

# ***GEOLOGY***

## Physiographic Region

The Jacks Fork Watershed lies within the Salem Plateau Subdivision of the Ozark Plateau Physiographic Region. The Salem Plateau subdivision is a highly dissected plateau with upland elevations ranging from 1,000 to 1,400 feet above mean sea level (msl) and local relief ranging from 100 - 200 feet in the uplands to 200 - 500 feet elsewhere (MDNR 1986). Elevations within the Jacks Fork Watershed range from a maximum of approximately 1,600 feet msl in the uplands to approximately 580 feet at the confluence of the Jacks Fork and Current Rivers. Local relief data obtained from the Missouri Department of Conservation (MDC) Fisheries Research Fish Collection Database (1998a) indicate a minimum local relief of 316 feet and a maximum of 468 for Missouri Department of Conservation fish collection sites within the watershed.

## Soils

The Jacks Fork Watershed occurs within the Ozarks Soil Region. Allgood and Persinger (1979) describe the Ozark Soils Region as "cherty limestone ridges that break sharply to steep side slopes of narrow valleys. Loess occurs in a thin mantle or is absent. Soils formed in the residuum from cherty limestone or dolomite range from deep to shallow and contain a high percentage of chert in most places. Some of the soils formed in a thin mantle of loess are on the ridges and have fragipans, which restrict root penetration. Soil mostly formed under forest vegetation with native, mid-tall and tall grasses common in open or glade area."

The following is a list of soil associations found in the Jacks Fork Watershed:

Captina-Clarksville-Doniphan: "Nearly level to very steep, moderately well drained to excessively drained loamy upland soils that have fragipans or soils that are cherty throughout." (Allgood and Persinger 1979) Captina-Macedonia-Doniphan-Poynor: "Nearly level to very steep well drained and moderately well drained, loamy upland soils that have fragipans or soils that are cherty throughout." (Allgood and Persinger 1979) Hobson-Coulstone-Clarksville: "Gently sloping to very steep, moderately well drained to somewhat excessively drained, loamy soils with fragipans or soils that are cherty throughout. Lebanon-Hobson-Clarksville: "Gently sloping to very steep, moderately well drained to somewhat excessively drained, loamy and clayey soils with fragipans or soils that are cherty throughout." (Allgood and Persinger 1979) Wilderness-Clarksville-Coulstone: "Gently sloping to very steep, moderately well drained to excessively drained, loamy upland soils that have cherty subsoils or fragipans." (Allgood and Persinger 1979)

## Geology

The geology of the Jacks Fork Watershed consists primarily of dolomites and sandstone/dolomites of Ordovician age (Figure Ge01). A significant exposure of Cambrian Dolomite is present in the lower portion of the watershed as well as small exposures of Mississippian limestone and Precambrian igneous rock. The existence of the Precambrian igneous rock within the watershed is the result of the watershed's close proximity to St. Francois uplift. As is the case in most watersheds of the Ozarks, the geology of the Jacks Fork Watershed (primarily consisting of soluble rock formations of dolomites and sandstone dolomites), in combination with an average annual precipitation of over 40 inches has created a karst landscape within the watershed. This karst landscape is characterized, in part, by a close relationship

between the surface water and groundwater systems. Within karst landscapes, points or areas of surface water/ground water interaction include losing streams, sinkholes, and springs.

Losing streams are one manner in which surface water is transported or "lost" to the groundwater system. Within the Jacks Fork Watershed, 8 miles of streams have been designated as "losing" in the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality (Table Ge01 and Figure Ge02) (MDNR 1999a). Within MDNR 1999a, a losing stream is defined as "A stream which distributes 30% or more of its flow during low flow conditions through natural processes, such as through permeable geologic materials into a bedrock aquifer within two (2) miles' flow distance downstream of an existing or proposed discharge". Due to the specific nature of this definition, many streams within the watershed, which possibly lose large amounts of flow to the groundwater system, may have yet to be surveyed or classified as being "losing" in the broader sense of the word. Further study may be needed in order to develop a comprehensive understanding of the role of losing streams within the watershed.

In addition to losing streams, sinkholes provide another point of surface to groundwater interaction. Based on information presented in Adamski et al. (1995), sinkhole densities within the Jacks Fork Watershed range from approximately 10 per 100 square miles in the middle one-third of the watershed to less than 1 per 100 square miles in most of the western one-third of the watershed with the eastern third having a density of 1 to 10 sinkholes per 100 square miles.

A limited number of dye traces were performed in the watershed by the USFS and the MDNR between 1972 and 1982 (Figure Ge02) (MDNR 1996a). These traces showed the general southeast movement of groundwater within the Jacks Fork Watershed. The longest of these traces was from Jam Up Creek to Big Spring (Current River Watershed), a distance of 37.7 miles. These traces indicated that the watershed not only lost ground water to the main Current River watershed, but also received ground water from the Current River Watershed. Additional dye traces are needed to further determine groundwater movement in the watershed.

Springs are the naturally occurring outlets of groundwater systems. Spring flow accounts, to a large extent, for the higher sustained flows of many Ozark streams relative to streams in other regions of Missouri. Likewise, stream flow within the Jacks Fork Watershed, is also enhanced by springs. Within the Jacks Fork Watershed there are 48 springs (1 per 9.3 square miles of watershed area) as determined from USGS 7.5 minute topographical maps and Vineyard and Feder (1974) (Figure Ge01). This seems to be a relatively low figure in comparison to the the North Fork Watershed which has a spring density of 20 springs per square mile. Preliminary results of surveys conducted within National Park Service boundaries in the watershed indicate that significantly more springs exist within the watershed than those displayed on USGS 7.5 minute maps (Gossett, personal communication). Vineyard and Feder (1974) list discharges for 9 springs within the watershed (Table Ge02). Four of these springs have discharges exceeding 1 cubic feet per second (cfs) (Vineyard and Feder 1974). The largest spring within the watershed is Alley Spring which has an average flow of approximately 125 cfs. Discharge data is needed for the remaining springs within the watershed in order to better quantify groundwater influence within the watershed.

### Stream Order, Mileage, and Permanency

Stream order is "a hierarchy in which stream segments are arranged" (Judson et al. 1987)

The process of stream ordering is accomplished by examining maps and assigning orders to stream segments based on other streams which flow into them. When two stream segments of the same order join, the new segment they create is the next highest order. For instance, a first order stream would be a stream in which no other streams intersect it. A second order stream is created by the joining of two first order streams. A third order stream is created by the joining of two second order streams and so on. If the main channel of a stream happens to be a lower order than that of the intersecting stream, the main channel assumes the higher order. If the main channel is a higher order stream than the intersecting stream, it maintains the higher order (Figure Ge03). Two types of order are discussed within this document: Horton order which is the maximum order of a stream at its mouth; and Strahler order which is the immediate order of a stream at any given segment of its length. For instance the Strahler order of No Name Creek at point A in Figure Ge02 is second order while the Horton Order for the main channel designated as No Name Creek is third order.

