NOAA I-ASC Project Lesson Cluster: MACROINVERTEBRATES

Key Question: How are diversity and sensitivity of macroinvertebrates used as indicators of water quality? Why does a diversity of organisms matter?

Environmental Impact Assessment Connections

Assessing current ecosystem diversity to use as a baseline to minimize environmental damage.

Virginia Standards of Learning Listed throughout this Lesson Cluster are: Science 2018, Mathematics 2016.

5 E	***Lesson***	***Learning Target***	***Integrated Content Connections*** ***Standards***	***Assessment*** ***(F)= Formative*** ***(S)- Summative***
ENGAGE	At school, prior to field visit. APPENDIX B: Before Blandy Visit Activity- Science Appendix C: **Web Rangers Macro-Invertebrates Activity Prior to Field Visit** Appendix D: **Macroinvertebrates**	Define and Identify Macroinvertebrate. Explain two ways to measure diversity, and provide examples of how macroinvertebrates are used to determine water health	Develop understanding VA: Science 6.1, 6.8 Math 6.2 NGSS: MS-LS2-1 DCI: LS2.A, LS2.C, LS4.D CCSS: SL.6.1	
EXPLORE	During field visit Appendix E: **Macroinvertebrate Investigation**	Evaluate macroinvertebrates as water quality indicators.	Data Collection VA: Science 6.1, 6.8, 6.9 Math 6.2, 6.10 NGSS: MS-LS2-4 DCI: LS2.A, LS2.C, LS4.D CCSS: SL.6.1, RST.6-8.3, RH.6-8.7	(F) Oral discussion among students: CER statement on water quality (macros)
ELABORATE	At school, after the field visit. Appendix F: Macroinvertebrate Data Analysis- After	Using student-collected data, analyze and find the water quality index using macroinvertebrates.	Data Analysis VA: Math 6.10, Sci 6.9 NGSS: MS-LS2-4 DCI: LS2.A, LS2.C, LS4.D CCSS: SL.6.1, RH.6-8.1, 6.SP.A.2, W.6.1	(S) Students compose report (written, oral, PPT, etc.) on water health at Blandy

Cluster Title: Using Macroinvertebrates to Assess Water Quality	Time Frame: at least three 45-minute periods	Grade Level: 6th

Cluster Summary: Briefly describe what the cluster will entail including curricular content and goals.

Identifying macroinvertebrates using distinguishing characteristics and ID keys, obtaining a water quality index, and assessing water health using student collected data.

Step 1. Essential Question(s): What are the questions (aligned to the core concepts and) that students will consider throughout the cluster and that will develop their deep understanding? (This may be a central problem that students will address.)

What do the living organisms in a habitat/ecosystem tell us about the health of the water?

How do we analyze and communicate the data? Why does a diversity of organisms matter?

Step 2. Core Concept(s): SOL/NGSS from two or more content areas to determine the focus, core concept, or enduring idea(s). What are the skills, concepts, and content knowledge that students will learn, apply, and develop deep understanding of through this cluster? Only include CORE here, put ancillary in Step 3.

VA SOL: Science 6.1, 6.8

NGSS: MS-LS2-4 **Ecosystems, Interactions, Energy, and Dynamics** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. APPENDIX A: Target NGSS

CCSS: CCSS.ELA-LITERACY.RST.6-8.3

Step 3. Integrated Content Strategies – NGSS and SOL for grade level An integrated cluster will help students meet standards in two or more content areas. Content areas include science, social studies, math, reading, writing, communications, the arts, and health and fitness.

Content Connection(s): list all the other connected standards here.

VA SOL: Science (2018) 6.1, 6.8, 6.9. Math 6.1, 6.2, 6.11

NGSS: MS-LS2-4, MS-LS-1, DCI LS2.C, LS2.A

CCSS: CCSS.ELA-LITERACY.RST.6-8.1, CCSS.ELA-LITERACY.RST.6-8.7

Step 4. Assessments: How will student knowledge, skills, and concepts be assessed throughout the cluster?

Formative:
Prior: Web Rangers or Cacapon Institute
During: Access Students' prior knowledge in order to meet students' cognitive levels

Summative (performance tasks) :
Student reports on macroinvertebrates. May use graphical representations, Powerpoint, written report, or oral report

Step 5. Key Vocabulary: What are the essential vocabulary words that students will understand and need to know in order to complete this cluster?

