STEM EDUCATION: THE CASE OF LIFE SCIENCES

Educational partnerships in ecology

Rodolfo Dirzo
Stanford University

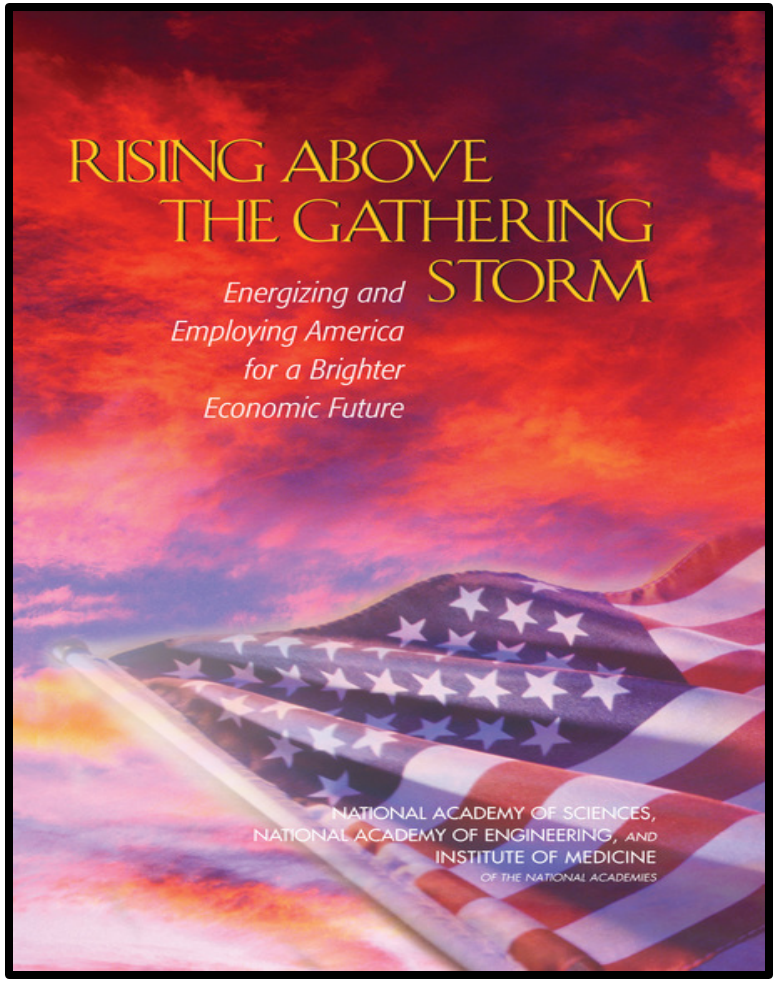
Motivation: two central problems

- **Basic science education in many countries (e.g., USA) is in trouble; urgent attention needed**
- **Need to appreciate the value of science in the context of real-life issues.** Example: Our environment is threatened – like never before

How can we contribute "locally"?

- Support students right from the start
- Special attention to groups that have not had opportunities

