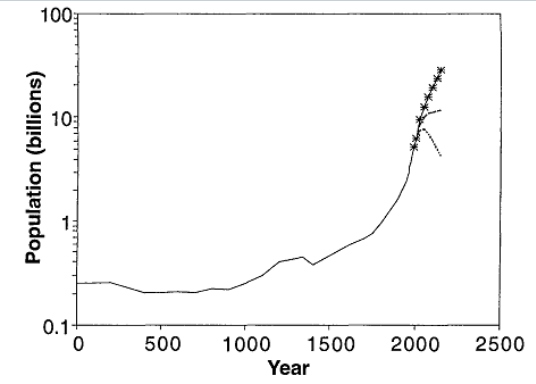
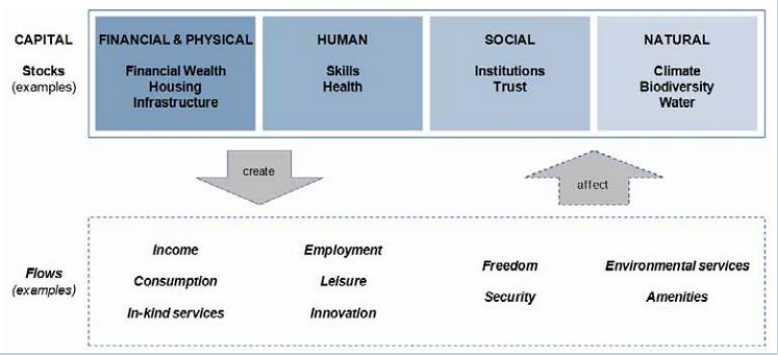
Expanding the Sustainable Carrying Capacity Concept to the Human Context





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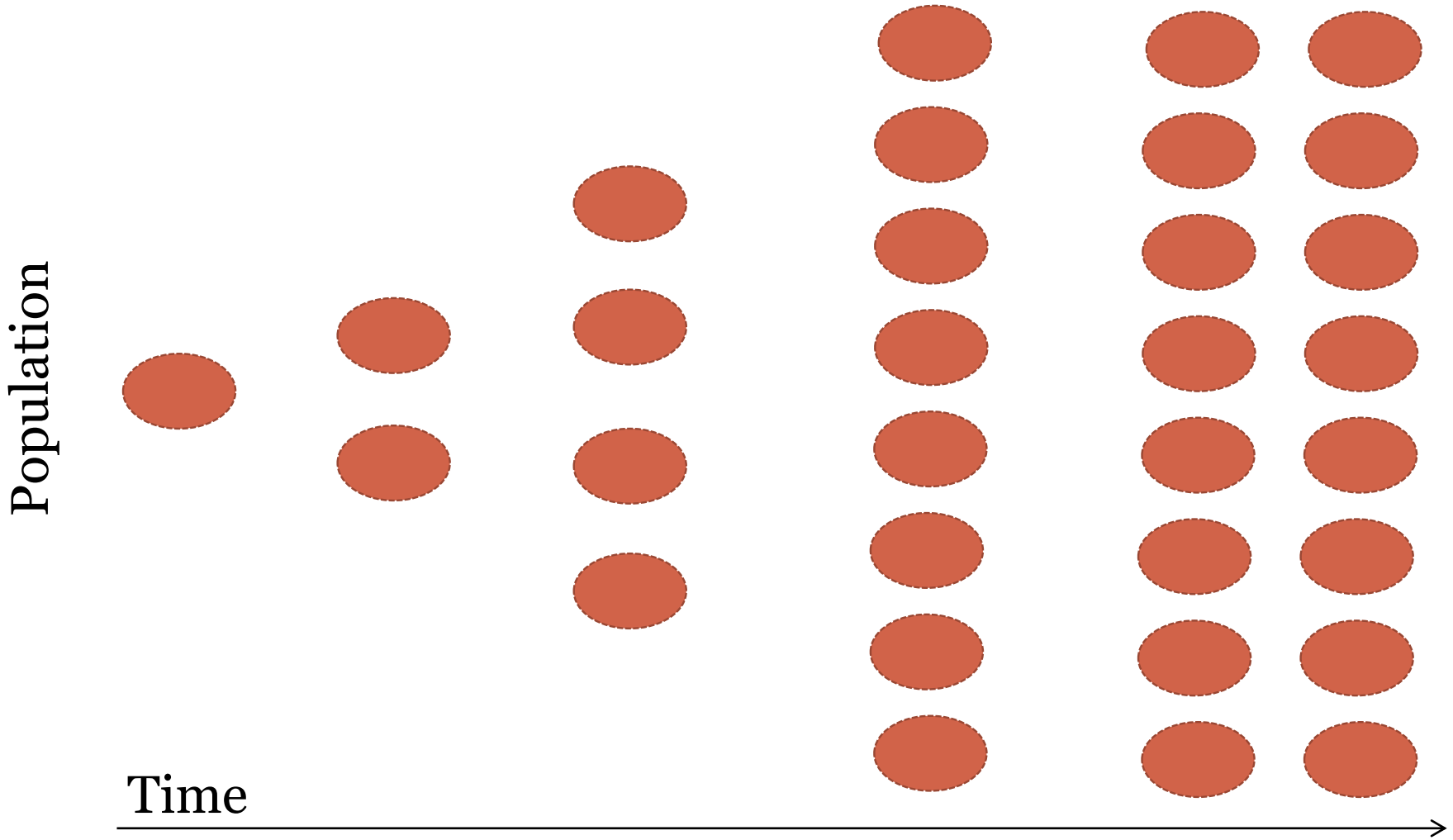
TE APĀRANGI
WELLINGTON
15 MARCH 2013

