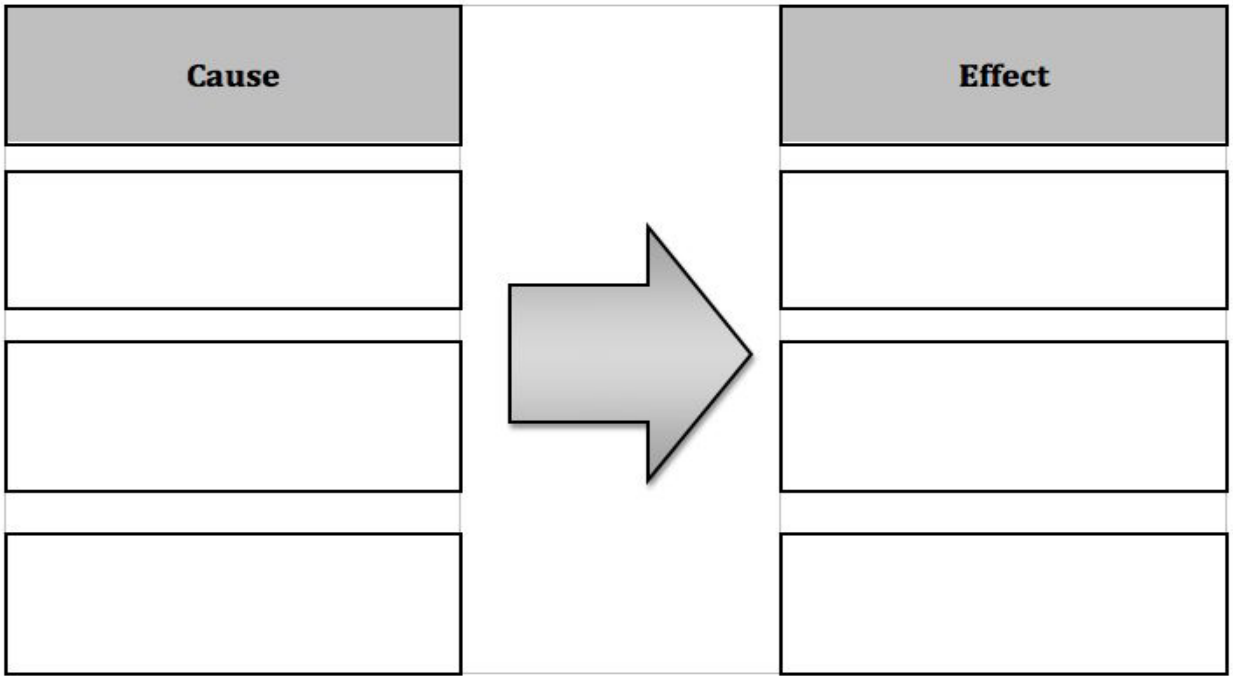
Graphic Organizer: Cause and Effect



Cause and Effect Graphic (Pugalee, pg. 59)

FIGURE 3

Specialist fact sheet.

Each Home Group contains five different specialists.

Ornithologist: A scientist who studies birds. Uses visual surveys (from ship or on land), diet analysis, and satellite tracking to collect data on penguins.

Oceanographer: A scientist who studies the ocean. Uses satellite imagery, underwater sensors, and manual measurements of sea ice thickness to collect data on sea ice conditions and ocean temperature.

Meteorologist: A scientist who studies the weather. Uses automatic weather stations and visual observations of the skies to collect data on precipitation, temperature, and cloud cover.

Marine ecologist: A scientist who studies the relationship between organisms and their ocean environment. Uses visual surveys, diet analysis, and satellite tracking to collect data on a variety of organisms, including penguins.

Fisheries biologist: A scientist who studies fish and their prey. Collects data on krill during research vessel cruises.

