Seminar
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Steve McLaughlin

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Natural Step

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Seminar
Packet 1 of 4

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SUSTAINABILITY THINKING

The sun also arises, and the sun goes down,
and hastens to the place where it arose.
The wind goes toward the south and turns about to the north,
it whirls about continuously
and the wind returns again according to its circuits.
All the rivers run into the sea, yet the sea is not full.
Unto the place where the rivers come, thither they return again.
The thing that has been; it is what shall be;
And that which is done is that which shall be done.

- *Ecclesiastes I:5-9*

In every deliberation, we must consider the impact
of our decisions on the next seven generations.

- Great Law of the
Hau de no sau nee

According to Jewish teachings, God brought Adam
to the Garden of Eden and warned:
Take heed not to corrupt and destroy My world.
For if you corrupt it,
there will be no one to set it right after you.

- *Ecclesiastes Rabba 7.13*

SUSTAINABILITY

A thing is right when it tends to preserve
integrity, stability and beauty of the biotic community.
It is wrong when it tends otherwise.

- Aldo Leopold
Sand County Almanac, 1949

A sustainable agriculture is one that
depletes neither the people nor the land.

- Wendell Berry, 1984

A sustainable agriculture is ecologically sound,
economically viable, socially just and humane.

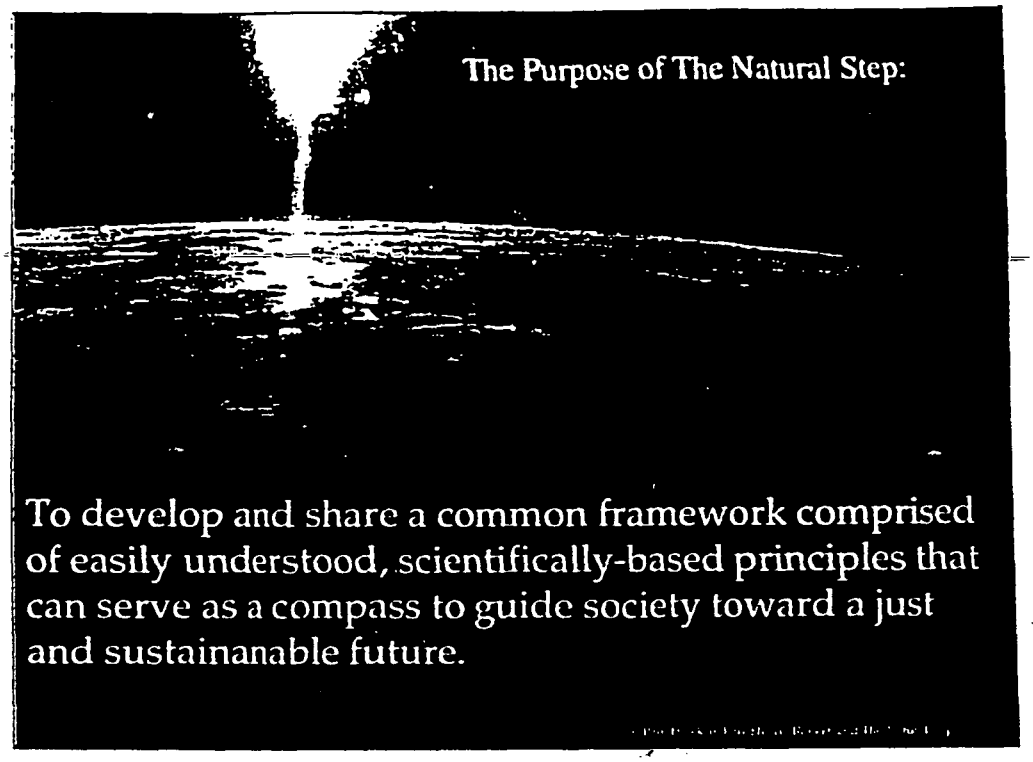
- International Alliance for
Sustainable Agriculture
Manna, 1984

Sustainable development meets the needs of the present
without compromising the ability
of future generations to meet their needs.

- U.N. World Commission on
Environment and Development
Our Common Future, 1987

Sustainability on the personal, organizational and planetary level
is an ecologically sound, economically viable, socially just and humane
ethic and system based on the wisdom of nature and science that
assures the health and wellness of present and future generations.

- Terry Gips, 1994



Accomplishments to date

- Over 60 corporations
- Over 30 municipalities
- 4.3 million households received booklet & tape
- 19 Professional Networks (10,000 people)
- Youth Parliament (100,000+ participants)
- International Organization (7 countries)
- TNS Investment Fund

The Character of Environmental Problems has Changed:

Local----------Global

Few Large Sources----------Diffuse

Short Time Delay----------Long Time Delay

Low Complexity----------High Complexity

Systems Thinking

A system is a collection of parts which interact with each other to function as a whole.

Systems thinking encourages us to look at the whole rather than solely at individual pieces or parts of a system.

If you don't understand the connections between things, often your solutions become your problems.

The primary cause of the problems is the solutions.
-Amory Lovins

There are no side-effects -- only system responses.

The significant problems we face cannot be solved at the same level of thinking we used when we created them.
-Albert Einstein

Why Do We Need Systems Thinking

1. Big Problems Can Be Addressed - Systems thinking is a way of tackling challenging problems that don't fit into various specialties.

2. Picture of the Whole - The average person (not just scientists and experts) gets a clear basic picture of how the world works without having to be an expert and know all the details of every subject.

3. Collaboration - It provides an opportunity for collaboration across areas of knowledge based on a shared mental model and language, both of which are necessary to have a shared goal to make decisions and to act.

System Overview

Trunk and branches
-fundamental principles

Foliage
-details

A Systems Perspective Emphasizes:

- Principles rather than details
- Shared framework and a common language
- Focusing "upstream"
- Necessary (non-negotiable) system conditions

