fRI Research
Informing Land & Resource Management

Smoky Headwaters Modelling:
Using GIS-based tools to support decision-making

February 2, 2022

Smoky Headwaters Project

Paired watershed study to measure how effectively restoration efforts reduce sediment loading in coldwater fish habitat (MPWA)

Water and Fish Program's role:

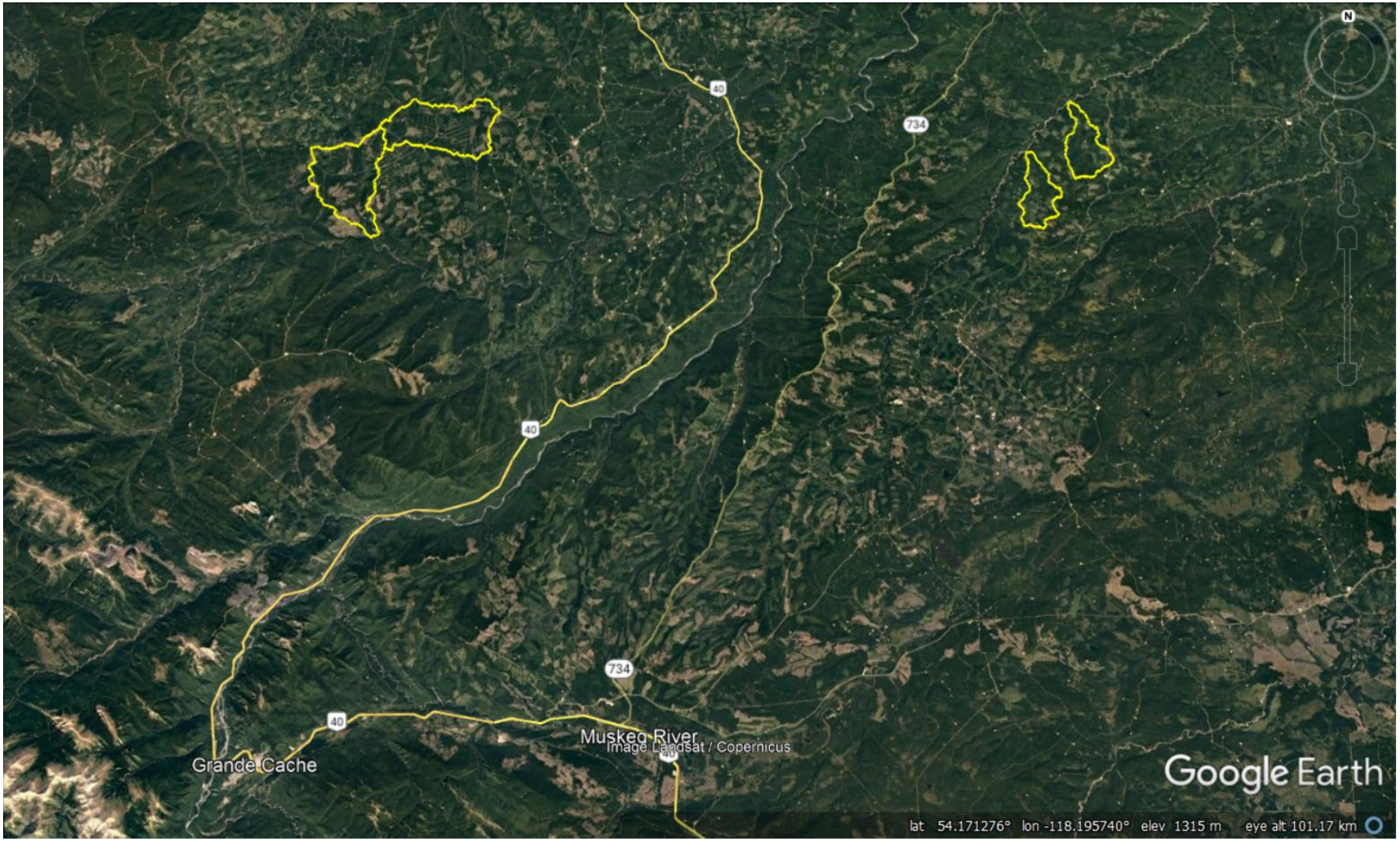
1) Help MPWA choose paired watersheds

2) Rank road erosion and sediment delivery

3) Conduct field surveys to verify model results from 2)

