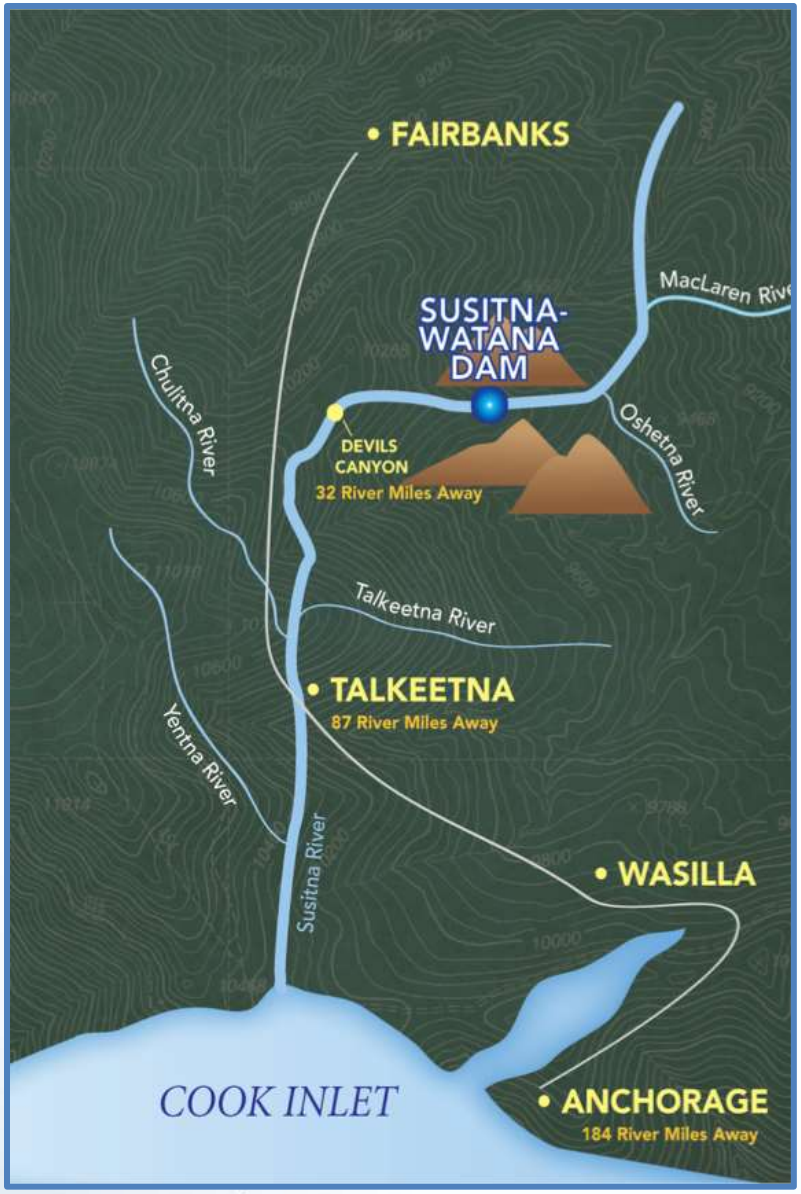

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Riparian IFS (Study 8.6)

Riparian & Riverine Modeling

Riparian IFS Technical Meeting Day One

April 29, 2014

Prepared by
R2 Resource Consultants

Welcome to the Riparian IFS Meeting

Riparian IFS Meeting Objectives

Goal:

Seek input from TWG regarding model development and how the models will be used to assess Project effects.

Key Objectives:

1. Provide a forum to review and discuss riparian/riverine modeling and study integration efforts.
2. Present and discuss proposed assessment metrics.

Riparian IFS Meeting Agenda Day One

8:30 – 8:45 (AKST)	Introductions and facilities/safety procedures
8:45 – 9:00	Meeting goals /objectives and agenda review (R2)
9:00 – 10:00	Review Riparian Instream Flow study & modeling design (R2, ABR, GWS)
10:00 – 10:15	Break
10:15 – 11:30	Fluvial Geomorphology: channel / floodplain evolution model; hydraulic and sediment modeling study objectives (TT)
11:30 – 12:30	Riparian fluvial geomorphology modeling and metrics (R2, ABR, TT)
12:30 – 1:30	Lunch (food and beverages provided)
1:30 – 3:00	Hydrology / Groundwater: empirical studies and modeling (GWS)
3:00 – 4:00	Riparian hydrology / groundwater study modeling and metrics details
4:00 – 4:30	Discussion, review day 1 action items, and day 2 agenda
4:30	Adjourn

Riparian IFS Meeting Agenda Day Two

8:30 – 9:00 (AKST)	Recap of day 1 activities, planned day 2 activities
9:00 – 10:30	Ice Processes: study objectives and riparian evaluation metrics (HDR)
10:30– 10:45	Break
10:45-11:30	Riparian ice studies modeling and metrics
11:30-12:30	Lunch
12:30-2:00	Riparian IFS Output: fluvial geomorphology, hydrology, and ice processes studies study modeling and metrics
2:00-3:00	Riparian IFS Output: wildlife habitat modeling & metrics overview (ABR)
3:00-4:00	Open discussion
4:00	Adjourn

Riparian IFS Goal

"The goal of the 2013–2014 Riparian Instream Flow Study is to provide a quantitative, spatially-explicit model to predict potential impacts to downstream floodplain vegetation from Project operational flow modification of natural Susitna River flow, sediment, and ice process regimes. To meet this goal, a physical and vegetation process modeling approach will be used." (RSP 8.6.1.1)

Riparian Instream Flow Study Objectives Related to Modeling

RSP 8.6.1.1 Objective:

3. Characterize **seed dispersal and seedling establishment** groundwater and surface water hydroregime requirements. Develop a predictive model of potential Project operational impacts to seed dispersal and seedling establishment.

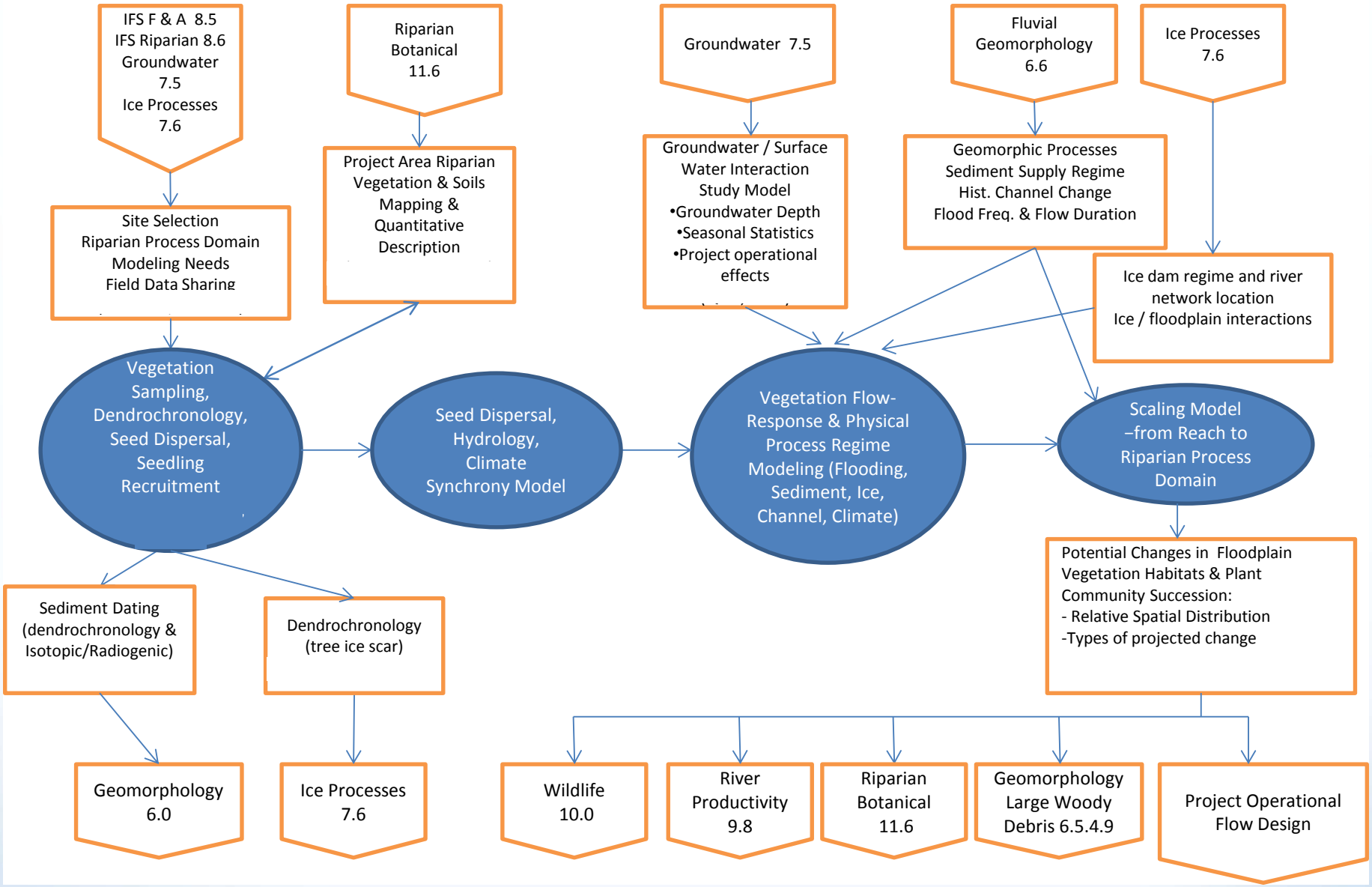
4. Characterize the **role of river ice in the establishment and recruitment of dominant floodplain vegetation**. Develop a predictive model of potential Project operational impacts to ice processes and dominant floodplain vegetation establishment and recruitment.

5. Characterize the **role of erosion and sediment deposition in the formation of floodplain surfaces, soils, and vegetation**. Develop a predictive model of Project operations changes to erosion and sediment deposition patterns and associated floodplain vegetation.

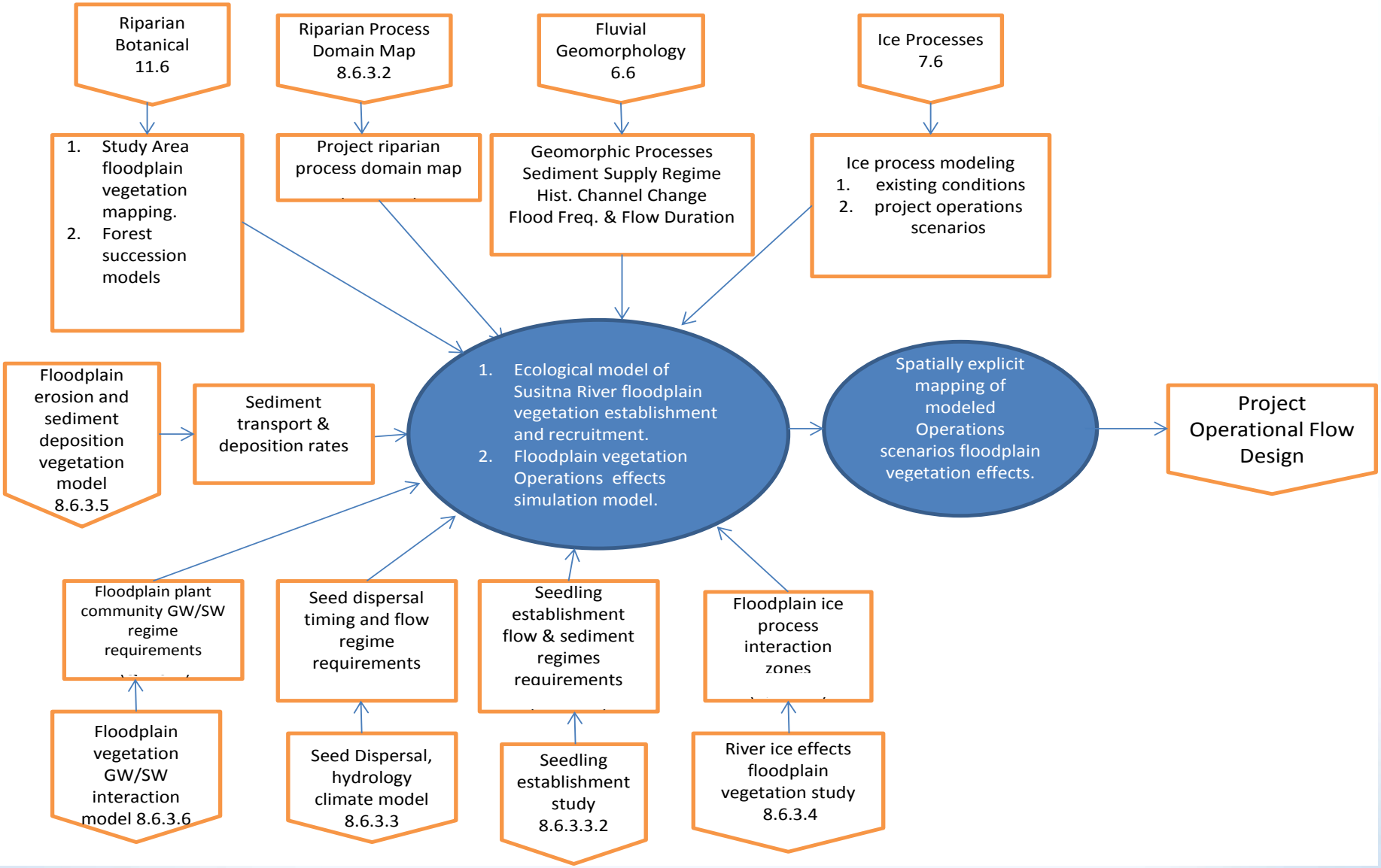
6. Characterize natural **floodplain vegetation groundwater and surface water maintenance hydroregime.** Develop a predictive model to assess potential changes to natural hydroregime and potential floodplain vegetation change.

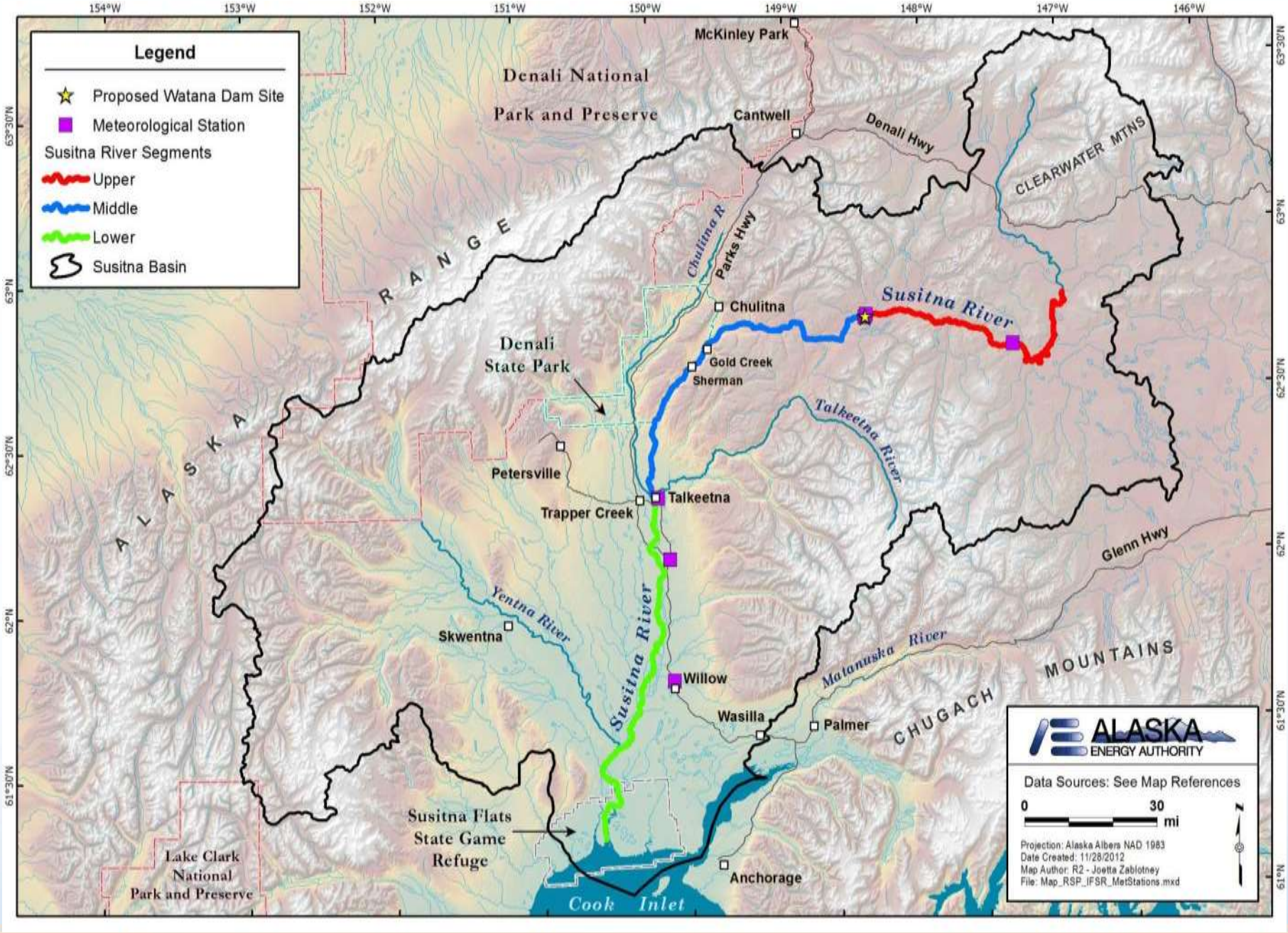
7. Develop floodplain vegetation study, **Focus Area to riparian process domain scaling** and **Project operations effects modeling**.

STUDY INTERDEPENDENCIES FOR RIPARIAN INSTREAM FLOW STUDY SECTION 8.6



FLOODPLAIN VEGETATION STUDY SYNTHESIS, FOCUS AREA TO RIPARIAN PROCESS DOMAIN SCALING & PROJECT OPERATIONS EFFECTS MODELING 8.6.3.7




Legend
Proposed Watana Dam Site
Meteorological Station
Susitna River Segments
Upper
Middle
Lower
Susitna Basin
Denali National Park and Preserve
McKinley Park
Cantwell
Denali Hwy
CLEARWATER MTNS
ALASKA RANGE
Chulitna R
Parks Hwy
Chulitna
Susitna River
Denali State Park
Gold Creek
Sherman
Talkeetna River
Petersville
Talkeetna
Trapper Creek
Glenn Hwy
Yentna River
Skwentna
Susitna River
Willow
Matanuska River
MOUNTAINS
CHUGACH
Wasilla
Palmer
Susitna Flats State Game Refuge
Lake Clark National Park and Preserve
Anchorage
Cook Inlet
ALASKA ENERGY AUTHORITY
Data Sources: See Map References
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30
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Projection: Alaska Albers NAD 1983
Date Created: 11/28/2012
Map Author: R2 - Joetta Zablotney
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RIFS Study 8.6.3.3.1 – Seed Release Study

Site Name	Number of Shrubs	Shrub Species	Number of Trees	Tree Species
Deshka Landing – PRM 32	12	*Salix alaxensis* & *Salix barclayi*	6	*Populus balsamifera*
Highway 3 Bridge – PRM 88	6	*Salix alaxensis* & *Salix sitchensis*	6	*Populus balsamifera*
Talkeetna – PRM102	6	*Salix barclayi*	6	*Populus balsamifera*
Indian River – PRM 142	12	*Salix alaxensis* & *Salix sitchensis*	6	*Populus balsamifera*

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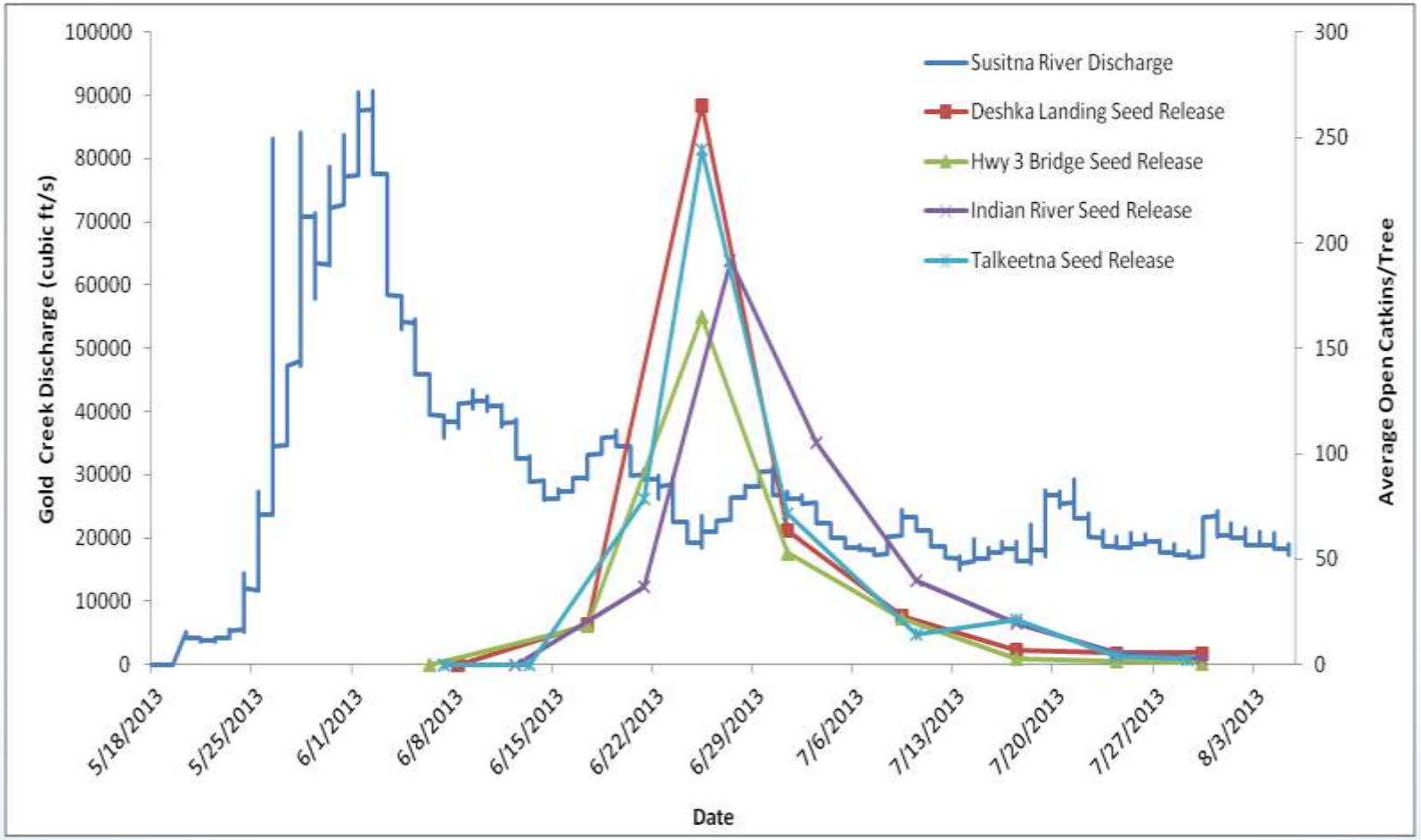
RIFS Study 8.6.3.3.1 - Seed Release Study



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RIFS Seedling Establishment and Recruitment Study (RSP 8.6.3.3.2)

Project River Mile	Focus Area	Number of Transects	Number of Plots
104	Whiskers Slough	5	114
115	Slough 6A	12	222
128	Slough 8A	8	194
138	Gold Creek	4	126
144	Slough 21	6	168

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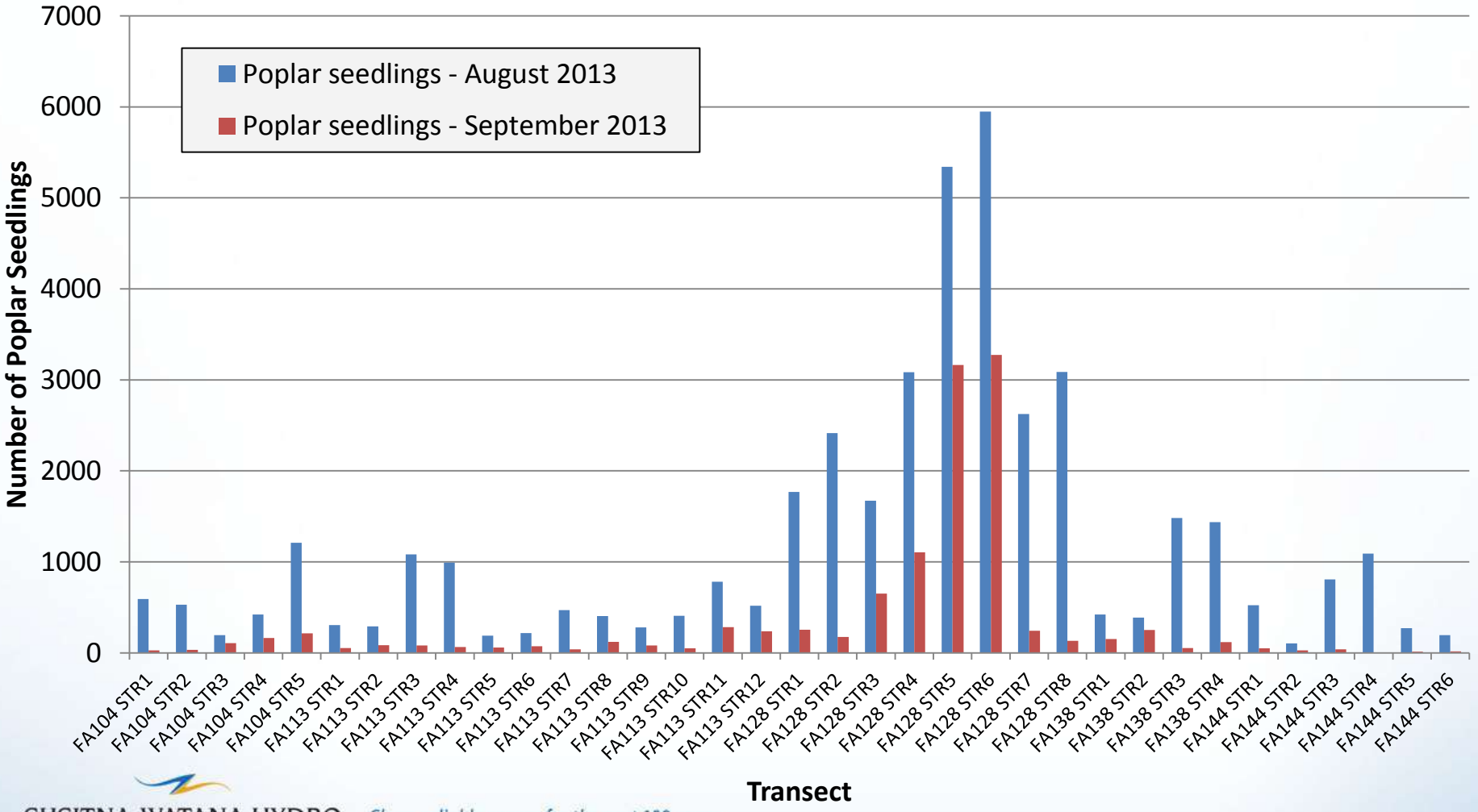
RIFS Seedling Establishment and Recruitment Study (RSP 8.6.3.3.2)

