Developing a Spatial Model of Yellow-billed Cuckoo Breeding Habitat

James R. Hatten[1]

[1]U.S. Geological Survey, Western Fisheries Research Center,
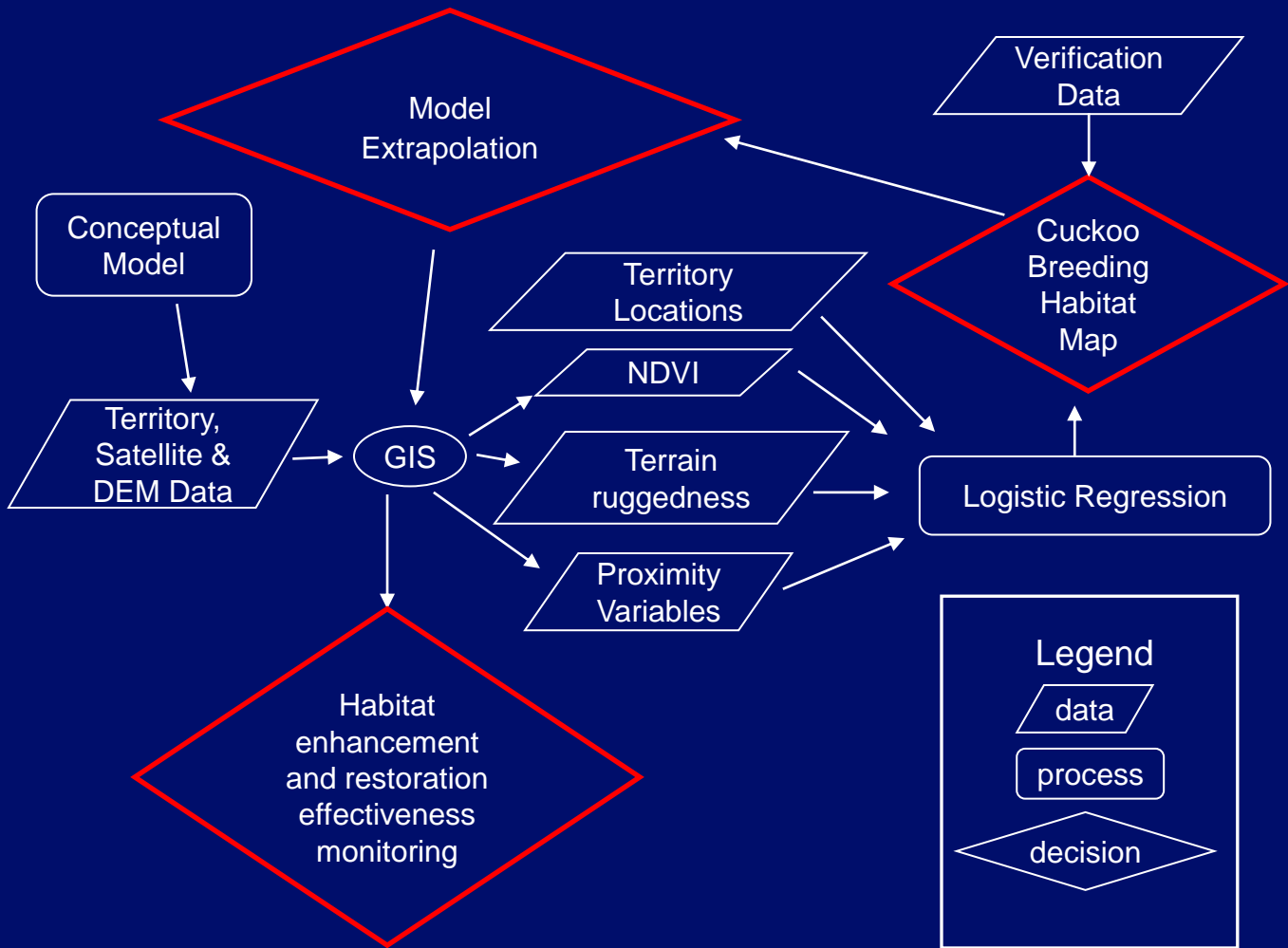Columbia River Research Laboratory, Cook, Washington

Matthew J. Johnson[2], Jennifer A. Holmes[2]

[2]U.S. Geological Survey, Southwest Biological Science Center,
Colorado Plateau Research Station, Flagstaff, Arizona
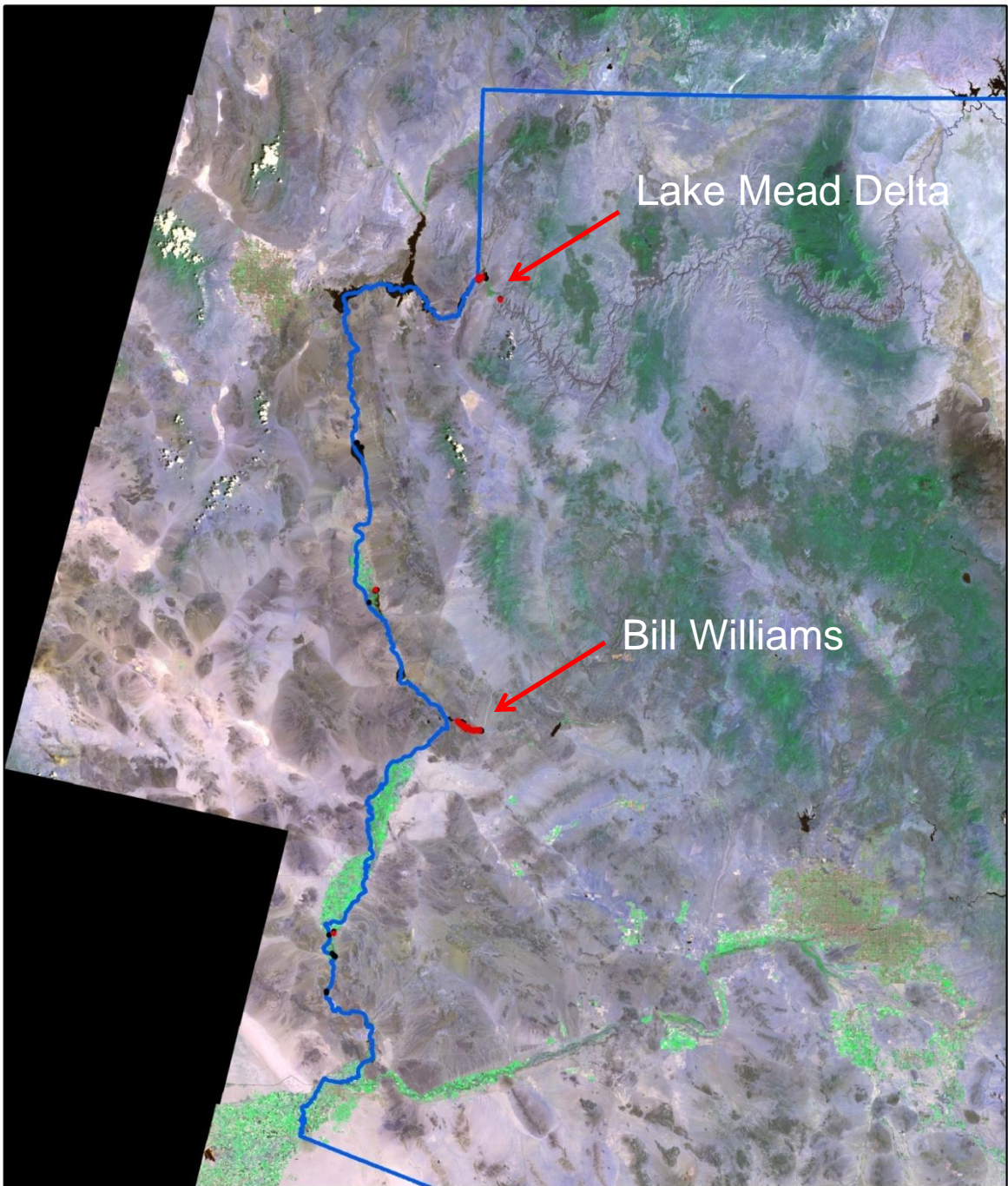
USGS
science for a changing world

Project Objectives

- Characterize Yellow-billed Cuckoo breeding habitat
- Develop spatially explicit models of cuckoo breeding habitat
- Identify all potential cuckoo habitat on the Lower Colorado River
- Extrapolate the model to other parts of the state
- Use the predictive model for habitat restoration and enhancement effectiveness monitoring
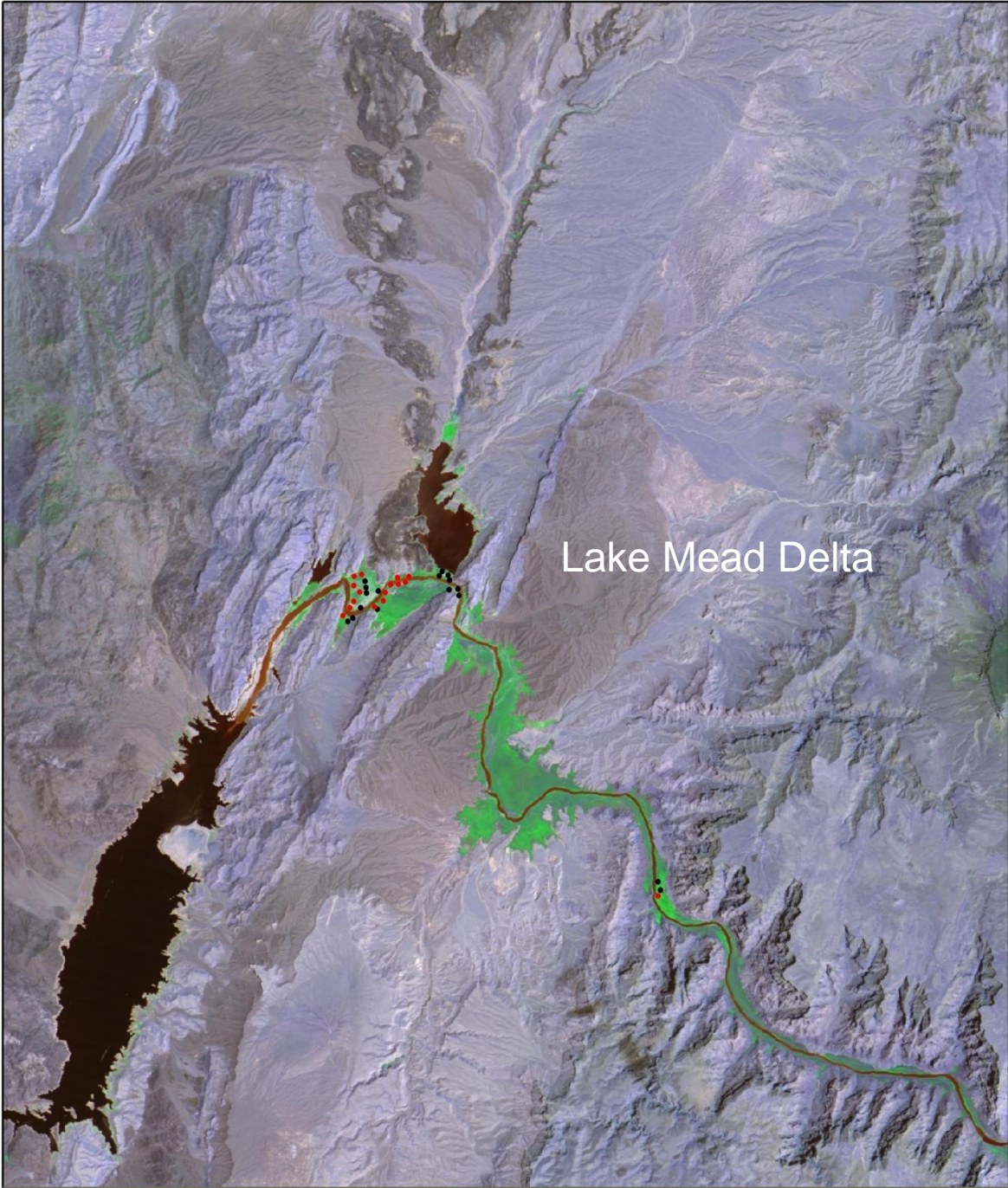
Modeling Approach

