

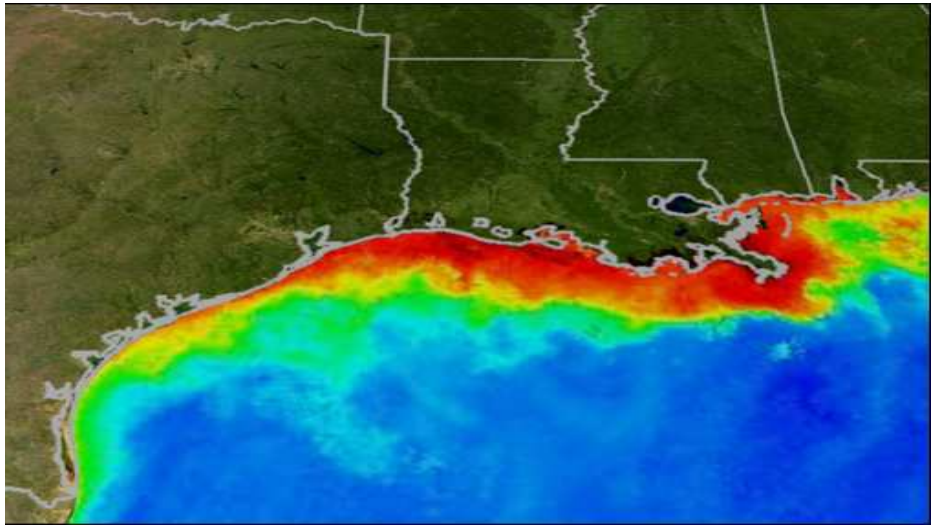
Science to Guide Floodplain Protection & Restoration in the Mississippi River Basin

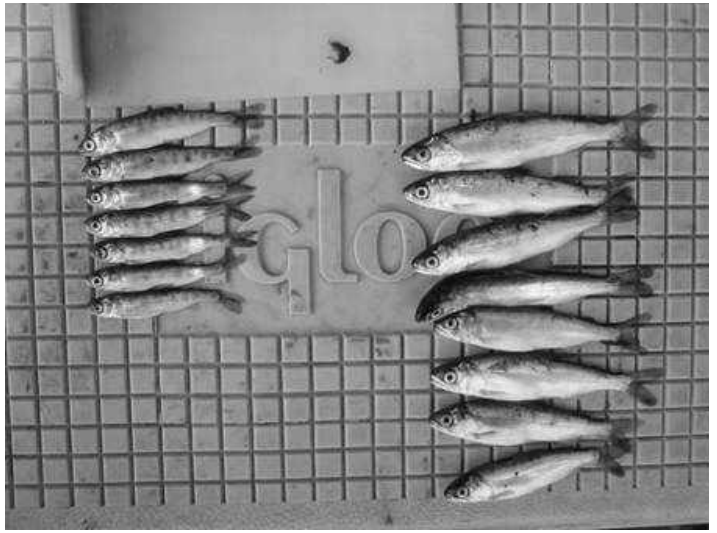
Kris Johnson, PhD

RNRF Congress
Charting a New Course for the Mississippi River Watershed
December 3, 2019

The Nature Conservancy

Multiple Benefits of Floodplains





Successful Floodplain Projects

Floodplain Prioritization

How do we scale up?

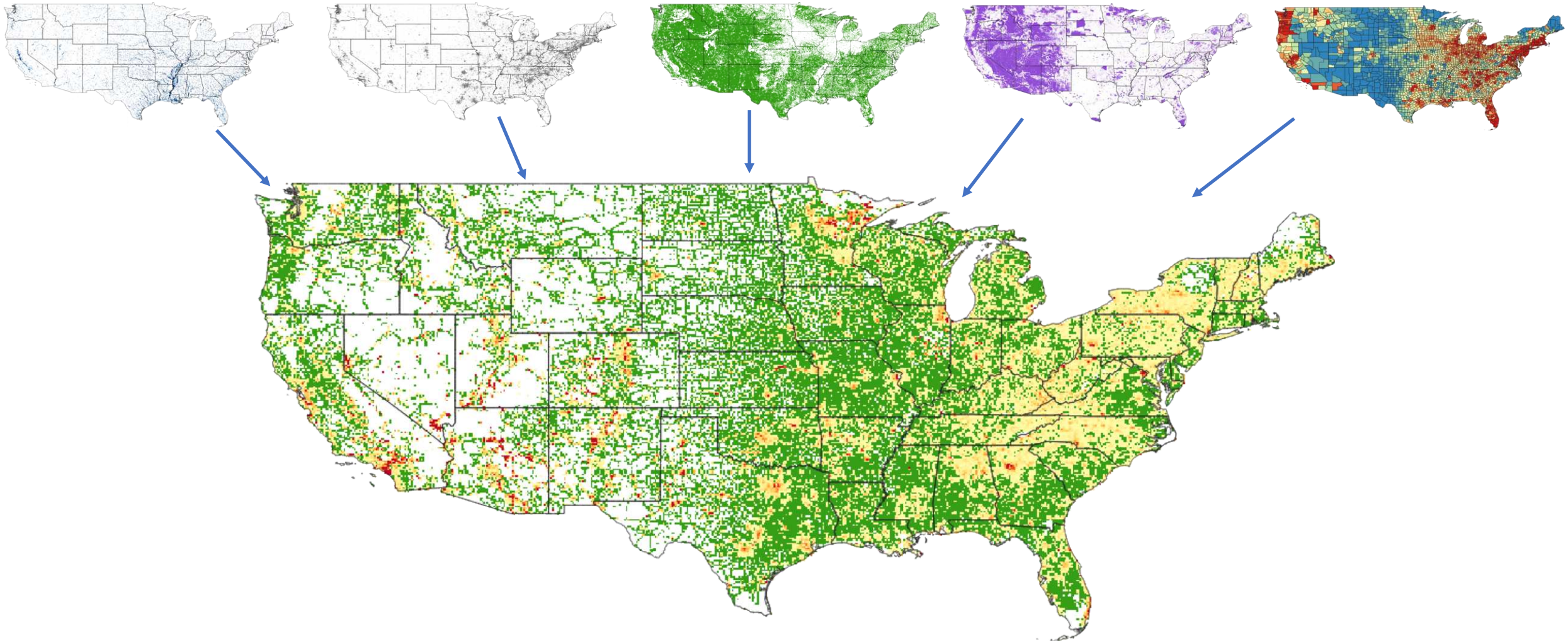
Where to invest?

US Floodplain Analysis

NEW US model

- LISFLOOD-FP routes flows through channels delineated by HydroSHEDS
- Regionalized flood frequency analysis
- 10 return periods from 5 to 1000 yrs
- Explicit representation of USACE NLD
- Validated with FEMA and USGS data *(Wing et al. 2017)*

US Floodplain Analysis



FATHOM

University of BRISTOL

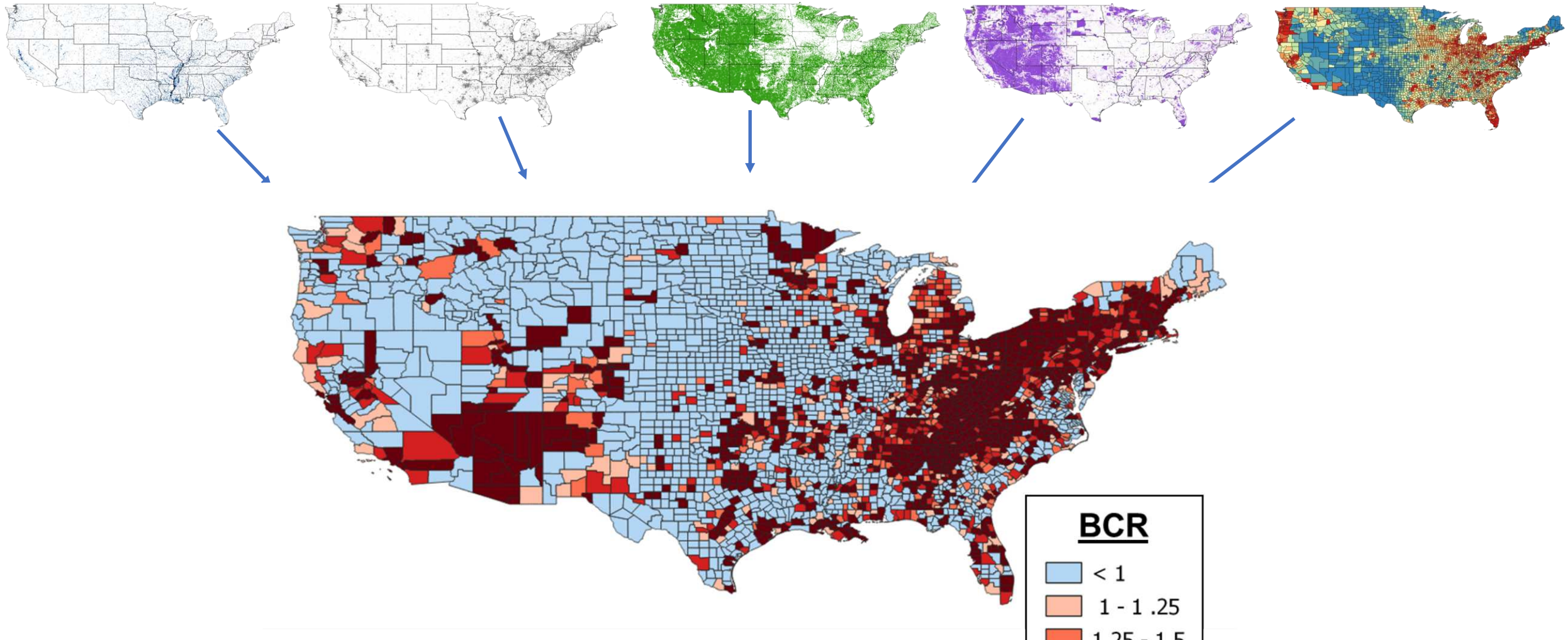
US Floodplain Analysis

41 million people at risk

$5 TRILLION exposed

Wing et al 2018

US Floodplain Analysis



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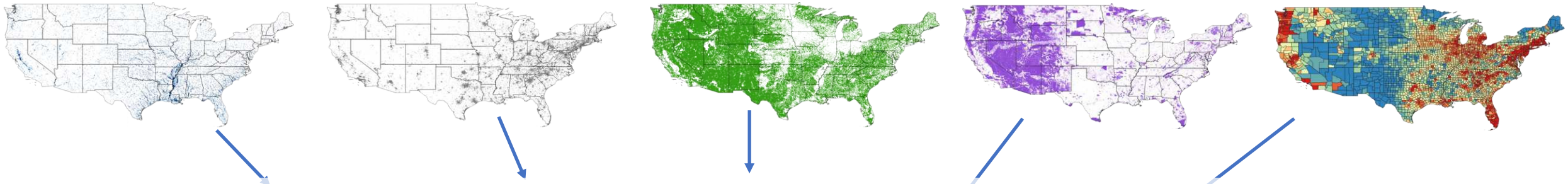
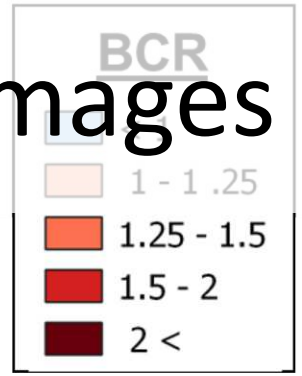
US Floodplain Analysis



675,919 km² natural area in 100-year floodplain

$306 B to acquire

avoids $593 Billion future damages by 2070



Johnson et al *in press*

FLOODPLAIN PRIORITIZATION TOOL

Identify places in the Mississippi River Basin where restoration or conservation would have the greatest impact on the overall health of this river system.

