Environments

Investigation 1: Terrestrial Environments

How this investigation fits within the Concept and Lesson Map:
This investigation serves as a way to elicit student preconceptions about what living things need to survive. It is not necessary that all students have the same plan or outcome from this investigation. There is added value in coming back to this investigation after investigation #3, as the terrariums continue to grow as well as the complexity of ideas surrounding the students understanding of environmental factors.

Overarching Question(s) for the Whole Investigation
What do plants need to sprout and survive?

How People Learn #1: Preconceptions
Eliciting Student Ideas:

- Conversation starter: “Have you ever tried to keep something alive?” (Refer to Chapter 5 in Ready Set Science, “Making Thinking Visible: Talk and Argument”)
- Concept Map: “Environment” - Ask students to pick a terrestrial environment (forest, desert, tundra, mountain, etc.) that is familiar to them. Brainstorm a list of important parts for that environment. Place each part in a circle somewhere on the page and ask students to draw lines to show connections. Label the lines to explain connections. (see example)
- Pre Assessment: Needs of Seeds Formative Assessment from Uncovering Student Ideas in Science Vol. 2 p. 101 Page Keeley
- Concept Cartoon: Seeds in the Dark 6.10 Concept Cartoons in Science Education p. 29 Stuart Naylor and Brenda Keogh.

Common Student Preconceptions:
- Some students will believe that plants need light for all parts of their life cycle although seeds in the dark and underground will still sprout.
- They might also assume that different plants need the same amounts of water and this assumption will influence how much water they choose to use in their terrarium.

How People Learn #2: Facts/Concepts/Knowledge

WA State Content Standards “Science Domains” (EALR 4)
4-5 LS2A An ecosystem includes all of the plant and animal populations and nonliving resources in a given area. Plants and animals depend on one another and the nonliving resources in their ecosystem to help them survive.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)
2-3 SYSA A system is a group of interacting parts that form a whole.

Key Understandings for the Teacher:
The terms ecosystem and environment are interchangeable at this level. WA standards use ecosystem and FOSS uses environment for the same concept. FOSS uses the term “environments” to lead students to an understanding of “ecosystems.” Both are composed of the living and non-living components. Changes in any component will have effects on other components.

How People Learn #3: Metacognition
Metacognition: How did my thinking change? What caused the change? How did I come to believe this?

- Revise concept map with new ideas and dates on a periodic basis.
- Coming back to this investigation after lesson 3 and at the end of the unit would help students understand how their ideas have changed over time.

Continued on back
Evidence of Student Understanding:
Students should have detailed descriptions and observations of the terrarium environment as it changes over time recorded in their science notebooks. Examples of entries could include: drawings of entire terrarium with labels and/or labeled drawings of specific parts that have changed over time; growing list of short observational notes with dates/times; written record of amount of water added to terrarium and placement of water.

Additional Information

Materials and Student Management
- Make sure you have ordered your organisms for investigations 2 and 4 as these can sometimes take 4-6 weeks for delivery. Contact Linda Pollino for an organisms card. You will need to call Delta Education with card information.
- Barley has a narrow range of tolerance for moisture, as it prefers a moist/dry environment.
- It is okay to let students make their own choices even if it may not “work”

Timing Considerations
- Keep in mind that the terrariums are used for approximately one month as students do investigations 2 and 3. Students will need time periodically to observe, record, and possibly alter their terrarium environments.
- The FOSS Overview folio suggests a minimum of 10 weeks to complete the investigations for the Environments Module. When a teacher embeds important elicitation, metacognition, technology and formative assessment strategies to improve student understandings the module will take longer to complete.