Model Extrapolation

Verification Data

Conceptual Model

Cuckoo Breeding Habitat Map

Territory, Satellite & DEM Data

GIS

Territory Locations

NDVI

Terrain ruggedness

Proximity Variables

Logistic Regression

Habitat enhancement and restoration effectiveness monitoring

Legend
data
process
decision

USGS

Sample Locations - 2006

Lake Mead Delta

Sample
Absence ·
Presence ·

0   3   6   12 Kilometers
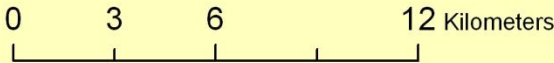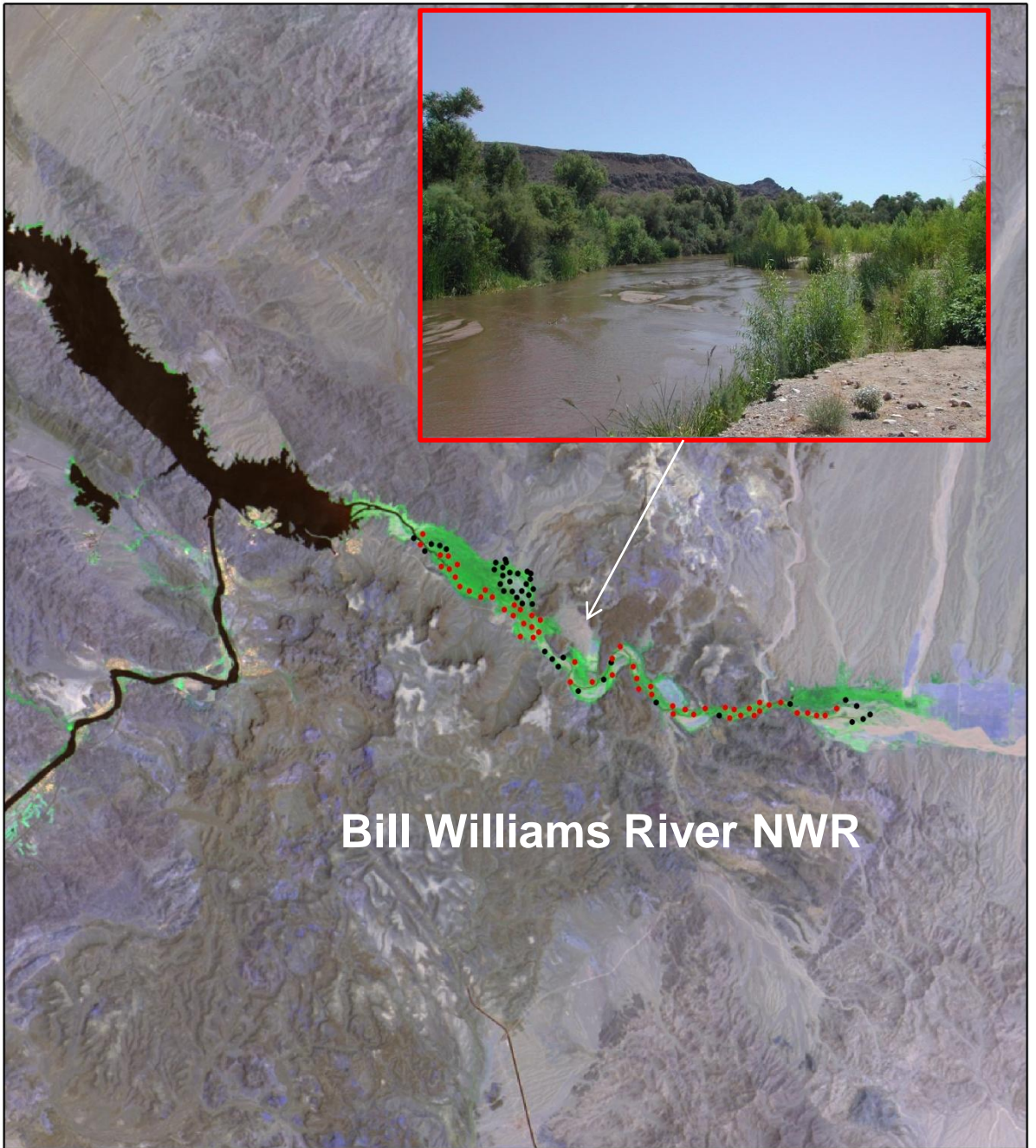
Bill Williams River NWR
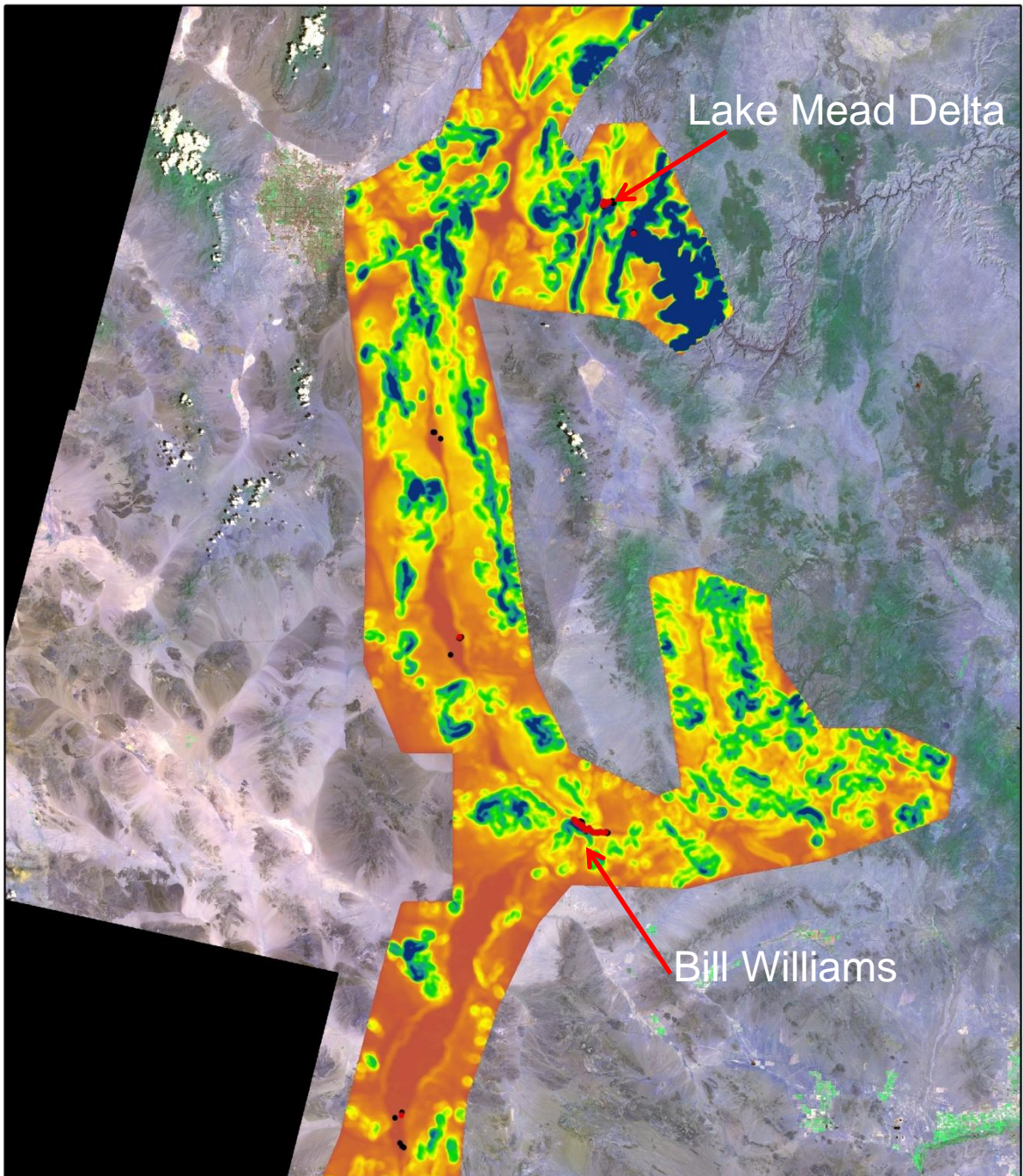
Sample
Absence ·
Presence ·

0   2.5   5   10 Kilometers
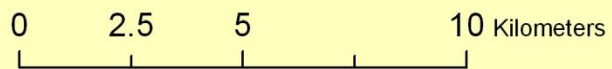
Exploratory Variables

- Terrain roughness (30-m DEMs)
- Distance to water
- Distance to agriculture or cities
- Vegetation density (Thematic Mapper)
  - NDVI
  - Tasseled Cap
- Vegetation heterogeneity
- Patch size and configuration
  - Multiple scales
- Hydro-geomorphic classification
  - Different approaches

≋ USGS

Terrain Ruggedness

Terrain Ruggedness (classified)

