

Adélie penguins are too small to see with satellites. But we can use satellites to see where they live and what they eat. We can even count them. We can see all of this based on what they leave behind: their poop.

Searching Antarctica by Satellite

Many scientists learn about Adélie penguins by visiting where they live. However, getting to Antarctica is challenging and often limited because of the frigid, long, and dark winters. Since scientists don't always know where many penguin **colonies** might be, they turn to satellite images to find them.

How Scientists Find Penguins

Researchers use a computer **algorithm** to scan Landsat satellite images for particular shades of red and pink — the color of penguin poop (also called **guano**). Because penguins nest in large groups and in the same location for generations, their poop builds up on rocky and icy surfaces. This buildup can be seen from space.

Antarctica is remote, hard to get to, and cold. It is bigger than the United States and India combined. Small islands surrounding the continent often get locked in sea ice, making them even harder to visit.



Credit: Photo courtesy of Megan Cimino/University of Delaware.

Biological oceanographer Megan Cimino meets some Adélie penguins near Palmer Station on the West Antarctic Peninsula.

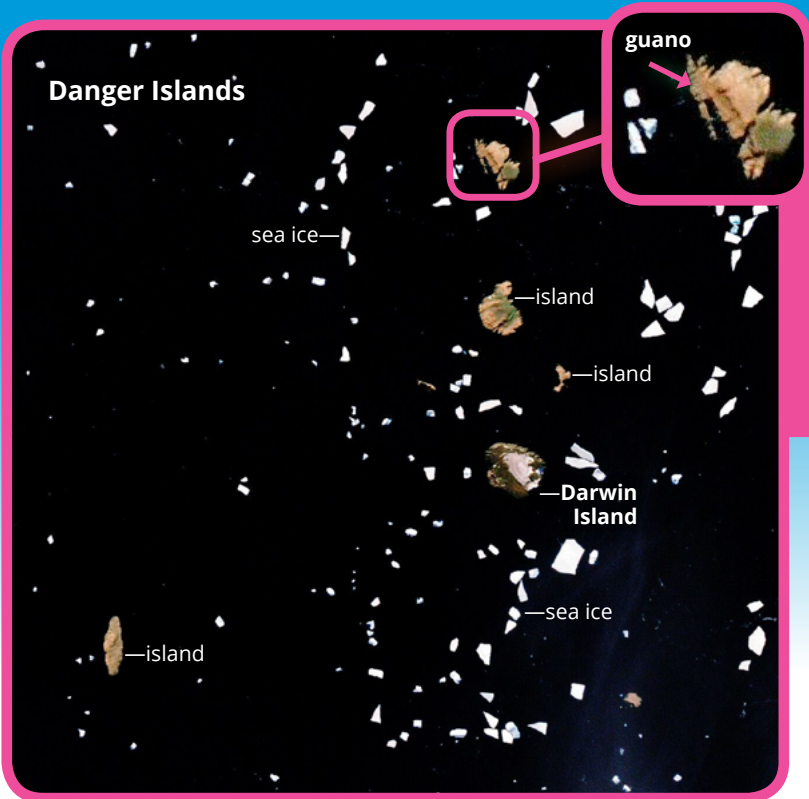


Vocabulary

colony – A group of animals that live closely together.

algorithm – A detailed sequence of rules used in mathematical calculations, most often by a computer.

guano – Old accumulated bird poop that is dry and hard. Guano can be used as fertilizer.



The Danger Islands got their name because sailors found them dangerous to navigate. The biggest problem was all of the sea ice, which made the islands hard to spot and hard to sail around.

Note the pink regions on the Danger Islands present in this true-color image from 2000. Those areas are covered with penguin guano.

When we think of poop, our immediate reaction is yuck, eww, and gross. Or maybe we laugh out loud. But poop can be useful for fertilizing crops, and many civilizations have used it for fuel and heating. Poop can also tell us a lot about diets and health.



Finding Unknown Penguin Colonies

Before satellites, we did not know much about the Adélie penguin colonies on the Danger Islands. Thanks to satellite data, researchers found more than 1.5 million penguins there!