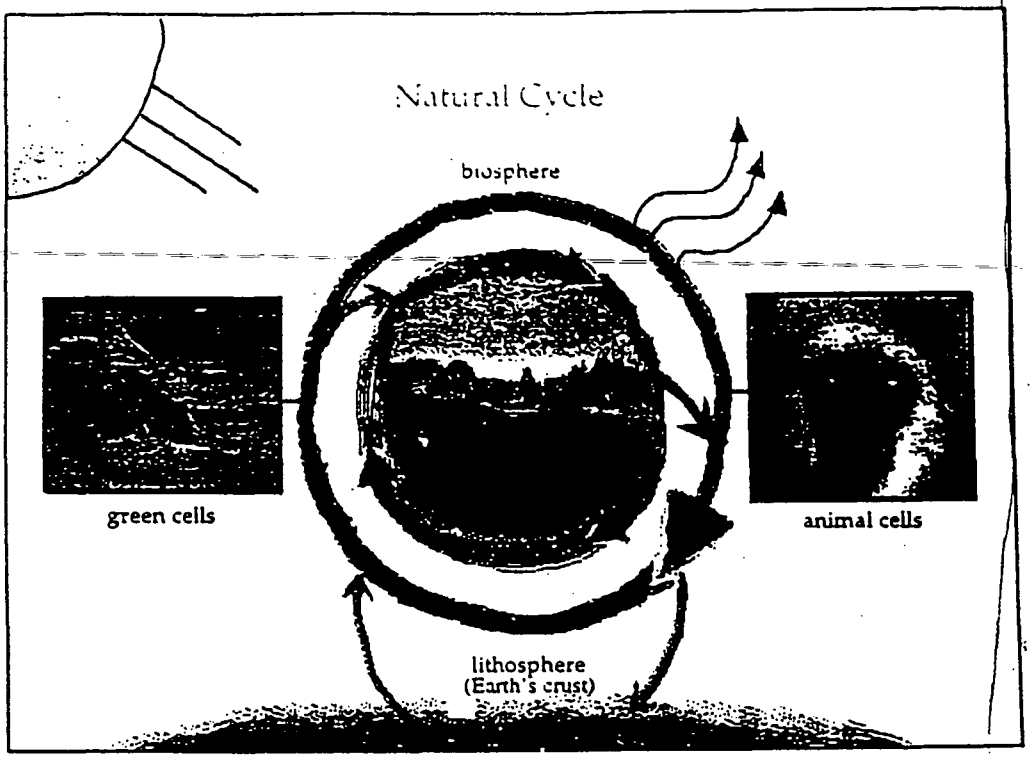
Science Principles

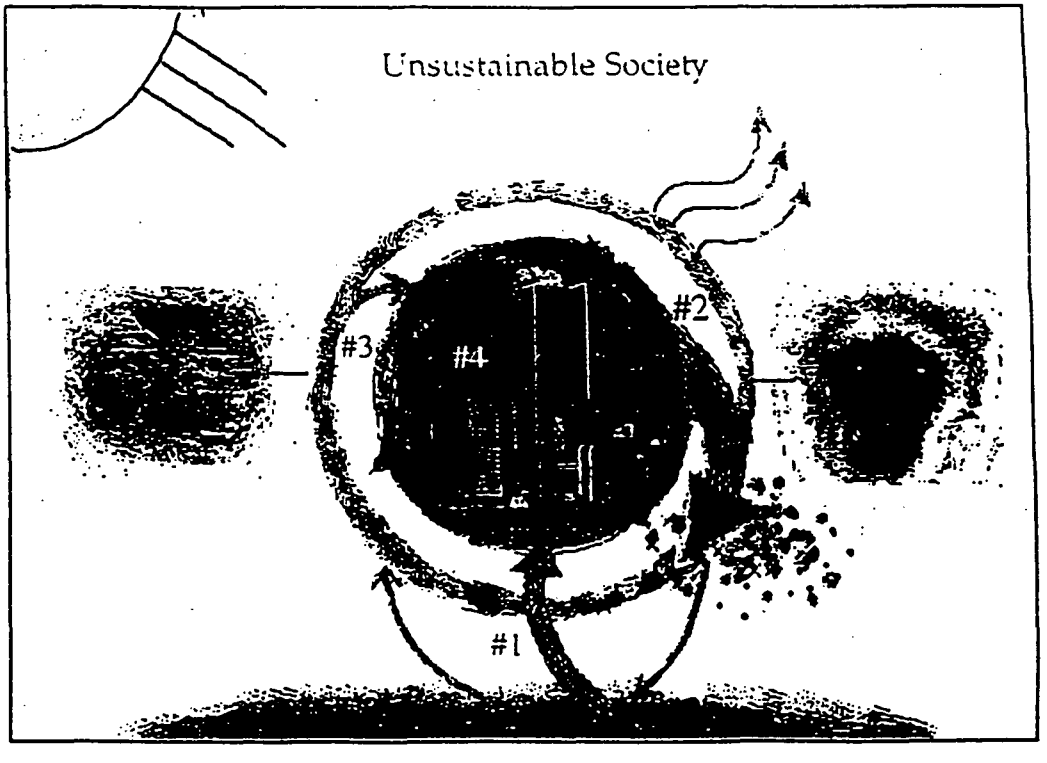
Matter and energy cannot be created or destroyed (the Conservation Law)

Matter and energy tend to spread spontaneously (2nd Law of Thermodynamics)

Biological and economic value (quality) is in concentration and structure of matter (What we consume)

Green cells are essentially the only net producer of concentration and structure (Photosynthesis)


Natural Cycle
biosphere
green cells
animal cells
lithosphere
(Earth's crust)


Unsustainable Society
#1
#2
#3
#4

First Condition for Sustainability: Reduce Mining and Use of Fossil Fuels

Natural Step Condition: "Substances from the Earth's crust must not systematically increase in nature. This means that fossil fuels, metals and other minerals must not be extracted at a faster rate than their slow redeposit into the Earth's crust."

Simply: We need to use renewable energy and nontoxic, reusable materials in order to avoid the spread of hazardous levels of mined metals and pollutants.

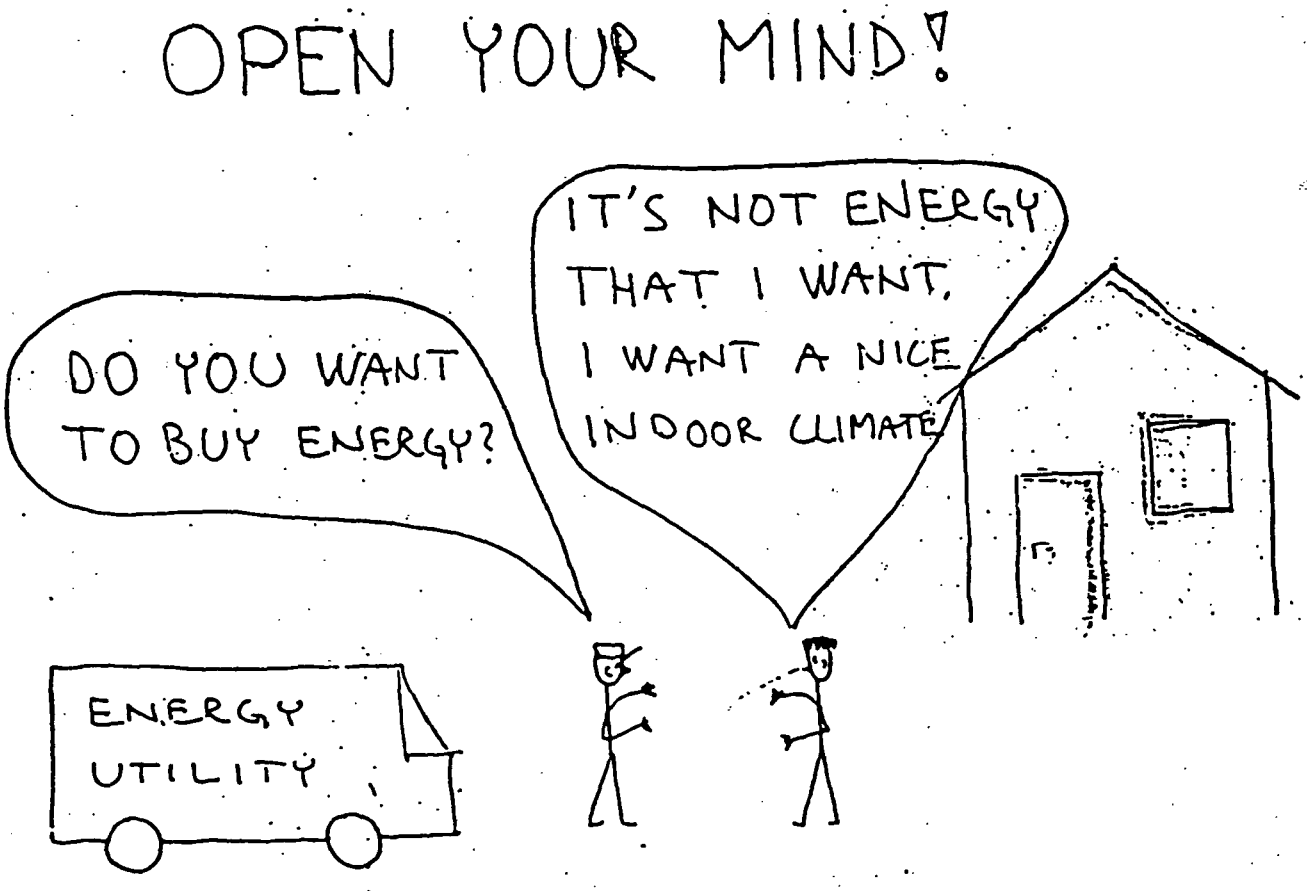
Why? Mining and burning fossil fuels release a wide range of substances that do not go away, but rather, continue to build-up and spread in our ecosphere. Nature has adapted over millions of years to specific amounts of these materials. Cells don't know how to handle significant amounts of lead, mercury, radioactive materials and other hazardous compounds from mining, often leading to learning disabilities, weakening of immune systems and improper development and functioning of the body. The burning of fossil fuels generates dangerous levels of invisible pollutants which contribute to smog, acid rain and global climate change.

