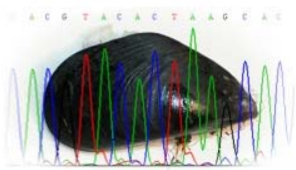
Marine Biotechnology and Bioinformatics for Teachers

March 29, 2007: 14:00-15:00

Presentation, Bio, Middle Level-High School

Location: Adam's Mark Hotel, Promenade D



Marine Biotechnology and Bioinformatics

Teacher Enhancement Program at Moss Landing Marine Labs

Funded by NSF - ITEST

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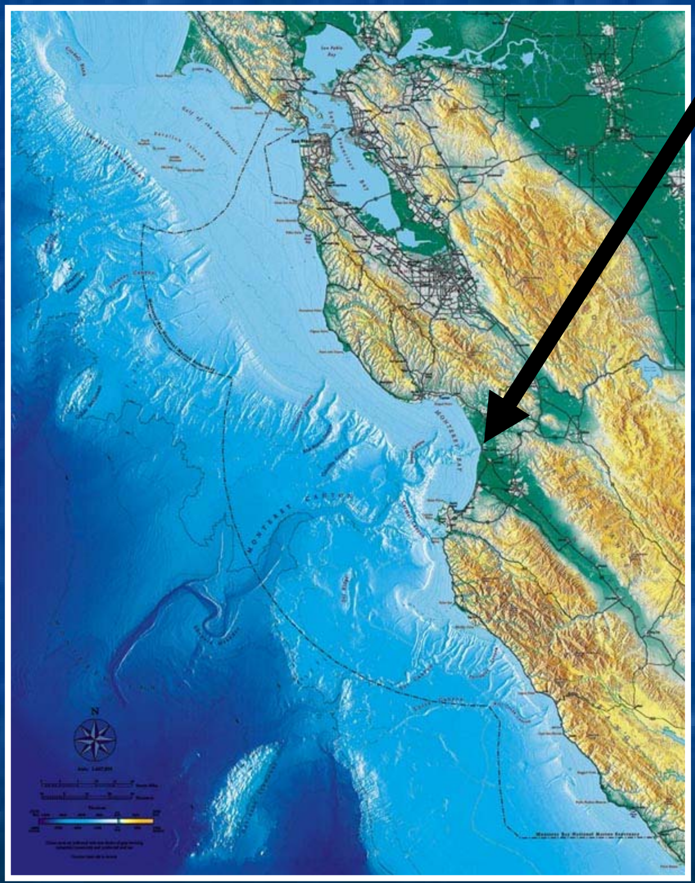
The Teacher Enhancement Program at Moss Landing Marine Laboratories

Dr. Simona Bartl, Director

Our Location: Monterey Bay



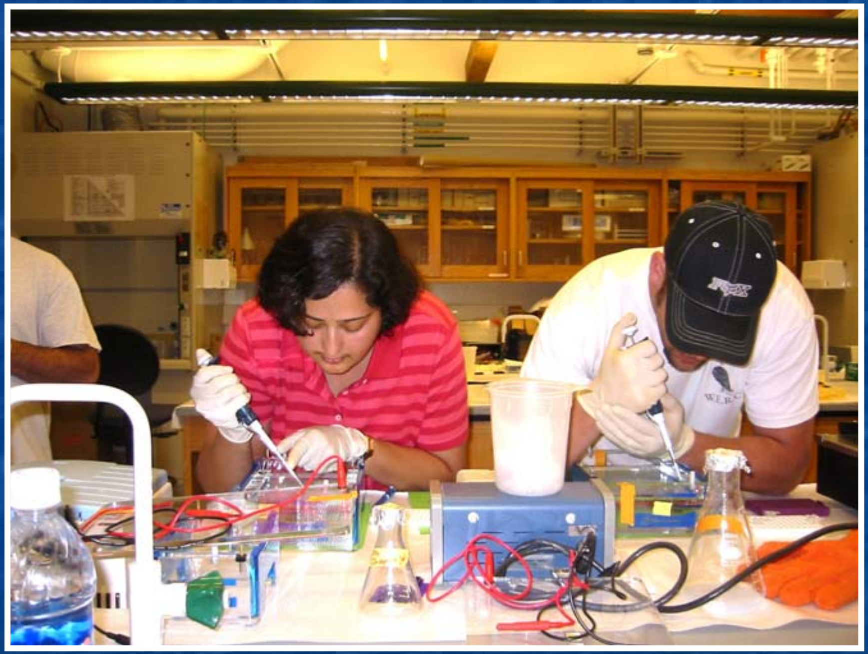
- Part of the Monterey Bay National Marine Sanctuary
- Federally protected marine area offshore of California's central coast, an underwater National Park

Overview

- I will describe
  - our program's activities
  - associated standards
  - evaluation findings
  - best practices

The program

- MLML - A Cal State University graduate program in marine science
- TEP - provides hands-on experience in marine research to teachers
- This workshop - 3 weeks of marine biotechnology and bioinformatics



Outline of teacher activities

- Background
  - Invasive species
  - Local cryptic invader
  - Marine mussels
- Hypothesis
- Materials and methods
- Expected results
- Possible conclusions

Carcinus maenas, the European green crab, invader of the Pacific west coast. Photo credit: Jim Carlton

Invasive species

- Non-native species are organisms introduced into an environment in which they did not evolve
- Invasive species are non-native species that significantly out-compete native species
- Largest threat to biodiversity after habitat loss

Caulerpa taxifolia, an invasive marine alga, in the Mediterranean Sea. Photo credit: U. of Nice, France

Some invasions are cryptic

- Cryptic meaning concealed, hidden
- Often invaders hybridize with natives significantly altering the genetics
- Before 1988 all “Bay mussels” were *Mytilus edulis*
- Thought to be distributed world-wide in temperate areas