4) Model thermal energy loading in stream reaches

Smoky Headwaters Project



Sediment and Unpaved Roads

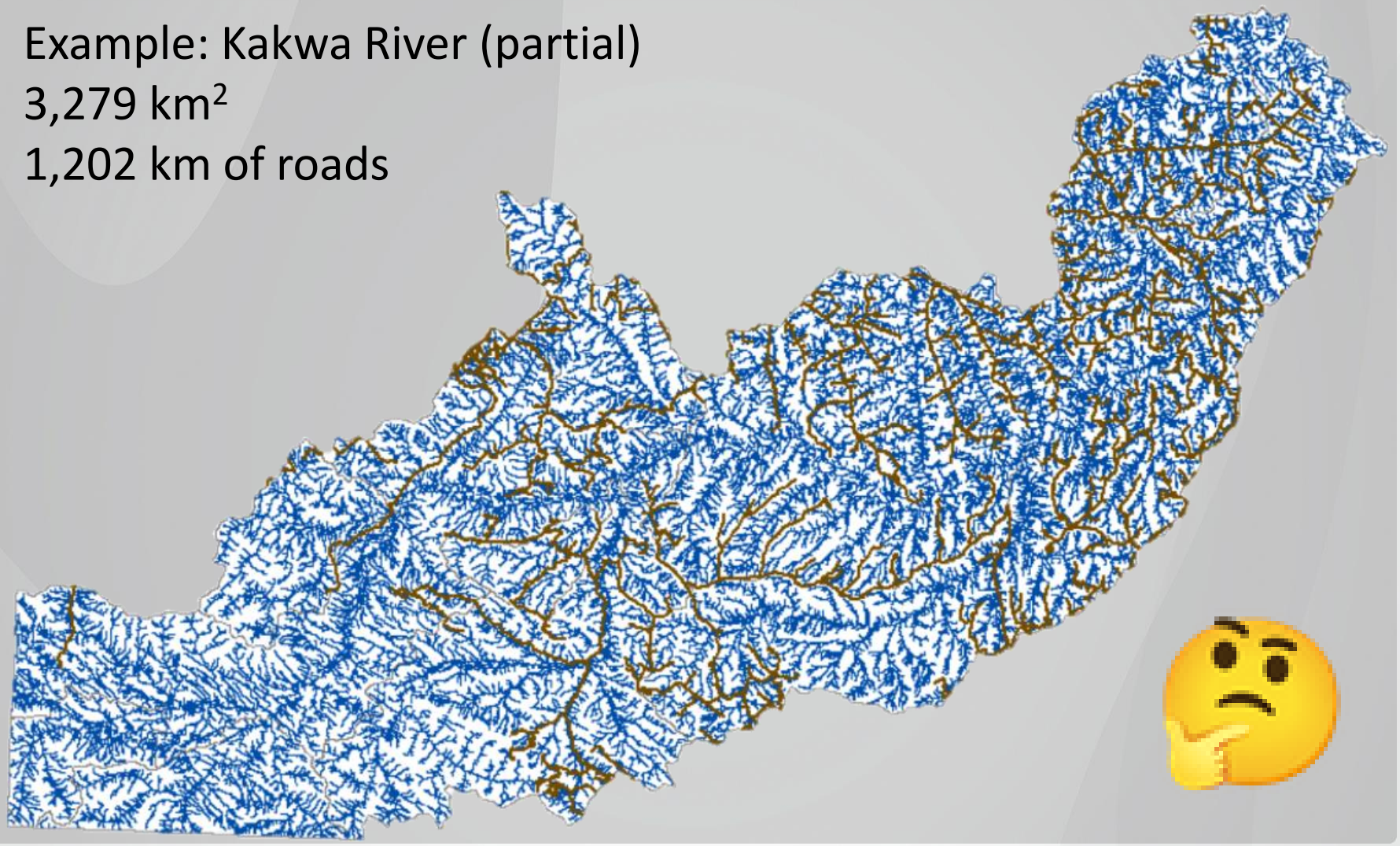
Photo credit: M. Wagner