Poplar seedling counts



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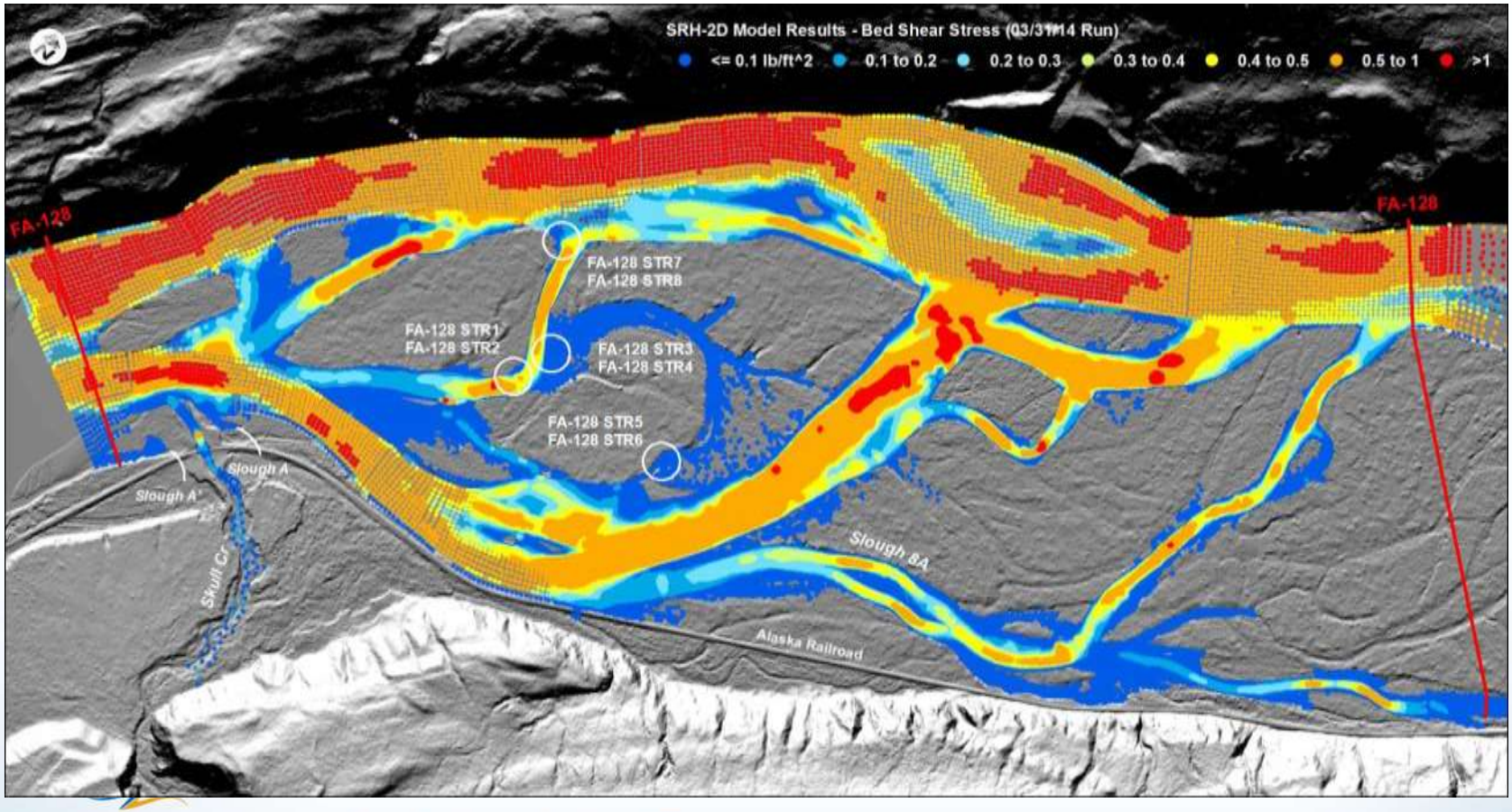
RIFS Seedling Establishment and Recruitment Study (RSP 8.6.3.3.2)
SRH-2D Bed Shear Stress Results (50,000 cfs)



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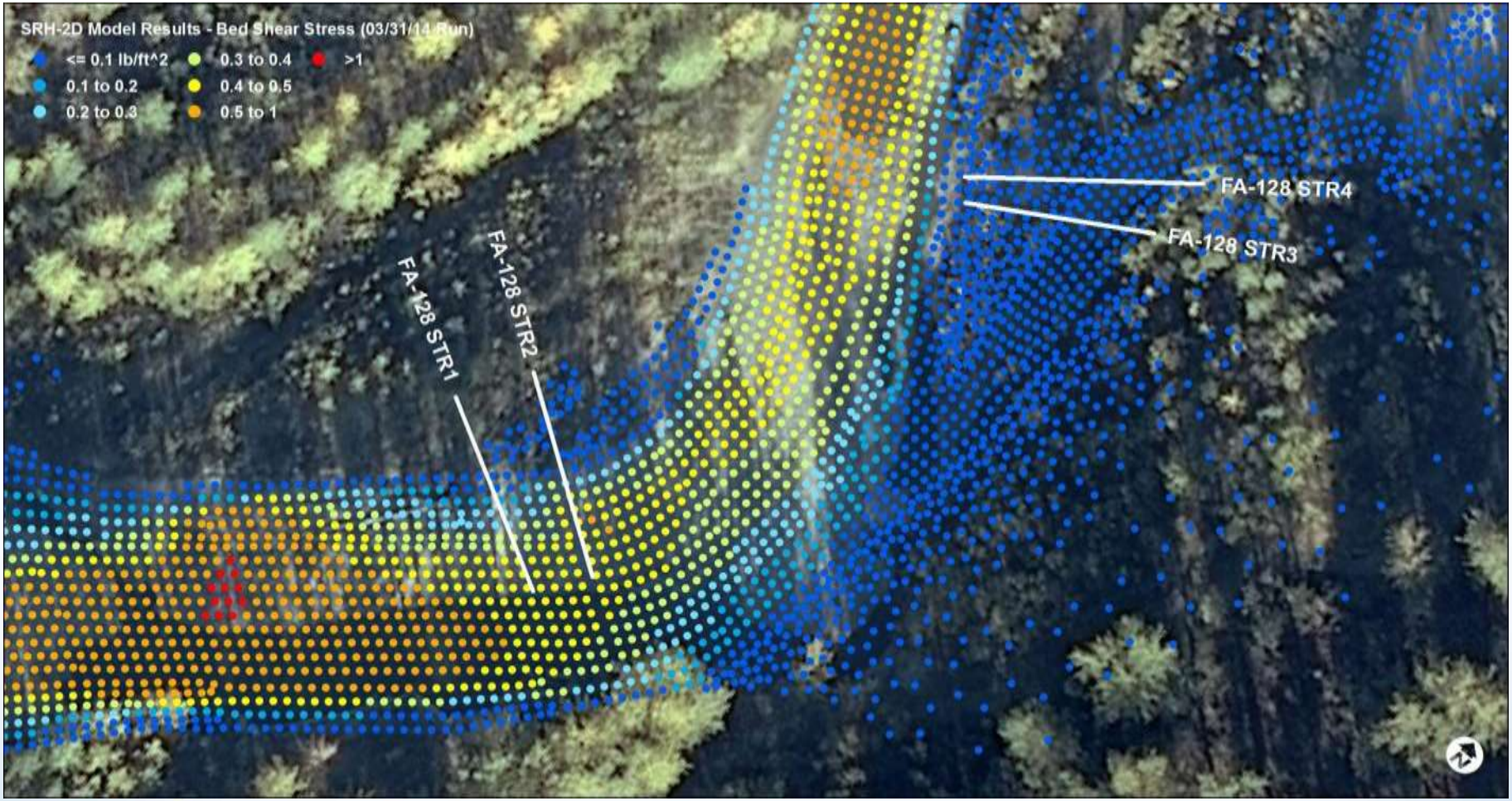
RIFS Seedling Establishment and Recruitment Study (RSP 8.6.3.3.2)
SRH-2D Bed Shear Stress Results (50,000 cfs)

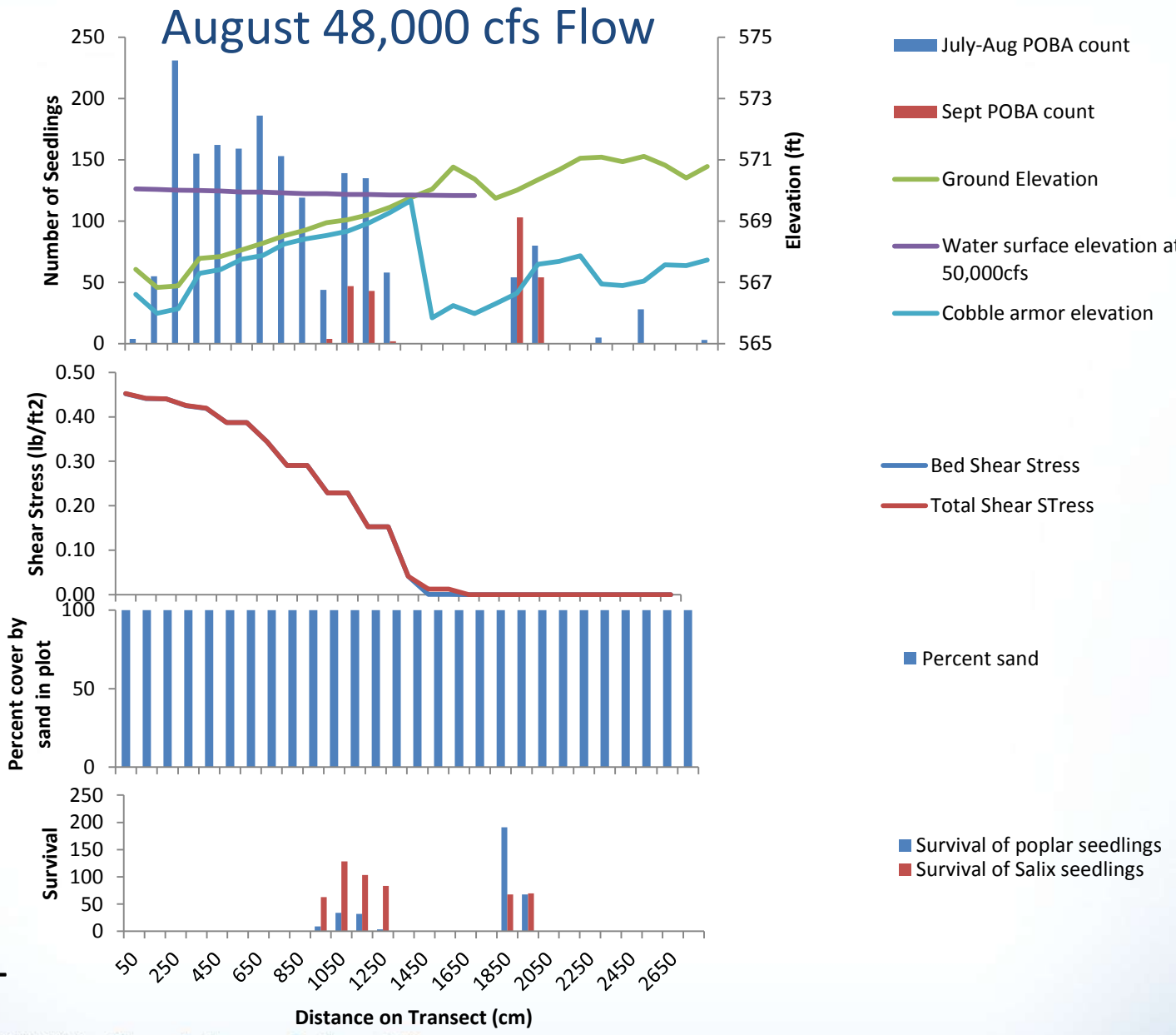


Seedling Counts and Plot Elevations

Shear Stress

Substrate

Survival rate



FA 128 STR 1

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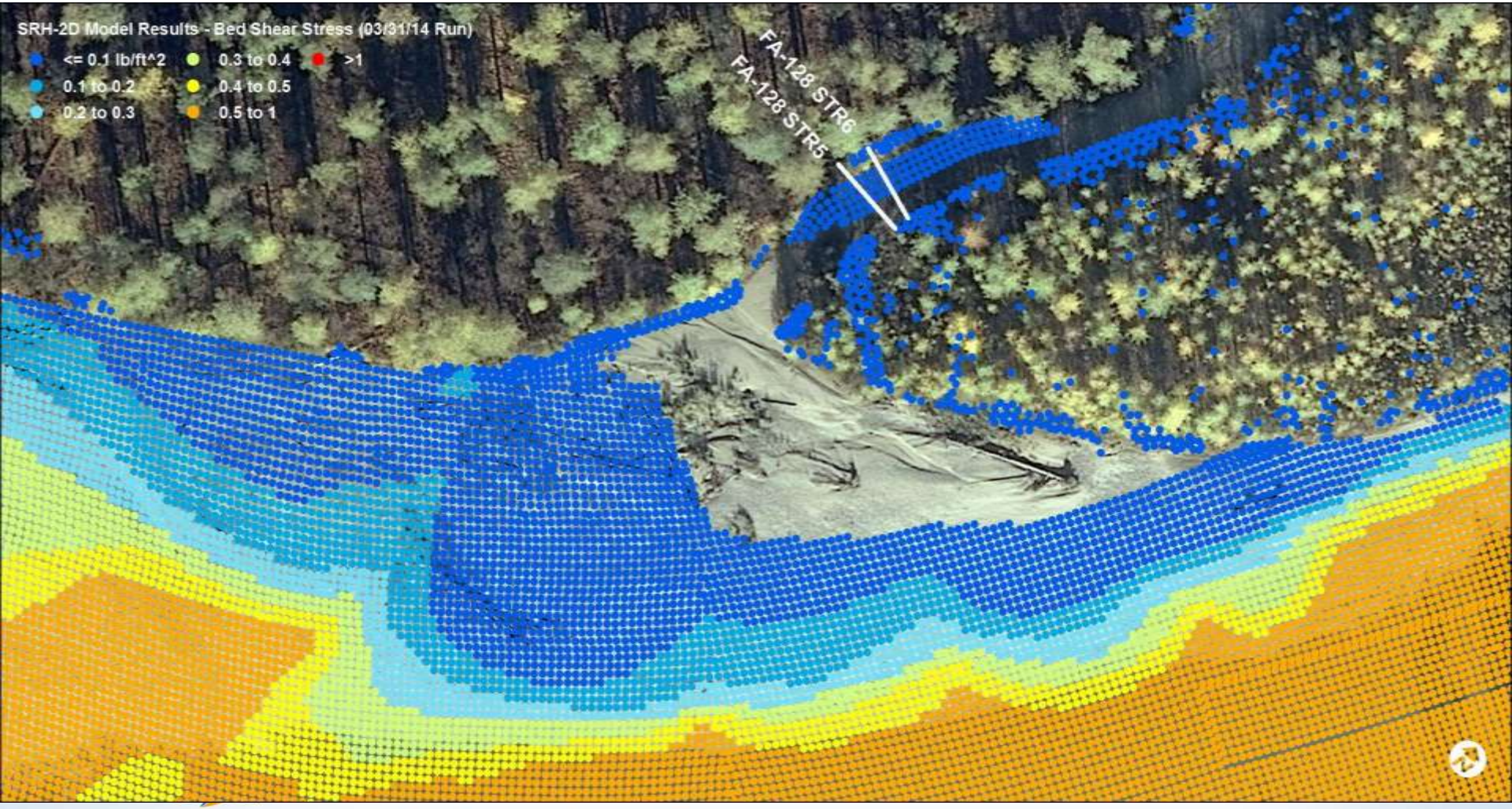
RIFS Seedling Establishment and Recruitment Study (RSP 8.6.3.3.2)
SRH-2D Bed Shear Stress Results (50,000 cfs)



(Auble and Scott 1998)

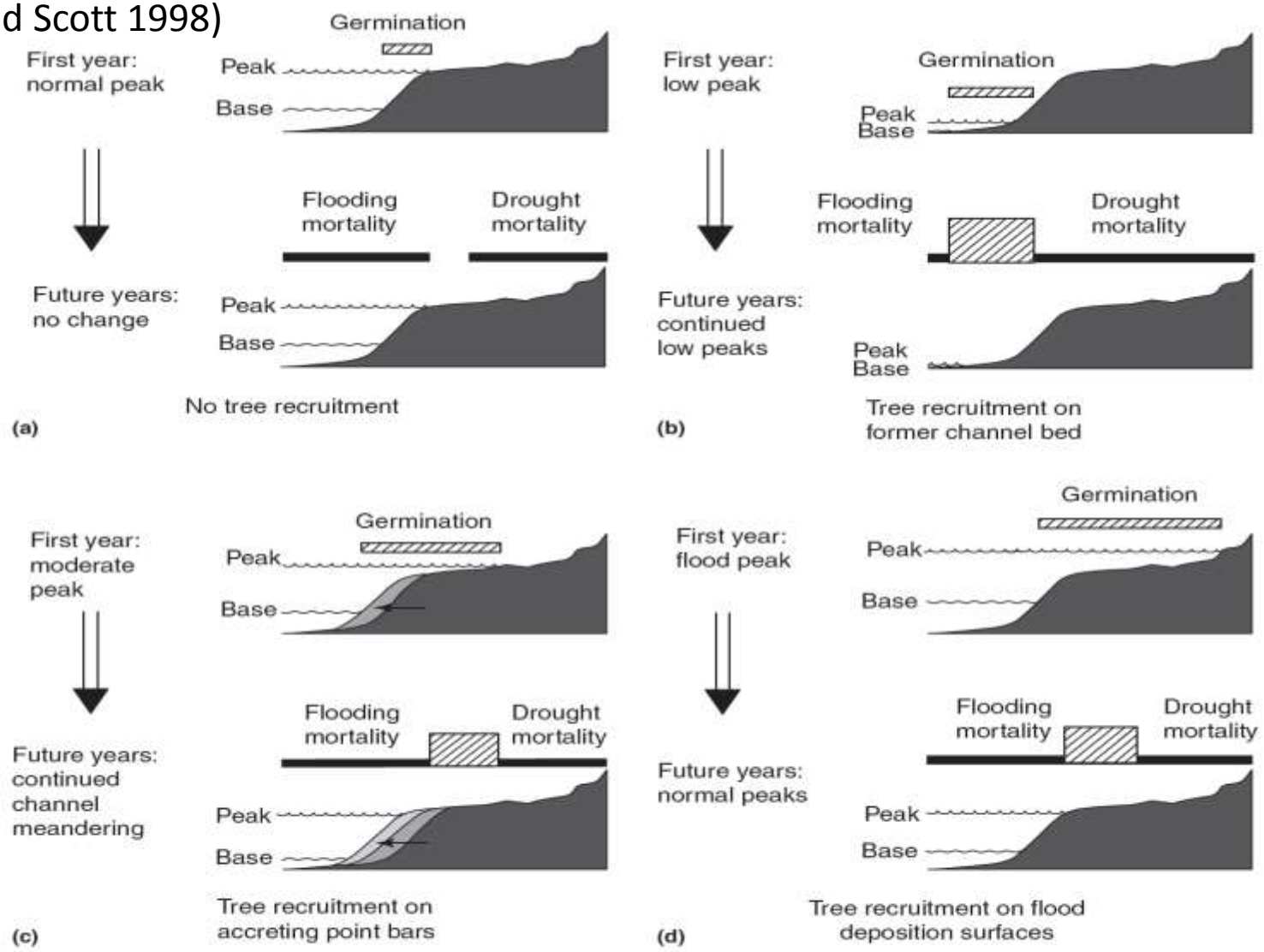
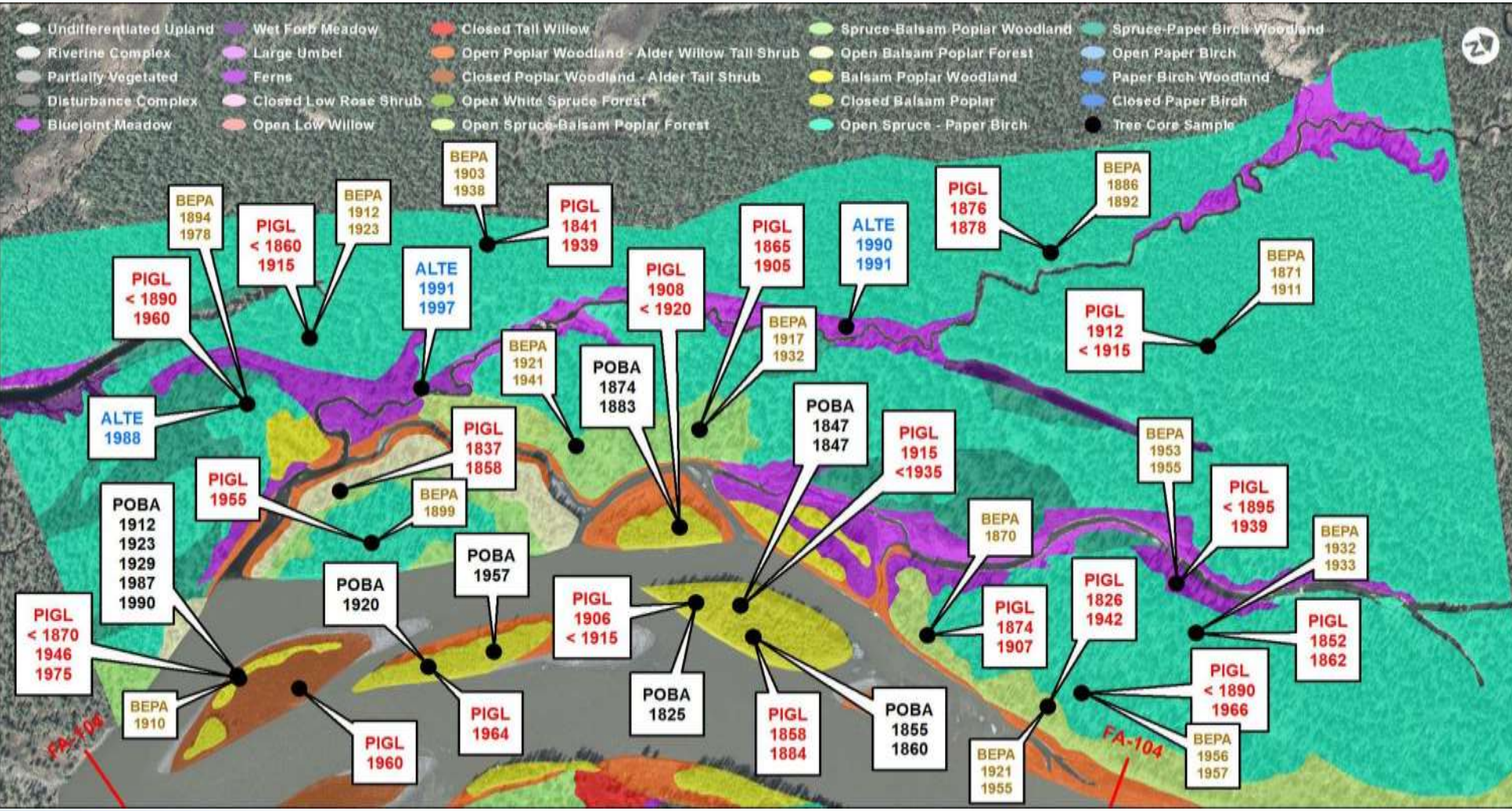


Figure 4 Hydrogeomorphic control of cottonwood recruitment: diagrammatic representations of cottonwood seed germination, early seedling mortality, and tree recruitment in relation to annual high and low flow lines along a riparian cross section. Four idealized situations are depicted: (a) little or no tree recruitment in the absence of inter-annual flow variability and channel movement, (b) channel narrowing with recruitment on the former channel bed, (c) recruitment on point bars of a meandering river, and (d) tree recruitment at high elevations associated with infrequent floods and no channel movement. Reproduced from Auble, G.T., Scott, M.L., 1998. Fluvial disturbance patches and cottonwood recruitment along the upper Missouri River, MT. Wetlands 18(4), 546–556, with permission from SWS.

RIFS Study 8.6.3.5 – Dendrochronology

Draft Tree Ages – FA-104 (Whiskers Slough)



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Tree Species

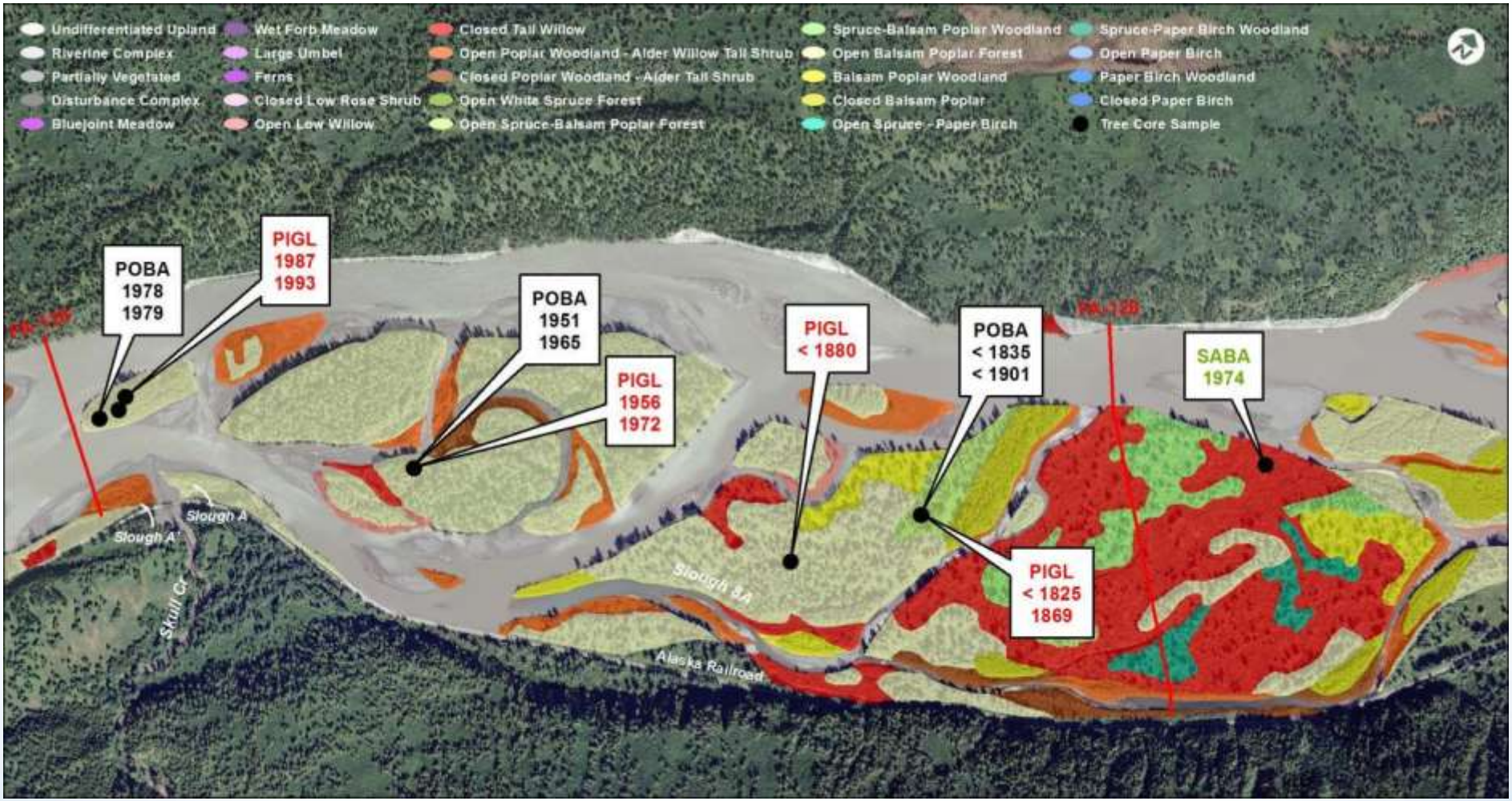
POBA = Populus balsamifera

ALTE = Alnus tenuifolia

PIGL = Picea glauca

BEPA = Betula papyrifera

Draft Tree Ages – FA-128 (Slough 8A)



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POBA = Populus balsamifera
SABA = Salix barclayi
PIGL = Picea glauca

Overview of Riparian Vegetation Study to date (RSP 11.6)

- In 2012
  - 90 ITU mapping plots along middle Susitna River
  - ITU plots vegetation and soils data used for mapping verification and classification of local scale ecosystems (ecotypes)
- In 2013
  - 217 ITU mapping plots, middle and lower river
  - 62 ELS plots, focus areas only, stratified-random sample design, set up as long-term plots

