

Weather 101: Fundamentals of River Ice Formation



*Slides provided by: Andy Dixon of GRR (formerly AFC)
Local photos & info provided by: Ed Plumb & Heather Best*

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WFO Fairbanks, AK

Meeting Etiquette

1. Everyone will be muted during the presentation except for when there are questions
2. There will be time at the end for questions BUT if you have one you want to ask in the moment, please feel free to either raise your hand OR send it in the chat
 - a. Same for poll questions/Q & As
3. Slides will be available at the end of the presentation for those who are interested!

Introductions!

Feel free to answer these questions in the chat:

1. Where are you joining from? (city, state, country, etc)
2. Do you already know about river ice/breakup?
3. What are you most excited to learn about in this presentation?

Definitions to know:

Anchor ice – submerged ice attached or “anchored” to the river bed, regardless of the nature of its formation

Border ice – ice formed along and fastened to the shore that does not extend across the entire width of the river (AKA “shore ice”)

Frazil ice – Fine, small, needle-like structures or thin, flat, circular plates of ice suspended in water

Ice chunks – small pieces of ice that are <10% of the river’s width in size

Ice pans – pieces of ice that are up to 10-50% of the river’s width in size

Definitions to know:

Ice sheets – large pieces of ice with length greater than width and the width is $>50\%$ of the river's width

Ice jam – when river ice has stopped moving due to any variety of reasons and is characterized by a long stretch of tightly packed chunk ice

Ice jam flood – water spreading over the river banks upstream from an ice jam

→ can lead to village floods and/or widespread flooding

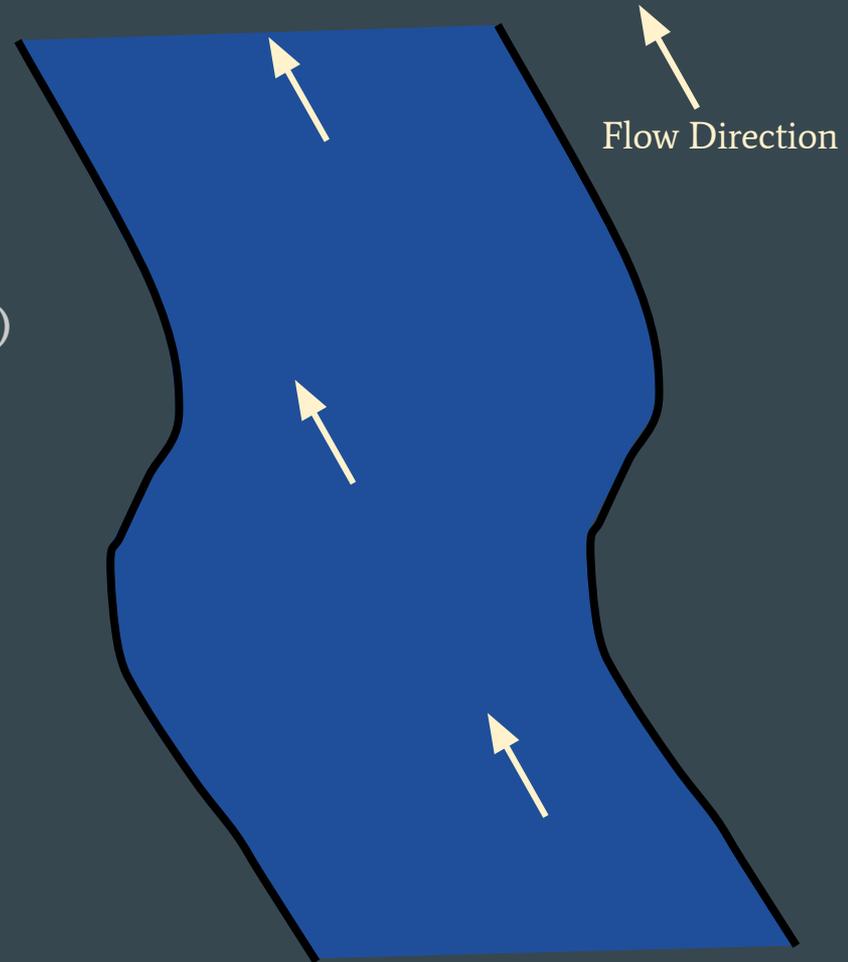
Breakup jam – accumulation of broken ice pieces that restrict the flow of water

Freezeup jam – accumulation of frazil ice that restricts the flow of water

River Ice Formation

River begins ice-free

Changes in the river (AKA river ice growth) doesn't start to occur until the river temperature uniformly reaches 32F.



River Ice Formation

Stationary and smooth **Border Ice** starts to form in the shallower and slower-moving water on the sides of the river (usually when daily avg T < 20F)

Frazil Ice (slush) forms in the turbulent flow and tumbles through the water as it is carried downriver

- Similar conditions across large sections of the river
- Water levels rise slowly because the “pipe is getting clogged” with ice

