

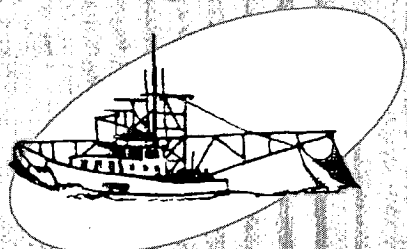
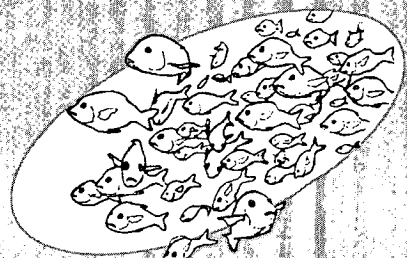
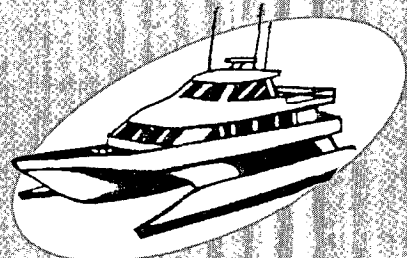
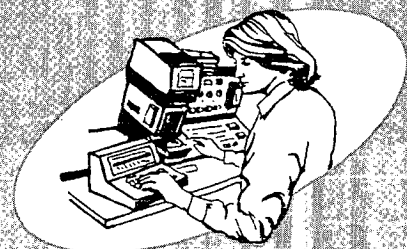
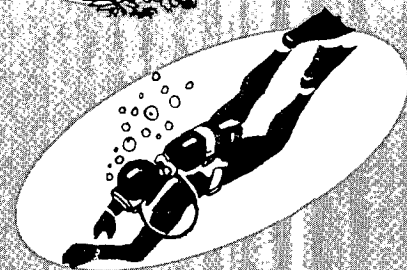
CRC REEF RESEARCH

TECHNICAL REPORT

Perceived meanings of 'Ecologically Sustainable Development' within the CRC Reef Research Centre

Claudia Maria Ludescher

Thesis Summary
James Cook University of North Queensland



Project Funded by the CRC Reef Research Centre

CRC REEF RESEARCH TECHNICAL REPORT

PERCEIVED MEANINGS OF 'ECOLOGICALLY SUSTAINABLE DEVELOPMENT' WITHIN THE CRC REEF RESEARCH CENTRE

**Thesis by Claudia Maria Ludescher
November 1995**

in partial fulfilment of the requirements for the Degree of Bachelor of Applied Science - Environment Studies with Honours, in the Department of Tropical Environment Studies and Geography, at James Cook University of North Queensland, Townsville, QLD, 4811.

The CRC Reef Research Centre was established under the Australian Government's Cooperative Research Centres Program.

The Centre, established in 1993, undertakes an integrated program of applied research and development, training and education, aimed at increasing opportunities for ecologically sustainable development of the Great Barrier Reef and providing an improved scientific basis for Reef management and regulatory decision making.

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List of abbreviations and acronyms

AIMS - Australian Institute of Marine Science

AMPTO - Association of Marine Park Tourism Operators

ANOVA - Analysis of Variance

CRC - Cooperative Research Centre

ESD - Ecologically sustainable development

ESDWG - Ecologically Sustainable Development Working Group

GBRMPA - Great Barrier Reef Marine Park Authority

IUCN - International Union for the Conservation of Nature and Natural Resources

JCU - James Cook University

MANOVA - Multivariate Analysis of Variance

MSY - Maximum sustainable yield

QDEH - Queensland Department of Environment and Heritage

QDPI - Queensland Department of Primary Industries

SPSS - statistics package for social science

UNEP - United Nations Environment Program

WCED - World Commission on Environment and Development

WWF - World Wide Fund for Nature

ABSTRACT

The phrase ecologically sustainable development (ESD) has been evolving over the past 25 years or more, as we become aware that current patterns of economic growth and consumption are unsustainable and must be decreased and transformed if future generations are to have the ability to meet their needs and aspirations.

The Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef has, as the name implies, the goal of "science for the ecologically sustainable development of the Great Barrier Reef World Heritage Area". The Centre is an unincorporated body including resources and expertise from a number of natural resource management, research and industry organisations who have their own goals and objectives in addition to that of Science for ESD. As the meaning of the ESD concept is somewhat ambiguous and open to interpretation, variation in interpretation among the CRC Reef Research Centre's participant agencies may prove to be a constraint on cooperative research. Thus the aim of this project was to determine if and how the meaning of ESD differs among and within agencies participating in the Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef.

Analytical survey techniques were used to compare opinions of all members of GBRMPA, AIMS, James Cook University, QDPI, QDEH and the Association of Marine Park Tourism Operators, who were recipients of the Centre's June newsletter. Mean responses on a number of factors associated with the concept and implementation of ESD were then compared among and within agency groups.

This study has found there to be variation in the recognition and importance placed on some key ESD principles; the forces influencing the fulfilment of those principles; and the measures needed in order to ensure that ESD principles are achieved. This appears to be a result of some disparities between priorities of the management, research and industry organisations reflecting on their interpretation of ESD. Science for the ecologically sustainable development of the Great Barrier Reef World Heritage Area is a very important goal. However, I believe that its principles must be practically defined in relation to research, the Great Barrier Reef, and the global community, in order to prevent cooperation towards this goal being hindered by ulterior agency goals and differing interpretations of the phrase, objectives and principles of ESD observed in this study.

1. INTRODUCTION

In the 1960's and 1970's an argument raged over the limits to economic and population growth. In 1971 The Club of Rome, a group of industrialists, economists, humanists and civil servants, commissioned a study into the patterns of economic and population growth and its possible consequences. The results of this study lead them to insist that the then existing population growth rate of 2% p.a. coupled with exponential economic growth, would cause food and mineral resources to run out within 120 years, and was thus obviously unsustainable (Forrester,1971; Meadows et al.1972, cited in Neurath,1994). John Maddox, editor of the eminent science journal *Nature*, counter argued that the world was big enough to accommodate all humans and any environmental damage that was not solved through legislation, and scientific and technological innovation. Meanwhile, Herman Kahn of the Hudson Institute, known to be a conservative think tank, argued that in 200 years time people would be numerous, rich and in control of the forces of nature; Kahn maintained that economic growth would allow third world countries to develop, before slowing to a low or zero rate guided by human intelligence and good management (Beder,1993).

As we near the 21st century, industries, human populations and pressure on the environment continue to increase. Awareness of the problems this will cause for the future of our children is also increasing however, as is our awareness of the natural environment and its importance. The limits to growth debate subsided in the 1980's, as governments and environmental managers began trying to find ways to make development ecologically sustainable (Beder,1993). The challenge of the future is to change the current dominant social paradigm (world view), which represents a maximisation of all benefits and hence our welfare and well-being through a value and worship of economic development at all costs (Goldsmith,1992). The new paradigm must be one of ecologically sustainable development rather than sustained growth.

1.1 History and evolution of the concept of ecologically sustainable development (ESD)

The concept of ESD emerged from the 1972 United Nations Conference on the Human Environment, although it had already been implicit in the 1968 Biosphere Conference and the 1968 Conference on the Ecological Aspects of International Development (Caldwell,1984).

However, only pollution problems were addressed in the 1972 conference (Munn,1992). Although the World Conservation Strategy (IUCN, UNEP and WWF,1980) and the Australian National Conservation Strategy (Australian Dept. of Arts, Heritage and the Environment,1986) are aimed at Living Resource Conservation for Sustainable Development, it was not until the 1987 publication of the World Commission on Environment and Development's (WCED) Brundtland Report (Our Common Future), that the concept of sustainable development was actually defined to be:

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

In 1992 the United Nations Conference on Environment and Development, formulated their program in the language of Sustainable Development. This resulted in the publication of Agenda 21, titled Earth's Action Plan, which was signed by over 150 nations (Clth of Australia,1995), and aimed at "halting and reversing the effects of environmental degradation and promoting sound and sustainable development in all countries" (Nitin Desai,1993:i).

The Australian Government, which prefers to use the phrase ecologically sustainable development (economic development that is ecologically sustainable), began to address the issue in 1990 with a discussion paper on the topic (Clth of Australia,1990). This was followed by the formulation of nine National ESD Working Groups, who addressed and made recommendations for the ecologically sustainable development of Australia's major industries (ESDWG Chairs,1991). The reports from each working group, presented in 1991, followed by an Intersectoral Issues Report and a Greenhouse Report by the ESD Working Group Chairs in 1992, provided the basis for the Australian National Strategy for ESD (Clth of Australia,1992a).

The Australian Commonwealth Government defines the goal and core objectives of ESD to be:

Goal:

- using, conserving and enhancing the community's resources so that ecological processes on which life depends, are maintained, and the total quality of life, now and in the future can be increased

Core Objectives:

- to enhance individual and community well-being;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life support systems (Clth of Australia,1992a).

The Objectives and Principles of ESD set by the WCED, The Australian Government and the national and international environmental organisations, also vary to some extent according to the interpretations and priorities of those organisations. These range from most economically oriented to most environmentally oriented respectively (see Appendix 1).

Despite the worthy goals and objectives shown above, the Commonwealth government has been criticised by the Australian environmental organisations (Hare,1990). Firstly for its marginal approach to policy change as shown in the National Greenhouse Response Strategy which will not be fully implemented if adverse economic effects are predicted (Clth of Australia,1992b). And secondly for its failure to set ESD principles which adequately address what is needed to implement ecologically sustainable development. Such as, for example, "establishment of a strong growing and diversified economy" (Clth of Australia,1992a: Principle 4), rather than the manufacturing of durable products to enable the reduction of consumption and waste.

Valentine (1993) points out that the principles of ESD put forward are couched in such broad managerial terms that it is necessary to put them into common language before they will be implemented by the general community. Babier (1989, cited in Hare,1990) maintains that there are essentially two interpretations of ESD. The first is concerned with environmentally sustainable development, with optimal resource and environmental management over time. This interpretation focuses on environmental conservation above social and/or economic considerations. The second interpretation involves sustainable economic, ecological and social development, placing less emphasis on environmental resource management. It is apparent that the variation in interpretation of the ESD concept, from the one side of this definition through to the other, and the dominant social paradigm primarily concerned with economic growth, are major complicating factors in policy formulation and implementation aimed at the attainment of this goal called ESD.

1.2 The Great Barrier Reef

The Great Barrier Reef is the largest reef complex in the world (GBRMPA,1994a) and is second only to the Philippine reefs in species diversity (Weber,1993). The majority of the Great Barrier Reef was declared a multi-use Marine Park in 1975 (GBRMPA,1994a), and the whole Great Barrier Reef was declared to be of World Heritage significance in 1981 (GBRMPA,1994b).

The Marine Park is managed by a Government funded statutory Marine Park Authority (GBRMPA,1994a). Additionally, World Heritage status has encouraged the development of a Great Barrier Reef World Heritage Area Strategic Plan to guide management and wise use by all industry and management groups on and adjacent to the Great Barrier Reef (GBRMPA,1994b). With such a management structure in place, and funding for research and development, Australia has the opportunity to ensure that the Great Barrier Reef will be there for future generations. That is if current and future fisheries; shipping, tourism and coastal developments are **ecologically sustainable**.

1.3 The Cooperative Research Centre For Ecologically Sustainable Development of the Great Barrier Reef (CRC Reef Research Centre)

The CRC Reef Research Centre was established at James Cook University in Townsville in 1993 under the Commonwealth Government CRC Australia Program which aims to achieve better cooperation between research and industry organisations. The Centre's mission statement and core objectives include:

Mission statement

- Science for the ecologically sustainable development of the Great Barrier Reef World Heritage Area

Core objectives

- to undertake an integrated program of applied research and development, training and extension aimed at enhancing the viability of, and expanding sustainable reef-based industries and economic activity, with particular emphasis on tourism, and providing an

improved scientific basis for reef management and regulatory decision making (CRC Reef Research Centre,1994).

The Centre is an unincorporated joint venture between the Australian Institute of Marine Science (AIMS), The Great Barrier Reef Marine Park Authority (GBRMPA), James Cook University (JCU), The Association of Marine Park Tourism Operators (AMPTO), and the Queensland Government through its Department of Primary Industries - Northern Fisheries Division (QDPI). It also receives input from the Queensland Department of Environment and Heritage (QDEH) and from commercial and recreational fishing organisations (CRC Reef Research Centre,1994). Five research programs are currently under way on the Great Barrier Reef including: 1 Regional environmental status; 2 operations (human use); 3 engineering; 4 education; and 5 extension and training.

The participants of the CRC Reef Research Centre have all, to a lesser or greater extent, taken steps towards the goal of ecologically sustainable development/use on and adjacent to the Great Barrier Reef (see Appendix 2). However, the motivation for ESD and the components of ESD that are emphasised, are likely to be influenced by the goals and objectives of each group. These goals vary from: multiple use management by GBRMPA to physical and natural science research by AIMS; and sustainable business development by AMPTO. As the agencies involved are part of the State and Federal Governments and the private sector, they are influenced by various political objectives.

The Centre recognises the nine broad principles of ecologically sustainable development put forward by the international environment organisations in 1991 (see Appendix 1). However, what these principles mean in practice for the development of the Great Barrier Reef and for the guidance of research has not been quantified.

This thesis gives a brief description of the literature concerning the problems of interpreting the meaning of ESD, and factors that influence the interpretation and implementation of single agency goals (Chapter 2). This study extended the latter question by specifically examining, if and how the people associated with the various agencies that comprise the CRC Reef Research Centre, differed in their interpretation of the concept, and implementation of ESD. Thus the aim and objectives of this study were:

Aim

- to determine if and how the interpretation of ESD differs among and within agencies associated with the Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef.

Objectives

1. to determine if and how interpretations of the concept of ESD differ; and
2. to determine if and how opinions on what is important to the implementation of ESD differ;
 - i) among agencies associated with the CRC Reef Research Centre
 - a) between all agencies
 - b) between management and research
 - c) between management and industry
 - d) between industry and research
 - ii) within agencies associated with the CRC Reef Research Centre
 - a) between staffing levels
 - b) between expertise / occupations
 - c) between age groups
 - d) between genders.

The study is important to the CRC Reef Research Centre, as an understanding of the variation in interpretation of ESD among its members, can aid in the formulation of some agreed upon practical definitions of its goal "Science for the Ecologically Sustainable Development of the Great Barrier Reef World Heritage Area" in order to enhance cooperative research. It is also hoped that the study will make a contribution to the understanding of influences on the interpretation of ecologically sustainable development.

