

## NABT OBTA Share-A-Thon

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### Enclosures

1. NUMB3RS: The Galapagos Population
  - Ecology and Evolution
  - Lincoln/Petersen Index (Mark and Recapture)
2. Evolution Resources Compiled during the 2008-2009 Academic Year
  - Books, articles, DVDs, websites
3. Case Study for Science Olympiad Science Crime Busters Middle School Event  
Cincinnati Zoo: Tortoise-Napping
  - Case study created following the guidelines provided by Science Olympiad
  - Case utilizes qualitative analysis, chromatography, fingerprint, and DNA analysis
  - Answer key includes the unknown samples utilized in the case study
4. Case Study for Science Olympiad Forensics High School Event  
Galapagos Islands Hostage Situation at the Charles Darwin Research Station
  - Case study created following the guidelines provided by Science Olympiad
  - Case utilizes qualitative analysis, chromatography, fingerprint, and DNA analysis
  - Answer key includes the unknown samples utilized in the case study

## NUMB3RS: The Galapagos Population

In biological and ecological sciences, one of the most basic field problems is the determination of how many individuals of a species are in a given area. One method used to estimate the population size is the capture-recapture or mark-recapture technique. The premise of this technique involves marking a known number of individuals, releasing them to mix with the population, and then taking a second sample of known size and finding the number of marked individuals it contains. Population size is then estimated from the proportion of the second sample that bears a mark from the first captured period.

In the field, the index demands specific assumptions such as the population is closed, meaning no births, death, or migrations and animals are equally likely to be captured. There are no behavioral differences in preference or avoidance of capture. Initially, utilized in estimating the mortality rates of fish populations, the now known Lincoln/Petersen Index is used by ecologists to determine the size of a population that is often too large and/or scattered to count directly.

### Lesson Rational: Link the Lincoln/Petersen Index to Unique Galapagos Populations

The Galapagos Islands are home to many endemic and newly introduced species. Over the years, endemic species have been threatened by the introduction of species such as dogs, goats, mice, cockroaches, and various plants which have diminished the food resources and habitats of the endemic species. Furthermore, endemic species are also threatened by illegal fishing activities, increased development, and tourism. Natural phenomenon like El Nino has also jeopardized population numbers. With all of these devastating effects on population, the number of individuals of a species is questionable. Whether studying the Galapagos Iguana, Tortoise, Penguin, Blue-Footed Booby, or Albatross, the knowledge of spatial and temporal distribution of animals is central to understanding the importance issues in ecology and conservation biology.

The investigation is designed to promote inquiry by instructing the students to work collaboratively to learn the mark and recapture technique to estimate population size, to utilize equations to calculate population size, and to think critically about how population estimates are affected by unforeseen circumstances.

### Lesson Outline:

Present a map of the Galapagos Islands without island names or relationship to other continents. Elicit students' comments about the archipelago by asking the following questions: Do you recognize this chain of islands? What do you know about these chains of islands? I have found that students are familiar with the Galapagos Islands, but do not understand the diversity of living organisms found on these Enchanted Isles. Present select passages from Charles Darwin's *On the Origin of Species* and *Voyage of the Beagle* without indicating the passage's source or author. As the discussion continues, many students realize the unmarked islands and the passages identify and describe the Galapagos Islands. Various biology textbooks offer links to video footage of the Galapagos diverse living organisms. Select video footage or photographs that highlight Galapagos living organisms.

Students work in groups of 3. Students are given bags of candy, beads, beans, or little toys to represent the various endemic animal species on the Galapagos Islands (such as the Giant

Galapagos Tortoises, Finches, Iguanas, etc...). The students are instructed to estimate the size of the population using the Lincoln/Petersen Index. Students randomly select/capture 10 animals from the bag. Using masking tape, students mark the captured animals and return the animals to the bag. Students will then randomly select 15 animals from the bag and record the number recaptured with the tape/mark. Return the 15 animals. Repeat this procedure for 10 recaptures. The counts are recorded in a data table designed by the student. Students will calculate the estimated population size based on the equation  $N = (n1*n2) / m2$ . In other words, the population estimate = (total number marked and returned to the bag \* the number of animals captured) / (total number recaptured with mark).

This initial bag can represent the population of a given Galapagos species before the introduction of an exotic species or human influence. Given a second bag, the students estimate the population size after the introduction of feral goats or another new species. Given another bag, students can estimate population size following El Nino or an oil spill. Students should estimate the population number before carrying out the calculation.

Students will create bags to represent populations for another student group to analyze based on researched environmental factors. Additionally, bags can be created to follow a particular species over several decades. Students are instructed to hypothesize reasons for any potential difference in population estimations. The estimates are compared to the true value of the bag's contents known to the teacher. Extensions include the algebraic calculation of the standard error of the estimate. Students can discuss the equation and learn the consequences of violations in the model's assumptions. Live organisms such as crickets in aquaria habitats can also be used to teach safety and ethical issues with working with live organisms.

Conservation biology, ecology, and statistics are easily incorporated in this activity. The Lincoln/Petersen Index has also shown to be beneficial in estimating the size of a faunal or human population represented only by skeletal remains. The index is based on the symmetry of the skeletal remains and the ability to accurately pair-match the elements. My research has focused on several quantification techniques and its application to reconstructing the original death assemblage in zooarchaeology and biological anthropology cases.

