Debris Flow Mapping Through Time

Data Management using ArcGIS and Implications for Fish Research

David Nagel – GIS Analyst

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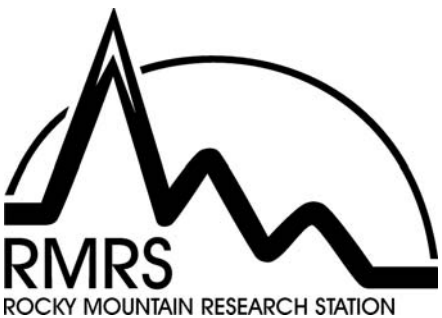
Jack King – Research Hydrologist

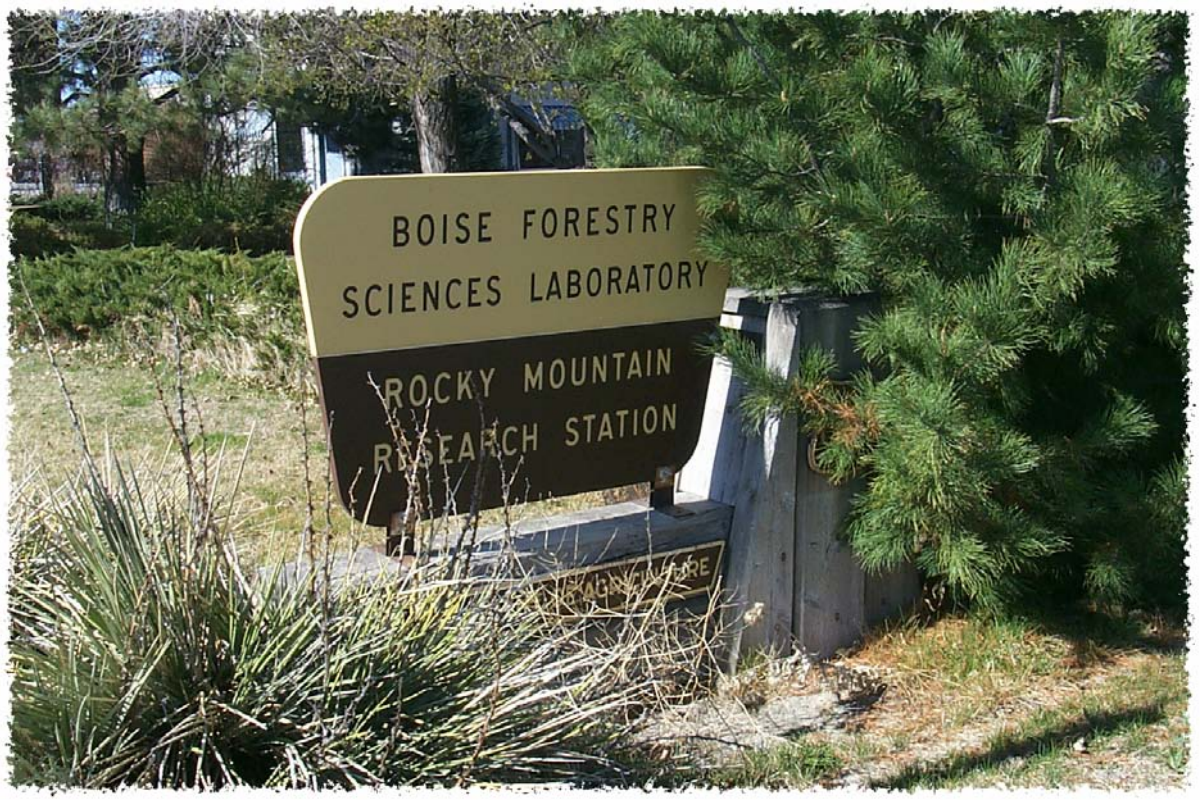
Bruce Rieman- Fisheries Research Biologist

Jason Dunham – Fisheries Research Biologist



Boise Aquatic
Sciences Lab

Boise Aquatic Sciences Lab



Idaho

Boise Lab Disciplines

Fisheries

Watershed

Middle Fork Boise River Native Trout

Threatened
Bull Trout

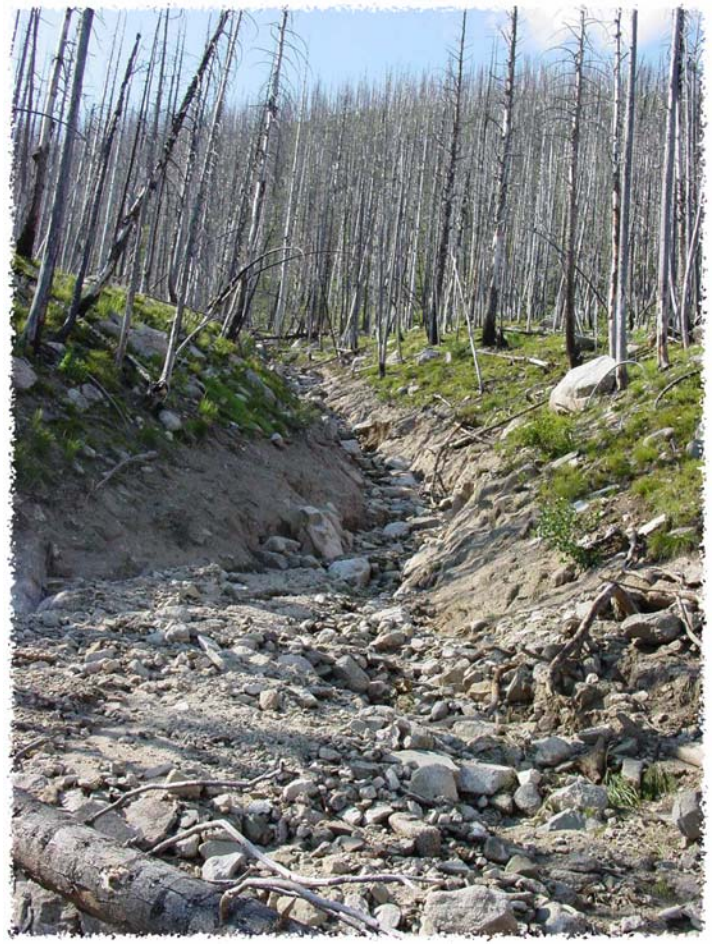
Redband Rainbow Trout

Channel Reorganizing Events

- Debris Flows
- Hyper-concentrated Flows

Debris Flow

1.The rapid, downward mass movement of particles coarser than sand, often including boulders one meter or more in diameter, at a rate ranging from 2 to 40 kilometers per hour. Debris flows occur along fairly steep slopes.



Hyper-concentrated Flow

Finer material

Debris Flow Causes

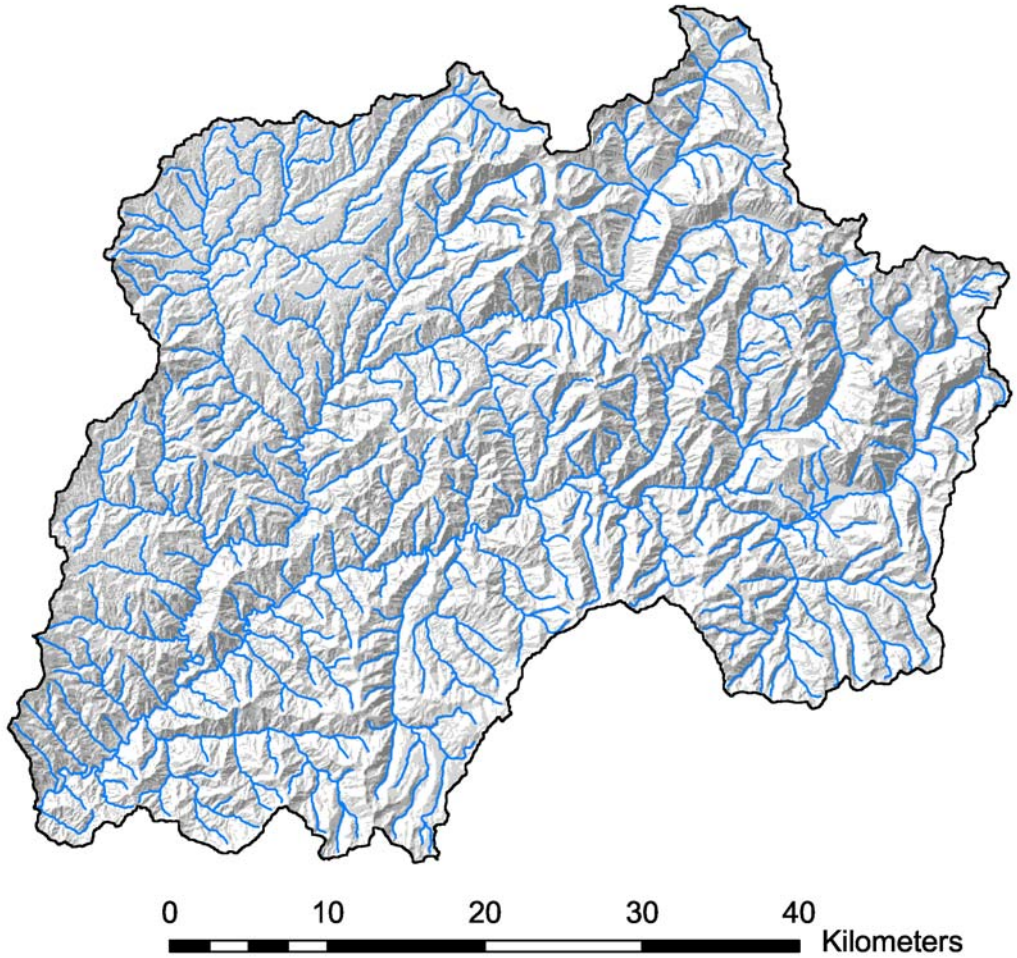
- Rain on snow events
- Heavy rain

Research Questions

1) Where are the debris flows? How does their spatial distribution change over time and does this dynamic influence fish populations?
2) Do fire and management activities influence debris flow occurrence?
3) How do debris flows and fire affect stream temperature?
4) Is there a relationship between debris flows and presence/absence of fish, such as bull trout?

