AMP Tools

- ***2-D Model***
- ***Operations Model & Flow Scenarios***
- ***Decision Tree Model***

2019 AMP Reporting Session
Omaha, NE
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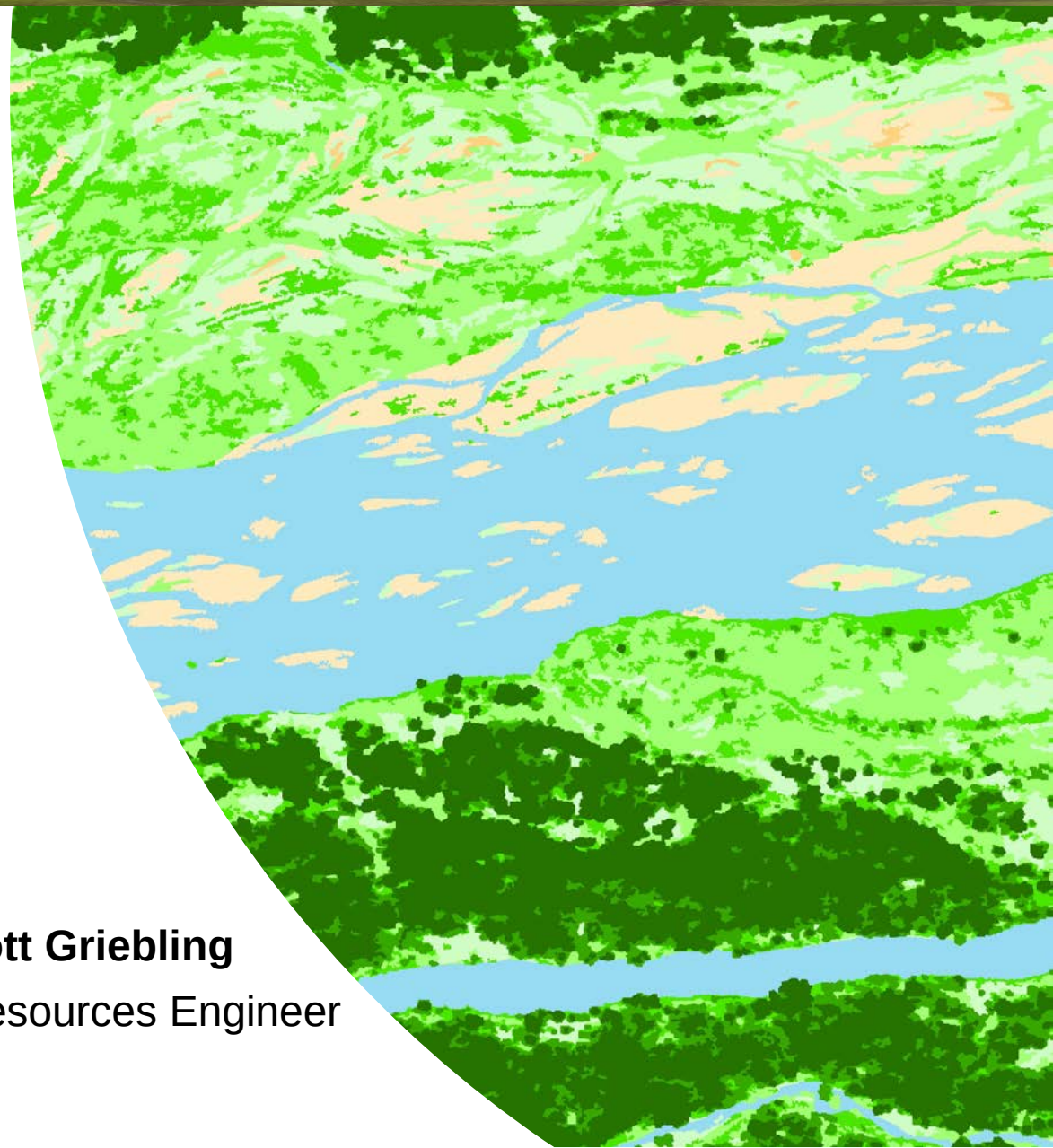
Patrick Farrell
Statistical Ecologist

Tom Smrdel
Fluvial Geomorphologist

Scott Griebling
Water Resources Engineer



"How can we best use Program water to meet species objectives?"

WC Metrics

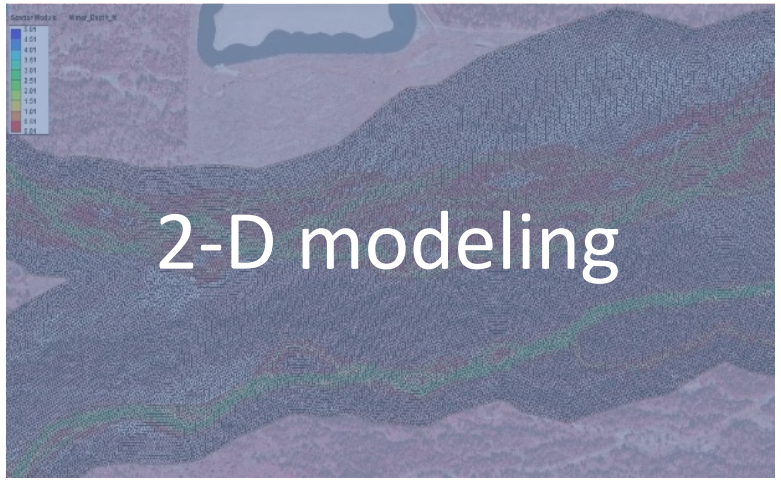
During Migration

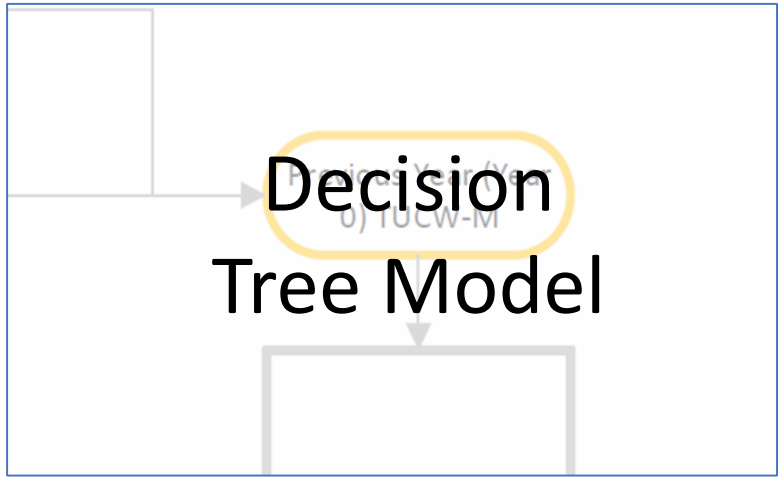
- MUCW of 650’
- water depth ≤0.7 ft

- **How can we best use Program water to provide suitable WC riverine habitat?**

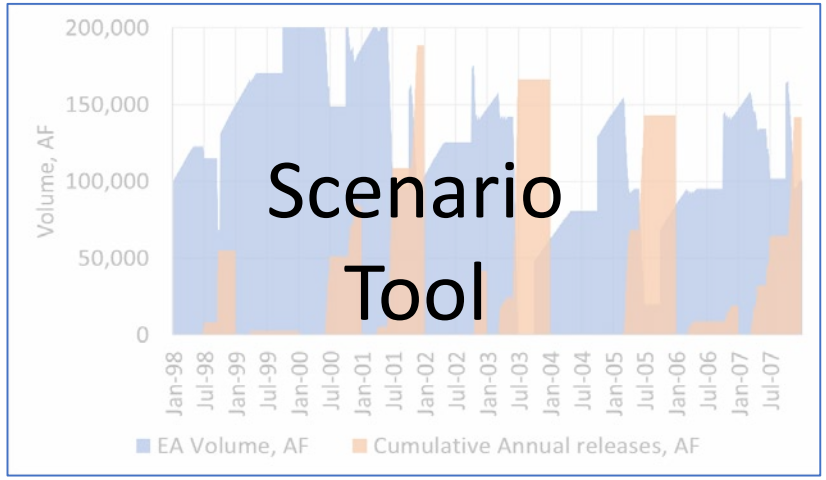
PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

Response to Flow Timing, Duration, Magnitude

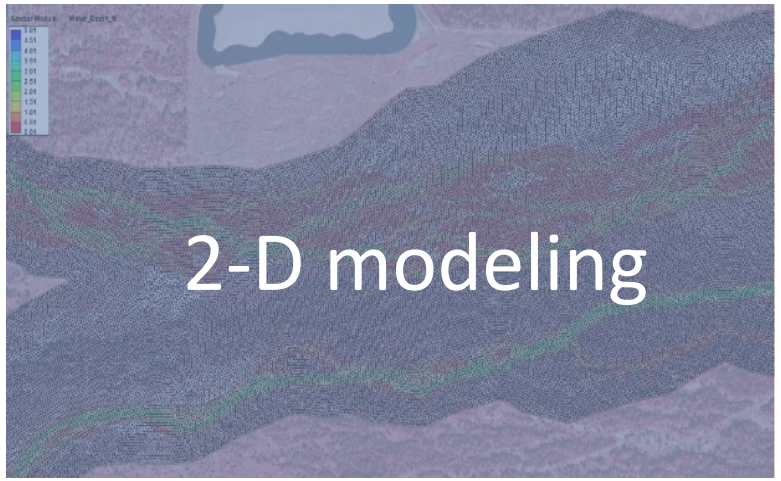


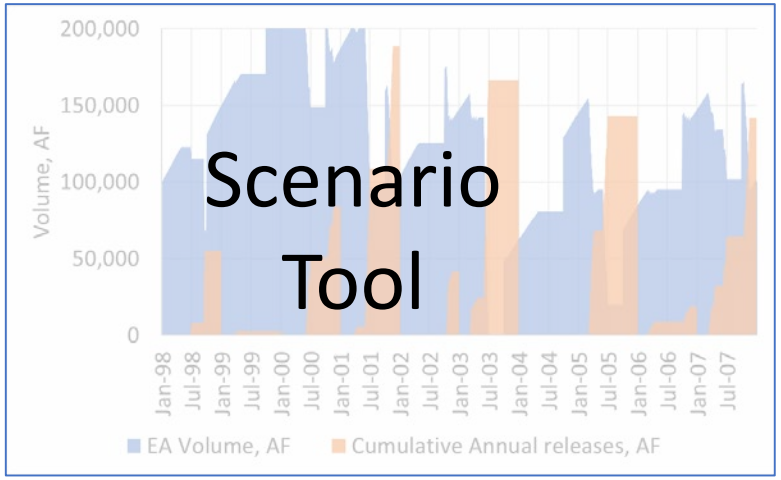


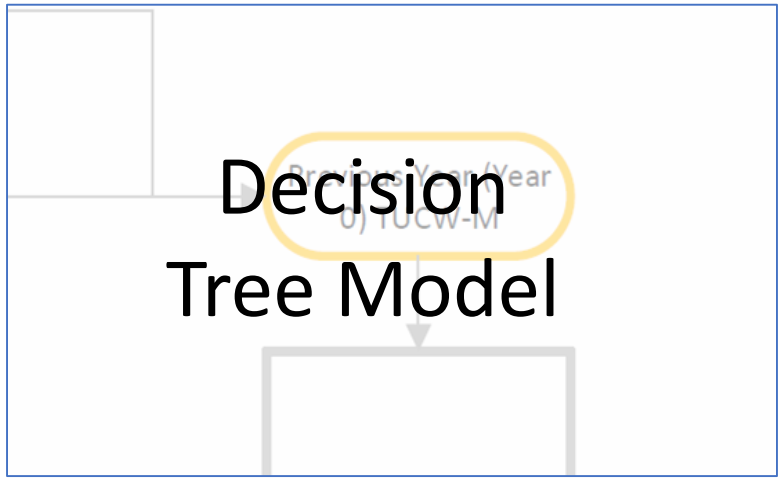
Flow Release Feasibility

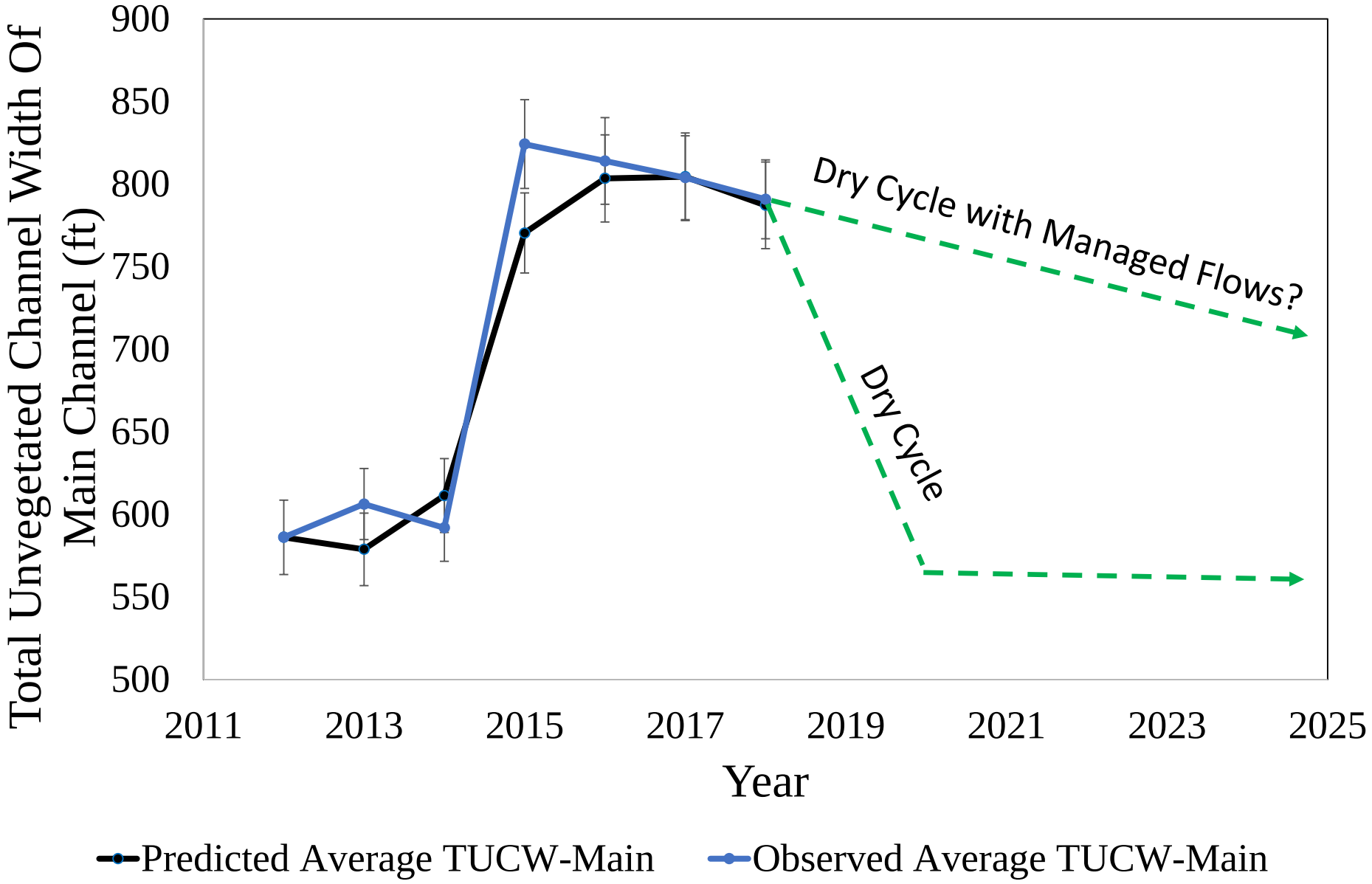


Program Example – Germination season and fall peak flows for channel width maintenance





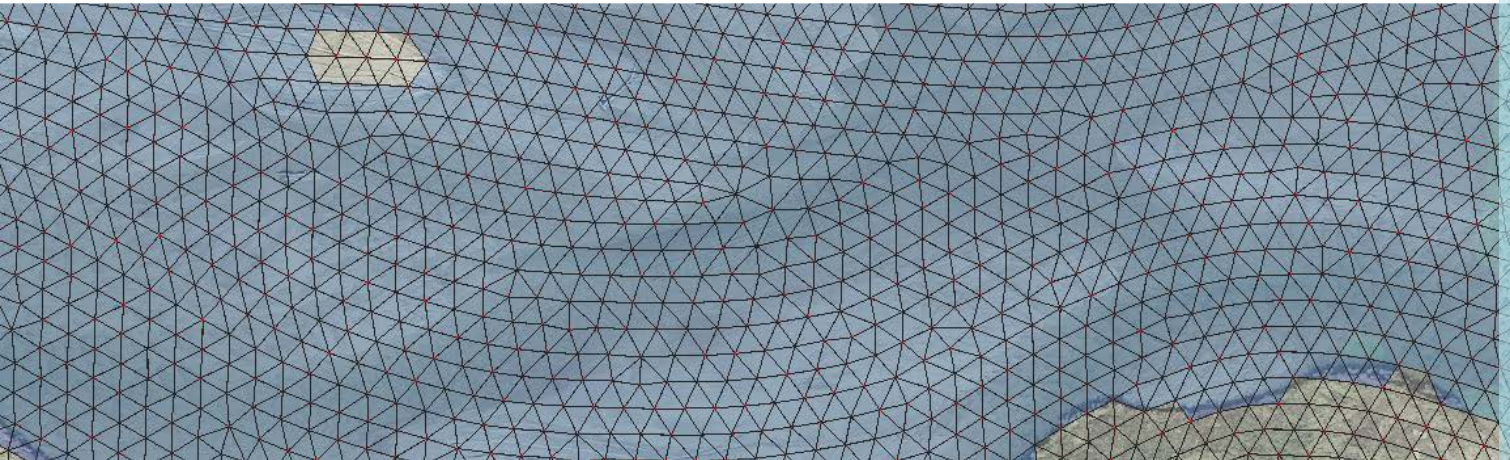



Total Unvegetated Channel Width Of Main Channel (ft)
900
850
800
750
700
650
600
550
500
2011
2013
2015
2017
2019
2021
2023
2025
Year
Dry Cycle with Managed Flows?
Dry Cycle
Predicted Average TUCW-Main
Observed Average TUCW-Main

AMP Tools

2-D MODELING

What is 2-D hydrodynamic modeling & why use it?



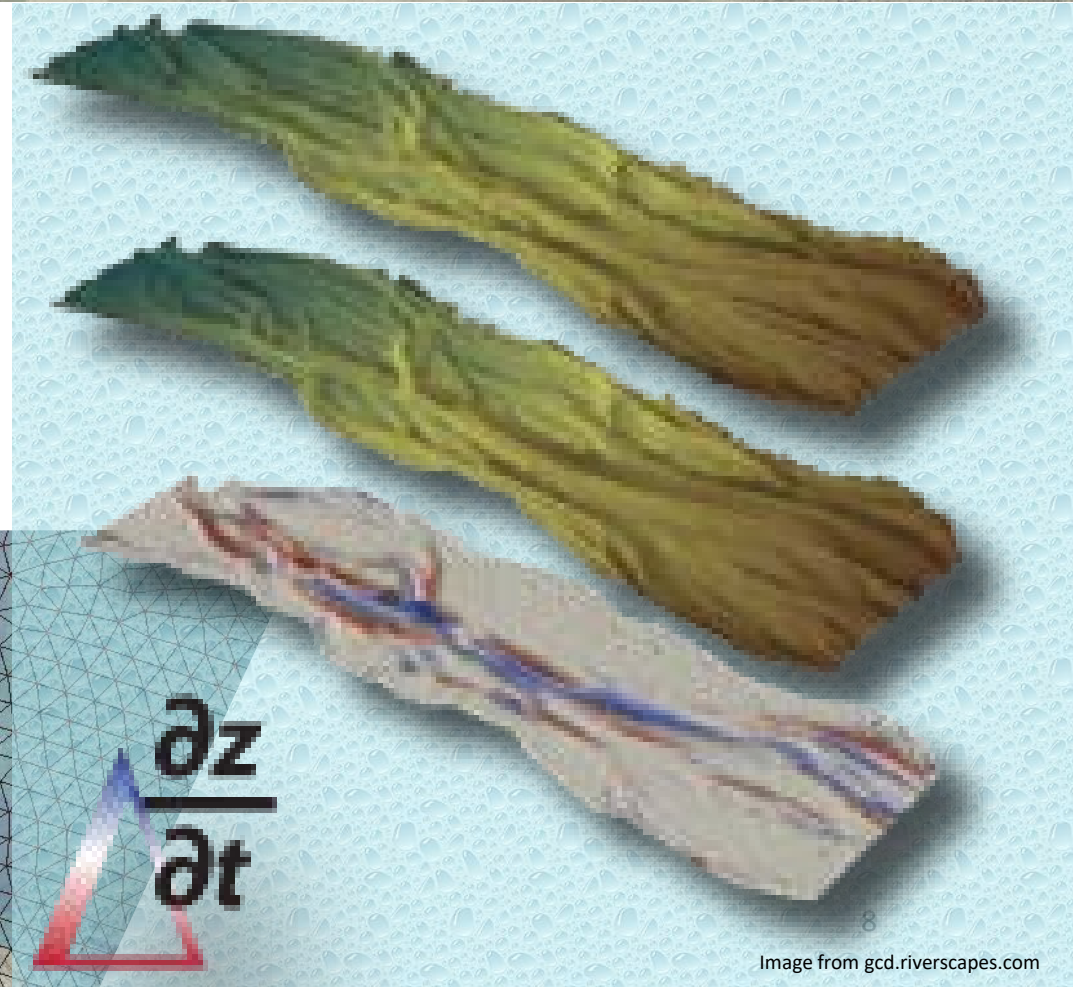
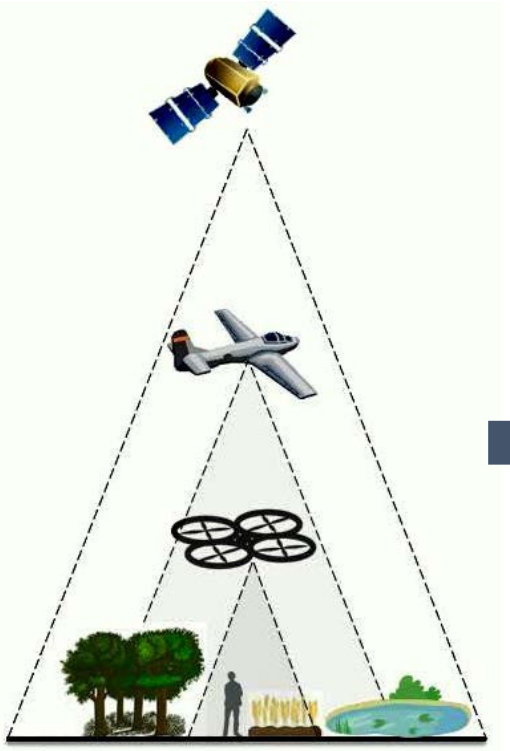


