CHAPTER 2

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National Animal Health Surveillance System (NAHSS)

NAHSS is a Veterinary Services (VS) initiative designed to integrate existing animal-health monitoring programs and surveillance activities into a comprehensive and coordinated system. NAHSS is charged with enhancing the collection, collation, and analysis of animal health data and facilitating timely and efficient dissemination of animal health information. NAHSS also augments the Nation's ability to detect the early signs of biological threats.

In December 2004, the NAHSS Steering Committee, in collaboration with the National Surveillance Coordinator and the National Surveillance Unit (NSU), finalized a strategic plan for national animal-health surveillance. VS established four primary goals for the NAHSS:

1. Early detection and global risk surveillance for foreign animal diseases (FADs),
2. Early detection and global risk surveillance for emerging diseases,
3. Enhanced surveillance for current program diseases, and
4. Monitoring and surveillance for diseases of major impact on production and marketing.

Program Disease Surveillance

The national eradication and certification programs, which eradicate, prevent, or minimize animal diseases of economic concern, are a fundamental component of VS' efforts to promote, ensure, and improve the biological and commercial health of U.S. livestock and poultry. VS eradication programs include scrapie in sheep and goats, tuberculosis in cattle and cervids, pseudorabies in swine, brucellosis in swine, and brucellosis in cattle and bison. Control and certification programs include chronic wasting disease in cervids, Johne's disease in cattle, trichinae in swine, and the Swine Health Protection Inspection Program, which regulates feeding of food waste to swine. More detailed information about these programs and their current status is provided in chapter 3.

FAD Surveillance and Programs

FAD Surveillance and Investigations

Efforts to detect FAD events in the United States include field investigations, disease-specific surveillance programs, and diagnostic laboratory surveillance. FAD field investigations are conducted by specially trained Federal, State, or private accredited veterinarians. VS operates disease-specific surveillance programs for the following diseases: bovine spongiform encephalopathy (BSE), exotic Newcastle disease (END), classical swine fever (CSF), avian influenza (AI), and infectious salmon anemia

(ISA). A National Animal Health Laboratory Network (NAHLN) was developed recently to screen routine and specific-risk samples for FADs. In addition, NAHSS, coordinated by VS' NSU, will improve early detection and global risk surveillance of FADs. The NAHSS 2005 strategic plan (<http://www.aphis.usda.gov/vs/ceah/ncahs/nsu/nahss/NAHSS_Strategic_Plan_2005_0216.pdf>) contains specific objectives to this end. Those objectives include enhancing domestic and global surveillance to identify elevated risks and encouraging the development and application of new technologies for early and rapid disease detection.

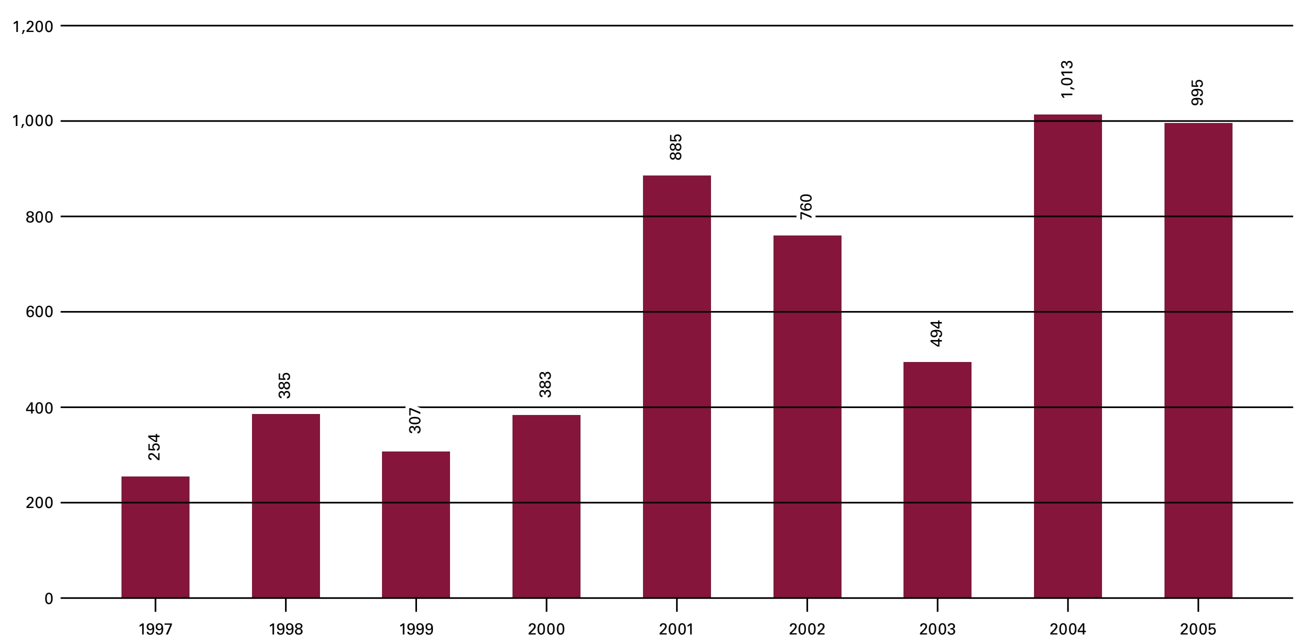
In 2005, VS conducted 995 investigations of FADs or emerging disease incidents in 47 States plus Puerto Rico (table A2.1 in appendix 2). Colorado, Utah, and Wyoming reported the most investigations (146, 144, and 130, respectively), of which 138, 143, and 124, respectively, were in response to a vesicular stomatitis outbreak that ultimately was reported in 6 additional States: Arizona, Idaho, Montana, Nebraska, New Mexico, and Texas. In addition to these 9 States, 25 more States, plus Puerto Rico, conducted 5 or more FAD investigations in 2005.

From 1997 through 2005, the number of investigations per year ranged from a low of 254 in 1997 to a high of 1,013 in 2004 (fig. 22). The high number of investigations in both 2004 and 2005 reflects the occurrence of the vesicular stomatitis outbreak.

Samples were submitted under Priority 1 status to the National Veterinary Services Laboratories (NVSL) for six investigations conducted in 2005. Priority 1 status is reserved for investigations for which the field investigator feels there is a high likelihood that the observed condition is an FAD or emerging disease incident (EDI) and requires prompt laboratory diagnostic information. Specimens submitted under Priority 1 are processed through diagnostic testing protocols in the most expedient way possible regardless of the time of day or the day of the week.

In 2005, vesicular conditions (painful, blisterlike lesions) of the muzzle and feet were the most common complaint investigated. There were 817 vesicular complaints: 603 in equids (horses, donkeys, and mules), 146 in cattle, 37 in goats, 14 in sheep, 12 in pigs, 4 in alpaca, and 1 in bison (table A2.2 in appendix 2). Differential diagnoses of FAD concern for vesicular conditions in equids include vesicular stomatitis. In ruminants, camelids, captive cervids, and swine, concern for any vesicular lesions would include not only vesicular stomatitis but also foot-and-mouth disease (FMD), which is a highly contagious viral infection of skin or mucous membranes that primarily affects cloven-hoofed domestic and wild animals. FMD would have a severe economic impact if it entered the United States and spread throughout the country.