2. A BACKGROUND ON INTERPRETATIONS OF THE ESD CONCEPT

The scope of ESD theory, interpretation and implementation is very broad and spread world wide. As the focus of this thesis is on eliciting the variation in interpretation of ESD, I have restricted this chapter to a brief look at the conflicting interpretations of the ESD phrase

argued in the literature, and to studies dealing with eliciting such variations in interpretation of goals among people.

2.1 Variation in interpretation of ecologically sustainable development: a review

2.1.1 Sustainability?

The word 'sustainability'

The word "sustain" from the phrase 'ecologically sustainable development', can be taken to mean - maintenance of the status quo. However a broader definition is - the maintenance of a preferred state of affairs (Caldwell,1990). Both these definitions are limiting with respect to providing for future generations, increasing human well-being or protecting biodiversity, as the 'status quo' may not be desirable, and a 'preferred state of affairs' may not be mutually agreed upon (Caldwell,1990).

Dixon and Fallon (1989), look at 'sustainability' from a resource use/management angle and take it to mean - to prolong/maintain the productive use of resources and the environment, and the integrity of the resource base. This definition may be useful, although it will be challenging when resources get low and it is not possible to maintain use and integrity of the resource base at the same time. Lubchenco et al. (1991 cited in Meyer and Helfman,1993), put forward a slightly less economic and more ecological and social perspective by stating that 'sustainability' requires that development and resource use do not degrade the exploited system or adjacent systems and that consumption standards are within the bounds of ecological possibility and can be aspired to by all. Both these definitions suggest that 'sustainability' refers to maintaining the ecological system and the human population, however, the questions do not end there.

The concept of sustainability

Sustainability for whom? sustainability for what purpose? sustainability at the subsistence or luxury level? sustainability of what? (Dixon and Fallon,1989; Munn,1992). Shearman (1990) states that it is not the meaning of sustainability that requires definition or classification, but rather the implications for any given context to which it is applied, such as industrial and agricultural development or biodiversity, and the various perspectives such as social, ecological

or economic. Agriculture for example, has biophysical, sociopolitical and techno-economic perspectives and must be sustainable throughout these:

- social perspective - sustain the society from hunger in the short and long term and keep production up with demand;
- ecological perspective - maintain biodiversity and the quality and productiveness of the biophysical resource base;
- economic perspective - maintain the economic performance and viability of the farmers and sustain production (Yunlong and Smit,1994).

Similar questions can be asked about sustainable fisheries and forestry who's managers have great difficulty determining maximum sustainable yields (MSY) (Erlach and Daily,1993). Is the sustainability goal from an ecological or economic perspective? And does the difficulty in quantifying MSY lie in the dynamics of ecological systems or in the interference of human greed for sustained profit? (Ludwig et al.1993).

If sustainability (within ESD), aims at ensuring that future generations will be able to fulfil their needs, there is still ambiguity as to how this should be achieved. The view of the Business Council of Australia is that we should leave behind capital that has been substituted for the environment (Beder,1993). This view is described by Pearce et al (1989), as 'weak sustainability'. They themselves advocate a view of 'strong sustainability' which maintains that the best way of providing for future generations is by not degrading the natural environment to begin with, as there is uncertainty, risk of irreversibility and non substitutability of many environmental resources and services, such as the uv protection offered by the ozone layer (Pearce et al.1989).

Developers advocate an anthropocentric approach to sustainability, generally supporting development over conservation (NSW Tourism Commission,1990: Aust. Tourism Industry Assoc.,1990: ESDWG's,1991 cited in McKercher,1991), while the conservation movement often advocates a biocentric ecological preservation approach (ACF,1989: Conservation Council of Ontario:1989: Hare,1990 cited in McKercher,1991). O'riordan (1988, cited in Dixon and Fallon,1989) observed that both environmentalists and developers use the concept of sustainability to justify their proposed actions. Developers seek to exploit the very ambiguities that give sustainability its staying power, while environmentalists demand safeguards and

compensatory investments that are not always socially just. Lee Kay (1993) suggests that such problems arise from the literal interpretation of sustainability and its perception as an end point, when it should really be seen as a goal towards change, like liberty and equality.

2.1.2 Development?

The Word 'development'

Development is a value word, implying 'desirable change' (Pearce et al.1990) or to make fuller, bigger, better (Turner,1987). However there is no consensus as to what is desirable, bigger or better. According to Pearce et al. (1990), what constitutes development depends on what social goals are being advocated at the time, because development is often seen as a vector for desirable social change (such as increased well-being and maintenance of the environment). However, the elements included in the development vector are open to ethical debate, and the relevant time horizon for practical decision making is similarly indeterminate outside inter-generational objectives. This makes such questions unresolvable other than through ethical consensus (Pearce et al.1990).

Development vs growth

Daly (1990 in Hare et al,1990) and Caldwell (1994) point out that, while to grow means to increase in size, to develop means to expand or realise the potentialities of. Thus development can embrace wider concerns of the quality of life than does economic growth. The latter is concerned primarily with the increase in income - traditionally regarded as the standard of living, and is measured on a national scale disregarding inequity of distribution (Young,1993).

Development addresses concerns of the quality of life such as educational attainment, nutrition status, access to basic freedom and spiritual welfare. The emphasis on sustainability means that these developments should last well into the future (Pearce et al.1990). However, the misunderstanding that sustainable growth rather than sustainable development is required to ensure human well being, intra and inter - generational equity, is deeply embedded in our dominant social paradigm of well being as increased production and consumption, and in the belief that development is a by-product of growth rather than growth being a by-product of development.

Gro Harlem Brundtland, leader of the World Commission on Environment and Development emphasises the need to produce more with less, that is to continue economic growth but

increase efficiency and change the focus of consumption from non renewable resources to services and renewable energy (Brundtland,1994). Unfortunately this allows organisations such as the Business Council of Australia to interpret the Commission's Report (Our Common Future) as a recipe for sustained economic growth rather than for sustainable development (Hare,1990). Ekins (1989) criticises the Brundtland Report for this reason and recommends Babier's (1987 cited in Ekins,1989) suggestion that, instead of advocating economic growth at the national level to alleviate poverty as the Commission suggests, policies should be directly concerned with increasing the material standard of living of the poor by increasing education, food, real income and sanitation. Alternatively, economic growth could reclaim its original meaning of an improvement in human welfare rather than an increase in production and consumption alone (Huetting cited in Ekins,1989). This does not mean 'no growth' but rather sets definite objectives for development which may lead to equitable growth (Ekins,1989). A sustainable development path will include economic progress through advancement in recycling, product redesign, conservation and low waste technology (Pearce,1991). This may even increase the GNP as a result of ESD goals and principles; if not as a means to achieving them (Caldwell,1994).

2.1.3 Sustainable Development?

An oxy-moron?

'Sustainable development' is considered by some to be an oxy-moron - a contradiction in terms. This may be true if sustainable development is seen as continued economic growth that is ecologically sustainable and if that growth is only possible through substitution of wealth for the natural environment (Caldwell,1994). Sustainable development of single fisheries has the potential to be an oxy-moron if those fisheries are already fully developed and any further attempts at development are in the name of economic growth (Socolow,1993). To make 'sustainable development' a viable concept, Holling (1993) suggests that we need to look at a broader scale than single resource industries, and concentrate on adaptive integrated and innovative resource management that looks at social, economic and ecological systems. If the current state of affairs, be it ecological degradation, poverty or inequality, is not the preferred one, then 'development' as 'favourable change' may be intrinsic to 'sustainability' as 'a preferred state of affairs'.

Definitions of 'sustainable development' by The WCED (1987), the World Bank (Foy,1990), and most economists, (Pearce et al.1990), all lean towards sustaining the environment that is essential for long term economic growth. In this case the 'golden egg as a natural resource' analogy, depicts the inherent problem, where a high quality place attracts immigration and economic growth (the golden egg) which in turn destroys the place so that future economic growth cannot occur (Gottlieb,1995). The dominant social paradigm of improving welfare and well-being through development (as economic growth) (Goldsmith,1992), is what is restricting 'sustainable development' to being seen as an oxy-moron.

The concept of sustainable development

The concept of sustainable development hides behind a shroud of words that cause it to be interpreted according to individual and political goals. Caldwell (1990) observed that the phrase eco-development did not catch on because it restricts development, whereas the phrase sustainable development has stayed because it means not damaging the environment too much but sustaining development. He maintains that 'sustainable development' glosses over the differences between particular economic and ecological values, and is sufficiently positive and sufficiently unspecific to become a catch phrase (Caldwell,1990).

As the dominant view of sustainable development is about integrating the environment into the economic system, discussion of sustainable development borrows heavily from the economic language such that it often describes nature and the environment as natural resources, natural capital and part of the communities stock of assets (Beder,1993). Pearce et al's (1990), interpretation that sustainable development of renewable resources means ensuring 'constant natural capital', is again open to interpretation, as most economists would take this to mean constant at the optimal balance between environment and development, based on cost benefit analysis and the efficiency criterion. Unfortunately the efficiency criterion does not do justice to inter and intra - generational equity as it causes decisions to be made on the basis of what is best for present generations; it tries to put a monetary value on the environment; it substitutes man-made capital for natural capital; and it does not take distribution of benefits into account (Young,1993). According to some economists, the efficiency criterion does provide for future generations, however, what should be provided then becomes the point of argument: an increase in flow of goods and services, information and technology, substituted for environmental assets, or a healthy resilient environment that leaves future generations as many options as we have today? (Foy,1990).

Broadly speaking sustainable development is interpreted by most people as a more harmonious relationship between people, economic development and nature (Rees,1991, cited in Carley and Christie,1992: Repetto,1985, cited in Brown et al.1987: WCED,1987). However, ideas as to how this would best be achieved vary according to individual orientation; from a focus on locally based eco-development (Dasman,1985, cited in Brown et al,1987), to world wide harmonisation of resource exploitation, direction of investment, orientation of technological development and institutional change, in order to ensure that future generations will be able to fulfil their needs (WCED,1987).

2.1.4 Ecologically Sustainable Development?

The words 'ecologically sustainable development'

All the ambiguities, arguments and definitions discussed above become even more so when the word 'ecologically' is added to 'sustainable development'. The word eco-development means - ecologically sound development (Holdridge et al.1982, cited in Brown et al,1987), or - positive management of the environment for human benefit (UNEP cited in Brown et al.1987). According to Dasman (1985, cited in Brown et al.1987), three components of the ESD concept are; basic needs, self reliance and ecological sustainability. Shearman (1990) points out that there cannot be ecologically sustainable development without socially and economically sustainable development, as is shown by links between poverty, inequality and environmental degradation. Thus the meaning of the word ecology should be taken to include the politics and economics of human ecology as well as that of the natural environment.

The concept of ecologically sustainable development

Caldwell (1990), maintains that we should not be trying to address the means by asking: what is ecologically sustainable development? Rather we should address the end by asking: how can we make ecologically desirable development sustainable? or how do we sustain or achieve a high quality of life? Walter et al. (1992, cited in Mott and Bridgewater,1994), agree that ESD is not a plan of action but rather a goal which needs a plan of action in order to be achieved.

Variations in interpretation of ESD result in some people seeing it purely as relating to the maintenance of the physical environment (Buckley,1994), while others such as the International Chamber of Commerce see it as maintenance of the environment in balance with other human goals, achieved through economic growth (Beder,1993). Upreti (1994), points out that the dominantly anthropocentric (human centred) ethic and the dominant social paradigm are

influencing the interpretation and implementation of ESD by putting too much emphasis on economic growth for improving living standards. He advocates a shift in the dominant social paradigm away from one of indefinite economic growth towards one of justice in the socio and bio spheres in order to reach the goal of ESD (Upreti,1994).

As can be seen from the review above, the ability to determine what ESD means in practice is hindered by the wide and varied interpretation of the concept as a goal or a means, and at what scale the concept is applied. Each word within the phrase can be interpreted in several ways. Depending on which interpretations are acted upon, sustainable development may or may not be an oxymoron, and future generations may or may not benefit from our efforts. It is thus necessary to concentrate on the objectives and principles within the goal of ESD such as intra and inter-generational equity, the maintenance of biodiversity and the improvement of individual and community well-being. However, these too are open to interpretation and must be practically defined in terms of context, scale and perspective if they are to be implemented and not just argued about. As human perceptions are so varied, questioning interpretation of such goals/concepts as ESD can be helpful in creating these practical definitions. As Chiras (1985:562) states in relation to defining a sustainable society; "Far better an approximate answer to the right question than an exact answer to the wrong question" or no questioning at all.

2.2 Variation in human perceptions of goals and the implications for implementing policy and change

Cardwell (1990) believes that although sustainable development is a positive step towards restraining the negative environmental effects of techno-economic proliferation, it does not support policy in its current form because it is so open to interpretation. This problem will remain unless policies are based on specific ESD goals and principles rather than just a reference to the concept as a whole.

Although there is broad acceptance of the need for ESD, the four world views quoted by Turner (1987 cited in Archibugi and Nijkamp,1989), are a likely influence on the interpretation of the concept. These are:

- extreme technocentrism - a resource exploitative -growth oriented perspective;

- accommodating technocentrism - resource conservation and managerial perspective;
- communalism ecocentrism - a resource preservation perspective; and
- extreme ecocentrism - an extreme resource preservation perspective, supported by an acceptance of bioethics.

Studies of the social bases for such differing environmental concerns have been reviewed by VanLeer and Dunlap (1980) who found that hypotheses based on demographics such as age, gender, social class, residence and political association, did not explain more than 15% of the variation in general environmental concern. They suggest therefore, that more specific environmental issues should be targeted when environmental policy making is the aim of such research, and that cognitive as well as demographic variables should be compared.

Several studies of variation in perception of goals and paradigms have been conducted within the United States Forest Service. Brown and Harris (1992) suggested that such a resource management agency would be in part ruled by the dominant social paradigm but have additional values and beliefs unique to its managerial position (a resource management paradigm). Using analytical survey techniques, they found that the old (timber industry) exploitationist paradigm within the US forest Service was slowly shifting towards a conservationist paradigm, and that this shift varied among age groups and staffing levels. Young decision makers (senior level staff) were found to be more conservation minded than old ones but not as conservation minded as employees (operational level staff), and change was mostly instigated from a technical, lower management level. Additionally, the social and natural scientists in the Forest Service were found to favour ecosystem protection, whereas the traditional foresters were more commodity oriented. Similar studies by Twilight and Lyden (1989, cited in Vining and Ebreo, 1991) also elicited that forest resource managers and industry groups had similar views on environmental protection and economic development while those of environment groups differed. Bullis and Kennedy (1991), who studied variations in perceptions of the US Forest Services' goal, found differences between engineers (who mentioned cost effective timber management), forest managers (who saw their goal as managing forestry for people) and biologists (who believed the agencies goal to be forest ecosystem management). Bullis and Kennedy stressed that the fundamental value differences among these groups would influence decision making and policy implementation within the one agency. Wellman, (1987, cited in Vining and Ebreo, 1991) found that the types of information used in decision making on resource management issues differed with professional status.

