# The power of one: developing a headline indicator for tracking progress to sustainability in New Zealand

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**Abstract:** New Zealand has recently adopted sustainable development policy goals in its Sustainable Development for New Zealand Programme of Action. One question the Programme of Action must address is how to communicate progress to decision-makers and the community. Drawing on the communicating power of headline indicators is one approach to this communication exercise. The Ministry for the Environment recently commissioned an analysis of potential headline indicators for tracking progress towards sustainable development goals. The findings from the consequent report prepared by Patterson [1] are summarised in this paper. The research revealed that definitions of 'headline indicators', sustainability, and selection criteria are essential for successfully selecting appropriate headline indicators. This analysis identified the Ecological Footprint and Genuine Progress Indicator as two potentially useful headline indicators. It also recommends that further investigations be undertaken into constructing a composite index of sustainable development for New Zealand that explicitly measures the economic, social and environmental aspects of progress.

**Keywords:** sustainable development; theory; national indicators; New Zealand; ecological footprint.

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**Biographical notes:** Professor Murray Patterson is the Director of the New Zealand Centre for Ecological Economics at Massey University. He has an extensive publications' record straddling a number of fields including: ecological economics, energy analysis, environmental valuation, environmental policy, and policy modelling. Much of this research is of an applied and interdisciplinary nature working at the interface of policy and sustainability concerns. Professor Patterson has 25 years of experience in central and local government as a policy advisor as well as working in the university sector. In recent years, he has lectured in the resource and environmental planning programme at Massey University on policy analysis and evaluation.

Nigel Jollands' career spans ten years in the energy, resource management and environmental indicators fields. He is currently Principal Ecological Economist with the New Zealand Centre for Ecological Economics at Landcare Research and a Senior Lecturer at Massey University. Jollands maintains an active research interest in ecological economics. In particular he has an interest in eco-efficiency analysis, sustainability indicator development, and the

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policy-science interface. He has published several papers on these areas and presented his work at a number of international conferences.

## 1 Introduction

The New Zealand Government is devoting increasing attention to sustainability. In August 2002, it released 'The Government's Approach to Sustainable Development' [2], outlining the actions New Zealand had taken to improve its environmental, economic and social sustainability. At the same time, Statistics New Zealand released its work on sustainable development indicators [3]. More recently, the New Zealand Government has continued this interest by setting out its Programme of Action for sustainable development [4]. Sustainable development is clearly on New Zealand's policy agenda.

Many challenges have emerged as a result of the policy attention given to sustainable development. One significant challenge is how to communicate progress towards sustainable development to decision makers and the public. The New Zealand Ministry for the Environment has acknowledged the need to address this issue, and recently commissioned an evaluation of the usefulness of headline indicators for communicating progress towards sustainable development goals (see [1]).

In 1998 Bryce Courteney [5] wrote *The Power of One*, about the power of an individual to influence other people. We draw on this metaphor and present our research that leads us to conclude that single headline indicators also have 'The Power of One' to change people – to influence the way people understand trends in sustainable development.

We also present our recommendations on the appropriate headline indicators for New Zealand. We begin with a discussion of the history and rationale of sustainability indicators. Next we address some definitional issues: What is sustainability, and what are headline indicators? We conclude with an evaluation of several candidate indicators, and our recommended course of action for the New Zealand Government.

## 2 History and rationale for sustainability indicators

Indicators of all aspects of society are becoming increasingly important in our everyday life. We receive a daily barrage of indicators and indexes in our newspapers and on our television screens. Economic indicators, particularly the gross domestic product (GDP), have also assumed a very important place in public policy debates and analysis. For all this, indicators are a relatively recent phenomenon, with even the GDP only really being used since the post-World War Two period [6].

Over this relatively short history, four developmental themes have emerged in indicator praxis. First, there is an overwhelming bias towards economic indicators in public policy. In response to this, as social issues assumed more importance in the 1960s and 1970s, the *social indicators' movement* attempted to establish social measures of progress [7]. The Human Development Index indicators developed by the United Nations [8] is one of the few social indicators to emerge with some credibility and acceptance. In the 1980s and 1990s, as the environmental movement became increasingly

dissatisfied with conventional economic measure of progress, there was also a concerted effort by governments, NGOs and academic researchers to establish environmental sustainability indicators.

The second main theme in the development of sustainability indicators is the ongoing attempts to standardise indicator collection. Two lead agencies in this regard are the United Nations and OECD. Both agencies have attempted to standardise the collection of environmental indicators across nations. The rationale for this was to enable countries to track their environmental performance against each other. Following the same theme in Australasia, the ANZECC have recommended a core set of environmental indicators, for use by both countries [9].

The need to move beyond treating 'economic', 'social' and 'environmental' indicators separately is another theme to emerge on the international indicators' scene. The United Nations' Commission on Sustainable Development's attempts to integrate environmental statistics with economic and social measures of progress is a good example of this.

The final theme is the lack of attention paid to communicating indicators effectively to the general public. Even the United Nations Project to Aggregate Indicators of Sustainable Development appears to be focussed on technocratic outcomes. While several community organisations have begun considering this issue at a national government level, little effort has been devoted to developing the much needed headline indicators of sustainability.

The considerable effort devoted to sustainability indicators has a strong rationale. It is based in part on the call for greater government accountability and policy performance evaluation. Public awareness and the 'public's right to know' about trends in the environment are also strong rationales driving the rapid development of sustainability indicators. The general thrust behind the many sustainability indicator initiatives is that a community needs to know how it performs economically, socially and environmentally. Without this information, it cannot rationally plan for the future and monitor progress towards any goals. This applies to all levels and dimensions of decision making in regional and national communities, ranging across the public and private sectors. For these reasons, international experience suggests sustainability progress needs to be measured, monitored and regularly reviewed by policy makers in much the same way as in the economic area.

### *2.1 New Zealand initiatives in sustainability indicators*

New Zealand has been relatively slow in developing sustainability indicator systems. In the early 1990s there were a number of joint efforts by the Ministry for the Environment and the Department of Statistics to promote 'state of the environment reporting' in New Zealand. These reports were very wide ranging, but they did contain specific recommendations to explore integrative economic-environmental accounting and environmental indicator systems.

Through 1996 progress continued in a piecemeal fashion. The Department of Statistics did publish compendiums on environmental statistics such as *Measuring Up* [10], and the Ministry for the Environment published a State of Environment report [11]. However, there was no attempt to establish an ongoing environmental indicators' capability until 1996.

