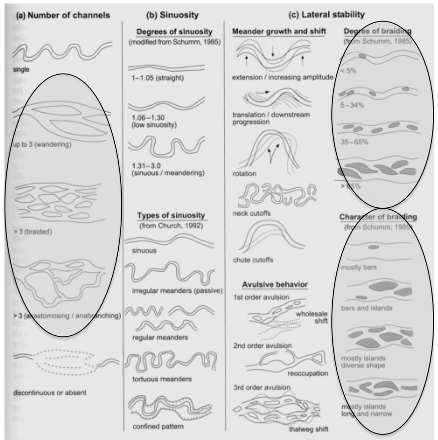
Number of channels | Sinuosity | Lateral stability

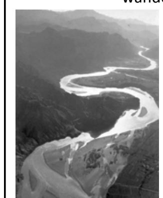


K: 230-241; B: 199-202

Multi-thread channels

braided

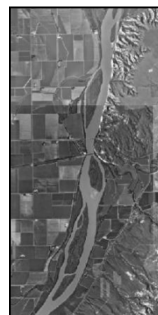
wandering

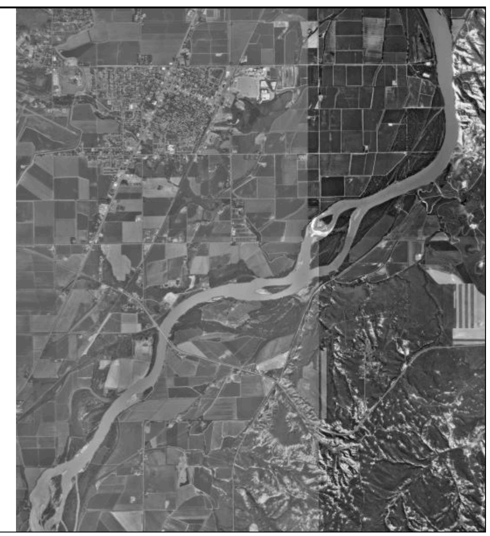


anastomosing

Braiding or anastomosing?

- Anastomosing -- channel splits around floodplain elements
  - Channel parts are longer than one curved channel part around one bar
  - Flow and sediment patterns in each anastomosing channel are independent from one another
- Braiding -- channel splits around bars or islands
- Bottom line -- terms are NOT mutually exclusive; anastomosed channels can themselves be braided!





Waimakariri River, NZ

Braided channels: the ways streams were before there was vegetation

southern France

Snake River, Grand Teton National Park

Snake River, Grand Teton N. P.

Braiding indices (see Table 5.1 of Bridge, 2003)

- Counting mean number of active channels or braid bars per transect across the valley
  - This is the **mode** of the river
- Ratio of sum of channel lengths to reach length, called **total sinuosity**
  - A combined measure of sinuosity of each channel part and degree of braiding
- Better to determine the mode of entire river and sinuosity of each channel part

What is the mode?

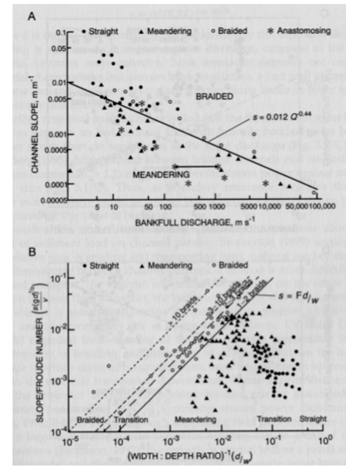
What is the total sinuosity?

