Coral Reefs

Most diverse
32 Phyla

Most complex
Symbiosis

Most productive
2,000 dg C m\(^{-2}\) y\(^{-1}\)

Oldest
400 million
# Species Richness

### Isla Vieques vs. the Florida Keys

<table>
<thead>
<tr>
<th>Location</th>
<th>Carysfort Reef</th>
<th>Rock Key Reef</th>
<th>Sand Key</th>
<th>Ensenada Honda, Vieques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scleractinian Coral Species</td>
<td>11</td>
<td>15</td>
<td>19</td>
<td>24</td>
</tr>
</tbody>
</table>

- Carysfort Reef, FL
- Rock Key Reef, FL
- Sand Key, FL
- Ensenada Honda, Vieques, PR
(1) Survey the coral reefs of Vieques. 
(2) Determine if there
Coral Species Richness

Isla Vieques, P.R.

$y = -1.42x + 0.51$

$R^2 = 0.86$

$p = 0.007$
Isla Vieques, Puerto Rico
Inverse relationship between military activity and measures of coral reef health
Minimal Mass (g)
Vieques: Highest Cancer Rate
Video 1: USN Killen Wreck Site (James W. Porter, 2003)
Ambient Marine Radiation

Count

Machine Noise

Channel

8000
6400
4800
3200
1600

80
40
120
160
200

Background
Killen stern
Killen bow
Killen barrels
Explosive Compounds in Water Samples collected inside the Bomb (Site 3)

Average Concentration (ppb)

- Hexahydro 1,3,5-trinitrobenzene
- 1,3-Dinitrobenzene
- 2,4,6-Trinitrotoluene
- 2,2’-Dinitrotoluene
- 2-Nitrotoluene

Compounds

* Exceeds EPA’s RBC for Tap Water
Explosive Compounds in the Brain Coral Montastraea faveolata collected near the Bomb (Site 3)

- Concentration (mg/kg)
  - 0
  - 200
  - 400
  - 600
  - 800

- Compounds
  - Not analyzed
  - Hexaethyl 1,2,3,5-tetranitrobenzene
  - 1,3-Dinitrobenzene
  - 2,4,6-Trinitrotoluene
  - 2,6-Dinitrotoluene
  - 4-Nitrotoluene

The graph shows the concentration of various compounds in mg/kg collected near the Bomb (Site 3).
Explosive Compounds in the Feather Duster Worm *Sabellastarte magnifica* on the Bomb (Site 3)

![Graph showing concentration of explosive compounds](image)

**Compounds**
- Hexahydro-1,3,5-trinitrobenzene
- 1,3,5-Trinitrobenzene
- 1,3-Dinitrobenzene
- 2,4,6-Trinitrobenzene
- 2,4-Dinitrobenzene
- 2,6-Dinitrobenzene
- 4-Nitrotoluene

**Concentration (mg/kg)**
- Detection Limit: 1.2-1.3 (mg/kg)
Explosive Compounds in the Long-spined Sea Urchin Diadema antillarum on the Bomb (Site 3)

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Concentration (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4,6-Trinitroanisole</td>
<td>Detect. limit 1.2-1.3</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene</td>
<td>Detect. limit 1.2-1.3</td>
</tr>
<tr>
<td>1,3-Dinitrobenzene</td>
<td>Detect. limit 1.2-1.3</td>
</tr>
<tr>
<td>Hexahydro-1,3,5-Trinitrobenzene</td>
<td>Detect. limit 1.2-1.3</td>
</tr>
</tbody>
</table>
38 mg / kg Arsenic

300 x’s EPA’s allowable level

( 0.16 mg / kg ) ( 2000 )

86 mg / kg new FDA Guide

( 2001 )

700 x’s EPA’s 2000 allowable level
Hazardous Materials Decay Exponentially
General Principles of Contamination

- [Near] > [Far]
- [Stationary] > [Mobile]
- [Coral] > [Worm] > [Urchin] > [Fish]
On May 1, 2003, the Navy left Vieques.

In January, 2005, EPA declared Vieques a Superfund site.
Video 2: Underwater Ordnance Removal
( James W. Porter, 2005)
We must defend our freedom, but without achieving a Pyrrhic Victory.