



# **Icicle Creek Water Resource Management Strategy**

**Icicle Workgroup**  
January 5, 2017

Aspect Consulting  
Dan Haller, PE

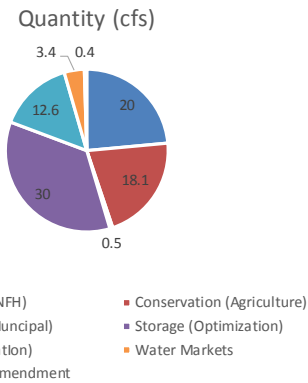
# Icicle Strategy Overview

## Guiding Principles for the Icicle Strategy

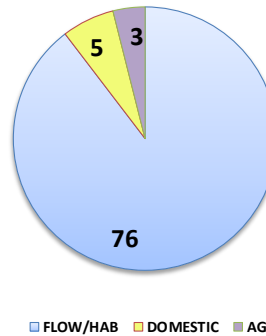


# Icicle Strategy Overview

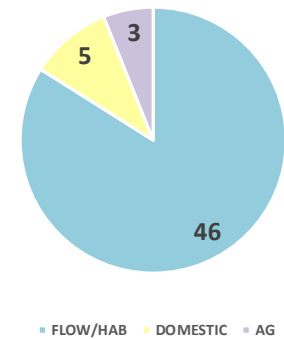
## Who Benefits? Who Gets The Water?



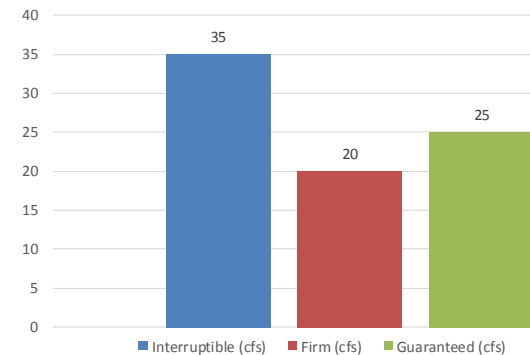
**Water Supply Benefit (cfs)**  
Average Year  
Augments Low Flow of 63 cfs



**Water Supply Benefits (cfs)**  
Drought Year  
Augments Low Flow of 20 cfs



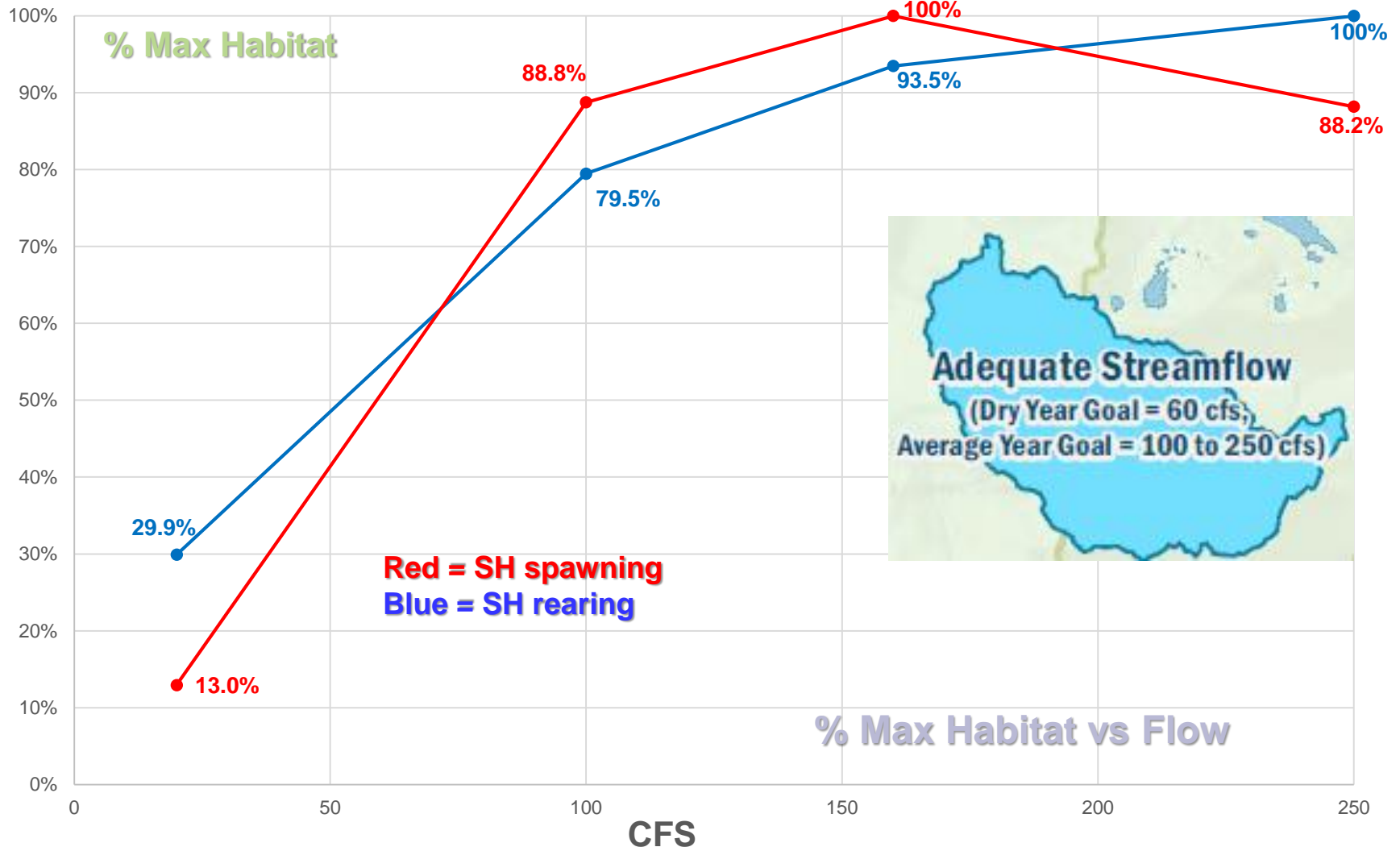
**Water Supply Benefit (84 cfs)**  
Average Year Pedigree of Water



# Icicle Strategy Overview

## Where Did the Flow Numbers Come From? Does It Help Fish?

USFWS Weighted Usable Area Curve for Icicle Creek Near LNFH



**Icicle Creek  
Instream Flow  
Sub Committee  
Report to the Icicle  
Work Group**

**May 16, 2014**

# Target Reaches

- ▶ **Reach 1** – Upstream of Icicle & Peshastin ID POD; RM 5.8 to headwaters.
  - Committee added a reach between 5.7 to 5.8 due to flow differences; no separate assessment though.
- ▶ **Reach 2** – IPID POD to LNFH POD; RM 5.7 to 4.5
- ▶ **Reach 3** – LNFH POD to Structure 2; RM 4.5 to 3.9
- ▶ **Reach 4** – Historic channel; RM 3.9 to 2.7
- ▶ **Reach 5** – Downstream of LNFH outflow to the Wenatchee River confluence; RM 2.7 to 0.0

