The Science Education Partnership (SEP) is a professional development program for secondary school science teachers in Washington sponsored by the Fred Hutchinson Cancer Research Center and the Howard Hughes Medical Institute. SEP provides training, resources, and ongoing support designed to enhance biology teaching and learning. A key goal is to foster long-term partnerships between teachers and the biomedical research community and support the resulting professional learning community.

We developed the Elephant Project as a way for high school students to gain experience with molecular biology and biotechnology tools and concepts within the framework of an engaging, interdisciplinary problem. As you will see if you get immersed in this topic, it is also a very dynamic context. For example, during the timeframe of developing this curriculum, research revealed that African elephants comprise not one, but two distinct species. Meanwhile international rules on the sale of ivory governed by CITIES (the Convention on International Trade in Endangered Species of Wild Flora and Fauna) have been and continue to be revised reflecting fluctuations in elephant populations, park boundaries, economic status, and political will. Biomedical science helps inform the decisions that people are making about these and many related issues.

Recognizing that each teacher and student class is unique, we used travel guidebooks as one influence on the project's design. Each of the Elephant Team members provided an itinerary for their own classroom journey through this rich terrain.

In addition to the five special teachers who together became the Elephant Team, we acknowledge and thank Sally Luttrell-Montes, Denise Simoneaux, Suzanne Black, plus the SEP teachers who field tested the curriculum and gave us thoughtful suggestions. Molecular and Cellular Biology graduate students Charlotte Berkes, Mara Jeffress, Carol O'Hear, and Alex Watters helped keep the science on track while learning how to communicate science. Sam Wasser and Kenine Comstock were generous with their time and knowledge. Ladawna Gievers and Celina Tam help pack all the kits used by SEP teachers. SEP and HutchLab staff contributed guidance, technical expertise, and chocolate.

We hope you, too, will be drawn in by the elephants. Since this is our first project at this scale of complexity, we ask for patience with its shortcomings and hope you will let us know of any significant errors or omissions.

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FRED HUTCHINSON CANCER RESEARCH CENTER
SCIENCE EDUCATION PARTNERSHIP

June 28, 2002

Dear fellow teachers,

We have had a wonderful and exciting time developing The Elephant Project for the Science Education Partnership. It has all the ingredients that an excellent teaching tool should have: engagement for students, integration between science, reading, writing, communication, mathematics, social studies, technology and the biotechnology workplace. It also addresses nearly all of the EALR's required by the state of Washington! It enables students to participate in real life applications of molecular biology tools, and gives them a perspective on the use of these techniques by a global society.

This particular project focuses on using biotechnology in the conservation efforts of a species, in this case the African Elephant, and can be incorporated in many different places in a biology curriculum. For example, this material could be placed in a genetics unit, focusing on the structure and function of the DNA molecule. Or it could be part of an evolution unit, focusing on populations and how minor changes in DNA could occur over time. Furthermore, it could be part of an ecology unit dealing with species conservation or even a culminating activity at the end of the year to combine all of the student's knowledge in a final project.

The options for its use will depend on you, since each teacher has his/her own style and focus. We have all included our "customized" approach to this project in the Appendix, and we hope you will find our alterations and timelines helpful as you decide how and where to use it in your curriculum.

We also strongly suggest you spend some time learning about elephants, poaching and the CITES council prior to engaging your students in this project. You will be more comfortable and confident in your ability to field student questions and guide them toward a better understanding of the social, political and financial issues regarding the conservation of elephants as a keystone species for African ecosystems.

We hope you will enjoy The Elephant Project as much as we have enjoyed being involved in its development. Please feel free to give us any feedback via SEP.

Best to all of you!

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Shorewood High School

Tom DeVries
Vashon High School

Mike Fellows
Lakewood High School

Sherry Stuber
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THE ELEPHANT PROJECT OVERVIEW

The global export of elephant ivory was banned in 1989 by the Convention on International Trade in Endangered Species (CITES) in a frantic effort to save the African elephant from catastrophic decline and possible extinction. From 1979 to 1987 the elephant population plummeted from 1.3 million to 600,000 (a 60% reduction), with up to 70,000 elephants being poached every year to satisfy the 80-ton global demand for ivory.

Many African countries stepped up conservation plans to improve habitats for the elephants and to aggressively pursue poachers and illegal marketers. By the mid '90's, some of these protected elephant populations had increased in such numbers that park rangers were given permission to kill entire families of elephants (culling). At the CITES conference in April 2000, Botswana, Namibia, Zimbabwe and South Africa requested to relax the ban to allow sales of their stockpiled ivory. Many other countries wanted the ban to stay in effect, fearing that opening up the market to this "culled" ivory would offer poachers a market for their "harvest" of ivory. It was agreed that more effective ways of determining the impact of ivory sales upon poaching must be developed before opening the ivory market.