Action: We can reduce our overall energy use. We can drive less, carpool, use public transportation, ride bikes or walk. We can conserve energy through energy-efficient lighting, proper insulation, passive solar, and reduced heating and cooling. We can support a shift to renewable energy such as solar and wind power instead of nuclear, coal or petroleum. We also can avoid chemical fertilizers and reduce our use of mined metals and minerals through recycling and preferably, re-use.

OK Petroleum

- Sweden's largest oil company
- Manufactures cleanest fuels in world
- Supports carbon taxes
- 2,172 employees

Avoid deviations from the natural state that are large in comparison to natural fluctuations. In particular, deviations should not be allowed to increase systematically. - John Holmberg



Material Flows Must be Kept in Balance

Natural systems have evolved over time to very specific amounts of inputs. Life cycles draw from the earth, air and water what they need and return used products in exactly the form needed for more life processes.

These material flows must be kept in balance because of their impact on cells. Cell function is non-negotiable. You can't convince cells to break down freons or urge them to survive a pollutant to which they've never adapted.

Everything can be a toxin; it is just a matter of concentration. Any systematic increase can harm the supporting conditions of life and lead to dangerous effects. For example, too much phosphorous, the essential building block of life, can cause problems.

Life is adapted to only small amounts of phosphorous, and it is the limiting factor of growth. There is a lot of nitrogen created by quick cycles but only small amounts of phosphorous, because it comes from an incredibly slow process from rocks breaking down, lightning and bat guano.

If we flood the system with lots of phosphorous,we get runaway growth. Nature doesn't know what to do with it.

Table 4.1. Indicators for elements extracted from the lithosphere. © John Holmberg

Element	Conc. in Soils [mg/kg]	Weathering & Volcanic [kton]	Mining [kton]	Fossil fuels [kton]	Index
Metals		A	B	C	Index $\frac{B+C}{A}$
Al Aluminum	72000	1100000	18000	34000	0.048
Fe Iron	26000	390000	540000	34000	1.4
K Potassium	15000	230000	24000	340	0.11
Mg Magnesium	9000	140000	3100	690	0.028
Ti Titanium	2900	44000	2500	1700	0.096
Mn Manganese	550	8300	8600	170	1.1
Zr Zirconium	230	3500	880	140	0.3
V Vanadium	80	1200	32	350	0.32
Zn Zinc	60	910	7300	260	8.3
Cr Chromium	54	830	3800	34	4.6
Cu Copper	25	380	9000	55	24
Li Lithium	24	360	9.9	220	0.64
Ni Nickel	19	300	880	570	4.8
Pb Lead	19	290	3300	85	12
Ga Gallium	17	260	0.055	24	0.093
Nb Niobium	11	170	14	14	0.17
U Uranium	2.7	41	47	3.4	1.2
Sn Tin	1.3	20	210	5.7	11

System condition 1

Substances from the Earth's crust must not systematically increase in nature

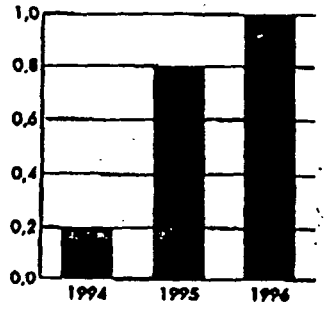
With effect from 1 September 1996, operations have been conducted using only renewable energy.

As of 1 January 1996, rape oil has been used for topping up heating, which is 65% based on marine heat exchangers in Lake Mälaren and heat pumps. Water for the pool and sauna is heated by means of heat pumps and solar panels, and ecologically labelled electricity is procured from Ekerö Energy, with effect from 1 July 1996. On 1 September, the VW coach was replaced by a new VW coach powered by rape oil. All gardening equipment operates on rape oil, apart from a lawnmower that is solar powered.

In the years ahead, the objective is to operate the facility using only renewable energy, even if this means higher operating costs. In the longer term, rape oil must be replaced by some other form of renewable energy.

Sånga-Säby

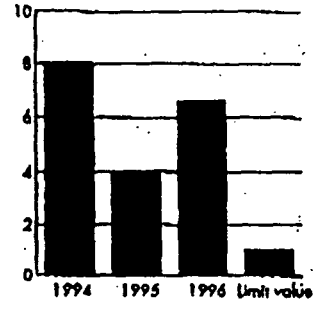
Proportion of environmental vehicles



Motor vehicles, biofuel-powered/Motor vehicles

This key ratio shows that 100% of our vehicles are powered with biofuel. During 1996, all fossil fuel was removed from the facility and the last fossil fuel-powered vehicle was replaced.

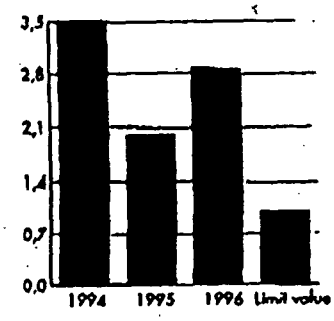
Heavy metal, mercury



Hg in sludge, limit value/Hg in sludge, annual mean value, mg/kg

If the result had been equal to 1, it would mean we had attained the limit value with no margin. The actual outcome is 6.5, which means that the margin is a comfortable one (see comparative staples). The deterioration in 1995 has now been corrected. This provided the desired result for all key ratios that monitor sludge quality in terms of heavy metal content.

Heavy metal, cadmium



Cd in sludge, limit value/Cd in sludge, annual mean value, mg/kg

We met the limit value for cadmium in sludge by a favourable margin (see comparative staples). Our sludge is almost three times better than the prescribed limit value for cadmium.

Second Condition for Sustainability: Eliminate Hazardous Substances Produced by Society

Natural Step Condition: "Substances produced by society must not systematically increase in nature. This means that substances must not be produced faster than they can be broken down and reintegrated into the cycles of nature."

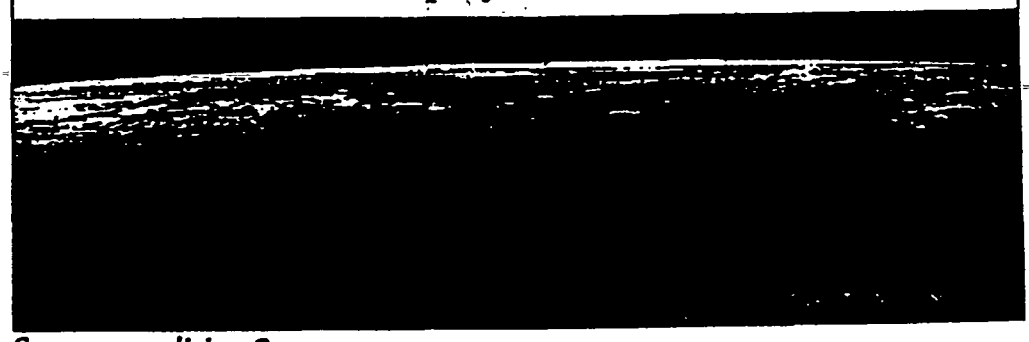
Simply: We need to use safe, biodegradable substances that do not cause the spread of toxins in the environment.

Why? Since World War II, our society has produced more than 70,000 chemicals, such as DDT and PCBs. Many of these substances do not go away, but rather, spread and bio-accumulate in nature and the fat cells of animals and humans. Cells don't know how to handle significant amounts of these chemicals, often leading to cancer, hormone disruption, improper development, birth defects and long-term genetic change.