Organisation

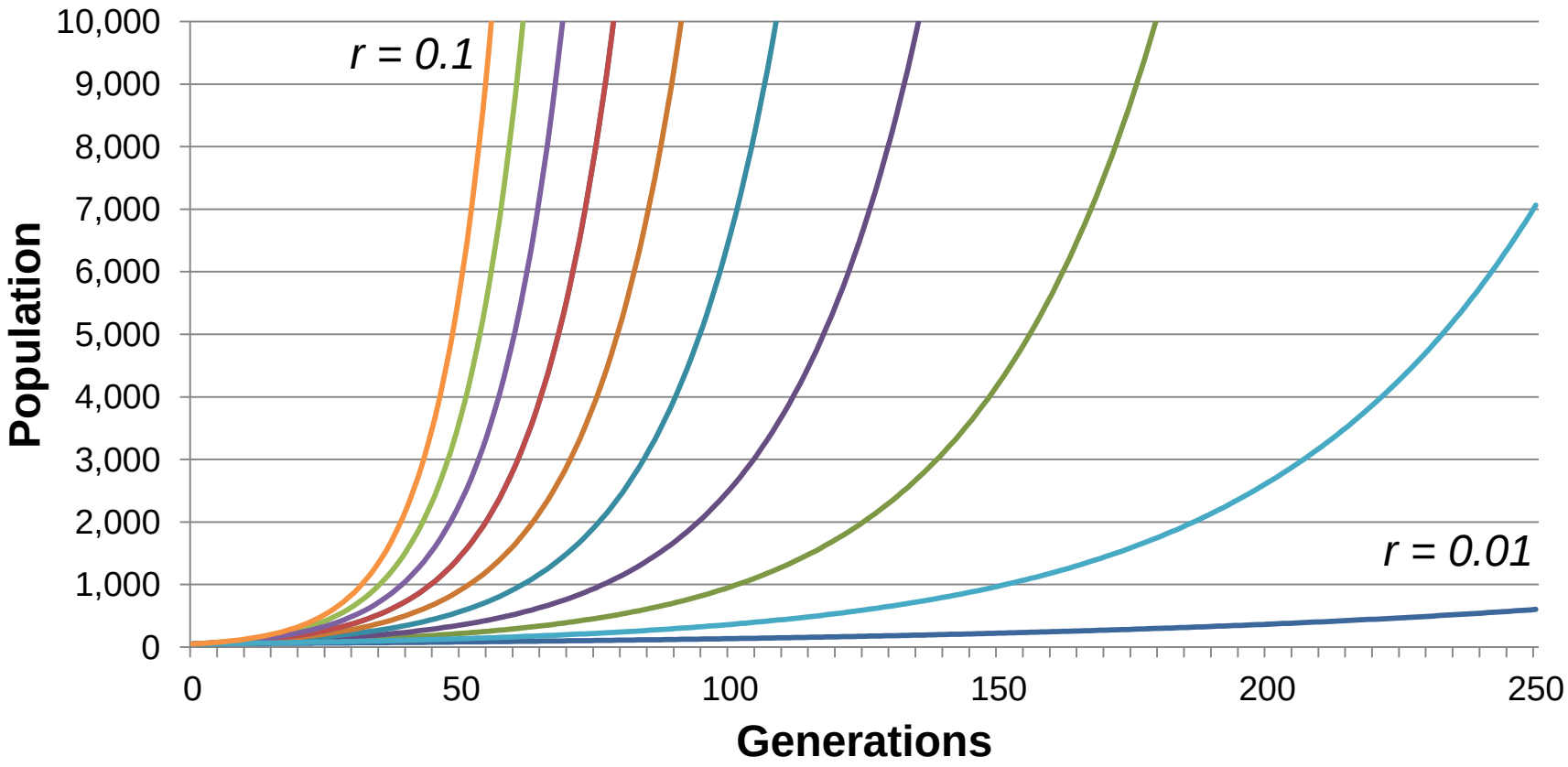
- Ecological Concept of Carrying Capacity
- Considerations of Human Ecological Carrying Capacity
- Expansion of Carrying Capacity to the Human Context
- Example: Human Carrying Capacity of Kapiti Coast District
- Reflections

Ecological Concept of Carrying Capacity



Ecological Concept of Carrying Capacity

$$N_{t+1} = rN_t$$



Ecological Concept of Carrying Capacity

$$dN/dt = rN\,(1-N/\mathbf{K})$$

$\mathbf{K}$ = *Carrying Capacity*

"The symbol *K* is called the carrying capacity because it is a measure of the amount of renewable resources in the environment in units of the number of organisms those resources can support."

Roughgarden J. 1979. *Theory of Population Genetics and Evolutionary Ecology: An Introduction*. MacMillan, New York. 612 pp.