FIGURE 22: **Number of FAD/EDI investigations, by year, 1997–2005.**



In cattle, BSE is one of the FAD differential diagnoses of concern for the complaint of central nervous system (CNS) signs, such as changes in temperament, abnormal posture, and ataxia. In 2005, VS continued surveillance for BSE through its Enhanced BSE Surveillance Plan established in 2004, testing 419,268 brain submissions and conducting 12 FAD investigations for the complaint of CNS signs in bovines.

Of the 995 investigations conducted in 2005, 447 resulted in a confirmed FAD finding with 445 diagnosed positive for vesicular stomatitis. One investigation, initiated for a complaint of maggots and ticks, resulted in a positive diagnosis of screwworm infestation; the other investigation for a complaint of high death loss in rabbits established a positive diagnosis for rabbit hemorrhagic disease. Early identification and quick response ensured that both FAD investigations were resolved with no indication of further spread.

FAD Programs

VS conducts surveillance specifically for AI, END, ISA, cattle fever ticks, CSF, tropical bont tick (TBT), and screwworm to improve detection of disease and to document that the United States is free from specific diseases. Brief descriptions of the programs are provided below.

END—The development of a national END surveillance program began in late 2003. The two primary goals of END surveillance are to (1) facilitate early detection of END in commercial and noncommercial poultry populations across the United States and (2) identify at-risk populations to enhance targeted surveillance activities. Surveillance relies on reporting of sick birds by owners and on active screening for birds entering the country illegally.

END Surveillance in 2005—NVSL has approved 30 laboratories to perform real-time reverse-transcriptase–polymerase chain reaction (RT–PCR) assays for END virus. Activities include surveillance of the live-bird market system (LBMS) and shows and fairs as well as passive surveillance of samples submitted to diagnostic laboratories. Under the program, 8,911 specimens from 19 States were tested for END in FY 2005, all with negative results. In addition, through the California Avian Health Program, 21,484 poultry on 1,783 premises tested negative for END.

Low-Pathogenicity AI Program: Commercial Industry Component—Through participation in the voluntary National Poultry Improvement Plan (NPIP), all commercial breeding operations producing primary and multiplier egg-type and meat-type chickens and turkeys are monitored for *Salmonella pullorum* (pullorum disease) and *S. gallinarum* (fowl typhoid). Nearly all primary poultry breeding operations—and many multiplier poultry breeding operations—are monitored for other egg-transmitted and hatchery-disseminated diseases such as *Salmonella enterica* serotype *enteritidis, Mycoplasma gallisepticum, M. synoviae,* and *M. meleagridis* (turkeys only). Flocks primarily producing meat-type chickens for breeding are monitored for all serotypes of *Salmonella.* In 2000, USDA–APHIS published its final rule for a U.S. Avian Influenza Clean classification for primary egg- and meat-type chicken breeding flocks. APHIS added both a U.S. Avian Influenza Clean program for exhibition poultry and upland gamebird breeding flocks and a U.S. H5/H7 Avian Influenza Clean classification for turkey breeding flocks in 2004. Finally, official delegates of the NPIP's 37th biennial conference ratified the addition of a provision in the Code of Federal Regulations that provides for participation by commercial table-egg layer, broiler, and meat-turkey operations. The code contains provisions for U.S. H5/H7 low-pathogenicity AI (LPAI) monitored classification for participating flocks and slaughter plants.

LBMS Program—The domestic LPAI program provides surveillance to prevent and control H5 and H7 LPAI in the LBMS. Surveillance in the LBMS began in 1986 when markets were first identified as sources of AI infection in domestic poultry. In 1994, H7N2 LPAI was introduced into the LBMS. In October 2004, VS published uniform standards for H5 and H7 LPAI to establish a more consistent approach to controlling LPAI in LBMS. States that volunteered to participate enacted regulations to ensure compliance within their LBMS, including producer, distributor, and retail market components.

Training was provided to State and Federal animal health technicians (AHTs), veterinary medical officers (VMOs), and other stakeholders working with the H5/H7 LPAI Program in the LBMS. This technical training focused on LBMS activities, diseases of poultry, laboratory testing, biosecurity, personal protective equipment, State regulations, the demonstration of correct euthanasia techniques, the use of geographic information systems, the role of the Animal and Plant Health Inspection Service's (APHIS) Investigative and Enforcement Services, risk assessment, the National Animal Identification System, and an update on H5N1 high-pathogenicity AI (HPAI) in Asia.

As a result of recent effort by VS and the States, the incidence of LPAI in the LBMS in the Northeastern United States decreased in fiscal year (FY) 05.

Biosecurity for the Birds Program—The Biosecurity for the Birds outreach and education program continued in 2005. To reach the program's target audience, program personnel placed information about Biosecurity for the Birds on feedsacks. In addition, the program was advertised in rural cooperative publications and community newspapers with a focus on reaching communities most likely to have backyard birds. Materials developed as part of the campaign included brochures, posters, giveaways, displays, videos, and a Web site (<http://www.aphis.usda.gov/vs/birdsecurity>). Materials were distributed at State and county fairs, poultry shows, veterinary conferences, universities, and 4–H meetings. In addition, the NPIP mailed information about the program to 3,000 targeted residences.

Infectious Salmon Anemia (ISA)—In 2001, ISA virus infection was detected at salmon sites in Cobscook Bay, ME. In December 2001, the Secretary of Agriculture declared an ISA disease emergency, which permitted allocation of funds to APHIS to provide indemnity, epidemiologic, and surveillance assistance to Maine's salmon industry over a 2-year period.

Disease Standards—To help prevent another large-scale ISA outbreak, APHIS continued the epidemiologic and surveillance assistance beyond the initial 2-year period. Between the beginning of the outbreak and the emergency declaration, a group of fish health veterinarians and biologists developed ISA disease control standards based on existing New Brunswick, Canada, ISA policies and practices implemented by the Norwegian salmon industry. The final standards were published in early 2002 as the USDA–APHIS Infectious Salmon Anemia Program Standards.

The standards delineate seven requirements for participating in the ISA program, which provides both disease control stipulations and compensation. These seven standards require farms to

- Develop a veterinarian–client–patient relationship;
- Participate in State-mandated surveillance;
- Develop and implement biosecurity protocols for marine sites, processing plants, and vessels;
- Develop action plans for ISA prevention and control;
- Participate in a statewide sea-lice control program;
- Report complete inventory, mortality, and fish health information; and
- Cooperate with program officials by completing periodic biosecurity audits.

Biosecurity and Surveillance—Biosecurity is a key component of the ISA program. Many important risk factors identified in the transmission of ISA are related to biosecurity issues, including handling and disposing of processing waste, blood, and stun-water; removing and disposing of dead salmon; controlling movements of vessels, equipment, and human site traffic; maintaining and using disinfection stations; and managing pens to control sea lice.

