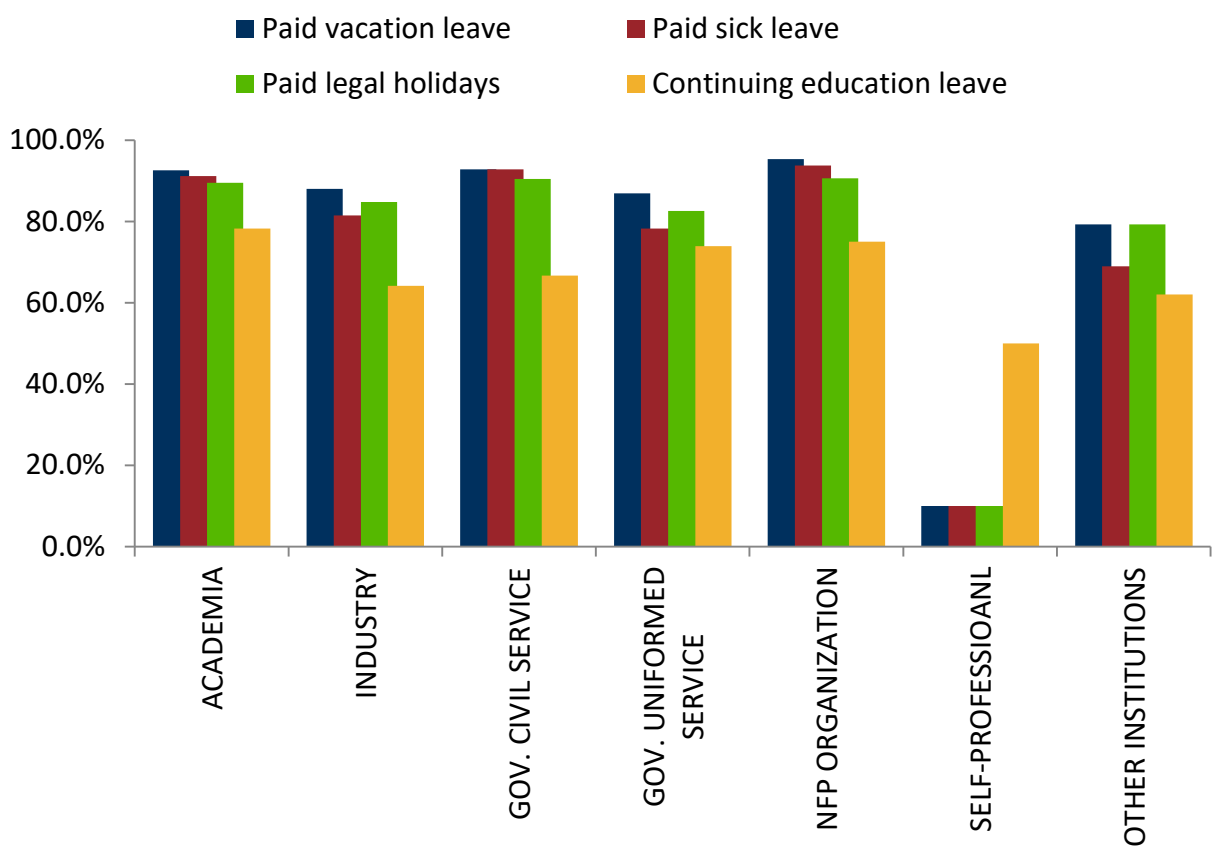


Figure 32*: Other Benefits Provided by Type of Employer*

SECTION VII: EDUCATIONAL DEBT AND DEBT REPAYMENT

An ongoing debate in the United States concerns student loan debt and the return on investment from higher education degrees. This section of the report looks at student loan debt incurred by laboratory animal veterinarians – that is, the amount of money borrowed to obtain the DVM degree. The sustainability of the profession depends largely on whether or not practicing veterinarians are able to obtain adequate return on their educational investment. Descriptive statistics are presented at the beginning of this section to provide an idea as to the level of debt, followed by an examination of factors affecting debt. A brief discussion follows about the ability of veterinarians to repay student loan debt.