Benthic
Macroinvertebrate

Step 6. Instructional Strategies: Inquiry, hands-on, outdoor components

Guided inquiry

Hands-on collection and identification using microscopes

Web-based 'before'

Step 7. Instructional Materials/Resources: What aligned instructional materials/resources will students use throughout the cluster? How will you ensure that students explore multiple perspectives and different points of views?

Textbooks/Kits/Instructional Guides:

Print Materials (Books, articles): Key to Macroinvertebrates, LaMotte Macroinvertebrate Flash Cards

Multimedia:

Websites: http://www.cacaponinstitute.org/Benthics/intro%20movie%20v.html
https://www.nps.gov/webrangers/activities/waterquality/

Tools:

* Forceps
* Pipettes
* Petri dishes
* Identification guides
* Dissecting Microscopes

Step 8. Lessons/Activities: What are the daily lessons and activities that students will do during the cluster? List lessons/activities and use the lesson plan template for daily plans.

Day 1, Before Blandy Visit Activity-Science: Introduction to Macroinvertebrates and Sampling Methods

Day 2, Blandy visit. Macroinvertebrate collection and identification

Day 3, After Blandy visit. Data Analysis, the 'So What'?

Step 9. Teacher Reflection: Use this space to record your thoughts, ideas, and comments during and after teaching the cluster. Include the elements that worked well and areas you would change the next time you and/or others teach the cluster.

PRIOR: INTRODUCTION TO MACROINVERTEBRATE SAMPLING

Lesson: Prior to field visit- Introduction to Macroinvertebrates and Sampling Methods	**Time Frame:** 45 minutes	**Grade Level:** 6th

Core Concept(s): Benthic macroinvertebrates are indicators of water quality.

Learning Targets	
Content Area	
SOL	Science 6.1, 6.8, 6.9
NGSS	MS-LS2-4, MS-LS-1, DCI LS2.C, LS2.A
CCSS	CCSS.ELA-LITERACY.RST.6-8.1, CCSS.ELA-LITERACY.RST.6-8.7
	SL.6.1

Focus Question(s) :
What can macroinvertebrates tell us about a watershed and water health?

Lesson Objectives

Knowledge Define macroinvertebrate and Explain two ways scientists can measure diversity in a body of water
Skills Use web based tools to virtually collect and identify organisms.
Values Give example of how macroinvertebrates are dependent on the health of a body of water.

Key Vocabulary:

Benthic
aquatic
macroinvertebrate

Assessments and Performance Tasks:

Draw a macroinvertebrate life cycle (formative).
Describe what features can be used to successfully identify a macroinvertebrate

Instructional Materials:
Textbooks/Kits/Instructional Guides:
Print Materials (Books, articles):
Multimedia:
Websites: Cacapon Institute
Tools:

Lesson Steps:
1. Engage/Hook (How will you interest students at the start of the lesson?)**:**

https://flyguys.net/aquatic-entomology/fly-fishing-dragonfly video is awesome!

2. Formative Assessment (how will you elicit students' preconceived ideas? e.g. KWL)**:**
- Use questioning strategies such as:
- In your own words, describe a macroinvertebrate.

- Think pair share: Why do we examine macroinvertebrates? Students then explain reasoning as a class. Ask each pair to choose another pair to add to the discussion (keeps it student focused and allows opportunity for you to assess where the gaps and misconceptions are.)

3. Instructional Practice

a) Navigate students to: Introduction to Stream Sampling (covers macro and water chemistry) http://www.cacaponinstitute.org/Benthics/intro%20movie%20v.html

b) After watching the slideshow, ask students to describe two ways to measure diversity of a freshwater stream or river.

Go to http://www.cacaponinstitute.org/Benthics/What%20is%20a%20Benthic%20Macroinvertebrate%20-%20V.html

c) Inquire:

- What is a benthic macroinvertebrate?
- What can macroinvertebrates tell us about watershed health?
- Describe two different roles (or niches) that macroinvertebrates have in a watershed.
- Describe or draw a benthic macroinvertebrate life cycle.

d) Go to http://www.cacaponinstitute.org/Benthics/BMI%20dich%20key_MS.html to practice using a Macroinvertebrate dicot key. This key is very similar to the one they will use while at Blandy. Practice identifying some of the macroinvertebrates. Students have the opportunity to draw macroinvertebrates and note distinguishing features.

