# Animal Health Survey: Livestock Diseases in the U.S. Commonwealth of the Northern Mariana Islands (CNMI) 2000 and 2009

**USDA ADAP and Hatch Animal Health and Livestock**
**Survey for the Commonwealth of the Northern Mariana Islands (CNMI)**
**2000 and 2009**

The health of the food animals is of great importance to the lives and livelihood of the native Chamorro, Carolinians and immigrant settlers. These are the first two studies to identify the current animal health status in CNMI.


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## NON-TECHNICAL SUMMARY

There are no scientific (published) records available to serve as base reference to the status of animal health within the Commonwealth of the Northern Mariana Islands (CNMI) and therefore, there is no veterinary treatment or control regimen in place. The large volume of foreign animal products imported to the CNMI place livestock and people at a heightened risk of exposure to new emerging diseases. 2000 and 2009 studies provide a starting point for understanding the level of animal diseases in the Commonwealth. The 2009 animal health study for the CNMI establishes baseline endemic and newly emerging epidemic disease conditions. This information can be used by the island's government to make informed decisions about how and where animal health issues need to be addresses, while expanding the least amount of money in the most efficient manner. It will also be of tremendous help to CNMI agricultural extension agents who must focus attention on livestock diseases of economic and public health concern in a logical and economically efficient manner.

**ABSTRACT**

Two animal health surveys were performed in the CNMI, first in 1994 under ADAP funding and second in 2007 under Hatch funding. Both were ultimately funded by the US Department of Agriculture (USDA).

The Animal health and livestock disease survey for the CNMI was started in early 1994 by Dr. Steve Nusbaum, Territorial Veterinarian for the Guam Department of Agriculture, and Dr. Ignacio I. dela Cruz, Chief of the Division of Animal Health and Industry (DAHI) for the CNMI Department of Land and Natural Resources (DLNR). It was felt that such a survey was needed to establish a list of all the important poultry and livestock diseases and parasites present in the CNMI, and to rule out any possible foreign or exotic animal diseases such as foot-and-mouth disease, exotic Newcastle disease, Rinderpest, hog cholera, etc. At the same time, Guam was also to establish its own animal disease list. By determining what diseases and parasites are present and absent in both US territories, the interstate movement of poultry and livestock, including pets and animal products, could possibly be relaxed between two quarantine jurisdictions. Routine testing for certain animal diseases could be halted, and vaccination requirements for some diseases could be lifted, all depending on the outcome of the disease survey. An understanding of this nature, however, required minimal manpower and a substantial amount of funding for supplies, materials, and transport media for certain suspected bacteriological specimens, packing materials, instruments, equipment, travel expenses, and payment for the laboratory tests and procedures and other laboratory work. For

financial assistance and technical support, Dr Peter Saville, former Animal Health Adviser for the Secretariat of the Pacific Community, then known as the South Pacific Commission and still referred to as "SPC" was approached. The USDA was probably contacted by Dr Nusbaum for possible financial and technical assistance. Unfortunately, Dr dela Cruz left the CNMI government in December 1994, Dr Nusbaum, however, was determined to pursue the proposed project to its completion. Along with Dr Manuel Duguies, Extension Veterinarian for the College of Agriculture of the University of Guam, Dr Peter Saville and Dr. Tony Martin, another SPC veterinarian, the animal disease survey for the CNMI was undertaken in 1995 and completed in 1997. The laboratory test results are presented here and discussed.

In 2007, NMC-CREES received a grant from USDA Hatch to follow up and closely monitor the animal health status of the islands. With the help of ADAP, SPC, DLNR and APHIS in reviewing and approving the protocol, we were able to initiate and complete that survey in 2009. The project was complemented by ADAP, SPC, and the University of South Pacific's Paraveteterinarian Distance Education Training Program in 2005. Eleven (11) paravets were trained with SPC Animal Health Officer and assisted by NMC Livestock Extension Specialist/Animal Scientist. Selected paravets also completed the Animal Health Laboratory Network Workshop and passed the certification from International Air Transport Association (IATA)- Dangerous Goods Training program on general Awareness, Function Specific and Security Awareness Training for Shipping Class 6.2 Infectious Substance (Category A and B). Due to recent avian and swine influenza hype, the CNMI residents participated in several trainings from both SPC and

ADAP on Pacific Avian Influenza Training, PPE and Infection Control Workshop, Foreign Animal disease Course, and GIS/GPS.

Both principal investigators of this project, Dr Nusbaum and Dr Sabaldica, feel that the survey that was conducted was by no means exhaustive or comprehensive. On the other hand, it was deemed very important because it was the first two surveys ever conducted that was backed by laboratory support of the world's finest, if not the best, veterinary diagnostic laboratories- the USDA's National Veterinary Services Laboratory (NVSL) in Ames, Iowa. The survey included serological testing, clinical observation and identification of certain parasites. It is not intended to be definitive, but instead, should be viewed as the initial step of a continuous program of disease surveillance, testing and confirmation.

The most significant findings of this disease surveys is that it completely ruled out the presence of exotic and foreign animal diseases in the CNMI. It did, however, confirm the presence of a number of important diseases of economic or public health concern. The zoonotic diseases that were identified in the survey were:

Cattle

1. *Leptospira canicola*
2. *Leptospira hardjo*
3. *Leptospira Pomona*
4. Q-fever

Swine

1. *Leptospira icterihaemorhagiae*
2. *Leptospira canicola*

Equine

1. Japanese “B” Encephalitis

Goats

1. Q-fever
2. Brucellosis
3. Toxoplasmosis

The diseases and parasites of economic importance found to exist or be present in the CNMI were as follows:

Goats

1. Bluetongue 17
2. Q-fever
3. CAE
4. Brucellosis
5. Toxoplasmosis

Cattle

1. Bluetongue
2. Blutongue 10, 11, 13 and 17
3. *Leptospira (canicola, hardjo, pomona*)
4. Q-fever
5. Anaplasmosis
6. Bovine leukosis
7. IBR
8. Paratuberculosis
9. Brucellosis (not reported in the survey but present in the Micronesian Development Company (MDC) herd of beef in Tinian)

Swine

1. Porcine parvovirus
2. *Leptospira icterohaemorrhagiae*
3. *Leptospira canicola*
4. Porcine enterovirus ( Porcine Tescho virus)

Poultry

1. Infectious Bronchitis (IB41, IB46, IBJMK)
2. Infectious Bursal Disease
3. Marek's Disease
4. *Mycoplasma gallisepticum*

5. *Mycoplasma synoviae*
6. Avian encephalomyelitis

Equine

1. Equine viral arteritis
2. Japanes "B" Encephalitis
3. Equine Herpes Virus

Although bovine brucellosis was not reported in the survey conducted by Nusbaum, et al. (1999) *Brucella abortus* biotype 1 was isolated in from 3 dairy cows owned by MDC in Tinian. Because the disease has not been eradicated, the MDC herd was put under Brucellosis quarantine until MDC closed their operation on 2010 and the remaining cattle were sold and given to ranchers of Tinian and Saipan.

