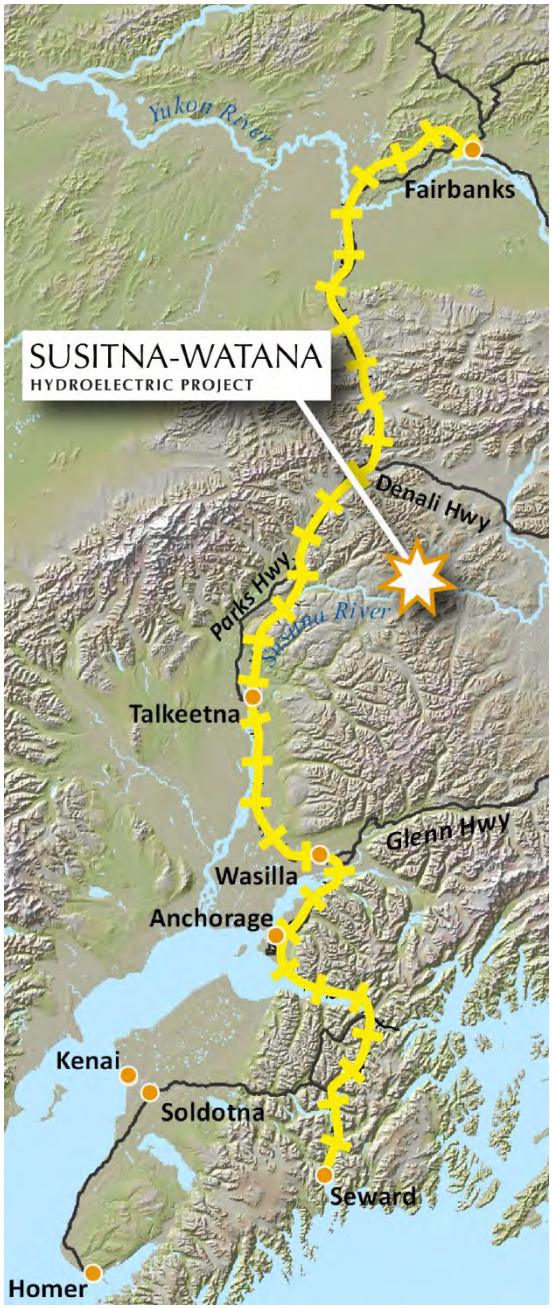

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Riparian Instream Flow Proposed Study Plan

August 16, 2012

Prepared by R2 Resource Consultants, Inc.

ALASKA ENERGY AUTHORITY

The overarching goal of the Riparian Instream Flow Study is to model riverine and riparian physical and vegetation processes to assess potential impacts of alternative Project operations to Susitna River floodplain vegetation.

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Riparian IFS Objectives

1. Synthesis of applicable 1980's riparian vegetation studies and dam / floodplain vegetation literature.
2. Coordinate selection of Instream Flow (ISF) intensive study sites.
3. Map and characterize Project area riparian floodplain vegetation.
4. Develop riverine and floodplain physical processes model of: geomorphology, ice processes, hydrology and groundwater / surface water interactions.
5. Develop Balsam poplar and willow species seed dispersal, hydrology and climate synchrony model.
6. Develop floodplain vegetation succession and flow response guild models.
7. Develop scaling model for reach to riparian process domain.
8. Model floodplain vegetation response to Project operations.
9. Provide aquatic and riparian wildlife studies riparian model output.
10. Coordinate groundwater modeling impact analysis with shallow groundwater well user analyses.

Methods:

1980's Riparian studies summary & hydro-dam / floodplain vegetation effects literature review.

1. Critical review of 1980's riparian vegetation studies and applicability to current study.
2. Review of relevant scientific literature regarding hydro-dam effects on downstream floodplain vegetation and applicability to Susitna River.

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Methods:
Project area and riparian process domain delineation & intensive study reach selection

1. Riparian IFS project area extends from the dam site downriver to the furthermost extent of Project operational hydrologic influence.
2. Extent of Project operational hydrological influence is to-be-determined by the flow routing modeling in 2012. (Tech Memo complete December 2012)
   a. Operational effects on Ice processes: to-be-determined
3. Final riparian intensive study project sites will then be selected 2012/2013, based on agency consultation.

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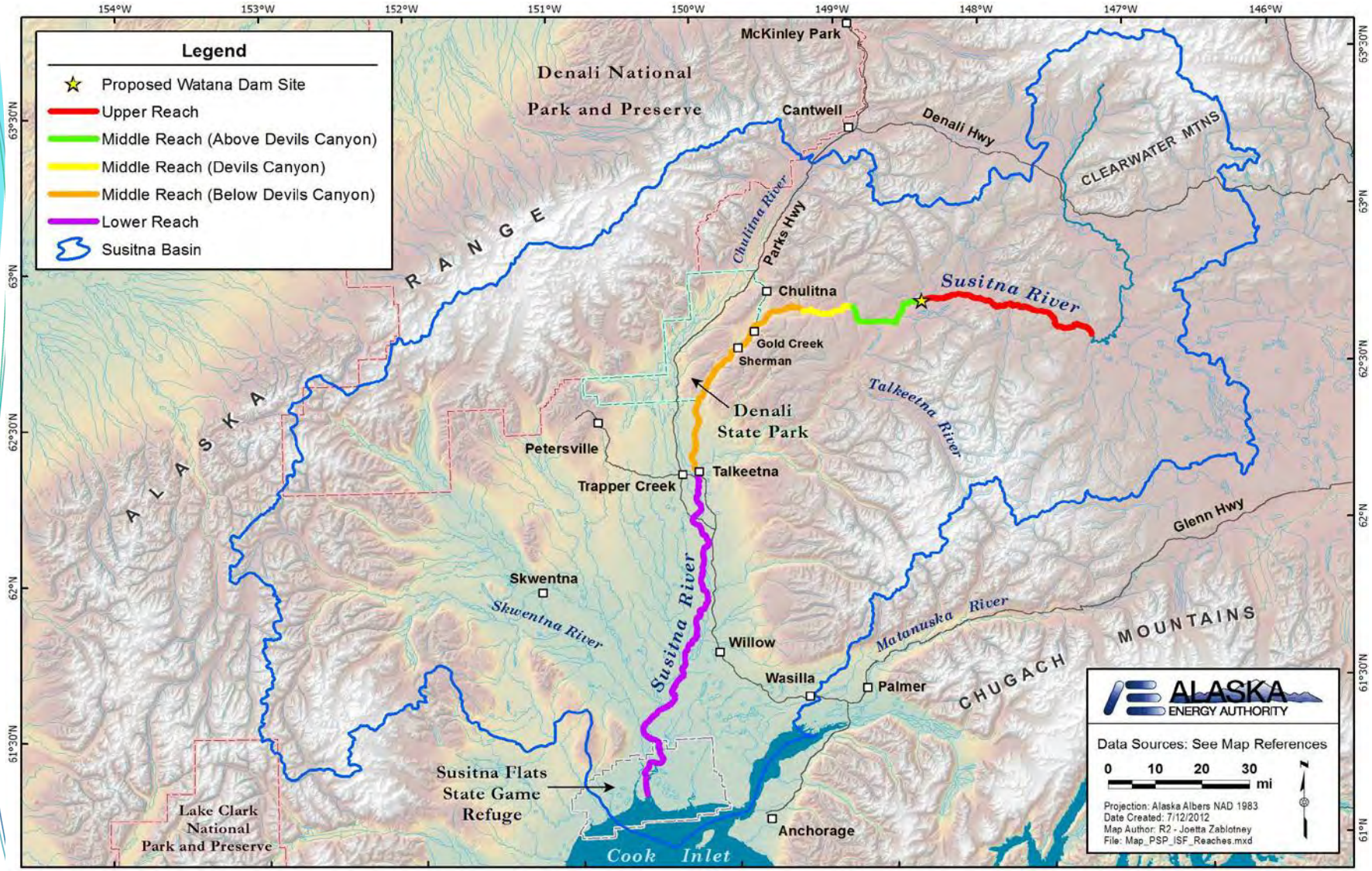
Riparian Instream Flow Study Area



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Methods:
Riparian floodplain vegetation mapping and characterization

1. Remote sensing mapping of plant community types (riparian botanical surveys)
2. Detailed sampling of vegetation composition and structure
3. Dendrochronology of vegetation patches
4. Seedling recruitment study

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Methods:
Physical process modeling–geomorphology and ice processes

1. Geomorphic reach analyses
   a. Sediment transport
   b. Channel migration
   c. Floodplain formation
2. Ice processes study
   a. Ice & floodplain vegetation interactions
   b. Ice dams, break-up and ice shearing effects

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Geomorphic Reach Analysis: Floodplain Dynamics & Vegetation Disturbance Regime (Queets River, WA)

