

# Risk management of the transmissible spongiform encephalopathies in North America

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## Summary

As North American Free Trade Agreement partners, Canada, the United States of America (USA) and Mexico apply independent but harmonised transmissible spongiform encephalopathy (TSE) risk management strategies in observance of Office International des Epizooties guidelines. The divergence between bovine spongiform encephalopathy (BSE) risk management approaches in North American and Europe reflects comparatively reduced external and internal BSE risks in North America. The external quarantine and internal surveillance measures adopted for BSE respond to several iterations of national risk assessments initiated in the early 1990s and revised as recently as 2002.

Feed bans applied since 1997 to preclude establishment of BSE also bear the potential to limit intra-species and inter-species exposure to scrapie, chronic wasting disease (CWD) and transmissible mink encephalopathy (TME). Surveillance continues for the four TSEs through collaborative efforts of national and sub-national veterinary infrastructures and accompanying laboratory networks. Mexico has never identified the presence of any TSE. The last diagnosed case of TME in North America dates back to 1985. Since the only recognised appearance in Canada through an import from Great Britain in 1993, BSE has not been detected in North America. Scrapie and CWD remain at generally low prevalence in Canada and the USA. Independent but harmonised eradication programmes target elimination of the latter two diseases.

## Keywords

Bovine spongiform encephalopathy – Chronic wasting disease – North America – Risk management – Scrapie – Transmissible mink encephalopathy – Transmissible spongiform encephalopathy.

## Introduction

The veterinary infrastructure in North America has encountered central nervous system (CNS) ailments of animals for centuries. The first recognised case of transmissible spongiform encephalopathy (TSE), scrapie, appeared on the continent in 1937 in sheep imported into Canada from the United Kingdom (UK) against this 'background radiation' of central nervous diseases (32). A decade later, transmissible mink encephalopathy (TME) was diagnosed on commercially related mink ranches in the states of Wisconsin and Minnesota in the United States of America (USA) (4). The USA had imported scrapie-affected sheep from Canada in the preceding decade (37). The feeding of scrapie-contaminated carcasses to rancher mink was one hypothesised source of the TME outbreak (16).

Chronic wasting disease (CWD) was first recognised in 1967, in wild deer raised as orphans in a research facility in the state of Colorado in the USA (44, 45). Of potential indigenous origin, the occurrence of CWD under circumstances of close association between deer and sheep nevertheless fuelled similar speculation regarding inter-species transmission (12), similar presumably to the speculation about scrapie and bovine spongiform encephalopathy (BSE).

The last of the four TSE agents to be discovered on the soil of North America was BSE. The disease appeared in the province of Alberta in Canada in 1993 in a beef cow imported from the UK (7). The entire herd and all other traced-out animals were eradicated. Since then, a decade of surveillance has yet to uncover an indigenous prevalence.

None of the four diseases has been diagnosed in Mexico. Transmissible mink encephalopathy has not been diagnosed in

North America since 1985. Bovine spongiform encephalopathy occurred only in 1993. However, CWD and scrapie remain the objects of eradication programmes within Canada and the USA (22).

This paper will outline the history of each TSE against a backdrop comprising the agricultural and veterinary infrastructures in North America and risk assessments completed to date. Risk mitigation measures in place in Canada, Mexico and the USA against the four TSEs will be presented.

Risk management practices in North America differ markedly from those of the European Union (EU). To understand why requires background knowledge of the agricultural and veterinary infrastructures and common husbandry practices of North America. Many of these factors – including the historically small size of the sheep industry, the relative abundance of vegetable-based protein supplements, the common practice of raising meat animals under extensive livestock management systems – are addressed in the background and risk assessment sections of this paper.

## Background

### Animal agriculture

The animal populations of commonly farmed species in North America are given in Table I. Free-range wildlife are not included.

**Table I**  
**Farmed animal species in North America**  
(millions)

Species	Population <sup>(a)</sup>			Total
	Canada	Mexico	United States of America	
Cattle	15.5 <sup>(b)</sup>	30.1 <sup>(d)</sup>	97.3	142.9
Sheep	1.2 <sup>(b)</sup>	5.9 <sup>(d)</sup>	7.0	14.1
Goats	0.18 <sup>(b)</sup>	9.1 <sup>(d)</sup>	1.4	10.7
Farmed cervids	0.127 <sup>(b)</sup>	0.3 <sup>(d)</sup>	0.157 <sup>(c)</sup>	0.58
Farmed mink	1.35 <sup>(b)</sup>	–	3.3 <sup>(c)</sup>	4.7
Pigs	14.0 <sup>(b)</sup>	15.7 <sup>(d)</sup>	59.1	88.8
Chickens	158	366.0 <sup>(d)</sup>	1.830	2.354
Turkeys	5.0	4.8 <sup>(d)</sup>	88.0	97.8
Horses	0.46	5.1 <sup>(d)</sup>	5.3	10.86

a) Includes stock of all ages

b) Statistics Canada, 2001 Census of Agriculture

c) United States Department of Agriculture, 2000

d) National Statistics 1999, Sistema Integral de Información Agroalimenaria y Pesquera (SIAP) - Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA) and statistics on white-tailed deer, 2000 Census of the Asociación Nacional de Ganaderos Diversificados Criadores de Fauna (ANGADI). In Mexico, there are no elk and mink ranches (33, 34)

Source: Food and Agriculture Organization statistical databases (FAOSTAT), July 2002, except for totals and where otherwise stated

### Beef and dairy cattle production

Beef cattle production takes place mainly in western and mid-western North America under extensive livestock management systems. Beef ranches are commonly family operated units of several dozen to several hundred breeding cows that occupy lands unsuitable for crop production. Most calves are born in spring and remain on pasture with their dams until weaning in the fall. At that time, calves are sold to enter feedlots or held over winter on the farm to become yearlings that will go back to pasture the following year before entering feedlots in the autumn.

The feedlot industry is well developed in North America and is concentrated in the prairie provinces of Canada, the plains states of the USA and the northern and central states of Mexico. Feedlots vary in size from a few thousand animals to many tens of thousands. Larger feedlots are characterised by corporate management structures, full-time staff and ongoing monitoring by veterinarians who specialise in feedlot medicine.

In the feedlot, cattle are fed high energy rations based primarily on cereal grains or corn until they reach a market weight of approximately 650 kg to 800 kg. By the time they are ready for slaughter, most beef animals will be between 18 and 24 months of age.

The dairy industry in North America is usually located near the larger population centres and is therefore more prominent in eastern regions of the continent. The dairy cow population is approximately one quarter that of beef cows. Traditionally, commercial dairy farms were often single family operations of up to 100 milking cows, but there is a trend towards fewer but larger dairy operations in the major milk producing areas. Calves are separated from their dams shortly after birth and raised on commercial milk replacers on the farm or on dedicated calf-rearing premises. Heifer calves are usually reared for replacements to the milking herd, whereas bull calves are raised for veal or enter a feedlot for fattening.

### Sheep and goat production

In Canada and the USA, sheep and goat populations are less than 9% as large as the bovine population, whereas in Mexico they represent a much larger fraction (50%). Pockets of small ruminant production are found in Canada in the provinces of Alberta, Ontario and Quebec, and in the western and central areas of the USA. Texas accounts for nearly 65% of the goat inventory in the USA. Sheep production is carried out throughout Mexico under extensive management by peasants who mainly raise animals for personal consumption. Goats in Mexico are raised under similar circumstances for both meat and milk.

Most sheep breeding operations in Canada and the USA are small, family-run farms that produce lambs for meat. Late winter and early spring-born lambs are slaughtered for the

Easter season market, while later lambs are fed to market weight on the farm or in a sheep feedlot.

### Farmed cervid production

Raising cervids under captive conditions is a relatively new industry in North America. Spurred on by similar endeavours in diversified agriculture in Africa, New Zealand and Europe, game ranching began in the USA in the 1970s and 1980s, and in Canada in the 1980s and 1990s. Cervids are not farmed in Mexico, but are protected in expansive hunting reserves with other native species under the auspices of the Asociación Nacional de Ganaderos Diversificados Criadores de Fauna (ANGADI: National Association of Diverse Rearing Fauna Ranches) (L. Guerrero, personal communication).

Control of cervid game ranching falls under provincial or state jurisdiction, resulting in a patchwork distribution of species farmed. Generally, elk (*Cervus elaphus nelsoni*) is the most popular species and most game ranching takes place on the rangelands of the prairies of Canada and the plains of the USA. Various species of deer, including white-tailed (*Odocoileus virginianus*) and mule (*Odocoileus hemionus*) deer are also raised. During the expansion phase of the industry over the last decade, most production has been aimed at raising breeding animals or harvesting velvet. Very few animals have been slaughtered for meat.

### Farmed mink production

Mink farming is a small, regional industry located in the central and eastern provinces of Canada and the Great Lakes and mountain states of the USA. Mexico has no record of mink ranching (L. Guerrero, personal communication).

Most farmed mink are raised and slaughtered on small, family-operated farms. The 1930s witnessed the growth of mink farming in Canada and the USA. At that time, mink were given fish and fish offal, as well as inedible materials from dead stock and slaughtered animals. They are now mainly fed rations of offal from nearby red meat, fish or poultry processors, mixed with grains. After pelting, carcasses are often composted.

### Animal identification

Effective animal identification programmes are a key component to regulation and enforcement of animal health programmes, including those for TSEs. In the USA, the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) leads a cattle re-identification effort, working closely with the Livestock Identification Committee of the United States Animal Health Association (USAHA) and similar non-governmental organisations. The organisation seeks to re-establish the universal identification seen in cattle during the 1970s and 1980s.

Similar efforts in Canada, through the Canadian Animal Health Consultative Committee (CAHCC), have culminated in the

Canadian Cattle Identification Program. Canadian legislation requires that all cattle be uniformly tagged upon departure from their sites of residence. The cattle sector manages the identification effort and the Canadian Food Inspection Agency (CFIA) enforces the national regulations on which it is based.

In the 1990s, Mexico instituted uniform mandatory identification in cattle populations from which animals were exported to the USA. The approach facilitated determination of the herds of origin of tuberculosis-infected animals from Mexico uncovered in slaughterhouses in the USA. Statistics were thus precluded from being otherwise inaccurately ascribed to the domestic herd in the USA. The approach could play an equivalent role in BSE.

Similar efforts are underway in sheep identification. Mandatory identification in sheep will begin 1 January 2004 in Canada (R. Robinson, personal communication) and is already being implemented in the USA.

The farmed cervid industry has been under varying degrees of regulatory control, including mandatory individual animal identification, herd inventories and movement permits, almost since the inception thereof. Controls have been greater in Canada than in the USA, under the Captive Ungulate Programme. The identification systems are operated by the states or provinces that license the farms. No national or sub-national identification system exists for mink.

### Producer organisations

Livestock producers in North America have formed a number of breed and production-specific organisations to promote their interests. This is perhaps best exemplified in the cattle sector where beef and dairy, commercial and purebred, breeders and feeders each have associations that represent various facets of the industry at the national and sub-national levels. Sheep and goats, farmed cervids and mink are also represented by associations, albeit at a lesser degree of specialisation within the species.

Although animal disease control infrastructures are traditionally ascribed to governments, animal health regulatory agencies in North America have established formal consultative mechanisms with academic experts and veterinary practitioners, industry and producer groups, the oldest being the USAHA. Modelled to some extent in the image of this organisation are the CAHCC and the National Technical Advisory Council on Animal Health (CONASA) of Mexico. These consultative bodies serve as means of educating industry, obtaining co-ordinated feedback and enlisting organised participation of the industry in surveillance and control programmes for TSEs and other diseases.

### Animal feed industry

The animal feed industry is well organised through vertical corporate integration or membership in associations with other

feed companies. All of the TSE-susceptible farmed species inhabit a continent so rich in grain production as to be described as 'bread basket to the world' and have virtually unparalleled access to inexpensive vegetable protein in rations.