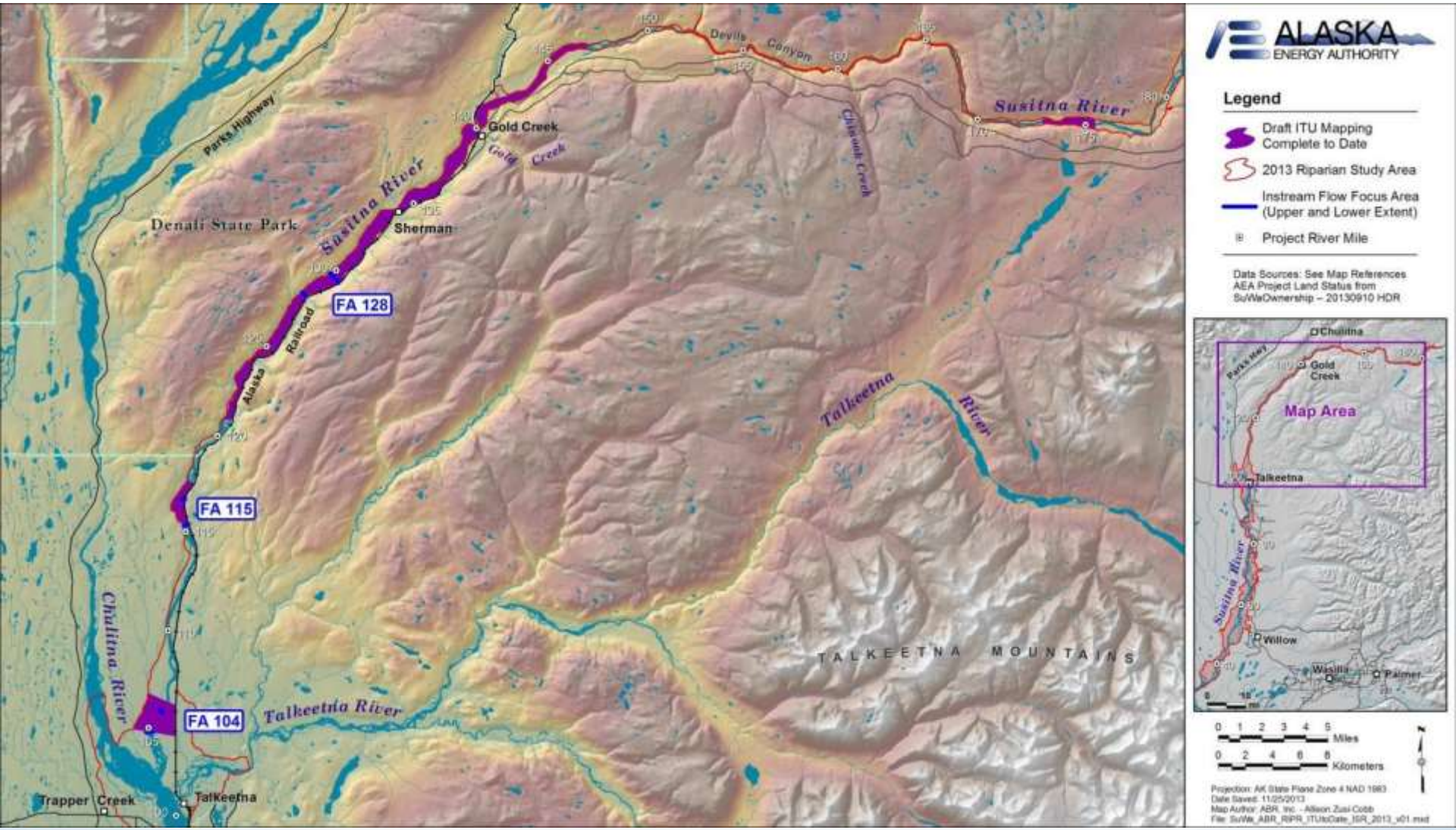
Overview of Riparian Vegetation Study to date (RSP 11.6)

- Integrated terrain unit (ITU) mapping is a multi-parameter mapping approach in which several landscape elements (e.g., vegetation, terrain unit) are mapping simultaneously
  - Terrain unit (e.g., Meander Active Channel Deposit)
  - Surface form (e.g., Mid-channel Bar)
  - Vegetation (e.g., Open Poplar Forest)
  - Poplar size class (e.g., Pole-sized)
  - Recent Disturbance (e.g., Ice-scour)

Overview of Riparian Vegetation Study to date (Study 11.6)

- Details provided in the Riparian Vegetation Study Initial Study Report
  - Field methods
  - Mapping methods
  - Preliminary data analysis and mapping

Riparian Vegetation Study (Study 11.6)



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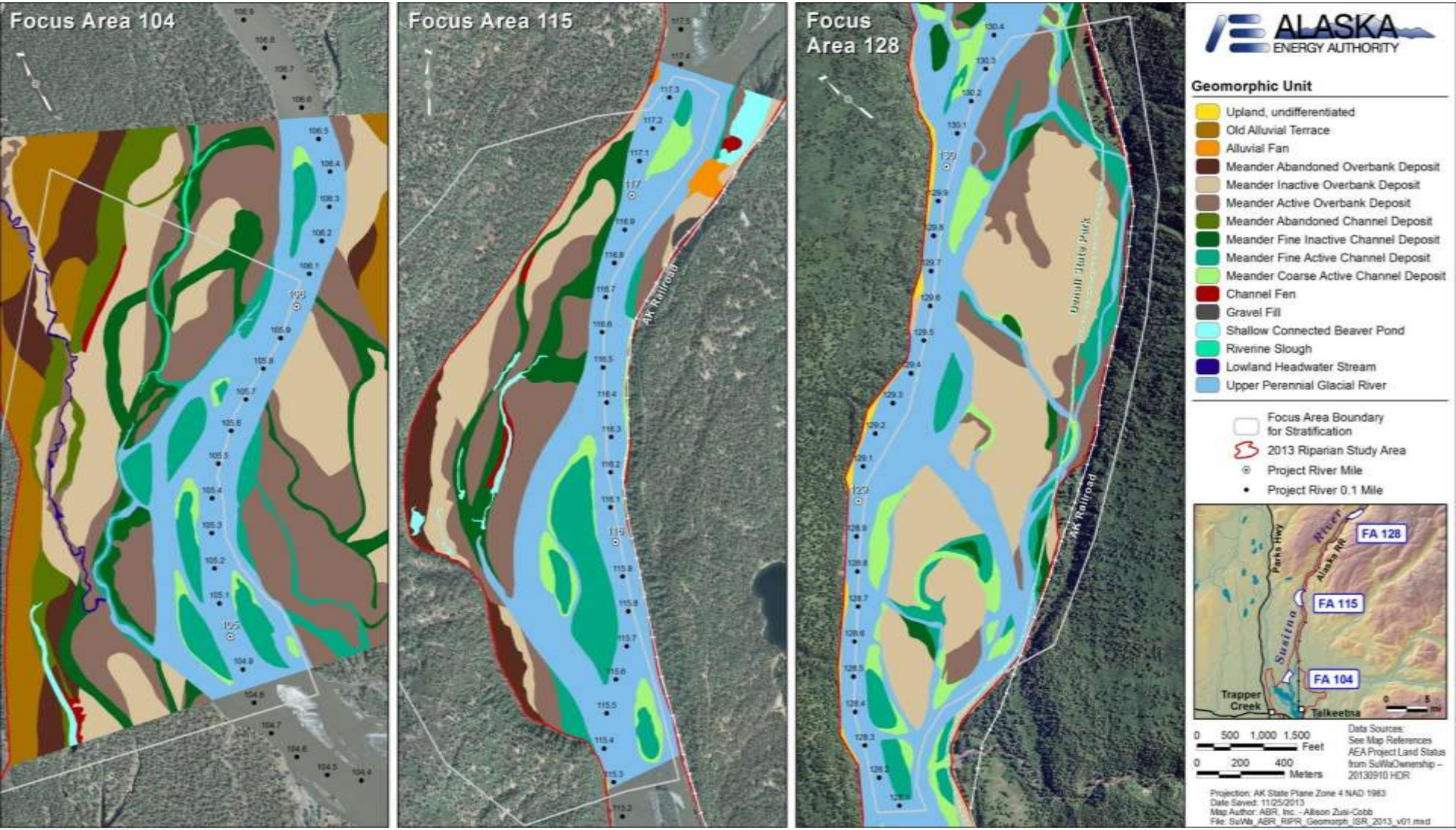
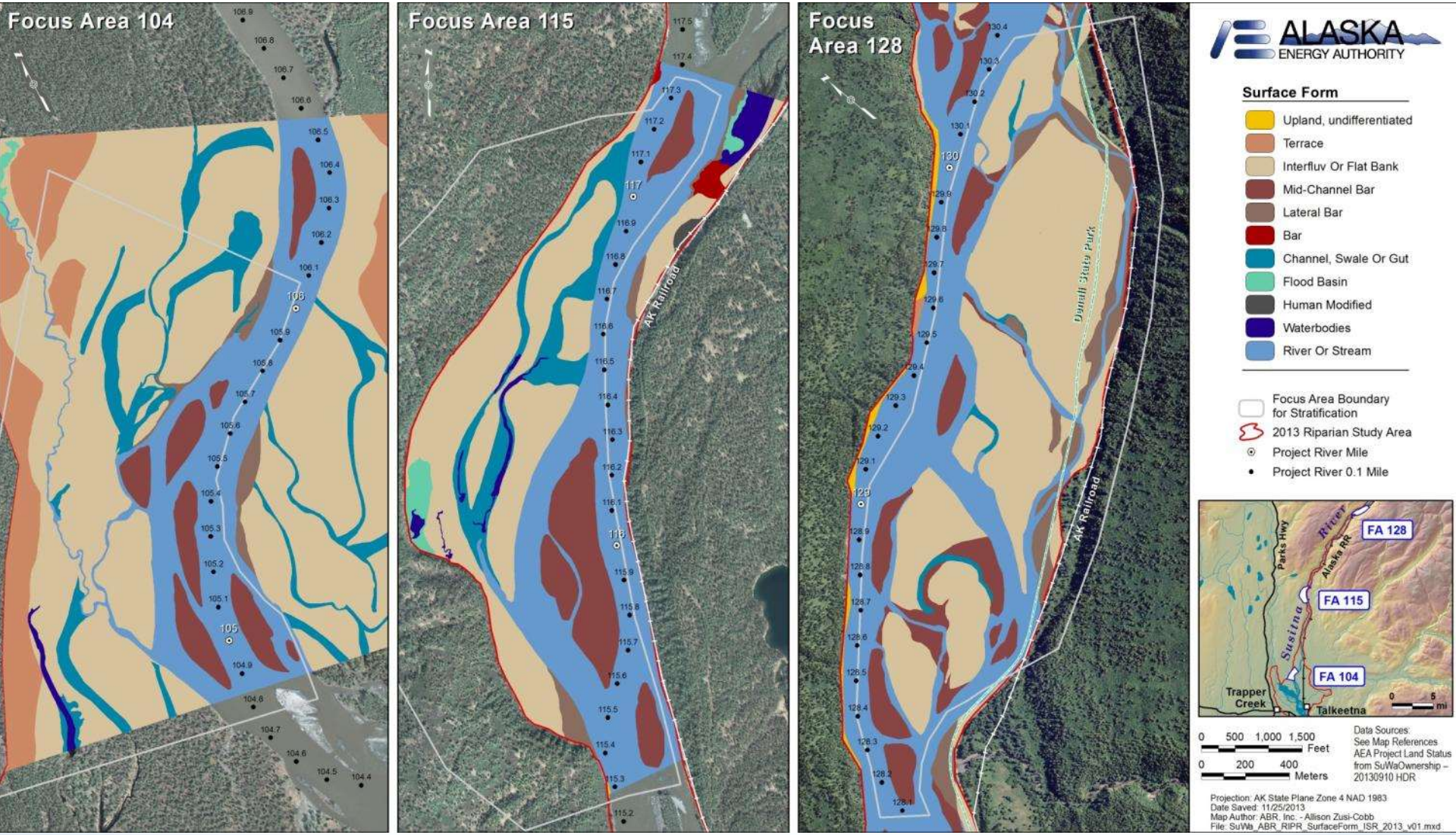
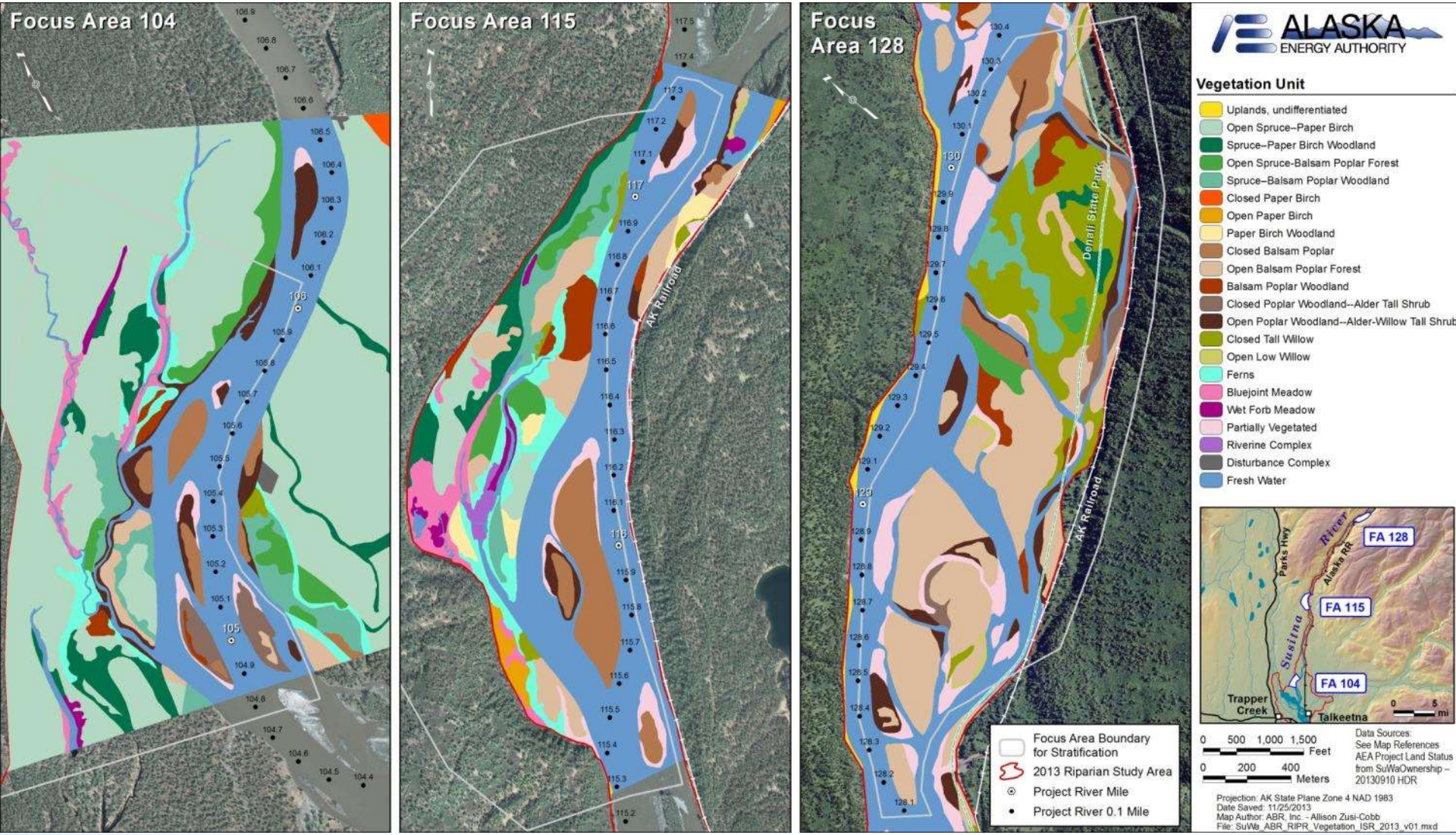
Riparian Vegetation Study (Study 11.6)



Riparian Vegetation Study (Study 11.6)



Riparian Vegetation Study (Study 11.6)



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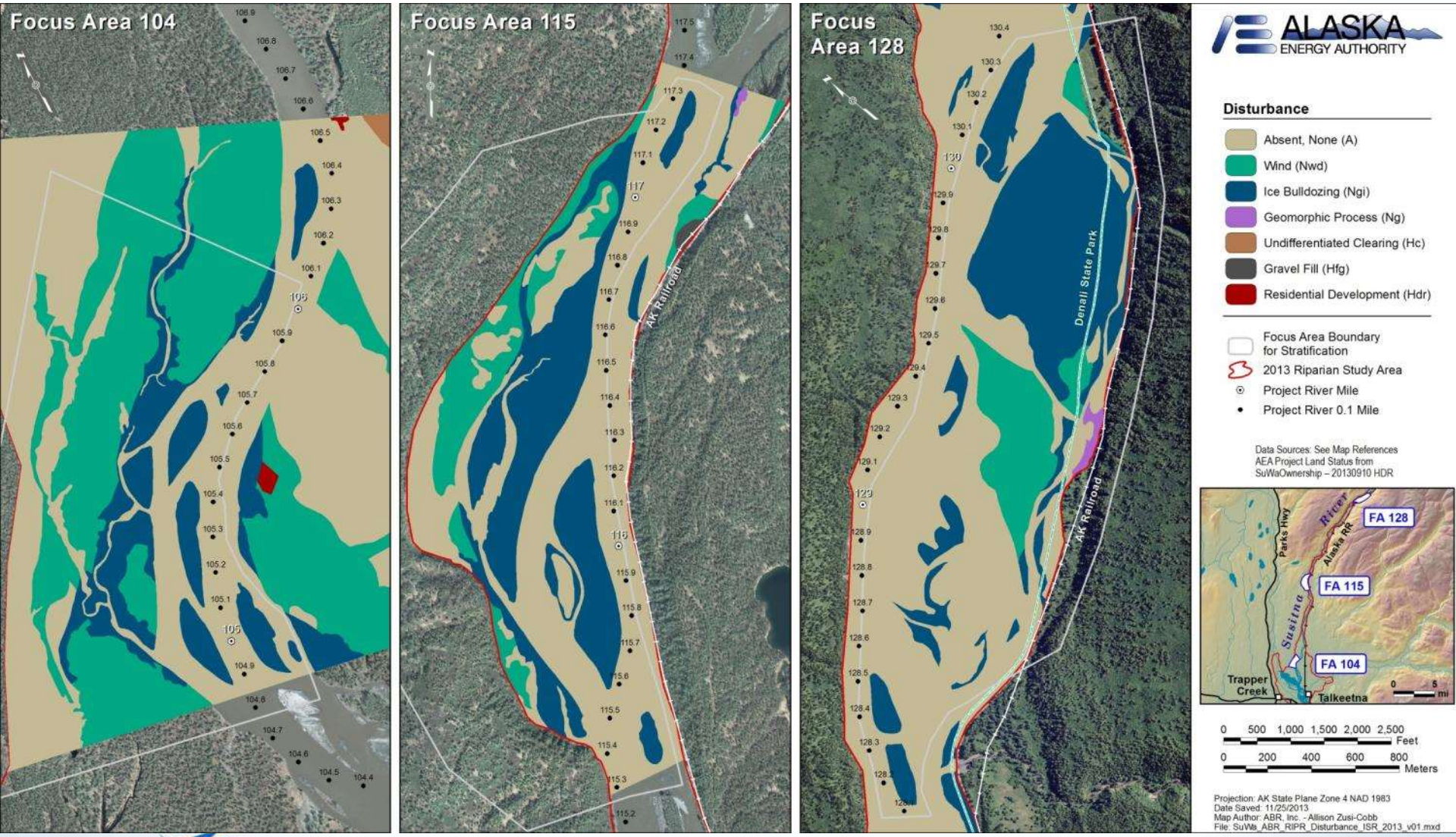
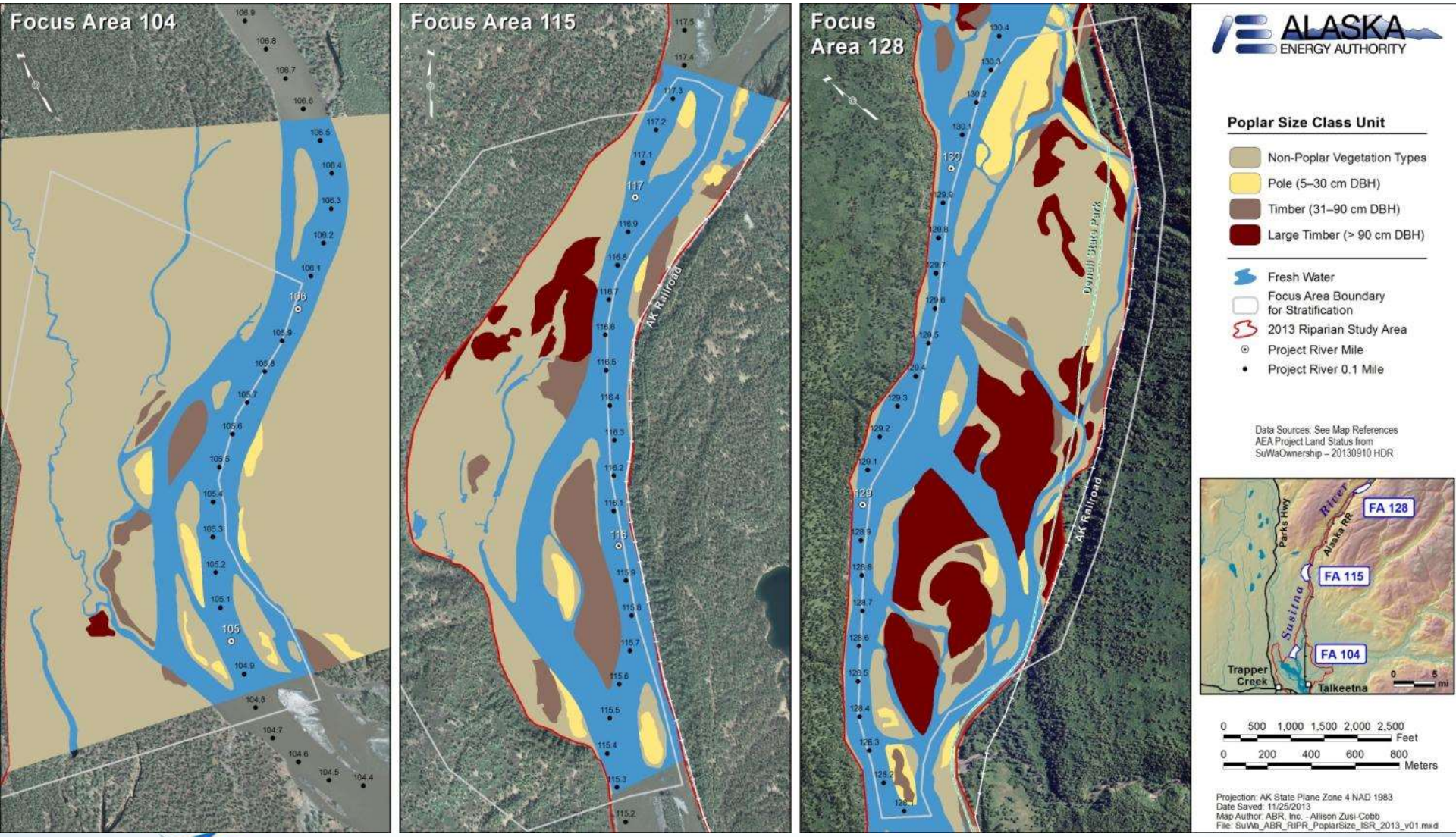
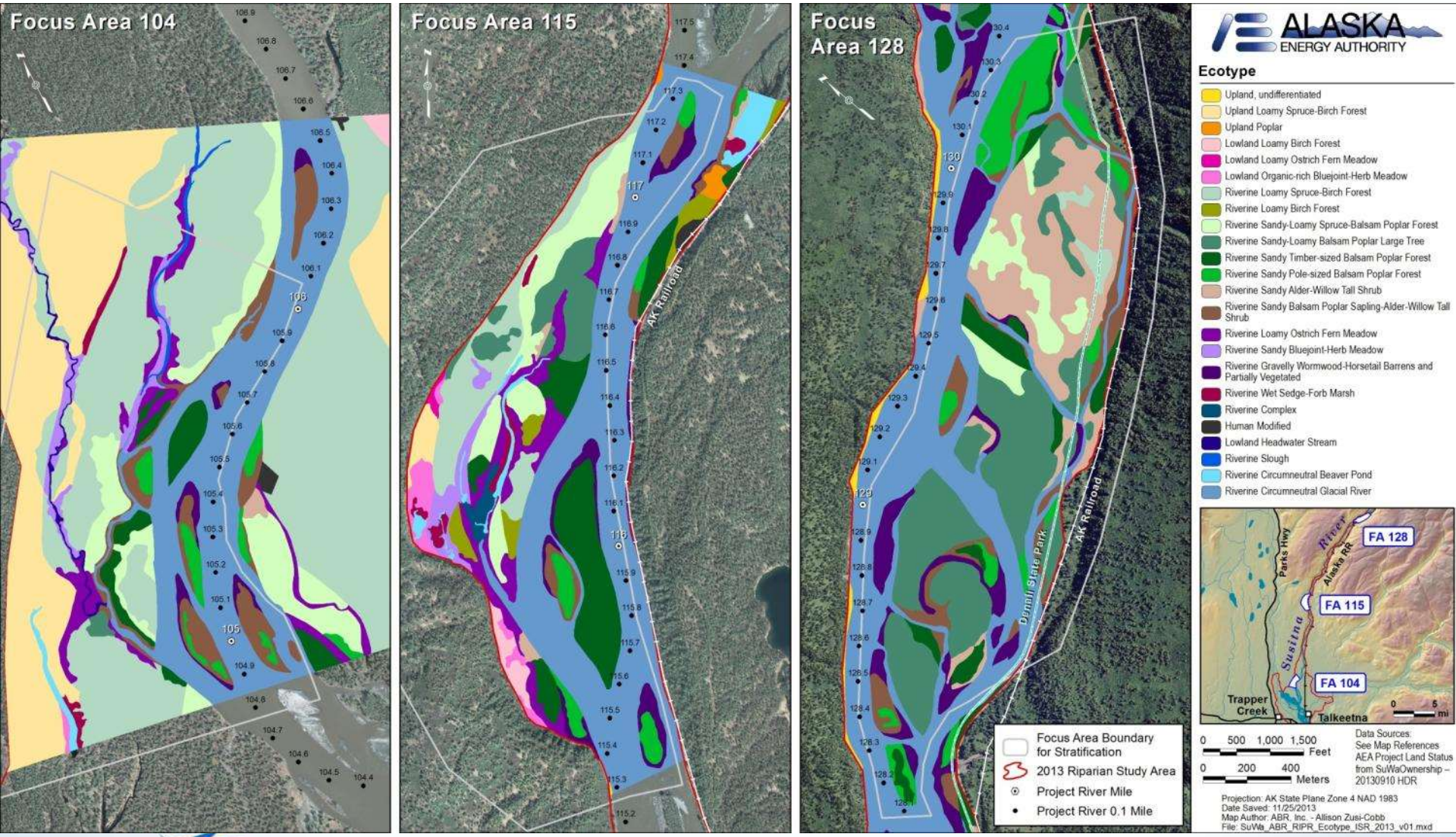
Riparian Vegetation Study (Study 11.6)



Riparian Vegetation Study (Study 11.6)



Riparian Vegetation Study (Study 11.6)