In 1996 the Ministry for the Environment established the Environmental Performance Indicators (EPI) programme, to set up a national system of environmental indicators. A number of areas were selected for indicator development including: land, air, fresh water, climate change, ozone, marine environment, terrestrial and freshwater biodiversity, waste, transport, energy, pests, weeds and disease, urban amenity and landscape values, and toxic contaminants. Much effort has been put into securing the support of Regional Councils and science providers, as well as identifying indicator variables through a consultative process. As yet, few indicator data series have been published by the EPI programme.

In an attempt to expand New Zealand's sustainability indicators beyond the environmental focus, Goldberg [12] provided a review of *Indicators of Sustainable Consumption*. He concluded that such indicators are relevant to New Zealand; however, the paucity of environmental data is a significant limitation for New Zealand.

Progress in the area of Environmental Accounting (integrating economic and environmental data and indicators) has been even slower. In the late 1980s Wright [13] called for the establishment of Environmental Accounts in New Zealand. However, Statistics New Zealand concluded in early 1990s that setting up Environmental Accounts in New Zealand 'was not feasible'. Despite this, independent researchers set up regional-level Environmental Accounts for the Northland, Auckland and Waikato regions [14].

The measurement of social progress is an allied field that needs to be mentioned here. The most comprehensive measure of social progress (or lack of it) is the construction of the New Zealand Deprivation Index using data from the 1991 and 1996 censuses. This measures social deprivation at the mesh block level using a composite index of nine variables [15]. There have also been other attempts at measuring social progress, poverty, income inequality and related measures such as Easton [16], Stephens et al. [17] and Davis et al. [18].

New Zealand has also followed the international example of devoting little attention to developing headline indicators. Instead, exercises like the EPI programme quickly became a "philatelic indicator collection exercise". Relatively little effort was devoted to communicating results to the general public. This lack of attention has contributed to the government's inability to capture the interest of much of the general public on sustainability issues.

In summary, it can be argued that New Zealand's sustainability indicators have been slow, piecemeal, disjointed and lacking in headline-indicator development.

## 3 What is an indicator?

As noted in our other paper in this issue, it is important to define what we mean by an indicator. Using semiotics we can define indicators as quantitative conventional proper communicative signs. In other words, an indicator is not merely a number or a statistic. It is a carefully selected operational measurement of some theoretical concept or idea. It is selected to inform the decisions of a clearly defined audience and attempts to measure the essential characteristics of a concept in the most efficient way possible. In a sense, an indicator attempts to condense as much information about a concept into just one numerical index. However, complete information condensation can often not be

achieved. Therefore, several indicators are usually required to provide a quantitative picture of the abstract concept.

### 3.1 What is a headline indicator?

Many indicators measure different aspects of sustainability performance, often at a localised level. Although these indicators are useful in the management of specific resources and ecosystems, they give no information about the overall performance of the system. In fact, decision makers are often overwhelmed by the sheer quantity and complexity of indicators, to the extent that indicators begin to become counterproductive.

Headline indicators are about trying to reduce the complexity to a manageable and understandable level, and trying to capture the communication power of a single number. They measure the overall performance of the system in terms of broad economic, social and environmental goals. The main audience of headline indicators should ideally be the general public. In the economic area, a well-known headline indicator, which measures economic performance, is the GDP or inflation rate. The meaning of these economic indicators is instantly apparent to the public and politicians and is therefore often reported without any explanation in the media.

Just as Bruce Courteney [5] writes of the power of one individual to change others, so too can headline indicators influence decisions. There is very good evidence that accurate, accessible headline information does influence decision making. A case in point is the use of the high-level economic and financial indicators (e.g., GDP, inflation) and their highly influential impact on decision making and public policy. For example, it has been convincingly argued that the USA had no labour-market policy, until the unemployment rate was codified into the USA Statistical Framework in the 1940s and 1950s [19].

When it comes to sustainable development, a headline indicator has to encapsulate the essential characteristics of social, economic, and environmental progress. This often, but not necessarily, requires the headline indicator to be a composite index – that is, an index made up of hierarchical structure of sub-indexes and variables. This is because one single variable is unlikely to be capable of capturing all the behaviour you wish to measure, whether it be economic, social or environmental behaviour.

The literature contains a wide range of potential headline sustainability indicators. These include ecological footprint, material flow indicators, environmental sustainability index, consumption pressure index, living planet index, European composite environmental performance index, among others. Several of these indicators are evaluated below.

### 3.2 What is sustainability? Developing the theoretical basis for sustainability indicators

Before we proceed with an evaluation of sustainability indicators, we must first establish the definitional basis for the underlying concept of ‘sustainability’. Unfortunately, little of the *sustainability indicators* literature addresses this critical issue. Instead, the approach tends to be to select indicators that have an intuitive and pragmatic appeal, without fully defining the concept of ‘sustainability’ itself. In places, the literature comes seriously close to measurement without theory. There is often an ‘absent referent’, where what is being measured seems to have no transparent or explicit theoretical basis.

It is clear from the burgeoning literature on sustainability that there is no one definition of 'sustainability', and different disciplines interpret the concept in fundamentally different ways. A comprehensive review of the sustainable development literature by Pezzoli [20] categorises these interpretations across eleven fields:

- policy and planning
- social conditions
- environmental law
- environmental sciences
- eco-design and the environment
- ecological economics
- eco-philosophy
- environmental values and ethics
- environmental history and geography
- utopianism, anarchism and bioregionalism
- political ecology [21].

Many reviews [20,22,23] of the concept of sustainable development almost routinely seem to begin by citing the 1987 Brundtland definition from *Our Common Future* by the World Commission on Environment and Development [24].

> "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

this is by no means the only or the first definition of sustainable development, although it was the first high-profile definition [25]. Furthermore, it is only one definition amongst very many that need to be considered.

In the report *Headline Indicators for Tracking Progress to* S*ustainability*, we restrict our discussion of the definition of sustainability to those main bodies of sustainability theory which lend themselves to *operational measurement* – briefly these include [26]:

- *Ecological interpretations* tend to emphasise the ideas of thresholds, the steady state (although this is hotly disputed), carrying capacity, interdependence between ecological process, and the idea that the socio-economic sub-system is embedded within the global biophysical system [27–29]. The Headline Indicators report particularly focuses on the conceptualisation of sustainability under the equilibrium and non-equilibrium paradigms of ecology, and how the interpretation of the sustainability concept depends on the level of organisation being considered (population, community, ecosystem and biosphere) as well as on scale. The specific ecological indicators covered include amoeba method, ecological footprint, material flow indicators, lifecycle assessment indicators, living planet index and ecological rucksack.

