Channel Width Modeling

I. INTRODUCTION

Recent sustained peak river flows have widened central Platte River channels throughout the riverine system (Farnsworth et al. 2018). Farnsworth et al. (2018) found 40-day peak river flows, wetted channel width, mechanical and chemical vegetation control were important to create suitable whooping crane channel widths in the central Platte River. Predictive models of unobstructed channel width have performed well within the time periods for which they were developed but have greatly underpredicted channel widths in recent years (Figure 1). Applying the previously developed model from 2016 forward predicted much narrower maximum unobstructed channel width than observed for 2016-2018, suggesting a fundamental change in the physical process relationships that are currently maintaining central Platte River channel width. Peak flows as well as maintenance flows are important for suitable whooping crane channel widths to persist in the central Platte River.

High water events in 2011 and 2015 widened the existing river channels and flows after 2015 maintained those channel widths despite low peak river flows. This suggests a predictive model of unobstructed channel width should account for both channel wide creation flows with recent high flow events and subsequent channel width maintenance flows in absence of high flow events. Our objectives were to 1) develop an improved predictive model of unobstructed channel width that incorporates variables to address both channel widening and width maintenance and 2) understand the influence of channel widening, channel maintenance flows, and physical river management tactics on unobstructed channel width.

II. DATA COLLECTION AND ANALYSIS

We measured main channel total unobstructed channel width (hereafter, TUCWMC) at PRRIP geomorphic monitoring transects spaced every 1000 ft along the active channels of the central Platte River within the Associated Habitat Reach from 2007-2020 (Figure 2). To predict TUCWMC, we included those variables considered in Farnsworth et al. (2018) and germination suppression and late summer peak flows to account for channel maintenance of wide unobstructed channel widths in absence of high annual peak flows (Table 1). To understand the impacts of variables on TUCWMC, we utilized a machine learning Random Forest regression model. Random Forest models provide advantages over the traditional regression models used by Farnsworth et al. (2018) including: accounting for highly complex relationships between variables, non-linear relationships, and resistance to overfitting (De'ath and Fabricius 2000, Breiman 2001, Olden et al. 2008, Thessen 2016).

To evaluate impacts of explanatory variables on TUCWMC, we used Random Forest variable importance plots and predicted future flow scenarios during the Program's First Increment Extension. Variable importance evaluates the predictive accuracy of an explanatory variable with transects left out of a model development process compared to accuracy when recalculated without the effect of that variable. The percent increase in mean squared error (%IncMSE) was then generated and the average increase was used to present predictive independent variable importance. Variables with the greatest percent increase were the most influential variables to explain TUCWMC. To understand influence of each channel maintenance flow variable, we calculated predicted future TUCWMC with scenarios to contrast flow magnitudes which included: (1) 500 cfs or 2000 cfs germination suppression flows and (2) 500 cfs or 3000 cfs late summer peak flow while keeping other flow variables constant (Table 2).

III. RESULTS

Model results indicated main channel total channel width was the most important predictor of TUCWMC from 2007-2020 (Figure 3). Peak flows, disking, germination suppression flows, and late summer peak flows also provided important explanatory ability to predict TUCWMC (Figure 3). Germination suppression flows or late summer peak flows of 500 cfs were predicted to decrease TUCWMC by ~100 ft compared to germination suppression flows of 2,000 cfs or late summer peak flows of 3,000 cfs when all other flow variables were held constant (Figure 4). If both germination suppression flows and late summer peak flows were low (500 cfs) and recent peak flows were lower than those experienced in 2015, channel widths were predicted to narrow more than in other scenarios. Median TUCWMC narrowed to <500 ft during the First Increment Extension under this scenario, which corresponds to an even narrower, unsuitable maximum unobstructed channel width for whooping cranes (Figure 4).

IV. NEXT STEPS

The Executive Director’s Office intends to also investigate the annual change in TUCWMC with the same methodology as modeling and predicting TUCWMC to explore and quantify additional evidence of channel maintenance flow impacts in the central Platte River.

V. DISCUSSION QUESTIONS

1. Do germination suppression and late summer peak flow variables, as defined here, capture the effect of annual maintenance flows? Should modified flow variables (magnitude/duration/timing) or others be considered to understand flow and maintenance of suitable whooping crane channel widths?

2. What First Increment Extension flow experimental designs could help validate predicted channel width relationships to maintenance flows?

