WH8102 to changes in levels of the trace metal cobalt is investigated. Common characteristics to the transcriptional profile dynamics in both cases are coregulation of polycistronic genes and overshoot dynamics that are ubiquitous in most biological systems. Results on specific genes and pathways will also be presented.

OS21H-05 1030h INVITED

Creating Large and Small Insert Chromosomal Libraries From Naturally Occurring Microbial Populations: Nuts And Bolts

Christina M Preston[1] (831-775-1754; preston@mbari.org)

Oded Beja[2,3] (beja@techunix.technion.ac.il)

Grieg F Steward[2,3] (gsteward@cats.ucsc.edu)

Edward F Delong[1] (delong@mbari.org)

[1]Monterey Bay Aquarium Research Insitute, 7700 Sandholdt Rd , Moss Landing, CA 93950, United States

[2]Department of Biology, Technion, Israel Institute of Technology, Haifa 32000, Israel

[3]Ocean Sciences Department, E&MS A44 University of California 1156 High Street, Santa Cruz, CA 95064, United States

Secrets of the natural microbial world, including the specific biological properties and function of microbes in Nature, can in part be revealed by directly sequencing the genomes of these organisms. There are a number of different strategies and approaches for archiving and extracting the genomic sequence from microbes present in natural populations. One approach, of course, is simply to cultivate the microbe, and sequence its genome using now standard shotgun sequencing strategies. This approach is not always practical, feasible, or possible. Another approach is to construct large or small insert genomic libraries from mixed microbial assemblages, and either randomly, or systematically, sequence and analyze microbial genomic fragments. The different strategies and vectors include small insert shotgun libraries (insert size around 3 kilobases (kb)), fosmid or cosmid libraries (insert sizes around 40kb), and bacterial artificial chromosome (BAC) libraries (inserts up to 200 kb), and each approach has its strengths and weaknesses. We have had success with preparing libraries from naturally occurring bacterial or viral populations. Libraries currently being analyzed include those from bacterial and viral populations of marine plankton, and microbial communities in anaerobic marine sediments. These are now providing significant new insight into the genomic and functional properties of microbes from diverse ecosystems.

OS21H-06 1100h

A General Method for Growing Unculturable Microorganisms

Tammi Kaeberlein[1] (781-581-7370; kaeber@ccs.neu.edu)

Kim Lewis[1] (617-373-8238; k.lewis@neu.edu)

Slava Epstein[1] (617-373-4048; s.epstein@neu.edu)

[1]Department of Biology, Northeastern University, Boston, MA 02115

The majority of microorganisms from the environment resist cultivation in the laboratory. Several Bacterial and Archaeal groups at the division level have been identified with no known cultivable representatives. The 16s rRNA approach provided important insights into the spectacular diversity of uncultivated microorganisms. However, it does not provide access to the actual cells and means to grow them. Such access would be highly desirable for both basic and applied environmental sciences. Here we report a new general method for growing previously uncultivated microorganisms. Diffusion growth chambers have been designed that allow the growth of these microorganisms in pure culture by providing a simulated natural environment. We will discuss design of the chambers, provide examples of first uncultivables growing in our laboratory, characterize these novel organisms using 16S rRNA data, and outline the potentials of the new method.

OS21H-07 1115h INVITED

Nitrogen Assimilation: from Genomes to Gene Expression in the Oceans

Jonathan P Zehr (831-459-4009; zehrj@cats.ucsc.edu)

Dept. of Ocean Sciences, University of California, Santa Cruz, CA 95064, United States

Nitrogen (N) assimilation is intimately linked to controls on primary production in the open ocean. The application of the polymerase chain reaction has provided information on the diversity and distribution of the genetic information for specific N utilization pathways, from transport to assimilation. Amplification of nitrogenase (nif), and assimilatory nitrate reductase (nar and nas) genes indicates that the genetic capability for different N metabolic pathways is dispersed throughout microbial phyla, and that genotypic as well as phenotypic differences among microbial assemblages are likely to be important in determining the pathways of nitrogen use, and the ecological distribution and activities of individual species. Gene expression assays provide ways of identifying important players in nitrogen metabolism.

