Topic: Investigating Crayfish Behavior in Response to Habitat Alteration

Lesson Objective: "Students will connect and apply concepts of ecological shifts induced by climate change by designing an observational experiment and will demonstrate their mastery by synthesizing results and analyzing patterns in data."

State Standards Addressed:

- *Next Generation Science Standards for Public Schools HS-LS2-8*: "Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce"
- *Next Generation Science Standards for Public Schools HS-LS2-2:* "Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales."
- *Next Generation Science Standards for California Public Schools HS-LS2-7:* "Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity."

Perceived Objective and Rationale:

- Today we will be using the experimental design components we identified last lesson to execute behavioral research projects using living red swamp crayfish
- We are going to use our prior knowledge of independent and dependent variables, control and experimental groups, and crayfish ecology to make predictions, draw observations, identify patterns, and create larger implications of our research
- In the first lesson we discussed how the media portrays climate change research, and how we can use scientific literacy to better understand the facts behind the figures. Then we modeled relationships between predator and prey species in local ecosystems, and determined that limiting resources and competition drastically change population sizes over time
- In the last lesson we talked about effective experimental design, and we were able to use independent and dependent variables in cause and effect relationships in order to craft our own hypotheses for today's experiment
- Today we will be looking for evidence that does or does not support our different hypotheses by describing materials and methods, observational data, experimental results, and then linking ideas in these sections to broader ecological concepts in our conclusions

Input

Materials Used in this Lesson

- Research project framework handout
- Hypothesis sentence stems handout
- Technical vocabulary handout
- Live crayfish
- Plastic shoebox containers
- Deionized water
- Dog biscuits (crayfish food source)
- Pebbles
- Crayfish shelters

Lesson Activities

Introduction to Crayfish Behavior Laboratory
Instruct students to focus on their laboratory framework handout that they have kept since the previous lesson. Students will ensure that they have completed the "Project Outline" and "Hypothesis" portion of their laboratory reports by following the prompts for each section. If they do not have these sections completed, instruct them to finish them prior to starting the observational period. Instruct students to turn their attention to the "Crayfish Lab Rules" handout on their desks. Students will read each safety rule silently, and then read each rule out loud in chorus. Then instruct students to turn their attention to the Laboratory Rubric on their desk. Students will use the lab rubric to inform them of the performance expectations for each section of the laboratory report. Remind students that they will need to staple their rubric to their completed lab report at the end of the period. Students will then move on to complete the "Materials & Methods" section of their reports prior to starting the observational and data collection period. Students may collaborate to remember which independent variable they selected last week, as well as to decide which methods they have revised to use. Students will work independently to respond to each prompt in their own words.

Crayfish Observational Period
Students will have 15 minutes to observe interactions between the two crayfish in the experimental chamber. Circulate throughout the room and ensure that each group is ready to begin their experiment and has the necessary independent variable to incorporate into their trial. When groups are ready, introduce the second crayfish into the chamber and instruct students to begin a 15-minute timer and start recording detailed observations using the prompts in their laboratory framework.

Discussion of Results
When all student groups have used the 15-minute observational period to complete their observations, instruct students to discuss trends and patterns they observed in behavior among their small four-person laboratory group. When students have finished discussing and reviewed common patterns, instruct them to move into their larger groups of eight in order to compare results between the control and experimental trial groups. As students are discussing in both small and large collaborative lab groups be sure to circulate throughout the room in order to informally assess student progress and engagement.

Vocabulary
Independent variable, dependent variable, experimental group, control group, aggression, agonistic, interaction, escape, climate change, climatic, invasive, abiotic, biotic

Modeling
- Use direct instruction as well as teacher-student discussion during group work to demonstrate examples of engaged observational behavior
- Prior to students breaking up into large discussion groups, use two small lab groups to model through direct instruction how discussion groups will come together and how the discussion should be focused on comparing trends between control and experimental trials
- The research lab handout will provide the necessary scaffolding needed to form an effective hypothesis, describe experimental methods, and list materials. This lab will include clear sections and prompts for each task