4. Conclusion- To small group or to a partner**.** Explain one thing you learned today that you did not know before and why you find it interesting.

Lesson Reflection (your thoughts, ideas, and recommended changes to the lesson):

Extension:

For Full Lesson Plans see Appendix B, C, D

DURING: MACROINVERTEBRATE INVESTIGATION IN THE FIELD

Lesson: Macroinvertebrates as Water Quality Indicators	**Time Frame:** 45 minutes	**Grade Level:** 6th

Core Concept(s): Macroinvertebrates are used to evaluate water quality. Sampling techniques impact data.

Learning Targets

Content Area(s)	
SOL	VA: Science 6.1, 6.8, 6.9 Math 6.2, 6.10
NGSS	MS-LS2-4 DCI: LS2.A, LS2.C, LS4.D
CCSS	SL.6.1, RST.6-8.3, RH.6-8.7

Focus Question(s):
What organisms are in the water ? How is data collected to analyze water quality?

Lesson Objectives

Knowledge: Students identify macroinvertebrates and evaluate them as indicators of water quality. Measure, record and analyze a variety of water quality indicators and describe what they mean to the health of an ecosystem.

Skills: Students develop observation skills and conduct a scientific tally of organisms.

Values: Students develop an appreciation for a diversity of organisms is part of/helps to create a healthy functioning ecosystem.

Key Vocabulary: water quality indicators, diversity, macroinvertebrate, sampling method

Assessments and Performance Tasks:

Formative: In student groups, discuss sampling methods. Each group shares out, teacher assesses if sampling methods need to review.
Performance: Students create a data table and a graphical representation of the data.

Instructional Materials:
Textbooks/Kits/Instructional Guides: Key to Macroinvertebrates, LaMotte Macroinvertebrate Flash Cards
Print Materials (Books, articles):
Multimedia:
Websites:
Tools: Nets, forceps, pipettes, petri dishes, ID guides, dissecting microscopes

1. Engage/Hook (How will you interest students at the start of the lesson?)**:** **Inquiry Questions:** a) what are ways people determine if water is healthy or not? B) What do we mean by 'healthy'? c) Why are we discussing water quality if our focus is on where to put a new building? **2. Formative Assessment** (how will you elicit students' preconceived ideas? e.g. KWL)**:** Recap: ask students to explain their 'before' activity and why they conducted it. Ask students who do not have their hands raised. Use constructivist questions to engage. **3. Sample!** Review sampling method with students. Ask: Why use the same sampling methods, why do we note this information? Review how to use equipment and goal of the activity. (To FIND, IDENTIFY and COUNT both the TYPE and NUMBER of each different organisms. Distribute macroinvertebrate tubs and begin identification and sorting of macros. Circulate around to groups to aid in identification. 10 minutes before class period ends, turn off scopes, enter data, and clean up stations. (One person from each group can compile and enter data; others will put all organisms back in containers, tidy up petri dishes and pipettes, turn off scopes. **4. Conclusion** Though you will analyze the data during the next session, what are you initial thoughts on the diversity of organisms and the water quality? Is it diverse? Support your thoughts with evidence from your recorded data.
Lesson Reflection (your thoughts, ideas, and recommended changes to the lesson): This lesson is easily differentiated for student levels. Can focus on looking at adaptations if that is an interest area. With visual impairments, you can locate larger specimens and keep those aside for students.
Extension:
For Full Lesson Plan, See Appendix E

AFTER: MACROINVERTEBRATE DATA ANALYSIS

Lesson:	**Time Frame:** 45 minutes	**Grade Level:** 6th

Core Concept(s):
Scientists analyze macroinvertebrate data in a variety of ways to assess stream health.

Learning Targets

Content Area(s)	
SOL	Math VA: 6.10, Science 6.9
NGSS	MS-LS2-4, MS-LS-1, DCI LS2.C, LS2.A
CCSS	CCSS.ELA-LITERACY.RST.6-8.1, CCSS.ELA-LITERACY.RST.6-8.7
	SL.6.1, RH.6-8.1, 6.SP.A.2, W.6.1

Focus Question(s) :
What did the macroinvertebrate diversity tell us about the health of the system ?

Lesson Objectives

Knowledge Diversity is measured in a number of ways, quantitative data is evidence to support an EIA.
Skills Create a circle graph.
Values A natural functioning system has intrinsic value in that it supports a diversity of life.

