***NSI Learning Outcomes***

**LO1: Explain natural phenomena using contemporary scientific concepts, theories, and/or principles. [blue bold]**

*LO 2: Describe the process of scientific inquiry. [red italic]*

LO 3: Analyze historical or contemporary societal subjects using scientific concepts and principles. [green underlined]

LO 4: Apply the scientific method to evaluate data. [pink small caps]

***Sample Assignment #1a: Lab Report Guidelines***

**Background Information**

We will perform an experiment to test effects of external factors on seed gemination. For more information on seed germination read page 409 in your lab manual and pages 888-890 in the textbook (Raven, 12th edition).

**Experimental Procedure**

1. Go to <https://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=637>
2. Create a free account to unlock unlimited time for the experiment
3. Drag seed A into all three trays. Set the heat to low and keep the light at high (all 3 lightbulbs).
4. Use the slider to adjust the daily water amount on each tray: 0 mL in tray 1, 20 mL in tray 2, 40 mL in tray 3
5. Run the simulation and record the number of sprouts in table 1 below. Reset the simulator with 60 mL in tray 1, 80 mL in tray 2, and 100 mL in tray 3.
6. Repeat for the other seed types.
7. Now set the water to 60 mL, use full light, and vary the heat. Record the data for each seed type in table 2 below.
8. Finally, set the water to 60 mL, the temperature to 16° C, and vary the amount of light for each seed type. Record the data in table 3 below.

Table 1. The number of seeds that germinated with varying amounts of water at low heat (16° C) and full light (3 bulbs).

|  |  |  |  |
| --- | --- | --- | --- |
| **Water Amount (mL)** | **Seed A** | **Seed B** | **Seed C** |
| 0 |  |  |  |
| 20 |  |  |  |
| 40 |  |  |  |
| 60 |  |  |  |
| 80 |  |  |  |
| 100 |  |  |  |

Table 2. The number of seeds that germinated with different levels of heat at 60 mL of water and full light (3 bulbs).

|  |  |  |  |
| --- | --- | --- | --- |
| **Heat (°C)** | **Seed A** | **Seed B** | **Seed C** |
| 8 |  |  |  |
| 16 |  |  |  |
| 24 |  |  |  |
| 32 |  |  |  |

Table 3. The number of seeds that germinated with varying amounts of light at low heat (16° C) and 60 mL of water per day.

|  |  |  |  |
| --- | --- | --- | --- |
| **Light (# lightbulbs)** | **Seed A** | **Seed B** | **Seed C** |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

**Questions to help you frame your discussion section of your lab report – Do not just write answers!!**

* 1. Did the treatment type and/or seed type affect germination? How? Why?
  2. Why didn’t all seeds germinate in each treatment when they were all treated the same?
  3. Which treatments were used as controls? Why are those necessary?
  4. Select and compare treatments that will address your hypothesis. Plot percent germination for each treatment. Compare the different seed types and their response to different treatments. Do you see any patterns or trends?
  5. Use the data from the tables to create graphs of each variable’s effect on each seed type. Is there an optimum amount of water, heat, and light for each seed type?
  6. What do the optimal conditions suggest about where each seed type might be found?

# Intro Bio Lab Report Rubric Introduction: 8 points

* **Background concepts and vocabulary introduced and explained in detail (2 points)**
* **Background information about the tests/methods used in lab (1 point)**
* Explanation of **specific** lab objectives (2 points)
* *Hypothesis/prediction in your own words (2 points)*
* Proper in-text citation of sources (1 point)

**Materials and Methods: 4 points**

* *Summarize the lab procedure in sentence/paragraph form; use only relevant information and* ***do not copy*** *from the manual or procedure (2 points; no points if copied)*
* *Note deviations to protocol or errors, or lack of these if there were none (1 points)*
* Proper lab manual citation (1 point)

# Results: 6 points (0 points if absent week of lab)

* Written text describing data and results without interpretation or opinions (2 points)
* Graphs and/or tables with proper format and axis labels (2 points)
* Graphs and tables have appropriate figure legends (1 point)
* Graphs and tables are referenced in text (1 point)
* Include raw data tables from class at the end of the report (0 points, -1 if missing)

