Flotsam & Jetsam

A Newsletter for Massachusetts Marine Educators

Spring 2006 www.massmarineeducators.org Vol. 34, No. 2

President's Message

Hard Lessons

We all wept when first words, then pictures reached us from across the other side of the world to convey the magnitude of the mega-disaster which befell Indian Ocean coastal communities on the day after Christmas 2004. The Great Sumatra Earthquake had generated an enormous and undetected tsunami which hit the shores of Indonesia with no warning, then continued to bring devastation to Thailand and India and Sri Lanka and on and on throughout the Indian Ocean basin. Dazed and helpless we watched and did our small part to help our sisters and brothers half a world away.

The events of December 2004 set off another quake in the scientific community, as research teams quickly assembled missions to find the source of the tsunami and technical teams worked around the clock to create a viable warning system to mitigate the impact of any future event.

For the educator, a wealth of scientific and technical oceanographic information became available and accessible for the classroom. While research capabilities were state-of-the-art and the science was cutting edge, the need to explain these events to a bewildered public ensured that data were conveyed in words and graphics that mere mortals could understand. As a result, we have a rich source of quality educational material about an occurrence which remains emotionally compelling for our students. And while we would never have wished such a horrible tragedy to transpire in the first place, the response of the world's scientific community to that event has led to a deeper and fuller understanding of the oceans, the dynamics of plate tectonics, the critical importance of detection capability and warning centers, and the suite of scientific and technical capabilities available to observe our precious water planet.

In the end, that fundamental understanding of the tremendous forces locked in our seas and the plates which underlie them will enable us to live more securely in waterfront communities clinging precariously to the edge of the world's great oceans.

Susan Wieber Nourse
Jaeger Chair for Marine Studies
President, Massachusetts Marine Educators

LEARNING FROM TSUNAMIS

by Don Lewis, New Bedford Oceanarium

The Indian Ocean tsunami of December 2004 took the world by surprise, bringing incalculable devastation to the region. After an unprecedented global response to relieve suffering and to rebuild lives and economies, science has taken on the disaster as a learning experience. What happened? Why did it happen? How can we prepare ourselves to mitigate the effects of future tsunamic events.

Today, fifteen months after the Christmas time tsunami, the World Wide Web hosts a rich and textured array of scientific and technical data about this specific event and about tsunamis in general. Maps, charts, graphs, imagery, video clips, models, simulations, and tutorials are pitched at diverse audiences ranging from NOAA professional staffs to John and Jane Q. Public. A complete learning experience lies within reach of the marine educator. The challenge is pulling it together in age and skill appropriate components for your classroom.

The New Bedford Oceanarium partnered with Tabor Academy's marine science program to develop an honors level high school module on the science of tsunami formation and detection based on analysis of the December 2004 event in the Indian Ocean. The genesis for this project was the Discovery Channel special, ***"America's Tsunami: Are We Next?"*** This scientific expedition to the Indian Ocean sought the cause of the Great Sumatra Quake and subsequent tsunami. University of Rhode Island oceanographer

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Inside This Issue

Next Issue of F&J will be posted on website June 10

Massachusetts Marine Educators
c/o Joe IRubin
New England Aquarium
Teacher Resource Center
Central Wharf
Boston, MA 02110-3399
Web site: www.massmarineeducators.org

For Members Only:
Members who would like to download the complete current issue of Flotsam and Jetsam from our web pages should do the following: Under the graphic of the first page of the newsletter where it says to, click to open a new screen. After the current issue, click to download, and enter the username mme and the password (for this year) cod (both words all in lower case). This will allow you to download the whole issue as a pdf.

Calendar 2006

March 8, 2006
MME Board Meeting
Swampscott Middle School
Swampscott, MA.
Contact: Bill Andrake
billandrake@hotmail.com

March 22, 2006
High School Marine Science Symposium
Program Details are now posted on the MME Website – click on High School Symposium on the home page.

April 6 - April 9, 2006
NSTA National Convention & NMEA Share-a-thon, Anaheim, CA

April 29, 2006
30th Woods Hole Conf and Meeting
Program Details on the MME website after March 15

May 10, 2006
MME Board Meeting.
Stellwagen Banks Sanctuary Marine Headquarters
Scituate, MA
Contact: Anne Smrcina at Anne.Smrcina@noaa.gov

Managing Editor.....Doug Corwine
webmaster@massmarineeducators.org

(continued from page 1)

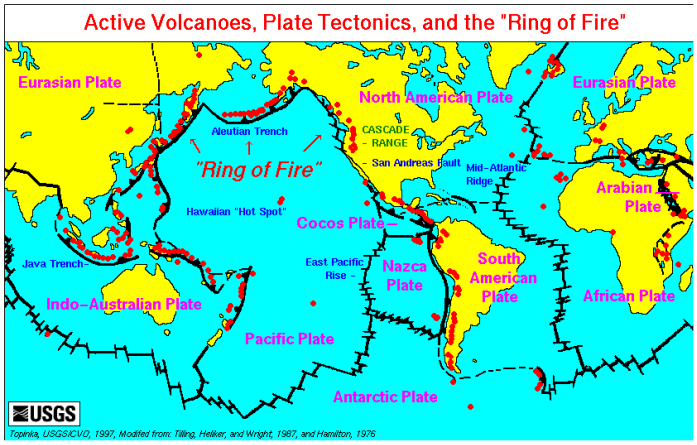
Kate Moran and her colleagues led us through an exciting adventure of underwater discovery to find the

source of the event. This program is often rebroadcast on the Discovery Channel and is available in DVD from the Discovery Channel store. The Discover Channel web site at http://dsc.discovery.com/convergence/tsunami/tsunami.html offers profiles, maps and reports.

