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Secure Zoo Strategy for Suidae

-African swine fever-

"It's kind of a pig deal!"






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USDA APHIS VS
April 29, 2021

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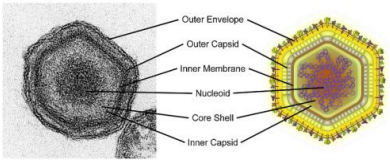
Outline

- Current US Swine Health Situation
- Why Worry About ASF?
- Background & Rationale
- Species Susceptibility
- Transmission & Infection
- Pathogenesis
- Differential Diagnoses
- Pathology
- Vulnerability
- Situational Awareness
- Communication & Coordination
- Response Capacity
- What can you do right now?
- Questions



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*African swine fever – A review of current knowledge, Virus Research, Volume 287, 2020.

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CURRENT US SWINE HEALTH SITUATION

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Disease Status of the United States

- **Free**:
  - African Swine Fever (ASF)/Classical Swine Fever (CSF)
  - Nipah virus
  - Porcine cysticercosis
- **Free** in commercial swine:
  - Pseudorabies/Aujeszky's Disease (AD)
  - *Brucella suis*
- Present:
  - Porcine reproductive and respiratory syndrome (note: PRRS 1-4-4)
  - Transmissible gastroenteritis (TGE)

Selected Disease Programs

- ***African Swine Fever*** and **Classical Swine** Fever Surveillance
  - Targets the following swine populations:
    - **Sick pigs** submitted to a veterinary diagnostic laboratory (VDL)
    - **Pigs condemned at slaughter** by the Food Safety and Inspection Service (FSIS) as well as sick or dead pigs at aggregation points
    - **Swine in high-risk herds** (waste-feeding operations or those with exposure to feral swine)
    - **Feral swine** as a part of a Foreign Animal Disease Investigation (FADI)

Selected Disease Programs (continued)

- **Brucellosis** and **Pseudorabies** (AD) Surveillance
  - Surveillance of U.S. swine for both diseases has two components:
    - **Commercial cull sow and boar surveillance**
    - **High-risk, outdoor-raised swine surveillance**
- **Swine Influenza A**
  - Voluntary
  - Samples only collected from animals displaying influenza-like illness

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Why worry about ASF?

- A virus that kills pigs *(suids)* for which there is no treatment or vaccine.
- ASF threatens global socioeconomics, livelihoods, food security and conservation of species.

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Zoological Collections

- While zoological collections may not seem to be at the highest risk…all stakeholders working with pigs *(suids)* should be familiar with both the clinical signs of ASF and understand the far reaching effects that the virus may have.

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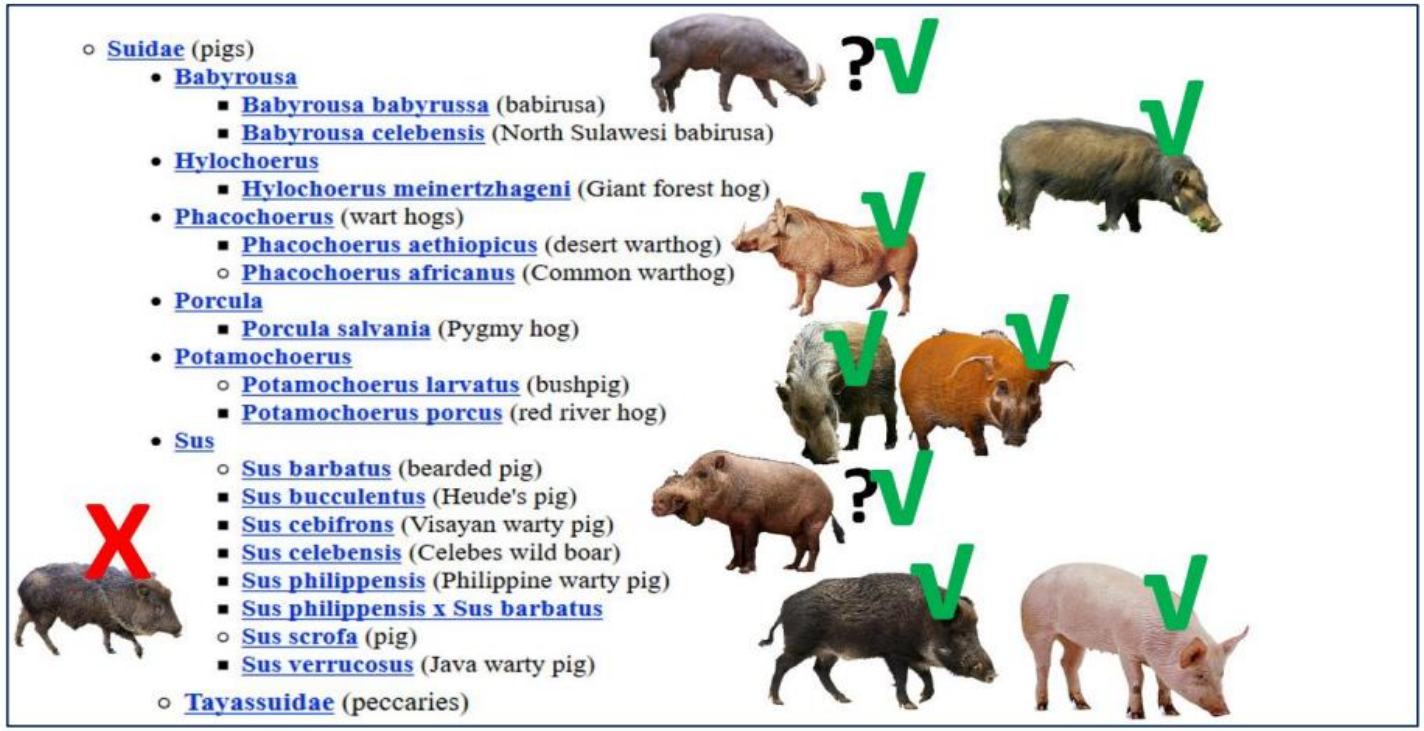
Species Susceptibility: Sixteen species of pigs and hogs in eight genera make up the modern family *Suidae*.



Slide 1. Graphic presentation of species susceptibility.

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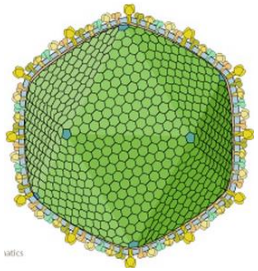
Background & Rationale



African Swine Fever Virus

- Only member of the genus **asf**ivirus in the family **Asfarviridae**
- Large, lipoprotein-enveloped, icosahedral, double- stranded DNA virus

- Tick-borne, contagious, febrile, systemic viral disease
- Highly contagious with up to 100% mortality
- Pigs die as a result of a ***hemorrhagic fever (104-107°F)***

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More ASF Facts…

Survival in pork products:

- 15 weeks in chilled meats
- 300 days in cured hams
- 15 years in frozen carcasses

Survives at least:

- 11 days in feces (room temp)
- 1 month in soiled pig pens
- 70 days in blood on wooden boards
- 15 weeks in putrefied blood
- 18 months in blood at 4°C

- **There is no *(approved)* vaccine for ASF**

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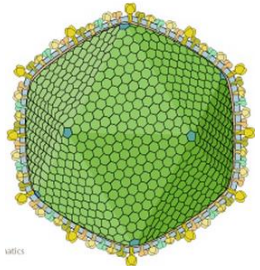
No Vaccine

- Vaccine development has been hindered by large gaps in knowledge concerning infection and immunity, the extent of ASFv strain variation and the identification of viral proteins.

Challenges for African swine fever vaccine development-"… perhaps the end of the beginning.", Vet Microbiol. 2017 Jul;206:52-58



No Vaccine

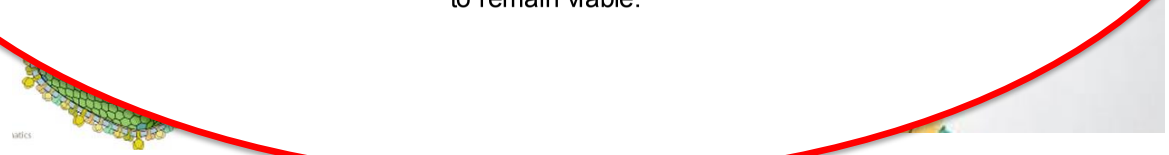
- Vaccin… …wledge con… …riation and th…

Concerns…

New African swine fever strains have been identified in Chinese swine farms and are suggested to be the result of illicit vaccine strategies…
https://www.reuters.com/article/us-china-swinefever-vaccines-insight/new-china-swine-fever-strains-point-to-unlicensed-vaccines-idUSKBN29R00X
https://www.agriculture.com/markets/newswire/chinese-researchers-find-natural-mutation-in-african-swine-fever-virus

Researchers at the Military Veterinary Institute in Changchun said there appeared to be a growing trend of lower mortality from African swine fever with more clinical symptoms that are **not as easy to detect and difficult to control**.

Others suggest that these lower virulent strains represent the virus naturally attempting to remain viable.



