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EVA

Equine Viral Arteritis and the U.S. Horse Industry

National Animal Health Monitoring System

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Study Collaborators

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 - Centers for Epidemiology and Animal Health (CEAH)
 - Veterinary Medical Officers and Animal Health Technicians in Equine '98 study states
 - National Veterinary Services Laboratories (NVSL)
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Introduction

Equine viral arteritis (EVA) is an infectious disease caused by the equine arteritis virus (EAV). While it is typically not life-threatening to otherwise healthy adult horses, EVA is a special concern to horse breeders because it can cause abortion in pregnant mares, death in young foals, and render breeding stallions permanent carriers of the virus.

Although EVA outbreaks occur infrequently, EAV has been found in horse populations in many countries. Horses of any breed can be infected with the virus, but the prevalence of infection has been reported to be much higher in certain breeds, most notably, Standardbreds. This may be due to the large number of carrier stallions being used for breeding. The number of reported outbreaks of EVA has increased in recent years due to an increased awareness of the disease, more widely available diagnostic testing, and as a result of greater international trade in horses.

A number of large-scale outbreaks of EVA occurred in North America in the past 25 years. The majority of the outbreaks were at race tracks. One outbreak involved 41 Thoroughbred breeding farms in Kentucky in late spring and summer of 1984, and a smaller outbreak occurred at a veterinary teaching hospital that same year.

EVA can have economic consequences for both the breeding and performance sectors of the horse industry. Direct financial losses resulting from outbreaks of the disease on breeding farms can be summarized as follows:

- Losses due to abortion and/or disease and death in very young foals,
- Decreased commercial value of stallions that become persistently infected with the virus,
- Reduced demand to breed to carrier stallions because of the added expense and inconvenience involved in vaccinating and isolating mares before and after breeding.
- Denied export markets for fillies, mares, colts and geldings, and non-carrier stallions positive for serum antibodies to the virus.
- Denied export markets for carrier stallions.

An outbreak of EVA at a racetrack, equestrian event, or horse show can have considerable impact because of the potential for widespread transmission of EAV among horses closely congregated with one another. Such occurrences can result in direct financial losses through disruption of training schedules, reduced competition entries, and even race meet cancellations. At the international level, EVA has significantly affected trade in horses and semen with denied export opportunities for carrier stallions, EAV infective semen and, in some cases, all categories of horses that are positive for antibodies to the virus.

Many horses exposed to the virus will develop no signs of disease. When illness does occur - usually within 3 to 7 days of exposure - EVA can be difficult to diagnose because it is clinically similar to several other equine diseases such as equine rhinopneumonitis, influenza, equine infectious anemia (EIA), hoary allysum intoxication, and purpura hemorrhagica. The clinical signs vary in range and severity and can last from 2 to 14 days. Clinical signs may comprise:

- Fever
- Swelling, most notably of the legs, scrotum, sheath or mammary glands
- Loss of appetite (anorexia)
- Depression
- Conjunctivitis - inflammation, discharge and swelling above or around the eyes
- Clear to cloudy nasal discharge
- Skin rash or urticaria (hives, frequently localized on the head and neck)
- Abortion in pregnant mares
- Pneumonia and death of young foals

EAV infection can be transmitted among horses in four different ways:

- 1) Respiratory - an acutely infected horse spreads the virus to other horses via respiratory secretions. (Exposure commonly occurs at racetracks, shows, sales, and other events.)
- 2) Venereal - virus shed in the semen of an infected stallion is transmitted to mares when they are bred.
- 3) Indirect contamination - tack and/or equipment shared among horses may serve as a source of infection.
- 4) In utero - virus passes across the placenta from an infected mare to her unborn foal (uncommon).

Some stallions infected with EAV may become permanent or long-term carriers of the virus. Even if a stallion never shows any signs of disease, the virus may remain in his reproductive tract indefinitely. It can be passed to mares via his semen when they are bred - whether live-covered or artificially inseminated. However, a carrier stallion's fertility does not appear to be adversely affected.

The only definite way to diagnose EVA is by means of laboratory testing. The virus can be detected in certain tissues and fluids such as nasal secretions, semen, blood, placenta, and a wide range of fetal tissues and fluids. More commonly, a horse's blood is screened for the presence of antibodies to the virus.

Sound management practices can help prevent and control EVA. Methods recommended by the American Association of Equine Practitioners (AAEP) include:

- 1) Isolate all new arrivals (and returning horses) to your farm or ranch for 3 to 5 weeks.
- 2) If possible, segregate pregnant mares from other horses.
- 3) Blood test all breeding stallions for EAV antibodies.
- 4) Check semen of any unvaccinated, antibody positive stallions to identify carriers before breeding.
- 5) Once tested negative for EAV antibodies, vaccinate all breeding stallions annually.
- 6) Physically isolate any EAV carrier stallions.
- 7) Restrict breeding EAV carrier stallions to vaccinated mares or mares which test positive for naturally acquired antibodies to the virus.
- 8) Vaccinate mares against EVA at least 3 weeks prior to breeding to a known carrier stallion.

- 9) Isolate mares vaccinated for the first time against EVA for 3 weeks following breeding to an EAV carrier stallion.
- 10) In breeds or areas with high rates of EAV infection, vaccinate all intact males between 6 to 12 months of age as advised by your veterinarian.

With the exception of abortion or death in very young foals, EVA is rarely fatal. Most horses that contract the disease make full and uneventful recoveries. Treatment, if applied, is directed at reducing the severity of clinical signs during the course of the illness.

NAHMS Equine '98 Study

The National Animal Health Monitoring System's (NAHMS) Equine '98 Study was designed to provide both participants and those affiliated with the equine industry with information on the nation's equine population for education and research. NAHMS is sponsored by the USDA:Animal and Plant Health Inspection Service (APHIS):Veterinary Services (VS).

NAHMS developed study objectives by exploring existing data sources and contacting industry members about their informational needs and priorities. The objectives are listed inside the back cover of this report.

The USDA's National Agricultural Statistics Service (NASS) collaborated with VS to select a statistically-valid sample such that inferences can be made to all places with equids (domestic horses, miniature horses, ponies, donkeys/burros, mules) and to all equids in the 28 states. The initial sample included 2,904 participating operations from 28 states for Equine '98 (see map). The 28-state target population represented 78.2 percent of U.S. horses and ponies and 78.0 percent of farms with horses and ponies (see Appendix II).

Parts I and II: Baseline Reference of 1998 Equine Health and Management were the first in a series of releases documenting Equine '98 Study results. NASS enumerators collected data on site from the 2,904 equine operations for these two initial reports via a questionnaire administered from March 16, 1998, through April 10, 1998. Inventory data from the 133 participating race tracks were only included in Part I.

The second phase of data collection was done by Federal and state Veterinary Medical Officers (VMO's) and Animal Health Technicians (AHT's) in the 28 states. Data were collected on site for *Part III: Management and Health of Horses in the U.S., 1998*, from April 20 through June 12, 1998, from 1,178 participating operations that had three or more horses present on January 1, 1998. Race tracks were excluded from this phase of the study. This 28-state target population with three or more horses present on January 1, 1998, was estimated to represent (based on NAHMS' projection):

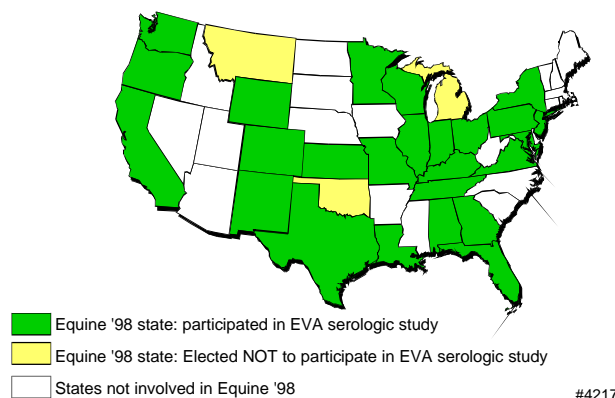
- 51.6 percent of operations with horses on January 1, 1998, in the 28 states.
- 83.9 percent of horses on January 1, 1998, in the 28 states.

VMO's and AHT's also collected data, including management data related to equine viral arteritis (EVA), for *Part IV: Reference of Health Management for Horses and Highlighted Diseases, 1998*, in the same 28 states. Questionnaire data were collected on site from June 15 through September 11, 1998, from 1,136 participating operations with three or more horses present on January 1, 1998.

Approximately one-half of the blood samples were collected during this time period and the other half were collected from November 11, 1998, through February 26, 1999. Twenty-five states participated in the blood collection phase of the Equine '98 study; Michigan, Montana, and Oklahoma elected not to participate in this phase. (See Section III of this report for additional information regarding sampling.)

The population estimates in Section I of this report were derived from questionnaire data collected from all 28 Equine '98 states. Estimates in Section II were derived from blood collected for serologic testing in 25 states.

Equine '98 States by Participation in Equine '98 Serologic Study



Terms Used in This Report

Equid: Member of the family *Equidae*. For this study, included only domestic horses, miniature horses, ponies, mules, and donkeys/burros.

Horse: For this study, a domestic horse that was at least 14 hands tall when full grown.

N/A: Not applicable.