NOAA has created a wonderful tutorial for its own professional staff called ***"A General Tsunami Guide for NOAA,"*** which provides a nice refresher for teachers, as well as a good learning experience for advanced students. This tutorial can be found at http://www.comet.ucar.edu/~rkoehler/tsunami/draft%20tsunami%20training%20module/ and while it cannot be download for classroom presentation, the URL can be hyperlinked in a PowerPoint show if you have broadband internet connectivity in your classroom. Other NOAA sites provide models in Quick Time which can be incorporated into learning modules for your students. The USGS site at http://walrus.wr.usgs.gov/tsunami/ offers Quick Time animation of the tsunami wave as seen from different perspectives. To convey the destructive impact of the wave, nothing is more compelling than the amateur video clips of the tsunami smashing through coastlines from Indonesia to Thailand to Sri Lanka … all available in usable format on various web servers.

Some of the more impressive videos of tsunami detection systems reside on NOAA servers with scientists, researchers and technologists describing the NOAA tsunami buoy system and warning centers. Technical animations of the DART II (Deep ocean Assessment and Reporting of Tsunamis) system offer students a deeper understanding of the scientific basis for tsunami detection and warning. The NOAA DART site at http://www.ndbc.noaa.gov/Dart/dart.shtml is a good place to begin this web quest.

No lesson plan on tsunamis would be complete without background information on the geology of plate tectonics and, as it relates directly to the Sumatra Quake, the Ring of Fire. The USGS offers a nice presentation quality graphic at its plate tectonics web site at http://vulcan.wr.usgs.gov/Glossary/PlateTectonics/description_plate_tectonics.html



Because geography is not always a strong suit for today's students, the marine educator's resource toolbox should include Google Earth (http://earth.google.com) which gives a teacher the power to create maps as broad as the visible earth from geostationary orbit to close-up aerial views of distant locations such as Banda Aceh. It brings the world home to your classroom.

For more information about tsunami web resources for your classroom, email Don Lewis at theturtleguy@comcast.net.

2006 High School Marine Science Symposium

Bob Rocha, HSMSS Coordinator

What is it like to voyage thousands of feet below the surface of the ocean? What educational and job opportunities await our budding marine scientists? What's the real story of the white shark that visited Naushon Island?

These questions, and a whole host of others, will be addressed by our keynote presenters and workshop leaders at this year's High School Marine Science Symposium. March 22, 2006. This is the 23rd year of this important event that connects high school students with local and national researchers and educators. Our host once again is the University of Massachusetts in Dartmouth. UMD and its School for Marine Science and Technology (SMAST) are leaders in fisheries research and technology.

Students and presenters are greeted with a variety of donut holes and morning beverages before they assemble for our first keynote speaker. We are pleased to welcome W. Bruce Strickrott, chief pilot for the famous Deep Submergence Vehicle ALVIN. After Bruce's tales of deep diving, students will attend two 45-minute workshops of their choice. Seven of our twenty presenters are new this year, helping us to keep our choices fresh and up-to-date. Options include the Naushon great white, basking sharks, stranded sea turtles, learning to dive and identification of marine creatures. We wrap up the morning with a presentation on marine careers by Dr. Brian Rothschild, the dean of UMD-SMAST. Dr. Rothschild's leadership and international contacts enable him to follow trends in the wide variety of marine disciplines.

Of course, being on a college campus is a new experience for many of our students, so they take advantage of the cafeteria food and the school store. While they dine, we treat our presenters to lunch in the campus center. They also all leave with a special MME t-shirt.

This event is important to MME. We are very grateful to all our workshop leaders, keynote presenters, volunteers, teachers and students who make the drive to spend the morning with us, and UMD for their hospitality. This day helps us to encourage students and connect them with marine professionals.

Massachusetts Marine Educators

Presents

The 23rd Annual

High School Student Marine Science Symposium

Wednesday, March 22nd 2006
8:00 AM – 1:00 PM
University of Massachusetts Dartmouth

Photo: Dan Fornari, Woods Hole Oceanographic Institution

Diving into Marine Careers

Featuring Keynote Speakers

W. Bruce Strickrott: Manned Deep Sea Research at Woods Hole Oceanographic
Dr. Brian Rothschild: Discovery, Education and Jobs in Marine Science

Twenty marine science workshop choices with key local and national scientists
Cost: $10.00 per student

TO REGISTER YOUR STUDENTS: Robert Rocha, New Bedford ECHO Project
New Bedford Whaling Museum, 18 Johnny Cake Hill, New Bedford, MA 02740
Phone: 508-997-0046 ext.149 E-mail: rrocha@whalingmuseum.org

FOR PROGRAM INFORMATION : Jack Crowley, UMD Center for University, School and Community Partnerships
ECHO Program: U.Mass-Dartmouth 800 Purchase St. , New Bedford, MA 02740
Phone: 508-990-1094 ext.122 E-mail: t.j.crowley@comcast.net

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Massachusetts Marine Educators, Inc.
www.massmarineeducators.org

Aquarium Field Trip

Joel Rubin, NEAQ Ed Dept

Are you planning a field trip to the New England (or any) Aquarium? Field trip experts (teachers like yourselves) encourage trip leaders to consider a number of options for increasing student odds of rich learning during visits.

Consider the "novelty" effect. Are your students familiar with the place you're going? If not, they may tend to dash about trying to take it all in and avoid missing anything. Unfortunately, this can result in a fairly superficial "we've seen it all, let's go home" attitude after about an hour. A holistic survey to become familiar with the lay of the land is certainly worthwhile, at the same time, it's good also to plan on taking the time to go deep, at least for some portion of the visit. This requires a measure of preparation and the setting of expectations about what students are to bring back from the trip.