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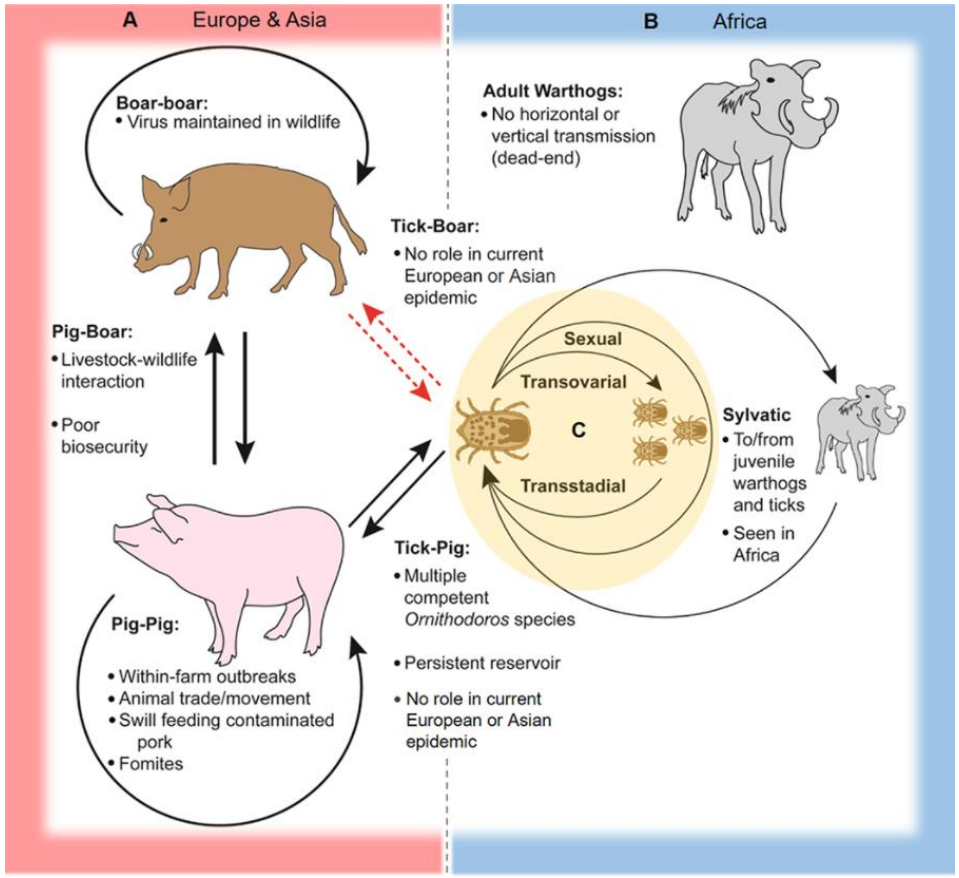
Transmission

- **Direct contact**
  - Usually oronasal
- **Indirect**
  - Uncooked garbage
  - Fomites
  - Bite of infected ticks
  - Mechanically by biting flies
- **Found in all tissues and body fluids**

TRANSMISSION CYCLES



Sylvatic: a scientific term referring to wild animals, often in context of diseases or pathogens that only affect them.

Domestic: referring to the spread among domestic pigs.

Ticks adapted to pigs…

Wild Boar: referring to the spread among wild boar.

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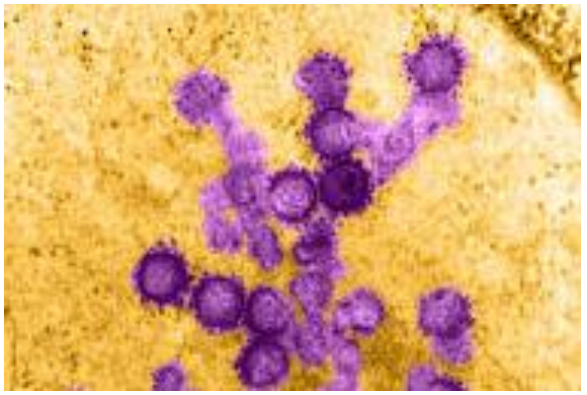
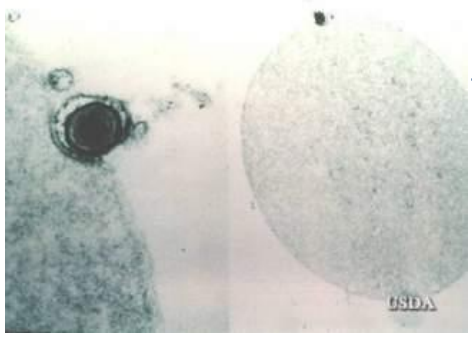
Infection

Transmission electron microscopy (TEM) electromicrograph of the African swine fever virus. Source: Institute for Animal Health

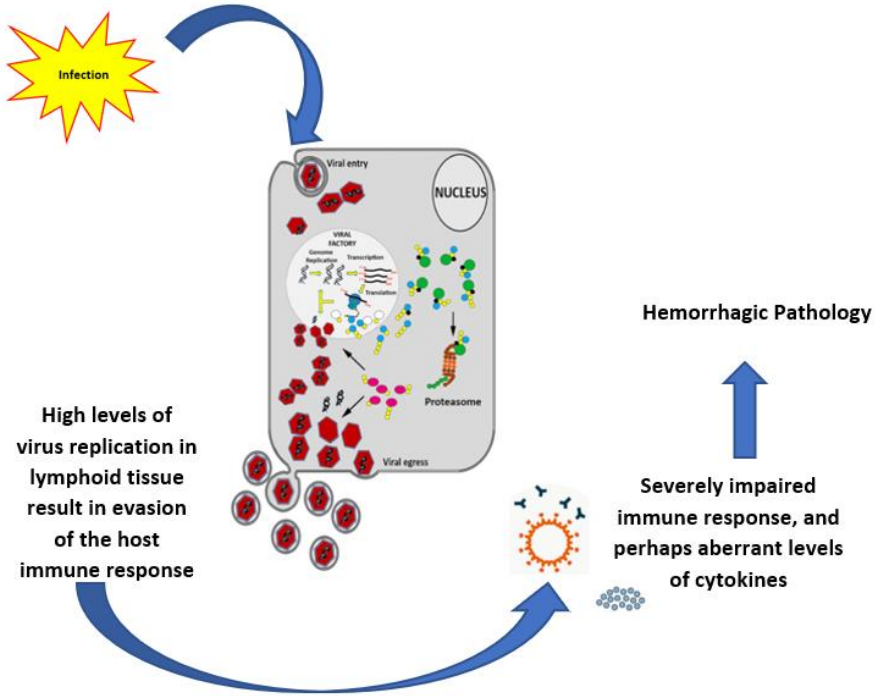
http://www.sciencephoto.com/media/156047/view



Color enhanced micrograph of the ASF virus porcine renal tissue.



Pathogenesis of ASF



NOTE: In **reservoir hosts**, such as warthogs and bushpigs, viral replication in lymphoid tissues is kept to a minimum so that hosts survive infection with **no clinical signs of disease.**

Journal of General Virology (1998) 79,1439-1443

https://www.researchgate.net/figure/Proposed-working-model-of-the-role-of-pI215L-during-ASFV-infection-Once-ASFV-enters-the_fig5_323337294

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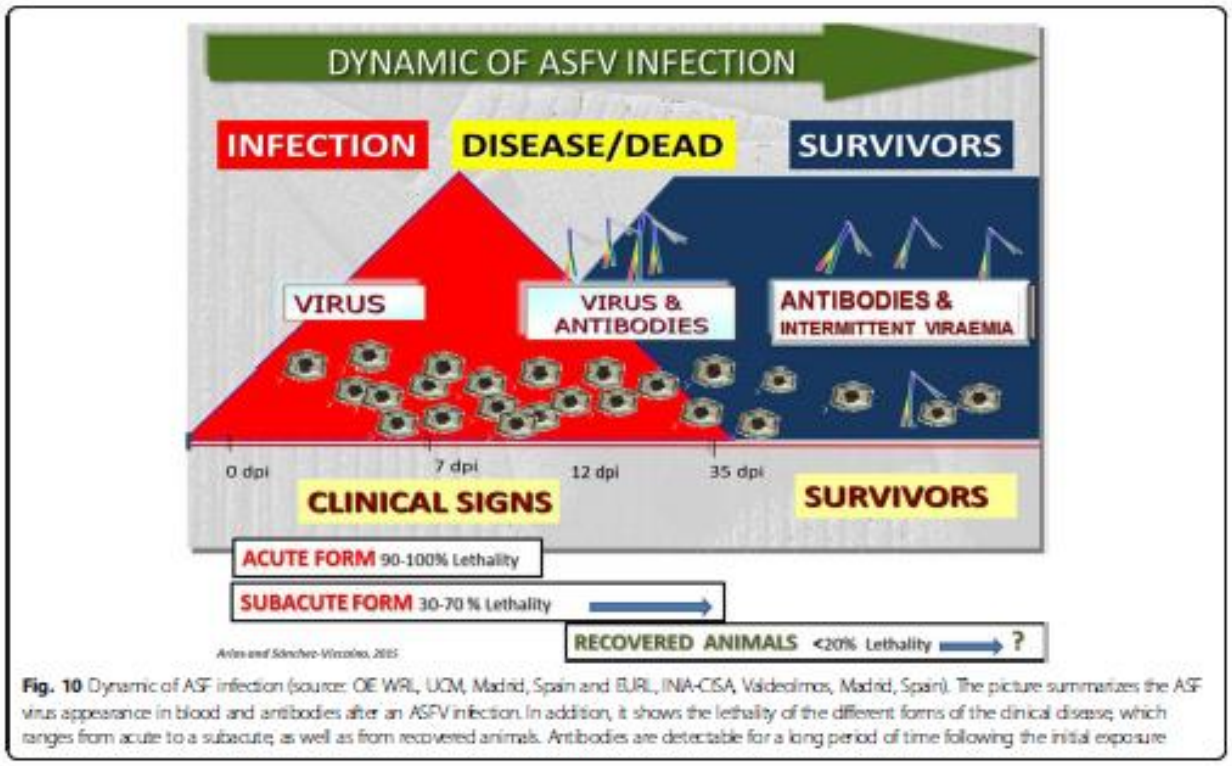

Fig. 10 Dynamic of ASF infection (source: OIE WRL, UCM, Madrid, Spain and EURL, INIA-CISA, Valdeolmos, Madrid, Spain). The picture summarizes the ASF virus appearance in blood and antibodies after an ASFV infection. In addition, it shows the lethality of the different forms of the clinical disease, which ranges from acute to a subacute, as well as from recovered animals. Antibodies are detectable for a long period of time following the initial exposure

Gallardo et al. 2015 African Swine Fever: A Global View of the Current Challenge, Porcine Health Management 1:21.