Middle Fork Boise River Watershed

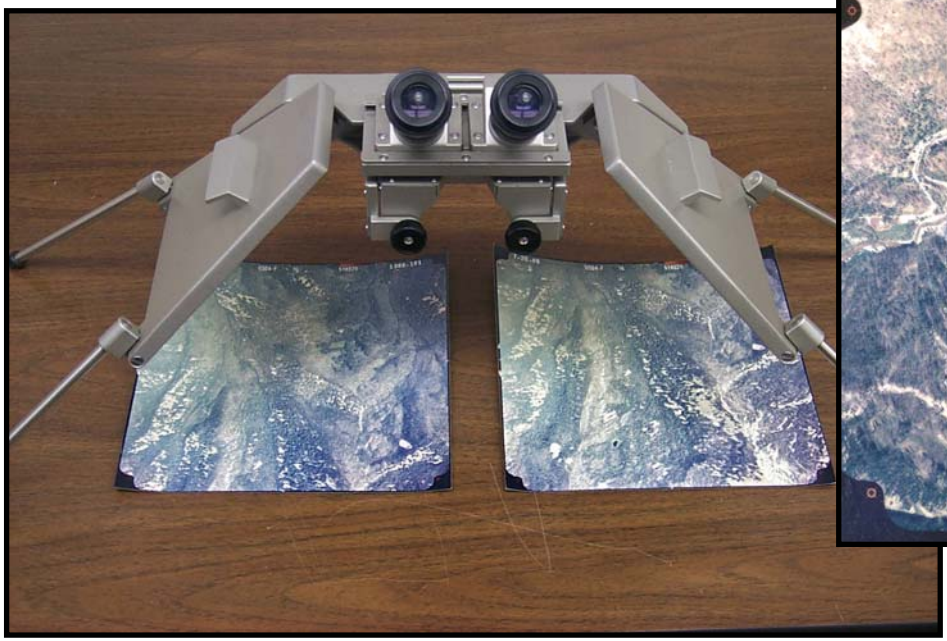
Boise National Forest



Middle Fork Boise River Landscape

Debris Flow Mapping Process

Photo Interpretation



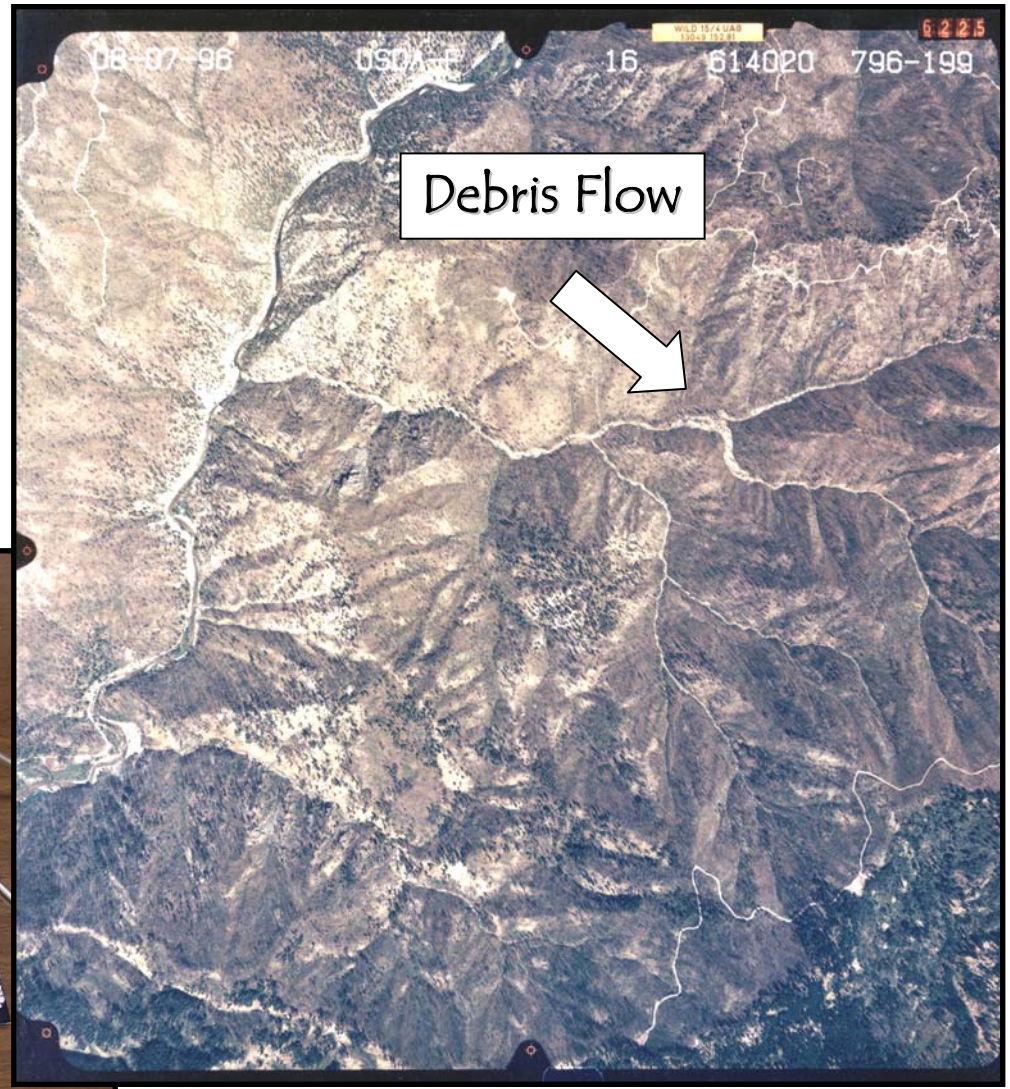
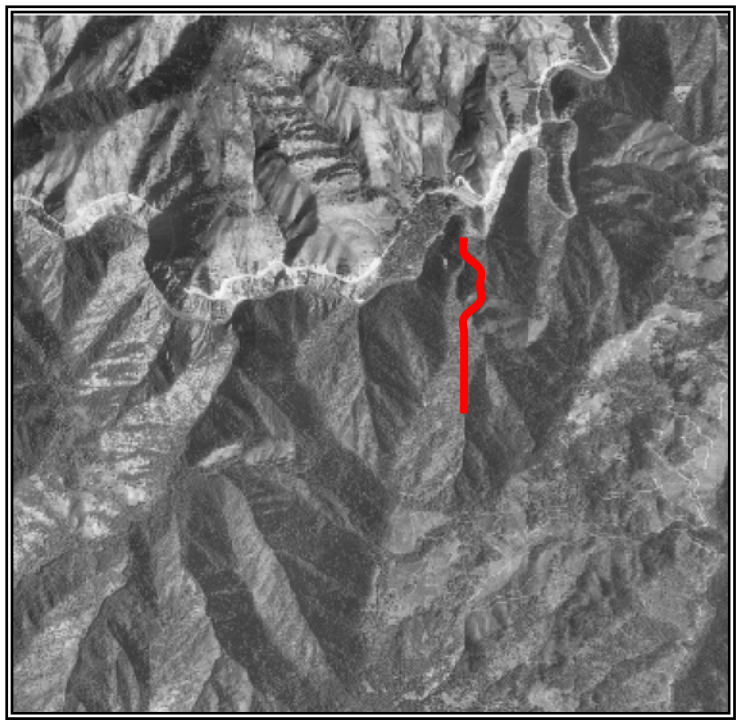


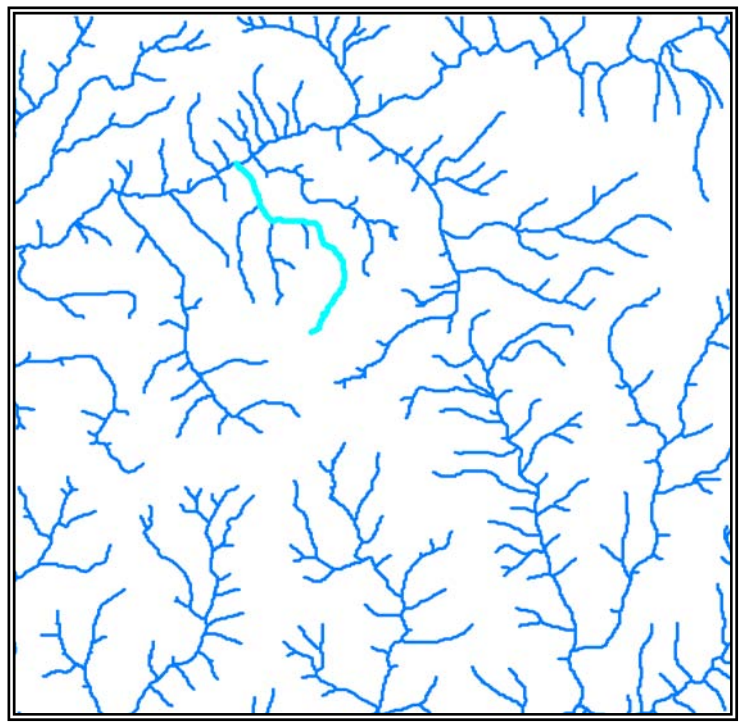
Photo Interpretation Facts

- Four photo acquisitions: 1969, 1979, 1988, and 1996
- Approximately 1,200 photos
- Full time work for one summer temporary employee

Mapping Debris Flows
Two Options



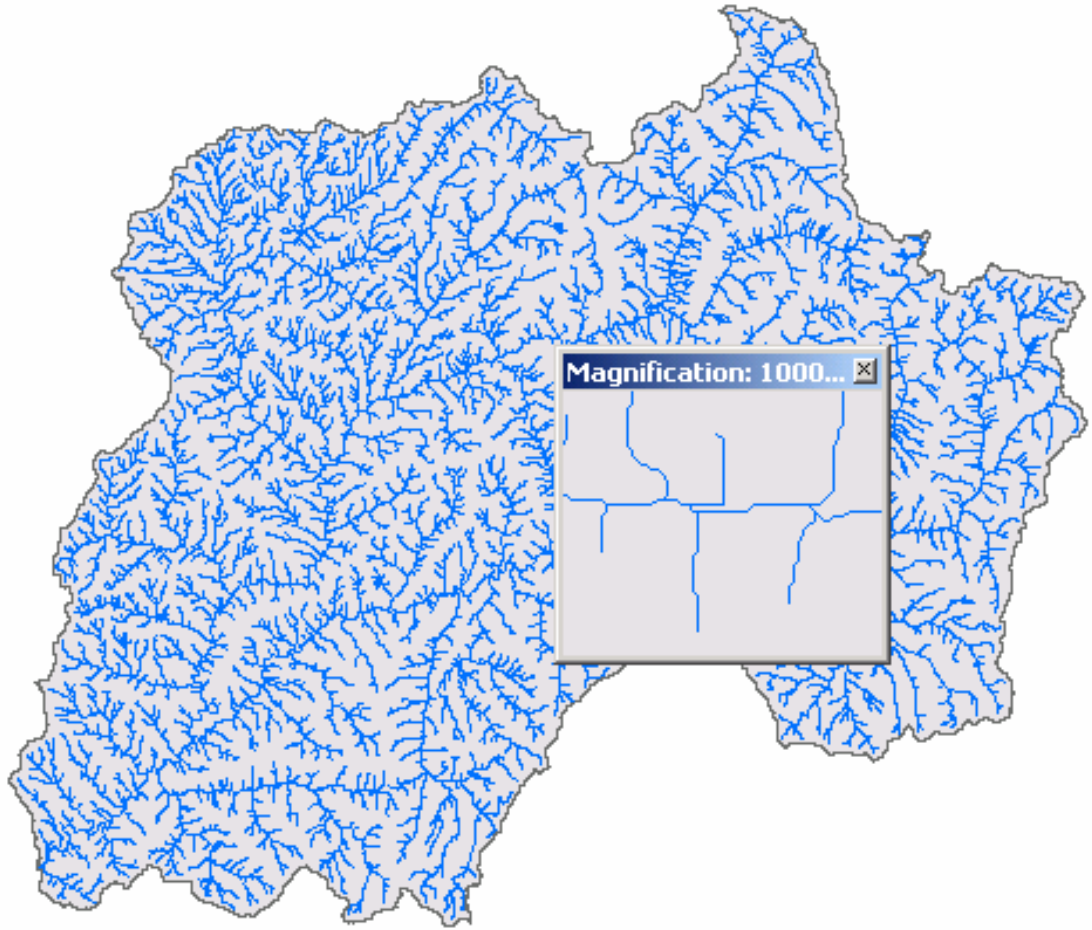
On-screen digitizing



Attribute existing streams

Map Debris Flows on TARDEM Streams

Streams derived from Digital Elevation Model (DEM)