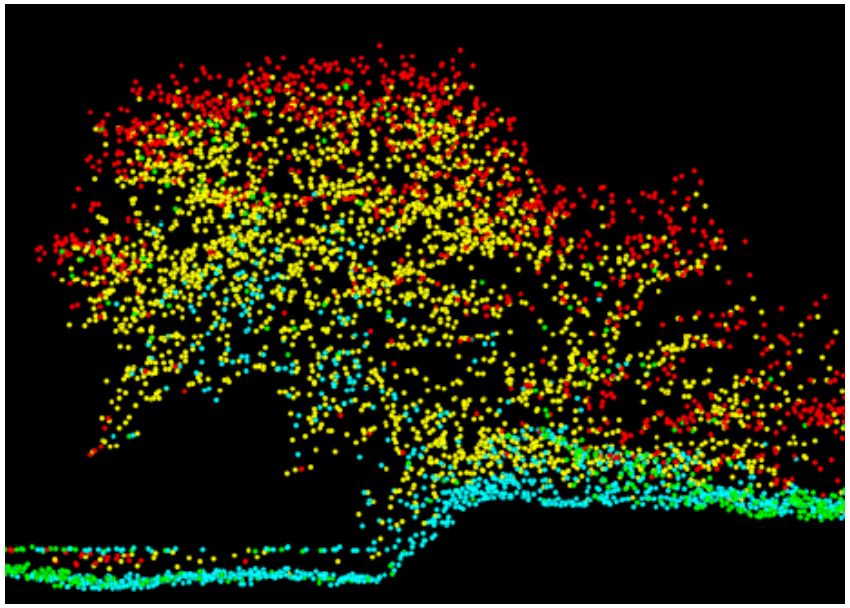
Image from gcd.riverscapes.com

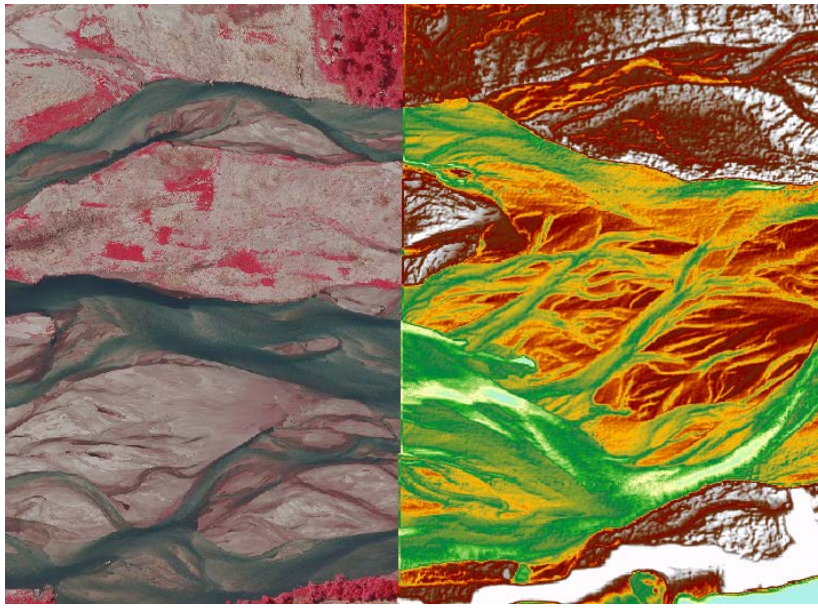
CHANNEL METRICS

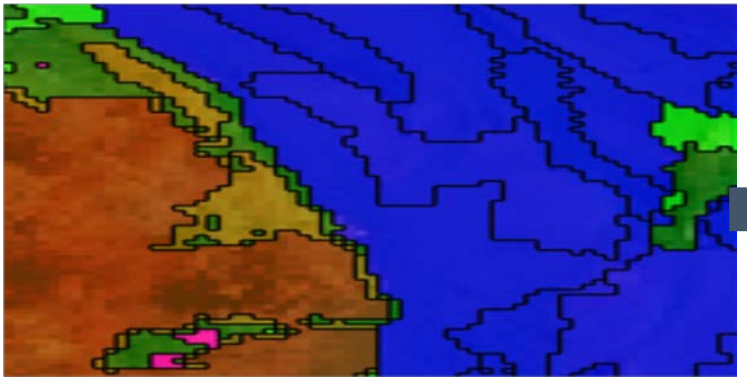
>>> Whooping Cranes

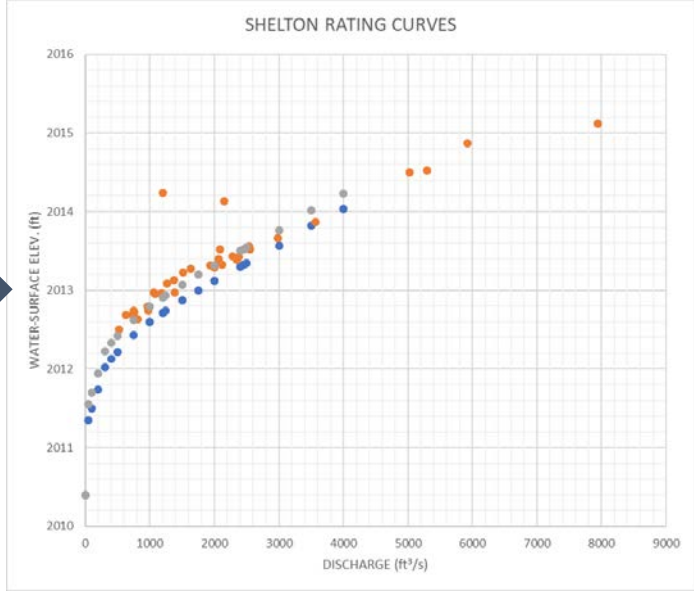
DATA REQUIREMENTS

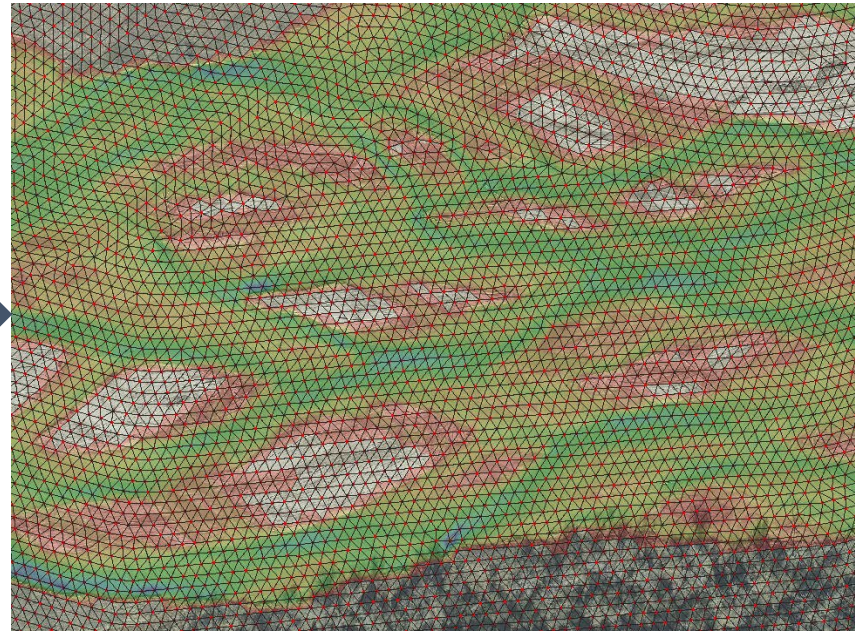




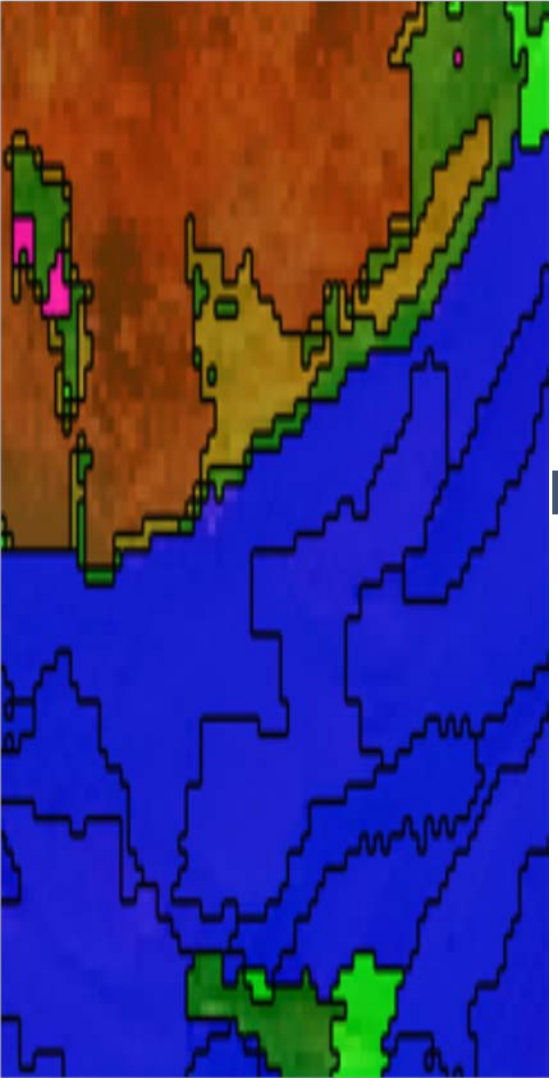






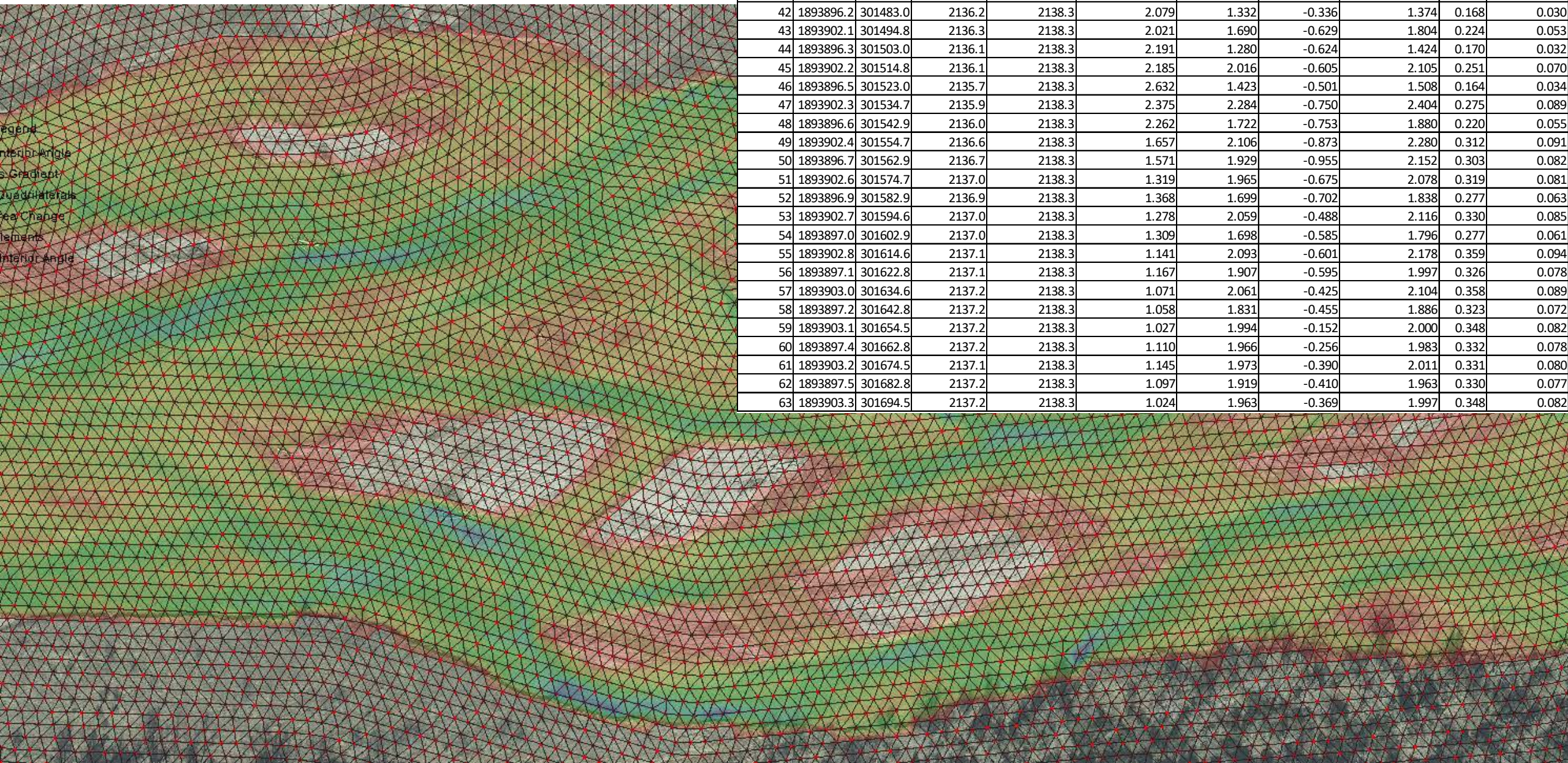


CALIBRATION & VALIDATION



ANSWERS

Point_ID	X_ft	Y_ft	Bed_Elev_ft	Water_Elev_ft	Water_Depth_ft	Vel_X_ft_p_s	Vel_Y_ft_p_s	Vel_Mag_ft_p_s	Froude	Strs_lb_p_ft2
37	1893901.7	301434.9	2138.0	2138.3	0.315	0.944	0.357	1.009	0.317	0.031
38	1893896.0	301443.0	2137.0	2138.3	1.219	0.447	0.424	0.617	0.098	0.007
39	1893901.8	301454.9	2136.5	2138.3	1.777	1.327	0.170	1.338	0.177	0.030
40	1893896.1	301463.0	2136.3	2138.3	1.997	1.244	0.055	1.245	0.155	0.025
41	1893901.9	301474.8	2136.2	2138.3	2.058	1.536	-0.262	1.558	0.191	0.039
42	1893896.2	301483.0	2136.2	2138.3	2.079	1.332	-0.336	1.374	0.168	0.030
43	1893902.1	301494.8	2136.3	2138.3	2.021	1.690	-0.629	1.804	0.224	0.053
44	1893896.3	301503.0	2136.1	2138.3	2.191	1.280	-0.624	1.424	0.170	0.032
45	1893902.2	301514.8	2136.1	2138.3	2.185	2.016	-0.605	2.105	0.251	0.070
46	1893896.5	301523.0	2135.7	2138.3	2.632	1.423	-0.501	1.508	0.164	0.034
47	1893902.3	301534.7	2135.9	2138.3	2.375	2.284	-0.750	2.404	0.275	0.089
48	1893896.6	301542.9	2136.0	2138.3	2.262	1.722	-0.753	1.880	0.220	0.055
49	1893902.4	301554.7	2136.6	2138.3	1.657	2.106	-0.873	2.280	0.312	0.091
50	1893896.7	301562.9	2136.7	2138.3	1.571	1.929	-0.955	2.152	0.303	0.082
51	1893902.6	301574.7	2137.0	2138.3	1.319	1.965	-0.675	2.078	0.319	0.081
52	1893896.9	301582.9	2136.9	2138.3	1.368	1.699	-0.702	1.838	0.277	0.063
53	1893902.7	301594.6	2137.0	2138.3	1.278	2.059	-0.488	2.116	0.330	0.085
54	1893897.0	301602.9	2137.0	2138.3	1.309	1.698	-0.585	1.796	0.277	0.061
55	1893902.8	301614.6	2137.1	2138.3	1.141	2.093	-0.601	2.178	0.359	0.094
56	1893897.1	301622.8	2137.1	2138.3	1.167	1.907	-0.595	1.997	0.326	0.078
57	1893903.0	301634.6	2137.2	2138.3	1.071	2.061	-0.425	2.104	0.358	0.089
58	1893897.2	301642.8	2137.2	2138.3	1.058	1.831	-0.455	1.886	0.323	0.072
59	1893903.1	301654.5	2137.2	2138.3	1.027	1.994	-0.152	2.000	0.348	0.082
60	1893897.4	301662.8	2137.2	2138.3	1.110	1.966	-0.256	1.983	0.332	0.078
61	1893903.2	301674.5	2137.1	2138.3	1.145	1.973	-0.390	2.011	0.331	0.080
62	1893897.5	301682.8	2137.2	2138.3	1.097	1.919	-0.410	1.963	0.330	0.077
63	1893903.3	301694.5	2137.2	2138.3	1.024	1.963	-0.369	1.997	0.348	0.082



Limitations & Performance

- 20 ft spacing
- single n-value
- in-channel flow
- takes time
- fall topography

- single calibration
- limited validation
- steady state
- 100 – 5,000 ft^3/s

- < 0.10 ft main channel
- < 0.17 ft side channels
- flow split predictions
- data heavy
- predictions are static

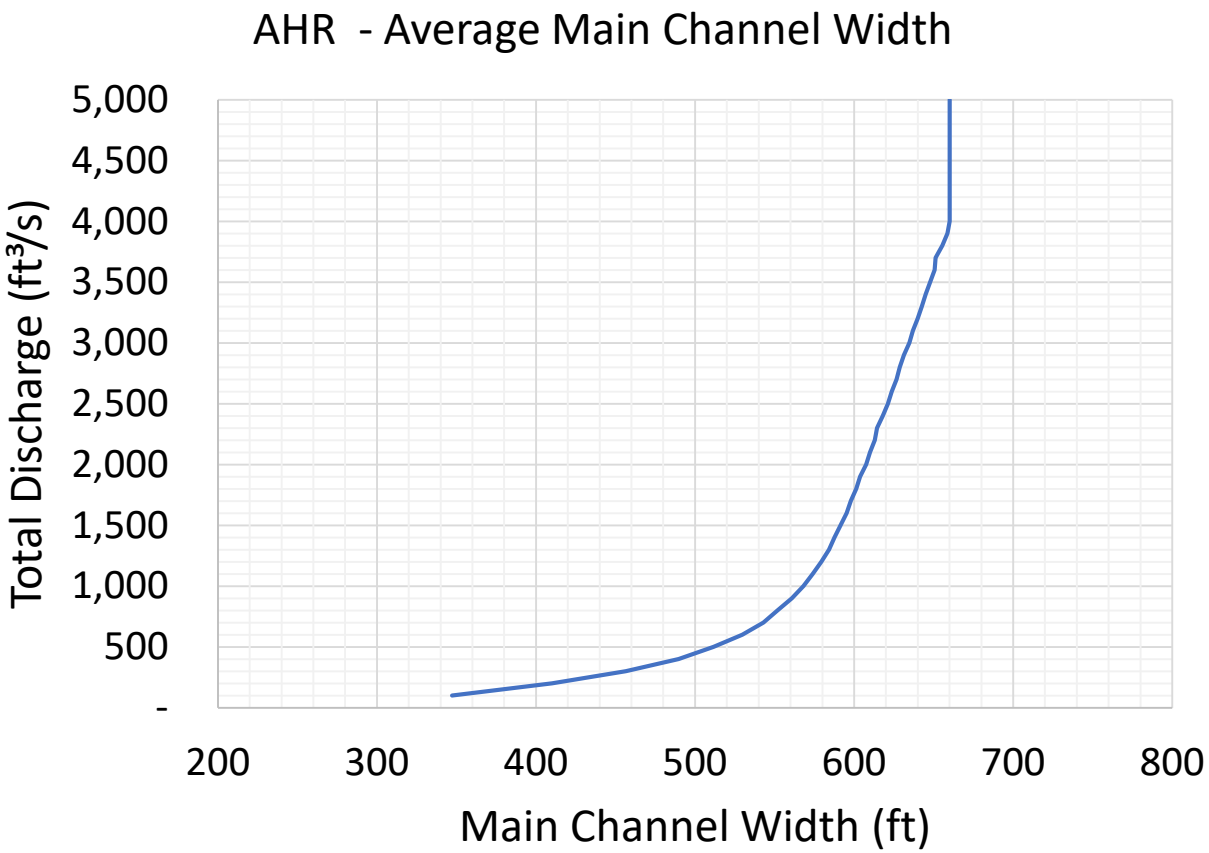
SPECIFIC APPLICATION

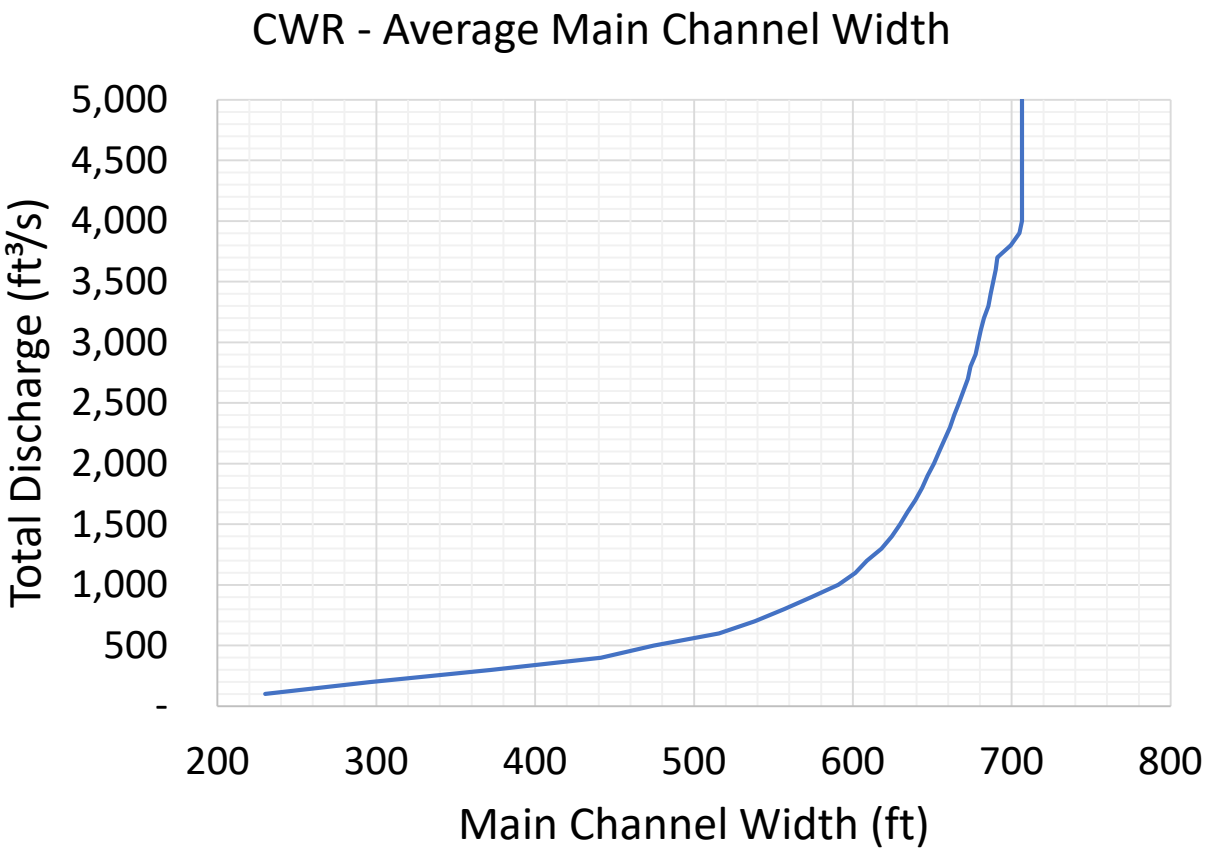
How can a 2-D model assist PRRIP with assessment channel conditions?