# Discussion: 8 points

* Discuss trends in the data using relevant content. What did the results reveal about the experiment? Explain what the results mean in context of your stated lab objectives (3 points)
* Hypotheses and/or predictions revisited – did your data support your initial predictions? Explicitly describe this (2 points)
* Questions from lab manual, procedures, or slideshows answered in sentence/paragraph form and worked into discussion (1 point)
* Ideas for future experiments, possible outcomes, and relevance for real world applications (1 point)
* Graphs and tables referenced where appropriate (1 point)

***Sample Assignment #1b: Student Work***

## Seed Germination Lab Report

Seed germination is a crucial process that every seed plant must go through to grow.

Germination is the process of a seed breaking open and forming a new generation of a plant (Pendarvis & Crawley, 409). Seeds are living units that contain an embryo, some sort of nutritive tissue (endosperm and cotyledons-small seed leaves, are examples) that acts as food storage and provides nutrients for the developing plant embryo, and an integument that constitutes its seed coat (DuPont, 1). **For a seed to germinate, and the root to emerge out of the seed and its outer coat, the conditions it is in must be ‘favorable’ to it, meaning the seed cannot break open and grow in just any of the conditions it is in. If the conditions are favorable, the seed can leave its stage of dormancy, or state of being temporality inactive. The conditions/factors that influence germination include temperature, light, water, and scarification (factors like stomach acid from an animal that ingested the seed, freezing, or fire) (Pendarvis & Crawley, 409). When these factors are provided to the seed and are favored by it, the seed increases its metabolic activities to produce energy to grow (*Seed Germination- Plants in Motion*). If these factors are absent or unfavorable to the seed, it is not going to germinate and grow.**

Seed dormancy is an important aspect of seed germination. A seed will generally not leave dormancy to "protect itself" from certain conditions like bad weather or animals that might ingest it (even though some seeds require ingestion to germinate) (DuPont, 2012). As previously stated, a seed houses an embryo and nutritive tissue like endosperm and/or cotyledons that allow for dormancy to even be possible, since they provide the embryo inside the seed with nutrients during its development. Dormancy is important, as germination cannot happen unless it ceases and the conditions a seed is in are appropriate and favored by it.

**Germination is generally thought to have a series of steps or stages as the metabolic processes of the seed increase and activate. The first stage is known as “imbibition,” and begins with the seed quickly taking up water and swelling as well as the seed coat softening. This first stage starts the growth process of the seed by activating enzymes within it that, in a way, call the seed to “action.”. The second stage entails the seed respiring and metabolizing the food that was stored within it (“Seed Germination”). The third stage occurs when the seed coat breaks and a small primary root known as a radicle, emerges and begins to grow down into the soil to absorb water. The fourth stage is when the seed grows a shoot called a hypocotyl (part of the stem) that begins to grow upwards towards the sun. The fifth and final stage is when the shoot system (entails the stems, leaves, and flowers of a plant) begins to grow small primary leaves known as cotyledons. The cells of the seed itself divide more and more and after a while, a small plant seedling has developed (“Seed Germination”).**

The test used in this lab included putting various seeds (A, B, C) into trays and varying the amount of light, water, and heat to see how much each of them germinate. The first test included varying the amount of water, the second test included varying the heat, and the third test included varying the amounts of light. All three of these tests were done to observe their effects on seed germination. Lab objectives include discovering what conditions affect seed germination, exploring the certain impacts of water, temperature, and light on germination, discovering the idea that certain conditions will vary with each seed, and finally, designing controlled experiments to test the impact of different conditions on germination.

*Regarding my predictions, I based them on optimum germination, meaning I chose which tests and amounts would result in the most germination done by each seed type in each treatment. In the first test where the amount of water was varied, I hypothesized that seeds A, B, and C would all germinate best with 60 mL of water. Since I did not know what kind of seeds either of them was, I predicted that all of them would germinate best with a water amount that was in the middle of all of the other amounts tested. In the second test where the heat was varied, I hypothesized that seed A would germinate best at 16°C, and that seed B and C would germinate best at 24°C. In the third test with varying light, I hypothesized that seed A would germinate best with one lightbulb, seed B with two lightbulbs, and seed C with three lightbulbs.*