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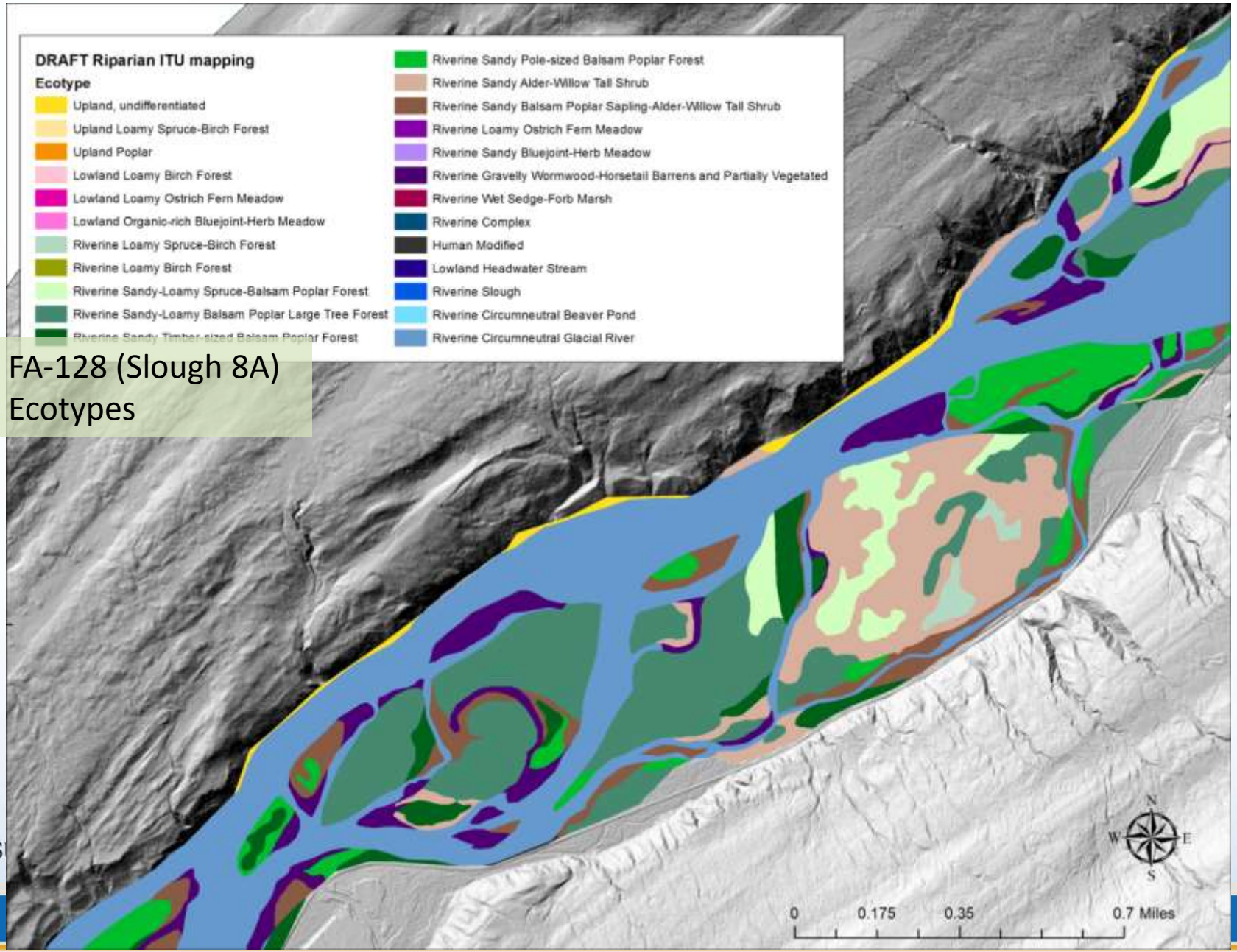
ITU mapping and flood extent modeling (Riparian Vegetation Study RSP 11.6)

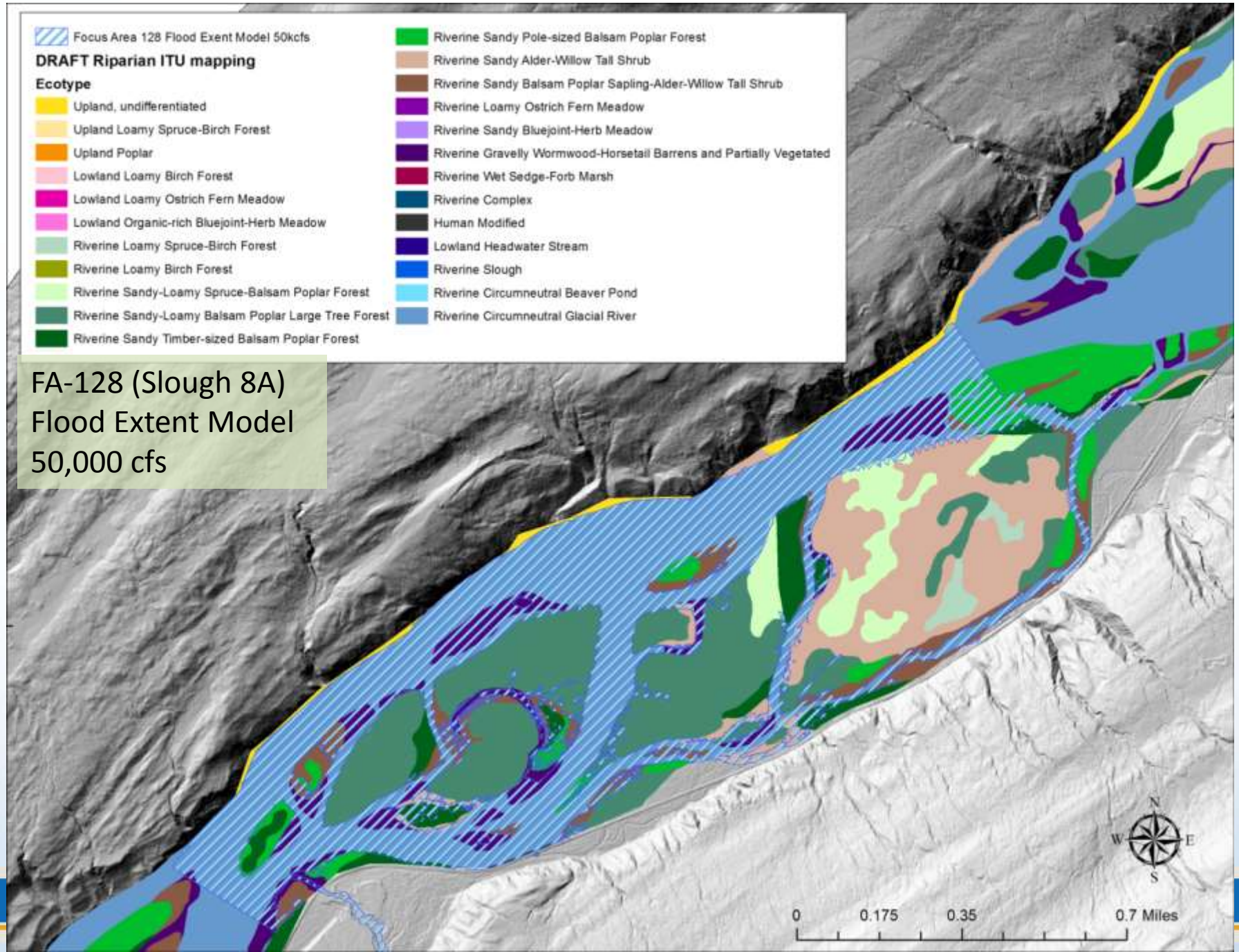
- Focus Area FA-128 (Slough 8A) as example
- Overlay the flood extent modeling over the ITU mapping
- Run a spatial “union” in GIS to combine the ITU mapping and flood extent layers
- Estimate the area flooded by ecotype and determine the areal extent of ecotypes flooded under various flood magnitudes

Riparian Vegetation Study (Study 11.6)

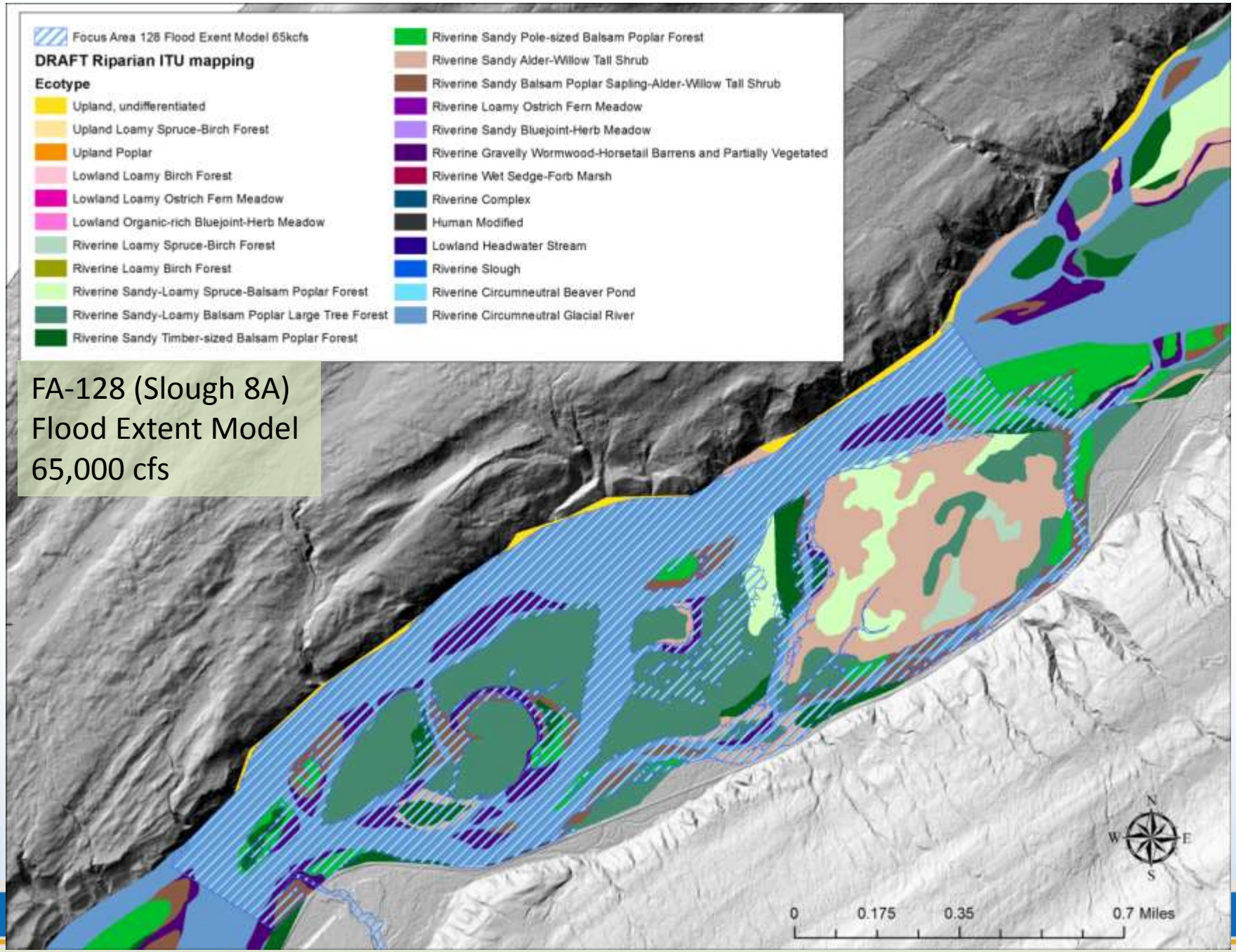


FA-128 (Slough 8A) Ecotypes

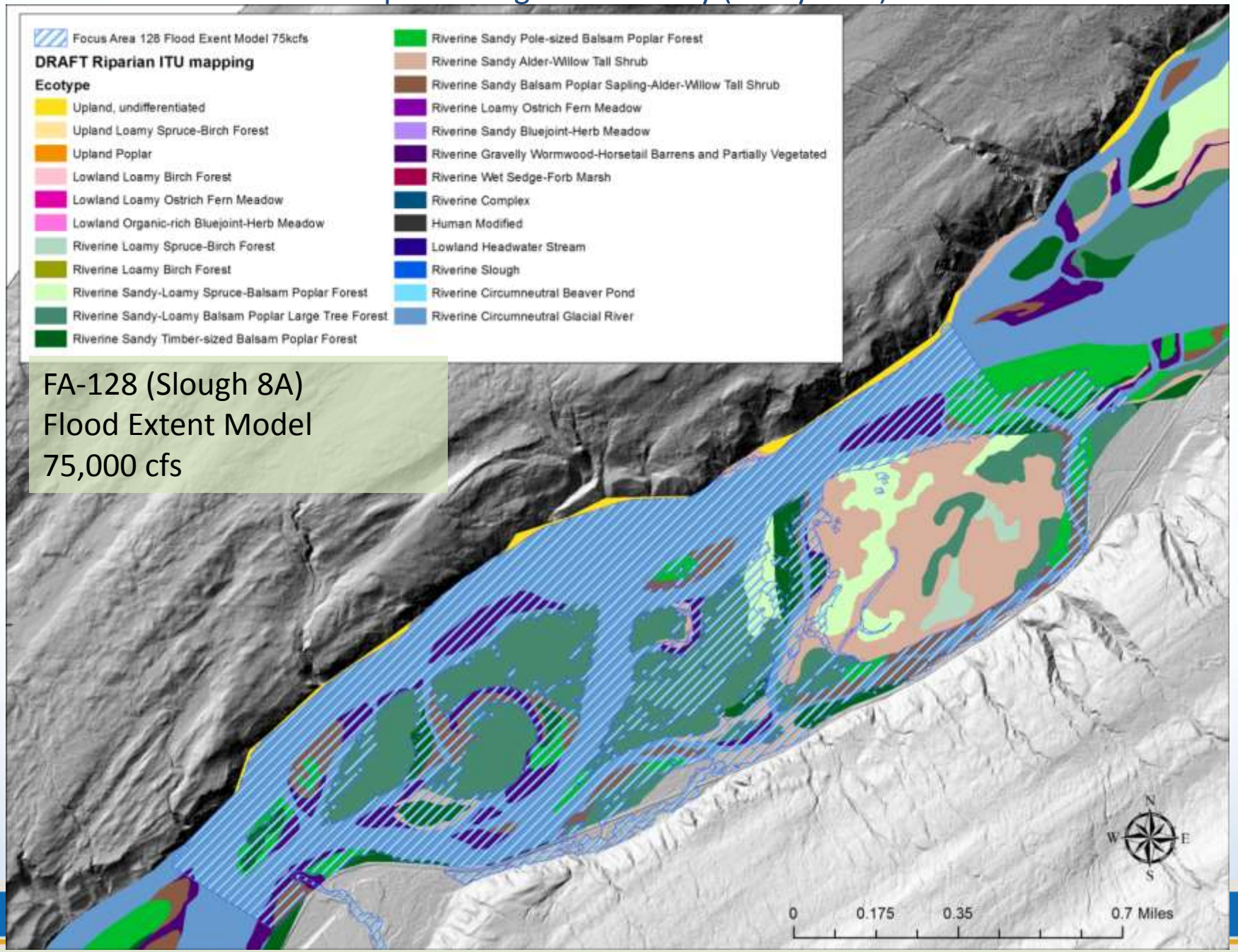
Riparian Vegetation Study (Study 11.6)



Riparian Vegetation Study (Study 11.6)



Riparian Vegetation Study (Study 11.6)



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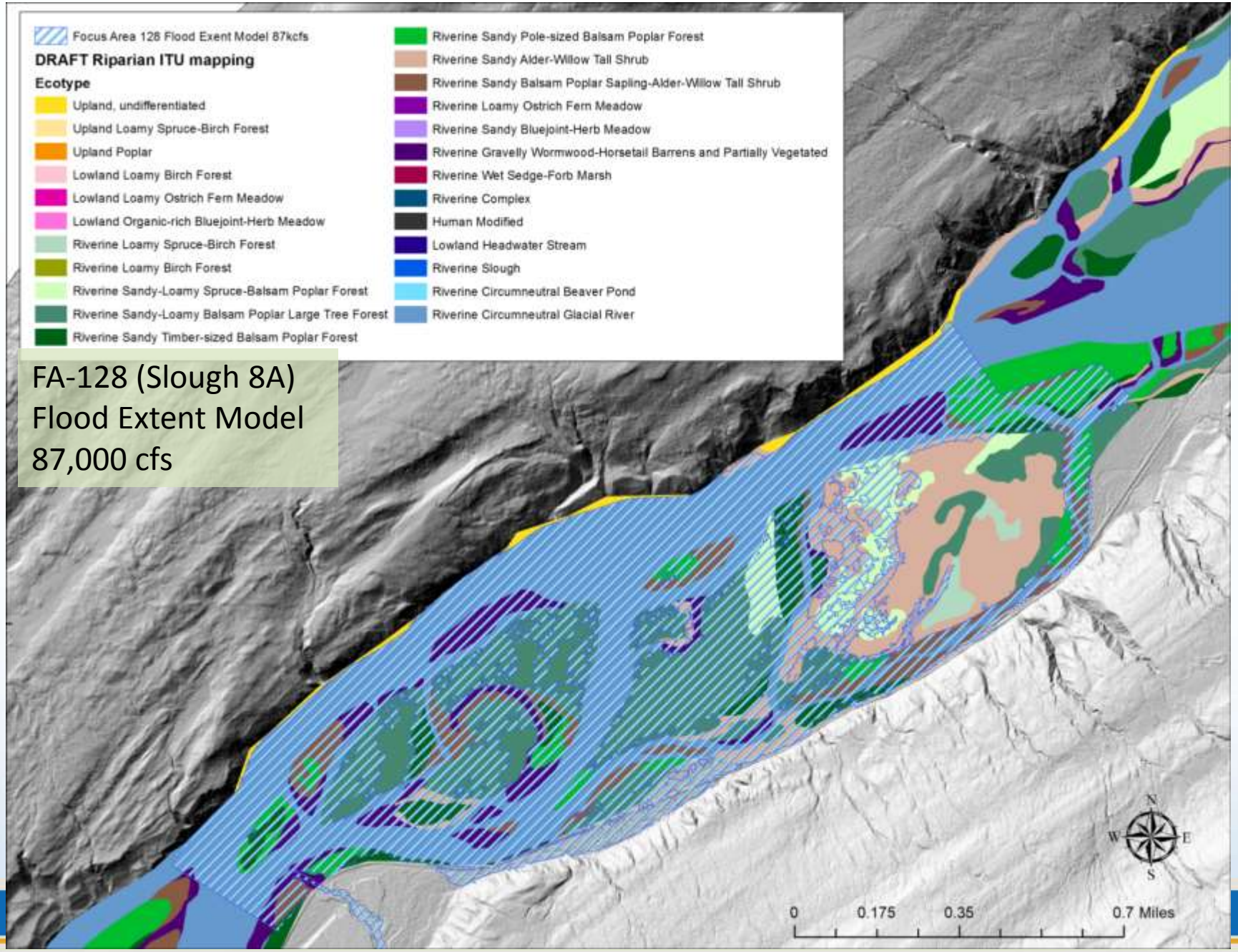
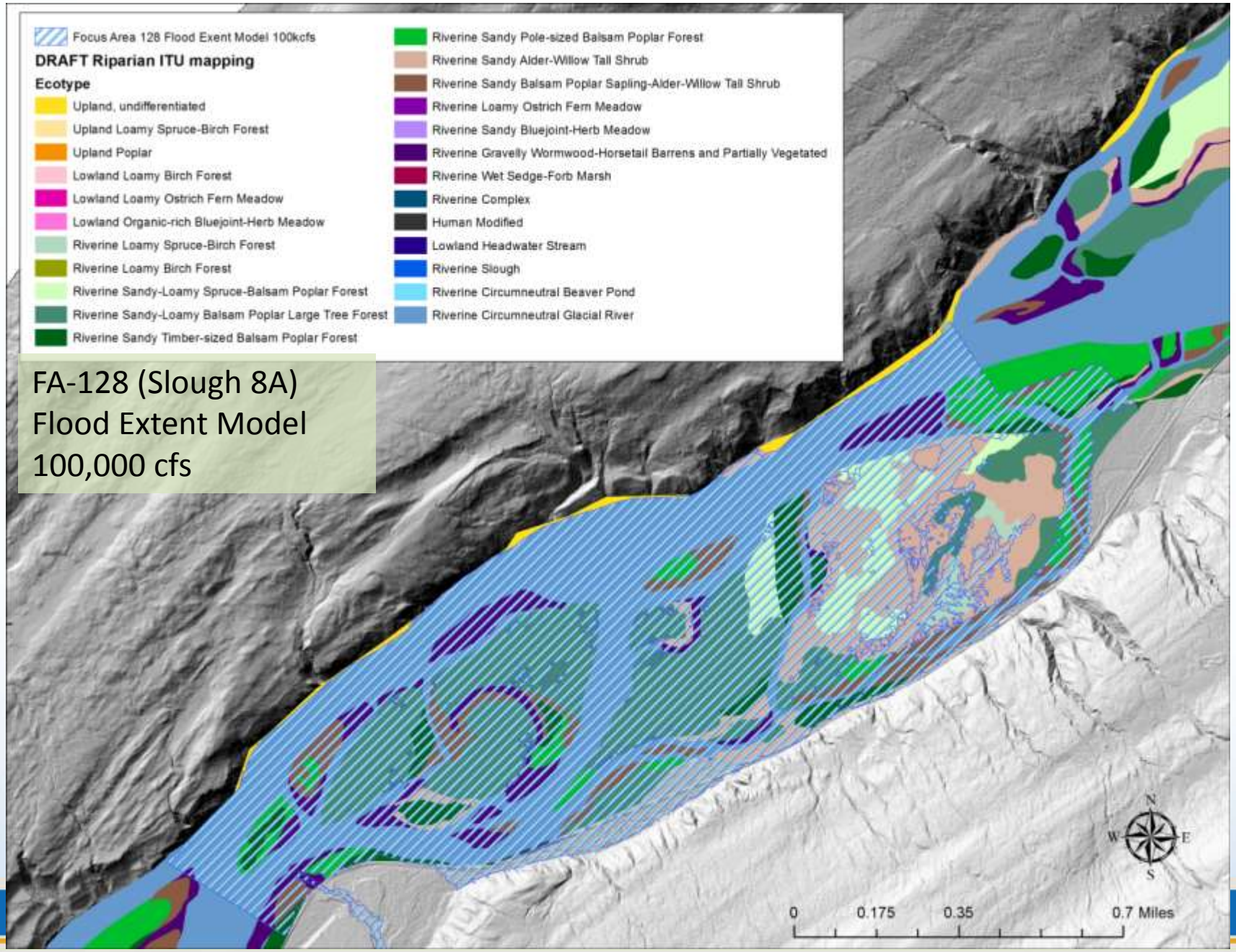


Riparian Vegetation Study (Study 11.6)

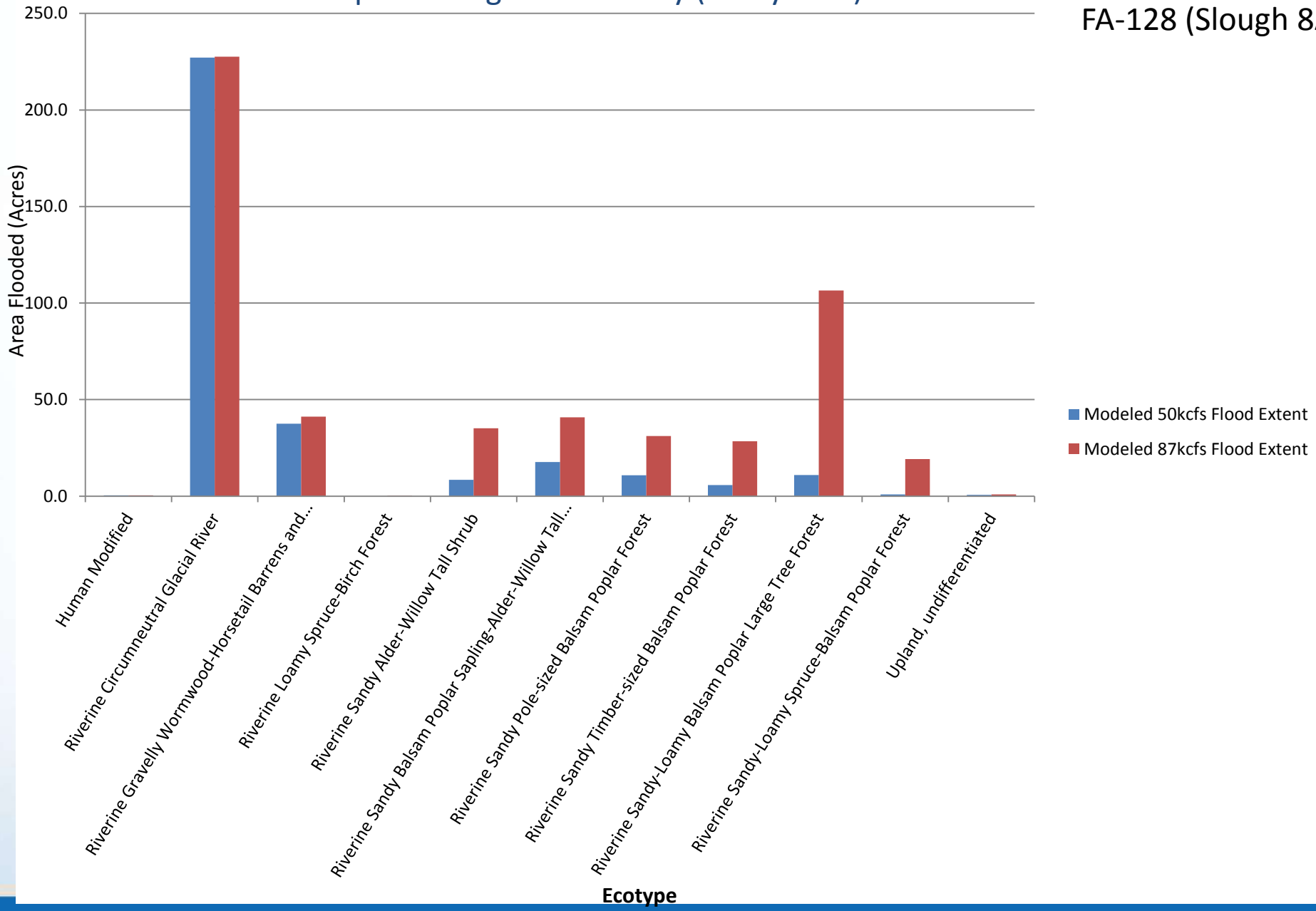


Areal Extent of Draft Ecotypes at FA-128 (Slough 8A)

Draft Ecotype Class	Modeled Flood Extent 50,000 cfs	Modeled Flood Extent 87,000 cfs
	Area Flooded (acres)	Area Flooded (acres)
Human Modified	0.4	0.5
Riverine Circumneutral Glacial River	227.1	227.6
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	37.6	41.2
Riverine Loamy Spruce-Birch Forest	0.0	0.2
Riverine Sandy Alder-Willow Tall Shrub	8.5	35.2
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	17.7	40.8
Riverine Sandy Pole-sized Balsam Poplar Forest	10.8	31.1
Riverine Sandy Timber-sized Balsam Poplar Forest	5.8	28.4
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	10.9	106.5
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	0.9	19.2
Upland, undifferentiated	0.7	0.9
Grand Total	320.4	531.6

Riparian Vegetation Study (Study 11.6)

FA-128 (Slough 8A)



State and Transition Models: example from intermountain west rangelands

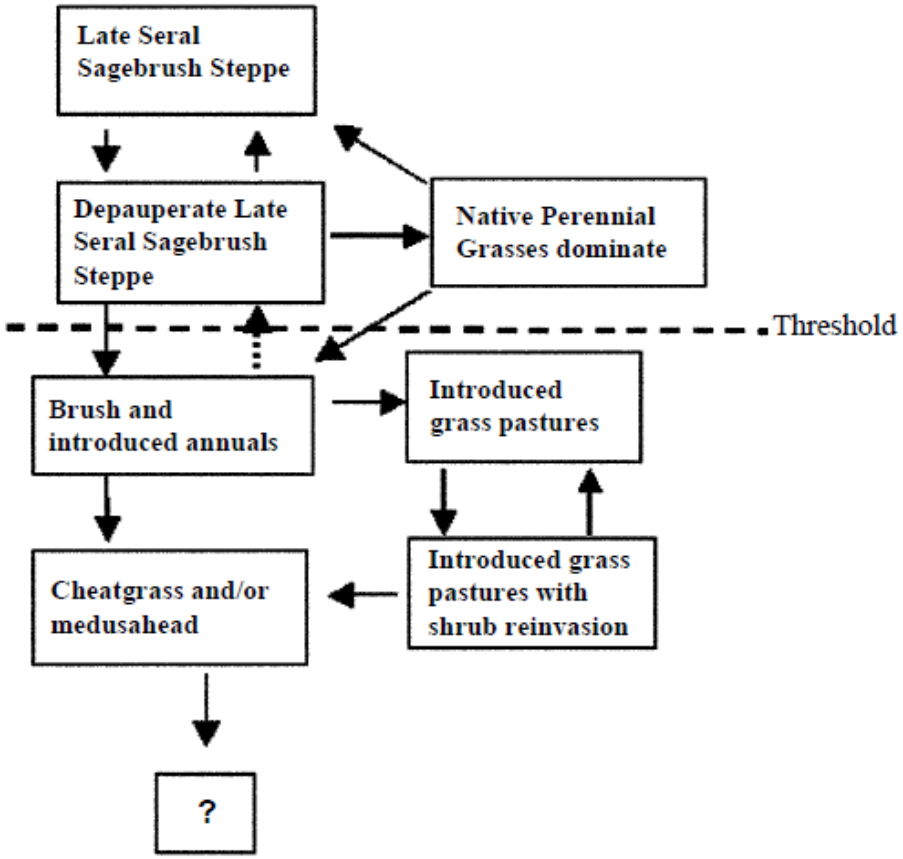
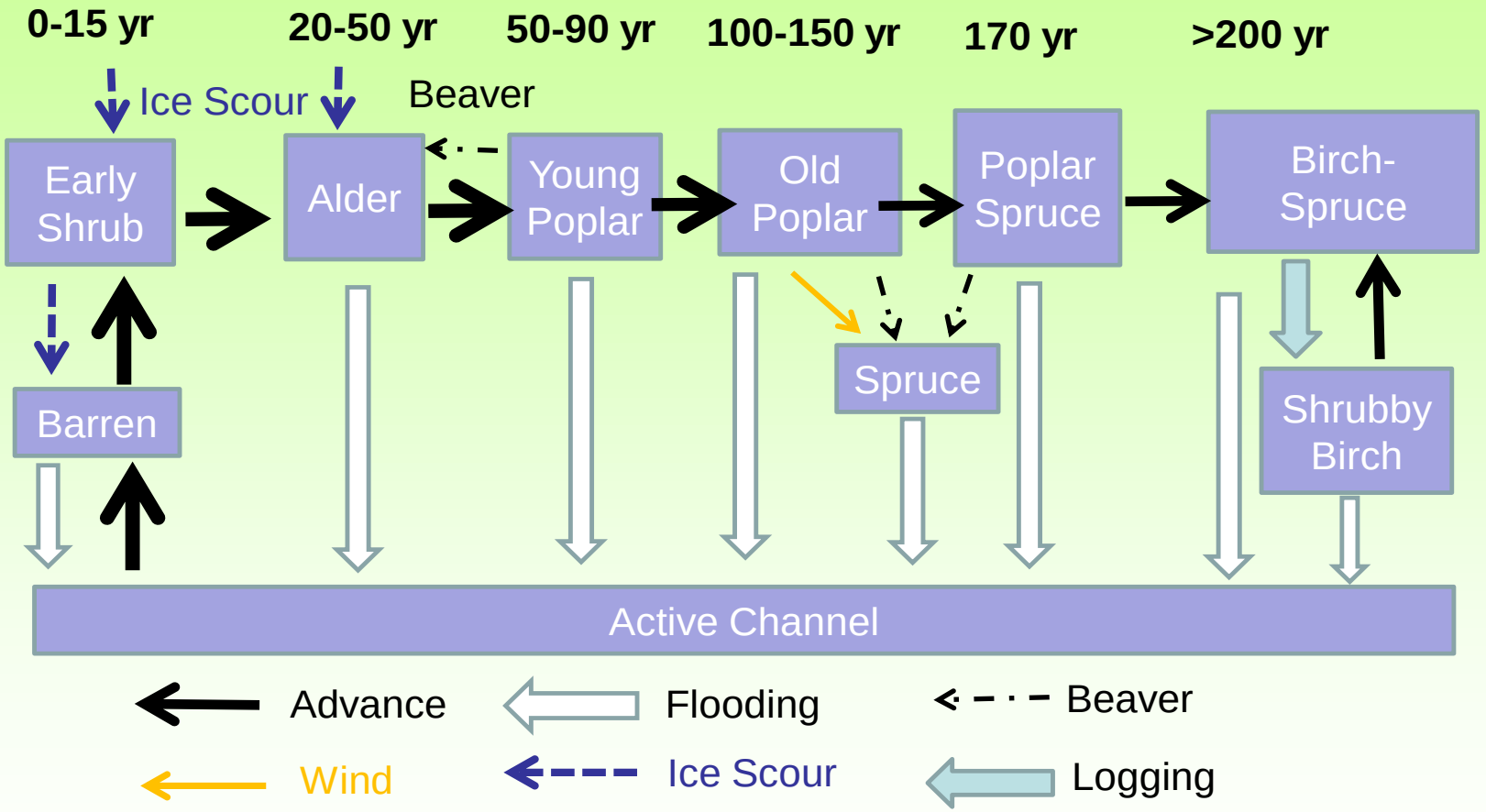


Fig. 2. Specific, or narrow, application of states with each state (box) representing 1 phase or seral stage of vegetation development. Transitions between states are indicated by arrows and the dashed line represents a threshold. The dashed transitional line signifies the requirement of substantial energy input to move the state back across the threshold. Modified from West (1999) and West and Young (2000).

