Our Notes from the First Lego League WHOI – Science Presentations
Tuesday, November 15, 2005, Redfield Auditorium
Virtual Visit and power points presentations at:
http://www.whoi.edu/sbl/liteSite.do?litesiteid=5192&articleId=7946

Oil Spills
Presentation by Chris Reddy, Associate Scientist, MCG
Chris is a chemist.
Oil is organic material that is cooked and squeezed over a long period of time.
There is a family of oil products and they have different characteristics.
To determine how serious an oil spill is, Chris asks "What type of oil is it?"
Some oils are more toxic. Some oils last longer in the environment.
A refinery is like a hot plate. Oil is heated to separate gas, diesel, oil for home heating, and lubrication oils.

What kind of oil is it?
Gasoline – not bad it will burn away in the sun.
Diesel fuel – more toxic and lasts for a while in the environment.

Oil Pollution Sources
47.3% - natural oil seeps
24.1% - transportation
11% - run off from land sources, oil dripping from cars onto streets
9.8% - accidental spills
4.2% - air pollution
2.9 % - extraction of petroleum from beneath the ocean floor
0.6% - jettisoned fuel

Historic Spills:
September 16, 1969, 700,000 of diesel fuel. You can still smell and see the oil today. Chris studies the spill. They take pipes and stomp them into the ground. They bang the pipes to take a core of mud. The mud is like a 'tape recorder' of events. Older information is at the bottom.

The concentrations of total petroleum hydrocarbons are measured at each depth. A 'Downpour Profile' shows the concentrations with the vertical axis labeled from deepest to shallowest going vertically up. The highest concentrations were at about 15 cm and were about 6 mg g-1 by dry weight. The study shows that oil lasts over 30 years.

Although oil lasts, the marsh looks beautiful. Bacteria 'make their living' off the oil. Is anything still affected by the oil? The researchers studied the marsh fiddler crab (uca pugnax). They poured plaster of Paris into the burrow depths of oiled and non-oiled areas. Burrows at Wild Harbor were 6.4 +/- 0.6 cm in the oil field area, and 13.7 +/- 0.6 cm in the non-oiled fields. The burrows at Great Sippe in non-oil locations were 13.7 +/- 3.2 cm. The oil burrows were also curved. The oil concentrations start to rise at about 6 cm, so it appear the fiddler crab burrows sideways rather than down into the oil.

OPA90 – changed rules of oil, not many spills after law passed.
Want non-polluting lubrication systems.

Whales & Ship Strikes
Presentation by Peter Tyack, Senior Scientist, Biology
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We compete with animals for use of the oceans. Shipping vessels go about 30 mph. Dr. Tyack showed us a photo of a fin back whale narrowly missing being run over by a ship when it swam in front of and across the ships path.

We need to prevent whales from hitting a ship. Dozens die every year. The North Atlantic Right Whale is very endangered. The mortality from fishing nets and ship strikes is keeping it endangered.

Can we emit a sound to repoint the whales?

The low frequency sound of the engine, the huge engine with its big propellers makes a loud noise. But can the whales tell where the sound comes from? Or is it that they hear the sound but don't react quickly enough?

Researchers study how whales respond to their own sounds. Whales can hear and localize low frequency sounds. Tags the size of a computer mouse are put on the whales. The tags measure audio, pitch with a hydrophone and depth with a pressure gauge and time.

If a vessel noise isn't associated with a negative effect, it is likely to habituate and no longer react.

Delay or interfere with reaction during rare close dangerous approach?

What happens as a ship closes in on a whale at 500 m, 100 m, 50 m, 10 m?

Big literature for making alarms that get the attention of humans but not a bad (panic) reaction.

Alarm responses:
Pros
- 5/6 whales had a rapid response
- started avoidance at low received level

Cons
- 5/6 whales had a rapid response
- started avoidance at low received level

During alarm, surface 68% of the time.

Forward directed beams in the zone of potential hearing and outside that zone don't hear. Must have something negative happen to avoid habituation. Caution re-use of ship-based alarms.

Question: Should WE get out the way, or should THEY get out of the way?

Reroute the ships. With aerial overflights we can know ere the whales are and move the shipping lanes away from the Bay of Fundy. Fines on people who kill marine mammals aren't enforced.

Hydrothermal Vents

Presentation by Breea Govenar, Biology

Bottom of oceans.

0 – 200m down = photic zone (light can penetrate)
200m or more = aphotic zone

Continental Shelf
Continental Slope
Abyssal Plane
Mid-Ocean Ridge

History:
1843: Azoic Hypothesis: No life below 500 m because samples at the bottom of the Aegean Sea were lifeless.

1872-1876: The Challenger Expedition. 4000 species were described and some were collected from a depth of 5500 m.

1960s: Diversity-Stability Hypothesis: High species diversity in the deep sea where there is no light.

1977: Discovery of hydrothermal vents and life without sunlight.