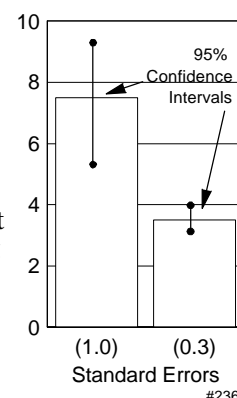
Operation: An area of land managed as a unit by an individual, partnership, or hired manager.

Percent horses: The total number of *horses* with a certain attribute divided by the total number of horses on all operations (or all operations within a certain category such as size or region).

Percent horses on those operations: The total number of horses residing on those *operations* with a given attribute, divided by the total number of horses on all operations (or all operations within a certain category such as size or region).

Population estimates: Averages and proportions weighted to represent the population. For this report, the reference population was all operations with three or more horses present on January 1, 1998, in the 28 selected states, excluding race tracks. Most of the estimates in this report are provided with a measure of precision called the *standard error*. If the only error is sampling error, chances are 95 out of 100 that the interval created by the estimate plus or minus two standard errors will contain the true population value. In the example illustrated at right, an estimate of 7.5 with a standard error of 1.0 results in a range of 5.5 to 9.5 (two times the standard error above and below the estimate). The second estimate of 3.4 shows a standard error of 0.3 and results in a range of 2.8 to 4.0. Similarly,

Examples of a 95% Confidence Interval



the 90 percent confidence interval would be created by multiplying the standard error by 1.65 instead of two. ***Where differences between groups are noted in this report, the 90 percent confidence intervals do not overlap.*** Most estimates in this report are rounded to the nearest tenth. If rounded to 0, the standard error was reported. If there were no reports of the event, no standard error was reported.

Previous 12 months: The period of time 12 months prior to the Equine '98 interviews conducted from June 15 through September 11, 1998.

Resident horse: A horse that spent or was expected to spend more time at the operation than at any other operation. The operation was its home base.

Regions for NAHMS Equine '98:

-**Western:** California, Colorado, Montana¹, New Mexico, Oregon, Washington, and Wyoming.

-**Northeast:** New Jersey, New York, Ohio, and Pennsylvania.

-**Southern:** Alabama, Florida, Georgia, Kentucky, Louisiana, Maryland, Oklahoma¹, Tennessee, Texas, and Virginia.

-**Central:** Illinois, Indiana, Kansas, Michigan¹, Minnesota, Missouri, and Wisconsin.

Sample profile: Information that describes characteristics of the operations from which Equine '98 data were collected. The sample (described in Appendix I on page 33) was selected to represent populations of horse operations and horses.

Size of operation: Size groupings based on number of resident horses at the *time of the initial VMO interview* (April 20 - June 12, 1998). Size of operation was categorized as 1-5, 6-19, and 20 or more horses at the time of the interview. Although operations were required to have three or more horses or horse foals on January 1, 1998, to qualify for this (second) phase of the study, the horse population on the operation could have decreased to one horse or horse foal at the time of the interview.

1 Elected to not participate in the EVA serologic phase of the Equine '98 study.

Section I: Population Estimates from Interview Results

Topics in this section are based on questionnaire data collected from respondents with three or more horses present on January 1, 1998, in 28 states. The data were weighted to represent this reference population.

A. Management Practices

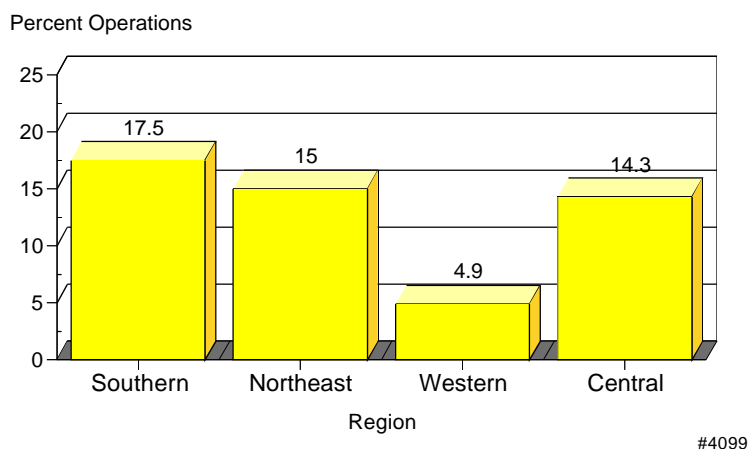
1. Familiarity

Overall, 59.4 percent of operations had never heard of equine viral arteritis (EVA), while 13.0 percent knew some basics or were knowledgeable of the disease. The Western region had the lowest percentage (4.9 percent) of operations that knew some basics or were knowledgeable of EVA.

a. Percent of operations by familiarity with the term equine viral arteritis (EVA) before the Equine '98 Study and by region:

Level of Familiarity	Southern		Northeast		Western		Central		All Operations	
	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
Never heard of it before	53.5	(5.4)	34.1	(8.2)	75.6	(5.0)	65.4	(5.8)	59.4	(3.3)
Recognized name, not much else	29.0	(5.2)	50.9	(9.4)	19.5	(4.7)	20.3	(4.6)	27.6	(3.0)
Knew some basics or was knowledgeable	<u>17.5</u>	(3.8)	<u>15.0</u>	(6.3)	<u>4.9</u>	(1.7)	<u>14.3</u>	(3.8)	<u>13.0</u>	(2.0)
Total	100.0		100.0		100.0		100.0		100.0	

Percent Operations that Knew Some Basics or were Knowledgeable about Equine Viral Arteritis (EVA) by Region



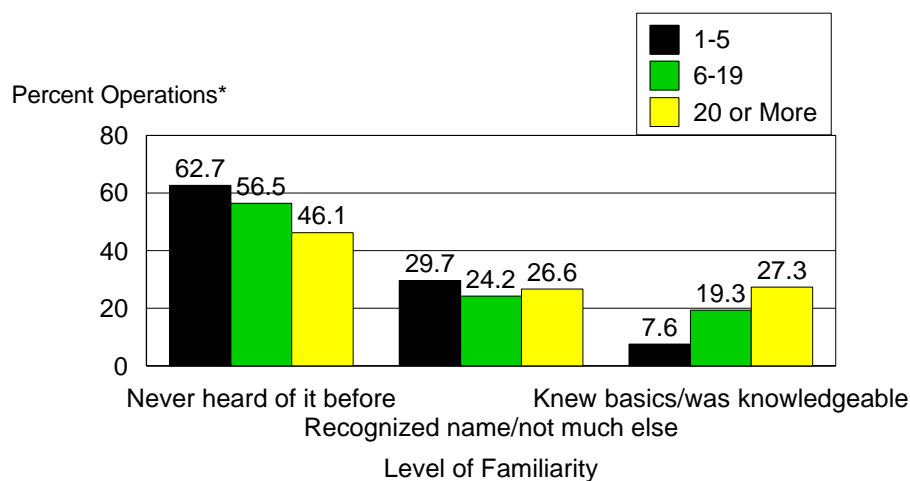
The percentage of operations that knew some basics or were knowledgeable regarding EVA increased with size of operation, from 7.6 percent of operations with one to five horses to 27.3 percent of operations with 20 or more horses.

i. Percent of operations by familiarity with the term equine viral arteritis (EVA) before the Equine '98 Study and by size of operation:

**Percent Operations by Size of Operation
(Number Resident Horses)**

Level of Familiarity	1-5		6-19		20 or More	
	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
Never heard of it before	62.7	(4.6)	56.5	(4.9)	46.1	(7.5)
Recognized name, not much else	29.7	(4.4)	24.2	(4.3)	26.6	(6.8)
Knew some basics or was knowledgeable	<u>7.6</u>	(2.4)	<u>19.3</u>	(3.8)	<u>27.3</u>	(6.8)
Total	100.0		100.0		100.0	

Percent Operations by Familiarity with Equine Viral Arteritis (EVA) by Size of Operation



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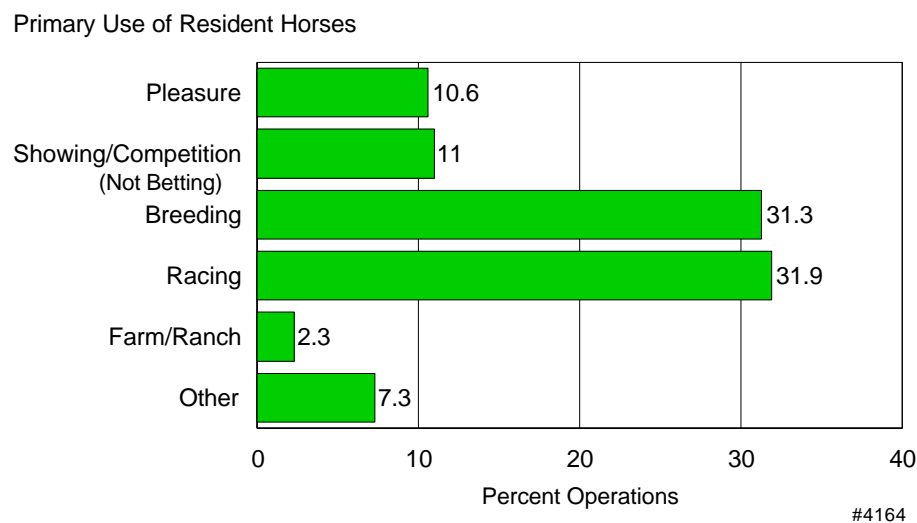
The percentages of operations that were familiar with EVA were highest in the racing (31.9 percent) and breeding (31.3 percent) categories of horse use and lowest in the farm/ranch category. Familiarity with diseases is often based on need to know, and to date, EVA has primarily impacted the breeding and racing industries.

