

Eyes on Earth: Teaching Earth Science from Space
Stan Feighny
10/29/2020

Cover Sheet - Hypoxic Zones in the Hydrosphere

Missy Holzer, Ph.D

General Notes:

This unit of eight lessons is rubric driven. There are six rubrics and a Google form for formative and summative assessment. I have found that using rubrics for the formative assessment allows the teacher to award daily progress points and keeps the class focused on producing a quality product. The rubrics are revised as the lesson progresses, building on the new understanding for both teacher and student. The final lab report is prepared and graded with the revised rubrics.

Using this submitted pdf should work well for grading. If you have any difficulty or would like to get additional data or documents, please use the following links to bring up the products. These files have "anyone who has a link" permissions and should open directly.

If it does not open, please send me an email, and I will fix the permissions.

The lesson plan, spreadsheets, and initial student lab report are in the Hypoxic Zones in the Hydrosphere Deliverables folder.

<https://drive.google.com/drive/folders/1LotsOxwQSR88tRmkmV5H2kOLwN4FLZuP?usp=sharing>

The rubrics are in the Rubrics for Hypoxic Zones in the Hydrosphere folder.

<https://drive.google.com/drive/folders/1DcQ-uxS1ybT2qorwjsGoZ6jGb5WQfQtw?usp=sharing>

Thank you for this opportunity,

Stan Feighny

Lesson Title: Hypoxic Zones in the Hydrosphere

Author: Stan Feighny

Student Take-away

(Post on one side of the board for students to read on entry and cover during warmup. Source citations are in the lesson plan)

Natural Resources

Fertile soil and seasonally beneficial rainfall attract industrial agriculture's widespread use in the Upper Mississippi River Basin.
Abundant natural gas (CH₄) lowers the cost of synthetic fertilizer production, increasing demand.

Natural Hazards

Algae is a natural part of the food web supporting water life.
Eutrophication (excessive nutrient concentration) causes algae to grow out of control, eventually dying and feeding bacteria that multiply and use the water's oxygen, creating hypoxic or "dead" zones.

Climate Change

Heavy spring rains boosting fertilizer runoff and expanding the hypoxic zones's area.
Tropical storms break up the formation of the hypoxic zones, thereby reducing the hypoxic zones' area.

Influence Human Activity

Hypoxic zones harm the economic productivity of fishing, shellfish harvesting, and tourism.

The use of Models in Environmental Science

Many environmental issues do not have a clear linear relationship like the Keating Curve.
Understanding and predicting changes in the hypoxic zone requires sophisticated models that are weather dependent.

Targeted Grade Level:

11,12 (Students who have completed Algebra II.) Co-enrollment with Physics or Pre-Calc is a benefit.

Schedule:

Most teachers use eight 45 minute blocks or four 90 minute extended blocks.

Until the teacher gets experience with this lesson, it would be better to plan for ten 45 minute blocks or five 90 minute extended blocks.

The links under the 5E Phases are to the lesson.

Each lesson has a return to this section.

Day	5E Phase	Topic (Key Phrase in NGSS Standard HS-ESS3.1)
1.	Engagement	Environmental neglect, understanding the source of hypoxic zones (dead zones) in the Gulf of Mexico.
	Engagement	Build the project folder to organize work on the project.
2.	Exploration	Build a working vocabulary and a basic understanding of the phenomena.
3.	Exploration	Load data and create a plot for the growth of industrial agriculture in the Midwest. (Natural Resources)
4.	Exploration	Load data and create a plot for the size of the hypoxic zone in the Gulf of Mexico. (Natural Hazards, Climate Change)
		Load data and create a plot for nitrogen flux into the Gulf of Mexico. (Natural Hazards, Climate Change)
5.	Exploration	Analyze shrimp landing volumes for 2002 - 2020 and compare to growth of the hypoxic zone. (Influence Human Activity)
6.	Explanation	Write phenomena and method sections of the lab report to acquire and analyze data to explain the hypoxic zone in the Gulf of Mexico.
7.	Elaboration	Use data to identify the impact of increased tropical storm activity.
8.	Evaluation	Check for understanding by using rubrics and peer review for Project Folder, Lab Report, Spreadsheet