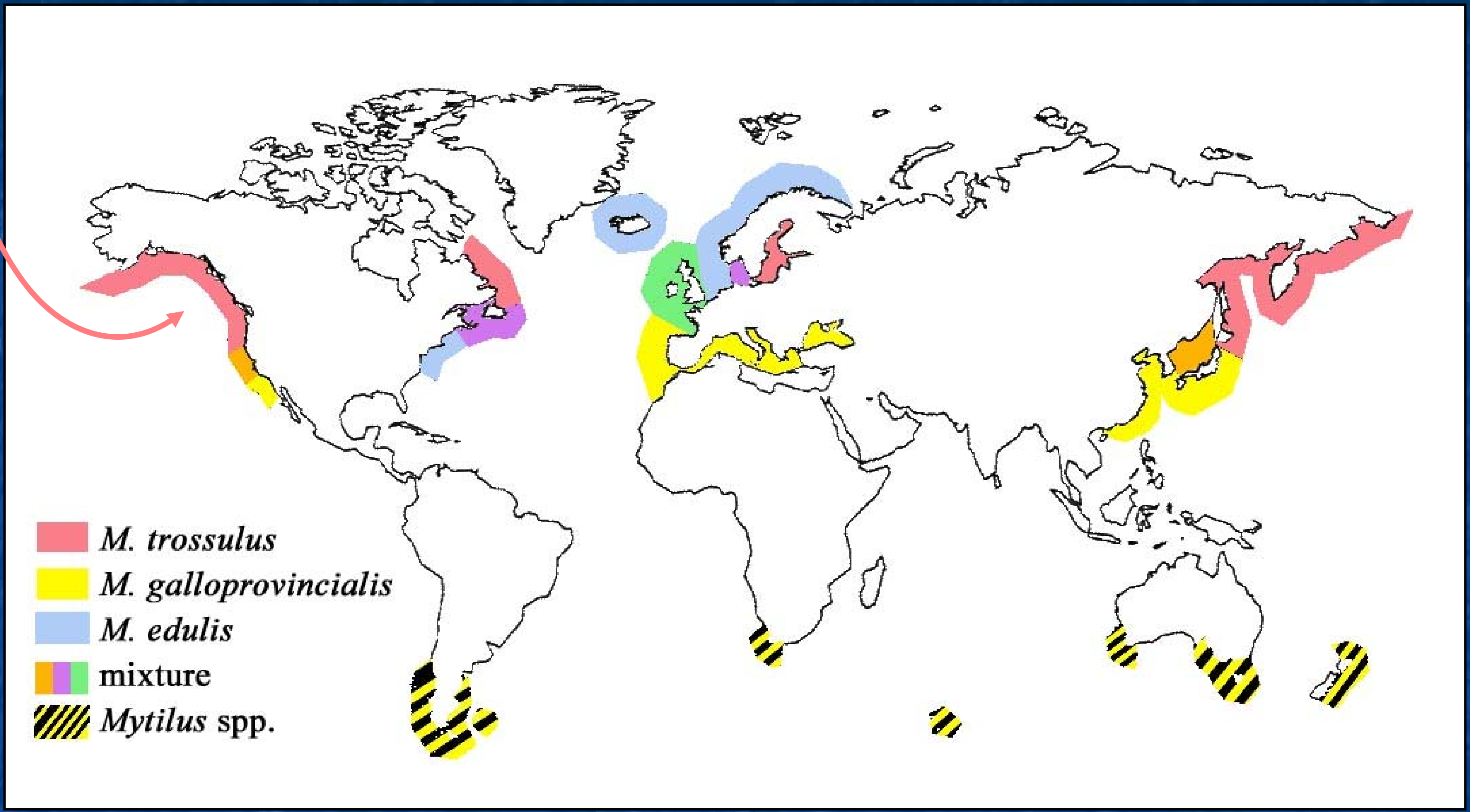
http://www.penncoveshellfish.com/PennCoveMussels.htm


Biotechnology and bioinformatics

- Found three morphologically indistinguishable species
  - *Mytilus edulis*
  - *Mytilus trossulus*
  - *Mytilus galloprovincialis*
- Only one is a successful invader

Photo credit: J. Geller

Our Native

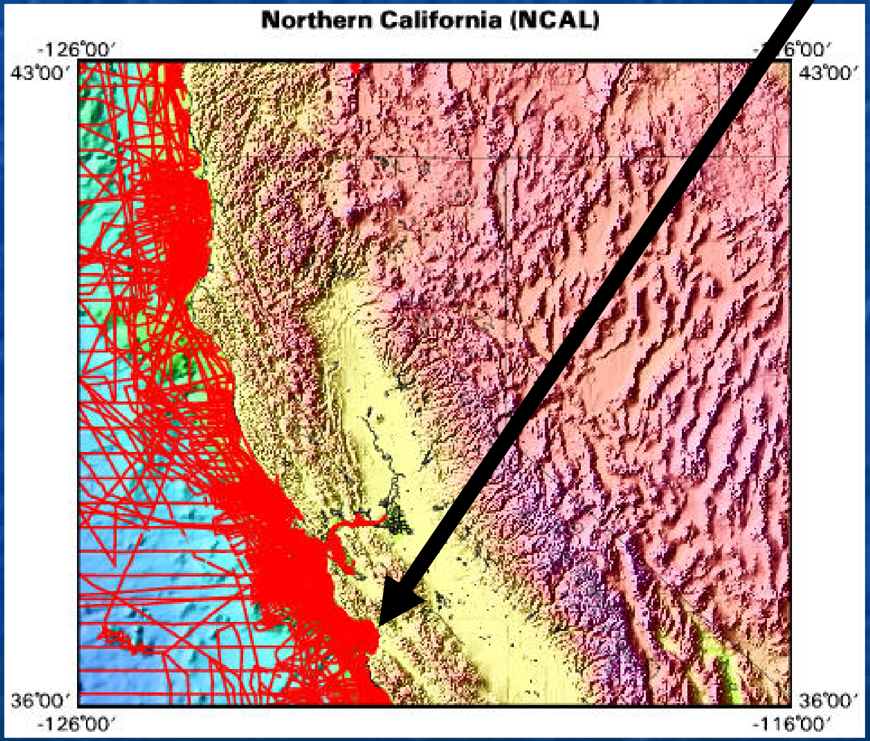

M. trossulus
M. galloprovincialis
M. edulis
mixture
Mytilus spp.

Biotechnology and bioinformatics

- *Mytilus galloprovincialis* is the successful invader
- Found with "investigative work" like in CSI

Photo credit: J. Geller

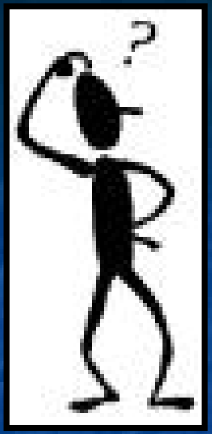
Our Location: Monterey Bay



- South of San Francisco Bay
  - a major harbor
  - source of invasive species
  - red lines = boat traffic
- Mixed population of native and invasive mussel

http://walrus.wr.usgs.gov/infobank/gazette/html/navigation/ncal.html

Why do we care?



