

Fishes of Sleven's Island

Target Grade Level: 9th-12th

Created and Adapted by:
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UNIVERSITY OF MONTANA GK-12 PROGRAM

1. CONTRIBUTOR'S NAME: Andrew Whiteley, Jennifer Woolf, and Frank Janes

2. NAME OF INQUIRY: FISHES OF SLEVEN'S ISLAND

3. GOALS AND OBJECTIVES:

a. Inquiry Questions: How does the morphology of fish relate to the habitat in which they are found?

b. Ecological Theme(s): Aquatic ecology, niche partitioning, morphological adaptations.

c. General Goal:

To implement an outdoor guided inquiry on the relationship between fishes and their habitat

d. Specific Objectives:

To identify local fishes

To teach students about the natural history of local fishes.

To teach students about habitats within local rivers.

To teach about morphological adaptations that allow fishes to specialize to habitats within rivers.

To teach students about aquatic sampling techniques.

To teach students data analysis and graphing skills.

e. Grade Level: High School (could apply to all grade levels)

f. Duration/Time Required:

→ Prep time: Approximately 3 hours. Time to gather gear and equipment and train participating instructors. Time to set minnow traps the day before the activity.

→ Implementing Exercise During Class. This activity was designed for a 45 minute period of time (this accounts for 30 minutes of travel time, 15 minutes each way, to the field site)

→ Assessment: Students are also asked to graph a) the combined class data on species distribution by habitat type and b) a histogram of sizes of the most commonly captured species (longnose dace). Students are asked four questions as a take home exercise. SEE ATTACHED ACTIVITY HANDOUT

4. ECOLOGICAL AND SCIENCE CONTEXT:

a. Background (for Teachers):

We developed the following activity for a tenth grade biology course at Big Sky High School in Missoula, Montana. We modified an activity used by Dr. Lisa Eby in her Biology and Management of Fishes course at the University of Montana. The Bitterroot River is a 15 minute walk from this school and offers an excellent place to sample freshwater fishes. What follows was developed specifically for this field site, but the general methods and concepts could be generally applied in any river in which wading and sampling fishes is possible.

Habitat requirements for species are an important consideration for ecology. Students are usually familiar with basic requirements of terrestrial plants and animals. Habitats within rivers are often less familiar. This lab is meant to introduce students to aquatic habitats, the fish that inhabit them, and some morphological adaptations that fish in different habitats possess. Students learn by sampling fishes from the different habitats and seeing first hand what kind of fish were found in each habitat type. Instructors should be familiar with the four basic river habitat types, how to identify local fishes (especially juvenile life stages), and different adaptations of these fish to the various habitat types.

There are four principal habitat types in rivers: pools, glides, runs, and riffles. Riffles are shallow areas of fast moving white water. The cobble/gravel bottoms and well-oxygenated water of riffles provide good habitat for many aquatic insects and spawning fishes. Pools are in deeper areas where the water slows down. Pools are often used by larger-bodied suckers and this is where a lot of fishes spend the winter. Runs are fast flowing areas but not shallow enough that the substrate creates white water riffles. Glides are relatively slow moving areas, but still faster than water moving through pools

The following information is specific to fishes in the Bitterroot River, Montana. One place to look for information about the local fishes in your area is a local state fish and wildlife office. For example, we were able to get posters and field guides of local fishes at the Montana Department of Fish, Wildlife & Parks. Mostly juvenile fish are captured during this activity, which makes species identification a little more challenging. It is often difficult to find field guides with pictures of juvenile fishes. If you are having trouble in your region, a local fisheries biologist may be able to offer some help.