The SE problematic:
A National Academies Report



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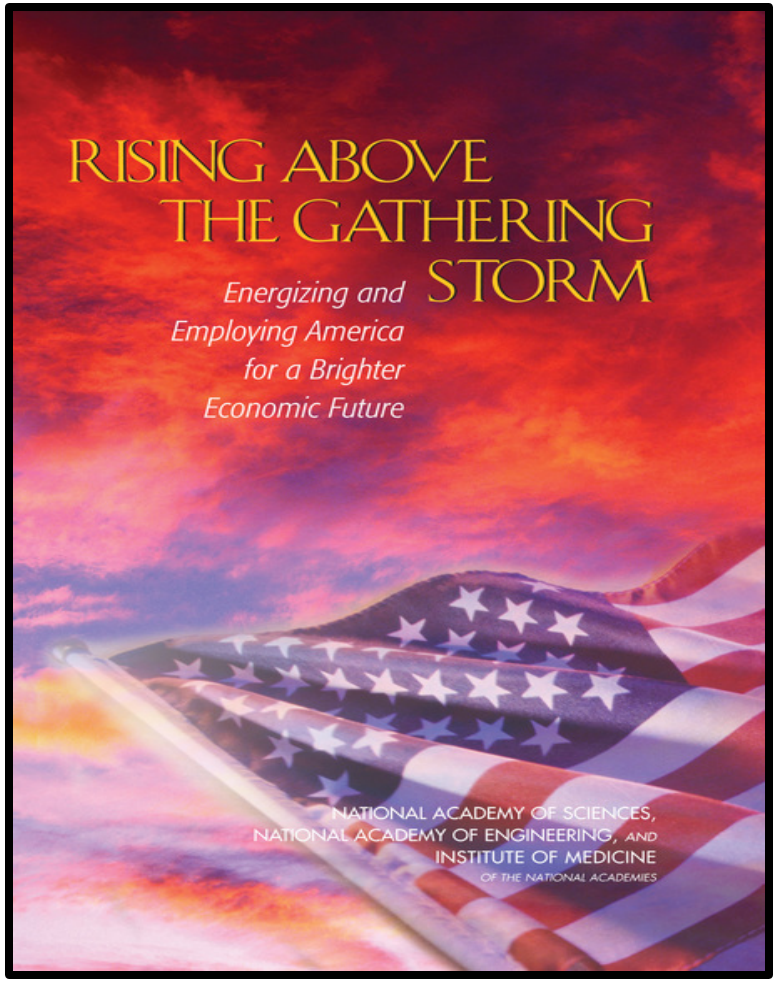


"Among OECD nations participating in a recent assessment of how well K-12 students can use mathematics and science knowledge, U.S. students were near the bottom of the 29 OECD members participating"

"…Nations must prepare today's K–12 students better to be tomorrow's productive workers and citizens"

RATIONALE UNDERLYING ACTION

Science education and literacy: Essential for social prosperity

- Increase the public's knowledge of, and appreciation for, the **importance of S&T in the context of quality of life, economic prosperity, and national security.**

- Informed citizens who understand basic science facts, concepts, and vocabulary, will be **more prepared to participate in public discourse on issues pertaining to science and technology**

RATIONALE UNDERLYING ACTION

Science education and literacy: Essential for social prosperity

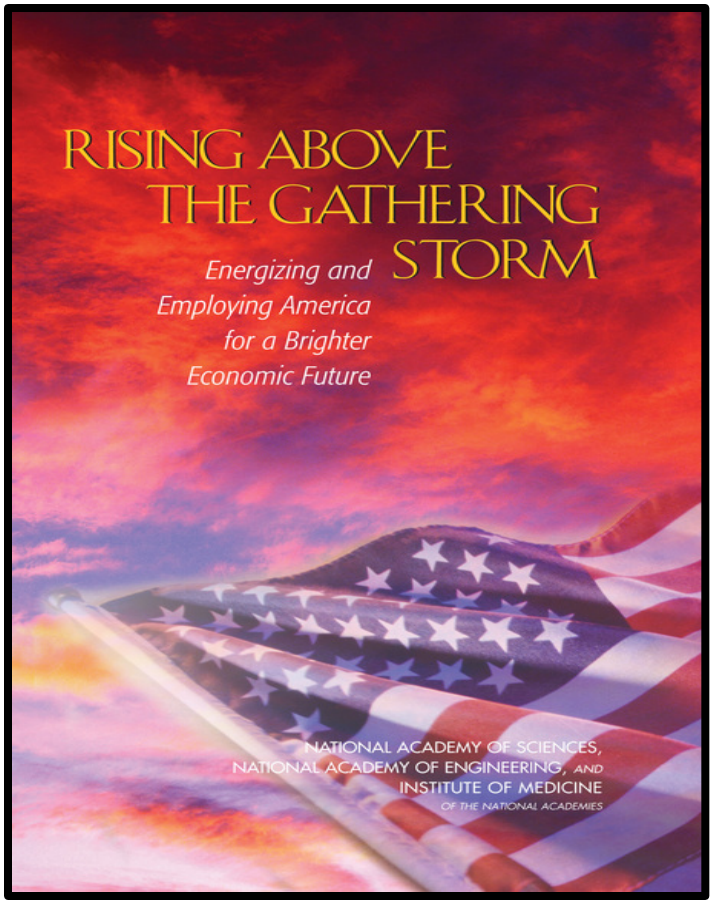
Science and Engineering Indicators (NSF, 2006) Recommendations:

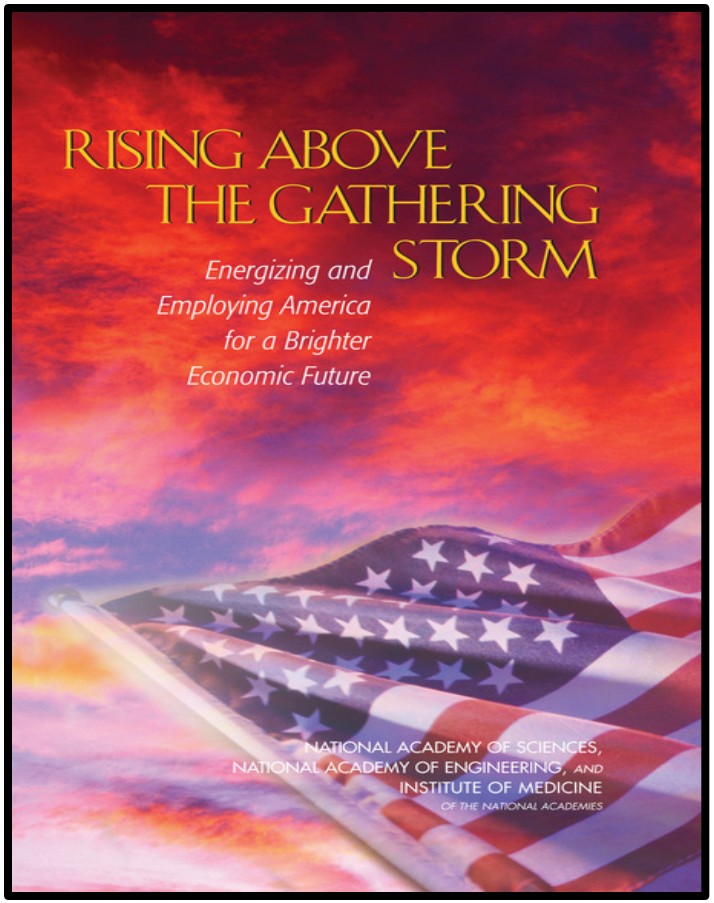
- "It is critical to increase the public's knowledge of, and appreciation for, the **importance of S&T in the context of quality of life, economic prosperity, and national security"**

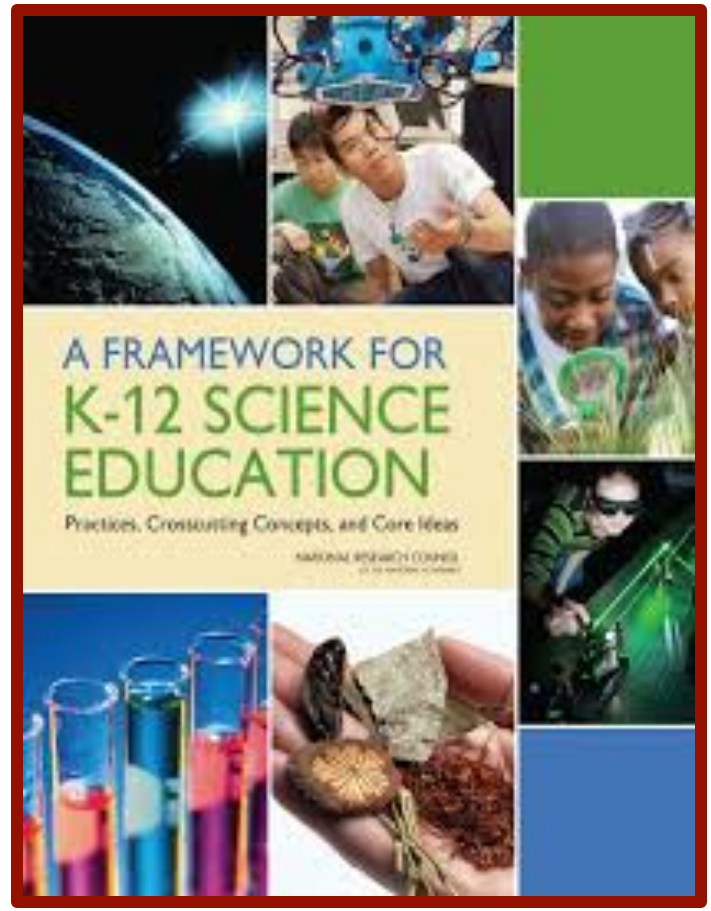
- "Informed citizens who understand basic science facts, concepts, and vocabulary, will be **more prepared to participate in public discourse on issues pertaining to science and technology"**