- ≥ 650 ft maximum unobstructed channel width
- ≤ 0.7 ft channel depth
- > 2.6 ft overtopping depth

PRELIMINARY RESULTS

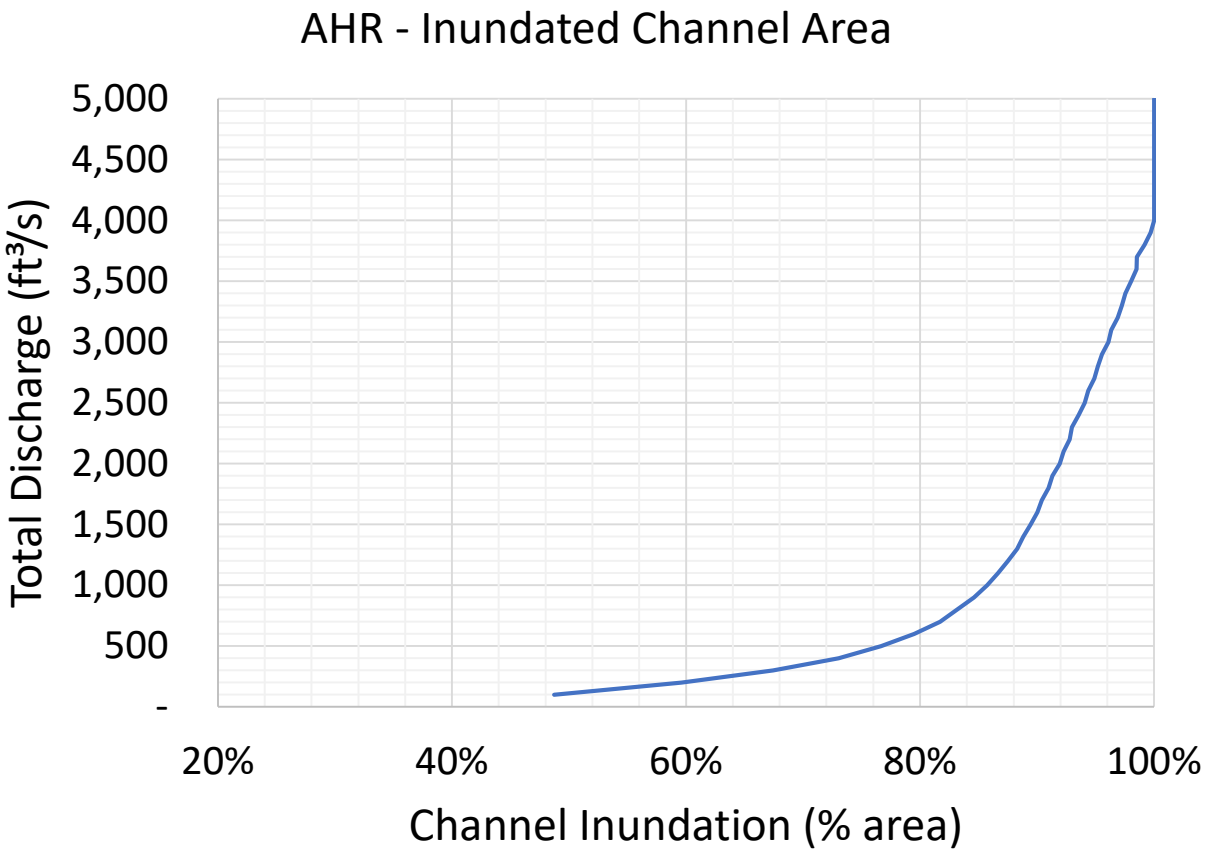
CHANNEL WIDTH (REACH AVERAGE)

