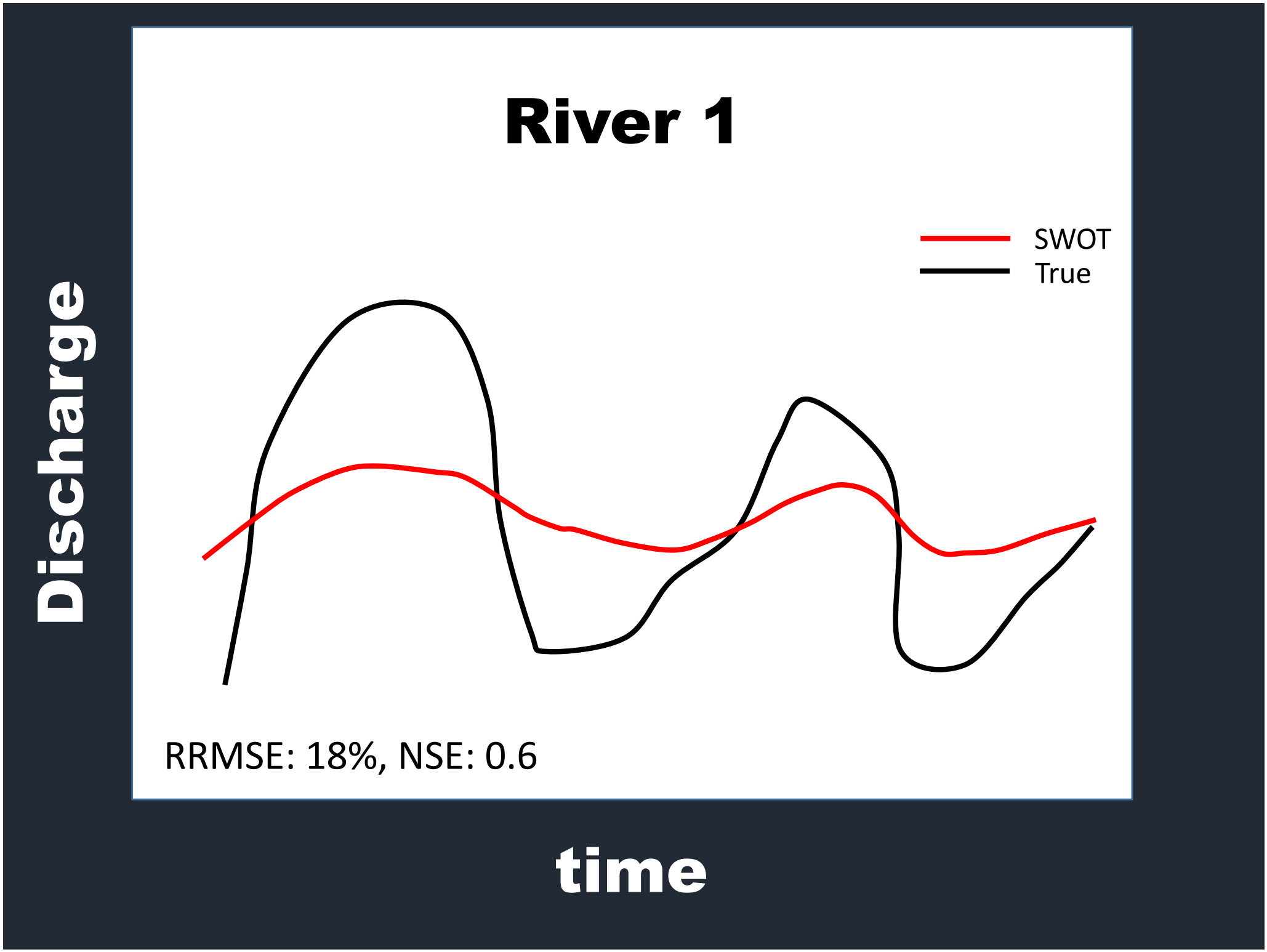
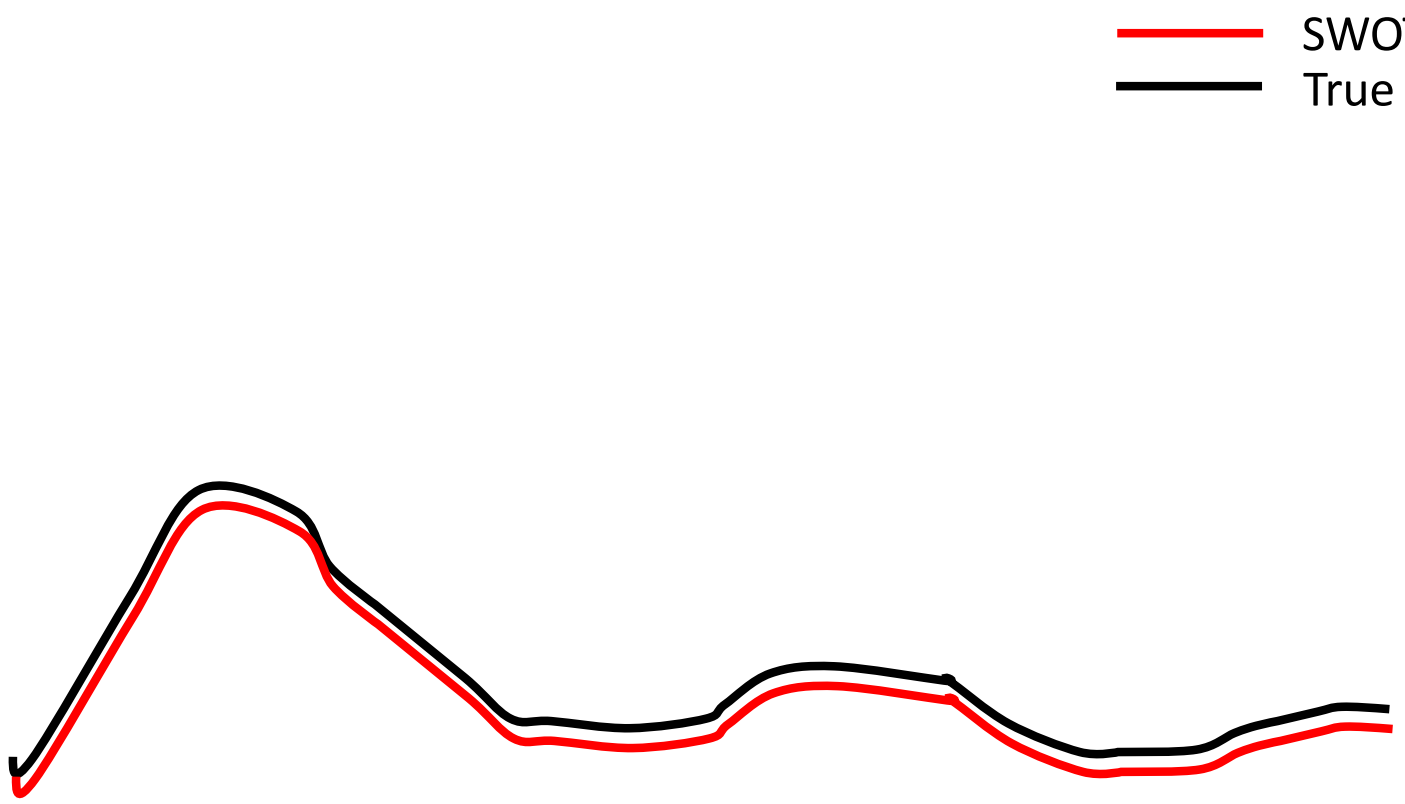
Getting SWOT discharge to pass the smell test

