Questions and Answers for Teacher-Led Classroom Discussion following each background video - Thinking like a lake sturgeon biologist

Lake Sturgeon 101

1. Part 1: https://www.youtube.com/watch?v=vud1OV03AXA&feature=emb_title
    a. Based on the placement of the cameras directly at the mouth of the river as it enters Black Lake we would expect to be able to record the passage of every fish entering the river. However, practically the numbers of fish you see is an 'estimate' of the true number. Can you think of other things that could be done so we can better understand how accurate our numbers are?

    Answer – There are several possibilities.

    (a) The cameras field of view does not cross the entire width of the river. Therefore, a proportion of fish migrating upstream and downstream are not recorded in the camera video. If the 'effective width of view (in other words the proportion of stream width actually visible) can be measured. We can multiple the number of fish seen by a 'correction factor'. For example, if the camera video records ½ the stream width we can multiple the total number of each fish species observed by 2.

    (b) the width of view for the camera is greater under conditions of lower stream velocity because of 'cloudiness' associated with higher sediment load. The total number of fish observed could be adjusted daily based on simultaneous measurements of water clarity (called turbidity).

    (c) There is probably a visual bias to seeing big fish and not seeing small fish. The total number of fish seen in the video could be adjusted based on species differences in body size. We could deploy nets above and below the camera to validate 'true' numbers to validate our adjustments.

2. Part 2: https://www.youtube.com/watch?v=TEi3xUOO0GM&feature=emb_title
    a. What were some of the important ecological characteristics of lake sturgeon? Compared to other fish species, do you think these features help or hurt lake sturgeon's abilities to increase in abundance and distribution?

    Answer – There are several feature of lake sturgeon that are important impediments to increased natural reproduction and recruitment in the future

    (a) Lake sturgeon do not reach sexual maturity for many years (probably 14-18 yrs for males and 18-24 yrs for females in the Black River). Therefore, even with increased stocking of hatchery fish or increased natural recruitment now will not result in increases in the sexually mature adult population for many years.

    (b) Low population sizes mean that there are few males available in any year to fertilize female eggs. Lake sturgeon are broadcast spawners meaning the eggs and sperm are released into the water column. If few males are present, then there is an insufficient amount of sperm in the water and many eggs will not be fertilized. Also because of 'broadcast spawning' eggs, even if fertilized, will be deposited unprotected on the surface of stream bottoms and will be exposed to predators.
3. Part 3: https://www.youtube.com/watch?v=DO9-QJ08k8o&feature=emb_title

a. What were some of the more important negative contributing factors to the loss of lake sturgeon populations and declines in abundance? Have any of these negative factors been eliminated? If yes, should lake sturgeon populations be increasing?

Answer

Negative contributing factors	*factors eliminated (yes/no)*	*Pop. Increase (?)*
Pollution	*largely yes*	*slightly*
Excessive harvest	*largely yes*	*slightly*
Landuse exploitation	*somewhat (agri and urban no)*	*slightly*
Dams and loss of connectivity	*no—still large problem*	*no*
Climate change	*no—recent problem*	*no*
Invasive species	*no—recent problem*	*no*

b. Artificial propagation and stocking are now widely used to restore lake sturgeon populations and increase population abundance. What are some of the advantages of using stream-side hatchery facilities as opposed to traditional

c. Answers

(a) Perhaps the most important consideration favoring use of streamside facilities is that early life stages of lake sturgeon are raised in waters where managers hope they will return to when sexually mature. It is widely believed that lake sturgeon use their sense of smell to identify which rivers they originated from and will return faithfully to their stream of origin to spawn. This is called 'imprinting'. If fish are raised in a 'traditional' hatchery that uses ground water, the fish will not become imprinted.

(b) Use of stream water in stream-side facilities will increase the 'complexity' of water 'smells'. Thus, fish will be exposed to a more variable environment that will include smell cues of natural predators and natural prey. There is a fear that fish raised in 'traditional' hatcheries will become 'domesticated'. In other words they will become familiar with a rather sterile hatchery environment which could mean that on release, these fish would be less adapted to survive in the natural environment.