For TSE-susceptible herbivores held under intensive livestock systems (dairy cattle, feedlot cattle and feedlot sheep) and fed mixed concentrate rations, the choice of protein supplement is based on availability and least cost. The USA is a major producer of soy, so this has been the traditional protein supplement of choice throughout most of North America.

Although the USA alone supplies as much as 60% of the world meat-and-bone meal (MBM), much of this is fed to pigs and poultry. As such, the material was not a significant ingredient in ruminant rations even before being prohibited. In Canada, financial analysis before the imposition of feed bans suggested that vegetable-derived protein was 95% the price of animal-derived protein. In the USA, in the interval which has followed application of the ban, prices for the competing proteins have remained essentially equivalent (2).

### Slaughter and rendering industries

In much of North America, fattened beef cattle presented for slaughter are derived from feedlots where they have been fed high energy rations. Slaughter establishments serving these feedlots are federally inspected, high-throughput plants which kill several hundred to several thousand animals per day. Most large plants are specialised to the extent that they slaughter one size and class of cattle. Other large plants specialise in slaughtering cull beef and dairy cows and bulls.

A number of small provincial- or state-regulated plants also operate throughout the continent, serving as community slaughter facilities. Some facilities kill moderate numbers of animals, but most process only a few locally grown animals each day for nearby individuals. While these smaller plants account for less than 5% of the slaughter capacity in Canada and the USA, they represent a large proportion of the slaughter capacity in the rural areas of Mexico.

Slaughter facilities for other species are less common. There are few dedicated sheep and goat slaughter facilities in North America, but many smaller, community plants will slaughter local sheep and goats if requested. Cervid slaughter volume has been minor to date, often taking place in slaughter facilities designed for alternate species, or on the farm. Mink slaughter and pelting occurs on the farm of origin.

Similarly to the slaughtering sector, the rendering industry is moving towards integration and consolidation of facilities. As recyclers of protein and fat, renderers associate with slaughter plants to remove the by-products of the meat industry and convert them to feed, pharmaceutical and industrial products. Rendering is regulated by national legislation in North America. Most rendering companies belong to the National Renderers

Association (NRA) (USA and Canada) or the National Association of Animal Origin Meal and Tallow Manufacturers AC (Mexico).

## Veterinary infrastructure

### Distribution of veterinarians

Animal health infrastructures in North America developed along the lines of their counterparts in Europe. Veterinarians are engaged in many aspects of disease control activities at national, sub-national and local levels (Table II).

**Table II**  
**Veterinary infrastructure in North America: numbers of veterinarians by employment category**

Employment category	Canada	United States of America	Mexico
National Veterinary Services	484	682	730
Sub-national Veterinary Services	187	554	97
Research/teaching	363	4,059	3,044
Large animal and mixed practice	2,903	8,551	7,669

*Sources:*

Canadian Veterinary Medical Association, 2001

American Veterinary Medical Association, 2001

Secretariat of Public Education and Federation of Veterinary Medical and Zootechnical Colleges and Associations of Mexico, 2000

Private practitioners deliver day-to-day veterinary services to individual livestock producers. They address herd health issues associated with common indigenous infectious agents which are not included in Lists A and B of the Office International des Epizooties (OIE: World organisation for animal health). Under certain circumstances, they are recruited by sub-national or national veterinary regulators to assist with OIE List B disease control or eradication campaigns. Together with producers, these practitioners are the first line of vigilance for TSEs. They are required under national legislation to report BSE suspects to national authorities. In Canada and Mexico, they face the same requirement for scrapie and CWD. In the USA, the mandatory reporting of these latter two diseases is governed by a combination of national and sub-national legislation.

Veterinary specialists occupy research and teaching positions at veterinary colleges and research laboratories throughout North America. Veterinary colleges often house diagnostic pathology laboratories, departments of epidemiology and large animal clinical services that offer referral services to veterinary practitioners in the field.

Sub-national Veterinary Services include provincial and state veterinarians and in many cases, diagnostic laboratories. Regulatory powers vary by country and species, but generally, sub-national services are concerned with OIE List B diseases of economic or public health importance. In their provinces or

states, these services may impose controls on animals (such as testing requirements) that exceed national requirements.

The national Veterinary Service in each country is concerned with OIE List A and in some cases, List B diseases of major importance to animal or public health. Federal veterinarians are involved in areas such as surveillance, risk assessment, disease investigation and control, meat inspection, national diagnostic services, import and export controls, as well as regulation of pharmaceuticals, biologicals and genetic materials. Federal regulators set the requirements for animals or products that move across international boundaries. In some cases, these requirements are also applied to inter-state or inter-provincial movements.

### Laboratory systems

If the first line of vigilance is the practising veterinarian, the second is the passive surveillance system provided by veterinary diagnostic laboratories. Provincial, state, university and private diagnostic laboratories routinely receive specimens from field cases submitted by veterinary practitioners. Certified pathologists examine the tissues of animals that die with CNS signs using OIE-approved histopathology (23) and in many cases, more sensitive immunohistochemistry techniques. If a TSE is suspected, samples are sent to federal or federally approved diagnostic laboratories for evaluation by both techniques.

Many of these laboratories are linked by formal and informal networks. In Canada, CFIA laboratories have formed a TSE laboratory network to share expertise and diagnostic load. A similar interchange of information functions in the USA. The Canadian Animal Health Network (CAHNet) sponsors periodic cross-country teleconferences to informally share information on new or emerging disease conditions. More formal conferences held by the American Association of Veterinary Laboratory Diagnosticians and the Canadian Laboratorians serve as scientific forums for disseminating information regarding laboratory techniques.

North America has not experienced the same demands for high volume, short response time, TSE diagnostic services as some countries in Europe, where all slaughter animals are tested. In their absence and following extensive analysis, North American Free Trade Agreement (NAFTA) partners have yet to be convinced as to the financial or epidemiological merit in adopting these more expensive and incompletely validated approaches (L. Detwiler, personal communication, S. Wilson, personal communication).

### Transmissible spongiform encephalopathy awareness and education

Never has the awareness of TSEs been as high in North America as in recent years. Arguably, the isolated BSE incident of 1993 was minor in comparison with the magnitude of outbreaks in Europe. On the other hand, the response of the three nations of

North America raised awareness among all of government, industry, practitioners and the consuming public. Interest in all TSEs was further bolstered by the 1996 findings of the UK Spongiform Encephalopathy Advisory Committee (47), associated with successive reports of the BSE epidemic in the EU. The massive media attention focused on the putative relationship of BSE to scrapie-infected sheep has fostered a major reawakening of interest in the disease in North America. This interest has translated into accelerated animal identification and scrapie eradication programmes in Canada and the USA.

Discoveries of CWD-infected wild cervids in an increasing number of states in the USA and one province in Canada have attracted widespread media interest, especially among hunters and consumers of venison. Each time an additional hunter in the USA is diagnosed with Creutzfeldt-Jakob disease (CJD) (3), the popular media pursue the possible CWD link although all cases to date have proven to be of the classical type. Nevertheless, their occurrence among venison eaters ensures that CWD commands more media presence than would otherwise have been expected.

The mink sector has not experienced the degree of government intervention dedicated to the education and awareness of TSEs in other species. Nevertheless, this industry is well aware of TME and the dead stock feeding practices that may have led to the appearance of the disease. The fur industry now dedicates education programmes specifically to the subject (L. Detwiler, personal communication).

With such a high interest in TSE diseases, virtually every major forum in North America on animal health issues attended by representatives from national and sub-national government, industry, academia or veterinary practice has included sessions on one TSE or another. Whether the issue be BSE, scrapie, or CWD, industry leaders share forum findings through newsletters with their members. They are assisted in the process by information provided by national governments in the form of fact sheets and pamphlets such as that entitled 'Encefalopatía espongiforme bovina, scrapie ovino y caprino' (bovine spongiform encephalopathy, ovine and caprine scrapie) produced in Mexico. Direct dialogue with national programme staff, presentations to veterinary groups, government-supported fact sheets and trade magazine articles all serve to raise awareness about TSEs.

Specialised training in TSE recognition, sampling and diagnosis is available at all levels of veterinary service delivery. The national Veterinary Services regularly present foreign animal disease recognition courses (including TSEs) to national and sub-national public veterinarians and laboratory diagnosticians. Furthermore, the three countries collaborate in harmonising diagnostic procedures through the Trilateral Meeting on TSEs. Knowledge about TSEs possessed by veterinary practitioners within the three nations is repeatedly updated through videos,

websites, veterinary journals and fact sheets as well as through continuing education courses offered at local, regional and national meetings (7).

## Animal health regulation

### Legislation

Bovine spongiform encephalopathy has been officially reportable under national veterinary legislation (Table III) since 1986 in the USA, 1994 in Mexico and 1990 in Canada. In Canada and Mexico, the same reporting requirement applies to scrapie and CWD. In the USA, scrapie and CWD reporting is governed by a combination of national and sub-national legislation. Transmissible mink encephalopathy is not specifically named, but under the general provisions of national regulations would be treated as a foreign animal disease. In Canada, the CFIA is the lead agency for animal disease control, including TSEs. In the USA, this falls under the mandate of the APHIS. Since none of the TSE diseases has been identified in Mexico, the National Animal Health Emergency Response System (SINESA) would respond, pursuant to the role it plays within the Mexico-United States Commission for the Prevention of Foot and Mouth Disease and Other Exotic Animal Diseases (Table IV).

Written protocols in all three countries assist federal veterinarians in conducting official duties with respect to TSEs. Federal veterinarians in Canada are guided by the Manuals of Procedures, in Mexico, by the Foreign Animal Disease Protocol, and in the USA by the Uniform Methods and Rules. In Canada and the USA, compensation is paid to producers who are ordered to destroy their animals.

### Regulatory bodies

Inspection and enforcement for TSEs is supplied by a number of regulatory agencies at national and sub-national levels (Table IV). While some agencies assign full time staff to TSE

issues, others provide ancillary support in areas such as import/export, border inspection or feed manufacturing. Provinces and states play an important role in implementing disease control programmes for scrapie and CWD.

In Canada and the USA, farmed cervids fall under both national and sub-national jurisdictions. Wild cervids are regulated by national and sub-national wildlife agencies. Confronted with requests to allow cervid husbandry, some jurisdictions refused, while others regulated under agriculture or wildlife legislation. When CWD was discovered in farmed cervids, Canada and the USA developed federal-provincial and federal-state action plans, respectively. The effort in the USA is guided by the Plan for Assisting States, Federal Agencies and Tribes in Managing Chronic Wasting Disease in Wild and Captive Cervids. The document was written in 2002 by a joint working group established by the United States Departments of Agriculture and the Interior. In Canada, the CFIA devoted a similar national working group towards the same goal in February 2000. Eradication efforts undertaken until December 2002 uncovered CWD in farmed elk herds in the provinces of Saskatchewan and Alberta in Canada and in eight mid-western states in the USA. The disease was found in farmed deer in the province of Alberta in Canada.