Helpful Resources and Bibliography:
- Concept Cartoons in Science Education (Naylor and Keogh, 2000)
- Uncovering Student Ideas in Science (Keeley, Eberle, Tugel, 2007)
- Science Curriculum Topic Study: Ecosystems, pg. 127 (Keeley, 2005)
- Atlas of Science Literacy, V2. (American Association for Advancement of Science, 2007)
- Ready Set Science (Michaels, Shouse, Schweingruber, 2008)
Environments

Investigation 2: Bugs and Beetles

How this investigation fits within the Concept and Lesson Map:
This investigation looks into the environmental preferences of animals (isopods and beetles) instead of plants. It continues to look at moisture and light conditions, but focuses on preferences. There is a direct link to Investigation 1, as students will introduce isopods or beetles into their terrariums at the end of the investigation. They will need to use evidence collected to possibly change their terrariums in order to better meet the needs of the organism.

Overarching Question(s) for the Whole Investigation
• What type of environment do isopods and beetles prefer?

How People Learn #1: Preconceptions
Eliciting student ideas:
• Conversation starter prior to beginning Investigation 2, Part 1: “Based on your own experiences, do you think beetles and isopods prefer the same environment?”

Common Student Preconceptions:
• Students may assume that the animals’ preferences are related to likes and dislikes. Observing the amount of time the animal spends in the area can be helpful to explain the idea of preference. An organism will choose a location based on the environmental location most closely resembling their natural environment.
• Students may tend to observe just one environmental factor at a time. In reality, an organism generally has a set of (more than one) environmental factors that need to be present.

How People Learn #2: Facts/Concepts/Knowledge
WA State Content Standards “Science Domains” (EALR 4)
4-5 LS2A An ecosystem includes all of the plant and animal populations and nonliving resources in a given area. Plants and animals depend on one another and the nonliving resources in their ecosystem to help them survive.
4-5 LS1C Certain structures and behaviors enable plants and animals to respond to changes in their environment.
4-5 LS1D Plants and animals have structures and behaviors that respond to internal needs.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)

Key Understandings for the Teacher:
• Isopods are drawn to damp and dark conditions and the beetles prefer dry and dark conditions.
• The idea is preference is separate from the needs of an organism and is a behavioural response to the environment. Mobile organisms like isopods and beetles can respond to their environmental conditions by moving closer to their optimum conditions.
• The idea of preference itself is not a big idea in science. However, the conceptual idea of preferences is a foundation for future understandings of biological evolution.
• Two environmental factors that affect living organisms are light and moisture (the amount of water).
• Students may have some experience with beetles and isopods. Both animals are present in Western WA.
• Students will need to be supported in planning each Bugs and Beetles controlled investigation. FOSS provides two WA Edition Modified Student Sheets with the Investigation 2 Formative Assessment (No. 6 Animal Investigations-Planning and No. 6a Animal Investigations-Results). Teachers should provide different levels of support for the use of these student sheets. For example, it could be assumed that 5th grade students have had experience writing
Teacher Tips
Version 1.0

- Isopods are drawn to damp and dark conditions and the beetles prefer dry and dark conditions.
- The idea is preference is separate from the needs of an organism and is a behavioural response to the environment. Mobile organisms like isopods and beetles can respond to their environmental conditions by moving closer to their optimum conditions.
- The idea of preference itself is not a big idea in science. However, the conceptual idea of preferences is a foundation for future understandings of biological evolution.
- Two environmental factors that affect living organisms are light and moisture (the amount of water).
- Students may have some experience with beetles and isopods. Both animals are present in Western WA.
- Students will need to be supported in planning each Bugs and Beetles controlled investigation. FOSS provides two WA Edition Modified Student Sheets with the Investigation 2 Formative Assessment (No. 6 Animal Investigations-Planning and No. 6a Animal Investigations-Results). Teachers should provide different levels of support for the use of these student sheets. For example, it could be assumed that 5th grade students have had experience writing how-to’s. Access prior knowledge of this skill and connect it with writing a procedure in science.