Orient students to the field trip site during a pre-visit classroom session. Take class time to go over field trip expectations and provide a briefing. Show a map of the site from the internet or confirmation packet: (http://www.neaq.org/visit/schedule.pdf)

Using an overhead transparency or projection from the website, walk students around a map of the building. Point out the places where they can meet their basic needs (bathrooms, when and where to eat, when and where to meet the buses, location of information booth/where to go if hurt or lost, behavioral expectations, your gift shop spending rules). Also use the map to show good places students can visit around the building for more extended viewing that they are required to do in order to meet your learning objectives (exhibits to feature in extended observation worksheets, special adaptations or habitats to compare and contrast, the locations of unique organisms, ecosystems, or conservation issues related to current units in your curriculum).

If you have designed a special scavenger hunt, make this too into an overhead transparency or powerpoint slide, compare the site map to the questions on your worksheet. Have students work out plausible answers to your questions during this pre-visit classroom session. As you conduct a virtual tour of the Aquarium you might point out the locations and landmarks for finding the octopus or tidepool exhibits. If your worksheet asks "where are some likely places to find animals with suction cups?" Students who are familiar with the location of these exhibits can spend time observing these animals instead of spending most of their time searching for them. Try to create search items that have more than one right answer or that force students to think hard and come up with complex responses, detailed drawings and organized tables, graphs or paragraphs. Provide graphic organizers so that students have models for the kinds of answers that you are looking for and understand why it is valuable to answer in a certain way.

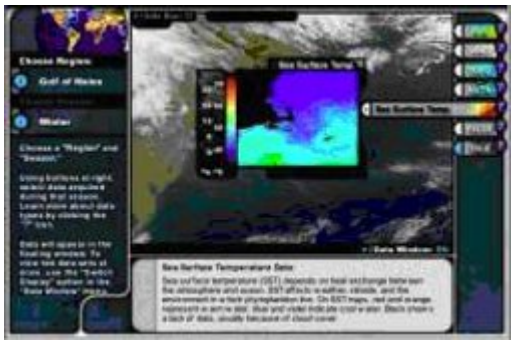
Encourage students to use the Aquarium staff: "If you see someone wearing the Aquarium logo, ask a question." Take time with your students during your pre-visit session to come up with some questions to ask Aquarium staff they'll meet. Encourage students to be curious and to come up with questions that can be answered with more interesting responses than a simple "yes" or "no."

You can download a PDF file of an activity (PreK-5) from the website at http://www.massmarineeducators.org/curriculum/pdf/fishcards.pdf

Phytopia CD

The Bigelow Laboratory for Ocean Sciences in West Boothbay, ME, and NASA's Jet Propulsion Laboratory have collaborated to produce ***Phytopia: Discovery of the Marine Ecosystem*** an educational CD-ROM. This resource promotes interaction with multimedia tools that enable users to discover why the marine ecosystem is critical to human existence. This product provides a window to the fascinating world of the oceans' microscopic life which, before *Phytopia*, only scientists saw. *Phytopia* consists of three major modules: "Phyto Files," "Phyto Factors," and "Special Topics."The culmination of these modules is a truly hybrid project benefiting both research and education. Other notable features are an image-based glossary, a detailed tutorial on how to use the CD-ROM,and summaries of relevant topics (e.g., microscopy, data types) in Acrobat Reader format.

The core technology of Phytopia is a first-ever searchable database of many important phytoplankton from the world's temperate oceans: The Phyto Files. Also included in this module are three-dimensional cell models and a virtual microscope tool that allows for the viewing of organisms at various magnifications, under various epifluorescence techniques, and by scanning electron microscopy. Users can better understand each species' unique form and function including cell wall type, motility, and potential harmfulness. The Phyto Factors module promotes discovery of the ties between physical forcing and marine ecosystem response, focusing on how environment affects the chlorophyll content and species composition of the upper ocean. It also helps users connect ocean primary productivity patterns with environmental factors in several geographic areas. Innovative tools allow investigation of co-registered temperature, wind, current, nutrient, and ocean color data. Special Topics provides a link from *Phytopia* to related resources on the Bigelow Lab website (www.bigelow.org/phytopia). This module will provide access to material that is developed after the CD-ROM is distributed, including interesting topics such as harmful algal blooms.



One of the featured presenters at the WHOI Conference this year will be from Bigelow Labs who will present a session on use of the CD Rom. Each participant will receive a copy of the CD-Rom during the presentation. See information in this issue of F&J on the WHOI Conference, and check the MME website for more details as the program is finalized www.massmarineeducators.org

2006 MARINE ART CONTEST FOR STUDENTS IN GRADES K-12 NOW OPEN

Right whales, mako sharks, Atlantic cod, diatoms – these are just a few of the possible subjects for artistic interpretation in this year's MME student art contest.

The Massachusetts Marine Educators and the Stellwagen Bank National Marine Sanctuary announce the 2006 Marine Art Contest for students in grades K-12. This year's theme is "Stellwagen Bank National Marine Sanctuary – A National Treasure," acknowledging the importance of this undersea area for its natural and cultural resources. The sanctuary is administered by the National Oceanic and Atmospheric Administration (NOAA), which holds this area in trust for the American people.

Students are asked to explore the fascinating world of New England's only national marine sanctuary through their art in this open competition. The deadline is May 6, 2006. The contest is co-sponsored with the New England Aquarium.

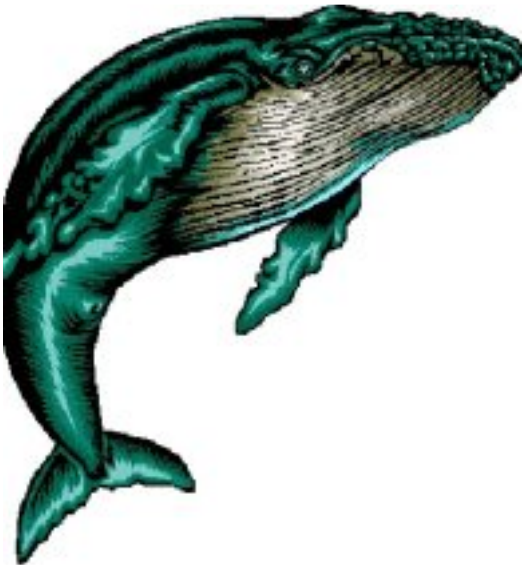
The competition will be judged in five divisions – grades K-4, 5-8, high school, scientific illustration, and computer graphics. Students may select any living or cultural resource, group of species, or habitat in the sanctuary as the subject of their artwork.

