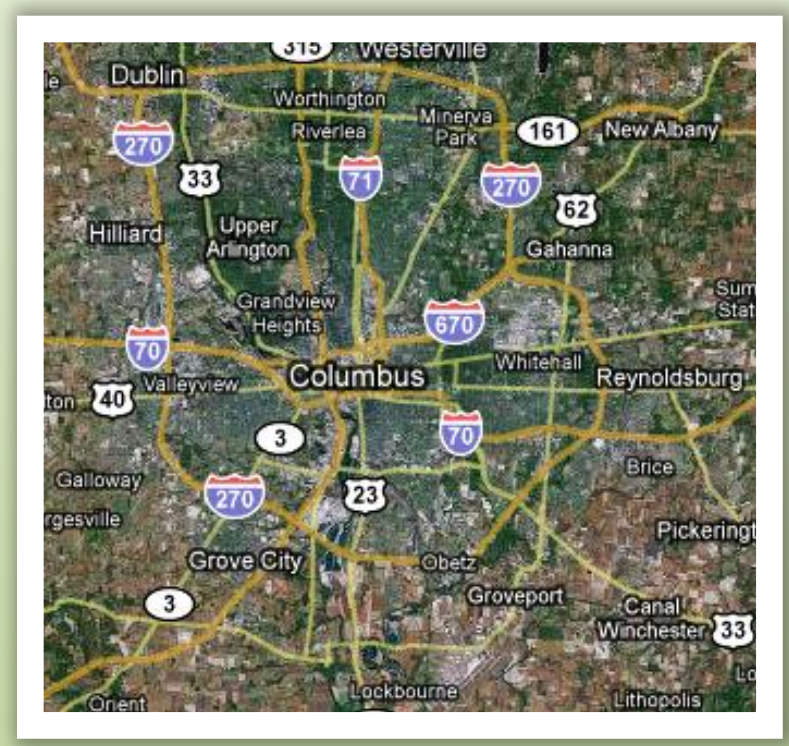
Risk Assessment
For Franklin County
2010



Franklin County
Emergency Management
and Homeland Security

Table of Contents

Executive Summary 3

Section 1 – Risk Assessment 7

Section 2 – Franklin County Profile 23

Section 3 – Hazard Identification 43

Section 4 – Franklin County Hazards 55

Appendix A - Lexicon 284

Executive Summary

Executive Summary

Franklin County Emergency Management and Homeland Security (FCEM&HS) has produced this 2010 update of the official Risk Assessment for Franklin County, the first comprehensive update of the assessment since 1996. FCEM&HS is a local government agency in Franklin County, Ohio, responsible for coordinating county-wide emergency/disaster planning, education, warning, response and recovery to minimize the adverse impact of disasters on people and property in the county. This document is a detailed study of the hazards most likely to impact Franklin County. Sixteen hazards – dangerous events such as winter storms, floods and terrorist attacks – were analyzed and ranked according to the potential risk they pose.

PURPOSE: In the U.S. Department of Homeland Security publication *DHS Risk Lexicon, September 2008*, "risk" is defined as the "potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences," and "risk assessment" is defined as the "product or process which collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making." Risk assessment provides the basis for planning and implementing measures to reduce risks and impacts of disasters by reducing either hazards or vulnerability, or both. This 2010 update of the Risk Assessment for Franklin County thus is critically important to the county in that it will serve as a foundation for future emergency and disaster planning by all local governments in the county. The purpose of this risk assessment is not to predict the occurrence of a particular hazard but to quantify the risk of one hazard compared to another – to provide a sense of hazard priorities, or relative risk.

METHODOLOGY: To produce the update, FCEM&HS worked over several months in 2009-10 to research and draft an assessment document outlining 16 natural, human-caused and technologically caused hazards that Franklin County may face. The agency then convened a group of local subject-matter experts to estimate which of these hazards likely posed the greatest risk today to the county's residents and workers. They helped determine how certain risk factors should be applied to each hazard. Those factors included:

- *Frequency.* The history of past occurrences is used as the indicator of the expected frequency of the hazard. A statistical probability is not used because such information is not consistent across hazards.
- *Average response duration* is defined as "time on the ground," or the time period of response to a hazard or threat.

- *Speed of onset* is the length of warning time that can be expected with a particular hazard. The lead time required to protect lives and property varies greatly with each hazard.
- *Exposure* is the geographic dispersion of the hazard – how much of the county will be impacted by the event.
- *Impact on population* is an indication of the percentage of the population that might be killed, injured or displaced.
- *Impact on property* is the amount of public and private property and infrastructure that could be potentially damaged by the event.
- *Impact on economy* is the enduring economic impact of the hazard – the duration of business interruption.

With this work, the experts evaluated and ranked the hazards in order of their likelihood and potential consequence, and their input formed the basis for the final ranking conducted by FCEM&HS and outlined in this document.

HAZARDS: Listed below in numerical order are brief descriptions of the 16 ranked hazards in Franklin County. The lower the numerical ranking for a hazard, the higher its likelihood and potential consequence:

No. 1: Flooding is, basically, the accumulation of too much water in too little time in too small a place. From 1999 to 2008, Franklin County received as many as 10 flood warnings in a single year. Besides being the top-ranked hazard in Franklin County, flooding is the No. 1 severe-weather related killer in the U.S.

No. 2: Severe winter weather includes snow, ice and extreme cold. Winter storms are events in which the dominant varieties of precipitation are those that occur only at cold temperatures. There were reports of 32 snow and ice events for Franklin County from January 1994 through March 2009, with five deaths, eight injuries and more than $16 million in damages.

No. 3: Dam failure is a catastrophic mishap characterized by the sudden, rapid, and uncontrolled release of impounded water. Dam failure can occur with little or no warning and for one or a combination of reasons, including overtopping, seepage (water percolating through the dam and its foundation) and structural failure caused by earthquakes, sliding and slope instability, or faulty construction. Two dams serving Franklin County are on the Ohio EMA's list of the ten most potentially hazardous dams in the state, based on the possible catastrophic consequences should they fail.

Franklin County Top 10 Hazard Rankings, 2010

1) Flooding
2) Severe Winter Weather
3) Dam Failure
4) Terrorism
5) Infectious Diseases
6) Tornadoes
7) Severe Summer Weather
8) Extreme Heat
9) Hazardous Materials
10) Drought

No. 4: Terrorism is a violent act or an act dangerous to human life, in violation of the criminal laws of the U.S. or any segment, to intimidate or coerce a government, the population or any segment of it, in furtherance of political or social objectives. Terrorist acts may produce chemical, biological, radiological, nuclear and/or explosive (CBRNE) events. Although Franklin County has never been the victim of a direct terrorist attack, the county has a history of terrorist activity. Franklin County and the City of Columbus have consistently received federal dollars for projects fostering terrorism preparedness.

No. 5: Infectious diseases are illnesses caused by the entrance into the body of harmful microbial organisms which grow and multiply. The diseases of most concern to the health and welfare of communities are those that are communicable – that is, those caused by microorganisms such as bacteria, viruses and parasites and transmitted from an infected person/animal and/or contaminated food or water source to another person or animal. Franklin County is susceptible to many common infectious diseases, such as seasonal flu, as well as diseases that are newly emerged, such as H1N1 Influenza.

No. 6: Tornadoes are nature's most violent windstorms – even weak ones can cause significant damage and fatalities. A tornado is defined as a violently rotating column of air, often visible as a funnel cloud, in contact with both the ground and the cloud base. Franklin County experienced 26 tornadoes from 1954 through 2008, all of which were rated F3 (or EF3) and under. This hazard was ranked No. 6 out of 16.

No. 7: Severe summer weather includes thunderstorms, hail, lightning and damaging wind, and often all four occur in one storm system, causing more damage than each hazard would have alone. Based on data from 1999 to 2008, Franklin County can undergo as many as 15 severe thunderstorm warnings each year.

No. 8: An **extreme heat** event is a prolonged period of excessively hot weather, which may be accompanied by high humidity. There has never been a confirmed heat related death in Franklin County, although it is the No. 1 non-severe-weather related killer in the U.S.

No. 9: A **hazardous materials incident** is the unintentional release of a hazardous material from its container or package in a sufficient concentration to pose a threat. Hazardous materials may be explosive, flammable, combustible, corrosive, reactive, poisonous, biological or radioactive, as well as solid, liquid or gaseous. As of 2009, Franklin County has 658 facilities required to report their hazardous materials. In 2008 there were nearly 400 spills in Franklin County reported to the Ohio EPA.

No. 10: Drought is a prolonged period of abnormally dry weather, where the lack of sufficient precipitation causes a serious hydrologic imbalance with economic and/or social consequences. Franklin County is primarily impacted by drought

relating to shortages in the water supply as well as a decrease in overall water quality. It also greatly impacts the 24% of county land in crops or pasture.

No. 11: Utility interruptions or failures may involve electrical power, natural gas, public water and communications systems. These systems are vulnerable to natural hazards as well as human-caused and technologically caused disruptions. Franklin County has experienced interruptions and failures of various kinds; remnant winds of Hurricane Ike in 2008, for example, caused over one-third of the county to lose power.

No. 12: Invasive species are any species not native to an ecosystem whose introduction causes or is likely to cause harm to the economy, environment or human health. An increasing threat of exotic diseases, such as the dangerous West Nile virus, exists because of increased transportation and encroachment of humans into previously remote ecosystems. Two events that have caused substantial economic and environmental damage in Ohio are the introduction of zebra mussels into waterways and the incursion of the emerald ash borer, responsible for killing ash trees.

No. 13: Air and water pollution/contamination is the contamination of water, land or the air by substances that can adversely impact the environment and human health. Franklin County is subject to point and nonpoint water pollution of streams, as well as ground level ozone.

No. 14: Transportation accident – aircraft is an occurrence associated with the operation of an aircraft which takes place between the time any person boards with the intent to fly and all persons have disembarked and in which a person is fatally or seriously injured, the aircraft sustains damage or structural failure and/or the aircraft is missing or is completely inaccessible. Franklin County has 4 operational airports, all located in densely populated areas. There have been only two reported air crashes in the county.

No. 15: A **civil disturbance** is a planned or random uproar or disturbance of ordinary community life by persons choosing to ignore laws, often to bring attention to a cause, concern or agenda. Franklin County has seen many types of civil disturbances through the years, from prison riots to university campus disturbances to political rallies.

No. 16: Earthquakes are caused by the movement of the earth's crustal plates along faults. Franklin County is not located on a fault line, nor have any epicenters been located here. Although earthquakes occurring in other areas have been felt in Franklin County, no damage has been reported here.

More detailed explanations of these hazards – as well as more information about the rationale for, significance of and methodology followed in producing the 2010 Risk Assessment for Franklin County – may be found in the following pages.

Section 1 – Risk Assessment

Contents

Risk Assessment Concept and Purpose 8
Risk Assessment Model 12
Risk Assessment Methodology 13
Risk Factors 14
Hazard Scoring 17
Risk Management Taxonomy 18

Risk Assessment Concept and Purpose

Risk Assessment Concept

Risk has always been and always will be part of our lives. There is no universally valid definition of risk because risk perception and level of risk acceptance varies from one individual to another. As could be expected, approaches, concepts, methods and terminology for risk assessment found in the literature and in practice are very diverse, and in some cases are contradictory.

The National Strategy for Homeland Security states:

> *"The assessment and management of risk underlies the full spectrum of our homeland security activities… We must apply a risk-based framework across all homeland security efforts in order to identify and assess potential hazards (including their downstream effects), determine what levels of relative risk are acceptable, and prioritize and allocate resources among all homeland security partners… We as a Nation must organize and help mature the profession of risk management by adopting common risk analysis principles and standards, <u>as well as a professional lexicon.</u>*

National Fire Prevention Association 1600, A.5.3 states:

> *"A comprehensive risk assessment identifies the range of possible hazards, threats, or perils that have or might impact the entity, surrounding area, or critical infrastructure supporting the entity. The potential impact of each hazard, threat, or peril is determined by the severity of each and the vulnerability of people, property, operations, the environment, and the entity to each threat, hazard or peril. The risk assessment should categorize threats, hazards, or perils by both their relative frequency and severity, keeping in mind there might be many possible combinations of frequency and severity for each. The entity should attempt to mitigate, prepare for, plan to respond to, and recover from those threats, hazards, or perils that are able to significantly impact people, property, operations, the environment, or the entity itself."*

Department of Homeland Security Risk Lexicon states:

> "*Risk Assessment*
> *Definition: product or process which collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.*
> *Example: The analysis produced a risk assessment outlining risks to the aviation industry.*
> *Extended Definition: appraisal of the risks facing an entity, asset, system, network, geographic area or other grouping.*
> *Annotation: A risk assessment can be the resulting product created through analysis of the component parts of risk."*

Risk assessment provides the basis for planning and implementing measures to reduce risks and impacts of disasters. Reducing the risk of a disaster can be done by both reducing the hazard and reducing vulnerability. Reducing the hazard is usually very difficult or even impossible. Vulnerability, on the other hand, is easier to influence by strengthening response, planning and protective capabilities.

Hazard Identification

A hazard is an event which can lead to loss of life or damage to objects, buildings and the environment. A hazard is measured and defined by its nature (type of hazard), location and extent, scope and intensity (damage potential) and its probability of occurrence, duration and frequency (repetition cycles).

There are three categories of hazards: naturally occurring hazards, human-caused events, and technologically caused events. Naturally occurring hazards are further categorized into geological, meteorological and biological hazards. Human-caused hazards include both accidental and intentional hazards.

Hazard identification investigates, identifies and documents potential hazards and threats, and examines their causes and impact chains. Hazards have impact chains, which can vary in length. For example, torrential rain can have direct impact on poorly constructed roofs, but the consequences of torrential rain – flooding, landslides, erosion, etc. – create a more severe and far reaching impact. The severity of impact is further influenced by vulnerability factors (water catchment areas, steep slopes) and whether there are elements present which are vulnerable to the hazard, e.g., structures in low lying areas.

Knowledge of the types of hazards that may impact an area is essential for analyzing and assessing risks. Hazards require different levels of risk assessment depending on the extent of the impact they can have on the community. A hazard that is unlikely to happen (and if it does, causes very little damage) will not require the same level of assessment as one that happens frequently and causes severe damage.

Steps in Hazard Identification

1. Identification and classification of hazards.
2. Determination of appropriate risk analysis level, based on potential impact and data available.
3. Identification and characterization of hazard-prone locations.
4. Estimation of the probability of occurrence.
5. Estimation of possible magnitude.

Hazard identification describes and assesses the frequency of occurrence, at a specific place, at a specific time, and with a specific intensity and duration, for a vulnerable population, property, economy and environment.

Vulnerability and Consequences

After the hazard identification process has studied possible hazard events, a vulnerability and consequence analysis can be conducted. Vulnerability and consequence are hard to separate. Vulnerability describes the amount of people, property and the environment exposed to the hazard. Consequence is the severity of damage that can happen to the exposed people, property and environment. Damage can be to the population (life, health, wellbeing), material assets (buildings, infrastructure), environmental assets (forest, agricultural land) or economic factors (loss and disruption of business).

Steps in Vulnerability and Consequence Analysis

1. Identification of potentially vulnerable locations.
2. Identification and analysis of factors influencing or resulting in vulnerability – physical, social, economic and environmental.
3. Development and identification of indicators for identifying possible damage and estimating the degree of damage.
4. Analysis of protection and preparedness measures.
5. Estimate of accepted risk.

Purpose of Risk Assessment

Risk assessments are developed for many different purposes. From a mitigation perspective, the focus is on property and infrastructure damage. For the purposes of emergency planning, hazards are prioritized using criteria including frequency, duration, speed of onset, exposure and economic impact, with more focus on life safety issues.

Risk assessment is the foundation of the emergency management program, providing information for evaluation, prioritization, and treatment of risks. It allows program elements to be based on realistic appraisals of the types of hazards and their impacts that the county is likely to face. The results of a risk assessment can:

- Create an awareness of hazards and risks.
- Provide a confident basis for decision making and planning.
- Prioritize hazards and potential impacts.
- Identify who and what may be at risk.
- Provide justification for the commitment of funding and resources.
- Highlight opportunities for mitigation efforts.
- Identify gaps and weaknesses in current protective measures.
- Improve existing capabilities.
- Develop effective warning and evacuation systems.
- Contribute to land use planning.
- Enhance public confidence.

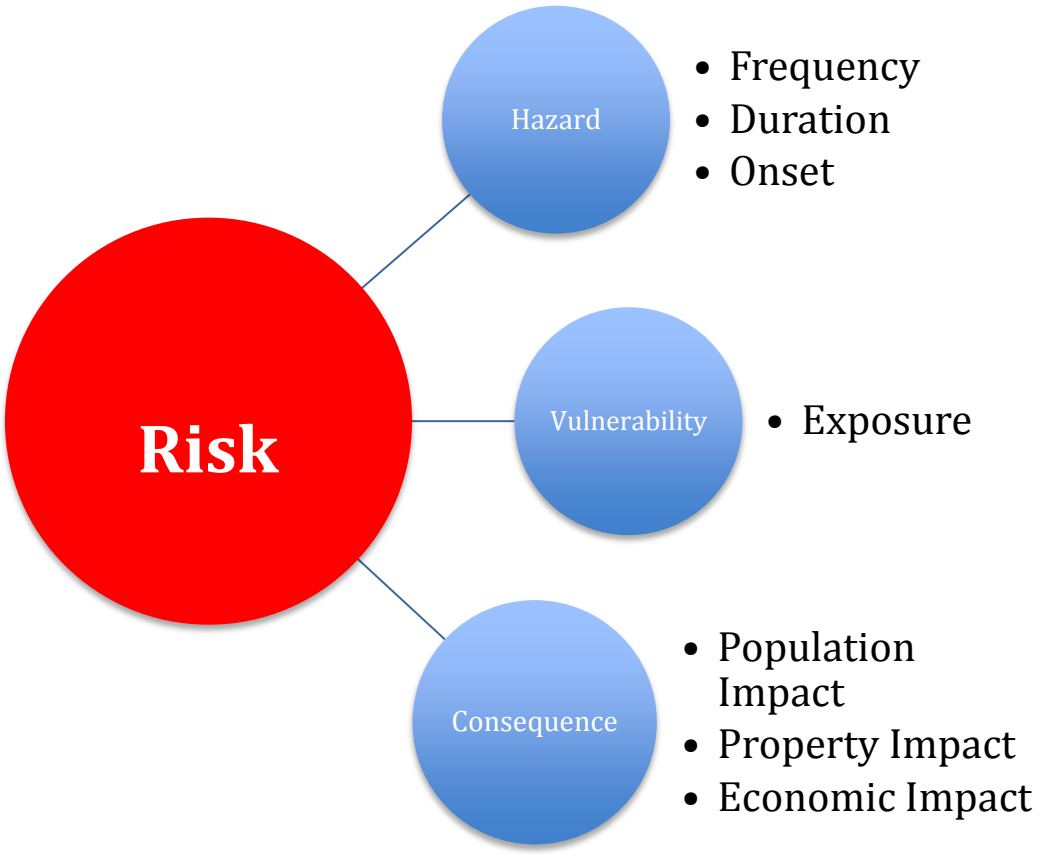
Risk assessment is based on the recognition that risk is the result of the link between hazard and the vulnerability of elements affected by the hazard. The goal of risk assessment is to use this link to estimate and evaluate the consequences and impacts of hazard events on the community.

Risk Assessment Model

The Department of Homeland Security (DHS) risk assessment model includes three elements of risk: threat, vulnerability, and consequences. These three elements were evaluated for this risk assessment using factors described in the Ohio Emergency Management Agency's (OEMA) *Hazard Identification and Risk Analysis.* Research for this risk assessment involved collecting both historical and statistical data. Generally, an average occurrence, not necessarily a catastrophic incident or worst-case scenario, was used in rating the hazards.

Adjustments were made for differences in state vs. county levels of assessment. The hazards were assessed using a set of seven risk factors. Risk factors are characteristics of a hazard that contribute to the potential losses that may occur. Three describe the nature of the hazard: frequency, duration, and speed of onset. One, exposure, describes the area that is vulnerable, and three others relate to the consequences of the event: the impact on the economy, impact on the population and impact on property. Numerical risk values were applied using descriptive benchmarks for each value level. These numerical values provide a basis upon which the hazards can be scored and compared to one another.

Risk Assessment Model



Risk Assessment Methodology

The purpose of this risk assessment is not to predict the occurrence of a particular hazard, but to quantify the risk of one hazard compared to another. It provides a sense of hazard priorities, or relative risk. **The total score of a single hazard is not as important as how it compares to the scores of the other hazards. Comparing the scores of all hazards will give us a method for prioritizing hazards and allow us to focus on those where relative risk is greatest.**

An extensive search of the literature and best practices for a credible risk assessment methodology led us to select three sources for guidance. Elements from all three sources were used and adapted as appropriate to local-level analysis.

- NFPA 1600, *Standard on Disaster/Emergency Management and Business Continuity Programs, 2007 Edition*: Section 5.3 Risk Assessment and Annex A Section A.5.3. Explanatory Material
- *Hazard Identification and Risk Analysis: Update*, Ohio Emergency Management Agency, 2007
- Department of Homeland Security's Risk Assessment Methodology

In this document, hazards are presented by hazard classification as recommended in NFPA 1600, A.5.3.2:

(1) Naturally occurring hazards
  (a) Geological hazards
  (b) Meteorological hazards
  (c) Biological hazards
(2) Human-caused hazards
  (a) Accidental
  (b) Intentional
(3) Technological-caused hazards

Using the NFPA 1600 list and the OEMA document, it was determined which hazards would be addressed and to what degree. The extent to which each was addressed depended on the extent that each could affect the county. The following types of analyses were used.

1. Cursory Analysis - A cursory analysis briefly describes the hazard's possible effects and explains why it is not considered a significant hazard for the county.
2. Standard Analysis - A standard analysis attempts to accurately and validly describe risks from and vulnerabilities to the county's significant hazards. In some cases limited data was available.
3. Advanced Analysis - An advanced analysis has fairly good information and resources available. This analysis requires more time but is appropriate for hazards that are likely to pose a high degree of risk to the county.

Risk Factors

Hazard Descriptive Factors

Frequency: OEMA based the frequency score on the number of Gubernatorial Declarations associated with the hazard. This is appropriate at the State level; however, at the county level, history of past occurrences is a more relevant indicator of expected frequency. Incident Reports at Franklin County Emergency Management and Homeland Security and data from the NOAA National Climatic Data Center were used to evaluate hazard frequency. A statistical probability was not used because information across hazards is not consistent.

Average Response Duration: Response Duration is defined as "time on the ground" or the time-period of response to a hazard or event. Duration is not necessarily an indicator of damage.

Speed of Onset: Speed of Onset is the length of warning time that may be expected. The lead time required for protecting lives and property varies greatly with each hazard.

Vulnerability Factor

Exposure: Exposure is the geographic dispersion of the hazard – how much of the county will be impacted by the event.

Consequence Factors

Impact on Population: Impact on the Population is an indication of the deaths and injuries expected, and protective measures required.

Impact on Property: Impact on Property is the amount of public and private property and infrastructure that could be damaged by the event.

Impact on Economy: Impact on Economy is the enduring economic impact of the hazard, including the duration of business interruption.

Each risk factor is scored on a scale of 1 – 5. Benchmark descriptions for each rating's numerical value are shown in the tables below. To make the ratings as objective as possible, all hazards were rated against the same criteria. The ratings are based on historical and statistical data, where available, and input from subject matter experts. Development of the benchmark descriptions and ratings was determined collectively, and was not the judgment of one person. The objective of scoring the hazards is to obtain ordinal data so the hazards can be compared to one another.

Risk Factor Rating Scales

Frequency: History of past occurrences	
Rating	Description
1	Occurs once in 50 years or less
2	Occurs once in 30-50 years
3	Occurs once in 10-30 years
4	Occurs once in 2-10 years
5	Occurs one or more times a year

Average Response Duration: Time period of response to the hazard	
Rating	Description
1	Less than six hours
2	6 – 12 hours
3	12 – 24 hours
4	Two days to one week
5	Greater than one week

Speed of Onset: The length of warning time that can be expected	
Rating	Description
1	More than 24 hours
2	12- 24 hours
3	6 - 12 hours
4	1 - 6 hours
5	Minimal to no warning

Exposure: How much of the county is likely to be impacted	
Rating	Description
1	One neighborhood
2	One jurisdiction
3	Multi-jurisdictions
4	Half of the county
5	Entire county

Impact on Population: Deaths and injuries expected, and protective measures required	
Rating	Description
1	Population not affected
2	Minimal effect on the population; minor inconvenience
3	Serious threat to a large number of people; a few deaths and injuries possible; minor population displacement
4	Significant number of people affected; deaths and injuries; sizable displacement of population
5	Severe effect in a widespread or concentrated area; large number of deaths and injuries; massive evacuation and shelter operations

Impact on Property: Amount of damage to public and private property and infrastructure	
Rating	Description
1	No impact on property
2	Minimal damage to property
3	Light damage to property; local resources adequate to repair or replace damaged property
4	Moderate damage to property over a widespread or concentrated area; damage may exceed local resources to repair or replace
5	Heavy damage to property over a widespread or concentrated area with severe effects; may result in a Presidential Declaration

Impact on Economy: Duration of business interruption	
Rating	Description
1	No shutdown of critical facilities or businesses
2	Shutdown of critical facilities or businesses for less than 24 hours
3	Shutdown of critical facilities or businesses for less than one week
4	Shutdown of critical facilities or businesses for at least two weeks
5	Shutdown of critical facilities or businesses for 30 days or more

Hazard Scoring

Some factors are key and therefore weighted more heavily as a percentage of the total score. Key factors can impact other factors. For example, if only a small portion of the county can possibly be affected, the impact on people, property, and the economy will likely be less. Weighting the factors helps to balance the total scoring. Weighting also converts the scores into a scoring scale of 0 – 100. The factors were weighted as follows:

Frequency	25%
Average Response Duration	5%
Speed of Onset	5%
Exposure	20%
Human Impact	15%
Property Impact	15%
Economic Impact	15%

Sample Scoring Table

Hazard/Threat:			
Factor	**Raw Score**	**Weight Factor***	**Converted Score**
Frequency		**5**	
Average Response Duration		**1**	
Speed of Onset		**1**	
Exposure		**3**	
Impact on Population		**3**	
Impact on Property		**3**	
Impact on Economy		**3**	
Total Converted Score			

*The weight factor will convert the raw score into the assigned percentage of total score.

Raw Score x Weight Factor = Converted Score

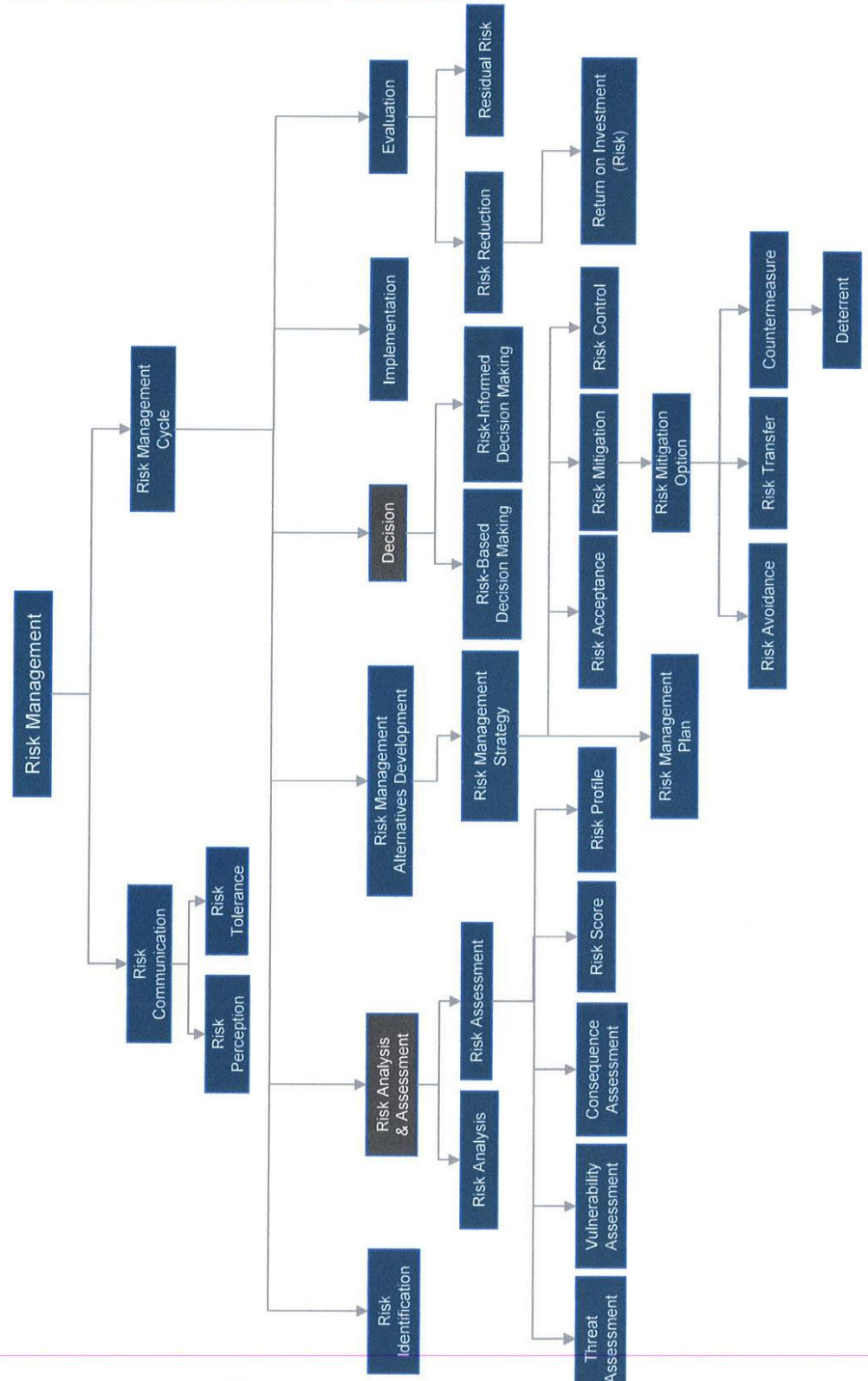
After all hazards are scored, they are ranked according to relative risk using the converted scores.

Risk Management Taxonomy

Risk assessment, the specific process that is at the core of this document, is part of the larger discipline of risk management, described in the U.S. Department of Homeland Security publication *DHS Risk Lexicon, September 2008* as the "process of identifying, analyzing, assessing, and communicating risk and accepting, avoiding, transferring or controlling it to an acceptable level at an acceptable cost…Risk management principles acknowledge that, while risk often cannot be eliminated, actions can usually be taken to reduce risk."

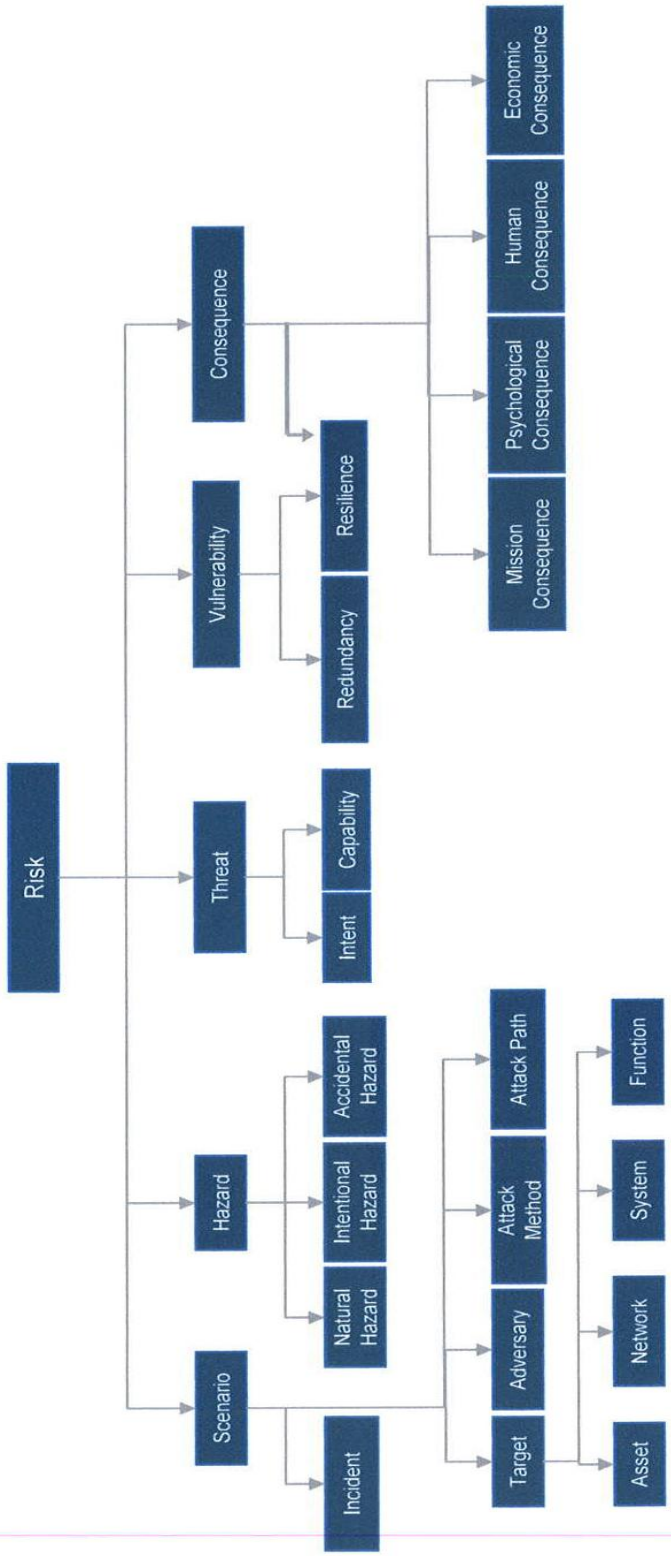
The *DHS Risk Lexicon* provides a series of taxonomy charts intended to show conceptual relationships among key risk management terms and foster better understanding of which concepts are broad and which are more specific. Toward that same end, two of those charts are displayed below.

CHART II: RISK MANAGEMENT BRANCH



U.S. DEPARTMENT OF HOMELAND SECURITY
DHS RISK LEXICON

CHART III: RISK BRANCH



U.S. DEPARTMENT OF HOMELAND SECURITY
DHS RISK LEXICON

Risk Assessment – References

Brnich, Michael J., Jr., CMSP, Mallett, Launa G., Ph.D. (2003) Focus on Prevention: Conducting a Hazard Risk Assessment. U.S. Department of Health and Human Services

Covello, Vincent T., Mumpower, Jeryl (1985) Risk Analysis and Risk Management: A Historical Prospective. Risk Analysis Vol. 5 (2) pp103-20

Emergency Management Australia (2004) Emergency Risk Management Applications Guide – Manual 5

Federal Emergency Management Agency (2001) State and Local Mitigation Planning How-to Guide: Understanding your Risks. Version 1.0

Federal Ministry for Economic Cooperation and Development (2004) Risk Analysis – A Basis for Disaster Risk Management. Duetsche Gesellechaff fur Technische Zusammenarbeit

Homeland Security Grant Program Risk – Based Distribution Methods (2008) Presentation to Congressional Committees

International Journal of Health Geographics (2008) Spatial Patterns of Natural Hazards Mortality in the United States

Louisville/Jefferson County Metro Emergency Management Agency (2005) Louisville Metro Hazard Mitigation Plan, Section 3.3, Risk Assessment

Michigan State Police – Emergency Management Division (2003) Hazard Mitigation Planning Workbook

National Fire Prevention Association (2007) NFPA 1600 – Section 5.3

Ohio Emergency Management Agency (2007) Hazard Identification and Risk Assessment – Update

Ohio Emergency Management Agency (2008) State of Ohio Mitigation Plan

SHELDUS/Spatial Hazard Events and Losses Database for the United States. http://webra.cas.sc.edu/huri/products/sheldus.aspx

State of Colorado, Division of Emergency Management (2004) Natural Hazards Risk Assessment for the State of Colorado

U.S. Department of Homeland Security, Lessons Learned Information Sharing. "Risk Assessment: Overview" [Online] 19 Feb 2009. www.LLIS.gov

U.S. Department of Homeland Security Risk Steering Committee (September 2008) DHS Risk Lexicon

Washtenaw County, Michigan (2004) Hazard Mitigation Plan

Section 2 – Franklin County Profile

Contents

History 24
Geography 26
Climate 27
Demographics 28
Land Use 29
Transportation 33
Economy 35
Government 37
Critical Facilities 39
Major Events 41

History

The earliest history of the region describes evidence of Native American mound-building societies near the confluence of the Scioto and Olentangy rivers. Mound Street in Columbus was so named because of proximity to a large burial mound. The ancient civilizations were later followed by the people of the Miami, Delaware, Wyandot, Shawnee, and Mingo nations--all familiar names today in Central Ohio. These nations resisted the expansion of the United States as explorers began moving into the region south of Lake Erie. After years of bitter conflict, the decisive battle at Fallen Timbers resulted in the Treaty of Greenville, which finally opened the way for new settlements.

In 1797 a new settlement, founded by a young surveyor from Virginia, Lucas Sullivant, flourished on the west bank of the forks of the Scioto River. Sullivant named his new settlement Franklinton, after Benjamin Franklin. His success was short lived when in 1798 the first of many floods wiped out the new settlement. Sullivant persevered and rebuilt the village, again in the same place so as to be near the navigable rivers. Over the years, Franklinton was flooded repeatedly until the building of the Franklinton Flood Wall, finished in 2004.

Ohio achieved statehood in 1803. Shortly after, Franklin County was created. Originally part of Ross County, it extended north to Lake Erie until Ohio further subdivided into more counties. The state capital was originally in Chillicothe, moved to Zanesville, then back to Chillicothe. The legislature finally decided a new capital would be located in the middle of the state. As a result, Columbus was founded in February 1812. Lessons had been learned, however, and the new city was located on the high banks opposite Franklinton at the forks of the Scioto known as Wolf's Ridge.

The National Road, now known as US Route 40, reached Columbus from Baltimore in 1831, complementing the city's new link to the 308 mile Ohio and Erie Canal system. During the Ohio and Erie Canal Era (1832-1904), many factories, warehouses and homes were built along both banks of the Scioto. Columbus was officially chartered as a city on March 3, 1834. Rail service reached Columbus in 1850, further enhancing the city as a transportation center.

From March 23 to March 27, 1913, a catastrophic flood reaching 22 feet inundated Franklinton, leaving 96 dead and thousands homeless. To stem future flooding, the Army Corps of Engineers recommended widening the Scioto through downtown and building a retaining wall along its banks. The only bridge to survive the flood was the new earth-filled concrete arch bridge at King Avenue. The survival of this bridge changed the way bridges were built throughout Franklin County. The devastating flood also led to several urban renewal projects, including the building of the O'Shaughnessy Dam and Reservoir and many structures that are now downtown landmarks.

Rapid suburban development in the county started in 1948 with the building of the Town and Country Shopping Center in Whitehall. The arrival of the interstate highway system

led to continued growth of the suburbs. Widespread urbanization of the county has continued, as well as revitalization efforts in downtown Columbus.

Geography

Franklin County is located near the geographic center of the state, in the Till Plains and the Appalachian Plateau land regions.

Franklin County's major drainage basin is the Scioto River, fed by major tributaries: the Olentangy River, Alum Creek, Big Darby Creek and Big Walnut Creek. It contains approximately 339 linear miles of major streams and rivers. The confluence of the Scioto and Olentangy rivers is just west of downtown Columbus. The county has relatively flat topography due to large glacial coverage during the Wisconsin Ice Age. The highest point in Franklin County is 1132 feet above sea level, near New Albany, and the low point is 670 feet, where the Scioto River leaves the county near Lockbourne. The county does have some variety in landscape due to numerous ravine areas near the creeks and rivers. Tributaries to Alum Creek and the Olentangy River cut through shale, while tributaries to the Scioto cut through limestone.

Topographical Land Cover in acres:

Land Cover	Acres
Total	348,029.4
Urban (open impervious surfaces)	88,614.3
Agriculture/Open Urban Areas	191,963.8
Shrub/Scrub	2,176.8
Wooded	58,695.9
Open Water	2,951.8
Non-forested Wetlands	2,935.9
Barren	690.8

Land Cover by percentage use:

Land Use/Land Cover	Percent
Urban (Residential/Commercial/Industrial/ Transportation and Urban Grasses)	61.05%
Cropland	22.71%
Pasture	1.48%
Forest	13.60%
Open Water	0.92%
Wetlands (Wooded/Herbaceous)	0.00%
Bare/Mines	0.23%

(Statistics in this section are from Ohio County Profiles, Ohio Department of Development)

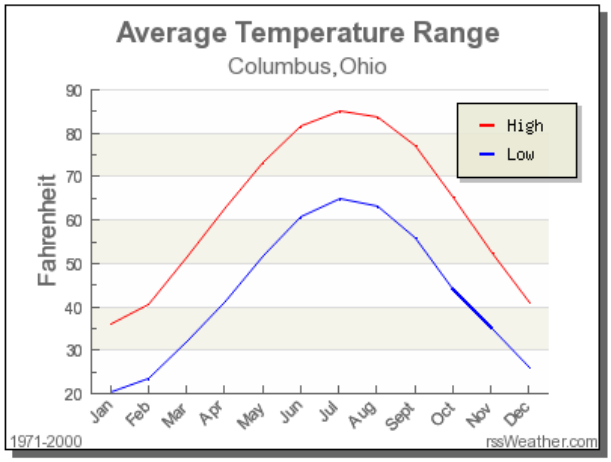
Climate

Franklin County is located in an area of changeable weather with four distinct seasons. Cold air masses from central and northwest Canada frequently invade the region. Tropical Gulf air masses reach central Ohio often during the summer and to a lesser extent in fall and winter. Annual averages are:

Rainfall	37 inches
Snow	28 inches
Temperature	54 degrees
High Temperature	73 degrees
Low Temperature	38 degrees

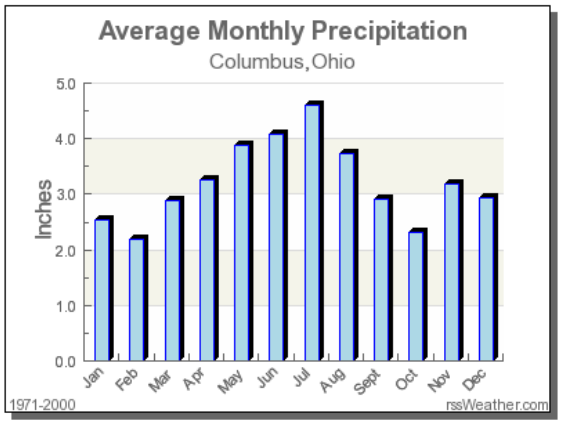
The hottest temperature ever recorded was 106°F, which occurred twice during the Dust Bowl drought of the 1930s. The coldest temperature ever recorded was -22°F on January 19, 1994. The county is subject to severe weather typical in the Midwest. Tornadoes are possible, as are floods, blizzards and severe thunderstorms.

Average Temperatures for Columbus



Month	Low	High
Jan	20.3°F	36.2°F
Feb	23.5°F	40.5°F
Mar	32.2°F	51.7°F
Apr	41.2°F	62.9°F
May	51.8°F	73.3°F
Jun	60.7°F	81.6°F
Jul	64.9°F	85.3°F
Aug	63.2°F	83.8°F
Sept	55.9°F	77.1°F
Oct	44.0°F	65.4°F
Nov	34.9°F	52.4°F
Dec	25.9°F	41.0°F

Average Rainfall for Columbus



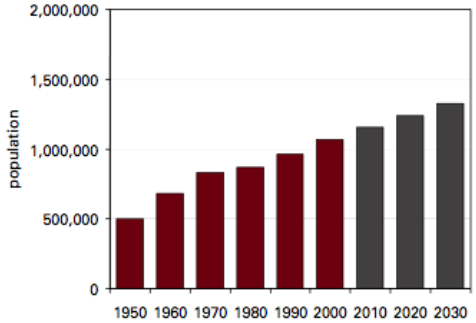
Month	Precipitation
Jan	2.53in.
Feb	2.20in.
Mar	2.89in.
Apr	3.25in.
May	3.88in.
Jun	4.07in.
Jul	4.61in.
Aug	3.72in.
Sept	2.92in.
Oct	2.31in.
Nov	3.19in.
Dec	2.93in.

Demographics

Franklin County has experienced steady population growth to 1,118,107, according to the U.S. Census Bureau's 2007 Population Estimates. This makes it the second largest county in Ohio after Cuyahoga, and the 34th largest county in population in the country. Columbus makes up about 66.5% of the population of the county, the rest being provided by various suburbs and townships.

Total Population

Census				Estimated	
1800		1900	164,460	2001	1,082,686
1810	3,486	1910	221,567	2002	1,087,882
1820	10,292	1920	283,951	2003	1,093,073
1830	14,741	1930	361,055	2004	1,096,810
1840	25,049	1940	388,712	2005	1,101,432
1850	42,909	1950	503,410	2006	1,109,067
1860	50,361	1960	682,962	2007	1,118,107
1870	63,019	1970	833,249	Projected	
1880	86,797	1980	869,132	2010	1,155,910
1890	124,087	1990	961,437	2020	1,238,250
		2000	1,068,978	2030	1,326,180



Largest Areas	Census 2000	Est. 2007
Columbus city (pt.)	702,132	736,359
Gahanna city	32,636	33,701
Grove City city	27,075	33,113
Dublin city (pt.)	27,087	32,528
Upper Arlington city	33,686	31,746
Westerville city (pt.)	29,418	28,990
Hilliard city	24,230	27,514
Reynoldsburg city (pt.)	26,388	26,844
Whitehall city	19,201	18,124
Prairie twp	17,118	16,733

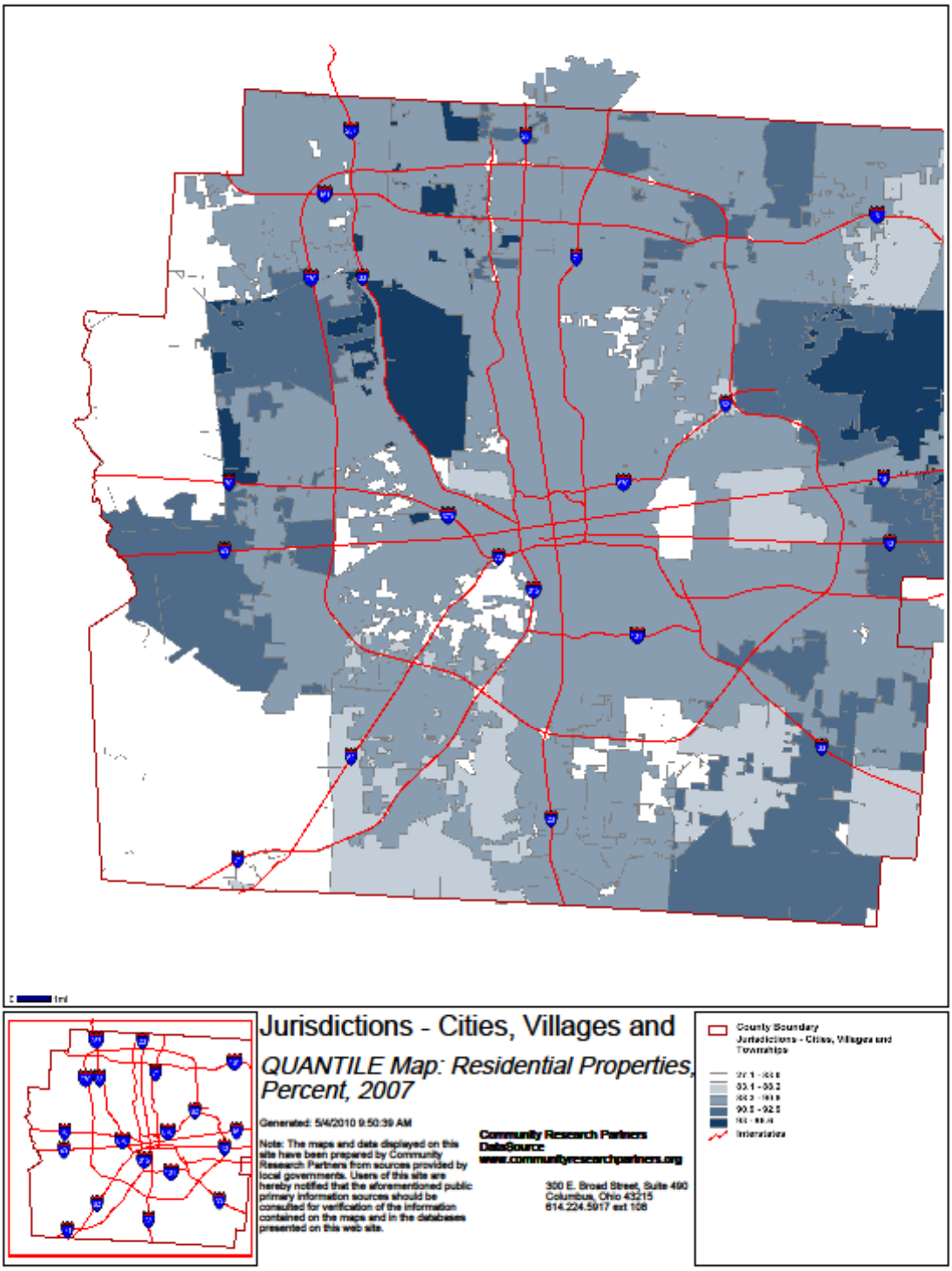
Housing Units	Number	Percent
Total housing units	471,016	100.0%
Occupied housing units	438,778	93.2%
Owner occupied	249,613	53.0%
Renter occupied	189,165	40.2%
Vacant housing units	32,238	6.8%

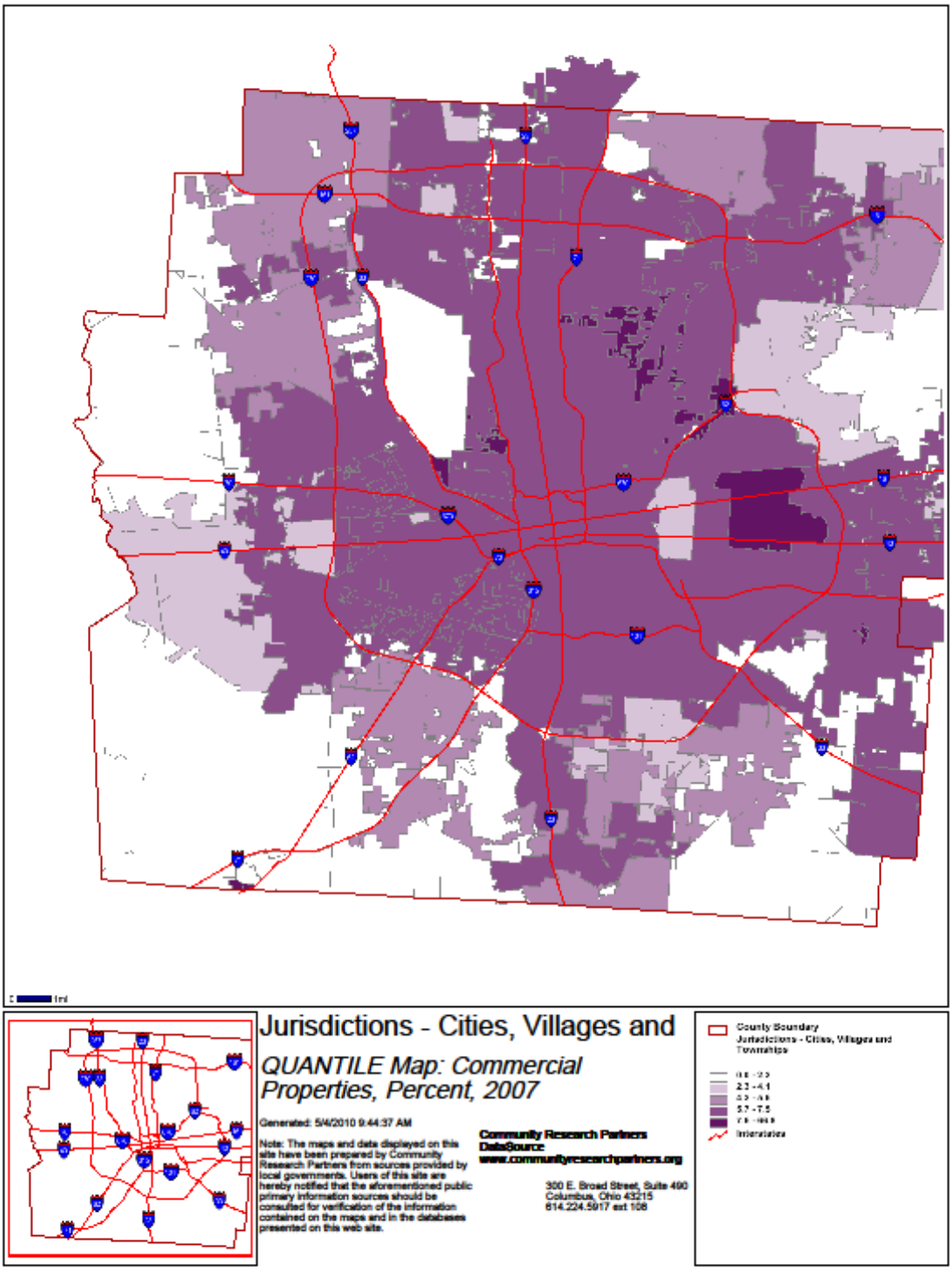
Population by Age	Number	Percent
Total Population	1,068,978	100.0%
Under 6 years	91,743	8.6%
6 to 17 years	176,113	16.5%
18 to 24 years	124,804	11.7%
25 to 44 years	357,916	33.5%
45 to 64 years	214,118	20.0%
65 years and more	104,284	9.8%
Median Age	32.5	

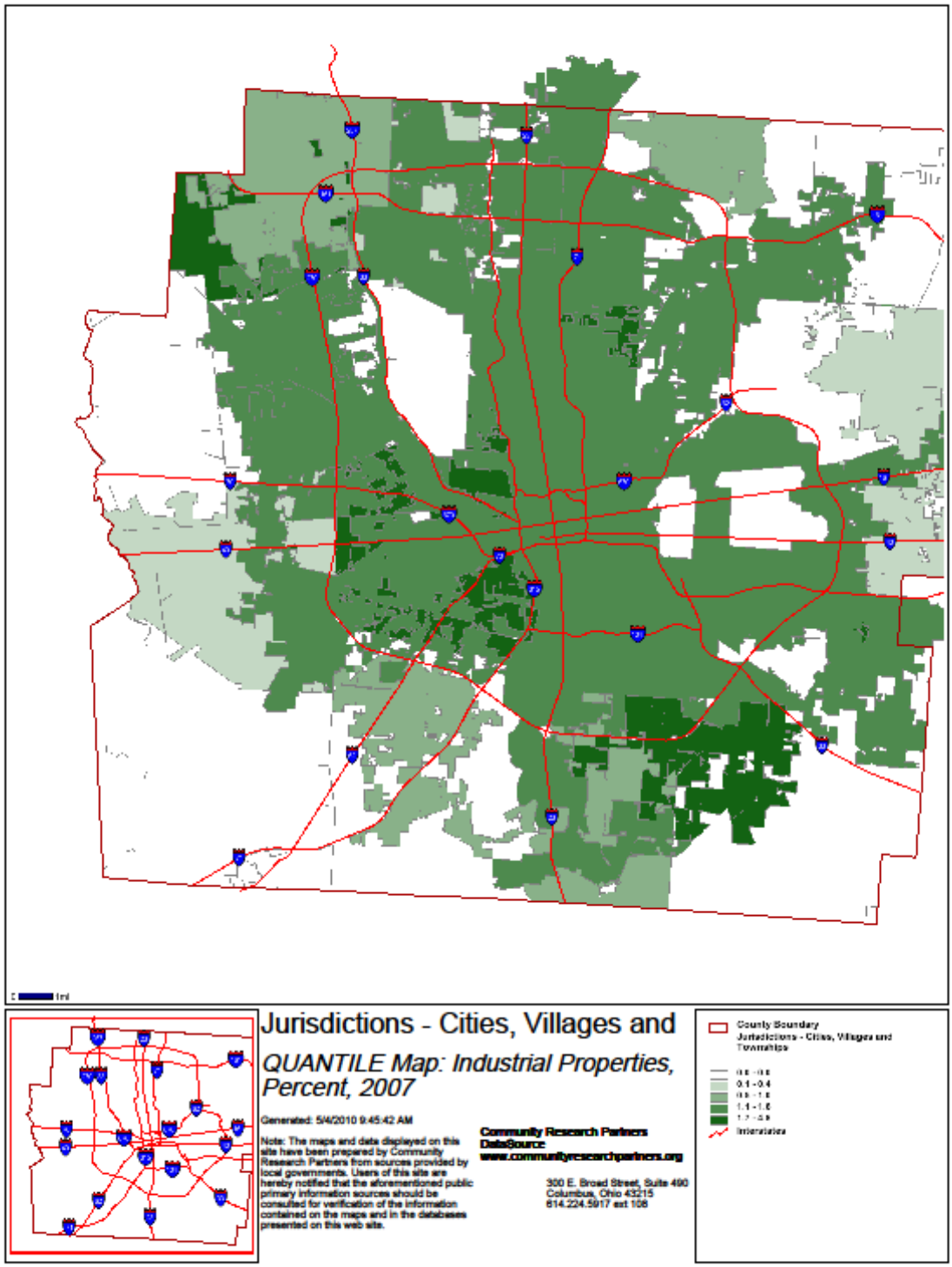
Population by Race	Number	Percent
Total Population	1,068,978	100.0%
White	807,104	75.5%
African-American	188,318	17.6%
Native American	3,552	0.3%
Asian	32,912	3.1%
Pacific Islander	362	0.0%
Other	9,909	0.9%
Two or More Races	26,821	2.5%
Hispanic (may be of any race)	24,121	2.3%
Total Minority	273,434	25.6%

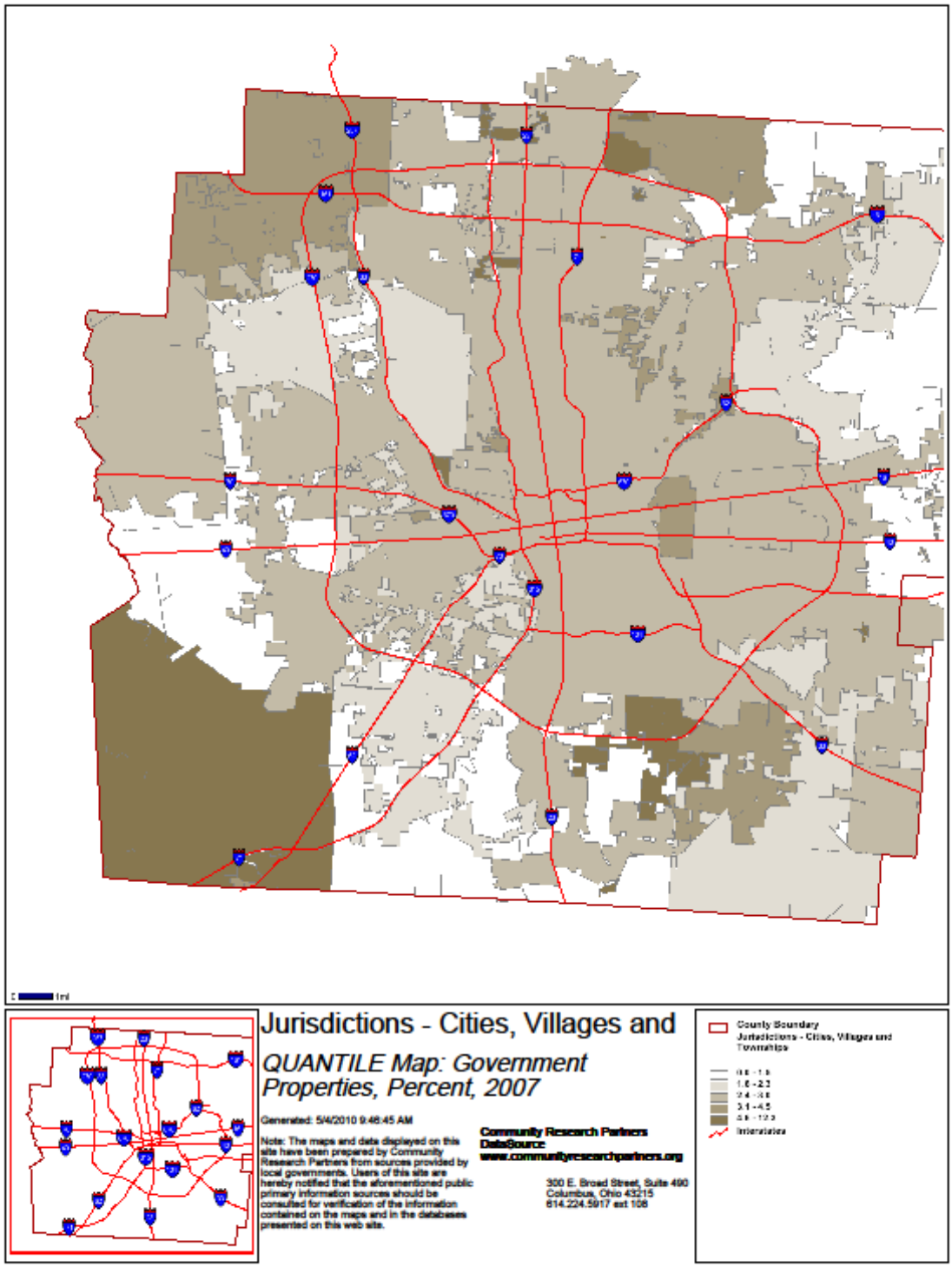
Land Use

Categories of land use by percentages: residential, commercial, industrial, government.




Jurisdictions - Cities, Villages and
QUANTILE Map: Commercial Properties, Percent, 2007
Generated: 5/4/2010 9:44:37 AM
Note: The maps and data displayed on this site have been prepared by Community Research Partners from sources provided by local governments. Users of this site are hereby notified that the aforementioned public primary information sources should be consulted for verification of the information contained on the maps and in the databases presented on this web site.
Community Research Partners
DataSource
www.communityresearchpartners.org
300 E. Broad Street, Suite 490
Columbus, Ohio 43215
614.224.5917 ext 108
County Boundary
Jurisdictions - Cities, Villages and Townships
Interstates


Jurisdictions - Cities, Villages and
QUANTILE Map: Industrial Properties, Percent, 2007
Generated: 5/4/2010 9:45:42 AM
Note: The maps and data displayed on this site have been prepared by Community Research Partners from sources provided by local governments. Users of this site are hereby notified that the aforementioned public primary information sources should be consulted for verification of the information contained on the maps and in the databases presented on this web site.
Community Research Partners
DataSource
www.communityresearchpartners.org
300 E. Broad Street, Suite 490
Columbus, Ohio 43215
614.224.5917 ext 108
County Boundary
Jurisdictions - Cities, Villages and Townships
Interstates

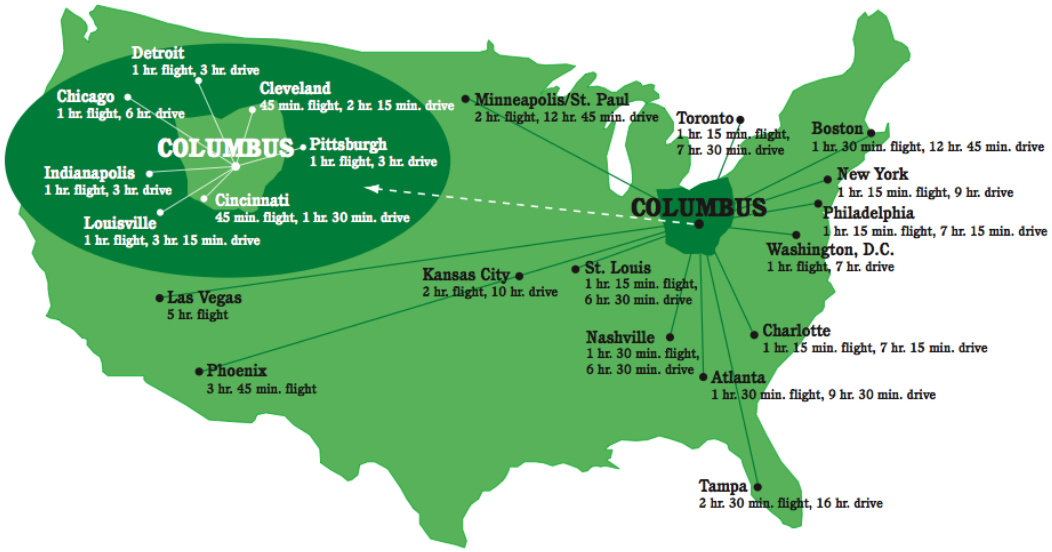

Jurisdictions - Cities, Villages and
QUANTILE Map: Government Properties, Percent, 2007
Generated: 5/4/2010 9:46:45 AM
Note: The maps and data displayed on this site have been prepared by Community Research Partners from sources provided by local governments. Users of this site are hereby notified that the aforementioned public primary information sources should be consulted for verification of the information contained on the maps and in the databases presented on this web site.
Community Research Partners
DataSource:
www.communityresearchpartners.org
300 E. Broad Street, Suite 490
Columbus, Ohio 43215
614.224.5917 ext 108
County Boundary
Jurisdictions - Cities, Villages and Townships
Interstates

Transportation

The county has 118.05 interstate highway miles, 117.17 U.S. highway miles, 122.26 state highway miles and 4,247.06 county, township and municipal road miles.

Franklin County is bisected by two major interstate highways, Interstate 70 running east-west, and Interstate 71 running north to southwest. The two highways run together for 1.5 miles through the city, creating a major traffic congestion point. The Interstate 270 Outerbelt encircles the vast majority of the city, providing traffic flow to and from suburban communities and surrounding counties. The Interstate 670 spur on the north side of the city continues to the east past the airport and west to a merger with I-70.

These highways are commuting routes for people in surrounding counties. In 2000, 101,256 commuters traveled into Franklin County from Delaware, Madison, Licking, Fairfield and Pickaway Counties. Due to its central location within the state, the abundance of outbound roadways makes nearly all of the state's destinations within a 2-hour drive. The county is also within 550 miles of half the U.S. population, making it a major transportation hub.



Map source: experiencecolumbus.org

In addition to commuters, Franklin County has the largest daily truck volume of any county in the state. Sixty-six per cent of the truck traffic passes through the county, to and from external destinations. In addition to Interstates 70 and 71, I-270 has very heavy truck traffic, especially in the Northwest quadrant. This area draws a large number of trucks due to the Buckeye Intermodal Yard and the large volume of warehouses in the area.

Franklin County is also considered a hub for rail activity in Ohio. The county has two intermodal rail facilities, CSX Buckeye Yard and Norfolk Southern Discovery Park Yard. There are also two classification yards, one at Buckeye Yard and one on Parsons Avenue. These are switching yards and serve the two major railroads plus regional and short-line railroads.

The Central Ohio Transit Authority provides bus service for limited routes throughout Franklin County. Commuter points are located in outlying suburbs to encourage the use of bus service to downtown businesses.

The county is served by two major airports. Port Columbus, on the east side of the county, provides passenger service and is a hub for NetJets, the world's largest fractional ownership carrier. Rickenbacker, in southern Franklin County, is a major cargo facility and services the Ohio National Guard. Don Scott OSU Airport and Bolton Field are significant general aviation facilities. The county also has several small airstrips and heliports.

Economy

Columbus has historically had strong and diverse economy. In 2006, Business First reported Columbus as having the strongest economy in Ohio and the seventh strongest in the country. It remains to be seen how the 2009-10 economic downturn will affect Columbus and Franklin County in the long term.

Franklin County has a large government presence, providing the largest single source of employment in the county, 16% of all workers. This includes the State Capitol as well as city, county and federal facilities and the Ohio State University. One of the largest facilities is the Defense Finance and Accounting Service.

Other sources of employment in the county are banking, insurance, research and development, manufacturing and technology.

The Mid-Ohio Regional Planning Commission (MORPC) projects the majority of growth in retail and office development will occur in the northern tier of the region, while new industrial warehouse and distribution centers will be located in the southern half of the county near Rickenbacker Airport.

The Franklin County Department of Development published the following statistics.

Civilian Labor Force	2003	2004	2005	2006	2007
Civilian labor force	599,700	600,000	599,700	608,000	618,800
Employed	567,700	567,100	568,600	579,700	589,900
Unemployed	32,000	32,900	31,100	28,300	28,900
Unemployment rate	5.3	5.5	5.2	4.7	4.7

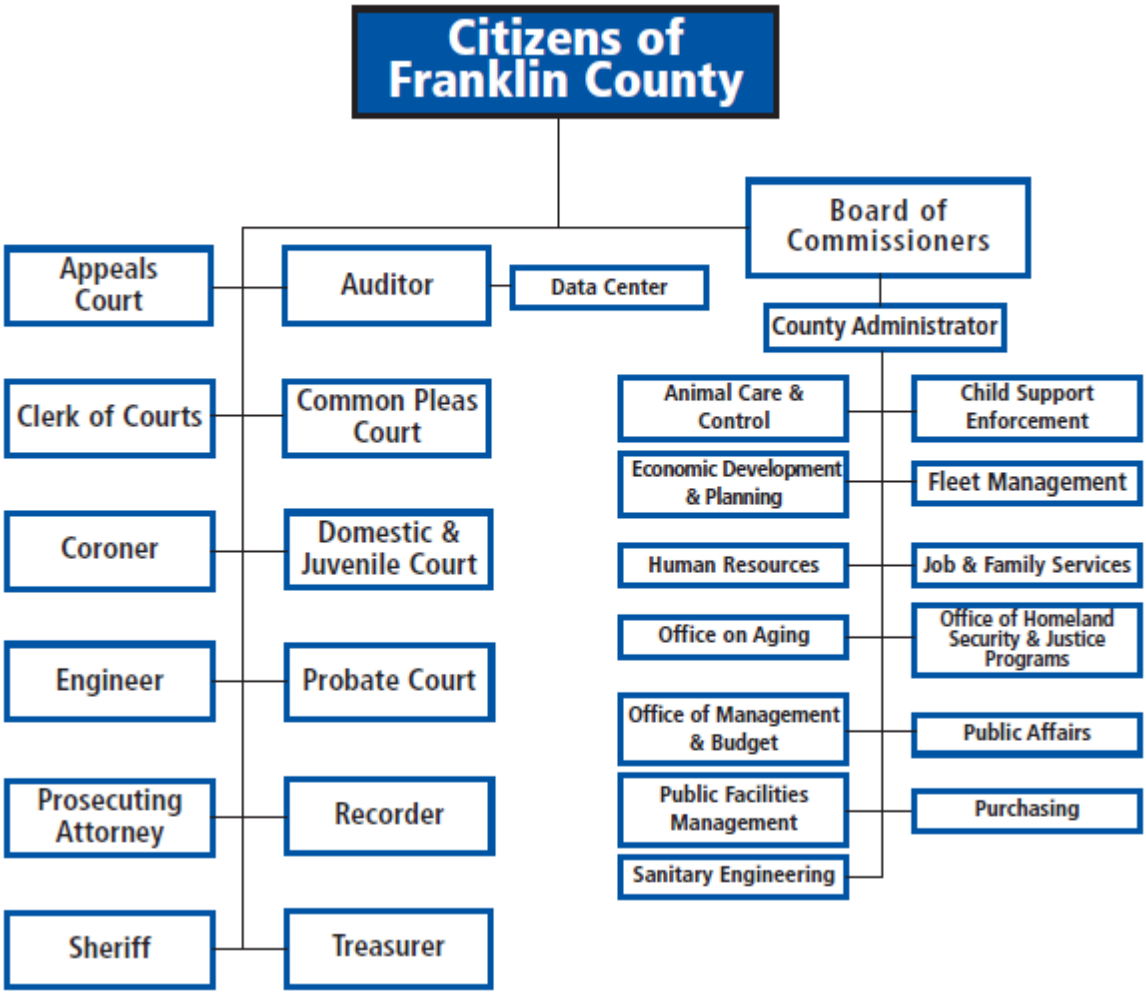
Business Numbers	2003	2004	2005	2006	2007
Business starts	4,936	3,493	3,503	4,541	3,367
Active businesses	23,351	24,021	24,066	24,203	23,172

Major Employers

Abbott Laboratories/Ross Products	Mfg
American Electric Power Co	Utility
Battelle Memorial Institute	R&D
Cardinal Health Inc	Trade
Huntington Bancshares Inc	Fin
JP Morgan Chase & Co	Fin
Limited Brands Inc	Trade
National City Corp	Fin
Nationwide Mutual Insurance Co	Ins
Ohio State University	Govt
OhioHealth	Serv
Schottenstein Stores Corp	Trade
State of Ohio	Govt
Wendy's International Inc	Trade

Government

The Franklin County Board of Commissioners serves as the administrative head of Franklin County Government. The three-member board manages county funds, oversees more than 130 county-owned buildings and serves as the county's sole contracting and taxing authority. The following is the organization of county government.



Franklin County is currently made up of 12 cities, 12 villages and 17 townships.

Cities

Bexley
Columbus
Dublin
Gahanna
Grandview Heights
Grove City
Hilliard
Reynoldsburg
Upper Arlington
Westerville
Worthington
Whitehall

Villages

Brice
Canal Winchester
Groveport
Harrisburg
Lockbourne
Marble Cliff
Minerva Part
New Albany
Obetz
Riverlea
Urbancrest
Valleyview

Townships

Blendon
Brown
Clinton
Franklin
Hamilton
Jackson
Jefferson
Madison
Mifflin
Norwich
Perry
Plain
Pleasant
Prairie
Sharon
Truro
Washington

Franklin County Cities, Villages, Townships

Source: Ohio County Profiles - ODOD

Critical Facilities

The following is a generic list of critical facilities in Franklin County. For security purposes specific addresses and descriptions are not included. While not all inclusive, the list illustrates the multitude of critical sites that could be affected in a disaster.

Emergency Response Facilities

- Hospitals/Medical Clinics
- Communications/Emergency Operations Centers
- Other Direction and Control Operations Centers
- Essential Government Buildings
- Fire Departments/EMS Services
- Law Enforcement/Sheriff, Police
- Jails/Correction Centers
- Emergency Shelters
- Disaster Recovery Centers/Disaster Field Offices
- Public Health Departments

Public Services and Utilities

- Emergency Alert System Stations and Towers: Radio, Television and Cable
- Other Radio and Television Stations and Towers
- Government Communications Towers and Repeaters
- Telephone System Distribution Points and Towers: Land Line, Cellular, Microwave
- Sewage Treatment and Plants
- Potable Water Distribution Systems, Treatment Plants, and Lift Stations
- Electrical Power Generating Plants and Electrical Substations
- Major Electrical Distribution Systems/Routes
- Essential Public Service Offices

Vital Private/Commercial Facilities

- Private Potable Water Treatment and Distribution Systems
- Private Sewage Treatment and Waste Systems
- Commercial Distribution Centers
- Building/Construction Materials
- Potable Water and Ice Suppliers
- Food Retailers
- Power Generators
- Suppliers of Fuels (Gasoline, Diesel, Propane, Natural Gas, etc.)
- Suppliers of Light Equipment (Chain Saws, Shovels, Barricades, etc.)
- Suppliers of Heavy Equipment (Bulldozers, Forklifts, etc.)
- Medical Supply Companies
- Food Processing Plants
- Restaurants/Cafeterias
- Community Centers/Auditoriums

Vital Private/Commercial Facilities (cont)

- Major Fuel Pipelines and Terminals
- Fuel Storage and Tank Farms

Transportation Facilities

- Airports/Heliports
- Response Operations Staging Areas
- Critical Transportation Routes
- High Risk Intersections/Critical Links/Bridges
- Railroad Stations

Other Facilities

- Churches/Synagogues
- Fellowship and Recreation Halls
- Colleges/Universities
- Public and Private Schools
- Motels/Hotels
- Nursing/Convalescent/Group Homes
- Animal Care/Animal Shelters
- Hazardous Materials Facilities
- Flood Control Stations and Devices

Major Events

There are several locations and facilities in Franklin County that are venues for many major festivals and events. As large congregate areas, these sites are of major consideration in emergency planning.

Downtown Columbus is the site of several events that draw huge crowds in the midst of the major State government center, as well as city, county and federal government facilities. These events include: Red, White and Boom; Columbus Arts Festival; Columbus Jazz and Ribs Festival and several others. Some of these events draw as many as 500,000 people to the center of Columbus.

Downtown Columbus is also the site of the Columbus Convention Center, Nationwide Arena, Veterans Memorial Auditorium and several theaters which host large crowds regularly.

In addition to the events in Columbus, several suburban communities also hold annual large-scale events, including the Dublin Irish Festival, the Tomato Festival in Reynoldsburg, and the Franklin County Fair in Hilliard.

Franklin County hosts a number of sporting events throughout the year. Ohio Stadium, with a capacity of over 100,000, is home to the Ohio State Buckeye football games. The Columbus Crew professional soccer team facility and the Ohio Expo Center are located along I-71 north of downtown Columbus. The Schottenstein Center on the Ohio State University Campus and Nationwide Arena in Columbus host sporting events, family shows and touring productions throughout the year.

