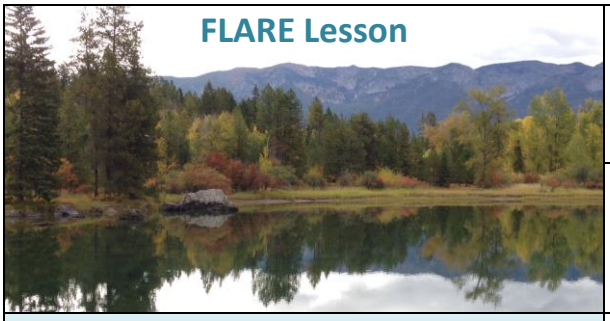

FLARE Lesson

Fish Habitats

What aquatic abiotic factors and habitats are necessary for native trout to survive?

Grade Level(s)
9-12th grades

Subject Areas
Biology, Ecology, Earth Science, and Environmental Science

Key Topics
Aquatic habitats, abiotic factors, fish spawning, habitat complexity

Duration
Preparation Time: 30 min
Activity Time: 1 x 50 min

Setting
Classroom (Individual or groups)

Skills
Apply information, designing solutions

Standards
NGSS & MT Science Std.:
HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem and design a solution to maintain stability in an ecosystem and analyze scientific concepts used by American Indians to maintain healthy relationships with environmental resources
CORE IDEA: LS2.C Ecosystem Dynamics, Functioning, and Resilience
CROSSCUTTING CONCEPT(S): Stability and Change
SCIENTIFIC & ENGINEERING PRACTICE(S): Constructing Explanations and Designing Solutions

Overview
Students will be introduced to the 4Cs or four important aquatic abiotic (non-living, physical) factors that all native trout in Montana need to survive. The eggs, alevin, fry, juvenile, and adult fish need four primary habitats that protect them from predators and provide shelter and/or food. Access to these complex habitats throughout their life stages helps the fish to reproduce and survive.

Objectives
Students will be able to:
- identify the 4Cs that all native trout need to survive; Cold, clean, complex, and connected water.
- describe the 4 primary stream habitats used by native fish to grow, find food, avoid predators, and reproduce.
- explain how habitat complexity helps the native trout to survive in their environment.
- Design a solution that would help protect fish spawning sites from human activity.

Materials
Warm Up / Activity / Wrap Up
- Computer, projector, and student worksheets
- Stream Features Cards
- Colored pencils

Advanced Preparation
- Copy the student worksheets #1-4 (double-sided).
- Copy and pre-cut the Stream Features Cards (1 set/pair)
- Prior to class, pre-load the Fish Habitats presentation found on the FLBS website: https://flbs.umt.edu/newflbs/k12teachingmaterial
- (Optional) To provide relevance, find or take photographs of local examples of the different stream features and habitats used by the fish throughout their life (ex. pools, riffles, side channels, gravel beds, woody debris, lakes, etc.). Be prepared to share these photographs during the lesson.

Fish Habitats

Background

All native salmonid fish like Bulltrout and Westslope Cutthroat Trout need varied habitats that **provide cold, clean, complex, and connected** water (Explore the River DVD, CSKT). These 4Cs are essential, **abiotic factors** necessary for fish spawning, development, and growth.

Photo credit: Jim Mogen/USFWS (public domain)

Bull Trout are native to Northwest Montana protected by the Endangered Species Act. They eat aquatic insects when young and larger fish as adults. Habitat degradation, climate change, hybridization with Brooke Trout, and competition with non-native species all negatively impact the Bull Trout populations.

Historically, the Westslope, Cutthroat Trout were found in the water west of the Continental Divide as well as, the Upper Missouri River drainage. The populations of these fish have been greatly reduced due to hybridization with non-native trout and habitat loss/degradation. According to the Westslope Cutthroat Trout website on the Montana Field Guide (2020), there are three possible life forms of Westslope Cutthroat trout: adluvial (migrates to lakes), fluvial (migrates to rivers), and resident (stays in streams). All three forms spawn in tributary streams in the spring when the water is approximately 10°C and the run-off is high (Liknes and Graham, 1988). Their growth is optimal when they are in 10- 17°C water (Bear, 2005).

