

# Water All Around Us

A KODU GAME LAB CURRICULUM EXAMPLE FOR EDUCATORS

MICROSOFT

## Water All Around Us

### Curriculum Overview: Water and its connection to weather, humans and ecosystems

The following lesson examples have been designed to align with prominent frameworks in STEM education such as the 2012 K-12 Standards for Science Education Proposed by the National Academy of Sciences and the National Academy of Engineering. They are meant to act as a starting point from which educators can build their own lessons on ecosystems and using Kodu to explore real-world concepts. In coordination with the 2013 Kodu [Imagine Cup](#), these lessons are themed around water. They allow students to explore the ways in which water connects humans, animals and weather within ecosystems.

### Lessons

**Lesson 1** is a guided inquiry activity that lets students explore the important role that water plays in underwater animal ecosystems through the lens of the life of a *cybersalmon*, a creature whose life in the Kodu world would be in close resemblance of the North American Sockeye Salmon. They do this exploration by playing a Kodu mini game designed to model how different characteristics of water (its depth, temperature, purity, speed, and nutrients) become key to the salmon's survival during different phases of its life.

**Lesson 2** presents students with a game world that reframes what they learned in lesson 1 and this time lets players observe a model representing how waterways connect underwater populations (in this case Salmon on their way to the ocean), with other populations, as well as with human beings. The game world gives students the baseline for a game they can complete by remixing the different level components. Using Kodu, they can take advantage of the characters provided (and the behaviors they have in them), to create their own salmon run game.

**Lesson 3** presents students with the challenge to construct their own model showing the relationship that exists between bodies of water, currents, temperature and weather patterns using tools, objects and techniques available in the Kodu community site.

*NOTE ON TEACHER RESOURCES: Some of the support materials referenced in this document are collected from publicly available sources external to Microsoft. They are provided as example reference material only. Microsoft does not maintain the material at these sites and has no affiliation with these outside organizations. Instructors are encouraged to verify that materials meet the standards of their classroom, or use alternative materials covering the same topics.*

## Standards Alignment

Some of the NAS 2012 Standards aligned with these lessons are the following:

- Scientific and Engineering Practices
  - Asking questions (what roles does water play with living organisms)
  - Developing and Using Models (water cycle, pollution, underwater populations)
  - Planning and Carrying Out Investigations (what if there are more factories, what if mother salmon chose a different redd)
  - Using Mathematics and Computational Thinking (calculating the amount of energy recovered from each food source consumed, creating new behaviors that more closely approximate those of the real life animals in the model)
  - Engaging in Argument from Evidence (discussing the similarities and differences between the game model and scientific knowledge of a salmon's lifecycle)
  - Obtaining, Evaluating, and Communicating Information (sharing a new game model with others)
- Crosscutting Concepts
  - Patterns
  - Cause and effect: Mechanism and Explanation (pollution and food contamination, fishing)
  - Systems and System Models (water speed and fish survival, predators and prey, food sources in different types of waterways, water temperatures and survival)
  - Stability and change
- Disciplinary Core
- Physical sciences
  - Matter and its interactions (water cycle)
- Earth and Space Sciences
  - Earth's systems (water as a system)
  - Earth and human activity
- Life Sciences
  - Ecosystems: Interactions, energy, and dynamics (all of the above)

## Lesson 1, Play

### *Mastery Objectives/Results*

Students will be able to use Kodu to:

- Observe, experiment with a computer model, and create hypotheses, of the relationship a fresh water ecosystem, and the survival of salmon during the earliest stages of its life.



### *Example Teacher Resources*

- Kodu Game Lab and Tutorial videos: <http://www.kodugamelab.com/About>
- 4th Grade Salmonids in the Classroom Lesson Units References published by the Canadian Department of Fisheries and Oceans
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_1.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_1.pdf)
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_2.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_2.pdf)
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_3.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_3.pdf)
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_4.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_4.pdf)

### *Lesson Sequence*

- This lesson assumes that students have some previous knowledge of the stages of a salmon's life. The teacher resources section provides links to materials that can help prepare students for this lesson.

### *Activator (5 minutes)*

- Review students' prior knowledge of the lifecycle of salmon.
  - What sort of ecosystem do salmon mothers lay their eggs in when they spawn?
  - What characteristics of water and ground conditions are important for a salmon mother to consider to maximize the chances of her eggs' survival?
  - What systems produce those conditions?
  - How do those conditions change as a salmon turns into an alevin, a fry, or an adult?
  - In what ways does the water level connect salmon to its predators at different stages? And to its prey?

### *Cybersalmon Eggs Guided Discovery: Water Quality is essential to the Life of a Salmon (25-30 minutes)*

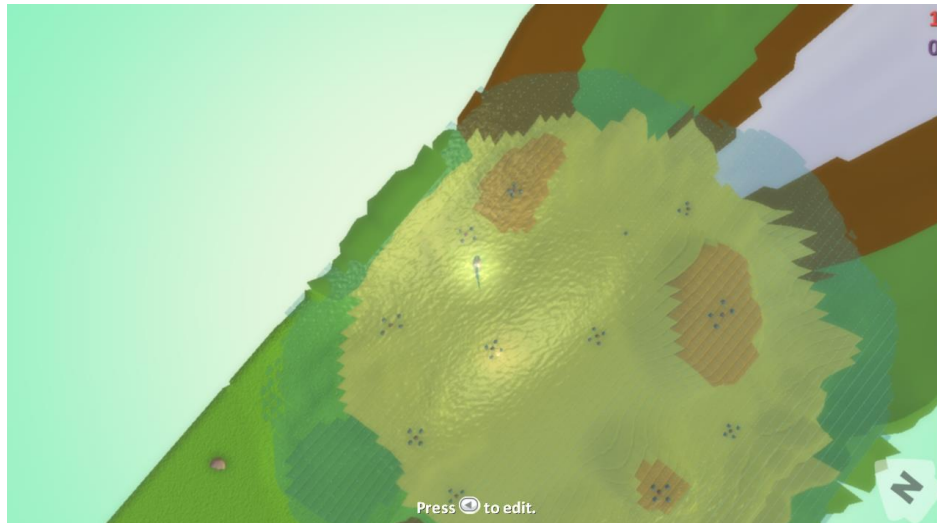
- Salmon Spawning Discussion: If students have not been exposed to the lifecycle before, have them read pages 39 and 40 of the Salmon Eggs Handout in CDFO Unit 4. ([http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_4.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_4.pdf)), which describes the factors that a Salmon ready to spawn must consider when choosing a spot (the redd)

