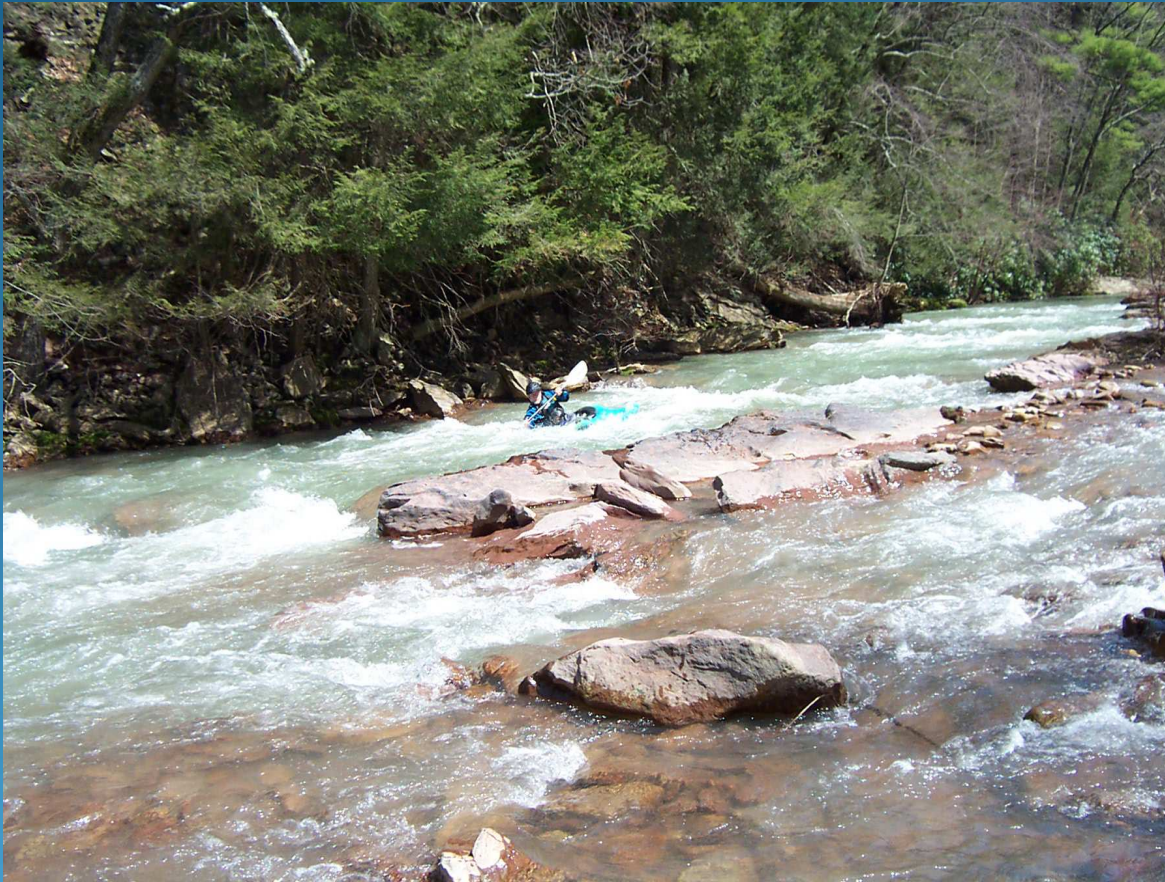


# River Features



*Nothing is weaker than water  
Yet nothing overcomes immovable objects  
As water does. There is no substitute.  
Thus, weakness overcomes strength  
And gentleness overcomes rigidity.  
No one denies it, and no one tries it.*  
— Laozi  
The Book of the Tao (6th century BC)

“When the well is dry, we know the  
worth of water.”  
— Benjamin Franklin

# Questions to answer:

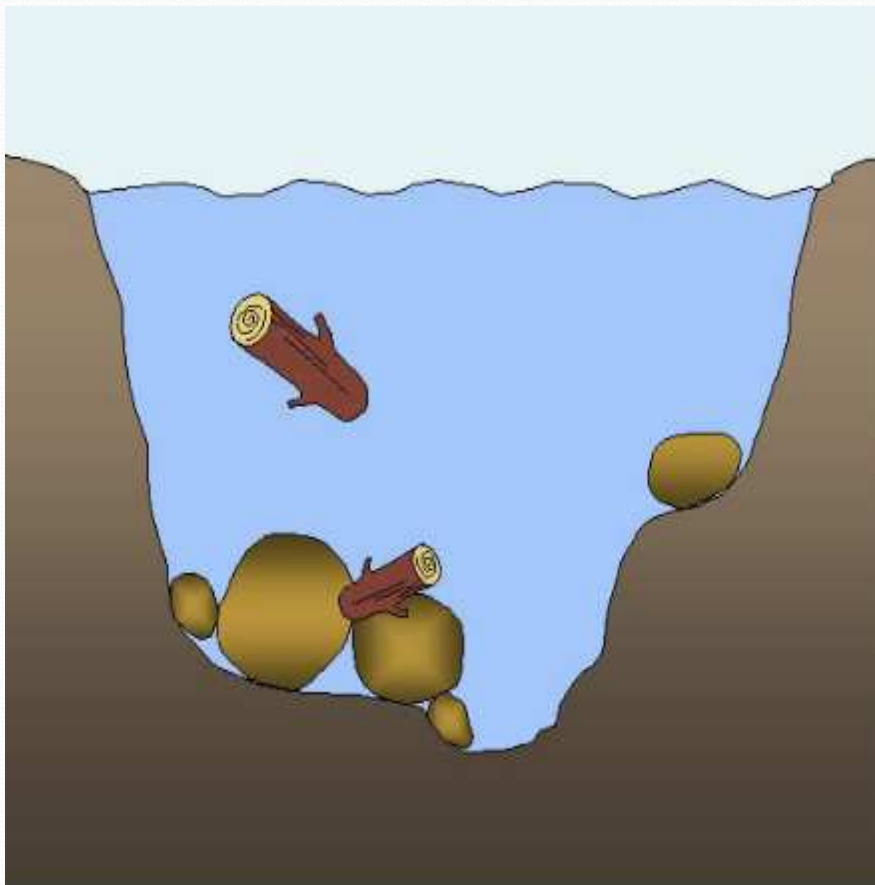
Consider these scenarios: Biker or skier on hill, paddler in a rapid.  
What is different about the paddler in terms of judging distance to objects?