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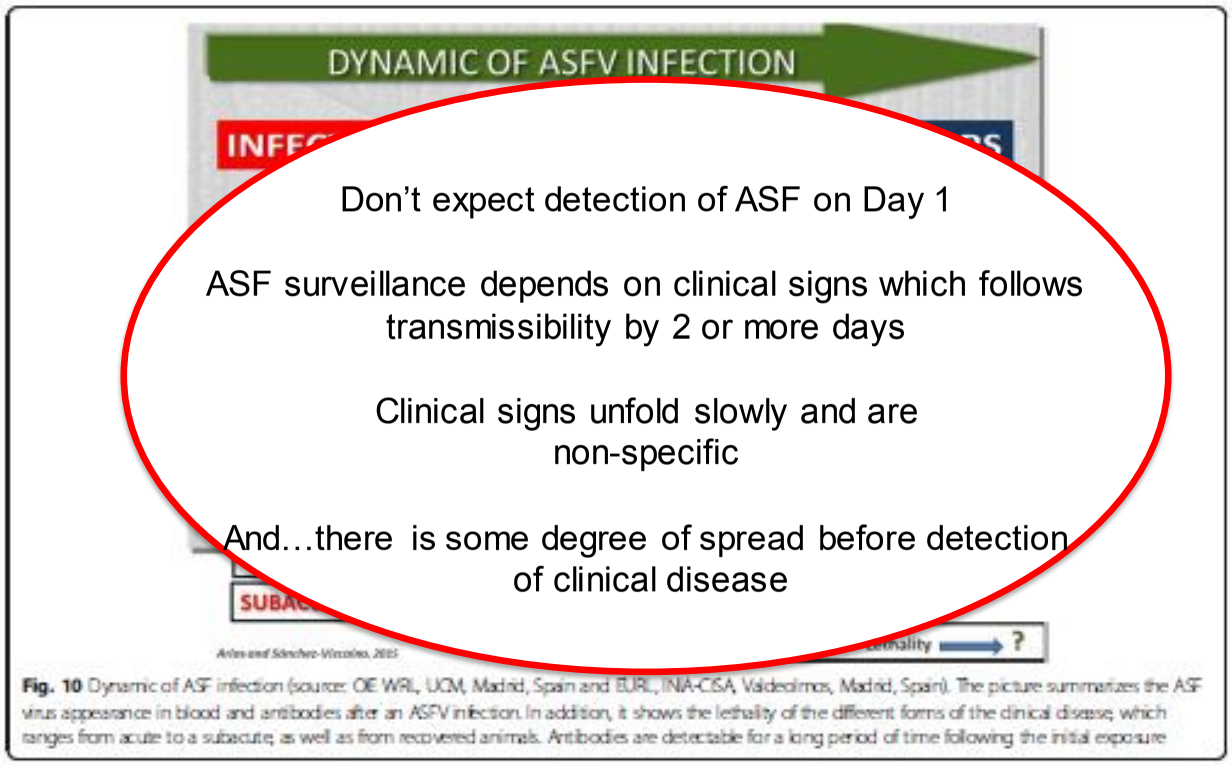

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Identifying a Sick or Compromised Pig

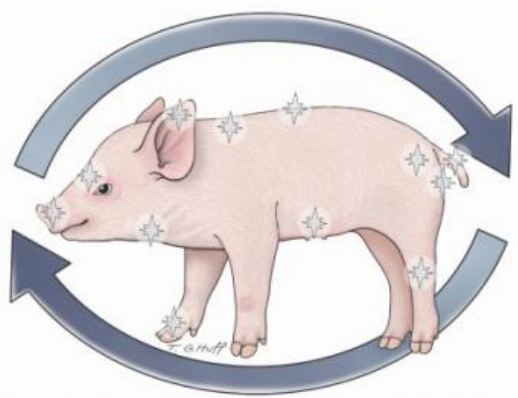
Gemus, M., Kramer, S. and Bratton, A. 2013 Identification and Prevention of the Sick or Compromised Nursery Pig. Pork Information Gateway, http://porkgateway.org/wp-content/uploads/2015/07/identification-of-the-sick-or-compromised-pig1.pdf.

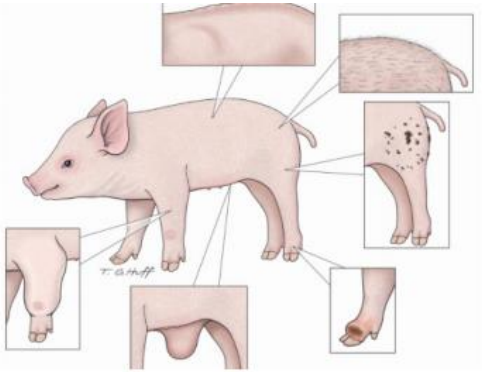
Body

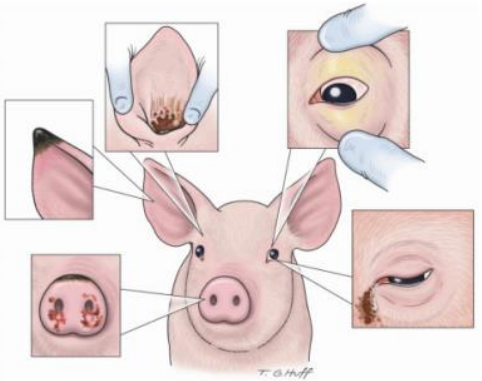
Eyes, ears, nose

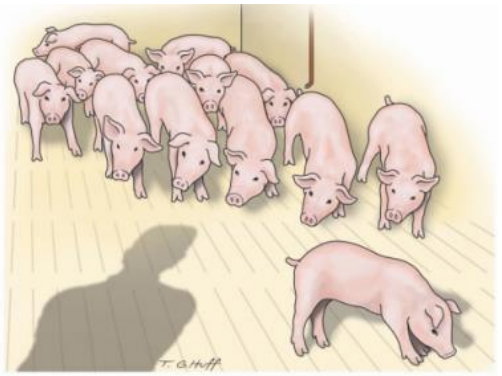
Skin

Temperament









Differential Diagnosis

- Classical swine fever (hog cholera)
- Acute PRRS
- Porcine dermatitis and nephropathy syndrome
- Erysipelas
- Salmonellosis
- Eperythrozoonosis
- Actinobacillosis
- Glasser's disease
- Aujeszky's disease (pseudorabies)
- Thrombocytopenic purpura
- Warfarin poisoning
- Heavy metal toxicity
- *Clostridium septicum*

Differential Diagnosis

- Classical swine fever
- Acute PRRS
- Porcine d
  nephror
- Erysipe
- Salmon
- Eperythro

inobacillosis
disease
ease
nic purpura
ing
toxicity
septicum

The challenge of relying on the observation of symptoms as flags for screening cases is confounded by the facts that these other conditions are all prominent and enhanced by numbers and concentrations

Thus…compatible lesions are often ignored.

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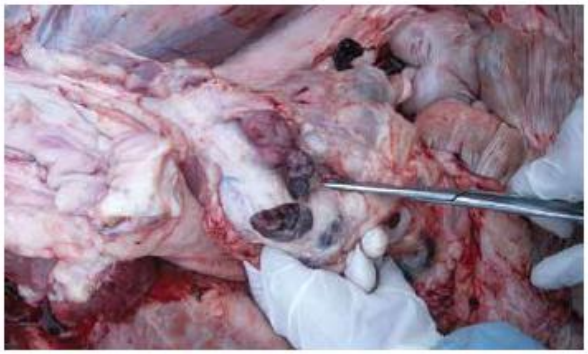
Classical Swine Fever

©RLI

Salmonellosis

©IOWA STATE DIAGNOSTIC LABORATORY

PRRS



©CHINA ANIMAL DISEASE CONTROL CENTER

Mycotoxin Poisoning

©IOWA STATE DIAGNOSTIC LABORATORY

PDNS

Erysipelas

Aujeszky's Disease

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Differential Diagnoses

TABLE 4

Summary of ASF differential diagnoses: clinical signs and postmortem differentials