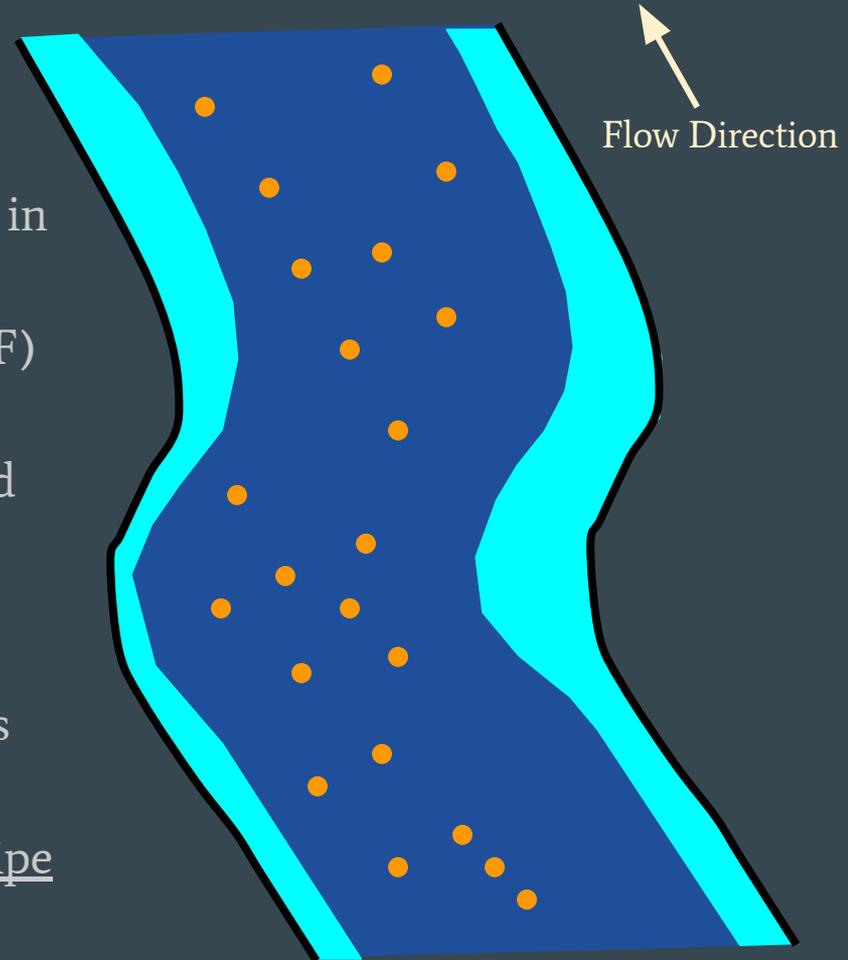




photo by S. Beltaos

Border Ice

Frazil Ice



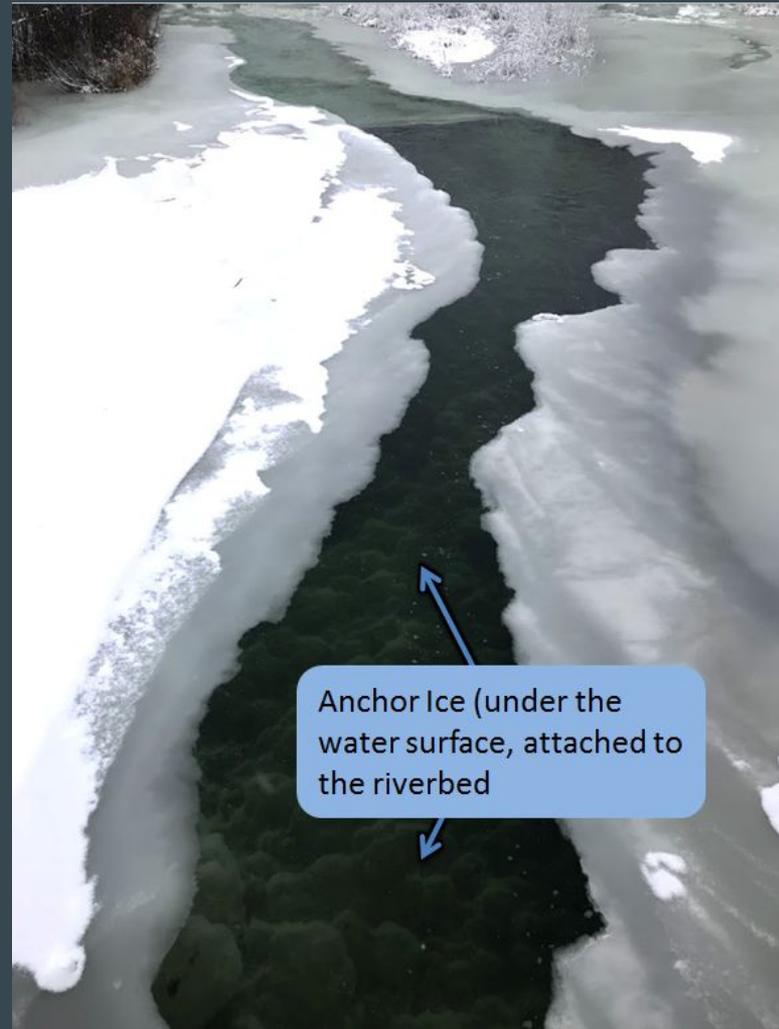
River Ice Formation

In some faster-flowing streams, a third type of ice called Anchor Ice forms during very cold temperatures.

This occurs when frazil particles “stick” to rocks and logs on the riverbed, obstructing flow down the river even more!

Can grow to become part of border ice.

Water levels continue to rise!