Students may use any medium, including markers, paints, pastels, pencil, pen and ink, collage or computer graphics (see competition categories) and are asked to keep artwork between 5x7 inches (minimum size) and 18x24 inches (maximum size). For more detailed information about the contest and the Stellwagen Bank natural and cultural resources, visit the sanctuary's Web page at http://stellwagen.noaa.gov. Contest information can also be accessed at the MME Web page at http://www.massmarineeducators.org.

Winning artists will receive passes to the New England Aquarium, passes to the Provincetown Museum, certificates and other prizes. All award-winning entries will be posted on the Stellwagen Bank National Marine Sanctuary Web site and may be displayed at sanctuary exhibits throughout New England.

Congress designated the Gerry E. Studds Stellwagen Bank National Marine Sanctuary in 1992 as "an area of special national significance." Virtually the size of the state of Rhode Island, the sanctuary stretches between Cape Ann and Cape Cod in federal waters off of Massachusetts. The sanctuary is renowned as a major feeding area for marine mammals, particularly humpback whales, and supports an ecosystem of diverse wildlife.

For more information about the contest, contact MME Board Member and SBNMS Education Coordinator Anne Smrcina at 781-545-8026 ext. 204 or anne.smrcina@noaa.gov.



2006 Green Eggs & Sand Workshop on Cape Cod

Looking to infuse a globally-significant ecological phenomenon and current real-world resource management controversy into your classroom?

Interested in meeting and learning first hand from a select and diverse group of experts and stakeholders offering a wealth of knowledge and experience with the issues?

Take part in a two-day, not-to-be-missed, activity and field-enriched workshop experience over the full moon June weekend on the Cape. Take home the national-standards-keyed, middle/high school-level-targeted, video-and-activity-rich, Green Eggs & Sand CD/DVD curriculum package.

Where: The South Shore YMCA Outdoor Education Center, Sandwich, MA
When: Sat. June 10 (starting 9 AM) through Sun. June 11 (ending 4 PM), 2006
Who to contact: Katy O'Connell: (302) 739-3436 x20; katy.oconnell@state.de.us
Fee: $85, covers all meals, lodging on site (Sat. night) & all workshop materials*

More about the workshop: The workshop will feature sessions with expert presenters on horseshoe crab (HSC) and shorebird ecology, bait and biomedical use of HSCs, and HSC management. A field trip to a nearby Cope Cod beach to observe HSC spawning will also be offered.

More about the lodging: Lodging will be provided for Saturday night only at the workshop site. This facility features units comprised of four individual cabins, connected by a deck and sharing a common bathhouse/meeting room building. Each individual, heated cabin can hold up to ten people in four bunk beds and two normal beds. The cabins are modern (built in the 1990s) but still retain a camp atmosphere. You are required to bring your own pillows and linens. Although these and other conditions may challenge the comfort level of those accustomed to more privacy, the trade-off comes in being on-hand after hours to socialize and network with the various experts and fellow participants. For those seeking alternative accommodations, visit http://www.sandwichma.org/ and click on the lodging link. Reservations for offsite lodging are to be made by the participants at their own expense, and it should be understood that this does not reduce the workshop registration fee. Please indicate your lodging preferences, along with any special dietary or accommodation needs in the spaces below.

Registration for June 10-11, 2006 Green Eggs & Sand Cape Cod Workshop

Name _____
Title _____
School/Affiliation _____

Vocation: ___ Public school teacher ___ Private school teacher ___ non-formal educator ___ other
Grade level(s) you teach: ___ Elementary ___ M.S. ___ H.S.___ college ___ other
Subject(s) you teach: ___ Science ___ Social Studies ___ Math ___ Language Arts ___ other
Approximate number of students you reach annually: ___ <25 ___25-50 ___ 51-100 ____ >100
Mailing address _____
Phone _____
E-mail (please print clearly!) _____

____ I would like to reserve a bed at the S. Shore YMCA Camp
____ I will reserve my own lodging elsewhere
____ I have the following dietary and/or accommodation needs (please be specific).
If you are not willing to sleep on a top bunk please make note of it here.

Please return completed form & check (payable to 'State of Delaware') to:
GE&S, DE National Estuarine Research Reserve, 818 Kitts Hummock Road, Dover, DE 19901
Deadline for submission is April 21, 2006.
Reservations are first-come-first-serve. The completed form and check are required to reserve your space for the workshop.

Massachusetts Marine Educators
30th Woods Hole Conference and Annual Meeting
Saturday, April 29, 2006
Redfield Auditorium, WHOI
8:30 AM – 4:30 PM
30th Anniversary Dinner 5:30-8:30 PM

Theme: Oceans and Climate

Image: NOAA/Department of Commerce

Join us for the 30th annual Massachusetts Marine Educators conference at the Woods Hole Oceanographic Institution (WHOI) as we investigate Oceans and Climate. Come hear marine scientists speak about their latest research, then try out frameworks-linked lessons led by master educators. You will be sure to find Oceans and Climate a hot topic for your students, as you collect teaching resources, exchange ideas, and earn PDPs. Top off your learning with an insider's tour of local institutions! Program information will be available one the MME website after 3/15/06

COST: $50 (includes lunch and teaching materials)
Space is limited so register by April 14 and save $5.
Find registration info at www.massmarineeducators.org/
Questions? contact Pat Harcourt (508) 457-0495 x 106 pat.harcourt@state.ma.us

Plan to stay for the 30th anniversary dinner–you're invited!

