Neʻepapa Ka Hana 2.0
Sixth-Grade Mathematics Resources
STEMD² Book Series

## STUDENT ACTIVITIES

# LET'S GO FROM MAUKA TO MAKAI

STEMD² Research & Development Group
University of Hawaiʻi at Manoa

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http://stemd2.com/

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Ne‘epapa Ka Hana Sixth-Grade Mathematics Resources

# Let’s Go from Mauka to Makai

*Student Activities*


| | |
|---|---|
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# Contents

# Unit 1: Numbers

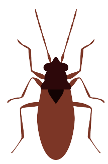
In this unit, we'll learn how to use positive and negative integers, fractions, and decimals to describe situations through Hawaiʻi's vast biodiversity and unique ecosystem. There are four activities in this unit. *Module 1* involves working with integers to find species at different altitudes on the Islands of Hawaiʻi, *Module 2* focuses on how to use factors and multiples to support our native environment, and *Module 3* explores the rain seasons of Hawaiʻi with the help of rational numbers. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

## Module 1: Integers *Activity*

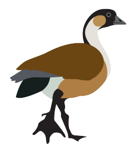
**Biodiversity** refers to how many different kinds of living organisms are present in an area. For example, a farm with $1000$ chickens has less biodiversity than a farm with a chicken, a duck, a cow, and a pig. The Hawaiian Islands are known for having incredible biodiversity. From the bottom of the ocean to the top of the mountains, we can find a large variety of plants, animals, and other types of life.

Let's take a few days to travel the Big Island of Hawai'i. We will write down some of the life we see and the altitude (height) above sea level that we see it.

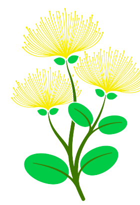
We will start the week by exploring the mountains. On the top of Mauna Kea we find a rare Wēkiu beetle at an altitude of $3725$ meters. At an altitude of $1432$ meters on a nearby mountain, we see the state bird of Hawai'i, the Nēnē goose. On the way down, we see an 'ōhi'a lehua plant with beautiful flowers at an altitude of $1202$ meters.



Wēkiu beetle

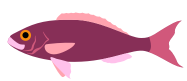


Nēnē goose

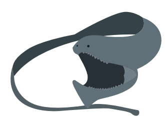


'Ōhi'a lehua

On Friday, we sail out into the ocean. You lower a fishing line down to $-642$ meters and catch an opakapaka. Your friend lowers a line as deep as she can. Her line goes down $1432$ meters below sea level, and she pulls up a skinny fish, with a huge mouth, called a gulper eel.

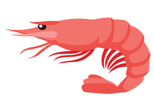


Opakapaka

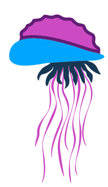


Gulper eel

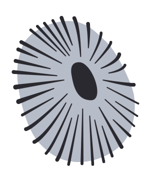
The following weekend, we visit a white sandy beach. While swimming offshore, we see a tiny krill at an altitude of about $-1$ m (or $1$ meter below sea level). At sea level, we spot a Portuguese man o' war floating around. We swim around it and carefully climb $1$ meter up a few slippery rocks to collect some delicious opihi.



Krill



Portuguese man o' war



Opihi

1. Use the following table to write down the names of the plants and animals that we saw and the altitude that we saw them. Be sure to use negative numbers for animals that were found below sea level.

| Plant/animal name | Altitude spotted (meters) |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

2. Write down the name of the plants/animals in a list from **lowest altitude to highest altitude**.

(Lowest altitude) (Highest altitude)

3. Write down the name of the plants/animals from **closest to furthest from sea level** ($0$ meters). If two plants/animals have the same distance from sea level, then write them next to each other.

(Closest to sea level) (Furthest from sea level)

4. With some practice, many people are able to dive down to $\mathbf{10}$ meters below sea level or hike up to an altitude of $1500$ meters without much effort. Let $x$ be the altitudes that we can go to.

   (a) If we cannot go any lower than $10$ meters below sea level, then what are the altitudes that we **can** go to?
   (Circle one): $x \geq 10$ $x \leq 10$ $x \geq -10$ $x \leq -10$

   (b) If we cannot go any higher than an altitude of $1500$ meters, then what are the altitudes that we **can** go to?
   (Circle one): $x \geq 1500$ $x \leq 1500$ $x \geq -1500$ $x \leq -1500$

   (c) List the animals that could have been spotted just by diving or hiking.

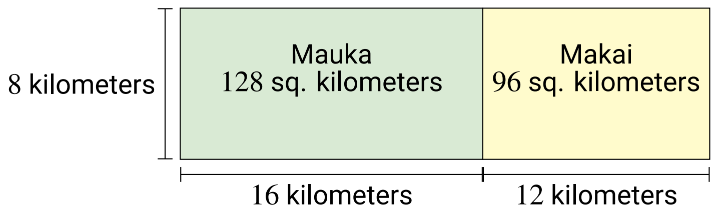
5. Which of these plants and animals have you seen in real life? Where did you see them?

6. What is the most interesting plant or animal that you have seen in Hawaiʻi? What was so interesting about it?

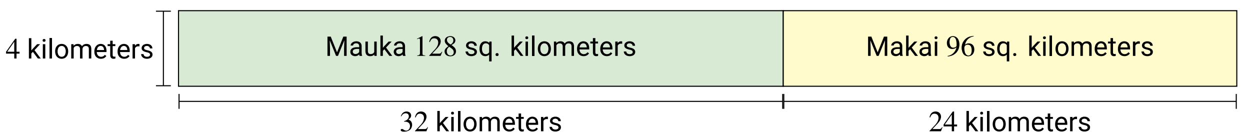
## Module 2: Factors and Multiples *Activity*

To improve the condition of our environment, the government has decided to protect a large slice of land called an ahupuaʻa. All ahupuaʻa are made up of two parts, the mauka and the makai. The mauka part is close to the mountains and the makai part is close to the sea. We don't know the exact measurements of the protected ahupuaʻa, but we do know that the **mauka part has an area of $128$ square kilometers**, and the **makai part has an area of $96$ square kilometers**. We also know that the ahupuaʻa and its parts are shaped like rectangles.

For example, if the protected ahupuaʻa is $8$ kilometers wide, then the mauka part must be $16$ kilometers long and the makai part must be $12$ kilometers long.




For another example, if the protected ahupuaʻa is only $4$ kilometers wide, then the mauka part must be $32$ kilometers long and the makai part must be $24$ kilometers long.




1. Suppose that the width is a **whole number**, draw at least two more possible rectangles to represent the protected area. Be sure to label the sides of your drawings just like in the example above.

2. If the width is a **whole number**, what is the largest width that the rectangle can be?

The government is asking for your help in taking care of this area by visiting it regularly. They want you to visit the mauka part **once every $8$ weeks** and let them know if that area is doing well. They also want you the visit the makai part **once every $3$ weeks** and let them know if it is doing well. This week, you will check on both the mauka and makai areas.

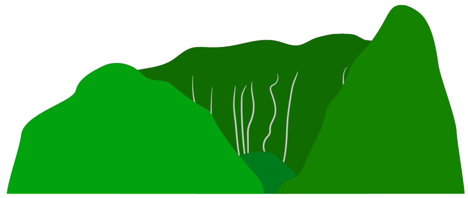
3. Sometimes you will have to visit both parts in the same week. **How often** does this happen?

4. If you needed to take care of the ahupuaʻa for the next $80$ weeks, during which weeks would you visit both parts? **How many times** will you need to visit both parts in the same week? Be sure to count this week as the first time.

5. If you visited these protected areas, what would you look for to determine if the area is doing okay? Why would you look for these specific things?

# Module 3: Rational Numbers *Activity*

Mount Wai‘ale‘ale on Kaua‘i is one of the rainiest places on Earth. Normally, rainfall is measured in inches, but since it rains so much on Mount Wai‘ale‘ale, we can measure it in feet.



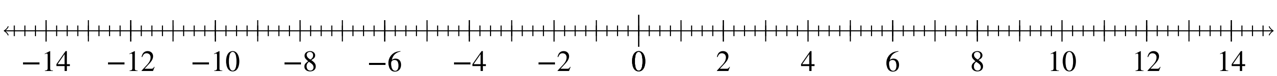
Mount Wai‘ale‘ale

We want to compare the rainfall on Mt. Wai‘ale‘ale with another rainy place called Mawsynram (“mah-sin-rem”) in India by calculating the difference. Let’s take the rainfall from Mt. Wai‘ale‘ale and subtract the rainfall from Mawsynram. Here is the data.

| | Rainfall (feet) | | |
|---|---|---|---|
| Season | Mt. Wai‘ale‘ale | Mawsynram | Difference |
| Spring | $8\frac{1}{2}$ | $6\frac{1}{5}$ | $2\frac{3}{10}$ |
| Summer | $7.3$ | $21.5$ | $-14.2$ |
| Fall | $7\frac{3}{5}$ | $4\frac{2}{5}$ | $3\frac{1}{5}$ |
| Winter | $7.05$ | $0.2$ | $6.85$ |

1. In the table above, are there any pairs of numbers that are exactly opposite? If so, which pairs?

2. For each season, plot the “difference” column on the number line. (Do not plot any of the other numbers on the table.)