7.1 EDUCATIONAL DEBT OF LABORATORY ANIMAL VETERINARIANS

7.1.1 Average Student Debt by Type of Employment

The mean student loan debt is presented in Table 10 for each lab animal veterinarian employment category. The mean student loan debt incurred for the entire sample is $52,754. This figure includes both respondents with and without student debt. When only respondents with debt are considered, the mean student debt exceeds $70,000.

Veterinarians in contract research organizations have the highest DVM debt ($61,400) followed by veterinarians in not-for-profit institutions ($58,083). Although veterinarians in contract research organizations have the highest mean DVM debt, they service their debt faster than self-employed veterinarians and veterinarians employed elsewhere in the industry. This indicates that factors other than the amount of the debt determine the ability of laboratory animal veterinarians to service their DVM debt.

Table 10: Average Student Debt by Type of Employer

	Mean Debt	Std. Dev
Academia	$ 52,509	59,798
Industry	$ 53,605	70,988
Contract Research Org.	$ 61,400	57,896
Civil Service	$ 55,700	80,935
Uniformed Service	$ 50,285	31,127
Non-Profit Organization	$ 58,083	74,830
Self-Employed	$ 37,200	44,852
Other Institutions	$ 29,916	40,817

7.1.2 Average Student Debt by Gender

Male laboratory animal veterinarians have a low mean DVM debt ($38,386) compared to their female colleagues ($64,822), as shown in *Table 11*.

Table 11: Average Student Debt by Gender

	Mean Debt	Std. Dev
Female	$ 64,822	65,535
Male	$ 38,386	55,756

7.1.3 Average Student Debt by Region

The mean DVM debt by region is illustrated in Table 12. Average student loan debt varies substantially across regions. This is due not only to the difference in tuition and fees across colleges of veterinary medicine but also to the difference in living expenses during the time of college enrollment. The mean student loan debt for respondents who graduated in Region 1 is about $68,000, whereas that for those who graduated in Region 6 is approximately $29,000.

Table 12: Average Student Debt by Region

	Mean Debt	Std. Dev
Region 0	64,000	79,593
Region 1	68,067	82,407
Region 2	44,522	67,747
Region 3	36,933	51,796
Region 4	53,385	55,070
Region 5	66,825	63,878
Region 6	28,661	37,317
Region 7	60,348	50,397
Region 8	33,767	37,012
Region 9	56,286	61,533

7.2 FACTORS AFFECTING STUDENT DEBT FOR LABORATORY ANIMAL VETERINARIANS

Identifying and understanding what factors affect student debt for laboratory animal veterinarians is important in developing strategies to reduce the debt of veterinarians. The variables examined to explain the variation in the amount of DVM debt incurred include the location of the veterinary school

(classified by one of the 10 regions of the country), the number of years since DVM graduation, gender, and income of the respondent. The location effect accounts for the difference in the cost of living across regions.

Because of missing or incomplete respondent information, only 202 observations were used in this analysis *(*Table 13*).* The R-squared (0.48) indicates that 48 percent of the variation from the mean level of DVM debt is attributable to the factors included in the model.

The constant corresponds to the expected DVM debt when none of the factors is taken into account. In other words, at the beginning of her career, a typical female ACLAM/ASLAP member graduating today can be expected to have a debt of $187,398 to service.

The results of the survey indicate that male LAV respondents have on average $8,122 less debt than their female counterparts; however, the coefficient is not statistically significant. The results also show that student loan debt decreases significantly with the number of years since graduation, meaning that newer graduates acquired more debt during their veterinary college education than did older graduates. Mean DVM debt has increased by an average of $3,327 each year.

Region 0 was used as the base region for comparing the mean DVM debt for laboratory animal veterinarians. The results indicate that lab animal veterinarians in most regions except Region 2 and Region 8 have statistically different mean debt levels than those lab animal veterinarians in Region 0. Region 1 lab animal veterinarians reported the highest mean DVM debt ($52,370 above the mean debt of veterinarians who graduated in veterinary colleges located in Region 0) followed by Region 7 ($51,328 above the mean of Region 0).