Once scientists located evidence of penguin guano, they used math to estimate how many penguins lived in these colonies. The area of the average nest is about 2 meters squared. Dividing this by the area covered in guano gave scientists an estimate of the number of nests on each island. And since each nest has at least two penguins – a mating pair – they multiplied this number by two to estimate the number of adult penguins. But math is better when you can check your answer. The scientists did just that when they visited the islands to verify their findings.

Penguins are seabirds that live together in large groups. A group of seabirds is called a wreck.



Scientists can use math to estimate the number of penguins because Adélies build their nests in a uniform manner and leave pretty equal spacing between them.

Answers: 1. 900 m^2 2. $900 \text{ m}^2 \div 2 \text{ m}^2 = 450 \text{ nests per pixel}$
 3. $450 \text{ nests} \times 2 \text{ penguins per nest} = 900 \text{ penguins per pixel}$
 4. $9 \text{ pixels} \times 900 \text{ penguins per pixel} \times 9 \text{ pixels} = 8,100 \text{ penguins}$

Why Monitor Penguins?

Comparing current and past views of penguin guano allows researchers to track the penguins' diet. Researchers found that penguin colonies in West Antarctica eat more krill, while those in East Antarctica eat more fish.

By looking at Landsat data over time, researchers also found that penguin populations have decreased by 10 to 15 percent since the 1980s. This may have to do with a changing climate, but the cause is still being investigated.

Warmer temperatures aren't all bad. Less ice means more breeding areas because the penguins only breed in ice-free zones. Less ice could also mean easier access to the krill and fish that live in the water. But it all falls apart if the water gets too warm for phytoplankton to survive.

If water temperatures rise too much, there may be less phytoplankton in the ocean. Since krill and fish eat phytoplankton, warming waters could reduce the amount of krill and fish available for penguins to eat — shrinking their populations, too.



Credit: Mike Lucibella, NSF/USAP

Adélie penguins are the smallest penguins in Antarctica.



Data Detective

Poop by the Pixel

Each mating pair nests on a space that measures about 2 square meters. And where a penguin nests is also where it poops. Scientists calculate the number of penguins by dividing the number of nests by the area covered in guano.



You can be like an Antarctic penguin researcher. First, color by number on Darwin Island to find the guano-stained areas. Then, calculate penguin populations by doing an area math problem.

The diet of Adélie penguins varies from year to year, depending on whether more fish or krill are available. For this exercise, assume the penguins ate mostly krill, so the guano areas will be pink. Follow the legend to color all of Darwin Island and the surrounding ocean as well.

Instructions:

Color by number the printout of Darwin Island (see color key). Do some area math to figure out the penguin population on Darwin Island.

Materials

- A printout of page 5
- Pink, brown, and blue colored pencils

1. If one pixel is covered in penguin guano and it is 30 by 30 meters square, then how many penguins are present in one pixel?

Find the area of a Landsat pixel (length x width = area).

$$30 \text{ m} \times 30 \text{ m} = \underline{\hspace{2cm}} \text{ m}^2$$

2. The area of one nest is 2 meters squared. How many nests could be in each Landsat pixel?

Divide the area of a Landsat pixel (the answer to #1) by the area of one nest.

$$\underline{\hspace{2cm}} \text{ m}^2 \div 2 \text{ m}^2 = \underline{\hspace{2cm}} \text{ nests per pixel}$$

3. Each nest equals at least two penguins (a mating pair). How many penguins are in each Landsat pixel?

Multiply the number of nests by the number of penguins per nest.

$$\underline{\hspace{2cm}} \text{ nests} \times 2 \text{ penguins per nest} = \underline{\hspace{2cm}} \text{ penguins per pixel}$$