**Methods**

A complete list of the lab procedure can be found on the Seed Germination Lab

Experiment procedure handout. A simplified explanation of this procedure includes putting seed A into all of the trays, setting the heat to low, and keeping all of the lightbulbs on. In the first test, the amount of water was varied in each tray, from 0 mL in tray one, 20 mL in tray two, and 40 mL in tray three. After this, data collection was done to see how many seeds germinated. Next, the trays were cleared, and the same seed (A) was put back into the trays, but this time with 60 mL of water in tray one, 80 mL in tray two, and 100 mL in tray three. Data collection was also done after this. Subsequently, repetition with seeds B and C was done using the same protocol. During the second test where the heat was altered, the water was set to 60 mL, all three lightbulbs were on, and the heat was varied with all three seed types. Data collection was done to see how many seeds germinated. Lastly, during the third test where the number of lightbulbs was varied, the water was set to 60 mL, the temperature to 16°C, and the number of lightbulbs (0, 1, 2, 3) were varied in each tray with each seed type. There were no deviations from protocol or errors done.

**Results**

All three results of each test that was done on seeds A, B, and C are included. Tables and graphs depicting results and data of each test are included.

**Table 1: The number of seeds that germinate with varying amounts of water at low heat**

**(16° C) and full light (3 lightbulbs).**

|  |  |  |  |
| --- | --- | --- | --- |
| **Water Amount (mL)** | **Seed A** | **Seed B** | **Seed C** |
| 0 | 0 | 0 | 0 |
| 20 | 11 | 6 | 0 |
| 40 | 17 | 9 | 8 |
| 60 | 18 | 12 | 11 |
| 80 | 15 | 15 | 12 |
| 100 | 12 | 12 | 11 |

*Table one (above) and graph one (below) depict the number of seeds that germinated when the water amount was varied. Both figures show that seed A germinated the most with 60 mL of water added to its tray, and seeds B and C germinated the most with 80 mL of water. All of the seeds did no germination with no water added to the trays. All three of the seeds showed an increase in germination as the water amount increased, but soon after that, germination declined.*

**Graph 1: The number of seeds that germinate with varying water amounts at low heat**

**(16°C) and full light (3 lightbulbs).**

0

11

17

18

15

12

0

6

9

12

15

12

0

0

8

11

12

11

0

5

10

15

20

0

20

40

60

80

100

Seed Germination

Water Amount (mL)

Seed Germination with Varying Water Amounts

Seed A

Seed B

Seed C

**Table 2: The number of seeds that germinated with different levels of heat at 60 mL of**

**water and full light (3 lightbulbs).**

|  |  |  |  |
| --- | --- | --- | --- |
| **Heat (°C)** | **Seed A** | **Seed B** | **Seed C** |
| 8 | 12 | 10 | 0 |
| 16 | 18 | 12 | 11 |
| 24 | 16 | 14 | 17 |
| 32 | 14 | 15 | 15 |

Table two (above) and graph two (below) depict the number of seeds that germinated with different levels of heat with 60 mL of water and three lightbulbs used. Seed A shows the greatest germination at 16° C, seed B at 32° C, and seed C at 24° C. Seed C did no germination at 8° C, unlike seeds A and B, but quickly increased as the heat did too.

**Graph 2: The number of seeds that germinated with different levels of heat 60 mL of water**

**and full light (3 lightbulbs).**

12

18

16

14

10

12

14

15

0

11

17

15

0

5

10

15

20

8

16

24

32

Seed Germination

Heat (

°

C)

Seed Germination with Varying Heat

Seed A

Seed B

Seed C

**Table 3: The number of seeds that germinated with varying amounts of light at low heat**

**(16° C) and 60 mL of water per day**.

|  |  |  |  |
| --- | --- | --- | --- |
| **Light (# lightbulbs)** | **Seed A** | **Seed B** | **Seed C** |
| 0 | 18 | 12 | 0 |
| 1 | 18 | 12 | 6 |
| 2 | 18 | 12 | 9 |
| 3 | 18 | 12 | 11 |

Table three (above) and graph three (below) show the number of seeds that germinated with varying amounts of light at low heat (16° C) and 60 mL of water per day. Seeds A and B showed the same number of seeds germinating with any number of lightbulbs. Seed C showed an increase in germination with each lightbulb added.