In contrast, Bull Trout are found in the Clark Fork and Flathead drainages. The fluvial adults from Flathead Lake migrate up the North and Middle Forks of the Flathead River to spawn in the tributaries during the fall and then return to the lake. They prefer to spawn in water lower than 9°C and their growth is optimal when they are in 11-15 °C water (Bull Trout, 2017). Juveniles can spend up to three years in their natal tributary before they migrate down to the Flathead Lake to further develop (Bull Trout, 2020).

Both species are very sensitive to warmer temperatures and sediment/silt. Their eggs need clean, cold water that is high in oxygen to develop. Sediment can cover the eggs and block them from the high levels of oxygen that they need to grow. When ready to **spawn**, adult females use their tail or caudal fin to create depressions in the gravel riverbed called **redds**. The female fish deposit their eggs into the gravel redds, while the male fish externally fertilize the eggs. The larval fish develop inside of a soft **chorion membrane** as they **incubate** in the gravel. Larval fish initially get their nutrients from an attached yolk sac. These larval fish absorb the oxygen from the surrounding water through the chorion membrane. Therefore, the eggs need cold, oxygen-rich water flowing through the gravel in which they reside. If the gravel redd is disturbed or covered in silt, the eggs may have difficulty getting enough oxygen to survive. Human development and recreation along rivers and streams can impact the amount of soil and silt that runs off into the water. Incubating eggs have the greatest chance for survival if their redds are not disturbed by human activity.

The larval fish become **alevin** when they hatch from the egg case into the surrounding water. These baby fish use their yolk sac for nutrients until they can catch their own food. A baby fish that can feed itself is called a **fry**. The fry often hide in the gravel and cobbles along the bottom of the river. The fry become a **fingerling** or **juvenile** fish after they have developed their scales and working fins. These young sexually immature fish shelter in calm, shallow areas along the margins, side channels, and sloughs along of the river. The juvenile fish need time to **rear** or develop into sexually mature fish and they can often be found feeding along the downstream end of the shallow, fast moving **riffles**. The adult fish that are sexually active often need to swim against the current to spawning sites upstream. These fish rest in deep **pools** as they swim from one section of the river to the next. These pools can serve as cool thermal refuges, during the warmer

summer months when the water levels are low and the water temperatures in the shallower areas are higher.

The adult, juvenile, fry, and alevin fish need different habitats at different stages in their life cycle. Healthy rivers with complex (varied) habitats provide pools, riffles, runs, glides, woody debris, quiet waters, beaver ponds, spring-fed channels, undercut banks, and ground water upwellings in roughly the same proportion.

Lesson Vocabulary

Abiotic factors – The non-living, physical factors that impact where an organism can live (ex. temperature).
Adult fish – A fish that is sexually mature.
Alevin – A freshly hatched fish that gets its nutrients from its yolk sac.
Fry – A baby fish that is capable of feeding itself.
Glide – The transition zone between a pool and a riffle, located just below the pool. The water moves slowly with little turbulence over fine gravel, sand, and organic matter.
Incubation – The period of time between the fertilization and hatching of a larval fish.
Juvenile/fingerling fish – A young sexually immature fish that has developed its scales and working fins.
Pool – A deep, cool area of a stream often found along the outer edge of a meander where the stream bottom is more easily eroded.
Rearing – The period of time between the hatching of a fish and sexual maturity.
Redd – A bowl-shaped spawning nest built in the gravel bed of a stream or river that often contains upturned gravel that looks cleaner than the surrounding gravel.
Riffle- A short, straight section of a stream found midway between two meanders. A riffle is often shallow and characterized by turbulent water flowing over and through gravels, cobbles, and boulders.
Run – An area in a stream with deep, fast water with little or no turbulence that typically follows a riffle.
Spawn – The act of releasing or depositing eggs.