Bovine tuberculosis has never been seen or reported in the CNMI. Although tuberculosis caused by Mycobacterium avium was reported to be present in full ranges chickens and gamebirds in Guam, the same disease has not been tested or reported for the CNMI. Anaplasmosis and babesiois are both present in the CNMI cattle. The MDC was reported to have lost at least 100 head of newly imported Angus beef cattle from Australia in the early 1970's from one or both diseases. Tick vectors for anaplasmosis and babesiosis (*Boophilus microplus* and *Rhipicephalus sanguineus*) are both present in the CNMI

Nusbaum, et al., (1999) reported the presence of porcine parvovirus but not TGE, trichinosis, pseudorabies and swine dysentery in CNMI pigs. On the other hand, Sabaldica reported Porcine Tescho virus appeared to be present in all three islands (2009). Swine Influenza were isolated mainly in the Island of Rota and Tinian but believed to be present to in the island of Saipan although test results never revealed. It was not clear if porcine reproductive and respiratory syndrome disease was present in the CNMI as not test results appeared in the NVSL laboratory report. The disease, however, is not present in Guam.

The CNMI and Guam appear to share the same poultry diseases except for Avian Tuberculosis and Infectious laryngotracheitis (ILT). Both of these diseases have not been reported in the CNMI. NVSL was not able to verify Tuberculosis. Sabaldica performed Rapid Test kits (Anigen) for Avian influenza and it was used to monitor and revealed negative throughout the course.

Interestingly, two equine diseases (Japanese B Encephalitis and Equine Viral Arteritis) reported in the CNMI were absent in the Guam horses. The only equine disease common to both was Equine herpes virus. Equine Influenza found in Guam was also not evident in the CNMI horses.

## INTRODUCTION

## LOCATION AND TOPOGRAPHY

The CNMI is made up of fourteen islands with about 185 square miles of land area. They are located north of Guam in the Mariana Islands. Ferdinand Magellan, a Portuguese navigator, discovered the islands on March 6, 1521. Farallon de Pajaros is the northernmost island that is located just south of 21 degree North latitude and has no inhabitants. These islands are situated between 144 and 146 degree east longitude.

Saipan, the largest island in the CNMI, is located 120 miles north and slightly to the east of Guam. Its land area is 47 square miles with three major features: a coastal flatland, terrace platforms and central divide. It is approximately 13 miles long and 6 miles across its widest point, with the average width measuring about 3 miles. The highest point on the island is Mt. Tapochao, with an elevation of 1,554 feet. About 90 percent of the CNMI population lives in Saipan, which has a resident population of approximately 66, 000. It is situated 1,272 miles south of Tokyo; 1,438 miles east of Manila; 5,530 miles west of Los Angeles; 3,226 miles west of Honolulu; and 2,951 miles north of Sydney, Australia.

Tinian, the second largest island in the CNMI with 39 square miles of land area, is located 3 miles south of Saipan across a 900-foot deep channel. It has a population of

approximately 3,000. The highest elevation on this flat island is 583 feet, and has a fertile agricultural valley called Marpo.

Rota, the third largest island in the CNMI with 33 square miles of land area is located 73 miles south-southwest of Saipan. Its peak elevation is 1,625 feet and has an excellent water supply from Mt. Hanom. It has a very fertile farmland on the savannah. It has a population of about 2,850.

Only one other island in the CNMI called Agrihan is inhabited with a population of less than a hundred people. It has a land area of approximately18 square miles and a peak elevation of 3,166 feet; the highest in the entire Mariana Islands archipelago.

The geology formation of the Mariana Islands began bout 42 million years ago through a long and slow process of volcanic building. Volcanoes form as a result of movements of the Earth's crust. The Pacific-Ocean plate and the Philippine continental plate were formed when the Earth's crust was broken into pieces. These two plates were pushing each other, with the Pacific Ocean plate moving under the Philippine continental plate. Along the line of movement, the Mariana Trench was formed. The deepest point of any ocean in the world lies within this trench. The volcanoes that formed as a result of the movement of the two plates created the Mariana Islands. These volcanoes were the hot spots on the edge of the Philippines continental plate.

There are four different types of islands in the Pacific: High volcanic, raised limestone, atolls and continental. The older southern island of Guam, Rota, Aguiguan, Tinian, Saipan and *Farallon de Medinilla* are raised limestone islands. The islands from Anatahan to the north are high volcanic islands and are much younger in age.

The locations of the Mariana Islands archipelago places them in the tropics and gives them a tropical climate featuring generally warm, sunny, humid weather. There are two seasons of the year in the Marianas: rainy season and the dry, windy season. Typhoons occur most often during the rainy season from July to October. These typhoons have been recorded to pack strengths in excess of 200 miles per hour, and have proven to be very costly and destructive over the past fifty years. The average annual rainfall is 82 inches, and the temperature varies between 75°F and 85°F for most day of the year. Occasionally, it can dip to 69° F or soar to 91° F, but these occurrences are extremely rare.

Tourism is the main industry in the CNMI after the closing down of major garment factories (2007). Construction comes next, although hotel building activities have slowed down considerably since 1995. Construction is now limited to building single family housing units, small apartments and motels, and road construction and repairs.

Fishing or fishery is not a significant source of government revenue, although there are quite a few small scale and part-time fisherman. Few locals are engaged in small-scale tilapia and shrimp farming, although, SyAqua, a semi-commercial shrimp operation is

currently doing export to neighboring Asian countries does not eliminate island's dependency to shrimp imports. The CNMI waters have an abundance of marketable fish, both pelagic and bottom fish, but finding a dependable, sustainable export market seems to be a challenge. The local markets are extremely limited because of the small population. More than half of the resident population is overseas workers who seem to have preference for imported fish such as tilapia and milkfish, among others, over the local catch, no matter how fresh they are! Because of this realization, aquaculture for tilapia and shrimp production is becoming popular.

