Use of remote sensing and modelling to assess morphologic change as a result of a hydro-peaking dam

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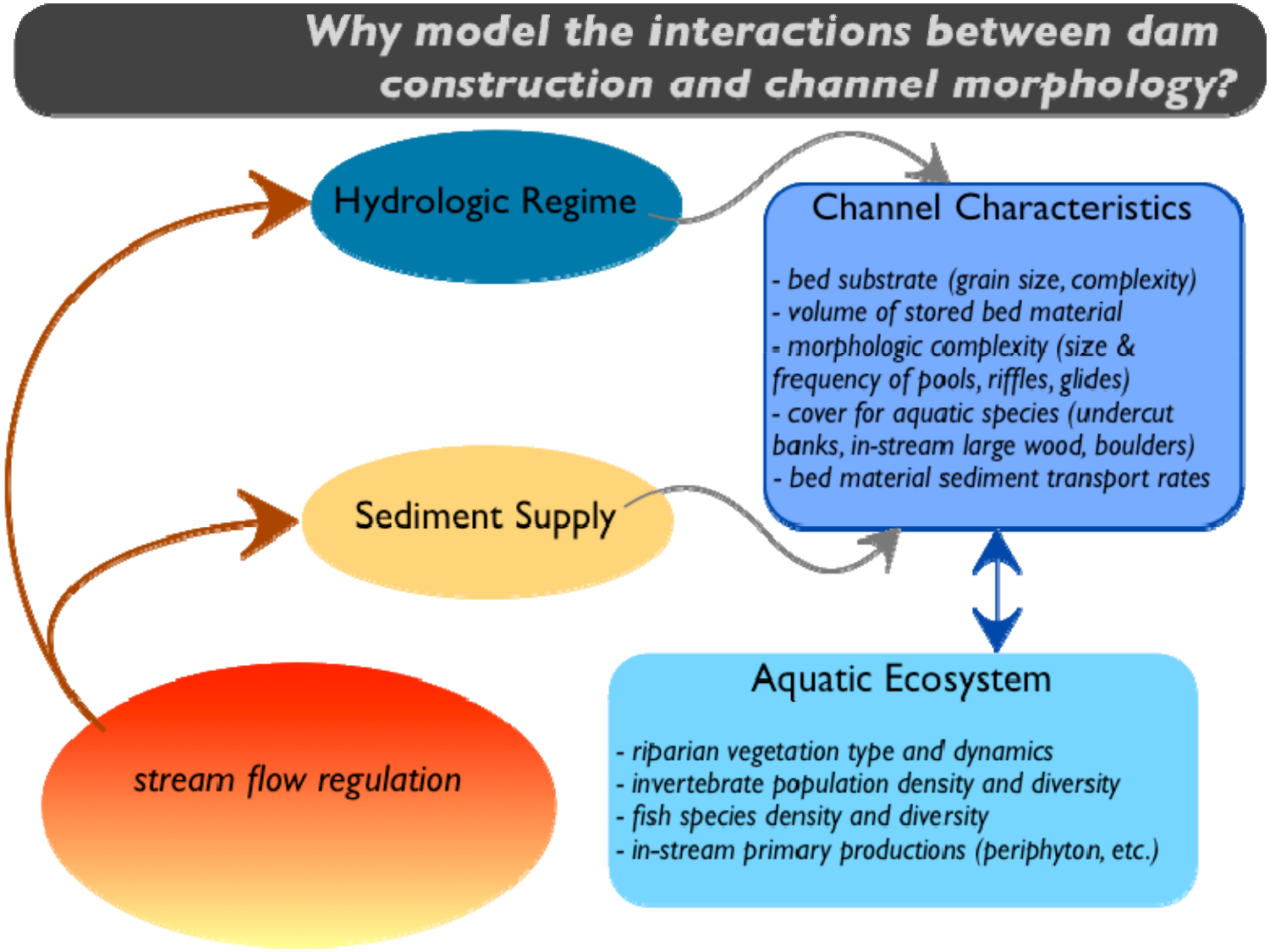
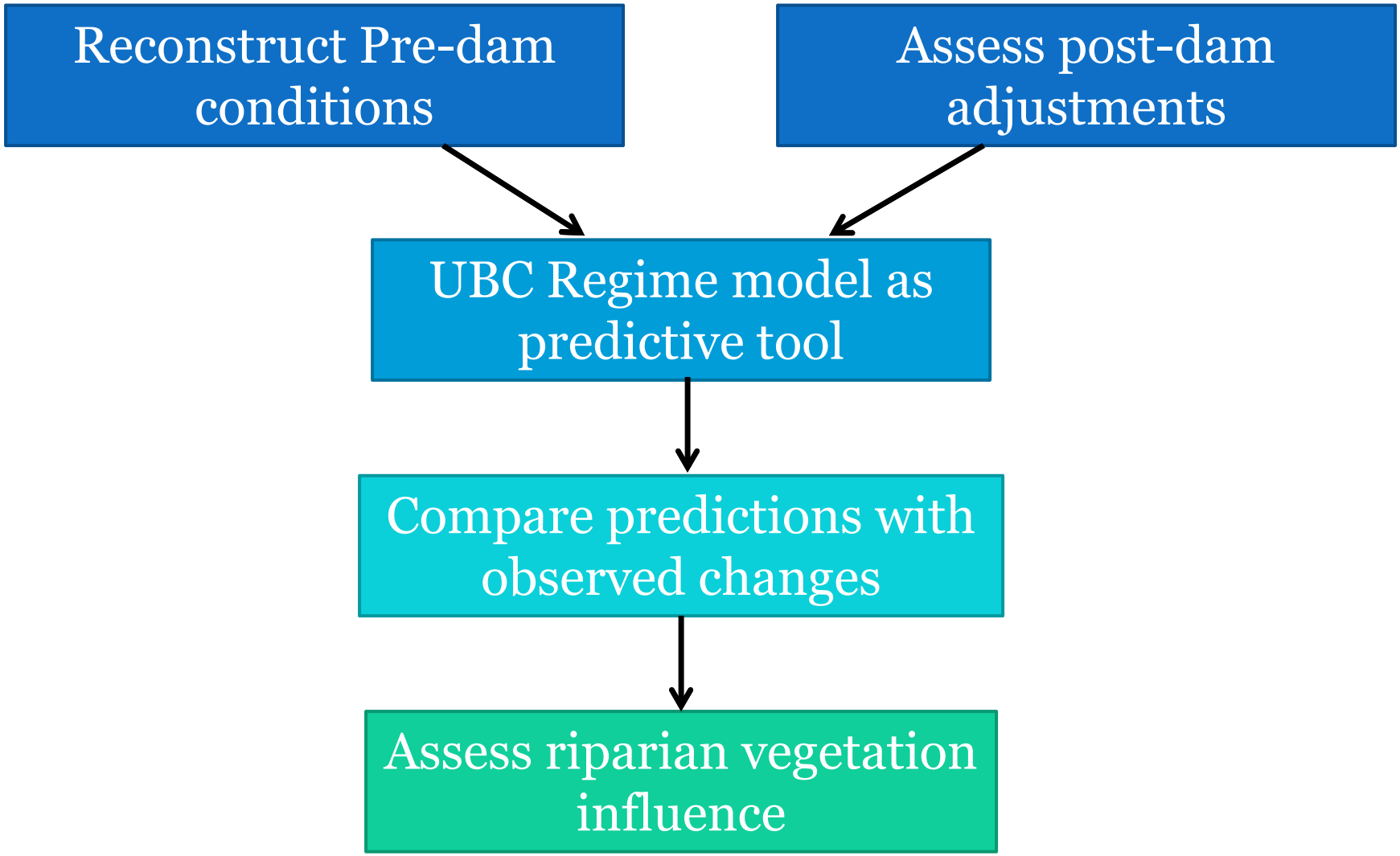