From Stringham et al. 2003, J. Range Management. 56: 106-113.

Susitna River Floodplain Forest Succession



(after Helm and Collins 1997)

Modeling potential changes in riparian vegetation (Study 11.6)

- State and transition model approach
- Develop conceptual model of ecological pathways on the Susitna floodplain
- Use Helm and Collins pathways as starting point, use our field data to the refine model

Modeling potential changes in riparian vegetation (Study 11.6)

- Physical (e.g., ice processes) and hydrologic (e.g., flood extent) modeling
- Integrated Terrain Unit (ITU) mapping is a spatial representation of the riparian vegetation and environment
- Apply model in a GIS to create maps of the predicted changes in riparian vegetation

Modeling potential changes in riparian vegetation (Study 11.6)

- Metrics
  - Areal extent of ecotypes for existing conditions and 50-years post-development.
  - Change in areal extent by ecotype

Riparian Fluvial Geomorphology & Hydraulic Modeling Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. Is there a relationship between flood recurrence interval and plant community type/distribution? What are individual plant community type flood regimes?

Baseline Studies:

1. Riparian plant community maps.
2. 1-D and 2-D modeling of floodplain terrain flooding recurrence intervals.
3. Sediment isotope geochronology analysis of sediment deposition rates.

Proposed Metric:

1. Comparison of pre and post-Project flow regime and plant community type flood regimes.

Riparian Fluvial Geomorphology & Hydraulic Modeling Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.4 and RSP 8.6.3.6):

1. Do floodplain flood recurrence intervals correlate with open water flow peak floods? With ice dam events?

Baseline Studies:

1. Dendrology tree aging / floodplain surface age data.
2. Floodplain surface mapping and flood recurrence modeling.
3. Sediment isotope geochronology analysis of sediment deposition rates.

Proposed Metric: Comparison of pre- and post-Project flow and sediment transport regime throughout Project area.

Proposed Metric: Comparison of pre- and post-Project ice formation aerial distribution.

Riparian Fluvial Geomorphology & Hydraulic Modeling Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.4 and RSP 8.6.3.5):

1. What are the dominant floodplain forming processes: open water flooding and sediment deposition vs.. ice dam backwater flooding and sediment deposition?

Baseline Studies:

1. Dendrology tree aging / floodplain surface age data.
2. Floodplain surface mapping and flood recurrence modeling.
3. Sediment isotope analysis of sediment deposition rates.
4. Analysis of channel/floodplain change from 1950s, 1980s and current aerial photography.

Proposed Metric: Comparison of pre- and post-Project flow and sediment transport regime throughout Project area.

Proposed Metric: Comparison of pre- and post-Project ice formation pattern.

Riparian Fluvial Geomorphology & Hydraulic Modeling
Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.5):

1. What are the rates of channel migration/floodplain erosion under the natural flow regime?

Baseline Studies:

1. Analysis of channel/floodplain change from 1950s, 1980s and current aerial photography.

Proposed Metric:

Comparison of pre- and post-Project Bank Energy Index (BEI).

Riparian Fluvial Geomorphology & Hydraulic Modeling
Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.3 and RSP 8.6.3.5):

1. What is the relationship between bed shear stress and seedling establishment pattern?
2. What is relationship between sediment size and seedling establishment?

Baseline Studies:

1. Seedling establishment transect surveys.

Proposed Metrics:

1. 2-D modeled change in channel distribution of ≥ 2-year flow bed shear stress.
2. Sediment transport modeling of changes in sediment deposition patterns.

Riparian Instream Flow Modeling

Mapping Riparian Inundation Areas Between Focus Areas

- Use HEC-RAS Open Water Flow Routing Model to identify wetted areas at cross-section locations

- Use LiDAR contours to map wetted areas between HEC-RAS cross-sections

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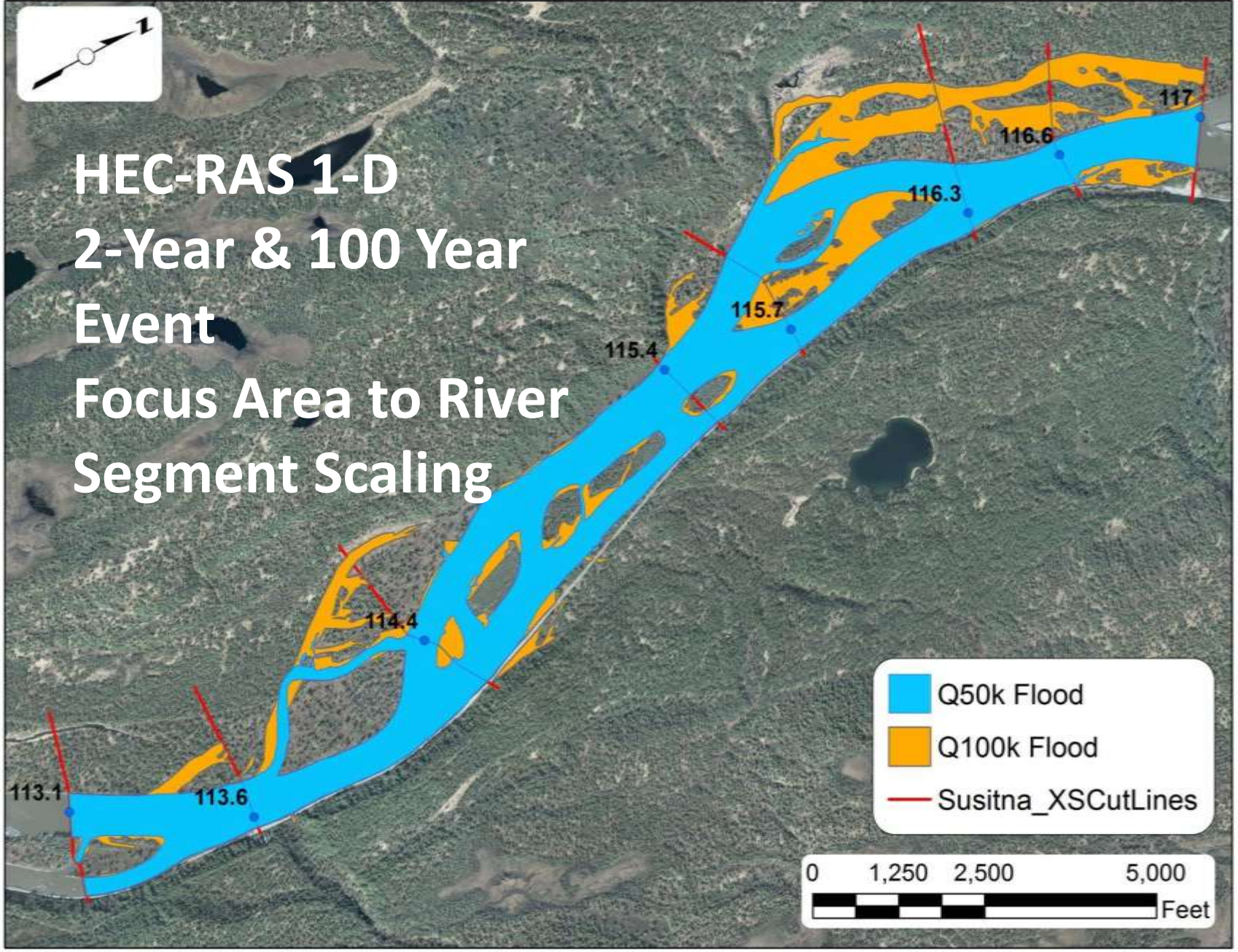
Riparian Instream Flow Modeling

Mapping Riparian Inundation Areas Between Focus Areas

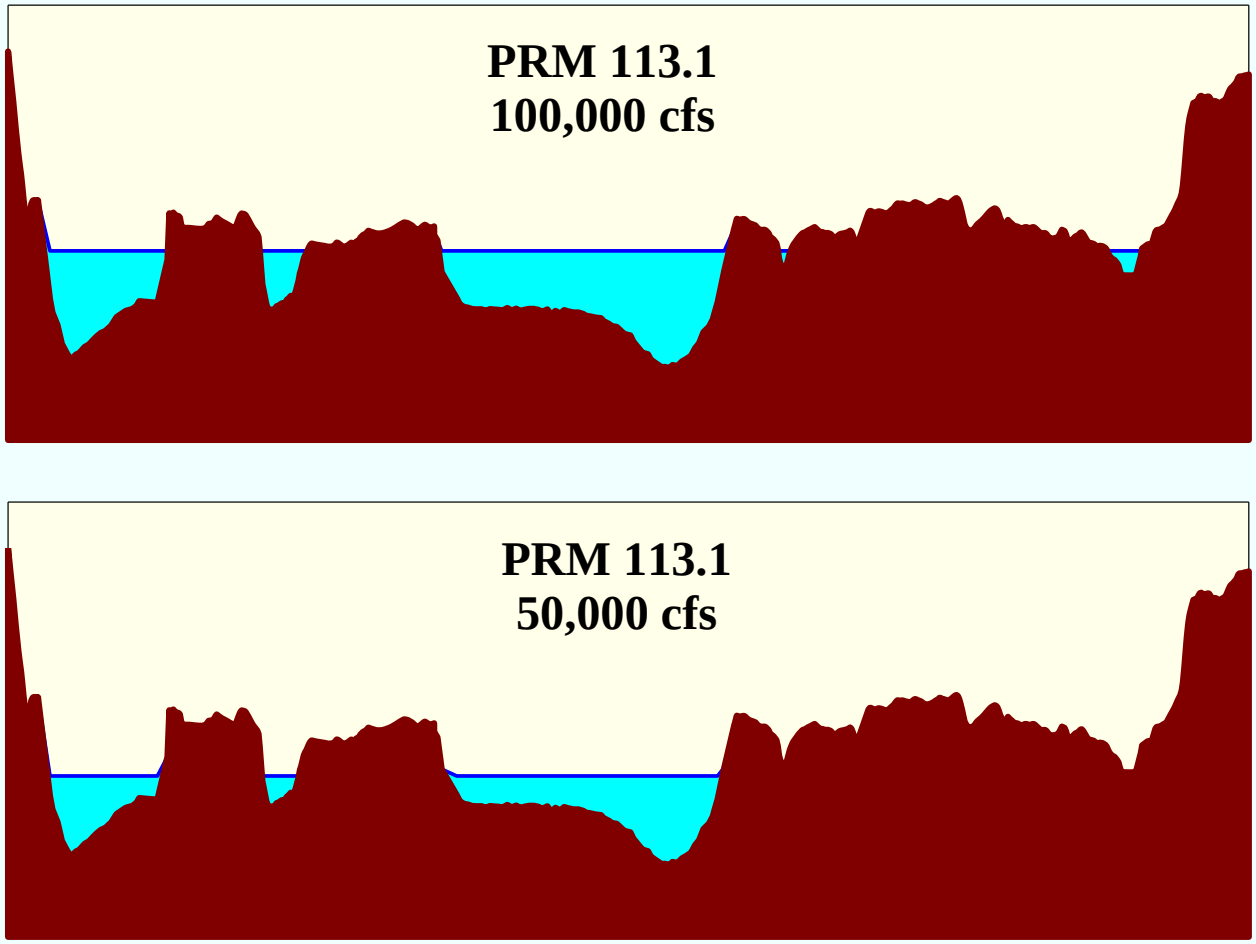
Limitations

- Accuracy of inundation mapping depends on accuracy of LiDAR data – less accurate in areas with vegetative canopy.

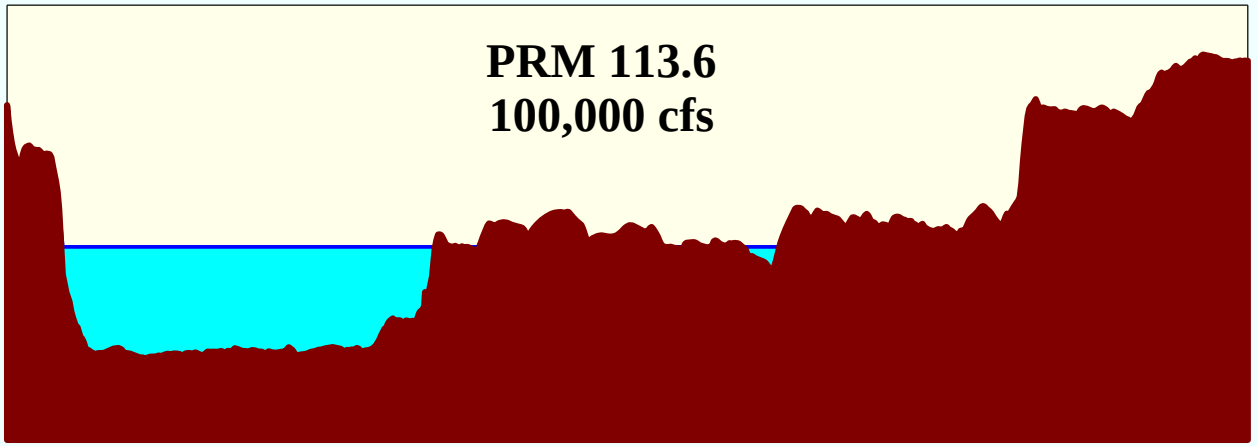
HEC-RAS 1-D 2-Year & 100 Year Event Focus Area to River Segment Scaling

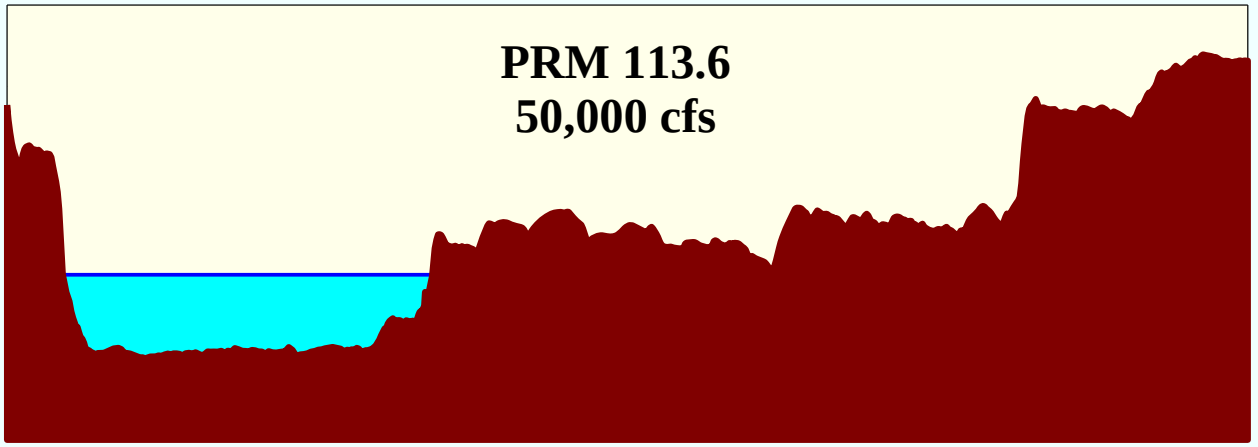


Riparian Instream Flow Modeling

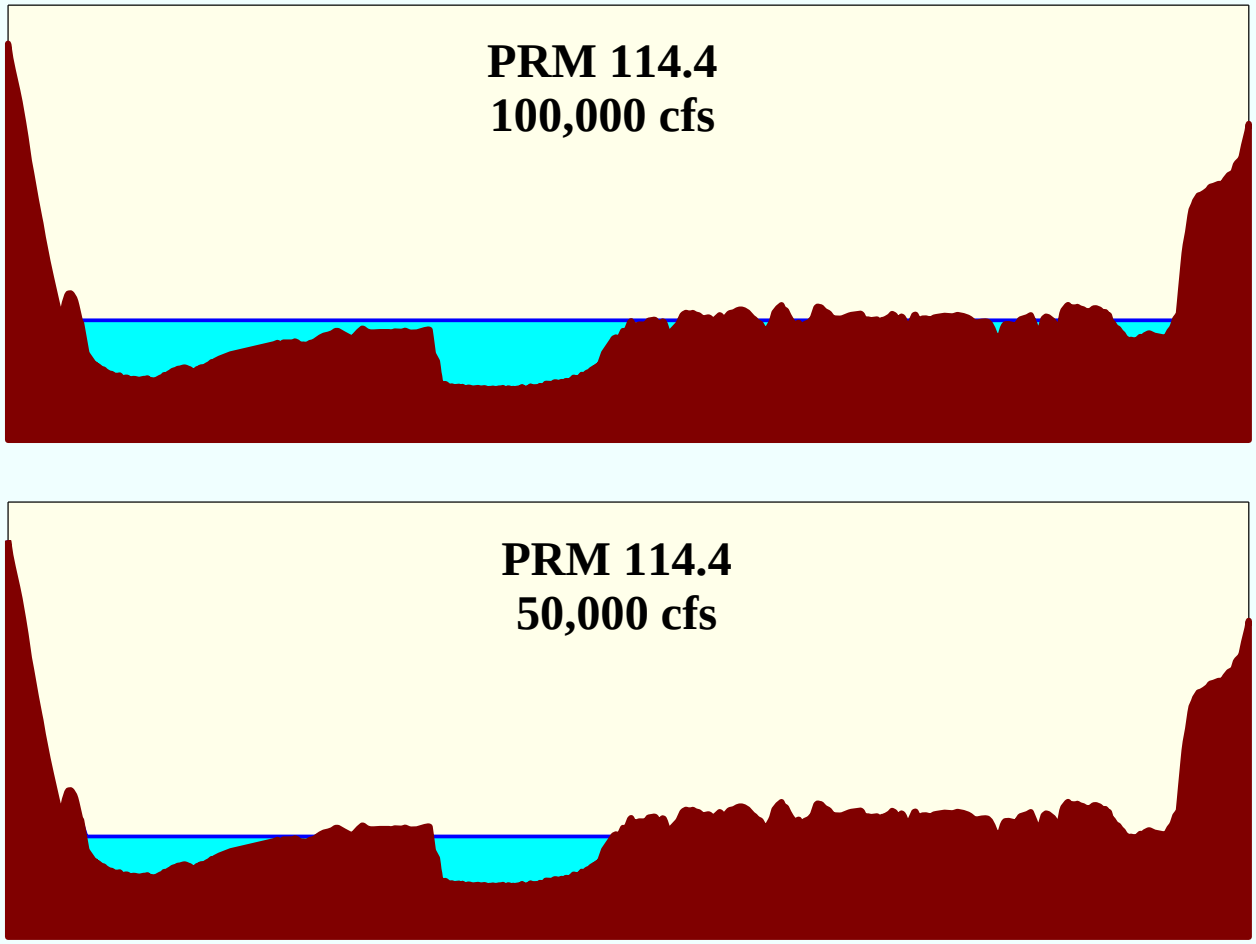


Riparian Instream Flow Modeling





Riparian Instream Flow Modeling



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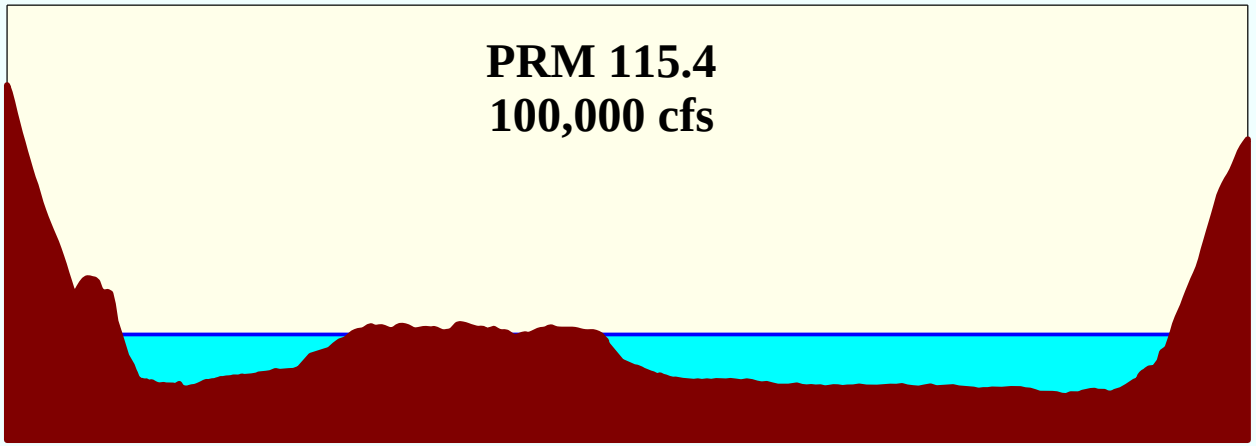
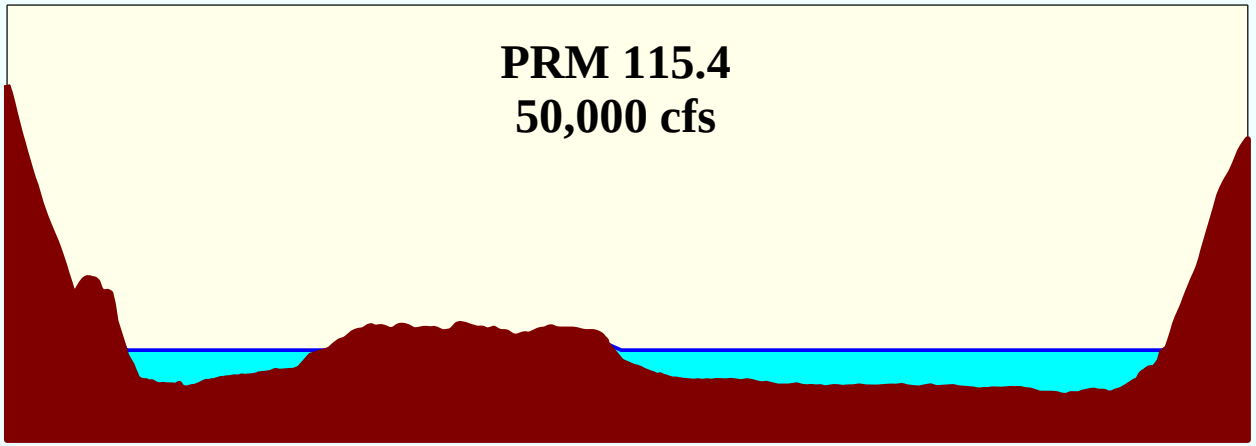
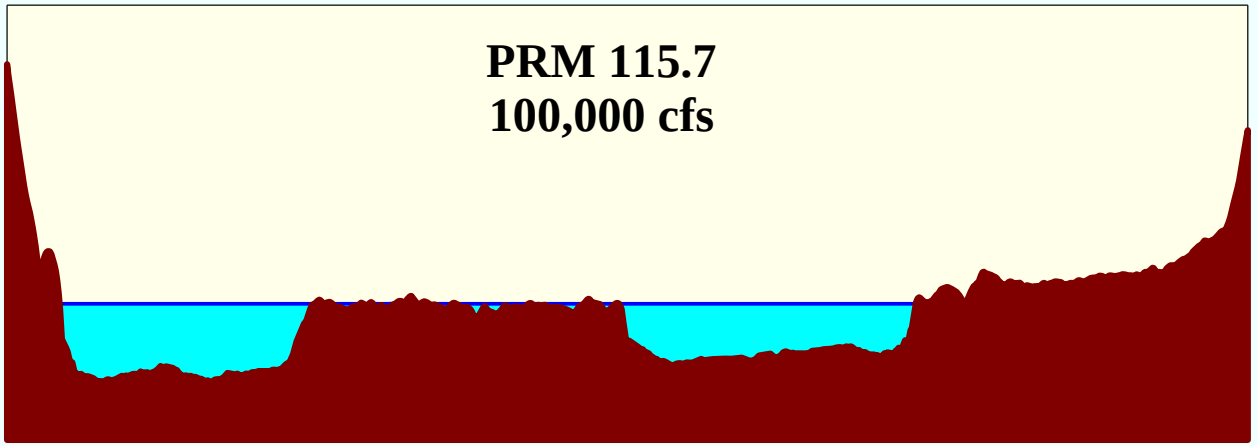
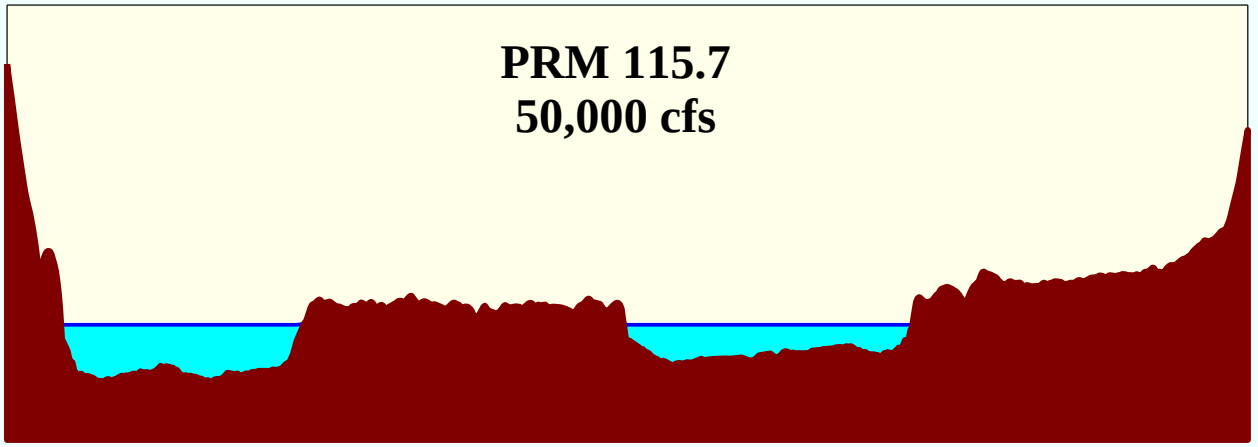
Riparian Instream Flow Modeling