It's important for students to understand that a quantification technique to estimate population size in ecology has applications in other venues. The conservationist biologists are able to utilize the estimates to understand the rise or fall of a particular species with hopes to return the population to a stable number. The biological anthropologist has adopted this ecological principle as an estimate death population. The Galapagos Islands represent a dramatic microcosm of organisms. The organisms live in a fragile ecosystem. By using the Lincoln/Petersen Index and the created animal populations, students calculate and estimate size and witness the change in population on the islands. By discussing the potential reasons for the change in population size, students recognize environmental threats. Hopefully, the students will never have to resort to the biological anthropologist's application of the Lincoln/Petersen Index.

## EVOLUTION RESOURCES

- “A Theory for Everyman.” *Scientific American*. January 2009: 32.
- Angermeyer, Johanna. *My Father's Island*. Sussex: Pelican Press, 1998.
- Baker, Joanne. “Darwin: heading to a town near you.” *Nature*. 20 November 2008: 322-323.
- Barry, Patrick. “Computing Evolution.” *Science News*. 31 January 2009: 27-31.
- Berra, Tim. *Charles Darwin The Concise Story of an Extraordinary Man*. Baltimore: John Hopkins University Press, 2009.
- Bosveld, Jane. “Evolution by Design.” *Discover*. March 2009: 58-59.
- Bowler, Peter J. “Darwin's Originality.” *Science*. 9 January 2009: 223-226.
- Branch, Glenn & Scott, Eugenie. “The Latest Face of Creationism.” *Scientific American*. January 2009: 92-99.
- Browne, Janet. “Birthdays to remember.” *Nature*. 20 November 2008: 324-325.
- Buller, David J. “Four Fallacies of Pop Evolutionary Psychology.” *Scientific American*. January 2009: 74-79.
- Chouard, Tanguy. “Beneath the surface.” *Nature*. 20 November 2008: 300-303.
- Darwin, Charles. *The Origin of Species*. Kent: Wordsworth Editions Limited, 1998.
- D'Orso, Michael. *Plundering Paradise The Hand of Man on the Galapagos Islands*. New York: HarperCollinsPublishers, 1999.
- Ehrenberg, Rachel. “Evolution's Evolution.” *Science News*. 31 January 2009: 6-12.
- Galapagos The Islands that Changed the World*. DVD. Producer Patrick Morris, BBC Video, 2007. 150 minutes.
- Hopkinson, Deborah. *Who Was Charles Darwin?* New York: Grosset & Dunlap, 2005.
- Ings, Simon. “An Eye For The Eye.” *Nature*. 20 November 2008: 304-309.
- Jackson, Michael H. *Galapagos A Natural History*. Calgary: University of Calgary Press, 2007.
- Jablonka, Eva. “Extending Darwinism.” *Seed*. December 2008: 25-26.

- Jacobs, Francine. *Lonesome George the Giant Tortoise*. New York: Walker & Company, 2003.
- Johnston, Tony. *An Old Shell Poems of the Galapagos*. New York: Farrar Straus Giroux, 1999.
- Kingsley, David M. "From Atoms to Traits." *Scientific American*. January 2009: 52-59.
- Kohn, Mark. "The Needs of the Many." *Nature*. 20 November 2008: 296-299.
- Lawson, Kristan. *Darwin and Evolution for Kids His Life And Ideas*. Chicago: Chicago Review Press, 2003.
- Lewin, Ted. *Nilo and the Tortoise*. New York: Scholastic Press, 1999.
- Marsa, Linda. "Galapagos Next." *Discover*. March 2009: 46-49.
- McAuliffe, Kathleen. "Are We Still Evolving?" *Discover*. March 2009: 50-56.
- Milius, Susan. "A Most Private Evolution." *Science News*. 31 January 2009: 32-36.
- Mindell, David. "Evolution in the Everyday World." *Scientific American*. January 2009: 82-89.
- Mirsky, Steve. "What's Good for the Group." *Scientific American*. January 2009: 51.
- Nicholls, Henry. "Let's Make a Mammoth." *Nature*. 20 November 2008: 310-314.
- Nicholls, Henry. *Lonesome George The Life and Loves of a Conservation Icon*. London: MacMillan, 2006.
- Orr, H. Allen. "Testing Natural Selection." *Scientific American*. January 2009: 44-50.
- Quammen, David. "Darwin's First Clues." *National Geographic*. February 2009: 34-55.
- Quammen, David, ed. *Charles Darwin On The Origin of Species The Illustrated Edition*. New York: Sterling, 2008.
- Perkins, Sid. "Step-by-step Evolution." *Science News*. 31 January 2009: 22-26.
- Regis, Ed. "The Science of Spore." *Scientific American*. January 2009: 90-91.
- Ridley, Matt. "Modern Darwins." *National Geographic*. February 2009: 56-71.
- Weiner, Jonathan. *The Beak of the Finch*. New York: Vintage Books, 1994.
- Saey, Tina. "Molecular Evolution." *Science News*. 31 January 2009: 13-21.