# Focal Fish Species by Reach

Reach	River Mile	Species	Life History & Life Stage
1	Headwaters to 5.8 (5.7)	Steelhead, Rainbow trout, bull trout, cutthroat trout	SH – <u>P</u> assage, <u>S</u> pawning, <u>R</u> earing RB – S, R CT – R BT – P, S, R
2	5.7 to 4.5	SH, BT	SH – P, R BT – P
3	4.5 to 3.9	SH, BT	SH – P, R BT – P
4	3.9 to 2.7	SH, BT, Lamprey	ST – P, R, S BT – P L – P
5	2.7 to 0.0	SH, BT, Lamprey	SH – S, R BT – P L – P

## Assumptions:

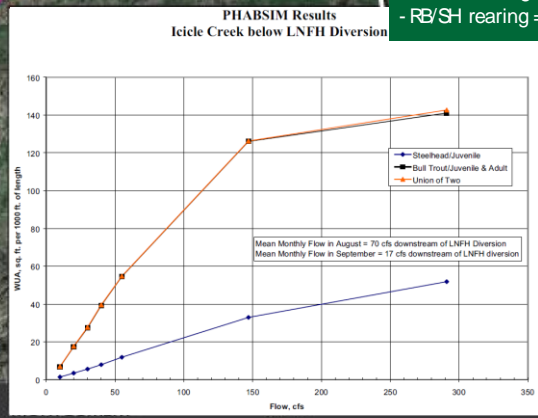
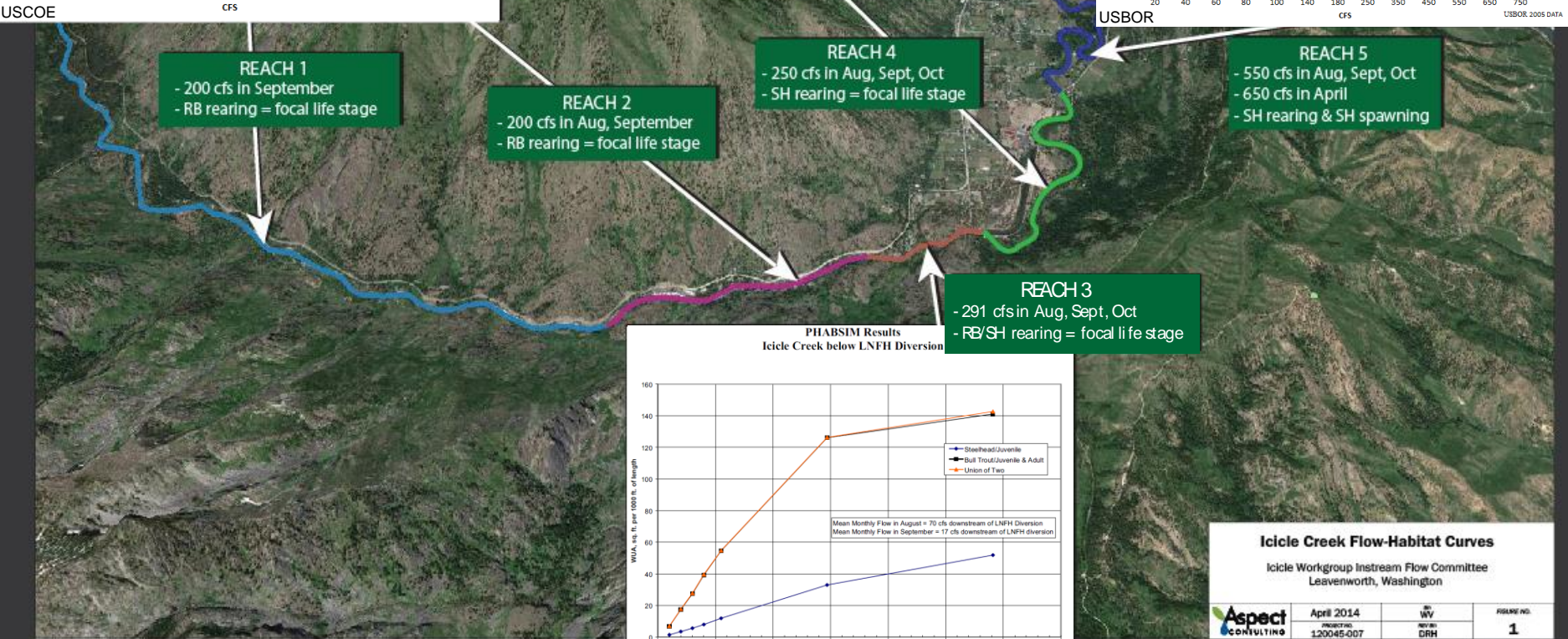
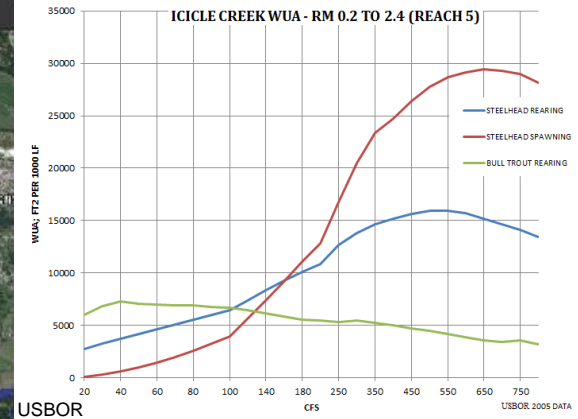
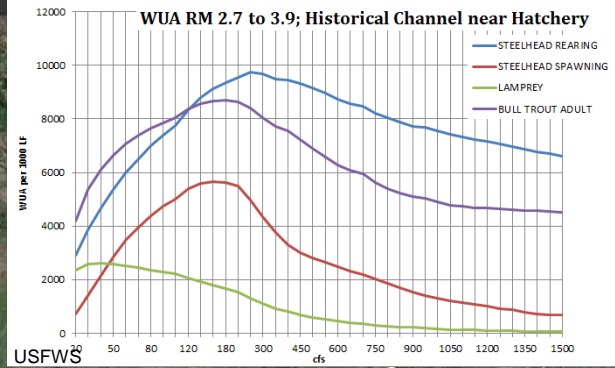
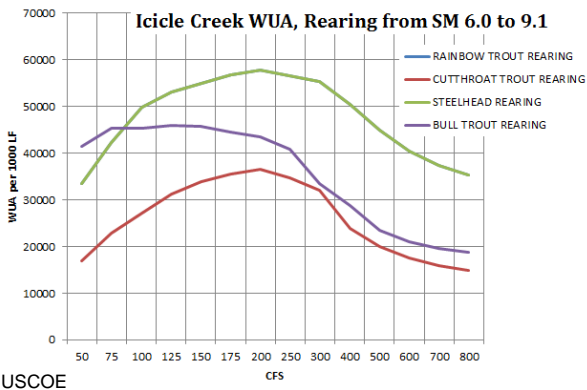
- No spring Chinook assessment
- Assume steelhead production is present