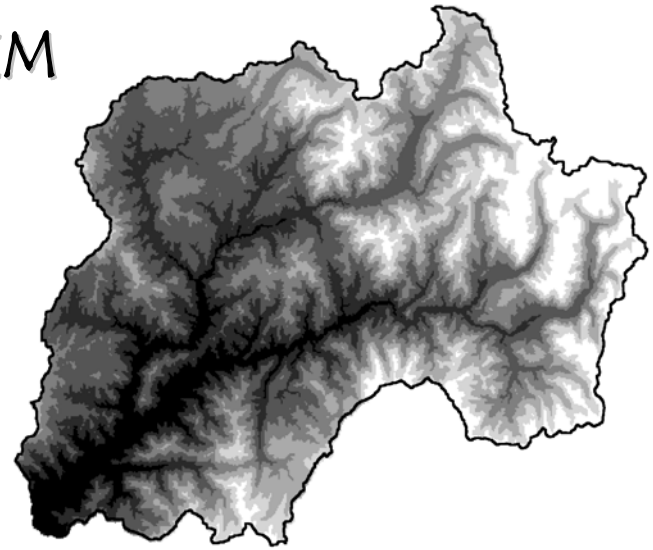
TARDEM Streams

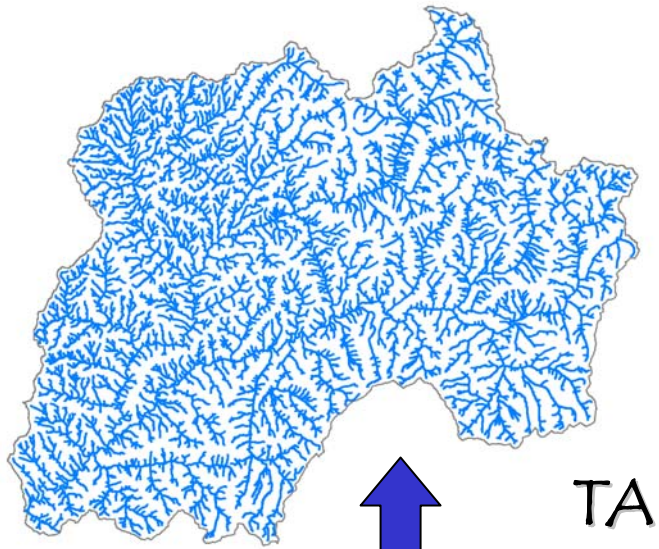
- Software developed by David Tarboton – Utah State University
- Streams derived from DEM data
- Output in ArcInfo coverage format
- Coverage contains useful stream characteristics attributes
- TauDEM – ArcGIS plug-in

http://www.engineering.usu.edu/dtarb/

Process and Attributes

DEM





TARDEM streams

Attribute table

Attributes of mfkb_li arc

LINKS	LINKE	DROP(M)	GEOM.LENGTH(M)	ORDER	MAGNITUDE	AREA(M**2)	SLOPE
1	1	185.366898	1064.048950	1	1	810000	0.160992
3	3	21.521000	152.970596	1	1	244800	0.132513
2	2	93.027832	342.052612	1	1	344700	0.260582
4	4	41.250980	234.307495	2	2	1112400	0.170316
5	5	65.900146	308.868896	2	3	1589400	0.198438
18	18	56.776119	391.152100	2	3	1026900	0.136154

Record: 1 Show: All Selected Records (0 out of 6347 Selected.) Options

Related Tables

- Relate has two separate tables – 8 and 16 fields respectively

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Record: 1 Show: All Selected Records (0 out of 6347 Selected.) Options

TARDEM Attribute Table (8 fields)

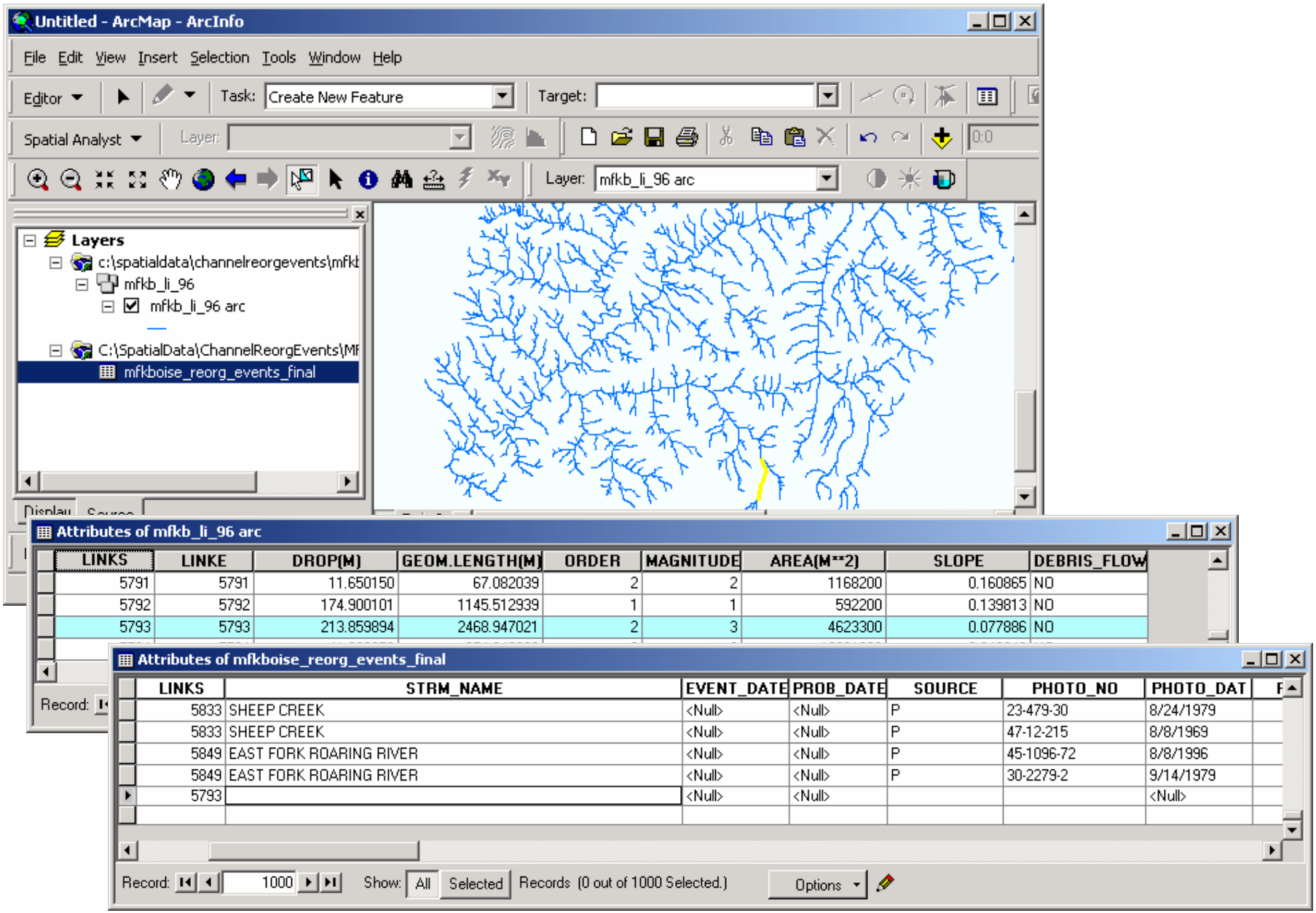
Debris flow dBase attribute table (16 fields)

Attributes of mfkboise_reorg_events

OID	LINKS	STRM_NAME	EVENT_DATE	PROB_DATE	SOURCE	PHOTO_NO	PHOTO_DATE	REPORT_NO	REPOR_DATE	PREV_PHOTO	PREV_DATE	CAUSE	STATUS	FRAC_SEG	COMMENTS

Record: 0 Show: All Selected Records (0 out of 0 Selected.) Options

Editing the dBase Table



One to Many Relationship

Untitled - ArcMap - ArcInfo

File Edit View Insert Selection Tools Window Help

Editor | Task: Create New Feature | Target:

Spatial Analyst | Layer:

Layer: mfkb_li_96 arc

Layers
- c:\spatialdata\channelreorgevents\mfkb
  - mfkb_li_96
    - mfkb_li_96 arc
- C:\SpatialData\ChannelReorgEvents\MF
  - mfkboise_reorg_events_final

Attributes of mfkb_li_96 arc

LENGTH	MFKB_LI_96#	MFKB_LI_96-ID	LINKS	LINKE	DROP(M)	GEOM.LENGTH(M)	ORDER	MAGNITUDE	AREA
337.279236	781	788	5831	5831	13.950070	301.496307	5	155	
416.984863	779	786	5832	5832	11.479980	381.837708	5	159	
1356.396118	56	59	5833	5833	50.289921	1214.906982	5	160	
1726.690430	3939	3963	5834	5834	87.370117	1564.609009	1	1	

