

Gila River Flow and Riparian Vegetation Health in the Cliff-Gila Valley

**Amber Whittaker, GIT
David Jordan, PE
Guillermo Martinez, PhD
Natalie Runyan**

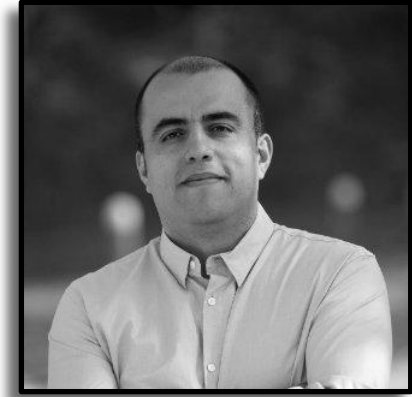


Who We Are



David Jordan

• *Project Manager*



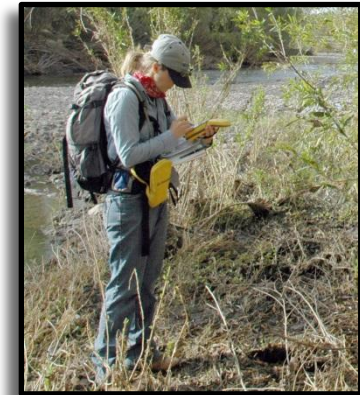
Guillermo Martinez

Hydrology/Remote Sensing •



Natalie Runyan

• *Biology/Fieldwork*



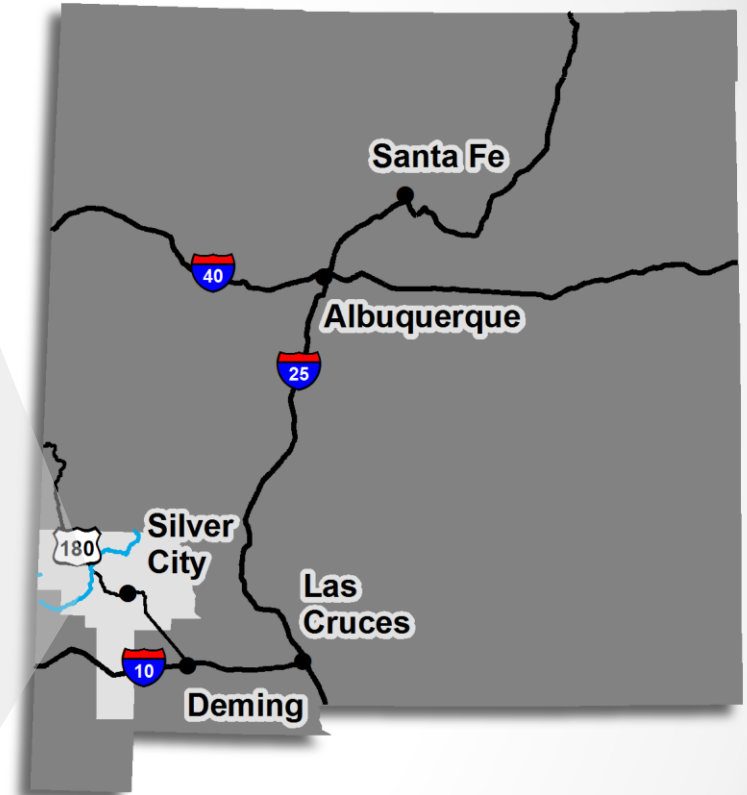
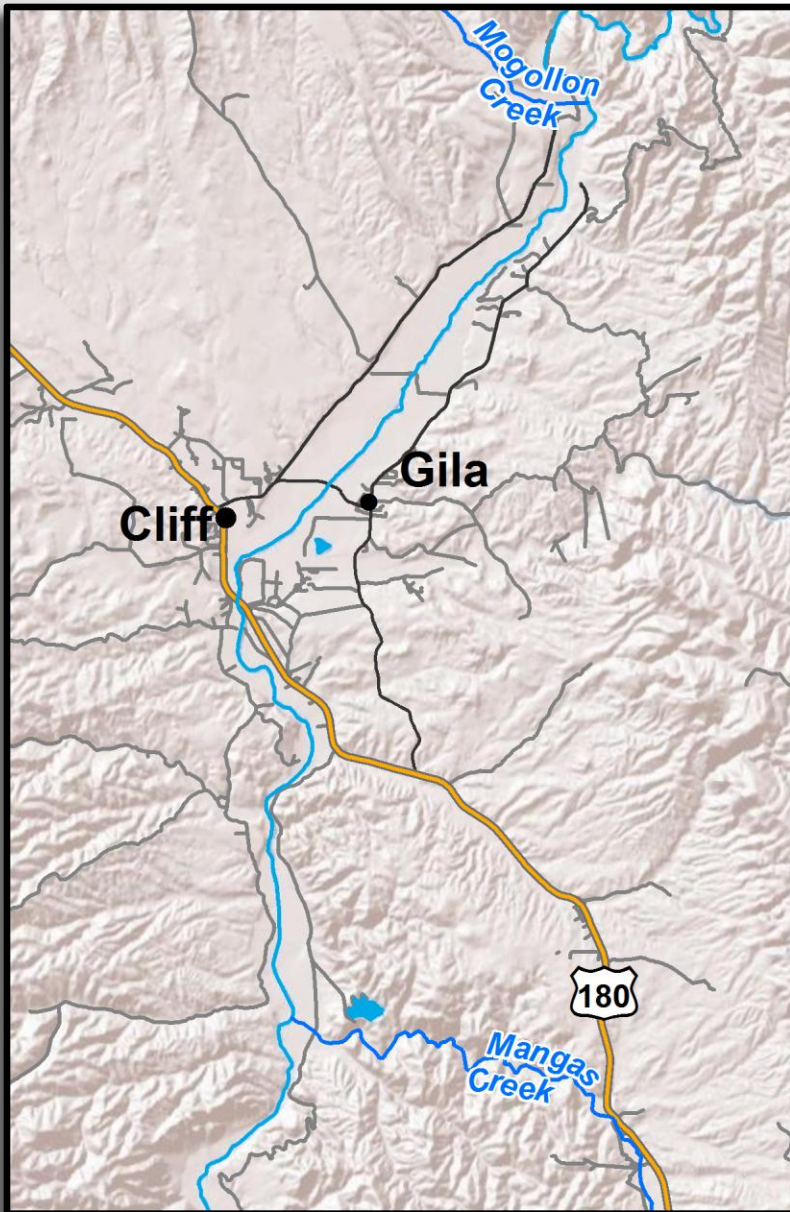
Amber Whittaker

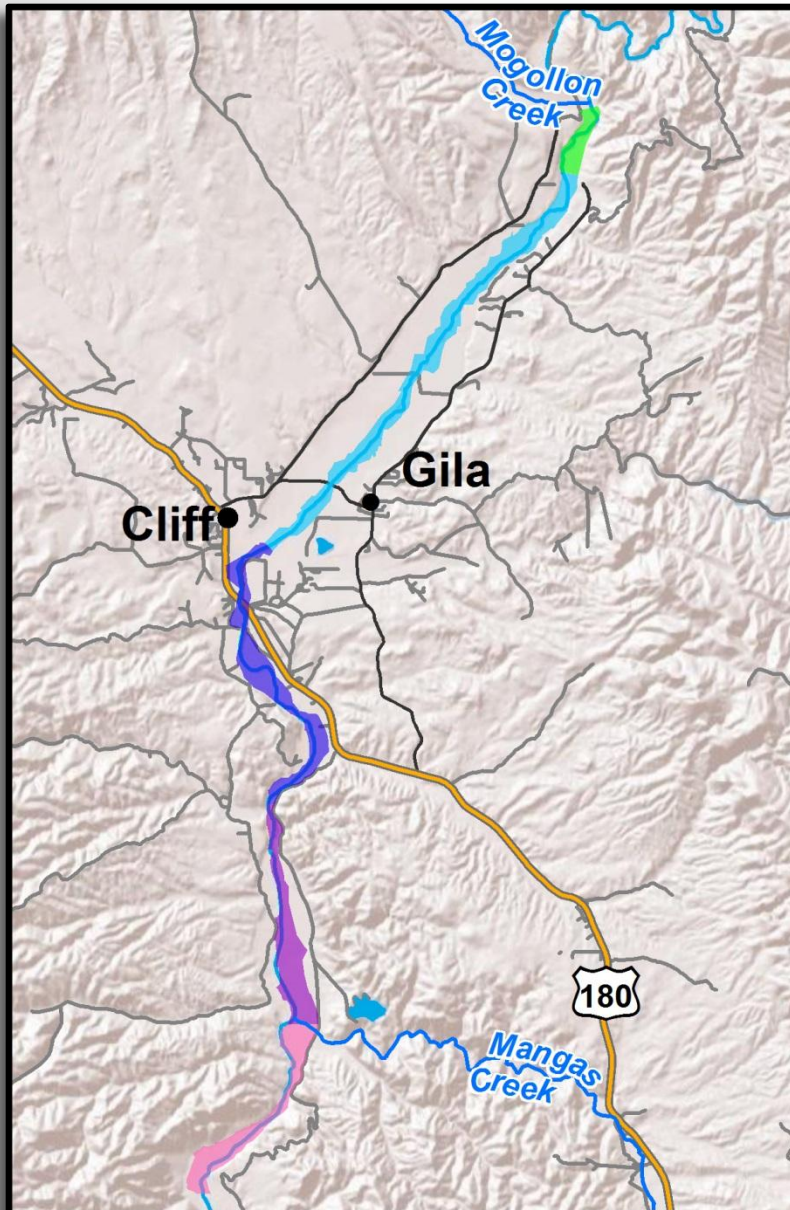
Remote Sensing/GIS •

Study Objective

New Mexico Interstate Stream Commission:

- Goal:
Compare riparian vegetation health to river flow
- Hypothesis (proposed explanation) and test
 - Riparian vegetation health increases with increasing flow in the Gila River
 - Determine and compare health and flows over time
 - Look for positive correlation
- Study area: Cliff-Gila Valley





Reach #1:

Mogollon Creek to diversions

Reach #2:

Diversions to south of 211 bridge

Reach #3:

South of 211 bridge to mine diversion

Reach #4:

Mine diversion to Mangas Creek

Reach #5:

Mangas Creek through Bird Area

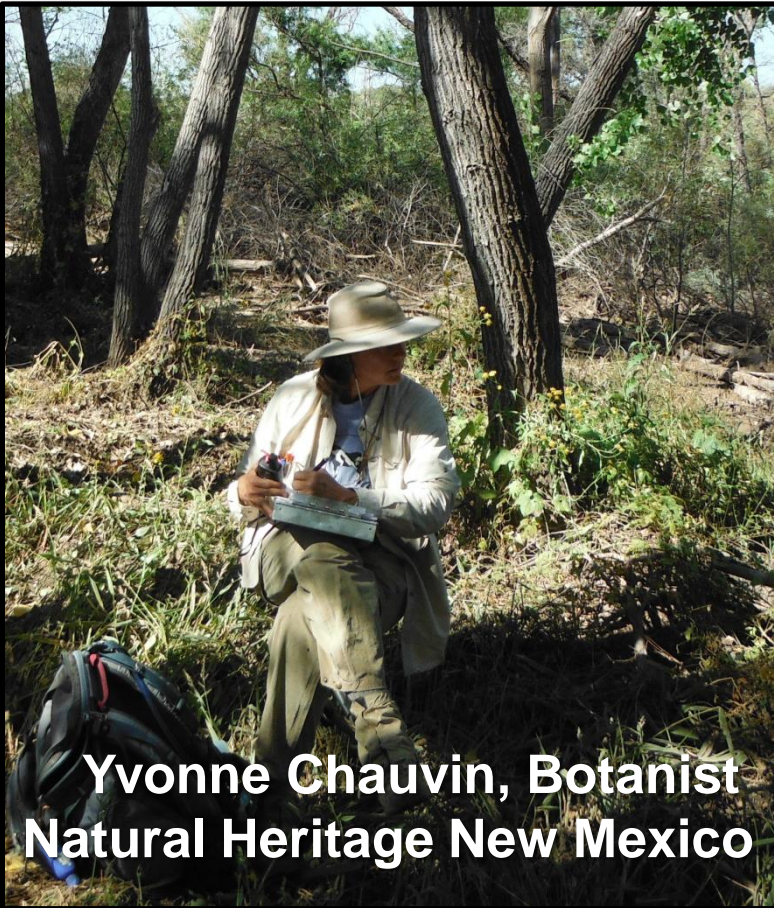
Study Design

- **Study dates:** 2005, 2009, 2010, 2011, 2013
- **1. Fieldwork:** Identify vegetation communities
- **2. Aerial photographs:** Estimate vegetation extent
- **3. Satellite imagery:** Estimate vegetation health
- **4. Hydrologic study:** Gila River flow estimates for each reach
- **5. Comparison:** Compare flow to vegetation health