Registration Form

Name: _____

Address:_____

City:_____ State: _____ Zip:_____

E-mail:_____

___Conference registration: $50.00 ___MME 30th anniversary dinner $25.00
___Register by April 15: $45.00
Please send a check made out to MME for the appropriate amount to Gail Brookings, 184 Highland Street, Taunton, MA 02780 Questions? contact Pat Harcourt (508) 457-0495 x 106 pat.harcourt@state.ma.us

Classroom Activity

Activity prepared by Howard T Dimmick, MA Marine Educators Association retiring president May 2005

TSUNAMI!! How can we warn those in danger?

Overview

This activity looks at the problems created when an earthquake, volcano, or other catastrophic event occurs near the coast, or under the ocean causing the release of tremendous amounts of energy into the water environment. It traces the transfer of this energy to the water and movement of that energy across the ocean to distant locations.

Time Frame

This activity can be completed in a single class period.

Objectives

1. Students will be able to calculate the speed of a tsunami created by a coastal earthquake and predict its arrival time.
2. Students will understand how a tsunami is generated and why it becomes a significant danger to coastal regions locally, and thousands of miles away.
3. Students will understand the dangers of tsunamis on coastal regions oceans away from the source.

Education Standards Reference

Massachusetts Science Frameworks

- Describe How movement of the earth's crustal Plates causes both slow and rapid changes in the earth's surface (E and S Grade 6-8 #5)
- Describe and give examples of ways in which the earth's surface is built up and torn down by natural processes…. (E and S Grade 6-8 #6)

National Science Education Standards

- Major geological events, such as earthquakes, volcanic eruptions and mountain building result from lithospheric plate movement. (NSS 5-8)
- All students should develop an understanding of the transfer of energy. (NSS 5-8))
- Use technology and mathematics to improve investigations and communications. (NSS 9-12)
- Waves on water have energy and can transfer energy when they interact with matter. (NSS 9-12)
- The outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe. (NSS 9-12)
- Explain the different ways in which places are connected and how these connections demonstrate interdependence and accessibility. (NGS 5-8)
- Predict the potential outcome of the continued movement of Earth's tectonic plates. (NGS 5-8)
- Explain the effects of different physical cycles on the physical earth (NGS 9-12)

Links across the curriculum

- Calculations for time of arrival relate to mathematics.
- Use of geography skills

Content background for teacher

When a major earthquake occurs along a subduction zone an especially hazardous wave called a **tsunami** may be generated in the ocean. Tsunami comes from two Japanese words, 'tsu' means harbor and 'nami' means wave. These waves are a potential danger to coastal communities and islands dotting the Pacific. During a major earthquake, the seafloor can move several meters and an enormous amount of water is suddenly set into motion and may slosh back and forth in the ocean basin for several hours. A series of waves that race across the oceans at speeds in excess of 800 km/hr can result. The momentum of these waves can take them thousands of kilometers from their origin before slamming into far distant islands or coastal regions. This activity will allow students to calculate the movement of a tsunami across an ocean body and predict when the tsunami will strike at various locations.

Instructions for activity

Distribute the map provided along with the instruction sheet

Distances can be provided to students if you have limited time

Additional resources Web Locations

http://www.pmel.noaa.gov/tsunami/indo_1204.html

Pacific Marine Environmental Laboratory – Tsunami Materials

http://www-misr.jpl.nasa.gov/gallery/galhistory/2005_jan_12.html
JPL's MISR (Multi-Angle Imaging Spectro-Radiometer) Tsunami Pix
http://www.pmel.noaa.gov/tsunami/
Pacific Marine Environmental Laboratory (SEA) Research on Tsunamis
http://tsun.sscc.ru/tsulab/20041226.htm
Institute of Computational Mathematics and Mathematical Geophysics. Novosibirsk, RUSSIA, Tsunami Laboratory
http://walrus.wr.usgs.gov/tsunami/
USGS Western Coastal and Marine Geology Site at Menlo Park/ Santa Cruz CA. Several good animations may be found on this site.

Scientific American May 1999, Vol 280 No. 5, Tsunami Frank I. Gonzales pp 56-65
National Geographic Video, Killer Wave

Assessment suggestions

Provide data from another Tsunami (real or manufactured) Ex: "What if a tsunami occurred on Hawaii, when would it reach a point on the North American coast?

Additional credits for the information used in this activity to:
This Dynamic Planet, publication of the USGS
Understanding of Tsunamis, online course presented by the College of Exploration 2005
http://coexploration.org/

TEACHER ANSWER KEY

1. Depending on accuracy of measurement, the answer should be about 15+ hours.
2. The ConcepciÓn to New Zealand time would have taken about 7 hours
3. The Valdez Tsunami would have reached HI in about 6 hours.
4. The Valdez Tsunami moved at a much faster rate than the Chile Tsunami.
5. Depending on the velocity of the Tsunami and the exact location on the Hawaiian coast, they would have less than 6 hours from the beginning of the event until the arrival of the Tsunami.
6. Police could move through the area with public announcementsI
   If this is an area of frequent tsunami activity a warning signal system could be used
   Radio and TV Notices
   Local weather forecast station could use NOAA weather radio announcements
   People should move to higher ground away from the coast immediately
7. A mass evacuation can cause major confusion as all move to a higher area
   Because of natural curiosity and lack of understanding, many may move toward the coast danger area to WATCH
   There may be more that one large wave and they may move into the path of later waves
8. The wave will arrive about 4 hours after the earthquake
   They had about a half-hour after the warning from the sheriff deputy
9. Difficulties and problems might include
   - cost of building and maintaining
   - ship to set the gauges
   - weather and ocean water reaction with the gauges
   - satellite maintenance
10. Weak Links
   - operation of equipment
   - human interpretation of information
   - Sending warnings to distant points in adequate time