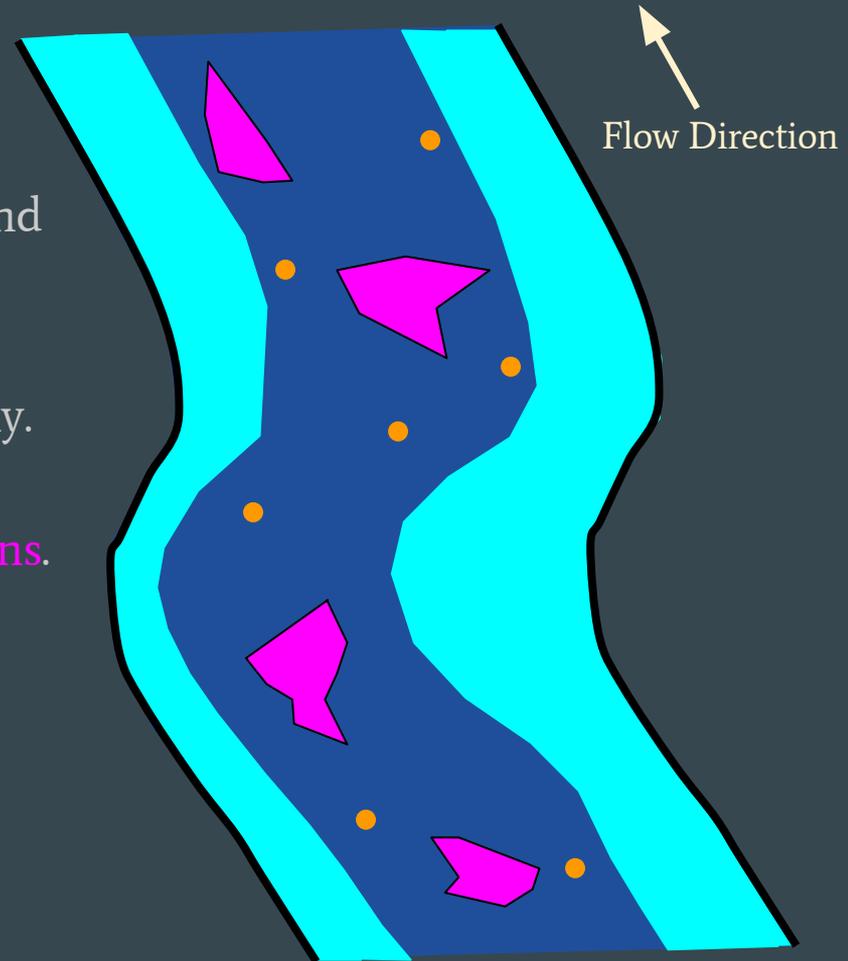


River Ice Formation

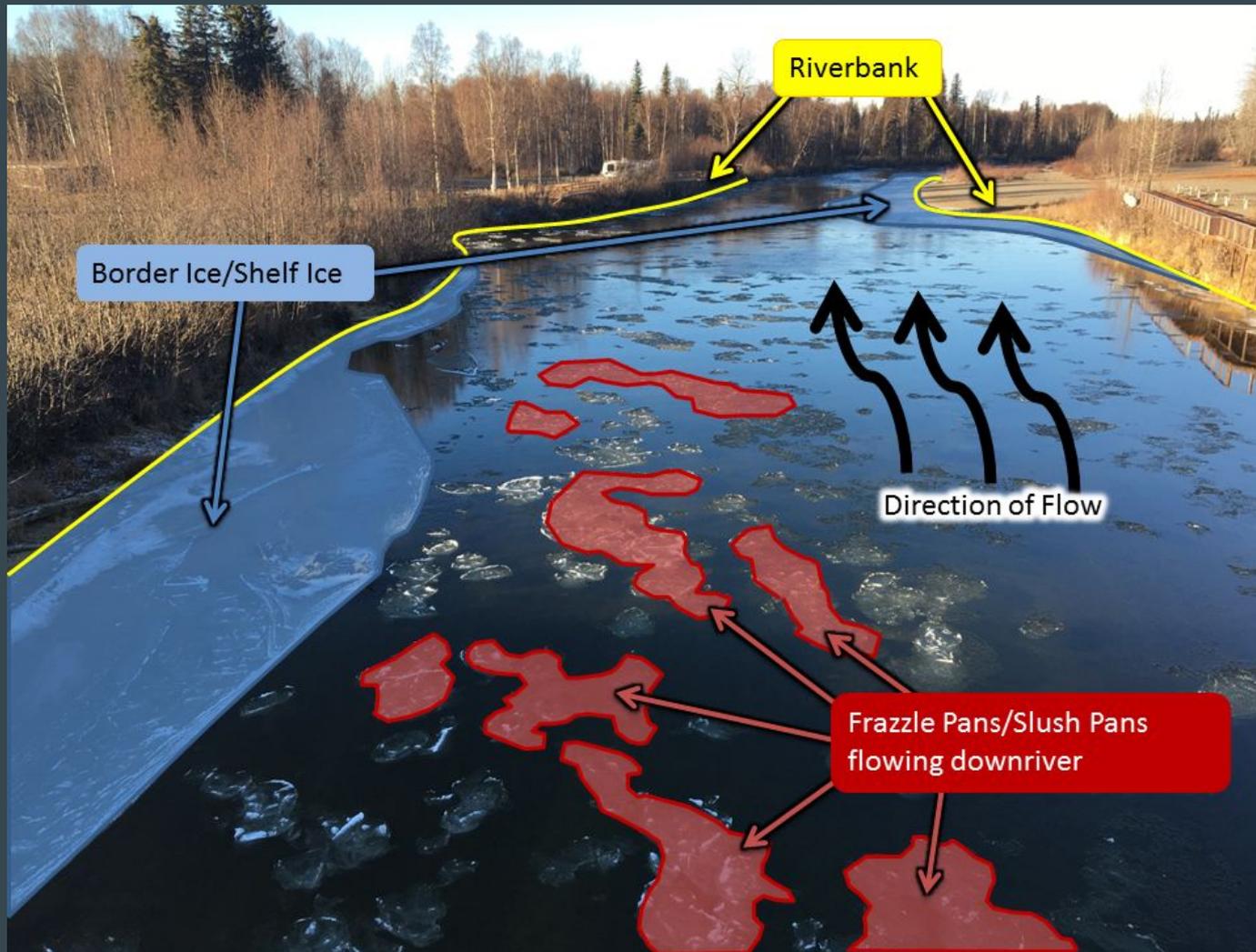
As cold continues, **Border Ice** continues to expand on both sides of the river

Frazil Ice particles are supercooled, and act sticky. Over time, they stick to each other and begin to float on the top of the moving water in **Frazil Pans**.

- Water levels continue to rise slowly



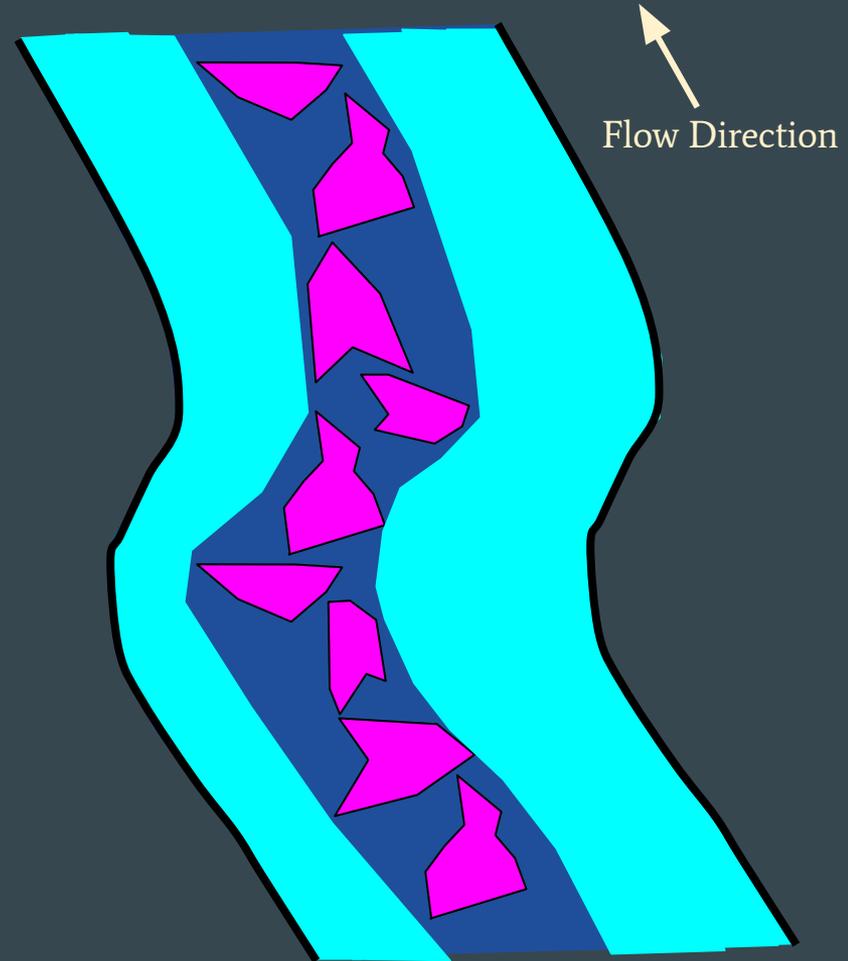




River Ice Formation

If cold (but not bitter cold) continues, **border ice** and **frazil pans** both continue growing in size. Eventually, the open channel is so small that the frazil pans can't make it through, and their forward progress is **stopped**.