Table 13: Factors Affecting DVM Debt for Laboratory Animal Veterinarians

Variable	Parameter estimate ($)	Standard error	*P* > | t |
Constant	187398.00	14980.00	0.0001
Number of years since DVM graduation	-3326.96	374.74	0.0001
Gender (male = 1, female = 0)	-8121.73	7311.38	0.2681
Professional income	-0.04	0.06	0.4975
School in region 0 (base)	.	.	.
School in region 1	-52370.00	26558.00	0.0501
School in region 2	-22504.00	16167.00	0.1656
School in region 3	-48092.00	16078.00	0.0031
School in region 4	-48614.00	15440.00	0.0019
School in region 5	-40428.00	16012.00	0.0124
School in region 6	-42651.00	15851.00	0.0078
School in region 7	-51328.00	15722.00	0.0013
School in region 8	23569.00	22934.00	0.3054
School in region 9	-41240.00	16132.00	0.0114
Number of observations	202		
R-squared	0.48		

7.3 DISCUSSION

The first section of this analysis used some macroeconomic variables such as real GDP, unemployment rate, and the civilian employment-population ratio to assess national economic performances and draw conclusions about the future of the laboratory animal veterinary specialty. These variables, although intuitively significant, may not ensure a sufficiently robust prediction of the demand for laboratory animal veterinary services. A time series data study of the amount of government and private investments in fundamental and translational research and development which relies upon the use of experimental animals and LAV services might instead be more valuable in predicting the future of the profession. In terms of supply of lab animal veterinarians, the applicant-to-seat ratio for veterinary college applicants is approximately 1.5, which is below the 10-year average for that parameter. This indicates that veterinary colleges have improved their capacity and applicants have a greater chance at getting the education they need to pursue a career in the field. Factors of interest in the market for

veterinary education remain the high inflation of college tuition and fees. One of the consequences of increased tuition and fees is that many veterinary medical students rely on the third-party payment method of student loans to fund their education and thereby end up facing challenges in debt repayment.

The second section provides a brief presentation of the laboratory animal veterinary industry workforce. Unlike the general population of veterinarians, in the LAV world the majority of laboratory animal veterinarians are male (57.01 percent) and are mostly employed in colleges or universities (52.5 percent). Certification takes additional years of training after DVM graduation and residencies. Concurrent with an aging male population in the profession and a lower rate of male student applicants for veterinary education, an increasingly younger population of veterinarians with an increasingly higher proportion of females will perhaps change the face of the profession in the near future. Motivators for becoming lab animal veterinarians, according to study respondents, are to increase professional opportunities, improve income, and satisfy personal goals. Although the lab animal veterinary discipline provides the highest compensation in the profession, the present data suggest that the supply of veterinarians to the sector remains somewhat below the need nationally, according to the factors measured at the time of this study. This apparent gap might well be a subject for further examination, but is beyond the scope of support through data available for the present report.

The net hours of underemployment for the entire profession were computed to provide an understanding of the current availability of lab animal veterinarians and the actual need for these skills in the sector. The result shows total net hours of underemployment of -471.5 hours and, assuming that a typical laboratory animal veterinarian works on average 40 hours per week, a total of 12 veterinarians will be needed to offset the net total underemployment hours. The data available for this report did not allow for identification of relevant factors that could be used to explain underemployment observed across regions and across types of institutions, so clear recommendations for addressing the underemployment in lab animal veterinary medicine are not offered.

Engaged longer

The average expected age of retirement in the lab animal veterinarian industry is 68, which is above the average age of retirement for the general population in the United States. This indicates that the

profession keeps workers engaged longer than is typical of other industries. A positive aspect of this tendency is the high-quality image of the profession that is conveyed. A downside, however, is that this scenario could keep younger professionals from potentially achieving a higher level of employment, as older workers hang on to their positions. Of the factors that were used in the regression model to explain variations in expected year of retirement, board certification emerges as a significant factor. People with board certification typically retire two years earlier than their colleagues who are not board certified. This might be explained by the fact that board certification improves income, which in turn might allow sooner retirement.

To determine factors affecting income, a least squares model was estimated. The result indicates that professional income of lab animal veterinarians increases by 3.4 percent each year and that people with board certification and residency participation see improved income. In addition, the computation indicates that veterinarians in industry earn more than those in academia. In terms of professional income with respect to region, the result indicates that salaries are higher in Region 0 compared to those in other geographic regions within the United States. Continuing study of the workforce issues pertinent to the laboratory animal veterinary sector, as for all other American Board of Veterinary Specialties-recognized disciplines, should be encouraged.