Why model the interactions between dam construction and channel morphology?
Hydrologic Regime
Channel Characteristics
- bed substrate (grain size, complexity)
- volume of stored bed material
- morphologic complexity (size & frequency of pools, riffles, glides)
- cover for aquatic species (undercut banks, in-stream large wood, boulders)
- bed material sediment transport rates
Sediment Supply
stream flow regulation
Aquatic Ecosystem
- riparian vegetation type and dynamics
- invertebrate population density and diversity
- fish species density and diversity
- in-stream primary productions (periphyton, etc.)

Research question

- How has the Kananaskis River adjusted to the 1955 damming?
  - Geomorphic
  - Downstream propagation
  - Ecologic

Research Methods

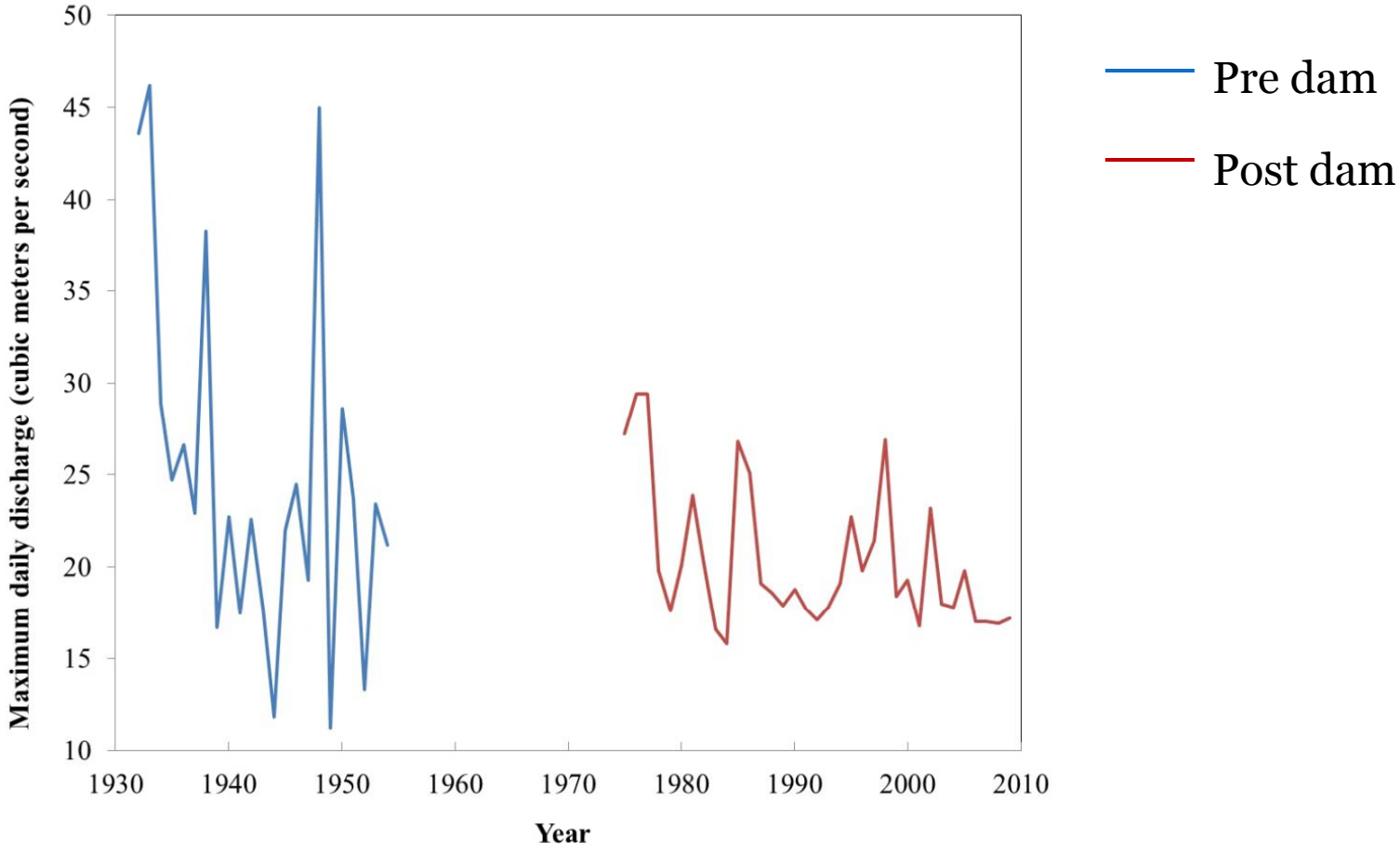


Study site

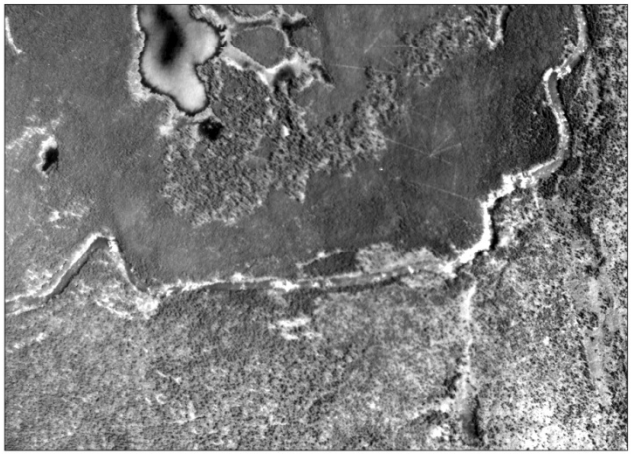

115°10'W
115°5'W
115°0'W
51°0'N
50°55'N
50°50'N
50°45'N
50°40'N
N
0 2 4 8
Kilometers
Contour Interval 100 m