- To address major questions in natural selection and biodiversity
  - How can the invader push out the native?
  - What makes an invader successful?
- To assess loss of genetic diversity
  - Of a major part in the rocky intertidal
- To monitor an invasive species in the Sanctuary

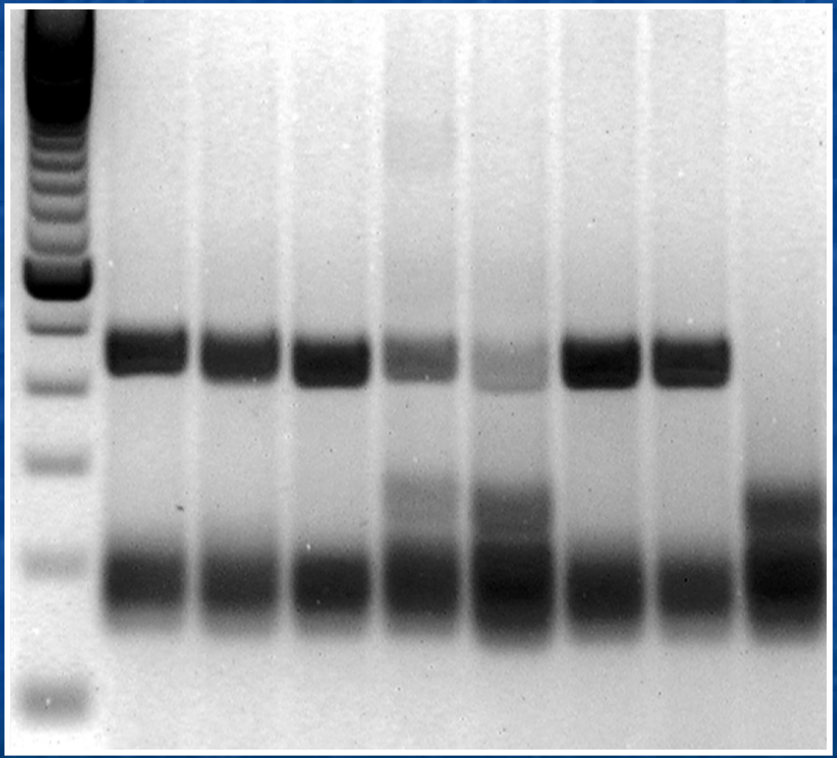
Hypothesis

- The invader, *Mytilus galloprovincialis*, is displacing the native *Mytilus trossulus*

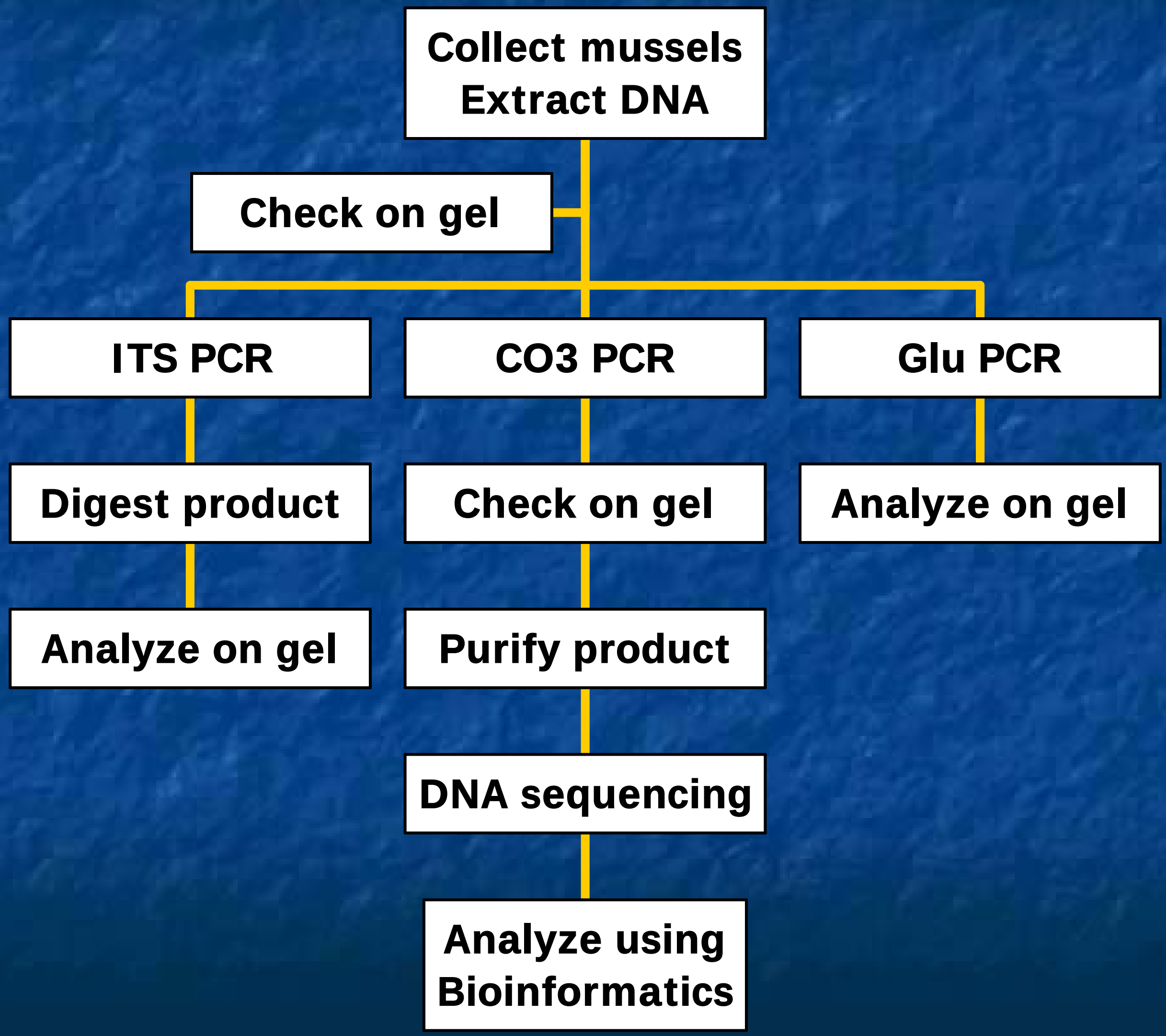
Washington Dept. of Fish and Wildlife

Materials and Methods

- Materials: Mussels
- Methods: Biotechnology:
  - DNA extraction -> Polymerase Chain Reaction -> Analysis
    - By gel electrophoresis
    - By DNA sequencing

