Using climate models to predict hydrologic and thermal effects on future habitat distributions of inland trout in the Western U.S.

Seth Wenger[1,2], Dan Isaak[2], Helen Neville[1],

Charlie Luce[2] and Bruce Rieman[2]

1. Trout Unlimited

2. USFS Rocky Mtn Research Station

OR

The cutthroat-climate project

Seth Wenger[1,2], Dan Isaak[2], Helen Neville[1],

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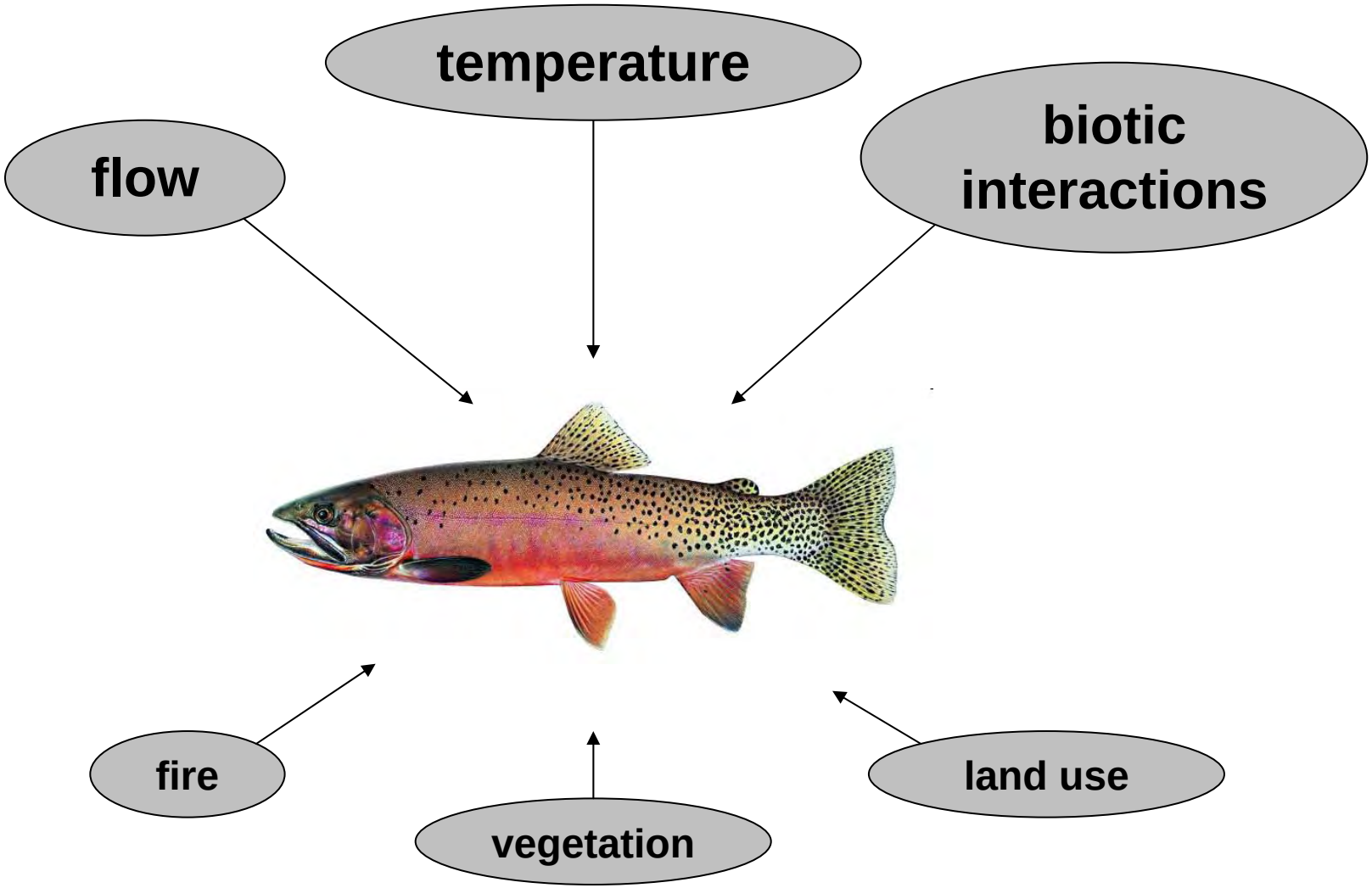
Mechanisms of climate effects on fish



Challenges in modeling climate effects

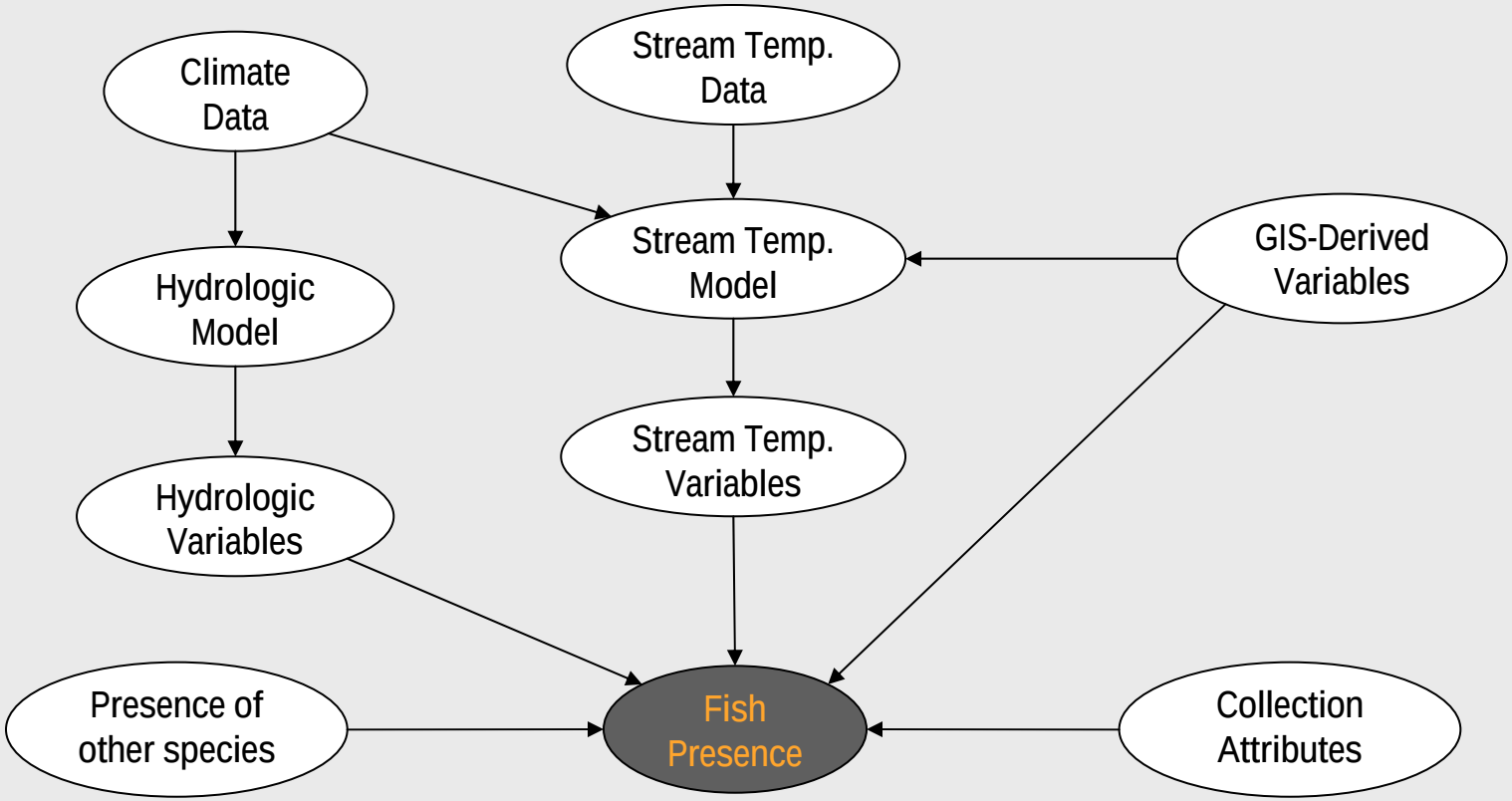
- Developing climate-fish relationships
- Obtaining good flow data
- Spatial variability in climate trends

Our Objective

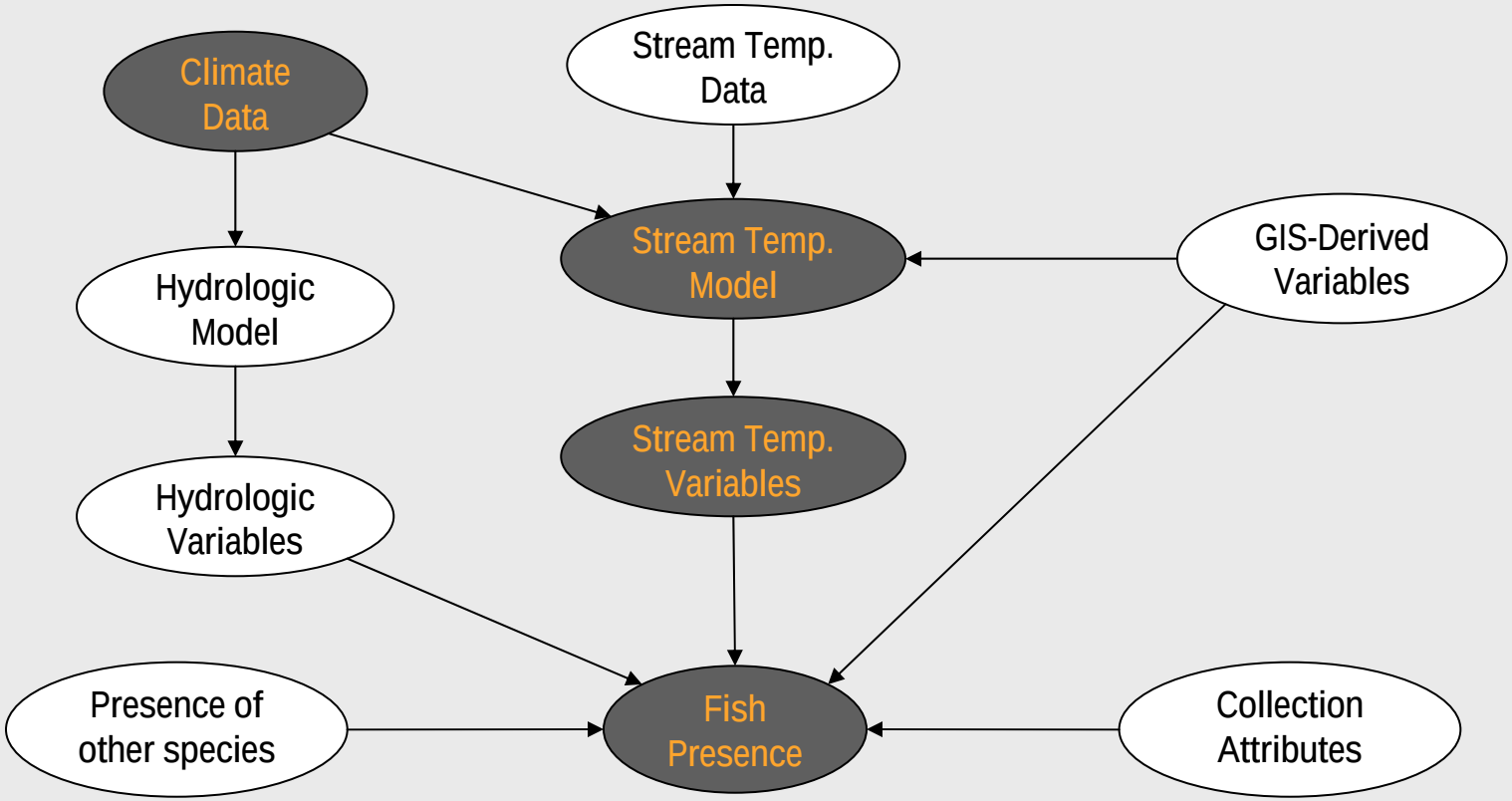
Accurate predictions of climate effects on inland cutthroat trout