RATIONALE UNDERLYING ACTION

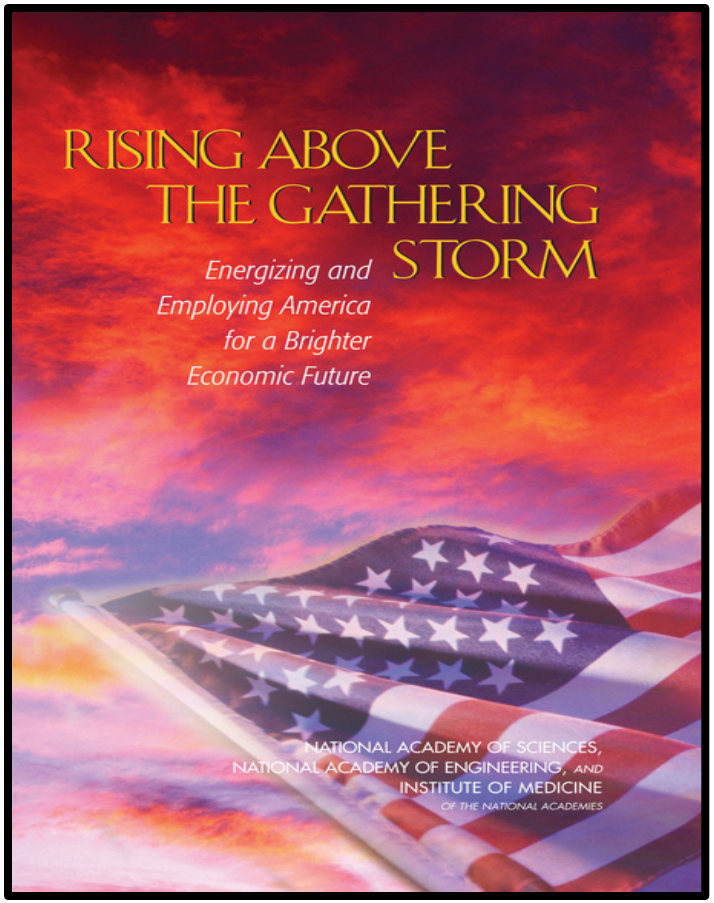
"As children move toward the day when their decisions will be the ones shaping societies, they will need to be equipped with the scientific tools necessary to meet those challenges…..”