The initial goal of surveillance is the prompt detection of ISA virus infection. Surveillance is a mandatory activity at all Maine salmon sites and is performed by the site veterinarian at a frequency dictated by the ISA status of the site. These inspections, required at least monthly, include a visual overview of the site, a review of mortality records, the collection and submission of at least 10 moribund or freshly expired salmon, and a completed submission form that is sent to an APHIS-approved laboratory.

Biosecurity audits are performed semiannually on high-risk sites, yearly on low-risk sites, and at least annually on vessels. Audit reports identify observed strengths and weaknesses, make recommendations for improvements, and prioritize response times by apparent relative risk.

Program Implementation—The ISA Program, initiated in early January 2002 in partnership with the Maine Department of Marine Resources, continued through 2005. In 2005, 1,454 samples were collected during 178 inspections at 12 cage sites (table 2). These samples bring the total number of samples collected during the program to 10,244 during 1,119 inspections. Two vessel audits and 11 site audits were conducted. The low number of vessel audits in 2005 reflects the U.S. acceptance of vessel audits performed by New Brunswick officials. Through the year, 19 cages were confirmed positive for ISA at 5 previously confirmed sites. All fish were removed from disease-confirmed cages.

The APHIS Eastport, ME, ISA staff published findings from several epidemiologic ISA studies in 2005. Topics included the predictability of apparent prevalence of ISA based on mortality rates, the importance of early depopulation of ISA-infected cages, identification of risk factors important to ISA outbreaks on Maine farms, and the impact of hydrographics on the distribution of ISA in Passamaquoddy and Cobscook Bays in Maine and New Brunswick. The hydrographics study prompted a dramatic change in bay management strategy. In 2006, Maine and New Brunswick salmon sites will begin to stock salmon in coordinated 3-year cycles, starting with Cobscook Bay and Canadian salmon sites around Deer Island and Campobello Island, NB.

In 2005, the number of ISA genotypes detected and reported continued to increase. At year's end, 15 New Brunswick genotypes were detected, 3 of which had also been detected in Maine. Ongoing epidemiologic studies target husbandry-related risk factors relevant to ISA, incorporation of geographic information system technologies into disease pattern assessment, field assessment of genotype variability, efficacy of sea-lice management practices, and improved integration of cross-border data exchange and management.

TABLE 2: **ISA inspections**

	2002	2003	2004	2005	Total
Samples	1,962	3,187	3,641	1,454	10,244
Inspections	189	371	381	178	1,119
Sites	20	22	21	12	N/A
Site audits	22	21	13	11	67
Vessel audits	8	11	0	2	21
Cages confirmed positive	0	5	17	19	41
Confirmed cages removed	0	5	17	19	41
New confirmed sites	1	2	6	5	N/A
Previously confirmed sites	0	0	1	5	N/A
Sites in water	20	22	21	12	N/A

Cattle Tick Surveillance—The Cattle Fever Tick Eradication Program began in 1906 with the objective of eradicating endemic populations of fever ticks *(Boophilus microplus* and *B. annulatus)* that had become endemic in the Southern United States. Fever ticks carry and transmit bovine babesiosis *(Babesia bigemina* and *B. bovis),* which causes illness and high mortality in naïve cattle. By 1943, the eradication campaign had been declared complete, and all that remained was a permanent quarantine zone along the Rio Grande in south Texas. That permanent quarantine zone exists to this day as a nearly 500-mile-long swath of land from Del Rio to Brownsville, TX, ranging in width from several hundred yards to about 10 miles.

Program personnel, including 61 mounted inspectors who patrol the Rio Grande along the Mexican border, conduct range inspections of premises within the quarantine zone and apprehend stray and smuggled livestock from Mexico. Program personnel also inspect and treat livestock on premises found to be infested with fever ticks, regularly inspect premises that have been quarantined for infestations or exposures, and perform the required inspection and treatment of all cattle and horses moving out of the quarantine zone.

In FY 2005, eradication personnel apprehended 35 stray and smuggled animals (16 cattle and 19 horses) from Mexico, 9 of which were infested with fever ticks. In FY 2005, 117 premises were found to be infested with fever ticks, 39 of which were outside the quarantine zone. These figures represent an increase in infestations over 2004 levels when 94 infestations were detected, 20 of which were outside the quarantine zone. Although fever-tick infestation rates tend to spike cyclically over a period of several years, the current infestation rate within the quarantine zone is higher than has ever been recorded, and there is an apparent increase in the maintenance of ticks on wildlife—most notably on white-tailed deer and nilgai.

TBT Surveillance—This tick species transmits heartwater, a fatal livestock and wildlife disease, and the lethal form of acute bovine dermatophilosis (a skin infection). These diseases are not themselves contagious but

are transmitted by the ticks. The TBT is endemic in the Caribbean. APHIS believes that much of the recent interisland spread of the TBT has occurred through movement of livestock and infested migratory birds—in particular cattle egrets. Because these egrets fly between the Caribbean and Florida, there is a chance they could bring TBTs to the Continental United States.

APHIS is now eradicating TBTs from the island of St. Croix and conducting surveillance activities on other islands such as St. Thomas and Puerto Rico. FAD diagnosticians have been sent to the Caribbean to conduct heightened surveillance activities. Imported reptiles (e.g., turtles) are inspected for ticks at ports-of-entry such as Miami.

Currently, nine areas on St. Croix are known to be infested. Four are now vacant and are being monitored for vacancy, and five are being treated actively. Ninety-two high-risk premises are under treatment because they are adjacent to TBT-positive premises. Capture and impoundment of stray cattle, sheep, goats, and horses has increased from preprogram levels—particularly in and near high-risk areas. The animals are scratched and treated with coumaphos, an acaricide approved by the Environmental Protection Agency (EPA), after being captured and impounded. Horses without a permanent identification are identified with a microchip. Cattle, sheep, and goats not otherwise identified are bangle-tagged in the right ear, and a radio-frequency ID button tag is applied in the left ear. Tick specimens are collected and submitted to NVSL for identification confirmation. Additional research continues, including examining birds and small mammals for ticks and using collars impregnated with amitraz, an EPA–approved acaricide, on Virgin Island white hair sheep.

Screwworm Surveillance—*Cochliomyia homnivorax* (Coquerel), the New World cattle screwworm, is found only in warm climates throughout the Americas. It is an obligate parasite that feeds on tissues or fluids of all warmblooded living animals, including humans. The pest has been eradicated from the southeastern United States (1959), southwestern United States (1966), Mexico (1991), Belize and Guatemala (1994), El Salvador (1995), Honduras (1998), Nicaragua (1999), Costa Rica (2000), and Panama up to the Canal Zone (2001).

A permanent barrier for screwworm prevention was established along with the permanent barrier for FMD in the Provinces of Darien and Comarca Kuna Yala in Panama. These provinces are regulated by laws governing animal production as a measure to reduce possible introduction of FMD into Panama. To maintain the barrier, an agreement was signed by the United States and Panama to build a screwworm-rearing facility to produce the sterile insects needed to maintain the barrier zone. A $40 million screwworm mass-rearing facility in Panama is now under construction. The plant is expected to be operational at the end of 2006.