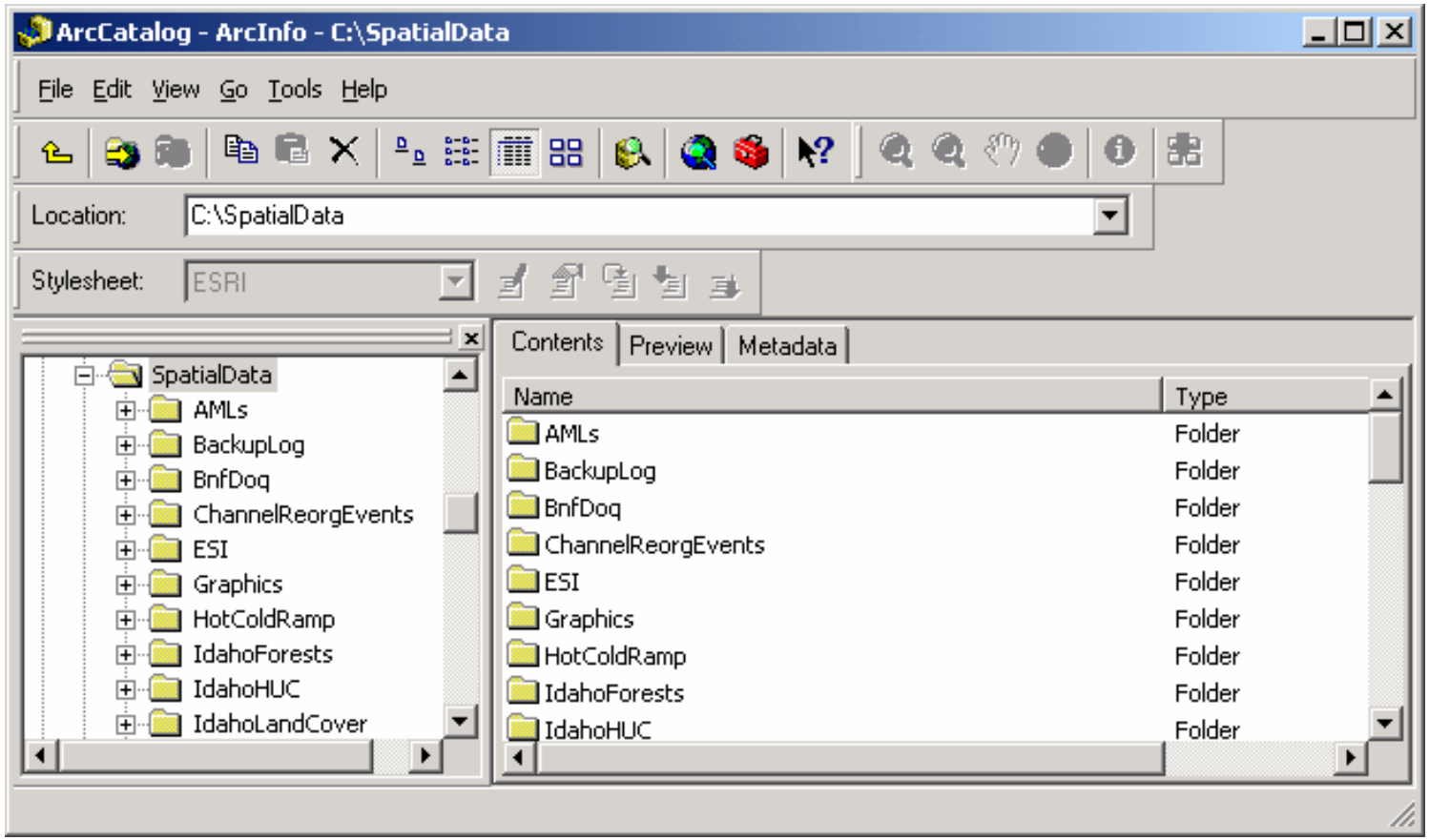
Record:

Attributes of mfkboise_reorg_events_final

LINKS	STRM_NAME	EVENT_DATE	PROB_DATE	SOURCE	PHOTO_NO	PHOTO_DAT
5832	SHEEP CREEK	<Null>	<Null>	P	47-12-215	8/8/1969
5833	SHEEP CREEK	<Null>	<Null>	P	38-1496-27	8/16/1996
5833	SHEEP CREEK	<Null>	<Null>	P	22-1088-205	7/17/1988
5833	SHEEP CREEK	<Null>	<Null>	P	23-479-30	8/24/1979
5833	SHEEP CREEK	<Null>	<Null>	P	47-12-215	8/8/1969
5849	EAST FORK ROARING RIVER	<Null>	<Null>	P	45-1096-72	8/8/1996

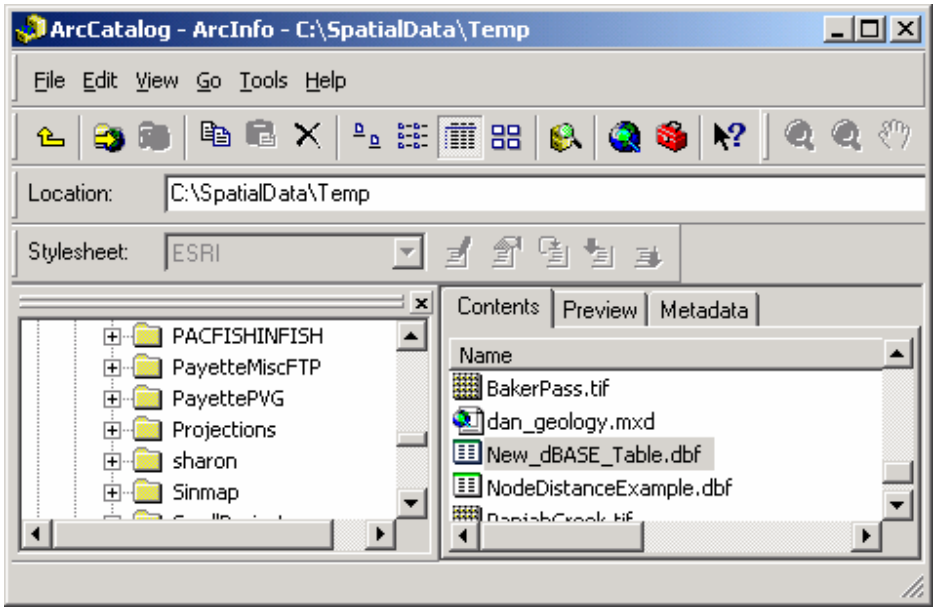
Record: 0 | Show: All | Selected | Records (4 out of 999 Selected.) | Options