In the Bitterroot River, the fish you are most likely to capture are: longnose dace (*Rhinichthys cataractae*), largescale suckers (*Catostomus macrocheilus*), northern pikeminnows (formerly squawfish; *Ptychocheilus oregonensis*), redbelt shiners (*Richardsonius balteatus*), mountain whitefish (*Prosopium williamsoni*), sculpins (most likely the slimy sculpin, *Cottus cognatus*); rainbow trout (*Oncorhynchus mykiss*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*, or hybrids between these two, see below). You may also catch an occasional introduced brown trout (*Salmo trutta*). Juveniles are rarely shown in fish field guides and they are challenging to identify. For the species just mentioned, we have photos available on the ECOS website (www.bioed.org/ecos/). Pay particular attention to body shape, mouth shape and location, and fin shape and location. For example, the longnose dace have a snout that protrudes over the mouth and have a black line along the sides of its head. This line resembles a mustache in front of the eye. The mouth is at the bottom of its head, facing the bottom of the river (this is called an inferior mouth). Juvenile largescale suckers lack this brown/black line, are more robust in body depth, do not have a protruding snout, and have a mouth that also is at the bottom of the head. However, if you look closely you can see fleshy lips that are used to scrape algae off of rocks. Because both species tend to be bottom-dwellers, their pectoral fins are located more

ventrally and they are broad, rounded, and spread out laterally. This can be hard to see on juvenile fish, however.

We used several sampling techniques (see glossary for description of different nets/traps and see material list for location of items). For sampling riffles and runs, kick seines and D-nets worked the best. D-nets and aquarium nets worked well along and under the riverbank. Minnow traps set overnight the day before the activity were used to capture pool dwelling fishes. We tried to use the larger seine in the pool but this is challenging and does not work well at Steven's Island. Be prepared to spend some time before the activity becoming familiar with the sampling techniques and the fishes you will encounter.



Jennifer Woolf (ECOS Fellow) helps students use a kick net to sample fishes in the Bitterroot River, Montana.

The fish mentioned above have several prominent adaptations to different habitats. These can be broadly classified into two groups: those that reside primarily in pools, and those that reside primarily in faster water (riffles, runs). The redbreasted sunfish is a great example of a pool resident. It has a deep body and its pectoral fins are placed high on its body. The longnose dace is a great example of a riffle/run-adapted fish. Its pectoral fins are very large for its body size and act as planes that help the fish stay near the river substrate with little effort. This trait is particularly exaggerated in sculpins, which also occur near the substrate in faster moving water, and which also have very large pectoral fins. As water flows over these fins, it creates a downward force that helps sculpins stay on the bottom without using much energy. Sculpins also have a relatively large head and a narrow tapering body, which also may help them hold to the

bottom as water flows over them. Longnose dace shift habitats as they grow. Younger fish are often found in slightly shallower and slower moving areas, while older fish are found in faster water. There is a tradeoff between the amount of food available in the faster water and the energy required to be in that location.

A note on hybridization between rainbow trout and westslope cutthroat trout: Rainbow trout are not native to the Bitterroot River (they are only native to the Kootenai River in Montana). This species hybridizes readily with westslope cutthroat trout throughout western Montana. In the Bitterroot River, juvenile trout may be rainbow trout, westslope cutthroat trout, or hybrids. In a hybridized population, it is not possible to morphologically differentiate pure form hybrid fish. If a fish does not have slashes under its throat, this does not guarantee that it is a rainbow trout. This is a very complicated issue for managers and population geneticists. For the purposes of this exercise, we recommend keeping this issue simple. If a juvenile rainbow or westslope cutthroat trout does not have slashes, call it a rainbow trout. If it has slashes, call it a westslope cutthroat trout. It may be worth mentioning that there is some uncertainty however, due to the hybridization issue.

b. Background (to present to Students):

The handout contains a list of species likely to be encountered at Slevens Island and pictures/descriptions of habitat types the students will observe. We found that an introduction to the species the students would observe and a brief introduction to habitat types in rivers worked well to prepare students for this activity. We recommend using field guides to introduce the fishes. Have the students draw pictures of some of the species. The pictures of habitat types should hopefully serve as a good way to introduce habitat types.

5. MOTIVATION AND INCENTIVE FOR LEARNING: Learning to use sampling equipment to catch fish in a local river. Getting wet and handling live animals. Learning more about the species that inhabit a river the students have seen their whole lives.