Action: We can use non-toxic natural cleaning materials and personal care products. We can decrease our use of plastics and reuse the ones we have, such as plastic bags, plates, cups and eating utensils. We can stop using CFCs and other ozone-depleting substances. We can use safe, natural pest control in our homes, lawns and gardens. We can support farmers in becoming sustainable and eliminating hazardous pesticides by voting with our food dollars for certified organic food and clothing. We can support the elimination of factory farm feedlots and manure ponds that cause air and water pollution.

McDonald's (Sweden)

- Part of largest food service company in world
- Over 100 restaurants (Sweden)
- Over 7000 employees



System condition 2

Substances produced by society must not systematically increase in nature

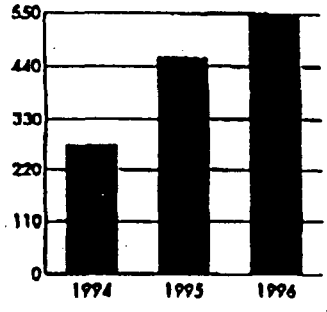
Sånga-Säby

The trend is positive for all key ratios except two.

The use of chlorine in the pool has increased. A review is currently in progress with a view to replacing sodium hypochlorite by UV-radiation and peroxide as the cleaning agents.

The key ratio for CFC efficiency shows an excessively high leakage of CFCs as a result of obsolete units. Consequently, it has been decided to replace the heat pumps with a more environmentally friendly alternative. The heat pumps using R 22 refrigerant will be replaced by new units using propane gas as the refrigerant.

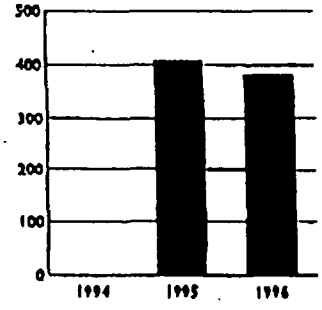
Chlorine for drinking water



Guest nights ÷ lunches/Salt for chlorination of drinking water, litres

We have steadily become more efficient in the use of chlorine in our water treatment system. Despite a summer conducive to algae blooming, we improved our result from 457 guests per litre of chlorine to 548 guests for the same dosage.

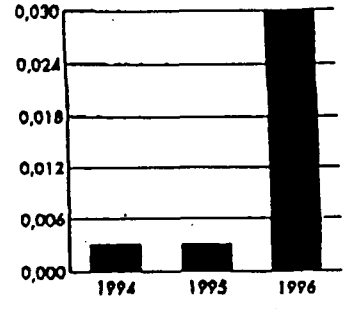
Chlorine for the pool



Guest nights ÷ lunches/salt for chlorination of pool, litres

We used more chlorine in the pool in 1996 than in previous years. In 1995 we coped with 408 guests per litre of chlorine while the corresponding figure for 1996 was only 381. We are not satisfied with this trend. A greater need for chlorine and the high concentrations required by a pool have prompted us to plan a replacement of the treatment system in 1997. The new system will not depend on chlorine.

KRAV foodstuffs margin



KRAV-labelled foodstuffs, SEK 000/Total foodstuffs, SEK 000

During the year, our restaurant was KRAV certified as one of the first fifteen restaurants in Sweden to gain such approval. In 1996, 3% of purchased foodstuffs were KRAV labelled.

Otherwise, we use only produce supplied by Swedish farmers whenever possible. In the use of KRAV products determined by demand, we impose requirements in respect of co-ordinated transport and Swedish products.

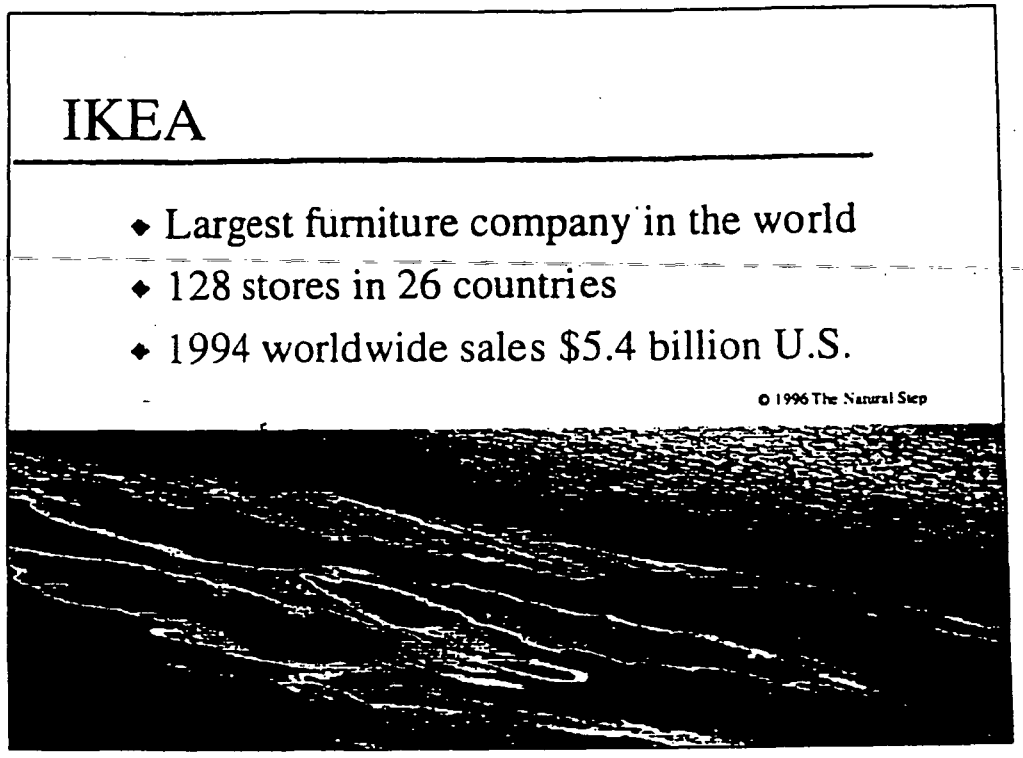
Third Condition for Sustainability: Protect Biodiversity and Ecosystems

Natural Step Condition: "The physical basis for the productivity and diversity of nature must not be systematically deteriorated. This means the productive surfaces of nature must not be diminished in quality or quantity, and we must not harvest more from nature than can be re-created and renewed."

Simply: We need to protect our soils, water and air, or we won't be able to eat, drink or breathe.

Why? Forests, soils, wetlands, lakes, oceans and other naturally productive eco-systems provide food, fiber, habitat and oxygen, waste handling, temperature moderation and a host of other essential goods and services. For millions of years they have been purifying the planet and creating a habitat suitable for human and other life. When we destroy or deplete these systems, we endanger both our livelihoods and the likelihood of human existence.

Action: We can purchase sustainably harvested forest products rather than destroying rainforests. We can reduce or eliminate our consumption of products that are not sustainably harvested, such as fish and seafood. We can shop with reusable bags rather than using more paper bags. We can decrease our use of water and use composting toilets that return valuable nutrients to the earth. We can fight urban sprawl and encourage the cleaning up of brownfields and other contaminated sites. We can safeguard endangered species by protecting wildlife habitat.



IKEA'S ENVIRONMENTAL COMMITMENT GROWS

Retail chain IKEA sells office and home furniture and housewares worldwide. The company's growing environmental commitment began in 1986 when it required suppliers to reduce formaldehyde in wood products. By 1991 IKEA banned furniture made from tropical wood except from sustainably managed sources and expanded its formaldehyde ban to include textiles and treatment materials. Then in 1993, IKEA began evaluating its products' environmental impacts, investigating life cycle processes of 9,000 products they manufacture or sell. Now the 1997 IKEA catalog introduces its Eco-Plus logo on about 30 products. Eco-Plus products will carry a label detailing applicable criteria including recycled material use and low energy production. - In Business, July/August 1996, p. 28, by B.J. Harris.