Assimilatory nitrate reductase genes are less widely distributed among cyanobacteria and heterotrophic bacteria than might be expected. It has recently been shown that Prochlorococcus does not contain nitrate reductase genes, which suggests that the genome has eliminated unnecessary genetic information for organisms living in oligotrophic surface ocean waters. Nitrogenase-containing microorganisms are more diverse and abundant in the open ocean than previously believed, but relatively few major clades have been discovered. There is a high diversity of nitrogenase-containing microorganisms in some high fixed N environments such as the Chesapeake Bay and deep waters of Mono Lake. Thus, ecosystem comparisons suggest that nitrogenase diversity is not selected for by N-limiting conditions, and that genes are not necessarily eliminated from the genome in non-N-limiting environments. The data indicate that there are multiple ecological and evolutionary forces selecting for genome composition of individual species or phylotypes, including selection at the organism or community level.

Over 50 microbial genomes have been sequenced or are in the process of being sequenced, as well as genomic fragments from marine environments. Statistics from these prokaryotic genomes indicate that 1) N metabolism genes are not well-represented in these genomes or that the genes have not been annotated correctly, 2) that the genomes that have been sequenced may not be good models for the study of N assimilation in the environment and/or 3) that nitrate might not be used by many prokaryotic microorganisms. Genomic information provides important contextual information, including gene arrangements and new genes to target in environmental studies, yet one of the major limitations of genomic information is that some biogeochemically-important microorganisms can be relatively low in abundance, making it difficult to obtain biogeochemically-relevant information directly from genomic fragments obtained from the environment.

OS21H-08 1145h

A Multisystematic Approach Towards Understanding the Metagenome of the Episymbiotic Community Associated With *Alvinella pompejana*

Barbara J. Campbell[1] (bjc@udel.edu); Maureen Dolan[2] (maureen.dolan@USA.dupont.com); Kathryn J. Coyne[1] (kcoyne@udel.edu); Benjamin Wheeler[1] (jaywh@udel.edu); Jens J. Hyldig-Nielsen[3] (jhyldig@bostonprobes.com); Robert A. Feldman[4] (robert.feldman@am.apbiotech.com); Jeffrey Stein[5] (jstein@quorex.com); S. Craig Cary[1] (caryc@udel.edu)

[1]University of Delaware, College of Marine Studies, 700 Pilottown Rd., Lewes, DE 19958

[2]Dupont Agricultural Biotechnology, Delaware Technology Park, Suite 100, PO Box 6107, Newark, DE 19714

[3]Boston Probes, Inc., 75E Wiggins Ave., Bedford, MA 01730

[4]Molecular Dynamics, Inc., 928 E. Arques Ave., Sunnyvale, CA 94086

[5]Quorex Pharmaceuticals, Inc., 2075-J Corte Del Nogal, Carlsbad, CA 92009

A diverse episymbiotic bacterial community is associated with the tube-dwelling polychaete, *Alvinella pompejana*. This association exists in an extreme deep-sea hydrothermal vent biotope characterized by high concentrations of heavy metals and the steepest thermal gradient experienced by any organism yet described. Detailed rRNA analysis of the episymbiotic communities associated with *A. pompejana* demonstrates the dominance of a diverse assemblage of a single subdivision (epsilon *Proteobacteria*). Because of the complex nature of this association, no specific roles have been defined for this unique symbiosis by habitat characterizations, in situ enzyme assays, classical cultivation techniques or molecular analysis. Initial approaches to investigate the symbionts centered on rRNA analysis, where two filamentous epsilon *Proteobacteria* dominate the microbial community. Current work in our laboratories centers on a whole genomics approach. High throughput sequencing efforts allow the creation of a metagenome, where genomes of a diverse ecological unit are cloned and sequenced. These collective genomes can be thought of as a core genome, containing all the genes necessary to perform the diverse biogeochemical reactions that make up a specific community function. Initial analyses presented here include the sequencing of two large insert fragments (approximately 40kb each) specifically linked to the two dominant symbiont phylotypes. We have also begun to use a metagenome approach in order to understand the symbiont community at a functional ecological level. A cDNA library has been made from ribosomal depleted RNAs isolated from an *A. pompejana* symbiont community from 9^{o}N, East Pacific Rise. Preliminary sequence analysis from this library will also be presented.