Procedure

- **Warm Up (15 minutes)**
  - At the beginning of class, turn on the projector, open the "Fish Habitats" presentation, and pass out the student worksheets.
  - Use slides 1-10 in the presentation to ask and discuss the following questions with the students:
    - *What are two native trout in Western Montana that were historically used as a source of protein for the Salish, Kootenai, and Pend d'Oreille tribes?* Bull Trout and Westslope Cutthroat Trout
    - *Where can you find these fish?* They can be found in local lakes, rivers, streams, and wetlands.
    - *Where do these fish spawn?* They spawn in gravel beds found in the tributaries of the Flathead and Clark Fork watersheds. More specifically, they create redds or bowl-shaped gravel nests in the glides or fast moving, low-turbulence areas in between the pools and riffles.
    - *During what time of year do they spawn*? Westslope Cutthroat spawn during the spring when the water temperature is 10 ° C and the run off is high, whereas, Bull Trout spawn in the fall in water below 9°C.
    - *What are two non-native trout that can impact these species of concern?* Non-native: Brook Trout, Brown Trout, Rainbow Trout, and Lake Trout all compete with the native trout for the same food resources. When Brook Trout fertilize Bull Trout eggs, infertile offspring are produced. When Rainbow Trout fertilize Westslope Cutthroat Trout eggs, fertile but less viable offspring are produced.
  - Slide 11: Share the video (1.37 min): www.viewpure.com/_nfGn-_MOT4?start=0&end=0
    - While watching the video, the students record two observations they have about the trout's behaviors and/or environment. Discuss how even though the Brown Trout in the video are non-

natives, they spawn in gravel redds just like the native trout. Ask them to record one reason why trout need to spawn in fast moving water. (Ex. high oxygen levels, protection from predators, etc.)

- Slide 12: Share the 4Cs: All native trout need COLD, CLEAN, COMPLEX, and CONNECTED water to survive. Students fill in the blanks on their worksheet as they read about the 4Cs.

◆ **Part I: Primary Fish Habitats (20 minutes)**

- Slides 13-20: Ask the students to color, label, and describe each of the four primary fish habitats.
  - Students label the pools, meanders, riffles, glides,
- Slide 21: Group the students in pairs or ask them to partner with their closest neighbor. Pass out the Stream Features Cards (one set/pair) and ask the students to match the descriptions to the stream features depicted on the cards.
- Slides 22-31: When all of the pairs have matched the cards, use the provided key (teacher resources) and slides to go over each stream feature with the class.
- Slide 32: Next, ask the students to complete the table on their worksheet by indicating whether they would expect to find the stream features in the four primary habitats (fish spawning, rearing, feeding, and adult holding). The students mark a "Y" for Yes and an "N" for No.
  - Discuss the importance of having a variety of features within each habitat that allow the fish of different stages to hide from predators, find food, and eventually reproduce. A healthy stream has all of these features and habitats with connectivity between them. This habitat complexity ensures the population's survival.

◆ **Part II: Human Impacts (10 minutes)**

- Slide 33: Working with the same partner, the students make two predictions based upon the following scenario: *The amount of annual precipitation in the region decreases drastically, which decreases the amount of spring melt and overall water flowing through the local tributaries during the spring, summer, and fall.*
  - Would you expect the native trout populations to increase or decrease? Pairs must provide a specific explanation for their answer.
  - What would you expect to happen to the habitat complexity and connectivity in the tributaries? Students provide a specific example of what they would expect to change.
- Slide 34: Students conduct a 3-minute Think-Pair-Share with their partner to list all of the potential ways humans could impact native trout populations. Answers may vary (ex. sediment pollution due to land development and/or the removal of the natural vegetation, recreation in spawning zones that would destroy or disturb the eggs, insertion of man-made objects that prevent the fish from reaching their spawning zones, overfishing, introduction of non-native species, climate change, nutrient pollution or other practices that cause eutrophication or biofouling, etc.).
  - Write the potential impacts on the whiteboard as each pair shares.
- Slide 35: Students work with their partner to create a solution to one of the human impacts previously listed. Their goal is to maintain stability of the native trout populations over time.
  - They must provide a proposal including at least three steps they would need to take to successfully maintain the populations over time. Including what information they would need to gather to know whether their plan worked.
  - Students share their impact and proposed solution with the class.