that can maximize the potential survival of her eggs. Pay particular attention to the connections that it makes between water and what makes a redd the best to lay salmon eggs in.

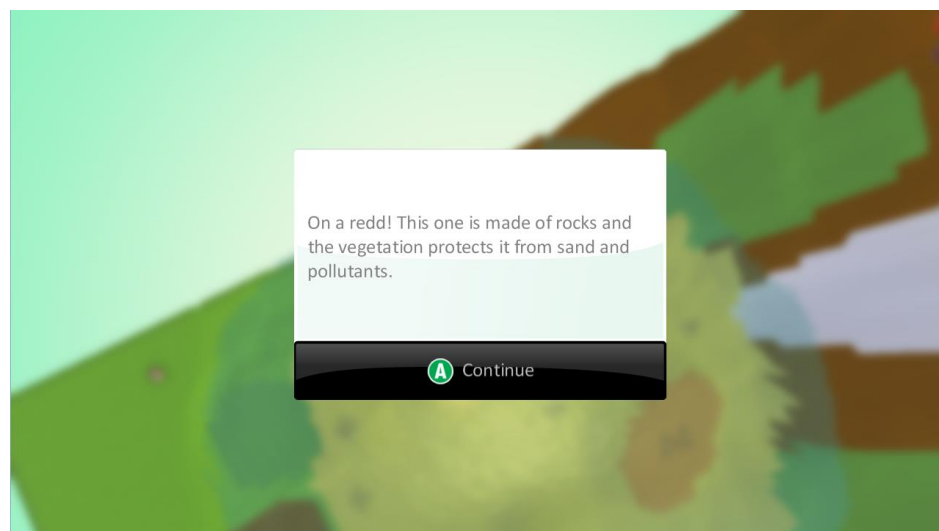
- Level Introduction Discussion: In the world of Kodu there are very interesting animals just as in our world. The cybersalmon is a fascinating creature that lives in three different habitats during the four main phases of its life, just like Salmon do on earth.
- In this activity, ask students to form pairs and take turns at *Cybersalmon eggs*, where they take the role of a Mother Salmon trying to find the best redd to lay her eggs on a mountain lake bed. While one of the students is playing, the other one should take notes as to the hints mother will give them about the sites they will explore.



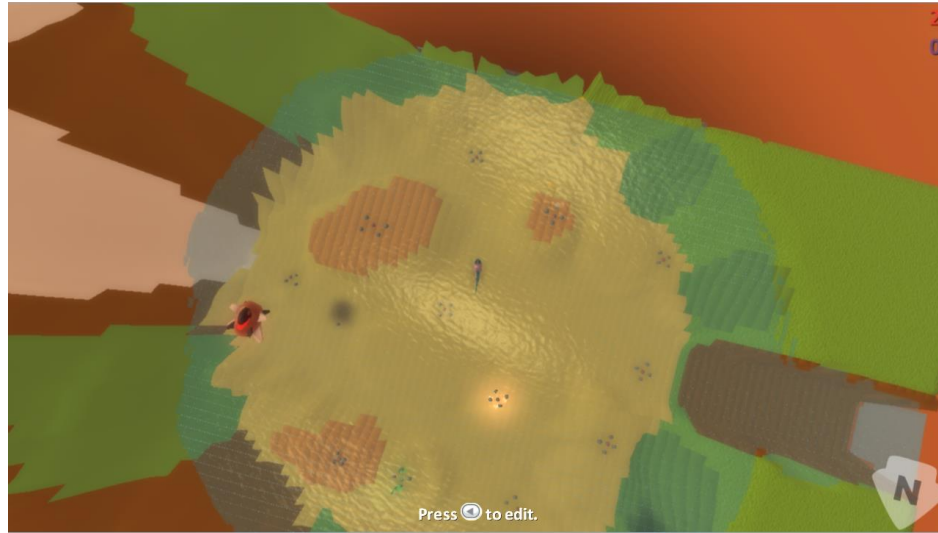
- The game has two phases. In **phase 1**, the goal is for the player to control cybersalmon mother to explore the lake and discover potential spawning sites. Players control the fish by either tapping on an area to explore or using the left joystick on the Xbox controller. Like in the real world, salmon choose redd location in areas covered by small rocks or pebbles in different locations on the base and the banks of a lake.



- Discovering a redd requires mother to get close to each pebble mound until she can examine it. Every time she has found a new redd (denoted by a mound of pebbles), she will give players information about specific characteristics she sees in the water around it. These are clues players should pay attention to, as they are tied to the aspects that are necessary for a redd to be a good spawning site. Like in the real world, by the time a cybersalmon gets to the spawning stage of her life, her time is running out and she will die soon. She must find the 10 redds before her life meter gets to zero or they will lose the game.