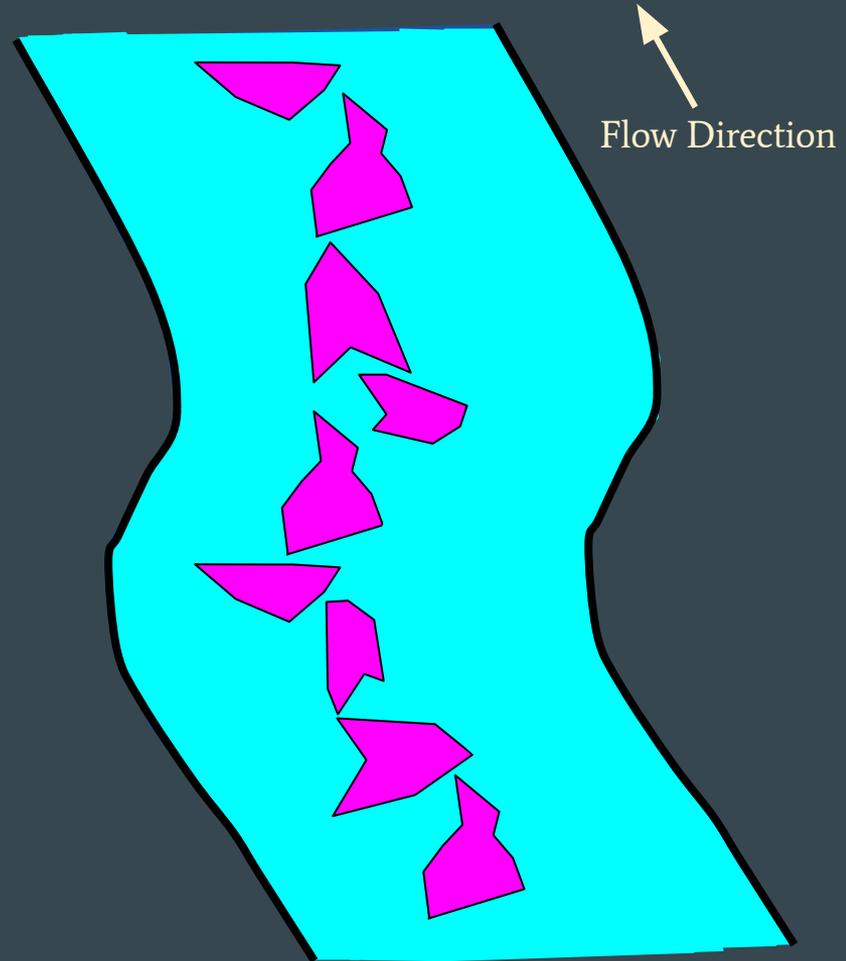
- Water levels continue to rise slowly



River Ice Formation

Border ice continues growing, surrounding the frazil pans, and eventually meets in the middle of the river. This thickens, and becomes a solid/stable ice cover.

- Water levels stabilize until the next significant warmup (or until Spring in far northern climates).





Question Time!

1. Which type of ice forms in shallow, slow-moving water on the sides of the river?
 - a. Border ice
 - b. Frazil ice
2. Which type of ice forms when frazil particles “stick” to rocks and logs on the riverbed, obstructing flow downriver?
 - a. Border ice
 - b. Anchor ice

Question Time!

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a. Border ice



b. Frazil ice

2. Which type of ice forms when frazil particles “stick” to rocks and logs on the riverbed, obstructing flow downriver?

a. Border ice

b. Anchor ice



Ice Jams

Two types:

Freeze-up Jams (rare)

- Happen when it's cold (<10F) and ice growth is rapid
- In most cases, **minor impacts** since flow is usually low and dropping
 - More likely to impact travel along river corridors than life/property

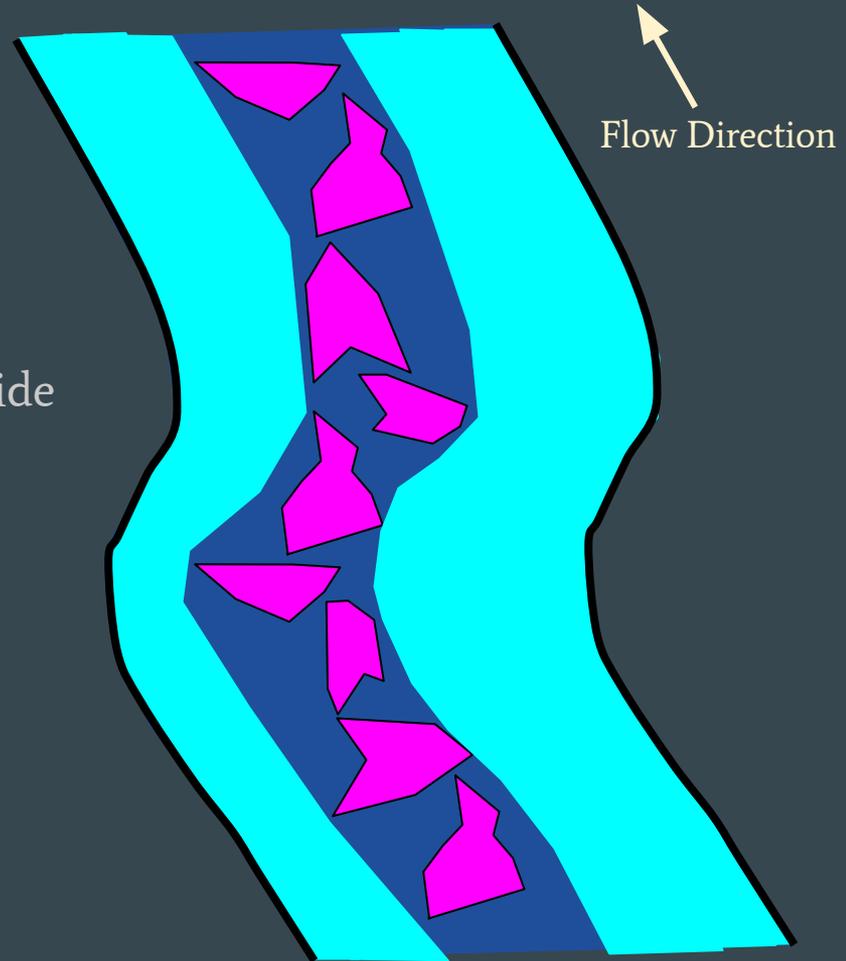
Break-up Jams (common)

- They occur every spring along most river channels
- Increasing snow melt and river flow can lead to **significant impacts**

Freeze-up Ice Jam

When it is really cold (<10F) the river makes ice faster than it can handle:

- There are so many frazil pans that they collide and may get jammed up in a constriction before freezing together.