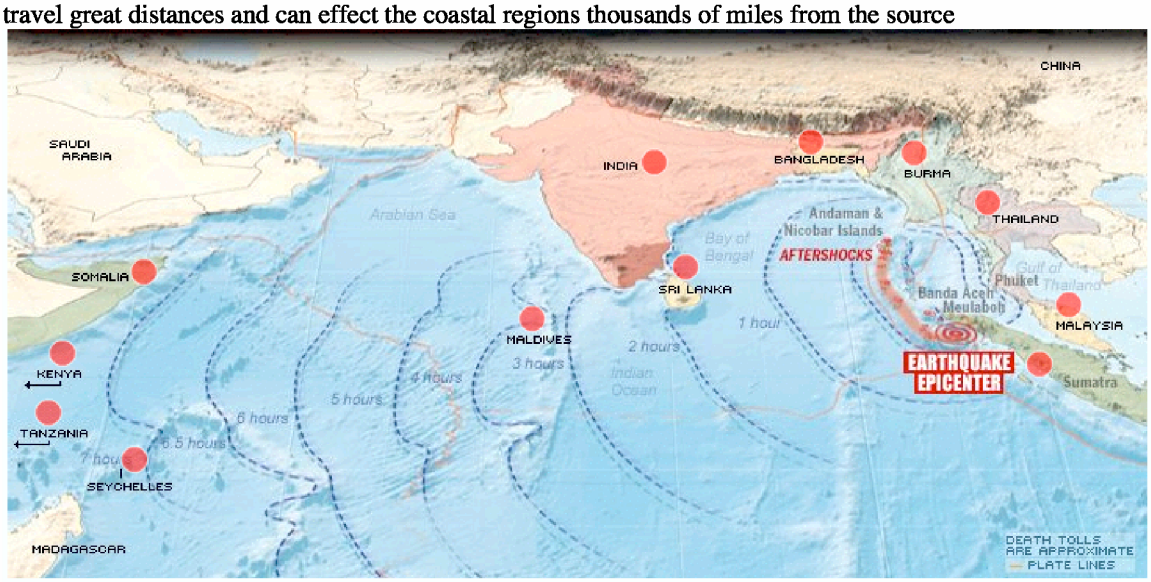
There may be many other responses which students will come up with for questions above which are acceptable.

TSUNAMI ACTIVITY
STUDENT SHEET

December 26, 2004 on the islands of Indonesia, Sumatra, Sri Lanka, and along the coast of the Indian Ocean dawned with many people at the beach resorts in the region. The people from many parts of the world were on holiday vacation in the region. They were unaware of geological events which were to occur that day that would have a profound effect on these coastal regions. Before the sun set for the day one of the largest disasters to occur in centuries would change their lives. In addition to the tourists in the region, many thousands of residents of the region, workers, fishermen and others would be numbered in the 300,000+ deaths.

On that morning, 250 km (~150 miles) south of Sumatra a large earthquake occurred south of the Sumatran Island about 30 km (~18miles)under the Indian Ocean. This quake set the ocean floor into movement and triggered a catastrophic earthquake. The quake, initially measured at 9.0 magnitude but later revised to 9.3 magnitude set into motion a large part of a subduction zone fault and started the water moving. This shift starts the overlying water layer moving, and generates a transfer of energy to the water. The energy is now transported away from its origin site through the movement of the water. This propagates waves, called **tsunamis**. Tsunami comes from two Japanese words, 'tsu' means harbor and 'nami' which means wave. Tsunamis are often referred to as 'tidal waves' which is an incorrect name as their formation is totally different than normal wave formation.

The tsunami wave is a wave with giant proportions. While most ocean waves have a short wavelength, a tsunami may have a wavelength of 100 km or more and a period of nearly an hour while in deep water. In deep water, the wave height is usually less than 1 meter, considerably less than wind or storm generated waves. If a ship were in the path of a tsunami, it would be hardly noticeable to those on board. Tsunami waves have a speed that varies between 600 and 1000 km/hr. (as fast as a modern jetliner). These waves travel great distances and can effect the coastal regions thousands of miles from the source



Time Magazine January 10, 2005

Map of the region showing time-distance movement across the Indian Ocean.

As a Tsunami approaches the shore, its speed decreases while the height increases dramatically. The approach of the first wave (there may be several), MAY BE accompanied by

- a rapid outward movement of the ocean from the shore, looking like a rapidly occurring low tide
- the shaking of the ground from the earthquakes occurrence (If you are close to its source)
- a loud bang or the sound of a rushing freight train.

These warning signs may occur minutes or hours before a tsunami strikes, and should result in those near the shore moving inland and to higher ground as quickly as possible

Because there may be more than a single wave people should remain in a safe area until emergency persons tell them it is safe to move back to the area. As the water withdraws, it builds the successive tsunami waves to heights of tens of meters. These waves, often many minutes apart, cause greater destruction and

loss of life than the initial wave. In several instances, people venture onto the beaches after the first wave, only to be met by the huge wall of water from successive waves. Those people on the Sumatra Island and other nearby islands had very little time to react, and in fact this is one of the reasons the death toll was so high. In one instance, a 10 year old British schoolgirl on winter holiday, remembering a lesson recently taught in school, warned her parents and many others that a tsunami had occurred, and this group of people moved to safety and survived. A geologist at one of the beachfront resorts also saw what was happening, and demanded the hotel manager to warn people to evacuate the lowland area on the beach. He did so, and again many people were saved due to this action.

In theory, the farther away from the event people were there should have been more time to warn them, but we have to remember several things:

- This was the height of the winter holiday season in the region
- Many tourists were there
- It was a Sunday morning
- This is not an area where large tsunamis are normally seen
- There is not in place a large network of warning devices

There are tremendous amounts of material available in the web to supplement the information presented above. Your teacher will supply some of these sites to you for further research.