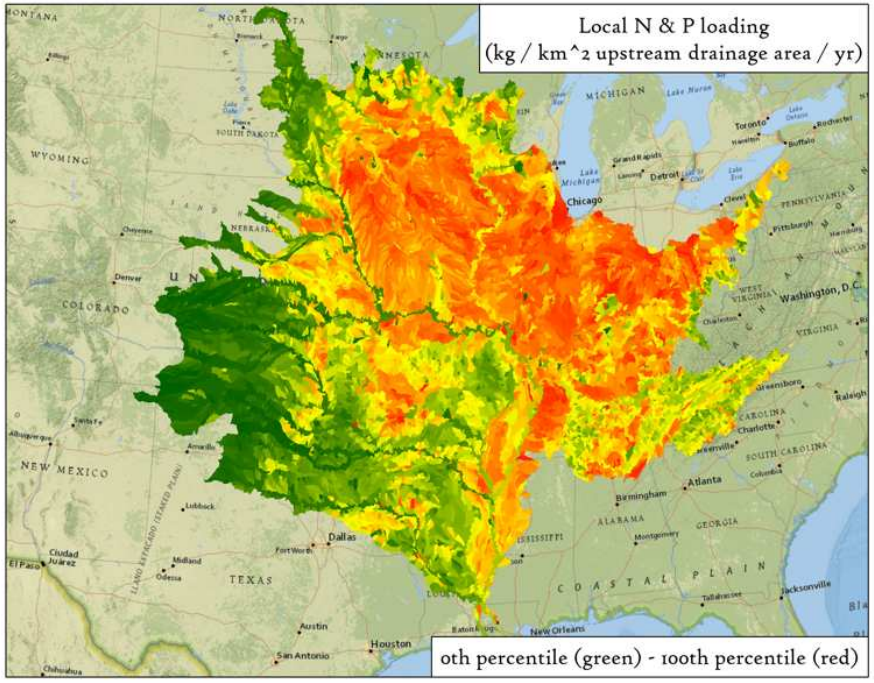
Photo credit: Byron Jorjorian

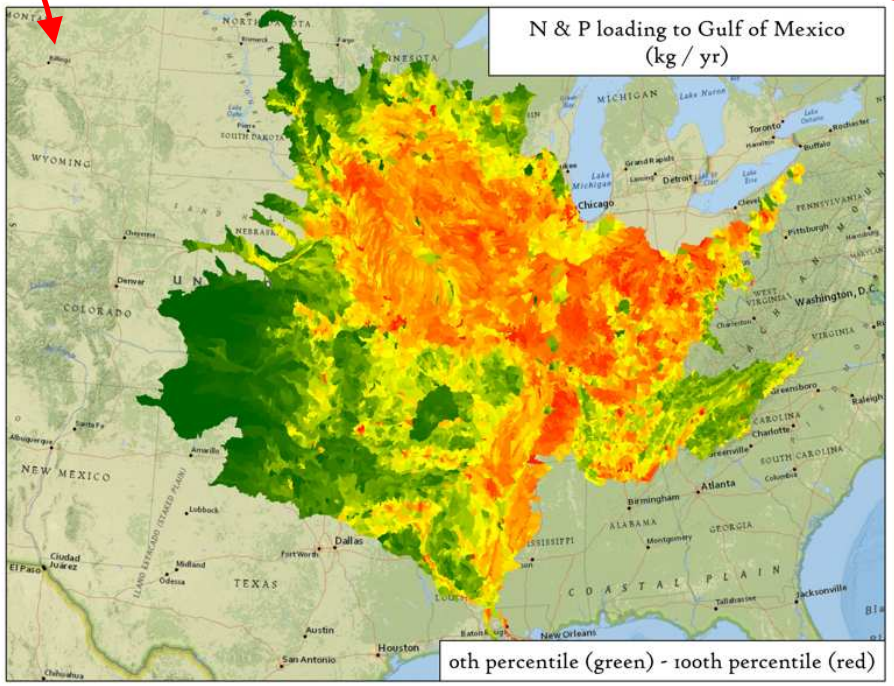
LEARN MORE

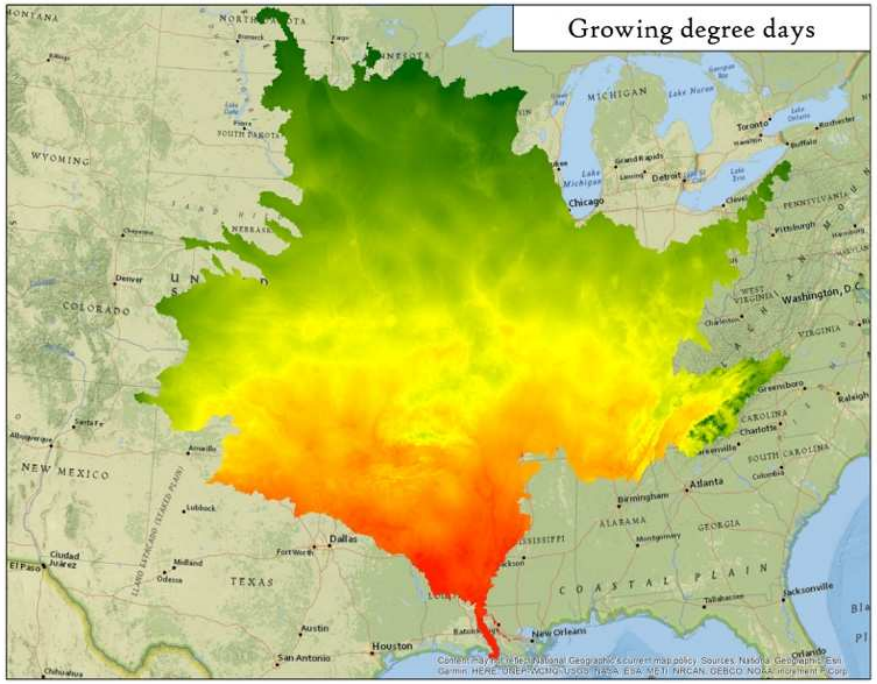
FPTool.org

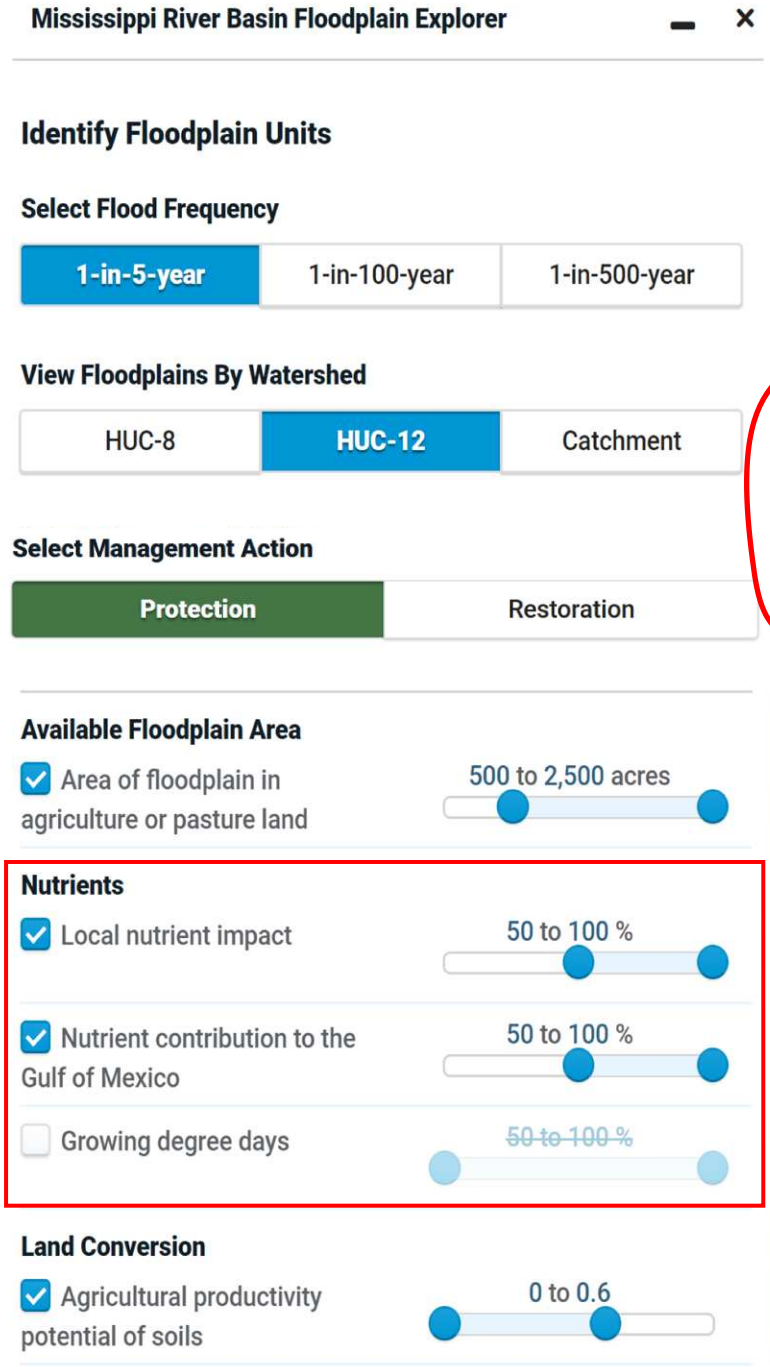
Water Quality

- Nutrient loading to ***local waters***
- Nutrient loading to ***Gulf of Mexico***
- Growing degree days – In conjunction with higher loading, facilitates ***denitrification***









Habitat

- Important Bird Areas — Present / Absent
- TNC Ecoregional Assessment Units — Present / Absent
- At-Risk Wetland Species — 0 to 8
- USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
- American Bird Conservancy Corridors & Key Habitat Bird Areas — Present / Absent
- National Fish Habitat Partnership Cumulative Habitat Condition Index — 0 to 5

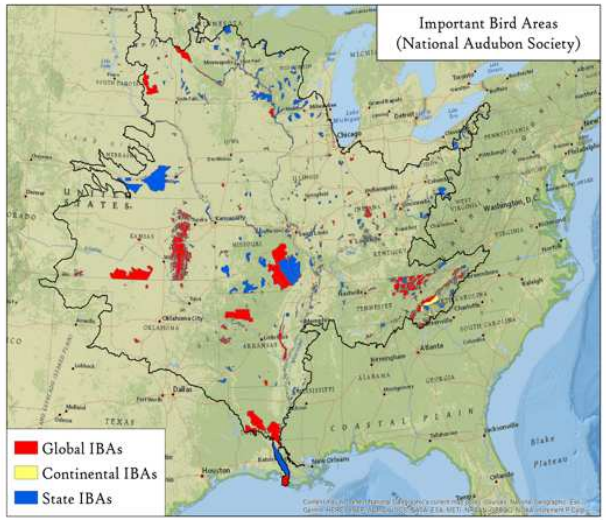
Population Exposure

- Current population — 0 to 700
- Projected population (2050) — 121 to 400

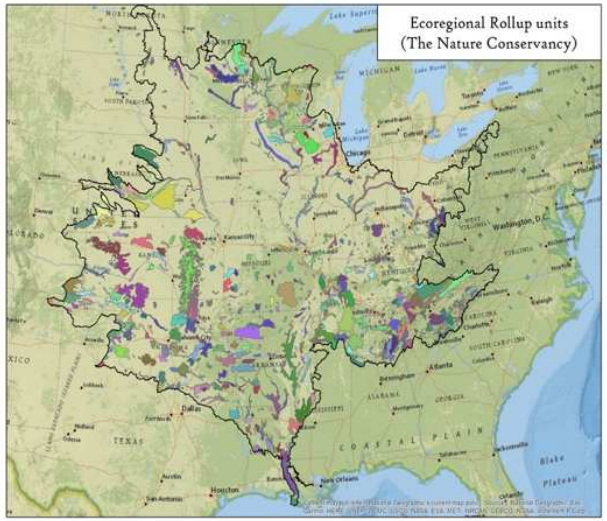
Future Economic Asset Exposure

- Economic asset exposure (2050) (SSP2) — 6 to 400
- Economic asset exposure (2050) (SSP5) — 0 to 400

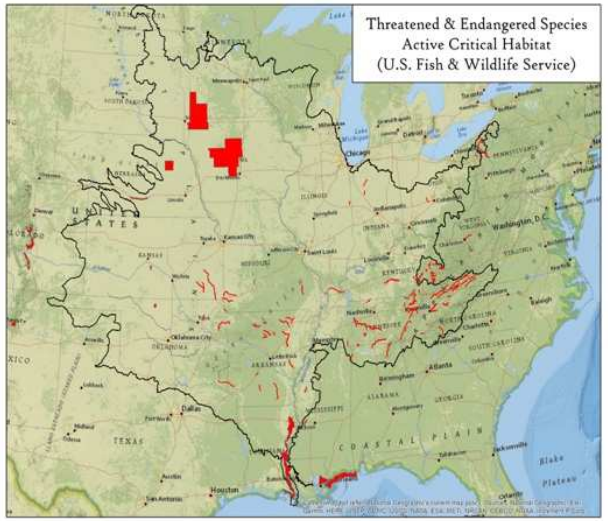
Important Bird Areas (Audubon)