6. VOCABULARY:

adaptation: a genetically determined characteristic that improves an organism's ability to survive and successfully reproduce under prevailing environmental conditions

aquarium net: small green net commonly used for aquarium fishes

D-net: mesh net with a flat bottom and hard metal perimeter used to sample benthic fishes and macroinvertebrates

fish/fishes: it is standard to refer one species as **fish** and more than one species as **fishes**

glide: relatively slow moving areas, but still faster than water moving through pools

habitat: place where a plant or animal lives

inferior mouth: mouth that opens downwards (commonly on fish that feed on algae or benthic organisms)

kick net: similar to seine but smaller. Lead line is placed against river substrate (often held down with rocks), a person holds each end, and one or more people kick at the substrate upstream from the net. The net is lifted in a hammock-like style

length frequency histogram: a graph made after a sample has been collected, lengths of individuals measured, and the number of fish (frequency) of each length is plotted.

morphology: having to do with size or shape of a plant or animal

pectoral fin: paired fins located on sides of the body (higher on the body of deeper-bodied pool-dwelling species)

pool: deeper area where the water slows down

riffle: shallow areas of fast moving white water

run: fast flowing areas but not shallow enough that the substrate creates white water riffles

Seine: large net used to drag through a pool to capture fish. Has a lead line on the bottom, top of net has styrofoam flotations

snout: area in front of the eye and above the mouth

superior mouth: a mouth that is turned upwards

terminal mouth: when the body ends in a mouth that opens forward

total length: one of several measures of a fish's length. Total length is determined by measuring the distance between the tip of the snout to the end of the tail fin while the tail fin is pinched together.

7. SAFETY INFORMATION: STUDENTS WILL BE IN THE RIVER AND WEARING WADING GEAR. RIVERS ARE OFTEN UNEXPECTEDLY SLIPPERY AND FAST MOVING. STUDENTS SHOULD BE WARNED BEFORE ENTERING THE WATER AND SHOULD BE SUPERVISED.

8. MATERIALS LIST (including any handouts or transparency masters):

Handout:

See handout for students

Fish sampling:

Kick nets (Big Sky High School, BSHS)

D-nets (BSHS)

Seine (for sampling pool, BSHS)

Minnow traps (Lisa Eby, U of M)

Bait for minnow traps (dried trout food, fish innards, etc.)

5-gallon buckets (from BSHS cafeteria and L. Eby)

Aquarium dip nets (Wild Trout and Salmon Genetics Lab, U of M)

Waders (BSHS)

Clipboards (BSHS)

Pencils

Data sheets (attached)

Field guides (AW's personal: these will need to be located, possibly L. Eby)

Laminated fish identification sheets (BSHS, constructed by K. Kennedy for this class)

Clear containers(s) for fish viewing (AW's personal)

Measuring boards (BSHS, constructed for this activity with PVC pipes and rulers)

9. METHODS/PROCEDURE FOR STUDENTS:

a. Pre-investigation work: Prior to the field activity, students should be exposed to 1) the local fishes they are likely to encounter and 2) the four habitat types they will see.

b. Investigation work:

Procedure:

We had students gather at the site by the river and gave them waders. It worked well to line up waders by size at the riverbank. Students were told to sketch the river and the habitat types they observed in their field notebooks. Then they were split into two groups. We had one group go to a pool and one group go to a riffle/run. The pool at Slevan's Island (immediately downstream from the large willow and along the near bank) is a little difficult to access and has limited space to work in, so we had fewer students go to this area (5-6 students is ideal). More students went to the riffle/run and could be further subdivided. At the riffle (or run, depending on water level), we found it best to have one instructor on the bank helping students identify fishes and at least one instructor in the water helping students collect fish. Other students could take D-nets or aquarium dip nets and catch fish along and under the bank.

Procedure at the riffle/run: Students were shown how to use D-nets and kick seines. Each kick seine had at least three students (two to hold the net, at least one to kick upstream from the net). After fish were collected, they were brought to the bank. We used one bucket for unmeasured fish and one for measured fish. Species identification and measurement technique were explained so that students could identify and measure all fish captured. There are several different ways that fisheries biologists measure the length of fish. We used total length, which is a measure from the front of a fish's snout to the end of its tail, when the tail is pinched together.



Sampling fishes in the Bitterroot River, Montana. Jennifer Woolf (left, blue shirt) helps students check the contents of a kick net on the left. Kathleen Kennedy (middle with black shirt, Big Sky High School teacher) helps a student in the middle of the photo.

