RoboTree

I. Abstract

Southern resident orcas are in danger. They live in the Puget Sound region in three pods J, K, and L. There are about 73 of them and their population has not grown in decades due to noise, pollution and hunger. In addition, the population of chinook salmon, the primary diet of orcas, has been on a decline. We want to make more food for orcas by increasing the population of salmon by improving its habitat.

Our invention is a RoboTree, an artificial robot tree that can absorb noise, measure and remove pollution from the air and water, and create shade to keep the rivers cold. Its roots can serve as a shelter for young salmon. In addition, the RoboTree will not use any water that real trees need, will operate using renewable solar energy, and will be made from materials that will not add any additional pollution to the environment.

II. DESCRIPTION SECTION

1. Present Technology:

Background on Southern Resident Orcas

Picture 1: Orcas in Puget Sound on November 30, 2024

The population of the Southern Resident Orcas in the Puget Sound is dwindling and they are currently at 73 orcas. The biggest reason why they're declining is because the Southern Residents are starving. Their primary food source is Chinook Salmon, which are declining too, but not because of orcas. The Chinook are dying because their ecosystem is unhealthy. The rivers they live in are warm and polluted, and lack shade. It is also very noisy because of the highways. We want to help orcas have more food by increasing the Chinook population in the Puget Sound by improving their ecosystem.

One can plant more real trees but it is difficult to regrow forests in the rivers in Puget Sound because young trees suck more water than old trees, and less water is left for salmon, plus the climate change has led to warmer temperatures.

The closest invention to our vision are the artificial trees that help to clean the carbon dioxide out of the air. Below is a short summary of current real and air pollution cleaning artificial trees.

Real trees provide shade, which keeps water cool. Trees also help keep water clean by filtering pollutants and sediment. Tree roots stabilize stream banks, which prevents erosion and keeps water clear. It can take between a decade to hundreds of years for a tree to get to an adult stage. New trees consume much more water than mature trees. Planting new trees reduces the level of water in rivers because it absorbs the water with its roots, soaking in water from the soil.

Green City Solutions has made a brand-new City Tree. This City Tree cleans air pollution called particulate matter (PM) which makes tens of thousands of lives shorter. This ‘smart’ tree uses pollution-absorbing moss and other things to remove PM and nitrous oxide from city streets that are polluted. These City Trees have been used in London and Brussels since 2015.

A Mexican company called BiomiTech has created technology called a BioUrban tree. This thirteen foot tree-like structure absorbs carbon from the air and cleans the air that about 3,000 people breathe in every day. This artificial tree has microalgae reactors that feed on pollution and then turn it into oxygen and biomass. BioUrban has been successfully used in the capital of the Mexican state of Puebla.

The MechanicalTree consumes carbon dioxide, the colorless and non-flammable gas that is a leading cause of climate change. The current tree consumes 1,000 times more carbon dioxide than its organic counterparts. The 33 foot tall tree has a stainless steel drum instead of a truck and its leaves are 5 foot metallic discs. To remove the carbon dioxide, the leaves are rinsed in water vapor and can air dry in the wind soaking more carbon dioxide.

The real trees take really long to grow and need lots of water. And the current mechanical trees are only sucking in the pollution. Our RoboTree will do all this and more.

2. History:

The History of Artificial Trees Starting in the 1880's artificial trees made with goose feathers were made for Christmas in Germany. Then, in the 1930s Christmas trees were made from wires and plastic brush bristles. During the 1950s and 1960s aluminum and plastic Christmas trees were mass produced. From 2000 to the present day artificial trees to capture Carbon Dioxide emissions to fight climate change were designed such as MechanicalTree, CityTree and BioUrban .

The History of Robotics In 1495 Leonardo Da Vinci made a mechanical knight. Then, in the 1800's factories started using automated mechanical machines. In 1921 the word "robot" came from the Czech Republic. In 1954 the first industrial robotic arm was patented. In 1972 Stanford University researchers developed the first robot that used AI. In 1980's Honda began to develop humanoid robots. Robots are currently used in many areas: medicine, self-driving cars and drones.