VI. FIGURES AND TABLES

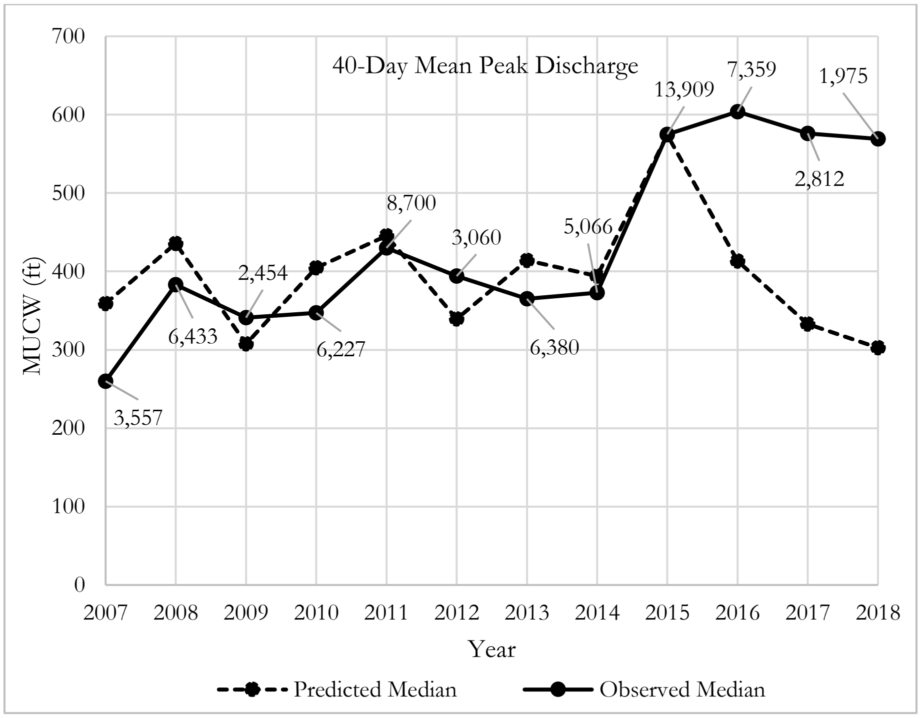

Figure 1. Farnsworth et al. (2018) predicted versus observed median maximum unobstructed channels width (MUCW) in the central Platte River during the period of 2007-2018.

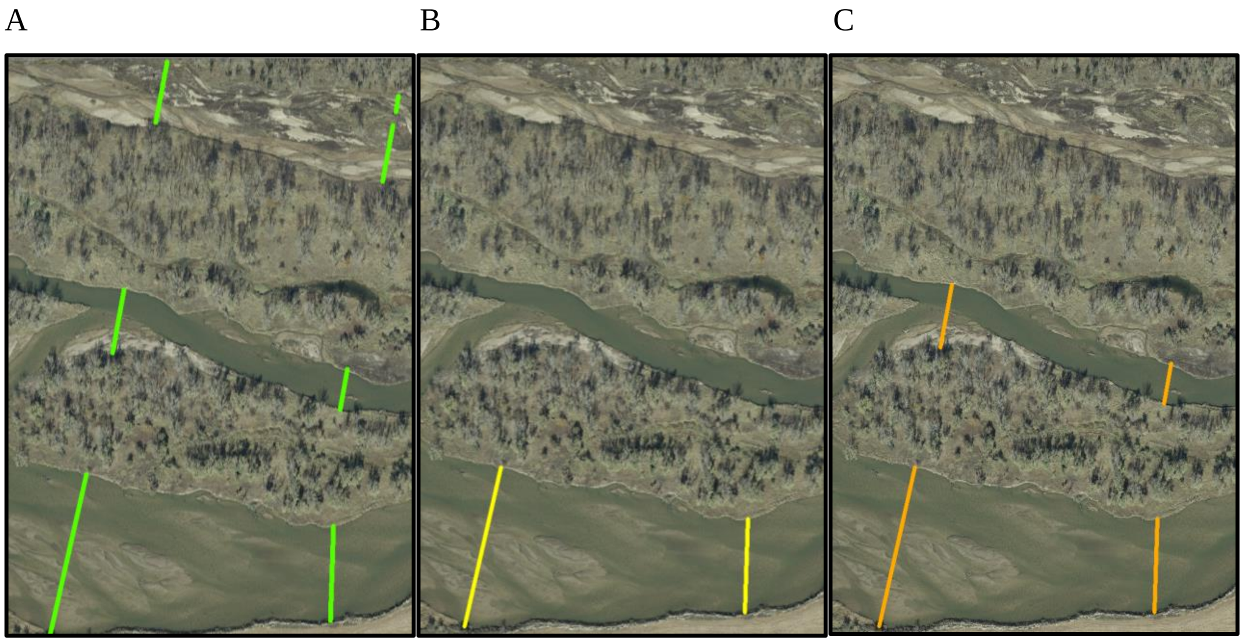

Figure 2. Examples of (A) total unobstructed channel width, (B) maximum unobstructed channel width, and (C) main channel total unobstructed channel width from 2018 aerial imagery.