ii. Percent of operations by familiarity with the term equine viral arteritis (EVA) before the Equine '98 Study and by primary use of resident horses:

Percent Operations by Primary Use of Resident Horses

Level of Familiarity	Pleasure		Showing/ Competition (Not Betting)		Breeding		Racing		Farm/Ranch		Other	
	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
Never heard of it before	61.9	(4.9)	61.0	(8.3)	41.8	(7.2)	31.6	(15.0)	70.8	(6.6)	85.8	(8.0)
Recognized name, not much else	27.5	(4.7)	28.0	(6.2)	26.9	(7.3)	36.5	(17.3)	26.9	(6.5)	6.9	(4.4)
Knew some basics or was knowledgeable	<u>10.6</u>	(2.7)	<u>11.0</u>	(5.0)	<u>31.3</u>	(7.0)	<u>31.9</u>	(15.9)	<u>2.3</u>	(1.7)	<u>7.3</u>	(4.7)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

Percent Operations that Knew Some Basics or were Knowledgeable about Equine Viral Arteritis (EVA) by Primary Use of Resident Horses



Population: Operations in the 28 Equine '98 states with 3 or more horses on January 1, 1998.

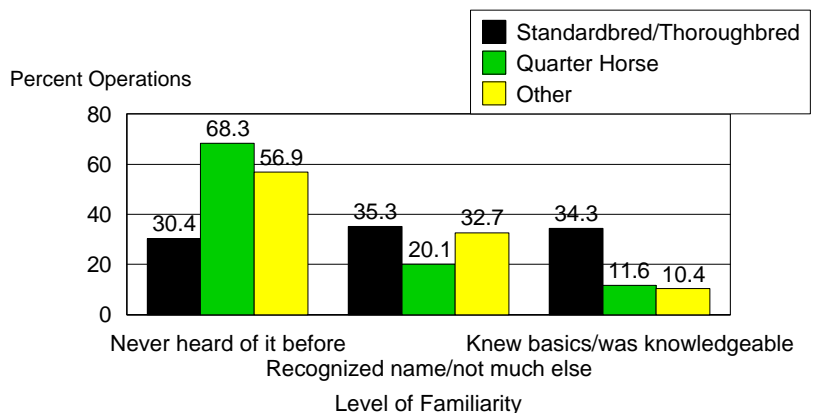
Familiarity with EVA was higher for operations with primarily¹ Thoroughbreds and Standardbreds compared to those with primarily Quarter Horses or other breeds.

iii. For operations where resident horses of the following breeds made up at least 50 percent of the resident horse inventory, percent of operations by familiarity with the term equine viral arteritis (EVA) before the Equine '98 Study and by breed:

Percent Operations by Breed

Level of Familiarity	Standardbred/ Thoroughbred		Quarter Horse		Other	
	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
Never heard of it before	30.4	(8.1)	68.3	(4.5)	56.9	(4.6)
Recognized name, not much else	35.3	(9.3)	20.1	(3.8)	32.7	(4.6)
Knew some basics or was knowledgeable	<u>34.3</u>	(9.4)	<u>11.6</u>	(3.2)	<u>10.4</u>	(2.5)
Total	100.0		100.0		100.0	

Percent Operations by Familiarity with Equine Viral Arteritis (EVA) by Primary Breed on the Operation*



*For operations where resident horses of these breeds made up at least 50% of the resident horse herd inventory.

1 At least 50 percent of the resident horse inventory.

2. Vaccination against EVA

Overall, only 1.6 percent of operations had a policy of vaccinating some or all resident horses against EVA. The Western region had the lowest percentage (0.1 percent) of operations that reported a policy of vaccinating against EVA. Vaccination practices were operator-reported and not verified by veterinary certificates or records.

a. Percent of operations that had a policy of vaccinating some or all resident horses against equine viral arteritis (EVA) by region:

Percent Operations by Region

Southern		Northeast		Western		Central		All Operations	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
1.1	(0.6)	2.7	(2.2)	0.1	(0.1)	3.5	(2.2)	1.6	(0.6)

The policy for just over 2 percent of operations with fewer than 20 horses was to vaccinate some or all resident horses against EVA compared to 7.5 percent of operations with 20 or more horses.

i. Percent of operations that had a policy of vaccinating some or all resident horses against equine viral arteritis (EVA) by size of operation:

Percent Operations by Size of Operation (Number Resident Horses)

1-5		6-19		20 or More		All Operations	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
1.2	(0.8)	1.1	(0.7)	7.5	(4.4)	1.6	(0.6)

The largest percentages of operations with a policy of vaccinating against EVA were those where the primary use of horses was for breeding (7.0 percent) and racing (5.4 percent). Horses housed at race tracks were not included in this phase of the study. The lowest percentage (0.1 percent) was for those operations where the primary use of horses was farming or ranching.

ii. Percent of operations that had a policy of vaccinating some or all resident horses against equine viral arteritis (EVA) by primary use of resident horses:

Percent Operations by Primary Use of Resident Horses

Pleasure		Showing/ Competition (Not Betting)		Breeding		Racing		Farm/Ranch		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
0.6	(0.5)	0.6	(0.3)	7.0	(3.6)	5.4	(4.8)	0.1	(0.1)	0.2	(0.2)

Larger percentages of operations where Standardbreds and Thoroughbreds made up at least 50 percent of the resident horses vaccinated against EVA compared to those with primarily Quarter Horses or other breeds.

iii. For operations where resident horses of the following breeds made up at least 50 percent of the resident horse inventory, percent of operations that had a policy of vaccinating some or all resident horses against equine viral arteritis (EVA) by breed:

Percent Operations by Breed

Standardbred/ Thoroughbred		Quarter Horse		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
10.1	(5.1)	0.8	(0.7)	0.8	(0.6)

Note: Estimates in the table below were derived from 1.6 percent of all operations. Standard errors are large due to this small sample size.

iv. For operations that vaccinated any resident horses against equine viral arteritis (1.6 percent of all operations), percent of operations by equine viral arteritis (EVA) vaccination practice:

Practice	Percent Operations	Standard Error
Vaccinate all horses	35.9	(13.9)
Vaccinate all breeding horses only	38.8	(16.5)
Vaccinate all breeding stallions only	4.1	(2.9)
Vaccinate specific horses only	<u>21.2</u>	(15.4)
Total	100.0	

3. Testing for EVA - Operations

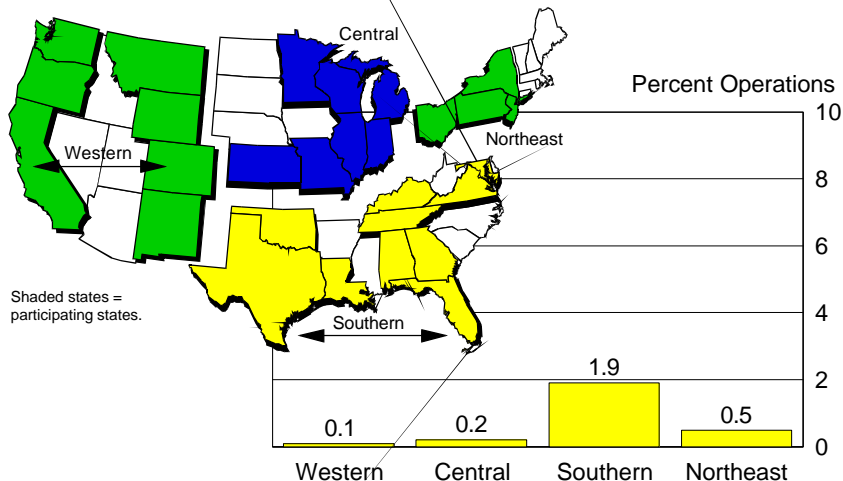
Overall, only 0.9 percent of operations indicated they had tested any horses for EVA in the previous 12 months. The highest percentage (1.9 percent) of operations that tested was in the Southern region.

a. Percent of operations that reported testing any horses for equine viral arteritis (EVA) in the previous 12 months¹ by region:

Percent Operations by Region

Southern		Northeast		Western		Central		All Operations	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
1.9	(1.7)	0.5	(0.4)	0.1	(0.1)	0.2	(0.1)	0.9	(0.6)

Percent Operations that Reported Testing Any Horses for Equine Arteritis Virus (EAV) in the Previous 12 Months by Region



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¹ Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

The percentage of operations that tested any horses for EVA in the previous 12 months increased with size of operation.

- i. Percent of operations that tested any horses for equine viral arteritis (EVA) in the previous 12 months¹ by size of operation:

Percent Operations by Size of Operation
(Number Resident Horses)

1-5		6-19		20 or More	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
0.0	(0.0)	1.9	(1.8)	2.7	(0.9)

The largest percentage (5.3 percent) of operations that tested any horses for EVA were those operations that primarily used horses for breeding. However, taking the standard errors into account, the percentages were not detectably different.