Ecological Concept of Carrying Capacity

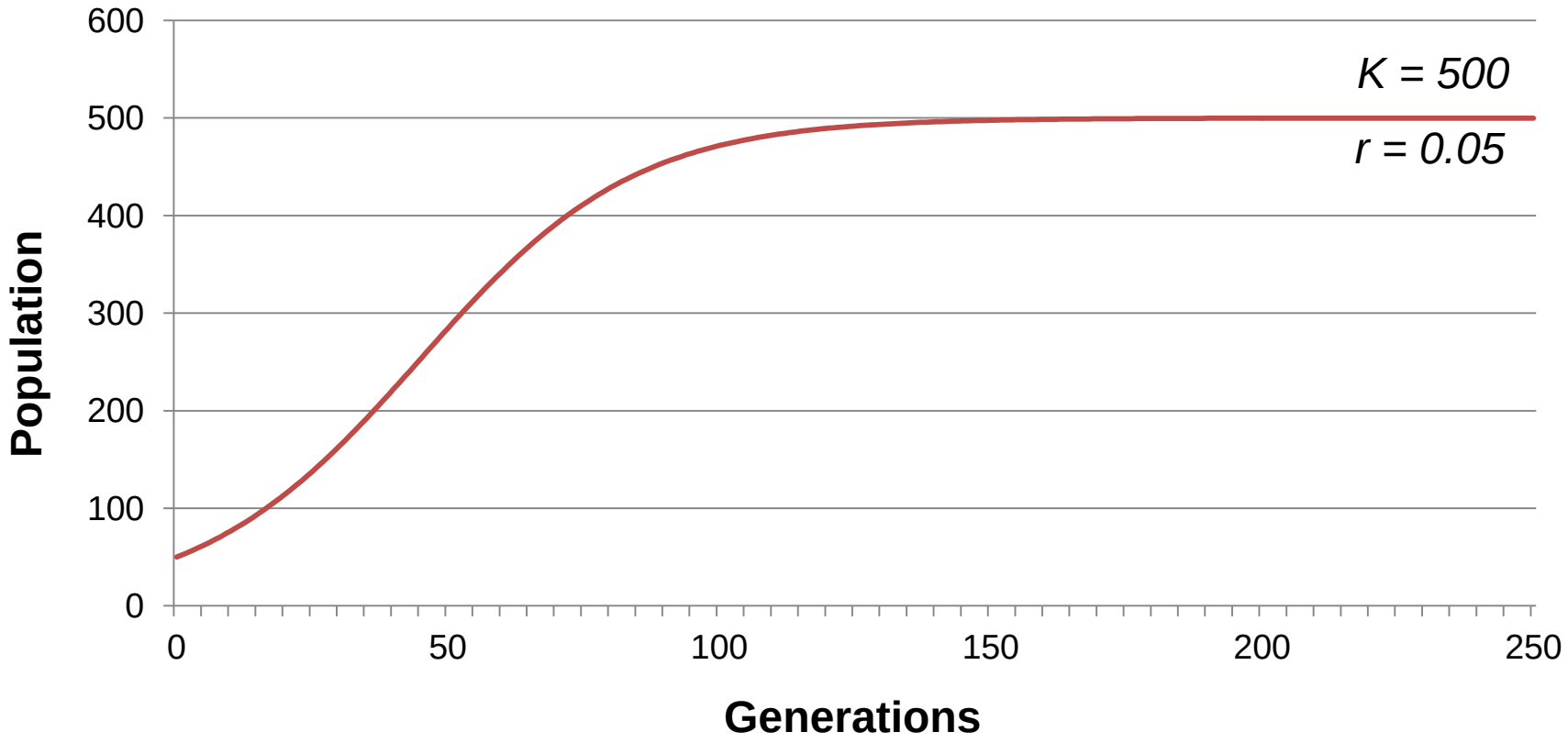
$$dN/dt = rN\,(1-N/K)$$

If $N << K$ *then* N/K *is* ≈ 0 *and N increases*

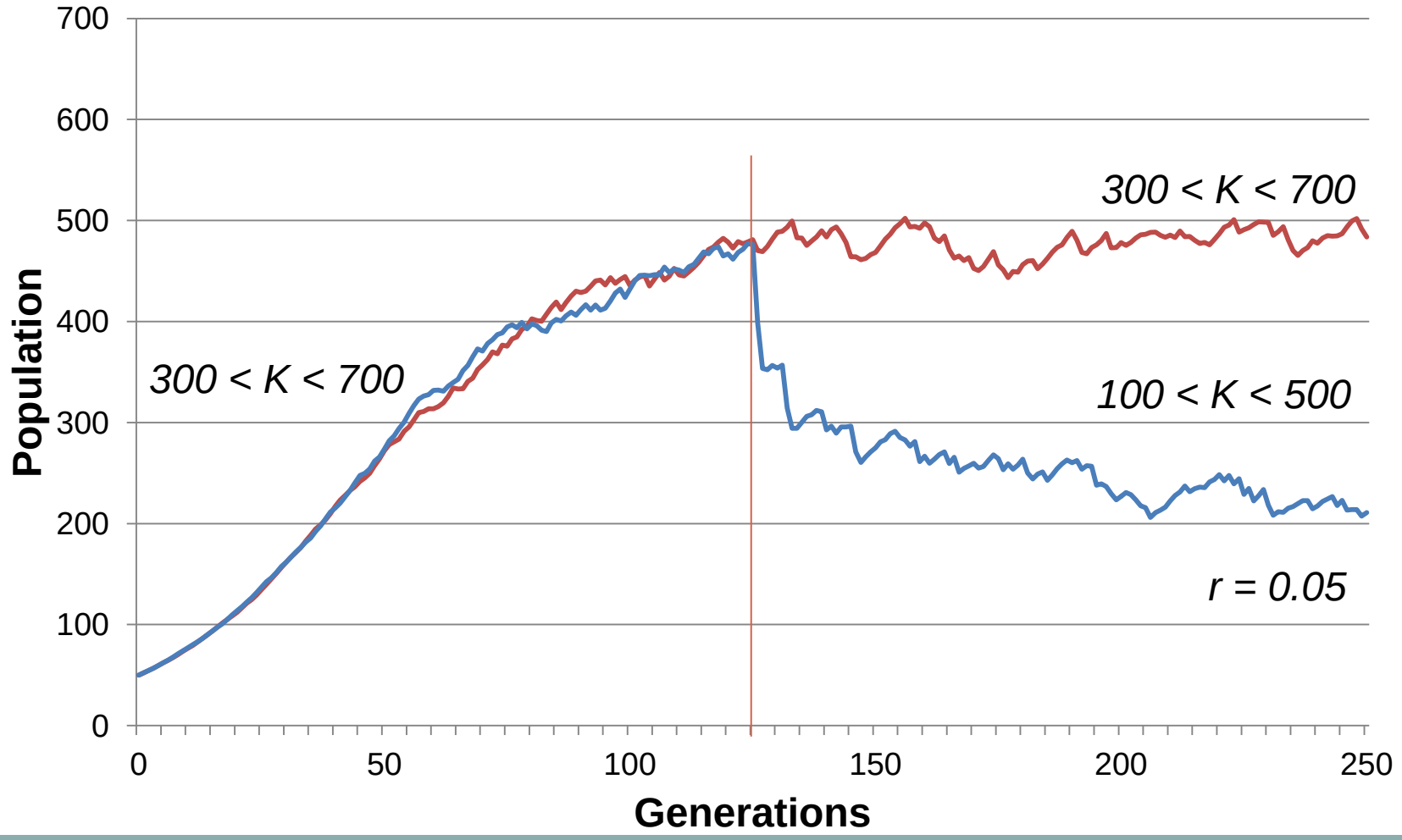
If $N \approx K$ *then* $N/K \approx 1$ *and N is stable*

