HANDS-ON ACTIVITY

What Do Alligators Eat?

TIME REQUIRED Two 45-minute class periods

LAB RATINGS Easy 1 2 3 4 Hard
Teacher Prep–1
Student Set-Up–1
Concept Level–3
Cleanup–1

3D LEARNING

- **SEP Using Mathematics and Computational Thinking**
- **DCI LS2.B Cycles of Matter and Energy Transfer in Ecosystems**
- **CCC Energy and Matter**

OBJECTIVE

Students view a video to analyze an alligator's food to determine where alligators fit in the Everglades food web.

SETUP AND PROCEDURE

- In this video, Mike Heithaus and doctoral student Adam Rosenblatt head to the Everglades to determine the trophic level of alligators in the Everglades ecosystem. While in the field, Mike, Adam, and their colleagues capture alligators, take body measurements including mass and body length, and then pump each individual alligator's stomach to determine its diet. Before releasing the alligators back into their habitat, the scientists also tag each animal.
- Before showing this video, ask students to make a claim about whether or not alligators are kings of the Everglades. Ask them what it means to be king. Student answers may include having no predators, being at the top of the food chain or food web, or being the biggest animal in size.
- Tell students that other animals do eat alligators. Bull sharks, birds, and even pythons (which are an introduced species in the Everglades ecosystem) can eat baby alligators. Even at lengths up to 180 cm, alligators may still be at risk of being eaten by big pythons. However, at longer body lengths, alligators are not going to be eaten by anything. Their only potential enemies are the American crocodile, which only lives in salty waters and humans.
- Remind students that a trophic level is a measure of how high up in the food chain an organism is found. Plants and other primary producers are the first trophic level. Herbivores, which are primary consumers, occupy the second trophic level. Secondary consumers, such as small predators that eat herbivores occupy the third trophic level, and so on.

ANSWER KEY

Analyze

1. 15

2. 70

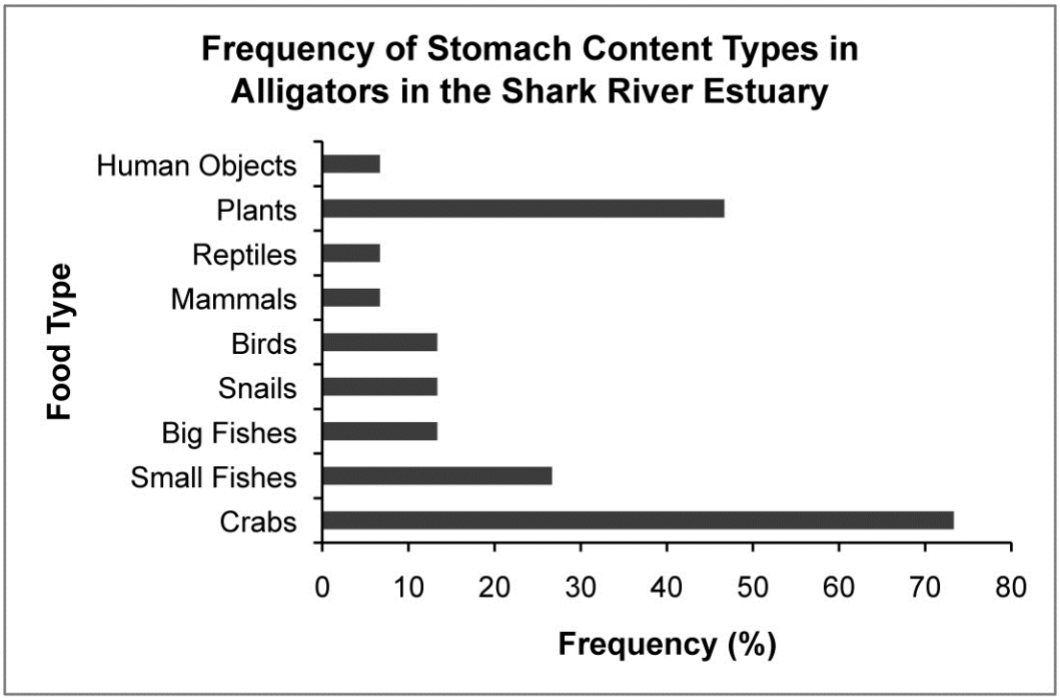
3. Data Table 2: The amount of different food types in alligator stomachs

Food type	Number of stomachs	Number of food items
Crabs	**11**	**24**
Small fishes	**4**	**20**
Big fishes	**2**	**2**
Snails	**2**	**3**
Birds	**2**	**2**
Mammals	**1**	**1**
Reptiles	**1**	**1**
Plants	**7**	**14**
Human objects	**1**	**3**

4. Data Table 3: Two measures of the relative importance of different food types to the diets of alligators in the Shark River Estuary

Food type	Frequency (%)	Number (%)
Crabs	**73.3**	**34.2**
Small fishes	**26.7**	**28.6**
Big fishes	**13.3**	**2.9**
Snails	**13.3**	**4.3**
Birds	**13.3**	**2.9**
Mammals	**6.7**	**1.4**
Reptiles	**6.7**	**1.4**
Plants	**46.7**	**20.0**
Human objects	**6.7**	**4.3**

5.