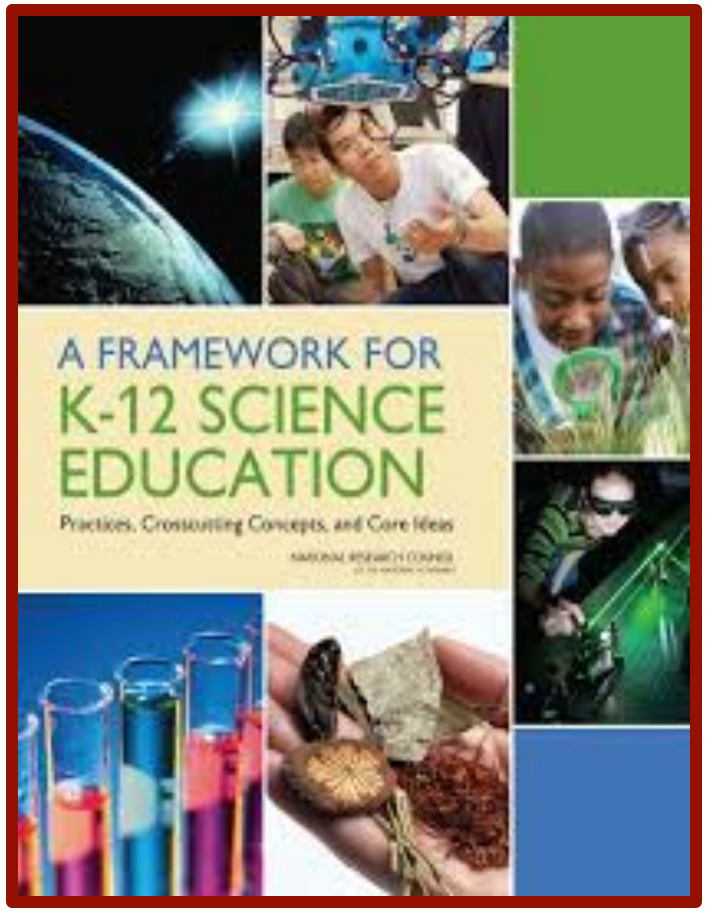

RISING ABOVE THE GATHERING STORM
Energizing and Employing America for a Brighter Economic Future
NATIONAL ACADEMY OF SCIENCES,
NATIONAL ACADEMY OF ENGINEERING, AND
INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

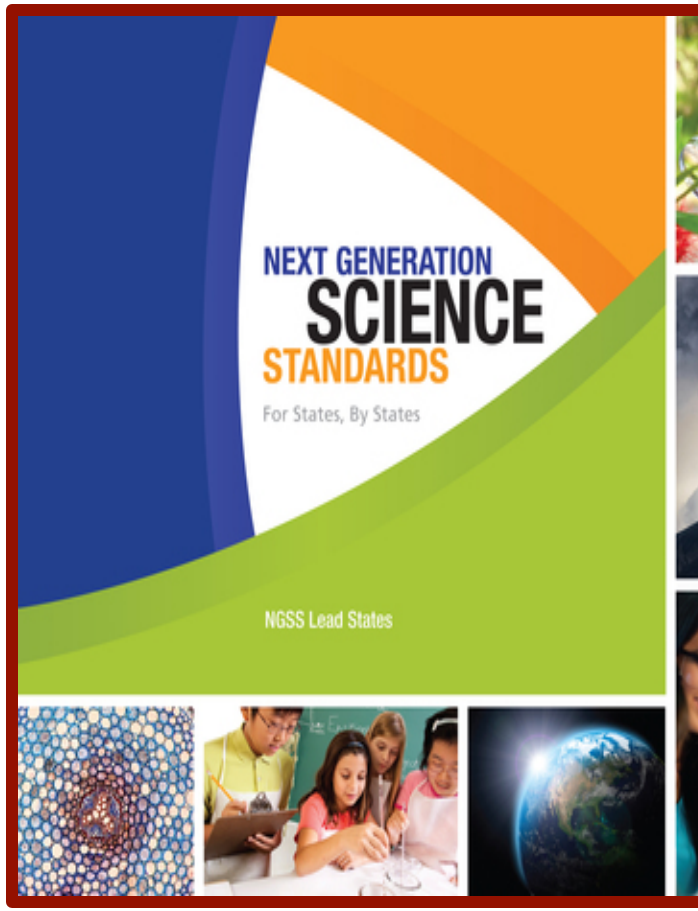




(Quinn et al. 2012)







(Quinn et al. 2012)

Science education and literacy: Essential for social prosperity

The K-12 Framework for teaching STEM

Use **inquiry-oriented, hands-on experiences** linked to relevant content

Enable students develop thinking skills (i.e., "learn to learn") and academic language

Recipe: Science with Three Dimensions

- Inquiry -> Scientific and engineering practices
- Crosscutting concepts
- Disciplinary core ideas

Henri Poincare: Science is made of facts, as a house is of stones, but a collection of facts is no more a science than a pile of stones is a house.