- *Economic interpretations* tend to emphasise the idea of social welfare and the external environmental costs associated with the economic activity; as well as the principle of intergenerational equity through the use of capital theory [30,31]. Economic interpretations also introduce the notion of weak and strong sustainability indicators (like the Genuine Savings Indicator).
- *Thermodynamic and ecological-economic interpretations* accept the essence of many of the ecological interpretations, but go further by situating ecological sustainability in the context of the entropic nature of economy-environmental interactions [32,33]. The economic system is considered to be a sub-system of the biophysical system. The economic system uses low entropy energy inputs (fossil fuel, nuclear energy), and low entropy matter resources (minerals, biomass, water). These inputs are transformed, sometimes stored, but ultimately degraded into high entropy emissions flowing back into the biophysical environment. There are a number of fundamental sustainability issues that arise from this model – these include the extent to which the economy's sustainability depends on the biosphere as a *source of resources* and *sink for wastes;* the extent to which the economy occupies the biosphere space; and critical thermodynamic limits that restrict 'decoupling' of the economy sub-system from the biosphere.
- *Public policy and planning* theory approaches to sustainability emphasise the social, institutional, economic and environmental dimensions of sustainability within a framework that seeks to achieve 'balance' or 'integration' of these factors [4]. In this respect, policy agencies and others have promoted *composite* indicator frameworks that seek to measure sustainability or sustainable development across all of these 'dimensions'. An example of such a perspective on sustainability is the New Zealand government's *Environment 2010 Strategy* definition of sustainable development, which is defined in terms of three components: economic, social, and environmental. The Wuppertal Institute in Germany also advocates a composite interpretation of Sustainable Development, in their publication by Spangerberg and Bonnoit [34]; as does the Ontario Ministry of Environment [35].

### *3.3 Criteria for evaluating headline indicators of sustainability*

The issue of criteria has been extensively covered in the literature, including papers in this issue. In addition to the generic discussion of criteria, there are several specific requirements of headline indicators that should be considered. These requirements are discussed below.

#### *3.3.1 Clarity of message to the public*

The primary audience for headline sustainability indicators is the general public. Such public indicators must be easily and instantaneously understood, and should not require any prior understanding. For headline indicators designed for the public, commentators have also pointed to the concept of 'resonance'. The indicator must 'ring true'. The public are not so much concerned with methodological details. Rather the indicator must seem meaningful and truthful in terms of how the public perceive matters.

### *3.3.2 Policy relevance: the need to measure performance*

It is intended that the headline indicators of sustainability be used to measure policy performance, in the sense of telling us if 'things are getting better' or 'things are getting worse'. This necessarily implies some reference point or benchmarking system. Such reference points or benchmarks could include policy targets, comparisons with other countries or against formal environmental standards, or departures from a base year.

### *3.3.3 Efficient representation of a concept*

Ideal headline indicators should convey the maximum possible information about sustainable development. Specifically, they should efficiently encapsulate the 'economic', 'social', and 'environmental' dimensions of the concept.

### *3.3.4 Temporal scale*

The government has indicated it is important that selected indicators can be backdated several years in order to establish trends. The selected indicator(s) should also be suitable for long-term repeated measurements. Care therefore is needed to ensure that whatever variables are selected have a consistent historical time series and a good prospect that these time series will be maintained in the future.

## 4 Finding the one: evaluating possible headline indicators for New Zealand

This section of the paper briefly describes and evaluates a range of possible headline indicators for New Zealand against a set of selection criteria. A comprehensive list of headline indicators [36] are evaluated in Patterson [1]. For the purpose of this paper, however, we have evaluated only a selection of headline indicators that appear most suited to the New Zealand context:

- the environmental sustainability index
- ecological footprint
- consumption pressure index
- living planet index
- green GDP.

The criteria used in this evaluation closely map those mentioned in our earlier paper. However, for conciseness, we have combined theoretical basis, philosophical bias, appropriate data transformations, and analytical validity under the heading 'scientific and theoretical basis'. Consequently, we evaluate the strength of headline indicators against seven criteria:

- clarity of message/public acceptance
- scientific and theoretical basis
- scale
- efficient representation of the sustainability development concept
- policy relevance (including timeliness)
- data availability and cost
- an overall assessment.

The results of the evaluations in the following pages are summarised in Table 1.

**Table 1** Evaluation of the headline indicators against each selection criterion

| | *Clarity of message/ public acceptance* | *Scientific and theoretical basis* | *Scale* | *Efficient representation of sustainable development concept* | *Policy relevance* | *Data availability and cost* | *Overall* |
|---|---|---|---|---|---|---|---|
| Environmental sustainability index | XXX | XX | XXXX | X | XX | XXX | XX |
| Ecological footprint | XXXX | XX | XXX | X | XXX | XXXX | XXX |
| Consumption pressure index | XXX | X | XXXX | X | XX | XX | XX |
| Living planet index | XXX | XXX | XX | X | XX | XXX | XX |
| 'Green' GDP (including ISEW and GPI) | XXXX | XXX | XXX | XXXX | XXX | XX | XXX |

Key: XXXX = excellent; XXX = good; XX = fair; X = poor.

## *4.1 Environmental sustainability index*

The environmental sustainability index (ESI) is a measure of the overall progress towards environmental sustainability of 122 countries. The ESI scores are based on a set of 22 core indicators, each of which combines two to six variables for a total of 67 underlying variables. The ESI has been developed by the World Economic Forum, in collaboration with the Yale Centre for Environmental Law and Policy and the Centre for International Earth Science Information Network. The first ESI was published by the World Economic Forum [37].

The ESI considers environmental sustainability to be a function of five phenomena:

- *state of environmental systems*, such as air, soil, ecosystems and water
- *stresses on environmental systems*, in the form of pollution and exploitation levels
- *human vulnerability* to environmental change in the form of loss of food resources or exposure to environmental diseases
- *social and institutional capacity* to cope with environmental challenges
- *global stewardship* by cooperating in collective efforts to conserve international environmental resources such as the atmosphere.

The strength of the ESI is that it is relatively comprehensive in its coverage of environmental variables. It is also a transparent method, both in terms of how the index is constructed, and in the way the results are presented.

Being a relatively new index, however, it has received a number of negative reviews [38]. There is concern (acknowledged by the World Economic Forum [37]) that the index favours developed countries, which on one level is an apparent contradiction, given the immense pressures these countries place on the environment. A particular case in point appears to be Norway, which is marked as the second most sustainable country according to the ESI, but ranked the least sustainable out of 122 countries in the WWF's Consumption Pressure Index. The reason for this is discussed below.

### *4.1.1 Clarity of the message and public acceptance (Good)*

This index is relatively easy to understand. There is an overall numerical score, which enables New Zealand to be easily ranked alongside other countries. The underlying components are presented using spider diagrams and bar charts, which can be interpreted with relative ease. The difficulty, however, emerges in explaining what the numbers means – e.g., what does an ESI at 71.3 for New Zealand actually mean? This question can only be answered with redress to difficult-to-explain technical detail.