The variation in values and subsequent interpretation and implementation of goals found within the one agency, suggests that such variation would also be inherent between agencies who, along side their own goals, share a goal of ESD. As shown above, the ESD goal is worded in such a way as to leave ample room for interpretations to be influenced by individual and agency values and priorities. Potential variation in values and subsequent interpretations among participant agencies within the CRC Reef Research Centre need to be understood in order for cooperative research to be implemented.

3. METHODOLOGY

The research aim: To determine if and how the meaning of ecologically sustainable development (ESD) differs among or within the agencies participating in the CRC Reef Research Centre.

The null hypothesis: There is no difference in the meaning given to ESD among or within agencies participating in the CRC Reef Research Centre.

3.1 The Questionnaire

In order to test the above hypothesis, this study used self administered, mail delivered questionnaires to obtain people's opinions about concepts and principles commonly associated with ESD. The structuring and distribution of the questionnaire followed a modified Dillman technique (Dillman, 1978) which was designed to obtain the highest and most accurate response from participants.

Concepts derived from the 9 principles of ESD advocated by the International Environmental Organisations, the ESD goals and principles put forward by the Australian Government and Environmental Organisations (Appendix 1), and key words from the vast literature on 'the meaning of ESD' were used to develop the two sections of the questionnaire. These aimed to elicit:

1. Participants' attitudes toward some of the stated principles of ESD, and to what extent the natural, social and economic environments prevailed in those interpretations. These included components of:

Concept recognition

- the precautionary principle;
- the need for community empowerment and social justice;
- the need to sustain renewable resources.

Concept interpretation

- the best means of providing for future generations;
- the reason for conserving the earth's vitality and diversity;
- the best way to integrate development and conservation;
- the best means of improving the quality of human life.

2. The importance participants attach to the roles of science, technology, and social, political and economic forces in the implementation of ESD, and whether or not participants believe ESD is in fact achievable.

A Likert response scale with five response categories (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree) was used to elicit agreement / disagreement with a number of statements regarding the above concepts. "Yes", "no" answers to one word items were also used to elicit recognition of the various aspects of the ESD concept.

3.2 The Sample

The population of interest included people from the six agencies who had some association with the Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef, and hence should have some familiarity with the concept of ESD. The CRC's newsletter mailing list provided a good sampling frame of people associated with the CRC Reef Research Centre through research, extension, management and administration. Newsletter recipients who were members of the agencies of interest included: JCU (41), GBRMPA (32), AIMS (30), AMPTO (69), QDPI (26), QDEH (31), CRC staff (13). These people comprised what were believed to be a representative sample of science, management and industry

organisations with an ESD platform. 242 people were sampled on the 13th of June 1995 and data collection ceased at the end of July.

3.3 Response Rate Analysis

All responses were coded according to agency and whether they were returned immediately, after one reminder or after two reminders. Non responses were also coded. Overall response was 63% (153) responses, however within agency response was considerably higher in agencies other than AMPTO and AIMS (see Appendix 3).

3.4 Statistical Analysis

Statistical comparisons of mean scores were carried out among the following demographic groups:

1. among agency groups

- all individual agencies (GBRMPA, AIMS/JCU, AMPTO, DEH and DPI)
- management (GBRMPA/QDEH)
- research (AIMS/JCU)
- industry (AMPTO)

2. within agency groups

- Senior staff (tour managers, heads of departments and program leaders); and middle and operational level staff (educators, researchers, boat crew, research assistants)
- Social experts (social scientists, education and public relations personnel and crew members); and natural science experts (natural scientists and engineers)
- Age categories (18-25, 26-35, 36-45, 46-55, >55)
- Gender (females and males)

3. Statistical tests

Factor Analysis was used to identify a small number of factors to represent the relationships among the many interrelated questionnaire items.

Cronbach's Alpha was used to test the reliability of items within each factor, as indicators of all items that could be used in a scale to measure that particular aspect of ESD. It is a measure of the ratio of test score variance to the sum of the variances (Babbie,1992).

Multivariate and univariate analysis of variance on grouped comparisons and independent t-tests on paired comparisons were used to test for differences in opinions between the different demographic groups. Transformations were applied where necessary to comply with statistical assumptions (See Tabachnick and Fidell,1989; Norusis,1993 for methodology).

3.5 Limitations

Data which concerns opinions and attitudes of people, and which has been obtained using self administered questionnaires, has some limitations. Questions may not be interpreted consistently, and answers can be biased. However, testing of reliability and careful structuring of questions reduced the potential occurrence of these problems.

The relatively small sample size and a subsequent limited number of data points within some demographic groups caused some limitations in the analysis. Responses from AIMS were thus combined with those from JCU as one group called "Research Agencies". Additionally, interaction effects between variables such as expertise and type of agency could not be statistically tested due to small or empty data cells. Due to the small sample sizes of QDPI and CRC-only respondents, any trends in these data were difficult to discern. As a result, the QDPI could not be identified as a primarily management, research or industry group.

4. RESULTS

4.1 Demographics

4.1.1 Agencies

Final sample sizes in the groups of interest included: 28 from GBRMPA (88% response), 12 from AIMS (47% response), 28 from JCU (71% response), 27 from AMPTO (42% response), 24 from QDEH (77% response), 17 from QDPI (65% response), and 12 employed by the CRC-Only (92% response) (see Appendix 3). James Cook University and AIMS samples were

combined as one research agency group (n,40) and when comparing management with research and industry organisations GBRMPA and QDEH responses were combined as one resource management group (n,52).

4.1.2 Staffing levels

The GBRMPA and AMPTO samples comprised mostly senior level staff (64.3% and 69.2% respectively); AIMS/JCU respondents included a fairly even mix of senior, middle and operational level staff (35%, 40% and 25% respectively); staff in the QDEH and QDPI samples were mostly at the middle (57% and 53% respectively) and operational level (35% and 29.4% respectively); and respondents employed by the CRC only, were mostly Post Graduate students - operational level staff (63.6%). These students are employed by the CRC as research scientists and are thus considered to represent the operational level views of the CRC as an integrated research unit. The board members (senior staff of the CRC) are, for the most part, also affiliated with outside government or industry bodies and were thus not well represented in the CRC staff sample. As mean responses from middle and operational level staff were consistently similar they were combined for analysis. This served to account for the fact that identification with one or the other of these two levels was confused by some respondents.

4.1.3 Expertise/occupations

Due to small sample sizes, the eight expertise/occupation categories listed in question 36 of the survey were combined to form three categories. The first entitled Social Experts comprised mostly social scientists, educators and public relations personnel, the second, titled Natural Science Experts, included natural scientists and some engineers, and the third was comprised of Managers. Only Social and Natural Science Experts were compared due to the small number of managers in a few of the samples, and as many managers also identified themselves as natural science experts. Social Experts were more numerous in the AMPTO sample (37% social vs 11% natural science); Natural Science Experts were more numerous than Social Experts in the samples from AIMS/JCU (85% vs 10%), QDEH (46% vs 29%) and QDPI (47% vs 23.6%); while the GBRMPA sample was evenly distributed across these occupations (7% vs 7%) (see Appendix 4).

4.1.4 Age and gender

Most respondents were in the 26-35 and 35-46 age groups (32% and 39% respectively), and the female to male ratio throughout the sample was approximately 1:3 (see Appendix 4 for all sample sizes).

Statistical comparison of mean scores on agency by staffing level, and box-plot visual analysis of all other potential interaction effects suggested that no interactions were present and hence that within agency comparisons could be made across the whole sample.

4.2 Part 1. The concept of ecologically sustainable development

4.2.1 Words commonly associated with the concept of ESD

Question 2 of the survey asked respondents to choose five words based on how well each defined the concept of ESD. From the list of fourteen words potentially associated with ESD, eight were most commonly identified. A χ^2 Homogeneity of Variance test between the six agency groups (see Appendix 5) found there to be a significant difference in the frequency with which agencies chose these eight descriptor words. Although the most commonly chosen words (*balance*, *conservation* and *wise use*), were shared by all agencies, Table 4.2 which ranks the five words most commonly chosen by each group of respondents, and Figures 4.2(a-f), show some notable exceptions. Namely, that Key descriptors appeared to be associated with each agency. Government resource management agencies included the words *biodiversity* and *health* more frequently, research agency staff the word *preservation*, and tourism operators chose the word *growth* as a descriptor of ESD more frequently than did other groups.

Table 4.2: Words selected as descriptors of the ESD concept in rank order by agency grouping

rank	GBRMPA	AIMS/JCU	AMPTO	DEH	DPI	CRC
1	wise use	wise use	wise use	balance	wise use	balance
2	balance	balance	conservation	wise use	balance	wise use
3	conservation	conservation	balance	conservation	conservation	conservation
4	limit	limit	preservation	limit	biodiversity	limit
5	health	preservation	growth	biodiversity	limit	b'div/presvn

Figures 4.2(a-f): Variation in the choice of descriptor words considered to be "one of five words most closely associated with the concept of ESD"