CLINICAL SIGNS	Reportable disease	Vaccine available	Treatment options	Fever	Loss of appetite	Dull or depressed	Red to purple skin lesions	Respiratory distress	Vomiting	Diarrhea	Bloody diarrhea	High mortality	Sudden death	Abortion	CLINICAL SIGN DIFFERENTIALS	Enlarged dark red to black & friable spleen	Hemorrhages on kidney	Hemorrhagic lymph nodes	Enlarged lymph nodes	Hemorrhages on mucous membranes	Excess fluid in body cavity & around heart	Pneumonia	POSTMORTEM DIFFERENTIALS
African swine fever (ASF)	X			X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
Classical swine fever (CSF)	X	X		X	X	X	X	X	X	X		X	X	X	Conjunctivitis. Ataxia. Central nervous system signs in piglets, hunched posture. Constipation may progress to a yellow-grey diarrhea. Longer clinical course.		X	X	X	X			Necrotic or 'button' ulcers in the mucosa of the gastrointestinal tract, epiglottis and larynx. Encephalitis. CSF pigs lose weight quickly. Pale areas on edge of spleen.
Highly pathogenic PRRS	X	X		X	X	X	X	X	X			X		X	Intensity of respiratory distress.		X	X	X				Interstitial pneumonia. Absence of enlarged spleen. Atrophy of the thyme.
Erysipelas		X		X		X	X							X	Most often seen in animals reaching market weight. Characteristic diamond-shaped skin lesions.		X			X			Arthritis and vegetative endocarditis. Hemorrhages in pleura and peritoneum. Perypheral lymph nodes affected (rather than gastrohepatic and renal).
Salmonellosis (S. choleraesuis)				X	X	X	X	X	X		X	X			Yellowish diarrhea. Central nervous system signs including tremor, weakness, paralysis and convulsions.		X					X	Enteritis and occasional encephalitis. Necrotic endocarditis. Miliary foci of necrosis in the liver. Absence of vascular lesions in the spleen and nymph nodes.
Pasteurellosis				X	X		X		X						Signs vary in severity.							X	Adhesions between lungs and ribcage.
Aujeszky's disease or pseudorabies		X			X	X	X		X					X	Signs vary, depending largely on the immune status of the dam and the age of the pigs affected. Hypothermia, trembling and ataxia, seizures. Rhinitis and sneezing.							X	Focal necrotic and encephalomyelitis lesions occur in the cerebrum, cerebellum, adrenals and other viscera such as lungs, liver or spleen. In fetuses or very young piglets, white spots on liver are pathognomonic of their infection by the virus. Necrotic enteritis.
Porcine dermatitis and nephropathy syndrome (PDNS)				X			X							X	Most often seen in grower/finisher pigs.		X		X			X	Enlarged pale kidneys. Fluid in the body cavity, subcutaneous edema, gastric ulceration, and increased synovial fluid.

http://www.fao.org/3/i7228EN/i7228en.pdf

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ASF External clinical signs: Acute ASF

Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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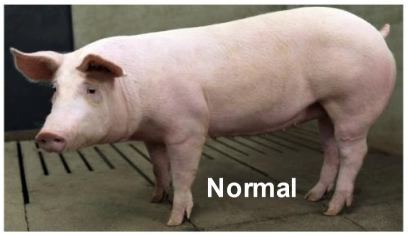
Skin

-Reddening of the skin - tips of ears, chest, abdomen and both front and hind legs.
-Cyanosis



Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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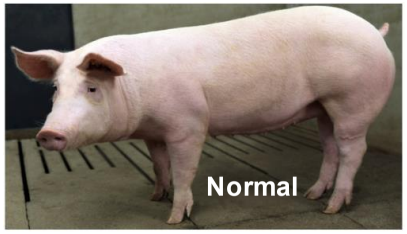
Skin

-Necrotic areas o the skin surface
-Subcutaneous hematomas
(ears, chest, abdomen and both front and hind legs)



Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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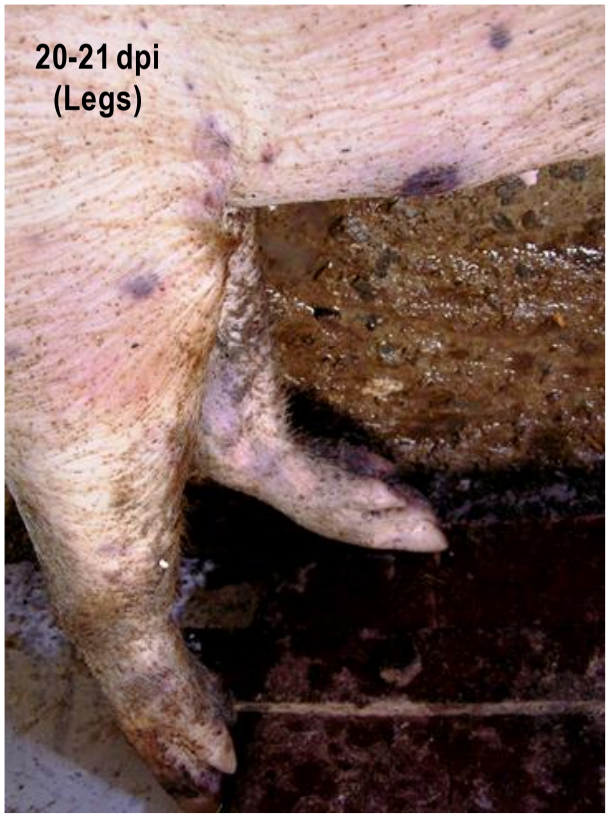
Skin/Feet

-Necrotic areas on the skin surface
-Subcutaneous haematomas
(ears, chest, abdomen and both front and hind legs)



Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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-Melena (dark sticky feces containing partly digested blood)
-Epistaxis (bloody nose)
-Foam in mouth/nose

Normal

Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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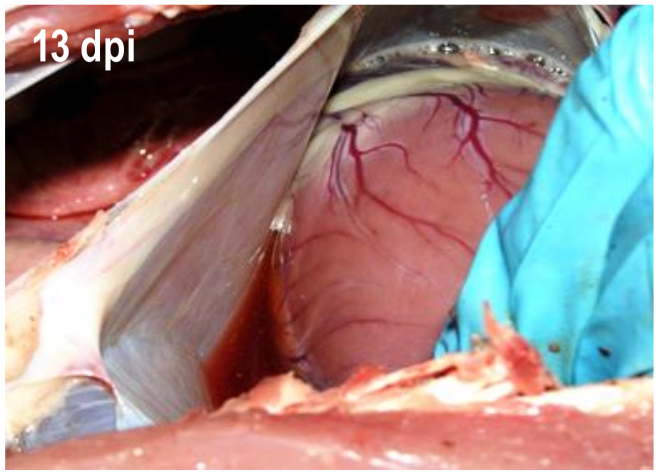
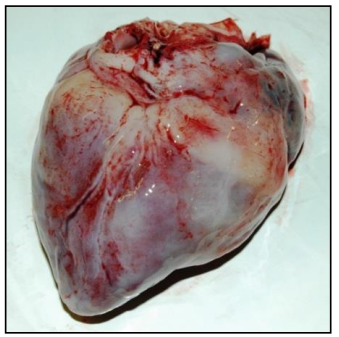
ASF Gross lesions:

Cardio-respiratory sytem

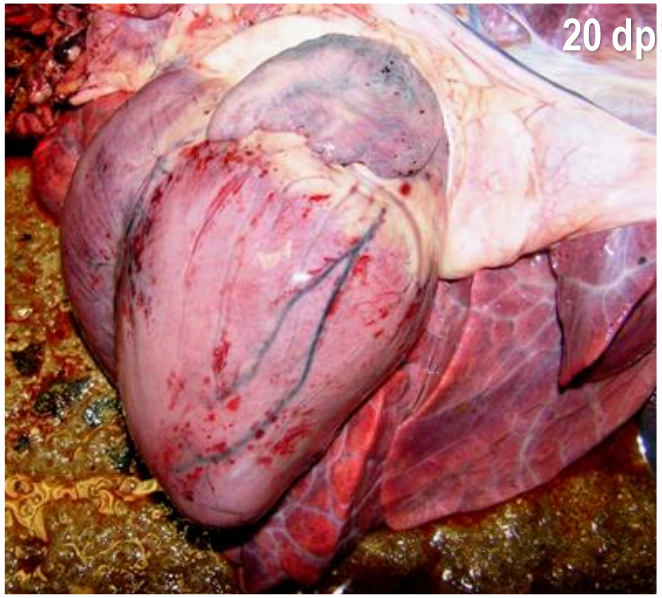
Hydrothorax





Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain


Normal



Heart
-Hydropericardium with red tinted fluid
-Petechial hemorrhages on epicardium
(small red to purple blood spots)

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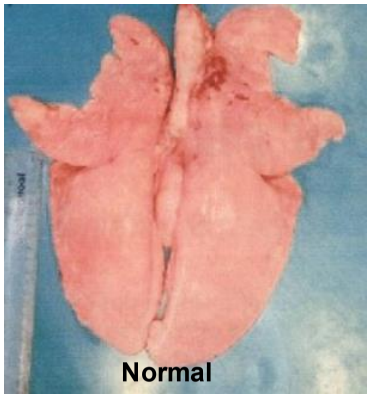
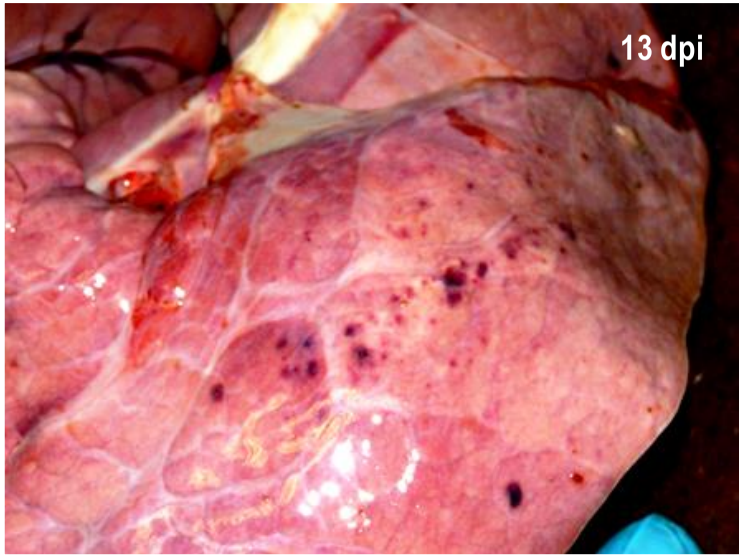
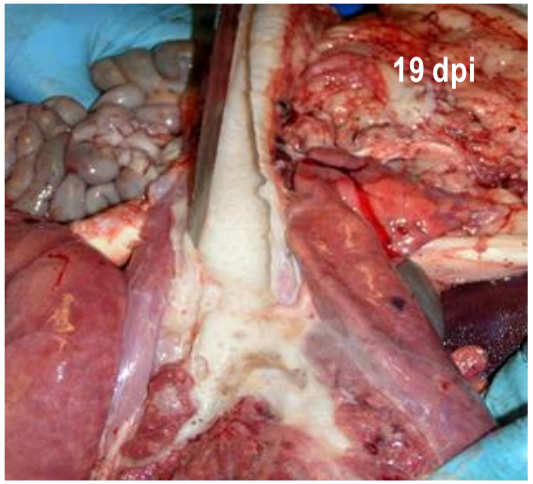
Cardio-respiratory sytem

Lung

-Congestion
-Petechial hemorrhages
-Froth in trachea and bronchus
-Severe alveolar and interstitial pulmonary edema.