Difference in rainfall (feet)

3. When the difference in rain is $0$, both Mt. Wai‘ale‘ale and Mawsynram have the same amount of rainfall. What about when the difference is negative or positive?

   Mt. Wai‘ale‘ale / Mawsynram ________ has more rainfall when the difference is **negative**.
   *(circle one)*

   Mt. Wai‘ale‘ale / Mawsynram ________ has more rainfall when the difference is **positive**.
   *(circle one)*

4. Which season has the largest difference between rainfall in Mount Waiʻaleʻale and Mawsynram? How can you tell?

5. Which season has the smallest difference between rainfall in Mount Waiʻaleʻale and Mawsynram? How can you tell?

6. Let’s compare the “difference” in the summer with the seasons that are not summer.

   (a) Write down the difference in rainfall in the summer.

   (b) Add up all of the differences from **spring**, **fall**, and **winter** to find the difference of the seasons that are not summer.

7. In one year, does it rain more in Mount Waiʻaleʻale or Mawsynram? How can you use part 6 to help you answer this question?

8. Of these two places, which one would you consider to have “the most unusual” weather and why?

# Unit 1: *Cumulative Activity*

Ancient Hawai‘i used to be full of strong koa trees and fragrant ‘iliahi (sandalwood) trees, but centuries of deforestation have made most of these trees and the animals that depend on them disappear. Now volunteers are working to bring the trees back.

Koa sapling

‘Iliahi sapling

Kahā and Kekai are two gardeners who specialize in growing saplings (baby trees) of native plants. Kahā plans to donate $180$ koa saplings, and Kekai will donate $120$ ‘iliahi saplings. They will put them into packages and give them to volunteers who will plant and take care of them. Each package will contain the same mix of saplings, and no saplings will be left over once the packages are filled.

1. Kahā and Kekai are trying to decide how many koa and ‘iliahi saplings to put in each package. For example, if each package has $18$ koa and $12$ ‘iliahi, then they can make $10$ packages.

   Work with a partner to list **other possible ways** to package the koa and ‘iliahi.

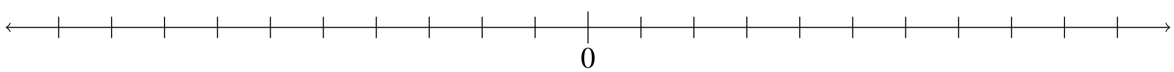
| | | |
|---|---|---|
| Koa per package **18**<br>‘Iliahi per package **12**<br>Number of packages **10** | Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages |
| Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages |
| Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages |
| Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages | Koa per package<br>‘Iliahi per package<br>Number of packages |

2. What is the maximum number of packages Kahā and Kekai can make?

After receiving the donations, the volunteers begin to plant their saplings. Over the next few weeks, many trees will be planted but some will die. Below is a table that shows how the number of trees have changed since the saplings were planted. For example, “$15$” means that there are $15$ more trees now than before the saplings were planted. “$-5$” means that there are $5$ less trees now than before the saplings were planted.

| Week | Change in number of trees |
|---|---|
| $0$ | $0$ |
| $1$ | $3$ |
| $2$ | $-2$ |
| $3$ | $-6$ |
| $4$ | $-5$ |
| $5$ | $1$ |
| $6$ | $6$ |

3. For each week, plot the “change in number of trees” on the number line. Make sure to label the number line.




4. Determine whether the following statements are **true or false**.
   (a) There were more trees in week $3$ than week $2$. True or False
   (b) There were more trees in week $4$ than week $3$. True or False
   (c) There were more trees in week $3$ than week $6$. True or False
   (d) There were more trees in week $5$ than week $4$. True or False
   (e) Two of the numbers in “change in number of trees” column are opposite. True or False

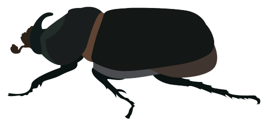
5. Restoring a forest doesn’t always work as planned. A new sapling has to fight for sun, water, and nutrients while facing bad weather, pollution, and pests. If you wanted to learn how to grow a plant, what kind of plant would you choose and why? Please share your thoughts with your partner or in the online comment section.

# Unit 2: Number Operations

In this unit, we'll learn how to use positive integers, fractions, and decimals to solve problems through exploration of invasive species and evaluating Hawai'i's ecosystem. There are three activities in this unit. *Module 4* involves tracking and evaluating the coconut beetle through the use of operations with fractions. *Module 5* focuses on operations with decimals by evaluating the rain fall on a ahupua'a. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

# Module 4: Operations with Fractions *Activity*

A $13\,\frac{1}{2}$ acre forest has been attacked by invasive coconut rhinoceros beetles. A team of $8$ researchers have decided to spread out and check on the health of the forest.



Coconut rhinoceros beetle

1. Each of the $8$ researchers have been assigned a equal share of the $13\frac{1}{2}$ acres of forest. This means that they have to watch $1\frac{11}{16}$ or $\frac{27}{16}$ acres of forest each. How did they come up with this number? Please show all of your work below.

Sometimes, we have different ways to describe the same thing. For example, when we say that "we lost half of our money," we can describe this by taking the amount of money we had and **dividing** by $2$. We can also take the money we had and **multiply** by $\frac{1}{2}$. It's the same thing.

2. After watching the forests for several years, each researcher saw that their part has gotten smaller. They wrote down a **number** that describes how much the forest has changed, but they didn't write down whether you are supposed to **multiply or divide** by that number. Write down the missing sign (× or ÷) that makes the forest size ($\frac{27}{16}$) **smaller**. Find the size of the smaller forest part. Give your answer as a mixed number.

   (a) Researcher 1: $\frac{27}{16} \div \frac{4}{3} = 1\frac{17}{64}$

   $$\begin{aligned}\frac{27}{16} \div \frac{4}{3} &= \frac{27}{16} \times \frac{3}{4} \\ &= \frac{81}{64} \\ &= 1\frac{17}{64}\end{aligned}$$

   (b) Researcher 2: $\frac{27}{16} \bigcirc \frac{16}{25} =$

   (c) Researcher 3: $\frac{27}{16} \bigcirc \frac{8}{15} =$

(d) Researcher 4: $\frac{27}{16} \bigcirc \frac{27}{20} =$

(e) Researcher 5: $\frac{27}{16} \bigcirc \frac{18}{5} =$

(f) Researcher 6: $\frac{27}{16} \bigcirc \frac{25}{24} =$

(g) Researcher 7: $\frac{27}{16} \bigcirc \frac{16}{21} =$

(h) Researcher 8: $\frac{27}{16} \bigcirc \frac{21}{20} =$

## Module 5: Operations with Decimals *Activity*

If you have taken a trip around a Hawaiian island, you may have noticed that the weather changes between different ahupuaʻa. Even neighboring ahupuaʻa can have very different amounts of wind, rain, and even sunlight. Let's look at three different ahupuaʻa on a day that has been raining on and off. We recorded the time of each rain shower and the total amount of rain that fell by the end of the day.

Ahupuaʻa 1

| | |
|---|---|
| Rain times | 1.55 hours<br>0.12 hours<br>1 hour |
| Rain amount | 2.1 inches |

Ahupuaʻa 2

| | |
|---|---|
| Rain times | 0.2 hours<br>5.15 hours<br>9.8 hours |
| Rain amount | 4.0 inches |

Ahupuaʻa 3

| | |
|---|---|
| Rain times | 0.8 hours<br>0.5 hours<br>0.2 hours |
| Rain amount | 2.9 inches |

1. On which ahupuaʻa did the most rain fall?

2. For each ahupuaʻa, calculate the total rain time. Then rank each ahupuaʻa from **least to greatest** total time spent under rain.

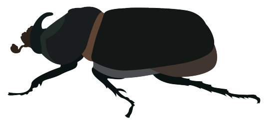
3. The **rain intensity** tells us whether it is raining lightly or whether it is raining heavily (known as "raining cats and dogs"). **Rain intensity** can be found by dividing the total amount of rain by the total rain time. Find the rain intensity for each ahupuaʻa. Round to two decimal places. Be sure to label your answer in inches per hour.

4. Discuss with a partner which ahupuaʻa has the lightest rain and which has the heaviest.
5. For each ahupuaʻa, draw a picture of it raining outside. Make sure it matches your discussion from part 4.

| Ahupuaʻa 1 | Ahupuaʻa 2 | Ahupuaʻa 3 |
|---|---|---|

## Unit 2: *Cumulative Activity*

The coconut rhinoceros beetle is an invasive beetle that is spreading and killing both coconut and palm trees. As of 2019, the rhinoceros beetle has been found in the ʻEwa moku of Oʻahu, mostly around Pearl Harbor. (A moku is a group of ahupuaʻa.)

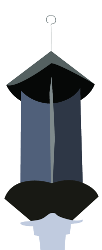


Coconut rhinoceros beetle

You are monitoring a small palm forest on Oʻahu that is under attack by the rhinoceros beetle.

1. The forest originally had a size of $10$ acres. (An acre is a little smaller than the size of a football field without the end zones.) A year ago, the beetle killed $\frac{11}{8}$ acres of the forest. How many acres of the forest are still alive? Give your answer as an improper fraction or a mixed number.

