

The Beagle's path

from the Esri GeoInquiries™ collection for Environmental Science

Audience – Advanced environmental science

Time required – 12 minutes

Activity	Explore the ideas and evidence that helped Charles Darwin create his theory of evolution.
Science Standards	APES: II.A. Ecosystem structure - Biological populations and communities; ecological niches APES: II.C. Ecosystem diversity - Biodiversity; natural selection; evolution; ecosystem services
Learning Outcomes	<ul style="list-style-type: none">• Students will search anecdotes and images of animals that Darwin experienced along his journeys on the Beagle to describe how species may have differentiated.• Students will identify key assumptions of the theory at select points along the trip.

Map URL: <http://esriurl.com/enviroGeoInquiry1>



Engage

What did Darwin see?

- Click the map URL link above to open the map.
- Click the button, Bookmarks. Select the option, Begins and Ends.
- ? How long was he on this trip? Hint: Click the start and end points of his journey. *[Four years, 10 months]*
- Click the button, Measure. Measure the distance that Darwin covered over this journey. *[~38,000 miles]*
- ? Turn off journal highlights and turn on the biomes. Considering the path of the Beagle, what types of bioregions was Darwin exposed to on his trips? Click the land along the shore. *[A wide range from tropical forests to grasslands and deserts, mountain tops to sea shores.]*



Explore

How does plankton demonstrate natural selection?

- An early observation dealt with the species that Darwin caught while trying out a new plankton net.
- Click the button, Bookmarks. Select Plankton Diversity. Click the map pin.
- ? What do you notice about the life that inhabits the top few meters of much of the world's ocean? *[The variety of traits in these species]*
- Zoom out and then click the marker near England.
- ? Which of Darwin's statements of natural selection are supported by this picture? *[Supposition #4 beneficial traits accumulate in future generations although others could be supported.]*



Explain

How did extinct species inform natural selection theories?

- ? Lyell was well known before Darwin; he championed the idea that species were immutable. What evidence helped Darwin refute this? *[Megatherium, glyptodont and mammoth showed species were likely descended from past similar species.]*
- ? How did these extinct species help Darwin shape Lamarck's ideas into his theory? *[Darwin proposed change happens in populations through offspring over time not to individuals.]*
- ? How did seashells prove Lyell's theory of slowly changing continents? *[The earthquake lifting clams above sea level and shells in the Andes showed this has been in progress for a long time.]*

Elaborate

What role did the tortoise play in forming Darwin's theory?

- Click the button, Bookmarks. select the option, Galapagos Tortoises.
- Click the Selected Journal points around this area.
- ? What animal started Darwin thinking about species diverging into separate lineages? [*The tortoises nicknamed galapago, Spanish for "saddle". The local mockingbird also varied between islands.*]
- ? What did the governor say to point this out? [*You could tell from which island any tortoise originated due to the shape of its shell.*]

Evaluate

How does observation shape theory formation?

- ? What experiences helped Darwin see what so many others did not? [*He noticed the diversity of life in the ocean around him; found fossils proving long-term change in species; saw shells high in mountains due to continents lifting; noticed that species changes based on environmental location (tortoise); read many books on current theories; and wrote to and met with other scientists thinking of these issues.*]
- ? What helps sharpen your mind for cross-checking explanations on how things work? [*Use these same techniques to explain observations with theories.*]
- Explore the Selected Journal Highlights to find how other experiences supported Darwin's theory.

ZOOM TO A BOOKMARK

- Click the button, Bookmarks.
- Select a bookmark name to zoom to its map location and scale.

TURN A MAP LAYER ON AND OFF

- Make sure that the Details pane is selected, and click the button, Show Contents Of Map.
- To show individual map layers, click the check boxes next to the layer names.
- Hint: If a map layer name is light gray, zoom in or out on the map until the layer name is black. The layer can now be turned on.

Next Steps

DID YOU KNOW? ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.esri.com/schools>.

THEN TRY THIS...

- Using an ArcGIS Online organizational account for schools, use one of the animal population datasets and calculate species density to explore how niche specialization helps maximize access to resources.
- Explore the IUCN Red List of Threatened Species story map at <http://esriurl.com/Geo4151>.



TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these texts.

- *Living in the Environment* by Thomson Reuters Publishers — Chapter 5
- *Biology* by Cummings/Pearson — Chapter 13
- *Environmental Science for AP* by W.H. Freeman — Chapter 5