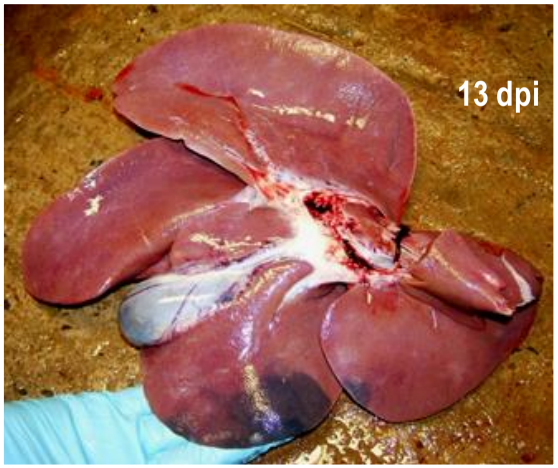


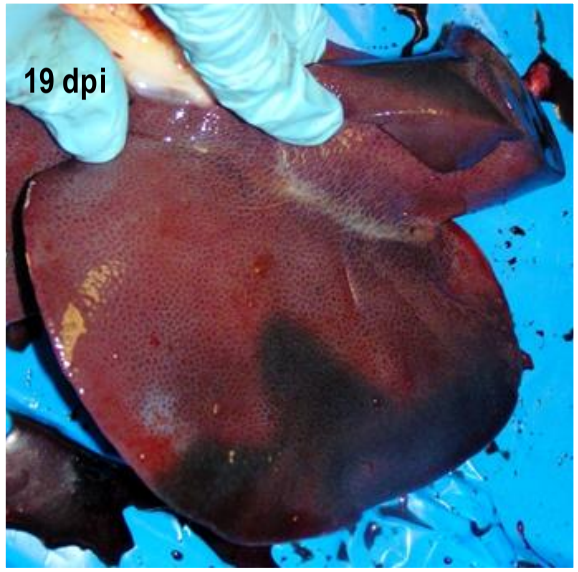


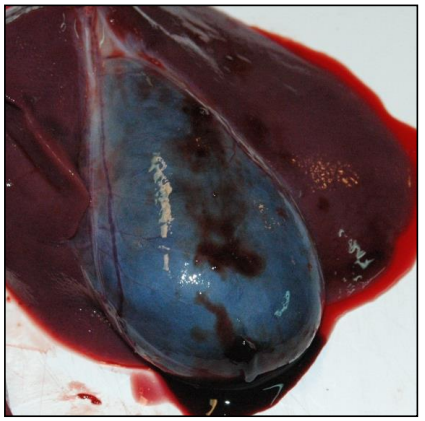
Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

Liver

-Congestion
-Hepatomegaly
-Hemorrhages on the serosal surface of gall bladder







Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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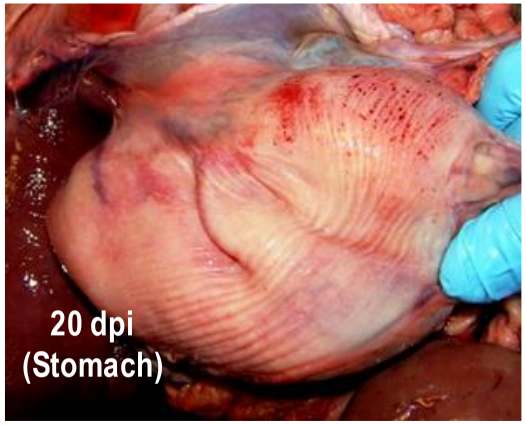
Stomach

-Petechial hemorrhages on serosa and mucosa



Small and Large Intestine

-Petechial hemorrhages on serosa and mucosa

Normal

Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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Kidney

-Petechiae in cortex

Turkey Egg

Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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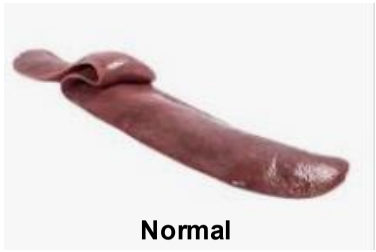
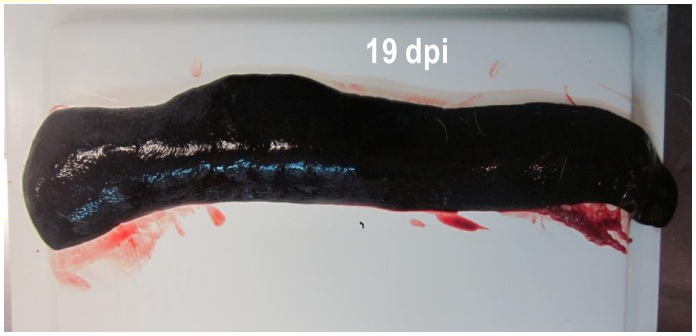
Spleen

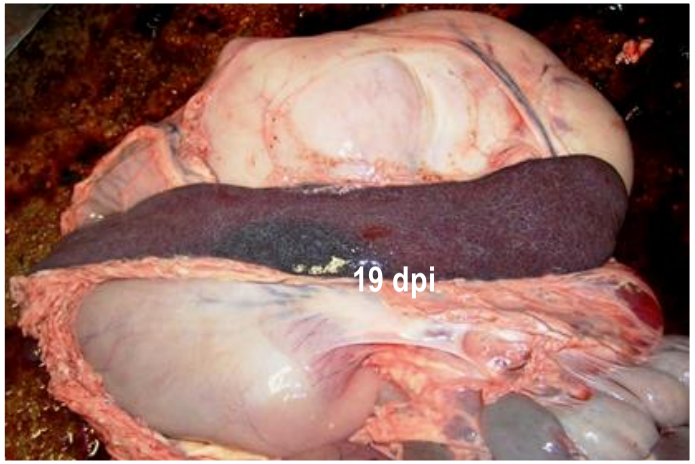
-Hyperemic splenomegaly

(enlarged dark red to black, rounded edges, friable/crumbly)



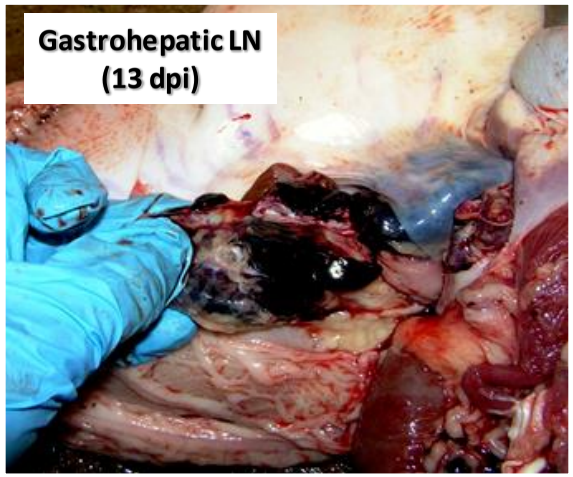
Normal



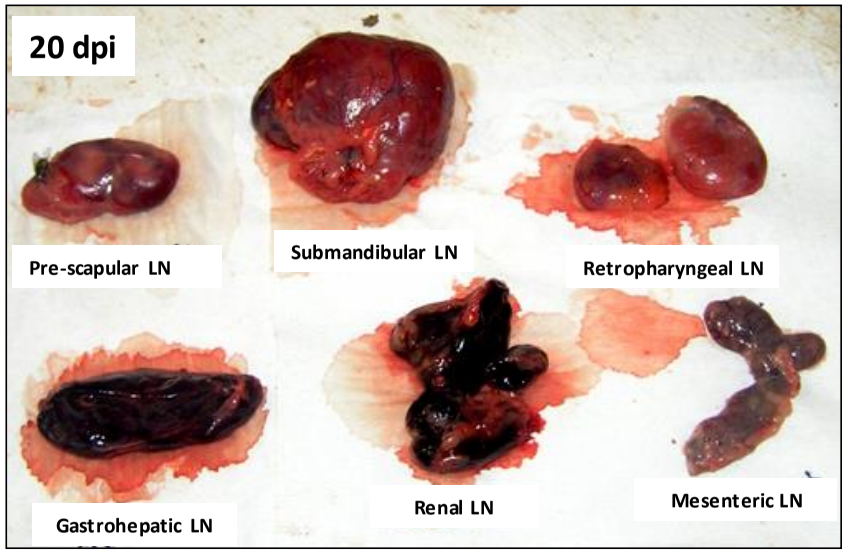


Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

Lymph nodes enlarged edematous and completely hemorrhagic similar to a blood clot, mainly gastro hepatic and renal LNs.