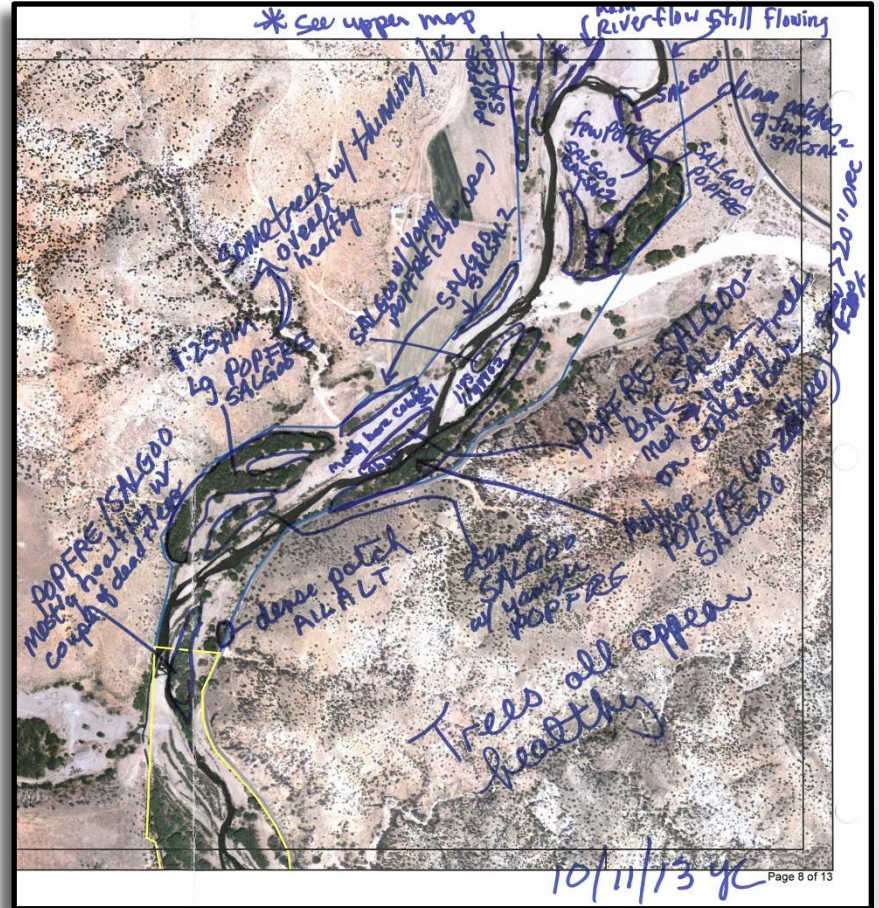
1. Fieldwork

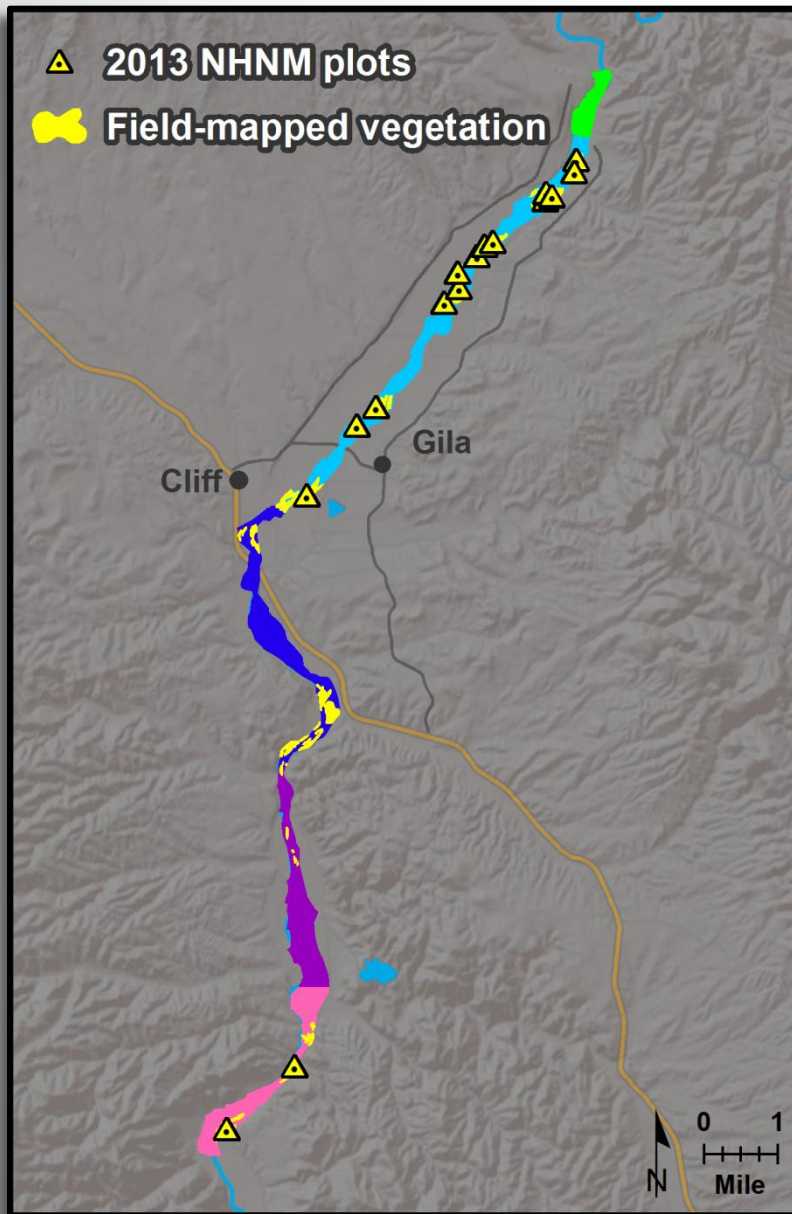
Goal: Identify current vegetation communities

Detailed plots



Vegetation mapping





Results:

- 16 plots in study area
 - 88 field-mapped vegetation areas
 - Native riparian species:
 - Freemont's cottonwood
 - Arizona sycamore
 - Boxelder
 - Goodding's willow
 - Shrubs
- **Used for
aerial photo interpretation**

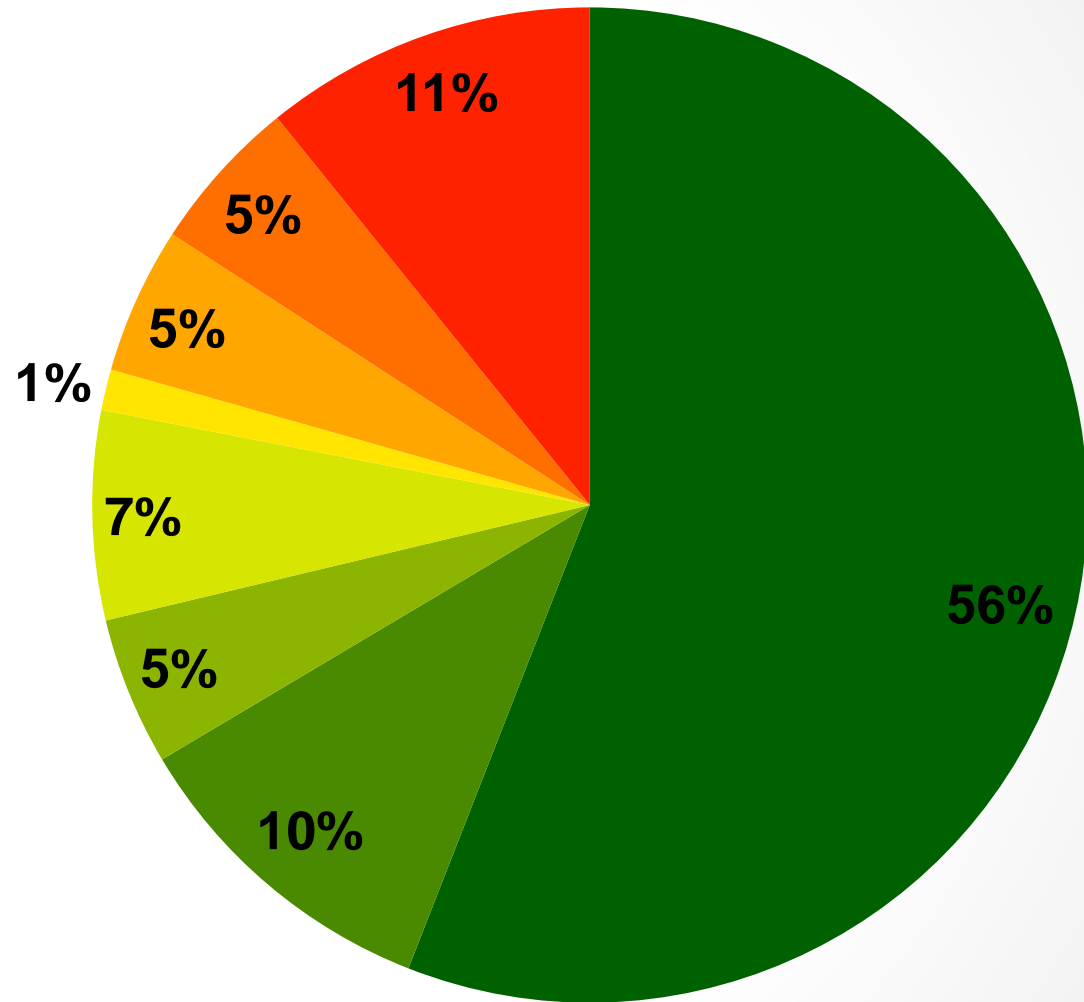
2. Aerial Photographs

Goal: Identify and outline vegetation community extent over all study areas and years



Study Area: General Vegetation Types

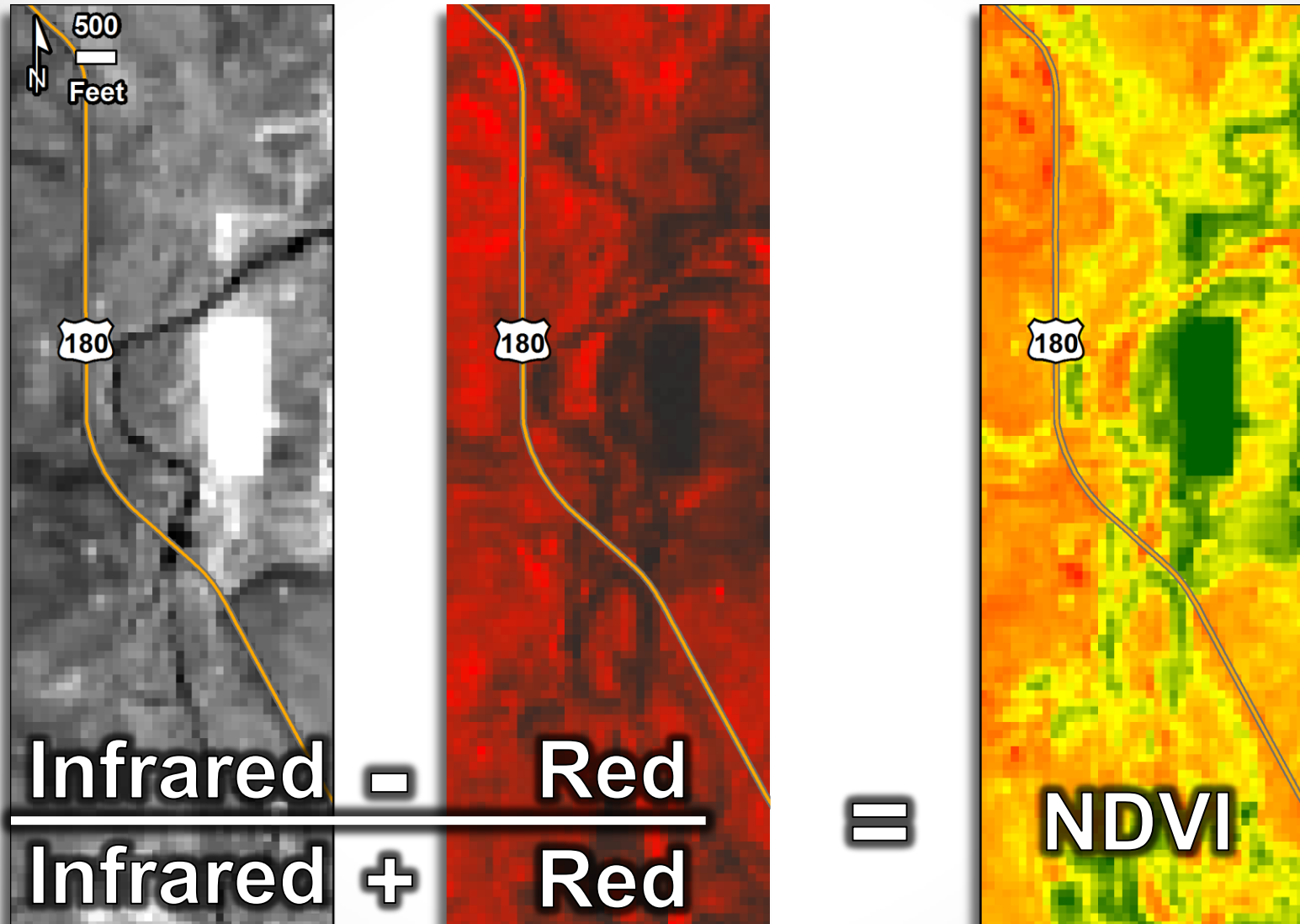
- Mixed Trees
- Mixed Trees/Shrubs
- Mixed Shrubs/Trees
- Mixed Shrubs
- Sparse Trees
- Sparse Trees/Shrubs
- Sparse Shrubs/Trees
- Sparse Shrubs