It is challenging to handle live fishes. It is important that the measuring board is wet and that the students wait until the fish is still. This may take several attempts with a fish and often takes longer than expected. The most important thing to consider is the fish itself: every second out of the water is a second without oxygen. If a fish won't be still long enough for a measurement, it should be put back in the water for a few seconds to allow it to breathe and then another attempt at a measurement can be made. Make sure

to emphasize the importance of having wet hands when handling fish (handling fishes with dry hands can affect their mucous coating). Fishes were released after all were measured. It is best to have extra buckets to rotate between students in the water and on the bank. Switching locations within the riffle/run is a good idea because we had lower capture rates towards the end of the activity.

Procedure for pool: Fewer fish were captured overall in the pool. The pool at Slevan's Island is hard to access and about 5 feet deep. It is against the bank with thick vegetation. With each class, attempts to seine the pool were made. Minnow traps were also demonstrated. Minnow traps were usually successful for overnight sets, but not for short time intervals between classes. These fish were kept in buckets for future periods, in case seining was not successful. This ensured all classes handled, identified, and measured fishes. After capture methods were demonstrated, students attempted to seine (with the help of an instructor), captured small fish along the bank with aquarium nets, and used a kick seine upstream from the pool. Fish were collected in one "unmeasured" bucket. Species identification and measurement technique were explained. Students then identified and measured all fish captured. Fish were moved to a "measured" bucket after data were collected. As mentioned above, make sure to emphasize the importance of having wet hands when handling fish (handling fishes with dry hands can affect their mucous coating). Fishes were either released or kept in a bucket with fresh water for the next class.



Andrew Whiteley (ECOS Fellow) hands Becky Hoerner a fish to measure as Jenna Courage looks on. Becky is holding the cut PVC pipe that we used to measure fish lengths. The bucket we used to hold the fish is behind Andrew.

We did not have enough time for groups to sample multiple habitat types. This would be a good addition to this activity if the logistics can be figured out.

1) *What evidence (data, samples) do students collect?* See data sheet. Students collect species identities and length (mm) for each fish captured.

2) *How do students present the evidence (data)?* Students answered questions and graphed species distribution by habitat and a length frequency histogram for longnose dace.

3) *What conclusions are drawn from the evidence students collect?* Fishes tend to be deeper bodied and have pectoral fins higher on their sides in pools. These fishes also tend to have terminal mouths. Fishes in runs and riffles tend to be less deeper bodied, have bigger pectoral fins that are located more ventrally on their bodies, and tend to have inferior mouths.

4) *Include examples of data sheets:* See attached data sheet.

10. ASSESSMENT:

After the data were combined across all classes, students were required to graph species occurrence by habitat and to construct a length frequency histogram for longnose dace.

We asked the following four questions as a take home assignment:

- 1) What species were associated with each of the habitats?
- 2) Choose one species that predominated in the pool and one that predominated in the riffle and describe three differences in body shape or fin placement between these species.
- 3) Describe the shape of the longnose dace graph. List two possible explanations for the way this graph looks.
- 4) Do you think this sample is a good representation of the longnose dace population in the Bitterroot River?

11. EXTENSION IDEAS:

It would be possible to do a more systematic sampling scheme to try to estimate species abundance and density, but this would be extremely difficult logistically.

12. SCALABILITY

This activity could be scaled to any grade level. Younger students could draw the longnose dace histogram. The questions could be made more general.

13. REFERENCES:

This lab is adapted from one used by Lisa Eby in her Biology and Management of Freshwater Fishes class at the University of Montana.

Helfman, G. S., Collette, B. B., and D. E. Facey. 1997. *The Diversity of Fishes*. Blackwell Science, Inc. Malden, MA.

Holton, G. D. and H. E. Johnson. 2003. *A Field Guide to Montana Fishes*, Third Edition. Montana Fish, Wildlife & Parks.

Moyle, P. B. and J. J. Cech Jr. 2004. *Fishes. An Introduction to Ichthyology, Fifth Edition*. Prentice-Hall, Inc. Upper Saddle River, NJ.