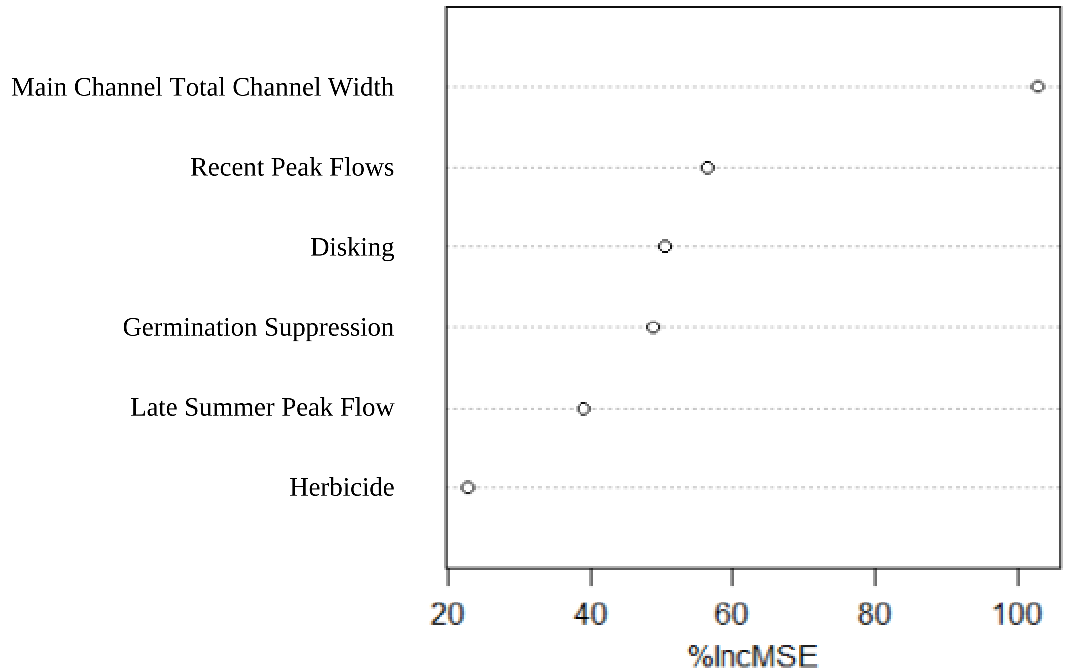

Figure 3. Random Forest variable explanatory variable percent increase in mean squared error (%IncMSE) when variable influenced is removed from the model. Greater values of %IncMSE correspond to greater impact on main channel total unobstructed channel width predictions.