2. To learn more about the beetle, scientists went into the remaining parts of the forest (from part 1) and placed a number of beetle traps. They decided to place at least one beetle trap every $3/4$ acres of living palm trees. What is the minimum number of traps they would need to place? (Please show your work.)



Beetle trap

3. As the beetles continued to spread, another $3.025$ acres of palm trees died in this forest. What is the size of the forest now? Give your answer as a decimal.

4. Your school wants to ask the government to do more to protect these forests. Let’s calculate some numbers that can help describe the situation. How many times bigger was the original forest compared to now? Give your answer as a decimal rounded to the nearest tenth.

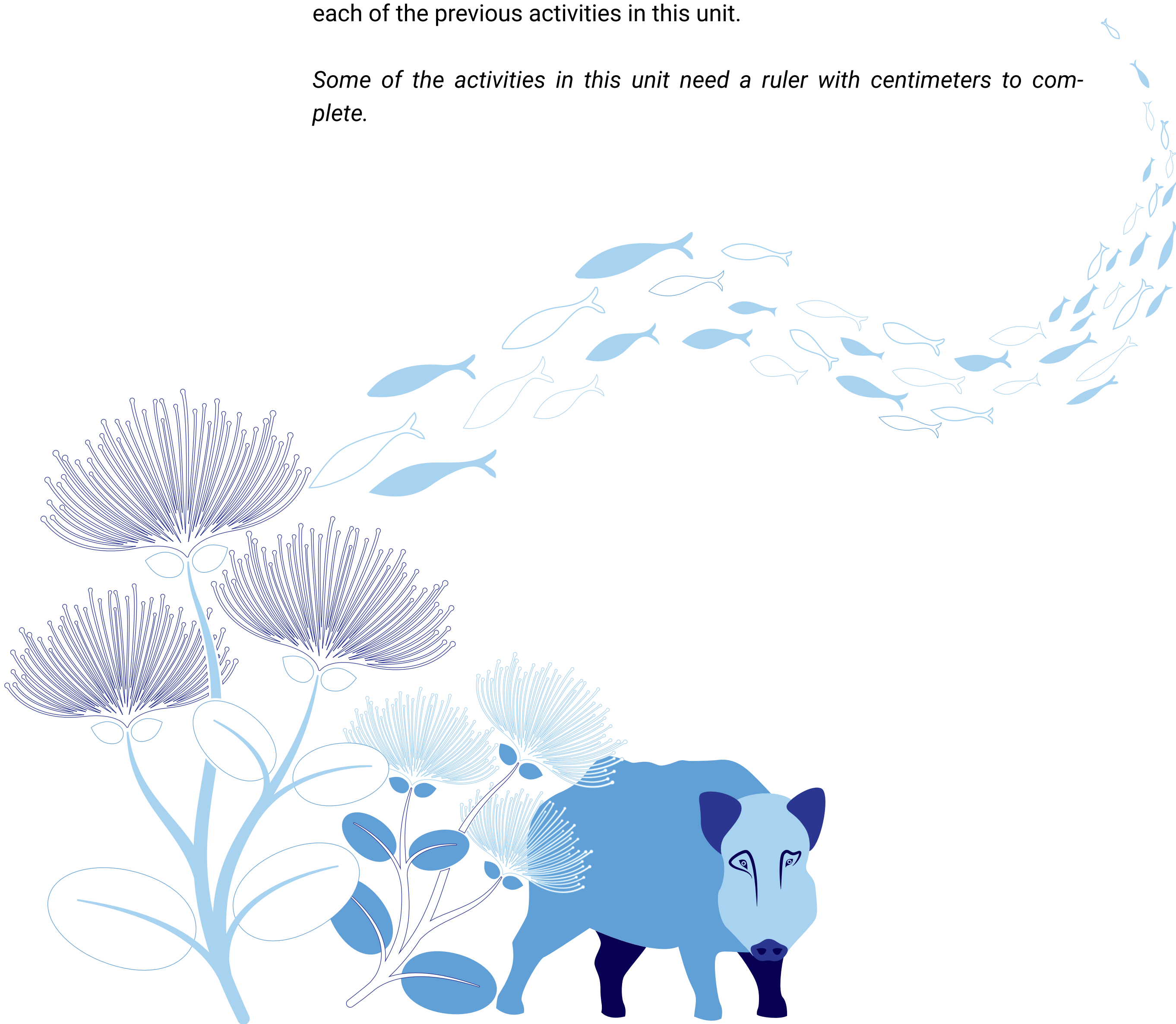
5. A lot of people do not pay attention to environmental issues. If you could get more information about the coconut beetle, what kind of information do you think would make people pay more attention? Share your thoughts in the online comment section. (Your answer does not have to be a mathy one. =])

6. If you have seen a coconut beetle trap, please take a picture and post it online along with the location of where you saw it! Or share it with your teacher and your classmates.

# Unit 3: Proportionality: Ratio and Rates

In this unit, we'll learn how to use ratios and rates to convert measurements and describe situations through avoiding lava flows and surveying invasive and non-invasive fish populations. There are five activities in this unit. *Module 6* involves representing ratios and rates by evaluating an invasive fish population. *Module 7* has two activities where students guide the keiki to safety by applying ratios and rates to a map in order to avoid Island dangers. *Module 8* explores a variety of fish populations through the use of percents. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

*Some of the activities in this unit need a ruler with centimeters to complete.*

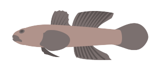
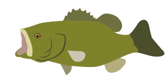
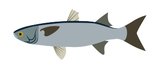
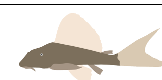
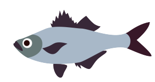


# Module 6: Representing Ratios and Rates *Activity*

When fish or other living things move to new locations, the fish can completely take over its new environment and everything that lives there. When this happens, the fish is called invasive. If the fish was there originally or if it doesn't cause harm, then the fish is called non-invasive. You are at a river in Downtown Honolulu and you are counting the number of invasive and non-invasive fish. You notice that there is a new fish in the river. Let's track the impact of the new fish on the invasive and non-invasive fish populations over the next few years.

| Year | Non-invasive fish | Invasive fish |
|---|---|---|
| 1 | 150 | 6 |
| 2 | 138 | 12 |
| 3 | 126 | 18 |
| 4 | 114 | 24 |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

Examples

| Non-invasive fish in Hawaii | Invasive fish in Hawaii |
|---|---|
|  ʻOʻopu (freshwater goby) |  Bass |
|  ʻAmaʻama (striped mullet) |  Catfish |
|  Āholehole (spotted flagtail) |  Cichlid |

1. It looks like the non-invasive fish population is dropping at a constant rate, and the invasive fish population is increasing at a constant rate. **What are the rates?** In other words, how much does the number of fish change per year? Make sure to use positive numbers to show that a number is growing and negative numbers to show that a number is shrinking.

   Non-invasive fish: __________ fish per year  Invasive fish: __________ fish per year

2. Complete the previous table for the remaining six years (years $5$ to $10$).

3. Find the ratio of *non-invasive* to *invasive* fish on the following years. Be sure to reduce your ratios to lowest terms.

   (a) Year $3$?

   (b) Year $5$?

4. In what year will the ratio of *non-invasive* to *invasive* fish be $1:1$?

5. How many of each type of fish do you expect to count in year $12$? Explain.

   Non-invasive fish: ___________ fish Invasive fish: ___________ fish

6. Many plants and animals like kalo (taro), ‘ulu (breadfruit), and the monarch butterfly were brought to Hawai‘i from other places, but they are **not** considered “invasive.” Why do you think that is? Can you name other plants or animals that are not from Hawai‘i and aren’t invasive either? Feel free to use the internet or work with a partner if your teacher allows.

## Module 7: Applying Ratios and Rates *Activity 1*

*For this activity you will need a ruler with centimeters.*

A lava flow is coming! You have to help the keiki navigate this ahupuaʻa to get home safely.


1. Using **straight lines**, draw a path from the **keiki** to the **home**. You may use the bridge or the sandbar to get across the river, but stay out of the water and off of the lava flow. Make sure that there are no breaks in the lines that you draw.

2. Use your ruler to measure the total length of your lines in centimeters. Round your final total to the nearest centimeter.

Total length: ___________ cm

3. For this map scale, $40$ feet in real life is represented by $5$ centimeters on the map. How many feet in real life does each centimeter on the map represent?

4. Complete the following table.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Centimeters on the map | 1 | 2 | | 4 | 5 | 10 | | 20 |
| Feet in real life | | | 24 | | 40 | 80 | 88 | |

5. How many feet was the length of your path?

## Module 7: Applying Ratios and Rates *Activity 2*

*This is a follow up of the last activity. Please complete Activity 1 before trying this one! For this activity you will need a ruler with centimeters.*

A lava flow is coming! You have to help the keiki navigate this ahupuaʻa to get home safely.


1. This time, let's work with a partner to find the **shortest** path from the keiki to the house. Using **straight lines**, draw a path from the **keiki** to the **home**. You may use the bridge or the sandbar to get across the river, but stay out of the water and off of the lava flow. Make sure that there are no breaks in the lines that you draw.