- **Phase 2** begins when players have found the 10 potential sites. At this point, a message will indicate it's now time to select the best one to lay her eggs in. Both students should examine the clues they have documented. Note that visual reminders appear at each site.



- Once players have made a decision of what site will be best, they should press A or tap on the site to begin laying eggs. In this phase choosing a spawning site quickly is important, as other mother fish will appear and try to spawn on the best sites. Players win the game by choosing a site where their eggs will survive (a redd that is protected, and away from drastic temperatures and predators) before their health runs out.



## Lesson 2, Remix: Water connects us all

### *Mastery Objectives/Results*

Students will be able to use Kodu to:

- Observe and experiment with a computer model, and create hypotheses, of the relationships between waterways, salmon, other animals, and human activity.
- Construct their own simulation life simulation level from a base template.



### *Example Teacher Resources*

- Kodu Game Lab and Tutorial videos: <http://www.kodugamelab.com/About>
- 4th Grade Salmonids in the Classroom Lesson Units References published by the Canadian Department of Fisheries and Oceans
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_1.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_1.pdf)
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_2.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_2.pdf)
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_3.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_3.pdf)
  - [http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_4.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_4.pdf)

### *Lesson Sequence*

- This lesson assumes that students have some previous knowledge of the stages of a salmon's life. The teacher resources section provides links to materials that can help prepare students for this lesson.

### *Activator (5 minutes)*

- Review students' prior knowledge of the life cycle of salmon.
  - What sort of ecosystem do salmon fry have to live in as they move out of their spawning grounds and toward the ocean?
  - How do salmon fry use waterways and water bodies with different current speeds to survive on their way to the ocean?
  - How does camouflage help salmon avoid predators in different water bodies?
  - In what ways is man's activity connected to water quality in the salmon's journey to the ocean?
  - What is the consequence of this activity for salmon and for humans?
  - In what ways do different aspects of waterways help or hinder the predators of salmon?
  - In what ways do the water currents and levels connect a salmon to its predators at different stages? And to its prey?

### *Guided Discovery: Water connects predators and prey below and above the surface (25-30 minutes)*

- Salmon Fry Discussion: If students have not been exposed to the lifecycle before, have them read page 65 of the Salmon Fry Handout in CDF Unit 6. ([http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic\\_primary\\_unit\\_6.pdf](http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_6.pdf)), which describes the factors involved in a fry's survival on its journey downstream to the ocean. Pay particular attention to the connections that it makes between different water bodies, their water speed and depth, and how salmon fry use them to survive predators and hunt for food.
- Level Introduction Discussion: In the world of Kodu there are very interesting animals just as in our world. The cybersalmon is a fascinating creature that lives in three different habitats during its life,

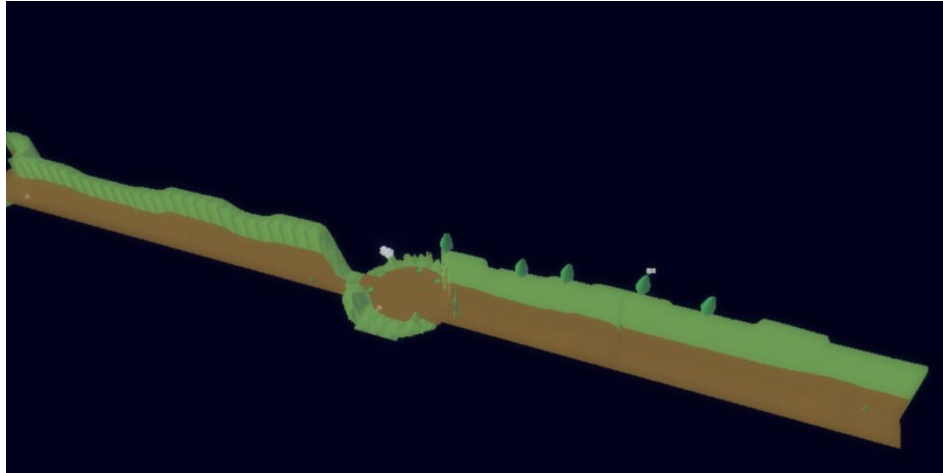


just like Salmon do on earth. In this lesson you will explore a Kodu level that shows some of the awesome ways in which waterways both help and challenge the survival of a young salmon on its way to the ocean. You will learn how to build this level, and how the relationships between salmon and water can be modeled using Kodu

- In this activity, ask students to form pairs and take turns at playing *Water connects us all*, where they take the role of a cybersalmon fry making its way from the spawning grounds where it was born down to the ocean to lead an adult life. The student not actually playing the game, should observe and make notes around the following questions:
  - What similarities exist between the journey of a salmon fry described in the handout and the life of the cybersalmon shown in the level?
  - How are they different? What sorts of predators does each one have, what sorts of prey?
  - How do different waterways help and challenge each one?
- Once both students have played the game and written down their questions, have them discuss their respective answers. Are they the same? Different? And why?
- In this level, players control a little fry as the river current pushes it downstream into the ocean. Fry flow with the currents downstream as they are not strong enough to swim upward. As the fry floats downstream, its energy diminishes, as it needs to eat to maintain its swim and to grow. The sooner it finds food, the more it will grow and the stronger it will get.
- The level is a small mini game that brings up ideas of how water bodies and water currents connect underwater populations, animals, and human activity. The teacher can encourage students to remix it to make their own version using the knowledge they have learned about salmon and Kodu.