NGSS Performance Expectation HS-ESS3.1
(NGSS Lead States, 2013)

Students who demonstrate understanding can:

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to freshwater (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.</p> <ul style="list-style-type: none"> Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. 	<p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Resource availability has guided the development of human society. <p>ESS3.B: Natural Hazards</p> <ul style="list-style-type: none"> Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. <p>-----</p> <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> Modern civilization depends on major technological systems.

Standards:

Links under Standards are to Common Core (National Governors, 2010), ISTE (ISTE 2016), and NGSS (NGSS Lead States 2013) reference site documents.

Links under Learning Objective are to the Measurable Student Learning Objectives in the next section.

Standards	Learning Objective	Description	Rubric Used
Technology ISTE Standard 3	Creating Structure	Curate a variety of resources using digital tools to construct knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others. <i>(ISTE Standards for Students ISTE, 2016)</i>	Project Folder
HS-ESS3-1	Explaining Phenomena	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (NGSS Lead States, 2013)	Lab Report
HS-ESS3-1	Identifying Evidence	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	Lab Report, Spreadsheets
HS-ESS3-1	Using Reasoning to connect evidence to explanation	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	Lab Report

HSN-Q.A.1	Solving Problems	<p>Use units to understand problems and guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. <i>(High School: Number and Quantity » Quantities* » Reason Quantitatively and Use Units to Solve Problems. » 1 Common Core State Standards Initiative, 2010)</i></p>	<p>Graphs in spreadsheets</p>
HSN.Q.A.3	Understanding Measurement	<p>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <i>(High School: Number and Quantity » Quantities* » Reason Quantitatively and Use Units to Solve Problems. » 3 Common Core State Standards Initiative, 2010)</i></p>	<p>Lab Report Spreadsheets: -Corn and Soy - Baton Rouge Readings - Bottom Area</p>
CCSS.ELA-LITERACY.RST.11-12.4	Research	<p>Determine the meaning of symbols, key terms, and other domain-specific words and phrases used in a specific scientific or technical context relevant to grades 11-12 texts and topics. <i>(English Language Arts Standards » Science & Technical Subjects » Grade 11-12 Common Core State Standards Initiative, 2010)</i></p>	<p>Lab Report - Visual Vocabulary</p>
CCSS.ELA-LITERACY.RST.11-12.2	Summarize Complex Concepts	<p>Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. <i>(English Language Arts Standards » Science & Technical Subjects » Grade 11-12 Common Core State Standards Initiative, 2010)</i></p>	<p>Lab Report - Overview Section</p>

Measurable Student Learning Objectives:

Standards (Return)	Observable features of the student performance
Technology ISTE Standard 3	Students work as responsible digital citizens by organizing Hypoxic Zones in the Hydrosphere folders for use by others.
Science NHS-ESS3-1 (1)	Students make a claim to support explaining the (hypoxic zone) phenomena and that the size of the hypoxic zone in the Gulf of Mexico is related to nitrogen discharge. Corn and soy production drives nitrogen runoff in the Mississippi River Basin. <i>(HS-ESS3-1 Evidence Statements June 2015 Asterisks.Pdf, 2015)</i>
Science NGSS HS-ESS3-1 (2)	Students use data from USGS, NASS, and Louisiana Universities Marine Consortium to identify evidence that the size of the Gulf of Mexico's hypoxic zone is related to nitrogen discharged in the Gulf of Mexico. Corn and soy production drives nitrogen runoff in the Mississippi River Basin. <i>(HS-ESS3-1 Evidence Statements June 2015 Asterisks.Pdf, 2015.)</i>
Science NGSS HS-ESS3-1 (3)	Students use reasoning to connect evidence to explain that the size of the hypoxic zone in the Gulf of Mexico is related to nitrogen discharge from soy and corn fields in the Mississippi River Basin. <i>(HS-ESS3-1 Evidence Statements June 2015 Asterisks.Pdf, 2015)</i>
HSN-Q.A.1	Choose the correct units for analysis and graphing of corn and soy production in the Mississippi River Basin. Choose the correct units for analysis and graphing of Nitrates, Nitrites, and Organic Nitrogen concentration in the Mississippi river at discharge into the Gulf of Mexico. Choose the correct units for analysis and graphing of the size of the Gulf of Mexico's hypoxic zone.
HSN.Q.A.3	Use measurement rules to determine the number of significant figures used to measure nitrogen concentration in the Mississippi river at the point of discharge into the Gulf of Mexico.
CCSS.ELA-LITERACY. RST.11-12.2	Students research sources and build a vocabulary list for the final lab report to describe the relationships between industrial farming, river nitrogen concentration, tropical storms, and the hypoxic zone in the Gulf of Mexico.
CCSS.ELA-LITERACY. RST.11-12.4	Students write and revise the Phenomena and Method sections in the final lab report summarizing how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

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Use rubrics for both formative and summative assessments.

Rubrics are revised during the project with the discovery of new requirements are. Revision is a fact of the working world - things change. Students are coached on accepting change every day, as this is an important life skill. Using rubrics for the formative assessment allows the teacher to award daily progress points and keep the class focused on producing a quality product.

[Hypoxic Zones in the Hydrosphere Project Folder Rubric](#)

[Hypoxic Zones in the Hydrosphere Lab Report Rubric](#)

[Corn and Soy Production Spreadsheet Rubric](#)

[Nitrogen Flux into the Gulf of Mexico Data Rubric](#)

[Bottom Area of Dissolved Oxygen Data Rubric](#)

[Shrimp Landings Data Rubric](#)

Materials

This unit is a computer-based activity that requires either Google Sheets or Excel and Internet access.

Data Sources

National Agricultural Statistics Service [Quick Stats Tool](#)

(USDA - National Agricultural Statistics Service - Data and Statistics, n.d.)

Figure 2 from [Gulf of Mexico Hypoxia: Past, Present, and Future Nancy N. Rabalais R. Eugene Turner](#)

(Rabalais & Turner, 2019)

USGS [Streamflow and Nutrient Delivery to the Gulf of Mexico](#)

(Streamflow and Nutrient Flux of the Mississippi-Atchafalaya River Basin and Subbasins Through Water Year 2016, 2016)

Shrimp Alliance [June 2020 Landings](#)

(June-2020-Landings.Pdf, n.d.NASA)

[Ocean Color Dead Zones](#) (Data is not available at this time, but I have contacted Elizabeth Joyner at LAEC)

5E Model - Engage

Introduce the lesson with an anchoring phenomenon.
Facilitate student questions, discussion, etc. as appropriate.
Learn about what students already know and want to know.

Day 1 Part 1 - Environmental neglect, understanding the source of hypoxic zones in the Gulf of Mexico.

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What the teacher does:

The teacher shows the YouTube video [Happening Now: Dead Zone in the Gulf 2019](#) (*Happening Now*, 2019) and leads a general discussion to establish student knowledge and interest. When the students get a feel for the concept, introduce the Work Scenario for the lesson by having students access LMS. The teacher walks the student through the scenario emphasizing the way Super Student networks and gets the next job. The first assignment is to write a summary of the three articles linked in the scenario. This assignment is the first draft of the Phenomena section of the lab report.

Work Scenario

The Arctic project completed, your internship at NASA, aside from stopping by and thanking your mentor, is over. Fortunately, you have been networking in the organization and getting the word out that you still have three weeks left in the summer and hope to land another gig. You have learned to ask people on the team and in the area directly, “Do you know anyone who might need some short term help?” Most people want to help, and since you have been getting in early and staying late to meet deadlines, most will give it some thought. Gabriella Anderson, one of the data scientists on a project next to yours, went to LSU and with another researcher in Louisiana at the Louisiana Universities Marine Consortium ([LUMCON](#)) who may have some work. She gives you the contact information for Stephanie Archer Ph.D. and says it is ok to use her name when you call. You think to yourself, who knows, this may work out.