Figure 4.2a: Department of Environment and Heritage

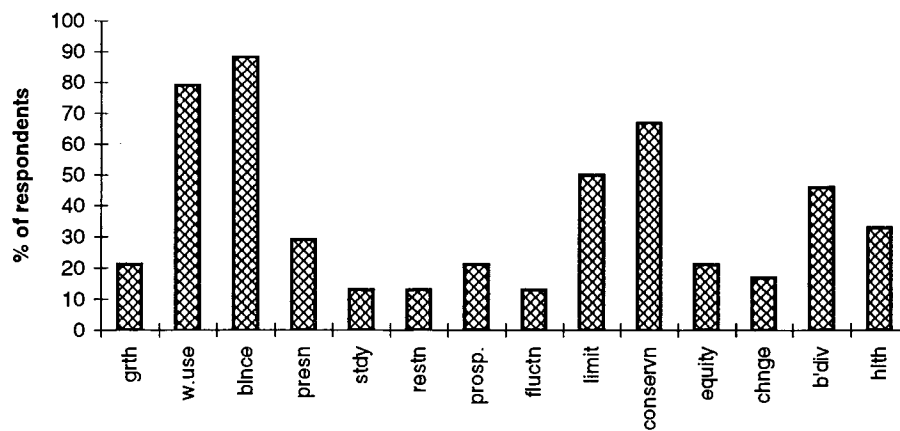


Figure 4.2b: Department of Primary Industries

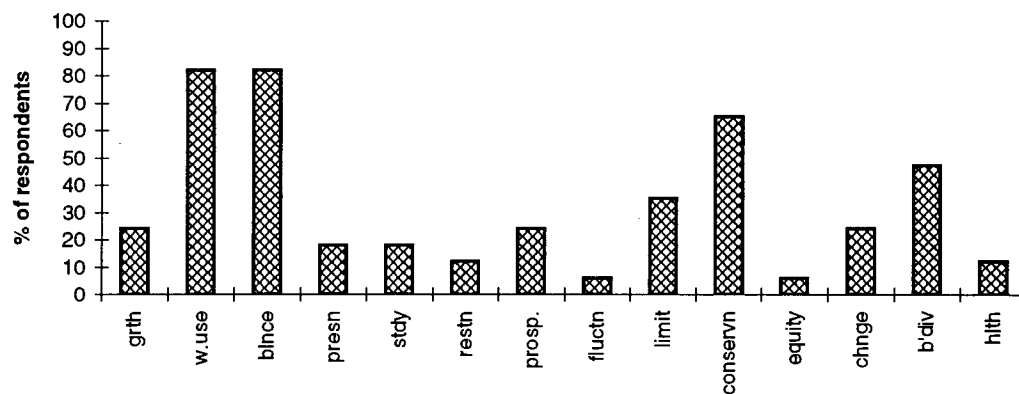


Figure 4.2c: Great Barrier Reef Marine Park Authority

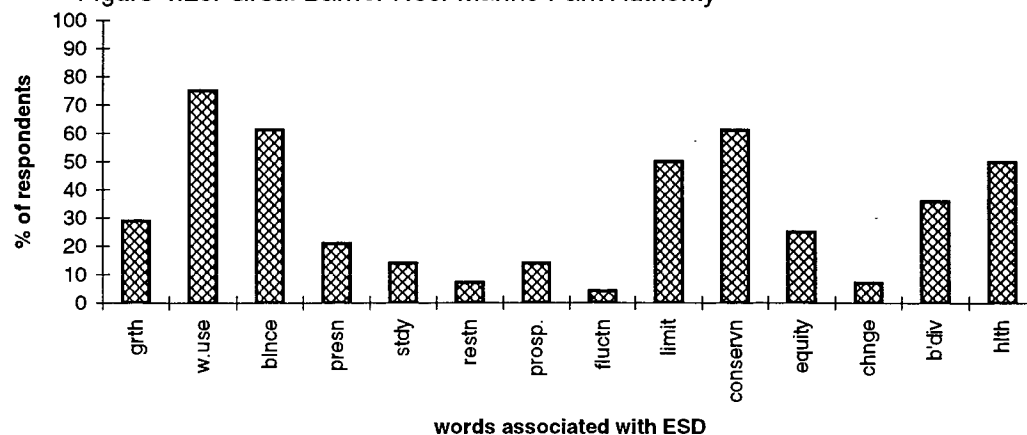


Figure 4.2d: AIMS and James Cook University

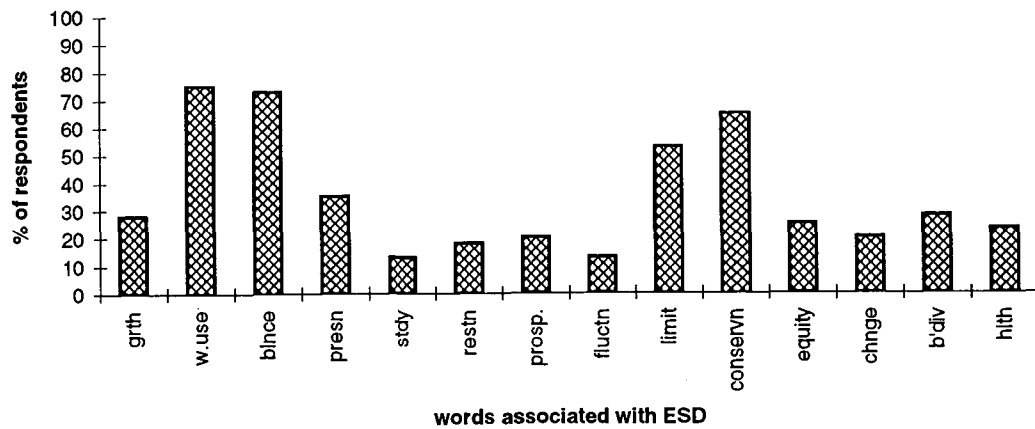


Figure 4.2e: Association of Marine Park Tourism Operators

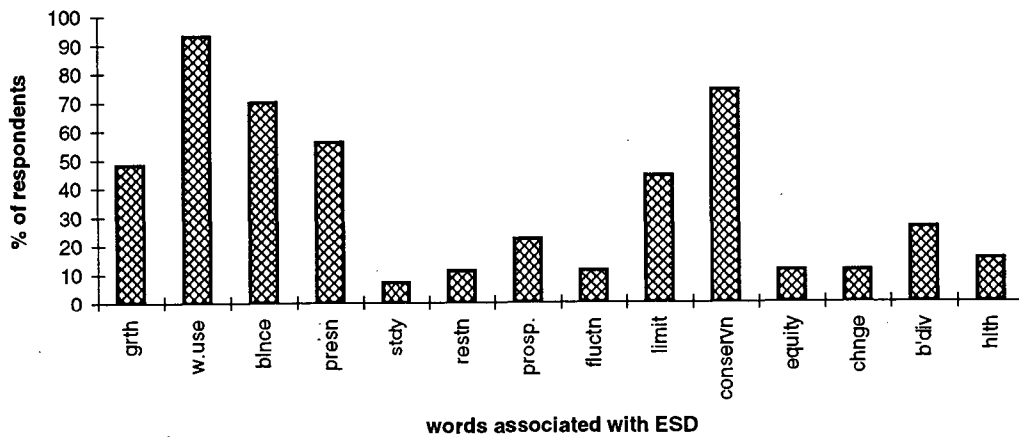
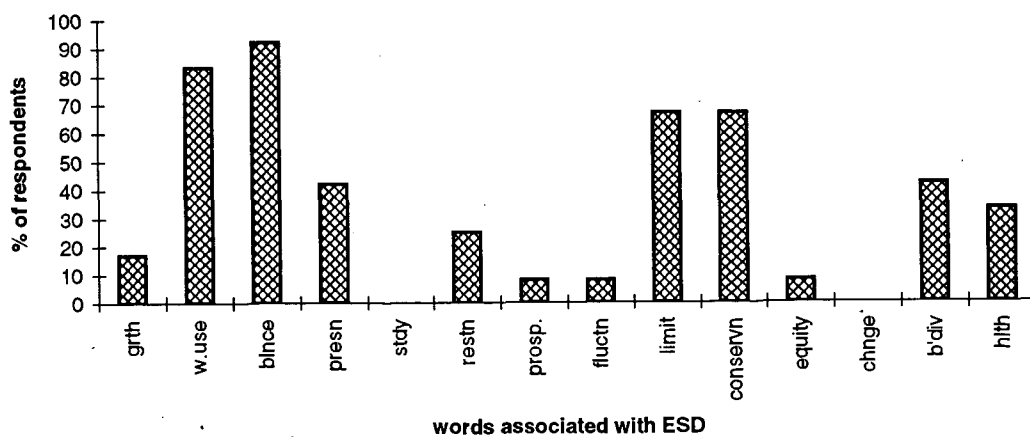


Figure 4.2f: CRC Reef Research Centre



4.2.2 Factor analysis

Question items in section 1 of the survey elicited agreement / disagreement with many statements concerning the principles of ESD in order to determine respondent's interpretations of the ESD concept. The response scale used was 1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree and 5 - strongly agree.

Factor analysis (summarised in Table 4.2.1), grouped the question items in such a way as to allow the measurement of responses to five different dimensions of meaning for the concept of ecologically sustainable development. These included:

- factor (1) community participation;
- factor (2) an ecocentric vs an anthropocentric orientation towards ESD;
- factor (3) the precautionary principle and the importance of indigenous peoples' interests;
- factor (4) intra-generational equity (equity within the present generation);
- factor (5) the appropriateness of current economic measures and principles in the ESD concept.

Factors 1, 3 and 4 related to the recognition of ESD principles, while factors 2 and 5 related to the interpretation of ESD principles from an ecological and an economic perspective.

Table 4.2.1: Summaries of Factor Analysis for Part 1 - The Concept of ESD

FACTOR	Eigenvalue	% of var.	cum% of var.	Alpha reliability
1	3.9	19.8	19.8	0.62
2	2.1	10.3	30.2	-0.70
3	1.8	9.10	39.3	0.50
4	1.3	6.70	46.0	0.50
5	1.2	6.10	52.2	0.56

FACTOR1: Recognition of the importance of community participation, community education and the quality of human life

Question summary	Factor loading
Q3 community participation in decision making	0.59
Q4 leave our children a healthy natural env.	0.50
Q7 dev. must increase the quality of life based more than economic assets	0.55
Q8 community participation in resource planning	0.81
Q11 enable communities to care for their own env.	0.58

FACTOR2: An ecocentric vs an anthropocentric interpretation of ESD

Question summary	Factor loading
Q14 ecocentric reason for conservation	0.64
Q16 no to an anthropocentric reason for conservation	0.55
Q19 intrinsic value of species and ecosystems	0.68
Q20 no to social considerations in ESD planning	0.53

FACTOR3: Recognition of the precautionary principle and social equity

Question summary	Factor loading
Q9 In the face of uncertainty or irreversibility lack of scientific evidence should not be an excuse to delay environmental protection	0.81
Q17 interests of indigenous people are important to ESD	0.52

FACTOR4: To be ecologically sustainable, dev. must allow for the maintenance of the physical environment and ensure the welfare of the whole community (intra - generational equity)

Question summary	Factor loading
Q21 to be ecologically sustainable, development must contribute to the whole community	0.65
Q22 maintaining the physical env. is the central issue in ESD	0.78

FACTOR5: Current economic measures and principles are not appropriate to ecologically sustainable development

Question summary	Factor loading
Q12 we cannot just leave our children a prosperous economy	0.74
Q15 we cannot improve the quality of life through economic means alone	0.62

NB: questions 5, 6 and 18 were excluded from factors 1, 3 and 2 respectively due to wording ambiguity and non reliability. Questions 3 and 9 were re-coded from negative to positive and questions 12, 15 and 16 were re-coded from positive to neagative for analysis

4.2.3 Comparison of mean scores (interpretation of the concept of ESD)

Staffing level was found to separate opinions at a multivariate level. That is, on average, individuals of the same staffing level had consistently similar opinions regarding several factors concerning the concept of ESD (see Table 4.2.2 for statistics). However, further investigation of univariate statistics, found additional patterns between several other demographic groupings.

The majority of scores on factor 1 (*community participation*) were high, with no significant differences being found between any demographic groupings. Additionally, no statistically significant difference was apparent between scores on factor 4 (*intra-generational equity*) although management agency staff, social experts and females were more likely to agree (scored above neutral) and research agency staff, natural scientists and industry staff were more likely to disagree (scored below neutral) (Tables 4.2.3c and 4.2.4).

4.2.3.1 Among agencies

When comparing all agencies together, opinions only differed significantly on question 13 (*putting a monetary value on the environment*), with AMPTO respondents being most likely to agree (mean score 3.8) while GBRMPA and AIMS/JCU respondents mostly disagreed (mean scores 2.8 and 2.9 respectively). All other agencies were variable (Figure 4.21, Tables 4.2.3a and 4.2.4). To aid interpretation of these trends various types of agencies were compared.

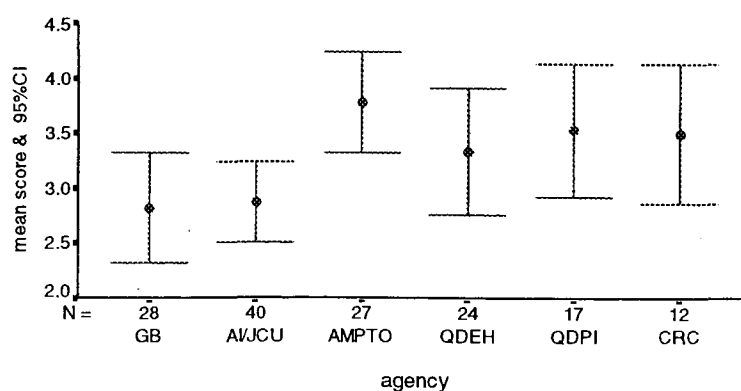


Figure 4.2.1: mean scores on Q13 - placing a monetary value on the environment, among all agencies.

Research vs Management (AIMS/JCU vs GBRMPA/DEH)

By isolating these two groups some significant differences in interpretation became apparent on factor 3 (*the precautionary principle and the importance of indigenous people's interests*) and on question 6 (*the relevance of economic considerations to ESD*). Respondents in management agencies were more likely than research agency staff, to agree with the precautionary principle and the importance of indigenous peoples' interests (mean scores 4.1 and 3.7 respectively); and felt that economic considerations were not relevant to ESD, while researchers felt they were (mean score 2.3 and 3.2 respectively) (Tables 4.2.3b, 4.2.3c and 4.2.4).

Research vs Industry (AIMS/JCU vs AMPTO)

These two groups only differed significantly on one aspect of the ESD concept, with respondents from AMPTO being most likely to agree with putting a monetary value on the environment (question 13), while research agency respondents were most likely to disagree with this concept (mean scores 3.8 and 2.9 respectively) (Tables 4.2.3b and 4.2.4).

Management vs Industry (GBRMPA/DEH vs AMPTO)

Managers only differed significantly from industry respondents on question 13, as they too were not likely to agree with putting a monetary value on the environment (mean scores 3.1 and 3.8 respectively) (Tables 4.2.3b and 4.2.4).

Thus it can be seen that management, research and industry groups did not differ significantly in opinions on most aspects of the concept of ESD measured. However:

- researchers and managers differed on some economic and social issues; and
- industry respondents differed from all others in their attitude towards economic valuation of the environment.

4.2.3.2 Within agencies

Senior vs middle and operational staffing levels

Senior and mid/operational staff were found to differ in opinions on several aspects of the concept of ESD. Senior staff were less likely than were mid/operational level staff, to agree with an ecocentric (ecology centred) orientation towards ESD (factor 2 - mean scores 3.2 and 3.7 respectively); the precautionary principle and the importance of indigenous peoples'

interests (factor 3 - mean scores 3.7 and 4 respectively); and that current economic measures and principles are not appropriate to ESD (factor 5 - mean scores 3.7 and 4.1 respectively) (Tables 4.2.3c and 4.2.4).

Social experts vs natural science experts

Only mean scores on factor 3 were found to differ with expertise/occupation, as social experts were more likely to agree with the precautionary principle and the importance of indigenous peoples' interests than were natural science experts (mean scores 4.2 and 3.8 respectively) (Tables 4.2.3c and 4.2.4).

Gender

Females were found to be more agreeable with an ecocentric orientation towards ESD than were males, (factor 2 - mean scores 3.7 and 3.4 respectively); more agreeable with the precautionary principle and the importance of indigenous people's interests (factor 3 - mean scores 4.1 and 3.8 respectively); and more likely to feel that current economic measures and principles are not appropriate to ESD (factor 5 - mean scores 4.2 and 3.9 respectively). Additionally, females were more likely than males to disagree with the statement that economic consequences are relevant to ESD planning (question 6 - mean scores 2 and 2.9 respectively) (Tables 4.2.3c and 4.2).

Age categories

Opinions were not found to differ significantly among age categories (Table 4.2.3c). However, there appeared to be a slight trend showing that younger respondents were more likely to agree that current economic measures and principles are not appropriate to ESD - (factor 5) (Figure 4.2.2).

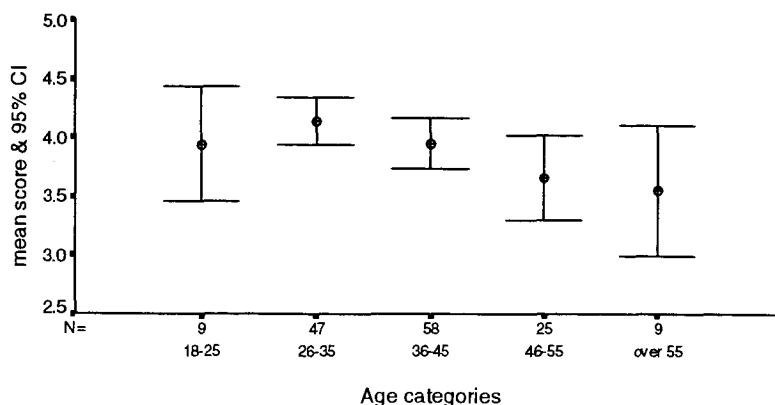


Figure 4.2.2: mean scores on F5 - the inappropriateness of current economic measures and principles, between age categories

Thus at the within agency level of comparison, opinions were found to differ on:

- social issues between staffing levels, between genders and between natural science and social experts; and
- ecological and economic issues between staffing levels and between genders.