OS21I HC: 314 Tuesday 0830h

Reforming Education in the Ocean Sciences for All Citizens II

Presiding: **J Cherrier,** Florida A&M UniversityUniversity**; C Thoroughgood,** University of Delaware**; P Coble,** University of South Florida

TUE

OS21I-01 0830h INVITED

The Art of the Possible, The Science of the Priorities: Educational Opportunities for the Ocean Sciences

Arthur R.M. Nowell (206-543-7160; nowell@ocean.washington.edu)

College of Ocean and Fishery Sciences, University of Washington, Box 355350, Seattle, WA 98195, United States

Graduate education in our field is changing as the focus of research moves to address the questions driven by the concerns and values of the twenty-first century. Undergraduate education is changing with the shift from teaching to learning, especially with the shift to experiential learning and collaborative learning. In ocean sciences we are coming to terms with how to integrate collaborative learning and experiential learning into our mandates for teaching and research on campus. The vast responsibility of public involvement and education still is open. At the K-12 levels four broad terms dominate the agenda, namely standards, assessment, technology and communication. How can ocean sciences help teachers gain the knowledge of the content areas and the skills of science for elementary level teaching? How can ocean sciences help teachers develop among their students problem solving skills? How can ocean sciences help students become adept at using technology in problem solving? And lastly, how can ocean sciences help students select and discuss a problem and its potential solutions and thereby demonstrate problem solving skills? I will discuss the range of possibilities and suggest some ideas that involve not just ourselves at research focused institutions, but also involve agencies, their staff and the chances for a higher level of collaboration.

OS21I-02 0900h

Inquiry Based Learning and Assessment in General Education Science Courses

Bob Chen[1] (bob.chen@umb.edu)

Daniel Brabander[1] (daniel.brabander@umb.edu)

[1]U. Mass. Boston, ECOS 100 Morrissey Blvd, Boston, MA 02125, United States

Two major goals of General Education Science Courses are to recruit top students into science and to provide a large number of non-science majors with the critical thinking skills that they may use throughout their adult lives. In this way ocean and/or environmental sciences may become an integral part of the daily lives of the general public. While most educators agree that effective science learning occurs in small groups with hands-on experiential learning and interaction between the teacher and student, many administrators prefer to maximize university resources by increasing class sizes.

In an attempt to provide quality science instruction to a large General Education audience, Introduction to Environmental Sciences was offered to 230 students at UMassBoston in the Fall of 2001. Due to unique circumstances, 50 of the students were required to attend weekly discussions (ES 120; 10-15 students/section) while the other 180 were required to write 4 papers (ES 101). All 230 students attended the same two 75 minute lectures each week. In class peer-instruction, group activities, and a class web site were used to engage students. On a traditional exam of multiple choice and short answer questions, ES 120 students performed

2 percent lower on average than similar students in smaller classes (40-50) taught in previous years, suggesting class size significantly lowered performance. ES 101 students without the benefit of the weekly discussion sections scored 4 percent lower than ES 120 students.

A second exam using inquiry-based assessment tools (critical thinking questions, an individual take home exam (Part I), and a group response to the same questions (Part II)) was attempted. Comparisons of the effectiveness of discussion sections (ES 120) and scientific writing (ES 101) in teaching critical thinking will be discussed.

Pre-course, mid-course, and post-course evaluations as well as progress in writing portfolios, in-class participation, and exam scores will be used to assess the effectiveness of group activities, discussion sections, and writing assignments in teaching critical thinking and the effectiveness of two different exam styles in assessing student learning. Overall, it appears that large class size offers some challenges to effective science learning, but novel instruction and assessment strategies can minimize this effect.