Doing LinkedIn and Google research, you get some background on Dr. Archer. Knowing more about her work, you send a quick email to her mentioning your job at NASA and that you got her name from Gabriella Anderson. She replies that she does have a project, but it is not very romantic. (Immediately, your dreams of SCUBA diving in the Gulf of Mexico evaporate.) The work is mostly grinding through data to verify models that her group has been developing on eutrophication, causing hypoxic zones in the Gulf. You assure her that one thing you have learned this summer is how to work with data. She seemed positively impressed and said that we would talk again on Monday.

Realizing that this job is hanging by a thread, you go to work building your knowledge of eutrophication, causing hypoxic zones in the Gulf. Researching current articles brings some pretty sobering news. Fertile soil and seasonally beneficial rainfall attract the widespread use of industrial agriculture in the Mississippi Basin. Industrial agriculture uses nitrogen and phosphorus to improve productivity but comes at a [significant hidden cost](#) (*Hidden Costs of Industrial Agriculture* | *Union of Concerned Scientists*, 2008). One of the hidden costs is the contamination of drinking water and downstream discharge into the Gulf of Mexico.

Since the 1970s, scientists have been tracking a hypoxic or “dead zone” in the Gulf of Mexico. According to NOAA, this year may be the largest on hypoxic zone record, covering over [6,000 square miles](#) (*Larger-than-Average Dead Zone Forecast for Gulf of Mexico in Summer 2020 | NOAA Climate.Gov*, 2020). Algae is a natural part of the food web supporting life in the hydrosphere. Too much nutrition for algae can cause it to expand into an algae bloom. Bacteria consume the algae after the plants die. The bacteria then grow and [consume the oxygen in the water](#) (*Gulf of Mexico Dead Zone*, n.d.)

To prepare for your first day, you write a summary that integrates these three articles' issues using the scientific writing style. You remember the keys to scientific writing are: descriptive, active voice, no personal pronouns, and no sequencing (first, second, third)

Monday, you wait for a call at your apartment. Instead of a meeting, you get an email from your new boss.

Super Student,

Welcome to LUMCON. I spoke to Gabriella over the weekend, and she told me about the data analysis work you have been doing. Based on her recommendation, I have put in the paperwork to get you assigned our team as a temporary contractor. Our contractor management company will contact you and set this up. You can work from home on this project, we need the results quickly, and we don't have the budget to fly you down here.

I have assigned another engineer (teacher's name goes here) to help you get started. Here is your work list for the next three weeks. We need this done before you go back to school.

1. Use the National Agricultural Statistics Service [Quick Stats Tool](#) to find the corn and soybean production for the top producing states in the Mississippi River Basin (Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Ohio, South Dakota, Wisconsin). Study the units and make a graph that shows the combined production in tons. Include a line of best fit from Google Sheets and show that the function works.
2. Use the USGS Hypoxia in the Gulf of Mexico website to find the [Nutrient Flux for the Mississippi-Atchafalaya River Basin](#). A [graphical image is here](#), so your graph should match figure 1.
3. The digital data for the Bottom Area of the hypoxic zone is difficult to find. You can use the graph from the Economics of Dead Zones (Rabotyagov et al., 2014) article in the Review of Environmental Economics and Policy. Cut the chart out of the paper and use the WebPlotDigitizer (WebPlotDigitizer - Extract Data from Plots, Images, and Maps, n.d.). This software is easy to use and produces accurate data if you have a graph's pdf or image.

After completing the data organization, review the tropical storm data and elaborate on how these storms impact the hypoxic zone's growth even when there are rich run-off conditions in the Mississippi-Atchafalaya river basin.

