Located adjacent to the San Diego Zoo Safari Park, the Arnold and Mabel Beckman Center for Conservation Research is headquarters for the largest zoo-based multidisciplinary research team in the world, the San Diego Zoo Institute for Conservation Research (ICR). At the ICR, the Community Engagement Team is dedicated to connecting students, teachers, and community members with the science of saving plants and animals worldwide, in the hopes of fostering a conservation literate and active public. Our Conservation Education Lab and Eddy Family Outdoor Learning Lab are respectively a full-service research laboratory classroom and restored native habitat outdoor classroom, both dedicated to students, teachers, and members of the community.

Exploring Conservation Science (ECS) programs in the Conservation Education Lab and Eddy Family Outdoor Learning Lab enable visitors to gain access to innovative research tools and participate in hands-on experiences that connect them to conservation science in new and meaningful ways. ECS programs support the Next Generation Science Standards. If your students are in 6th-8th grade, they may participate in our Middle School (MS) modules. If they are in 9th-12th grade or an undergraduate, they may participate in our High School (HS) modules. Please read through the following pages for detailed descriptions of each module before making selections for your students.

**Our Exploring Conservation Science field trip program offers 5 module choices, activities vary depending on grade level:**

- African Elephant Reproductive Endocrinology
- California Condor Genetics
- Desert Tortoise Spatial Ecology
- Life in a Biodiversity Hotspot
- Polar Bear Bioacoustics (MS) / Energetics (HS)

**Length:** 2.5 hours

**Maximum students:** 40 (minimum students: 15)

**Fee:** $10 per student

Additional discounted admission fees may apply.

For more information, or to schedule a visit, contact us at: conservationeducation@sandiegozoo.org.
Next Generation Science Standards

Crosscutting Concepts (CCC):

- Patterns
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change

Science and Engineering Practices (SEP):

- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Disciplinary Core Ideas (DCI) / Performance Expectations (PE):

<table>
<thead>
<tr>
<th>Physical Science</th>
<th>Life Science</th>
<th>Earth &amp; Space Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 Matter and its interactions</td>
<td>LS1 From Molecules to Organisms: Structures and Processes</td>
<td>ESS1 Earth’s Place in the Universe</td>
</tr>
<tr>
<td>PS2 Motion and stability: Forces and interactions</td>
<td>LS2 Ecosystems: Interactions, Energy, and Dynamics</td>
<td>ESS2 Earth’s Systems</td>
</tr>
<tr>
<td>PS3 Energy</td>
<td>LS3 Heredity: Inheritance and Variation of Traits</td>
<td>ESS3 Earth and Human Activity</td>
</tr>
<tr>
<td>PS4 Waves and their applications</td>
<td>LS4 Biological Evolution: Unity and Diversity</td>
<td></td>
</tr>
<tr>
<td>technologies for information transfer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Engineering, Technology, and the Application of Science

Bloom’s Taxonomy Levels (BTL)

Level 1: Remembering
Level 2: Understanding
Level 3: Applying
Level 4: Analyzing
Level 5: Evaluating
Level 6: Creating
High School
African Elephant Reproduction

Students will explore how San Diego Zoo Global has contributed to the recovery effort of the vulnerable African elephant. Our reproductive endocrinology research will be highlighted, with students exploring and utilizing a mock competitive ELISA as a tool to diagnose reproductive state of our female elephants. After conducting their investigations, students will analyze, graph, and share their results, culminating with applying their knowledge to make recommendations for a mock managed care breeding program.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)
- Lab equipment (micropipettes)
- Hormones (chemical signalers, receptors, feedback mechanisms, etc.)
- Competitive ELISA

Student Outcomes: (Students will…)
- Identify threats that African elephants face in the wild (BTL1-Remembering)
  **CCC: Cause and effect OR Stability and change**
- Outline key hormones and feedback mechanisms in the female reproductive cycle (BTL2-Understanding)
  **CCC: Systems and system models**
- Discuss the steps of competitive ELISA (BTL2-Understanding)
  **SEP: Planning and carrying out investigations**
- Determine reproductive state by generating and graphing hormone data (BTL5-Evaluating)
  **SEP: Analyzing and interpreting data**
- Make elephant husbandry recommendations and defend with evidence (BTL5-Evaluating)
  **SEP: Obtaining, evaluating, and communicating information**

Skills Practiced:
- Variable-volume micro-pipetting
- Proper sample handling techniques
- Graphing

NGSS Performance Expectations Supported:
- **PE: HS-LS1-2** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- **PE: HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.
- **PE: HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
High School California Condor Genetics