Water for Life strategy (2008):

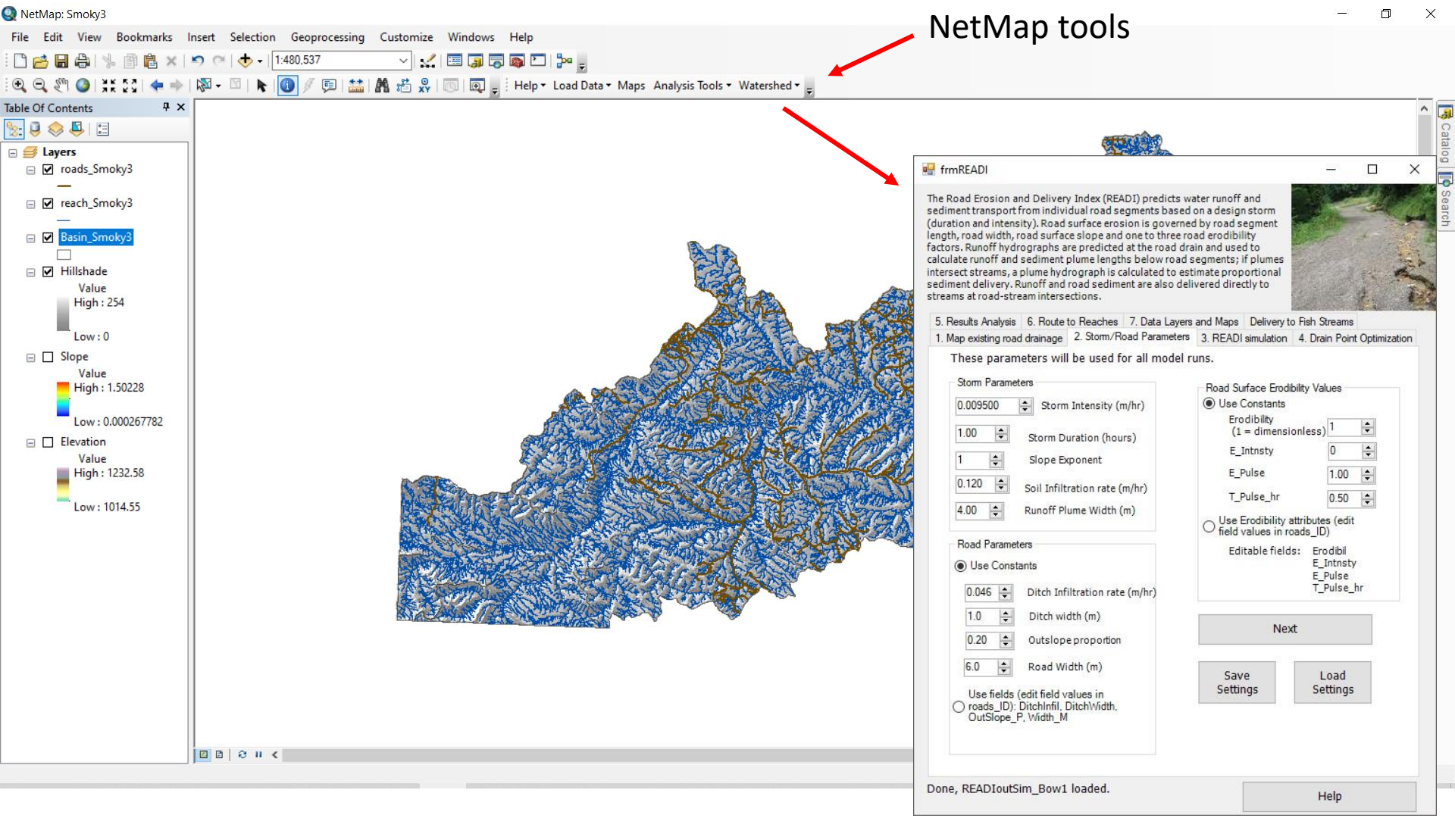
- Safe, secure drinking water supply
- Healthy aquatic ecosystems
- Reliable, quality water supplies for a sustainable economy