Franklin County Profile – References

Central Ohio Indicators (2008) Central Ohio Data Access Tools

Franklin County Emergency Management and Homeland Security (2003) Natural Hazards Mitigation Plan – Community Profile

Franklin County Emergency Management and Homeland Security (2006) Franklin County Basic Emergency Operations Plan

Franklin County Government Website www.franklincountyohio.gov

Mid Ohio Regional Planning Commission. Demographic Fact Sheet for Franklin County

Mid Ohio Regional Planning Commission (2004) Central Ohio Freight Fact Book – Rail Operations - Central Ohio

Mid Ohio Regional Planning Commission. Truck Freight Overview – Central Ohio

Office of Policy, Research and Strategic Planning, Ohio Department of Development (2007) Ohio County Profiles – Franklin County

Ohio History Central – Ohio Historical Society. "Franklin County" [Online] 19 Feb 2009. www.ohiohistorycentral.org

Ohio State University. "The OSU Extension Fact Sheet: Water Resources of Franklin County" [Online] 23 Feb 2009. http://ohioline.osu.edu/aex-fact/0480-25.html

U.S. Census Bureau. "Franklin County Ohio" [Online] 26 Feb 2009

Section 3 – Hazard Identification

Contents

Hazard Identification 44
Hazard Relationships 45
Types of Hazards 47
Ohio Hazards 48
Disasters and Declarations 50

Hazard Identification

A hazard is a source of harm to a community, including its population, environment, private and public property, infrastructure and businesses. In the days of Civil Defense, hazards were thought of in two categories: natural hazards and enemy attack. Later, as hazardous materials began to be a problem, technological hazards were added as a category. Since the end of the Cold War, hazards have been classified into three groups: natural, technological, and human-caused.

NFPA 1600 A.5.3.2 describes the following types of hazards:

> Naturally occurring hazards that can occur without influence of people and have potential direct or indirect impact on the entity (people, property, the environment).
>
> Human-caused events, accidental or intentional.
>
> Technological-caused events that can be unrelated to natural or human-caused events.

Hazards in one category may cause a secondary hazard or disaster in the same or another category that increases the impact. Some examples:

> A hurricane may produce tornadoes.
>
> A major flood may cause a dam to break.
>
> A highway accident may lead to a hazardous materials spill.
>
> A train derailment may produce a wildfire.
>
> Excessive flooding may result in infectious disease.
>
> A bombing may lead to a fire.
>
> Computer sabotage may lead to a power failure.
>
> A terrorist attack may spread deadly disease.

Almost any combination of hazards is possible. The relationships between many types of hazards may become complex. One or more secondary, tertiary, or even further events may occur. The following table illustrates these relationships. The table also shows that an event may be either a primary or secondary event depending on circumstances.

Hazard Relationships

Primary Event / Secondary Events	Aircraft Accident	Animals-Loss/injured/dead	Crop Damage	Dam/Dike Failure	Epidemic	Explosion	Fallout	Fire	Flash Flood	Food Shortage	Fuel Shortage	Hazardous Materials Incident	Housing Shortage	Human Injured/Dead	Industrial Accident	Power/Gas Failure	Radiological Incident	Structural Collapse	Train Derailment	Vehicular Wreck	Water Shortage
Natural																					
Flood																					
River		X	X	X	X	X		X				X	X	X		X		X	X	X	X
Creeks		X	X	X	X	X		X				X	X	X		X		X	X	X	X
Flash		X	X	X	X	X		X				X	X	X		X		X	X	X	X
Tornadoes	X	X	X		X	X		X		X		X	X	X	X	X		X	X	X	X
Storms																					
Lightning	X	X	X			X		X				X	X	X							X
Hail	X	X	X							X				X	X					X	
Wind	X	X	X			X						X	X	X	X	X		X		X	
Blizzard																					
Heavy Snow	X	X	X		X			X	X	X	X	X	X	X	X	X		X	X	X	X
Ice	X	X	X			X		X	X	X		X	X	X						X	X
Drought		X	X		X					X				X							X
Earthquake				X	X	X		X			X	X	X	X	X	X		X	X	X	X
Fog	X											X		X					X	X	
Infectious Disease		X			X									X							
Human-caused																					
Hazardous Materials																					
Transportation																					
Vehicular Wreck		X				X		X				X		X			X		X	X	
Train Derailment		X				X		X				X		X							
Downed Aircraft		X				X		X				X		X							
Industrial																					
Explosion						X	X	X				X		X	X	X	X	X			
Fire						X		X				X		X	X	X	X	X			
Accidental Release		X			X							X		X	X		X				
Theft/Loss												X					X				
Nuclear Emergencies		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Infectious Disease		X			X									X							
Fire																					
High Rise													X	X				X			
Multiple Buildings						X		X					X	X				X			

Primary Event / Secondary Events	Aircraft Accident	Animals-Loss/injured/dead	Crop Damage	Dam/Dike Failure	Epidemic	Explosion	Fallout	Fire	Flash Flood	Food Shortage	Fuel Shortage	Hazardous Materials Incident	Housing Shortage	Human Injured/Dead	Industrial Accident	Power/Gas Failure	Radiological Incident	Structural Collapse	Train Derailment	Vehicular Wreck	Water Shortage
Fire (cont)																					
Industrial						X		X				X		X	X	X	X	X			
Gas Lines						X		X			X	X		X	X						
Chemical Plant			X		X	X		X				X		X	X						
Health Care Facility					X			X				X		X		X					
Explosion																					
Pipelines						X		X			X	X		X	X	X		X	X		
Industrial						X		X				X		X	X	X	X	X	X		
Chemical						X						X		X		X			X		
Dam Failure		X	X	X				X	X				X	X		X		X	X	X	X
Transportation Accidents																					
Highway		X				X		X			X	X		X			X	X	X	X	
Rail		X				X		X			X	X		X			X	X	X		
Air	X	X				X		X				X		X			X				
Civil Disturbance																					
Riot						X		X		X	X		X	X						X	
Bomb Threat	X			X		X		X				X		X					X	X	X
Terrorism/Sabotage	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Technological-Caused																					
Computer Related	X										X	X			X	X	X		X		X
Telecommunications	X											X			X		X				
Utility																					
Power/Light						X		X			X					X					
Natural Gas						X		X			X	X	X			X					
Water System																					
Water Plant											X					X					X
Water Mains																					X
Storm Drainage																					
Sanitary Drainage																					
Disposal Plant					X						X					X					
Mains						X												X			
Lift Stations					X											X					

Adapted from Sedgwick, Kansas *Hazard Analysis* 2006

Types of Hazards

Natural Hazards

Natural hazards are an ever present risk to life and property throughout the United States. Often, natural hazards can be predicted. They tend to occur repeatedly in the same geographical locations because they are related to weather patterns or physical characteristics of an area. Natural hazards can be classified into three groups:

> Geological Hazards – related to the geographical characteristics or natural earth processes of the area, e.g. earthquakes, volcano, landslides.
>
> Meteorological Hazards – natural processes or phenomena of an atmospheric, hydrological or oceanographic nature, including weather patterns of the area, e.g. floods, tornadoes, winter storms.
>
> Biological Hazards – processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic microorganisms, toxins and bioactive substances; these include epidemics and insect infestations. May be intentionally caused.

Human-caused Events

Human-caused events are divided into two groups: accidental and intentional. Accidental human-caused events include hazardous material spills, transportation accidents, air/water pollution and dam failure. Intentional human-caused events include civil disturbances, criminal activity and terrorism.

Technological Hazards

Technological hazards are events that can be unrelated to natural or human-caused events, such as central computer, mainframe, software or application failure; telecommunication system failure; and energy, power or utility failure.

Ohio Hazards

There is a wide range of hazards and disasters to consider when preparing a risk assessment for a specific area. Many hazards are large and obvious; however, there are many everyday emergency situations at the local level that need attention.

Ohio EMA reviewed the hazard analysis literature and identified nearly sixty hazards. These hazards include those listed in NFPA 1600, the 15 National Planning Scenarios, the National Plan Review and Ohio EMA's Enhanced Mitigation Plan. These hazards are listed in the following table. Those not considered by OEMA as Ohio hazards are not considered as hazards for Franklin County. Some Ohio hazards are not germane to Franklin County and not likely enough a scenario to warrant consideration. Those that are identified for Franklin County are included in this risk assessment.

Hazards Identified in OEMA's Hazard Identification and Risk Analysis: Update 2007

Natural Hazards/Events	Human Caused Events
Biological Animal or Insect Infestation or Damage Emerging Disease Geological Earthquake Landslide, Mudslide, Subsidence Meteorological Drought Extreme Temperatures Fire Flood, Flash Flood, Seiche Lightning Strikes Snow, Ice, Hail, Sleet Windstorm, Tornado	Accidental Air/Water Pollution, Contamination Building/Structure Collapse Communications System Interruptions Energy/Power/Utility Failure Explosion/Fire Fuel/Resource Shortage Hazardous Material Transportation Accident Water Control Structure Intentional Civil Disturbance, Public Unrest, Mass Hysteria Criminal Activity Product Defect Terrorism
Technological Hazards/Events	Not Analyzed for OEMA HIRA
Central Computer, Mainframe, Software or Application Failure Energy/Power/Utility Telecommunications	Ancillary Support Equipment Failure (support and lab-based equipment) Avalanche Discrimination Disinformation (deliberate) Dust Storm Electromagnetic Pulse (intensely fluctuating magnetic field) Enemy Attack/War Famine Financial Issues (Economic Depression, Inflation, Financial System Collapse) Geomagnetic Storm (temporary disturbance of atmosphere, causing communications disruption, among other things) Glacier Harassment Hurricane Iceberg Insurrection (revolt) Misinformation (non-deliberate) Sabotage Sand Storm Strike or Labor Dispute Tidal Surge Tropical Cyclone Tsunami Water Spout Workplace Violence Volcano

Disasters and Declarations

1980-2008 Billion Dollar U.S. Weather Disasters

(Damage Amounts in Billions of Dollars and Costs Normalized to 2007 Dollars Using GNP Inflation / Wealth Index)

1980	Drought / Heat Wave e $55.4 ~10,000 Deaths				
1983	Hurricane Alicia $6.3 21 Deaths	Florida Freeze ~ $4.2 No Deaths	Gulf Storms / Flooding ~ $2.3 ~ 50 Deaths	W Storms / Flooding ~ $2.3 ~ 45 Deaths	
1985	Florida Freeze ~ $2.3 No Deaths	Hurricane Elena $2.5 4 Deaths	Hurricane Juan $2.9 63 Deaths		
1986	Drought / Heat Wave $2.4 ~100 Deaths				
1988	Drought / Heat Wave e $71.2 ~7,500 Deaths				
1989	Hurricane Hugo > $15.3 86 Deaths	N Plains Drought > $1.7 No Deaths			
1990	S Plains Flooding > $1.6 13 Deaths	California Freeze $5.5 No Deaths			
1991	Hurricane Bob $2.3 18 Deaths	Oakland CA Firestorm ~ $3.9 25 Deaths			
1992	Hurricane Andrew ~ $40.0 61 Deaths	Hurricane Iniki ~ $2.7 7 Deaths	Nor'easter $2.3 19 Deaths		
1993	E Storm / Blizzard $7.9 ~ 270 Deaths	SE Drought / Heat Wave ~ $1.4 > 16 Deaths	Midwest Flooding ~ $30.2 48 Deaths	CA Wildfires ~ $1.4 4 Deaths	
1994	SE Ice Storm ~ $4.2 9 Deaths	Tropical Storm Alberto ~ $1.4 32 Deaths	Texas Flooding ~ $1.4 19 Deaths	W Fire Season ~ $1.4 No Deaths	
1995	CA Flooding > $4.1 27 Deaths	SE / SW Severe Wx $7.5 32 Deaths	Hurricane Marilyn e $2.9 13 Deaths	Hurricane Opal > $4.1 27 Deaths	
1996	Blizzard / Flooding ~ $4.0 187 Deaths	Pacific NW Flooding ~ $1.3 9 Deaths	S Plains Drought ~ $6.8 No Deaths	Hurricane Fran > $6.6 37 Deaths	
1997	Midwest Flood / Tornadoes e $1.3 67 Deaths	N Plains Flooding ~ $4.8 11 Deaths	W Coast Flooding ~ $3.9 36 Deaths		
1998	New England Ice Storm > $1.8 16 Deaths	SE Severe Wx > $1.3 132 Deaths	MN Severe Storms / Hail > $1.9 1 Death	S Drought / Heat Wave $9.5 > 200 Deaths	Hurricane Bonnie ~ $1.3 3 Deaths
	Hurricane Georges e $7.4 16 Deaths	Texas Flooding ~ $1.3 31 Deaths	California Freeze $3.2 No Deaths		
1999	AR - TN Tornadoes ~ $1.6 17 Deaths	OK - KS Tornadoes > $2.0 55 Deaths	E Drought / Heat Wave > $1.2 e 502 Deaths	Hurricane Floyd e > $7.4 77 Deaths	
2000	Drought / Heat Wave e > $4.8 ~ 140 Deaths	Western Fires > $2.4 No Deaths			
2001	Tropical Storm Allison e ~ $5.6 > 43 Deaths	Midwest / OH Valley Hail / Tornadoes > $2.2 > 3 Deaths			
2002	30-State Drought e > $11.4 No Deaths	Western Fires > $2.3 ~21 Deaths	Severe Wx / Tornadoes > $1.9 7 Deaths		
2003	Severe Wx / Hail > $1.8 3 Deaths	Severe Wx / Tornadoes > $3.8 51 Deaths	Hurricane Isabel ~ $5.6 55 Deaths	S California Wildfires > $2.8 22 Deaths	
2004	Hurricane Charley e ~ $16.5 35 Deaths	Hurricane Frances e ~ $9.9 48 Deaths	Hurricane Ivan e > $15.4 57 Deaths	Hurricane Jeanne e > $7.7 28 Deaths	
2005	Hurricane Dennis e > $2.1 > 15 Deaths	Hurricane Katrina e ~ $133.8 > 1833 Deaths	Hurricane Rita e ~ $17.1 ~ 119 Deaths	Midwest Drought e > $1.1 No Deaths	Hurricne Wilma e ~ $17.1 35 Deaths
2006	Numerous Wildfires > $1.0 28 Deaths	Widespread Drought e > $6.2 * Deaths	Severe Storms Tornadoes e > $1.0 10 Deaths	Northeast Flooding > $1.0 20 Deaths	MW / SE Tornadoes > $1.5 10 Deaths
	MW / Ohio Valley Tornadoes ~ $1.1 27 Deaths				
2007	Great Plains / East Drought > $5.0 * Deaths	Western Wildfires > $1.0 12 Deaths	Spring Freeze > $2.0 No Deaths	East / South Severe Weather > $1.5 9 Deaths	California Freeze > $1.4 1 Deaths
2008	Southeast / Midwest Tornadoes > $1.0 57 Deaths	MW / Ohio Valley Svr Wx / Tornadoes > $2.4 13 Deaths	MW / Mid- Atl. Svr Wx Tornadoes > $1.1 18 Deaths	Midwest Flood e > $15.0 24 Deaths	U. S. Wild Fires > $2.0 16 Deaths
	Hurricane Dolly > $1.2 3 Deaths	Hurricane Gustav > $5.0 43 Deaths	Hurricane Ike > $27.0 > 100 Deaths	Widespread Drought > $2.0 No Deaths	

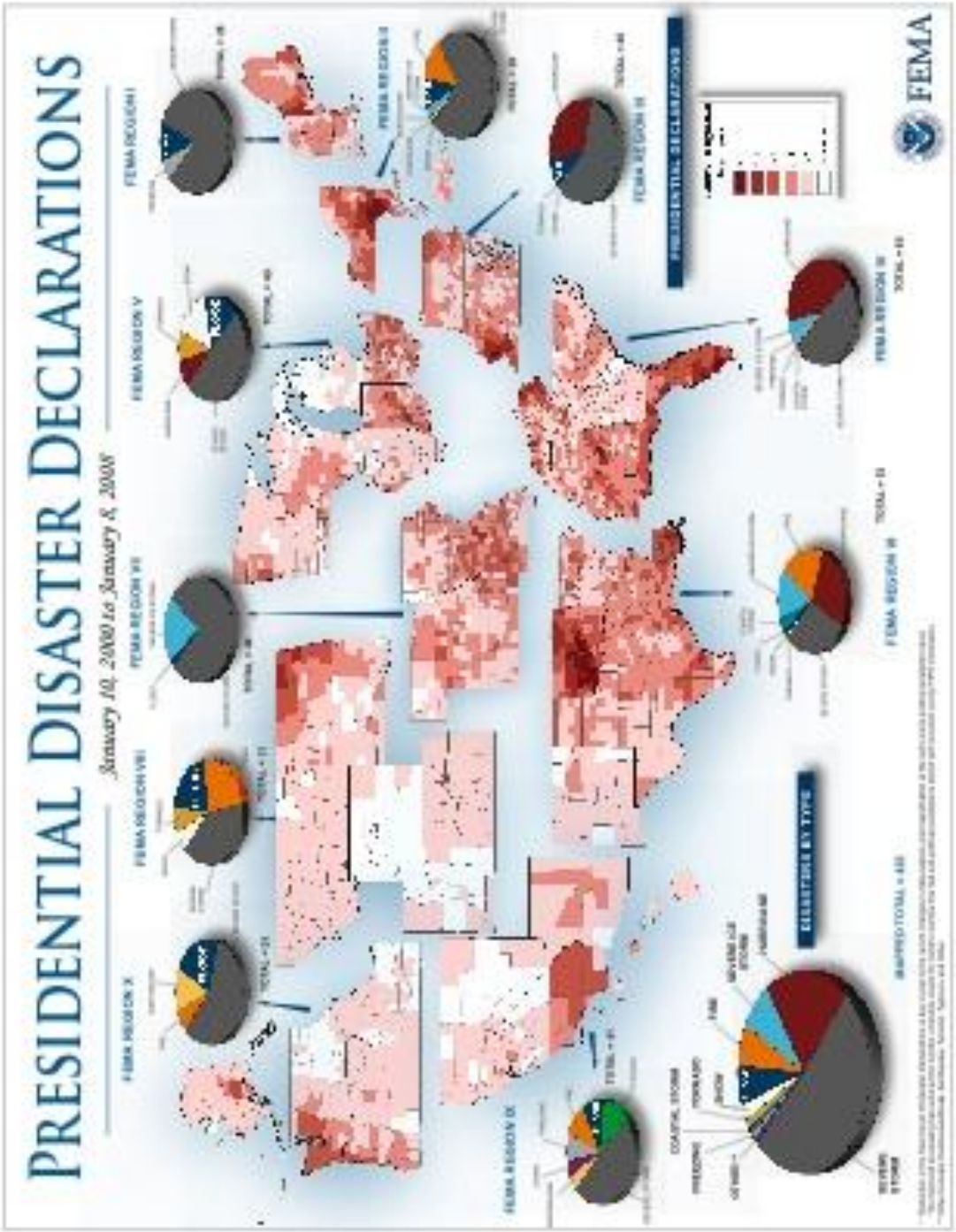
e = estimated > = greater than/at least ~ = approximately/about
* = undetermined

< 5	5-20	20-30	30-40	> 40

Amounts in Billions of Dollars

Source: NOAA's National Climatic Data Center Asheville, NC 28801-5001
www.ncdc.noaa.gov/oa/reports/billionz.html

The following table illustrates Presidential Declarations by FEMA Region from January 10, 2000 to January 8, 2008.



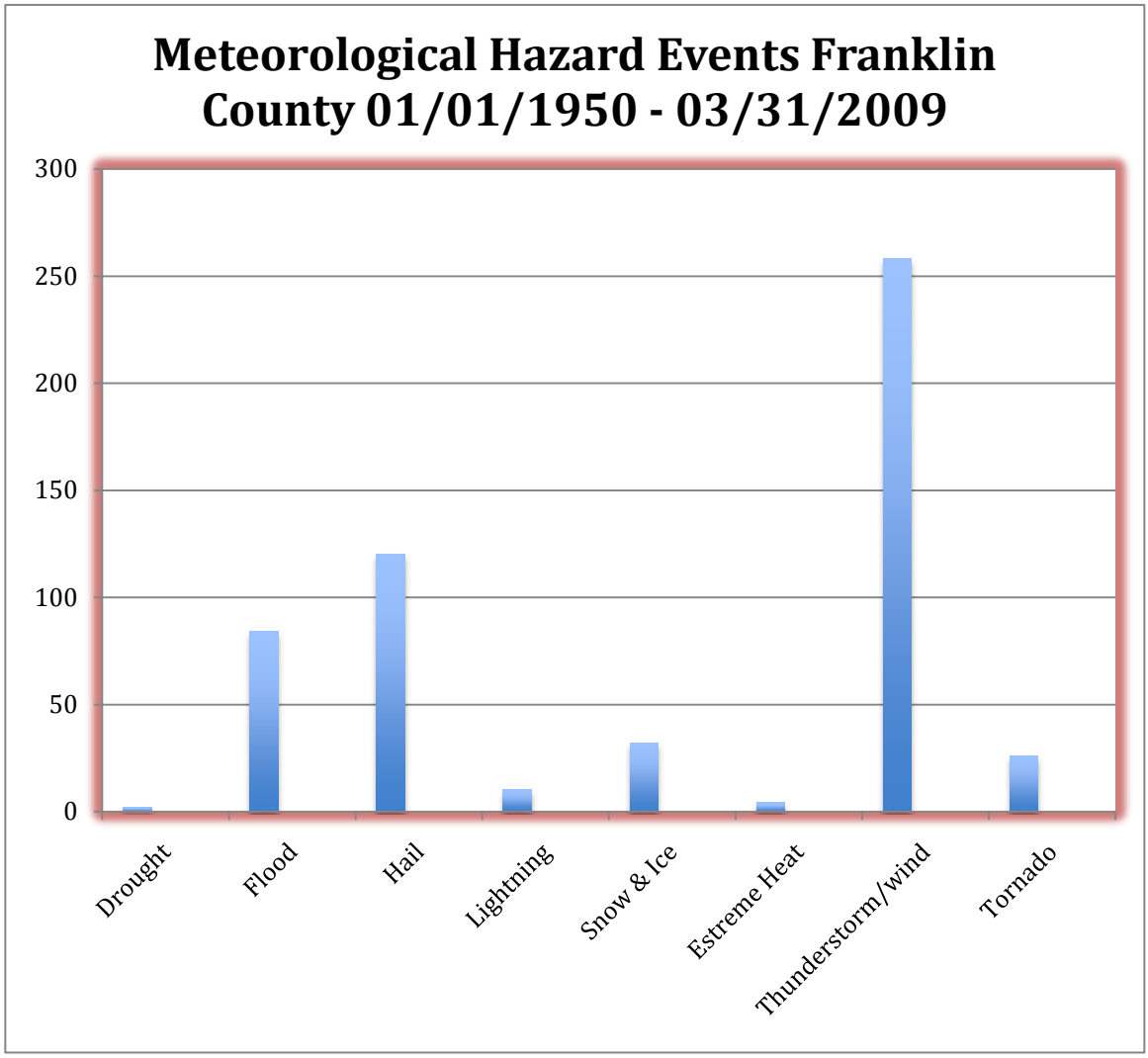
Franklin County Declarations

March 24, 1964	Heavy rains and flooding
June 5, 1968	Heavy rains and flooding
April 4, 1974	Tornadoes and high winds
January 26, 1978	Severe blizzard
June 10, 1989	Severe storms and flooding
June 6, 1990	Severe storms, tornadoes, and flooding
August 4, 1992	Severe storms, tornadoes, and flooding
June 30, 1998	Flash flooding, flooding, high winds and tornadoes
November 18, 2002	Tornadoes, severe storms
March 24, 2003	Ice/snow storm
August 1, 2003	Severe storms , tornadoes and flooding
January 26, 2004	Severe storms and landslides
January 11, 2005	Snow removal and response
February 15, 2005	Severe winter storms, ice and mudslides
September 13, 2005	Hurricane Katrina Emergency Shelter Operations
September 2008	Hurricane Ike, severe wind damage

Source: Ohio Emergency Management Agency

Declarations were for multiple events in multiple counties in the state.

NOAA's National Climatic Data Center reported the following meteorological hazards for Franklin County from January 1, 1950 to March 31, 2009.



Hazard Identification – References

Absolute Astronomy. "Disaster." [Online] 5 Mar 2009 http://www.absoluteastronomy.com

FEMA, State and Local Mitigation Planning, how-to Guide: Hazard Identification, Version 1.0. August 2001

Franklin County Emergency Management and Homeland Security, Hazard Analysis for Franklin County. 1996

Franklin County Emergency Management and Homeland Security, Natural Hazards Mitigation Plan. 2003

General Accounting Office. "Natural Hazard Mitigation." [Online] 5 Mar 2009 www.gao/gov/ogi-bin/getrpt?GAO-07-403

National Fire Prevention Association. NFPA 1600 2007, Section 5.3

NOAA, NWS, General Hazard Information

OEMA, Hazard Identification and Risk Assessment. 2007

OEMA, State of Ohio Mitigation Plan. 2008

Quarantelli, E.L., "Catastrophes Are Different from Disasters: Some Implications for Crisis Planning and Managing, Drawn from Katrina." Disaster Research Center, University of Delaware. 11 June 2006

Tulane University, Natural Disasters and Assessing Hazards and Risks. Updated 26 Aug 2007

Section 4 – Franklin County Hazards

Contents

#1 Flooding 56

#2 Severe Winter Weather 83

#3 Dam Failure 97

#4 Terrorism 108

#5 Infectious Diseases 124

#6 Tornadoes 159

#7 Severe Summer Weather 185

#8 Extreme Heat 203

#9 Hazardous Material Incidents 213

#10 Drought 220

#11 Utility/Energy Interruption or Failure 231

#12 Invasive Species 237

#13 Air and Water Pollution/Contamination 251

#14 Transportation Accident – Aircraft 258

#15 Civil Disturbance 268

#16 Earthquakes 276

Flooding - #1

Contents

Hazard Profile 57
Flooding in the United States 63
Flooding in Ohio 64
Flooding in Franklin County 68
Franklin County Watersheds 73

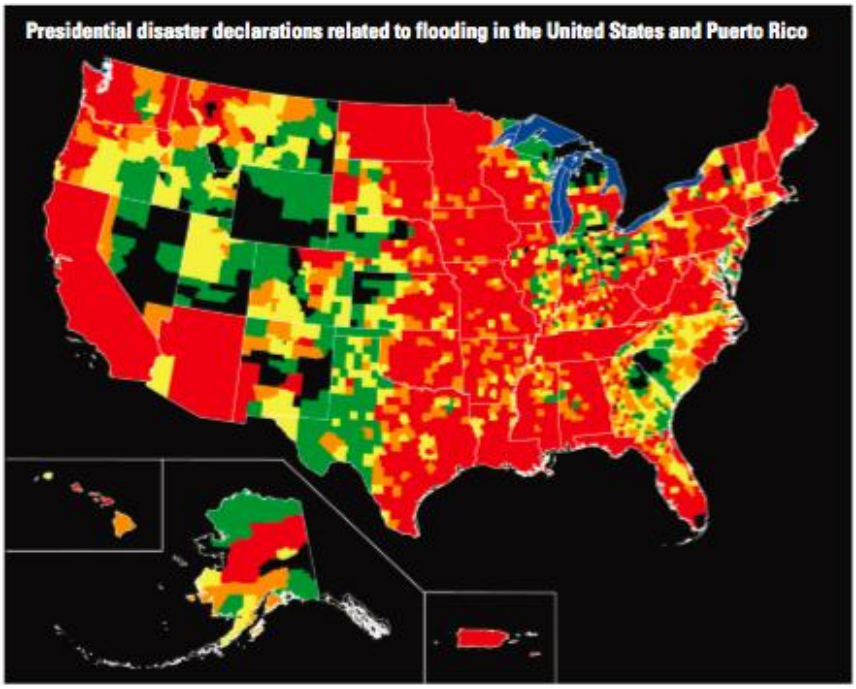
Hazard Summary

Flooding occurs in many forms, from naturally occurring to human-induced. Common to all flooding is the accumulation of too much water in too little time in too small a place. From 1999 to 2008 Franklin County was subject to many different types of flooding and received as many as 10 flood warnings in a single year. Flooding is the No. 1 severe weather related killer in the U.S. This hazard was ranked No. 1 out of 16.

Hazard Profile

Throughout history, people have found it desirable to live along streams. Streams provide water for consumption, agriculture and industry; transportation routes; energy; and a means of waste disposal. All these resources are essential for sustaining communities. However, streams also put people at risk of the most frequent and costly natural hazard worldwide, flooding.

During the 20th century, floods were the No. 1 natural disaster in the United States in terms of lives lost and property damage. Floods have caused the deaths of more than 10,000 people since 1900. Floods can roll boulders the size of cars, tear out trees and destroy buildings and bridges.



Presidential disaster declarations related to flooding in the United States, shown by county: Green areas represent one declaration; yellow areas represent two declarations; orange areas represent three declarations; red areas represent four or more declarations between June 1, 1965, and June 1, 2003. Map not to scale. Sources: FEMA, Michael Baker Jr., Inc., the National Atlas, and the USGS

Flooding happens during heavy rains, when rivers overflow, when ocean waves come onshore, when snow melts too fast or when dams or levees break. The National Flood Insurance Program defines flooding as a general and temporary condition of partial or complete inundation of two or more areas of normally dry land area, or of two or more properties from:

- overflow of inland or tidal waters;
- unusual and rapid accumulation or runoff of surface water from any source;
- a mudflow; or
- a collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood.

Three fourths of all presidential disaster declarations are associated with flooding.

Types of Floods

Floods are the result of a multitude of naturally occurring and human-caused factors, but all can be defined as the accumulation of too much water, in too little time, in too small a place.

Regional flooding occurs seasonally when winter or spring rains coupled with melting snow fill river basins with too much water too quickly. Excess runoff can be amplified by frozen ground or saturated soil conditions. Regional floods are associated with slow-moving, low-pressure or frontal storm systems, including decaying hurricanes or tropical storms. Persistent, wet meteorological patterns are usually responsible for very large regional floods such as the Mississippi River Basin flood in 1993, with $20 billion in damages reported.

Riverine flooding is a high flow or overflow of water from a river or similar body of water. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Riverine flooding can range from minor overbank events to massive, widespread inundation. Such flooding may be caused by excessive rainfall alone or a combination of heavy rainfall and snowmelt, and it occurs over a period of time too long to be considered a flash flood.

Flash floods are quick-rising floods that usually occur as the result of heavy rain over a short period of time, often only several hours or less. Flash floods can happen within several seconds to several hours and with little warning. Several factors can contribute to flash flooding: rainfall intensity, rainfall duration, surface conditions and topography and slope of the receiving basin. Year in and year out, flash floods take more lives than any other type of flooding.

Flood Terms

100 Year Flood Plain. The area that has a 1% chance, on average, of flooding in any given year. (Also known as the Base Flood)

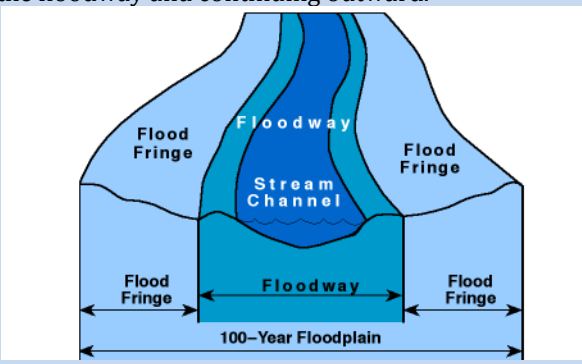
500 Year Flood Plain. The area that has a 0.2% chance, on average, of flooding in any given year.

Base Flood. Represents a compromise between minor floods and the greatest flood likely to occur in a given area. The elevation of water surface resulting from a flood that has a 1% chance of occurring in a given year.

Floodplain. The land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: The floodway and the flood fringe.

Floodway. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved, in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot." The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties.

Flood Fringe. The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward.



Urban flooding happens when land is converted from fields or woodlands to roads and parking lots, thus losing its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. Water moves from clouds to ground and into streams at a much faster rate in urban areas. Streets can become swift moving rivers, while basements and viaducts can become death traps as they fill with water. Storm drains often back up with vegetative debris, causing additional localized flooding.

Urban Flooding - Columbus, Ohio **10/04/2006**

Photographer's description: A severe autumn thunderstorm struck the Ohio State campus in Columbus causing urban flooding, quarter sized hail, and widespread wind damage.

Photographer	Brett Hartley
Date taken	October 4, 2006
Location	Columbus, Ohio (Franklin County) **map**
Event	Urban flooding

Additional notes

As seen here, urbanized areas are more prone to flooding since impervious surfaces such as roads, parking lots and structures prevent rainfall from being absorbed into the ground. This leads to much more runoff which can overload sewers and other drainage systems (evidenced here by the water gushing out of the ground on the left-hand side of the photo). Flooding becomes worse when heavy rainfall occurs over a short period of time.

This photo shows typical minor urban flooding which is covered by a flood advisory. Generally this type of flooding will result in standing water over local streets and other "nuisance" flooding, especially in urban areas.

National Weather Service, Wilmington OH

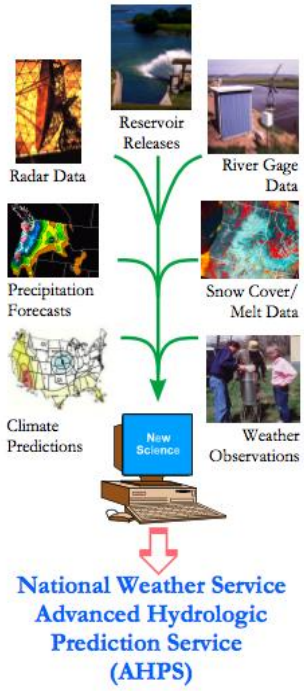
Ice-jam flooding occurs on rivers that are totally or partially frozen. When rivers clogged with ice rise rapidly due to rainfall and/or snowmelt, the ice breaks up into chunks, some larger than an automobile. These chunks of ice move downstream and can jam at constrictions in rivers such as bends, bridge abutments or shallow areas. The jam can act as a dam, causing water to back up behind it. River levels behind the ice jam can rise rapidly. On occasion, the ice jam can release quickly, sending huge chunks of ice downstream in the torrent, leaving destruction in its wake.

Snowmelt floods. Snow melts slowly enough that it seldom causes flooding. However, warm, moist conditions and heavy rain can combine with snowmelt to cause dramatic winter and spring flooding. In relatively flat areas in the Midwest, river beds drop very slowly along the length of the river. As a result, the water in the river glides slowly downstream. In such areas, accumulation of melt water from extensive snow-covered areas can cause significant flooding. This situation is often compounded by the effects of ice jams.

Debris, landslide, and mudflow flooding is created by the accumulation of debris, mud, rocks, and/or logs in a channel, forming a temporary dam. Flooding occurs upstream as water becomes stored behind the temporary dam and then becomes a flash flood when the dam is breached and rapidly washes away. Landslides can create large waves on lakes or embayments and can also be deadly.

Flood Monitoring

The National Weather Service is responsible for providing our nation's flood warnings and water resource forecasts. These warnings and forecasts are critical to public safety and the economy. The NWS is improving these warnings and forecasts with the Advanced Hydrologic Prediction Service (AHPS).



AHPS provides improved river and flood forecasting and water information and has a suite of graphical Internet products to assist community leaders and emergency managers in making better decisions about evacuating people and moving property before a flood occurs.

AHPS's major themes include:

- Short-term through long-term forecasts (from minutes to months) including probabilistic products for risk management decisions.
- Real-time flood forecast maps depicting a real extent of flooding.
- More timely and accurate flash flood warnings through the use of enhanced flash flood decision assistance tools.

This includes forecast information such as:

- How high a river will rise
- When a river will reach its peak
- Where property will be flooded
- How long flooding will continue
- How long a drought will last

Flood Severity Categories

The NWS characterizes flood severity to more effectively communicate the impact of flooding. It uses the following categories:

Minor Flooding – minimal or no property damage, but possibly some public threat or inconvenience.

Moderate Flooding – some inundation of structures and roads near streams. Some evacuation of people and/or transfer of property to higher elevations.

Major Flooding – extensive inundation of structures and roads. Significant evacuation of people and/or transfer of property to higher ground.

This information helps minimize flooding impacts by allowing communities more time to mitigate and prepare for flood events, as well as improve reservoir management and better predict how long drought conditions will affect river levels.

For more than 100 years, the U.S. Geological Survey (USGS) has played a critical role in reducing flood losses by operating a nationwide stream-gage network that monitors the water level and flow of the nation's rivers and streams. The USGS works closely with the NWS, the Army Corps of Engineers, and other federal agencies and partners in every state, as well as many local governments, to fund and maintain about 7,000 stream-gaging stations.

What is a:

Flash Flood Watch – Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.

Flash Flood Warning – Issued to inform the public, emergency management, and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.

Flood Watch – Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.

Flood Warning – In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is serious threat to life or property. A flood warning will usually contain river stage forecasts.

Through satellite and computer technology, stream-gages transmit real-time information, which the National Weather Service uses to issue warnings so local emergency managers can get people out of harm's way, and operators of flood-control dams and levees can take action to reduce flood impacts. Stream-gage data can also help in designing structures resilient to flooding and are the basis for the Federal Emergency Management Agency's National Flood Insurance Program.

The basic building block for a streamflow data network is the stage-discharge relation that is developed at each gauging station location. Measurements of the flow (discharge) are related graphically to the respective water depths (stage), which then enables discharge to be determined from stage data. USGS streamflow gages in Franklin County are: Alum Creek and Scioto River at Columbus, Scioto River below O'Shaughnessy Dam, Big Walnut at Central College and Reese, and the Olentangy River at Worthington.

Flooding Impact

In most years, flooding causes more deaths and damage than any other hydro-meteorological phenomena. In many years, it is common for three-quarters of all federally declared disaster declarations to be due, at least in part, to flooding.

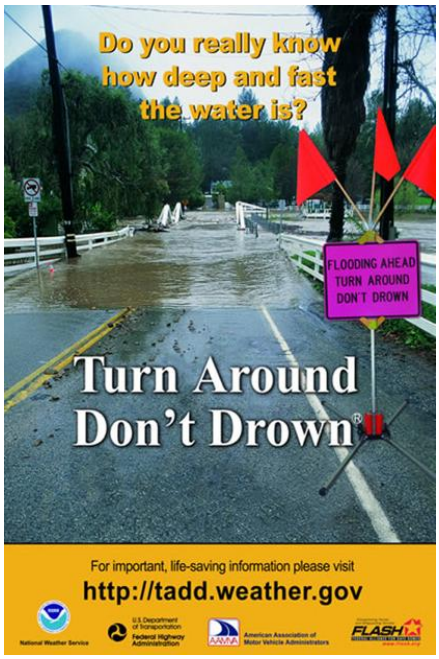
Trying to characterize what these losses mean in terms of impacts over time is difficult at best. Loss/damage estimates are reported in many different ways, from several sources. There is usually not enough information to easily determine the degree of overlap among the various sources of loss estimates. For example, NWS flood damage estimates do not include flooding due to winds, such as coastal flooding (e.g. hurricane storm surges).

However, there is no question that flooding is one of the most frequent and costly natural hazard in the United States and continues to escalate. According to the National Weather Service, in the 20 year period from 1987 to 2007, an average of $6 million was lost in floods. By far the most costly year was 2005 as a result of Hurricanes Katrina and Rita. By any estimate source, flooding causes about 100 deaths each year. The Centers for Disease Control and Prevention reports that over half of all flood-related drownings occur when a vehicle is driven into hazardous floodwater and swept downstream. The next highest percentage of flood-related deaths is due to walking into or near floodwaters.

Flood Fatalities													
Year	Annual Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	79/51	3/3	2/0	3/3	9/9	13/13	2/2	5/4	9/8	25/5	2/1	3/2	3/1
2003	99/47	0/0	7/5	0/0	8/2	14/9	14/12	9/3	14/9	1/1	3/3	12/3	17/0
2002	50/31	7/4	0/0	4/2	2/1	15/8	0/0	10/6	2/1	1/1	3/3	1/0	5/5
2001	66/31	0/0	5/4	3/1	1/1	6/2	21/8	12/5	7/2	0/0	0/0	9/7	2/1
2000	41/20	0/0	5/2	2/2	0/0	0/0	6/5	3/0	6/3	4/2	9/1	4/4	2/1
1999	77/40	12/11	0/0	0/0	7/2	2/1	7/4	6/2	2/0	38/17	3/3	0/0	0/0
1998	136/86	18/14	10/6	16/13	6/4	3/0	16/9	8/4	16/4	3/0	38/31	2/1	0/0
1997	98										3/0	4/0	2/2

Vehicle related fatalities are shown in red. NWS

People underestimate the force and power of water and drive around barriers that warn of a flooded road. A mere six inches of fast-moving water can knock over an adult. Most cars can be swept away in 18-24 inches of water. Trucks and SUVs do not fare much better with an additional 6-12 inches of clearance. In moving water, all that needs to happen is for the vehicle to become buoyant enough for the force of the moving water to push it sideways. Once swept downstream, the vehicle will often roll to one side or flip over entirely.



Many flood fatalities are preventable. To that end, the National Weather Service has developed an awareness campaign to warn people of the hazards of walking or driving a vehicle through flood waters, "Turn Around Don't Drown."

Flooding in the United States

Floods are one of the most chronic and costly natural disasters in the United States. Despite advances in flood science and implementation of federal hazard-reduction policies, damage from flooding continues. Flood damage is the result of the great power of flowing water and the concentration of people and property along rivers and streams. In the United States, about 3,800 towns and cities are on floodplains.

Water draws people to it. Generations of Americans have continued to settle along waterways, risking periodic floods for the opportunity and convenience that comes with easy access to water. Floods become problems when people occupy space that streams require for their own natural flood patterns. The problems have become so great over the years that the federal government has increasingly become involved in flood control throughout the nation.

Starting in 1917, a series of laws known as the Flood Control Acts was passed by Congress. These laws are typically administered by the United States Army Corps of Engineers. The Flood Control Act of 1917 was the first act aimed exclusively at controlling floods and was passed after extensive flooding on the Mississippi and Ohio Rivers.

In the late 1950's and 1960's, the country moved away from a "we can build our way out of almost any problem" attitude toward floodplain management, leading to the passage of the National Flood Insurance Program in 1968. In Ohio, 733 communities participated in the NFIP. Flooding is the only disaster insured against by the federal government.

Significant Floods of the 20th Century

[M, million; B, billion]

Flood type	Map no.	Date	Area or stream with flooding	Reported deaths	Approximate cost (uninflated)	Comments
Regional flood	1	Mar.–Apr. 1913	Ohio, statewide	467	$143M	Excessive regional rain.
	2	Apr.–May 1927	Mississippi River from Missouri to Louisiana	unknown	$230M	Record discharge downstream from Cairo, Illinois.
	3	Mar. 1936	New England	150+	$300M	Excessive rainfall on snow.
	4	July 1951	Kansas and Neosho River Basins in Kansas	15	$800M	Excessive regional rain.
	5	Dec. 1964–Jan. 1965	Pacific Northwest	47	$430M	Excessive rainfall on snow.
	6	June 1965	South Platte and Arkansas Rivers in Colorado	24	$570M	14 inches of rain in a few hours in eastern Colorado.
	7	June 1972	Northeastern United States	117	$3.2B	Extratropical remnants of Hurricane Agnes.
	8	Apr.–June 1983 June 1983–1986	Shoreline of Great Salt Lake, Utah	unknown	$621M	In June 1986, the Great Salt Lake reached its highest elevation and caused $268M more in property damage.
	9	May 1983	Central and northeast Mississippi	1	$500M	Excessive regional rain.
	10	Nov. 1985	Shenandoah, James, and Roanoke Rivers in Virginia and West Virginia	69	$1.25B	Excessive regional rain.
	11	Apr. 1990	Trinity, Arkansas, and Red Rivers in Texas, Arkansas, and Oklahoma	17	$1B	Recurring intense thunderstorms.
	12	Jan. 1993	Gila, Salt, and Santa Cruz Rivers in Arizona	unknown	$400M	Persistent winter precipitation.
	13	May–Sept. 1993	Mississippi River Basin in central United States	48	$20B	Long period of excessive rainfall.
	14	May 1995	South-central United States	32	$5-6B	Rain from recurring thunderstorms.
	15	Jan.–Mar. 1995	California	27	$3B	Frequent winter storms.
	16	Feb. 1996	Pacific Northwest and western Montana	9	$1B	Torrential rains and snowmelt.
	17	Dec. 1996–Jan. 1997	Pacific Northwest and Montana	36	$2-3B	Torrential rains and snowmelt.
	18	Mar. 1997	Ohio River and tributaries	50+	$500M	Slow-moving frontal system.
	19	Apr.–May 1997	Red River of the North in North Dakota and Minnesota	8	$2B	Very rapid snowmelt.
	20	Sept. 1999	Eastern North Carolina	42	$6B	Slow-moving Hurricane Floyd.
Flash flood	21	June 14, 1903	Willow Creek in Oregon	225	unknown	City of Heppner, Oregon, destroyed.
	22	June 9–10, 1972	Rapid City, South Dakota	237	$160M	15 inches of rain in 5 hours.
	23	July 31, 1976	Big Thompson and Cache la Poudre Rivers in Colorado	144	$39M	Flash flood in canyon after excessive rainfall.
	24	July 19–20, 1977	Conemaugh River in Pennsylvania	78	$300M	12 inches of rain in 6-8 hours.
Ice-jam flood	25	May 1992	Yukon River in Alaska	0	unknown	100-year flood on Yukon River.
Storm-surge flood	26	Sept. 1900	Galveston, Texas	6,000+	unknown	Hurricane.
	27	Sept. 1938	Northeast United States	494	$306M	Hurricane.
	28	Aug. 1969	Gulf Coast, Mississippi and Louisiana	259	$1.4B	Hurricane Camille.
Dam-failure flood	29	Feb. 2, 1972	Buffalo Creek in West Virginia	125	$60M	Dam failure after excessive rainfall.
	30	June 5, 1976	Teton River in Idaho	11	$400M	Earthen dam breached.
	31	Nov. 8, 1977	Toccoa Creek in Georgia	39	$2.8M	Dam failure after excessive rainfall.
Mudflow flood	32	May 18, 1980	Toutle and lower Cowlitz Rivers in Washington	60	unknown	Result of eruption of Mt. St. Helens.

Flooding in Ohio

No area in Ohio is free from the threat of flooding. Flooding occurs in Ohio every year, although the location and seriousness vary according to weather and ground conditions. Large floods in Ohio, such as those experienced in 1913, 1937, 1959, 1963, 1964, 1969, 1990, 1997 and 1998 have caused the loss of many lives as well as cost billions of dollars in property damage.

Numerous factors can cause flooding in Ohio, including heavy and/or prolonged periods of rainfall, snowmelt, soil saturation, ground freeze, severe wind events and inadequate drainage systems. Ohio floods can be of several types: riverine, flash flooding, coastal flooding and urban flooding.

There are two major drainage basins in Ohio, the Lake Erie and Ohio River basins. Streams in the northern third of the state flow into Lake Erie; those in the southern two-thirds of the state flow into the Ohio River.

Ohio's Appalachian Region is particularly vulnerable to flash flooding because of the steep terrain and narrow stream valleys. Ohio has several highly urbanized counties susceptible to urban flooding. Coastal flooding occurs along Lake Erie.

Sources of Riverine Flooding in Ohio

Ohio River
Scioto River
Great Miami River
Muskingum River
Hocking River
Maumee River
Sandusky River
Cuyahoga River
Grand River
Little Miami River
Mahoning River
and their tributaries

Historically Significant Floods in Ohio

May 12, 1886: Xenia Flood Runoff from 7 to 9 inches of rain poured into Shawnee Creek and a wall of water several feet high moved through Xenia. The waters rose so quickly that sleeping families had little time to escape. Sixteen people died in two homes that were carried into the flood and collapsed. A total of 28 people were killed. The flood left 300 people homeless. Debris collected at bridges through Xenia and caused a temporary rise in floodwater that washed downstream with renewed vigor when the debris and bridge gave way. After the flood, the city council announced it intended to widen Shawnee Creek and asked residents not to rebuild houses along the creek.

March 14-18, 1907 All rivers flowing southward into the Ohio River flooded when more than 4 inches of rain fell across the southern third of Ohio; the heaviest rain was 5 to 6 inches in a band from Cincinnati to Athens and Noble County. There were 32 deaths in Ohio; 15 were along the Hocking River at Athens and Nelsonville. The Scioto washed out every railroad leading into the city of Waverly. Six hundred people were forced from their homes in Zanesville. As the waters flowed into the Ohio River, the flood extended from Pittsburgh to past Cincinnati. At Marietta, the Ohio River rose 30 feet in two days, leaving 5,000 homeless. Portsmouth was inundated by the flood.

March 23-27, 1913: Statewide Flood

Broad St. looking northwest, Columbus.

Ohio Historical Society collections.

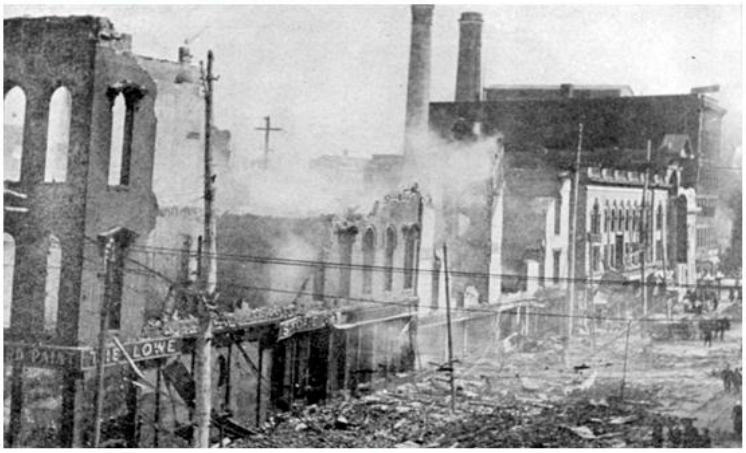
Call Number: SC4670

March 23-27, 1913 The Flood of 1913 is known as the greatest natural disaster in Ohio history. The extent of death and destruction exceeds all other weather events in Ohio: 467 deaths and more than 40,000 homes flooded.

Heavy rains exacerbated usual spring flooding conditions. Most communities along rivers in the state experienced flooding. The most severe flooding occurred along the Great Miami River. At Dayton, the river flooded 14 square miles of the city, killing 123 people. Downstream on the Miami River, there were about 100 deaths in Hamilton, where water was 10 to 18 feet deep. Approximately 100 died in Columbus when the Scioto River reached record levels and poured 9 to 17 feet of water through neighborhoods. Many Columbus residents escaped to the safety of rooftops and trees. Thirteen people were rescued from a single tree. Downstream, most of Chillicothe was under water.

The Muskingum River at Zanesville crested 27 feet above flood stage and water was 20 feet deep at several downtown intersections. The Cuyahoga River washed away docks, lumberyards, trains and rail yards in Cleveland. Seven locks were dynamited on the Ohio Canal at Akron, allowing the floodwaters to pour into the Cuyahoga. Levees along the Ohio River at Portsmouth were topped. The Ohio River at Cincinnati rose 21 feet in 24 hours.

March 23-27, 1913: Statewide Flood



Scene in the heart of the business section of Dayton, showing houses destroyed by flood and fire.

Photo courtesy of National Oceanic and Atmospheric Administration/ Department of Commerce

After the flood, the Vonderheide Act, also known as the Ohio Conservancy Law, was passed in 1914. The law gave the state the authority to establish watershed districts and to raise funds for improvements through taxes. The Miami Conservancy District was created in response to the Vonderheide Act in 1915. It became the first major watershed district in the nation.

January 26, 1937: Statewide Flood

The Grant Memorial Bridge in Point Pleasant.
Ohio Historical Society collection
Call number: P 365/7/2

January 26, 1937 Ohio-Mississippi Valley Flood All Ohio River communities were flooded on January 26-27, 1937 by the greatest volume of water ever known to pass along Ohio's southern boundary from Gallipolis downstream past Cincinnati. In all, 196 counties in 12 states were flooded. Two hundred and fifty people died--low for such a devastating flood, compared to the 467 who died in the 1913 flood.

January 1937 was the wettest month ever recorded in Ohio. Six to 12 inches of rain fell during January 12-25 over a large area of Ohio. The Ohio River crested at 80 feet at Cincinnati. The rising river at Portsmouth overtopped a floodwall erected 10 feet above flood stage. Floodgates were opened to allow water to flow into the business district to prevent catastrophic breaching of the floodwall. The river eventually crested at 14 feet over the top of the floodwall.

January 21, 1959 Classic winter flood conditions existed across Ohio during January 1959. Soil frozen a foot deep was overlain by a snow cover. A band of heavy rain fell across central Ohio on the headwaters of many of the state's largest rivers, causing the snow to melt, and, with frozen ground, nearly all of the water poured into streams. For many of the streams, flood levels were the highest since March 1913. Columbus was the most severely affected of Ohio's major cities. One-third of Chillicothe was flooded, and ice jams on the Sandusky River flooded Upper Sandusky, Tiffin and Fremont. Flood-control reservoirs built after 1913 helped reduce deaths and damage.

June 14, 1990: Shadyside Flood

A fifteen-acre "raft" of debris formed at Hannibal Locks and Dam thirty miles downstream on the Ohio River.

Photo courtesy of Belmont County Emergency Management Office

June 14, 1990 Shadyside Flood A deadly flash flood occurred in the steep Appalachian valleys of Belmont County near the town of Shadyside on the evening of June 14, 1990. Three to four inches of rain fell in an hour onto the steep-sided valleys and saturated soils along Pipe and Wegee Creeks. With the soil already saturated, nearly all the water ran off the slopes directly into the creeks, creating a wall of water, reported by some witnesses at between 10 and 30 feet, rapidly moving downstream about 45 minutes after the onset of the heavy rain. Trees, cars, and collapsed buildings carried in the flow created debris dams at bridges along the creeks, causing higher flood levels and greater flows as the dams broke.

Most residents lived along the narrow flat land along the creek. About 80 houses were destroyed, 79 sustained major damage and 172 sustained minor damage, according to the National Weather Service. Twenty-six people were killed. Most were found downstream in the Ohio River.

March 1-2, 1997 Heavy rains resulted in severe flooding in 18 southern Ohio counties. The largest accumulations of rainfall were in Adams and Brown Counties, ranging from 10 to 12 inches. Parts of Athens and Vinton Counties received about 6 inches of rainfall. Amounts of 4 or more inches fell on most of the counties along or near the southern border of Ohio.

The most severe flooding was observed in streams located within 50-70 miles north of the Ohio River. Flood damage estimates were over $180 million. Nearly 20,000 people were evacuated, and about 6,500 residences and 833 businesses were affected. Five deaths were attributed to the flooding, all the result of attempts to drive through flooded roads.

August 19-21, 2007 Heavy rainfall inundated multiple communities across Northern Ohio during a two-day period. The heaviest rains redeveloped each night from August 19 to August 21. The 24-hour rainfall totals at 8 a.m. on August 21 exceeded the 1000/year 24-hour frequency. Peak flood stage of the Blanchard River in Findlay was just 0.04 less than the flood of record in 1913. Approximately 2,500 structures were flooded.

Ohio Flood Data Summary from the National Climatic Data Center

Year	Number of Reported Flood Events [2]	Deaths	Injuries	Estimated Property Damage ($) [3]	Crop Damage ($)
2000	44	3	2	10.60 Million	None Reported
2001	37	3	1	14.60 Million	None Reported
2002	38	1	None Reported	2.56 Million	None Reported
2003	63	4	None Reported	353.64 Million	2.95 Million
2004	40	2	None Reported	148.82 Million	.97 Million
2005	39	3	None Reported	65.08 Million	None Reported
2006	33	4	1	561.16 Million	38.36 Million
2007 [1]	21	None Reported	None Reported	279.22 Million	16.50 Million
Total:	**315**	**20**	**4**	**1.81707 Billion**	**58.78 Million**

1 - The data for 2004 is from 1/1/07 to 8/31/07.

2 - The number of reported flood events was calculated by adding one record for each date in the data set.

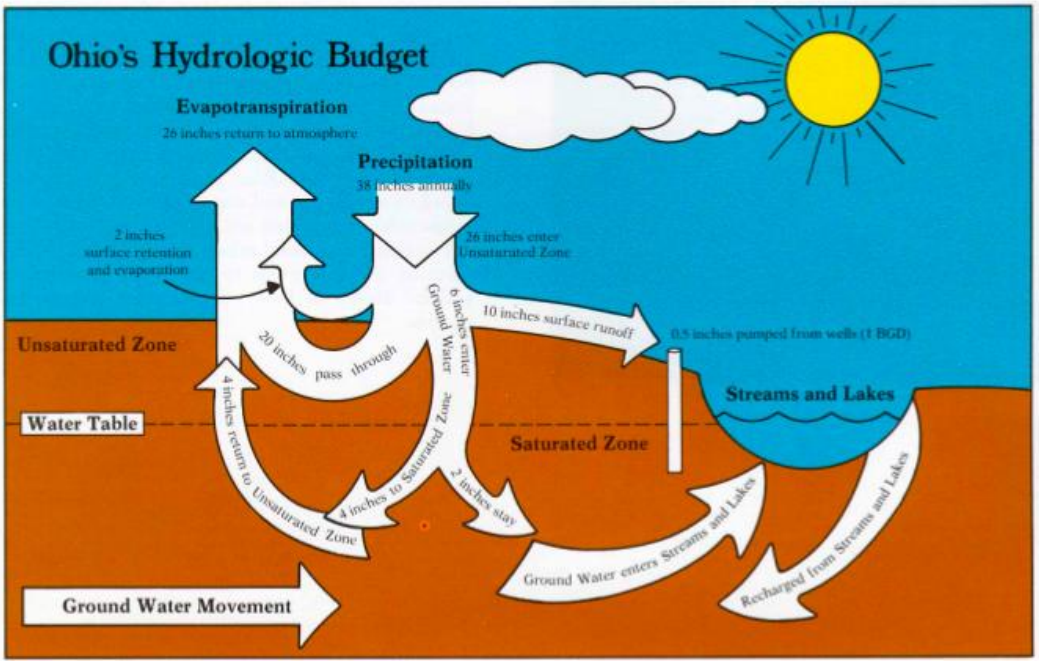
3 - Property damage values prior to 2007 were converted to 2007 dollars.

Source: NOAA, NCDC, Storm Events Database

Flooding in Franklin County

Franklin County receives approximately 38 inches of precipitation every year. October, December, and February are the months that receive the least amount of precipitation, while January, May, June, and July are the wettest months. The average monthly precipitation recorded is approximately 3.14 inches.

Of these 38 inches, about 10 inches become run-off, which moves immediately to surface-water bodies. Most of the precipitation eventually returns to the atmosphere through evaporation and transpiration. The bulk of the flow of water in streams and rivers is from surface water run-off, augmented to varying degrees by groundwater discharge to these surface waters.



Watersheds

The area of land over which water runs on its way to a river or stream is a watershed. Every watershed combines with other adjacent watersheds to form a basin, and basins combine to form larger watersheds. In Franklin County, the Scioto River Basin drains into the Ohio River, which in turn drains into the Mississippi, which makes its way south to the Gulf of Mexico. Watersheds are characterized by the pour-point, or mouth, of the main flow of water to which all other points flow. The four major watersheds in Franklin County are the Scioto River, Olentangy River, Alum Creek and Big Walnut Creek. A distinguishing feature of these waterways is the sub-parallel, nearly straight, north-south direction of flow through the county. Another significant stream, the Big Darby, flows diagonally, northwest- southeast through the southwest corner of the county.

A "watershed approach" uses hydrologically defined areas (watersheds) to coordinate the management of water resources. The approach is advantageous because it considers all activities within the landscape that affect the watershed. Movement within the watershed is defined by the physical boundaries, hills, ridgelines, valleys; vegetative cover; urbanization; mining; transportation; agriculture; and, construction of dams. Other human impacts on the watershed are large-volume users, primarily municipal water systems that divert large quantities of water from the stream on a regular basis, and large releases into the stream by municipal wastewater treatment plants.

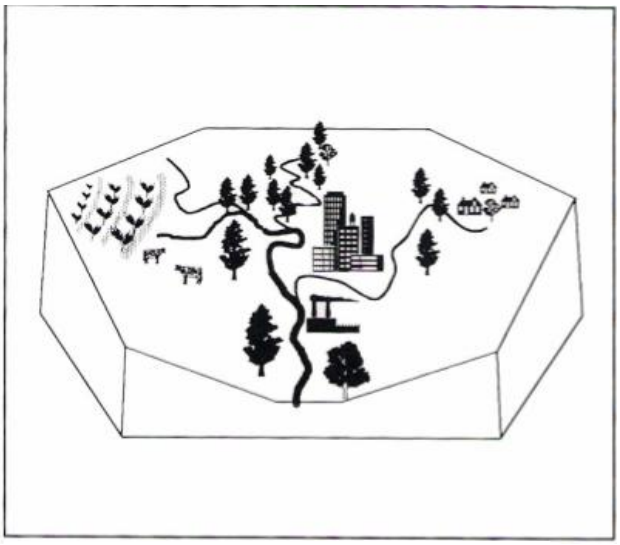


Diagram of watershed

Floodplains

Floodplains along the banks of a river or stream also serve as an important storage site for water during periods of heavy runoff. When the runoff becomes too big, the stream widens its channel by overtopping its banks and flooding the low-lying areas surrounding the stream. The areas that become flooded are called floodplains.

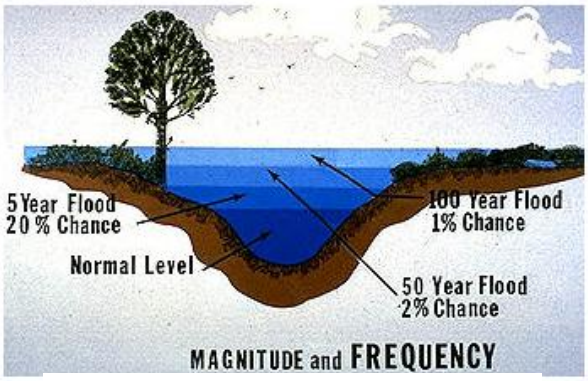


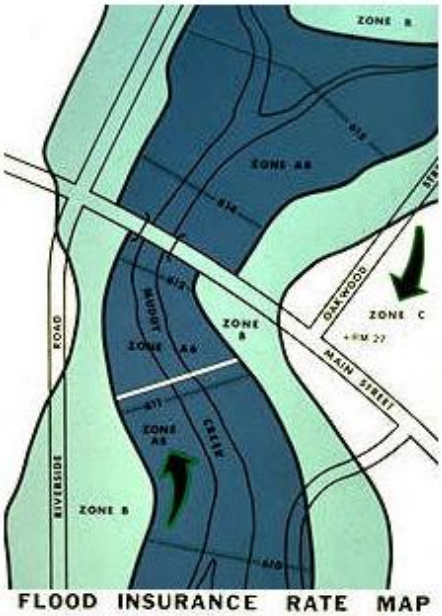
Diagram of a floodplain

Floodplains serve as a storage area for increased water quantities during and after large rain or snow-melt events. A floodplain allows water to slowly infilterate into the ground, recharging groundwater levels. The most important function of floodplains to people is the ability to keep floodwaters away from structures, unless, of course, we have built in the floodplain.

The 100-year flood has become the accepted national standard for regulatory purposes. It is defined as the flood event that has a 1% chance of occurring in any given year or, on average, occurs once in a 100-year period. However, 100-year floods can and do occur more frequently.

For regulatory purposes, the floodplain is divided into two areas based on water velocity: the floodway and the flood fringe. The floodway includes the channel and the portion of

the adjacent floodplain required to pass the 100-year flood without increasing flood heights. Typically, this is the most hazardous portion of the floodplain where the fastest flow of water occurs. Due to the high degree of hazard, most floodplain regulations require that proposed floodway developments do not block the free flow of flood water as this could dangerously increase that water's depth and velocity.



FLOOD INSURANCE RATE MAP

The flood fringe is the remainng portion of the floodplain, outside of the floodway, that usually contains slow-moving or standing water. Development in the fringe will not normally interfere as much with the flow of water. Therefore, floodplain regulations for the flood fringe typically allow development to occur but require protection from the flood waters through the elevation of the buildings above the 100-year flood level, or floodproofing buildings so that water cannot enter the structure.

What is the Likelihood of Flooding?

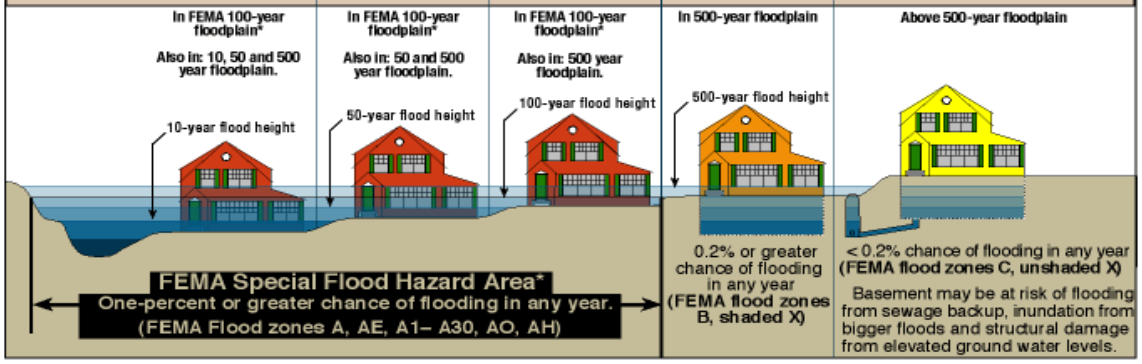
Years in floodplain	Chance of at least one **10-year flood**	Chance of at least one **50-year flood**	Chance of at least one **100-year flood**	Chance of at least one **500-year flood**
1	10%	2%	1%	<1%
2	19%	4%	2%	<1%
3	27%	6%	3%	1%
4	34%	8%	4%	1%
5	41%	10%	5%	1%
10	65%	18%	10%	2%
15	79%	26%	14%	3%
20	88%	33%	18%	4%
25	93%	40%	22%	5%
30	96%	45%	26%**	6%
Risk Level:	**High Risk**	**High Risk**	**High Risk**	**Medium Risk**

The longer you occupy the floodplain, the greater your chance of being flooded.

FEMA has not identified all areas that may be at risk of flooding. Between 20%–25% of flood insurance claims are from areas OUTSIDE of the FEMA Special Flood Hazard Area in supposedly "low risk" areas.

**Over a 30 year mortgage, there is a 26% chance of a 100-year flood.

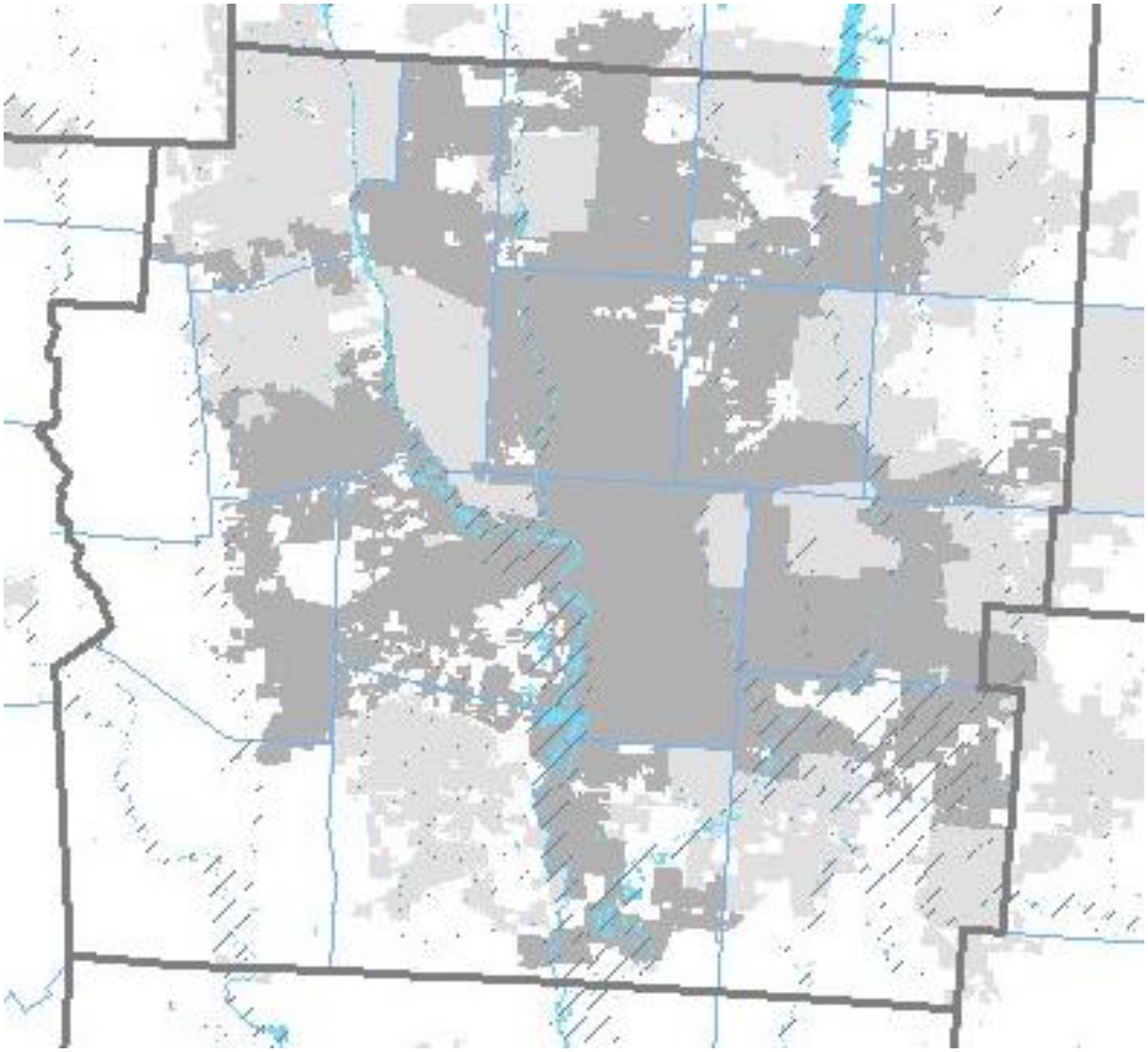
Low Risk



*The Special Flood Hazard Area has a 1% or greater chance of flooding in any year. On average floodwaters will get high enough to flood this area once in every 100 years. It is known as the 100-year floodplain. A 100-year flood can occur more than once in a 100-year period. Refer to the FEMA Flood Insurance Study and Flood Insurance Rate Map for your community to help determine your flood risk.

What damages/repairs can you expect following a flood?	Depth of flooding				
	1-4 inches	5-8 inches	9-12 inches	13-15 inches	16-18 inches
Remove Dirt and Debris	x	x	x	x	x
Clean and Sanitize	x	x	x	x	x
Replace Carpet/Flooring	x	x	x	x	x
Repair Drywall	x	x	x	x	x
Replace Insulation in Exterior Walls	x	x	x	x	x
Replace Baseboard Molding	x	x	x	x	x
Repair/Replace Baseboard Heaters	x	x	x	x	x
Replace Bookshelves and Floor Lamps	x	x	x	x	x
Some Furniture Damaged or Destroyed		x	x	x	x
Computer Accessories		x	x	x	x
Some CDs and Books Destroyed		x	x	x	x
Repaint Interior		x	x	x	x
Repair/Replace Washer/Dryer		x	x	x	x
Replace Kitchen/Bath Cabinetry			x	x	x
Repair/Replace Kitchen Appliances			x	x	x
Replace Living Room Furniture			x	x	x
Replace Bedroom Furniture			x	x	x
Clean Exterior			x	x	x
Repair/Replace Furnace/AC				x	x
Repair/Replace Hot Water Tank				x	x
Repair Electrical System				x	x
Replace Warped Doors					x
Replace TV, DVD, Stereo					x
Replace Personal Items					x
Repaint Exterior					x

Floodplains in Franklin County



Source MORPC

The National Climatic Data Center reported 84 flood events for Franklin County from 1950 to April of 2009, resulting in $3.83 million in property damage and $890,000 in crop damage. No deaths or injuries were reported.

Franklin County Watersheds

Scioto River Watershed

The upper Scioto River begins in west central Ohio and flows southeast to the confluence with the Olentangy River in Columbus. Over 1,000 square miles of drainage flows into the upper Scioto River watershed before completing its journey to the Ohio River. At more than 231 miles in length, the Scioto is one of the largest rivers in the state. The river and its 3,000 miles of tributaries flow 6,300 miles through all or part of 31 central and southern Ohio counties, draining nearly a half million acres before it joins the Ohio at Portsmouth.

Scioto River Flood Impacts – Frank Road Gage

24.0' While much of the city remains protected at this stage, widespread flooding occurs along the river outside the City of Columbus. This level will cause flooding along the Scioto River in southern Franklin County, mainly in Franklin and Jackson Townships.

26.0' Lowland flooding worsens especially in Marion Township. Columbus erected the Franklinton Floodwall to protect the city itself from flooding. Outside the floodwall moderate flooding occurs with widespread high water throughout Franklin County.

27.0' Major river flooding outside the City of Columbus. The Franklinton Floodwall closes off several roadways….including McKinley, Harmon and Greenlawn Avenues.

27.2' Major river flooding outside the City of Columbus. While the city itself is protected at stages above this level….the Franklinton Floodwall closes off several roadways… including potentially State Route 315.

Flood Categories (in feet)

Major Flood Stage	27
Moderate Flood Stage	25
Flood Stage	24
Action Stage	16

The Scioto River basin is the second largest watershed in Ohio. Flowing almost due north to south, the river collects all the water from Franklin County rivers, streams, and ditches by the time it reaches Circleville. The watershed is home to nearly two million Ohioans and a major source of public drinking water. More than twenty municipal water systems use surface water, while others draw water from wells adjacent to tributaries and the river.

Upstream from Columbus, the Scioto River is impounded by two major reservoirs, O'Shaughnessy near Dublin and Griggs near Upper Arlington. There are about five miles of free-flowing water between these reservoirs, and a similar stretch between Griggs Dam and the confluence with the Olentangy. The entire Scioto River corridor from the Delaware County line south through Dublin to Trabue Road in Upper Arlington is visible from Riverside Drive.

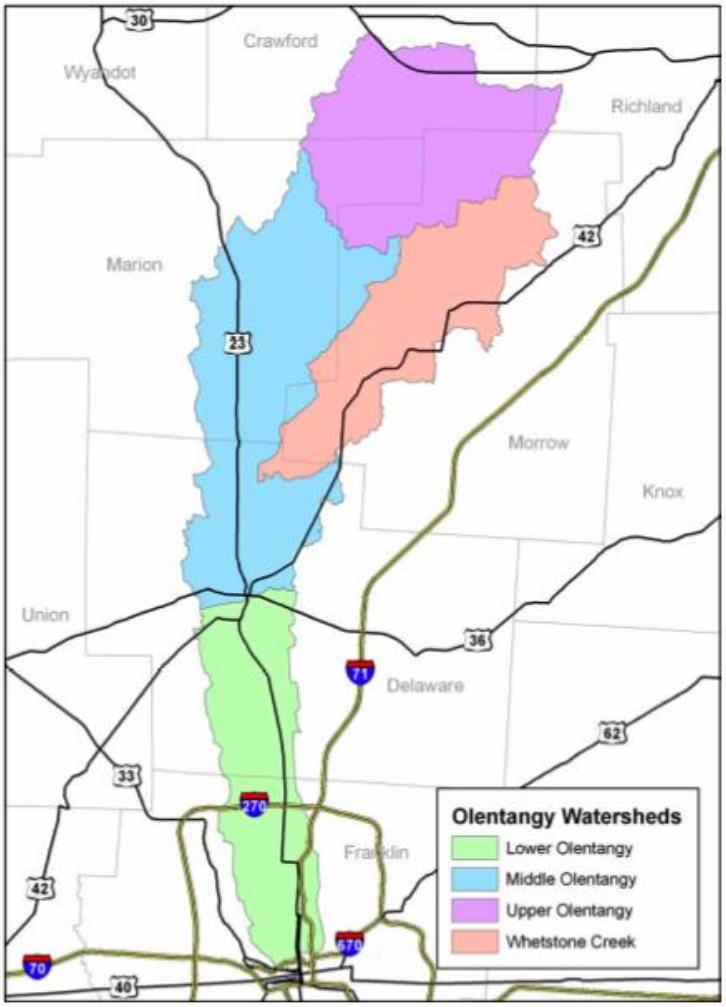
Below the confluence with the Olentangy River, the Scioto serves a drainage area of 1,629 square miles, larger at this point than any other Franklin County stream as it opens out into a wide floodplain. This wide

floodplain has made the region vulnerable to flooding. Franklinton, the region's first settlement, was built on the floodplain and has suffered flooding on numerous occasions, with 1913 being the most severe.