- ii. Percent of operations that tested any horses for equine viral arteritis (EVA) in the previous 12 months¹ by primary use of resident horses:

Percent Operations by Primary Use of Resident Horses

Pleasure		Showing/ Competition (Not Betting)		Breeding		Racing		Farm/Ranch		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
0.1	(0.0)	0.3	(0.1)	5.3	(4.4)	0.3	(0.2)	0.0	(--)	0.0	(--)

Operations that had predominantly Standardbred or Thoroughbred horses had the largest percentage that tested for EVA. However taking the standard errors of the estimates into account, the percentages were not detectably different across breeds.

- iii. For operations where the following breeds made up at least 50 percent of the resident horse herd,¹ percent of operations that tested any horses for equine viral arteritis (EVA) in the previous 12 months¹ by breed:

Percent Operations by Breed

Standardbred/ Thoroughbred		Quarter Horse		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
9.0	(7.1)	0.0	(0.0)	0.2	(0.0)

¹ Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

Approximately one-third of all operations had resident stallions. However, not all of these operations used stallions for breeding purposes.

b. Percent of operations that had resident stallions in the previous 12 months¹:

Percent Operations	Standard Error
32.7	(3.0)

Of the operations with stallions, just under one-half (47.6 percent) used one or more of these stallions for breeding purposes in the previous 12 months. The number of mares bred per stallion was not determined.

i. For operations that had resident stallions in the previous 12 months¹, percent of operations that used any resident stallions for breeding:

Percent Operations	Standard Error
47.6	(5.1)

Of the operations that used stallions for breeding in the previous 12 months, only 3.0 percent shipped semen within the U.S. and 0.1 percent shipped semen internationally. Just over 1 percent of operations with breeding stallions indicated they tested all of these stallions for equine viral arteritis (EVA). Two states have EVA programs (New York and Kentucky), and 0.4 percent of operations had stallions enrolled in one of these programs.

ii. For operations that used resident stallions for breeding in the previous 12 months¹, percent of operations that:

Practice	Percent Operations	Standard Error
Shipped equine semen within the U.S.	3.0	(1.4)
Shipped equine semen outside of the U.S.	0.1	(0.0)
Had <i>all</i> breeding stallions tested for EVA	1.2	(0.6)
Had any of these stallions enrolled in a state EVA control program	0.4	(0.4)

1 Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

Overall, 88.4 percent of operations had resident mares in the previous 12 months. Not all of these operations used these mares for breeding purposes.

c. Percent of operations that had resident mares in the previous 12 months¹

Percent Operations	Standard Error
88.4	(2.0)

For operations with mares, 42.3 percent used one or more of these mares for breeding purposes in the previous 12 months.

i. For operations that had intact mares in the previous 12 months¹, percent of operations where any resident mares were bred whether or not they became pregnant:

Percent Operations	Standard Error
42.3	(3.3)

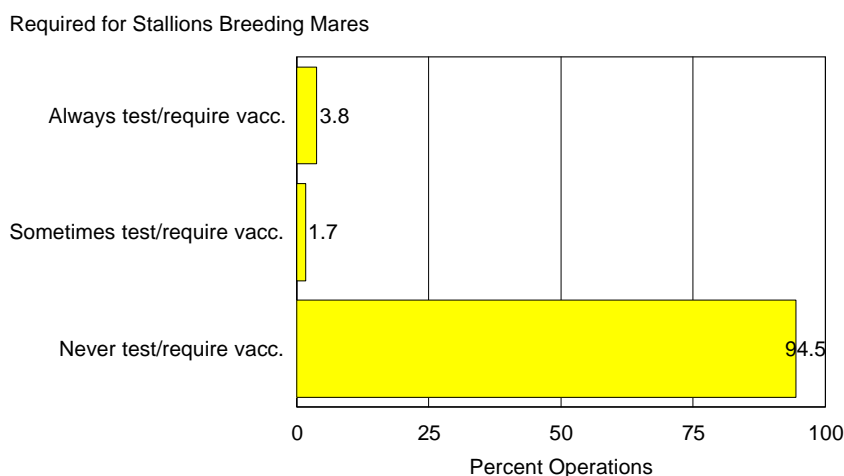
¹ Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

Only 5.5 percent of operations that bred one or more resident mares sometimes or always required the stallion to be tested or vaccinated against equine viral arteritis (EVA).

ii. For operations that bred any resident mares in the previous 12 months¹, percent of operations by equine viral arteritis (EVA) testing or vaccination requirements for stallions breeding these mares either by natural service or artificial insemination:

Practice	Percent Operations	Standard Error
Always test for EVA or always require stallions to be vaccinated against EVA	3.8	(1.9)
Sometimes test for EVA or sometimes require stallions to be vaccinated against EVA	1.7	(0.9)
Never test for EVA or never require stallions to be vaccinated against EVA	<u>94.5</u>	(2.1)
Total	100.0	

Percent Operations* by Equine Arteritis Virus (EAV) Testing or Vaccination Requirements for Stallions Breeding Mares**



* For operations that bred any resident mares in the previous 12 months. #4102
 **Either by natural service or artificial insemination.

Less than 1 percent of mares that aborted or had stillborn foals were tested for EVA. As reported in Equine '98 Part I: *Baseline Reference of 1998 Equine Health and Management*, 0.7 percent of mares aborted or had foals born dead during 1997.

iii. Percent of mares that aborted or had stillborn foals that were tested for EVA:

Percent Mares	Standard Error
0.7	(0.3)

1 Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

Section II: Population Estimates from Serologic Results

Topics in this section are based on laboratory test results and specific information collected for each horse tested (as reported by respondents on operations with three or more horses present on January 1, 1998, in the 25 participating states). Data were weighted to represent this reference population.

A. All Horses and Operations

It is logical that a larger percentage of horses that were reportedly vaccinated against EVA at any time in their lives were seropositive, based on serum neutralization (SN) test to detect antibody to the equine arteritis virus, than horses that were not vaccinated. Not all horses with a history of vaccination were antibody positive which may have been because there was a prolonged period between vaccination and the time of testing, these horses may have failed to develop antibody in response to vaccination, or the owners/operators had false impressions as to what the horses had been vaccinated against, e.g., “We vaccinate against everything.” All vaccination history was owner/operator-reported and not validated via veterinary medical records. It is also possible that a horse had been vaccinated against EVA without owner/operator knowledge.

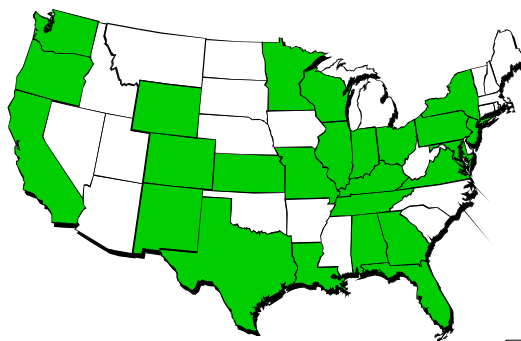
Overall, 2.0 percent of horses lacking a history of vaccination against EVA were seropositive to the virus. Note: Estimates in Section II were derived from data collected in 25 of the Equine '98 states (see map below).

1. Serologic results by vaccination status

a. Percent of *horses* positive for serum neutralizing antibodies to equine arteritis virus (EAV) by vaccination status against EVA:

Horse Vaccination Status	Percent Horses Positive	Standard Error
Vaccinated	25.3	7.9
Not vaccinated	2.0	0.4

Equine '98 States Participating in Equine '98 Serologic Testing for Equine Arteritis Virus (EAV)



#4216

POSITIVE:
 Serum neutralization (SN) titer of
 1:4 or greater to EAV.

The percentage of operations with at least one horse seropositive to EAV increased with vaccination use. However due to the very small number (1.6 percent) of operations that vaccinated, these estimates are imprecise (large standard errors). Over one-half (53.7 percent) of operations where *all* the tested horses were reportedly vaccinated against EVA had one or more horses seropositive to EAV. A total of 28.8 percent of operations where *some* of the horses tested were reportedly vaccinated had one or more seropositive horses. A total of 8.4 percent of operations where *none* of the horses tested were reportedly vaccinated had one or more horses seropositive to EAV.

b. Percent of *operations* that had at least one horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) by vaccination status against EVA:

Operation Vaccination Status	Percent Operations with Positive Horses	Standard Error
All vaccinated	53.7	(30.7)
Some vaccinated	28.8	(22.8)
None vaccinated	8.4	(2.0)

B. Unvaccinated Horses Only

NOTE: Estimates in Section II.B.1 *exclude* operations that vaccinated all horses against EVA. For operations that vaccinated some horses and not others, status of the operation as positive or negative was based on test results from *unvaccinated* horses only.

Larger percentages of operations in the Northeast and Central regions had one or more horses test positive for antibodies to EAV. However, detectable differences were not noted between the Southern, Northeast, and Central regions when standard errors were taken into consideration. Differences were noted between the Northeast and Western regions and the Central and Western regions with the Western region having the lowest (2.1 percent) percentage of operations with one or more seropositive horses.