2. Find the real distance of your path. Remember, $5$ centimeters of your map is $40$ feet in real life. Share your solution (map and distance, in feet) and strategy with other groups!

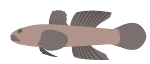
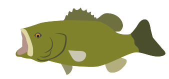
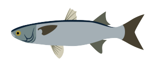
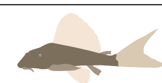
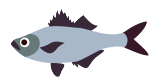
# Module 8: Percents *Activity*

Volunteers are visiting several streams in Honolulu to compare how many fish in the streams are invasive. Unfortunately, each volunteer wrote their numbers in a different formats.

Here is what they found.

| Stream | Proportion of invasive fish |
|---|---|
| Kapālama | $19\%$ |
| Makiki | $\frac{2}{7}$ |
| Mānoa | $0.21$ |
| Nuʻuanu | $9\%$ |
| Pālolo | $\frac{1}{5}$ |
| Waiʻalae | $0.3$ |

Examples

| Non-invasive fish in Hawaii | Invasive fish in Hawaii |
|---|---|
|  ʻOʻopu (freshwater goby) |  Bass |
|  ʻAmaʻama (striped mullet) |  Catfish |
|  Āholehole (spotted flagtail) |  Cichlid |

1. One way to get this kind of data is to catch a lot of fish and count how many of the fish are invasive. If the volunteers caught $100$ fish in each stream, how many invasive fish would you find in each stream? Round to the nearest whole number if needed. Kapālama is already done for you.

| Stream | Number of invasive fish out of $100$ |
|---|---|
| Kapālama | $19$ |
| Makiki | |
| Mānoa | |
| Nuʻuanu | |
| Pālolo | |
| Waiʻalae | |

2. Rank the streams from the *lowest* proportion of invasive fish to non-invasive fish to *highest*.

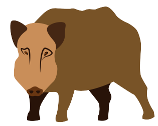
lowest ratio highest ratio

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |

3. Discuss the following questions with a partner. Write your answers and share them with others in your class.
   (a) How do you think the invasive fish got to the rivers in the first place?
   (b) How do you think some of these invasive fish end up taking over a new environment?

## Unit 3: *Cumulative Activity*

The puaʻa (pig) was introduced to the Hawaiian islands by the first Polynesian explorers. Although this animal is important to the Hawaiian culture, the puaʻa can be pretty destructive to the environment. This is mainly because they eat a lot of food and they can eat almost anything. When they are looking for food, they may dig up and chew up native plants. After they eat, they may leave poop that contain seeds of invasive plants.



Puaʻa (feral pigs)

The puaʻa can often be found eating plants, roots, mushrooms, bugs, and even small mammals. Typically, the diet of a puaʻa in your ahupuaʻa consists of $17$ pounds of plants (and fungi) for every $3$ pounds of animal meat.

1. Represent this typical diet as a **ratio** of plants (and fungi) to animals.

2. What **percent** of this diet would be of plants? Please explain how you got this answer.

3. What **percent** of this diet would be of animals?

4. Suppose that you found a baby puaʻa in your yard. You know not to let it go because of the damage that it can do to the environment, so your family decides to keep it as a pet. If you had to prepare $500$ pounds of food for this puaʻa, how many pounds of plants, and how many pounds of animal meat do you need?

5. As we saw before, the pua‘a in this ahupua‘a eats $17$ pounds of plants for every $3$ pounds of animal meat. How many pounds of plants does the pua‘a eat for one $(1)$ pound of animal meat? Round your answer to the nearest tenth.

6. If a baby pua‘a is eating $10$ pounds of meat, how many pounds of plant should it also eat? Round to the nearest whole number.

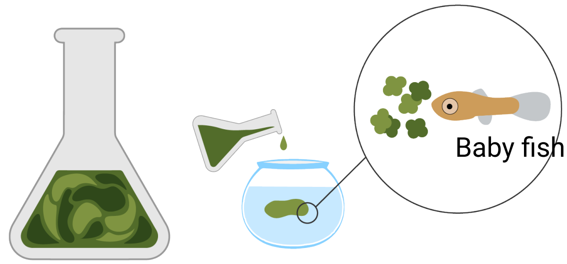
7. The diet of a pua‘a in one ahupua‘a can be different from a pua‘a in a different ahupua‘a. Why do you think their diets might be different?

# Unit 4: Equivalent Expressions

In this unit, we'll learn how to write algebraic expressions in different ways to describe situations through supporting Hawai'i's unique environment by farming. There are three activities in this unit. *Module 9* involves exploring the growth of algae through generating equivalent numerical expressions. *Module 10* focuses on generating equivalent algebraic expressions while evaluating donations to a reforestation project. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

## Module 9: Generating Equivalent Numerical Expressions *Activity*

To help the native fish populations, you have decided to raise baby fish at home. First, you need to grow some algae for the fish to eat. You have three types of algae called Type $1$, Type $2$, and Type $3$, and each type grows differently.




1. The Type $1$ algae is tripling its population every day. After two days, its starting population has multiplied by a factor of $9$ or $3^2$ (in exponent form). After three days, its starting population has multiplied by a factor of $27$ or $3^3$ (in exponent form). Please fill out the following table.

| | Number of times the Type $1$ population has multiplied by | |
|---|---|---|
| Day | Factor | In exponent form |
| $1$ | $3$ | $3^1$ |
| $2$ | $9$ | $3^2$ |
| $3$ | $27$ | $3^3$ |
| $4$ | | |
| $5$ | | |
| $6$ | | |
| $7$ | | |
| $8$ | | |
| $9$ | | |
| $10$ | | |

2. The Type $2$ algae grows more unpredictably. During the first few days, the algae quintupled (multiplied its population by a factor of $5$). Then, it tripled its populations for a few days. Finally, it began to double its population every day. After a total of ten $(10)$ days of growth, the Type $2$ algae has multiplied its starting population by a factor of $12960$.

   (a) Find the prime factorization of $12960$ in exponential form.

   (b) Using your answer from 2a, find out how many days, out of the ten days, the Type $2$ algae doubled $(\times 2)$, tripled $(\times 3)$, and quintupled $(\times 5)$ its population.

   Double:__________ Triple:__________ Quintuple:__________

3. After $D$ days, the Type $3$ algae has multiplied by the following number.

$$1000 \div \left(1024 \div 2^D - 0.8\right)$$

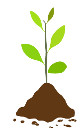
   How many times did the original population of this algae multiply after ten days $(D = 10)$?

4. Rank the three types of algae from **slowest** to **fastest** growing after ten $(10)$ days

# Module 10: Generating Equivalent Algebraic Expressions *Activity*

A small high school on Hawai'i Island is raising money to buy and plant koa and ʻiliahi trees.

Koa sapling



ʻIliahi sapling

Below, on the left side are several **classes and a description** of how much money they have each raised. Below, on the right side are several mathematical expressions that describe the **amount of money raised**. The cost of a koa tree is $k$ and the cost of an ʻiliahi tree is $h$.

1. Match each class with at least one expression. A few expressions are equal so **some classes will be matched with more than one expression**.

**Freshman class (grade 9)**:

Each student raised enough money to buy 3 koa and 2 ʻiliahi trees. There were 7 students. •

**Sophomore class (grade 10)**:

The students raised enough money to buy 4 koa and 6 ʻiliahi trees. Then a local company decided to doubled the money they raised. •

**Junior class (grade 11)**:

The students raised enough money to buy 21 koa trees, 14 ʻiliahi trees, and had \$21 left over. •

**Senior class (grade 12)**:

The students raised enough money to buy 21 ʻiliahi trees and had \$14 left over. •

- $21k + 14h$
- $2(4k + 6h)$
- $7(3k + 2h)$
- $7(3k + 2h + 3)$
- $21k + 14h + 21$
- $12h + 8k$
- $21h + 14$
- $7(2 + 3h)$

2. If each koa tree cost $\$90$, and each ‘iliahi tree cost $\$110$, find the total amount of money that each class raised.

   (a) Freshman class

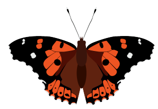
   (b) Sophomore class

   (c) Junior class

   (d) Senior class

# Unit 4: *Cumulative Activity*

Many animals depend on plants, not just for food, but for shelter as well. For example, the Kamehameha butterfly is an animal that, as a caterpillar, lives on the māmaki plants of Hawaiʻi.

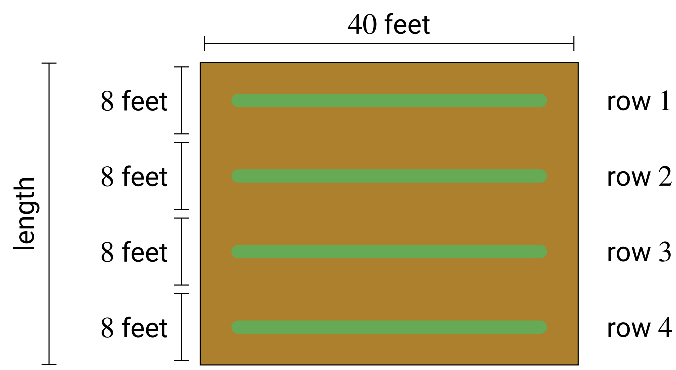


Kamehameha butterfly

Māmaki plant

There are signs that the Kamehameha butterfly is disappearing from many of its natural habitats. Let's grow a field of māmaki plants to help the butterfly thrive.