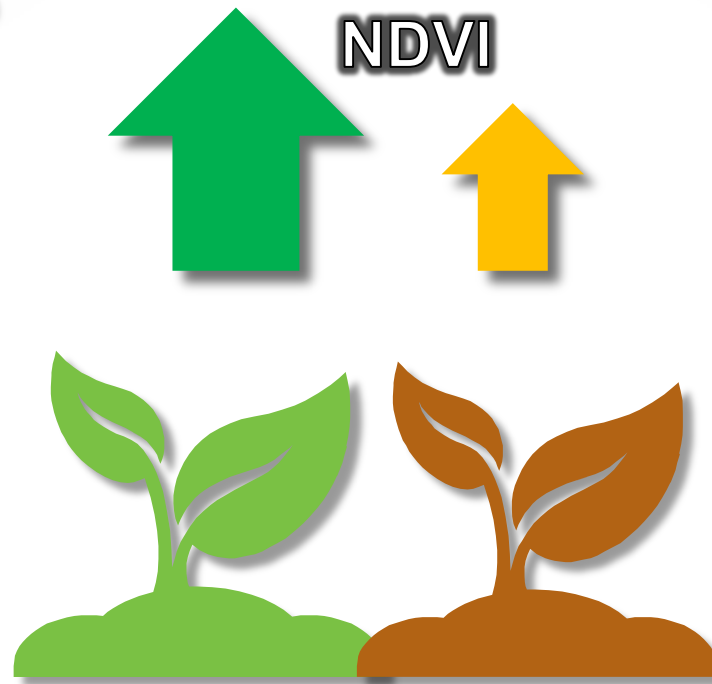
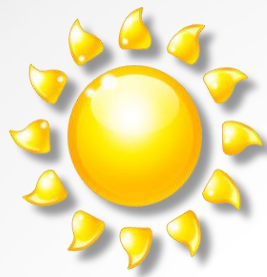


3. Satellite Imagery

- Goal: Evaluate vegetation health over all study areas and years
- How is it used to evaluate vegetation health?
Normalized Difference Vegetation Index
- Explain NDVI and calculation
- Results:
 - Scenes for three dates during the growing season, May – August;
 - Average NDVI per reach for each year

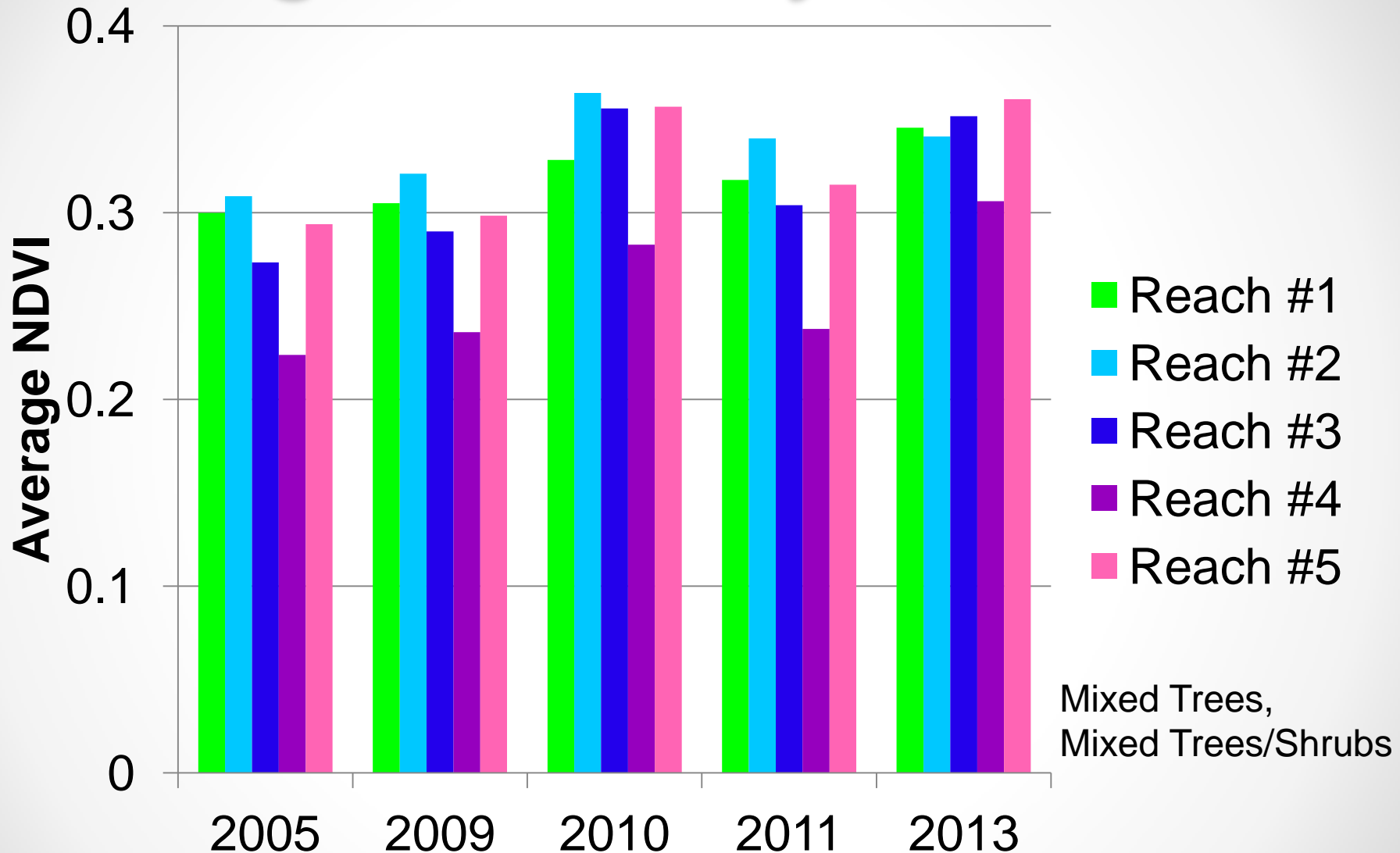
Normalized Difference Vegetation Index





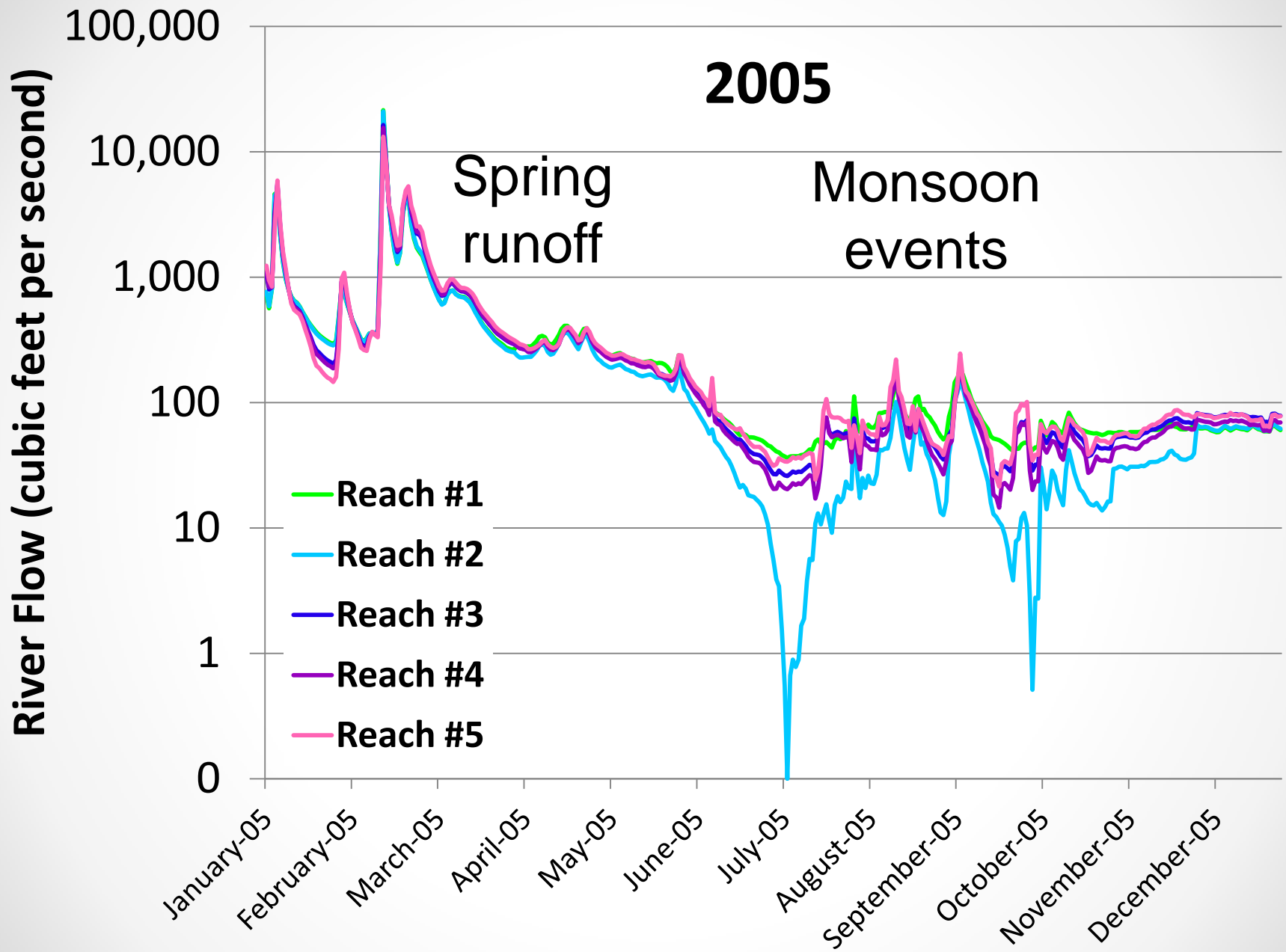
- **Healthier plants = higher NDVI**

Average NDVI by Year

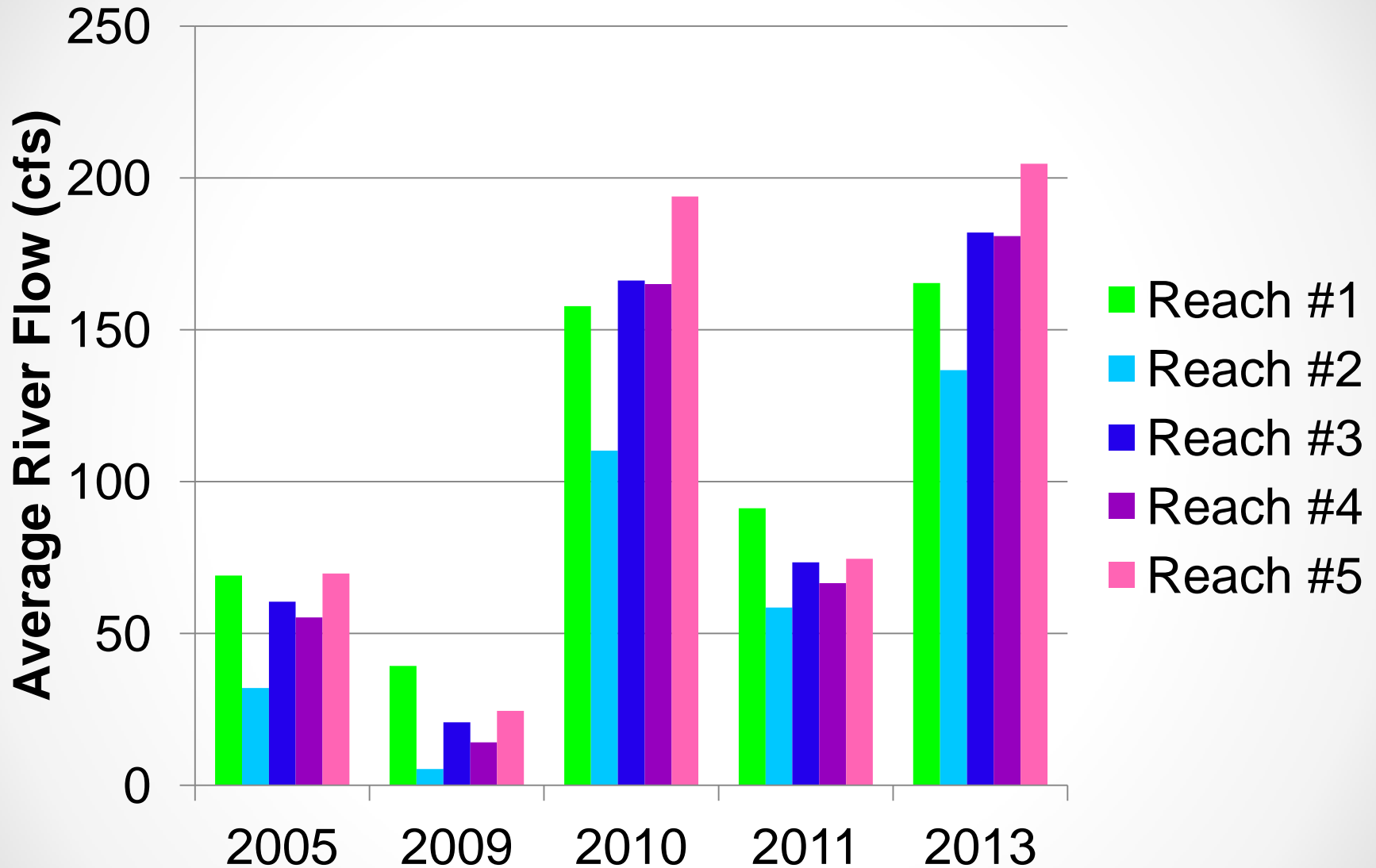


4. Hydrologic Study

- Goal: Estimate river flow in and out of each study reach for all study years
- No gages = model flow in reaches
- Model based on:
 - USGS gages
 - Contributing watershed areas
 - Diversion reports from NMISC
- Model results
 - Examples from 2005
 - Average flows June-August