Lake Mead Delta

Bill Williams

Sample
Absence ·
Presence ·

N
W ✦ E
S

0   25   50   100 Kilometers

Terrain ruggedness

Flat
Low
Moderate
High

USGS

Distance to Water

Lake Mead Delta

Bill Williams

Distance to water

- 0 - 1 km
- 1 - 2 km
- 2 - 3 km
- 3 - 4 km
- 4 - 5 km

0   25   50   100 Kilometers

USGS
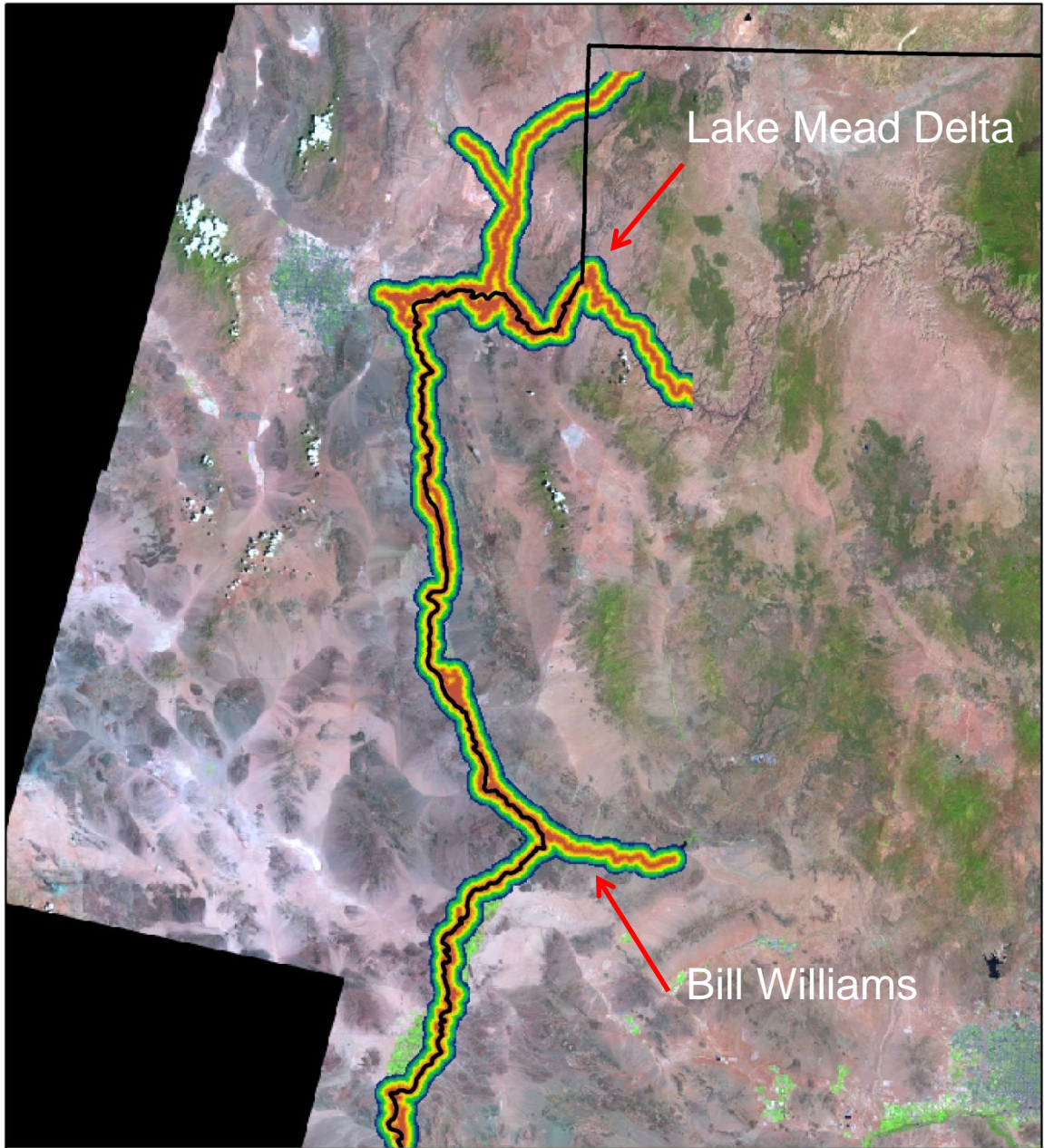
Vegetation Density (NDVI)

Bill Williams

Sample
Absence ·
Presence ·

N
W — E
S
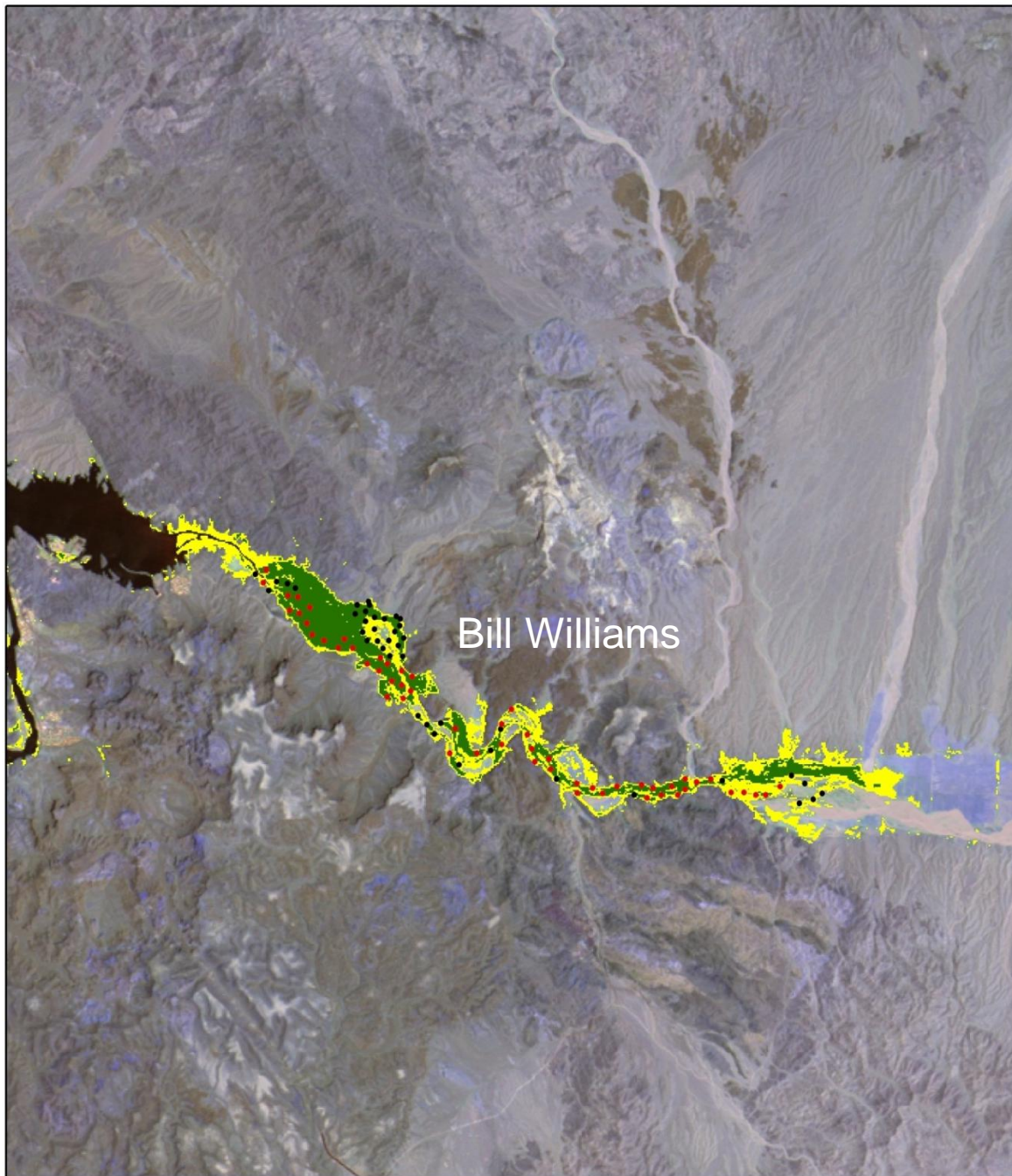
0   1.5   3   6 Kilometers

Vegetation density
High
Low - moderate

USGS
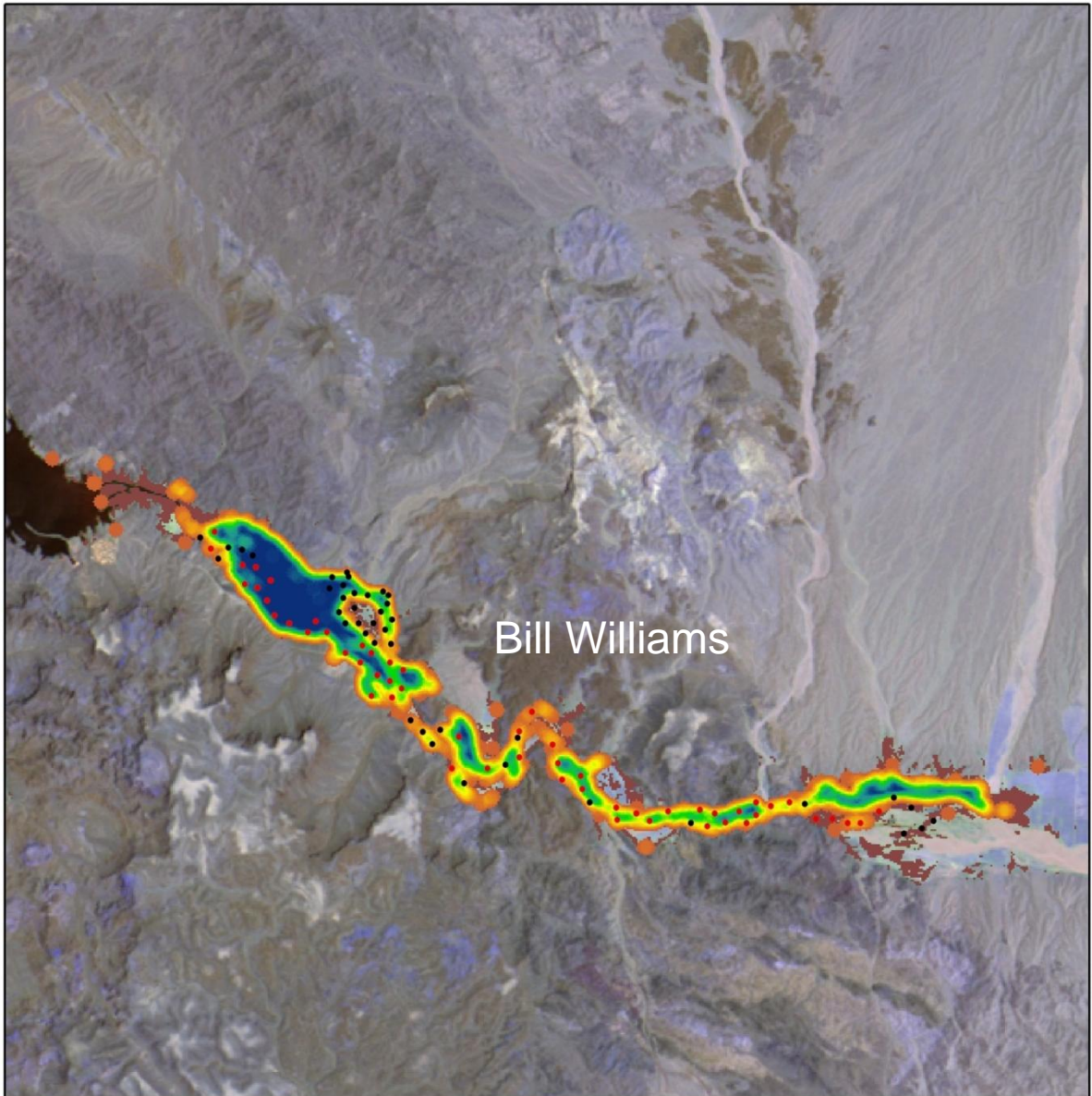
Patch (120-m radius)

Bill Williams

Amount of dense vegetation within 120-m radius

Sample
Absence ·
Presence ·

Low

Moderate

High

0   1.25   2.5   5 Kilometers
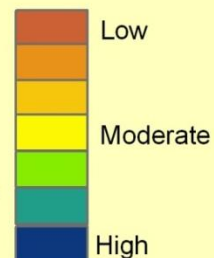
Vegetation Heterogeneity (480-m radius)