### *4.1.2 Scientific and theoretical basis (Fair)*

The World Economic Forum [37] has taken some care to construct the ESI in terms of statistical procedures. Issues such as the normalisation of data and weighting systems have certainly been well addressed. In spite of this, the ESI has received a number of critical reviews (e.g., [38]). The inclusion of the parameters 'Global Stewardship', 'Social and Institutional Capacity', and 'Reducing Vulnerability' (worth 60% of the index) biased the ESI in favour of developing countries. Arguably these factors have little or nothing to do with achieving environmental outcomes and therefore should not be in the index. This brings the theoretical basis of the index into question, and prompted the suggestion that the ESI has an ideological bias towards rich countries.

### *4.1.3 Scale (Excellent)*

In terms of temporal scale, this index has good prospects of a long-term data series as a result of the New Zealand EPI programme coming on stream.

#### 4.1.4 Efficient representation of sustainable development concept (partial coverage of environmental dimension)

The ESI only covers the environmental dimension of sustainable development. It provides a good coverage of pollutants and emissions, and the effect they have on the state of the environment – i.e. it has very much a 'sink' side orientation. The 'source' functions of the environment as they relate to ecological sustainability are ignored, which is an obvious bias of the indicator.

#### 4.1.5 Policy relevance (Fair)

The ESI is very up to date, drawing on readily available data for 122 countries. However, only departures from base year and inter-country comparisons are possible. The World Economic Forum [37] argues that scientific knowledge is not well advanced to measure the variables in the index against sustainability policy performance criteria. The publication by the World Economic Forum [37] provides a useful analysis where it compares the ESI against other economic and social performance indicators (e.g., with GDP and the Human Development Index).

#### 4.1.6 Data availability and cost (Fair)

Data for this headline indicator could be abstracted on a regular basis from the World Economic Forum [37] publication. However, one does have to seriously question the reliability and accuracy of the data for New Zealand for variables such as air quality and water quality; which appear to be estimates rather than based on comprehensive and reliable data. With the implementation of the EPI programme, some of these variables will be more reliably and routinely estimated on a national basis.

The cost is very low, if the Ministry for the Environment is prepared to rely on the New Zealand data as compiled by the World Economic Forum [37]. The marginal cost is also low if the Ministry is prepared to rely on base data from the EPI Programme. However, if reliable and accurate data need to be collected from scratch, the cost would be very high.

#### 4.1.7 Overall (Fair)

There are real concerns about the choice of three of the parameters (60% of the value of ESI) [39], and the way these bias the results in favour of developed countries. If these three parameters were excluded from the index, the ESI would be a good headline indicator for the New Zealand government to use. Although it does ignore the 'source' functions of the environment, it is relatively easy to understand, and New Zealand's performance can readily be compared against 122 other countries.

### 4.2 Ecological Footprint

The Ecological Footprint has been proposed as a sustainability indicator by Wackernagel and Rees [40]. It is the total amount of land required to sustain economic activity directly and indirectly.

The Ecological Footprint not only calculates the land embodied in the supply of goods and services, but also the land required to absorb $CO_2$ emissions from energy use.

For example, in New Zealand *pinus radiata* trees could be planted to absorb $CO_2$ emissions – this requires a further 0.0758 hectares per tonne of $CO_2$ emissions [41]. In principle, the land required to absorb other wastes and pollutants could also be factored into the footprint calculations.

The Ecological Footprint is a sustainability indicator in two senses. Firstly, it measures the *total ecological cost* (in land area) of supplying all the goods and services to a human population. This recognises that land is not only *directly* required by people for agricultural production, roads, buildings and so forth, but is *indirectly* embodied in goods and services. In this sense, the Ecological Footprint makes visible the 'hidden' ecological cost of an activity or population.

A second, and more controversial interpretation of the Ecological Footprint as a sustainability indicator, invokes the idea of carrying capacity. 'Carrying capacity' in ecology is the maximum population a given land area can support indefinitely. The idea is relatively straightforward when applied to well-defined biological populations – e.g., a certain number of hectares are required to support a herd of deer. This idea is more controversial when applied to human populations, as in the 'Limits to Growth' study, which predicted a decline in global human population as it overshot its carrying capacity [42]. For example, Loh [43] argues that the total embodied land area required by a population should not 'overshoot' its actual productive land area.

The Ecological Footprint indicator of sustainability has been widely applied to a number of countries, regions, and cities throughout the world. In New Zealand, for example, McDonald and Patterson [41] estimate Auckland's ecological footprint as 483 323 ha. This is 4.8 times the actual land area of the Auckland region.

### *4.2.1 Clarity of message and public acceptance (Excellent)*

The Ecological Footprint has been one of the most successful indicators of sustainability, judged by its widespread use and application [44]. It seems to provide a vivid indicator of ecological appropriation that is easily understood. This is probably in part due to Wacknernagel and Rees' [40] effective use of graphics in their early publications. In spite of the many theoretical misgivings about this indicator, it is difficult not to rate the Ecological Footprint highly in terms of its effectiveness as a communication tool.

### *4.2.2 Scientific and theoretical basis (Fair)*

Despite the success of the Ecological Footprint indicator, there are a number of theoretical and methodological problems that have made it the subject of criticism (refer to Volume 32 of *Ecological Economics*, which was devoted to this topic). These issues include:

- Why is embodied land used as the only numeraire of sustainability? Land is not the only scarce natural resource, so why should it be the only resource entered into the calculations?
- Not all land is the same in terms of its productive quality and other attributes.
- The spatial boundaries used in the analysis have a critical impact on the calculations, but these are hard to select in a non-arbitrary way.
- It is a static indicator that tells us nothing about the future dynamics of the system.

#### 4.2.3 Scale (Good)

It is possible to obtain good measures of the ecological footprint using input-output analysis [41,45]. The ability to calculate such an ecological footprint by using this method depends on the availability of the base data (input-output matrix land vector; $CO_2$ vector). While there is a good time series of economic data, there are not much historical data in the environmental vectors. This situation is changing, and both economic and environmental data are likely to be collected well into the future.

#### 4.2.4 Efficient representation of sustainable development concept (weak coverage of the environmental dimension)

The Ecological Footprint attempts to cover only the environmental dimension, and in doing so, covers only one resource input (land) and only one pollutant ($CO_2$). This is clearly an inadequate coverage of resources, pollutants and their impacts, even though land is an all pervasive resource and $CO_2$ is critical in terms of climate change.