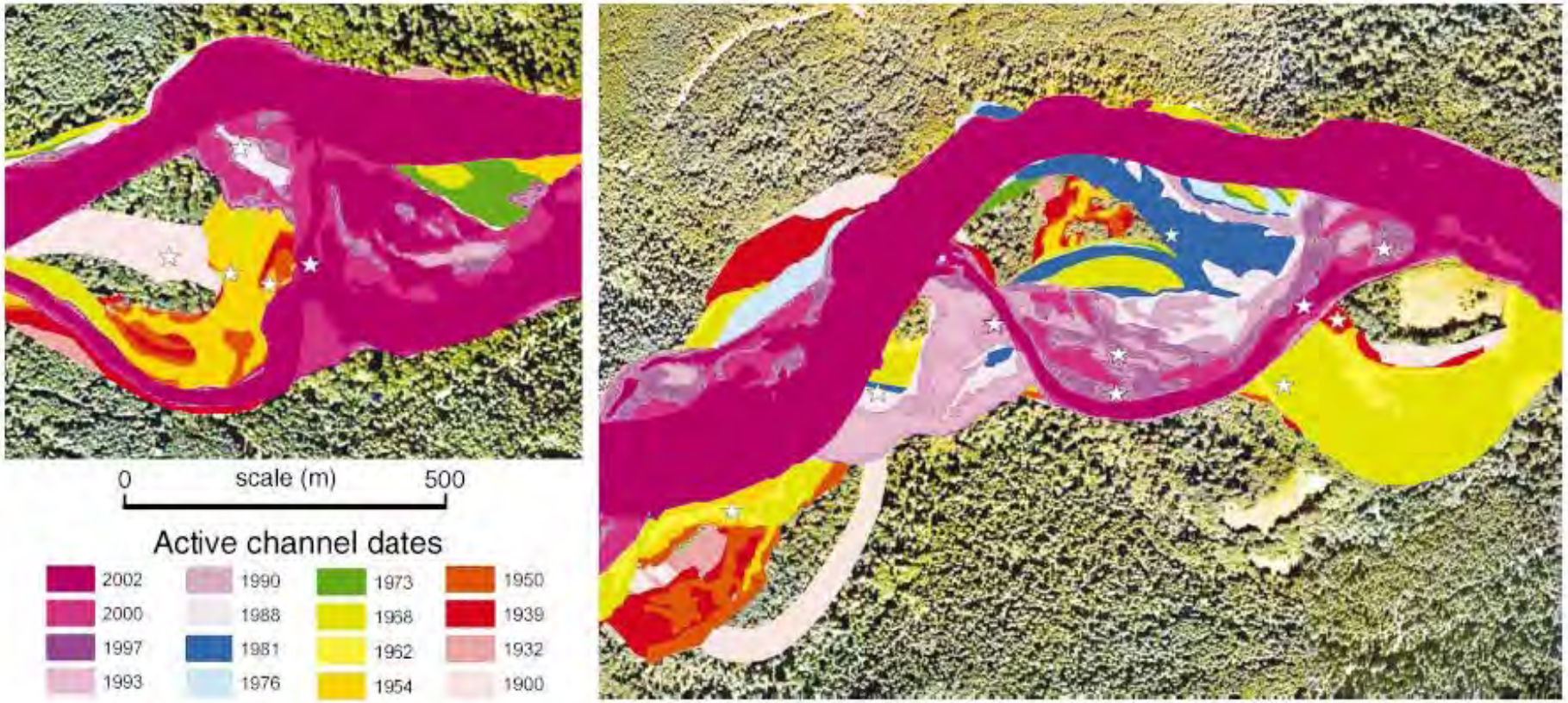

FIG. 8. Twentieth-century disturbance maps for the two study reaches. The 16 dates represented are not specific years of major river action, simply the years for which we have accurate spatial data. The maps therefore represent a minimum of river activity; a complete coverage would undoubtedly show as of yet unmapped river movements. The stars represent plot locations of stands that originated within the 20th century.

(Van Pelt et al., 2006)

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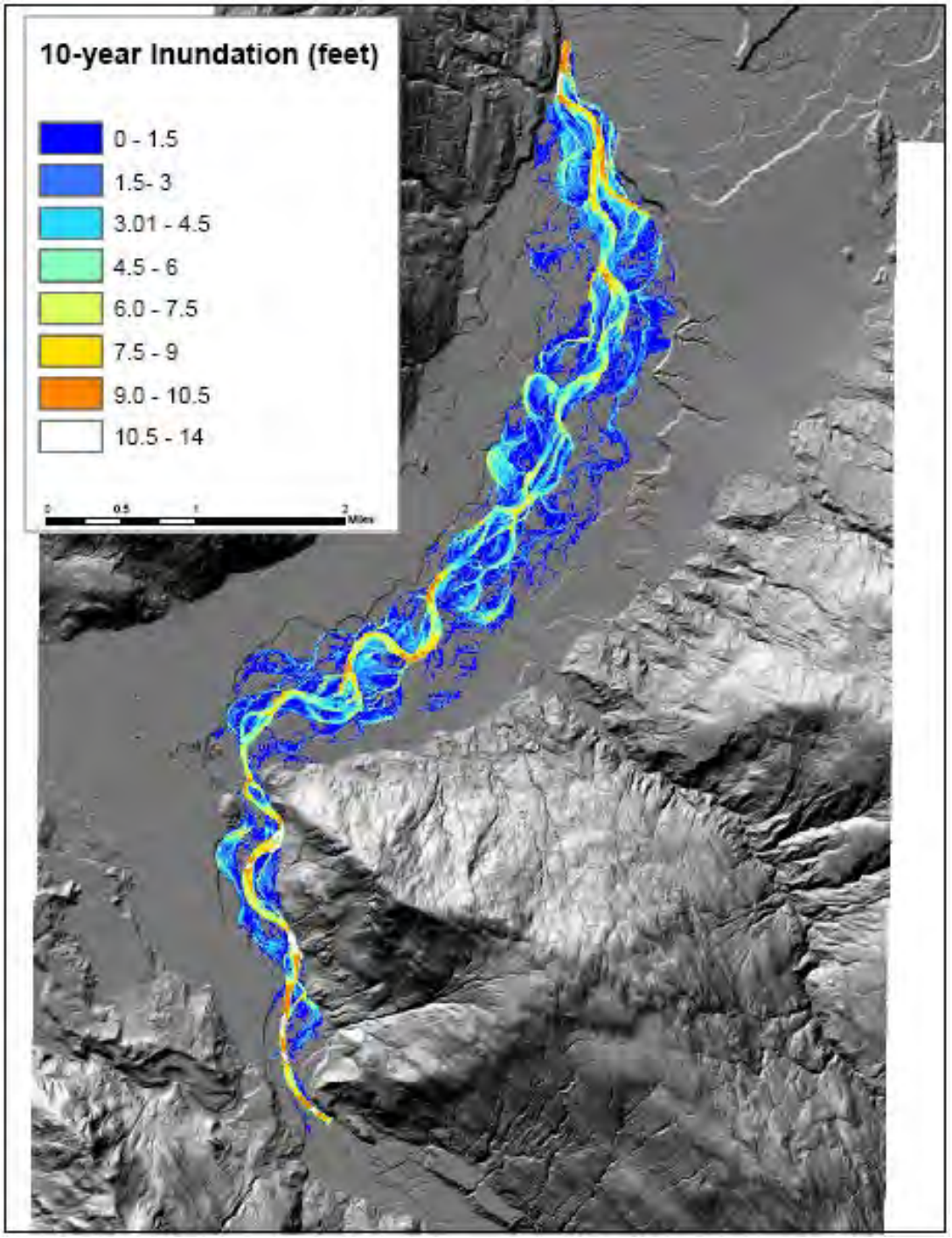
1-D & 2-D Modeling Results & Geospatial Display

- Analysis of active valley alluvial terrain surfaces stage/discharge inundation and associated riparian vegetation
- Basis for alluvial terrain / riparian vegetation predictive model