OS21I-03 0915h

A Quantitative and Qualitative Analysis of the Impact of High School Marine Science Curricula and Instructional Strategies on Science Literacy of Students

Julie Lambert (305-365-0259; julielambert@att.net)

University of Miami School of Education, 1551 Brescia Avenue, Coral Gables, FL 33146, United States

Students who take earth science, biology, chemistry, and physics are most likely to become scientifically literate adults by learning the content outlined in the *National Science Education Standards (Standards)* and the *Benchmarks for Science Literacy (Benchmarks)*. The majority of students do not complete this sequence, and integrated science courses have been proposed as one solution. Marine science courses are naturally integrated science courses that have been in existence for decades. Yet marine science has not received recognition for the role it could play in reforming science education. Through analysis of quantitative and qualitative data, this study assesses the impact of high school marine science curricula and instructional strategies on students conceptual understanding of general science and attitudes toward science, technology, and society-related issues.

Nine high school teachers, located in seven counties throughout Florida, administered instruments to a diverse population of students before and after they took a marine science course. Three instruments were developed to measure (a) students knowledge of general science concepts (Science Assessment in Literacy - SAIL), (b) attitudes toward science, technology, and society-related issues (My Attitudes toward Science, Technology, and Society - MASTS), and (c) views relative to marine science (Students Worldviews and Interest in Marine Science - SWIMS). SAIL is a multiple-choice, science content assessment directly correlated to the *Standards* and *Benchmarks*.

Paired-sample t-tests revealed a significant difference ($p < 0.001$, t-value = 4.42, n = 399) between pre- and post-SAIL scores, indicating an increase in students general scientific knowledge. SAIL results were also analyzed by comparing pre and post means for physical science, life science, and earth science sections. Students' mean scores significantly improved in all three areas. Students attitudes toward science, technology, and society-related issues did not significantly change, but reflected of the goals of the *Standards* and *Benchmarks* at the beginning and end of their marine science course. Students' post responses indicated that they became more motivated to learn science and developed attitudes reflective of the *Standards* and *Benchmarks* and goals of an integrated curriculum.

There were commonalties in curriculum and instruction among the nine teachers. Teachers did not have a curriculum guide or an appropriate level textbook. Six teachers used college level textbooks more than seven years old. The curriculum content varied, with a few teachers emphasizing marine biology. Most teachers taught in fragmented ways, emphasizing separate scientific disciplines, but in the context of the oceans. Two teachers taught in an integrated and coherent manner, emphasizing synthesis of multiple science disciplines science, while focusing on real-world issues in local settings. Their students made the most significant improvement on the SAIL assessment.

This research suggests that marine science can provide an integrated curriculum that not only increases students knowledge of science, but students motivation to learn science. Marine science is a complex systems-based science, requiring teachers to have deep content knowledge, not only of marine science, but also of biology, chemistry, geology, physics, and meteorology. This has important implications for marine science teacher preparation and professional development programs.

OS21I-04 0930h

Educational Reform in the Ocean Sciences Begins by Understanding the Resistance to it

Dean A. McManus (1-206-543-0587; mcmanus@ocean.washington.edu)

University of Washington, School of Oceanography and Center for Instructional Development and Research Box 357940, Seattle, WA 98195-7940, United States

In spite of clarion calls for the reform of K-12 and undergraduate science education by the "National Science Education Standards" (NRC), "Benchmarks for Science Literacy" (AAAS Project 2061), "Shaping the Future" (NSF), "From Analysis to Action" (NRC), and other reports, firm resistance to such reform persists in the ocean sciences education community. Educational changes to date within the community are marginal and isolated. One step in overcoming the resistance may be for us to understand the basis for the resistance, which, I submit, is that too many educators rationally see no need for change.

They see no need for change because they are following a paradigm of education that satisfies them, the Teaching-Centered Paradigm. (By "paradigm" is meant a framework that makes sense out of how they teach students.) It determines, not only their teaching methods and classroom environment, but their educational assumptions, goals, and assessments, their sense of educational responsibilities, their relationship with students, and even their students' sense of responsibilities. Further, this paradigm is "invisible" to them; it is accepted from their experience as student and educator as "a force of nature." Anyone supported by "a (presumed) force of nature" will naturally resist change.