Northwest Territories
British Columbia
Alberta
Saskatchewan

Reconstruct Pre-dam conditions: Historic flow data



Reconstruct Pre-dam conditions: Aerial Photos



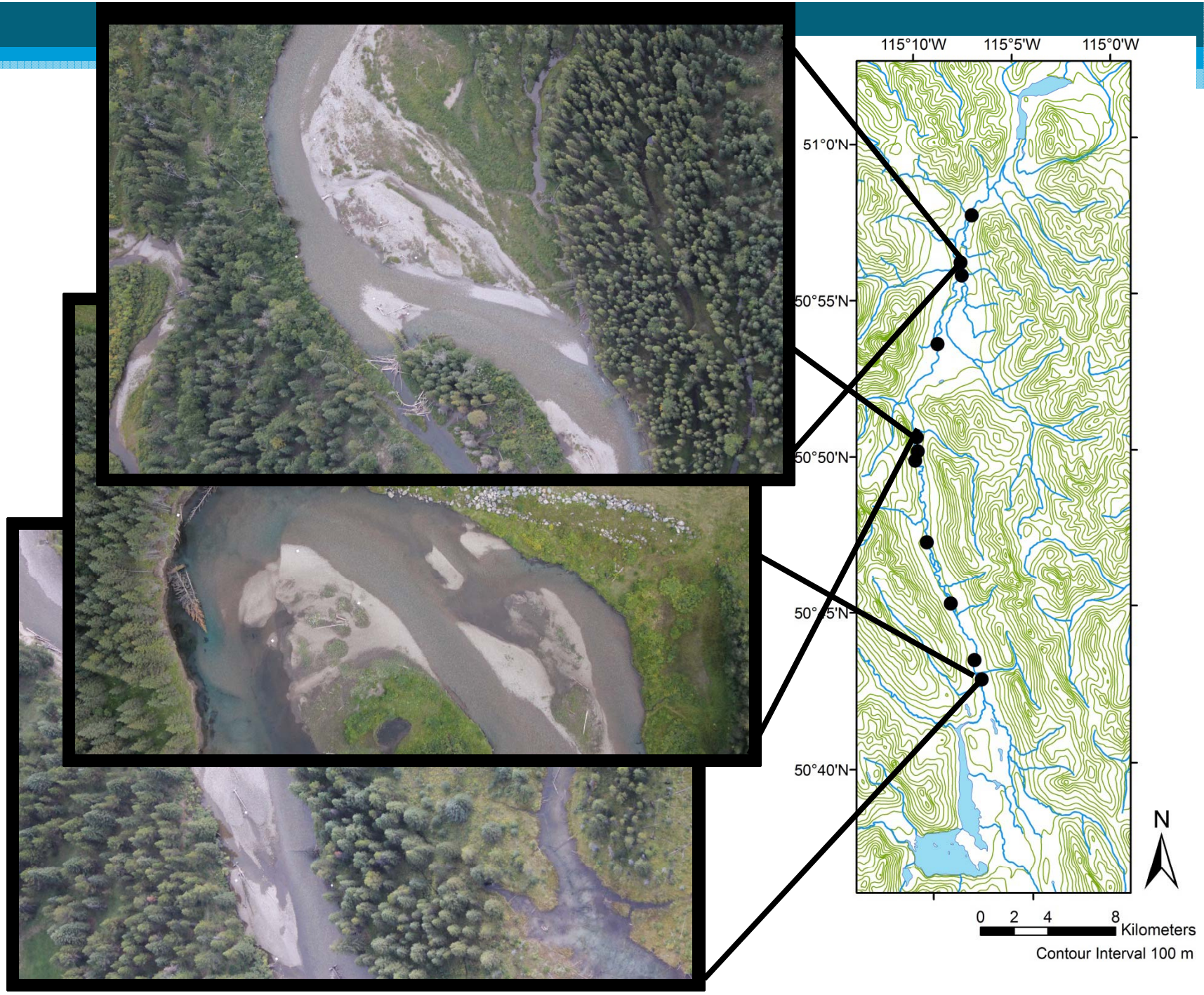
1948

1958

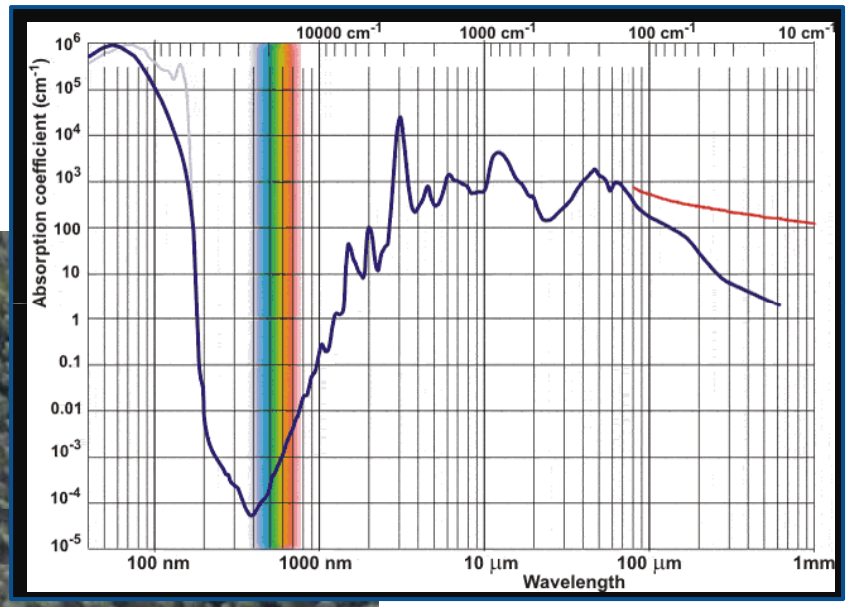
Assessment of post dam conditions

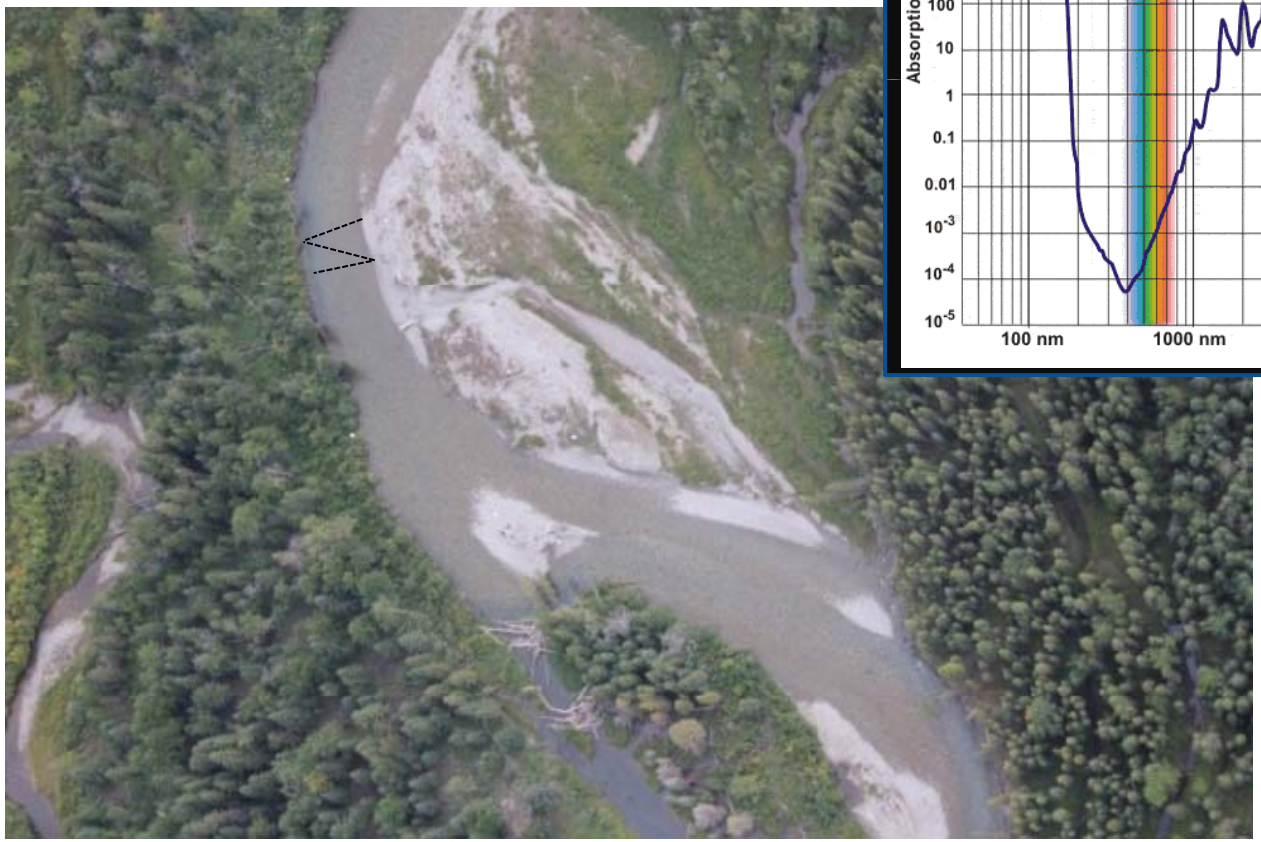