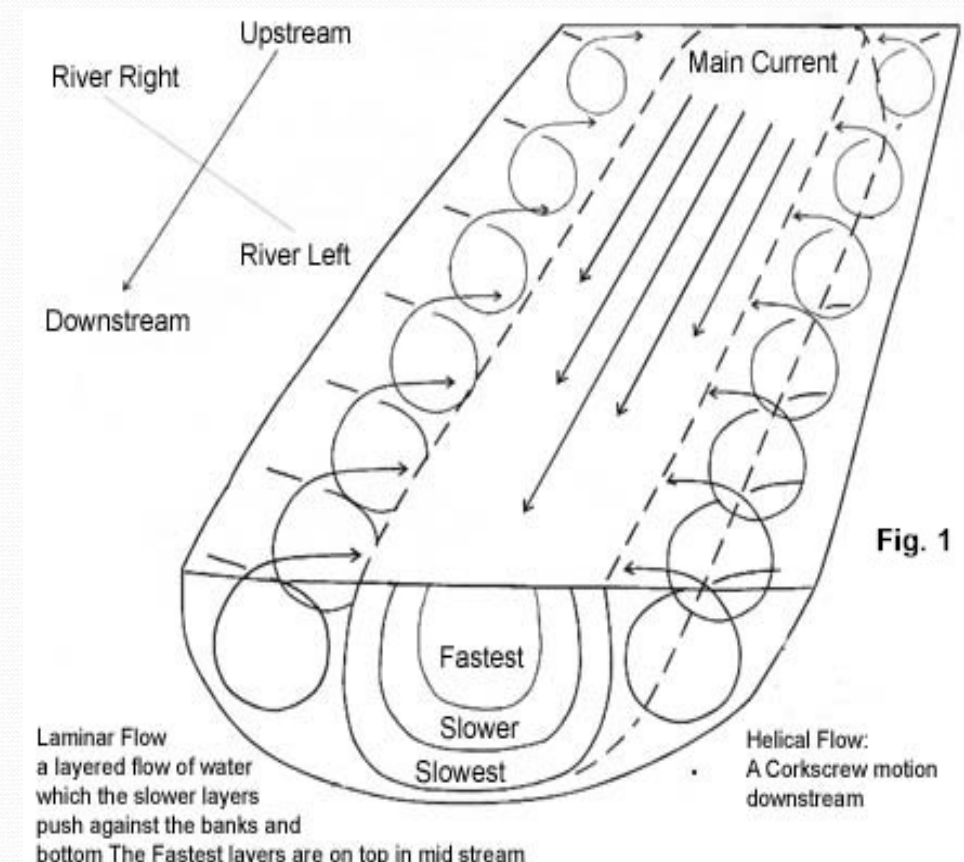
- When does water flow upstream?
- A downstream “V” indicates....?
- A “Horizon-Line” indicates...?
- A “Hole” can be dangerous because...?
- A “Strainer” can be dangerous because...?
- An “Eddy-Turn” is used to...?
- A “Peel-Out” is used to...?
- A “Ferry” is used to...?
- Why is a river-wave different than an ocean wave?

# How Does Water Flow?

Stream bed cross-section.

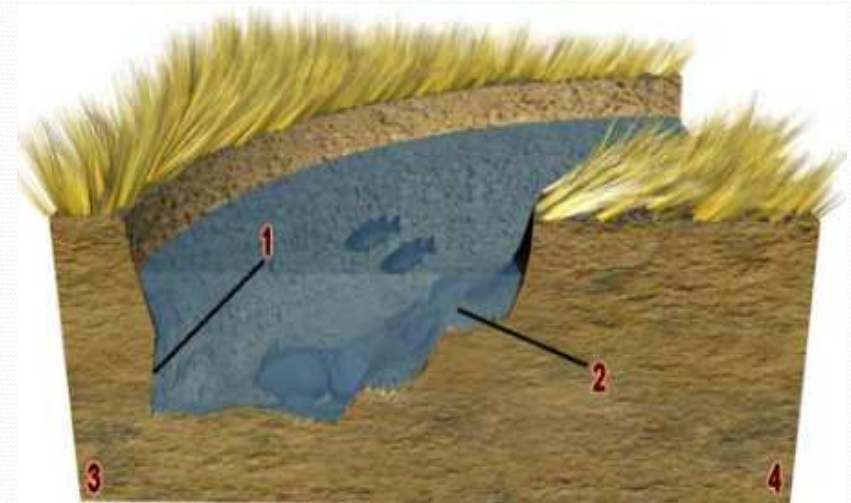
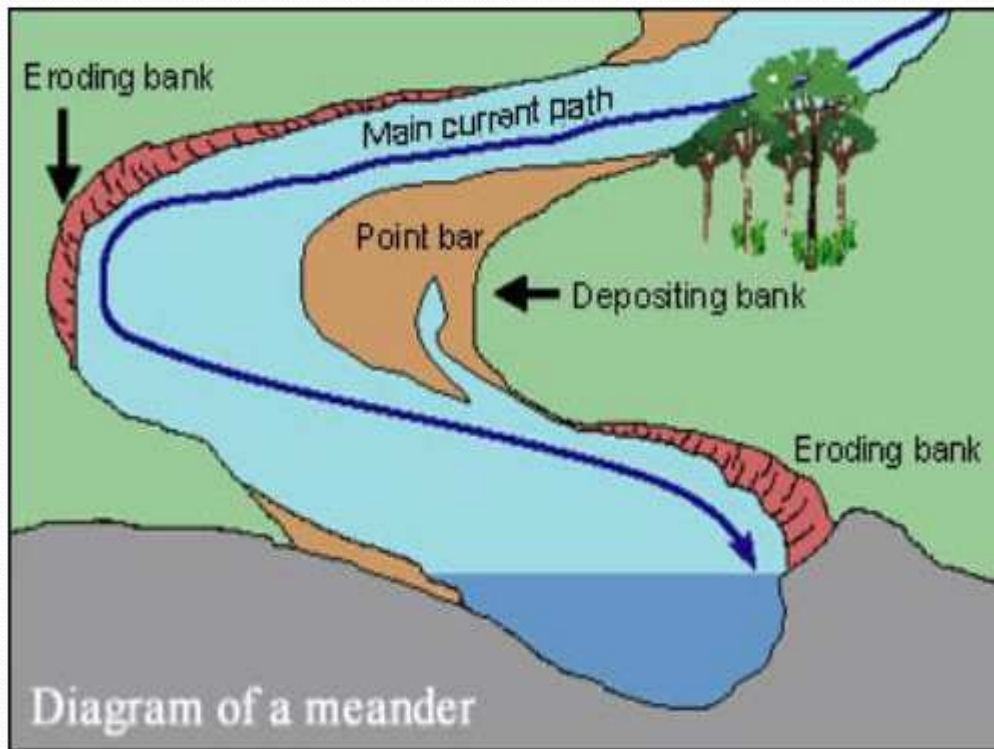


Where is it slow? Where is it fast?