The West Columbus Local Protection Project, better known as the Franklinton Floodwall, began construction in 1993 and is now complete. The floodwall protects downtown's west riverbank area and the Franklinton neighborhood. In the event of a major flooding event along the Scioto River, the wall would serve as a dam to hold back water rising from the river.

The river is considerably wider than it would be naturally due to lowhead dams, which make navigation by anything but small craft quite difficult. In its natural state, the Scioto would barely keep a canoe afloat during periods of drought. As it is, the river is difficult to canoe due to numerous impediments and is clearly not conducive to commercial boating uses.

Many miles of the Scioto River corridor are owned by the City of Columbus, including lands adjacent to the two reservoirs and the corridor from the Olentangy confluence south to Frank Road. Most of the Columbus acreage is along the east bank of Griggs Reservoir. Dublin also has significant riverfront holdings.



Olentangy River Watershed

The Olentangy River is 88.5 miles long and spans five counties, including Franklin, Delaware, Marion, Morrow and Crawford. A portion of the Olentangy was dammed in 1948 by the U.S. Corps of Engineers, creating Delaware Lake, a flood control reservoir. The lower Olentangy River is the last 32 mile stretch, extending from the Delaware Dam to the confluence with the Scioto in downtown Columbus.

The lower Olentangy flows north to south for 13 miles in Franklin County, connecting the two oldest settled areas in central Ohio, Worthington and Franklinton. The lower Olentangy watershed encompasses about 150 square miles of land that drains into the river and its streams. The watershed is home to 250,000 people, and the population is growing.

Flood Impacts – Worthington Gage

8.0' Flooding of property begins along the river at Mount Air in northern Franklin County.

10.0' Flood waters approach residences along the river in Mount Air. Flooding does not occur in Worthington until stage near 13 feet.

13.0' Flooding worsens in low areas along the river at Mount Air and Worthington experiences flooding.

Flood Categories (in feet)

Major Flood Stage	18
Moderate Flood Stage	15
Flood Stage	13
Action Stage	7

The Olentangy flows all year long and has a steeper slope than many other central Ohio waterways. Many ravines are formed by the river's tributary streams. Exposed bedrock, steep slopes and in a few cases rock ledges and small waterfalls along these tributaries are unique in the otherwise flat terrain of the region. Stream flow in the Olentangy is directly influenced by rainfall events in the watershed. The lack of forest cover in the Upper Olentangy sub-basin and the high percentage of impermeable surface in the Lower Olentangy sub-basin allow rainfall events to generate short pulses of high surface-water flow.

The Delaware Dam also controls downstream flow in the river, mitigating the impact of flood events generated by heavy rainfall events in the Upper Olentangy sub-basin and maintaining a minimum rate of flow during droughts.

Six lowhead dams lie along the Olentangy, more than any other stream in Franklin County. Two smaller structures impound the river on the south side of Worthington; three are located in the one-mile stretch between North Broadway and Dodridge Street, and a large lowhead sits just north of 5th Avenue. Following the national trend of lowhead dam removal, the 5th Avenue dam has been slated for removal, but the project has faced funding issues.

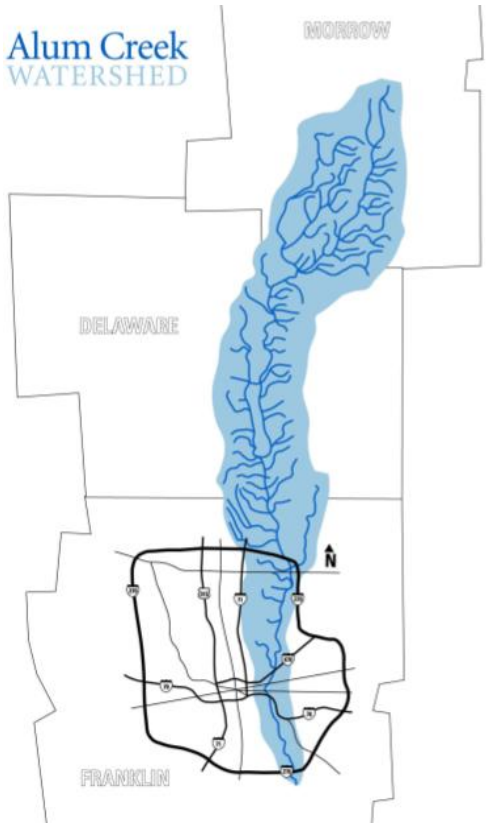
The Alum Creek Watershed

The Alum Creek watershed is located in central Ohio, running through portions of Morrow, Delaware, and Franklin Counties. The creek is 55.8 miles long and the watershed basin drains 199 square miles. The lower Alum Creek watershed extends from the Alum Creek Lake Reservoir in southern Delaware County to the creek's mouth and confluence with Big Walnut and Blacklick Creeks in southeastern Franklin County at Three Rivers Park.

The lower Alum Creek watershed drains 100 square miles and contains almost 27 miles of Alum Creek. Along the mainstem of Alum Creek, the boundary between the upper and lower sub-watersheds falls near Schrock Road in Westerville. The lower Alum Creek watershed contains portions of 11 political jurisdictions in Franklin County, including the cities of Westerville, Columbus and Bexley. Alum Creek's surface water is the primary source of Westerville's public water system.

Streamflow in the lower Alum Creek watershed is highly affected by the presence of Alum Creek Lake, a 10½ mile long, 3,400 acre reservoir located in south-central Delaware County between I-71 and US 23. The dam was built in 1974, spurred by the tremendous flood in 1959. The reservoir is operated by the Corps of Engineers, which maintains specific pool levels for summer and winter to accommodate seasonal variations in precipitation. The winter pool level is kept lower in anticipation of spring rains and snow melt, while the optimal summer pool is kept higher to maintain drinking water supplies and opportunities for recreation. Often large rain events are passed through the dam, especially in late winter and early spring in preparation for accommodating heavy spring rains.

The existence of this structure and its operation in accordance with flood control and water supply needs has dramatically altered Alum Creek stream flow compared with pre-dam flows, both within the current reservoir area and downstream of the reservoir. Water flow has been smoothed out to avoid both flood and drought events.



The major impetus for the construction of the dam was the devastating flood of January, 1959. Damages were estimated at $37 million (in current dollar value), including about $17 million in the Alum Creek watershed. Compared to average annual flow rates that have ranged from 39.1 cubic feet per second (cfs) in 1934 to 329 cfs in 1979, the 1959 flow of 26,400 cfs was indeed monumental. Instantaneous peak flows associated with 10-year storm events typically range near 6,000 – 8,000 cfs. Incredibly, the flow associated with this storm was only about half that which could be estimated for a realistic worst-case event for a watershed of its size in Ohio, according to ODNR.

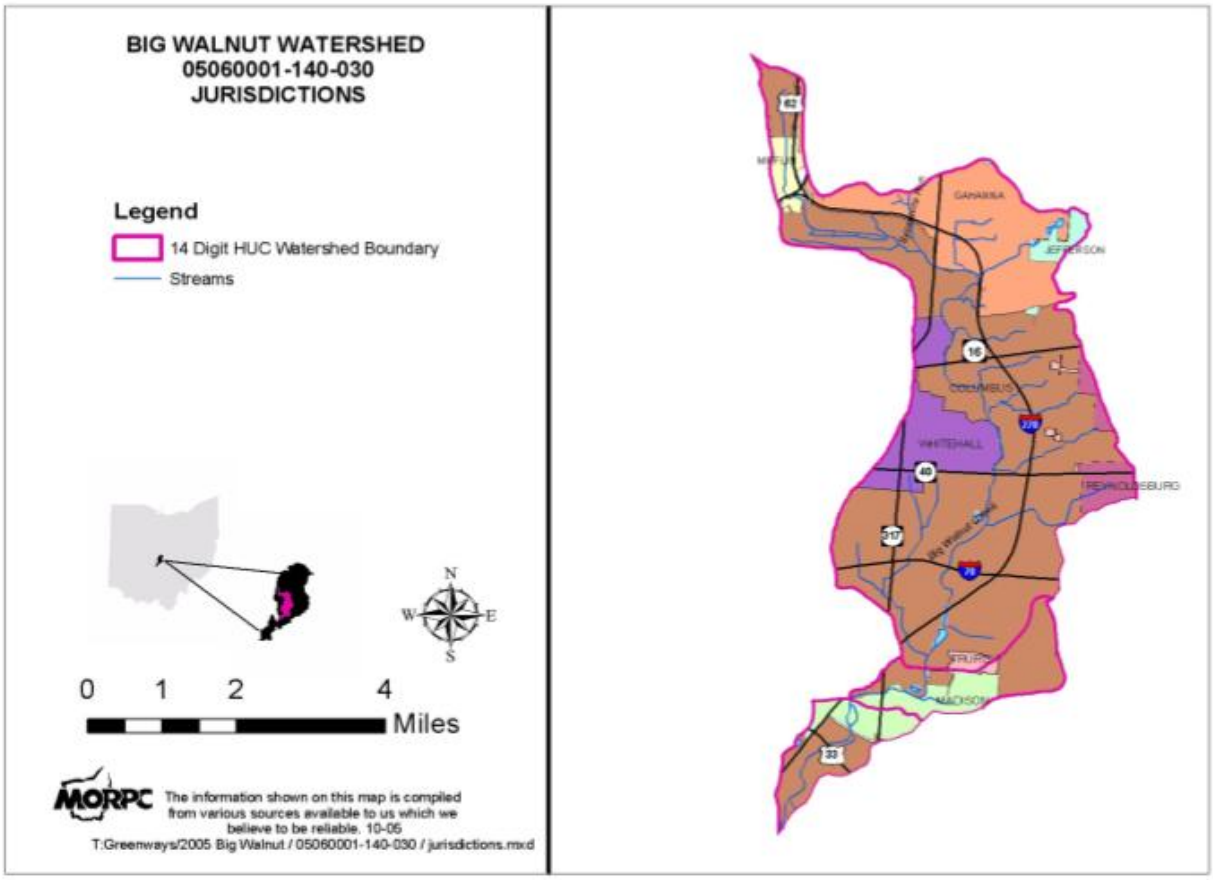
Based on geographical interpretation of other severe flood events in Ohio, it is probable that a reasonable 50-year storm event could still cause peak flow rates in the lower watershed portion of the river in the order of 20,000+ cfs. Due to channel constraints and floodplain filling, the potential high water elevations during this type of flood event could conceivably equal or exceed those in 1959. Damage from such an event would be undoubtedly severe.

Beyond the reservoir, other impoundments within the watershed include five lowhead dams on the Alum Creek mainstem and numerous small dams on tributaries. Two lowhead dams, Nelson Park Dam and Wolfe Park Dam, were removed in 2008.

The majority of the watershed is now dominated by urban and suburban land uses. The most heavily urbanized portion of the watershed is located roughly along the Interstate 70 corridor, which is close to downtown Columbus. Much of the rest of the watershed is covered by suburban or industrial development. The construction of two large regional shopping centers in the watershed in the past ten years helps illustrate the growth trend: the Polaris Fashion Place and surrounding shopping area, north of I-270, on either side of I-71, and the Easton Town Center, south of Morse Road between Sunbury Road and I-270. Growth is expected to continue in the watershed, especially in southern Delaware County.

Big Walnut Creek Watershed

Big Walnut Creek originates near Mount Gilead, Ohio, in Morrow County. The stream flows due south across Morrow County, continues into Delaware County and enters the Hoover Reservoir at Galena. Lower Big Walnut Creek is 37.6 miles long, begins at the Hoover Reservoir Dam and flows south through eastern Franklin County to its confluence with the Scioto River, 0.25 miles south of the Pickaway County line. The creek flows through Gahanna, then to east of Port Columbus before bisecting the communities of Whitehall and Reynoldsburg. Two major tributaries, Alum Creek and Blacklick Creek, conjoin with Big Walnut at Three Rivers Park. Rocky Fork Creek joins Big Walnut in Gahanna.



Hoover Dam, built in 1955, dams Big Walnut Creek near Westerville. The reservoir holds 20.8 billion gallons of water and has a surface area of 3,272 acres. The reservoir supplies roughly 50% of the region's drinking water. The dam has no flood control function.

The land area drained by the Big Walnut system is 556.7 square miles. The Lower Big Walnut watershed encompasses 145.4 square miles of drainage area, almost entirely in Franklin County. The stream falls 148 feet or 3.9 feet per mile. The watershed is flanked by rolling elevations that separate it from the watersheds of Blacklick Creek to the east and Alum Creek directly to the west. Six townships in Franklin County have areas in the watershed. Whitehall and Lockbourne are entirely within the watershed. Westerville, Gahanna, Columbus, Obetz, and Groveport are partly within the watershed.

The Lower Big Walnut Creek Watershed experiences areas of flooding during high water events. In January 2005, several major precipitation events occurred within a short time period and caused extensive flooding in Franklin County. Within the Big Walnut watershed, the Gould Park subdivision, located west of Cherry Bottom Road in Columbus, was flooded so badly that residents had to be evacuated from their rooftops. The southern portion of the watershed also experienced flooding but, being more agricultural than the north, was affected less severely by floodwaters. The record flood along Big Walnut Creek in January 1959 produced the second highest crests in Columbus.

Significant land use activity centering along the Big Walnut includes the Limited Distribution Center, Port Columbus International Airport, several sand and gravel quarries, two Columbus water treatment plants, and Rickenbacker Airport.

Rocky Fork and Blacklick Creeks are major tributaries to the Big Walnut. They are located within a mile and a half of each other and are similar in size. Rocky Fork begins as a small rural stream in Harlem Township in Delaware County. It flows about 13 miles until it reaches the confluence with Big Walnut Creek in suburbanized Gahanna, approximately three miles downstream of the intake of the City of Columbus' Hap Cremean Water Treatment Plant. It drains approximately 30 square miles. This sub-watershed of the Big Walnut is within the townships of Plain, Jefferson and Harlem and the municipalities of New Albany, Gahanna and Columbus.

Blacklick Creek begins in the northwest edge of Licking County and continues south and west until it joins the Big Walnut and Alum Creek confluence at Three Rivers Park.

Blacklick is a pastoral, meandering stream, 30 miles long and fed by a 63 square mile watershed. It flows through four counties and 17 jurisdictions. The Blacklick Creek watershed forms the eastern-most secondary drainage system for the Upper Scioto River Basin. The Blacklick watershed is the smallest and the highest topographically of the Scioto Basin watersheds.

The Big Darby Watershed

Another major waterway in Franklin County is Big Darby Creek, which originates in Logan County and flows more than 80 miles before joining the Scioto River near Circleville. It flows along the Madison County–Franklin County border, then northwest to southeast across the southwest corner of Franklin County. The entire Darby watershed is 580 square miles in portions of six counties. Historically, land use in the watershed has been mostly row crop agriculture, except for the suburbanized eastern edges along the border of Madison and Franklin counties. Low lying areas along the Big Darby have a history of flooding in Franklin County, particularly at Darbydale in the southwestern part of the county.

The Big Darby is part of state and federal wild and scenic river systems, and has long been the focus of protection groups. The watershed contains some of the most biologically diverse streams of their size in the Midwest. It also provides habitat for several state and federally listed endangered species. The most visible threat to the watershed is conversion of farmland to suburban and commercial land uses.

Flooding – References

American Rivers. "River Facts." [Online] 7 May 2009
http://www.americanrivers.org/library/river-facts.html

Changnon, Stanley A., Assessment of Flood Losses in the United States. Journal of Contemporary Water Research and Education 138: 38-44, April 2008

City of Columbus. "Franklinton Floodwall." [Online] 4 June 2009
http://utilities.columbus.gov/dosd/franklinton-floodwall.htm

Community Based Watershed Management. The OSU School of Natural Resources WS-000100

Darby Creek Association. "Historical Notes of Darby Creek Association." [Online] 4 June 2009 http://www.darbycreek.org/History.htm

FEMA. Flooding: America's #1 Natural Hazard. News Release 1530-027, 16 Aug 2004

Flood and Flood Damage Prevention: Ohio's Flood History. ODNR Fact Sheet 92-12

Flood Insurance and Rate Maps and Flood Insurance Studies. ODNR Fact Sheet 9321

Franklin County Engineers Office. "Flood of 1913." [Online] 11 June 2009
http://www.franklin.oh.us/1913%20flood.html

Friends of Alum Creek and Tributaries. Lower Alum Creek Watershed Action Plan

Friends of Big Walnut Creek. Lower Big Walnut Creek Action Plan

Friends of Blacklick Creek. Newsletter Vol. 1, Spring 2009

Friends of the Lower Olentangy Watershed. Lower Olentangy River Watershed Inventory. March 2002/edited 2003

Jackson, K.S., Vivian, Steven, A., Flood of March 1997 in Southern Ohio. USGS Water Resources Investigations Report 97-4149, 1997

Kentucky Climate Center. "Ohio River Floods." [Online] 6 May 2009
http://Kyclim.wku.edu/factSheets/ohioRiver.htm

LaPenta, K.D., et.al., The Challenge of Forecasting Heavy Rain and Flooding throughout the Eastern Region of the National Weather Service. Part 1: Characteristics and Events. Weather and Forecasting. 10: 78, 1994

MORPC, Greenways: A Plan for Franklin County. 1997

Meyers, Mary Fran, Trends in Floods. Natural Hazards Research and Applications Information Center, University of Colorado

NOAA – NCDC, "Flood Query Results for Franklin County [Online] 6 May 2009 http://www4.ncdc.noaa.gov/cgi-win/uucgi.dll?wwevent~storms

NOAA – NWS. "Turn Around Don't Drown." [Online] 12 May 2009 http://tadd.weather.gov/tadd-intro.shtml

NOAA Watch – www.noaawatch.gov/themes/flooding.php

NWS Advanced Hydrologic Prediction Service (AHPS) Brochure

NWS, Flood Hazards – A National Threat. Fact Sheet 2006-3026

NWS Hydrologic Information Center. "Flood Fatalities." [Online] 14 May 2009 http://www.weather.gov/hic/flood_stats/recent_individual_deaths.shtml

NWS Hydrologic Information Center. "Flood Losses: Compilation of Flood Loss Statistics. ' [Online] 14 May 2009 http://www.weather.gov/hic/flood_stats/Flood_Loss_Time_Series.shtml

National Weather Service Wilmington Ohio – Advanced Hydrologic Prediction Service. Flood Impact Sheets for Olentangy River, Scioto River, and Big Darby Creek

O'Connor, Jim E., Costa, John E., Large Floods in the United States: Where They Happen and Why. USGS Circular 1245, 2003

ODNR. "About the Floodplain Program." [Online] 9 June 2009 http://www.dnr.state.oh.us/water/tabid/3506/Default.aspx

ODNR, Ohio Stream Management Guide – Introduction to Stream Management. Guide #1

OEMA, State of Ohio Mitigation Plan. 2008

OEPA, Big Darby Creek Watershed TMDL, 2006

Ohio Historical Society. Numerous articles on Ohio flood events http://www.ohiohistory.org and http://www.ohiohistorycentral.org

Perry, Charles A., Significant Floods in the United States During the 20th Century – USGS Measures a Century of Floods. USGS Fact Sheet 0-24-00, March 2000

Rocky Fork Creek Watershed Action Plan

Scioto River Valley Federation. "History of the Scioto River [Online] 7 May 2009
http://www.sciotoriverfriends.org

Tulane University. "River Systems and Causes of Flooding." [Online] 12 May 2009
http://www.tulane.edu/~sanelson/geol204/riversystems.htm

U.S. Army Corps of Engineers. "Alum Creek Lake." [Online] 6 June 2009
http://www.lrh.usace.army.mil.projects/lakes/acs/

USGS, Flood Hazards – A National Threat. Fact Sheet 2006-3026

Weather – www.weather.gov/os/hazstats.shtml

Severe Winter Weather: Snow, Ice, Extreme Cold - #2

Contents

Hazard Profile 84
Detecting and Forecasting Winter Weather 90
Severe Winter Weather in the United States 92
Severe Winter Weather in Ohio 93
Severe Winter Weather in Franklin County 95

Hazard Summary

Severe winter weather is classified as snow, ice and extremely cold conditions. Winter storms are events in which the dominant varieties of precipitation are forms that occur only at cold temperatures. There were reports of 32 snow and ice events for Franklin County from January 1, 1994 to March 31, 2009, with five deaths, eight injuries and $16.65 million in damages. This hazard was ranked No. 2 out of 16.

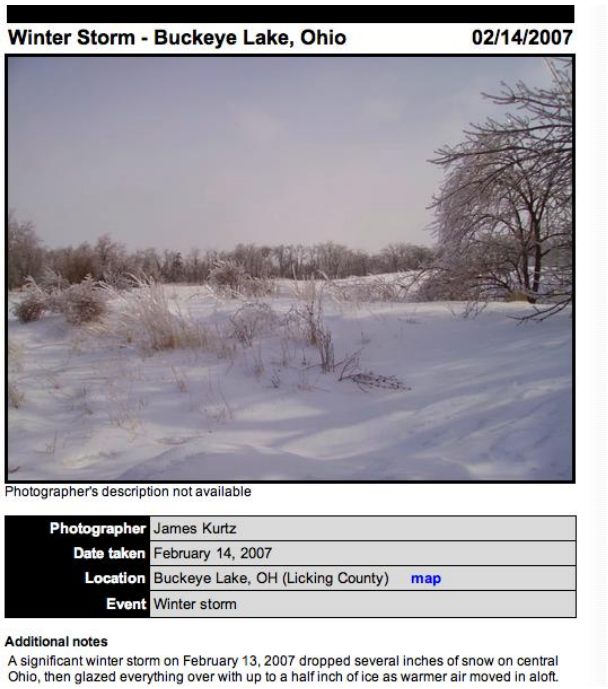
Hazard Profile

A winter storm is an event in which the dominant varieties of precipitation are forms that only occur at cold temperatures. Every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, drifting snow, extreme-cold temperatures and dangerous wind chill. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city. Storms near the coast can cause coastal flooding and beach erosion. The economic impact of winter weather each year is huge, with costs for snow removal, damage and loss of business in the millions.

Winter Storm Formation

Just like any other storm at other times of the year, the right combination of ingredients is necessary for a winter storm to develop. The three basic ingredients necessary to make a winter storm are:

- Cold air – below freezing temperatures in the clouds and near the ground are necessary to make snow and/or ice.
- Lift – something to raise the moist air to form the clouds and cause precipitation, such as a front or air flowing up a mountainside.
- Moisture – to form clouds and precipitation, such as air blowing across a body of water. A large lake or the ocean is an excellent source of moisture.

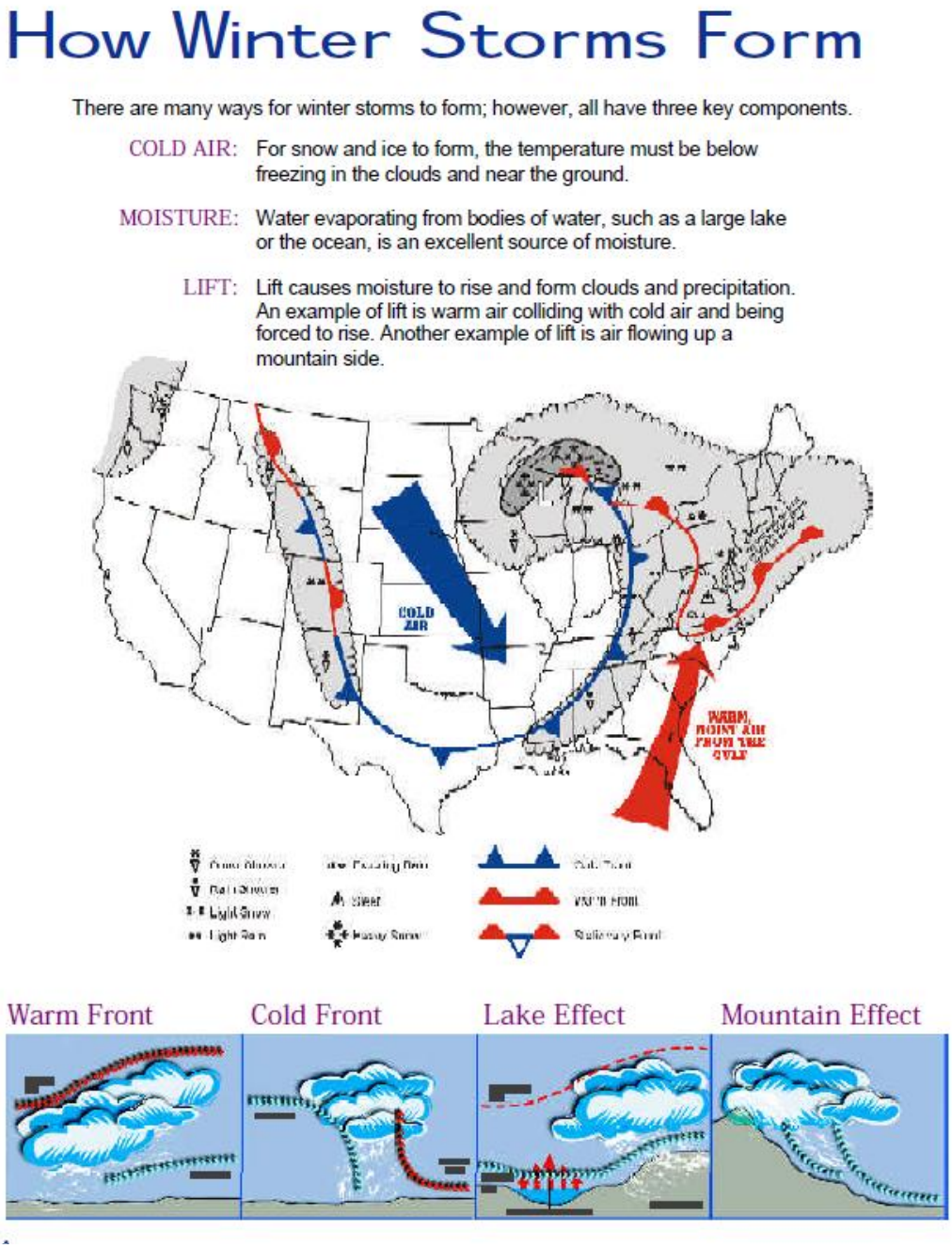


Source: NWS, Wilmington Ohio

The intensity of a storm depends upon several conditions, such as the strength and positioning of the jet stream and associated upper air disturbances, the related strength of the horizontal temperature gradients, and the availability of moisture. If cold temperatures are in place and a significant amount of moisture is pumped into a storm system, the result could be a major winter storm.

Winter storms have various components, including low pressure centers, warm fronts, and cold fronts. In the continental United States, winter storms are common from November through April, and sometimes as early as October or as late as May.

The winter dip in the jet stream allows polar air to surge south. This cold, dry air brings with it temperatures cold enough for snow, sleet, or freezing rain. Warm tropical air from the gulf of Mexico often continues to flow up from the south during the winter months. When this warm, moist air mass from the south meets the cold, dry air from the north, winter storms can result.

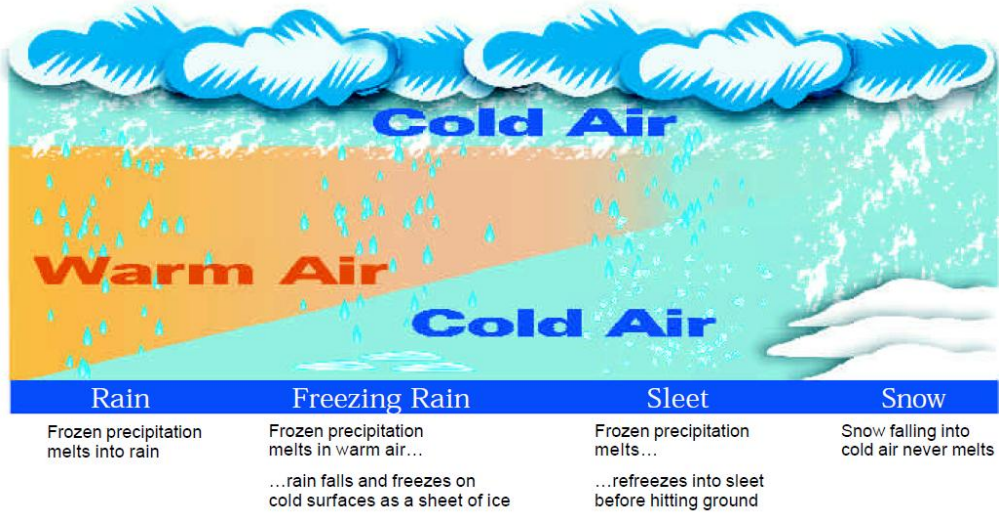


Source: *Winter Storms*, NOAA

Types of Winter Precipitation

Several kinds of precipitation can occur during winter: rain, freezing rain, snow, and sleet. For significant amounts of precipitation to fall, there must be an adequate amount of moisture in the atmosphere. There must also be a way to lift this moisture so that it can turn into precipitation.

Both these conditions are met in the storm systems that commonly form in the Plains or along the East Coast in winter, as well as in storm systems that move onshore along the West Coast.



Source: *Winter Storms*, NOAA

Rain – Wintertime rain is generally produced by nimbostratus or stratus clouds. All precipitation starts out as ice or snow crystals at cloud level. When this frozen precipitation falls into a layer of sufficiently warmer air (with temperatures above freezing), it melts into rain. If this warm air extends all the way to the surface of the earth, rain will fall at ground level.

Elevation plays an important role in determining precipitation type. For example, in the Pacific Northwest, cool, moist air sweeps in from the ocean along and ahead of a cold front. Cities at low elevations near the coast, such as Portland and Seattle, usually receive rain.

Freezing Rain – Rain droplets that fall into a shallow layer of cold air near the earth's surface can freeze upon contact with the ground, leaving a coating of glaze. This is known as freezing rain. Freezing rain occurs most often when mild, moist air moves over a cold polar or arctic air mass near the earth's surface. Lower elevations are often vulnerable to ice storms – significant and damaging accumulations of ice – because cold, dense air will naturally settle into lower elevations.

Freezing rain causes dangerous weather conditions. Rain can freeze on anything it contacts, including roads, bridges and overpasses, which typically freeze quicker than other surfaces, creating hazardous conditions for drivers.

Power outages are also common in an ice storm. The weight of ice and freezing rain often brings down power lines and tree limbs.

Snow – Snow is frozen precipitation in the form of a six-sided ice crystal. Snow requires temperatures to be below freezing in all or most of the atmosphere from the surface to cloud level. Most precipitation that forms in wintertime clouds starts out as snow because the top layer of the storm is usually cold enough to create snowflakes. Snowflakes are collections of ice crystals that cling to each other as they fall toward the ground. Precipitation continues to fall as snow when the temperature remains at or below 32^{0}F from the cloud base to the ground. Generally, 10 inches of snow will melt into one inch of water.

- Snow Flurries – Light snow falling for short durations. No accumulation or light dusting is all that is expected.
- Snow Showers – Snow falling at varying intensities for brief periods of time. Some accumulation possible.
- Snow Squalls – Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant. Snow squalls are best known in the Great Lakes Region.
- Blowing Snow – Wind-driven snow that reduces visibility and causes significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.
- Blizzard – Winds over 35 mph with snow and blowing snow, reducing visibility to ¼ mile or less for at least 3 hours.

Heavy Snow - Kettering, Ohio **03/08/2008**

Photographer's Description: County Line Road at Patterson Road

Photographer	Ken LeBlanc
Date taken	March 8, 2008
Location	Kettering, OH (Montgomery County) map
Event	Heavy snow

Additional notes

A major late winter snowstorm dropped 12 to 20 inches of snow across much of the region March 7 and 8, 2008. Combined with 20-30 mph winds, substantial blowing and drifting occurred, with drifts up to 4 feet. Countless schools and businesses closed, and about half of the counties in ILN's CWA went into a level 3 snow emergency.

This photo shows visibility near a quarter of a mile, which classifies the snowfall as heavy snow.

Source: NWS Wilmington OH

Sleet – Occurs when snowflakes only partially melt when they fall through a shallow layer of warm air. These slushy drops refreeze as they next fall through a deep layer of freezing air above the surface, and eventually reach the ground as frozen raindrops that bounce on impact. Sleet can accumulate like snow and cause a hazard to motorists.

Types of Winter Storms

Wherever they occur, classic winter storms can differ in their characteristics, intensities, and paths. Some storms can be characterized specifically.

Blizzards

Blizzards are characterized by low temperatures (usually below 20^0F) and accompanied by winds that are at least 35 mph or greater. Blizzards also have sufficient falling and/or blowing snow to reduce visibility to ¼ mile or less for at least three hours.

A severe blizzard is considered to have temperatures near or below 10^0F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard conditions often develop on the northwest side of these storm systems.

Ice Storm - Cincinnati, Ohio **02/13/2007**

Photographer's description not available

Photographer	Robin Mahan
Date taken	February 13, 2007
Location	Cincinnati, OH (Hamilton County) map
Event	Ice storm

Additional notes

It took between 1/4" and 1/2" of ice to cause these trees to sag heavily and threaten the nearby power lines. This resulted in numerous power outages across metropolitan Cincinnati. Tree limbs begin to sag and/or break with around 1/4" ice accumulation, so this is the threshold for issuing an **ice storm warning** instead of a **freezing rain advisory**.

Ice Storms

Ice storms result when freezing rain accumulates to at least ¼ inch or more. As the rain freezes, ice accumulates on roads, tree limbs and power lines, creating dangerous driving conditions and potential power outages. Heavy ice accumulations can bring down trees, topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair extensive damage.

Lake Effect Storms

Lake effect snow storms occur when a mass of sufficiently cold air moves over a body of warmer water, creating an unstable temperature profile in the atmosphere. As a result, clouds build up over the lake and eventually develop into snow showers and squalls as they move downwind. The intensity of lake effect snow is increased when higher elevations downwind of the lake force the cold, snow-producing air to rise even further.

Nor'easter

Nor'easters are among winter's most ferocious storms. A Nor'easter gets its name from its continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over coastal areas. They are strong areas of low pressure that often form either in the Gulf of Mexico or off the East Coast in the Atlantic Ocean. Nor'easters are notorious for producing heavy snow, rain and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Wind gusts associated with these storms can exceed hurricane force.

Other Severe Winter Weather Events

Extreme Cold

Extreme cold often accompanies a winter storm or is left in its wake. What constitutes extreme cold varies across different areas of the U.S. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat. In the north, below-zero temperatures may be considered extreme cold.

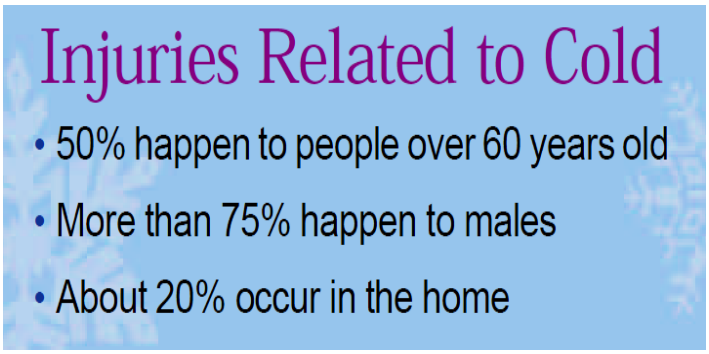
The Wind Chill is the temperature your body feels when the air temperature is combined with the wind speed. It is based on the rate of heat loss from exposed skin caused by the effects of wind and cold. As the speed of the wind increases, it can carry heat away from the body much more quickly, causing skin temperature to drop. Animals are also affected by Wind Chill; however, cars, plants and other objects are not. The Wind Chill chart shows the difference between the actual air temperature and perceived temperature, and amount of time until frostbite occurs.

	Temperature (#F)																	
Wind (mph)	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40
60	-98	-91	-84	-76	-69	-62	-55	-48	-40	-33	-26	-19	-11	-4	3	10	17	25
55	-97	-89	-82	-75	-68	-61	-54	-46	-39	-32	-25	-18	-11	-3	4	11	18	25
50	-95	-88	-81	-74	-67	-60	-52	-45	-38	-31	-24	-17	-10	-3	4	12	19	26
45	-93	-86	-79	-72	-65	-58	-51	-44	-37	-30	-23	-16	-9	-2	5	12	19	26
40	-91	-84	-78	-71	-64	-57	-50	-43	-36	-29	-22	-15	-8	-1	6	13	20	27
35	-89	-82	-76	-69	-62	-55	-48	-41	-34	-27	-21	-14	-7	0	7	14	21	28
30	-87	-80	-73	-67	-60	-53	-46	-39	-33	-26	-19	-12	-5	1	8	15	22	28
25	-84	-78	-71	-64	-58	-51	-44	-37	-31	-24	-17	-11	-4	3	9	16	23	29
20	-81	-74	-69	-61	-55	-48	-42	-35	-29	-22	-15	-9	-2	4	11	17	24	30
15	-77	-71	-64	-58	-51	-45	-39	-32	-26	-19	-13	-7	0	6	13	19	25	32
10	-72	-66	-59	-53	-47	-41	-35	-28	-22	-16	-10	-4	3	9	15	21	27	34
5	-63	-57	-52	-46	-40	-34	-28	-22	-16	-11	-5	1	7	13	19	25	31	36

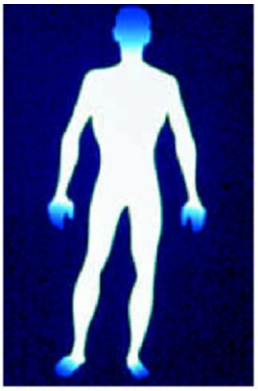
Frostbite Times:		
5 Minutes	10 Minutes	30 Minutes

Exposure to cold can cause frostbite or hypothermia and become life-threatening. Infants and the elderly are the most susceptible.

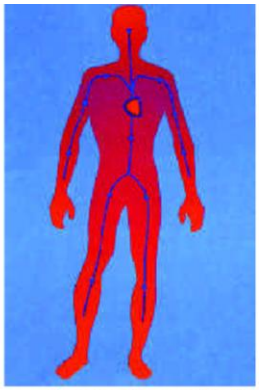
Frostbite is damage to body tissues caused by extreme cold. A wind chill of -20^{0}F will cause frostbite in just 30 minutes. Frostbite causes a loss of feeling and a white or pale appearance in extremities, such as fingers, toes, ear lobes or the tip of the nose. Medical help is immediately required.



Source: NOAA



Hypothermia occurs when the extremities are excessively cold (blue)



Improperly warming the body will drive cold blood from the extremities to the heart, leading to heart failure

Source: NOAA

Hypothermia is a condition brought on when the body temperature drops to less than 95^{0}F. It can kill. For those who survive, there are likely to be lasting kidney, liver and pancreas problems. Warning signs include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness and apparent exhaustion. Medical attention is needed immediately.

<u>Winter Flooding</u>

Winter storms can also generate flooding:

- Coastal Floods: Winds generated from intense winter storms can cause widespread tidal flooding and severe beach erosion along coastal areas.
- Ice Jams: Long cold spells can cause rivers and lakes to freeze. A rise in the water level or a thaw breaks the ice into large chunks that become jammed at man-made and natural obstructions. Ice jams can act as a dam, resulting in severe flooding.
- Snowmelt: Sudden thaw of heavy snowpack often leads to flooding.

Detecting and Forecasting Winter Weather

From the ground, a winter storm just looks like a cloudy, gray day. However, winter storms are usually easily detected by satellite, and areas of precipitation are visible on radar. Unlike thunderstorms, we can usually tell well in advance that a winter storm will be coming.

A useful tool in winter weather forecasting and determining cloud patterns and movement of winter storms is satellite imagery. Satellite imagery can be very helpful when used by forecasters to monitor rapidly developing winter storms off the east and west coasts of the U.S. By looping a series of satellite pictures, forecasters can monitor a storm's development and its movement with greater accuracy.

Using satellite evidence, meteorologists look for jet streaks and dry slots, areas of greatest spin, shear zones, areas of sinking air and cold cloud tops, among others. Comma clouds are a little easier seen on satellite by the untrained eye and can be associated with winter storms.

Radar is particularly successful in tracking the motion of precipitation, allowing forecasters to make accurate short-term forecasts of when and where winter storms will strike. Radar can give clues as to what type of precipitation is falling. Sleet shows up well on radar because it is a solid ball of ice. Sometimes it can be mistaken for heavy snow. Extremely light snow can go undetected because snowflakes have lower moisture and higher air content than other types of precipitation. Forecasters must combine both surface observations and information from Doppler radar to determine where and how fast the snow is falling and accumulating.

Another way weather data is gathered is by weather observation balloons launched from selected NWS observation sites. Weather balloons record air pressure, wind flow, moisture, dew point and temperature at various levels within the atmosphere from the ground to above the jet stream. Forecasters track winter storms in much the same way they track any other type of weather. However, because the heaviest snow usually falls on the north, northwest or northeast side of most winter storms, the forecaster must know where and how quickly the storm is moving to know what area will get the heaviest snow.

Winter Weather Terms

Winter Storm Warning: Issued when hazardous winter weather in the form of heavy snow, heavy freezing rain or heavy sleet is imminent or occurring, usually issued 12 to 24 hours before the event is expected to begin.

Winter Storm Watch: Alerts the public to the possibility of a blizzard, heavy snow, heavy freezing rain or heavy sleet, usually issued 12 to 48 hours before the beginning of a storm.

Winter Storm Outlook: Issued prior to a Winter Storm Watch. The Outlook is given when forecasters believe winter storm conditions are possible, usually issued 3 to 5 days in advance of the storm.

Blizzard Warning: Issued for sustained or gusty winds of 35 mph or more, and falling or blowing snow creating visibilities at or below ¼ mile, and persisting for at least 3 hours.

Lake Effect Snow Warning: Issued when heavy snow is imminent or occurring.

Lake Effect Snow Advisory: Issued when accumulation of lake effect snow will cause significant inconvenience.

Wind Chill Warning: Issued when wind chill temperatures are expected to be hazardous to life within several minutes of exposure.

Wind Chill Advisory: Issued when wind chill temperatures are expected to be a significant inconvenience to life with prolonged exposure.

Winter Weather Advisories: Issued for accumulations of snow, freezing rain, freezing drizzle and sleet which will cause significant inconveniences and, if caution is not exercised, could lead to life-threatening situations.

Dense Fog Advisory: Issued when fog will reduce visibility to ¼ mile or less over a widespread area.

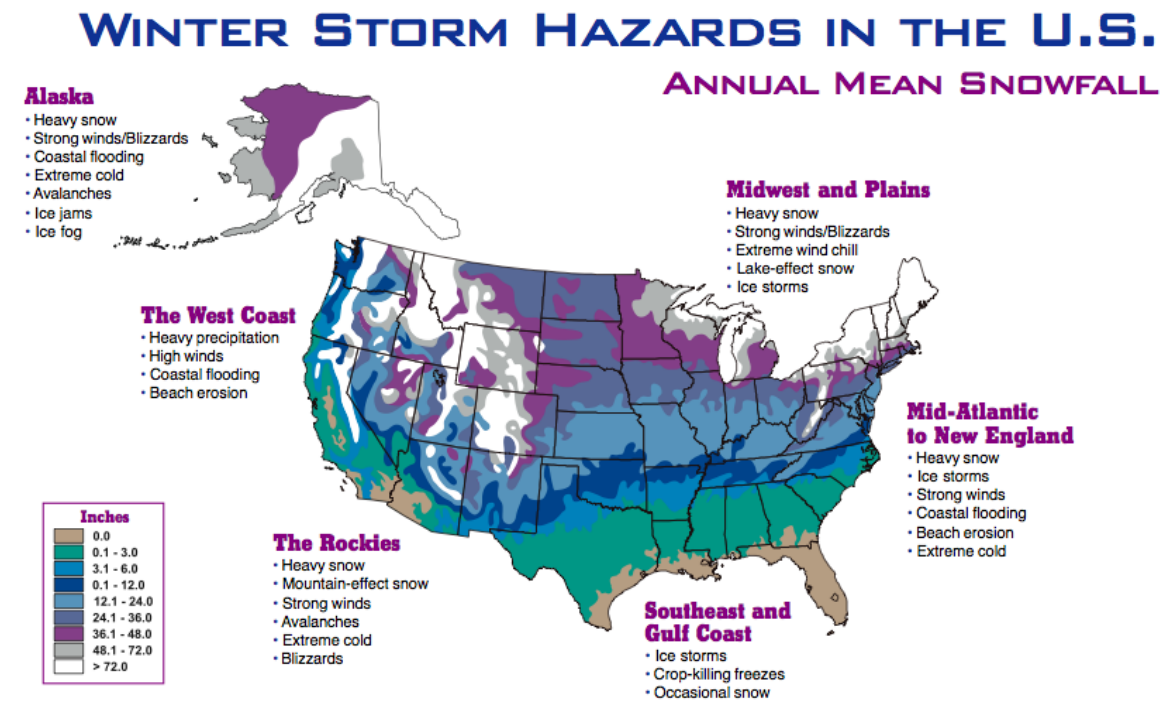
Snow Flurries: Light snow falling for short durations, no accumulation or light dusting.

Snow Showers: Snow falling at varying intensities for brief periods of time, some accumulation possible.

The forecaster must also know where the rain, snow, or icy areas are and how they might change over time. Analyzing current conditions and identifying areas of low pressure, wind flow patterns, surface temperatures and dew points help forecasters answer those questions.

Severe Winter Weather in the United States

Winter storms can affect all areas of the United States, including the Deep South and the deserts of the southwest. They also come in various sizes and are created by different combinations of atmospheric conditions and local geography.



Source: Winter Storms – The Deceptive Killers, NOAA

Winter storms vary greatly across the United States. In the Mid-Atlantic Coast and New England region, Nor'easters are common. Storms tap moisture from the Atlantic and dump heavy snow over the densely populated area. Ice storms are also a problem in this region.

The area along the Gulf Coast and Southeast is generally unaccustomed to snow, ice, and freezing temperatures. Once in a while, cold air will penetrate the region, killing tender vegetation and damaging citrus crops. People in this region are not accustomed to driving on slick roads, and accidents increase.

The Midwest and Plains states experience severe winter weather, including heavy snow and sometimes blizzards, as well as extremely low wind chill temperatures. This area is also subject to lake-effect snow.

Strong storms off the north Pacific sometimes slam into the coast from California to Washington. If cold enough, snow falls over Washington and Oregon and sometimes in northern California. Strong winds through canyons or over ridges can reach 100 mph and combine with the snow to cause blizzards.

In Alaska, intense storms crossing the Bering Sea can produce coastal flooding and drive large chunks of ice inland, causing damage to buildings and shoreline. Alaska's Arctic coast experiences blinding blizzards and wind chill temperatures to 90^0F below zero. Extreme cold and ice fog may last a week at a time. Snow accumulates through the winter months, and if thawed too quickly, flooding occurs.

Severe Winter Weather in Ohio

Severe winter weather in Ohio consists of freezing temperatures and heavy precipitation, usually in the form of snow, freezing rain or sleet. All parts of Ohio experience severe winter weather. Ohio residents are accustomed to winter storms; however, occasionally a severe event can be very disruptive. Heavy snow volumes make removal difficult and costly. Ice storms can be extremely damaging, causing telecommunications and power outages that last for days.

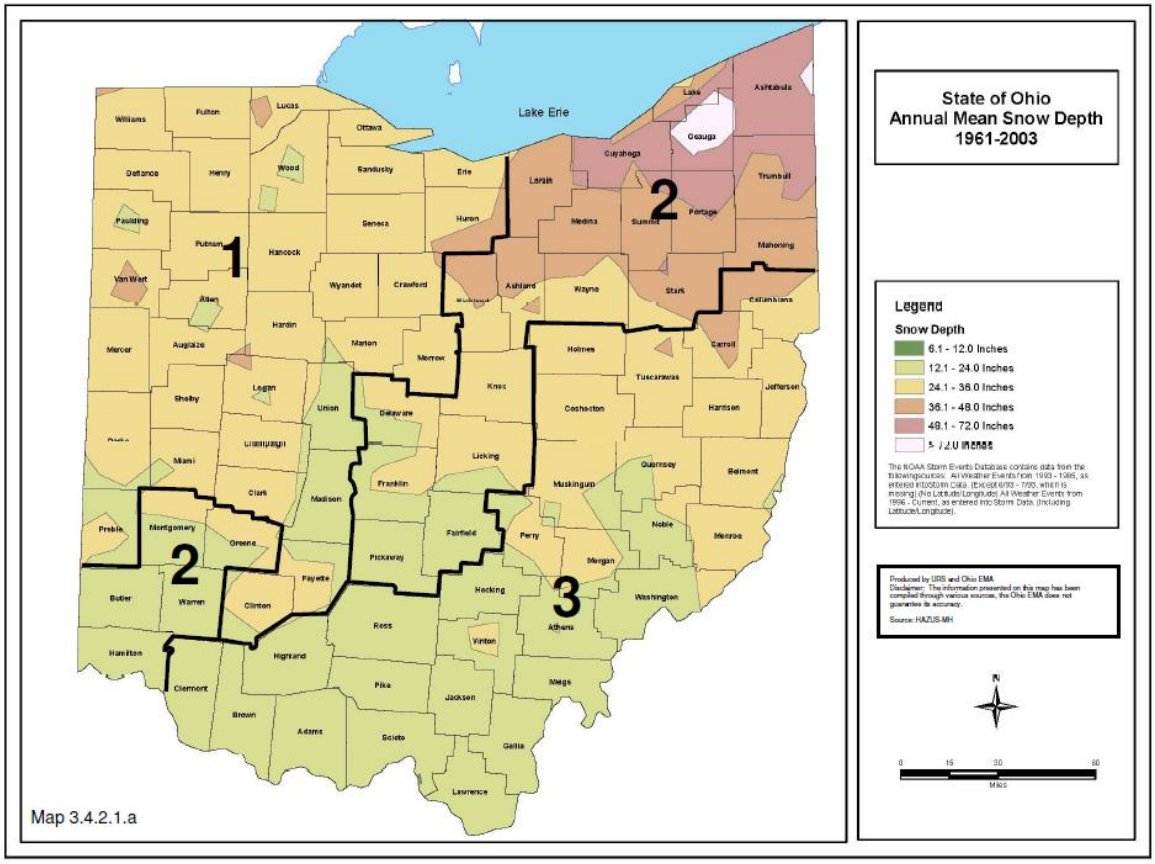
Northeastern Ohio near the Great Lakes experiences lake-effect snow. The worst of these storms are generally during late autumn/early winter. Lake-effect snowfall can vary greatly, with areas of deep snowfall adjacent to areas with relatively little snow.

The Ohio Emergency Management Agency mapped the annual mean snowfall depth for Ohio from 1961 to 2003. (See map on following page.) The map divides the State into three regions.

Most of the counties in Region 1 have experienced a mid-level of snow during these years. Higher snow levels were experienced in sparse areas of Lucas, Van Wert, Auglaize, Logan, and Hardin counties.

Region 2 contains all the counties that have experienced the highest annual mean snow depth. Parts of Geauga and Ashtabula counties have had the highest levels in the state.

Region 3 counties have had moderate snow depth. The upper section of this region has higher snow levels than the lower part of the region. The counties with the lowest snow depths in the state are in the lower part of Region 3.



Source: State of Ohio Hazard Mitigation Plan, OEMA

Historic Winter Events

Ohio experienced more than 270 severe winter storms between 1925 and 2003. Several were considered notable storms:

<u>November 23-27, 1950</u> The Thanksgiving snowstorm of 1950 left at least 10 inches of snow over the entire state, with the counties in the eastern half of Ohio receiving 20 to 30 inches of snow. Winds increased to over 40 mph, and a severe cold wave swept the state, dropping temperatures to near zero. Eastern Ohio had snow drifts 25 feet deep. Bulldozers were used to clear roads for emergency vehicles. Many buildings collapsed under the weight of 2 to 3 feet of snow.

<u>January 26, 1978</u> The storm of January 26, 1978, was a rare and dangerous storm. It was declared a severe blizzard by the NWS. Winds gusted to more than 100 mph over much of the state, with sustained winds in the 50 to 70 mph range. Enormous snowdrifts covered cars and houses, blocked highways and railways, and closed all airports for two days.

February 1994 Heavy freezing rain and sleet fell across southern and central Ohio counties. Ice accumulations averaged 0.75 to 2 inches, leading to downed trees and power lines. Very low temperatures slowed ice removal. Six vehicular fatalities and one death due to exposure occurred.

March 7-8, 2008 Though technically not a blizzard, this storm was a record-setting event. The storm dumped 20.4 inches of snow on Columbus, breaking the city's previous record of 15.3 inches, set in 1910. Cincinnati and Cleveland also received about a foot of snow. At the peak of the storm, approximately two-thirds of Ohio's counties had declared Level Two or Level Three Snow Emergencies, restricting automobile travel.

Severe Winter Weather in Franklin County

The National Climactic Data Center reports 32 snow and ice events for Franklin County from January 1, 1994 to March 31, 2009, with five deaths, eight injuries and $16.65 M in damages.

Franklin County has been affected by many widespread snowstorms. The March 7-8, 2008, storm is a good example of how the county can be impacted. The storm dumped more than 20 inches of snow on Columbus. Blizzard-like conditions shut down highways and stranded air travelers. At Port Columbus International Airport, a plane skidded a few hundred feet off a runway while landing. Many flights in and out of Columbus were delayed or canceled. Luckily, the storm struck over the weekend, which helped minimize closures and disruptions.

Severe Winter Weather – References

FEMA, "Know your Winter Storm and Extreme Cold Terms." [Online] 2 July 2009
http://www.fema.gov/hazard/winter

NCDC – NOAA Query Result, Winter Storms, Franklin County, Ohio

NOAA – NWS, Winter Storms: Deceptive Killers, Nov 1991

NOAA, "Know your Winter Weather Terms." [Online] 2 July 2009
http://www.noaanews.noaa.gov/stories/s794chtm

NOAA, "Winter Weather," [Online] 2 July 2007

NSSL, "Understanding Winter Weather Risks," 29 June 2009
http://www.nssl.noaa.gov/primer/winter

National Snow and Ice Data Center, "All About Snow." [Online]
http://www.nsidc.colorado.edu/snow

OEMA, State of Ohio Mitigation Plan, 2008

Ohio Historical Society, Ohio History Central, Numerous articles on winter events in Ohio,
http://www.ohiohistory.org ; http://www.ohiohistorycentral.org

Ohio Insurance Institute, Ohio Winter Storm Reference Information, 5 Dec 2007

Dam Failure - #3

Contents

Hazard Profile 98
Dams in the United States 101
Dams in Ohio 102
Dams in Franklin County 103

Hazard Summary

Dam failure is defined as a catastrophic mishap characterized by the sudden, rapid, and uncontrolled release of impounded water. Dam failure can occur with little or no warning and for one or a combination of reasons, including overtopping, seepage (water percolating through the dam and its foundation) and structural failure caused by earthquakes, sliding and slope instability, or faulty construction. Two dams serving Franklin County are on the Ohio EMA's list of the ten most potentially hazardous dams in the state, based on the possible catastrophic consequences should they fail. This hazard was ranked No. 3 out of 16.

Hazard Profile

A dam is an artificial barrier usually constructed across a stream channel to impound water. The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, and any combination of these materials. Dams provide flood control, water supply for drinking, irrigation for farming, recreational areas and clean, renewable energy through hydropower. Many dams fulfill a combination of the above functions.

There are different types of dams classified by the material and design used in construction. Embankment dams are the most common type of dam in use today. Materials used for embankment dams include natural soil or rock, or waste materials obtained from mining or milling operations. An embankment dam is also referred to as an "earthfill" or "rockfill" dam, depending on whether it is comprised of compacted earth or mostly compacted or dumped rock. The ability of an embankment dam to resist the reservoir water pressure is primarily a result of the mass weight, type and strength of the materials from which the dam is made.

Concrete dams may be categorized into gravity and arch dams according to the designs used to resist the stress due to reservoir pressure. Concrete gravity dams are the most common form of concrete dam. The mass weight of concrete and friction resist the reservoir water pressure. A buttress dam is a specific type of gravity dam in which the large mass of concrete is reduced and the forces are diverted to the dam foundation through vertical or sloping buttresses. Gravity dams are constructed of vertical blocks of concrete with flexible seals in the joints between the blocks. Concrete arch dams are rather thin in cross-section. The reservoir water forces acting on an arch dam are carried laterally into the abutments.

<u>Why Dams Fail</u>

The Federal Emergency Management Agency defines dam failure as a "catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release." Dam failure can occur with little warning and for one or a combination of several reasons:

- Overtopping – accounts for 34% of all dam failures nationally. Overtopping failures result from the erosive action of water on the embankment. Erosion is due to uncontrolled flow of water over, around and adjacent to the dam. Once erosion has begun during overtopping, it is almost impossible to stop. Overtopping is caused by inadequate spillway design, debris blockage of spillway or settlement of dam crest.
- Seepage – accounts for 20% of all dam failures nationally. Seepage failures are caused by uncontrolled seepage from water percolating slowly through the dam and its foundation. Progressively eroding the soil from the embankment or its foundation can result in rapid failure of the dam. The erosion starts on the downstream side of the embankment, eventually develops a "pipe," and if fully

developed is impossible to control and will likely cause failure. Seepage and erosion can occur along hydraulic structures such as outlet conduits or spillways.
- Structural failure – accounts for 30% of all dam failures nationally. Structural failures can occur either in the embankment or the appurtenances such as spillways or lake drains. Cracking, settlement, and slides are the more common signs of structural failure and usually require emergency measures to ensure safety. Structural failures can be caused by earthquakes, sliding and slope instability, or faulty construction.

These types of dam failures are often interrelated. For example, uncontrolled seepage may weaken the soil and lead to structural failure.

Dam Classification

The classification of dams in Ohio is defined in the Ohio Administrative Code. This classification covers dams under the control of the Ohio Department of Natural Resources, Division of Water. The classification system for dams in Ohio was modeled after the Federal Guidelines for Dam Safety and are based on three parameters: height of the dam, storage volume of the pool, and potential downstream hazard.

Class I – Dams having a total storage volume greater than 5,000 acre-feet or a height of greater than 60 feet. A dam shall be placed in Class I when sudden failure of the dam would result in one of the following conditions.

- Probable loss of human life.
- Structural collapse of at least one residence or one commercial or industrial business.

Class II – Dams having a total storage volume greater than 500 acre-feet or a height of greater than 40 feet. A dam shall be placed in Class II when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.

- Disruption of a public water supply or wastewater treatment facility, release of health hazardous industrial or commercial waste or other health hazard.
- Flooding of residential, commercial, industrial or publicly owned structures.
- Flooding of high-value property.
- Damage or disruption to major roads including but not limited to interstate and state highways, and to the only access roads to residential or other critical areas such as hospitals, nursing homes or correctional facilities.
- Damage or disruption to railroads or public utilities.
- Damage to downstream Class I, II, or III dams or levees, or other dams or levees of high value. Damage to dams or levees can include but is not limited to overtopping or failure of the structure.

Class III – Dams having a total storage volume greater than 50 acre-feet or a height of greater than 25 feet. A dam shall be placed in Class III when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.

- Property losses include but is not limited to rural buildings not otherwise described, and Class IV dams and levees not otherwise listed as high-value property.
- Damage or disruption to local roads includes but is not limited to roads not otherwise listed as major roads.

Class IV – Dams which are 25 feet or less in height and have a total storage volume of 50 acre-feet or less. A dam shall be placed in Class IV when sudden failure of the dam would result in property losses restricted mainly to the dam and rural lands, and loss of human life is not probable.

The federal classification of dams uses three categories: low, significant, and high, in order of increasing adverse incremental consequences. The classification levels build on each other; the higher order classification levels add to the list of consequences for the lower classification levels.

Low Hazard – dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the dam owner's property.

Significant Hazard – dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities, or can impact other concerns. Significant-hazard dams are often located in predominately rural or agricultural areas but could be located in areas with population and significant infrastructure.

High Hazard – dams where failure or mis-operation will probably cause loss of human life.

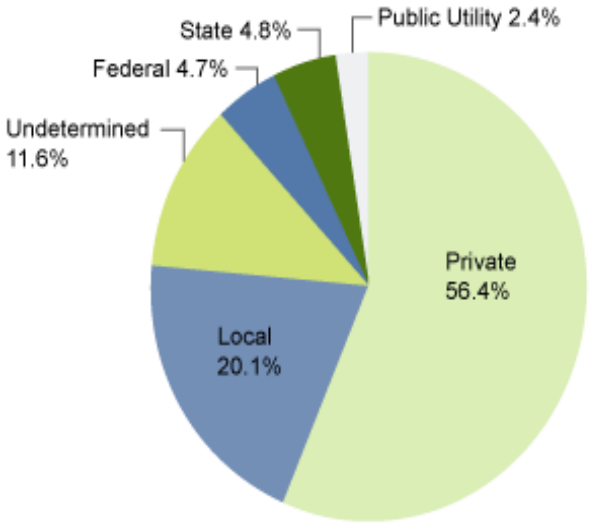
The two classification systems are compared in the table below.

Ohio and Federal Dam Classification Systems		
Ohio Hazard Classification	**Description**	**Corresponding Federal Classification**
Class I	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)	High
Class II	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas	High
Class III	Damage to low value non- residential structures, local roads, agricultural crops and livestock	Significant
Class IV	Losses restricted mainly to the dam	Low

Source: State of Ohio Hazard Mitigation Plan

Dams in the United States

There are more than 80,000 dams in the United States, according to the 2007 update to the National Inventory of Dams. Approximately one third of these pose a "high" or "significant" hazard to life and property if failure occurs. The majority of dams in the U.S. are privately owned. In general, very large dams are owned and regulated by the federal government. The safety and security of a dam can affect persons and property across local, state and even national borders. As a result, there is a substantial federal role in coordinating federal, state and local dam safety efforts.



Source: National Inventory of Dams, Feb. 2005

Despite best efforts to promote dam safety, failures sometimes occur. Some notable dam failures in the United States:

1977 – The Kelly Barns Dam, an old earthen dam in Georgia, gave way in the middle of the night, probably as a result of internal erosion. Thirty-nine people were killed at a small Bible college below the dam.

1976 – The Teton Dam, a massive $100 million dollar earthen dam that had just been built by the U.S. government in southeast Idaho, collapsed as it was being filled for the first time. Poor construction had caused the dam face to erode. Water swept into several small towns, destroying thousands of homes and killing eleven people.

1972 – In West Virginia, a coal slurry dam, weakly constructed and with an inadequate spillway, collapsed during a period of moderately heavy rain, killing 125 people in Buffalo Creek Hollow.

1963 – The Baldwin Hills reservoir in Los Angeles gave way, probably due to subsidence caused by a nearby oil field, destroying 277 homes and killing five people.

1889 – By far the most famous dam failure, and one of the worst disasters in U.S. history, was the Johnstown, Pennsylvania, flood of 1889. An abandoned earthen dam was restored by a hunting and fishing club to create Lake Conemaugh, a pleasure lake used for sailing and ice boating and stocked with expensive fish. The water outlet at the base of the dam had been filled in, and the emergency spillway had been reduced in size and covered with screens to prevent the fish from escaping, causing a buildup of debris.

In May of 1889, after several days of extraordinarily heavy rains, the dam overtopped and eventually gave way. Twenty million tons of water crashed down the valley, hit the city of Johnstown, flattening everything in its path until it was stopped by an immense stone bridge at the far end of town. The bridge caused a disaster of its own. It acted like another dam, causing the water to back up over the city. Then the entire debris mass of wires, wood, rail cars and bodies caught fire. More than 2,200 people died.

Dams in Ohio

There are more than 2,600 dams in Ohio. With the exception of those federally owned, dams in Ohio are subject to regulation through the Ohio Dam Safety Program in the Ohio Department of Natural Resources. There were 1,597 state-regulated dams in Ohio in 2007, with 375 of those classified as High Hazard Class I dams, 543 classified as Significant Hazard Class II dams, and 679 classified as Low Hazard Class III dams. There are nearly 1,000 additional Class IV dams. There is also an undetermined number of mostly small dams for coal mining ponds regulated by ODNR.

Ohio EMA lists the following as the top ten dams in Ohio whose failure could have catastrophic consequences.

- Salt Fork Dam – Guernsey County
- Hoover Dam – Franklin County
- O'Shaughnessy Reservoir Dam – Delaware County
- Indian Lake Dam – Logan County
- Grand Lake St. Mary's Dam – Auglaize County
- Mineral Ridge Dam – Trumbull County
- Lake Milton Dam – Mahoning County
- Bridge Creek Dam – Geauga County
- Rocky Fork Lake Dam – Highland County
- Wolf Run Lake Dam – Noble County

According to ODNR's Dam Safety Program, there has been little property damage that has resulted from a dam failure alone. However, there has been property damage that was a combination of downstream flooding due to excessive precipitation and dam failure. It is difficult to assess which property damage was a direct result of the dam failure and which damage was a result of downstream flooding due to excessive precipitation. There has been some infrastructure loss in terms of roads washing away, but there has been no loss of critical facilities due to dam failure.

The Dam Safety Program provides oversight for dam/levee repairs, oversees and issues construction permits, enforces safety standards and mandates, conducts periodic safety inspections, and provides public information to dam and levee owners, engineers, and the general public. This proactive approach to managing dam safety reduces the number of losses to property and life as a result of dam failure or near failure. However, for reasons

uncontrollable by humans, it is possible a dam can fail at any time, given the right circumstances.

Dams in Franklin County

The National Performance of Dams Program lists 20 dams in Franklin County. Most are small dams less than 25 feet in height. One Franklin County dam, Hoover Dam, is on Ohio EMA's list of the ten most potentially hazardous dams in the state. In addition to Hoover Dam, there are several other dams in Franklin County and in Delaware County of significant interest.

Hoover Dam
Hoover Dam, near Westerville, dams Big Walnut Creek to form the Hoover Memorial Reservoir. It is much smaller than the better-known Hoover Dam on the Colorado River. It was not named for President Herbert Hoover, as was the Colorado dam, but for two brothers, Charles and Clarence Hoover, to honor their careers with the City of Columbus Waterworks.

Source: City of Columbus

Owned by the City of Columbus, construction began in 1953 and was completed in 1956, with spillway gates added in 1970. The dam has a concrete gravity overflow spillway section flanked by zoned, rolled earth embankment sections. It is 2,583 feet long and 85.5 feet high. The reservoir has a surface area of 3,373 acres and can hold 20.8 billion gallons of water. It supplies water for the entire northeast portion of Franklin County. In addition to its function as a water supply reservoir, the area is used for recreation.

OEMA estimates that discharge from failure of the dam would be at least 10 times greater than the 1% flood discharge. Communities downstream include Gould Park at 4 miles, Gahanna at 7 miles, Whitehall at 10 miles, and Columbus at 12 miles. Inundation is expected to be noticed in Circleville 30 miles downstream. Damage is expected to be extensive and would include many residential structures, state routes, local roads, interstate highways and businesses. Loss of life would be expected.

Julian Griggs Dam
The Julian Griggs Dam is located on the Scioto River near Upper Arlington, 6 .5 miles upstream of the Olentangy River confluence and 9.3 miles downstream of O'Shaughnessy Dam. The dam was named after the City's chief engineer, Julian Griggs. The dam is a concrete gravity structure about 983 feet long and 52 feet high at the maximum section.

Construction was completed in 1905. Flashboards were added onto the 500 foot long curved spillway in 1945. The reservoir is almost six miles long with a 1.2 billion gallon capacity. It was the first major reservoir supplying drinking water for the City of Columbus and served as the only one for 20 years.

Dam failure could result in severe property damage with possible loss of life. Many buildings downstream are within an area which was inundated by the floods of 1959 and 1913.

The Ohio State University (OSU) Golf Course Dam

The OSU Golf Course dam is located on Turkey Run Stream on the OSU Golf Course in Upper Arlington. It was built in 1935-36 as a Works Progress Administration (WPA) project. The dam is an earthen embankment with a spillway system consisting of a concrete drop box connected to concrete box culvert with an asphalt-lined overflow channel. Dam height at maximum section is about 17 feet.

The dam is owned by The Ohio State University and supplies water for golf course irrigation. Failure would flood 16 or more dwellings between Kenny Road and the railroad embankment, resulting in possible loss of life.

O'Shaughnessy Reservoir Dam

The O'Shaughnessy Dam is located on the Scioto River in Concord and Liberty Townships in Delaware County. The dam is 4 miles upstream from Dublin, 9.3 miles upstream from the Griggs Dam, and 16.5 miles upstream from downtown Columbus. The Columbus Zoo is located on the east bank of the reservoir, near the dam.

The dam was constructed between 1922 and 1925 at the urging of Superintendent of Waterworks Jerry O'Shaughnessy. He fought efforts to add to Griggs dam, pressing the city to build an additional storage dam further up the river. Upon completion, the dam was said to be the "best inland city reservoir and dam in the United States." Unfortunately, Mr. O'Shaughnessy did not live to see the completion of the project. In 1990, the dam was placed on the U.S. National Register of Historic Places.

Source: City of Columbus

The dam is a concrete masonry, gravity overflow structure flanked by rolled earth embankments. The dam is 1,750 feet long, containing a central concrete masonry section of 879 feet in length and 84 feet high. A reinforced concrete bridge with 12 arched supports crosses the dam above the spillway, serving vehicular traffic on Glick Road.

The reservoir holds 6.3 billion gallons of water covering a surface area of 845 acres. When completed, the reservoir could supply water for half a million people, twice the size of the city at that time. The dam has no flood control function.

In 1987, the City of Columbus installed a pair of hydroelectric turbines. They can only be operated when there is sufficient flow, so they can only intermittently provide power, producing up to 5 megawatts.

The dam is on Ohio EMA's list of the ten most potentially hazardous dams in the state. Failure of the dam could result in severe property damage with the possible loss of many lives. Significant encroachments on the Scioto River floodplain, including residences, commercial establishments, and the Julian Griggs Dam are located within the first 15 miles downstream. Many of these structures are within the area that was inundated by the floods of 1959 and 1913.

Delaware Dam

The Delaware Dam is located on the Olentangy River in Delaware County, 4 miles upstream of the city of Delaware and 32 miles north of Columbus. Authorized by the Flood Control Act of 1938 for the purposes of flood reduction, low-flow control for pollution reduction, water supply, and recreation, the project was constructed between 1947 and 1951 at a cost of $4,307,000. The project was constructed and is operated by the U.S. Army Corps of Engineers, Huntington District.

Source: U.S. Army Corps of Engineers

The dam is a rolled earth-fill type with a concrete gated spillway section. It is 3 ½ miles long and 92 feet high. It controls a drainage area of 386 square miles through the use of five gated sluices and six 25 foot by 32 foot tainter/radial gates. The Delaware Dam is a unit in the larger comprehensive flood control plan for the Ohio River Basin.

Dam failure would result in extensive property damage and possible loss of life in the many population centers downstream.

Alum Creek Dam

The Alum Creek Dam is located in Delaware County, between I-71 and U.S. 23, 12 miles southeast of the city of Delaware and 25 miles northeast of Columbus. It was built and is operated by the U.S. Army Corps of Engineers to reduce the flood hazard along Alum and Big Walnut Creeks, the Scioto River and the Ohio River. The City of Columbus shared part of the additional project cost for water supply. The majority of the recreational area is leased to ODNR and operated as a state park.

The dam was constructed between 1970 and 1974. It is a rolled earth-fill embankment, 10,000 feet in length, with a maximum height of 93 feet. The spillway is located high on the right abutment with the raceway dropping off in front of it to the stilling basin below. Control is provided by three 34 by 25 foot tainter gates, supported by 8 foot wide concrete piers resting on concrete ogee sections. In 1978, the dam was retrofitted by installing seven cable anchors deep into the bedrock to secure the concrete monolith.

Source: U.S. Army Corps of Engineers

Dam failure would result in property damage with possible loss of life, as development continues to grow south of the lake. When the dam was built, it was considered "out in the country." Today, homes reach nearly to the base of the dam.

January, 2005 Flooding

In January of 2005, after record snowfall in December, 2004, a rapid warm-up of temperatures into the upper 50s allowed for rapid melting of snow pack. A frontal boundary brought heavy rain into the region. In Columbus, the monthly rainfall total was 8.95 inches, 6.42 inches above normal. The total rainfall from January 1 to 13 was 8.25 inches.

Rivers rose to levels that had not been reached in several years. Record levels were also reached at the U.S. Army Corps of Engineers reservoirs. On January 13, 2005, Delaware Lake was in danger of overtopping. The lake normally sits at 905 feet above sea level. On this day, it peaked at 946 feet, one foot away from overtopping the spillway and requiring main spill gates to be opened. These gates have never been used.

On January 16, Alum Creek Reservoir reached its highest level since construction was completed. Control was maintained through the discharge pipe, and it was not necessary to open the three main spillway gates.

Delaware Dam on Olentangy River.
Viewed at typical normal pool, and near peak pool elevation on January 15, 2005

Source: Sky Scoop, NWS Wilmington, OH, Spring/Summer 2006

Dam Failure – References

American Society of Civil Engineers, 2009 Ohio Infrastructure Report Card. Dam Fact Sheet 2009

Association of Dam Safety Officials, "Ohio Dam Safety Program." [Online] 15 July 2009 http://www.damsafety.org/map/state.aspx?s=35

City of Columbus – Department of Utilities, "Water Sources." [Online] 17 July 2009 http://utilities.columbus.gov/water/WaterSources%20.htm

Dam Safety: Classification of Structures, ODNR-Division of Water Fact Sheet 94-29, 28 June 1994

Dam Safety Coalition, "Dam Safety 101." [Online] 15 July 2009 http://www.damsafetycoalition.org/about/101.html

Dam Safety: Probable Maximum Flood, ODNR-Division of Water Fact Sheet 95-37, 4 Apr 1995

FEMA, "Dam Ownership in the United States." [Online] 15 July 2009 http://www.fema.gov/hazard/damdailure/ownership.shtm

FWMA, "Dam Failure." [Online[15 July 2009 http://www.fema.gov/hazard/damfailure/index.shtm

National Performance of Dams Program, "Query Ohio." [Online] 15 July 2009 http://npdp.stanford.edu/DamDirectory

ODNR, "Dam Definition, Classification and Statistics." [Online] 15 July 2009 http://www.dnr.staate.ohio.us/water/safety/tabid/3342/Default.aspx

ODNR, "Ohio Flood History." [Online] 3 June 2009 http://www.dnr.state.oh.us/water/pubs/fs_div/fctsht12/tabid/4095/Default.aspx

OEMA, Hazard Identification and Risk Assessment, 2007

OEMA, State of Ohio Mitigation Plan, 2008

Schotts, Walter H., O'Shaughnessy Dam. The Ohio State Engineer

US Army Corps of Engineers, "Delaware Lake." [Online] 20 July 2009 http://www.rh.usace.army.mil/projects/lakes/deo/

Terrorism- #4

Contents

Hazard Profile 109
CBRNE Weapons 113
Terrorism in the United States 117
Terrorism in Ohio 118
Terrorism in Franklin County 120

Hazard Summary

Terrorism is defined as a violent act or an act dangerous to human life, in violation of the criminal laws of the U.S. or any segment, to intimidate or coerce a government, the population or any segment thereof, in furtherance of political or social objectives. Franklin County and the City of Columbus have consistently received federal dollars for projects fostering terrorism preparedness. Franklin County has never been the victim of a direct terrorist attack yet has a history of terrorist activity. This, along with the difficulties in predicting which U.S. cities are future targets and the potential impact of a terrorist attack on the county's population, property and economy, makes terrorism more of a "wild card" than other hazards and therefore more difficult to prioritize. This hazard was ranked No. 4 out of 16.

Hazard Profile

The U.S. Department of Justice defines terrorism as:

> *"A violent act or an act dangerous to human life, in violation of the criminal laws of the United States or any segment to intimidate or coerce a government, the population or any segment thereof, in furtherance of political or social objectives."*

Terrorism has become a fact of life in today's society. Terrorists' acts may result in the destruction of public confidence in the ability of government to protect its citizens. Mass casualties and fatalities; catastrophic damage to buildings, physical infrastructure, or other types of property; contamination of buildings and property; psychosomatic responses from non-affected citizens; contamination/targeting of first responders – all could have a major impact on the county's ability to respond and could place a major burden on the medical system and area hospitals.

Local emergency-response agencies frequently train for the reality that terrorists may employ secondary or multiple devices intended to injure responders, impede response actions, or divert attention and resources from other activities. Devices may be employed at numerous locations in any combination or sequence and are often designed with anti-tampering devices.

Historically, terrorist events have occurred at places of special significance, against identifiable segments of the population, on dates of interest to the terrorist or the intended victims, and at special events. However, any place people gather could be a terrorist target.

Federal, state and local governments each have a role in terrorism prevention, protection, response and recovery. The federal government is the investigative lead and the prosecutor of terrorism cases. The first responder agencies of Franklin County must be equipped and trained to respond immediately and effectively to any incident. Significant help from the federal government will be 24 to 48 hours, or longer, in arriving. Local and State agencies are the first line of defense when responding to the consequences of terrorism.