To build the house of science knowledge: all 3 dimensions work together

Science education and literacy: Essential for social prosperity

The K-12 Framework for teaching STEM

Move away from memorizing emphasis; focus on: cross-cutting concepts/principles and core disciplinary ideas

Expand **incentives for students** to study STEM fields and enter STEM careers, including **underrepresented groups**

Motivation: two central problems

- **Basic science education in many countries (e.g., USA) is in trouble; needs attention**
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How can we contribute "locally"?

- **Support students right from the start**
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Scientific consensus on the critical situation of the global environment in the Anthropocene

http://consensusforaction.stanford.edu

Scientific Consensus on

Maintaining Humanity's Life Support Systems in the 21st Century

Information for Policy Makers

THREATS TO LIFE SUPPORTING SYSTEMS

CLIMATIC CHANGE: More intense and fastest since we appeared as a species

HABITAT DESTRUCTION: >40% of land surface; oceanic floor ~ doble del territorio USA

CONTAMINATION: Contaminants at record levels and increasing; impacts on humans and wild life

POPULATION: 7000 M now; 9,500 M by2050; unequal consumption

BIOLOGICAL EXTINCTION: The greatest since K-T (75M) (dinosaurs)

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How can *we* contribute "locally"?

- **Support local schools** (students) **from the get-go**
- **Special attention to groups w/ limited opportunities**
- **Engage in science education projects–Partnerships**

Stanford's Outreach Partnerships

"Extra-muros" (outdoors) science learning
Education and outreach to the community

"Ecology: Learning by Doing" → REAL

R – Redwood
E – Environmental
A – Academy of
L – Leadership

GOALS OF REAL PROGRAM

- Provide students/teachers with resources to teach/learn ecology
- Design hands-on project(s) that inspire students to learn science – Ecology
- Give students confidence to know they can do well in study (science)
- Link students across borders via technology to enrich their knowledge of global ecological problems

ULTIMATE ASPIRATION

Engage students/teachers/families in appreciating the fascination and societal value of ecology as a scientific discipline

METHODOLOGY

Developing an academy of leadership

- Develop curricular program: Overarching modules and “sessions”
- Get basic physical infrastructure: equipped classroom, outdoor teaching space (garden → field station), materials, tools
- Engage university students + faculty **AND** school teachers and leadership
- Execute hands-on science projects
- Complement with “field trips” (labs, museums, job market place)

Examples of Curriculum Sessions

(Hands-on Activities)

- Ecological connections: Watershed to creek
- Invasion of exotic species in native ecosystems
- Photosynthesis in your garden
- Ecological analysis and global biodiversity data
- Art and Science: Hip-hop and fish conservation

- Framework, conceptual introduction
- Hands-on activity: fieldwork execution
- Analysis of findings: Math, language
- Discussion and evidence-based debate
- Share, communicate
- Student journal

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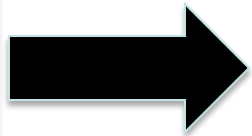