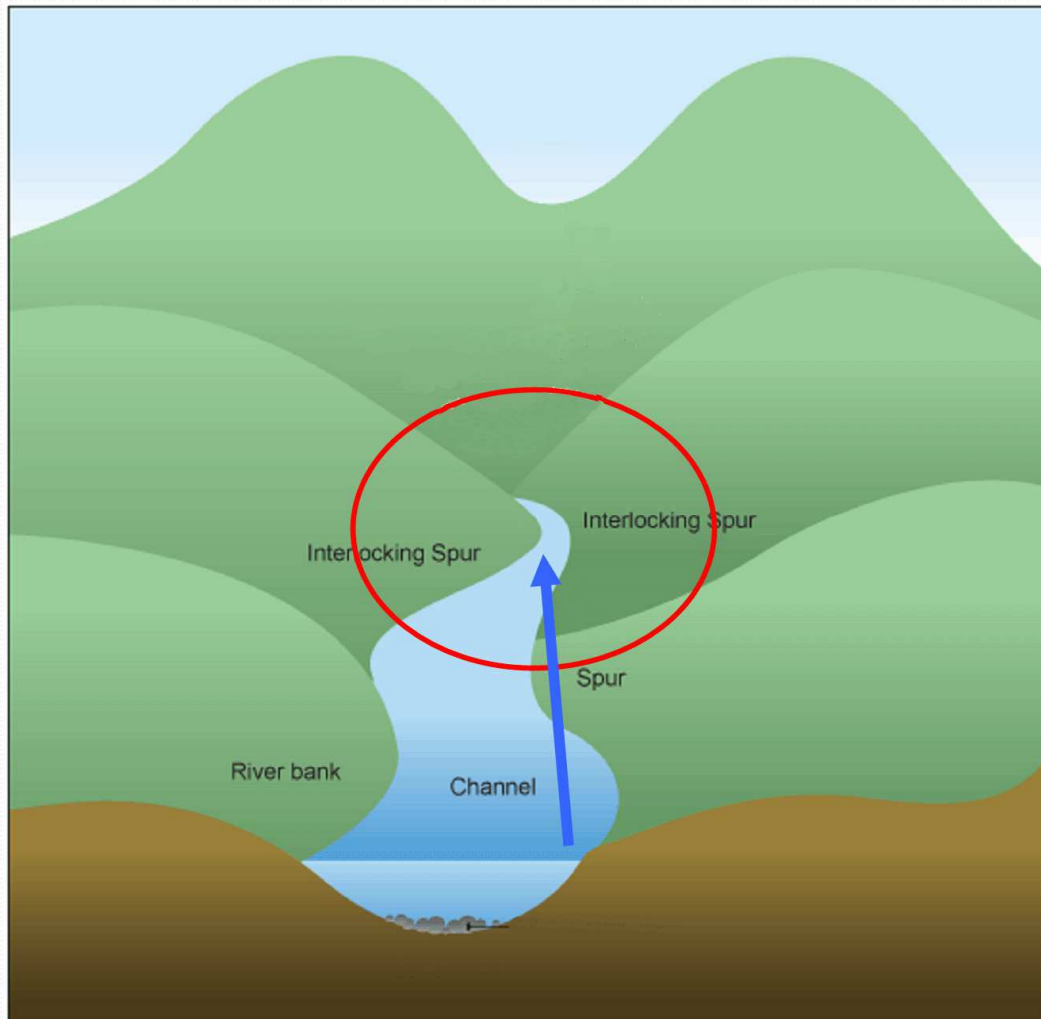


# River Bends (Meanders)

Changes in geology, terrain and elevation cause rivers to bend. Water volume and inertia erodes banks on the outside of bends. Sediment deposits build up on the inside of bends.



# Where Is This River Going?



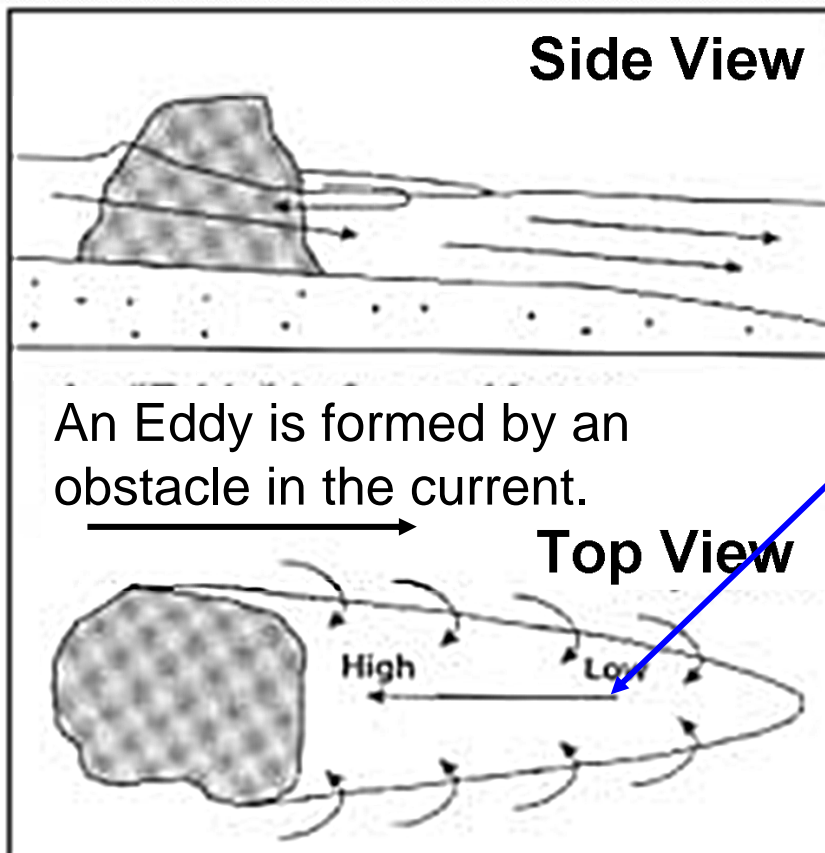
By observing changes in the terrain, a paddler can make an informed decision about the safest place to direct his/her boat.

The outside of a bend is likely to be deep, but water volume could push your boat against an eroded river bank.

Directing your boat toward the inside of a bend means that you are more likely to be in slower water and retain boat control.

# Eddy

An eddy is a place in the river immediately downstream of an obstacle, such as a rock or stump. The water seeks to back-fill the lower-pressure area behind an obstacle, forming a pocket of upstream current.