Two Seattle scientists began using molecular biology techniques to determine the characteristics of specific populations of African elephants. Dr. Sam Wasser of the University of Washington and Dr. Kenine Comstock of Fred Hutchinson Cancer Research Center collaborate with researchers in various African countries to collect and analyze genetic data from elephants. The goal is to develop a genetic method for assessing the geographic origin of disputed elephant ivory to inhibit illicit ivory from entering the market. This involves matching the genotype from a piece of ivory to the continent-wide distribution and frequency of elephant-specific markers.

Using a non-invasive technique of collecting DNA used by Dr. Wasser in the study of grizzly and black bears, DNA can be isolated from the intestinal epithelial cells that are sloughed off and deposited in the abundant supply of the animal's dung. Because of the biohazard issues involved, Dr. Nick Georgiadis in Africa extracts the DNA, then sends the "raw" DNA to Dr. Comstock. At her lab at FHCRC in Seattle, she and her colleagues use a variety of techniques to isolate and amplify mitochondrial genes and microsatellite DNA markers. Wasser's work demonstrates that DNA can be extracted from any part of a tusk/ivory since it is essentially the dentin of a highly modified incisor tooth.

To date, Dr. Comstock has identified seventeen elephant-specific markers. In the spirit of this ongoing work, this simulation is designed to give students the experience of performing a DNA restriction digest, analyzing results of a gel electrophoresis, and contributing "new" data to the collection of DNA markers. The simulation includes matching DNA from a piece of confiscated ivory to a known population of elephants, and allows students to explore their own values about species conservation using an ethics module.

Consistent with the nature of all scientific research, new discoveries lead to new understandings, which in turn can shape the course of events in unexpected ways. When we began developing the Elephant Project there were two recognized elephant species, the African Elephant, *Loxodonta Africana,* and the Asian Elephant, *Elephas maximus*. In the past year genetic research has demonstrated that there at least 2, and perhaps even 3 distinct species of African Elephants. This and other recent events emphasize the dynamic nature of the science, and the politics, associated with an issue as complex as elephant conservation.

THE ELEPHANT PROJECT USER'S GUIDE

PLANNING

Think of the Elephant Project as a sort of "travel guide." If you have an extended period of time for your students to work through the Elephant Project, you can have your students do all or many of the activities (internet research and bioethics, for example) that are available, or you may just touch on what you feel to be the most relevant points for your students. Also, the Elephant Project can fit into many aspects of general curriculum. Some teachers use the Elephant Project as a means of teaching conservation biology and biodiversity, others use it in conjunction with their genetics unit, whereas others use it when teaching about biotechnology. The Project can also be integrated with social studies or geography to coincide with a time that students are learning about Africa or world events.

To give you some specific details about how the Elephant Project has been incorporated into the classroom, each member of the Elephant Project curriculum development team has included his or her own personal "itinerary" for their class's journey through the Elephant Project (see Appendix 1). These itineraries include pertinent information such as what grade level and class the project is being used with, length of class period, total time the Project is given, and context in which the Project is taught.

ESSENTIALS

The Elephant Project is laid in sections comprised of activities. **Essential** pages are designated by a border on the right hand margin, same as on this page. These pages are essential for the teacher, who can then decide which are appropriate/essential for the students. Some activities have alternate versions that may be used (no page border). Two examples are the paper RFLP and the option to use semi-log plotting Vs size estimation to determine the RFLP DNA band sizes.

TEACHER GUIDES AND STUDENT HANDOUTS

Certain activities have designated Teacher Guides. These will have the name of the activity followed by "Teacher Guide."

SIMULATION

Finally, please keep in mind that the RFLP lab is a simulation and the DNA used in the lab is lambda DNA. Some teachers prefer to tell students that this lab is a simulation up front, explaining the logistical issues (obtaining and transporting elephant DNA from Africa to the US) behind using actual Elephant DNA. Other teachers don't tell the students that the lab is a simulation until the end. They feel that this is more engaging for the students. What you choose to do with your class is entirely up to you (although students should be told at some point in time that this is a simulation).