Horton orders for streams within the Jacks Fork Watershed have been obtained from a 1:24,000 scale Geographic Information System (GIS) hydrography coverage. There are 44 third order and larger streams within the watershed (Table Ge03 and Figures Ge04 and Ge05). These streams account for a total of approximately 311 stream miles or 26% of the total stream miles within the watershed. Of the 44 third order and larger streams within the watershed, 33 are third order (161.5 miles), 7 are fourth order (53.1 miles), and 3 are fifth order (46.8 miles). The Jacks Fork River is 49.1 miles long and becomes sixth order at the confluence of the North Prong and the South Prong of the Jacks Fork.

Stream mileage per order (Strahler) for the Jacks Fork Watershed has been obtained from a 1:24,000 scale GIS hydrography coverage. Of a total of 1,189 miles of stream within the watershed, approximately 749 miles (63%) are first order segments; 219 miles (18%) are second order; 114 miles (10%) are third order; 39 miles (3%) are fourth order; 21 miles (2%) are fifth order; and 49 miles (4%) are sixth order. Table Ge04 lists length by order for fourth order and larger streams within the Jacks Fork Watershed.

Permanent stream mileage data obtained from a 1:24,000 scale GIS hydrography coverage for the Jacks Fork Watershed indicates that approximately 152 stream miles (13%) within the watershed have permanent water. This equals approximately 1 mile of permanent stream for every 2.9 square miles of drainage area. Lengths of permanent stream by Strahler Order are as follows: first order-6 miles (<1% of all first order miles); second order-11 miles (5%); third order-33 miles (29%); fourth order-32 miles (82%); fifth order- 21 miles (98%); sixth order-49 miles (100%). Table Ge01 lists estimated permanent stream mileage for third order and larger streams within the watershed.

### Drainage Area

The drainage area of the Jacks Fork Watershed is 284,454 acres or 445 square miles. In order to facilitate analysis of watershed characteristics the watershed was divided into 12 units, hence forth referred to as drainage units, based on modified fourteen digit hydrologic units (Figure Ge06). The largest of these drainage units is the North Prong of the Jacks Fork which drains approximately 58.7 square miles (37,568 acres).

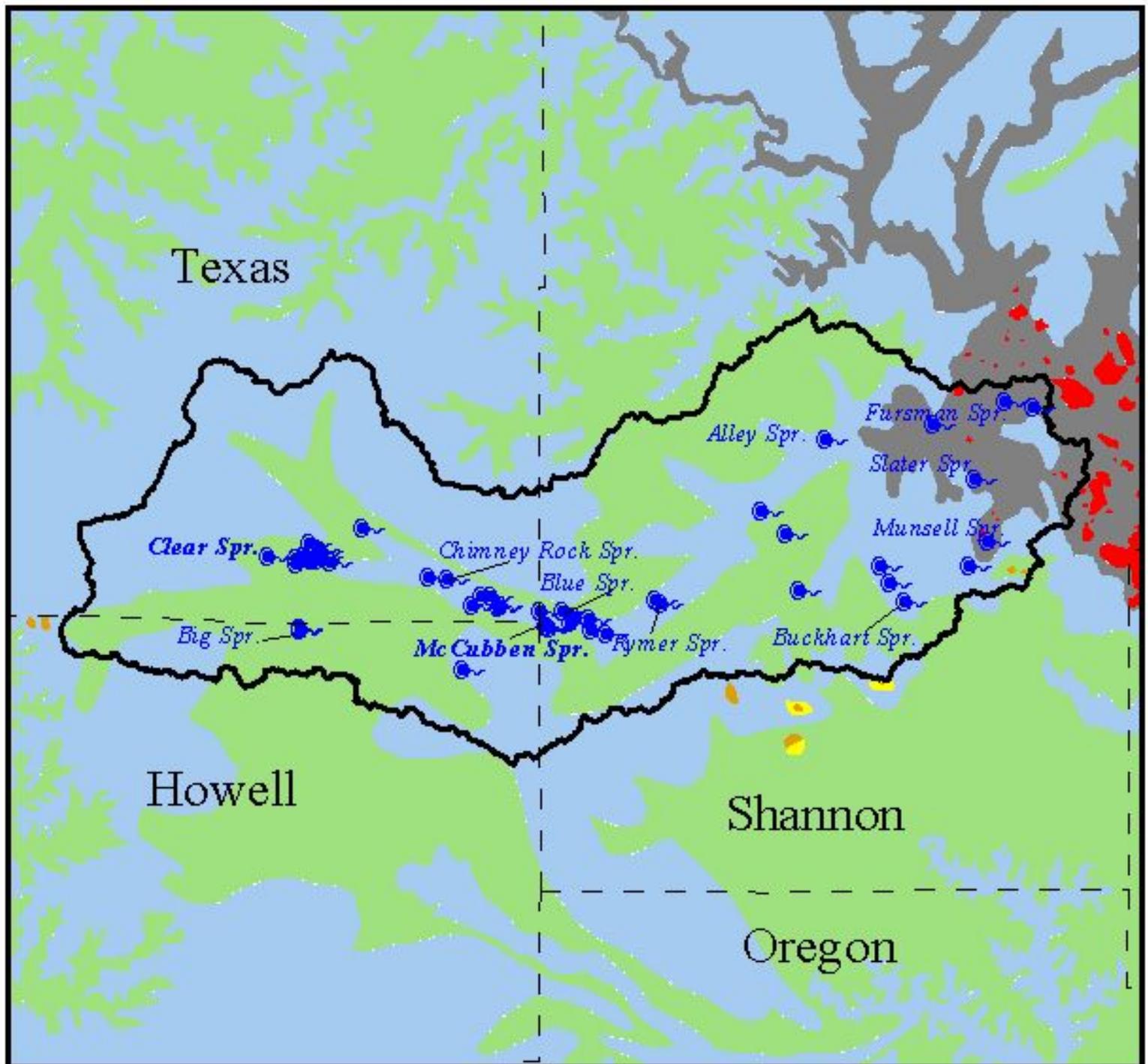
### Stream Channel Gradient

Stream channel gradient is important for the assessment of problems associated with channel degradation and aggradation, inter and intrawatershed comparisons, selection of fish community and habitat sampling sites, as well as understanding fish community distribution patterns. Channel gradient has been

determined using data digitized from USGS 7.5 minute topographic maps for all fourth order and larger streams within the Jacks Fork Watershed. Composite gradient graphs have been constructed for all fifth order and larger streams within the watershed (Figures Ge07, Ge08, Ge09, and Ge10). Average gradients as well as gradient by Strahler order for all fourth order (Horton) and larger streams are given in Table Ge05. The Jacks Fork River has an average gradient of 7.1 feet/mile. The primary reason for such a relatively low gradient in comparison to other larger Ozark streams is due to the fact that the mainstem of the Jacks Fork splits into the North and South Prongs. Thus the calculation of average gradient does not include the higher values which would be reflected if the mainstem included headwater stream segments.

Figure Ge01.