- Driven by empirical data using a database of >10,000 fish collection points
- Incorporating best available hydrologic data
- Accounting for spatial variability in climate trends by using downscaled climate model output

The approach: model development



The approach: model development



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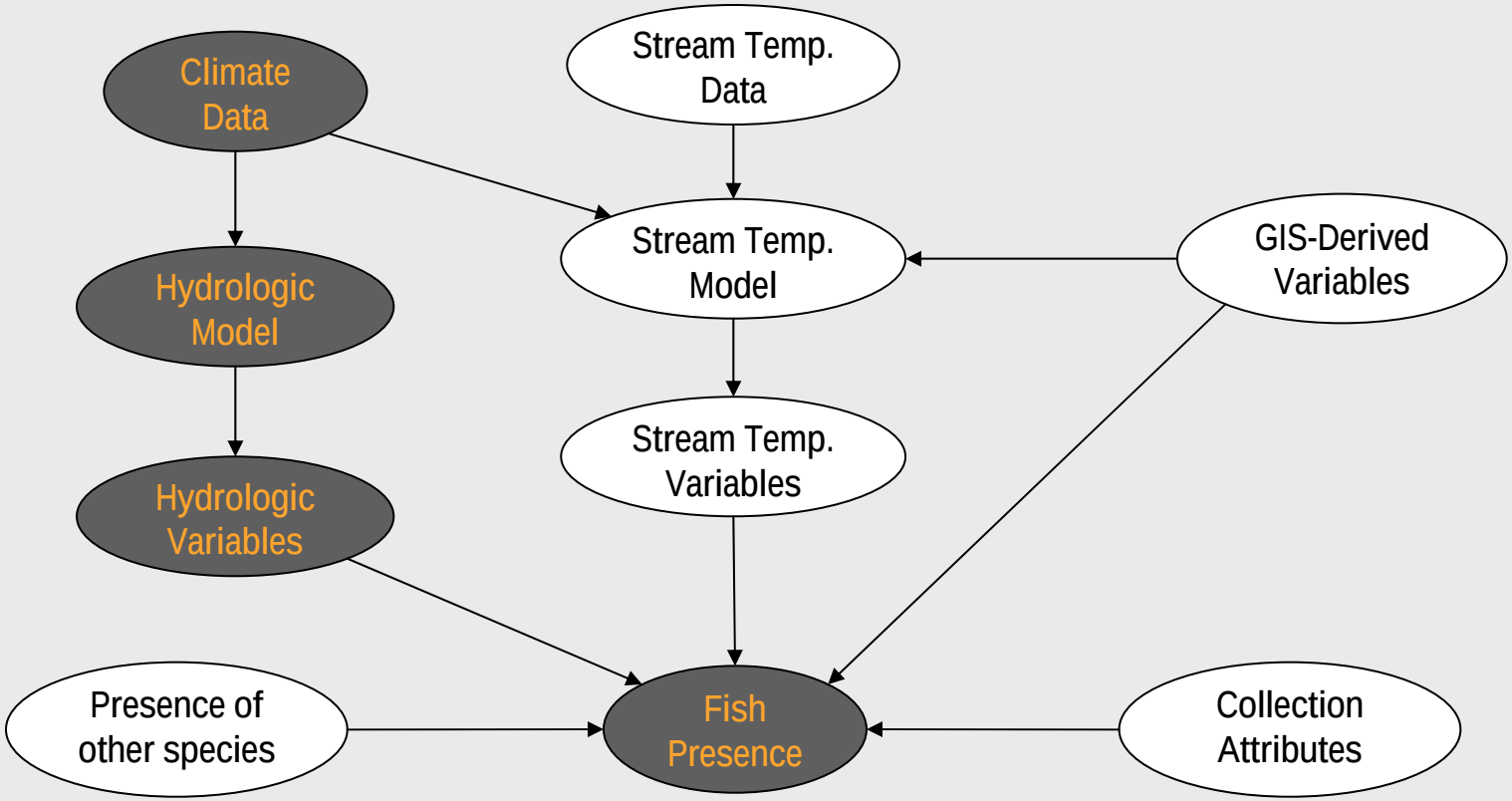
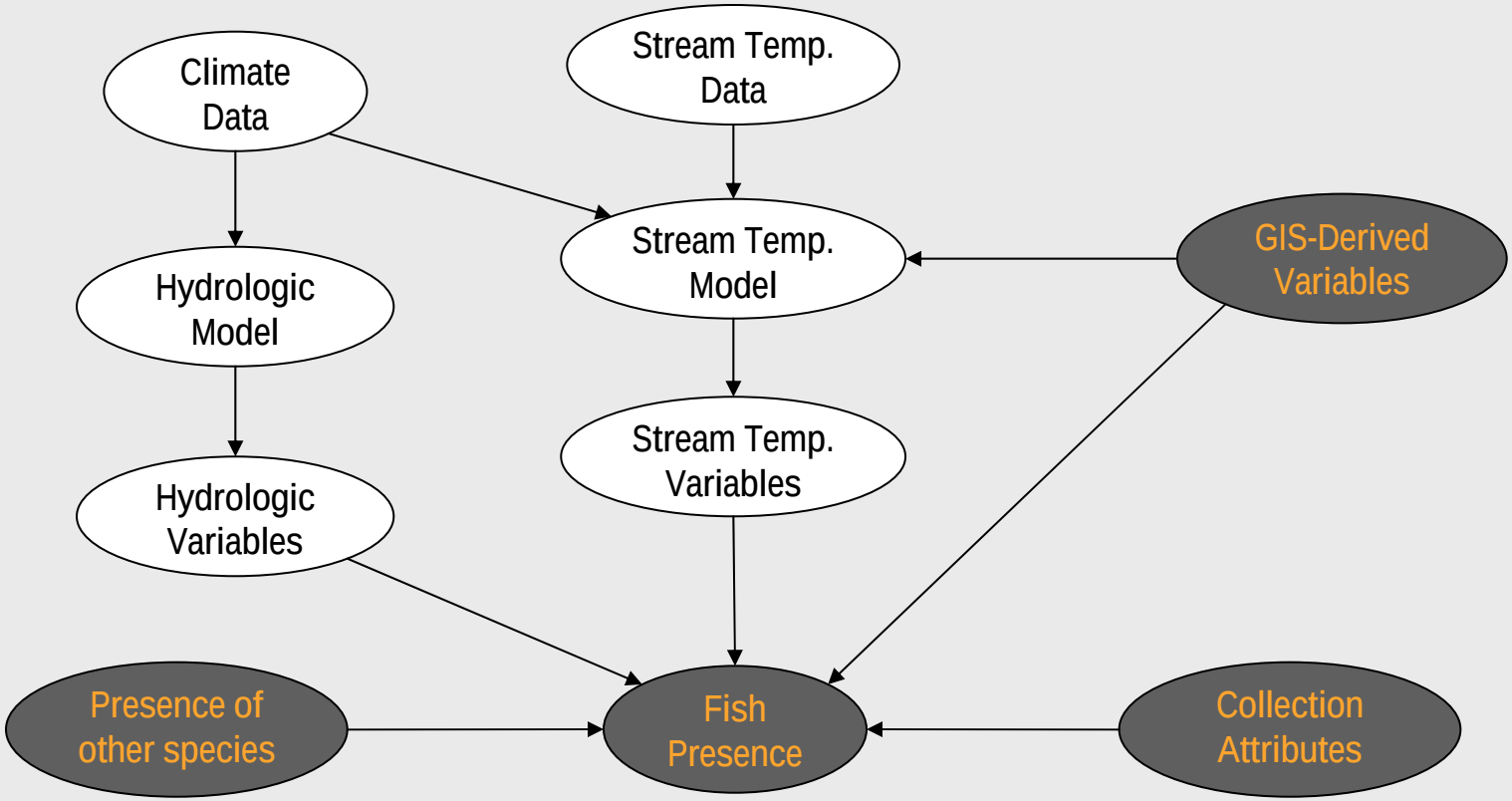
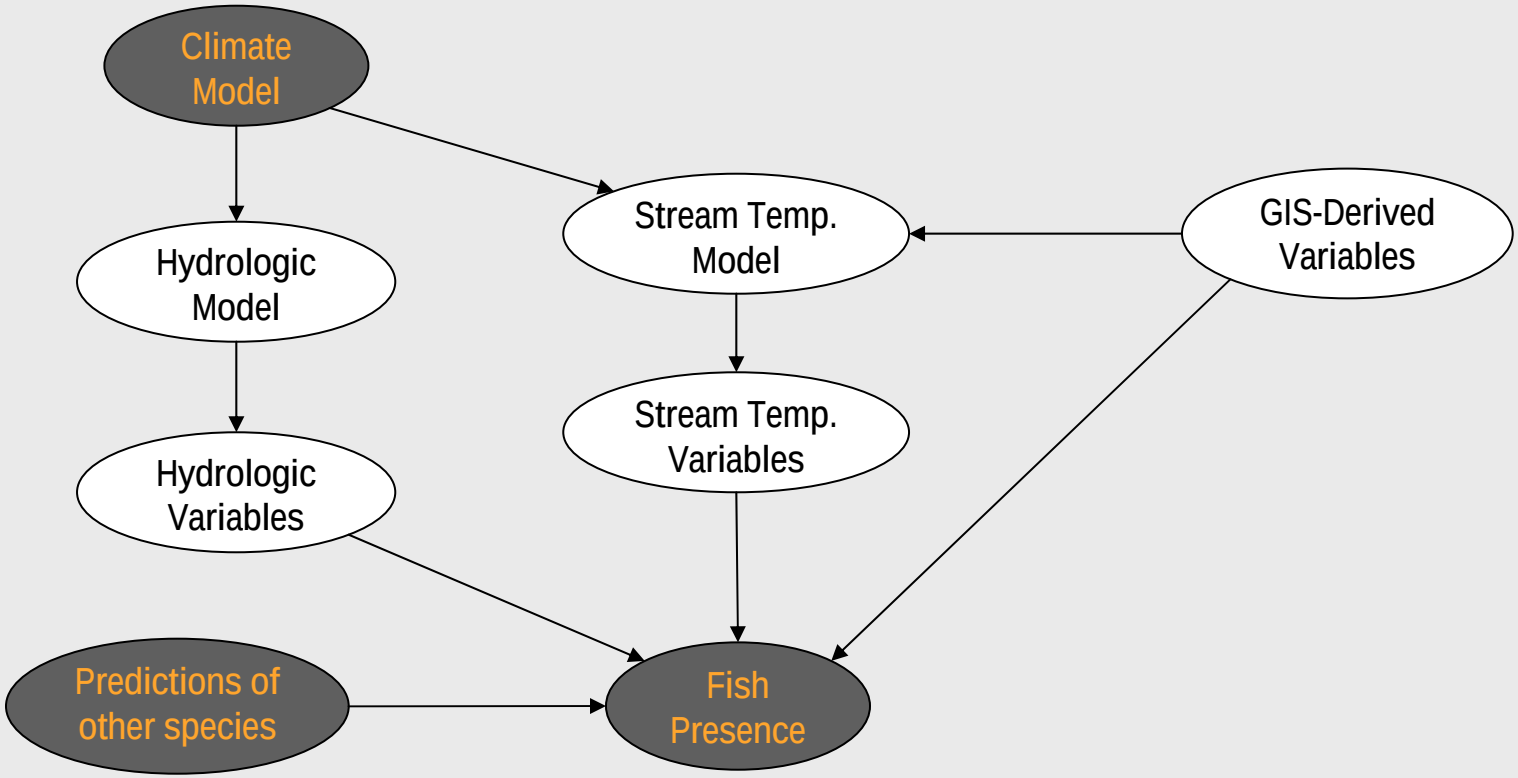