If $N >> K$ *then* $(K-N)/K < 1$ *and N decreases*

Ecological Concept of Carrying Capacity

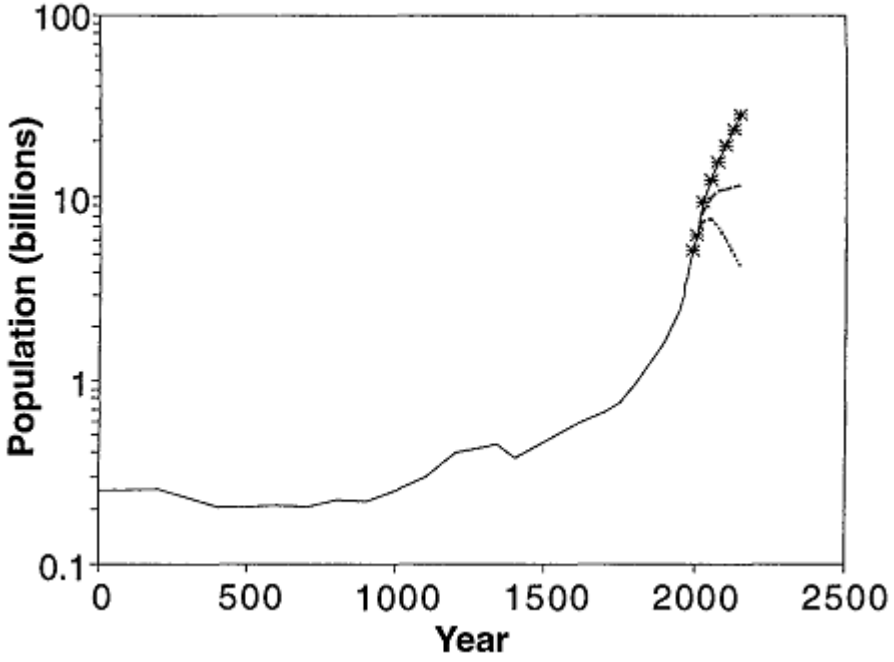


Ecological Concept of Carrying Capacity

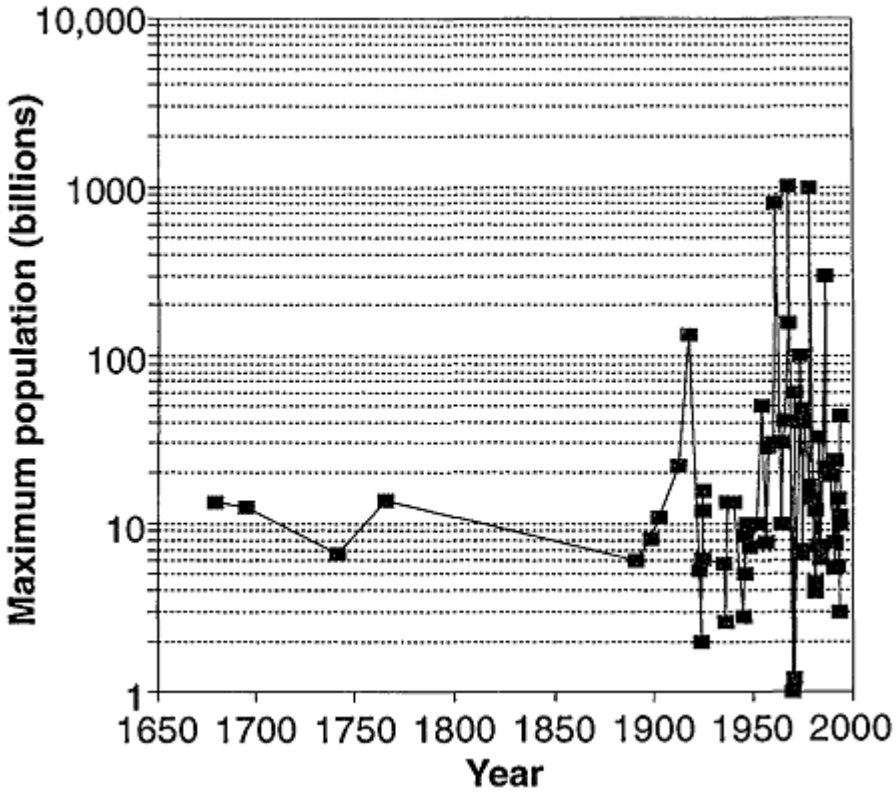


Considerations of Human Ecological Carrying Capacity

Global Human Population

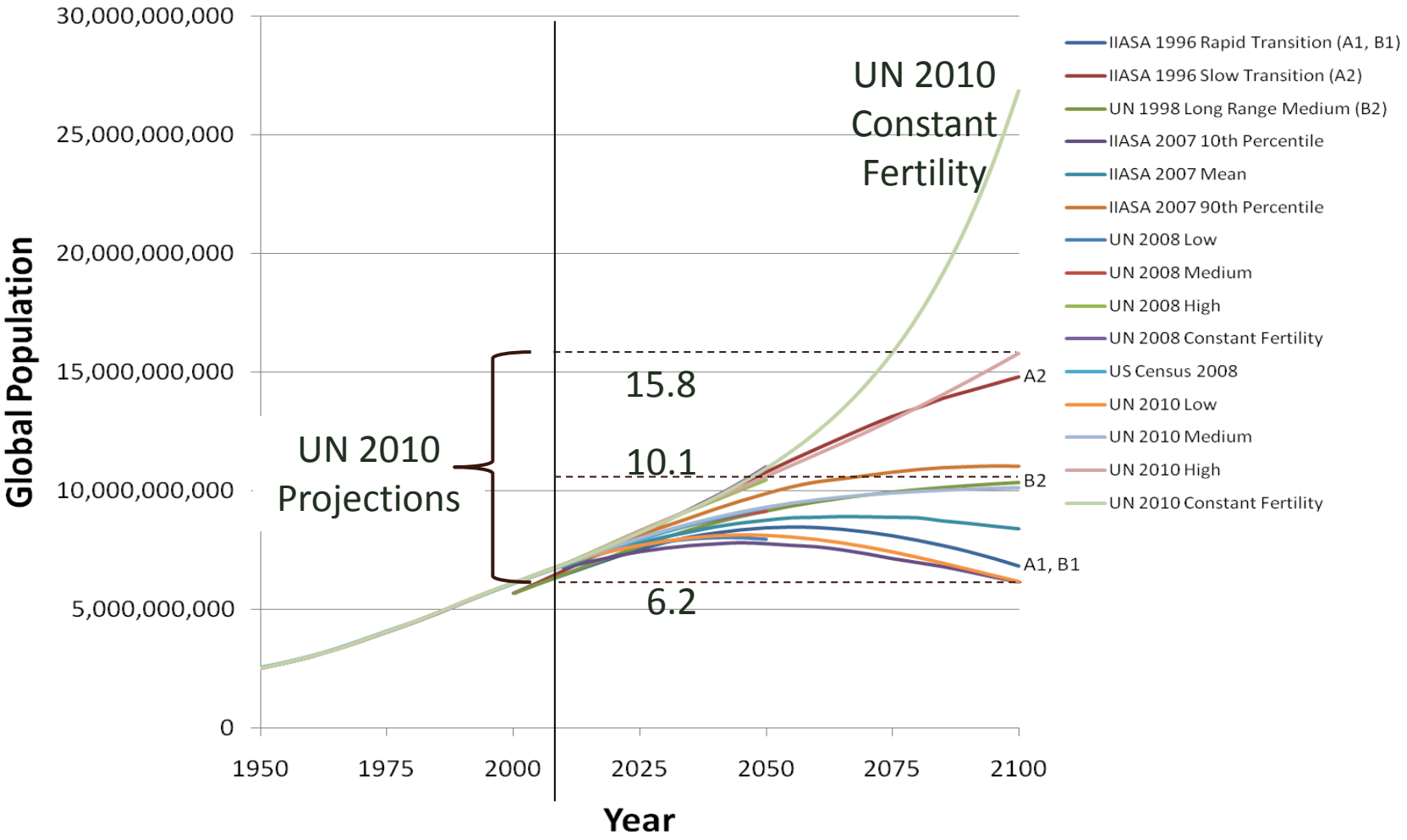


Estimates of Global
Human Carrying Capacity



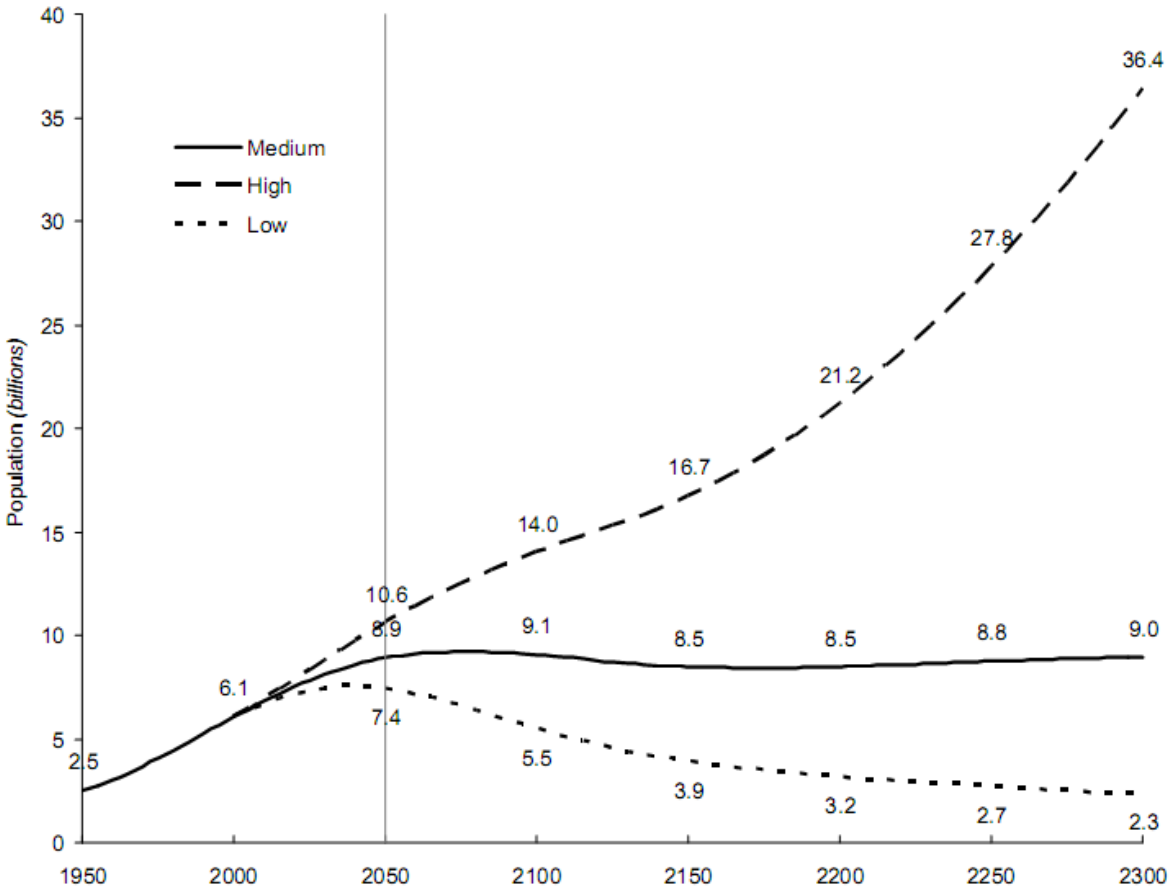
Cohen J. 2005. Population Growth and Earth's Human Carrying Capacity. *Science* 269(5222):341-346.