### International collaboration

In addition to the TSE networks developed within the three nations, international working relationships have been fostered within North America and globally. Physical contiguity and historic trade inter-dependence has led the USA to establish special working relationships with Mexico regarding issues such as screwworm eradication and foot and mouth disease (FMD) surveillance. Similar bilateral arrangements have developed between Canada and the USA to support joint efforts in bovine tuberculosis and brucellosis eradication. Under NAFTA, the three nations increasingly co-ordinate activity against diseases considered foreign to North America and in

**Table III**  
**National legislation applied in risk management of transmissible spongiform encephalopathies in North America**

Canada	Mexico	United States of America <sup>(a)</sup>
Health of Animals Act and Regulations	Ley Federal de Sanidad Animal	Animal Health Protection Act Title 9, Code of Federal Regulations Virus-Serum-Toxin Act
Meat Inspection Act and Regulations	Ley de la Industrialización Sanitaria de la Carne, Reglamento de la Industrialización Sanitaria de la Carne Tipo Inspección Federal	Federal Meat Inspection Act, Title 9, Code of Federal Regulations
Feeds Act and Regulations	Reglamento de Control Sanitario de Productos y Servicios. Especificaciones zoonosanitarias para la transformación de despojos animales y su empleo en la alimentación animal. Especificaciones zoonosanitarias de los productos alimenticios para consumo animal	Federal Food, Drug and Cosmetic Act
Food and Drug Act	Ley General de Salud and Norma Oficial Mexicana <sup>(b)</sup>	Public Health Service Act

a) National legislation is harmonised with sub-national legislation in national eradication efforts against scrapie and chronic wasting disease (41)

b) As published in *Diario Oficial de la Federación* (33, 34)

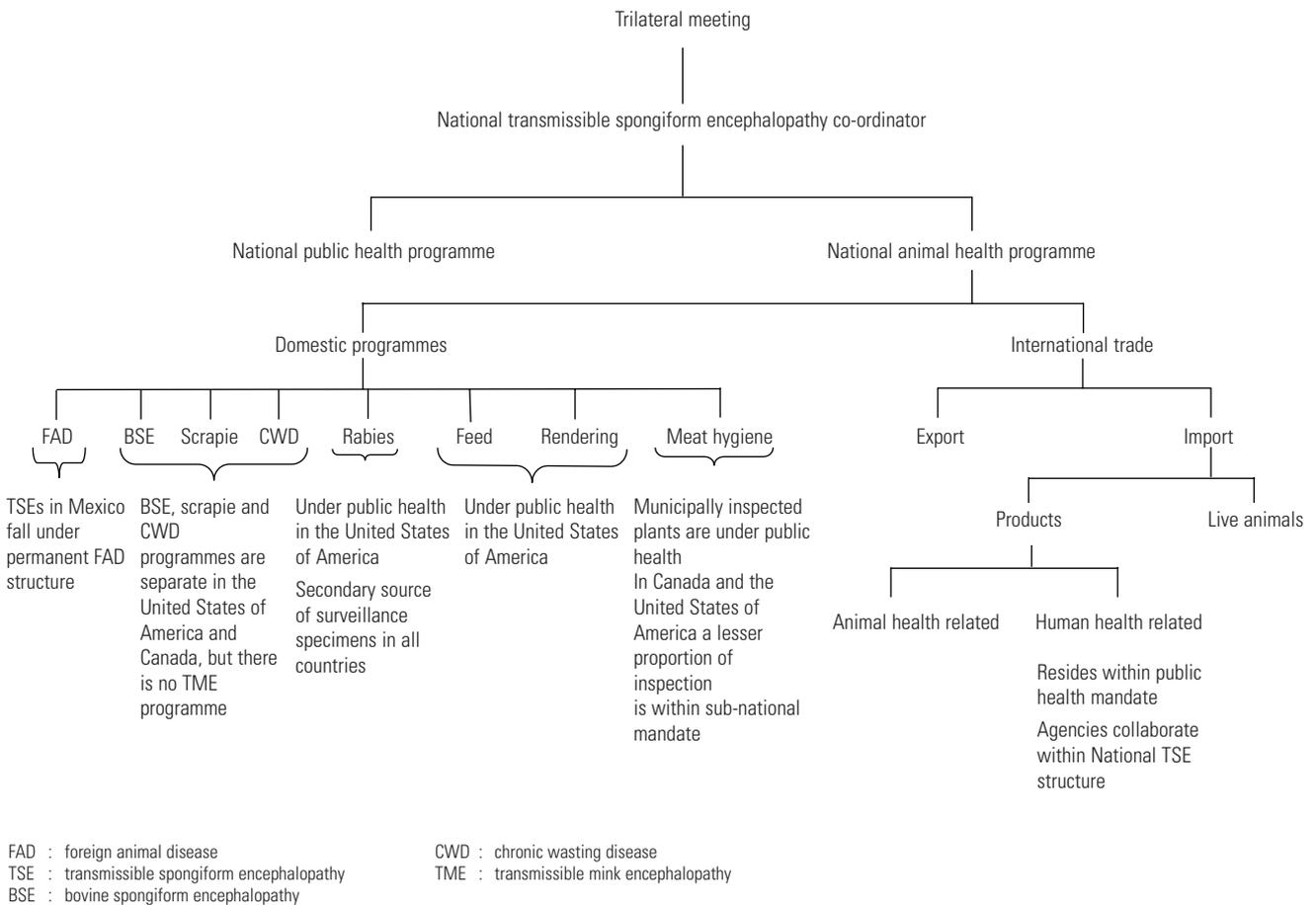
**Table IV**  
**Organisations that manage transmissible spongiform encephalopathies risk in North America**

Canada	Mexico	United States of America
Canadian Food Inspection Agency	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación	United States Department of Agriculture
Health Canada (human)	Mexican Secretariat of Health	Department of Health and Human Services, Food and Drug Administration (human and veterinary)
Canada Customs and Revenue Agency	Mexico Customs and Immigration	United States Customs Services
Provincial Veterinary Services	Comisión México-EUA para la Prevención de la Fiebre Aftosa y otras Enfermedades Exóticas de los Animales	State Veterinary Services

2000, held the first fully integrated continental FMD outbreak simulation.

In October 1998, the three nations established a forum referred to as the Trilateral Meeting on TSEs. Emerging scientific developments and international findings are incorporated on a harmonised basis into the three independent national policies via this mechanism. Points of emphasis include import and export, surveillance and control, as well as diagnostics and research. This enhanced relationship has served to facilitate

reciprocal BSE status evaluations and the implementation of mutually acceptable TSE-related trading provisions that comply with OIE guidelines (21). For the fifty scientists and programme officers who derive policy recommendations during the annual sessions, the continuing goal is that of a unified position on TSE issues in North America. Figure 1 portrays the generic outline of the TSE risk management infrastructure as it exists within the nations of North America. National approaches which differ from the generic template are noted in the figure.



**Fig. 1**  
**Transmissible spongiform encephalopathy risk management in North America: generic portrayal of national infrastructures**

As members of the OIE, the three nations have continually supported the adoption of internationally recognised and scientifically based disease control principles. These standards, as in the case of BSE and scrapie, have often been adopted within the OIE *International Animal Health Code* (24, 25). In their risk management responses to TSE agents, the nations of North America have continuously turned to that reference source.

For jurisdictionally shared zoonotic conditions such as BSE, animal and human health agencies in North America work together and seek over-arching guidance and the best scientific advice available from the World Health Organization (WHO) and the OIE. Instruction derives from forums such as the Joint WHO/Food and Agriculture Organization (FAO)/OIE Technical Consultation on BSE held in 2001 (27, 28).

## Assessing risk

### Risk assessments

Since the 1980s, the nations of North America have accompanied OIE colleagues in what has seemed an endless roller coaster of revelations regarding, and regulatory adaptations to, emerging scientific facts about BSE. They have watched the disease, which effectively dislodged scrapie as the animal TSE of international interest, displace other animal health issues within the mandate of the World Trade Organization (WTO) (19). The magnitude of the impact of BSE on North America, despite the absence of indigenous cases, is reflected in the risk management activities described in this paper.

Throughout the recognised course of the BSE epidemic in the UK and Europe, the three nations of North America were continuously represented at WHO and OIE forums dedicated to the issue. They received continuous research and epidemiological updating from those organisations and the UK. Canada and the USA hosted symposiums featuring experts from the UK and sent researchers and epidemiologists there to study the issue *in situ*. A series of risk assessments emerged from these intelligence gathering initiatives.

The chapter on BSE of the OIE *Code* serves as a guide to assessing and managing, within and between nations, the risk associated with BSE from internal or external sources (24). The methods advocated are dependent upon the status ascribed to the originating nation pursuant to that chapter. Each Member State is encouraged to independently assess BSE status in accordance with Articles 2.3.13.2. to 2.3.13.6. (24).

Guided by the chapter, nations and trading blocks such as NAFTA and the EU have also undertaken to evaluate the BSE status of their trading partners. Table V records the status of the three NAFTA members, as judged by themselves, their neighbours in North America and the EU.

**Table V**  
**Comparative assessment of the bovine spongiform encephalopathy (BSE) status of the nations of North America**

Assessed by	Assessment assigned to		
	Canada	Mexico	United States of America
Canada <sup>(a)</sup>	Free	In progress	Free
United States of America <sup>(b)</sup>	Not infected with or at high risk of BSE	Not infected with or at high risk of BSE	Not infected with or at high risk of BSE
Mexico <sup>(c)</sup>	Free	Free	Free
European Union <sup>(d)</sup>	GBR Level II	In progress	GBR Level II

a) Canada rates Mexico – Mexico BSE Evaluation (H60), 2001. Animal Health Risk Analysis, Animal, Plant and Food Risk Analysis Network (APFRAN), CFIA, Ottawa  
Canada rates USA – R.S. Morley, Animal Health Risk Analysis, Animal, Plant and Food Risk Analysis Network (APFRAN), CFIA, Ottawa, personal communication  
Canada rates Canada – (Draft) Analysis of the Potential for BSE in Canada, Animal Health Risk Analysis, Animal, Plant and Food Risk Analysis Network (APFRAN), CFIA, Ottawa, 2002  
b) United States of America rates USA – Evaluation of the Potential for Bovine Spongiform Encephalopathy in the USA (8)  
USA rates Canada and Mexico – L. Ferguson, United States Department of Agriculture/Animal and Plant Health Inspection Service, personal communication  
c) Mexico rates Mexico, the USA and Canada – M. de Lourdes Guerrero López, Comisión México-EUA par la Prevención de la Fiebre Aftosa y otras Enfermedades Exóticas de los Animales, personal communication  
d) Update of the Opinion of the European Union (EU) Scientific Steering Committee on the Geographical Risk of Bovine Spongiform Encephalopathy (31)

In the early 1990s, predicated on the generally accepted scrapie hypothesis, Canada and the USA completed the precursors of their more recent risk assessments (14) (J.A. Kellar, unpublished data). Mexico completed an equivalent evaluation, which has been updated periodically since that time (L. Guerrero, personal communication).

Canada and the USA compared the magnitude of BSE-critical risk factors in the UK with their own. Ratios of comparative BSE risk were established within their respective nations. The two nations determined independently that the respective levels of risk of deriving BSE through the entry of scrapie prion into bovine feed were one thousand to ten thousand times less than that of the UK. These findings were congruent with the view expressed by Wilesmith, the leading epidemiologist in the issue. They also matched those of the OIE BSE Ad Hoc Working Group. All indications suggested that BSE would not arise within indigenous cattle populations beyond the UK unless the animals were exposed to direct or indirect contamination from the primary source (43). The assessment conducted in Mexico determined that the BSE risk factors present in the UK and Europe were essentially absent within the production system of the country (C. Zepeda, personal communication).

In the later Geographic BSE Risk Assessments of Table V, the EU cited the lack of ruminant-to-ruminant feeding bans in the USA and Canada during that era as one of several reasons for denying them BSE-free status (31). The two nations had verified the absence of significant ban-triggering external risk

factors from their own respective viewpoints. These positions were later confirmed by the more formal risk assessments cited in the following paragraphs. The absence of considerable importation of BSE-exposed materials which characterised the situation in the EU was noted and the absence of the emerging clinical prevalence that plagued Europe was noted for North America. Guided by their own informal risk assessments, in the mid-1990s, Canada, Mexico and the USA considered existing risk management procedures commensurate with the minimal exposure experienced by the three nations.