**Graph 3: The number of seeds that germinated with varying amounts of light at low heat**

**(16° C) and 60 mL of water per day**.

18

18

18

18

12

12

12

12

0

6

9

11

0

5

10

15

20

0

1

2

3

Seed Germination

Light (# of Lightbulbs)

Seed Germination with Varying Light

Seed A

Seed B

Seed C

**Discussion**

Regarding trends in the data sets and what the results revealed, each seed had its favored treatments/conditions in which they germinated best. Because of this, both the treatment type and seed type affected germination. Every treatment type, for the most part, impacted the amount of germination each seed did. Since seeds can only germinate when conditions are favorable for them, the treatment type as well as the amount of each, affected germination. This wasn't always the case, however, as table three and graph three show that light had no impact at all on seeds A and B. Other than that, all of the other treatments had a profound impact on the seeds.

Some of the treatments were used as controls which were necessary to be able to compare the

amount of germination each seed did with each treatment. Controls are always

necessary for controlled experiments like these because we want to be able to see the impact of the treatment/test we are doing on something, and the best way to do that is to compare it with something that has had little to nothing done to it. The control in the first test was no water in the trays, the second was the lowest heat level at 8° C, and in the third was no lightbulbs used. All of these controls were used to see how the seed reacted to varying treatments and amounts.

The type of seed used impacted germination as well. Not every seed will germinate the same amount, as they all require different conditions/treatments to do so. Some of the seeds showed the same amount of germination at certain points, but it is safe to infer that the type of seed one is, affects the amount of germination it will do. Similarly, even though all of the seeds were treated the same in each treatment, not all of them germinated because of the different seed types and the conditions they were in at the time were not favorable for all of them.

In the first test, my hypothesis of all of the seeds germinating best with 60 mL was not supported. I guessed with this hypothesis since I had no prior knowledge of what kind of seed each of them was. As shown in table one and graph one, each seed germinated with different amounts of water. Seed C didn't have a single seed undergo germination until 40 mL of water was added to its tray. Each seed also had an optimum range at which they germinated, seed A at 60 mL of water, and seed B and C at 80 mL of water. A pattern seen with water amount is that all of the seeds optimally germinated around the median amounts of water, giving rise to the idea that seeds can have neither too little nor too much water.

In the second test, my hypothesis of seed A germinating best at 16° C and seed C germinating best at 24° C was supported, however my hypothesis of seed B germinating at 24° C was not supported. Table two and graph two show that seed B optimally germinated at 32° C.

Seed B and C required more heat than seed A, giving rise to the idea that seed B and C are found in warmer climates than seed A. In the third test, my hypothesis of seeds A and B germinating best with one and two lightbulbs was not supported. However, my hypothesis of seed C optimally germinating with three lightbulbs was supported. Table three and graph three show that the number of lightbulbs had no effect on germination on seeds A and B, and that seed C showed more and more germination with each lightbulb added. This allows me to infer that seed C is most likely found in an area with lots of light for optimum germination and growth.

Gathering all of this information, it is clear that each seed has an optimum range of water, heat, and light in which they germinate best. We can use this information to infer where each seed type might be found in. With seed A's data, its optimum water amount at 60 mL, heat at 16°C, and light having no impact on overall germination, seed A is probably found in a place with a pretty normal climate, as the seed germinated best in treatment amounts around the median. The fact that seed A germinated with either number of lightbulbs tells me that this seed can grow in either dark or light places and it would have no effect on its germination.

Seed B’s optimum data was 80 mL of water, heat at 32° C, and no effect of light. With this information, seed B is probably found in a place that has an abundant water supply and/or maybe a wet/swampy land. Seed B overall needed the most heat, giving rise to the idea that it is found in warmer areas, maybe even tropical ones. However, light did not affect seed B, so this seed, like seed A, can grow in either light or dark places and it would have no effect on the germination of the seed.