1. Right now we are building rows of māmaki plants in a $40$ feet wide garden. The length of the garden depends on the number of rows. We need **eight feet for every row of māmaki**. For example, if our garden has $4$ rows, then it needs a length of $32$ feet.




   If you are building $n$ rows, write an algebraic expression to show what the length of your garden must be.

2. Use the algebraic expression for length (in part 1) to write an expression for the area of the māmaki garden. Check with a friend to see if you have similar answers.

3. Use your expression in part 2 to determine whether the following statements are true or false.

   (a) The area is the **sum** of $320$ and $n$. True or False

   (b) The area is the **product** of $40$ and $8n$. True or False

   (c) The area is the **quotient** of $320$ and $n$. True or False

   (d) $320$ and $n$ are **factors** in your expression in part 2. True or False

   (e) $40$ and $8n$ are **terms** in your expression in part 2. True or False

   (f) $n$ is a **coefficient** in your expression in part 2. True or False

4. You decide to plant $10$ rows of māmaki in this garden. What is the total area of the garden? Check with a neighbor to see if you got the same answer.

5. Find the prime factorization of the answer in part 4.

6. Work with a partner to sketch, and label the widths and lengths, of at least $3$ other rectangles that have the same area as the garden in part 4.

7. How can the prime factorization of part 5 help you in part 6?

8. Suppose that $d$ number of Kamehameha butterflies land in the garden in part 4, and the Kamehameha butterflies spread out evenly in the area of the garden. Write an expression for the amount of area each of the $d$ Kamehameha butterflies will have to themselves.

9. How much area would each Kamehameha butterfly have if there were...

   (a) $5$ Kamehameha butterflies ($d = 5$)? (Round to the nearest tenth if needed.)

   (b) $9$ Kamehameha butterflies? (Round to the nearest tenth if needed.)

10. There are $5$ Kamehameha butterflies right now. Suppose that the butterfly population doubles every year. How many Kamehameha butterflies would there be in $4$ years?

# Unit 5: Equations and Inequalities

In this unit, we'll learn how to use algebraic equations and inequalities to solve problems through exploring different ahupuaʻa and the lengths of various Hawaiian trees in the ahupuaʻa. There are three activities in this unit. *Module 11* involves the use of equations and relationships to help describe the growth of native Hawaiian trees. *Module 12* focuses evaluating the distance between neighbors in a ahupuaʻa with the help of relationships on two variables. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

# Module 11: Equations and Relationships *Activity*

This house is built right next to a forest. Near the house are some fast-growing trees.

After $x$ years, the height of the trees (in feet) are given by the following expressions.

| Tree | Height after $x$ years |
|---|---|
| Maiʻa (banana) | $2x + 2$ |
| Loulu (palm) | $\frac{3}{2}x$ |
| Niu (coconut) | $3x + 1$ |
| ʻOhe (bamboo) | $\frac{5}{2}x + 3$ |

1. When writing equations and inequalities about these trees, we can replace "the height of the tree" with the expression that describes it.
   For example,
   "the height of the ʻohe is greater than or equal to 15 feet" can be written as
   $\frac{5}{2}x + 3 \geq 15$
   and
   "the height of the ʻohe is the height of the niu" can be written as
   $\frac{5}{2}x + 3 = 3x + 1.$
   Write the equations and inequalities for each of the following sentences. You **do not** need to solve them.

   (a) The height of the loulu is $3$ feet.

   (b) The height of the niu is half of the height of the maiʻa.

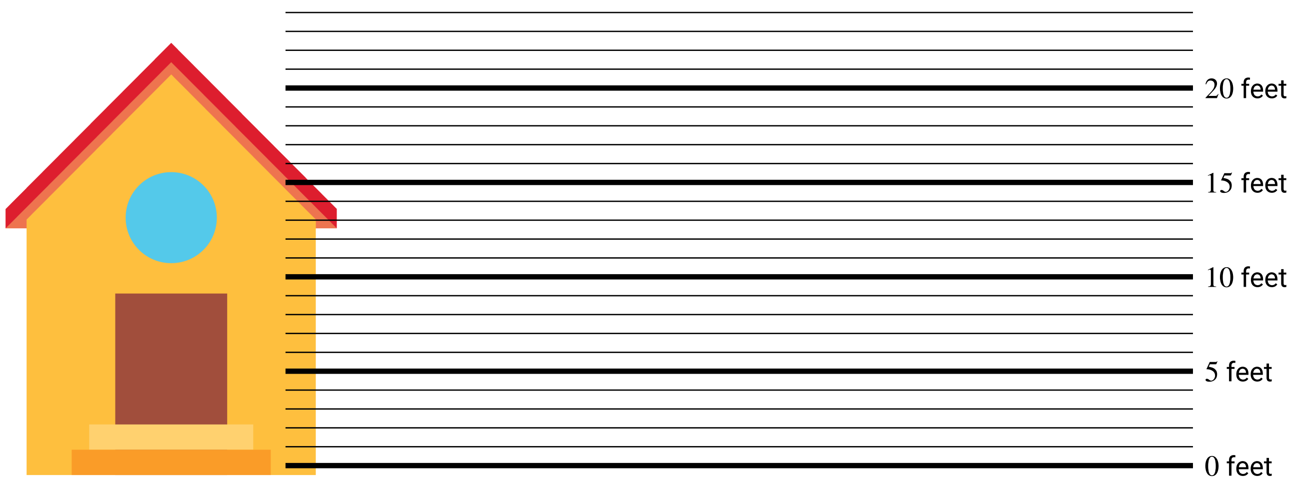
   (c) The height of the maiʻa is less than the height of the ʻohe.

   (d) The height of the niu is $2$ feet more than the height of the ʻohe.

2. How tall will each tree be after $2$, $4$, and $6$ years?

| | Tree height (feet) | | | |
|---|---|---|---|---|
| Number of years | Mai'a | Loulu | Niu | 'Ohe |
| $x$ | $2x+2$ | $\frac{3}{2}x$ | $3x+1$ | $\frac{5}{2}x+3$ |
| $2$ | | $3$ | | $8$ |
| $4$ | | | $13$ | |
| $6$ | $14$ | | | |

3. Draw the trees after $6$ years ($x = 6$).



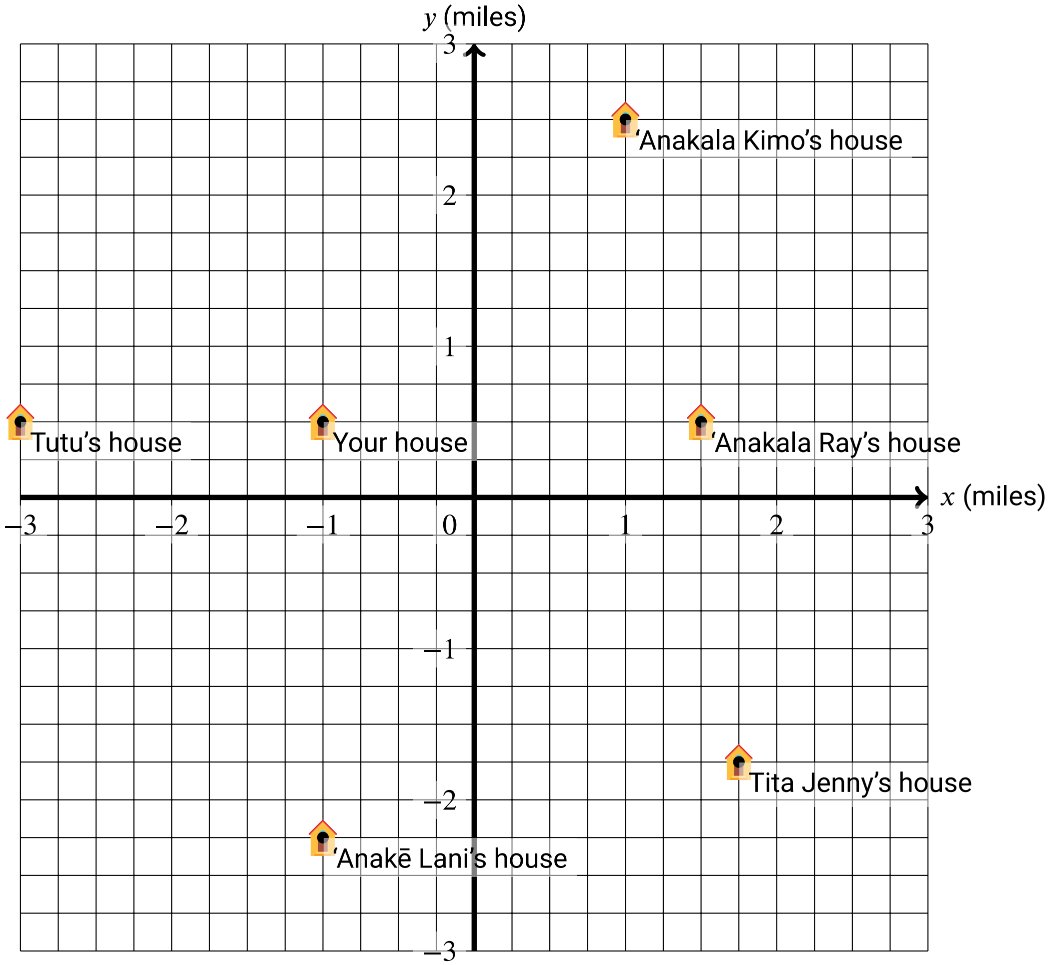

4. There is a $15$-foot tall power line connected to this house. We need to make sure that the trees doesn't grow as tall as the power line.

