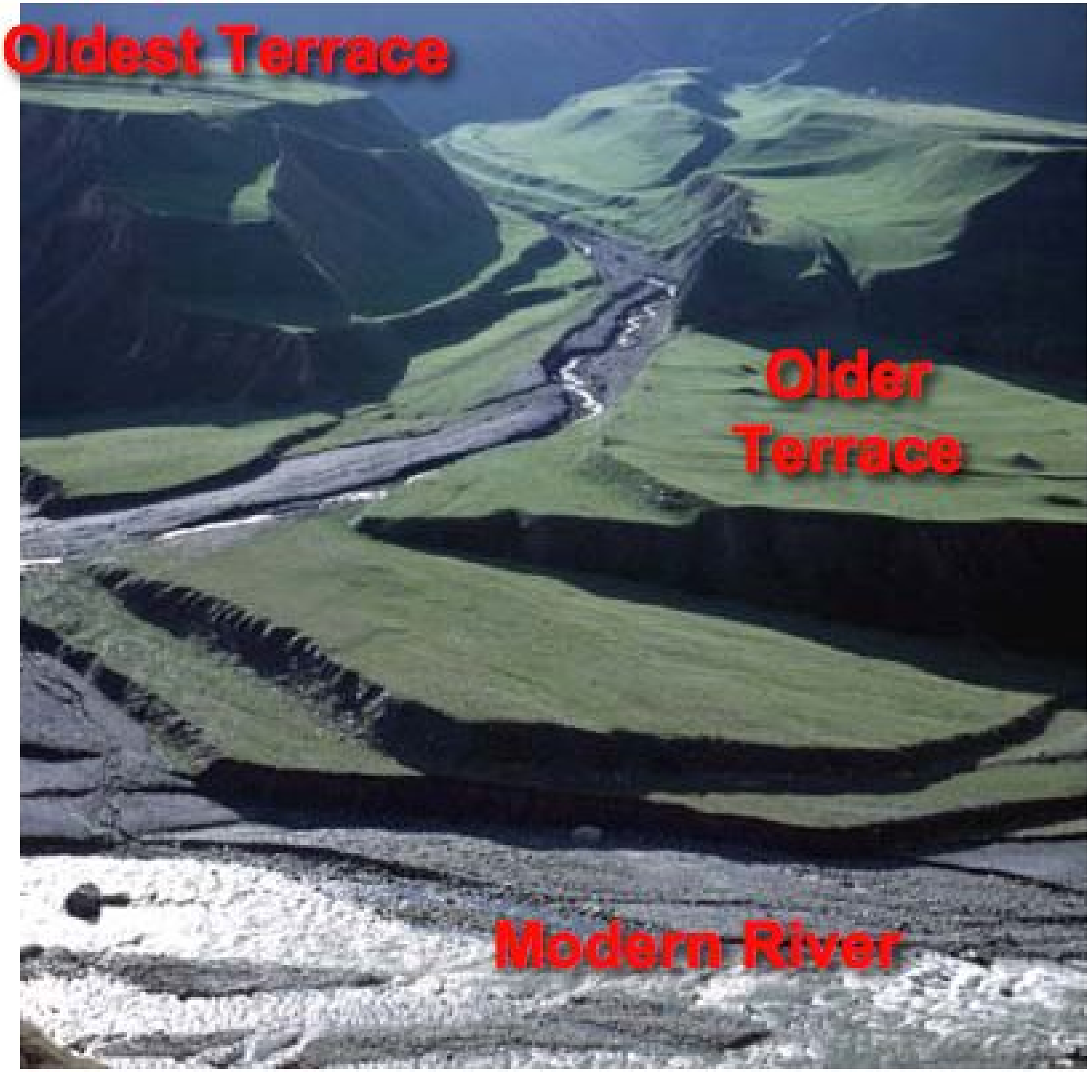
Week 4: River Channels Through Time:
Fluvial Terrace Development and History

1 - Models of terrace formation and development:
- •Terrace formation
- •Classification - erosional vs. depositional
- •Graded long-profiles and energy
- •Diverging vs. converging terraces
- •Knickpoints and river adjustment

2 - Quick exercise looking at terraces through time and space, followed by a group discussion.

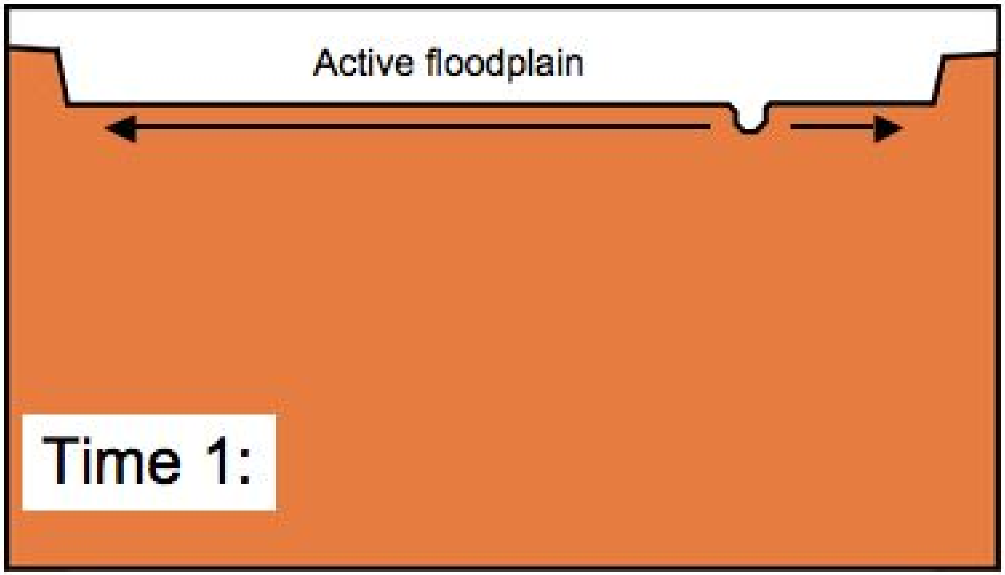
What's A River Terrace?



What do they tell us about equilibrium / disequilibrium

Terrace Formation in Cross-Setion:

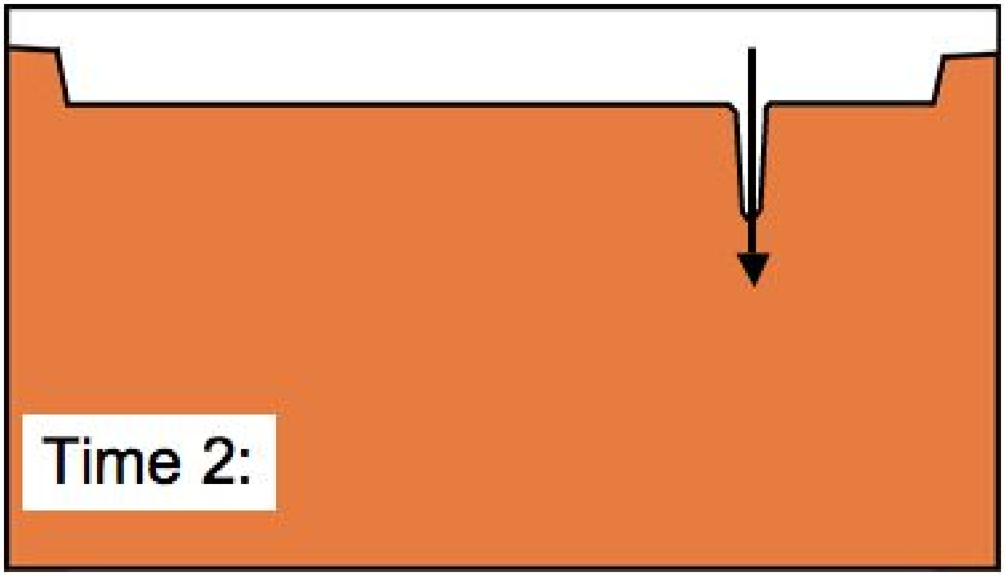
River in **Equilibrium** - Floodplain and Valley Formation



River swings back and forth laterally beveling valley floor

Terrace Formation in Cross-Setion:

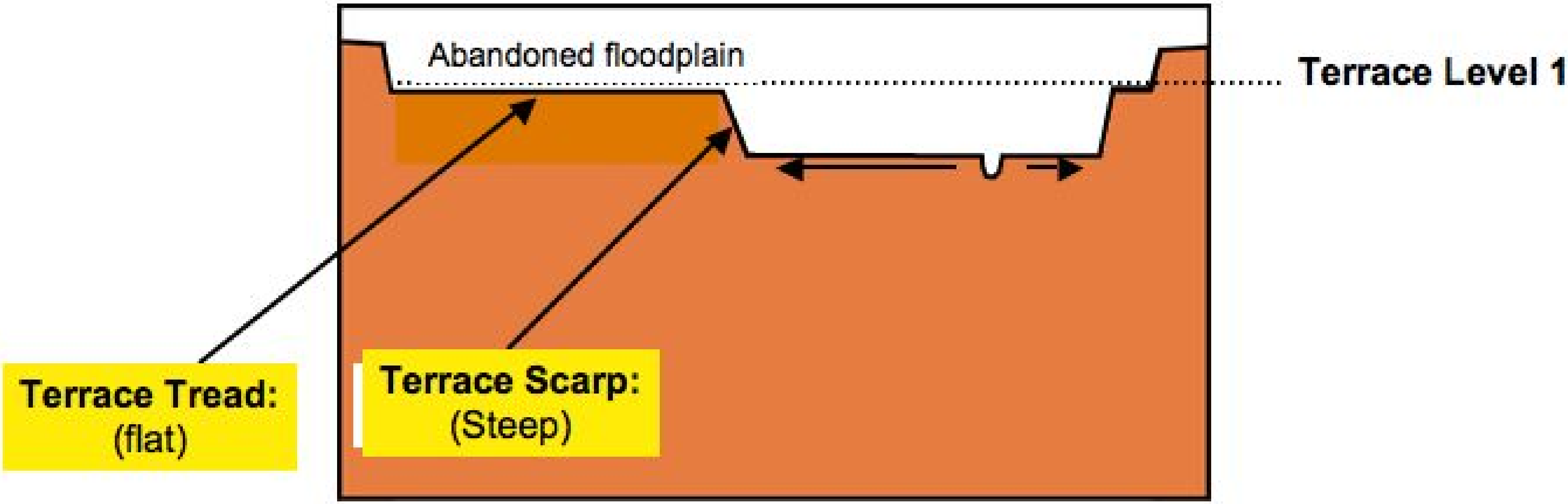
River **Disequilibrium** - Incision



Change in the system: Driving force
Exceeds resisting force.

Terrace Formation in Cross-Setion:

New equilibrium established:



Lateral Beveling forms a new floodplain

Terrace Formation in Cross-Setion:

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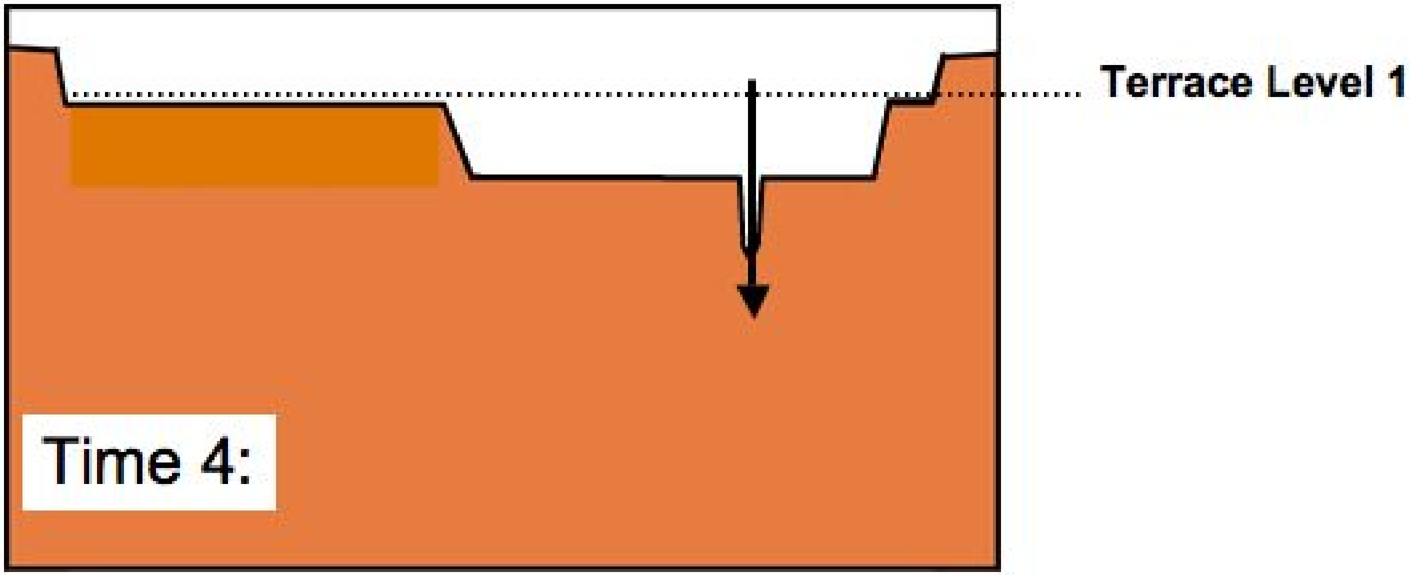

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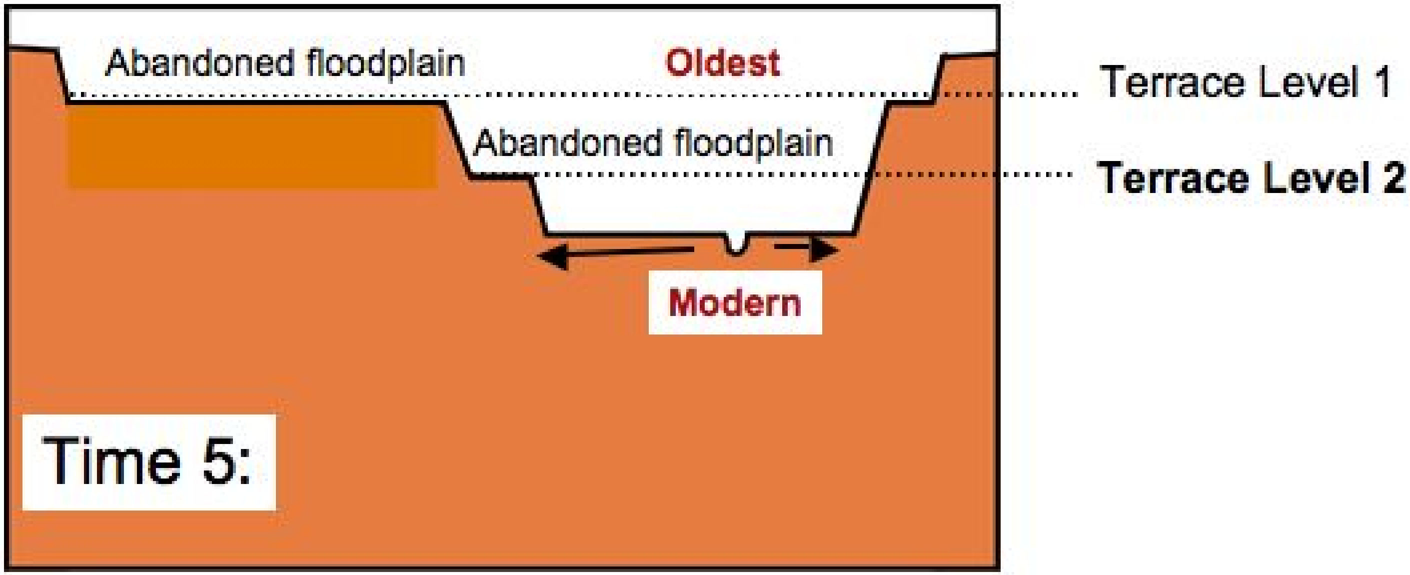
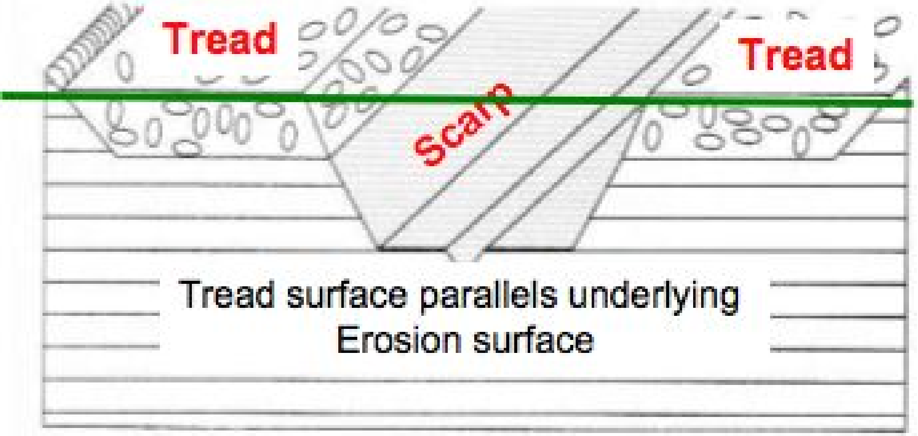
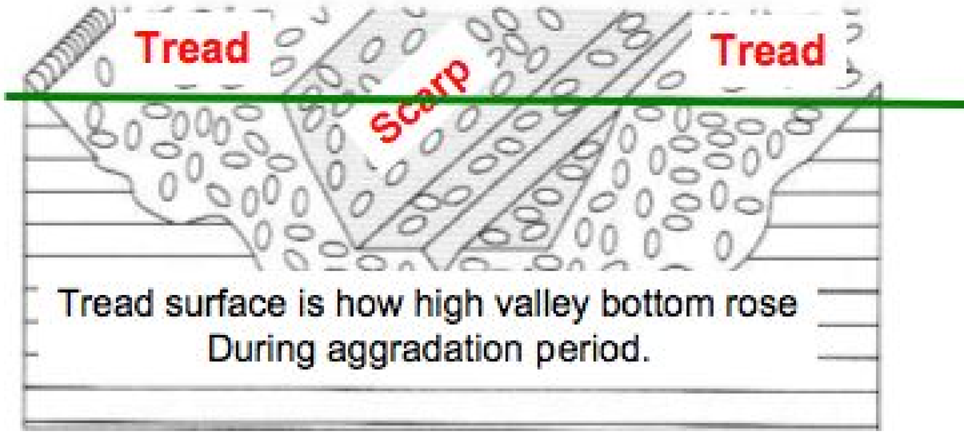


Lateral Beveling forms a new floodplain

The formation of terraces requires equilibrium
And disequilibrium!