1. Operation-level serologic results

a. Percent of operations that had at least one unvaccinated horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) in the previous 12 months¹ by region:

Percent Operations by Region									
Southern		Northeast		Western		Central		All Operations	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
5.9	(3.3)	19.3	(7.1)	2.1	(1.1)	11.8	(4.2)	8.3	(1.9)

**POSITIVE OPERATION:
One or more unvaccinated horses
had a serum neutralization (SN)
titer of 1:4 or greater to EAV.**

¹ Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

There was a trend for the percentage of operations with at least one unvaccinated horse positive for antibodies to EAV to increase with size of operation.

- b. Percent of operations that had at least one unvaccinated horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) in the previous 12 months¹ by size of operation:

Percent Operations by Size of Operation
(Number Resident Horses)

Less than 6		6-19		20 or More	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
4.7	(1.9)	11.9	(4.3)	18.5	(6.9)

Higher percentages of operations that were primarily boarding/training facilities (27.3 percent) and breeding farms (20.5 percent) had at least one unvaccinated horse positive for antibodies to EAV than operations that were primarily farms/ranches (3.2 percent) or residences with horses for personal use (2.6 percent).

- c. Percent of operations that had at least one unvaccinated horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) by primary function of operation:

Percent Operations by Primary Function of Operation

Boarding/Training Facility		Breeding Farm		Farm/Ranch		Residence (Personal Use)		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
27.3	(10.9)	20.5	(7.5)	3.2	(2.6)	2.6	(1.7)	22.0	(11.5)

**POSITIVE OPERATION:
One or more unvaccinated horses
had a serum neutralization (SN)
titer of 1:4 or greater to EAV.**

¹ Last 12 months prior to the Equine '98 interview conducted between June 15, 1998, and September 11, 1998.

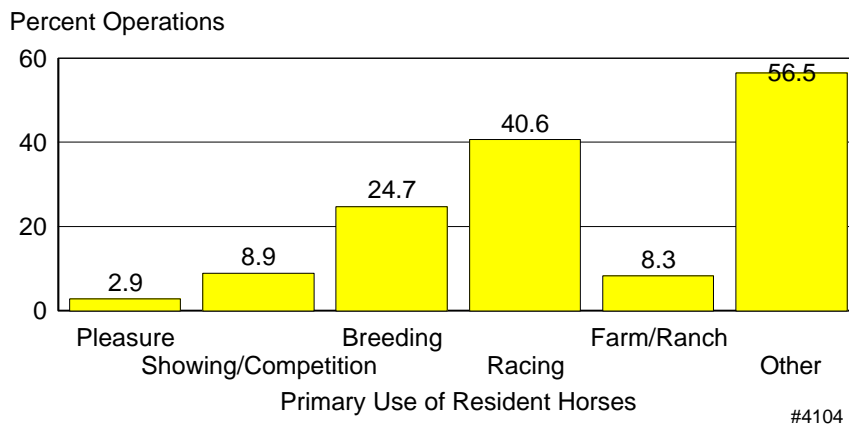
A lower percentage (2.9 percent) of operations that had primarily horses for pleasure were positive for antibodies to EAV than operations with horses used primarily for breeding (24.7 percent) and those operations in the Other (56.5 percent) category.

d. Percent of operations that had at least one unvaccinated horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) by primary use of resident horses:

Percent Operations by Primary Use of Resident Horses

Pleasure		Showing/ Competition (Not Betting)		Breeding		Racing		Farm/Ranch		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
2.9	(1.4)	8.9	(4.1)	24.7	(9.1)	40.6	(21.5)	8.3	(6.1)	56.5	(23.5)

Percent Operations that Had at Least One Unvaccinated Horse Positive for Serum Neutralizing Antibodies to EAV by Primary Use of Resident Horses



POSITIVE OPERATION:
One or more unvaccinated horses had a serum neutralization (SN) titer of 1:4 or greater to EAV.

A larger percentage (26.0 percent) of operations on which the owner/operator knew some basics or was knowledgeable about EVA had at least one unvaccinated horse positive for antibodies to EAV than on operations where the owner/operator was less knowledgeable. It is possible that operators would know more about the disease on operations where EVA had occurred or where horses were more likely to be exposed to EAV. **NOTE:** These serology results are for horses with no history of vaccination.

- e. Percent of operations that had at least one unvaccinated horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) by familiarity with the term equine viral arteritis (EVA) before the Equine '98 Study:

Level of Familiarity	Percent Operations	Standard Error
Never heard of it before	5.9	(1.9)
Recognized name, not much else	5.1	(2.7)
Knew some basics or was knowledgeable	26.0	(9.7)

Percentages of operations with one or more unvaccinated horses with a titer to EAV was higher (17.4 percent) on operations which had taken a horse outside of the state within the previous 12 months than on those operations that did not take horses out of the state (5.4 percent).

- f. Percent of operations that had at least one unvaccinated horse positive for serum neutralizing antibodies to equine arteritis virus (EAV) by transportation of any equid on the operation outside of the state, but within the United States:

Transported Outside State/ Within United States	Percent Operations	Standard Error
Yes	17.4	(5.6)
No	5.4	(1.7)

**POSITIVE OPERATION:
One or more unvaccinated horses
had a serum neutralization (SN)
titer of 1:4 or greater to EAV.**

NOTE: Estimates in Section II.B.2 *exclude* horses that had a history of ever being vaccinated against EVA.

It is possible that some horses were previously vaccinated without the current owner/operator’s knowledge. The percentage of horses with a positive antibody titer to EAV was lower in the Western region (0.7 percent) than in the Northeast (4.3 percent) and Central (3.3 percent) regions. Significant differences were not detected across the Northeast, Central, and Southern regions when standard errors were taken into account. These regional estimates do not account for factors such as certain breeds of horses being more common in the region.

2. Horse-level serologic results

a. Percent of unvaccinated horses positive for serum neutralizing antibodies to equine arteritis virus (EAV) by region:

Percent Horses by Region

Southern		Northeast		Western		Central		All Horses	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
1.2	(0.6)	4.3	(1.6)	0.7	(0.3)	3.3	(1.0)	2.0	(0.4)

The percentage of horses with a detectable titer to EAV was higher for horses 5 years or older than for the horses 6 months to 5 years old. Detectable titer to EAV in horses of less than 6 months of age could have been due to maternally acquired antibody. Data regarding vaccination history of dams were not collected.

b. Percent of unvaccinated horses positive for serum neutralizing antibodies to equine arteritis virus (EAV) by age group:

Percent Horses by Age Group

Less than 6 Months		6 - Less than 18 Months		18 Months - Less than 5 Years		5 - Less than 20 Years		20 or More Years	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
2.5	(2.5)	0.0	(0.0)	0.6	(0.4)	2.7	(0.6)	2.3	(1.0)

**POSITIVE:
Serum neutralization (SN) titer of
1:4 or greater to EAV.**

A larger percentage of female horses was seropositive to EAV (3.4 percent) than castrated males. Although the estimate for females positive for antibodies to EAV was higher than those for intact males, significant differences were not detected when standard errors were taken into account.

c. Percent of unvaccinated horses 18 months and older positive for serum neutralizing antibodies to equine arteritis virus (EAV) by gender:

Percent Horses 18 Months and Older by Gender

Intact Male		Castrated Male		Female (Intact or Spayed)		All Horses	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
1.0	(0.7)	1.2	(0.3)	3.4	(0.8)	2.2	(0.4)

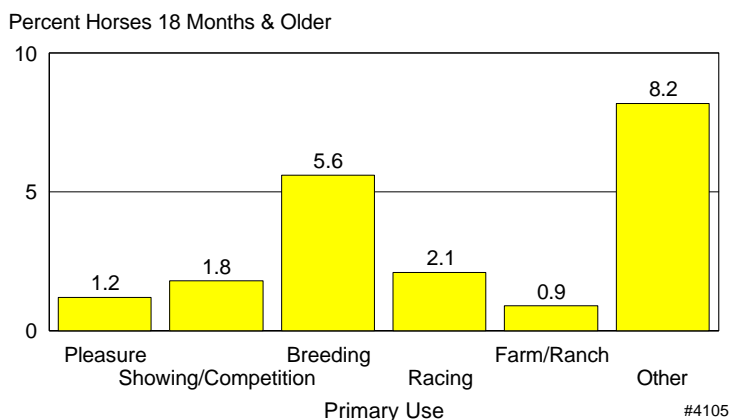
A higher percentage of horses 18 months and older were positive for antibodies to equine arteritis virus (EAV) for horses primarily used for breeding (5.6 percent) than for horses primarily used for showing or competition (1.8 percent), pleasure (1.2 percent), and farm or ranch use (0.9 percent).

d. Percent of unvaccinated horses 18 months and older positive for serum neutralizing antibodies to equine arteritis virus (EAV) by primary use:

Percent Horses 18 Months and Older by Primary Use of Resident Horses

Pleasure		Showing/ Competition (Not Betting)		Breeding		Racing		Farm/Ranch		Other		All Horses	
Percent	Stand. Error	Percent	Stand. Error	Percent	Stand. Error	Percent	Stand. Error	Percent	Stand. Error	Percent	Stand. Error	Percent	Stand. Error
1.2	(0.4)	1.8	(0.6)	5.6	(1.7)	2.1	(1.0)	0.9	(0.9)	8.2	(4.6)	2.2	(0.4)

Percent Unvaccinated Horses 18 Months & Older Positive for Serum Neutralizing Antibodies to Equine Arteritis Virus (EAV) by Primary Use



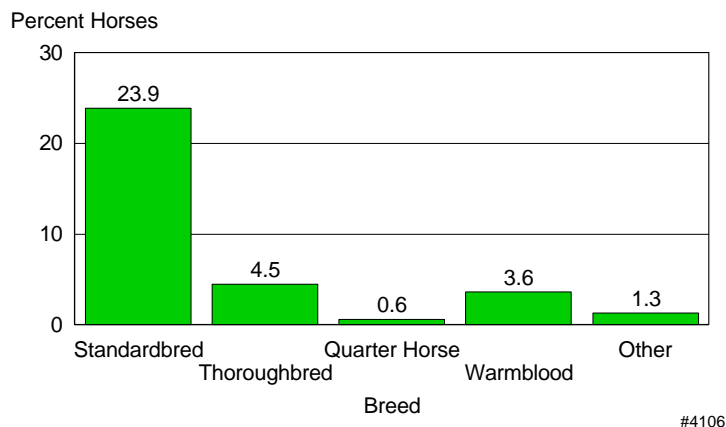
POSITIVE:
Serum neutralization (SN) titer of
1:4 or greater to EAV.