Great Lakes Literacy 101

1. Part 1: https://www.youtube.com/watch?v=AJDmBUde4_o&feature=emb_title
   a. Why is it important to have formal and mathematic methods to be able to estimate alpha, beta, and gamma diversity? Is any of these 3 diversity measures more useful than others?

Answer – It is important for biologists to establish measures of diversity that can be applied everyone in the same manner. In this way, biologists can compare diversity measures across different areas to be able establish relationships with other variables that can be used to understand what features of different places results in higher or lower levels of diversity.

   b. Can you suggest diversity measures other than the number of species that would be better suited to be used to compare different rivers?

Answer

(a) Species can be subdivided based on the habitats used. For example, lake sturgeon are 'benthivores' or 'bottom-living' species
(b) Species can be subdivided based on feeding strategies – for example, some fish prey on insects and some prey on other fish

2. Part 2: https://www.youtube.com/watch?v=NHjvFDg8U1o&feature=emb_title
    a. Many of the negative changes to the environment caused by humans have taken place on land adjacent to rivers and not in the rivers themselves. Why are they a negative influence of fishes and connectivity between Great Lakes and rivers if they are not happening in the river?

Answer – Rainfall and snow melt lead to transport of materials from terrestrial areas around rivers into the river itself. The landuses in adjoining terrestrial landscapes will dictate what materials are transported into rivers. Examples
Urban landuse – output from runoff from road surfaces, sewage treatment facilities and storm sewers
Agriculture landuse – sediments from plowed fields, elevated levels of nutrients like nitrogen and phosforous that are applied as fertilizers
Forest landuse – decomposed leaf liter

The runoff of certain materials may be perceived as a 'barrier' and fish will not pass or reproduce in waters with certain runoff materials.

Predator-Prey Relationships 101

1. Who Eats Who Part 1:
   https://www.youtube.com/watch?v=pxuCNhXQd4I&feature=emb_title
    a. When biologists conduct predator-prey studies, why do you think it is more important to record the 'biomass' of prey rather than simply reporting the number of prey?

Answer – biomass is what is important. It is the amount of prey eaten that will cause a predator to become 'full' and stop eating. Eating many 'little' prey can be equal to eating a 'single' or 'few' prey in terms of biomass.

    b. How many predators and how many prey species did we count from the video? We there differences in the timing (day) of entry into the river between predator fish, prey fish, and lake sturgeon?

Answer – Students can look at the data from the PIT tag readers which is the highest quality data because it records movements of all lake sturgeon tagged. Students should see that lake sturgeon enter the river during 2 times periods consistently each day.

    c. If we assume that the timing of reproduction, production of eggs, hatching of eggs and initiation of dispersal of larvae can be predicted based on the timing of river entry (and appearance on our videos), and are equal for all fish predators, prey, and lake sturgeon, would we expect lake sturgeon larvae to be dispersing

with a greater or lower number of other prey (fish) earlier or later in the drift period?

Answer – This is an important question student citizen scientist are helping biologist with. We know for example that there are multiple 'peaks' of spawning activity during the year. More adult lake sturgeon spawn early in the year than later in the year. We also know that more larval lake sturgeon enter the 'drift' early in the year compared to later in the year. So….given that information what does your data for other 'predators fish' and 'prey fish' (e.g. suckers) tell you?

2. Who Eats Who Part 2:
   https://www.youtube.com/watch?v=kABY7GCbu00&feature=emb_title
   a. You may remember from the lake sturgeon 101 presentations that the body size of lake sturgeon at the time eggs hatch and afterwards varies as a function of the water temperature. Eggs incubating earlier in the year, when water is colder are larger at hatch than are eggs that incubate later in the year when water is warmer. We saw in this presentation that the probability of lake sturgeon being eaten increases as the proportion of lunar illumination increases (i.e., at a full moon). Do you think larval lake sturgeon produced early in the year would be more or less visible during a full moon?