Midocean ridge and hydrothermal vent environment. Deep sea water is cold (35ºF) and oxygenated. Vent fluids are 400ºC/750ºF and contain reduced, toxic chemicals. (Fornari et al, 1994)

The fluid dramatically rises like smoke and is visually interesting. Most vent species live below 100ºF. The tube worms (phylum polyceats, relatives of earth worms) live in tubes made of kitten, like the material of finger nails. Bivalves that are morphologically similar to New England bivalves live there (clams and mussels). Riftia Pachyptila The tube is less than 3 m and 650 grams. There is no digestive tract. The trophosome full of bacteria, the powerhouse of the tubeworm – a symbiotic relationship – a close association between two organisms.

Bacteria that uses chemical energy.

Photosynthesis: Sunlight + CO_2 + H_2O -> CH_2O simple sugar and energy
Chemosynthesis: S^- + SO_2 + CO_2 + H_2O -> CH_2O simple sugar and energy

The host supplies the materials, the symbiont supplies the product. Symbiotic host supplies materials, essential nutrients, turbulent mixing of cold seawater and hot vent fluids. The H_2S of the vent mixes with the hemoglobin in the tubeworm blood. They take HS^- and O_2 across the plume. Mussels have symbionts and filter feed. They take H_2S and O_2 through the siphon. Clams use low flux and take O_2 across the siphon and H_2S across the foot.

Sulfide oxidation is an energy source. Sulfide is toxic and binds to hemoglobin. It inhibits cellular respiration causing suffocation. DSV Alvin http://www.whoi.edu/marine/ndsf/vehicles/
Autonomous vehicles study the Galapagos Rift - location of 1st hydrothermal vents.
Juan de Fuca Ridge
Lau Back – Arc Basin

Large gastropod – blue blood but also uses chemosymbiosis.

Shrimp at the mid-Atlantic ridge are episymbionts, no eyes, light sensitive organs, detect 'heat' light from a vent

Putting together: biology, microbiology, chemistry, volcanism, plate techtonics

Galapagos dive on submarine weight sinks 1.5 hour to go 1.5 miles –
Dr. Govenar has gone on 10 dives
Sub drives at ½ mile per hour on floor.

Hurricanes
Presentation by Jonathan Woodruff, G&G

We have 150 years of data to base hurricane statistics upon. "Hunting for hurricanes in the mud using all the stuff I learned in High School"
The number of storms per year can be found in the mud. There are hyperactive intervals in the 1950s and now. Is it global warming or is it part of natural history.

Paleotempestology – old storm study

A competition to see how very deep you can get the core down – takes physical fitness.

1635 – earliest hurricane recorded and dated in New England.

We have to learn foreign languages to talk to other people.
Physics – laser diffraction particle size detector
Chemistry – sediment chemistry spectroscopy

Clues from the environment
Depth (cm) vs. Photo Grain Size

Vieques Sediment Cores
History – lawless for a while Blackbeard in the 1700s
Then 1840s law came, sugar can cleared land and there is run-off and changes in radioactivity
Used to have a tract to see a mushroom cloud
1963 – UN stopped limited nuclear test ban treaty

BP = years before present – which is 1950

El Nino – the fishermen in Peru notice fish change

Impacts hurricane: 1st seasons; 2nd el Nino
The upper layer atmosphere sheer
There are El Niño hunters that ID el Niño events
When El Niño increases the number of hurricanes decreases
When El Niño decreases the number of hurricanes increases

Hurricanes leave a record on earth

Q&A: Deadliest on record – Galveston 1900s Isaac Storm, a meteorologist had a theory that storms would not hit Galveston

The storm surge causes the most deaths

Do all hurricanes come from Africa? No Katrina was a Bahama Mamma

Ship Wrecks
Presentation by Brendan Foley, AOP&E

http://www.whoi.edu/sites/archaeology

Why care about the ancient world? What is deep? Why shipwrecks? The past is prolog?

4000m = 12000 ft

Titanic – 1985/`986 Deep Submergents Lab – Alvin discovered and explored

Ancient = 4000 years ago when the pyramids were new.
Ancient Greece 2500 years ago, before cars everything traveled by water – it was the safest, fastest, easiest way to travel and transport things. Biggest causes of sinking are: fire from oil lamps used for nighttime illumination, storms, shifting weights of cargo

1000 yards range high frequency target see something metallic – he hopes it is bronze artwork. It is a soda can found ½ mile away!

Greek accidents: amphera – liquid vessels 'milk jugs' carried olive oils, wine, etc. These can be used to tell where and what was carried and originated because Greek pottery styles can be typed. Ampheres Big boulders and currents – roll the pottery vessels across the sea floor

Palmer and Crery – two ships that collided and sank – schooners that were carrying coal and collided in the fog and locked and sank together

Driving a robot (from office but half a world away) you can create large photo mosaics.