With the general OIE membership, the three trading partners of North America responded nevertheless to the heightened concerns which accompanied the announced confirmation of transmission to humans in 1996 (W. Hueston, personal communication). Mexico updated the former risk assessment of the country and felt challenged only through considerable importation of slaughter sheep from the USA. Concerns revolved around the possibility that ewes destined for abattoirs might carry scrapie and be diverted to production (C. Zepeda, personal communication).

The USA Government commissioned what is commonly termed the Harvard Risk Assessment, an 'Evaluation of the Potential for Bovine Spongiform Encephalopathy in the United States' (8). The study concluded that the nation was '... highly resistant to any introduction of BSE or a similar disease' and added that 'BSE is extremely unlikely to become established in the US'. Import restrictions and the mammalian-to-ruminant feeding ban were cited as the measures most effective in assuring this degree of risk mitigation.

In a parallel study, the epidemiological parameters of Canada were applied to the Harvard Risk Assessment model (2). The likelihood that BSE would become established in the country was defined as 'extremely low to negligible'. Import policies, surveillance, TSE disease control measures and the 1997 mammalian-to-ruminant feed ban were quoted as key contributors to the success of Canada.

Driven by individual assessments, nations in Europe and North America have chosen diverging BSE risk management paths which reflect differing BSE prevalence and risk exposure. Within the EU, the clinical and subclinical prevalence of BSE has exacted a much publicised toll in animal and human health. Responsive guidance from the WHO, tailored to the accepted prevalence and underlying exposure gradients, interpreted by health officials in Europe and discussed with their animal health counterparts, has resulted in immense animal health resources being committed to BSE risk management.

In contrast, a decade ago, North America suffered a single imported case of BSE. Bovine spongiform encephalopathy risk assessments conducted in North America at intervals throughout the outbreak in Europe revealed minimal exposure

risk. A decade of surveillance has yet to uncover indigenous prevalence of the disease. Continual discussion has ensued between national animal and human health authorities. In consideration of WHO guidelines and the apparent continental absence of indigenous disease, the two groups jointly initiated the BSE risk mitigating actions described throughout this paper. The approaches differ markedly from the more aggressive stance dictated by the contrasting prevalence of BSE encountered within the EU. Measures in North America reflect WHO advice, the extent of mandates of national and sub-national governments and the infrastructures which promote collective compliance of industry.

### **Cross-species exposure considerations**

The BSE risk assessments for North America described above considered the possibility of non-bovine prion origins. Sources as diverse as cross-species transmission studies and empirical observations periodically raise the spectre of such transmission of TSEs from one species to another (12, 13, 30). Transmissible spongiform encephalopathy risk managers on a continent replete with wildlife have experienced four different TSE infections in domestic stock and farmed wild animals and remain vigilant to this possibility. Transmissible spongiform encephalopathy risk management measures described in the following sections address intra-species transmission. However, these approaches also curb the cross-species exposure of animals naturally or experimentally susceptible to TSEs. Cross-species considerations are grouped in the following paragraph to avoid interfering with later intra-species descriptions.

Voluntary and mandatory preventive measures introduced for BSE prevent exposure of non-bovine ruminants and mink to raw and rendered mammalian products. Seven to nine ft (2.13 m to 2.74 m) tall fences achieve varying degrees of success in attempts by producers to prevent commingling of wild and captive cervids. The identification of CWD in either group, through farmed cervid herd certification and surveillance programmes or through wildlife surveys, triggers all-encompassing depopulations, which also serve to limit the degree of cross-species contact in known infected areas. Quarantine, extensive destruction and decontamination measures applied to infected sites in CWD and scrapie eradication programmes reduce or eliminate the fomite-borne prion exposure of wildlife and other domestic species. Industry-driven cleanups and husbandry shifts adopted during the era of TME achieved similar results in the mink farming sector.

## **Risk mitigation**

When, in 1996, the Western Hemisphere OIE Member States resolved anew to preclude the establishment of BSE within their collective territory, North America had already suffered the effects of four animal TSEs. Both Canada and the USA continued to wage an unending battle against imported scrapie

that, half a century before, had eluded conservative risk management approaches. Inspired by the success of the more draconian approach taken by Australia to the same, these countries now lead a continental BSE risk management effort which embraces and expands upon OIE guidelines.

Risk management applications in North America have evolved over time in response to the emerging (CWD and TME) and introduced (BSE and scrapie) conditions. The reflection of ever-changing science, they vary from the conservative control tactics applied to sheep half a century ago to the aggressive eradication practices adopted for cattle and cervids today. The latter reflect a determination not to repeat, for CWD and BSE, the approaches which permitted scrapie to gain a foothold in the New World several generations ago.

The TSE risks have been segregated into those which arise outside North America and those that originate within. While there may be some cross-over in risk mitigation between the two distinctions, they form a useful framework for dealing with TSE prevention and control.

## Managing external risks

### Imported cattle and genetics

Under current import controls, the USA excludes cattle from countries known to be affected by BSE or at high risk of harbouring the disease. Mexico excludes cattle imports from BSE-infected countries. Canada, on the basis of a risk assessment conducted in accordance with OIE principles, imports cattle only from those nations designated as BSE-free. The harmonised continental approach to TSEs permits subtle shades of variation in policy application while safeguarding the principles of the chapter on BSE in the OIE *Code* (24). The net impact of the approach is that the 2% of cattle imports which originate beyond the continent of North America (Table VI) come almost exclusively from Australia and New Zealand (38).

The recently concluded study in the UK on embryos transplanted from BSE-infected dams demonstrated no transmission of the disease when the process incorporated approved washing techniques. The three nations of North America supported the resulting rescission of all references to bovine embryos as a risk factor from the BSE chapter. Given the findings, imports of both (appropriately treated) bovine embryos and semen are accepted.

In 1993, among monitored imports of UK origin from the pre-import ban interval of the 1980s, the single diagnosed case of BSE recorded in North America emerged in Canada (7). The cow and the offspring thereof, the herd of residence and all other monitored imports were quarantined and then repatriated, or slaughtered with compensation and incinerated. The disposition of the balance of the original cohorts, lost to natural attrition and export before monitoring began in 1990,

**Table VI**  
**Third nation contributions to transmissible spongiform encephalopathy risk-mitigated animals and products imported by North American Free Trade Agreement (NAFTA) partners in 2000 and 2001**

(expressed as a percentage of total imports by commodity by NAFTA member)

Commodity	Percentage of imports of NAFTA partners originating in third nations			
	Canada	Mexico	United States of America	NAFTA
Cattle	1% <sup>(a)</sup>	16%	0%	2%
Beef	14%	1%	13%	9%
Inedible meat meals and offal	7%	<1%	62%	24% <sup>(b)</sup>
Sheep	0%	26%	<1%	20%
Goats	0%	<1%	0%	<1%

a) 1% of imports of cattle into Canada came from third nations

b) 24% of all the inedible meat meals and offal imported into North America came from third nations (Australia and New Zealand)

Source: Derived and rounded to the nearest percent from dollar values sourced within the United Nations Conference on Trade and Development (UNCTAD)-Trade Analysis and Information System (TRAIS) (38)

was recorded and reported. Delegations from the USA and Mexico participated in the responsive efforts initiated by Canada. Once the scope of the outbreak and remedial measures were confirmed, trans-border trade, until that time essentially closed, was reopened to Canadian cattle and beef products.

The USA and Mexico had imported a number of animals from Canada, augmenting those which they had received directly from Ireland and the UK. The two nations launched a trace of them all. The animals in question, similarly to those destroyed in Canada, were almost exclusively members of beef breeds. None had originated in a birth cohort in which BSE had been identified. Both countries mirrored the efforts in Canada, facing similar legal challenges from affected individuals, to the extent of their enabling legislation (8) (C. Zepeda, personal communication). Most imports have been removed. In the USA, for example, of the approximately 500 head recorded, only three remain alive (8). The balance await controlled disposition at the end of their natural productive and reproductive cycles.

As additional countries reported first diagnoses of BSE within their jurisdictions to the OIE, the nations of North America extended similar controls to live animals from those sources. Parallel retrospective searches for prior imports were launched. The three NAFTA partners applied to those animals still alive the risk mitigating efforts which their respective feeding practices demanded and their legislative authorities allowed. Imports from Switzerland, France, Italy, Germany, Austria, Denmark, Spain and Japan were among those requiring such attention. Some groups, such as importations to Mexico of

fighting bull cohorts from Spain in 1996 and 1997, were traced but considered not at risk of BSE by virtue of the absence of exposure to MBM (L. Guerrero, personal communication). Small residual numbers of risk-associated animals await controlled natural attrition (2, 8).

### Imported sheep and goats

Sheep and goats imported for breeding purposes by Canada and the USA must come from countries that are either recognised free of BSE (Canada) or that are not restricted for BSE reasons (USA). The animals must also originate in countries either free of scrapie or with control or eradication programmes equivalent to those of Canada or the USA, respectively. Small ruminants imported into Mexico for breeding must originate from scrapie-free nations or flocks and herds determined free of the disease during at least five years of enrolment in a control programme.

All breeding animals entering North America must originate in flocks and herds certified as free of scrapie by the originating national veterinary authorities and have been subjected to clinical veterinary examination under national veterinary service supervision within a statutory interval preceding importation. Small ruminant embryos are similarly restricted. The USA does not import them at all, while Canada does so only on the basis of a risk assessment conducted in accordance with OIE principles.

Sheep and goats imported into the nations of North America for direct slaughter are conveyed to establishments in sealed vehicles. Imports to Mexico from the USA are destined almost exclusively to slaughter.

Table VI profiles recent importation flows of small ruminants into and within North America. Of the three countries, Mexico is the largest importer, with nearly 75% of sheep imports and almost all goat imports originating in the USA. Overall, 20% of sheep imports into countries of North America originate from outside North America and are obtained from Australia and New Zealand.

As the investigation of the BSE epidemic and inter-species transmission studies progressed, the three NAFTA partners shared the emerging concern of the EU that some of the sheep and goat populations of Europe might have been exposed to BSE-contaminated feed.

As in the case of cattle, the nations of North America found themselves in possession of small ruminants legally imported from countries such as Belgium, the Netherlands and Denmark which subsequently reported BSE infection (10). Retrospective investigations and risk assessments were conducted and destruction orders issued as warranted (2, 8) (L. Guerrero, personal communication).

### Imported cervids

Movements of cervids into and among the three NAFTA partners are minimal, in the wake of sequential tuberculosis and CWD outbreaks. Regulations at the national level require that cervids be imported under permit conditions. The stipulations are analogous to those for BSE and scrapie. The health status of the originating nation, herd and animal must be documented and the cervids are subject to veterinary inspection at the time of importation.

Efforts conducted by Canada to manage CWD import risks are buttressed by the national Captive Ungulate Program. Initiated in 1990 for tuberculosis and brucellosis surveillance, the programme has effectively controlled all post-entry cervid movements since that time (5) and is the epidemiological backbone of the domestic CWD eradication effort. In September 2001, the USA also initiated a CWD eradication effort. Through the American Federal-State co-operative approach to disease control, the programme will unify and harmonise independently motivated actions already underway within many states and in the process, cervid movement will be controlled across sub-national jurisdictions. Sub-national provisions also apply within Canada, whereby a number of provinces control movement into as well as within their territories. Several states and provinces have banned the importation of cervids in the face of growing knowledge regarding the distribution of CWD within farmed and wild herds on the continent.

Twelve years of records retained by the Captive Ungulate Program and provincial agencies, in addition to import files, are being employed in the retrospective trace and assessment of all cervid imports from the USA. The discovery of infection in herds in the USA with links to Canada triggers reciprocal tracing in that jurisdiction.

### Imported mink

Mink imports from abroad are infrequent. They are subject to permits and certification which describes the health status of the originating nation, farm and shipped animals (4) (D. Barr, personal communication).