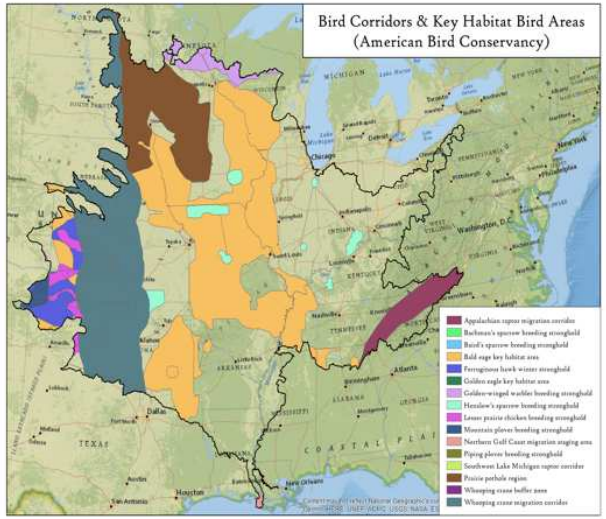


TNC Ecoregional Rollup Units

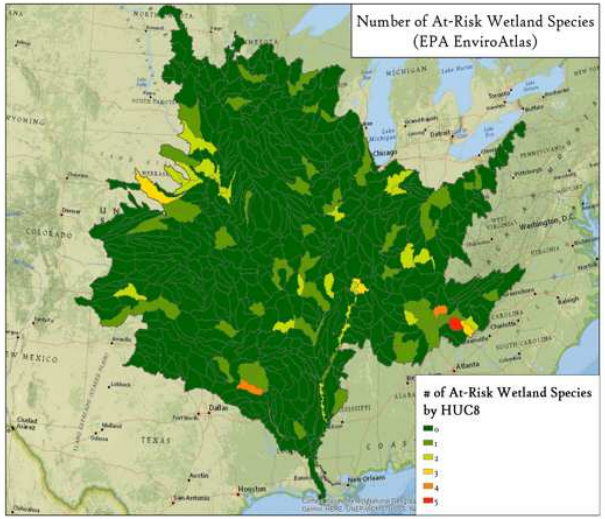


USFWS Threatened & Endangered Species

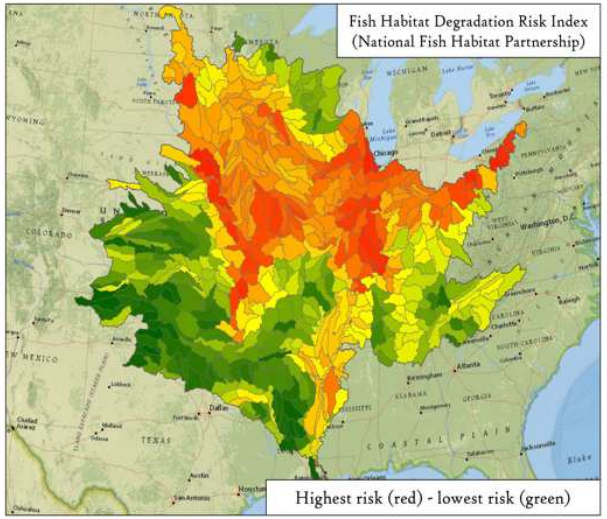




Bird Corridors & Key Habitat Areas (American Bird Conservancy)



Number of At-Risk Wetland Species (EPA)

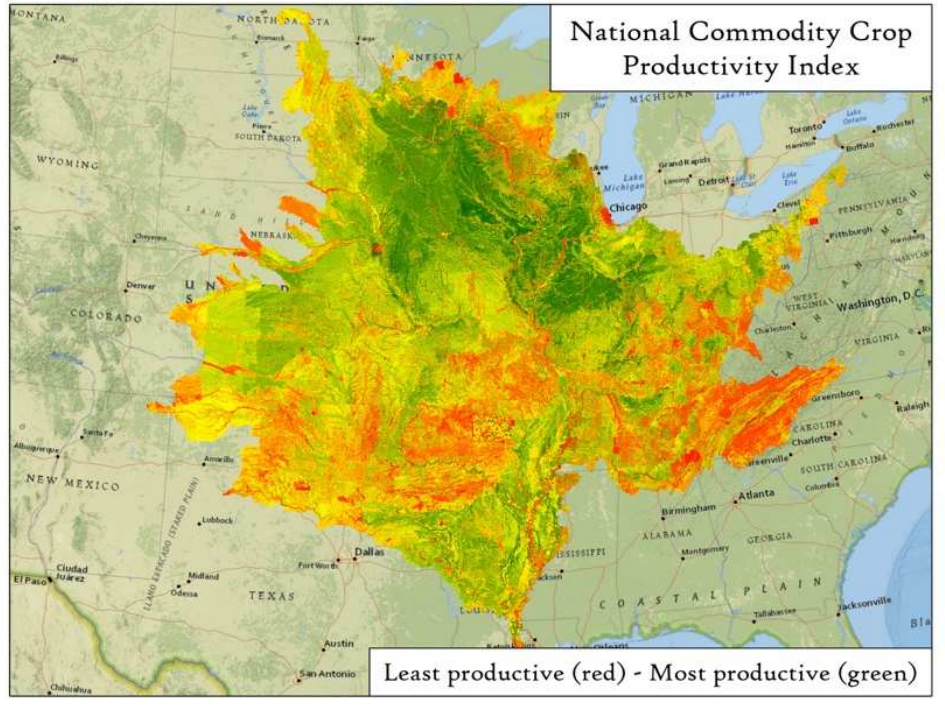


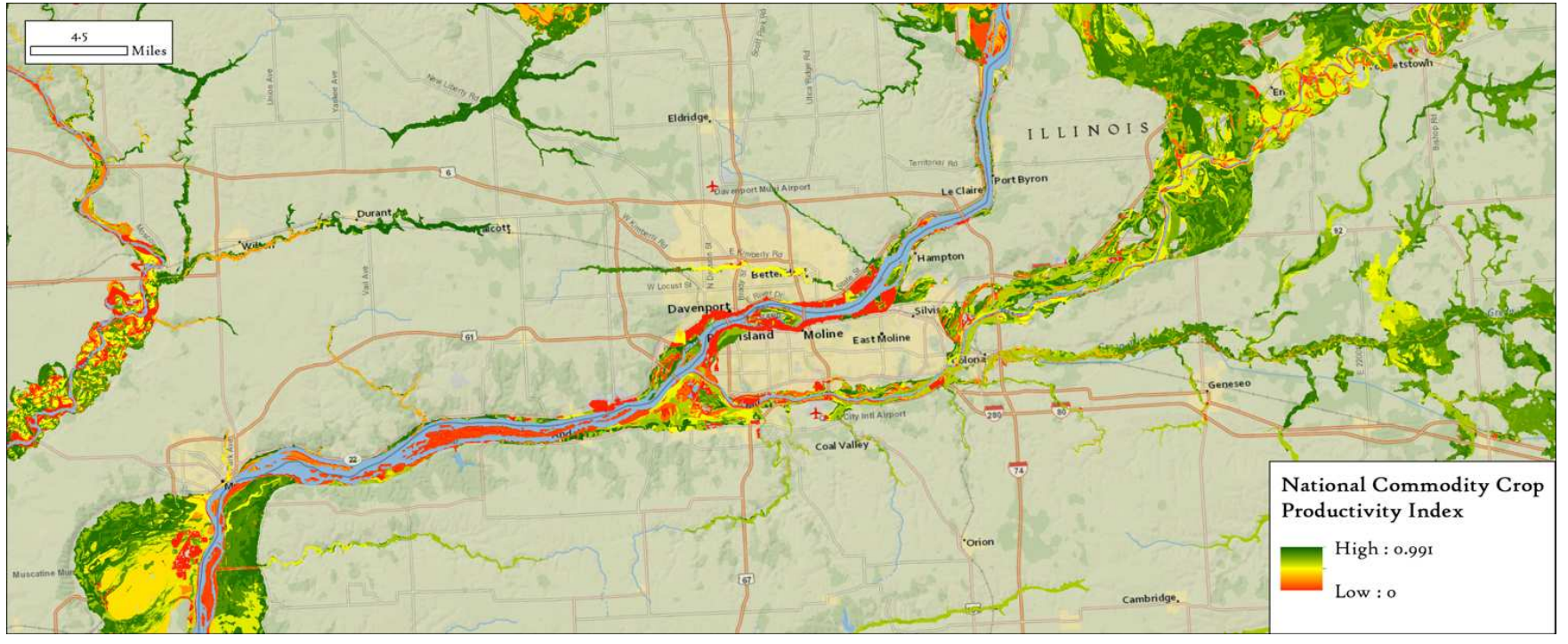
Fish Habitat Degradation Risk Index (NFHP)

Soil Quality

- National Commodity Crop Productivity Index – A measure of ***soils' inherent capacity to produce commodity crops***

- Draw restoration efforts to relatively less desirable soils





Mississippi River Basin Floodplain Explorer

Identify Floodplain Units

Select Flood Frequency

1-in-5-year | 1-in-100-year | 1-in-500-year

View Floodplains By Watershed

HUC-8 | HUC-12 | Catchment

Select Management Action

Protection | Restoration

Available Floodplain Area

☑ Area of floodplain in agriculture or pasture land — 500 to 2,500 acres

Nutrients

☑ Local nutrient impact — 50 to 100 %

☑ Nutrient contribution to the Gulf of Mexico — 50 to 100 %

☐ Growing degree days — 50 to 100 %

Land Conversion

☑ Agricultural productivity potential of soils — 0 to 0.6

Flood Risk

Habitat

- Important Bird Areas — Present / Absent
- TNC Ecoregional Assessment Units — Present / Absent
- At-Risk Wetland Species — 0 to 8
- USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
- American Bird Conservancy Corridors & Key Habitat Bird Areas — Present / Absent
- National Fish Habitat Partnership Cumulative Habitat Condition Index — 0 to 5

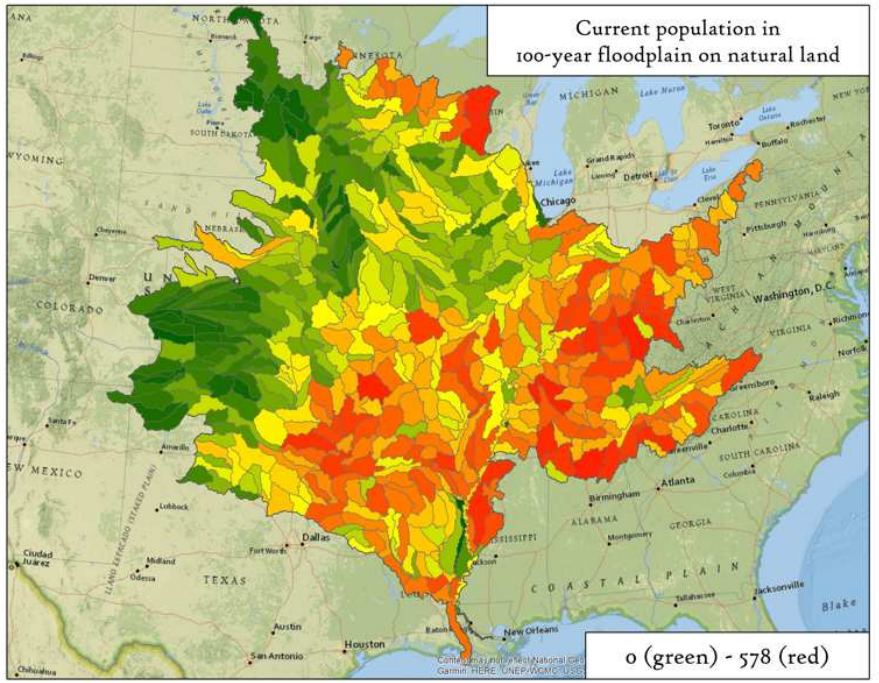
Population Exposure

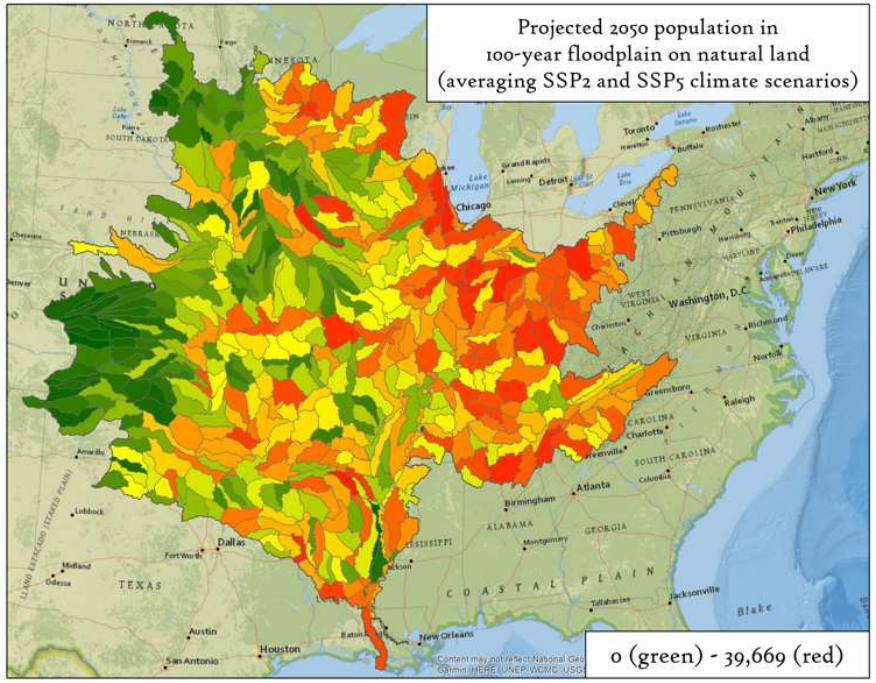
- Current population — 0 to 700
- Projected population (2050) — 121 to 400