- Shubin, Neil. "This Old Body." *Scientific American*. January 2009: 64-67.
- Siegfried, Tom. "Darwin turns 200." *Science News*. 31 January 2009: 1-5.
- Stewart, Paul D. *Galapagos The Islands that Changed the World*. New Haven: Yale University Press, 2006.
- Stix, Gary. "Darwin's Living Legacy." *Scientific American*. January 2009: 38-43.
- Sugden, A., et al. "A Celebration and a Challenge." *Science*. 9 January 2009: 185.
- Van Dousselaere, Monique. *Galapagos Discover and Colour*. Quito: Editorial Ecuador F.B.T. Cia. Ltda, 1989.
- Ward, Peter. "What Will Become of Homo Sapiens?" *Scientific American*. January 2009: 68-73.
- Weintraub, Pamela. "The Discover Interview Sean Carroll." *Discover*. March 2009: 40-44.
- Winston, Robert. *Evolution Revolution*. New York: DK Publishing, 2009.
- Wong, Katie. "The Human Pedigree." *Scientific American*. January 2009: 60-63.
- Wright, Karen. "The Ascent of Darwin." *Discover*. March 2009: 34-38.
- Zimmer, Carol. "On the Origin of Life on Earth." *Science*. 9 January 2009: 198-199.

### **Internet Resources**

The Voyage of the Beagle, by Charles Darwin

<http://www.literature.org/authors/darwin-charles/the-voyage-of-the-beagle/>

GalapagosQuest: An Interactive Expedition

<http://cnn.com/NATURE/9903/10/galapagosquest/>

Galapagos Geology on the Web

<http://www.geo.cornell.edu/geology/Galapagos.html>

On the Origins of Species, by Charles Darwin

<http://www.literature.org/authors/darwin-charles/the-origin-of-the-species/>

Charles Darwin Research Station

<http://www.darwinfoundation.org/>

Restoring the Tortoise Dynasty

<http://www.darwinfoundation.org/Restoring/index.html>

The Endangered Galapagos Giant Tortoise  
<http://www.discovergalapagos.com/tortoise.html>

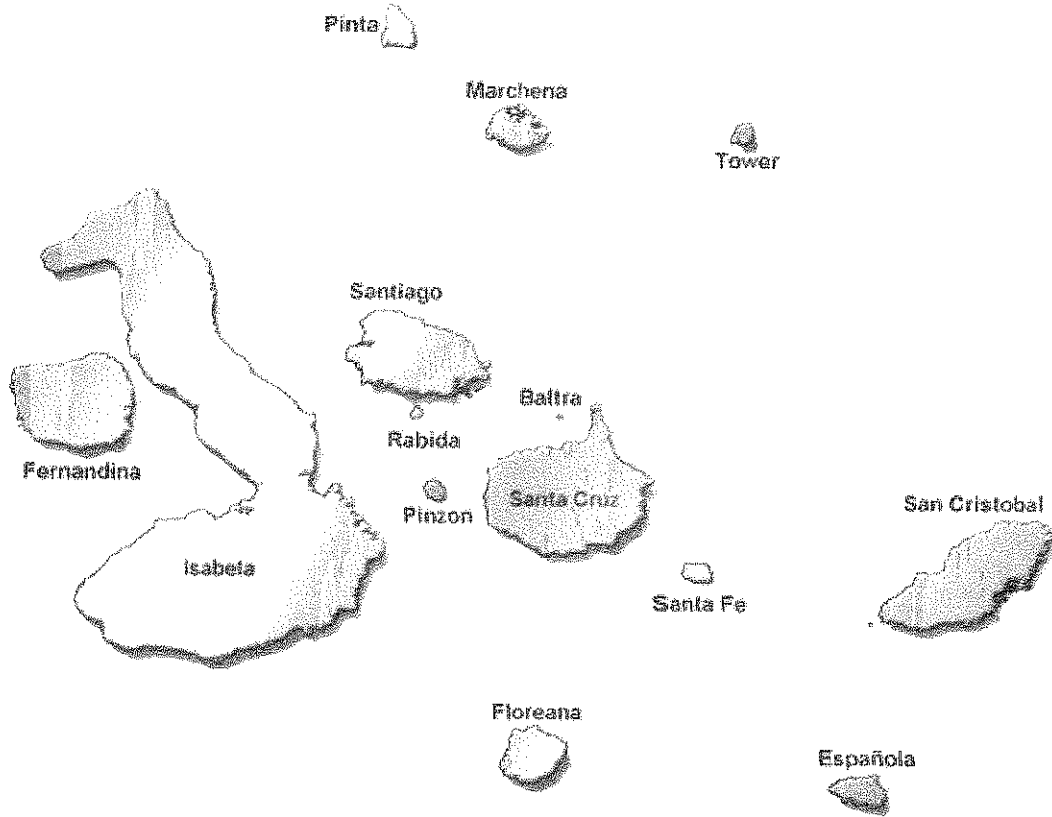
The Pepineros: The Sea Cucumber Fishermen  
<http://www.polaris.net/sui/jpinson/pml/gal/pepino/pepino.html>

Galapagos Coalition  
<http://www.law.emory.edu/PI/GALAPAGOS>

Galapagos Conservation Trust  
<http://www.gct.org/>

The Extinction Files  
<http://www.bbc.co.uk/education/darwin/exfiles/index.htm>

New York Times Science Section Darwin Interactive  
<http://www.nytimes.com/interactive/2009/02/09/science/20090209-darwin-evolution-documents.html?ref=science>