In addition, reform is undermined when presented as solitary classroom techniques, such as active learning, group work, or assessment of learning outcomes. The elements of reform comprise a paradigm, the Learning-Centered Paradigm, which likewise determines the educator's educational assumptions, goals, assessments, teaching methods, classroom environment, responsibilities, and relationships. I do not accept these paradigms as the end points of a gradation. The appearance of gradation arises from uncritical cross-paradigm borrowing of teaching methods by educators who have not accepted the assumptions underpinning the paradigmatic application of those methods. I believe that the fundamental difference between these paradigms is the extent to which they require educators to reflect critically on teaching and student learning, as can be demonstrated by comparing elements of the two paradigms. The Learning-Centered educator cannot function without critical reflection; the Teaching-Centered educator can.

Only through critical reflection can a faculty articulate clearly their educational perspectives. And only through this articulation, as studies have concluded, are they best able to compare their educational ideas and evidence with those of the Learning-Centered Paradigm and change their insight of education to accept the reform into their practice and into the educational program of their department. Critical reflection on their educational perspectives by ocean sciences educators can thus begin a systemic reform of ocean sciences education.

OS21I-05 1005h INVITED

Promotion Ocean Science Education Excellence at the National Science Foundation

Margaret Leinen (703-292-8500; mleinen@nsf.gov)

National Science Foundation, 4201 Wilson Blvd, Arlington, VA 22230, United States

The National Science Foundation has assigned a high priority to linking research to education in science and math. Ocean science research is by its nature fascinating to students and they quickly grasp math and science concepts when presented in the context of ocean science. The Geosciences Directorate of the National Science Foundation has developed several programs to take advantage of the interest in ocean science to enhance education in general and ocean science education in particular. We are currently fostering the formation of a Center for Ocean Science Education Excellence (COSEE) that will provide the ocean science community with additional capabilities to develop curricular materials and resources that can be used to reform education in the ocean sciences.

OS21I-06 1035h

Global Heartbeat: An Environmental Education Program

Judith Lemus (213-740-1965; jdlemus@usc.edu)

Southern California Sea Grant Program, University of Southern California, AHF 209, Los Angeles, CA 90089-0373, United States

Global Heartbeat is a hands-on environmental science and educational program being developed by a number of partnering organizations, including the College of Exploration, USC Sea Grant, the Plymouth Environmental Research Centre, and the Bermuda Biological Research Center. The Global Heartbeat Project uses a technique developed by Dr. Mike Depledge at the University of Plymouth, England, in which the heartbeats of certain invertebrates such as crabs and mussels can be measured with an infrared sensor that is glued to the shell of the animal. The heart rate can then be monitored under different environmental conditions to assess the ability of the animals to adapt to the environmental stress. This technology is referred to as Computer Assisted Physiological Monitoring, or CAPMON. With funding from USC Sea Grant, a two-year pilot project has begun to develop a research curriculum for high school students using this environmental monitoring system. During the summer of 2001, high school participants at the Wrigley Institute of Environmental Studies, on Catalina Island, were involved in the testing of this system for use in the classroom and other educational settings. After learning some basic crab physiology, students were instructed on how to use the CAPMON system and participated in all aspects of the research, from catching their own crabs in the intertidal zone to designing their own experiments and reporting their results. We are presently working to develop protocols and a curriculum for using the CAPMON system in a classroom setting, which will be used to help train educators at other institutes in utilizing the system in their education programs. The long-term goal of Global Heartbeat is to bring together students, research scientists, and colleagues at marine aquariums in a pollution monitoring network. Participants will submit the data they collect to a central website that will collate and visually present these data. This website will also include educational materials to support student learning and online discussion forums will offer a place where scientists can talk with students and answer questions.

URL: http://www.usc.edu/go/seagrant

OS21I-07 1050h

A Strategy for Improving Marine Technical Education

Deidre Sullivan[1]; Tom Murphree[2] (831 656-2723; murphree@nps.navy.mil); Bruce Ford[2]; Jill Zande[1]; Saundra Butcher[1]; Nicole Crane[1]; Jim Hall[1]

[1]Marine Advanced Technology Education Center Marine Advanced Technology Education Center Marine Advanced Technology Education Center, Monterey Peninsula College 980 Fremont St., Monterey, CA 93940, United States

[2]Naval Postgraduate School, 254 Root Hall 589 Dyer Road, Monterey, CA 93943, United States

Although marine science attracts thousands of students every year, there are limited job opportunities in this field. In addition, many students find themselves drawn not so much toward the study of marine science concepts as toward the more technological aspects of marine science, especially the application of science, engineering, and technology knowledge and skills in support of science or industry. Careers in these technological areas may also attract students because salaries can be considerably higher than for more research-oriented careers.