C.J. Gleason, UMass Amherst
M.T. Durand, OSU


River 1
SWOT
True
Discharge
time
RRMSE: 18%, NSE: 0.6

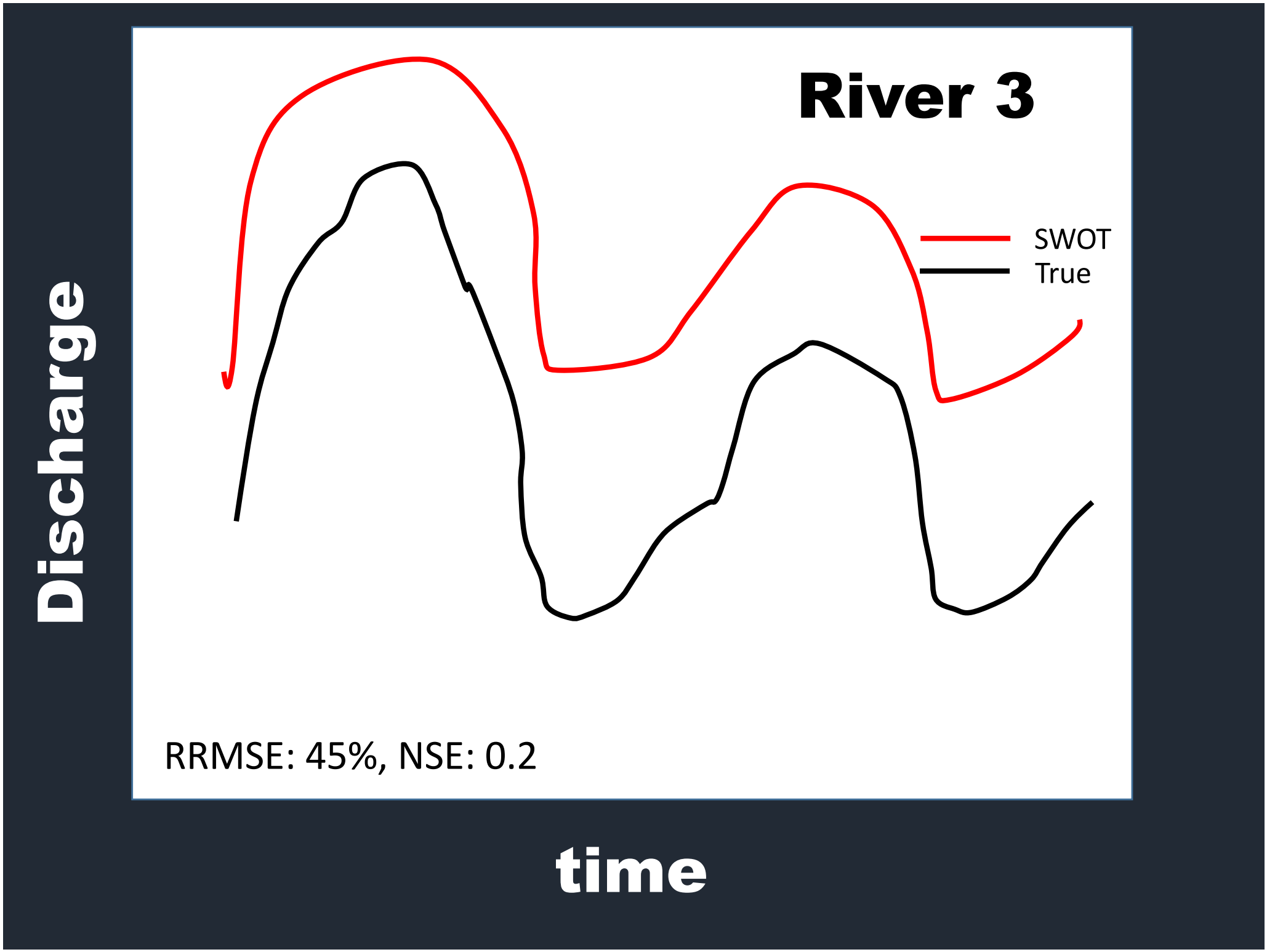