Not all terraces are created equal:





Erosional Terraces:

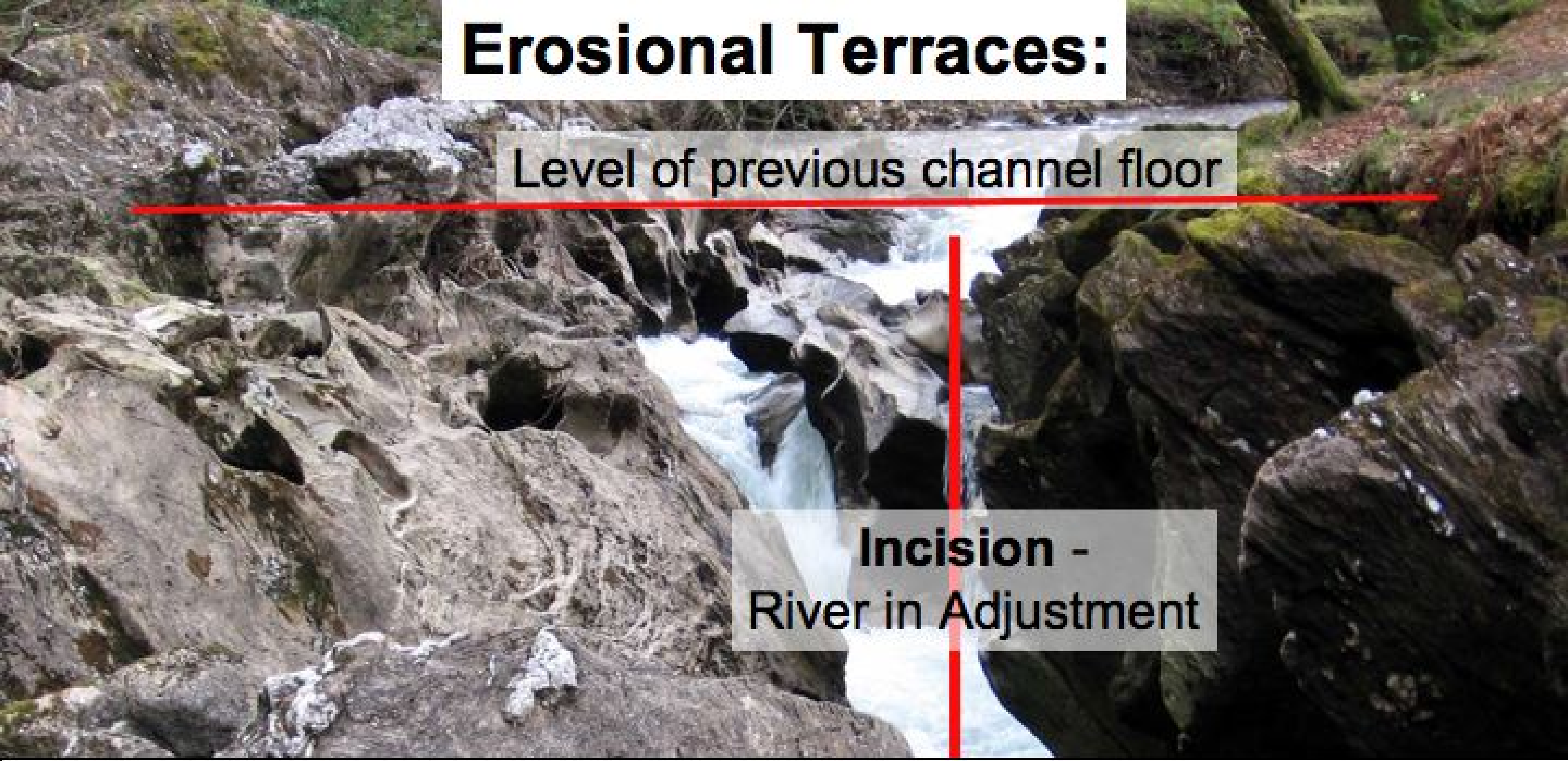
Depositional (Fill) Terraces:

Incision through fill: ***fill-cut terrace***
Incision through rock: ***rock-cut terrace***

Key Difference is what the **Treads** represent:

- **Erosional:** Tread represents underlying erosion surface
- **Depositional:** Tread represents the height of FILL

Erosional Terraces:



Typically **Tectonically Driven Formation**:

- Uplift increases stream power and erosion
- Rivers run on rock Instead of through sediments

Not always the case: Huntington, Holtwood Gorge

Depositional (Fill) Terraces:

Typically Climatically Driven:

•Changes in climate…
•Some favor aggradation
•Some favor incision

•Rivers bounce between Equilibrium conditions.

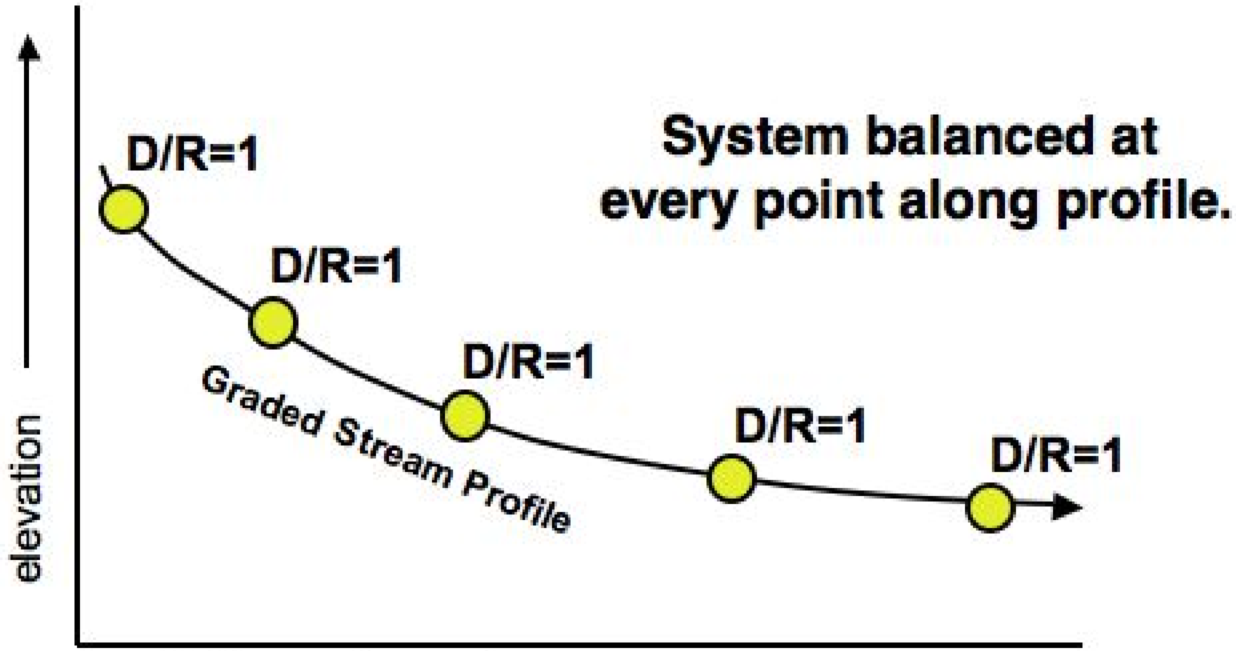
•Can also result from Fluctuations in sizes and Amounts of sediment fed To channels.

•Land-use practices can Cause valley aggradation

Energy and Equilibrium:
The “Graded” Stream Profile

System Equilibrium - Graded Long-Profile:

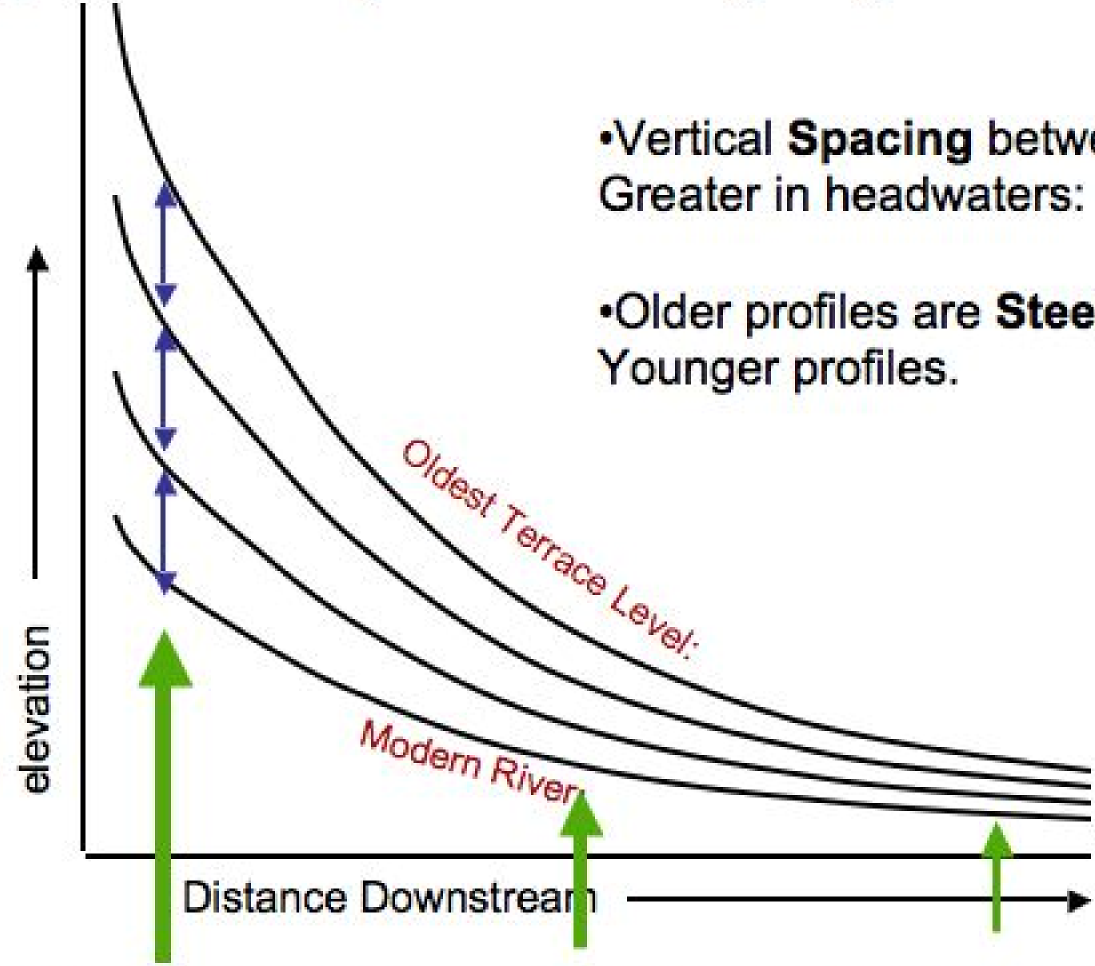
Driving Force (stream Power) = Resisting Force (channel)
Considered over LONG TIME frames



Never Perfect though. Terrace formed when you depart from one Graded period, and adjust to new conditions

- If Driving > Resisting, Get Incision - erosional terraces
- If Resisting (sed load) > Driving, can get aggradation and later Fill terraces

Longitudinally Converging Terraces:



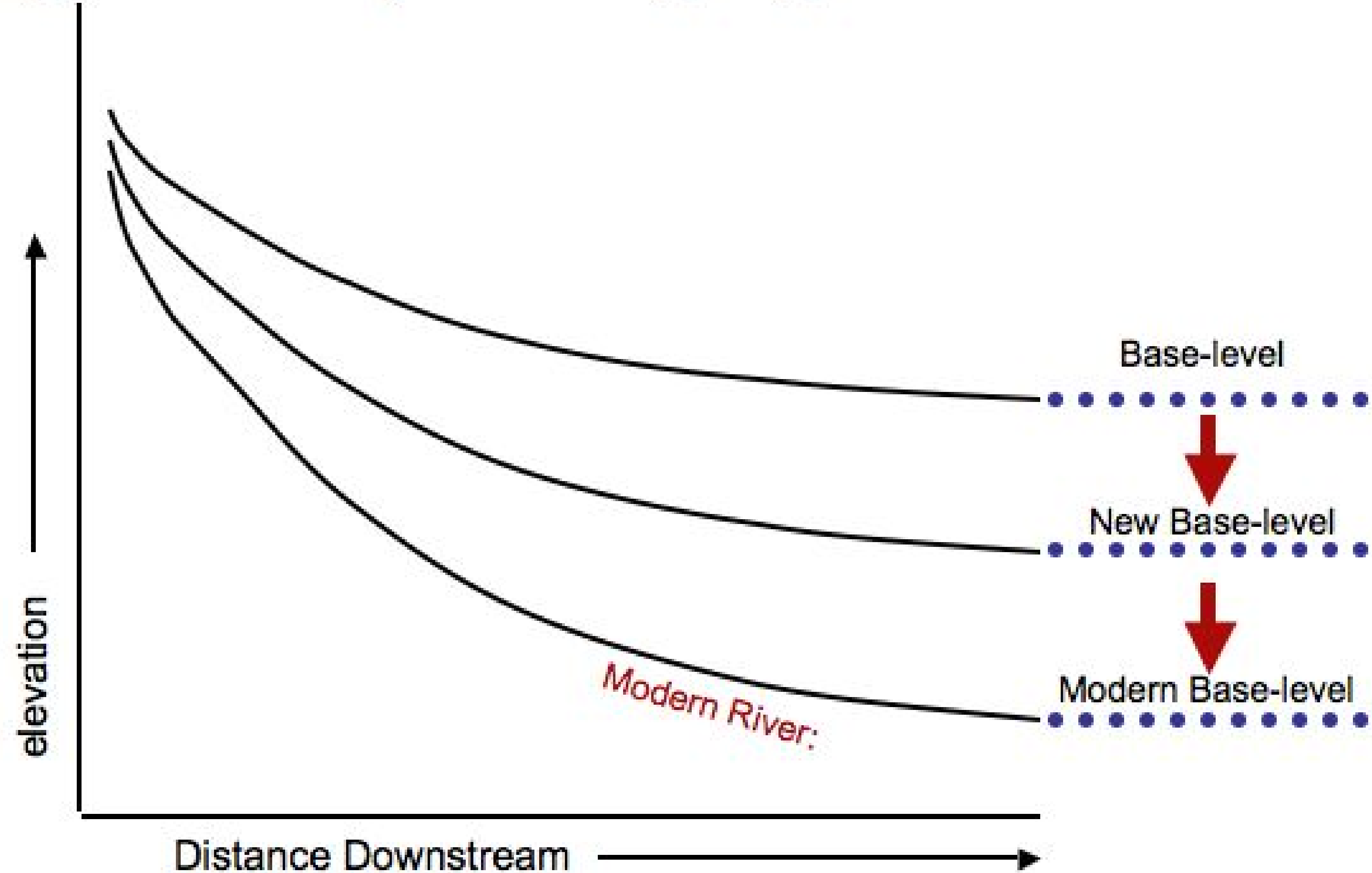
•Vertical **Spacing** between terraces Greater in headwaters:

•Older profiles are **Steeper** than Younger profiles.

Possible Interpretation: Uplift Greater in Headwaters

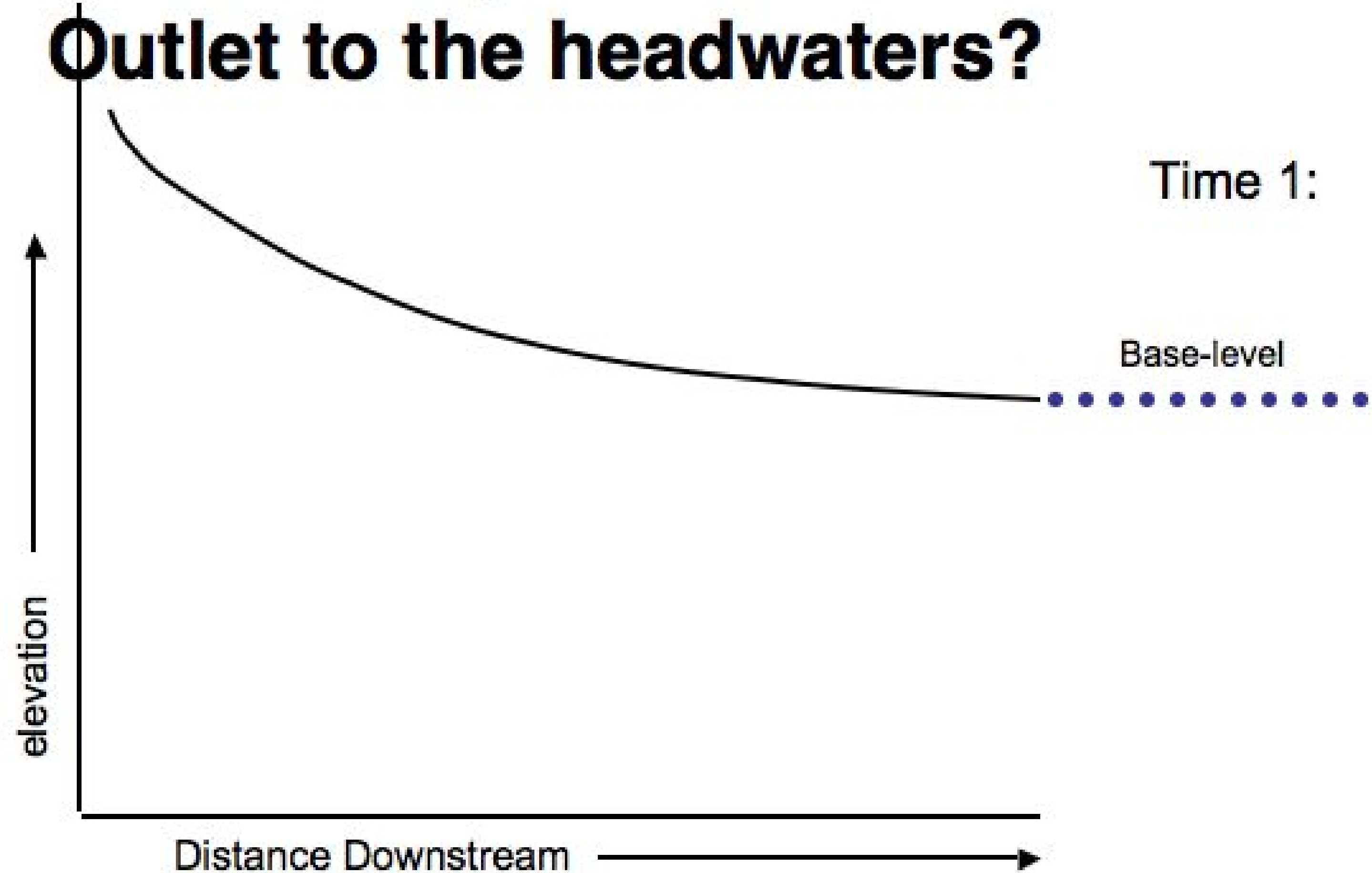
Or…greater sediment load in the past - steeper gradient