### Other imported animals

The expression of BSE in zoo ruminants and isolation of an indistinguishable TSE agent from zoo felines raised the prospect that the disease might have been internationally distributed through the exchange of zoological specimens (15, 21). Chronic wasting disease had already entered a zoo in Canada from the USA by this means (44, 45). The nations of North America have taken a series of mitigating steps to address associated TSE risk.

Permits required by national Veterinary Services limit the disposition of imported zoo animals. Provisions in Canada and the USA include permanent quarantine on zoo premises. Although many small zoos are unaffiliated, the significant

zoological parks (the major importers) in North America belong to either the American Zoo and Aquarium Association (AZA) or the Canadian Association of Zoos and Aquariums (CAZA). The AZA- and CAZA-member zoological institutions employ their own resident or retained veterinarians.

These practitioners share the awareness of governments in regard to TSEs and are committed by association protocols to conduct post-mortem examinations of dead stock. In 1978, prior to the definition of CWD as a syndrome, a spongiform encephalopathy, subsequently confirmed by immunohistochemistry as CWD, was diagnosed in the brain of a mule deer with neurological signs held by a CAZA-member zoo. The herd of deer involved was affected by a wasting syndrome, and contact could be traced back to a mule deer imported from Colorado (I.K. Barker, personal communication).

Zoos are governed by a series of overlapping controls imposed by governments and the rendering industry. All are subject to legislation under which BSE, scrapie and CWD are reportable and mammalian tissue, with the exception of porcine and equine materials, cannot be fed to ruminants. Without species exceptions, dead stock from zoos are barred from the feed chain via the voluntary ban established by the NRA on behalf of member establishments in Canada and the USA (11). The NRA is a member of the national consultative bodies described elsewhere in this paper as supporting government management of TSE issues. Association members produce the majority of MBM made on the continent, including virtually all that is utilised in Mexico, a nation without indigenous meat meal production. The NRA similarly bans the carcasses of cervids, adult sheep and goats, animals of unknown origin and TSE-susceptible zoo species sold as surplus stock to non-commercial breeders. In Canada, captive ruminant populations in zoos and on farms also fall under the monitoring provisions of the nationally mandated Captive Ungulate Program. While not directed specifically at TSEs, the programme augments preceding controls by serving as a record of animal movements and dispositions since 1990.

### Imported animal-derived products

The three NAFTA nations follow OIE recommendations (*International Animal Health Code*, Article 2.3.13.7.) regarding imports of bovine products considered exempt from controls (24). Milk and milk products, protein-free tallow and derivatives, protein-and-fat-free dicalcium phosphate, hides and skins, as well as gelatine and collagen of hide and skin origin enter North America without challenge.

Oral exposure is continuously cited as the principal, if not universal, means of transmitting BSE. Nevertheless, experimental BSE transmission studies and iatrogenic experience with CJD in humans have prompted caution in North America as regards importation of biological materials incorporating bovine tissues. In that regard, NAFTA partners

adhere to the guidelines of Article 2.3.13.22. of the OIE *International Animal Health Code* (24).

Mexican Official Standard NOM-012-ZOO-1993 regulates chemical, pharmaceutical, biological and feed products for use in animals (33). The standard requires that raw material imports be verified in a quality control laboratory, that they bear the name of the originating production laboratory and that they be accompanied by a certificate of origin. It establishes the manufacturing protocol for each production stage, listing raw materials, equipment and manufacturing processes, labelling and storage, quality control, as well as cleaning and disinfection procedures (L. Guerrero, personal communication).

The United States Department of Health and Human Services, Food and Drug Administration (FDA) is charged with regulating pharmaceuticals and human vaccines, in addition to animal feeds. Veterinary biologicals are regulated by the APHIS. Both agencies have import restrictions in place. Import controls imposed by the APHIS on bulk and veterinary products were enacted in 1989. Veterinary biologicals containing ruminant or ruminant-derived products are prohibited from countries known to have BSE or to be at high risk of harbouring the disease. The FDA has issued related import guidance since 1992.

The FDA must approve all products under the regulatory authority of the agency, along with changes to them, and inspects manufacturers for compliance. Similarly, the APHIS must approve all veterinary biologicals and inspects manufacturers for compliance. On guidance from the FDA, manufacturers in the USA have reviewed the geographic origin of all bovine-derived materials in human vaccines. They are in the process of ensuring that associated TSE-susceptible seed and cell banks are re-derived from countries that are not restricted by the USDA for either having, or being at risk of having, BSE.

The CFIA regulates the importation of biologicals as well as the manufacture thereof in Canada. Biological imports must be accompanied by permits which cite the limiting conditions of entry. Vaccines and other biologicals containing ruminant materials and destined for animal administration may only be imported from countries Canada has determined to be free of BSE on the basis of a risk assessment conducted in accordance with OIE principles (24). Diagnostic kits are only rarely procured from beyond North America. They are subject to import permits, conditions of usage and assessed on a case-by-case basis. Biological manufacturers sign a Declaration of Compliance stating the species, sources and countries of origin of all materials used in their products. They certify the origins as free from animal-related TSEs and contamination.

Imported pharmaceuticals reside at a jurisdictional interface between the human and animal health communities. Transmissible spongiform encephalopathy control measures

applied to them benefit considerably from the collaboration achieved between the two major enforcement bodies. In Canada, for example, while Health Canada regulates human therapeutics and cosmetics, this is done in conjunction with Agriculture and Agri-Food Canada and the CFIA. In the USA, the FDA hosts a formal TSE Advisory Committee comprising researchers (federal, state and private), academics, consumer representatives and representatives of other government agencies. The process facilitates regulation of TSE-susceptible cosmetics in the USA, along with pharmaceuticals and areas such as medical devices and dietary supplements. The Trilateral Meetings on TSEs of North America seek to achieve continental harmony of approach in all of these areas.

### Imported meat and meat products

Canada permits importation of edible ruminant meat and meat products only from countries designated BSE-free on the basis of a risk assessment conducted in accordance with OIE principles. The USA imports only from nations which have passed a similar risk assessment. Mexico imports only from countries which continue to profess BSE freedom. The 9% of fresh meat originating from beyond the continent (Table VI) derives from countries considered as representing acceptable BSE risk. As in the case of cattle, Australia and New Zealand are the major suppliers from abroad of meat and meat products to North America.

### Imported meat-and-bone meal

The concerns regarding FMD had decades before led to the establishment of strict rules for the origins of MBM and feed. Upon the emergence of BSE, imports of both products from Europe were prohibited. Mexico imposes the same ban on BSE-infected countries as to bovine imports. This, and the economics of supply, have contributed to virtually complete reliance of Mexico (Table VI) on the USA as the source of MBM imports (L. Guerrero, personal communication). Canada imports only from nations designated BSE-free on the basis of a risk assessment conducted in accordance with OIE principles. The same considerations as those undertaken by Mexico have served to limit substantial imports into Canada, amounting to half the annual consumption of the country, to the same American sources (2). The USA prohibits all processed animal protein products from countries known to have BSE or to be at high risk of harbouring the disease (8). Approximately 24% of products imported in composite by the three NAFTA nations come from third parties. Virtually all is consigned to the USA and originates in Australia and New Zealand.

Perhaps no commodity is subject to greater speculation with respect to BSE transmission than MBM. The controversy does not involve the role of MBM in the disease as much as the unpredictability associated with international customs records. They confound risk assessment by grouping MBM together with fish meal and sundry other products considered innocuous for TSEs.

Canada is shown in export records of the UK as having taken receipt of considerable quantities of MBM during the interval of BSE transmission in that nation. The computerised import record keeping systems employed could not themselves resolve the misclassification of the product. Only intensive and protracted search into the initial paper consignment documents proved the export entries erroneous. A second misinterpretation involves Mexico. That nation is described as having received considerable quantities of MBM from France. Only close scrutiny revealed the actual product to be fish meal.

## Managing internal risks

### Feed ban

National legislation in Canada and the USA imposed mammalian-to-ruminant feeding bans (with the exception of equine and porcine materials) in 1997, the same year that the industry in Mexico accepted a code of practice. Many establishments in Mexico were members of multinational organisations whose codes of practice already included these provisions. On 11 October 2000, Mexico published Article 4.19 of the Mexican Official Standard NOM-061-ZOO-1999 in the Official Federal Gazette, making the code of practice mandatory (34) (L. Guerrero, personal communication).

Control approaches common to the three nations include separation of prohibited and non-prohibited materials during processing, a ban on rendering of materials from animals suspected of other TSEs, labelling of prohibited materials and periodic inspection of production and distribution facilities. As additional safeguards, the carcasses of animals from scrapie and CWD-infected flocks and herds are not rendered, but rather diverted to incineration or burial, as are road-killed wild cervids, zoo animals and pets.

Even before legislation was enacted, the NRA (Canada and the USA), the National Association of Animal Origin Meal and Tallow Manufacturers A.C. (Mexico) and independent renderers had been educated by the three governments, commencing in the late 1980s. The putative emergence of BSE through ingestion of feedstuffs bearing abnormal prions was understood. Association members adopted voluntary restrictions by progressively banning sheep heads and carcasses, mink, cervids and goats in the early 1990s. In the face of national restrictions on ruminant protein sources, establishments have increasingly shifted away from ruminant product manufacture or instituted dedicated facilities for ruminant feeds.

The mink industry did not wait for the government to control nutritional exposure to TME. A decade before government regulation of ruminant nutrition, the mink sector had already achieved awareness of the TME issue and educated members regarding dietary exposure. Seventeen years of dietary controls have passed without observed coincident TME outbreaks (16). The mammal-to-ruminant feed ban, similarly to the voluntary

ban adopted by members of the NRA, now excludes mink carcasses from MBM production (2, 8, 11).

In Canada, the Health of Animals Act authorises a national ban enforced by the CFIA. Renderers and feed mills are inspected annually. An audit of all federally inspected rendering plants conducted in 2002 found the sites to be in compliance. Retail outlets and on-site feeding operations are subject to inspection once every five years, with spot checks at any time in response to complaints or investigations (S. Tolusso, personal communication).

In the USA, those roles fall to the FDA. By March 2002, inspection and reinspection (applied to offenders) approaches had confirmed 99% compliance among those facilities handling prohibited products.

In Mexico, pursuant to regulation NOM-061-ZOO-1999, rendering plants and feed mills are subject to annual verification. State (sub-national) veterinarians, in their frequent contacts with the facilities, collaborate in enforcement (34).

Table VII provides the number of facilities subject to inspection. Cost-effectiveness dictates that most emphasis be placed on inspecting the smaller number of renderers and feed mills, as opposed to the hundreds of thousands of sites they supply within the broader retail and ruminant producer sectors.

### Transmissible spongiform encephalopathies surveillance in general

Conscious of the challenges associated with trying to detect the presence of TSEs, the three NAFTA governments intervene to encourage voluntary reporting of suspected presence of the

**Table VII**  
**Premises subject to inspection in the enforcement of the mammal-to-ruminant feed ban in North America (except for equine and porcine materials)**

Country	Total premises (by type)	Premises handling prohibited materials
Canada	Renderers	32
	Feed mills	594
	Farms	>100,000
Mexico	Renderers	64*
	Feed mills	360
	Farms	Not stated
United States of America	Renderers	239
	Feed mills	6,070
	Farms	>1,000,000

\* 57 process tallow, bone, horn and hoof and seven process tannery and hide waste. Virtually 100% of meat-and-bone meal and feed supplements are from the United States of America

#### Sources:

Canada: S. Tolusso, Canadian Food Inspection Agency, personal communication  
USA: B. Pritchett, Food and Drug Administration, personal communication  
Mexico: L. Guerrero, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, personal communication

diseases. Each country employs methods applicable to the national culture and industry demographics. Education and awareness efforts common to the three nations have been described. They aim at industry and practitioners and employ the consultative strengths of industry sectors themselves through organisations such as the USAHA in the USA and the CAHCC in Canada.