- Fieldwork:
  - Slope
  - Grain size
  - Width
  - Riparian species

- Airborne remote sensing:
  - Grain size
  - Depth
  - Channel pattern
  - Riparian structure

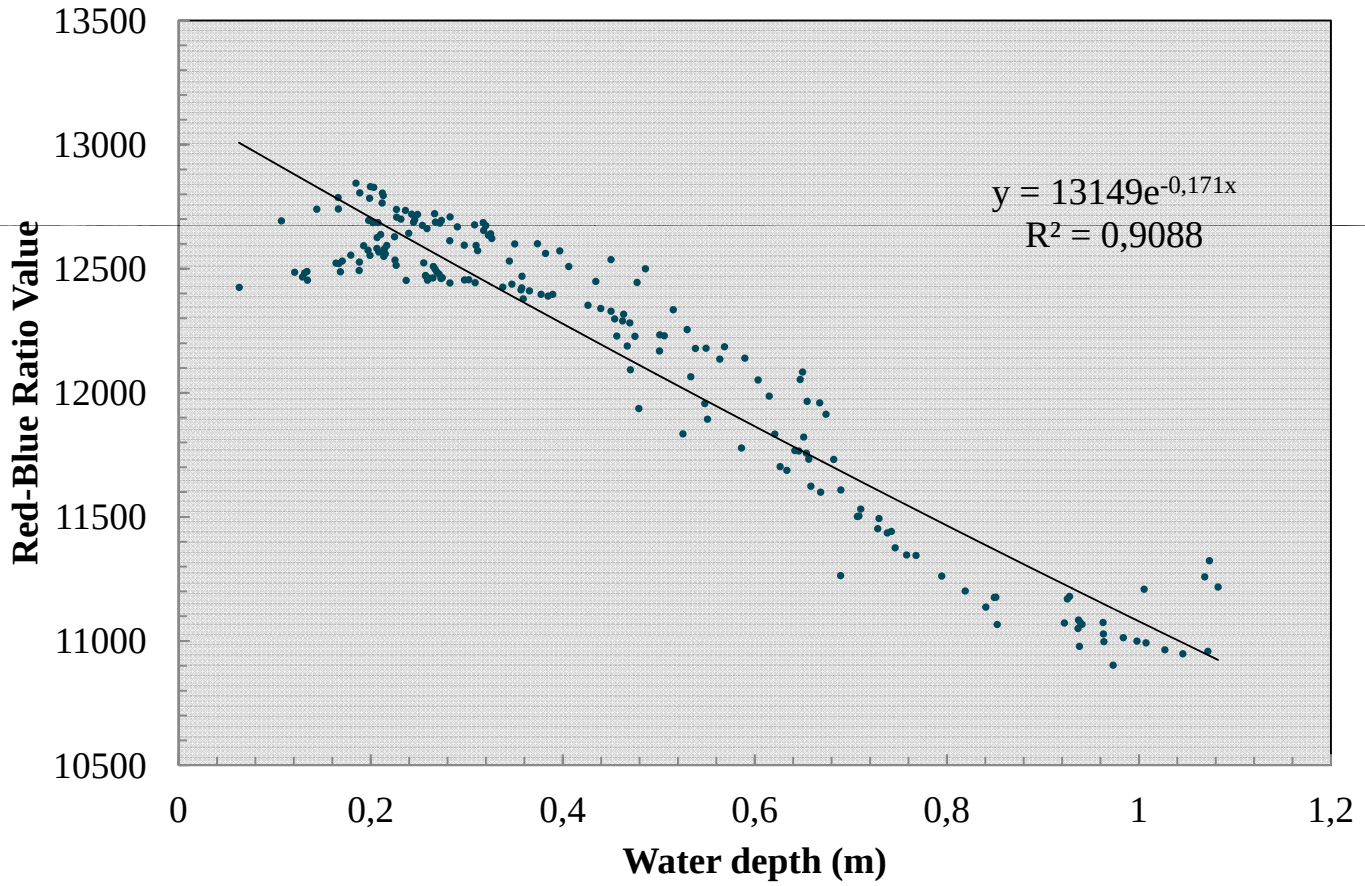

115°10'W
115°5'W
115°0'W
51°0'N
50°55'N
50°50'N
50°40'N
N
0 2 4 8
Kilometers
Contour Interval 100 m