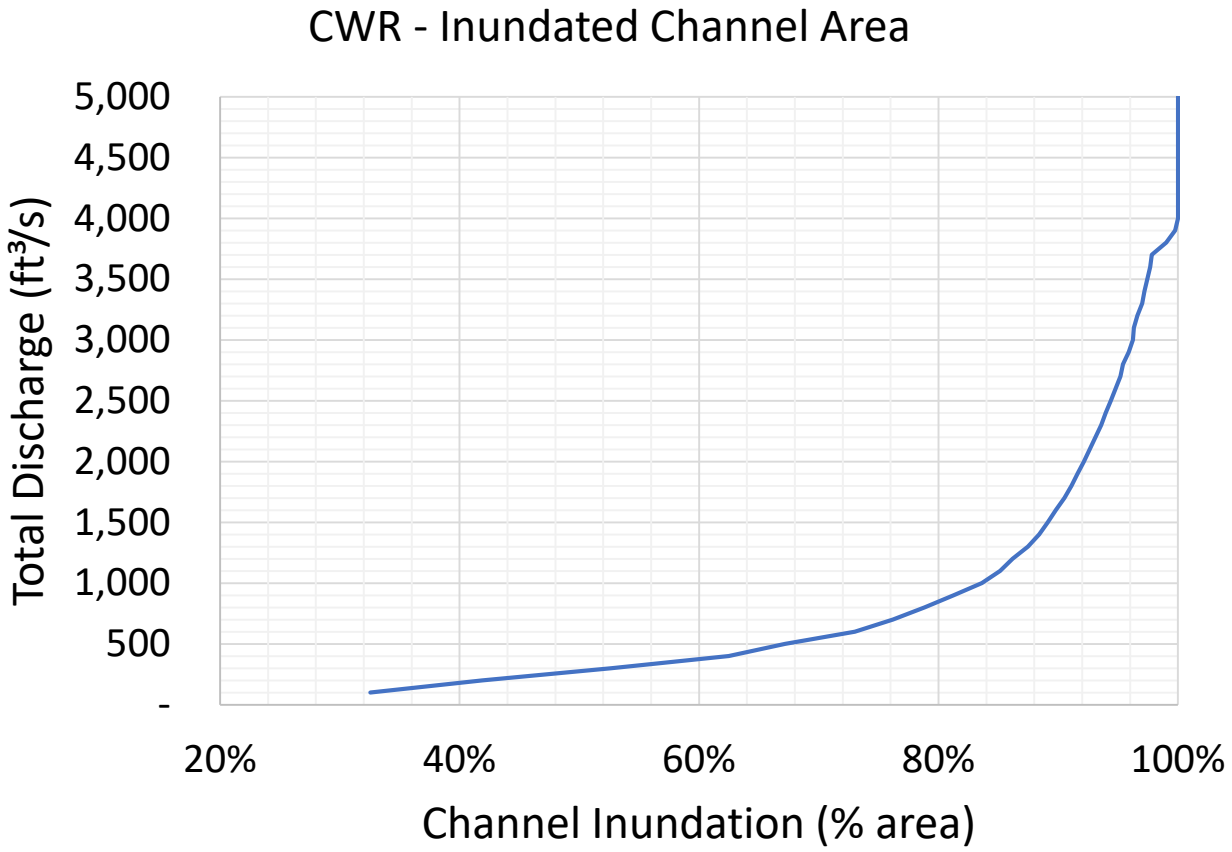




PRELIMINARY RESULTS

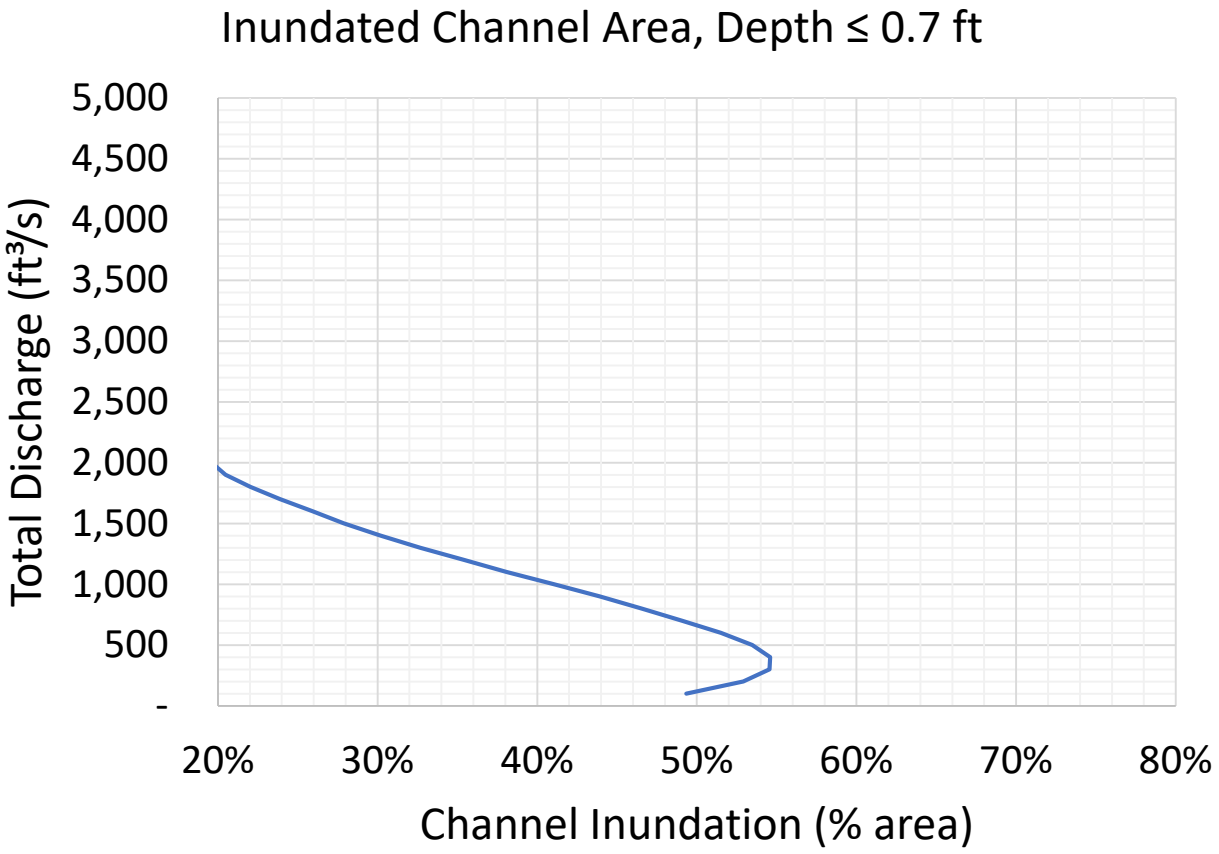
INUNDATED CHANNEL AREA

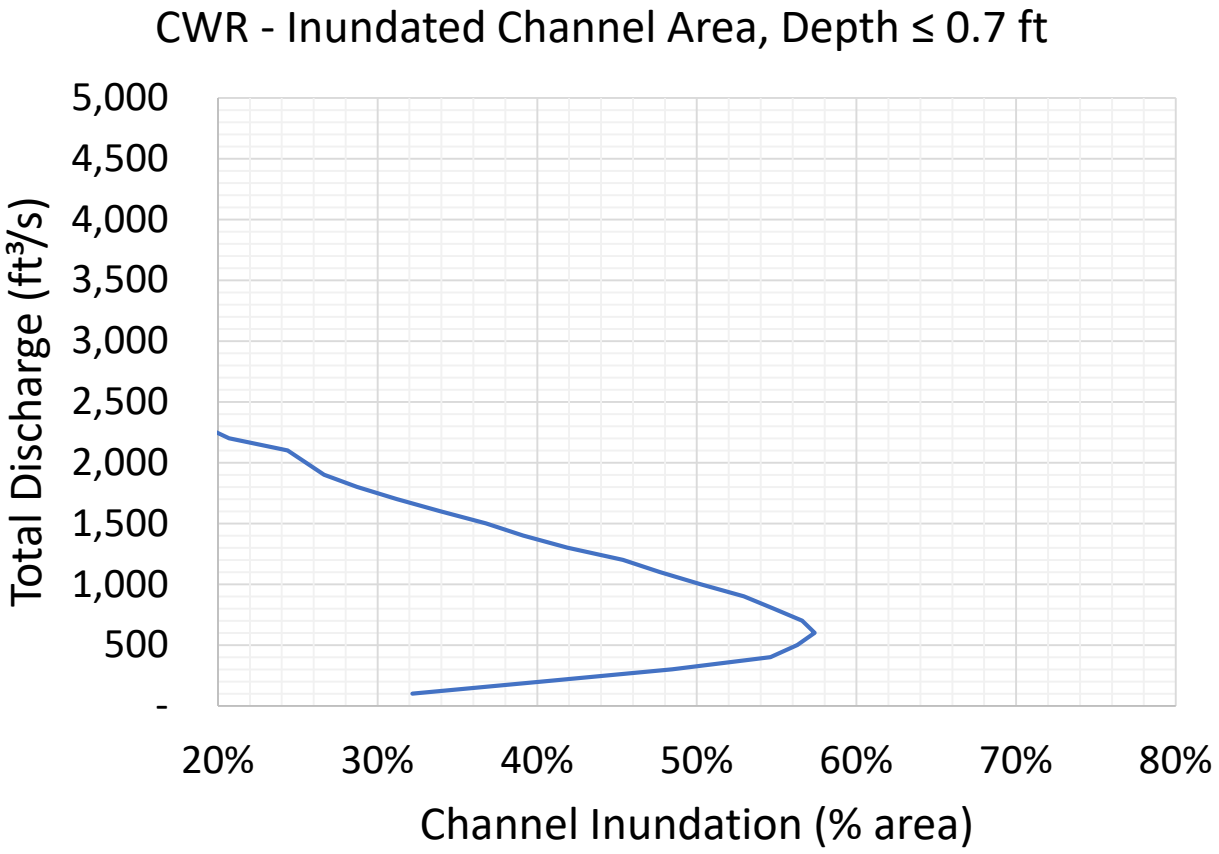




PRELIMINARY RESULTS

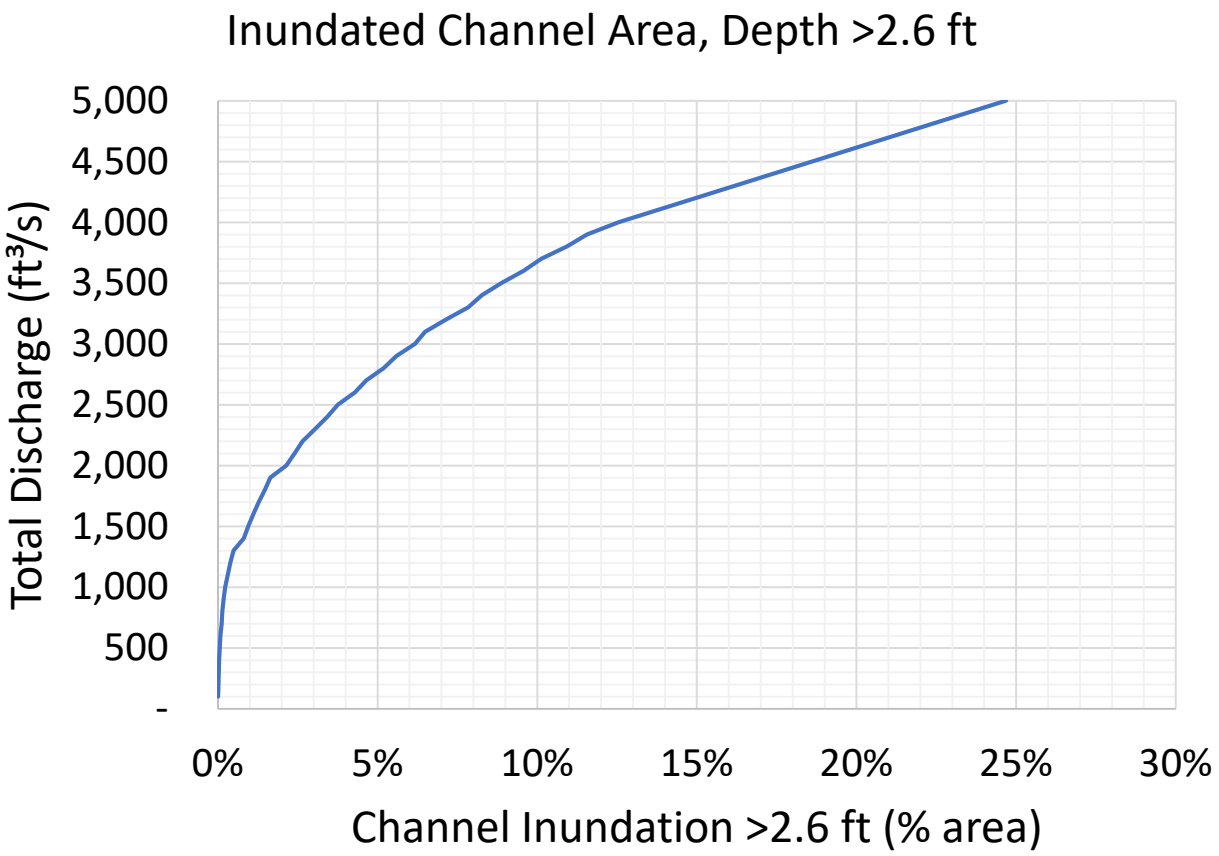
INUNDATED CHANNEL AREA ≤ 0.7 FT DEEP

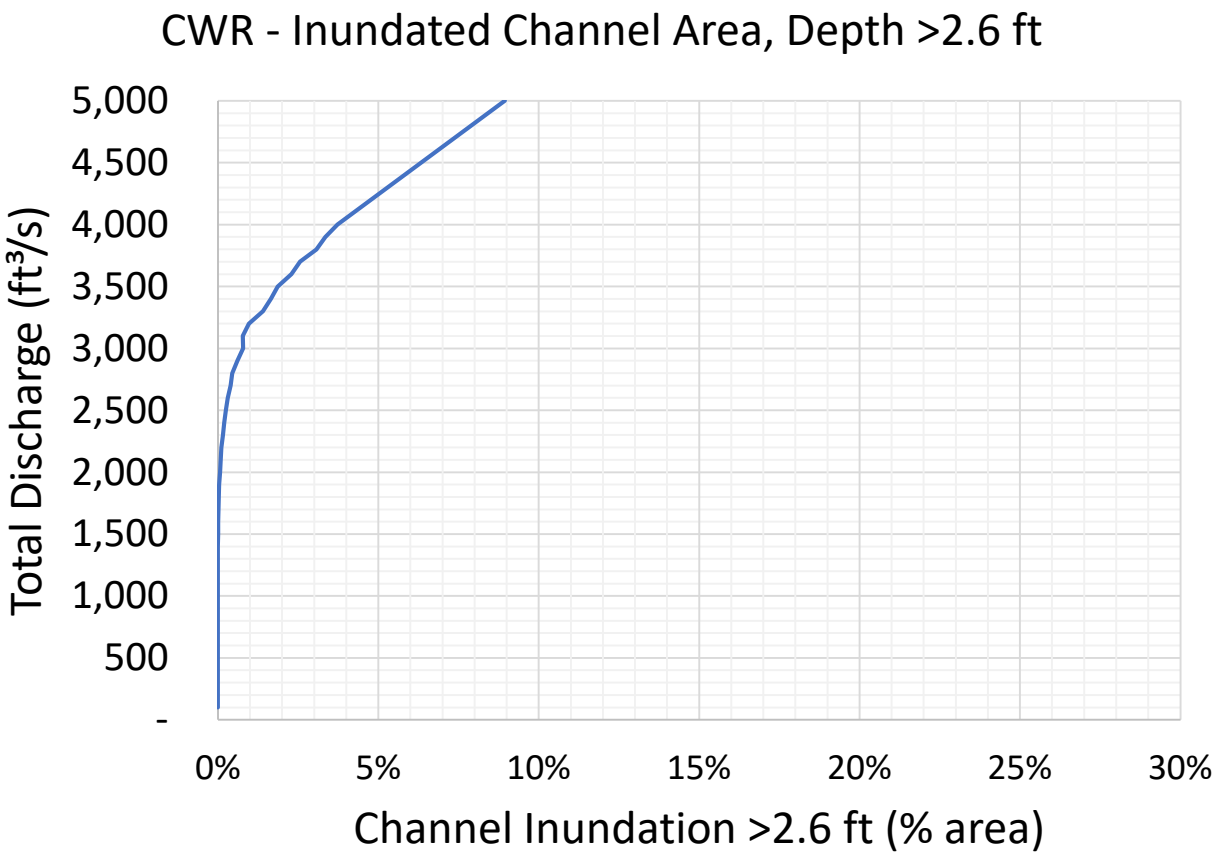




PRELIMINARY RESULTS

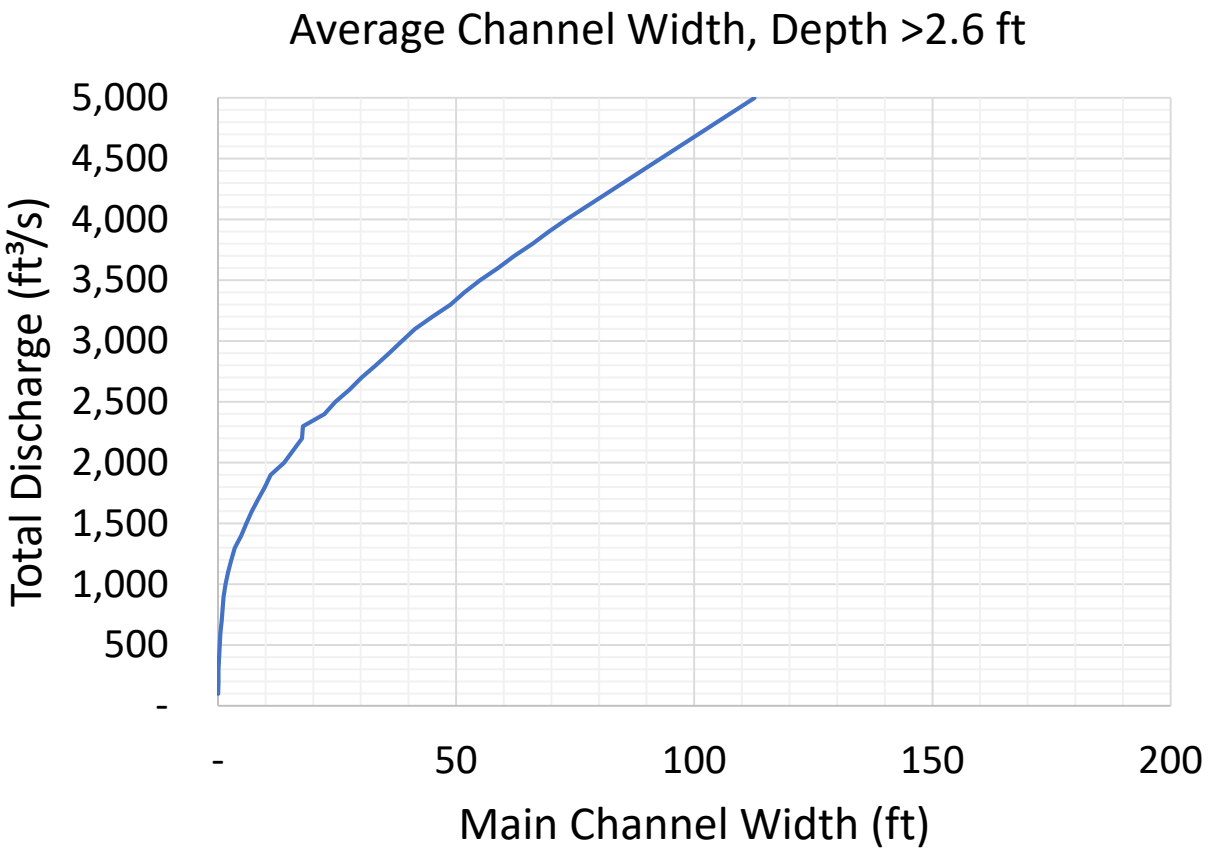
INUNDATED CHANNEL AREA >2.6 FT DEEP

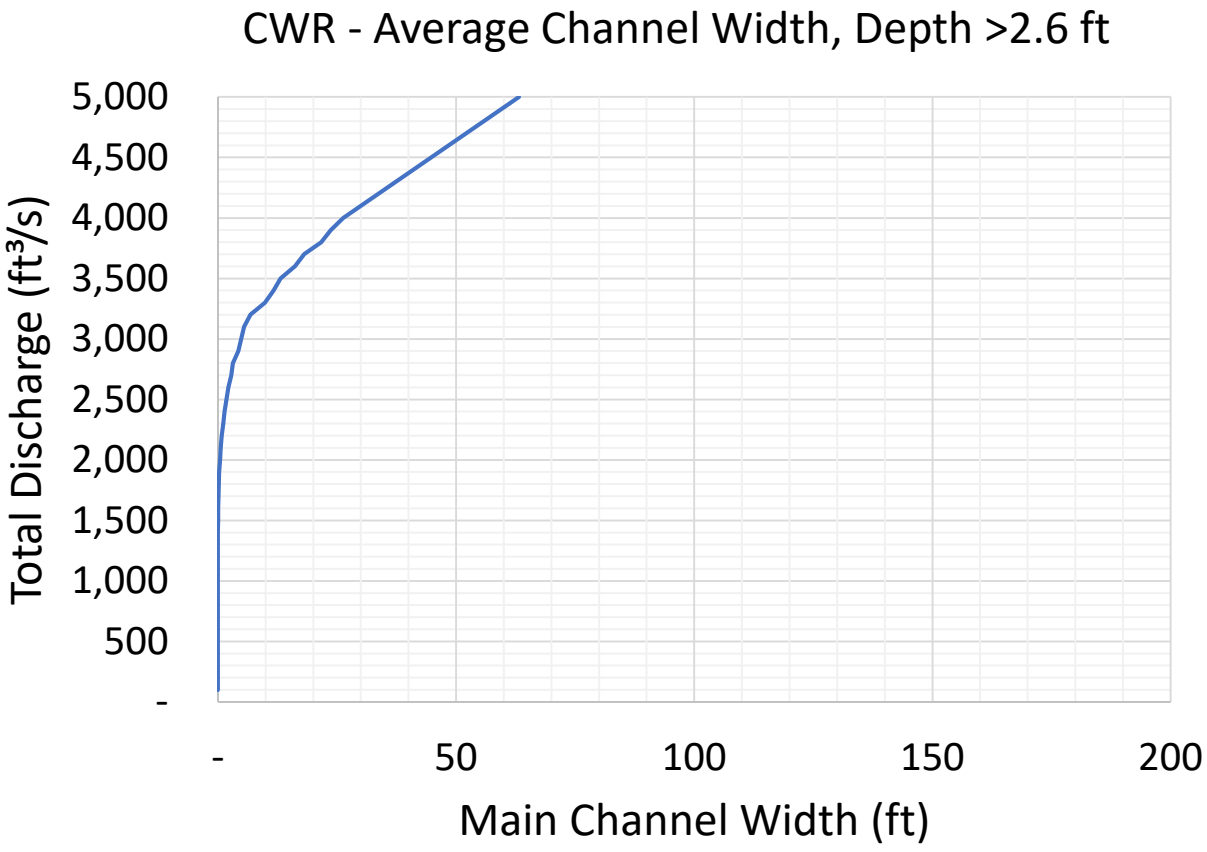




PRELIMINARY RESULTS

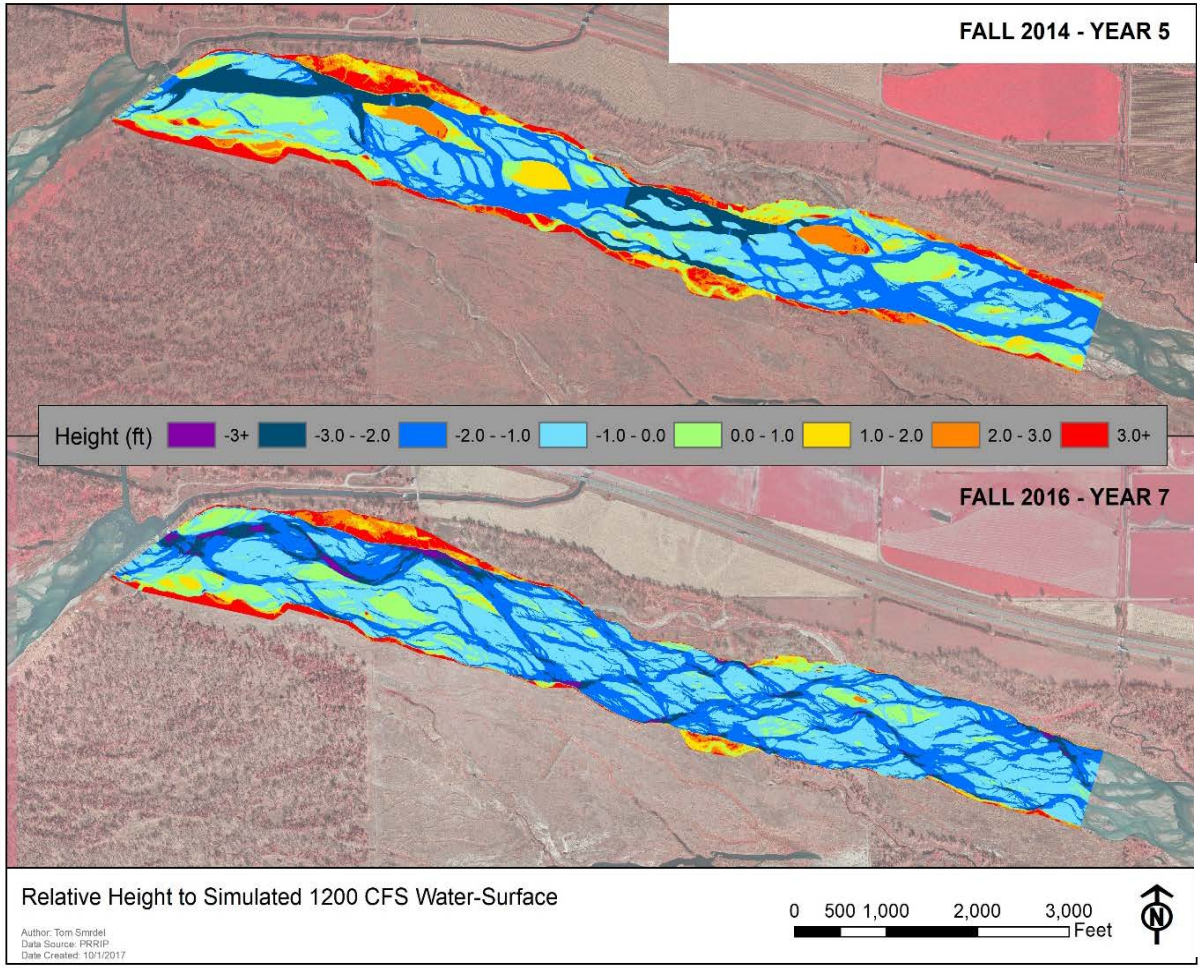
REACH AVERAGE CHANNEL WIDTH >2.6 FT DEEP