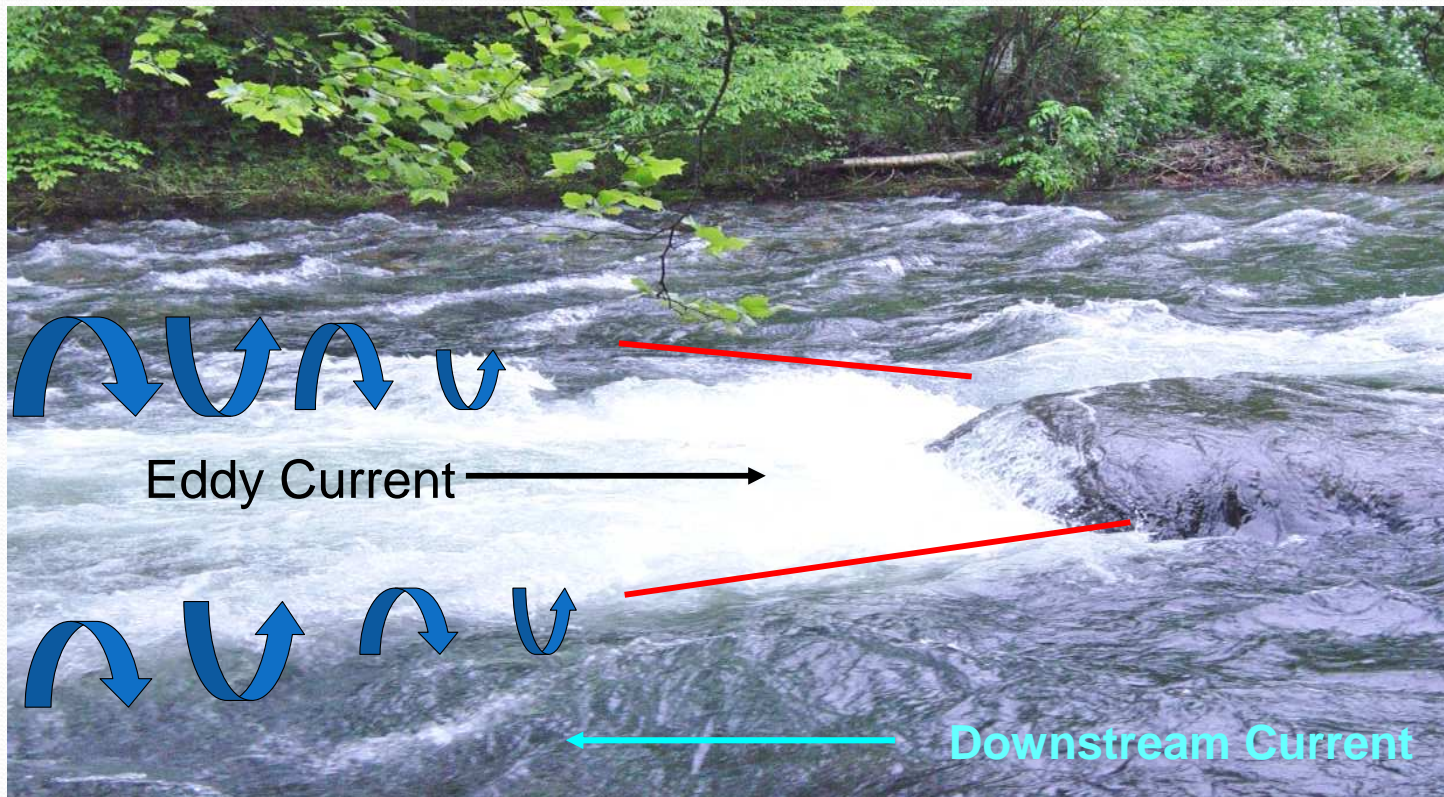


In an eddy, water flows UPSTREAM

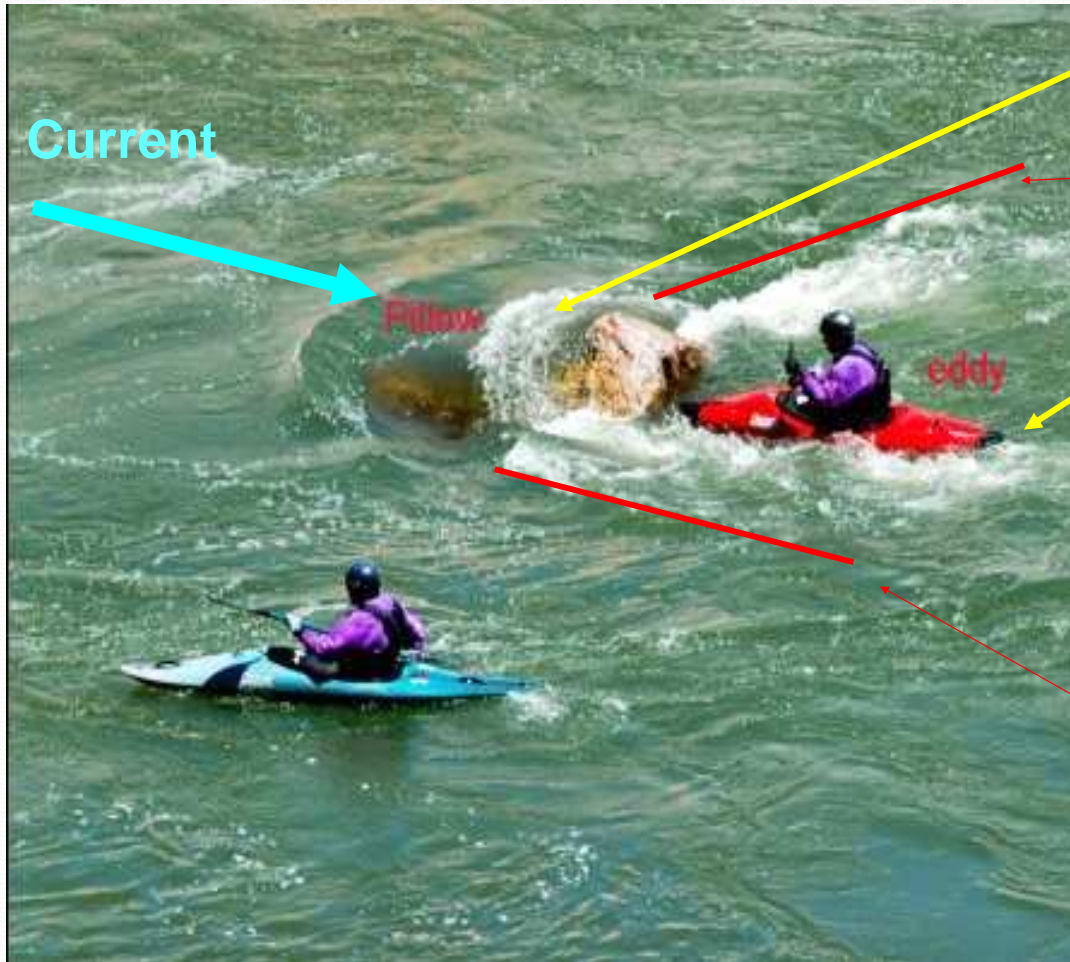


# Eddy Lines

- The line formed between the downstream current and the upstream current of an eddy.
- Eddy lines are well defined and predicable closest to the obstruction.
- Eddy and river currents mix in less-predictable patterns further from the obstruction.