Bill Williams

Heterogeneity of vegetation density within 480-m radius

Low

Moderate

High

Sample
Absence
Presence

0 0.5 1   2 Kilometers

USGS
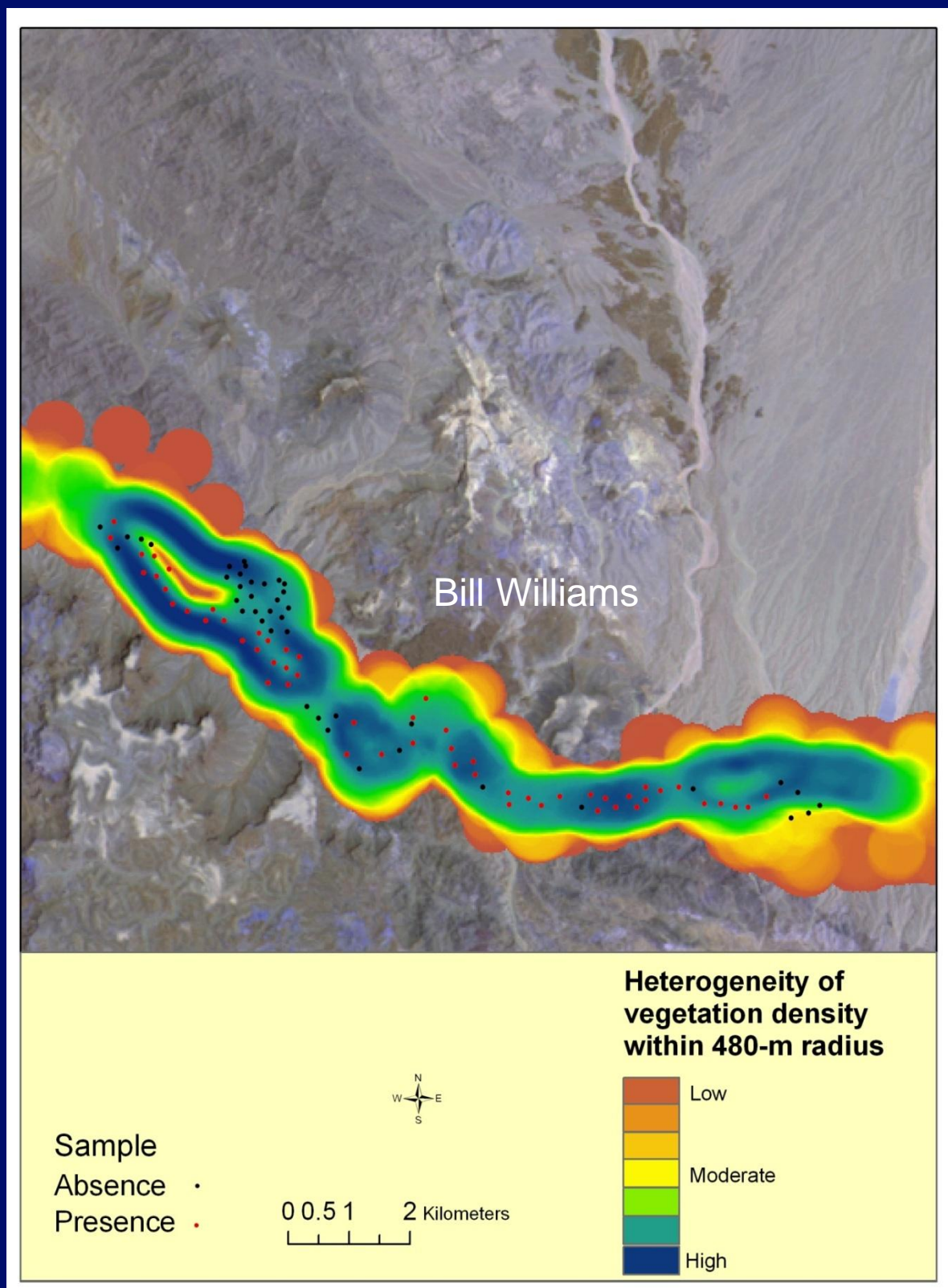
Significant Variables

- **Terrain ruggedness**
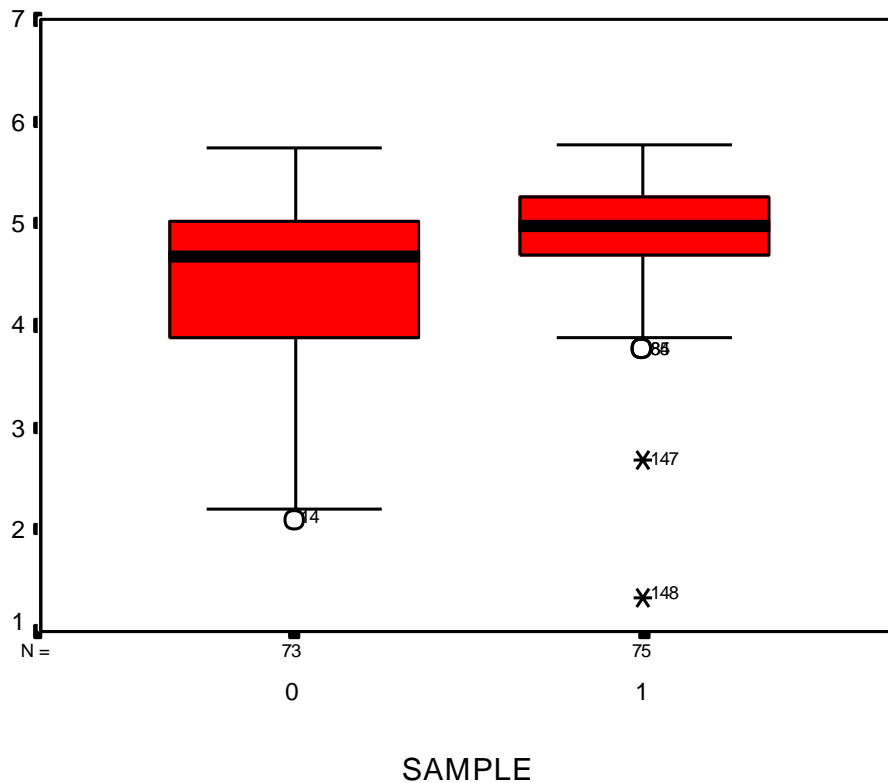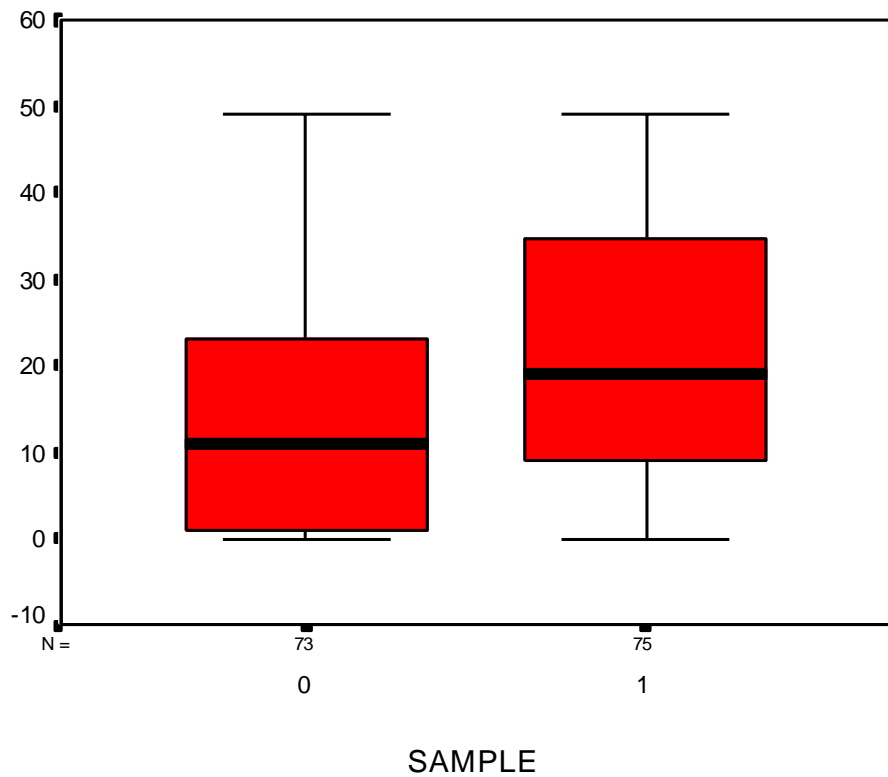
  4 classes: flat, low, moderate, high

- **Patch density**

  Amount of dense vegetation (NDVI > 0.41) within 120-m radius (4.5 ha)
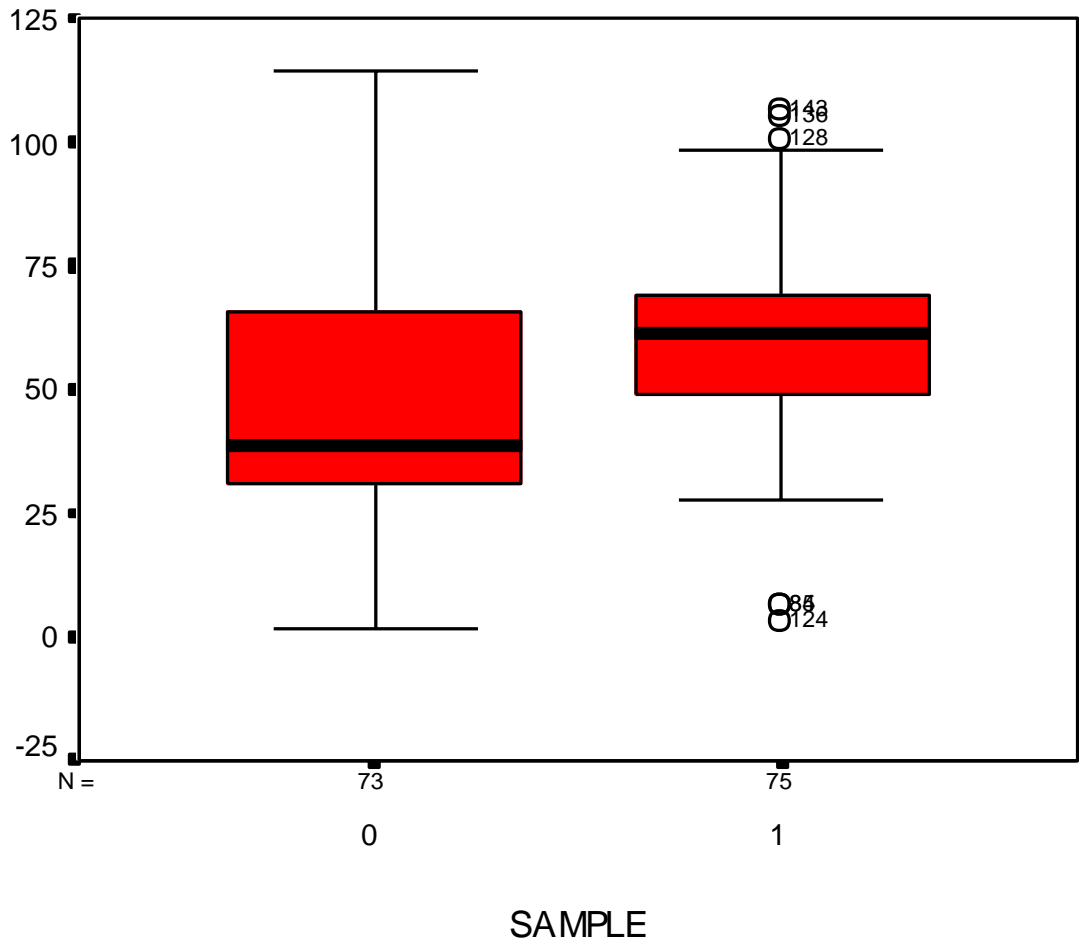
- **Patch heterogenity**