Create dBase Table

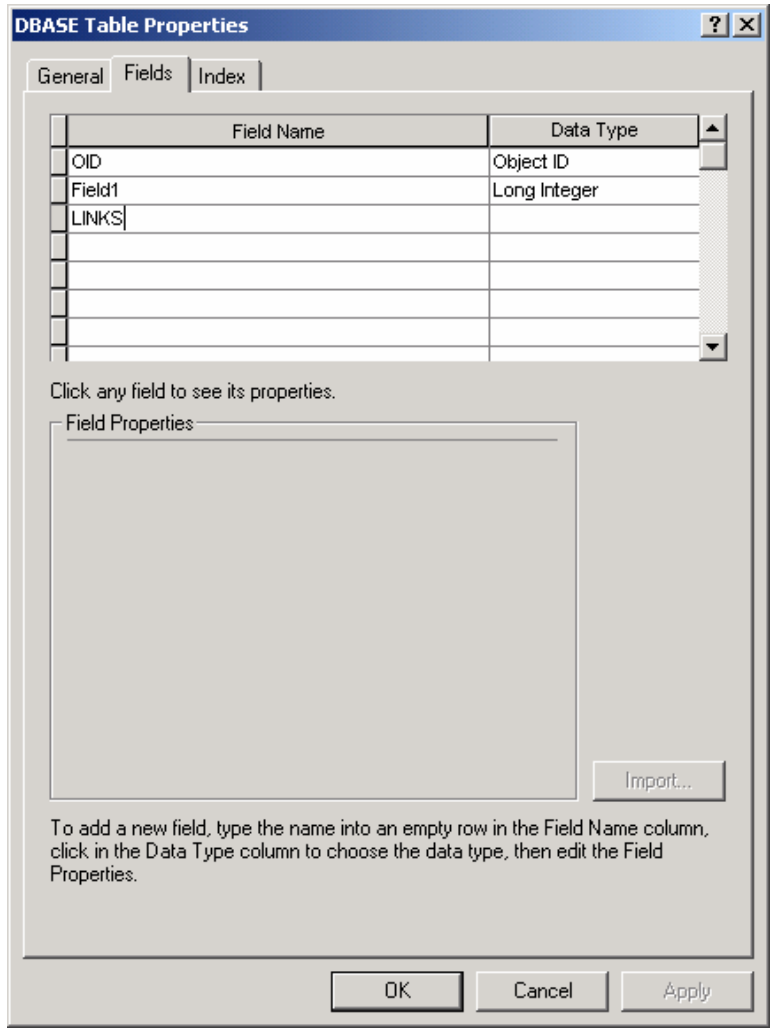


File › New › dBase Table

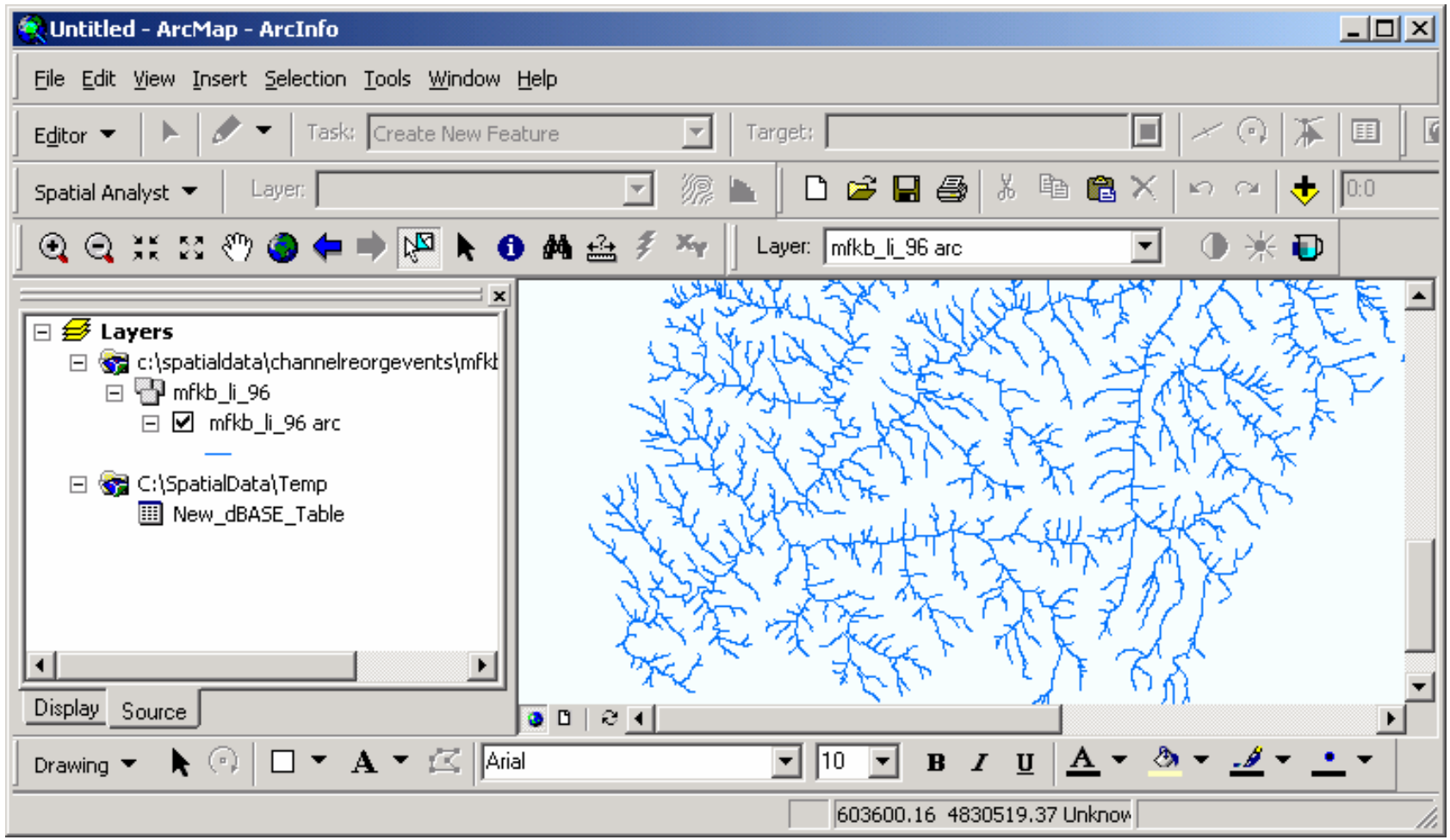
Create Fields



Right click > Properties



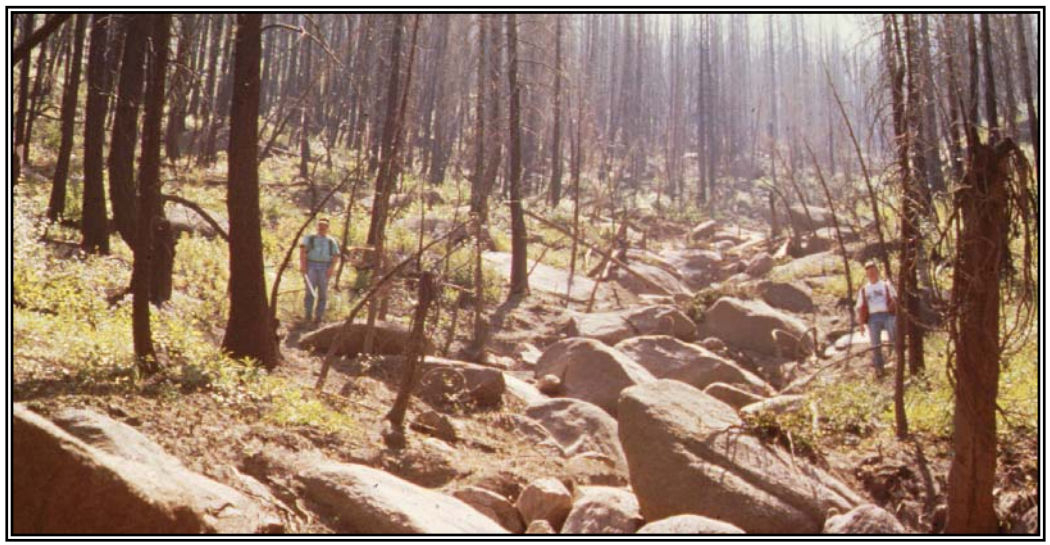
Add dBase Table to Map Document



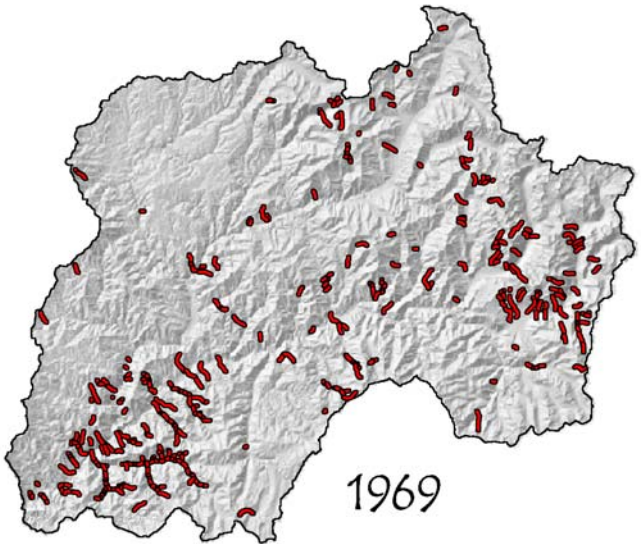
Applications

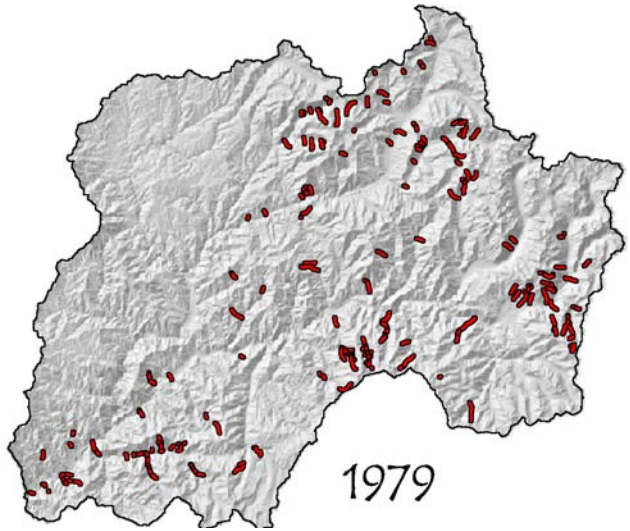
Research Question

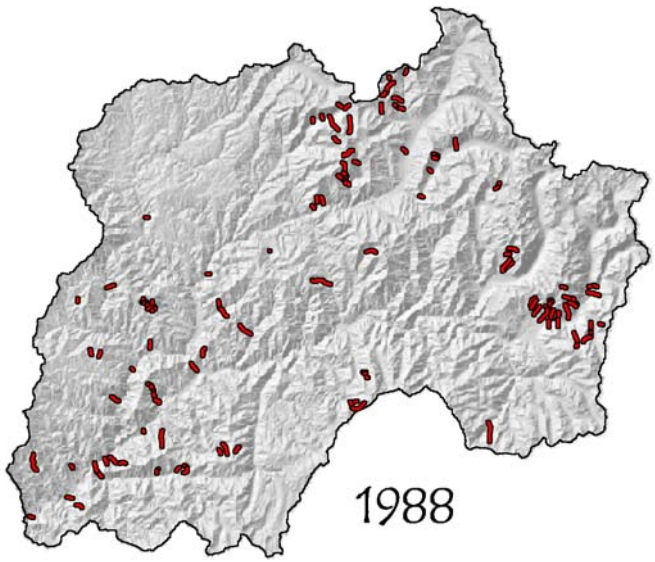
1) Where are the debris flows? How does their spatial distribution change over time and does this dynamic influence fish populations?