**CINCINNATI ZOO**  
**Tortoise Napping**  
**7 Baby Giant Galapagos**  
**Tortoises Missing**

**SCIENCE CRIME**  
**BUSTERS**

**School** \_\_\_\_\_  
**Participants** \_\_\_\_\_

*The Galápagos Islands are an archipelago of geologically young volcanic islands distributed around the equator in the Pacific Ocean, 600 miles west of continental Ecuador. Famed for their vast number of endemic species studied by Charles Darwin during the voyage of the Beagle, the Islands were instrumental to the inception of Darwin's theory of evolution by natural selection. In honor of the 200<sup>th</sup> anniversary of Charles Darwin's Birthday, the Cincinnati Zoo has acquired 7 baby Giant Tortoises for display in the zoo's Reptile House.*



## SCIENCE OLYMPIAD – SCIENCE CRIME BUSTERS– DIVISION B



“This is George Saddleback reporting LIVE for Channel 9 News. I am standing outside the Reptile House of the Cincinnati Zoo where seven baby Giant Galapagos Tortoises have gone missing. The grapefruit-size Galapagos Tortoises are 6 to 9 months old and weigh about three-quarters of a pound each. They have been on display in the Reptile House in honor of the 200<sup>th</sup> anniversary of Charles Darwin’s birthday. Native to the Galapagos Islands, the tortoises are considered endangered organisms with a population of 10,000 to 15,000 scattered throughout the archipelago. Darwin’s observations of the tortoises helped him formulate the theory of evolution by natural selection. With 13 to 14 subspecies of Giant Tortoises, many scientists can distinguish a tortoise’s island of origin by the unique shell shape in correlation to available vegetation. The whereabouts of these seven baby Giant Tortoises are unknown and police and zoo officials are seeking your help for additional information. This is George Saddleback reporting LIVE for Channel 9 News.”

### Suspects in Custody

- Suspect 1: Building & Grounds Maintenance Staff - *Seth Campbell*: Finished repairing the Reptile House roof following the recent wind and snow/ice storms. Has publicly declared that the baby tortoises would make great soup!
- Suspect 2: Zoo Volunteer – *Chuck Dorwin*: Senior citizen volunteer who assists in the educational programs at the Reptile House. Recently overheard saying “those tortoises would be great pets for my grandkids.”
- Suspect 3: Reptile House Keeper – *Ima Slow*: Employed at the Cincinnati Zoo for 25 years, duties include providing daily care to the institution’s animals, including diet preparation, general exhibit maintenance, and record keeping. Last seen exiting the Reptile House carrying a large box.

### Evidence to be Analyzed

**QUALITATIVE ANALYSIS:** A mysterious powder was found near the employee entrance to the Reptile House. A wet towel soaked with an unknown liquid was seen at the base of the baby Giant Tortoises’ enclosure.

**POLYMER TESTING/NATURAL & MAN-MADE SUBSTANCES:** Several traces of physical evidence have been recovered from the Tortoises’ enclosure. Fibers and hairs were collected and waiting to be analyzed.

**CHROMATOGRAPHY:** The Reptile House’s security code had been scribbled on a piece of notebook paper and left near the security keypad. The ink will be analyzed.

**FINGERPRINT ANALYSIS:** Several fingerprints were successfully lifted from the security keypad and the piece of notebook paper with the scribbled security code.

**DNA:** One of the glass panes of the Tortoises’ enclosure had been broken. A few drops of blood were found among the shards of glass.

Team # \_\_\_\_\_

School \_\_\_\_\_

KEY - KAREN CRUSE

Participants \_\_\_\_\_

SCORE \_\_\_\_\_ RANK \_\_\_\_\_

**DIRECTIONS:** COMPLETE THE ANALYSIS OF THE COLLECTED EVIDENCE. EVIDENCE IS LABELED AS CRIME SCENE SAMPLE OR COLLECTED FROM AND/OR ASSOCIATED WITH A PARTICULAR SUSPECT. PAY SPECIAL ATTENTION TO THE EVIDENCE BAG LABELING. DO NOT CROSSCONTAMINATE SAMPLES. POINT VALUE IS NOTED FOR EACH SECTION.

**QUALITATIVE ANALYSIS - 50 Points**

**IDENTIFY SAMPLES - UNKNOWN POWDERS**

Crime Scene Sample	<u>cornstarch</u>	(4 PTS)
Suspect 1	<u>cornstarch</u>	(4 PTS)
Suspect 2	<u>table salt NaCl</u>	(4 PTS)
Suspect 2 b	<u>calcium sulfate</u>	(4 PTS)
Suspect 3	<u>sucrose/baking soda</u>	(4 PTS)
INDICATE MATCH	<u># 1</u>	(3 PTS)

**IDENTIFY SAMPLES - UNKNOWN LIQUIDS**

Crime Scene Sample	<u>Vinegar</u>	(4 PTS)
Suspect 1	<u>H<sub>2</sub>O</u>	(4 PTS)
Suspect 2	<u>H<sub>2</sub>O<sub>2</sub></u>	(4 PTS)
Suspect 2 b	<u>isopropyl alcohol</u>	(4 PTS)
Suspect 3	<u>vinegar</u>	(4 PTS)
Suspect 3 b	<u>ammonia</u>	(4 PTS)
INDICATE MATCH	<u># 3</u>	(3 PTS)

**POLYMER TESTING/NATURAL/MAND-MADE - 10 Points**

**FIBERS - IDENTIFY SAMPLES**

Using a forceps, remove one thread from the swatch provided.