  Variation in vegetation density (SD of NDVI) inside a 480-m radius (72 ha)
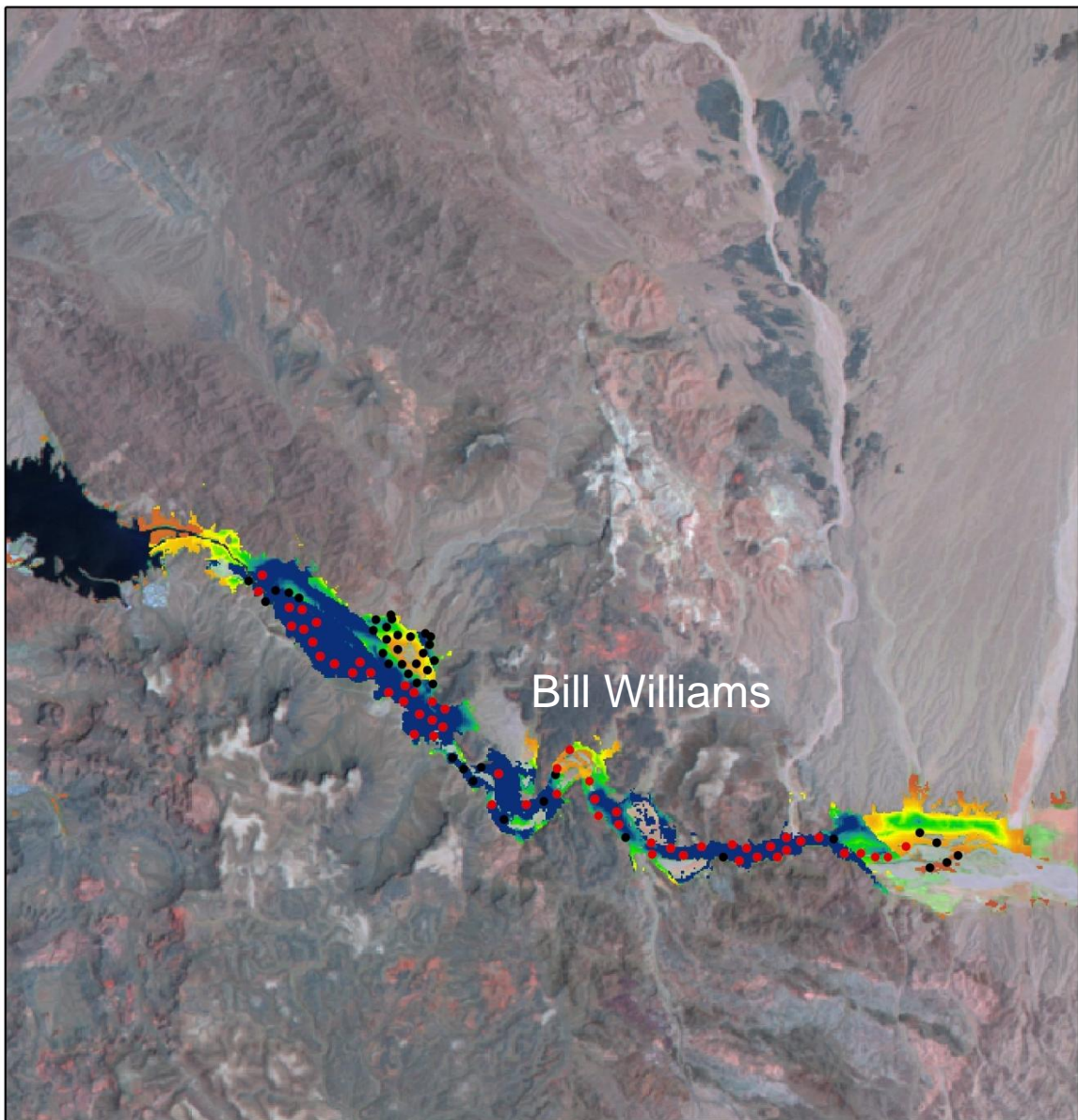
Significant Covariates

Significant Covariates

Model Outputs

- Probability grids
- Spatially explicit maps
- Multiple classification approaches
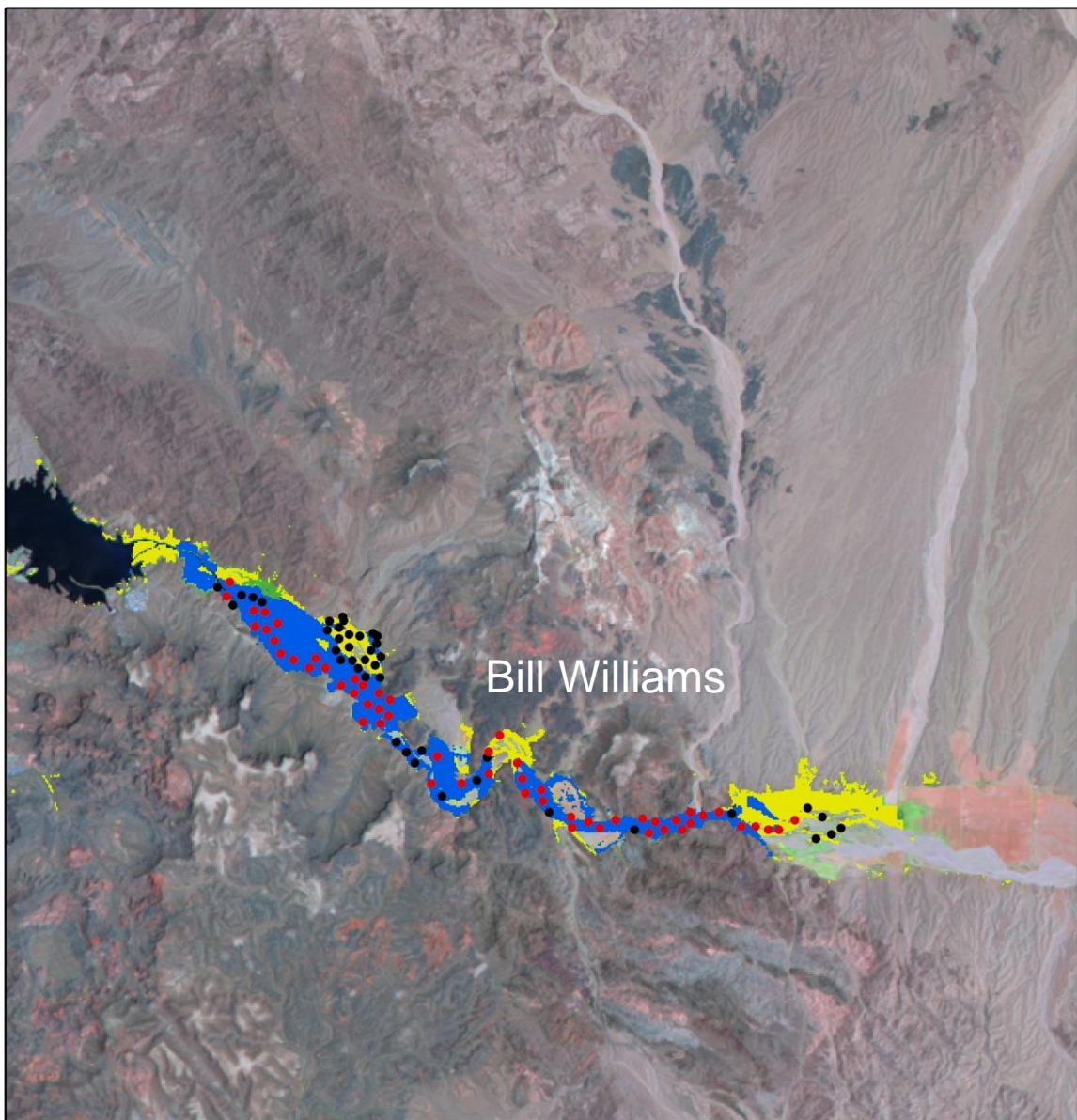
≋ USGS