River 2



RRMSE: 4%, NSE: 0.9

Discharge

time


River 3
SWOT
True
RRMSE: 45%, NSE: 0.2
Discharge
time

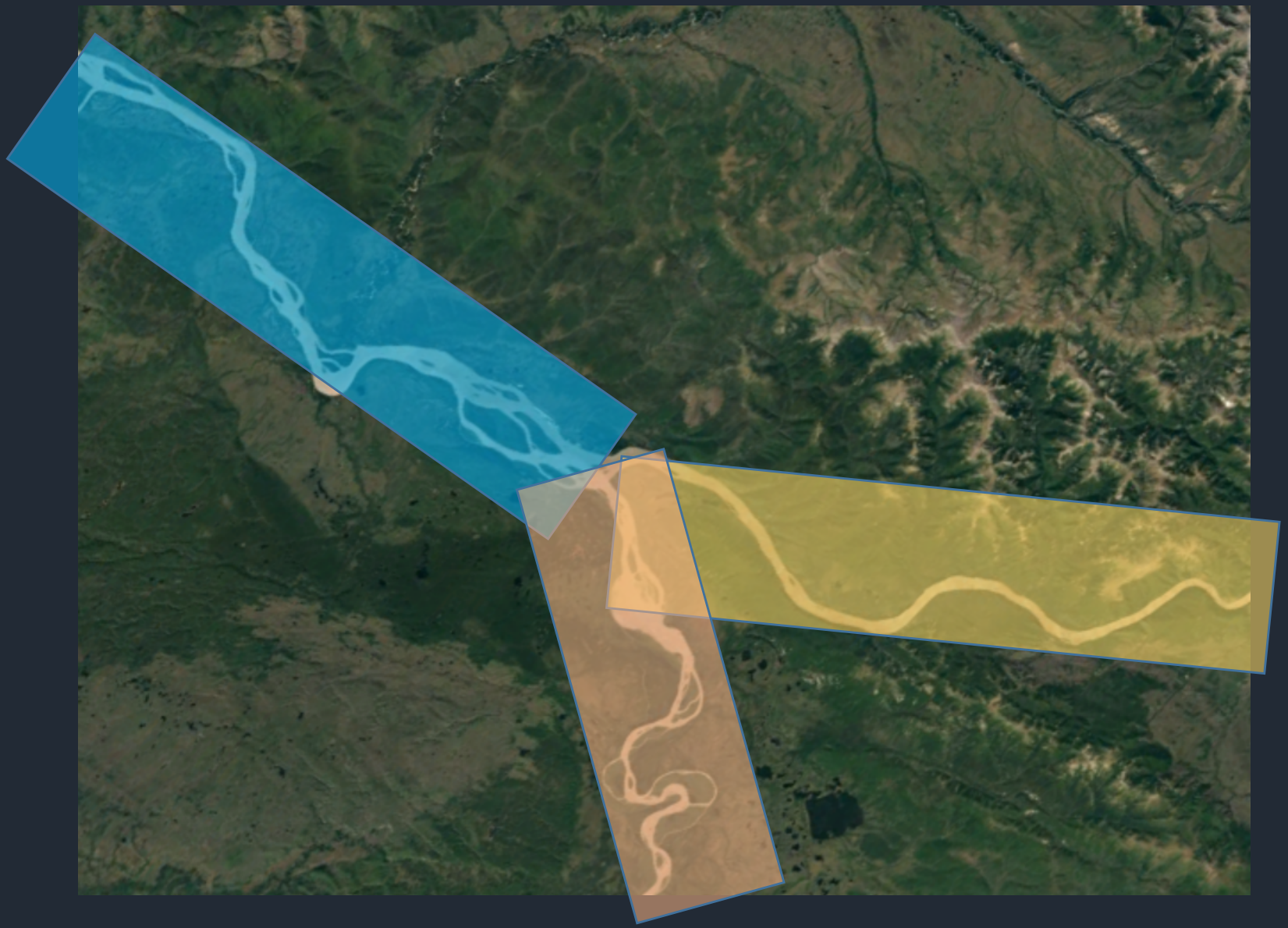