◆ **Wrap Up (5 minutes)**

- Slide 36: Exit pass - Students to take 5 minutes to respond to the following writing prompt: *Why is habitat complexity and connectivity in the streams critical for native trout reproduction and survival?*

Teacher Resources

Assessment Options

Have students:

- **complete the Fish Habitats activity** as described.
- **survey** the abundance and distribution of pools, riffles, runs, glides, woody debris, quiet waters, beaver ponds, spring-fed channels, undercut banks, and upwelling areas along a local stream.

Modifications

- Students can target a specific human impact in a nearby stream, conduct research, and submit a more formal proposal that will help promote fish population stability over time.
- The worksheets can be enlarged for students in need of larger text.

Extensions

Students can:

- **determine** the abundance, distribution, and diversity of aquatic insects in the pools, riffles, runs, glides, woody debris, quiet waters, beaver ponds, spring-fed channels, or undercut banks.
- **analyze** scientific strategies used by American Indians to maintain healthy river ecosystems that promoted sustainability in fish populations in the area.
- **research** the life cycle of salmonid fish that live in the local rivers.
- **graph** the changes in fish populations in an area over time.

References

Bear, E. A. 2005. Effects of temperature on survival and growth of westslope cutthroat trout and rainbow trout : implications for conservation and restoration. Montana State University thesis.

Bull Trout — Salvelinus confluentus. 2020. Montana Field Guide. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks. Retrieved on April 28, 2020, from http://FieldGuide.mt.gov/speciesDetail.aspx?elcode=AFCHA05020

Bull Trout Thermal Tolerances. 2017. Fish, Wildlife, and Parks. Retrieved on April 28, 2020 from Liknes, G. A. and P. J. Graham. 1988. Westslope cutthroat trout in Montana: life history, status, and management. American Fisheries Society Symposium 4:53-60.

Westslope Cutthroat Trout — Oncorhynchus clarkii lewisi. 2020. Montana Field Guide. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks. Retrieved on April 28, 2020, from http://FieldGuide.mt.gov/speciesDetail.aspx?elcode=AFCHA02088

Online Resources

To order an Explore the River DVD go to the following website: http://exploretheriver.org/
Montana Field Guide: http://fieldguide.mt.gov/
Efforts to preserve Yellowstone Cutthroat Trout: https://www.youtube.com/watch?v=qJK8EXdZ30o
Brown trout mating spawning and laying eggs: https://www.youtube.com/watch?v=qvy46JF8v2o&vl=en

Acknowledgements

Content from this lesson was retrieved from the Explore the River DVD created by the Confederated Salish & Kootenai Tribes and the online Montana Field Guide.

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Fish Habitats

Name _____

Warm Up

Student Worksheet (1 of 4)

Watch the provided video www.viewpure.com/_nfGn-_MOT4?start=0&end=0 and record two observations you have about the Brown Trout's behaviors and/or their surrounding environment.

-
-

Although this video depicts a non-native Brown Trout spawning, the native trout in Montana also release their eggs in a similar manner. *Why do you think the trout lay their eggs in swift moving water?*

THE 4Cs…

Native Bulltrout and Westslope Cutthroat Trout both need _____, _____, _____, and _____water for growth, reproduction, and basic survival.

Fill in the Blanks.

oxygenated hybridization redds non-native thermal sediment

COLD water is critical for native trout survival. More specifically, Bull Trout grow optimally in 11-15°C water, whereas, Westslope Cutthroat Trout grow optimally in 10-17°C water. Unfortunately, _____ trout that have a higher tolerance for warmer water are now encroaching on the native trout's habitat due to climate change. In fact, one major cause of the native trout's population decline is due to their _____ or crossbreeding with non-native Rainbow and Brooke Trout. **CLEAN**, clear water free of suspended _____ is necessary for their eggs to develop. As a result, both species create _____ or bowl-shaped spawning nests in gravel beds. Redds are often created in glides, the areas in between the calmer pools and turbulent riffles, that have swift, highly _____ water. To avoid predation, the young alevin that hatch from these eggs quickly move to the slower shallow areas and side channels filled with woody debris and vegetation. As the fish grow, they hunt for larger aquatic insects often found in the faster moving riffles. Deep pools, undercut banks, and large woody debris provide protection from predators and serve as _____ refuges during the summer. The variety or **COMPLEXITY** of habitats is key for fish development and reproduction. If the rivers did not contain a wide variety of habitats, the fish would not be able to avoid predators as they search for food or survive the warmer summer and icy winter months. Lastly, all of these habitats need to be **CONNECTED** in order for the fish to move freely between them as they grow and develop through their life stages.