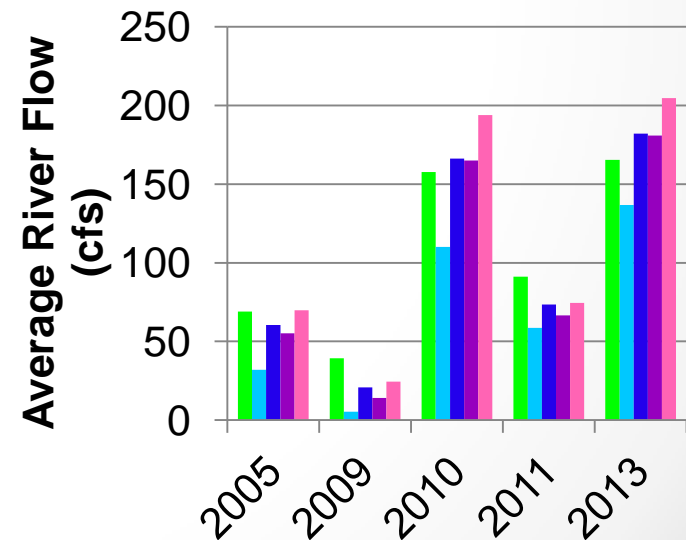
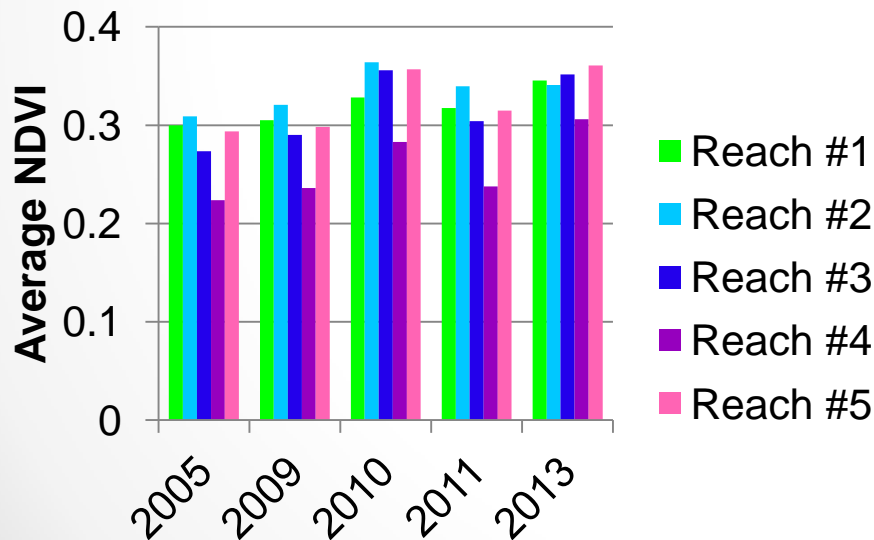


Average Flow (June – August) by Year

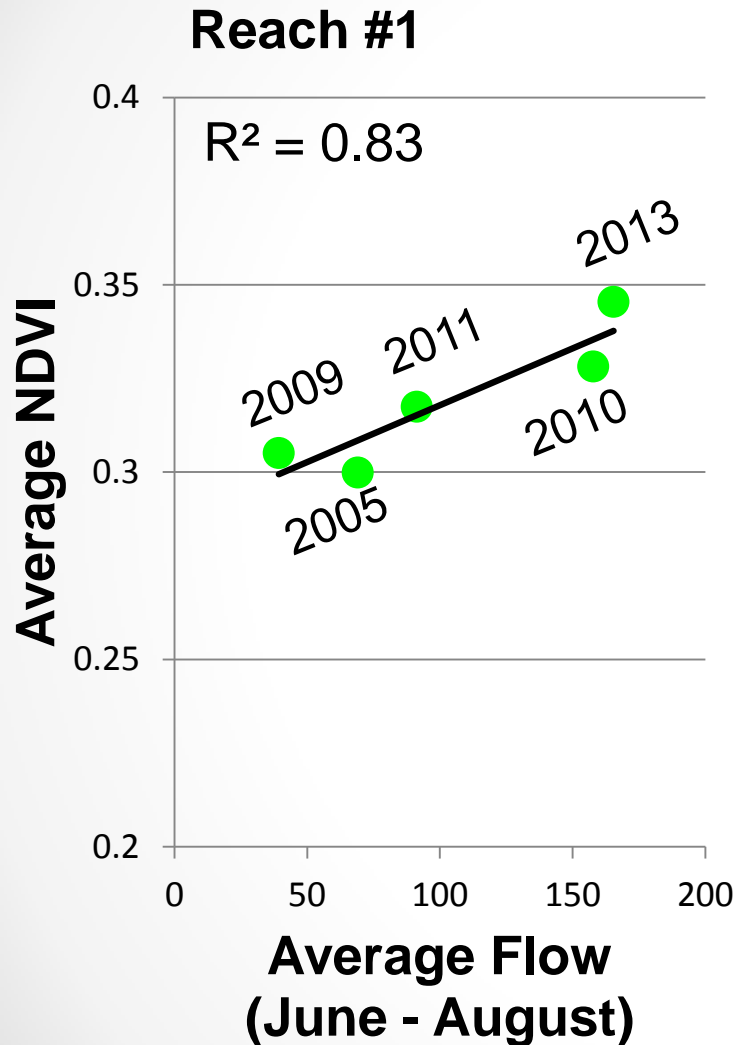


5. Comparison

- Results of the NDVI analysis and hydrologic study are compared
 - What is correlation?
 - How do we evaluate it?
- Results of comparison of average NDVI and flow

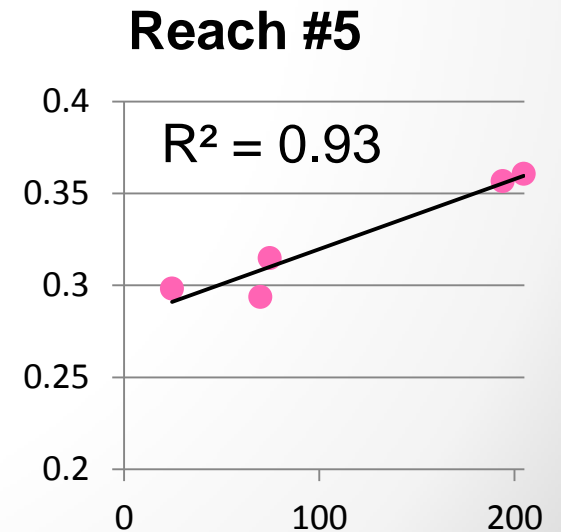
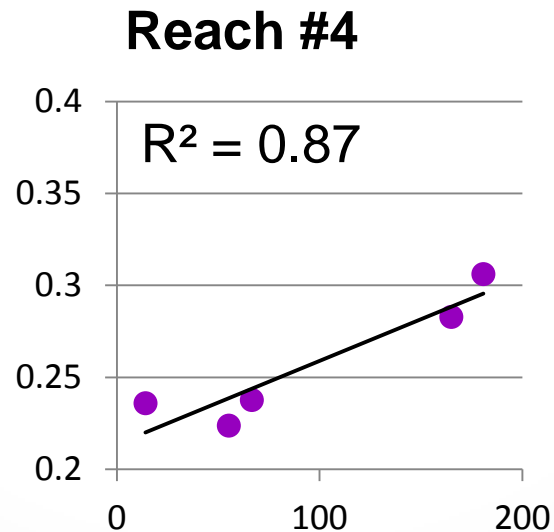
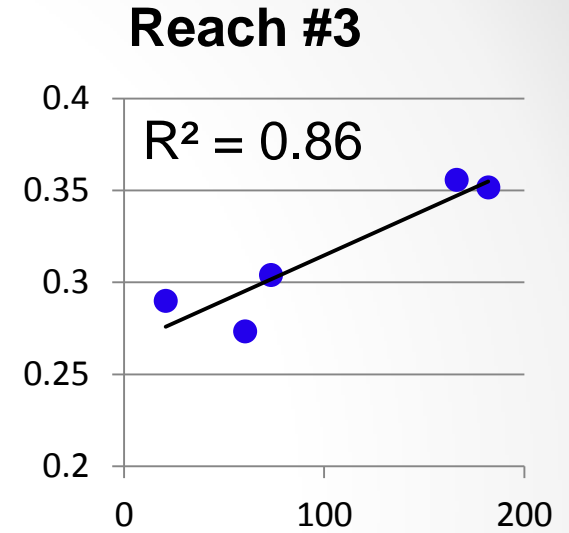
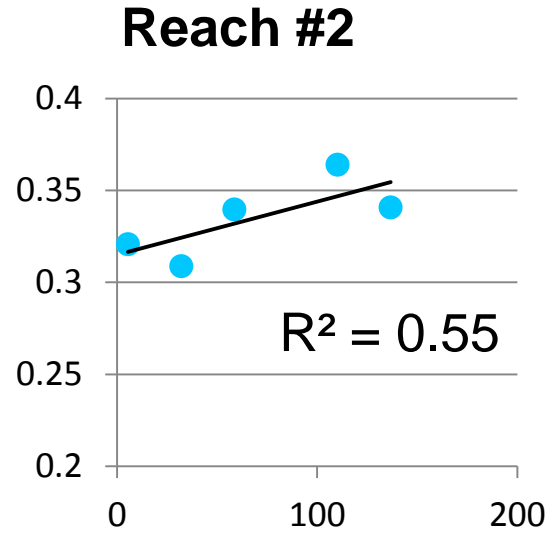
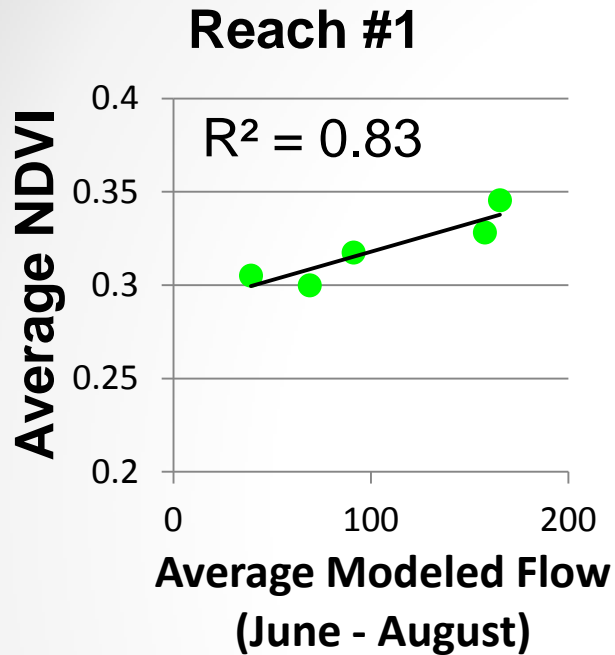


Correlations



- Determine whether two data sets have a relationship
- Reported with a goodness-of-fit or R^2 value (between 0 and 1):
- Higher R^2 = better correlation = relationship

NDVI vs Flow



Interpretations

1. Fieldwork: Primarily native tree dominated
2. Aerial photographs: Extent has not changed significantly since 2005
3. Satellite imagery: NDVI patterns within each reach are complicated;
Reach #2 often has highest NDVI
4. Hydrology: Consistently lower flow conditions in Reach #2
5. Comparison: Vegetation health generally increases with increasing river flow, and the response is rapid;
Reach #2 poor correlation