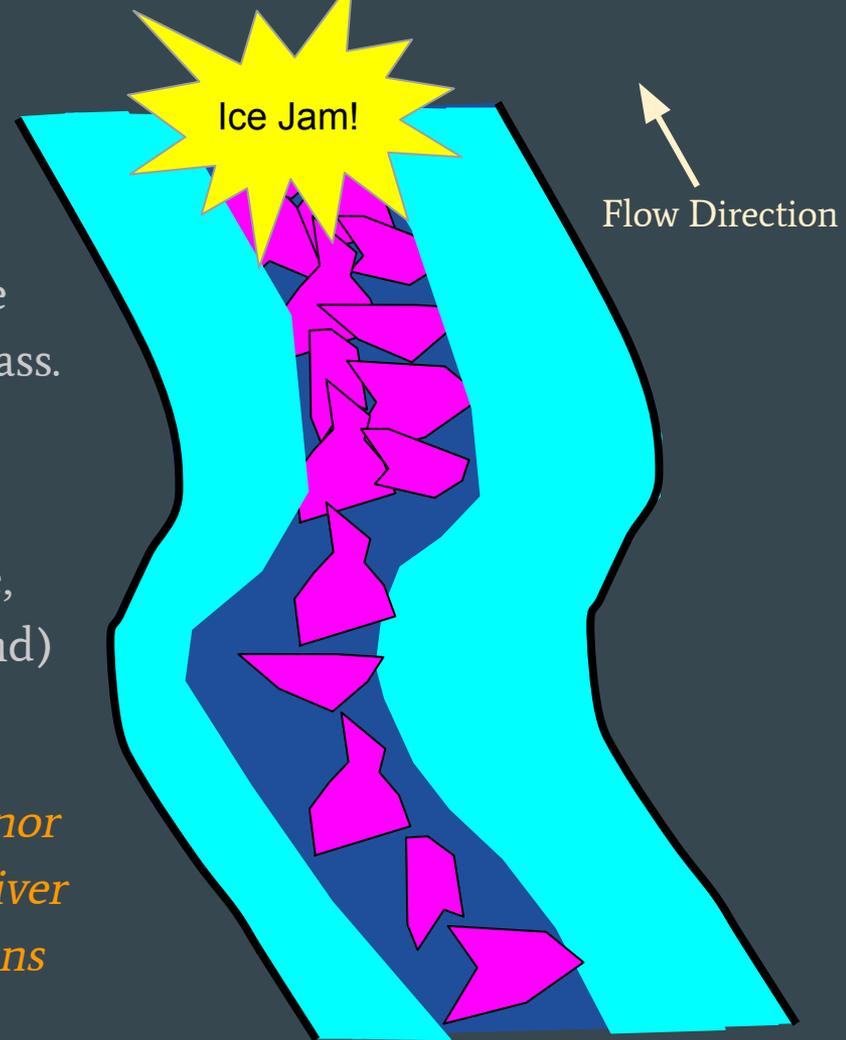
Freeze-up Ice Jam

This causes a collapse and thickening of the frazil ice into an increasingly obstructive mass.

BOOM! → **Freeze-up Ice Jam!**

The ice jam now “clogs the pipe” even more, causing water levels to rise upstream (behind) the jam

**Note: Freeze-up ice jams usually only cause minor flooding, as the overall amount of water in the river is typically low and falling during these conditions*





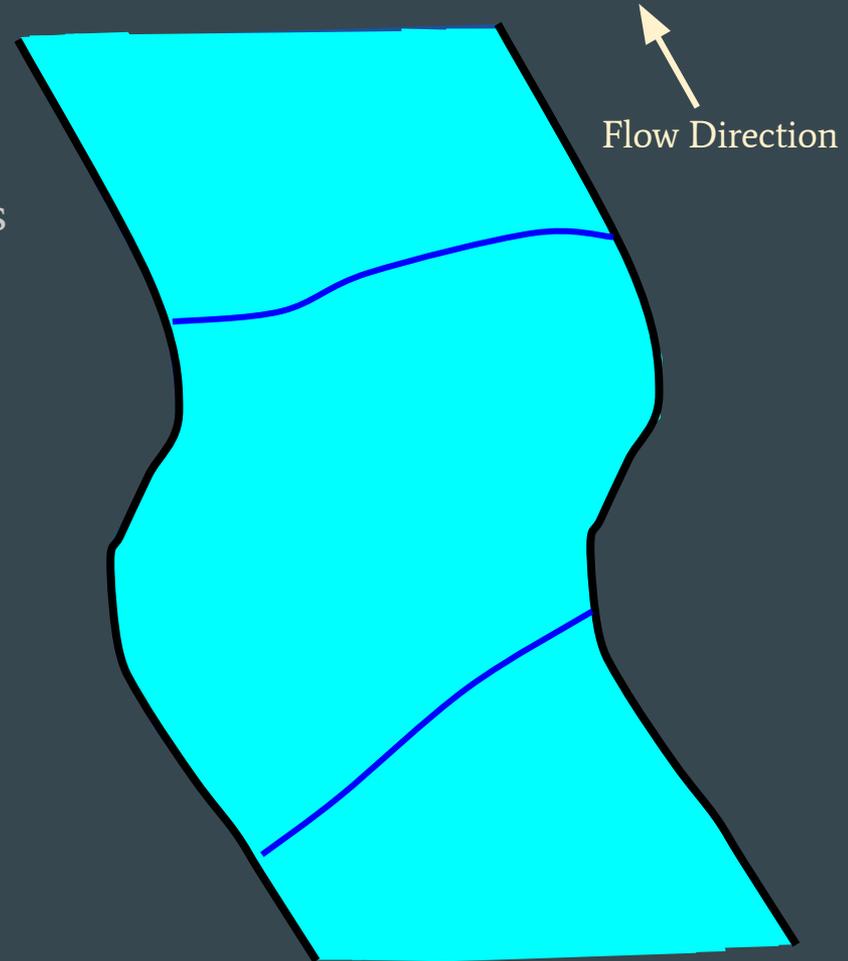


Break-up Ice Jam

The river starts out with stable ice cover that has evolved in place for most of the winter season

Warmer weather, melting snow/ice, and perhaps rainfall increases the amount of water entering the river.

When the amount of water rise is approx. equal to 1.5x the thickness of the ice, the ice cover fractures into large pieces with cracks that run from one bank to the other bank.