Seed C’s optimum data was 80 mL of water, heat at 24° C, and light at three bulbs. Similarly to seed B, seed C also needs quite a bit of water to grow, meaning it is probably found in an area with an abundant water supply. Unlike the other two seeds, seed C showed a linear increase in germination when more lightbulbs were used with it. It optimally germinated with three lightbulbs, meaning that seed C needs a lot of light to grow. With this information, I can infer that seed C is found in an area with a warm climate, abundant water supply, and lots of light. Seed C can probably be found in tropical areas.

This experiment of testing various treatments and their effects on the amount of germination of three different types of seeds will do gives rise to other potential ideas for future experiments. As stated in the introduction, several factors can account for and influence seed germination. In this experiment, we tested three of them: water, heat (temperature), and light. However, we did not test for the last one, scarification. An idea for a future experiment would be to test different scarification factors that seeds can germinate in like exposing them to fires, freezing temperatures, and the stomach acid of an animal. Seed germination in general has useful real-world applications that can be used to test where to plant various seeds. Experiments like these give insight into where in the world various seeds can germinate, grow, and thrive in as developed plants.

## Works Cited

DuPont, Tianna. “Seed and Seedling Biology.” *Penn State Extension*, 28 Aug. 2012,

extension.psu.edu/seed-and-seedling-biology.

*Germination.* Germination Gizmo: ExploreLearning. Accessed 14 Oct. 2020, https://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=6

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Pendarvis, Murray P, and John L Crawley. *Custom: Ebook:* *Exploring Biology in the Laboratory: Customized for Wayne State University*. 3rd ed., Morton Publishing, 2020, Accessed 13 Oct. 2020.

*Seed Germination-Plants in Motion*.

plantsinmotion.bio.indiana.edu/plantmotion/earlygrowth/germination/germ.html.

“Seed Germination - Process, Necessity, and Its Major Factors.” *BYJUS The Learning App*,

BYJU'S, 6 Oct. 2020, byjus.com/biology/seed-germination/.

***Sample Assignment #2a: Lab Report Guidelines***

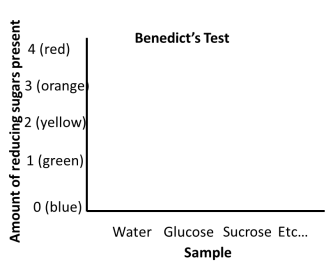
**Lab Report on Biomolecules**

1. **Report Format:**
   * You must write your own individual lab report.
   * Must be typed in 12 point Times New Roman font.
   * Each section must be labeled using the following: Intruduction, Materials and Methods, Results, and Discussion. Use the style shown below as an example.
2. **Introduction (5 points):**
   * This provides the background information on the subject. Use the lab manual and the powerpoint covered in lab to write this section. You can also include information from your lecture text book on biomolecules for this section.
   * **Introduce the subject, what are biomolecules? Why are they important?**
   * What is the purpose of the lab exercise?
   * **Explain what each of the biomolecules covered in lab are, how they are similar to each other, and how they are different from each other. How are biomolecules made? How are they broken down?**
   * *What are the tests used to assess biomolecules? What is a positive and a negative result for each test?*

*What does a positive result indicate?*

* + *What are your hypotheses?*

1. **Materials and Methods (2 points):**
   * *BRIEFLY summarize the methods for each test.*
   * Do NOT provide lists or numbered steps, this should be written in a paragraph form.
2. **Results (5 points):**
   * *Simply state your data. In this section you do not make any statements about whether or not your data agrees with your ideas, conclusions, hypotheses, etc (this belongs in the discussion).*
   * Present your test data in tables. Make sure your tables are properly labeled. Refer to Appendix B of your lab manual for guidance.
   * Create a graph for the Benedict test results. This should be made in excel. Refer to Appendix B for your lab manual for guidance. Use the following bar graph format:



**5. Discussion (7 points):**

* + This is the meat of your lab report and the section you should spend most of your effort writing.
  + Make conclusions on what biomolecules make up each sample. For example: Sample X was positive for the paper test, positive for the Benedict’s test, negative for the Barfoed’s test, negative for the Iodine test, Negative for the Biuret test, thus it contains lipids and disaccharides. Etc.
  + Address whether your conclusions supported your hypotheses or not. Why or why not?
  + Why does testing food for biomolecules matter? What is the bigger picture?