The Challenge

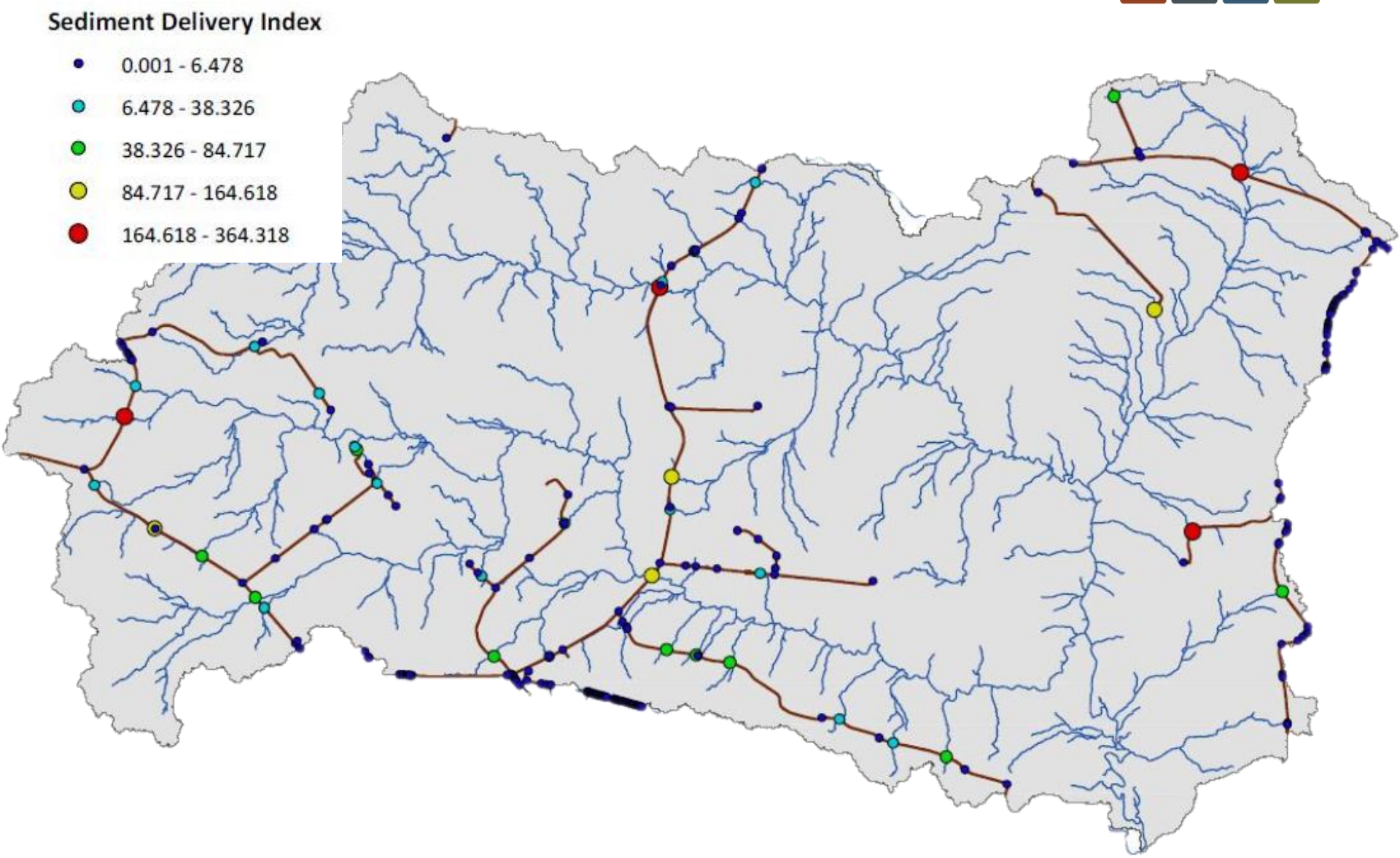
Example: Kakwa River (partial)
3,279 km^2
1,202 km of roads