# Jacks Fork Watershed Geology & Springs



5 0 5 10 Miles

## Legend

 Watershed Boundary

NT

 **County Boundary**

 **Spring** (Based on USGS 7.5 min. Topographical Maps.  
Unnamed springs included.)

**Geology\***

-  Cambrian Dolomite
-  Mississippian Limestone
-  Mississippian Limestone/Sandstone
-  Ordovician Dolomite
-  Ordovician Sandstone/Dolomite
-  Precambrian Y Igneous

\*Based on digitized version of 1979 1:500,000  
scale state geologic map (Missouri Spatial Data  
Information Service-MSDIS 1998).

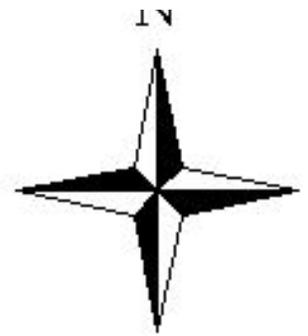
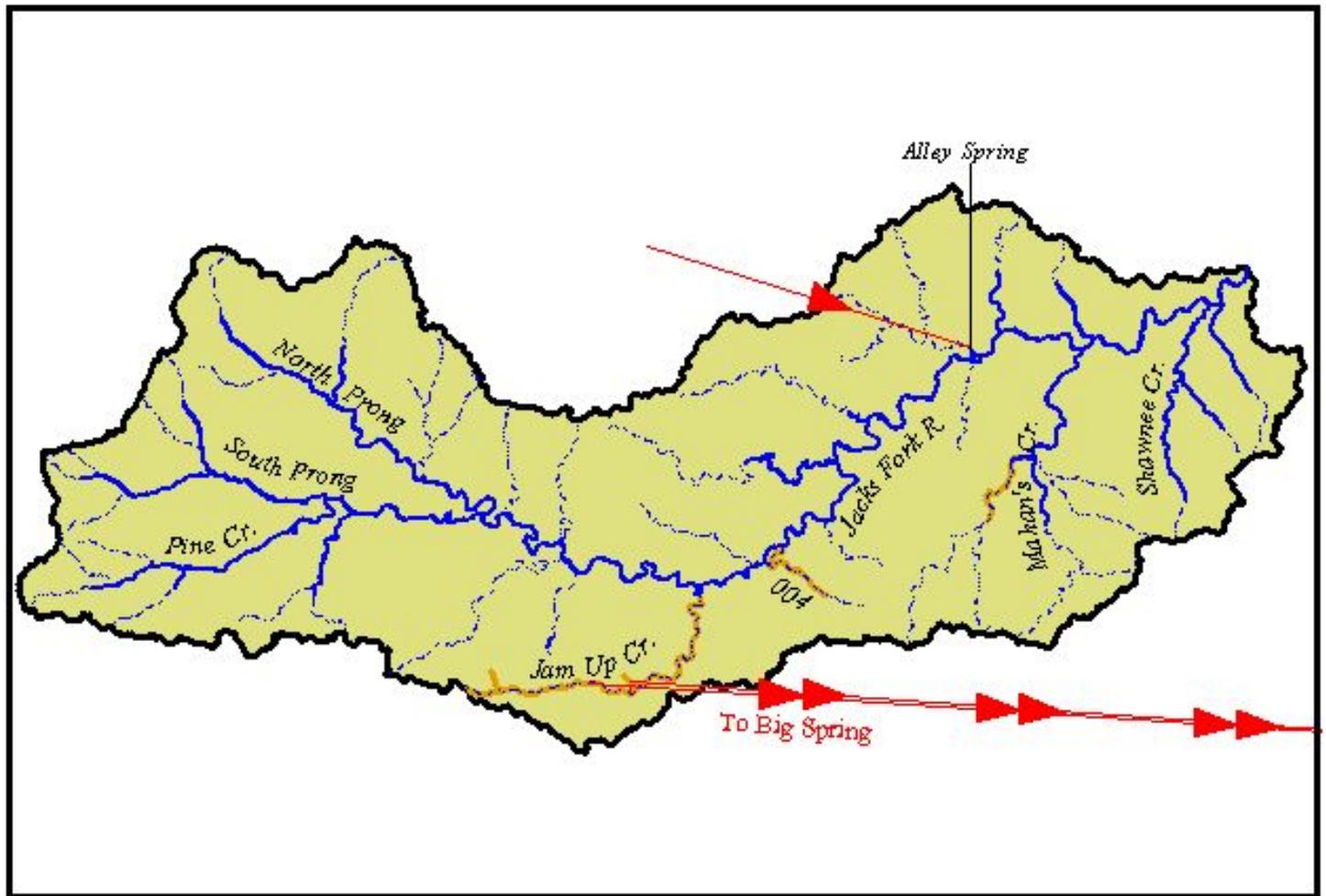


Figure Ge02.

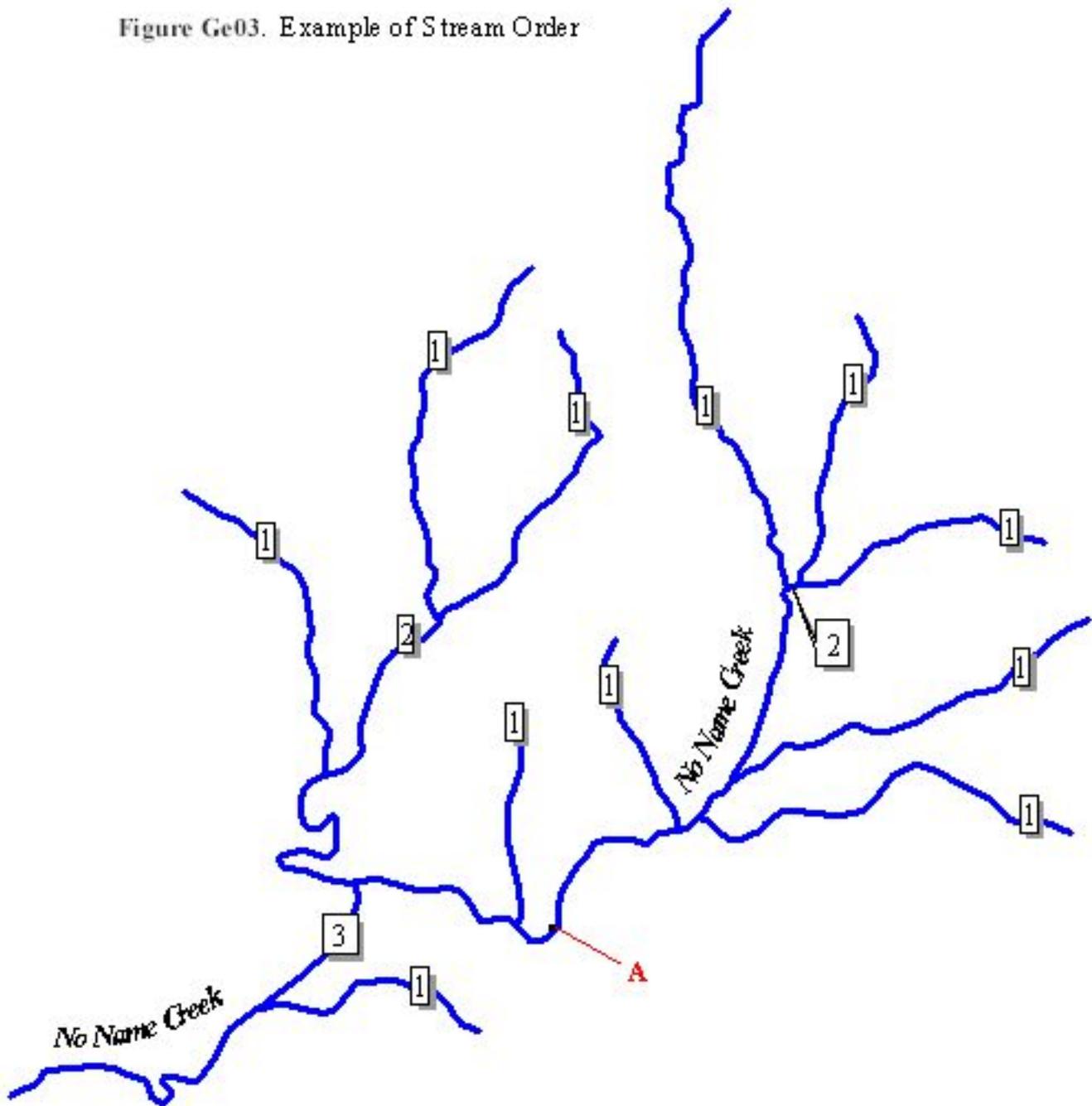
# Jacks Fork Watershed Ground Water Transport