Ice Processes and Floodplain Vegetation

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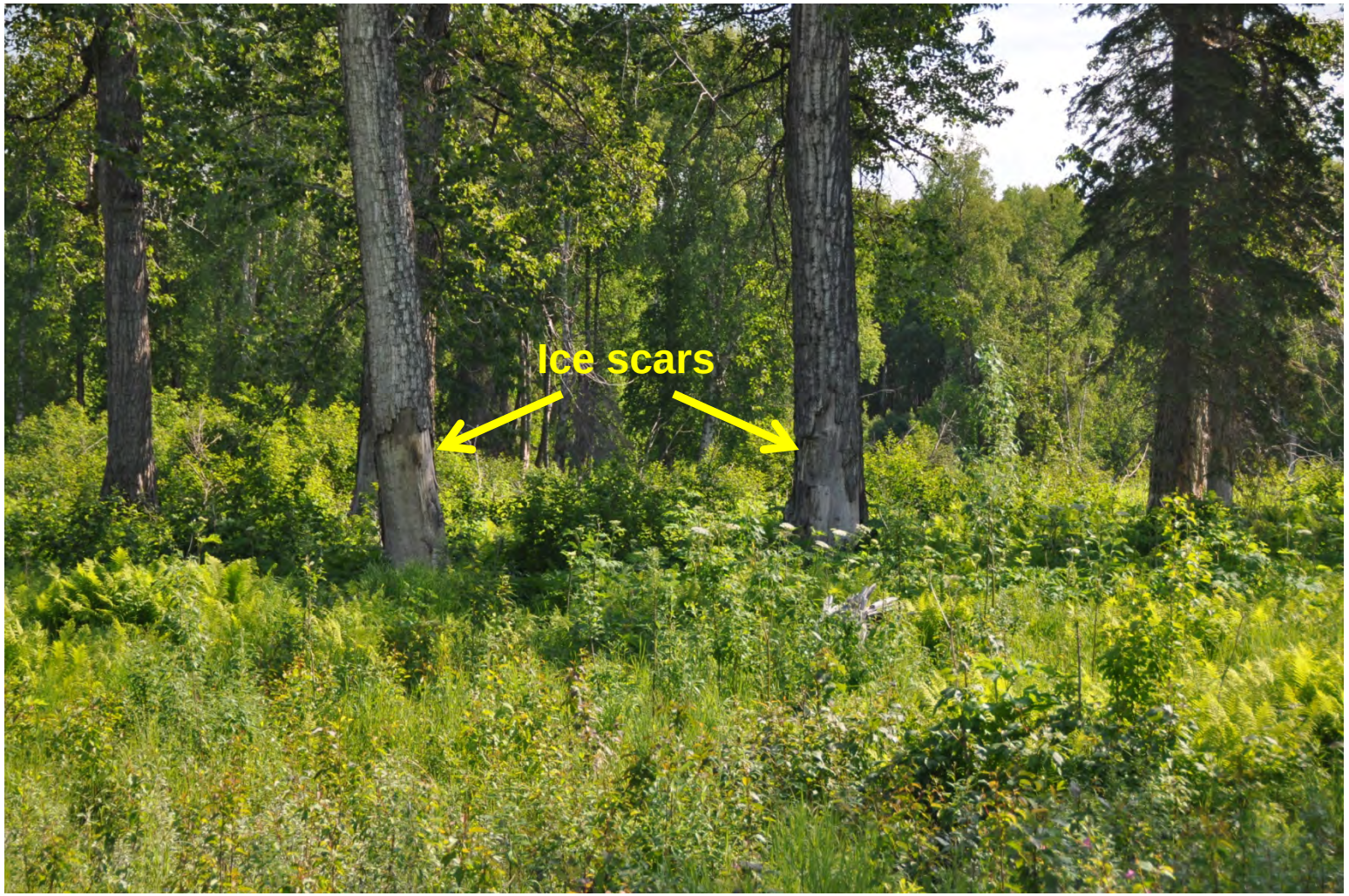
Ice Processes and Floodplain Vegetation



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Ice Processes and Floodplain Vegetation

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Ice Processes and Floodplain Vegetation

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Methods:
Physical process modeling– groundwater / surface water interaction study

1. Develop GW/SW interaction model coupled with riparian vegetation-flow response guild models
2. MODFLOW (USGS, 2005) & RIP-ET (riparian evapo-transpiration, 2012)
3. Groundwater /surface water well and stage gage transect array

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Riparian IFS Modeling Coordination

Dam/Reservoir Operations Model
Alternate Operational Scenarios

Reach (G-S2) / Habitat Type (F-S5) / Sampling Site Designations (F, G, WQ, WR, B, W)

Hydrology
- Representative Water Years
- Hourly Dam Releases
- Flood Flows

Biological Information
- Periodicity (F-S1, S2, S4)
- Distribution (F-S1, S2, S4)
- Abundance (F-S1, S2, S4)
- Seasonal Habitat Utilization (F-S3)
- HSI (F-S5)
- Riparian (B-S1, S2, S3)

Mainstem Flow Routing HEC-RES, HEC-RAS (WR-S1)
- Accretion
- Attenuation
- Hourly Q, WSE by River Mile

Habitat Specific Models (F-S5)
- Habitat vs. Flow (1D / 2D)
- Habitat vs. Stage
- Effective Spawning Analyses
- Riparian Vegetation
- Varial Zone
  - Stranding – Salmon Fry, Benthic Macroinvertebrates
  - Trapping

Riverine Processes
- Geomorphology
  - Sediment Transport (G-S1)
  - Future Channel Changes (G-S2, S3)
- Ice (WR-S2)
- Large Woody Debris (LWD) (G-S3)
- Groundwater
- Water Quality / Temperature (WQ-S1)

Side Sloughs

Low Flow Active	High Flow Active	Relict

- Riverine Processes
- Habitat Specific Modeling
- Fish Passage

Mainstem / Side Channels
- Riverine Processes
- Habitat Modeling
- Fish Passage

Tributary Deltas
- Riverine Processes
- Habitat Modeling
- Fish Passage

Riparian
- Riverine Processes
- Vegetation Modeling

Hourly / Daily / Monthly Habitat by Operational Scenario

Integrated Resource Analysis
- Fish Habitat (F)
- Water Quality (WQ)
- Geomorphology (G)
- Riparian (B)
- Wildlife (W)
- Cultural (C)
- Recreation (R)
- Aesthetics (A)
- Project Economics
- Subsistence (S)

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Methods:
Physical process modeling– groundwater / surface water interaction study

1. Develop GW/SW interaction model coupled with riparian vegetation-flow response guild models
2. MODFLOW (USGS 2005) & RIP-ET (riparian evapo-transpiration, 2012)
3. Groundwater /surface water well and stage gage array

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Methods:
Synchrony of cottonwood and willow seed dispersal, hydrology and Susitna River climate

1. Measure cottonwood and select willow species seed dispersal timing,
2. Model local Susitna River valley climate
3. Develop recruitment model of seed dispersal, river flow regime and cottonwood / willow recruitment.
4. Operational flow recommendations.

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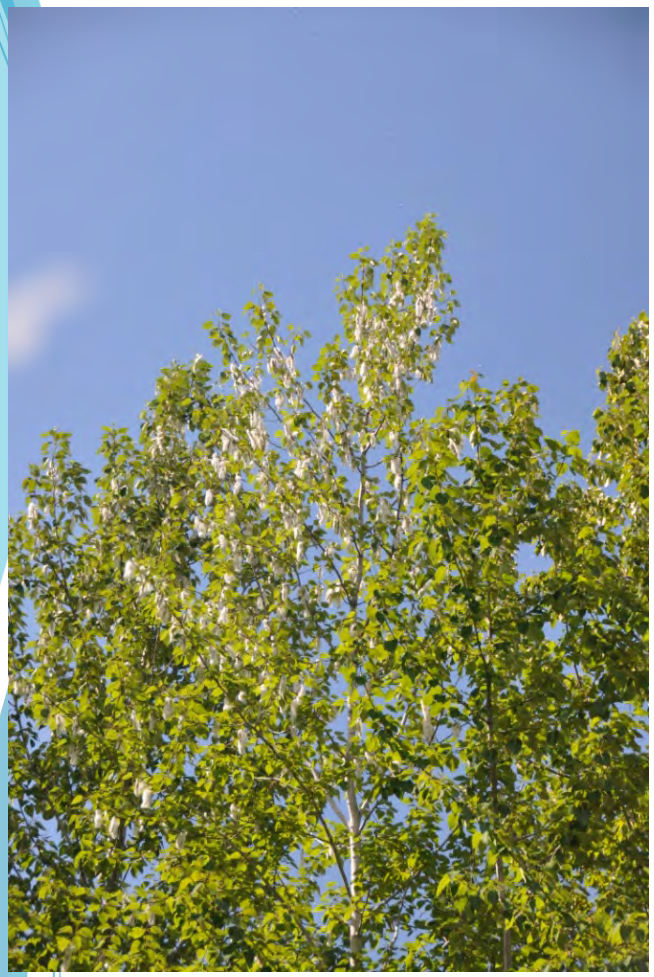