Terrorism Risk

Determining the risk of a terrorist attack requires an assessment of the threat and an evaluation of the probable target's vulnerability to attack. Threat assessment requires cooperation between various local, state and federal agencies to collect, evaluate, and disseminate intelligence concerning terrorist and extremist groups. Such information may include:

- Terrorist movements or operations in a given geographical area
- Preferred terrorist targets, methods, tactics, and weapons

- Indications that terrorists have been collecting intelligence in a given area or near a particular target
- Political, social and economic changes or ongoing criminal or subversive activities which could lead to or support terrorism

Such information is law enforcement sensitive. In Franklin County, the Terrorism Early Warning Group, in communication with the Joint Terrorism Task Force, monitors, compiles and evaluates this information continuously.

Estimating Terrorism Risk, published by the RAND Center for Terrorism Risk Management Policy, describes three components of terrorism risk: threat, vulnerability and consequences.

Threat

The Department of Homeland Security's Risk Lexicon defines threat as "a natural or man-made occurrence, individual, entity or action that has or indicates the potential to harm life, information, operations, the environment, and/or property." It further states that "Threat as defined refers to an individual, entity, action, or occurrence; however, for the purpose of calculating risk, the threat of an intentional hazard is generally estimated as the likelihood of an attack (that accounts for both the intent and capability of the adversary) being attempted by an adversary. For other hazards, threat is generally estimated as the likelihood that a hazard will manifest." Specific information on threat groups or individuals is sensitive and beyond the scope of this document. However, there are some noteworthy generalizations outlined below.

Terrorism is divided into two broad categories, domestic terrorism and international terrorism. Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of the government or population without foreign direction. International terrorism involves groups or individuals whose terrorist activities are foreign based and directed by countries or groups outside the Unites States or whose activities transcend national boundaries. The bombings of the World Trade Center in New York (1993), the Murrah Federal Building in Oklahoma City and the infamous attacks of September 11, 2001 proved the United States is not immune to domestic and international terrorism.

Motivation is a key consideration when analyzing the potential for a group or individual to commit an act of terrorism. Motivations provide insight into the specific sites that a terrorist may consider a target.

The FBI established four major classifications of terrorist groups:

- Anti-government-groups want no government or a very weak central government, are pro-socialist or anti-capitalist, desire Nazi/fascist government or are anarchists.

  - Right Wing – groups commonly associated with militia movements or groups opposing government control and power.
  - Left Wing – political motivations that are commonly associated with socialist ideology.
- Religious Radicals– terrorist motivated by religious causes, often considered the most dangerous because of their fanaticism and willingness to die for their cause.
- Racist/Hate-Based – often referred to as hate groups. These groups have a belief in a social order based on the supposed superiority of a particular race.
- Special Interest/ Single Issue – includes a variety of causes, each with a single focus not included in the previous categories, e.g., animal rights, anti-abortion and environmental extremism.

Vulnerability and Consequence

Franklin County is a large, heavily populated and diverse jurisdiction. The county has many sites that are potential terrorist targets. There are several ways to address potential targets. Some locations are considered targets because they are associated with common terrorist motives.

Terrorist Groups	Potential Targets
Antigovernment - Right Wing - Extremist Militia Movements - Anti-government Groups - Left Wing - Communist Supporters	- Federal Court House – other court houses - Government Buildings - Presidential or other dignitary visits
Religious Radicals - Islamic - Catholic - Protestant - Jewish - Cults	- Opposing religions and houses of worship - Financial institutions - Women's health clinics
Racist/Hate-Based - Separatist Groups	- Ethnic facilities or symbols - Organizations that promote equality - Places of worship
Special Interest/ Single Issue - Environmental Protection Groups - Animal Rights Groups - Anti-technology Groups - Anti-abortion Groups	- Mining, logging or oil explorations sites - Construction sites - Sources of water or air pollution - Women's health clinics - University animal research facilities - Animal breeders - Research and technology companies

Some locations are inherently vulnerable:

Locations of special significance – In Franklin County this could include the Federal Courthouse, other courts of law, religious buildings, financial centers, Statehouse and other government offices, Battelle and other research and medical facilities, OSU and other universities or schools, and police and fire stations.

Transportation infrastructure – Particularly significant: Port Columbus, Rickenbacker and OSU Don Scott airports; Interstate Highways 70, 71, 270 & 670, other major roadways, rail yards, and natural gas and petroleum transmission pipelines.

Public utilities – Electricity, water, natural gas, waste treatment plants, e.g., American Electric Power stations, Dublin Road Water Treatment Plant, Columbia Gas.

Health care facilities – All hospitals and other public and private health care facilities.

Cyber/information technology service facilities – Discover Card, Verizon.

Defense and defense–related sites – Defense Supply Center Columbus, military recruiting facilities.

Large gathering places – Franklin County has many large sports arenas: Schottenstein, on the OSU campus; Nationwide, in downtown Columbus; OSU and other school stadiums. Other venues include the Columbus Convention Center and Veterans Memorial Auditorium, State Fairgrounds, Easton shopping center, and several smaller shopping centers. The area along the river in downtown Columbus is the scene of several festivals and events throughout the year.

Any potential target's vulnerability is also affected by the strengths and weaknesses of each location. These include: level of visibility, ingress and egress routes, security, individual systems within the facility such as hazardous materials, and degree of preparedness planning.

Potential target populations include:

- Religious or ethnic minorities
- Political opposition groups
- Controversial groups
- Government agencies or workers, including first responders

Dates or anniversaries of significance may include:

- Government holidays
- Days of special religious observances

- Dates related to famous or controversial figures, or celebrated martyrs.
- Famous anniversaries such as: April 19–Waco Texas raid and Oklahoma bombing, September 11–World Trade Center and Pentagon Attack, January 22–Roe vs. Wade.

Vulnerability can also be time-related when damage would be greatest and response the most difficult: morning or evening rush hour, after OSU football games, during response to a natural disaster, during Presidential or other dignitary visits.

Consequence is the magnitude and type of damage resulting from a successful terrorist attack. Consequence can be expressed in terms of fatalities, injuries, economic losses, or other types of damage. In other words, consequence is the impact of the attack on the target. The impact may be limited to a specific target site or may be of a magnitude to affect a large area or community.

When analyzing the potential impact of a terrorist event, in addition to considering the characteristics of the target, number of possible victims, criticality of the facility and economic importance, the type of terrorist weapon employed must also be considered. The impact on the community will vary greatly depending on the nature of the weapon employed.

CBRNE Weapons

DOJ uses the acronym CBRNE to describe the five categories of Weapons of Mass Destruction (WMD):

Chemical
Biological
Radiological
Nuclear
Explosive (including incendiary devices)

Chemical Weapons

Chemical weapons are man-made mixtures or compounds used to kill or disable people. The deliberate release of a chemical warfare agent would have a highly debilitating and largely unpredictable impact within a community. The probable target choice would be a densely populated, highly visible site, such as a place of public assembly, public buildings, mass transit system, or a location with historical or symbolic significance. Such a site would put large numbers of people in danger and stress support and infrastructure systems. Victims in the target area could suffer the effects of a chemical agent immediately, or, with some agents, the effects can be delayed, causing casualties hours or days after the initial impact.

Introduction of a chemical agent into a vital segment of a community's infrastructure (such as the water distribution system) could be a means of further dissemination of the agent.

An agent placed inside a ventilation system can be disseminated by the system itself, contaminating an entire structure.

The psychological effects of a chemical weapons attack could have a severe impact on the community as well. The implications of such an attack could cause panic among a wider population than actually affected, with greater numbers of people seeking treatment than have been physically harmed. Frightened citizens could clog medical facilities, hampering the treatment of the victims suffering physical effects of the agent and overwhelming emergency medical capabilities.

The unpredictability of a chemical attack with regard to the choice of target, the difficulty of agent identification, the danger of widespread contamination, the damage to infrastructure and the reaction of victims and responders all complicate emergency response efforts.

There are four ways that chemical (and biological) agents can enter the body: ingestion, inhalation, absorption and injection. Inhalation and absorption are the most effective means of contaminating large numbers of individuals. The process of weaponizing chemical agents is relatively simple compared to the difficult process of weaponizing a biological agent. A biological agent requires a specific particle size to be effective, while a chemical agent does not have to be as precise.

Categories of Chemical Agents

- Nerve Agents – effective as military weapons because of their formulation. They are extremely toxic to the intended target but break down rapidly. Chemical agents were used extensively in World War I.
- Blister Agents – also developed and used during World War I. They are capable of causing extreme pain and large blisters on contact. If the vapors are inhaled, lung tissue forms large obstructing blisters. Once the blisters break, a large open wound results that allows the establishment of overwhelming infections, which may cause death.
- Blood Agents – chemicals commercially used by industry for heat treating, plating, fumigation and plastics production. Military applications include hydrogen cyanide and cyanogen chloride. These compounds interfere with the ability of hemoglobin in red blood cells to bond with oxygen for transport to the cells throughout the body, resulting in cellular suffocation.
- Choking Agents – respiratory irritants such as chlorine, phosgene and diphosgene. These agents have a long history of military use and remain in military arsenals around the world. These agents destroy the alveolar tissue in the lungs, resulting in fluid from the bloodstream advancing into the airways. The victim drowns in his own blood.

Biological Weapons

Bioterrorism involves the release of infectious microorganisms or toxins intended to kill or cause disease in a large number of people in an unsuspecting population. The result is not immediate, becoming apparent over several hours or days. Biological agents are a variety of either microorganisms or biological toxins.

The deliberate release of a biological agent such as anthrax would have a highly debilitating and largely unpredictable impact within a community. The probable target choice would be a densely populated, highly visible site, similar to that of a chemical attack.

The lag time from exposure to the exhibition of initial symptoms, plus the potential for misdiagnosis, could enable widespread dispersion of victims far beyond the initial target area and for an unpredictable period of time after release.

A widespread outbreak of an infectious disease would threaten the ability of emergency and medical facilities to respond. Response personnel could be at risk of infection themselves, especially prior to a definitive diagnosis of the disease. The collection and disposal of contaminated material, including human remains, would present additional long-term problems.

The psychological effects of a biological agent release could have a severe impact. A panicked response by the population, including widespread psychosomatic reactions, could magnify the crisis by further overwhelming treatment facilities and possibly clogging transportation systems as people search for treatment or escape.

Biological agents may be living bacteria, rickettsia or viruses that are able to establish deadly infections in their victims. Biological toxins include poisonous chemical compounds produced by plants, animals or microbes.

Categories of Biological Agents

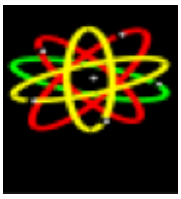
- Bacterial Agents – totally self sufficient, single celled living microorganisms that may infect the body tissue, e.g., anthrax, cholera, plague, tularemia and salmonella.
- Viral Agents – smaller than bacteria and live on or within other cells, e.g., smallpox, viral hemorrhagic fevers, and viral encephalitis.
- Biological Toxins – naturally occurring, poisonous substances produced by an animal, plant or microbe, e.g., Botulinum toxin, Ricin.
- Rickettsia – Viral agents between bacteria and viruses in size with characteristics of both, e.g., Typhus, Rocky Mountain Spotted Fever.

Radiological Weapons

The use of a radiological dispersion device (RDD), or "dirty bomb," is more likely than a thermonuclear fusion bomb or atomic bomb. An RDD is a conventional explosive charge laced with radioactive materials, which are

dispersed over a wide area upon detonation of the explosive charge. Weapons-grade fissionable material is not required for this type of device. Radioactive materials used to test bridges and buildings and radioactive medical material can be used to contaminate an area. Cesium, a radioactive material used legally for the treatment of cancer, can be weaponized and dispersed by an explosive device to contaminate the surrounding area.

Nuclear Weapons



A nuclear weapon is one that releases nuclear energy in an explosive manner as a result of a chain reaction involving fusion or fission. Nuclear weapons are considered the most unlikely CBRNE weapon to be used because of extreme expense and enormous amount of technology needed.

Few ideas instill as much fear as the thought of nuclear capability in the wrong hands. Considering the difficulty in producing a nuclear warhead, the most feasible, and therefore most likely, form of nuclear terrorism is a direct assault on a nuclear facility, such as a power station. Considering the amount of radiation housed at such a facility, the magnitude of a single attack of this kind could cause thousands of deaths and ruin surrounding land for decades.

Explosives

Historically, explosives have been the weapons of choice for terrorists. The materials and technology needed are readily available. Instructions to build an explosive device can be found on the internet. These types of bombs, also known as homemade explosives (HMEs), have been detonated in Franklin County as recently as mid-2009. Bombs have the potential to generate mass casualties depending on the type, amount and placement of the material.

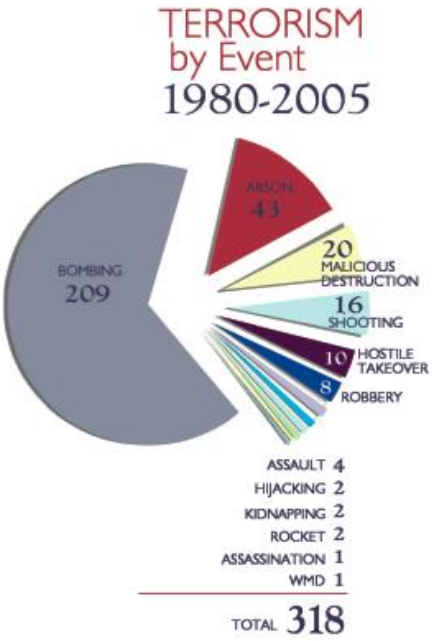
Explosives are defined as unstable chemical compounds and mixtures that, when detonated, undergo a rapid reaction, producing large amounts of gas under pressure. Explosives have the potential for producing mass casualties, depending on several factors, including:

- Type and amount of explosive
- Placement of explosive in relation to intended target
- Secondary chemicals or other hazards that could enhance a device's effectiveness, either as part of the device or present at the target
- Surrounding structures' susceptibility to blast overpressure
- Immediate surroundings of device that may influence detonation (i.e. containment)

Incendiary devices also fall in the explosives category. An incendiary device is any mechanical, electrical or chemical device used to intentionally start a fire, e.g., gasoline, lighter fluid.

Terrorism in the United States

The conclusion of the FBI publication *Terrorism 2002-2005* gives a good summary terrorism in America.



"During the first 75 years of its history the FBI encountered a predominatly domestic terrorist threat that underlay larger criminal trends. Between the World Wars, this threat came primarily from right-wing extremists, then shifted to left-wing, socialist-oriented groups beginning in the 1950s and continuing into the 1980s. In the early 1980s, international terrorism sponsored primarily by states or organizations began to impact US interests overseas and led to legislation that extended the FBI's responsbilities to cover terrorist threats originating outside the United States and its territories. The 1990s saw a new era of domestic and international terrorism in which terrorists sought to inflict massive and indiscriminate casualties upon civilian populations. This threat grew as terrorists began to seek out unconventional weapons and weapons of mass destruction. The 1990s also saw the rise of terrorism pursued by loosely-affiliated extremists, with examples ranging from terrorists involved with domestic special interest causes to militants engaged in international jihad. These terrorism trends combined into the September 11, 2001, attack that has set in motion an international effort to counter the global terrorist threat and elevated counterterrorism to the FBI's preeminent mission."

The terrorist events of 9/11 in New York, at the Pentagon, and in Pennylvania marked a dramatic escalation toward more detructive attacks. These incidents, coupled with a series of anthrax-related incidents occuring after 9/11, are indicative of an increasing interest in using CBRNE to target the United States. There has been a tremendous increase in the number of hoaxes involving the use of chemical, nuclear, or biological agents perpetrated by individuls and/or terrorists wishing to instill fear and disrupt communities.

<u>Umar Farouk Abdulmutallab</u>

The most recent attempted attack on the U.S. came on December 25, 2009. Al-Qaida in the Arabian Peninsula claimed responsibility for the attack on a U.S. airliner bound for Detroit on Christmas Day, saying it was retaliation for a U.S. operation against the group in Yemen.

23-year-old Nigerian Umar Farouk Abdulmutallab coordinated with members of the group, an alliance of militants based in Saudi Arabia and Yemen, to attempt to detonate an explosive device hidden on his body as the plane approached Detroit on a flight from Amsterdam. Law enforcement officials say he tucked below his waist a small bag holding a potentially deadly concoction of liquid and powder explosive materials. The device burst

into flames without exploding, according to authorities, and Abdulmutallab was subdued by passengers. The plane landed safely.

Officials said he had come to the attention of U.S. intelligence previoiusly when his father, Alhaji Umar Mutallab, a prominent Nigerian banker, reported to the American Embassy in Nigeria about his son's increasingly extremist religious views. He had been placed in a U.S. database of people suspected of terrorist ties in November, but officials say there was not enough information about his activities to place him on a watch list that could have kept him from flying.

Terrorism in Ohio

Despite the fact that events such as the World Trade Center attacks of 1993 and 2001 and the Oklahoma City bombing in 1995 have not happened in Ohio, based upon historical review of terrorism-related incidents in the state, the threat of terrorism in Ohio is real.

There are groups representing all four main FBI terrorist group classifications operating in Ohio. Here are many of them, along with Web sites with information showing the potential threat they pose:

Anti-government groups:

Posse Comitatus:
http://www.start.umd.edu/start/data/tops/terrorist_organization_profile.asp?id=110
http://www.adl.org/hate_symbols/groups_posse_comitatus.asp

Common law courts:
http://www.adl.org/poisoning_web/militias.asp

Sovereign Citizens:
http://www.adl.org/Learn/ext_us/SCM.asp?xpicked=4&item=20
http://www.thesovereigncitizen.com/

Militias:
http://www.adl.org/learn/ext_us/militia_m.asp

New Black Panther Party:
http://www.newblackpanther.com/
http://www.adl.org/learn/ext_us/Black_Panther.asp?LEARN_Cat=Extremism&LEARN_SubCat=Extremism_in_America&xpicked=3&item=Black_Panther
http://www.nbpp-boston.com/

Religious radicals:

Christian Identity:
http://www.christianidentityministries.com/
http://www.adl.org/learn/ext_us/Christian_Identity.asp?LEARN_Cat=Extremism&LEARN_SubCat=Extremism_in_America&xpicked=4&item=Christian_ID
http://foia.fbi.gov/foiaindex/christianidentity.htm

Phineas Priesthood:
http://www.adl.org/hate_symbols/Phineas.asp

World Church of the Creator/Creativity Movement:
http://www.adl.org/backgrounders/wcotc.asp
http://www.creativitymovement.net/index1.html
http://www.adl.org/Learn/ext_us/WCOTC.asp

Church of Jesus Christ Christian:
http://www.adl.org/Learn/Ext_US/aryan_nations.asp

Odinism:
http://www.odinistfellowship.co.uk/
http://www.odinbrotherhood.com/

Racist/Hate Based Groups:

National Socialist Movement:
http://www.nsm88.org/
http://www.adl.org/Learn/Ext_US/nsm/default.asp?LEARN_Cat=Extremism&LEARN_SubCat=Extremism_in_America&xpicked=3&item=nsm
http://www.ohio.nsm88.org/main.html

American Nationalist Socialist Workers Party:
http://www.adl.org/learn/extremism_in_america_updates/groups/national_socialist_movement/national+socialist+movement_update_10052006.htm

Blood and Honour:
http://www.bloodandhonour.com/index.html
http://www.bloodandhonour-usa.com/sect/intro.html
http://www.adl.org/hate_symbols/groups_blood_honour.asp

National Alliance:
http://www.adl.org/LEARN/Ext_US/n_alliance.asp
http://www.natvan.com/

KKK:
http://www.kkk.com/
http://www.adl.org/learn/ext_us/kkk/default.asp

Skinheads:
http://www.adl.org/racist_skinheads/

Aryan Nations:
http://www.aryan-nations.org/
http://www.aryannations.org/
http://foia.fbi.gov/foiaindex/anation.htm

Special Interest/ Single Issue Groups:

Stop Huntingdon Animal Cruelty (SHAC):
http://www.shac.net/

Earth Liberation Front (ELF):
http://earth-liberation-front.org/

Religious Radicals:

Islamic Terror Groups—al-Qaeda:
http://www.globalsecurity.org/military/world/para/al-qaida.htm
http://www.cfr.org/publication/9126/

Terrorist Activity in Franklin County

Columbus was one of the original 120 cities to receive funding under the Nunn-Lugar-Domenici Domestic Preparedness Program. Additionally, since 2004, Franklin County has received funds from the Urban Area Security Initiative (UASI), designed to better prepare at-risk urban areas.

While Franklin County has not suffered a serious terrorist attack to date, the area has a history of terrorist related activity:

International

Three men from Central Ohio have been charged with terrorism-related acts and linked to al-Qaida since September 11:

Iyman Faris
Iyman Faris was born in Pakistan and was a naturalized US citizen working as a truck driver in Columbus. In 2003, Farris began cooperating with the FBI and admitted to having gone to an Afghan training camp and scouting the Brooklyn Bridge for al-Qaida, and was

linked to Khalid Sheikh Mohammed (one of the 9/11 terrorists). Faris was convicted of material support and conspiracy to provide material support to al-Qaida and is serving a 20 year prison sentence. He is no longer cooperating with the FBI. Prosecutors said he provided al-Qaida with plane tickets and cell phones and traveled to Afghanistan in 2000 to meet with Osama bin Laden in a terrorist training camp. Faris identified Nuradin Abdi and Christopher Paul as his associates.

Nuradin Abdi

Nuradin Abdi, a native of Somalia, was arrested in November of 2003 as a national security threat. Until February 2004 he cooperated with the FBI, admitting he falsified travel documents to attend an al-Qaida-linked training camp and that he initiated a plot to blow up a Columbus shopping mall. In July 2007 he pled guilty to material support to terrorism and was sentenced to 10 years in prison. Prosecutors said he trained in Ethiopia and supplied Christopher Paul with credit-card numbers stolen from his cell phone business to help fund their activities.

Christopher Paul

Christopher Paul is a native of Worthington who attended training camps in Pakistan and Afghanistan. Around 1991 he joined al-Qaida and was selected for advanced training. Paul returned to the United States and conducted his own trainings in Burr Oak State Park with other co-conspirators. During the investigation of Paul, authorities discovered contact information for al-Qaida leaders and associates and materials on how to make explosive devices. Paul pled guilty to conspiring with others to use a weapon of mass destruction, namely explosive devices, against targets in Europe and the United States. He was sentenced to 20 years in prison.

Paul was the last of the three Columbus associates to be convicted and sentenced for terrorist plots against the United States. Mahjir Sherif, Abdi's attorney, said in a Columbus Dispatch article in 2007 that the three men were part of a larger group of nine or ten men, several of whom have left the country. All three of these men were radicalized at a mosque in Franklin County and had ties to The Ohio State University.

Franklin County currently operates two separate Joint Terrorism Task Forces (JTTF). One task force deals solely with issues related to the Horn of Africa, while the other focuses on all other terrorism related issues. The task force dealing with the Horn of Africa was developed out of a need for close monitoring and careful attention to a growing population with the potential for radical behaviors in Central Ohio.

Domestic

Environmental Extremist Activity

Franklin County is not immune to environmental extremists. These groups use violence to end what they perceive as degradation of the environment. In the recent past, roughly 100 members of the group Earth First! deployed to the office of American Municipal Power

(AMP) Ohio in Columbus. In protest of the construction of a new coal-fired power plant in Meigs County, members of this group demonstrated in the lobby while others locked themselves together with a home-made device known as "sleeping dragon," designed to make it difficult for law enforcement to separate them. During this protest, two members attempted to climb flagpoles in order to hang a protest banner but were stopped by an AMP Ohio employee. Eight members were arrested.

The Ohio State University

The Ohio State University home football games are held at Ohio Stadium. This venue is seen as one of the largest vulnerabilities in the state as there are over 105,000 fans in attendance on any given game day and an additional 40,000 fans within close proximity of the stadium.

Subscribing to the National Incident Management System (NIMS) model, the Homeland Security contingency for OSU football is made up of many different elements. The team consists of members from the Ohio State University Police Division, the Columbus Division of Police, the Ohio Highway Patrol, the FBI JTTF, the US Army 52nd Civil Support Division, the Columbus Division of Fire, the Ohio State University Environmental Health and Safety, the Ohio State University Department of Public Safety and the Department of Homeland Security.

This program has been viewed as a model program by federal, state, and other university agencies. OSU DPS recently completed a best-practices video that will be used to train other agencies on large-venue event management.

Terrorism – References

Al-Qaida Claims Responsibility for Attempted Bombing of U.S. Plan, Associated Press. 28 Dec 2009. http://www.foxnews.com/story/0,2933,581307,00.html

Andes, Jodi, Mayhood Kevin, (2005) Assessing and Managing the Terrorism Threat. Bureau of Justice Assistance

FBI Terrorism 2002-2005 Report

FEMA, Integrating Manmade Hazards Into Mitigation Planning FEMA 386-7 Version 2.0 2003

FEMA, Threat And Risk Assessment, First Responder Training Manual, 2008

Futty, John, Et.al., Al-Qaida Conspirator 20 Years Scolding for Local Terrorist. The Columbus Dispatch 27 Feb 2009

Mayhood, K., Futty, J., Local al-Qaida Bomb Suspect Appears I Court. The Columbus Dispatch. 12 Apr 2007

National Counterterrorism Center, 2008 Report on Terrorism. 30 Apr 2009

Ohio Man Pleads Guilty to Conspiracy to Bomb Targets in Europe and the United States. US Department of Justice Press Release. 3 June 2008

Press Conference by Attorney General Alberto R. Gonzales on Ohio Terrorism Indictments, 22 Feb 2006

Willis, H.H., Morral, A.R., Kelly, T.K., Medby, J.J., (2005) Estimating Terrorism Risk. Rand Center for Terrorism Risk Policy

Dolasinski, Amanda, Utility protest ends in arrests. The Columbus Dispatch, 7 July 2008. http://www.dispatch.com/live/content/local_news/stories/2008/07/07/protest.html?sid=101

Azweil, Sarah, Lockdown at American Municipal Power: The Ohio Rendezvous Action. Earth First! Journal. Mabon 2008, Volume 28, Issue 6. http://www.earthfirstjournal.org/article.php?id=399

Infectious Diseases - #5

Contents

Hazard Profile....125
Infectious Diseases in the United States....127
Infectious Diseases in Ohio....132
Infectious Diseases in Franklin County....133

Hazard Summary

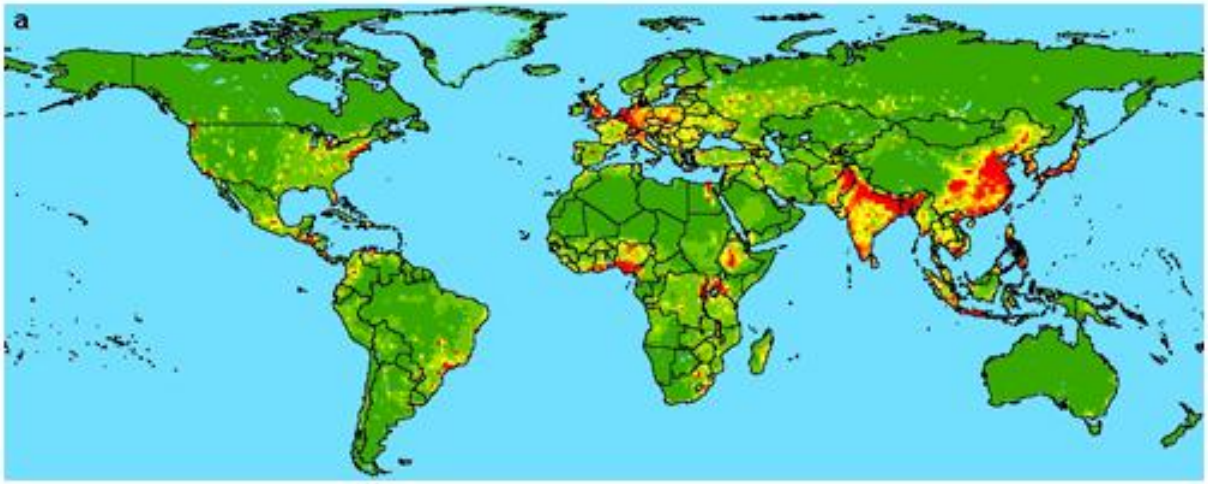
Infectious diseases are illnesses caused by the entrance into the body of harmful microbial organisms which grow and multiply. The diseases of most concern to the health and welfare of communities are those that are communicable. Communicable diseases are caused by microorganisms such as bacteria, viruses and parasites and are transmitted from an infected person/animal and/or contaminated food or water source to another person or animal. Franklin County is susceptible to many common infectious diseases, such as seasonal flu, as well as diseases that are newly emerged, such as H1N1 Influenza. This hazard was ranked No. 5 out of 16.

Hazard Profile

Infectious diseases are a major threat to the public's health and have caused devastating outbreaks. H1N1 influenza, AIDS, SARS, drug-resistant bacteria and Ebola virus are some more recent examples. Infectious diseases are newly identified pathogens or old ones moving to new regions. These diseases, which respect no natural boundaries, include:

- New infections resulting from changes or evolution of existing organisms.
- Known infections spreading to new geographic areas or populations.
- Previously unrecognized infections appearing in areas undergoing ecologic transformation.
- Old infections reemerging as a result of antimicrobial resistance in known agents or breakdowns in public health measures.

Emerging diseases have roughly quadrupled over the past 50 years. Some 60% of the diseases traveled from animals to humans (zoonoses), and the majority of those came from wild creatures. A study reported in the science journal *Nature*, Feb. 21, 2008, identified and mapped world disease "hot spots."



Zoonotic pathogens passed from wildlife to humans. From lowest occurrence (green) to highest (red).

Source: Nature, February 21, 2008

Hot spots jump out in areas spanning sub-Saharan Africa, India and China, with smaller spots in Europe and North and South America. The study indicated the greatest threat to humans is from wild animals in poor nations. Meanwhile, richer nations are experiencing other outbreaks, including multidrug-resistant pathogen strains through overuse of antibiotics, centralized food processing and other technologies. About 20% of known emergences are multidrug-resistant strains of previously known pathogens, including tuberculosis. Some strains, such as lethal variants of the common bacteria *E. coli*, now spread widely with great speed because products like raw vegetables are processed in huge, centralized facilities.

Disease emergence has been viewed as a two-step procedure:

1. Introduction of an agent into a new host group or population.
2. Adoption, *i.e.*, establishment and dissemination of the agent in the new host population.

The process by which these agents may be transferred across populations has been called "microbial traffic," defined as the process by which infectious agents may transfer from animals to humans or disseminate from isolated groups into new populations. A variety of natural and human activities promote microbial traffic. They include:

- Changes in human and animal demographics, living/husbandry conditions and behavior. Examples: population growth and migration due to economic or cultural changes, civil unrest and war, disease, poverty, sexual behavior.
- Ecological changes, including those due to economic development and land use through agricultural and industrial expansion, and resulting pollution.
- Advances in technology and industry, including changes in food production, processing and distribution, advances in medical techniques (transplantation) and products (drugs).
- Increased global travel and commerce.
- Microbial adaptation and change.

Emerging diseases are often zoonotic, *i.e.,* diseases that may be transmitted between humans and animals. These include:

- Those which can be transmitted directly from animals to humans (e.g., rabies)
- Diseases that can be acquired indirectly by humans through ingestion, inhalation or contact with infected animal products, soil, water, or other environmental surfaces which have been contaminated with animal waste or a dead animal (e.g., anthrax)
- Vector-borne diseases which require a mosquito or other arthropod to transmit the disease from animals to humans (e.g., West Nile Virus)

Zoonotic diseases cannot usually be eradicated due to the fact that it is not possible to eliminate all of the animal reservoirs or vectors that might be carrying the zoonosis.

Currently, the World Health Organization (WHO) is monitoring about 40 emerging infectious diseases. These have been around only a few decades. The list includes acquired immune deficiency syndrome (AIDS), Ebola, dengue hemorrhagic fever, Lassa fever, Nipah, Hendra, hantavirus, Marburg, monkeypox, mad cow disease, severe acute respiratory syndrome (SARS), West Nile virus, Lyme disease, Legionnaires' disease, the cyclospora parasite, and the latest pandemic (H1N1) 2009 influenza A virus. These pathogens – or disease-causing agents – have either mutated or genetically recombined to become new strains or novel microbes, or they may have existed for millennia but weren't discovered until recent years. According to the WHO, at least one new infectious disease has emerged

each year since 1980, many of which evade traditional therapies and have no vaccine or cure. At the same time, old infectious diseases once believed to be controlled, such as tuberculosis, are reemerging as deadly new, often drug-resistant strains, or are springing up in new regions of the world. Of the estimated 57 million deaths that occur annually in the world, the WHO estimates that 15 million of them are directly caused by infectious diseases. Millions more deaths are due to secondary effects of infections.

Left unchecked, today's emerging diseases can become the endemic diseases of tomorrow. This is what happened with HIV/AIDS, which emerged in a remote part of Africa during the 1970s, spread throughout the world during the 1980s, and is now entrenched on all continents.

Infectious Diseases in the United States

Recent outbreaks underscore the potential for the sudden appearance of infectious diseases in currently unaffected populations. Each year approximately 25% of physician visits in the U.S. are attributed to infectious diseases, with direct and indirect costs – including those for human immunodeficiency virus (HIV) infection and related illnesses – estimated at more than $120 billion.

Contamination of the municipal water supply in Milwaukee, Wisconsin, in 1993 resulted in an outbreak of cryptosporidiosis that sickened an estimated 400,000 people; approximately 4,400 persons required hospitalization. In the 1990s, epidemic cholera reappeared in the Americas after being absent for nearly a century. During the 1980s, tuberculosis reemerged in the United States after decades of decline, and drug-resistant strains have made its control more difficult. The increasing prevalence of antibiotic-resistant strains suggests rising treatment and control problems. Many other cases of emerging infections can be identified. As examples, four of the more recent ones to affect the United States will be discussed here: Lyme disease, West Nile Virus, SARS, and pandemic H1N1 influenza.

Intentional releases of biologic agents in the United States have also intensified concerns about bioterrorism. This will be discussed in the terrorism section of this document.

<u>Lyme Disease</u>

In 1975, two concerned mothers from Lyme, Connecticut, reported a cluster of children thought to have juvenile rheumatoid arthritis. A surveillance system was created to identify children with inflammatory joint disease, and a study was undertaken at Yale University to determine the cause.

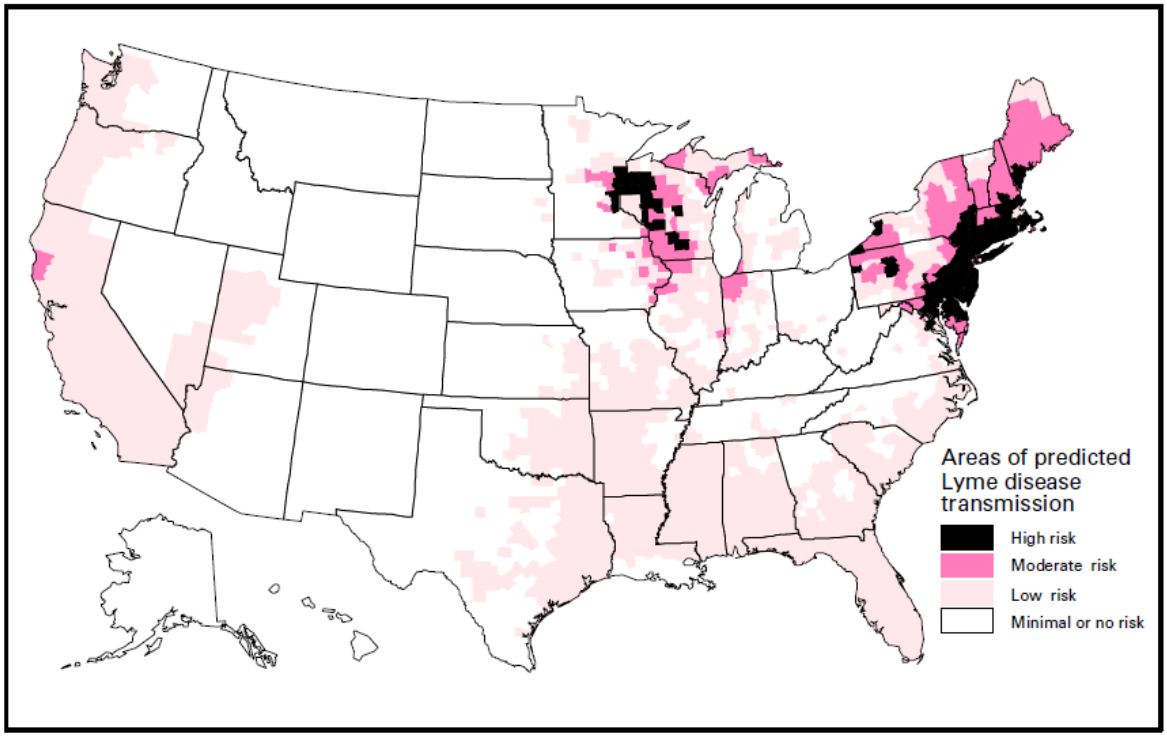
The study showed that the cases were clustered with a frequency rate 100 times that of juvenile rheumatoid arthritis. Some families had more than one affected member. Half the affected residents lived in heavily wooded areas on two adjoining county roads. The majority of patients noted onset of symptoms in the summer or early fall. These features

seemed most compatible with an arthropod-vectored illness (carried by insects or arachnids.)

Many patients reported an expanding lesion around the area thought to be an insect bite. Many remembered being bitten by a tick at the site of the lesion about 12 days before the symptom onset. One patient had saved the tick, identified as the black-legged tick found on white-footed mice and white-tailed deer. Subsequent studies into the vector and affected patients revealed the disease agent, the spirochete *Borrelia burgdoferi,* in the early 1980s.

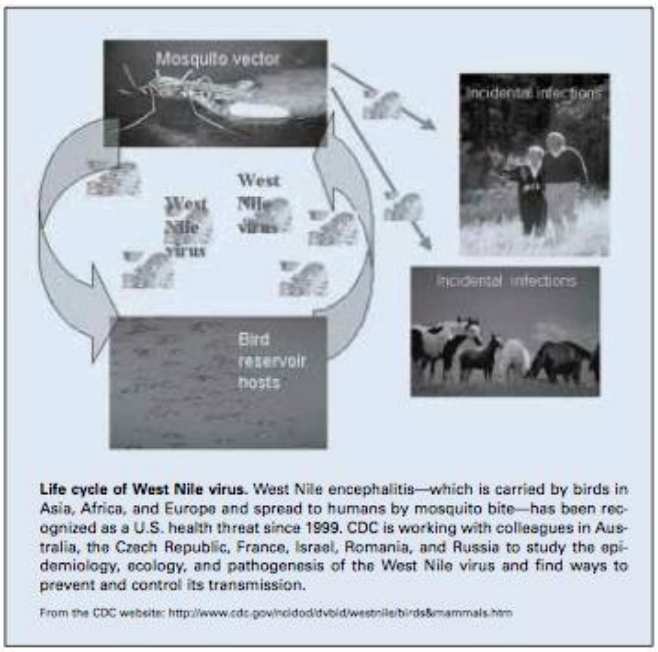
Since its discovery, Lyme disease has become the most reported vector-borne disease in the United States. In 2000, approximately 16,000 cases were reported to the CDC. Lyme disease is prevalent in the Northeast and much of the North Central United States. It is also prevalent in the Pacific Northwest, vectored by the western black-legged tick.

National Lyme disease risk map with four categories of risk



Source: CDC

West Nile Virus



Life cycle of West Nile virus. West Nile encephalitis—which is carried by birds in Asia, Africa, and Europe and spread to humans by mosquito bite—has been recognized as a U.S. health threat since 1999. CDC is working with colleagues in Australia, the Czech Republic, France, Israel, Romania, and Russia to study the epidemiology, ecology, and pathogenesis of the West Nile virus and find ways to prevent and control its transmission.

From the CDC website: http://www.cdc.gov/ncidod/dvbid/westnile/birds&mammals.htm

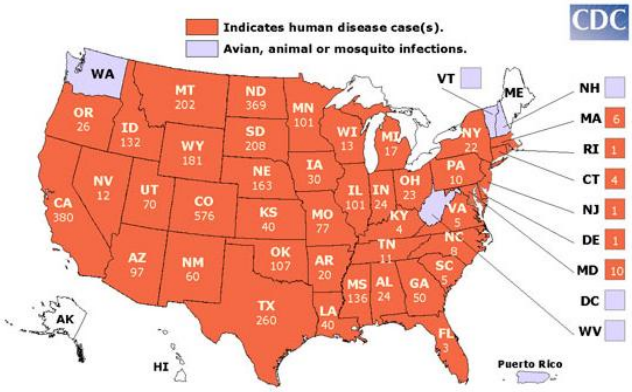
West Nile Virus is a mosquito-borne virus that can cause encephalitis (inflammation of the brain) and/or meningitis (inflammation of the lining of the brain and spinal cord). Outbreaks of the disease caused by WNV have occurred in Egypt, Asia, Israel, South Africa, some parts of Europe and Australia. The virus was first seen in the U.S. in the fall of 1999 in New York City and has since spread across the country to the Pacific Ocean, into several Canadian Provinces, and possibly into Mexico.

West Nile Virus primarily infects and multiplies in birds, which serve as reservoirs for the virus. The virus is spread between birds mostly through the bite of an infected mosquito. It has been detected in more than 162 species of birds; however, crows and blue jays are more severely affected than other species and often die as a result of their infection. When the level of the virus circulating among birds and mosquitoes becomes high, horses and humans can be infected.

In the United States since 1999, West Nile Virus activity has been reported in all states except Hawaii, Alaska and Oregon. In 2002 and 2003 WNV was the cause of significant illness in the United States. In 2007 there were human cases in 45 states.

Final 2007 West Nile Virus Activity in the United States

This map reflects surveillance findings occurring between January 1, 2007 through December 31, 2007 as reported to CDC's ArboNET system for public distribution by state and local health departments.



Map shows the distribution of avian, animal, or mosquito infection occurring during 2007 with number of human cases if any, by state. If West Nile virus infection is reported to CDC from any area of a state, that entire state is shaded.

Source: CDC

Severe Acute Respiratory Syndrome (SARS)

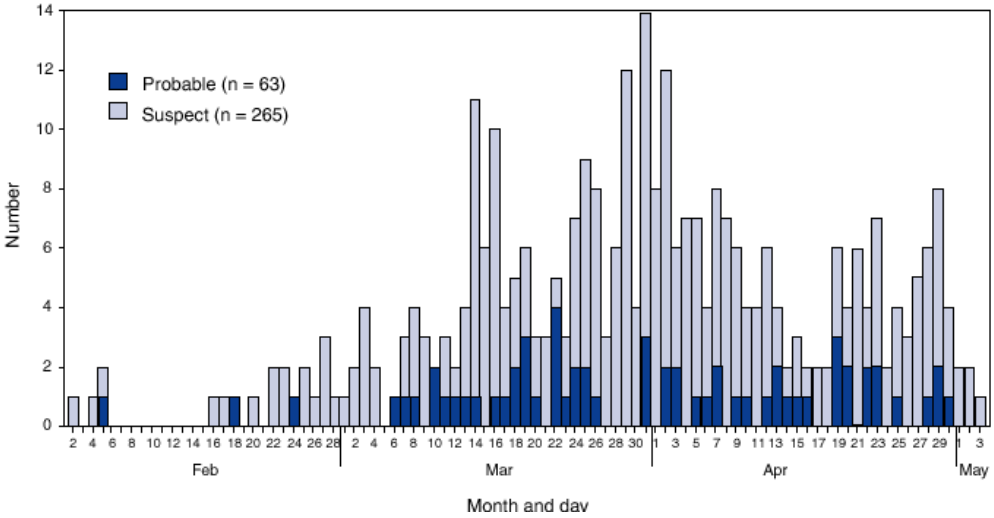
Severe acute respiratory syndrome (SARS) is a viral respiratory illness caused by the SARS-associated coronavirus. Coronaviruses are viruses that have a halo or crown-like (corona) appearance. Coronaviruses are a common cause of mild to moderate upper-respiratory illness in humans. They are also known to cause diseases in animals. The coronavirus that causes SARS was not previously known to cause human illness.

The illness usually begins with a high fever. People may also have chills or other symptoms, including headache, general feeling of discomfort, body aches and diarrhea. After two to seven days, SARS patients may develop a dry cough, with most developing pneumonia.

SARS is mainly spread by close person-to-person contact, most readily by being within three feet of respiratory droplets produced when an infected person sneezes, and/or by touching a surface or object contaminated with infectious droplets. Close contact is defined as having cared for or lived with a person known to have SARS or having a high likelihood of direct contact with respiratory secretions and/or body fluids of a person known to have SARS.

SARS was first reported in Asia in February 2003. In early March 2003, the World Health Organization (WHO) issued a global alert about SARS. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia. By late July, no new cases were being reported and the illness was considered contained. According to WHO, more than 8,000 people worldwide became ill during the outbreak; of these, 813 died. The United States had 159 suspected cases and 33 probable cases; of the 33 probable cases only 8 had laboratory evidence of the SARS virus. No SARS related deaths occurred in the U.S.

Number of reported cases of severe acute respiratory syndrome, by classification and date of illness onset – United States, 2003 (Source CDC)



Pandemic (H1N1) 2009 Influenza A

Pandemic influenza has occurred naturally throughout history. There have been three flu pandemics in the last 100 years.

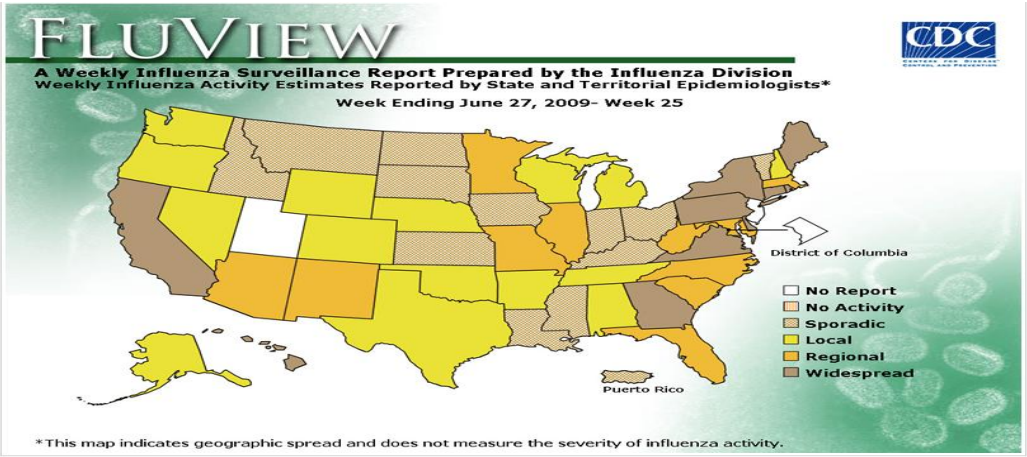
- 1918 – 1919: Spanish Flu, 675,000 deaths in the U.S.
- 1957 – 1958: Asian Flu, 70,000 deaths in the U.S.
- 1968 – 1969: Hong Kong Flu, 34,000 deaths in the U.S.

The 2009 H1N1 influenza is a virus of swine origin that first caused human illness in Mexico and the United States in March and April 2009. It is thought H1N1 flu spreads in the same way regular seasonal flu viruses spread, mainly through the coughs and sneezes of people who are sick, but it may also be spread by touching infected objects and then touching your nose or mouth.

H1N1 infection has been reported to cause a wide range of flu-like symptoms, including fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills and fatigue. In addition, many people also have reported nausea, vomiting and/or diarrhea.

The first cases of H1N1 were detected in Mexico in April 2009. Aided by modern transportation, the virus spread rapidly. The first two U.S. cases of H1N1 were confirmed by laboratory testing at CDC on April 15 and 17, 2009. It was quickly determined that the virus was spreading from person to person. On April 22, the CDC activated its Emergency Operations Center to better coordinate the public health response. On April 26, 2009, the U.S. government declared a public health emergency and implemented the nation's pandemic response plan. On June 11, 2009, the WHO raised the worldwide pandemic alert level to Phase 6 in response to the ongoing global spread of the disease – the first pandemic alert issued by WHO since 1968.

From April 15, 2009 to July 24, 2009, states reported a total of 43,771 confirmed and probable cases of novel influenza A (H1N1) infection. Of these cases reported, 5,011 people were hospitalized and 302 people died. On July 24, 2009, confirmed and probable case counts were discontinued.



Source: CDC

Infectious Diseases in Ohio

Infectious diseases know no geographic boundaries. The information on emerging infectious diseases in the United States also applies to Ohio and Franklin County.

Pandemic Influenza

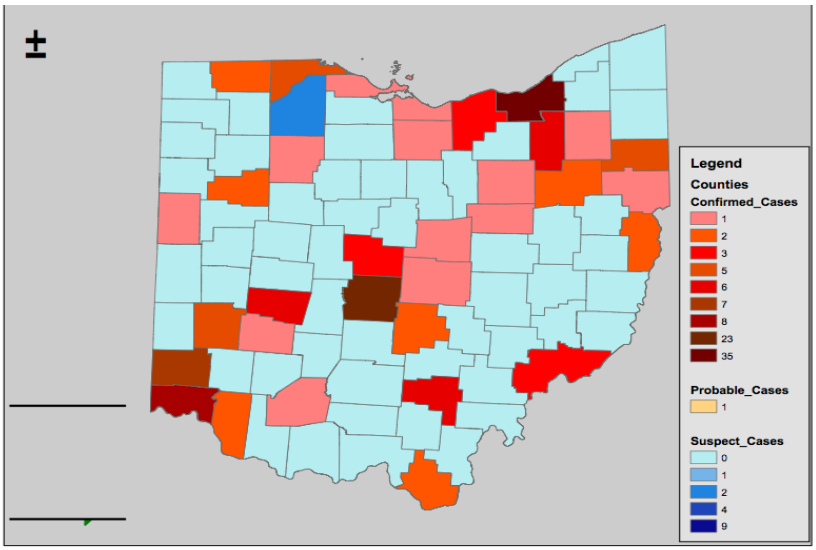
Ohio was impacted by the three 20th century pandemics:

- 1918 – 1919: Spanish flu, 8,602 deaths
- 1957 – 1958: Asian flu, outbreaks reported in 71 counties with deaths in 63 counties.
- 1968 – 1969: Hong Kong flu, milder pandemic, similar to seasonal flu.

Likewise, Ohio was impacted by the 2009 H1N1 influenza pandemic. As of August 4, 2009, Ohio reported 227 confirmed H1N1 cases. The first Ohio death was a 40 year old Butler County man, on June 29, 2009. (See http://www.odh.ohio.gov/ASSETS/4FF646242E8142DFAB49FAEF13925F76/h1n1cases.pdf for report as of Aug. 4, 2009. Update the map below with newer image.)

Ohio created a comprehensive pandemic flu plan in 2004. An operational plan was written during a 120-day planning period from Mid-December 2005 to mid-March 2006 to ensure the Ohio pandemic flu response is operationally consistent with federal and local issues and concerns. The document brought together the efforts of several Ohio state agencies, led by the Ohio Department of Health.

The Ohio Department of Health has extensive human monitoring and reporting systems in place that include medical practitioners, hospitals and local health departments to detect and monitor flu outbreaks, and year-round laboratory testing capability.



Confirmed H1N1 cases in Ohio, August 4, 2009

Source: Ohio Department of Health Website

West Nile Virus

Ohio had birds and mosquitoes that tested positive for West Nile Virus in 2002. Ohio had its first human case of West Nile Virus in 2002, and eventually had a total of 441 human cases. This dropped to 23 human cases by 2007. There were 15 human cases in 2008, including one death.

The ODH Vector-borne Disease Lab monitors the occurrence of disease vectors, provides programs for surveillance of vector-borne diseases through laboratory testing of mosquitoes for infectious viruses, conducts laboratory testing of animal tissues for evidence of infection, provides consultation in prevention and control of arthropod vectors and pests, and provides a service of arthropod identification.

Infectious Diseases in Franklin County

Introduction

Columbus Public Health and the Franklin County Board of Health are committed to reducing the risk and impact of the hazards presented by infectious diseases to its residents. The hazard analysis described below is an essential part of these efforts and serves to inform and shape the departments' risk reduction activities. These activities include:

- Detection and disruption of infectious diseases that threaten the health of the residents of Columbus and Franklin County – Prevent.
- Reduction of the vulnerability of the public in order to mitigate or neutralize the impact of infectious diseases – Protect.
- Action to address the short-term, direct effects of an outbreak of infectious disease – Response.
- Provision of public health services to identify health needs, define health resources, and address the long-term health and treatment of affected persons – Recovery.

Infectious Disease Summary

This summary represents the 2007 communicable disease data, the latest available for this publication, reported to state and local public health agencies as required by Ohio Administrative Code 3701-3-02. Only selected communicable diseases determined to be of public health significance are reportable; therefore, the data presented here do not represent all cases of communicable disease that occur among residents in Columbus and Franklin County. Additionally, only confirmed cases of disease have been analyzed for this summary. The data are considered provisional but provide valuable insight into these diseases.

Key findings are summarized below:

- In 2007, a total of 2,183 cases of communicable disease (excluding sexually transmitted diseases and tuberculosis) were reported and confirmed among Franklin County residents.
- Franklin County's rate of confirmed communicable diseases in 2007 was 195 cases per 100,000 people.
- The incidence rates of sexually transmitted diseases (gonorrhea, chlamydia, and syphilis) and hepatitis C rank high among all the counties in the state.
- The rate of pertussis increased significantly to 26.8 cases per 100,000 in 2007 from 14.4 cases per 100,000 in 2006.
- The rate of varicella decreased significantly to 5.1 cases per 100,000 in 2007 from 11.4 cases per 100,000 in 2006.

Reportable Disease Data 2005-2007 for Franklin County, Ohio

	2005		2006		2007	
Population	1,090,771		1,095,662		1,118,107	
DISEASE NAME	# of Cases	Case Rate*	# of Cases	Case Rate*	# of Cases	Case Rate*
HIV/AIDS*	274	25.1	222	20.3	259	23.2
Amebiasis	9	0.8	7	0.6	16	1.4
Anthrax	0	0.0	0	0.0	0	0.0
Botulism (foodborne)	0	0.0	0	0.0	0	0.0
Botulism (infant)	0	0.0	0	0.0	0	0.0
Brucellosis	0	0.0	0	0.0	0	0.0
Campylobacteriosis	88	8.1	101	9.2	73	6.5
Cholera	0	0.0	0	0.0	0	0.0
Chlamydia*	4,908	450.0	5,429	495.5	6,276	561.3
Cryptosporidiosis	33	3.0	17	1.6	27	2.4
Cytomegalovirus	0	0.0	1	0.1	5	0.4
Dengue	0	0.0	1	0.1	0	0.0
Diphtheria	0	0.0	0	0.0	0	0.0
E. coli O157:H7	9	0.8	24	2.2	6	0.5
E. coli Unspecified	2	0.2	7	0.6	2	0.2
Encephalitis, (primary viral)	1	0.1	1	0.1	1	0.1
Encephalitis, West Nile	0	0.0	1	0.1	0	0.0
Ehrlichiosis	N/A	N/A	N/A	N/A	1	0.1
Giardiasis	93	8.5	125	11.4	112	10.0
Gonorrhea*	3,155	289.2	3,286	299.9	3,817	341.4
Haemophilus influenzae-Type B	3	0.3	2	0.2	3	0.3
Hantavirus	0	0.0	0	0.0	0	0.0
Hemolytic uremic syndrome	0	0.0	3	0.3	0	0.0
Hepatitis A	7	0.6	7	0.6	10	0.9
Hepatitis B (acute, chronic, undetermined)*	77	7.1	97	8.9	120	10.7
Hepatitis C (acute, chronic, undetermined)*	812	74.4	826	75.4	1,000	89.4
Herpes (congenital)	N/A	N/A	N/A	N/A	1	0.1
Legionellosis	35	3.2	52	4.7	38	3.4
Leprosy	0	0.0	0	0.0	0	0.0
Leptospirosis	0	0.0	0	0.0	0	0.0
Listeriosis	3	0.3	0	0.0	6	0.5
Lyme disease	5	0.5	5	0.5	2	0.2
Malaria	5	0.5	6	0.5	8	0.7
Measles	0	0.0	0	0.0	0	0.0
Meningitis, aseptic (viral)	86	7.9	67	6.1	74	6.6
Meningococcal disease (N. meningitidis)	10	0.9	8	0.7	5	0.4
Meningitis (bacterial)	2	0.2	0	0.0	0	0.0

Reportable Disease Data 2005-2007 for Franklin County, Ohio

	2005		2006		2007	
Population	1,090,771		1,095,662		1,118,107	
DISEASE NAME	# of Cases	Case Rate*	# of Cases	Case Rate*	# of Cases	Case Rate*
Kawasaki Disease	0	0.0	0	0.0	2	0.2
Mumps	0	0.0	0	0.0	0	0.0
Pertussis	256	23.5	158	14.4	300	26.8
Plague	0	0.0	0	0.0	0	0.0
Polio	0	0.0	0	0.0	0	0.0
Psittacosis	0	0.0	0	0.0	0	0.0
Rocky Mountain Spotted Fever (RMSF)	0	0.0	0	0.0	0	0.0
Rubella (congenital)	0	0.0	0	0.0	0	0.0
Salmonellosis	110	10.1	110	10.0	120	10.7
Severe Acute Respiratory Syndrome (SARS)	0	0.0	0	0.0	0	0.0
Shigellosis	13	1.2	11	1.0	15	1.3
Smallpox	0	0.0	0	0.0	0	0.0
Streptococcus pneumoniae, invasive	105	9.6	113	10.3	125	11.2
Streptococcal disease-group A, invasive	18	1.7	28	2.6	35	3.1
Streptococcal disease-group B (perinatal)	11	1.0	9	0.8	6	0.5
Streptococcal toxic shock syndrome (STSS)	N/A	N/A	N/A	N/A	2	0.2
Syphilis*	105	9.6	103	9.4	69	6.2
Tetanus	0	0.0	0	0.0	0	0.0
Tuberculosis (TB)*	77	7.1	85	7.8	78	7.0
Tularemia	0	0.0	0	0.0	0	0.0
Typhoid Fever	2	0.2	3	0.3	1	0.1
Varicella*	N/A	N/A	125	11.4	57	5.1
Vibriosis	2	0.2	1	0.1	1	0.1
Yersiniosis	11	1.0	9	0.8	8	0.7
Yellow Fever	0	0.0	0	0.0	0	0.0

*Notes on specific diseases and rates

- Rates are per 100,000.
- Varicella: became a Class A reportable disease January 1, 2006. Prior to 2006, varicella was a Class B reportable disease, reported in aggregate form on a weekly basis
- Chlamydia, Gonorrhea, Syphilis, TB and HIV/AIDS data are from separate ODH sources.
- Syphilis numbers include primary and secondary cases only.
- Disease totals and calculated disease rates are limited to confirmed cases. Suspects and probable cases are not included.
- Population estimates obtained from the United States Census Bureau for each year were used in annual rate calculations.

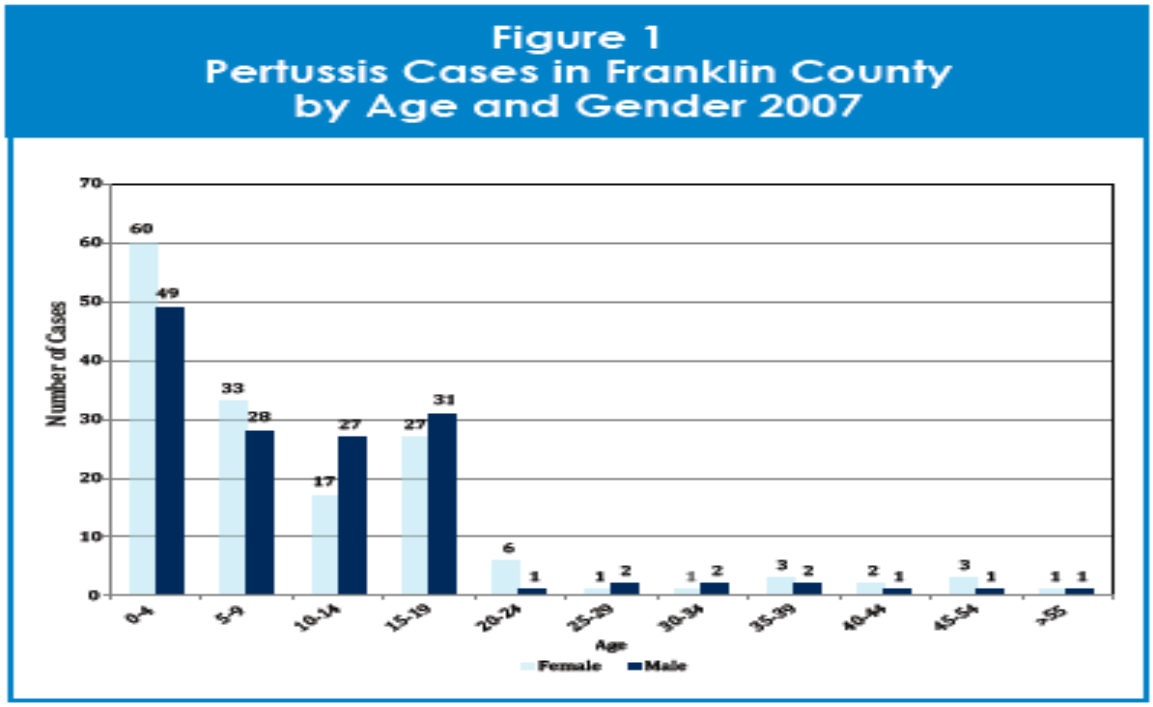
Highlights of Selected Diseases

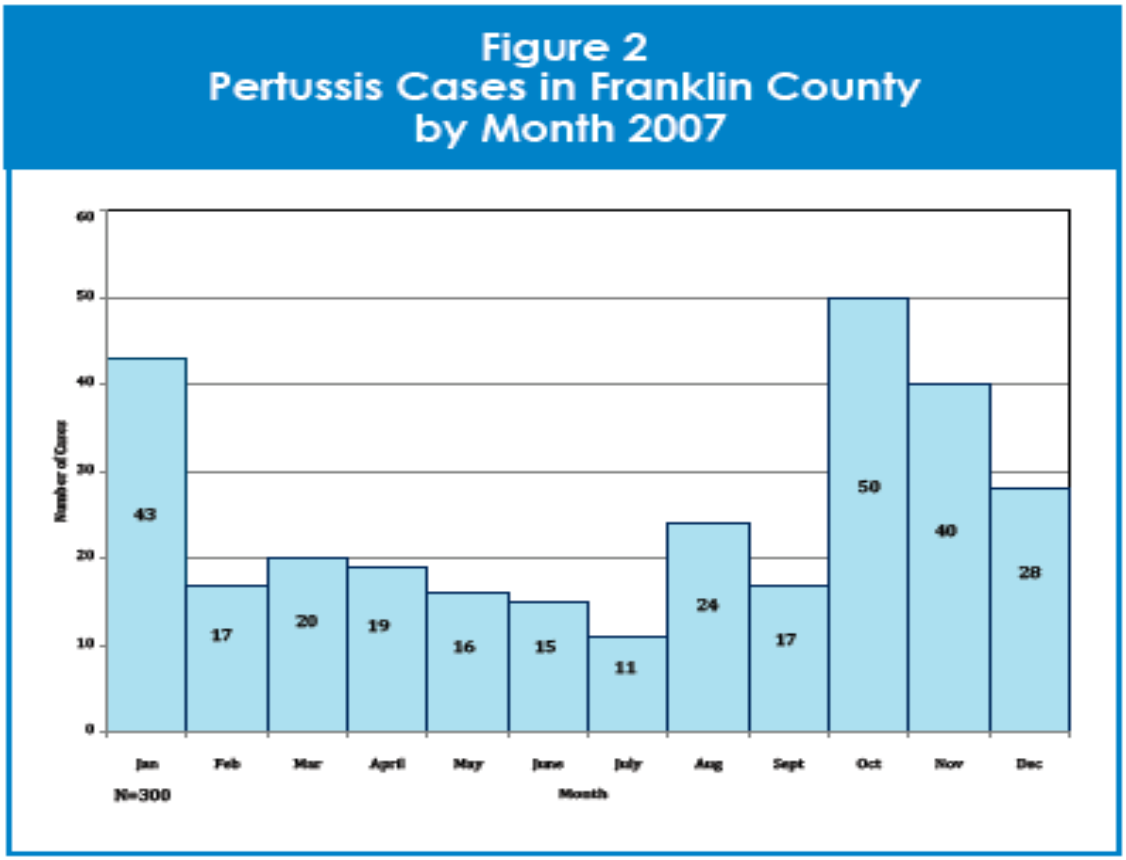
Pertussis (Whooping Cough)

Pertussis, also known as whooping cough, is a highly contagious bacterial infection of the respiratory tract caused by the bacterium *Bordetella pertussis*. Pertussis causes violent spells of coughing that may be followed by breathing difficulties, vomiting, or "whooping." Transmission of pertussis occurs primarily by aerosol droplet and is most easily transmitted in the period starting seven days after exposure to three weeks after the onset of spasmodic coughing. Seventy to 90 percent of susceptible household and other close contacts of a person with pertussis will develop the disease within seven to 14 days, commonly five to 10 days. The disease may last up to three months and be complicated by pneumonia, seizures, or encephalopathy.

Because of immunity induced by pertussis, vaccine wanes six to 10 years after complete childhood vaccination, making adolescents and adults susceptible to infection and transmission. In recent years, older patients are accounting for higher percentages of pertussis cases. Given this, neonates and infants who are too young to have received full vaccination are at risk of infection from contact with infectious adults.

The number of pertussis cases reported in Franklin County nearly doubled from 2006 to 2007, from 158 cases to 300. This resulted in an incidence rate of 26.8 cases per 100,000 population in 2007. Among the 300 cases with known age, 37% occurred among children under 4 years, while 34% of all the cases were among adolescents 10-19 years (Figure 1). Six of the 300 cases were hospitalized. Typically, after the start of the school year, the number of reported cases increases in Franklin County (Figure 2).

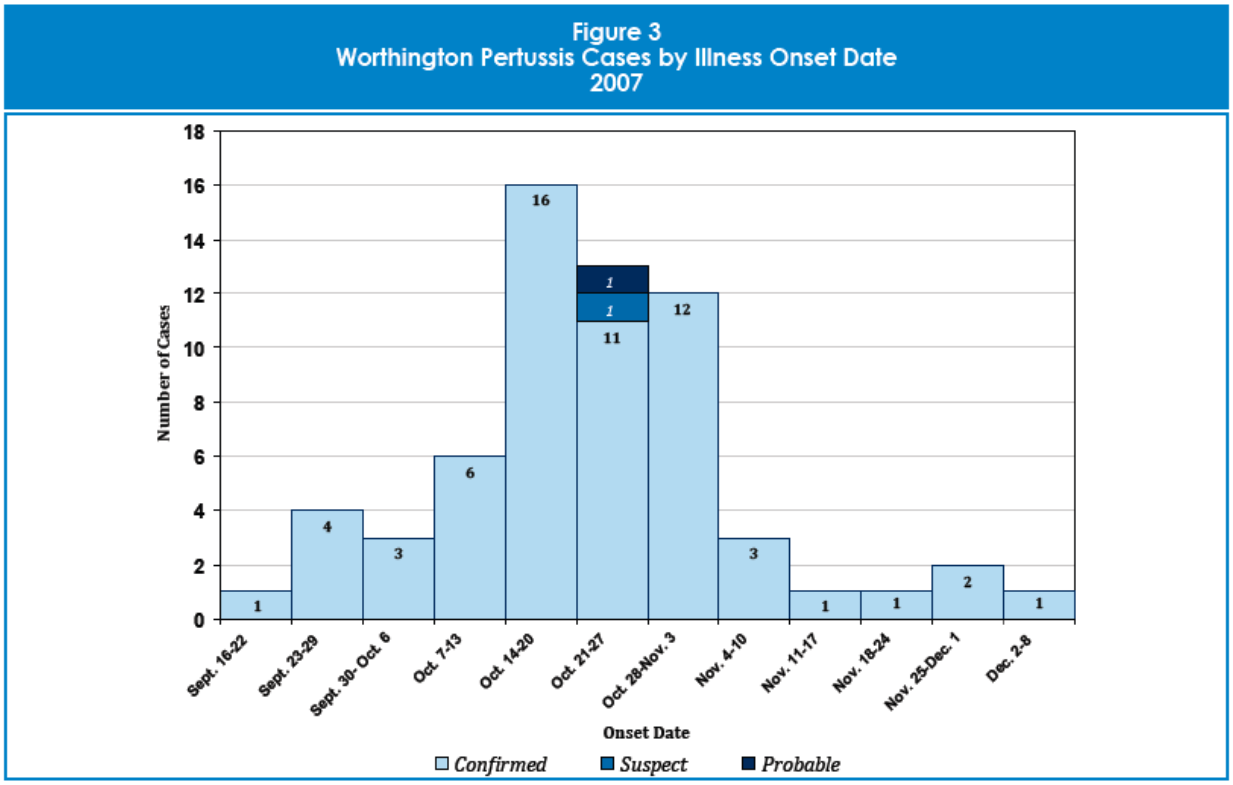




Worthington Pertussis Outbreak

On October 8, 2007, Columbus Public Health (CPH) was notified about a case of pertussis in a Worthington high school student with a symptom onset date of September 24, 2007. This index case was a member of a sports team at the local high school. (NOTE: Worthington is a suburb in the northern part of Franklin County that contracts with CPH for Public Health services.)

By October 10, 2007, four cases of pertussis were confirmed among students at two high schools in the Worthington area. Due to the increasing number of cases confirmed among vulnerable children, CPH encouraged strict adherence to the Centers for Disease Control and Prevention's (CDC) recommendations for handling a pertussis outbreak by encouraging all close contacts of a confirmed case to receive prophylactic antibiotics. This included any member of any extracurricular activity that had a confirmed case of pertussis. Throughout the course of the outbreak, CPH worked with the Worthington school district, Nationwide Children's Hospital (NCH) and the local media outlets to provide information and guidance to the public about pertussis. A total of 65 confirmed cases of pertussis were identified as a part of this outbreak in the Worthington area, with the last case reported on December 26, 2007 (Figure 3).



Salmonellosis

Salmonellosis is a bacterial illness characterized by acute abdominal pain, diarrhea, and often fever that begins 12 hours to five days after infection. The majority of human infections are thought to result from the ingestion of fecally contaminated food or water. Undercooked or raw products of animal origin such as eggs, milk, meat, and poultry have been implicated as common sources of human salmonellosis. A wide range of domestic and wild animals are carriers of Salmonella, including poultry, swine, cattle, rodents, iguanas, tortoises, turtles, terrapins, chicks, dogs and cats. Though uncommon, person-to-person spread can occur in humans via acutely ill patients, convalescent carriers and especially mild and unrecognized cases. In general, the incidence of infection is highest in infants and young children.

Salmonella contamination can be prevented by thoroughly cooking all animal-derived foods, especially those from poultry. Cross-contamination can be avoided by hand washing after handling animals or raw poultry and thoroughly washing cutting boards and utensils with soap after contact with food.

In 2007, a total of 120 confirmed cases were reported in Franklin County with an incidence rate of 10.7 cases per 100,000 population. The ages ranged from less than 1 year to 90 years of age with a median age of 28 years. Sixty-seven percent of the cases were females (Figure 4).

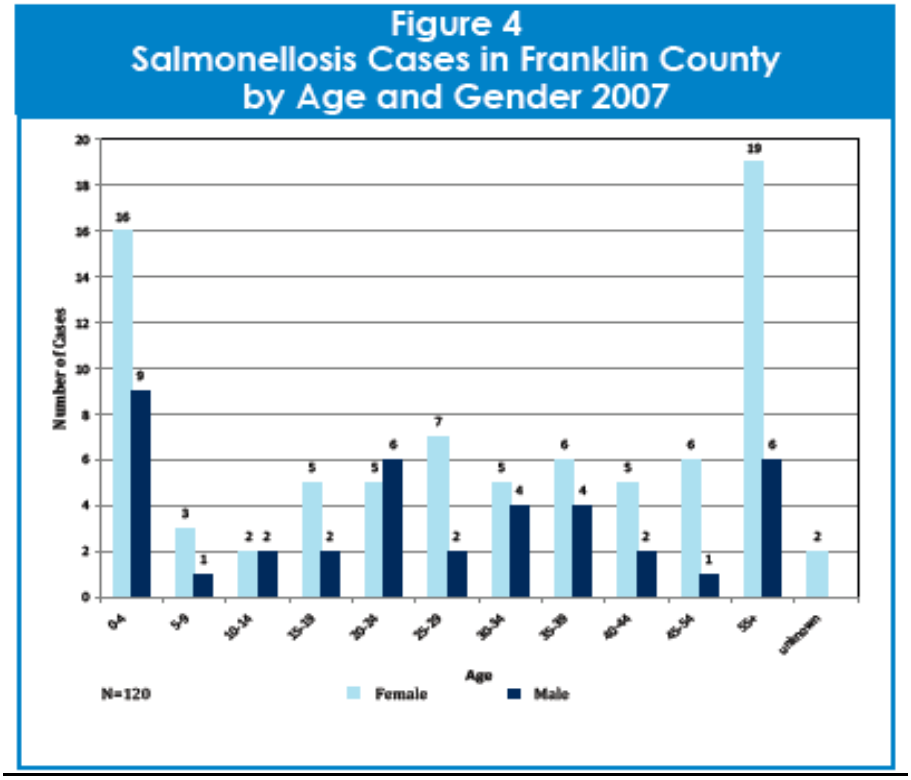


Figure 4
Salmonellosis Cases in Franklin County
by Age and Gender 2007
Number of Cases
Age
N=120
Female
Male

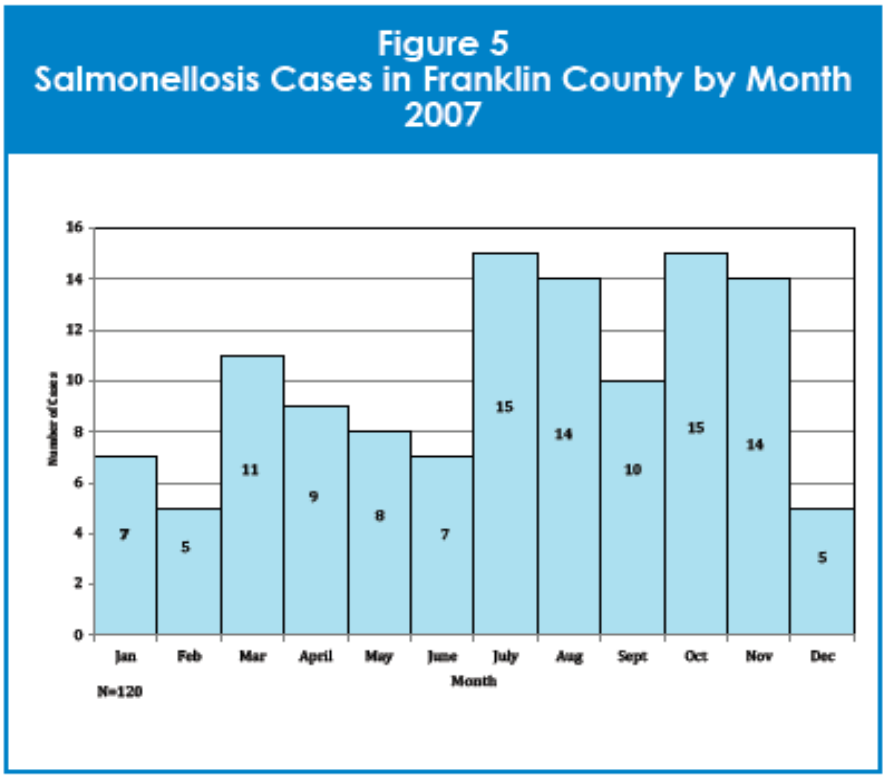
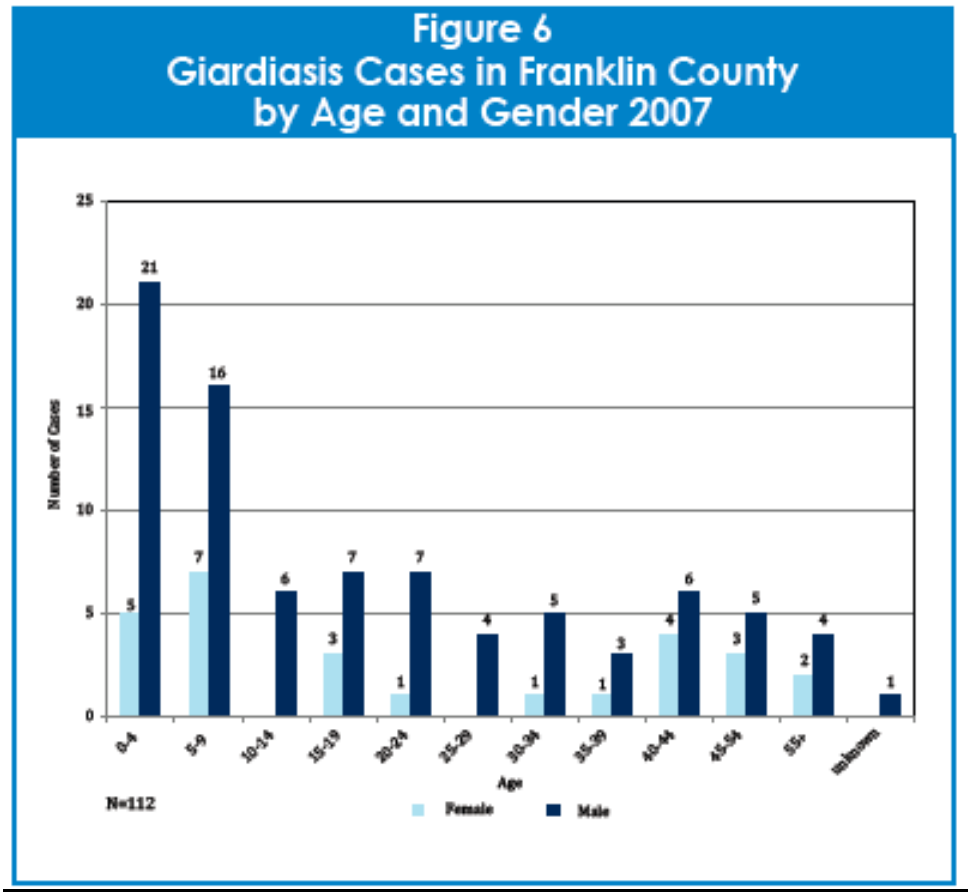


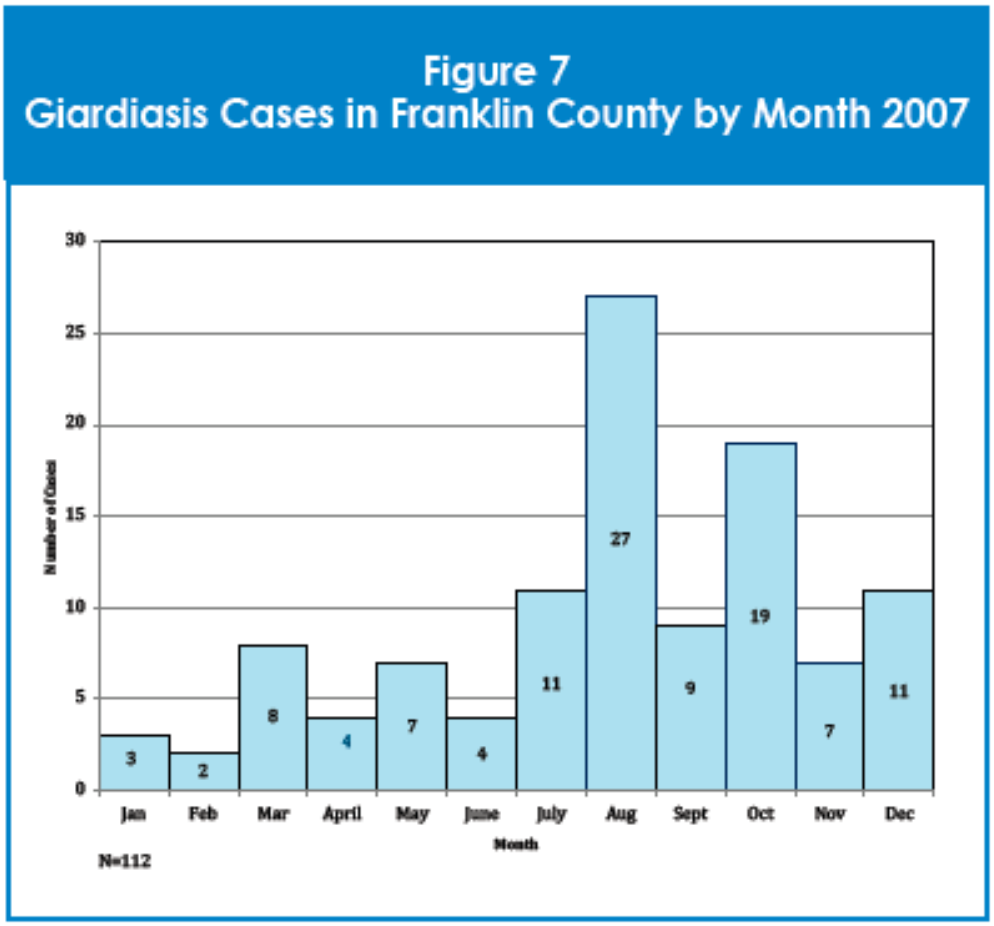
Figure 5
Salmonellosis Cases in Franklin County by Month
2007
Number of Cases
Jan
Feb
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
N=120

Giardiasis

Giardiasis is a diarrheal illness caused by the protozoan, *Giardia lamblia*, a single-celled microscopic parasite. Once an animal or person has been infected, the most common symptoms are chronic diarrhea, abdominal cramps, bloating, and loose, pale, greasy stools. Symptoms appear 1-2 weeks after exposure to the protozoan. Asymptomatic infections and prolonged shedding in the feces are common. Transmission through the fecal-oral route, person-to-person especially in institutions and day care centers and animal-to-person are the principal modes of spread.