Difficulties

- Channels and bars look different at different stage
  - Best rule -- evaluate planform at intermediate flow stage, if possible; even better to evaluate at different stages in a sequence of years
- Must decide which parts of the channel and the bars are to be used in determining the degree of channel splitting and sinuosity
  - Efforts to define different orders of channels
- Braid bars or islands?
  - Best rule -- distinguish individual braid bars (occur within a braided channel) from bar assemblages or floodplain segments (that separate anastomosing channels)

(Leopold and Wolman, 1957)

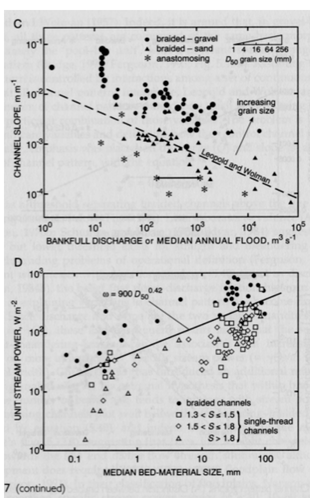
(Parker, 1976)



- **General controls of braided channels**
- **(*B 153-181)**

Braided channels are steeper than meandering channels

Leopold and Wolman (1957), River channel patterns: braided, meandering, and straight. USGS Professional Paper 282-D.



(Ferguson, 1987; Knighton and Nanson, 1993)

(van den Berg, 1995)

unit stream power = f (discharge x slope)

General controls

- Increasing Q S leads to increased degree of braiding
  - Increasing Q S leads to increasing sediment transport
- Increasing sediment supply to an equilibrium channel induces aggradation and increase in braid index
- Increasing Q leads to increasing braid index and w/d
- Decreasing grain size leads to braiding at lower Q or lower S

Conditions conducive to braiding

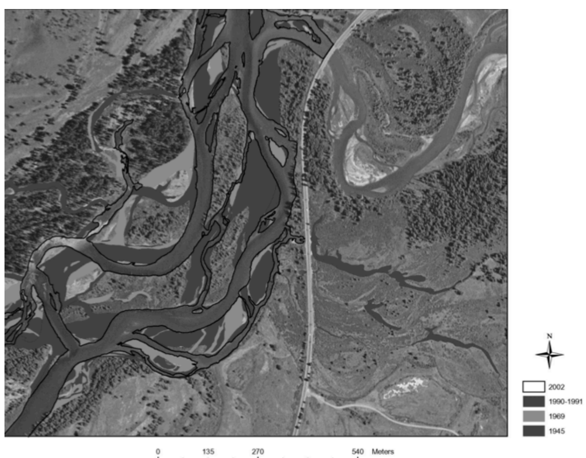
Abundant bed load (a necessary condition)
- lack of capacity to transport the entire load
- lack of competence to transport all sizes
- (either of these situations leads to mid-channel bars)

Erodible banks (a necessary condition)
- banks are a source of sediment; erodible banks allow channel widening
- many studies show braiding where B/h > 50

Highly variable discharge

Steep valley slope

Instability of a gravel bed braided channel



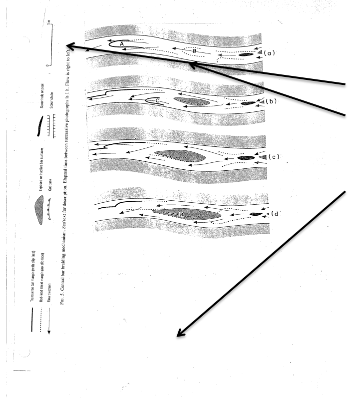
Implications to floodplain formation

Braiding Mechanisms

Ashmore, 1991

- Central bar initiation (D)

Central bar initiation



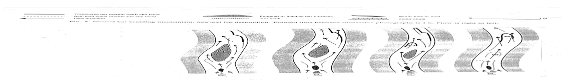
Slight bank erosion produces low sinuosity channel

Migration of an elongate bedload sheet; bed elevation rises here

Second sheet advances; coarsest grains downstream margin of sheet

Central bar begins to emerge; bedload sheets pass around the bar

Central bar grows by accretion at its head and sides; coarse sediment at bar head, finer sediment at downstream end of bar

