Settling Space:

Implications for Population Growth

By

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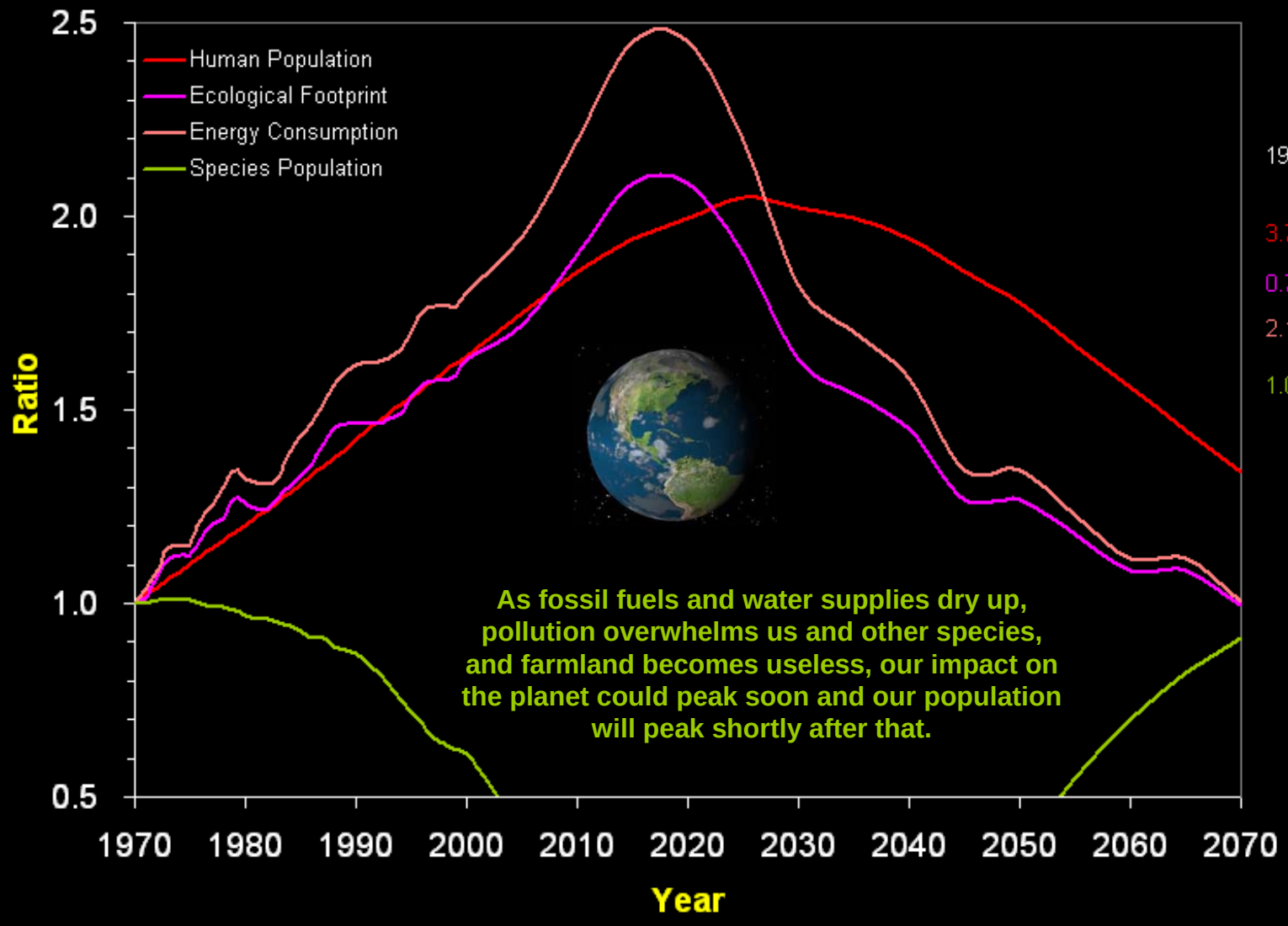
We are at a critical point in history.

Business as usual means the end of civilization.

Population and Consumption (1970=1)



1970 values:

3.71 B people

0.73 world

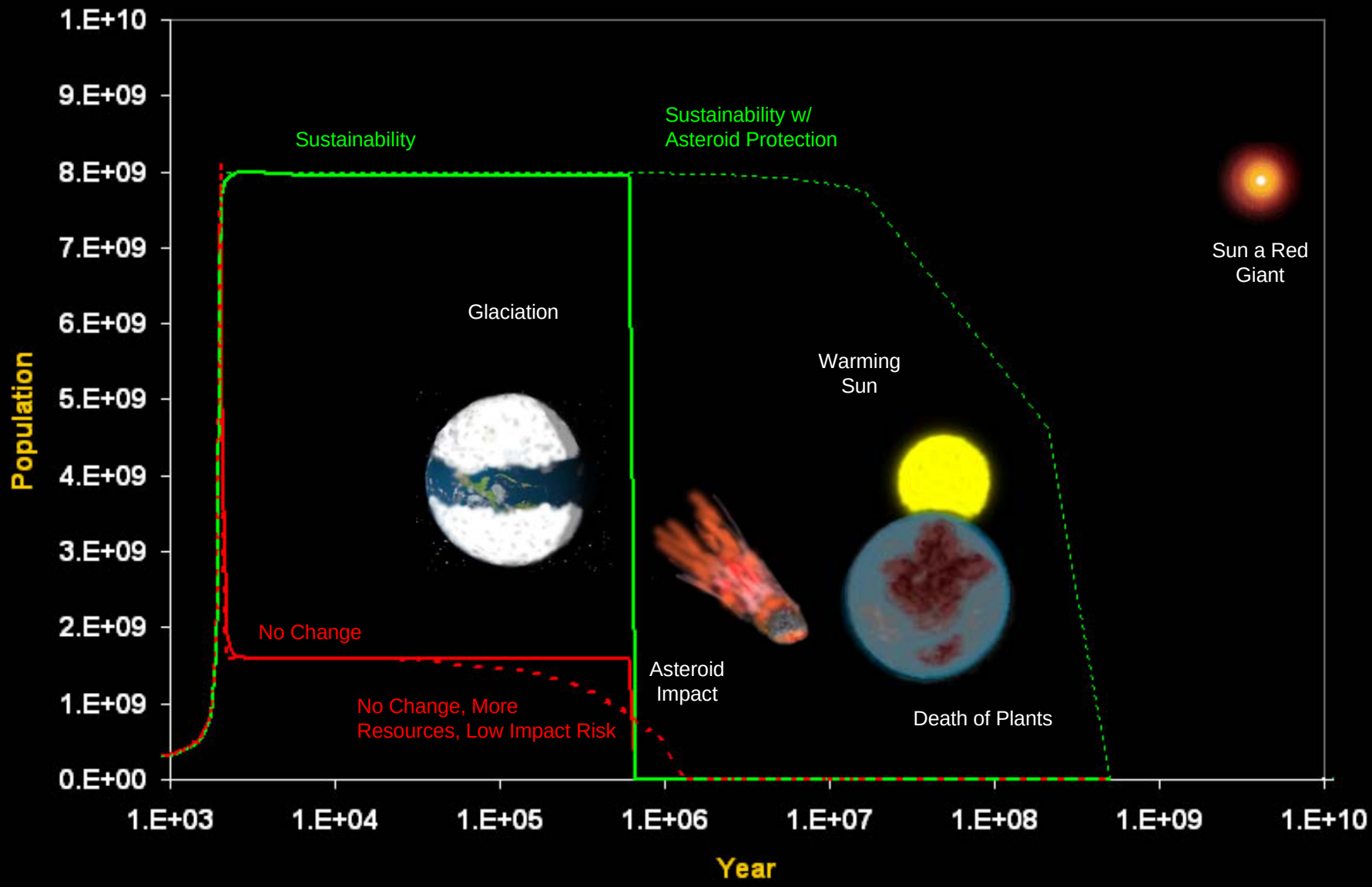
2.11E+20 Joules

1.0 index

Based on:

- *Limits to Growth - the 30-Year Update*
- *BP Statistical Review of World Energy June 2005*
- *WWF Living Planet Report 2004*

Staying on Earth means eventual extinction.