The percentage of horses of the Standardbred breed with a positive EAV titer was higher (23.9 percent) than percentages for any other breed category shown in the table below. The percentage of Thoroughbreds positive for antibodies to EAV was higher (4.5 percent) than for Quarter Horses (0.6 percent) and other breeds combined (1.3 percent). Horses included in the Other category were non-registered horses and those of registered breeds that are not shown. Results include only horses with no history of vaccination against EVA.

e. Percent of unvaccinated horses positive for serum neutralizing antibodies to equine arteritis virus (EAV) by breed:

Percent Horses by Breed									
Standardbred		Thoroughbred		Quarter Horse		Warmblood		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
23.9	(4.9)	4.5	(1.5)	0.6	(0.2)	3.6	(2.6)	1.3	(0.4)

Percent Unvaccinated Horses Positive for Serum Neutralizing Antibodies to Equine Arteritis Virus (EAV) by Breed



No significant differences were detected in percent of horses positive for antibodies to EAV by size of operation when standard errors were taken into account.

f. Percent of unvaccinated horses positive for serum neutralizing antibodies to equine arteritis virus (EAV) by size of operation:

Percent Horses by Size of Operation					
1-5		6-19		20 or More	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
1.4	(0.6)	2.5	(0.8)	2.0	(0.5)

POSITIVE:
Serum neutralization (SN) titer of 1:4 or greater to EAV.

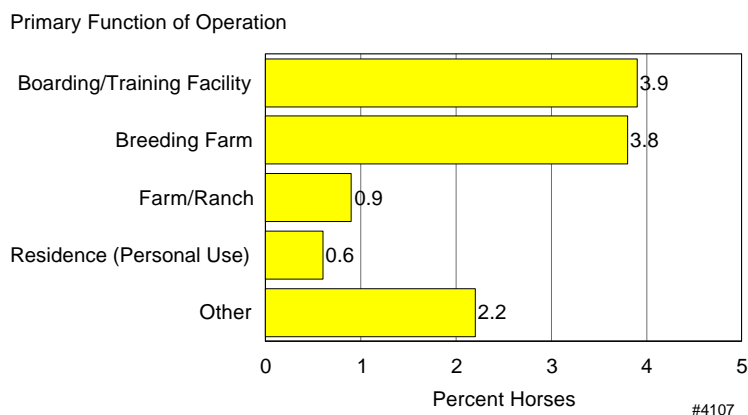
The percentages of horses with an EAV titer were higher on operations with primary functions of boarding/training (3.9 percent) and breeding (3.8 percent) than on operations with primary functions of farming/ranching (0.9 percent) and residence with horses for personal use (0.6 percent).

g. Percent of unvaccinated horses positive for serum neutralizing antibodies to equine arteritis virus (EAV) by primary function of operation:

Percent Horses by Primary Function of Operation

Boarding/Training Facility		Breeding Farm		Farm/Ranch		Residence (Personal Use)		Other	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
3.9	(1.0)	3.8	(1.4)	0.9	(0.8)	0.6	(0.3)	2.2	(1.1)

Percent Unvaccinated Horses Positive for Serum Neutralizing Antibodies to Equine Arteritis Virus (EAV) by Primary Function of Operation



Operations that were familiar with EVA had a higher percentage of horses with an EAV titer (4.5 percent) than operations that had never heard of the disease (1.5 percent) or just recognized the name (1.1 percent).

h. Percent of unvaccinated horses positive for serum neutralizing antibodies to equine arteritis virus (EAV) by operation familiarity with the term equine viral arteritis (EVA) before the Equine '98 Study:

Level of Familiarity	Percent Horses	Standard Error
Never heard of it before	1.5	(0.5)
Recognized name, not much else	1.1	(0.4)
Knew some basics or was knowledgeable	4.5	(1.3)

POSITIVE:
Serum neutralization (SN) titer of 1:4 or greater to EAV.

Section III: Methodology

A. Early Planning

Early planning was the key to success in providing equine statistics. In 1996, two USDA Agencies, APHIS and NASS, committed to provide equine health statistics via the Equine '98 Study (first report disseminated in August 1998, followed by a number of reports through 1999) and demographic statistics (January 1, 1998, and January 1, 1999, equine inventories published by NASS in March 1999).

B. Sampling and Estimation Details

1. NASS sampling frames - area frame

The sampling phase for providing equine statistics began in early 1997. USDA/NASS livestock estimates were historically based on a multiple frame sampling technique which incorporates the benefits of sampling from both a list and area frame. The NASS area frame within each of the 48 continental states was based on a land use stratification such as intensively cultivated land, range land, urban land areas, and land in cities. The sampling units were actual land areas and were approximately the same size within each stratum. These sampling units are called segments which vary in size from stratum to stratum. For example, in the intensively cultivated or crop production stratum, the segment size was one square mile, whereas in the agricultural and mixed urban strata, the size could be as small as one-fourth square mile. Since equids are more often located in fringe areas around towns or cities such as found in the agriculture/urban strata compared to other livestock, additional segments from these strata were allocated to the sample.

Once a segment was selected, maps and/or photographs were prepared for a field interview. The entire land area of each segment was reviewed through site visits so that all land was associated with an operator (person responsible for the day-to-day decisions). Each segment was thus sub-divided into smaller land areas called tracts. The tract operator's name is very important in creating the multiple frame estimates to avoid duplication with the list. There were 7,122 segments selected in all 48 states. NASS collected data for the Fall Area Survey during December 1997. Respondents reported the number of equids expected to be on hand January 1, 1998, on the total acres operated including acres operated outside the tract. The estimate for an Area Frame operation such as for total equids is then prorated back to the tract by the ratio of the operation's acres within the tract divided by the operation's total acres.

2. NASS sample frames - list frame

Since NASS did not previously have a list frame for equids, one had to be built. The goal was to compile names of operators/operations with large numbers of equids not normally considered to qualify as a farm (since farms would be estimated based on the area frame). A farm was defined as any place that produced and sold \$1,000 or more in agricultural products or had five or more horses. Therefore, list building concentrated on larger places with horses, such as service providers, that would generally not have other agriculture interests. Such operations included boarding stables, riding and training facilities breeding operations, and race tracks. These large, non-farm operations were rare and would not be accurately measured by the Area Frame. This list development occurred during summer and fall of 1997. From January 1 through January 15, 1998, all list names in all 48 states were contacted by telephone or personal interview and asked for their equine inventory on January 1, 1998.

3. Multiple frame estimation

The Area Frame sample data and the List Frame sample data were then combined. The List Frame names were matched against the Area Frame names to assure accounting of all equids while avoiding duplication. Whenever a match occurred, the Area Frame data were not used, i.e., if an operation was on the list, it was represented by using the List Frame data. The multiple frame estimate was therefore comprised of an area estimate of the list incompleteness plus the list estimate. NASS considers multiple frame estimation to be most efficient for a given cost and to yield more precise estimates for livestock than other Area Frame estimators. This estimator was used in providing both the demographic and health statistics.

4. Population inferences

The inverse of the probability of selection was used as the initial weight and then adjusted for the various phases of selection and non-response. Weights were further adjusted to account for operation inventory versus number of animals tested. For both the demographic and the health statistics, the reference population was any place/operation with one or more equid on January 1, 1998. The NASS estimates of equine inventory in the U.S. for January 1, 1998, was published in March 1999 along with the January 1, 1999, inventory estimates. The reference population for equine inventory (NASS estimates) is 48 states, and the reference population for health statistics provided in Equine '98's Parts I and II is limited to 28 states. The reference population for subsequent health reports (Equine '98's Parts III and IV) is limited to operations with three or more horses present on January 1, 1998, in the 28 states. (For the EAV serologic results, the reference population was 25 states; see the discussion on page 4.)

C. Equine '98 Methods

1. Identifying industry informational needs

Preparation for Equine '98 began with a project to identify all of the existing sources of information for monitoring equine health. A *Catalog of Opportunities for Equine Health Monitoring* was compiled and distributed in June 1995. Second, a needs assessment was undertaken to identify industry informational needs. Next, objectives (shown on the inside back cover of this report) were developed for the Equine '98 Study from input via a number of focus groups. These focus groups included industry representatives, researchers, and state and Federal animal health officials. In addition, web site and 1-800 telephone call-in surveys were conducted from January 1 through March 15, 1997, to provide needs assessment input. This collective feedback formed the basis for the study objectives.