Remote sensing of Depth

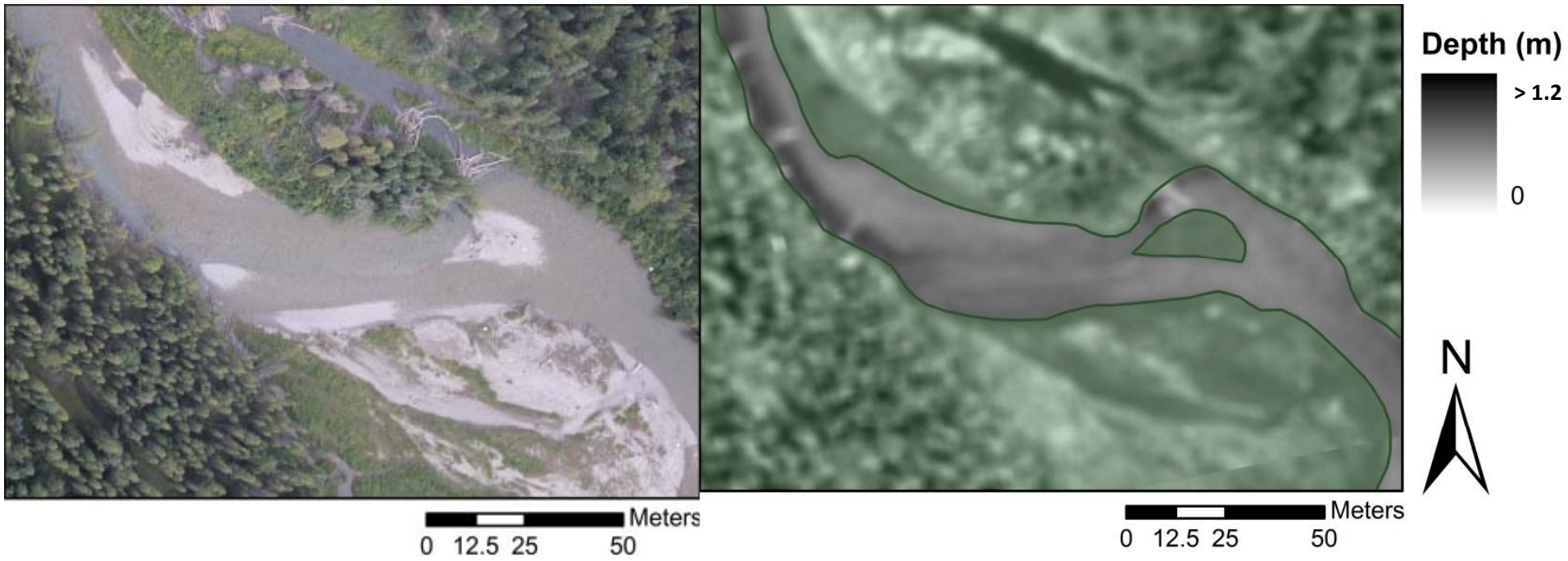




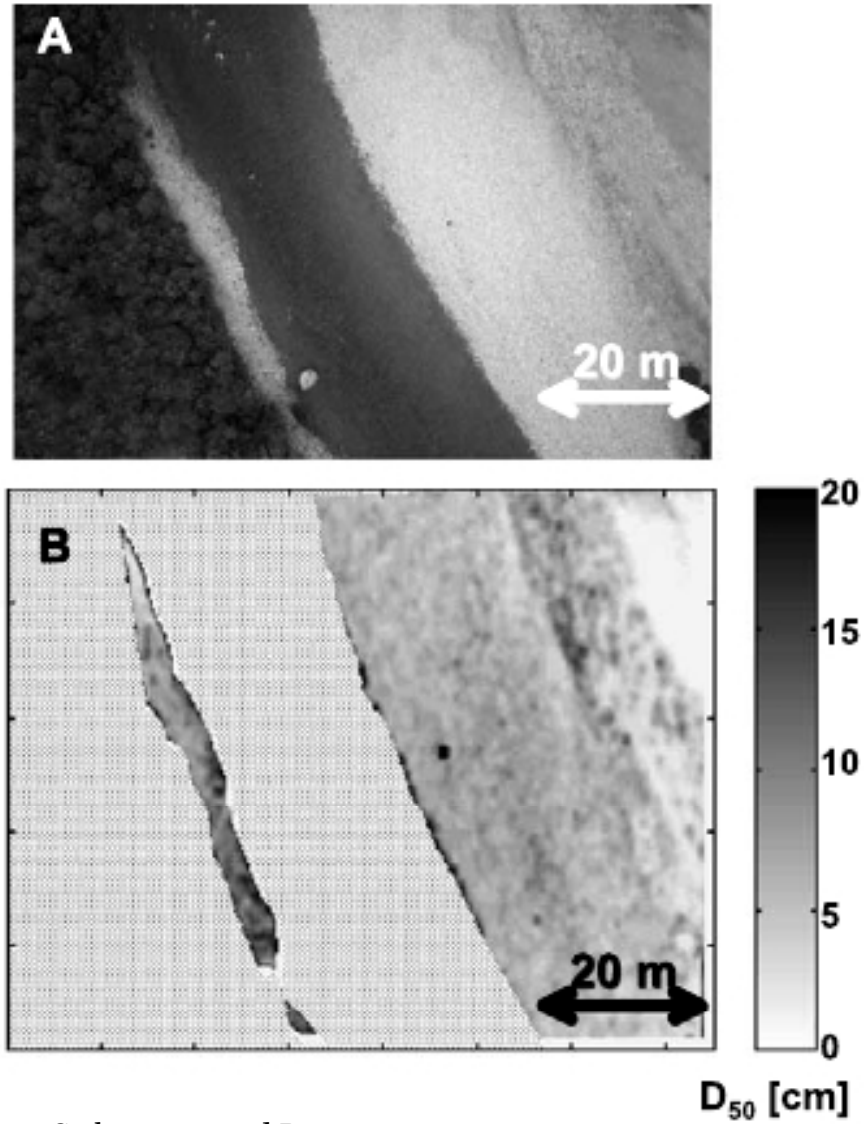
Depth Maps


13500
13000
12500
12000
11500
11000
10500
Red-Blue Ratio Value
0
0,2
0,4
0,6
0,8
1
1,2
Water depth (m)
y = 13149e-0,171x
R² = 0,9088