ACTIVITY MATRIX

FIVE E's	ACTIVITIES/TOPICS	ESSEN-TIALS	ECOLOGY NATURAL HISTORY	SCIENCE AND SOCIETY
Prerequisites	Micropipeting Skills	•		
	Basic Electrophoresis Concepts	•		
Engage	Scenario (20 min)	•		
	Video: "Wildlife Warriors" (25 min segment on poaching)	•		
	Video: "An Animal's World: African Elephant" Discovery Channel	•		
	Biographies and/or Articles: Kenine Comstock, Sam Wasser (20min)	•		
	Readings: Natural History of the Elephant		•	
	Readings: Bioethics, Societal Issues			•
Explore	Internet Research Assignment		•	•
	Paper RFLP Activity (55 min)	•		
	Additional Paper RFLP Activities (Elephant sentence version and "DNA Scissors" in <u>Recombinant DNA and Biotechnology</u>)		•	
	Lab: Gel Electrophoresis (~110 min)	•		
	Flow Chart (student generated)			
	Concept Questions: Part I (20 min)	•		
Explain	Concept Questions: Part II (20 min) Vocabulary (20 min)	•		
	Analysis of Comstock Data Comparison of RFLPs (55 min)	•		
	Semi-log Graphing			
	Analysis of Student Data Comparison of RFLPs (55 min)	•		
	Semi-log Graphing			
	Identification of Ivory Source (10 min)	•		
Elaborate	Discussion of Scenario Outcome -What happened to grandpa? (20 min)	•		
	Bioethical Extensions			
	Bioethical Questions			•
	Internet Research Results		•	•
	"Stakeholders" Model			•
	Why Conserve a Species?		•	•
Evaluate	Assessment: Whale Scenario (55 min)	•		
	Assessment: Designing and Performing independent research Lab			
	Application of Biotechnology to Other Areas of Research			•

RECOMMENDED SUPPLEMENTARY MATERIALS TO ENHANCE THE ELEPHANT PROJECT (CONTENTS OF THE SEP ELEPHANT TRUNK)

MAPS, VIDEOS, PUBLICATIONS, AND BOOKS

Map: Africa Threatened (by National Geographic Society)

Map: Africa (by Gabelli US Inc.)

Video: Wildlife Warriors: Defending Africa's Animals (1995, by National Geographic Television)

Video: An Animal's World: African Elephant (VHS #744540 by Discovery Channel Video)

Publication: Without Borders: Uniting Africa's Wildlife Reserves (by Peter Godwin, published by National Geographic, September 2001)

Publication: Ivory Markets of Africa (by Esmond Martin and Daniel Stiles, published by Save the Elephants, March 2000)

Publication: Lethal Experiment (by Allan Thronton and Clare Perry et.al, printed by Emmerson Press)

Book: Elephant Woman by Laurence Pringle

Book: Elephants by Joyce Pool

STAMPS AND FUN STUFF

Simulated elephant tooth (#TQ-86, Skulls Unlimited International, Inc)

Simulated ivory artifacts
- Necklace
- Earrings
- Hairpin

Inkpad and stamps (used to student flow charts, journal pages, etc.)
- African masks
- Elephants
- African Elephants

To The Teacher: Beginning Assumptions

For success with the DNA laboratory work in The Elephant Project, students need conceptual understanding plus experience with micropipetting and electrophoresis.

Before starting the actual RFLP portion of The Elephant Project, it is assumed that:

1. Your students are very familiar with DNA structure, protein synthesis, mutations and the effects of mutations (good, bad and neutral) on cell structure and function.
2. Your students are competent and practiced with the use of a micropipet.
3. Your students have a functional understanding of the principles of electrophoresis, anode and cathode, charge, voltage and amperage, current, and pH.
4. Your students are practiced at making and pouring an agarose gel, loading the electrophoresis chamber with running buffer and loading a sample into the wells.
5. The students have a fundamental understanding that electrophoresis works by separating molecules using their polarity, size and molecular weight. They should know that smaller molecules are able to move faster, and therefore migrate further from the well, while larger molecules will be found close to the wells.
6. Procedural flow charts are a routine part of your preparation for labs, and that your students are competent at taking written procedures and drawing appropriate and accurate flow charts.

To prepare your students for the new Elephant scenario, it is recommended that you review with your students:

1. How to draw a flow chart. (Directions are included in "Basic Skills" section).

To prepare yourself for these new activities, we recommend that you:

1. Familiarize yourself with the plight of African elephants and the effort to save them. Conduct your own web-based information search.
2. Be able to describe the goals of Kenine Comstock and Sam Wasser as they tackle both science and socio-political issues. Emphasize to your students that Sam and Kenine ARE real people who have a passion for using DNA science to save these gentle giants.
3. Be reasonably familiar with the history of elephant/ivory hunting, the continental and global economics involved, and how war in these African countries puts all of their animals at risk. Many reference materials are included in this kit.
4. Familiarize yourself with the ethics module that follows the electrophoresis lab.
5. Consider starting your students on internet web searches concerning elephant conservation before actually starting the RFLP activity and electrophoresis lab.
6. Make connections with your social studies and language arts colleagues as to how this might be integrated into their academic disciplines.