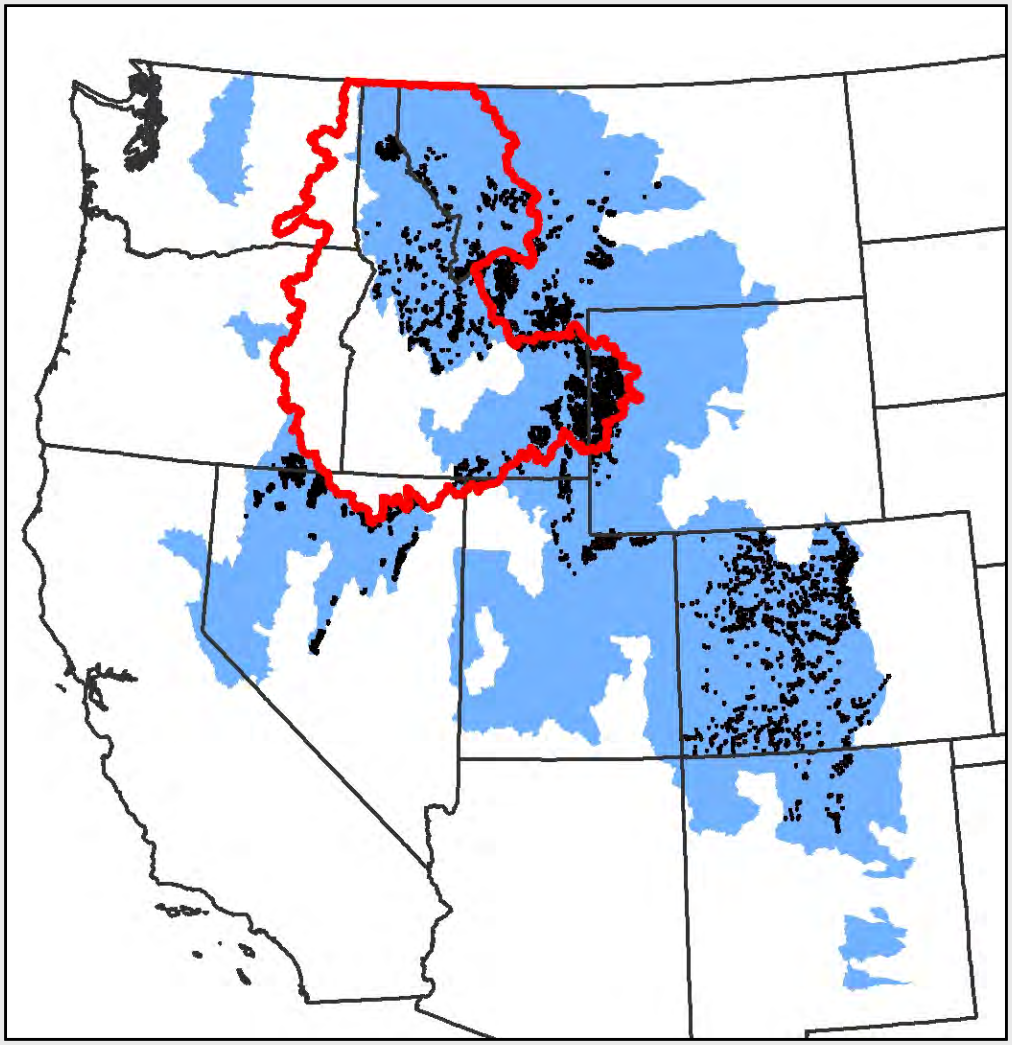
The approach: model development



The approach: forecasting



Project scope



Native range of inland cutthroat trout in U.S.

Starting with a pilot in the eastern Columbia basin.

Scale of predictions: 1:100K NHD plus stream segment

Today’s focus: flow

Hypotheses: flow & fish

- High flows post-spawning are bad
  - Winter floods bad for fall spawners

  - Summer floods bad for spring spawners?

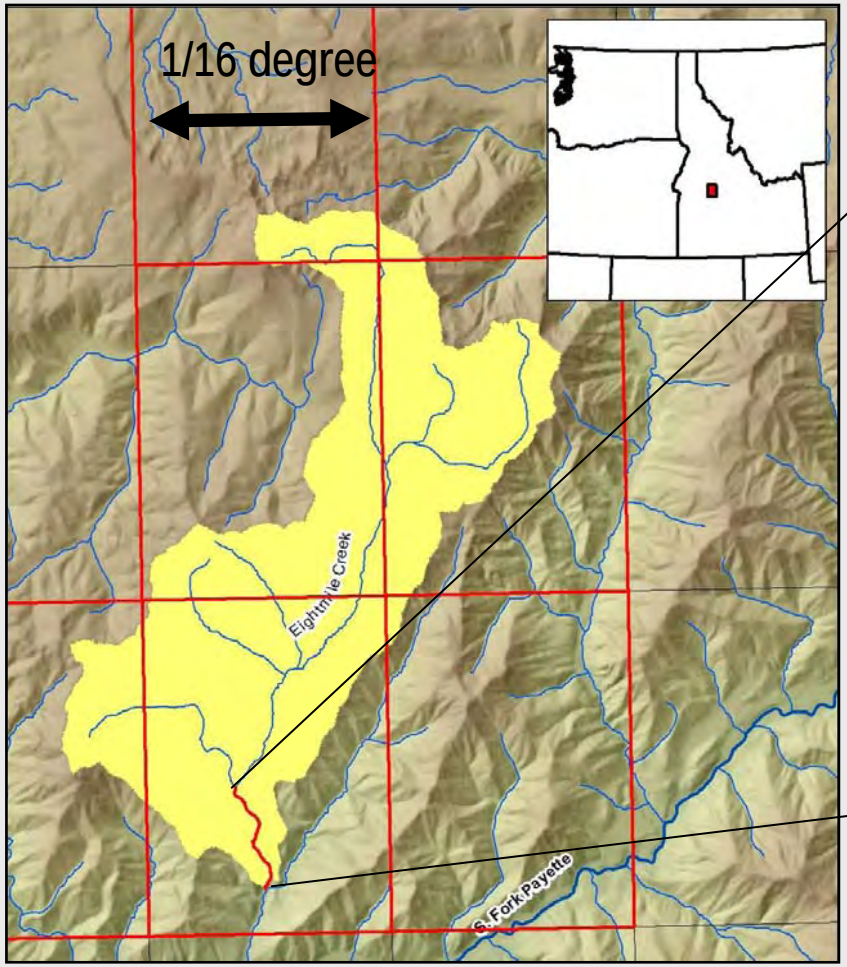
- Very low summer flows are bad
- Generally: fish are adapted to flow regimes

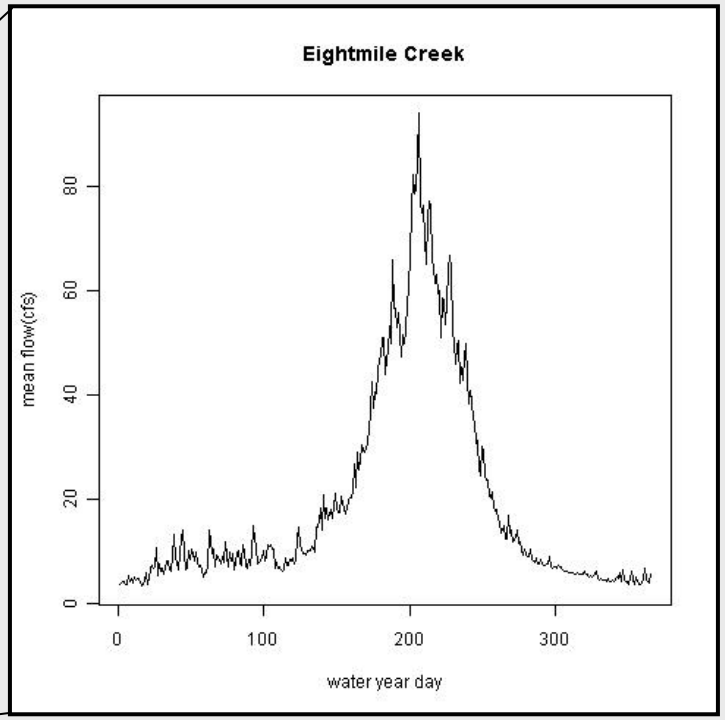
Climate & hydrologic modeling

- Models are built using historical climate data
- Climate data drive the Variable Infiltration Capacity (VIC) hydrologic model
- Forecasting using a suite of climate models
- A1B emissions scenario