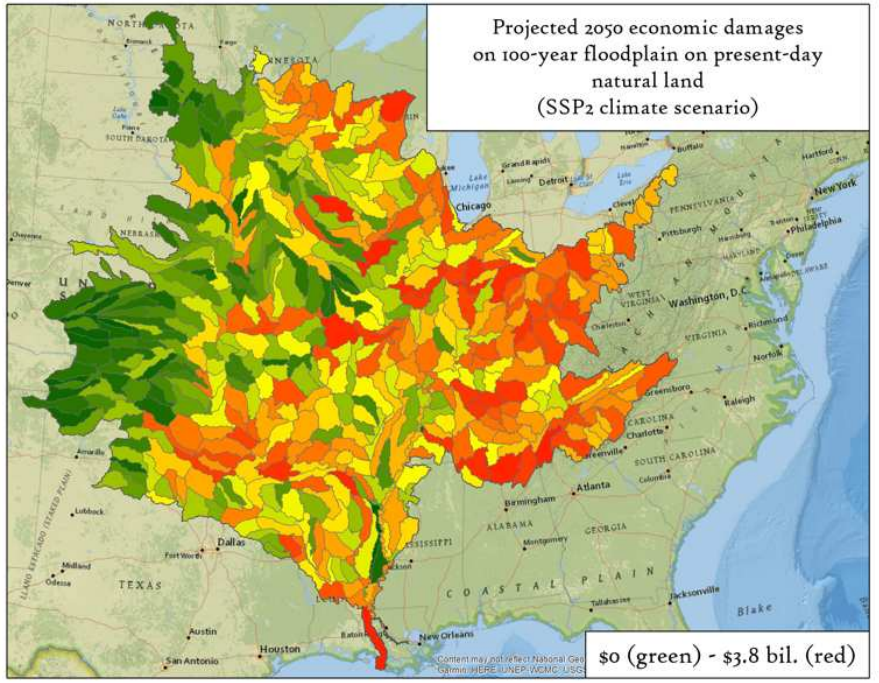
Future Economic Asset Exposure

- Economic asset exposure (2050) (SSP2) — 6 to 400
- Economic asset exposure (2050) (SSP5) — 0 to 400

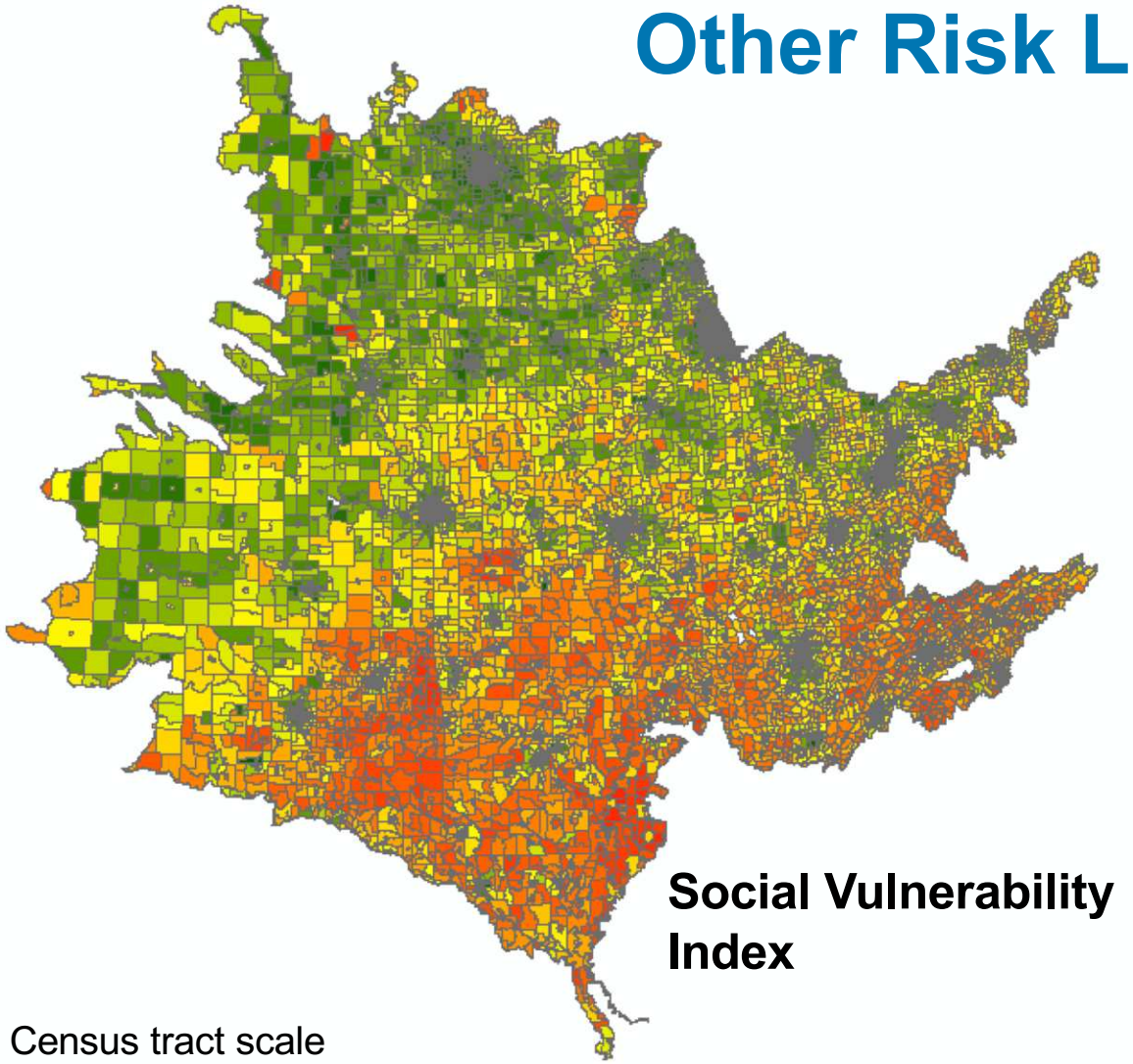
- ***Current population*** in the floodplain
- ***Future population (2050)*** in the floodplain
- ***Future property damage (2050)*** from flooding





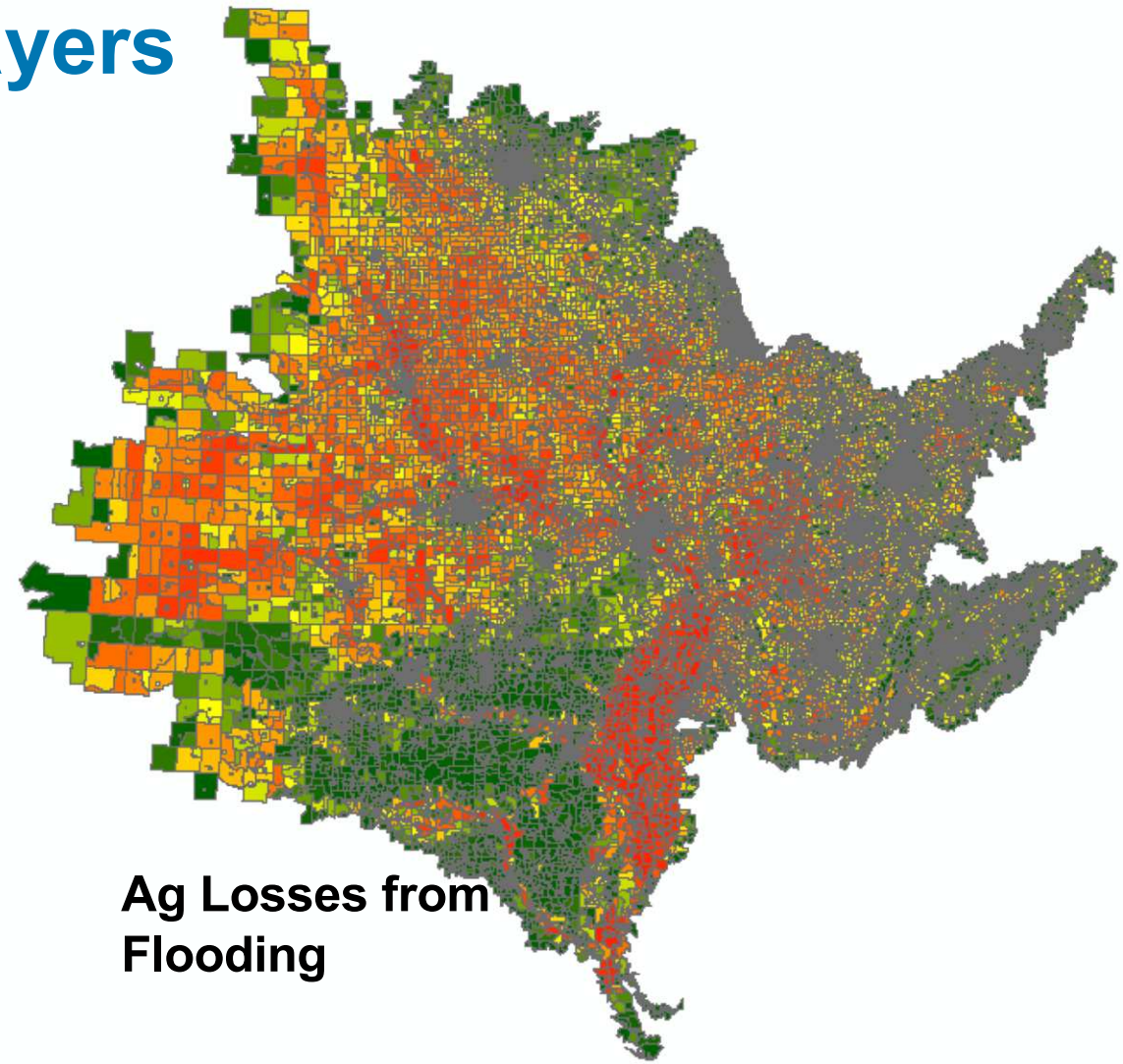


Other Risk Layers



Social Vulnerability Index

- Census tract scale
- Index of social vulnerability to disaster based on 22 variables from American Community Survey
- E.g. ***per-capita income***, % pop. ***<20 and >64 yrs. old***, % ***Native American***, % with ***less than 12th-grade education***, % ***Hispanic***, etc.



Ag Losses from Flooding

- Census block group scale
- ***$ value of row-crop losses*** assuming 100-year flood of 24 hrs. duration on June 1, modeled with HEC-FIA

Freshwater Network - Mississippi River Basin Floodplain Tool

The Floodplains Prioritization Tool (FP Tool) is designed to identify critical opportunities for floodplain protection and restoration in the Mississippi River Basin. Use the selector widgets below to specify criteria related to water quality, wildlife habitat, and human exposure to flood risk. The map on the right will change in response to your selections to identify sites meeting these criteria and identify those geographies where floodplain restoration or conservation is likely to have the greatest positive impact on the health of this river system.