# Paddlers Use Eddies To Maneuver



**Pillow on upstream face of rock.**

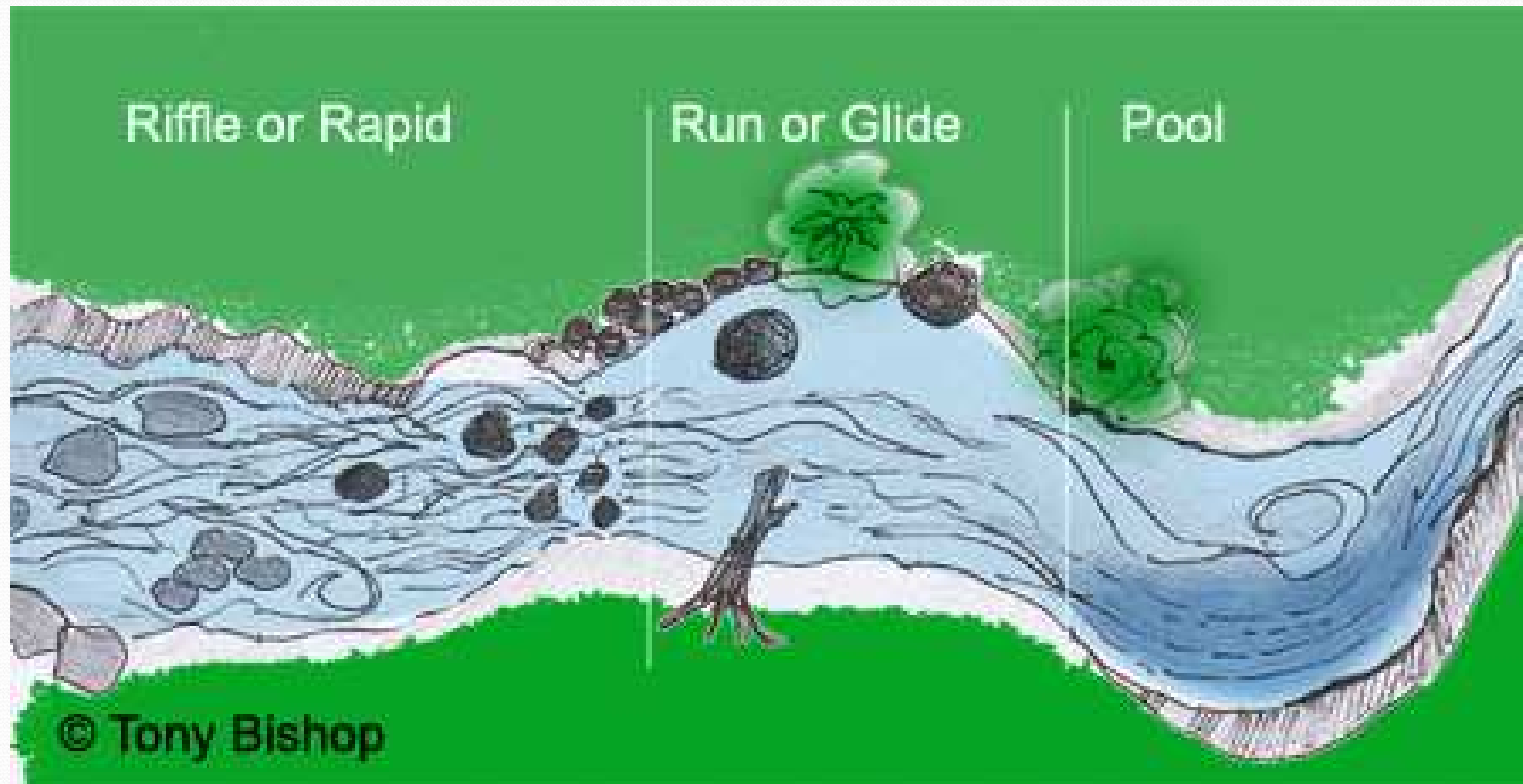
Eddy line

**Kayaker sitting in eddy and facing upstream. He is being drawn toward the rock.**

Eddy line

# What Forms a River Rapid?

- Gradient – Steepness or rate of descent.
- Water volume – Without water, no rapid.
- Obstacles - Rocks, logs, objects.
- Constriction – A narrowing of flow.



# Rapid and River Classification

Rivers and Rapids are rated in terms of difficulty in classes from I to VI.

- Class I rapids are easy to negotiate and require no maneuvering
- Class VI rapids pose threat to life with little or no chance for rescue.

**Example: Upper Lehigh River is rated Class II+ (normal flows) because it has some Class III rapids.**

River sections can also be rated in terms of Gradient:

- Gradient refers to the steepness of a rivers descent in elevation.
- Gradient is generally measured in feet per mile.

**Example: Upper Lehigh River gradient is 30 ft/mile (put-in to take-out).**

Water Volume (how much is flowing) is measured by USGS Gauges.

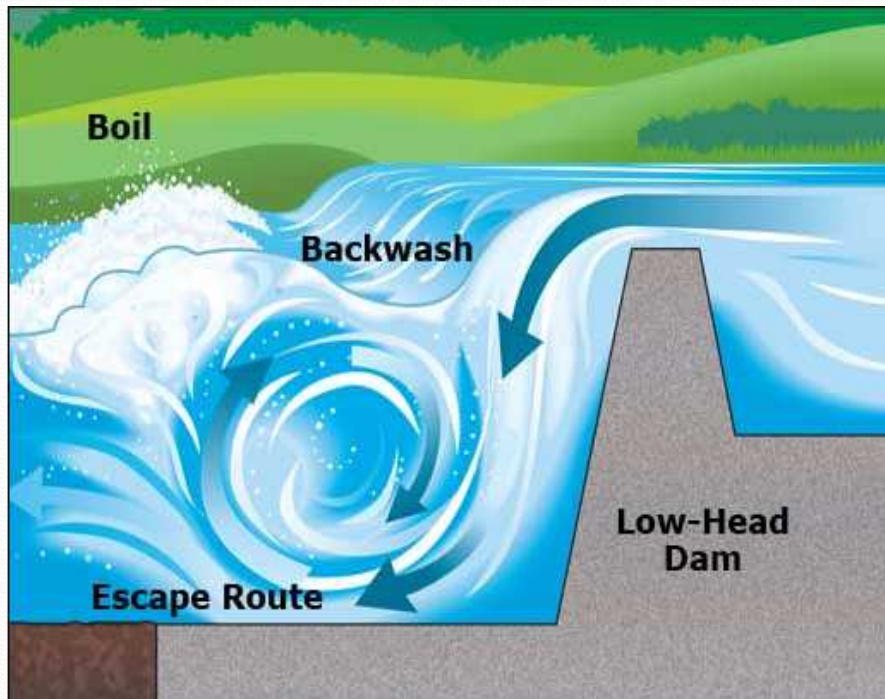
- CFS – Cubic Feet per Second (think... basketballs passing you in 1 second).
- Stage/Ft – Measurement by water height

**Example: Typical whitewater dam release on Upper Lehigh ranges from 600 - 800cfs.**

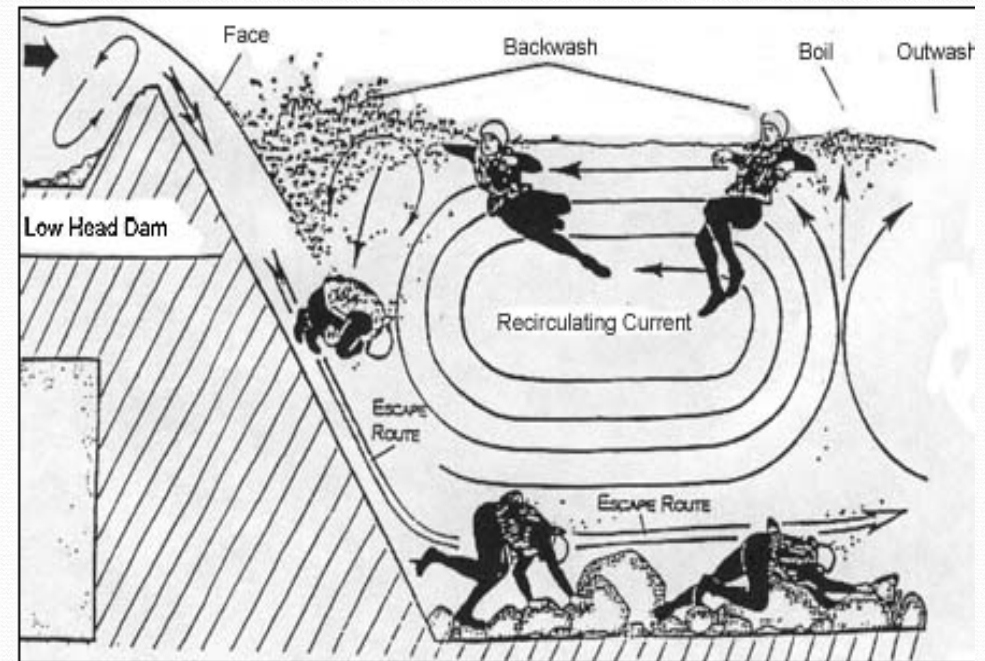
# Hazard: Hydraulics (aka Holes)

When water falls over an object, it picks up speed and air. Vertical drop creates recirculation effect. The more vertical the drop, the more the recirculation (hydraulic) effect.