Conclusions

- Hypothesis:
Vegetation health increases with increasing river flow
- Positive, significant correlations between NDVI and river flow support the hypothesis in *most* of the reaches
 - Reach #2 is different
- Further study needed

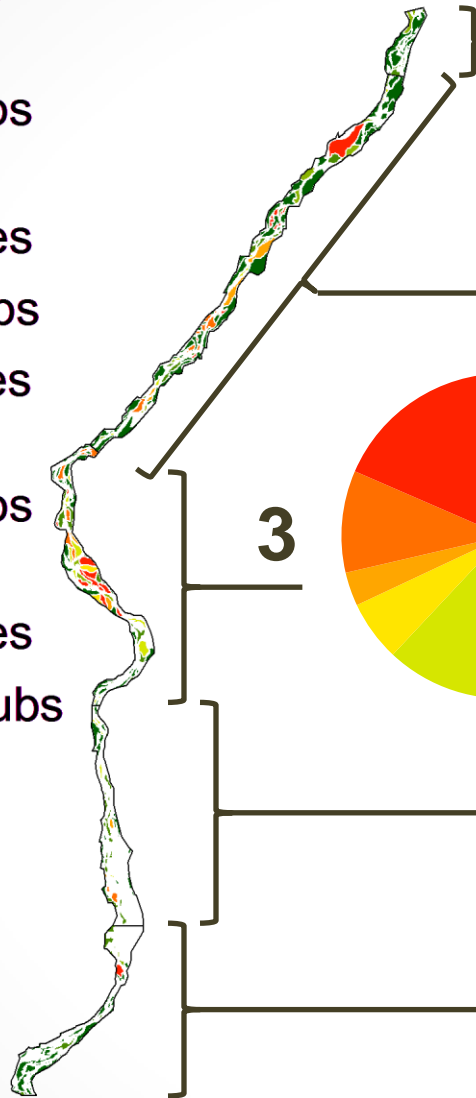
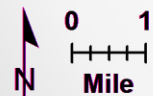
Questions



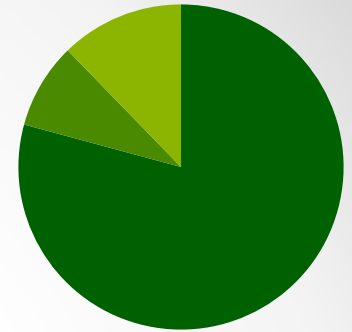
Additional Slides

...

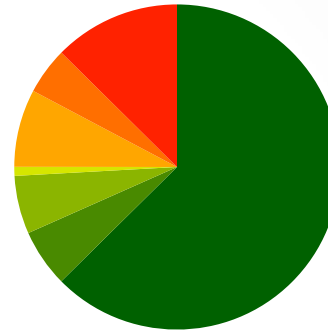
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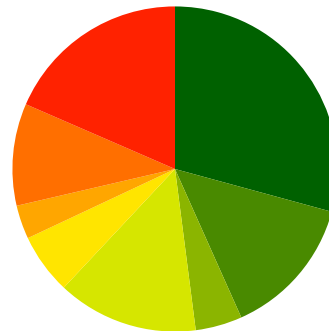
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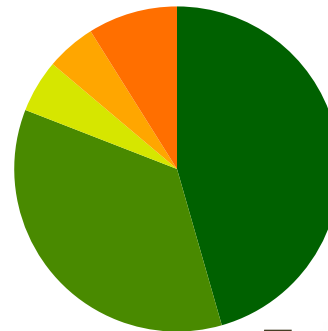
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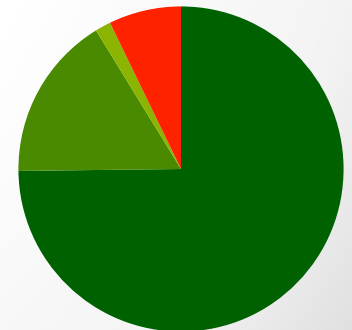
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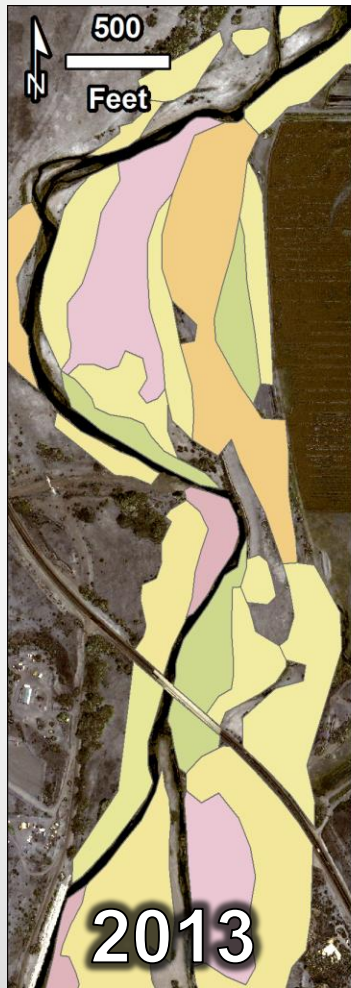
4