Balsam poplar seed release
June 30, 2012
Susitna River below Three Rivers

Cottonwood seeds, gravel bar 2012

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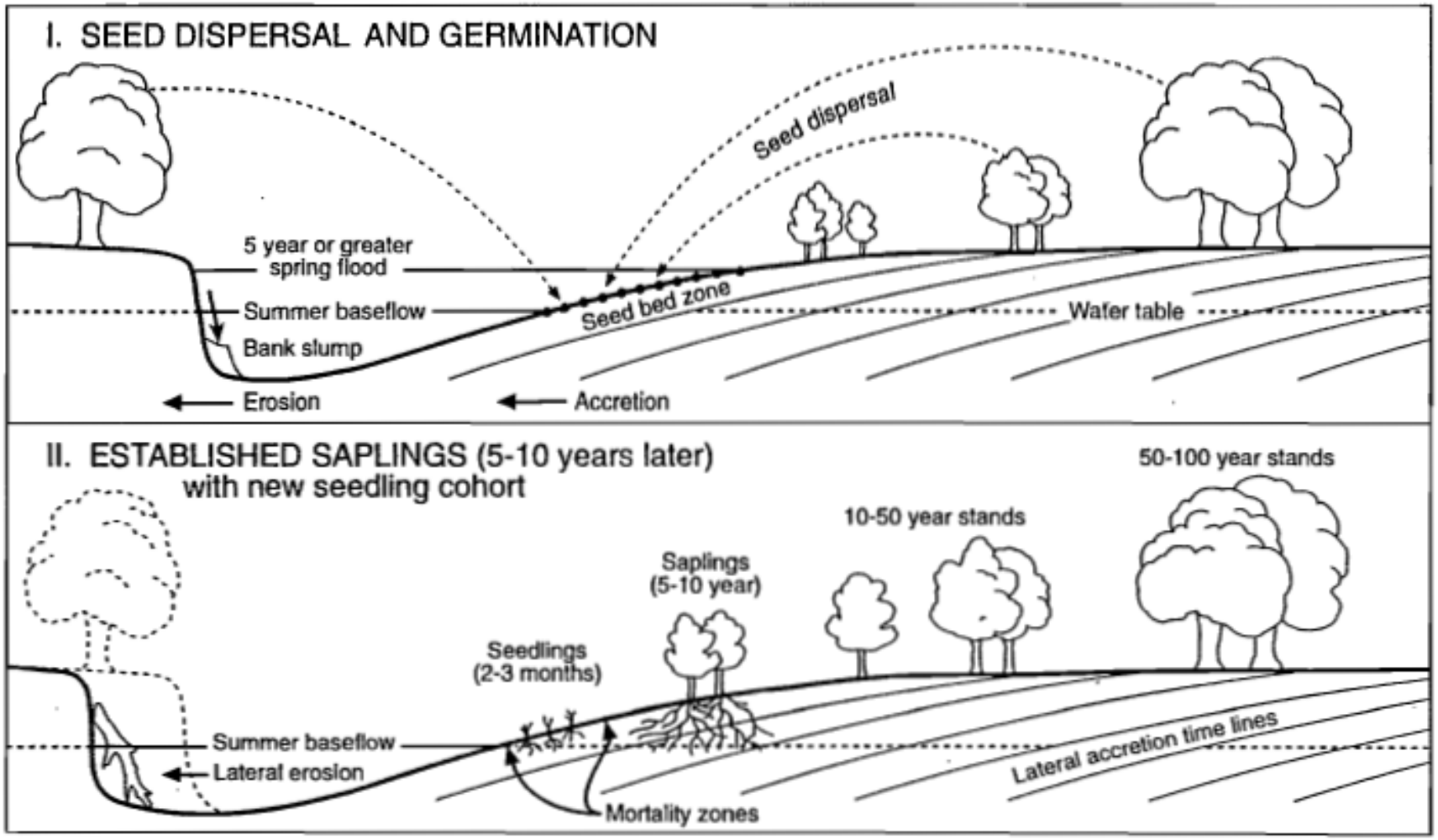
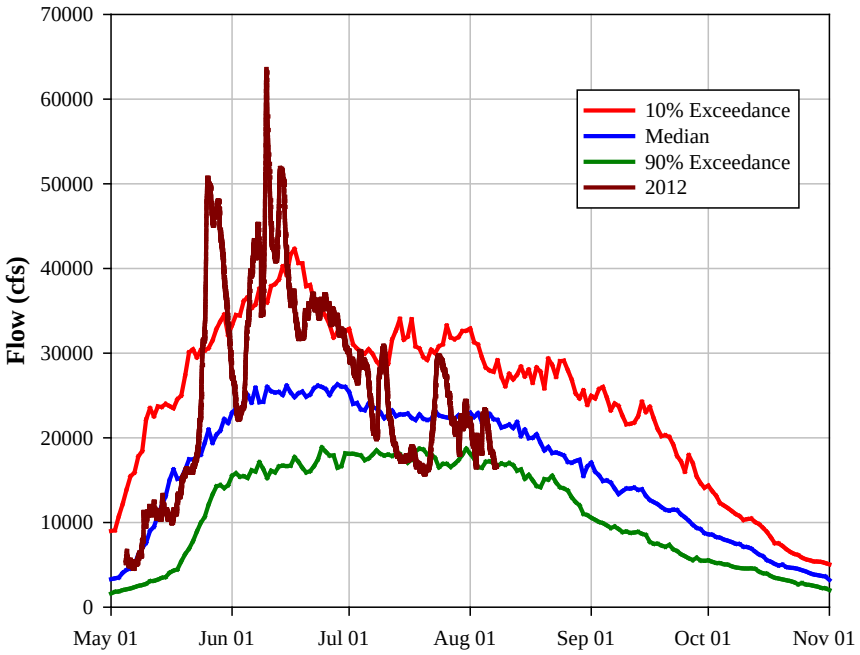
Cottonwood (*Populus* spp) Recruitment Life History Trait: Reproductive Strategy



(Modified from Bradley and Smith 1986)

Synchrony of Cottonwood Seed Dispersal & Natural Flow Regime

2012 riparian botanical survey:
two year old cottonwood seedlings



Susitna River Gold Creek Gauge

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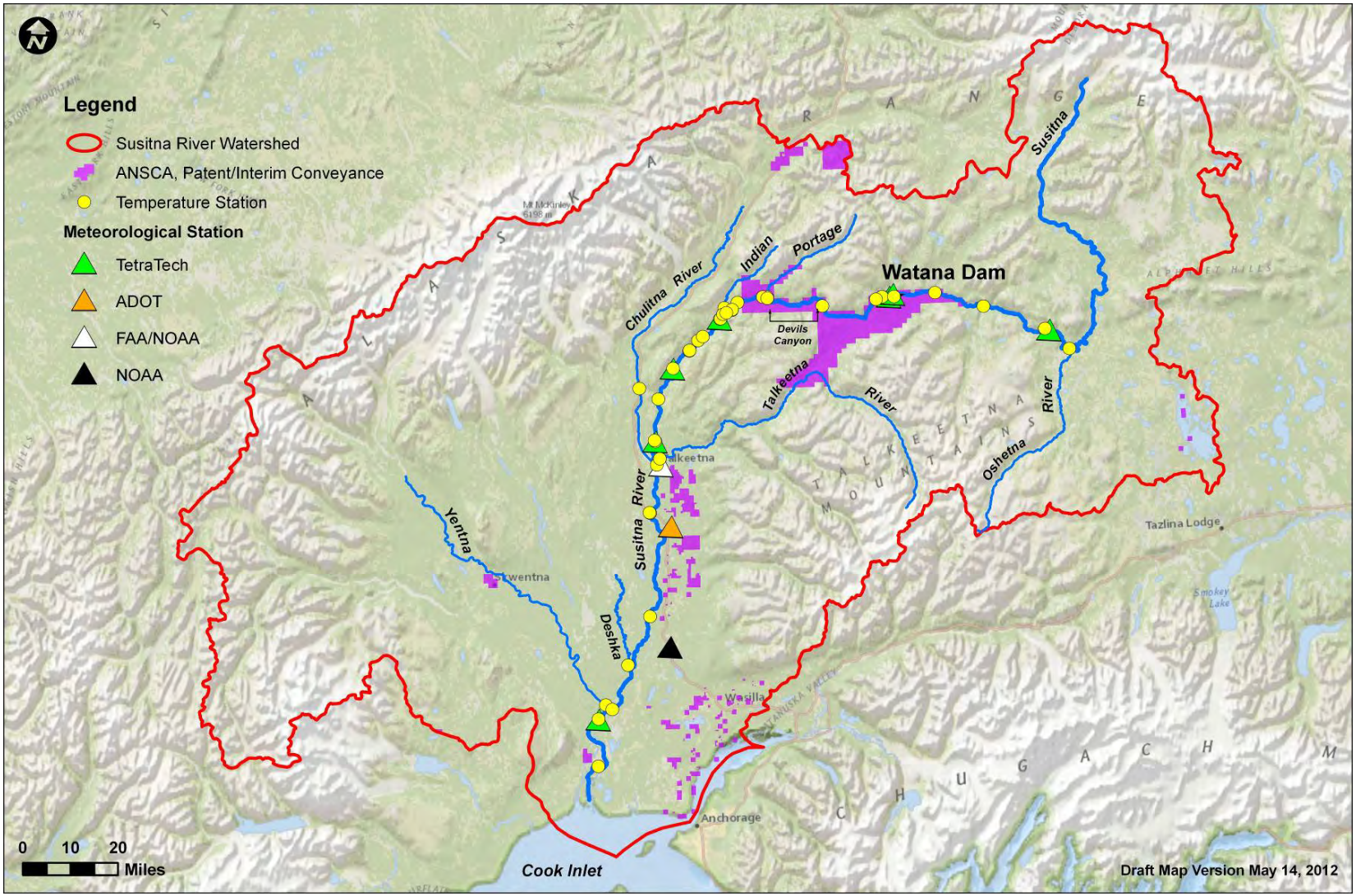
Susitna River Meteorological Stations



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Methods:
Riparian floodplain vegetation succession models

1. Build on 1980/90's succession model
2. Develop more comprehensive set of succession models, as necessary.
3. Focus on plant community recruitment conditions & conditions that will change under Project operational flows.