Gastrohepatic LN
(9 dpi)



Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

Renal LN
(13 dpi)

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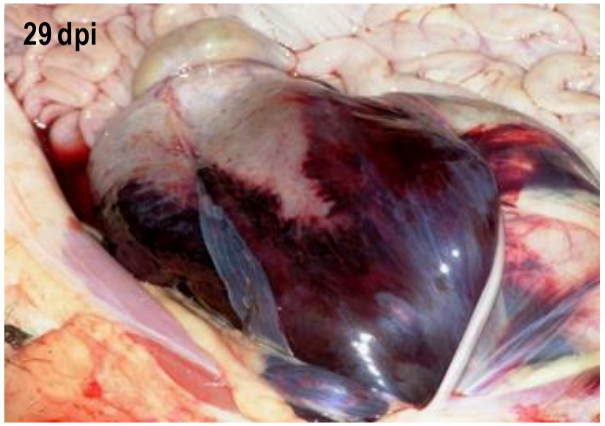
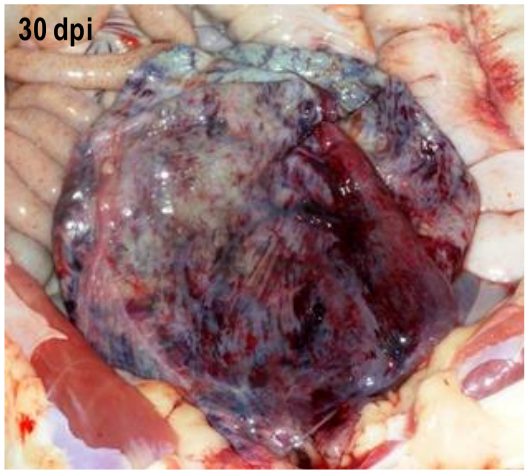
Urinary Bladder


Normal


29 dpi


30 dpi

Images: EURL, INIA-CISA, Valdeolmos, Madrid, Spain

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Exercise: What do you think?

Barn Supervisors had segregated a gilt that they thought had "suspicious" lesions…resembling the images in the ASF literature.

Signalment:

- 250 lb, market weight gilt
- Temperature 104.7 F
- Mild lameness in the right rear limb
- Hematuria (blood in urine)
- Well-demarcated areas of dark red to purple skin on the ears as well as on the ventral skin that included the ventral cervical, ventral thoracic, ventral abdominal, and ventral inguinal areas were observed.

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How Vulnerable Are We/You?

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Consider Situational Awareness

Domestic Swine Production

Feral Pigs

Zoos

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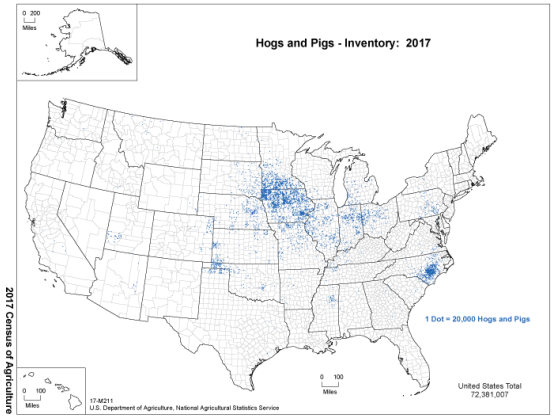
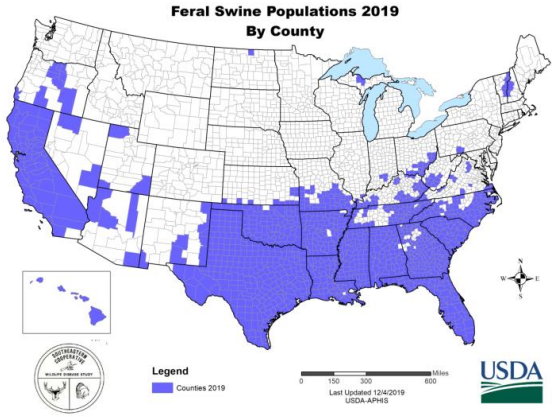
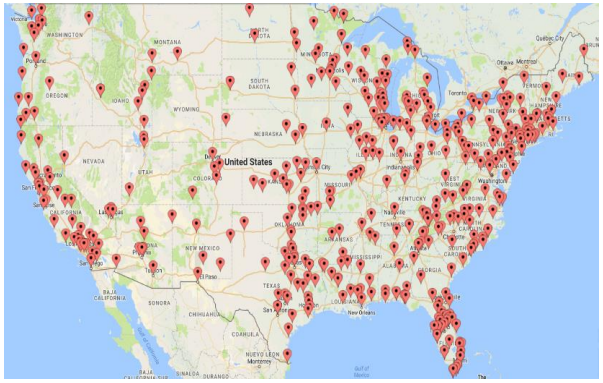
SWINE DEMOGRAPHICS



DOMESTIC SWINE



FERAL SWINE



ZOOS

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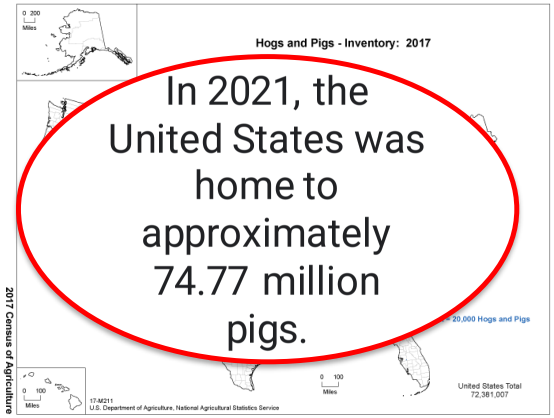
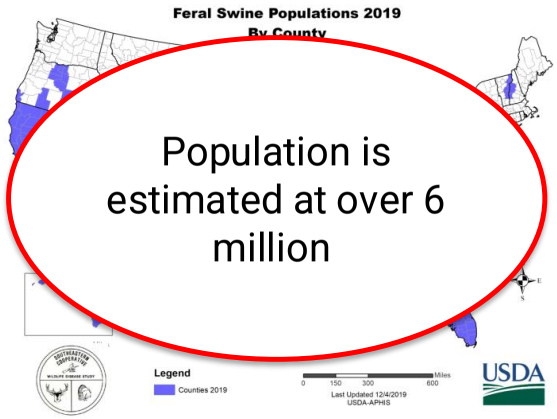
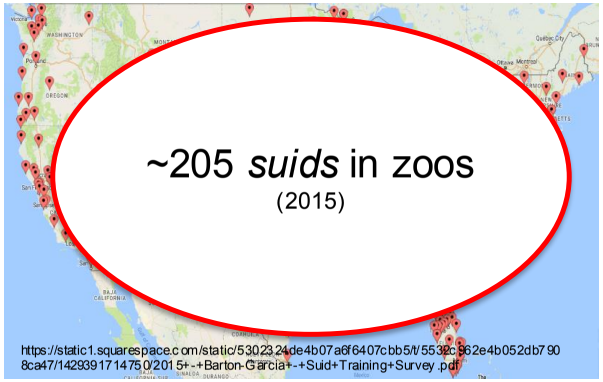
SWINE DEMOGRAPHICS



DOMESTIC SWINE



FERAL SWINE



ZOOS

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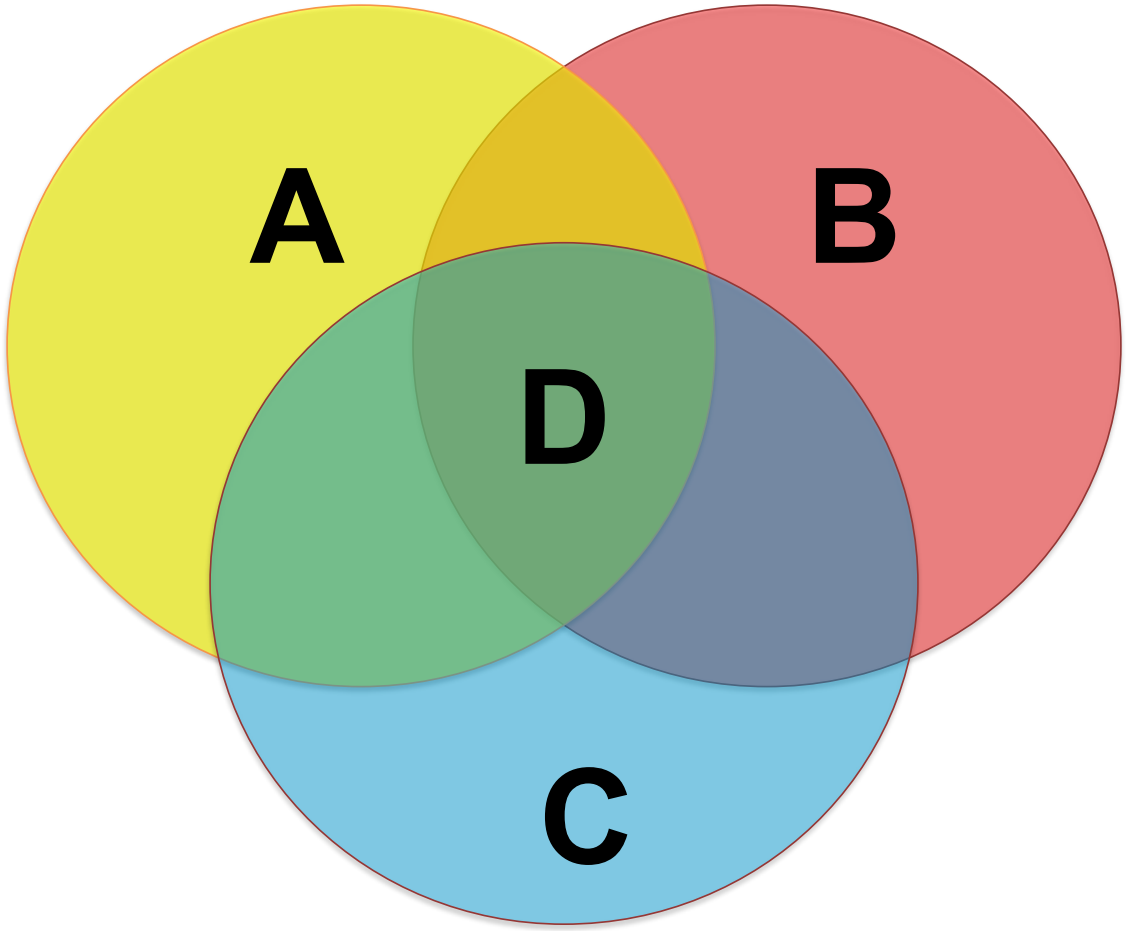