Here is a possible suggestion of how to gradually release responsibility to the student for writing about a controlled investigation as the students continue on with Parts 3 and 4. The teacher models how to plan Part 2: Responding to Moisture via a teacher demonstration. This will be the standard Bugs and Beetles procedure. As the teacher models, students copy the procedure into their science notebooks or onto the student sheets. In Part 3: Responding to Light, students should be given more responsibility in planning the investigation. The teacher should post the previous investigation and refer students back to it in their science notebooks. In planning the new investigation, student groups use the previous standard investigation to change or add based on the new focus question. Groups may use whiteboards or a large piece of paper to write their drafts. Each group can share their plans with the class and get feedback via a discussion. Not all group plans will be exactly the same, but should be somewhat similar. When plans are complete, students copy them into their science notebooks or onto the student sheets. Part 4: Designing an Animal Investigation allows students to have greater independence and choice in designing an investigation. While some students may be ready for taking ownership of the entire process, it should not be assumed that all students are totally independent. The teacher should provide continued support and scaffolding for these students.

How People Learn #3: Metacognition

Metacognition: How did my thinking change? What caused the change? How did I come to believe this?
- After Part 3: Student science notebook reflection, “How do the environmental factors in our terrarium match the preferences for beetles and/or isopods? What changes could we make to our terrariums to better meet the needs of isopods and/or beetles?” Allow them to use words, pictures, labeled diagrams. When students finish individual reflections, ask them to share their ideas and make a plan to introduce isopods or beetles into their terrariums after part 4 is complete (in a week or two).
- Post Assessment science notebook prompt after Part 4: “Based on the evidence from our 4 animal investigations, explain how the environmental conditions in your terrariums match the preferences of beetles and/or isopods?”

Evidence of Student Understanding:
- Part 3 of Student Sheet 6: Conclusion: Animal Investigations or equivalent prompt in science notebook. Use provided rubric to analyze.

Additional Information

Materials and Student Management
Teacher Tips
Version 1.0

- Building of runways in Part 1 can be done by a few students ahead of time instead of using class time.
- Order beetles and isopods 4-6 weeks ahead of time. Contact: Linda Pollino at Carl Cozier (refurbishes kits). Beetles should be placed in a large terrarium type container with a couple inches of bran or oatmeal cereal. Put dry crinkled paper towels sheets on top to provide a hidden, climbing environment. Delta Education also suggests a couple chunks of apple. Isopods should be placed in a terrarium containing most/wet soil and woody debris. A couple slices of apple are also recommended. Make sure these environments are kept out of the view of students, as to not give them clues to their investigation purpose.
- Investigations 2 and 3 both require potting soil that is totally dry – spread potting soil out on newspaper to dry for two days in order to have a ready supply.

Timing Considerations
- Part 4: Groups will have various time frames for their own investigations. Groups may also need additional materials.

Helpful Resources and Bibliography:
How does this investigation fit within the Concept and Lesson Map:
To run a controlled experiment with plants in order to learn more about the environmental factors, moisture, impacting the terrarium ecosystem. The idea of an optimum soil moisture condition within a plant’s range of tolerance is introduced and is the main focus of this investigation.

Overarching Question(s) for the Whole Investigation
- How do plants respond to changes in environmental factors?
- How specific are the needs of plants?
- “For any particular environment, some kinds of plants and animals thrive, some do not live as well, and some do not survive at all.” (Atlas, p. 33)
- How do the key understandings connect to real world agricultural problems?

How People Learn #1: Preconceptions

Eliciting Student Ideas:
- Formative assessment: Response Sheet for Investigation 3 (WA Edition, Modified Student Sheet No. 11)
- After all data has been collected, students may share conclusions with their classmates by drawing their own “tolerance gauge” on whiteboards and explaining how their evidence supports the gauge. (NCOSP Supplementary material, July, 2009)
- Strategies that the teacher could use to help students recognize the strengths and weaknesses of their data collection procedures (student sheet #10):
  - Create a class line plot to the shape of the data and outliers.
  - Ask students how they measured each growth structure (technique as well as units).
  - Explain why these growth structures might provide evidence for a range of tolerance and an optimum condition.