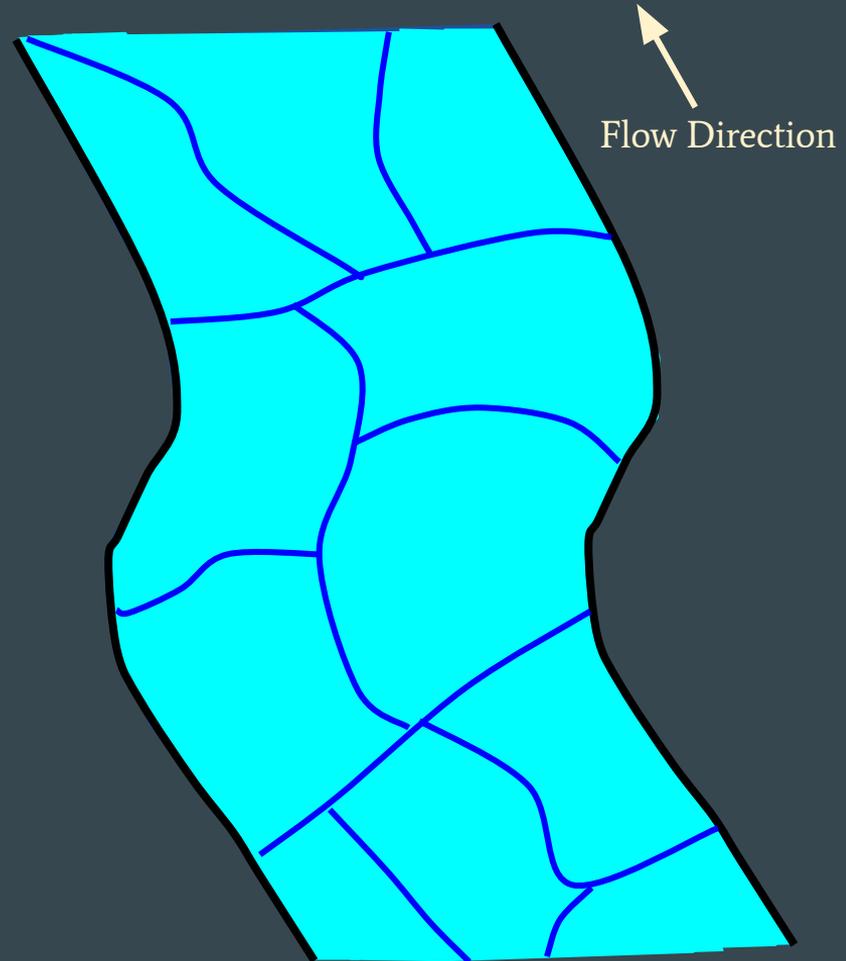


Break-up Ice Jam

As the water keeps rising, the large pieces start to break up into smaller pieces.

At some point, these smaller pieces are able to start moving downriver with the current.

As these still-large chunks of ice move downriver, they tend to get stuck at narrow points, bends, shallow spots, bridge piers, and still frozen sections of the river.



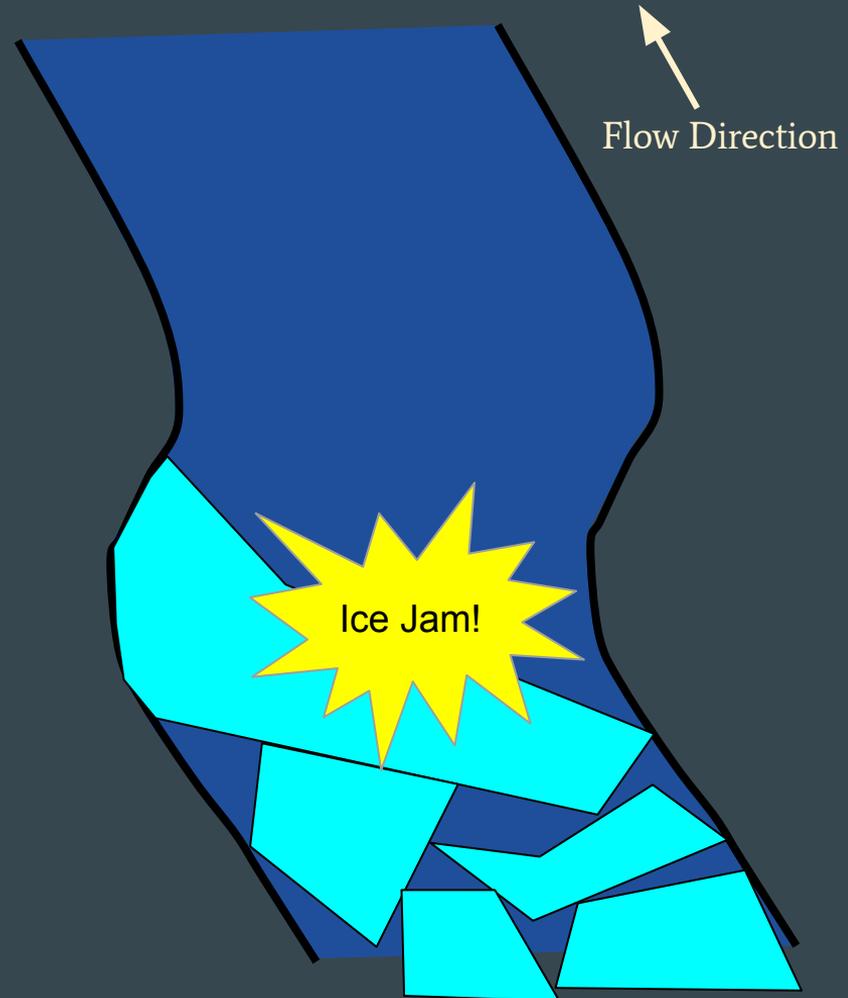
Break-up Ice Jam

Moving blocks of ice from upstream come down and slam into the blockage, causing it to thicken and obstruct more and more flow.

This is a **Break-up Ice Jam!**

Water levels rise, often significantly, upstream of the jam.

Break-up jams are often very significant, and can quickly escalate into life-threatening flooding. In part, this is because the river has so much more energy during this time, with lots of water pushing downriver.