Identify Floodplain Units

Select Flood Frequency

1-in-5-year | 1-in-100-year | 1-in-500-year

View Floodplains By Watershed

Zoom in to Activate

HUC-8 | HUC-12 | Catchment

Select Management Action

Protection | Restoration

Filter Floodplain Units

Available Floodplain Area

Available floodplain area for given flood frequency and management action

0 to > 40,000 acres

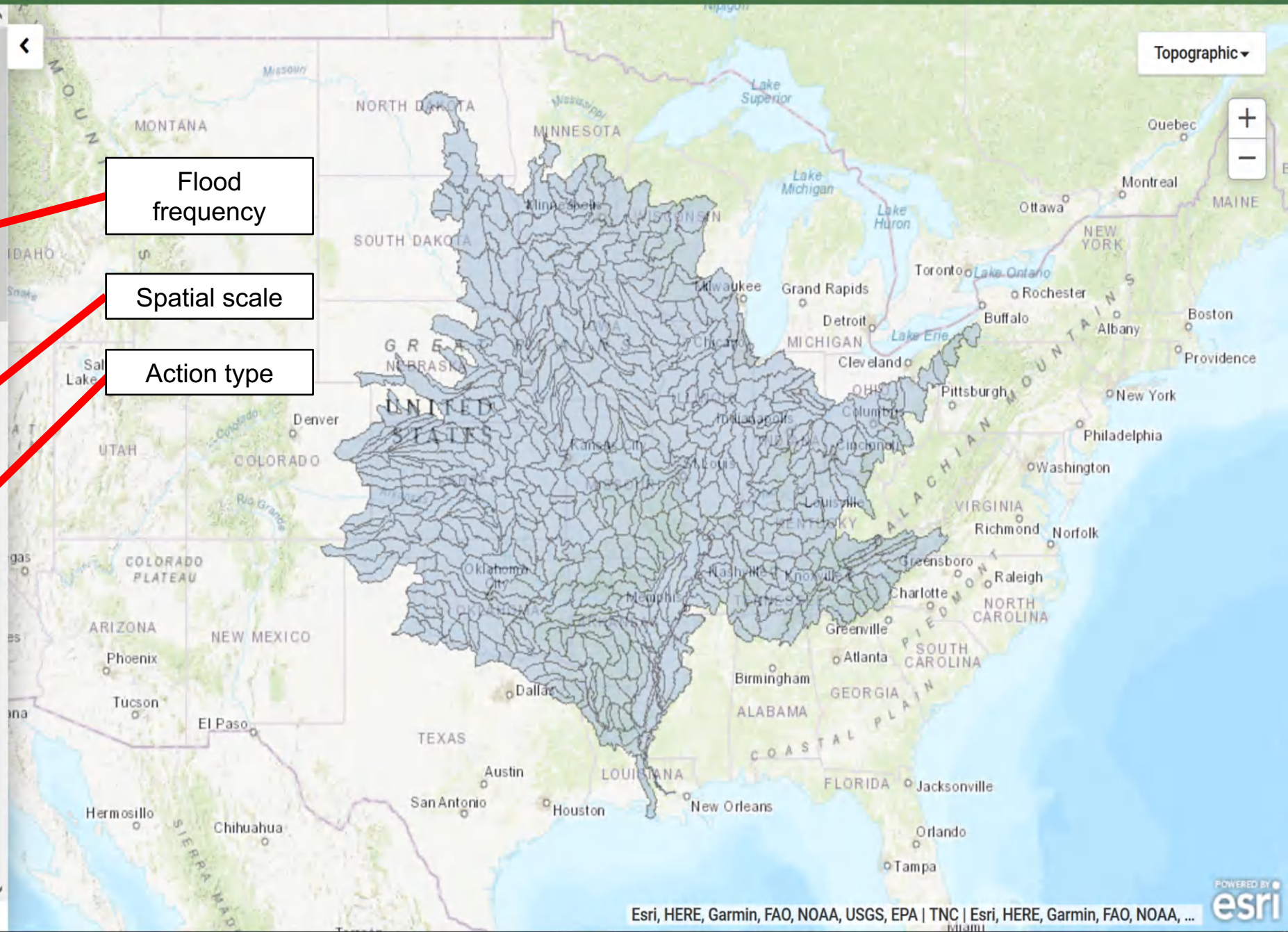
Nutrients

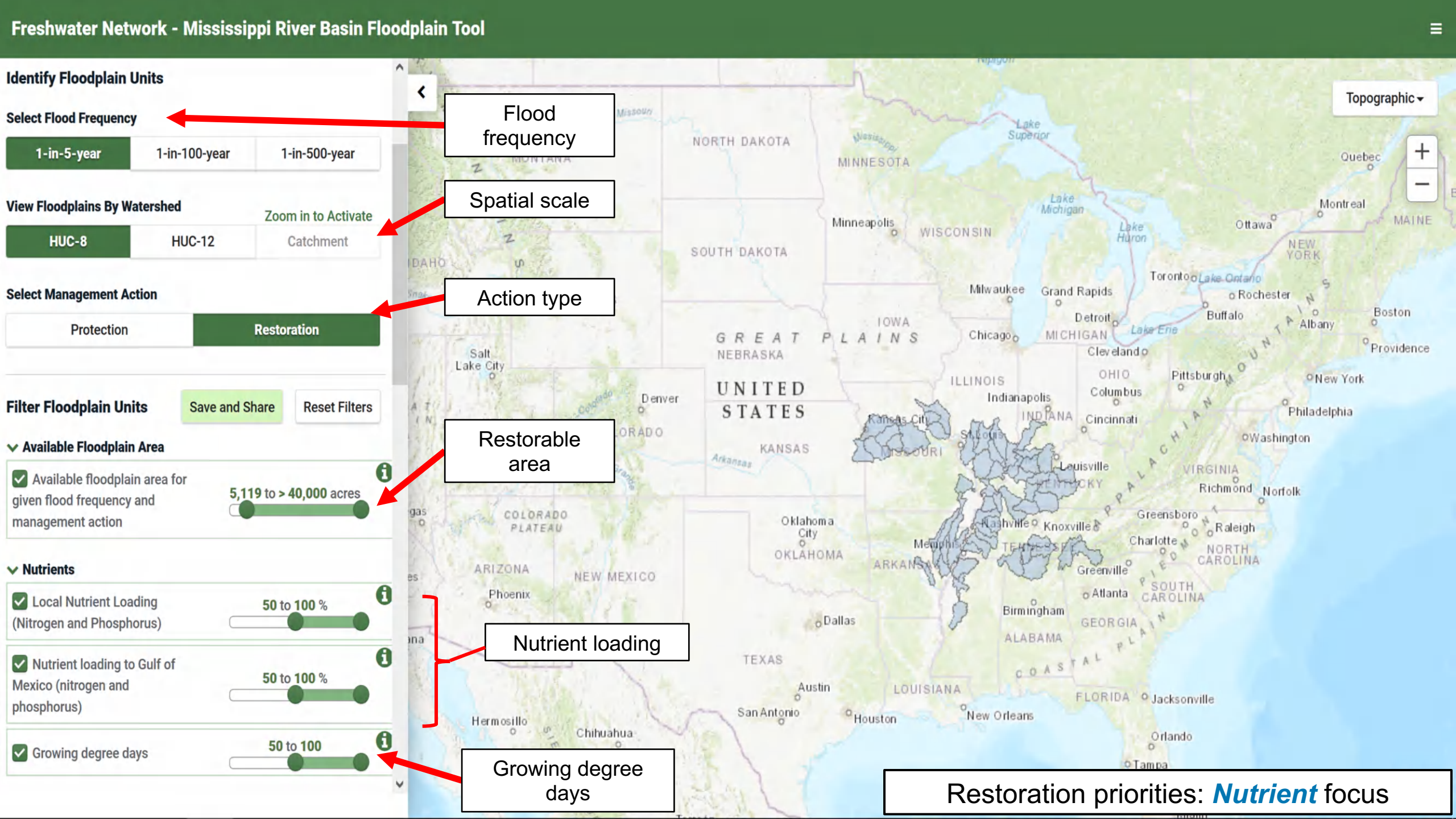
Local Nutrient Loading

Flood frequency

Spatial scale

Action type




Freshwater Network - Mississippi River Basin Floodplain Tool
Identify Floodplain Units
Select Flood Frequency
1-in-5-year
1-in-100-year
1-in-500-year
View Floodplains By Watershed
Zoom in to Activate
HUC-8
HUC-12
Catchment
Select Management Action
Protection
Restoration
Filter Floodplain Units
Save and Share
Reset Filters
Available Floodplain Area
Available floodplain area for given flood frequency and management action
5,119 to > 40,000 acres
Nutrients
Local Nutrient Loading (Nitrogen and Phosphorus)
50 to 100 %
Nutrient loading to Gulf of Mexico (nitrogen and phosphorus)
50 to 100 %
Growing degree days
50 to 100
Flood frequency
Spatial scale
Action type
Restorable area
Nutrient loading
Growing degree days
Topographic
Restoration priorities: Nutrient focus

Freshwater Network - Mississippi River Basin Floodplain Tool

Identify Floodplain Units

Select Flood Frequency

1-in-5-year | 1-in-100-year | 1-in-500-year

View Floodplains By Watershed

Zoom in to Activate

HUC-8 | HUC-12 | Catchment

Select Management Action

Protection | Restoration

Filter Floodplain Units Save and Share | Reset Filters

Available Floodplain Area

- Available floodplain area for given flood frequency and management action: 5,119 to > 40,000 acres

Nutrients

- Local Nutrient Loading (Nitrogen and Phosphorus): 50 to 100 %
- Nutrient loading to Gulf of Mexico (nitrogen and phosphorus): 50 to 100 %
- Growing degree days: 50 to 100

Name	Big Muddy
Watershed area (acres)	1.5 million
Floodplain (100-year) in forest or wetland (acres)	77,630.76
Floodplain (100-year) in ag or pasture (acres)	72,893.74
Local nutrient loading, percentile (1-100 scale)	74.85
Nutrient loading to Gulf, percentile (1-100 scale)	73.10
Current population in 100-year floodplain	201.00
Damage ($) to buildings exposed to flooding in 2050	394 million
Social vulnerability index	0.09

Topographic

Restoration priorities: ***Nutrient*** focus

Freshwater Network - Mississippi River Basin Floodplain Tool

Identify Floodplain Units

Select Flood Frequency

1-in-5-year | 1-in-100-year | 1-in-500-year

View Floodplains By Watershed

Zoom in to Activate

HUC-8 | HUC-12 | Catchment

Select Management Action

Protection | Restoration

Filter Floodplain Units

Save and Share | Reset Filters

Available Floodplain Area

- [x] Available floodplain area for given flood frequency and management action — 505 to > 2,500 acres

Nutrients

- [ ] Local Nutrient Loading (Nitrogen and Phosphorus) — 50 to 100 %
- [ ] Nutrient loading to Gulf of Mexico (nitrogen and phosphorus) — 51 to 100 %
- [ ] Growing degree days — 50 to 100

Switch spatial scale

Topographic

Esri, HERE, Garmin, FAO, USGS, NGA, EPA, NPS | TNC

Freshwater Network - Mississippi River Basin Floodplain Tool

Land Conversion

- [x] Agricultural Productivity Potential of Soils — 0 to 0.503

Habitat

- [ ] Important Bird Areas — Present / Absent
- [x] Nature Conservancy Ecoregional Assessment Units — Present / Absent
- [ ] At-Risk Wetland Species — 0 to 8
- [ ] USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
- [ ] American Bird Conservancy Corridors & Key Habitat Bird Areas — Present / Absent
- [x] National Fish Habitat Partnership Cumulative Habitat Condition Index — 0.999 to 2.825

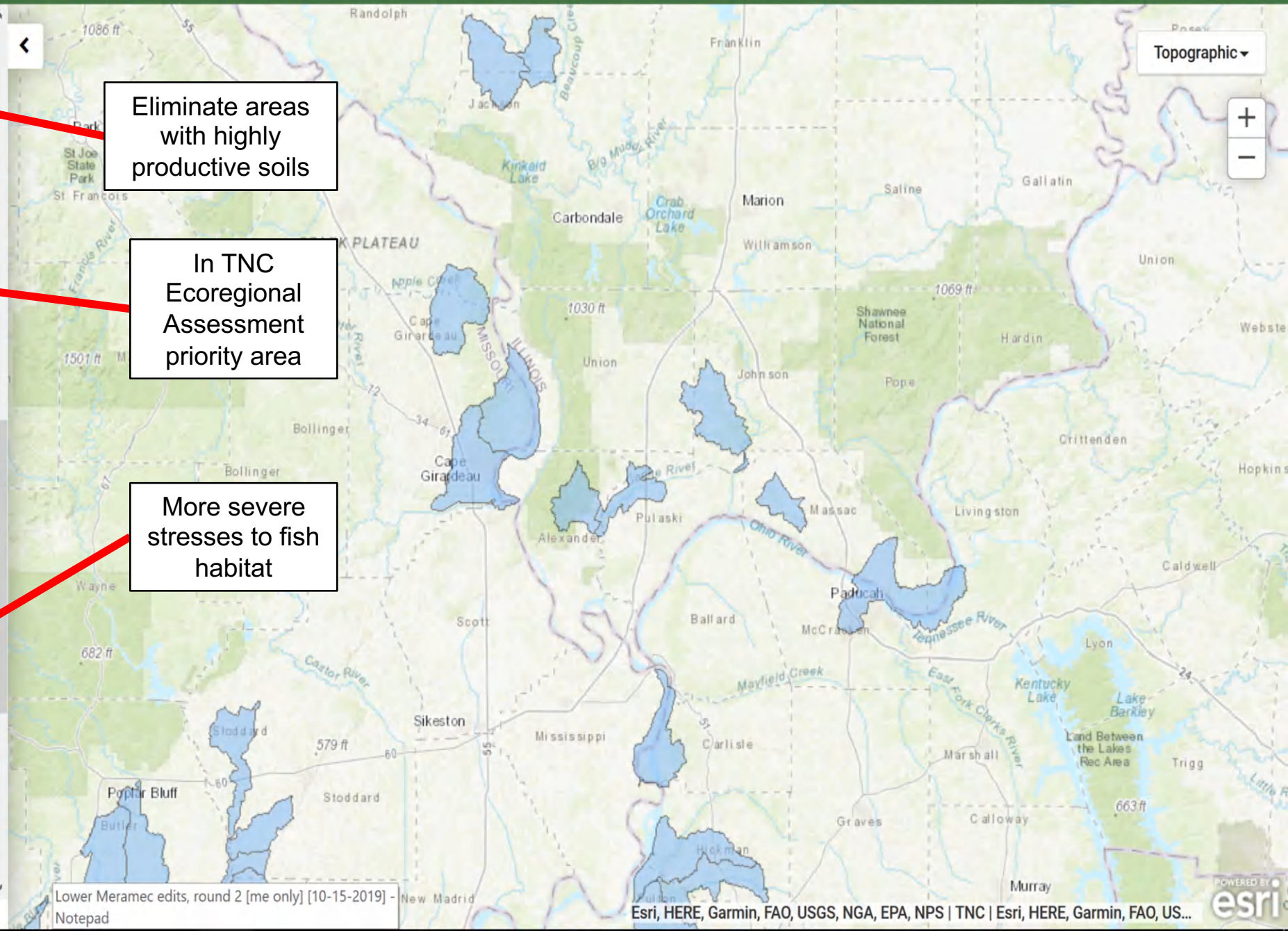
Population Exposure

- [ ] Population Exposed to Floods (Present-Day) — 0 to > 11
- [ ] Population Exposed to Floods (2050) — 52 to > 501