***Sample Assignment #2b: Student Work***

Lab Report

Biomolecules Laboratory Tests on Lipids, Carbohydrates, Amino Acids and Proteins

Author

Introduction

1. **The eleven samples of foods tested will determine if its contents contain lipids, monosaccharides, disaccharides, branched or unbranched polysaccharides, or proteins.**
2. **The data will track the original color of the samples before the reagents test and the final color after boiling.**
3. *My hypothesis is that the each contents will change color with the addition of test reagents.*

Methods

1. *The scientific test methods used are a paper test for lipids, Benedict’s test, Barfoed’s test, Lugol’s Iodine test, and Biuret’s test.*

Participants

1. *The carbohydrate contents used were water, glucose, sucrose, starch, albumin, potato flakes, coconut sugar, stevia, olive oil, pretzels, and grapes.*
2. *The carbohydrate contents are everyday food items that can be purchased and consumed.*
3. *A small amount of each contents will go through a grind process for placement into the test beakers.*

Procedures

1. The first test was for the presence of lipids on paper.
2. The second test was for carbohydrates via the Benedict’s test.
3. The third test was for carbohydrates via the Barfoed’s test.
4. The fourth test was for carbohydrates via the Lugol’s Iodine test.
5. The fifth test was for amino acids and proteins via the Biuret’s test.

Results

1. The first test either yielded a presence of grease spots on the dried paper or not.
2. The rest of the test yielded either no change in color or various changes in color.
3. Each change in color provided the conclusions of containing monosaccharides, unbranded polysaccharides, polysaccharides or protein.
4. My hypothesis is not supported that the colors would all change with the additional of the test reagents.

Discussion

1. During the paper test for lipids five test samples yielded a grease spot and six test samples were absent a grease spot.
2. My hypothesis that each test example would yield a color change was not accurate. During the Benedict’s test two test examples remained blue while the others changed colors.
3. During the Barfoed’s test four test examples remained blue while the others changed colors.
4. During the Lugol’s Iodine test all the test examples changed colors.
5. During the Biuret’s test four test examples had a final color of clear.
6. In conclusion the addition of test reagents does not ensure a color change.

***Sample Assignment #3a: Scientific Argumentation Guidelines***

**Scientific Argumentation: The Endangered Species Act – At What Cost?**

This exercise will allow you to investigate the issue of the implementation and effectiveness of the Endangered Species Act (ESA). You will examine two positions: pro supports the ESA as it is (benefits outweigh the costs), con supports changing the ESA (costs outweigh the benefits). After completing this assignment you will be able to:

* Determine and distinguish between the different roles of facts, predictions, and opinions/values regarding the use of science
* Use facts to support a claim
* Explore different sides of a scientific issue in an objective manner



1. Read the following articles and listen to the podcast. PDFs of the articles are posted on Canvas.

Miller, L. (2010, June 28). Weighing good intentions. RadioLab @ RadioLab podcast. Retrieved from:

<https://www.wnycstudios.org/story/91723-weighing-good-intentions>

Kahn, J. (2018, March 13). Should some species be allowed to die out? The New York Times. Retrieved from: [https://www.nytimes.com/2018/03/13/magazine/should-some-speciesbeallowed-to-die-out.html](https://www.nytimes.com/2018/03/13/magazine/should-some-speciesbe-allowed-to-die-out.html)

Wroland, J. (2018, July 25). Endangered Species Act has economic benefits - and costs. Time. Retrieved from: <http://time.com/5347260/endangered-species-act-reform/>

Doyle, M. (2019, October 8). After 50-year conservation effort, songbird flies off U.S. endangered species list. Science News. Retrieved from:

[https://www.sciencemag.org/news/2019/10/after-50-year-conservation-effort-songbirdflies-us-endangered-species-list](https://www.sciencemag.org/news/2019/10/after-50-year-conservation-effort-songbird-flies-us-endangered-species-list)

1. While reading these papers, consider the following questions (do not write out answers to these):
   * **What characteristics of a species are considered when listing through the ESA?** Who makes those decisions? What are those decisions based on and how is that information weighed?
   * What are some of the costs and benefits of listing and protecting endangered species to the environment and to society?
   * Should we give more weight to some considerations than others? How much of a voice should we allow outside/special interest groups to have?
   * **How might climate change affect threatened and endangered species, ecosystems, and society?**
   * What other research might be done to determine the “value” of a species? Can we actually put a price tag on that? Why or why not?
2. Complete the first page of the worksheet to list and discuss the following:
   * Facts about the Endangered Species Act and its costs/benefits
   * Predictions about the possible outcomes of changing the ESA • Opinions and values involved in decision-making on this issue
3. Finally, answer the questions on the last page of this worksheet.