Common Student Preconceptions:
- “Most children recognized plants’ need for soil, water and sunlight in their habitat. Consumers were thought to need water, food and shelter” (Making Sense of Secondary Science page 63)
- “...they often think of organisms as independent of each other but dependent on people to supply them with food and shelter” (Benchmarks for Science Literacy page 342)
- “...younger children (up to 13) seemed to think in terms of the needs of individual organisms rather than of populations” (Making Sense of Secondary Science page 63)
- Students might also assume that different plants need the same amounts of water.

How People Learn #2: Facts/Concepts/Knowledge

WA State Content Standards “Science Domains” (EALR 4)
- 4-5 LS1C Certain structures and behaviors enable plants and animals to respond to changes in their environment.
- 4-5 LS1D Plants and animals have structures and behaviors that respond to internal needs.
- 4-5 LS2D Ecosystems can change slowly or rapidly. Big changes over a short period of time can have a major impact on the ecosystem and the populations of plants and animals living there.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)
- 4-5 INQD Investigations involve systematic collection and recording of relevant observations and data.
- 4-5 SYSC Systems have inputs and outputs. Changes in inputs may change the outputs of a system.
Key Understandings for the Teacher:
- The soil moisture needs of plants become more specific as the seeds move through the stages of growth from germination to adult.
- The range of tolerance for the environmental factor of soil moisture varies for different plants.
- Students may require more scaffolding for experimental design if they have not had previous experience through FOSS or other lessons.
- “The conditions that are most favourable to an organism’s survival, growth, and reproduction are optimum conditions.” (FOSS: Environments: Water Tolerance, p.4)
- The only environmental factor tested in this investigation is soil moisture, but the class conversation should be directed toward the idea of range of tolerance for environmental factors as a whole.
- This investigation provides a great opportunity to return to their terrariums from Investigation 1. They should be able to apply understandings from this investigation to environmental factors within their terrarium ecosystem.

How People Learn #3: Metacognition
Metacognition: How did my thinking change? What caused the change? How did I come to believe this?
Part 1: In Step 12, have students compare their results with their original prediction.

Evidence of Student Understanding:
- At end of Part 2: Response Sheet (WA Edition Modified Student Sheet No. 11) use provided rubric
- At end of Part 3: Notebook Prompt (WA Edition Assessment p. 28) Teacher modeling for writing a conclusion might be necessary.
- Observations Rubric (FOSS Assessment Folio, p.11) use during Part 3
- At end of Part 3: Students should apply their new learning to their observations (written in science notebooks or expressed during conversations) of their terrariums from Investigation 1.

Additional Information

Materials and Student Management
- Start using the “tolerance gauge” (NCOSP Supplementary material, July, 2009)
- Prior to Investigation soil needs to be dried.
- Plants might grow better with use of a grow light. It’s important that all plants receive the same light treatment. Currently, each school has one grow light with stand.
- In Part 3, slow down and organize the uprooting procedures so it is easy for groups to determine which sprouts are from each moisture condition. One student at a time can dismantle one planter and distribute the plants to the student(s) responsible for each type of plant profile. For example, the student with the “dry condition” planter uproots all the plants and carefully distributes the pea plants to the student with the “pea plant profile” so he/she can tape those “dry condition pea plants” onto the pea profile in the right place (and then continues this process with the barley, corn, and radish until this planter’s sprouts are sorted out correctly and taped in the right places on the plant profiles).
- In Part 3, plant profiles wilt quickly. Take digital photos to save evidence for discussions.

Timing Considerations
Because growth time for the plants is necessary, this Investigation will be running concurrently with Investigation 1 and 4, as students may be continuing to collect data from the Investigation 1 terrariums and you may be beginning Investigation 4.

Helpful Resources and Bibliography:
- Benchmarks for Science Literacy (AAAS, 1993)
• Science Curriculum Topic Study: Ecosystems, pg. 127 (Keeley, 2005)
• Atlas of Science Literacy, V2., p. 33 (American Association for Advancement of Science, 2007)
Investigation 4: Aquatic Environments

How this investigation fits within the Concept and Lesson Map:
In the prior investigations, students had experiences with identifying environmental factors and observing a range of tolerance in terrestrial environments. Now, in an aquatic environment, students are ready to discover that organisms can change the environmental factors. In this case a goldfish changes the acidity of the water environment by giving off CO2. This investigation helps students generalize their ideas about organisms to other environments beyond terrestrial.