Hydraulic effect of water falling.



Recirculation Danger



# Human-Made Hydraulics

The more river-wide and even a dam is, the more dangerous it is due to difficulty of escape for a swimmer.

Nickname for low-head dams: “Drowning Machines.”



## Boil Line

An often visible line where water that is being drawn back into the hydraulic is divided from water flowing downstream.

# Natural Hydraulics (Holes)

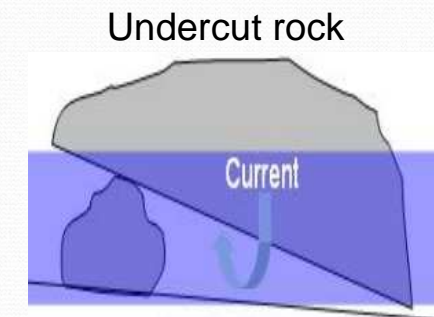
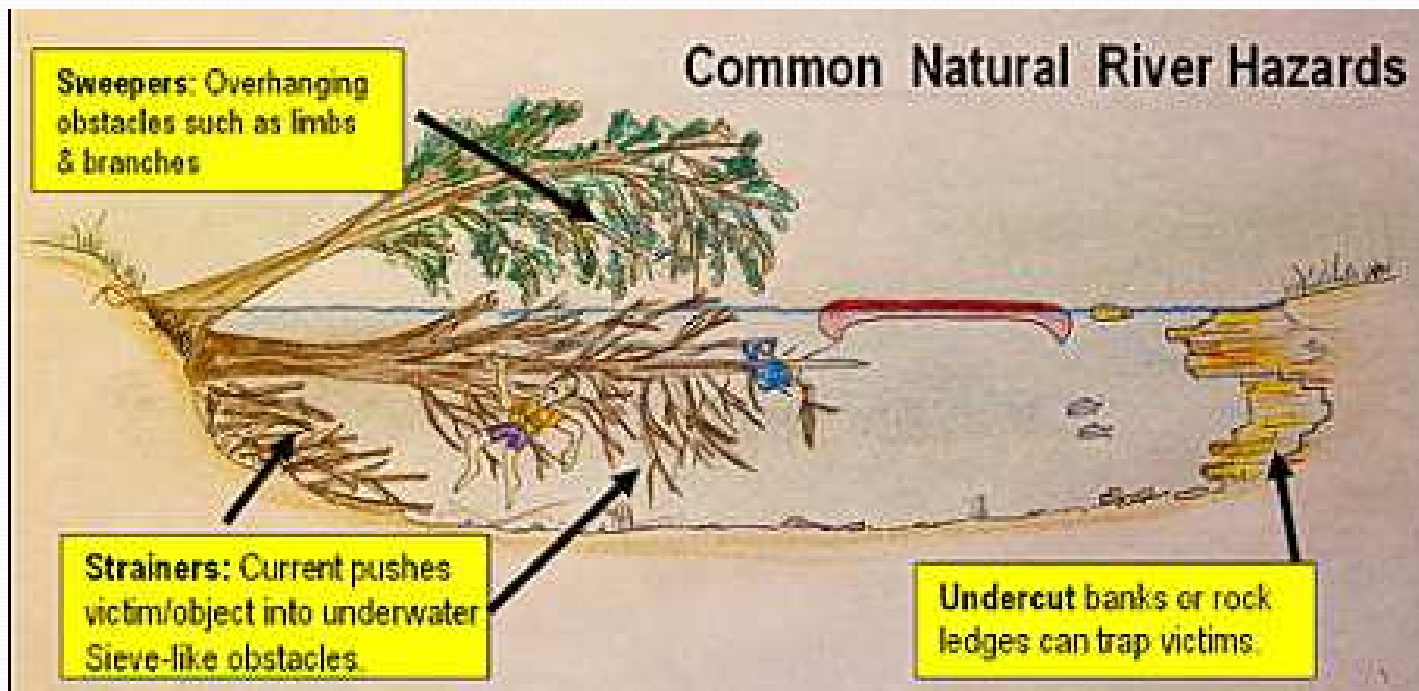
**Rocks and uneven ledges can be as dangerous as low-head dams and also form hydraulics. Natural hydraulics are usually uneven and can present both challenges and fun for paddlers.**

**Experienced paddlers learn to distinguish the difference between fun and dangerous holes.**



# Hazard: Strainers

**Anything that water can move through, but you can't!** They can be natural or man-made. High-water conditions can break loose trees and man-made objects. Loose cable, rope or fishing line can cause strainer-like entanglement. Undercut rocks allow current to pass and have little or no upstream pillow.



Strainer: Tree in current



# Approach Potential Hazards With Caution

Pour-overs, dams and ledges are often visible from upstream as a Horizon Line.



A narrowing of the river and a “line” indicates a drop.

When in doubt – get out and scout!