Depth Maps



Remote sensing of grain size

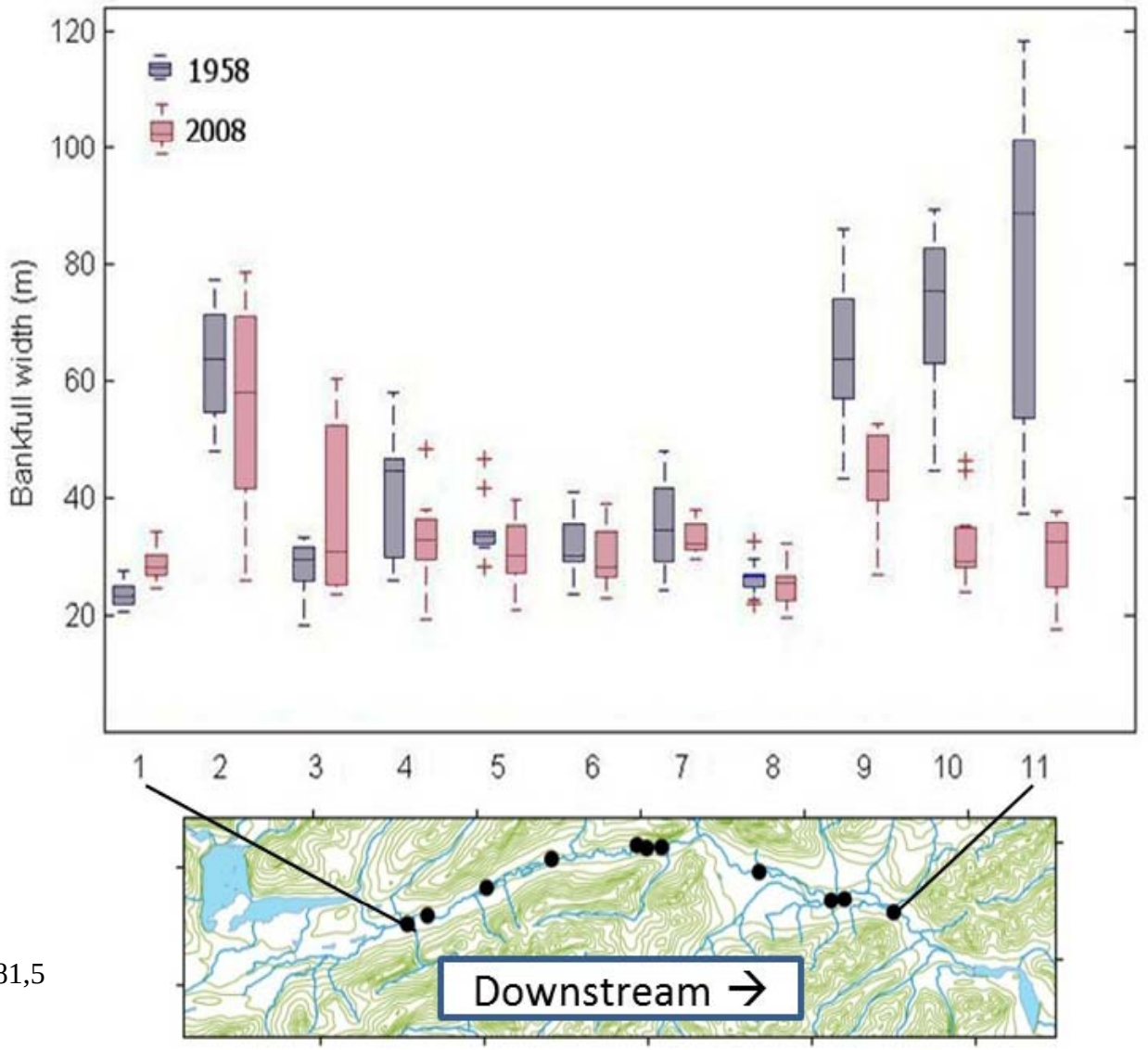


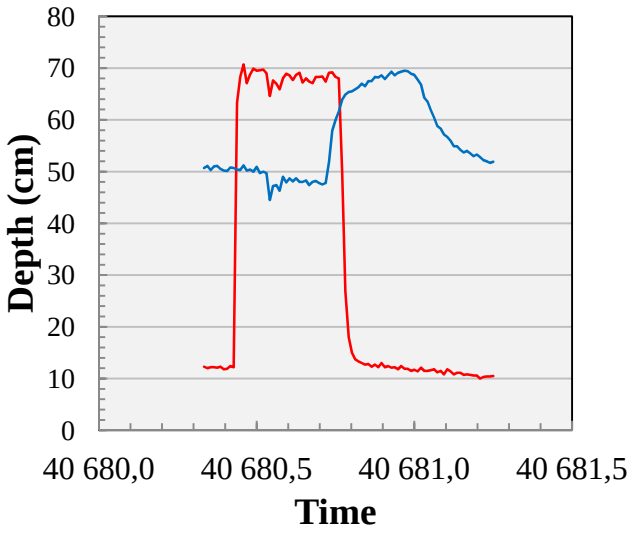
From: Carbonneau, and Bergeron, 2005.