Crime Scene Sample	<u>cotton</u>	(1.5 PTS)
Suspect 1	<u>cotton</u>	(1.5 PTS)
Suspect 2	<u>wool</u>	(1.5 PTS)
Suspect 3	<u>silk</u>	(1.5 PTS)
INDICATE MATCH	<u># 1</u>	(2 PTS)

**HAIR SAMPLE-IDENTIFY AS HUMAN, DOG, OR CAT.**

human (2 PTS)

**CHROMATOGRAPHY - 5 Points**

Match the Crime Scene chromatogram to the suspect samples below.



Staple your chromatogram HERE (2.5 PTS)

Suspect 1 Suspect 2 Suspect 3  
INDICATE MATCH # 1 (2.5 PTS)

**FINGERPRINT ANALYSIS - 5 Points**

Match the fingerprints with the ten-print cards provided for each suspect

Security Keypad # 3 Ima Alvar (2.5 PTS)  
Notebook paper # 1 Josh Campbell (2.5 PTS)

**DNA ANALYSIS - 5 Points**

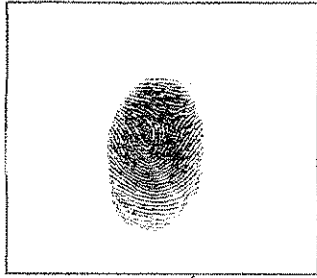
Explain the DNA electrophoresis/fingerprinting results:

suspect #1 matches to broken glass  
↳ blood drops

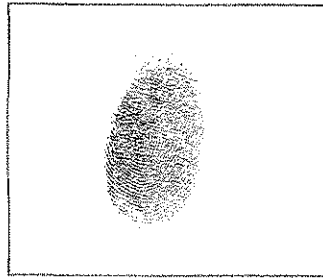


FINGERPRINT ANALYSIS

CRIME SCENE PRINTS



*Security Keypad*



*Notebook Paper*

DNA ANALYSIS

Control

Control

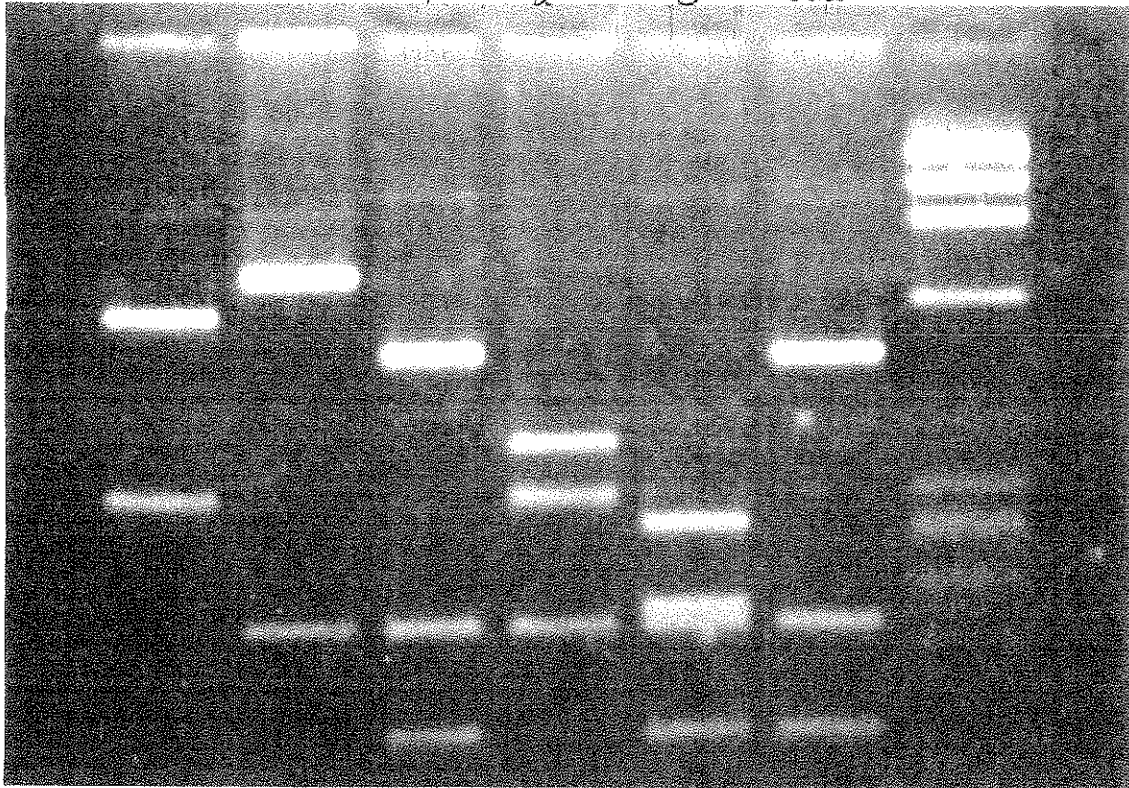
Suspect

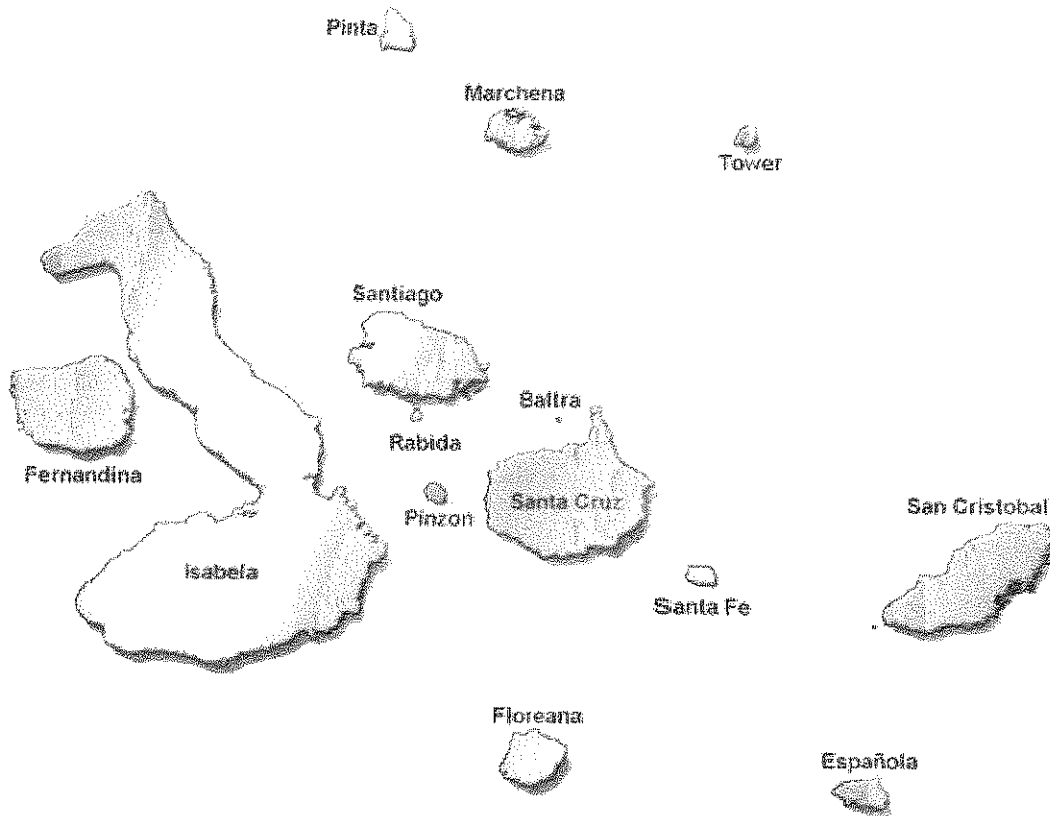
Suspect  
2

Suspect  
3

Blood from  
Class

LADDER





# Galápagos Islands

## Hostage Situation at the Charles Darwin Research Station

### FORENSICS

**School** \_\_\_\_\_  
**Participants** \_\_\_\_\_

*The Galápagos Islands are an archipelago of geologically young volcanic islands distributed around the equator in the Pacific Ocean, 600 miles west of continental Ecuador. Famed for their vast number of endemic species studied by Charles Darwin during the voyage of the Beagle, the Islands were instrumental to the inception of Darwin's theory of evolution by natural selection.*

## SCIENCE OLYMPIAD – FORENSIC – DIVISION C – HIGH SCHOOL - CASE



The Charles Darwin Research Station (CDRS) located on the Island of Santa Cruz in the Galápagos archipelago is the home of scientific research and environmental education for conservation. The Station has a team of over a hundred scientists, educators, volunteers, research students and support staff from all over the world. Home to one of the most famous inhabitants of the archipelago, Lonesome George, a Giant Galápagos Tortoise, resides in a special enclosure where tourists can catch a glimpse at the last remaining tortoise of Pinta Island. The CDRS and its satellites throughout the archipelago have breeding centers to help reestablish the Giant Tortoise population. Due to intense conservation efforts and strict restrictions on fishing, local Galápaguano protesters arrived at the CRDS. The conservation efforts were designed to protect the native wildlife, but threatened the livelihood and economic gain of the locals. As a result, protesters held scientists hostage and threatened to kill the conservation icon, Lonesome George. One of the protesters escaped leaving behind a slew of evidence to his identity.

### Suspects in Custody

- Suspect 1: Sea Cucumber Fisherman – *Marcos Pepinero*: Forced to stop harvesting sea cucumbers after illegally fishing in the Marine Reserve Waters of the Archipelago
- Suspect 2: Galapagos Fishery Inspector - *Bajardo Pez*: Previously arrested for illegally trafficking protected marine organisms during the fishing ban
- Suspect 3: Dismissed Research Station Scientist - *Emiliano Cientifico*: Forced to return to mainland Ecuador after numerous research endeavors failed. Thought to have remained in the archipelago illegally in the fishing industry

### Evidence to be Analyzed

**QUALITATIVE ANALYSIS:** A mysterious powder was found near the entrance of Lonesome George's enclosure.

**POLYMER TESTING/NATURAL & MAN-MADE SUBSTANCES:** Several traces of physical evidence have been recovered from the research laboratories and libraries where the scientists were held hostage. Fibers and hairs were collected and waiting to be analyzed.

**CHROMATOGRAPHY:** A letter written to the CDRS was recovered stating: "We live off fishing and our boats are tied up because of the lobster and sea cucumber ban. The Darwin station people want to keep the Galapagos as their own private plantation. We need to support our families!" The letter's ink will be analyzed.

**FINGERPRINT ANALYSIS:** Several fingerprints were successfully lifted from a weapon (crowbar found at the scene) and the letter written to the CDRS.

**DNA:** Small drops of blood were found near a broken window where the protesters entered one of the laboratories. None of the identified arrested protesters have injuries.