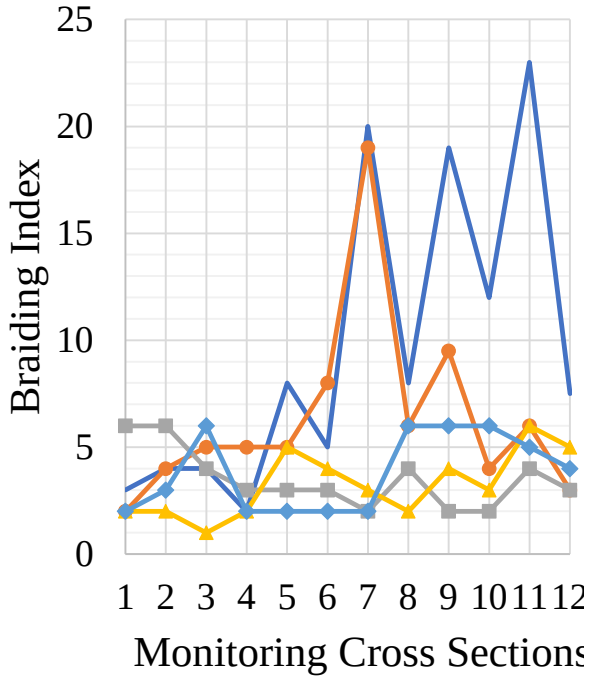


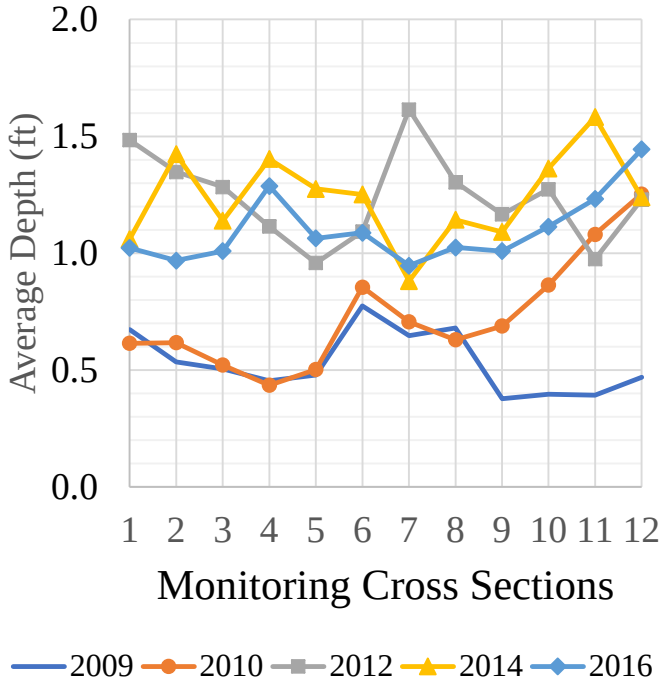


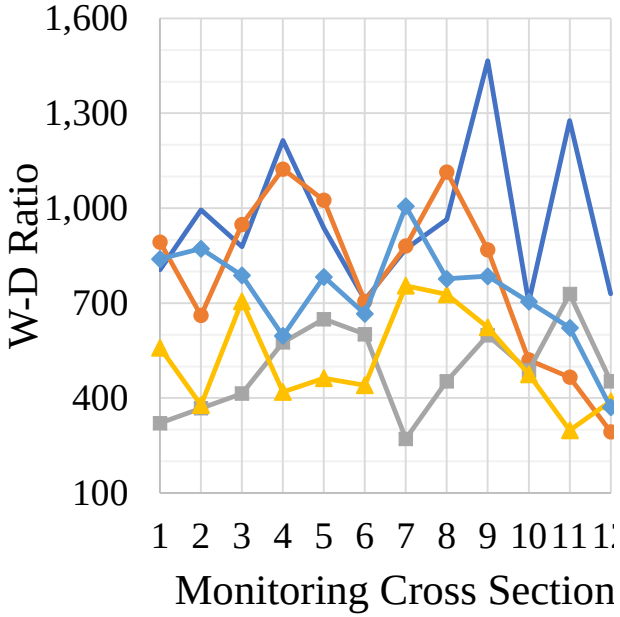
OTHER APPLICATIONS

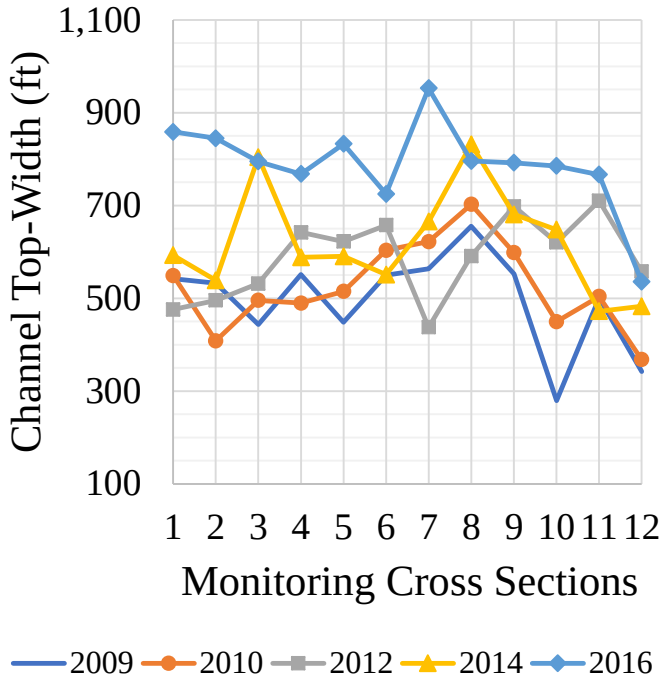
ELM CREEK



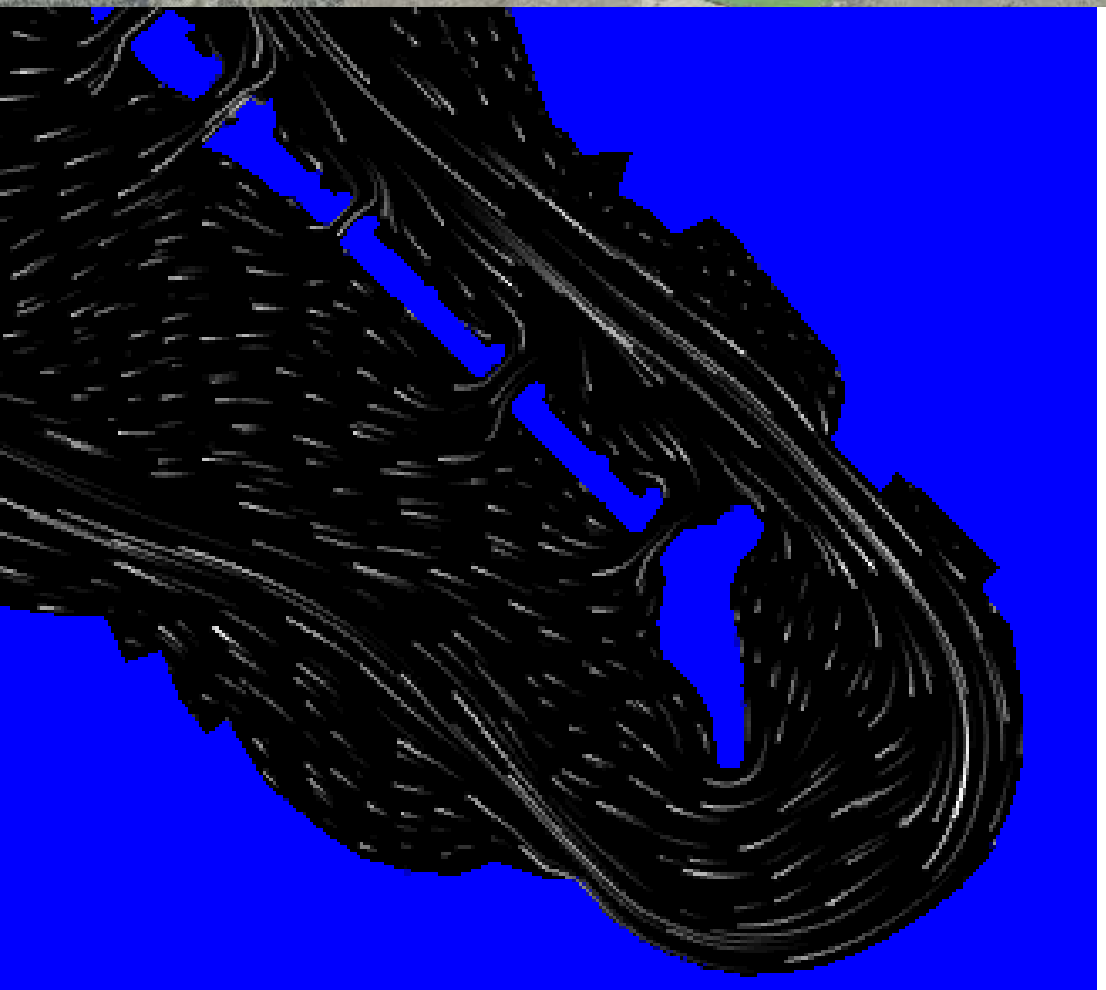


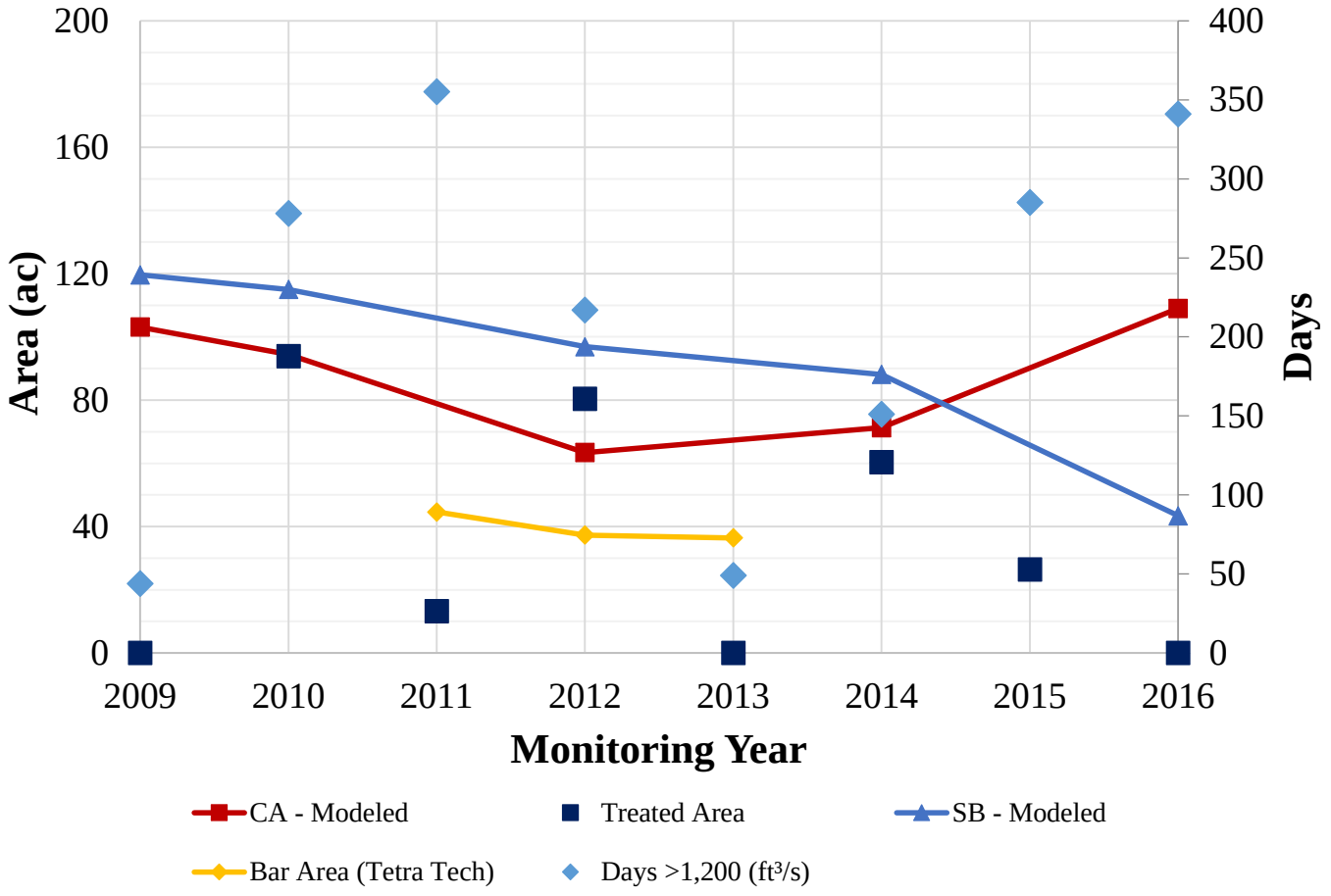






OTHER APPLICATIONS





OTHER APPLICATIONS

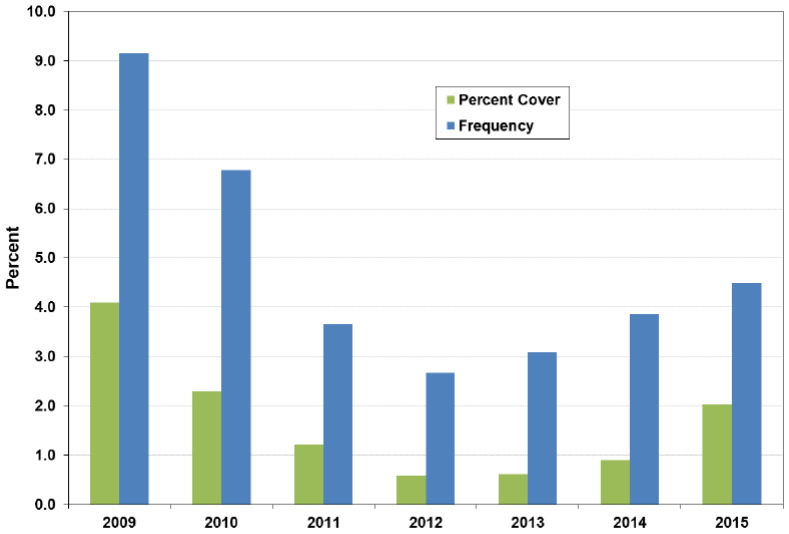
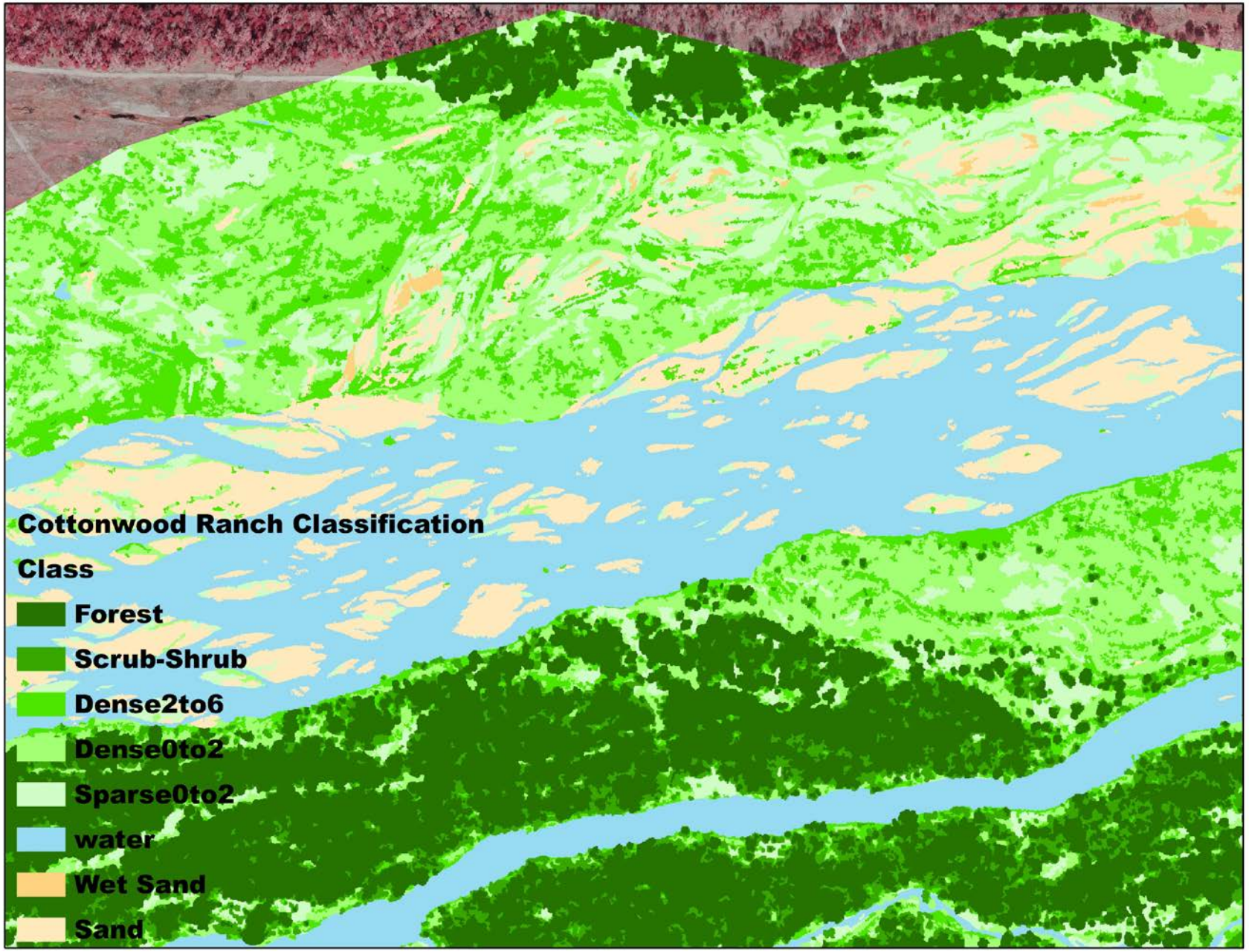
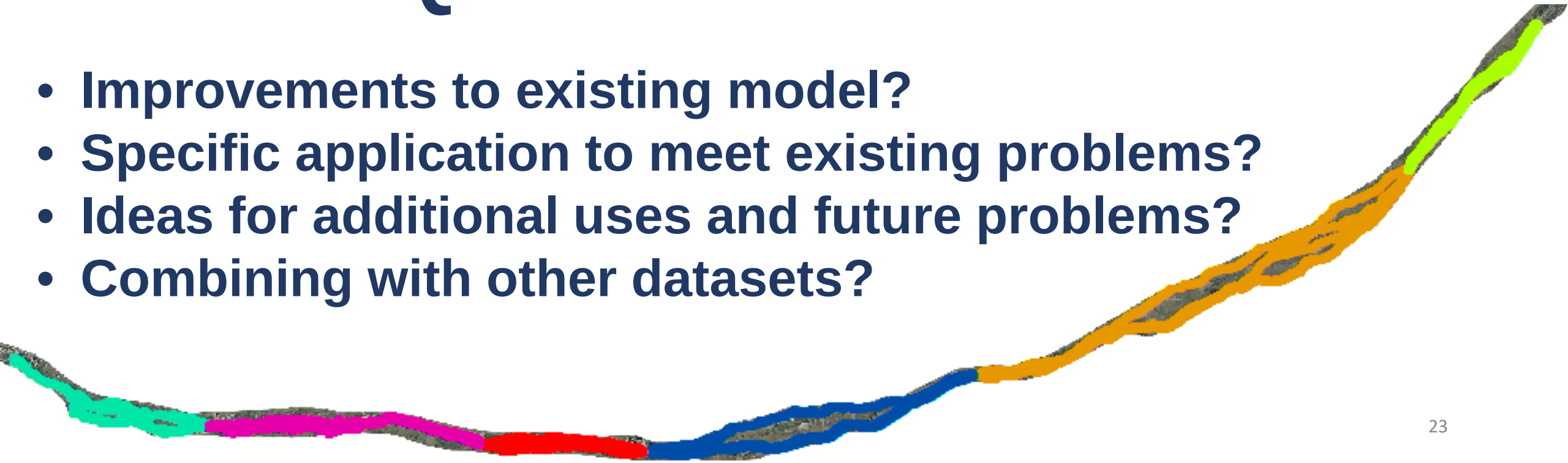


Figure 4.27. Average frequency of occurrence and percent cover for common reed (*Phragmites australis*) on a reach averaged basis observed during each of the six monitoring surveys.



QUESTIONS?

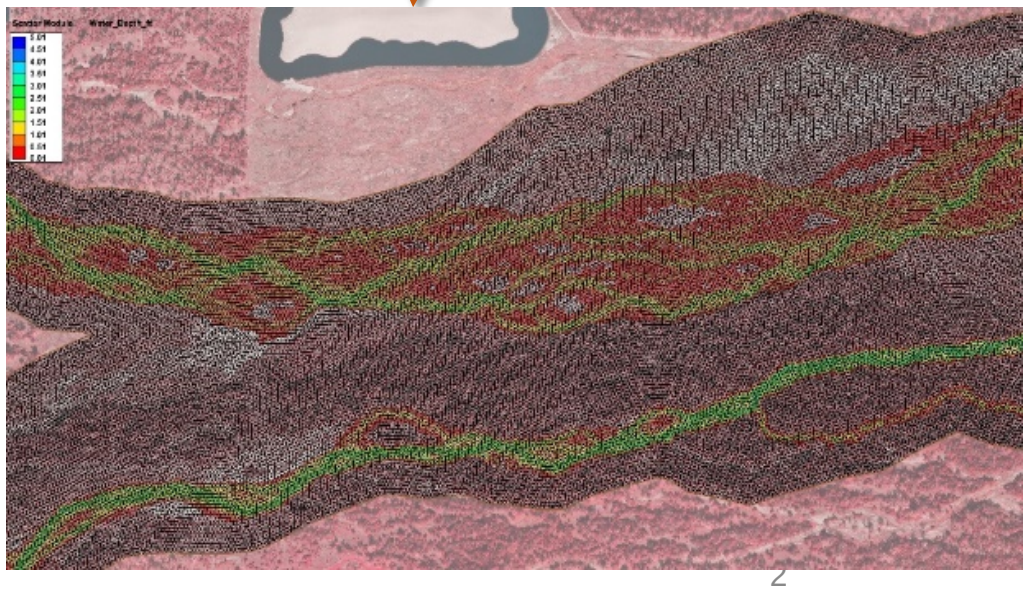
- Improvements to existing model?
- Specific application to meet existing problems?
- Ideas for additional uses and future problems?
- Combining with other datasets?



AMP Tools

Flow Scenario Tool
&
Operations Model

Release Feasibility Tools



Question to think about:

Level of complexity

Underlying hydrology

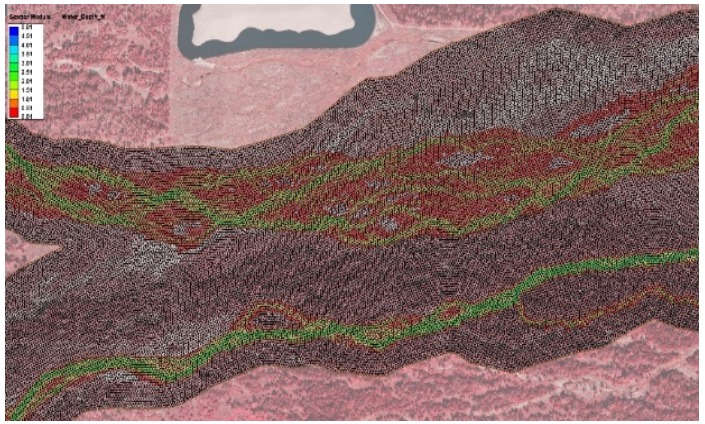
Scenarios

Losses

Scenario Tool

Why a Scenario Tool?

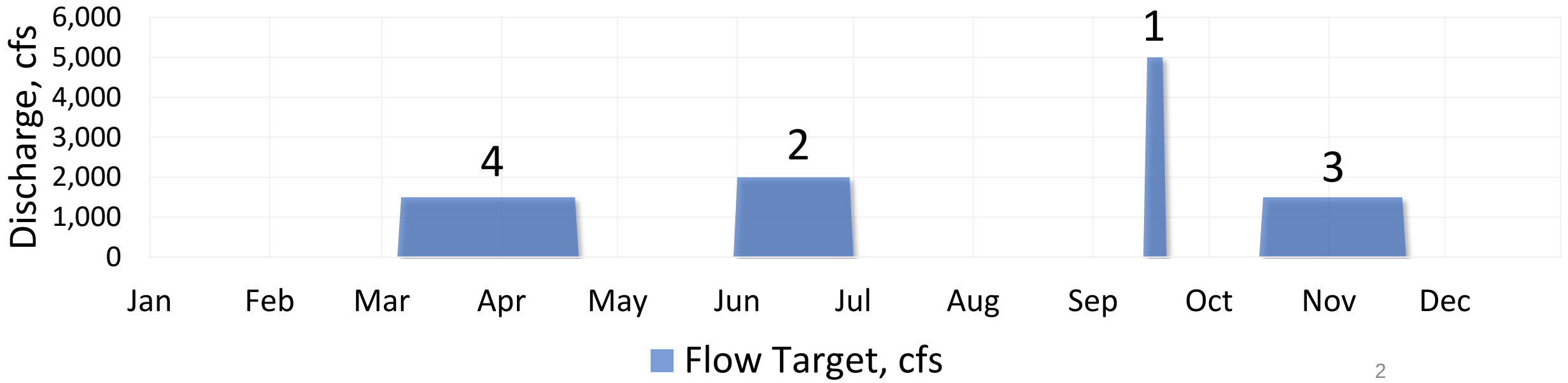
- Quantify EA water needed for a release
- Evaluate feasibility of a combination of releases



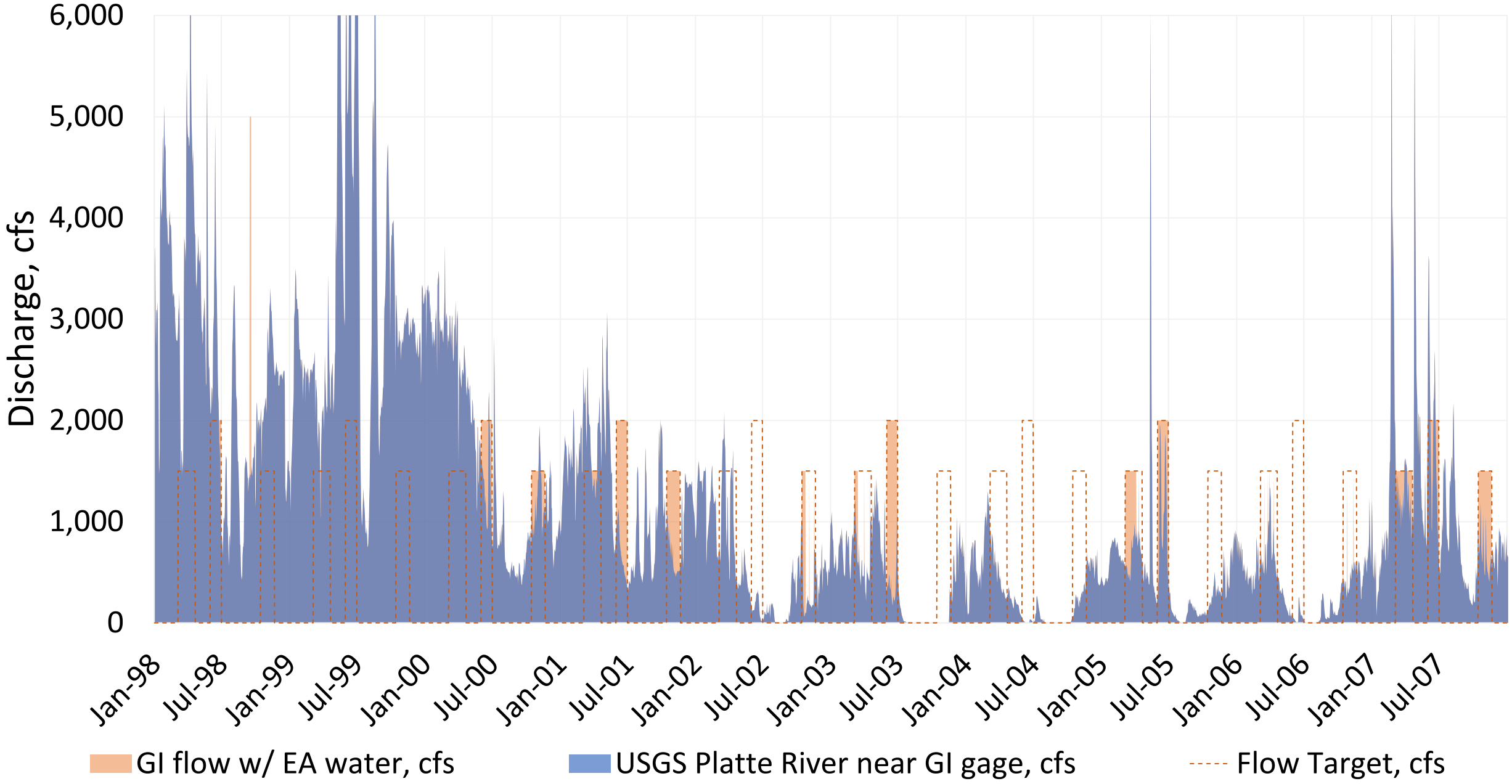
How does it work?

Example release logic:

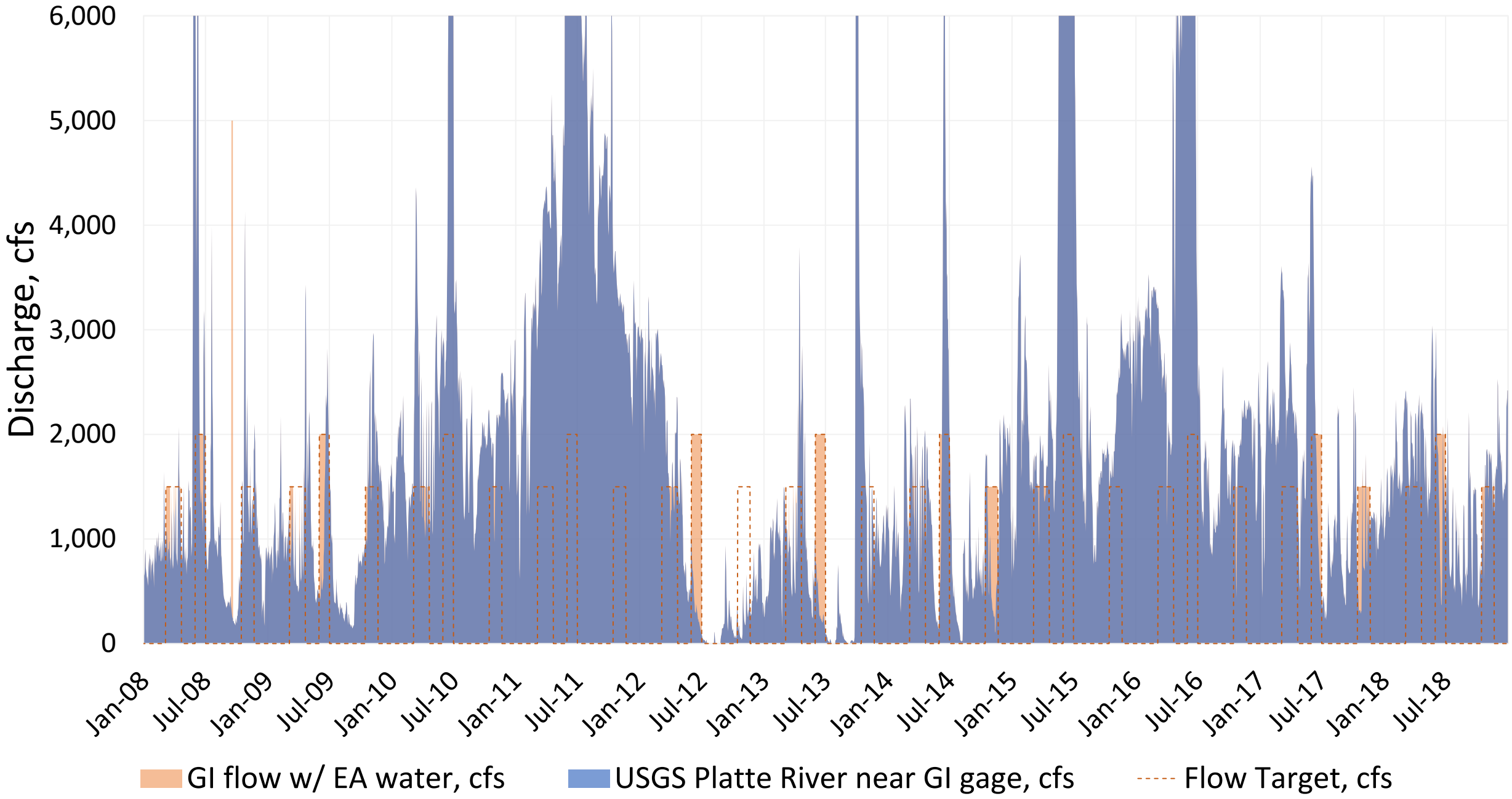
1. Make a SDHF release as soon as water is available
2. Reserve median volume for germination release
3. Make a fall WC release if extra water in fall
4. Make a spring WC release if extra water in spring