2. Materials development

Specific estimates for information needed to meet the objectives were identified via a mockup of the report without any data. Questionnaire design then began, followed by pre-testing in September and October 1997. The initial training school for NAHMS Coordinators (one from each of 28 participating states) took place in January 1998 in Fort Collins, Colorado. Subsequent training schools were held for NASS enumerators and APHIS VMO's (Veterinary Medical Officers) and AHT's (Animal Health Technicians) in each state.

3. Selection of states

A goal for all NAHMS national studies is to include states that account for at least 70 percent of the animal and producer/owner populations in the U.S. Budget constraints beyond this level of coverage were an important consideration. The most recent data available on which to base the selection of states to be included in Equine '98 Study was the 1992 Census of Agriculture data for horses and ponies (shown in Appendix II for states selected). Use of these data is limited in that the data represented horses and ponies on farms only. For the purpose of the Census, a farm is defined as any

place with \$1,000 or more sales of agriculture products during the year or having at least five horses. Based on this definition, a large number of horses and operations with horses were not included in the Census of Agriculture data. These data were the best available for choosing states to be in the study.

Each state's contribution to the U.S. total for number of horses and ponies and number of farms reporting horses or ponies was calculated. The animal contribution was given a weight of 0.6 and the number of farms a weight of 0.4. This weighted contribution (single number for percent of total) was a key determinant in selecting the states. Every state that accounted for 2 percent or more of the U.S. total horses and ponies was included in the study except for Iowa and Idaho which were excluded due to expected resource conflicts with a then proposed NAHMS cattle on feed study. Thus, 21 states were initially selected based on this criterion. In addition, seven states were included that individually contributed less than 2 percent. Georgia, Maryland, and New Jersey were included due to a high level of state equine industry interest, and Alabama, Louisiana, New Mexico, and Wyoming were included to improve geographical representation. A total of 28 states were eventually included in the Equine '98 Study which accounted for 78.2 percent of the U.S. 1992 Census horses and ponies and 78.0 percent of the farms with horses and ponies.

4. Selection of the sample

The combined NASS Area and List data set (demographic sample) which provided estimates for the January 1, 1998, inventory for all states in the U.S. then became the basis for selecting the sample for the Equine '98 Study for the 28 target states. The Equine '98 sample selection is therefore a subsample of the NASS Fall 1997 Area Survey and January 1998 Equine Survey respondents that reported one or more equid on hand on January 1, 1998. The sub-sampling was done within size groups based on total number of equids for list and area separately. Distribution of the sample to individual states was based primarily on the U.S. 1992 Census size indicator (previously discussed).

The following table is provided to facilitate further understanding of the Equine '98 sampling process. NASS enumerators initially collected data from the sample (4,311) from March 16 through April 10, 1998. The sample for subsequent data collections was a subset of participants from the initial sample who had three or more horses present on January 1, 1998, and who wanted to participate in further phases of the study.

Equine '98 Sampling Process ¹		NASS Collection	Equine '98 Sample
Area Sampling Frame:	Number of segments selected for Fall survey	5,491	
	Number of tracts reported	38,482	
	Number of tracts reporting equine	6,125	
	Number of tracts selected for Equine '98		2,244
List Sampling Frame:	Number list records	14,856	
	Number selected for January survey	14,856	
	Number reporting equine in January survey	9,032	
	Number selected for Equine '98 (excluding race tracks)		1,904
	Number race tracks included in Equine '98 (office handling)		<u>163</u>
	Total sample collected for Equine '98		4,311

¹ For the 28 states, a total of 2,244 samples were selected as a subsample of operators with one or more equid reported on the Fall Area Survey. Likewise, 1,904 list operators were selected as a subsample of operators with one or more equid reported on the January 1998 Equine Survey (list). Inventory data (only) from 163 race tracks were included as reported on the January 1998 Equine Survey.

5. Data collection

Approximately 200 NASS enumerators collected data for the Parts I and II baseline health descriptive reports via personal, on-site interviews from March 16, 1998, through April 10, 1998. Approximately 150 VMO's and AHT's collected data for subsequent Equine '98 health reports in the 28 states. The following table provides a summary of the data collection activities.

Data Collection	Data Collector	Questionnaire Name	Reference Report ¹ & Date
March 16 - April 19, 1998	NASS Enumerator	Equine Management Report	Part I, released August 1998 & Part II, released September 1998
April 20 - June 12, 1998	Federal & State VMO's & AHT's	Initial Visit (horse management and health)	Part III, released January 1999
June 15 - September 11, 1998	Federal & State VMO's & AHT's	Summer Visit (horse management and health)	Part IV, released May 1999
November 2, 1998 - February 26, 1999	Federal & State VMO's & AHT's	Winter Visit (horse health)	Part IV, released May 1999
March 1- 31, 1999	Federal & State VMO's & AHT's	Follow Up Phone Call (horse health)	

¹ See the inside back cover of this report for a list of additional Equine '98 Study products.

6. Editing and estimation

Initial data entry and editing for Equine '98 Parts I and II baseline reports were performed in each individual NASS state office. NAHMS personnel performed additional data edits on the entire data set after data from all states were combined.

Data entry and editing for subsequent reports (Parts III and IV) were done by the NAHMS national staff in Fort Collins, Colorado. The manual edit and follow-up with operators were done by VS field staff. The national staff did all summarization and estimation.

7. Response rates for Parts I & II reports

The response categories for Parts I and II are shown below. These data were collected by NASS Enumerators from March 16 through April 10, 1998.

Category	Number	Percent
1 - race track office handling	163	3.8
2 - zero equids on hand January 1, 1998	199	4.6
3 - no resident equids on January 1, 1998	13	0.3
4 - refused	787	18.2
5 - 7 complete	2,758	64.0
8 - out of scope	37	0.9
9 - inaccessible	<u>354</u>	<u>8.2</u>
Total	4,311	100.0

The numerator for the response rate calculation includes the 2,758 complete questionnaires, 199 responses with zero equine, and 13 responses with no resident equine for a total of 2,970 good responses. The denominator includes 2,970 good responses plus 787 refusals and 354 inaccessible for a total of 4,111. The response rate was therefore 72.2 percent. The two categories excluded from the response rate calculation were 163 race tracks and 37 out of scope questionnaires such as prison

farms and university farms. Race tracks were contacted for inventory data on the January Equine Survey and were not re-contacted.

Data for Parts I and II of the baseline health statistics were summarized from 2,904 good reports. These reports were 2,758 complete responses plus 133 race tracks which had some equine inventory on January 1, 1998, plus 13 reports with equine present but no *resident* equine on January 1, 1998. Non-response adjustments were made to the initial sampling weights to account for those operators not responding. This adjustment allowed inferences to be made to the target population of any place with one or more equids on January 1, 1998, in the 28 states.

8. Response rates for Part III and IV reports and serologic testing for EAV

The sample for this data collection was a subset of those participants from the first data collection. Respondents from the March 16 - April 10 data collection had to have three or more horses on hand January 1, 1998, to be eligible for the next phase of data collection. Out of the 2,758 complete responses in Phase 1, there were 2,238 (81.1 percent) operations eligible for participation in further components of the study. Of these operations, 1,576 (70.4 percent) elected to have their names turned over to APHIS for VMO contact about participating further in the study. Nearly three-fourths (74.7 percent of the operations contacted) of the sample turned over for VMO contact participated in the second phase of the study (Part III, data collected from April 10th through June 12th). Nearly all (96.4 percent) of the Part III participants remained in the study for the June 15 through September 11, 1998, visit (Part IV).

Management data related to equine viral arteritis (EVA) were collected via questionnaire during the June 15 through September 11, 1998, visit. Michigan, Montana, and Oklahoma elected not to participate in serologic testing for equine arteritis virus (EAV). Blood serum specimens were collected from a total of 837 (81.8 percent of 1,023) operations in the other participating states in two periods: June 15 through September 11, 1998, and November 2, 1998, through February 26, 1999.

Complete responses from Phase I collection (March 16 - April 10, 1998; Part I & II reports)	2,758
Eligible for Phase 2 with three or more horses present January 1, 1998	2,238
Agreed to have their name turned over to APHIS for VMO contact (Phase 2 collection, Parts III and IV)	1,576
Complete responses for Part III (April 10 - June 12, 1998)	1,178
Complete responses for Part IV (June 15 - September 11, 1998)	1,136
Operations eligible for EAV serologic results (excludes Michigan, Montana, and Oklahoma)	1,023
Completed serologic testing for EAV	837

See also Sample Profile in the Appendix I for response rates by type of operation, region, and number of resident horses.

The number of horses tested for antibodies to equine arteritis virus (EAV) per operation was based on horse inventory and willingness of the owner/operator to allow testing. VMO's/AHT's were instructed to collect blood samples from resident horses only, based on the following criteria:

<u>Number of Resident Horses</u>	<u>Number of Horses Sampled</u>
Less than 10	All
10 to 19 horses	10
20 to 49 horses	15
50 or more horses	20

If all horses were not sampled on the operation, horses were randomly selected (by owner/operator or VMO) that represented the resident horse inventory on the premises in terms of sex, breed, age, and use. Foals and stallions were to be included.