The goal to eradicate screwworm in the United States, Mexico, and Central America has been realized with the barrier established in the Isthmus of Panama and a buffer zone 20 nautical miles into Colombia. No case of screwworm has been found in Panama since August 2005. Dispersal of sterile screwworm flies is ongoing as a preventive measure at the rate of about 36 million flies per week.

NVSL personnel perform identifications for suspected screwworm infestations in the United States. Table 3 lists the number of submissions NVSL received for myiases and suspected screwworms during each of the past few years.

TABLE 3: **Screwworm submissions tested by NVSL**

Year	Number of submissions	Positives
2001	161	0
2002	102	0
2003	74	0
2004	74	0
2005	49	1

CSF Surveillance—The United States has been free of CSF since 1978. CSF is still endemic in many other countries in the Western Hemisphere, including Mexico, Cuba, Haiti, and the Dominican Republic. In 2005, VS developed a comprehensive surveillance plan for CSF. Included are three main surveillance programs for detecting CSF in domestically raised commercial swine. The first is a reporting system through which private practitioners, producers, diagnosticians, and slaughter inspectors report all cases that display clinical signs similar to an FAD. A CSF case definition was created and published to assist in the reporting of suspicious cases to either the State Veterinarian or VS' Area Veterinarian-in-Charge. Reported cases initiate an FAD field investigation. The second program is based on testing tonsil specimens from sick pigs submitted to the NAHLN. Domestic specimens are collected at participating veterinary diagnostic laboratories, selected slaughter plants, or by APHIS–Wildlife Services' biologists from feral pigs. The third component of the comprehensive surveillance plan allows for more discretionary testing of high-risk swine in selected States, such as monitoring sick pigs on waste-feeding sites in Texas or pigs in Puerto Rico adjacent to illegal boat landings.

This CSF surveillance plan was implemented late in 2005. All CSF testing in 2005 was done by VS' Foreign Animal Disease Diagnostic Laboratory (FADDL). Testing was done on sera and tissues collected from high-risk healthy and sick pigs and submitted from various sources—mostly diagnostic labs and VS field VMOs. All samples tested by FADDL in the past 3 years were negative (table 4).

TABLE 4: **Classical swine fever samples tested by FADDL**

CY	Serum samples tested	Tissue samples tested	Number of source States
2003	17,524	1,037	35
2004	17,188	1,166	31
2005	12,440	410	24

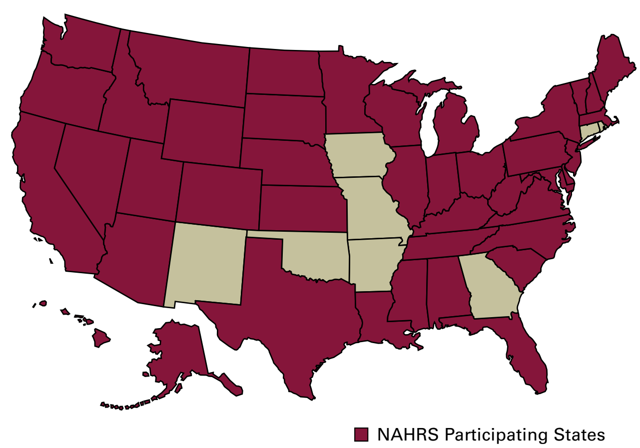
National Animal Health Reporting System (NAHRS)

The United States is a signatory country of the World Trade Organization (WTO). Member countries are obligated to comply with the WTO's Agreement on the Application of Sanitary and Phytosanitary Standards. The WTO assigned standards-setting authority to the World Organization for Animal Health (OIE) for international trade-related animal health issues. For more than 25 years, VS has reported the occurrence of OIE-notifiable diseases in the United States. The U.S. status of OIE-reportable diseases is listed in table A2.3 appendix 2.

NAHRS is a voluntary, cooperative animal-disease reporting system designed to collect monthly data through State animal health officials on the presence or absence of confirmed OIE-reportable diseases in commercial livestock, poultry, and aquaculture species in participating States. NAHRS is a joint effort of the United States Animal Health Association (USAHA), the American Association of Veterinary Laboratory Diagnosticians, and APHIS. NAHRS provides a summary-level overview of the status of OIE-reportable diseases in participating States. States that do not participate in NAHRS are still required to report to the FAD surveillance and National Program Disease surveillance data systems of APHIS and VS.

In 2005, 42 States reported disease information to NAHRS (fig. 23). Several nonparticipating States are preparing to report to NAHRS. The States participating in NAHRS in 2005 accounted for 86, 66, 90, 67, and 84 percent of the value of production for the U.S. cattle, swine, sheep, poultry, and catfish commodities, respectively.

FIGURE 23: **States participating in NAHRS in 2005.**



Emerging Issues

An emerging animal disease can be defined as a newly identified pathogen or strain, a known pathogen in a new location, or a new presentation of a known pathogen. It is an event that has a negative impact—real or perceived—on animal health, economics, or public health. Agricultural producers and scientists around the world are discovering and identifying emerging animal diseases and other issues that threaten animal production and related industries. Nipah virus in Malaysia and Hendra virus in Australia are two recent examples. Avian pneumovirus, ISA, West Nile virus, and monkeypox virus are recent examples of such emerging diseases occurring domestically. Recent controversy about levels of dioxin in meat and dairy products is an example of an emerging issue that affects animal health and production but is not related to a pathogen.

Within VS' Centers for Epidemiology and Animal Health (CEAH), the Center for Emerging Issues (CEI) identifies and tracks potential emerging animal health issues, assesses and analyzes emerging animal health issues, and forecasts disease emergence. CEI has developed an electronic surveillance process that transforms animal disease event information into actionable intelligence for VS.

Identification and Tracking of Emerging Animal Health Issues

Emerging animal health issues are identified through electronic scanning of open-source media and text mining. Using a combination of complex predefined queries and software capable of receiving large amounts of text data, CEI processes reduce about 25,000 records to 8,000 records of greatest interest each month. Analysts then read, organize, and store the records to monitor emerging animal-health issues and trends at both the national and international levels. To track emerging animal-health issues after the filtering process, analysts transfer records into the Emerging Veterinary Events (eVe) system, which is a Web-based application used to house all records of emerging issues. Compiling records from multiple data sources into one centralized database permits timely identification and tracking of emerging issues over time. Disease events in the eVe database are prioritized by analysts using an algorithm to gauge the relative importance of events. An Animal Disease Analysis Mapping module is being developed and will be integrated with the existing eVe system, providing Web-based mapping and basic spatial analysis capability for the analysis of emerging animal-health issues.

Assessment and Analysis of Emerging Animal-Health Issues

After identifying a potential emerging animal-health issue, analysts verify the authenticity and accuracy of the reported event. Once details of the event are verified, CEI may develop reports regarding the event. For example, an impact worksheet is designed to provide a qualitative risk assessment to VS decisionmakers rapidly to determine if the disease event has the potential to substantially impact the U.S. livestock industry. Emerging disease notices provide an indepth overview of the epidemiology and ecology of an emerging or reemerging animal disease. Specific reports on emerging issues are also available.