Continuous Maps

- Depth
- Grain size
- Width
- Vegetation mapping

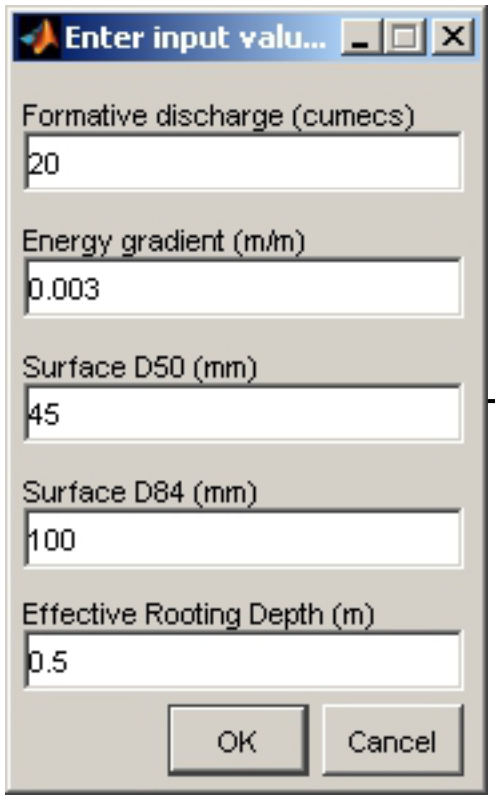
Changes in Width





Vegetation Change

UBCRM
Sample output

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      RESULTS OF THE ANALYSIS
      0.3437    Time required for calculation [s]
       10.80    Channel width [m]
        1.17    Mean depth [m]
        1.58    Mean velocity [m/s]
3.935e-006    transport rate [kg/s]
       12.13    Wetted perimeter [m]
        1.04    Hydraulic radius [m]
        0.82    Trapezoid depth [m]
        22.5    Bank side angle [degrees]
         6.8    Trapezoid bottom width [m]