   (a) Which tree(s) would reach the power line in $6$ years?

   (b) What are three things that we can do to the trees if they get too tall?

## Module 12: Relationships in Two Variables *Activity*

You and your ʻohana (family) live in this ahupuaʻa. Here is a map of your ahupuaʻa.




1. If you only move left, right, up, or down (not diagonal or in a curve), how many miles away **from your house** does each relative live?

   (a) Tutu

   (b) ʻAnakala Ray

   (c) ʻAnakē Lani

   (d) ʻAnakala Kimo

   (e) Tita Jenny

2. Suppose that you can jog $4$ miles per hour. Write an equation describing the distance you jog ($d$) after $t$ hours.

3. Using your equation from part 2 and the distances from part 1, calculate how many hours, $t$, it takes to jog from your house to...
   (a) Tutu’s house
   (b) ‘Anakala Ray’s house
   (c) ‘Anakē Lani’s house
   (d) ‘Anakala Kimo’s house
   (e) Tita Jenny’s house

## Unit 5: *Cumulative Activity*

A pond in your ahupuaʻa is badly polluted. You want to clean it up but, it is big pond and you wont be able to clean it alone so you decide to ask some of your neighbors to help out.

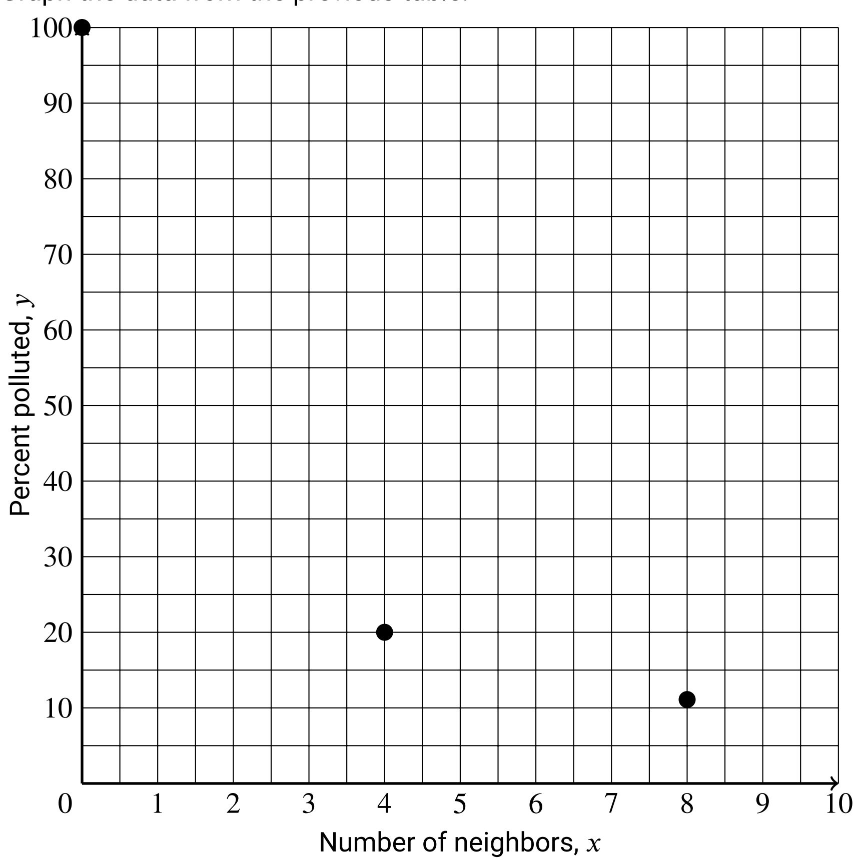
1. If $x$ is the number of neighbors who will help, write an expression for the total number of workers (including yourself) who will clean up the pond.

2. The percent of pollution remaining in the pond can be given by a simple algebraic equation: "The *percent of pollution* is $100\%$ divided by the *total number of workers* cleaning it up." Write this algebraic equation for percent of pollution, $y$ in terms of number of neighbors, $x$.

3. Complete the following table (round to one decimal place, if needed).

| Number of neighbors, $x$ | Percent polluted, $y$ |
|---|---|
| 0 | 100 |
| 1 | |
| 2 | |
| 3 | |
| 4 | 20 |
| 5 | |
| 6 | |
| 7 | |
| 8 | 11.1 |
| 9 | |
| 10 | |

4. Graph the data from the previous table.



5. The graph in part 4 only shows Quadrant I. Do you think there is important information in any of the other three quadrants? Why or why not? Feel free to discuss with your friends.

Due to the pollution, there hasn't been a lot of animals visiting this pond.

6. Birds will return to the pond if it is less than $15\%$ polluted. Modify the equation from part 2 to describe this as an inequality in terms of $x$.

7. Use the previous table or graph to answer this question. How many neighbors need to help in order to get this pond clean enough for birds to return?

At the end of the cleanup effort, the birds started to return to the pond. Here are the number of birds, $b$, $d$ days after the cleanup.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Days ($d$) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Birds ($b$) | 0 | 3 | 6 | 9 | 12 | 15 | 18 |

8. Which variable, $b$ or $d$, is the independent variable, and which variable is the dependent variable? How do you know?

9. Write the equation for $b$ in terms of $d$.

10. With a partner or in the online comment section, describe a place that you have been to that was really polluted. Describe what it would look like if people took the time to clean it up.

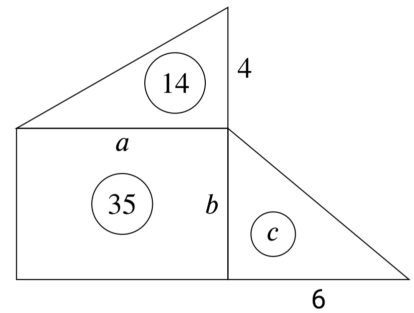
# Unit 6: Relationships in Geometry

In this unit, we'll learn how to draw shapes on a grid and calculate length, area, and surface area through surveying Hawaiian land, exploring the lengthy process of kapa making, and building a hale. There are four activities in this unit. *Module 13* involves helping a land surveyor with the use of area and polygons. *Module 14* focuses on distance and area in the coordinate plane to help wahine make kapa. *Module 15* explores how to build a hale with the help of surface area and volume of solids. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

*For some of the activities in this unit, a yard stick or measuring tape would be helpful but is not required.*

# Module 13: Area and Polygons *Activity*

A land surveyor is a person who measures and maps out the details of a piece of land. Let's survey two pieces of land.




The first piece of land is from the ahupuaʻa of Waiʻanae. We made it easier to measure the land by breaking it up into right triangles and rectangles. Some of the sides and areas (the numbers in a circle) have been measured.

1. Find the two missing sides and then the missing area.

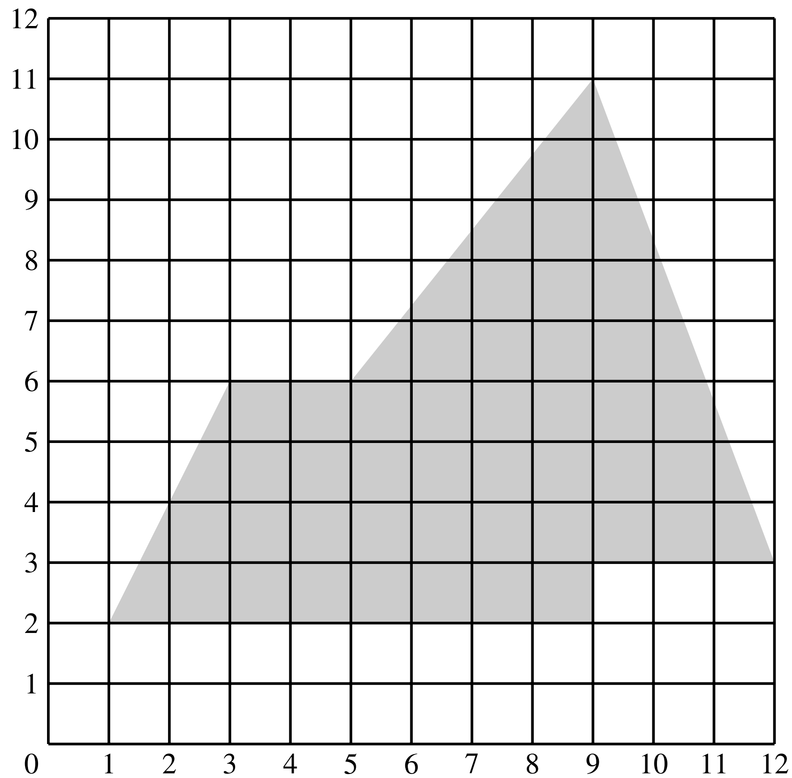
   (a) Side $a$:

   (b) Side $b$:

   (c) Area $c$:

2. Find the total area of the land in Waiʻanae.

Here is a piece of land from the ahupuaʻa of Waiau.