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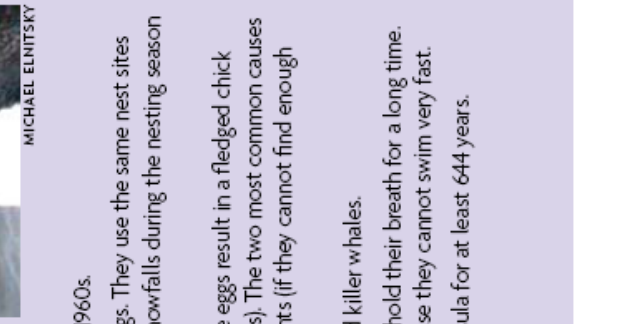
FIGURE 5

Ornithologists: Adélie penguin dataset.

Year	# Breeding pairs of Adélie penguins
1975	15,202
1979	13,788
1983	13,515
1986	13,180
1987	10,150
1989	12,983
1990	11,554
1991	12,359
1992	12,055
1993	11,964
1994	11,052
1995	11,052
1996	9,228
1997	8,817
1998	8,315
1999	7,707
2000	7,160
2001	6,887
2002	4,059

Data source: Smith, Fraser, and Stammerjohn 2003.



MICHAEL ELNITSKY

- Adélie penguins spend their summers on land, where they breed. They spend winters on the outer extent of the sea ice surrounding Antarctica, where they molt their feathers and fatten up.
- Adélies are visual predators, meaning they need enough light to see their prey. Near the outer part of the pack ice, there are only a few hours of daylight in the middle of the winter. There is less sunlight as one moves further south (closer to land).
- On the western Antarctic Peninsula, Adélie penguins mostly eat krill, a shrimplike crustacean.
- Several countries have been harvesting krill since the mid 1960s.
- Adélie penguins need dry, snow-free places to lay their eggs. They use the same nest sites each year and at about the same time every year. Heavy snowfalls during the nesting season can bury adult Adélies and kill their eggs.
- Female Adélies lay two eggs, but usually only one of those eggs result in a fledged chick (fledged chicks have a good chance of maturing into adults). The two most common causes of death of eggs and chicks are abandonment by the parents (if they cannot find enough food) and predation by skuas (hawklike birds).
- In the water, Adélies are eaten mostly by leopard seals and killer whales.
- Adélies can look for food under sea ice because they can hold their breath for a long time. They are not as good at foraging in the open ocean, because they cannot swim very fast.
- Adélie penguins have lived in the western Antarctic Peninsula for at least 644 years.

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FIGURE 6

Oceanographers: Sea ice dataset.

- In the winter (August), sea ice covers over 18 × 106 km², or 40%, of the Southern Ocean (an area larger than Europe). In the summer (February), only 3 × 106 km² (about 7%) of the ocean is covered by sea ice.
- Sea ice keeps the air of the Antarctic region cool by reflecting most of the solar radiation back into space.
- Open water absorbs solar radiation instead of reflecting it and converts it to heat. This heat warms up the atmosphere.
- Sea ice reduces evaporation of the ocean, thus reducing the amount of moisture that is released to the atmosphere.
- As sea ice melts, bacteria and other particles are released into the atmosphere. These particles form condensation or freezing nuclei, which grow into rain or snow.
- Rain helps to stabilize the sea ice by freezing on the surface.
- Sea ice can be broken up by strong winds that last a week or more.
- An icebreaker is a ship used to break up ice and keep channels open for navigation. Icebreakers were first used in the Antarctic in 1947.

Year	Area of sea ice extending from the Antarctic Peninsula (km^2)
1980	146,298
1981	136,511
1982	118,676
1983	88,229
1984	85,686
1985	78,792
1986	118,333
1987	142,480
1988	90,310
1989	44,082
1990	79,391
1991	111,959
1992	110,471
1993	94,374
1994	103,485
1995	95,544
1996	86,398
1997	100,784
1998	73,598
1999	79,223
2000	79,200
2001	69,914

MARIA NHE KAPUT

Data source: Palmer LTER Data Archive (*http://pal.lternet.edu/data/dataset_catalog.php*), supported by NSF Grant No. OPP-96-32763.