Stephanie Archer, Ph.D.
Ecologist

Day 1 Part 2 - Build the project folder to organize work on the project.

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The mentor hands out the [Project Folder Rubric](#) and goes over setting up the project folder. She explains that this is not your data but the organization's data, and it is your job to make sure it is organized and accessible.

Standards Addressed

[Technology ISTE, Standard 3b.3C](#)

Students work as responsible digital citizens by organizing data for use by others.

[CCSS.ELA-LITERACY.RST.11-12.2](#)

Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Formative/Summative Assessments

Use the rubric to walk-through and check student progress on the project folder. Give students progress points. Find out why some are falling behind.

What the Student Does:

Participates in the discussion about the Hypoxic Zone in the Gulf of Mexico

Writes a background document (three paragraphs) of the current hypoxic zone issues.

Creates the project folder according to the rubric.

Uses the LMS to create a personal copy of the lab report.

Explore

Plan for students to engage in hands-on activities that are designed to facilitate conceptual change.

Day 2 - Build a working vocabulary and basic understanding for study.

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What the teacher does:

Reviews the importance of setting up the project folder and checks for progress on the project folder.

Opens up the [starting lab report](#) and walks the students through the different sections.

Hands out the rubric and sets expectations for progress.

Standards Addressed

[CCSS.ELA-LITERACY.RST.11-12.4](#)

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

Formative/Summative Assessments

The teacher performs a walk-through check of each student's progress on unit lab report and vocabulary, giving students progress points and investigates why some are falling behind.

What the Student Does:

Students research sources and build the visual vocabulary section of the lab report.

Students make a citation and link for each source used.

Day 3 - Load data and create a plot for the growth of industrial agriculture in the Midwest.

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What the teacher does:

Walks students through how to use the National Agricultural Statistics Service [Quick Stats Tool](#) to find the corn and soybean production for the top producing states in the Mississippi River Basin (Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Ohio, South Dakota, Wisconsin). Here is an [example query](#) from the tool. Reviews units and makes a graph that shows the combined production in tons. Include a line of best fit from Google Sheets and show that the function works. Walks students through the spreadsheet and how to combine the data to get the combined values in millions of tons.

Uses the [Corn and Soy 1979-2019 USDA spreadsheet](#) (tab Final %) as an example showing style and organization. If class is behind schedule, create a CSV from the Corn and Soy sheet and have the students load the data. Go over the difficulties with trendline on charts and how to use LINEST(). Students will take things on a spreadsheet as correct unless they test results for accuracy.

Day 4 - Load data and create a plot for the size of the hypoxic zone in the Gulf of Mexico.

[Return to Schedule](#)

What the teacher does:

When this lesson plan was published, the digital data for this step could not be located. If it does come available, it will be posted in the teachers' project folder [Hypoxic Zones in the Hydrosphere](#). At this point, the teacher has two choices: 1) Have the students load the data from the CSV file [Bottom Area of Dissolved Oxygen CSV.csv](#). or 2) Have the students use the graphic Figure 2 from [Gulf of Mexico Hypoxia: Past, Present, and Future](#). This image can be reverse-engineered (graph to digital) with the tool [WebPlotDigitizer](#) (*WebPlotDigitizer - Extract Data from Plots, Images, and Maps*, n.d.), which runs on the web. In either case, the teacher can walk the student through the rubric and example at the [Bottom Area of Dissolved Oxygen](#) in the project folder. Cover the Shrimp Landing on Day 5.

Day 4 - Load data and create a plot for nitrogen flux into the Gulf of Mexico.