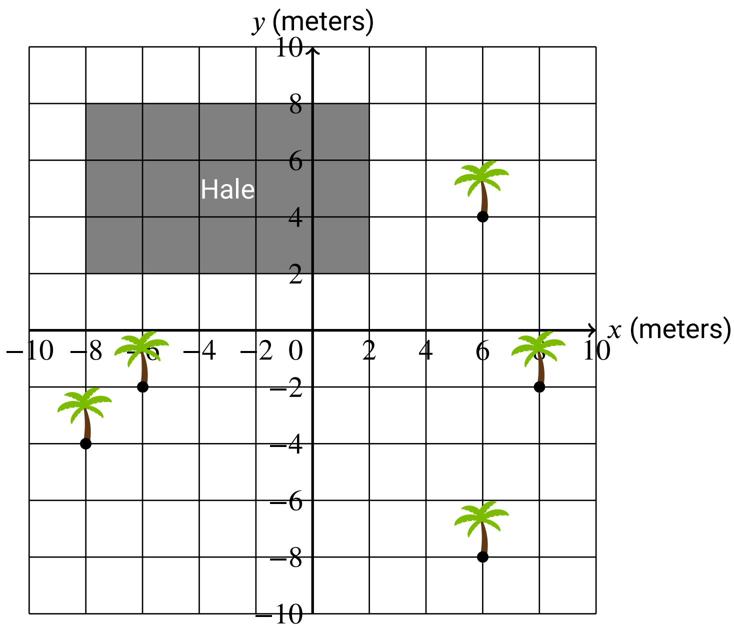

3. Break up the Waiau land into right triangles and rectangles.
4. Find the total area of the land in Waiau.
5. Which piece has a larger total area, Waiʻanae or Waiau?

# Module 14: Distance and Area in the Coordinate Plane *Activity*

Kapa is a cloth made from the wauke (paper mulberry) plant. It takes a lot of hard work to make kapa. In old Hawaiʻi, Hawaiians gathered strips of young wauke bark and repeatedly battered it until the fabric was soft. Then they had to forage for more pieces, line them up next to each other, and pound the edges until the different strips connected. It would take a very long time to make a large piece that was soft, strong, flat, and had the same thickness throughout. After the pieces were beaten together, they had to be dried in the sun before being made into clothing, furniture, or wraps.

The making of kapa was very important to the ancient Hawaiians. It was said that the demi-god, Maui, threw a hook into the Sun to slow it down so that his mom, Hina, could dry her kapa that she had worked so hard to make.

A wahine in our village is making kapa and she needs a place to dry it in the sun. However, we need to build a fence to keep animals and kolohe kids away from the kapa while it is drying.




1. Draw a triangle connecting the three points on the map above: $(2, 2)$, $(8, -2)$, and $(6, -8)$.
2. Let's find the area of this triangle by drawing simple shapes around it. Draw a rectangle by connecting the following points: $(2, 2)$, $(8, 2)$, $(8, -8)$, and $(2, -8)$. You should see four triangles: the original one and three right triangles.
3. Use the rectangle and the three right triangles in part 2 to find the area of the original triangle in part 1. Show your work below.

4. The wahine needs at least $40$ square meters to dry all of the kapa. Is there enough area in the triangle?

5. Draw a new drying area by connecting the following points in order.
$(2, 2) \rightarrow (-2, 1) \rightarrow (-4, -2) \rightarrow (-6, -2) \rightarrow (-6, -4) \rightarrow (-8, -4) \rightarrow (-8, -8) \rightarrow (2, -8) \rightarrow (2, 2)$

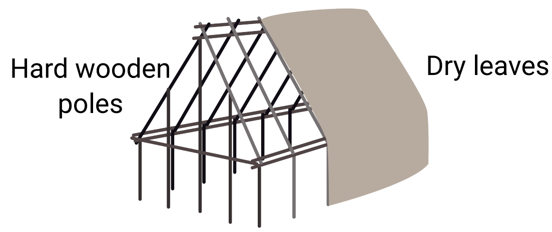
6. Find the area of the polygon that you drew in part 5.

7. Is there enough area in this polygon for the wahine to dry her kapa?

# Module 15: Surface Area and Volume of Solids *Activity*

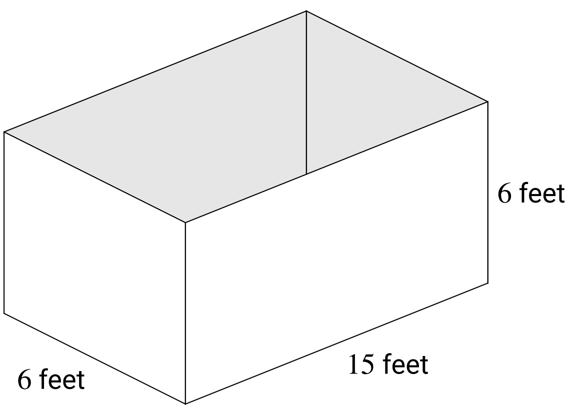
*A yard stick or measuring tape could be helpful in this activity.*

In parts of Hawaiʻi that stay warm all year long, the ancient Hawaiians rarely spent much time in their hale. The doors on hale were often made very small to keep pets and pests out, and the insides of the hale were often very warm and dark. The hale was mostly used for storage and rituals, except for cold and rainy weather or special occasions.




A hale under construction

We are building a hale. Let's first look at it without a roof.

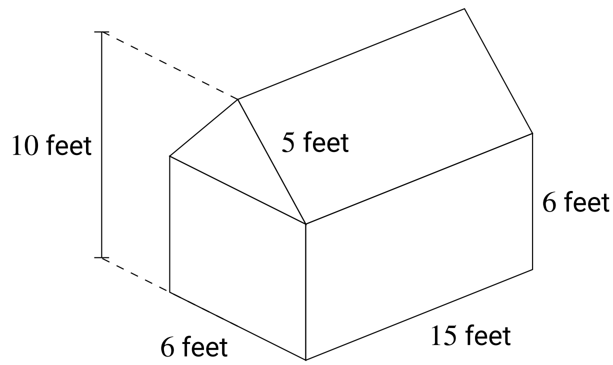



1. Find the volume of the rectangular prism.

2. How many of your classmates do you think can fit in a hale of this size? Discuss with a friend. Walking around the classroom with a yard stick or measuring tape while imagining a space this size can also help.

3. Divide your answer in part 1 by your answer in part 2 to find out how much space each of your classmates would take up in this hale. Round to the nearest tenth.

Now let's look at the hale with its roof.



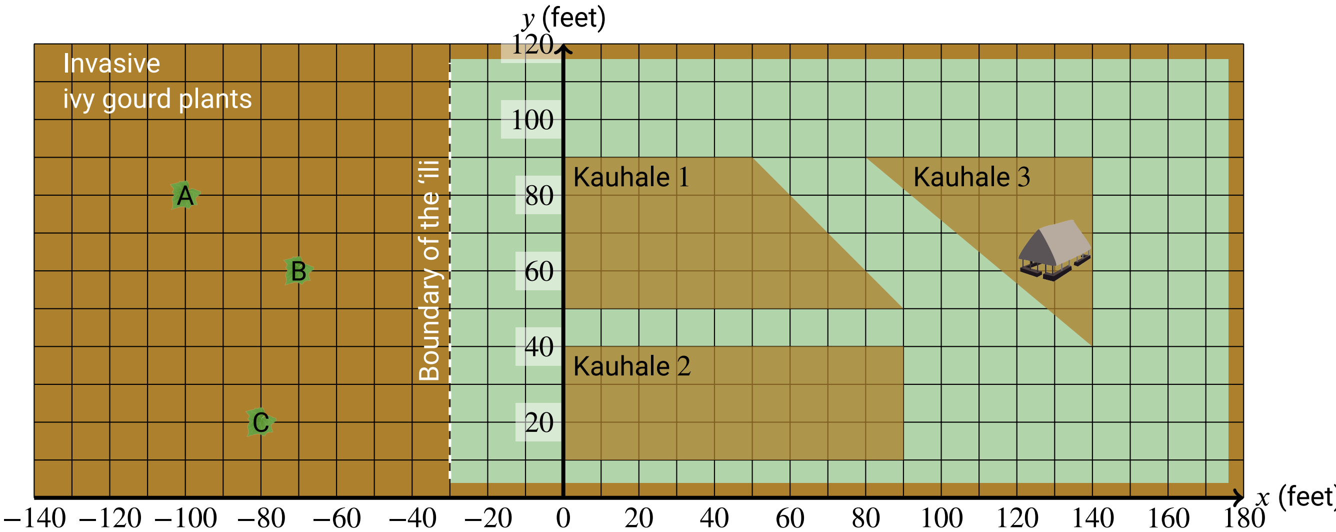

4. Sketch the four walls and the four sides of the roof as a geometric net. Label each edge with its length. You only need to use triangles, squares, and rectangles.