5



2. Aerial Photographs



Mixed Trees

POPFRE-
SALGOO

Mixed
Trees/Shrubs

Mixed
Shrubs/Trees

Mixed Shrubs

Sparse
Shrubs/Trees

Sparse Shrubs



Mixed Trees

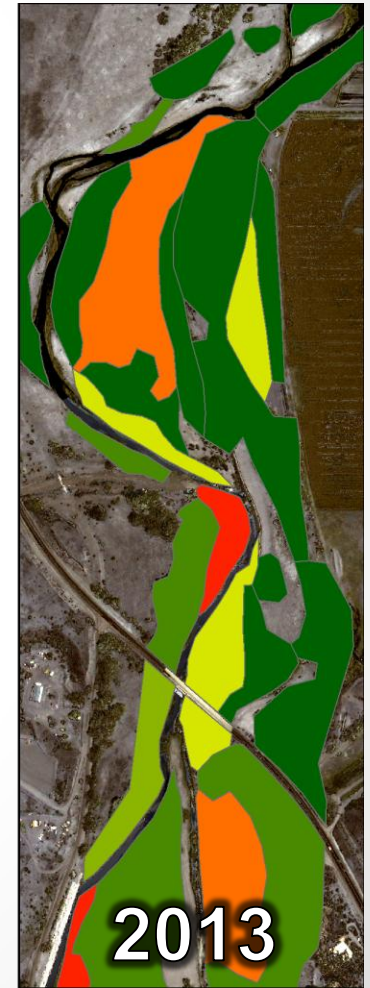
Mixed
Trees/Shrubs

Mixed
Shrubs/Trees

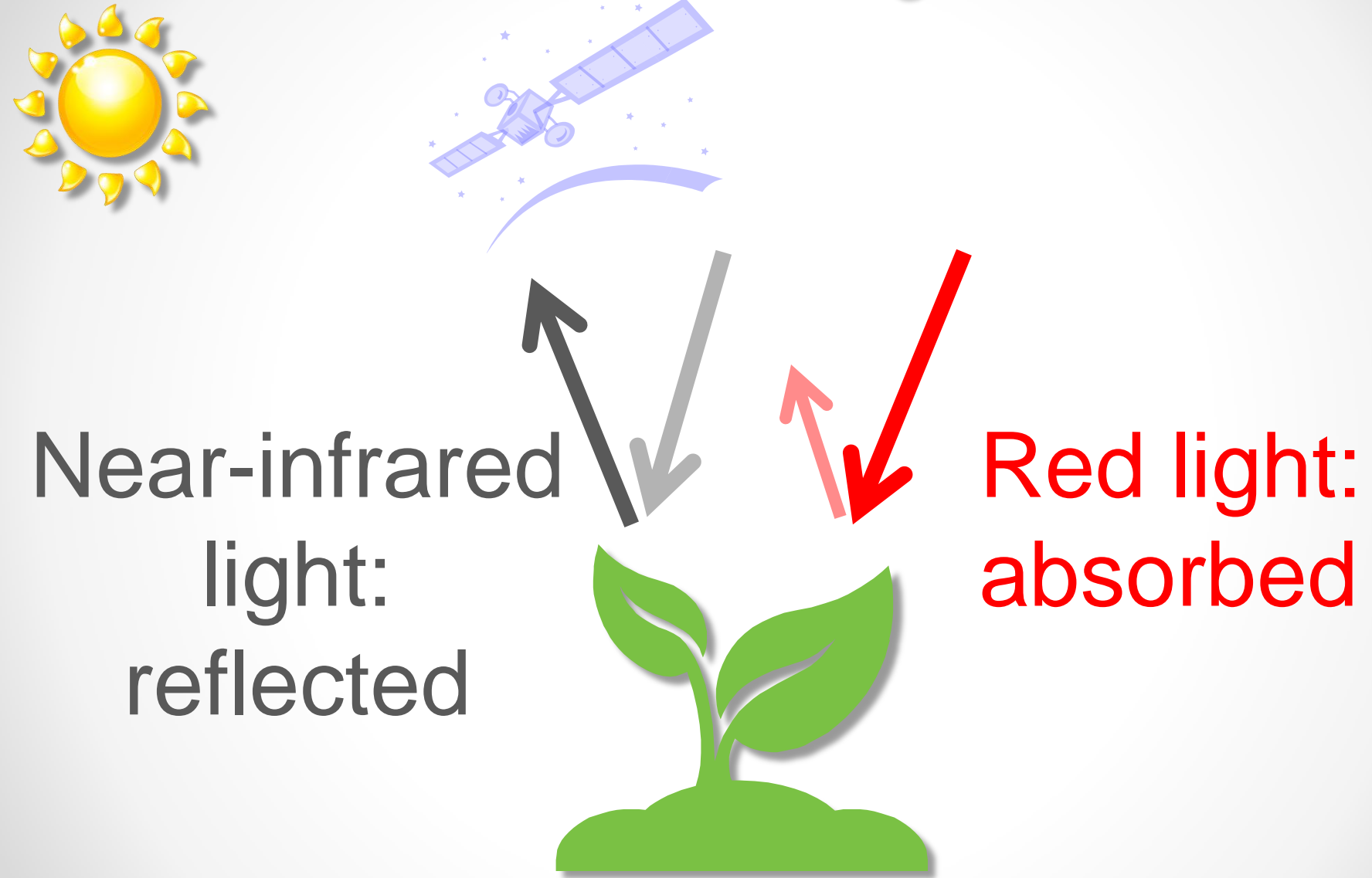
Mixed Shrubs

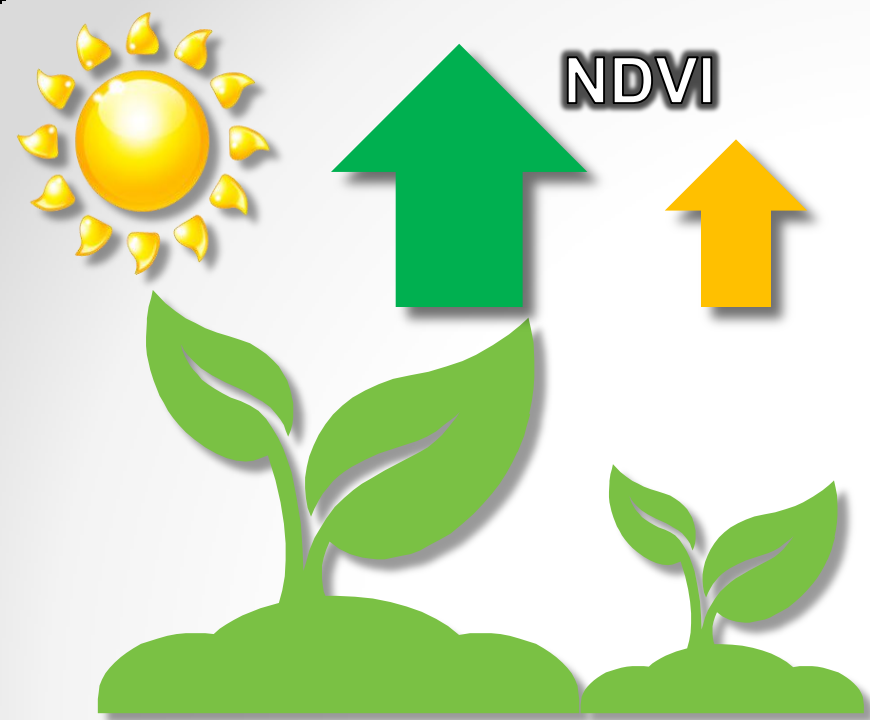
Sparse
Shrubs/Trees

Sparse Shrubs



Normalized Difference Vegetation Index

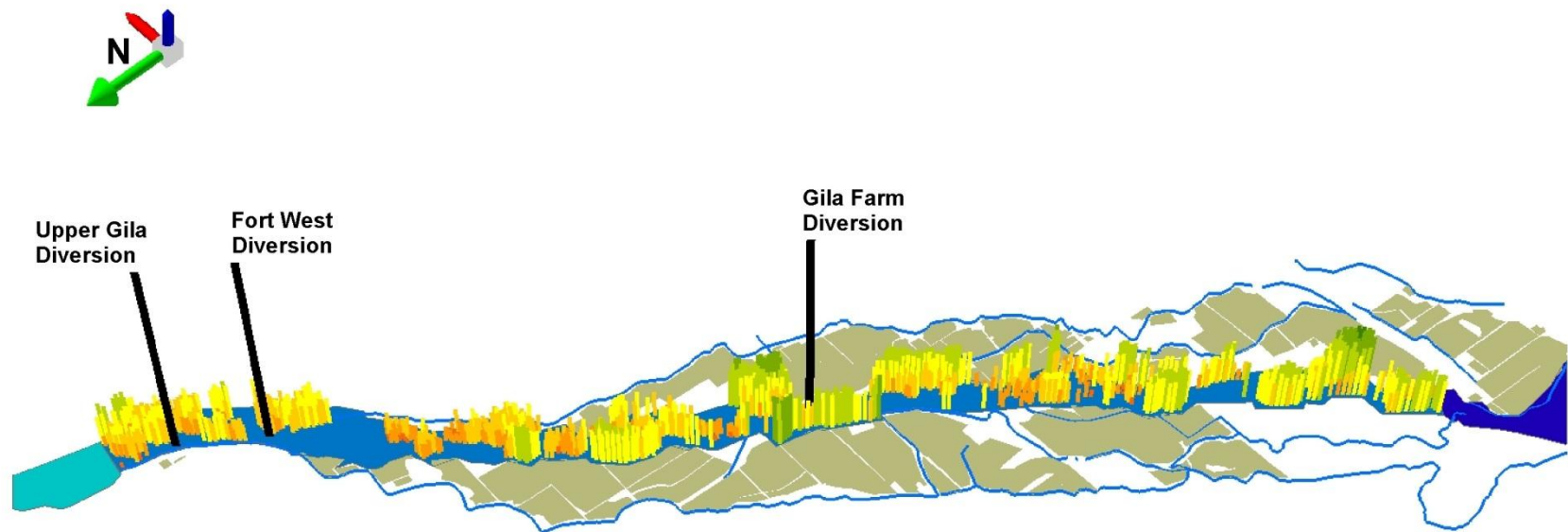




- Bigger plants absorb and reflect more than smaller plants
- Bigger plants = higher NDVI
- **Trees vs shrubs, young vs mature**



- Healthy plants absorb and reflect more than weaker plants
- Healthier plants = higher NDVI
- **Stressed vs non-stressed**



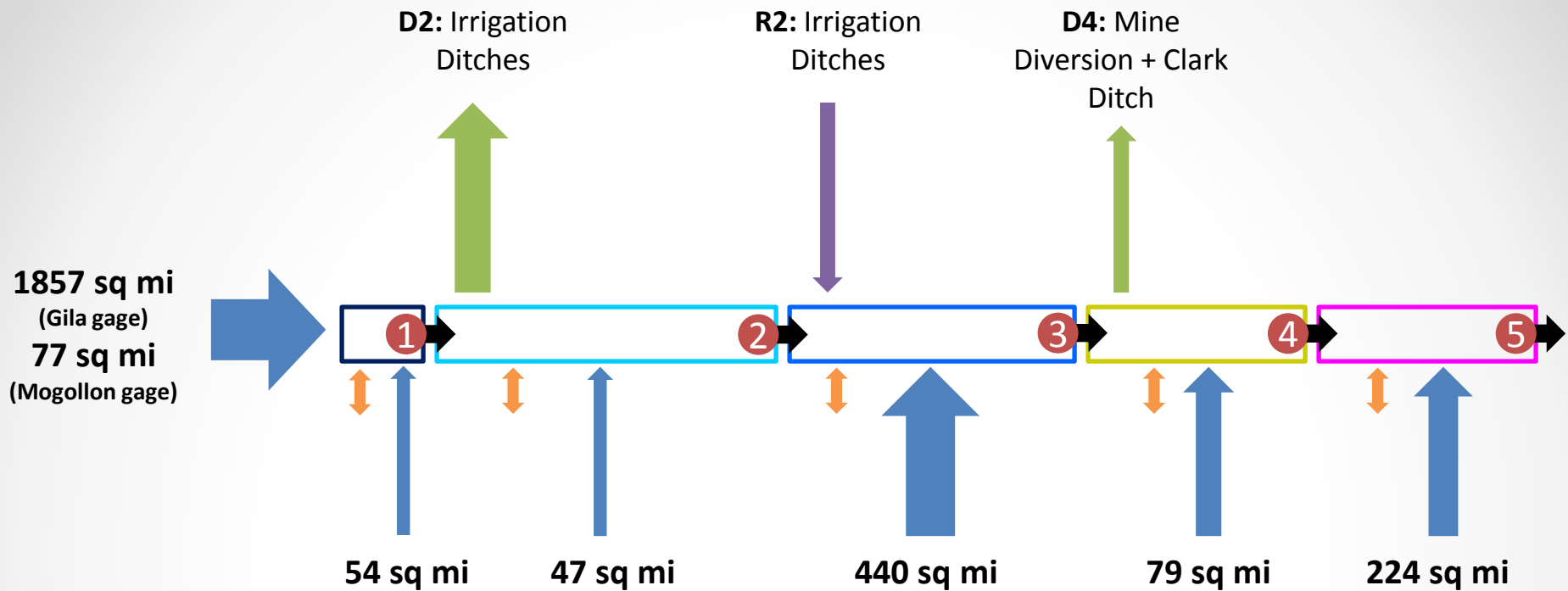
Legend

NDVI		● Diversion location
0.71 - 0.81	0.31 - 0.40	— Ditches
0.61 - 0.70	0.21 - 0.30	■ Irrigated fields
0.51 - 0.60	0.11 - 0.20	
0.41 - 0.50	0.01 - 0.10	
	-0.07 - 0.00	

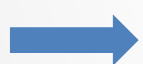
Figure A.16
Reach 2
May 22, 2005
Gila Riparian Vegetation Health