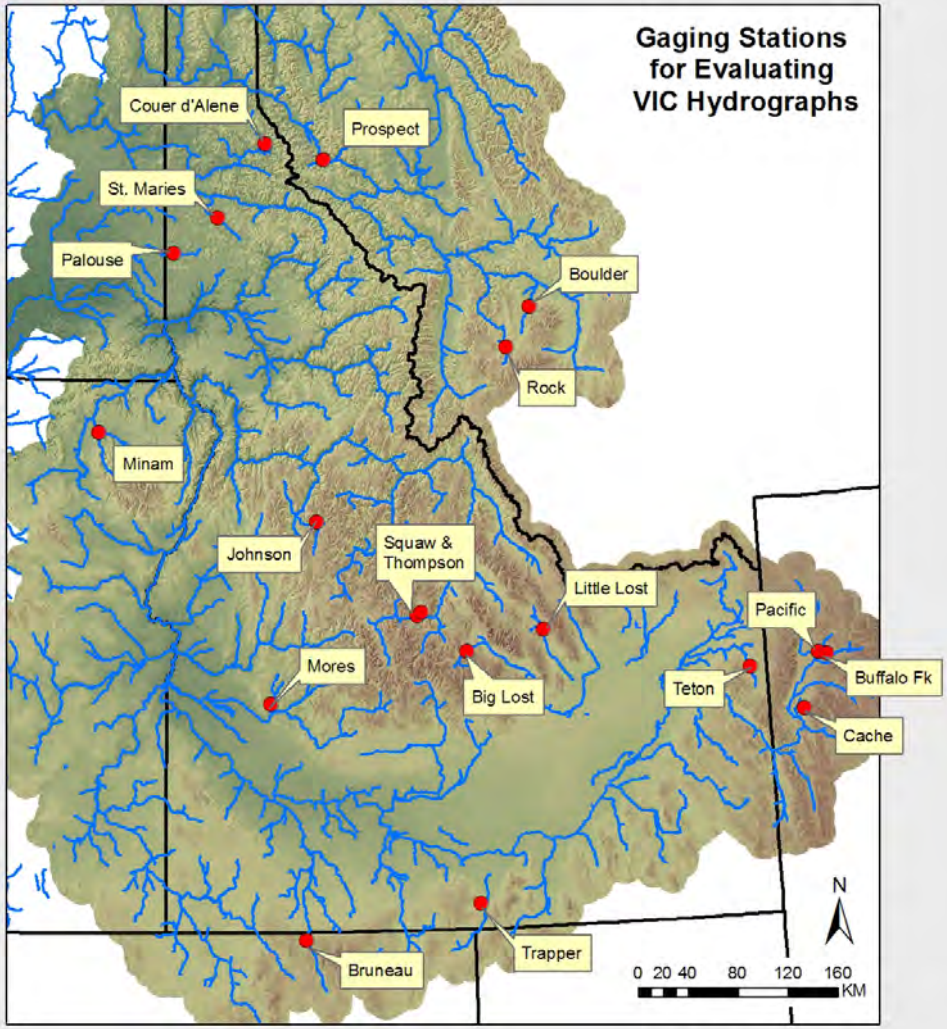
University of Washington's Climate Impacts Group is running models

Developing hydrographs for streams



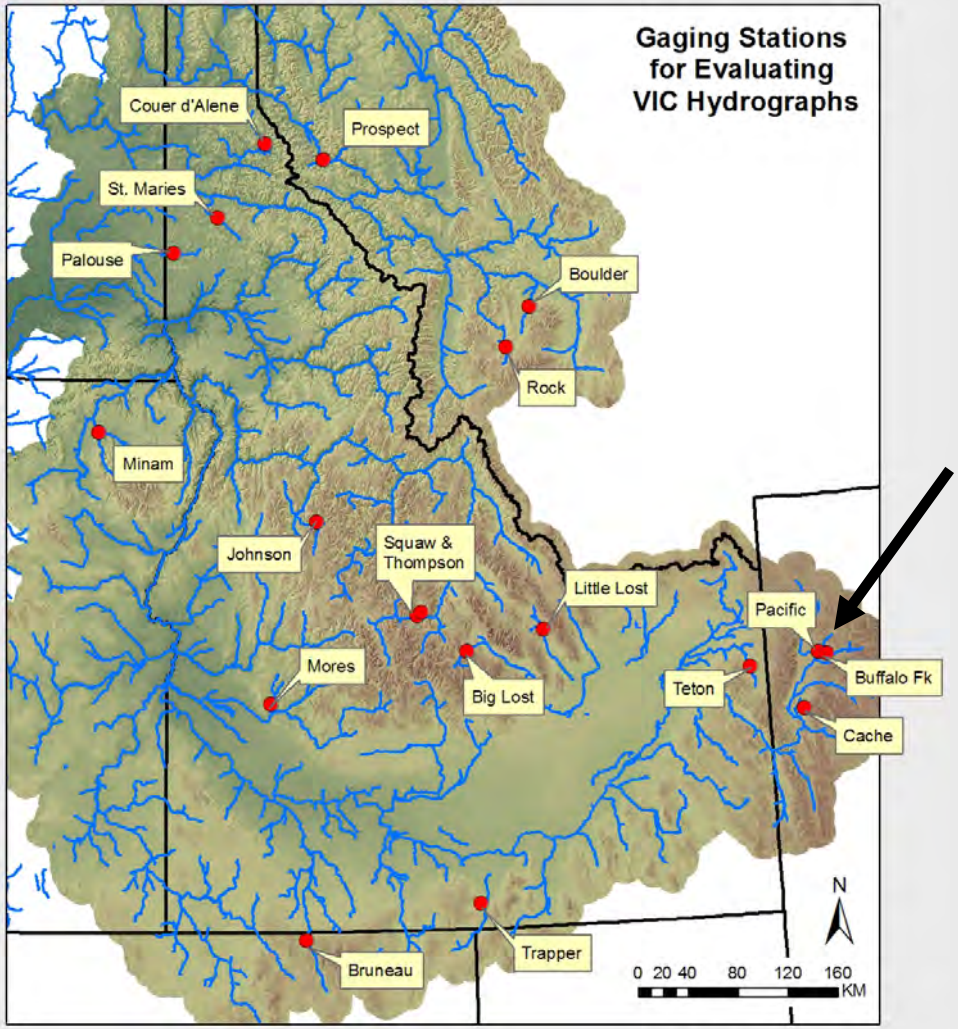


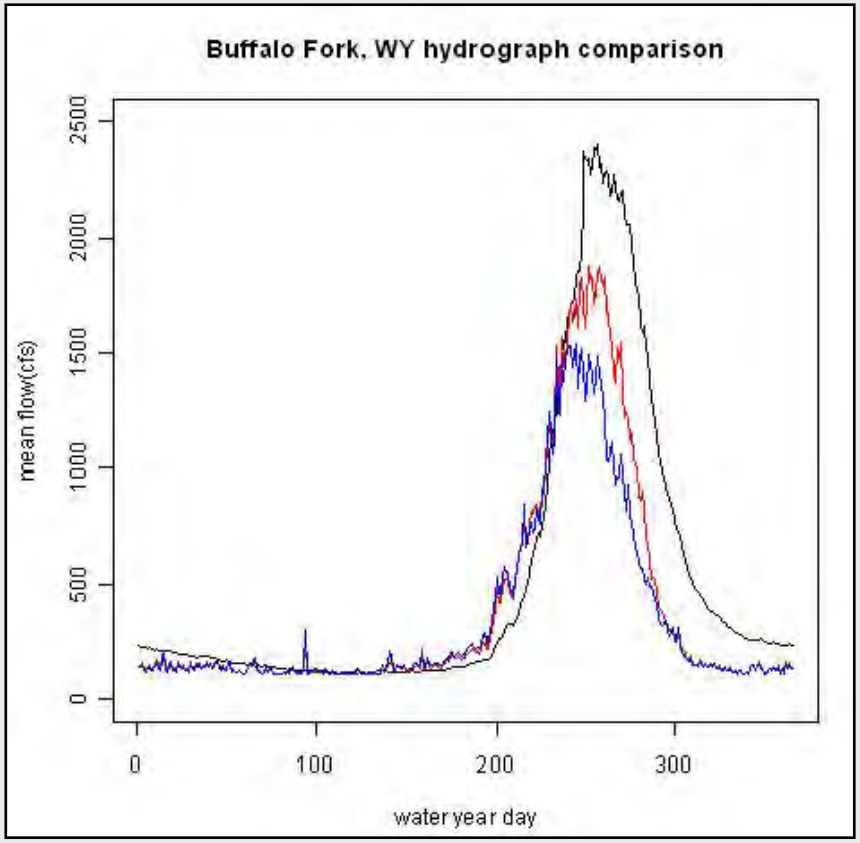
How good is the hydrologic modeling?