#### *Creating your own salmon journey level*

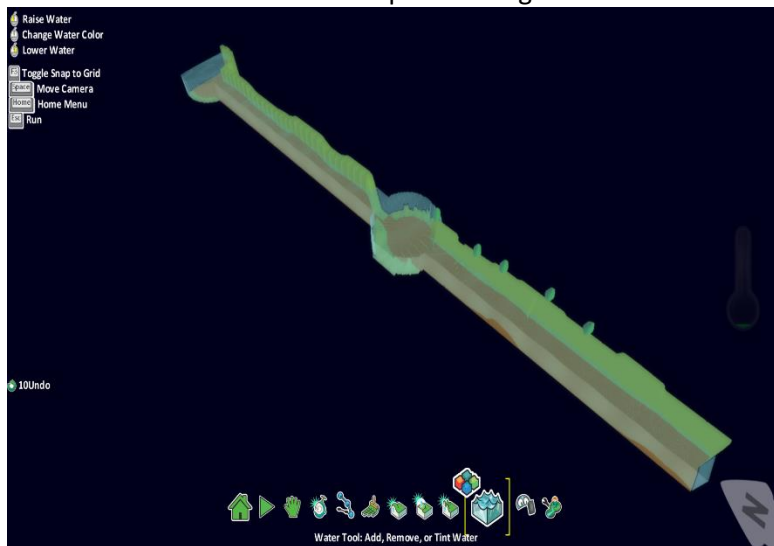
- In this activity, students will learn to create their own version of the game they just played, and in the process learn how to use Kodu to model the interactions in the waterways salmon travel.
- Once students have played the level, ask them to load the Cybersalmon Level 2 Baseline file.
- The level is a partially completed version of the one they have played, and already includes several mechanics that players can explore and then use to remix their own level. The following lessons will take them into completing the example level.



- Students will build the level by constructing three main sections or stages, organized from south to north as described in the following sections.

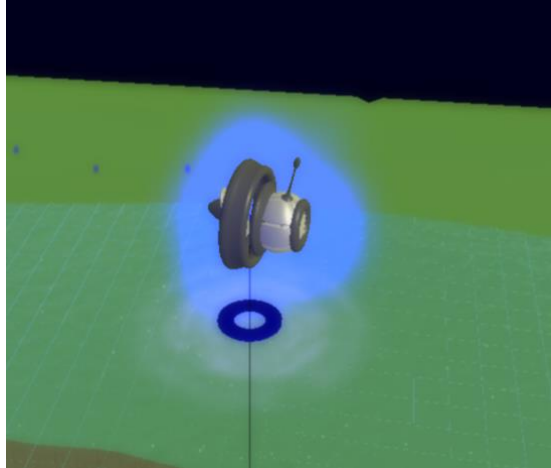
### Stage 1: The Swift River

- The first part of the level students will build shows a high speed waterway which could be found in a waterway salmon must travel on their way to the ocean. Notice that the fish are currently sitting in mid-air when they should be underwater. To create this, students should select the water tool, and then click and hold or tap and hold on the brown terrain area to flood it. They should do this until the water has flooded up to the edge of the riverbank.

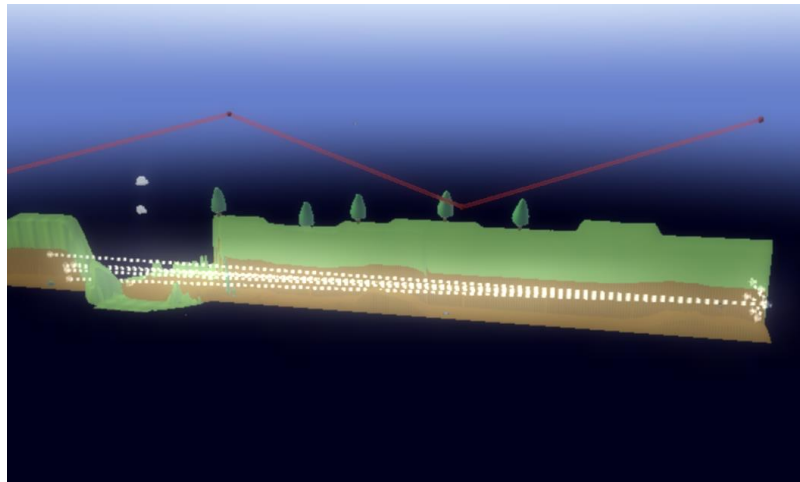
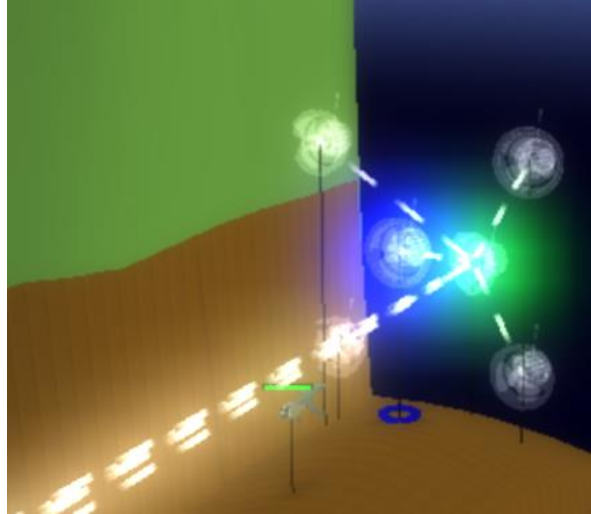


- Next comes creating the current. As with real salmon fry, the little cybersalmon is pushed by the strong current downstream, being too weak yet to overcome it. To create the current, this level will use invisible turbines which can be seen and programmed in edit mode.