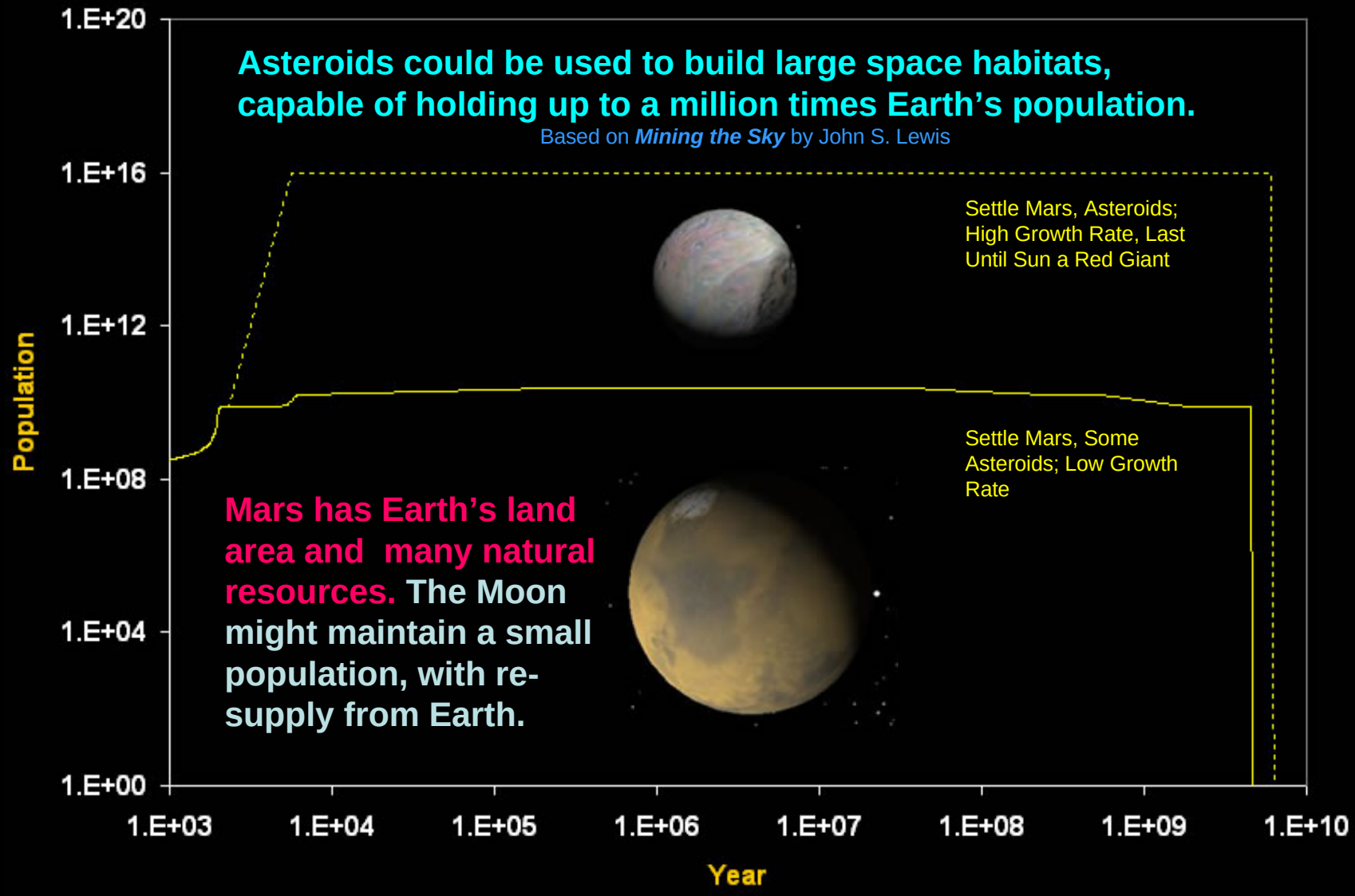
Settling Space: Implications for Population Growth

For our population to continue to grow, we must begin settling space.

Destinations include:

1. The Moon and Mars
2. The asteroids
3. Local stars
4. The rest of our galaxy (“the Galaxy”)
5. The Local Group of galaxies
6. Galaxies beyond the Local Group

The Solar System has several candidates for settlement.