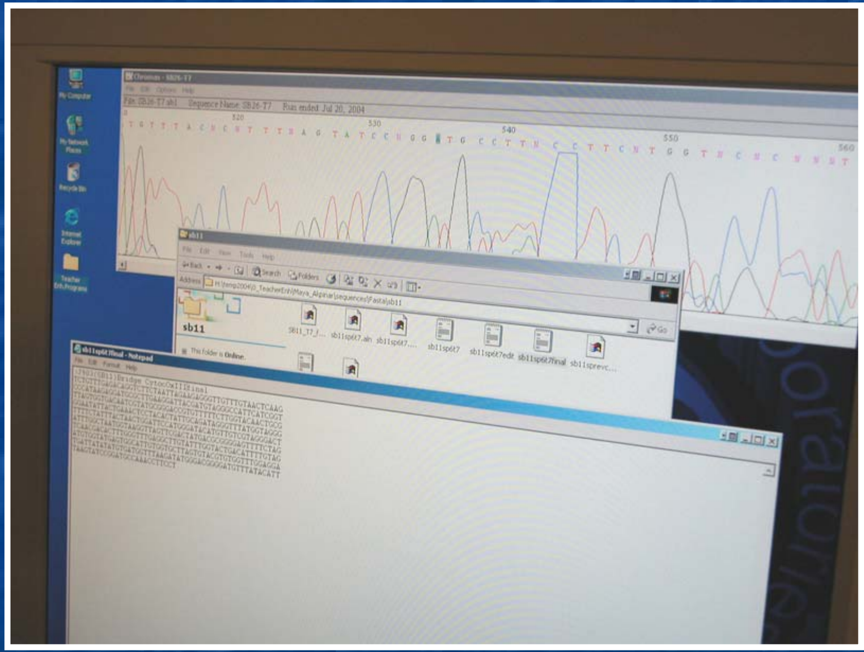


Biotech Flowchart

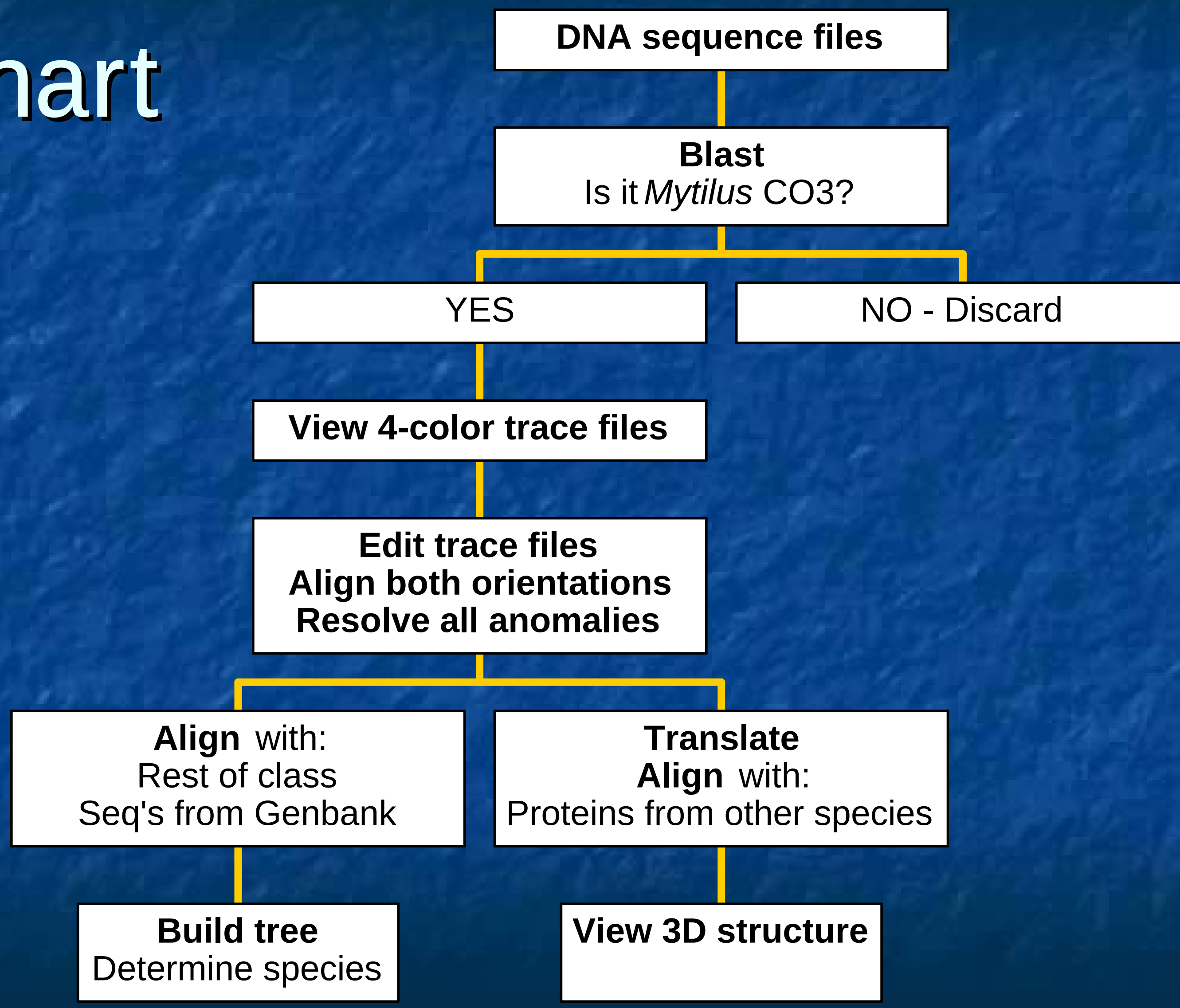


Materials and Methods (cont'd)

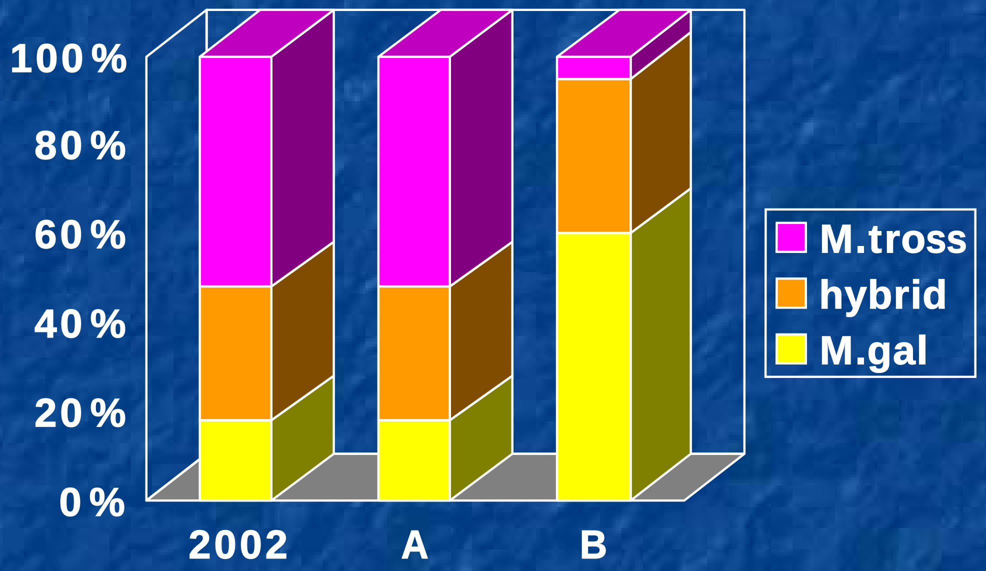
- Methods: Bioinformatics:
  - DNA sequences -> Edit -> Align
    - Search databases
    - Translate DNA sequences to protein sequences