Table 4.2.2: Summary of MANOVA for Part 1 - The Concept of ESD (using sequential sums of squares)

Source of variation	DF	Pillais Trace	F	p
Agency by Staff.L.	12, 160	0.03	0.21	0.990
Agency	25, 675	0.15	0.85	0.670
Man/Research	5, 81	0.09	1.51	0.210
Man/Industry	5, 68	0.48	0.69	0.630
Res/Industry	5, 57	0.05	0.61	0.690
Staffing Level	5, 79	0.11	3.34*	0.010
Soc/Nat.Sci. Expert.	5, 97	0.10	2.17*	0.062
Age category	20, 540	0.13	0.89*	0.600
Gender	5, 134	0.067	1.92	0.095

NB: * = approx. F

Table 4.2.3a: Summary of one-way ANOVA comparing agencies on question 13 - the appropriateness of placing a monetary value on the environment

Source of Variation	DF	SS	MS	F	p
Agency	5,142	20.47	4.09	2.83	0.018

Table 4.2.3b: Summary of univariate t-tests comparing agency types on questions 13 - the appropriateness of placing a monetary value on the env. and question 6 - economic consequences and ESD

Q13

Source of Variation	DF	t-value	SE diff.	p
Man/Industry	77	-2.38	0.3	0.020
Res/Industry	65	-3.17	0.29	0.002

Q6

Source of Variation	DF	t-value	SE diff.	p
Man/Research	87	-2.8	0.30	0.006
Soc/Nat. Sci. Expert.	141	2.3	0.24	0.023
Gender	59	-3.7	0.26	0.000

Table 4.2.3c: Summary of univariate F - tests for factors 1 - 5 of Part 1 - The Concept of ESD (using sequential sums of squares)

F1 - Community participation

Source of Variation	DF	SS	MS	F	p
Agency	5, 135	44.6	0.3	0.6	0.735
Man/Research	1, 85	30.4	0.4	0.4	0.526
Man/Industry	1, 72	26.1	0.4	1.2	0.268
Res/ Industry	1, 65	21.4	0.1	0.3	0.589
Staffing Level	1, 139	44.6	0.3	2.9	0.094
Soc/Nat sci. Expert.	1, 101	31.2	0.3	1.9	0.170
Age Category	4, 136	44.9	0.3	0.4	0.802
Gender	1, 138	44.99	0.33	0.95	0.331

F2 - An ecocentric vs anthropocentric interpretation of ESD

Source of Variation	DF	SS	MS	F	p
Agency	5, 135	77.02	0.57	1.18	0.320
Man/Research	1, 85	44.62	0.52	3.68	0.058
Man/Industry	1, 72	39.24	0.55	0.49	0.490
Res/ Industry	1, 65	29.85	0.49	0.92	0.340
Staffing Level	1, 139	76.27	0.55	7.51	0.010
Soc/Nat sci. Expert.	1, 101	54.37	0.54	2.97	0.088
Age Category	4, 136	75.62	0.56	2.14	0.079
Gender	1, 138	76.70	0.56	5.82	0.017

F3 - The precautionary principle and indigenous peoples interests

Source of Variation	DF	SS	MS	F	p
Agency	5, 135	84.89	0.63	1.48	0.200
Man/Research	1, 85	47.39	0.56	4.80	0.031
Man/Industry	1, 72	41.46	0.58	0.49	0.485
Res/ Industry	1, 65	30.61	0.75	1.49	0.227
Staffing Level	1, 139	86.24	0.62	5.33	0.022
Soc/Nat sci. Expert.	1, 101	60.78	0.60	6.55	0.012
Age Category	4, 136	86.16	0.63	1.33	0.260
Gender	1, 138	86.78	0.63	4.15	0.043

F4 - Intragenerational equity

Source of Variation	DF	SS	MS	F	p
Agency	5, 135	1.27	0.01	0.57	0.271
Man/Research	1, 85	65.70	0.77	3.26	0.074
Man/Industry	1, 72	49.39	0.69	1.31	0.257
Res/ Industry	1, 65	39.32	0.18	0.29	0.595
Staffing Level	1, 139	104.54	0.75	1.59	0.210
Soc/Nat sci. Expert.	1, 101	73.08	0.72	2.97	0.088
Age Category	4, 136	105.05	0.77	0.22	0.926
Gender	1, 138	105.01	0.76	0.61	0.437

F5 - The inappropriateness of current economic measures and principles

Source of Variation	DF	SS	MS	F	p
Agency	5, 135	1.27	0.01	0.57	0.721
Man/Research	1, 85	0.67	0.01	0.83	0.364
Man/Industry	1, 72	0.61	0.01	1.46	0.231
Res/ Industry	1, 65	0.64	0.00	0.14	0.711
Staffing Level	1, 139	1.21	0.01	9.65	0.002
Soc/Nat sci. Expert.	1, 101	0.80	0.01	3.23	0.075
Age Category	4, 136	1.22	0.01	2.16	0.077
Gender	1, 138	1.21	0.01	5.28	0.023

Table 4.2.4: Mean scores and 95% CI for all demographic groupings on Part 1 - The Concept of ESD

	Agency						Agency type			Staffing Level		Expertise		Gender	
	gbrmpa n = 28	aims/jcu n = 40	ampto n = 27	qdeh n = 24	qdpi n = 17	crc reef n = 12	m'ment n = 52	r'search n = 40	industry n = 27	senior n = 59	mid/op. n = 88	social n = 34	nat.sci. n = 72	Female n = 36	Male n = 111
Q6 economic consequences are important to ESD	2.54 0.52	3.16 0.5	2.89 0.64	2.09 0.58	2.63 0.62	2.67 0.10	2.33 0.47	3.16 0.50	2.89 0.64	3.05 0.38	2.50 0.35	2.36 0.56	2.87 0.37	2.00 0.59	2.94 0.52
Q13 put a monetary value on the environment	2.82 0.57	2.88 0.37	3.78 0.47	3.33 0.61	3.53 0.65	3.50 0.64	3.06 0.36	2.88 0.37	3.78 0.47	3.24 0.34	3.20 0.28	3.15 0.55	3.14 0.67	3.12 0.52	3.26 0.19
F1 community participation	4.25 0.22	4.17 0.20	4.10 0.25	4.13 0.22	4.35 0.21	4.22 0.37	4.24 0.23	4.17 0.20	4.1 0.25	4.12 0.36	4.26 0.22	4.31 0.25	4.15 0.29	4.34 0.47	4.20 0.19
F2 ecocentric interpretation of ESD	3.46 0.36	3.24 0.23	3.44 0.33	3.66 0.32	3.57 0.39	3.38 0.60	3.58 0.26	3.24 0.23	3.44 0.33	3.23 0.43	3.71 0.25	3.57 0.30	3.56 0.36	3.66 0.47	3.35 0.24
F3 precautionary principle & indig. peoples interests	3.96 0.37	3.66 0.23	3.94 0.31	4.21 0.35	4.00 0.46	3.63 0.75	4.08 0.31	3.66 0.23	3.94 0.31	3.71 0.52	4.01 0.26	4.19 0.30	3.76 0.40	4.11 0.40	3.82 0.30
F4 intragenerational equity	3.06 0.31	2.79 0.30	2.90 0.29	3.19 0.44	2.88 0.51	3.38 0.63	3.12 0.31	2.79 0.30	2.90 0.29	2.88 0.40	3.06 0.32	3.19 0.30	2.87 0.46	3.07 0.48	2.96 0.32
F5 current economics are not appropriate to ESD	3.89 0.28	3.85 0.27	3.83 0.36	4.17 0.35	3.94 0.45	4.08 0.57	4.02 0.24	3.85 0.27	3.83 0.36	3.70 0.44	4.09 0.22	4.19 0.26	3.91 0.36	4.19 0.39	3.85 0.23

4.3 Part 2. The implementation of ESD

4.3.1 Is ecologically sustainable development possible?

Question 1 of the survey elicited that most respondents believed ESD to be either possible (answered *yes*) or only possible under certain circumstances (answered *maybe*), with only a limited number answering *no*. Respondents from GBRMPA, QDEH and QDPI were most likely to answer *maybe* followed by *yes*, those from AIMS/JCU, the CRC were most likely to answer *yes* followed by *maybe*, and all except five respondents from AMPTO answered *yes*. The highest number of *no* responses from any one agency was only four, however QDPI, GBRMPA and the CRC had the highest relative *no* response.

Thus the data show that respondents from management agencies were most likely to be sceptical about the possibility of implementing ESD, while AMPTO respondents were most likely to believe it to be possible. This could either be due to different levels of faith in human ability to achieve ESD or to different interpretations of what ESD is and at what scale it should be implemented.

4.3.2 The importance of various actions and influences on the implementation of ESD

Question 23 of the survey asked participants to score various actions and influences according to their perceived importance in the implementation of ESD. The response scale used was 0 = undecided, 1 = unimportant, 2 = somewhat unimportant, 3 = somewhat important, 4 = important, 5 = very important. Of the thirteen possible actions/influences on the implementation of ESD offered, on average, *long term planning*, *ecological research*, *education* and *environmental policy* were considered most important (mean score 5). *Community attitudes*, *ethical conduct*, *short term planning*, *social science research* and *economic priorities* were variously scored however, with mean scores within the different agency groups ranging from somewhat important to important (mean scores 3 to 4).

Statistical comparisons among and within the groups found that only *social science research* was scored significantly differently between groups. This was due to research agency staff (Figure 4.3) and natural science experts (Figure 4.31) being more likely to judge *social science*

research only somewhat important (mean scores 3.1 and 3.4 respectively). These scores were significantly lower than all other agencies except the CRC (see Tables 4.3.3a, 4.3.3b and 4.3.4 for statistics).

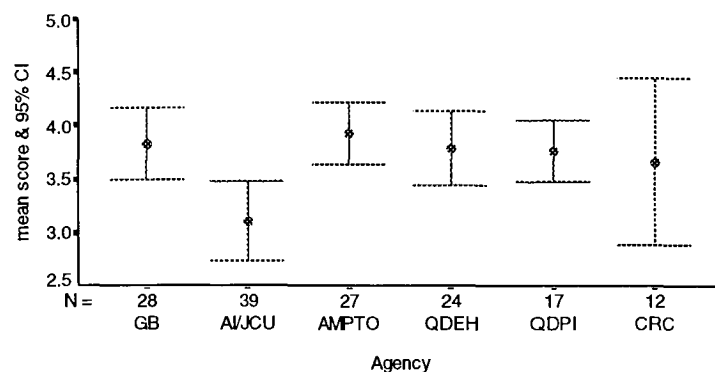


Figure 4.3.1: mean scores on Q23d - the importance of social science research, among all agencies.

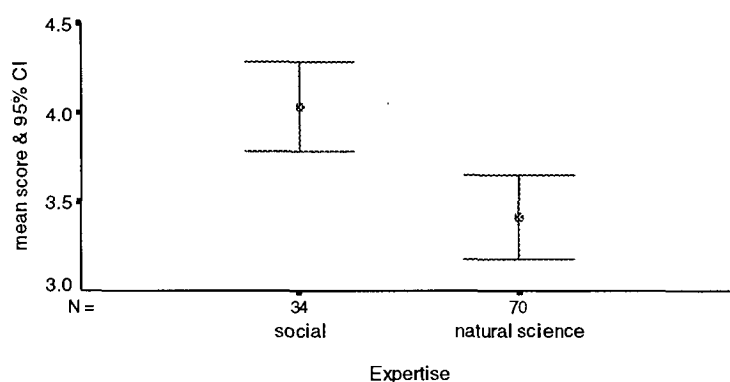


Figure 4.3.2: mean scores on Q23d - the importance of social science research, between expertise / occupations.

4.3.3 Factor Analysis

Many of the question items in part 2 of the survey aimed to elicit agreement/disagreement with statements concerning the implementation of ESD through socio-political, ecological and techno-economic means. The five point Likert response scale ranging from 1 - strongly disagree to 5 - strongly agree was again used to measure all responses. Factor Analysis performed on these question was successful in combining them into three groups of actions that may influence the implementation of ESD (Table 4.31). These were:

- factor (1) the need for greater understanding of ecological systems, and for movement away from the continuous growth ideal;

- factor (2) the role of science and technology in the implementation of ESD; and
- factor (3) the role of social and political forces in the implementation of ESD.

T 4.3.1: Summaries of Factor Analysis for Part 2-The Implementation of ESD

FACTOR	Eigenvalue	% of var.	cum% of var.	Alpha reliability
1	1.75	25.0	25.0	0.46
2	1.42	20.3	45.3	0.57
3	1.10	15.3	60.5	0.33

FACTOR 1: The need for greater understanding of ecological systems and for movement away from the continuous growth ideal

Question summary	Factor loading
Q24 understanding ecology is the most important tool in management for ESD	0.69
Q25 the future of ESD is a critical issue for scientists	0.67
Q27 ESD requires a change in economic thought away from continuous growth	0.66

FACTOR 2: ESD is achievable through science and technology

Question summary	Factor loading
Q26 science will provide the knowledge for implementing ESD	0.69
Q30 Technology will allow ESD to become a reality	0.78

FACTOR 3: Social and political forces play an important role in the implementation of ESD

Question summary	Factor loading
Q28 social and political forces play a major role in the implementation of ESD	0.69
Q29 understanding peoples motivations and perceptions is the most important tool in management for ESD	0.78

NB: Question 28 was re-coded from negative to positive for analysis.

4.3.4 Comparison of mean scores (interpretation of what is important to the implementation of ESD)

Statistical comparisons among all agencies, management and research agencies, management and industry organisations and social and natural science expertise/occupations found opinions to differ in similar patterns across the three factors (that is at a multivariate level) (statistics are summarised in Table 4.3.2). Further patterns were found at a univariate level of comparison.

4.3.4.1 Among agencies

The strongest among all agency differences in opinions about the implementation of ESD were on factor 3 (*the importance of social and political forces*), as AIMS/JCU respondents were less likely to agree (mean score 3.8) than GBRMPA and DEH who agreed strongly (mean scores 4.4 and 4.3 respectively) (Figure 4.3.2, Tables 4.3.3c and 4.3.4). Opinions also differed on factor 2 with AMPTO respondents being most likely to agree that *ESD will be achieved through science and technology* while GBRMPA respondents were most likely to disagree with this statement (mean scores 3.4 and 2.7 respectively). Most other agencies also scored relatively low on this factor (Figure 4.3.3, Tables 4.3.3c and 4.3.4).

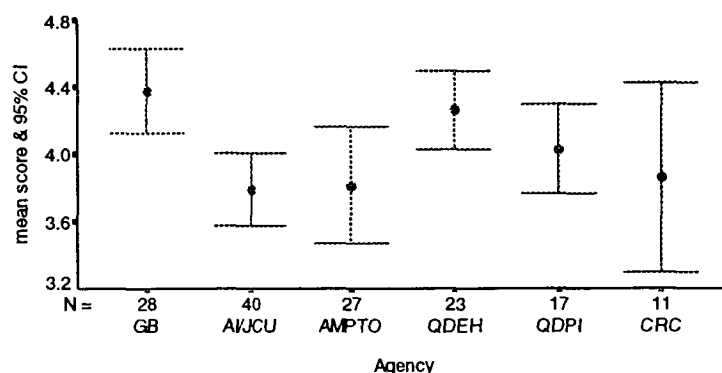


Figure 4.3.3: mean scores on F3 - the importance of social and political forces to the implementation of ESD, among all agencies.