4 0 4 Miles



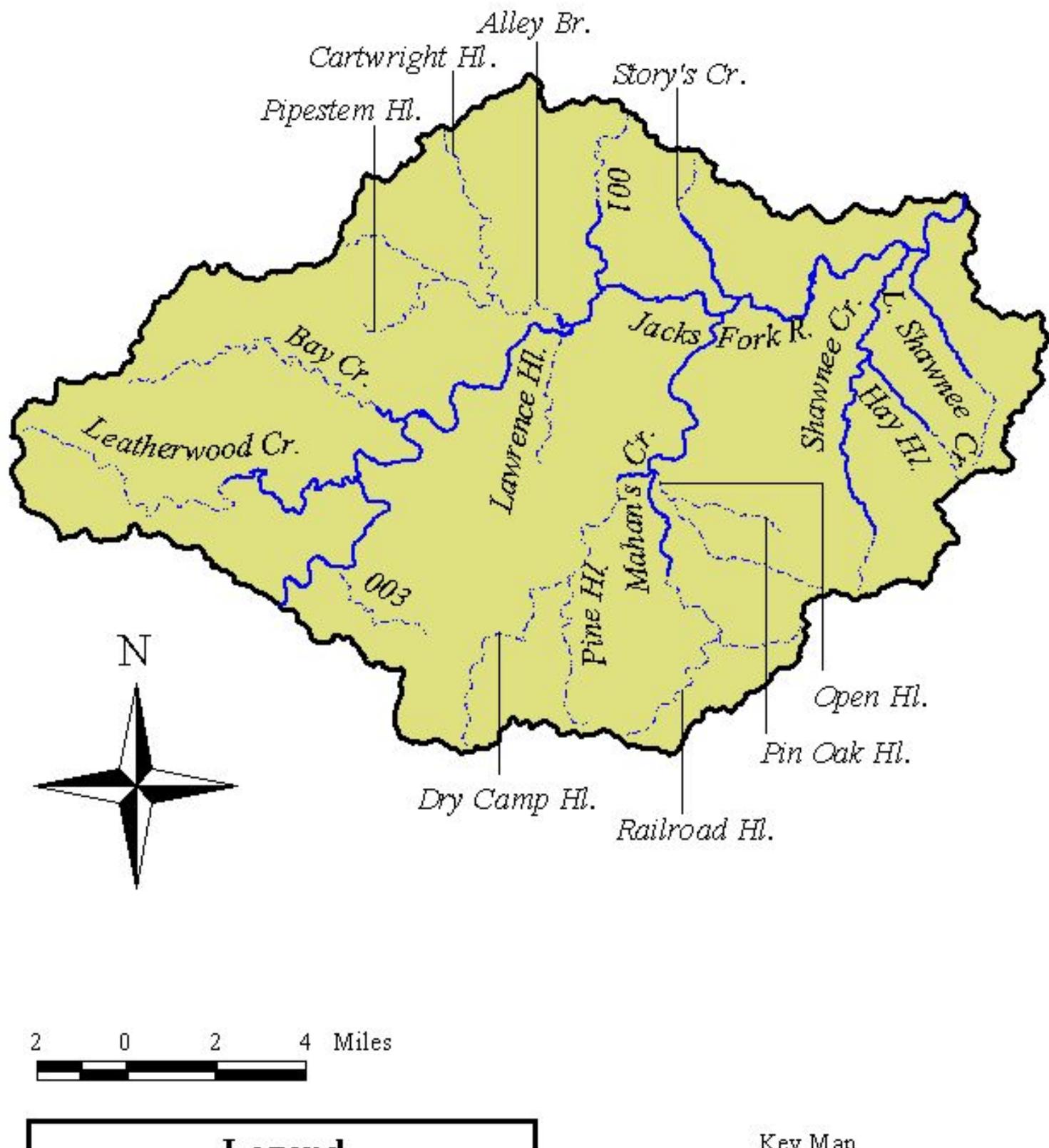
Figure Ge03. Example of Stream Order



The stream segment at Point A has a Horton order of 3 and a Strahler order of 2.

Figure Ge04.