Big Iron River @ Silver City, MI
Ice contained in river channel
Impacts mainly to travel

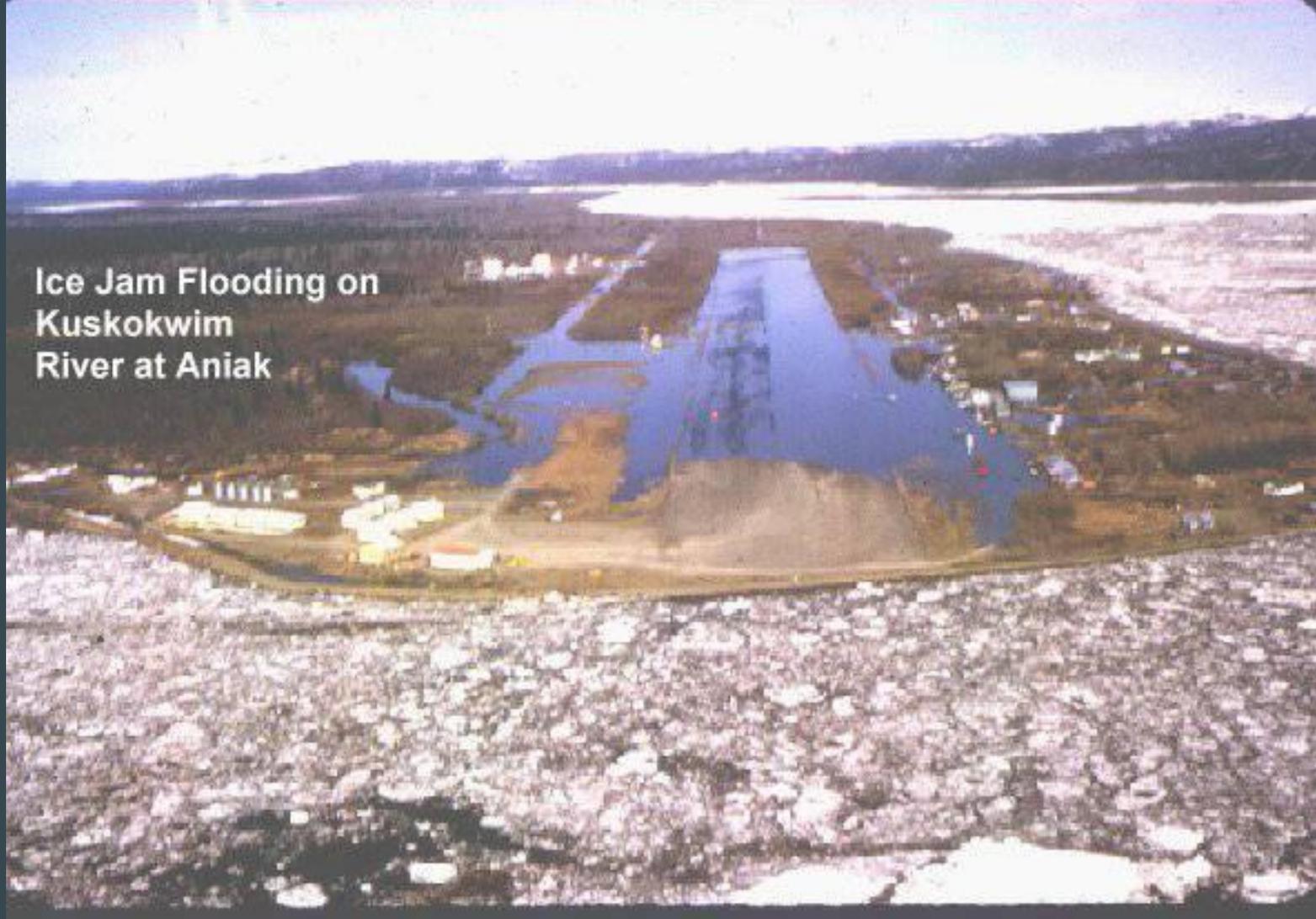
Ice Jam Impacts

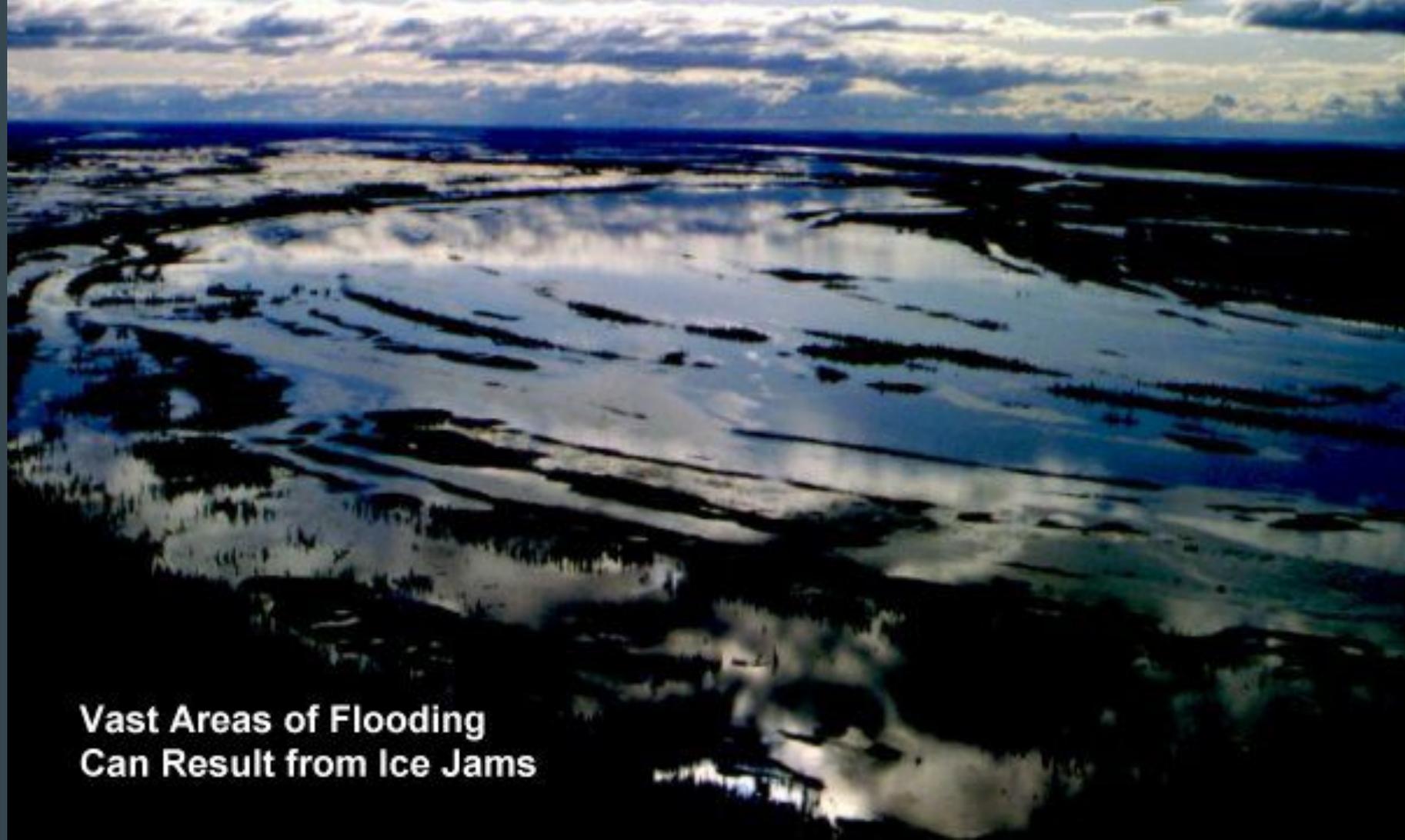
1. Fast water level rise → potential flooding (sometimes significant)
2. Ice damage to anything in its path
 - a. Rising waters can push large chunks of ice over banks causing damage to infrastructure (houses, buildings, etc)

Ice damage to infrastructure due to ice chunks being pushed on land in Eagle, AK



Ice Jam Flooding on
Kuskokwim
River at Aniak





**Vast Areas of Flooding
Can Result from Ice Jams**

Question Time!