Longitudinally Diverging Terraces:



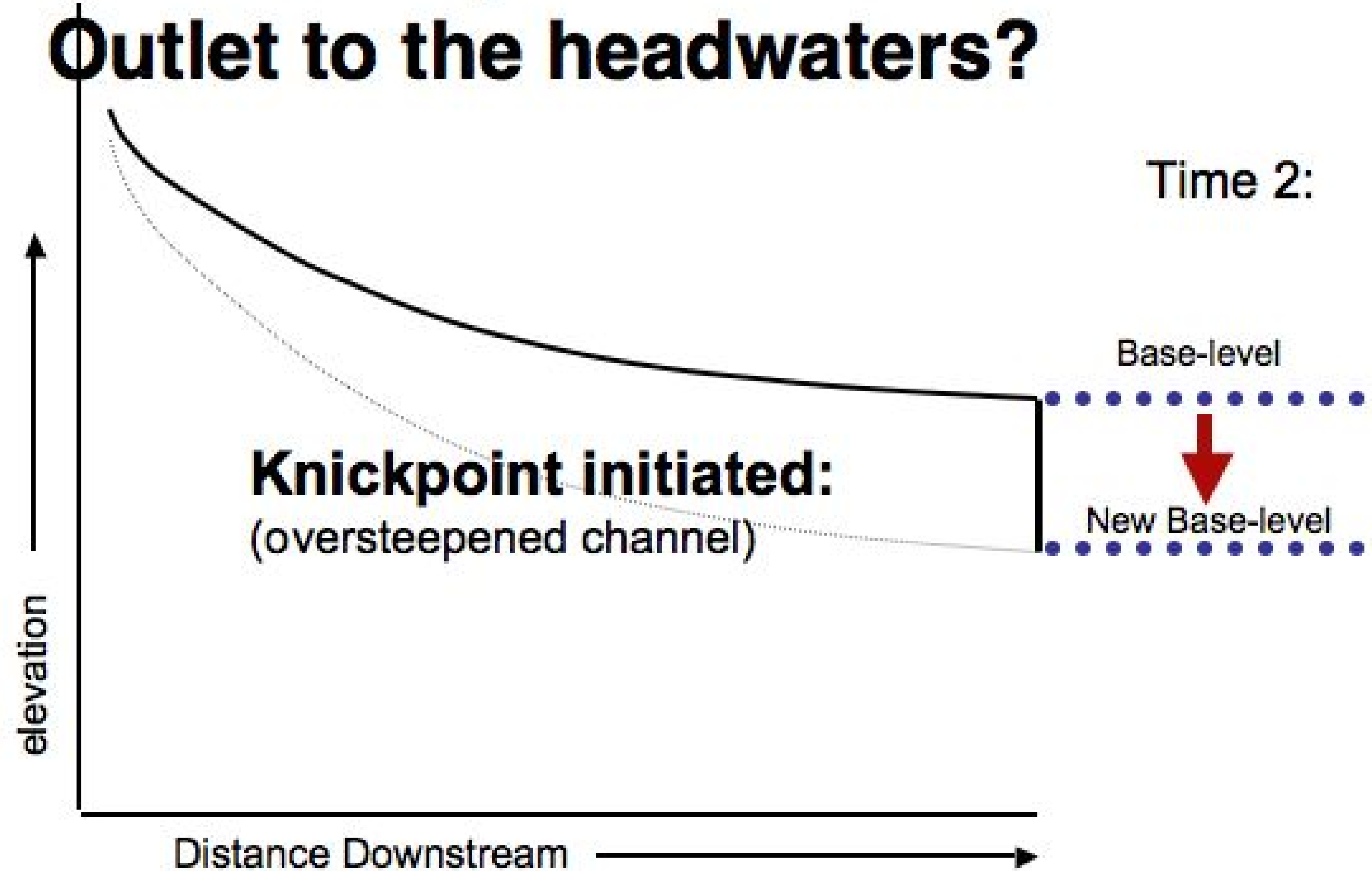
Diverging Terraces usually the result of base-level drops

How are these drops translated from the Outlet to the headwaters?



River is doing its thing.

How are these drops translated from the Outlet to the headwaters?



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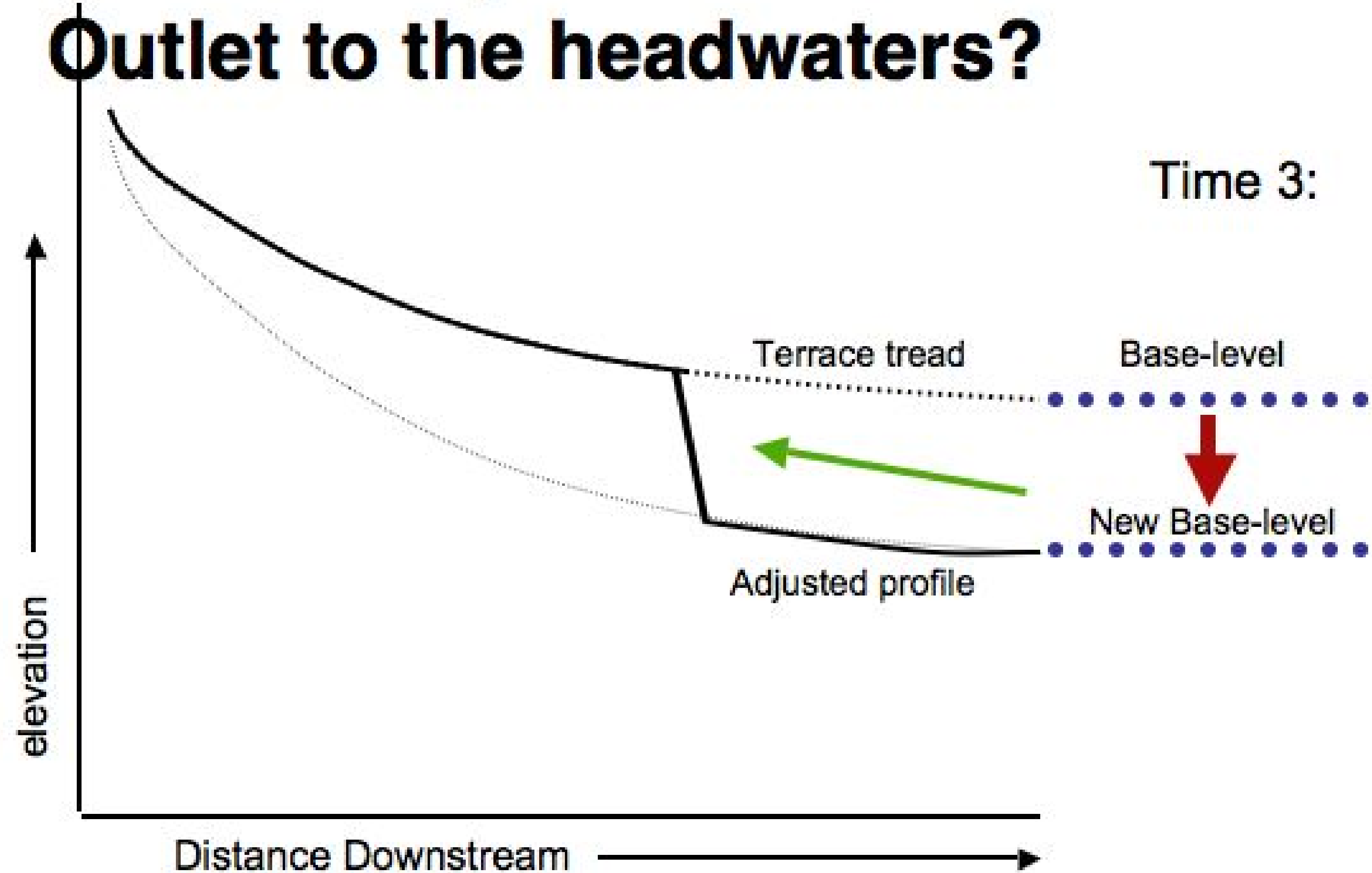
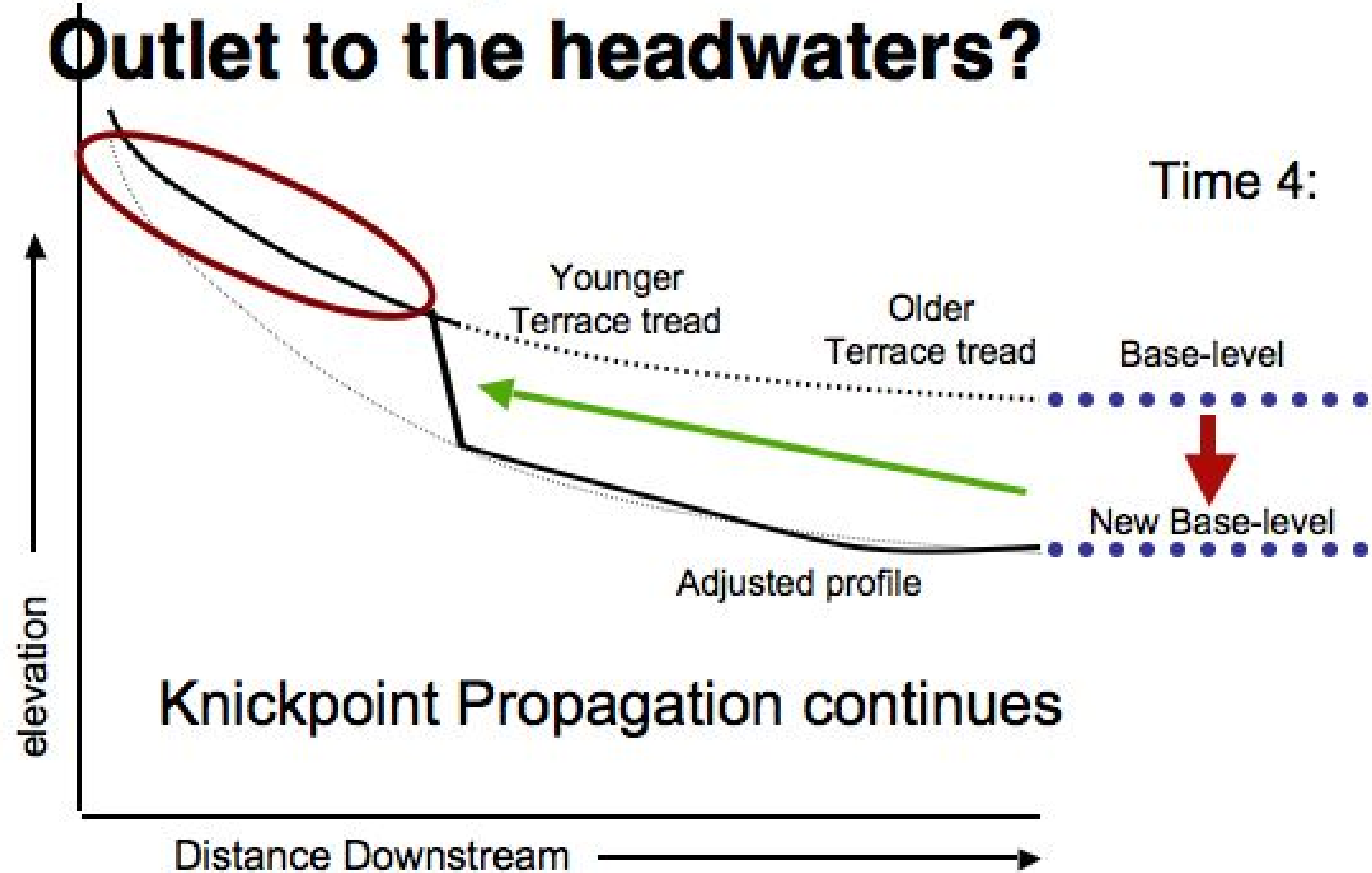