Overarching Question(s) for the Whole Investigation
How do organisms change the environment and how do we measure these changes?

How People Learn #1: Preconceptions
Elicit student ideas:
Concept cartoons- Small Fish 6.8 and Pond Life 6.10. Both of these help students activate background knowledge about: invisible environmental factors (gases), that organisms have a range of tolerance (live or die based on environmental factors), how fish/plants use and produce gases, how the environment influences living organisms and how the organisms can change the environment. Cartoon 6.8 is best used before Part I and cartoon 6.10 before Part 2.

Common Student Preconceptions:
- Students often think of organisms as independent of each other (Leach et al., 1992). This could lead them to not look beyond the simple food web connections and remain unaware of subtle relationships between an organism and the environment.
- The logical thinking required to understand the connection between the fish and the changing acidity involves causes and effects that might be challenging for many students. Refer to the bulleted list on page 6 of the investigation booklet to support student understandings.

How People Learn #2: Facts/Concepts/Knowledge
WA State Content Standards “Science Domains” (EALR 4)
- 4-5 LS2E All plants and animals change the ecosystem where they live. If this change reduces another organism’s access to resources, that organism may move to another location or die.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)
- 4-5 SYSC Systems have inputs and outputs. Changes in inputs may change the outputs of a system.
- 4-5 INQD Investigations involve systematic collection and recording of relevant observations and data.
- 4-5 INQF A scientific model is a simplified representation of an object, event, system, or process created to understand some aspect of the natural world. When learning from a model, it is important to realize that the model is not exactly the same as the thing being modeled.

Key Understandings for the Teacher:
- The acidity is an important environmental factor in aquatic environments.
- When CO2 dissolves in water, it makes the water acidic.
- Bromothymol Blue (BTB) is a chemical indicator that changes color depending on the acidity of the water. This allows students to observe and infer that the fish is making the water more acidic. Without the BTB indicator, this change in acidity would be invisible to students. When the acidity increases the water with BTB will change from sky-blue to green or yellow (see pg. FOSS Investigation 4, pg. 14).
How People Learn #3: Metacognition

Metacognition: How did my thinking change? What caused the change? How did I come to believe this?
Students journal throughout investigation 4 in science notebooks using the prompt, “How are the plants and animals changing the aquarium environment and what factors are being changed?” For example, this could be an on-going list of evidence that helps students understand that there are many visible and invisible changes happening to both the organisms and the environment. Students revisit their list of changes over time at end of investigation.

Evidence of Student Understanding:
- Looking at Student Work (LASW): Science notebooks, FOSS student response sheets, assessments.
- As a way to reflect on the class’s collective growth of understanding about how organisms influence their environments, the teacher can guide a whole class sharing of student journal responses to the metacognitive prompt (record on whiteboard).
- Teams of students design (draw) a labeled diagram showing an investigation similar to the aquatic environments investigation, but using a new environment and organism(s). Prompt students to add details showing how their new organism(s) possibly influence the environment and each other. During team presentations, look for evidence of student understanding of environmental factors/changes and vocabulary usage.