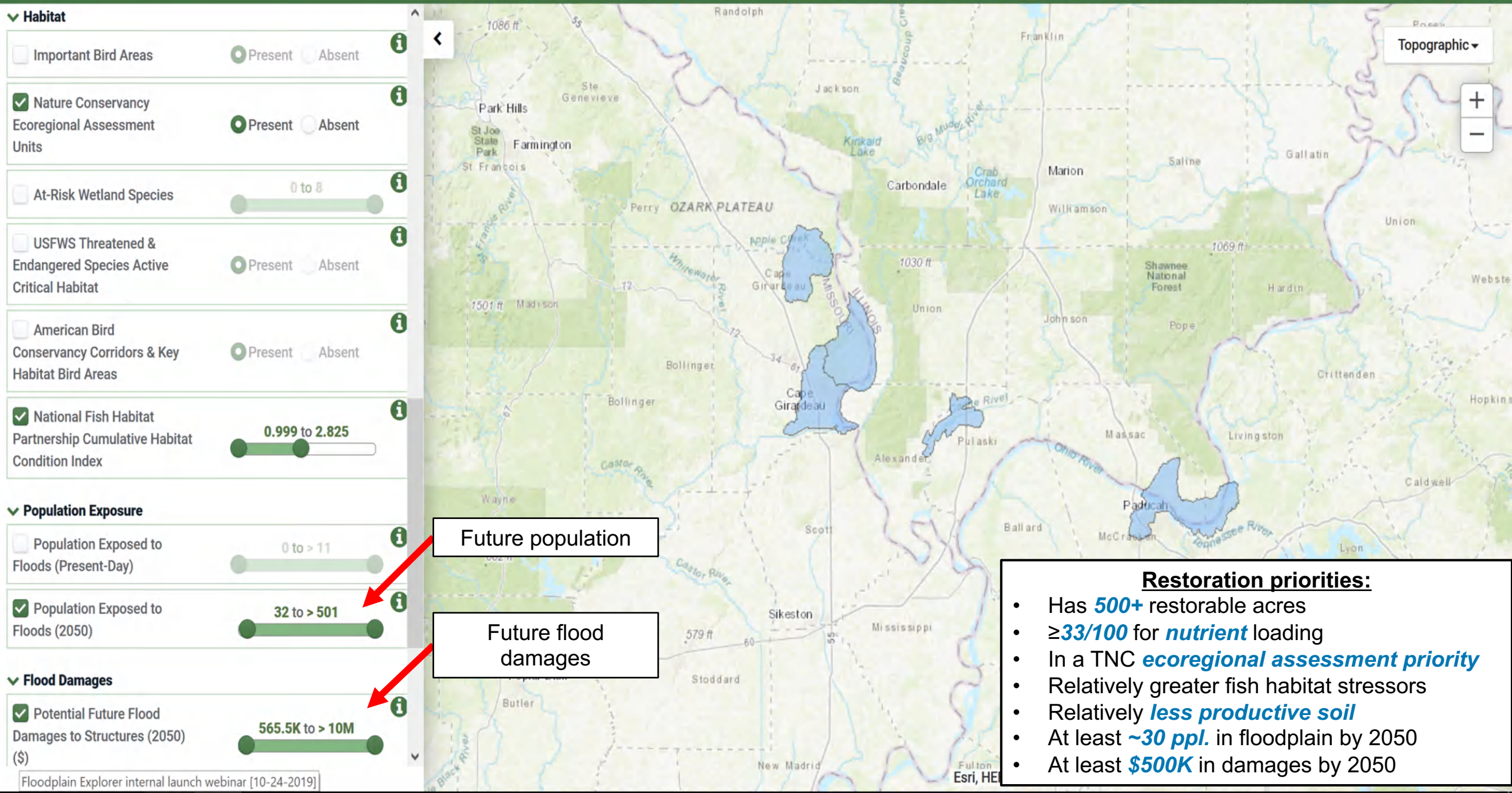
Eliminate areas with highly productive soils

In TNC Ecoregional Assessment priority area

More severe stresses to fish habitat



Freshwater Network - Mississippi River Basin Floodplain Tool



Freshwater Network - Mississippi River Basin Floodplain Tool

Habitat

- Important Bird Areas — Present / Absent
- Nature Conservancy Ecoregional Assessment Units — Present / Absent
- At-Risk Wetland Species — 0 to 8
- USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
- American Bird Conservancy Corridors & Key Habitat Bird Areas — Present / Absent
- National Fish Habitat Partnership Cumulative Habitat Condition Index — 0.999 to 2.825

Population Exposure

- Population Exposed to Floods (Present-Day) — 0 to > 11
- Population Exposed to Floods (2050) — 32 to > 501

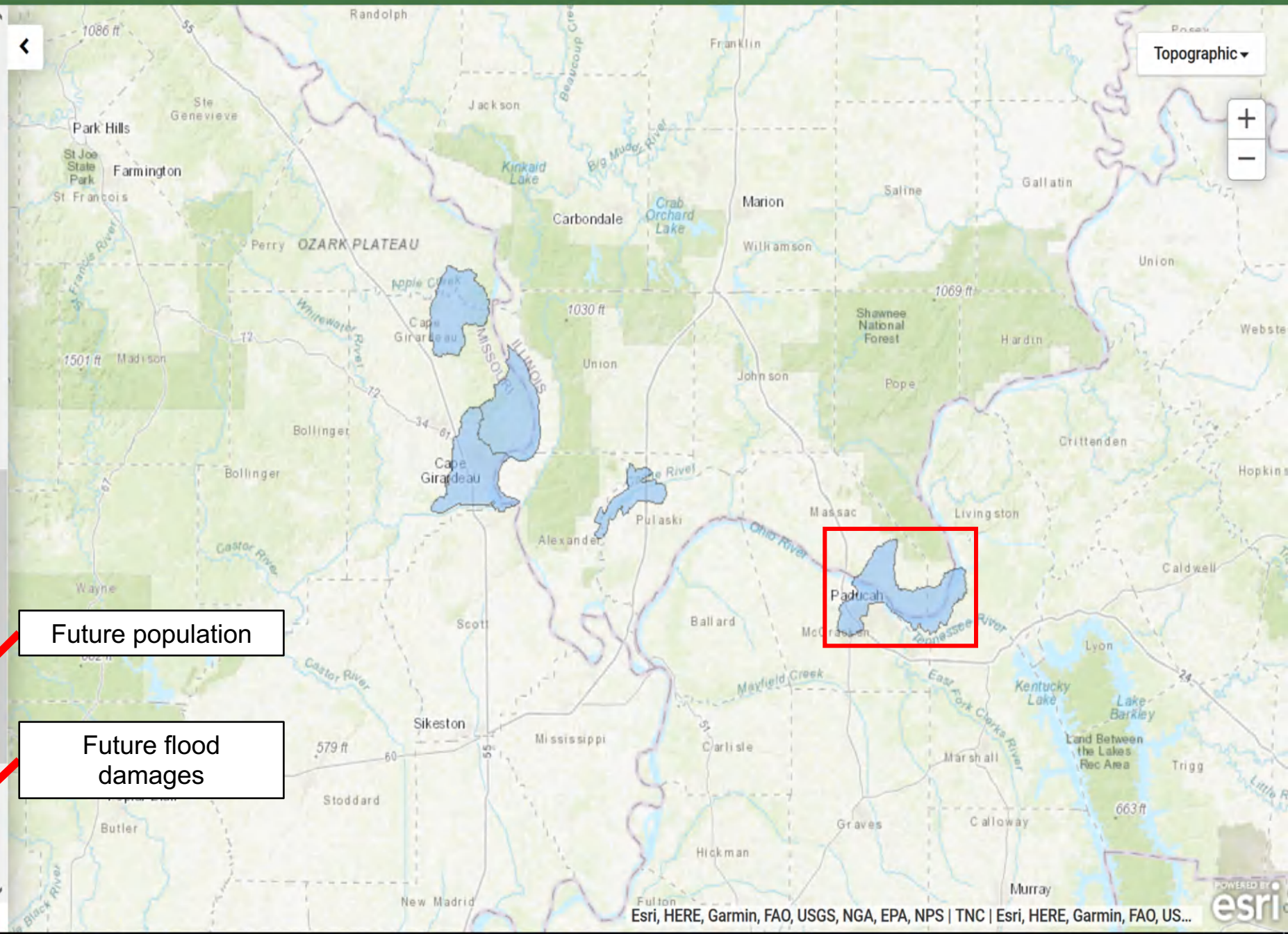
Flood Damages

- Potential Future Flood Damages to Structures (2050) ($) — 565.5K to > 10M

Floodplain Explorer internal launch webinar [10-24-2019]

Future population

Future flood damages



Freshwater Network - Mississippi River Basin Floodplain Tool

Identify Floodplain Units

Select Flood Frequency

1-in-5-year | **1-in-100-year** | 1-in-500-year

View Floodplains By Watershed

HUC-8 | HUC-12 | **Catchment**

Select Management Action

Protection | **Restoration**

Filter Floodplain Units Save and Share Reset Filters

Available Floodplain Area

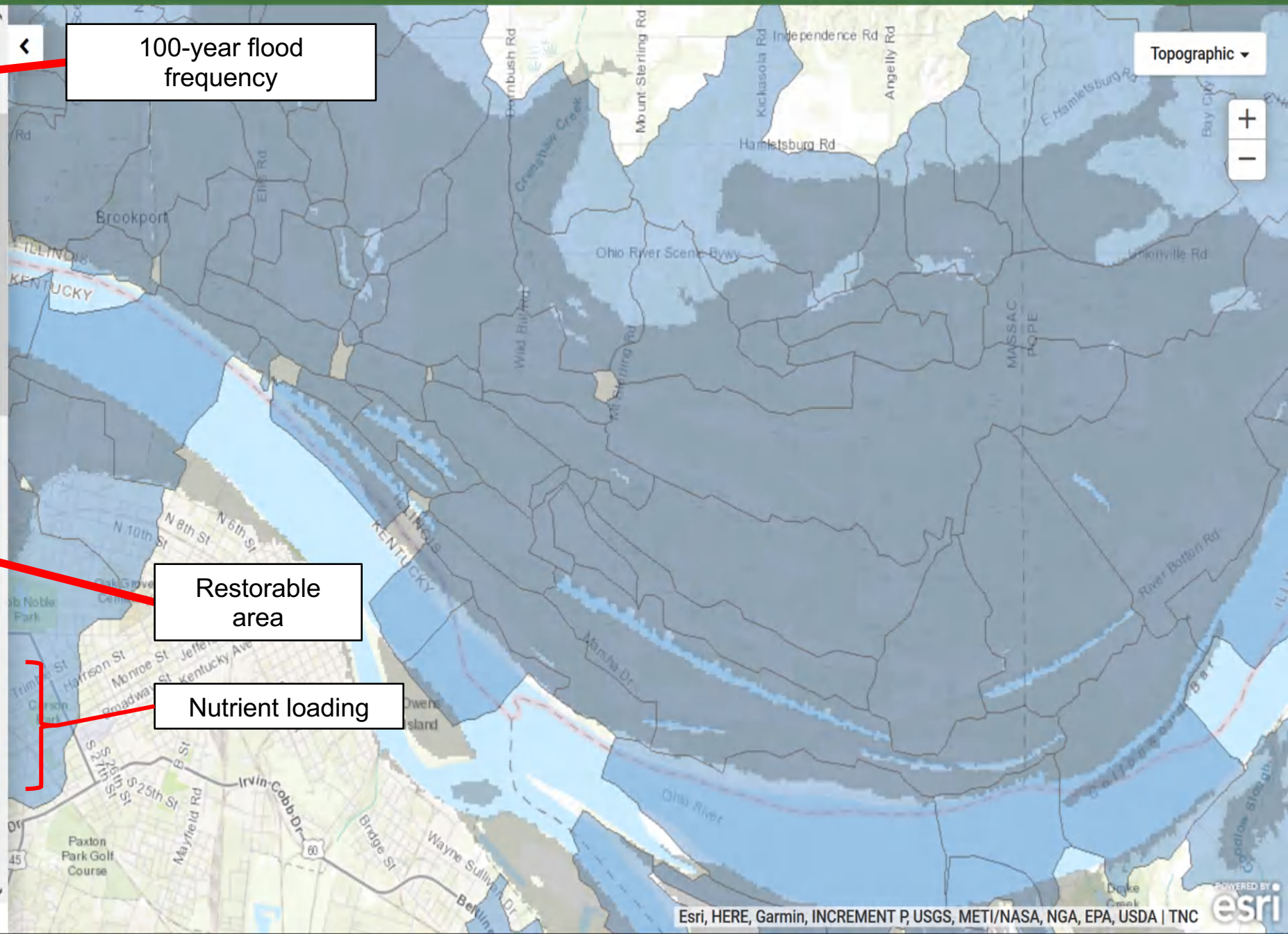
- [x] Available floodplain area for given flood frequency and management action — 10 to > 250 acres