# Lower Jacks Fork Third Order (Horton) and Larger Streams



## Legend



Permanent Stream\*



Intermittent Stream\*

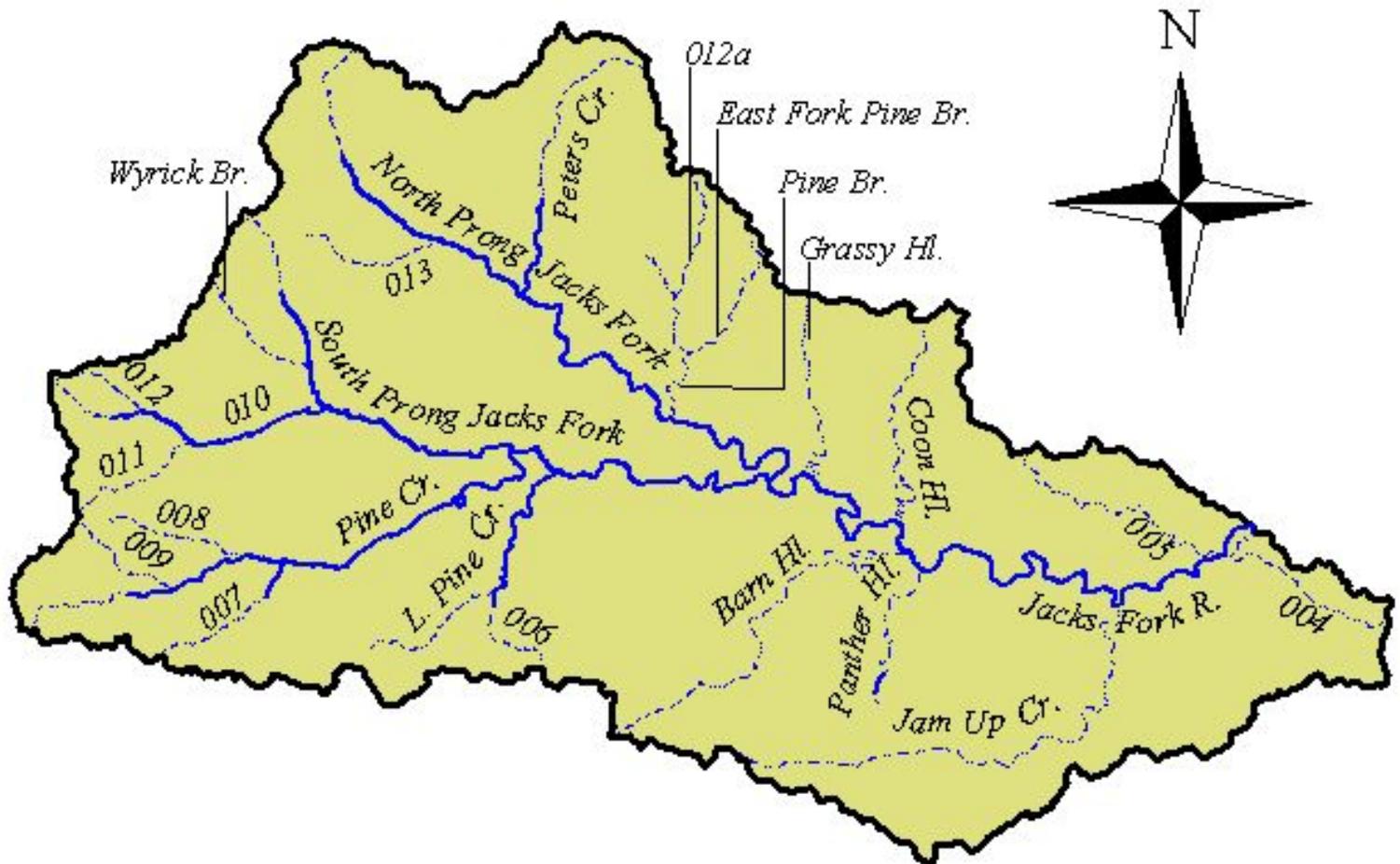
\* Based on 1:24,000 GIS State Hydrography Layer.



Figure Ge05.

# Upper Jacks Fork

## Third Order (Horton) and Larger Streams



2 0 2 4 Miles



### Legend

-  Permanent Stream\*
-  Intermittent Stream\*

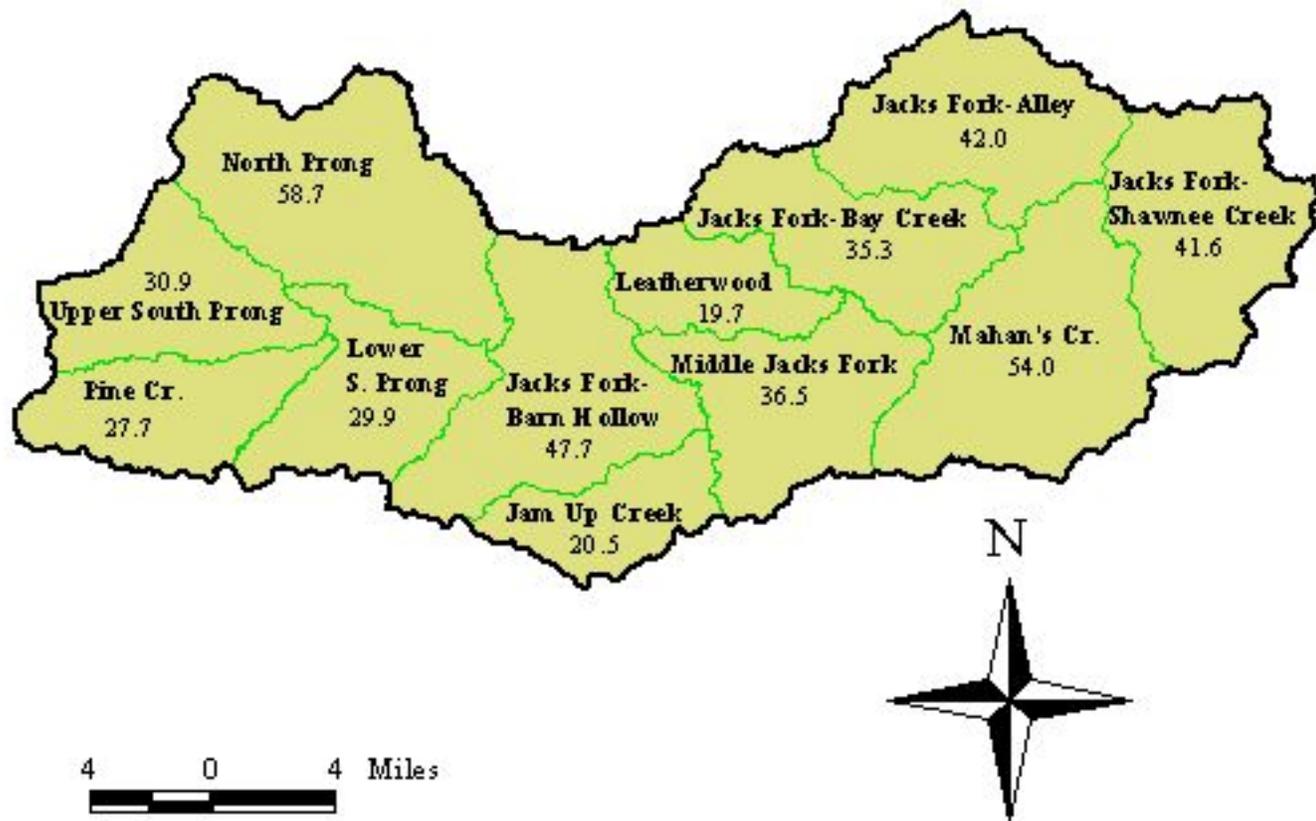
\* Based on 1:24,000 GIS State Hydrography Layer.

Key Map



Figure Ge06.

