Animals of the Benthic Environment
The Benthos

• *By definition:* organisms (animals and plants) that live on, in or attached to the sea floor

• **Includes 98% of all marine species**

• Coral Reefs alone contain 25% of all marine species!

• Community composition determined by benthic composition
Benthic vs. Pelagic

- Benthic organisms are **not** adapted to wide ranges in pressure.
- There are **very few** transparent organisms.
- Generally stay to a **smaller** spatial area (they don’t move around as much).
- We classify them in relation to the type of shoreline or bottom structure.
Benthic Substrates

- Rocky, sandy, or muddy intertidal
- Muddy deposits or hydrothermal deposits in the deep sea
- Biomass is closely related to surface-water primary production
Benthic Diversity, Biomass

• Benthic diversity is largely controlled by
  – Temperature (more in warmer waters)
  – Currents (this affects the benthic structure)
  – Wave Energy (infauna vs. epifauna)

• Benthic Biomass is largely controlled by
  – Water column primary productivity
Primary Production

Benthic Biomass

Figure 17-1  Distribution of Benthic Biomass of the World Ocean (g/m², wet weight)
Coral Reefs

• Contain 25% of all species
• Are not strongly related to primary production in surface waters
• Can only exist in warm (>18°C), clear waters--the tropics
Symbiosis

- Reef-building corals are called *hermatypic* corals, and rely on *zooxanthallae* (*dinoflagellates*)
- The zooxanthallae consume waste nitrogen, carbon dioxide and provide sugars
- Hermatypic corals are ultimately light (and therefore depth) limited
Hydrothermal Vents

- Also rely on symbiosis, but use *chemosynthesis* instead of photosynthesis
- Types:
  - Black, white smokers
  - Cold Seeps
  - Hydrocarbon Seeps
  - Hypersaline Seeps
Seep Communities (as of 1999)

Hydrothermal Vent Communities
The Law of the Sea

- **1702**: The first “territorial sea” was designated as the distance a canon could fire.
- **1772**: British set the limit at 1 league.
- **1950-1975**: Iceland extended its fishing rights to 200 nautical miles.
The Law of the Sea

- **1958-1982**: the United Nations establishes a series of treaties ("The Law of the Sea"), signed by 130 countries, but **NOT** the US

- Signed by the US in 1993 and enforced in **1994** but never ratified by Congress
The Law of the Sea

- **Law of the Sea** includes:
  - **EEZ**: each coastal country has a 200 nautical mile economic zone
  - **Rights of Ship Passage** through important waterways, regardless of the EEZ
  - **Deep Ocean Mineral Resources**
  - **Arbitration** of Disputes in International court
The Exclusive Economic Zone

- 1995: Halibut Wars between Canada, Spain
- 1997: Salmon Wars with Canada over fishing rights
Fishing Pressure

- Before 1950, >90% of fish caught were for human consumption
- Since 1950, world fisheries increased 6X, but only ~50% of fish go to feed human populations (as fish)
Fishing and the Food Chain (Web)

- To assess this scientifically, we can assign a *trophic value* to each organism
- **Sustainable** fisheries generally start with low values
CHARTING THE COURSE FOR OCEAN SCIENCE IN THE UNITED STATES FOR THE NEXT DECADE

AN OCEAN RESEARCH PRIORITIES PLAN AND IMPLEMENTATION STRATEGY

NSTC JOINT SUBCOMMITTEE ON OCEAN SCIENCE AND TECHNOLOGY
JANUARY 26, 2007
The Polar Cap is Shrinking

A comparison of September minimum sea ice concentration over the Arctic Circle, acquired in 1979 (top) and 2005 (bottom).

Image courtesy of Scientific Visualization Studio, NASA Goddard Space Flight Center
Disease & HABs are Spreading

Figure 2. Infectious and neoplastic emerging diseases in marine mammals may have ecosystem and public health significance. Examples of these diseases are (top to bottom) oral sessile papillomas associated with a novel herpesvirus in bottlenose dolphins; cutaneous papillomas caused by a novel papillomavirus in manatees; and cutaneous lobomycosis, a zoonotic fungal disease of bottlenose dolphins.