Used 19 USGS gaging stations to test predictions

Hydrologic modeling often good…



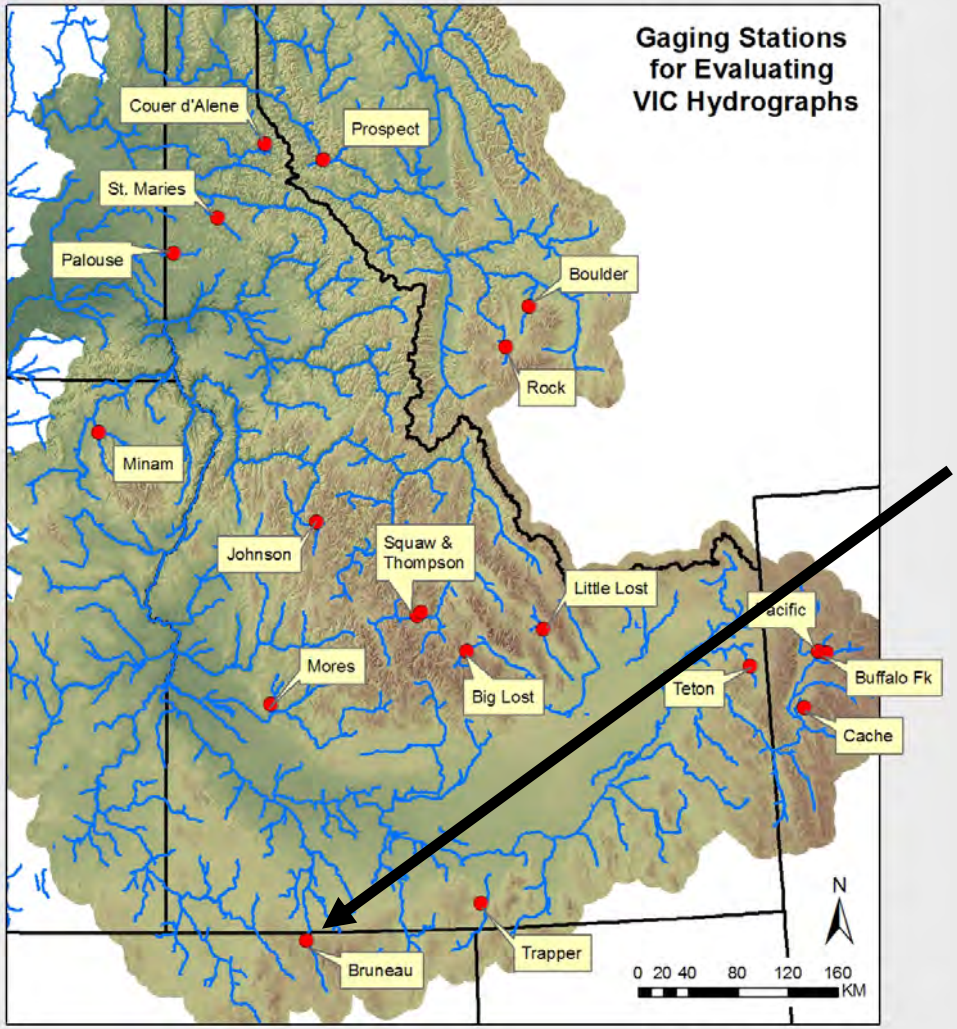


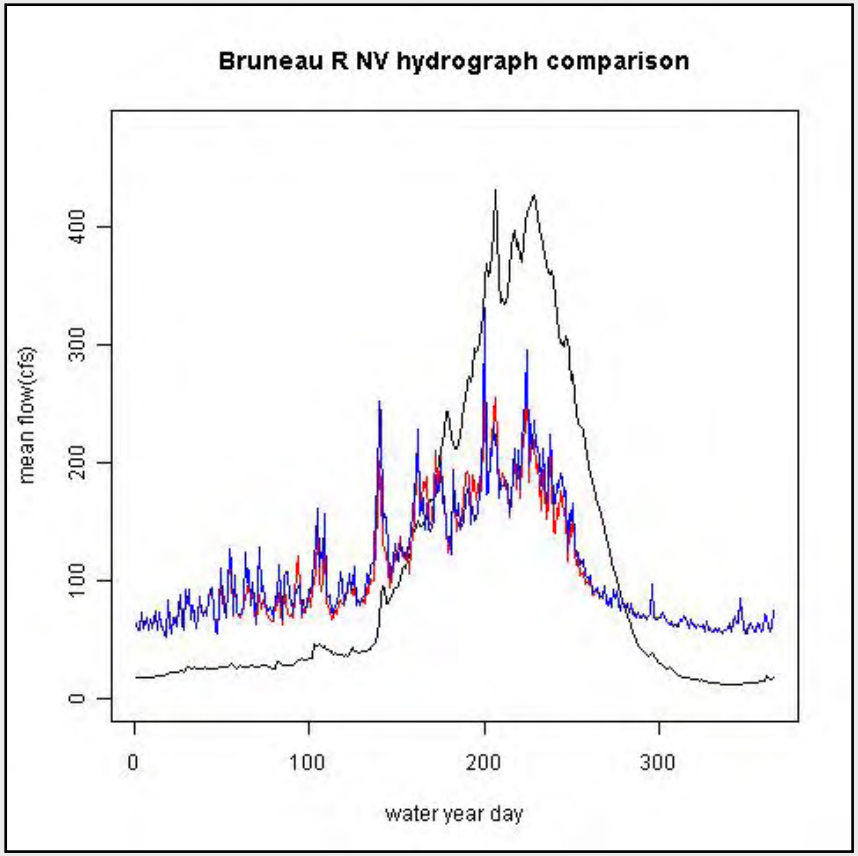
1/16th

1/8th

Observed

… and sometimes not so good.