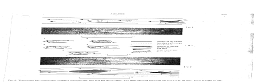


Braiding Mechanisms

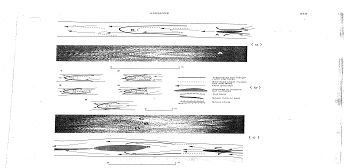
Ashmore, 1991

- Transverse bar conversion (D)

Braiding initiated by flow division around downstream end of a symmetrical transverse unit bar

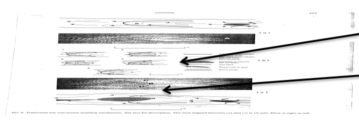


Symmetrical transverse unit bar downstream from a confluence scour; coarse grains at downstream end of bar



Bedload sheets migrate across the surface of the unit bar and stall out before moving beyond the bar; thus, they aggrade the bar surface

Flows begin to diverge around the bar



Flow divides aroudn the bar head where coarse grains have accumulated

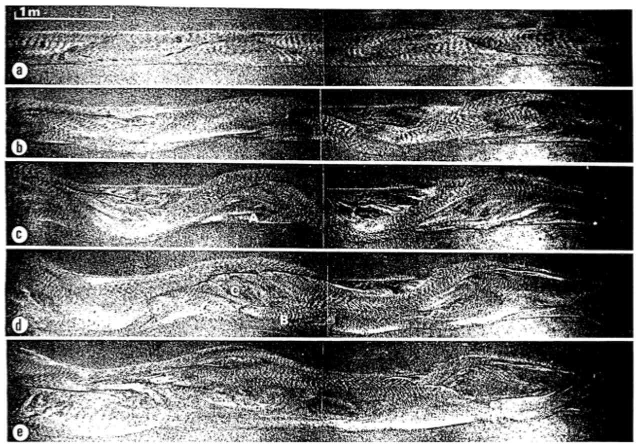
Bar margin deforms to become 2 asymmetrical diagonal bars

Braiding Mechanisms

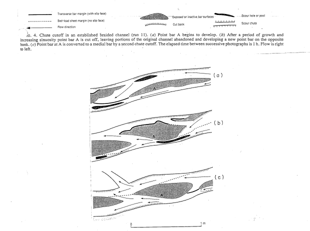
Ashmore, 1991

- Chute cutoffs (E)

Development of chute channels across alternating point bars



Pulse of a bedload sheet astalls at upstream end of the point bar, forcing flow over the point bar, leading to a chute coutoff on its bank side



Initial point bar is cut off through the slough channel on bankward side of bar

Original main channel is abandoned and flow is concentrated in former slough channel;

thus former point bar is converted into a braid bar after flow goes back to original main channel

Braiding Mechanisms

- Chute cutoffs (E)
- Multiple bar braiding (E)
- Central bar initiation (D)
- Transverse bar conversion (D)
- Relative importance depends on
  - Flow strength
  - Bank erodibility
  - Bed mobility
- All mechanisms related to rapidly changing Q and Qs
- Braiding begins by stalling and vertical accretion of bedload sheets

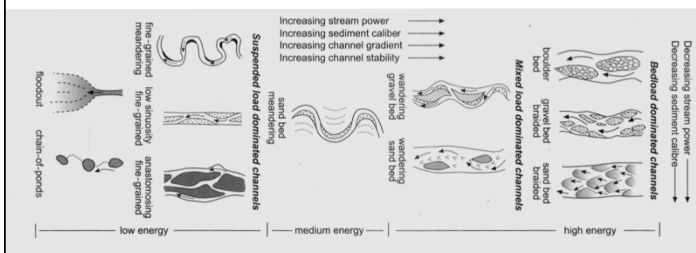
Ashmore, 1991

references

- *Ashmore, P. E. (1991), How do gravel-bed rivers braid? Canadian Journal of Earth Science 28: 326-341.*
- *Paola, C. (2000), Modelling stream braiding over a range of scales.*
- *Gran and Paola (2001), Riparian vegetation controls on braided stream dynamics. Water Resources Research 37(12): 3275-3283.*

