# Information, Modeling, and Analysis – Project 19 Year 3 Annual Report

## Avian Influenza Economic Modeling

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|---|---|---|---|---|---|
| DHS Priority Areas Addressed | ☐ Prevention | ☐ Detection | ☒ Response | ☐ Recovery | ☐ Education/Risk Communication |
| Proposal Section Addressed | Sections: NA | | | | |
| Investigators | TAMU: Michael Ward | | | | |

| Objectives | Deliverables | Progress Toward Deliverables | Percent Complete |
|---|---|---|---|
| Produce a risk map of AI virus introduction and spread in the U.S. (lower 48 states), and identify regions at greatest risk. | Identify risk factors for AI virus introduction and develop a county-level GIS database describing characteristics for known risk factors for AI virus introduction and spread. | Risk factors Identified based on literature review and expert opinion.<br><br>A database that contained all risk factors at a county level was developed for Texas. | 100% |
| | Develop a model of the risk of AI virus introduction and spread by linking putative risk factors in a causal pathway | A base risk model was developed.<br>The following factors were identified as proportions (wild birds, domestic ducks, total poultry, hobby, wetlands)<br>The livebird markets (+ spatial buffer), distributors, and sellers were classified as a binary variable classification of counties and weighted by perceived importance | 100% |
| | Parameterize risk assessment model via expert opinion. Apply risk scores for each U.S. county. Use geostatistical methods to identify clusters of high risk counties | Risk maps of AI virus introduction and spread<br><br>Identification of groups of counties at greatest risk of AI virus introduction and spread | |
| | Validate risk maps with known outbreaks of AI (both low and high path) in the last 20 years. Undertake a sensitivity analysis to identify key variables | Qualitative assessment of those factors that may influence the risk of a given county | |

**Highlight for Research Briefs**

- Transmission of highly pathogenic avian influenza (HPAI) within poultry populations poses a threat to human and animal health, and the

economic consequences are devastating.

- Outbreaks of AI occur sporadically in commercial poultry flocks in the United States, but the mode of introduction is rarely conclusively determined.
- The spread of viruses between regions is often attributed to migratory waterfowl that inhabit water bodies such as ponds and drainage ditches in close proximity to commercial farms.
- Counties with large poultry populations and markets in which poultry from different sources intermingle are at high risk for spread of AI viruses.
- In addition, counties with a large pet and hobby sector might be at increased risk, since biosecurity is likely to be suboptimal and existing surveillance systems may be less sensitive.
- A simplified model of the risk of HPAI virus introduction and spread – based on county estimates of numbers of poultry, pet and hobby fanciers, migratory waterfowl, presence of live bird markets and the area of wetlands – was developed within a geographic information system.
- Results indicate that high risk counties were those with greater numbers of poultry and pet fanciers. Two regions of Texas were identified where these conditions exist. This model will be extended to a national scale. Decision-makers will benefit from a model that identifies regional trends in risk.

## Interpretive Summary

**Background**

HPAI is a reportable disease and is included on the OIE (Office International des Epizooties) list A, along with Newcastle disease (OIE). LPAI is not categorized as a reportable disease. Most HPAI and LPAI in poultry are assumed to occur from exposure to wild avian species. Wild birds including waterfowl have been shown to concurrently harbor influenza and Newcastle disease in the same areas geographically as domestic poultry. The movement of the virus from waterfowl to domestic birds or humans is a rare event. In Asia, there appears to be a relationship between the virus in waterfowl and domestic chickens. Several methods of influenza introduction into poultry can occur. First, viruses that are introduced through live bird markets can enter a poultry facility. Several subtypes have been continuously isolated within live bird markets in the northeast suggesting the markets perpetuate the maintenance and spread of these viruses. Also, the contamination of items moving back and forth from areas where type A influenza's are endemic such as in Mexico can subsequently be introduced into a poultry facility.

The poultry industry in Texas is ranked 6$^{th}$ in the U.S.A. in broiler production and seventh in egg production (USDA-NASS). In 2003, chickens were produced in 5,933 rearing houses (5,544 of which were on 1,165 contract farms). The poultry industry is fragile when considering outbreaks of avian influenza on a commercial poultry farm where one outbreak can cost millions and can result in the closing of borders for trade. In an effort to reduce the impact of an influenza outbreak on the commercial poultry industry, in 1995 a voluntary AI surveillance program was

initiated for commercial poultry farms and was implemented by the Texas Poultry Federation and the Texas Animal Health Commission and in 2000, the National Poultry Improvement Plan. Since that time, several surveillance systems have been established within the states on a risk or needs-based approach. The surveillance program in Texas tests eggs, broilers, and turkeys throughout the state and to date 1,216,036 tests have been performed and only 2 positive birds were detected (2 chickens in 2002 tested positive for LPIA) (TVMDL, 2005 personal communication). Since the implementation of this surveillance system, the commercial poultry industry has been able to contain outbreaks quickly with early detection being the key to containment with a few exceptions (i.e. Gonzales county outbreak; Hopkins county outbreak). Outbreaks have been quickly contained by stomping out, creating zones around the infected flocks, and expanded area surveillance.