***Sample Assignment #3b: Student Work***

|  |  |
| --- | --- |
| Facts and sources - cite the article in (author, year) format  **Pro Con** | |
| 1. **The ESA not only protects individual species, but the ecosystem that supports it as well. It helps ensure a hospitable climate for us and other animals and even clean drinking water (Worland, 2018).** 2. The value of the ESA to the United States economy is enormous and is similarly thought of as birds eating mosquitoes that would otherwise spread various diseases to us (Worland, 2018). 3. The ESA supports local tourism and vastly improves residential land values that are near nature preserves (Worland, 2018). 4. “Of all the species listed since 1973, 99 percent are still around” (Kahn, 2018). 5. Protecting a species ultimately means preserving its habitat as well as many other plants and animals that live in the same ecosystem (Kahn, 2018). 6. The Kirtland’s Warbler being taken off of the endangered species list is a great example of the ESA doing what it’s meant to do: save species from extinction (Doyle, 2019). | 1. Under the ESA law, once a species is considered to be at risk of extinction, agencies must step in to take the appropriate actions to save it. Because of this, the law itself may undermine the ability to weigh a species’ value or to consider the economic effects of its preservation (Kahn, 2018). 2. The effort to save every species that is on the risk of extinction is inefficient and unrealistic (Kahn, 2018). 3. **Government agencies that try to help all species at risk end up using important resources on “lessimportant” species, rather than using them on “more important” ones (Kahn, 2018).** 4. “On the flip side, critics observe, is that only one percent of those species have been sufficiently rehabilitated to leave the list” (Kahn, 2018). 5. Critics argue that the ESA limits industry and hurts loggers and ranchers (Kahn, 2018). 6. The lengths taken to save a species are sometimes costly, dangerous, and do not even assure that the species will not be endangered after such efforts (Miller, 2010). |

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| 1. Ecosystem services generate about $1.6 trillion annually and have a whole bunch of other benefits the Trump administration is blind to (Worland, 2018). 2. A biodiverse plant can defend against global warming and act as a storage for potential discoveries, like an anticancer drug coming from   Amazonian moss (Kahn, 2018). | 1. Because efforts to save a species are large and sometimes dangerous, wildlife workers are prone to life endangering practices and situations to protect species. A situation like this happened to James Swiderksi, who dedicated his life to saving the Kirtland’s Warbler. He died in one of the fire’s that were started in Michigan to test the effect of habitats on the population of the Warbler (Miller, 2010). 2. **The ESA has the potential of killing other animals/species to save another. This can be seen with the killing of cowbirds to ultimately protect the Kirtland’s Warbler, since cowbirds are brood parasites to them (Miller, 2010).** |
| Predictions or Potentials | |
| 1. Changes to the ESA could possibly implement safer, smarter, and more efficient ways of saving species on the verge of extinction. One way would be for the government to take it more seriously, and for the Trump administration to stop trying to change it under their terms and defund it   (Worland, 2018).   1. More political support, resources, and better planning are needed for the ESA to work efficiently and effectively (Kahn, 2018). | 1. Changes to the ESA could completely dismantle the act and all the work that has gone into it by wildlife techs saving certain species on the verge of extinction (Kahn, 2018). 2. Efforts taken towards defunding and dismantling the ESA in general puts species at a greater risk of extinction, since there would be minimal government funding and resources to help limit it from happening (Kahn, 2018). |