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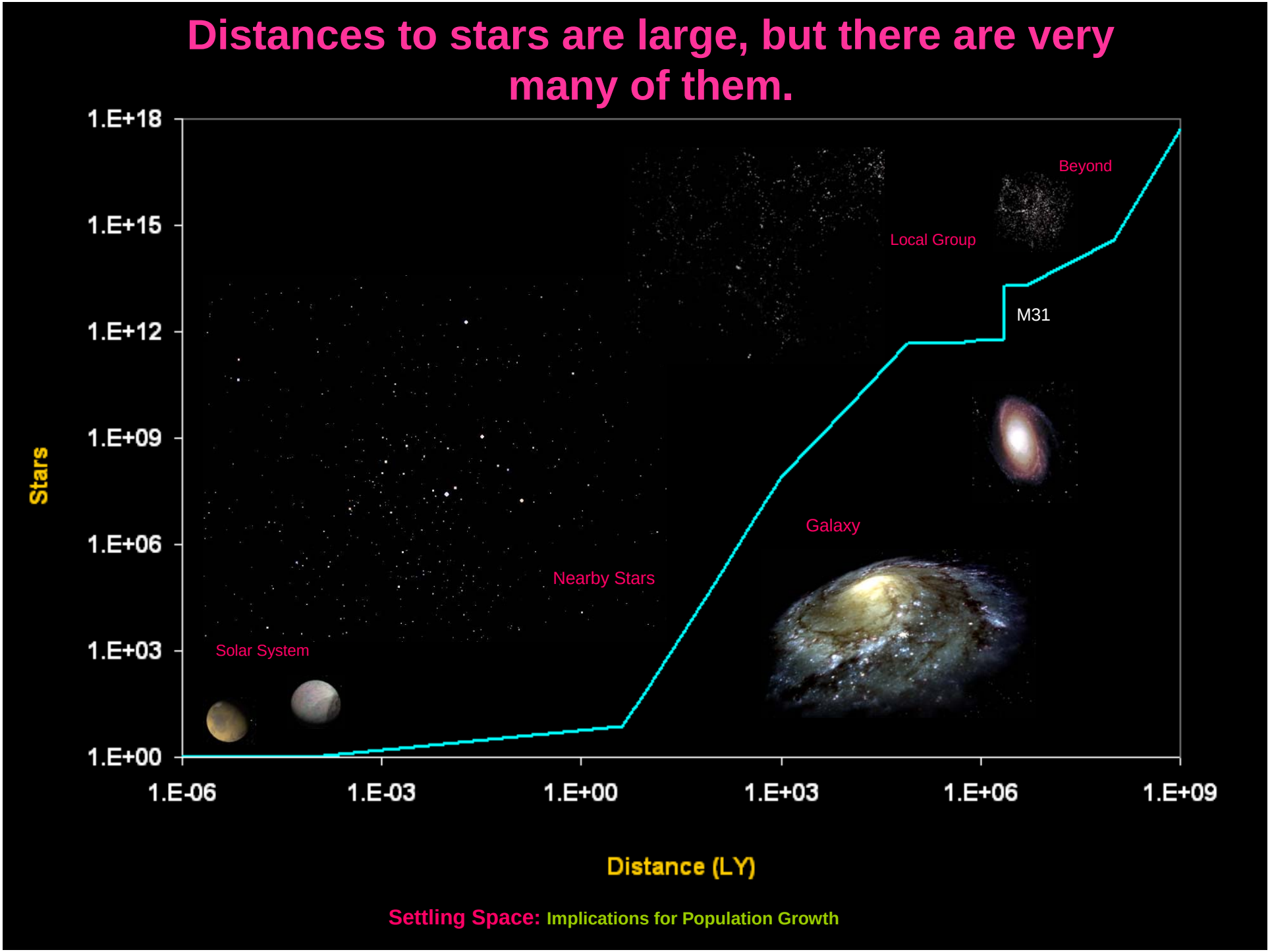
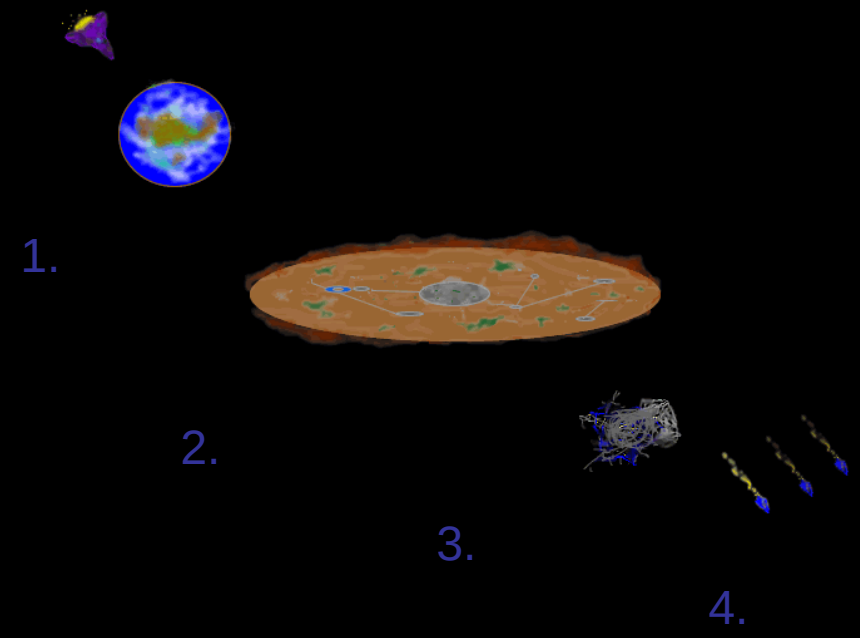
Distances to stars are large, but there are very many of them.