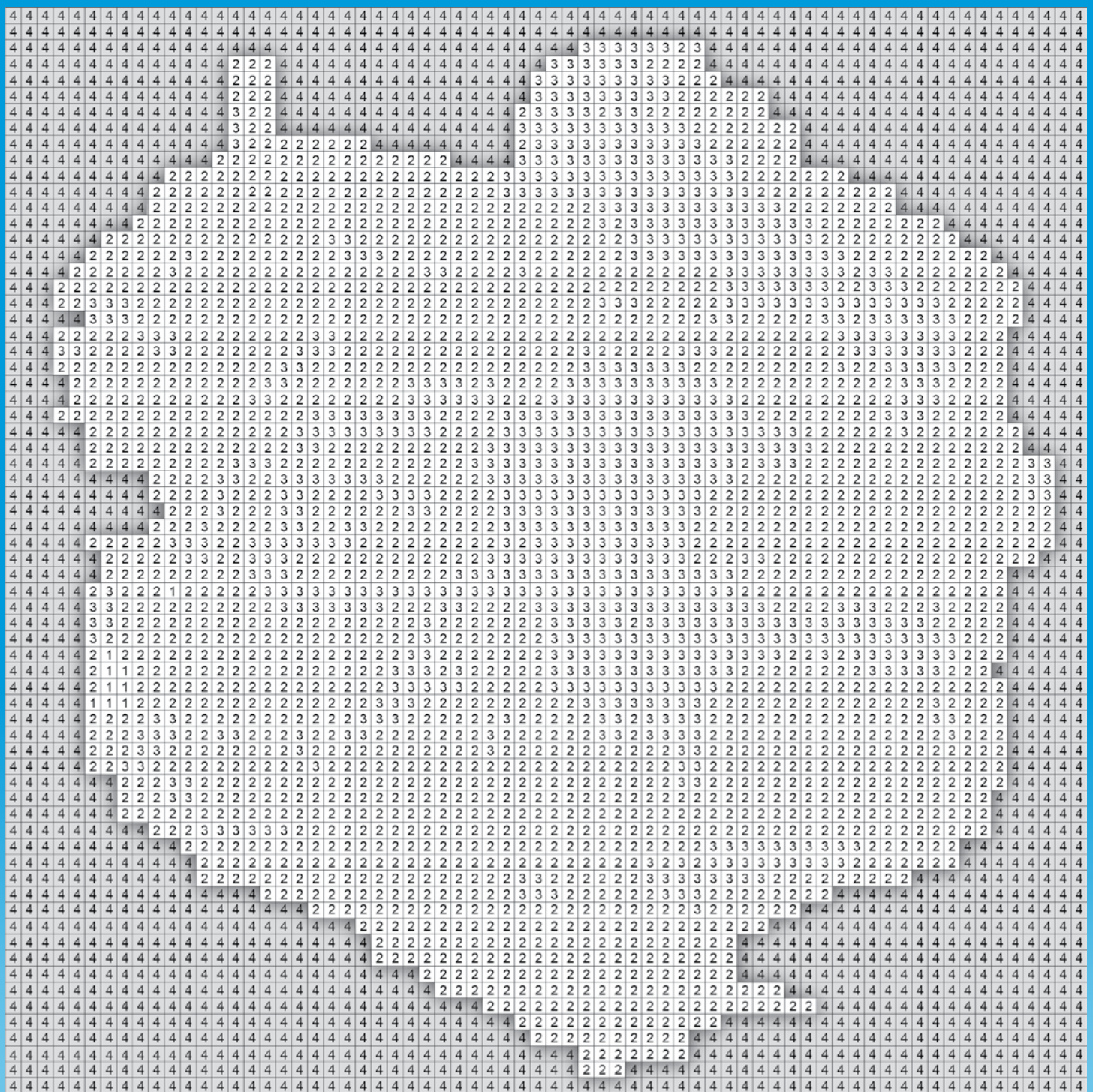
4. How many pixels are covered in guano in print out? $\underline{\hspace{2cm}}$ pixels

5. How many penguins live on Darwin Island?

Multiply the number of penguins per pixel by the number of pixels covered in guano.

$$\underline{\hspace{2cm}} \text{ penguins per pixel} \times \underline{\hspace{2cm}} \text{ pixels} = \underline{\hspace{2cm}} \text{ penguins}$$

Color by number on this map of Darwin Island to see where guano is present.



This printout of Darwin Island assigns numbers that identify what is in each pixel according to the legend. Satellite data begins as numbers that tell us what colors of light are being reflected into space. The numbers (or values) in the satellite data tell us if the ground is reflecting pink — which means that there is penguin guano covering most of that pixel — or if there is a different color like white, which could mean snow or ice is present.

Color Key

- 1 = Pink for the guano
- 2 = Brown for the land
- 3 = White for the snow
- 4 = Blue for the ocean