Considerations of Human Ecological Carrying Capacity



Considerations of Human Ecological Carrying Capacity

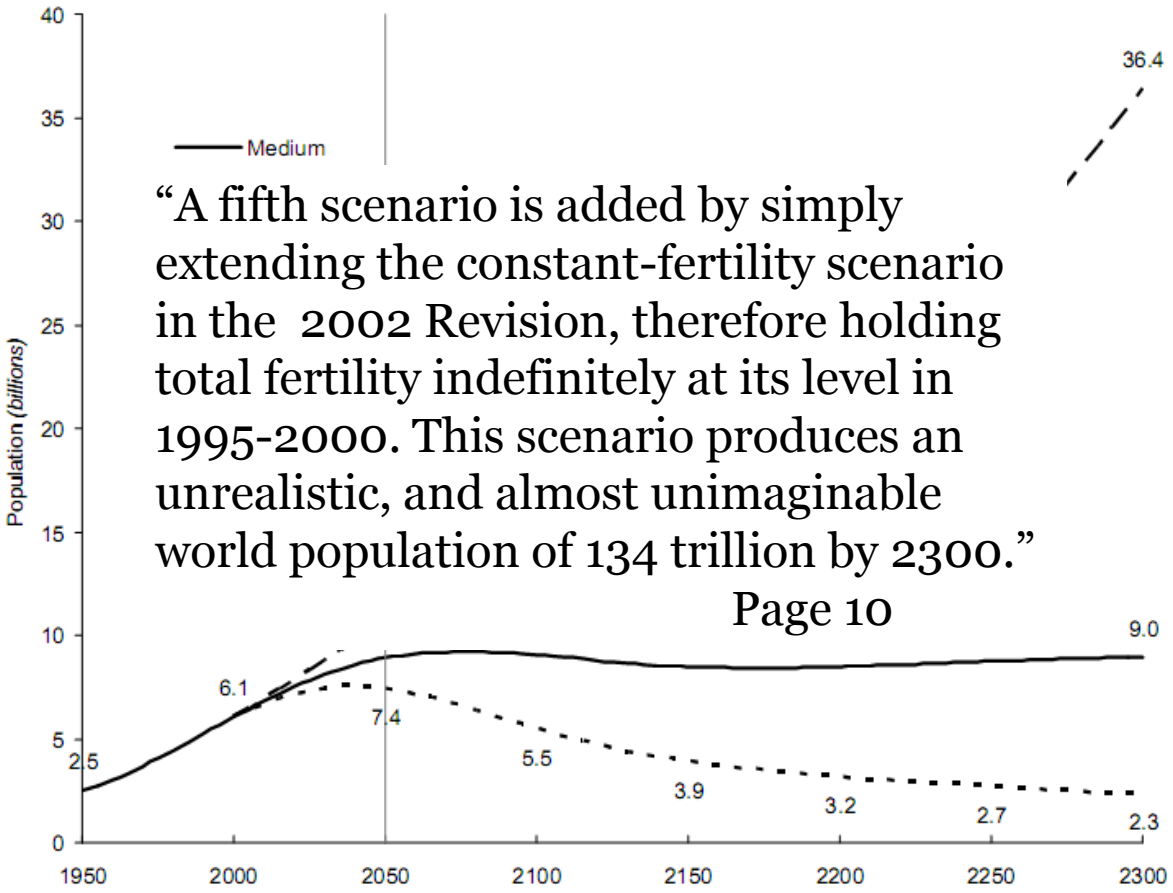
Figure 6. Estimated world population: 1950-2000, and projections: 2000-2300



United Nations. 2004. World Population to 2300. 240 pp.

Considerations of Human Ecological Carrying Capacity

Figure 6. Estimated world population: 1950-2000, and projections: 2000-2300

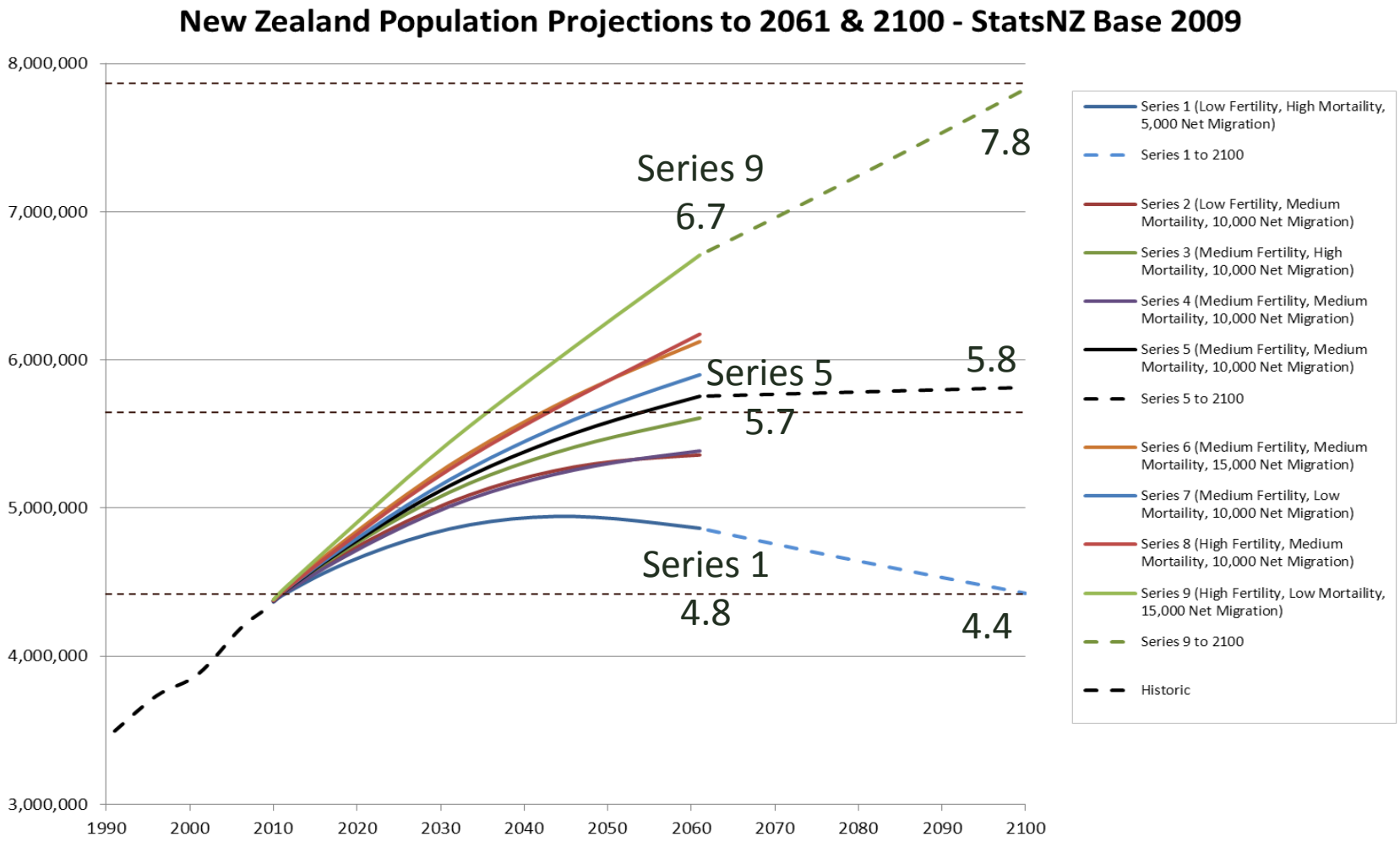


"A fifth scenario is added by simply extending the constant-fertility scenario in the 2002 Revision, therefore holding total fertility indefinitely at its level in 1995-2000. This scenario produces an unrealistic, and almost unimaginable world population of 134 trillion by 2300."

