

Unit	Hydrology
Lesson	2.4 Assessing human impacts on hydrology
Essential question	What are the impacts of human activity and how can it be mitigated?
Objective	Students will be able to explain how human activity impacts stream hydrology and evaluate mitigation strategies.
Key words	Dam, reservoir, barrier to fish passage, water diversion, channelization, culvert, perched culvert, channelization
Related Standards	
NGSS standard	HS-ESS3-4
AP Env Sci topic	6.9
IB Biology topic	
IB ESS topic	4.2
Suggested sequence of learning activities	<p>Classroom-based lesson(s):</p> <ol style="list-style-type: none"> 1. Starter quiz/prior knowledge check 2. Direct instruction (if traditional) or classroom discussion (if flipped). Slides here. 3. Two in-class activity options: <ol style="list-style-type: none"> a. Students research and present on a Trout Unlimited stream improvement project (individual or pairs). Presentation instructions and example here. b. Students conduct a role play debate on the construction of a dam. Teacher instructions here. Post-debate student reflection questions here. 4. Individual exit ticket/comprehension check <p>Additional or alternative field-based lesson:</p> <ol style="list-style-type: none"> 1. Students go to a stream to evaluate habitat quality. Teacher instructions here. Student reference guides (from Georgia Adopt-A-Stream program) here.
Assessment	Exit ticket/comprehension check
Possible modifications	<ul style="list-style-type: none"> ● Give a keyword list (with or without definitions already included) to students before or during class ● Be intentional about student groupings (can be individual or group task with heterogeneous skill levels)

	<ul style="list-style-type: none"> ● Be intentional about student assignment of roles and groups for role play debate ● Provide list of projects to choose from rather than have students identify their own
Resources required	<p>Classroom-based activities:</p> <ul style="list-style-type: none"> ● Student presentations– digital distribution or showing of student presentation instructions and model presentation ● Role play debate– hard copy print out of role descriptions. Found at the end of teacher instructions here. <p>Field-based activity:</p> <ul style="list-style-type: none"> ● Copies of Habitat Reference Guide from Georgia Adopt-A-Stream program, one per student.
Starter questions	<ol style="list-style-type: none"> 1. What are two changes that humans might want to make to a stream? 2. What would be the impact on trout and other species for both of those changes?
Concepts covered in lesson	<p>Humans build dams across rivers to form reservoirs for many reasons including:</p> <ul style="list-style-type: none"> ● water storage for drinking and irrigation water ● hydroelectric power ● flood control ● recreation (boating and fishing in the reservoir) ● prior to the development of engines, to use water to drive mill wheels and other machinery <p>Although all these uses bring significant benefits, including carbon-free electricity in the case of hydroelectric power, there are significant negative effects on the river ecosystem. These harms include:</p> <ul style="list-style-type: none"> ● preventing fish from migrating up and down rivers ● changing a flowing river habitat into a still lake habitat in the reservoir ● changing the natural flow patterns of a river ● preventing most sediment from being carried downstream (it is trapped behind the dam instead) ● increasing water temperatures and evaporation in the still water of the reservoir (depending on the climate and depth of the

	<p>reservoir)</p> <p>As migratory species, trout and salmon are particularly affected by dams as a barrier to fish passage. Some dam operators try to mitigate this by installing a fish ladder, which are a series of steps serving as an artificial waterfall that migrating fish can use to get past the dam. Other efforts include capturing the fish below the dam and transporting them up over the dam. These efforts are not completely effective as some fish are stopped by the dam anyway. In addition, the presence of a large stretch of still water in the reservoir confuses fish both on the way upstream and the juvenile smolts on the way down who are adapted to be carried downstream with the current. The most effective way to mitigate the harms of a dam, particularly if it is no longer serving its original purpose, is removal.</p> <p>Another change that humans make to rivers is taking water out of rivers, called water diversions, for use as drinking water or even more significantly, irrigation. This is particularly harmful as irrigation is most needed during dry conditions which is also when rivers need the most water. In addition, trout can get caught and die in irrigation channels. The harms of water diversions can be reduced by improving the channels, like installing screens to keep fish out, or to reduce the amount of water used for domestic or irrigation use.</p> <p>When building roads across small streams in particular, sometimes water is directed through a culvert. If the end of the culvert is suspended above the stream, making an artificial waterfall, it is called a perched culvert and can be a barrier to fish passage. This is mitigated by replacing the culvert with a bridge, allowing the stream to flow naturally across the ground.</p> <p>Another change that humans make, particularly when a stream runs through an urban or suburban area, is to straighten the stream and reinforce its banks to keep it in place and protect buildings and property. This is called channelization and prevents the natural meandering pattern of rivers. It reduces the diversity of habitat available to fish and other aquatic species and often increases water temperatures because the river is shallow and unshaded.</p>
Slide presentation	Link here

Activities	Student presentations of Trout Unlimited or other local projects addressing human impacts on hydrology. Student presentation instructions and model presentation here .
Exit ticket questions	<ol style="list-style-type: none"> 1. What are two benefits and two environmental harms from dams? 2. What are two ways that you can reduce your water use? <p><u>Answers:</u></p> <ol style="list-style-type: none"> 1. See above 2. Many reasonable answers including: shorter showers, low flow appliances, turn off water while brushing teeth, choosing foods that use less water, less watering lawns, etc.
Extension questions/activities/resources	<p>Many good videos on dam removal success stories including the Edwards Dam in Maine (video here), the Elwha Dam in Washington (video here), Klamath Dam in California and Oregon (long video here).</p> <p>Have students research the effects of dam removals.</p> <p>Have students research proposed dams in other countries like the Mekong River.</p>