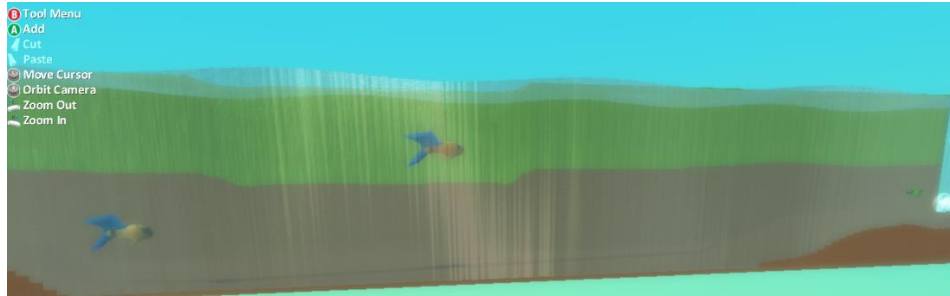
- To create a turbine, students begin by using the Kodu object tool and then tap or click on any terrain area to bring the object selector leaf menus. Tap on the objects menu and select the fan object. This will place a fan on the terrain or the surface of the water.



- Next, students will place the fan underwater and give it enough strength and reach to push the fish downstream. To do so, double tap or right click on the fan to bring up the change settings menu. In the menu, scroll with the mouse wheel or swipe up and down to select and change different turbine properties. They should be set as follows:
  - **Push Range** = 101 (Sets the turbine to its max strength)
  - **Immobile** = ON (Stops other bots from pushing the turbine)
  - **Creatable** = ON (Makes this turbine a template for others, see below)
  - **Stay Above Water** = OFF (Lets the turbine be underwater)
  - **Invisible** = ON (Makes the turbine invisible during play)
  - **Mute** = ON (Makes the turbine silent during the game)
- Setting the turbine as a creatable has now turned it into a template that we can use to duplicate its look, feel and behavior anywhere else in the level (You can learn more about creatables [here](#)). Programming or modifying the settings of a creatable immediately propagates to all its copies, thus properties such as the strength and reach of the current each turbine creates, as well as their programmed behaviors can be updated by configuring them once on the template.
- Right clicking or double tapping on the creatable will now copy and paste multiple instances of the turbine. Students should place multiple turbines at the beginning of the river just behind the fry, and at the mouth of the river, just north of the pool (the circular area) to ensure the fish is pushed forward no matter where it is. As an example, a cross configuration using five turbines could be used (pictured below) but students can experiment with the effects of different configurations. What is the minimum number of turbines required to prevent the cybersalmon from escaping the current?



- Once the turbines and the water are in place, ask students to test their level. The fry, now underwater, will be pushed downstream. It has been preprogrammed to move up and down based on input just as it does in the game.
- In the real world, a little fry floating downstream would find that its survival depends on being able to both dodge predators and find food to help it grow. Students will create these threats, starting with larger fish that will swim in the same stream and will surely eat it if it gets too close.
- To do this, players will tap or click on the object tool, and then tap or click on the leaf menu with the satellite and the turret, in there, they can select the fish and place it anywhere on the water. They should edit the new fish's settings to change the fish size and color (refer to the Kodu tutorials for help in changing object properties). Fish should be any color except grey, and they should be larger than the fry. (ASK: What happens if the enemy fish are grey? See Kode below)



- Once a fish has been placed, students will now program its brain to chase and eat the fry when it is nearby. Right click or double tap on the fish to bring up the brain editor. The following lines of code should be entered:



- Line 1 sets the fish to move in a north-south wandering motion, in line with the river direction.
- Line 2 configures the fish to move toward the fry (the grey fish) very slowly when it sees one
- Line 3 configures the fish to eat the fry if it touches it
- Line 4 sends the message "Yum...salmon lunch! Try again and be careful next time not to be fish food!" the once tile ensures this message is not repeated over and over to players. Students can insert their own game ending message here if they wish.
- Line 5 ends the game.

Once students have programmed the fish, they should exit the editor and test their game. There will be one enemy for the fry to avoid. Next, they should place more fish in the waterway. Encourage them to

turn one of them into a creatable in order to add more fish faster, but note that if they want to give different behaviors to each fish, they should create them individually. Add some variety by changing their starting height so there is a challenge for players.

## Stage 2: The Calm Pool

- The game is programmed so that if players they survive the stream, the game will be taken into the second type of waterway important to salmon fry, the calm pool. As with real fry, slow-moving and deep waters are places where they can more safely find creatures they can eat, and avoid predators. In this part, students will complete the game by placing two sources of food for the fry to eat. The fry has already been programmed to respond to them. They are:

- plankton (sub-plankton in Kodu land)

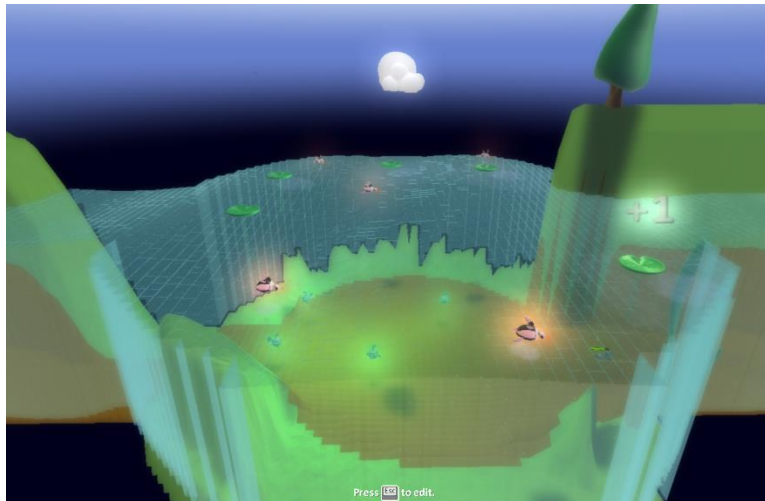


- insects (insectrons in Kodu land)