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| 1. More support and good change to the ESA could greatly impact species on the verge of extinction. This could potentially have them completely off the endangered species list and not considered a   “conservation reliant species” after doing so  (Kahn, 2018).   1. “Behind closed doors, I think most conservationists would agree that some judicious modifications to the act could improve the situation” (Kahn, 2018). | 1. Changes focused on dismantling the ESA to help industries and companies thrive should not even be in the question, as not everything is centered around business and money. Animals like the Kirtland’s Warbler do not have the means of protecting their species from extinction, so human intervention is sometimes needed. Changing the ESA to help industries and businesses would be cruel and would potentially cease the existence of some species (like the Kirtland’s Warbler) alltogether (Miller, 2010). 2. The changes the Trump administration would implement would severely ignore key components of the ESA, rendering it almost useless (Worland,   2018). |
| Values and Ethics | |
| 1. Since animals do not always have the means of protecting themselves, especially when extinction is a possibility, it seems ethically right for humans to step in and do something if they have the means and resources to do so (Kahn, 2018). 2. “Nothing is more priceless and more worthy of preservation than the rich array of animal life with which our country has been blessed” -President   Nixon (Kahn, 2018). | 1. The killing of cowbirds to protect the Kirtland’s Warbler seems to counteract the values of the ESA   (Miller, 2010).   1. The preservation of the Kirtland’s Warbler requires other large efforts like wildfires in areas abundant with jack pines. Such acts could cease the habitats of other animals and potentially spread to where people are living (Miller, 2010). |
| 1. **Conservationists want to prioritize the genetic and/or functional diversity of ecosystems not because those things are valuable to people, though they can be, but because they’re essential to the health, wellness, and resiliency of all ecosystems themselves (Kahn, 2018).** 2. “We don’t want a planet that’s nothing but pavement, cattle farms and monoculture farmland… even if you never see a lemur or an arctic fox in person, the world can be a richer place by having such creatures in it… others simply see conservation as a moral duty: because we’re the ones creating these problems, isn’t it up to us to fix them?” (Kahn, 2018). | 1. Picking a species to save based on their “value” is not ethically right nor is there a clear and concise way of doing so (Kahn, 2018). 2. “Conservation of a species isn’t always a straightforward choice; in countries like Brazil and Kenya, do we prioritize protecting wild animals and their habitats or the farmers facing hunger who hunt those animals and who log forests to plant crops?” (Kahn, 2018). |

 What are three main takeaways you learned about the costs and benefits of the Endangered Species Act?

The first takeaway I learned about the costs and benefits of the ESA is how much effort really goes in to saving a species. **The fact that species that are saved from extinction are often times conservation reliant and can never be fully put into the wild without risking extinction from those same reasons that brought them on the verge of it in the first place, is surprising to me. It’s almost like a never-ending cycle.**

The second takeaway I learned was just how passionate and dedicated the wildlife technicians are to saving species on the verge of extinction. When I was listening to the podcast by Lulu Miller and found out that one of the technicians working towards saving the Kirtland’s Warbler in Michigan had lost his life in the fire started by the workers, it was quite shocking and sad. However, I then realized he probably died doing something he loved, as Lulu had mentioned that he took a huge pay cut and quit his job to save the Kirtland’s Warbler that was on the verge of extinction.

The third takeaway I learned was how dedicated the Trump administration is to dismantling the act itself. It’s quite sad that the people in charge of our country are not taking the necessary measures to save the biodiversity on our planet. As Justin Worland stated at the end of his article,

“if a single company can make a single dollar from the destruction or displacement of an endangered species, it’s full speed ahead” (2018).

* Describe how the Endangered Species Act has affected the field of biodiversity science since its’ establishment.

The ESA ensures species that are on the risk of extinction have measures taken towards saving it. Because of this, species are more abundant and account for the large biodiversity seen on our planet today. Without the act, certain species would for sure be extinct, making our plant less biologically diverse, and therefore impacting biodiversity science. Since its establishment, I think it is safe to say the ESA has made the field of biodiversity science alive and well.

* What is your final position on whether or not the Endangered Species Act is worth the costs and why?

I think the ESA is worth the costs. I believe we should live in a planet that is biologically diverse, as there is a slew of other benefits to preserving such species. Humans are quite individualistic and tend to only look for reasons that benefit them, especially economic ones. But for the sake of biodiversity and species in general, I think the ESA is a good thing. However, I think it should be regulated a bit more and taken more seriously by the government. Whether that’s through more funding or through more awareness of the general population, I believe the ESA is worth the costs.