Live bird markets are of great concern in Asia. In North American, the Northeast has continuously been a reservoir for LPAI. An ongoing surveillance system has been implemented in the Northeast. In addition to poultry, AI has been isolated from domestic ducks, game birds, and environmental samples in these live bird markets. The live bird markets in Texas consist of known markets in the Houston and Fort Worth metropolitan areas. The structure and function of the Texas markets differ greatly from the Northeast markets in that the Texas markets are limited to local suppliers with little or no out of state movement. The local suppliers to the markets would most likely be within 1-2 county buffer around the actual markets. We used a one county buffer in this model.

Risk factors for infection of HPAI in Hong Kong were most likely associated with bird movement. Farms that sold chickens directly to a retail market had a greater odds of infection compared to farms that did not sell. Farms that hosted visitors from retail markets had a greater odds. Farms with owners who lived off the facility also had a higher odds.

Domestic ducks are usually year round residents of ponds and lakes that are often co-inhabited by migratory waterfowl. They may be immuno-genetically naïve to viruses circulating in migratory fowl. They are also more likely to frequent lagoons and drainages near poultry farms. In the recent HPAI outbreak in Asia, domestic ducks have been infected and in one case a source of infection to humans.

Outbreaks occur in areas where movement of poultry occurs, where high numbers of poultry coexist, and where biosecurity is lacking. Although the commercial poultry industry in the United States has high biosecurity, small farms and breeders may not. In addition, gamefowl enthusiast frequently move birds illegally and a complete assessment of this industry is not available.

## Results and Interpretations

RISK FACTORS

1. Historically a number of outbreaks in poultry have been correlated with a H5 strain that has been identified in wild birds. Outbreaks in

poultry facilities would be likely in counties with high numbers of wild birds or wetlands that may support these species. We used the National landcover data set which provides 21 categories of land cover types, to determine the percentage of wetlands per county. Suitable habitats for most waterfowl include fresh and salt water marshes (estuarine and palustrine wetlands) and lakes and ponds or potholes (open water).

2. High numbers of poultry such as poultry farms including broilers, layers, and pullets that lack biosecurity are more likely to have outbreaks than smaller farms or backyard flocks

3. A distributor is described by the Texas Administrative code; Texas Animal Health Commission (TAHC), (Title 4: Agriculture, Part 2, TAHC; Chapter 54 Domestic and Exotic Fowl registration) is a person engaged in sales and/or movement of live domestic or exotic fowl between a production system and a live bird market or fowl market or acquires domestic or exotic fowl from multiple flocks or geographic areas for resale to another person.

4. The Texas Parks and Wildlife (TPW) definition of domestic ducks includes only domestic ducks found on small ponds at parks or other areas that humans may visit and includes non-migratory ducks. Whereas, domestic fowl includes any species domestically propagated and maintained for food, eggs, or agricultural exhibition and recreation (i.e. Chickens, turkeys, domestic mallard ducks, muscovy ducks, and domestic geese). This definition is used by TAHC but the domestic ducks definition for TPW is different and would not include poultry.

5. Live Bird Markets (LBM) or a fowl market is any facility on which live domestic fowl or domestic and exotic fowl are congregated for sale or to be sold live for any purpose. A fowl market is a location where fowl are assemble at regular intervals for sale, trade, barter, or exchange.

6. Seller is any person who sells, trades, exchanges or barters domestic or exotic fowl

7. Transporter is a person who transports, for hire, domestic or exotic fowl from a producer premises to another premises, a live bird market, a fowl market or to another person.

8. Hobby/ fanciers/ pets may register with TAHC under the Fowl Registration program.

**Note: Sellers, distributors, or transporters of live domestic or exotic fowl in the state shall register with the commission.