#### 4.2.5 Policy relevance (Good)

The performance criterion that is often used in conjunction with the Ecological Footprint is that of carrying capacity. Although this is an explicit criterion, its use is highly controversial and has limited links to policy goals. Inter-country comparisons and departures from base years are valid and often used performance criteria in ecological footprinting. One problem with the relevance of this index is that, due to processing requirements, there is likely to be a lag time of two to three years in reporting the Ecological Footprint using this method.

#### 4.2.6 Data availability and cost (Excellent)

The base data are available and easily obtained. Using the input-output method of analysis, reasonably accurate results can be obtained at a low cost, because the required data are routinely produced by statistical agencies.

#### 4.2.7 Overall (Good)

On pragmatic grounds, if the New Zealand Government wishes to select one environmental headline indicator, then the Ecological Footprint represents a strong candidate. In spite of the theoretical limitations of this indicator, it can be easily and regularly calculated at relatively low cost, and it is an indicator that will be easily understood by the public.

### 4.3 Consumption pressure index

The World Wildlife Fund [46] has constructed a consumption pressure index (CPI), designed to measure the pressure individual nations place on natural ecosystems. It is based on resource consumption and pollution data for 122 countries.

There are six components to the CPI:

- grain consumption
- marine fish consumption
- wood consumption
- fresh water withdrawals
- carbon dioxide emissions as a proxy for fossil fields
- cement consumption as a proxy for land consumption.

Each component is given equal weighting.

The CPI is a very useful complement to the World Wildlife Fund's Living Planet Index (LPI) (see below). The CPI measures 'pressures' on the biophysical environment, whereas LPI measures the 'state' of biotic environment. To complete this suite of indexes, it would be useful to have an indicator that measures the 'state' of the abiotic environment (e.g., water quality and quantity).

A weakness of the CPI is that there is no rationale given for the choice of indicators, other than the fact they are available on a consistent, updateable basis for most countries. Notably, five of the six indicators are resource indicators and only one of them ($CO_2$) is a pollutant indicator. Perhaps there should be more pollutant ('sink') indicators to provide a more balanced picture.

The results of the CPI are very inconsistent with the Environment Sustainability Index. Norway is the obvious anomaly – ranked 2nd most sustainable by the ESI, but most unsustainable by the CRI. This apparent anomaly can be explained by the fact that the CPI essentially covers only one of the five categories of the ESI (reducing stresses), the one in which Norway happens to perform poorly.

### *4.3.1 Clarity of message and public acceptance (Good)*

'Consumption Pressure per Person' is not a particularly accessible language. The document does, however, explain that it is the pressure exerted on the environment by the average consumer, for the six variables. This explanation does improve the situation.

### *4.3.2 Scientific and theoretical basis (Poor)*

There appears to be no sound theoretical rationale for selecting the six indicator variables. It seems to be a pragmatic choice based on the availability of the data series across a number of countries. The rationale given for using equal weighting to each variable is also weak.

### *4.3.3 Scale (Excellent)*

All the variables (except wood and freshwater withdrawals) have good prospects for long-term data series and are available in a timely fashion in New Zealand.

#### 4.3.4 Efficient representation of sustainable development concept (narrow range of environmental factors)

It measures the environmental dimension of sustainable development only from a 'source' side perspective, which is a reasonably narrow perspective.

#### 4.3.5 Policy relevance (Fair)

The index is only capable of measuring inter-country comparisons and departures from a base year. It lacks any other explicit performance criteria, and is not particularly aligned to any specific policy in New Zealand.

#### 4.3.6 Data availability and cost (Fair and inexpensive)

As mentioned above, data are available on an annual basis for four of the six variables. For the other two variables, there are no reliable annual data. Developing the CPI for New Zealand (certainly for grain, marine fish, $CO_2$ emissions, cement consumption) would be relatively inexpensive (<NZ $10,000 per annum). No reliable annual data series are available for wood and freshwater withdrawals, and it would obviously be expensive to collect these primary data.

#### 4.3.7 Overall (Fair)

To enable comparisons between New Zealand and other countries, it may be useful to adopt the CPI as a headline index for New Zealand. It is easy to calculate, and is regularly published by the World Wildlife Fund. There are, however, doubts about the reliability and availability of the New Zealand data that the World Wildlife Fund uses.

### 4.4 Living planet index

Constructed and maintained by the World Wildlife Fund, the living planet index (LPI) measures the state of the world's biodiversity, covering forest ecosystems, freshwater species and marine species. It provides a time series from 1970 to 1999 [41].

The LPI averages three sub-indexes for forests, freshwater and marine systems: the Forest Sub-Index, which includes 319 species populations; the Freshwater Sub-Index, which includes about 194 species populations; and the Marine Sub-Index, which includes about 217 species populations. The species are selected as not necessarily being the best indicator species of their respective habitats, but rather because of the availability of time series population data for them.

The LPI is not available on a country-by-country basis, although there is a broad-level spatial disaggregation – e.g., for forest cover the index can be split into Asia/Pacific, Africa, Latin America and the Caribbean, North America, Europe (not the Russian Federation), and the Russian Federation. In order to achieve country-by-country coverage, the World Wildlife Fund in their *Living Planet Report 2000*, includes Ecological Footprint calculations on a country-by-country basis, although obviously these Ecological Footprints do not measure the decline in biodiversity.

The strength of the LPI is that it is a very detailed index (730 species populations), and it has an excellent temporal coverage from 1970 to 1999. It is the only worldwide index of biodiversity decline, and serves this purpose well.

There is a regrettable lack of transparency on how the sub-indices (Forest, Freshwater, Marine) are calculated. Presumably, all species populations in each sub-index have equal weightings. If so, there is no reason given for equal weightings other than expediency. Some species may be closer to some critical threshold (e.g., extinction) or some may be classified as endangered species, but in the LPI seemingly no such distinctions are made in the way the species populations are weighted.

### *4.4.1 Clarity of the message and public acceptance (Good)*

The simple graphical time series data are easy to interpret. All the graphs, however, exhibit smooth downward trends, with few variations, which tends to invoke a "so what – things are getting worse" response. They do not tell interesting stories. The use of an index set at 100 for 1970 probably would not help public interpretation – the actual numbers of animals or hectares of forest are probably more meaningful than a standardised index number.

### *4.4.2 Scientific and theoretical basis (Good)*

While it is a very detailed index (730 species populations), the lack of transparency in terms of how it is calculated (particularly concerning what weights are used) is of concern. Exactly how the LPI would be adapted for New Zealand presents not only practical problems but also theoretical problems concerning indicator species selection.

### *4.4.3 Scale (Fair)*

It is highly unlikely that good historical data series will be available on a national basis for any species or ecosystem type. The prospects of any such data series being available in the future are also dim.