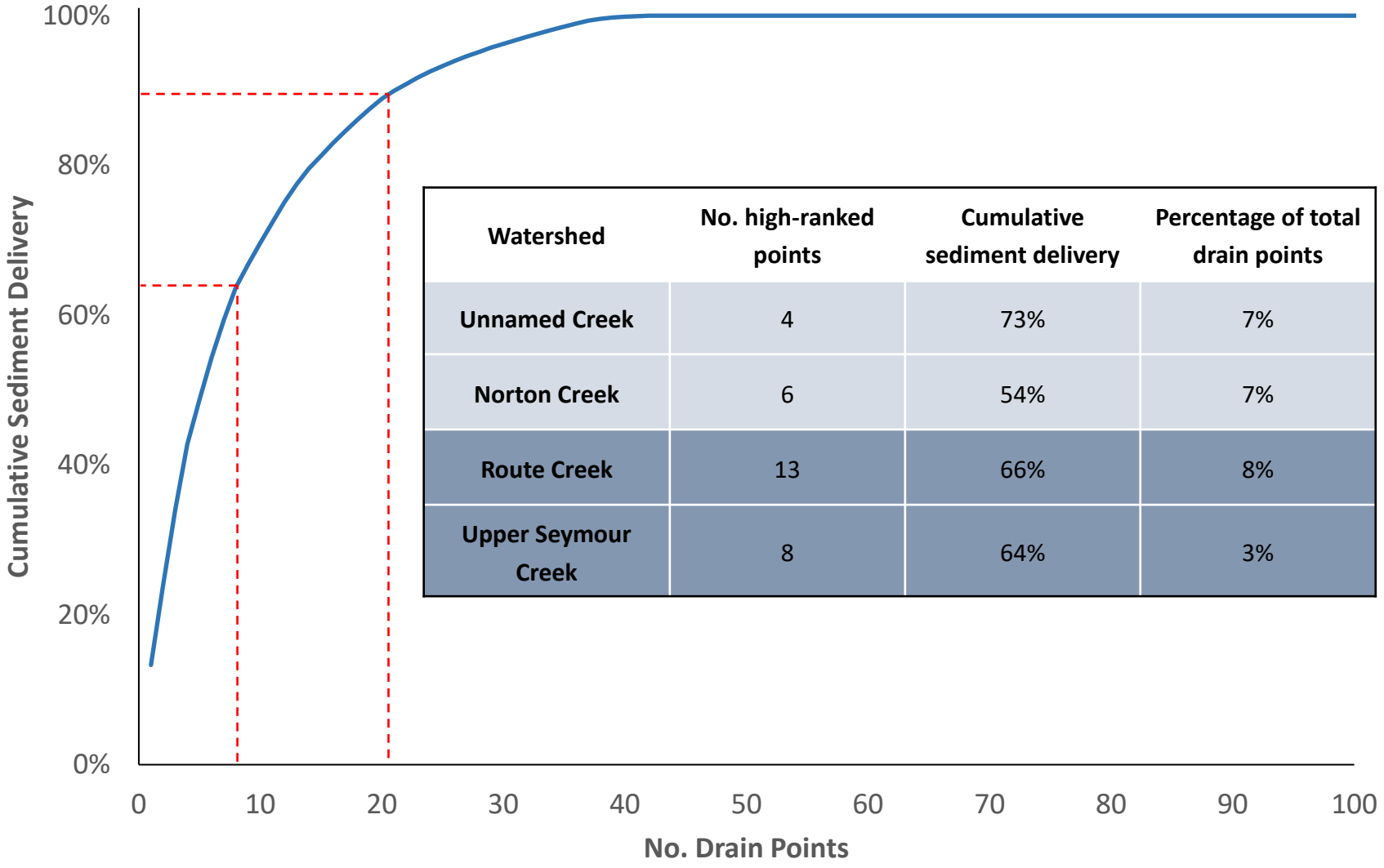
READI


NetMap: Smoky3
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:480,537
Help Load Data Maps Analysis Tools Watershed
Table Of Contents
Layers
roads_Smoky3
reach_Smoky3
Basin_Smoky3
Hillshade
Value
High : 254
Low : 0
Slope
Value
High : 1.50228
Low : 0.000267782
Elevation
Value
High : 1232.58
Low : 1014.55
NetMap tools
frmREADI
The Road Erosion and Delivery Index (READI) predicts water runoff and sediment transport from individual road segments based on a design storm (duration and intensity). Road surface erosion is governed by road segment length, road width, road surface slope and one to three road erodibility factors. Runoff hydrographs are predicted at the road drain and used to calculate runoff and sediment plume lengths below road segments; if plumes intersect streams, a plume hydrograph is calculated to estimate proportional sediment delivery. Runoff and road sediment are also delivered directly to streams at road-stream intersections.
5. Results Analysis
6. Route to Reaches
7. Data Layers and Maps
Delivery to Fish Streams
1. Map existing road drainage
2. Storm/Road Parameters
3. READI simulation
4. Drain Point Optimization
These parameters will be used for all model runs.
Storm Parameters
0.009500 Storm Intensity (m/hr)
1.00 Storm Duration (hours)
1 Slope Exponent
0.120 Soil Infiltration rate (m/hr)
4.00 Runoff Plume Width (m)
Road Parameters
Use Constants
0.046 Ditch Infiltration rate (m/hr)
1.0 Ditch width (m)
0.20 Outslope proportion
6.0 Road Width (m)
Use fields (edit field values in roads_ID): DitchInfil, DitchWidth, OutSlope_P, Width_M
Road Surface Erodibility Values
Use Constants
Erodibility (1 = dimensionless) 1
E_Intnsty 0
E_Pulse 1.00
T_Pulse_hr 0.50
Use Erodibility attributes (edit field values in roads_ID)
Editable fields: Erodibil E_Intnsty E_Pulse T_Pulse_hr
Next
Save Settings
Load Settings
Done, READIoutSim_Bow1 loaded.
Help

Visualizing Results



Visualizing Results Cont'd



Watershed	No. high-ranked points	Cumulative sediment delivery	Percentage of total drain points
Unnamed Creek	4	73%	7%
Norton Creek	6	54%	7%
Route Creek	13	66%	8%
Upper Seymour Creek	8	64%	3%