Students will explore how San Diego Zoo Global has contributed to the recovery effort of the critically endangered California condor. Our genetic research will be highlighted, with students exploring and utilizing polymerase chain reaction and gel electrophoresis as tools to determine sex of this sexually monomorphic species. While waiting for gel electrophoresis results, students will learn about the use of pedigrees to manage genetic disease, and apply their knowledge to make recommendations for a mock managed care breeding program.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)
- Lab equipment (micropipettes, thermal cyclers, gel electrophoresis rigs)
- DNA (replication, chromosomes, genes)
- Pedigrees & Punnett squares

Student Outcomes: (Students will…)
- Identify threats that California condors face in the wild (BTL1-Remembering)
  CCC: Cause and effect OR Stability and change
- Illustrate the steps of polymerase chain reaction (BTL2-Understanding)
  CCC: Patterns
- Interpret gel electrophoresis results to diagnose sex (BTL3-Applying)
  SEP: Analyzing and interpreting data
- Predict probability of genetic disease transfer using a Punnett square (BTL5-Evaluating)
  SEP: Using mathematics and computational thinking
- Recommend new California condor breeding pairs and defend choices (BTL5-Evaluating)
  SEP: Engaging in argument from evidence

Skills Practiced:
- Variable-volume micro-pipetting
- Proper sample handling techniques
- Loading agarose gel cassettes

NGSS Performance Expectations Supported:
- **PE: HS-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- **PE: HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- **PE: HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
High School
Desert Tortoise Spatial Ecology

Students will explore how San Diego Zoo Global uses spatial data to inform species management practices and conservation programs. We focus on our desert tortoise translocation program to engage students with radio telemetry devices in order to develop an understanding of spatial ecology through hands-on experience with modern technologies. Students will engage in a simulated spatial ecology study where they will be charged with tracking a plush tortoise and recording their tortoise’s history, health status, and location. Students will then couple this experience with wild desert tortoise bionomics to generate ideas to improve post-release monitoring of reintroduced and translocated populations.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)

- Desert ecosystem components
- Desert geographical features
- General reptile morphology and taxonomy

Student Outcomes: (Students will…)

- Understand spatial and temporal patterns of habitat use (BTL2-Understanding)
  CCC: Patterns; Cause and effect
- Apply tortoise ecology knowledge to connect species conservation to human impacts (BTL3-Applying)
  CCC: Cause and effect
- Describe the use of GPS and radio telemetry in collecting minimally biased data (BTL2-Understanding)
  SEP: Analyzing and interpreting data
- Practice the radio telemetry process and explain its application to ecological monitoring (BTL3-Applying)
  SEP: Obtaining, evaluating, and communicating information
- Interpret spatial data with life history knowledge to inform species management plans (BTL5-Evaluating)
  SEP: Engaging in argument from evidence

Skills Practiced:

- Using radio telemetry equipment
- Accessing and analyzing spatial data with Google Earth Pro
- Using mapping software to find perimeter and area averages

NGSS Performance Expectations Supported:

- PE: HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- PE: HS-LS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information.
- PE: HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
High School
Life in a Biodiversity Hotspot

Students will explore how San Diego Zoo Global has contributed to the recovery effort of the threatened coastal sage scrub ecosystem. Starting in the Eddy Family Outdoor Learning Lab, students will engage with this southern California ecosystem in a variety of ways: participating in an intricate web to model ecosystem dynamics, identifying and measuring plants, and learning about quadrant and point intercept sampling techniques. After moving into the Conservation Education Lab, students will analyze audio trap data as a third ecosystem assessment tool, and discuss pros and cons of all 3 techniques in relation to conservation activities.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)
- Biodiversity hotspots
- Ecosystem trophic levels
- Human impacts to the environment (climate change, habitat degradation, invasive species, etc.)

Student Outcomes: (Students will…)
- Identify threats to the coastal sage scrub ecosystem (BTL1-Remembering)
  CCC: Cause and effect
- Describe key features of biodiversity hotspots (BTL2-Understanding)
  CCC: Patterns
- Model coastal sage scrub ecosystem dynamics with their peers (BTL3-Applying)
  CCC: Systems and system models
- Carry out small-scale ecosystem assessments and contribute to real, ongoing dataset (BTL3-Applying)
  SEP: Planning and carrying out investigations
- Evaluate quadrant, point intercept, and audio trap sampling techniques as ecosystem assessment tools (BTL5-Evaluating)
  SEP: Engaging in argument from evidence