# Fun Hydraulics and Surf Waves

**OCEAN WAVES are MOVING and caused by surface water friction from wind.**

**Ocean wave surfing**



**RIVER WAVES are STATIONARY and caused by water flowing over obstacles.**

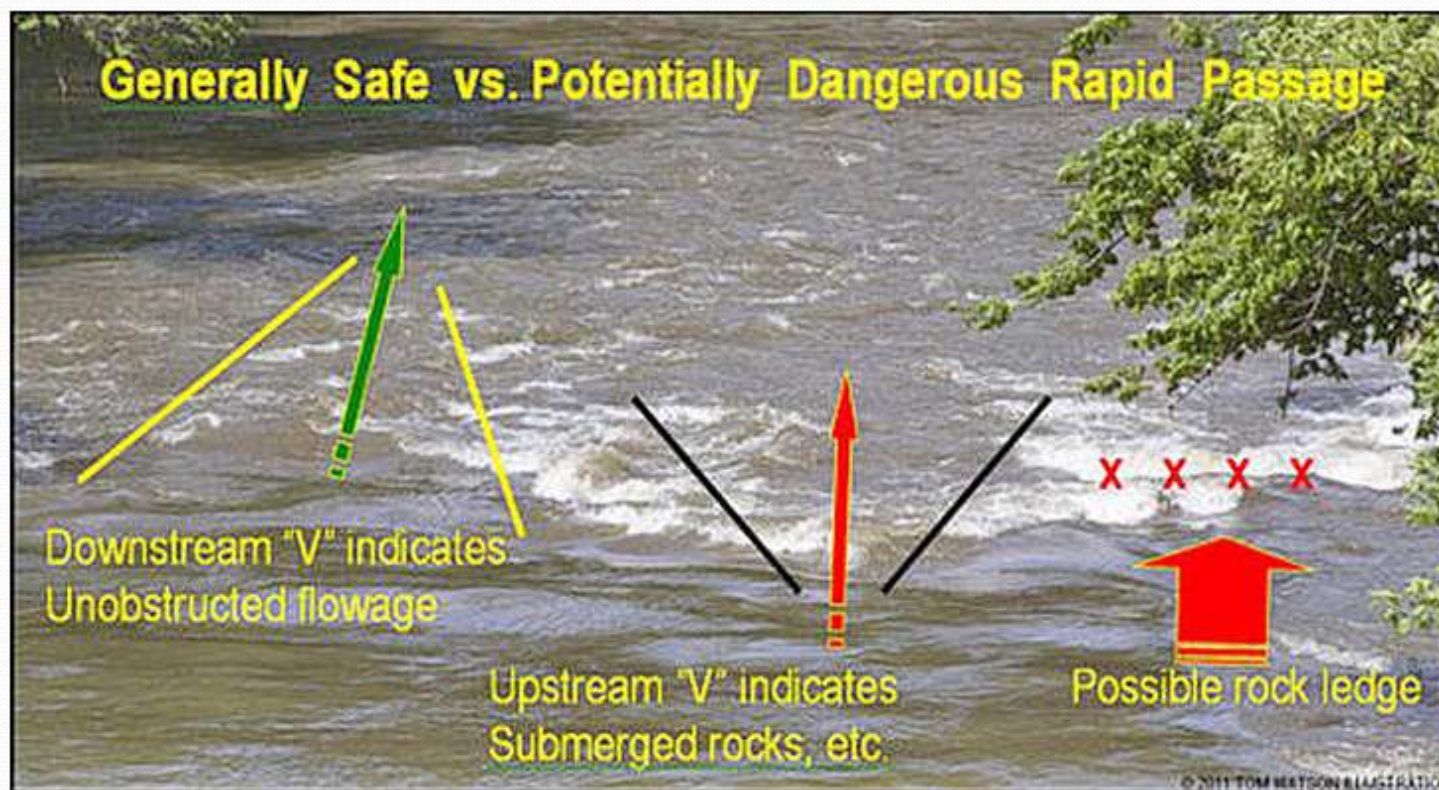
**River wave surfing**



# Reading Water

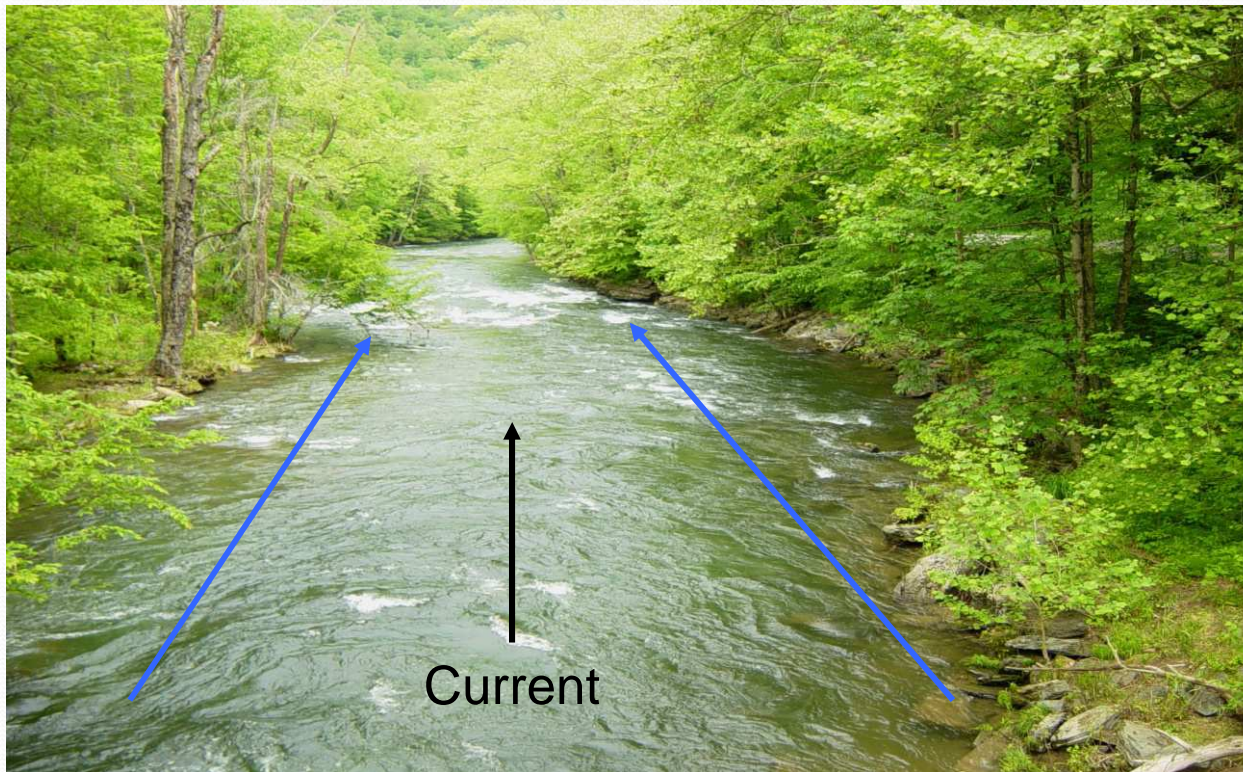
Water always takes the path of least resistance. Generally, wherever most of the water is going, will be the *least-resistant* route for a paddler.

Looking from upstream, eddies formed by rocks will create down-stream “V”s



# River Left/River Right

- Describes position on the river as you look downstream.
- Downstream is ALWAYS the frame of reference.



River Left

River Right

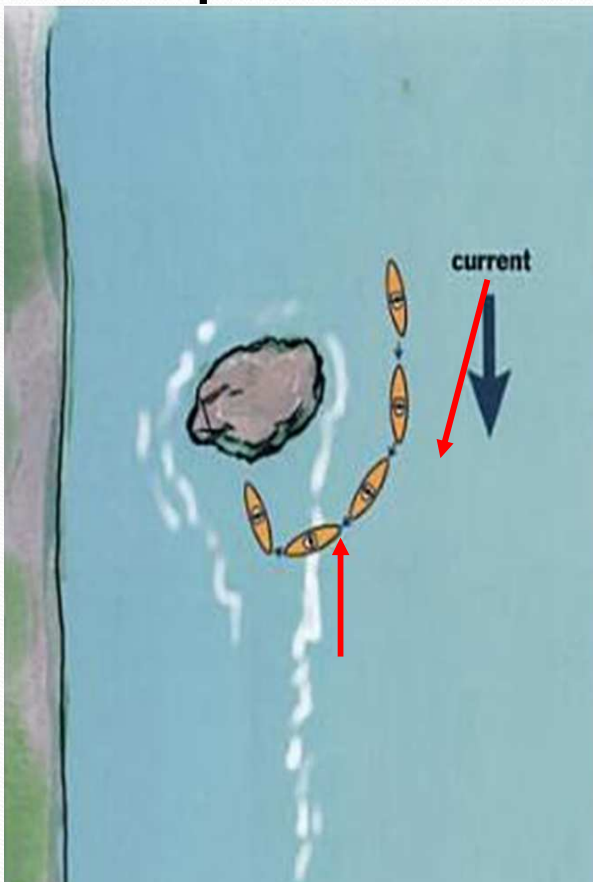
# How Do Paddlers Maneuver In Rapids?