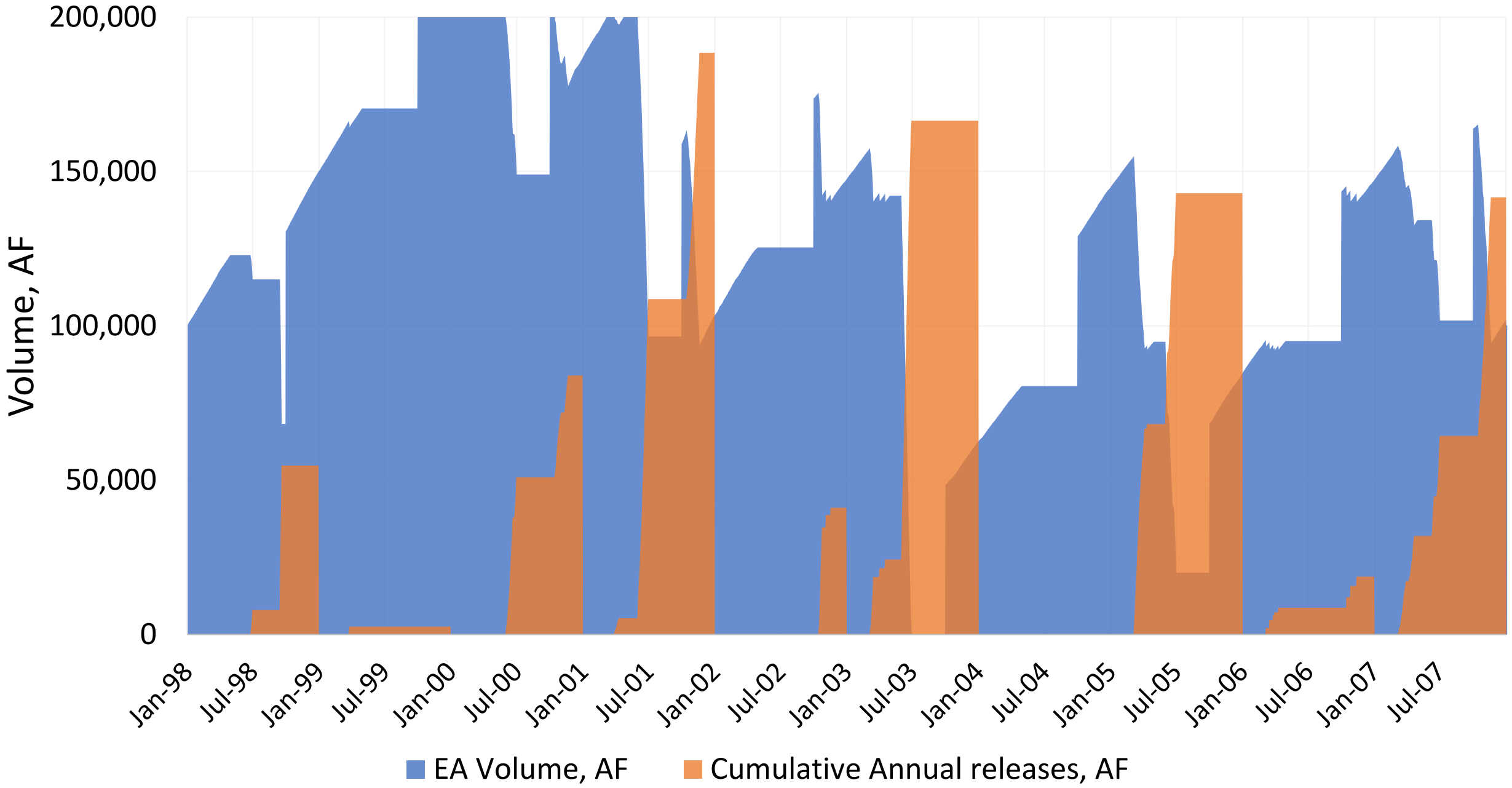
Results: 1998 to 2007



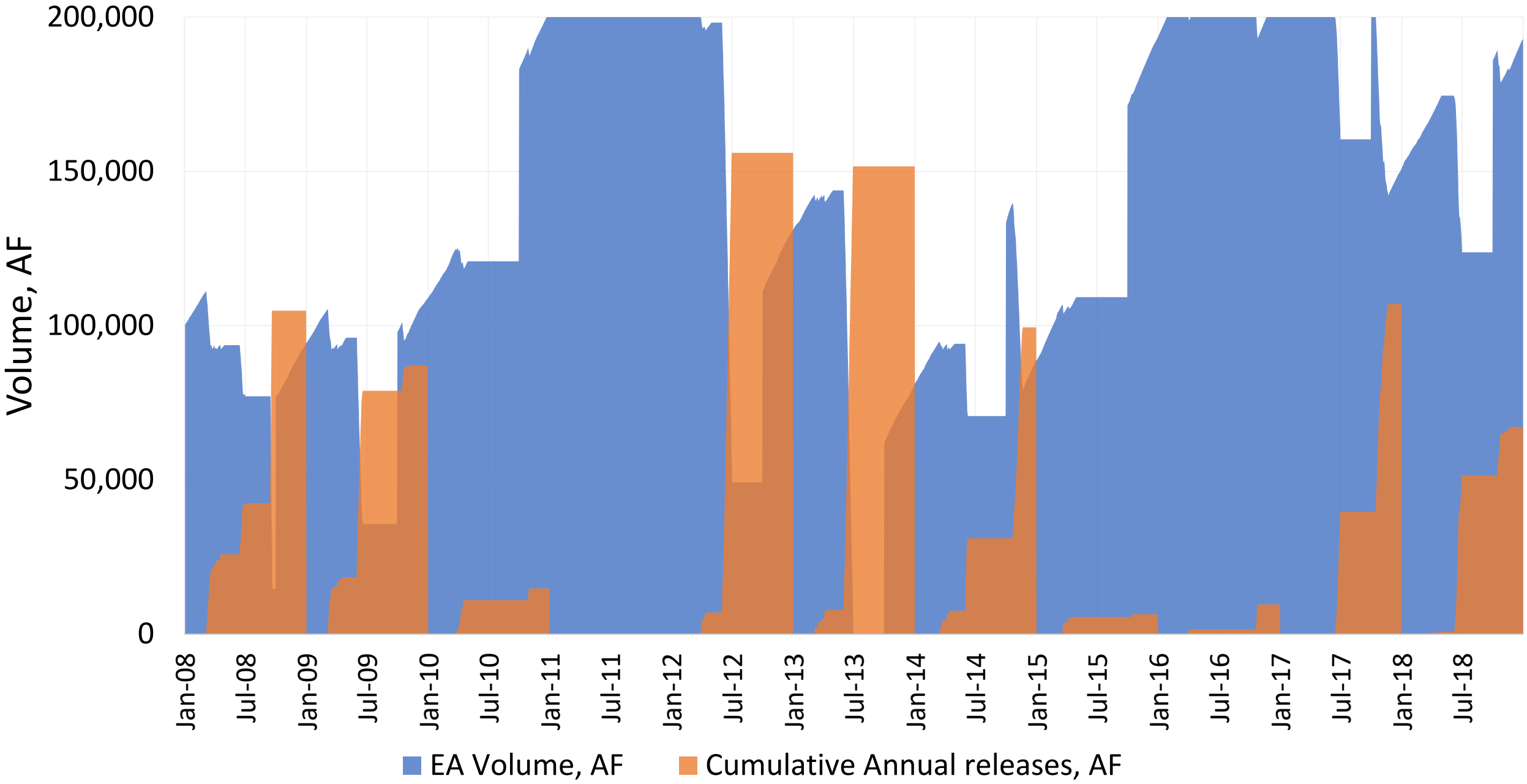
Results: 2008 to 2018



Results: 1998 to 2007

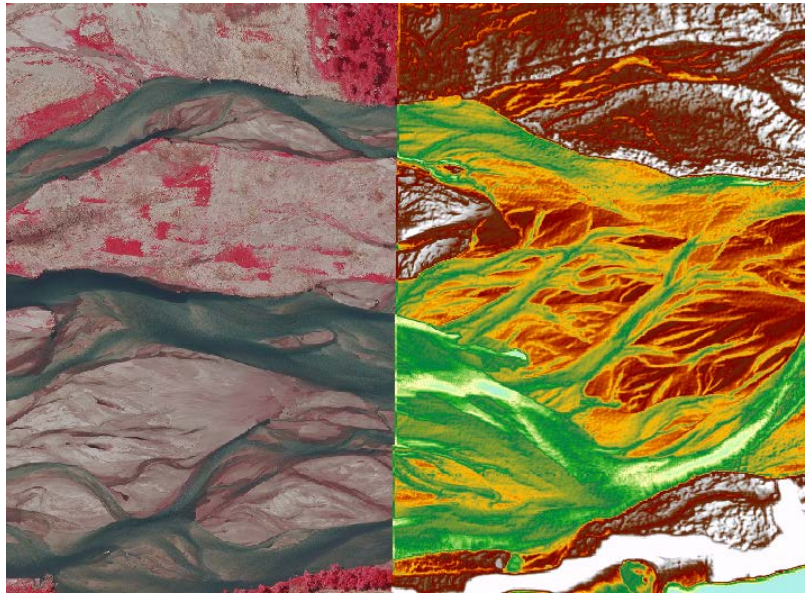


Results: 2008 to 2018

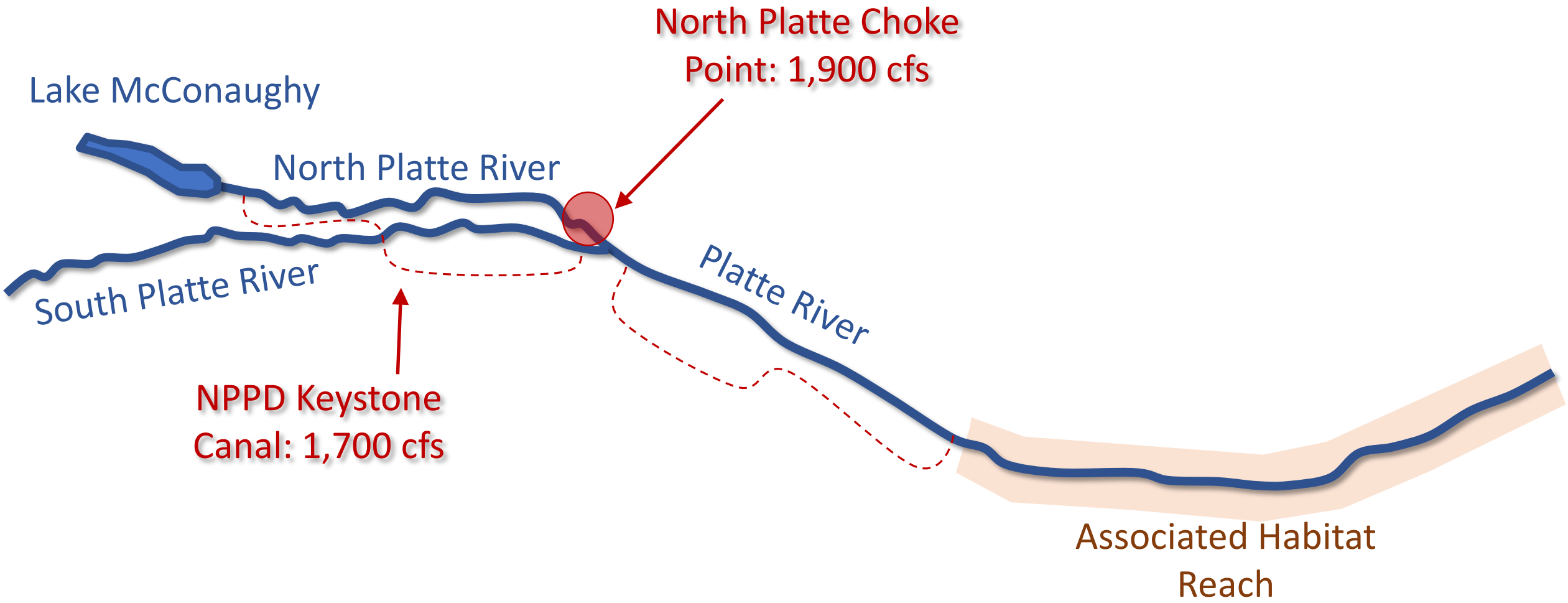


???

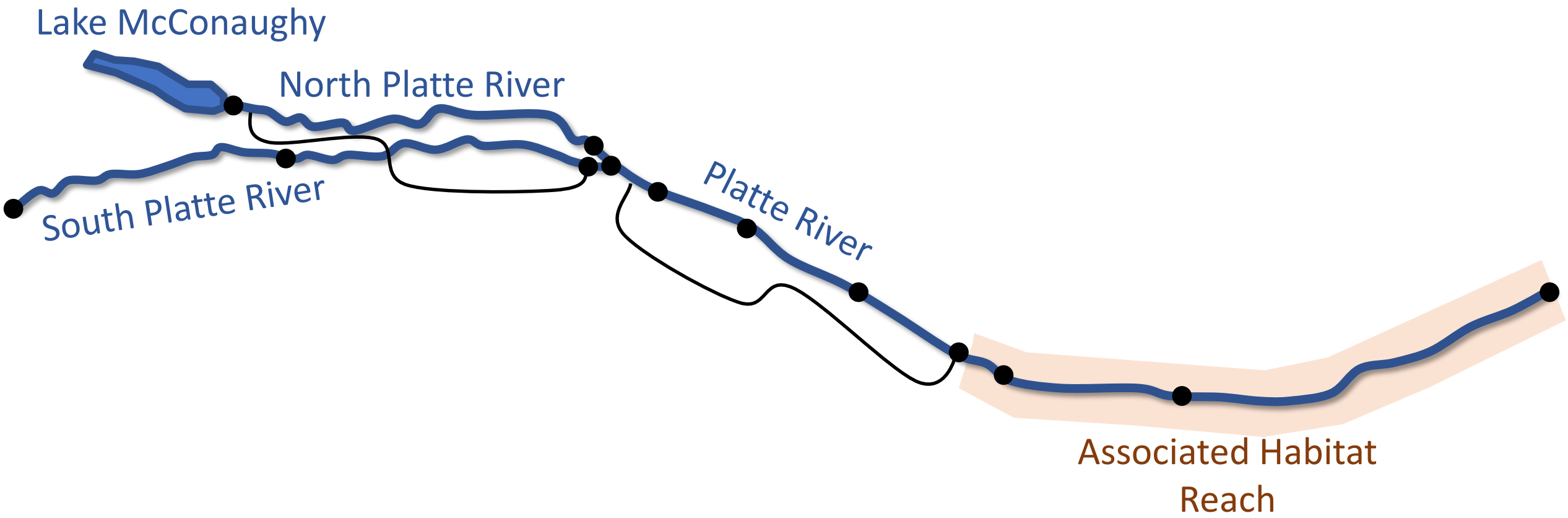
Why an operations model?



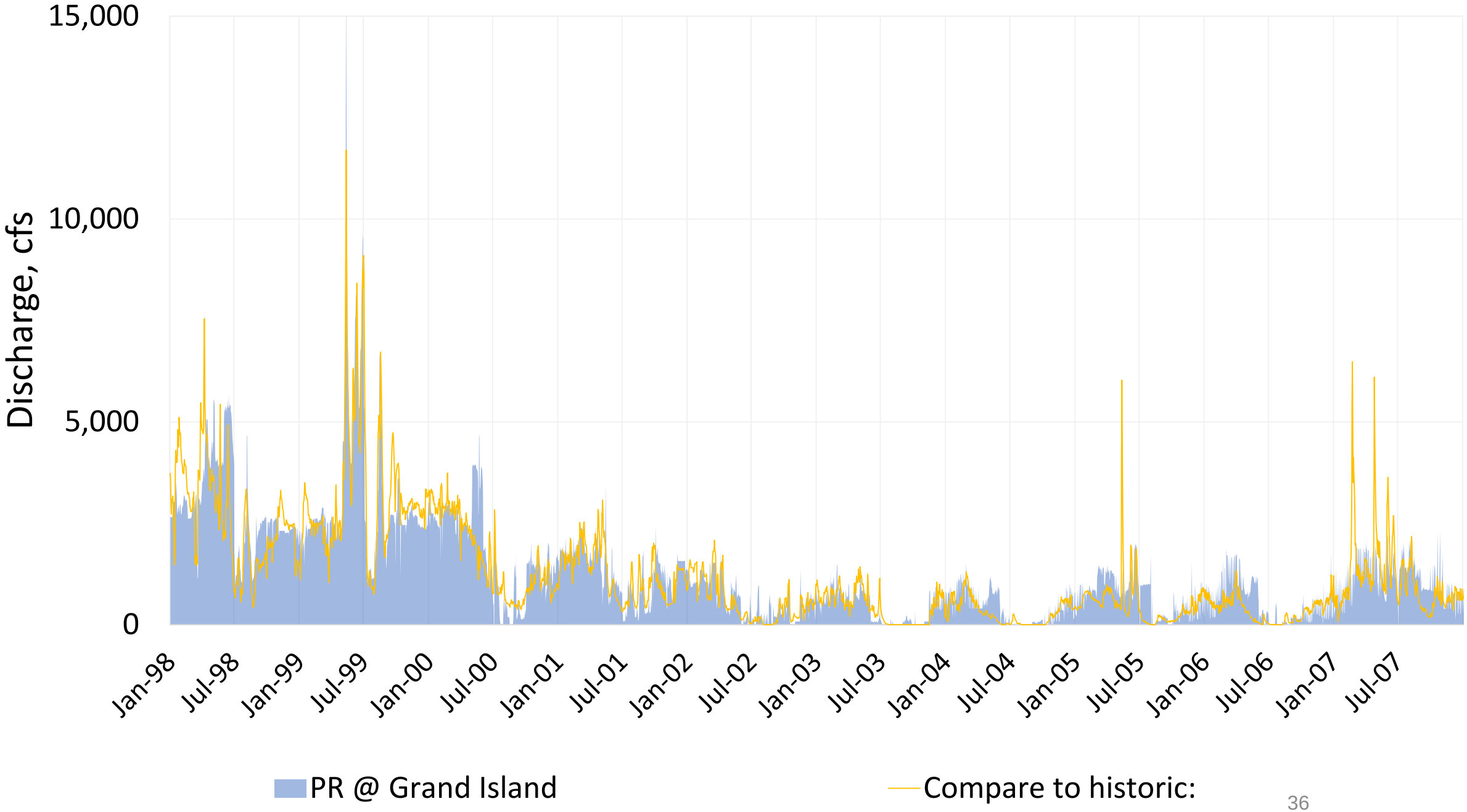
Capacity Constraints


North Platte Choke Point: 1,900 cfs
Lake McConaughy
North Platte River
South Platte River
Platte River
NPPD Keystone Canal: 1,700 cfs
Associated Habitat Reach

How does it work?



Results: 1998 to 2007



Scenario Tool vs. Operations Model

Question to think about:

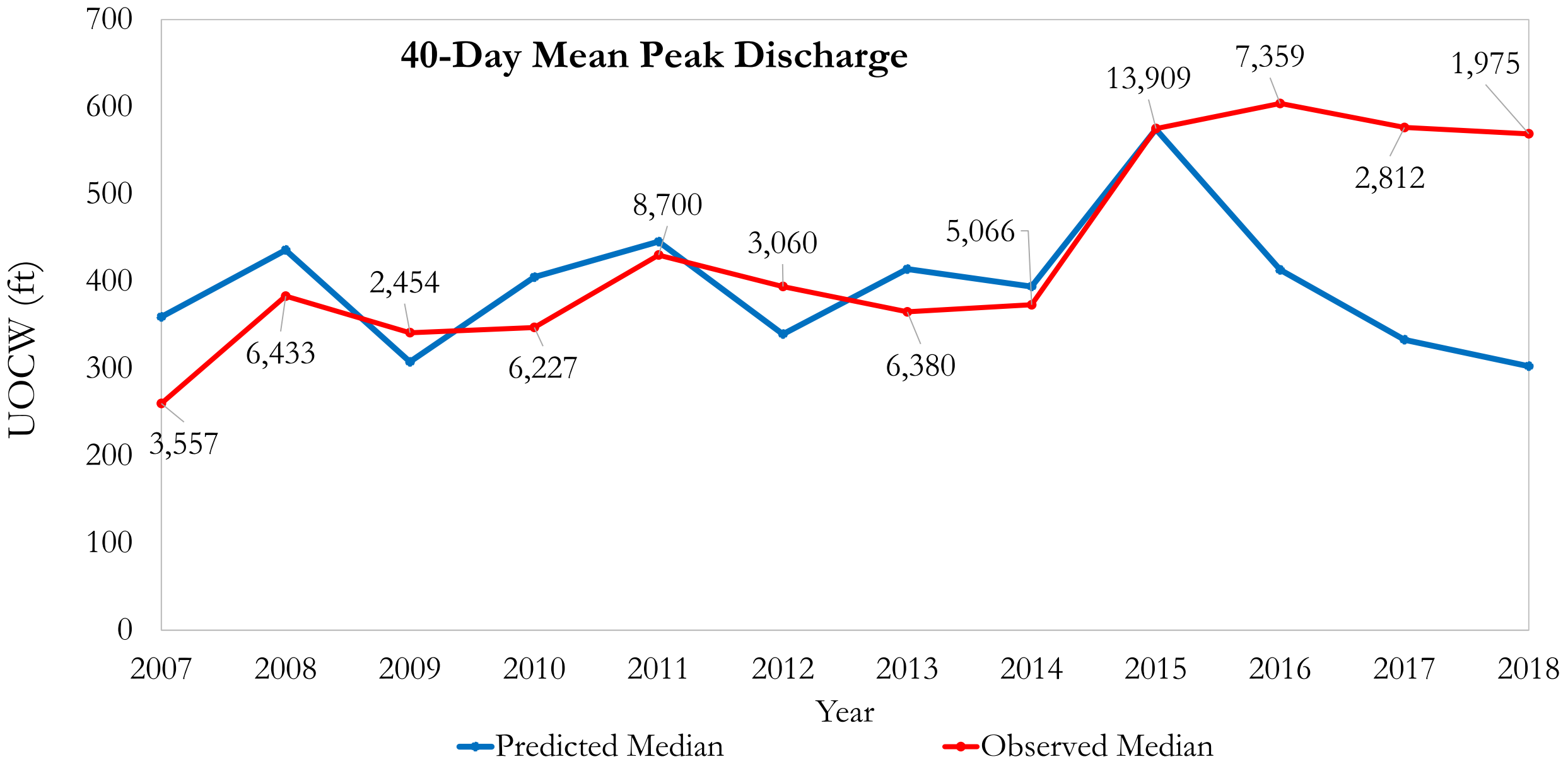
Level of complexity

Underlying hydrology

Scenarios

Losses

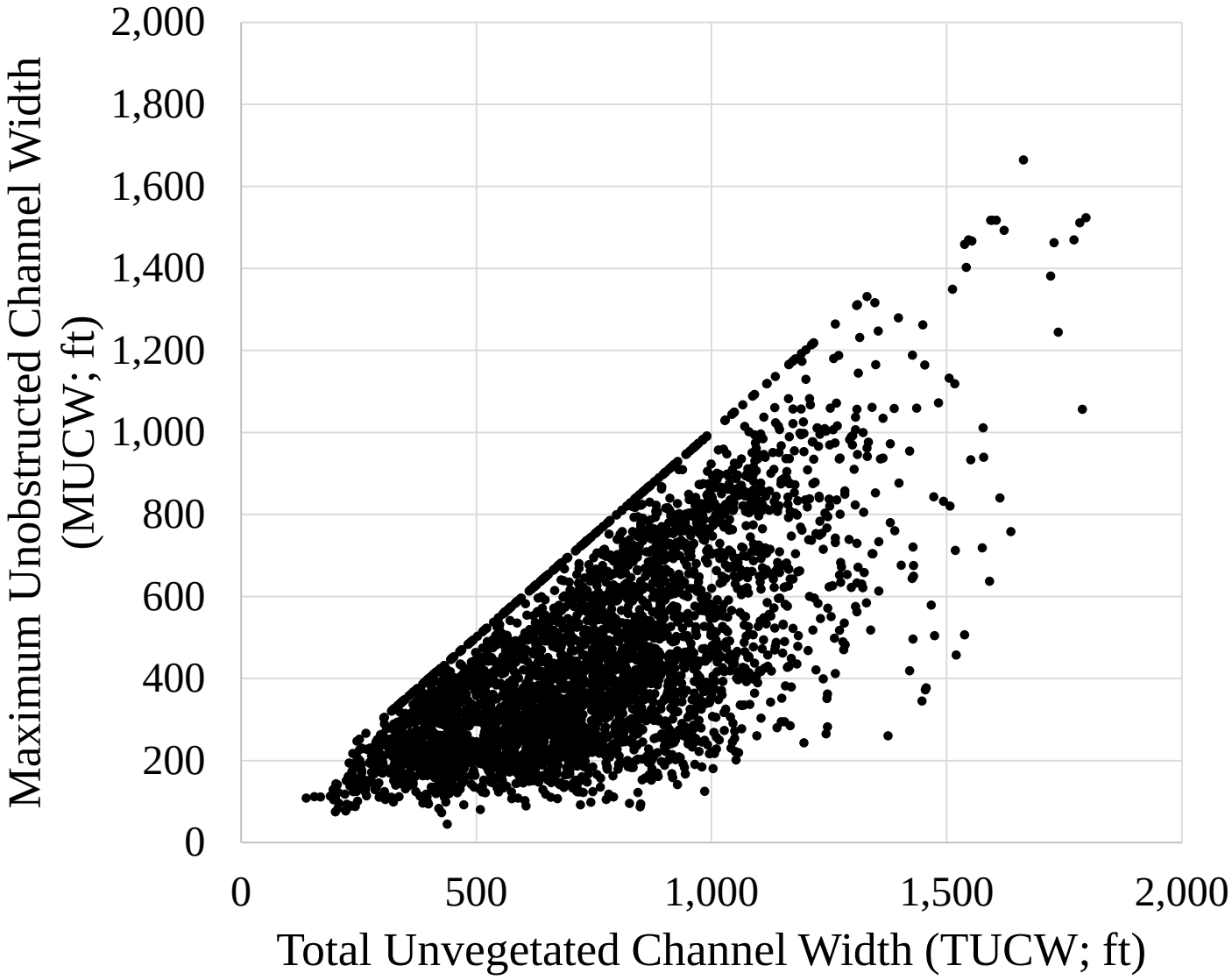
Decision Tree Model


40-Day Mean Peak Discharge
UOCW (ft)
700
600
500
400
300
200
100
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
3,557
6,433
2,454
6,227
8,700
3,060
6,380
5,066
13,909
7,359
2,812
1,975
Predicted Median
Observed Median

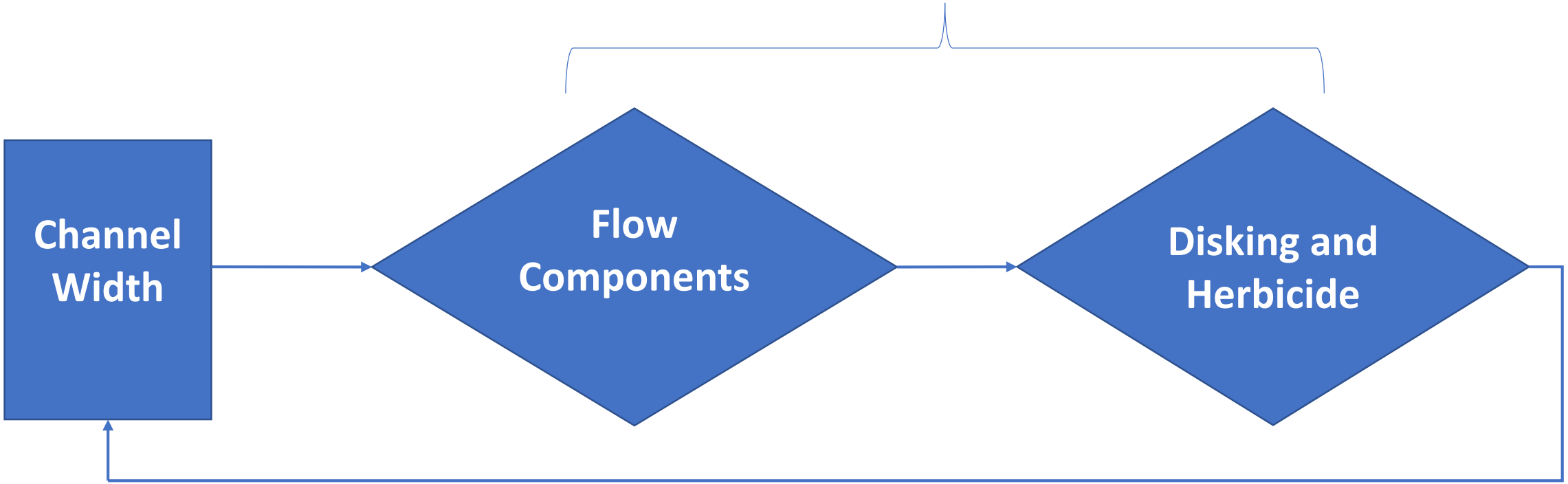
River Process

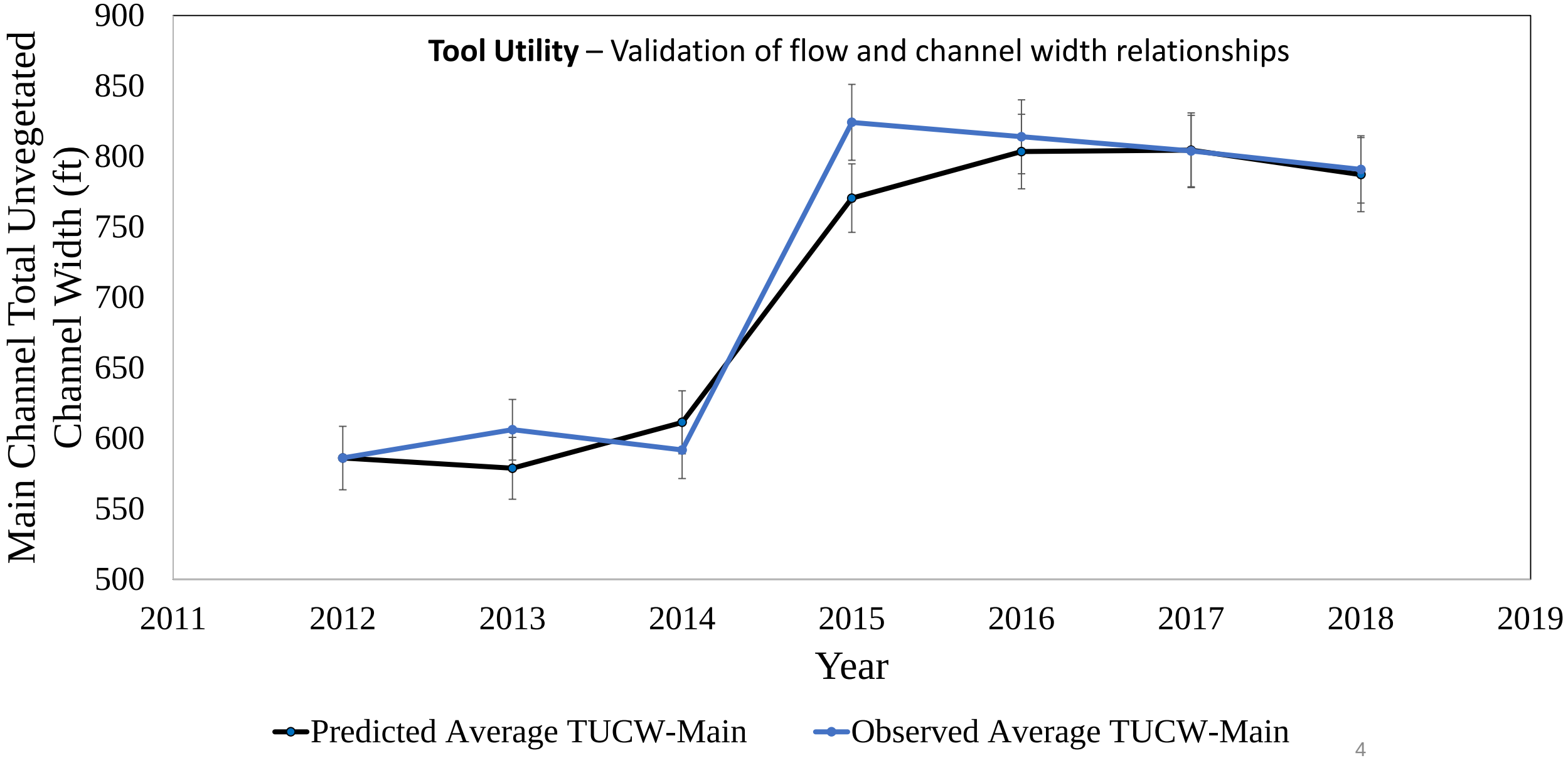
- Total Unobstructed Channel Width
- Main Channel Total Unobstructed Channel Width
- Maximum Unobstructed Channel Width