Additional Information

Materials and Student Management
- Warning: Timing for ordering organisms from Delta Education can be tricky due to availability and shipping delays. Typical orders will take 4-6 weeks to process and deliver. Water conditioning suggestions: fish will die unless tap water is pre-treated (set out overnight, add de-chlorinator drops, or use distilled water).
- Goldfish purchased from local pet stores or those mailed by Delta Education may have underlying health issues, which might cause them to prematurely die. Even healthy goldfish might show signs of stress that could upset students. Be ready by having extra goldfish and time for students to process feelings.
- Mobile Inquiry Technology (real time data collection using pH and temp probeware, computers): inquiry-based investigations designed to support FOSS Environments Module. You can check out a variety of probes at SMATE at WWU or your local university. http://probesight.concord.org/curriculum/template_section.htm Scroll down to Environmental Studies and find: Monitoring an Aquarium, Monitoring a Pond, Creating a pH Scale

Timing Considerations

Helpful Resources and Bibliography:
Concept Cartoons in Science Education by Stuart Naylor and Brenda Keogh pg. 38, 40.
Atlas of Science Literacy pg. 32-33.
Pre-conceptions: Refer to Benchmarks pg. 342, SD Interdependence of Life
Mobile Inquiry Technology (real time data collection using pH and temp probeware, computers): inquiry-based investigations designed to support FOSS Environments Module.
http://probesight.concord.org/curriculum/template_section.htm Scroll down to Environmental Studies and find: Monitoring an Aquarium, Monitoring a Pond, Creating a pH Scale
Investigation 5: Brine Shrimp Hatching

How this investigation fits within the Concept and Lesson Map:
This investigation builds upon the idea that optimum conditions are within a range of tolerance. The concept of viability is also introduced. This investigation is the first to investigate populations, rather than individual plant’s response to environmental factors. Salinity is introduced as an aquatic environmental factor. The understanding of experimenting with just one variable is significantly important in this experiment. Student understanding and skills in designing a controlled investigation will continue to grow and differentiation should be given to those students ready for greater independence.

Overarching Question(s) for the Whole Investigation
- How do populations respond to the environmental factors within the ecosystem?
- How did the brine shrimp population respond to changes within the Mono Lake ecosystem?

How People Learn #1: Preconceptions
Eliciting Student Ideas:
- Beginning of Investigation: What is an egg? How do birds hatch?

Common Student Preconceptions:
- Students may think there is one ‘best’ salinity. However, a purpose of this investigation is to continue to build understanding of the idea of range of tolerance.
- Students will think that Brine Shrimp that don’t hatch are dead. Usually, the case is that the eggs have not hatched because the optimum conditions for hatching have not been met.
- Students may not know the definition of salinity.
- Students may not understand that bodies of water other than oceans contain salt.

How People Learn #2: Facts/Concepts/Knowledge
WA State Content Standards “Science Domains” (EALR 4)
- 4-5 LS2D Ecosystems can change slowly or rapidly. Big changes over a short period of time can have a major impact on the ecosystem and the populations of plants and animals living there.
- 4-5 LS2F People affect ecosystems both positively and negatively.
- 4-5 LS3A In any ecosystem, some populations of organisms thrive and grow, some decline, and others do not survive at all.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)
- 4-5 SYSC Systems have inputs and outputs. Changes in inputs may change the outputs of a system.
- 4-5 INQC An experiment involves a comparison. For an experiment to be valid and fair, all of the things that can possibly change the outcome of the experiment should be kept the same, if possible.
- 4-5 APPD Scientists and engineers often work in teams with other individuals to generate different ideas for solving a problem.

Key Understandings for the Teacher:
- Brine Shrimp are not shrimp, they are crustaceans, “sea monkeys”.
- Brine shrimp eggs have a narrow range of tolerance for salinity.
- Mono Lake is used as the engaging scenario to support the focus question for the investigation. Google images and Google Earth are additional resources a teacher could use to visually show this ecosystem and location.
How People Learn #3: Metacognition

Metacognition: How did my thinking change? What caused the change? How did I come to believe this?

- At end of Student science notebook prompt for report to Dr. Bryan: How does the change in salinity of Mono Lake have an effect on brine shrimp hatching? What evidence do you have to support your claims? What suggestions do you have for those who manage the Mono Lake ecosystem?