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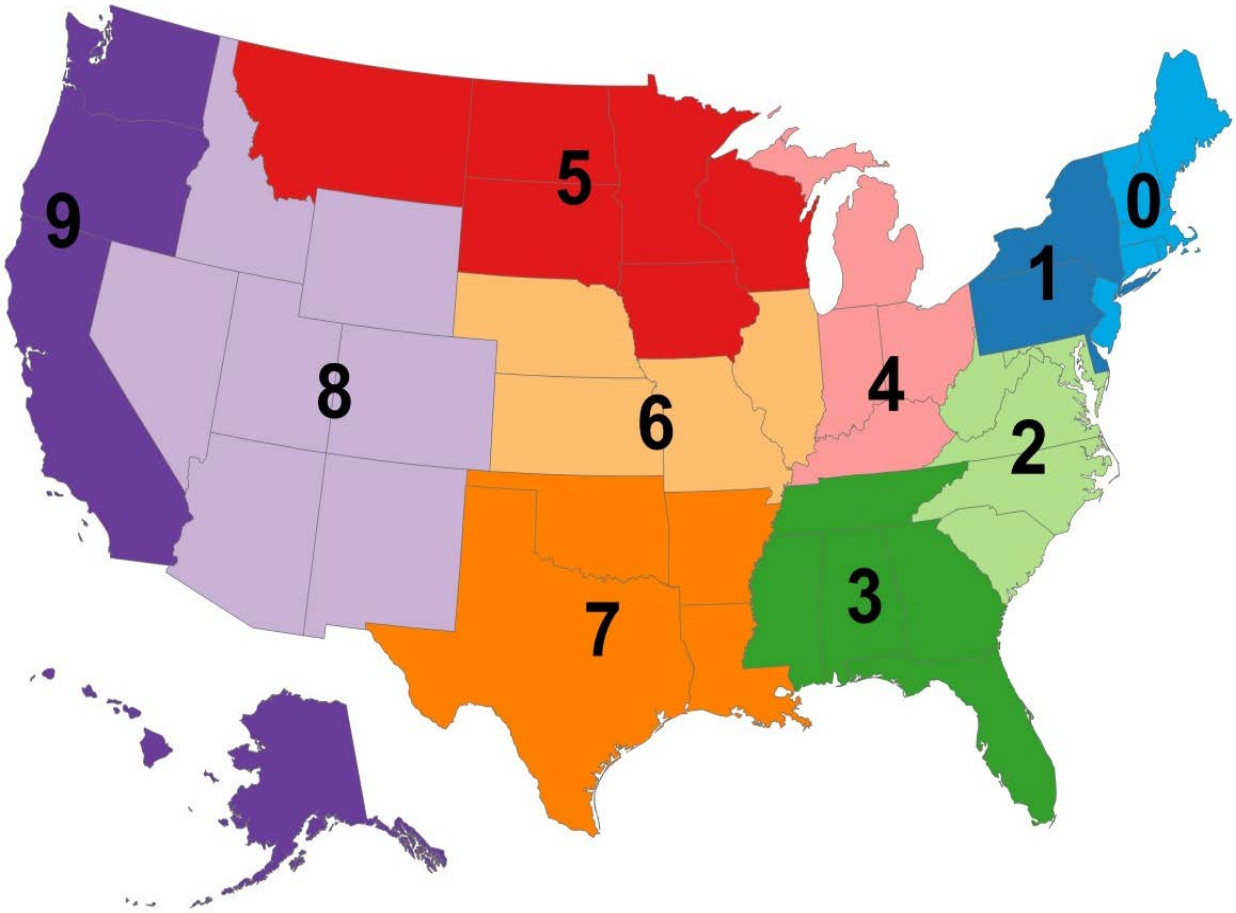
APPENDIX A