Farming and ranching are also not a very significant source of private or government revenue, although there are many small scale and part-time farmers, gardeners, and backyard producers of pork and poultry. They farm and raise animals to supplement their income and provide their own garden fresh vegetables and meat for the family table. A lot of government retirees fall under this category. Although many of the vegetables on sale in the stores and supermarkets can be produced locally, the volume of imports continues to grow or remain steady. Part of the reasons for this unfavorable economic picture is quality, availability, dependability, competitive prices, and other market or business considerations.

Gambling in the form of poker machines, lottery, cock fighting and bingo are also favorite games and money activities in the CNMI. Tinian and Rota are the only islands where casino type gambling is legalized. Due to Asian economic slump, the Tinian

casino is reeling from lack of tourist and gambling patrons. Its possible closure can no longer be shocking to anybody. Its very survival is now in question.

## CNMI's General Population

The estimated total population in the CNMI in October 2005 was 65,927. The estimated total population for the island of Saipan was 60,608, Tinian was 2,829, and Rota was 2,490. (CNMI Dept of Commerce, 2005). The largest single ethnic group in the CNMI was Filipino at about 30% of the estimated total CNMI population in 2005, followed by Chamorro (23%) and Chinese (16%). The Carolinians were about 5% of the total population. Asians made up more than half (53%) of the CNMI's total population, Pacific Islanders about 37%, and Caucasian less than 2%. Multiple ethnic persons made up about 8% of the Commonwealth's total. The estimated total population for the island of Saipan was 60,608. Saipan's population was 92% of the CNMI's total population in 2005. The largest single ethnic group in Saipan, in 2005, was Filipino at about 31% of Saipan's total population, followed by Chamorro (20%), and Chinese (16%). The Carolinians were about 6% of the Saipan's population. Asians made up more than half (54%) of Saipan's total population, Pacific Islanders about 36%, and Caucasian less than 2%. Multiple ethnic persons made up about 9% of Saipan's total population. The estimated total population for Tinian was 2,829. Tinian's population was just over 4% of the CNMI's total population in 2005. The largest single ethnic group in Tinian was Chamorro, which was 44% of Tinian's total population in 2005, followed by Filipino (32%), and Chinese (9%). Asians made up almost half (49%) of Tinian's total population.

Pacific Islanders about 45 % and Caucasian 1%; multiple ethnic persons made up almost

5 % of Tinian's total population in 2005. The estimated total population for the island of Rota was 2,490. Rota's population was just under 4% of the CNMI total population in 2005. The largest single ethnic group in Rota, in 2005, was Chamorro at 65% of Rota's total population, followed by Filipino (22%). Asians made up about 25% of Rota's total population, Pacific Islanders about 67% and Caucasian just over 1%. Multiple ethnic persons made up 7% of Rota's total population Due to Asian economic crisis in 1996 and the recent US financial instability, the number of foreign overseas workers has continually declines. Once the economic climate and picture become favorable, this outflow of workers will stop, and the trend most likely will reverse in record time.

**Agriculture and Livestock**

**Cattle Industry**

Cattle beef and dairy operation has been the primary industry once in the 80's during the Jones and Guererro Company prior to selling to MDC. They used to export beef in neighboring countries. But due to quarantine issues on Brucellosis, cattle numbers started to decline. Today, the CNMI has about 150 subsistence cattle farms with approximately 2,200 cattle throughout the islands of Saipan, Tinian and Rota (DLNR 2010, unpublished surveys). A typical rancher has 5-50 cattle. These cattle are confined on pastures areas or tethered around grazing areas. Inbreeding is a problem, as there have been no live importations of breeding cattle for the past 20 years. It was only this year (2010) that Artificial Insemination (AI) program has been introduced to the three islands through a

USDA Western SARE funding. In addition, there is no approved slaughterhouse present on island; thus CNMI ranchers can not market animal products to local consumers.

**Swine Industry**

Due to lack of marketing capabilities for export, some semi-commercial swine farms in Saipan have closed and/or simply reduced their production numbers to small-scale operations. Farms range from 1-50 sow. Backyard (free-range) to semi-intensive operations collectively have about 1,500 head (DLNR 2010 survey, unpublished). The local breeding stock has been improved through the years by the importation of live breeders and the introduction of Swine AI in 1992 (ADAP) continuing to the present. Typical breeds are Landrace, Large Whites, Duroc and Hampshire. Just like in Guam, hog farms are "farrow to grower" operations as the market is for grower pigs for roasting.

**Poultry Industry**

In 2005, the CNMI used to have three semi- poultry layer operations in the three islands supplying some egg and meat requirements that supplemented imports. However, due to Avian flu scare, Tinian layer operation close down leaving only Rota and Saipan in operation. Unfortunately, farmers are discouraged to pursue the poultry business due to high feed cost. There are ducks, ostrich, guinea fowls in the CNMI but present in few numbers and are raised for other reasons other that food production.

## Goat Industry

The goat population is very low number in the islands. Most of these goats were taken during hunting season from the island of Aguiguan. Goat farms vary from 1-10 head. Goats are tethered or free grazing.

## MATERIALS AND METHODS

The survey protocol that was used in 1999 was patterned after the ADAP's Animal Health Survey in 2000. The format of which was based on the recommendations from SPC, the SPC has been recognized by OIE as the coordinating body for animal health activities in the region, and guidance from the United State Department of Agriculture-Animal and Plant Health Inspection System (APHIS) and the National Veterinary Laboratory Service (NVSL).

The two animal health surveys performed in 2000 and 2009 included animal physical examinations, case observations, and serological tests. Blood collection was carried out over a period of two years for each survey. A team of land grant veterinarians, local Department of Agriculture, the Secretariat of the Pacific Community, and the trained paravets assisted both Principal Investigators. A representative number of animals based on AusVet WinEpicope were used (95% CI, expected standard deviation and absolute error of 5% and 2%). Samples size varied according to the presence of each species and their numbers. Animals were examined at the time of blood sampling and clinical

investigation was performed if indicated. Additional serum sampling was included if indicated.