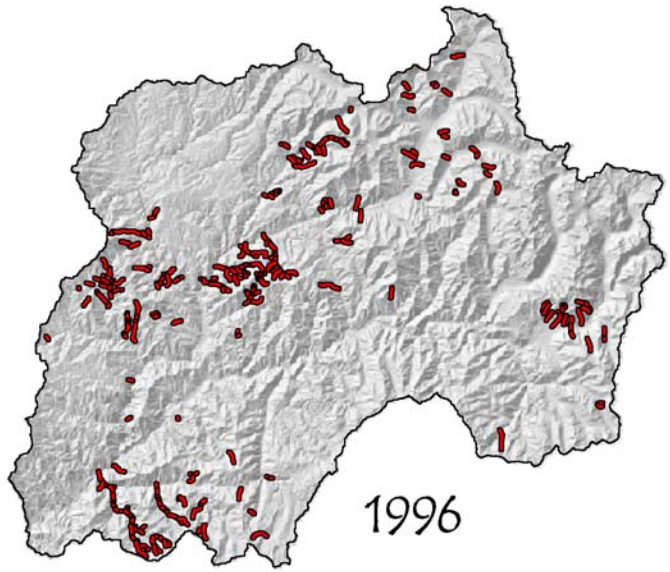


Inventory

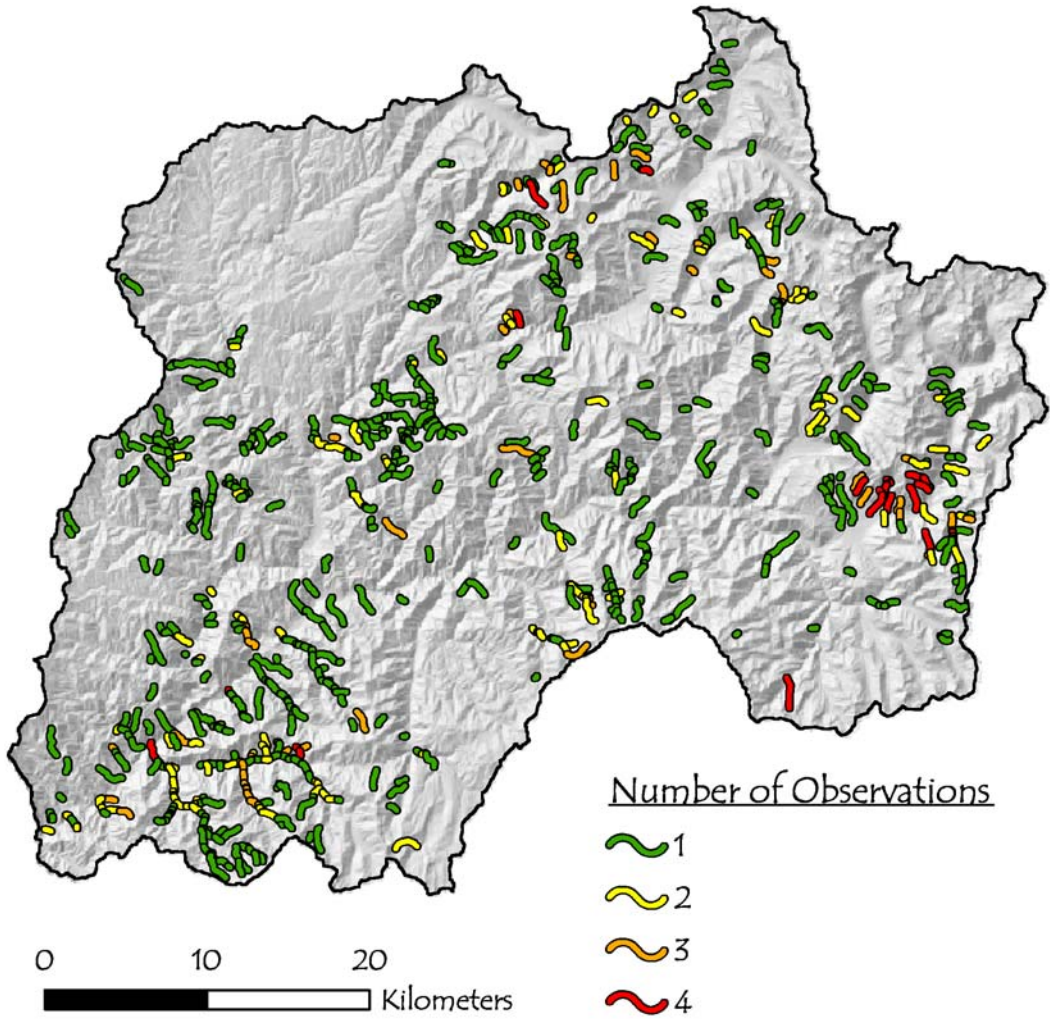




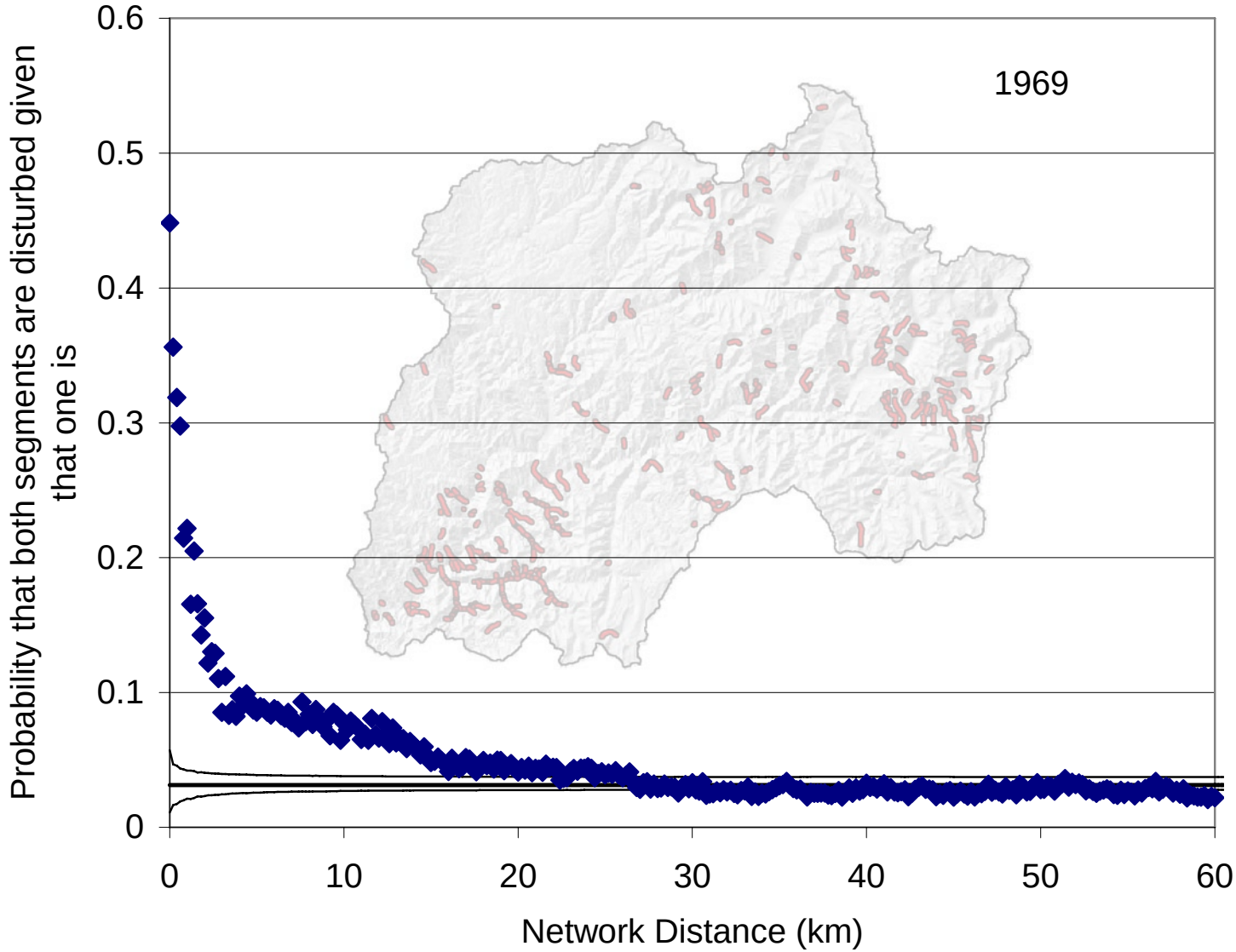




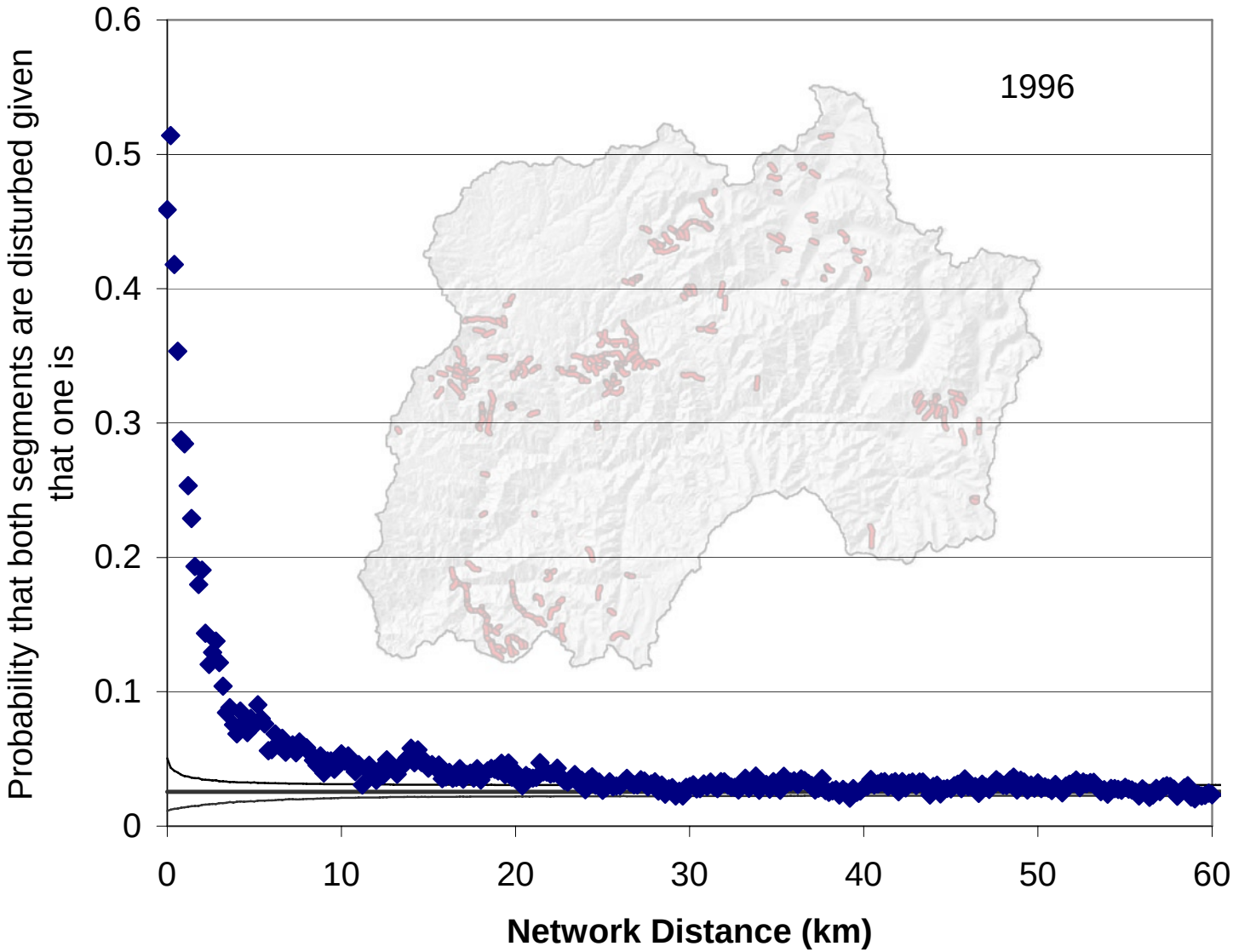
Recurrence of Debris Flows



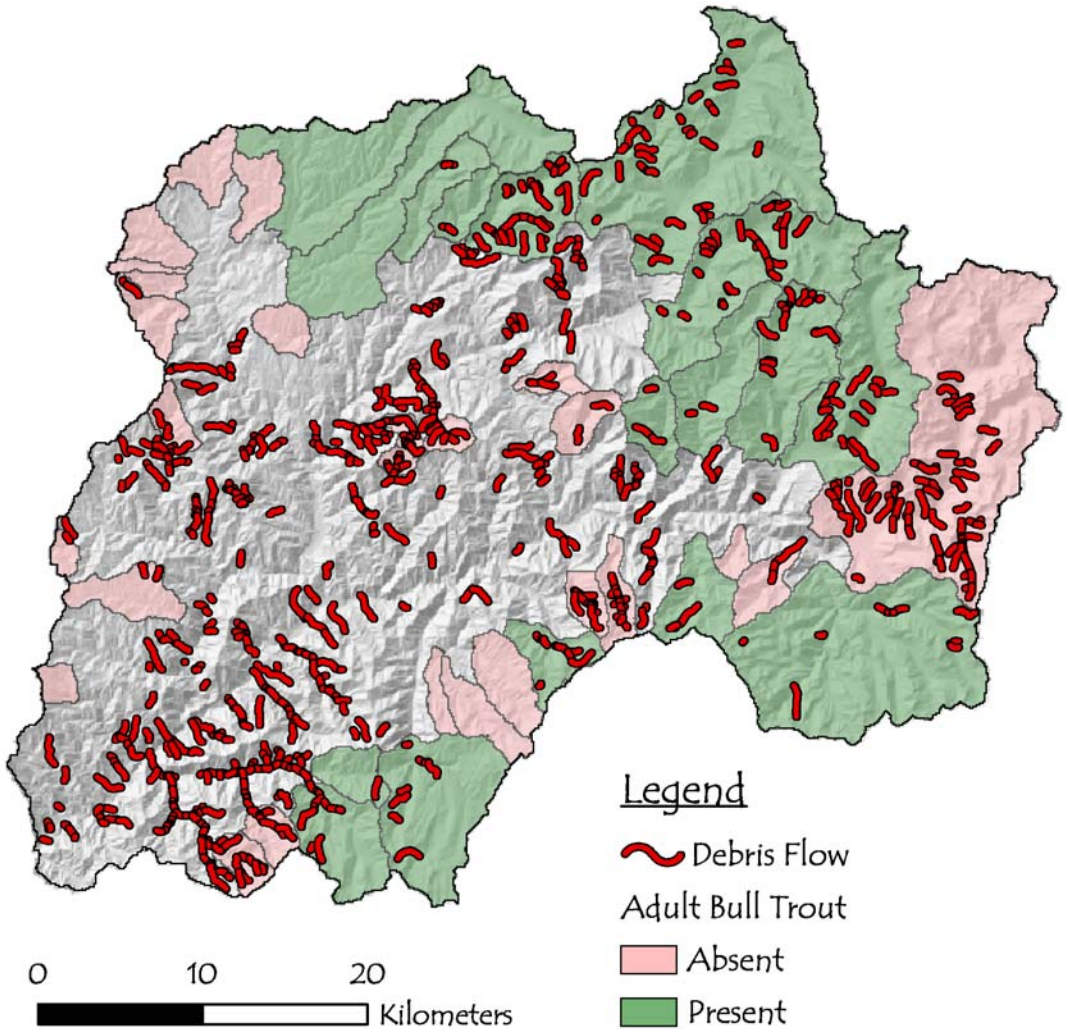
Spatial Correlation - 1969



Spatial Correlation - 1996

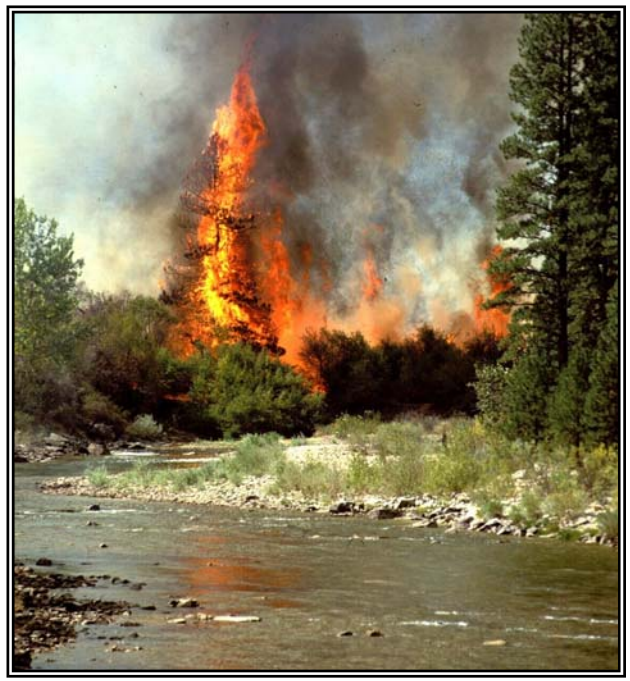