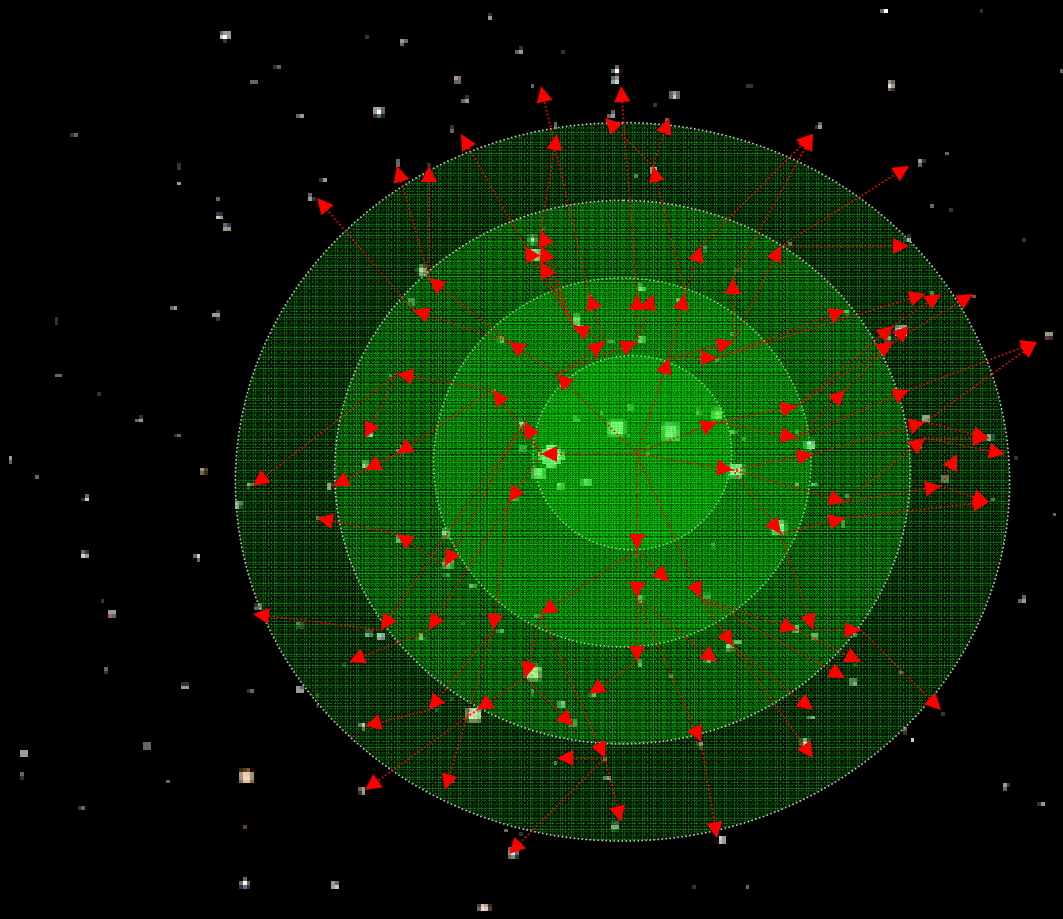


In a typical scenario:

1. A world is visited by enough people to grow a population (about 200).
2. The population grows by at least enough people to both crew ships and sustain further population growth.
3. Technology and energy are acquired for additional settlement.
4. Ships are sent to other worlds.



As people move from region to region, the inhabited space may resemble an expanding sphere centered on the Sun.

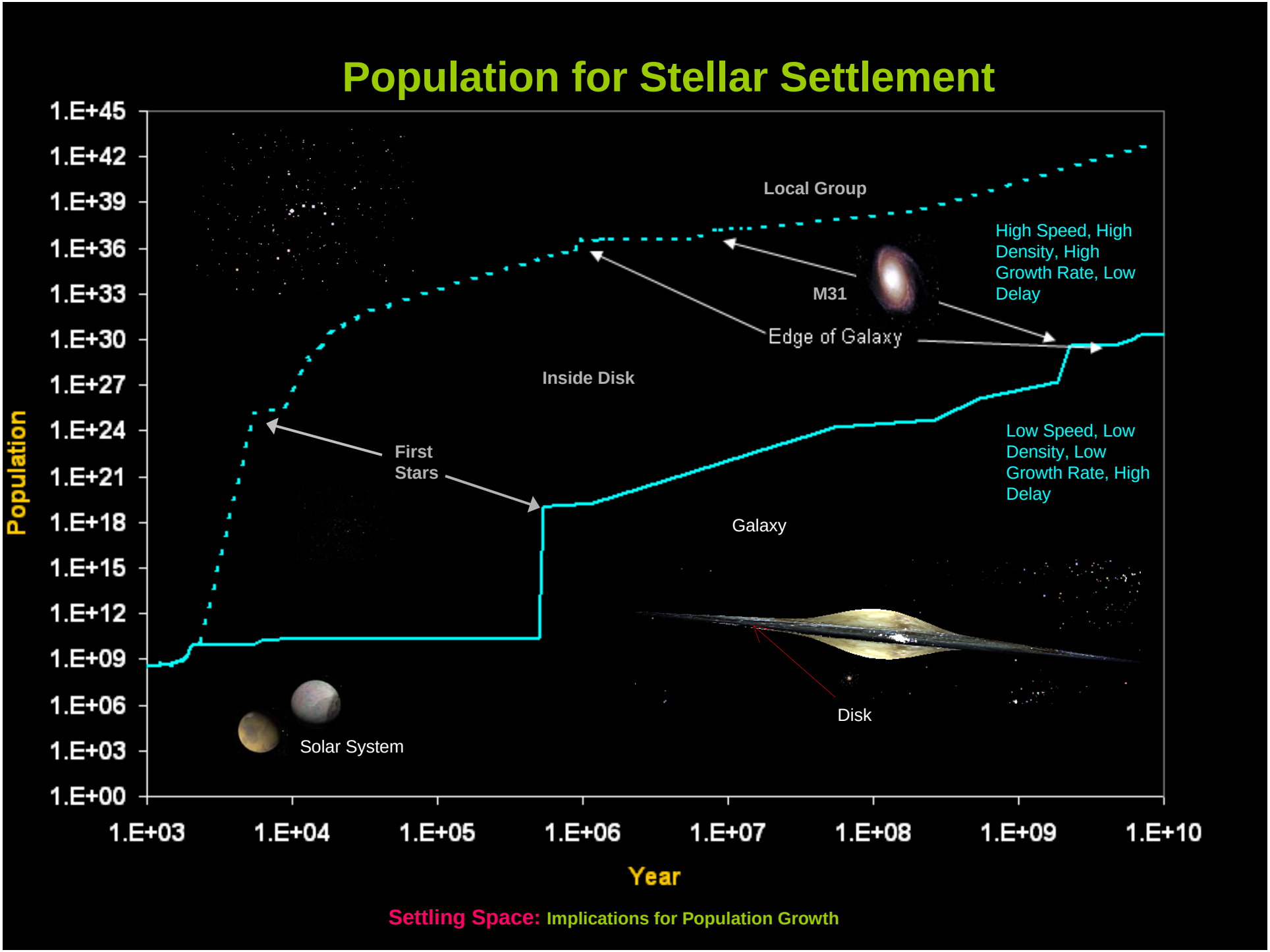


Each arrowhead is a world.

