**Warm-up Activity**: Working with 2 – 3 students sitting near you, discuss your answers to the “Lesson 2 Flipped Learning Assignment”. Construct a diagram showing the pathway of nutrients moving through a stream ecosystem. Consider movement among trophic levels and upstream and downstream movement. Incorporate the effect of an annual spawning migration by a fish such as a Smallmouth Buffalo or Redhorse. Be prepared to share with the class.

**Research Paper Analysis:**

Redhorses are a distinct genus of fish in the Family Catostomidae. Catostomids are distinguished by an inferior mouth with fleshy lips that are used to suck food from the bottom of streams, rivers, and lakes. Therefore, they are commonly referred to as “suckers”. Similar to salmon and smallmouth buffalo, redhorses make annual upstream migrations from reservoirs and large rivers to headwaters where they spawn. In southern Appalachia, the spawning migrations typically occur in early Spring in March and April. Review the paper by Hudson et al. (2023).

How many species of redhorses occur?

*Photo by J. Davis, Wofford College*

What was the research objective of this paper?

Where was the study conducted?

Consider Figure 2 from the paper shown to the right and answer the following questions.

When did redhorse migration begin in Brasstown Creek and when did the migration reach it peak?

Based upon Figure 2a, hypothesize as to what triggered the redhorse migration.

The authors considered the ratio of N inputs (i.e., the estimated contribution of N by redhorses) to N exports (i.e., the amount of nitrogen leaving the stream). What does a value greater than 1.0 in figure 2b represent?

Describe the relationship of the amount in nitrogen in the ecosystem to the abundance of redhorses.

Research has found that the concentrations of nitrogen in streams is higher during late winter and early summer but relatively low during spring in southeastern U.S. streams. This is likely the result of biological demand by organisms such as algae. In the space below, discuss the ecological relevance of redhorse migrations in the spring.

**Application and Evaluation:**

Consider the histogram below. It shows the stream discharge, a measure of the amount of water flowing through the stream, in 2017 and 2018 in the Valley River, North Carolina. The Valley River is within the same watershed as Brasstown Creek, is assumed to represent flows similar to those experienced by Brasstown Creek, and supports a similar community of redhorses. Using the results from Hudson et al. (2013), indicate the typical start of the redhorse migration and the peak of the spawning migration. This can be done by adding a second y-axis to the right of the graph that is labeled abundance.

Compare the pattern of discharge between 2017 and 2018. How do they differ?

Speculate as to how the differences in discharge could impact spawning success and nitrogen availability in the stream. Review the discussion in Hudson et al. (2023) to guide you.

**Critical Thinking and Analysis:** Research suggests that redhorse migration may be triggered by a high flow event in early spring. Peak redhorse migration also occurs when stream temperature nears 15°C. In addition, the timing of spring flows may affect how much of the nitrogen imported by redhorses is actually used in the headwater stream. Consider the figures below showing the observed changes in temperature and precipitation in the southeastern US. Summarize each figure.



![[object Object]]()

Hypothesize how climate change may impact the redhorse migration, nitrogen availability, and headwater streams.