**Collection Methods:**

1. Animals were restrained to perform venipuncture. The following sites were used: swine and horse (brachiocephalic vein), cattle (tail vein), goats (jugular vein) and poultry (wing vein);
2. (i) The site for venipuncture was cleansed with alcohol. A vacutainer tube was used with 18-20 gauge, 1 ½ inch needle. At least 10 ml of blood was collected

   (ii) For poultry, a 25-27 gauge ½ to 5/8 inch needle and 5 cc syringe was use to aspirate the blood from the wing vein. Samples were placed in a cooler after collection.
3. Samples were centrifuged at 5,000rpm for 5 minutes and in areas with no available centrifuge we let it stand for 24 hours until serum floats and red blood cells (RBC) settle.
4. Extracted serum were kept frozen prior to shipment to the laboratory.
5. Samples were sent to NVSL in Iowa.

## RESULTS AND DISCUSSION

### A. Cattle

The cattle population in the CNMI appears to be free of the major infectious and contagious diseases, no reports of OIE List A diseases. Clinically, ectoparasitism and warts are the most commonly diagnosed condition. The range of clinical conditions is provided in Table 1.

**Table 1. Clinical Observations for Cattle**

REPRODUCTIVE SYSTEM

- Metritis
- Udder diseases
    - Mastitis
    - Necrotic dermatitis
    - Failure of milk letdown
    - Udder edema
- Agalactia

TOXIC PLANTS

*Lantana camara*

*Chromolena odorata*

*Crotolaria polleda* (rattle box)

ENDOPARASITES

Nematodes

- *Ascaris spp.*
- *Strongyloides spp.*
- *Cooperia spp.*
- *Oesophagostomum spp.*
- *Bunostomum spp*.

Trematodes

- *Fasciola hepatica*

Protozoa

- *Trichomonas spp.*
- *Giardia spp.*

Ectoparasites

- *Boophilus microplus*

Miscellaneous

- Dermatophytosis
- Fibro-papilomatosis (warts)
- Bloat
- Traumatic diseases
- Uterine prolapse
- Conjunctivitis
- Trauma

- Foot rot
- Alopecia-idiopathic

Serology was carried out for the diseases listed in Table 2.

**Table 2. Disease Serology Results for Cattle**

| Diseases | 2000 Tested | Positive | Apparent Prevalence AP % | 2009 Tested | Positive | Apparent Prevalence AP% | Test Used | Remarks |
|---|---|---|---|---|---|---|---|---|
| Bluetongue | 55 | 21 | 38 | 0 | 0 | 0 | SN | NVSL do not test Bluetongue |
| Leptospirosis Hardjo | 86 | 17 | 20 | 40 | 6 | 15 | Micro-Agg | |
| Q-fever | 74 | 6 | 8 | 40 | 0 | 0 | CF | 1:10 (-) |
| Anaplasmosis | 34 | 18 | 52 | 40 | 6 | 15 | CF | |
| Babeisa bovis | 34 | 0 | 0 | 40 | 0 | 0 | IFA | |
| Babesia bigemina | 34 | 0 | 0 | 40 | 0 | 0 | IFA | |
| Brucellosis | 34 | 0 | 0 | 40 | 0 | 0 | Card/ CF | |
| Bovine leucosis virus | 74 | 8 | 10 | 40 | 0 | 0 | AGID//ELISA | |
| Infectious Bovine rhinotracheatis | 107 | 56 | 52 | 0 | 0 | 0 | SN | |
| Paratuberculosis Johne's disease | 107 | 56 | 52 | 40 | 0 | 0 | CFT | <1:8 (-) |

Remarks: The results from the serological survey further demonstrate that cattle in the CNMI is free from important infectious diseases.

**Bluetongue.** Bluetongue has not been detected on CNMI. All specimens tested negative for serotypes 2, 10, 11, and 13. Advice from NVSL suggests the positive results for BT 17 may be due to cross reaction.

**Leptospirosis.** In the CNMI, Leptospirosis has been clinically diagnosed in dogs. There were case reported in the CNMI of human's who died from Leptospirosis but no study has been done about serotyping.

**Q'fever.** Q-fever is not present in Guam. There is a need to be sure about the presence of the disease in the CNMI. The authors are not sure if the positive or negative test revealed true or false positive. As one recommendation of this study, further work needs to be carried out for the CNMI.

**Tuberculosis**. There is no serological test for Tuberculosis at NVSL.

**Anaplasmosis and Babesiosis**. No definitive clinical case were reported in the CNMI, however, titers of both disease revealed positive and both intermediate host are found in the CNMI and Guam.

**Infectious Bovine Rhinotracheitis**. IBR in the CNMI is still present from findings of 2000 and 2009. However, there was no clinical case being reported. Guam IBR status is fading out in 2000. More work must be done to investigate presence of disease in the region.

**B. Swine**

Clinically, a wide range of disease conditions have been diagnosed in the CNMI. Isolated disease outbreaks have been reported to local agriculture department affecting growing hogs at 70-80% mortality. The presence of Porcine Teschovirus, Parvo virus, Corona virus, Leptospirosis and swine influenza compromised the overall swine health in the CNMI. Clinical observations are provided in Table 3 and disease serology in Table 4.

**Table 3**. **Clinical Observations for Swine**

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**Neonatal**

- Piglet anemia
- Hypoglycemia
- Scouring/ Neonatal diarrhea
- Umbilical hernia
- Atresia ani
- Micropthalmia
- Splayleg
- Cleft palate/lip
- Post weaning diarrhea
- Navel infection

**Digestive System**

- Colibacillosis
- Edema disease
- Bloody scours- Swine dysentery
- Proliferative enteritis
- Rectal prolapse

**Integumentary System**

- Dermatophylosis (fungal diseases)
- Exudative dermatitis ( *Staph*. Infection)
- Greasy pig disease
- Photosensitization
- Aural hematoma
- Contact dermatitis
- Baby knee necrosis
- Abscess dermatitis

**Respiratory System**

- Pneumonia (*Pasteurella, Haemophilus, Mycoplasma* etc.)
- Swine influenza
- Actinobacillosis

**Musculoskeletal System**

- Arthritis
- Degenerative joint disease
- Leg injuries/fracture
- Cellulitis

**Reproductive System**

- Mastitis Metritis Agalactia (MMA syndrome)
- Dystocia
- Prolapse vagina/uterus
- Abortion
- Penile injuries/infection
- Still birth
- Mummified fetus
- Infertility