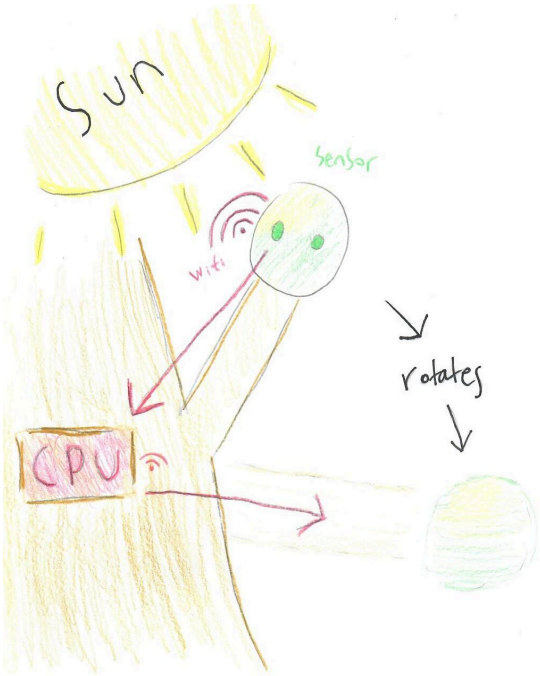
3. Future Technology:

The RoboTree is to be planted where fish in the past laid eggs, as salmon always return to their birthplace to spawn. This is called innate sense. We have three parts of our tree: the leaf cover, the trunk, and the roots, each having their own role to play.

Picture 2: RoboTree

Tree Leaf Cover will provide optimal shade to keep the river cold during every hour of a day, measure air quality, and clean carbon dioxide pollution. Salmon thrive in cool temperatures. Cold water holds more oxygen than warm water. Oxygen is beneficial for young smolts so they can make the long journey to the saltwater region. The tree will be a robot tree with a computer inside. It will have a large area of leaves “green umbrella” that would provide shade and move

with the sun. It will have a sensor on it and the sensor will send a command to the computer to shift the branch with the green umbrella to provide the most shade for the river during that hour that sun is shining on the river a lot. Picture 3 shows how the shade mechanism works. We will have to put some type of coating on the leaves so they don't disintegrate or become chalky in the UV light.



Picture 3: Shade Mechanism

Tree will measure air quality using a laser sensor (to measure particulates), and a gas sensor (to measure gases) and then the information from the sensors will be reported to the main computer. The tree will take in carbon dioxide. We can use microalgae that act like tiny filters by taking in polluting particles (carbon dioxide) and using them as fuel for photosynthesis and converting it into oxygen. The tree will be powered by solar energy. Solar energy is a renewable energy, so

there won't be additional pollution. Solar panels in the shape of flowers will be installed on the tree.

Tree Trunk will house the main computer, communicate with the scientists, and be made from soundproof and zero-microplastic shedding materials. The brain of the RoboTree is the Central Processing Unit that works by taking the information from the sensors and deciding what to do with it. It will collect and send data to the scientists using wireless communications. Wireless communications work by transmitting information through radio waves. Radio waves are part of the electromagnetic spectrum which ranges from long radio waves to short gamma waves. Radio waves travel through space and even through some objects, allowing devices to communicate without being physically connected. Radio waves are generated artificially by an electronic device called a transmitter, which is connected to an antenna, which radiates the waves.

Man-made noise can affect the fishes' ability to hear each other, prey, and predators. Also, it makes them do things like change migration routes or stay away from their spawning grounds. Sound is vibrations that travel like waves through the air or water. Sound is measured in hertz. Higher measurements make higher pitched sounds. In empty rooms the sound waves bounce off the walls making it echo. Things in the room can change how the sound works. For example, metal can reflect and cloth can absorb. In the inside of the trunk is metal that is wrapped in plastic. Plastic is durable but it sheds microplastics that contaminate water, animals and the environment. We will create the final layer to cover the plastic shell of a trunk using materials that are made from recycled plastic bottles that will be soundproof and have nano pockets that will capture microplastics over time and using chemical reactions will convert them into useful

compounds. This soundproof and zero-microplastic shedding layer will come in a variety of colors, which means it could be a brown that looks like a natural tree. The coloring has UV protection built in. We can use the same material to coat the leaf cover to prevent microplastics shedding.