In Canada and the USA, financial incentives have been added in the form of compensation for animals slaughtered in national eradication efforts for scrapie and CWD. The fair level of compensation received by producers in Canada implicated in the 1993 BSE episode, from government and industry sources, showed the continental industry that owners would be equally well supported in the event of an incursion of that disease.

As necessary, the nations employ national and sub-national regulatory powers to augment collaborative efforts. Throughout the three NAFTA countries, pursuant to national legislation cited in Table III, BSE has been mandatorily reportable since 1990 in Canada, 1994 in Mexico, and 1986 in the USA. Preceding those declarations, longstanding national laws requiring the reporting and histopathological examination of brains from suspect rabies cases in North America served as partial continental surrogates for these regulations. Scrapie and CWD are reportable under national legislation in Canada and Mexico. In the USA, scrapie and CWD reporting is governed by a combination of national and sub-national legislation. Transmissible mink encephalopathy, last diagnosed in 1985, is not reportable in the manner of the other TSEs. The nations rely upon the appearance of the characteristically high morbidity and mortality of the disease to signal the presence thereof to the passive sub-national diagnostic networks linked to the national government within each country.

### Bovine spongiform encephalopathy surveillance

As OIE members, the three nations accept the surveillance challenge of trying to detect BSE at a prevalence rate as low as one mature animal within one million. They accept OIE guidance as to the impracticability of trying to do so through random sampling within the general adult cattle population. Similarly to other OIE members, they augment passive surveillance flows from that general population with active surveillance that targets subpopulations considered at greater risk of harbouring the disease (2, 8) (C. Zepeda, personal communication). Histopathology and immunohistochemistry are employed in the formal surveys.

One selected subgroup in North America comprises mature cattle showing intractable CNS signs which cannot be clinically explained in terms of other more common conditions such as non-progressive rabies and hypomagnesemic tetany. A second includes mature recumbent or 'downer' animals whose status, again, cannot be attributed to differential diagnoses. To these are added mature animals inexplicably found dead and those negative on rabies examination in laboratories.

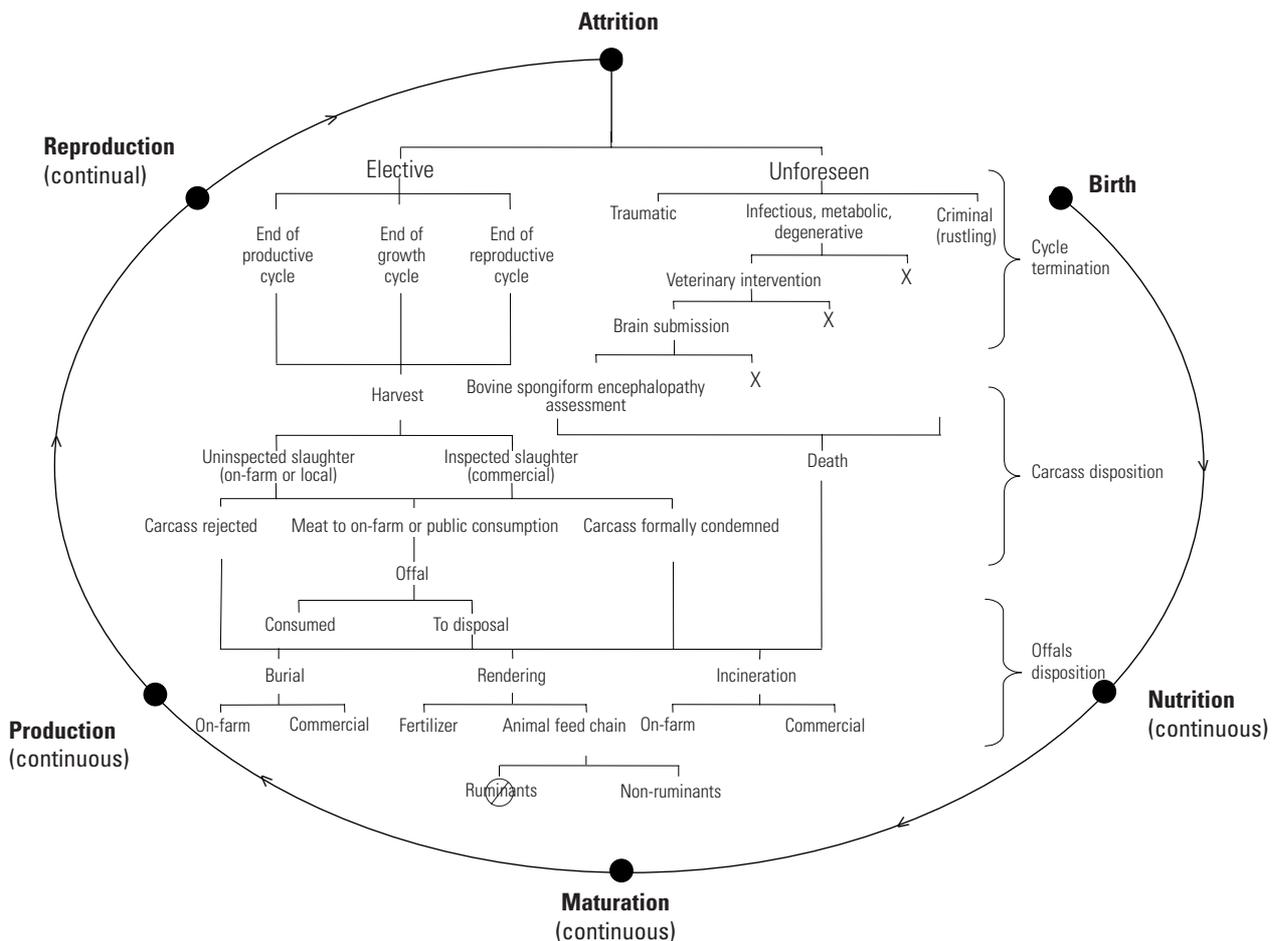
Commercial slaughter provides convenient access to several of these subpopulations in Canada and the USA, where up to 95% of cattle are killed in nationally or sub-nationally inspected facilities. In Figure 2, a visual depiction of the cattle cycle in North America, the process is referred to as 'inspected slaughter'. In Mexico, a much lower (20%) commercial slaughter flow increases the surveillance challenge. Humane transport regulations in some sub-national jurisdictions have begun to limit the shipment of 'downer' animals to slaughterhouses. Canada and the USA, in partial response and to broaden their respective surveillance bases, have applied ever-increasing resources to on-farm collections.

The three nations rely on producer and practitioner goodwill for surveillance applications aimed at farms. As shown in Figure 2, the on-farm approach relies on a producer calling a practitioner to examine animals exhibiting signs associated with infectious, metabolic and degenerative conditions which could include BSE. The approach then depends on the harvest and laboratory submission by the practitioner of the brains of suspected animals. Beyond educational programmes, several sub-national governments have waived or otherwise offset the

cost of post-mortem diagnostics to encourage these submissions. For example, the province of Alberta pays practitioners CDN\$65 (US\$42) for each cattle head submitted (1). The province of Quebec subsidises the cost of veterinary visits.

Experience in Europe has validated the cost-effectiveness of these more focused approaches on farm and at slaughter (9). In the case of Mexico and the USA, the preceding collections are accompanied by samples from the monitored imported cattle described earlier in this document. The animals had been legally imported from nations subsequently identified as BSE-infected and form part of the respective national herds. They remain in the possession of owners resistant to their pre-emptive slaughter and are sampled as controlled natural attrition removes them from the cattle cycle of Figure 2.

Table VIII documents the samples collected in the quests of the three nations to meet the numbers of surveillance samples that the OIE, with qualifying remarks as to statistical applicability, recommends (26). Canada and the USA continuously exceed the recommended levels. Denied a major commercial slaughter



X : not performed  
 ⊗ : feed ban restriction

**Fig. 2**  
**The cattle cycle in North America**

**Table VIII**  
**Surveillance of bovine spongiform encephalopathy in North America between 1997 and 2001: number of cattle  $\geq$  24 months tested**

Year	Canada	United States of America	Mexico
1997	712	2,713	140
1998	926	1,080	407
1999	895	1,302	289
2000	1,020	2,681	194
2001	1,575 <sup>(a)</sup>	5,272 <sup>(b)</sup>	358 <sup>(c)</sup>

a) 624 exhibited mental, locomotor or sensory evidence of neurological dysfunction; the remaining 951 were principally animals arriving at nationally and sub-nationally inspected abattoirs as non-ambulatory ('downers' in North American terminology), emergency slaughter or dead

b) In subdividing the total, the authors caution the reader against over-interpreting the distinction between neurological cases and others; the former, numbering 808, presented with ostensible CNS signs; as in Canada, the latter 4,464 included downers, emergency slaughter and dead animals. An undefined number of these presented with evidence or history of some degree of mental, locomotor or sensory dysfunction, rendering the two subcategories somewhat less than mutually exclusive

c) 25 exhibited mental, locomotor or sensory evidence of neurological dysfunction; the remaining 333 presented at nationally inspected slaughter as in Canada and the United States of America

*Sources:*

Canada: G. Little, Canadian Food Inspection Agency, personal communication  
 USA: L. Ferguson, United States Department of Agriculture/Animal and Plant Health Inspection Service, Veterinary Services, personal communication  
 Mexico: L. Guerrero, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, personal communication

flow, Mexico has experienced difficulty in obtaining the OIE-recommended 367 annual submissions in several of the years described.

The USA conducted an initial assessment of BSE risk in the early 1990s and considered the geographical clustering of exposure parameters across the considerable expanse of the country (14). Having initiated surveillance in the early 1990s on a national basis like Canada and Mexico, the USA has of late created eight surveillance regions (Fig. 3). Cattle within each region are considered autonomous from those in others, in terms of their attrition from the cattle cycle depicted in Figure 2. The USA has now established surveillance goals for each region, based on resident dairy cattle populations (39, 40).

### Scrapie surveillance

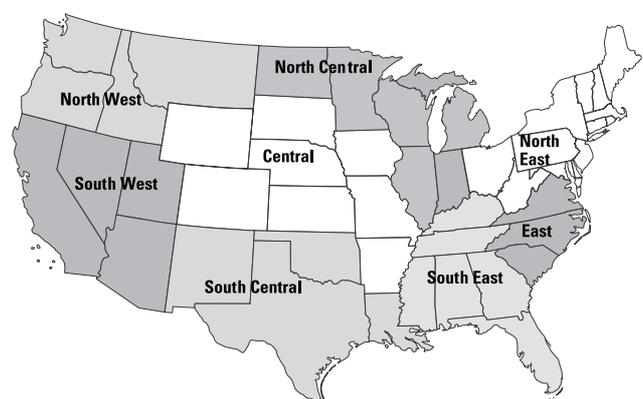
In Mexico, scrapie surveillance falls within the national overarching foreign animal disease detection and response system. In Canada and the USA, passive surveillance has dominated within the respective control programmes of both countries for half a century. In the wake of BSE and CWD, however, scrapie is receiving increasing attention as both nations move from control to an accelerated eradication mode. As part of the process, the value of passive surveillance has been seriously

re-examined. Both countries note that the currently low market value of commercial stock may deter owners from calling veterinarians to examine a single sick animal. Recent evidence from voluntary screening in the USA suggests that subclinical infection may contribute considerably to the limitations of self-reporting. In recognition of these and other factors, active surveillance has become the goal in both countries (P. Greenwood, personal communication; D. Sutton, personal communication).

In the USA, an infusion of resources supports a programme described as in a state of transition pursuant to Title 9 Code of Federal Regulations, Parts 54 and 79 (41). The funding supports an assessment of the national scrapie prevalence via active surveillance across nearly 90% of the domestic mature sheep slaughter. In the 2002 fiscal year, the USA set a target of 15,000 samples to be collected (L. Detwiler, personal communication). Even spent animals normally lost to surveillance by virtue of export to slaughter in Mexico are being diverted to the study. The formal application of active slaughter surveillance within the emerging eradication programme in the USA is in the design and planning stage.