# Focal Fish Species and Relevant Life Stages Periodicity Within Icicle Work Group Study Reaches

		Migration	Spawning	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead, Rainbow trout	Adult	Dark	Light	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
	Rearing	Light	Dark	Light	Light	Light	Dark	Dark	Dark	Light	Light	Light	Light	Light	Light
Bull trout	Adult/Subadult	Dark	Light	Light	Light	Light	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
	Rearing	Light	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Cutthroat trout	Adult	Dark	Light	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
	Rearing	Light	Dark	Light	Light	Light	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Lamprey	Adult	Dark	Light	Light	Light	Light	Light	Light	Dark	Dark	Dark	Dark	Dark	Light	Light
		Light	Dark	Light	Light	Light	Dark	Dark	Dark	Light	Light	Light	Light	Light	Light

Source: USFWS 2013 draft





### Icicle Creek Flow-Habitat Curves

Icicle Workgroup Instream Flow Committee  
 Leavenworth, Washington

Aspect CONSULTING	April 2014	WV	FIGURE NO. <b>1</b>
	PROJECT NO. 120045-007	DRH	

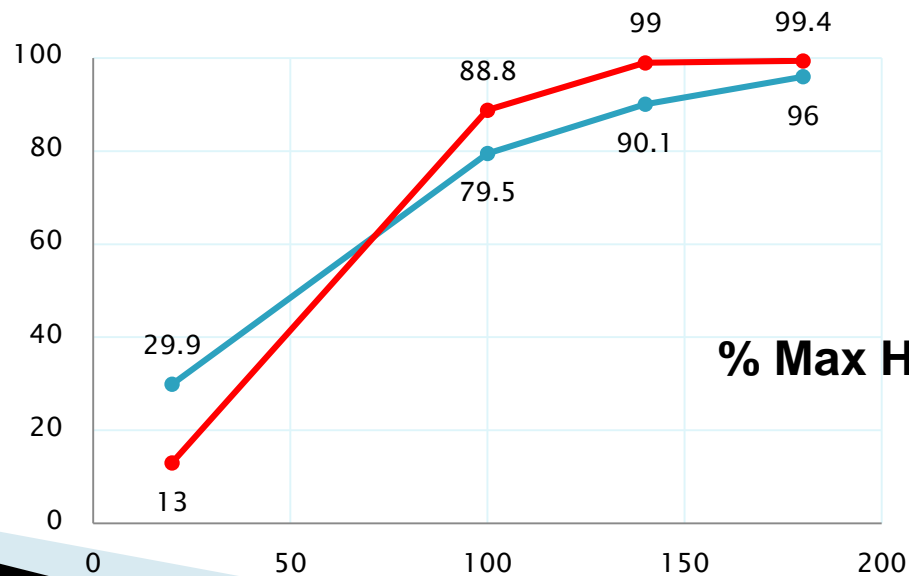
# Reach 4 Flow Recommendation

? - Maximum habitat steelhead spawning & rearing flows are far below actual Q in historic channel.

Idea: Supplement hatchery channel flows during the spring with excess Q? Just don't go below 250 cfs.

Month	Gage Q	+ Snow Cr	(-) W/D	Focal Species & Life Stage WUA	Reach Q	Flow Rule (cfs)	Q Deficit	Recommended Flow
April	661	24	127	Steelhead Rearing 250 cfs	558		No	?
May	1,690	56	152		1,594		No	
June	1,890	30	155		1,765		No	
July	874	44	170	Fluvial Bull Trout Passage; 1.0-ft depth requirement 180 cfs	748		No	250 cfs
Aug	264	37	170		131	400	(-) 119 cfs	
Sept	161	43	141		63	275	(-) 187 cfs	
Oct	235	33	59		209	267	(-) 41 cfs	