**Internal parasites**

- *Ascaris spp.*
- *Oesophagostumum spp.*
- *Stephanurus dentatus*
- *Coccidiosis*
- *Trichuris spp.*

**External Parasites**

- *Sarcoptes scabiei*
- *Psoroptes spp*
- Lice

**Miscellaneous**

- Conjunctivitis
- Salt poisoning
- Heat stroke
- Suspected swine pox

## Table 4. Disease Serology Results for Swine

| Diseases | 2000 Tested | Positive | AP % | 2009 Tested | Positive | AP % | Test Used | Remarks |
|---|---|---|---|---|---|---|---|---|
| Pseudorabies | 71 | 0 | 0 | 50 | 0 | 0 | LAT | 1:4 (-) |
| Brucellosis | 115 | 0 | 0 | 126 | 0 | 0 | Card (8%) | |
| Trichinellosis | 27 | 0 | 0 | 0 | 0 | 0 | ELISA | |
| Swine Influenza<br>H1N1<br>H3N2 | 47 | 0 | 0 | 50 | <br>2<br>2 | 8 | HI | 1:10 (-)<br>1:20;1:80<br>1:160 (+)<br>1:20; 1:640 (+) |
| Transmissible Gastrenteritis | 47 | 0 | 0 | 50 | 2 | 4 | VN | 1:8 (-)<br>1:32 (+)<br>1:128 (+) |
| Parvo virus | 71 | 17 | 24 | 50 | 2 | 4 | HI | 1:32 (-)<br>1:2048 (+)<br>1:512 (+) |
| Leptospirosis | 105 | 2 | 0 | | | | Micro-Agg | |
| L.ictero | | | | 21 | 3 | 14 | MicroAggl | 1:200 |
| L.canicola | | | | 21 | 4 | 19 | | 1:200 |
| L grippo | | | | 21 | 0 | 0 | | 1:100 |
| L.hardjo | | | | 21 | 0 | 0 | | 1:100 |
| Porcine Teschovirus 1-7, A | | | | 135 | 64 | 47 | IFA | 1:20 |
| PRRS | | | | 50 | 0 | 0 | ELISA | |
| Pseudorabies | | | | 50 | 0 | 0 | LAT | |
| Porcine corona | | | | 50 | 0 | 0 | IFA | 1:20 |

**Note:** Based on IFA serology: The serums were tested for antibodies against porcine corona at the 1:20, 1:200, and 1:2000 dilutions for the presence of antibodies against porcine by the indirect immuno-fluorescence assay. Likewise, serum submitted were tested at the 1:20 dilution for the presence of antibodies against porcine teschovirus 1-7 and 11 (formerly known as porcine enterovirus (1-7)) and porcine enterovirus A (formerly known as porcine enterovirus 8) and by the indirect immunofluorescence assay (IFA). Note: The statement above reflects recent nomenclature changes which have been instituted for the (formerly) porcine enteroviruses. The testing procedures and interpretation for the IFA have not changed.

**Leptospirosis.** In 2009, serotypes canicola and ictero at 1:200 titers were positive. Other serotypes were not identified. None of the serum was not tested for serotype *Bratislava*. All test revealed negative under 1:100 titers.

**Porcine tescho virus** (*Porcine enterovirus*). Tescho virus is responsible for the porcine enteroviral encephalomyelitis disease causing high mortalities in pigs in the CNMI. Serotypes 2, 3, 4, 5, 6, 7 and A were distributed throughout the CNMI and infecting pigs asymptomatically or cause disease only in young animals. However, some strains of the most virulent serotype (PTV-1) cause teschovirus encephalomyelitis, a highly contagious, often fatal, neurological disease that affects pigs of all ages. The clinical signs of teschovirus encephalomyelitis, caused by highly virulent strains of PTV-1, typically include fever, anorexia, depression and incoordination, followed by painful hypersensitivity, paralysis and death within 3 to 4 days. Muscle tremors, stiffness or

rigidity, nystagmus, seizures, changes in or loss of the voice, opisthotonos and clonic spasms of the legs may be seen. Some pigs may grind their teeth, smack their lips or squeal as if they are in pain. In the final stages of the disease, progressive paralysis develops, beginning in the hindquarters and ascending toward the head. During this stage, pigs became hypothermic. Death is usually caused by paralysis of the respiratory muscles. Animals with milder clinical signs sometimes recover. There is no indication that porcine teschoviruses are zoonotic.

**Porcine Parvo**. In the 2000 survey, parvo was identified with 24% (apparent) prevalence. In 2009, results show a decrease to 4%; most likely due to the few numbers of sow, i.e. that the virus might have died back significantly. However, it is clear that the virus is still present in the CNMI. The virus has no effect on the female only on the fetus. Small litters associated with embryo loss before 35 days were evident and swine farmers complained about these losses. Some effects of the virus included: mummified pigs of varying size, (30-160mm); increased numbers of stillbirths: , and abortions associated with PPV infection are uncommon.

**Transmissible Gastro Enteritis (TGE**). As seen on the table above, there was an increase prevalence from 0 to 4% for TGE at > 1:32 titers. Typical clinical signs of TBE include transient vomiting; watery, yellow diarrhea which contained undigested milk, weight loss; dehydration; and high morbidity/mortality, especially in pigs less than two weeks of age. TGE impacts younger pigs more because their enterocytes are not able to be replaced as quickly as those in an older animal. Another explanatory reason of the higher morbidity/mortality in younger pigs is that the compensatory fluid absorption

takes place in the large intestine of older pigs, compared with younger pigs. One of the most significant signs observed was the smell of the diarrhea - foul steatorrhea (excess fat in feces) due to mal-digestion. Many pigs older than three weeks of age survived but remain stunted. Growing and finishing pigs that have TGE may show inappetance, diarrhea, agalactia, or vomiting of variable period of time. At this point, we can not consider if TGE is endemic. Further study is needed to establish disease prevalence of absence.

**Brucellosis tested** in swine via CARD test revealed 8% negative samples. Although, test results revealed negative, the author believes, that further works are needed to show disease freedom to Brucellosis given the high cases of undocumented abortion and infertility in sows and boars. Although this disease does not kill pigs outright, it causes losses in reproduction that decrease profits for swine producers.