Key Vocabulary: biodiversity, diversity

Assessments and Performance Tasks:
Creation of a circle graph comparing # of each type of the organisms.
Explanation of results with reasoning for how arrived at their conclusion.

Instructional Materials:
Textbooks/Kits/Instructional Guides:
Print Materials (Books, articles):
Multimedia:
Websites: Google Drive spreadsheet
Tools:

Lesson A Steps:
1. **Engage/Hook** (How will you interest students at the start of the lesson?)**:**
   Draw what you remember from the macroinvertebrate sampling.
2. **Inquiry Discussion:** in small groups, discuss what is data analysis, how is data analysis used? After five minutes of group discussion, each group shared responses to these questions (ideally they could be displayed on a white board to engage in a class discussion, what language do we have in common, what are we missing?
3. **Data Analysis:** Working solo or in groups (depending on students), review your group's data and create a circle graph to attractively display your data.
   Differentiation, if needed, use the table below for students to analyze the data.

Tolerance Level	# of Orgs	Total # of organisms	Fraction	Decimal	Percentage
Pollution Sensitive (green)					
Somewhat Pollution Sensitive (Blue)					
Somewhat Pollution Tolerant (Purple)					
Pollution Tolerant (Red)					

4. **Class discussion:** Share graphs and use the data within them to support a response to: The water is healthy/not healthy based on my data which shows……
5. **Formative Assessment** (how will you elicit students' preconceived ideas? e.g. KWL)**:**

Lesson B Steps:

Lesson Reflection (your thoughts, ideas, and recommended changes to the lesson):

Extension: Compare data from year to year (if you have it from previous years) to create graphs showing change over time.

For Full Lesson Plan, Go to Appendix F & G

APPENDIX A: Target NGSS

Students who demonstrate understanding can:

MS-LS2-1. **Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

MS-LS2-2. **Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.**[Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

MS-LS2-3. **Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.**[Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [*Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.*]

MS-LS2-4. **Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

MS-LS2-5. **Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*** [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to describe phenomena. (MS-LS2-3)

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

- -

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)
- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)

LS4.D: Biodiversity and Humans

Crosscutting Concepts

Patterns

- Patterns can be used to identify cause and effect relationships. (MS-LS2-2)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

Energy and Matter

- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (MS-LS2-4),(MS-LS2-5)

- -

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)

- -

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

	• Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. *(secondary to MS-LS2-5)* ETS1.B: Developing Possible Solutions • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary to MS-LS2-5)*	

Connections to other DCIs in this grade-band:
MS.PS1.B (MS-LS2-3); **MS.LS1.B** (MS-LS2-2); **MS.LS4.C** (MS-LS2-4); **MS.LS4.D** (MS-LS2-4); **MS.ESS2.A** (MS-LS2-3),(MS-LS2-4); **MS.ESS3.A** (MS-LS2-1),(MS-LS2-4);**MS.ESS3.C** (MS-LS2-1),(MS-LS2-4),(MS-LS2-5)

Articulation of DCIs across grade-bands:
1.LS1.B (MS-LS2-2); **3.LS2.C** (MS-LS2-1),(MS-LS2-4); **3.LS4.D** (MS-LS2-1),(MS-LS2-4); **5.LS2.A** (MS-LS2-1),(MS-LS2-3); **5.LS2.B** (MS-LS2-3); **HS.PS3.B** (MS-LS2-3);**HS.LS1.C** (MS-LS2-3); **HS.LS2.A** (MS-LS2-1),(MS-LS2-2),(MS-LS2-5); **HS.LS2.B** (MS-LS2-2),(MS-LS2-3); **HS.LS2.C** (MS-LS2-4),(MS-LS2-5); **HS.LS2.D** (MS-LS2-2);**HS.LS4.C** (MS-LS2-1),(MS-LS2-4); **HS.LS4.D** (MS-LS2-1),(MS-LS2-4),(MS-LS2-5); **HS.ESS2.A** (MS-LS2-3); **HS.ESS2.E** (MS-LS2-4); **HS.ESS3.A** (MS-LS2-1),(MS-LS2-5); **HS.ESS3.B** (MS-LS2-4); **HS.ESS3.C** (MS-LS2-4),(MS-LS2-5); **HS.ESS3.D** (MS-LS2-5)