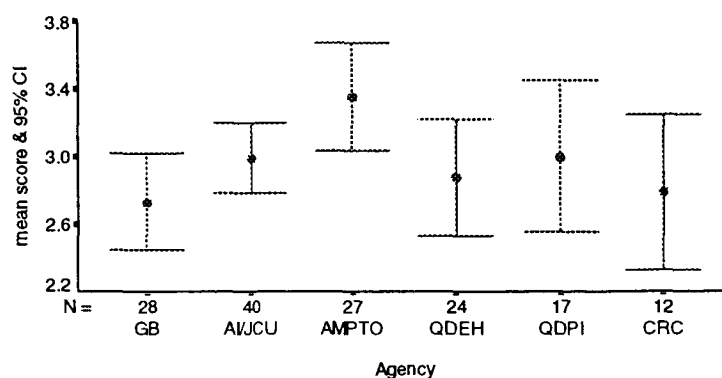


Figure 4.3.4: mean scores on F2 - ESD will be achieved through science and technology, among all agencies.

There was a slight but not statistically significant difference in opinions on factor 1 as DEH respondents were more likely to agree strongly with *the importance of ecological research and movement away from the continuous growth ideal* (mean score 4.4) than were AIMS/JCU and

AMPTO (mean scores 3.9 and 4 respectively) (Tables 4.3.3c and 4.3.4). By isolating pairs of agencies these patterns became more clear.

Management vs Research (GBRMPA/DEH vs AIMS/JCU)

As shown above, management and research agency staff were those respondents most likely to differ in opinion on the role of social and political forces in implementing ESD. Managers felt these forces were important while researchers felt they were less so (factor 3 - mean scores 4.3 and 3.8 respectively). (Tables 4.3.3c and 4.3.4). When these groups were isolated, the difference between their mean scores on factor 1 became significant, as management staff were more likely than research agency staff, to agree with the importance of ecological research and movement away from the continuous growth ideal (mean scores 4.3 and 3.9 respectively) (Tables 4.3.3c and 4.3.4).

Management vs Industry (GBRMPA/DEH vs AMPTO)

The management also felt that social and political forces (factor 3), the role of ecological research and the need to move away from the continuous growth ideal (factor 1), were more important in implementing ESD than did industry staff (Tables 4.3.3c and 4.3.4). Additionally, respondents from these two agency types disagreed on the role of science and technology in the implementation of ESD. AMPTO staff mostly agreed that science and technology will achieve ESD, while the management agency staff tended to disagree (mean scores 3.4 and 2.7 respectively) (Tables 4.3.3c and 4.3.4).

Research vs Industry (AIMS/JCU vs AMPTO)

Research and industry respondents only differed significantly in their opinions about whether ESD will be achieved through science and technology, as research agency respondents were neutral to disagreeing on this issue (factor 2 - mean score 2.99) (Tables 4.3.3c and 4.3.4).

Thus at the among agency level, the major variations in opinion as to how ESD must be implemented included:

- management agency staff having the strongest opinions about the importance of social and ecological issues and the need to move away from the continuous growth ideal;
- Researchers being least concerned with social forces and social research in the implementation of ESD; and

- industry feeling strongly that ESD will be implemented through science and technology, while both researchers and managers did not feel this to be the case.

4.3.4.2 Within agencies

Senior and mid/operational staff were found to only have significantly different opinions on the importance of ecological research and the need for movement away from the continuous growth ideal, with senior staff being less likely to agree than mid/operational level staff (factor 1 - mean scores 3.9 and 4.2 respectively) (Tables 4.3.3c and 4.3.4).

Social and Natural Science Experts differed significantly in opinions about the importance of social and political forces, with social experts deeming them more important to the implementation of ESD than did natural science experts (factor 3 - mean scores 4 and 3.4 respectively) (Tables 4.3.3c and 4.3.4).

There were no detectably significant differences in attitudes towards the implementation of ESD between genders or age groups (Tables 4.3.3 and 4.3.4)

Thus at the within agency level of comparison:

- staffing levels divided attitudes on the importance of ecological understanding and the need for movement away from the continuous growth ideal; and
- expertise divided attitudes on the importance of social and political forces and social research.

Table 4.3.2: Summary of MANOVA for Part 2 - The Implementation of ESD (using sequential sums of squares)

Source of variation	DF	Pillais value	F	p
Agency by Staff.L.	6, 172	0.09	0.65*	0.692
Agency	15, 417	0.23	2.35*	0.003
Man/Research	3, 86	0.22	8.26	0.000
Man/Industry	3, 74	0.26	8.56	0.000
Ind/Research	3, 62	0.63	1.39	0.254
Staffing Level	3, 140	0.07	3.51	0.017
Soc/Nat.Sci. Expert.	3, 99	0.08	2.73	0.048
Age category	12, 420	0.10	1.18	0.294
Gender	3, 140	0.05	2.36	0.074

NB: * = approx. F

Table 4.3.3a: Summary of one-way ANOVA comparing agencies on question 23d - The role of social science research in the implementation of ESD

Source of Variation	DF	SS	MS	F	p
Agency	5, 140	11.83	2.37	2.98	0.014

Table 4.3.3b: Summary of univariate t-tests comparing expertise and agency types on questions 23d - The role of social science research in the implementation of ESD

Source of Variation	DF	t-value	SE diff.	p
Soc/Nat sci. Expertise	103	3.27	0.20	0.001
Man/Research	89	3.22	0.03	0.002
Res/Industry	64	-3.02	0.03	0.004

Table 4.3.3c: Summary of univariate F- tests for factors 1 - 3 of Part 2 - The Implementation of ESD (using sequential sums of squares)

F1 - Understand ecology and change economic thinking

Source of Variation	DF	SS	MS	F	p
Agency	5, 139	0.81	0.01	2.24	0.054
Man/Research	1, 88	0.50	0.01	8.36	0.005
Man/Industry	1, 76	0.40	0.01	4.40	0.039
Res/Industry	1, 64	0.45	0.01	0.24	0.627
Staffing Level	1, 142	0.81	0.01	10.45	0.002
Soc/Nat sci. Expertise	1, 101	0.58	0.01	2.71	0.103
Age category	4, 140	0.83	0.01	1.75	0.142
Gender	1, 142	0.86	0.01	2.18	0.142

F2 - The role of science and technology

Source of Variation	DF	SS	MS	F	p
Agency	5, 139	78.86	0.57	2.30	0.048
Man/Research	1, 88	46.22	0.53	1.27	0.264
Man/Industry	1, 76	46.39	0.61	8.38	0.005
Res/Industry	1, 64	33.65	0.53	4.04	0.049
Staffing Level	1, 142	85.07	0.60	0.07	0.790
Soc/Nat sci. expertise	1, 101	55.82	0.55	1.98	0.163
Age category	4, 140	83.51	0.60	0.79	0.534
Gender	1, 142	84.24	0.59	1.94	0.165

F3 - The role of social and political forces

Source of Variation	DF	SS	MS	F	p
Agency	5, 139	1.03	0.01	3.05	0.012
Man/Research	1, 88	0.47	0.01	13.94	0.000
Man/Industry	1, 76	0.60	0.01	9.30	0.003
Res/Industry	1, 64	0.66	0.01	0.06	0.806
Staffing Level	1, 142	1.14	0.01	0.13	0.722
Soc/Nat sci. expertise	1, 101	0.65	0.01	5.78	0.018
Age category	4, 140	1.12	0.01	1.05	0.390
Gender	1, 142	1.12	0.01	3.18	0.077

Table 4.3.4: Mean scores and 95% CI for all demographic groupings on Part 2 - The Implementation of ESD

	Agency						Agency type			Staffing Level		Expertise		Gender	
	gbrmpa n = 28	aims/jcu n = 40	ampto n = 27	qdeh n = 24	qdpi n = 17	crc reef n = 12	m'ment n = 52	r'search n = 40	industry n = 27	senior n = 59	mid/op. n = 88	social n = 34	nat.sci. n = 72	Female n = 36	Male n = 111
q23d															
the importance of social science research	3.82 0.34	3.1 0.32	3.93 0.29	3.79 0.33	3.76 0.28	3.67 0.79	3.81 0.22	3.1 0.32	3.93 0.29	3.59 0.52	3.66 0.24	4.03 0.30	3.37 0.36	3.80 0.27	3.60 0.20
F1															
understand ecology and change economic thinking	4.17 0.22	3.86 0.22	3.95 0.26	4.42 0.26	4.2 0.40	4.03 0.37	4.28 0.24	3.86 0.22	3.95 0.26	3.88 0.20	4.21 0.10	4.25 0.22	4.05 0.33	4.21 0.46	4.02 0.21
F2															
the role of science and technology	2.73 0.28	2.99 0.23	3.35 0.32	2.88 0.34	3 0.45	2.79 0.43	2.8 0.28	2.99 0.23	3.35 0.32	2.97 0.60	2.97 0.27	3.12 0.33	2.9 0.39	2.81 0.39	3.03 0.32
F3															
the role of social and political forces	4.38 0.26	3.79 0.21	3.81 0.32	4.26 0.23	4.03 0.27	3.86 0.56	4.32 0.22	3.79 0.21	3.81 0.32	4 0.34	4.02 0.24	4.25 0.22	3.89 0.35	4.21 0.43	3.96 0.23

5. DISCUSSION

Fulfilment of the CRC Reef Research Centre's goal; Science for the ecologically sustainable development of the Great Barrier Reef World Heritage Area, requires shared recognition and understanding of the goals, objectives and principles that make up the ESD concept. This study has found there to be variation in the recognition of and importance placed on some key ESD principles; the forces influencing the fulfilment of those principles; and the measures needed in order to ensure that ESD principles are achieved. This chapter discusses these findings and looks at what their implications might be for decision making within the CRC. Recommendations are made and directions for future research are identified

5.1 The concept of ESD

Before discussing the findings of the study, it must be stated that repeated statistical tests on the same data increase the probability of type I error occurring. That is, of wrongly judging two groups to have significantly differing opinions. Post-hoc Bonferroni error correction equations (the 0.05α level/# of repeated tests) were hence applied to comparisons subjected to several tests. The results of these error corrections suggests that the differences between managers and industry operators regarding placing a monetary value on the environment, and between managers and researchers regarding the importance of the precautionary principle and indigenous peoples' interests, must be interpreted conservatively as they are not statistically significant when correction factors are applied. The new α levels were $0.05/6=0.008$ and $0.05/8=0.006$ respectively. Similar precaution must be taken with comparisons between expertise/occupations regarding the appropriateness of economic considerations to ESD, and with all comparisons on factors 1-5 of Part 1 - The Concept of ESD. The exception being between staffing levels, which also differed significantly when correction factors were applied.

In Part 2 - The Implementation of ESD, all significant results at a univariate level were also found to be significant at a multivariate level, rendering correction factors unnecessary. The exception being differences in opinions between industry operators and researchers, regarding the role of science and technology in achieving ESD. This difference was not statistically significant when a correction factor was applied and must hence also be interpreted conservatively.

When differences among and within agencies were found to be statistically significant, the mean scores did not always differ greatly. For example, in some instances respondents from one agency considered a factor 'very important' while those from another agency considered it only 'important'. This may not have as serious implications for decision making as would opposing opinions or interpretations of ESD. Nevertheless, it gives an indication as to where disparities may be occurring.

Differences among agencies

It appears that there are some disparities among priorities of the management, research and industry organisations which reflect on their recognition and interpretation of the ESD principles and how they would best be implemented. Physical and biological scientists did not place as much importance on social components of the ESD concept such as indigenous peoples' interests. Managers on the other hand, appeared to be more balanced in their concern for both ecological and social issues. Conservation science has had a long history of ignoring the interests of local indigenous people, for example removing them from their land when National Parks are created. As pointed out by Pretty and Pimbert (1995) this stems from the ethic that all people are destructive to the environment. It is hoped that future integration between the natural and social sciences will serve to alter this ethic toward one that recognises the important interactions between people and their environment. It appears, from the findings of this study, that managers are more willing to accept this approach, or are more cognisant of the need to accept it than are researchers.

Researchers also appeared to feel less of a need for the precautionary principle than did managers. The precautionary principle is based on preventative action before scientific (statistically significant) evidence proves that environmental damage will or has occurred. There is extensive argument in the literature as to the relationship between the precautionary principle and science (Gray, 1990; Johnstone and Simmons, 1990; Earll, 1992; Stebbing, 1992). Gray (1990) and Stebbing (1992) feel that the use of this principle is undermining scientific methodology and hence scientific "truth," the traditional basis for decisions regarding pollution control. Erlich and Daily (1993) on the other hand, stress that it is current scientific methodology that is not appropriate, and that we need a broader, more useful notion of science as systematised knowledge, obtained by observation and experiment, rather than by some arbitrary level of uncertainty on which current scientific evidence is based. Precaution and prevention are key steps towards intra-generational equity, the maintenance of biodiversity and the improvement of individual and community well being. As Earll (1992) pointed out, and as

indicated by the establishment of research centres for ESD, scientific evidence has an important role in this process, even if there is no time to wait for statistical certainty before action is taken. Constable (1993) stated that the new management process that is evolving must determine the public interest through the use of social science, and deal with the problems of uncertainty during the formulation stage of management through scientific evidence and adaptive management.

The key single word responses chosen by researchers and managers as descriptors of the ESD concept, were *preservation*; and *biodiversity* and *health* respectively. These may also reflect a narrower scientific concern with *preserving* the ecological environment on the one hand, and a wider management concern with maintaining the *health* and *biodiversity* of the environment on the other.

The tourism (industry) operators differed from both managers and researchers in their belief that development and conservation can best be integrated by placing a monetary value on the environment. This is likely a reflection of the economic value they place on the environmental amenities they package for their customers. They also differed from researchers and managers in their choice of the word *growth* as one of five descriptors of the ESD concept. While equating the word development with growth causes doubts about the possibility of achieving ecologically sustainable development, the five words chosen by tourism industry respondents seem to reflect a belief that *growth* and *wise use* can be *balanced* with *conservation*, and *preservation* in order to perpetuate that growth and wise use. This appears to be common throughout the tourism sector.

The proposed Queensland Tourism strategy being developed by the Queensland Government and stakeholders, refers to the aim of sustainable growth as, or more, often than it refers to ecologically sustainable development (QLD Government, 1995a). The development of State wide and regional tourism strategies for ecologically sustainable development of the tourism industry, was a major recommendation of the ESD Working Group on Tourism (1991). The ESD principle highlighted by the Working Group was the improvement of material and non material well being, to be measured by the tourist experience given, and not just by the money made. It also highlighted tourism's stewardship role of the environment and the opportunity that new tourism developers have to implement energy and waste minimisation strategies (ESDWG Tourism, 1991). The Queensland Government, however, maintains that the need for the Queensland tourism strategy is to ensure national and international competitiveness and

continued profit, with only a brief mention of the need to ensure that tourism develops in an ecologically as well as a socially and economically sustainable manner. The stated justification for ecologically and socially sustainable development, was the growing desire among tourists and local residents to enhance their knowledge and understanding of the natural and cultural environments, rather than the need to ensure inter-generational equity. One of the strategy's 7 issues papers was focused on ESD (Chenoweth and Assoc. and Vaux-Oelrichs Partners, 1994), and the need for ESD was stated in the discussion paper (QLD Government, 1995a). However, the meaning of ESD in relation to tourism is not quantified in the latter, despite the extensive suggestions put forward by the ESD Working Group.