**Swine Influenza** (H1N1 and H3N2). The famous H1N1 Swine Influenza has been identified on swine farms in the island of Tinian. The case was suspected to be typical respiratory problem and later diagnosed as an isolated case of influenza from which the owner decided to close down her operation. Common symptoms were nasal secretions, a barking-like cough, decreased appetite, and listless behavior were noticed. Since swine flu produces most of the same symptoms in pigs as human flu produces in people, it is difficult to link the relationships as well as the origin. Some precautionary measures were mentioned in the recommendations.

## B. Poultry

The overall poultry health is good in the CNMI for both feral and domestic species in 2000 and domestic poultry in 2009. There were no significant poultry diseases such as Avian Influenza or " Bird flu", and New Castle Disease that has been identified during the course of the project. Perhaps, it could be attributed to a strict rules in bird movements especially the game birds and show birds from neighboring countries such as Asia. While endemic conditions of some diseases have appeared, the incidence of clinical signs is very low (Table 5 and 6).

**Table 5. Clinical Observations for Poultry**

| |
|---|
| **Miscellaneous** |
| Ammonia burn |
| Cannibalism |
| Pendulous crop |
| Swollen head syndrome |
| Necrotic dermatitis |
| Mycosis |
| Fowl pox |
| Ulcerative enteritis |
| Aflatoxicosis in feeds |
| Conjunctivitis |
| Trauma |

**Endoparasites**

Eimeria sp.

Capillaria spp.

Ascaridia spp.

Heterakis spp.

**Ectoparasites**

Lice

Mites

## Table 6. Disease Serology Results for Poultry

| Diseases | 2000 Tested | Positive | AP % | 2009 Tested | Positive | Ap % | Test Used | Remarks |
|---|---|---|---|---|---|---|---|---|
| Infectious Bronchitis 41 | 45 | 18 | 40 | 66 | 4 | 6 | HI | 1:10 |
| Infectious bronchitis 46 | 45 | 28 | 62 | 66 | 3 | 4 | HI | 1:10 |
| Infectious bronchitis JMK | 45 | 22 | 48 | 66 | 3 | 4 | HI | 1:10 |
| ILT | 45 | 0 | 0 | 66 | 0 | 0 | IFA | |
| IBD | 45 | 6 | 13 | 66 | 1 | 2 | AGID | |
| Marek's Disease | 45 | 25 | 55 | 66 | 5 | 8 | AGID | |
| Mycoplasma gallisepticum | 61 | 6 | 9 | 66 | 9 | 14 | HI | 1:160 (+)<br>1:40 (+)<br>1:20 (-) |
| Mycoplasma synoviae | 61 | 35 | 57 | 66 | 7 | 11 | HI | 1:40 (+)<br>1:20 (-) |
| Egg drop syndrome | 45 | 0 | 0 | 0 | 0 | 0 | HI | |
| New castle Disease | 45 | 0 | 0 | 66 | 0 | 0 | HI | |
| Avian Influenza | 45 | 0 | 0 | 66<br>150 | 0<br>0 | 0<br>0 | AGID<br>Anigent Test Kits | |
| Avia n Encephalomyelitis | 45 | 19 | 42 | 66 | 15 | 22 | AGID | |
| Fowl Pox | 0 | 0 | 0 | 66 | 18 | 27 | IFA | |
| Salmonellosis | 0 | 0 | 0 | 45 | 11 | 24 | SPull | 1:40 (+) |

Note: Wild birds are not included in the 2009 animal health survey as well as other domesticated birds such as turkey, guinea fowl, ducks and pigeons.

With the bird flu scare in 2007 and 2008, it is very fortunate for the CNMI and the neighboring islands to be free from Avian flu considering the closeness to southeast Asian countries like China, Thailand and Vietnam where Avian flu is a very prominent problem.

In 2009, specimens were tested by the avian paramyxovirus type-1 and infectious bronchitis virus (IBV) ARK, CONN, JMK and MASS hemmaglutination-inhibition (HI) assays, by the avian influenza virus (AIV), infectious bursal disease (IBD), and Mareks disease (MDV) agar gel diffusion (AGID) tests, and by the infectious laryncgotracheitis (ILT) and fowl pox by indirect immunoassay (IFA). APMV-1 titers of 1:8 or higher are indicative of exposure to APMV-1 virus or vaccine. IBV HI titers of 1:10 are indicative of exposure to IBV virus or vaccine.

Specimens were tested by the avian paramyxovirus type -1 (APMV) and Infectious bronchitis (IB) by hemagglutination-inhibition (HI), fowl pox by fluorescent antibody (IFA) as well as the infectious bursal disease (IBD) by agar gel immunodiffusion (AGID test). The specimen were tested by the HI test for antibody to Arkansas (ARK), Connecticut (Conn), Massachusetts (mass) 41 and JMK strains of IBV. HI titers of 1:8 or higher are indicative of exposure to AI virus or vaccine.

**D. Goats**

The goat population in the CNMI seems to be healthy and free from infectious and contagious diseases. Clinically, the most commonly diagnosed conditions were endoparasitism. Few cases have been reported and if mortality is encountered, it is mainly due to poor management and husbandry (Table 7 and 8).

**Table 7. Clinical Observations for Goats**

---

**Toxic plants**

*Chromolena odorata*

*Crotolaria polleda (rattle box)*

*Micania spp*

Wild eggplant??

**Endoparasites**

*Haemonchus spp.*

*Eimeria spp.*

*Strongyloides spp.*

*Trichostrongyloides spp.*

**Ectoparasites**

Psoroptic mange

**Miscellaneous**

Trauma

Conjunctivitis

Foot rot

Alopecia

Pregnancy toxemia

Post weaning Diarrhea

**Table 8. Disease Serology Results for Goats**

| Diseases | 2000 Tested | Positive | AP % | 2009 Tested | Positive | AP % | Test Used | Remarks |
|---|---|---|---|---|---|---|---|---|
| Bluetongue | 70 | 12 | | 15 | 0 | 0 | SN | |
| Q-fever | 66 | 4 | 6 | 15 | 0 | 0 | CF | |
| CAE | 66 | 0 | 0 | 15 | 0 | 0 | AGID | |
| Brucellosis | 67 | 0 | 0 | 15 | 0 | 0 | Card | |
| Toxoplasmosis | 30 | 21 | 70 | 15 | 0 | 0 | ELISA | |

Samples tested in 2009 for Blue tongue, Q-fever, CAE, Brucellosis and Toxoplasmosis revealed negative. It is assumed that perhaps the disease is dying out but not completely certain. More sampling and surveillance is needed for confirmation considering the future demand for meat goat.