### *4.4.4 Efficient representation of sustainable development concept (narrow coverage of the environmental dimension)*

The LPI measures only biodiversity decline, which is only one aspect of the environmental dimension of sustainable development, and is therefore quite narrow in coverage. It could only really be used in conjunction with other headline indicators.

### *4.4.5 Policy Relevance (Fair)*

The index is only capable of measuring inter-country comparisons and departures from a base year. It lacks any other explicit policy goals to compare against. It is also difficult to know if timely and up-to-date data could be reliably obtained to construct and update the LPI for New Zealand.

### *4.4.6 Data availability and cost (probably limited, but inexpensive)*

This is difficult to ascertain, but it is likely good time-series data are only available for a few species. This requires further investigation. Developing an LPI for a few indicator species may be relatively inexpensive, as data collected by Crown Research Institutes and the Department of Conservation or perhaps eventually through the EPI programme could

be utilised at only a small marginal cost. Collecting comprehensive data across a number of species would obviously be problematical.

### *4.4.7 Overall (Fair)*

There are many difficulties involved in constructing a reliable New Zealand version of the LPI. Furthermore, it may not be strictly comparable with the world LPI. It is therefore not recommended, at least in the short term, that such a headline indicator be developed for New Zealand.

## *4.5 Green GDP (including ISEW and GPI [47])*

There have been several attempts to design a modified GDP indicator to take account of the shortcomings of the conventional GDP measure. These date back to the work of Nordhaus and Tobin [48]. In recent years, Daly and Cobb [49] constructed the Index of Sustainable Economic Welfare (ISEW) in an appendix in their influential book *For the Common Good.* This index placed much emphasis on adjusting the conventional GDP to take account of environmental factors and has hence been dubbed a 'green GDP' [50,51].

Typically 'green GDPs', such as that outlined by Pearce [52], take account of two factors: resource depletion and degradation ('source function'), and pollution and wastes ('ink' function). It is thereby recognised that there are two categories of environmental costs resulting from economic activity. *First of all*, natural resources (natural capital) are depleted or degraded over time. This is a cost that needs to be subtracted from the GDP, as future generations have lost the opportunity to gain benefit from this non-renewable resource. *Secondly*, there are 'defensive expenditures' associated with the output of pollutants and wastes that exceed the assimilative capacity of the biophysical environment. These expenditures can include:

- expenditures incurred in attempting to reduce the levels of pollutants/wastes, by, say, investing in abatement technology
- expenditure in dealing with the negative effects of the pollutants/wastes such as health costs or clean-up costs associated with dealing with pollution events like an oil spill.

The so-called green GDP nearly always includes allowances for other externalities apart from those strictly associated with the environment – e.g., value of unpaid household work, and income distribution effects. 'Green GDPs' have been calculated for many countries.

The 'green GDP' at the national level, is probably the most widely used indicator of sustainability. It has the advantage of being directly comparable with the conventional GDP, and for this reason, green GDP calculations have attracted much media attention. There are, however, a number of practical and methodological difficulties in calculating the green GDP:

- Debates ensue over what to include in its calculation. For example, most green GDPs tend to focus on cost externalities (depreciation of natural capital, defensive expenditures) but there are significant benefit externalities associated with the environment that are rarely factored into the calculations – e.g., the benefit of terrestrial biodiversity to New Zealand was calculated to be NZ$ 40 billion per annum by Patterson and Cole [53], which would be ignored in most green GDP calculations.
- The monetisation and valuation of externalities associated with the environment is notoriously difficult and a controversial area. It is unlikely that most externalities can be valued with much accuracy and precision at all. Furthermore, many commentators criticise non-market valuation methods on philosophical grounds for ignoring intrinsic values and being too anthropocentric [54].

### *4.5.1 Clarity of message and public acceptance (Excellent)*

The green GDPs that have been produced seemed to have had a very significant impact. The public, politicians and decision makers seem readily to recognise how the GDP measurement has been adjusted for environmental and social factors.

### *4.5.2 Scientific and theoretical basis (Good)*

The foundations of the green GDP are firmly grounded in welfare theory. It provides a theoretically justifiable way of overcoming some well-known weaknesses in the conventional GDP. It does, however, depend on the ability to validly and reliably monetise the externalities, which is a controversial area in Welfare Economics. The estimation of the green GDP also depends on being able to identify correctly and comprehensively all the externalities – the 'recipe book' approach to the construction of the GPI may not identify all the externalities relevant to New Zealand and care needs to be taken in this regard.

### *4.5.3 Scale (Good)*

For many of the underlying variables, particularly the environmental categories, no long-term data series exists in New Zealand. This means they will need to be interpolated or otherwise estimated to get a time series comparable to the Australian one, which tracks the last 37 years. With the coming on stream of the EPI programme, many of the environmental variables may be tracked in the future. Generally speaking, there are good historical time series for the social and economic data.

### *4.5.4 Efficient representation of sustainable development concept (Excellent)*

The green GDP covers all the economic, social and environmental dimensions of sustainable development. The only real area for debate is whether all the cost and benefit externalities are included, and whether there is any double counting or overlaps between these externalities. For most green GDPs, the list of environmental and social externalities tends not to be underpinned by a systematic framework; instead they often appear to be just an ad hoc list of externalities. Pragmatic factors, such as data availability, often assume importance in defining what is measured in the green GDP.

### 4.5.5 Policy relevance (Good)

The implicit performance criterion in the green GDP is that of maximisation of welfare. This is axiomatic to neoclassical economics and tends to underpin Government policy goals. Departure from base years and inter-country comparisons are possible with the green GDP. Most of the data series to construct a green GDP (like the Genuine Progress Indicator) for New Zealand are readily available and therefore there should not be undue time delays.

### 4.5.6 Data availability and cost (Fair and relatively inexpensive)

The Australian Genuine Progress Indicator provides a good template for data requirements for a New Zealand indicator (refer to [55]). Some of the necessary data are readily available in New Zealand in monetised form.

For the remaining items, two sets of data are required:

- *physical/non-monetary quantification* of the variable – e.g., hectares of land degradation, number of unemployed people
- *pricing data* for each of the physical/non-monetary variables – e.g., NZ$/ha for land degradation or NZ$/person for the cost of unemployment.

In most cases in New Zealand, the physical/non-monetary data do not readily exist and will need to be estimated from partial datasets. This will require considerable effort. The price data are even scarcer, given the lack of non-market valuation studies in New Zealand. It would be likely in most cases that standard values from international literature sources and databases would need to be relied on. These would be reasonably reliable, but might not necessarily accurately reflect New Zealand conditions [56].