Probability Surface - 2006

SAMPLE
• Absence
• Presence

Model probability
High : 0.999999
Low : 0.0122897

Bill Williams

0   1.25   2.5   5 Kilometers

Binary Habitat Map - 2006

Bill Williams

75% overall accuracy

SAMPLE

- • Absence
- • Presence
- ▢ Predicted unsuitable
- ▢ Predicted suitable

N
W E
S

0   1.5   3   6 Kilometers

USGS

Probability Surface - 2006

Lake Mead Delta

SAMPLE
- Absence
- Presence

Model probability

High : 0.999999

Low : 0.0122897

0   1.25   2.5   5 Kilometers

USGS
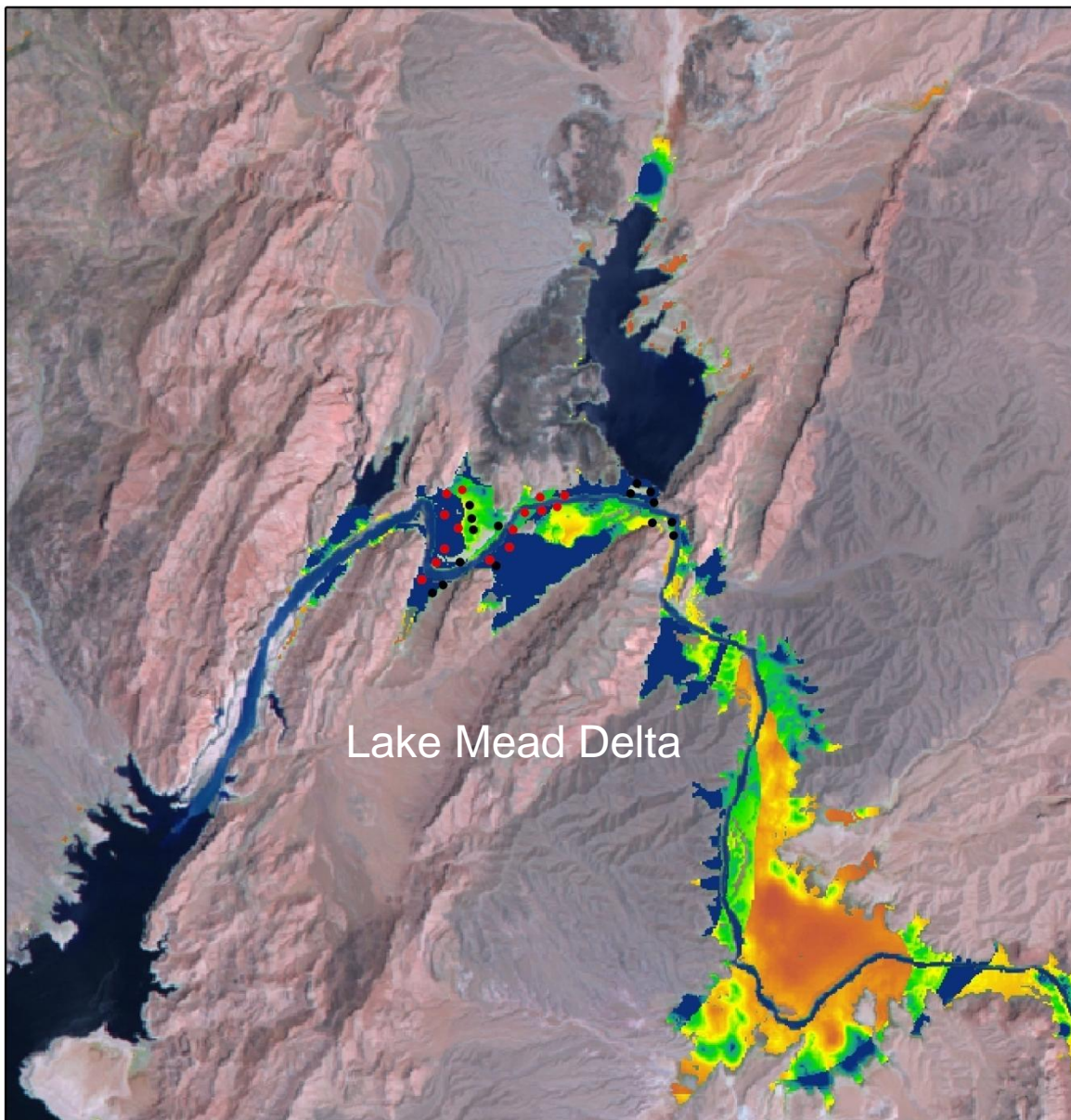
Binary Habitat Map - 2007
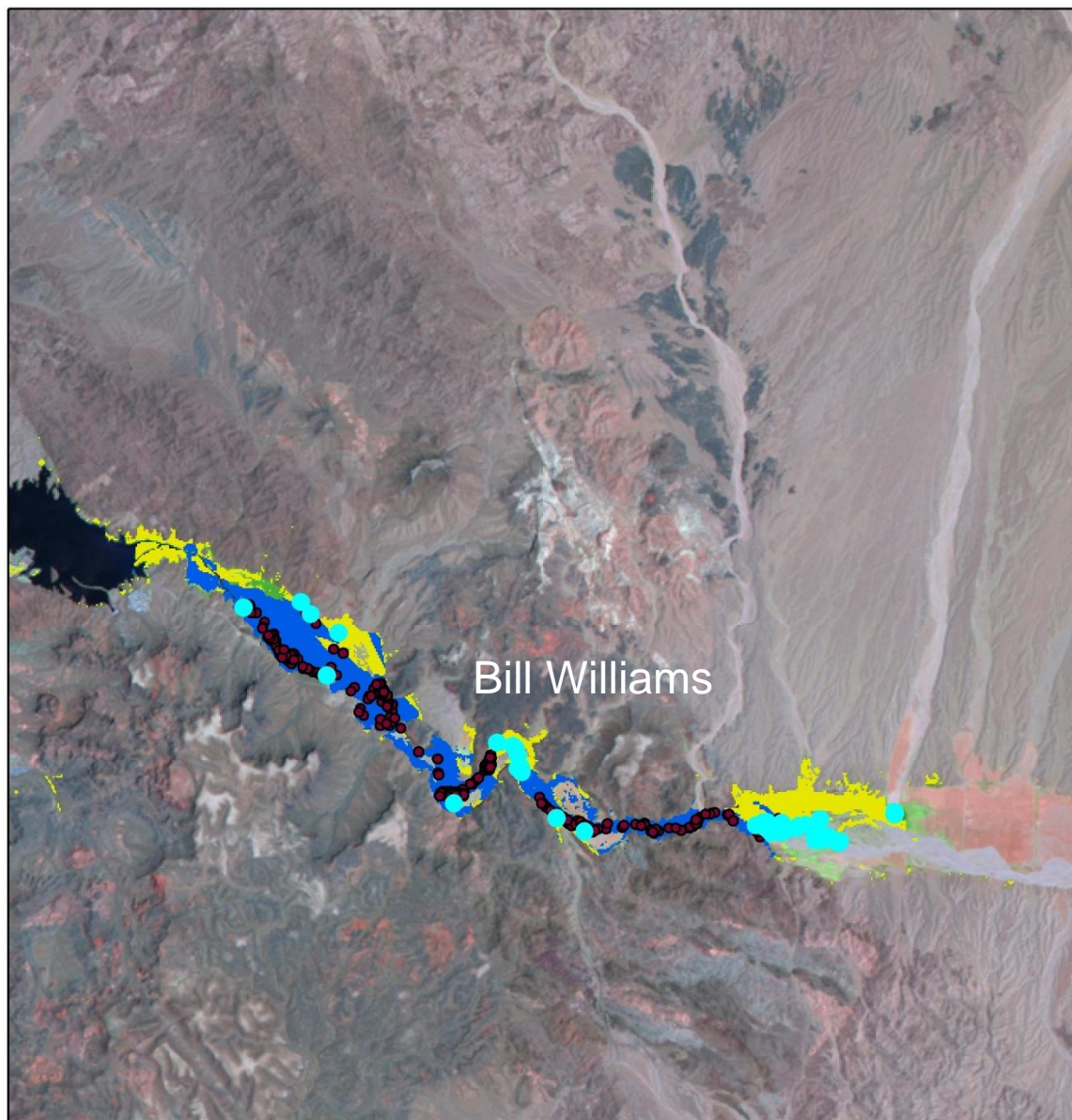
75% accuracy

Legend

- 2007 Yellow-billed Cuckoo detection
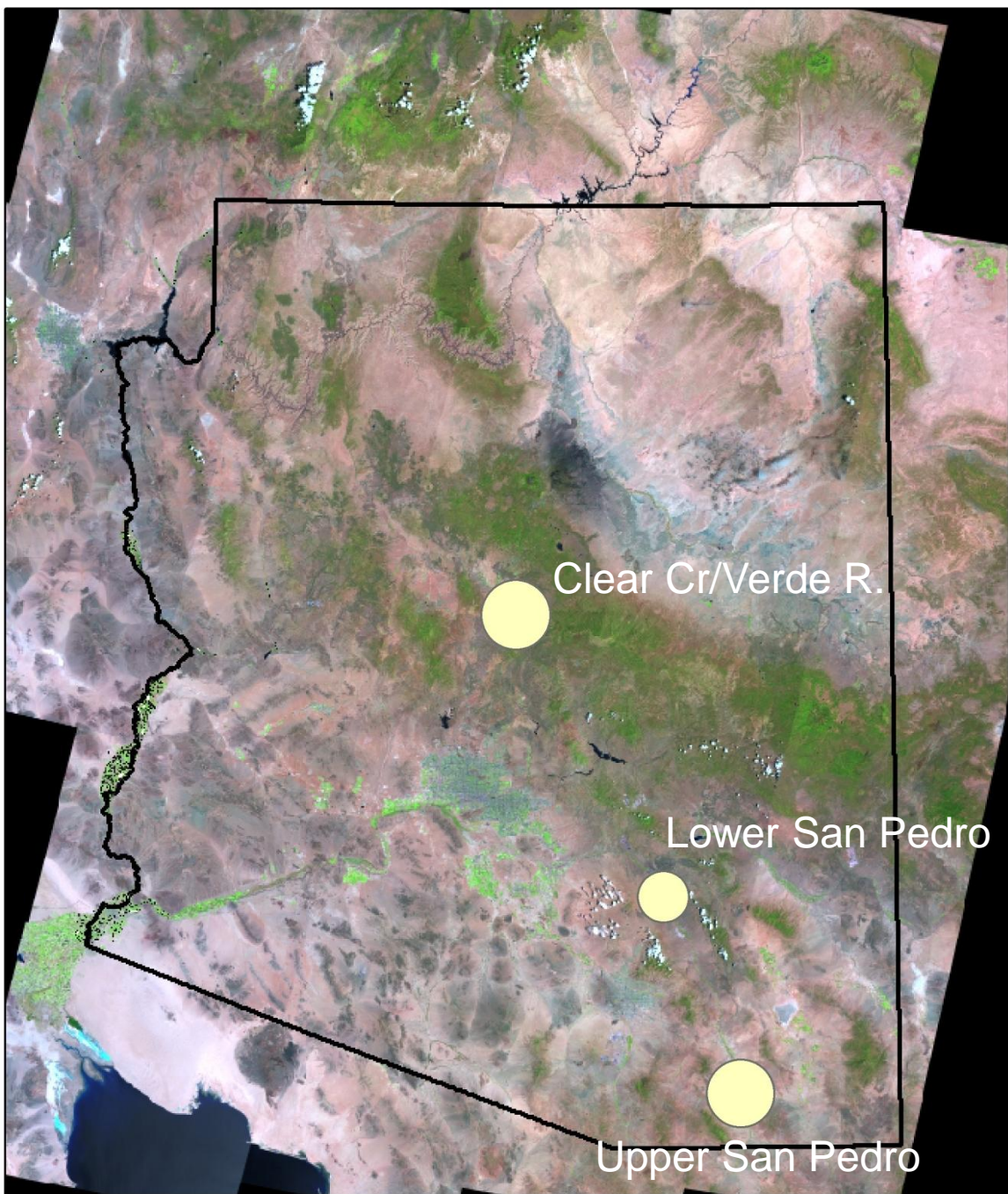- Predicted unsuitable
- Predicted suitable

Bill Williams

0   1.5   3   6 Kilometers

N
W — E
S

≈ USGS

Potential Cuckoo Habitat 2007
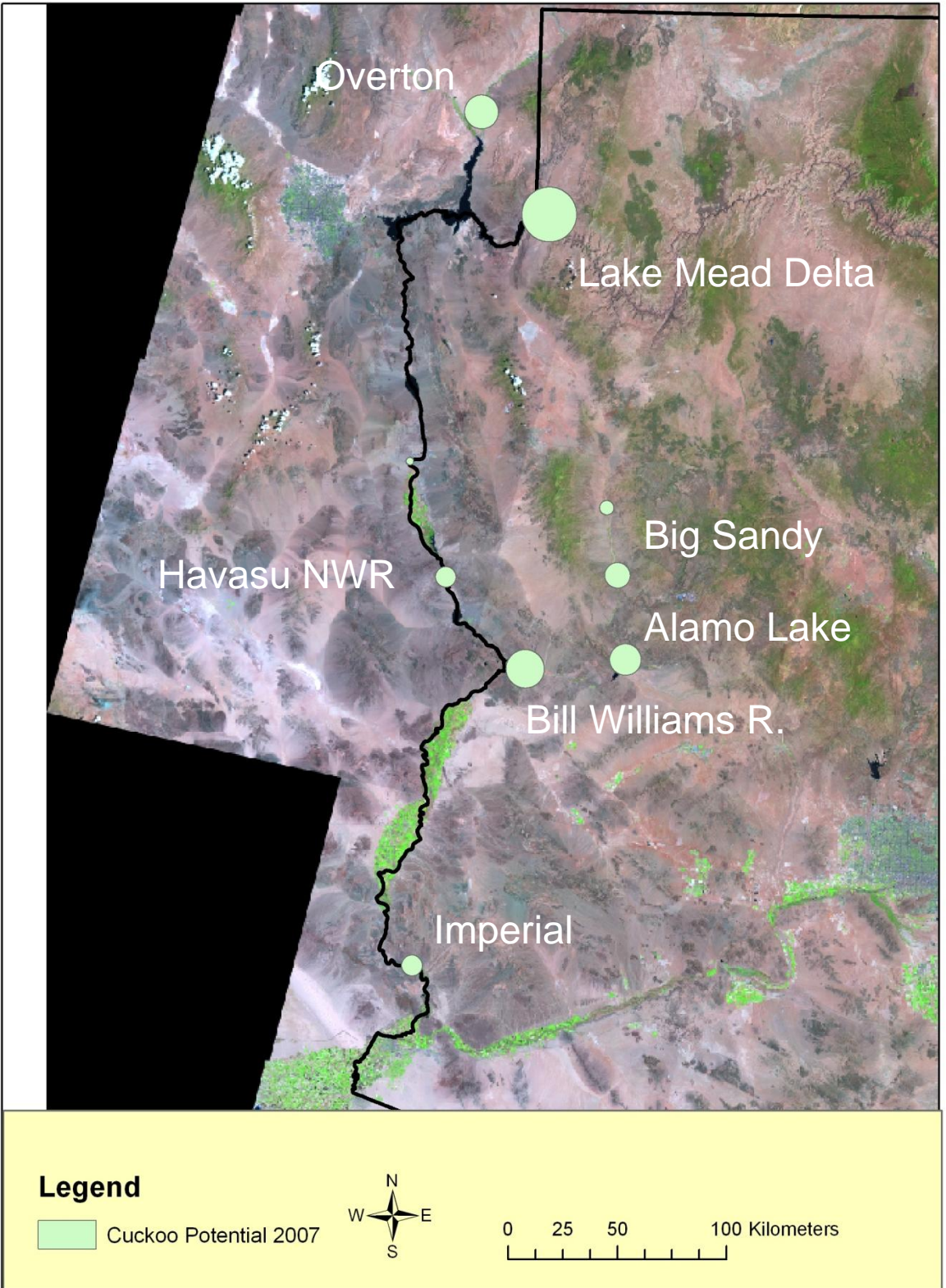
Overton

Lake Mead Delta

Big Sandy

Havasu NWR

Alamo Lake

Bill Williams R.