A = Domestic Swine Production

B = Feral Swine

C = Zoos

D = High Risk Area

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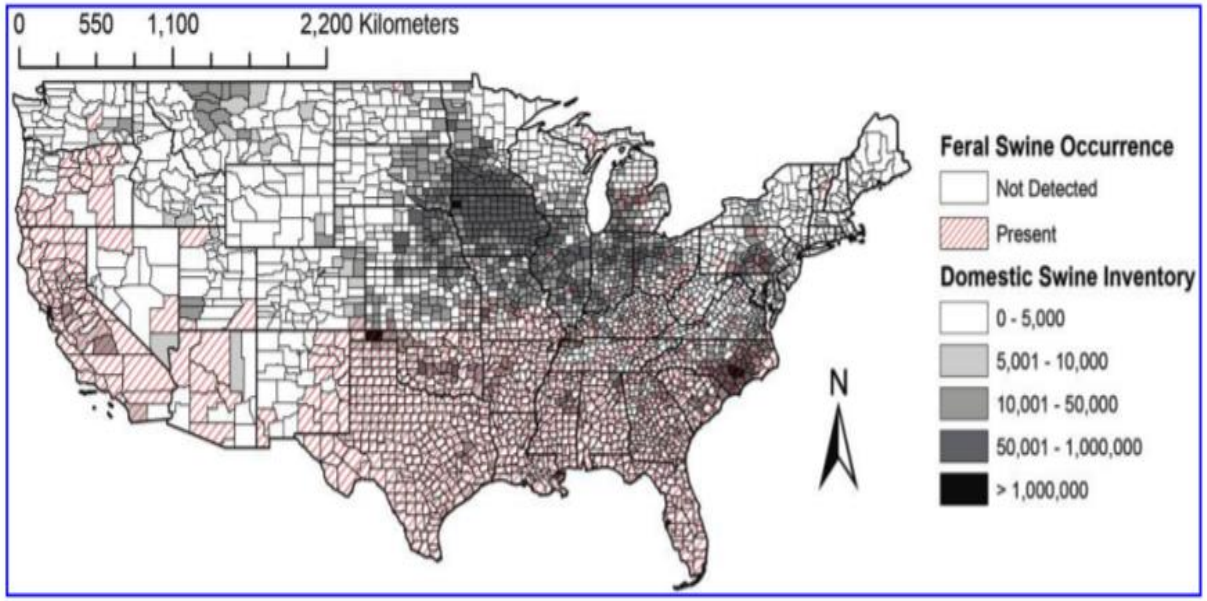
DOMESTIC SWINE & FERAL SWINE



- Much of North Carolina and parts of Oklahoma are of particularly of high concern for direct swine-to-swine virus transmission due to the presence of feral swine and high densities of domestic swine.

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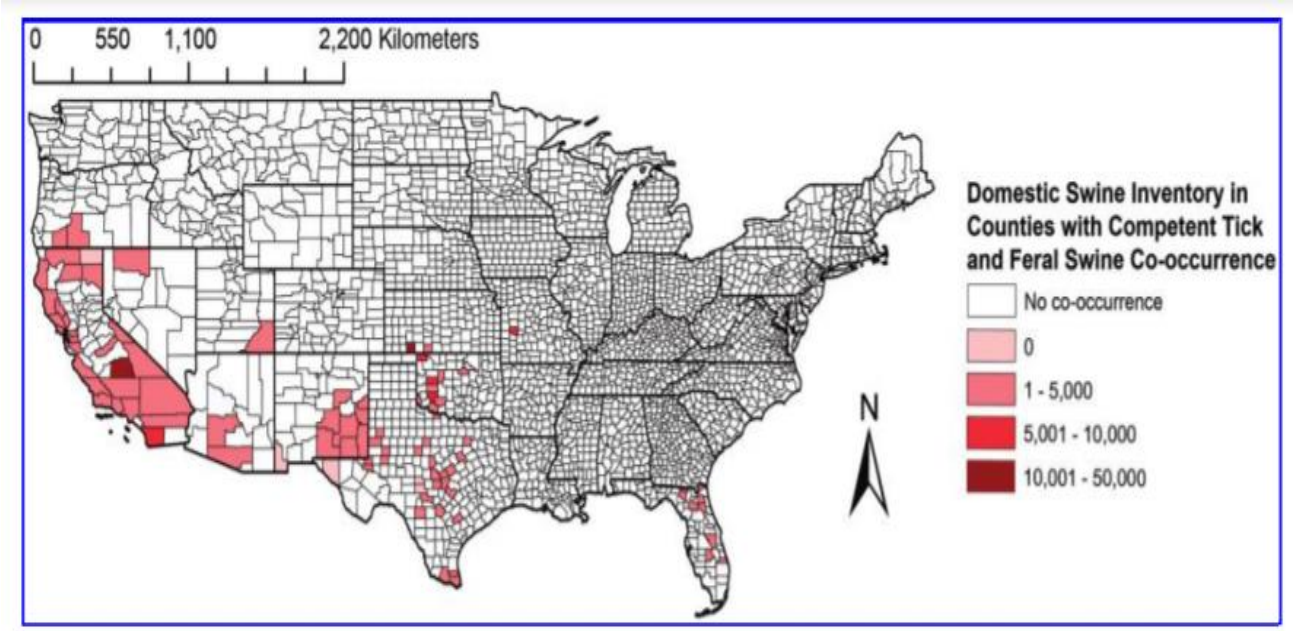
SPILLOVER IN ALL 3 AREAS



- **Fortunately**, within those counties with co-occurrence of known competent tick vectors and feral swine, domestic swine typically **do not** reach high inventory.
- Areas of California, Oregon, Nevada, Arizona, New Mexico, Oklahoma, Texas, and Florida are potentially at risk of ASFV spillover due to the co-occurrence of Ornithodoros ticks, feral swine, and domestic swine.

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COMMUNICATION AND COORDINATION

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“The nine most terrifying words in the English language are:

I’m from the government and I’m here to help.”

Ronald Regan 8-12-86
Chicago Mercantile Exchange

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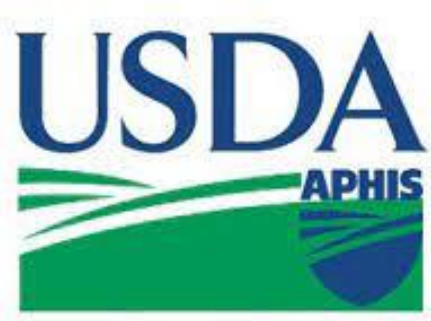
USDA-APHIS VS has the primary responsibility for investigating foreign animal diseases (FADs).

This is a cooperative effort between the state and federal personnel.

Actual roles will vary from state to state.



Disease Reporting and Investigation

- Reporting is required for suspect or confirmed cases of foreign animal diseases (FADs), program diseases, or diseases not known to exist in United States
- Who reports?
  - Anyone
  - Veterinarians
  - Meat inspectors
  - Producers
  - Diagnostic laboratories
  - Extension agents





Disease Reporting and Investigation

- The APHIS–VS Area Veterinarian in Charge (AVIC) and the State Animal Health Official (SAHO) are notified
- A trained FAD diagnostician (State or Federal) visits the premises, investigates the report, and takes diagnostic samples

NAHRS

- The National Animal Health Reporting System (NAHRS)
  - Collects data from State Animal Health Officials on the presence of confirmed diseases on the proposed National List of Reportable Animal Diseases (NLRAD)
    - Includes World Organization for Animal Health (OIE) reportable diseases and other diseases of interest in specific livestock, poultry, and aquaculture species in the United States

WHAT IS OUR RESPONSE CAPACITY?