Tree Roots will clean polluted water, provide a safe home for the salmon eggs, and use sonars and sensors to measure water temperature, oxygen and count fish. Pollution is bad for salmon because it shortens their lives and they can't get to a spawning area before dying, which means they can't reproduce, which means extinction is getting closer. Polychlorinated Biphenyls (PCBs) and Polybrominated Diphenyl Ethers (PBDEs) are man made chemicals and materials that are the main water pollution sources. We can use reverse osmosis to clean the water. Reverse osmosis filters work by using a high pressure pump to force water to another side of the membrane, and the membrane is so tiny it can remove microplastics, which will help a lot. The water gets sucked in by one root, the membrane filters out the microplastics and other impurities, and then, it will expel the water out of another root, which will result in purified water with no pollutants. Starting from the bottom, the roots are made to warp around in weird and squiggly ways to protect the young smolts from predators. Less water available from rain and melted snow, may lead to salmon struggling to travel the great distances between their spawning grounds and the ocean. The RoboTree can measure how much water is in the rivers and artificially pump in more water for Chinook. The Tree will have a sonar device that will send pulses of sound waves down through the water. When these pulses hit objects like fish, vegetation or the bottom, they are reflected back. This information will be used to count the amount of salmon going upriver and do modeling based on that number. We could also count the

amount that hatched. We will also use sensors to measure water temperature and dissolved oxygen. Measuring oxygen is essential for aquatic organism survival. When water gets colder more oxygen comes in and salmon need both of those things to survive. When water becomes warmer the oxygen cannot dissolve and that is bad for salmon.

4. Breakthroughs:

There will have to be a breakthrough for us to create a zero-microplastic shedding layer. This layer will be made from recycled plastic bottles that will be soundproof and have nano pockets that will capture microplastics over time and using chemical reactions will convert them into useful compounds. At the moment all plastics shed microplastics. Microplastics are tiny plastics that are under 5 millimeters in length. Scientists are working on ways to convert microplastics into useful nontoxic materials but there is no readily available solution at the moment. We will test the zero-microplastic shedding layer by doing the following: have two types of tree trunks to start. The first one is soundproof and made of recycled bottles, but doesn't have the nano pockets, while the other does. We would use FTIR (Fourier transform infrared) spectroscopy to determine the amount of microplastics in each trunk model using infrared light. If it works, there will be no microplastic molecules that will be detected.

5. Design Process:

Idea rejected #1: Originally wanted to design a robot Chinook fish to provide food with all required nutrients and vitamins to the orcas directly. But feeding orcas fish directly is illegal as they will rely on humans for food and lose their hunting skills. The next best alternative is to

improve the salmon ecosystem so their population would increase and thus, more salmon to eat for orcas.

Idea changed #2: We were originally going to use peridotite which seals the carbon dioxide. We also could have used the basalt rock cliffs which have little holes that suck in carbon dioxide. But these options would require more storage in our tree. Instead we decided to use microalgae which is more efficient.

Idea changed #3: To measure air quality we wanted to use tape at first like in old air monitoring stations but then decided to use lasers because it will require less maintenance.

6. Consequences

Picture 4: RoboTree as a part of the riparian ecosystem

A positive consequence is the RoboTree will provide shade to the river. Doing this will make the salmon healthier so that when the salmon venture down the rivers into the ocean, the salmon will be able to make it all the way to where the orcas are. This means the orcas can eat the salmon when they are more healthy and more nutrient rich which will make the orca population grow. The RoboTree will purify and clear pollutants from the water so the salmon can be healthy, so orcas eat less toxic fish. Another positive consequence is the RoboTree will be part of the riparian ecosystem so it will help other plants grow, by purifying the air and water and providing shade (See Picture 4). It will also attract more animals to make their home there. Because of the zero-microplastic shedding layer, the tree will not make any additional pollution. Negative consequences can be that the RoboTree might glitch which might make the tree malfunction. It may be a long and costly process to obtain permission to install the RoboTree in the environment.