Common Core State Standards Connections:
ELA/Literacy -

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-1),(MS-LS2-2),(MS-LS2-4)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)

RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)

RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-4),(MS-LS2-5)

WHST.6-8.1 Write arguments to support claims with clear reasons and relevant evidence. (MS-LS2-4)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS2-2)

WHST.6-8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS2-2),(MS-LS2-4)

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. *(MS-LS2-2)*

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(MS-LS2-2)*

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-LS2-3)*

Mathematics -

MP.4 Model with mathematics. *(MS-LS2-5)*

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. *(MS-LS2-5)*

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS2-3)*

6.SP.B.5 Summarize numerical data sets in relation to their context. *(MS-LS2-2)*

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas*. Integrated and reprinted with permission from the National Academy of Sciences.

APPENDIX B: Before Blandy Visit Activity-Science

Introduction to Macroinvertebrates and Sampling Methods

Investigative question: What can macroinvertebrates tell us about a watershed and water health?

Goal- Students learn about the connections between water chemistry and macroinvertebrate health and how to identify macroinvertebrates.

Objectives

Students:

- Define macroinvertebrate.
- Explain two ways scientists can measure diversity in a body of water.
- Give example of how macroinvertebrates are dependent on the health of a body of water.

Virginia SOL: Science 6.1, 6.7

Procedure/Instructional Practice

a) Navigate students to: Introduction to Stream Sampling (covers macro and water chemistry) http://www.cacaponinstitute.org/Benthics/intro%20movie%20v.html
b) After watching the slideshow, ask students to describe two ways to measure diversity of a freshwater stream or river. Go to the Benthic Macroinvertebrate page
c) Inquire:
   - What is a benthic macroinvertebrate?
   - What can macroinvertebrates tell us about watershed health?
   - Describe two different roles (or niches) that macroinvertebrates have in a watershed.
   - Describe or draw a benthic macroinvertebrate life cycle.
d) Go to http://www.cacaponinstitute.org/Benthics/BMI%20dich%20key_MS.html to practice using a Macroinvertebrate dicot key. This key is very similar to the one they will use while at Blandy. Practice identifying some of the macroinvertebrates. Students have the opportunity to draw macroinvertebrates and note distinguishing features.

Appendix C: Before Blandy Visit Activity-Science

Web Rangers Macro-Invertebrates Activity Prior to Field Visit

Complete the activity using the Web Rangers Macro-Invertebrates Activity HERE.

1. **Macro-Invertebrates:** Animals with no______________________ large enough to see without a _________________________.

2. Scientists classify macroinvertebrates according to how tolerant they are to pollution. Group 1 is the least tolerant (they only live in clean water), group 2 can live in some pollution, group 3 is the most tolerant (they can live in polluted water). List the organisms given in each group.

Group 1:

Group 2:

Group 3:

3. Water Quality Testing

Stream 1

Number of types of macro-invertebrates in each group

Group 1 =

Group 2 =

Group 3 =

Value of each group

Group 1 =

Group 2 =

Group 3 =

Cumulative Index Value =

Water quality of the stream is

___________________________.

Stream 2

Number of types of macro-invertebrates in each group

Group 1 =

Group 2 =

Group 3 =

Value of each group

Group 1 =

Group 2 =

Group 3 =

Cumulative Index Value =

Water quality of the stream is

___________________________.

Appendix D: **Macroinvertebrates**

Mathematics Prior to Field Visit

Goal- Students analyze data to determine a stream's health and compare final data to nearby streams.

Objective- Given the macroinvertebrate datasheet, students use percent composition and circle graphs to compare the diversity of several streams to determine health of stream.

Procedure

1. Distribute data set to each team.
2. Sample Inquiry questions for your students:
    a. What can data tell us? How can we examine data? Generate a list of student responses.
    b. What do you notice about the data? Are there any similarities or differences?
    c. Are the total numbers of organisms roughly the same at each stream? Or do they vary from location to location?
    d. Were the same organisms found at each sampling site?
    e. What are the ways you can display the data?
3. Explain to students that they will use actual data from 2012 to compare three streams to determine the percent composition and make circle graphs. On their upcoming field investigation at Blandy, the students will gather their own data and analyze this data in the classroom to determine the water quality.
4. Make a Circle Graph.