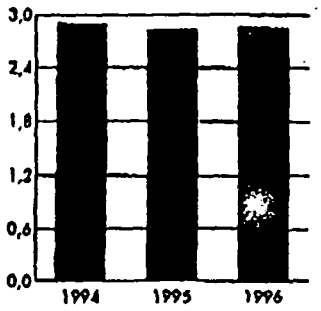
System condition 3

The physical basis for the productivity and diversity of nature must not be systematically diminished

Sånga-Säby

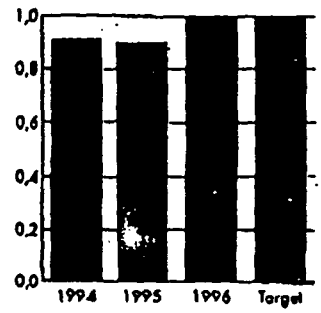
This cluster calls for more detailed analysis of a number of key ratios during 1997. The increase in the water intake in relation to guest nights + lunches is difficult to interpret since the water intake is also used for the farm and others living in the area. These factors must be excluded from the key ratio in 1997 in order to be relevant to our measurements.

The BOD7 content and nitrogen in sewage have shown negative trends in the past year. The reasons for this may be temporary but nevertheless require attention and more detailed analysis.



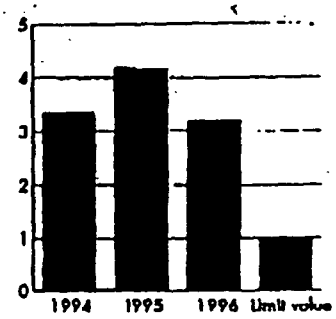
Guest nights + lunches/Water consumption, cubic metres

Water consumption remains rather stable throughout the year. We manage three guests per cubic metre of water. The calculation also includes water that supplies Sånga-Säby's exhibition farm, which means that the key ratio is not unambiguous. Nevertheless, we use it in an effort to gain prompt signals regarding development in this area.



Sewage samples, approved/Sewage samples per year

All sewage samples during the year were approved. This is an improvement compared with previous years when there were a few qualifications.



BOD7 content, limit value/BOD7 content, mean value, mg/l/year

The key ratio shows the content of oxygen-consuming substances in sewage. If the result had been equal to 1, this would mean that we had attained the limit value, but with no margin. The actual outcome was slightly more than 3, which means that the margin is a comfortable one (see comparative staples). Another way of expressing this is that we are three times better than the limit value.

Fourth Condition for Sustainability: Efficient Use of Resources to Meet Human Needs

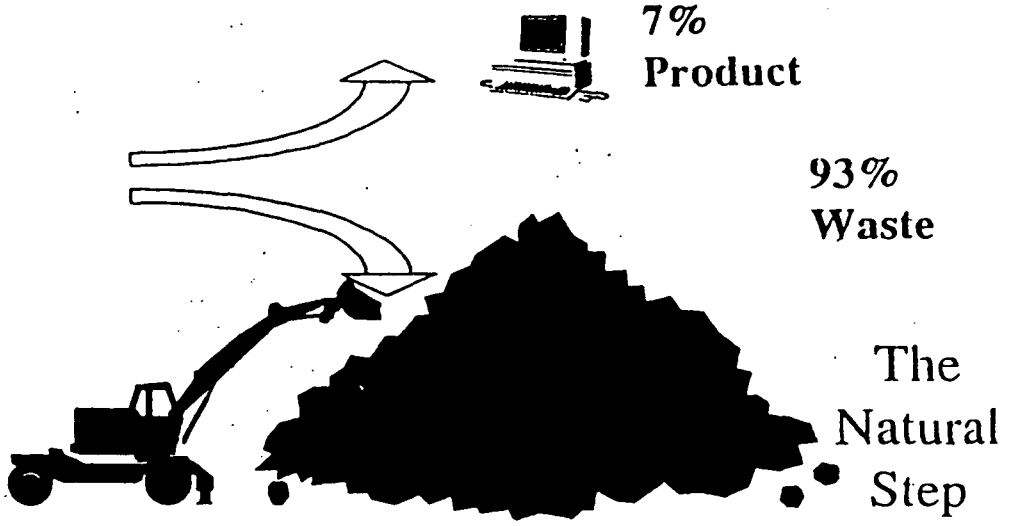
Natural Step Condition: "There must be just and efficient use of resources with respect to meeting human needs. This means that basic human needs must be met with the most resource efficient methods possible, including equitable resource distribution."

Simply: We can use less stuff and save money while meeting the needs of every human on this planet.

Why? Our society is extremely inefficient in making and using things. About 93% of what is made is waste and only 7% is the product. The American Society of Engineering estimates that we are only about 2-3% efficient in our use of resources. The planet cannot withstand our continued level of consumption and population growth. The US makes up only 4% of the world's population but consumes about 25% of its resources and produces about half of its waste. The people living in the lowest 20% by income receive only 1.4% of the world's income. Just to survive, they need to cut down rainforests, overfish and burn dirty coal. We're 30% beyond the planet's carrying capacity, and if everyone in the world consumed as we do, we'd need three more planets.

Action: Let people know the opportunity for saving money, creating jobs and reducing waste as part of the needed ten-fold increase in efficiency, including reducing, re-using, recycling and composting. We can redesign buildings and products so that they can be safe and sustainable. We can discuss our basic needs (work of Manfred Max Neef), ask if we really need more stuff, and design our lives to give us more of what we want (healthy, attractive and nurturing environments) and less of what we don't want (pollution, waste, stress, and expense).

Resource Inefficiency in Linear Production



System condition 4

Just and efficient use of energy and other resources

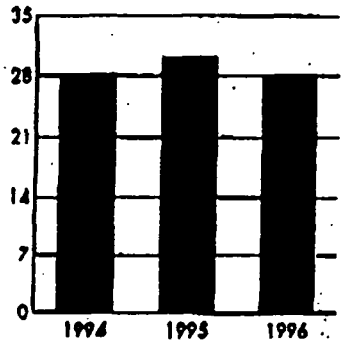
Sånga-Säby

The cluster as a whole shows negative results. The primary reason for this was the colder weather than in previous years, combined with the expansion in operations, as shown by the key ratio "Energy-thrift, turnover" which indicates that we have been more efficient (see page 14).

The key ratio "Local supplies" takes only into account products from the municipality. Since we look for high quality produce, temporary declines can occur. Even in a major metropolitan region like Stockholm, the area is very limited if one regards the municipality as the local area.

We are studying to determine whether it may be relevant instead to use a key ratio based on the Lake Mälaren area or, alternatively, on Swedish produce.

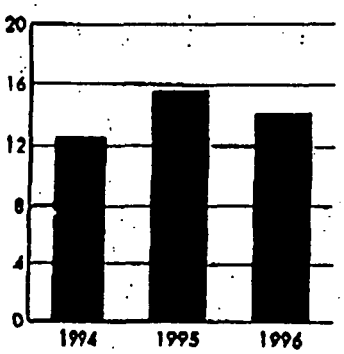
Electricity thrift



Guest nights + lunches/Electricity consumption

This key ratio shows a deterioration compared with the preceding year. We used more electricity in 1996. From having coped with 30 guests per MWh of electricity in 1995, we are now down to 28 guests per MWh of electricity. Part of the decrease is due to a colder winter. It is worth noting that the plant's electricity is environmentally labelled ("green" electricity).