- To create these food sources, students will use creatables one more time. First, to create plankton, students will use the object tool and from the bots menu (the one with the fish and the motorcycle), choose the submarine bot, and then place it on the pool. Use its color properties (the palette that appears on top when the bot is selected with the object tool) to give it a **green color** (very important, otherwise the fry will not eat it). In its settings to set the following values:
  - **Push Range** = 101 (Sets the turbine to its max strength)
  - **Scale** = 0.5 (Makes the bot half its original size)
  - **Creatable** = ON (Makes this bot a template for others, see below)
  - **Mute** = ON (Makes the bot silent during the game)
- Once the first plankton has been created, students should follow the same process they used to create multiple copies of the turbines, but this time spread them across the bottom of the lake. Five or six should suffice. Ask them to test their game.
- Creating the insectrons is the same process than the one used for plankton with the following exceptions:
  - Use the turtle object as the base creatable, and set its color to brown. Configure it with the following settings
    - **Scale** = 0.5 (Makes the bot half its original size)
    - **Creatable** = ON (Makes this bot a template for others, see below)
    - **Mute** = ON (Makes the bot silent during the game)
    - **Stay Above Water** = ON (Lets the bot float on the surface)

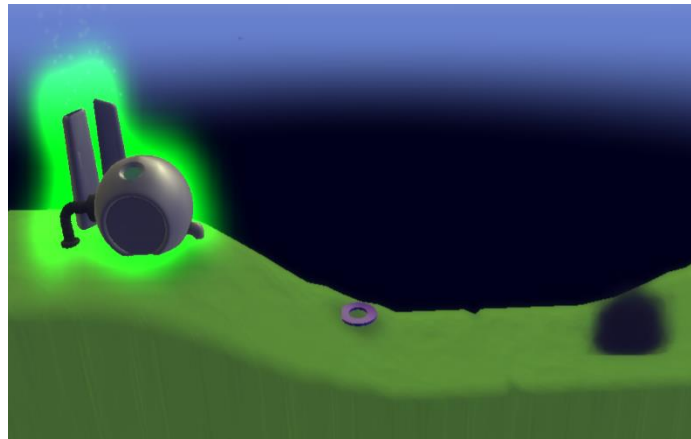
- At the end of this, they should have a pool where five or six insectrons float on the surface, and five or six plankton float near the bottom.



- Students should test their game, the fry has been programmed to respond to these food sources, and to grow as it consumes them.
- The pool is not without its risks. As the fry attempts to eat surface insects, it exposes itself to birds of prey, and underwater, it's possible that the same fish it escaped could find it as well. Thus it is best for the little fry to keep moving, eat as much as it can and get bigger and stronger.
- Encourage students to explore this area. In this pool there are also two other entities worth noting. Students can open the brains of these objects to better understand the flow of the game state in this world.
  - **The Sea Grass** – The sea grass that sits at the entrance to the pool is programmed to sense the presence of the player's fry and to update the grey score from a value of 0 to a value of 1. This update serves as a signal to the player's fish letting it know it is now in the calm pool, and to update its controls from up and down arrows to tapping or clicking on food sources. It also signals the second entity below.
  - **The Invisible Blimp** - The invisible blimp floats slightly above the pool and is only visible in edit mode. It serves multiple functions.
    1. On the signal by the sea grass, it takes away the camera focus from the fish and places it on the blimp looking down at the pool. In this way, the view of the pool allows players to better find the food to seek.
    2. When it receives the signal from the sea grass, it also starts a 30 second timer. At the end of that 30 seconds, it updates a score A with a value of 1 to indicate the start of the third stage of the game. When this happens all food sources disappear, and the player fish automatically moves downstream.

### Stage 3: The polluted stream and game end

- As with real fry, after a while the food in the pool gets dragged downstream by the current. When this happens, the fry (now a bigger fish if players had it eat some food) will float downstream to the last stage of the game.
- In this stage, the game mechanics are very similar to those in stage 1, with one key exception. Along the river bank there are a number of factories that periodically produce pollution they release into the stream. To create these factories, students should complete the following steps:



- Using the object tool, tap or click on any land area next to the stream south of the pool.
- From the Objects leaf menu (the one with the castle tower) select the factory, place it in the terrain and color it black. IMPORTANT: Make sure the factory door is facing the stream, as pollution will come out of it. Configure the factory settings with the following values:
  - **Immobile** = ON (Makes the factory stay still even if other objects hit it)
  - **Invulnerable** = ON (Prevents the factory's destruction by its own pollution)
  - **Creatable** = ON (Makes this factory a template for others)
  - **Scale** = 0.3 (Makes the factory 30% of its original size)
- To create the pollution the factory will generate, students should create an ink cloud object from the Objects menu, and place it anywhere near the first factory. The only setting that should be configured should be:
  - **Creatable** = ON (Makes this ink cloud a template for others)
- Once the factory and cloud have been created, the factory should be programmed to launch pollution into the stream. Students should enter the factory's brain editor, and create the following code:





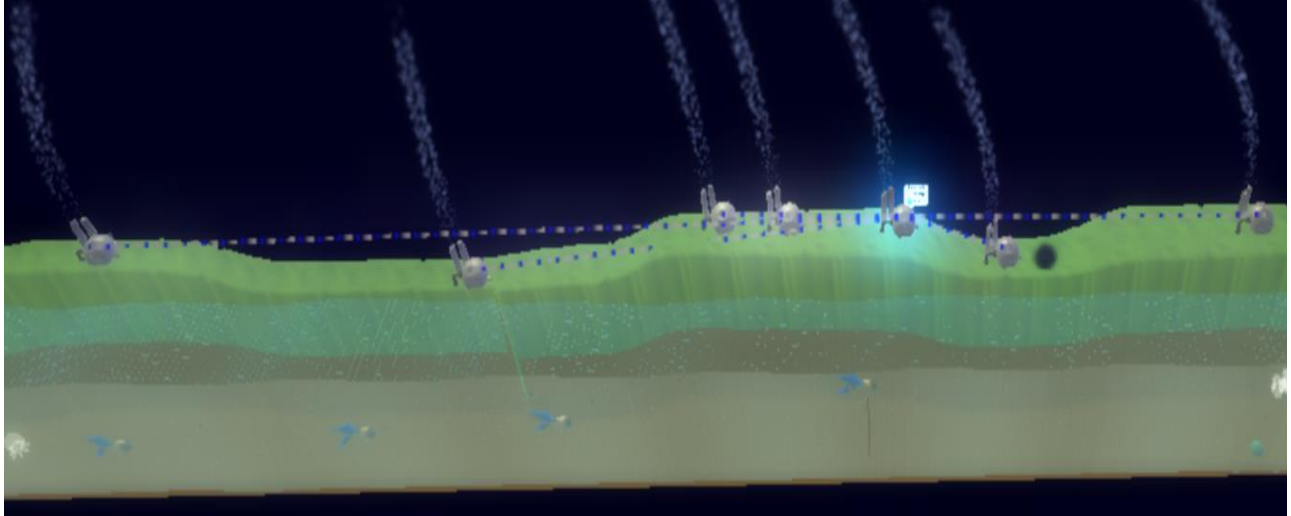
- Line 1 sets the factory to launch an ink cloud every three seconds, at a low angle and not very strongly, so it can fall right into the stream.

- In the ink cloud brain editor, they should enter the following code:



- Line 1 sets the cloud to constantly shoot black blips downward, creating the effect of oily spill into it. These blips directly harm the fry if they touch it.
- Line 2 sets the cloud to damage the fry by 10 health points if it comes in contact.
- Line 3 makes the ink cloud disappear after 5 seconds

- Once they have created and programmed the factory and cloud, students should test their creation to ensure it is working as expected. Then copy the creatable factory template to put several of them along the stream coastline.



- To close the lesson, bring their attention to the end of the stream. If the players survive the stream, they will reach the end of the game and win. Encourage students to explore the brain of the invisible surprise character who awaits to give them a hint for the next lesson.

#### *Lesson Project: Remix your own waterway game*

- Once students have played, examined, and discussed the level in detail, it is time for them to test their mettle by remixing their own Kodu level. Students should use the fry level as the basis for their work.
- The goal of the project is to make the game more fun while trying to keep the basic principles of a salmon's life represented in it, or by adding other mechanics that show the connection between animals, waterways, or human activity. Students can add or remove characters, and change their positions or their programming in order to achieve the project's goals.
- Students can also add new mechanics, if they will demonstrate more deeply the way in which waterways connect animals with other animals as well as human beings. Some ideas they could expand on are:
  - Could you make a bird of prey that catches the fry if it's too close to the surface?
  - Could you create a Kodu that "fishes" the fry or other fish from the stream?
- At the end of the game the octopus suggests to players that they try their hand at creating a game about fishing and pollution, this is meant as a starting point for a brainstorming session that students can perform in order to generate ideas for their game project. Students should use both research as well as their imagination to do so. For example, using the polluted factories and waterway designs in this level, encourage players to research the connection between pollutants, underwater animal populations, and our own food supplies, and then use their creativity to make a game out of them. Characters such as Kodu or the Boat should be good places to start when creating this game.

## Lesson 3, Create: Water Cycle Model

### *Mastery Objectives/Results*

Students will be able to use Kodu to:



- Observe, experiment with a computer model, and create hypotheses, of the relationships between water bodies, underwater populations, and human activity.
- Research, Design, and Construct a model of the water cycle using Kodu Game Lab.
- Demonstrate an understanding of the water cycle and the major factors contributing to it by presenting the model to their instructor and peers.
- Demonstrate an understanding of the role that human activity can have on the environment through the water cycle, by modelling phenomena such as acid rain in their Kodu level.

### *Example Teacher Resources*

- Kodu Game Lab and Tutorial videos: <http://www.kodugamelab.com/About>
- University of Washington's Department of Atmospheric Sciences water cycle materials
  - [http://www-k12.atmos.washington.edu/k12/pilot/water\\_cycle/teacherpage.html](http://www-k12.atmos.washington.edu/k12/pilot/water_cycle/teacherpage.html)
- Microsoft Education Acid Rain Lesson Plans
  - [http://www.microsoft.com/education/en-us/teachers/plans/Pages/acid\\_rain.aspx](http://www.microsoft.com/education/en-us/teachers/plans/Pages/acid_rain.aspx)
- Project-Based Learning Lesson Plans and formats (for teachers to have a reference to help organize their students' project execution)
  - <http://kidseducationalwebsites.blogspot.com/2011/01/pbl-examples-of-science-lesson-ideas.html>

### *Lesson Sequence*

- This lesson assumes that students have some previous knowledge of the water cycle and the states of matter. The teacher resources section provides links to materials that can help prepare students for this lesson.