In Canada, a similar active surveillance plan has been drawn up to monitor mature slaughter sheep and dead stock, but awaits funding approval. In the interim, the province of Alberta has already collected and examined the proportion of the national sample assigned to the jurisdiction, with negative results, albeit on the basis of convenience sampling.

The American Scrapie Flock Certification Program (1992) serves as an active adjunct to the passive surveillance system. Member flocks represent slightly more than 1% of the national total, but in terms of animals, their contribution is markedly greater in a nation in which 2% of farms husband 55% of all sheep. A similar flock certification programme is proposed in Canada.



**Fig. 3**  
**Bovine spongiform encephalopathy surveillance regions in the United States of America**

Longstanding reliance upon brain tissue is being augmented in Canada and the USA through immunohistochemistry applied to lymphoid follicles from the nictitating membrane of live animals. Genotype-specific sensitivity and specificity values are emerging from validation studies in both countries. They suggest the epidemiological merit of the approach on a flock, if not an animal, basis. As a result, the method is finding experimental application in a number of individual states. At the same time, the USDA Center for Veterinary Biologics is evaluating licensing applications from a number of companies producing rapid tests for scrapie and CWD (L. Ferguson, personal communication).

Genotype assessment is entering into programme procedures in both Canada and the USA. Use of the method has advanced in the USA for selective application among options available to state-designated epidemiologists. In the revised programme in the USA, genotype joins a series of more traditional exposure variables that can be used in determining the disposition of animals within infected sheep flocks. Findings in the USA with respect to scrapie surveillance are often applicable to, and incorporated within, the programme in Canada. Table IX summarises the preceding domestic surveillance applications among the three nations.

**Chronic wasting disease surveillance**

Passive and active surveillance approaches, supported by national and sub-national legislation, are applied to both wild and farmed cervid populations in Canada and the USA.

**Table IX**  
**Scrapie surveillance in North America**

Surveillance targets	Canada	Mexico	United States of America
Clinical field cases	Passive	Passive and active <sup>(a)</sup>	Passive
Pathology laboratory accessions	Passive	Passive	Passive and active
Slaughterhouse accessions <sup>(b)</sup>	Ante-mortem and post-mortem samples from suspicious cases	Ante-mortem and post-mortem samples from suspicious cases	Ante-mortem and post-mortem samples from suspicious cases
Dead stock/rendering	Programme planned	–	Programme planned
Voluntary flock certification	Programme planned	–	Active (in 1% of flocks)
Voluntary flock screening	–	–	Active (in several states)

a) As part of the Central Nervous Signs Monitoring Program  
 b) Surveillance focuses on the percentage of total slaughter that is inspected by the national or sub-national governments, with considerably higher coverage achieved in Canada and the United States of America

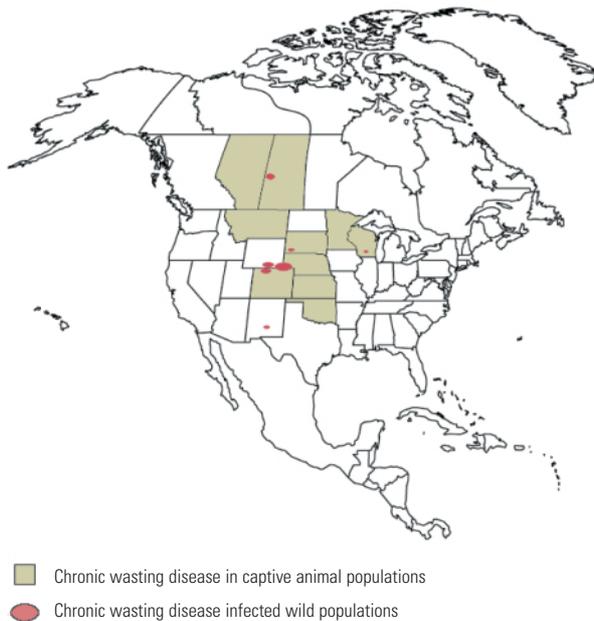
Histopathological examination is applied to the brains of suspected animals, based on OIE guidelines and the published literature (23, 46). The method reveals characteristic grey matter vacuolation in affected animals (44). The approach is augmented by immunohistochemistry, based on an internationally accepted protocol, as well as by electrophoresis with Western blotting. Diagnoses are undertaken in national laboratories as well as sub-national and university facilities accredited by them. The broadly based diagnostic collaboration is a function of multidisciplinary Working Groups established for CWD in both Canada and the USA.

As an adjunct to the mandatory reporting of clinically expressed CWD, Canada is developing a voluntary national herd programme. This will encompass brain submissions from deaths of all participating animals over 12 months of age. Similar plans are being drawn up in the USA, to be implemented by individual states in accordance with standards set by national Government.

In the interim, several sub-national jurisdictions have launched their own surveillance initiatives. The provinces of Alberta and Saskatchewan in Canada, as dominant elk-producing regions, run herd certification programmes (1) whereby brain samples must be submitted from all farmed cervids dying at 12 months or older. In addition, every animal that goes to slaughter is tested before the carcass is released for human consumption.

In Canada, in the face of the recent outbreak in North America, a retrospective search of laboratory accessions revealed the infrequency with which cervid brain material is banked in the national passive surveillance network of sub-national and university diagnostic laboratories. Lymphatic materials are banked from elk sacrificed during the cervid tuberculosis outbreak in North America a decade ago; however, the specimens do not lend themselves to current diagnostic approaches for CWD (20, 36) (A. Balachandran, personal communication).

Many provinces and states, especially in the mid-western areas of North America, have incorporated active CWD surveillance within wildlife management programmes. Hunters have submitted large numbers of cervid heads in response to special government surveillance efforts of recent years. In the provinces of Alberta, Saskatchewan and Manitoba in Canada, over 6,000 wild cervids have been harvested since the late 1990s. Wild cervid surveillance across multiple states in the USA has produced over 15,000 specimens since the 1983 launch of the programme in Colorado and Wyoming. Media coverage of the infrequent positive findings from these surveys provides continuing education and awareness value. Infected wild cervids have been found to date in the province of Saskatchewan and the states of Colorado, Wyoming, South Dakota, Nebraska, Wisconsin and New Mexico (Fig. 4). Provinces and states containing infected farmed cervids (previously described) are also depicted in the diagram.



**Fig. 4**  
**Geographic areas of North America in which chronic wasting disease has been diagnosed in farmed and wild cervid populations**

Source: United States Department of the Interior, United States Geological Survey, National Wildlife Health Center (42)

In Canada, potentially exposed farmed cervids which are not depopulated under the provisions of the national CWD eradication programme are surveyed through repeated official veterinary visits and inventories until sixty months following their last possible CWD exposure. The interval is considered to encompass the maximum time to clinical expression (17, 18). Figure 5 portrays the surveillance-supportive tracing forward phase of the national CWD eradication programme. Generally equivalent processes underway at the sub-national level in the USA are being consolidated in accordance with the Plan for Assisting States, Federal Agencies and Tribes in Management of CWD in Wild and Captive Cervids.

#### Transmissible mink encephalopathy surveillance

Transmissible mink encephalopathy, together with vesicular exanthema of swine, is a dramatically infectious North American clinical entity found to have been eliminated in the face of changing feeding practices (29). The disease also joins CWD as a TSE of unproven origin. Similarly to CWD, TME might reflect inter-species transmission of another TSE agent. Alternatively, the disease might be the expression, under the stress and population pressure of captivity, of a mustelid disease which exists in an ecological balance in nature.

The TME outbreak in 1985 represented the only notification of the dramatic clinical entity in North America in the last four decades. Additional cases would probably not have gone

unnoticed within the passive surveillance systems of Canada and the USA despite the absence of universal reportable status (16) and this may be accredited to management changes. During that interval, awareness had grown within the ranks of mink producers in regard to the apparent disease transmission risk associated with feeding animals the carcasses of sheep, pigs and their own species. In addition, commercialisation of feed supply had served to drive down to less than 1% the number of farms still accessing dead stock and downer animals (4).

#### Eradication programmes

Bovine spongiform encephalopathy and TME are presently foreign to North America. As such, they would be dealt with as foreign animal diseases should outbreaks be discovered. Scrapie and CWD, present in Canada and the USA, are the objects of eradication programmes.

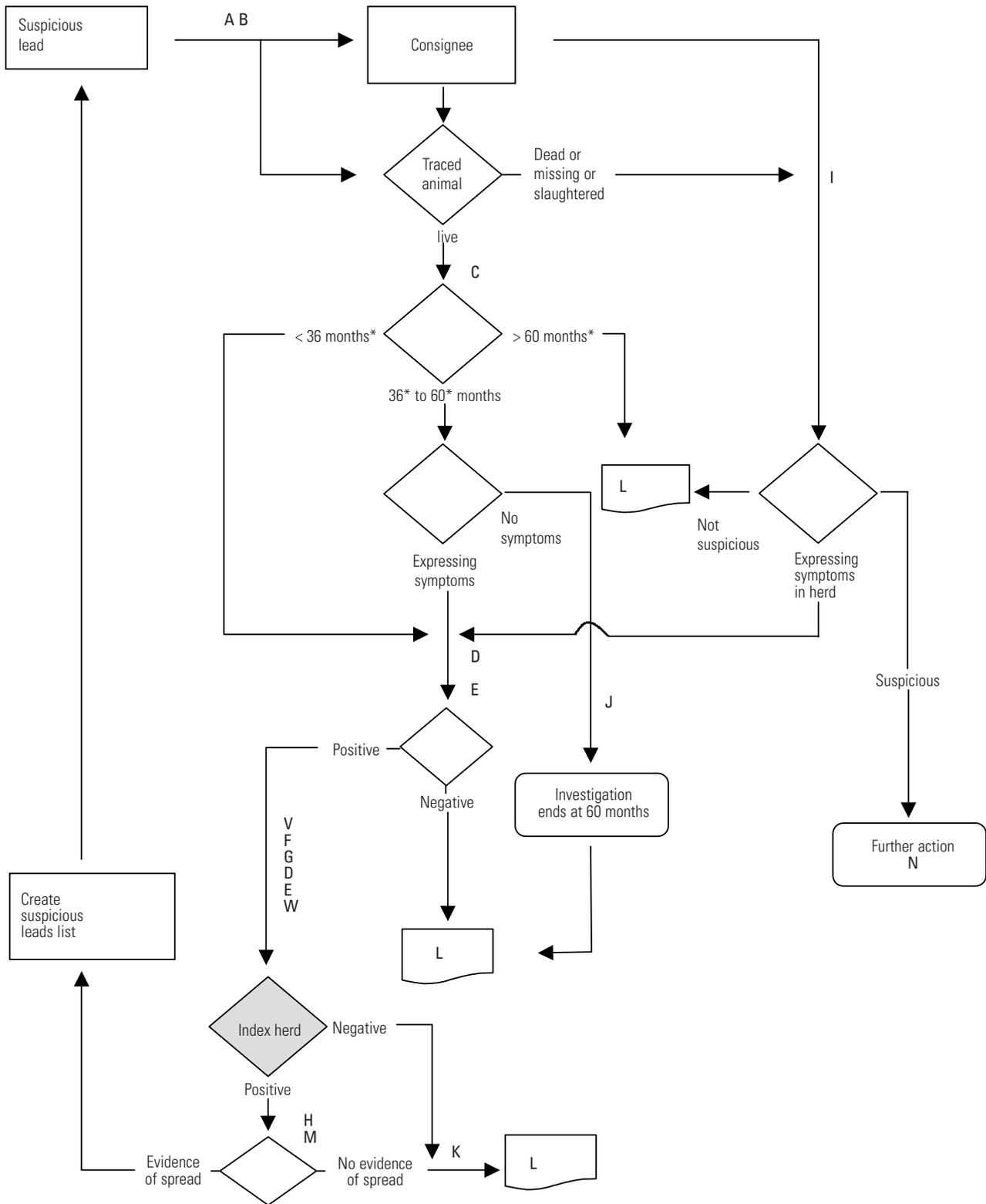
#### Scrapie eradication

Both Canada and the USA apply traditional disease elimination tactics to scrapie in both sheep and goats. The comments which follow apply generally to goats (last herd infected in Canada in 1973) as well as sheep; however, they will be discussed mostly in terms of sheep because of the dominant role of that species in scrapie prevalence.