In this activity, we will look at the Pacific Ocean, and try to see how scientists are able to warn those in coastal regions of the possible approach of a tsunami. The map on the next page is from material prepared by Dr Gerald J. Fryer, an Associate Geophysicist at the University of Hawaii at Manoa, shows travel time to Hawaii from several parts of the Pacific for a Tsunami.

Use the map on the following page to answer these questions

Two large earthquake generated tsunamis have occurred in this region over the past 40 years. The earthquake in ConcepciÓn, Chile occurred in 1960 and the earthquake at Valdez, Alaska (single red star in the Alaskan coast east of the Aleutians which occurred in 1964. Concentric lines have been drawn from Hilo HI representing the time of tsunami movement from Hilo to each of these events. (The ConcepciÓn earthquake produced a tsunami more than ten meters high at Waiakea, HI.)

1. Using this map measure the time of travel from Chile to Hawaii._____

2. The tsunami also crashed into the northeast coast of New Zealand. Assuming the same speed, how long did it take to reach New Zealand? _____

3. Estimate how long the earthquake from Alaska took to travel from Valdez and Hawaii.

_____

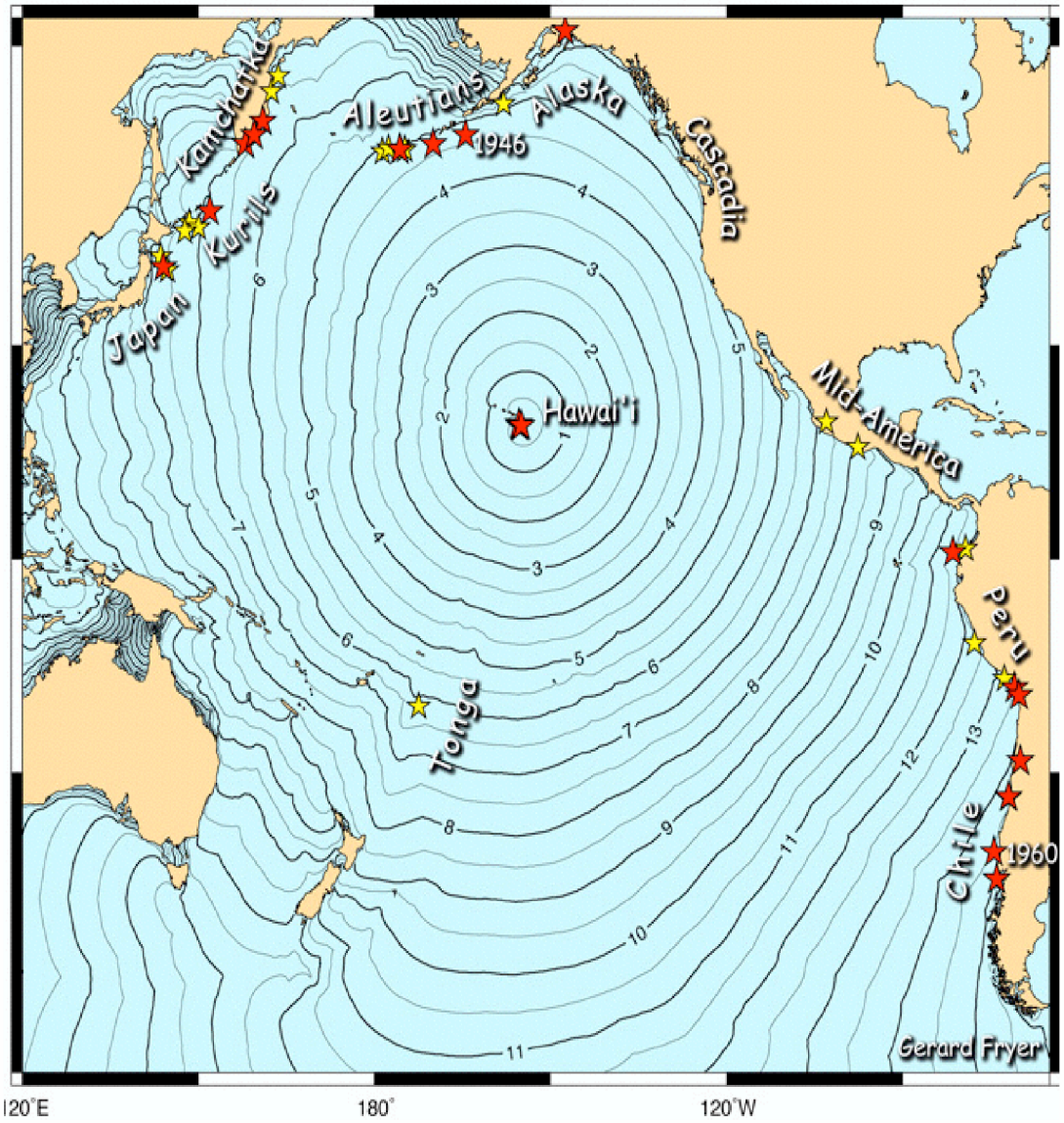
4. Can you estimate the differences in distance based on the arrival speeds of the two tsunamis at Hawaii?

5. If an earthquake occurs along the coast of Alaska, and you are made aware of its occurrence, how much time would you have to warn people along the north shore of Hawaii?

6. How could people living on a island coast with little elevation above sea level be warned that they would be in the path of an approaching tsunami? What should they do?

Early detection of a possible tsunami has resulted in a Sea Wave Warning Center being established in Honolulu. This center is notified when a potential tsunami producing event occurs factors such as the direction to the source of the tsunami, how strong an earthquake event has occurred, and the potential danger that could occurs determined by the center. The center then determines when and where there is potential for a tsunami to strike a coastal region. Tsunami warnings are then issued to areas in potential danger.