The most cost effective option for constructing a green GDP for New Zealand would be to construct a Genuine Progress Indicator using the Australian template.

Constructing a green GDP fashioned on the Australian GPI seems a strong option. It covers all dimensions of sustainable development, is easy-to-understand, theoretically sound with a few reservations, and is practically achievable within a reasonable budget.

### 4.5.7 Overall (Good)

Constructing a green GDP fashioned on the Australian GPI seems a strong option. It covers all dimensions of sustainable development, is easy-to-understand with a few reservations, and it is practically achievable within a reasonable budget.

## 5 Final evaluation and conclusions

The New Zealand Government is committed to pursuing sustainable development policy goals. There is a consequent need for headline indicators to communicate progress towards these goals. Table 1 summarises the evaluation of five headline indicators across the six evaluation criteria. The Ecological Footprint and the Green GDP are ranked highest in terms of clarity of message/public acceptance. This is consistent with the fact that these two headline indicators are most widely used.

Our research finds that if the Government intends to pursue an ecological indicator of sustainability, there are a number of candidate headline indicators, including Ecological Footprint, Environmental Sustainability Index, Consumption Pressure Index, the Living Planet Index and Green GDP. Most of the headline indicators focus only on ecological sustainability, often in quite a restricted way that led to relatively low scores for reflecting all the dimensions of sustainable development – the green GDP most adequately reflected all aspects of sustainable development. A significant weakness in all headline indicators was the lack of explicit performance criteria, with the Ecological Footprint (carrying capacity) and green GDP (maximisation of welfare) standing out as having explicit performance criteria, albeit controversial ones. In terms of practicalities (data availability, cost, long-term data available), the Ecological Footprint was rated highest.

The Ecological Footprint's most significant weakness is its less than convincing scientific and theoretical basis, which has been widely debated in the literature. Furthermore, it is far from being a comprehensive indicator of ecological sustainability as it covers only one resource input (land) and only one pollutant ($CO_2$).

However, if the Government wants to broaden the definition to encompass environmental, economic and social aspects of sustainable development, two clear options emerge from this research. First, the green GDP (operationalised by the Genuine Progress Indicator). The Genuine Progress Indicator has the advantage that it can be implemented immediately at relatively low cost (NZ$ 160,000–NZ$ 260,000) using a known protocol, thereby minimising the risk. Although the GPI may not be that well adapted to New Zealand circumstances, New Zealand does have the advantage of being able to compare its performance with other countries.

Second, in the longer term, the Government could investigate setting up a unique composite index of sustainable development. A composite index is an index made of a hierarchical structure of sub-indices and variables. A composite index of sustainable development should be constructed consisting of environmental, social and economic sub-indices. These sub-indices could be drawn from the OECD Indicators of sustainable development or could be developed following guidelines set out in Patterson [1].

To hark back to the Power of One metaphor, Bryce Courteney's character Peekay struggled to assert the power of his individuality, and in doing so profoundly influenced those that he touched. Headline indicators also have significant potential to influence people. Armed with the headline indicators proposed in this paper, the New Zealand Government can begin the process of communicating progress towards sustainable development goals.

## References and Notes

**1** Patterson, M.G. (2002) *Headline Indicators for Tracking Progress to Sustainability in New Zealand*, Ministry for the Environment.

**2** Ministry of Economic Development (2002) *The Government's Approach to Sustainable Development*, Ministry of Economic Development, Wellington.

**3** Statistics New Zealand (2002) *Monitoring Progress Towards a Sustainable New Zealand*, Statistics New Zealand, Wellington.

**4** Department of Prime Minister and Cabinet (2003) *Sustainable Development for New Zealand – Programme of Action*, Department of Prime Minister and Cabinet, Wellington.

**5** Courteney B. (1998) *The Power of One*, Random House, New York.

**6** The UN System of National Accounts (SNA) was established in all nations following World War Two as the basis for measuring economic performance, principally through the Gross Domestic Product. It was first introduced by John Maynard Keynes in Britain, then advance by Simon Kuznets in the United States.

**7** Fox, K.A. (1985) *Social Systems Accounts: Linking Social and Economic Indicators Through Tangible Behaviour Settings*, Dodrecht, D.R.

**8** United Nations (1990) *Human Development Report*, Oxford University Press, New York.

**9** Australia New Zealand Environment and Conservation Council (2000) *Core Environmental Indicators for Reporting on the State of the Environment*, Environment Australia, Canberra.

**10** Statistics New Zealand (1993) *Measuring Up – New Zealanders and the Environment*, Statistics New Zealand, Wellington.

**11** Taylor, R. and Smith, I. (1997) *The State of New Zealand's Environment*, Ministry for the Environment & GP Publications, Wellington.

**12** Goldberg, E. (1999) *Indicators of Sustainable Consumption: Messages for Policymakers*, Statistics New Zealand, Wellington.

**13** Wright, J. (1989) *Natural Resource Accounting: A Technique for Improving Planning in New Zealand*, Centre for Resource Management, Lincoln University, Lincoln.

**14** McDonald, G. and Patterson, M.G. (1999) *EcoLink Economic Accounts – Technical Report*, Massey University and McDermot Fairgray, Palmerston North.

**15** Crampton, P., Salmond, C., Kirkpatrick, C., Scarborough, R. and Skelly, C. (2000) *Degrees of Deprivation in New Zealand: An Atlas of Socio-Economic Difference*, David Bateman, Auckland.

**16** Easton, B. (1995) *New Zealand Sociology*, Vol. 10, pp.182–213.

**17** Stephens, C., Waldegrave C. and Frater, P. (1995) *Social Policy Journal of New Zealand*, Vol. 5, pp.88–112.

**18** Davis, D., Howden-Chapman, P. and McLeod, K. (1996) *Socio-Economic Inequalities and Health* (Anonymous Institute of Policy Studies), Victoria University of Wellington, Wellington.

**19** Anielski, M., Griffiths, M., Pollock, D., Taylor, A., Wilson, J. and Wilson, S. (2001) *Alberta Sustainability Trends 2000: The Genuine Progress Indicators Report 1961 to 1999*, Pembina Institute For Appropriate Development, Drayton Valley, Alberta.

**20** Pezzoli, K. (1997) *Journal of Environmental Planning and Management*, Vol. 40, pp.549–574.

**21** Although this review is extensive and detailed, there are serious question marks over the way Pezzoli [20] categorizes the literature. Furthermore, although Pezzoli's [20] review is very detailed across its eleven categories, it is very biased towards the Social Sciences and Humanities, ignoring significant ecological and scientific literature on the topic.