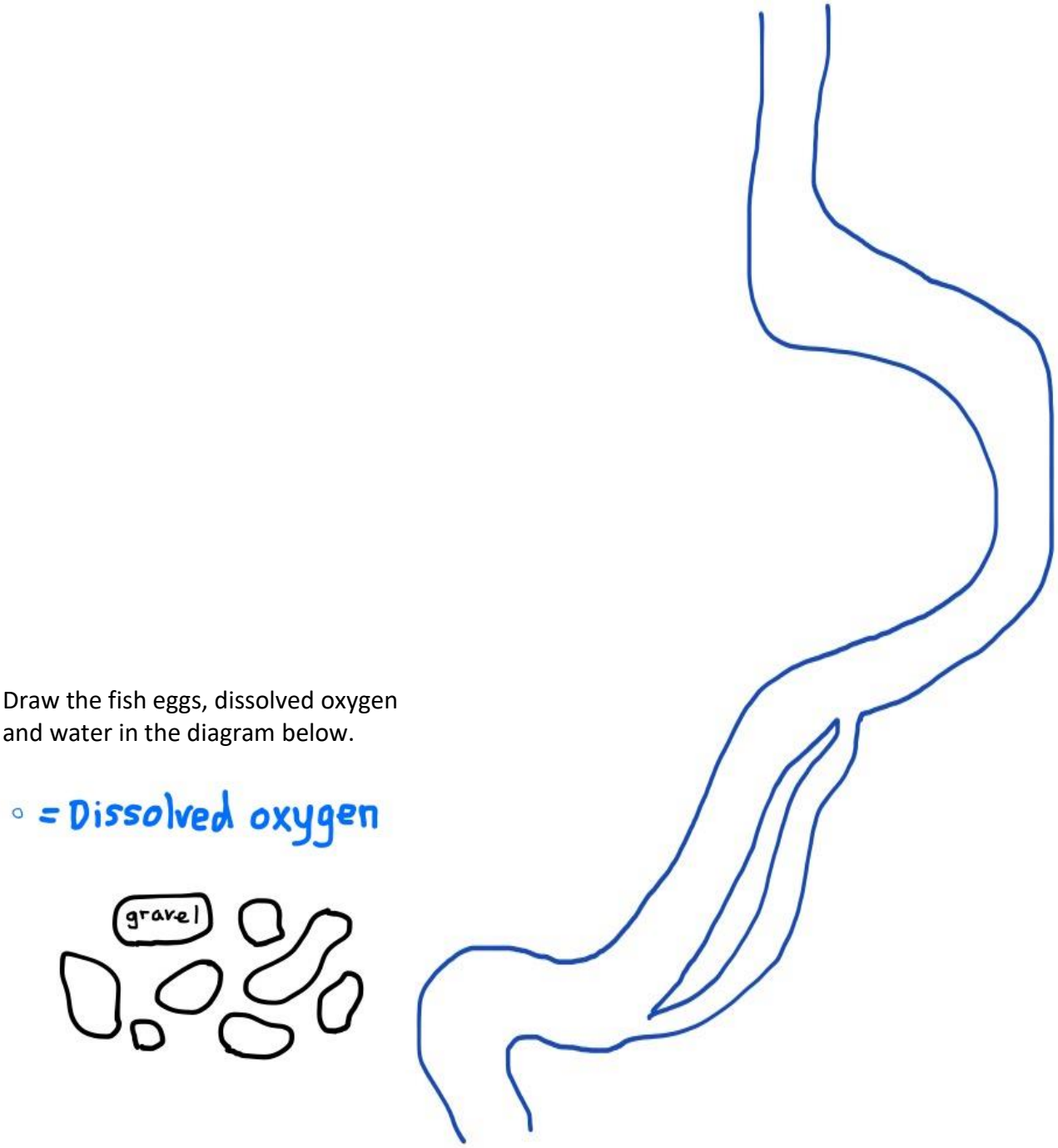
Fish Habitats

Part I: Primary Fish Habitats

Use the colors indicated in the key below and the provided presentation to identify, label, and describe the four primary fish habitats on the diagram below.