In the USA, scrapie controls are applied through a Federal-State co-operative programme, based on both federal and state regulations. The mechanism follows a successful, longstanding model of sharing of jurisdiction between those two levels of government under the constitution of the USA. On 21 August 2001, Federal legislation – Title 9, Code of Federal Regulations, Parts 54 and 79 – authorised a revised collaborative programme with which all states will be consistent by 2003 (41); however, the main provisions of the programme are already in effect. In Canada, the Health of Animals Act grants the CFIA sole jurisdiction in this area.

In both nations, the initial effort is directed at uncovering the origin of the animal diagnosed with scrapie. To that end, the countries have renewed longstanding efforts to uniformly identify their small ruminant sectors. By virtue of their numbers and predominance in scrapie expression, most effort is being directed at sheep. In Canada, mandatory national identification regulations will come into effect on 1 January 2004. Pursuant to these, animals will bear uniquely identified eartags. Sheep, in the USA, under federal regulations, bear two identification numbers. One describes the flock, while the other uniquely identifies the animal itself. Certain exemptions apply as in the case of sheep destined for immediate slaughter, where only flock identification is required.

In Canada, confirmation of the site of origin of the scrapie-affected flock leads to quarantine. Those animals considered epidemiologically at high risk of having been directly or indirectly exposed to the infectious source are destroyed with



\* Since date of last exposure to chronic wasting disease

- A : Co-ordinate investigation and record management
- B : Search consignee records for permit to new consignee
- C : Locate animal and verify identification
- D : Mark, evaluate, transport, sample, slaughter, post-mortem
- E : Collect specimens, ship, report

- F : Order trace-out animals slaughtered
- G : Quarantine
- H : Epidemiological investigation
- I : Premises inspection and detailed retrospective investigation
- J : Surveillance at three month intervals

- K : Decontamination
- L : Documentation
- M : Trace-back investigation initiated
- N : Future action such as surveillance of a premises
- V : Search trace-out permits
- W : Site selection/method for disposal

**Fig. 5**  
**Chronic wasting disease in Canada**

Steps A to W in the tracing forward phase of the programme applied to an infected herd

compensation by the CFIA. If the degree of infection throughout the flock and across the blood lines thereof is extensive and pervasive, the entire production unit must be destroyed. Lower risk animals are permanently identified and monitored for a protracted period. The interval equates to the upper age limit at which exposed animals can be expected to clinically express the disease. The suspicion of infection in epidemiologically related animals on contributing or recipient sites yields parallel application within those flocks.

The programme in the USA, while similar to that of Canada, provides more flexibility in the disposition of the herd or flock of origin. As is traditional in the Federal-State co-operative approach to national disease control, an epidemiologist establishes an individual flock plan based on the findings of the initial investigation. The owner of a scrapie-affected flock can elect to depopulate or select an alternate course of action based on the degree of exposure, genotype and gender of the individual animal.

In both nations, the environment inhabited by animals during intervals in which they might have been discharging the infectious organism is cleaned and disinfected. Methods observe recommendations emerging from research findings on the viability of infectious prions (6, 35). Equipment and other materials are rigorously cleaned and disinfected.

Infected and otherwise destroyed sheep are incinerated or buried or both, in accordance with local environmental regulations. No animals from infected flocks or epidemiologically related to them are allowed entry into the food or feed chains.

### Chronic wasting disease eradication

Chronic wasting disease eradication programmes for farmed cervids in Canada and the USA mirror the model described for scrapie. In Canada, the CFIA has overseen the depopulation, disposal of and compensation for infected herds since 1996 under the general provisions of the Health of Animals Act. A close working relationship is maintained with provincial agriculture and wildlife officials. In the USA, similar efforts initially mandated by individually involved states are being harmonised via a Federal-State co-operative application commenced in 2001. Infected elk herds in participating states have been depopulated under national provisions as promulgation of the full collaborative protocol continues.

Infected and otherwise destroyed cervids are incinerated or buried or both in the two countries, in accordance with local environmental regulations. Animals from infected herds or epidemiologically related to them cannot enter the food or feed chains. Antler velvet is the principal commodity of the industry and the CFIA prohibits the sale thereof from infected animals.

Infected sites in both nations often occupy hundreds of hectares. They are assessed epidemiologically to determine the

relative degree of contamination they might harbour from one pen or pasture area to another. The findings guide the application of a series of classical decontamination approaches derived from world experience with scrapie (6, 35). Fomites, such as porous watering bowls and feeders, which cannot be cleaned and disinfected, are incinerated or buried or both. Materials like metal handling chutes that can withstand the caustic process are cleaned and disinfected with TSE-proven chemicals, such as bleach. To sequester whatever contamination might linger following cleaning and disinfection, paint or a sealant is applied to buildings and fences. In Canada, topsoil from areas of heavy animal congregation is removed and buried and replaced with clean gravel or new topsoil. On heavily contaminated sites in Canada, soil on the periphery of watering holes (sloughs) is also removed and buried, or the slough is drained and covered with earth. In both nations, quarantine is maintained until the epidemiologist-directed processes have been completed.

Eradication measures in Canada incorporate a 'quantitative' assessment of the degree of contamination of a site. They establish the number of infected animals, their stages of infection and the length of time each resided on parts of the premises. In theory, environmental prion deposition per unit of area correlates with the three variables. Sites in Canada that are determined to be heavily contaminated on the basis of an associated epidemiological assessment by a team of federal and provincial experts are subject to additional controls which include several years of quarantine and the potential introduction of sentinel animals. These sites are maintained in quarantine, in isolation from all livestock, until such time as the preceding activities have been completed.

## Conclusion

Throughout eight decades, North America has experienced the sequential importation or emergence of four animal-borne TSE infections in introduced and native species. Bovine spongiform encephalopathy, eradicated in an import consignment, has never been detected in the cattle population indigenous to North America. The NAFTA partners which occupy the continent have taken the previously described measures to preclude both a repeated entry from external sources and the emergence thereof from within. Surveillance efforts to date would appear to signal the success of these measures.

While Mexico asserts a similar free status regarding all of the TSEs, Canada and the USA continue efforts aimed at eradicating scrapie and CWD. In the management of what was the first recognised TSE challenge of both countries, the two governments had applied to scrapie an unsuccessful conservative approach throughout much of the last century. They are now motivated to eradicate the disease by the theorised relationship between scrapie and BSE and access to

recent diagnostic and genetic advances in disease detection and control. Their concerted efforts to eliminate CWD within the farmed cervid population are augmented by an expanding assessment of the significance of infection in wild cervids. While this TSE of farmed wildlife in North America continues to challenge, another would appear to have become a part of history. Transmissible mink encephalopathy has not been observed on the continent since 1985.

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## La gestion des risques posés par les encéphalopathies subaiguës spongiformes transmissibles en Amérique du Nord

J.A. Kellar et V.W. Lees

### Résumé

Le Canada, les États-Unis d'Amérique et le Mexique participent à l'Accord de libre-échange nord-américain et appliquent à ce titre des stratégies de gestion du risque en matière d'encéphalopathie subaiguë spongiforme transmissible (ESST). Ces stratégies sont harmonisées mais indépendantes, et respectent les lignes directrices de l'Office international des épizooties. La divergence des méthodes appliquées par l'Amérique du Nord par rapport aux pays européens en matière de gestion du risque d'encéphalopathie spongiforme bovine (ESB) s'explique par le fait que les risques internes et externes d'ESB y sont relativement réduits. Les mesures de quarantaine externe et de surveillance interne adoptées pour l'ESB sont le fruit de plusieurs évaluations successives des risques nationaux réalisées au début des années 1990 et réactualisées pas plus tard qu'en 2002.

Les interdictions relatives à l'alimentation animale appliquées depuis 1997 pour empêcher la propagation de l'ESB permettent également de limiter l'exposition inter- ou intra-spécifique à la tremblante, à la maladie du dépérissement chronique des cervidés et à l'encéphalopathie transmissible du vison. La surveillance des quatre ESST se poursuit grâce aux actions de collaboration des infrastructures vétérinaires nationales et régionales et aux réseaux de laboratoires associés. Aucune ESST n'a jamais été identifiée au Mexique. Le dernier cas d'encéphalopathie transmissible du vison diagnostiqué en Amérique du Nord remonte à 1985. L'ESB n'a pas été détectée en Amérique du Nord depuis son unique apparition reconnue au Canada, chez un animal importé de Grande Bretagne en 1993. Les taux de prévalence de la tremblante et de la maladie du dépérissement chronique restent généralement faibles au Canada et aux États-Unis d'Amérique. Les programmes d'éradication indépendants mais harmonisés visent à éliminer ces deux dernières maladies.

### Mots-clés

Amérique du Nord – Encéphalopathie spongiforme bovine – Encéphalopathie subaiguë spongiforme transmissible – Encéphalopathie transmissible du vison – Gestion du risque – Maladie du dépérissement chronique des cervidés – Tremblante.



## Gestión del riesgo de encefalopatías espongiformes transmisibles en Norteamérica

J.A. Kellar et V.W. Lees

### Resumen

Como firmantes del Tratado de Libre Comercio de América del Norte, Canadá, los Estados Unidos de América y México aplican estrategias independientes pero armonizadas para gestionar el riesgo de encefalopatías espongiformes transmisibles, en cumplimiento de las directrices de la Oficina Internacional de Epizootias. Las diferencias entre los modelos norteamericano y europeo de gestión del riesgo de encefalopatía espongiforme bovina (EEB) son reflejo del menor grado de riesgo, tanto externo como interno, que existe en Norteamérica del Norte en comparación con Europa. Las medidas de cuarentena (externa) y vigilancia (interna) adoptadas para combatir la EEB son fruto de sucesivos ejercicios de determinación del riesgo a escala nacional, emprendidos a principios de los noventa y revisados con regularidad hasta 2002.

La prohibición que pesa desde 1997 sobre el uso de piensos animales, destinada a evitar la propagación de la EEB, puede ser útil también para reducir la exposición intra e interespecífica al prurigo lumbar, la caquexia crónica y la encefalopatía transmisible del visón. Gracias al trabajo conjunto de estructuras veterinarias nacionales y subnacionales y de las redes de laboratorios complementarias, siguen aplicándose medidas de vigilancia de las cuatro encefalopatías espongiformes transmisibles. En México no se ha identificado ninguna encefalopatía espongiforme transmisible. El último caso diagnosticado de encefalopatía transmisible del visón en América del Norte se remonta a 1985. No se ha detectado ningún caso de EEB en Norteamérica desde que en 1993 se comunicara en Canadá por primera y última vez la presencia de la enfermedad en un animal importado de Gran Bretaña. El prurigo lumbar y la caquexia crónica permanecen a niveles generalmente bajos de prevalencia tanto en Canadá como en Estados Unidos. Para eliminar estas dos enfermedades ambos países aplican sendos programas de eliminación, independientes pero armonizados.

### Palabras clave

Caquexia crónica – Encefalopatía espongiforme bovina – Encefalopatía espongiforme transmisible – Encefalopatía transmisible del visón – Gestión del riesgo – Norteamérica – Prurigo lumbar.



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