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What the teacher does:

Walk the students through the [Streamflow and Nutrient Delivery to the Gulf of Mexico](#) website maintained by the USGS. Highlight the [Graphics of Streamflow page](#) as the students will recreate their own version of this page. Explain the difference between $\text{NO}_2 + \text{NO}_3$ (Metric Tons as N), TKN (Metric Tons as N) NH_3 (Metric Tons as N). $\text{NO}_2 + \text{NO}_3$ (Nitrites and Nitrate), TKN (Organic Nitrogen), NH_3 (Ammonia). The current student example is for $\text{NO}_2 + \text{NO}_3$ only as this is the most significant source of nitrogen discharged. Follow link to view [example of the spreadsheet](#) for student work. Allow students to load data using [Combined Mississippi-Atchafalaya Nitrogen Flux CSV.csv](#) if the class is behind schedule.

[NASA Data Here]

The website has moved or is down.

Day 5 - Load data and create a plot on how hypoxic zones influence human activity.

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Have the students load the data from the CSV file [Shrimp Landings.CSV](#) into the second tab of Bottom Area of Dissolved Oxygen Data they have been working on for Day 4. Walk the student through the rubric and example for [Shrimp Landings](#). Notice how this link moves to the correct tab after it opens the workbook. The Shrimp Alliance is a trade organization for Gulf Coast Shrimping. CSV data is from the Shrimp Alliance pdf page 13 of 21. (*June-2020-Landings.Pdf*, n.d.)

Add the trendline to the Chart. Use the LINEST to project landings for 2021- 2025. Keep working on the graph until the students get it to match the example. If the students are getting better with Google Sheets, simply give them a copy of the chart and have them build their own. It will take a while to get all the parts working. Use the Show Formulas function on Google Sheets to help the students get the formulas correct.

Days 3 - 4 - 5 Standards Addressed

[HS-ESS3-1](#)

Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (NGSS Lead States, 2013)

[HSN-Q.A.1](#)

Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas (Pounds 1,000); choose and interpret the scale and the origin in graphs and data displays.

[HSN.Q.A.3](#)

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
(Should 1,000 have a decimal, based on the magnitude of the measurement?)

Formative/Summative Assessments

At the end of class, do a walk-through check of the spreadsheet. Award students progress points as a daily grade. Find out why some are falling behind. Review Dependent and Independent variables on graphs.

Use matching rubric for each spreadsheet

[Corn and Soy Production Spreadsheet Rubric](#)

[Nitrogen Flux into the Gulf of Mexico Data Rubric](#)

[Bottom Area of Dissolved Oxygen Data Rubric](#)

[Shrimp Landings Data Rubric](#)

What the student does:

Uses the links in the lesson and the scenario to find and download appropriate data sets.

Uses the teacher supplied rubrics to format the spreadsheet and add graphs to the data.

Answers the questions in the data section of the lab report.

Explain

Provide opportunities for students to demonstrate their new conceptual understanding, process skills, or behaviors.

Day 6 - Write the phenomena and method sections for acquiring and analyzing data to explain the hypoxic zone in the Gulf of Mexico.

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What the teacher does:

Shows examples of the phenomena and methods section of the lab report and explains the structure and grammar conventions of each. The phenomena section is descriptive and explanatory. Write the method section in an active voice with a prescriptive tone. These are the most common styles in STEM technical writing.

Example Phenomena Section

Scientific studies since the early 1800s have identified the existence of gases that insulate the earth. Over time these gases have become known as greenhouse gases as they allow the earth to warm like the glass surrounding the plants in a greenhouse. CO₂ is a powerful component in these gases. The global average temperature of the planet has been steadily rising. Scientists observe a clear linear and strongly correlated relationship by studying the statistical relationship between CO₂ and global average temperature.

Example Method Section

Download CO₂ and Temperature files from the links to the NASA website. Use the example spreadsheet to create tabs for CO₂, Temperature, Annual Average CO₂, Correlation Coefficient, and LINEST() exercise. Load Temperature Data, transform and use Split-Text-To-Column function under Data dropdown to load data into columns. Repeat process for CO₂ data. Average Monthly CO₂ to Annual data and create a chart and line of best fit for annual data. Use external reference to populate Annual CO₂ data and Annual Temperature data to the Correlation Coefficient Tab.