Forecasting Disease Emergence

CEI's 2005 report, "Overview of Predictive Infectious-Disease Modeling," contains important considerations for developing predictive infectious-disease models, including a brief overview of model types and methodologies used to predict known and new infectious diseases, and describes examples of early warning systems utilizing models. Numerous authors have suggested using the biological, ecological, environmental, and societal factors associated with disease emergence as a way to improve prediction; however, interactions among these emergence factors can be complex, making modeling difficult. To address this issue, CEI is developing the disease-emergence risk-assessment tool for assessing the disease emergence potential in the U.S. food-fish aquaculture industries.

Developing the disease-emergence risk-assessment tool has required aligning potential emergence risk factors into a structured model permitting a qualitative risk assessment. Key factors associated with disease emergence were identified, and for each risk factor various risk levels were established so that individual industry sectors could be assessed based on the sector's characteristics. Within the assessment tool, disease emergence is separated into three separate elements: disease evolution (which examines the potential for novel pathogens to develop or for existing pathogens to evolve), pathways (which examines the potential for known or new pathogens to move from country to country), and spread (which examines the potential for newly emerged, evolved, or introduced pathogens to spread from the point of emergence, evolution, or introduction).

Once completed, the disease-emergence assessment tool can be used to identify areas of vulnerability and mitigation measures, as well as to monitor how changes in the dynamics associated with an industry increase or decrease disease emergence potential over time. A detailed description of the disease-emergence tool and results from its application to the aquaculture industry will be available in late 2006.

Monitoring Activities (NAHSS)

Goal 4 of the NAHSS Strategic Plan addresses monitoring and surveillance for diseases of major impact on animal production and marketing. Objectives within this goal include coordinating and collaborating on monitoring animal-health and production trends and contributing to animal-disease-awareness education for producers and veterinarians. The National Center for Animal Health Surveillance (NCAHS), which is part of CEAH, is responsible for coordinating surveillance and monitoring activities. Within NCAHS is the National Animal Health Monitoring Program Unit. This unit designs, analyzes, and reports results from the National Animal Health Monitoring System (NAHMS) studies that began in 1990.

The NAHMS unit has created a niche of expertise, combining the knowledge of veterinarians, economists, and statisticians to address information needs primarily via national livestock and poultry study development, analysis, and reporting of results. Much of the information collected in a NAHMS study relates to biosecurity, animal movement, and risk of disease. This information not only describes industry health and management practices but also provides input to risk analyses for determining disease introduction probabilities and helps to define at-risk populations more clearly, giving some insight into how best to assess those populations for surveillance purposes. In addition, the NAHMS unit identifies long-term key animal-health indicators to monitor through various means, including sentinel surveillance.

The core attributes of NAHMS national studies include

- Probability-based sampling,
- Statistically valid estimates,
- National focus,
- Collection of farm-based management and biologic information,
- Nonregulatory nature,
- Voluntary participation,
- Confidentiality of data, and
- Increased awareness of participating producers as to improved husbandry methods, animal disease events, biosecurity, etc.

NAHMS national studies have been conducted for swine and dairy (three studies each), poultry (two), feedlot (two), beef cow and calf (two), sheep (two), equine (two), and aquaculture (two). Reports from these studies are available on the NAHMS Web site (<http://nahms.aphis.usda.gov>).

To fill the gap between NAHMS national studies, which provide periodic snapshots on the health and management of a given industry, NAHMS conducts ongoing efforts such as the Sentinel Feedlot Monitoring Program. Each month, NAHMS receives reports on morbidity and mortality of feedlot cattle. Feedlot consulting veterinarians provide the data and are given comparison reports.

The NAHMS unit has worked with three USDA agencies (APHIS, the Agricultural Research Service, and the Food Safety and Inspection Service) to create the Collaboration in Animal Health and Food Safety Epidemiology Program. The mission of this surveillance has two components: food safety and animal health.

The NAHMS unit also receives data from States and analyzes and reports results on an ongoing basis for the National Johne's Disease Demonstration Herd Project.

NAHMS Equine 2005 Study

The NAHMS Equine 2005 study collected health and management information from 2,893 equine operations regarding health practices influencing equine infectious-disease incidence and estimated the occurrence of selected equine health-related events. For details regarding study design and data analysis, and to view the full report, go to <http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/equine>.

Mortality Rate and Causes of Death for Equids—In the 12 months preceding the study interview, 4.9 percent of foals born alive died in the first 30 days of life. The largest percentage of foal deaths was attributed to injury or trauma followed by failure to get milk or colostrum.

The overall mortality rate for resident equids 30 days and older during the 12 months before the interview was 1.8 percent. Old age was the leading cause of death in equids older than 6 months, followed by injury, wounds, trauma, and colic.

Vaccination Practices for Equids—Overall, 75.9 percent of operations indicated that they had given at least some type of vaccines to resident equids during the 12 months preceding the interview.

Movement of Equids—Overall, 36.6 percent of operations had not moved resident equids off the operation and back onto it in the previous 12 months.

NAHMS Poultry 2004 Study

FAD introduction into noncommercial poultry, such as the END outbreak in California in 2002, poses risk to all segments of the U.S. poultry industries. Compared with the commercial segment of the poultry industries, information on the noncommercial segment was sparse. To define noncommercial poultry populations better—in particular, backyard flocks, gamefowl breeder flocks, and live-poultry markets—NAHMS conducted the Poultry 2004 study.

To estimate the density of backyard flocks located within 1 mile of commercial operations, the National Agricultural Statistics Service (NASS) selected a sample of 350 commercial poultry operations in 18 top poultry-producing States (accounting for 81 percent of the U.S. value of poultry production) from its list of poultry operations. A 1-mile-radius circle was "drawn" around each operation, and door-to-door canvassing was conducted within these circles to enumerate premises with birds. Premises with backyard flocks completed a questionnaire focusing on bird health, movement, and biosecurity practices. In addition, a similar questionnaire, provided in both English and Spanish, was mailed to all members of State affiliates of the United Gamefowl Breeders Association as well as to members of State associations not affiliated with it.

Brief results from the two components of the study (backyard flocks and gamefowl breeder flocks) show that an average of less than two residences per circle had backyard flocks. Gamefowl breeder flocks were larger, used more health care and biosecurity practices, and moved birds more frequently compared with backyard flocks.

A third area of the noncommercial segment was also examined in 2005, entailing a survey in 183 live-poultry markets throughout the United States. A questionnaire was administered to markets addressing types of birds and other animals in the market, biosecurity, and cleaning and disinfecting practices. Testing for AI was conducted more frequently in the North, where 98.4 percent of markets were tested at least once and 86.4 percent of markets were tested four or more times between March 2004 and March 2005; 83.1 percent of markets in the South region were tested at least once, and 18 percent were tested four or more times during the year. Factors associated with persistent presence of LPAI included region, number of times markets were cleaned and disinfected, and trash disposal of dead birds. Detailed results from each of the three studies were published and are available on the NAHMS Web site.