III. Bibliography

Picture 1 a photo taken of Orcas in Puget Sound from the ferry by one of the teammates on Nov 30, 2024.

Pictures 2-4 drawn by the team.

Lecture "Hostile Waters: Orcas in peril" by the Seattle Times reporter Lynda Mapes at University of Washington, October 16, 2024

Conversation with Elizabeth Phillips, Research Fish Biologist at Northwest Fisheries Science Center
Fishery Resource Analysis and Monitoring Division, Groundfish Ecology, December 18, 2024

“How to Choose the Best Plastic for Outdoor Use.” *Advanced Plastiform, Inc.*, 21 Nov. 2024, advancedplastiform.com/how-to-choose-the-best-plastic-for-outdoor-use/.

“Materials.” *Laser Felt (n)*, 30 Aug. 2024, www.laserfelt.com/materials/

A Landowner’s Guide to Riparian Areas (Oregon State, www.landcan.org/pdfs/pnw559.pdf. Accessed 15 Jan. 2025.

Anderson, Svea. “Investigate How Sunlight Affects Your Favorite Plastic Toys.” *Science Friday*, 23 Oct. 2024, www.sciencefriday.com/educational-resources/investigate-how-sunlight-affects-plastic-toys

Scientists Achieve Rapid Upcycling of Microplastics to Graphene, phys.org/news/2024-08-scientists-rapid-upcycling-microplastics-graphene.html. Accessed 21 Jan. 2025.

Woodward, Aylin. “Scientists Have Created Magnetic Coils Thinner than a Human Hair That Could Break down Plastic in the Ocean.” *Business Insider*, Business Insider, www.businessinsider.com/plastic-pollution-magnetic-coils-could-break-down-microplastics-2019-8. Accessed 20 Jan. 2025.

“Methods for Microplastics Detection.” *Applied Sciences from Technology Networks*, www.technologynetworks.com/applied-sciences/articles/methods-for-microplastics-detection-394279. Accessed 20 Jan. 2025.

“Plastics and PCBS: Ocean Pollutants Causing Big Problems.” *Good Nature Travel Blog | Stories Are Made on Adventures*, 29 Mar. 2023, www.nathab.com/blog/plastics-and-pcbs-ocean-pollutants-causing-big-problems/

Bornsworth, John. “Trees and Salmon.” *Peninsula Environmental*, 21 Feb. 2023, peninsulaenvironmental.com/blog/trees-and-salmon/

Trees to Seas: Instruction Packet - Wa - DNR, www.dnr.wa.gov/Publications/rp_urban_salmngameinstruct.pdf. Accessed 15 Jan. 2025.

“Planting Trees for Water.” *The Rivers Trust*, theriverstrust.org/our-work/working-with-nature/trees-for-water Accessed 20 Jan. 2025.

“Trees and Water Conservation: Edmond, OK - Official Website.” *Trees and Water Conservation | Edmond, OK - Official Website*, www.edmondok.gov/1082/Trees-and-Water-Conservation. Accessed 20 Jan. 2025.

Fisheries, NOAA. “Food for Southern Resident Killer Whales: Protecting Their Wild Behavior and Instincts.” *NOAA*, 28 Nov. 2022, www.fisheries.noaa.gov/west-coast/endangered-species-conservation/food-southern-resident-killer-whales-protecting-their-wild-behavior-and-instincts

“Orcas and Salmon.” *Skagit Fisheries Enhancement Group*, 12 June 2024, www.skagitfisheries.org/education/orcas-and-salmon/

"Puget Sound Water Quality and Quantity." *State of Salmon*, 28 Feb. 2023, stateofsalmon.wa.gov/regions/puget-sound/water/

Toxic Contaminants in Juvenile Chinook Salmon, wdfw.wa.gov/sites/default/files/publications/01796/wdfw01796.pdf. Accessed 21 Jan. 2025.

