We're using stuff up!

Stuff vs time when stuff does not grow but is used by a growing population

Extrinsic decline
Carrying capacity

- **maximum sustainable population**
- **human c.c. depends on**...
  - **affluence** -- resource needs
  - **technology** -- amplifier or silencer of affluence
  - **impact** -- activities that degrade the biocapacity

Defined by Daly's Criteria
Carrying capacity

many components

( go to the board and list them )
Energy

how does it relate to c.c.?

How does energy input into (the land, water, manufacturing, health, education) affect that resource?

( go back to the board )
Oil is not renewable

Food production, heat, transportation all depend largely on oil, a non-renewable resource. Are we spending our savings?

http://www.peakoil.net/
Sinks

What are they?  What do they absorb?
Overshoot

Are we already there, according to Daly?

Fresh water
Forests
Ice
Overshooting carrying capacity by using non-renewable water

The Ogallala aquifer is being depleted due to irrigation.

NASA ASTER image of an approx. 557 mi² area of fields (1443 km²) in Kansas which are watered from the Ogallala aquifer with center pivot irrigation systems.
alfalfa culture in the AZ desert

How can this be economical?
Fossil water
Center-pivot irrigation.
Deforestation

MAP OF DEFORESTATION FRONTS

MISSING THE FOREST FOR THE TREES: NASA reveals 37 years of Amazon deforestation by juxtaposing satellite photos of western Brazil taken in 1975 and 2012.
Satellite images of Rondônia in western Brazil, taken in 1975 (left) and 2009 (right). (NASA, Images of Change)

<table>
<thead>
<tr>
<th>Year</th>
<th>Area cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>4,200 km²</td>
</tr>
<tr>
<td>1988</td>
<td>30,000 km²</td>
</tr>
<tr>
<td>1998</td>
<td>53,300 km²</td>
</tr>
<tr>
<td>2003</td>
<td>67,764 km²</td>
</tr>
</tbody>
</table>
Chernobyl


http://world.time.com/timelapse/
Arctic Ice Loss

NASA VIDEO SHOWS HOW THE ARCTIC SEA ICE HAS CHANGED SINCE THE 1980S
All arctic sea ice could be gone by 2020

https://www.youtube.com/watch?v=ezdiqPEDXKE
Let's talk about solutions!
<table>
<thead>
<tr>
<th>Geoengineering option</th>
<th>Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur injection[7, 8]</td>
<td>Injection of sulfur aerosols into the stratosphere by aircraft</td>
<td>Concept demonstrated by volcanic eruptions; delivery technology in the form of tanker aircraft is proven</td>
<td>Does not reduce the actual atmospheric greenhouse gas concentration, so must be constantly deployed</td>
</tr>
<tr>
<td>Sea spray injection[9, 10]</td>
<td>Injection of sea water droplets into the air to thicken low-level maritime clouds, thereby increasing albedo</td>
<td>Enhances an existing natural process; does not introduce any chemicals into the environment</td>
<td>Does not reduce the actual atmospheric greenhouse gas concentration, so must be constantly deployed; unproven delivery technology; geographically limited</td>
</tr>
<tr>
<td>Ocean fertilization[11-14]</td>
<td>Addition of nutrients (such as iron, nitrogen, or phosphorus) to the ocean to enhance the natural biological carbon pump</td>
<td>Enhances an existing natural process; actually removes CO₂ from the atmosphere; easily deployed using tanker ships</td>
<td>Potential adverse impacts to marine environments</td>
</tr>
<tr>
<td>Tree planting</td>
<td>Planting trees to absorb CO₂</td>
<td>No special technology required; additional economic and environmental benefits, such as lumber and erosion protection</td>
<td>Net CO₂ absorption stops once trees mature; significant land area required which could compete with other uses</td>
</tr>
</tbody>
</table>
Algal blooms

Sparks fly over theory that volcano caused salmon boom

Could volcanic ash feed ailing fish populations?

Nicola Jones

Speculation has been flying this week that a 2008 volcanic eruption on an Alaskan island was responsible for this year’s glut of salmon in rivers in British Columbia, Canada. If confirmed, the idea will improve biologist’s understanding of the notoriously unpredictable size of salmon runs, and add fuel to the controversial idea of intentionally seeding the ocean with iron to boost diminishing fish stocks. But some researchers contacted

The eruption of the Kasatochi volcano in 2008 has been linked to an unexpected boom in the numbers of salmon in Canadian rivers this year.

J. Morris/AVO/USGS
Opinions about ocean fertilization

ters carbon is uncertain. A study\(^1\) by Smetacek published in July — based on analysis of an experiment in 2004 — found that at least half of the carbon taken up by the iron-fertilized plankton was buried after they sank to the bottom of the sea. But other studies\(^2\) have found that carbon in the blooms remains in the active biological cycle and is not sequestered at all.

It is unclear whether the project will restore the salmon. A bumper run of sockeye salmon (Oncorhynchus nerka) in 2010 came two years after a volcanic eruption in Alaska sent a layer of iron-rich ash over the ocean, fertilizing a plankton bloom\(^3\). But many scientists remain sceptical.
Fertilizing the ocean absorbs CO2.

Fertilizing the ocean via volcanic eruption creates algal blooms.

Algal blooms in the deep ocean create trophic cascades leading to more fish.

Fertilizing the ocean with iron sulfate always creates algal blooms. There are other nutrients in volcanic ash.

Percentage of carbon absorbed into the marine ecosystem remains trapped.
Debate 3 topic

Is geoengineering stupid?

**Affirmative**


**Negative**