Page, L. M. and B. M. Burr. 1991. *A Field Guide to Freshwater Fishes, North American North of Mexico*. The Peterson Field Guide Series. Houghton Mifflin Company. New York, NY.

14. LIST OF EXPERTS AND CONSULTANTS

We recommend contacting a local fish and wildlife office for information on local fishes and good locations to do this type of activity. If a college or university is nearby, call the biology or wildlife department and ask for a fish biologist for additional help and advice. In Missoula, we have contacted the student chapter of the American Fisheries Society at the University of Montana to continue this activity with Big Sky High School.

15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:

This activity went very well overall. Students were motivated to sample fish and to learn about the different species we captured. As a combined set of classes we caught a lot of fish and had some good data afterwards. This activity provided a closer look at a natural setting the students have seen there whole lives and have probably not thought much about.

The sampling went well. Only a few students fell in the water and we had enough boots for most of the students who wanted to try to sample. We were pleased that students came up with own ways to catch fish (for example, using a D-net under the bank to catch brown trout). Overall, Big Sky High School is very well equipped for this activity.

Sampling at the pool was more difficult. We ended up sampling the run upstream from the pool so that the students could catch fish. We also had students use dip nets to catch young of the year redbreast shiners along the bank. Keeping fish in buckets in between classes worked well as a way to have everyone see all the fish.

We had enough instructors for most class periods. It is important to have at least three instructors present for each class. More instructors is better because more people can help with fish identification and making sure data are collected accurately and carefully.

We recommend at least three instructors at all times: one in the pool, at least one in the riffle, and one on shore at the riffle supervising data collection. One additional person at the pool would be helpful for data collection, but two more is too many due to space limitations. More people (at least two more) could be in the water at the riffle helping students use kick nets. Thus, a maximum of 6 people could help with this activity. There was a tendency for students to try to measure only a subset of the fish and to be a little sloppy with measurements/species identification. If we did this activity again, we would be sure to place greater stress on the importance of accurate data collection.

We heard one anecdote from a mother of one of our students. Her daughter had been worried about this activity because she had never been in the river before and she hadn't worn waders. This student was pleasantly surprised by the activity and apparently enjoyed it. We did assume the students were familiar with waders during this activity. We probably should have taken more time with showing the students the waders and making sure they were all comfortable.

The students who had been exposed to the fishes and the habitat types during the class period prior to this activity seemed to take more from this activity. If prior exposure is not possible, we recommend a mini-lecture at the river. This lecture should stress the

habitat types (while showing them) and briefly explain the types of fishes that will be captured. A few fish could be on hand to demonstrate species identities. This mini-lecture could be done instead of giving the students time to sketch the different habitat types.

Field Activity
Fishes of Sleven's Island
Fall 2004

The Bitterroot River is a tributary of the Clark Fork River, which is the largest river (by volume) in Montana. The Bitterroot River begins with the union of several streams in the mountains near the LosTrail Pass and flows north to Missoula, where it joins the Clark Fork River.

Fishes Most Often Observed at Sleven's Island, Bitterroot River, Montana

N = native to the Bitterroot River system

I = introduced to the Bitterroot River system

Salmonidae (salmon, trout, char, grayling, whitefish):

Prosopium williamsoni Mountain whitefish

N

Salvelinus confluentus Bull trout N

Salvelinus fontinalis Brook trout

I

Salmo trutta Brown trout

I

Oncorhynchus clarki lewisi Westslope cutthroat trout

N

Oncorhynchus mykiss Rainbow trout

I

Escocidae (pike):

Esox lucius Northern pike

I

Cyprinidae (minnows):

Ptychocheilus oregonensis Northern pikeminnow (formerly

Squawfish) N

Mylocheilus caurinus Peamouth N

Richardsonius balteatus Redside shiner

N

Rhinichthys cataractae Longnose dace

N

Catostomidae (suckers):

Catostomus catostomus Longnose sucker N

Catostomus macrocheilus Largescale sucker

N

Cottidae (sculpins):

Cottus cognatus Slimy sculpin

N

Cottus confusus Shorthead sculpin

N

This lab will give you an introduction to some local fish species and allow you to try a few sampling techniques. There are various features within and along stream channels that provide important fish habitat, we will be sampling a few of them.