   a. sediment, flow-regime, groundwater, geomorphic terrain position

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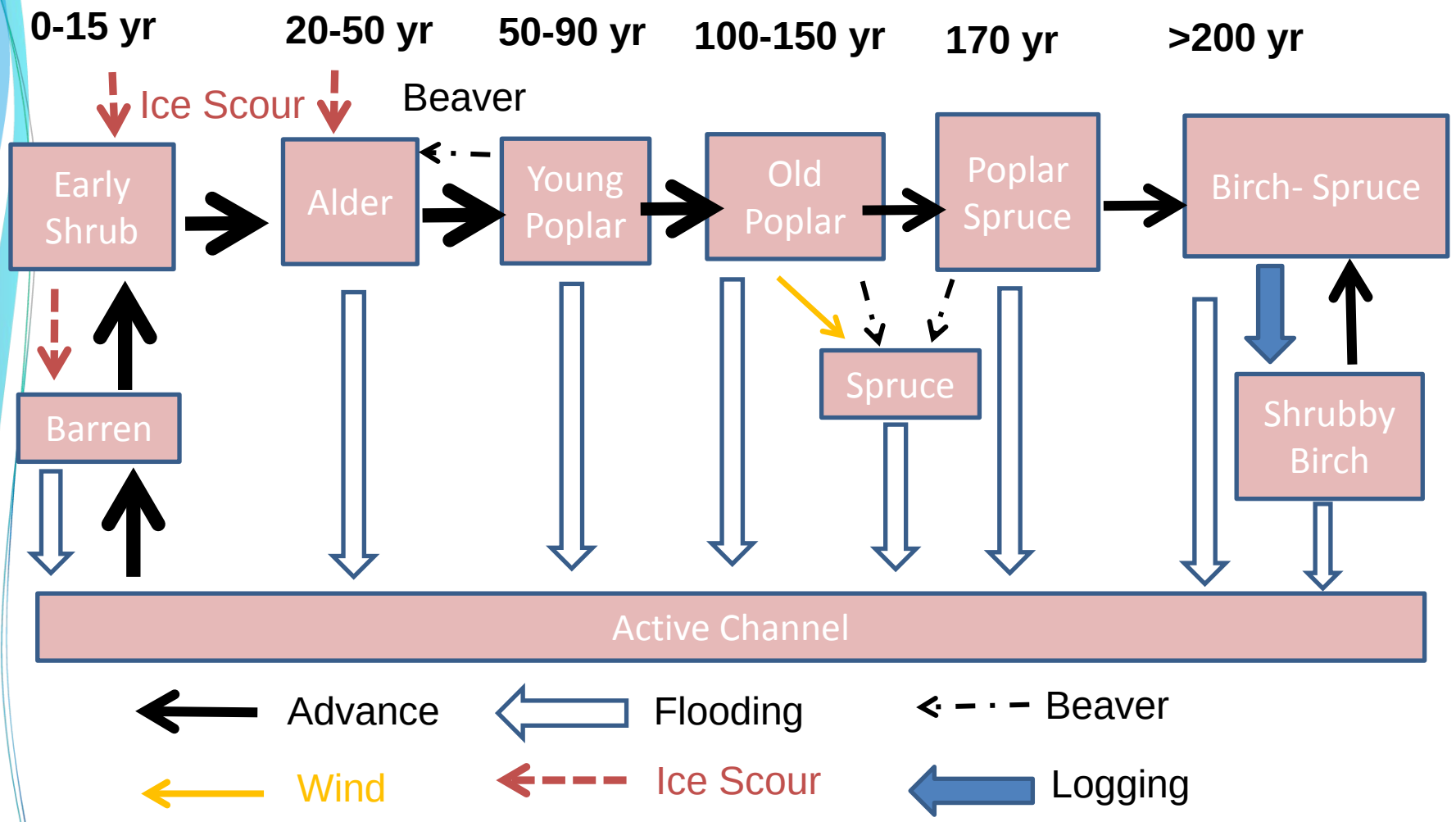
Susitna River Floodplain Forest Succession



(after Helm and Collins 1997)

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Methods:
Riparian floodplain vegetation–flow response guilds

1. Group plant species into guilds with shared life history traits related to natural flow hydroregime:
   a. Reproductive strategy (Cottonwood & willow)
   b. Morphology (willow, alder, cottonwood)
   c. Disturbance adaptations (rhizomatous herbaceous species and ice shearing regime)
2. Develop probabilistic response curves for guilds and physical processes:
   a. Flood regime
   b. Groundwater regime
   c. Ice shearing
   d. Sediment type

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Riparian Guilds based on life history traits: sediment burial and shear resistance guild *(Salix / Populus / Alnus)*

Methods:
Physical and vegetation model scaling–intensive study reach to riparian process domain

1. ARCMAP GIS applications
2. Geospatial analyses
3. Projection of intensive study reach results to larger riparian process domain

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Methods Application:
Whiskers Slough Intensive Study Reach

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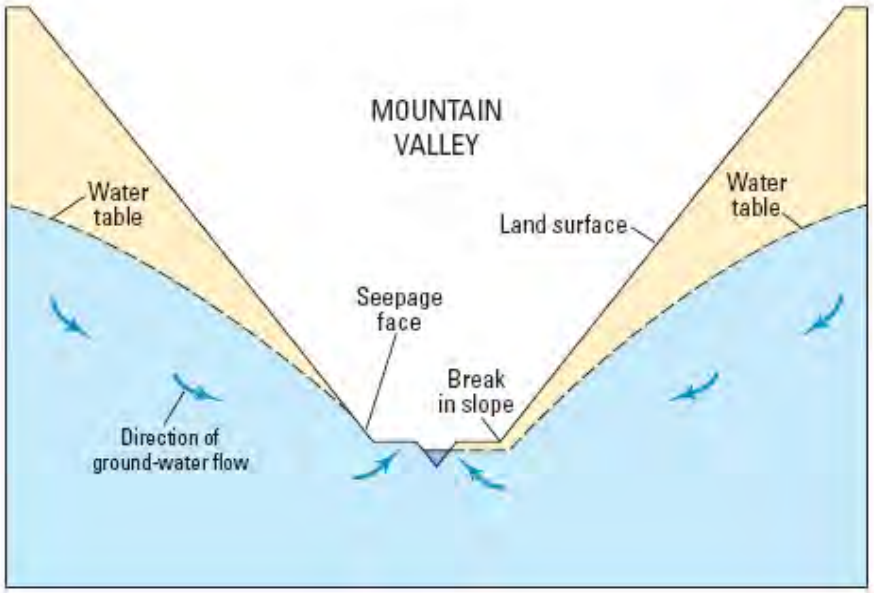
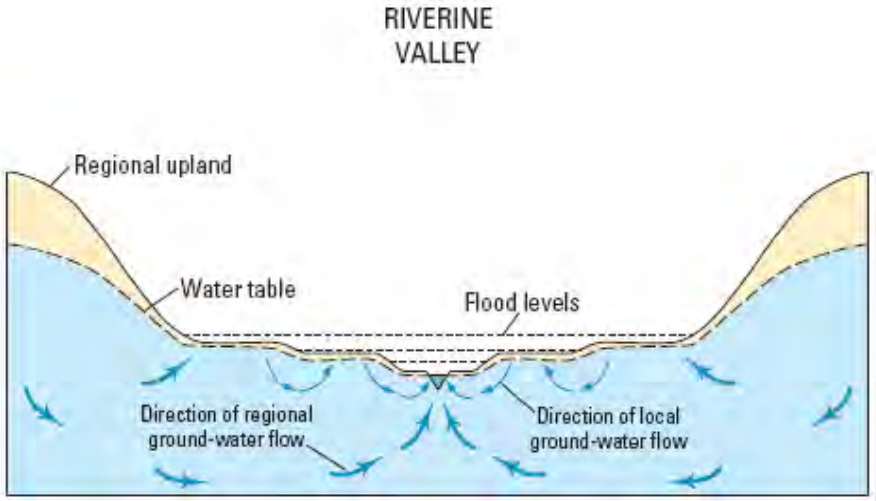
Whiskers Slough
Riverine Hydrologic Landscape (Winter 2001)