Imperial

Legend

Cuckoo Potential 2007

N
W E
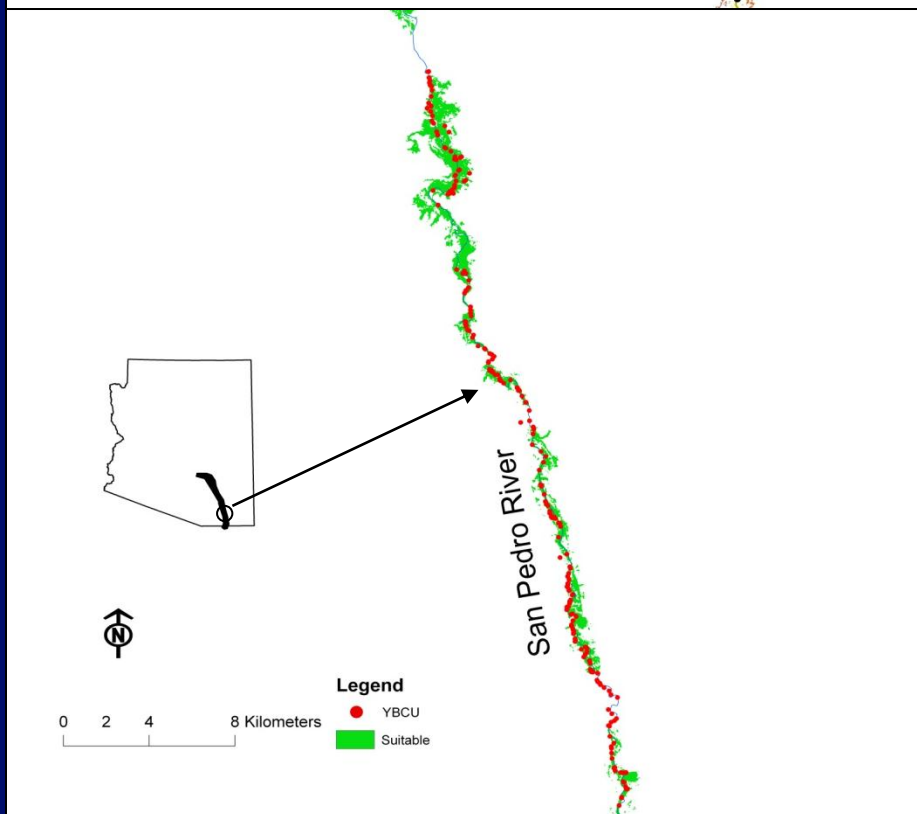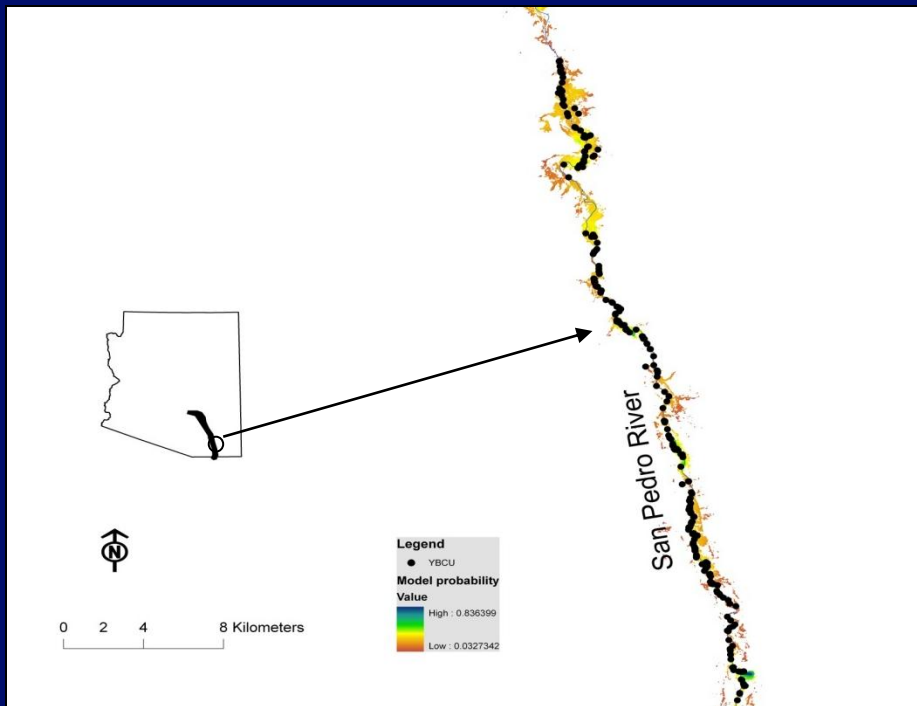S

0   25   50   100 Kilometers

Model Extrapolation

Verde River YBCU Model Results
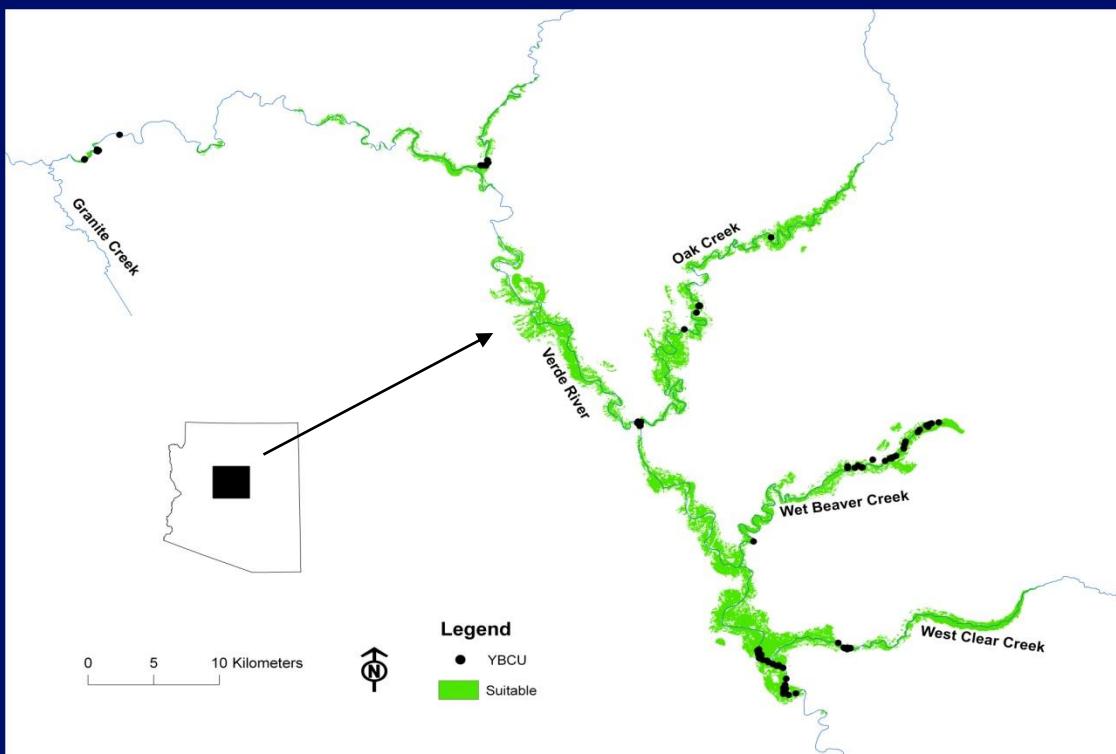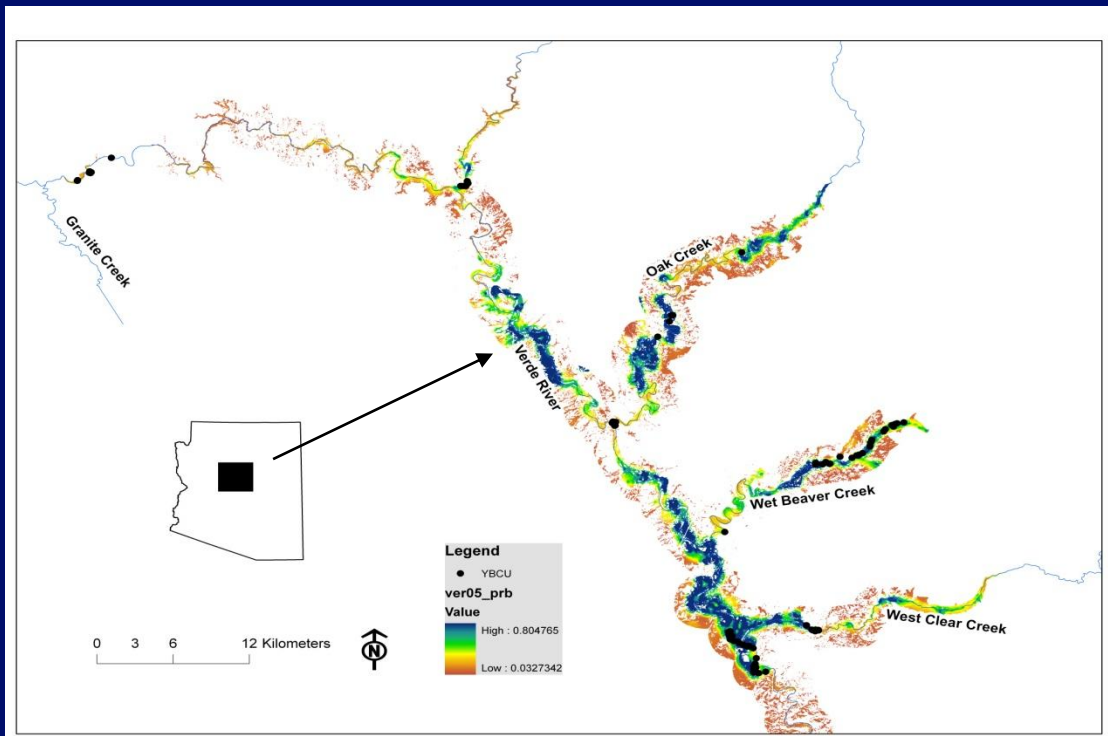
San Pedro YBCU Model

Conclusions

Terrain ruggedness most important

>
-moderate terrain ruggedness the best (>20 times as likely to have YBCU as flat terrain)