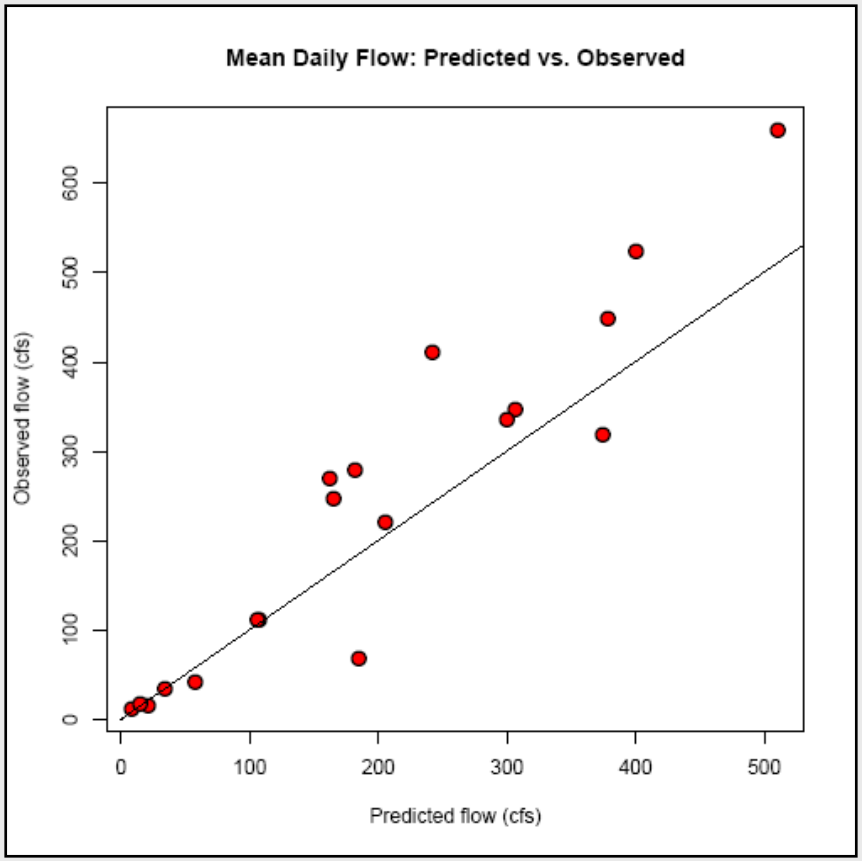
1/16th

1/8th

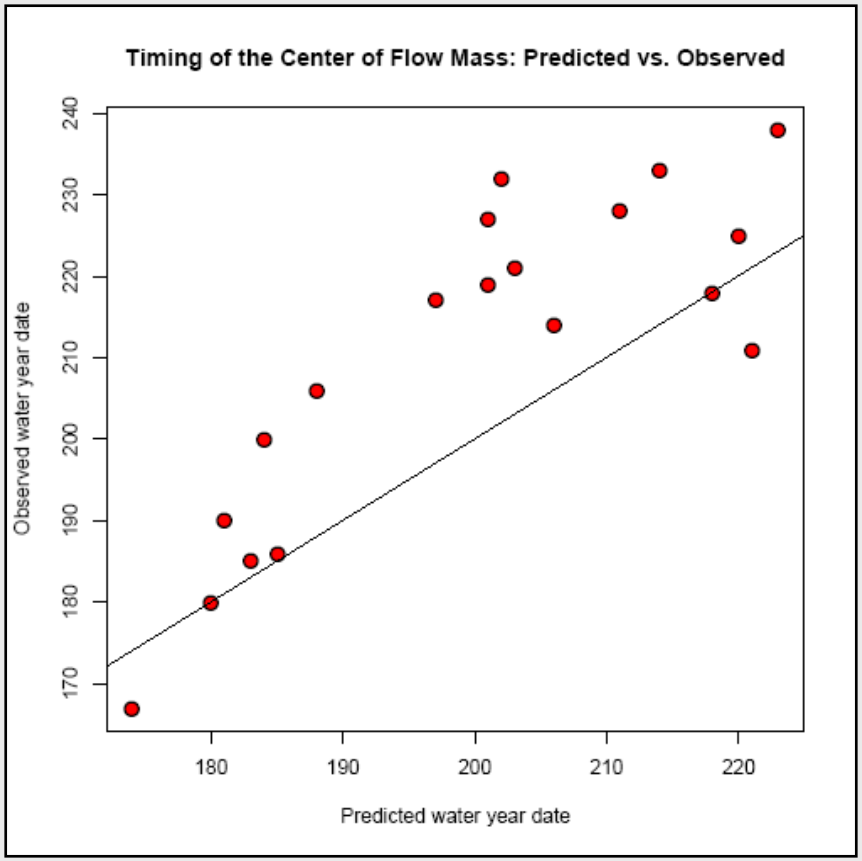
Observed

Mean flow and runoff timing OK

Mean flow

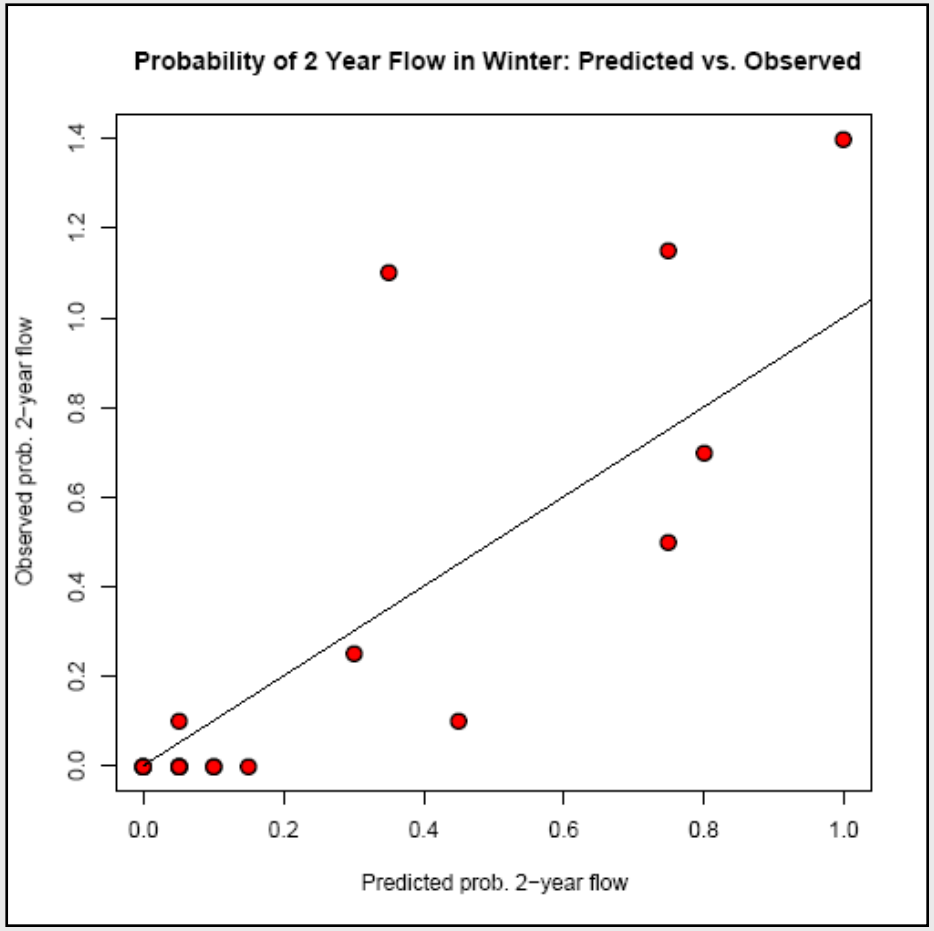


Timing of flow / snowmelt



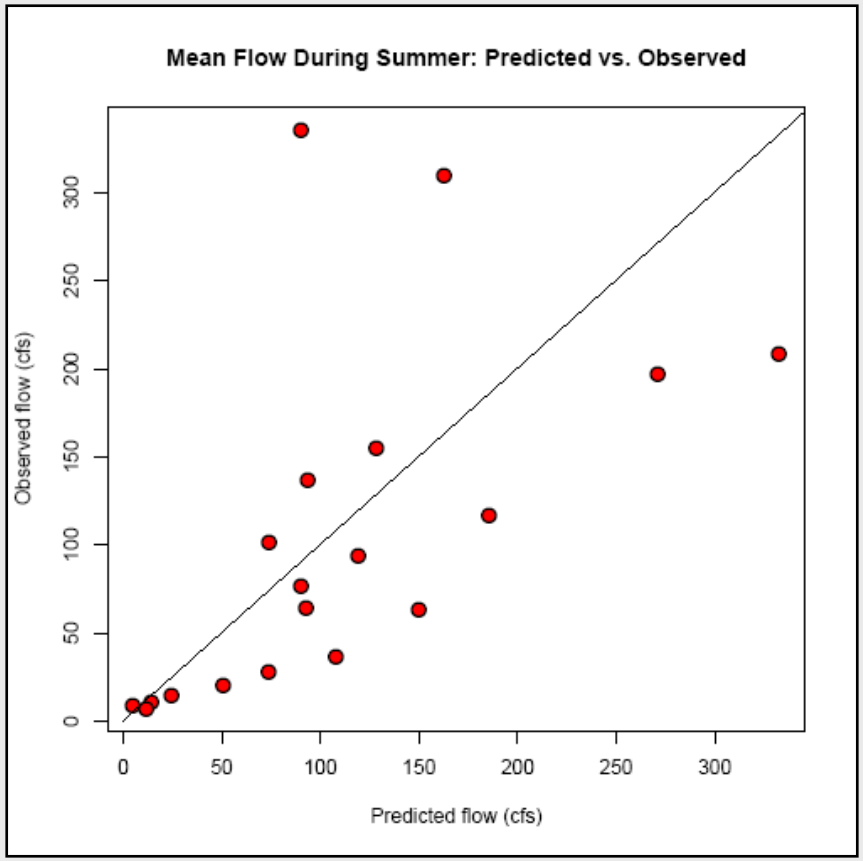
Winter high flows decent

Probability of winter flood

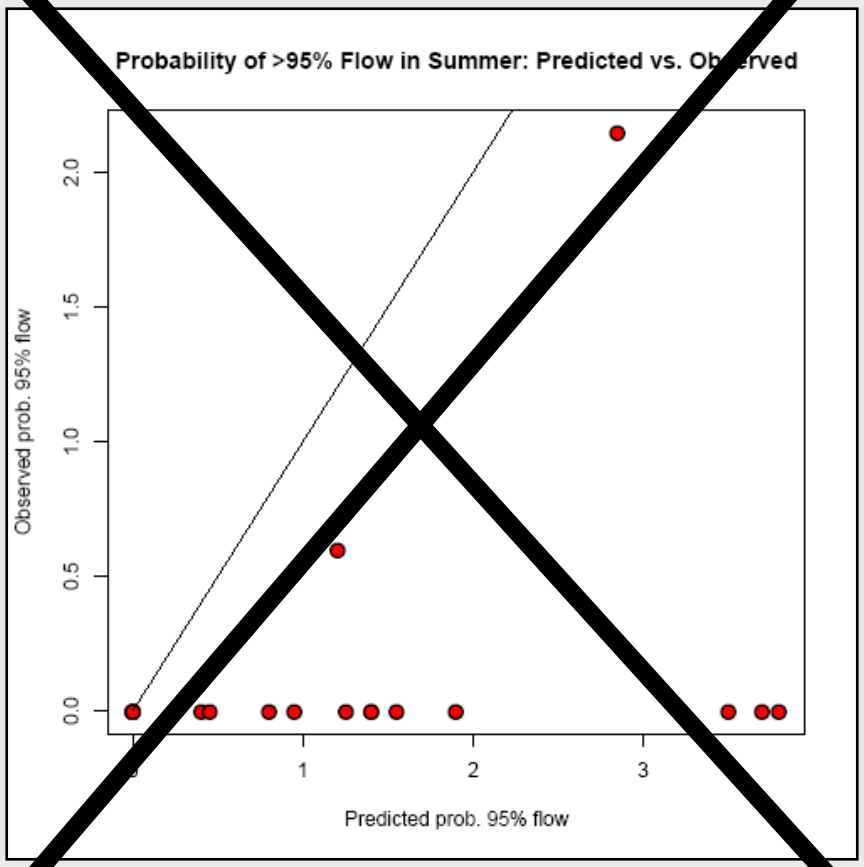


Summer flows less predictable

Mean summer flow

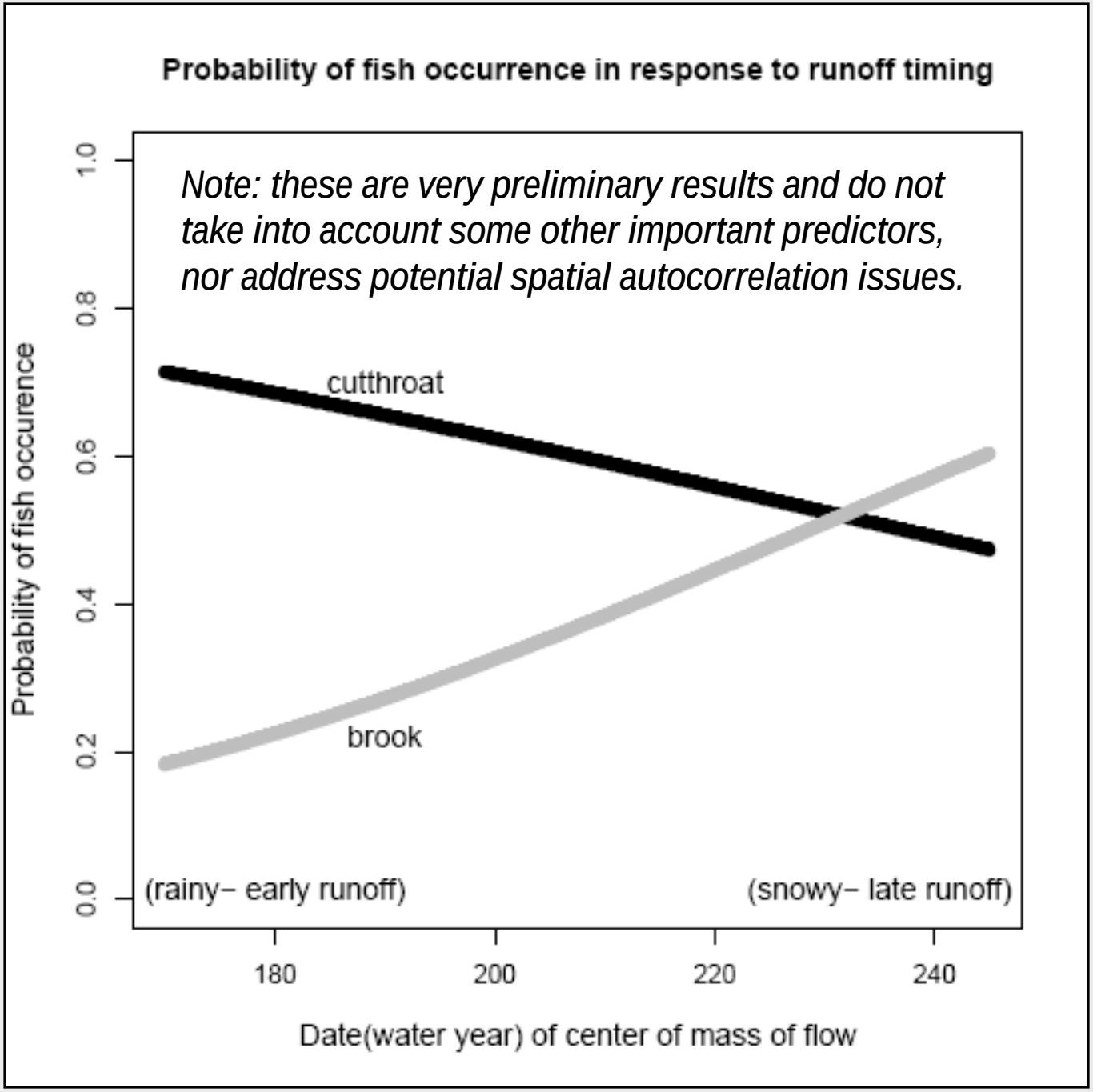


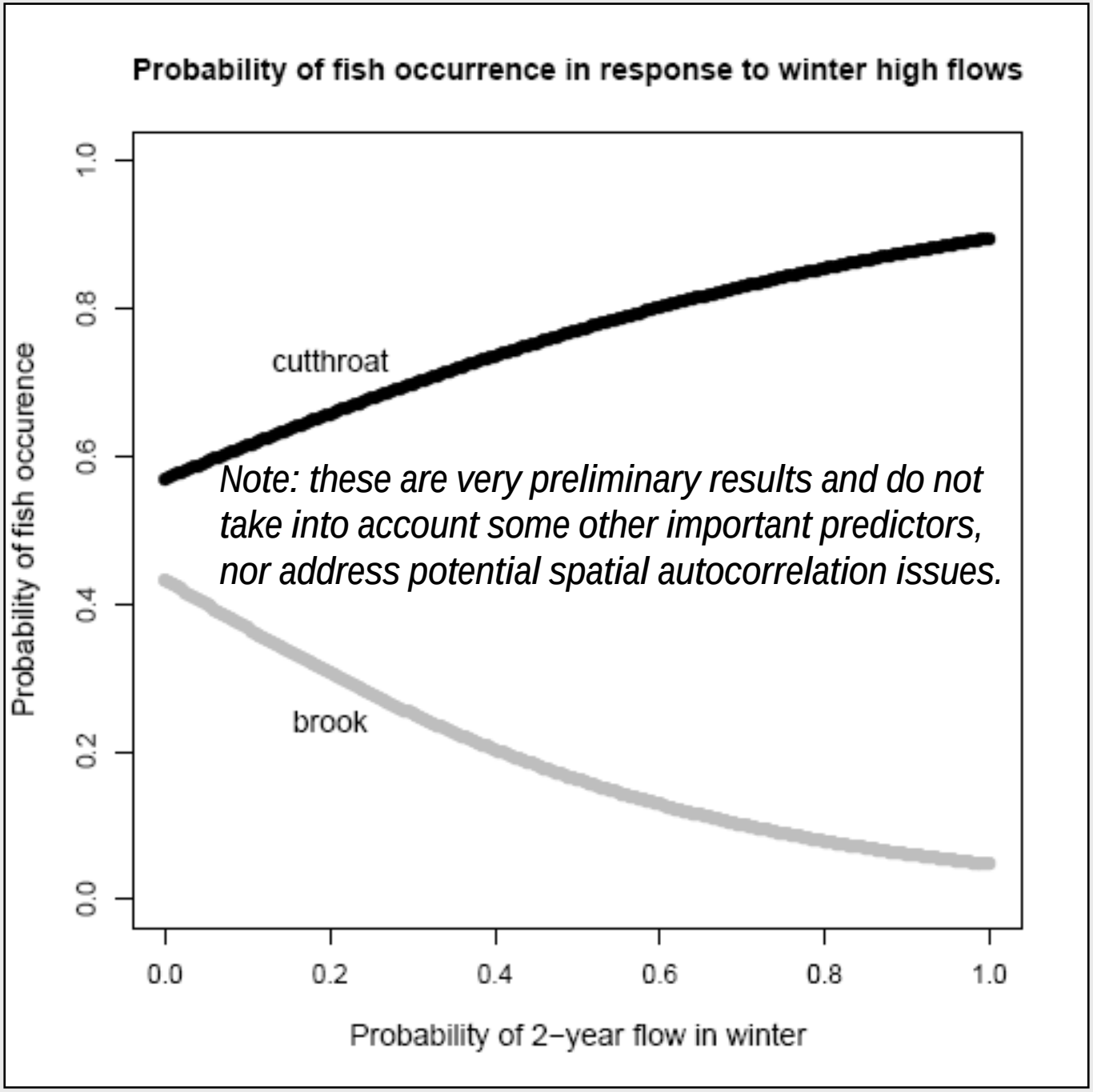
Probability of summer high flow



Trout distributions and flow regime

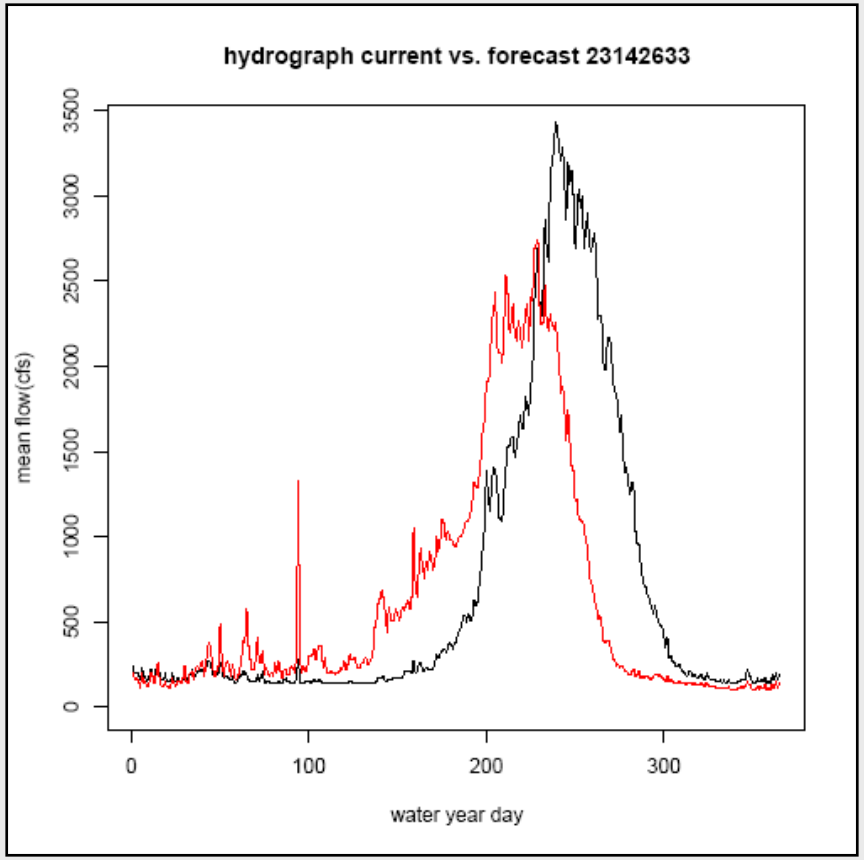
Is there are relationship between current trout distribution and flow metrics?

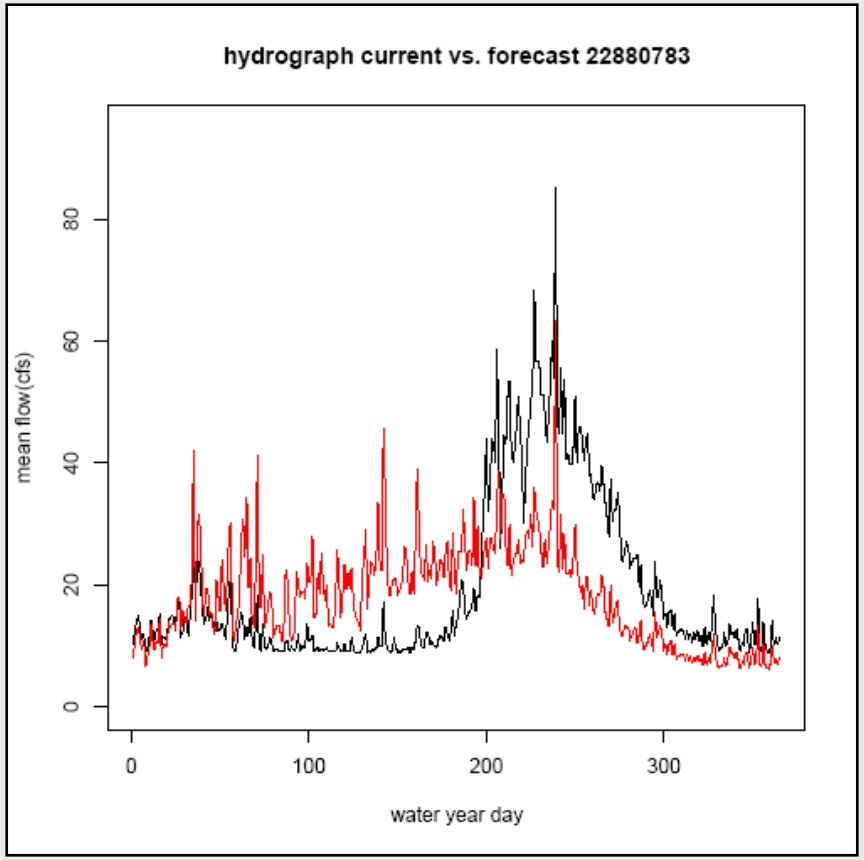

Probability of fish occurrence in response to runoff timing
Note: these are very preliminary results and do not take into account some other important predictors, nor address potential spatial autocorrelation issues.
cutthroat
brook
(rainy– early runoff)
(snowy– late runoff)
Probability of fish occurence
0.0
0.2
0.4
0.6
0.8
1.0
180
200
220
240
Date(water year) of center of mass of flow


Probability of fish occurrence in response to winter high flows
Probability of fish occurence
0.0
0.2
0.4
0.6
0.8
1.0
cutthroat
brook
Note: these are very preliminary results and do not take into account some other important predictors, nor address potential spatial autocorrelation issues.
0.0
0.2
0.4
0.6
0.8
1.0
Probability of 2−year flow in winter

How will flows change?