- ☐ Adult Holding Habitat (sky blue)
- ☐ Feeding Habitat (orange red)
- ☐ Spawning Habitat (red)
- ☐ Alevin, Fry, & Juvenile Rearing Habitat (yellow)

Draw the fish eggs, dissolved oxygen and water in the diagram below.



A HEALTHY, COMPLEX RIVER HAS ALL OF THE ABOVE HABITATS IN ROUGHLY THE <u>SAME PROPORTION</u>!

Fish Habitats

Complete the following with a partner:
Match the provided Stream Feature Cards to their descriptions. When finished, ask you instructor to check your cards.

Indicate whether you would expect to find the stream features below in the four primary fish habitats by marking a "Y" for YES or an "N" for NO. Be prepared to share your results with the class.

Stream Features	Four Primary Fish Habitats			
	Adult Holding Habitat	**Spawning Habitat**	**Rearing Habitat**	**Feeding Habitat**
Pool				
Glide				
Riffle				
Run				
Quiet Water				
Undercut Bank				
Spring-fed Channel				
Woody Debris				
Beaver Pond				
Groundwater Upwelling Area				

Part II: Human Impacts

Complete the following with a partner:
Make two predictions based upon the following scenario: *Changes to local climate caused the amount of annual precipitation to drastically decrease, which in turn decreased the amount of spring melt and water flowing through local tributaries throughout the year.*

- Would you expect the native trout populations to increase or decrease? Please provide a specific explanation for your answer.

- What would you expect to happen to the habitat complexity and connectivity in the tributaries? Please provide a specific example of what you would expect to change.

Conduct a Think-Pair-Share. List all of the potential ways humans could negatively impact the native trout populations.

Create a solution to one of the human impacts previously listed. Your goal is to maintain the stability of the native trout populations over time.

Human Impact: _____

Please provide a proposal including at least three steps that you would need to take to successfully maintain the populations over time. Including what information you would need to gather to know whether your plan worked.

Proposed Solution:

1.

2.

3.

Wrap Up

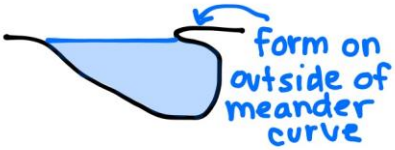
Individually, respond to the following prompt:

Why *is habitat complexity and connectivity in the streams critical for native trout reproduction and survival? Be specific and provide details from this activity to explain.*