In 2007, a total of 112 confirmed cases were reported in Franklin County with an incidence rate of 10 cases per 100,000 population. The ages ranged from less than 1 year to 85 years of age with a median age of 14 years. Sixty-six percent of the cases were males (Figure 6).





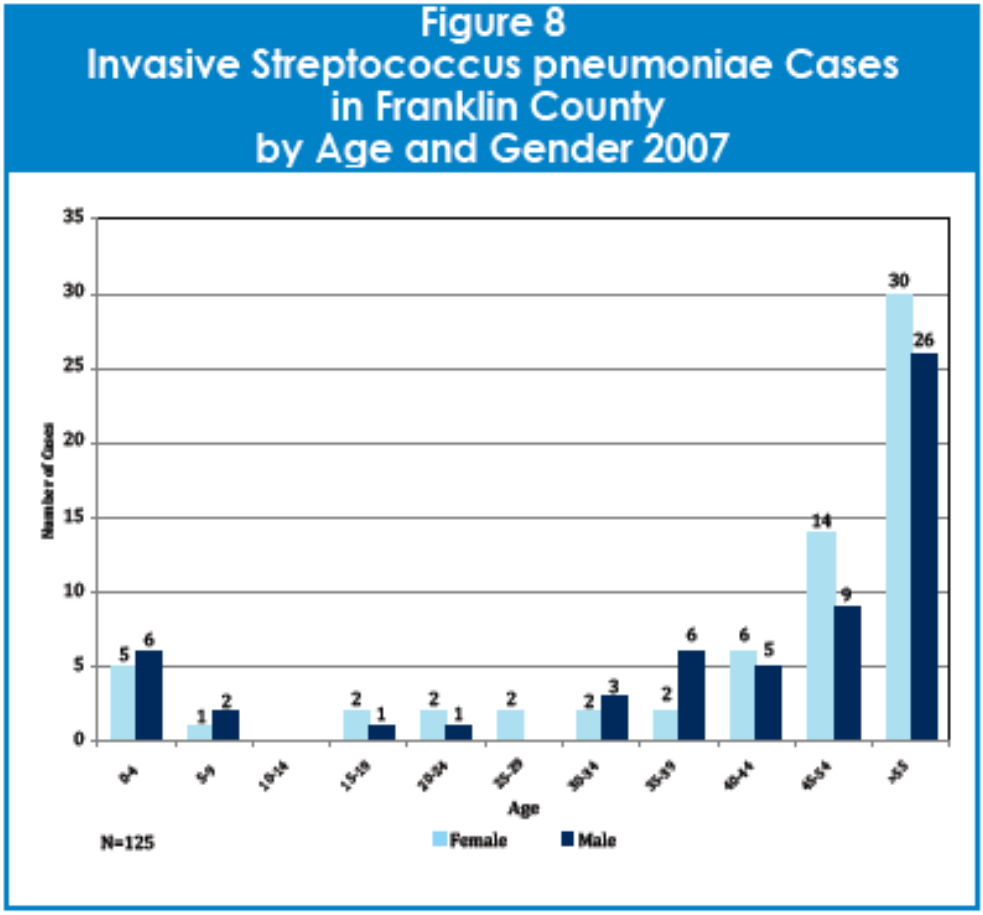
Invasive Streptococcus pneumoniae

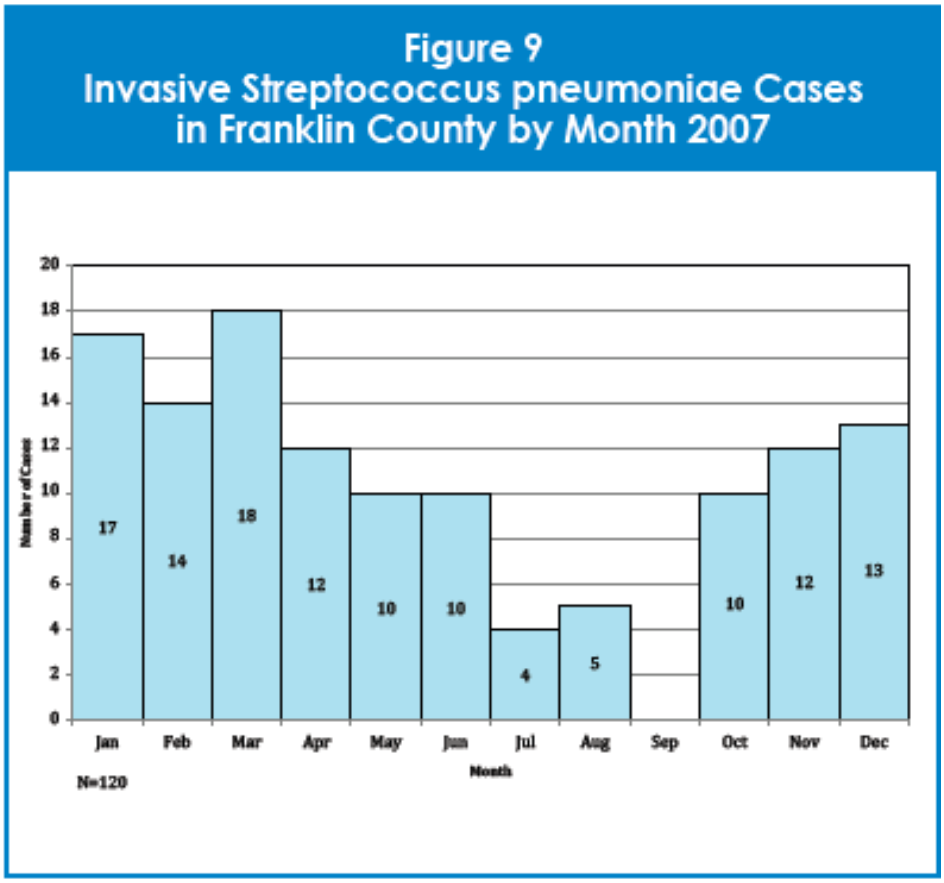
Streptococcus pneumoniae causes many clinical syndromes, depending upon the site of infection (e.g., acute otitis media, pneumonia, bacteremia, meningitis). Certain serotypes are more prevalent in adults; others are more prevalent in children. Throughout the past two decades, several serotypes have developed resistance to penicillin, to which they were formerly highly susceptible.

Humans are the reservoir of pneumococci, commonly found in the upper respiratory tract of healthy persons throughout the world. Pneumococci are transmitted person-to-person by droplet spread, by direct oral contact and indirectly through articles freshly soiled with respiratory discharges. Although these routes of transmission are easily accomplished, illness among casual contacts and attendants of patients is infrequent.

Treatment with an antibiotic to which the infecting organism is sensitive can be expected to terminate communicability within 24 hours. The incubation period varies by type of infection and can be as short as one to three days.

The Franklin County incidence rate of invasive S. pneumoniae disease in 2007 was 11.2 cases per 100,000 population. This represents an 8.7% increase over the 2006 rate of 10.3 cases per 100,000. The reported cases ranged from less than 1 year old to 97 years of age, with 45% of the cases 55 years old or older (Figure 8). The median age range was 52 years. Fifty-three percent of the cases were females.





Influenza Surveillance 2007-2008 Season Summary

During the 2007-08 season, influenza activity was fairly high. The higher activity may have been in part due to reduced effectiveness in two of the three strains of the vaccine that were less than optimally matched to circulating viruses (more detailed explanation can be found at www.cdc.gov/flu/about/qa/season.htm).

In 2007-08, locally, there were no discernable peaks in pneumonia and influenza mortality figures, although it does appear that the numbers of deaths were higher from February through April. Other local data sources indicate that flu activity peaked anywhere between the fifth (week ending February 2, 2008) and seventh (week ending February 16, 2008) week of 2008. Nationally, flu activity increased slowly from mid-December through the end of the year, with more rapid increases during January and through the week ending February 16. Flu activity peaked in mid-February and then decreased through the end of the flu season on May 17.

Pneumonia and Influenza (P&I) Mortality

Locally in the 2007-08 flu season, the percentage of P&I deaths in Franklin County was highest (12.3%) during week 16, the week ending April 19th, 2008 (Figure1).

Influenza Morbidity and Influenza-Like Illness (ILI) Reports

The percentage of patient visits to Franklin County sentinel providers for influenza-like-illness (ILI) increased in the fourth week of 2008 (week ending January 26), peaked on the fifth week (week ending February 2, 2008), and gradually declined in the next three weeks. The number and percentage of patient visits to BioSense hospitals coded as ILI sub-syndrome also started to increase in the fourth week of 2008, peaked in the seventh week (week ending February 16), and gradually decreased till the end of the season (Figure 2).

Columbus Public Schools (CPS): Absenteeism

The percent of Columbus Public Schools students absent was highest (11.2%) the week ending February 23, 2008 (Figure 3).

Laboratory Surveillance

The 2007-08 season was the third season implementing comprehensive laboratory surveillance in Franklin County. The percentage of positive labs started to increase at the beginning of the year and peaked on the sixth week of 2008 (week ending February 9). From January 1 through the end of reporting, a total of 9,451 specimens were tested for influenza and 2,701 (29%) were positive, higher than the percentages during similar times the previous seasons (2006-07 = 21%, 2005-06 = 22%). Nationally, during a similar time period, the World Health Organization (WHO) and National Respiratory and Enteric Virus Surveillance System (NREVSS) laboratories tested 168,350 specimens for influenza viruses, of which 37,683 (22%) were positive (Figure 4).

Emergency Department Visits and Over-the-Counter Medication Sales

For the 2007-08 season, there was a rapid increase in percentage of respiratory and constitutional ED visits starting on the fourth week of 2008 (week ending January 26), and a peak in the sixth week (week ending February 9). Compared to the previous two seasons, the peak was slightly earlier. In general, the OTC cough and cold, pediatric electrolyte, and thermometer sales followed the same increases and peak as the ED visits stated above, although additional increases and peaks are also noted in late December 2007 (Figures 5 & 6).

Figure 1: Percentage of Deaths due to Pneumonia and Influenza
Columbus, Ohio 2007-08

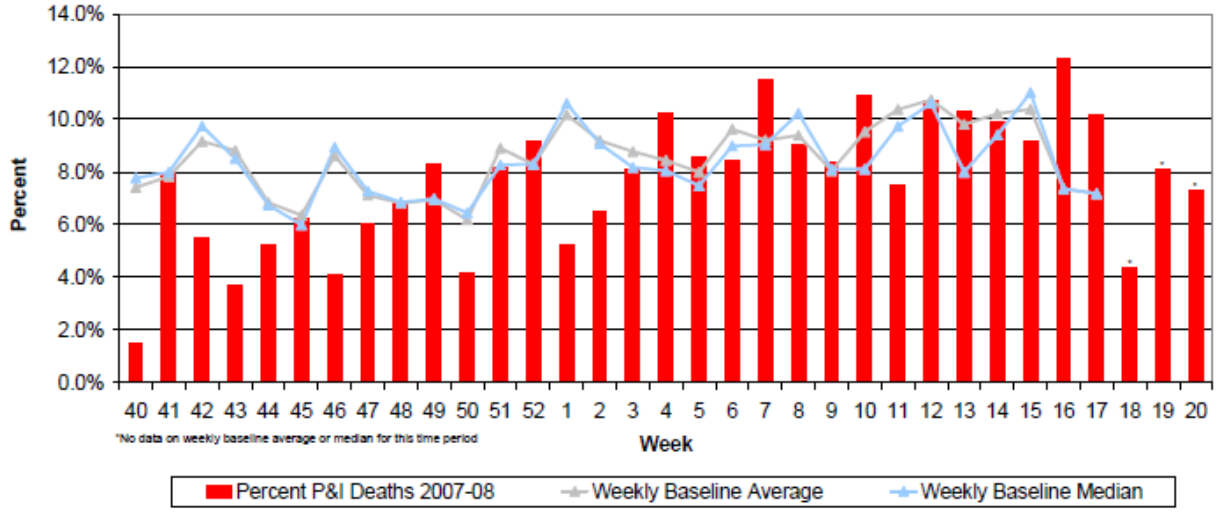


Figure 2: Percentage of Local, National and North East Central Region ILI Outpatient visits and Percentage of Franklin County Resident BioSense Hospital ED visits coded* as ILI sub-syndrome, 2007-08

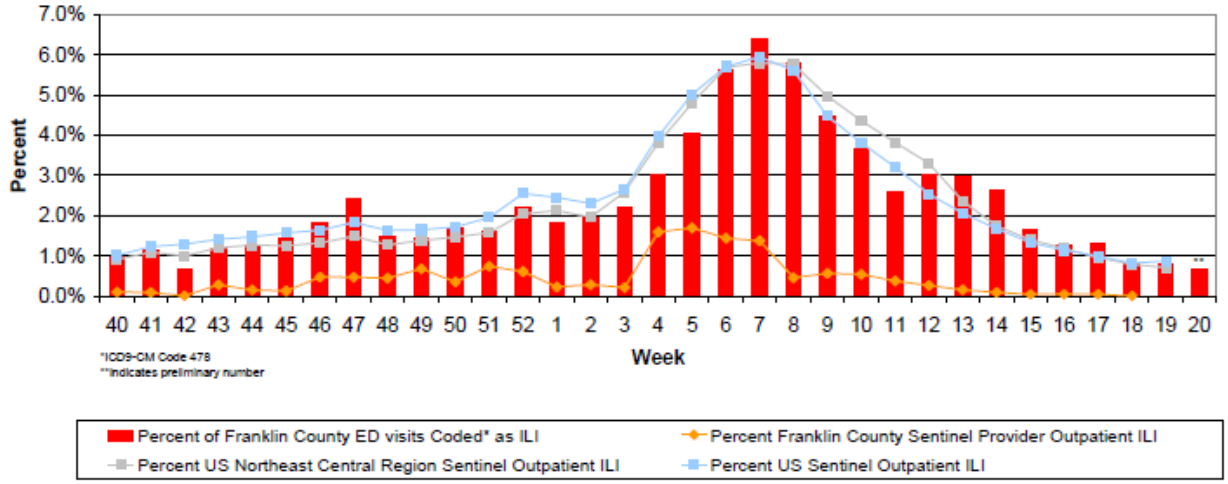


Figure 3: Percentage of Students Absent from Columbus Public Schools 2007-08

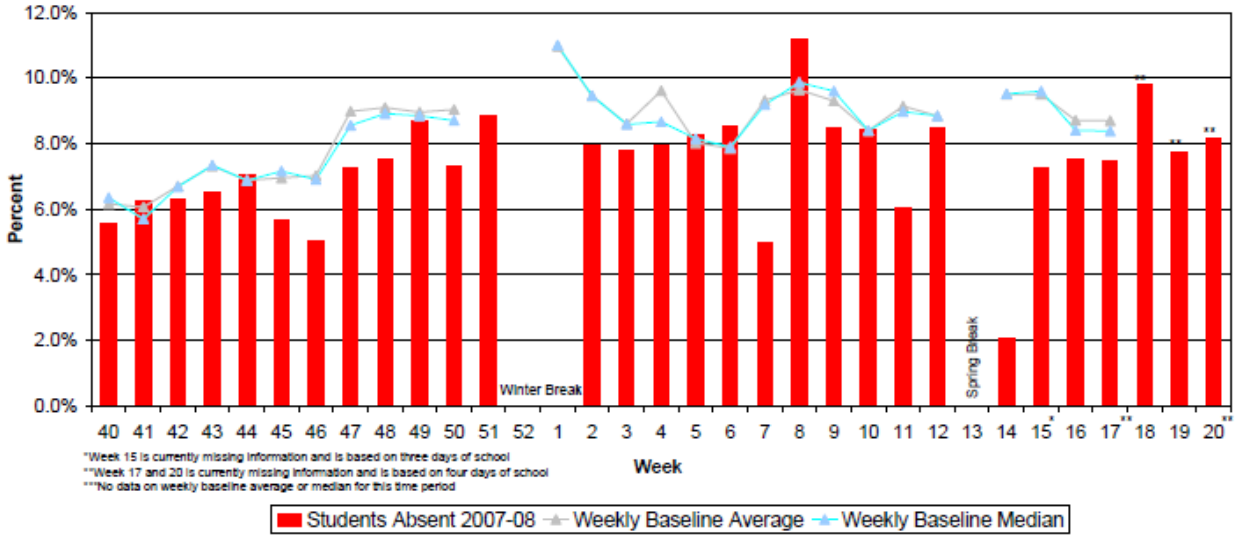


Figure 4: Percentage of Local Reporting, National and East North Central Region Laboratory Positive Influenza Tests by Week, 2007-08

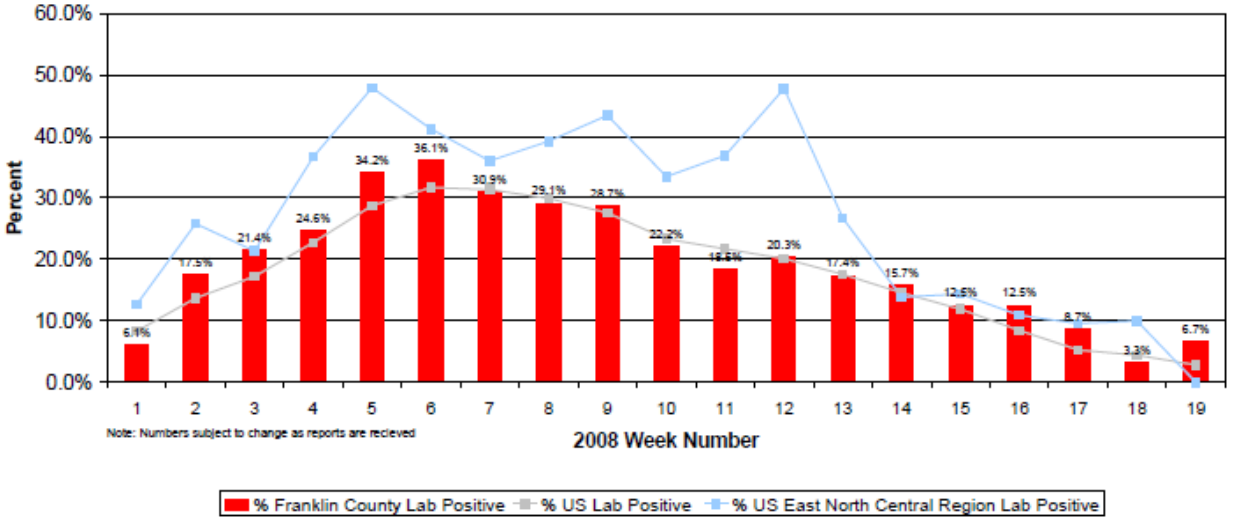


Figure 5: Respiratory and Constitutional ED Visits and 4 Yr. Weekly Baseline Averages and Medians, 2007-08, Franklin County, OH

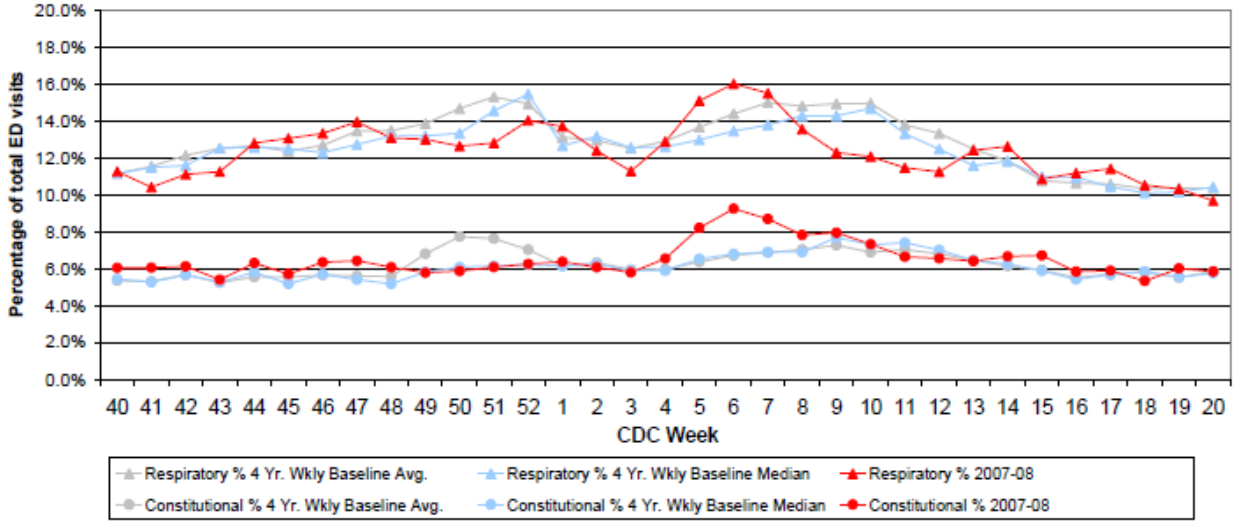
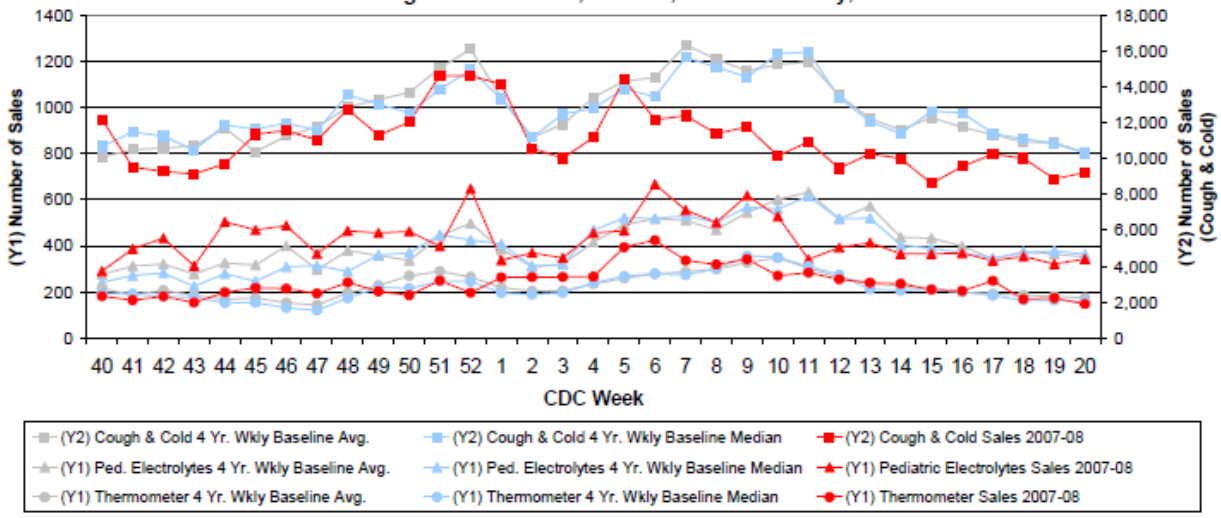


Figure 6: Selected Number of Over-the-Counter Medication Sales and 4 Yr. Weekly Baseline Averages and Medians, 2007-08, Franklin County, OH



Emerging Infectious Disease Summary

<u>Pandemic Influenza Hazard Analysis</u>

The illustrations of the potential impact of the next influenza pandemic outlines below are intended to help Franklin County public health officials and policy makers plan, prepare and practice for the next influenza pandemic.

Summary of results - Estimates of the potential impact of the next influenza pandemic in Franklin County, Ohio: Two scenarios

Estimates of impact: Cases: Table 1 below contains a range of estimates of the potential impact of the next influenza pandemic in Franklin County. The conservatively low estimates, labeled "Moderate scenario, 1968 – type," were primarily generated using rates of influenza-related illness measured during the 1960s and 1970s. The estimates labeled "Severe scenario, 1918-type" were generated using rates of influenza-related morbidity and mortality from the influenza pandemic of 1918.

Table 1: Total estimates, per health outcome, from two scenarios of potential impact of next influenza pandemic in Franklin County: Most likely (minimum, maximum)

Health outcome	Gross attack rate 25%*	
	Moderate scenario (1968 - type)†	**Severe scenario (1918 - type) †**
Deaths	**914**	**7,508**
Hospitalizations§	**2,827**	**23,238**
Total hospital beds needed: Hospitalizations + deaths-in-hospital§	**3,647**	**23,768**
Outpatients	**71,160**	**118,449**
Ill, no medical care	**142,321**	**236,499**

*Gross attack rates = 25% of entire population who are assumed to become clinically ill with influenza during the next pandemic.
†Source: Calculated using FluAid 2.0 available at: http://www.dhhs.gov/nvpo/pandemics/ See Appendix I for further details.
§ As a health outcome, the term "hospitalizations" refers to those who are hospitalized due to influenza-related illness but survive (i.e., their end health outcome is hospitalization). However, a percentage of those who will die from influenza-related illnesses are likely to die in hospital. Thus, total hospital beds required will be the sum of hospitalizations + deaths in hospital. We have assumed, for the sake of illustration, that 70% of influenza-related deaths will occur in hospital.

Assumptions

Table AI.1: Franklin County's Population & High Risk Percentage by Age Group

Age group, years	Subtotal	High Risk %
0–18	285,685	10.3%
19–64	679,009	34%
65+	104,284	10%
Total	**1,068,978**	**54.3%**

Source: Summary File 3. Census of Population and Housing. U.S. Bureau of the Census, 2000

Table AII.1: Assumptions used for both scenarios to calculate demand for hospital-based resources over duration of pandemic

	Input assumptions	Unit	Values
No. 1	Average length of non-ICU hospital stay for influenza-related illness	days	5
No. 2	Average length of ICU stay for influenza-related illness	days	10
No. 3	Average length of ventilator usage for influenza-related illness	days	10
No. 4	Average proportion of admitted influenza patients will need ICU care	Proportion	0.15
No. 5	Average proportion of admitted influenza patients will need ventilators	Proportion	0.075
No. 6	Average proportion of influenza deaths assumed to be hospitalized	Proportion	0.7
No. 7	Daily percentage increase in cases arriving compared to previous day	Percent	5

Table AII.2: Assumptions used for both scenarios to calculate demand for hospital-based resources over duration of pandemic

Total licensed non-ICU beds	4,144
% licensed non-ICU beds staffed:	90%
Total staffed non-ICU beds:	3,730
Total licensed ICU beds:	661
% licensed ICU beds staffed:	92%
Total staffed ICU beds:	608
Total number of ventilators:	391
% ventilators available:	2%
Total number of ventilators available:	8

Table 2: Results: Demand for hospital-based resources: 1968 – type scenario (MODERATE): 25% attack rate: 8 weeks duration

Pandemic Influenza Impact		Weeks									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hospital Admission	**Weekly admissions**	206	344	516	**653**	**653**	516	344	206		
	Peak admissions/day				102	**102**					
Hospital Capacity	**# of influenza patients in hospital**	152	253	379	480	497	437	335	220		
	% of hospital capacity needed*	4%	7%	10%	13%	**13%**	12%	9%	6%		
ICU Capacity	**# of influenza patients in ICU**	31	66	101	133	144	140	111	77		
	% of ICU capacity needed*	5%	11%	17%	22%	**24%**	23%	18%	13%		
Ventilator Capacity	**# of influenza patients on ventilators**	15	33	50	67	72	70	56	38		
	% usage of ventilator	198%	419%	644%	851%	**921%**	896%	712%	492%		
Deaths	**# of deaths from influenza**			39	65	97	**123**	**123**	97	65	39
	# of influenza deaths in hospital			27	45	68	86	86	68	45	27

* % capacity calculated assuming **4144** beds available and **661** ICU beds. These numbers of beds represent the total hospital bed capacity. Actual capacity to absorb pandemic influenza patients will be less than that, and thus the estimates of percentage of capacity needed are smaller than what may occur.
Source: Calculated using FluSurge 2.0 – see Appendix II for additional details

Table 3: Results: Demand for hospital-based resources: 1918-type scenario (SEVERE): 25% attack rate: 8 weeks duration

Pandemic Influenza Impact		Weeks									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hospital Admission	Weekly admissions	1,394	2,324	3,486	**4,415**	**4,415**	3,486	2,324	1,394		
	Peak admissions/day				688	**688**					
Hospital Capacity	# of influenza patients in hospital	1,025	1,708	2,562	3,246	3,361	2,954	2,265	1,486		
	% of hospital capacity needed	27%	45%	68%	86%	**89%**	79%	60%	40%		
ICU Capacity	# of influenza patients in ICU	209	444	681	900	974	947	753	520		
	% of ICU capacity needed	34%	73%	112%	147%	**160%**	155%	123%	85%		
Ventilator Capacity	# of influenza patients on ventilators	105	222	341	450	487	474	376	260		
	% usage of ventilator	1337%	2836%	4355%	5752%	**6225%**	6056%	4812%	3323%		
Deaths	# of deaths from influenza			450	751	1,126	1,427	1,427	1,126	751	450
	# of influenza deaths in hospital			315	526	788	999	999	788	526	315

Source: Calculated using FluSurge 2.0

Pandemic Influenza

Like Ohio and the rest of the U.S. and world, Franklin County was impacted by the 2009 influenza pandemic. As of August 4, 2009, there were 35 confirmed cases of 2009 H1N1 influenza among Franklin County residents; however, more than 360 reports required public health follow-up. Since that time, individual cases of disease were no longer reportable in Ohio. Both Columbus Public Health and Franklin County Board of Health continue heightened surveillance as a result of the pandemic and continue collaboration with the Ohio Department of Health and the Centers for Disease Control and Prevention.

The focus since the spring of 2009 was on planning for a coordinated public health response to a resurgence of the virus in the fall in conjunction with the occurrence of seasonal influenza illnesses. Mass vaccination, as well as refining and distributing prevention messages (through the media, schools, health care practitioners and other key partners), were high priority areas.

Once the 2009 H1N1 vaccine was approved by the FDA in mid-September, the CDC permitted states to order supplies to be distributed locally. Vaccination clinics were held in Columbus starting on October 14.

As with any virus, mutation is likely to occur as the disease spreads. This could make the current vaccine less effective, leaving unknown segments of the population vulnerable. It is this threat that makes it necessary for public health professionals to continue to monitor the pandemic and for communities to stay vigilant with prevention practices. Limiting the spread slows the virus's ability to mutate.

Since 2006, the health departments have worked with over 50 additional agencies in Central Ohio to build a unified command system that involves every potential response agency in the area. Planning is ongoing.

West Nile Virus

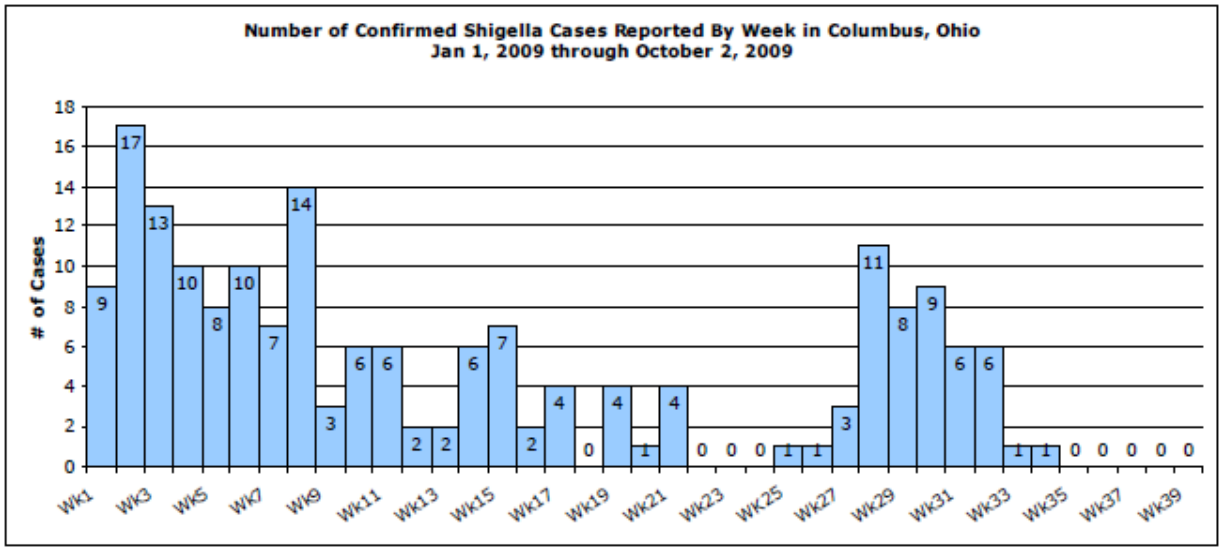
West Nile Virus is detected in mosquito pools in Franklin County each year. Columbus reported no human cases in 2008 or 2007, and one case in 2006.

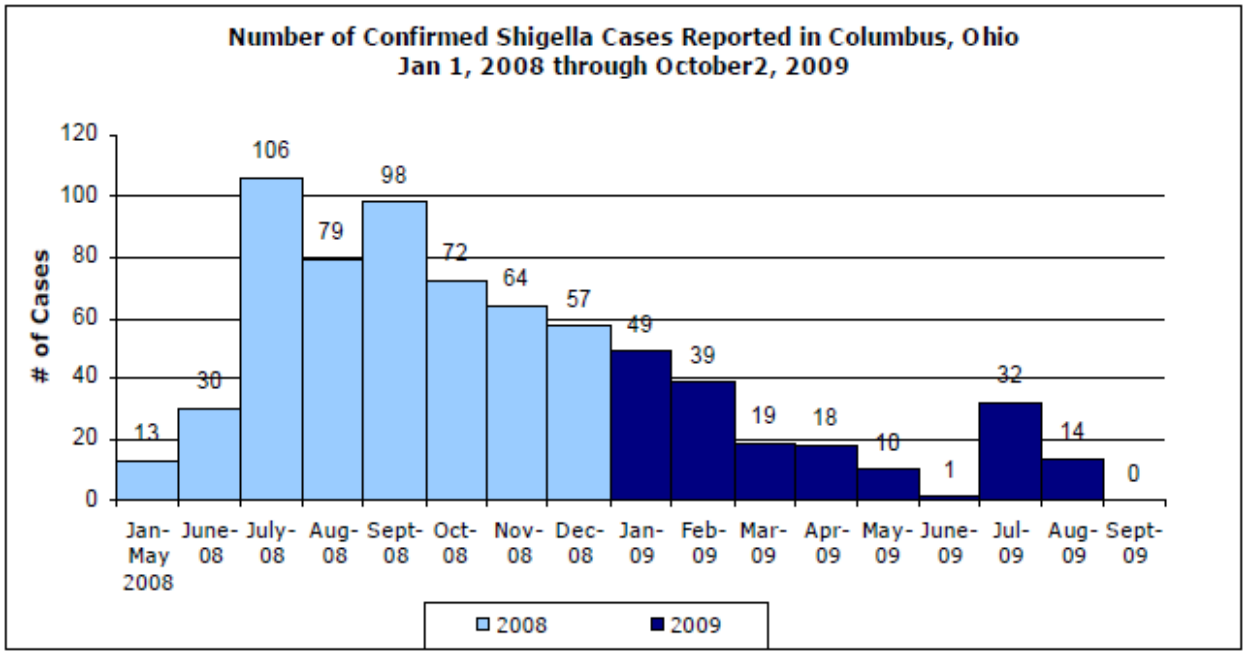
Both Columbus Public Health and Franklin County Board of Health have aggressive programs to trap and test mosquitoes. Both health departments also have mosquito-control spraying programs during summer months.

Shigellosis Outbreak

In October 2009, Columbus Public Health (CPH) completed an investigation of a community outbreak of shigellosis that began the summer of 2008. The outbreak was considered "ended" when there three or fewer cases reported for each of eight consecutive weeks. No cases of shigellosis were reported for the final six weeks (ending October 9, 2009).

For 2009 (through Oct. 9), 182 cases of shigellosis were reported in Columbus: 103 cases (57%) were female; 95 cases (52%) were children age 5 and under; 71 cases (39%) attended child care; and 104 cases (57%) were African American.

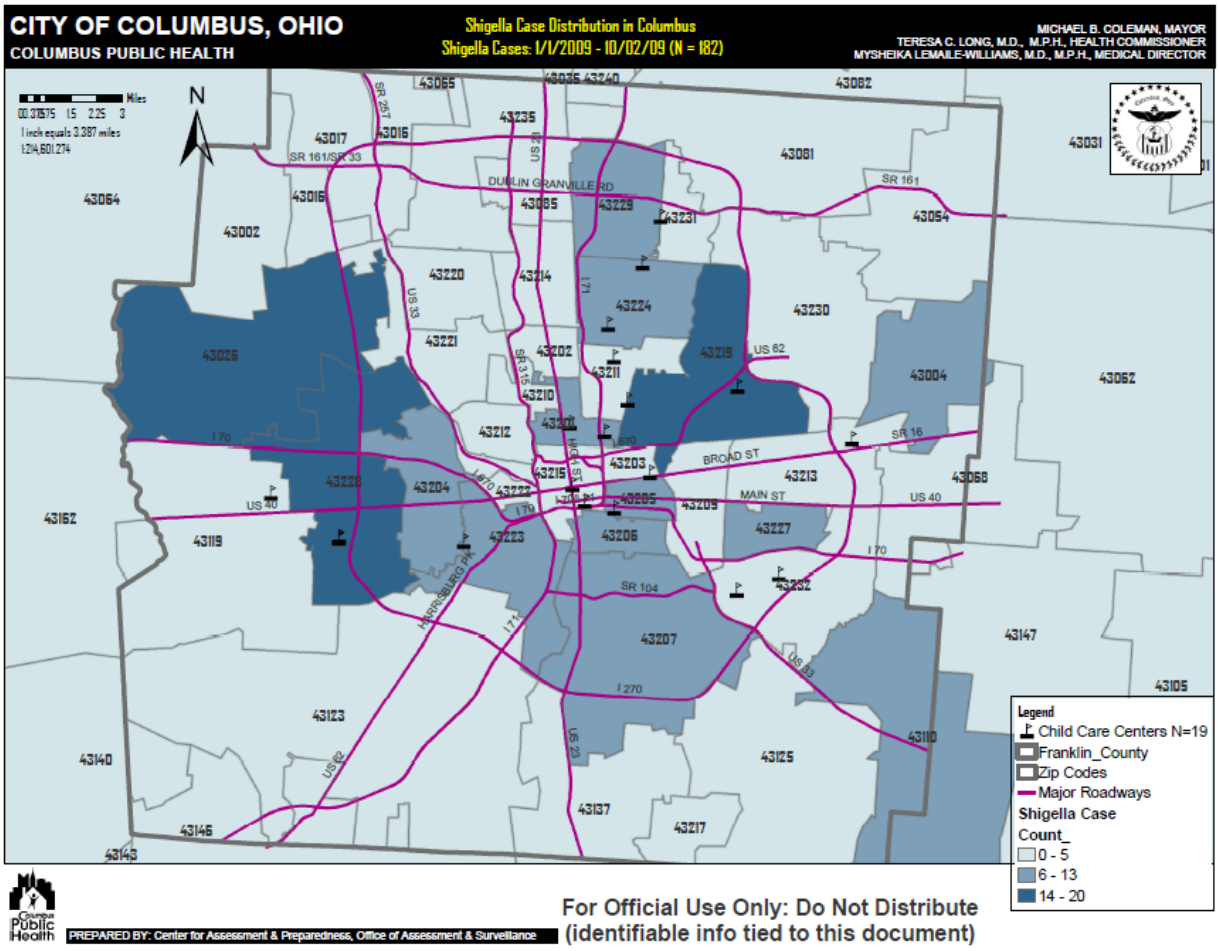




Since the beginning of the outbreak (June 1, 2008), 701 cases were reported (519 cases in 2008 and 182 cases in 2009). Incidence peaked between July and September 2008, with a steady downward trend up to June of 2009 before increasing again in July of 2009.

Interventions undertaken by CPH to address the shigellosis outbreak included:

- Creation of a special *Shigella* task force utilizing CPH staff to identify and implement prevention activities to bring the outbreak under control and the incidence of shigellosis back to normal levels
- Thorough case investigations of all reported shigellosis cases
- Epidemiologic analysis of shigellosis incidence, as well as identification of individuals at highest risk and areas of the community most affected
- Education and outreach visits to child care centers with shigellosis cases and cohort testing to identify other cases and interrupt transmission
- Development and dissemination of health education materials to all child care centers
- Revisiting all of the child care centers which previously had shigellosis cases and providing educational materials and health tips



Source: Weekly Shigella Update, Columbus Public Health: October 2, 2009

Technical Notes

Disease Reporting

The Ohio Administrative Code 3701-3-02, 3701-5-05, and 3701-3-12 requires by law that communicable diseases be reported to local health departments. Reportable diseases are grouped by class. All the diseases in this summary are class A, which is defined as: Disease of major public health concern because of the severity of disease or potential for epidemic spread. For a complete list of reportable diseases in Ohio, please visit http://www.odh.ohio.gov.

Case criteria and definitions

Case definitions are determined by the Council of State and Territorial Epidemiologists (CSTE) in conjunction with the CDC and are published in the MMWR [1997; 46(RR-10)]. Cases are grouped into the following categories:

Suspected case: a case for which a reportable condition is being considered in the differential diagnosis, but for which confirmatory laboratory testing has not yet been completed

Confirmed case: a case that is classified as "confirmed" for reporting purposes

Probable case: a case that is classified as "probable" for reporting purposes

Notes on specific diseases and rates

STDs, TB and HIV/AIDS data are from separate ODH sources. HIV/AIDS data are provisional and subject to change. Syphilis numbers include primary and secondary cases only. Disease totals and calculated disease rates are limited to confirmed cases. Suspects and probable cases are not included in this report. Population estimates obtained from the United States Census Bureau for each year were used in annual rate calculations.

Diseases not included in the Reportable Disease Data table

There were no confirmed cases in Franklin County of the following Class A reportable diseases; therefore, they were not included in the table: Creutzfeldt-Jakob disease, coccidioidomycosis, Q fever, rabies, Reye syndrome, rheumatic fever, rubella (not congenital), *Staph aureus* (VRSA, VISA), toxic shock syndrome (TSS), toxoplasmosis, and trichinosis. Class B and C reportable diseases are also not included in the table.

Notes on reporting systems

Data are from the Ohio Department of Health and the Communicable Disease Reporting system (CDRS, a joint effort between Columbus Public Health Department and the Franklin County Board of Health). Cases of sexually transmitted diseases, tuberculosis, AIDS, and HIV have separate reporting systems. Cases may have been excluded due to the reporting time, onset date, or when the supplemental information was received.

Infectious Diseases – References

Centers for Disease Control and Prevention Coordinating Center for Infectious Diseases, http://www.cdc.gov/about/organization/ccid.htm

CDC's Summary of Notifiable Diseases: http://www.cdc.gov/epo/dphsi/annsum/index.htm

CDC – MMWR Weekly, "Update: Severe Acute Respiratory Syndrome – U.S., 2003." [Online] 9 July 2009 http://www.cdc.gov/mmwr/prevoew/mmwrhtml/mm5218a2.htm

CDC, "Novel H1N1 Flu Situation Update." [Online] 7 July 2009 http://www.cdc.gov/h1n1flu/update.htm?s_cid=cs_001

ColumbusPandemicflu, "Local Preparation for Pandemic Flu." [Online] 7 July 2009 http://www.columbuspandemicflu.org

Columbus Public Health, "Assessment and Surveillance." [Online] 9 July 2009 http://publichealth.columbus.gov/assessment-and-surveillance.aspx

Columbus Public Health, "H1N1 Influenza – Columbus/Franklin County Alert." [Online] 10 July 2009 http://www.publichealth.columbus.gov/health_ehealthalerts.aspx?id=10154

Earth Institute at Columbia University, "Zoonotic Pathogens Passed from Wildlife to Humans." [Online] 7 July 2009 http://www.earth.columbia.edu/articles/view/2033

Franklin County Board of Health, "Avian (Bird) Flu and Pandemic Flu Planning and Preparedness." [Online] 7 July 2009 http://www.franklincountyohio.gov/bpard_of_health/pandemicFlu.html

Murphy, Maureen, R.N., Koch, Elizabeth, M.D., (2003) Severe Acute Respiratory Syndrome. ODH Infectious Disease Quarterly 1(1)

ODH, Handling Biological Incidents in Ohio. 12 Oct 2001

ODH, Novel Influenza A (H1N1) Confirmed, Probable Cases by County as of 6 July 2009

ODH, "Zoonotic Disease Program." [Online] 9 July 2009 http://www.odh.ohio.gov/odhPrograms/dis/zoonoses/wnvUpdate.aspx

OEMA, Hazard Identification and Risk Assessment, 2007

Satcher, David, M.D., Ph.D., Emerging Infections; Getting Ahead of the Curve, Emerging Infectious Diseases 1:(1) Jan-Mar 1995

The Ohio Department of Health Infectious Disease Control Manual:
http://www.odh.ohio.gov/healthResources/ infectiousDiseaseManual.aspx

Ticks and Tick-borne Disease in Ohio 2009, Infectious Disease Quarterly 6:(1)

World Health Organization, "Current WHO Phase of Pandemic Alert." [Online] 7 July 2009
http://www.who.int/csr/disease/avaian_influenza/phase/en/

Tornadoes - #6

Contents

Hazard Profile 160
Tornadoes in the United States 172
Tornadoes in Ohio 174
Tornadoes in Franklin County 179
Franklin County Outdoor Warning System 182

Hazard Summary

Tornadoes are nature's most violent windstorms – even weak ones can cause significant damage and fatalities. A tornado is defined as a violently rotating column of air, often visible as a funnel cloud, in contact with both the ground and the cloud base. Franklin County experienced 26 tornadoes from 1954 through 2008, all of which were rated F3 (or EF3) and under. This hazard was ranked No. 6 out of 16.

Hazard Profile

According to the *Glossary of Meteorology* (AMS 2000), a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." In practice, for a vortex to be classified as a tornado, it must be in contact with both the ground and the cloud base. There is some debate, however, as to whether separate touchdowns of the same funnel constitute separate tornadoes, and how close must two or more different tornadic circulations become to qualify as a one multiple-vortex tornado instead of separate tornadoes.

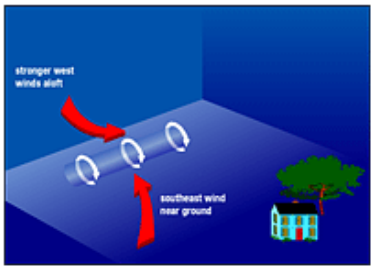
A funnel cloud is any rotating cloud pendant from a cumulus or cumulonimbus cloud. A funnel cloud rotates but has no ground contact or debris and creates no damage. A funnel cloud is not associated with strong winds at the surface. Tornadoes often begin as funnel clouds with no associated strong surface winds; however, not all of these funnel clouds evolve into a tornado. Most tornadoes produce strong winds at the surface while the visible funnel is still above ground, so it is difficult to discern the difference between a funnel cloud and a tornado from a distance.

Occasionally, a single storm will produce more than one tornado, either simultaneously or in succession. Multiple tornadoes produced by the same storm are referred to as a tornado family. Sometimes, several tornadoes are spawned from the same large-scale storm system. If there is no break in activity, this is considered a tornado outbreak.

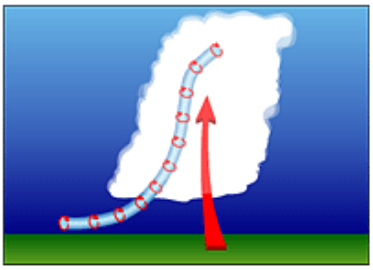
Unless otherwise noted, all pictures and graphics in this section are from the NOAA National Severe Storms Laboratory

Tornado Life Cycle

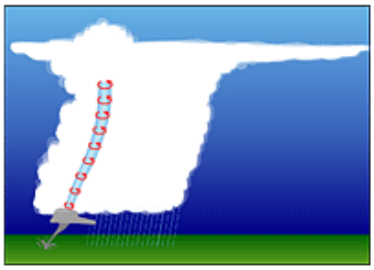
Tornadoes often develop from a class of thunderstorms known as supercells. Supercells contain a mesocyclone, an area of organized rotation a few miles up in the atmosphere, usually 1 to 6 miles across. The most destructive and deadly tornadoes occur from supercells. Supercells can also produce damaging hail, severe non-tornadic winds, lightning and flash floods.



▲ Before thunderstorms develop, a change in wind direction and an increase in wind speed with increasing height creates an invisible, horizontal spinning effect in the lower atmosphere.



▲ Rising air within the thunderstorm updraft tilts the rotating air from horizontal to vertical.



▲ An area of rotation, 2-6 miles wide, now extends through much of the storm. Most strong and violent tornadoes form within this area of strong rotation.

Woodward OK (Ron Przybylinski)

▲ A lower cloud base in the center of the photograph identifies an area of rotation known as a rotating wall cloud. This area is often nearly rain-free. Note rain in the background.

Woodward OK (Ron Przybylinski)

▲ Moments later a strong tornado develops in this area. Softball-size hail and damaging "straight-line" winds also occurred with this storm.

Source: NOAA

Thunderstorms develop in warm, moist air in advance of eastward-moving cold fronts. These thunderstorms often produce large hail, strong winds, and tornadoes.

Initially, the tornado has a good source of warm, moist inflow to power it, so it grows until it reaches the mature stage. This can last anywhere from a few minutes to more than an hour, and it is during that time that a tornado often causes the most damage.

As the tornado enters the dissipating stage, its associated mesocyclone often weakens as well. Even though the tornado is dissipating, it is still capable of causing damage. The storm is contracting into a rope-like tube, and like an ice skater who pulls her arms in to spin faster, winds can increase at this point.

A sequence of images showing the birth of a tornado. First, the rotating cloud base lowers. This lowering becomes a funnel, which continues descending while winds build near the surface, kicking up dust and other debris. Finally, the visible funnel extends to the ground, and the tornado begins causing major damage. This tornado, near Dimmitt, Texas, was one of the best-observed violent tornadoes in history.

Source: NOAA

Types of Tornadoes

Multiple Vortex Tornadoes

Multiple vortex tornadoes contain two or more small, intense columns of spinning air orbiting the center of the larger tornado circulation. These vortices may form and die within a few seconds, sometimes appearing to train through the same part of the tornado one after another. They can happen in all sorts of tornado sizes. These vortices often create small areas of heavier damage along the main tornado path.

Satellite Tornadoes

A satellite tornado develops independently from the primary tornado, not inside it. The tornadoes remain separate and distinct as the satellite tornado orbits its much larger companion within the same mesocyclone. Their cause is unknown but they seem to form most often in the vicinity of exceptionally large and intense tornadoes.

Waterspouts

A water spout is simply a tornado over water. They are common along the southeast U.S. coast, especially off southern Florida and the Keys. They can happen over seas, bays, and lakes worldwide. They are smaller and weaker than the most intense Great Plains

tornadoes but can still be dangerous. They can overturn boats, damage larger ships, and do significant damage when they hit land.

A landspout near North Platte, Nebraska on May 22, 2004.

Source: NOAA

Landspout

A landspout is officially known as a dust-tube tornado and is not associated with a mesocyclone. They are essentially a fair weather waterspout on land. Landspouts are relatively weak, short lived, small, smooth condensation funnels, which often do not touch the ground. Although usually weaker than classic tornadoes, they will produce strong winds and may cause serious damage.

Tornado-like Circulations

A *gustnado* or gust front tornado is a small, vertical swirl associated with a gust front or downburst. Because they are not associated with the cloud base, there is some question as to whether or not gustnadoes are actually tornadoes. They are formed when fast moving cold, dry outflow air from a thunderstorm is blown through a mass of stationary, warm, moist air near the outflow boundary, resulting in a "rolling " effect (often exemplified through a roll cloud). If the low level wind shear is strong enough, the rotation can be turned horizontally or diagonally and make contact with the ground. The result is a gustnado. They usually cause small areas of heavier rotational wind damage among areas of straight-line wind damage.

A *dust devil* resembles a tornado in that it is a vertical swirling column of air. However, they form under clear skies and are rarely as strong as even the weakest tornado. They form when a strong convective updraft is formed near the ground on a hot day. They can occasionally result in major damage, especially in arid areas.

Fire whirls are tornado-like circulations occasionally occurring near large, intense wildfires. They are not considered tornadoes and are not as strong. However, they can produce significant damage.

A *steam devil* is a rotating updraft that involves steam or smoke. A steam devil is very rare, but they mainly form from smoke emitting from a power plant smoke stack. There have also been reports of cold air steam devils as well.

Tornado Characteristics

Shape

Most tornadoes take on the appearance of a narrow funnel, a few hundred yards across, with a small cloud of debris near the ground. However, tornadoes can appear in many shapes and sizes. Large single vortex tornadoes can look like a large wedge stuck into the ground, and so are known as *wedge tornadoes*. Wedge tornadoes appear to be at least as wide as they are tall from ground to ambient cloud base. A wedge can be so wide that it appears to be a block of dark clouds, making it difficult to tell the difference between a wedge tornado and a low-hanging cloud. Many but not all major tornadoes are wedges.

A *wedge tornado*, nearly a mile wide. This tornado hit Binger, Oklahoma.

Source: NOAA

A *rope tornado* in its dissipating stage. Tecumseh, OK.

Source: NOAA

Rope tornadoes are very narrow or snake-like. Many tornadoes assume the rope shape in their last stage. Rope tornadoes often curl or twist into complex shapes. Even though they may be in the last stage of the tornado, they can still do violent damage of an EF4 or EF5. Tornado shape and size does not say anything about its strength.

Size

In the United States, tornadoes average around 500 feet across and stay on the ground for five miles. However, there is an extremely wide range of tornado sizes. Weak tornadoes, or strong dissipating tornadoes, can be exceedingly narrow, sometimes only a few feet across. On the other hand, wedge tornadoes can have a damage path a mile wide or more.

As for path length, many tornadoes which appear to have path lengths of 100 miles or longer are actually a family of tornadoes which have formed in quick succession. One exception, the Tri-State Tornado, which affected parts of Missouri, Illinois, and Indiana on March 18, 1925, was officially on the ground continuously for 219 miles.

Color

Tornadoes can have a wide range of colors, depending on the environment in which they are formed. In a dry environment, a tornado can be nearly invisible, marked only by swirling debris at the base of the funnel. Water spouts can turn very white or even blue. Funnels, which move slowly and pick up a lot of debris, are usually darker, taking on the color of the debris. Tornadoes in the Great Plains can turn red from the reddish tint of the soil.

Lighting conditions are also a major factor in the appearance of a tornado. A tornado which is back-lit (viewed with the sun behind it) appears very dark. The same tornado, viewed with the sun at the observer's back may appear gray or brilliant white. Tornadoes which occur near sunset can be many different colors, appearing in hues of yellow, orange, and pink.

Dust, rain, hail, and the darkness of night can reduce the visibility of tornadoes. Tornadoes occurring in these conditions are especially dangerous as only radar observations or possibly the sound of the tornado can provide any warning to those in the storm's path. Fortunately, most tornadoes form in the rain-free base of the storm where there is little or no rain. Most tornadoes occur in the late afternoon, when the bright sun can illuminate the dark clouds.

Photographs of the Waurika, Oklahoma tornado of May 30, 1976, taken at nearly the same time by two photographers. In the top picture, the tornado is *front-lit*, with the sun behind the east-facing camera, so the funnel appears nearly white. In the lower image, where the camera is facing the opposite direction, the tornado is *back-lit*, with the sun behind the clouds.[27]

Sound

The most common tornado sound reported is a continuous rumble, like a nearby train. Sometimes a tornado will produce a loud whooshing sound, like a waterfall or open car window. Tornadoes moving through densely populated areas may produce all kinds of noises at once, producing a loud roar. Small tornadoes or funnel clouds may produce whistling, humming or buzzing sounds.

Direction and Rotation

Tornadoes can appear from any direction. Most move from southwest to northeast or west to east. Some have changed direction mid-path or even backtracked.

Tornadoes normally rotate cyclonically in one direction (counterclockwise in the northern hemisphere, clockwise in the southern).

Climatology

The United States has the most tornadoes of any country, about 1,000 yearly. This is mostly due to the unique geography of the continent. (Discussed further in the United States Tornadoes section.)

Tornadoes are most common in spring and least common in winter. Since fall and spring are transitional seasons (warm to cool and vice versa), there are more chances of cooler air meeting with warmer air, resulting in thunderstorms. However, favorable conditions can occur any time of the year. Tornadoes have been reported in all months. Most tornadoes occur in the late afternoon, between 3 p.m. and 7 p.m., peaking around 5 p.m..

Tornado Intensity and Damage

Tornadoes vary in intensity regardless of shape, size, and location. Typically, strong tornadoes are larger than weak tornadoes. For many years scientists had nothing more than educated guesses as to the speed of the winds in a tornado. The only evidence indicating the wind speeds was in the damage left behind.

In 1971, Dr. Tetseya Theodore Fujita introduced the idea for a scale of tornado winds. He introduced what came to be known as the Fujita scale in 1973. The scale was supposed to relate the intensity of the wind to the degree of damage. Research conducted in the late 1980s and1990s suggested tornado winds were notoriously overestimated, especially in significant and violent tornadoes. In 2006, the American Meteorological Society introduced the Enhanced Fujita Scale to help assign realistic wind speeds to tornado damage. The scale was designed so that a tornado assessed on the Fujita scale would receive the same ranking on the Enhanced Fujita scale. The EF-scale is more specific in detailing the degrees of damage on different types of structures for a given wind speed. It classifies F0-F5 damage as calibrated by engineers and meteorologists across 28 different types of damage indicators. The Enhanced Fujita scale went into effect in the United States in 2007.

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

***** IMPORTANT NOTE ABOUT ENHANCED F-SCALE WINDS:** *The Enhanced F-scale still is a set of wind estimates (not measurements) based on damage*. Its uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators listed below. These estimates vary with height and exposure. **Important**: The 3 second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, "one minute mile" speed.

Chart from the NOAA Storm Prediction Center
(The 28 indicators noted above can be found at http://www.noaa.gov/faq/tornado/ef-scale.html.)

Weak Tornadoes

The vast majority of tornadoes are designated F0 or F1, also known as weak tornadoes. However, even weak tornadoes can cause significant damage and fatalities. F0 and F1 tornadoes are typically short lived and stay on the ground for one mile or less.

An example of **F0** damage. The only significant damage to structures in this picture was caused by falling tree branches. Even though well-built structures are typically unscathed by **F0** tornadoes, falling trees and tree branches can injure and kill people, even inside a sturdy structure.

An example of **F1** damage. **F1** tornadoes cause major damage to mobile homes and automobiles, and can cause minor structural damage to well-constructed homes. This particular mobile home appears to be a double-wide, and it was still moved off its foundations, with its roof badly damaged. A mobile home or car is a very poor shelter, even during severe thunderstorms which do not contain a tornado.

Strong Tornadoes

Strong Tornadoes, F2 and F3, are stronger than most tropical cyclones, although cyclones affect a much larger area. An F2 tornado can remove the roof of a well-built structure. And

F3 damage is a serious risk to life and limb. Few parts of affected buildings are left standing. Wooded areas will suffer almost total loss of vegetation.

An example of **F2** damage. At this intensity, tornadoes have a more significant impact on well-built structures, damaging roofs, collapsing walls, and generating large amounts of flying debris. This wood-frame home was unroofed, with many outer walls collapsed or destroyed.

An example of **F3** damage. Here, the roof and some inner walls of this brick building have been demolished. While taking shelter in a basement, cellar, or inner room improves your odds of surviving a tornado drastically, occasionally even this is not enough. **F3** and stronger tornadoes only account for about 6% of all tornadoes in the United States, and yet since 1980 they have accounted for more than 75% of tornado-related deaths.

Violent Tornadoes

Violent tornadoes are the F4s and F5s. F4 damage typically results in a total loss of the affected structure. No matter how well built, homes are reduced to a pile of debris. Even heavy vehicles can become airborne and flung some distance.

F5 damage is almost always total. F5 tornadoes demolish well-built houses and sweep the foundation clean. Since 1950, only 50 F5 tornadoes have been reported in the United States, and yet these have been responsible for more than 1,000 deaths. In recorded history, F5 tornadoes have performed awesome displays of power, including twisting skyscrapers, leveling entire communities, and stripping asphalt from the ground.

An example of **F4** damage. Above-ground structures are almost completely vulnerable to **F4** tornadoes, which level well-built structures, toss heavy vehicles through the air, and uproot trees, turning them into flying missiles.

An example of **F5** damage. These tornadoes cause incredible destruction, obliterating and sweeping away almost anything in their paths. Fortunately, they are extremely rare, and often only a small portion of the tornado's path contains **F5** damage.[5] While these tornadoes often destroy everything in their path, it is possible to survive. Some survived a direct hit by the Jarrell Tornado by lying down in a bathtub as the tornado swept the rest of the house away.[6]

Weak Tornadoes

- 69% of all tornadoes
- Less than 5% of tornado deaths
- Lifetime 1-10+ minutes
- Winds less than 110 mph

Strong Tornadoes

- 29% of all tornadoes
- Nearly 30% of all tornado deaths
- May last 20 minutes or longer
- Winds 110-205 mph

Violent Tornadoes

- Only 2% of all tornadoes
- 70% of all tornado deaths
- Lifetime can exceed 1 hour
- Lifetime can exceed 1 hour

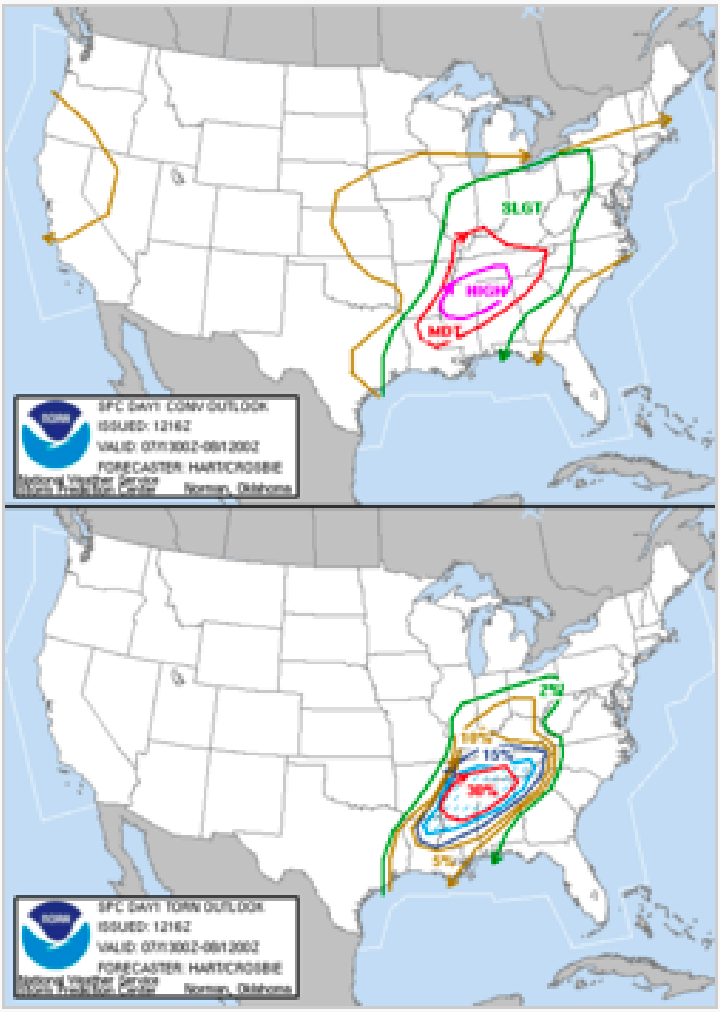
Source: NOAA

Tornado Forecasting

Until the 1950s, you would never see the word "tornado" in a weather forecast. Tornado watches and warnings were unheard of because of fear that predicting tornadoes might cause panic. Now, the National Weather Service issues more than 1,000 watches and nearly 30,000 warnings for severe storms and tornadoes each year. The average lead time for warnings increased to 13 minutes by 2006.

NOAA's Storm Prediction Center (SPC) in Norman, Okla., is responsible for hazardous-weather forecasting across the contiguous United States and supports NWS Forecast Offices by providing short-to-medium range guidance and watch products.

Every tornado and severe thunderstorm watch issued in the U.S. originates at the SPC. Watches issued by the SPC are disseminated through local National Weather Service Forecast Offices.



Probabilistic maps issued by the Storm Prediction Center during the heart of the April 6-8, 2006 Tornado Outbreak. The top map indicates the risk of general severe weather (including large hail, damaging winds, and tornadoes), while the bottom map specifically shows the percent risk of a tornado forming within 25 miles (40 km) of any point within the enclosed area. The hashed area on the bottom map indicates a 10% or greater risk of an F2 or stronger tornado forming within 25 miles (40 km) of a point.

National Weather Service Forecast Office issues severe weather forecasts and warnings. Warnings are issued when a severe thunderstorm or tornado is occurring or is imminent. Each NWS office uses output from at least one Doppler radar to help determine if a warning is needed. Doppler radar indicates strong winds blowing toward and away from it in a way that tells forecasters an intense circulation probably exists in the storm, and a tornado is possible. Possible doesn't mean certain, so local forecasters also depend on spotter reports.

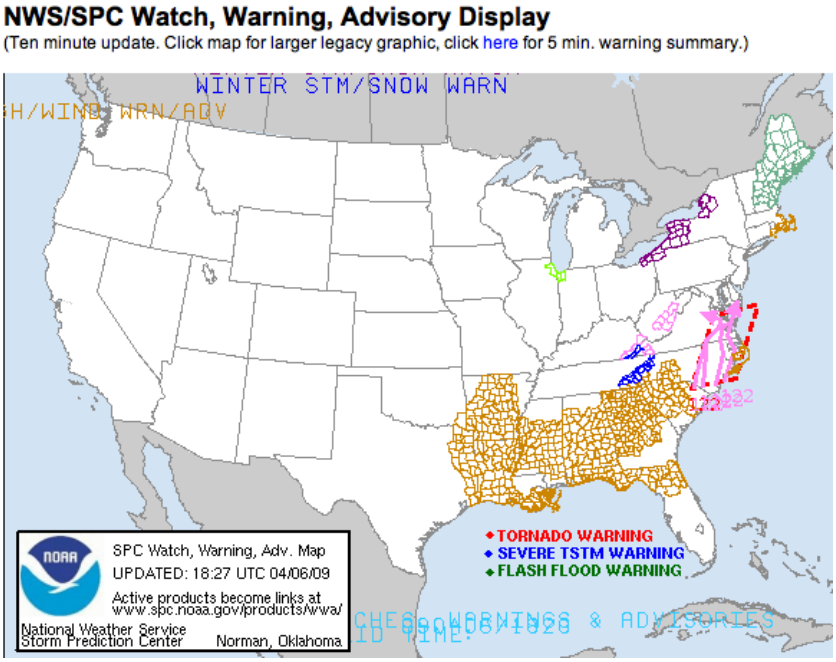
When predicting severe weather (including tornadoes) a day or two in advance, the NWS looks for the development of temperature and wind flow patterns in the atmosphere, which can cause enough moisture, instability, lift, and wind shear for tornadic thunderstorms. Those are the four needed ingredients.

A tornado *watch* means that conditions are favorable for the development of a tornado. Watches are issued by the SPC, usually for four to eight hour periods. A tornado *warning* means a tornado has been sighted or indicated by weather radar. Warnings are issued by the local NWS Forecast Office.

The first public tornado warnings were issued in 1950 and the first tornado watches and convective outlooks in 1952. In 1953, it was confirmed that hook echoes are associated with tornadoes. By recognizing these radar signatures, meteorologists could detect thunderstorms that were likely producing tornadoes from dozens of miles away.

In the mid 1970s, the NWS increased its efforts to train storm spotters to spot severe-weather signs indicating hail, damaging winds and tornadoes, as well as flood damage. When severe weather is anticipated, local weather service offices request these spotters observe and report any tornadoes immediately to assist the offices in issuing a timely warning.

Storm spotters are trained to identify supercell storms. The vast majority of intense tornadoes occur within a wall cloud on the backside of a supercell. Only wall clouds that rotate spawn tornadoes, and they usually precede the tornado by five to thirty minutes. Tornadoes may also occur without wall clouds, under flanking lines, and on the leading edge. Spotters watch all areas of a storm, as well as the cloud base and surface.



Tornadoes in the United States

The United States has the most tornadoes of any country. Over the last ten years, an average of 1,200 tornadoes occurred across the continental United States. This is mostly due to the unique geography of the continent. North America is a relatively large continent that extends from the tropical south into arctic areas and has no major east-west mountain range to block air flow between these two areas. Nearly a third of the tornadoes occur in Texas, Oklahoma, Kansas, and Nebraska, an area known as "Tornado Alley." In this area during the springtime and early summer, conditions combine for the formation of supercell thunderstorms and tornadoes. Over 55% of a year's tornadoes occur between the months of April and June, when cool, dry air from Canada clashes with warm, moist air from the Gulf of Mexico. The most tornadoes in one year occurred in 2004, when 1,819 tornadoes were reported.

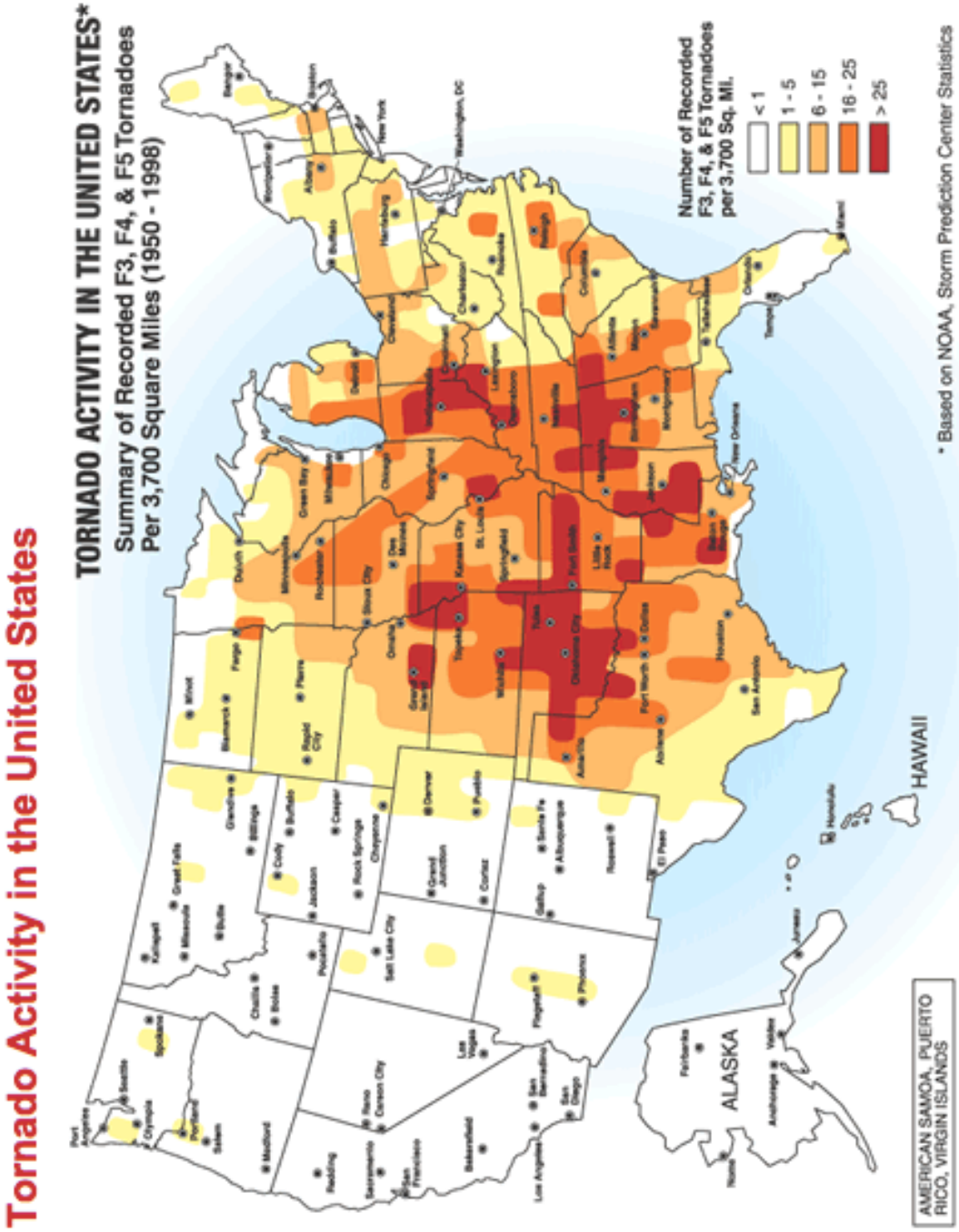
The deadliest tornado in the United States was the "Tri-state" tornado of March 18, 1925. It killed 695 people as it raced along at 60-73 mph in a 219 mile long track across parts of Missouri, Illinois and Indiana. This tornado also holds the record for the most tornado fatalities in a single city; at least 234 people died in Murphysboro, Illinois.