Page 10

United Nations. 2004. World Population to 2300. 240 pp.

Considerations of Human Ecological Carrying Capacity



Expansion of Carrying Capacity to the Human Context

- For ourselves, we are concerned with much more than just the size of our population

- Globally
  - UN Human Development Index
  - Economist Quality of Life Index

- New Zealand
  - Treasury's Living Standards Framework
  - Statistics NZ Sustainable Development Framework
  - Quality of Life Survey

Expansion of Carrying Capacity to the Human Context

- UN Human Development Index

Table 1
Reference values for the primary indicators

Parameter	Unit	Down limit	Up limit
Longevity	years	25	85
Education			
Adults literacy index	%	0	100
Registration combined index	%	0	100
GDP per capita	PPP US$	100	40 000

- Note: HDI will depend on but does not explicitly consider total human population size

R.A. Dias et al. 2006. The limits of human development and the use of energy and natural resources. *Energy Policy* 34: 1026–1031.

Expansion of Carrying Capacity to the Human Context

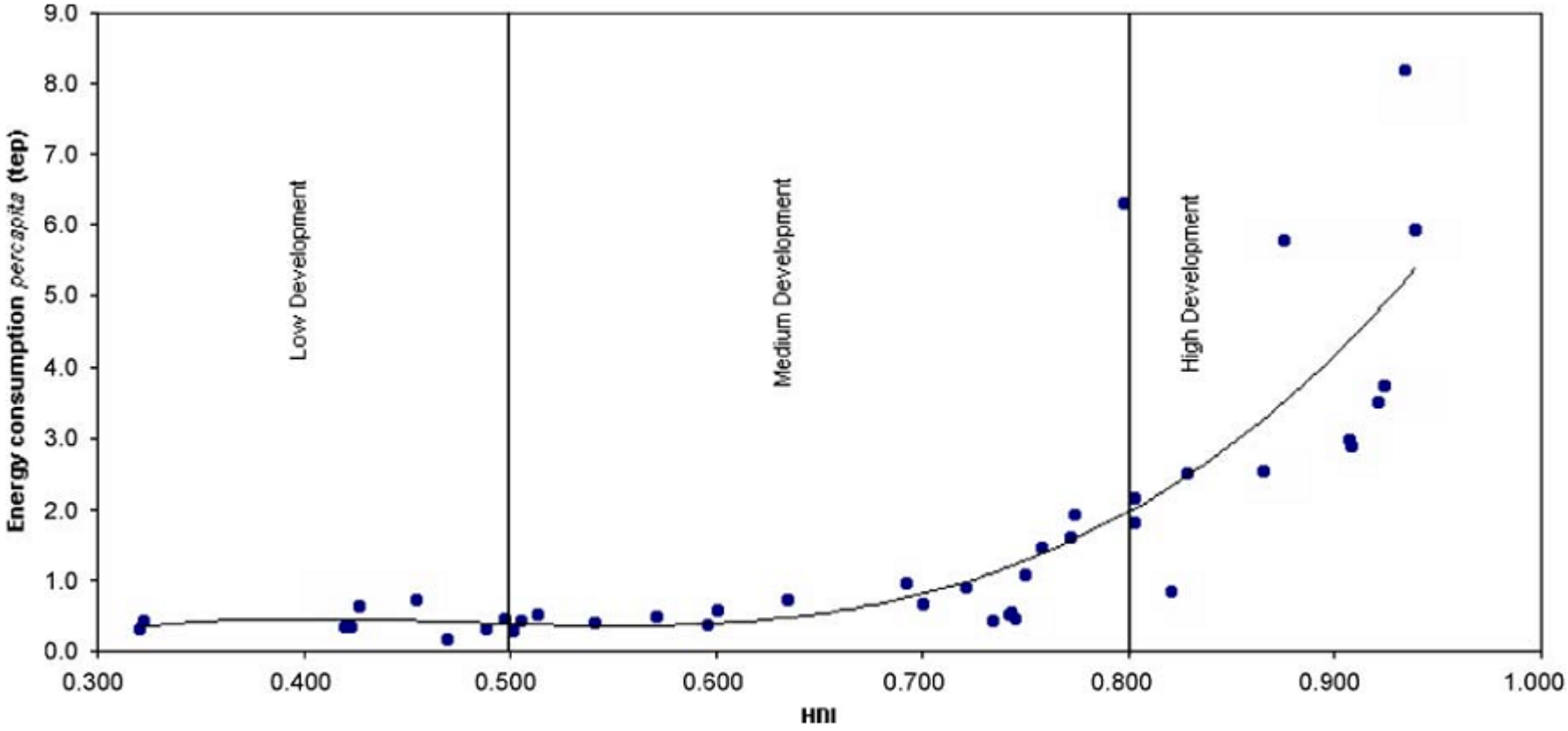


Fig. 1. Graphic of HDI versus energy consumption.

R.A. Dias et al. 2006. The limits of human development and the use of energy and natural resources. *Energy Policy* 34: 1026–1031.

Expansion of Carrying Capacity to the Human Context

- *The Economist* Quality of Life Index (2005)