Nutrients

- [x] Local Nutrient Loading (Nitrogen and Phosphorus) — 50 to 100 %
- [x] Nutrient loading to Gulf of Mexico (nitrogen and phosphorus) — 50 to 100 %

Land Conversion

- [ ] Agricultural Productivity — 0 to 0.838



Freshwater Network - Mississippi River Basin Floodplain Tool

Habitat

- Important Bird Areas — Present / Absent
- Nature Conservancy Ecoregional Assessment Units — Present / Absent
- At-Risk Wetland Species — 1 to 8
- USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
- American Bird Conservancy Corridors & Key Habitat Bird Areas — Present / Absent
- National Fish Habitat Partnership Cumulative Habitat Condition Index — 0.999 to 2.017

Population Exposure

- Population Exposed to Floods (Present-Day) — 1 to > 11
- Population Exposed to Floods (2050) — 11 to > 501

Flood Damages

- Potential Future Flood Damages to Structures (2050) ($) — 10,000 to > 1M

Floodplain Explorer internal launch webinar [10-24-2019]

At-risk wetland species

More severe stresses to fish habitat

Future population

Topographic

Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, NGA, EPA, USDA | TNC | Esri...

Freshwater Network - Mississippi River Basin Floodplain Tool

Habitat

- Important Bird Areas — Present / Absent
- Nature Conservancy Ecoregional Assessment Units — Present / Absent
- At-Risk Wetland Species — 1 to 8
- USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
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Population Exposure

- Population Exposed to Floods (Present-Day) — 1 to > 11
- Population Exposed to Floods (2050) — 11 to > 501

Flood Damages

- Potential Future Flood Damages to Structures (2050) ($) — 10,000 to > 1M

Restoration priorities:

- Has ***nonzero*** restorable acres
- ≥***50/100*** for ***nutrient*** loading
- In a TNC ***ecoregional assessment priority***
- Has at-risk wetland species
- Relatively greater fish habitat stressors
- At least ***~10 ppl.*** in floodplain by 2050
- At least ***$10K*** in damages by 2050

At-risk wetland species

More severe stresses to fish habitat

Future population

Future flood damages

The FP Tool utilized on Missouri's Meramec River

MEET YOUR 2016-17 ST. LOUIS AREA **SCHOLAR ATHLETES** • SECTION INSIDE TODAY

STL TODAY **ST. LOUIS POST-DISPATCH**

TUESDAY • 05.02.2017 • $1.50

RISING RIVERS

ROAD CLOSURES
MoDOT warns of long delays as traffic is diverted in southwest St. Louis, Jefferson counties

EVACUATIONS
Residents pack up in Valley Park, but some say they are staying put, convinced levee will hold

FORECAST
A predicted 3 inches of rain over next few days could prolong flooding, cause secondary crest

Emerson Poulin, 10, lugs a sandbag Monday as volunteers work to protect downtown Eureka from the rising Meramec River. Emerson, a fourth-grader, was off school because the Rockwood School District canceled classes in the Eureka quadrant of the district.

DAVID CARSON • dcarson@post-dispatch.com

Dozens of closed

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THURSDAY • 05.04.2017 • $1.50

MERAMEC CRESTING

HUMP DAY
Officials in Eureka, Valley Park and Pacific hope the worst has flowed past

ROAD CLOSURES
More than 100 roads still affected, including Interstate 55; Arnold is nearly cut off

RAIN IN FORECAST
2-4 inches more rain is expected in the area through Friday morning

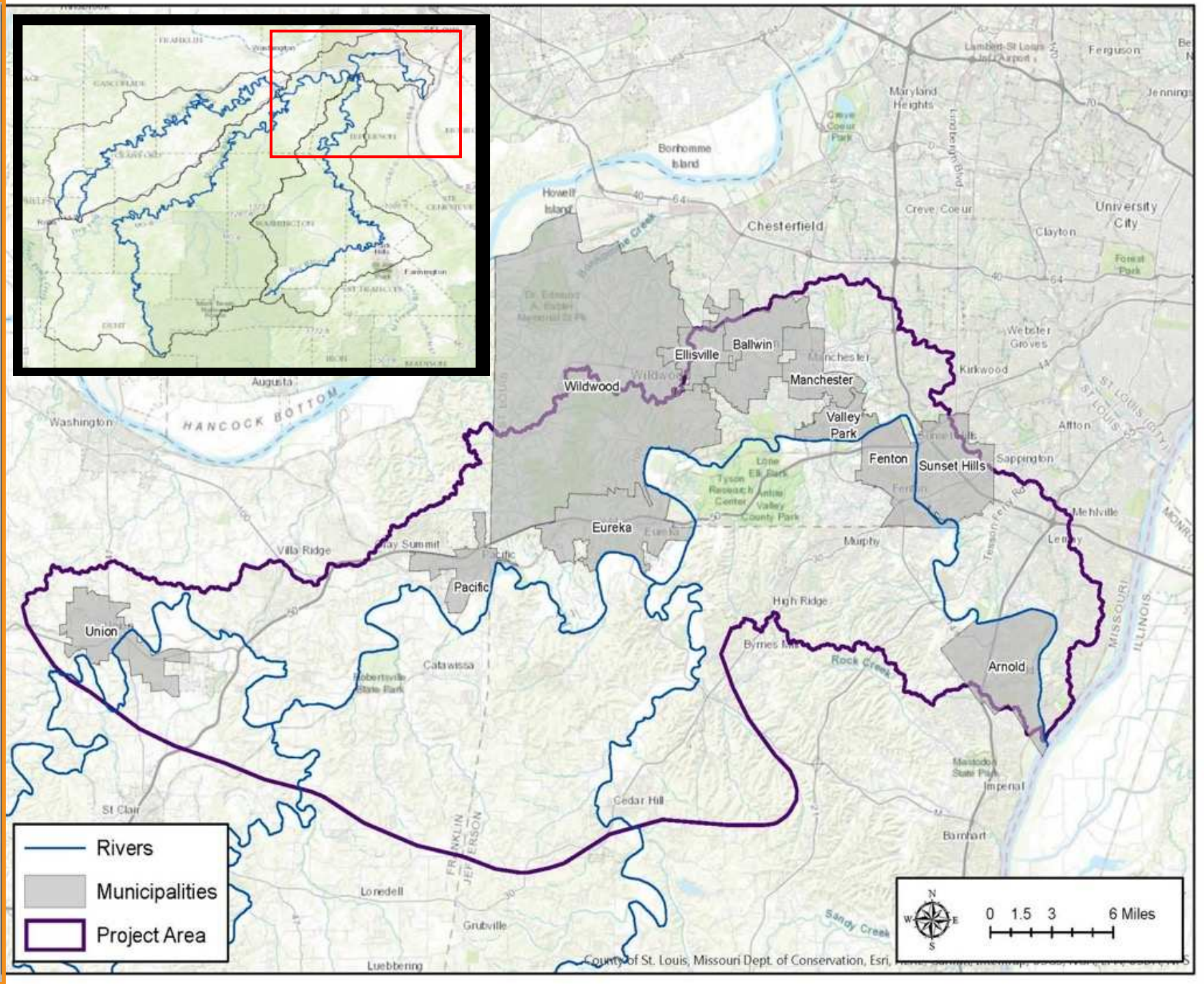
Pacific building and fire inspectors look through Pacific Package Liquor to deem it safe for occupancy on East Osage Street on Wednesday. Business owners in the strip shopping center planned to begin cleaning up by Friday. In Pacific, the water had risen to about 33 feet Tuesday, just short of the December 2015 record.

ROBERT COHEN • rcohen@post-dispatch.com

As floodwater recedes, a

Lower Meramec River Multi-Jurisdictional Flood Management Plan

- 70 river miles on the Meramec
- 25 river miles on the Bourbeuse
- 20 river miles on the Big River



Silver Jacket's Lower Meramec Floodplain Management Plan Partners

Saint Louis COUNTY

CITY OF UNION · STATE OF MISSOURI

FENTON CITY OF PARKS Missouri

FEMA

JEFFERSON COUNTY 1818 MISSOURI

Eureka PROUD PAST

CITY OF ARNOLD MISSOURI

USGS science for a changing world

COMMISSION FRANKLIN COUNTY, MO.

City of Valley Park

City of Sunset Hills

Missouri Department of Natural Resources

MISSOURI DEPT OF PUBLIC SAFETY EMERGENCY MANAGEMENT

EAST-WEST GATEWAY Council of Governments

The Nature Conservancy nature.org

WILDWOOD

Habitat

- Important Bird Areas — Present / Absent
- TNC Ecoregional Assessment Units — Present / Absent
- At-Risk Wetland Species — 1 to 8
- USFWS Threatened & Endangered Species Active Critical Habitat — Present / Absent
- American Bird Conservancy Corridors & Key Habitat Bird Areas — Present / Absent
- National Fish Habitat Partnership Cumulative Habitat Condition Index — 0 to 5