Skills Practiced:
- Percent cover quadrant sampling
- Point intercept sampling
- Audio trap data analysis

NGSS Performance Expectations Supported:
- PE: HS-LS2-6 Evaluate claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing condition may result in a new ecosystem.
- PE: HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- PE: HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
High School
Polar Bear Energetics

Students will explore how San Diego Zoo Global has contributed to polar bear recovery efforts by employing novel technology like accelerometers. Our recovery ecology research will be highlighted, with students exploring the effects of climate change on the Arctic, and polar bear energy budgets and demands. Students will learn the importance of managed care research for conservation in the wild by creating their own accelerometer data keys, and using them to determine cryptic polar bear behaviors.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)
- Causes and effects of climate change
- Physics behind accelerometers and fit bits
- Energy and motion

Student Outcomes: (Students will…)
- Identify concrete consequences to polar bears as a result of climate change (BTL1-Remembering)
  CCC: Cause and effect
- Give examples of ways that researchers collect data on wild polar bear behaviors (BTL2-Understanding)
  SEP: Obtaining, evaluating, and communicating information
- Discover how accelerometers work, and their use to collect behavioral data (BTL4-Analyzing)
  CCC: Systems and system models
- Generate accelerometer keys that correlate to different polar bear behaviors (BTL6-Creating)
  SEP: Developing and using models
- Analyze cryptic accelerometer data with their keys to determine polar bear behaviors (BTL4-Analyzing)
  SEP: Analyzing and interpreting data

Skills Practiced:
- Graphing
- Data interpretation
- Collaboration

NGSS Performance Expectations Supported:
- PE: HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- PE: HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- PE: HS-PS 3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
Students will explore how San Diego Zoo Global has contributed to the recovery effort of the vulnerable African elephant. Our reproductive endocrinology research will be highlighted, with students exploring and utilizing a mock competitive ELISA as a tool to diagnose reproductive state of our female elephants. After conducting their investigations, students will analyze, graph, and share their results, culminating with applying their knowledge to make recommendations for a mock managed care breeding program.

**Suggested Review:** (We recommend you review these concepts with your students BEFORE your visit)
- Lab equipment (fixed-volume micropipettes)
- Hormones (chemical signalers, receptors, etc.)
- Competitive ELISA

**Student Outcomes:** (Students will…)
- Identify threats that African elephants face in the wild (BTL1-Remembering)
  
  **CCC: Cause and effect OR Stability and change**
- Outline key hormones in the female reproductive cycle (BTL2-Understanding)
  
  **CCC: Systems and system models**
- Discuss the steps of competitive ELISA (BTL2-Understanding)
  
  **SEP: Planning and carrying out investigations**
- Determine reproductive state by generating and graphing hormone data (BTL5-Evaluating)
  
  **SEP: Analyzing and interpreting data**
- Make elephant husbandry recommendations and defend with evidence (BTL5-Evaluating)
  
  **SEP: Obtaining, evaluating, and communicating information**

**Skills Practiced:**
- Fixed-volume micro-pipetting
- Proper sample handling techniques
- Graphing

**NGSS Performance Expectations Supported:**
- **PE: MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- **PE: MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- **PE: MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.
Middle School
California Condor Genetics

Students will explore how San Diego Zoo Global has contributed to the recovery effort of the critically endangered California condor. Our genetic research will be highlighted, with students exploring cytogenetics. After learning about cell structure and phases, students will practice creating mock cell media solution for cell culture. Students will learn about the use of pedigrees to manage genetic disease, and apply their knowledge to make recommendations for a mock managed care breeding program.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)
- Lab equipment (fixed-volume micropipette, erlenmeyer flask, petri dish)
- Cell structure (nucleus, mitochondrion, etc.)
- Pedigrees & Punnett squares

Student Outcomes: (Students will…)
- Identify threats that California condors face in the wild (BTL1-Remembering)
  CCC: Cause and effect
- Illustrate cell structure and function (BTL2-Understanding)
  CCC: Systems and system models
- Analyze California condor cell phases (BTL4-Analyzing)
  SEP: Analyzing and interpreting data
- Carry out mock cell media preparation for cell culture (BTL3-Applying)
  CCC: Energy and matter
- Predict probability of genetic disease transfer using a Punnett square (BTL5-Evaluating)
  SEP: Using mathematics and computational thinking

Skills Practiced:
- Fixed-volume micro-pipetting
- Proper sample handling techniques
- Punnett squares

NGSS Performance Expectations Supported:
- PE: MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- PE: MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- PE: MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
Middle School
Desert Tortoise Spatial Ecology