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FIGURE 7

Meteorologists: Winter snow dataset.

- In the winter, most of the precipitation in the western Antarctic Peninsula occurs as snow. There is an even mix of snow and rain the rest of the year.
- It is difficult to accurately measure the amount of snowfall in the Antarctic because strong winds blow the snow around.
- The Antarctic Peninsula has a relatively warm maritime climate, so gets more rain and snow than the rest of the Antarctic continent.
- Most of the rain and snow on the Peninsula is generated by cyclones from outside the Southern Ocean. Cyclones are areas of low atmospheric pressure and rotating winds.
- When there is less sea ice covering the ocean, there is more evaporation of the ocean and therefore more moisture in the atmosphere.
- As sea ice melts, bacteria and other particles are released into the atmosphere. These particles form condensation or freezing nuclei, which grow into rain or snow.

Year	% of precipitation events that are snow
1982	49
1983	67
1984	72
1985	67
1986	81
1987	80
1988	69
1989	69
1990	68
1991	72
1992	70
1993	70
1994	83
1995	77
1996	74
1997	81
1998	81
1999	83
2000	77
2001	90
2002	82
2003	76

LUKE SANDRO

Data source: Antarctic Meteorology Online, British Antarctic Survey (*www.antarctica.ac.uk/met/metlog/*).

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FIGURE 8

Marine ecologists: Chinstrap penguin dataset.

- Chinstrap penguins breed on land in the spring and summer and spend the rest of the year in open water north of the sea ice. The number of chinstraps that successfully breed is much lower in years when the sea ice does not melt until late spring.
- Chinstraps mostly eat krill, a shrimplike crustacean.
- Whalers and sealers overhunted seals and whales, which also eat krill, until the late 1960s.
- Chinstraps primarily hunt in open water, because they cannot hold their breath for very long.
- The main predators of chinstraps are skuas (hawklike birds), leopard seals, and killer whales.
- Chinstraps will aggressively displace Adélie penguins from nest sites in order to start their own nests, and may compete with Adélies for feeding areas.
- Although chinstrap penguins have occupied the western Antarctic Peninsula for over 600 years, they have become numerous near Palmer Station only in the last 35 years.

Year	# of breeding pairs of chinstrap penguins
1976	10
1977	42
1983	100
1984	109
1985	150
1989	205
1990	223
1991	164
1992	180
1993	216
1994	205
1995	255
1996	234
1997	250
1998	186
1999	220
2000	325
2001	325
2002	250

Data source: Smith, Fraser, and Stammerjohn 2003.

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FIGURE 9

Biologists: Krill dataset.

- Krill are a keystone species, meaning they are one of the most important links in the Antarctic food web. All the vertebrate animals in the Antarctic either eat krill or another animal that eats krill.
- Krill eat mostly algae. In the winter, the only place algae can grow is on the underside of sea ice.
- Several countries have been harvesting krill since the mid 1960s.
- Ultraviolet radiation is harmful to krill, and can even kill them. Worldwide, ozone depletion is highest over Antarctica.
- Salps, which are small, marine animals that look like blobs of jelly, may compete with krill for food resources. As the salt content of the ocean decreases, salp populations increase and krill populations increase.

Year	Density of krill in the Southern Ocean (no./m²)
1982	91
1984	50
1985	41
1987	36
1988	57
1989	15
1990	8
1992	7
1993	22
1994	6
1995	9
1996	31
1997	53
1998	46
1999	4
2000	8
2001	31
2002	8
2003	3

Data source: Atkinson et al. 2004

RICHARD E. LEE JR.

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Report Sheet

Name:

Scientist Title:

1. Summarize the trends or patterns that you see in the data.

2. What might be possible explanations for the patterns you are seeing?

3. Choose the explanation that you think is the most likely. Use the data to provide evidence for your claim. Give a reason why you think that explanation is the most likely.