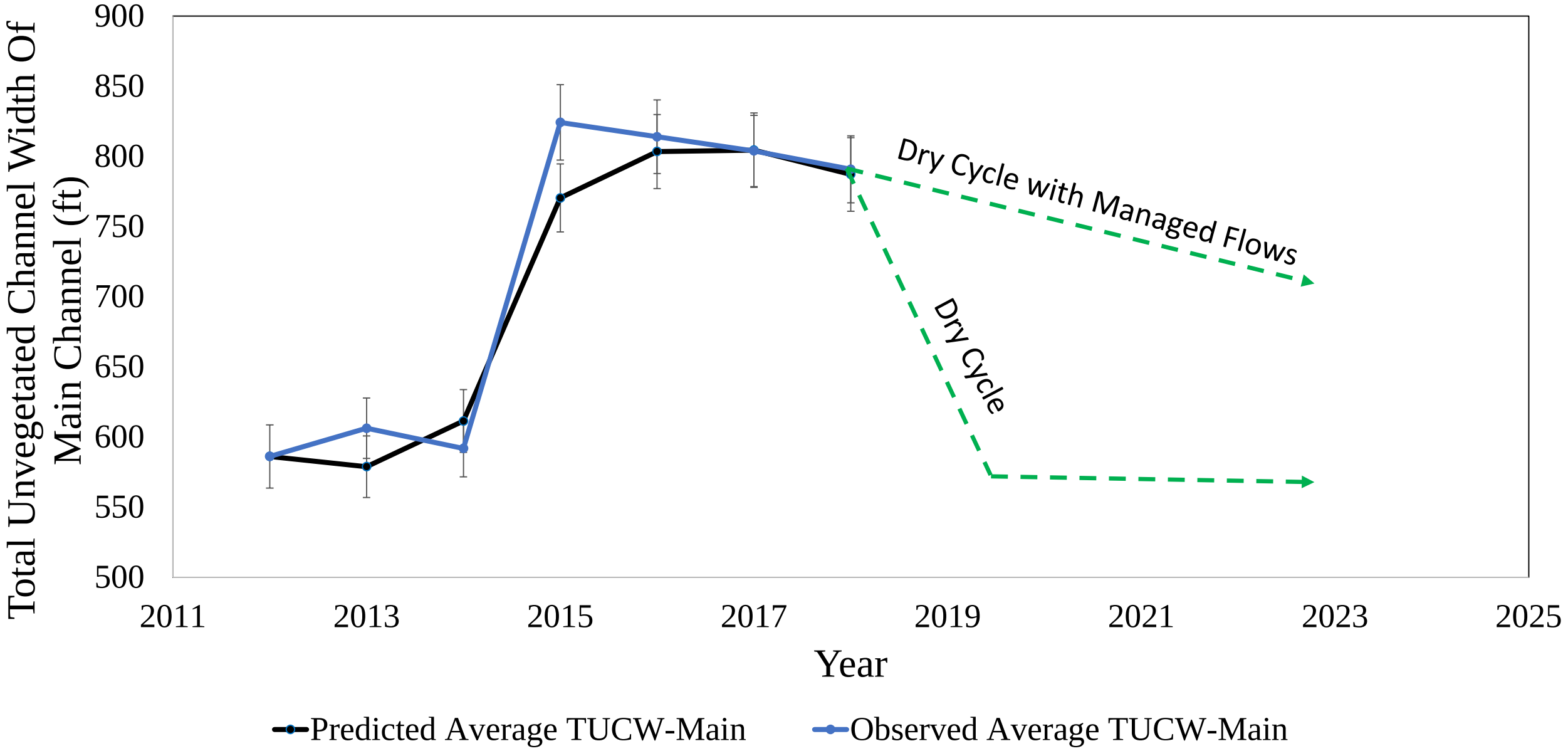
Habitat Metric



Determines annual changes in TUCW-Main

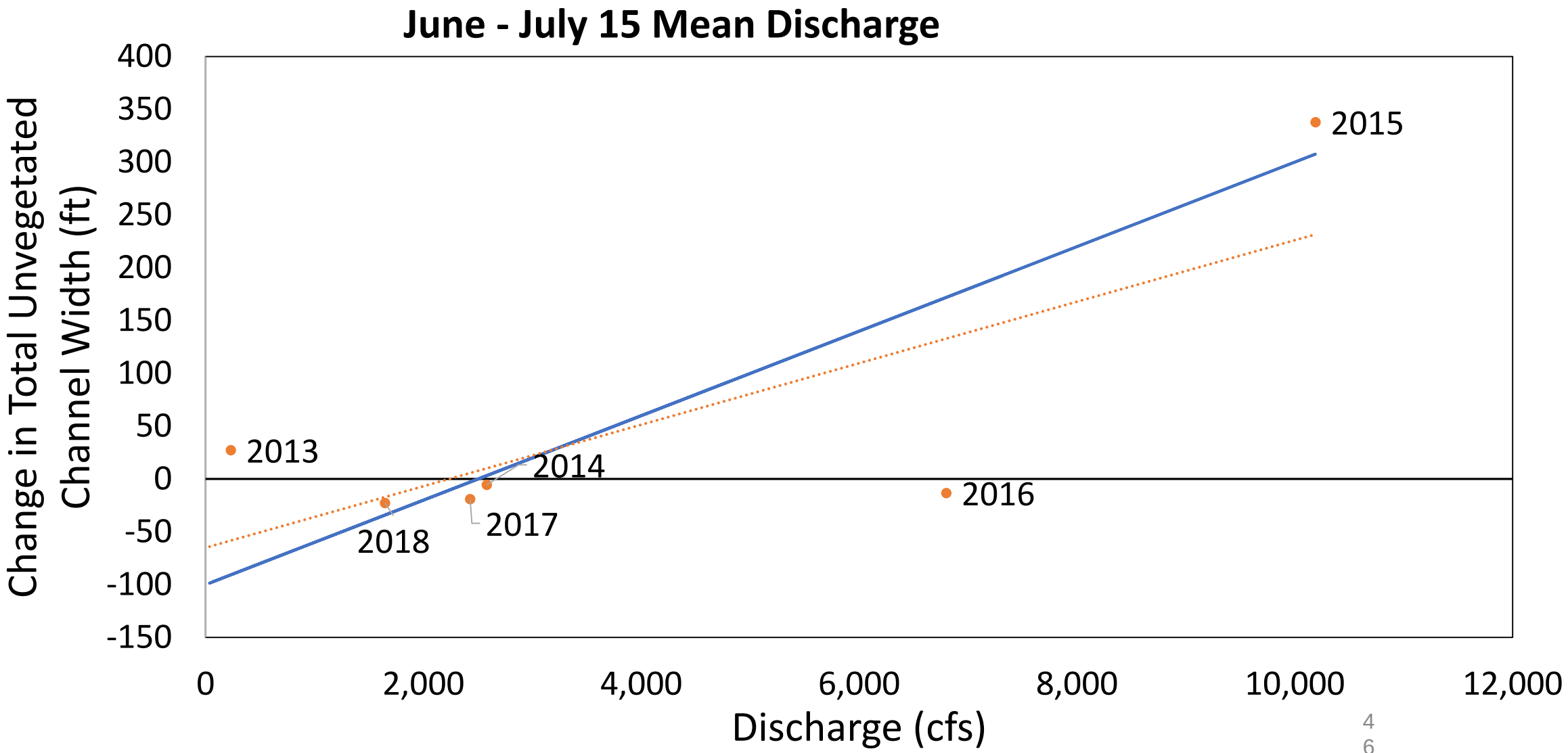



Tool Utility – Validation of flow and channel width relationships
Main Channel Total Unvegetated Channel Width (ft)
900
850
800
750
700
650
600
550
500
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year
Predicted Average TUCW-Main
Observed Average TUCW-Main

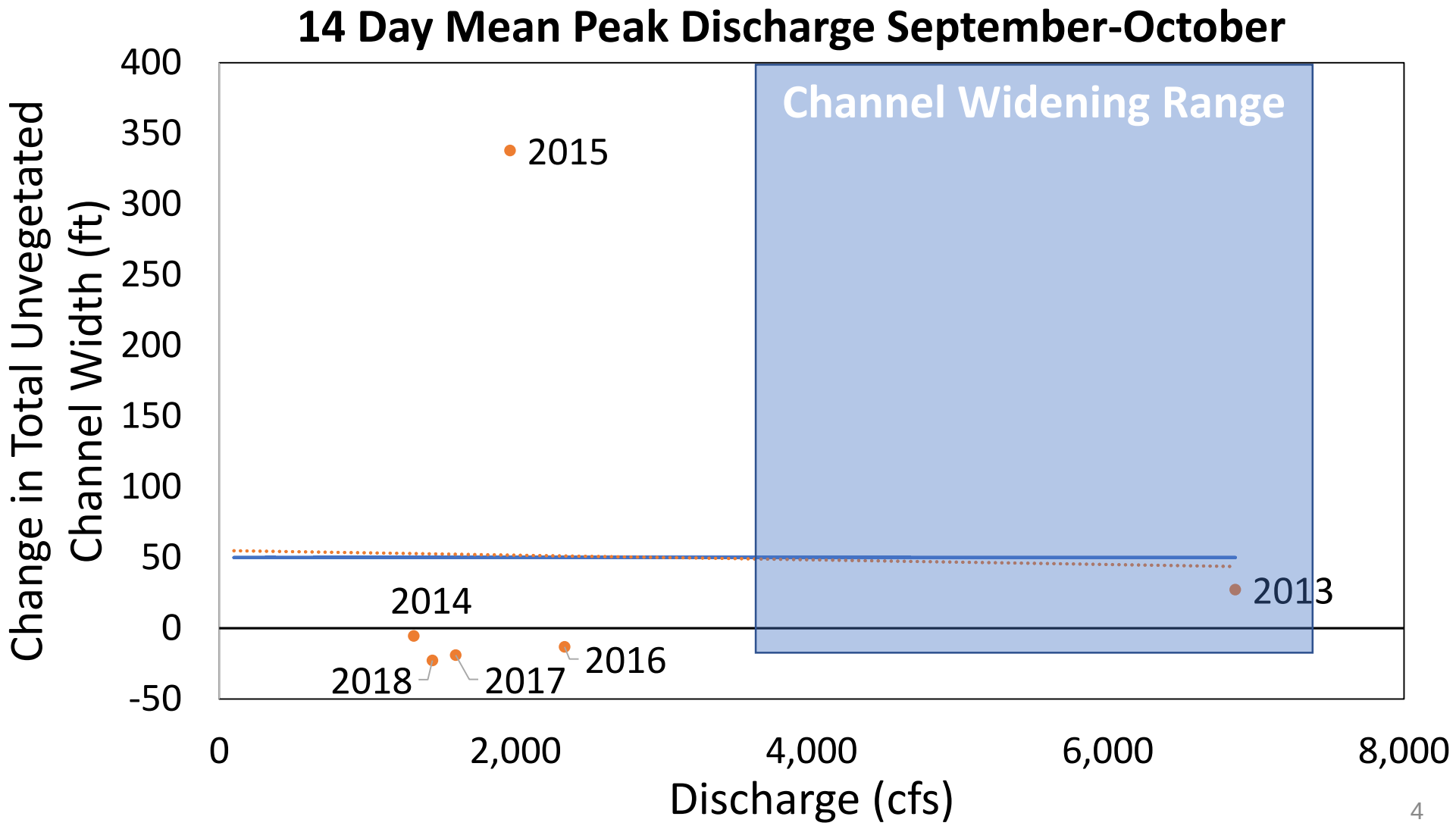

Total Unvegetated Channel Width Of Main Channel (ft)
900
850
800
750
700
650
600
550
500
2011
2013
2015
2017
2019
2021
2023
2025
Year
Dry Cycle with Managed Flows
Dry Cycle
Predicted Average TUCW-Main
Observed Average TUCW-Main

Inputs – Starting Year Total Unvegetated Channel Width (TUCW) and Main Channel Total Unvegetated Channel Width (TUCW-Main)

Inputs – Flow Component: Germination Season Flows



Inputs – Flow Component: Fall Peak Flows



Inputs – Herbicide (Systematic)

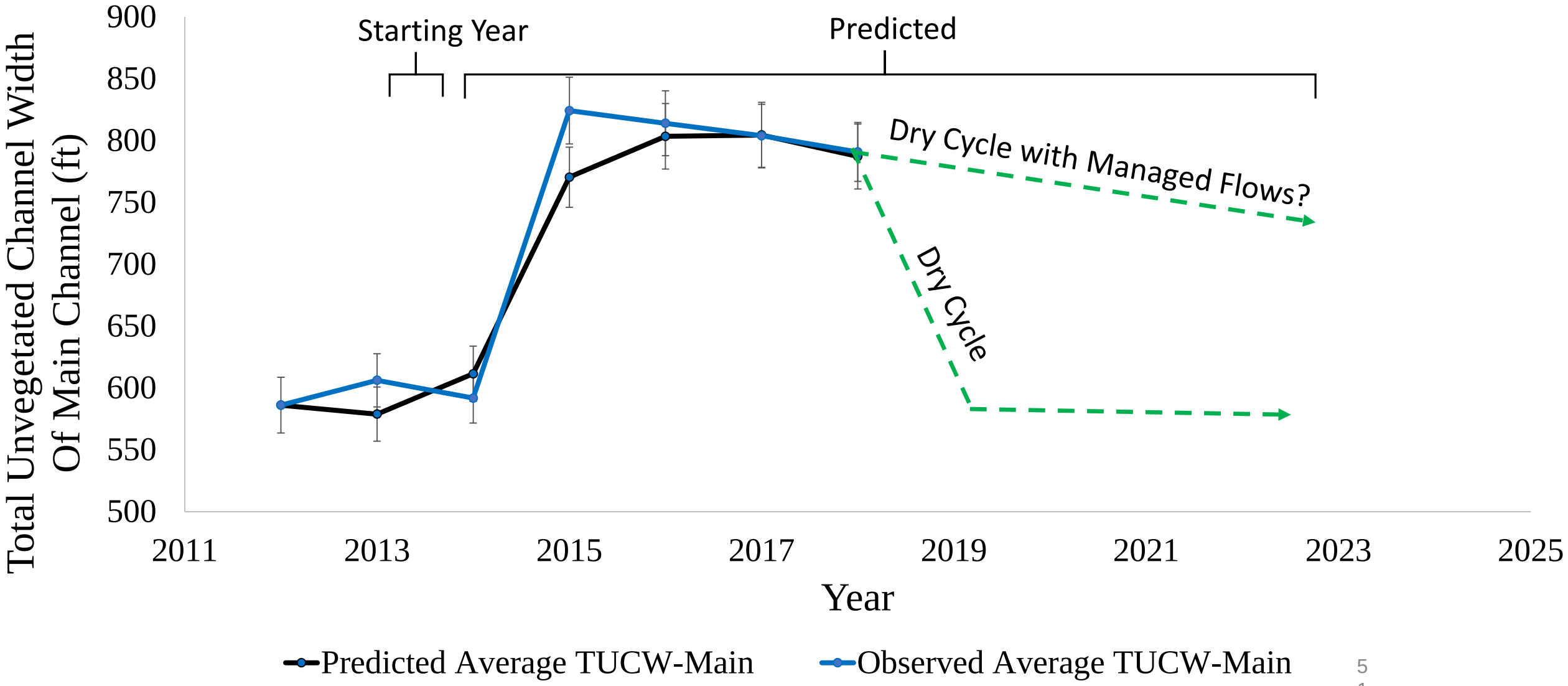
Without

With

Inputs – Disking (Transect-Specific)

N
TUCW-Main – Width limits
Maximum = Main channel total channel width (White)
Minimum = 300 ft
RM 199

Output – Predicted Main Channel Total Unvegetated Channel Width (TUCW-Main)



Possible Improvements

- More robust regression relationship
  - Non-linear relationships
- More specific minimum channel width constraints
- Winter flow consideration
- Other mechanical channel activities included (woody vegetation removal)

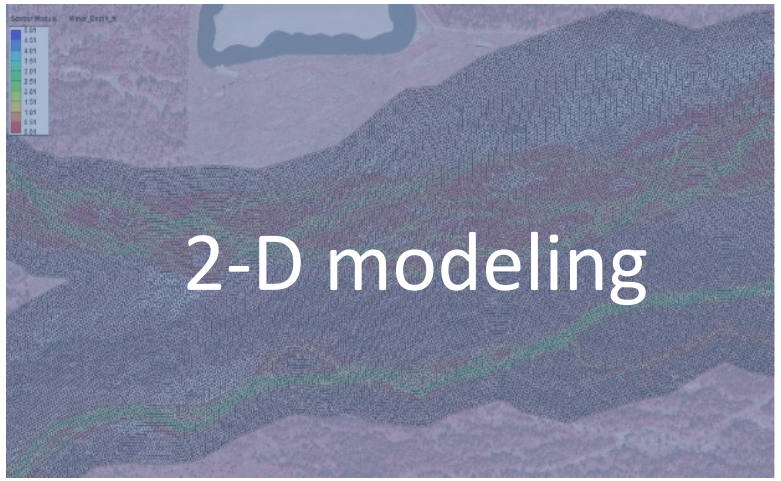
Decision Tree Model Uncertainties

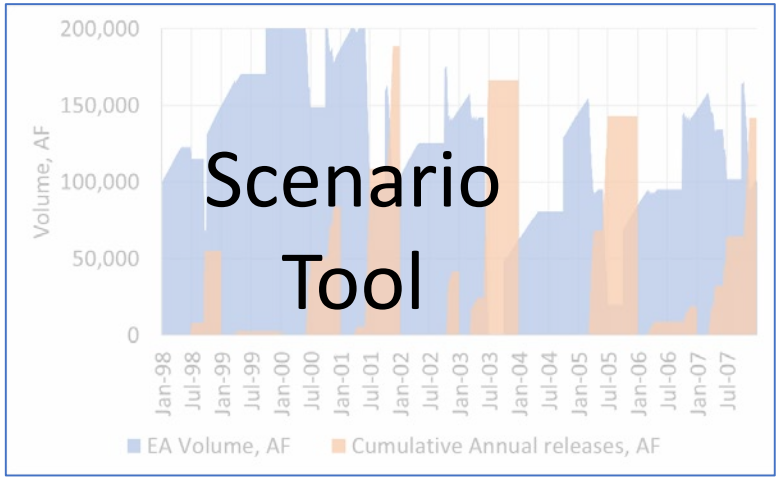
- Are current model assumptions appropriate?
- What other physical processes would increase predictability?
- Are we capturing flow/channel widths relationships appropriately (functional form, etc.)?
- Should wet/dry cycles have different flow/channel width relationships?
- How to integrate direct measures of channel suitability for whooping cranes (maximum unobstructed channel width)?