A major goal of the Marine Advanced Technology Education (MATE) Center is the creation of appropriate standards, assessments, curricula, and programs to provide students and workers with the knowledge and skills they need to excel in marine technology careers.

The process of developing a competent marine workforce that is well prepared for employment requires collaborating with a wide range of people and organizations. One of the methods used by the MATE Center to accomplish this is the development and use of industry-based knowledge and skill guidelines (KSGs). These guidelines provide educators with a foundation for building and modifying curricula and programs to meet the needs of students entering marine science and technology fields. To date, the MATE Center has developed KSGs for ROV technicians, hydrographic survey technicians, marine technicians, aquaculture technicians, and aquarists. These KSGs have been used to identify requirements, or competencies, that are common to two or more occupations.

Competencies are a critical link between the workplace and the classroom, since they connect job requirements to educational subject areas. Competencies are the basis for the development of instructional materials, starting with assessments based on the competencies, and instructional modules based on the assessments. The MATE Center has developed competencies in over two dozen subject areas, including safety and seamanship, hydraulic equipment, electronics, navigation, surveying, submersibles, GIS, and technical writing.

Through these efforts, students and workers are discovering a broad range of career opportunities and can easily access detailed, current career information to make better and more informed choices about their education and future. In addition, MATE Center faculty

development programs are assisting educators in aligning their curricula to meet workforce needs and to give students the tools for success when they enter or re-enter the workforce.

One example of the MATE Centers projects that link students, educators, and employers is the national ROV design and building competition co-sponsored by the Marine Technology Society ROV Committee. In addition to being fun and educational, this event connects high school and college students and faculty with employers from marine industries in order to highlight career opportunities and strengthen technical, problem solving, and teamwork skills.

URL: http://www.marinetech.org

OS21I-08 1105h

Outreach and Science: A Primary School Teachers Experience in the Arctic

Kathie Stevens[1] (+1.865.966.5848; bkstevens3@earthlink.net)

Jacqueline M Grebmeier[2] (+1.865.974.2592; jgrebmei@utk.edu)

Lee W Cooper[2] (+1.865.974.2990; lcooper1@utk.edu)

[1]Farragut Primary School, 509 Campbell Station Road, Knoxville, TN 37922, United States

[2]University of Tennessee, Department of Ecology and Evolutionary Biology, Knoxville, TN 37996, United States

TEA: Teachers Experiencing Antarctica and the Arctic is a program funded by the National Science Foundation and is facilitated through Rice University, the Cold Regions Research and Engineering Laboratory and the American Museum of Natural History. The cornerstone of this program is a research experience in which selected K-12 teachers participate in polar expeditions. Immersion in the scientific process occurs through contact with a research scientist. The teacher is exposed to new technology and cutting edge research. The TEA website (address below) maintains the daily cruise journal. The TEA program aspires to improve science literacy, to change how science education is conducted in the classroom, and to alter the general public's attitude about science.

A research team from the University of Tennessee, as well as other institutions have been conducting long-term ecosystem research in the Bering Sea just south of St. Lawrence Island. The goal of this project is to study how hydrographic and other potential forcing factors may influence the benthic food source of threatened diving sea ducks (Spectacled Eiders) and marine mammals in this region. During a March 2001 icebreaker cruise on the USCGC Polar Star, educational experiences through the TEA program were shared with teachers on St. Lawrence Island, Nome, and Little Diomede Island in Alaska as well as students and the general public. The TEA experience includes interactions with teachers on Little Diomede Island in Bering Strait, the location of a NSF Long term Observatory (LTO) to measure seawater and marine mammal data in an effort to track long-term global change in the region. Select marine sites from the northern Bering and Chukchi Seas have been sampled annually as part of the oceanographic sampling program of the LTO project. Ultimately, results from the marine and land-based LTO project will be published and are also available on a public web site, http://arctic.bio.utk.edu

This presentation will outline the TEA experience obtained as part of these research efforts. Opportunities for professional growth, transfer of the research while in the field, public outreach, and present and future collaboration with the research team will be shared.