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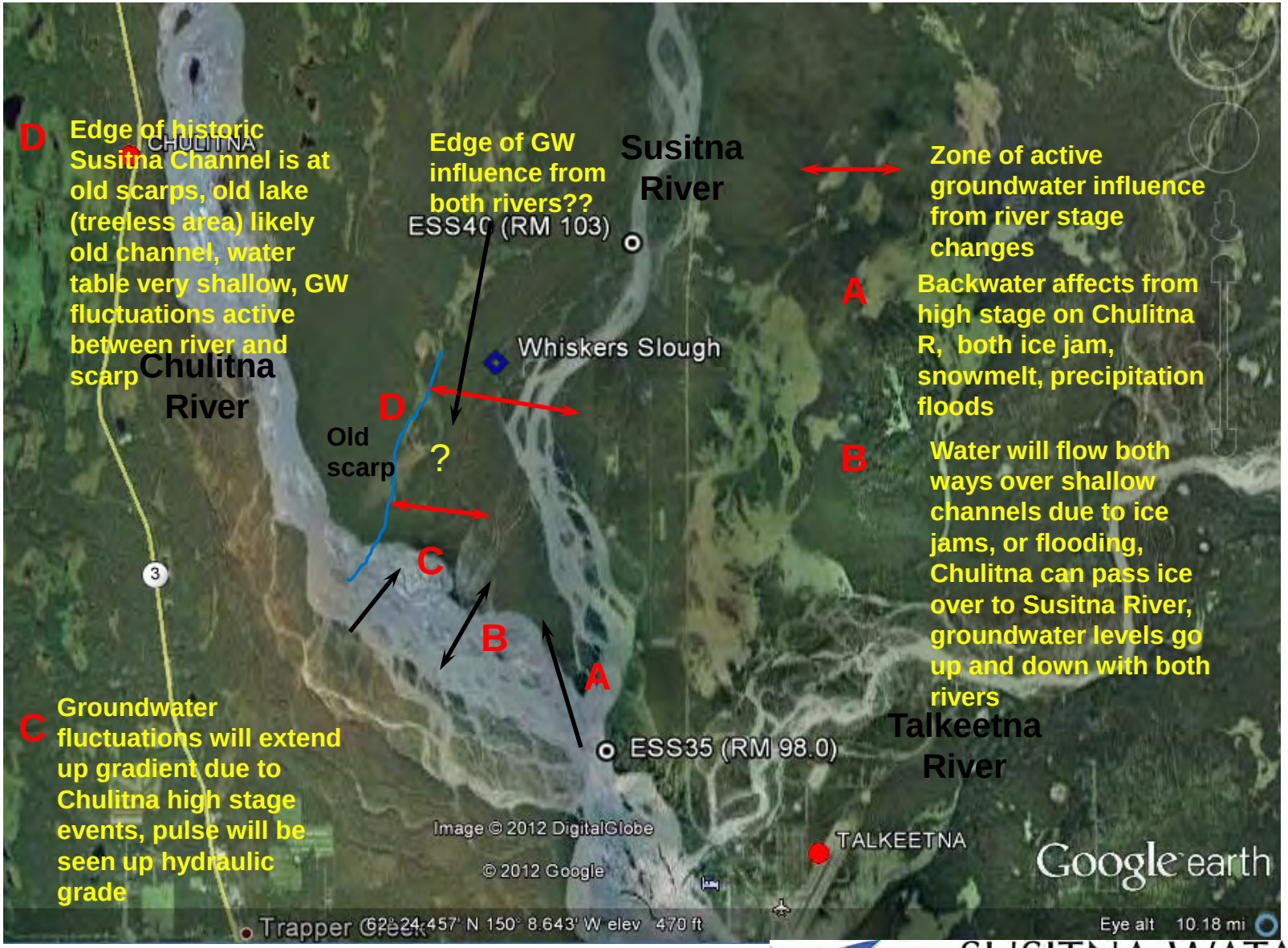
Three Rivers – Whiskers Slough Hydrology



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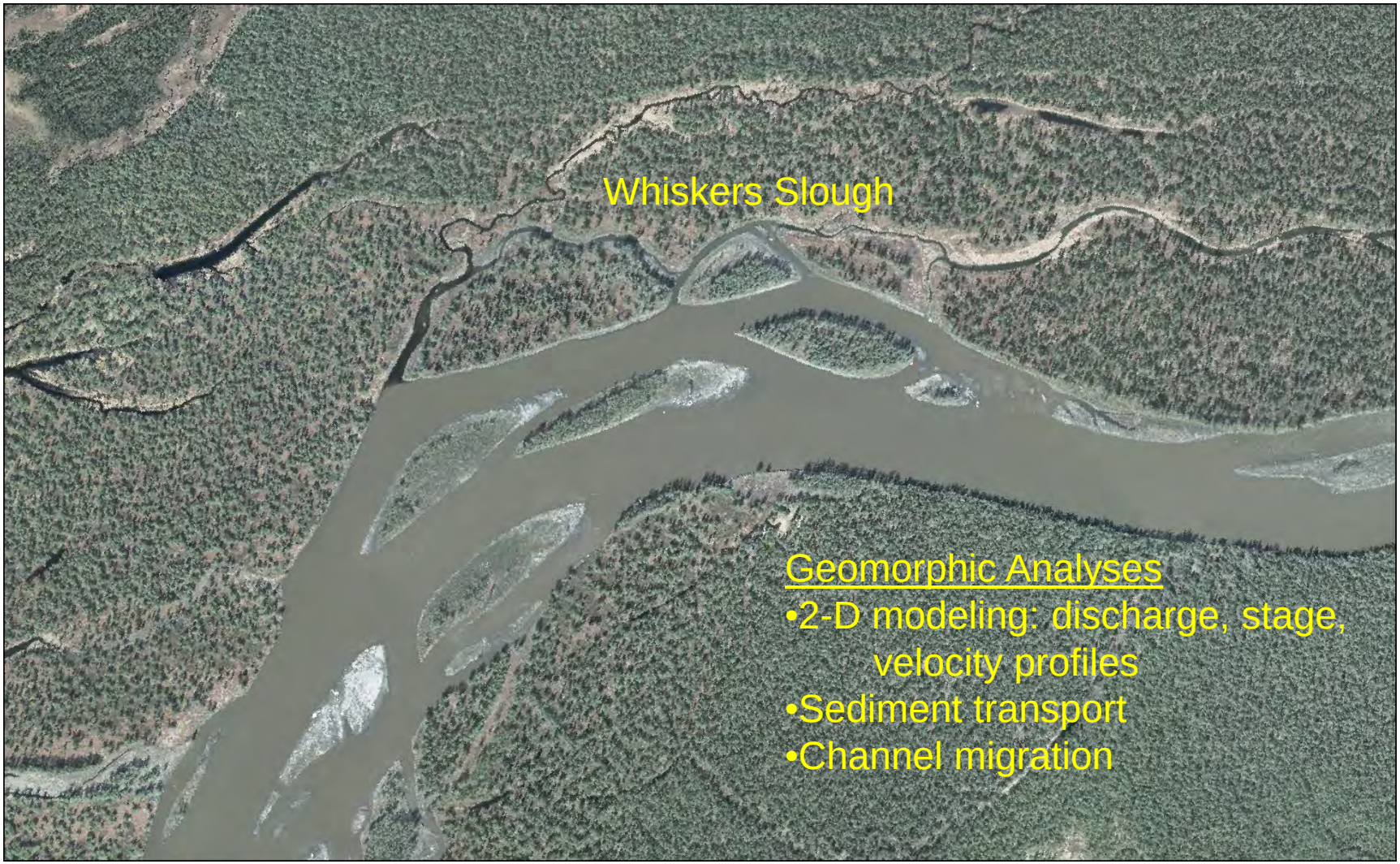
Geomorphic Reach Analysis Scale



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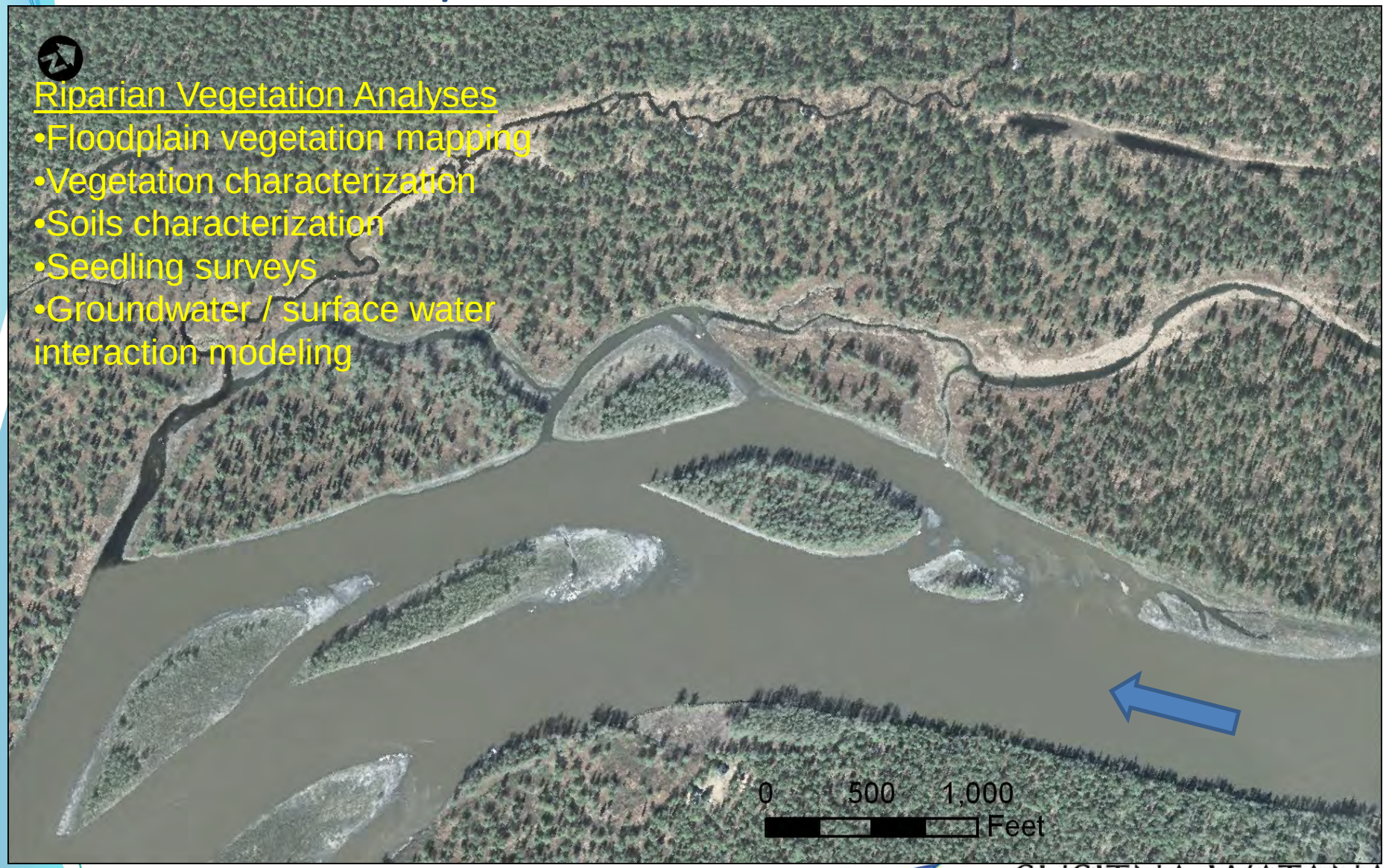
Whiskers Slough Riparian Study: Groundwater / Surface Water Interaction Scale