The draft Queensland Ecotourism Plan looks at a specialised sector of Queensland's nature based tourism which focuses on minimal impact; ecological sustainability; and environmental education and interpretation (QLD Government, 1995b). Growth (development) of the tourism industry may be sustainable if it is in the direction of diversity in ecotourism experiences rather than through an increase in the size of tourism operations and centres. However, there is a danger that "ecological sustainability" will be concentrated on this tourism sector only, while other forms of tourism continue to function within the paradigm of continuous economic growth as the primary determinant of individual and community well-being.

Differences within agencies

Comparisons among staffing levels across all CRC related agencies, paralleled Brown and Harris' (1992) findings within the United States Forest Service. That is, mid/operational level staff (employees) appeared to have the most positive attitudes towards ESD principles. And believed more strongly that changing the current economic paradigm is necessary, if ESD is to be achieved. A similar pattern between genders became apparent in this study, with females feeling more strongly than males about the need for change. However, similar differences among age groups found by Brown and Harris, were not statistically significant in this study. This was perhaps an artefact of the small sample sizes within different age groups.

5.2 The implementation of ESD

Differences among agencies

Attitudes toward the implementation of ESD also appeared to differ according to priorities of the different agency groups. In addition, attitudes seemed to be influenced by the scale at which ESD implementation was being considered, be it the global, national, regional or individual

operation scale. The managers had the widest and strongest concerns for social and ecological aspects of ESD implementation, and for the need to change current economic thinking away from the continuous growth ideal. Comments on question 1 of the survey (is ESD possible: why?) found that resource managers were among those respondents most likely to be sceptical about the possibility of implementing ESD due to political and economic opposition and subsequent influences on decision making (see Appendix 6 for comments on question 1). The researchers, being more narrowly focused, seemed less passionate about changing current paradigms and practices, as indicated by their milder concerns for these broad issues. However, they shared some of the managers' scepticism about the implementation of ESD due to their concerns for sustaining ecological systems when they are not well understood. Extreme scepticism of this kind was shown by the biological scientists Ludwig et al (1993) who argued that the rate of learning about ecological systems is too slow in the race against human greed to exploit those systems.

The tourism industry operators appeared to have rather straight-forward interpretations of ESD, several industry respondents answering question 1 with the statement that 'Yes ESD is possible - tourism needs the environment so the environment will be preserved' (see Appendix 8). Industry operators were those respondents most likely to believe that ESD is possible and that it will be implemented through science and technology, and were not as likely to believe that social and political forces and current economics may enhance or restrict the implementation process. This is rather interesting as tourism itself represents a social force. It appears that tourism industry respondents were answering question 1 with reference to the scale of their own operations on the Great Barrier Reef only. That is, global scale population problems were not often mentioned, while monitoring and impact assessment of single tour operations, and industry growth on and continuing wise use of the reef, were commonly highlighted. One respondent stated that ESD is possible if you consider each development individually, but that restrictions only, not refusals of projects are essential ... (see Appendix 6). Presumably this means essential to continued growth of the industry.

Differences within agencies

When considering the implementation of ESD, mid/operational levels staff were again most likely to agree with the need to change economic thought patterns, and to feel that understanding ecology in management is of primary importance for ESD to be achieved. Perhaps senior staff are more sceptical about the ability to change the dominant social paradigm of economic growth, or maybe the mid/operational level staff are those working

towards a paradigm change while the senior staff still operate within the old one. Not surprisingly, attitudes towards the importance of understanding social and political forces in the ESD process differed among social and natural science experts. Natural scientists placed less importance on these forces as they are probably not perceived as being immediately related to the natural environment (Pretty and Pimbert, 1995), most often central to their view of ESD.

Where does the ESD concept belong?

When ESD was considered at the large scale, respondents frequently raised the issue that overpopulation and economic and political objectives would interfere with its implementation. At the specific ecosystem scale concerns were voiced as to how to sustain natural resources that are variable and not well understood. Wording ambiguities were also apparent in suggestions that 'ecologically viable development' or 'ecologically sustainable use' are more appropriate concepts than ESD, and in questioning as to whether or not development means growth? Several positive answers to question 1 of the survey suggested ways of overcoming these ambiguities regarding the meaning and implementation of ESD. For example:

'Yes. Sustain is a relative concept, but still ESD is a useful term as it encourages ecological thinking during the development process' (CRC respondent)

'Yes. Because ESD is an abstraction, a philosophy almost, and can take form as a framework for action and decision making on resource use issues' (AIMS respondent).

'Yes. The key is education and understanding, and development in ways that don't require impact' (JCU respondent) (see Appendix 6).

These suggestions give a clear picture of the level at which the ESD goal is most likely to be appropriate. As a framework for action and decision making and as a goal towards enhancing understanding and development in ways that do not require adverse social and ecological impacts. This sample of CRC participants showed a recurrent theme of variation in the recognition and interpretation of the various social, ecological and economic dimensions of ESD and the need to *change* current economic measures, principles, and continuous growth ideals if an ESD framework is to be achieved. Thus it can be seen that to make use of such a framework and to ensure cooperation towards enhancement of welfare, maintenance of biodiversity and intra and inter-generational equity, these objectives and principles of the ESD

“framework” must be focused down for each type of industry or operation, and practically defined within the context of implementation.

5.3 Implications for decision making and direction of research within the CRC Reef Research Centre

Differences among agencies

The disparities observed in recognition of and concerns for aspects of ESD such as social equity and the need to change current economic thinking, may have implications for cooperation on decisions regarding priorities for research between the ecological, social and economic aspects of development.

- AIMS and JCU participants of the CRC may not place as much importance on research which addresses social questions, in comparison to that which addresses biophysical ones;
- Tourism industry (AMPTO) participants appear least likely to agree with research that is associated with restricting economic growth of the industry, or research into environmental protection that is not also beneficial to the industry; while
- Management agency staff (GBRMPA and DEH) appear to have the most balanced view with regards to social and ecological research, but may be less inclined towards research aimed specifically at furthering economic development.

Differences within agencies

The mid/operational level staff are those most likely to implement new policies concerning ecologically sustainable development, use or operations within the different agencies and within the CRC's research programs. At the expertise/occupation scale, the balance between social and natural science experts may sway decisions on the priority of different kinds of research even if the overall goal is science for ESD. The gender imbalance in the sample may also influence the rate at which ESD related policies are implemented, as the female minority were found to have significantly stronger positive attitudes towards ESD principles than were males.

It is important to note that this survey looked at average scores among and within the agencies. Individual interpretations and attitudes towards the concept and implementation of ESD may

also play a major role in decision making and direction of research if strongly opinionated individuals hold important decision making positions. As senior level staff were generally more conservative with respect to ESD principles and their implementation, strong opinions at the decision making level have a higher chance of being conservative.

5.4 Conclusion and recommendations

5.4.1 Conclusion

Many people are becoming aware of the imminent necessity for a change in the dominant social paradigm. A paradigm which, through its basic goal of 'progress through economic growth at all costs' has facilitated the unsustainable, environmentally damaging lifestyle of the modern world. The earth, humanity and the biotic environment must keep evolving and developing, but can only achieve this if they are not destroyed in the process. Ecologically sustainable development is a phrase coined to describe this need and has become a goal in an attempt to address the situation. The words used however, have created confusion in our attempted achievement of this goal, as they are open to interpretation from various perspective's and because of various ulterior motives. Australia has deemed that science for the ecologically sustainable development of the Great Barrier Reef World Heritage Area is very important. This is evident in the fact that the CRC Reef Research Centre was even established. However, I believe that its principles must be practically defined in relation to research, the Great Barrier Reef and the global community in order to prevent cooperation towards this goal being hindered by ulterior agency goals and differing interpretations of the objectives and principles observed in this study.

On a global scale, the goals, objectives and principles of ESD will not be implemented until the dominant social paradigm changes from one of economic growth at all costs to one of ecologically sustainable development. This change must be aided by a shift in the dominant science paradigm, from one of reductionism to one of broader integration of research and learning. At present, the implementation of ESD goals, objectives and principles is hindered by varying interpretations and ulterior goals influenced by the current world view that increased welfare and well-being must be achieved through sustained economic growth.

5.4.2 Recommendations for enhancing cooperative research towards the ecologically sustainable development of the Great Barrier Reef World Heritage Area

1. Recognition of how the perceived meaning of ESD differs among the CRC Reef Research Centre participant agencies can serve to open discussion towards the formulation of some agreed upon practical definitions of ESD in relation to research, the Great Barrier Reef and the global community. It is possible in this light, that all research initiated by the CRC should relate the Centre's specific ESD values and goals.
2. Cooperative research centres are a step towards implementing the integrated research necessary to answer current resource use and management questions. However, the results of this survey suggest that more integration between disciplines and agency types would be helpful in broadening understanding of the ESD concept and enhancing cooperation between groups.
3. The phrase ecologically sustainable development should never be quoted as a goal without the support of practical definitions associated with the context, scale and perspective concerned (in the context of research and development; at the scale of the Great Barrier Reef; from a social, ecological and economic perspective).
4. As the tourism industry is one of the major foci of the CRC Reef Research Centre, it is important to understand the motivations and perceptions within the industry, and to clearly define the priorities of the research centre in relation to ESD in that sector specifically.

5.4.3 Recommendations for further research

1. In depth interviews with participants of the CRC Reef Research Centre could elicit useful information on the causes for variation in interpretation of ESD. This would strengthen the discussion platform from which a shared practical definition of the concept could evolve.
2. Further analytical survey research would be useful in eliciting interpretations of several ESD principles not fully covered by this questionnaire. Additionally, information on

people's reactions to various scenarios concerning the implementation of ESD could aid the determination of likely consequences of varying interpretations.

3. A wider sample of people that may influence CRC Reef Research Centre decisions could be surveyed, including the fishing industry and the general public.
4. Analysis of recognition, interpretation and implementation of the ESD concept over time, would be an interesting means of identifying whether or not a paradigm shift towards a more 'sustainable' life style is perceived by those charged with making it happen.

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World Commission on Environment and development

Principles of Sustainability

The first step in integrating ecology and economics is to define sustainability in both economic and ecological terms. Based on our best understanding of how economies and ecosystems operate, we must try to generate rules of behavior which, if followed, would sustain each. We can think of economic and ecological sustainability precepts as overlapping circles. Where they overlap is found the terrain of sustainable development and the starting point for a national strategy.

Economic sustainability can be defined as the way that humans must manage an economy to preserve its productivity. It can be described by the following four key precepts.

1 *Efficiency* Projects undertaken and processes used in production should be those which are efficient; that is, they yield the greatest output per unit input given existing technologies. For market economies, inputs and outputs are measured by their monetary values.

2 *Investment* The productive base—human, technological, and natural—should not be run down. Investment should be sufficient to at least replenish and preferably to expand the capital base so that it does not deteriorate. While there are short-term consumption gains from depleting the productive stock (whether it is the knowledge base or the physical environment), in the long term depletion destroys the capability for an economy to function. Of course, investment requires that the economy generates an investible surplus.

3 *Diversification* Sources of inputs and the range of outputs should be diversified so that the system as a whole can be made less vulnerable to external or internal shocks.

4 *External balance* Over the long term, the value of goods and services exported and those purchased from outside the economy should balance.

Other requirements for maintaining economic stability and productivity include institutional structures which establish rules and regulations which are perceived to be politically legitimate, including the definition of property rights.

Ecological sustainability can be defined as the way in which humans should interact with the biosphere to maintain its life-support function. It might be described by the following five precepts.

1 *Biological diversity* All species of flora and fauna and their habitats should be conserved, maintaining the potential for species evolution.

2 *Ecosystem conservation* There are limits to the regeneration of the natural stock of ecological resources, including soil, ground and surface water, land biomass, and water biomass. Since they are necessary to sustain life, they should be protected.

3 *Interconnectedness* Improvements in one nation's or region's environment should not be undertaken at the expense of another's.

4 *Aversion to risk* It is best to assume that the future is unpredictable and to make decisions based on avoiding bad potential consequences, even if it means that returns are not maximized in the short term. This is particularly important given potential unknown threshold effects wherein incremental change in an ecosystem (such as global climate patterns) suddenly gives way to sweeping systemic change. Any activity which could tip the ecosystem irreversibly from one state to another should be avoided.

5 *Scale of impact* Humans should minimize their use of mass and energy flows relative to the total mass and energy flows of the relevant ecosystem.

AUSTRALIA'S GOAL, CORE OBJECTIVES AND GUIDING PRINCIPLES FOR THE STRATEGY

THE GOAL IS:

Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

THE CORE OBJECTIVES ARE:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations
- to provide for equity within and between generations
- to protect biological diversity and maintain essential ecological processes and life-support systems

THE GUIDING PRINCIPLES ARE:

- decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations
- where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- the global dimension of environmental impacts of actions and policies should be recognised and considered
- the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised
- the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised
- cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms
- decisions and actions should provide for broad community involvement on issues which affect them

AUSTRALIAN MAINSTREAM ENVIRONMENT GROUPS PRINCIPLES OF SUSTAINABLE DEVELOPMENT

Inter-generational equity

The present generation should ensure that the next generation is left with an environment that is at least as healthy, diverse and productive as the one the present generation experiences. Owing to the massive and irreversible role of loss of species and habitats at present, we have an additional responsibility to give the highest priority to conserving the world's natural environment and species.

Conservation of biodiversity and ecological integrity

Conservation of biodiversity and the protection of ecological integrity should be a fundamental constraint on all economic activity. The non-evolutionary loss of species and genetic diversity needs to be halted and the future of evolutionary processes secured.

Constant natural capital and 'sustainable income'

Natural capital (e.g. biological diversity, healthy environments, freshwater supplies, productive soils) must be maintained or enhanced from one generation to the next. Only that income which can be sustained indefinitely, taking account of the biodiversity conservation principle, should be taken.

Anticipatory and precautionary policy approach

Policy decisions should err on the side of caution, placing the burden of proof on technological and industrial developments to demonstrate that they are ecologically sustainable.

Social equity

Social equity must be a key principle to be applied in developing economic and social policies as part of an ecologically sustainable society.