Bioinformatics Flowchart

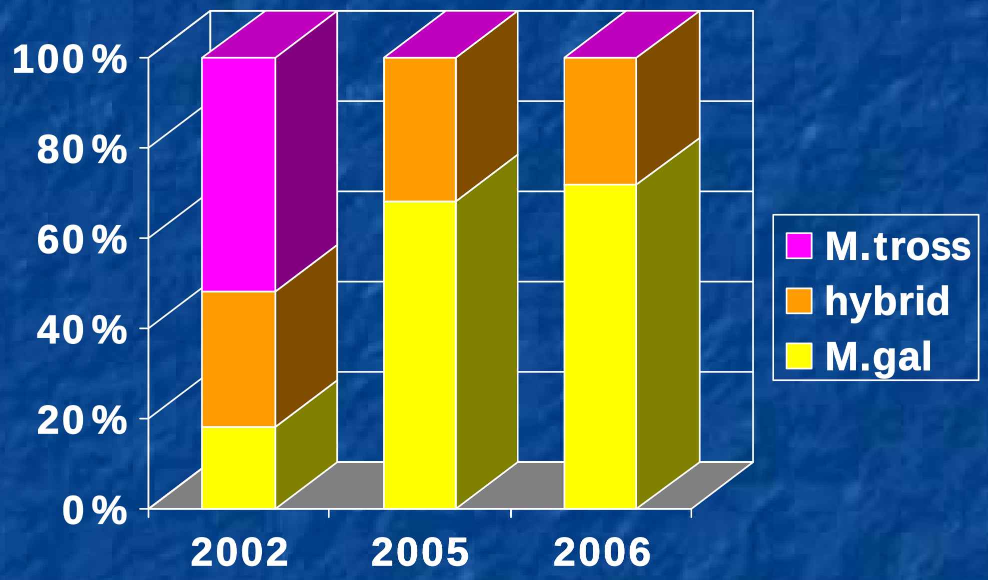


Two possible expected results



- A: The native population is stable over time
- B: Displacement is occurring

Conclusions



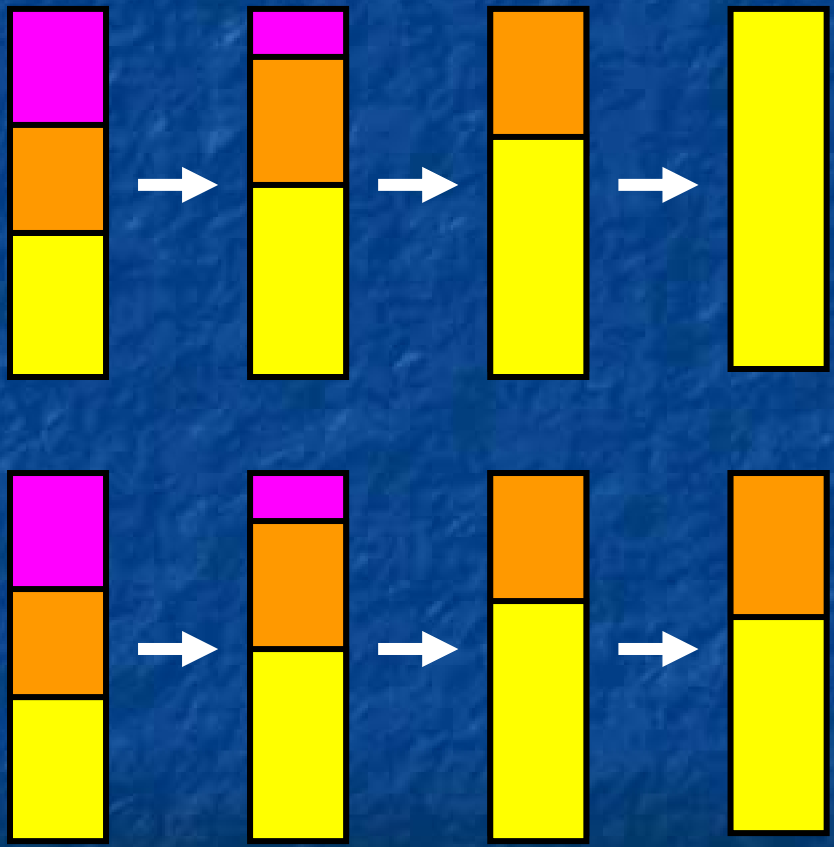
- Is displacement occurring OR
- Does our sampling and analysis differ from the 2002 study * ?