       29.17    Stress on the bed [Pa]
       20.79    Stress on the banks [kg/s]
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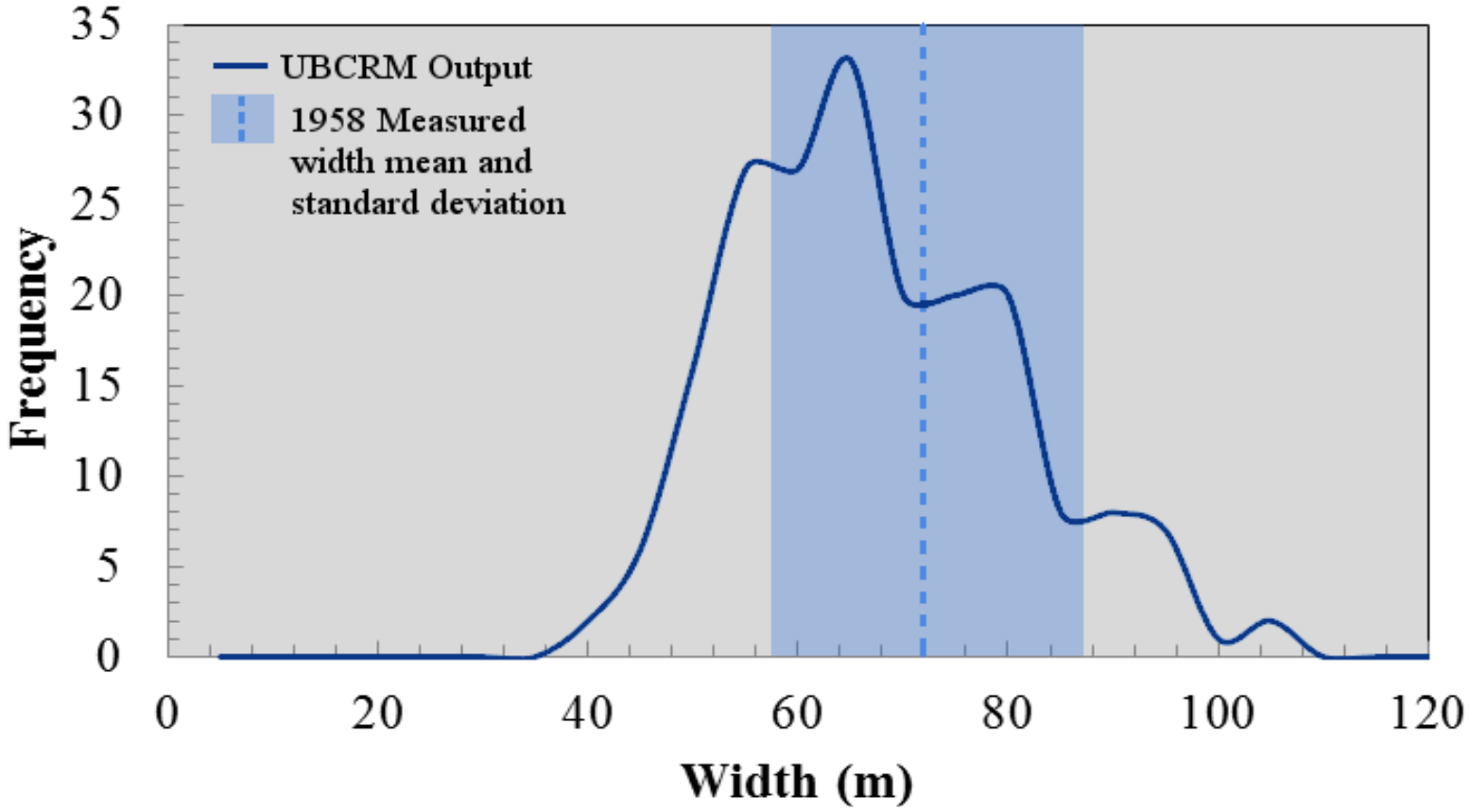
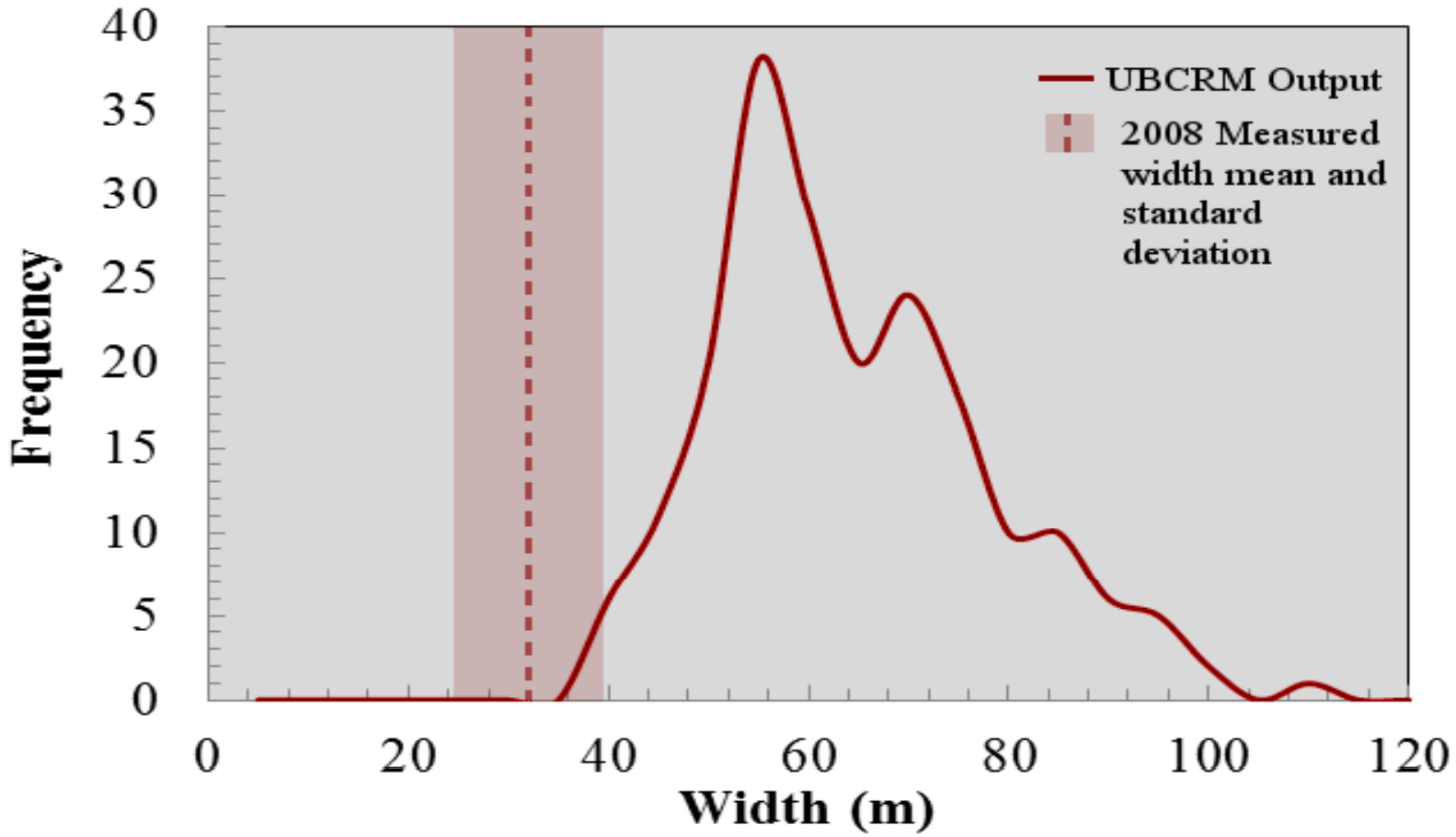
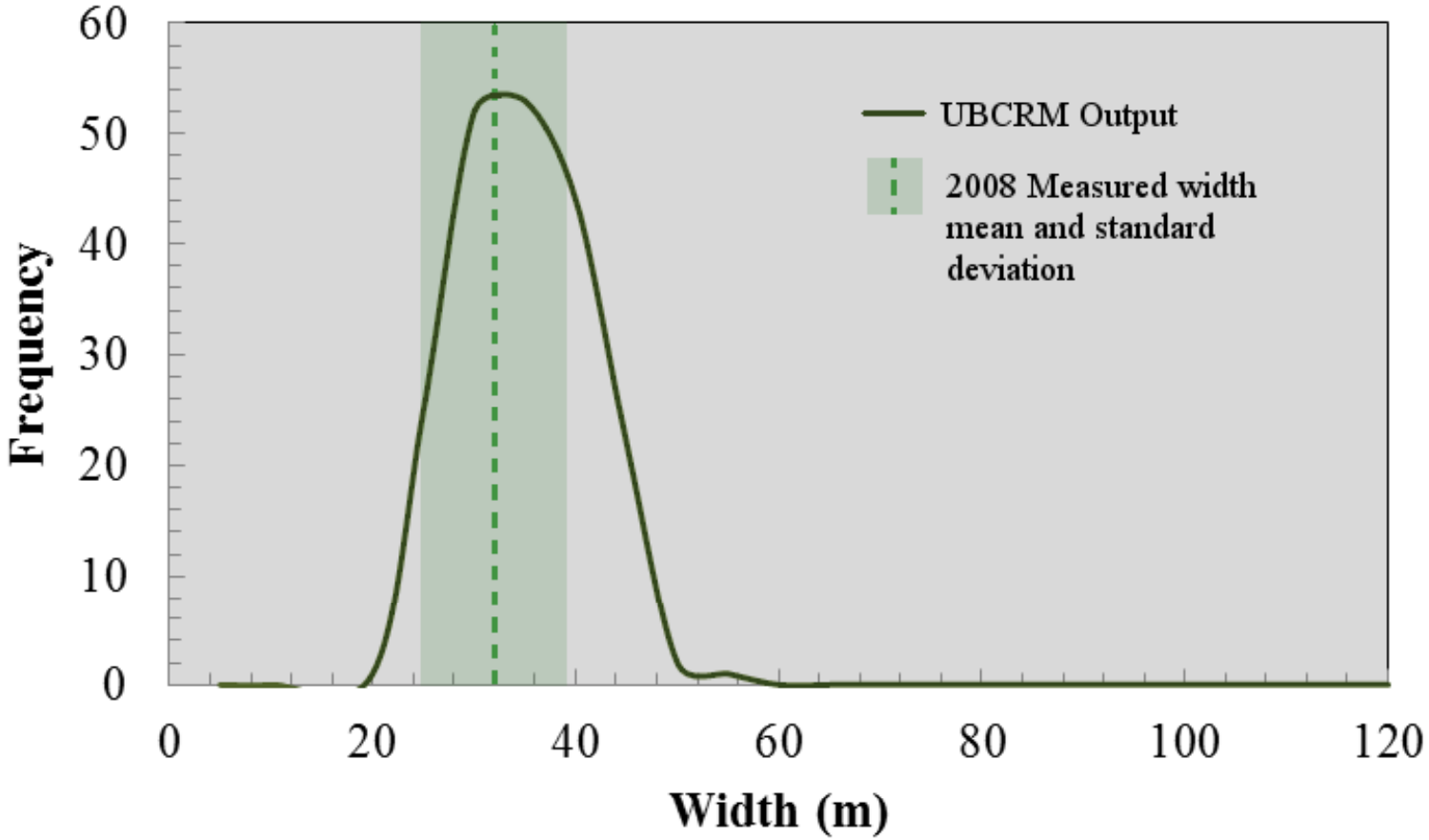
UBCRM 1958 Calibrated



UBCRM 2008 predictions



2008 with vegetation alteration



Conclusions

- Narrowing trend in channel adjustment with greatest changes downstream
- Changes cannot be explained solely by flow regime, but also by vegetation dynamics
- Observations of channel change can be simulated by models, though complexities such as ice dynamics and flow duration remain difficult to quantify.