Assumptions

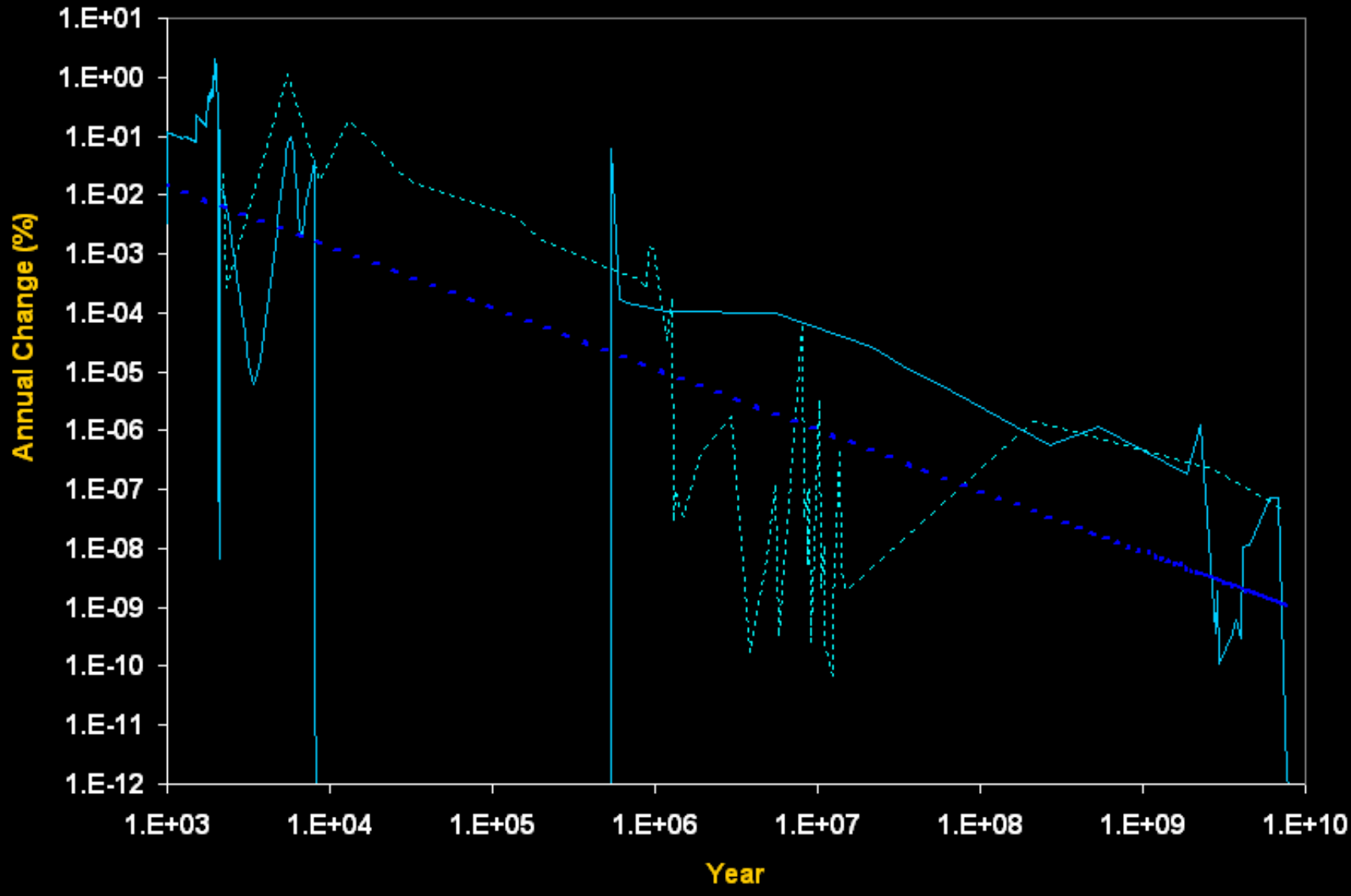
Variable	Worst	Best
Jump Distance	10 LY	3 LY
Speed	0.00002 c	0.5 c
System Pop.	8×10^9	1×10^{16}
Delay	500 y	30 y