- * Reference: Braby & Somero, 2005, Marine Biology

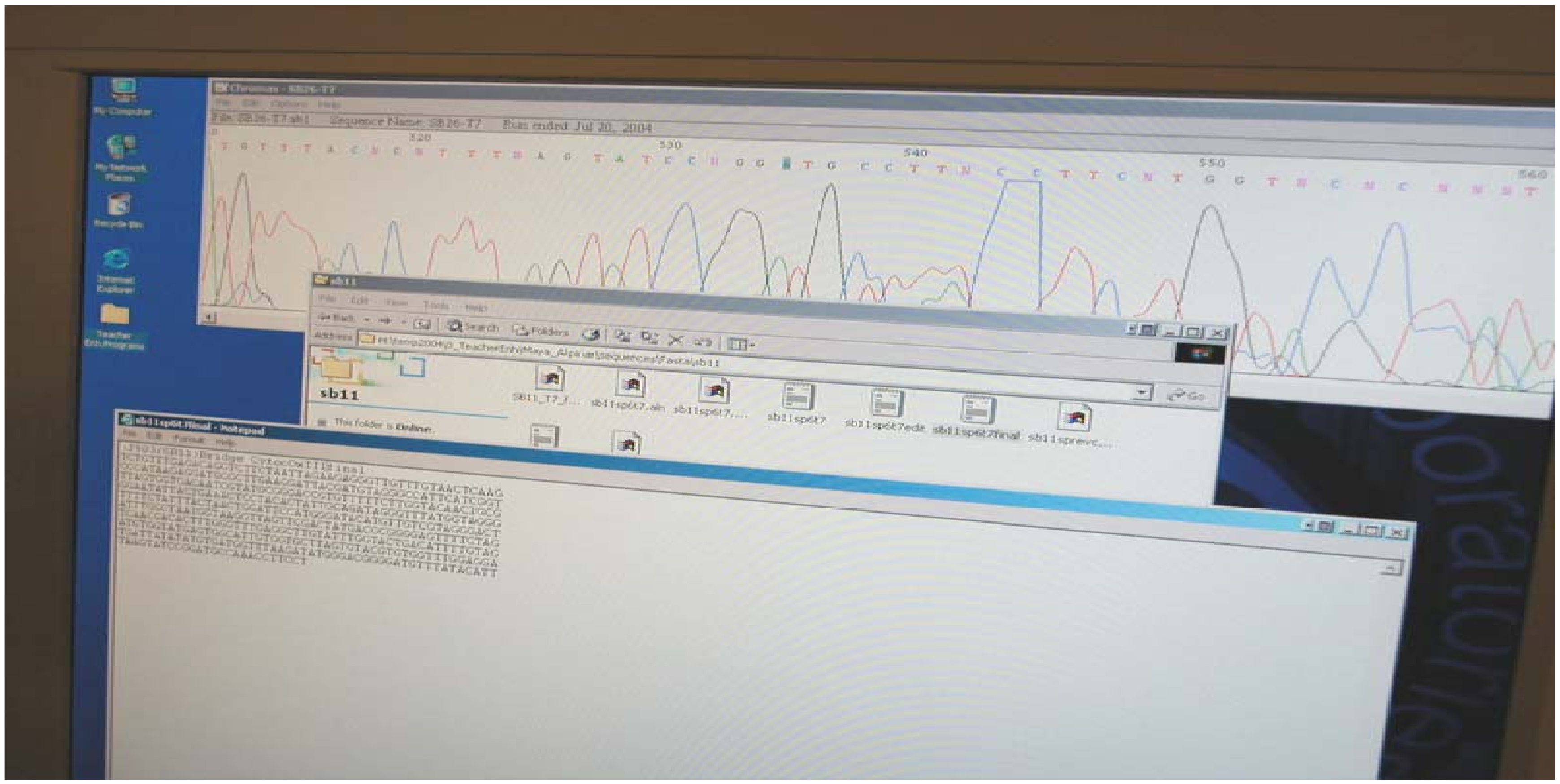
Possible conclusions

- Displacement
  - The native may disappear from the central coast in the future
  - The invader will have very limited genetic diversity
- Stable hybrid population
  - Although displacement may be occurring the native genes will be retained

Future workshops will follow the trend



Questions & Discussion



National Science Education Standards: PROFESSIONAL DEVELOPMENT

- Professional development for teachers of science requires:
  - A: learning essential science content through the perspectives and methods of inquiry.
  - B: integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching.
  - C: building understanding and ability for lifelong learning.
  - D: Professional development programs for teachers of science must be coherent and integrated.

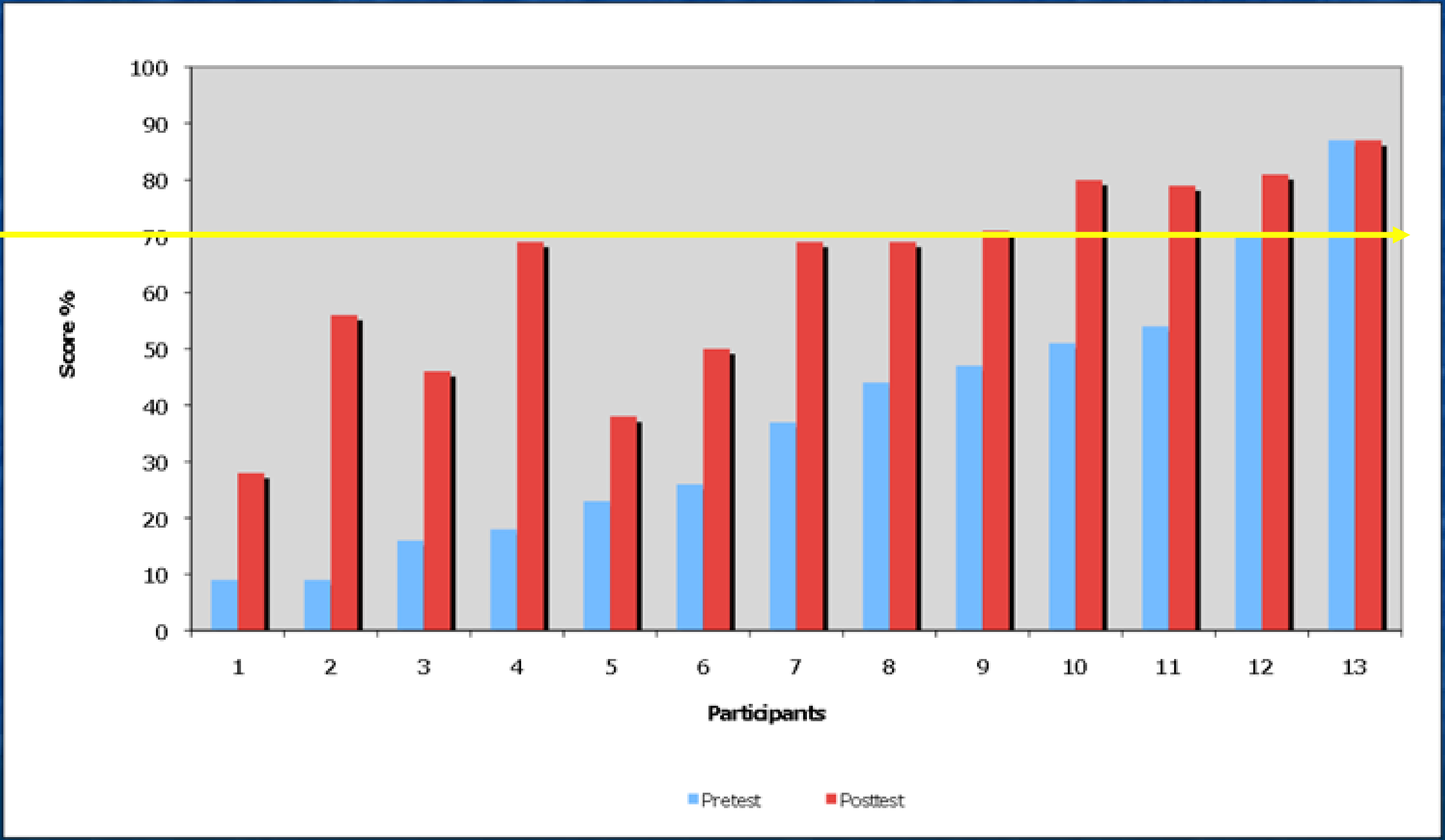
Evaluation Results

- Teachers Benefited
  - Experienced authentic science and cutting edge technologies
  - Mastered new information and skills
  - Implemented best teaching practices
  - Increased self-confidence
  - Developed a learning community
- Students Benefited
  - Experienced authentic science and authentic assessment
  - Did cutting-edge hands-on science and technology
  - Saw the ocean for the first time
  - Became part of a college-bound peer community
  - Worked in peer teams to present their findings