Our Pepsi Table looks like this

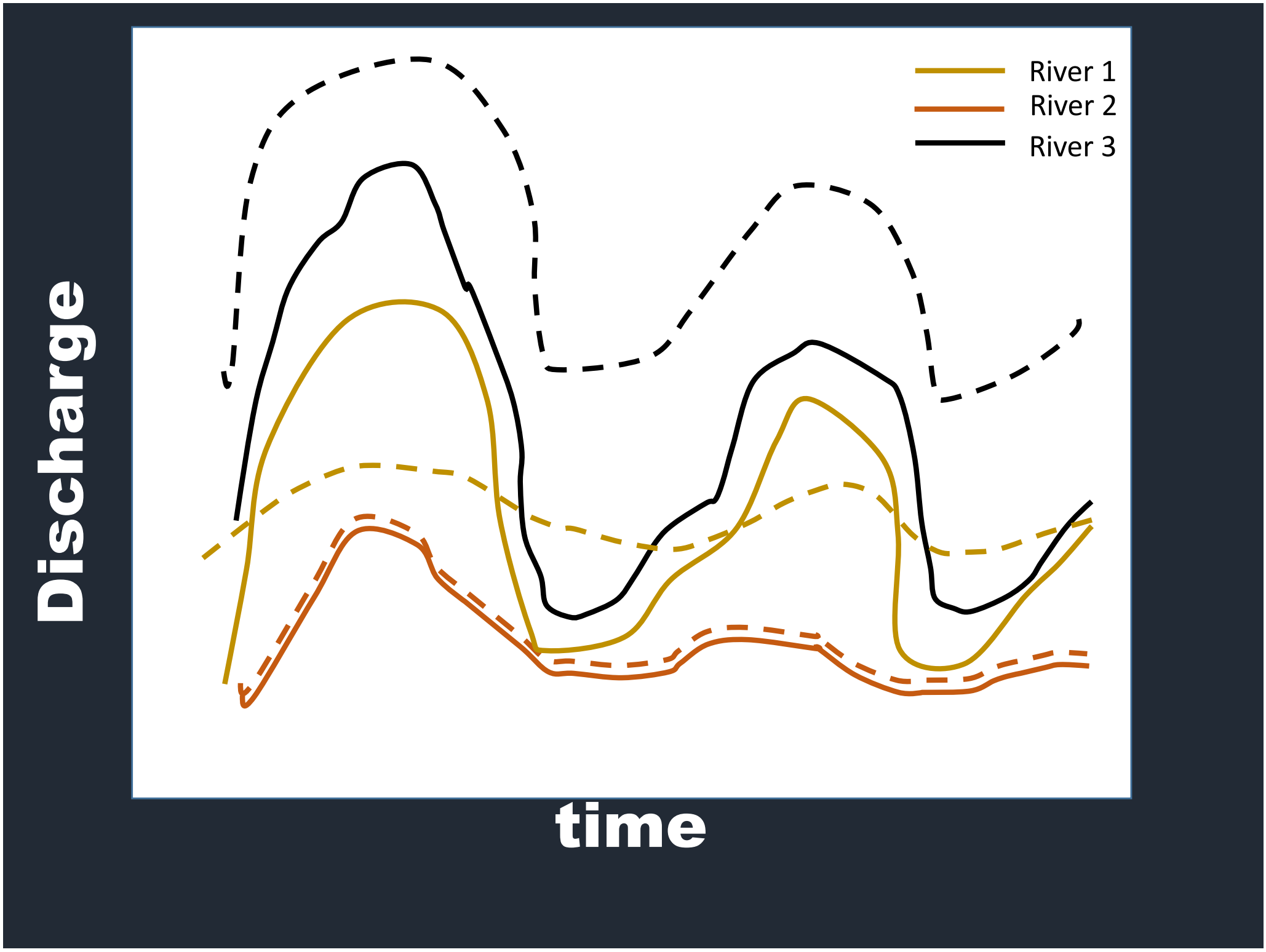
River	RRMSE (%)	NSE
1	18	0.6
2	4	0.9
3	45	0.2