Student data sheet

A team of water ecologists wanted to determine the health of a nearby watershed. They sampled macroinvertebrates in three areas of the stream and recorded their data. Once back in the lab, how do the ecologists analyze the data to figure out the diversity of each section of the stream? Look at the data; make suggestions as to how you can compare this data.

To Find Percent Composition of each macroinvertebrate:

Example: For Mayflies in Millwood stream,

# of Mayflies is **20**

Total # of Macroinvertebrates is **150**

20 /150 = **0.133**

Multiply this by 100 0.1333 * 100= **13.3%**

Determine the percent composition for each of the organisms below.

Macroinvertebrates	Millwood		Powhatan		BRWC	
Type	# of Organisms	% Composition	# of Organisms	% Composition	# of Organisms	% Composition
Mayflies	20		5		10	
Caddisflies	25		0		30	
Stoneflies	16		10		12	
Riffle Beetles	4		1		18	
Net spinning caddisflies	45		40		53	
Craneflies	20		2		0	
Scuds	15		15		16	
Aquatic Sowbugs	5		130		1	
Total Number of Organisms	150		203		140	

Appendix E: **Macroinvertebrate Investigation**

Investigative Questions: What is diversity? Why does a diversity of organisms matter? How does diversity and sensitivity of organisms used as indicators of water quality?

Goal: Students will understand the importance of macroinvertebrates as indicators of long term health of aquatic environments in an ecosystem. Students will understand how scientists classify organisms.

Learning Objectives

Knowledge: Students identify macroinvertebrates and evaluate them as indicators of water quality. Measure, record and analyze a variety of water quality indicators and describe what they mean to the health of an ecosystem.

Skills: Students develop observation skills and conduct a scientific tally of organisms.

Values: Students develop an appreciation for a diversity of organisms is part of/helps to create a healthy functioning ecosystem.

Virginia SOL: Science 6.1, 6.7, 6.9

Materials

* Buckets
* Small Nets
* Forceps
* Pipettes
* Petri dishes
* Datasheet for students
* Identification guides
* Dissecting Microscopes
* Ice cube trays (for sorting)

Special Safety: These organisms needs to be returned alive to the water, DO NOT harm the organisms!

Procedure

1. This activity usually takes place in the Parkfield Learning Center. Once students arrive, give them a brief history of the PLC. This information is also found in student journals.
2. Instruct students to find the corresponding data sheets in their student journals (see below) to answer and discuss the questions.
3. Next, inform students that one of the things they are investigating today is determining the overall health of Lake Georgette. Inquire:
    a. What are some ways in which we can determine if a body of water is healthy or not?
    b. What are things that we can see with the human eye? (trash, erosion) What may be things that we may not see with our human eye? (invertebrates, Ph, nitrates, phosphates)
    c. What tools do scientists use to see organisms that are too small to see?
4. What is a macroinvertebrate? It is a small aquatic organism without vertebrae.
5. What is a microinvertebrate i.e. zooplankton? extremely small or microscopic animals such as copepods, daphnia, and rotifers
6. Inform students they are to determine the health of the water with macroinvertebrates as indicators of health. Ask: What is an indicator? What does tolerance mean? Broadly, able to withstand a certain amount of change. Ask for an example of a tolerant organism. Or give examples if students have not yet discussed in class.
7. What is diversity? What is biological diversity?
    a. The number and variety of species present in an area. If students have trouble understanding diversity, feel free to use food as an example. Give two examples that are starkly different (ex. In waterbody X I found 100 organisms, 99 mosquitos and one dragonfly. In waterbody Y, I found 100 organisms, 10 each of 10 different creatures.) and ask them which is more diverse.
8. How do we measure diversity? Why do we measure diversity? Why do we care about the health of the system?
9. Review microscope rules and how to handle the macroinvertebrates properly with the students. Be sure to include: These organisms are sensitive and are going back to the body of water when we are done. Take care to not harm them.
10. Explain the sampling method used to collect the organisms. Would we be able to use and accurately assess the health of our water if scientist used a different sampling method each time? What if a scientist only selected organisms that they wanted to look at? Would that be a representative sample? Doe that show bias?
11. Inform students where the organisms were collected. Explain sampling method (Ex. Used a D-Net and sampled 6 times for 10 seconds at each location). Again, why is important that we sample the same way each time? (to be able to have accurate information to compare and to be able to replicate the experiment)
12. Instruct students to use the identification guides to identify organisms and record the data on the Macroinvertebrate Data Sheet in their Journal. Explain how scientists use dichotomous keys to help classify organisms. This includes plants, animals, insects etc.
13. Once organisms are identified, they need to be placed into the sorting trays on the tables. At the end of the activity, students will tally and record the organisms at their table and enter into a

data sheet on computer. ***Where do these organisms live? IN THE WATER! Please have the organism in a small drop of water while you are viewing them so they are able to keep living!