## E. Horse

Overall health of horse population on CNMI is good and no serious case has been reported. Negligence and poor husbandry among owners is the most common problems encountered (Table 9 and 10).

**Table 9. Clinical Observations for Horse**

| **Miscellaneous** |
| --- |
| Mastitis |
| Colic |
| Conjunctivitis |
| Founder |
| Foot lesions |
| Poor nutrition |
| Neglect |
| Trauma |

**Table 10. Disease Serology Results for Horse**

| Diseases | 2000 Tested | Positive | AP % | 2009 Tested | Positive | AP % | Test Used | Remarks |
|---|---|---|---|---|---|---|---|---|
| Equine Viral Arteritis | 10 | 1 | 1 | 5 | 0 | 0 | VN | |
| Equine Influenza AI | 10 | 0 | | 5 | 0 | 0 | HI | 1:10 |
| Equine Influenza A2 | 10 | 0 | | | | | HI | |
| Equine Influenza A3 A1 Prague A2KY A3 Miami | 10 | 0 | | 6<br>6<br>6 | 0<br>0<br>0 | 0<br>0<br>0 | HI | |
| Equine Herpes virus | 10 | 1 | 1 | 5 | 0 | 0 | SN | |
| Japanese Encephalitis | 10 | 3 | 3 | | | | HI | |
| Equine Infectious Anemia | 10 | 0 | 0 | | | | AGID | |

The positive titers in the 2000 study for Equine Viral Arteritis and herpes virus perhaps were due to cross reactions from previous outbreaks. However, when tested again in 2009, all significant diseases such as Equine Viral Arteritis (1:4), Equine Herpes virus 1 (1:4), Equine Influenza A-1, A2, and A-3 (1:10) revealed negative. No clinical diseases have been reported in the last 10 years. Positive titers cannot be attributed to vaccination. There were no vaccination reports for CNMI horses in the last 20 years.

## RECOMMENDATIONS AND SUGGESTIONS

The 2000 and 2009 surveys served as a preliminary assessment and basal reference guide for future research endeavor and do not claim to be definitive for the CNMI. The following recommendations and suggestions are made to increase the value of survey work and responses to disease.

Strengthen the collaboration through a constant, dynamic and open communication between NMC-CREES, the DLNR, the CNMI veterinarians, animal health technicians, and the local producers as well as other local and federal agencies;

Enrich the Paravet Training Program: Empowering the animal health staff through series of professional development opportunities and the creation of a point of contact and animal reporting system within each island;

Animal health program regimen is highly needed and expected for the CNMI. Working with animal health technicians and paravets on reporting and diagnostic system will make a significant impact;

Public Health Information Awareness Program. Simple and basic educational campaign about significant diseases that affects both humans and animals, how to prevent disease transmission.

Further monitoring and surveillance on significant diseases that may impact import and export of livestock produce to the neighboring islands. Active involvement and participation in ONE HEALTH program for all concerned to better monitor the human-animal trans-boundary diseases complex;

Since, aquaculture farming is getting popular in the CNMI the creation of fish disease surveillance program is very timely;

To lessen negative impacts of inbreeding in the CNMI as well as to the region, the use of Artificial Insemination (AI) and Embryo transfer- disease free animals in upgrading breedstocks is highly recommended;

Thorough investigation of the feral or wild animal diseases in relation to the most significant economic and public health diseases in the CNMI;

Follow-up monitoring for Porcine Enteroviral Disease in swine;

Inclusion of additional approved USDA diagnostic laboratory should be available for sample submission in the future;

For Avian influenza, the inclusion of other avian species in an intensive animal health survey and monitoring

There must be a clear protocol on collaboration from human side with animal side for most of the emerging diseases are results of mutation from both humans and animal origin.

There must be a Disease Risk Management plan/ emergency plan complementary with public health program;

## APPENDIX

### A. List of Abbreviations

| | | |
|---|---|---|
| AGID | - | Agar Gel Immuno- diffusion |
| APHIS | - | Animal and Plant Health Inspection System |
| CF | - | Complement Fixation |
| CNMI | - | Commonwealth of the Northern Mariana Islands |
| ELISA | - | Enzyme linked imminuosorbent Assay |
| HI | - | Hemmaggglutination Inhibition |
| LAT | - | Latex Agglutination |
| MAT | - | Microscopic Agglutination |
| Micro-Agg | - | Micro- Agglutination |
| NIFA | - | National Institute of Food and Agriculture |
| NVSL | - | National Veterinary Services Laboratory |
| SPC | - | Secretary of the Pacific Community |
| USDA | - | United State Department of Agriculture |
| VN | - | Virus Neutralization |

## B. General Considerations from NVSL

### Packaging and Labeling Submissions

The packaging and labeling of biological substances for shipment requires familiarity with current rules and regulations, which frequently change. Shippers are responsible for proper packaging, marking and labeling, documentation, classification, and identification of each shipment. **Failure to follow regulations can result in substantial financial penalties.**

### Applicable Regulations

Anyone sending material to the NVSL should be in compliance with all applicable regulations. Regulations governing packaging and labeling of interstate shipments of etiologic agents are found in:

Title 9 Code of Federal Regulations (CFR), Parts 121 and 122: These USDA regulations cover 1) the transfer of select agents/toxins and 2) the permits needed to ship organisms and vectors.

Title 42 CFR Part 72: These Health and Human Services regulations define terms such as biological products, diagnostic specimens, and etiologic agents, and provide requirements for packaging and labeling these materials for transportation in interstate commerce

Title 49 CFR Part 173: These Department of Transportation regulations contain general requirements for shipments and packaging. 49 CFR 173.134 defines infectious substances and related terms. 49 CFR 173.217 has additional requirements for shipments containing solid carbon dioxide (dry ice).

Airline shipments also should be in compliance with current International Air Transport Association (IATA) regulations (www.iata.org) for dangerous goods.