% Max Habitat



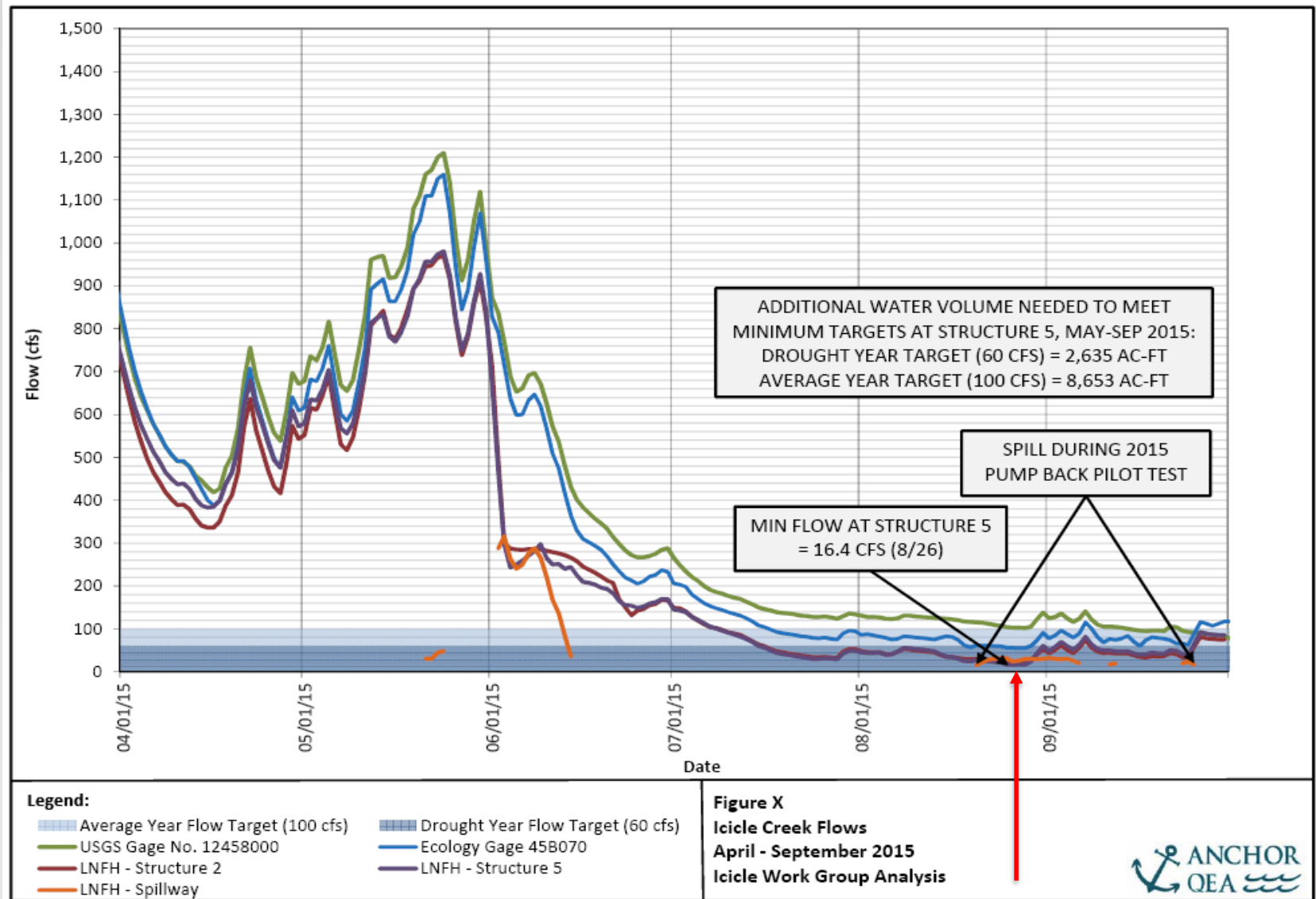
Red = SH spawning  
Blue = SH rearing

% Max Habitat vs Flow

CFS

# 2015 Drought Icicle Creek Flow

## How Bad Does Instream Flow in Icicle Creek Get?



# What Does Flow In Icicle Creek Look Like?



Low flow in late 2001 was about 20 cfs (and 16.4 cfs in 2015)

# Icicle Creek Looking Upstream of Structure 2



**148 cfs**

August 30, 2016



**85 cfs**

Sept. 15, 2016

- Guiding Principle is 100 cfs in non-drought years and 60 cfs in drought years

# Icicle Creek Looking Upstream of Structure 5 Near LNFH



**1800 cfs**  
July 6, 2016



**107 cfs**  
August 23, 2016

- Guiding Principle is 100 cfs in non-drought years and 60 cfs in drought years

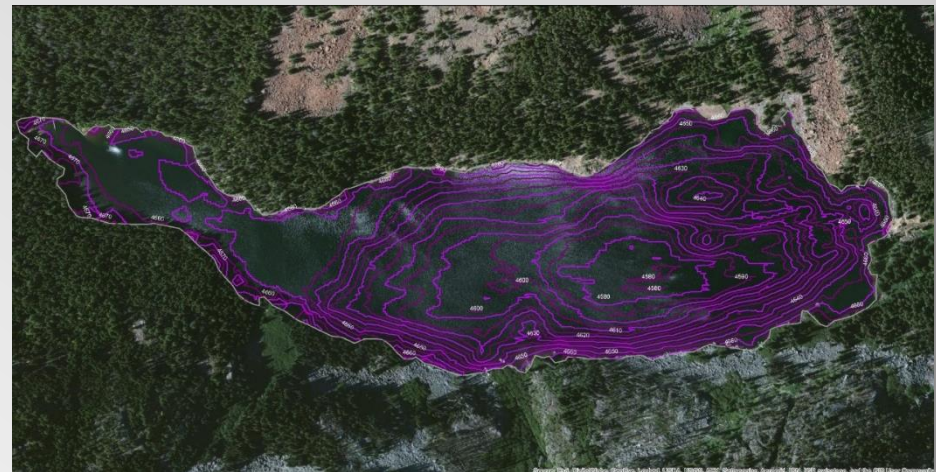
# Modification of Existing Storage

## ■ Alpine Lakes Optimization

- Automate and re-operate Lakes
- 30-42 cfs Interruptible
- \$86K - \$3.5M
- \$16 - \$450 /ac-ft

## ■ Eight-Mile Lake Restoration

- Restore up to 1125 ac-ft (2500 ac-ft total)
- 5-10 cfs Guaranteed
- Dam repair and/or siphon
- \$1.5 - \$1.7M
- \$1400 - \$2400 / ac-ft



# 2016 Flow Augmentation Pilot Study

## Water Donations

- If donated for instream flows, Ecology shall accept it (RCW 90.42.080(1)(b)).
- IPID Trust Donation of Water Rights:
  - Square Lake 2,000 acre-feet
  - Klonaqu Lake 2,500 acre-feet
  - Eightmile Lake 1,600 acre-feet
  - Colchuck Lake 2,500 acre-feet
  - Snow Lake 1000 acre-feet

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9,600 acre-feet



# 2016 Flow Augmentation Pilot Study

## Goals

Maintenance on all Alpine Lakes in 2016 created opportunity for evaluating instream flow benefits via trust donations.

1. **Maintain 100 cfs at Structure 2** (adaptive based on actual flows)
2. **Colchuck** - 700 ac-ft drawdown by Sept. 1<sup>st</sup> for maintenance.
3. **Eightmile** - peak release early for design inspection and natural seepage. No weekly adjustments due to submerged headgate.
4. **Square and Klonauqua** - Maximum 10 cfs after Sept. 15<sup>th</sup> for Bull Trout spawning in Leland Creek and French Creeks.
5. **Upper Snow** - Initial release 5 cfs due to valve limitations (adaptive later in the year depending on LNFH flow needs).
6. **Avoid significant ramping changes** (more than 10 cfs) in a week in the late summer/fall.

# Augmentation Monitoring

## Outflow Monitoring

- Staff gauges in outlet channels
- Develop rating curves (various flows)