Predicted flow changes in 2080

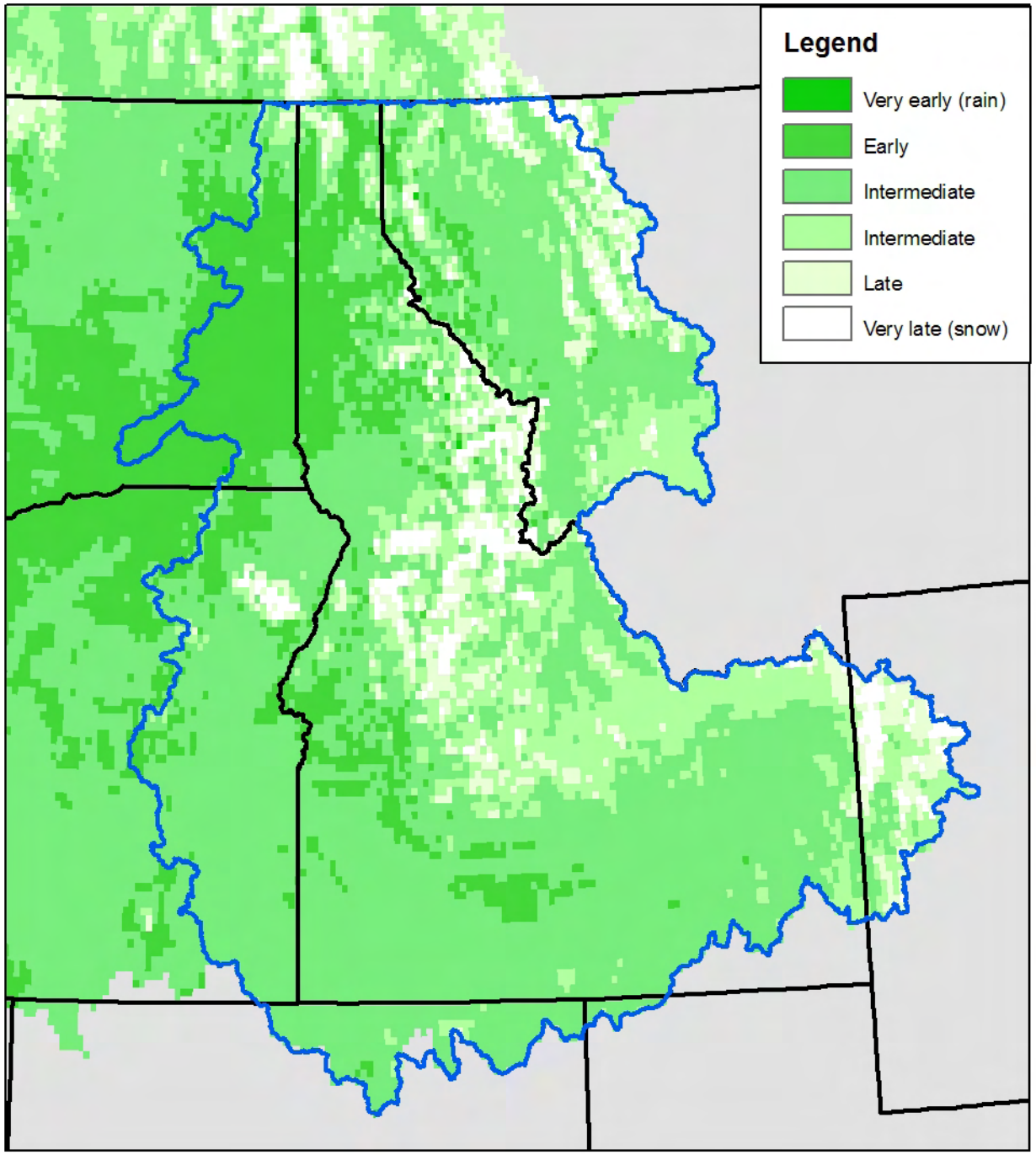




Current

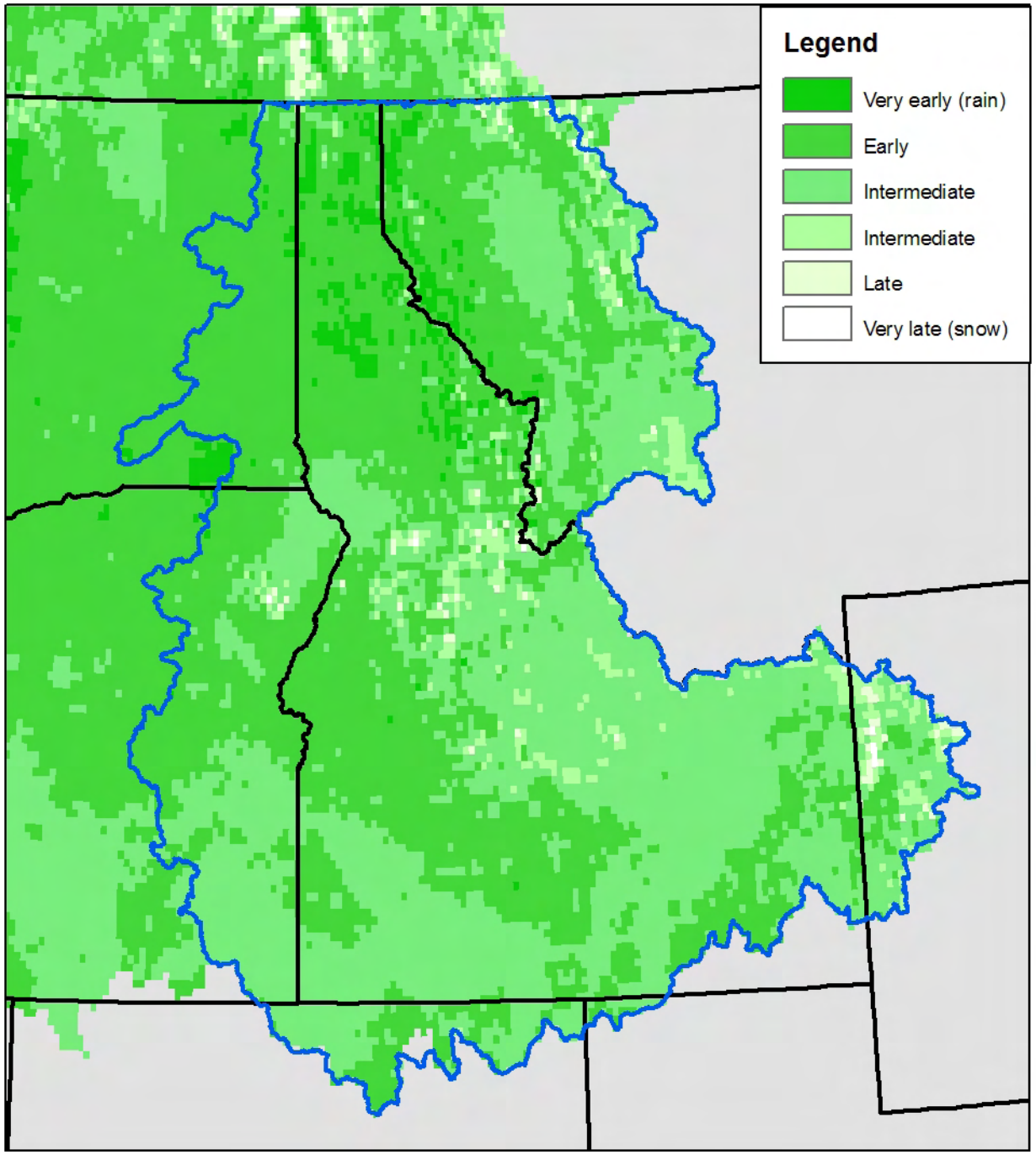
Forecast 2080, A1B

Historical runoff timing

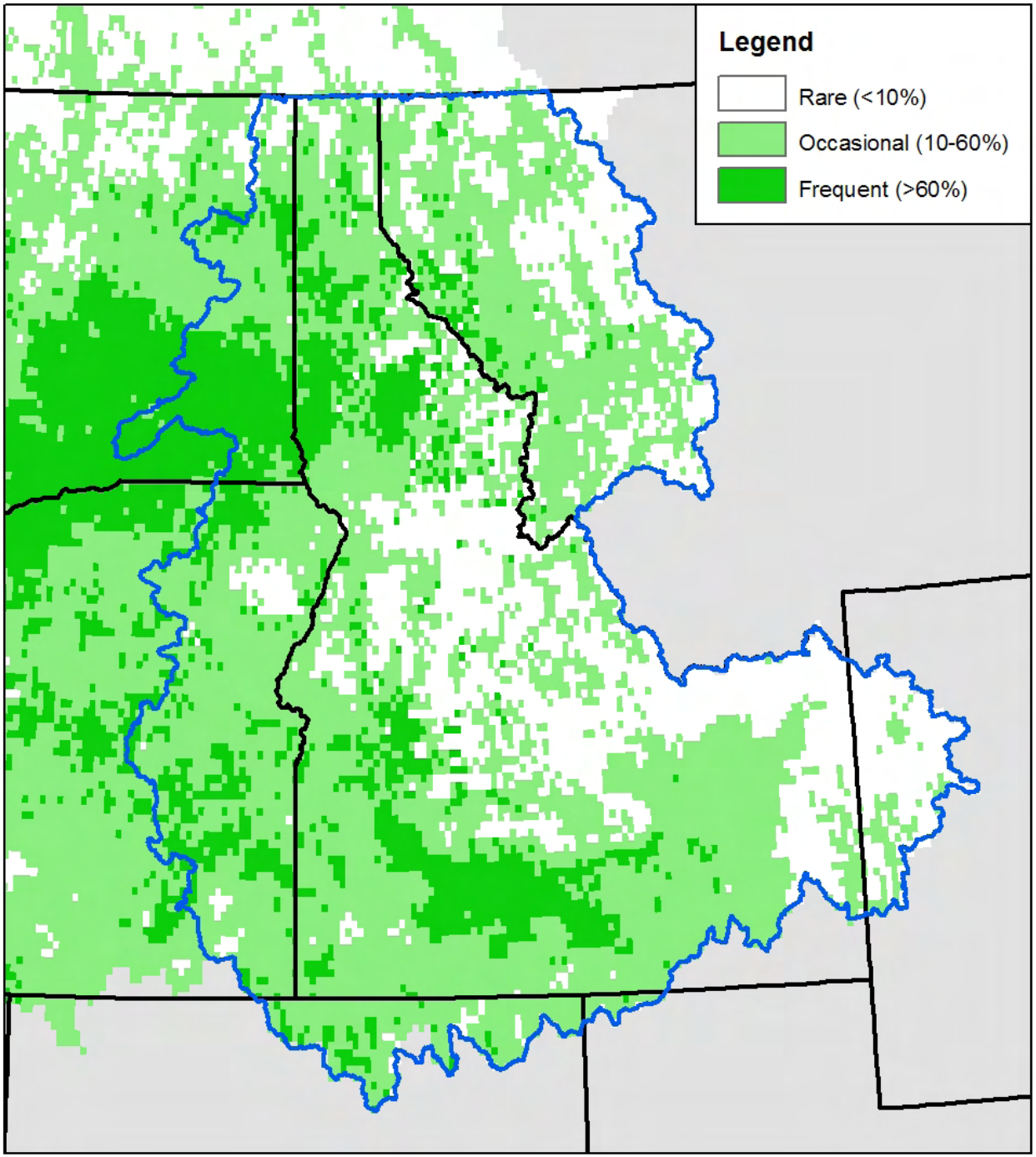


Forecast runoff timing

Predicted under A1B 2080 climate scenario

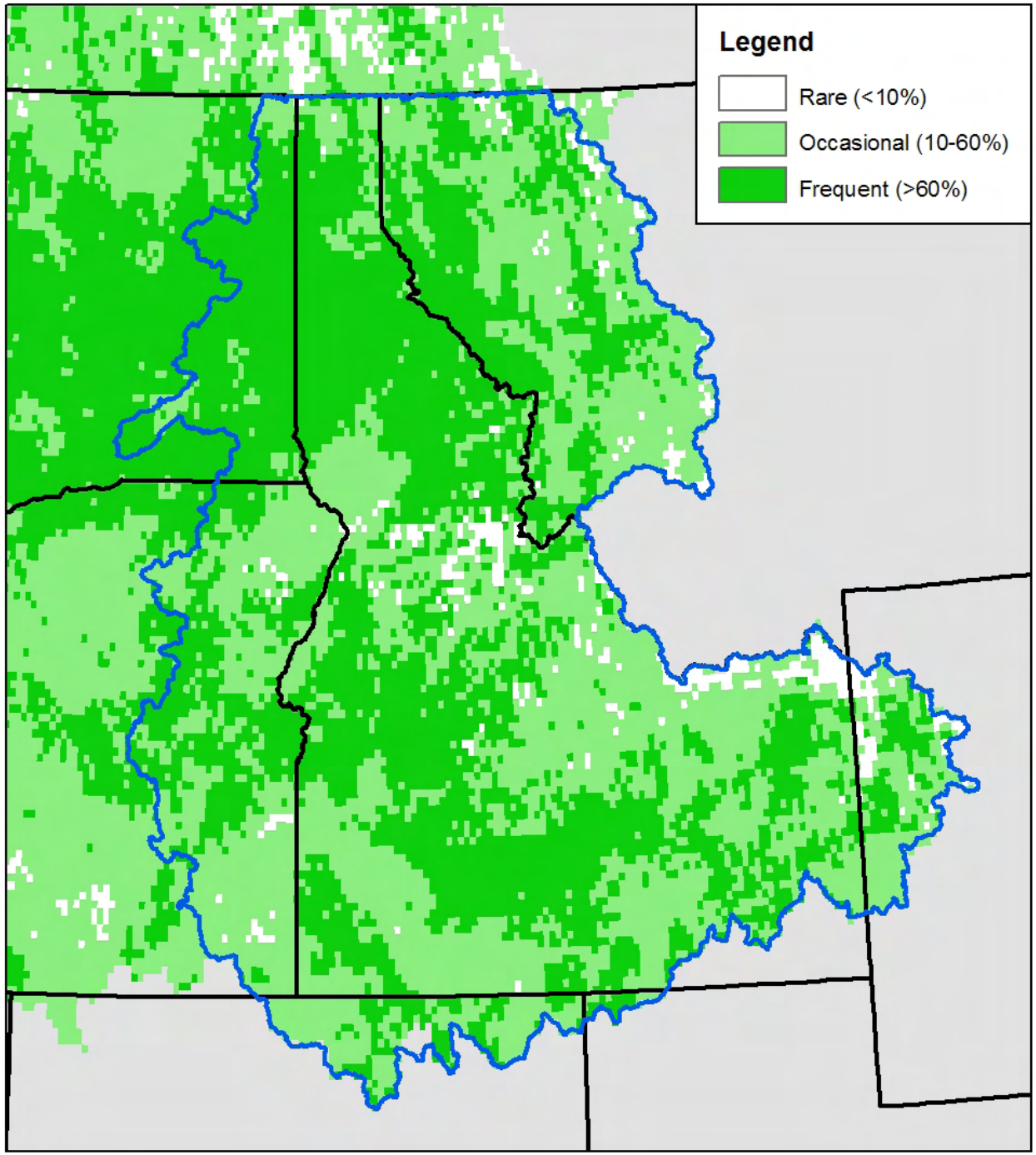


Historical winter flood frequency



Future winter flood frequency

Predicted under A1B 2080 climate scenario



Expected products

- Manuscripts
- Flow metric data attachable to NHD streams
- Stream temperature data (?)
- Databases of fish collections and predictor variables
- Maps

For more information

- Email swenger@tu.org
- Will post updates to Trout Unlimited and Rocky Mountain Research Station web sites later this year

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Kevin Meyer
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Kirk Patton
Hilda Sexauer
Brad Shepard
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