Students will explore how San Diego Zoo Global uses spatial data to inform species management practices and conservation programs. We focus on our desert tortoise translocation program to engage students with radio telemetry devices in order to develop an understanding of spatial ecology through hands-on experience with modern technologies. Students will engage in a simulated spatial ecology study where they will be charged with tracking a plush tortoise and recording their tortoise’s history, health status, and location. Students will then couple this experience with wild desert tortoise bionomics to generate ideas to improve post-release monitoring of reintroduced and translocated populations.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)
- Desert ecosystem components
- Desert geographical features
- Latitude and longitude

Student Outcomes: (Students will…)
- Understand spatial and temporal patterns of habitat use (BTL2-Understanding)
  CCC: Patterns; Cause and effect
- Apply tortoise ecology knowledge to connect species conservation to human impacts (BTL3-Applying)
  CCC: Cause and effect
- Practice radio-telemetry and explain its application in wildlife conservation programs (BTL3-Applying)
  SEP: Constructing explanations and designing solutions
- Understand the use of different technologies in spatial ecology research (BTL2-Understanding)
  SEP: Constructing explanations and designing solutions
- Interpret spatial data with life history knowledge to inform species management plans (BTL5-Evaluating)
  SEP: Engaging in argument from evidence

Skills Practiced:
- Using radio telemetry technology in an outdoor setting
- Recording spatial data
- Using maps to find average distances

NGSS Performance Expectations Supported:
- PE: MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- PE: MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems
- PE: MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
Students will explore how San Diego Zoo Global has contributed to the recovery effort of the threatened coastal sage scrub ecosystem. Starting in the Eddy Family Outdoor Learning Lab, students will engage with this southern California ecosystem in a variety of ways: participating in an intricate web to model ecosystem dynamics, identifying and measuring plants, and learning about seed banking as a conservation tool. After moving into the Conservation Education Lab, students will process and sort real seeds to emulate seed banking work, and analyze camera trap photos to practice ecosystem health assessment.

**Suggested Review:** (We recommend you review these concepts with your students BEFORE your visit)
- Biodiversity hotspots
- Ecosystem trophic levels
- Human impacts to the environment (climate change, habitat degradation, invasive species, etc.)

**Student Outcomes:** (Students will…)
- Identify threats to the coastal sage scrub ecosystem (BTL1-Remembering)  
  **CCC: Cause and effect**
- Describe key features of biodiversity hotspots (BTL2-Understanding)  
  **CCC: Patterns**
- Model coastal sage scrub ecosystem dynamics with their peers (BTL3-Applying)  
  **CCC: Systems and system models**
- Carry out seed processing and sorting activities (BTL3-Applying)  
  **SEP: Constructing explanations and designing solutions**
- Analyze camera trap data to assess ecosystem health (BTL4-Analyzing)  
  **SEP: Analyzing and interpreting data**

**Skills Practiced:**
- Plant identification
- Seed processing
- Camera trap data analysis

**NGSS Performance Expectations Supported:**
- **PE: MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- **PE: MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- **PE: MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
Middle School
Polar Bear Bioacoustics

Students will explore how San Diego Zoo Global has contributed to polar bear recovery efforts through increased understanding of their biology. Our recovery ecology research will be highlighted, with students exploring the effects of climate change on the Arctic, and noise pollution caused by petroleum extraction sites on polar bears. Students will also learn the importance of managed care research for conservation in the wild, and conduct a hearing study to determine human range of hearing.

Suggested Review: (We recommend you review these concepts with your students BEFORE your visit)

- Causes and effects of climate change
- Frequency and hertz
- Scientific methods and processes

Student Outcomes: (Students will…)

- Identify concrete consequences to polar bears as a result of climate change (BTL1-Remembering)
  CCC: Cause and effect

- Outline an experiment to test the effects of noise pollution on wild polar bears (BTL2-Understanding)
  SEP: Planning and carrying out investigations

- Apply positive reinforcement behavior techniques (BTL3 -Applying)
  CCC: Patterns

- Analyze data regarding the hearing ranges of classmates and other species (BTL4-Analyzing)
  SEP: Analyzing and interpreting data

- Determine if wild polar bears can hear noise pollution from petroleum extraction sites (BTL5-Evaluating)
  SEP: Analyzing and interpreting data

Skills Practiced:

- Recording data
- Graphing results
- Applying positive reinforcement behavior training

NGSS Performance Expectations Supported:

- **PE: MS-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- **PE: MS-LS1-8** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- **PE: MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.