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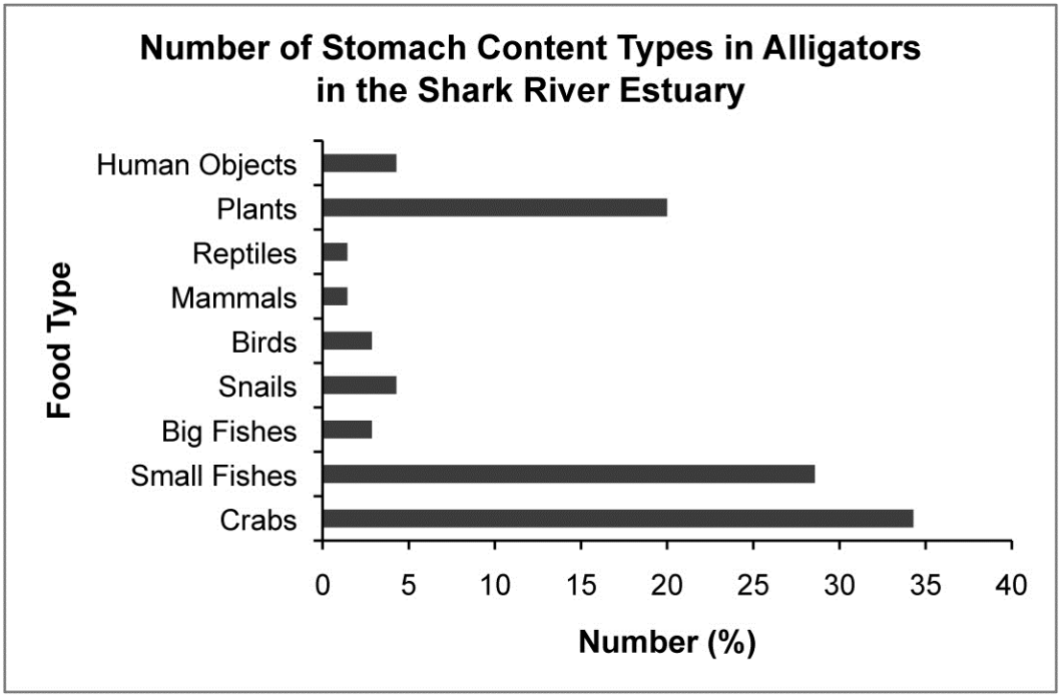

7. Accept all reasonable answers. Crabs, pond apples, and small fishes should be listed as foods that they eat most frequently.

8. The two measures lead to similar conclusions about the relative importance of various food items in the alligators' diet, with the exception of plants and small fishes. From the Frequency (%) graph, it appears that plants are more important than small fishes, but the Number (%) graph shows the opposite. This discrepancy exists because Frequency (%) is food type relative to the total number of alligators, and Number (%) is food type relative to the total number of food items. Only four alligators had small fish in their stomachs, so the Frequency (%) is relatively low. However, because those four alligators each had numerous small fish in their stomachs (totaling 20), the Number (%) was relatively high.

9. **Data Table 4: *delta*$_{15}$N values and trophic levels of organisms in the Shark River Estuary**
The lengths of individuals sampled are given in parentheses.

Organism	*delta*$_{15}$n	Trophic level
Mangrove	2.0	1
Phytoplankton	2.0	1
Herbivorous snail	5.0	2
Florida gar (fish 35-50 cm long fish)	11.0	**4**
Snook (fish 50-70 cm long)	12.0	**4.3**
Juvenile bull shark (70-120 cm long)	12.5	**4.5**
American crocodile (320 cm)	14.0	**5.0**
Alligator (150 cm)	8	**3**
Alligator (235 cm)	9	**3.3**
Alligator (265 cm)	8.5	**3.2**
Alligator (185 cm)	9.5	**3.5**
Alligator (270 cm)	9	**3.3**
Alligator (220 cm)	8	**3**
Alligator (195 cm)	8.5	**3.2**
Alligator (240 cm)	9	**3.3**
Alligator (160 cm)	9.5	**3.5**
Alligator (250 cm)	8	**3**
Alligator average	8.7	**3.2**

Construct an Explanation

1. Based on the data, not really—there are other predators that are feeding at higher trophic levels than alligators.
2. Accept all reasonable answers. Students will likely be surprised that alligators ate so many pond apples and small fish. They might have thought they would have eaten more birds, mammals, or big fish. Note: In fact, Adam and Mike thought the same thing when they started their research. Students may also be surprised that alligators feed at a trophic level below much smaller animals—including fish like gar that might have been alligator prey!