NDVI Results: Reach 2

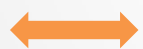
2005 - 2013



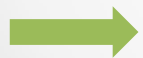
Reach Outlet #



Flow contributing areas



Streambed loss/gain

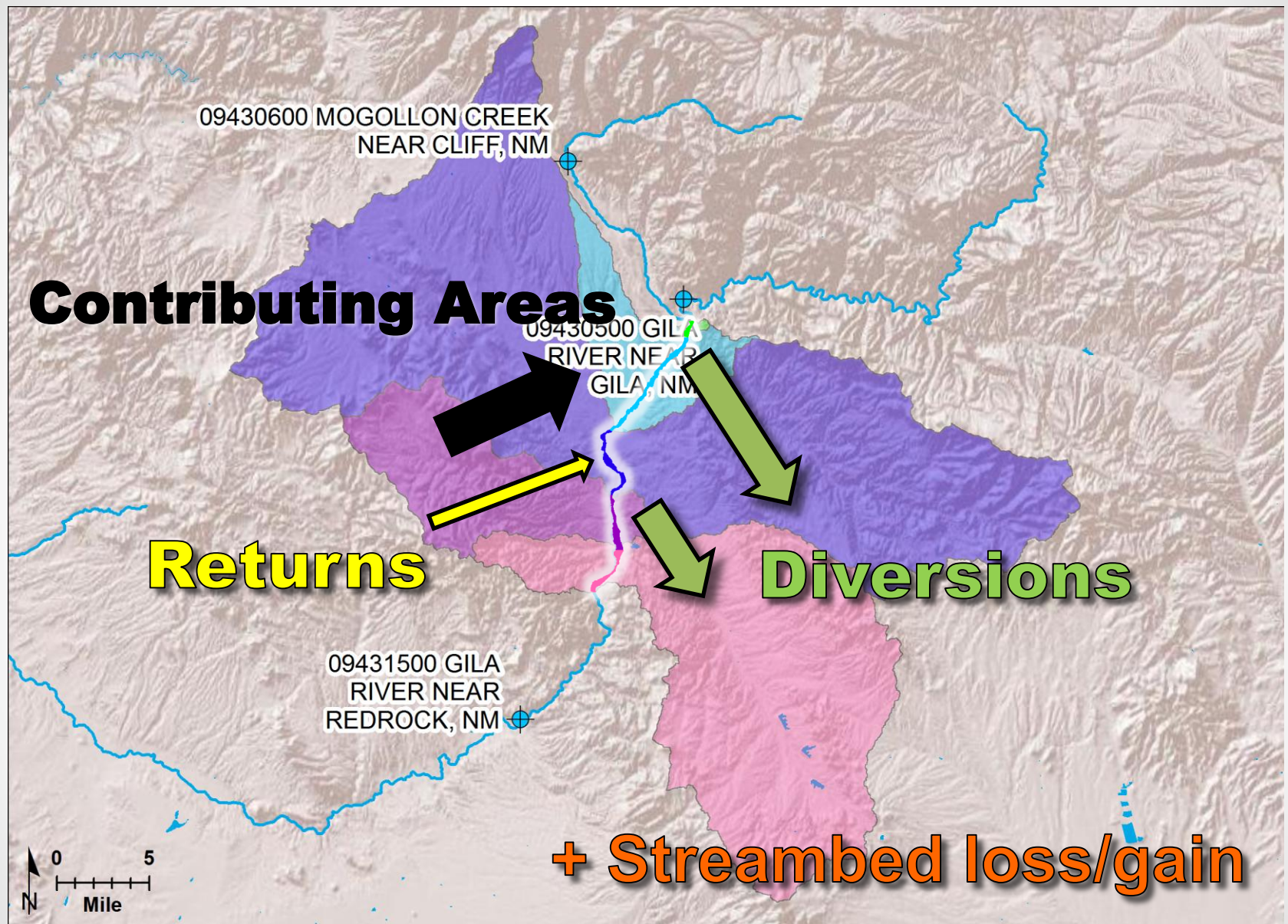


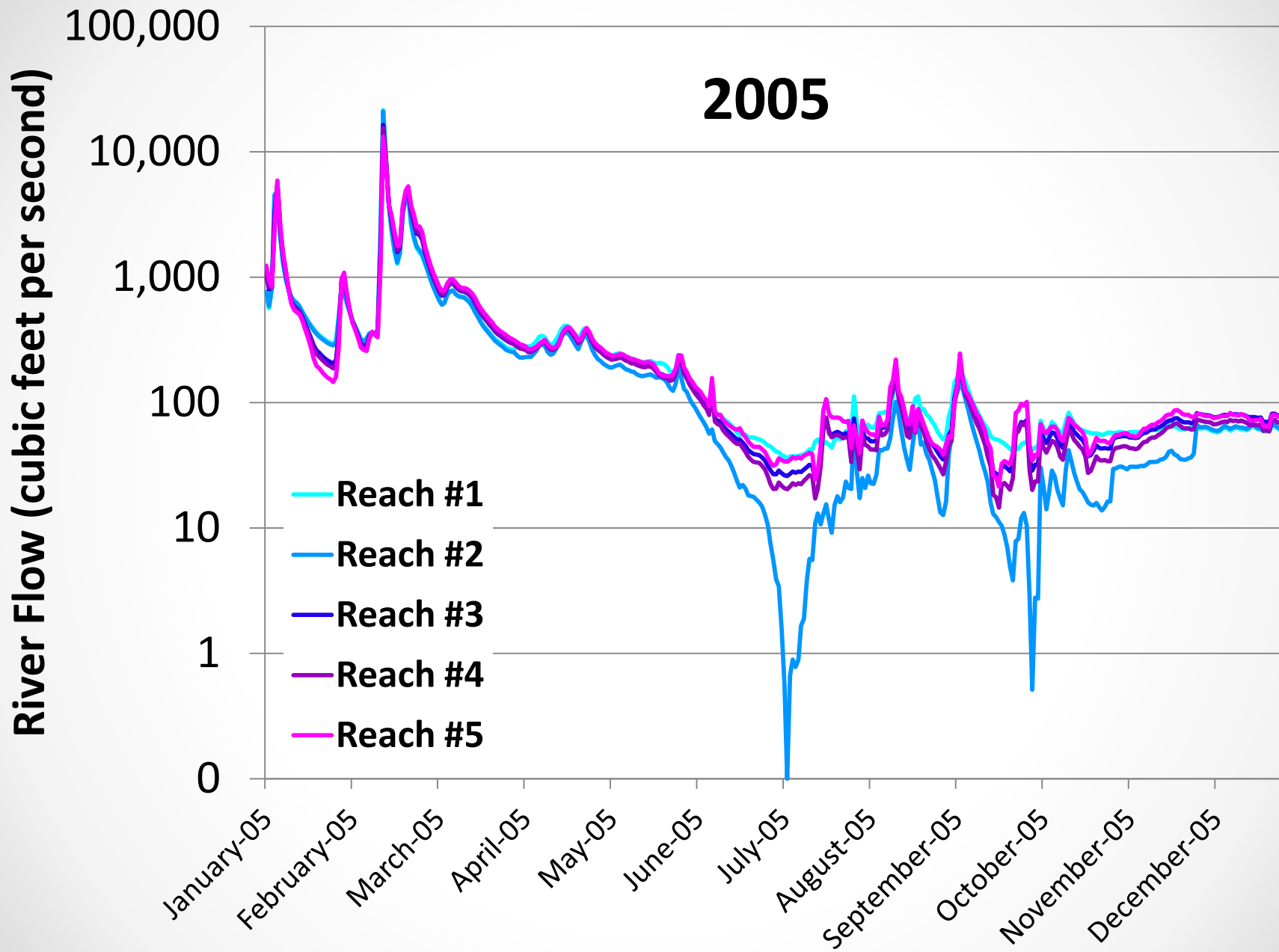
Diversions

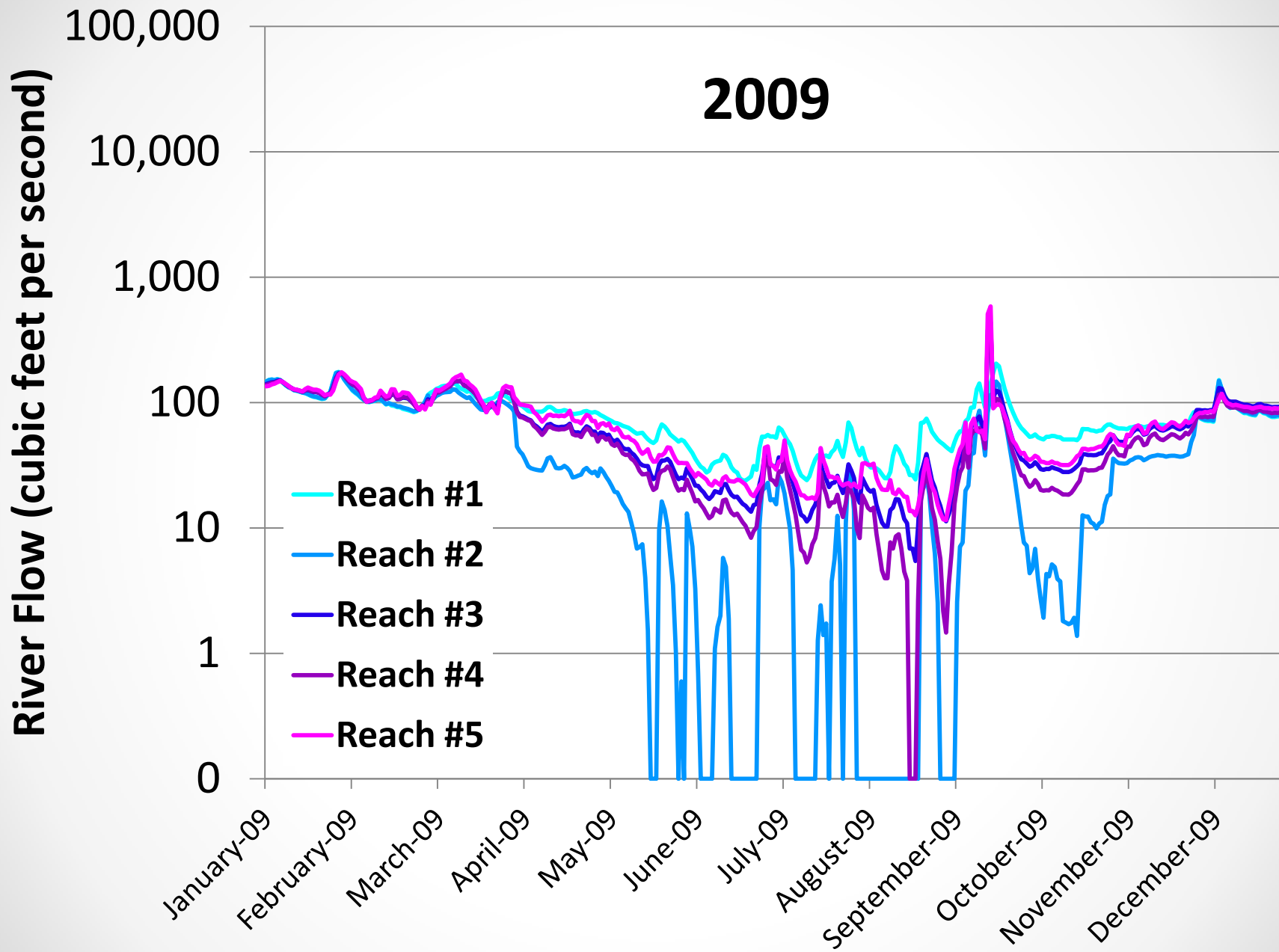


Returns

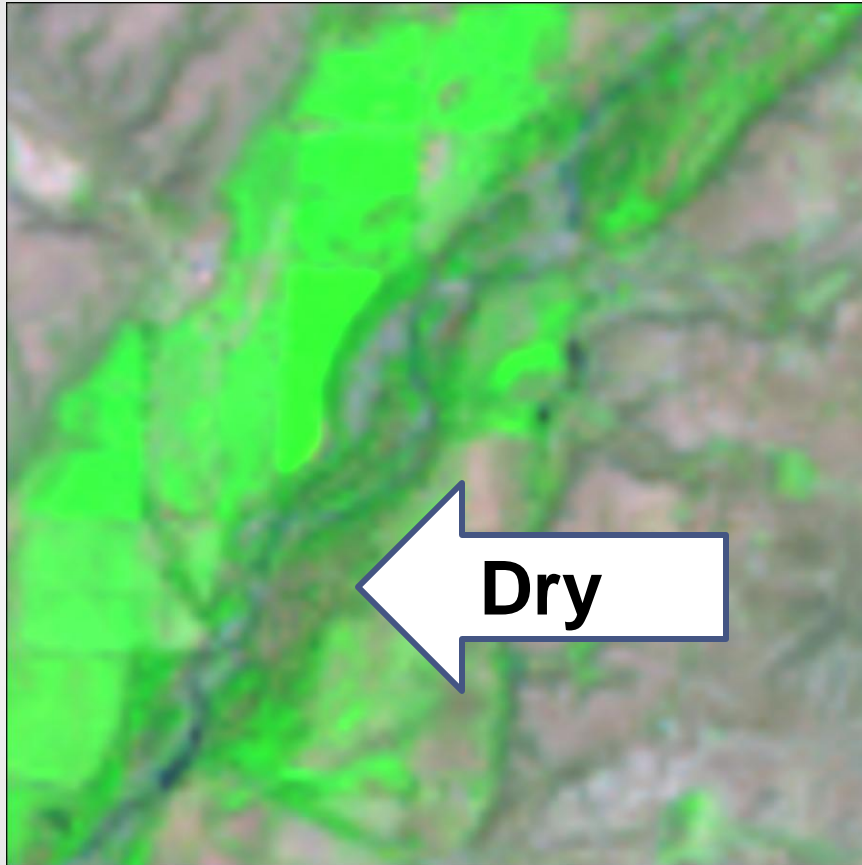
“Channel Flux”