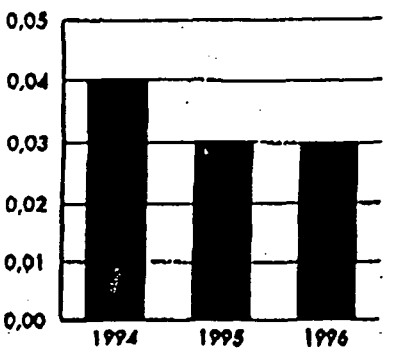
Energy thrift



Guest nights + lunches/Total energy consumption

Guest nights + lunches is an indicator of the extent of operations at Sånga-Säby. We use this ratio to measure how many guests we have annually. The key ratio shows that in 1995 we were able to satisfy 16 guests' energy requirements per MWh compared with 14 guests per MWh in 1996.

Local supplies



Foodstuffs from Lake Mälaren islands, SEK 000/ Total foodstuffs, SEK 000

This key ratio shows how large a share of the company's purchases of foodstuffs is produced on the islands in Lake Mälaren. Figures are expressed in SEK 000. Only 3% of our foodstuffs were produced locally in 1996. We find it difficult to find local produce that meets our quality and environmental requirements but it is an important issue and we are continuing our efforts to

Distribution of Income

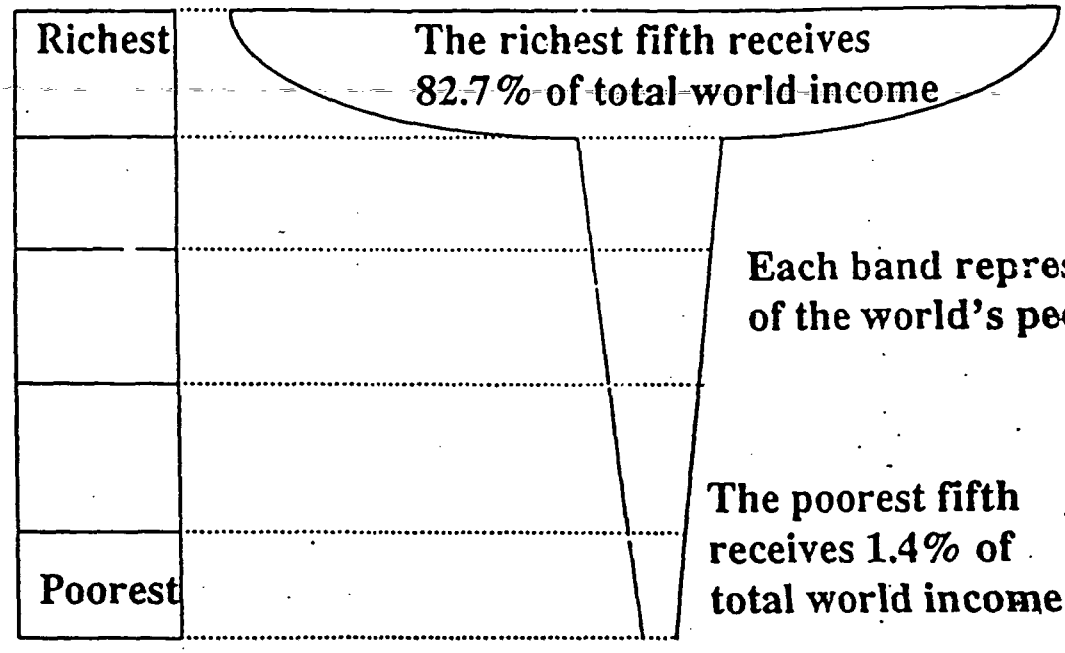


Table 3.4: Comparing people's average consumption in the US, Canada, India and the world"

Consumption per person in 1991	Canada	USA	India	World
CO_2 emission [in tonnes per yr]	15.2	19.5	0.81	4.2
Purchasing Power [in $ US]	19,320	22,130	1,150	3,800
Vehicles per 100 persons	46	57	0.2	10
Paper consumption [in kilograms/yr]	247	317	2	44
Fossil energy use [in Gigajoules/yr]	250 (234)	287	5	56
Fresh water withdrawal [in m^3/yr]	1,688	1,868	612	644
Ecological Footprint [ha/person]	4.3	5.1	0.4	1.8

HUMAN NEEDS

according to the Chilean economist Manfred Max-Neef

- -Physical needs
- -Protection / Security
- -Affection
- -Understanding
- -Participation
- -Leisure
- -Creativity
- -Identity / Meaning
- -Freedom

Human needs are:

- -defined and possible to classify
- -the same in all cultures and in all historic times (but with different ways to satisfy them)
- -not interchangeable among each other
- -possible to satisfy at a high degree and at the same time decrease society's turnover of natural resources.

We can no longer have everything we want,
but we can be more than we ever imagined.

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Figure 2.5: Measuring the World in Monetary Units Makes us Blind to the Ecological Constraints on Sustainability. Acknowledging the limitations of monetary assessments becomes an additional argument against "weak sustainability." As noted earlier, the weak criterion assumes the substitutability of human-made for natural capital, allowing (false) "trade-offs" in terms of equivalent stock values or income-generating potential. An alternative approach is to assess our natural capital requirements from an ecological and biophysical perspective.

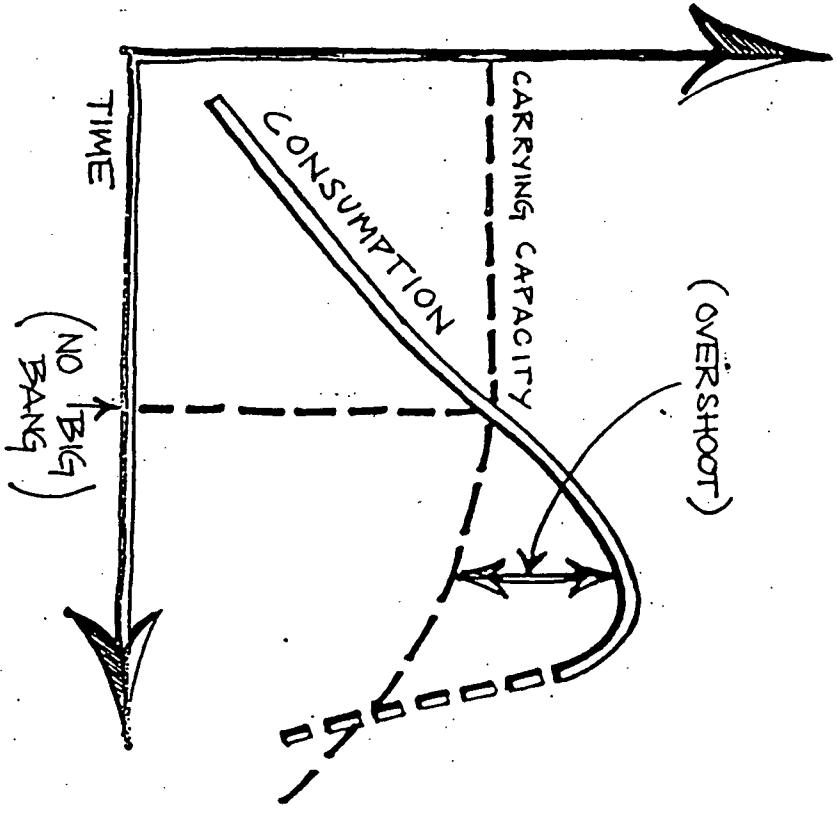

Figure 2.8: Overshoot is growth beyond carrying capacity. Carrying capacity limits can be overshot without a "big bang" because of the availability of large capital stocks. Harvests can still increase and money incomes rise, and while there may be indications of ecological stress, all else may seem normal. Ultimately, however, the consequences of eroded natural capital may be felt as eco-catastrophe and population crash.

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-Mathis Wackernagel

Figure 4.5: The Boiled Frog Syndrome. A frog placed in slowly heating water will not notice the gradual but eventually lethal trend.