Team # \_\_\_\_\_

School \_\_\_\_\_

Participants \_\_\_\_\_

SCORE \_\_\_\_\_ RANK \_\_\_\_\_

**DIRECTIONS:** COMPLETE THE ANALYSIS OF THE COLLECTED EVIDENCE. EVIDENCE IS LABELED AS CRIME SCENE SAMPLE OR COLLECTED FROM AND/OR ASSOCIATED WITH A PARTICULAR SUSPECT. PAY SPECIAL ATTENTION TO THE EVIDENCE BAG LABELING. DO NOT CROSSCONTAMINATE SAMPLES. POINT VALUE IS NOTED FOR EACH SECTION.

**QUALITATIVE ANALYSIS - 20 Points**

**IDENTIFY SAMPLES - UNKNOWN POWDERS**

Crime Scene Sample	<u>cornstarch</u>	(4 PTS)
Suspect 1	<u>cornstarch</u>	(4 PTS)
Suspect 2	<u>NaCl</u>	(4 PTS)
Suspect 3	<u>sucrose</u>	(4 PTS)
INDICATE MATCH	<u>#1</u>	(4 PTS)

**DNA ANALYSIS - 7.5 Points**

Explain the DNA electrophoresis/fingerprinting results:

suspect 1	<u>ladder?</u>
	<u>distance bands travel</u>

**POLYMER TESTING/NATURAL/MAND-MADE - 20 Points**

**FIBERS - IDENTIFY SAMPLES**

Using a forceps, remove one thread from the swatch provided.

Crime Scene Sample	<u>cotton</u>	(3.5 PTS)
Suspect 1	<u>cotton</u>	(3.5 PTS)
Suspect 2	<u>wool</u>	(3.5 PTS)
Suspect 3	<u>silk</u>	(3.5 PTS)
INDICATE MATCH	<u>#1</u>	(4 PTS)

**HAIR SAMPLE-IDENTIFY AS HUMAN, DOG, OR CAT.**

~~human~~ cat (2 PTS)

**FINGERPRINT ANALYSIS - 7.5 POINTS**

Match the fingerprints with the ten-print cards provided for each suspect


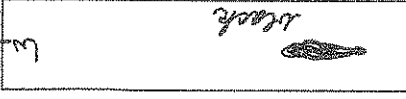

Weapon	<u>#3</u>	(2 PTS)
Notebook paper	<u>#1</u>	(2 PTS)

Identify the technique for each surface that would yield the best print.

Weapon	<u>cyanoacrylate fuming</u>	(1.75 PTS)
Notebook paper	<u>iodine or ninhydrin</u>	(1.75 PTS)

**CHROMATOGRAPHY - 15 Points**

Match the Crime Scene chromatogram to the suspect samples below.

Suspect 1		Suspect 3	
Suspect 2			

Staple Chromatogram Here (5 PTS)

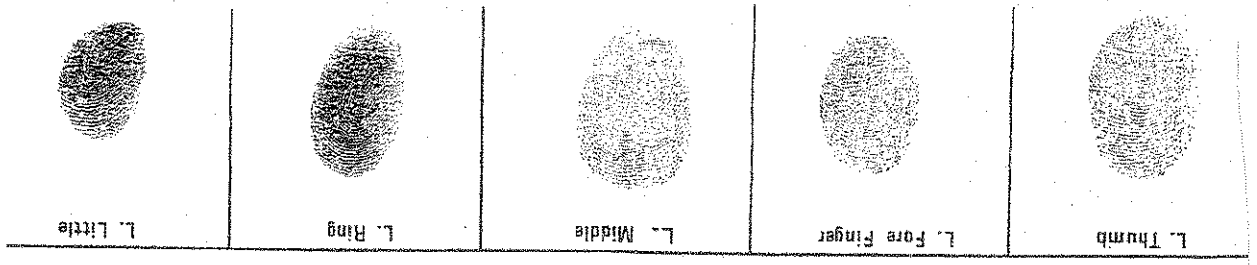
#1

Calculate Rate of Flow (R<sub>f</sub>) for the matching chromatogram in the space below: (10 PTS for correct match and corresponding R<sub>f</sub>s)

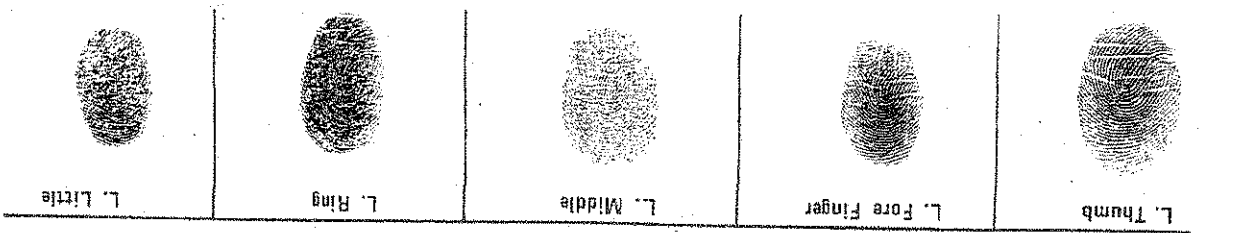
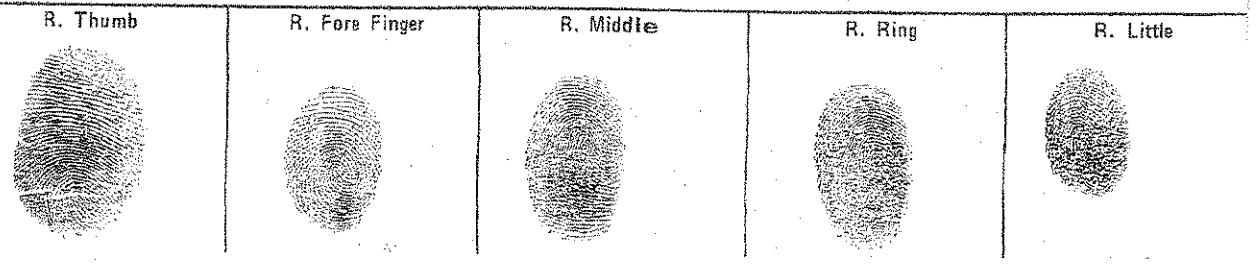