Evidence of Student Understanding:

- Student report to scientist Dr. Bryan at Mono Lake can be used as a formative assessment. Student claims and evidence from the controlled experiment should be generalized to the problem at Mono Lake. Students may describe their investigation set up and results. They may advise how the Mono Lake ecosystem should be managed in order to be within the Brine Shrimp’s range of tolerance.
- Use the modified WA Edition: Assessment Environments response sheets and science notebook prompts. Response sheet for this investigation on pg. 18 of this assessment packet directly assesses the idea of viability.
- Part 3: After Part 3 students should be given a chance to relate population ideas to individual organisms studied earlier.

Additional Information

Materials and Student Management

- Overhead or document camera can be used to view the hatchings as a class. Initial hatchlings are very tiny and might be overlooked by students. As FOSS states, movement of containers and/or low light can impair observation.
- You may want to use distilled water for this investigation if there are problems using tap water. Test ahead of time as FOSS suggests.
- Be sure to not use iodinated salt.

Timing Considerations

Timing is key for this investigation, as hatching may or may not occur between days 1-3. Students should be given time each day to observe for brine shrimp hatching.

Helpful Resources and Bibliography:

- Atlas of Science Literacy, V2. (American Association for Advancement of Science, 2007)
- Google images, Google Earth
Investigation 6: Salt of the Earth

How this investigation fits within the Concept and Lesson Map:
This summative investigation offers students opportunities to link the ideas of range of tolerance and the effect of optimum conditions on populations of organisms to local and global environmental issues. There is also an opportunity to carry out simple independent investigations or research projects, where students can apply their understanding of scientific processes.

Overarching Question(s) for the Whole Investigation
How does what you learned about tolerances, optimum conditions, and preferences relate to organisms in an ecosystem?

How People Learn #1: Preconception
Eliciting Student Ideas:
- Use the Farmer Johnson story (on page 11 of the FOSS folio for this investigation) to elicit student ideas about using an optimum condition and range of tolerance investigation to help Farmer Johnson solve his plant growing problem.

Common Student Preconceptions:
Students may not see the links among their previous experiments and this one. They also may not understand the links between the models they have created in the investigations and the real world.

How People Learn #2: Facts/Concepts/Knowledge
WA State Content Standards “Science Domains” (EALR 4)
4-5 LS2D Ecosystems can change slowly or rapidly. Big changes over a short period of time can have a major impact on the ecosystem and the populations of plants and animals living there.
4-5 LS2F People affect ecosystems both positively and negatively.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)
4-5 INQA Scientific investigations involve asking and answering questions and comparing the answers with evidence from the real world.
4-5 INQB Scientists plan and conduct different kinds of investigations, depending on the questions they are trying to answer. Types of investigations include systematic observations and descriptions, field studies, models, and open-ended explorations as well as controlled experiments.
4-5 INQH Scientists communicate the results of their investigations verbally and in writing. They review and ask questions about the results of other scientists’ work.
4-5 INQL Scientists communicate the results of their investigations verbally and in writing. They review and ask questions about the results of other scientists’ work.

Key Understandings for the Teacher:
- Please be sure to read pages 6-7 of this Investigation packet.
- Sodium Chloride=NaCl=salt

How People Learn #3: Metacognition
Metacognition: How did my thinking change? What caused the change? How did I come to believe this?
- How can I use the skills I learned and practiced in previous experiments to design and conduct my own experiment?
- How have your ideas about the needs of organisms changed?
Evidence of Student Understanding:

- Students will demonstrate their growth in planning and conducting an investigation about the concepts from this and previous investigations. Compare written work involving designing and implementing controlled investigations from investigations 2, 3, and 5 to student work in investigation 6 (looking back through science notebook).

Additional Information

Materials and Student Management

- You may need additional supplies for the various student projects proposed by students.
- Kosher salt should be used for this investigation.
- Students may conduct a controlled investigation using their terrarium from Investigation 1.

Timing Considerations

- This investigation could be very open-ended depending on the research and experiments that students propose.
- This investigation provides opportunity for many extensions.

Helpful Resources and Bibliography:

- Atlas of Science Literacy, V2. (American Association for Advancement of Science, 2007)