## Reservoir Monitoring

- Pressure transducers
- Manual measurements
- Lidar survey



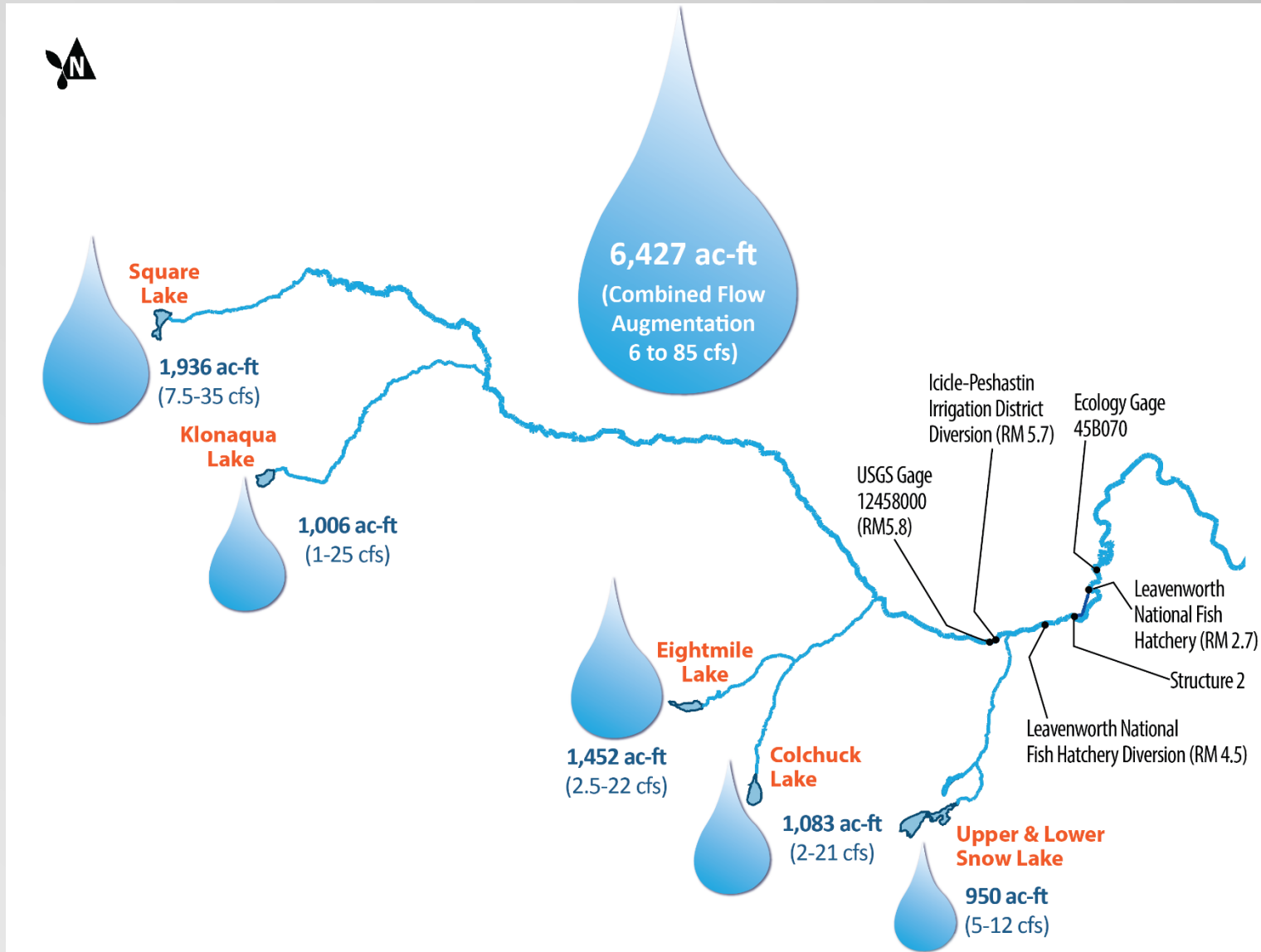
# Augmentation Management

## Weekly Cycle

- Monitor Icicle flows
- Plan release flows
  - consider remaining volume, project goals, flow decay
- Runners operate control structures
- Measure effect on Icicle flows
- Update email

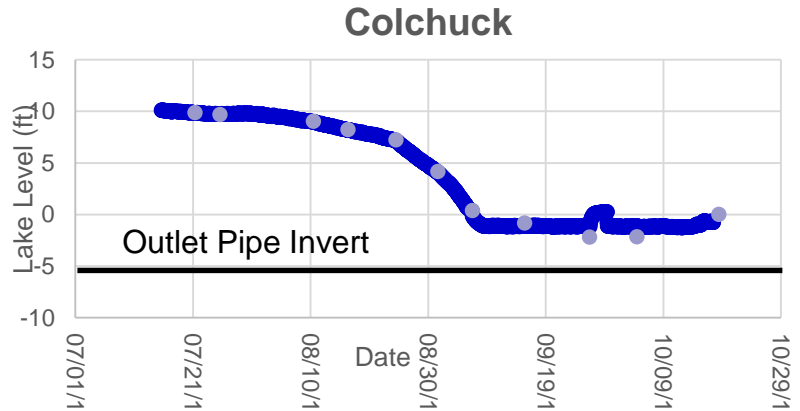
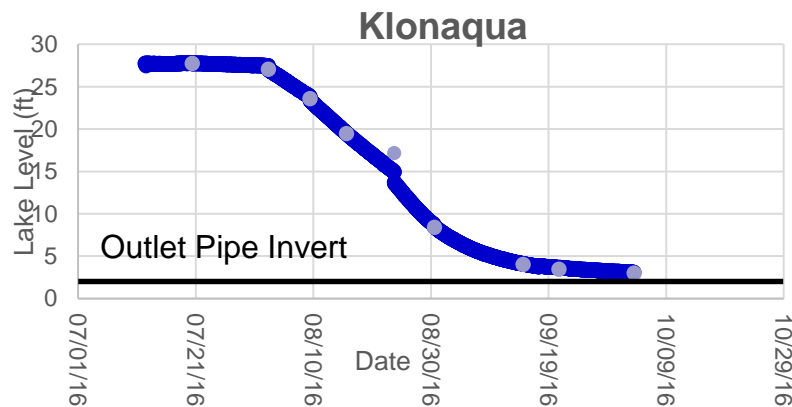
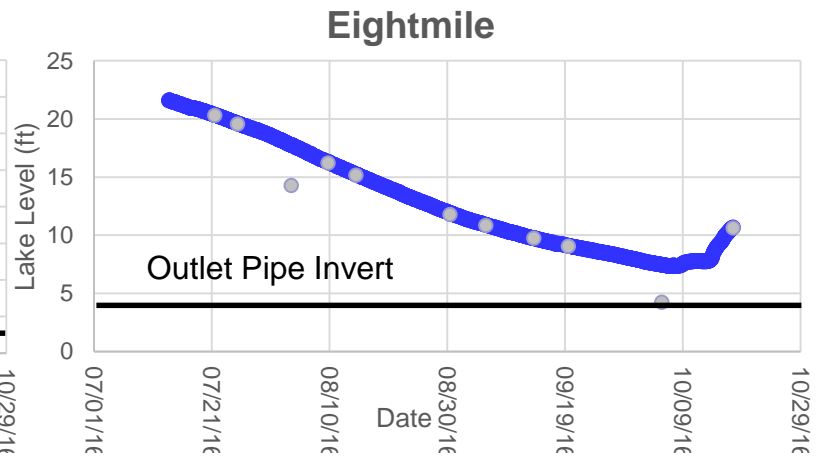
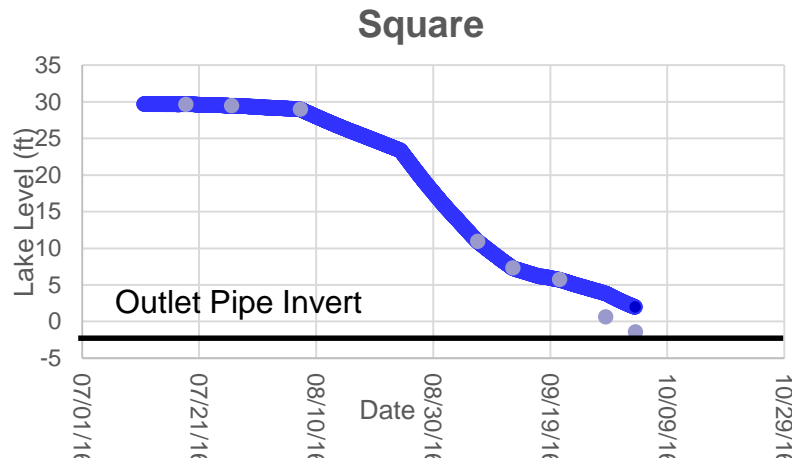