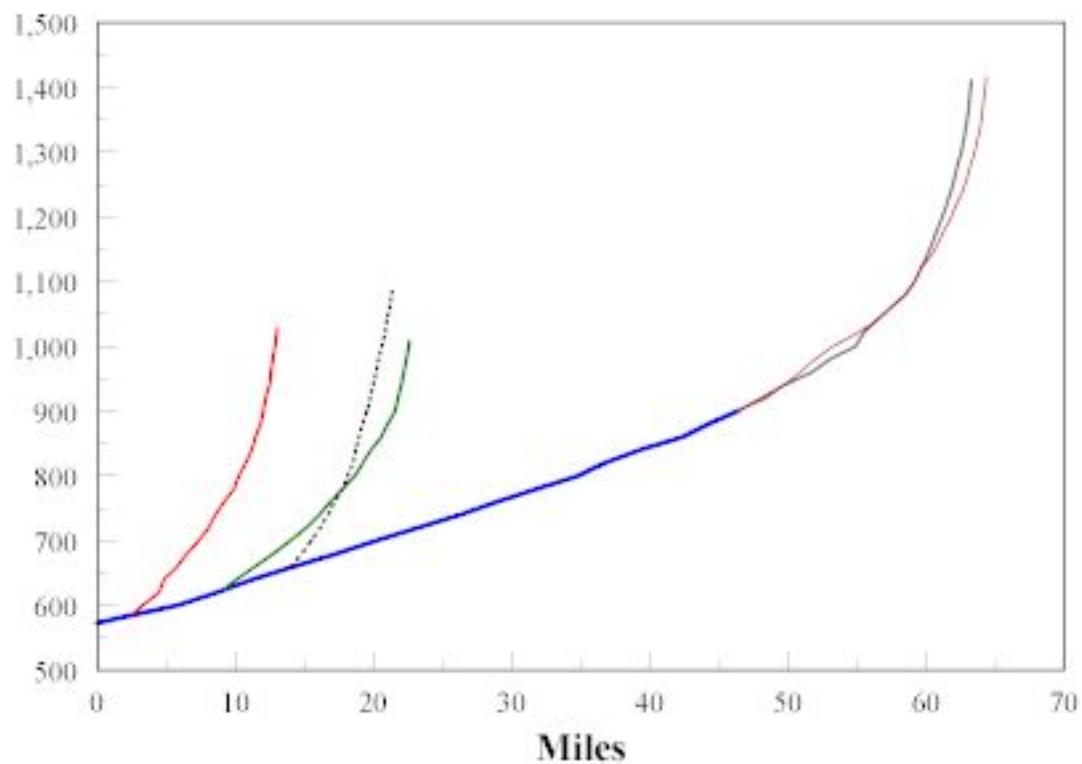
# Jacks Fork Watershed Drainage Units



Drainage units based on modified 14 digit hydrologic units.  
Watershed areas given in square miles.

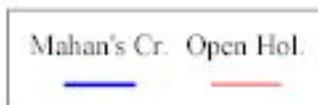
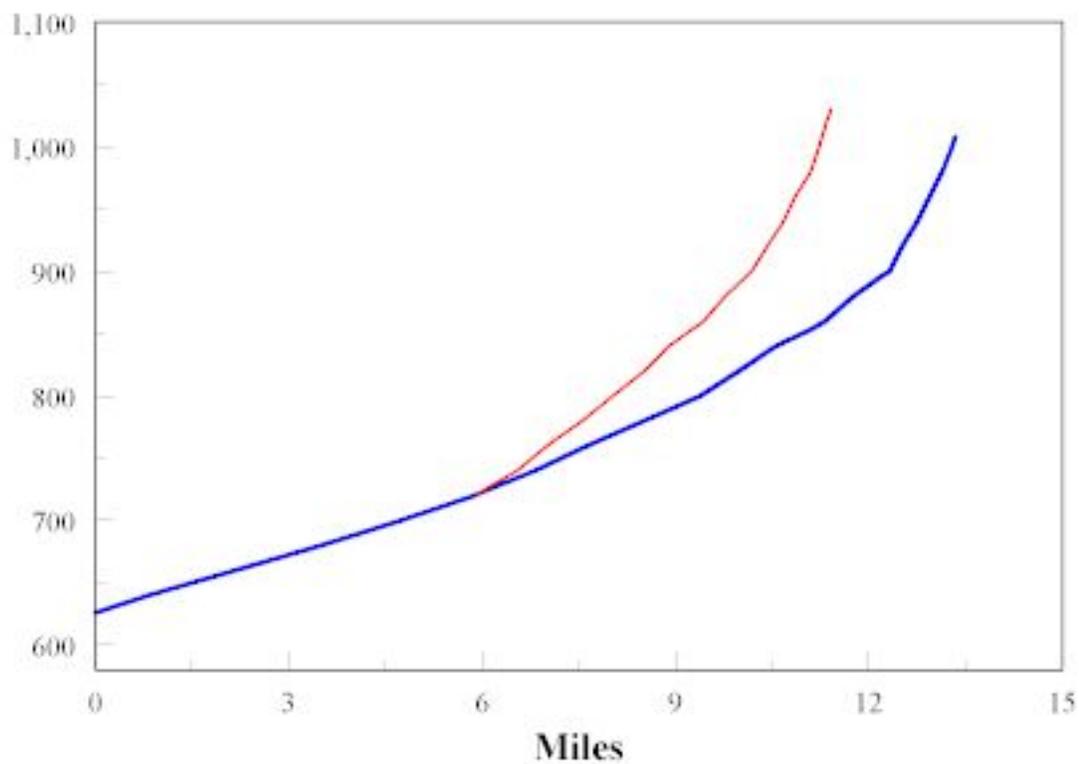
# Gradient Plot for Jacks Fork River & Major Tributaries

Elevation (feet)



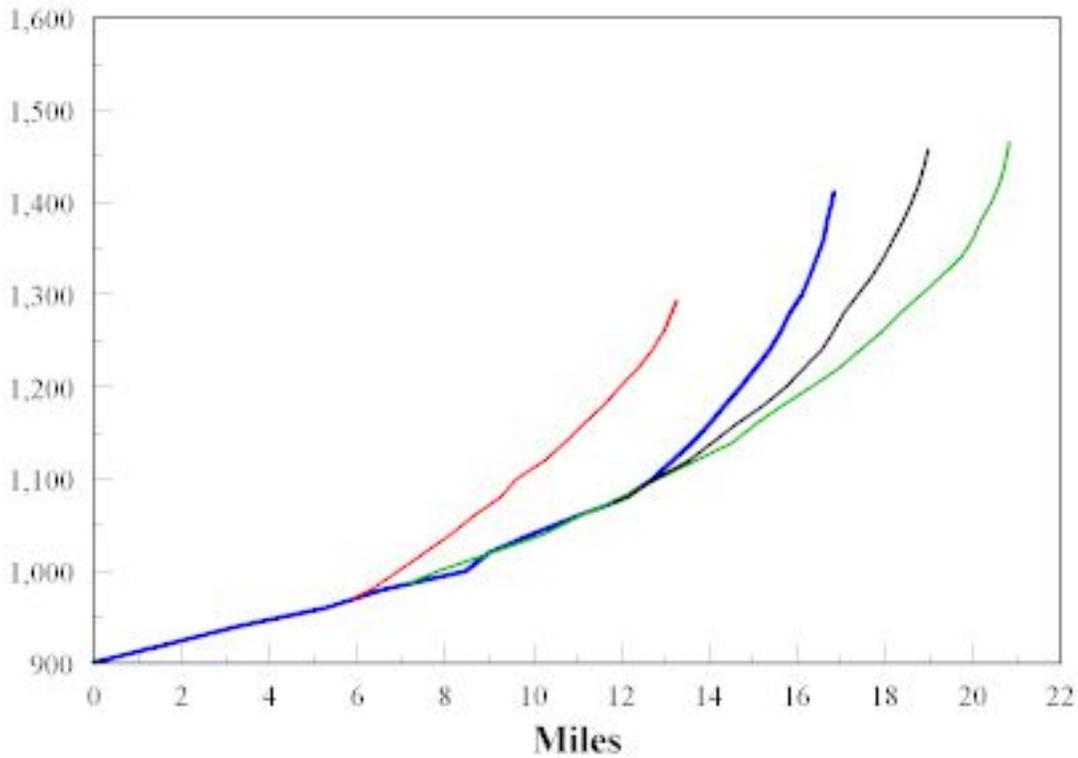
## Gradient Plot for Mahan's Creek & Major Tributary