Verification

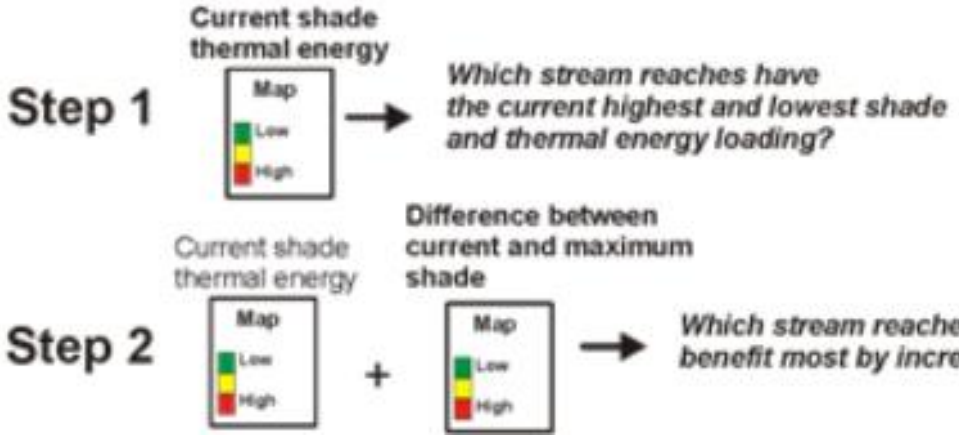
Photo credit: C. Tomaszewski

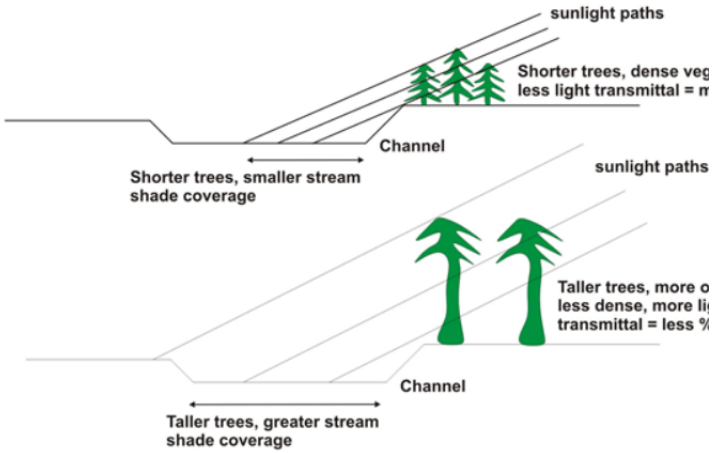
Verification

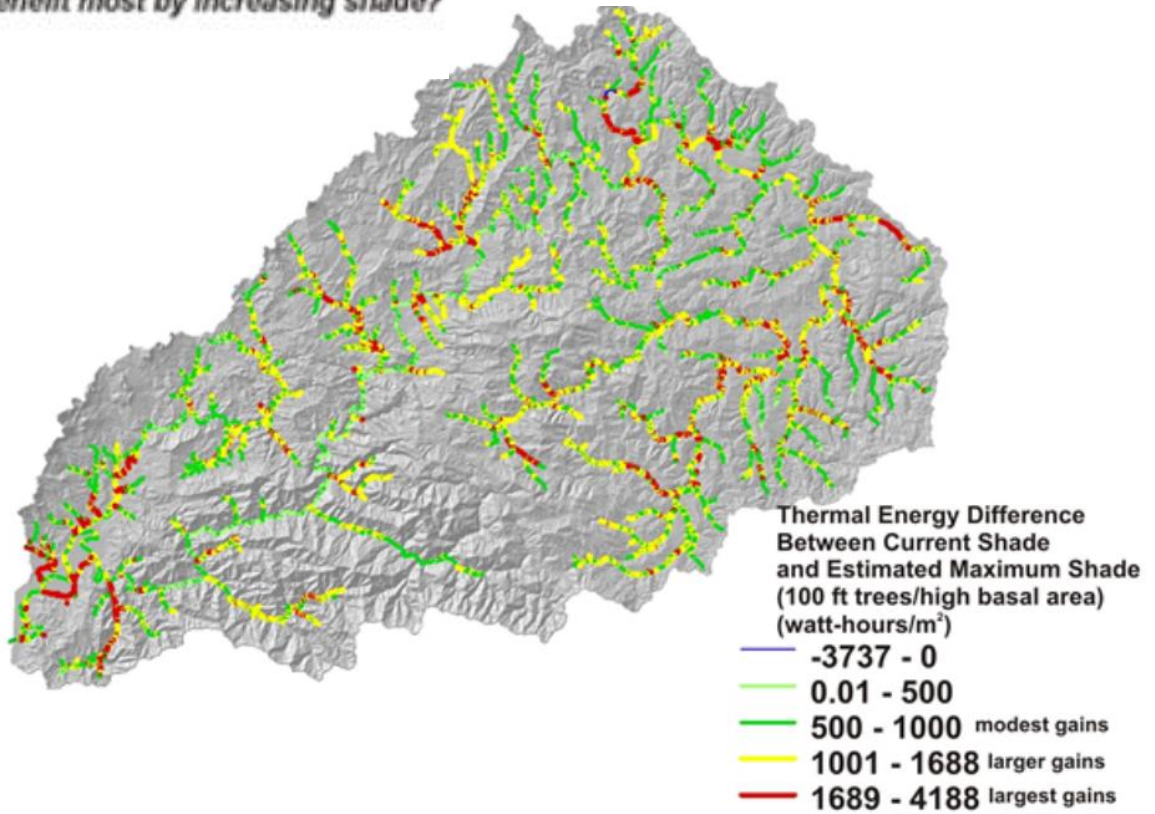
Watershed	Erosion observed*	Sediment delivery likely (past or present)	Structural issues present	Potential barrier to fish passage
Unnamed Creek	29, **36**, 37, 47	36, 37, 47	47	29, 37
Norton Creek	9, 36	6, 9, 36	6	9
Route Creek	18, 26, **43**, 98, **99**, 105, 105-extra point, **140**, **142**	15, 18, 26, 43, 98, 99, 105, 140	15, 26, 43, 99, 105, 140, 169	15, 99, 140, 169
Upper Seymour Creek	**10**, **47**, **69**	10, 31, 47, 69	47	–