The following data were collected for each horse tested: horse ID, age, gender, primary use, breed, if the horse had direct contact with other horses in the previous 30 days, if the horse had acute upper respiratory infection in the previous 30 days, the date of the last vaccination against equine viral arteritis (EVA), the date of the last vaccination against influenza, the number of influenza vaccinations in the previous 12 months, and date of blood sample collection.

Samples were shipped on ice by the day after collection or were spun and refrigerated, then shipped on ice within 5 days to the National Veterinary Services Laboratories (NVSL). Samples were tested at the NVSL Virology Laboratory. A serum neutralization titer was determined using the following method:

A virus neutralization assay was performed to determine the presence of neutralizing antibodies to EAV in serum. This test, also called a serum neutralization assay, was performed in two stages. In the first stage, serial twofold dilutions of test serum were mixed with a standard dose of a reference strain of EAV and the mixture incubated to allow interaction to occur. In the second stage, the serum/virus mixtures were tested for virus activity using cultures of mammalian cells susceptible to the virus. If residual virus was still present after the incubation period, it infected the mammalian cells which died. This result is easily detected by examination with a light microscope. Cell death indicated that the test serum did not contain neutralizing antibodies to EAV. If the test serum contained neutralizing antibodies to EAV, the virus was unavailable to infect the cells and the cells remained viable. Results of a VN test are reported as an antibody titer, e.g., positive at 1:16. The titer refers to the highest dilution of antibody tested that has detectable neutralizing activity. The serum dilutions typically tested for EAV ranged from 1:4 through 1:512. If a test serum does not neutralize virus at the lowest dilution tested, the result is reported as either "negative at 1:4" or "less than 1:4." Internationally, a titer of 1:4 or greater is considered positive for neutralizing antibodies to EAV.

9. Data analysis methods for EAV serology

This report contains population estimates and not raw sample percentages. Data were weighted based on probability of selection of the operation and adjusted for nonresponse. Weights were further adjusted to account for operation inventory versus number of animals tested. Estimates were expanded to represent the horse population in the 25 states that participated in sample collection for serologic testing for equine arteritis virus (EAV). Population estimates and standard errors of the estimates were obtained using Sudaan¹ software which is able to account for this complex survey design.

¹ Sudaan, Version 6.4, 1996. Research Triangle Park, NC.

D. Suggested Readings

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Appendix I: Sample Profile

A. Responding Operations and Number of Tests Performed

1. Type of operation

Primary Function of Operation	Number Participating Operations		
	June 15 - September 11, 1998	EAV Serologic Testing	Number Tests for EAV
Boarding/Training facility	368	283	2,889
Breeding farm	194	144	1,370
Farm/Ranch	208	136	798
Residence with equids for personal use	217	158	711
Other	<u>149</u>	<u>116</u>	<u>1,259</u>
Total	1,136	837	7,027

2. Region

Region	Number Participating Operations		
	June 15 - September 11, 1998	EAV Serologic Testing	Number Tests for EAV
Southern	418	280	2,171
Northeast	153	132	1,208
Western	307	245	2,118
Central	<u>258</u>	<u>180</u>	<u>1,530</u>
Total	1,136	837	7,027

3. Resident horses (whether or not present) at the time of interview

Number	Number Participating Operations	
	June 15 - September 11, 1998	EAV Serologic Testing
1 - 5	261	199
6 - 19	453	316
20 or more	<u>422</u>	<u>322</u>
Total	1,136	837

Appendix II: U.S. Equine Populations

Region	State	Census: Number Horses and Ponies ¹ on Farms (Thousand Head)		Census: Number Farms Reporting Horses and Ponies ¹ (Thousand Farms)		NASS: Number Equine ² - All Locations (Thousand Head)
		1992	1997	1992	1997	January 1, 1998
Central	Illinois	46.1	51.7	7.3	7.6	99.0
	Indiana	48.1	58.6	8.4	9.2	140.0
	Kansas	42.9	52.8	9.7	10.6	104.0
	Michigan	54.0	66.2	7.8	9.1	130.0
	Minnesota	43.1	55.9	7.7	8.8	155.0
	Missouri	64.6	85.7	14.2	15.9	140.0
	Wisconsin	<u>43.6</u>	<u>52.4</u>	<u>8.1</u>	<u>8.8</u>	<u>115.0</u>
	Total	342.4	423.3	63.2	70.0	883.0
Northeast	New Jersey	23.9	22.6	2.5	2.3	45.0
	New York	43.3	47.8	6.4	6.5	157.0
	Ohio	72.0	76.2	10.9	11.7	155.0
	Pennsylvania	<u>58.0</u>	<u>65.1</u>	<u>9.2</u>	<u>9.9</u>	<u>165.0</u>
	Total	197.2	211.7	29.0	30.4	522.0
Southern	Alabama	29.7	42.5	5.7	7.4	130.0
	Florida	52.0	54.9	6.7	6.8	170.0
	Georgia	31.1	35.3	5.6	5.9	69.0
	Kentucky	78.1	95.9	12.4	13.4	150.0
	Louisiana	28.0	30.1	5.1	5.3	65.0
	Maryland	24.3	22.5	2.8	2.6	45.0
	Oklahoma	70.0	93.7	14.9	18.4	165.0
	Tennessee	61.1	89.0	12.4	15.3	185.0
	Texas	209.1	242.0	38.5	44.2	595.0
	Virginia	<u>44.0</u>	<u>50.3</u>	<u>7.1</u>	<u>7.5</u>	<u>145.0</u>
Total	627.4	756.2	111.2	126.8	1,719.0	
Western	California	124.9	113.1	15.0	13.0	235.0
	Colorado	69.4	81.7	9.9	11.2	140.0
	Montana	56.4	71.2	8.2	10.2	130.0
	New Mexico	41.4	38.8	5.7	5.9	64.0
	Oregon	51.9	68.3	9.2	10.7	120.0
	Washington	51.1	58.8	7.9	8.1	155.0
	Wyoming	<u>40.7</u>	<u>50.6</u>	<u>4.5</u>	<u>5.3</u>	<u>61.0</u>
	Total	435.8	482.5	60.4	64.4	905.0
Total (28 states)		1,602.8 (78.2% of US)	1,873.7 (77.2% of US)	263.8 (78.0% of US)	291.6 (77.7% of US)	4,029.0 (76.7% of US)
Total (25 states: MI, MT, OK not included)		1,422.4 (69.4% of US)	1,642.6 (67.7% of US)	232.9 (68.8% of US)	253.9 (67.7% of US)	3,604.0 (68.6% of US)
Total U.S. (50 states)		2,049.5	2,427.3	338.3	375.2	5,250.4

1 Horses and ponies and farms reporting horses and ponies. Source: Census of Agriculture 1992 and 1997.

2 Equine includes horses, ponies, mules, burros, and donkeys. Equine located on farms totaled 3.20 million head and 2.05 million head were located on non-farm places. Source: National Agricultural Statistics Service (NASS), March 2, 1999.

Completed and Expected Equine '98 Study Outputs and Related Study Objectives

1. Provide baseline information on equine health.
 - Part I: Baseline Reference of 1998 Equine Health and Management, August 1998
 - Part II: Baseline Reference of 1998 Equine Health and Management, September 1998
 - Equine morbidity and mortality (info sheet), September 1998
2. Estimate uses of equine health-related management practices.
 - Part II: Baseline Reference of 1998 Equine Health and Management, September 1998
 - Part III: Management and Health of Horses in the U.S., 1998, January 1999
 - Part IV: Reference of Health Management for Horses and Highlighted Diseases, 1998, May 1999
 - Sources of information/use of veterinarian (info sheet), August 1998
 - Biosecurity practices on U.S. equine facilities (info sheet), August 1998
 - Information sources and use of veterinarians for equine health care, August 1998
 - Unique identification methods for U.S. equids (info sheet), May 1999
 - Equine management practices (info sheet), January 1999
 - Transportation of U.S. equids (info sheet), January 1999
3. Determine type and use of animals in the U.S. equine population by type of operation.
 - Part I: Baseline Reference of 1998 Equine Health and Management, August 1998
 - Composition of the U.S. equine population (info sheet), August 1998
4. Measure the prevalence of specific infectious agents or frequency of antibodies to specific infectious agents.
 - *Salmonella* and the U.S. horse population (info sheet), expected summer 2000
 - Internal parasites: strongyles and ascarids (info sheets), April 2000
5. Gather data related to specific health problems.
 - Testing for equine infectious anemia (EIA) in the U.S. (info sheet), September 1998
 - ***Equine Viral Arteritis (EVA) and the U.S. Horse Industry*** (interpretive report), April 2000
 - Equine Protozoal Myeloencephalitis, EPM (interpretive report), expected summer 2000
 - Lameness and Laminitis in U.S. Horses (interpretive report), April 2000
 - Colic (info sheet), expected spring 2000
 - Respiratory disease (info sheet), expected spring 2000
6. Feed problems.
 - Endophytes in U.S. horse pastures (info sheet), April 2000
 - Fumonisin toxin B₁ in on-farm horse grain/concentrate in the U.S. (info sheet), April 2000

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