5. We need to cover the four walls and the four sides of the roof with thick leaves. Find the total surface area of these eight pieces.

6. When a hale needs to be built, many people must come together to build it. When was the last time you built something with your hands? What did you make?

## Unit 6: *Cumulative Activity*

Ivy gourd is an invasive vine that covers and kills other plants. A bird pooped in a field next to your ‘ili (neighborhood) and three ivy gourd plants are starting to grow from the seeds in the bird poop.




1. How far away is each plant from the boundary of the ‘ili?
   (a) Plant A:

   (b) Plant B:

   (c) Plant C:

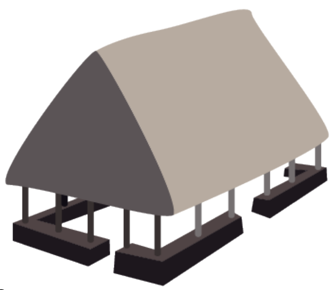
2. Look at the coordinates of each ivy gourd plant. If we changed the signs of each x-coordinate to it’s opposite, would the plant be moved into a kauhale? If so, which kauhale would it be in?
   (a) Plant A:

   (b) Plant B:

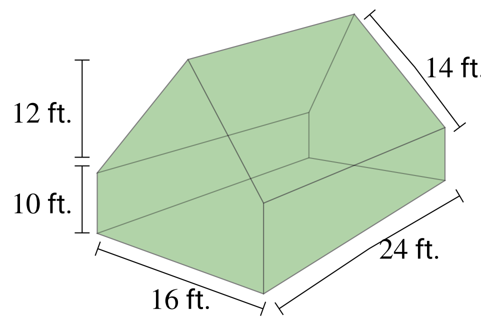
   (c) Plant C:

3. After the ivy gourd plants enter your ʻili, they quickly cover the three kauhale, where the hale (houses) are built. What is the **total** area of the three kauhale?

4. In kauhale 3, the ivy gourd is invading a hale. First, it covers the floor of the hale, then the walls and the roof. What is the surface area of the covered hale?



Hale




*Hint: The front and back walls is a triangle on top of a rectangle. The roofs, side walls, and floor are rectangles.*

5. Most plants are good for the environment and good for people, but certain plants, when grown in wrong places, can cause a lot of trouble. Describe a plant in your neighborhood or school that you think is out of place. Describe why you think it might be bad for your neighborhood. You may also find or draw a picture of it. Please share with your partner or in the online comment section. (If sharing online, please don't post pictures of people's faces or anything that can be used to find a personal address.)

# Unit 7: Measurement and Data

In this unit, we'll learn how to use statistics to summarize and display data through evaluating the shape and length of a Hawaiian spear and the exploration of the Big Island. There are two activities in this unit. *Module 16* explores the Hawaiian spear, pololū, through displaying, analyzing, and summarizing data. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

# Module 16: Displaying, Analyzing, and Summarizing Data *Activity*

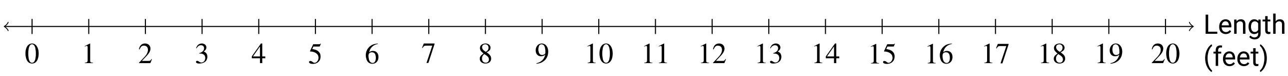
The ancient Hawaiians were very fortunate to have plenty of woody plants around them. The wood from koa trees and kauila shrubs, in particular, are very solid. This quality made them very important for making tools and weapons in ancient Hawai'i. Let's use statistics to figure out the typical length of a Hawaiian spear called the pololū.

Pololū

There is a collection of ancient pololū in a museum. Let's take a look at their lengths (in feet).

| | | | | | |
|---|---|---|---|---|---|
| 11 | 15 | 8 | 7 | 11 | 10 |
| 9 | 6 | 12 | 10 | 13 | 10 |
| 9 | 9 | 9 | 8 | 7 | 12 |

1. Plot the lengths on a dot plot.




2. Describe the shape of this data distribution.

3. Which pololū length was the most common? How many of the ancient pololū were this length?

4. Find the mean and median of this data. Round to the nearest tenth.

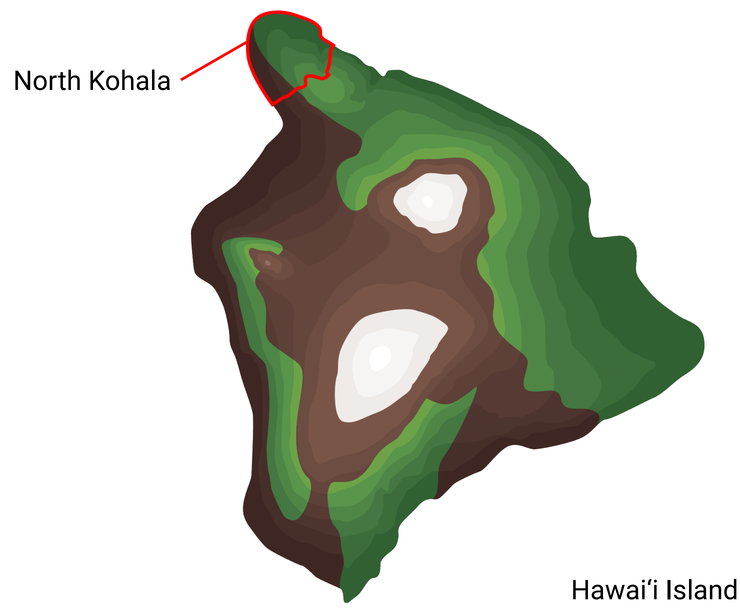
5. Could any of your answers from parts 3 and 4 be used to represent the typical length of a pololū? Why or why not? If not, which one of those answers do you think is best?

6. How do you think life would have been different in ancient Hawaiʻi if woody plants were rare? Please share with your partner or in the online comment section.

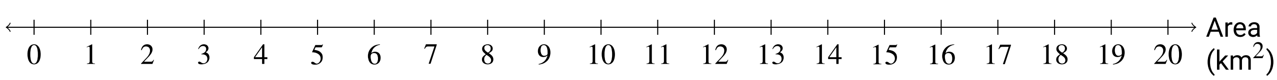
## Unit 7: *Cumulative Activity*

King Kamehameha the Great was born in the moku of Kohala, on the northern end of Hawaiʻi Island. Today, Kohala is split into North Kohala and South Kohala. Let's look at the sizes of some ahupuaʻa in North Kohala.

| Ahupuaʻa | Area ($km^2$) |
|---|---|
| ʻAʻamakāō | 7.06 |
| ʻĀinakea | 2.18 |
| ʻĀpuakaohau | 1.19 |
| ʻĀwini | 8.00 |
| Halaʻula | 2.45 |
| Hālawa | 6.42 |
| Halelua | 3.03 |
| Hanaʻula | 2.53 |
| Hāwī | 1.29 |
| Honokāne | 19.03 |
| Honomakaʻu | 1.46 |
| Honopueo | 3.30 |




1. Make a box and whisker graph using the area of each ahupuaʻa.



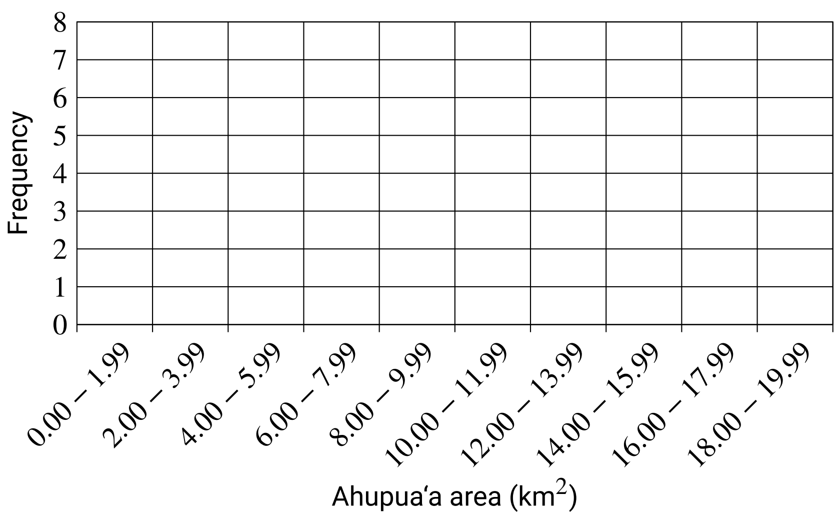

2. Calculate the range and interquartile range of the areas.

3. Calculate the mean of the areas. Round to two decimal places.

4. If we removed Honokāne from the table, how would this affect your box and whisker graph?

5. Would removing Honokāne from your table affect the mean? If so, how would it be affected? (You do not need to calculate the mean again.)

6. Make a histogram using the area of each ahupuaʻa.




7. Which measure of center better describes the typical size of an ahupuaʻa in North Kohala–the median or the mean? Explain.

8. Choose an ahupuaʻa that you are familiar with but do NOT live in. Share something that you really like about that ahupuaʻa. Please share with your partner or in the online comment section.