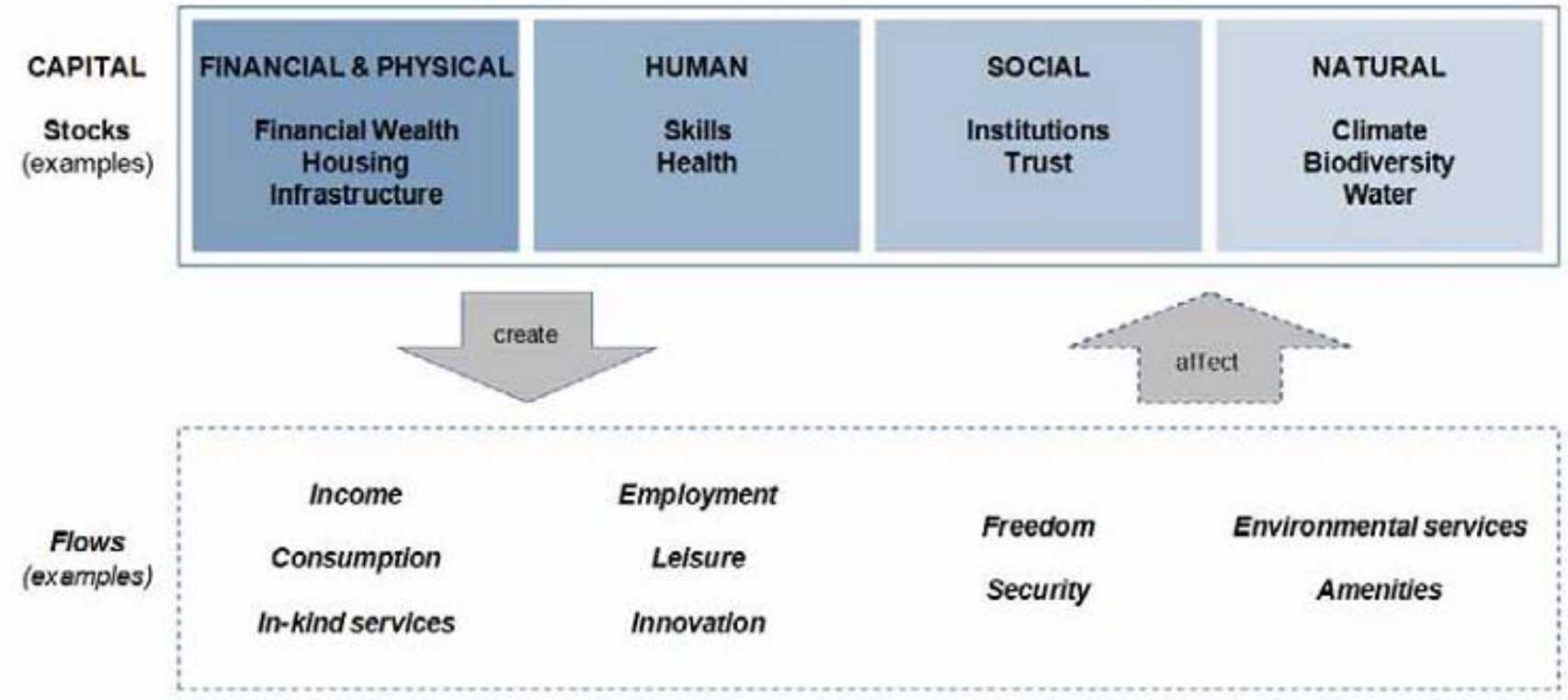
1. Material Wellbeing: GPD per Capita, PPP in $
2. Health: Life expectancy at birth, years
3. Political Stability and Security
4. Family Life: Divorce rate (per 1,000 population), converted into index from 1 (low to 5 (high)
5. Community Life: Dummy variable; 1 = high rate of church attendance or trade-union membership; zero therwise.
6. Climate and geography: Latitude, to distinguish between warmer and colder climes
7. Job security: Unemployment rate
8. Political freedom: Average of indices of political and civil liberties. 1 (completely free) to 7 (unfree)
9. Gender equality: Ratio of average male and female earnings, latest available data.

	Quality of life		GDP per person		Difference
	Score	Rank	$ (at PPP)	Rank	in ranks
Ireland	8.333	1	36,790	4	3
Switzerland	8.068	2	33,580	7	5
Norway	8.051	3	39,590	3	0
Luxembourg	8.015	4	54,690	1	-3
Sweden	7.937	5	30,590	19	14
Australia	7.925	6	31,010	14	8
Iceland	7.911	7	33,560	8	1
Italy	7.810	8	27,960	23	15
Denmark	7.796	9	32,490	10	1
Spain	7.727	10	25,370	24	14
Singapore	7.719	11	32,530	9	-2
Finland	7.618	12	29,650	20	8
United States	7.615	13	41,529	2	-11
Canada	7.599	14	34,150	5	-9
New Zealand	7.436	15	25,110	25	10

The Economist Intelligence Unit. 2005. Quality-of-life Index.

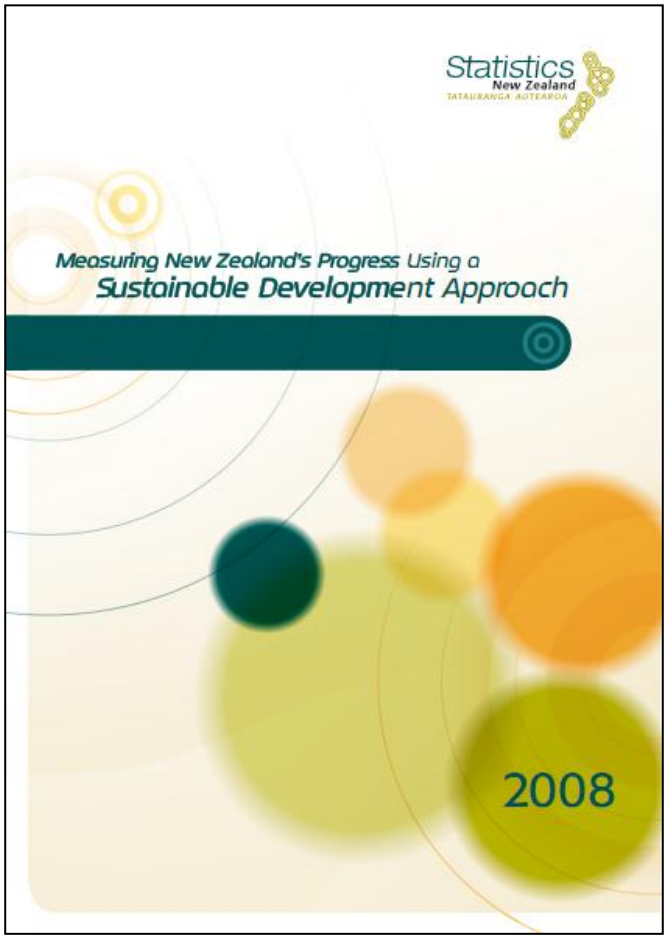
Expansion of Carrying Capacity to the Human Context

Figure 1 – Treasury's Living Standards Framework



New Zealand Treasury. 2011. Working Towards Higher Living Standards for New Zealanders. New Zealand Treasury Paper 11/02. 58 pp.

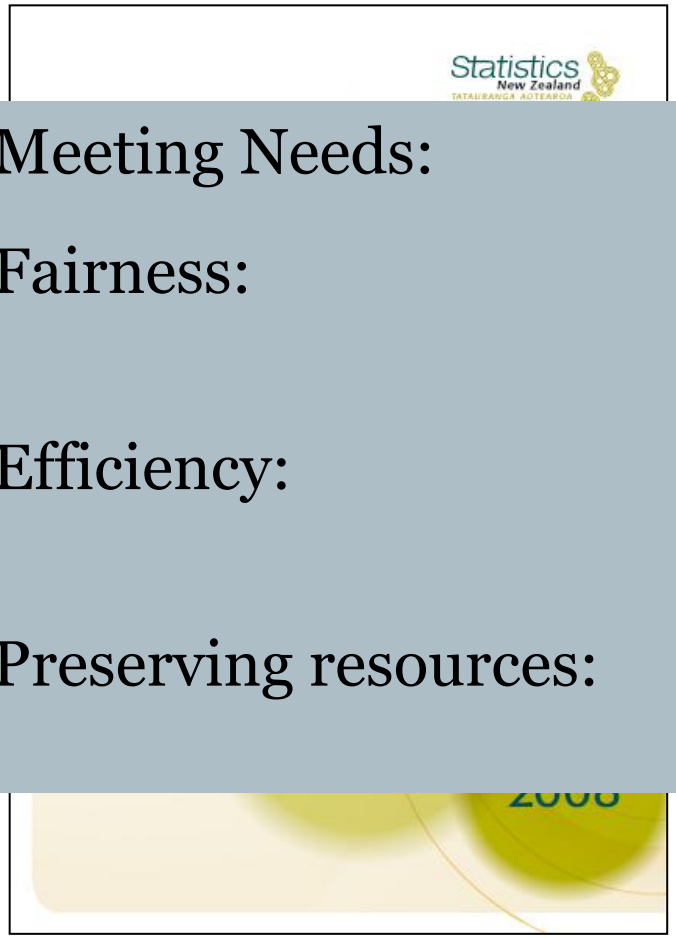
Expansion of Carrying Capacity to the Human Context



1 Population
2 Biodiversity
3 Air and atmosphere
4 Water
5 Land use
6 Energy
7 Transport
8 Waste
9 Innovation
10 Work, knowledge, and skills
11 Economic resilience
12 Living conditions
13 Health
14 Social connection and governance
15 Culture and identity

Statistics NZ. 2008. *Measuring New Zealand's Progress Using a Sustainable Development Approach*. 157 pp.