Riffles are shallow areas of fast moving white water. These cobble/gravel bottoms and well-oxygenated water of riffles provide good habitat for many aquatic insects and spawning fishes.

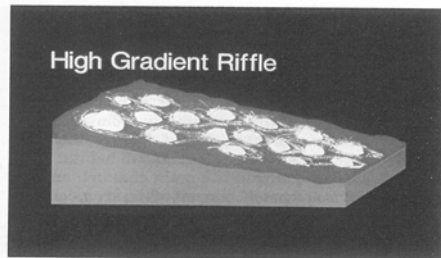
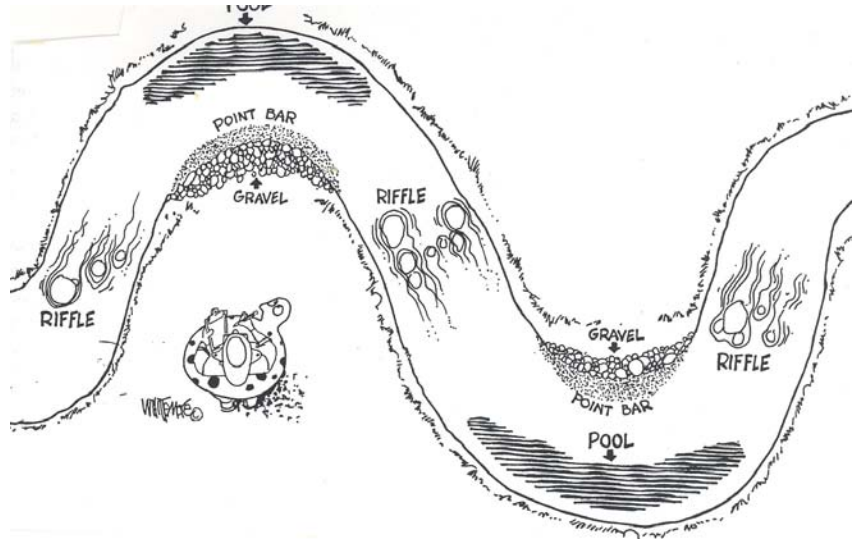


Figure 18—High gradient riffle (HGR) habitat type schematic.

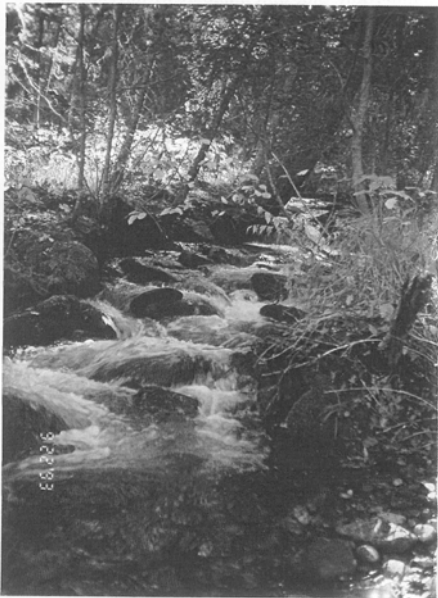


Figure 19—High gradient riffle (HGR).

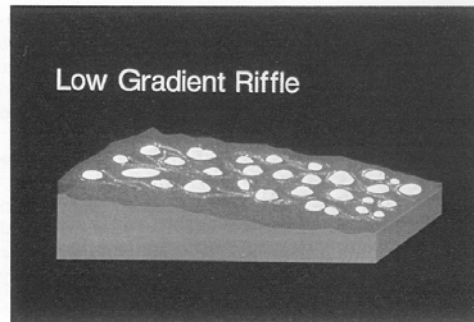


Figure 20—Low gradient riffle (LGR) habitat type schematic.



Figure 21—Low gradient riffle (LGR).

Pools are in deeper areas where the water slows down. Pools are often used by larger-bodied suckers and this is where a lot of fishes spend the winter.