Figure 3. Harmful algal bloom biotoxins poison dolphins and manatees causing singular and mass strandings and sometimes large epidemics (top to bottom, singular stranded manatee with suspected brevetoxins and skin lesions, stranded beaked whale [Mesoplodon europaeus] and bottlenose dolphin). Harmful algal bloom biotoxins impact dolphins and manatees via ingestion and/or inhalation of toxins similar to humans.
There is not just one problem (or solution)
Fishing and the Food Chain (Web)

- To assess this scientifically, we can assign a trophic value to each organism
- **Sustainable** fisheries generally start with low values
There ARE some positive trends!

**Figure 40**

Comparison of discard estimates and retained catches

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FAO (1994)</td>
<td>77</td>
<td>77</td>
<td>84</td>
</tr>
<tr>
<td>FAO (1998)</td>
<td>27</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>FAO (2004)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Retained catches

Discards
Wetland Restoration in San Francisco

Remember, wetlands provide a “nursery” for animals, and act as a filter to remove pollutants....
More Wetlands and Less Pollution
The Oceans As Drugstore....

25% of ALL marine species are found on coral reefs....

Figure 1. Close-up underwater photograph of the invertebrate and plant diversity typically observed on coral reefs. Diversity can reach 1000 species per square meter.

Figure 2. The widely distributed red seaweed Laurencia was the first to be recognized as a robust source for halogenated natural products. This and related seaweeds produce a diversity of halogenated compounds (some with 5–6 bromine and chlorine atoms) by processes involving halogenating enzymes. Laurinterol (shown) was the first brominated terpene to be isolated (1968).
Figure 3. The Caribbean sea whip, *Pseudopterogorgia elisabethae* (Gorgonacea), contains the pseudopsterosins (shown) which possess potent topical anti-allergenic and anti-inflammatory properties. Estee Lauder, in collaboration with California Sea Grant researchers, developed these agents as skin care additives. The first application was in their "Resilience" cosmetic line. Photo courtesy V.J. Paul, Smithsonian Institution Marine Laboratory, Fort Pierce, Florida.
<table>
<thead>
<tr>
<th>Compound Name</th>
<th>Source</th>
<th>Status (Disease)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryostatin 1</td>
<td>Bryozoan Bugula neritina</td>
<td>Phase II (Cancer)</td>
<td>Now in combination therapy trials licensed to CPC Biotech by Arizona State University</td>
</tr>
<tr>
<td>TZT-1027</td>
<td>Synthetic Dolastatin</td>
<td>Phase II (Cancer)</td>
<td>Also known as Auristatin PE and Sobolotin.</td>
</tr>
<tr>
<td>Ceratodin</td>
<td>Synthetic derivative of Dolastatin 15</td>
<td>Phase I/II (Cancer)</td>
<td>Some positive effects in melanoma</td>
</tr>
<tr>
<td>ILX 651, Synthetolin</td>
<td>Synthetic derivative of Dolastatin 15</td>
<td>Phase I/II (Cancer)</td>
<td>For melanoma, breast, and non-small cell lung cancer (NSCLC).</td>
</tr>
<tr>
<td>Apilicine</td>
<td>Ascidian Apilidium albicans</td>
<td>Phase II (Cancer)</td>
<td>Dehydrocudemin B, made by total synthesis.</td>
</tr>
<tr>
<td>E7389</td>
<td>Sponge Lissodendoryx sp.</td>
<td>Phase II (Cancer)</td>