Knickpoint Propagates upstream

How are these drops translated from the Outlet to the headwaters?



•River channel upstream of knickpoint has no idea
That base-level has fallen.
•Still graded to old base-level

Enough Models:
How does this all look in VT?

Deglacial and Post-glacial History
Of the Winooski and Huntington River Valleys.

For this weeks lab, need to read:
Late Pleistocene-Holocene History…northern Vermont. 1997
(Wright, Whalen, Zehfuss, and Bierman)

(p. C4-12 to C4-28)

PROGLACIAL LAKE AND RIVER HISTORY IN THE WINOOSKI DRAINAGE BASIN

Timothy N. Whalen

Introduction

When the Hudson-Champlain lobe of the Laurentide ice sheet retreated from this mountainous region, proglacial lakes developed between the ice and the valley walls, leaving behind a scattered record of deltas and shorelines. As the lakes withdrew from the valleys, rivers began to incise the lake deposits. The subsequent fluvial activity in the Winooski Drainage Basin removed much of the glacial deposits and lowered the valley floors more than 40 m in the lower reaches. The purposes of this paper are 1) to provide an overview of the history of proglacial lakes occupying the Winooski River Valley and its tributaries, with special attention given to the Huntington Valley, 2) to identify when the transition occurred between lacustrine and fluvial processes in each of these valleys, and 3) to describe the mechanisms responsible for river incision in the Winooski Drainage Basin.

Deglacial History

The deglacial record of the Winooski Drainage Basin is one of northwestward ice retreat, ice lowering, and decreasing proglacial lake levels. Larsen (1972; 1987a & b) has previously described the sequence of proglacial lakes in the Winooski Drainage Basin and his five stage model (Table 1) is used as the basis for this discussion. Larsen specifically addressed the chronologies in the Mad, Dog, and Stevens Branch Valleys, but work in the Huntington River Valley (Wagner, 1972; Bryan, 1995) and in the Little River Valley (Merwin, 1908; Connally, 1972) also demonstrates that the history of proglacial lakes in these valleys can be placed within the context of Larsen's model. The following section focuses on the proglacial lake levels in the Huntington Valley and the reader is encouraged to review Larsen (1972; 1987a & b) for specifics concerning the other valleys in the Winooski Basin and Chapman (1937) for the Champlain Valley lake levels.

Table1: Winooski Drainage Basin Proglacial Lake Levels and Ice Positions

Stage	Winooski River	Huntington River	Little River	Mad River	Dog River	Stevens Branch
I	Ice Retreats to Valley Mouths	Lake Jerusalem to Southern Divide	Ice and Local Lakes	Lake Granville to Granville Gulf Divide	Roxbury Divide	Lake Williamstown to Williamstown Divide
II	Ice Retreats to Jonesville	Lake Huntington to Hollow Brook Divide	Lake Winooski above Divide	Lake Winooski to Warren	Lake Winooski to South Northfield	Lake Winooski to Divide
III	Ice Retreats to Richmond	Lake Huntington to Hollow Brook Divide	Lake Mansfield I to Divide	Lake Mansfield I to Moretown	Fluvial	Fluvial
IV	Ice Retreats to Green Mountain Front	Lake Mansfield II to Hollow Brook Divide	Lake Mansfield II to Stowe	Fluvial	Fluvial	Fluvial
V	Lake Coveville to Waterbury	Lake Coveville to Huntington	Lake Coveville to Moscow	Fluvial	Fluvial	Fluvial

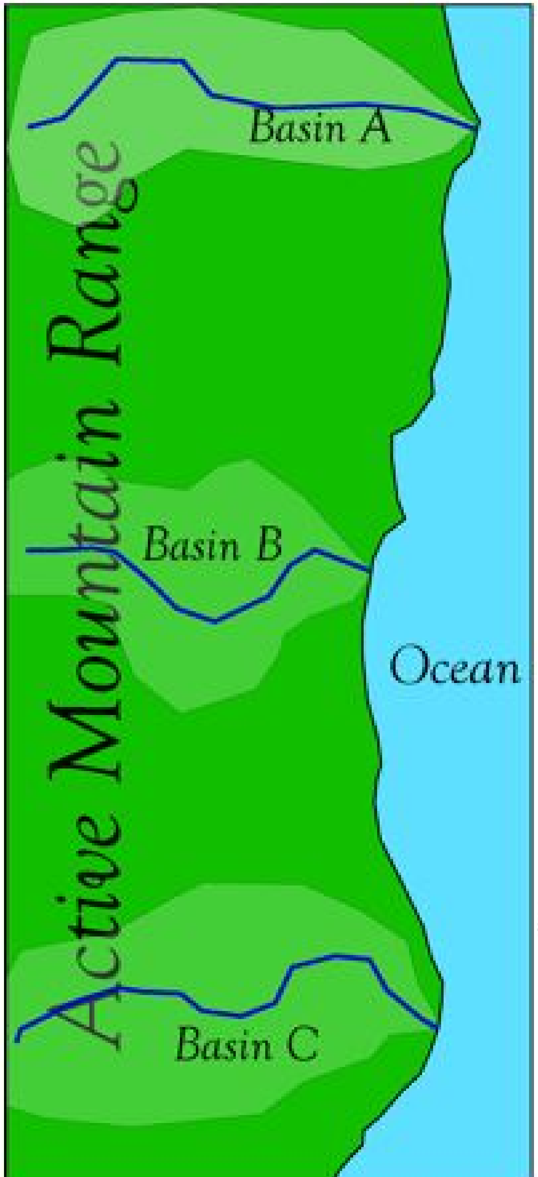
Note: The lake positions are cited as the farthest upvalley location for stage and ice positions are cited as position at end of stage.