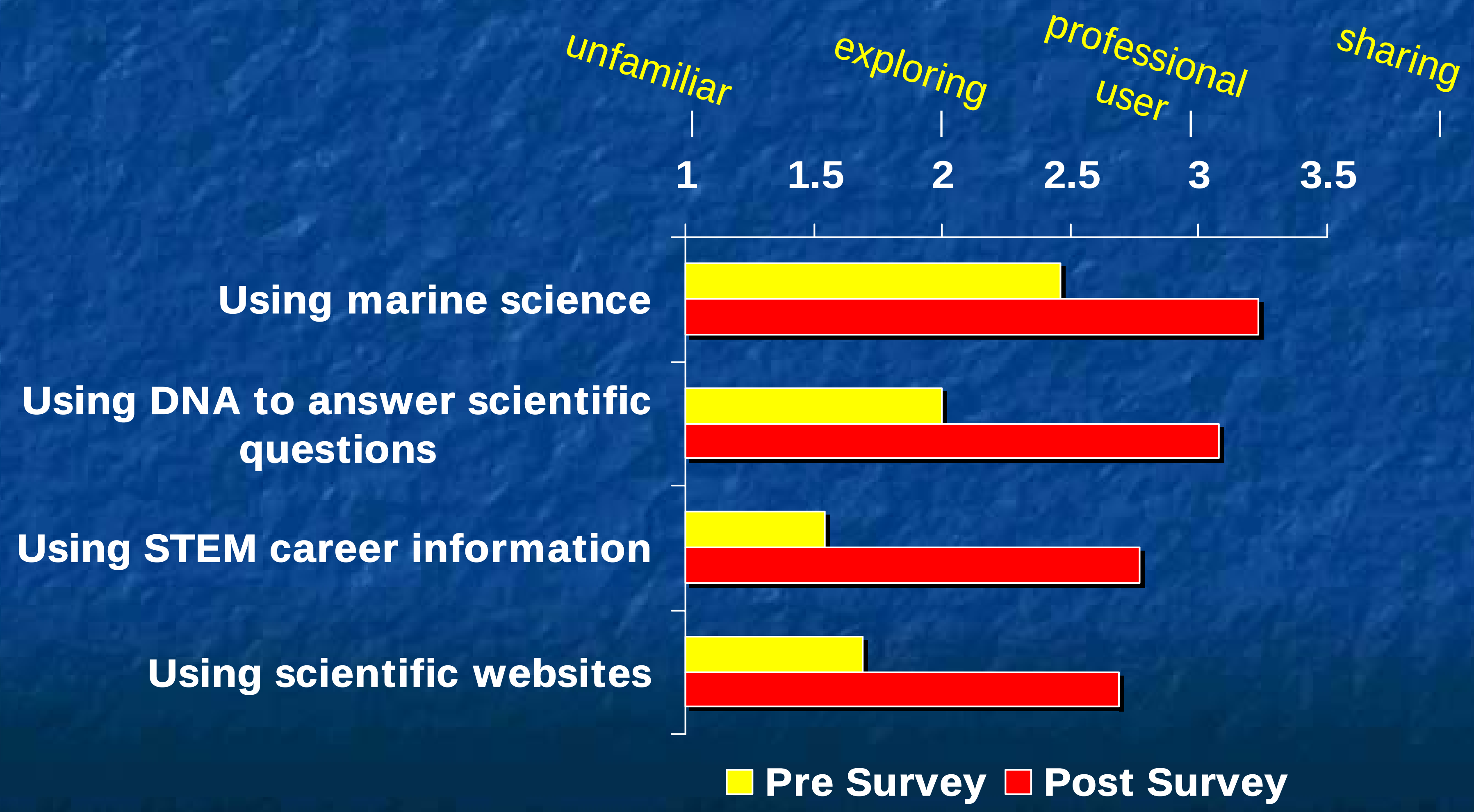
Findings: Reasons for Attending

Participants mastered the science

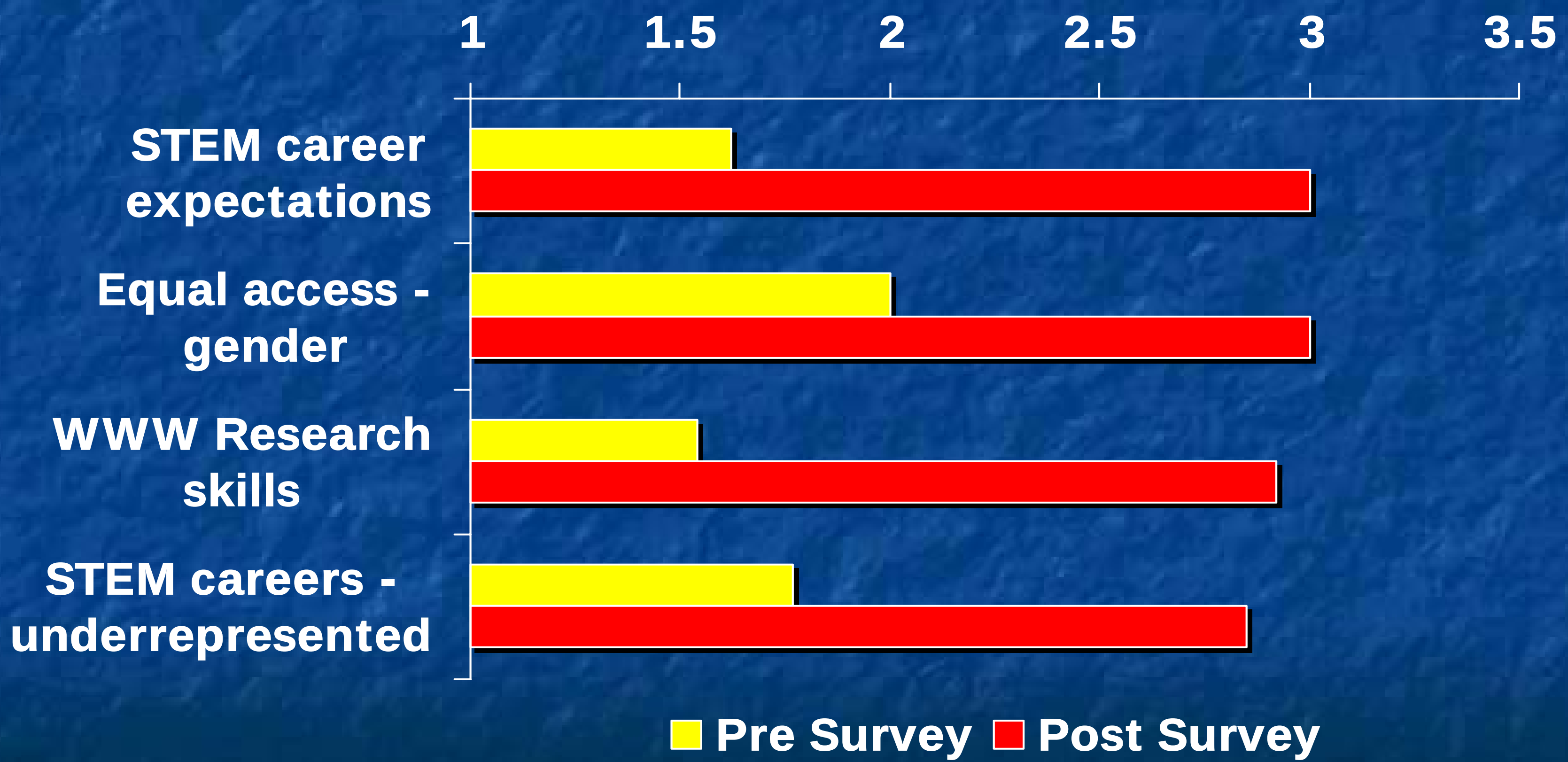
70% mastery level



Participants learned to teach the science more effectively.



Participants learned to integrate STEM careers in their lessons



Lessons Learned

- Begin targeted recruitment earlier.
- Use self-paced instruction and question sessions to accommodate individual differences.
- Review daily goals, tasks, and priorities to help participants use their time more effectively.
- Use participants' goals, including STEM career component, to focus curriculum.
- Enrich out of class time, an under-exploited resource.
- The workshop motivated high school participants to study science and work harder in school.