Sheep and Lamb Death Loss by Cause, 2004

The United States publishes sheep death loss (number of head) annually and cause of loss on a periodic basis (roughly every 5 years). Since 1994, the percentage of sheep inventory or lamb crop lost to all causes has remained relatively constant at about 6 and 10 percent, respectively (fig. 24). Since 2000, however, losses of both sheep and lambs have decreased slightly, and both reached a 10-year low in 2005, when 5.5 percent of the sheep inventory and 9.3 percent of the lamb crop were lost.

Cause-of-Loss Estimates—Predator and nonpredator cause-of-loss estimates for the United States (at the State level) started in 1994 and were repeated in 1999 and 2004 as a cooperative effort between NASS and APHIS. For 2004, nonpredator loss accounted for 69.2 percent of sheep loss and 59.0 percent of lamb loss.

The most common nonpredator cause of loss for sheep was old age (26.8 percent of nonpredator losses), followed by lambing problems (13.4 percent) and digestive problems (12.9 percent) (fig. 25).

In 2004, the most common nonpredator causes of lamb loss were respiratory problems (22.8 percent of nonpredator losses), followed by digestive problems (19.8 percent) and weather (14.8 percent) (fig. 26).

FIGURE 24: **Sheep and lamb losses due to all causes, 1994–2005.**

Sheep = percent end-of-year inventory
Lambs = percent lamb crop

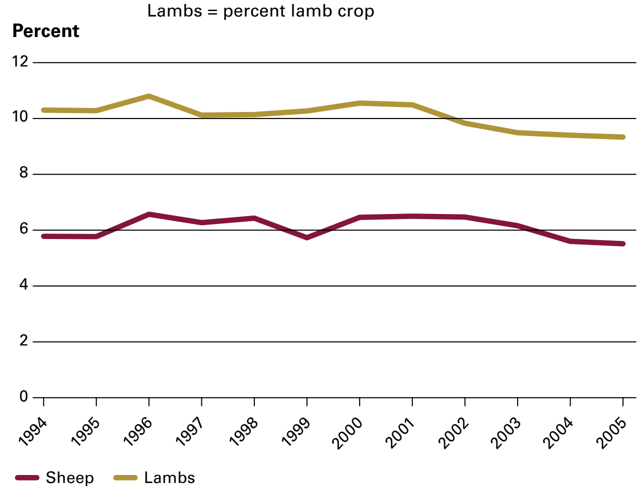


FIGURE 25: **Nonpredator sheep losses, in percentages by cause, 2004.**

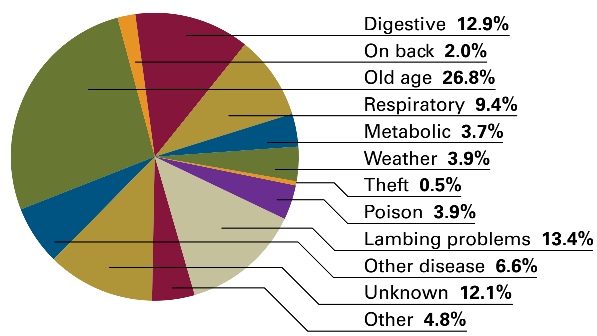
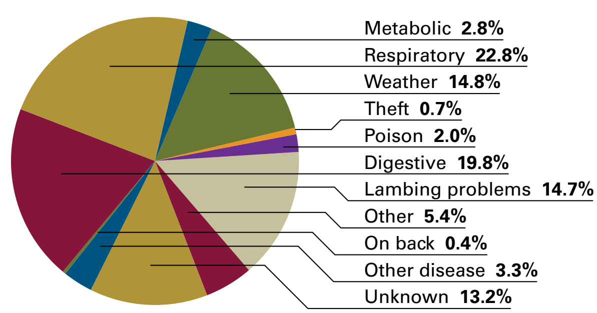


FIGURE 26: **Nonpredator lamb losses, in percentages by cause, 2004.**



Cattle Death Loss by Cause, 2005

Since 1990, the percentage of cattle inventory lost to all causes has remained relatively constant at approximately 2 percent. The percentage of calf crop lost decreased from 7.25 percent in 1990 to just over 6 percent in 2005 (fig. 27).

Cause of Loss—Predator and nonpredator cause-of-loss estimates for cattle and calves started in 1991 and were repeated for 1995, 2000, and 2005 as a cooperative effort between NASS and APHIS. The most recent estimates (2005) are presented here (fig. 28). Overall, 98.0 percent of cattle losses and 93.3 percent of calf losses were due to nonpredator causes. Important causes of loss for cattle were calving problems (11.1 percent), digestive problems (11.1 percent), and respiratory problems (24.8 percent).

The most frequently reported causes of loss for calves were respiratory problems (31.8 percent), digestive problems (21.2 percent), and calving problems (17.7 percent) (fig. 29).

FIGURE 27: **Death-loss statistics for cattle and calves, by percentage, 1990–2005.**

Cattle = percent end-of-year inventory
Calves = percent calf crop

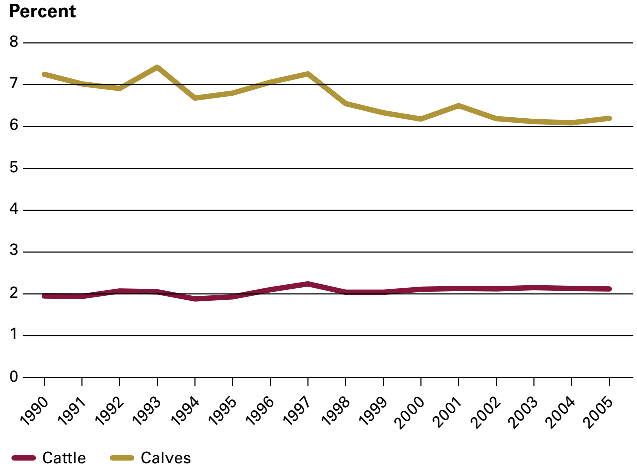


FIGURE 28: **Causes of death in cattle (excluding predators), by percentage, 2005.**

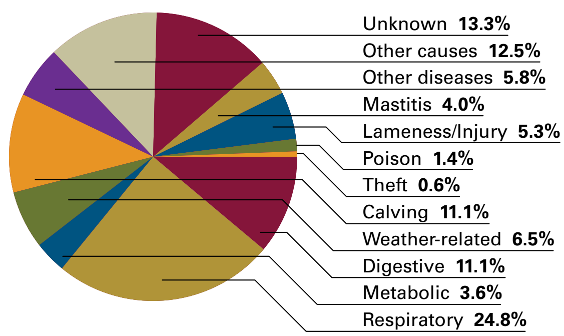
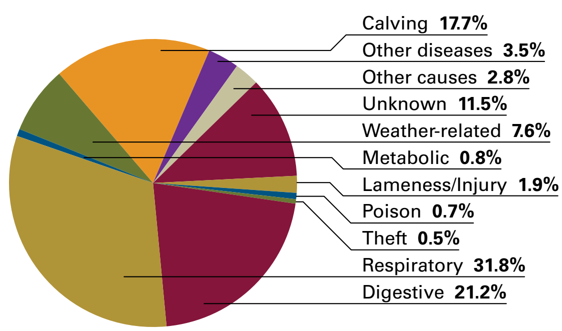


FIGURE 29: **Causes of death in calves (excluding predators), by percentage, 2005.**



Surveillance Planning, Analysis, and Development

Pseudorabies Surveillance Plan

Swine are the only natural host for pseudorabies virus (PRV), a contagious herpesvirus causing reproductive problems such as abortions, stillbirths, mummies, and infertility. Death loss, especially in suckling pigs, can be extremely high. Pigs that survive develop a permanent latent infection. PRV infection may be lethal in other species as well, including cattle, sheep, goats, raccoons, rats, cats, and dogs.