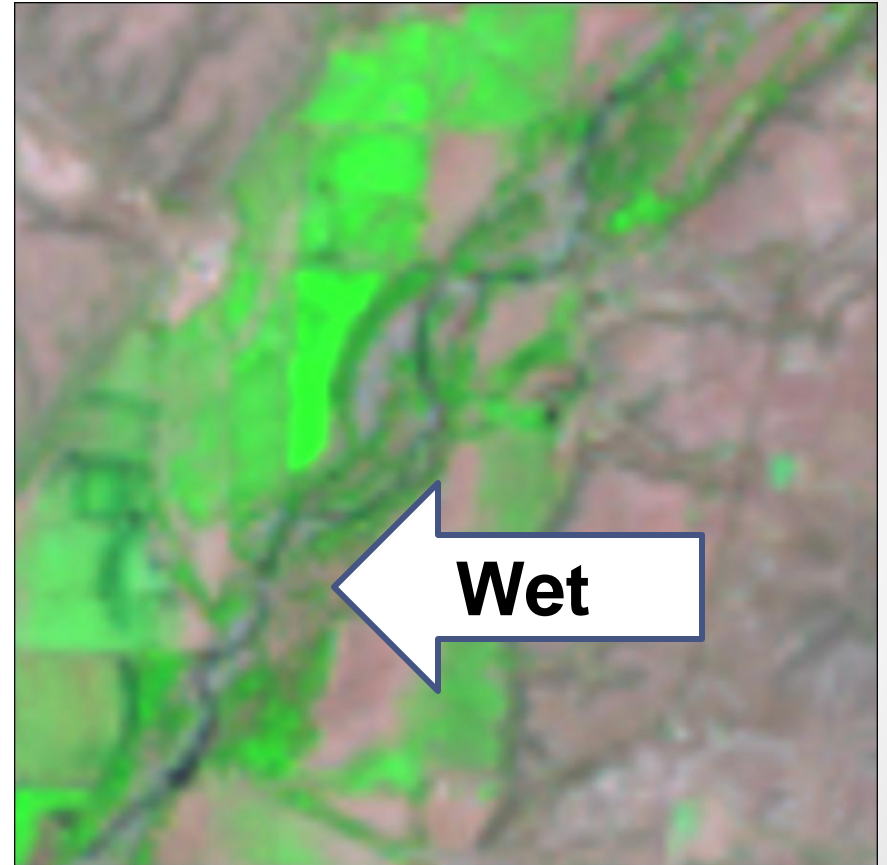




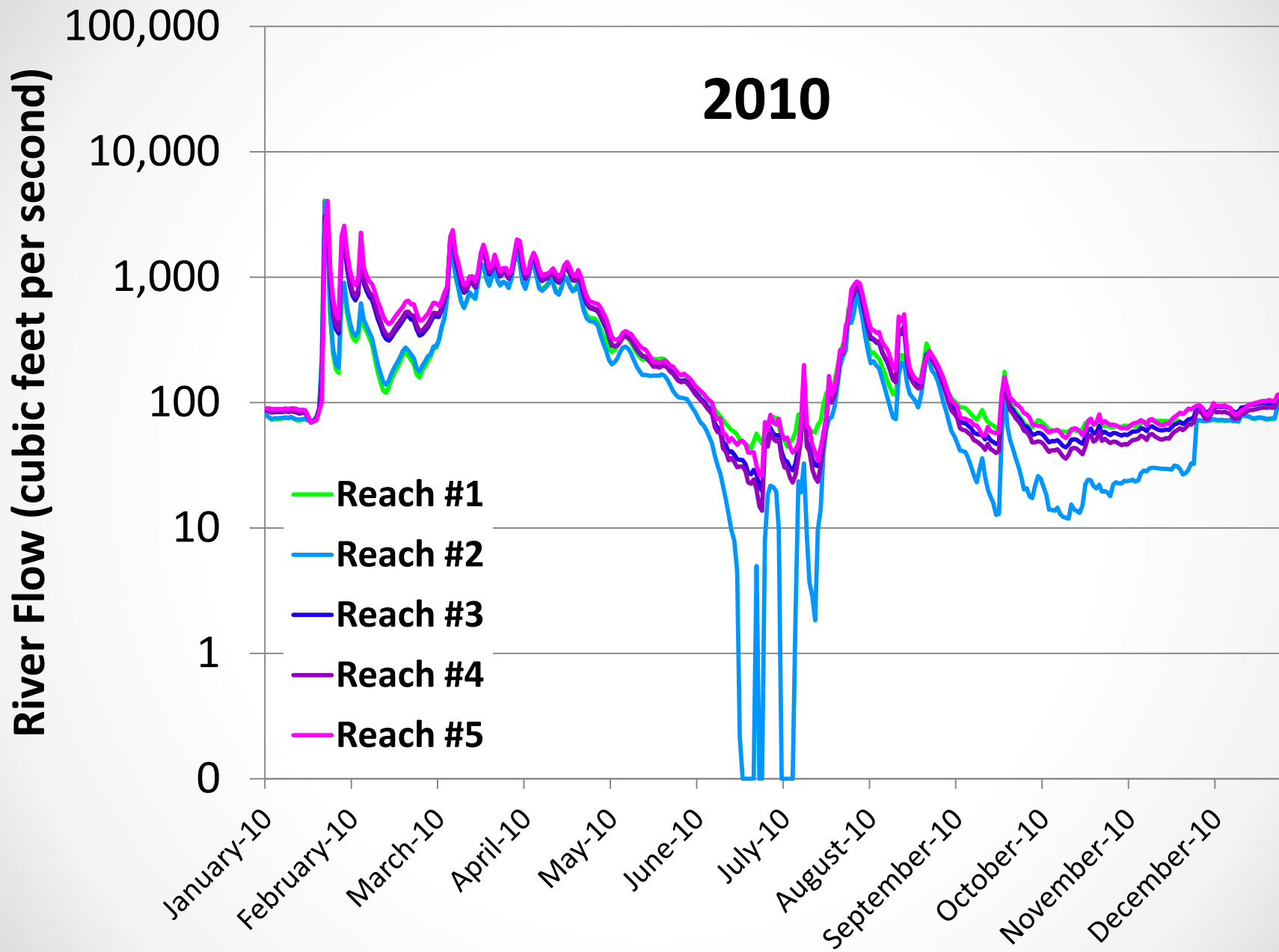
Intermittently dry riverbed

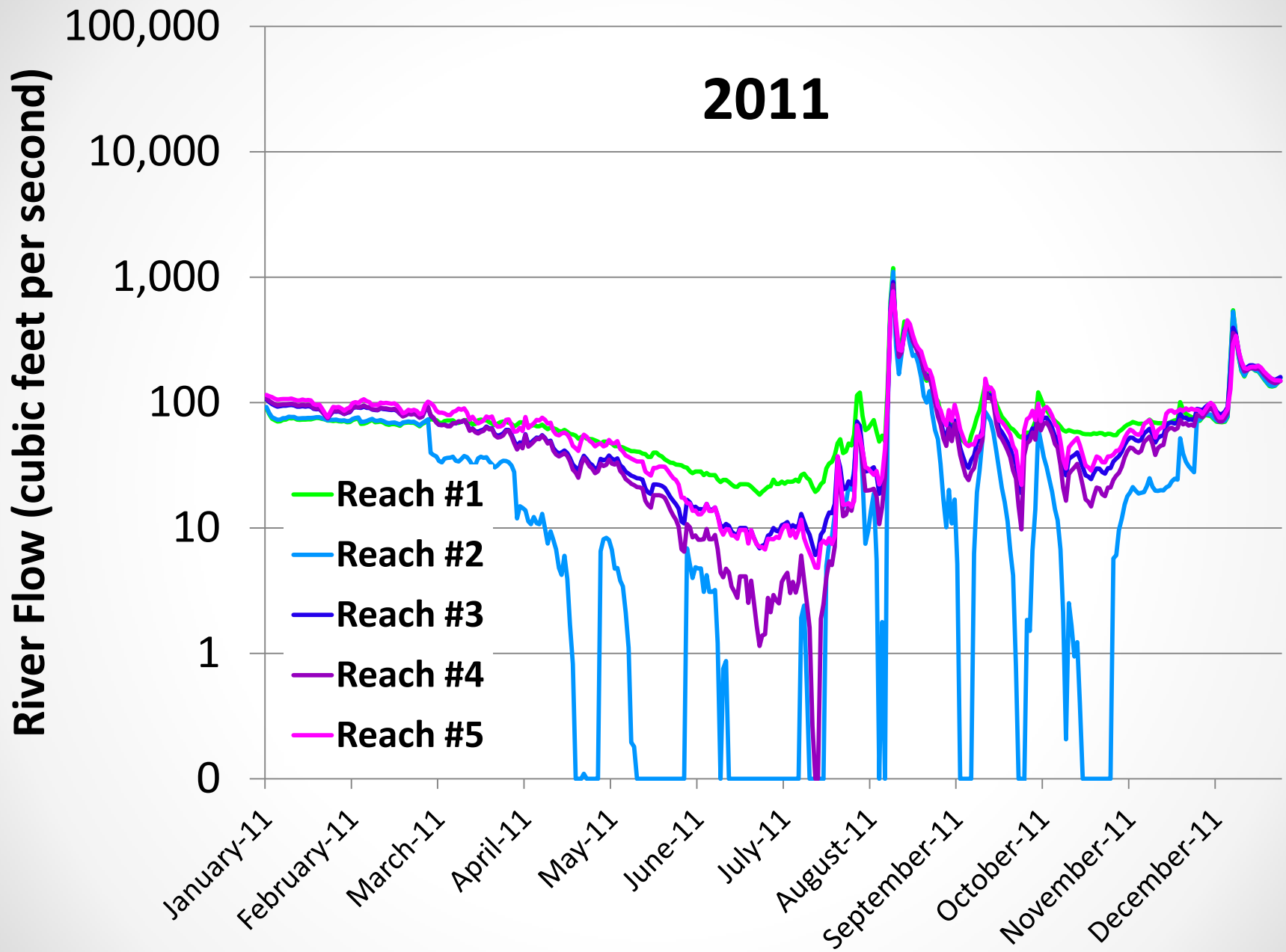


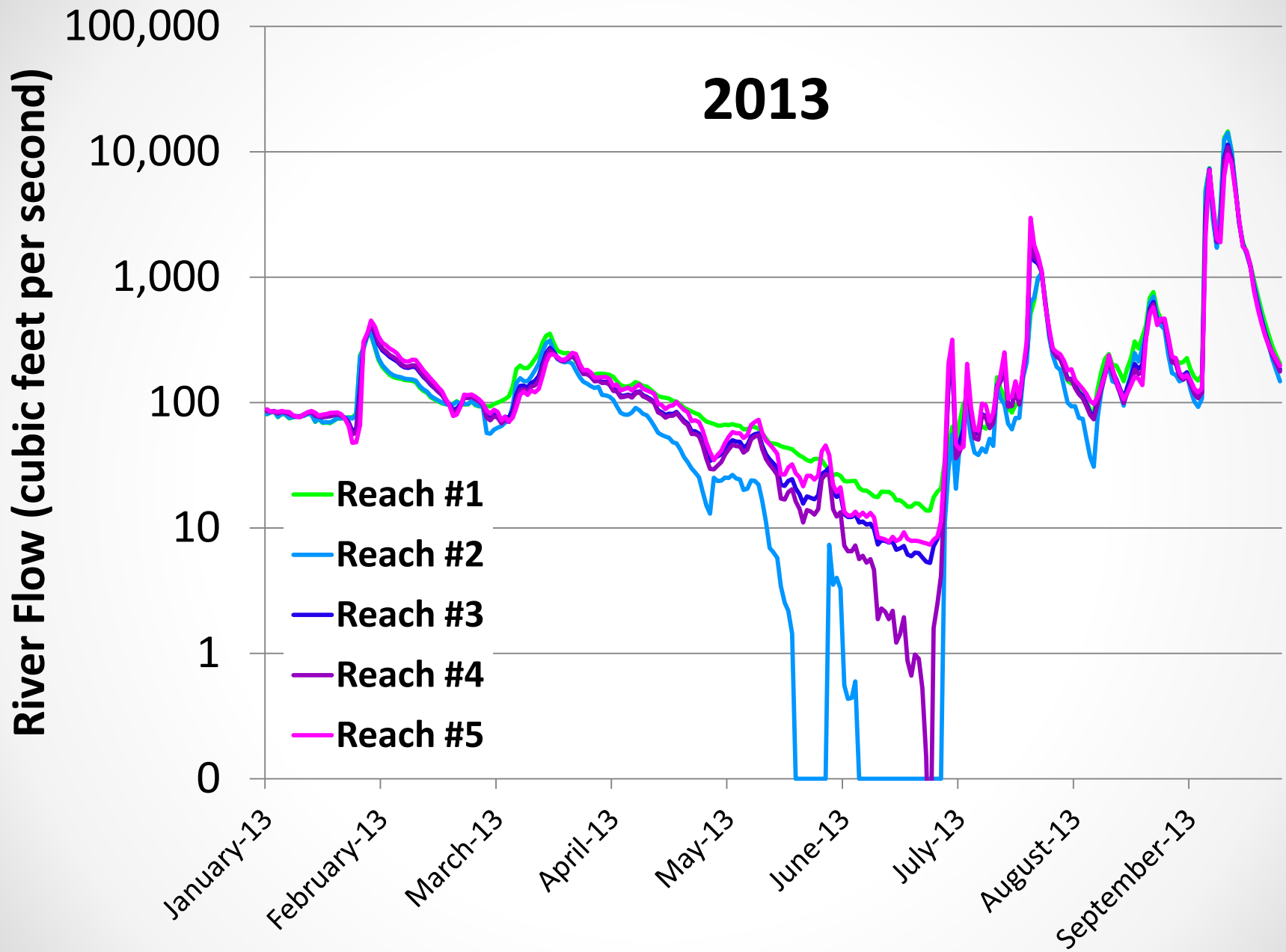
August 5, 2009



May 17, 2009







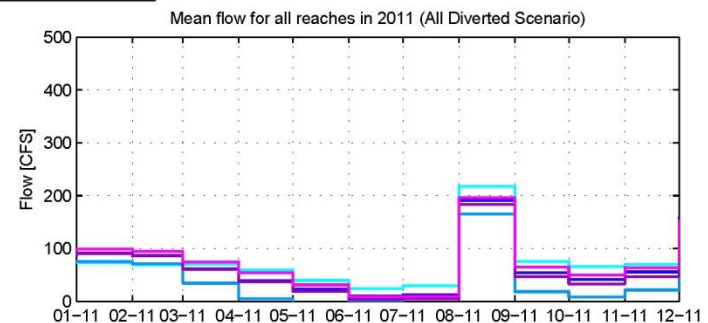
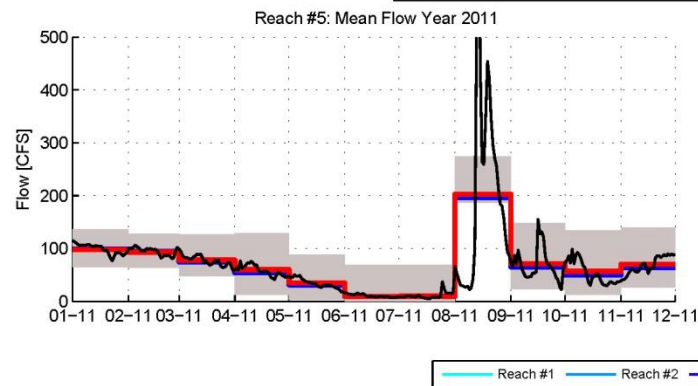
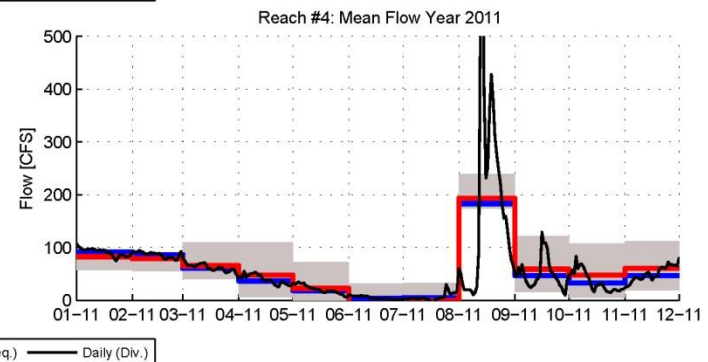
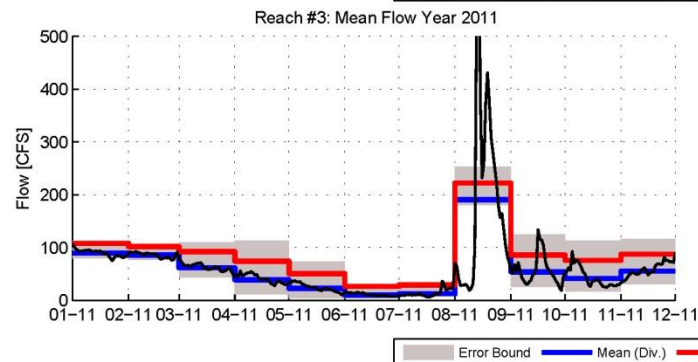
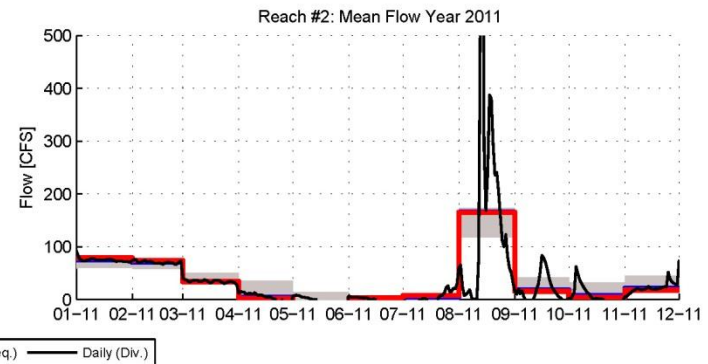
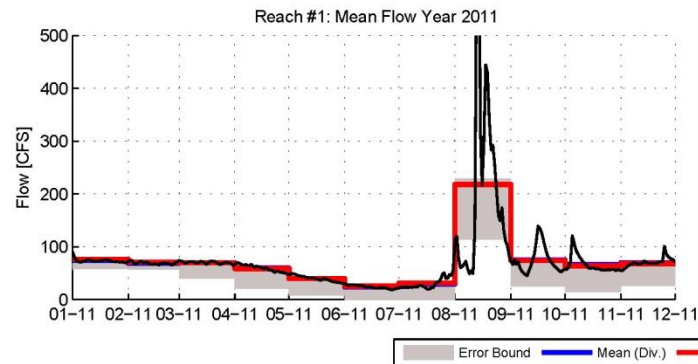


Figure 15
Mean Monthly Flow and
Error Bounds per Reach (2011)
Gila Riparian Vegetation Health