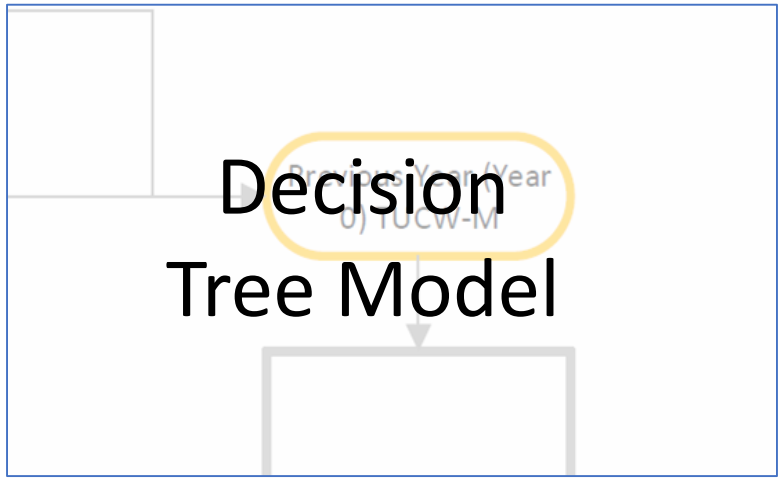
AMP Tools

Example

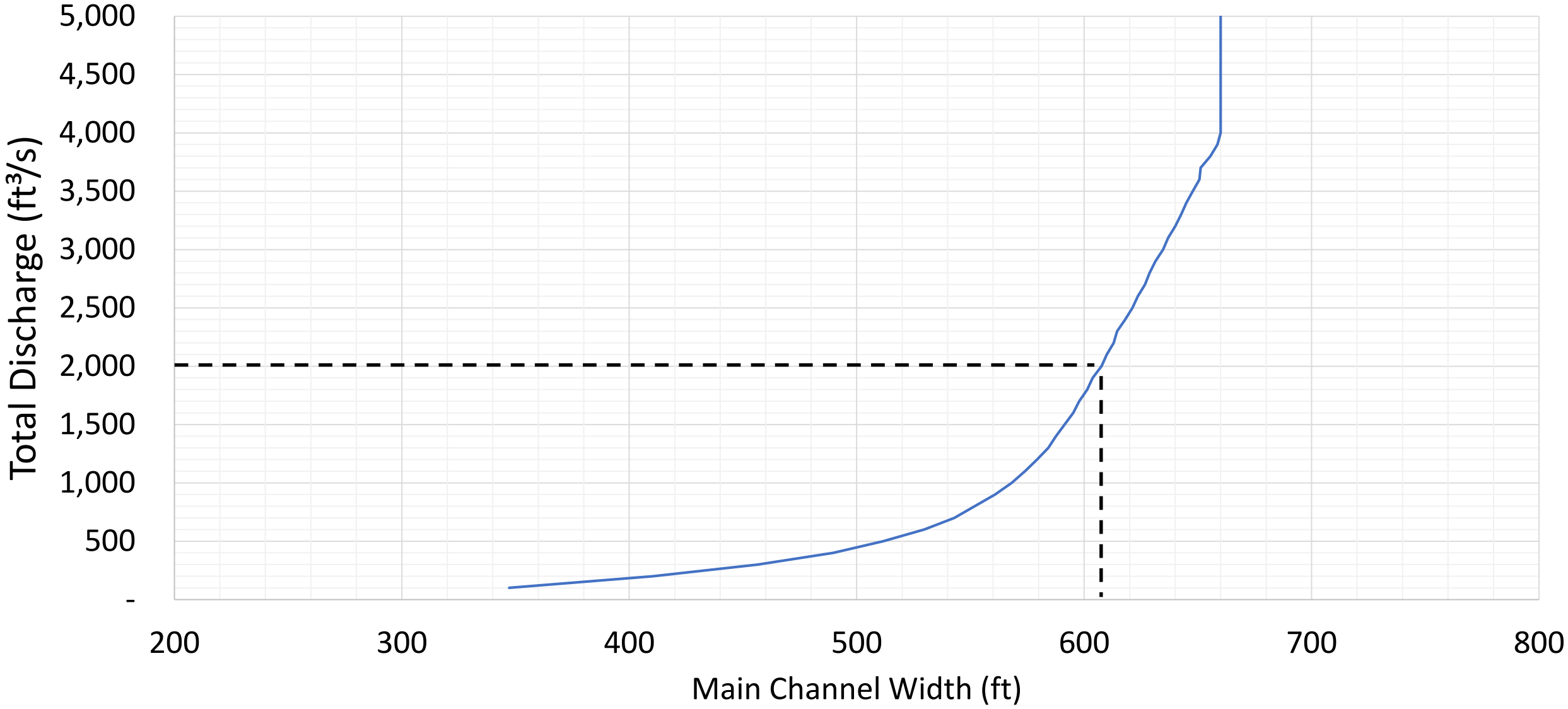
Program Example – Germination season and fall peak flows for channel width maintenance

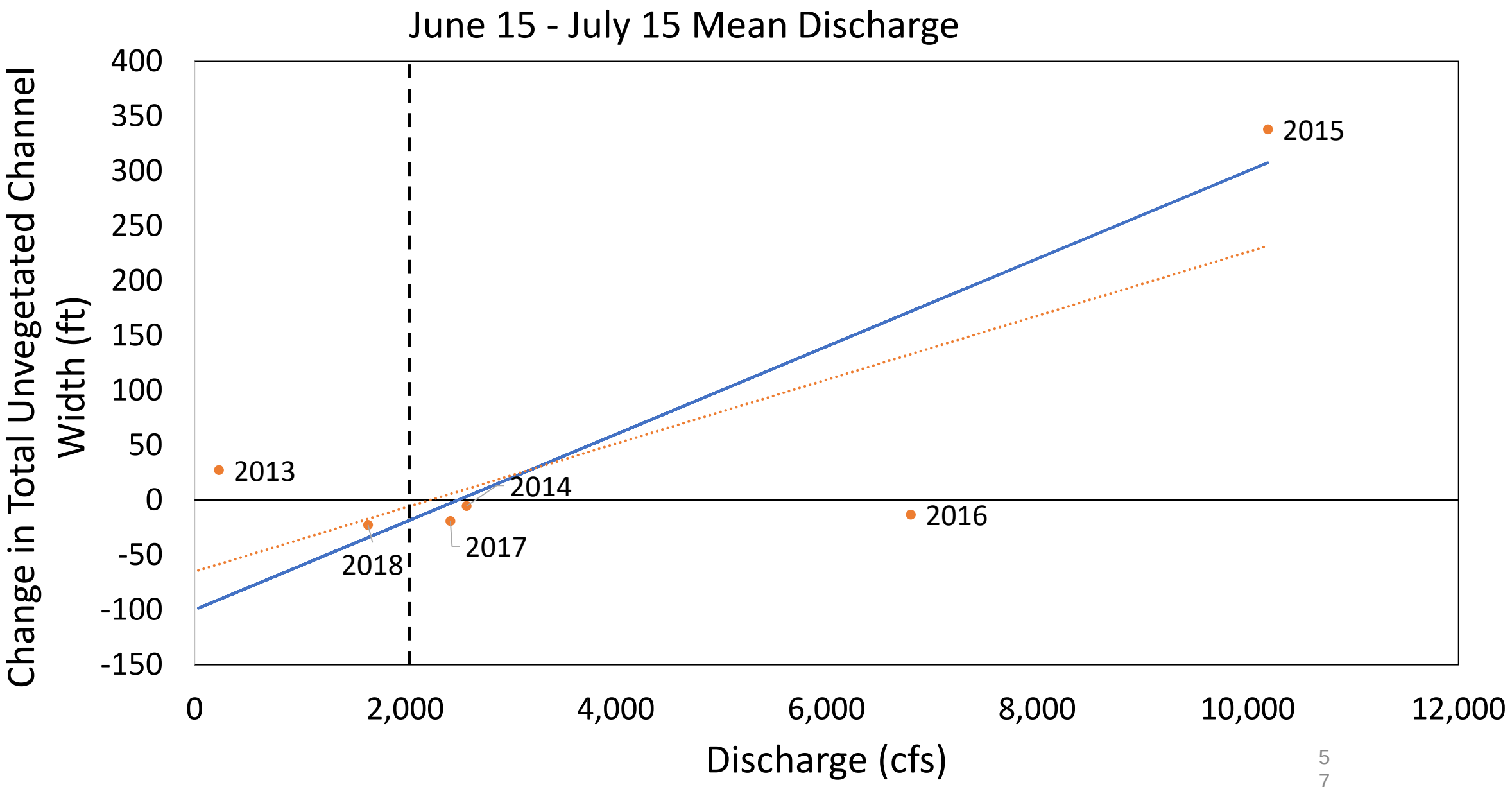


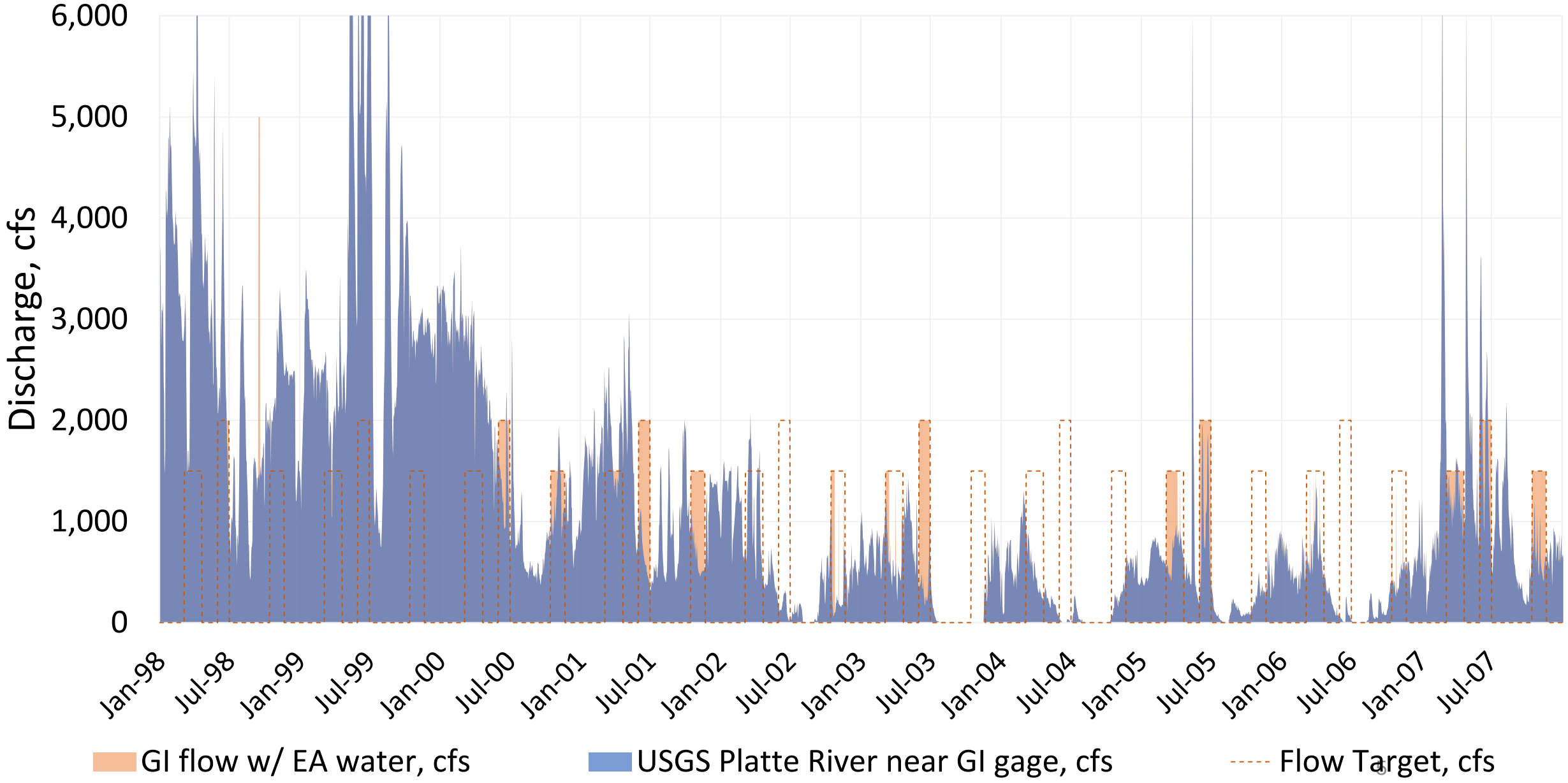


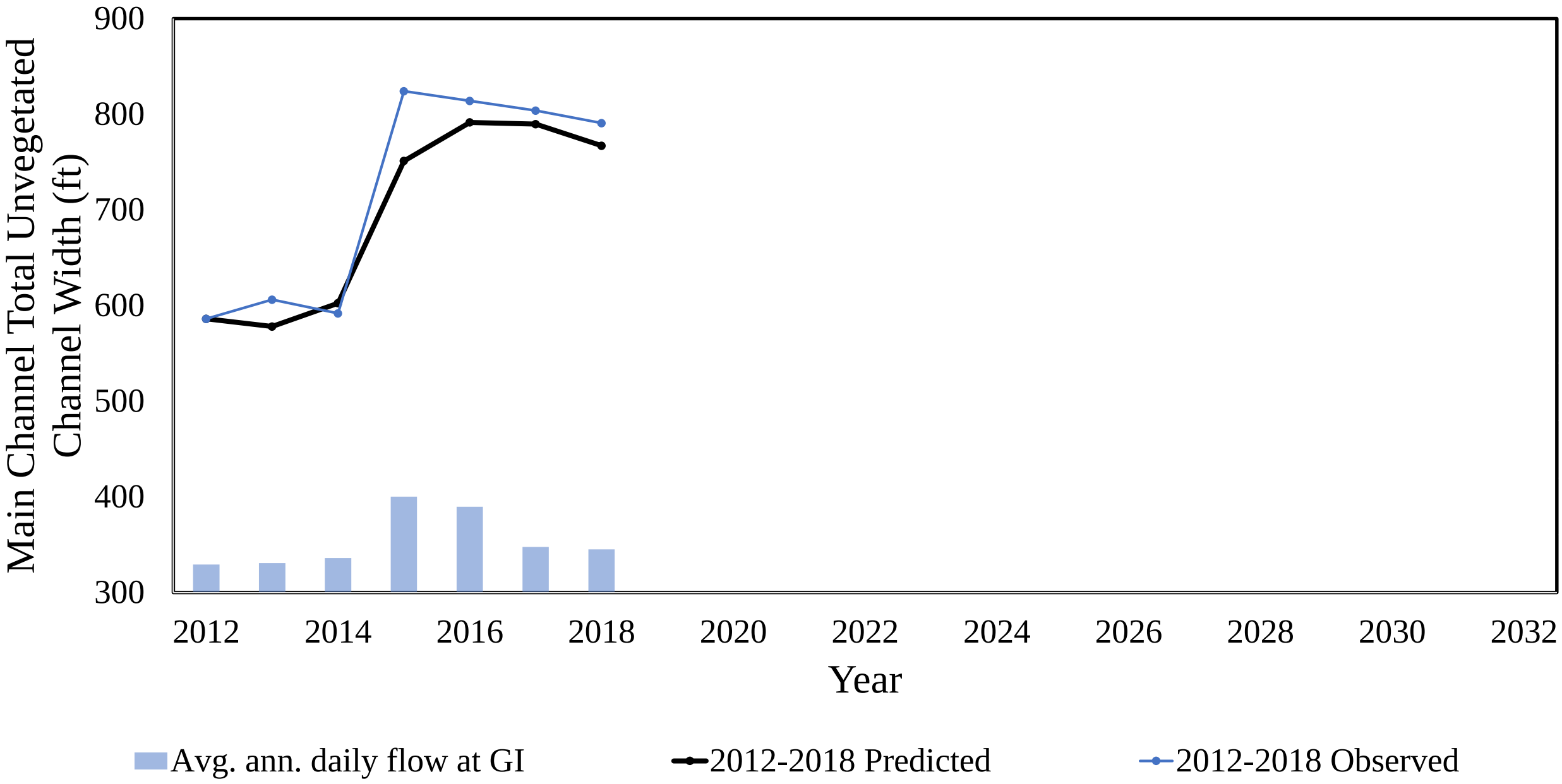


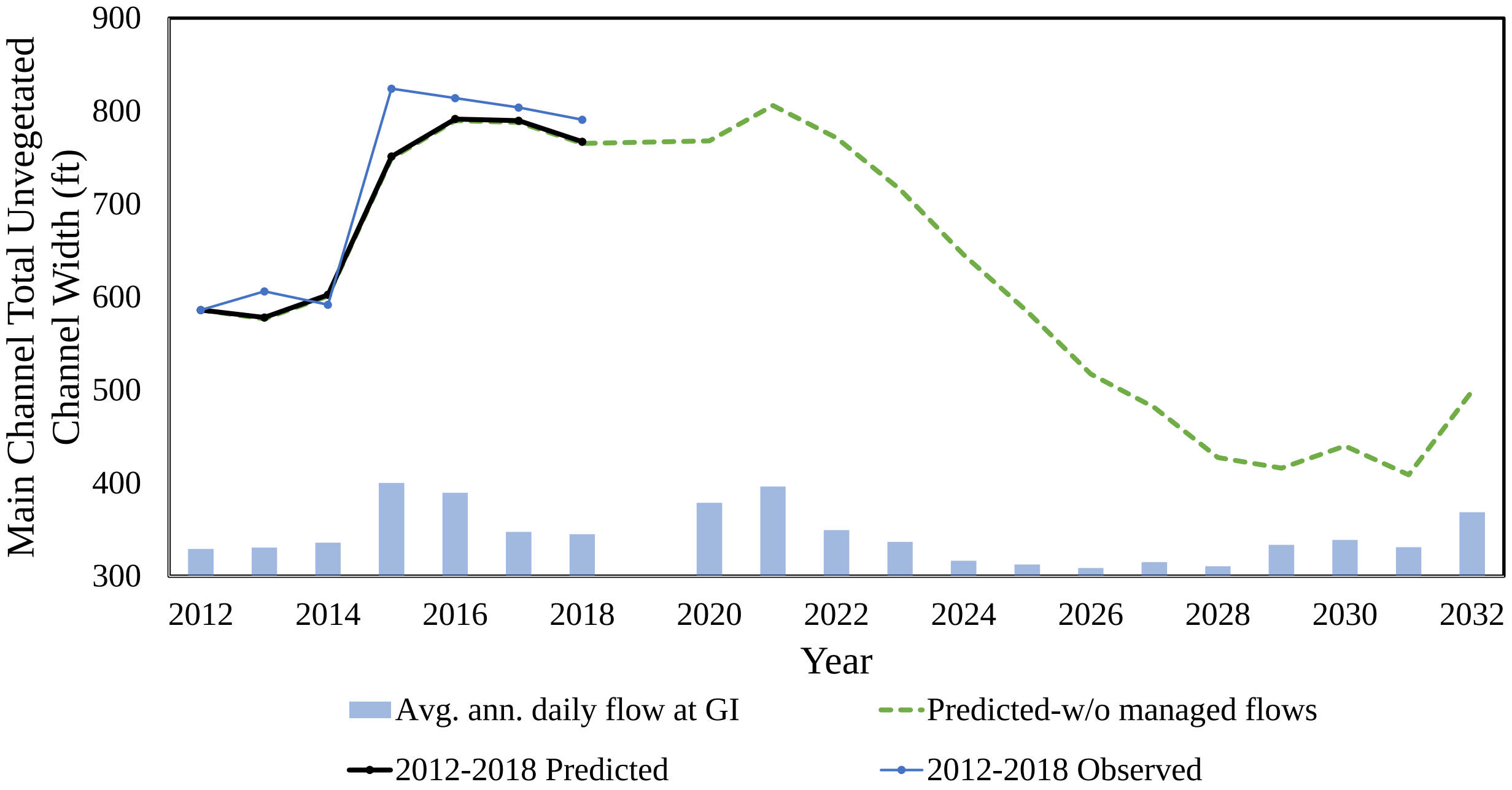
AHR - Average Main Channel Width

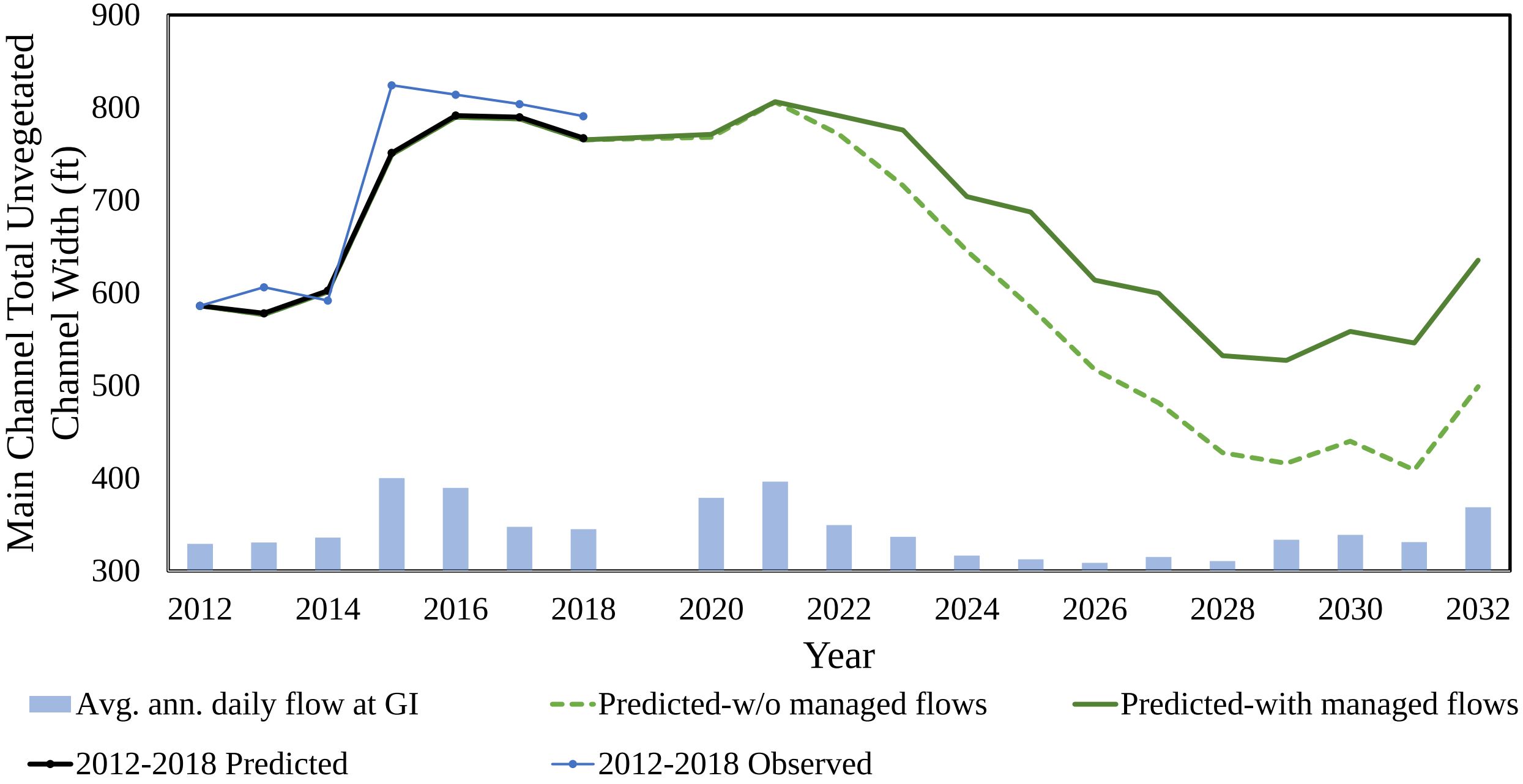



June 15 - July 15 Mean Discharge
Change in Total Unvegetated Channel Width (ft)
400
350
300
250
200
150
100
50
0
-50
-100
-150
0
2,000
4,000
6,000
8,000
10,000
12,000
Discharge (cfs)
2013
2014
2015
2016
2017
2018


Discharge, cfs
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
Jul-07
GI flow w/ EA water, cfs
USGS Platte River near GI gage, cfs
Flow Target, cfs


Main Channel Total Unvegetated Channel Width (ft)
900
800
700
600
500
400
300
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
Year
Avg. ann. daily flow at GI
2012-2018 Predicted
2012-2018 Observed


Main Channel Total Unvegetated Channel Width (ft)
900
800
700
600
500
400
300
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
Year
Avg. ann. daily flow at GI
Predicted-w/o managed flows
2012-2018 Predicted
2012-2018 Observed


Main Channel Total Unvegetated Channel Width (ft)
900
800
700
600
500
400
300
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
Year
Avg. ann. daily flow at GI
Predicted-w/o managed flows
Predicted-with managed flows
2012-2018 Predicted
2012-2018 Observed

Flow Scenario Uncertainties

- **Magnitude**
  - Flow versus inundation and inundation patterns
- **Timing**
  - Cottonwood Inundation versus germination suppression
- **Duration**
  - What flow duration is necessary to suppress germination? Cottonwood establishment?
- **Flow Variability**
  - Should hydrocycling be considered in flow identification?
- **Vegetation types to inundate/control**