The largest tornado outbreak occurred on April 3 and 4, 1974. This tornado outbreak, known as the "Super Outbreak," produced 148 tornadoes in less than 24 hours from Michigan to Alabama. Ohio was one of the hardest hit states. The Super Outbreak is discussed in more detail in the Ohio Tornado History section of this document.

One of the largest known tornados is the Hallam, Nebraska, F4 tornado of May 22, 2004. It is the record holder for width at 2.5 miles. The Tri-state tornado holds the record for longest path, 219 miles. The strongest tornado wind speed ever recorded was 318 mph at Bridge Creek, Oklahoma. However, ground speeds of the most violent tornadoes have never been directly measured because they destroyed weather instruments.

Tornadoes routinely cause millions of dollars in property damage; the 10 costliest tornadoes alone have caused nearly $6 billion in damage. The costliest tornado outbreak occurred in 1999 in Oklahoma. From May 3 to May 6, more than 66 tornadoes tore through the state. The largest one destroyed more than 10,500 buildings, killed 42 people, and caused $1.1 billion in damages. This is the tornado mentioned above that struck Bridge Creek, Oklahoma.

American tornadoes are still killers, but they cause significantly fewer deaths today than in the previous century. The last tornado to kill more than 100 people happened over 50 years ago in Flint, Michigan. Forecast and warning systems have improved over the years, and with increased awareness and education have saved lives.


Tornado Activity in the United States
TORNADO ACTIVITY IN THE UNITED STATES*
Summary of Recorded F3, F4, & F5 Tornadoes
Per 3,700 Square Miles (1950 - 1998)
Number of Recorded
F3, F4, & F5 Tornadoes
per 3,700 Sq. Mi.
< 1
1 - 5
6 - 15
16 - 25
> 25
* Based on NOAA, Storm Prediction Center Statistics
HAWAII
ALASKA
AMERICAN SAMOA, PUERTO
RICO, VIRGIN ISLANDS

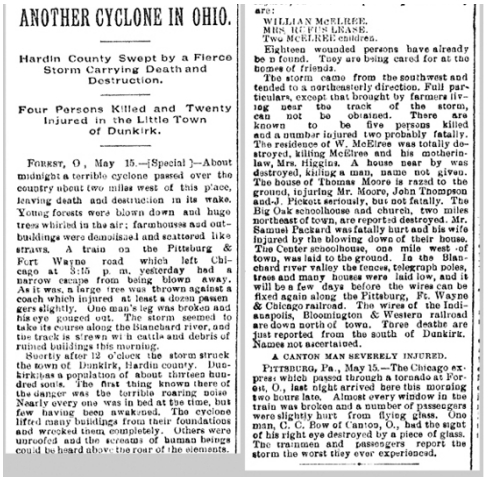
Tornadoes in Ohio

Ohio is no stranger to tornadoes. Located on the eastern edge of Tornado Alley, Ohio averages 16 tornadoes a year. The peak tornado season for Ohio is April through July. June has the most tornado occurrences, but many of the state's major tornado outbreaks have taken place in April and May. Most tornadoes occurred between 2 and 10 p.m. However, history has proven that tornadoes can occur during any month of the year at any time of the day or night.

Significant Tornado Events in Ohio

May 14, 1886 was a deadly month in Ohio weather. Floods killed 28 people at Xenia on May 12, and two days later, on May 14, Ohio's deadliest tornado outbreak of the 19th century occurred. Three separate tornadoes cut a path 110 miles long, killing 17 people, in Mercer, Wyandot and Seneca counties.

Notice the headline from the Cleveland Plain Dealer. The storm was called a cyclone, not a tornado. At that time the word tornado was not used for fear of causing panic.



ANOTHER CYCLONE IN OHIO.

Hardin County Swept by a Fierce Storm Carrying Death and Destruction.

Four Persons Killed and Twenty Injured in the Little Town of Dunkirk.

FOREST, O., May 15.—[Special.]—About midnight a terrible cyclone passed over the country about two miles west of this place, leaving death and destruction in its wake. Young forests were blown down and huge trees whirled in the air; farmhouses and outbuildings were demolished and scattered like straws. A train on the Pittsburg & Fort Wayne road which left Chicago at 8:15 p. m. yesterday had a narrow escape from being blown away. As it was, a large tree was thrown against a coach which injured at least a dozen passengers slightly. One man's leg was broken and his eye gouged out. The storm seemed to take its course along the Blanchard river, and the track is strewn with cattle and debris of ruined buildings this morning.

Shortly after 12 o'clock the storm struck the town of Dunkirk, Hardin county. Dunkirk has a population of about thirteen hundred souls. The first thing known there of the danger was the terrible roaring noise. Nearly every one was in bed at the time, but few having been awakened. The cyclone lifted many buildings from their foundations and wrecked them completely. Others were unroofed and the screams of human beings could be heard above the roar of the elements.

are:
WILLIAM McELREE.
MRS. HUGHS LEASE.
Two McELREE children.

Eighteen wounded persons have already been found. They are being cared for at the homes of friends.

The storm came from the southwest and tended to a northeasterly direction. Full particulars, except that brought by farmers living near the track of the storm, can not be obtained. There are known to be five persons killed and a number injured two probably fatally. The residence of W. McElree was totally destroyed, killing McElree and his mother-in-law, Mrs. Higgins. A house near by was destroyed, killing a man, name not given. The house of Thomas Moore is razed to the ground, injuring Mr. Moore, John Thompson and J. Pickett seriously, but not fatally. The Big Oak schoolhouse and church, two miles northeast of town, are reported destroyed. Mr. Samuel Packard was fatally hurt and his wife injured by the blowing down of their house. The Center schoolhouse, one mile west of town, was laid to the ground. In the Blanchard river valley the fences, telegraph poles, trees and many houses were laid low, and it will be a few days before the wires can be fixed again along the Pittsburg, Ft. Wayne & Chicago railroad. The wires of the Indianapolis, Bloomington & Western railroad are down north of town. Three deaths are just reported from the south of Dunkirk. Names not ascertained.

A CANTON MAN SEVERELY INJURED.

PITTSBURG, Pa., May 15.—The Chicago express which passed through a tornado at Forest, O., last night arrived here this morning two hours late. Almost every window in the train was broken and a number of passengers were slightly hurt from flying glass. One man, C. C. Bow of Canton, O., had the sight of his right eye destroyed by a piece of glass. The trainmen and passengers report the storm the worst they ever experienced.

Cleveland Plain Dealer, Saturday evening, May 15, 1886.

Ohio Historical Society microfilm collection, roll #37131

March 28, 1920 was the first of two Palm Sunday tornado outbreaks to hit Ohio. This outbreak of 30 tornadoes across eight states killed 153 people. Four killer tornadoes moved into western Ohio from Indiana and another moved across Wood and Ottawa Counties. There were 29 deaths in Ohio from these tornadoes.

March 28, 1920: Western Tornadoes

TOLEDO BLADE. HOME EDITION

RECONSTRUCTION WORK STARTS IN STORM AREA WHERE 22 DIED

DEADLOCK ON WAGE BOOST

DANES DEMAND REPUBLIC BE ESTABLISHED

TWO WRECKED HOMES NEAR DEFIANCE

WORKERS START MOVING DEBRIS IN GALE'S WAKE

Nurses With Auto Laden With Relief Supplies Sent From Toledo to Help Sufferers

PALMER-BLAIR IN $225,000 DEAL

DEFENDS FIRM ROLE OF IRISH

DEATH TAKES 158 IN SUNDAY STORM

June 28, 1924, the deadliest tornado in Ohio history struck Lorain and Sandusky. It struck an urban area where 85 people were killed, 72 in Lorain. Buildings were damaged for 35 blocks along Broadway and at least 200 automobiles were buried in bricks and rubble. More than 1,000 homes were damaged and 500 destroyed in Lorain. The death toll of 15 in the State Theater is the most ever killed by a tornado in one building in Ohio.

June 28, 1924: Lorain Tornado

First Congregational Church, Lorain

Ohio Historical Society collection

Call Number: SC 169

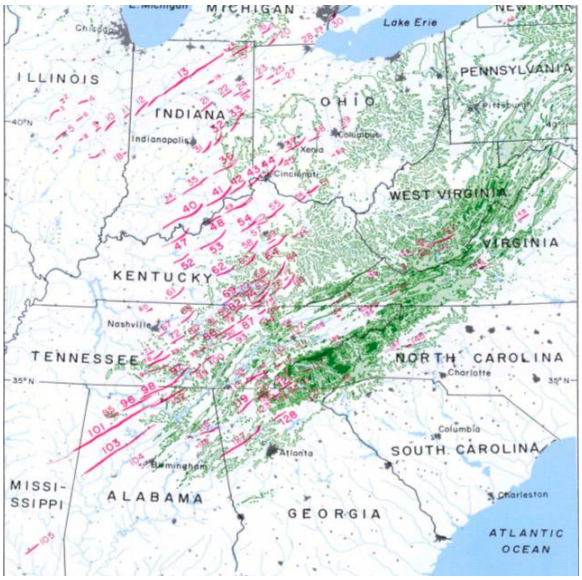
April 11, 1965 was the second Palm Sunday tornado outbreak. Thirty-seven tornadoes killed 256 people, mostly in Ohio, Michigan, and Indiana. The 55 people killed in Ohio made this the second deadliest tornado day in Ohio history, after the 1924 Lorain tornado. Nineteen tornadoes in this outbreak were of F4 or F5 intensity, with the strongest tornadoes occurring in Elkhart, Indiana and Strongsville, Ohio. Damage estimates were over $200 million for the event.

April 11, 1965: Palm Sunday Tornadoes

Twin funnels in Elkhart, Indiana on April 11, 1965. A double tornado was also sighted nea Toledo during this tornado outbreak.

Photo courtesy of National Oceanic and Atmospheric Administration/ Department of Commerce

April 3 - 4, 1974 the most intense and widespread tornado outbreak in recorded history occurred. Known as the Super Outbreak, a total of 148 tornadoes spanned 13 states, producing about 900 square miles of tornado damage in less than 18 hours.



This tornado outbreak represented a rare occurrence. Several factors came together at the right time to allow for the magnitude of the outbreak. These factors include: (1) the location and energy of the upper level wave (disturbance) with respect to the surface low pressure region; (2) the relatively warm Gulf region providing an abundance of warm, moist surface air; (3) the extent of the upper level dry air and the resulting subsidence (lid effect); and (4) the extent of the solar heating. Take away one or more of these factors and the enormity of the outbreak would likely have been greatly reduced. Speculation is that it might be several hundred years before such a confluence of factors occurs again.

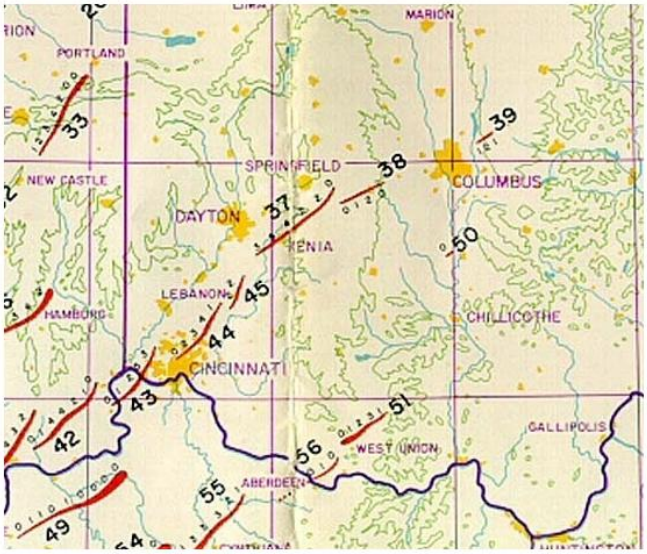
The most deadly tornado in the entire Super Outbreak devastated Xenia (pop 25,000) in Greene County, Ohio, shortly after 3:30 p.m. Thirty-four people were killed and more than 1,600 injured. The F5 tornado destroyed around 1,300 buildings and damaged 2,000 others, causing losses of over $130 million.

The Xenia tornado was rated an F5. It was one of two F5s that affected Ohio during the outbreak, the other struck the Cincinnati area and was known as the Sayler Park tornado.

In Ohio, 12 tornadoes touched down, killing 36 people. The last tornado in the outbreak touched down in Franklin County, just west of New Albany (number 39 on the map). This tornado destroyed one home and three barns and damaged 20 houses along a 25 mile path.

Twenty-six years later, on September 20, 2000, Xenia was hit again. This time an F4 tornado struck at an unusual time, in autumn after dark. This tornado cut a path roughly parallel to and just north of the 1974 tornado, killing one, injuring nearly 100, and damaging over 300 homes. Some homes damaged or destroyed in the 1974 tornado were hit again.

April 3, 1974: Xenia Tornado



Tornado tracks of the historic 1974 Tornado Superoutbreak. This outbreak included the devastating storm that nearly destroyed Xenia, Ohio. This storm killed 30, injured 1100, and destroyed over 1000 homes. NWS/Forecast Offices and River Forecast Centers; WFO Wilmington, Ohio.

Xenia, named after the Greek word for "hospitality," has a long history of severe storms going back to the early 1800s. Local records show 20 tornadoes in Greene County since 1884. It is said that before the area now known as Xenia was settled, the Shawnee tribe who lived close by referred to the area as the "Land of Devil Winds" and refused to settle there.

EF5 Tornado Damage - Xenia, Ohio **04/03/1974**

Photographer's description not available.

Photographer	Unknown, Berrien County Michigan Emergency Management
Date taken	Unknown
Location	Xenia, OH (Greene County) map
Event	Tornado damage

EF3 Tornado Damage - Xenia, Ohio **09/20/2000**

Photographer's description: This photo was taken September 21, 2000. Xenia, Ohio. The building was Grocery Land, a grocery collapsed by the storm with a person trapped in building. The rescue crew I was assigned with searched the building for the person who used his cell phone to report his location behind coolers . Dayton Police canine searched the building, however, the trapped person self extricated himself from building. Notice the undisturbed soft drinks on shelves.

Photographer	Don Parker, Dayton Skywarn Coordinator
Date taken	September 21, 2000
Location	Xenia, Ohio (Greene County) map
Event	Tornado damage

The 1974 Super Outbreak was especially significant for several reasons. Prior to the 1974 Super Outbreak, researchers were unable to characterize the intensity distribution within a tornado's path. Fujita's extensive aerial survey after the outbreak provided the necessary data to develop an empirical relationship for the width of each F-scale damage area within a tornado path. This survey data provided a new means for assessing tornado intensity probabilities that accounted for the gradation of damage within the tornado path. To this day, this relationship remains the basis for estimating the intensity distribution within tornadoes. (RMS special report)

Research from the 1974 event also provided further evidence of intense vortices embedded inside a tornado and led to the discovery of downbursts (small scale damaging downdrafts) that were recognized as the cause of several major airline accidents in the following decade.

In addition to the scientific advances, the outbreak also led to NOAA's rapid expansion of its weather radio network. During the 1974 event, tornado warnings were being posted so frequently, they could not be transmitted from the NWS offices fast enough using teletype. Commercial radio stations also had difficulty re-transmitting the information. After the outbreak, NOAA initiated an immediate expansion of its weather radio network across the country, along with a modernization program that allowed the National Weather Service to adopt new technology, improving weather warning lead-times and accuracy.

There have also been great advances in weather radar capabilities since 1974. At that time, NWS forecasters could see only green blobs on their radar scopes and relied on visual confirmation to issue tornado warnings. The NWS depended on 1950s and 1970s vintage radar technology to operate a combination of network and local warning radars to monitor weather systems. They were obsolete and difficult to service, and large areas were not served by any NWS radar.

Source: NWS Wilmington OH

After a $4.5 billion modernization program and explosive growth in technology, today's NWS has significantly advanced its warning capabilities. NWS forecasters now warn of severe weather events threatening life and property using Doppler Weather Surveillance Radars. Doppler radar observes the presence and calculates the speed and direction of severe weather elements such as tornadoes and thunderstorms. They also provide quantitative area precipitation measurements, important in hydrologic forecasting of potential flooding. The severe weather and motion detection capabilities offered by radars contribute toward an increase in the accuracy and timeliness of NWS warning services. (NOAA and the 1974 Tornado Outbreak – Radar Technology Then and Now)

May 31, 1985, 14 killer tornadoes struck northeastern Ohio, western Pennsylvania, and southern Ontario. With 11 dead in Trumbull County, Ohio, this was Ohio's deadliest tornado outbreak since the Xenia Tornado of 1974. The most famous Ohio tornado of this outbreak touched down in Portage County and cut a 47 mile path through Newton Falls, Niles, and Hubbard before entering Pennsylvania. This was the only F5 tornado in the United States in 1985.

This video still shows a beam that penetrated the roof of a residence during the tornado.
Video still courtesy of WBNS-TV Film Archives Department

July 12, 1992, 28 tornadoes occurred in Ohio, the most recorded in a single day. They also contributed to the July 1992 record of 44 tornadoes in one month and a record annual total of 61 tornadoes. Fortunately, summer tornadoes tend to be weaker than spring storms and none of the 44 tornadoes were violent. There were no fatalities and only 36 injuries from this record number of tornadoes.

April 9, 1999, a tornado struck the Cincinnati area in the early morning hours. It killed four people in the Blue Ash and Montgomery area. The storm was classified as an F4. Two fatalities were in vehicles and two others in homes. The storm was a quarter mile wide and destroyed 91 homes and apartments and 37 businesses in Hamilton County. Another 674 homes and apartments and 44 businesses were damaged. Several homes, garages and barns were damaged in Warren County.

Photographer's description not available

Photographer	Mary Jo Parker, NWS Wilmington, OH
Date taken	April 9, 1999
Location	Blue Ash, Ohio (Hamilton County) map
Event	Tornado damage

November 10, 2002, an F4 tornado moved through Van Wert, Ohio, destroying the entire northwest corner of the city. This tornado was part of a large outbreak of 70 tornadoes occurring over two days. Four people died and 26 were injured. The storm caused $490 million in damages.

The manager of a Van Wert movie theater received a tornado warning through a system directly tied to the Van Wert County siren system. He and his staff got more than 50 people to safety in hallways and restrooms. The theater was destroyed. The county had just become a Storm Ready county on January 22, 2002, which was credited with saving many lives.

Tornadoes in Franklin County

The National Weather Service National Climatic Data Center reported 26 tornadoes in Franklin County from 1954 through 2008. There were five tornadoes reported in 1973, the most of any year, followed by 2006 with three tornadoes.

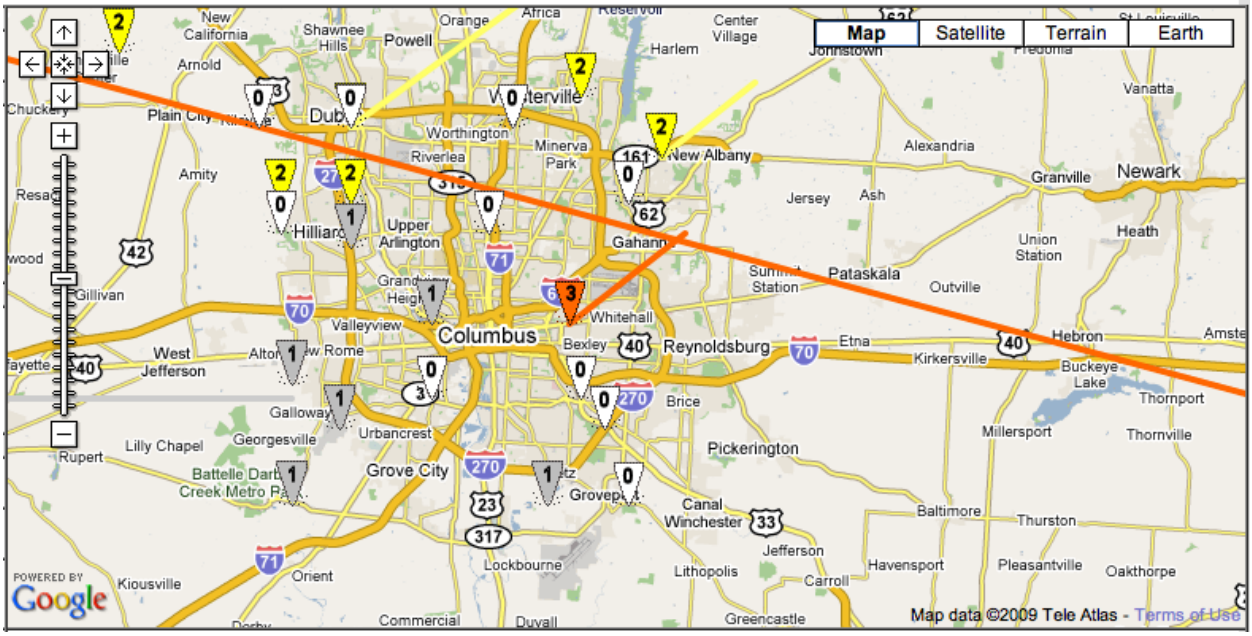
26 TORNADO(s) were reported in **Franklin County, Ohio** between **01/01/1950** and **12/31/2008**.

*Click on **Location or County** to display Details.*

Mag: Magnitude
Dth: Deaths
Inj: Injuries
PrD: Property Damage
CrD: Crop Damage

Ohio

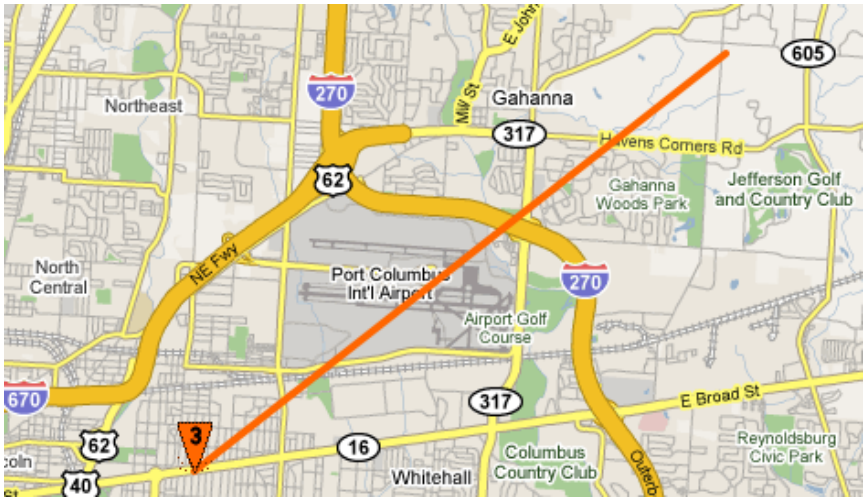
Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 FRANKLIN	06/26/1954	1115	Tornado	F0	0	0	25K	0
2 FRANKLIN	10/11/1954	1730	Tornado	F1	0	0	3K	0
3 FRANKLIN	04/28/1958	0545	Tornado	F1	0	0	25K	0
4 FRANKLIN	07/05/1959	1520	Tornado	F1	0	0	3K	0
5 FRANKLIN	07/28/1961	2230	Tornado	F0	0	0	25K	0
6 FRANKLIN	09/12/1963	1245	Tornado	F0	0	0	3K	0
7 FRANKLIN	04/02/1970	0706	Tornado	F2	0	0	250K	0
8 FRANKLIN	02/22/1971	1555	Tornado	F3	0	7	2.5M	0
9 FRANKLIN	05/08/1973	1310	Tornado	F2	0	0	250K	0
10 FRANKLIN	05/10/1973	1800	Tornado	F3	0	3	3K	0
11 FRANKLIN	05/25/1973	1730	Tornado	F2	0	0	250K	0
12 FRANKLIN	05/30/1973	1255	Tornado	F2	0	1	2.5M	0
13 FRANKLIN	07/26/1973	1500	Tornado	F1	0	0	0K	0
14 FRANKLIN	04/03/1974	1605	Tornado	F2	0	0	250K	0
15 FRANKLIN	06/17/1975	1545	Tornado	F1	0	0	25K	0
16 FRANKLIN	09/11/1975	1840	Tornado	F1	0	0	25K	0
17 FRANKLIN	06/13/1981	1330	Tornado	F0	0	0	3K	0
18 FRANKLIN	08/07/1984	1300	Tornado	F1	0	0	250K	0
19 FRANKLIN	06/10/1986	1750	Tornado	F1	0	0	250K	0
20 FRANKLIN	06/02/1991	1600	Tornado	F0	0	0	25K	0
21 FRANKLIN	08/27/1992	1550	Tornado	F0	0	0	25K	0
22 Dublin	07/02/1997	05:30 PM	Tornado	F0	0	0	30K	0
23 Grove City	08/28/2006	06:10 PM	Tornado	F0	0	0	1K	0
24 Bexley	08/28/2006	06:28 PM	Tornado	F0	0	0	1K	0
25 New Albany	10/11/2006	17:49 PM	Tornado	F2	0	0	50.0M	0K
26 Mudsock	05/11/2008	12:12 PM	Tornado	F0	0	0	5K	0K



Map of Franklin County Tornadoes, The Tornado History Project

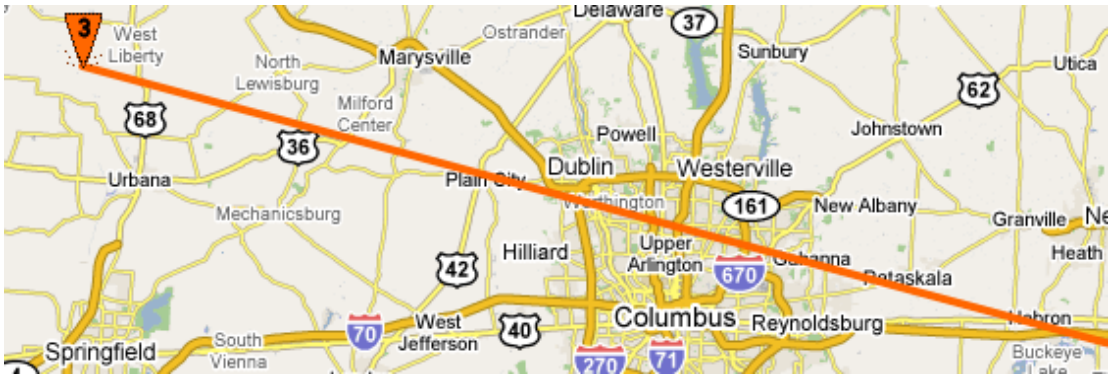
(Note: The tornadoes are scattered throughout the entire county.)

The strongest tornadoes reported in the county were F3s. One on February 22, 1971, moved northeast across the east side of Columbus, near Port Columbus through Gahanna. The path of this tornado was 7 miles long and 100 yards wide. Seven people were injured and $2.5M in damage was reported. Below is a map of the path of this tornado.



May 8, 1971 tornado, The Tornado History Project

The other F3 tornado to touch down in Franklin County was two years later on May 10, 1973. This tornado entered the county north of Hilliard and moved through the northern suburbs of Columbus, Gahanna and Pataskala, lifting up on the Licking/Perry County line east of Buckeye Lake. This tornado appeared to skip throughout its path. The tornado was 300 yards wide and traveled 90 miles through five counties. Eight people were injured and damage was reported at $5K (map below). Note the direction of tornado path, northwest to southeast.



May 10, 1973 Tornado, The Tornado History Project

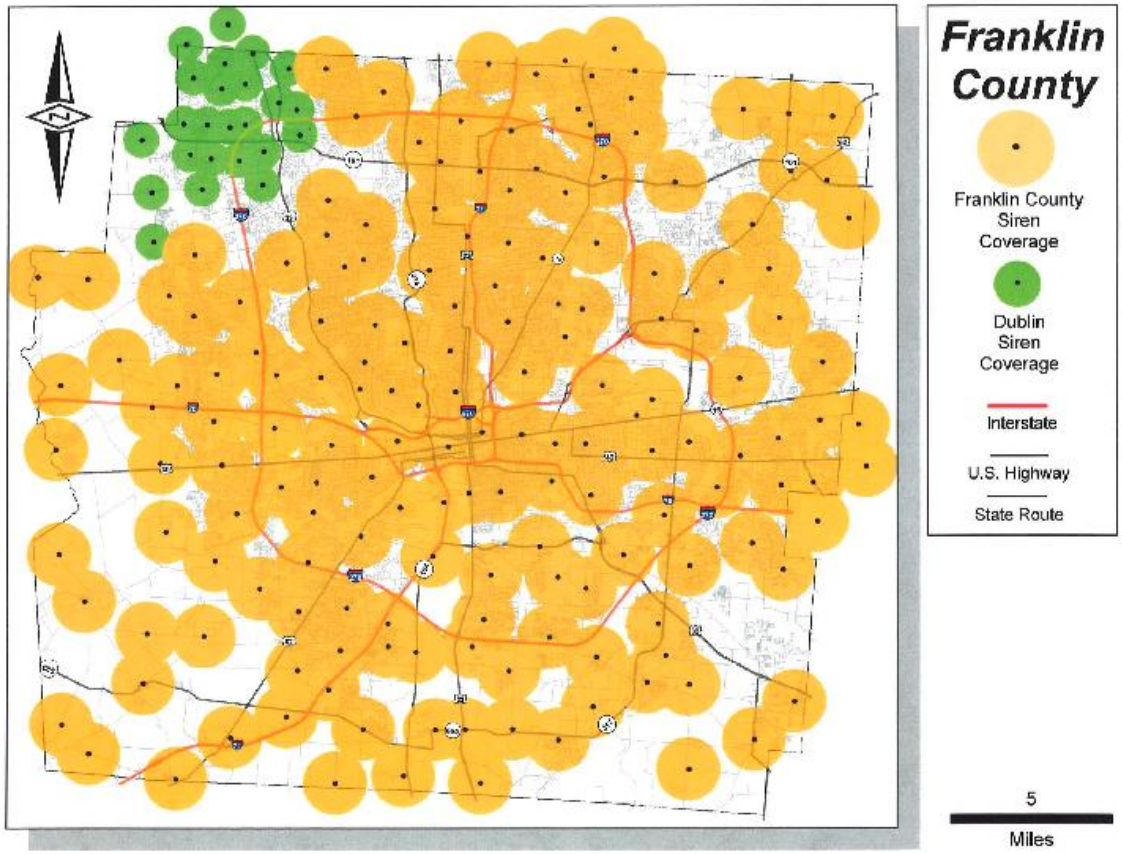
Six F2 tornadoes have been reported in Franklin County. One F2 tornado, on October 11, 2006, was one of the most expensive in damages. The tornado touched down and moved through the Upper Albany West subdivision one mile northwest of New Albany. Sixty-seven homes were damaged, sixteen of them severely, and an additional eight were destroyed. Many homes sustained significant roof, siding and window damage. Property damage was estimated a $50M.

Franklin County Outdoor Warning System

FCEM&HS OUTDOOR WARNING SYSTEM ACTIVATION POINT

At 172 sirens, Franklin County has one of the largest siren systems in Ohio. The system is complemented by 24 sirens operated by the City of Dublin, the yellow sirens on the map below.

The siren system is an outdoor warning system; the sirens are not intended to be heard indoors. The sirens are activated when the National Weather Service issues a tornado warning—when a tornado is occurring or imminent in Franklin County. Citizens are also strongly encouraged to purchase and use a Weather Alert Radio for reliable tornado watch and warning notifications when they are indoors.



Tornadoes – References

Analysis and Reconstruction of the 1994 Tornado Super Outbreak, Risk Management Solutions Special Report, 2004

Boruff, B.J, Easoz, J.A., Jones, D.D., Landry, H.R., Mitchem, J.D., Cutter, S. L., Tornado Hazards in the United States. Climate Research 24:103-117, 2003

Federal Emergency Management Agency, "Ohio Disaster History." [Online] 7 April 2009. http://www.fema.gov/news/disaster_state.fema?id=39

Franklin County Emergency Management and Homeland Security, Hazard Analysis for Franklin County 1996

Franklin County Emergency Management and Homeland Security, What You Need to Know About Tornadoes

NCDC – NOAA, "Query Results, Tornadoes, Franklin County, Ohio." [Online] 10 Apr 2009 http://www4.ncdc.noaa.gov/cgi-wincgi.dll?wwevent~storms

NOAA, Advanced Spotters Field Guide NOAA PA 92055

NOAA Basic Spotters Field Guide NOAA PA 97050

NOAA, "Enhanced F Scale for Tornado Damage." [Online] 19 Mar 2009 http://www.spc.noaa.gov/faq/tornado/ef-scale.html

NOAA, "Forecasting Tornadoes," [Online] 24 Mar 2009 http://www.publicaffairs.noaa.gov/grounders/tornadoforecast.html

NOAA, "Radar Technology – Then and Now," [Online] 7 Apr 2009 http://www.publicaffairs.noaa.gov/storms/radar.html

NOAA, "The Widespread Tornado Outbreak of April 3-4, 1974," [Online] http://www.publicafairs.noaa.gov/storms/discription.html

NSSL – NOAA, Tornadoes: Natures Most Violent Storms. USDC, NOAA-NWS, Sept 1992

NWS Norman Oklahoma, "Forecasting Tornadoes Today." [Online] 24 Mar 2009 http://www.srh.noaa.gov/oun/tornadodata/firstforecast/noaafacts.php

NWS Wilmington Ohio, "Franklin County Ohio Tornadoes." [Online] http://www.erh.noaa.gov/iln/tornado/franklin_oh.html

Ohio Committee for Severe Weather Awareness, "When Seconds Count Storm Ready Communities Are Prepared." [Online] 9 Apr 2009
http://www.weathersafety.ohio.gov/StormReady;aspx

OEMA, Hazard Identification and Risk Assessment, 2007

OEMA, State of Ohio Mitigation Plan, 2008

Ohio Insurance Institute, "Tornadoes in Ohio and U.S." [Online] 7 Apr 2009
http://ohioinsurance.org/factbook2001/chapter4

Ohio Historical Society, Ohio History Central, Numerous articles on specific tornado events in Ohio. http://www.ohiohistory.org http://ohiohistorycentral.org

Storm Prediction Center NOAA, "The Online Tornado FAQ." [Online] 19 Mar 2009
http://www.spc.noaa.gov/faq/tornado/

Tornado History Project, "Franklin County Query." [Online] 10 Apr 2009
http://www.tornadohistoryproject.com

Tornado Newspaper Archive, "American Tornado History." [Online] 6 Apr 2009
http://www.tornadoarchive.com/History.aspx

Severe Summer Weather: Thunderstorms, Lightning, Wind and Hail - #7

Contents

Hazard Profile....186
Thunderstorms....186
Lightning....189
Damaging Winds....190
Hail....192
Forecasting Severe Summer Weather....193
Severe Summer Weather in the United States....195
Severe Summer Weather in Ohio....197
Severe Summer Weather in Franklin County....200

Hazard Summary

Severe summer weather is classified as thunderstorms, hail, lightning and damaging wind. Each of these hazards has its own severity measure and often all four occur in one storm system, causing much more damage than each would have alone. Based on data from 1999 to 2008, Franklin County can undergo as many as 15 severe thunderstorm warnings each year. This hazard was ranked No. 7 out of 16.

Hazard Profile

Thunderstorms

Thunderstorms can occur at any time of the year and just about anywhere in the world. A thunderstorm forms when moist, unstable air is lifted vertically into the atmosphere. Every thunderstorm needs:

Moisture – to form clouds and rain,
Unstable air – warm air that can rise rapidly, and
Lift – cold or warm fronts, sea breezes, mountains, or the sun's heat capable of lifting air to help form the storm.

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. Thunderstorms are typically about 15 miles in diameter and last an average of 30 minutes. Regardless of their size, all thunderstorms are dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe.

A severe thunderstorm is a thunderstorm that contains one or more of the following three weather conditions:

- Hail that is ¾ of an inch or greater in diameter
- Winds 58 miles per hour or greater
- Tornadoes

Severe thunderstorms are the most prevalent during the spring and fall. Air mass thunderstorms are usually associated with certain geographic regions, and others are associated with frontal systems. An air mass thunderstorm is typically associated with a warm, moist air mass that is in place over a region and usually occurs during the summertime. Thunderstorms associated with approaching frontal systems are characteristically more severe than air mass thunderstorms.

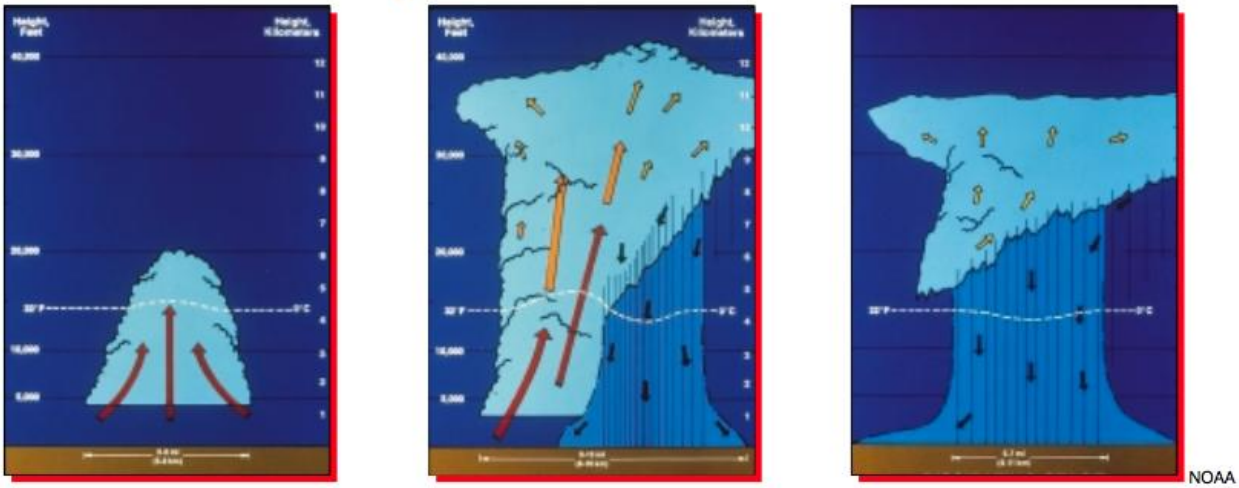
<u>Thunderstorm Life Cycle</u>

Thunderstorms go through a three-stage life cycle whether they become severe or not. The first stage is the cumulus, or development stage. At this stage, the storm consists only of updrafts (upward moving air currents). Updraft heights can reach 20,000 feet above the ground. As moisture becomes more plentiful, the base of the storm may lower. At this stage, parcels of warm humid air rise and cool to form clusters of puffy white cumulus clouds. Added heat energy from condensation and deposition keeps the air inside the cloud warmer than the air around it. The cloud continues to develop as long as more humid air is added to it from below. Updrafts dominate the patterns within the cloud.

The mature stage is the strongest and most dangerous stage of the storm's life cycle. At this stage, the storm contains both upward and downward moving air currents (updrafts and downdrafts), with precipitation in the downdraft area. The downdraft results from precipitation evaporating, which causes cooling. When the cool downdraft hits the ground, it spreads out and forms a gust front, which may include damaging winds called a downburst. At the top of the storm, the updraft rapidly decelerates, and clouds spread out to form an anvil. If the updraft is strong, a "bubble" of cloud, called an "overshooting top," will be pushed above the anvil.

During the third stage, the dissipating stage, excessive precipitation and downdraft weakens the updraft. Downdrafts dominate the storm, and any overshooting top disappears. At the surface, the gust front will move away from the storm and cut off the inflow of energy into the storm.

Life Cycle of a Thunderstorm



Developing Stage

- Towering cumulus cloud indicates rising air.
- Usually little if any rain during this stage.
- Lasts about 10 minutes.
- Occasional lightning.

Mature Stage

- Most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes.
- Storm occasionally has a black or dark green appearance.
- Lasts an average of 10 to 20 minutes but may last much longer in some storms.

Dissipating Stage

- Rainfall decreases in intensity.
- Can still produce a burst of strong winds.
- Lightning remains a danger.

Source: NOAA

Thunderstorm Categories

Single cell storms are generally weak, short-lived, and poorly organized. They usually do not produce violent weather on the ground. These are local, isolated thunderstorms, mostly occurring in the late afternoon and early evening, when surface temperatures are highest.

Multicell cluster storms are the most common type of storm and consist of a series of cells moving along as one unit. Within the cluster, one cell dominates for a time before weakening, and then another cell repeats the cycle.

Multicell line storms, commonly called "squall lines," consist of a long line of storms with a continuous gust front at the leading edge. In squall lines, thunderstorms form in an organized line and create a single, continuous gust front. The most intense region of convection tends to be rather narrow, and the line can extend for hundreds of miles. Squall lines contain numerous individual cells but can contain a few supercell storms.

Supercell storms have a single, intense updraft, are very strong, and always produce significant severe weather. When environmental winds are favorable, the updraft and downdraft of a storm become organized and twist around and reinforce each other. The result is a long-lived supercell storm. In the central United States, supercells typically have a broad, intense updraft that enters from the southeast and brings moist surface air into the storm. The updraft rises, rotates counterclockwise, and exits to the east, forming an anvil. Updraft speeds in supercell storms can exceed 130 feet per second and are capable of suspending hailstones as large as grapefruit. Supercells can last two to six hours. They are the most likely storm to produce spectacular wind and hail damage as well as powerful tornadoes.

Source: NOAA

Lightning

NOAA Photo Library, NSSL

Lightning occurs in all thunderstorms. It is estimated that lightning hits the Earth 100 times each second. That's 8.6 million strikes per day and over 3 billion each year. The frequency of lightning over land tends to peak in the mid-afternoon between 3:00 p.m. and 6:00 p.m. local time. Lightning is five times hotter than the sun. A single bolt can reach 50,000 degrees Fahrenheit.

Lightning is an electrical discharge produced to balance the differences between positive and negative charges within a cloud, between two clouds, or between a cloud and the ground. Rising and descending air within a thunderstorm separates these positive and negative charges. Water and ice particles also affect charge distribution.

Lightning Facts

- Lightning causes an average of 60 fatalities and 300 injuries each year.
- Lightning occurs in all thunderstorms; each year lightning strikes the Earth 25 million times.
- The energy from one lighting flash could light a 100-watt light bulb for more than 3 months.
- Most lightning fatalities and injuries occur when people are caught outdoors in the summer months during the afternoon or evening.
- Lightning can occur from cloud-to-cloud, within a cloud, cloud-to-ground, or cloud-to-air.
- Many fires in the western United States and Alaska are started by lightning.
- The air near a lightning strike is heated to 50,000°F – hotter than the surface of the sun. The rapid heating and cooling of the air near the lightning channel causes a shock wave that results in thunder.

A cloud-to-ground lightning strike begins as an invisible channel of electrically charged air moving from the cloud toward the ground. When one channel nears an object on the ground, a powerful surge of electricity from the ground moves upward to the clouds and produces the visible lightning strike. During a thunderstorm, not only is the ground positively charged, so is everything on it. The tallest object in the area is most likely to be struck, whether it is a building, a tree, or a person standing alone in a field.

Although cloud-to-ground lightning strikes pose the most danger to people on the ground, they make up only about 20% of all lightning strikes. The most common type of lightning in a thunderstorm is in-cloud lightning, which occurs within the cloud itself. Cloud-to-cloud lightning is a common occurrence in which opposite electrical charges in one cloud attract those in another.

Heat lightning has nothing to do with how warm temperatures are on a summer's night. It is actually lightning seen from a distant thunderstorm too far away for the thunder to be heard.

Damaging Winds

The rotating winds of tornadoes usually come to mind when thinking of the worst storm damage. However, high winds can cause damage whether they are rotating or going straight. In fact, straight-line winds are responsible for most thunderstorm wind damage and can exceed 100 mph.

Damage from a severe thunderstorm is far more common than damage from tornadoes. The paths of these storms could extend for hundreds of miles and create widespread damage. Severe thunderstorm wind damage accounts for half of all severe weather reports in the U.S. Winds meeting or exceeding 58 mph are categorized as severe.

Air moves up and down vertically in a thunderstorm. Updrafts (air moving up) tend to take warmer air aloft, while downdrafts (air moving down) tend to bring cooler air to the warmer surface. The stronger these updrafts and downdrafts are, the easier it is for the formation of strong straight-line winds. If the storm system as a whole is moving quickly, this will add to the strength of the straight-line winds. The speed of the downdraft will combine with the forward motion of the storm to create strong to severe winds out ahead of the storm.

The National Severe Storms Laboratory defines several types of damaging winds:

Straight–line winds – a term used to define any thunderstorm wind that is not associated with rotation and is used mainly to differentiate from tornadic winds.

Downdrafts – A small-scale column of air that rapidly sinks toward the ground. A downburst is a result of a strong downdraft.

Downbursts – A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst of damaging winds on or near the ground, similar to the way water comes out of a faucet and hits the bottom of the sink. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado.

Microbursts – A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally small, extending 2 ½ miles or less, lasting 5 to 15 minutes, with winds as high as 168 mph. Microbursts can be accompanied by heavy rain or with no rain in places like the high plains. Macrobursts are larger downbursts.

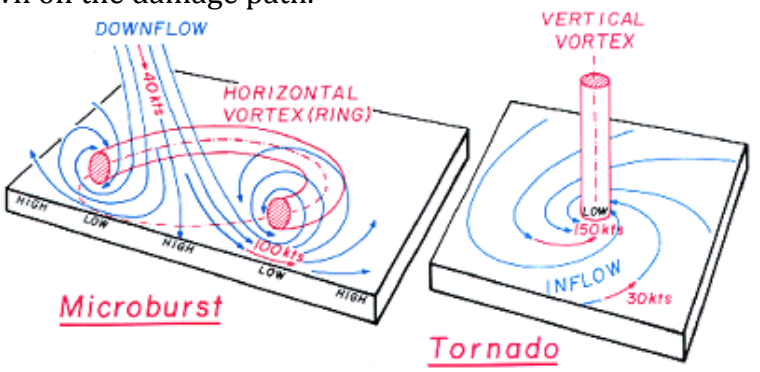
Gust Front – A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by wind shift, temperature drop, and gusty winds out ahead of the thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

Derecho – A derecho is a widespread thunderstorm/wind event caused when new thunderstorms form along the leading edge of an outflow boundary. The thunderstorms feed on this boundary and continue to reproduce themselves. Usually these thunderstorms produce heavy rain and severe wind reports as they rumble across several states during the night. They are particularly dangerous because the damaging winds can last a long time and can cover a large area.

Bow Echo – A radar echo which is linear but bent outward in a bow shape. Damaging straight-line winds often occur near the "crest" or center of a bow echo. Bow echoes can last for several hours and produce extensive swaths of wind damage at the ground.

Downburst or Tornado?
Downbursts and tornadoes both produce damaging winds. Tornado winds range from 40 to over 300 mph. Downburst winds can exceed 165 mph. Wind speeds of 75 mph or more, straight-line or tornadic, will often sound very loud, leading some to believe they heard a tornado when, in fact, they heard a straight-line wind.

The key difference is in two words – in and out. All wind flows into a tornado. Debris is often lying at angles due to the curving of the inflow winds. All wind flows out from a downburst. Debris is often lying in a straight line parallel to the outward wind flow. The best way to determine if damage was caused by a tornado or a downburst is to fly over the area and look down on the damage path.



Graphic by T. Fujita
Downburst

In this photograph, trees are blown down in a straight line - a very strong indication of a microburst as opposed to a tornado.

Graphic by T. Fujita
Downburst

According to forecasters at the Storm Prediction Center, severe wind is the most difficult threat to forecast because it comes from a wider range of environments than supercells, tornadoes, or large hail. Damaging winds can be produced by Mesoscale Convective Systems, squall lines, or even just a dying thunderstorm or hurricane, such as the remnants of Hurricane Ike in 2008.

Damaging wind events can develop with little advanced warning. In an extremely dry environment, little or no rain may reach the surface, but the wind may exceed hurricane force and may approach the speeds of a weak to moderate tornado. In a wet environment, the microburst may be embedded in heavy rain, but its onset may be so sudden that it can catch people unaware.

Wind Speed Estimates

Speed (MPH)	Effects
25-31	Large branches in motion; whistling in telephone wires
32-38	Whole trees in motion
39-54	Twigs break off trees; wind impedes walking
55-72	Damage to chimneys and TV antennas; pushes over shallow rooted trees.
73-112	Peels surface off roofs; windows broken; mobile homes overturned
113+	Roofs torn off houses; weak buildings and mobile homes destroyed; large trees uprooted

Hail

Hail is a form of precipitation that occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere, where they freeze into ice. Hail forms only in thunderstorms, in huge cumulonimbus clouds that contain vast amounts of energy in the form of updrafts and downdrafts. Hail formation requires air moving up (thunderstorm updraft) that keeps the pieces of ice from falling. Drops of supercooled water hit the ice and freeze on it, causing it to grow. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth. The stronger the updraft, the larger the hailstone can grow.

There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few layers if they are "balanced" in an updraft. These layers are caused by the different rates of accumulation and freezing of supercooled water as the hailstone forms. The more supercooled water a hailstone makes contact with, the larger and heavier the stone is likely to become. When the hailstone becomes so heavy that the updraft can no longer support it, it falls from the sky.

Hail Size Comparisons

- Pea = ¼ inch diameter
- Marble/mothball = ½ inch diameter
- **Dime/Penny = ¾ inch diameter – hail penny size or larger is considered severe**
- Nickel = 7/8 inch
- Quarter = 1 inch
- Ping-Pong Ball = 1 ½ inch
- Golf Ball = 1 ¾ inches
- Tennis Ball = 2 ½ inches
- Tea cup = 3 inches
- Grapefruit = 4 inches
- Softball = 4 ½ inches

Hail size is estimated by comparing it to a known object. The NWS requests weather spotters not use the term "marble" when reporting ½ inch hail, since marbles can come in a variety of sizes.

Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail. The largest hailstone recovered in the U.S. fell in Aurora, NE on June 22, 2003. It had a diameter of 7 inches and a circumference of 18.75 inches.

A hailshaft is a column of hail falling from a single thunderstorm cell. The first sign that hail may be arriving is a growing whitening among the shafts of rain. Hail falls in paths known as hail swaths. They can range in size from a few acres to an area 10 miles wide and 100 miles long. Piles of hail in hail swaths have been so deep, a snowplow was required to remove them, and occasionally, hail drifts have been reported.

Forecasting Severe Summer Weather

Thunderstorm forecasting is very similar to the forecasting used to predict tornadoes. Three times daily, a severe weather outlook is issued on a nationwide basis indicating whether conditions are either favorable or unfavorable for thunderstorms to develop in specific regions in the United States.

To forecast thunderstorms, meteorologists use a variety of data. Surface and upper air observations are studied to find areas of low level moisture and instability, and to determine how winds aloft might influence storm development.

Satellite imagery is used to help track the movement of weather systems that might generate thunderstorms. Radar and satellites are used to trace the storms once they do form.

Meteorologists at the Storm Prediction Center in Norman, Oklahoma are tasked with monitoring for signs of severe thunderstorms and tornado development. They issue Severe

Thunderstorm Watches for areas where conditions are favorable for the formation of severe storms. Warnings are issued by local National Weather Service Forecast Offices.

Advanced Weather Radar Sees "Inside" the Storm

NOAA NOAA

Doppler Radars, which are being strategically deployed around the country, are capable of seeing "inside" a thunderstorm to detect hazardous weather conditions. In the photo at left, the bright green colors near the center indicate strong winds blowing from south to north. This storm produced wind damage to mobile homes and trees. At right, the same storm, but this radar display indicates precipitation intensity. Heaviest rainfall is in the red-shaded areas. Note the thin light blue line which nearly surrounds the storm. This marks the leading edge of the storm's cool-air outflow. New storms often form along this feature.

A well-defined gustfront/outflow boundary was associated with later tornado formation in this Missouri storm.

Doppler radar is also used to identify damaging wind hazards. Sometimes a thin line appears on the radar display indicating a gust front. Doppler radar velocity data can show areas of diverging winds at the surface and even the strength of those winds. Winds coming together at the upper levels of the storm can also be seen on velocity displays and can indicate the development of a microburst.

Source: NOAA – National Severe Storms Laboratory

Major airports routinely use Terminal Doppler Weather Radars to monitor weather conditions occurring within a few miles of the airport. Of special interest are conditions that might cause microbursts, which can be deadly to aircraft.

The possibility of lightning can be predicted, but it is impossible to forecast individual strikes since lightning is so widespread, frequent and random. Currently, cloud-to-ground

and intra-cloud lightning flashes are detected by antennas and mapped in real-time across the entire U.S. by the National Lightning Detection Network.

Weather spotters play a vital role in the warning and information process by observing storms and making reports back to the National Weather Service. Spotters are trained to identify and describe severe local storms. Spotter information, coupled with Doppler radar, satellite, and other data, has enabled the National Weather Service to issue more timely and accurate warnings to save thousands of lives.

Watches and Warnings

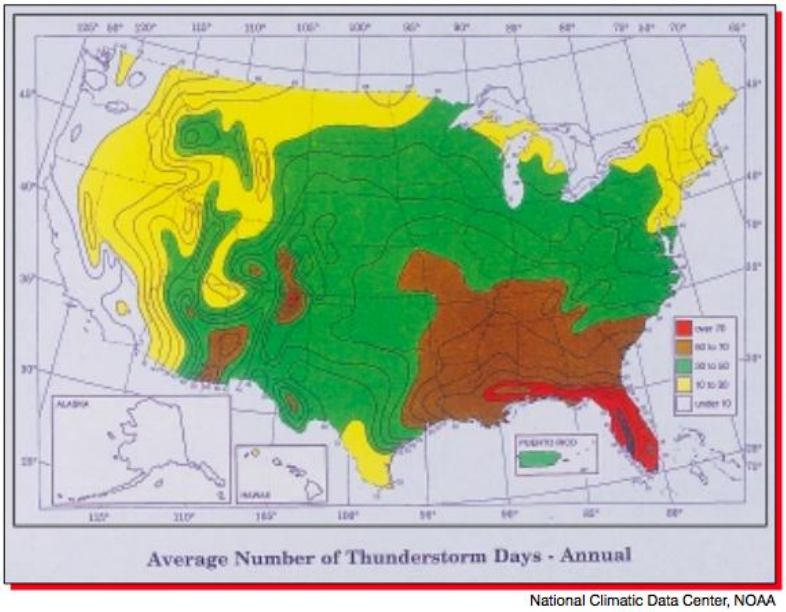
- **Severe Thunderstorm Watch** – Issued by the Storm Prediction Center when conditions are favorable for severe thunderstorm formation.
- **Severe Thunderstorm Warning** – Issued by local NWS Forecast Office when severe weather has been reported by spotters or indicated on radar. Warnings indicate imminent danger to life and property to those in the path of the storm.
- **High Wind Advisory** – Issued by the NWS when high wind speeds may pose a hazard.
- **High Wind Watch** – Issued by the NWS when there is the potential of high wind speeds developing that may pose a hazard or is life threatening.
- **High Wind Warning** – Issued by the NWS when high wind speeds may pose a hazard or is life threatening.

Criteria for wind advisories, warnings and watches vary from state to state.

Severe Summer Weather in the United States

Thunderstorms are known to occur in almost every region of the world. There are about 1,800 thunderstorms occurring at any one moment around the world, or 16 million a year.

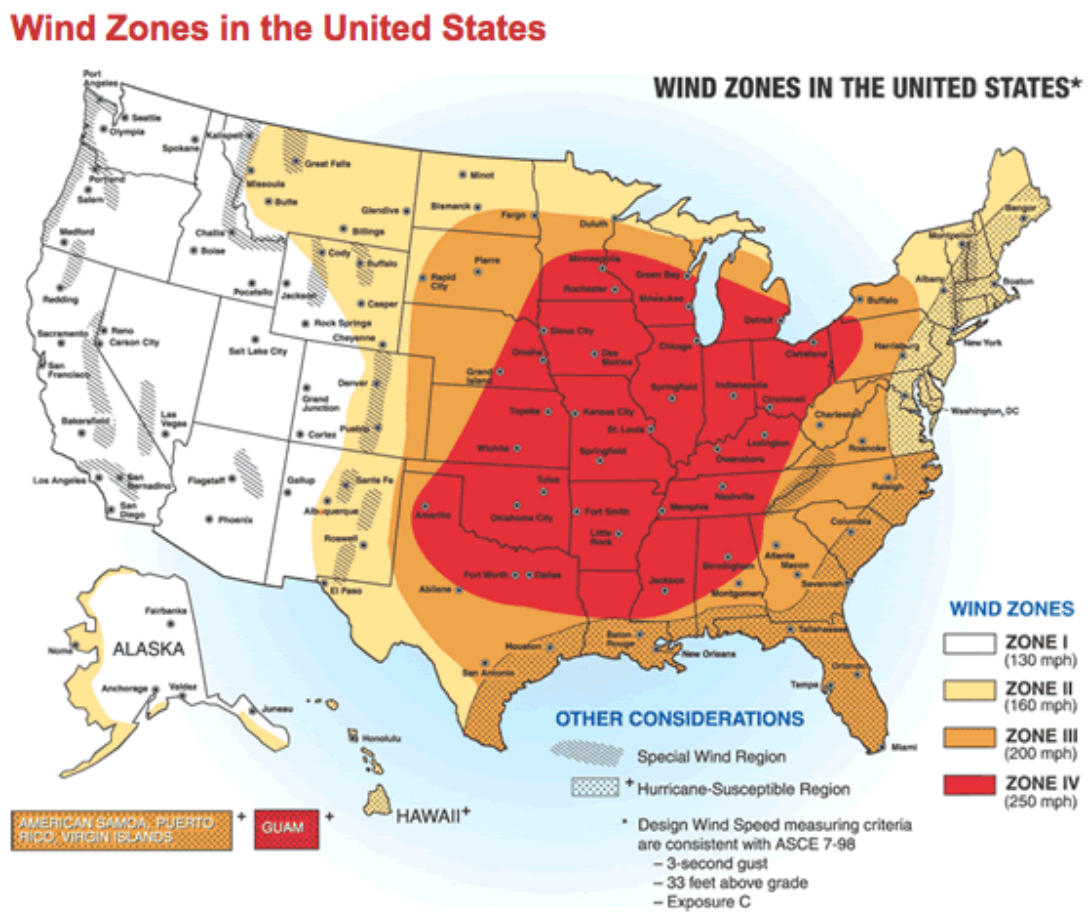
In the United States, the Florida peninsula and the southeast plains of Colorado have the highest thunderstorm frequency. Relatively small thunderstorms occur about once a year in Alaska and two to three times a year in the Pacific Northwest. Although the greatest severe weather threat in the United States extends from Texas to Minnesota, it is important to note that no place in the United States is completely immune to the threats of severe weather.



National Climatic Data Center, NOAA

Every year, most of the United States experiences about five cloud-to-ground lightning strikes per square mile. Most of the interior of the country east of the Rocky Mountains has about ten discharges per square mile. Maximum flash densities are found along the Gulf Coast and Florida peninsula, where over a year's time 25 strikes per square mile have been measured. More than 20 million cloud-to-ground flashes strike the United States annually, and lightning is clearly among the country's most severe weather hazards. An average of 300 people are injured and 60 people are killed each year in the U.S. by lightning.

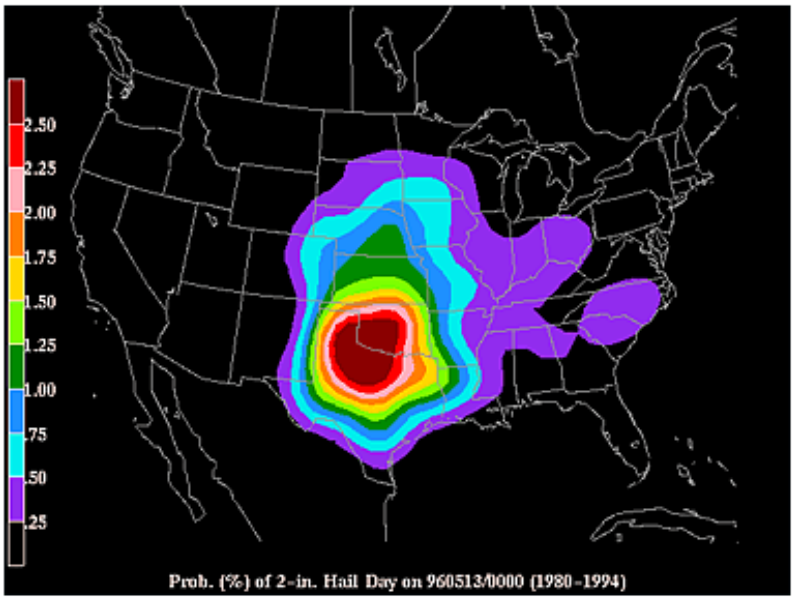
Damage from severe thunderstorm winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Since most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft, anyone living in thunderstorm-prone areas is at risk for experiencing this phenomenon.



Source: FEMA

Though Florida has the most thunderstorms, Nebraska, Colorado and Wyoming usually have the most hailstorms. The area where these three states meet – "hail alley," averages seven to nine hail days per year. The reason why this area gets so much hail is that the

freezing levels (the area of the atmosphere at 32 degrees or less) in the high plains are much closer to the ground than they are at sea level, where hail has plenty of time to melt before reaching the ground. Hailstorms may occur anywhere in the United States if convective activity and sufficient moisture are present and if the freezing level aloft is relatively low.



Source: NOAA National Severe Storms Laboratory

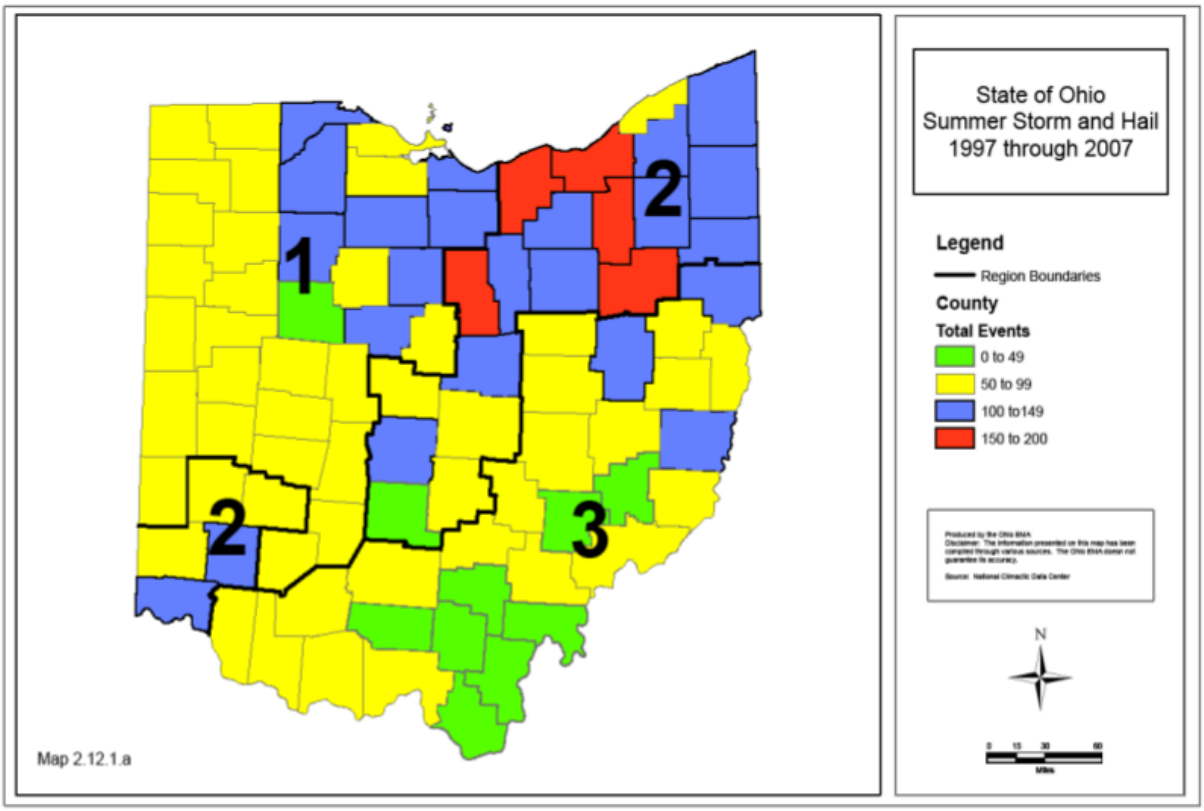
Severe Summer Weather in Ohio

Severe summer weather events – thunderstorms and lightning, wind and hail events – are common throughout Ohio and reported hundreds of times each year. From April 30, 1997, to April 30, 2007, over 5,000 summer storm events were reported by the National Climactic Data Center. Over 15,000 events were documented since 1950. Based on available data, severe summer storms are the most prevalent natural hazard in Ohio.

The five counties with the highest number of reported occurrences, 150 to 200 over 10 years, are Richland, Lorain, Cuyahoga, Summit and Stark. The area with the lowest reported occurrences is in south-central Ohio. Over half of the counties in Ohio have reported between 50 and 99 summer storm events over the course of 10 years. Based on the dispersion pattern (see map), proximity to Lake Erie appears to influence the number of summer storms.

From January 1997 to August 2007, 16 of 19 Presidential Declarations received by Ohio specifically cite severe storms as part of the description. Only in 1999 did Ohio not receive a federal declaration for severe storms. Historically, Ohio has experienced at least one storm every two years large enough to trigger a federal declaration.

Source: Ohio EMA



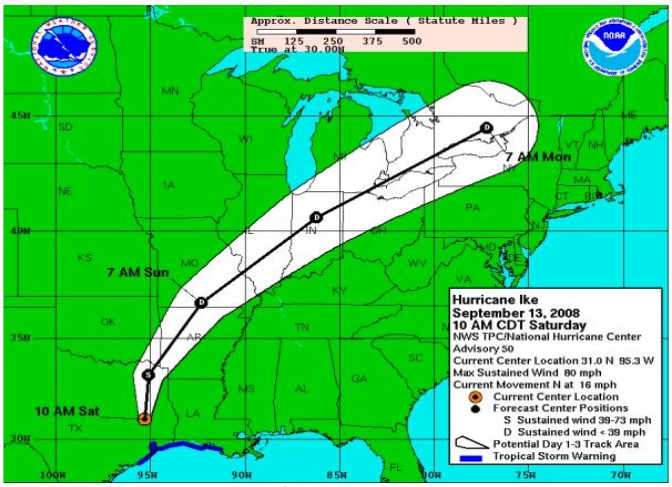
Hail has caused high-dollar damages in Ohio:

2001	Montgomery County	$ 70,000,000
2003	Franklin and Delaware Counties	$145,000,000
2006	Licking County	$100,000,000

On September 14, 2008, Ohio experienced a storm that did enough damage to rival that of the 1974 Xenia tornado. The remnants of Hurricane Ike merged with a frontal boundary across the lower Ohio Valley on Sunday morning. Due to the very low pressure of this system, the pressure gradient to the south and east of the surface low remained very tight as it raced into northwest Ohio through Sunday evening. This led to widespread damaging winds across much of the Ohio Valley, with gusts in excess of 70 mph reported.

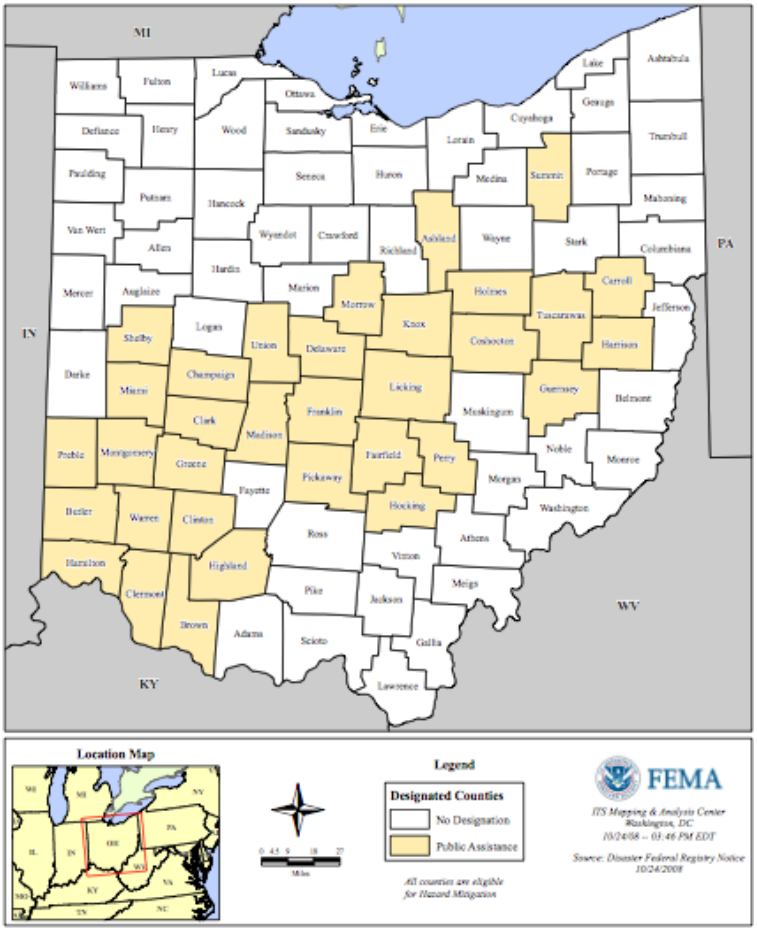
These severe winds persisted for several hours, which resulted in much more widespread damage than typical severe thunderstorm winds, which usually last a matter of minutes. The highest official measured gust was 79 mph at Dayton International Airport, and the highest unofficial measured wind gust was 84 mph in West Chester, Ohio. Winds of 75 mph were reported at Port Columbus International Airport. Initial damage total: $533,000,000.

The heaviest damage occurred roughly along a corridor extending along and just north of the Ohio River through Indiana and Kentucky, and along and just north of the I-71 corridor into Central Ohio. The Cincinnati, Columbus, and Dayton metro areas were all strongly impacted. Damage to trees and structures across this corridor was widespread, and there were numerous injuries. Damage on either side of this corridor was less severe and was mostly limited to large tree branches and a few power lines blown down.



Widespread power outages affecting more than 2.6 million people were reported, and numerous roads and highways were blocked or closed due to debris and fallen power lines. Three fatalities were reported in the Cincinnati area, one in Central Ohio and two in southeast Indiana. It was weeks before all power was restored.

FEMA-1805-DR, Ohio
Disaster Declaration as of 10/24/2008



Severe Summer Weather in Franklin County

Like Ohio, Franklin County is no stranger to severe summer weather. From January 1, 1950, to March 31, 2009, the National Climatic Data Center reported the following for Franklin County:

Thunderstorm/High Wind Events	
Number of Events	258
Deaths	4
Injuries	56
Damage	$138.085M
Lightning Events	
Number of Events	10
Deaths	4
Injuries	13
Damage	$25K
Hail Events	
Number of Events	120
Deaths	0
Injuries	0
Damage	$181.306M

Wind Damage - Lockbourne, Ohio **09/14/2008**

Photographer's description: A Shorts 330 aircraft operated by Air Cargo Carriers, a company that does contract work for UPS. It was overturned on the ramp at Rickenbacker Airport (KLCK) on Sunday afternoon. The photo was taken on Monday early evening from near the base of the control tower looking southwest. The aircraft was unattended and not tied down. It weighs approximately 15,000 lbs empty.

Photographer	David Penney - NWS Spotter
Date taken	September 14, 2008
Location	Rickenbacker Airport - Near Lockbourne, OH (Franklin County) map
Event	Wind damage

Source: NWS Wilmington Ohio

And like Ohio, the remnants of Hurricane Ike was one of the most damaging events for Franklin County. The National Climatic Data Center reported $128.7 million in damages for the county. Over 300,000 people were without power, some for over a week.

Wind Damage - Columbus, Ohio **09/14/2008**

Photographer's description: Tree of large circumference blown over onto power, cable and phone lines causing 2 utility poles to break on a residential street north of Ohio State University.

Photographer	James Delewese
Date taken	September 15, 2008
Location	Columbus, OH (Franklin County) map
Event	Wind damage

Source: NWS Wilmington Ohio

Franklin County Emergency Management and Homeland Security reported storm-related cost reimbursement from FEMA at over $3.7 million. The City of Columbus reported reaching nearly $4.3 million in storm related costs, most of it related to power failures, damaged equipment and buildings, and debris removal. Westerville led the suburbs with $406,188 in storm-related costs, more than half related to power failures.

Severe Summer Weather – References

Alexander, William H., Thunderstorms: Especially those of Ohio. Presidential Address delivered at the Cleveland meeting of the Ohio Academy of Science, Nov 1921

Columbus Dispatch, "Damage in Ohio from Hurricane Ike at $553 Million and Counting. ' [Online] 29 June 2009
http://www.dispatch.com/live/content/local_news/stories/2008/10/07/ikedamage.html

DiStefano, John T., Mesocyclone and RFD Induced Damaging Winds Observed in the 27 May 2004 Southwest Ohio Supercell. NWS Office, Wilmington Ohio

FEMA, "Thunderstorms and Lightning." [Online] 29 June 2009
http://www.fema.gov/plan/prevent/saferoom/tsfsp2/wnd_zones.shtm

FEMA, "Wind Zones in the U.S." [Online] 23 June 2009
http://www.fema.gov/hazard/thunderstorm/omdex/shtm

NCDC, Query Results – Hail Franklin County

NCDC, Query Results – Lightning Franklin County

NOAA – NWS, Advanced Spotter Field Guide NOAA PA 92055

NOAA – NWS, Basic Spotter Field Guide NOAA pa 97050

NOAA – NWS, Columbia SC. "Downbursts" [Online] 27 June 2009
http://www.erh.noaa.gov/cae/svrwx/downburst.htm

NOAA, "Severe Weather." [Online] 24 June 2009
http://www.noaawatch.gov/themes/severe.php

NSSL, "Detecting and Forecasting Damaging Winds." [Online] 29 June 2009
http://www.nssl.noaa.gov/primer/wind

NSSL, "Detecting and Forecasting Hail." [Online] 26 June 2009
http://www.nssl.noaa.gov/primer/hail

NSSL, "Lightning Detection and Prediction.: [Online] 1 July 2009
http://www.nssl.noaa.gov/primer/lightning

NWS, National Hurricane Center. IKE Graphics Archive. September 13, 2008
www.nhc.noaa.gov/archive/2008/graphics/al09/loop.5W.shtml

NWS, "Lightning Safety." [Online] 1 July 2009 http://www.lightningsafety.noaa.gov

NWS Norman Oklahoma, "The Basics of Storm Spotting." 25 June 2009
http://www.srh.noaa.gov/oun/stormspotting/basics.php

NWS Wilmington, Ohio, "Comments on the Remnants of Hurricane Ike by Dr. Jay Hobgood of OSU." [Online] 30 June 2009
http://www.erh.noaa.gov/iln/sept122008/hpbgoodike.html

NWS Wilmington, Ohio, "Thunderstorm Images." [Online] 25 June 2009
http://www.erh/noaa.gov/er/iln/gallery

NWS Wilmington, Ohio, "Upper Air Conditions Contributing to 12 Sept 2008 Widespread Damaging Winds." [Online] http://www/her/noaa.gov/iln_2008/soundingwriteup.html

Ohio Committee for Severe Weather Awareness, "Thunderstorms and Lightning Safety." [Online] 1 July 2009
http://www.weathersafety.ohio.gov/ThunderstormsAndLightningSafety.aspx

OEMA, State of Ohio Mitigation Plan, 2008

Ohio Historical Society, "July 7, 1915 Cincinnati's Deadliest Winds." [Online]
http://www.ohiohistory.org

Ohio Weather Library, "Hailstorms." [Online] 30 June 2007
http://www.hailstorms.owlinc.org

Extreme Heat - #8

Contents

Hazard Profile 204
The Effect of Excessive Heat on the Human Body.....206
Extreme Heat in the United States 209
Extreme Heat in Ohio 211
Extreme Heat in Franklin County 211

Hazard Summary

An extreme heat event, or heat wave, is a prolonged period of excessively hot weather, which may be accompanied by high humidity. There has never been a confirmed heat related death in Franklin County, although it is the No. 1 non-severe weather related killer in the U.S. This hazard was ranked No. 8 of 16.

Hazard Profile

Extreme heat events are characterized by stagnant, warm air masses and consecutive nights with high minimum temperatures. An extreme heat event, or heat wave, is a prolonged period of excessively hot weather, which may be accompanied by high humidity. Extreme heat is relative to the usual weather of an area. Temperatures considered normal in a hotter climate may be considered extreme in a normally cooler area.

North American summers are hot; most summers see heat waves in one section or another of the United States. East of the Rockies, they tend to combine both high temperature and high humidity, although some of the worst have been catastrophically dry.

Heat is the number one non-severe weather-related killer. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. These are the direct casualties. No one knows how many more deaths are advanced by heat wave weather – how many diseased or aging hearts surrender that under better conditions would have continued functioning.

People respond differently to extreme heat based on their place of residence, the precautions they take, and their personal susceptibility to heat. In regions of high humidity, excessive heat can make being outside unbearable. In regions of low humidity, the most common human response to extreme heat is dehydration.