Salmon Sighing Experience Guide, experience.arcgis.com/experience/f175e5c6f9ca487b80e795001e276a26/page/Spawning-H Accessed 20 Jan. 2025.

"Home." *Sauk County Historical Society*, saukcountyhistory.org/christmas-feather-tree. Accessed 20 Jan. 2025.

"Artificial Christmas Tree, 1930s." *Digitalcollections.Lib.Washington.Edu*, digitalcollections.lib.washington.edu/digital/collection/imlsmohai/id/14565/. Accessed 22 Jan. 2025.

"When Was the Artificial Christmas Tree Invented?" *Encyclopædia Britannica*, Encyclopædia Britannica, inc., www.britannica.com/question/When-was-the-artificial-Christmas-tree-invented. Accessed 22 Jan. 2025.

"Aluminum Christmas Tree." *Wikipedia*, Wikimedia Foundation, 7 Dec. 2024, en.wikipedia.org/wiki/Aluminum_Christmas_tree.

"Christmas Tree Facts." *Illinois Extension*, extension.illinois.edu/christmas-trees/christmas-tree-facts. Accessed 22 Jan. 2025.

Vince, Gaia. "Sucking CO2 from the Skies with Artificial Trees." *BBC News*, BBC, 24 Feb. 2022, www.bbc.com/future/article/20121004-fake-trees-to-clean-the-skies

Robertson, Louise. "The Filtration of Microplastics in Drinking Water." *Youth STEM 2030*, Youth STEM 2030, 11 Mar. 2021, www.youthstem2030.org/youth-stem-matters/read/the-filtration-of-microplastics-in-drinking-water.

"Top 3 Countertop Reverse Osmosis Microplastic Water Filters in 2024." *No Plastic, No Problem.*, www.noplasticnoproblem.com/blog/top-3-countertop-reverse-osmosis-microplastic-water-filters-in-2024. Accessed 20 Jan. 2025.

Plasencia, Jade. "Biourban: The Trees of the Future." *ClimateTrade*, 21 Dec. 2021, climatetrade.com/meet-the-trees-of-the-future-biourban-microalgae-reactors-to-purify-the-air-in-large-cities/.

Weiss, Elias. “World’s First Mechanical Tree ‘planted’ in Tempe, and It Sucks. in a Good Way.” *Phoenix New Times*, Phoenix New Times, 19 Apr. 2022, www.phoenixnewtimes.com/news/worlds-first-mechanical-tree-stands-tall-at-arizona-state-university-13456686.

“Building the Ultimate Carbon Capture Tree.” *ASME*, www.asme.org/topics-resources/content/building-ultimate-carbon-capture-tree. Accessed 20 Jan. 2025.

“Pollution-Sucking ‘smart’ Trees Bring Clean Air to London and Brussels - Climate-Kic.” *Climate*, www.climate-kic.org/news/citytree-london-brussels/. Accessed 20 Jan. 2025.

“Artificial Trees Could Offset Carbon Dioxide Emissions.” *Climate Change*, climatechange.medill.northwestern.edu/artificial-trees-might-be-needed-to-offset-carbon-dioxide-emissions/. Accessed 20 Jan. 2025.

“Statewide Habitat Data.” *State of Salmon*, 17 Feb. 2023, stateofsalmon.wa.gov/statewide-data/habitat/#pattern2_2.

Planting Streamside Forests to Keep Salmon Cool, www.fs.usda.gov/pnw/sciencef/scifi228.pdf. Accessed 21 Jan. 2025.

"Bigleaf Maple (Acer Macrophyllum)." *Bigleaf Maple (Acer Macrophyllum) | Oregon Wood Innovation Center*, owic.oregonstate.edu/bigleaf-maple-acer-macrophyllum. Accessed 20 Jan. 2025.

Fisheries, NOAA. "Ecosystem Interactions and Pacific Salmon." *NOAA*, 23 Aug. 2024, www.fisheries.noaa.gov/west-coast/sustainable-fisheries/ecosystem-interactions-and-pacific-salmon.