Draw Conclusions

Students' answers will vary, so accept reasonable arguments supported by data. A couple of valid points include:

- Yes, alligators are the kings because, once they are really big, there is nothing that can eat them.
- No, alligators are not the kings because there are many other predators at higher trophic levels. They eat pond apples, for goodness sake!

Note: It may be worthwhile to discuss bears here—they are undoubtedly kings of the wilderness in many places, but most spend time eating berries or other plant material during some periods of time.

Evidence will vary but examples should come from students' data. Students may suggest studies that gather more information on alligator diets (larger sample sizes, samples from larger alligators) or their interactions with other organisms (for example, who wins in competition with American crocodiles or interactions with possible predators).

Optional Extensions

The trophic level of a species is important for determining the species' population size. Energy transfer between trophic levels can range from 5-20 percent, depending on the type of ecosystem. So, for every trophic level you go up, only 5-20 percent of the energy at one trophic level ends up in biomass at the next higher trophic level. Why is most of the energy lost at each step in a food chain? Animals have to use energy for running their bodies and moving around. Some energy is lost as a waste product (as heat) to the environment.

1. Let's assume that alligators are at trophic level three. If herbivores in the Everglades ate 1,000,000 kg of primary producers, and the alligators ate all these herbivores, how many kg of alligators would there be? If each alligator weighs an average of 50 kg, how big would the population be?
   Answer: 1,000,000 kg of producers eaten $\times$ 0.1 = 100,000 kg of herbivores (trophic level 2)
   100,000 kg herbivores $\times$ 0.1 = 10,000 kg of alligators (at trophic level 3)
   10,000 kg of alligators/50 kg per alligator = 200 alligators
2. If alligators were at trophic level four, how many alligators would there be if we started with 1,000,000 kg of primary producers?
   Answer: 1,000,000 kg of producers x 0.1 = 100,000 kg of herbivores (trophic level 2)
   100,000 kg of herbivores $\times$ 0.1 = 10,000 kg of consumers (trophic level 3)
   10,000 kg at trophic level 3 $\times$ 0.1 = 1000 kg of alligators (trophic level 4)
   1000 kg of alligators/50 kg per alligator = 20 alligators

3. Using what you just learned, can you think of a way that humans could more efficiently use the energy of ecosystems to produce the food that we eat?
Answer: Consume greater amounts of food from lower trophic levels.

Note: This is one major issue in using some farmed fish—often the fish are fed other fish as food so they are eating at a higher trophic level than they would in the wild. This higher trophic level diet results in a less efficient use of the productivity of the oceans.

For many animals, their diets and trophic level change as they grow. This change occurs because as they get bigger they are able to catch larger or faster prey. Is this the case for alligators in the Everglades? We know that very small alligators (less than 100 cm long) eat different things (insects, small fish) than do larger individuals, but what about the individuals in Adam's study? To find out, use the data in the tables provided in the worksheet. Have the students divide into groups and work together to calculate Frequency (%), Number (%), and mean *delta*^{15}N for alligators of length (a) <200 cm and (b) >200 cm.

Name Date

HANDS-ON ACTIVITY

What Do Alligators Eat?

In this investigation, you will look at where alligators fit in the Everglades food web and what trophic level they occupy.

MATERIALS

- pencil
- ruler

MAKE A CLAIM

Are alligators kings of the Everglades? Explain your answer.

ANALYZE

We'll start our investigation by figuring out what the alligators in Shark River are eating. During the study, Mike, Adam, and the team flushed the stomachs of 20 alligators that ranged in size from 140 cm to 270 cm long. They identified everything that came out and counted the number of each item in each stomach. The contents are listed in Data Table 1.

1. How many alligators had food in their stomachs? _____
2. How many food items, in total, were found in alligators?_____
3. Use the information in Data Table 1 to fill out Data Table 2.

Name **Date**

Data Table 1: Stomach contents of 20 alligators captured in the Shark River Estuary

Numbers in parentheses are total number of each prey type found in the stomach.