Heat Index

In an effort to alert the public and appropriate authorities to the hazards of extreme heat, the National Weather Service developed the heat index (sometimes referred to as the "apparent temperature"). The heat index, given in degrees F, is an accurate measure of how hot it really feels when effects of the relative humidity are added to the actual air temperature.

The National Weather Service will initiate alert procedures when the heat index (HI) is expected to exceed 105 degrees for at least one day. The procedures are:

- Include HI values in zone and city forecasts.
- Issue Special Weather Statements and/or Public Information Statements presenting a detailed discussion of:
    - The extent of the hazard including HI values.
    - Who is most at risk.
    - Safety rules for reducing the risk.
- Assist state/local health officials in preparing emergency messages, including meteorological information, detailed medical information, advice and names and phone numbers of health officials.
- Release to the media and over NOAA Weather Radio all of the above information.

HEAT INDEX °F (°C)													
	RELATIVE HUMIDITY (%)												
Temp.	40	45	50	55	60	65	70	75	80	85	90	95	100
110 (47)	136 (58)												
108 (43)	130 (54)	137 (58)											
106 (41)	124 (51)	130 (54)	137 (58)										
104 (40)	119 (48)	124 (51)	131 (55)	137 (58)									
102 (39)	114 (46)	119 (48)	124 (51)	130 (54)	137 (58)								
100 (38)	109 (43)	114 (46)	118 (48)	124 (51)	129 (54)	136 (58)							
98 (37)	105 (41)	109 (43)	113 (45)	117 (47)	123 (51)	128 (53)	134 (57)						
96 (36)	101 (38)	104 (40)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	132 (56)					
94 (34)	97 (36)	100 (38)	103 (39)	106 (41)	110 (43)	114 (46)	119 (48)	124 (51)	129 (54)	135 (57)			
92 (33)	94 (34)	96 (36)	99 (37)	101 (38)	105 (41)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	131 (55)		
90 (32)	91 (33)	93 (34)	95 (35)	97 (36)	100 (38)	103 (39)	106 (41)	109 (43)	113 (45)	117 (47)	122 (50)	127 (53)	132 (56)
88 (31)	88 (31)	89 (32)	91 (33)	93 (34)	95 (35)	98 (37)	100 (38)	103 (39)	106 (41)	110 (43)	113 (45)	117 (47)	121 (49)
86 (30)	85 (29)	87 (31)	88 (31)	89 (32)	91 (33)	93 (34)	95 (35)	97 (36)	100 (38)	102 (39)	105 (41)	108 (42)	112 (44)
84 (29)	83 (28)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	90 (32)	92 (33)	94 (34)	96 (36)	98 (37)	100 (38)	103 (39)
82 (28)	81 (27)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	90 (32)	91 (33)	93 (34)	95 (35)
80 (27)	80 (27)	80 (27)	81 (27)	81 (27)	82 (28)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	86 (30)	87 (31)

Heat Index/Heat Disorders

Category	Heat Index	Possible heat disorders for people in high risk groups
Extreme Danger	130°F or higher (54°C or higher)	Heat stroke or sunstroke likely.
Danger	105 - 129°F (41 - 54°C)	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90 - 105°F (32 - 41°C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80 - 90°F (27 - 32°C)	Fatigue possible with prolonged exposure and/or physical activity.

To find the heat index, look at the Heat Index Chart above. As an example, if the air temperature is 96 degrees F (found on the left side of the table) and the Relative Humidity (RH) is 55% (found at the top of the table), the HI, or how hot it really feels, is 112 degrees F. This is at the intersection of the 96 degree row and the 55% humidity column.

Note: Since HI values were devised for shady light wind conditions, exposure to full sunshine can increase HI values by up to 15 degrees F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

NOAA's Extreme Heat Advisory Products

Excessive Heat Outlook: When the potential exists for an excessive heat event in the next three to seven days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

Excessive Heat Watch: When conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing are still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

Excessive Heat Warning/Advisory: When an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

Heat Health Watch/Warning System: NOAA/NWS has supported the implementation of the new Heat Health Watch/Warning System (HHWS). This system was developed in conjunction with researchers at the University of Delaware. As of summer 2007, about 20 Weather Forecast Offices utilized the HHWS as additional guidance in their forecast decision-making process.

The HHWS, tailored for each urban locale, is the first and only meteorological tool based upon the occurrence of certain air masses that have historically been associated with elevated mortality levels. The HHWS considers numerous meteorological, seasonal, and social factors based on actual human health responses. Through the use of HHWS, it is possible to predict the likelihood of excess mortality given the synoptic conditions present at specific cities, the number of consecutive days an oppressive air mass is present, and the time of year the event occurs. Cincinnati and Dayton are the only cities in Ohio with HHWS coverage. Both have a history of heat related fatalities.

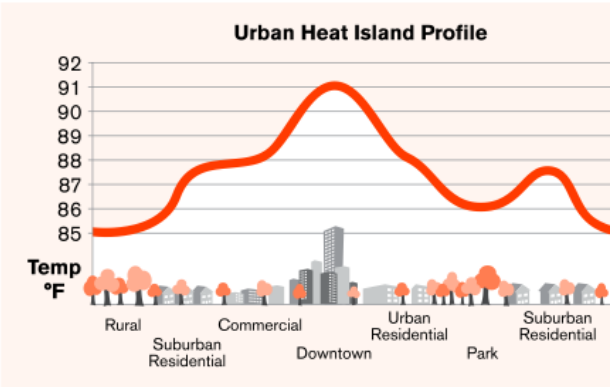
The Effect of Excessive Heat on the Human Body

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Ranging in severity, heat disorders share one common feature: the individual has overexposed or over exercised for his age and physical condition in the existing thermal environment. Studies indicate that, other things being equal, the severity of heat disorders tend to increase with

age. Acclimation has to do with adjusting sweat-salt concentrations, among other things. The idea is to lose enough water to regulate body temperature with the least possible chemical disturbance.

Cities pose special hazards. The stagnant atmospheric conditions of a heat wave can trap pollutants in urban areas and add the stresses of severe pollution to the already dangerous stresses of hot weather, creating a compounded public health problem. High inner-city death rates can also be read as poor access to air-conditioned rooms. The cost of running air conditioners may be too high for some elderly people on fixed incomes. Some high-rise city buildings cannot be ventilated without air conditioning. Also, fear of crime will keep people locked up in closed apartments and homes, as was evident in the deadly Chicago heat wave of 1995.

The following chart shows the impact of the urban heat island on ambient temperatures.



Source: U. S. EPA, 2006

Symptoms of Heat Related Disorders

- Sunburn: Redness and pain; in severe cases skin swelling, blisters, fever, and headaches.

- Heat Cramps: Painful spasms usually in muscles of legs and abdomen possible, heavy sweating. Any activity that results in profuse sweating followed by too little or too much fluid intake can result in these painful muscle spasms. Cramping is probably secondary to sodium depletion.

- Heat Exhaustion: Occurs as two types, water depleted and sodium depleted, although in reality they often overlap. Signs and symptoms include fatigue and malaise, anorexia, nausea, vomiting, anxiety, and confusion. Potentially dangerous clinical manifestations include circulatory collapse and excessive temperature. Core body temperature is usually higher than 100.4^0 F but below the cutoff for heatstroke, which is 104^0 F.

Heat exhaustion from water depletion tends to occur in the elderly, who are more likely to have pre-existing conditions or take medications that predispose them to dehydration. Signs of dehydration include excessive thirst, fatigue, dry oral mucosa, and decreased urinary output. Heat exhaustion from sodium depletion occurs most often in unacclimated persons who maintain volume status with water but fail to replace sodium lost in sweat. Symptoms such as weakness, fatigue, and headache appear acutely, but the onset tends to occur over a period of several days.

- Heatstroke: Heatstroke is the deadliest of heat illnesses, occurs in two forms – classic and exertional – and is defined by a core body temperature above 104^0 F. Treatment must begin immediately to ensure survival. Classic heatstroke occurs during summer months and predominantly affects those of advanced age or with chronic medical conditions. Symptoms of heatstroke are hot dry skin, rapid and strong pulse, and possible unconsciousness.

  Exertional heatstroke most often occurs in the summer and primarily affects laborers or athletes. Symptoms are similar to those of classic heatstroke, but with one major difference: many people with exertional heatstroke continue to sweat. Heatstroke is a medical emergency. Multiple organ systems can be affected. Heat exhaustion, if not promptly treated, can lead to heatstroke, and the two conditions may overlap.

Factors that increase the risk of experiencing a heat related disorder

Meteorological Characteristics

- Increased temperature
- Increased relative humidity
- Dry, hot winds

Demographic Characteristics

- Physical constraints (including underlying medical conditions)
- Mobility constraints
- Cognitive impairments
- Economic constraints
- Social isolation

Behavioral Choices

- Wearing inappropriate clothing
- Failing to stay adequately hydrated
- Consuming alcohol
- Engaging in outdoor activities
- Eating heavy and/or hot foods

Regional Characteristics

- Living in an area with a variable climate
- Living in an urban area
- Living on the upper floors of buildings

Source: Excessive Heat Events Guidebook, USEPA

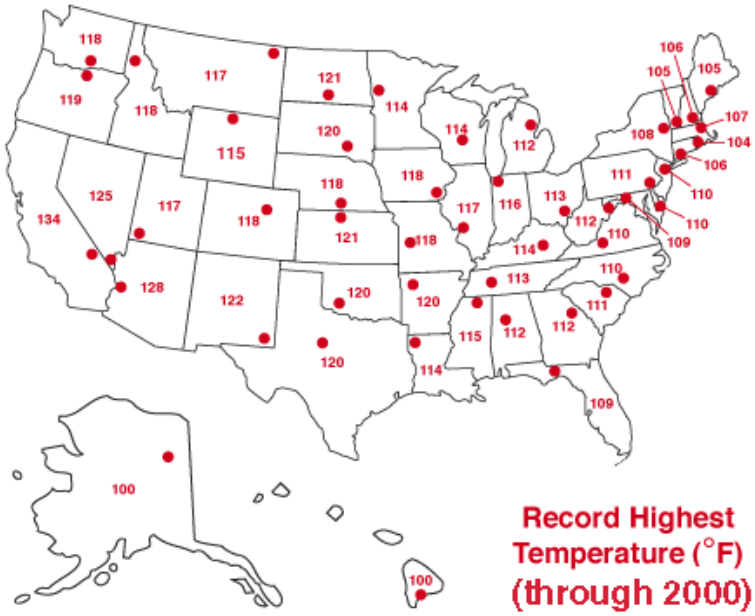
Other Effects of Heat Waves

In addition to physical stress, excessive heat causes psychological stress to a degree which affects performance and is associated with increase in violent crime. Heat waves often lead to electricity spikes due to increased air conditioning use, which can create power outages. If a heat wave occurs during a drought, which dries out vegetation, it can contribute to wildfires. And heat waves can cause roads and highways to buckle, water lines to burst, and power transformers to detonate.

Extreme Heat in the United States

Heat waves are a particularly lethal type of weather phenomenon with an average of 1,500 people dying from extreme heat each year. Between 1992 and 2001, deaths from excessive heat in the United States numbered 2,190, compared to 880 deaths from floods and 150 from hurricanes. The average annual number of fatalities directly attributed to heat in the United States is about 400. The 1995 Chicago heat wave, one of the worst in U.S. history, led to approximately 600 heat-related deaths over a period of five days.

In the United States, lack of a uniform definition for heat-related death results in substantial variation in the criteria used to certify such deaths. The most stringent definition of heat-related death is: a core body temperature of greater than or equal to 105^{0}F taken at the time of death, with no other reasonable explanation of death. Revised criteria used by some medical examiners say that a death also can be classified as heat-related if the person is "found in an enclosed environment with a high ambient temperature without adequate cooling devices and the individual had been known to be alive at the onset of the heat wave."



Alternative mortality estimates come from analyses of daily urban summertime mortality patterns in the United States developed by Kalkstein and colleagues at the University of Delaware. This method calculates the number of heat-related deaths based on differences in daily deaths on extreme heat days compared to longer-term averages.

Whatever method is used, studies show significant regional variation. Extreme heat events have the greatest impact in the Northeast and Midwest and the least impact in the South and Southwest. This is consistent with the hypotheses that populations in the most vulnerable areas are not as acclimatized to elevated temperatures and the structures in less susceptible areas are better designed to accommodate elevated temperatures. There have been heat waves in warmer climates; however, the death rates appear to be lower.

1936 North American Heat Wave The Dust Bowl years of 1930-1936 brought some of the hottest summers on record to the United States, especially across the Plains, Upper Midwest and Great Lakes states. For the Upper Mississippi River valley, the first few weeks of July 1936 brought the hottest temperatures of that period, including several all-time highs. The heat wave took place in the middle of the Great Depression, and it contributed to it, leading to catastrophic human suffering and an enormous economic toll. The death toll exceeded 5,000. Many of the deaths occurred in built up city areas of Chicago, Detroit, St. Louis, Milwaukee, Cleveland, Toronto and other urban areas.

July 1995 Heat Wave The heat wave of 1995 was one of the worst weather-related disasters in Illinois history with approximately 525 deaths over a 5-day period. The hottest weather occurred from July 12 to July 16. The 106^0 F temperature on July 13 set the record for the warmest July temperature since measurements began at Midway in Chicago. Not only were the daytime temperatures high, the nighttime low temperatures were high (upper 70s and lower 80s) as well. Record humidity levels also accompanied the hot weather.

Many of the victims were the elderly in the heart of the urban area. Many of the poorer older citizens either had no air conditioning or could not afford to operate the system they had. Many older citizens were also hesitant to open windows and doors at night for fear of crime.

Record heat related deaths were also reported in Milwaukee, Philadelphia, and St. Louis. This heat wave led to a nationwide call to cities to examine their heat emergency warning and response plans.

July 2006 North American Heat Wave This long-lasting heat wave, 43 days, began in the center of North America in the Plains and the Midwest on July 15, 2006. By July 21, the heat had moved to the West Coast and then returned to the Plains on July 28. The high temperature spread to the East Coast and made its way to the South by August 4, 2006.

The demand for electricity caused a 5-day blackout in Queens, New York, causing the closure of LaGuardia Airport and subway lines. Many roads buckled and water lines ruptured. The hardest hit cities were Oklahoma City, Dallas and Shreveport. Crops dried up and livestock perished in the heat. The heat wave killed over 200 people nationwide. At least half the victims were elderly.

Extreme Heat In Ohio

Summer 1934 The summer of 1934 ranks as the hottest in Ohio since temperature records began in 1883. The average temperature of 75.7 ^{0} F for the months of June, July, and August broke the old record set in 1891 and was five degrees above normal.

July 1934 was the hottest month ever recorded in Ohio. Many heat records were set on July 21, including 106^0 F in Columbus, 109^0 F in Cincinnati and 111^0 F in Wilmington and Hamilton. A weather station four miles northwest of Gallipolis recorded 113^0 F. Estimates of the death toll in Ohio were 160 dead, just during the week of July 20-26.

July 1995 Heat Wave The state suffered an unusually long period of hot weather with afternoon temperatures generally in the 90s with high humidity. Peak heat and humidity occurred on July 14, with high temperatures near or exceeding 100^0 F. Dewpoints were also unusually high, averaging near 80^0 F which produced a heat index as high as 126^{0}F in Toledo. A number of roads and sidewalks buckled from the heat. Older utility systems suffered a high incidence of breakdown due to prolonged high demand. It was so hot that a heat kink occurred on the railroad tracks in Athens County. A Conrail freight train had 16 cars derail, and a chemical leak prompted a six-hour evacuation in the vicinity. Thirteen fatalities were reported, all in Cuyahoga County, in the Cleveland urban area.

July – August 1999 During a heat wave in the Midwestern and Eastern U.S., Ohio recorded some of the highest rates for heat-related deaths, with Cincinnati reporting 21 per million and Dayton reporting 7 per million, according to the CDC.

The last part of July was very hot and humid across the state with temperatures reaching into the 90s most days and above 100^0 F for a few days. The dewpoints and overnight lows were in the 70s through much of the period.

July 2006 Ohio also was part of the 2006 nationwide heat wave. Ohio farmers reportedly used fans and cold showers to keep their cattle cool. Even with those efforts, the animals produced about 10 pounds less milk per day because of the heat.

Extreme Heat in Franklin County

Franklin County has been affected by nationwide and statewide heat waves, but has not reported heat-related deaths as has Cincinnati, Dayton, and Cleveland. A couple of explanations suggested are that Columbus is a newer city with fewer older buildings, and the humidity in Central Ohio is not as great as in northeastern and southwestern Ohio.

Nevertheless, the citizens of Franklin County are vulnerable to extreme heat and need to practice personal preventative strategies to avoid heat-related disorders. Local health departments offer heat-related advice and several organizations in Columbus offer summer cooling programs, such as free fans and help with utility costs. The NWS issued numerous heat watches for Franklin County in 1999 and in 2001.

Extreme Heat – References

CDC, Heat-Related Deaths – Chicago, Ill, 1996-2001 and U.S. 1979-1999. MMWR Weekly. 52(26): 610-613, 4 July 2003

CDC, Heat-Related Deaths – U.S. 1999-2003. MMWR Weekly. 55(29): 796-798, 28 July 2006

CDC, Heat-Related Illnesses, Deaths, and Risk Factors – Cincinnati and Dayton, Ohio, 1999, and U.S. 1979-1997. MMRW Weekly. 49(21): 470-03, 2 June 2000

CDC, Heat-Related Mortality, Chicago, July 1995. MMWR Weekly. 44(31): 577-579, 11 Aug 1995

Columbus Public Health, "Keeping Cool, Healthy and Safe." [Online] 18 June 2009 http://www.publichealth.columbus.gov/media/news-168.asp

Illinois State Climatologist Office, "The 1995 Heat Wave in Chicago, ILL [Online] 18 June 2009 http://www.isws.illinois.edu/atmos/Statecil/General/1995Chicago.htm

Luber, George, MA, Ph.D., McGeehin, Michael, Ph.D., MSPH, Climate Change and Extreme Heat Events. American Journal of Preventive Medicine 35(5): 429-435

NCDC – NOAA, Query Results, Heat Events Franklin County Ohio

NOAA, "Heat Wave: A Major Summer Killer" [Online] 12 June 2009 http://noaawatch.gov/themes/heat.php

Ohio Historical Society, "Summer 1934: Statewide Heat Wave." [Online] 11 June 2009 http://www.ohiohistory.org

Sheridan, Scott C., Dolney, Timothy J., Heat Mortality, and Level of Urbanization: Measuring Vulnerability Across Ohio, USA. Climate Research 24: 255-265, 2003

USEPA, Excessive Heat Events Guidebook EPA 430-B-06-005, June 2006

Hazardous Material Incidents - #9

Contents

Hazard Profile....214
Hazardous Material Incidents in the United States....216
Hazardous Material Incidents in Ohio....216
Hazardous Material Incidents in Franklin County....218

Hazard Summary

A hazardous materials incident is the unintentional release of a hazardous material from its container or package in a sufficient concentration to pose a threat. Hazardous materials may be explosive, flammable, combustible, corrosive, reactive, poisonous, biological or radioactive, as well as solid, liquid or gaseous. As of 2009, Franklin County has 658 facilities required to report their hazardous materials. In 2008 there were nearly 400 spills in Franklin County reported to the Ohio EPA. This hazard was ranked No. 9 out of 16.

Hazard Profile

Hazardous materials are prevalent throughout society. Industry is the primary user and maintainer of hazardous chemicals and other materials, but we also have them in our homes, cars, places of work and recreation. Hazardous materials move through the country on highways and rail lines, in pipelines, and by ship and barge.

A hazardous materials incident is the unintentional release of a hazardous material from its container or package in a sufficient concentration to pose a threat. When not properly contained, the chemical, physical and biological properties of hazardous materials pose a potential risk to life, health, the environment and property. Most incidents are small in scope and only require a limited response. Occasionally, there will be a large incident or one involving a chemical or other material that requires evacuation of the surrounding area.

Hazardous materials may be explosive, flammable, combustible, corrosive, reactive, poisonous, biological or radioactive, as well as, solid, liquid or gaseous. The U.S. Department of Transportation classification of hazardous materials and the required signage is as follows:

Source: U.S. Department of Transportation

<u>Types of Hazardous Material Incidents</u>
Most hazardous materials incidents fall into two general categories, fixed site or transportation related incidents. Additional potential types of hazardous material releases may include terrorism incidents (discussed in the Terrorism Section of this document), illegal drug labs, illegal dumping and during a natural hazard event such as an earthquake or flood.

Fixed Site Incidents

More hazardous materials incidents are reported from fixed sites than from other causes. Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States – from major industrial plants to local dry cleaning establishments or gardening supply stores. Communities located near chemical manufacturing plants are particularly at risk. Generally with a fixed facility, the hazards are pre-identified, and the facility is required by law to report the chemicals on site and prepare a risk management plan.

Transportation Related Incidents

The most common type of transportation hazardous material incident is from highway crashes, followed by railroad incidents. Discharges may also come from pipelines, storage tanks and aircraft. The exact location of a transportation incident is impossible to predict as hazardous materials are transported on our roadways, railways and waterways daily. Any area is vulnerable to an accident.

The National Response Center, the national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges, reported the following causes of hazardous material incidents.

Incident Type	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fixed	11,813	12,441	11,917	11,975	12,975	13,017	13,621	11,913	10,909
Unknown Sheen	4,016	4,147	3,426	3,733	3,411	3,934	3,797	4,199	4,278
Vessel	3,945	4,378	3,919	3,962	4,385	4,611	4,767	4,931	5,030
Mobile	3,597	3,216	2,942	2,947	3,192	3,215	3,267	3,297	3,238
Pipeline	1,618	1,841	1,621	1,643	1,574	1,896	1,839	1,580	1,379
Platform	1,428	1,355	1,233	1,344	1,198	1,395	1,606	1,407	1,362
Storage Tank	1,379	3,140	3,044	2,808	2,838	2,687	2,577	2,519	2,460
Railroad Non-Release	1,335	1,235	1,124	1,173	1,476	1,685	1,868	1,913	1,482
Railroad	1,332	1,241	1,200	1,074	1,276	1,532	1,451	1,390	1,649
Continuous	938	238	393	462	112	189	150	284	62
Aircraft	248	297	278	262	277	211	217	214	204
Drill/Exercise	669	789	908	743	1,073	1,223	1,578	1,584	1,829
Unknown	84	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Terrorist Non-Release	33	42	180	105	125	119	117	43	0
TOTAL INCIDENTS	**32,435**	**34,360**	**32,185**	**32,231**	**33,912**	**35,714**	**36,855**	**35,274**	**33,882**

Source: National Response Center

SARA Title III and Hazardous Substances Reporting

The Superfund Amendment and Reauthorization Act, or SARA, was passed in 1986, in part due to concerns following the incident at a Union Carbide plant in Bhopal, India. In December 1984, a methyl isocyanate gas leak from the plant killed or injured thousands of people. SARA Title III and the Clean Air Act of 1990 mandate "cradle to grave" tracking of specific hazardous materials by requiring users to report what chemicals they are using on releasing into the air and how they will respond to an emergency. EPA delegates implementation to the states.

SARA Title III requires reporting for over 350 specific chemicals designated as "extremely hazardous substances" and others designated as hazardous chemicals. Extremely hazardous substances are substances that when released from their container are considered immediately dangerous to life or health. Chlorine gas is an example. A specific "threshold planning quantity" (TPQ) is specified for each chemical. TPQs vary, the average being 500 pounds; however, some are as low as one pound. When a facility meets or exceeds the TPQ for a chemical, it must notify the response community, the State Emergency Response Commission, and the Local Emergency Planning Committee.

SARA Title III also establishes spill reporting requirements, triggered when the release of a chemical reaches a specific "reportable quantity" for that chemical. Sara also requires chemical inventory reporting: the location, quantity, storage conditions, and properties of EHSs or "hazardous chemicals," Tier II Reports.

The Toxic Release Inventory Reporting is another feature of SARA Title III. TRI requires certain facilities to report information on chemical use, release, recycling, energy recovery and treatment information, as well as pollution prevention activities.

These reporting programs overlap depending upon whether the materials are oils, hazardous chemicals, hazardous substances, extremely hazardous substances or toxic chemicals.

Hazardous Material Incidents in the United States

Almost 50 hazardous materials incidents happen every day in the United States. In 2000, there were 17,514 hazmat incidents resulting in 13 fatalities, 246 injuries and more than $72.7 million in damages, according to the American Society of Safety Engineers. Ohio had the most incidents, with Texas second and California third. Texas has the highest amount of hazardous material shipments in the U.S. flowing annually through the state either by truck, rail, water, pipeline or air, according to the U.S. Department of Transportation Commodity Flow Survey.

Hazardous Material Incidents in Ohio

Incidents involving hazardous materials can occur almost anywhere and at any time in Ohio, and greatly affect people, animals, the environment and property. There are tens of

thousands of hazardous materials produced, transported, used, and stored throughout Ohio. Ohio is a transportation crossroads, with several major cross country interstate highways and railroads crossing the state.

Chapter 3750 of the Ohio Revised Code provides for the implementation of the Emergency Planning Community Right-to-Know Act (SARA Title III) in Ohio. The administrative body is the State Emergency Response Commission (SERC). SERC is made up of nine state agencies plus ten appointed members and two members of the state legislature. SERC appoints members of the Local Emergency Planning Committees (LEPC) of each planning district and oversees emergency planning and chemical reporting in Ohio. SERC is co-chaired by Ohio Emergency Management Agency and Ohio Environmental Protection Agency.

The chart below lists the total number of statewide incidents reported to the Ohio Environmental Protection Agency (EPA) from January 1, 2008 through December 31, 2008:

Districts				
	Total	%	Responded	%
CD	842	17.5%	842	17.5%
NE	1,252	26.0%	1,252	26.0%
NW	922	19.2%	922	19.2%
SE	609	12.7%	609	12.7%
SW	1,188	24.7%	1,188	24.7%
	4,813	100.0%	4,813	100.0%

The chart below indicates the number of individual chemicals released during the same time period as above.

Incidents by Type		
Hydrocarbon	1,531	27.6%
Waste Chemical	76	1.4%
Waste Water	439	7.9%
Chemical	359	6.5%
Air Chemical	341	6.2%
Other	766	13.8%
None	84	1.5%
Proprietary	14	0.3%
Sewage	1,777	32.1%
Grant Chemical	78	1.4%
Farm Chemical	70	1.3%
Brine Chemical	4	0.1%
Total	5,539	100.0%

Hazardous Material Incidents in Franklin County

There is a large number of chemicals manufactured, used, stored and transported in Franklin County. The Chemical Emergency Preparedness Advisory Council (CEPAC) serves as the Local Emergency Planning Committee (LEPC) for Franklin County. CEPAC receives over 600 chemical inventory reports each year. In addition to fixed site facilities, Franklin County, located in the center of the state, is the crossroads for major interstate highways and railways transporting hazardous materials every day.

Below are Franklin County incidents reported to the Ohio EPA during 2005-2009:
2009: 150 separate incidents
2008: 179 separate incidents
2007:213 separate incidents
2006: 206 separate incidents
2005: 205 separate incidents

In 2009, CEPAC received 659 chemical inventory reports from facilities with hazardous substances. There were 292 EHS (extremely hazardous substance) sites. Some sites have more than one chemical. Other than the 292 EHS sites, the most common chemicals found were gasoline, kerosene, fuel oil #2, and propane.

Of the 50 hazardous gases analyzed by Aloha software, 29 are ammonia, 17 are chlorine, and 4 are miscellaneous chemicals. Of these chemicals, 11 have a threat zone for 1 mile or more, 11 have a threat zone of at least ½ mile, and the remaining 28 have threat zones of less than ½ mile.

Almost any chemical could be transported through the county at any time. Some of the most commonly reported transported chemicals include:

Liquefied Petroleum Gases
Anhydrous Ammonia
Denatured Alcohol
Fuels, gasoline, diesel, jet fuel
Corrosive materials, acids, hydroxides, etc.

In the ten-year period from 1999 through 2008, the National Response Center received 331 spill reports from Franklin County.

Most of the reported spills involved not extremely hazardous substances (EHS) but petroleum products such as transformer oil, diesel, fuel oil, gasoline, jet fuel and others. These are the most common hazardous materials used and transported in the county. Ethylene glycol, the most reported material spilled, is used for deicing aircraft. During periods of severe winter weather, when daily discharge amounts exceed the allowed limits, it must be reported.

Hazardous Material Spills – References

2008 Emergency Response Guide Book, US Department of Transportation, 2008

Chemical Emergency Preparedness Advisory Council (CEPAC) Records and Reports

FEMA, "Hazardous Materials. " [Online] 21 July 2009
http://www.fema.gov/hazard/hazmat/intex.shtm

Federal Railroad Administration, Query Franklin County, 22 July 2009

Franklin County Emergency Management and Homeland Security, Records and Incident Reports

National Response Center, Query Franklin County, 22 July 2009

OEMA, Emergency Operations Plan

OEPA, "State Emergency Response Commission, SERC." [Online] 22 July 2009
http://www.epa.state.oh.us/dapc/serc/background.html

Research and Innovative Technology Administration, Top 20 Hazardous Material Incidents, 2007

Drought - #10

Contents

Hazard Profile 221
Drought in the United States 225
Drought in Ohio 227
Drought in Franklin County 228

Hazard Summary

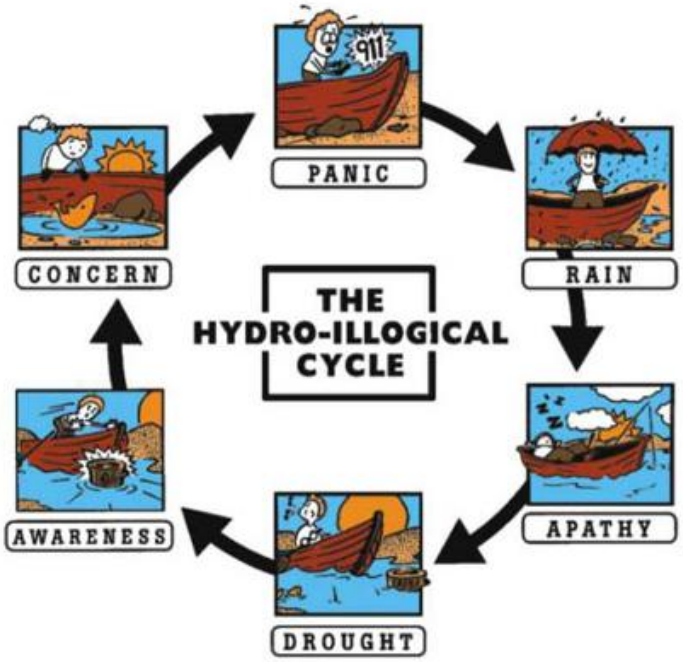
Drought is defined as a prolonged period of abnormally dry weather, where the lack of sufficient precipitation causes a serious hydrologic imbalance with economic and/or social consequences. Franklin County is primarily impacted by drought relating to shortages in the water supply as well as a decrease in overall water quality. Drought also greatly impacts the 24.19% of Franklin County land utilized as cropland or pasture. This hazard was ranked No. 10 of 16.

Hazard Profile

There are several definitions of drought; however, the Glossary of Meteorology defines drought as a period of abnormally dry weather sufficiently prolonged by the lack of water to cause serious hydrological imbalance of the affected area. Drought is considered relative to some long-term average condition of balance between precipitation and evapotranspiration (i.e., evaporation + transpiration) in a particular area, a condition often perceived as "normal." It is also related to timing and climatic factors such as high temperature, high wind, and low relative humidity.

The impact of drought on society results from the interplay between a natural event (less precipitation than expected resulting from natural climatic variability) and the demand people place on water supply. Humans often exacerbate the impact of drought.

Unlike other natural hazards, drought does not have a clearly defined beginning and end. As a result, our reaction to drought traditionally has not been timely.



Source: The Hydro-Illogical Cycle, I.R. Tannehil

Four Perspectives on Drought

Meteorological Drought
Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. Meteorological droughts are region specific, based on the number of days with precipitation less than some specific threshold, on seasonal rainfall pattern, or on periods without rainfall. Actual precipitation departures from average amounts may be related on monthly, seasonal, or annual time scales.

Hydrological Drought
Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., stream flow, reservoir, lake levels, and ground water). The frequency and severity of hydrological drought is often defined on a watershed or river-basin scale.

Changes in land use, land degradation, and construction of dams – all affect the hydrological characteristics of the basin. Changes in land use upstream may alter hydrologic characteristics such as infiltration and runoff rates, resulting in more variable stream flow and higher incidence of hydrologic drought downstream. Land-use change is one of the ways human actions alter the frequency of water shortage even when no change in the frequency of meteorological drought has been observed.

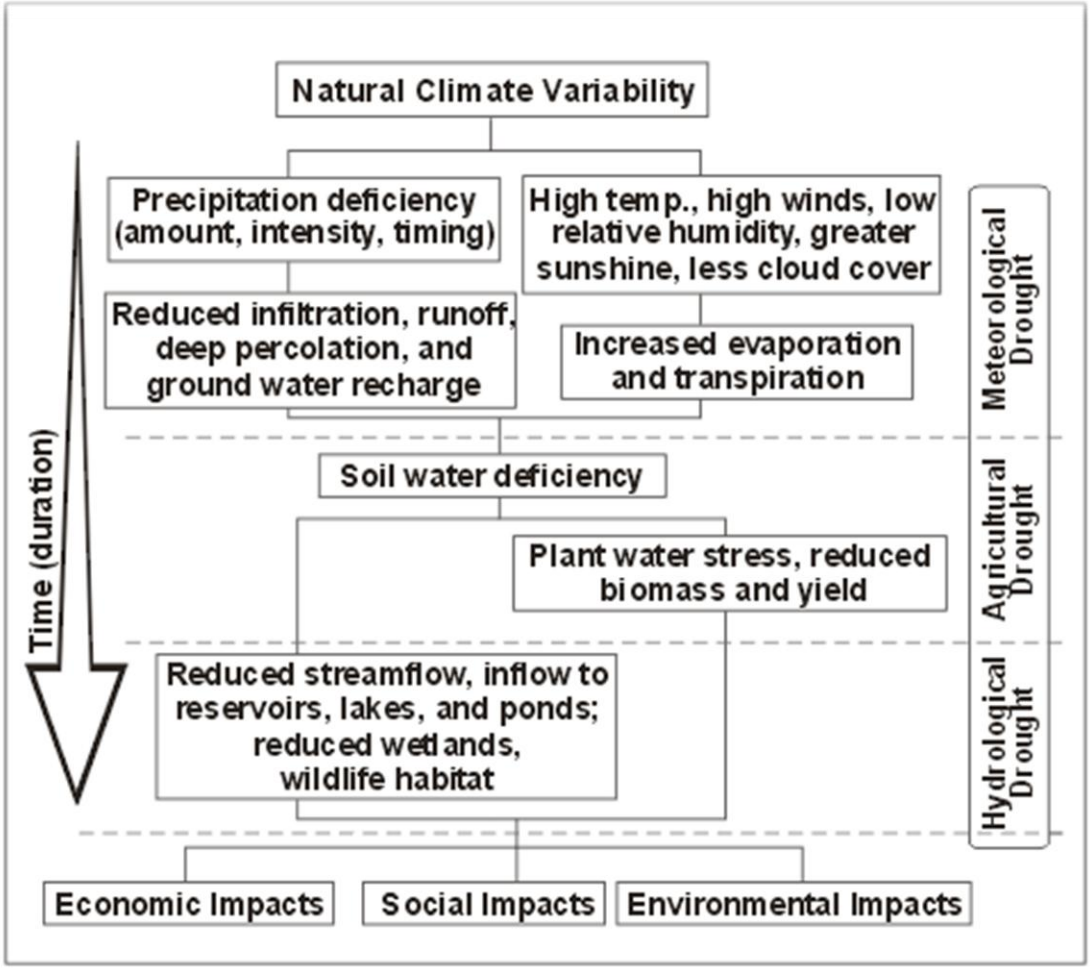
Agricultural Drought
Agricultural drought links various characteristics of meteorological or hydrological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil and water deficits, reduced ground water or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of a specific plant, a plant's stage of growth, weather conditions, and biological properties of the soil.

Socioeconomic Drought
Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Because of the natural variability of climate, water supply is ample in some years but unable to meet human and environmental needs in other years.

Sequence of Drought Impacts

The sequence of impacts associated with meteorological, agricultural, and hydrological drought further emphasizes their differences. When drought begins, the agricultural sector is usually the first to be affected because of its heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other sources of water will begin to feel the effects of

the shortage. Those who rely on surface water (i.e., reservoirs and lakes) and subsurface water (i.e., ground water) are usually the last to be affected.



National Drought Mitigation Center, University of Nebraska, Lincoln

Monitoring Drought

There are several indices that measure how much precipitation for a given period of time has deviated from historically established norms. The two most widely used are the Palmer Drought Severity Index and the Standardized Precipitation Index.

<u>Palmer Drought Severity Index</u>

W.C. Palmer developed the first comprehensive drought index in the United States, in 1965. The object of the Palmer Drought Severity Index (PDSI) is to provide measurements of moisture conditions that are standardized so the comparisons using the index can be made between locations and between months. The PDSI is a meteorological drought index and responds to weather conditions that have been abnormally dry or abnormally wet.

The Palmer Index is popular and has been widely used for a variety of applications across the United States. It is most effective measuring impacts sensitive to soil moisture conditions, such as agriculture. It has also been useful as a drought monitoring tool and has been used to trigger actions associated with drought contingency plans. Three positive characteristics of the PDSI are:

1. It provides decision makers with a measurement of the abnormality of recent weather for a region.
2. It provides an opportunity to place current conditions in historical perspective.
3. It provides spatial and temporal representations of historical droughts.

The Palmer Index has typically been calculated on a monthly basis, and a long-term archive of the monthly PDSI values is maintained at the National Climatic Data Center.

Palmer Classifications	
4.0 or more	extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is based on the probability of precipitation for any time scale. It can be computed for different time scales, can provide early warning of drought, can help assess drought severity, and is less complex than Palmer. The SPI reflects the impact of drought on the availability of the different water resources.

SPI Values	
2.0 +	extremely wet
1.5 to 1.99	very wet
1.0 to 1.49	moderately wet
-.99 to .99	near normal
-1.0 to -1.49	moderately dry
-1.5 to -1.99	severely dry
-2.0 and less	extremely dry

The SPI calculation for any location is based on the long-term precipitation record for a desired period. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. Positive SPI values indicate greater than median precipitation, while negative values indicate less than median precipitation.

A drought event occurs any time the SPI is continuously negative and reaches an intensity where the SPI becomes -1.0 or less. The event ends when the SPI becomes positive. Each drought event, therefore, has a duration defined by its beginning and end, and an intensity for each month the event continues.

Drought in the United States

The cost of losses due to drought in the United States averages $6-8 billion every year. For the three-year drought of 1987-1989, the losses were $39 billion, the most costly natural disaster documented in the U.S. up to that time.

Droughts occur all across the country. The major droughts of the 20th century, the 1930s Dust Bowl and the 1950s droughts, had the most severe impact on the central U.S. Florida, Oklahoma and Texas suffered from the 1998 drought. The West Coast experienced a six-year drought in the late 1980s and early 1990s, causing California to take aggressive water conservation measures. Even the typically humid northeastern U.S. experienced a 5-year drought in the 1960s that drained reservoirs in New York City down to 25% of capacity. In fact, almost every year, some region of the country experiences drought.

<u>The Dust Bowl</u>
The Dust Bowl drought severely affected much of the United States during the 1930s. In some regions of the High Plains, it lasted for eight years. The "dust bowl" effect was caused by sustained drought conditions compounded by years of land management practices that left topsoil susceptible to the forces of wind.

The agricultural and economic damage devastated residents of the Great Plains who were trying to recover from the Great Depression. Lessons were learned, and because of this drought, farmers adopted new cultivation methods to help control soil erosion in dry-land ecosystems. Subsequent droughts in this region have had less impact due to these cultivation practices.

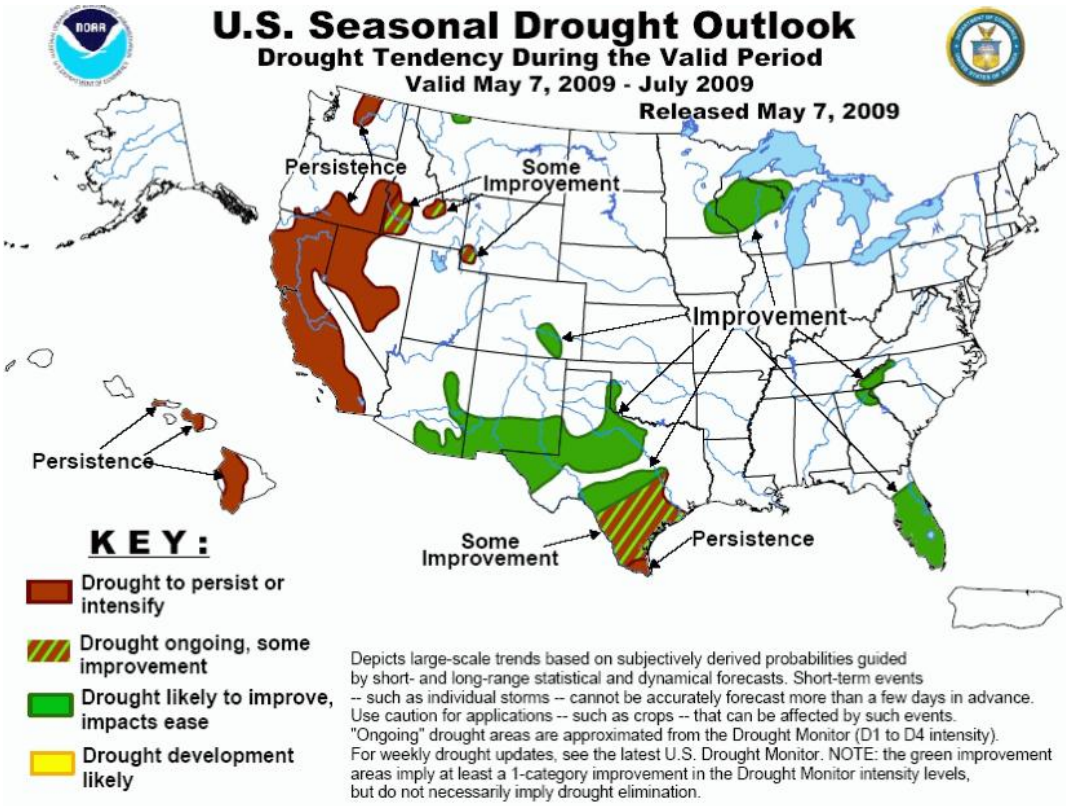
<u>The 1950s Drought</u>
While much of the country celebrated a resurgence of well-being during the post-war era, many residents of the Great Plains and southwestern United States were suffering. During the 1950s, these areas withstood a five-year drought. In three of those years, the drought reached coast to coast. The drought reached a peak in 1956 and subsided in most areas with the spring rains of 1957.

This drought created severe social and economic repercussions, devastating the region's agriculture. Crop yields dropped by as much as 50%, and excessive temperatures and low rainfall scorched grasslands used for grazing. By the time the drought subsided in 1957, many counties across the region were declared Federal drought disaster areas.

<u>The 1987-1989 Drought</u>
The three-year drought of the late 1980s covered 36% of the United States at its peak and was the costliest drought in U.S. history at $39 billion in damages.

The drought began along the west coast and extended into the northwestern U.S., with greatest impact in the northern Great Plains. By 1988, the drought had intensified and spread across much of the eastern half of the United States. This drought affected much of

the nation's primary corn and soybean growing areas, where total precipitation for April through July of 1988 was even lower than during the Dust Bowl. The drought also encompassed the upper Mississippi River Basin, where low river levels caused major problems for barge navigation. The summer of 1988 is well known for extensive forest fires, including the catastrophic Yellowstone fire.



Drought in Ohio

The Ohio Emergency Management Agency describes drought as a prolonged period of abnormally dry weather, where the lack of sufficient precipitation causes a serious hydrologic imbalance, having economic and/or social consequences, which may affect all or a portion of the State of Ohio. The State of Ohio monitors precipitation, groundwater levels, stream flows, snowpack, and water quality and utilizes the Palmer Drought Severity Index and other indices to ascertain drought potential.

Ohio receives an annual average of 37.98 inches of precipitation, which recharges ground water and reservoirs. Extended droughts severely diminish the amount of water in streams, reservoirs and aquifers. The population of Ohio is dependent on public ground water systems or private wells and surface water for their water supply.

The most significant impacts which confront the State are in the areas of agriculture, forestry, fish and wildlife, recreation and tourism, public and private water supplies, water quality, and economic impacts. Drought severity depends upon the degree of moisture deficiency, drought duration, and size of the affected area.

The Ohio Environmental Protection Agency lists the following operating difficulties connected with long-term dry weather in Ohio:

1. A general increase in system demand as water use for irrigation becomes widespread and privately owned wells fail.
2. A decrease in the ground water levels resulting in reduced well production or complete failure.
3. Diminished surface water supplies resulting from reduced stream flows and limited replenishment of raw water shortage reservoirs.
4. Increased contaminant levels in surface water as the ratio of contaminants to water volume rises.

Correlations between Ohio monthly precipitation and mean air temperature suggest that drought is linked to unusually high summer temperatures. The link between high summer air temperatures and low precipitation is enhanced by strong evapotranspiration and drying of the surface soil layer.

Ohio was the geographic center of the 1991-1992 drought. The central and three northeastern Ohio climatic divisions were the driest places in the country aside from three climatic divisions in Oregon and Washington. National droughts in the past have been focused in virtually every other part of the country aside from the Ohio River Valley region.

Ohio Environmental Protection Agency

Climatic data indicate that periods of persistent subnormal precipitation, lasting well over one year, have occurred only in three instances in Ohio: 1893-1896, 1952-1954, and 1963-1964. Overall, however, the worst drought in Ohio was that of 1930-1931, when precipitation reached its lowest amount on record from April 1930 to March 1931.

Drought in Franklin County

Central Ohio normally receives about 37 inches of annual precipitation. Recorded annual extremes for Columbus are 21.6 inches during 1930 and 51.3 inches during 1883. The longest period of record having only a trace of or no precipitation is 48 consecutive days, from September 13 through October 30, 1963. The driest summer was 1933, which had only 4.6 inches of rain.

As most of Franklin County is urbanized, the maximum impact of severe prolonged drought would be shortages in the water supply. Water quality could suffer and progressive restrictions on water use could be mandated as conditions require. These restrictions could include watering of lawns, parks, and golf courses; swimming pool use; washing of motor vehicles; and ornamental purposes such as fountains and reflecting pools.

About 22.71% of the county is used for cropland and 1.48% is used for pasture. These areas would be impacted by prolonged drought. These areas represent about one fourth of the county.

The most severe impact in the county would most likely be a water shortage. Fortunately, however, the building of judiciously located dams and storage reservoirs has created a water supply system that by some estimates could be developed to supply 2,500,000 people. The three systems, Griggs, O'Shaughnessy, and Hoover, currently supply 85% of the 130 million gallons of water used in the county daily. The four Ranney Collector Wells in southern Franklin County supply the other 15%, 20 million gallons daily. As surface reservoirs are the last to be affected by drought, it would take a long and severe drought to seriously impact the county.

Drought – References

OEMA, Emergency Operations Plan. 2008

OEMA, Hazard Identification and Risk Assessment. 2007

OEMA, State of Ohio Mitigation Plan. 2008

OEPA – Division of Drinking and Ground Water, "Drought in Ohio." [Online] 27 Apr 2009, http://www.epa.state.oh.us//ddaga/Drought

National Drought Mitigation Center, University of Nebraska Lincoln, Drought. 2006

NOAA Paleoclimatology Program, North American Drought: A Paleo Perspective. 12 Nov 2003

Rogers, Jeffrey C., Climatological Aspects of Drought in Ohio, Ohio Journal of Science 93(3): 51-59, 1993

Tannehill, I.R., The Hydro-illogical Cycle, Drought: Its Causes and Effects, Princeton University Press. Princeton, NJ. 1947

Utility/Energy Interruption or Failure - #11

Contents

Hazard Profile 232
Events 234

Hazard Summary

Utility interruptions and failures may involve electrical power, natural gas, public water and communications systems. These systems are vulnerable to natural hazards as well as intentional disruptions. Franklin County has experienced interruptions and failures of various kinds. Remnant winds of Hurricane Ike in 2008 caused over one-third of the county to lose power. This hazard was ranked No. 11 out of 16.

Hazard Profile

Utility interruptions and failures may involve electrical power, natural gas, public water and communications systems. All of these systems or a combination of these utility systems exist virtually everywhere in the country there are people. Many utilities are localized and serve only one community, while others are regional, often dispersed over a wide area.

To rise to the level of major emergency or disaster, a utility failure would typically be an extended-duration event impacting a significantly populated area. Such might be the case in an extended power outage, a disruption in natural gas delivery, loss of water supply or loss of communication service.

There is increasing interdependency among utility sectors. Electric generation is increasingly dependent on the availability and deliverability of natural gas. Telecommunications systems rely on electricity to run. Electric industry communications rely on telecommunications infrastructure.

Energy infrastructure is potentially vulnerable not only to natural disasters but also to cyber and physical attack. Energy emergencies may develop over time and may impact some groups more than others. An energy supply or price event may develop slowly; effects may seem to be scattered, but they accumulate over time. Energy events may not be regarded as emergencies, but as economic or personal problems.

Causes

More than two-thirds of all power outages in the U.S. are caused by weather-related events, including thunderstorms, ice storms, heavy winds, and lightning strikes, as well as other natural disasters such as floods, hurricanes, or tornadoes. Animals contacting live wires, auto accidents damaging poles or other equipment, and other unknown factors can also cause power outages.

Major Causes of Power Outages

Weather-related	70%
Animals	11%
Unknown	11%
Auto Accidents	4%
Utility Maintenance	4%
Human Error	1%

Total exceeds 100% due to rounding
Source: Edison Electric Institute

Power outages may vary by season and can last from minutes to hours, and even days or weeks, depending on the severity of the event. If a storm causes severe widespread damage, it can take several days to assess the damage and restore power.

Because utilities exist everywhere, damage may occur frequently. Many small events may go unreported. Damage to electrical equipment is not always obvious or immediately visible. Any interruption in electricity will have immediate impact on those affected. Sudden power outages can be frustrating and troublesome, especially when they are prolonged.

Cause and effect are interrelated in telephone system failure. There are two types of communication system failures: call volume overload and infrastructure damage and failure. Which happens first depends on the event. In a hurricane, the first to occur is call volume overload, followed by infrastructure damage and failure. In a tornado, typically, infrastructure damage will happen first, and the effect will be almost immediate.

Factors that could separately or in combination result in energy events include weather, world events, and industry conditions. For example, here are some plausible scenarios:

- Severe winter cold creates an increased demand for heating fuels at the same time as iced-in ports delay terminal deliveries.
- A natural disaster such as a hurricane or ice storm destroys energy delivery infrastructure or hinders its use.
- High summer gasoline demand results in continued refinery production of gasoline and delayed production of home heating oil; cold weather creates demand for home heating oil before inventories are built.
- Political events result in actions against the U.S., such as the oil embargo imposed in the 1970s.
- Terrorist acts or acts of war destroy energy infrastructure or supply, or slow deliveries to key ports due to safety concerns.
- Unexpected refinery outages delay just-in-time production and/or delivery of fuels at a time when storage levels are already low.

Energy resources are interrelated, and disruptions in one type of energy may result in disruptions or issues in other energy markets. Energy disruptions may affect other utility sectors; the electricity and telecommunications sectors in particular are increasingly inter-dependent.

<u>Impact</u>
Utility outages and interruptions can be localized or region-wide. Their greatest impact is generally upon the very young or elderly, who can be expected to have greater health risks associated with resultant loss of heating/cooling systems and with loss of medical equipment that requires a power source. Loss of communications can also adversely affect the provision of emergency services, making it difficult to contact utility providers for emergency assistance. In addition, utility outages can cause significant problems within the financial community should there be a long-term loss of their data communications.

An energy event may stress certain resources which are already stressed (e.g., public assistance programs, shelters) or resources which are not available in all areas (e.g., outreach to elderly and those with special needs), and redirection of other community resources may be necessary.

Events Affecting Ohio

<u>The Northeast Blackout of 2003</u>
The Northeast Blackout of 2003 was a massive widespread power outage throughout parts of the northeastern and midwestern United States and Ontario, Canada, on August 14, 2003. At the time, it was the most widespread electrical blackout in history. The blackout affected an estimated 10 million people in Ontario and 45 million people in eight U.S. states. Eventually, a large triangular area bounded by Lansing, Michigan; Sault Ste. Marie, Ontario; the shore of James Bay, Ottawa; New York; and Toledo was left without power. More than 508 generating units at 265 power plants shut down during the outage.

A joint federal task force was formed by the governments of Canada and the U.S. to oversee the investigation. In February 2004, the U.S. – Canada Power System Outage Task Force released its final report, placing the main cause of the blackout on FirstEnergy Corporation's failure to trim trees in part of its Ohio service area. The report said that a generating plant in Eastlake, Ohio, a suburb of Cleveland, went offline amid high electrical demand that strained high-voltage power lines located in a distant rural setting. Power lines will sag when overloaded. The overloaded power lines later went out of service when they came in contact with "overgrown trees." The cascading effect ultimately forced the shutdown of more than 100 power plants. A software bug that prevented alarms from showing on their control systems exacerbated the situation. After the alarm system failed, the backup server also failed. Therefore, other control centers were not warned until it was too late.

With the power fluctuations on the grid, power plants automatically went into "safe mode" to prevent damage in the case of an overload. This put much of the normally available nuclear power offline. Some areas lost water pressure because pumps didn't have power. This loss of pressure caused potential contamination of the water supply. Four million people in Detroit were under a boil water advisory for four days. Cleveland and New York had sewage spills into waterways, requiring beach closures.

Amtrak's northeast corridor railroad service was stopped north of Philadelphia, and all trains running in and out of New York City were shut down. Passenger screenings at affected airports ceased. Regional airports were shut down for this reason. In New York, flights were cancelled even after power had been restored to the airports because of difficulties accessing electronic ticket information.

Many gas stations were unable to pump fuel due to lack of electricity. This held up transport trucks, unable to continue without refueling. Many oil refineries on the East Coast shut down as a result of the blackout and were slow to resume gasoline production, increasing gasoline prices.

Cellular communication devices were disrupted. This was mainly due to the loss of backup power at the cellular sites, where generators ran out of fuel or cell phone batteries ran out of charge. Wired telephone lines continued to work, although some systems were overwhelmed by the volume of traffic, and millions of home users had only cordless telephones depending on house current.

Cable television systems were disabled, and areas that had power restored could not receive information until power was restored to cable providers. Internet services were similarly disrupted.

Large numbers of factories were closed in the affected area, and others outside the area were forced to close or slow work because of supply problems and the need to conserve energy. Freeway congestion in affected areas disrupted "just-in-time" supply systems.

In Ohio, over 540,000 homes and businesses were without power. In Cleveland, water service stopped because the city is supplied by electric pumps, and backup electricity was available only on a very limited basis. Portions of Akron, Mansfield, Marion and Ashland were without power.

Hurricane Ike, September 14, 2008

The remnants of Hurricane Ike caused massive power outages across Ohio and Kentucky and into western Pennsylvania. The power failure went on record as Ohio's biggest storm-related blackout. Over a million customers were affected. Almost one third of Franklin County was without power.

The National Weather Service issued a high wind warning, forecasting wind gusts of up to 65 mph. The damage rivaled that of the 1974 Xenia tornado. Insurance industry experts say the total could reach $1 billion. Franklin County's cities, schools, and some nonprofit agencies incurred $6.9 million in costs.

Ohio homeowners filed 108,600 claims totaling about $460 million for damage from wind and falling trees, according to the Ohio Insurance Institute. There were 9,254 automobile claims representing $22.7 million and 13,564 commercial property claims totaling $69.1 million.

Utility/Energy Interruption or Failure – References

AEP, What to Do when the Lights Go Out

Duke Energy, Understanding How Power Outages Occur. 2007

Illinois Commerce Commission, Glossary of Interruption Causes – 2007 Annual Franchise Report

Missouri EMA, Missouri Hazard Analysis: Utilities (Interruptions and System Failures. 2007

NY Independent System Operator – Interim Report on the Aug 14, 2003 Blackout

New York State Mitigation Plan – Power Failure, 2008

NERC, North American Electric Reliability Corporation, August 14, 2003 Blackout Investigation, Final Report . 5 April 2004

NERC, Glossary of Terms Used in Reliability Statistics, Updated 20 Apr 2009

NWS Wilmington, Ohio, "Comments on the Remnants of Hurricane Ike by Dr. Jay Hobgood of OSU." [Online] 30 June 2009
http://www.erh.noaa.gov/iln/sept12_2008/hpbgood_ike.html

PUCO, Ohio Energy Reports

Southern California Edison, Power Outage Causes 23 June 2006

Invasive Species - #12

Contents

Hazard Profile 238
Invasive Species in the United States 242
Invasive Species in Ohio and Franklin County 243

Hazard Summary

Invasive species are defined as any species that is not native to an ecosystem and whose introduction causes or is likely to cause harm to the economy, environment, or human health. An increasing threat of exotic diseases, such as the dangerous West Nile virus, exists because of increased transportation and encroachment of humans into previously remote ecosystems. Two events that have caused substantial economic and environmental damage in Ohio are the introduction of zebra mussels into waterways and the incursion of the emerald ash borer, responsible for killing ash trees. This hazard was ranked No. 12 out of 16.

Hazard Profile

America is under siege by many harmful non-native species of plants, animals, and microorganisms. More than 6,500 nonindigenous species are now established in the United States, posing risks to native species, valued ecosystems, and human and wildlife health. Many invaders cause huge losses in agriculture, livestock, fisheries, and other resource production systems. Some significantly alter ecosystems, resulting in costly damages due to increases in fire, flooding and erosion. A few are vectors, or carriers, of human diseases. By some estimates, the current annual environmental, economic, and health-related costs of invasive species may even exceed those of all other natural disasters combined.

The United States Geological Survey defines invasive species as any species that is not native to an ecosystem and whose introduction does (or is likely to) cause harm to the economy, environment, or human health. Invasive species comprise "biological pollution," which (unlike chemical pollution) multiplies on its own, often explosively, with far-reaching consequences. Many invaders often go unnoticed until they have spread to many locations, making eradication difficult.

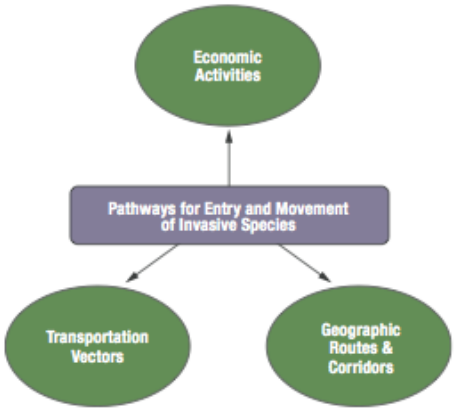
Increased global travel and trade provides pathways for both intentional and unintentional introductions of invasive species. Many species introduced for beneficial purposes are now harmful. An example is kudzu, which was first planted in the U.S. for erosion control. Over 80% of tree and shrub invaders in the U.S. arrived as landscape plants. Accidental introductions often hitchhike across borders where they are not expected. Zebra mussels traveled to the Great Lakes unnoticed in ballast water from Europe. The chestnut blight fungus arrived with imported ornamental trees from Asia and destroyed the American chestnut during the early 20th century.

from left to right: kudzu-covered landscape, zebra mussel, and chestnut blight fungus

Source: USGS

Movement Pathways

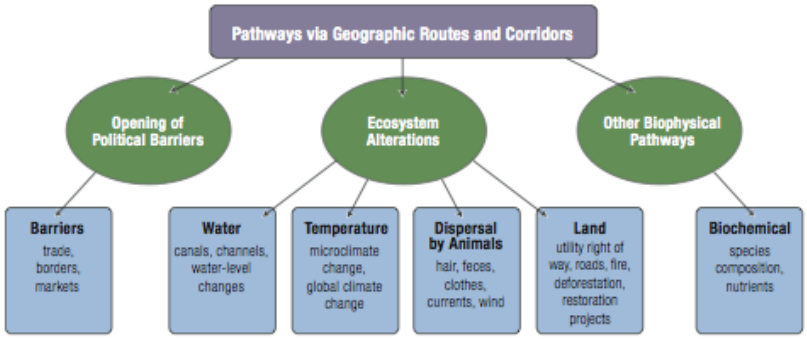
The mechanism by which species reach new habitats is called "pathways." Pathways are the geographic routes that non-native species take, the economic activities that involve them, and the means of transportation that carry them. Pathways operate at all levels, from local to global, and almost all are related to human activity. Commerce in goods and services, recreational and business travel, and changes in land use all facilitate the introduction of new species to new places every day.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

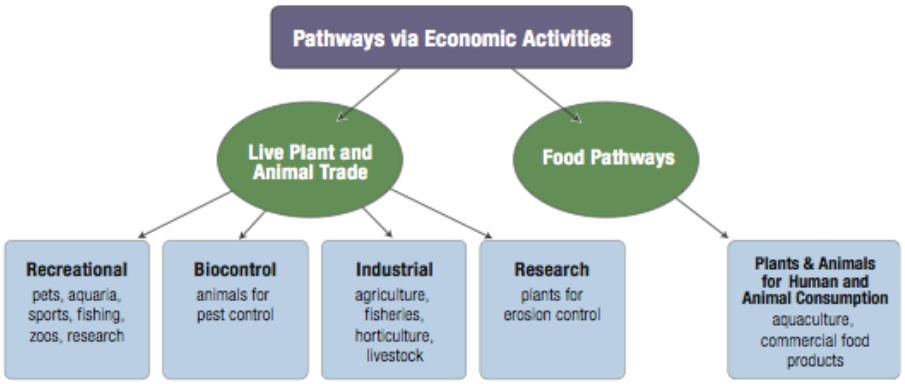
Geographic routes and corridors – Non-native species can move into new areas when barriers are removed or altered; highways, canals, and trade routes provide such opportunities. Canals connect water bodies, and highways, railways, and tunnels cross mountains and link valleys. Today, modern modes of travel provide access to places previously inaccessible, and political, social, and economic barriers that once isolated large parts of the world are mostly gone. Together, these changes provide extensive routes and corridors not only for the movement of people but also for other species.

The movement of species is greatly facilitated by infrastructure. Artificial waterways have been built to link bodies of water, especially in the Great Lakes region. The end points, direction, and frequency of travel in maritime trade all influence movement of species. Ships tend to ply established routes, so the same species are likely to be introduced many times, increasing the probability of successful establishment in a new habitat. Roadsides provide a conduit of movement of seeds or parts of plants, either by wind or attached to animals or vehicles. In some cases, the problem is exacerbated by the intentional planting of non-native invasives along roads for aesthetic, erosion control or other reasons.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

Economic Activities – Numerous economic activities drive interstate and international trade in live plants and animals. Commercial trade can allow non-native plants and animals to escape and spread. Horticulture, the aquarium and pet trades, zoos, botanical gardens, and agriculture are some of the significant pathways of intentional introduction. These intentionally introduced species may cause little or no harm, or they may be labeled invasive if unintended negative consequences result. Unintentional introductions are a side effect of these economic activities. Species hitchhike in transported soil, on vegetation, on animal fur, or with human travelers.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

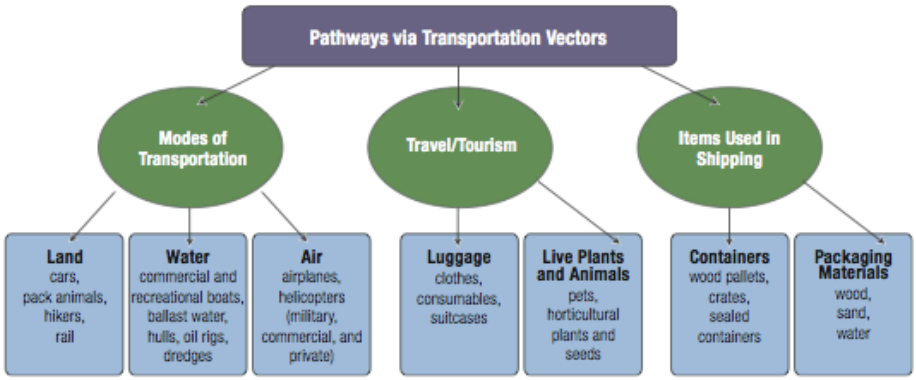
Transportation Vectors – Goods and organisms move from place to place by countless means. Invasives may hitchhike on transport vessels themselves, in packaging and storage containers, on clothes, and inside the bodies of living things (including humans). Typically, a species arrives by one pathway and spreads by another. Any single species may arrive repeatedly from different parts of the world.

Ballast water from ocean-going vessels has created a global dispersal mechanism for plant and animal non-native aquatic species. An estimated 7,000 species of plants and animals are transported around the world in ships' ballast water each day. They can then travel from one body of water to another via recreational boats. Since 1993, ships entering the Great Lakes have first been required to exchange the fresh or estuarine ballast water that they pick up in other ports for ocean water. Ideally, this water's high salinity kills any potential freshwater invaders. But discoveries of new non-native species continue to increase with the intensity of shipping in the Great Lakes.

Aquatic non-natives can attach to hulls, decks, propellers, or other physical parts of ships and watercraft. Boats can also transport non-native species in live wells, bait buckets, and other places where water is carried.

Wooden cases and pallets, as well as materials such as straw or wood chips that are used to protect the contents of shipping containers, can harbor hitchhikers. Bark beetles, one of the most damaging groups of insects worldwide, are often transported in the packing material within a ship's cargo.

Travelers and tourists move plants, insects, and diseases, sometimes accidentally and sometimes intentionally.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

Impacts of Invasive Species

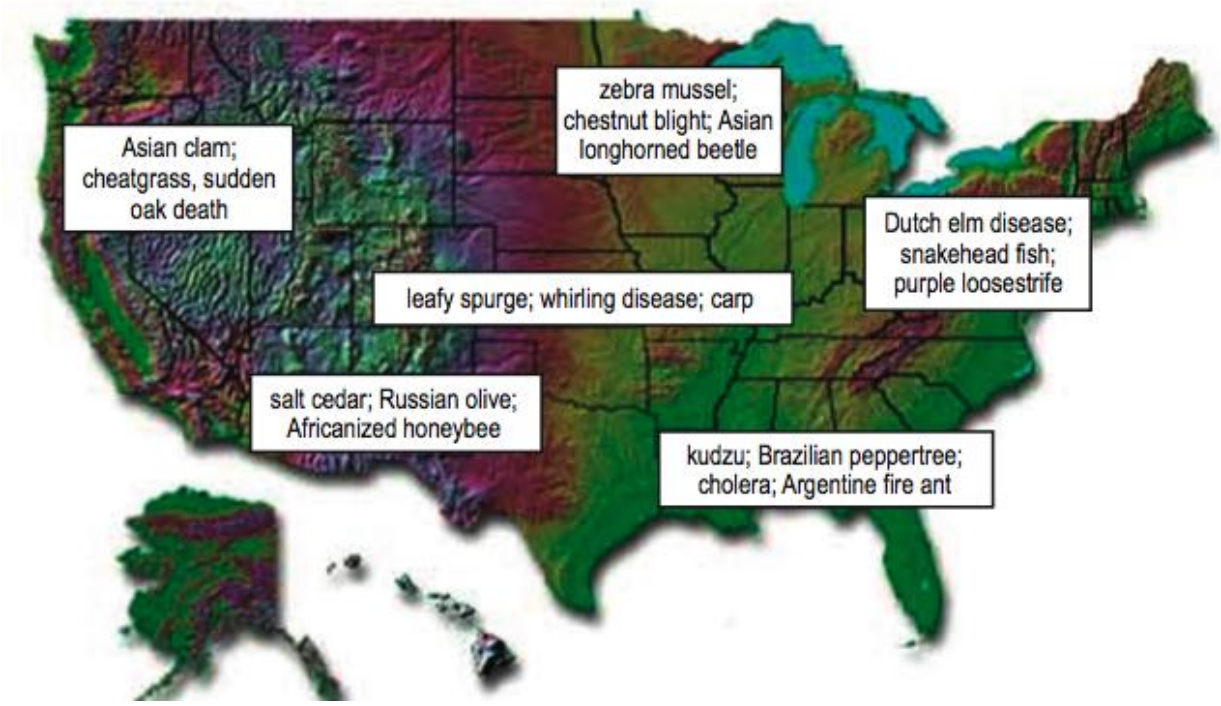
Invasive species have destructive effects that can be economic, environmental, or health-related, but are not always easy to measure and not necessarily obvious. Putting a dollar value on the impacts of invasive species is not a straightforward process. While some economic costs, such as those of the labor and pesticides used for control of a species, are direct, other costs – such as losses to fisheries, recreation or crops – are indirect. Still others, such as impacts on native species or damage to ecosystems, do not have a monetary value.

Insect pests kill trees, thereby affecting the forestry industry. Aquatic plants and animals outcompete or hybridize with native populations, obstruct cooling systems, damage docks, hurt the fishing industry, and reduce recreational opportunities. Invasive plants increase the environment's susceptibility to erosion, wildfires, and flood events, with each having their own effect on the environment. They can also alter the soil chemistry and reduce the water table levels.

An increasing threat of exotic diseases exists because of increased transportation and encroachment of humans into previously remote ecosystems. This can lead to new associations between a disease and a human host. Introduced birds, rodents, and insects can serve as vectors and reservoirs of human diseases. Throughout recorded history, epidemics of human diseases such as malaria, yellow fever, typhus and bubonic plague have been associated with these vectors. A recent example of an introduced disease is the spread of the West Nile Virus across North America from birds brought to a New York zoo, resulting in deaths of humans, birds, mammals, and reptiles. The full range of impacts of invasive species and their control goes beyond immediate effects and can have long term public health implications.

Invasive Species in the United States

Hundreds of species from other countries arrive in the United States unintentionally each year – and introductions are on the rise. The current environmental, economic, and health-related costs of invasive species could exceed $138 billion per year – more than all other natural disasters combined. Current notorious examples can be seen on the map below.



Source: National Biological Information Infrastructure

In the United States alone, scientists estimate that about 7,000 invasive species of plants, mammals, birds, amphibians, reptiles, fish, arthropods, and mollusks are established. Invasive species adversely affect every ecosystem in the United States, from Alaska to Florida, from urban centers to wilderness.

Plants – Most alien plants now established in the United States were introduced for food, fiber, or ornamental purposes. An estimated 5,000 plant species have escaped and now exist in U.S. natural ecosystems, compared with a total of about 17,000 native U.S. plants. Most of the alien plants established in the U.S. natural ecosystems have displaced several native plant species. Many introduced plant species established in the wild are having a negative effect on U.S. national parks.

Mammals – About 20 species of mammals have been introduced into the United States; these include dogs, cats, horses, burros, cattle, sheep, pigs, goats, and deer. Several of these species have escaped or were released into the wild; many have become pests by preying on native animals, grazing on vegetation, or intensifying soil erosion. Many small animals

have also been introduced into the U.S. These include a number of rodents that have become serious pests on farms, in industries, and in homes.

Birds – About 97 of the 1,000 bird species in the United States are exotic. Of the 97 introduced bird species, only 5% are considered beneficial, while most (56%) are pests. Several species, including chickens and pigeons, were introduced into the United States for agricultural purposes.

Amphibians and reptiles – About 53 species of amphibians and reptiles have been introduced into the United States. All these alien species occur in states where it seldom freezes. The negative ecological impacts of a few of these exotic species have been enormous.

Fish – A total of 138 alien fish species have been introduced into the United States. Most of these introduced fish have been established in states with mild climates. Forty-four native species of fish are threatened or endangered by alien invasive fish.

Arthropods – Thousands of arthropod species have been introduced in the country. More than 95% of these introductions were accidental, with many species gaining entrance via plants or through soil and water ballast from ships.

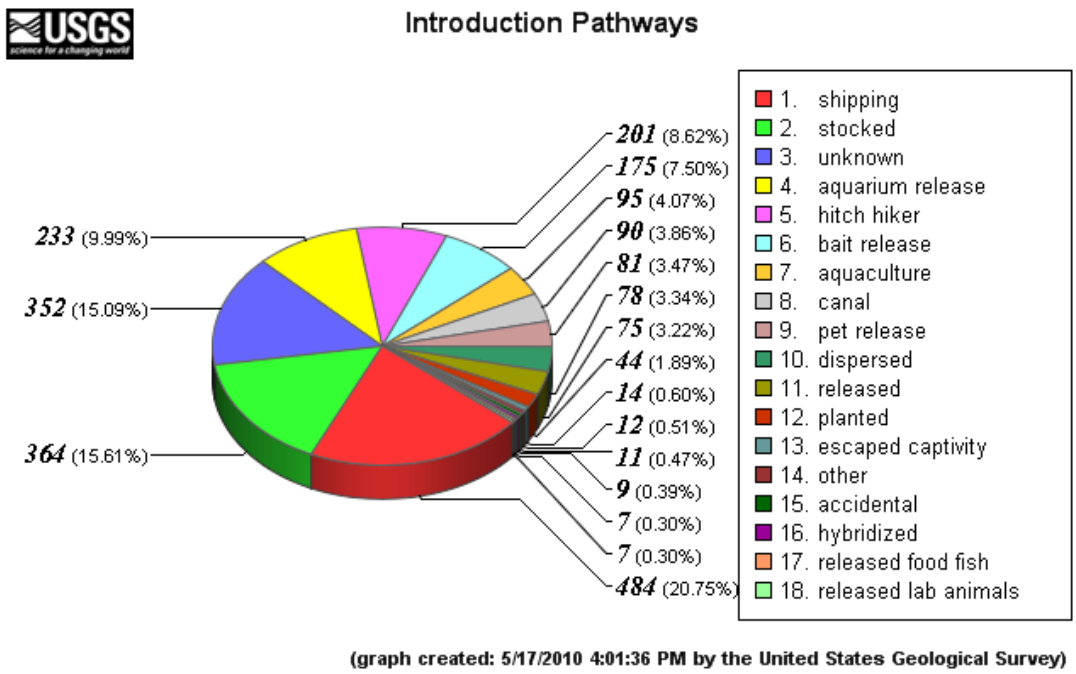
Mollusks – Eighty-eight species of mollusks have been introduced and established in the U.S. aquatic ecosystems. Three of the most serious pests are the zebra mussel, Asian clam, and quagga mussels.

Overall, the number of non-native species in the United States has grown exponentially in recent years, along with the international trade that primarily brings them.

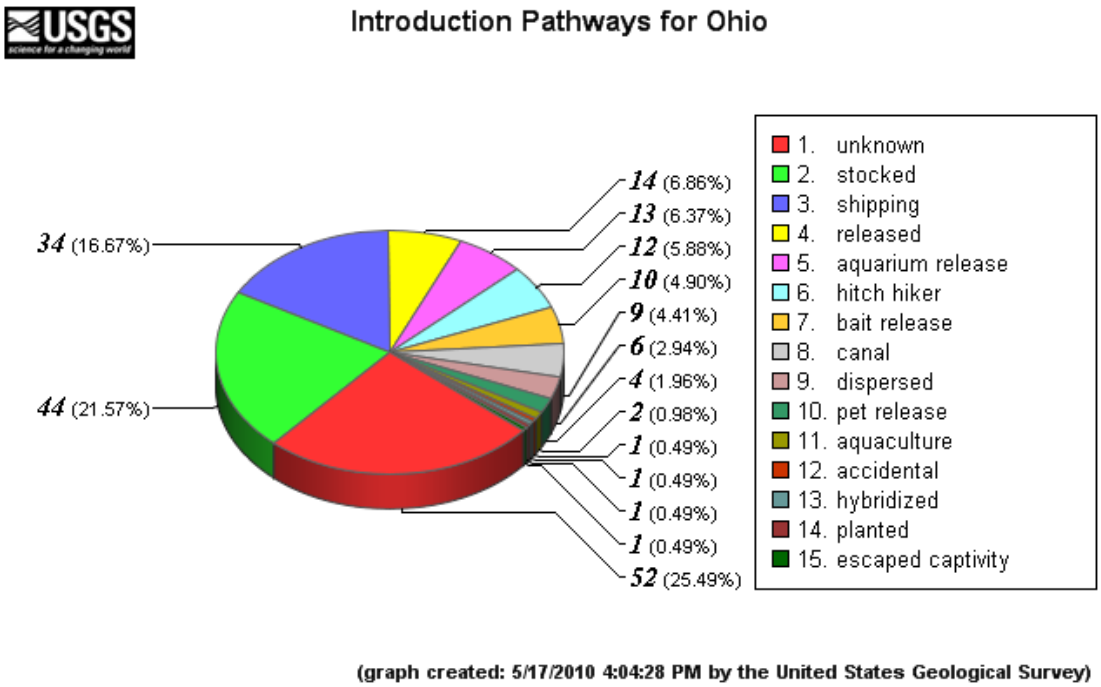
Invasive Species in Ohio and Franklin County

Like infectious diseases, invasive species can travel beyond the borders of any one state or county. Therefore, Franklin County and the State of Ohio will be discussed together in this one section.