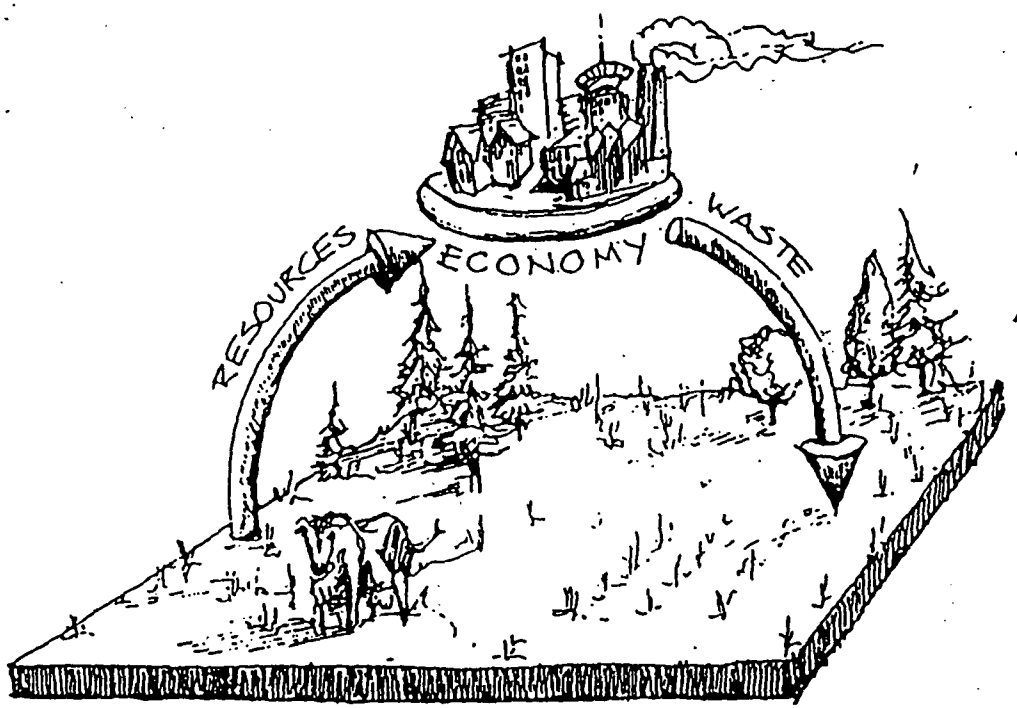

Figure 1.3: What is an Ecological Footprint?
Think of an economy as having an "industrial metabolism." In this respect it is similar to a cow in its pasture. The economy needs to "eat" resources, and eventually, all this intake becomes waste and has to leave the organism — the economy — again. So the question becomes: how big a pasture is necessary to support that economy — to produce all its feed and absorb all its waste? Alternatively, how much land would be necessary to support a defined economy sustainably at its current material standard of living?

1 meter - about 3 ft . 138 sq meters

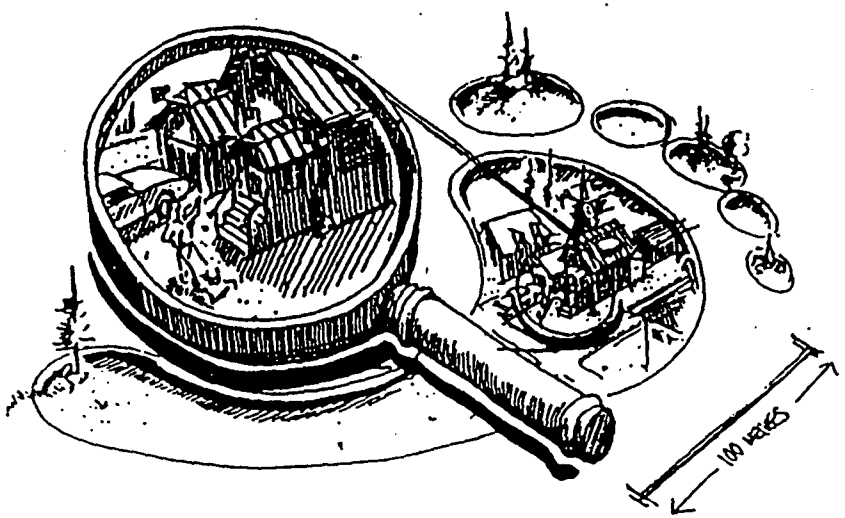

Figure 1.4: Your Footprint. The average North American Footprint measures 4 to 5 hectares or is comparable to three-plus city blocks.

The Ecological Footprint is a measure of the "load" imposed by a given population on nature. It represents the land area necessary to sustain current levels of resource consumption and waste discharge by that population.

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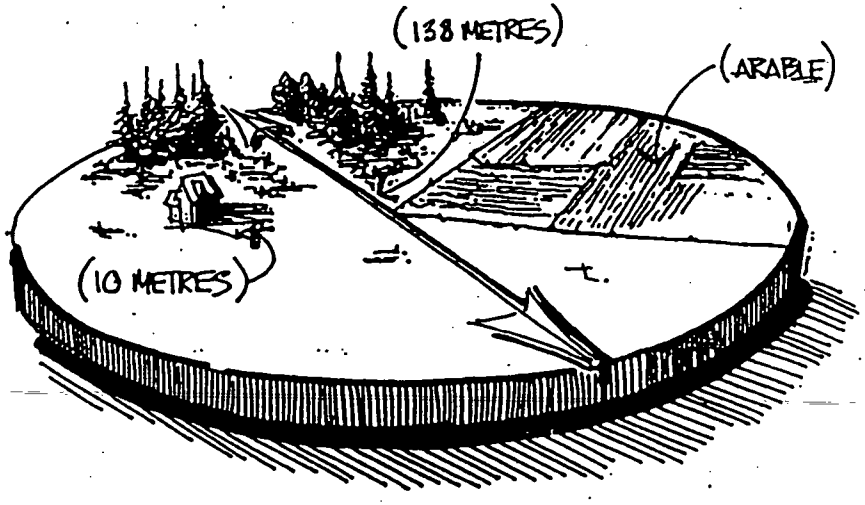

Figure 2.7: A fair Earthshare is the amount of land each person would get if all the ecologically productive land on Earth were divided evenly among the present world population. If your present Earthshare were a circular island it would have a diameter of just 138 metres. One sixth of your island would be arable land, the rest pasture, forest and wilderness, and built-up area. Clearly, as the population increases, our earthshares shrink. Also, for each person whose Ecological Footprint exceeds his/her fair earthshare by, say, a factor of three (as do North Americans'), three other people would have to content themselves with only a third of a share for global sustainability. —Any volunteers?

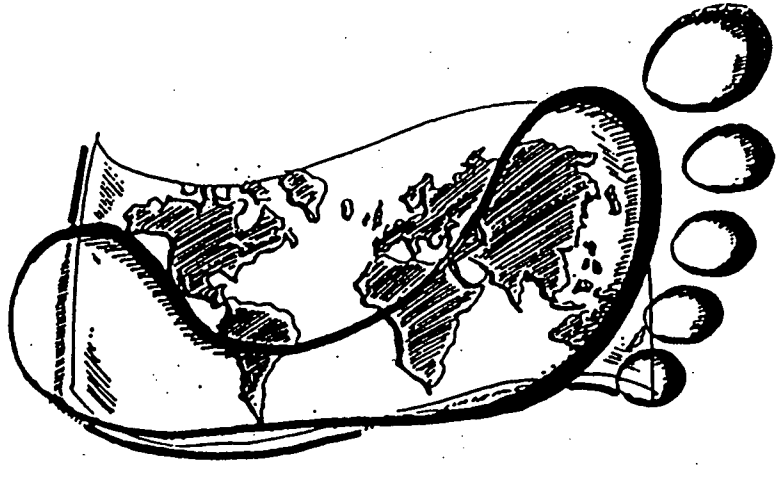

Figure 3.7: Humanity's Ecological Footprint is as much as 30 percent larger than nature can sustain in the long run. In other words, present consumption exceeds natural income by 30 percent and is therefore partially dependent on capital (wealth) depletion. The lavish partying by the wealthy today means a hefty bill for everyone tomorrow.