*Bold face indicates high erosion

Shade—Thermal Energy







From TerrainWorks Inc.

https://www.netmaptools.org/Pages/NetMapHelp/8_4_shade_thermal_energy.htm?mw=MzQ2&st=MQ==&sct=MzUyMw==&ms=AAAAAAA=

https://www.netmaptools.org/Pages/NetMapHelp/current_shade_thermal_energy.htm?mw=MzQ2&st=MQ==&sct=MzUyMw==&ms=AAAAAAA=

THANK YOU!

fRI Research.ca

Resources

READI

TerrainWorks:
https://www.netmaptools.org/Pages/NetMapHelp/road_erosion_sediment_delivery__readi_.htm?mw=MzQ2&st=MQ==&sct=MzM3OQ==&ms=AAAAAAA=

Benda, L., James, C., Miller, D., and Andras, K.. 2019. Road erosion and delivery index (READI): a model for evaluating unpaved road erosion and stream sediment delivery. Journal of the American Water Resources Association, 55 (2): 459– 484. https://doi.org/10.1111/1752-1688.12729.

Sediment Risk and Road Design (presentation; Michael Wagner, Alberta Agriculture and Forestry)
https://drive.google.com/file/d/1j38WsfWHWn2nZ0ZIc02rWbXlpZHXg02t/view

fRI Research QuickNotes:
https://friresearch.ca/resource/identifying-unpaved-road-sediment-delivery-critical-fish-habitats-strategic-prioritization
https://friresearch.ca/resource/road-erosion-simonette-part-4-instream-consequences-and-road-crossings

Shade-thermal energy

TerrainWorks:
https://www.netmaptools.org/Pages/NetMapHelp/8_4_shade_thermal_energy.htm?mw=MzQ2&st=MQ==&sct=MzM3OQ==&ms=AAAAAAA=

ABWCI
https://open.alberta.ca/dataset/8cff676f-e6fa-4d1c-b589-b54fafc3a67d/resource/a499fa66-a9e4-4136-b950-95826aa679fd/download/aep-alberta-watercourse-crossing-inventory-app-2021-05-25.pdf