<td>Eisa's synthetic Iaichondin B derivative; breast and lung.</td>
</tr>
<tr>
<td>Discodermolide</td>
<td>Sponge Discodermia dissoluta</td>
<td>Phase I (Cancer)</td>
<td>Licensed to Novartis by Harbor Branch Oceanographic Institution.</td>
</tr>
<tr>
<td>Kahalalide F</td>
<td>Micrasteria rubescens and Alga Bryopsis sp.</td>
<td>Phase II (Cancer)</td>
<td>Licensed to PharmaMar by University of Hawaii.</td>
</tr>
<tr>
<td>Zalypsis</td>
<td>Synthetic Saffrin B derivative</td>
<td>Phase I (Cancer)</td>
<td>PharmaMar (based on safranycin molecule).</td>
</tr>
<tr>
<td>KR1-7000</td>
<td>Sponge Agelas mauritianae</td>
<td>Phase I (Cancer)</td>
<td>An agelaspin derivative.</td>
</tr>
<tr>
<td>Squalamine</td>
<td>Shark Squaleus acanthias</td>
<td>Phase II (Cancer)</td>
<td>Anti-angiogenic activity as well.</td>
</tr>
<tr>
<td>A-941 (Neovastat)</td>
<td>Shark Squaleus acanthias</td>
<td>Phase II/III (Cancer)</td>
<td>Defined mixture of &lt; 500 kDa from cartilage; anti-angiogenic.</td>
</tr>
<tr>
<td>NVP-LAQ824</td>
<td>Synthetic</td>
<td>Phase I (Cancer)</td>
<td>Derived from Psammaegin, Trichostatin and Trapoxin structures.</td>
</tr>
<tr>
<td>E7924</td>
<td>Synthetic</td>
<td>Phase I (Cancer)</td>
<td>Carboxylate-end modified hemisastatin.</td>
</tr>
<tr>
<td>Salinosporamide A</td>
<td>Bacillus Salinispora tropica</td>
<td>Phase I (Cancer)</td>
<td>Protease inhibitor Nerus Pharma</td>
</tr>
<tr>
<td>GTS-21 (aka DMXX)</td>
<td>Marine worm</td>
<td>Phase I (Alzheimer's)</td>
<td>Licensed to Taiho by the University of Florida.</td>
</tr>
<tr>
<td>IPL-576,092 (aka HAR-4011A)</td>
<td>Sponge Petroxina contignata</td>
<td>Phase II (anti-asthmatic)</td>
<td>Derivative of contignastain; Inflazyme Pharma.</td>
</tr>
<tr>
<td>CGX-1160</td>
<td>Corus geographus</td>
<td>Phase I (Pain)</td>
<td>Cognetix and Elan Corporation (Ireland); Phase II late 2005.</td>
</tr>
<tr>
<td>ACV2</td>
<td>Corus victoriae</td>
<td>Phase I (Pain)</td>
<td>Metabolic Pharma (Australia)(06/2006); conotoxin Yc1.1.</td>
</tr>
</tbody>
</table>
Free Energy?
Dutch Wind Farms

70 feet into the bedrock, 100 feet of water, with a 200 foot tower

Boston recently (March) approved the first US wind farm....
Wave Energy

Already installed off Portugal
Harnessing the Gulf Stream

A series of underwater turbines could harness the Gulf Stream's energy, researchers say.

Illustration courtesy FAU Florida Center for Electronic Communications

This 10-foot-diameter rotor at a research center in Dania Beach, Fla., is about one-tenth the size of those that will be used in full-sized turbines. The yellow fiberglass nacelles will house the pressure tank holding the generator seen at the bottom of the photo.
Ocean Observatories--An Example
A regional, cabled observatory… geology, chemistry, physics, biology, fisheries, etc.
Final Thoughts....

There are still two opposing views about the health of the oceans--you should now have enough information to decide whether you believe the evidence or not.

“Much of the debate over global warming is predicated on fear, rather than science.”
-- Senator James Inhofe

“Our world faces a true planetary emergency. I know the phrase sounds shrill, and I know it's a challenge to the moral imagination.”
-- Al Gore

http://www.youtube.com/watch?v=Wq_Bj-av3g0
http://www.thankyouocean.org/