Guided Practice

- During small group observations, circulate throughout the classroom and emphasize the importance of noting patterns or trends in behavior. Ask for an example of behavior they have already observed, then verbally demonstrate how they could note the reoccurrence of that behavior over time to record patterns and trends
- Ask guiding questions about physical crayfish characteristics. What do they see? Ask them how they would describe not only behavioral changes but also more permanent characteristics as well
- As larger lab groups are collaborating in discussion, refer to specific students by name in each group to share their results. Ask members of the contrasting group about the similarities and differences they noted during their trial

Check for Understanding (Questioning techniques)
During the observational period:

- "What patterns in behavior have you observed so far? Why do you think these behaviors are reoccurring?"
- "What has your crayfish been doing in the past couple of minutes? Is this different than what they were doing at the beginning of the observational period?"
- "How are your crayfish interacting with each other? What academic words do we use to describe animal behavior such as this?"
- "If your crayfish pair appears to be doing nothing… maybe there is a rationale for the lack of movement and aggression; Why could this be?"
- "How are your crayfish interacting with your manipulated or independent variable?"
- "Why did you choose the independent variable that you chose? Have the patterns in behavior you have observed consistent with what you expected so far?"

During the discussion period:

- "What are some trends in behavior that you noticed over the course of the observational period?"
- "How did the trends and patterns you observed differ between control and experimental groups? Why do you think this is?"
- "In the end of the experiment, do you feel that the data you collected support your hypothesis? Why or why not."
- "What external factors do you think could have contributed to an increase or a lack of observable behaviors during the experiment?"
- "How could we eliminate some confounding variables?"
- "What gives your hypothesis validity, if anything?"
- "How do the behaviors you are observing in these controlled experiments relate to crayfish behavior in their natural environment?"
- "Why are crayfish considered invasive?"
- "What is the link between what we are able to observe in controlled experiments such as this one and what we are able to conclude from field experiments and observations?"

Independent Practice & Formal and Informal Assessments
The informal assessment will come in the form of teacher-student discussions during circulation of the classroom. As students record observations and lead discussion groups, the teacher will spend time at each desk asking guiding questions and informally assessing progress.

The formal assessment time will be the segment in which students have finished discussing in their large lab groups and they are working independently to respond to the prompts in each section of the laboratory framework. Students will complete the "Materials & Methods", "Data

Collection", "Results", and "Conclusion" sections by responding carefully to each prompt, which will serve as their formal summative assessment.

Closure

- Now that we have observed agonistic or aggressive interactions between real crayfish in a controlled setting, we can begin to understand how different changing factors may affect crayfish behavior in a stream ecosystem in the "real-world"
- What is the connection between the behaviors we were able to observe in these experiments and what animals do in their natural settings?
- We may also consider how these abiotic factors could be influenced by climate change, and how resultant behavioral changes in crayfish may alter the abundance of other species
- What are the abiotic factors we manipulated in these experiments? How do we draw parallels to the expanded ways these and different factors change in nature?

Differentiation:

Lesson differentiation and adaptation will include:

- A variety of teaching techniques cater to a variety of learners: there are listening, kinesthetic, visual, and tactile components to this lesson which will be useful for students with an IEP who struggles with written, independent work, and thrives in group settings
- Hypothesis sentence stem sheet will help every learner continue to organize their thoughts, and provide them with a framework for formulating scientific predictions in a predictable syntax. Thiss will be especially helpful for students that have difficulty perceiving verbal cues, or those that struggle with academic English
- A list of vocabulary terms used throughout the lesson will assist students that need improvement with their academic regsiters and use of technical vocabulary
- Whole-class instruction mixed with small collaborative groups provide discrete verbal and visual cues to refocus attention without penalty through teacher-student interactions and peer feedback
- Written prompts will refocus students that typically have difficulty organizing their thoughts in order to produce a written product
- The lesson is structured so that students will never have to go more than a few minutes without interacting by talking. This breaks the lesson up and creates a more engaging environment for students who might have trouble participating in other ways
- All necessary directions and prompts will be stated in the laboratory framework handout