URL: http://tea.rice.edu/tea_stevensfrontpage.html

OS21I-09 1120h

Southeast Regional Aquatic Nuisance Species Education Network

Howard D. Walters[1] (228-374-5550; howard.walters@usm.edu)

John J. Dindo[2] (215-861-7558; jdindo@disl.org)

Michael S. Spranger[3] (352-392-1837; msspranger@mail.ifas.ufl.edu)

[1]The J.L. Scott Marine Education Center and Aquarium, 115 Beach Blvd., Biloxi, MS 39530, United States

[2]Dauphin Island Sea Lab, Dauphin Island Sea Lab, Dauphin Island, AL 36528, United States

[3]University of Florida, P.O. Box 110400, Gainesville, FL 32611-0400, United States

A critical need in the United States is a public education component to complement research on the types and impacts of Aquatic Nuisance Species (ANS) in the Gulf of Mexico Region. It is estimated approximately 6,500 nonindigenous species have established populations in the US (Pimentel, et al. 1999, Williams and Meffe, 1999). While only a subset of these directly and negatively impact indigenous species, nevertheless, the overall economic impact of these organisms is estimated to be approximately $138 billion per year (Pimentel, et al. 1999).

The Gulf of Mexico Program (2000) has released a report documenting by U.S. state, the current Priority Aquatic Nuisance Species of most concern in coastal areas. From this detailed listing of Priority Aquatic Nuisance Species, the Principal Investigators (PIs) for this regional educational project selected representative species as typical examples on which to focus this teacher education effort. The list also included a number of historically significant introduced species and included terrestrial and aquatic plants, a terrestrial vertebrate/mammal, an aquatic vertebrate/fish, and invertebrates. By selecting from different classes of organisms, the overall pertinence of the teacher education program was enhanced to accommodate the needs of both inland and coastal teachers, and teachers from the multi-state area included in this effort, i.e. Louisiana, Mississippi, Alabama, and Florida. Further, this selection facilitated meaningful field trips throughout the year while preserving a capability to view example nonindigenous species in the environment.

This project focused on ANS by addressing content needs of classroom teachers, who are now in turn, incorporating the latest scientific knowledge in these areas in their classrooms. Participating teachers now have enhanced content knowledge for nonindigenous species and related population ecology concepts, their regional and national impact, and management attempts. Previous research experience by the principal investigators indicates inservice teacher education for marine and coastal science content areas is an effective mechanism for reaching the general public, due in part to the scope of the general populace directly impacted by the public education system, i.e. through familial relationships with students, and the students and teachers themselves.

To date, four workshops have been completed with 72 teachers. Statistical measurement of changes in content knowledge of participants reflects significant increases in their understanding of identified content and concepts. Four additional workshops are scheduled for 2002 with funding provided by the Mississippi-Alabama Sea Grant Consortium and the Environmental Protection Agency. Additionally, the project has been expanded through funding from the National Sea Grant College program, Mississippi-Alabama Sea Grant and Florida Sea Grant to include teachers throughout Florida. Further, this expanded effort includes funding for 13 formal workshops, 57 school-based workshops, and one, national internet-enabled, virtual workshop. Finally, current funding includes costs for the publication and dissemination of three research reports and lesson plan packages for K-12 teachers over the next three years.

OS21I-10 1135h INVITED

The Role of Scientists in Public Policy

William A. Stiles (757-623-4835; skipstiles@att.net)

S and T Consulting, 1121 Graydon Ave., Norfolk, VA 23507, United States

Science education has expanded to include a number of non-traditional approaches directed at a wider audience. Likewise, the professional responsibilities of scientists have broadened to include public outreach and involvement with the policy processes of government. Citizen scientists have a significant role to play in the shaping of policy, public opinion, and the ways in which research results are applied in the broader society. However, these non-traditional roles in education and outreach can be time consuming and need to be carefully focused and conducted if they are to be effective. They also need to be adequately recognized and rewarded within the profession.