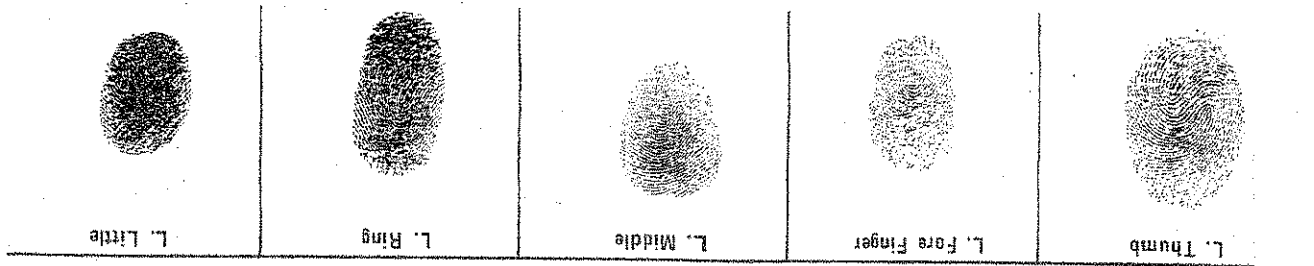
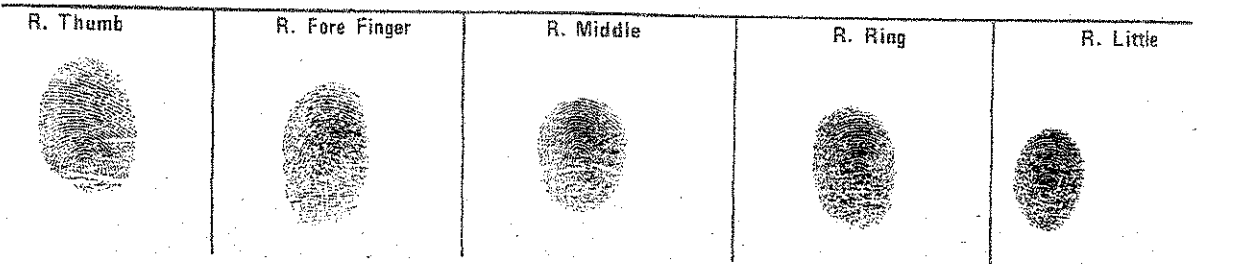
Suspect 1



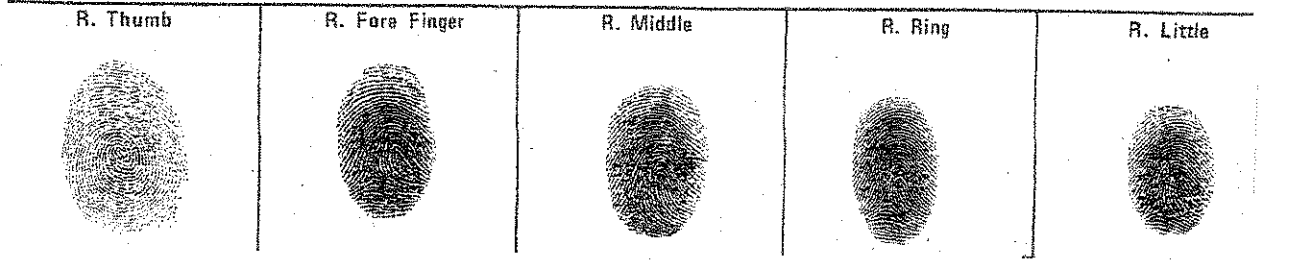
SEARCH COMPARISON AND ELIMINATION FINGER PRINT RECORD



SEARCH COMPARISON AND ELIMINATION FINGER PRINT RECORD



SEARCH COMPARISON AND ELIMINATION FINGER PRINT RECORD

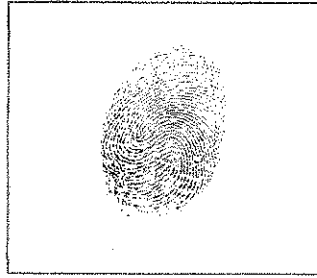


Suspect 2

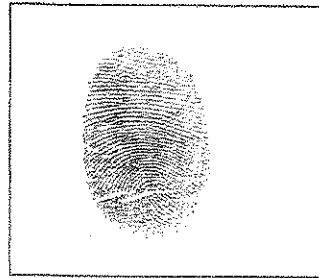
Suspect 3

FINGERPRINT ANALYSIS

CRIME SCENE PRINTS



Weapon left at CDRS



Letter written to CDRS

DNA ANALYSIS