Fisheries, NOAA. "Salmon Life Cycle and Seasonal Fishery Planning." *NOAA*, 6 Oct. 2022, www.fisheries.noaa.gov/west-coast/sustainable-fisheries/salmon-life-cycle-and-seasonal-fishery-planning

"New Forests Planted Near Rivers Could Use Up All the Water, Study Finds." *EcoWatch*, EcoWatch, 9 Dec. 2021, www.ecowatch.com/reforestation-rivers-water-level-2644866095.html.

Woodland Trust. "Lifecycle of a Tree: How Do Trees Grow." *Woodland Trust*, www.woodlandtrust.org.uk/blog/2019/06/tree-lifecycle. Accessed 20 Jan. 2025.

What is Sound? YouTube, www.youtube.com/watch?v=3-xKZKxXuu0. Accessed 20 Jan. 2025.

How Sound Works, YouTube, www.youtube.com/watch?v=JPYt10zrclQ. Accessed 20 Jan. 2025.

"Alaska Sonar Technology Tools." *Request Rejected*, www.adfg.alaska.gov/index.cfm?adfg=sonar.sonartools. Accessed 22 Jan. 2025.

Aquasensor, aquasensor.co.uk/. Accessed 22 Jan. 2025.

"How Is Air Quality Measured?" *UNEP*, www.unep.org/news-and-stories/story/how-air-quality-measured. Accessed 22 Jan. 2025.

"How to Choose the Best Plastic for Outdoor Use." *Advanced Plastiform, Inc.*, 21 Nov. 2024, advancedplastiform.com/how-to-choose-the-best-plastic-for-outdoor-use/

"How We Measure Air Quality." *YouTube*, YouTube, www.youtube.com/watch?v=mp3kztZy7ow. Accessed 22 Jan. 2025.

"Lesson Three: Measuring Particles in the Air." *NIWA*, niwa.co.nz/air-aware-air-quality-lessons-teachers-and-experiments-curious-kids/lesson-three-measuring-particles-air. Accessed 22 Jan. 2025.

Noise Pollution Also Threatens Fish | American Association for the Advancement of Science (AAAS), www.aaas.org/taxonomy/term/9/noise-pollution-also-threatens-fish. Accessed 22 Jan. 2025.

"*PBDES (Polybrominated Diphenyl Ethers)*"
www.hss.gov.nt.ca/en/services/contaminants-environnementaux/pbdes-polybrominated-diphenyl-ethers. Accessed 22 Jan. 2025.