Expansion of Carrying Capacity to the Human Context



Meeting Needs:	How well do we live?
Fairness:	How well are resources distributed?
Efficiency:	How efficiently are we using our resources?
Preserving resources:	What are we leaving behind for our children?

1 Population
2 Biodiversity

13 Health
14 Social connection and governance
15 Culture and identity

Statistics NZ. 2008. *Measuring New Zealand's Progress Using a Sustainable Development Approach*. 157 pp.

Expansion of Carrying Capacity to the Human Context

- Quality of Life Survey 2012
  - Health and wellbeing
  - Crime and safety
  - Community, culture and social networks
  - Council decision-making processes
  - Environment
  - Public Transport
  - Lifestyle – work and study

Human Carrying Capacity of Kāpiti Coast District

- Challenges
  - Council alignment with strong sustainability principle while being practical about definition and implementation
  - Linkages and interdependencies with broader regional, national and global systems
  - Current strongly reliance on non-renewable resources
- Working Definition

The Human Carrying Capacity of the Kapiti Coast District is the number of people that the district can sustainably support given aggregate lifestyle choices, where sustainability is strong for a community-selected set of indicators, weak for a second set of indicators, and flexible for remaining indicators. Indicators will also be clearly defined as locally or globally sustainable.

Andrew et al. 2011. Human Carrying Capacity Stage 1: Working Definition for Kāpiti Coast District Council. AECOM Report 11 pp.

Human Carrying Capacity of Kāpiti Coast District

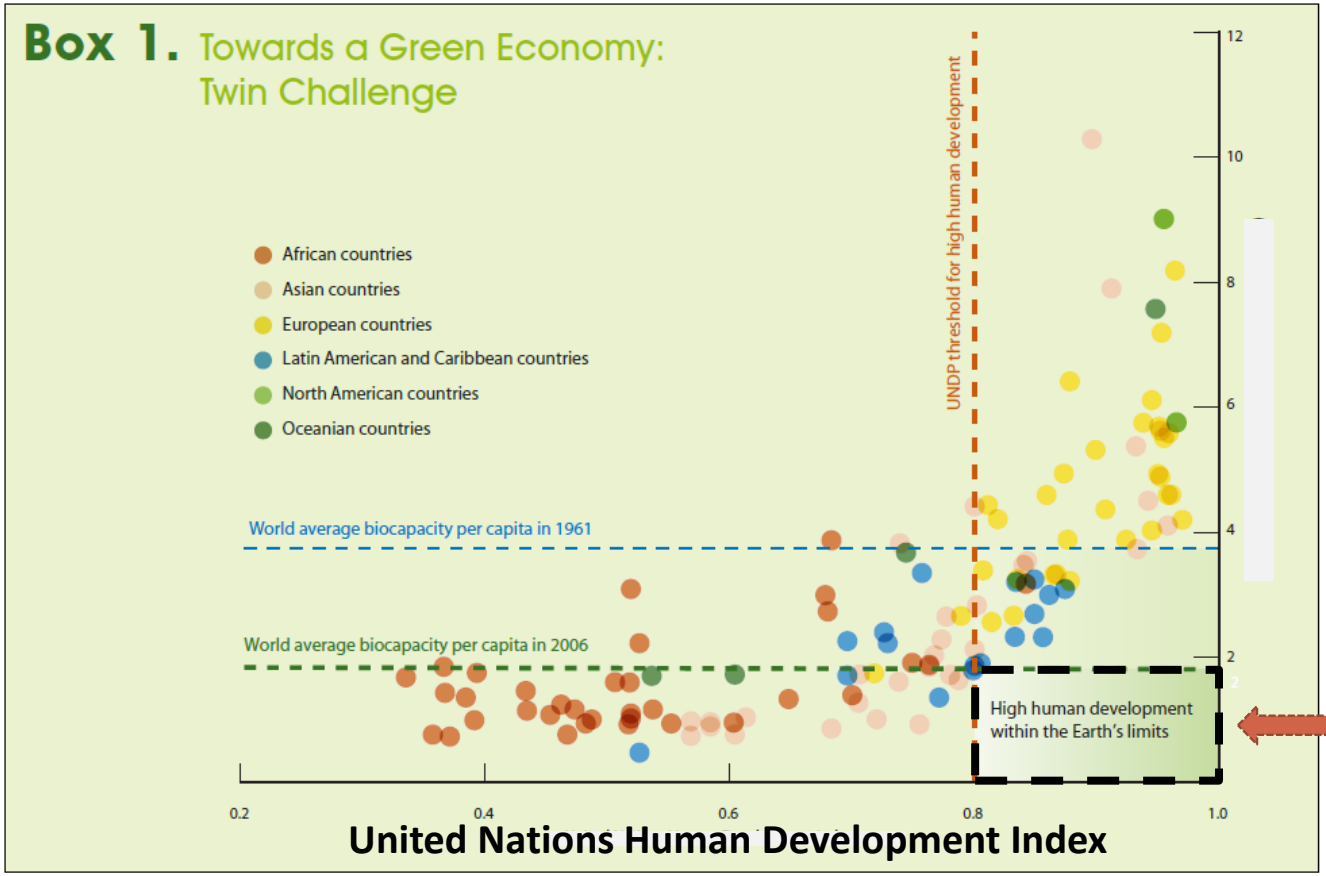
- Identify important values in for sustainability in consultation with the community
- Establish a list of indicators that could provide information about the state of these values
- Perform an assessment for each indicator (resilience, links, community importance, monitoring, regulation, desired limits)
- When this process is complete, evaluate potential to develop a composite indicator
- Report all individual indicators separately

Andrew & Rutledge .2011. Human Carrying Capacity Stage 2: Application of Concept to Kāpiti Coast District. AECOM Report.

Reflections

- Carrying capacity is a useful concept but has its limitations
- When applied to humans, carrying capacity must be enhanced to include concepts of fairness, equity, justice, safety, belonging, satisfaction, well-being, quality of life, etc.
- Sustainable human carrying capacity is therefore variable and depends on
  - Availability of renewable resources – hard limits
  - Behaviour and choices (i.e. lifestyles) – soft limits
  - Ingenuity, technology, and innovation – mediation of hard & soft

Reflections



Source: *The Ecological Wealth of Nations: Earth's Biocapacity as a New Framework for International Cooperation. Global Footprint Network (2010), p. 13; Human Development Index data from Human Development Report 2009 – Overcoming Barriers: Human Mobility and Development.* UNDP (2009).

Ecological Footprint

(Global Hectares per Person)

An Example of Sustainable Human Carrying Capacity

Kia ora