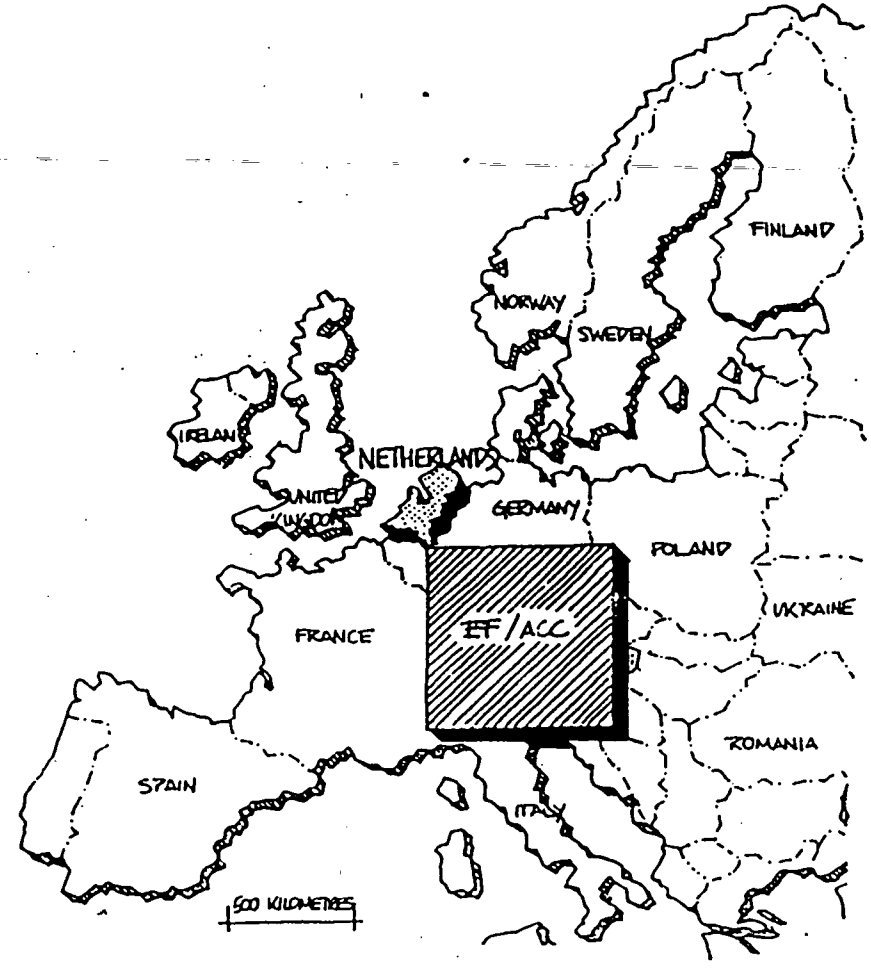

Figure 3.8: For urbanization, food, forest products and fossil fuel use, the Dutch use the ecological functions of a land area over 15 times larger than their country.

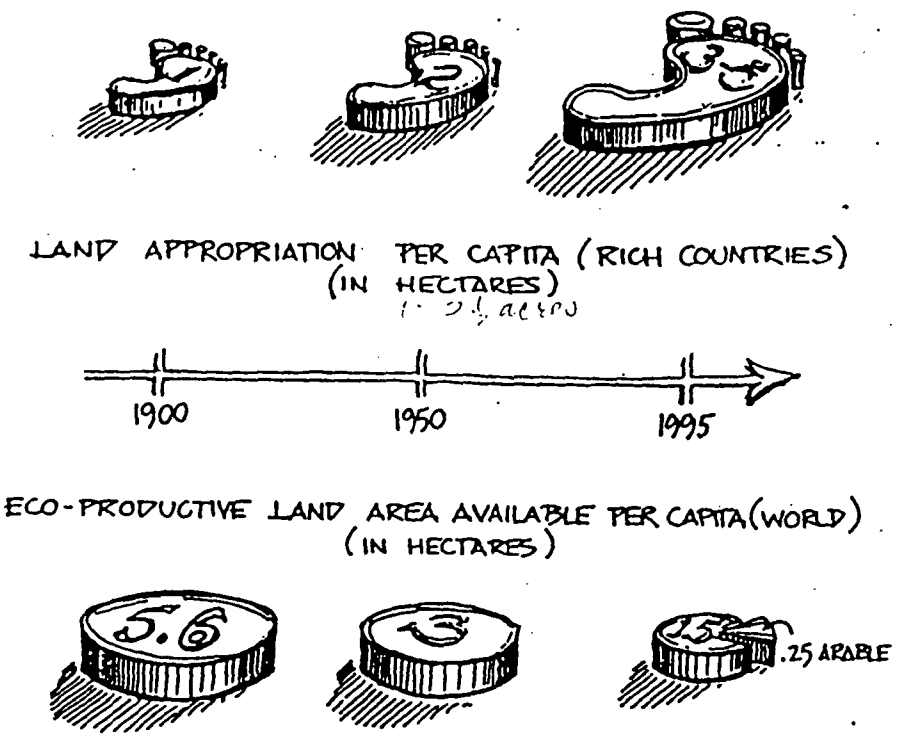

Figure 1.5: Our Ecological Footprints Keep Growing While Our per capita "Earth-shares" Continue to Shrink. Since the beginning of this century, the available ecologically productive land has decreased from over five hectares to less than 1.5 hectares per person in 1995. At the same time, the average North American's Footprint has grown to over 4 hectares. These opposing trends are in fundamental conflict: the ecological demands of average citizens in rich countries exceed *per capita* supply by a factor of three. This means that the Earth could not support even today's population of 5.8 billion sustainably at North American material standards.

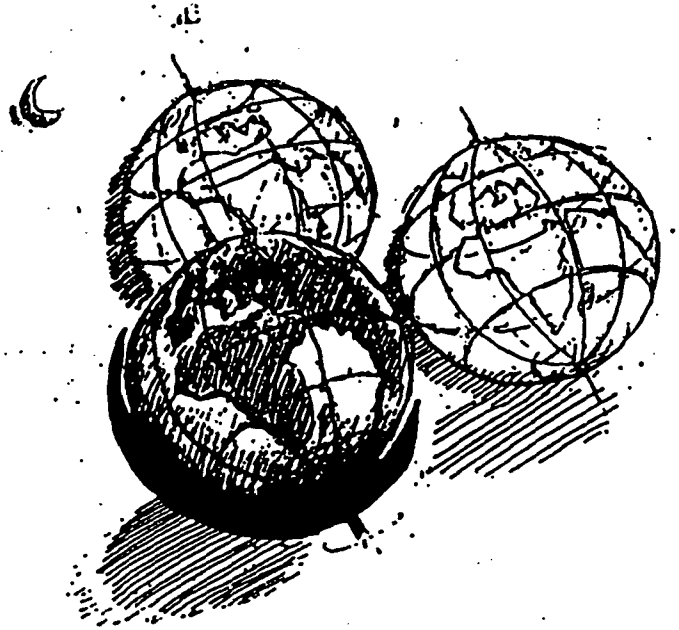

Figure 1.6: Wanted: Two (Phantom) Planets. If everybody lived like today's North Americans, it would take at least two additional planet Earths to produce the resources, absorb the wastes, and otherwise maintain life-support. Unfortunately, good planets are hard to find...

Figure 3.19: The eco-label of this newspaper could say: "Regular purchase and disposal of this product will claim just over 10% of your daily Earthshare or 2.5 hours of your daily fair share of global ecological output."