**22** Howarth, R. (1997) *Land Economics*, Vol. 73, pp.445–447.

**23** Morrey, C. (1997) *Sustainability Indicators: A Report on the Project on Indicators of Sustainable Development*, in Moldan, B., Billharz, S. and Matravers, R. (Eds.): John Wiley & Sons on behalf of the Scientific Committee on Problems of the Environment (SCOPE), New York, pp.318–327.

**24** World Commission on Environment and Development (1987) *Our Common Future*, Oxford University Press, Oxford.

**25** Hunt, D. (1979) *Sustainability: Resources and Technology*, Commission for the Future, Wellington –a publication for the New Zealand Commission for 'Future sustainability: resources and technology'. Hunt in fact advocated Sustainability as a management principle eight years before the Brundtland report. She defined sustainability for renewable resources as "… one in which the resource is used at a rate no faster than it is renewed" and for non-renewable resources she argued "… that use can never be made sustainable, (but) … that non-renewable resources could be use more efficiently … "and the products into which it is incorporated made durable, and those products recycled and re-used".

**26** The list that follows only provides a brief synopsis of the theoretical literature. For a more detailed discussion, readers are referred to the publication *Headline Indicators for Tracking Progress to Sustainability* by Patterson [1].

**27** Common, M. and Perrings, C. (1992) *Ecological Economics*, Vol. 6, pp.7–34.

**28** Hardin, G. (1968) *Science*, Vol. 162, pp.1243–1248.

**29** Holling, C.S. (1978) *Adaptive Environmental Assessment and Management*, John Wiley & Sons, Chichester.

**30** Pearce, D. and Turner, R.K. (1990) *Economics of Natural Resources and the Environment*, Harvester Wheatsheaf, London.

**31** Common, M. (1995) *Sustainability and Policy – Limits to Economics*, Cambridge University Press, Cambridge.

**32** Georgescu-Roegen, N. (1971) *The Entropy Law and the Economic Process*, Harvard University Press, Cambridge.

**33** Peet, J. (1992) *Energy and the Ecological Economics of Sustainability*, Island Press, Washington, DC.

**34** Spangerberg, J.H. and Bonniot, O. (1998) *Sustainability Indicators – A Compass on the Road Toward Sustainability*, Wuppertal Institute, Wuppertal, Germany.

**35** Ontario Ministry for the Environment (1992) *Toward an Ecosystem Approach to Land Use Planning: Discussion Paper*, Ministry for the Environment, Ottawa.

**36** Environmental Sustainability Index; Living Planet Index; Consumption Pressure Index; Composite Indices for European Countries; Human Development Index; New Zealand Deprivation Index; Sustainable Development Composite Indices; United Nations Project to Aggregate Indicators of Sustainable Development; Ecological Footprint; Material Flow Indicators; Weak and Strong Sustainability Indicators; 'Green' GDPs.

**37** World Economic Forum (2001) *2001 Environmental Sustainability Index*, World Economic Forum, Davos, Switzerland.

**38** Jesinghaus, J. (1997) *Sustainability Indicators: A Report on the Project on Indicators of Sustainable Development*, in Moldan, B., Billharz, S. and Matravers, R. (Eds.): John Wiley & Sons on behalf of the Scientific Committee on Problems of the Environment (SCOPE), New York, pp.84–91.

**39** Global stewardship, social and institutional capacity, reducing vulnerability.

**40** Wackernagel, M. and Rees, W.E. (1996) *Our Ecological Footprint: Reducing Human Impact on the Earth*, New Society Publishers, Philadelphia.

**41** McDonald, G. and Patterson, M.G. (2004) *Ecological Footprint and Interdependencies of New Zealand Regions, Ecological Economics*, In press.

**42** Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W. (1972) *The Limits to Growth*, Universe, New York.

**43** Loh, J. (2000) *Living Planet Report 2000*, WWF-World Fund for Nature, Gland, Switzerland.

**44** Costanza, R. (2000) *Ecological Economics*, Vol. 32, pp.341–345.

**45** Bicknell, K., Ball, R., Cullen, R. and Bigsby, H. (1998) *Ecological Economics*, Vol. 27, pp.149–160.

**46** World Wildlife Fund (1998) *Living Planet Report 1998*, World Wildlife Fund, London.

**47** Originally the Genuine Progress Indicator (GPI) referred to a GDP measurement that had to be adjusted for social and environment costs and other externalities. These externalities were monetized. The Genuine Progress Indicator now seems to be taken on a broader meaning, for any indicator system that measures 'true' societal progress. Under this interpretation, the externalities are not necessarily monetized.

**48** Nordhaus, W.D. and Tobin, J. (1972) *Economic Research: Retrospect and Prospect: Economic Growth (General Series, No 96)*, National Bureau of Economic Research, Washington.

**49** Daly, H.E. and Cobb, J. (1994) *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future*, Beacon Press, Boston.

**50** The original Daly and Cobb ISEW has been subjected to much criticism and has been subsequently refined. Much of this debate is summarised in Daly and Cobb [49]. In 1995, the ISEW was reformulated by Cobb, *et al.* [51] and renamed the Genuine Progress Indicator (GPI). The GPI covers a range of environmental and social externalities – e.g., the Australian GPI covers income distribution effects, value of household and community work, cost of unemployment, cost of under-employment, cost of overwork, defensive expenditures on health and education, services of public capital, costs of commuting, cost of noise pollution, cost of transport accidents, cost of industrial accidents, costs of irrigation water use, cost of urban water pollution, cost of air pollution, cost of land degradation, cost of loss of old-growth forests, cost of depleting non-renewable energy measures, cost of climate change, cost of ozone depletion, cost of crime, net capital growth and net foreign lending.

**51** Cobb, J., Halstead, T. and Rowe J. (1995) *The Genuine Progress Indicator: Summary of Data and Methodology*, Redefining Progress, San Francisco.

**52** Pearce, D. (1993) *Blueprint 3: Measuring Sustainable Development*, Earthscan Publications, London.

**53** Patterson, M.G. and Cole, A. (1999) *Assessing the Value of New Zealand's Biodiversity*, School of Resource and Environmental Planning, Massey University, Palmerston North.

**54** Blamey, R. and Common, M. (1994) *Toward Sustainable Development – Concepts, Methods and Policy*, in Van den Bergh, J. and Van der Straaten, J. (Eds.): Island Press, Washington, DC, pp.165–205.

**55** Hamilton, C. and Saddler, H. (1997) *The Genuine Progress Indicator: A New Index of Changes in the Well-Being in Australia*, Australian Institute, Canberra.

**56** The valuation of New Zealand biodiversity by Patterson and Cole [53] provides one example of how standard values can be used to obtain reasonably accurate results when there is a lack of local data.