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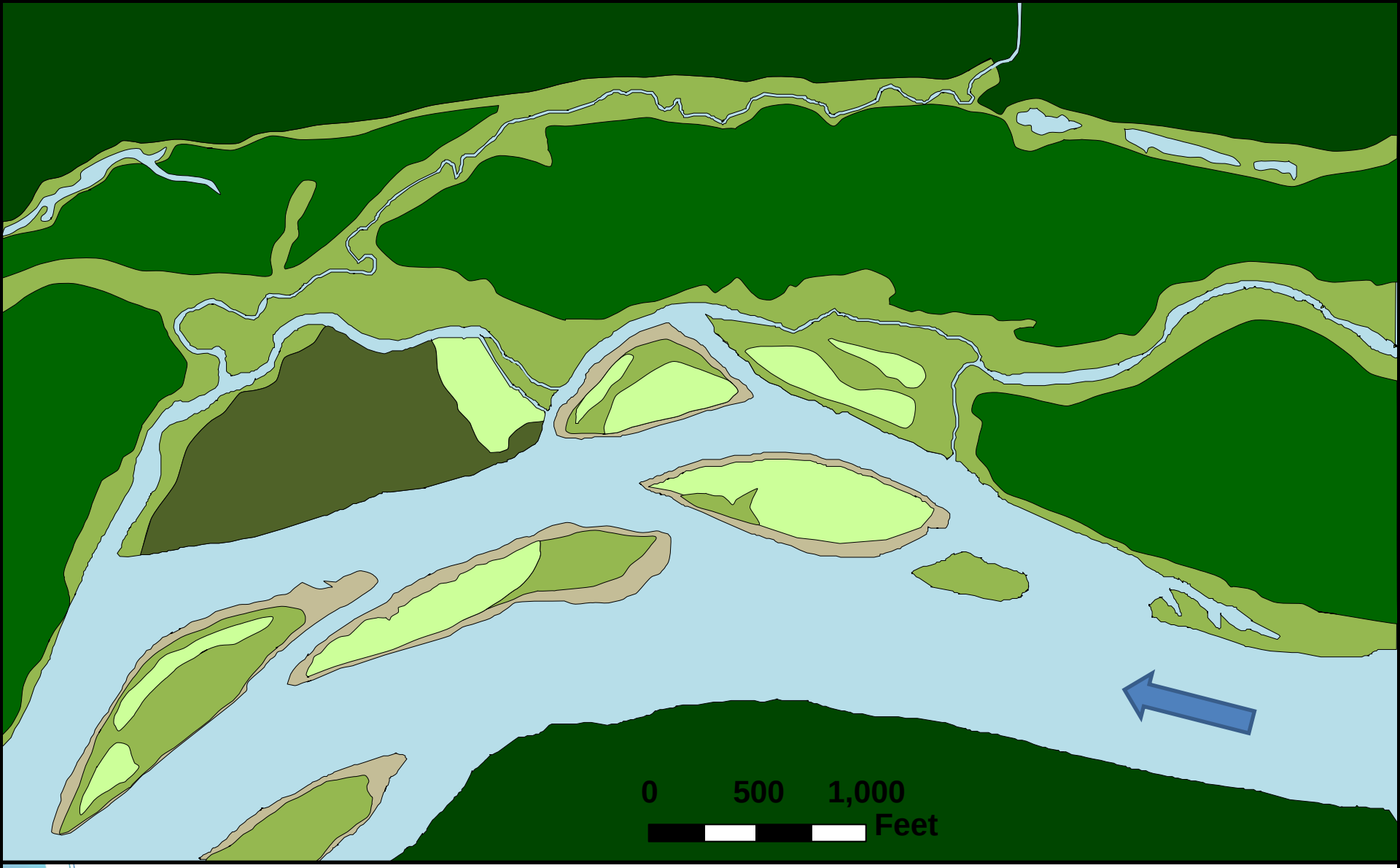
Whiskers Slough Wet Meadow Floodplain Vegetation

Whiskers Slough Sedge Meadow

Whiskers Slough



Spruce/Birch
Poplar/Spruce/Birch
Poplar/Spruce
Balsam Poplar
Willow/Alder
Alder/Wet Meadow

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Methods:
Floodplain vegetation groundwater / surface water interaction modeling

- Investigation to quantify groundwater / surface water interactions within floodplain shallow aquifers.
- Vegetation modeling linkage with hydraulic model and groundwater models
- Develop empirical model of riparian plant community / groundwater associations to assess potential changes due to hydroregulation.
- Design with Michael Lilly, GW Scientific

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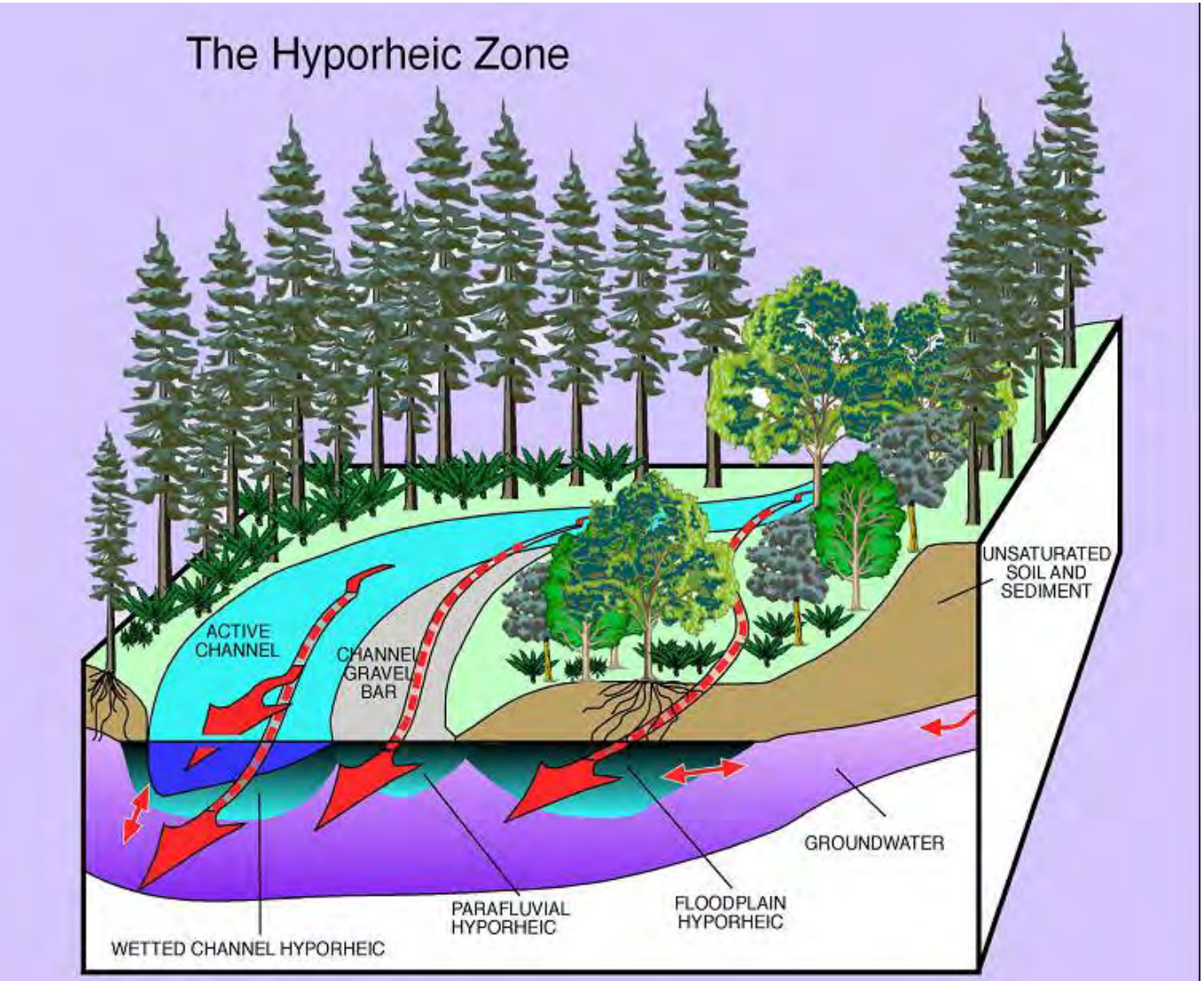
Shallow Floodplain Aquifer, the Hyporheos