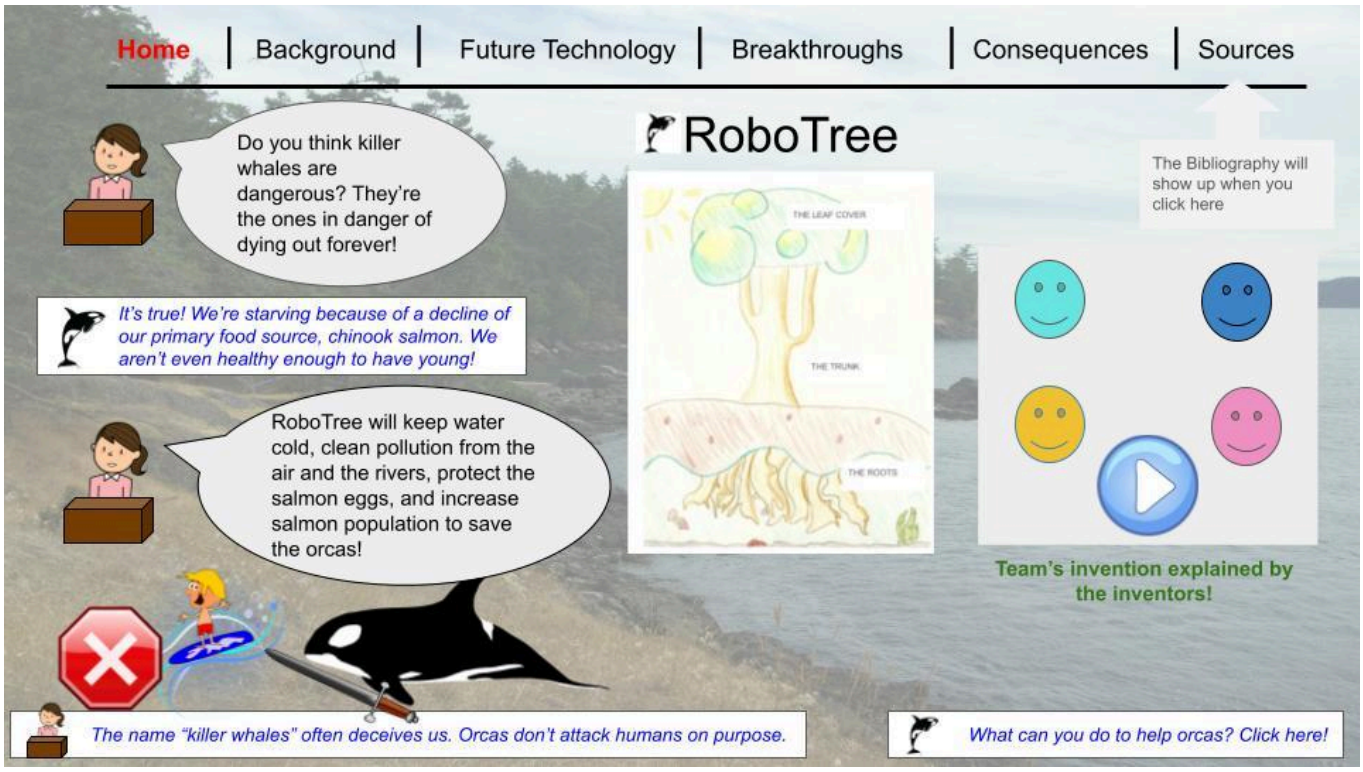
Sonar 101,
www.adfg.alaska.gov/static/fishing/pdfs/research/sonar/UCI_Sonar_101_Brochure_2011.pdf. Accessed 22 Jan. 2025.

"History of Robotics for Kids: Explore the First Robots." *Kids' Coding Corner | Create & Learn*, Kids' Coding Corner | Create & Learn, 23 Aug. 2024, www.create-learn.us/blog/history-of-robotics-for-kids/.

US Department of Commerce, National Oceanic and Atmospheric Administration. "What Is Lidar." *NOAA's National Ocean Service*, 11 Mar. 2015, oceanservice.noaa.gov/facts/fish-sonar.html.

"What Is FTIR Spectroscopy." *YouTube*, YouTube, www.youtube.com/watch?v=0e_xBwQ7znI. Accessed 22 Jan. 2025.

IV. Web Pages


Home
Background
Future Technology
Breakthroughs
Consequences
Sources
Do you think killer whales are dangerous? They're the ones in danger of dying out forever!
It's true! We're starving because of a decline of our primary food source, chinook salmon. We aren't even healthy enough to have young!
RoboTree will keep water cold, clean pollution from the air and the rivers, protect the salmon eggs, and increase salmon population to save the orcas!
RoboTree
THE LEAF COVER
THE TRUNK
THE ROOTS
The Bibliography will show up when you click here
Team's invention explained by the inventors!
The name "killer whales" often deceives us. Orcas don't attack humans on purpose.
What can you do to help orcas? Click here!

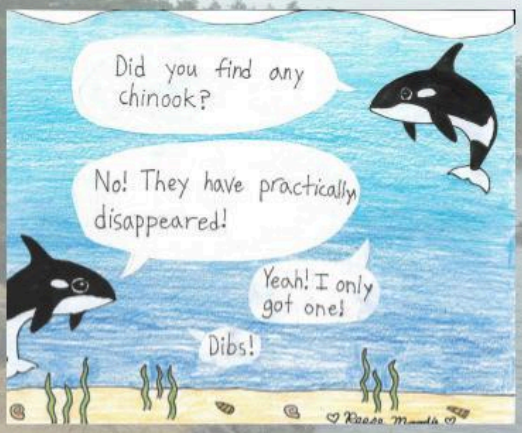
Home | **Background** | Future Technology | Breakthroughs | Consequences | Sources

Background

The population of the Southern Resident Orcas in the Puget Sound is dwindling because they are hungry.