Alligator number	Total length (cm)	Stomach contents	Total items
1	150	crab (2); small fish (8)	10
2	240	empty	0
3	260	crab (1); pond apple (2)	3
4	230	crab (2); raccoon hair (from one raccoon)	3
5	180	crab (4); pond apple (1)	5
6	220	small fish (7); snail (2), crab (3)	12
7	175	turtle (1); pond apples (3)	4
8	155	crab (4); mangrove seed (1)	5
9	200	empty	0
10	265	small fish (2); big fish (1); crab (1); bird feathers (from one bird)	5
11	235	pond apples (5); crab (1)	6
12	190	pond apples (1); bird feathers (from one bird)	2
13	165	empty	0
14	240	empty	0
15	195	crab (1)	1
16	255	crab (4)	4
17	185	small fish (3); balloon (3)	6
18	205	big fish (1); pond apple (1)	2
19	215	empty	0
20	230	crab (1); snail (1)	2

Data Table 2: The amount of different food types in alligator stomachs

Food type	Number of stomachs	Number of food items
Crabs		
Small fishes		
Big fishes		
Snails		
Birds		
Mammals		
Reptiles		
Plants		
Human objects		

One way that biologists measure diet is by determining the proportion of individuals that have a particular type of food in their stomachs (Frequency %). Another method is to calculate the proportion of total food items that a particular type of food makes up (Number %).

4. Use the following formulas to fill out Data Table 3.

$$\text{Frequency \%} = \frac{\text{Number of stomachs with a particular food type}}{\text{Total number of stomachs with any food present}}$$

$$\text{Number \%} = \frac{\text{Total number of a particular food item in stomachs of all alligators}}{\text{Total number of food items from all alligator stomachs combined}}$$

Data Table 3: Two measures of the relative importance of different food types to the diets of alligators in the Shark River Estuary

Food type	Frequency (%)	Number (%)
Crabs		
Small fishes		
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Mammals		
Reptiles		
Plants		
Human objects		

5. In your Evidence Notebook, draw a bar graph of the Frequency (%) for each food type in the diets of alligators.

6. Draw a bar graph of the Number (%) for each food type in the diets of alligators.

7. Describe the diets of alligators. What foods do they eat most frequently?

_____

_____

_____

_____

_____

8. Do the measures of Frequency (%) and Number (%) in alligator diets give you different information about what these alligators eat? Explain your answer.

_____

_____

_____

_____

_____

When we look at the stomach contents of alligators, we can only see what they ate at their most recent meal. In order to quantify their trophic level more accurately, we need to analyze what the alligators have been eating over the past several months. It turns out that the tissue samples that Mike and Adam took can help us find out!

One way to determine trophic level is to analyze the nitrogen isotopes present in an organism's tissues. Two isotopes of nitrogen present in organisms are used to build proteins—^{14}N and ^{15}N. The amount of ^{15}N is given by the value *delta*^{15}N. When predators eat prey, they accumulate more ^{15}N than ^{14}N. So, you can infer an organism's level in a food chain by its relative level of ^{15}N—the higher the *delta*^{15}N, the higher the trophic level of an organism. In fact, based on many studies in the laboratory and in the field, we know that *delta*^{15}N increases by an average of 3 parts per thousand (‰) at each trophic level.

For example, if the *delta*^{15}N of a certain plant is 2.0 ‰, then an herbivore that eats that plant will have a *delta*^{15}N of 5.0 ‰, and if a predator eats just that herbivore it will have a *delta*^{15}N of 8.0 ‰. However, it isn't always that simple. Usually ecosystems are better represented by food webs than by food chains, because most organisms eat more than one type of food. That means that the actual *delta*^{15}N values of organisms in the wild are usually not whole numbers. Table 4 shows the *delta*^{15}N values of 10 alligators and the mean *delta*^{15}N for other organisms in the Shark River.

9. Calculate the trophic level of the following organisms to complete the table, using the following formula:

$$Trophic\ level = 1 + \frac{\delta\ ^{15}N\ for\ organism - \delta\ ^{15}N\ for\ primary\ producer}{3}$$

Data Table 4: *delta*$_{15}$N values and trophic levels of organisms in the Shark River Estuary

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CONSTRUCT AN EXPLANATION

1. Based on the ^{15}N isotope data, are alligators the top predators in the Florida Everglades? Explain your answer.

_____

_____

_____

_____

_____

2. How did the results of the diet studies compare to what you expected to find?

_____

_____

_____

_____

_____

_____

Name **Date**

DRAW CONCLUSIONS

Write a conclusion that addresses each of the points below.

Claim Are alligators the kings of the Everglades? Was your initial claim correct?

Evidence Give specific examples from your data to support your claim.

Reasoning Explain how the evidence you gave supports your claim. Describe, in detail, the connections between the evidence you cited and the argument you are making. What further studies would you propose to do to help answer this question?