(Naiman et al. 2000)

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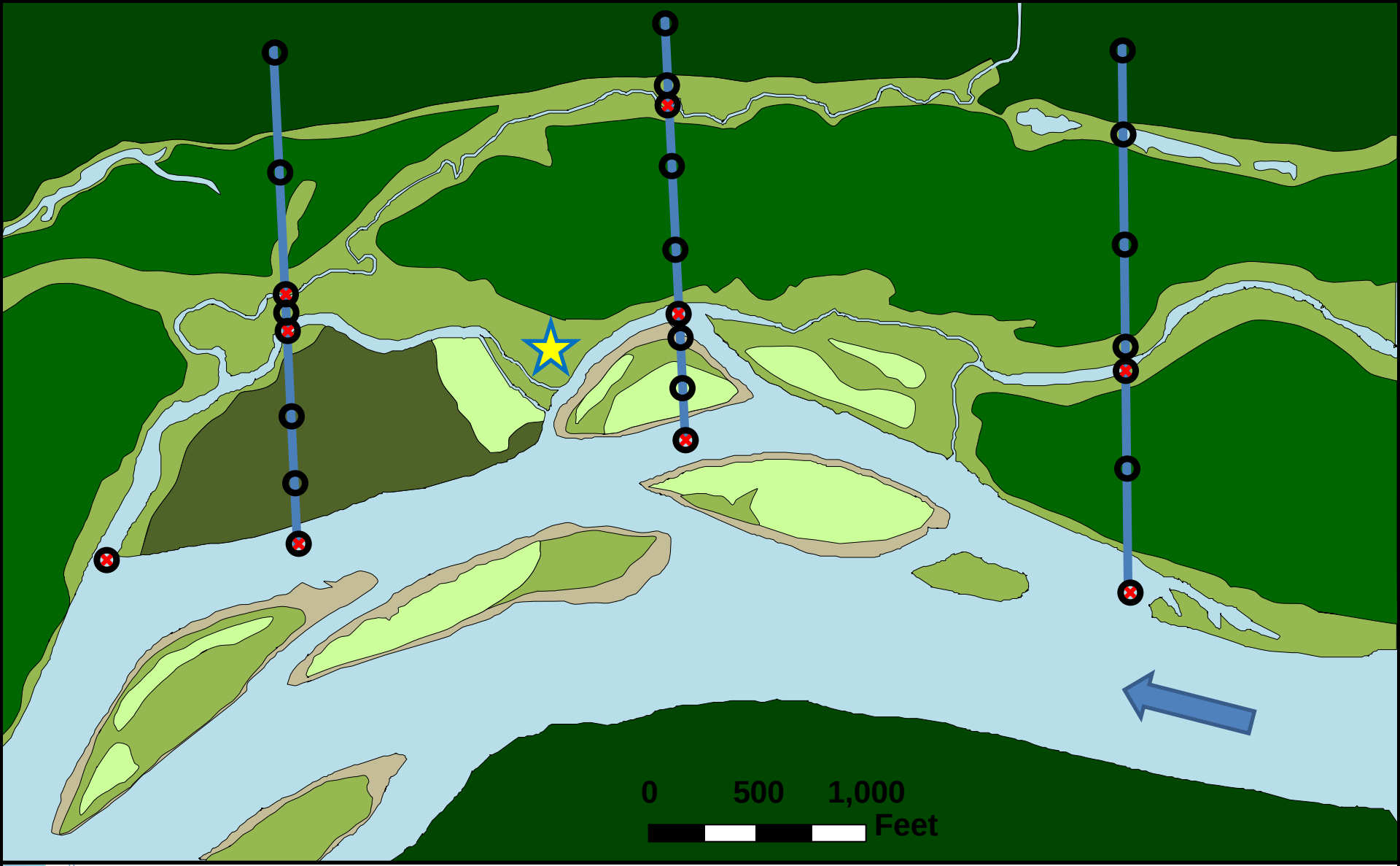

Spruce/Birch
Poplar/Spruce/Birch
Poplar/Spruce
Sampling Transects

Balsam Poplar
Willow/Alder/Wet Meadow
Willow/Wet Meadow
Meteorology Station (ET)

Monitoring Wells
Soil Temperature
Soil Moisture
Stage Recorders

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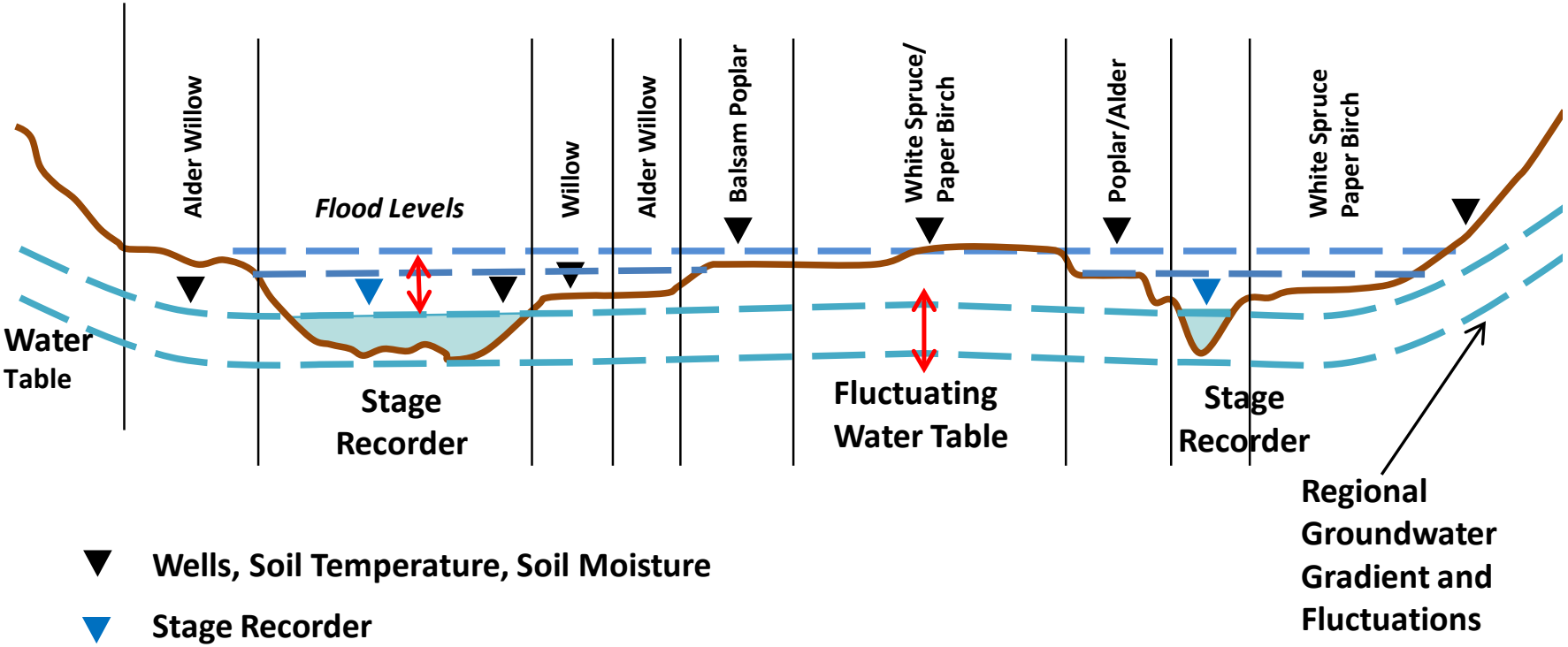
Study Site Cross-Section



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Large Wood Jams

Large Wood Jams

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Riparian Instream Flow Study
Expected Results

- 2012 riparian botanical survey fieldwork will guide 2013/14 efforts
- 2013-2014 riparian IFS modeling will provide a quantitative assessment of potential impacts of Project operational flows on Project Area floodplain forming processes and floodplain plant community composition, structure, spatial distribution and potential future condition.

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Riparian Instream Flow Study
Relationship to other Studies

- Riparian IFS is totally integrated with the Riparian Botanical Survey.
- Riparian IFS results will inform geomorphology and ice processes studies (e.g. dendrochronology, floodplain age, channel dynamics, ice dam occurrence).
- Floodplain vegetation results will inform both fish and wildlife habitat analyses.
- Riparian groundwater / surface water interaction study results will inform shallow groundwater well user analyses.

Riparian Instream Flow
Summary of 2012 Activities

- Primary 2012 work has been integrated Riparian Botanical field survey and Riparian IFS field studies.
- Field work results will inform final intensive study site design and site selection.
- Large wood field reconnaissance study.

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Questions?

- Groundwater / surface water interaction study duration 2013-2014
  - Wells & stage recorders to be installed early summer 2013
  - Groundwater / surface water data collection planned for 1.5 yrs

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