Of special significance to larger-scale natural sciences, like limnology and oceanography, is the role that they play in setting policy around longer-term ecological effects (long-range pollutant/nutrient transport, acid-rain lake impacts, climate change, etc.). Well before public awareness raises these issues to thresholds of political action, scientists are aware of the problems and can play an early role in shaping public reaction and any eventual political activity.

OS21I-11 1205h

Educational Outreach Efforts of the Monterey Bay Aquarium Research Institute (MBARI)

George I. Matsumoto[1] (mage@mbari.org)

Judith Connor[1] (conn@mbari.org)

[1]Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, CA 95039, United States

The overall goal of this session is to challenge ocean scientists to take a leadership role in national science education reform. One important challenge and contribution is to engage ocean scientists in conveying the excitement and value of their research to ocean sciences educators, K-12 and post-secondary students, and the general public. This talk will review and preview the educational outreach efforts of MBARI staff and of the institution itself. These efforts include "Cruising to the Classroom" expedition webpages, an internship program, and strong links to an informal educational institution, the Monterey Bay Aquarium.

URL: http://www.mbari.org

OS21J HC: 318 B Tuesday 0830h

Application and Assessment of Coastal Sediment Transport Models II

Presiding: **C Harris,** Virginia Institute of Marine Science**; R P Signell,** NATO/SACLANTCEN

OS21J-01 0830h INVITED

A systems approach to sedimentation modeling for the twenty-first century

Timothy R. Keen (228-688-4950; keen@nrlssc.navy.mil)

Naval Research Laboratory, Oceanography Division, Stennis Space Center, MS 39529, United States

TUE

The Distributed Marine Environmental Forecast System (DMEFS) project is examining methods of calculating ocean variables using modern High Performance Computing (HPC) methods. One of the requirements of the project is to develop a forecast capability for sediment-related marine properties, such as optical scattering and bottom scour. As part of this requirement, we are examining the characteristics of different methods of making sedimentation and hydrodynamic calculations concurrently in a distributed HPC environment. The application of such a system is not necessarily limited to DOD interests. A few common applications for sedimentation modeling are water quality, engineering, geological, and naval. These applications have a common thread in that they all must calculate the quantity of sediment being entrained and/or transported in the coastal ocean. They differ in time and spatial scales of application, however. These differences make it difficult to construct a single sedimentation model for all applications.

There are five basic paradigms for constructing coastal ocean hydrodynamic/sedimentation modeling systems: (1) In the tracer paradigm the sedimentation model uses the same equations as the hydrodynamic. Some of the sediment calculations are independent but vertical and horizontal mixing processes are identical to the hydrodynamic model. It is simple to code this type of model but difficult to debug and the hydrodynamics must be run every time a different sedimentation run is needed. (2) The coupled paradigm uses an independent sedimentation model that is based on the same spatial grid as the hydrodynamic. It must also run with the hydrodynamic model but the time constraint is relaxed somewhat. Independent vertical mixing can be calculated and feedback is more limited. (3) The linked paradigm differs from the coupled only in that no feedback is allowed with the hydrodynamic model. (4) In the stand-alone paradigm, the sedimentation model is completely independent of all hydrodynamic forcing. All forcing fields must be interpolated in space and time to the sedimentation domain. No feedback is possible. (5) The distributed paradigm has the advantages of the stand-alone with respect to spatial and temporal independence but also the feedback of the tracer paradigm.

All of these paradigms have been used at one time or another, with the tracer method being most common. However, the rapid advancement in distributed HPC resources favors the distributed paradigm, which allows each model (e.g., currents, waves, surf, sedimentation, morphodynamic) to run in the appropriate configuration for optimal performance. Furthermore, research funded by the Common High Performance Computing Software Support Initiative (CHSSI) directly supports development of the distributed paradigm. Thus, our efforts in the DMEFS project are towards a standalone model that will be later incorporated into the final modeling and data system.

OS21J-02 0855h

ECOMSED: Some History and Its Future

Alan F. Blumberg[1] (201-529-5151; ablumberg@hydroqual.com)

Parmeshwar L. Shrestha[1] (201-529-5151; pshrestha@hydroqual.com)