Bull Trout Patches

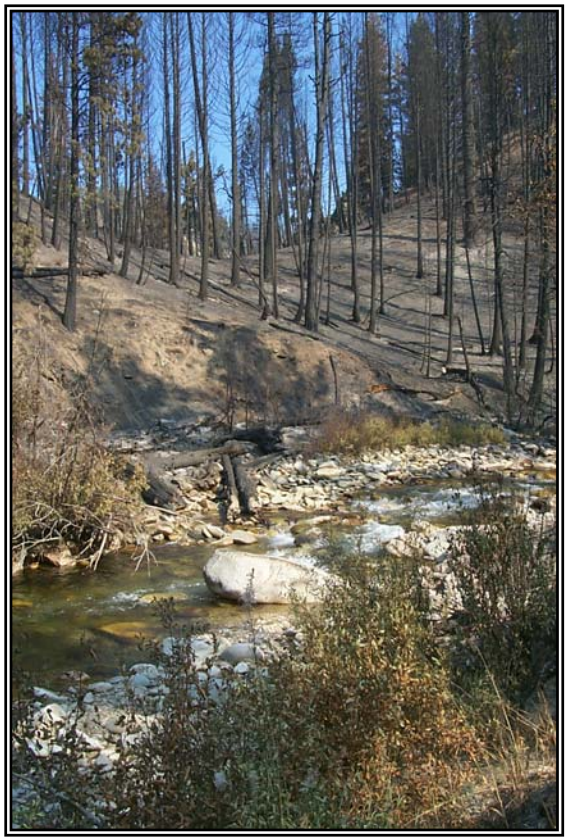


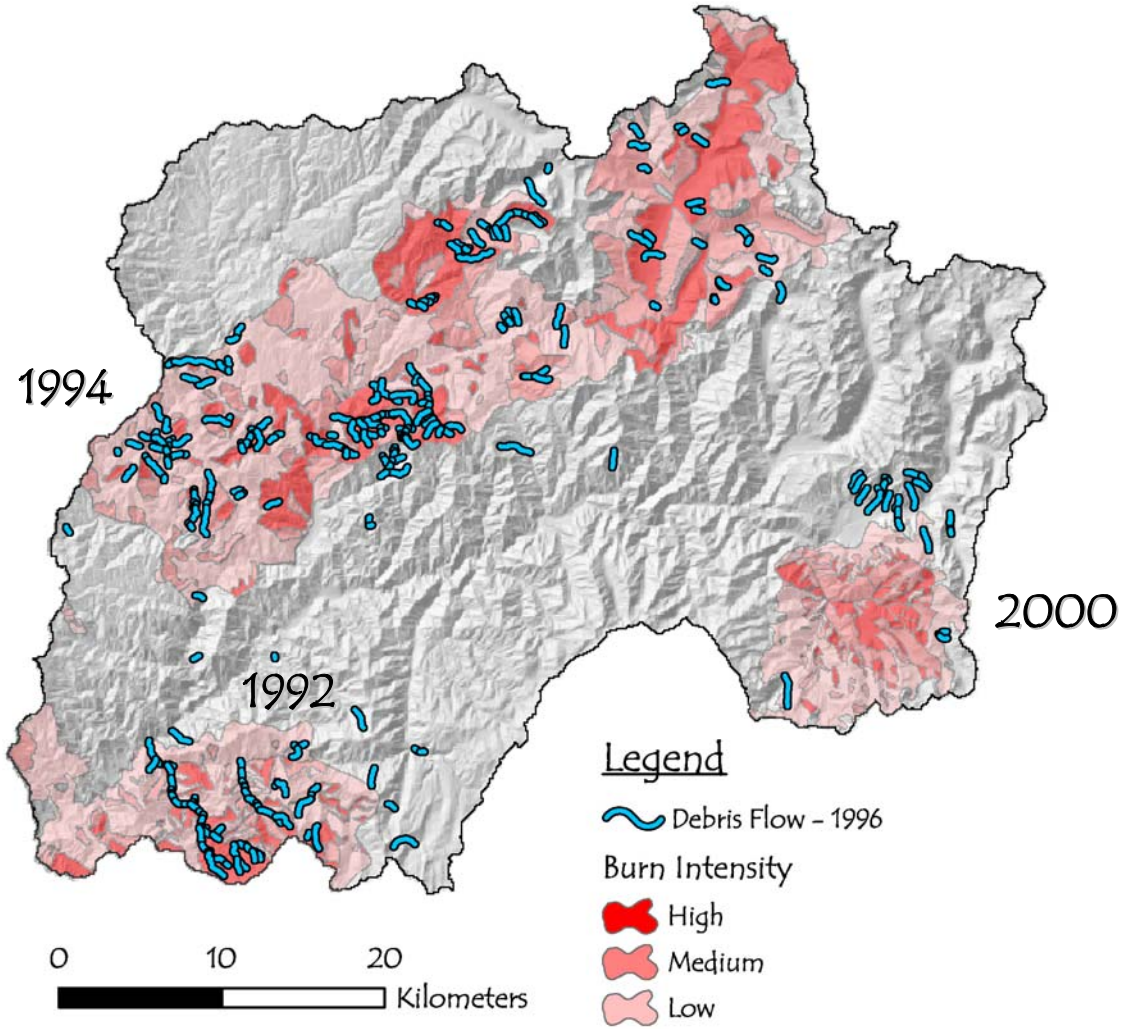
Research Question

2) Do fire and management activities influence debris flow occurrence?



Relationship to Fire

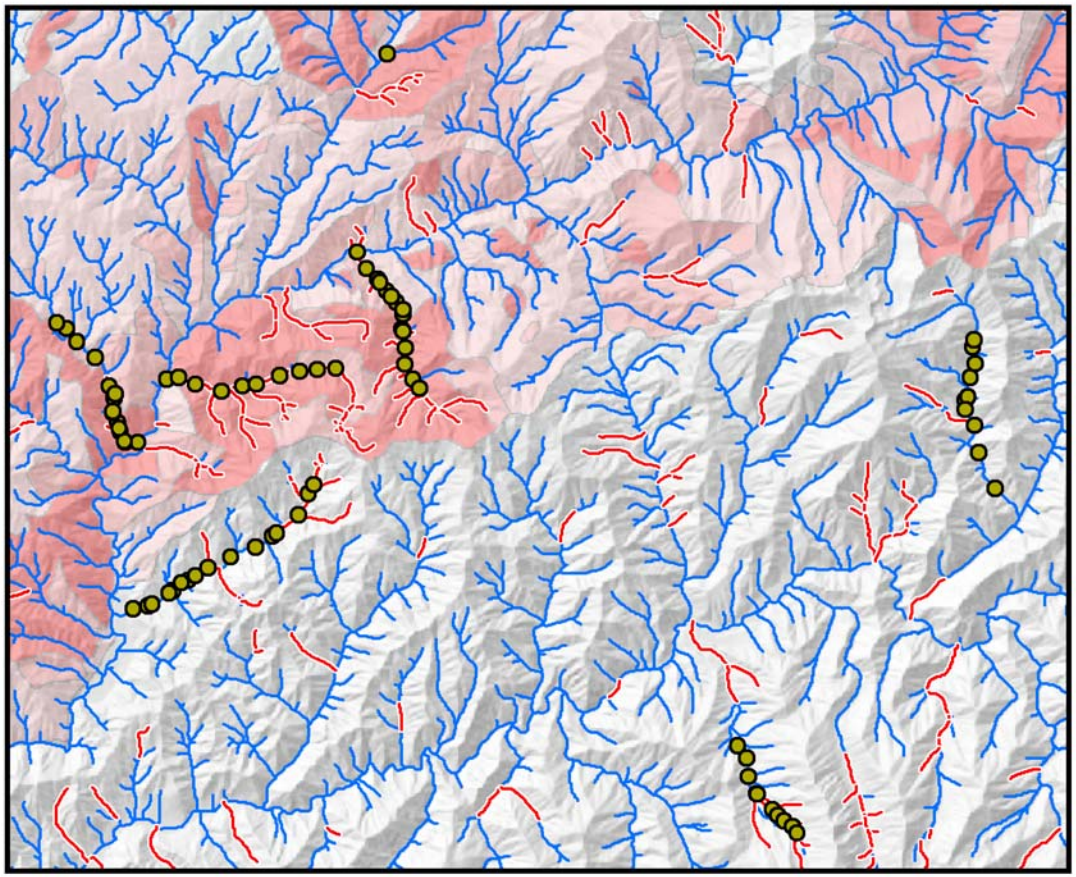




Research Question

3) How do debris flows and fire affect stream temperature?