Population Exposure

- Current population — 1 to > 10
- Projected population (2050) — 100 to > 1,000

Future Economic Assset Exposure

- Economic asset exposure (2050) (SSP2) — 10M to > 50M

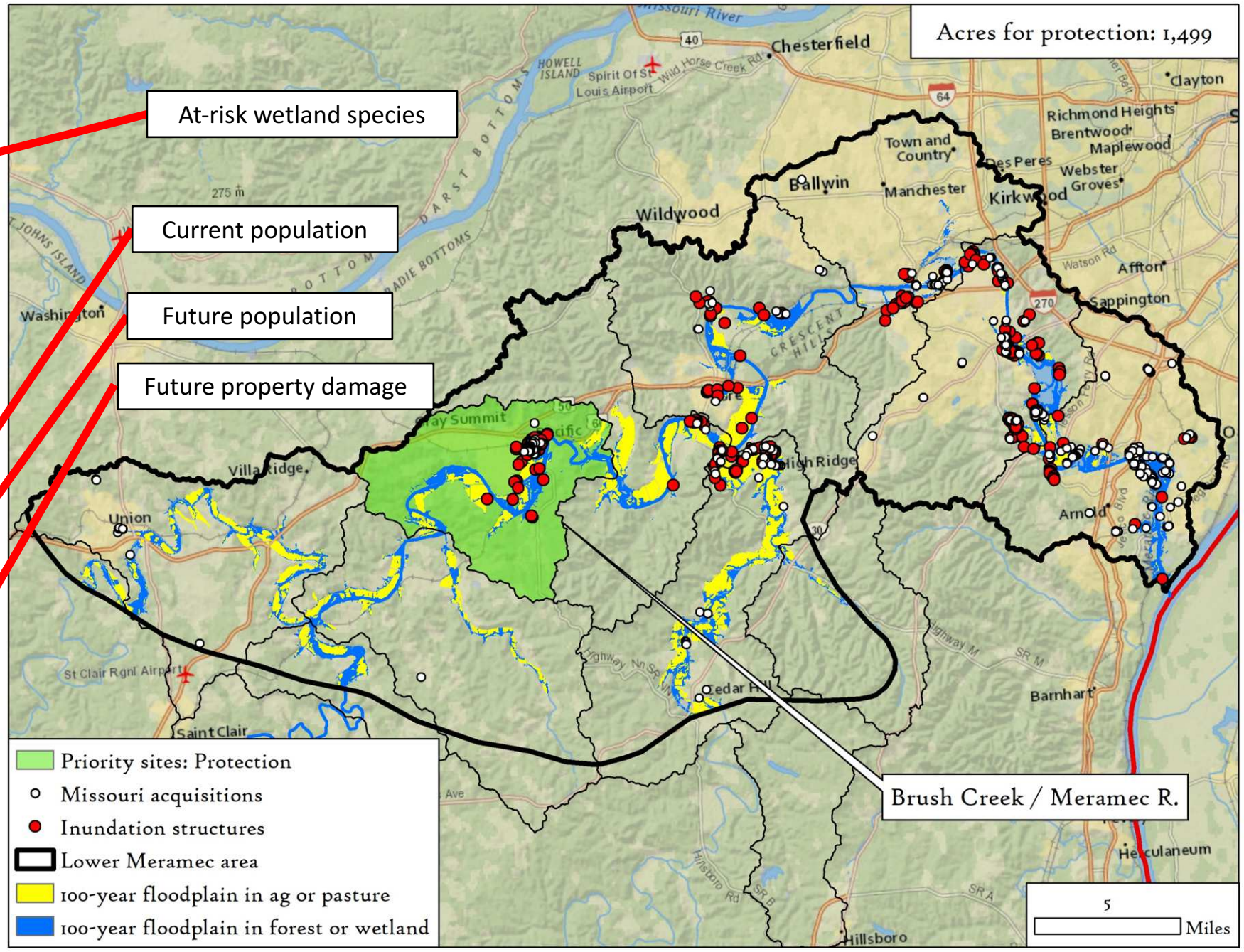
At-risk wetland species

Current population

Future population

Future property damage

Acres for protection: 1,499

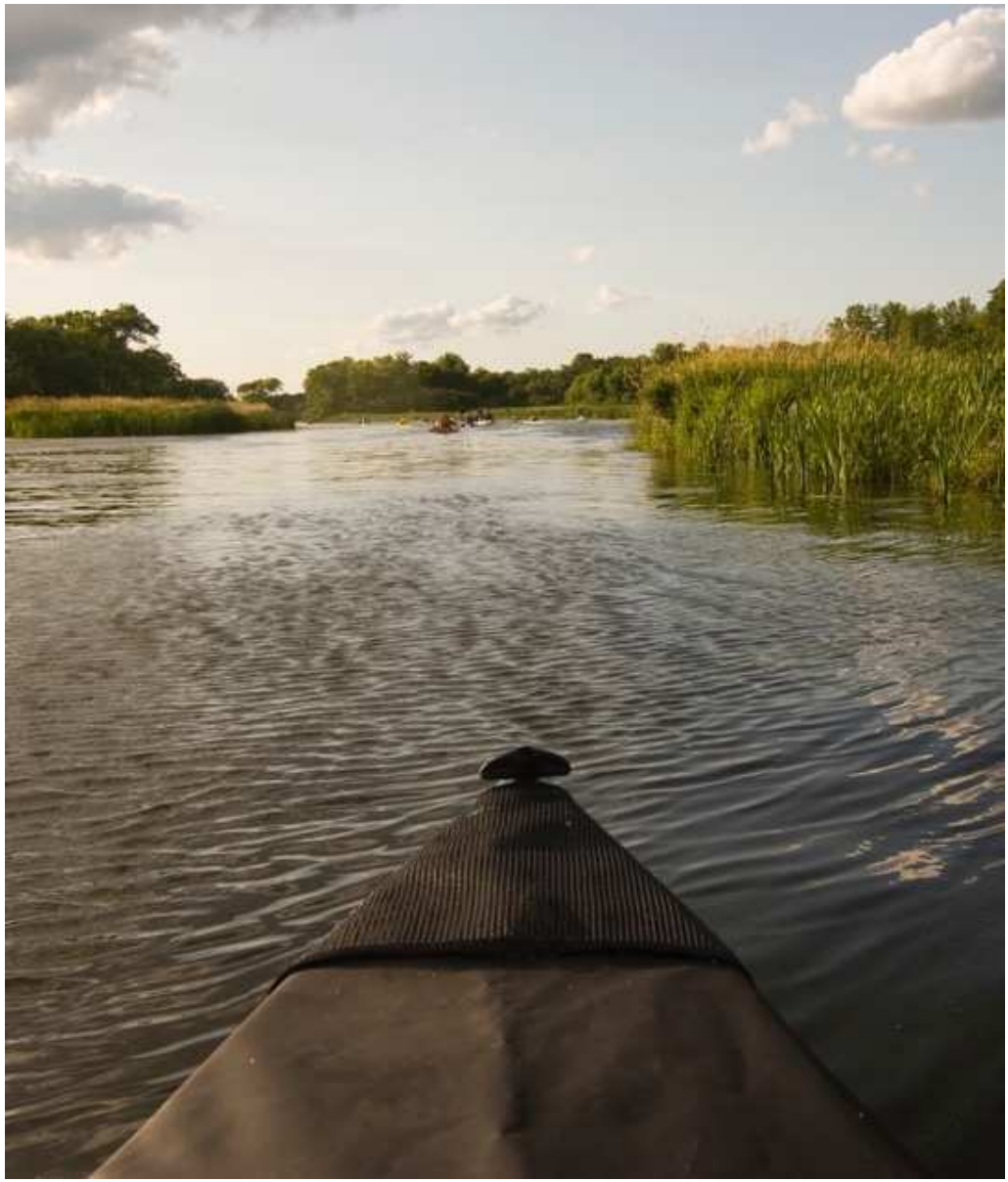


Criteria for **PROTECTION:**

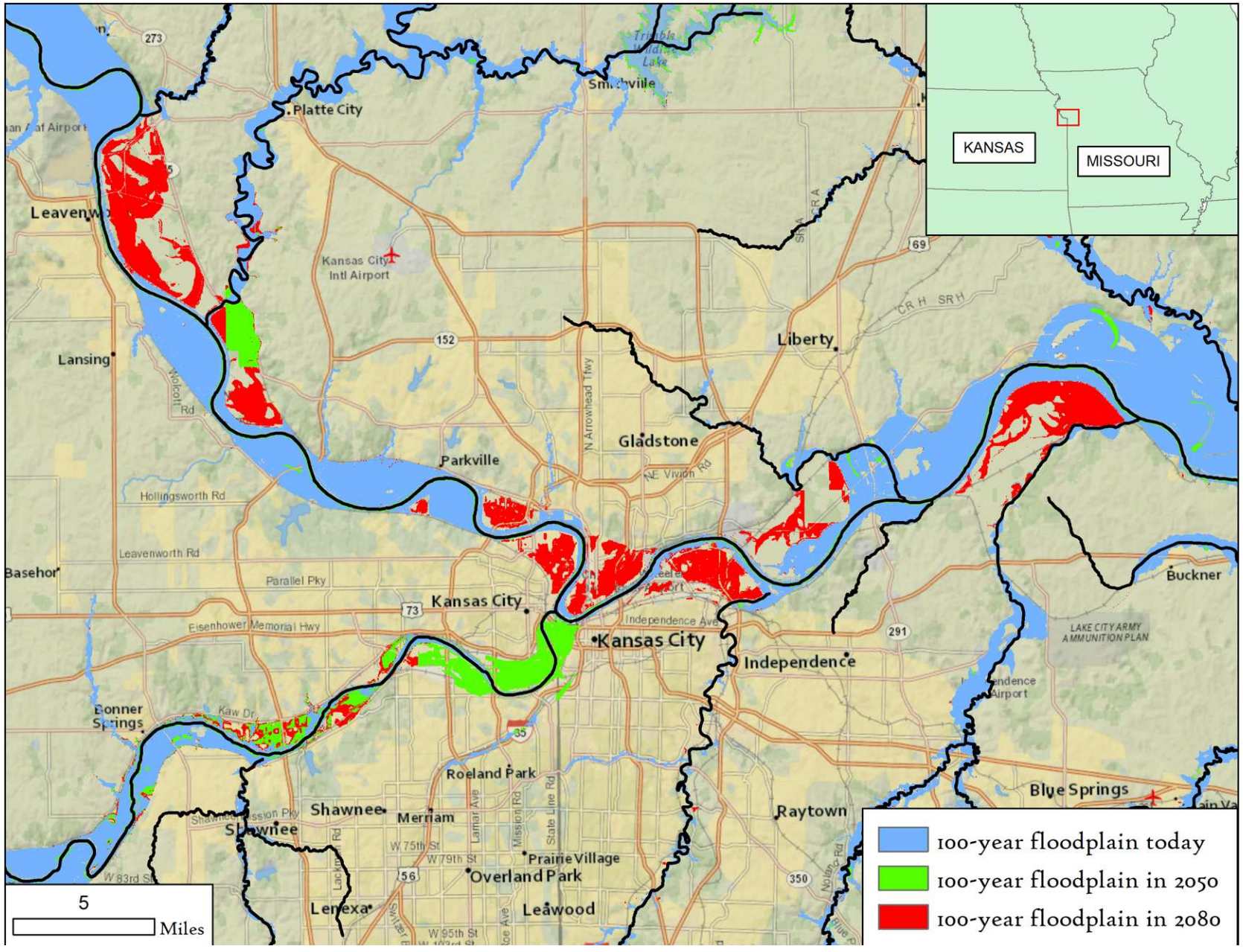
- At least 1,000 acres of floodplain in forest or wetland
- Bottom 50% for nutrient loading
- Nonzero current pop. & projected 2050 pop. >100 ppl.
- Projected 2050 flood damage >=$10,000,000
- Presence of at-risk wetland species

Upcoming Data & Development

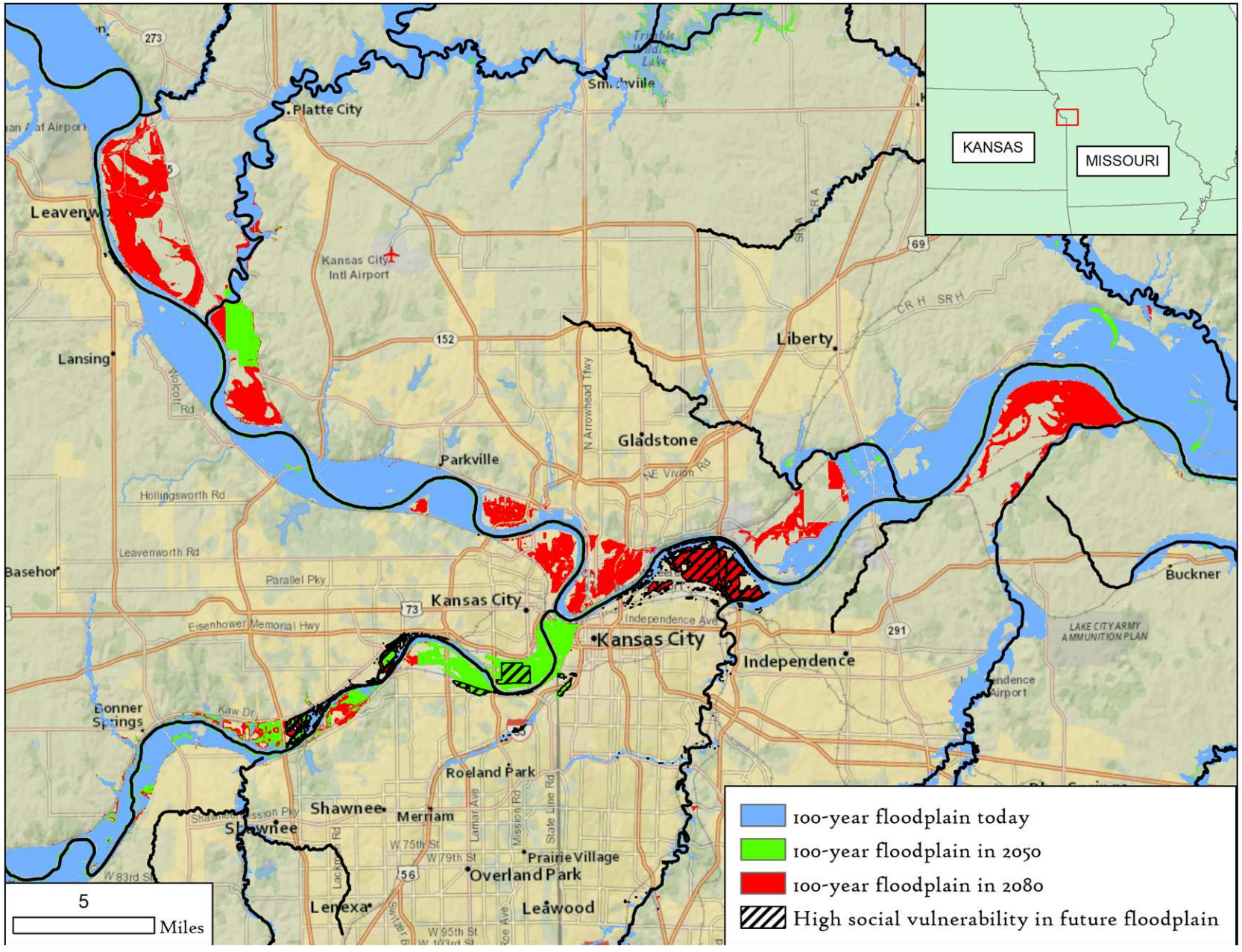
- Updated data from ***USGS SPARROW model***
- Places ***resilient to climate change***
- Improved mapping of ***levee locations***
- Estimate of ***Carbon sequestration*** in floodplain
- ***Future floodplain maps*** based on climate change
- Development of ***customized tools*** for local geographies – e.g. lower Meramec River in Missouri



Upcoming Data & Development



Upcoming Data & Development




Thank You!
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