Patch size and composition important
- 120 m radius (core density)
- 480 m radius (vegetation heterogeneity)
- Each 10% of core area covered in dense vegetation = 15% increase in YBCU
- Each 1SD increase in vegetation heterogeneity = 68% increase in YBCU
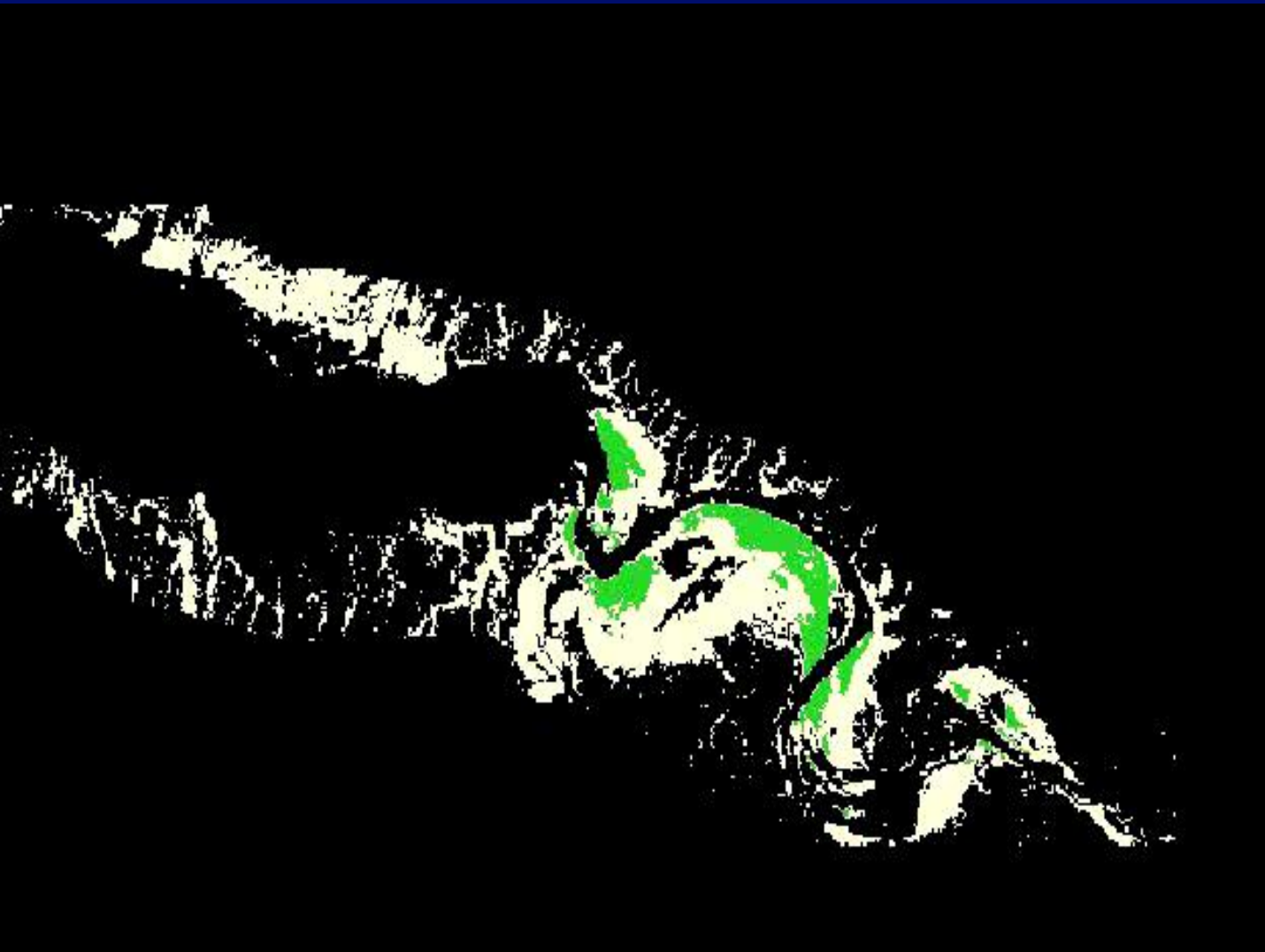
Classification accuracy ~75%

Extrapolation produced results on the Verde and San Pedro that were not as specific as on the LCR.
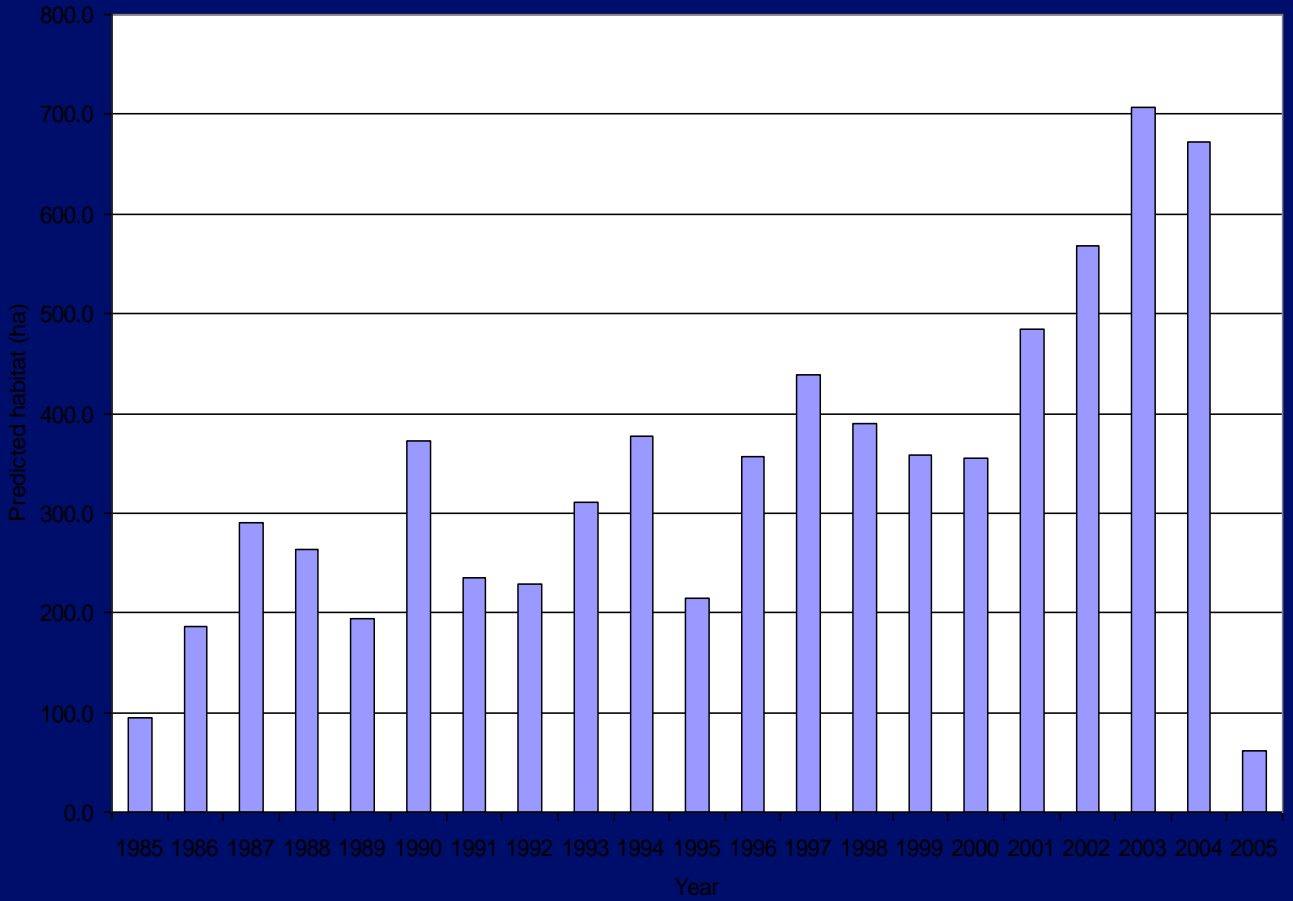
≋ USGS

Southwestern Willow Flycatcher Modeling

Landsat TM Imagery: Salt/Roosevelt 1994 – 2005
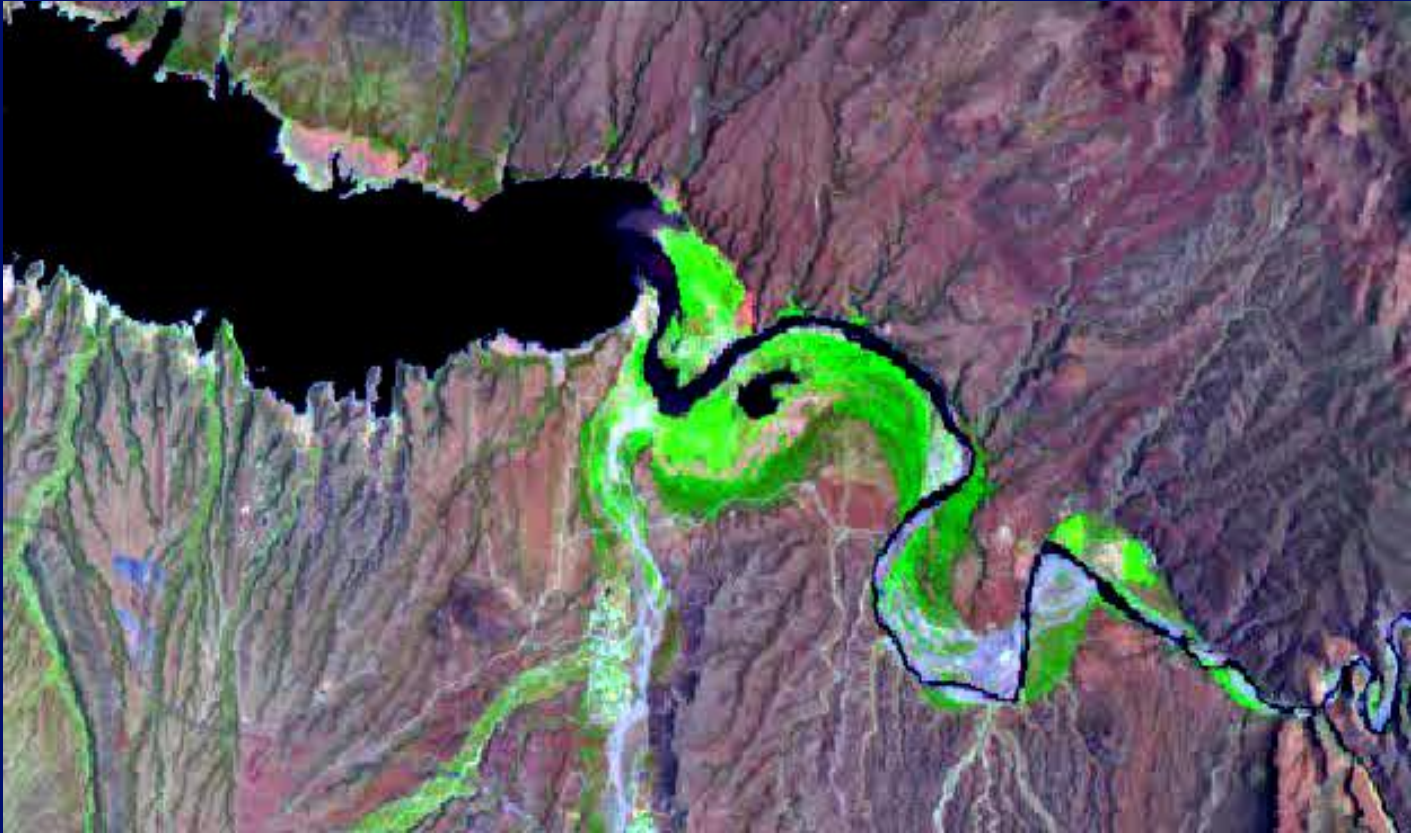
Predicted SWFL Breeding Habitat: Salt/Roosevelt 1994 – 2005

20-yr Habitat Analysis

Temporal Model Accuracy: 1994 - 2004