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"In zoo settings, USDA-APHIS policy is to work with the zoo to determine the best course of action"

"There may be unique circumstances which need to be reviewed by APHIS and State Officials during the outbreak"

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ASF Response Strategy

- **STAMPING OUT** is the primary control and eradication strategy for ASF
  - Establishment of quarantines and movement controls
  - Supported by quarantine and movement controls with enhanced biosecurity.
    - **3 Km Infected Zone**
    - **2 Km Buffer Zone**
    - **5 Km Surveillance Zone (in the Free Area)**
- 72-hour National Movement Standstill*
  - Upon initial and immediate response **upon detection** of ASF in feral or domestic swine
  - Complete stop in live swine movement across the United States

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Restrictions for *Suidae* - African Swine Fever Outbreak		
Control Area	**Infected Zone (IZ)**	All pigs on the infected premises (IP) would be depopulated without delay. Criteria required for movement will depend on the risk of that movement, and may include biosecurity, C&D, and/or diagnostic testing on the specific permit and surveillance activities.Infected Premises (IP) are quarantined
Control Area	**Buffer Zone (BZ)**	Criteria required for movement will depend on the risk of that movement, and may include biosecurity, C&D, and/or diagnostic testing on the specific permit and surveillance activities.
Free Area	**Surveillance Zone (SZ)**	Criteria required for movement will depend on the risk of that movement, and may include biosecurity, C&D, and/or diagnostic testing on the specific permit. May include targeted surveillance.
Free Area	**Free Zone (FZ)**	Area not included in any control area. Routine or program surveillance may be implemented.
https://www.aphis.usda.gov/animal_health/emergency_management/downloads/premises_and_zones.pdf		

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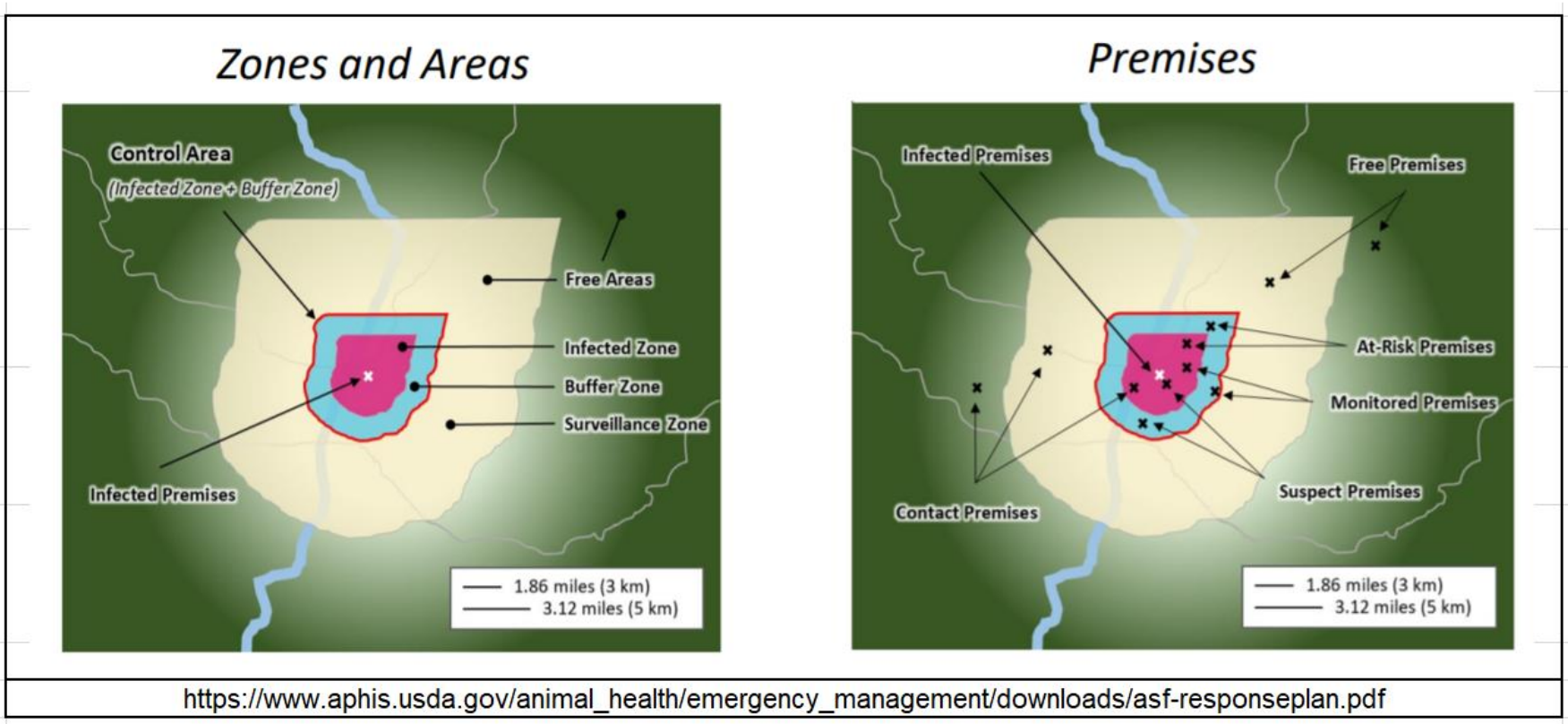

https://www.aphis.usda.gov/animal_health/emergency_management/downloads/asf-responseplan.pdf

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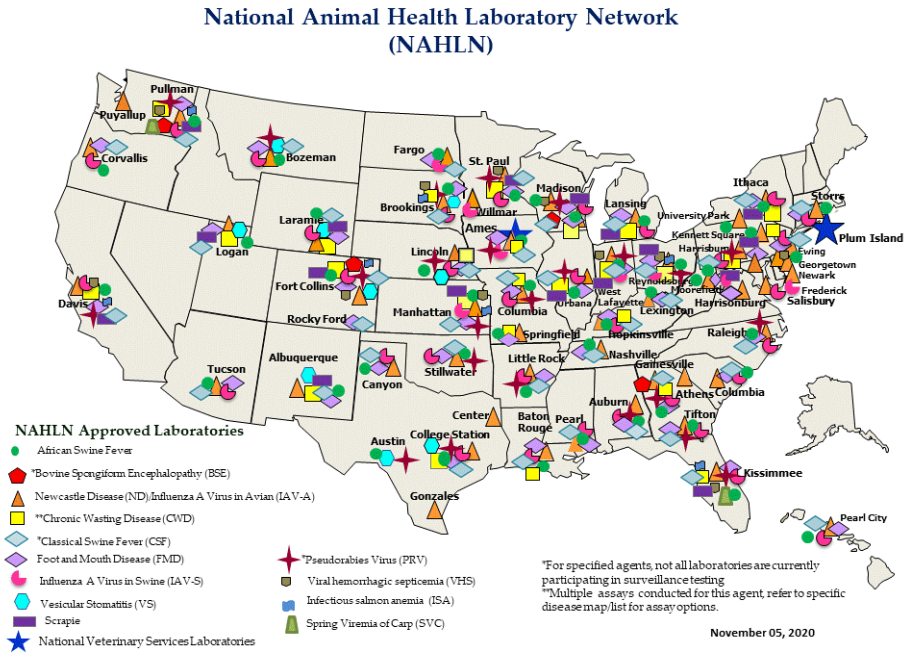
Diagnostic Testing and Capacity

- The National Veterinary Services Laboratories (NVSL)
- The United States' animal health testing capabilities are expanded by the National Animal Health Laboratory Network (NAHLN)
- **Approved sample types include whole blood, tonsil, spleen and lymph node**



What can you do right now?

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Contingency Plan

What is a contingency plan?

- A detailed site specific plan
- Graded according to the level of risk
- Aims to decrease the risk to your collection!

RISK = HAZARD + LIKELIHOOD

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Identify the HAZARD

Hazards posed by ASF:

- Direct threat to the collection
  - Clinical Disease
  - Culling by the government
- Indirect threats to conservation & breeding programs
  - Loss of key genetic stock
- Movement bans
  - National & International
- Direct and Indirect threats to business continuity
  - Zoo forced to close
  - Visitors forced to stay away

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Reduce the likelihood of hazard impacts

- Each of the hazards should be evaluated as well as their impact on the zoo.
- Produce a list of measures to be undertaken AND defining what the triggers for those measures should be.

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Pulling it all together…

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KEEP ASF OUT OF YOUR ZOO!

- Keep wild *suids* out of your zoo
  - Pig proof the perimeter
  - Know which enclosures are high risk and make sure they are serviced last or by other staff
- Consider other wildlife visitors (mice, rats, birds)
- No feeding of animals by visitors
- Check source of all animal feeds

  (viruses can be transported long distances via feed ingredients, https://onlinelibrary.wiley.com/doi/full/10.1111/tbed.13606)
- Consider banning pork products from your zoo

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KEEP ASF OUT OF YOUR ZOO!

- **New Stock**
  - Known source and medical history
  - Quarantine protocols
  - Stop all *suid* movements at times of higher risk

- **Vectors**
  - Soft tick prophylaxis

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KEEP ASF OUT OF YOUR ZOO!

- **Visitors**
  - Prevent touching any part of a pigs environment
  - **NO FEEDING!**
  - Separate keeper pathways and visitor flow

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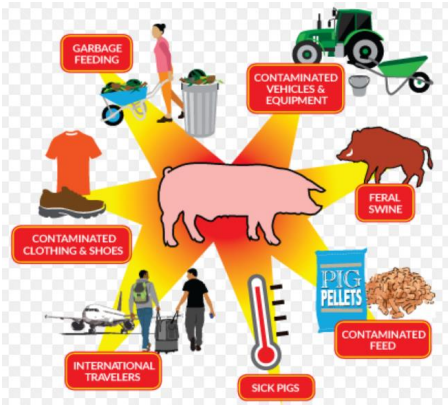
KEEP ASF OUT OF YOUR ZOO!

- **Biosecurity, Biosecurity, Biosecurity**
  - Practice good hygiene practices
  - Follow appropriate protocols
    - Clothing
    - Footwear
    - Equipment
    - Travel
    - Hunting
    - Pets
- Awareness campaigns



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In conclusion…key points include:

Preparedness/Contingency Planning
Surveillance
Biosecurity
Risk Communication and Awareness Training

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Questions?

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