The State–Federal–industry pseudorabies eradication program culminated with a declaration by the Pseudorabies Control Board at the 2004 USAHA meeting that all States had achieved Stage V—Free status. This USAHA Pseudorabies Committee recognized that USDA should undertake a complete overhaul of PRV surveillance. As a result, CEAH's NSU was charged with developing a comprehensive surveillance plan for PRV.

The objectives of PRV surveillance covered in this comprehensive plan include the following:

Objective 1—Conduct surveillance for rapid detection of PRV in U.S. commercial production swine. Although PRV has been eradicated from commercial production swine, it is still endemic in feral swine and can also be found occasionally in transitional swine herds, which are defined as captured feral swine or domestic swine in contact (or potentially in contact) with feral swine.

In spring 2005, CEAH's Trade Risk Team conducted an "Assessment of the Risk on a State-by-State Basis for Re-exposure of Commercial Production Swine Herds to Pseudorabies Virus in the United States."

The two primary means by which PRV may reappear in U.S. commercial production swine are via reactivation in an old sow or reintroduction by exposure to feral swine. Cases in which reactivation is a clinical event (recrudescence) will be identified through laboratory-based surveillance of submissions that feature high mortality in pigs, CNS symptoms in suckling pigs, abortions, still births, mummification, embryonic death, and infertility. The most efficient surveillance mechanism to detect reactivation without the presence of overt clinical symptoms will be random testing of PRV exposure of cull sows at slaughter.

Reintroduction of PRV into commercial production swine would most likely occur via direct exposure to free-roaming feral hogs or indirect exposure to wild boar on premises owned by hunting clubs. The majority of feral swine are found in the Southern States. Surveillance will be conducted via onfarm testing on a routine basis and in response to passively reported "direct exposure" events between feral and commercial swine.

Objective 2—Monitor the risk of introducing PRV into U.S. commercial swine. Clearly, the greatest risk of introducing PRV into commercial swine comes from direct or indirect exposure to feral pigs. Because PRV remains endemic in feral swine, it is important to monitor the distribution of the feral swine population. Another aspect that will be monitored is the size of the population at risk for exposure, i.e., outdoor production sites.

Objective 3—Surveillance of international PRV status. The PRV status of neighboring countries and trading partners is particularly important and will be monitored on a regular basis.

Development of the surveillance plan for PRV will continue in 2006 with implementation of the plan expected to begin in 2007.

BSE Surveillance

Since 1990, the U.S. Department of Agriculture (USDA) has taken aggressive measures to prevent the introduction and potential spread of BSE. Following confirmation of BSE in an imported cow in December 2003, USDA designed and implemented an Enhanced BSE Surveillance Program to more accurately determine the level of disease present in the U.S. cattle population.

The Enhanced BSE Surveillance Program tested as many cattle as possible in the targeted high-risk population beginning June 1, 2004. Collection at an enhanced level has continued beyond 18 months to ameliorate concerns of trading partners. Experience in the United Kingdom and Europe has shown that, if present, BSE is most likely to be detected in adult cattle exhibiting clinical signs consistent with the disease.

In general, the highest risk categories are adult cattle showing clinical signs involving the central nervous system (CNS) and dead and nonambulatory cattle with clinical signs that could not be adequately evaluated. This population was estimated to total 445,886 adult cattle per year in the United States. This number was derived in part from National Animal Health Monitoring System (NAHMS) surveys of livestock producers and other estimates.

This estimate includes adult cattle in the following categories:

- Condemned at slaughter for CNS signs;
- Moribund, dead, injured, or emaciated (FSIS data 2002);
- CNS abnormalities reported for FAD investigations (APHIS data 2003);
- Died onfarm of unknown causes;
- Lameness or injury that resulted in euthanasia; and
- Cattle that died with signs of incoordination or severe depression.

The sampling strategy was designed to target animals in these categories.

Between June 1, 2004, and March 17, 2006, BSE samples were collected from 5,776 unique locations across the United States. These locations included slaughter plants, renderers, farms, public health laboratories, veterinary diagnostic laboratories, and salvage slaughter (3D–4D)[1] plants.

To determine the extent to which the U.S. surveillance is consistent with OIE guidelines, we have evaluated and classified surveillance data over the past 7 years according to OIE standards (table 5).

In May 2005, the OIE General Assembly approved a new chapter and appendix for BSE surveillance. This approach assigned point values to each sample, based on animal age and the subpopulation it was from, and the likelihood of detecting infected cattle of that age in that

[1] 3D–4D facilities are slaughter facilities that salvage meat from dead, dying, disabled, or diseased animals, the meat from which would not likely pass inspection for human consumption (i.e., edible meat). Much of this meat goes into either pet food or rendering.

TABLE 5: **OIE points from BSE surveillance in the U.S. accumulated for 7 years**

Year of testing[1]	Total samples[2]	Clinical suspects	Fallen stock	Casualty slaughter	Healthy slaughter	OIE points[3]
10/1/05 to 03/17/06[4]	181,564	438	142,337	18,991	19,798	285,491
FY[5] 2005	413,647	1,527	361,557	50,557	6	899,642
FY 2004	90,085	1,066	62,054	25,096	1,869	592,369
FY 2003	20,778	577	3,106	16,613	482	267,480
FY 2002	20,380	569	2,818	16,045	948	251,740
FY 2001	5,340	665	1	4,515	159	299,177
FY 2000	2,753	664	0	2,064	25	266,891
4/1/99 to 9/30/99[6]	666	265	15	351	35	111,014
Total surveillance (including enhanced surveillance)	**[7]735,213**	**5,771**	**571,888**	**134,232**	**23,322**	**2,973,804**
Total for enhanced surveillance only 6/1/04 to 3/17/06	**667,767**	**2,602**	**559,546**	**84,534**	**21,085**	**1,583,127**

1 Testing includes the most recent 7 years of data collected from Apr. 1, 1999, through March 17, 2006.

2 Number of samples and clinical suspects represents animals eligible for surveillance according to the Terrestrial Animal Health Code Article 3.8.4.