Ohio is a major player in interstate and global trade. With a thousand miles of navigable waterways, the 10th largest highway network in the nation, and international seaports, the state is a hub for commerce. Once the nation's leading agricultural state, it is now the second highest in manufacturing output. Sixty percent of all U.S. households lie within 600 miles of Ohio, and more than 50% of the Canadian market is within the same range. While this is good for the state's economy, it also provides the circumstances for entry and establishment of damaging non-native species, which arrive through canals, shipping containers, ships' ballast water, the intentional import of live commercial plants and animals, and many other mechanisms.



Each category represents a combination of species introduced into the U.S. via a pathway. A single species can be introduced by more than one pathway and may therefore be counted more than once.



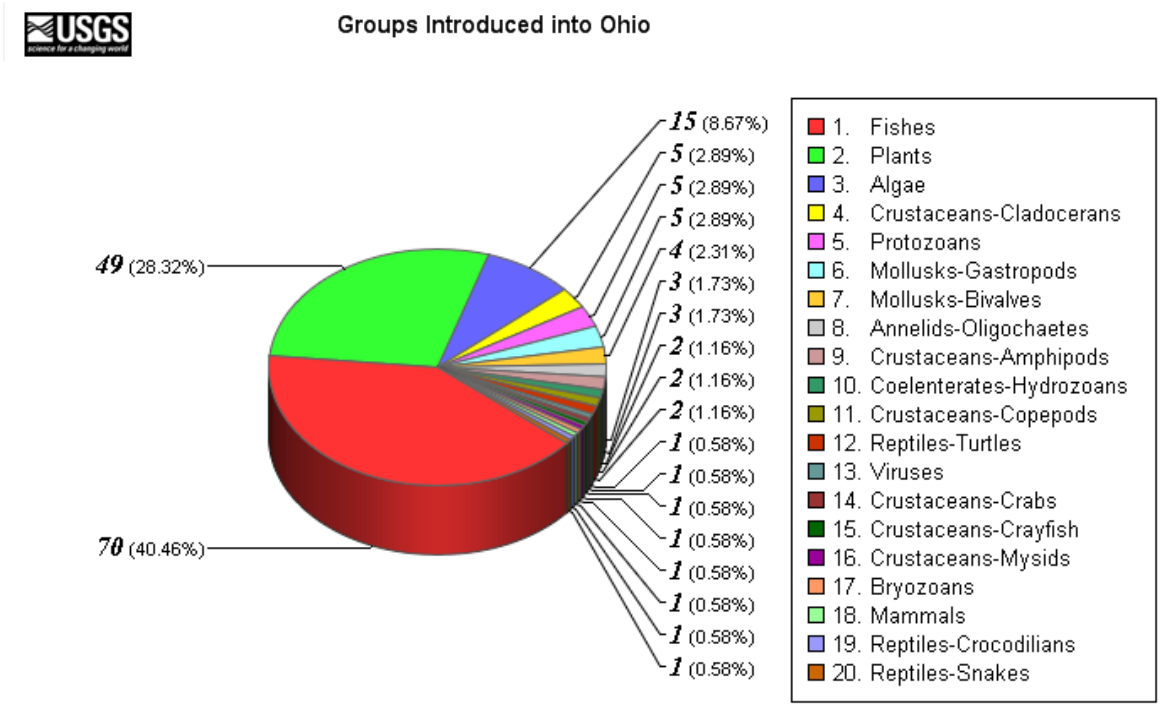
Each category represents a combination of species introduced via a pathway. A single species can be introduced by more than one pathway and may therefore be counted more than once.

Source: USGS

Non-native species arrive in Ohio from all parts of the world and by a variety of pathways, which continue to expand and change over time. Organisms arrive by intent – for commercial exchange – or unintentionally, as hitchhikers in the constant movement of goods and people from place to place.

These invasive species have affected all of the state's economic sectors, including agriculture, fisheries, forestry, energy production, and recreation. Invaders cost at least tens of millions of dollars each year, and damage could reach into the billions.

Aquatic Species – Of the 1,555 species of non-native aquatic species identified in the United States and its territories, 145 are found in Ohio's waters. Fish alone account for almost half of these species, and aquatic plants another 22%.



This graph shows the proportion of species that have been introduced into the United States that belong to various taxonomic groups.

Source: USGS, Center for Aquatic Resource Studies, Nonindigenous Aquatic Species Program

Plants – Three thousand plant species are known to occur in Ohio. Of these, approximately 25% are non-native. The Ohio Department of Natural Resources (ODNR) and The Nature Conservancy have identified more than 60 of these plants as invasive to Ohio's nature preserves, wildlife areas, parks, and forests. Ten that are considered the worst are listed in the following table.

Ohio's Top Ten Invasive Plants

Common Name	Scientific Name
Autumn-olive	*Elaeagnus umbellate*
Bush honeysuckles: Amur, Tatarian, and Morrow's	*Lonicera maackii, L. tatarica, L. morrowii*
Buckthorns: alder (or glossy), and European (or common)	*Frangula alnus, Rhamnus cathartica*
Common reed	*Phragmites australis*
Garlic mustard	*Alliaria petiolata*
Japanese honeysuckle	*Lonicera japonica*
Japanese knotweed	*Polygonum cuspidatum*
Multiflora rose	*Rosa multiflora*
Purple loosestrife	*Lythrum salicaria*
Reed canarygrass	*Phalaris arundinacea*

Source: ODNR, Division of Natural Areas and Preserves

Terrestrial Invertebrates, Vertebrates, and Pathogens – A number of invasive terrestrial animals and pathogens cause considerable damage in Ohio. Vertebrates include the Norway rat, English sparrow, European starling, and common rock pigeons. These species are found in Ohio's cities as well as most of the United States.

Invasive insect and plant pathogens (including bacteria, viruses, and fungi) are some of the costliest invaders. Among insects, the Asian longhorned beetle, emerald ash borer, hemlock wooly adelgid and European gypsy moth are considered the worst.

Fungal diseases also cause considerable damage to trees and forests. They include beech bark disease, chestnut blight, Dutch elm disease and sudden oak death. Insects and pathogens affect animals as well, with West Nile Virus probably being the best-known example.

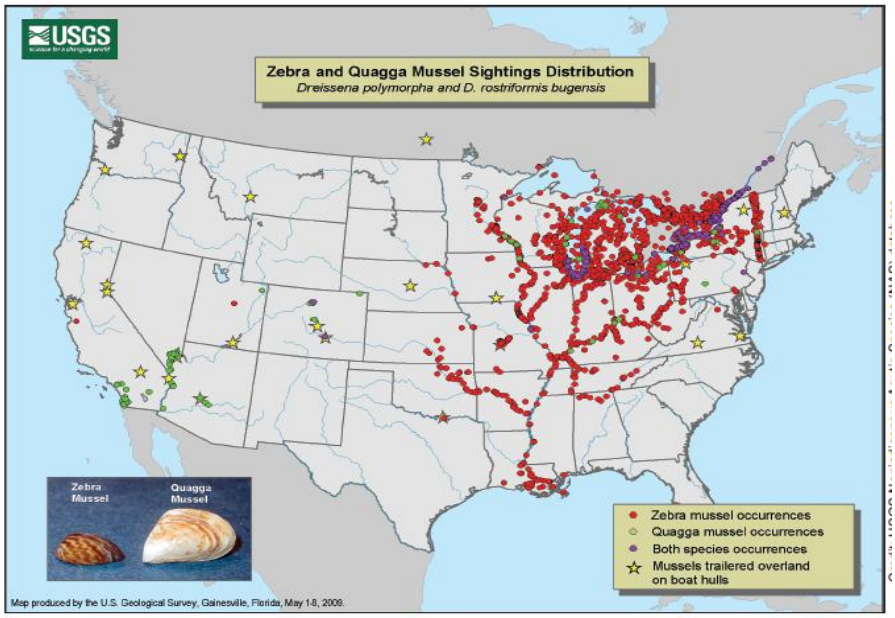
Impact of Invasive Species in Ohio

Of the invasive species in Ohio, two that pose some of the greatest economic and environmental threats are the zebra mussel and the emerald ash borer. Each has already caused a substantial amount of economic and environmental damage in the state and is expected to do more.

Zebra Mussels – These small invertebrates, who originated in the Black and Caspian Seas, are thought to have arrived in ballast water in the Great Lakes in the 1980s. They are now found throughout the Great Lakes and in inland waters of Ohio and other states, and rank as one of the most costly aquatic invasions in the United States. These mussels outcompete native species, alter water quality, and damage industrial equipment. The zebra mussel slows or blocks flow through the water intakes of municipal water systems, electric generating plants, and factories that draw cooling water from the Great Lakes or their tributaries.

Once in the water bodies, zebra mussels reproduce rapidly and are spread further via ships' ballast water-exchanges, recreational boating, and water currents. They will attach to any unprotected surface. Zebra mussels are particularly good travelers and can survive in small amounts of water. Examinations of recreational boats have found larval and adult zebra mussels in all of their onboard water. In boats taken out of the water frequently, adult zebra mussels have been found attached to transportation trailers.

From 1993 to 2003, rapidly multiplying zebra mussels caused $3 billion in damage to the Great Lakes region. One Michigan town lost water for three days after a mussel colony clogged its water-intake pipe. Great Lakes officials estimate that $5 billion will be spent in ten years on zebra mussel control.



Source: USGS

Emerald Ash Borer – The emerald ash borer arrived from Asia in wooden packing material carried in cargo ships and airplanes. First identified in Michigan in 2002 and confirmed in Ohio in 2003, it continues to expand into neighboring states.

The emerald ash borer first entered Ohio from Michigan in infested nursery stock and is now spreading primarily through the pathways of firewood and other ash products. There are federal and state quarantines on specific areas of Ohio. More than one-third of Ohio's counties had been federally quarantined as of April 1, 2008. The movement of ash trees, ash tree materials, and hardwood firewood out of the state is prohibited without certification from the U.S. Department of Agricultural (USDA). There is also an intrastate quarantine. The Ohio Department of Agriculture prohibits movement of these materials out of the 41 counties on its quarantine list.

Ohio Counties under Quarantine for Emerald Ash Borer

Source: Ohio Department of Agriculture, Division of Industry

Because ash is one of the most commonly planted shade trees, the cost of removing and disposing of dead and dying ash trees has severely strained the budgets of municipalities and property owners. Statewide, removing the estimated one to four million ash trees

currently growing in Ohio's parks, along streets, and on private property is expected to cost between $700 million and $2.9 billion. The cost to replace each ash tree with another small shade tree is estimated at an additional $300 million to $1.3 billion.

In Franklin County, the emerald ash borer has been concentrated in the northeastern part of the county, but just recently was identified in Bexley and other communities.

Invasive Species – References

National Biological Information Infrastructure, Invasive Species Information Node. June 2009

OEMA, State of Ohio Mitigation Plan

Pimenetel, David, Zungia, R., Morrison, D., Update on the Environmental and Economic Costa Associated with Alien-invasive species in the United States. Ecological Economics article in press

USDA, "Invasive Species Management." [Online] 10 July 2009 http://www.ers.usda.gov/Briefing/InvasiveSpecies/

USGS, "Invasive Species Program." [Online] 10 July 2009 http://biology.usgs/Invasive/

Windle, Phillis N., Kranz, Rhonda h., La,Monica, Invasive Species in Ohio, Pathways, Policies, and Costs. Union of Concerned Scientists, Oct 2008

Air and Water Pollution/Contamination - #13

Contents

Hazard Profile 252
Air Pollution/Contamination 252
Water Pollution/Contamination 253
Clean Air and Water Laws 255

Hazard Summary

Pollution refers to the contamination of water, land or the air by substances that can adversely impact the environment and human health. Franklin County is subject to point and nonpoint water pollution of streams, as well as ground level ozone. This hazard was ranked No. 13 out of 16.

Hazard Profile

Pollution refers to the contamination of water, land or the air by substances that can adversely impact the environment and human health. Usually these substances are waste materials. Sometimes it is not the type of material but its concentration that determines if it is a pollutant. For example, nutrients such as nitrogen and phosphorus are essential elements for plant growth. If they are overabundant in a body of water, however, they can lead to conditions that have a negative effect on people's health.

Air Pollution/Contamination

Causes of Air Pollution

Air pollution is caused when the air gets filled with too much gas, particulate matter, and droplets of liquid. In cities, the air gets polluted by the exhaust fumes of vehicles, along with the pollutants given off by construction work and industry. In rural areas, dust given off by tractors, vehicles being driven on gravel or dirt tracks, smoke given off by crop and wood burning, and work in rock quarries are some of the causes of air pollution.

Every industrial process exhibits its own pattern of air pollution. Petroleum refineries are responsible for extensive hydrocarbon and particulate pollution. Iron and steel mills, metal smelters, pulp and paper mills, chemical plants, and cement and asphalt plants all discharge vast amounts of various particulates. Uninsulated high-voltage power lines ionize the adjacent air, forming ozone and other hazardous pollutants. Airborne pollutants from other sources include insecticides, herbicides, radioactive fallout and dust from fertilizers, mining operations, and livestock feedlots.

Facts about Air Pollution
American Lung Association

- The health of 137.2 million Americans – including as many as 29.8 million children under the age of 14 and close to 2 million children suffering from asthma attacks – are potentially exposed to unhealthful levels of ozone (smog) air pollution, based on the current 0.08 parts per million federal ozone standard.
- Scientific evidence increasingly shows that air pollution plays a major role as a trigger for asthma episodes. Specifically, fine particles, sulfur dioxide and ozone have been linked to increases in patients' use of asthma medication, emergency department visits and hospital admissions.
- Power plant particle pollution is estimated to cause more than 603,000 asthma episodes per year, 366,000 of which could be avoided by cleaning up the power plants.
- Estimates of the annual human health costs of outdoor air pollution range from $14 billion to $55 billion annually.
- Each year, pollution claims 70,000 lives in the U.S.
- Globally, an estimated 200,000 to 570,000 people die each year from ambient air pollution.

The Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards for six common air pollutants. These commonly found air pollutants (also known as "criteria pollutants") are found all over the United States. They are as follows:

- Ozone – can be found at ground level or miles above the planet. Its effects can be negative or positive depending on its location in the atmosphere. Low level ozone in the lower atmosphere, or ground level, is negative because it creates health dangers such as smog and is believed to contribute to the effects of global warming. Low level ozone is mostly produced by car exhausts and industrial emissions.
- Particulate matter – can be produced by power plants, car exhausts, forest fires, and some industries. These particles are particularly dangerous to health because they fall into the category of fine particles 2.5 micrometer in diameter or smaller. Fine particles can pass through the throat and nose to the lungs, causing breathing problems.
- Carbon Monoxide – is a odorless gas formed from incomplete burning of fossil fuels. Fifty-six percent of all such emissions come from automobiles burning gasoline.
- Nitrogen Oxides – are highly reactive gases. They can be odorless and colorless. The reddish-brown smog seen hanging over large metropolitan areas is attributable to nitrogen dioxide. Nitrogen oxides such as nitrogen dioxide, nitric acid, nitrous oxide, and other nitrates create smog at lower levels and acid rain at higher levels. Many health problems are related to these compounds.
- Sulfur Dioxide – is formed by the burning of fuel containing sulfur. A major contributor is the burning of coal and oil. People who can suffer from this pollution are the elderly, children, asthma sufferers, and those with heart or lung problems.
- Lead – can be found in some household products, including children's toys. It can also be found in the atmosphere due to the emissions of motor vehicles and some industrial plants. Lead can be introduced into the atmosphere by the burning of waste. When taken into the body, lead accumulates in bones. It can cause nervous system, kidney, immune, reproductive, and cardiovascular system problems.

For each of these pollutants, the EPA tracks two kinds of air pollution trends: air concentrations based on actual measurements of pollutant concentrations in the ambient air at selected monitoring sites throughout the country, and emissions based on engineering estimates of the total tons of pollutants released into the air each year.

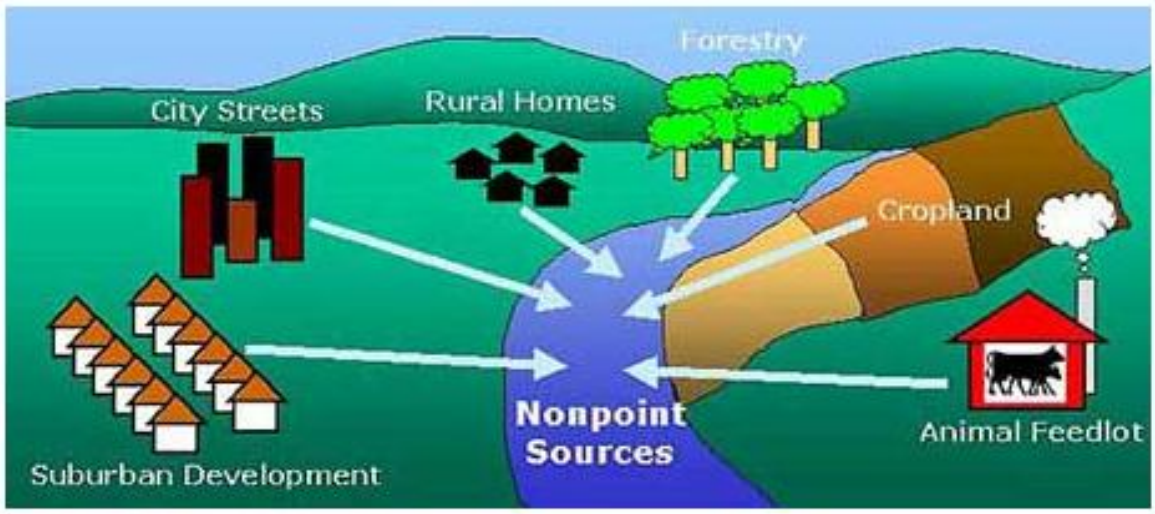
Water Pollution/Contamination

Pollution affecting water quality may come from point or nonpoint sources, or a combination of both. The EPA defines point source pollution as "any single identifiable source of pollution from which pollutants are discharged such as a pipe, ditch, ship or factory smokestack." Factories and sewage treatment plants are two common types of point sources. Unregulated discharges from point sources can result in water pollution and unsafe drinking water, and can restrict activities like fishing and swimming.

An example of harmful point pollution was the release of Hexavalent Chromium in the ground by Pacific Gas and Electric at their plant in Hinkley, California, in 1993. Hexavalent Chromium was found in well water in the town, and the company covered up knowledge of the pollution. Community members suffered medical conditions ranging from nosebleeds to cancer. The situation was exposed by a legal assistant investigating on her own and documented in the movie "Erin Brockovich."

Nonpoint source pollution comes from many diffuse sources. Nonpoint pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and underground sources of drinking water.

Sources of Nonpoint Pollution



Source: NOAA

According to the USDA and other state and federal agencies, most nonpoint pollutants fall into six major categories.

Nonpoint Source Pollutants and Major Sources

Sediment	Nutrients (Fertilizers, Grease, Organic Matter)	Acids and Salts	Heavy Metals (Lead, Mercury, Zinc)	Toxic Chemicals (Pesticides, Organic, Inorganic Compounds)	Pathogens (Bacteria, Viruses)
• Construction Sites • Mining Operations • Croplands • Logging Operations • Streambank Erosion • Shoreline Erosion • Grazed Woodland	• Croplands • Nurseries • Orchards • Livestock Operations • Gardens, Lawns, Forests • Petroleum Storage Areas • Landfills	• Irrigated Lands • Mining Operations • Urban Runoff, Roads, Parking Lots • Landfills	• Mining Operations • Vehicle Emissions • Urban Runoff, Roads, Parking Lots • Landfills	• Croplands, • Nurseries, Orchards • Building Sites • Gardens, Lawns • Landfills	• Domestic Sewage • Livestock Waste • Landfills

Source: OSU Extension Fact Sheet: Nonpoint Source Pollution: Water Primer

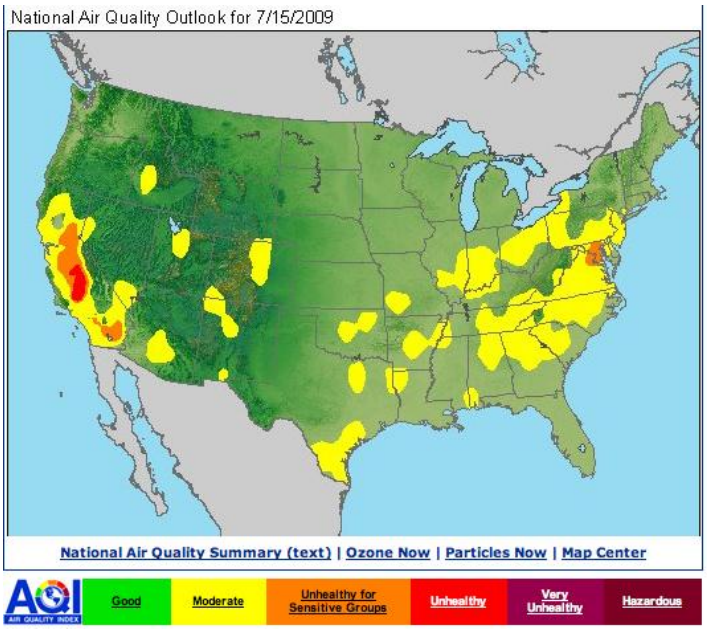
Concentration of some pollutants from runoff may be lower than the concentration from a point source. The total amount of a pollutant delivered from nonpoint sources may be higher – and is more difficult to control – because the pollutants come from many places. It also varies over time in terms of the flow and the types of pollutants it contains.

The Ohio EPA and ODNR have identified 13,000 stream miles in Ohio that have been affected by nonpoint source pollution. Franklin County contains portions of several streams and their tributaries that have been classified as being affected by nonpoint pollution.

Clean Air and Water Laws

Pollution and contamination prevention is much easier than cleaning up after the fact. This has led to a series of federal and state laws and regulations, but not until hard lessons had been learned.

Clean Air Laws



In the town of Donora, Pennsylvania, population 14,000, October 26 to 31, 1948, 20 people died and 7,000 became ill in one of the worst pollution incidents in history. The town was accustomed to air pollution and smog from the zinc and iron works that dominated the town. On a heavily foggy night, sulfur dioxide fumes from the zinc works mixed with fog to produce a sulfuric acid mist that settled over the town. The nation was outraged. The incident led to the passage of the Air Pollution Control Act of 1955. This was the first federal attempt to control air pollution. Since then, clean air legislation has been revised and strengthened. The Clean Air Act of 1990 set limits on the discharge of air pollutants from industrial facilities and motor vehicles and addressed acid rain and ozone depletion.

The EPA has established national air quality standards to protect public health. The Air Quality Index (AQI) is an index for reporting daily air quality. It reports how clean or polluted the air is and what associated health effects might be of concern. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.

Year-round, the Mid Ohio Planning Commission (MORPC) monitors ground-level ozone and particle pollution levels and issues daily air quality forecasts for all of Central Ohio. When

there is a potential for high pollution levels, usually on hot, sunny days, an Air Quality Alert may be issued – at first for sensitive groups and then for everyone else as levels get higher. The community is alerted through the local media, MORPC website, and the Central Ohio Air Quality Hotline.

Clean Water Laws

Like clean air laws, the passage of clean water laws was spurred by an event. The Cuyahoga River in Cleveland, Ohio, had a history of catching on fire since 1936. On June 22, 1969, an oil slick and debris in the river caught fire. The fire lasted just thirty minutes but received national attention with an article in TIME magazine. The magazine described the river as "chocolate-brown, oily, bubbling with subsurface gases, it oozes rather than flows." The event led to the passage of the Clean Water Act in 1972. The U.S. EPA set standards to regulate the discharge of industrial and municipal waste – so called "end-of-pipe" pollution.

The Ohio EPA, ODNR, and USGS have several programs to monitor and regulate Ohio source waters. These laws have significantly reduced the amount of pollution released into the environment. Grossly contaminated water and air are much less common today than they were 50 years ago. However, there is still concern about the possible risks of continuous low-level exposure to pollutants, and particularly to nonpoint source pollutants.

Air and water pollution are under federal and state regulatory agencies; thus, they are not an emergency management issue except under extreme and acute circumstances.

Air and Water Contamination/Pollution – References

AIRnow, "Air Quality Index (AQI) – A Guide to Air Quality and Your Health." [Online] 14 July 2009 www.epa.gov/airnow/aqi_brochure_08-09.pdf

MORPC, "Air Quality." [Online] 14 July 2009
http://www.morpc.org/energy/center/AirQuality.asp

NOAA, "Nonpoint Source Pollution." [Online] 15 July 2009
http://oceanservice.noaa.gov/education/kits/pollution/04nonpointsource.html

ODNR., "Protection and Preservation Programs." [Online] 15 July 2009
http://www/dnr.state.oh.us/

OEPA, Environmental Improvements Achieved through Enforcement in 2005

Ohio Historical Society, "Cuyahoga River Fire." [Online]15 July 2009
http://www.ohiohistorycentral.org/entry.php?rec=1642

OSU, "Nonpoint Source Pollution: Water Primer." [Online] 14 July 2009
http://ohioline.ose.edu/aex-fact/046shtml

OSU, "Water Resources of Franklin County." [Online] 14 July 2009
http://ohioline.ose.edu/aex-fact/0480_25.html

USGS, "Forty Years Later, Cuyahoga River No Longer Burns." [Online] 15 July 2009
http://oh.water.usgs.gov

USEPA, "What are the Six Common Air Pollutants?' [Online] 15 July 2009
http://www/epa.gov/air/urbanair

USEPA, "What is Nonpoint Source Pollution." [Online] 15 July 2009
http://www.epa.gov/owow/nps/ga.html

USGS, "Water Quality Data for Ohio." [Online] 15 July 2009
http://waterdata.usgs.gov/oh/nwis/qwl

Transportation Accident – Aircraft - #14

Contents

Hazard Profile 259
Aircraft Accidents in the United States 262
Aircraft Accidents in Ohio 263
Aircraft Accidents in Franklin County 264

Hazard Summary

An aviation accident is defined as an occurrence associated with the operation of an aircraft which takes place between the time any person boards with the intent to fly and all persons have disembarked, in which a person is fatally or seriously injured, the aircraft sustains damage or structural failure, and/or the aircraft is missing or is completely inaccessible. Franklin County has 4 operational airports, all located in densely populated areas. However, there have been only two reported air crashes in the county. This hazard was ranked No. 14 out of 16.

Hazard Profile

The Convention on International Civil Aviation Annex 13 defines an aviation accident as an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, in which a person is fatally or seriously injured, the aircraft sustains damage or structural failure and/or the aircraft is missing or is completely inaccessible.

Air crashes are an ever-present danger because of the unforgiving nature of flight. Aircraft are designed to minimize the chance of failure, and pilots are trained with safety as a primary consideration. Despite this, accidents still occur, although statistically, flying is arguably the safest form of transport. The relative rarity of incidents, coupled with the often-dramatic outcome, is one reason why they still make headline news. The odds of a plane crash today are distinctly low compared to those in other transportation modes, but the chance of fatalities in such a disaster is notably higher.

Plane crashes with large numbers of casualties started with the early passenger flights of the 1920s. The yearly death toll of plane crashes exceeded 100 for the first time in 1928, and 1000 for the first time in 1943. Since 1945, the number of deaths has fallen below 1,000/year only five times, in 1974, 1975, 2004, 2007, and 2008.

Causes of Fatal Aircraft Accidents

A study compiled by PlaneCrashInfo.com representing 1,300 fatal accidents involving commercial aircraft world-wide from 1950 through 2008 for which a specific cause is known, showed the following results. Aircraft with 10 or less people aboard, military aircraft, private aircraft and helicopters are not included.

Causes of Fatal Accidents by Decade (percentage)

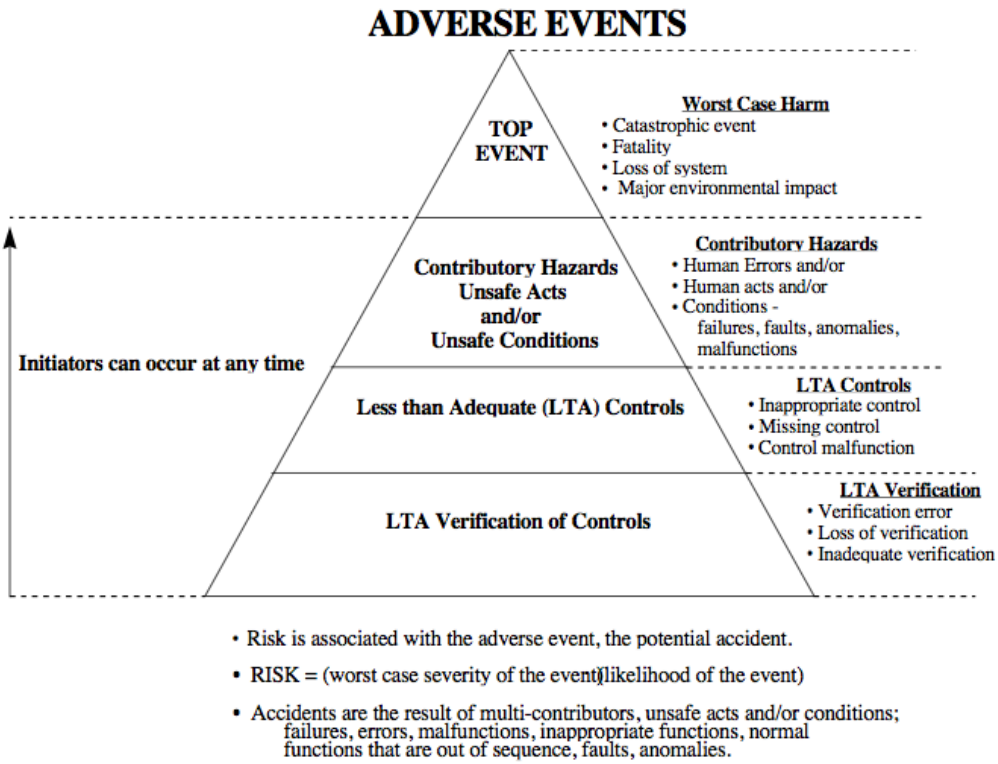
Cause	1950s	1960s	1970s	1980s	1990s	2000s	All
Pilot Error	40	32	24	25	27	25	29
Pilot Error (weather related)	11	18	14	17	21	17	16
Pilot Error (mechanical related)	7	5	4	2	4	3	4
Total Pilot Error	58	57	42	44	53	45	50
Other Human Error	0	8	9	6	8	9	7
Weather	16	10	13	15	9	8	12
Mechanical Failure	21	20	23	21	21	28	22
Sabotage	5	5	11	13	10	9	9
Other Cause	0	2	2	1	0	1	1

Source: PlaneCrashInfo.com

Pilot error was the most reported cause, accounting for an average of 50% of all accidents, followed by mechanical failure at 22%. Roughly, 12% were reported as weather related. A study by Boeing of 183 accidents (134 with known causes) determined the primary cause of airline hull loss accidents from 1996 through 2005 to be:

- 55% Flight crew error
- 17% Airplane
- 13% Weather
- 7% Misc./other
- 5% Air traffic control
- 3% Maintenance

The FAA System Safety Handbook states that accidents are the result of multi-contributors: unsafe acts and/or conditions, failures, errors, malfunctions, inappropriate functions, normal functions that are out of sequence, faults and anomalies.



Source: FAA System Safety Handbook

Aviation Safety

Despite the growing demands on the U.S. aviation system, the system continues to maintain its high level of safety. The accident rate for commercial aircraft has remained about the same for the past two decades. However, increased traffic projected over the next ten years will surely be accompanied by a commensurate increase in the number of aircraft accidents.

Aviation has come a long way in the last 100 years. Heavy passenger aircraft for the civilian market is manufactured by two major companies – Boeing, of the United States, and the European company Airbus. Both place a huge emphasis on safety. When measured on a passenger-distance calculation, air travel is the safest form of transportation available. The following are the figures quoted by the airline industry. For every billion kilometers traveled, trains have a fatality rate 12 times larger than air travel, while automobiles have a fatality rate 62 times larger. However, when measured by fatalities per person transported, buses are the safest form of transportation.

The Federal Code of Regulations classifies commercial carriers as CRF 14 Part 121 and CRF 14 Part 135. Part 121 applies to air carriers, such as major airlines and cargo haulers that fly large transport aircraft. Part 135 applies to commercial carriers commonly referred to as commuter airlines and on-demand air taxi operations. In 1997, the classifications were changed to include Part 135 carriers with 10 or more seats as Part 121. General aviation, or private carriers, are Part 91.

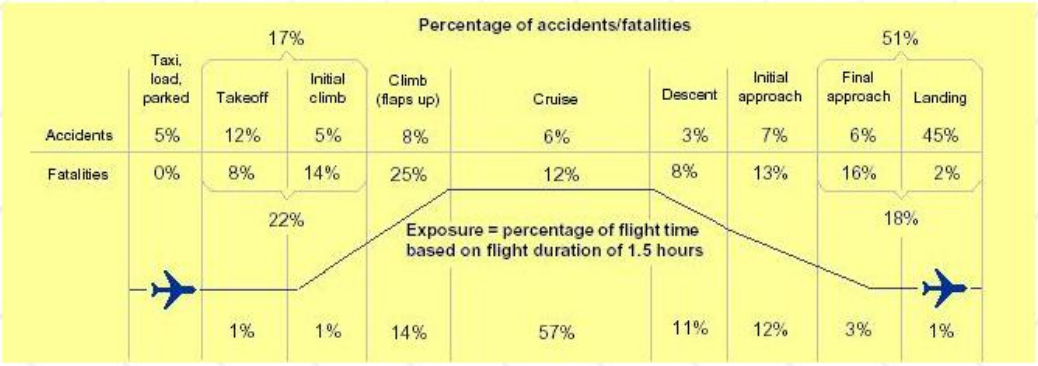
The National Transportation and Safety Board (NTSB) reported the following statistics:

Fatalities by Type of Flight

Source: NTSB Accidents and Accidents Rates by NTSB Classification 1998-2007

Type of Flight	Fatalities per million flight hours
Airliner (Scheduled and nonscheduled Part 121)	4.03
Commuter Airline (Scheduled Part 135)	10.74
Commuter Plane (Nonscheduled Part 135 - Air taxi on demand)	12.24
General Aviation (Private Part 91)	22.43

Airline crashes can happen anywhere. It is known that 16% of all major crashes are low-impact crashes on the airport runway, while 79% are high impact crashes within one and one half miles of the airport. The remaining occur in route.



Source: Statistical Summary of Commercial Jet Airplane Accidents, Boeing

Aircraft Accidents in the United States

The deadliest aviation-related disaster of any kind, considering fatalities on both the aircraft and on the ground, was the destruction of the World Trade Center in New York City on September 11, 2001. The crashes killed 2,988, most of them in the World Trade Center Towers or emergency personnel responding to the disaster.

The NTSB reports the following accidents and accidents rates for U.S. Air Carriers, Part 121, 1989 through 2008.

Table 2. Accidents and Accident Rates by NTSB Classification, 1989 through 2008, for U.S. Air Carriers Operating Under 14 CFR 121

Year	Accidents				Aircraft Hours Flown (Millions)	Accidents per Million Hours Flown			
	Major	Serious	Injury	Damage		Major	Serious	Injury	Damage
1989	8	4	6	10	11.275	0.710	0.355	0.532	0.887
1990	4	3	10	7	12.150	0.329	0.247	0.823	0.576
1991	5	2	10	9	11.781	0.424	0.170	0.849	0.764
1992	3	3	10	2	12.360	0.243	0.243	0.809	0.162
1993	1	2	12	8	12.706	0.079	0.157	0.944	0.630
1994	4	0	12	7	13.124	0.305	0.000	0.914	0.533
1995	3	2	14	17	13.505	0.222	0.148	1.037	1.259
1996	6	0	18	13	13.746	0.436	0.000	1.309	0.946
1997	2	4	24	19	15.838	0.126	0.253	1.515	1.200
1998	0	3	21	26	16.817	0.000	0.178	1.249	1.546
1999	2	2	20	27	17.555	0.114	0.114	1.139	1.538
2000	3	3	20	30	18.299	0.109	0.109	1.093	1.475
2001	5	1	19	21	17.814	0.281	0.056	1.067	1.179
2002	1	1	14	25	17.290	0.058	0.058	0.810	1.446
2003	2	3	24	25	17.468	0.114	0.172	1.374	1.431
2004	4	0	15	11	18.883	0.212	0.000	0.794	0.583
2005	2	3	11	24	19.390	0.103	0.155	0.567	1.238
2006	2	2	7	22	19.263	0.104	0.104	0.363	1.142
2007	0	2	14	12	19.441	0.000	0.103	0.720	0.617
2008	3	1	8	16	19.351	0.155	0.052	0.413	0.827

In the United States, most civil aviation incidents are investigated by the National Transportation Safety Board (NTSB). The NTSB will also investigate incidents which occur overseas in collaboration with local investigation authorities where the crash has involved a U.S.-registered aircraft, where there has been significant loss of American lives, or when the type of aircraft involved was built by an American manufacturer.

Aircraft Accidents in Ohio

The Ohio Department of Transportation, Aviation Division reports the following aviation facts for Ohio:

Ohio Aviation Facts

Air Transportation Facts

- **166** public use airports
  - **106** Public Owned
  - **60** Privately Owned
- **5th** in the Nation for airports included in the Federal Aviation Administration (FAA) National Plan of Integrated Airport Systems
- **84** of **88** Ohio Counties are served by publicly owned airports
- **10,879** FAA registered aircraft and approx. **18,000** FAA registered pilots (2001)

Commercial Service Airports

- Ohio's six commercial service airports enplaned more than **11.2 million** passengers (2004)
- **90%** of Ohio's population is within a **30 minute drive** to one or more airports able to land a business aircraft (5,000 foot long runway)
- Employs **125,500** with a total payroll of $2.7 billion (2004)
- Total Economic Impact of **$8.8 billion** (2004)

Ohio's Entitlement Airports

- Enplane more than 10,000 people per year or land more than 100 million pounds of cargo per year
- Directly funded by the FAA – based on number of passenger enplanements or the weight of air cargo landed
- Ohio has seven entitlement airports
  - Akron-Canton Regional
  - Cleveland Hopkins International
  - Port Columbus International
  - Rickenbacker International
  - James M. Cox Dayton International
  - Toledo Express
  - Youngstown-Warren Regional

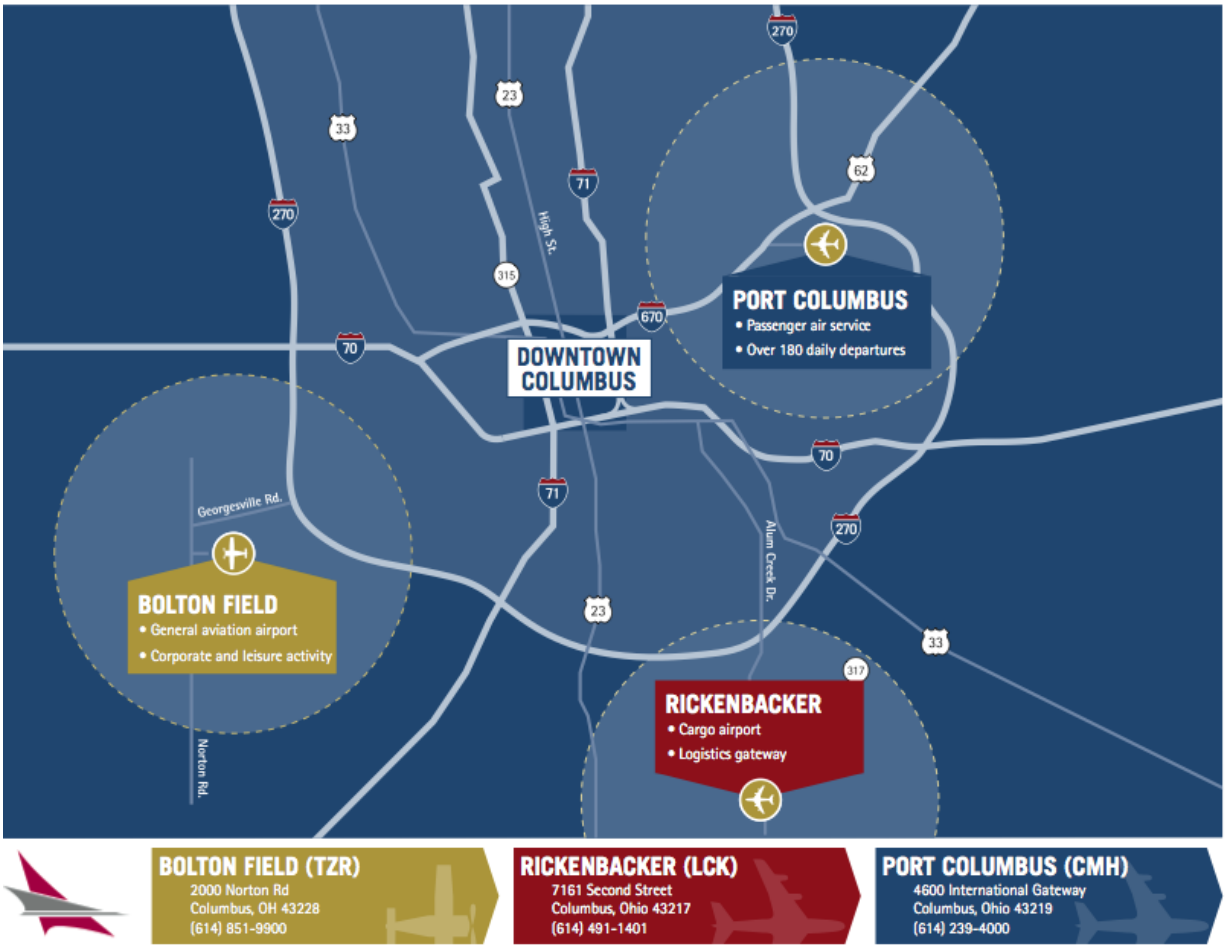
Source: ODOT

There have been 147 air crashes in Ohio since 1920, with total fatalities of 458. Included in these statistics are crashes that occurred on approach to the Greater Cincinnati Airport, which is actually located in Covington, Kentucky. The worst plane crash to take place on Ohio soil was near Marseilles, Ohio. A Lake Central Airlines Convair CV-380 crashed on March 5, 1967, when all four blades fell off the right propeller. The No. 2 blade penetrated and destroyed the structural integrity of the fuselage. All 38 people on board were killed, 35 passengers and three crew.

Aircraft Accidents in Franklin County

Areas adjacent to airports present the greatest potential locations for an aircraft incident. Franklin County has four airports in highly populated areas. Should a plane go down, chances are high it could hit people or property on the ground. This increases the county's vulnerability to an air crash incident. Three of the airports are operated by the Columbus Regional Airport Authority: Port Columbus, Rickenbacker, and Bolton Field. The fourth, Don Scott Field, is operated by The Ohio State University.

Source: Columbus Regional Airport Authority



Nationally, the airports serve as a vital link between the Central Ohio business community and their principal destinations. Businesses benefit from a brief two-hour flight to 60% of the nation's population, 60% of the nation's manufacturing, and 60% of the nation's purchasing power.

Port Columbus

Port Columbus International Airport was opened in 1929 as part of the first Transcontinental Air/Rail Service from New York to the West Coast.

Source: Port Columbus

Over 6.9 million passengers used Port Columbus in 2008, making it the second busiest year in the airport's history behind the 7.7 million in 2007.

Rickenbacker

Rickenbacker is an international cargo-dedicated airport, a multimodal logistics hub, a charter passenger terminal, a U.S. Foreign-Trade Zone, and a major component of the economic engine of Central Ohio.

Bolton Field

Bolton Field, constructed in 1970, serves as a reliever to Port Columbus. It has 5,500 feet of runway and parallel taxiway. It serves corporate and business transportation, aircraft re-fueling and maintenance, aircraft charters, flight training, recreational flying, aerial advertising, and traffic reporting. Events and activities such as fly-ins, banner towing and ballooning also take place on airport grounds.

The Ohio State University Airport – Don Scott Field

Don Scott Field is home to 230 aircraft, including single and multi-engine, piston and turbine engine aircraft and rotorcraft.

In 1967, the crew of a TWA 707 mistook the OSU Airport for Port Columbus. After shuttling all passengers and baggage to Port Columbus, and removing all galley equipment and seats, the plane was light enough to depart for the larger facility across town.

Source: OSU Airport

Even with such proximity to aircraft activity, there have been only two air crashes reported for Franklin County by the NTSB. The first was on January 7, 1994. A United Express Jetstream J4101 commuter plane stalled while executing the ILS approach to runway 28L during a snowstorm. The plane struck a concrete block building about 1.2 miles east of the runway. Seven of the 12 people on board died. The plane was destroyed by a post crash fire. There was damage on the ground to numerous trees, the storage warehouse was destroyed along with heavy mechanical equipment and an automobile, which were inside.

The second reported air crash was on September 1, 2008. A scheduled cargo flight, an Air Tahoma Convair CV-580, took off from Rickenbacker on a flight to Mansfield, Ohio. The pilot radioed he was returning to the airport, but crashed in a cornfield and caught fire. All three people on board died.

Source: Port Columbus

Aircraft Accidents – References

Columbus Regional Airport Authority, "About Bolton Field." [Online] 27 July 2009 http://www.columbusairports.com/bolton

Columbus Regional Airport Authority, "About Port Columbus." [Online] 27 July 2009 http://www.port-columbus.com

Columbus Regional Airport Authority, "About Rickenbacker." [Online] 27 July 2009 http://www.rickenbacker.org

FAA, System Safety Handbook, Chapter 7: Integrated System Hazard Analysis. 30 Dec 2000

NTSB, "Aviation Accident Statistics." [Online] 24 July 2009 http://www.ntsb.gov/aviation

NTSB, Public Aircraft Safety. NTSB #SS-01/01, 2001

NTSB, Risk Factors Associated with Weather-Related General Aviation Accidents. NTSB # SS-05-01, 2005

Ohio State University, "The Ohio State University Airport." [Online] 27 July 2009 http://www.osuairport.org

Research and Innovation Technology Administration – Bureau of Transportation Statistics, "Transportation Accidents by Mode." [Online] 24 July 2009 http://www.bts.gov/publications/national_transporttion_statistics/html

Civil Disturbance - #15

Contents

Hazard Profile 269
Civil Disturbances in the United States 270
Civil Disturbances in Ohio 271
Civil Disturbances in Franklin County 273

Hazard Summary

A civil disturbance is a planned or random uproar or disturbance of ordinary community life by persons choosing to ignore laws, often to bring attention to a cause, concern, or agenda. Franklin County has seen many types of civil disturbances through the years, from prison riots to university campus disturbances to political rallies. This hazard was ranked No. 15 out of 16.

Hazard Profile

A civil disturbance is a planned or random public uproar or disturbance of ordinary community life. Civil disturbance refers to groups of people purposely choosing not to observe laws, usually to bring attention to their cause, concern, or agenda.

Civil disturbances can take the form of small gatherings or large groups that disrupt normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot in which a mob burns or destroys property and terrorizes individuals. Generally, there are two types of large gatherings typically associated with disturbances: a crowd and a mob. A crowd may be defined as a casual, temporary collection of people. Crowds can be classified into four categories:

- Casual Crowd – A casual crowd is a group of people who merely happen to be in the same place at the same time. The likelihood of violent conduct is non-existent.
- Cohesive Crowd – A cohesive crowd consists of people who are involved in some type of unified behavior, such as worshiping, dancing, or watching a sporting event. This type of crowd would require substantial provocation to arouse to action.
- Expressive Crowd – An expressive crowd is one held together by a common commitment or purpose. Although they may not be formally organized, they are assembled as an expression of common sentiment of frustration. Members wish to be seen as a formidable influence.
- Aggressive Crowd – An aggressive crowd is comprised of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and often taunt authorities. They tend to be impulsive and highly emotional and require only minimal stimulation to arouse them to violence.

A mob can be defined as a large, disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Like crowds, mobs have different levels of commitment and can be classified into four categories. Mobs are more committed than crowds.

- Aggressive Mob – An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity.
- Escape Mob – An escape mob attempts to flee from something such as a fire, bomb, flood, or other catastrophe. They are characterized by terror.
- Acquisitive Mob – An acquisitive mob is one motivated by a desire to acquire something. Riots often caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property, such as the looting mobs in New Orleans after Hurricane Katrina.
- Expressive Mob – An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration.

Civil disturbance spans a wide variety of actions and includes but is not limited to: labor unrest, strikes, civil disobedience, demonstrations, riots, prison riots, rebellions, and celebrations.

While possible in any area, they typically occur in areas of dense population. Different disturbances will center around different centers of the community. Labor disturbances will tend to happen at individual companies that are being struck. Anti-abortion violence will happen around abortion clinic offices or medical facilities. Racial violence can happen in areas with racial tensions. Political demonstrations will happen around government buildings. The modern civil disturbance has also become increasingly associated with sports events and related to substance abuse.

Consequences of Civil Disturbance

Civil disturbance threatens the safety and well being of large populations and can damage millions of dollars in property. Local government operations and the delivery of services in the community may experience short-term disruptions. First responders are often overwhelmed and unable to respond to both the disturbance and normal day-to-day calls for service. Environmental impact is likely to be limited, unless acts of sabotage are performed.

The economic impact to urban areas during civil unrest, and following such events, can be profound. Direct impacts include looting and vandalism, as well as endangerment of shop owners and customers. Looting and general vandalism are the most common activities associated with civil disturbance. Arson is also quite common and can quickly spread due to slow response times of overwhelmed fire departments. Transportation routes can become blocked, making it difficult for non-rioters to leave the area and for the emergency responders to arrive.

Indirect economic impacts result from the loss of business and customer base due to evacuations and looting. More serious acts of vandalism may result in limited power failure or hazardous material spills, leading to a possible public health emergency. Altered traffic patterns may increase the probability of a transportation accident.

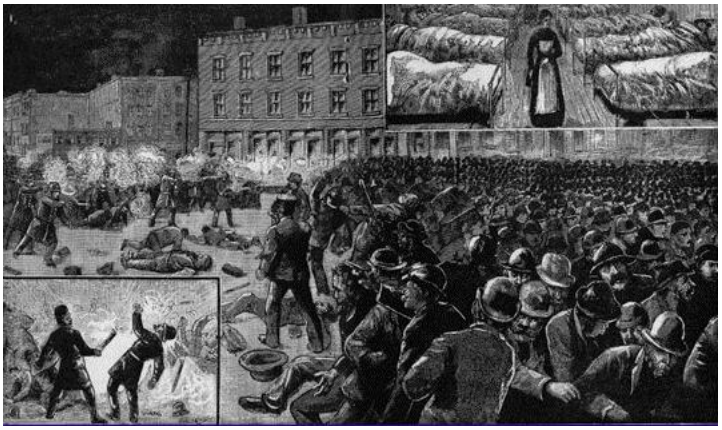
Civil Disturbance in the United States

There was rioting in North America even before there was a United States. The right to protest peacefully is a hallmark of our nation's liberties handed down from the 18th century. Depending on perspective, the Boston Tea Party was a mob action or a heroic insurrection.

Those in law enforcement or who are targets of mob violence consider it criminal; for those who sympathize with rioters, these actions are political expressions of a desperate and powerless people.

The New York Draft Riot in 1863 was in response to a new draft law. What began as political violence turned into a generalized sacking, with arson and attacks on firefighters. Throughout the 19th century, countless people died in episodes of racial, religious, ethnic, labor and political conflict, including the anti-Chinese riots in San Francisco during the 1870s.

The late 1800s and early 1900s saw an increase in labor strikes as labor unions began to grow. A riot in 1886 resulted when someone threw a bomb into the ranks of Chicago policemen drawn up at a labor rally, and the ensuing mayhem has gone down in history as the Haymarket Square riot. The 1894 strike against Pullman Palace Car Co., which shut down the nation's railroads, wasn't settled until the President sent federal troops into Chicago, provoking widespread violence and arson.



Haymarket Square Riot, 1886
Source: Chicago Historical Society

The rise of civil disobedience in the1960s was in the form of racially motivated rioting in Los Angeles, Newark, Detroit and Washington, among many other cities. The 1970s saw demonstrations against the Vietnam War, especially on college campuses across the country.

The Los Angeles riots in 1992, in response to the Rodney King case, were some of the deadliest in U.S. history, with 52 deaths, 2,500 injuries, and $446 million in property damage.

In recent years, civil disorder has typically begun as nonviolent gatherings. Injuries are usually restricted to police and participating individuals.

Civil Disturbance in Ohio

The history of civil disturbance in Ohio parallels events in the rest of the country. On May 1, 1886, an estimated 32,000 workers in Cincinnati took part in a nationwide work stoppage to demand the adoption of a standard eight-hour workday. The May Day strikes continued throughout the 1880s, helping convince President Grover Cleveland to implement Labor Day, a holiday to celebrate the American Worker.

In the mid 1960s, Cleveland was the scene of several nationally prominent civil disturbances that were racially charged. The first disturbance, the Hough Riots, lasted for several days in 1966. It took 2,200 Ohio National Guardsmen to reestablish order. The

Cleveland disturbances were similar to other disturbances throughout the country at that time.

One of the most nationally prominent Ohio civil disturbance events was the Kent State shootings, May 4, 1970. By 1970, thousands of Americans were protesting the Vietnam War. The protests escalated on college campuses when it was announced that college deferments from the draft would end. The following account of the Kent State Shootings was taken from two sources, *The May 4 Shootings at Kent State University: The Search for Historical Accuracy*, published in the Ohio Council for the Social Studies Review, Summer 1998, and *Kent State Shootings*, published by the Ohio Historical Society:

On April 30, 1970, President Nixon announced the movement toward an invasion of Cambodia. Protests occurred the next day, Friday, May 1, across the United States on college campuses where anti-war sentiment ran high. At Kent State University, an anti-war rally was held on campus. Friday night, what began as peaceful socializing in downtown Kent bars escalated to bonfires, cars stopped, police cars hit with bottles, and store windows broken. The mayor declared a state of emergency and contacted Governor James Rhodes' office to request assistance from the Ohio National Guard.

Source: Ohio Historical Society

The Guard mobilized quickly to move into Kent. When they arrived, they found the ROTC building ablaze and over 1000 demonstrators surrounding the building. The protestors were interfering with the efforts of firefighters. Confrontations between the Guard and the demonstrators continued into the night, with tear gas filling the campus and numerous arrests.

On Sunday May 3, Governor Rhodes flew to Kent and made provocative statements at a press conference, further enhancing the situation. It was assumed that the Guard was in control of the campus and that all rallies were banned. A rally had been planned for noon on May 4, the next day. Although university officials attempted to inform the campus that the rally was prohibited, a crown began to gather as early as 11 AM. By this time, the consensus was that the active participants in the rally were primarily protesting the presence of the Guard on campus.

Shortly before noon, an announcement was made by Guard command and a Kent State police officer, via bullhorn, ordering the demonstrators to disperse. There is still much controversy over what actually led to the shootings. The protestors did not disperse and began throwing rocks at Guardsmen. The Guard members fired tear gas at the demonstrators, which was ineffective due to wind. Eventually 77 Guardsmen advanced on

the protestors with loaded rifles and bayonets. Twenty-nine solders eventually opened fire. The gunfire lasted only thirteen seconds, leaving 4 students dead and nine wounded.

The University was closed immediately, and classes did not resume until summer of 1970. Colleges and universities across the United States cancelled classes and actually closed their doors for the remainder of the academic year. The Ohio State University dismissed its Spring Quarter classes.

Civil Disturbance in Franklin County

As in the State of Ohio, civil disturbance in Franklin County has followed the same pattern as the rest of the country. The county has been the site of labor strikes, civil rights demonstrations, and anti-war protests. All have been discussed in previously in this section.

There have been other events unique to the county. Columbus was the location of the former Ohio Penitentiary. The facility was the site of numerous prison riots before being closed in 1984.

The Ohio State University campus area in Columbus has long been the site of demonstrations, protests and celebratory disturbances. An OSU Task Force on Preventing Celebratory Riots, published in 2003, reported that during the last two decades, student disturbances have seldom been related to protests and have been almost exclusively celebratory in nature. Between the years of 1996 and 2002, in the neighborhoods east of High Street, eight riots involving violent confrontation between students, guests, community residents, "outsiders," and the Columbus police were identified by the task force. In addition, 10 disturbances that did not end in violent confrontation were identified.

Celebratory Riots:

- Are sometimes, but not always, associated with sporting events.
- Typically occur very late at night and extend into the early morning hours.
- Are almost always associated with high volume alcohol consumption.
- Involve fire setting as a common practice along with destruction of public and private property, such as overturning and burning cars.
- Involve active participants who are nearly all white, young adult males with a large crowd of onlookers who are predominantly white, young adults of both sexes. Many are students of the "host" institutions, but other young adults (students and non-students) are often involved.
- Involve eventual police intervention that is met with considerable resistance and lack of respect for authority.

Source: OSU Task Force

At Ohio State, police estimate that on football game days, 190,000 people gather adjacent to the university stadium. During one year's eight home football games, Ohio State spent nearly $1 million for police, an average of $108,000 per game.

As an example of how costly these events can be, following the November 2002 Ohio State–Michigan game, fans rushed the stadium field and attempted to tear down the goal post to celebrate securing a place in the Bowl Championship Series title game. The mob began to tear up the turf on the field when they were faced with a barrage of pepper spray from authorities. That night, a celebratory riot ensued on the streets of Columbus,

costing the city almost $125,000 in overtime police pay. According to Columbus Police, 250 officers were working the university district dressed in riot gear and armed with tear gas.

Subsequently, 48 people were arrested, nine of whom were students. During the riot, approximately 20 vehicles were burned or damaged in a 10-block area east of campus. In addition, firefighters responded to 107 small fires, which resulted in damage to property that was estimated to exceed $400,000.

OSU Riot November 2002
Source: An Analysis of Issues Related to Celebratory Riots at Higher Education Institutions.

In addition to the university, Franklin County is home to types of facilities that commonly see disturbances: State and local government buildings, Federal Courthouse, abortion clinics, and correctional facilities.

Civil Disturbance – References

Lewis, Jerry M., Hensley, Thomas R., (1998), The May 4 Shootings at Kent State University: The search for Historical Accuracy. The Ohio council for the Social Studies Review 34:(1)

Ohio Historical Society, "Cleveland Civil Disorders, 1966-1968." [Online] 29 July 2009 http://ohiohistorycentral.org/entry.php?rec=1670&nm=Cleveland-Civel-Disorders-1966-1968

Ohio Historical Society, "Halloween Riot," [Online] 29 July 2009 http://ohiohistorycentral.org/entry.php?rec=2095&nm=Halloween-Riot

Ohio Historical Society, ''Kent State Shootings." [Online] 29 July 2009 http://ohiohistorycentral.org/entry.php?rec=1595&nm=Kent-State-Shootings

OSU, "Hall Gives Update on Investigation of Campus-area Riots. ' [Online] 29 July 2009 http://www.osu.edu/news/newsitem292

Van Slyke, Jeffrey, M., An Analysis of Issues Related to Celebratory Riots at Higher Education Institutions. Education Law Consortium Forum 2005.

Von Hoffman, Nicholas, U.S. Riots: A Threat of Mob Violence – Civil Unrest. Los Angeles Times 15 May 1992

Wordpress, "Worst Riots in U.S. History by Death Toll." [Online] 29 July 2009 http://history.wordpress.com

Earthquakes - #16

Contents

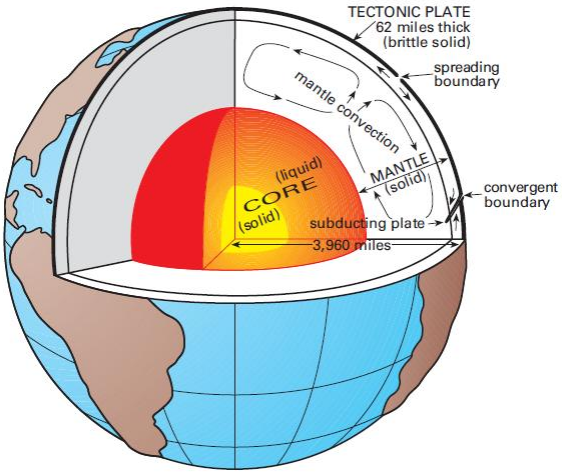
Hazard Profile 277
Earthquakes in the United States 278
Earthquakes in Ohio 280
Earthquakes in Franklin County 282

Hazard Summary

Earthquakes are caused by the movement of the earth's crustal plates along faults. Franklin County is not located on a fault line, nor have any epicenters been located in Franklin County. Earthquakes occurring in other areas have been felt in Franklin County; however, no damage has been reported. This hazard was ranked No. 16 out of 16.

Hazard Profile

Earthquakes are among the most frightening and devastating of natural events. They strike without warning, allowing no time for preparation or evacuation. Some 10,000 people die in earthquakes annually. Collapsing buildings claim by far the majority of lives. The destruction is often compounded by mudslides, fires, floods or tsunamis.



Interior zones of the Earth (figure modified from Washington Division of Geology and Earth Resources, Information Circular No. 85, 1988). The Earth's crust consists of great plates that slowly move across the surface of the Earth in response to convection cells in the mantle. Most earthquakes occur where plates meet, such as at spreading or convergent boundaries.

Earthquakes are the consequence of the slow movement of the earth's crustal plates. At the sites where these plates collide, earthquakes are a regular phenomenon. More than 100,000 earthquakes with magnitudes of 3 or greater occur worldwide each year, and 98% of these happen at plate boundaries. California is the site of numerous earthquakes because it is on the boundary between the Pacific and North American Plates.

Earthquakes occur along faults, which are zones of weakness in the upper crust, when sufficient strain builds up to overcome the frictional resistance of the blocks of rock on either side of the fault. When the blocks of rock snap, or quickly move past one another, an earthquake happens, releasing energy in the form of seismic waves.

There are two types of seismic waves: body waves and surface waves. Body waves are divided into primary (P) waves and secondary (S) waves. P-waves are the fastest and move with a push-pull motion.
Earthquakes in Ohio ODNR Geological Services

S-waves, also called shear waves, move more slowly and displace materials perpendicular to their direction of travel. Surface waves travel more slowly than either P-waves or S-waves and are responsible for most of the destructive effects of earthquakes. The velocity of a wave depends on the density and elastic properties of the materials through which the wave passes.

Measuring Earthquakes

Seismographs are instruments that record seismic waves generated by earthquakes. A seismometer is the component that transforms seismic-wave energy into electrical voltage that can be analyzed in digital form by computer or into analog form that is displayed on paper or file. The squiggly up-and-down series of lines that correspond to seismic wave energy on these records are called seismograms.

Earthquakes are measured in a number of ways, but two types of scales are most common. Magnitude Scale and Modified Mercalli Intensity Scale each portray useful information.

A Magnitude Scale is an instrumental scale that depicts the total energy released during an earthquake. It is expressed in Arabic numerals and is calculated by measuring the amplitude of seismic waves on a seismogram. The magnitude of an earthquake is the same at any location where it can be adequately measured. An increase of one whole number on the magnitude scale corresponds to a 10-fold increase in ground motion. The scale is logarithmic; therefore, an increase of two whole numbers on the scale is a 100-fold increase of seismic-wave amplitude. The amount of energy released during an earthquake is about 31 times greater for each whole-number increase in the magnitude scale. The Richter Scale is the most common magnitude scale used.

The Modified Mercalli Intensity Scale portrays the amount of ground shaking at a particular location on the basis of the effects felt by people and the observed damage to buildings and terrain. It is similar to the way the Fujita Scale works in estimating the strength of tornadoes.

Modified Mercalli Intensity Scale		Magnitude Scale
I	Detected only by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing	2
III	Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibrations like passing truck	2.5
IV	Felt indoors by many, outdoors by few, at night some awaken; dishes, windows, doors disturbed; standing autos rock noticeably	3
V	Felt by most people; some breakage of dishes, windows, and plaster; disturbance of tall objects	3.5
VI	Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small	4
VII	Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of autos	4.5
VIII	Panel walls thrown out of frames; walls, monuments, chimneys fall; sand and mud ejected; drivers of autos disturbed	5
IX	Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken	5.5
X	Most masonry and frame structures destroyed; ground cracked, rails bent, landslides	6
XI	Few structures remain standing; bridges destroyed, fissures in ground, pipes broken, landslides, rails bent	6.5
XII	Damage total; waves seen on ground surface, lines of sight and level distorted, objects thrown up into air	7
		7.5
		8

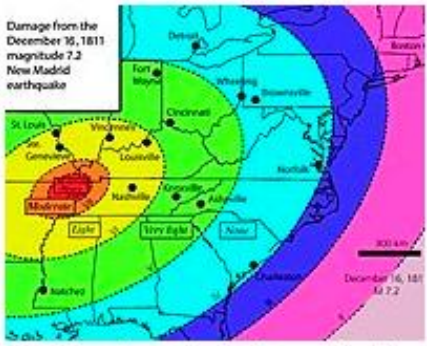
General relationship between epicentral Modified Mercalli intensities and magnitude. Intensities can be highly variable, depending on local geologic conditions. (Modified from D. W. Steeples, 1978, Earthquakes: Kansas Geological Survey pamphlet.)

The Modified Mercalli Scale is defined by Roman Numerals from I to XII. I represents not felt and XII represents total destruction. Intensity is commonly greatest at the epicenter and decreases with distance away from this point. The chart above shows the general relationship between the Modified Mercalli Scale and the magnitude scale.

Earthquakes in the United States

Since its early history, earthquakes have affected the United States. The greatest seismic activity in the United States is along the Pacific Coast in California and Alaska. Nationwide, at least 40 states are considered at risk from moderate to great earthquakes. Earthquakes have stuck many areas of the United States, including the Central and East Coast states as well as the more familiar earthquake activity in West Coast states.

The deadliest earthquake in the United States was the April 18, 1906, San Francisco earthquake, taking an estimated 3,000 lives. Aftershocks were felt as far away as Oregon and Nevada. The quake caused major damage to the city and is known as one of the worst natural disasters in U.S. history.

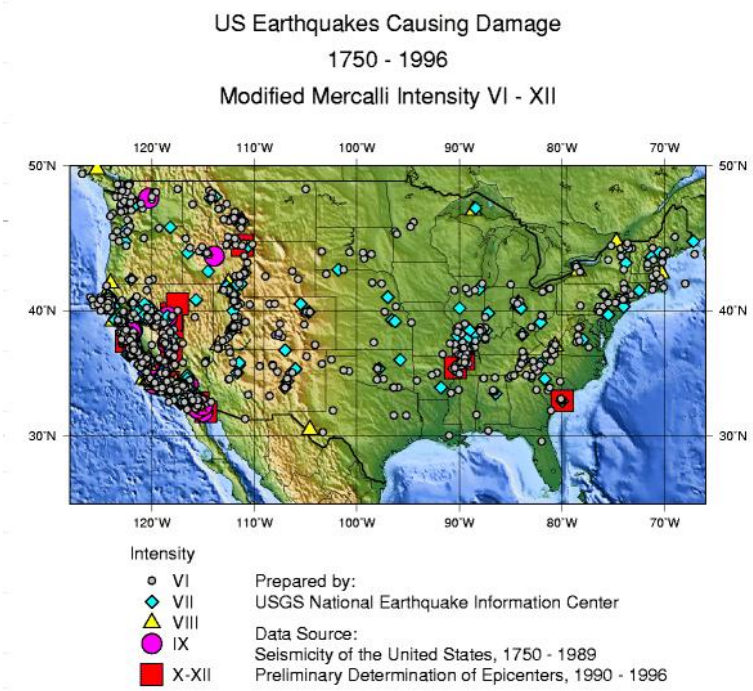


This map shows areas damaged by the Dec. 16, 1811, magnitude 7.2 earthquake. That earthquake was the first of three major temblors along the New Madrid fault in 1811 and 1812. (Image courtesy of Seth Stein, based on results by Susan Hough)

The 1811-1812 series of earthquakes at New Madrid, Missouri were the largest earthquakes in historic times in the continental United States. (Prince William Sound, Alaska, was largest in the U.S.) Half the town of New Madrid was destroyed. Large areas sank into the earth and new lakes were formed. The Mississippi River changed its course, creating numerous geographic exclaves, including Kentucky Bend. Some sections of the Mississippi River appeared to run backward for a short time. Church bells were reported to ring as far as Boston and sidewalks were reported cracked and broken in Washington, DC.

A recent study suggests the New Madrid fault system may be in the process of shutting down. A team from Purdue and Northwestern universities analyzed the fault motion for eight years using global positioning system measurements and found that it is much less than expected. The team determined that the ground surrounding the fault system is moving at a rate of less than 0.2 millimeters per year and there is likely no motion. Their findings were published in Science Magazine.

While large earthquakes can still be expected in the United States, compared to the millions who have been killed by earthquakes in Europe, Asia, and South America, the United States has been comparatively fortunate.



Source: USGS

Earthquakes in Ohio

Although not thought of as an earthquake-prone state, at least 120 earthquakes with epicenters in Ohio have been felt since 1776. At least 14 moderately-sized earthquakes have caused minor to moderate damage in Ohio. Most of these earthquakes have been felt only locally and have caused no damage or injuries.

In addition, a number of earthquakes with origins outside Ohio have been felt in the state. Ohio is on the periphery of the New Madrid Seismic Zone. The great New Madrid earthquakes of 1811 and 1812 were felt throughout Ohio, causing chimneys to topple in Cincinnati.

A major earthquake centered near Charleston, South Carolina, in 1886 was strongly felt in Ohio. More recently, a 5.3 magnitude earthquake centered at Sharpsburg, Kentucky in 1980 and caused minor to moderate damage in communities near the Ohio River in southwestern Ohio.

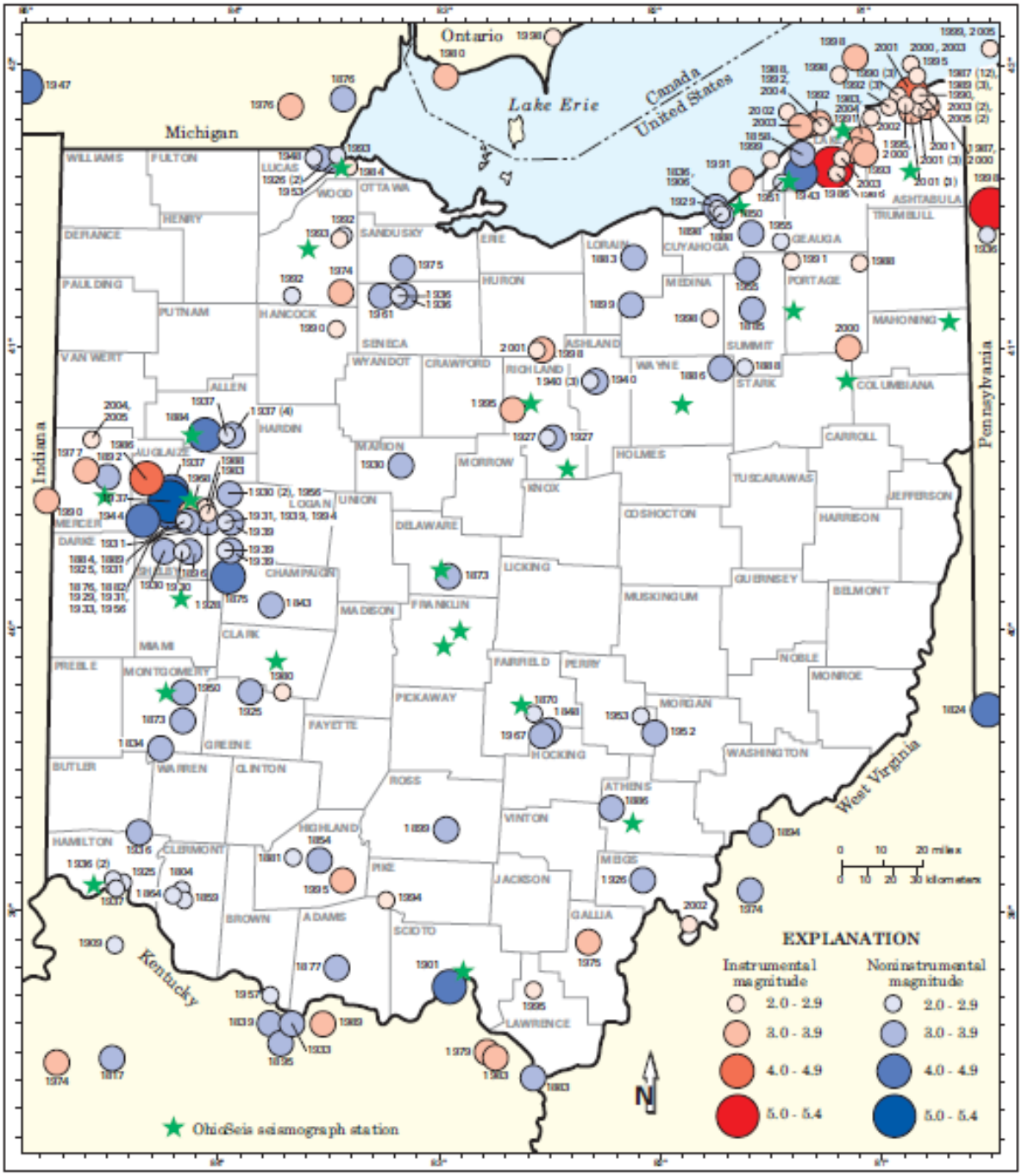
Three areas of Ohio appear to be particularly susceptible to seismic activity. The most active area is Shelby County and surrounding counties in western Ohio. At least 40 felt earthquakes have occurred in this area since 1875. Although most of these events have caused little to no damage, some minor to moderate damage has occurred. Two earthquakes in 1937, on March 2 and March 9, caused significant damage in the Shelby County community of Anna, including toppled chimneys, cracked plaster, broken windows, and structural damage to buildings.

Northeastern Ohio has experienced at least 20 felt earthquakes since 1836. Most of these events were small and caused little or no damage. One earthquake on January 31, 1986, strongly shook Ohio and was felt in 10 other states and southern Canada. This event was a 5.0 magnitude earthquake and caused moderate damage in the epicenter area of Lake and Geauga counties.

Southeastern Ohio has been the site of at least 10 felt earthquakes, with epicenters in the area, since 1776. These earthquakes caused minor to moderate damage in several Ohio River counties.

Ohio earthquakes appear to be associated with ancient zones of weakness in the earth's crust. These zones are characterized by deeply buried and poorly known faults. Active faults do not reach the surface in Ohio and therefore are difficult to map.

Earthquakes in the eastern United States are difficult to predict because they have very long recurrent intervals. This is complicated by the fact that seismic waves tend to travel for very long distances in the eastern states. The relatively brittle and flat-lying sedimentary rocks of this region tend to carry seismic waves throughout an area of thousands of square miles for even a moderate-sized earthquake.



Locations of felt earthquakes or those with magnitudes of 2.0 or greater in Ohio and its border area. Locations and magnitudes of historic earthquakes are represented by symbols corresponding to felt area or maximum epicentral Modified Mercalli intensities. Noninstrumental locations may be in error by a considerable distance, especially for early events.

Earthquakes in Ohio, ODNR Geological Survey

Earthquakes in Franklin County

There have been no recorded earthquake epicenters in Franklin County. Earthquake movement has been felt in the county from epicenters in other parts of Ohio; however no damage has been reported.

The brief historic record of Ohio earthquakes suggests a magnitude 5 earthquake is about the maximum event for the state. Earthquakes would most likely happen in the western seismic zone, or in northeastern Ohio, with a lesser possibility in southeastern Ohio. Such earthquakes would be expected to cause little or no damage in Franklin County.

It has been estimated that even a large earthquake in the New Madrid Seismic Zone would cause slight damage in Franklin County.

Earthquakes – References

Cincinnati Enquirer, "Earthquake Risk in Ohio." 9 July 2000

FEMA, "Earthquakes in the United States." [Online] 20 Apr 2009
http://www.fema.gov/hazard/earthquake/usquakes.shtm

Hansen, Michael C., Earthquakes in Ohio. Educational Leaflet #9 Revised Edition 2005, ODNR – Division of Geological Survey

ODNR, "Earthquakes and Seismic Risk on Ohio." [Online] 20 Apr 2009
http://www.dnr.state.oh.us/geosurvey/html/geo_f03/tabid/8307/Default

OEMA, Hazard Identification and Risk Assessment, 2007

OEMA, State of Ohio Mitigation Plan, 2008

Purdue University, "New Madrid Fault System May Be Shutting Down." [Online] 20 Mar 2009 http://news.uns.purdue.edu/x/2009a/190313calaisSteinMadrid.html

USGS, "Earthquake Hazards Program." [Online] 20 Apr 2009
http://earthquake.usgs.gov/regional/states/ohio/history.php

USGS, "Top Earthquake States." [Online] 20 Apr 2009
http://earthquake.usgs.gov/regional/states/top_states.php

Appendix A.

Contents

The U.S. Department of Homeland Security Risk Steering Committee DHS Risk Lexicon (September 2008) is a separate PDF document. This document is available from:

- U.S. Department of Homeland Security (DHS) website at www.dhs.gov.
- Franklin County Emergency Management and Homeland Security website at www.franklincountyohio.gov/emahs/planning_recovery.cfm.