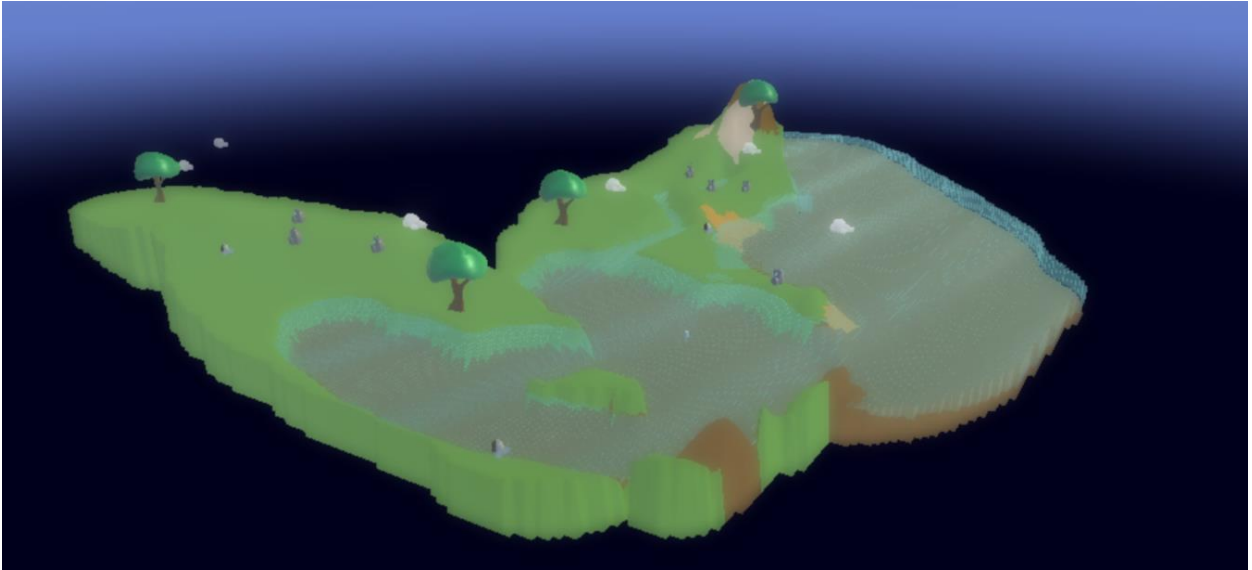
### *Activator (5 minutes)*

- Review students' prior knowledge of the water cycle.
  - Does the earth have more or less water now than 1,000 years ago? Explain.
  - From where does water that is on the ground come?
  - How does water get into the oceans?
  - What are clouds?
  - What are clouds made of?
  - How does rain form?
  - What is snow? How does it form?
  - What is acid rain and how does it form?

### *Project-Based Learning: Creating a Water Cycle Model Game in Kodu*

- Level Introduction Discussion: For this activity, students will work in teams of 2-3 people and use Kodu Game Lab to create a game that models the water cycle.
  
- Project-based lessons (PBL) can be organized in several ways, but very often, it is useful to have a specific checklist and format that students should complete in order to ensure that all the requirements requested by their instructor are met.
  
- To create the checklist, begin with a brainstorming session where students and the instructor determine what the requirements of the project will be. The session should aim to give answers to the key questions that the instructor will use to assess the model. The answers become the items that students will check for completion as they work on their project. Key questions included in the brainstorm could be:
  - What are the big ideas about the water cycle that the model present to players? (e.g. three states of matter, solid, liquid, gas)
  - In what ways will the model expose these concepts to players? (e.g. players can play mini games where they control the change in state of water from liquid, to gas, to solid)
  - What activities in the game will let players interact with the model to explore those concepts? (e.g. players get to help Kodus maintain their tree groves by moving rain clouds to their farms when they need water)
  - What bots, objects, and characters are needed to create those activities? (e.g. clouds, trees, Kodus, rain)
  - What Kodu brains need to be programmed to make those activities work? (e.g. programming a raincloud object to move when the arrow keys are pressed, and drop rain when it moves over a cooler land area)
  - How will the completed project be shared with others and in what format? (e.g. conducting a presentation and demonstration of the model to peers)
  
- For examples on creating PBL formats for checklists, see the teacher resources section.
  
- Students may begin their project using the baseline level provided. This level includes a topography consisting of multiple altitudes from the bottom of the ocean to a high mountain peak. It features sandy coastlines and rivers that run through the landscape. This variety is designed to inspire ideas, and to encourage them to modify it as necessary to produce their model. As a first step, encourage them to spend some time brainstorming on ways they could present the water cycle in fun and creative ways using Kodu. Some starter ideas suggested are:
  - A resource management game about Kodu farming and industry, and its role on the acid rain phenomenon. Use the factory pollution idea presented in the Water connects us all level to show how pollution of the water changes water PH. Use trees to represent crops, and show the way in which increased fertilizer runoff can come back and hurt us by damaging our crops and communities.

- Examine water currents, pollution and food safety. Show how the more runoff Kodus place into the ocean, the more likely they are to get that pollution in their food through the fish they catch. Show how as pollution increases, fish populations can decline.



- Students should also be encouraged to research the water cycle using online materials, to explore some of the ways in which different phenomena involved in the cycle can be represented in Kodu. For example, water evaporation can easily be represented using a creatable cloud programmed to raise from a water body.



- Students can take advantage of the kodugamelab.com community for inspiration. Here are some useful water phenomenon examples from the Kodu community:
  - Rain or snow out of wisp particle systems:  
<http://koduwebdnn.cloudapp.net/Home/tabid/55/forumid/5/threadid/76/scope/posts/Default.aspx>
  - Waterfalls using creatables:  
<http://www.kodugamelab.com/world/UMv2OoO2HUmwqonmqOswgw==>
- Students should present their model to the whole group. The presentation should include an explanation of the aspects of the water cycle they have represented and how they are simulated in the students' creation.