Population for Stellar Settlement

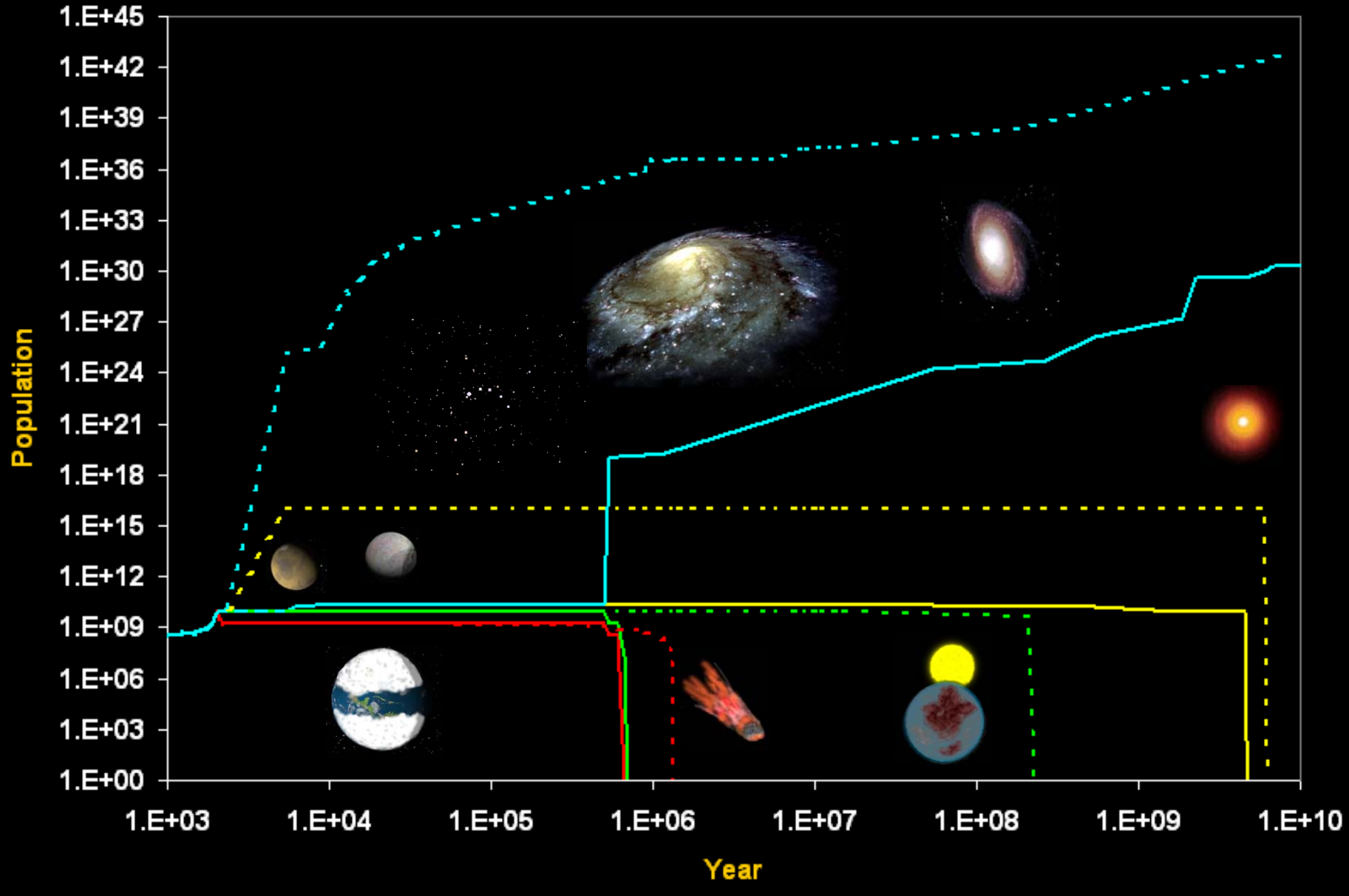


Settling Space: Implications for Population Growth

In even the best case, we are at the peak growth rate for the entire human population. Individual worlds may be different.