Chinook Salmon, the primary food of orcas is declining as well.

The salmon population is under threat from an unhealthy ecosystem: low and polluted waters, lack of shade and highway noise.



Present Technology

Real trees take time and lots of water to grow and start protecting the ecosystem.

Today, there are artificial trees designed to capture CO2 to help fight climate change.

Using existing technologies and developing new eco-friendly materials, we can build the artificial trees to improve the habitat of salmon and orcas.

There have been only 74 Southern Resident Orcas for the past couple of decades, and then we fell down to 73.

Home | Background | **Future Technology** | Breakthroughs | Consequences | Sources

Key Technologies

The Leaf Cover	SHADE MECHANISM	AIR QUALITY SENSOR
The Trunk	CARBON DIOXIDE	SOLAR PANELS
The Roots		

Pop up window with detailed technology

Learn how Shade Mechanism works

Key Capabilities of RoboTree

Acts like a real tree.

Measures air and water quality, cleans water pollution, protects and tracks salmon population.

Does NOT need water and does NOT pollute the environment with microplastics.

Click here to learn more.

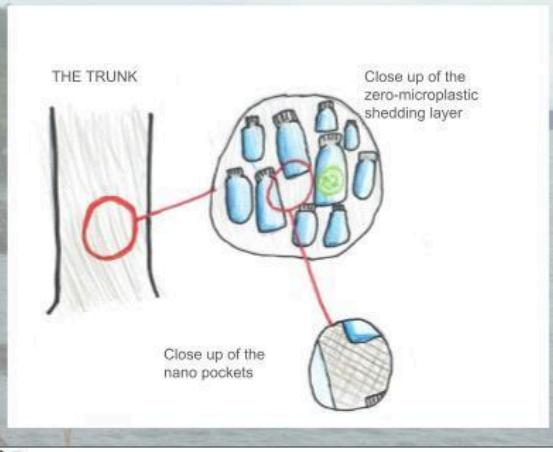
Yay! Since the salmon are safe in this tree we get more food!

*When you click a button under Key Technologies the box will turn **red** and a pop up window will appear on the right explaining the technology.*

Home | Background | Future Technology | **Breakthroughs** | Consequences | Sources

Breakthroughs

The trunk and leaves are coated with a layer containing tons of nano pockets to eliminate the amount of additional plastic and turn it into something new, useful, and friendly to the environment. It is also soundproof and made from recycled bottles.



We definitely don't want to eat microplastic-filled salmon!

Testing Breakthroughs: click on the orca to find out more!

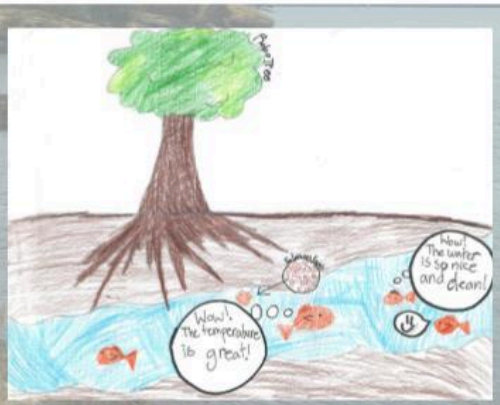
Home | Background | Future Technology | Breakthroughs | **Consequences** | Sources

🙂Good Consequences:

1. RoboTree will provide shade to the river.
2. The RoboTree will purify and clear pollutants from the water so the salmon can be healthy, so orcas eat less toxic fish.

☹️Bad Consequences:

1. The RoboTree might glitch which will make the tree malfunction.
2. It may be a long and costly process to obtain permission to install the RoboTree in the environment.



I hope the RoboTree can help us!