## Three basic moves:

- **1) Eddy-Turn** - Used to enter an eddy from upstream.
- **2) Peel-Out** - Used to exit an eddy and continue downstream.
- **3) Ferry** – Used to move laterally from one side of river to another.

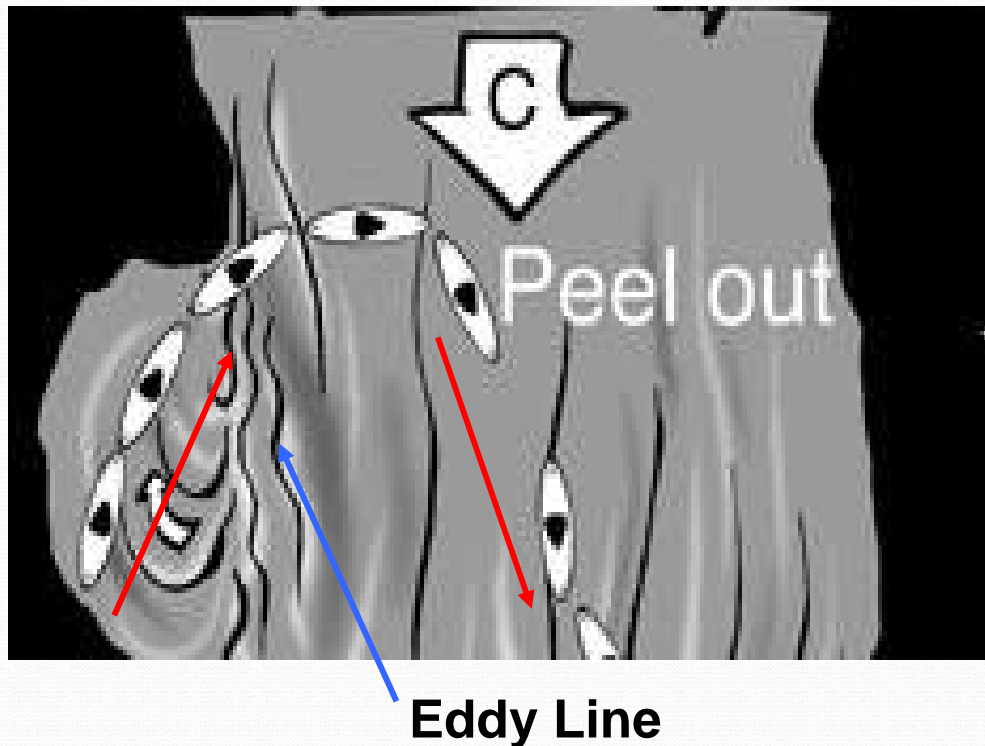
# Eddy Turn

- Used to get INTO an eddy.
- From upstream, enter an eddy and allow boat to spin. End up facing upstream.



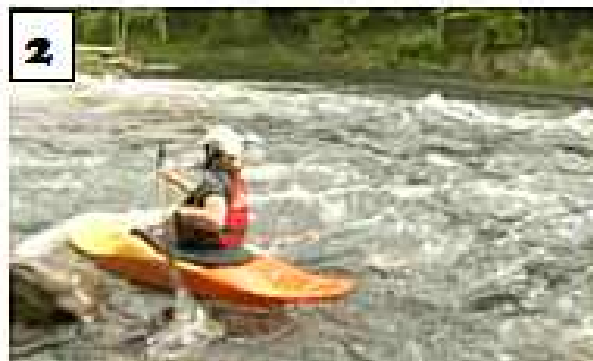
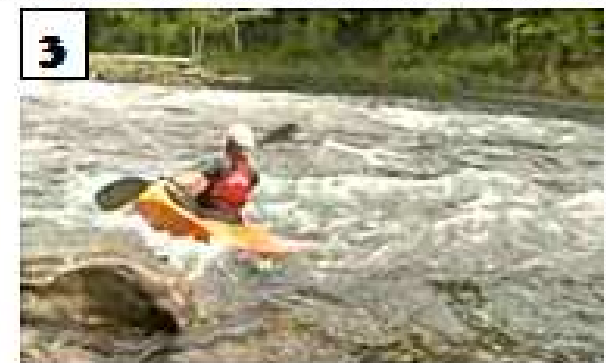
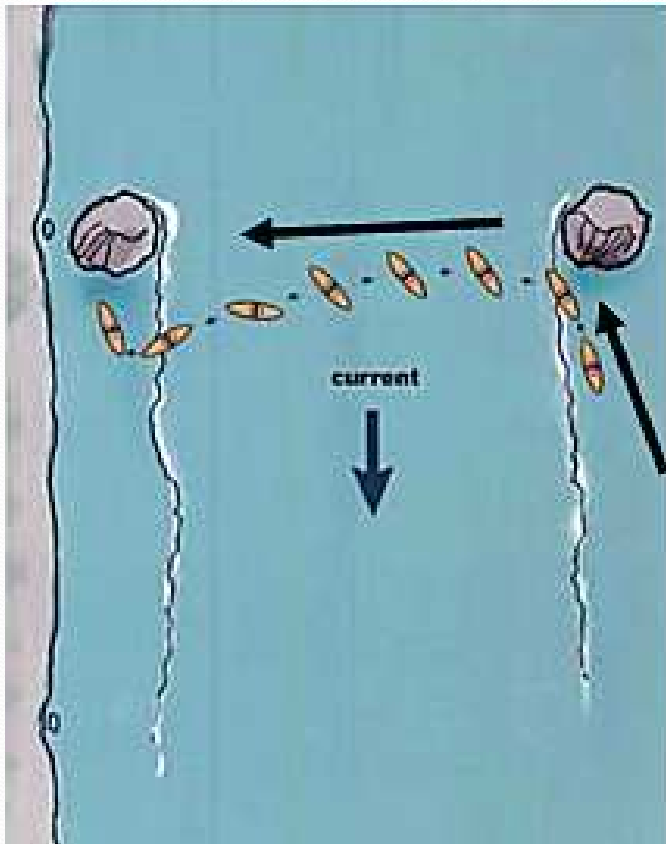
# Peel-Out

- Used to get OUT of an eddy and back into current.
- Facing upstream, exit eddy, allow boat to spin. End up paddling downstream.



# Ferry

- Used to cross current laterally.
- Facing upstream, exit eddy, keep boated pointed (mostly) upstream, maintain a angle, cross to opposite side of current (river).





A class II rapid.



A class III rapid.