3 Note: Animals counted as eligible for OIE points included animals older than 1 year according to the OIE point allocation table. Removal of points from the "juvenile" category of the OIE points table would decrease the total by 2,843 points. Other documents showing U.S. data may vary due to inclusion or exclusion of young animals.

4 Includes 6 months of fiscal year 2006.

5 The U.S. Government's fiscal year extends from October 1 through September 30 (e.g., FY 2005 began on 10/1/2004 and ended on 9/30/2005).

6 Includes 6 months of FY 1999.

7 Total includes two positive indigenous animals and one positive animal imported from Canada.

subpopulation. (Prior to May 2005, OIE had recommended a surveillance level based on the size of the adult cattle population—for the United States that number was 433 samples with clinical signs consistent with BSE per year.) Sample values were classified in the OIE system as belonging to four surveillance strata (streams): clinical suspect, casualty slaughter, fallen stock, and healthy slaughter. Samples were also stratified by age.

Cattle were categorized in the clinical suspect stream if they were submitted under the submission types of highly suspicious for BSE, rabies suspects, CNS signs, or antemortem-condemned by FSIS with condemnation codes for CNS signs or rabies. In addition, many samples with a clinical history of signs likely to be associated with BSE were submitted in other categories. Many of these represented valuable samples, but the OIE definition of "clinical suspect" did not readily differentiate them from animals with other clinical signs compatible with BSE. Some of these cattle were subsequently categorized as clinical suspects by comparing the likelihood of finding the signs in histopathologically confirmed cases reported in the United Kingdom[2] with the likelihood of finding the signs in uninfected animals from the enhanced-surveillance targeted population. For example, if a sign or combination of signs were found 30 percent of the time in BSE cases but only once in every 1,000 uninfected animals (0.1 percent), then it would be 0.30/0.001 = 300 times more likely to occur in the cases (likelihood ratio = 300 in this case). A likelihood ratio threshold of 807 was established as a cutoff value for determination of clinical suspects. This threshold was estimated using input data from the United Kingdom in the BSurvE[3] model, which provided the average (expected) value for the ratio of probability of an infected animal showing clinical signs to an uninfected animal showing clinical signs. Thus, if a

2 Wilesmith, J. W.; Ryan, J. B.; Hueston, W. D. 1992. Bovine spongiform encephalopathy: case-control studies of calf feeding practices and meat and bonemeal inclusion in proprietary concentrates. Research in Veterinary Science 52(3): 325–331.

3 Available, as of April 20, 2006, at <http://www.bsurve.com>. The BSurvE tool is a Microsoft Excel™ spreadsheet application designed to estimate BSE prevalence based on targeted sampling strategies.

sample was submitted from an animal with combinations of clinical signs at least 807 times more likely to have been seen in BSE cases than in the U.S. high-risk population, it was classified as a clinical suspect.

Cattle with likelihood ratios below the threshold were allocated into surveillance streams according to the animal's submission type as follows:

- Submission types of "Nonambulatory" were classified in the "casualty slaughter" stream;
- Submission types of "Other clinical signs that may be associated with BSE" were classified in the "casualty slaughter" stream;
- Submission types of "FSIS antemortem condemned" were classified in the "casualty slaughter" stream as long as the condemnation reason was not "dead";
- Submission types of "FSIS antemortem condemned" with a condemnation code of "dead" were classified in the "fallen stock" stream;
- Submission types of "dead" were classified in the "fallen stock" stream;
- Submission types of "apparently healthy" were classified in the "healthy slaughter" stream.

BSE surveillance samples from 1999 through 2003 were collected before the OIE surveillance streams were established in 2005 and were not submitted with the same clinical history as that used for the enhanced surveillance in 2004–05. In order to apply the OIE point tables, data about these samples were requested from the National Veterinary Services Laboratories (NVSL) and were sorted by Centers for Epidemiology and Animal Health (CEAH) epidemiologists based on the history included with the sample.

This information is excerpted from the report *Summary of BSE Surveillance in the United States* accessed and available on the Web as of May 2, 2006, at <http://www.aphis.usda.gov/newsroom/hot_issues/bse/content/printable_version/SummaryEnhancedBSE-Surv4-26-06.pdf>. Details on the Enhanced BSE Surveillance Program are posted at <http://www.aphis.usda.gov/lpa/issues/bse/BSEOIG.pdf>.

Scrapie Surveillance Evaluation

In general, evaluating a surveillance program entails a systematic review to assess the degree to which the program fulfills its stated objectives and meets accepted surveillance standards. Program strengths and areas for improvement are identified, and the program's ability to adapt to changing situations is evaluated. Evaluating the surveillance component of one VS program disease was identified as a key action item in the NAHSS strategic plan (see <http://www.aphis.usda.gov/vs/ceah/ncahs/nsu/nahss/NAHSS_Strategic_Plan_2005_0216.pdf>).

The surveillance component of the VS scrapie program was chosen for evaluation. Led by the NSU, an interdisciplinary working group was developed consisting of an economist, statistician, several veterinary epidemiologists, and an industry representative.

The evaluation process focused on four main areas: surveillance structures (organization and communication), surveillance processes (data collection, data analysis and interpretation, and dissemination of results), qualitative attributes (i.e., simplicity, flexibility, acceptability), and resource distribution and utilization. Characteristics of the system were compared with the draft VS Surveillance Standards, as noted throughout the evaluation.

The evaluation and data gathered focused primarily on the Regulatory Scrapie Slaughter Surveillance Program testing and other nonslaughter surveillance testing in sheep implemented since 2001. Although most of the evaluation results should be applicable to scrapie surveillance in goats, this component was not specifically evaluated. Phone interviews were conducted with State and/or VS field personnel involved in scrapie surveillance activities in nine different States representing both APHIS' Eastern and Western Regions. Questions addressed the general objectives, importance, and efficiency of the program; the communication within the program; and the acceptability, compliance, and coverage of the program. Personnel interviewed were assured anonymity.

The evaluation report has been completed and delivered to VS' National Center for Animal Health Programs.

Interagency Zoonotic Disease

Recently, the USDA, the U.S. Department of Health and Human Services' Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration formed a working group tasked with coordinating human and animal disease surveillance. Subsquently, additional staff was added at USDA and CDC to (1) identify needed elements and essential partners, (2) develop a system of communication and triggers for action, (3) divide the workload to maximize efficiency and identify roles and responsibilities, and (4) incorporate animal health surveillance into existing systems.

In collaboration with the USAHA, the working group administered a survey beginning July 1, 2005, to all designated State animal and public health veterinarians seeking input to improve communications. Although the majority of respondents were either satisfied or highly satisfied with current working relationships with their counterpart, 95 percent of respondents indicated that combined meetings would improve communications.

Another working-group effort to improve communication and coordination among agencies brought together representatives from the various national laboratory networks (NAHLN, the Laboratory Response Network, and the Food Emergency Response Network) to begin discussions on how to coordinate laboratory surveillance activities to mutual benefit. As a result of this meeting, methods for sharing summary human and animal surveillance data and influenza isolates were identified and are being implemented.