# Augmentation Volume

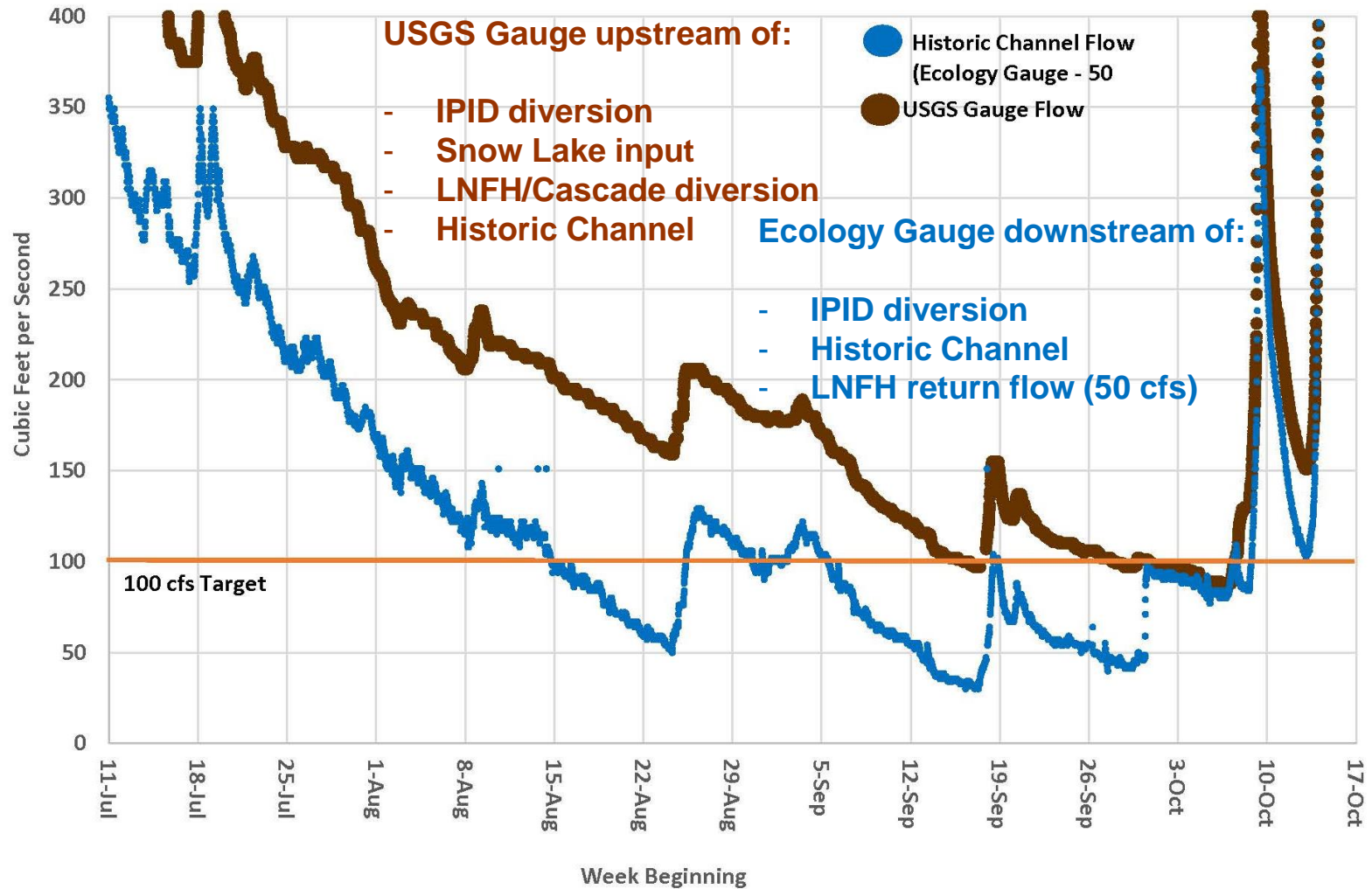


# Lake Levels

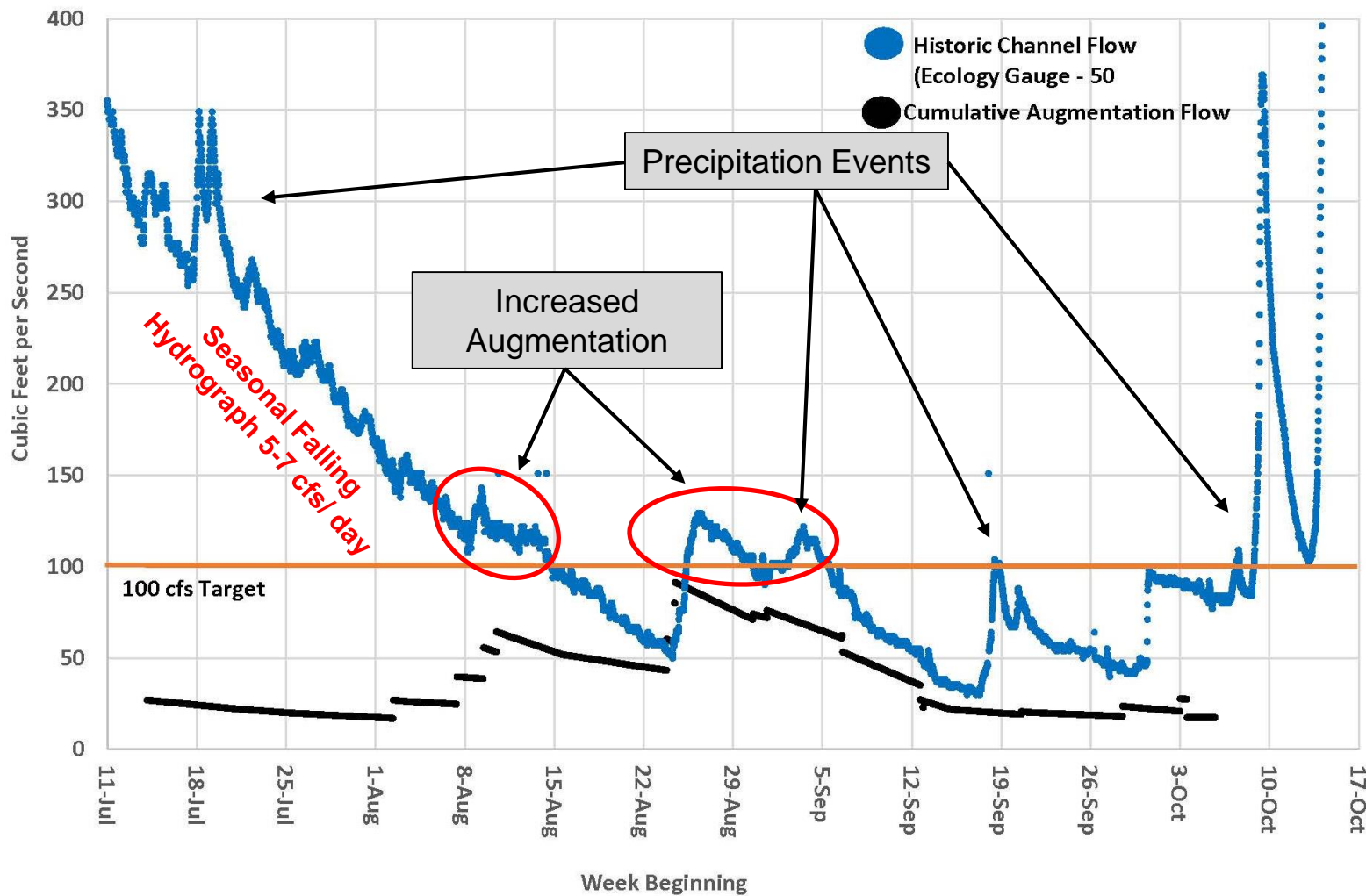
## Lake Hydrographs



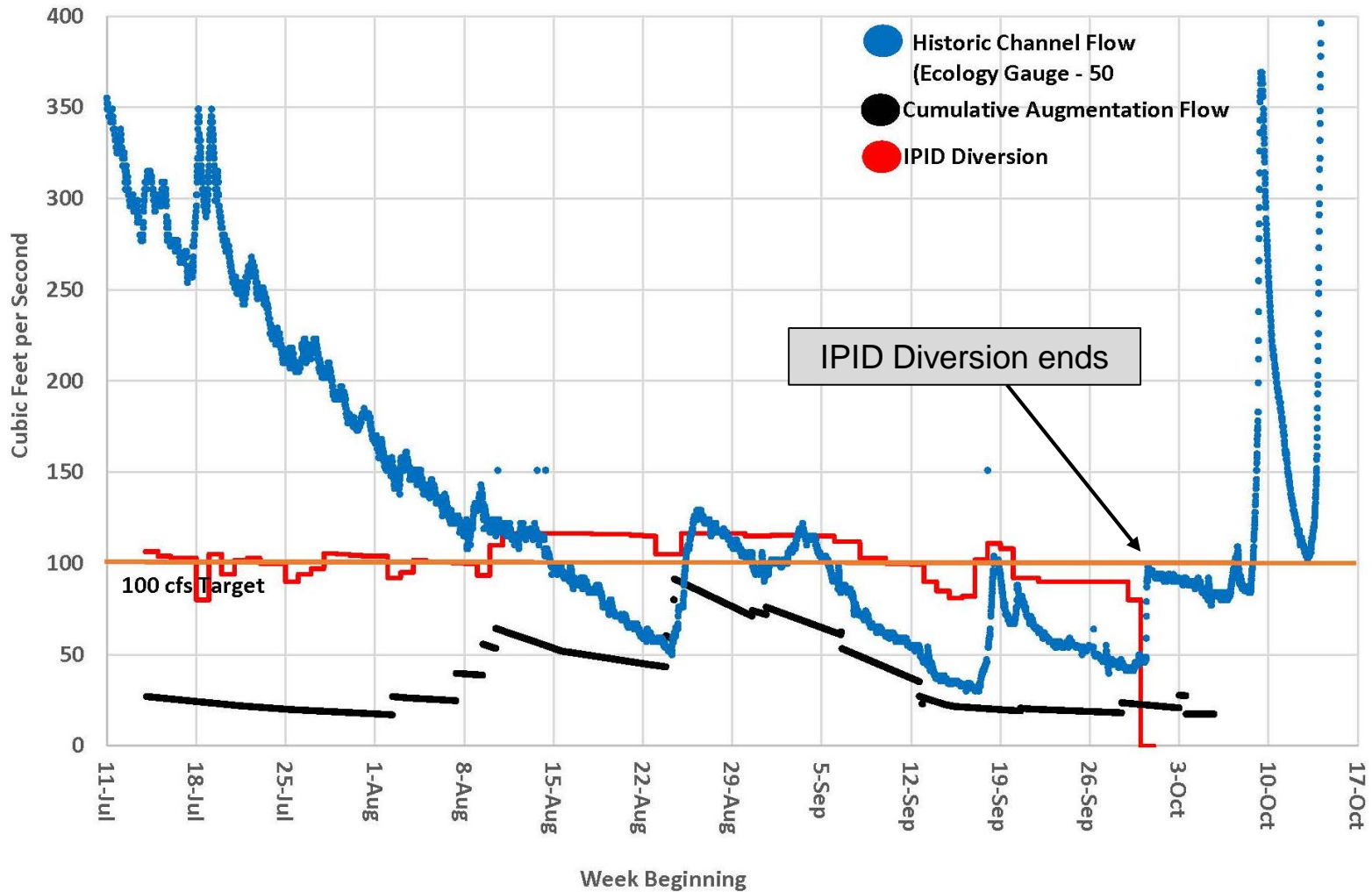
# Icicle Flow and Augmentation



# Icicle Flow and Augmentation

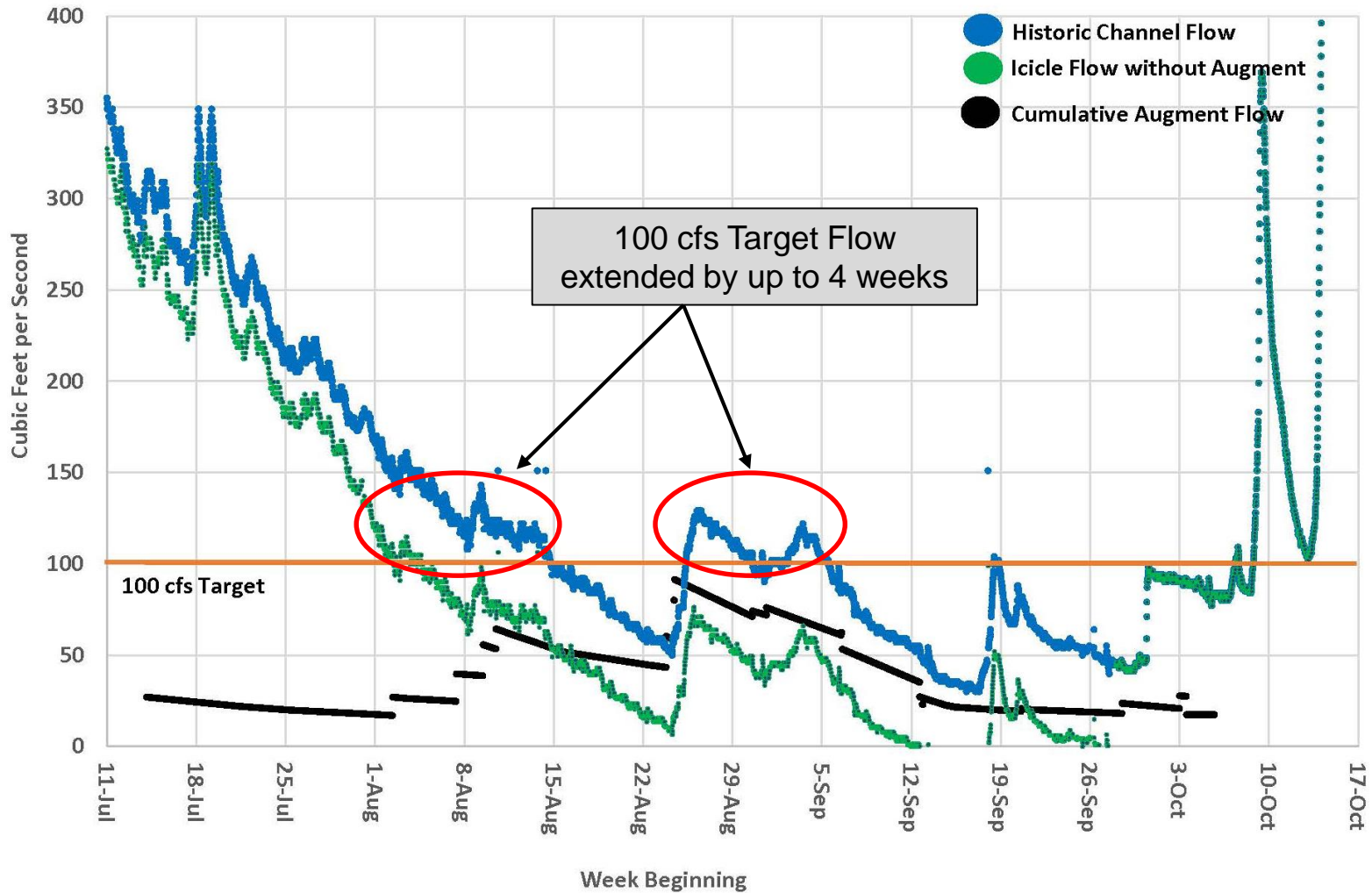


# Icicle Flow and Augmentation

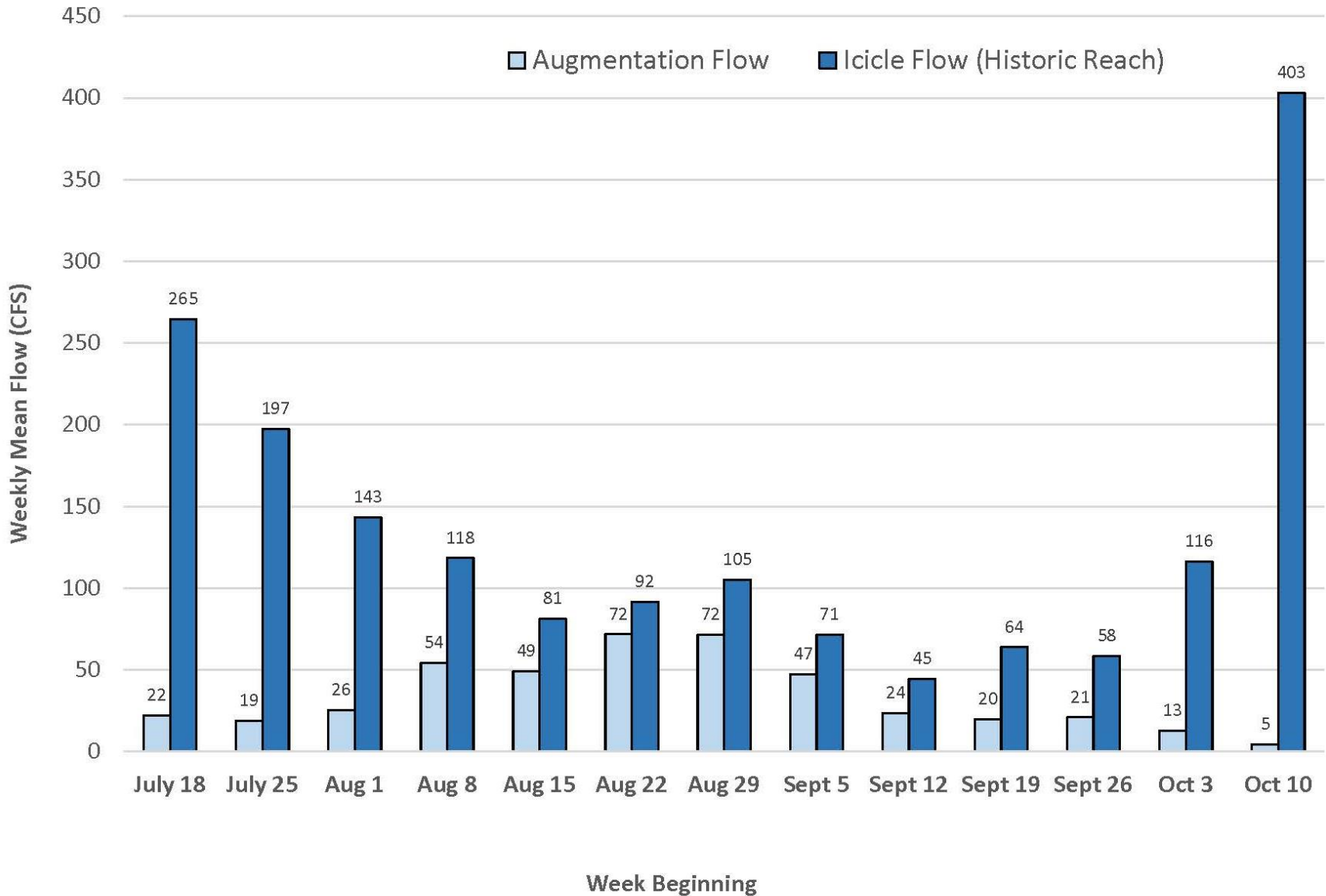




# Icicle Flow and Augmentation



# Augmentation Contribution



# Icicle Flow and Augmentation

## Summary Results

- Total volume released from storage – 6,400 acre-feet
- Peak augmentation flow – 85 cfs
- Comprised 2/3 to 3/4 of late season discharge
- Sustained 100 cfs Target Flow during 4 weeks in late season (50% of time)
- Improved infrastructure: monitoring equipment

# Follow On Study

- Rating curves high and low flows (fall and spring)
- Minimize impact of storage release flow decay
- Improve coordination to separate variables (e.g. with USFWS release, IPID diversion, weather)
- Structure 2 real time flows, below IPID/City diversion flows
- Clarity on release goals to protect bull trout in tributaries
  - QAPP/Action Plan—water quality, temperature, flows, piezometers
- Install precipitation gauge(s) near lakes



# Questions?

Aspect Consulting

Dan Haller, PE