7. When a tsunami warning is issued, what problems might this create for that area? Think of what might happen in the area between the time a tsunami warning is issued and the time that the tsunami is predicted to strike the area.



Map from Dr Gerald Fryer, University of Hawaii at Manoa

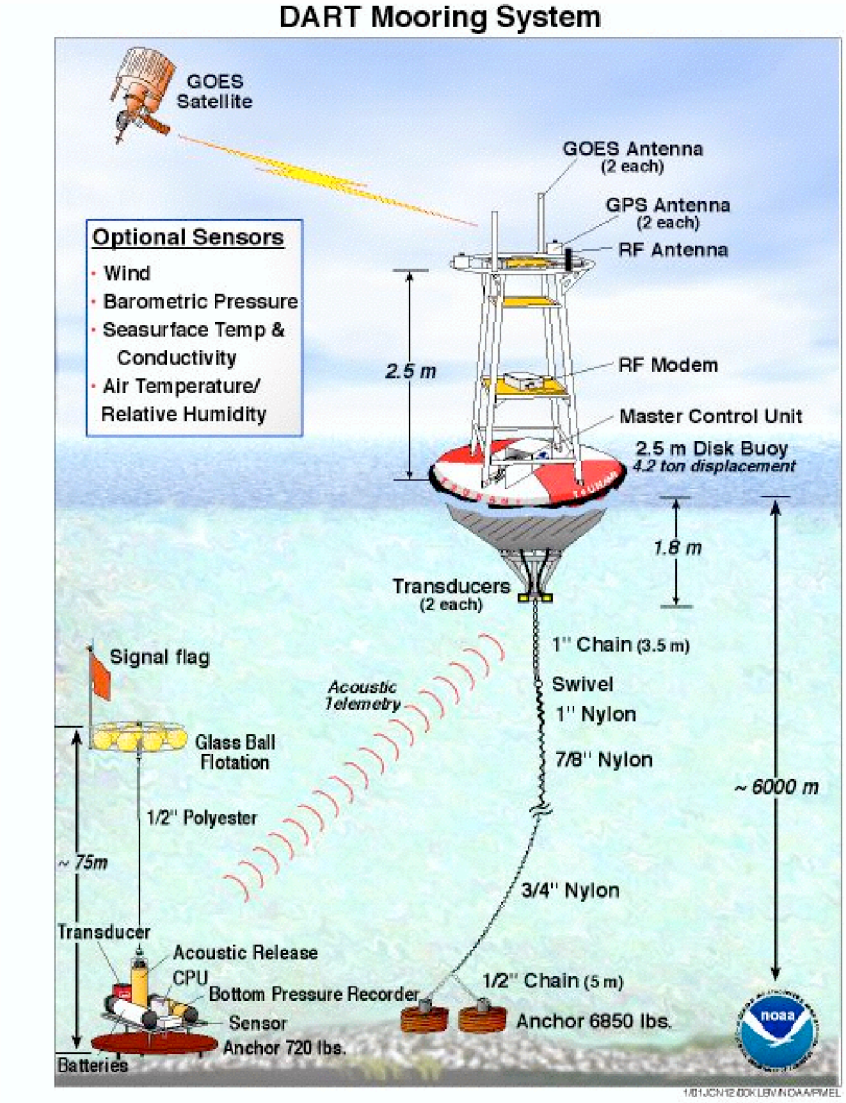
Concentric Circles represent one hour travel time.

The Valdez earthquake of 1964 produced one of the most damaging tsunami waves on the US West Coast in the past century causing $100 million in damages. Most of the damage was at Crescent City, on the far northern California coast. Crescent City is about 5mm south of the "A" in Concordia at the black indentation.. The earthquake occurred at 3:36 AM GMT, and the warning reached the Honolulu Center at 3:44 AM GMT. The center accurately determined the focus, magnitude, and potential locations for a tsunami strike and issued an warning bulletin which was received in California at 6:44 AM GMT. The sheriff at Crescent City received this notification at 7:08AM GMT and notified people in the low-lying regions to evacuate.

8. On the map locate Crescent City, and determine the amount of time that people had to evacuate from when the warning was broadcast and the first wave reached Crescent City. (Use a ruler to measure the distance from AK to Cresent City. Now determine the time using th e scale from AK

to HI to estimate the time travel distance).The wave arrived at Crescent City _____ hours after the earthquake. This gave the people _____ (label hours/minutes) time to move from the low-lying coastal regions.

The Oceans of the world have only a few warning instruments to watch for tsunamis and to warn of their approach. Most of these are in the Pacific Ocean. Since the December 2004 tsunami, the governments of the world have discussed the placing of some of these instruments in all the oceans. This is a very expensive proposal with the cost of each site being about $250,000 and a yearly maintenance cost for each. A diagram of these NOAA Dart (Deep-Ocean Assessment and Reporting of Tsunamis) gauge.



NOAA Image from the Pacific Marine Environmental Laboratory.

How it works. A pressure gauge on the bottom (BPR = Bottom Pressure Gauge) measures the height of waves as they go by overhead. It transmits its measurement to a buoy on the surface. The buoy radios the measurement to a satellite, which sends the signal on to a receiving station on the Internet. The bottom package transmits its signal acoustically (using sound waves), which means that it has to be powered by batteries. For more information, visit The Pacific Marine Environmental Laboratory at http://www.pmel.noaa.gov/tsunami/Dart/

9. Take some time to think about this project. In the space below, discuss some of the difficulties that a project of this size would have in being implemented. What would be the most difficult parts of preparing and maintaining the project. What are some of the problems of keeping a system of this type operating in all the worlds oceans?

10. With a system of this type in place, how successful do you think it would be in warning people of an approaching tsunami? What are the weak links in the project?

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