Elevation (feet)



# Gradient Plot for South Prong Jacks Fork & Major Tributaries

Elevation (feet)



# Gradient Plot for North Prong Jacks Fork & Major Tributary

Elevation (feet)

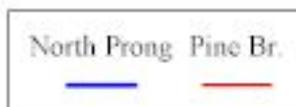
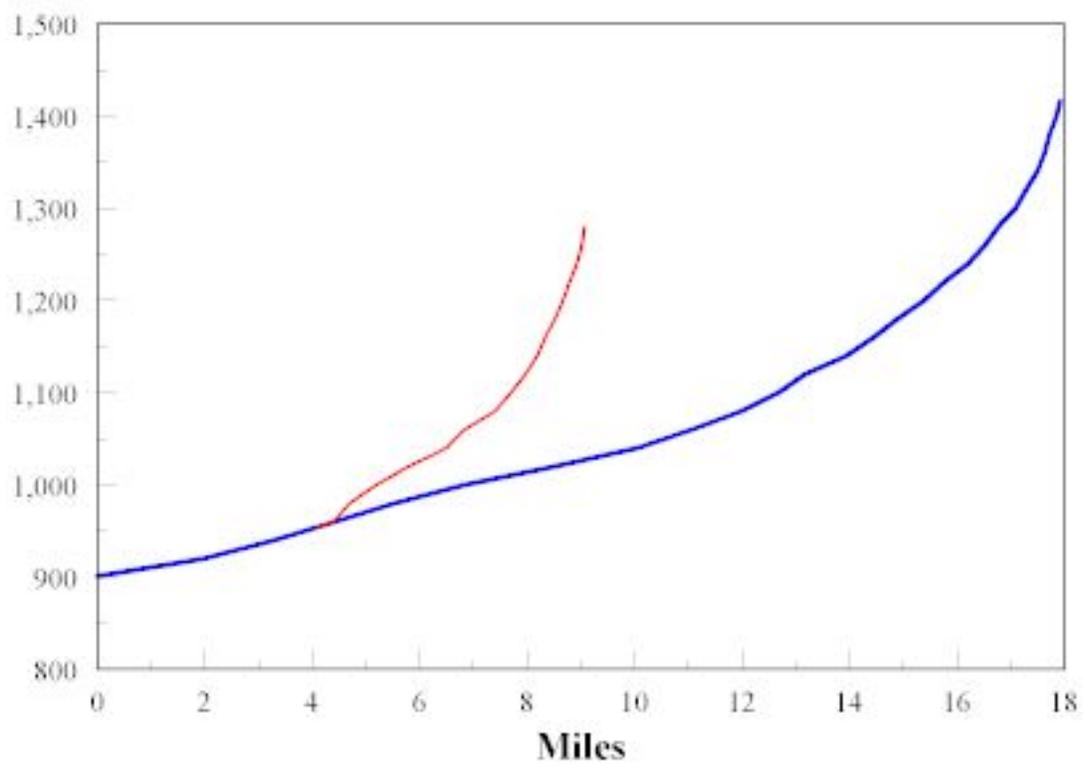


Table Ge01. Jacks Fork Watershed stream reaches designated as losing in Table J Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7- Water Quality. Code of State Regulations (MDNR 1999a).

Stream	Miles	From	To
<b>Jam Up Creek</b>	5.0	SW,NE,SE,22,27N,07W	NW,SE,SE,04,27N,06W
<b>Johnny Hollow</b>	1.0	SW,NE,SE,06,27N,05W	SW,NW,SE,36,28N,06W
<b>Pine Hollow</b>	2.0	SW,NW,NW,30,28N,04W	NE,NW,NE,17,28N,04W

Note: This table is not a final authority.

Table Ge02. Location and discharge (in cubic feet per second) of selected springs in the Jacks Fork Watershed (Vineyard and Feder 1974).

<b>Name</b>	<b>County</b>	<b>USGS 7.5' Quad. Name</b>	<b>Discharge (cfs)</b>
<b>Alley Spring</b>	Shannon	Alley Spring	125.00
<b>Big Spring</b>	Howell	Clear Spring	1.41
<b>Blue Spring</b>	Shannon	Pine Crest	7.70
<b>Clear Spring</b>	Texas	Clear Spring	1.41
<b>McCubben Spring</b>	Shannon	Clear Spring	0.88
<b>Rymer Spring</b>	Shannon	Jam Up Cave	0.36
<b>Slater Spring</b>	Shannon	Eminence	0.11
<b>Unnamed</b>	Texas	Pine Crest	0.06
<b>Unnamed</b>	Texas	Pine Crest	0.01

Table Ge03. Third order (Horton) and larger streams of the Jacks Fork Watershed.

Stream Name	Order	USGS 7.5' Quad at Stream Mouth	Name and Order Receiving Stream	Length	
				P	T
<b>Jacks Fork R.</b>	6	Eminence, MO	Current R.-7	49.1	49.1
<b>Little Shawnee Cr.</b>	3	Eminence, MO	Jacks Fork R.-6	3.8	6.0
<b>Shawnee Cr.</b>	4	Eminence, MO	Jacks Fork R.-6	8.5	9.9
<b>Hay Hol.</b>	3	Eminence, MO	Shawnee Cr.-4	2.6	3.9
<b>Story's Cr.</b>	3	Eminence, MO	Jacks Fork R.-6	2.7	4.1
<b>Mahan's Cr.</b>	5	Alley Spring, MO	Jacks Fork R.-6	8.7	13.2
<b>Pine Hol.</b>	3	Bartlett, MO	Mahan's Cr.-5	0.9	8.1
<b>Dry Camp Hol.</b>	3	Bartlett, MO	Pine Hol.- 3	0.0	6.0
<b>Open Hol.</b>	4	Bartlett, MO	Mahan's Cr.-5	0.0	5.2
<b>Pin Oak Hol.</b>	3	Bartlett, MO	Open Hol.-4	0.0	2.8
<b>Railroad Hol.</b>	3	Bartlett, MO	Mahan's Cr.-4	0.0	4.0
<b>JFW001</b>	3	Alley Spring, MO	Jacks Fork R.-6	2.5	5.5
<b>Alley Branch</b>	4	Alley Spring, MO	Jacks Fork R.-6	0.6	7.1
<b>Pipestem Hol.</b>	3	Alley Spring, MO	Alley Branch-4	0.0	3.2
<b>Cartwright Hol.</b>	3	Alley Spring, MO	Alley Branch-4	0.0	5.1
<b>Lawrence Hol.</b>	3	Alley Spring, MO	Jacks Fork R.-6	0.0	3.5
<b>Bay Cr.</b>	3	Jam Up Cave, MO	Jacks Fork R.-6	1.0	9.2
<b>Leatherwood Cr.</b>	3	Jam Up Cave, MO	Jacks Fork R.-6	5.6	5.6