**Definitions**

All specimens or reagents sent to the NVSL (Ames or Plum Island) are biological substances. These include, but are not restricted to, excreta, secreta, blood, serum, tissues, organs, animals or animal parts, tissue cultures, and viruses or other microorganisms (either infectious or inactivated).

Biological materials that are known to contain, or could contain, etiologic agents are divided into two groups:

1. **Biological Substance, Category A**: Materials known to contain certain **etiologic agents** (i.e., an infectious substance transported in a form which, when exposure occurs, is capable of causing permanent disability or a life-threatening or fatal disease to humans or animals)
2. **Biological Substance, Category B** : Excreta, secreta, blood and its components, tissue, tissue fluids, etc., which the shipper *reasonably believes* may contain an etiologic agent and that is being shipped for purposes of diagnosis (i.e., a diagnostic specimen)

**General Recommendations**

- For routine serological testing, submit one tube containing 2 ml of clear serum per animal for each test requested. (Disease investigation cases may require additional volume.) Label each tube with the Sample ID, exactly as indicated in Block 20 in Form VS 10-4.
- Pack fresh and formalin-fixed specimens separately. Ship in separate containers when possible.
- Double bag all fresh tissues.
- Formalin-fixed specimens: Specimens may be shipped in a plastic specimen jar containing a 10:1 (liquid to tissue) volume of formalin. Alternatively, adequately fixed specimens may be removed from formalin; wrapped with formalin saturated gauze or paper towels; then placed in a leak-proof plastic bag. Submission forms should be protected by placing in separate sealed bag.
- Cool with ice packs if the sample will reach the NVSL within 24 hours. Use "foam" ice, picnic packs, or sealed frozen containers of ice. Never use cubed or crushed ice, even if it is enclosed in a plastic bag.
- If tissues or swabs are to be in transit more than 48 hours, package with dry ice, unless the samples should not be frozen. When using dry ice, tightly seal all containers; CO2 gas can inactivate some viruses and prohibit diagnostic isolation. Do not freeze dry ice or use dry ice in boxes that contain formalin-fixed tissues. Dry ice is considered a dangerous good; packages with dry ice must meet Category A Biological Substance shipping requirements, and not all carriers will accept packages containing dry ice.

**Packaging and Labeling submissions**

Packaging kits are available upon request from the NVSL. These kits contain instructions, labels, an acceptable secondary vessel, and a shipping box meeting drop-test requirements. Contact the NVSL Shipping Department at (515) 663-7530 for more information.

The following information is intended as a general guideline only. Shippers should read official rules and regulations for detailed information.

**Category B Biological Substances** (most diagnostic specimens)

- Packaged according to regulations in 42 CFR 72.3
- Place samples in a sealed primary container. Maximum volume per primary container is 1 L.
- Wrap the primary container in sufficient dry absorbent material (e.g., cotton) to absorb liquid contents in case of breakage. Do not use sawdust or vermiculite. Absorbent material is not required for solid shipments unless there is a risk of residual liquid.
- Place the primary container in a secondary container. The primary or secondary container must be able to withstand a 95 kPa pressure test.
- Place the secondary container in a certified outer box that will pass a 1.2 meter drop test. The maximum liquid volume allowed per box is 4 L. Solids must not exceed 4 kg (or 8 lb) per box.
- Include an itemized list of contents between the secondary container and the outer box.
- Label the box properly. Mark the proper shipping name (Biological Substance, Category B) in letters at least 5 mm high adjacent to a "UN3373" mark or label. Add the name, address, and telephone number of the shipper **and** the consignee.
- Add the NVSL Priority Designation to the shipping box and the submission form.
- Samples preserved in formaldehyde are exempt from Category B regulations *provided that* the concentration of formaldehyde does not exceed 10%.

**Category A Biological Substances** (known etiological agents)

- Packaged in accordance with regulations in 42 CFR 72.2.
- Category A samples must be packaged to withstand leakage of contents, shocks, pressure changes, and other conditions in ordinary transportation handling.
- Individuals shipping Category A items must be certified shippers, formally trained in handling Dangerous Goods. Certification is needed to sign the "Declaration of Dangerous Goods" form.
- Follow the procedures for Category B, with the following additional procedures:
    - The primary container must be watertight and sealed with waterproof tape. The primary container must contain a label identifying the contents.
    - Each primary container must be separately wrapped with packing material.

- The name, address, and telephone number of the shipper must be on the secondary container.
- The outer box requires an Infectious Substance label. The UN number is UN2814 or UN2900, depending on known medical history, symptoms of the source (human or animal), endemic local conditions, and professional judgment.
- Interstate movement of Category A substances requires a US Veterinary Permit for the Importation and Transportation of Controlled Material and Organisms and Vectors. The permit is provided by the **recipient** of the shipment.
    - To submit Category A substances to the NVSL, a copy of the necessary permit must be enclosed in the shipment.
    - Individuals wishing to receive Category A substances from the NVSL must apply for a permit from the National Center for Import-Export.
    - Place one copy of the permit in the shipping box, outside the secondary container. Affix 5 additional copies to the outside of the shipping box.

- Affix a signed Declaration of Dangerous Goods form to the outer box.

- Packages containing dry ice are handled as Category A shipments. Place dry ice between the secondary container and outer shipping container. Add a Dry Ice (medical use only) label to the outer box.

- Shipments over 50 ml or 50 gms must be sent by cargo aircraft only.

## REFERENCES

**Duguies, M, Nusbaum, S., and Saville, P, 1999**. Animal Health Survey for Guam, Northern Mariana Islands, Palau, Federated State of Micronesia, and American Samoa. Agricultural Developments in the American Pacific (ADAP) 2000-25, December 2000.

**Martin, Tony., 1998**. Animal Health Survey for the Solomon Islands, Wallis and Futuna, Samoa and Tokelau . Secretariat of the Pacific Community (SPC). SPC Animal Health and Production publications. New Caledonia.

**Saville, P., 1998**. Animal Health Survey for the Republic of Palau. Animal Health and Production, Secretariat of the Pacific Community, New Caledonia.

**Saville, P.,1996**. Animal Health Survey for Niue, Tonga, Kiribati and Cook Islands. Animal Health and Production, Secretariat of the Pacific Community, New Caledonia.

**Simms, James, 1997**. Swine Disease Survey in the Federated State of Micronesia: results and Recommendation 1995-1997. ADAP Animal Health Survey 2000. College of Micronesia. Agriculture Experimental Station.