14. Students may ask what the colors on their datasheet mean. These colors indicate whether the species is very tolerant, tolerant, or not tolerant to pollution. The green organisms mean that they are not tolerant to pollution. They are green because we connect green with healthy. When these species, which cannot tolerate a lot of pollution, are present in our water, then the stream has little pollution and is healthy. The red colored organisms are very tolerant of pollution meaning they are able to live in conditions that are not as favorable. Meaning our water is not as healthy.
15. Remember to stress the importance of diversity of organisms in our water. Yes, we want green but we like to be diverse. A rainbow is favorable! Reds, orange, greens and blues!
16. Wrap up- Ask if students think the water is diverse and healthy or not? Explain your reasoning using evidence!

AQUATIC MACROINVERTEBRATE DATA SHEET

Sample Site ______________________________

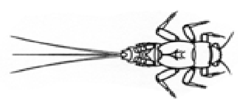
Date: _________________________ **Time of day:** _____________

Group Members: ____

- INVERTEBRATE – organism without a backbone
- MACRO – visible to the naked eye
- AQUATIC – lives in the water for part of its life cycle
- INDICATOR- tells us about the health of an ecosystem

In your water Sample, find, identify, count and record the number of EACH type of macroinvertebrate.
You will use the data to find DIVERSITY and an INDEX of water quality.

Macroinvertebrate	Number found
Whirligig Beetle	
Water Strider	
Mosquito	
Giant Water Bug	
Back Swimmer	
Water Boatman	
Predacious Diving Beetle	
Ostracod	
Copepod	
Daphnia/ Water flea	
Pyralid Caterpillar	
Fishing Spider	



	INDICATOR Macroinvertebrate	**Number found**	Check if Present √	Number of Checks	Multiply by	Group Score
Pollution Sensitive	Mayflies				4	
	Caddisflies					
	Stoneflies					
	Dobsonflies					
	Gilled Snails					
	Water Penny					
	Riffle Beetle					
	Water Scorpion					
Moderately Sensitive	Damselfly				3	
	Dragonflies					
	Scuds					
	Craneflies					
	Aquatic Sowbug					
Moderately Tolerant	Water Mite				2	
	Midges					
	Blackfly					
	Flatworm					
	Leeches					
	Crawling Water Beetle					
Pollution Tolerant	Pouch Snails				1	
	Threadworm					
	Horsefly					
	Tubifex Worms					
	Blood Midge					
	TOTAL # of ORGANISMS =		TOTAL SCORE= ≥ 23 Potentially Excellent Water Quality 17-22 Potentially Good Water Quality 11-16 Potentially Fair Water Quality ≤ 10 Potentially Poor Water Quality			

Adapted from Mitchell, 1997. Blandy Experimental Farm Education Programs NOAA B-WET project 2014-2017

Developed by Blandy Experimental Farm Education Department & Frederick County Public Schools
2014-2017 www.virginia.edu/blandy 540-837-1758

NOAA B-WET Project 2014-2017

Appendix F: Macroinvertebrate Data Analysis- After

Use the data below to create a circle graph in your math class. You will use this data as evidence to decide if Lake Georgette is an important part of the environment at Blandy.

Tolerance Level	Number Organisms	Total Organisms	Fraction	Decimal	Percentage
Pollution Sensitive (green)					
Pollution Somewhat Sensitive (Blue)					
Pollution Somewhat Tolerant (Purple)					
Pollution Tolerant (Red)					
TOTAL					

<u>Directions:</u> Construct the circle graph to illustrate the percentage of each of the four types of macroinvertebrates from our trip to Blandy Experimental Farm.

1) Was there a diverse group of macroinvertebrates?

2) Explain why you think so.

3) From the data collected, do you think the water was healthy or unhealthy?

4) Explain why you think so.

5) If construction increases pollution in Lake Georgette, predict the effect on the different types of organisms in your data set. How would the graph change?