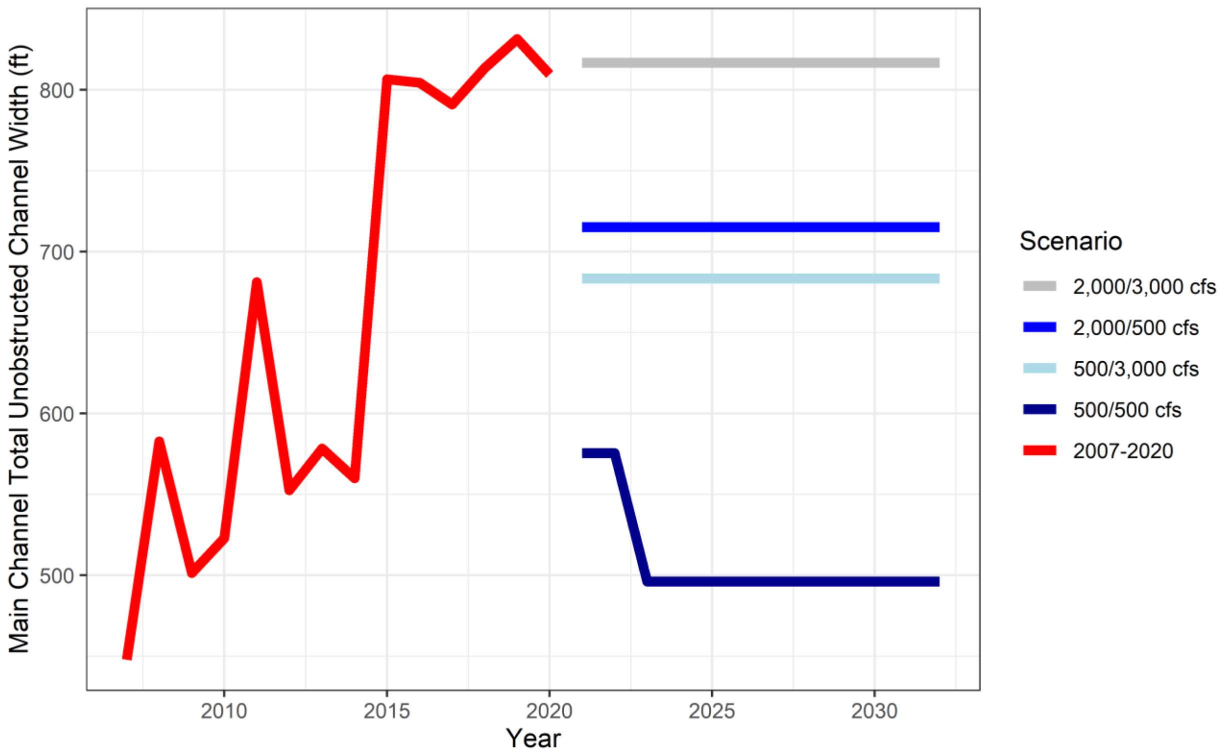

Figure 4. Median main channel total unobstructed channel width measurements (TUCWMC) in the central Platte River from 2007 to 2020 and predicted median TUCWMC under different channel maintenance flow scenarios from 2021-2032 (Table 2).

Table 1. Hydrologic, geomorphic and management variables included in the Random Forest analyses for main channel total unvegetated channel width (TUCWMC) for the period of 2007–2020. Type, units of measurement and a description of data acquisition are included for each metric.

Metric	Type	Units	Description
Total Channel Width	Geomorphic	ft	Total channel width of the channel at bankfull discharge. Metric included to represent “vegetation ratchet” control on width adjustment potential. Widths were delineated from June 2011 aerial imagery, which was flown at near bankfull discharge. Areas of shallow overbank flow were omitted.
Germination Suppression	Hydrologic	ft^3/s	Mean daily discharge during the early growing season (1-June through 15-July).
Late Summer Peak Flows	Hydrologic	ft^3/s	Mean peak 14-day discharge during the portion of the year irrigation usage subsides and annual in-channel vegetation growth can be scoured by peak flows. Peak period was defined as 1-September through 15-October.
Annual Disking	Management	Categorical	Annual delineations of disking and herbicide application were used to classify transects in GIS as to whether these management actions were applied. If any portion of a transect was intersected by the disking polygon, the transect was considered disked. If any portion of a transect was intersected by an herbicide polygon, the transect was treated with herbicide.
Annual Herbicide	Management	Categorical	Herbicide application was either applied to across the central Platte River system (1) or not (0). Systematic spraying occurred from 2008-2020 but was absent prior.
Peak Flows	Hydrologic	Categorical	Identified and classified the highest 40 day mean peak discharge within the last 4 years into low (≤2500 cfs), medium (>2500 and ≤10,000 cfs), or high (>10,000 cfs).

Table 2. Future flow condition management scenarios projected from 2021 – 2032 in the central Platte River to predict main channel total unobstructed channel width as an indicator of riverine roosting habitat quality for migrating whooping cranes.

Scenario	Recent Peak Discharge	Germination Suppression	Late Summer Peak Flow	Herbicide[a]	Disking[b]	Total Channel Width
2,000/3,000 cfs	High	2,000 cfs	3,000 cfs	X		X
500/3,000 cfs	High	500 cfs	3,000 cfs	X		X
2,000/500 cfs	High	2,000 cfs	500 cfs	X	X	X
500/500 cfs	Medium	500 cfs	500 cfs	X	X	X

[a]Systematic herbicide application is expected to continue throughout the central Platte River during the First Increment Extension.

[b]Disking was transect-based and only occurred in scenarios when late germination peak flows were <1,000 cfs.

REFERENCES

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