**MODEL:**

**Risk Assessment Model:**

1. Wild birds: **Prop_wild** = Percent birds/ total birds in state
2. Domestic Wild birds: **Prop_Dduck** = percent birds/ total birds in state
3. Poultry: **Prop_poul** = percent birds/ total birds in state
4. Registered Sellers: Yes= 0.1; No=-0.1
5. LBMs, Buffer, and Suppliers for LBMs: Yes=0.5; No=-0.5
6. Distributors/ Combo (seller/distributor) Yes=0.25; No=-0.25

7. Fanciers/hobby/pets: **Prop_hobby** = percent birds/total birds in state
8. Wetlands: **Prop_wetlands** = percent wetlands in county/ total wetlands in state

| **Variable** | **Source** |
|---|---|
| 1. Wild birds | Texas Parks and Wildlife Dept. (TPWD) |
| 2. Domestic Wild Birds | TPWD, National Ag. Statistics Service (NASS) |
| 3. Poultry | NASS |
| 4. Registered Fowl Sellers | Texas Animal Health Commission (TAHC) |
| 5. Live Bird Markets/Suppliers | TAHC |
| 6. Distributors | TAHC |
| 7. Fanciers | TAHC |
| 8. Wetlands | U.S. Geologic Survey (NLCD) |

Figure 1

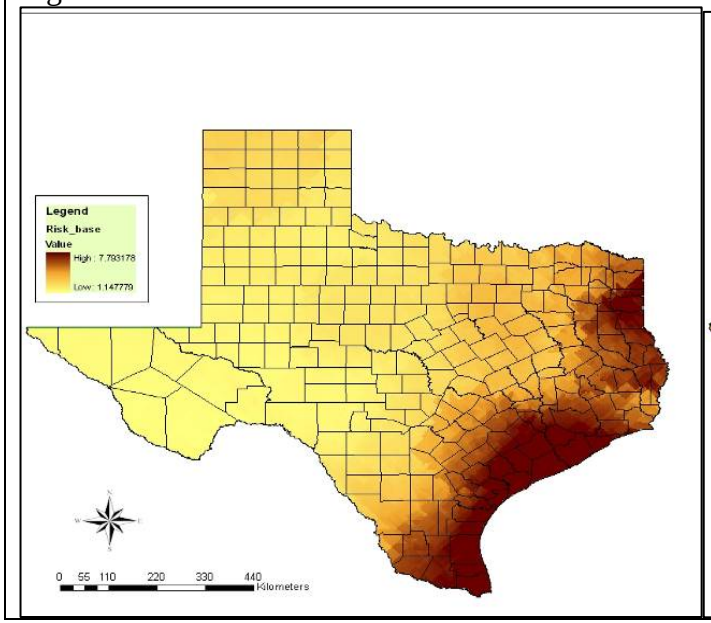


Figure 2.

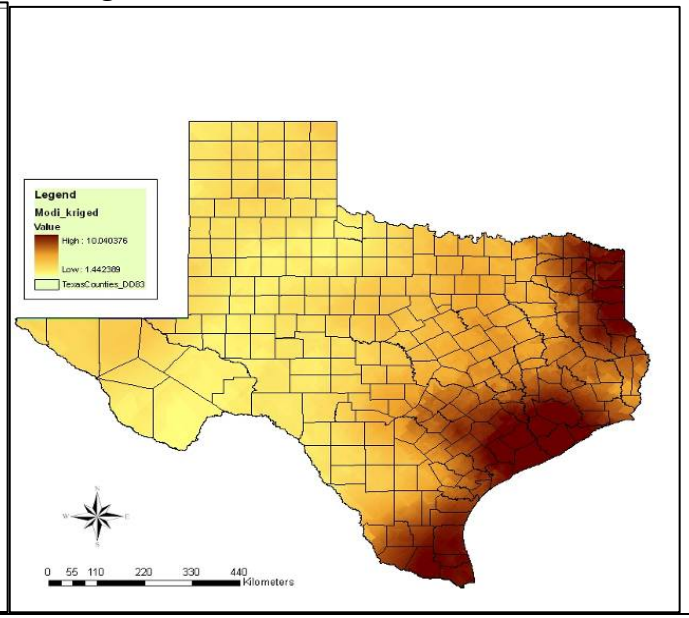

Figure 1. Base risk model including variables above

Figure 2. Risk model modified based on sensitivity analysis, to weigh factors that involve movement of birds at a higher value

## Technology Transition

In addition to the DHS, expected customers for the deliverables produced by this project include the USDA:APHIS Emergency Management and Wildlife Services, the USGS, the U.S. and Mexican governments, state and local responders, emergency response planners, and other University Centers of Excellence.

Potential collaborators include APHIS Center for Epidemiology and Animal Health and State Animal Health Authorities and Colleges of Veterinary Medicine and Medicine, particularly those in border states. Collaborative research proposals could target the USDA National Research Initiative (Animal Protection program), the National Institutes of Health NIAID Bioterrorism and Emerging Diseases program, the CDC Emerging Diseases program, and the NSF Ecology of Infectious Disease program.

## Status of Funding

End of project is September 30, 2007