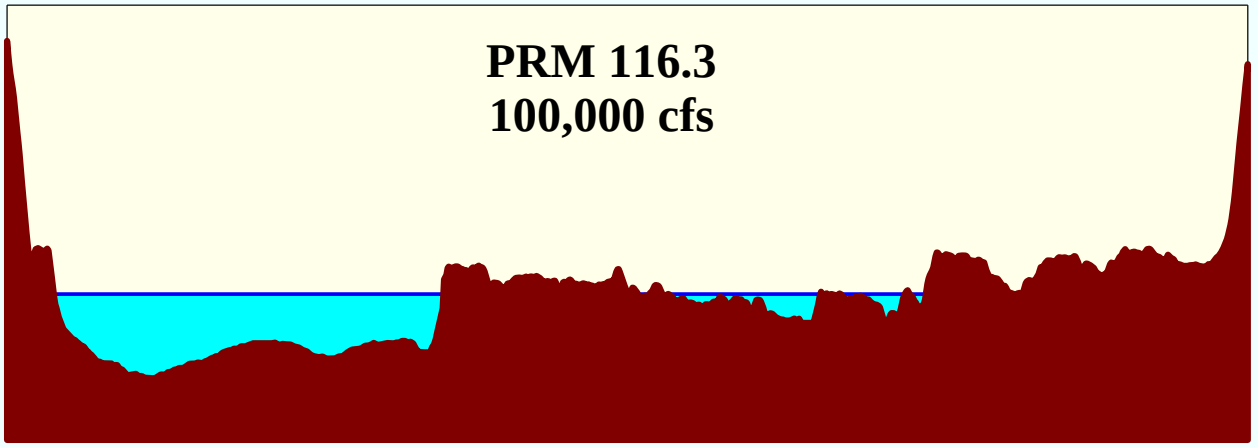


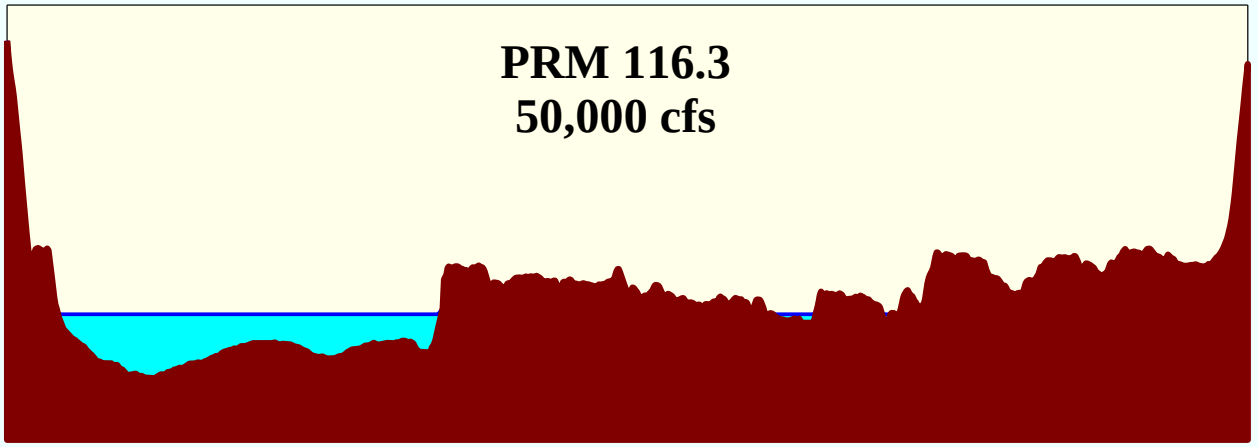
Riparian Instream Flow Modeling



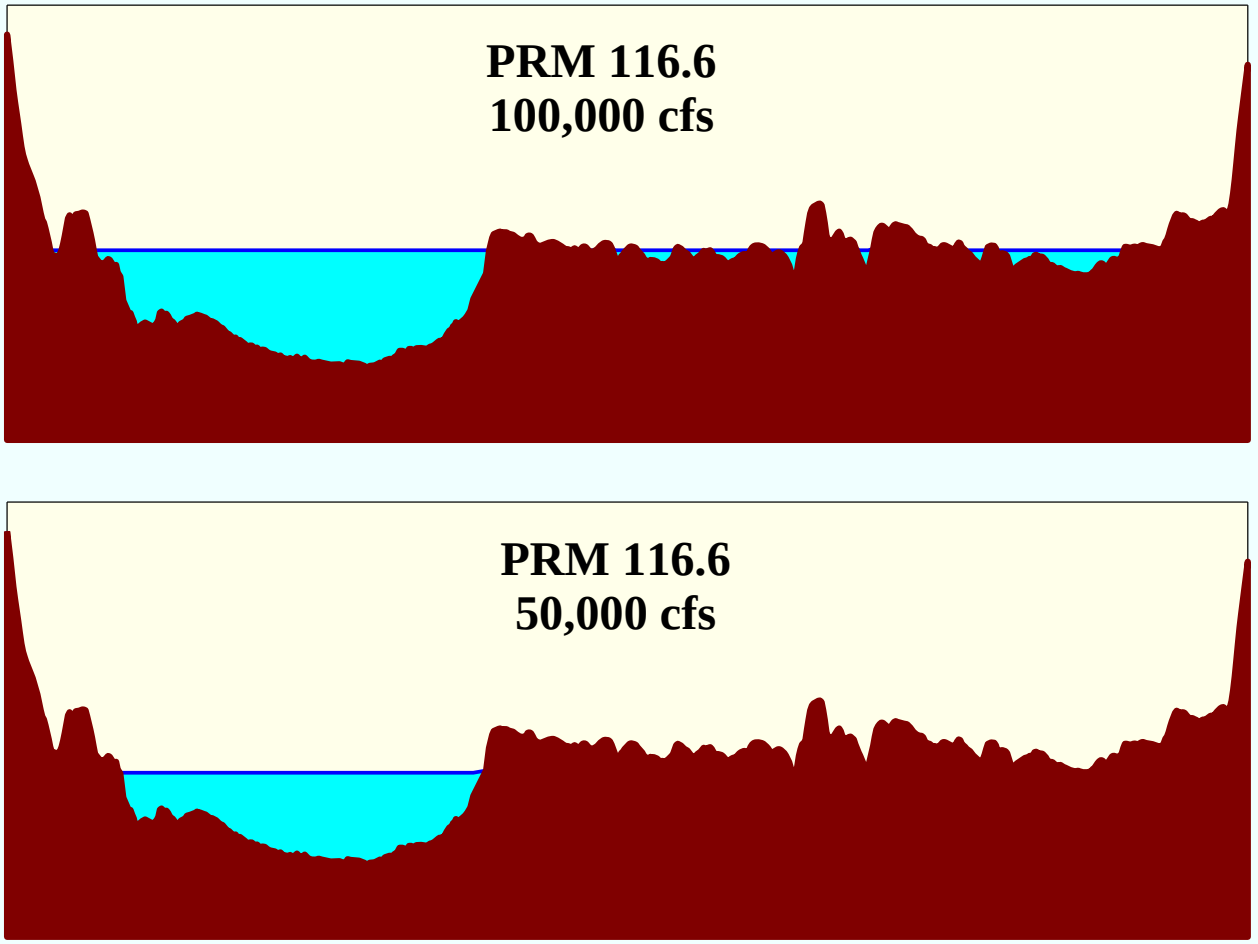


Riparian Instream Flow Modeling

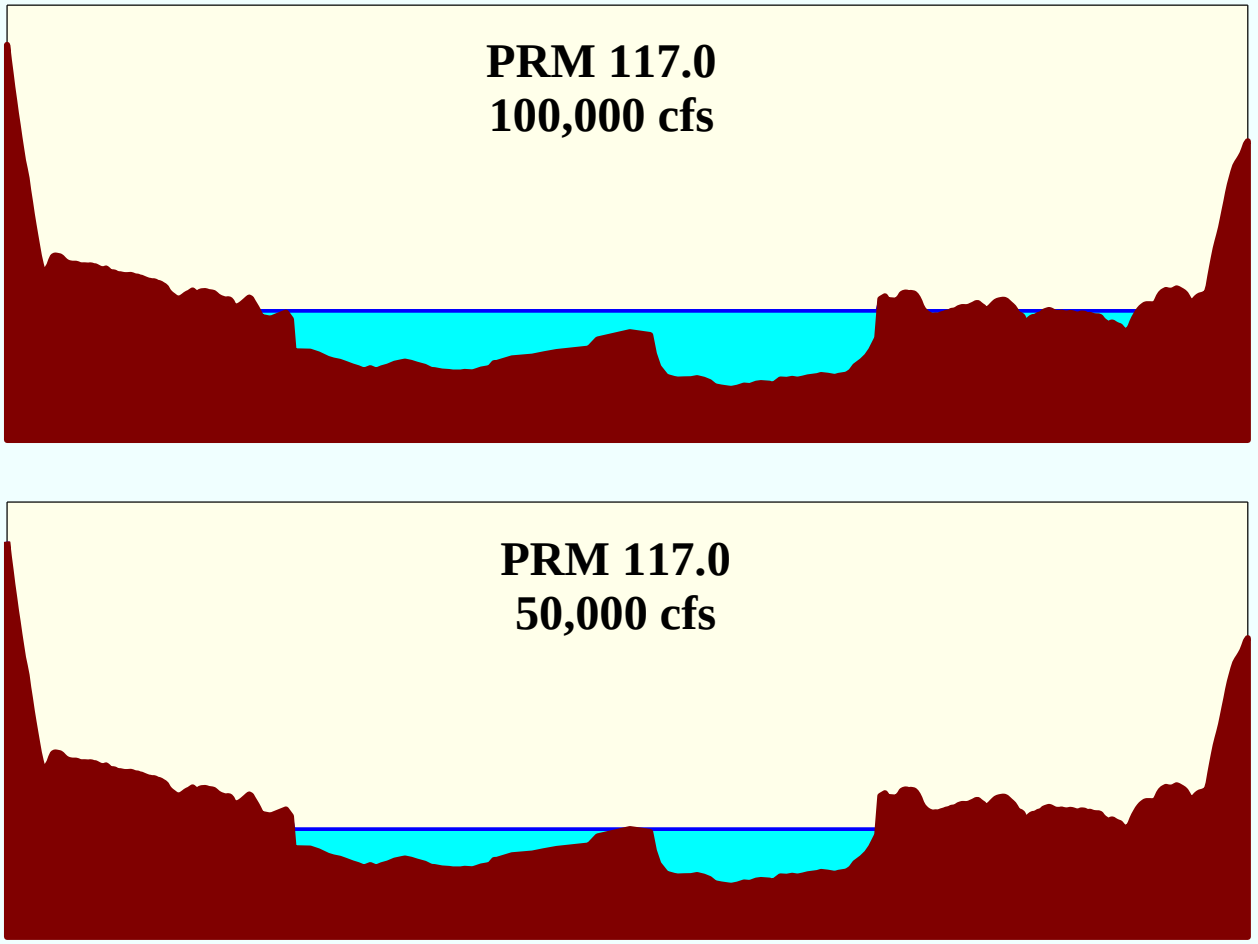




Riparian Instream Flow Modeling

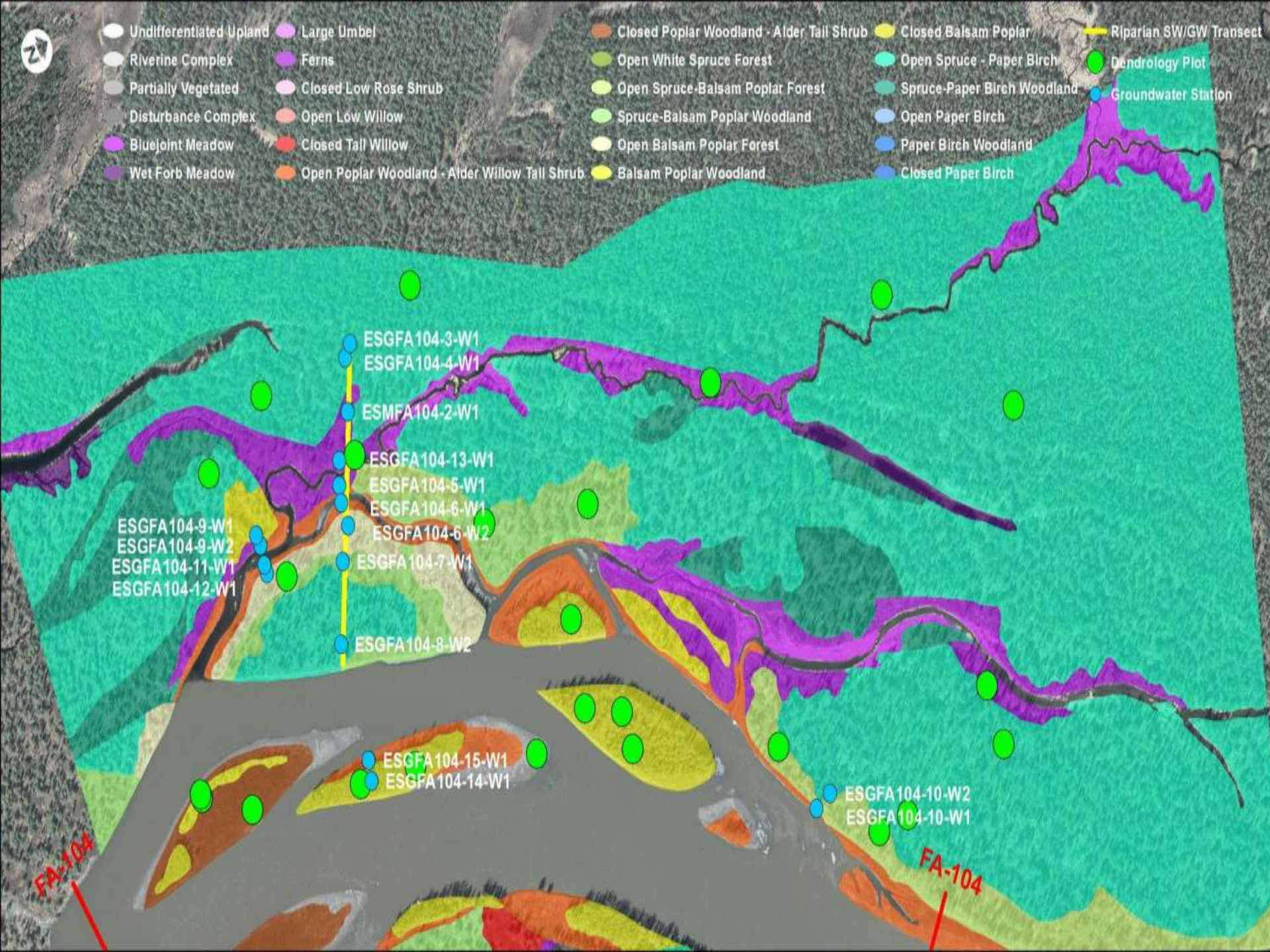


Riparian Instream Flow Modeling

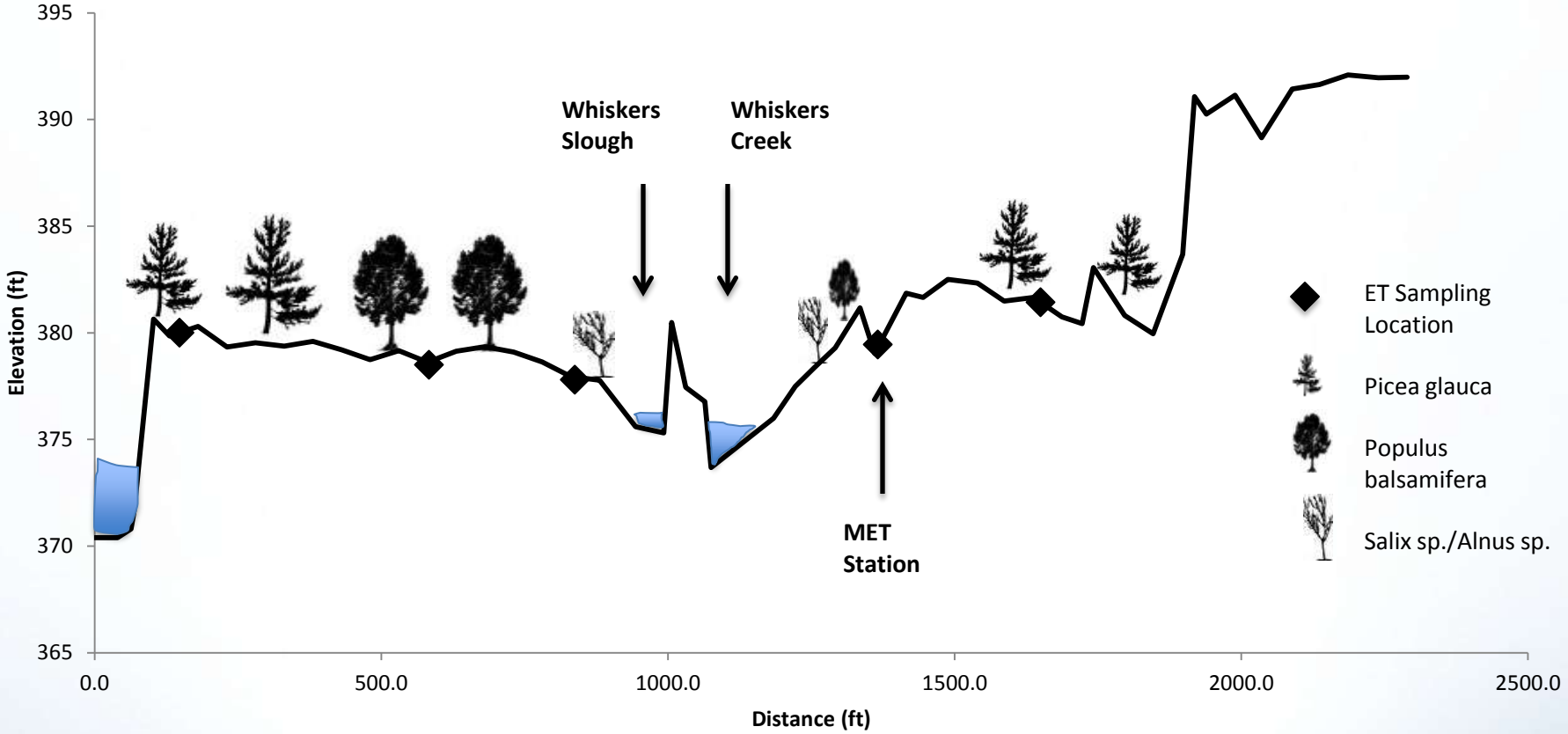


Groundwater / Surface water Study Design–Parameters Measured in 2013

- Groundwater elevations
- Surface water stage heights
- Soil volumetric water content
- Soil temperature
- Meteorological drivers of evapotranspiration
- Root depth
- Stomatal Conductance
- Sap Flow
- LAI
- Water isotopes


Undifferentiated Upland
Riverine Complex
Partially Vegetated
Disturbance Complex
Bluejoint Meadow
Wet Forb Meadow
Large Umbel
Ferns
Closed Low Rose Shrub
Open Low Willow
Closed Tall Willow
Open Poplar Woodland - Alder Willow Tall Shrub
Closed Poplar Woodland - Alder Tall Shrub
Open White Spruce Forest
Open Spruce-Balsam Poplar Forest
Spruce-Balsam Poplar Woodland
Open Balsam Poplar Forest
Balsam Poplar Woodland
Closed Balsam Poplar
Open Spruce - Paper Birch
Spruce-Paper Birch Woodland
Open Paper Birch
Paper Birch Woodland
Closed Paper Birch
Riparian SW/GW Transect
Dendrology Plot
Groundwater Station
ESGFA104-3-W1
ESGFA104-4-W1
ESMFA104-2-W1
ESGFA104-13-W1
ESGFA104-5-W1
ESGFA104-6-W1
ESGFA104-6-W2
ESGFA104-7-W1
ESGFA104-8-W2
ESGFA104-9-W1
ESGFA104-9-W2
ESGFA104-11-W1
ESGFA104-12-W1
ESGFA104-15-W1
ESGFA104-14-W1
ESGFA104-10-W2
ESGFA104-10-W1
FA-104
FA-104