Questions & Discussion

Best Practices

- Real science:
  - Real question:Tracking invasive species
  - Scientific method and novel data
- Information in Small Bits (Kernel Objects)
- Emerging Technologies:
  - Voice-over-internet-protocol (VOIP),E-Quizzes, E-surveys, Websites, Digital cameras/camcorders, Pod-casts
- Templates:
  - Lesson plans, Handouts, Activities (PowerPoint presentations, Webquests), Posters

Best Practices

- Communications
  - Website, Email list, Academic year meetings
  - Web conferences: Experts in classroom or Virtual field trips or visits (Skype and Breeze)
- Learner to Teacher
  - Japanese Lesson Study, Team teaching, Project-based learning, Reflective evaluation
- Distributed Education
  - Intensive experience in summer, Academic year follow up, Telecommunications - monthly

Best Practices

- Paperless Environment
  - CDs, ftp server, Electronic archives, E-surveys and quizzes
- Publications
  - Gene sequences, Conferences, Open-access publications on Web, Showcase, Professional organizations
- Learning Community
  - Mentoring (Scientist - teacher, Teacher - grad student TAs, Teacher - teacher), Teaching (Scientist - teacher, Teacher - student, Networking, Sharing

Best Practices

- STEM Careers
  - STEM career activities integrated into lessons
  - Field trips (Biotech Company and Marine Lab)
  - Virtual field trip and visits to classrooms

Why the STEM career emphasis?

- NSF requirement
- Work place demands – since 1990 new STEM jobs have grown at 3 X rate of other occupations
  - 30% of current STEM workers are nearing retirement
  - 25% of current STEM workers in USA are foreign born
- STEM jobs on average pay 50% more than non-STEM
- Minorities and women are still grossly under represented
  - Women from 12% of STEM workforce in 1980 and 25% today
  - Minorities (Black & Hispanic) from 2.3% in 1980 to 6% today

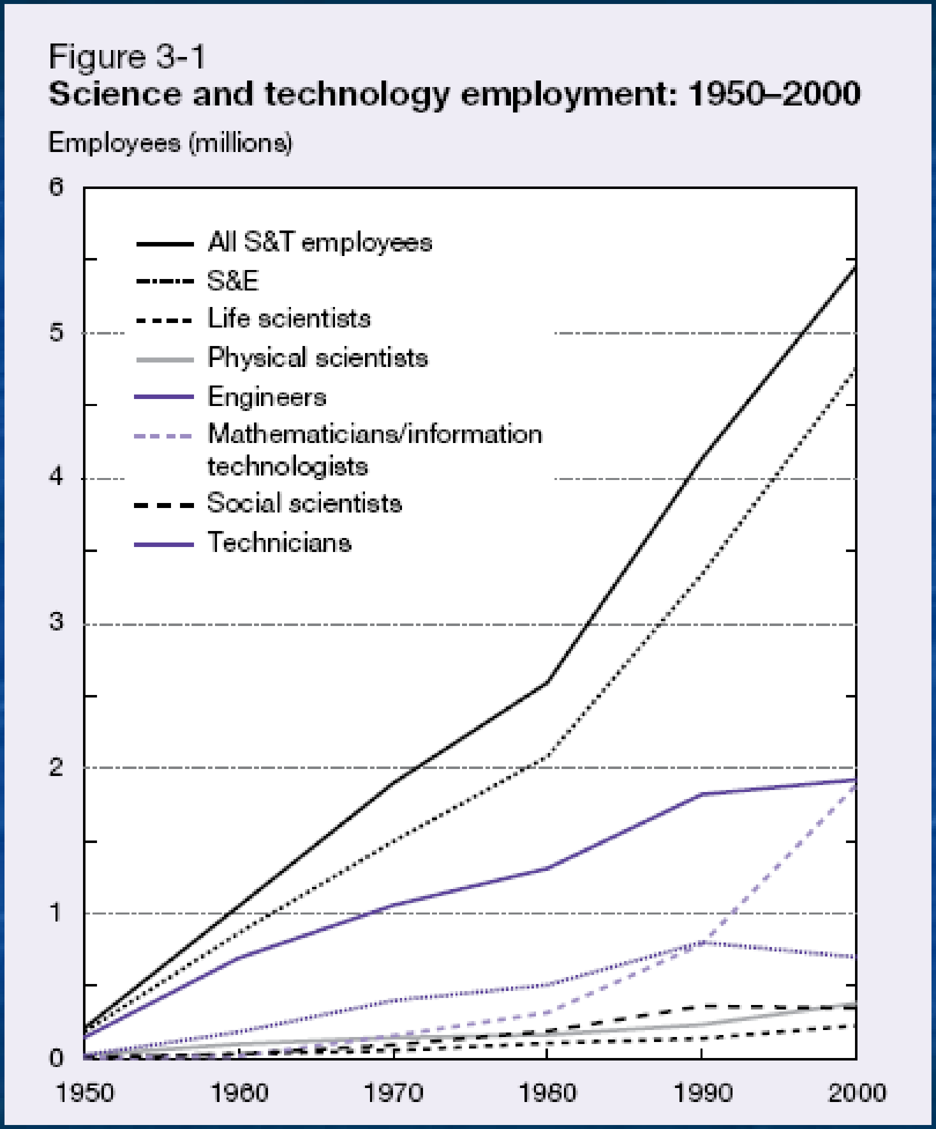
What works?

- Project-based learning and Webquests
- "Hands-on/minds-on" science
- Career counseling - kids limit career choices to 3 - 5 in middle school
- M, S, T integration activities in middle school
- Tutoring in content areas
- Mentoring (visits, field trips)
- Integration of career components in regular instruction (name dropping)

and

- Modeling M, S, T in every day work and classroom
- “Real-world” learning and/or connections of classroom learning to real-world practice
- Constructivist viewpoint toward teaching and learning: tasks, groups, and sharing
- Internships, summer programs, and work experiences

Big picture



Science and Engineering Indicators 2006 – U.S.Dept. Labor

Implementing STEM

- Include careers often – mention career connections as part of basic instruction
- Participate in school career activities
- Invite guest speakers to the classroom
- Field trips to job sites
- Include career awareness activities throughout the year
- What do you do?

Resources

- CEOSE (2004). Broadening Participation in America's Science and Engineering Workforce. Committee on Equal Opportunities in Science and Engineering. Washington, DC.
- ITEST Learning Resource Center (2004). Active Learning in the Information Age. Washington, DC.
- National Science Board (2006). America's Pressing Challenge - Building a Stronger Foundation. National Science Foundation. Washington, DC.

Questions & Discussion

- Lab and Field Explorations in Marine Science, June 25-29
- http://teach.mlml.calstate.edu/
- Marine Biotechnology and Bioinformatics, July 9 -27
- http://www.marinebiotech.net/