1. Which type of ice jam is more common?
 - a. Freeze-up Ice Jam
 - b. Break-up Ice Jam
2. Which type of ice jam causes more significant flooding?
 - a. Freeze-up Ice Jam
 - b. Break-up Ice Jam

Question Time!

1. Which type of ice jam is more common?
 - a. Freeze-up Ice Jam
 - b. Break-up Ice Jam ←
2. Which type of ice jam causes more significant flooding?
 - a. Freeze-up Ice Jam
 - b. Break-up Ice Jam ←

Ice Jam Trouble Spots

1. Slow and relatively flat, meandering (winding) river segments
2. Sharp river bends, islands, and/or shallow spots
3. Bridges or other man made constrictions
4. Areas upstream of dam impoundments (reservoirs created behind a dam)

River Watch Program (AK Specific)



What is it? – a partner effort between the state and the NWS which uses manned aircraft to monitor breakup on the Kuskokwim and Yukon Rivers

Purpose? – to provide sufficient flood warning to vulnerable riverside communities across AK

How? – hydrologists and emergency response specialists fly daily along the breakup front observing ice dynamics and water levels

→ public reports also contribute to river observations through phone, emails, web forms, and/or social media (can include aerial or ground observations)

River Watch Program Benefits



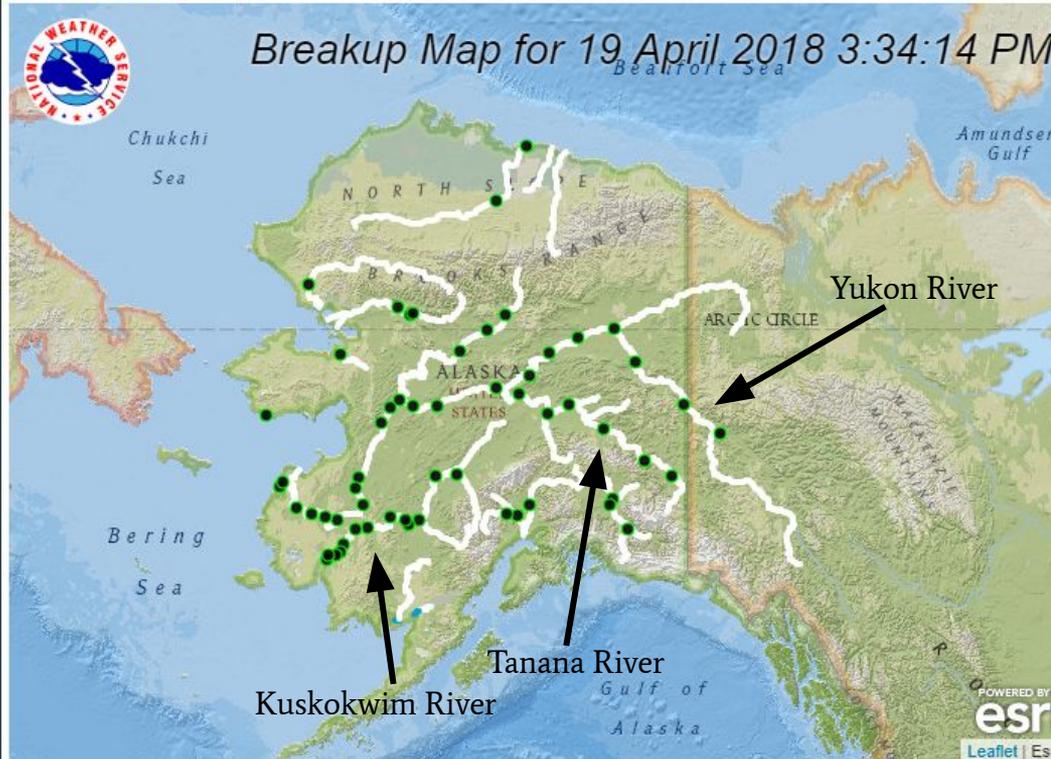
Other monitoring methods leave voids in data for river/lake ice conditions:

i.e. village observers, satellite imagery, selective aircraft deployment aren't enough

Additional aerial observations from aircraft flying at lower altitudes have **significantly enhanced** the spatial and temporal coverage of information on ice characteristics

[Click here to send us a storm or flood report](#)

APRFC Breakup Map



This map allows you to view the breakup status of major rivers. Click a site for more breakup information.

River Status

- Unknown
- Mostly Ice
- Some Open
- Mostly Open
- Open
- Flood Watch
- Flood Warning

Community Status

- No Warning
- Flood Advisory
- Flood Watch
- Flood Warning

Flood Advisory

Issued when flooding is imminent or occurring, generally within the next 1 to 3 hours, but is not expected to substantially threaten life and property.

Flood Watch

Issued when there is the possibility of widespread general flooding over an area within the next 36 hours.

Flood Warning for River Fcst Point

Issued when a river level has exceeded, or is forecast to exceed, moderate or major flood stage.



A winter scene with snow-covered trees and a purple and blue sky. The trees are dark and silhouetted against the bright sky. The sky is a gradient of purple and blue, with some small white specks. The text is centered in the upper half of the image.

Thank you!

Any questions? :)

<https://www.weather.gov/ohx/weather101presentations>



The National Weather Service Presents

Weather101

Upcoming classes (times are CT):

Mon, Dec 15	7 pm	River Ice
Tue, Dec 16	10 am	AI in Convective Outlooks
Tue, Dec 16	7 pm	The Radar
Wed, Dec 17	10 am	Tsunamis
Thu, Dec 18	10 am	Fire Weather

To register and for a full list of classes, visit to weather.gov/ohx/weather101

These ONLINE classes are FREE and open to people of all ages

Each class is hosted by a NWS meteorologist

Classes run 1 hour or less including a Q&A session