Perform regression analysis on CO₂ data and Annual Temperature data. Create a key for regression analysis results. Answer post lab questions using spreadsheets as the data source. [The Method Section will be modified after the Elaborate phase to include the steps completed during that phase.]

Standards Addressed

[CCSS.ELA-LITERACY.RST.11-12.2](#)

Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Formative/Summative Assessments

Teacher shares [Google form to collect the written sections from students](#). These are made anonymous by the teacher.
Teacher uses the collected examples to model good writing and what to avoid

Elaborate

Create more challenging experiences to help the students develop a deeper and broader understanding, sharpen process skills, or solidify behaviors.

Day 7 - Use data to identify the impact of increased tropical storm activity.

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What the teacher does:

Play the first two minutes of [Happening Now: Dead Zone in the Gulf 2020](#) (US Department of Commerce, 2019) video Engages students by discussing why the 2020 zone was forecasted to be the largest and turned out to be the third smallest.

[Hands-out the Gulf of Mexico Hypoxia: Past Present and Future](#) (Rabalais & Turner, 2019) article and discusses Figure 2.

Ask the question: What is the unpredictable part of the new hypoxic zone models?

Challenges the class to work in teams to find other examples where the hypoxic bottom area was smaller because of tropical storms using the [Historical Hurricane Tracks](#) website (*Historical Hurricane Tracks*, n.d.). Use the [List of Louisiana Hurricanes 2000–present](#) (“List of Louisiana Hurricanes (2000–Present),” 2020) to find the storms that match changes in the years of smaller hypoxia footprint. Share data as students discover other weather events that have reduced the size of the zone.

What the student does:

Participates in the discussion about the size of the 2020 hypoxic zone.

Works on a team to find other years that tropical storms reduced the area of the hypoxic zone.

Completes the Day 7 section of the lab report.

Standards Addressed

[HS-ESS3-1](#)

Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (NGSS Lead States, 2013)

Formative/Summative Assessments

During the discussion and weather event search, award students daily progress points for engagement and sharing. Find out why some students are falling behind or not engaged. Reinforce ideas on how modern models are comprehensive but still have problems based on weather changes.

Evaluate

**Encourage students to assess their understanding and abilities.
Evaluate student progress toward achieving the educational objectives.**

Day 8 - Check for understanding by using rubrics and peer review for Project Folder, Lab Report, Spreadsheets

(May take two days depending on how the students have kept up.)

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[Return to Rubrics](#)

What the teacher does:

Reviews and updates the rubrics for the folder, spreadsheets, and lab report.

What the student does:

Completes the lab report question section.

Checks spreadsheets with rubrics.

Rewrites the Phenomena and Method sections of the lab report to include new activities and understanding.

Checks lab report with rubric.

Review another student's spreadsheet and lab report using an updated rubric.

Organizes all project work in a folder and checks with Project Folder Rubric

Checks all files have names that explain use.

Fixes lab report and google sheet to incorporate peer review recommendations.

Turns in clean rubric with name and class with peer-reviewed rubric attached.

Submits link to **folder** on LMS for teacher grading.

Standards Addressed

[CCSS.ELA-LITERACY.RST.11-12.2](#)

Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Formative/Summative Assessments

The teacher performs a summative assessment based on the updated rubrics for [Project Folder, Spreadsheets, Lab Report.](#)

References

Gulf of Mexico Dead Zone. (n.d.). Retrieved October 20, 2020, from

<https://www.nature.org/en-us/about-us/where-we-work/priority-landscapes/gulf-of-mexico/stories-in-the-gulf-of-mexico/gulf-of-mexico-dead-zone/>

Happening Now: Dead Zone in the Gulf 2019. (2019, August 5). <https://www.youtube.com/watch?v=zeVVQmBkgiU>

Hidden Costs of Industrial Agriculture | Union of Concerned Scientists. (2008, July 11). <https://www.ucsusa.org/resources/hidden-costs-industrial-agriculture>

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