FA-104 (Whiskers Slough) ET sampling cross-section



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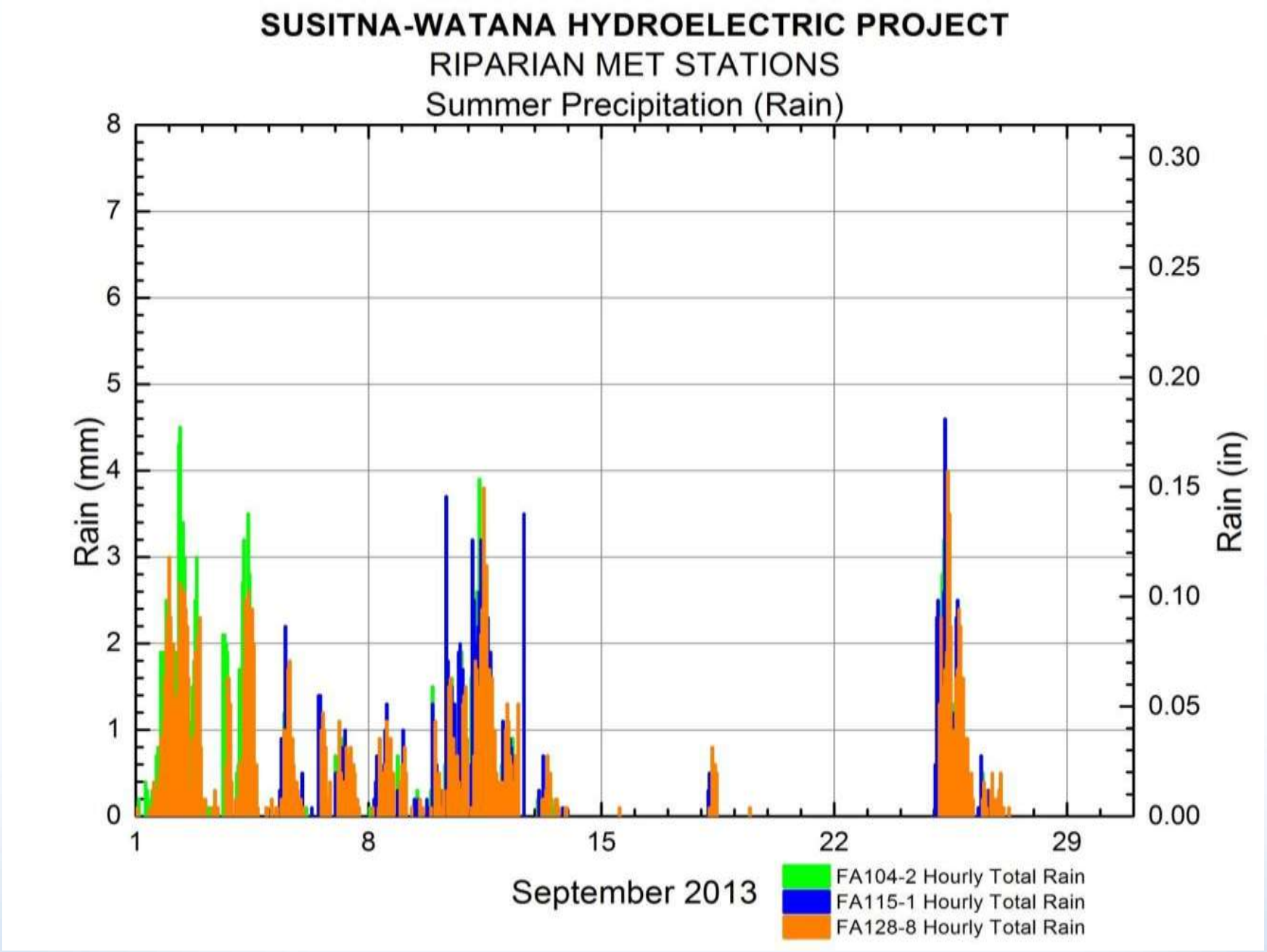
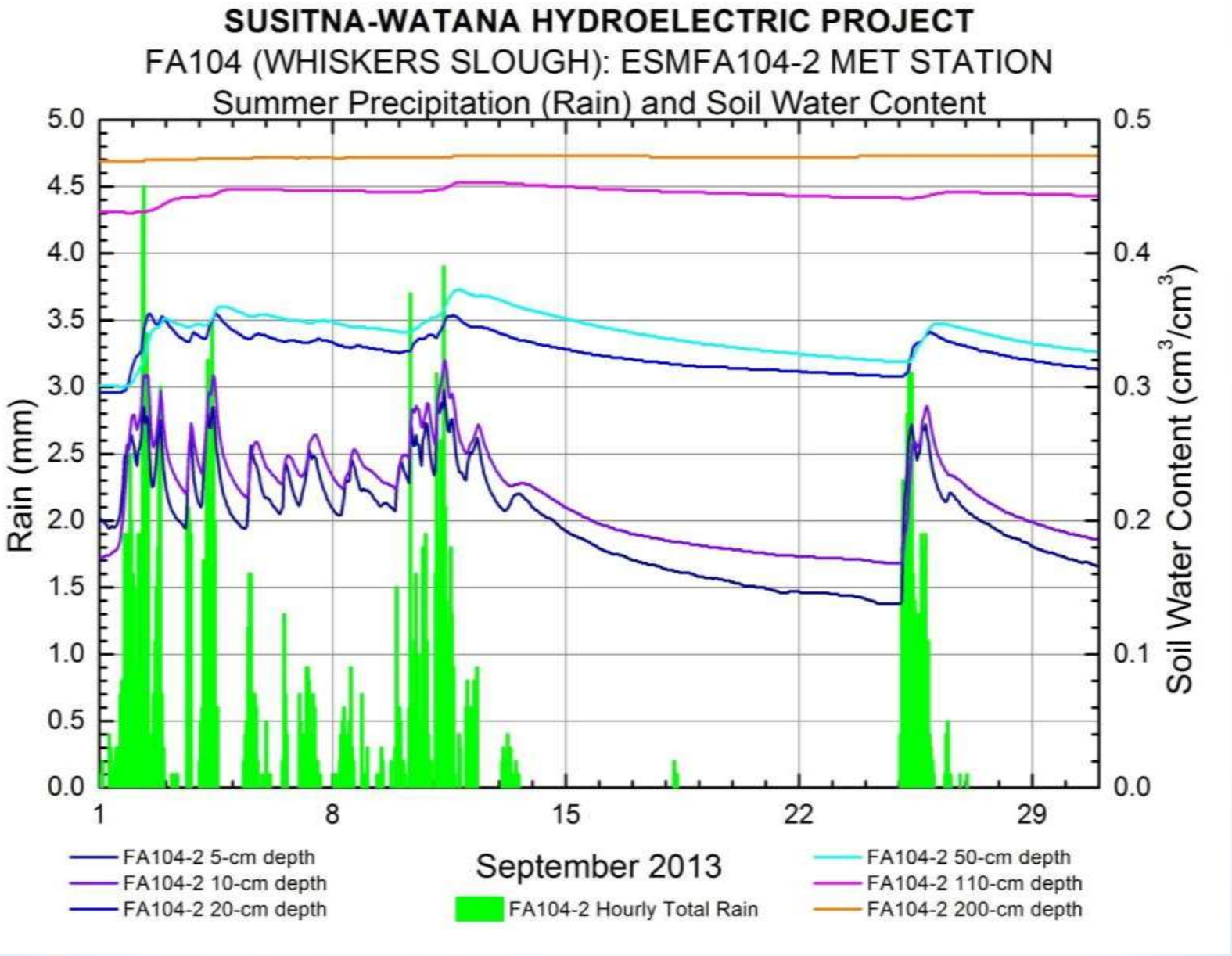
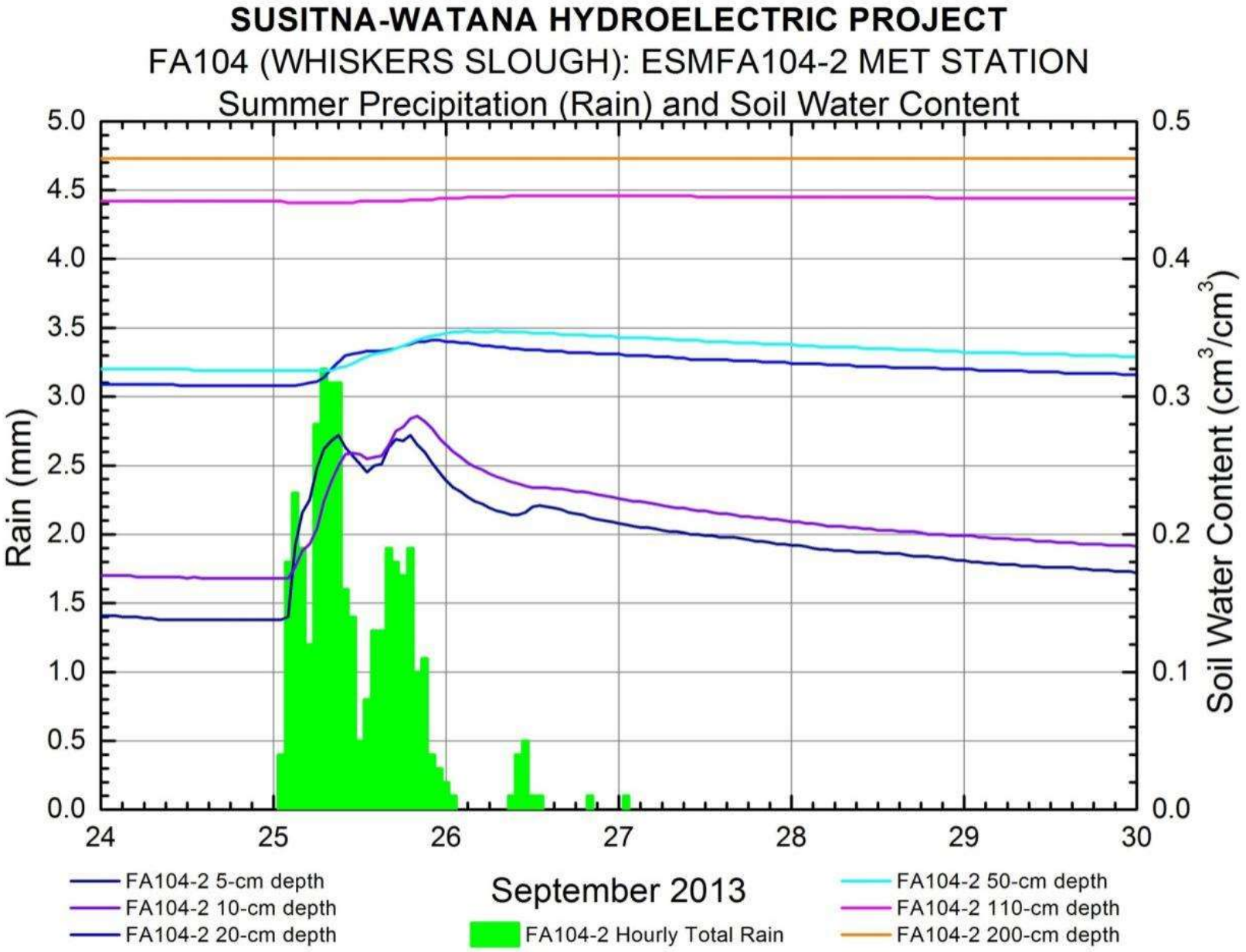
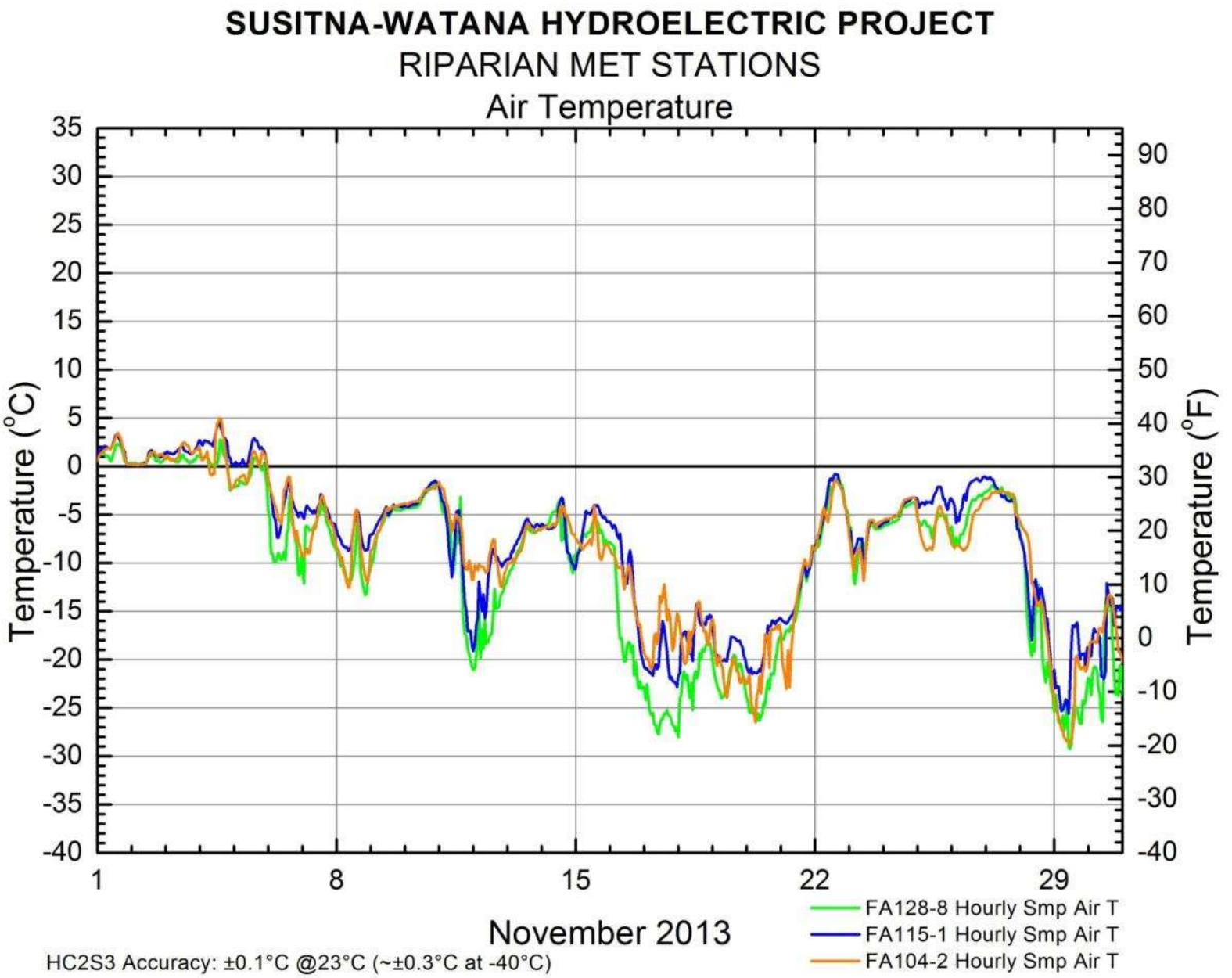
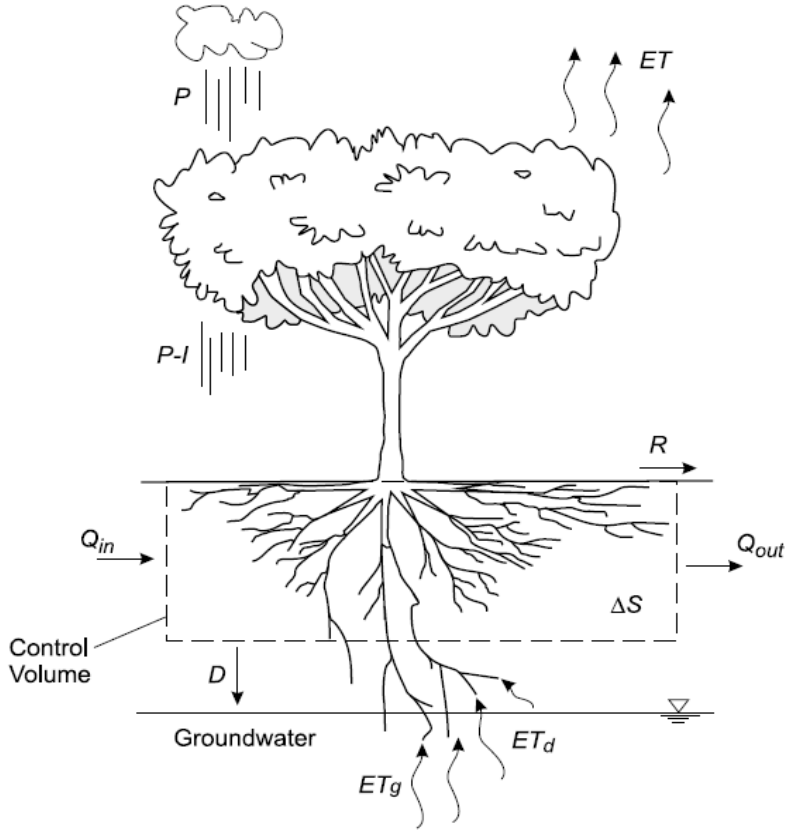

SUSITNA-WATANA HYDROELECTRIC PROJECT
RIPARIAN MET STATIONS
Summer Precipitation (Rain)
Rain (mm)
Rain (in)
0
1
2
3
4
5
6
7
8
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1
8
15
22
29
September 2013
FA104-2 Hourly Total Rain
FA115-1 Hourly Total Rain
FA128-8 Hourly Total Rain


SUSITNA-WATANA HYDROELECTRIC PROJECT
FA104 (WHISKERS SLOUGH): ESMFA104-2 MET STATION
Summer Precipitation (Rain) and Soil Water Content
Rain (mm)
Soil Water Content (cm3/cm3)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.5
0.4
0.3
0.2
0.1
0.0
1
8
15
22
29
September 2013
FA104-2 5-cm depth
FA104-2 10-cm depth
FA104-2 20-cm depth
FA104-2 Hourly Total Rain
FA104-2 50-cm depth
FA104-2 110-cm depth
FA104-2 200-cm depth


SUSITNA-WATANA HYDROELECTRIC PROJECT
FA104 (WHISKERS SLOUGH): ESMFA104-2 MET STATION
Summer Precipitation (Rain) and Soil Water Content
Rain (mm)
Soil Water Content (cm3/cm3)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.5
0.4
0.3
0.2
0.1
0.0
24
25
26
27
28
29
30
September 2013
FA104-2 5-cm depth
FA104-2 10-cm depth
FA104-2 20-cm depth
FA104-2 Hourly Total Rain
FA104-2 50-cm depth
FA104-2 110-cm depth
FA104-2 200-cm depth


SUSITNA-WATANA HYDROELECTRIC PROJECT
RIPARIAN MET STATIONS
Air Temperature
Temperature (°C)
Temperature (°F)
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
1
8
15
22
29
November 2013
FA128-8 Hourly Smp Air T
FA115-1 Hourly Smp Air T
FA104-2 Hourly Smp Air T
HC2S3 Accuracy: ±0.1°C @23°C (~±0.3°C at -40°C)

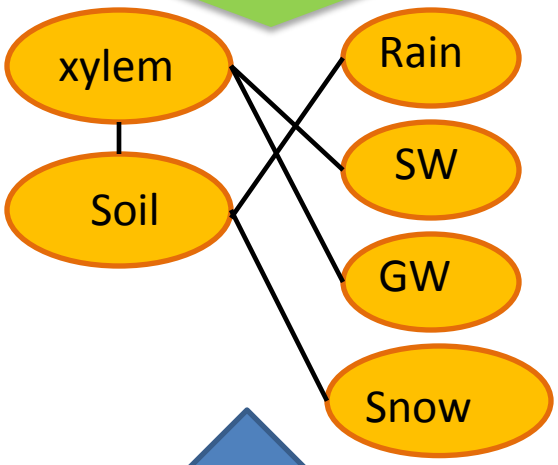
Groundwater / Surface Water Study 7.5 Design Objectives



1. What is primary water source dominant plant species/ communities are utilizing?
2. How much water are plants using on a landscape scale?
3. Are there species/locations where plant communities are affected/limited by groundwater level?
4. To what extent does groundwater flow influence plant community structure/distribution? How do surface flows influence the groundwater flows underlying different plant communities?

What is the primary water source that dominant plant species/ communities are utilizing? (Study Objective #6; RSP 8.6.3.6)

Natural abundance isotope as tracers



Mixing Model to determine plant water source

SUSITNA-WATANA HYDRO

Stable isotope and tracers

For Discussion:

Given likely co-linearity between ^{18}O and ^{2}H in this environment, other tracers may be needed.

How much water are plants using on a landscape scale?
(Study Objective #6; RSP 8.6.3.6)

Sap Flow Sensors installed in spruce , poplar, birch, willow, and alder trees

Sap Flow out puts in cm^3hr^{-1}

Penman Monteith (mm of water per hour)

MODFLOW
RIPET

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Groundwater / Surface water Study Design–MODFLOW ET Flux Curves

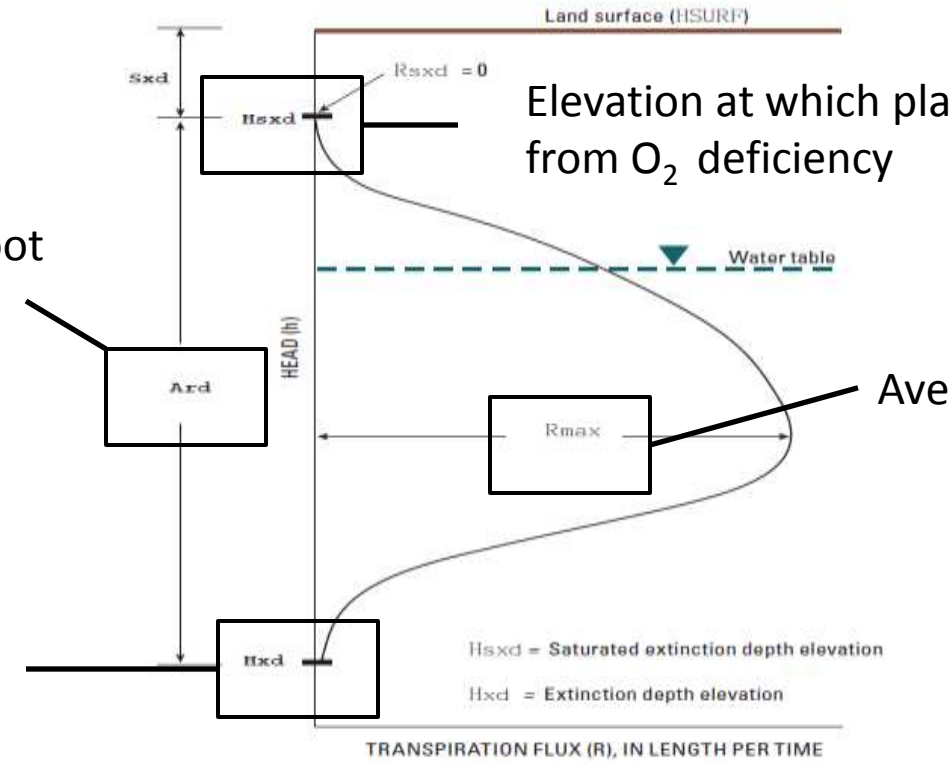


Figure 2. Generic transpiration flux curve (modified from Baird and Maddock, 2005).

Elevation at which plants die from O_2 deficiency

Active Root Zone

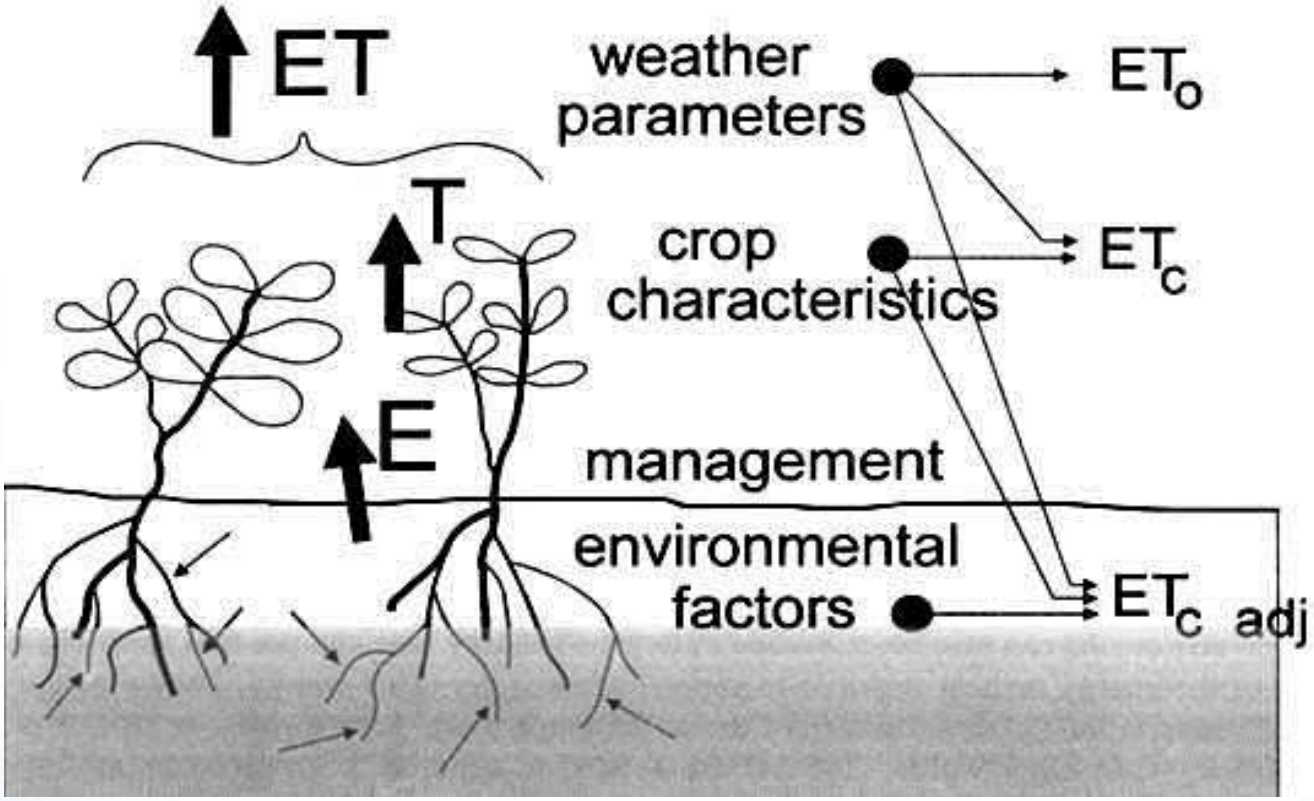
Average daily maximum ET

Depth at which roots can no longer obtain water

ET and Its Components

$$\lambda ET = \frac{\Delta(R_n - G) + \rho_a c_p \dfrac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \dfrac{r_s}{r_a}\right)}$$

Evapotranspiration Study
Trees & Shrubs



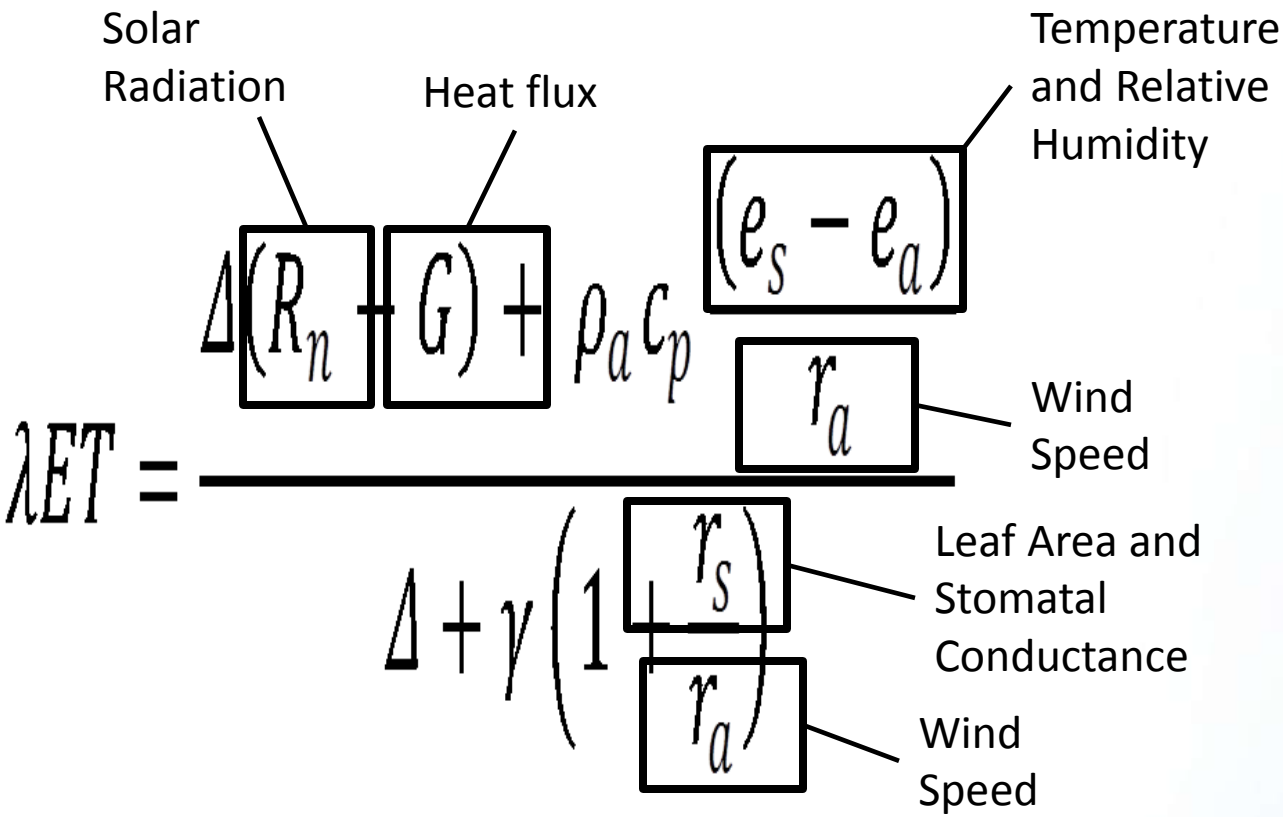
Evapotranspiration Study Approach

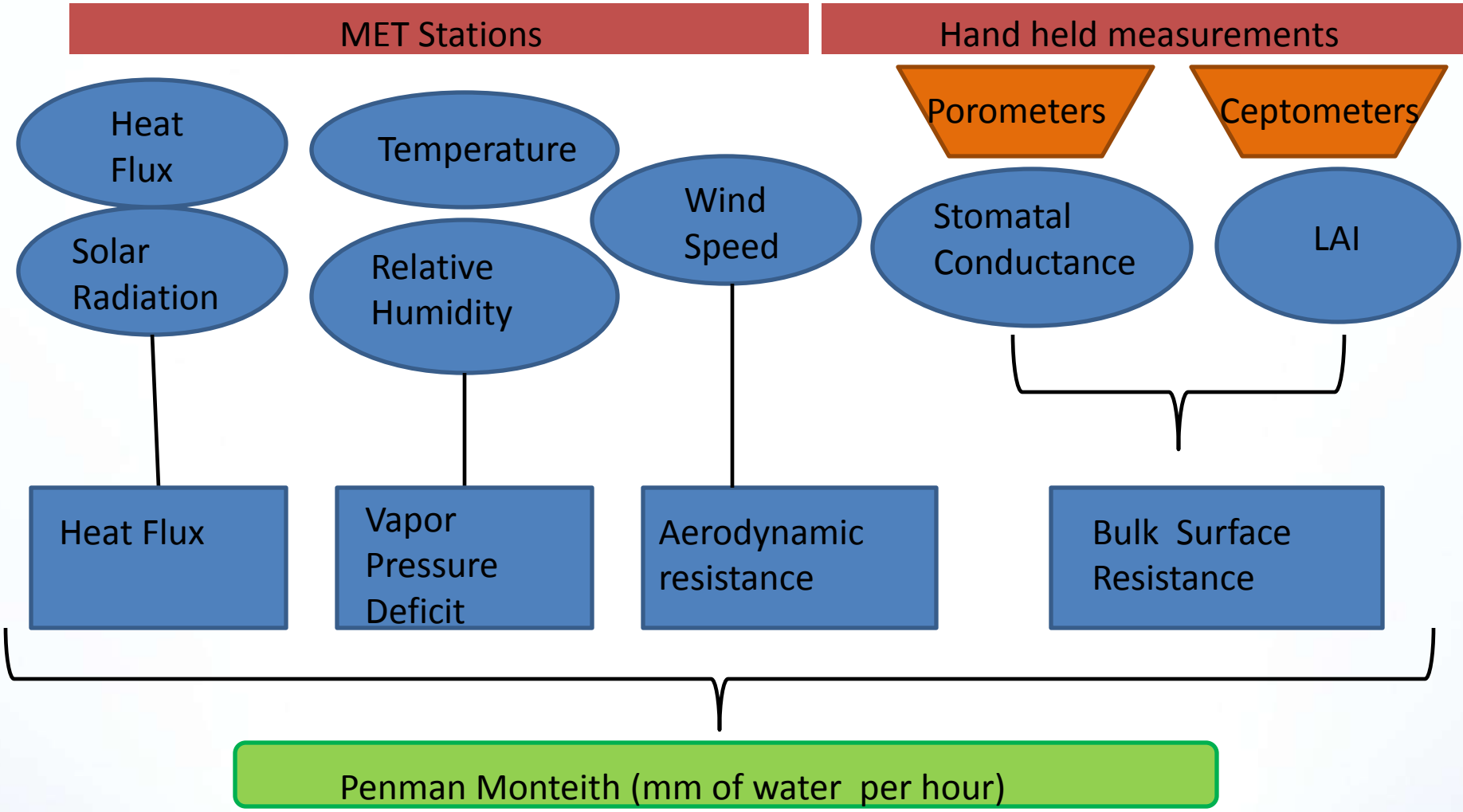
Measureable components to the Penman/Monteith approach:

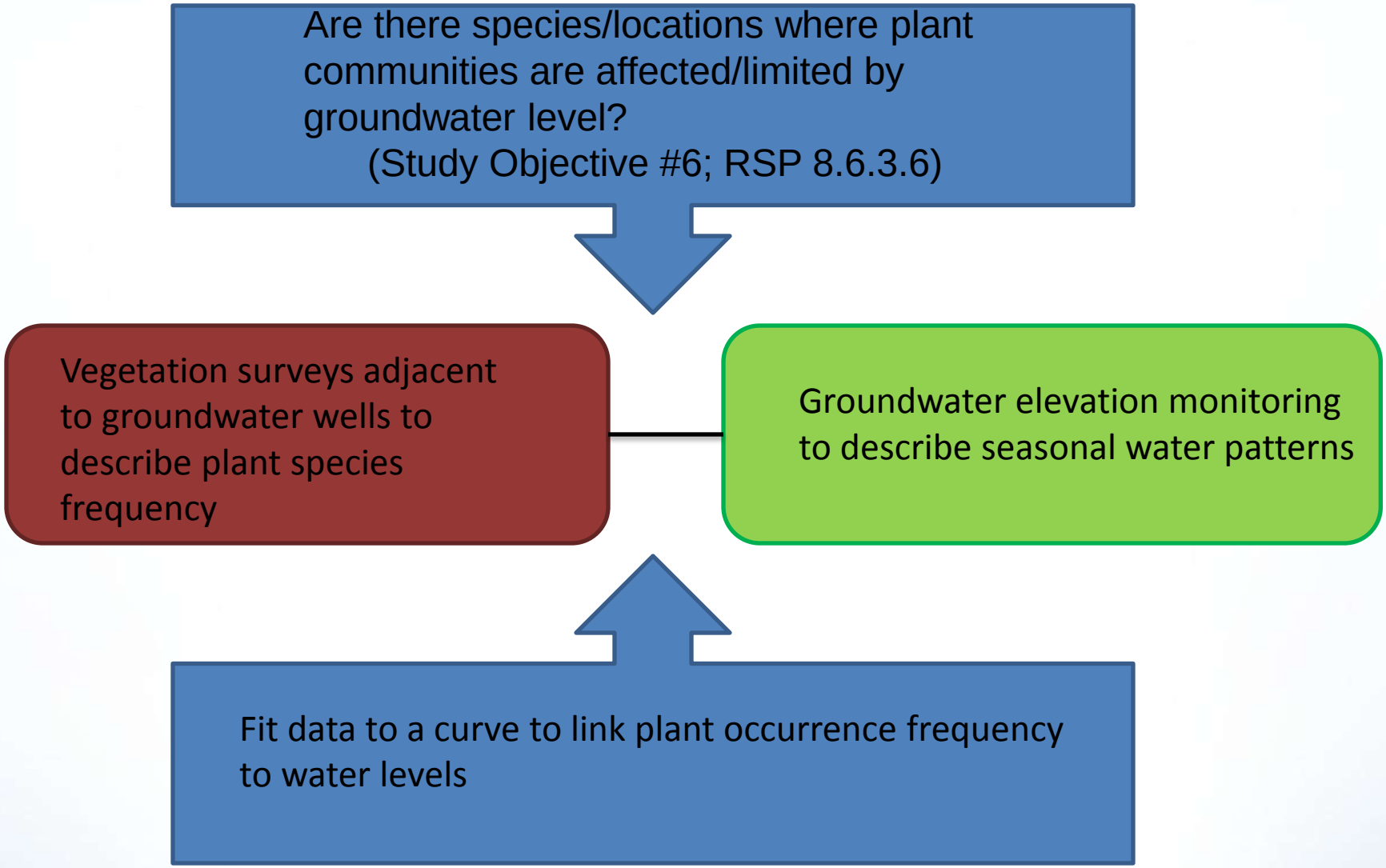
- Temperature
- Wind speed
- Relative humidity
- Solar radiation
- Leaf area
- Stomatal conductance

$$\lambda ET = \frac{\Delta(R_n - G) + \rho_a c_p \dfrac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \dfrac{r_s}{r_a}\right)}$$

Penman/Monteith Equation




MET Stations
Hand held measurements
Heat Flux
Solar Radiation
Temperature
Relative Humidity
Wind Speed
Porometers
Ceptometers
Stomatal Conductance
LAI
Heat Flux
Vapor Pressure Deficit
Aerodynamic resistance
Bulk Surface Resistance
Penman Monteith (mm of water per hour)

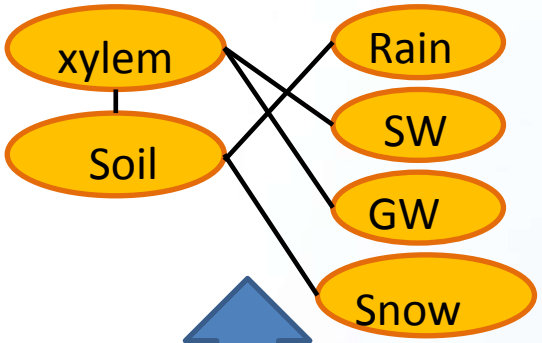

Are there species/locations where plant communities are affected/limited by groundwater level?
(Study Objective #6; RSP 8.6.3.6)
Vegetation surveys adjacent to groundwater wells to describe plant species frequency
Groundwater elevation monitoring to describe seasonal water patterns
Fit data to a curve to link plant occurrence frequency to water levels

To what extent does groundwater flow influence plant community structure/distribution? How do surface flows influence the groundwater flows underlying different plant communities? (Study Objective #6; RSP 8.6.3.6)

Penman Monteith (mm of water per hour)

Sap Flow out puts in cm^3hr^{-1}

Isotope

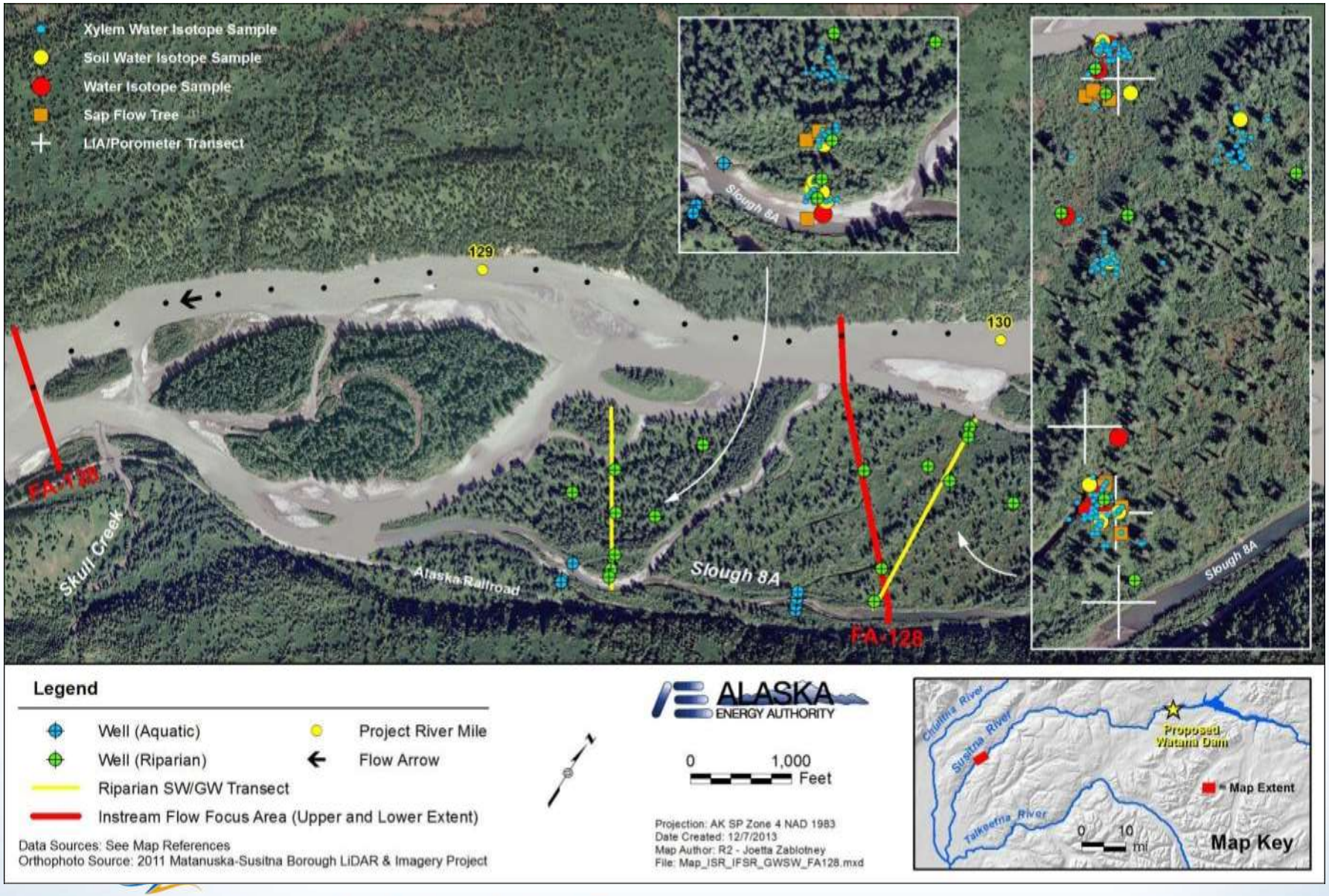


MODFLOW
RIPET

Curve Analysis

Mixing Model to determine plant water source

Combine data with Riparian, Geomorphology, Groundwater models to understand project effects



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Plant Functional Groups Revisited

First Tier

- Species will be classified into one of three moisture classes
  - hydroriparian, mesoriparian, and xeroriparian

Second Tier

- Species to be assigned one of four life plant strategy types:
  - Herbaceous annual, herbaceous perennial, shrub, and tree

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. Will Project operations result in lower groundwater levels in the floodplain and to what extent?

Baseline Studies:

1. MODFLOW groundwater / surface water model.

Proposed Metrics:

1. Change in seasonal groundwater depths from pre-project natural flow regime to Project operations flow regimes.

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. What are the primary water sources (precipitation–rain and snowmelt; groundwater; surface water) for dominant riparian plant species/ communities?
2. What is the relationship between riparian plant communities rooting depth and extinction and saturated extinction depths?

Baseline Studies:

1. Stable isotope studies.
2. Root depth measurements: soil cores, soil trenches; cut river bank photographic image analyses.
3. Water depth measurements taken at wells located in riparian plant community types.
4. MODFLOW modeling of landscape scale groundwater depths relative to mapped riparian plant community types.
5. MODFLOW groundwater / surface water model.

Proposed Metrics:

1. Compare natural GW/SW hydroregime / riparian vegetation relationships with MODFLOW Project operational results.

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. What are dominant riparian plant species water use patterns at the local and landscape scales?

Baseline Studies:

1. Evapotranspiration study: sap flow measurements, porometer measurements.
2. MODFLOW modeling.
3. Plant community type maps and type percent cover by dominant species.

Proposed Metrics:

1. Compare natural GW/SW hydroregime / riparian vegetation relationships with MODFLOW Project operational results. Compare natural GW/SW hydroregime / riparian vegetation relationships with MODFLOW Project operational results.

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. What riparian plant communities are limited / controlled by access to groundwater (sedge meadows, emergent wetlands, etc.)?

Baseline Studies:

1. GW/SW monitoring data.
2. Plant community type maps.
3. Water elevation metrics from groundwater wells, seeps, springs, and surface-water sources recharged by groundwater.
4. Isotope studies. Evapotranspiration study: sap flow measurements, porometer measurements.

Proposed Metrics:

1. Compare natural GW/SW hydroregime / riparian vegetation relationships with MODFLOW Project operational results predictions.

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. To what extent are groundwater levels dependent on surface water levels in the main channel?

Baseline Studies:

1. Surface water and groundwater monitoring measurements.
2. MODFLOW groundwater / surface water model.

Proposed Metrics:

1. Change in groundwater depths relative to surface water regime.

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. Will precipitation and groundwater inflow be sufficient for limiting Project influences on riparian vegetation?

Baseline Studies:

1. Riparian vegetation evapotranspiration measurement and modeling.
2. Riparian vegetation water source isotope study.

Proposed Metrics:

1. Measured relationships between riparian plant species, plant community types and surface water and groundwater regimes.

Groundwater Study Modeling & Analysis Questions/Baseline Studies/Proposed Metrics

Key Question (RSP 8.6.3.6):

1. To what extent do modeled surface water and groundwater differences vary in multiple geohydrologic and riparian units?

Baseline Studies:

1. MODFLOW groundwater / surface water model.
2. Valley bottom hydrogeomorphic domain analysis and mapping.

Proposed Metrics:

1. Mapped modeled change in surface water and groundwater regimes pre-project and with Project operations.

Valley Bottom Hydrogeomorphic Domain Analysis

FA-115 (Slough 6A)

FA-138 (Gold Creek) Focus Area
Hydrogeomorphic Domain Analysis
Upland Wetland Hydrology Observations
(Study Objective #6; RSP 8.6.3.6)

- How Are Upland Sloughs and Wetlands Impacted By River Stage Levels?
- How Does this Vary Over The Annual Hydrologic Cycle?
- At What Scale are GW/SW Interactions Significant?

FA-138 (Gold Creek) Focus Area, Right Bank Upland Sloughs and Wetlands, during heavy rainfall and precipitation flood peak on the Susitna River, August 22, 2013

FA-138, Gold Creek Focus Area
Upland Wetland Hydrology Observations
(Study Objective #6; RSP 8.6.3.6)

- Does Recharge From Groundwater Help Maintain Wetland Vegetation?
- What Winter Observations Help Understand This?
- What Snowmelt Transition Observations Help Understand This?

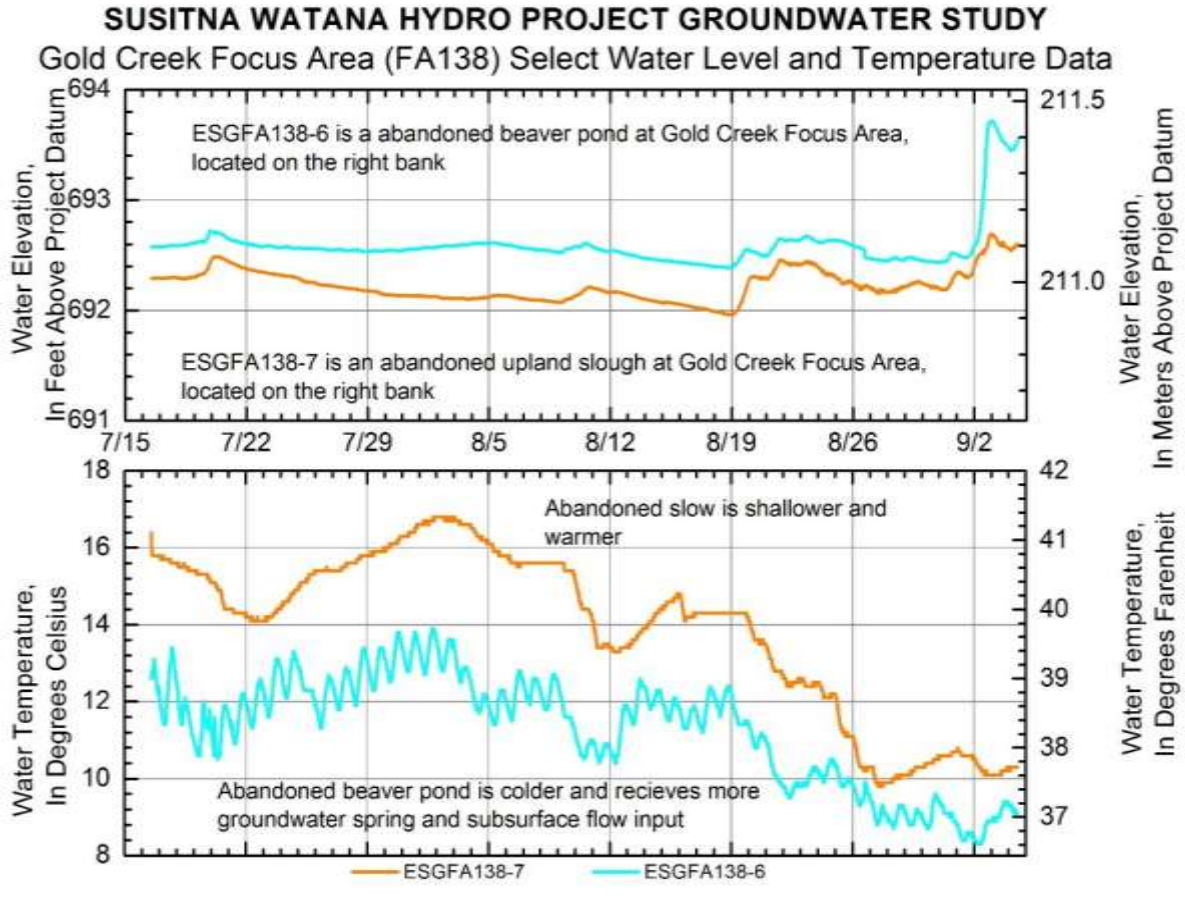
FA-138 (Gold Creek) Focus Area, Right Bank Upland abandoned beaver pond during periods of heavy rains, August 22, 2013

FA-138, Gold Creek Focus Area Upland Wetland Hydrology Observations

- Future Shallow Groundwater and Surface Water Level Monitoring
- Seasonal Observations
- Measuring Interactions (Or Lack Of) With River

FA-138, Gold Creek Focus Area, Right Bank Abandoned Upland Sloughs and Wetlands, During Periods of Heavy Rain, August 22, 2013

FA-138, Gold Creek Focus Area
Upland Wetland Hydrology Observations



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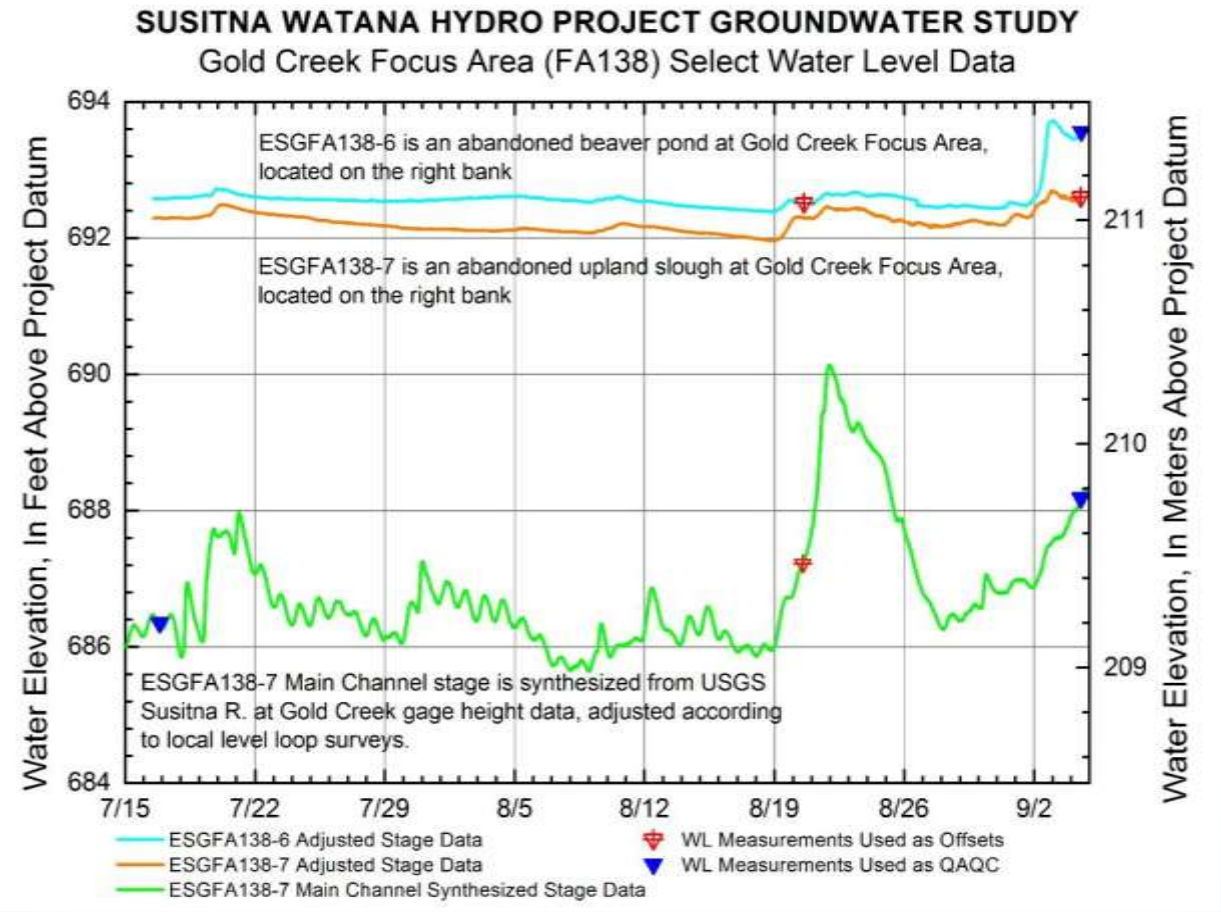
FA-138, Gold Creek Focus Area
Upland Wetland Hydrology Observations



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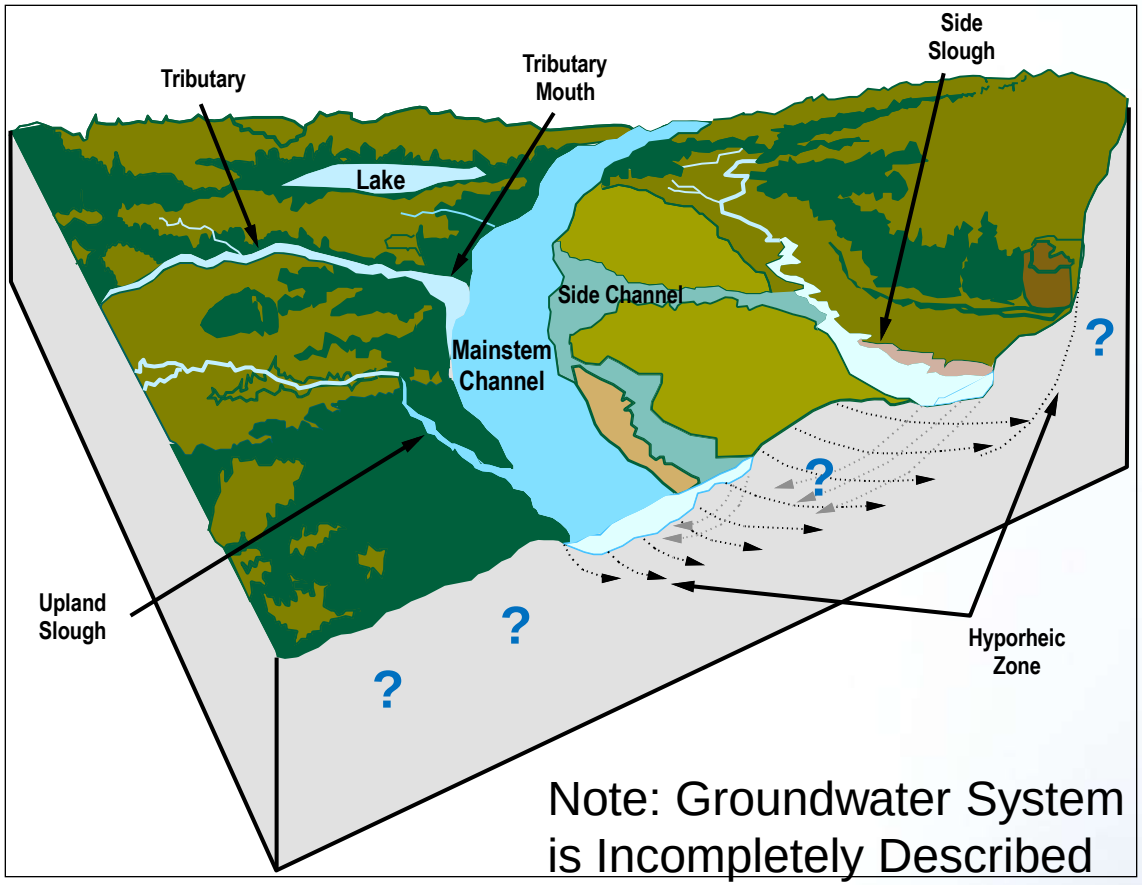
Aquatic and Riparian Resources

- Inter-Related
- Impacts on Riparian = Impacts on Aquatic
- Groundwater Questions Have Many Overlaps



Habitat types identified in the middle reach of the Susitna River during the 1980s studies (adapted from ADF&G 1983; Trihey 1982).

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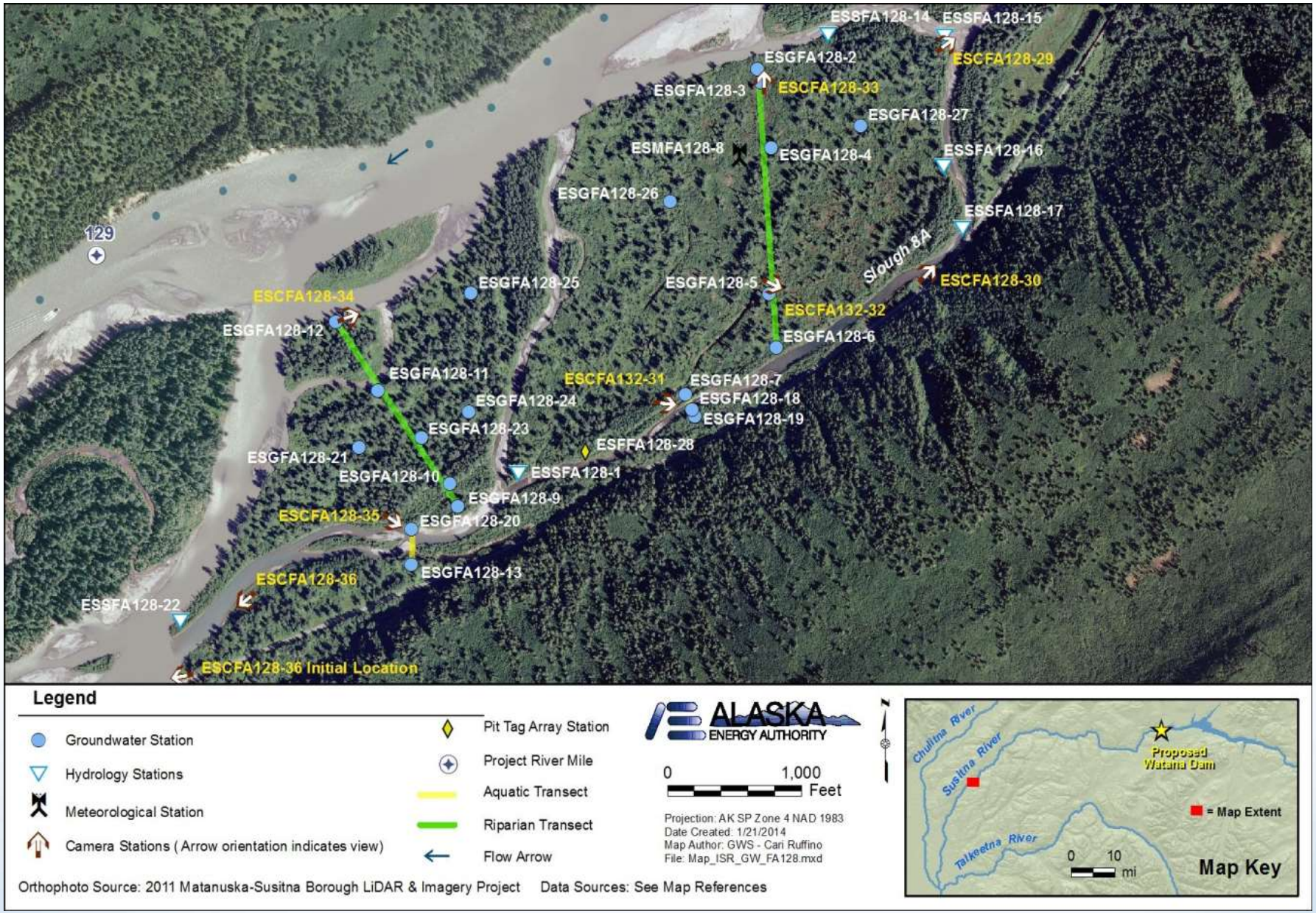
ESSFA128-14
ESSFA128-15
ESGFA128-2
ESCFA128-29
ESGFA128-3
ESCFA128-33
ESGFA128-27
ESMFA128-8
ESGFA128-4
ESSFA128-16
ESGFA128-26
ESSFA128-17
129
Slough 8A
ESCFA128-30
ESGFA128-25
ESGFA128-5
ESCFA128-34
ESCFA132-32
ESGFA128-12
ESGFA128-6
ESGFA128-11
ESCFA132-31
ESGFA128-7
ESGFA128-24
ESGFA128-18
ESGFA128-19
ESGFA128-23
ESFFA128-28
ESGFA128-21
ESSFA128-1
ESGFA128-10
ESGFA128-9
ESCFA128-35
ESGFA128-20
ESGFA128-13
ESCFA128-36
ESSFA128-22
ESCFA128-36 Initial Location
Legend
Groundwater Station
Hydrology Stations
Meteorological Station
Camera Stations (Arrow orientation indicates view)
Pit Tag Array Station
Project River Mile
Aquatic Transect
Riparian Transect
Flow Arrow
ALASKA ENERGY AUTHORITY
0
1,000
Feet
Projection: AK SP Zone 4 NAD 1983
Date Created: 1/21/2014
Map Author: GWS - Cari Ruffino
File: Map_ISR_GW_FA128.mxd
Chulitna River
Susitna River
Proposed Watana Dam
= Map Extent
Talkeetna River
0
10
mi
Map Key
Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project
Data Sources: See Map References