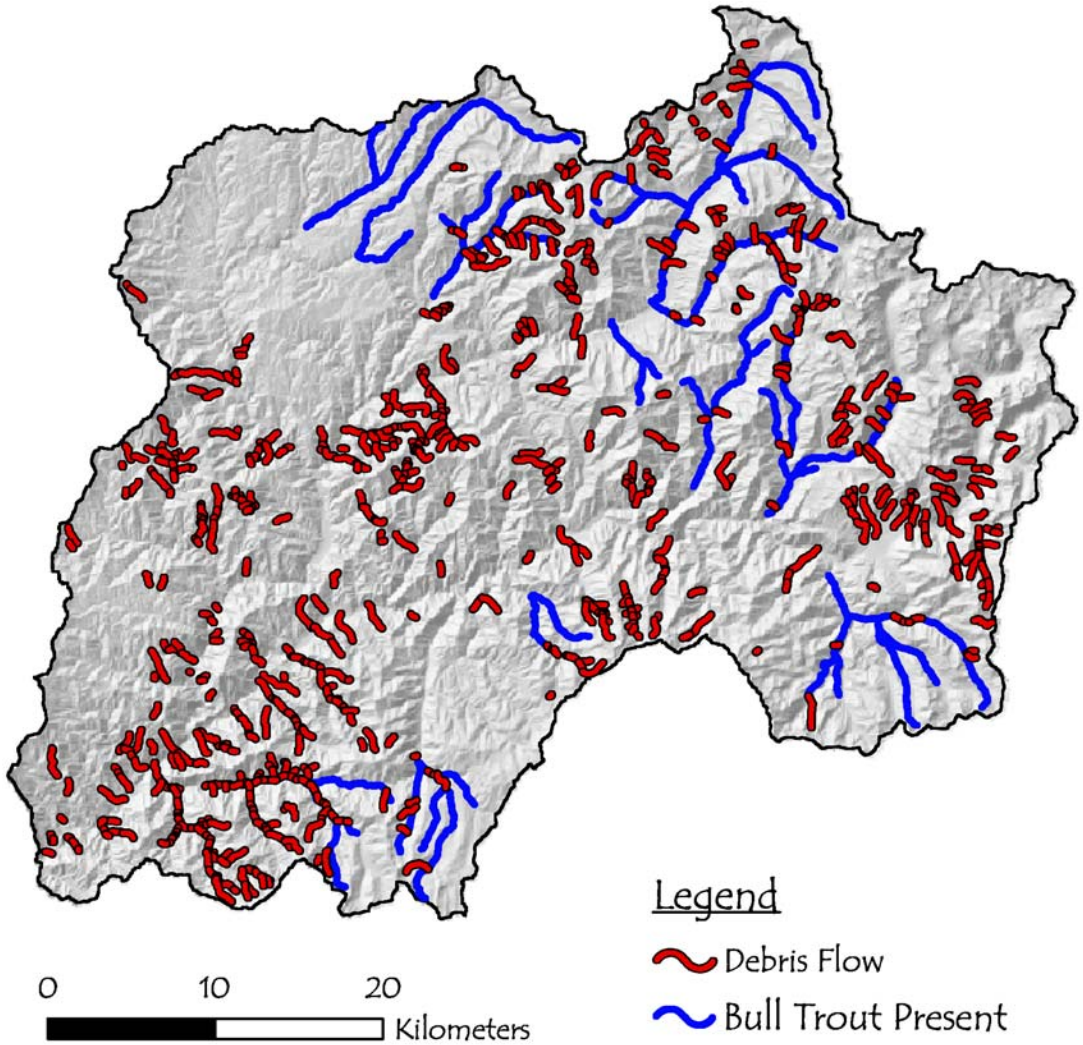
Stream Temperature



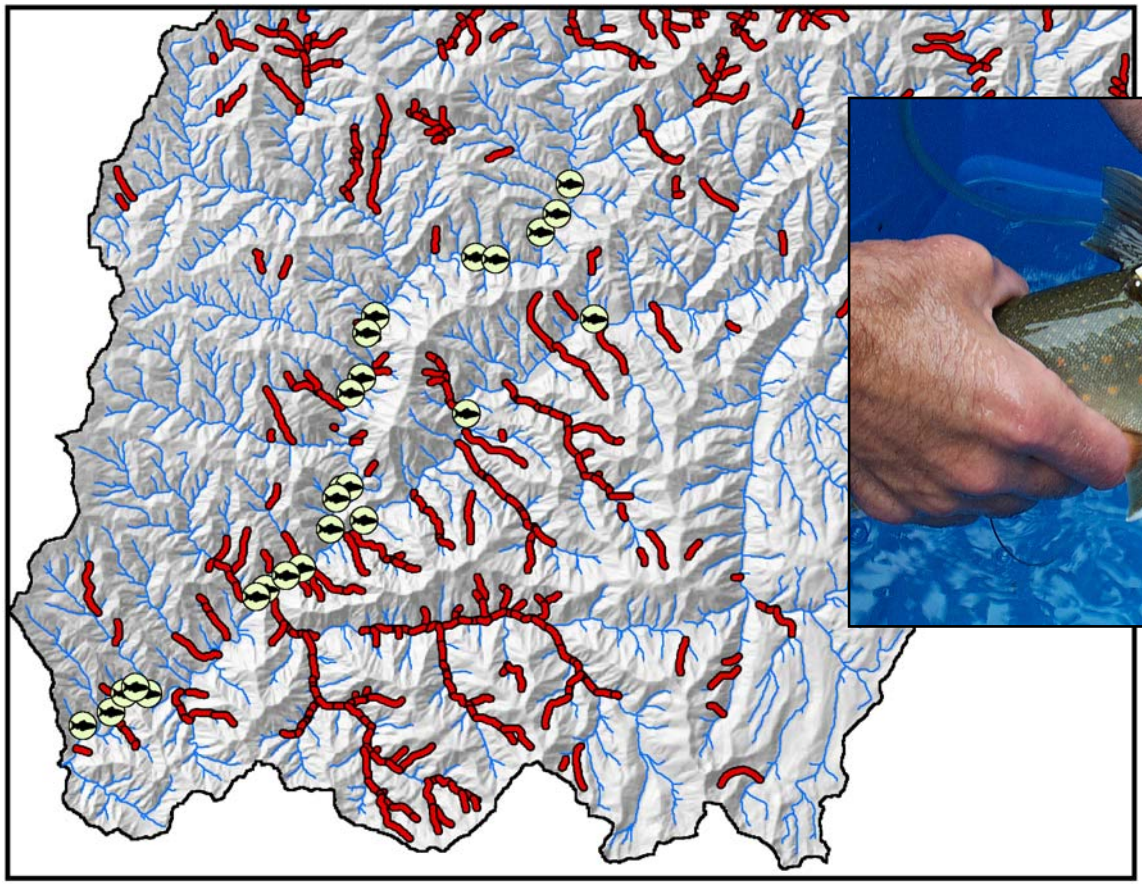
Research Question

4) Is there a relationship between debris flows and presence/absence of fish, such as bull trout?

Fish Occurrence and Debris Flows



Bureau of Reclamation Radio Tagged Fish



0 5 10 Kilometers

Legend

Debris Flow

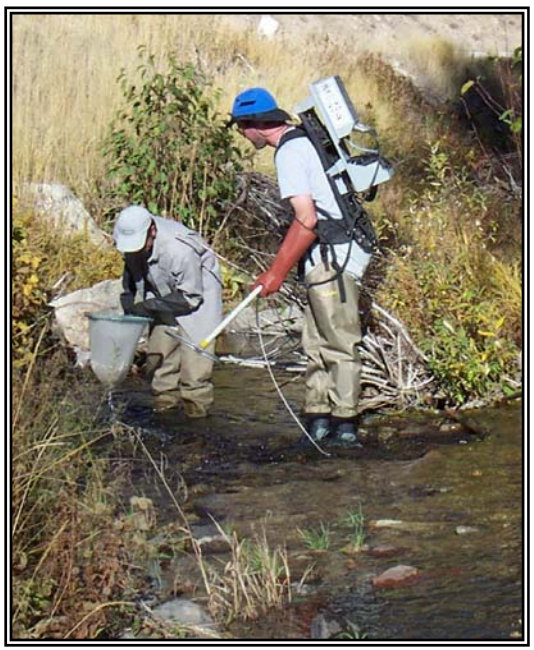
Bull Trout

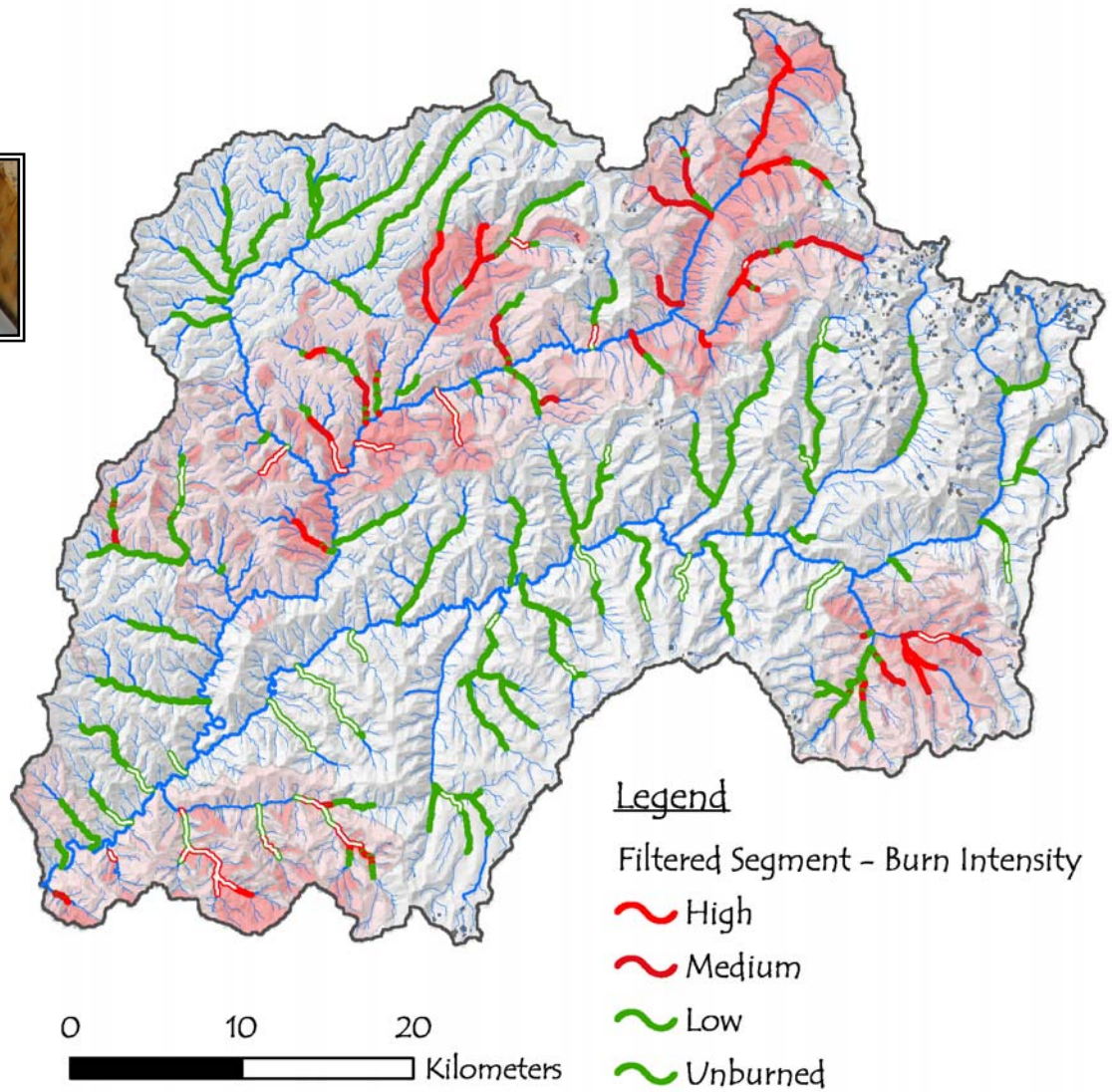
National Fire Plan

Burned

Unburned

Summer 2003 Sample Site Selection





Acknowledgements

RMRS Boise Lab

Joe Benjamin, Gwynne Chandler, Jason Dunham, Dona Horan, Jack King, Bryan Lanspery, Charlie Luce, Erin Morgan Bruce Rieman, and Sherry Wollrab

US Bureau of Reclamation

Tammy Salow