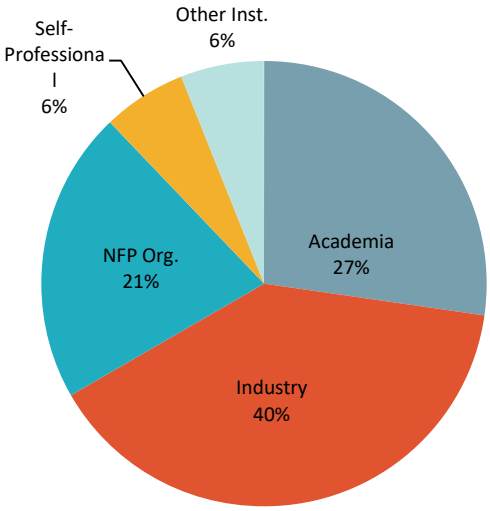
APPENDIX 1:

REGIONS OF THE UNITED STATES



APPENDIX 2:

LABORATORY ANIMAL VETERINARIANS BY TYPE OF EMPLOYMENT



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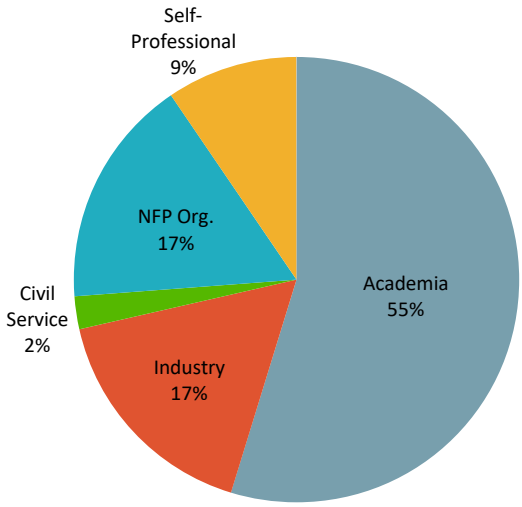
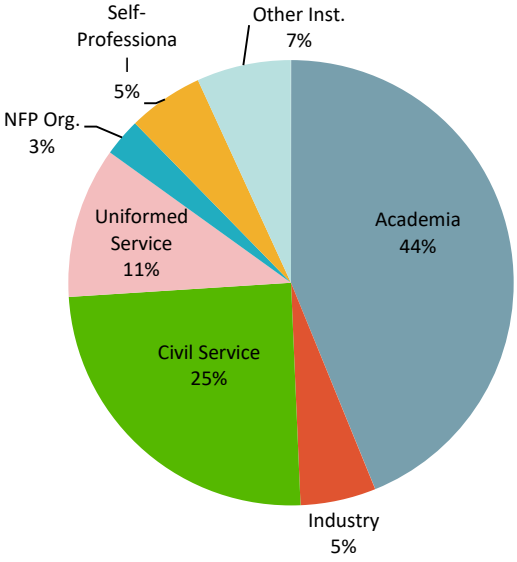


REGION 1



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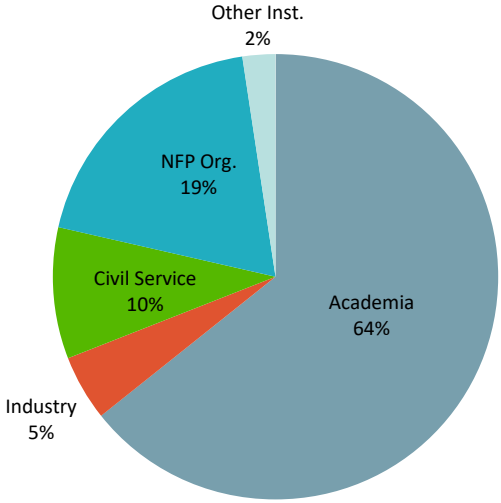

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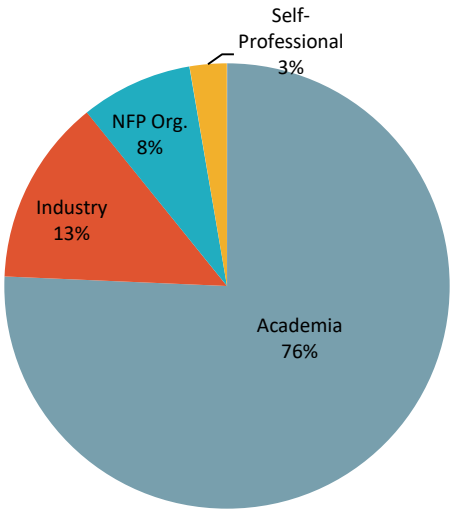