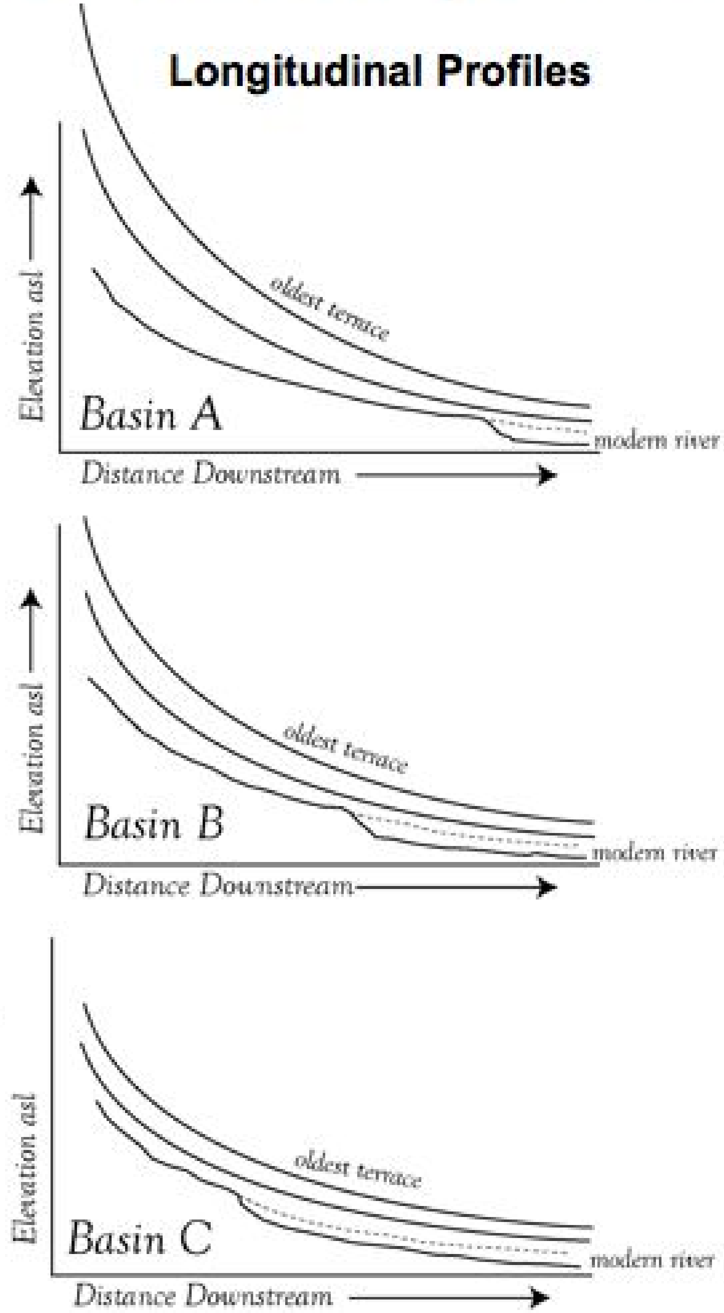
Stage I lakes were limited to single north-draining valleys because they were bordered to the north by the retreating ice. These lakes drained over southern spillways, located at different elevations, and into the Champlain (Huntington Valley) and Connecticut (Mad, Dog, and Stevens Branch Valleys) Basins. The Stage I spillway in the Huntington Valley is located at the southern divide at an elevation of 460 m (1510 ft), controlling a previously unnamed lake Stage I lake (Fig. 6). Following Larsen's (1972) criteria for naming Stage I lakes based on the nearest village, the name Lake Jerusalem is suggested. Evidence for Lake Jerusalem includes clay deposits found at 240 m (787 ft) south of Huntington Center (Bryan, 1995). During Stage II, the lakes east of the Huntington Valley


Winooski
Jericho
Essex Junction
Burlington
South Burlington
Stowe
Richmond
Shelburne
Waterbury
Montpelier
Vergennes
Bristol
Northfield
Vermont

See if you can
Use all this to figure out
Something completely differnt

Find a Partner or two…try and figure this out





- Similar sized basins
- Climate similar for all basins
- Climate not necessarily Constant over time.

- Active Tectonics

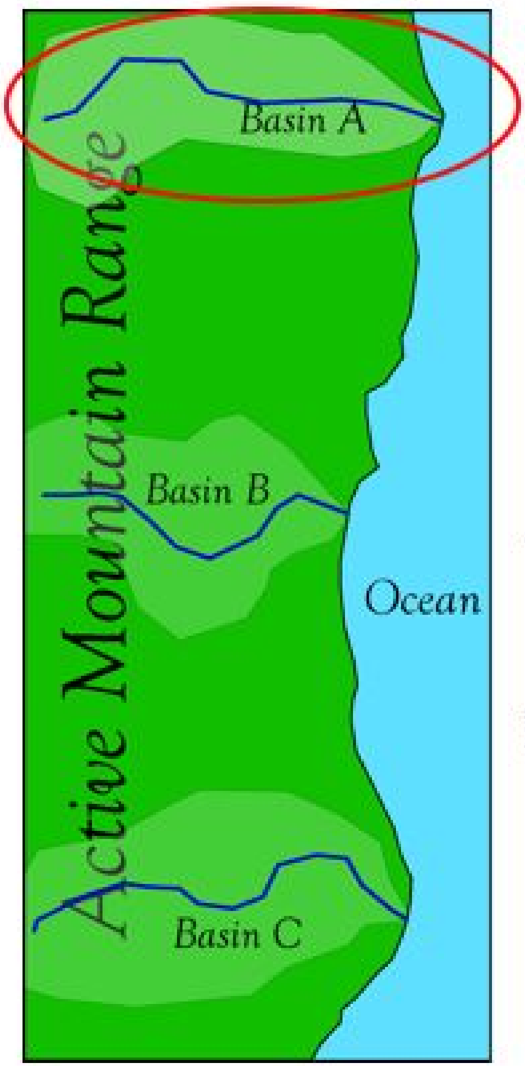
- What's happening with base-level?

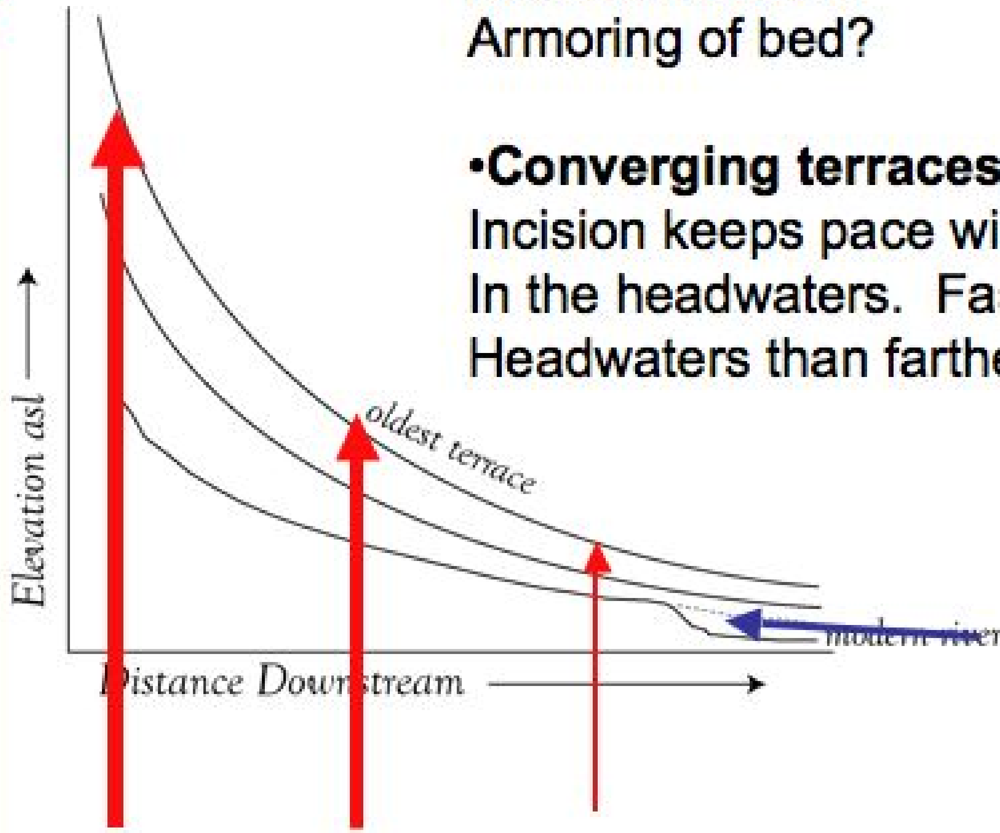
- Consider each basin Individually

-then-

- consider on relative Differences between basins

Basin A:



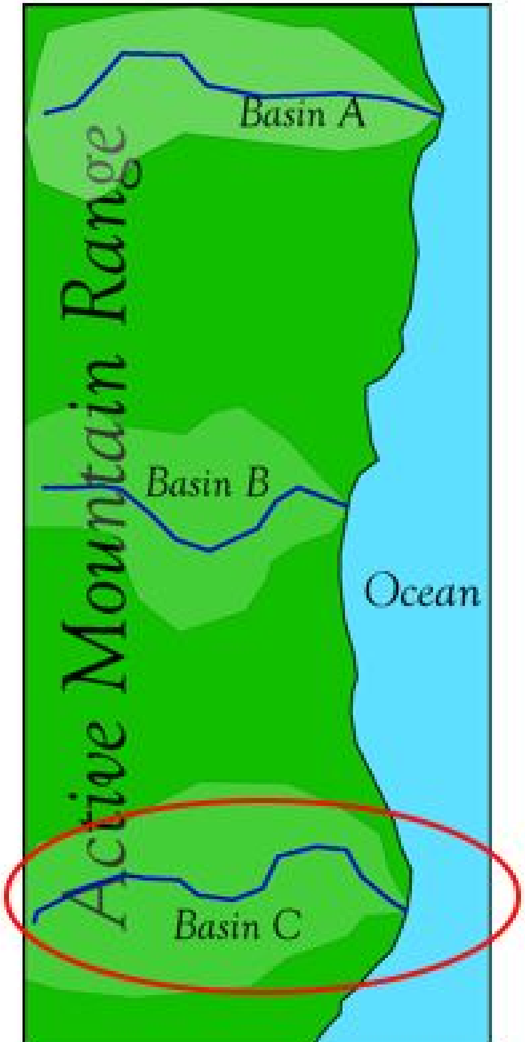


Differential Uplift

•**Headcut (knickpoint**) - sea-level fall
Not very far from base-level
Resistant rocks?
Armoring of bed?

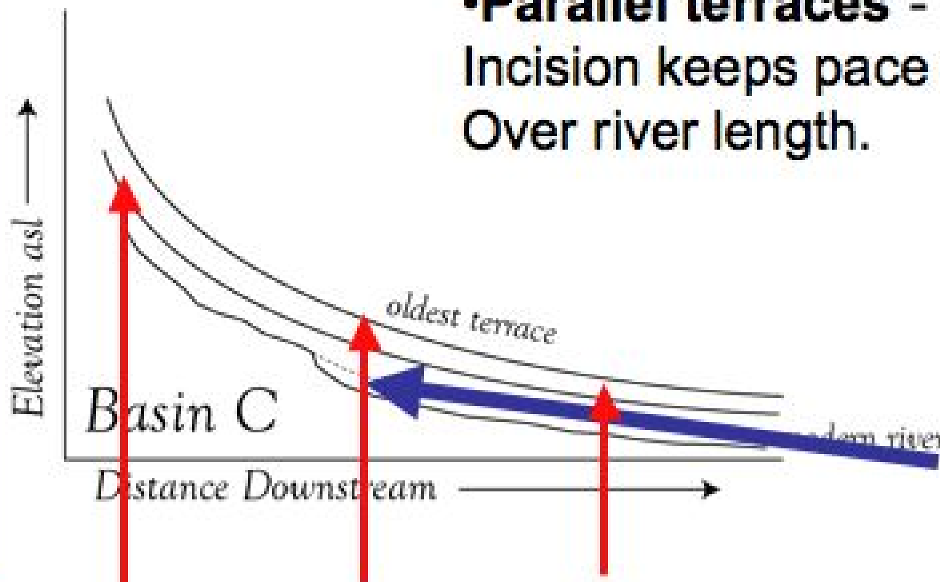
•**Converging terraces** - River
Incision keeps pace with uplift
In the headwaters. Faster in
Headwaters than farther downstream.

Basin C:



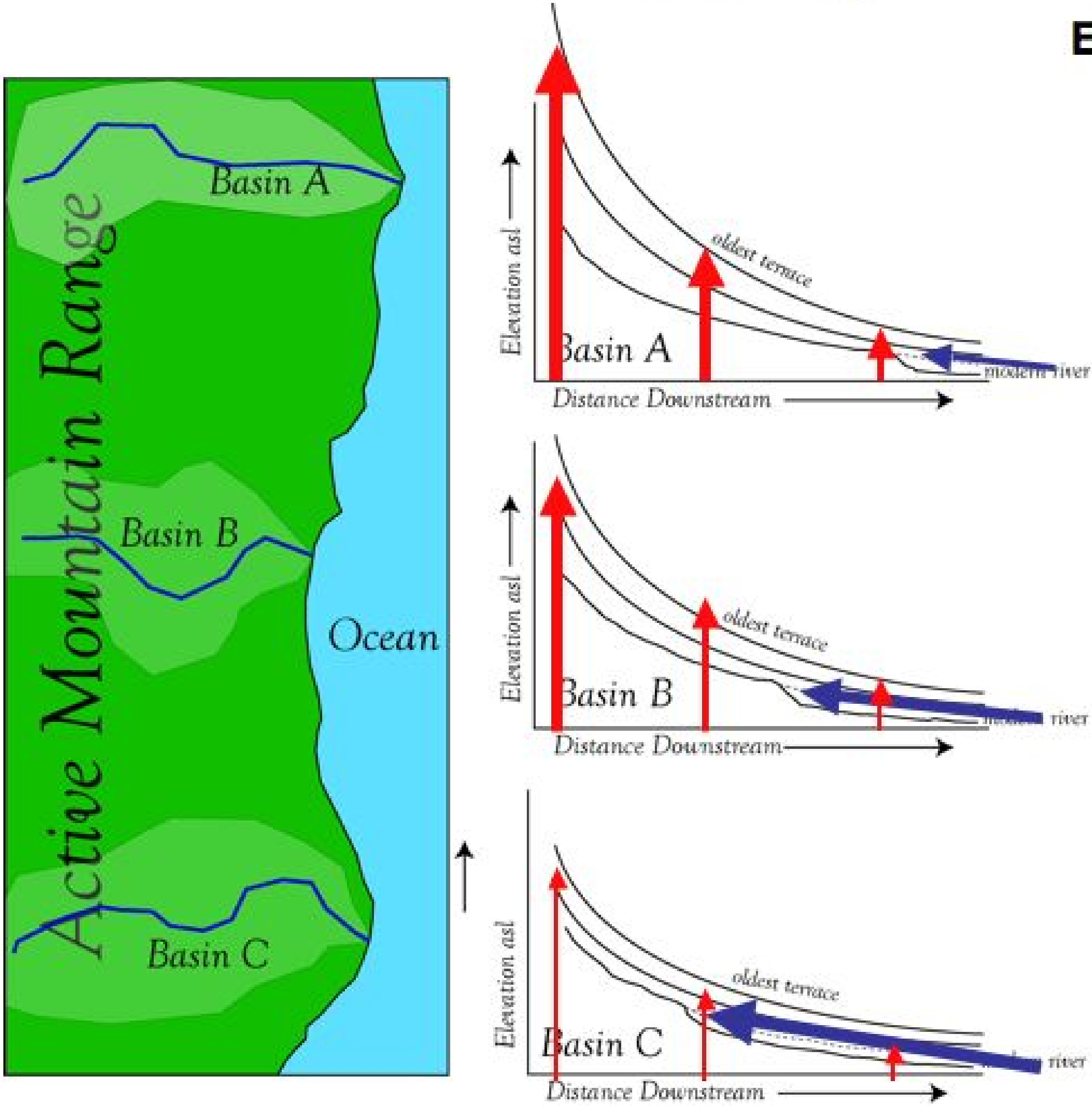
- **Headcut (knickpoint)** - sea-level fall
Pretty far from base-level
Less Resistant rocks?
Less Armoring of bed?

- **Parallel terraces** - River
Incision keeps pace with uplift
Over river length.

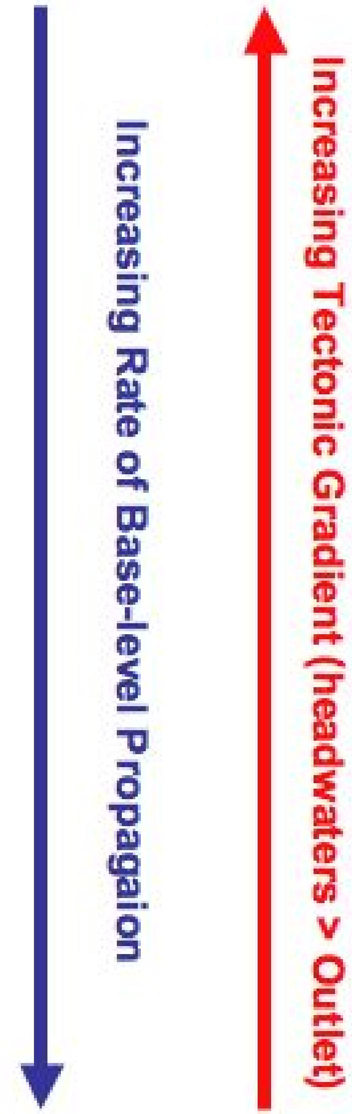


Uplift Rates same in headwaters
And outlet

Sum Up:



Easiest Interpretation:
(by no means the only one)



Lab Logistics:

- Back to the Huntington River Audubon center: Surveying terraces this time!
- Unraveling the deglacial and postglacial sequence of terraces.

What to bring:

- **Sturdy shoes or hiking boots**. We'll be scrambling up terrace scarps.
- Weather looks good (yeah!) but bring appropriate clothing just in case,
- Bring some food if you need constant calories like me,
- Pencil and clipboard for data collection,
- Cameras if you like pitures.