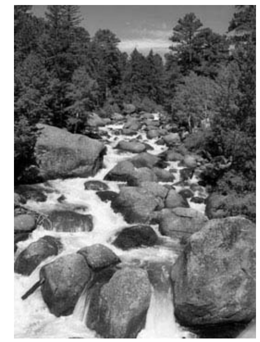
Alluvial river morphology

Putting it all together B/F: 79-142, esp 120-142



Alluvial river morphology: categories of river character

- Laterally-unconfined, high-energy rivers
  - **Boulder-bed rivers**



- **Laterally-unconfined, high-energy rivers**
  - Boulder-bed rivers
  - **Braided rivers**

- **Laterally-unconfined, high-energy rivers**
  - Boulder-bed rivers
  - Braided rivers
  - **Wandering gravel-bed rivers**
    - Intermediary type between braided and meandering channels

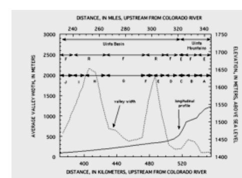
- Laterally-unconfined, high-energy rivers
  - Boulder-bed rivers
  - Braided rivers
  - Wandering gravel-bed rivers
- Laterally-unconfined, medium-energy rivers
  - Meandering rivers

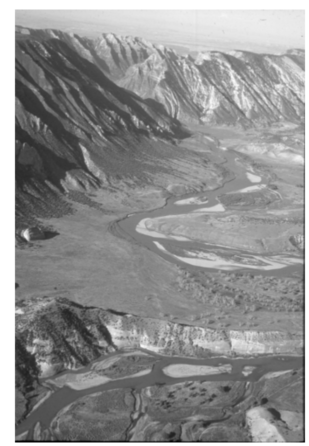
- Laterally-unconfined, low-energy rivers with continuous channels
  - Low sinuosity rivers
  - Anabranching rivers
- Laterally-unconfined, low-energy rivers with continuous bedrock-based channels
- Laterally-unconfined, low energy rivers with discontinuous channels
  - Cut-and-fill rivers with discontinuous channels
  - Floodout rivers with discontinuous channels

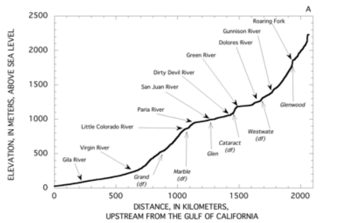
Valley confinement

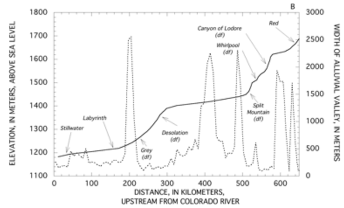
- Primary control on differentiating geomorphic process zones (sediment source, transfer, accumulation zones)
- Control spatial patterns of erosion during large floods
- Situations where confined valleys occur; floodplain pockets may exist
  - Steep headwater rivers and mountain streams
  - Gorges/canyons
- Partly-confined valleys (lateral and vertical accretion models)

Valley width constraint on channel/ floodplain form






A
ELEVATION, IN METERS, ABOVE SEA LEVEL
DISTANCE, IN KILOMETERS,
UPSTREAM FROM THE GULF OF CALIFORNIA
Roaring Fork
Gunnison River
Dolores River
Green River
Dirty Devil River
San Juan River
Paria River
Little Colorado River
Virgin River
Gila River
Glenwood
Westwate (df)
Cataract (df)
Glen
Marble (df)
Grand (df)


B
ELEVATION, IN METERS, ABOVE SEA LEVEL
WIDTH OF ALLUVIAL VALLEY, IN METERS
DISTANCE, IN KILOMETERS,
UPSTREAM FROM COLORADO RIVER
Canyon of Lodore (df)
Red
Whirlpool (df)
Split Mountain (df)
Labyrinth
Stillwater
Desolation (df)
Grey (df)