River 1

River 2

River 3



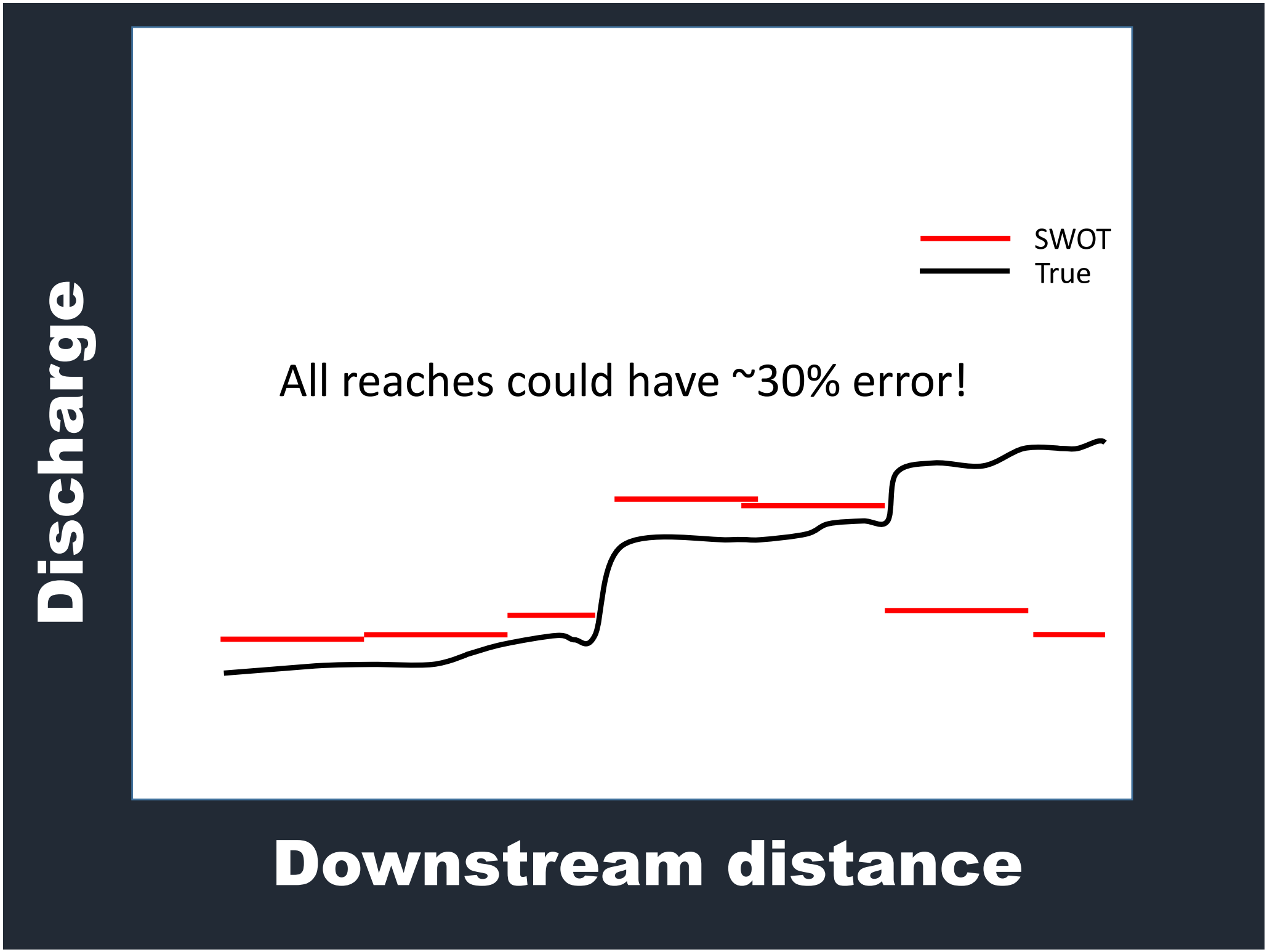

River 1
River 2
River 3
Discharge
time

We have a few major issues here:

1. **Our discharge estimation does not use all hydrology information available to us**

2. **SWOT 1 + SWOT 2 DNE SWOT 3**

3. **This is a problem of too much water, but we could also predict flow decreases downstream as if massive amounts of water were withdrawn**


Discharge
SWOT
True
All reaches could have ~30% error!
Downstream distance

Hundreds of thousands in our SWOT river database, and the problem isn't limited to confluences

What can we do about this?

We need an ‘integrator’: some way to ensure that our discharge products don’t violate the simplest of hydrologic strictures.

Of course, it’s better if we get results that align with other things we know besides mass conservation, but conservation is a minimum

Three ways to integrate discharge estimates:

1. **Route reach-scale flows**

2. **Assimilate flows into a model**

3. **Force integrated flows from the get-go without a hydrology model**

Routing reach-scale flows a posteriori

This is simple, elegant, and assures downstream conservation of mass and momentum.

Pros: computationally efficient, elegant, easy to implement, needed ancillary data are already in SWOT a priori database

Cons: can’t get rid of excess water, bed slope errors propagate, errors in roughness inversion are double counted

Assimilation into a hydrologic or hydraulic model

Pros: additional data are used to estimate Q, makes flows consistent with other hydrology, easily traced error, theoretically reduces impact of poor SWOT- Q reaches, scalable, integration with existing hydrology community

Cons: reliant on model physics, susceptible to errors in parametrization or inputs (especially ungauged), computationally more expensive

Integration by design:

Set up the inverse problem with routing physics built in: solve for Q in all mass conserved reaches at the same time while also solving for continuity

Pros: elegant, should help with equifinality, relies only on SWOT

Cons: untested/untried, likely computationally expensive, does not use additional hydrology information

Discussion prompt:

1. **Do we agree that integration is necessary? Are we ok with reach by reach products - this is more ‘pure’ and SWOT derived.**

2. **If answer to #1 is yes, then we need to do integration before passing parameters to the project, yes?**

3. **Best ways to integrate**