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An enquiry-based project

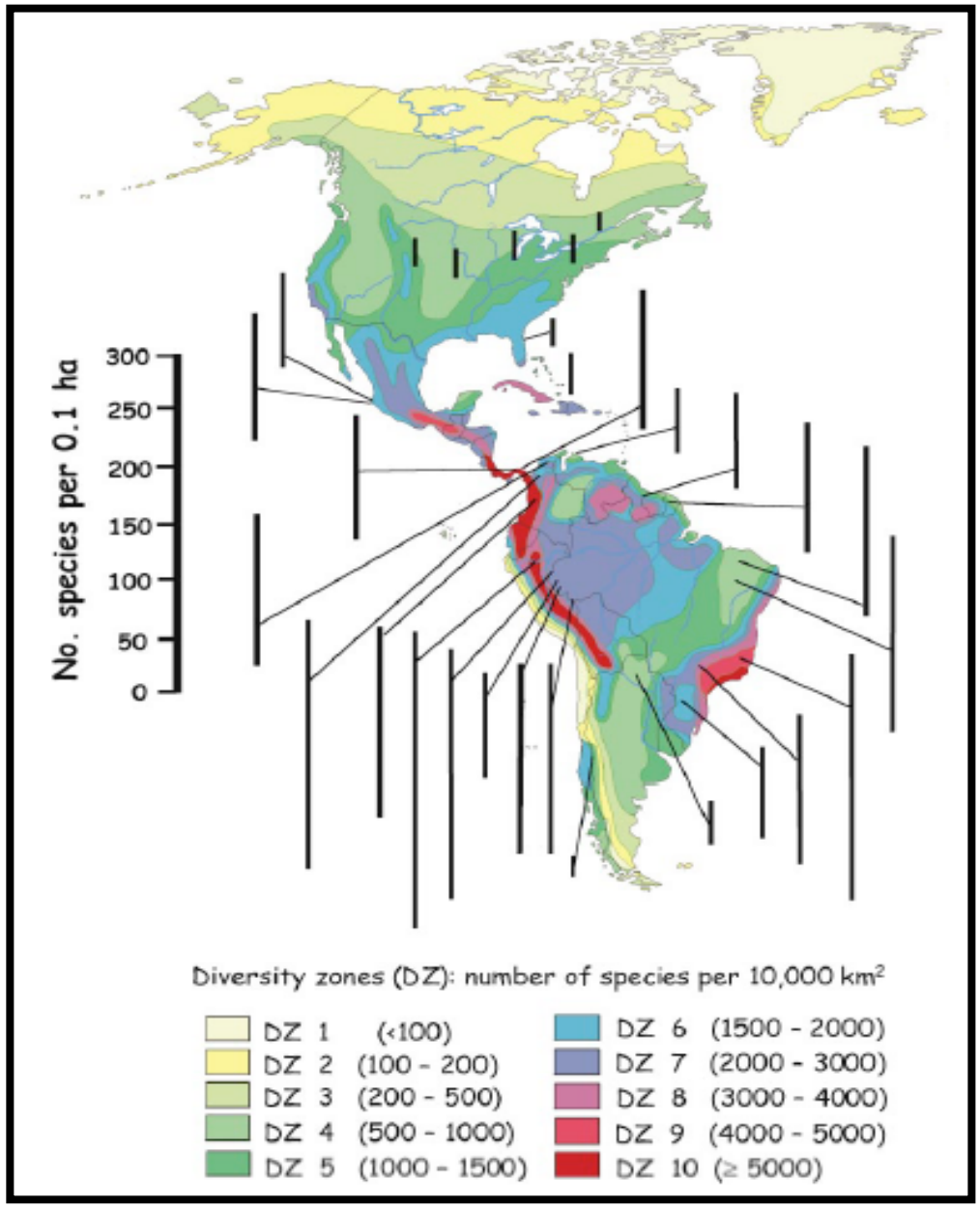
How does plant biodiversity change across the world?

[How can scientists know? Why does it matter?]

- **A local analysis**
- **A global context**

Plant species diversity in the continent

(trees DBH >2.5 cm)



(Dirzo & Raven 2003)

Objectives

- Appreciate plant diversity via “sampling”
- Conduct a scientific analysis of a plant community at JRBP
  - *A repeatable methodology; collect data*
  - *Plant species richness*
- Analyze and discuss results in a broad geographic context; contribute to global knowledge

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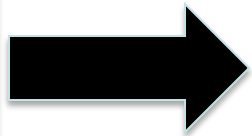
Examples of Curriculum Sessions
(Hands-on Activities)

- Ecological connections: Watershed to creek
- Invasion of exotic species in riparian ecosystems
- Ecology of plant-animal interactions – at RHS and JRBP
- Vegetation analysis and global biodiversity data
- Art and Science: Hip-hop and fish conservation



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REAL Program:

Art, science, social responsibility
(making a difference)

Save the fishes: A short video
(YouTube REAL)

Evaluation of REAL outcomes at year 2

(By Melissa Arnold, ESA Education Officer)