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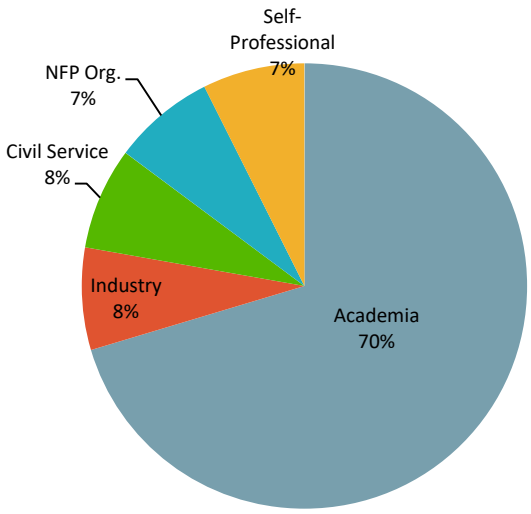

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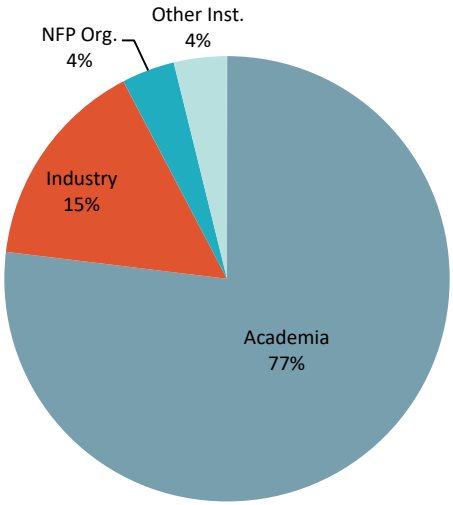

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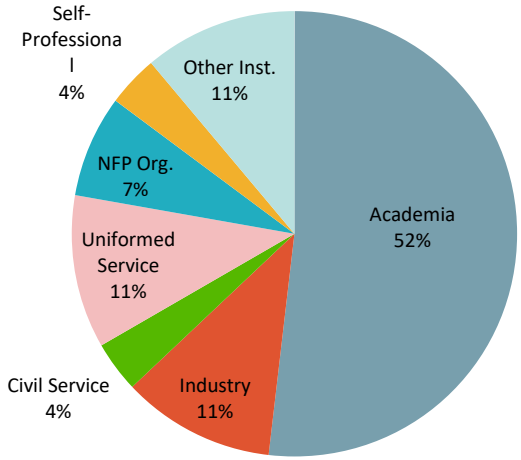

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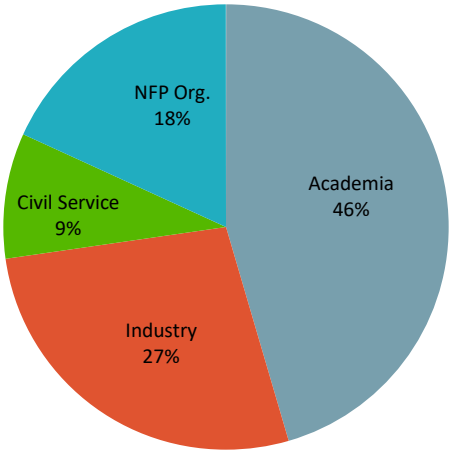

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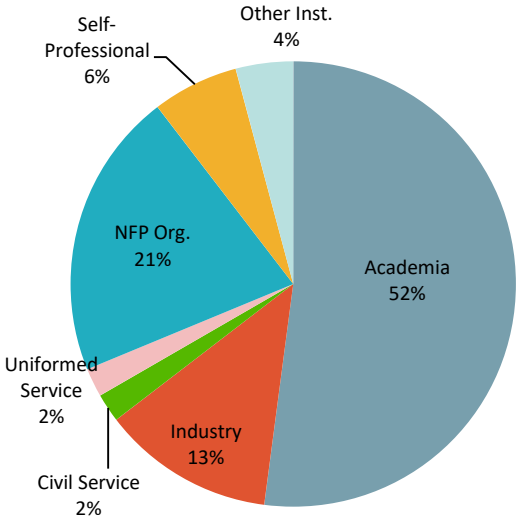

REGION 9