   Answer – many fish predators are 'visual predators' which means they eat what they can see. Therefore, individuals of larger body size are more visible to predators and are thus more vulnerable. Therefore, it would be advantageous for early spawning adults to spawn at a time that would result in the hatching and dispersal of their larvae (of large body size) to be drifting during a new moon. Isn't it cool that this is exactly what is happening!

   b. In this presentation we saw that the probability of lake sturgeon larval predation decreased as the proportion of insects drifting increased. This is a phenomena called 'prey shielding'. How do you think fisheries biologists and natural resource management agencies generally could improve conditions in streams to increase the amount of insects available to help 'shield' lake sturgeon larvae?

   Answer – There are multiple parts to the answer. First, it would be advantageous to increase the overall number (and biomass) of insects. Second, there are some insects like certain families of mayflies that are 'preferred' by predators. Therefore, increasing the number (biomass) of mayflies would be important.
   What can be done to increase insect numbers (biomass)---insects are reliable predictor species of habitat quality. Degradation of stream habitats such as increased sedimentation associated with human disturbances like logging, housing construction, and agriculture can increase sand load that decreases insect numbers and diversity.
   All insect species of their own habitat preferences. Some species like sand bottoms and some species like gravel bottoms. Many of the preferred prey species live in gravel substrate, which again is particularly vulnerable to sedimentation.

The vast majority of insect species emerge from the water to 'metamorphose' into flight-capable adults. Adults live for only a short period of time but these life stages also have habitat requirements for stream-side (riparian) and terrestrial habitats to complete their lives. Insect species lay eggs in shallow water habitats next the to shore line which are particularly vulnerable to disturbance by humans.

Human Disturbances

1. Part 1: https://www.youtube.com/watch?v=rWefZ-Vilzg&feature=emb_title
    a. Throughout this section we have been exposed to many stressors to coupled Great Lakes-Tributary ecosystems. Stressors include raising temperatures, human development, pollution, invasive species. Thinking back to the presentation on lake sturgeon 101, what life history stages of lake sturgeon are most likely to be affected by each of these stressors and why?

    Answer – climate variability and change (e.g., precipitation and temperature changes) are particularly important during the spawning periods. Disruption of 'reliable' spawning cues may result in eggs and early life stages of lake sturgeon to be exposed to river flow and temperature conditions that will be lethal.

2. Part 2: https://www.youtube.com/watch?v=A1QJNVFLgbM&feature=emb_title
    a. In an earlier presentation on Great Lakes Literacy 101, we learned that connectivity between Great Lakes and upstream habitats of tributaries is extremely important to increase levels of biodiversity (e.g, number of fish species). Here we see impediments to connectivity (dams) having other effects that include changing of reproductive behavior for lake sturgeon. Based on the data shown why are environmental changes caused by dams (e.g., river flow and temperature) an 'ecological trap' to lake sturgeon?

    Answer – The answer to this question is the same and for the question previously. Dams change stream flow and temperature regimes. Water up-stream from dams in shallow reservoirs increase in temperature more quickly then free-flowing streams which can accelerate spawning timing during early spring when severe weather could compromise successful reproduction. Dams will also cause water flow to change more drastically which is known to change spawning behavior of lake sturgeon.

    b. Think back to our discussions during the Lake Sturgeon 101 presentation. Given the ecological characteristics of lake sturgeon, do you think lake sturgeon are better or worse equipment to adapt to environmental changes caused by dams?

Answer – Dams generally are the largest impediment to natural recruitment of lake sturgeon

(a) Dams impede passage of spawning adults. Lake sturgeon are 'forced' to spawning immediately below dams in less optimal habitats.

(b) Habitats immediately below dams are also widely used by invasive species which eat lake sturgeon eggs and larvae (e.g., rusty crayfish, round goby) and which grow on the bottom that prevent eggs from being deposited in between gravel (e.g., zebra mussels).

(c) *Dams increase the variability of temperature and flow regimes that affect the timing and duration of reproduction and the timing and duration of larval dispersal.*