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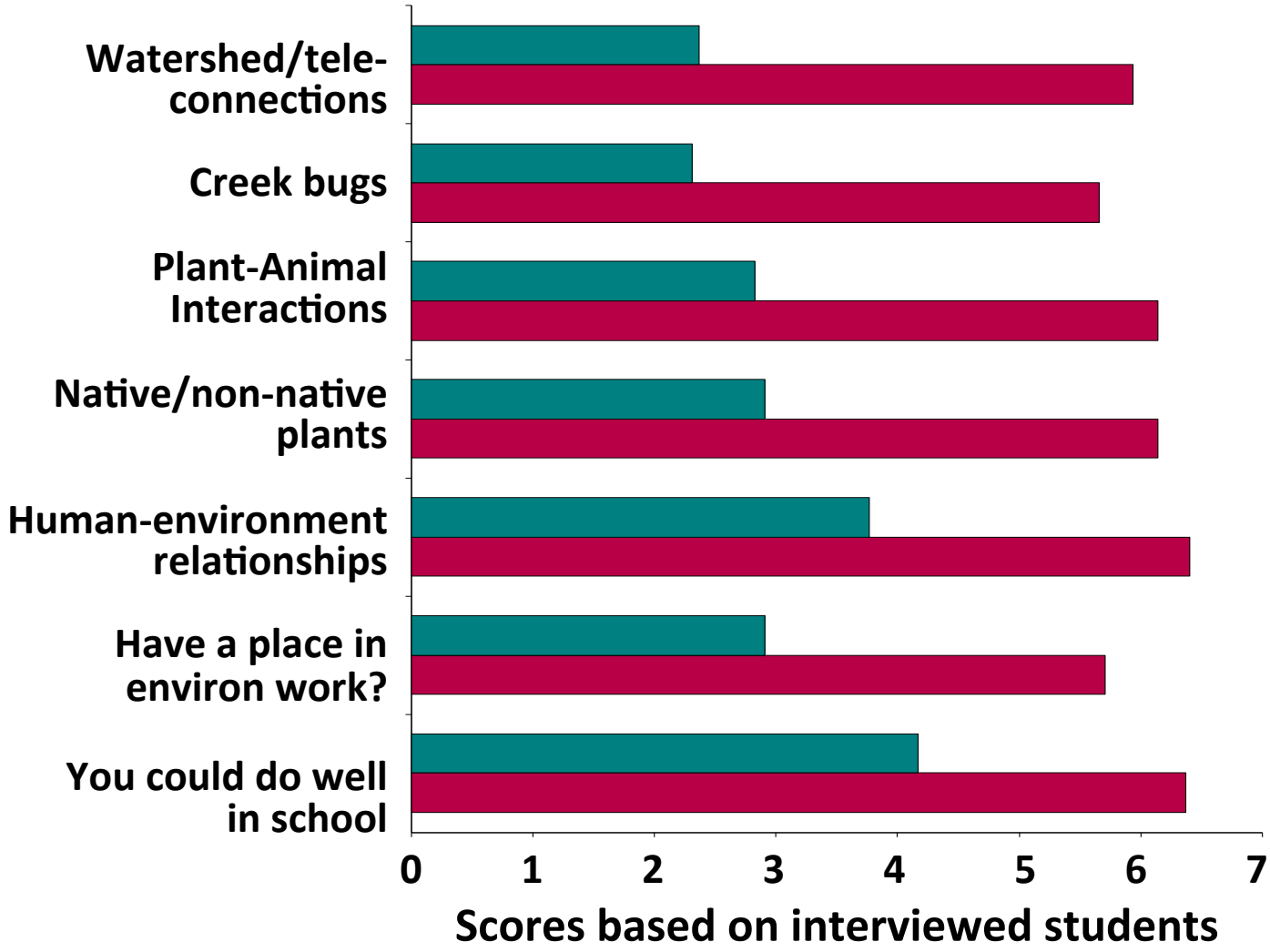

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THE "REAL" PROGRAM
Guiding principle: *"Learning by doing"*

A program of direct participation of students in "doing"ecology – three *practical* aspects

- Outdoor learning (science – ecology)
- Ecology projects
- A learning community, partnership
  - Local Middle and High School
  - Stanford/Jasper Ridge, Dirzo Lab
  - Support: Stanford University (Outreach Program)