Range of Possible Future Population Growth



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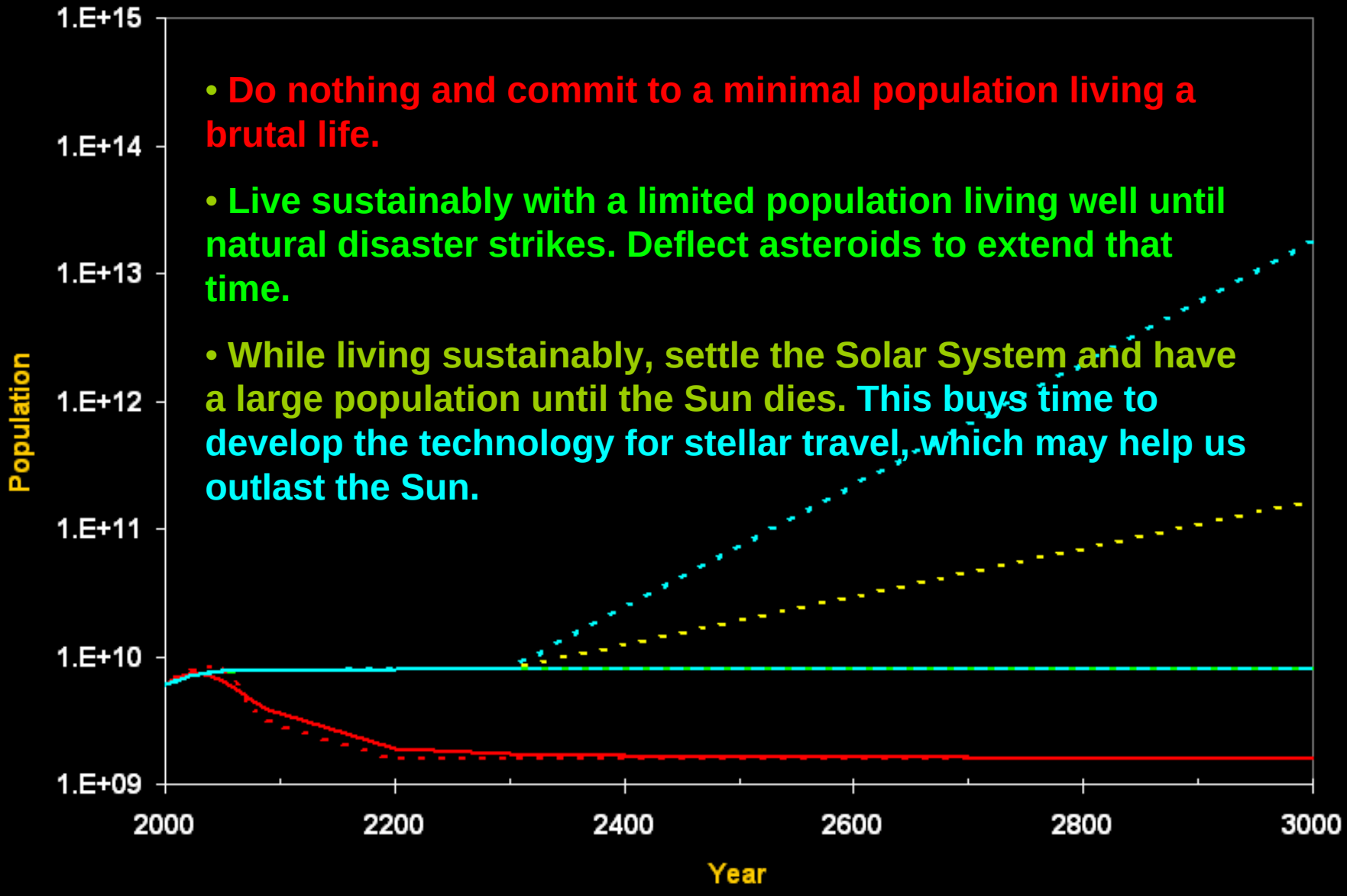
The choice is ours.



- Do nothing and commit to a minimal population living a brutal life.
- Live sustainably with a limited population living well until natural disaster strikes. Deflect asteroids to extend that time.
- While living sustainably, settle the Solar System and have a large population until the Sun dies. This buys time to develop the technology for stellar travel, which may help us outlast the Sun.

Sources

- **Historical population:** Robert Engelman, Population Action International, based on various written works by historians and demographers; United Nations, *World Population Prospects: The 2002 Revision* (New York: 2003) as quoted by Worldwatch Institute, 2004. Also: *Time Almanac 2005,* Pearson Education, Needham, MA, 2004.
- **"No Change" projections (2000-2090):** Population from scenarios 1 and 2 in Dennis Meadows, World3 - 03 global simulation model as presented in Donella Meadows, et. al., *Limits to Growth - the 30-Year Update*, Chelsea Green Press, White River Junction, VT, 2004. Scenario 1 footprint used to derive energy consumption from energy values (also shown) in *BP Statistical Review of World Energy June 2005* (www.bp.com/statisticalreview) and future ecological footprint from values based on historical values (also shown) in *WWF Living Planet Report 2004* (WWF International, 2004). The Living Planet Index (for species population) is also from the WWF report, and projected based on close correlation with human population.
- **Future Earth events:** Peter Ward and Donald Brownlee, *The Life and Death of Planet Earth*, Henry Holt and Company, New York, NY, 2002. Asteroid impact probabilities from several sources, including www.geocities.com/dtmcbride/reference/deaths.html.
- **Future population of the Solar System:** John S. Lewis, *Mining the Sky: Untold Riches from the Asteroids, Comets, and Planets*, Addison-Wesley, Reading, MA, 1996.
- **Space images:** *Deep Space Explorer* software (Space.com).

Derivation of Population Growth Beyond Solar System

- **Density of habitable worlds in the Galaxy:** Calculated from probabilities of existence of Earth-like worlds quoted in www.space.com/scienceastronomy/050405_earth-like.html
- **Stars in other galaxies:** Calculated from dimensions in *Deep Space Explorer* software (Space.com). M31 dimensions from www.cnn.com/2005/TECH/Space/05/30/space.andromeda.reut/index.html. Stars beyond Local Group from www.anzwers.org/free/universe/.
- **Radial velocities of galaxies:** http://www.ast.cam.ac.uk/~mike/local_more.html.