Stream Features Cards

Pool

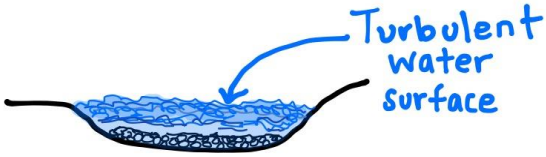
Undercut Bank



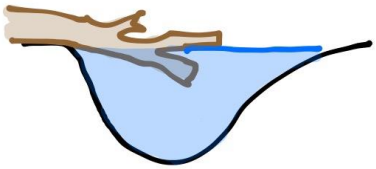
Glide

Spring-fed Channel

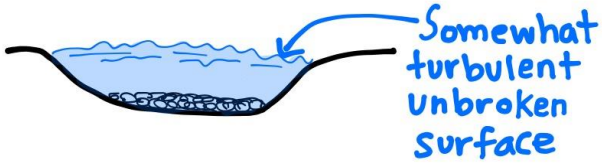
Riffle



Woody Debris

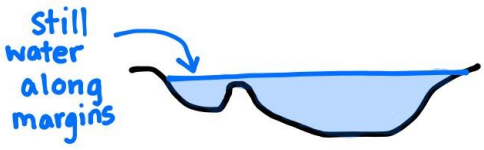


Run

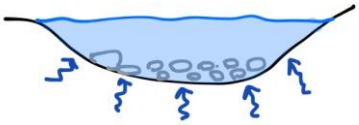


Beaver Pond

Quiet Water



Groundwater Upwelling Area



Stream Features Cards

• Formed by the erosion of the deep area of a pool • Provides shade and cover within the deeper pools • Refuge from warmer channel in the summer • Fish shelter from high water flow events	• Ponds created by beaver dams • Buffers flow of water & slows the downstream movement of sediment & nutrients • Rearing & wintering area • Promotes channel movement • Transported plants recolonize
• ~20/river mile • Swift water along outer edge, point (sand) bar along inner edge • May contain logs or rootwads that provide shelter for the fish • Eddies form at the base of boulders here • Deep adult fish holding habitat	• Large downed trees or debris • Deflects flow to create slower areas and scours deep pools • Promotes channel shifting and floodplain flooding • Diverts flow into aquifers • Breaks up ice in the winter
• Former/abandoned stream channels • Habitat for juvenile fish, amphibians, birds, mammals, and mollusks • Overwintering habitat • Filled by seeping spring water	• Between two meanders • Juvenile fish feeding area • Fast moving water rushes and boils over & through gravels, cobbles, and boulders • Lots of dissolved oxygen • Highest aquatic insect diversity
• Transition between a pool and a riffle • Smooth surface water • Spawning site • Fish form redds here • Contains small cobbles, fine gravel, sand, & organic matter on the bottom	• Deep pools, low-velocity backwaters, & spring brooks with nutrient-rich ground water seeping up from the aquifers • Buffers against freeze/thaw cycle • Thermal refuge • High productivity = lots of food
• Low velocity rearing area in channel margins • Supplies food, shade, & refuge for juveniles. • Found in backwaters, spring-fed channels, floodplain ponds, and sloughs	• Transition zone from a riffle to a pool • Deep, swift water with minor turbulence • Moderately high insect diversity

Stream Features Cards KEY

UNDERCUT BANK • Formed by the erosion of the deep area of a pool • Provides shade and cover within the deeper pools • Refuge from warmer channel in the summer • Fish shelter from high water flow events	**BEAVER POND** • Ponds created by beaver dams • Buffers flow of water & slows the downstream movement of sediment & nutrients • Rearing & wintering area • Promotes channel movement • Transported plants recolonize
POOL • ~20/river mile • Swift water along outer edge; point (sand) bar along inner edge • May contain logs or rootwads that provide shelter for the fish • Eddies form at the base of boulders here • Deep adult fish holding habitat	**WOODY DEBRIS** • Large downed trees or debris • Deflects flow to create slower areas and scours deep pools • Promotes channel shifting and floodplain flooding • Diverts flow into aquifers • Breaks up ice in the winter
SPRING-FED CHANNEL • Former/abandoned stream channels • Habitat for juvenile fish, amphibians, birds, mammals, and mollusks • Overwintering habitat • Filled by seeping spring water	**RIFFLE** • Between two meanders • Juvenile fish feeding area • Fast moving water rushes and boils over & through gravels, cobbles, and boulders • Lots of dissolved oxygen • Highest aquatic insect diversity
GLIDE • Transition between a pool and a riffle • Smooth surface water • Spawning site • Fish form redds here • Contains small cobbles, fine gravel, sand, & organic matter on the bottom	**GROUNDWATER UPWELLING AREA** • Deep pools, low-velocity backwaters, & spring brooks with nutrient-rich ground water seeping up from the aquifers • Buffers against freeze/thaw cycle • Thermal refuge • High productivity = lots of food
QUIET WATER • Low velocity rearing area in channel margins • Supplies food, shade, & refuge for juveniles. • Found in backwaters, spring-fed channels, floodplain ponds, and sloughs	**RUN** • Transition zone from a riffle to a pool • Deep, swift water with minor turbulence • Moderately high insect diversity

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