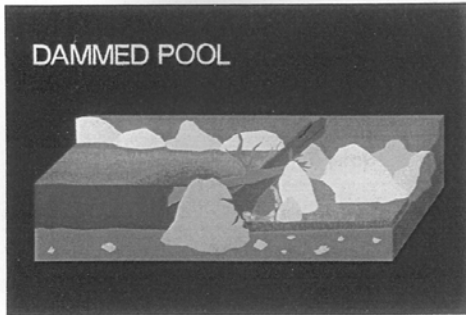


Figure 28—Dammed pool habitat type schematic.

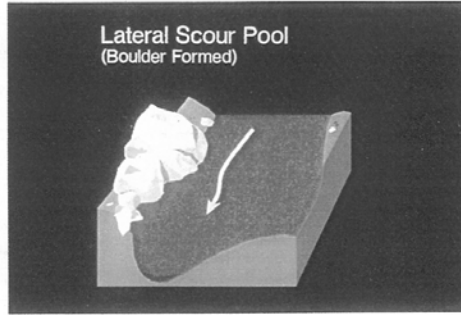


Figure 31—Lateral scour pool habitat type schematic.



Figure 29—Dammed, main channel, beaver formed (DMV).



Figure 32—Scour, lateral, large woody debris formed (SLW).

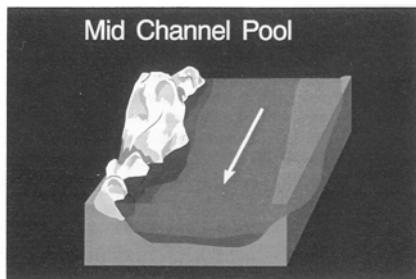


Figure 34—Mid-channel scour pool habitat type schematic.



Figure 37—Plunge pool habitat type schematic.



Figure 35—Scour, mid channel, boulder formed (SMB).



Figure 38—Scour, plunge, large woody debris formed (SPW).

Runs are fast flowing areas but not shallow enough that the substrate creates white water riffles. *Glides* are relatively slow moving areas, but still faster than water moving through pools.

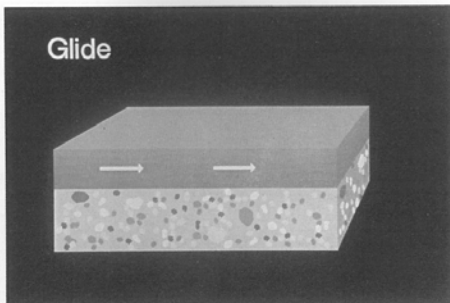


Figure 24—Glide (GLD) habitat type schematic.

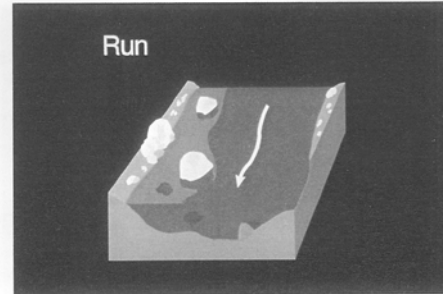


Figure 22—Run (RUN) habitat type schematic.



Figure 25—Glide (GLD).



Figure 23—Run (RUN).

Figures from: Overton et al. 1997. R1/R4 Fish and Fish Habitat Standard Inventory Procedures Handbook

This Exercise:

You will see some of these habitat types where we will be working on Sleven's Island. Draw a picture of the area where we will be working and identify the four different habitat types.

We are going to focus on all four of these habitat types. Your group will sample fishes from a pool, riffle, glide, or run at Sleven's Island. Using the different gear that is provided, collect fish from your assigned habitat. After capturing fish in your habitat, use the data sheet provided to collect the species identification and size of each fish. Pay close attention to each fish's body shape, where the fins are placed, and the shape of fins.

Assignment:

You will be given data from all of the classes combined. Use these data to a) graph species occurrence by habitat type and b) construct a length frequency histogram for longnose dace.

Answer the following questions:

- 1) What species were associated with each of the habitats?
- 2) Choose one species that predominated in the pool and one that predominated in the riffle and describe three differences in body shape or fin placement between these species.

- 3) Describe the shape of the longnose dace graph. List two possible explanations for the way this graph looks.
- 4) Do you think this sample is a good representation of the longnose dace population in the Bitterroot River?