<b>South Prong Leatherwood Cr.</b>	3	Jam Up Cave, MO	Leatherwood Cr.-3	0.0	7.4
<b>JFW003</b>	3	Jam Up Cave, MO	Jacks Fork R.-6	0.0	4.3
<b>JFW004</b>	3	Jam Up Cave, MO	Jacks Fork R.-6	0.0	4.8
<b>JFW005</b>	3	Jam Up Cave, MO	Jacks Fork R.-6	0.0	5.5
<b>Jam Up Cr.</b>	3	Jam Up Cave, MO	Jacks Fork R.-6	0.0	11.8
<b>Panther Hol.</b>	3	Pine Crest, MO	Jacks Fork R.-6	0.0	3.6
<b>Barn Hol.</b>	3	Pine Crest, MO	Jacks Fork R.-6	0.0	10.0

**P**-Permanent Stream Miles (Determined from 1:24,000 scale GIS hydrography coverage)

**T**-Total Stream Miles (Determined from 1:24,000 scale GIS hydrography coverage)

**Abbreviations:** Br.-Branch, Cr.-Creek, Hol.-Hollow, R-River

Table Ge03. Third order (Horton) and larger streams of the Jacks Fork Watershed.

Stream Name	Order	USGS 7.5' Quad at Stream Mouth	Name and Order Receiving Stream	Length	
				P	T
<b>Coon Hol.</b>	3	Pine Crest, MO	Jacks Fork R.-6	0.0	6.5
<b>Grassy Hol.</b>	3	Pine Crest, MO	Jacks Fork R.-6	0.0	4.9
<b>South Prong Jacks Fork</b>	5	Pine Crest, MO	Jacks Fork R.-6	14.4	16.3
<b>Little Pine Cr.</b>	4	Clear Springs, MO	S. Prong Jacks Fork-5	3.6	6.9
<b>JFW006</b>	3	Clear Springs, MO	L. Pine Cr.-4	0.4	2.3
<b>Pine Cr.</b>	4	Clear Springs, MO	S. Prong Jacks Fork-5	10.6	13.0
<b>JFW007</b>	3	Willow Springs, MO	Pine Cr.-4	0.9	3.5
<b>JFW008</b>	3	Willow Springs, MO	Pine Cr.-4	0.0	3.3

<b>JFW009</b>	3	Willow Springs, MO	Pine Cr.-4	0.0	2.5
<b>JFW010</b>	4	Willow Springs, MO	S. Prong Jacks Fork-5	5.2	6.7
<b>JFW011</b>	3	Willow Springs, MO	JFW010-4	0.0	3.0
<b>JFW012</b>	3	Willow Springs, MO	JFW010-4	0.0	1.7
<b>Wyrick/Nigman Branch</b>	3	Willow Springs, MO	S. Prong Jacks Fork-4	0.0	3.0
<b>North Prong Jacks Fork</b>	5	Pine Crest, MO	Jacks Fork R.-6	15.4	17.3
<b>Pine Branch</b>	4	Clear Springs, MO	N. Prong Jacks Fork-5	0.0	4.3
<b>JFW012a</b>	3	Eunice, MO	Pine Branch-3	0.0	2.8
<b>East Fork Pine Branch</b>	3	Clear Springs, MO	Pine Branch-4	0.0	3.5
<b>Peters Cr.</b>	3	Eunice, MO	N. Prong Jacks Fork-4	2.3	6.7
<b>JFW013</b>	3	Eunice, MO	N. Prong Jacks Fork-4	0.0	3.4

**P**-Permanent Stream Miles (Determined from 1:24,000 scale GIS hydrography coverage)

**T**-Total Stream Miles (Determined from 1:24,000 scale GIS hydrography coverage)

**Abbreviations:** Br.-Branch, Cr.-Creek, Hol.-Hollow, R-River

Table Ge04. Stream length for order and total length for fourth order and larger streams in the Jacks Fork Watershed.

Stream Name	Length for Order (miles)						Total Length
	6	5	4	3	2	1	
<b>Jacks Fork R.</b>	49.6	North Prong/South Prong					49.6
<b>Shawnee Cr.</b>			3.2	5.5	0.7	0.5	9.9
<b>Mahan's Cr.</b>		5.7	5.1	1.0	0.4	1.0	13.2
<b>Open Hol.</b>			0.8	2.9	0.2	1.4	5.2
<b>Alley Br.</b>			2.7	1.5	1.1	1.8	7.1
<b>South Prong Jacks Fork</b>		11.6	1.0	1.8	1.0	0.9	16.3
<b>Little Pine Cr.</b>			3.6	2.1	0.6	1.2	7.4
<b>Pine Cr.</b>			9.5	2.5	0.6	0.4	13.0
<b>JFW010</b>			3.2	1.3	1.5	0.6	6.7
<b>North Prong Jacks Fork</b>		4.0	7.7	3.1	1.7	0.9	17.3
<b>Pine Br.</b>			1.7	1.5	0.4	0.7	4.3

Table Ge05. Stream gradient by Strahler Order and average gradient for fourth order (Horton) and larger streams in the Jacks Fork Watershed.

Stream Name	Gradient by Order (feet per mile)						Average Gradient ft/mi
	6	5	4	3	2	1	
<b>Jacks Fork R.</b>	7.1	North/South Prong					7.1
<b>Shawnee Cr.</b>			22.7	36.0	80.6	138.0	42.1
<b>Mahan's Cr.</b>		16.1	25.5	39.3	77.6	110.4	28.6
<b>Open Hol.</b>			33.7	43.3	57.4	95.6	56.2
<b>Alley Br.</b>			28.4	42.1	75.6	101.5	57.5
<b>South Prong Jacks Fork</b>		14.7	30.9	50.9	73.1	130.1	30.3
<b>Little Pine Cr.</b>			34.5	43.7	59.5	96.8	43.7
<b>Pine Cr.</b>			24.0	44.1	89.8	158.5	35.0
<b>JFW010</b>			31.1	47.0	74.7	130.7	53.7
<b>North Prong Jacks Fork</b>		12.2	15.8	35.3	55.9	130.1	28.7
<b>Pine Br.</b>			38.7	39.8	69.3	138.3	65.4