Limits on natural resource use

The scale and throughput of material resources

will need to be limited by the capacity of the environment to both supply renewable resources and assimilate wastes.

Qualitative development

Increases in the qualitative dimension of human welfare and not the quantitative growth in resource throughput is a key objective.

Pricing environmental values and natural resources

Prices for natural resources should be set to recover the full social and environmental costs of their use and extraction. Many environmental values cannot be priced in monetary terms and hence pricing policies will form part of a broader framework of decision making.

Global perspective

A global perspective is needed to ensure that Australia does not simply move its environmental problems elsewhere.

Efficiency

Efficiency of resource use must become a major objective in economic policy.

Resilience

Economic policy needs to focus on developing a resilience to external economic or ecological shocks. A resource-driven economy is unlikely to be resilient.

External balance

Australia's economy needs to be brought into balance. External imbalance creates pressure to deplete natural capital and could undermine the prospect for an ecologically sustainable economy.

Community participation

Strong community participation will be a vital prerequisite for effecting a smooth transition to an ecologically sustainable society.

Source: Cth Government of Australia, 1992a

Source: IUCN, UNEP, WWF, 1991 cited in Beder, 1993

INTERNATIONAL ENVIRONMENTAL ORGANISATIONS PRINCIPLES OF SUSTAINABLE DEVELOPMENT

Respect and care for the community of life

This principle reflects the duty of care for other people and other forms of life, now and in the future. It is an ethical principle. It means that development should not be at the expense of other groups or later generations. We should aim to share fairly the benefits and costs of resource use and environmental conservation among different communities and interest groups, among people who are poor and those who are affluent, and between our generation and those who will come after us.

All life on earth is part of one great interdependent system, which influences and depends on the non-living components of the planet—rocks, soils, waters and air. Disturbing one part of this biosphere can affect the whole. Just as human societies are interdependent and future generations are affected by our present actions, so the world of nature is increasingly dominated by our behaviour. It is a matter of ethics as well as practicality to manage development so that it does not threaten the survival of other species or eliminate their habitats. While our survival depends on the use of other species, we need not and should not use them cruelly or wastefully.

Improve the quality of human life

The real aim of development is to improve the quality of human life. It is a process that enables human beings to realize their potential, build self-confidence and lead lives of dignity and fulfilment. Economic growth is an important component of development, but it cannot be a goal in itself, nor can it go on indefinitely. Although people differ in the goals that they would set for development, some are virtually universal. These include a long and healthy life, education, access to the resources needed for a decent standard of living, political freedom, guaranteed human rights, and freedom from

violence. Development is real only if it makes our lives better in all these respects.

Conserve the Earth's vitality and diversity
Conservation-based development needs to include deliberate action to protect the structure, functions and diversity of the world's natural systems, on which our species utterly depends. This requires us to:

- **Conserve life-support systems.** These are the ecological processes that keep the planet fit for life. They shape climate, cleanse air and water, regulate water flow, recycle essential elements, create and regenerate soil, and enable ecosystems to renew themselves;
- **Conserve biodiversity.** This includes not only all species of plants, animals and other organisms, but also the range of genetic stocks within each species, and the variety of ecosystems;
- **Ensure that uses of renewable resources are sustainable.** Renewable resources include soil, wild and domesticated organisms, forests, rangelands, cultivated land, and the marine and freshwater ecosystems that support fisheries. A use is sustainable if it is within the resource's capacity for renewal.

Minimize the depletion of non-renewable resources

Minerals, oil, gas and coal are effectively non-renewable. Unlike plants, fish or soil, they cannot be used sustainably. However, their 'life' can be extended, for example, by recycling, by using less of a resource to make a particular product, or by switching to renewable substitutes where possible. Widespread adoption of such practices is essential if the Earth is to sustain billions more people in future, and give everyone a life of decent quality.

Keep within the Earth's carrying capacity
Precise definition is difficult, but there are finite limits to the 'carrying capacity' of the Earth's

ecosystems—to the impacts that they and the biosphere as a whole can withstand without dangerous deterioration. The limits vary from region to region, and the impacts depend on how many people there are and how much food, water, energy and raw materials each uses and wastes. A few people consuming a lot can cause as much damage as a lot of people consuming a little. Policies that bring human numbers and life-styles into balance with nature's capacity must be developed alongside technologies that enhance that capacity by careful management.

Change personal attitudes and practices

To adopt the ethic for living sustainably, people must re-examine their values and alter their behaviour. Society must promote values that support the new ethic and discourage those that are incompatible with a sustainable way of life. Information must be disseminated through formal and informal educational systems so that the policies and actions needed for the survival and well-being of the world's societies can be explained and understood.

Enable communities to care for their own environments

Most of the creative and productive activities of individuals or groups take place in communities. Communities and citizens' groups provide the most readily accessible means for people to take socially valuable action as well as to express their concerns. Properly mandated, empowered and informed, communities can contribute to decisions that affect them and play an indispensable part in creating a securely-based sustainable society.

Provide a national framework for integrating development and conservation
All societies need a foundation of information and knowledge, a framework of law and institutions, and consistent economic and social policies if

they are to advance in a rational way. A national programme for achieving sustainability should involve all interests, and seek to identify and prevent problems before they arise. It must be adaptive, continually redirecting its course in response to experience and to new needs. National measures should:

- treat each region as an integrated system, taking account of the interactions among land, air, water, organisms and human activities;
- recognize that each system influences and is influenced by larger and smaller systems—whether ecological, economic, social or political;
- consider people as the central element in the system, evaluating the social, economic, technical and political factors that affect how they use natural resources;
- relate economic policy to environmental carrying capacity;
- increase the benefits obtained from each stock of resources;
- promote technologies that use resources more efficiently;
- ensure that resource users pay the full social costs of the benefits they enjoy.

Create a global alliance

No nation today is self-sufficient. If we are to achieve global sustainability a firm alliance must be established among all countries. The levels of development in the world are unequal, and the lower-income countries must be helped to develop sustainably and protect their environments. Global and shared resources, especially the atmosphere, oceans and shared ecosystems, can be managed only on the basis of common purpose and resolve. The ethic of care applies at the international as well as the national and individual levels. All nations stand to gain from sustainability—and are threatened if we fail to obtain it.

Appendix 2 - The CRC Reef Research Centre's participant agencies

The extent to which ESD goals and principles are incorporated into policy, strategic planning, legislation, and internal operations.

The Great Barrier Reef Marine Park Authority (GBRMPA)

GBRMPA is a Commonwealth statutory authority. It was established in 1975 under the Great Barrier Reef Marine Park Act (Clth), to advise the Commonwealth Government on the care and development of the Great Barrier Reef and to establish and manage the world's largest Marine Park. The goal of the Authority is:

"to provide for the protection, wise use, understanding and enjoyment of the Great Barrier Reef in perpetuity through the care and development of the Great Barrier Reef Marine Park" (GBRMPA,1994:6).

The 12 aims of the authority, to be read in conjunction with the goal, cover the protection of the natural environment while allowing for wise use; community involvement in the care of the Marine Park; research and information dissemination to ensure proper management of the Marine Park; relevant economic development; recognition of Aboriginal and Torres Strait Islander affiliations and rights in management of the Marine Park; and global sharing of knowledge and expertise (GBRMPA,1994:6-7).

The goal of the authority suggests that any development within the Marine Park must be ecologically sustainable if the reef is to be there for people to use and enjoy in perpetuity. However, it was only in the 1994 amendment of the Act that the phrase 'ecologically sustainable use' was incorporated into section 39y (the objects of plans of management within the Marine Park). Current reviewal of the Act proposes to incorporate ESD goals into the object of the Act (S. Sparks, pers. comm.,1995).

In recent years GBRMPA has been involved in regional, national and international initiatives towards the implementation of ecologically sustainable use and development of the marine environment. On the regional scale the authority initiated, managed and published the 25 year Strategic Plan for the Great Barrier Reef World Heritage Area 1994-2019. This plan is a

future vision with long and short term goals, objectives and strategies cooperatively devised by the user and interest groups on and adjacent to the Great Barrier Reef. GBRMPA is working towards fulfilling the Plan's objectives within its management capacity.

Nationally GBRMPA is involved in the Ocean Rescue 2000 program initiated by the Commonwealth Government as part of its implementation of ecologically sustainable development policy in Australia. GBRMPA is coordinating Ocean Rescue 2000's National Marine Education Program and it provided the expertise for the compilation of the National State of the Marine Environment Report which was completed in early 1995.

Internationally, GBRMPA is part of INTROMARC (the International Tropical Marine Resource Centre) in cooperation with James Cook University of North Queensland and the Australian Institute of Marine Science (AIMS). The focus of this Centre is the provision of quality education, training and scientific capabilities and management expertise in tropical marine aspects of ecologically sustainable development. Among other things, the Centre is currently assisting with projects in Malaysia and Indonesia (GBRMPA, 1994a).

The Australian Institute of Marine Science (AIMS)

The mission statement of AIMS is:

"To undertake research and development to generate new knowledge in marine science and technology, promote its application in industry, government and ecosystem management; and undertake complementary activities to disseminate knowledge, collaborate effectively, assist in the development of a national marine science policy and enhance the institute's standing as a centre of excellence" (AIMS, 1994:1).

The corporate objectives include the emphasis on tropical marine science research for the advancement and application of scientific knowledge to national needs and priorities; and the communication of research results and the importance of marine science in the management, maintenance and development of resources based on marine ecosystems.

Enhanced scientific understanding of the marine environment can benefit the sustainable development of marine industries such as seafood, shipping, marine biotechnology and tourism,

and can serve to mitigate the impacts of industries such as oil and gas drilling. Scientific research is also essential to the proper management and conservation of tropical reefs, coastal waters and mangrove systems. The Chairman of the AIMS Council recognises that Australia's marine sector needs to make increasing use of science and technology if Australia is to meet the goals of ESD in our seas and oceans (Steedman,1994 cited in AIMS,1994:7). AIMS has the ability to provide a lot of scientific knowledge towards the fulfilment of this need. Its three programs; Coastal and Shelf Processes, Coral Reef Ecosystems and Environmental Studies and Biotechnology, have among other things, made advancements in sustainable prawn farming, and in climate change history from coral banding studies. This research has benefited all levels of government; port authorities; fishing, coastal engineering, tourism, mariculture and pharmaceutical industries and management authorities (AIMS,1994).

The Queensland Government

Local Government

The objectives of the Local Government (Planning and Environment) Act, 1990 (QLD), are; to facilitate orderly development and the protection of the environment; and to provide an adequate framework for applications and approval for development (section 1.3). The environment is defined as including ecosystems; people and communities; natural and physical resources; aesthetics; and social, economic and cultural conditions.

Part 8 section 2 (Environmental Impacts), addresses the need for ensuring that present development does not reduce future options (ESD), through the requirement of the submission of an Environmental Impact Statement (EIS) with all proposals for designated developments. These being developments known to have a potential detrimental impact on the environment. The Local Authority and the Minister also have the power to require an EIS for a proposed non designated development if it poses a threat to the environment (part 8 section 12). A 30 days period of public notice is required when an EIS is submitted, however there is no requirement for the redrafting of an EIS to take into account any public submissions.

Queensland Department of Environment and Heritage (QDEH)

The QDEH is in charge of administering the Queensland Nature Conservation Act, (1992) and the Queensland Environmental Protection Act (1994). The objective of the Nature Conservation Act, is the conservation of nature. This is to be implemented through the

establishment of protected areas together with the protection of wildlife, and through the ecologically sustainable use of those areas and that wildlife.

Ecologically sustainable use is defined as; "a) the taking or use of wildlife; and b) the use of areas; within their capacity to sustain natural processes while - c) maintaining the life support system of nature; and d) ensuring that the benefit of the use to present generations does not diminish the potential to meet the needs and aspirations of future generations" (section 11). This is to be achieved through the preparation and implementation of management and conservation plans dealing with the management of: protected areas; taking and use of wildlife; protected wildlife and its habitat; critical habitats; and areas of major interest (part 2 section 5e).

The Act also provides for community education and community participation in the administration of the Act (as far as practicable), and for the cooperative involvement of landholders in the conservation of nature. Additionally it recognises the interests of Aboriginal and Torres Strait Islander peoples in nature and provides for their cooperative involvement in its conservation.

There are 10 kinds of protected areas defined by the Act, allowing for different scales and degrees of use and conservation on government as well as on private lands. Conservation agreements between the State Government and a landholder can ensure that wildlife and habitat are conserved outside of isolated National Parks, while not restricting all use in such areas. In the event of large scale threats to species or habitats on private land, the Act provides for Interim Conservation Orders to be placed on that land and for compulsory Government acquisition of that land if no Conservation Agreement is signed (part 6).

The Nature Conservation Act is making a long awaited attempt at integrating land use and nature conservation, and thus aiding the implementation of the ESD principles of maintaining biodiversity, integrating conservation and development and also helping the community to care for its own environment (Appendix).

The Environmental Protection Act, 1994 (QLD) has the objective of "protecting Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends

('ESD')" (section 3). Implementation of this objective is to be achieved through an integrated cyclic management program that is consistent with ESD and has the following phases:

- a) establishing the state of the environment and defining environmental objectives;
- b) developing effective environmental strategies (environmental protection policies);
- c) implementing environmental strategies and integrating them into effective resource management; and
- d) ensuring accountability of environmental strategies (section 4).

Queensland Department of Primary Industries - Land Use and Fisheries Division (QDPI)

The QDPI is responsible for the administration of the Fisheries Act, 1994 (QLD) the objectives of which are: to ensure fisheries resources are used in an ecologically sustainable way; to achieve the optimum community, economic and other benefits obtainable from fisheries resources; and to ensure that access to fisheries resources is fair (section 3). The meaning of ecologically sustainable use is not defined.

The objectives of the Act were implemented through the establishment of the Queensland Fisheries Policy Council as a representative body to advise on policy issues affecting fisheries resources and fish habitats; and the establishment of the Queensland Fisheries Management Authority to manage and protect fisheries resources. Additionally the Act provides for the management and protection of fish habitats and commercial, recreational and indigenous fishing; the prevention, control and eradication of diseased and exotic fish; the management of aquaculture; and law enforcement power.

The Association of Marine Park Tourism Operators (AMPTO)

AMPTO was established in 1988 with the aim of representing the Great Barrier Reef Marine Park tourism operators' views and interests in government and other decision making arenas. AMPTO has no written policy on tourism development on the Great Barrier Reef, however they advocate that ecologically sustainable use and development is necessary in order to keep business going in the long term and to ensure the continued enjoyment and appreciation of the Great Barrier Reef by visitors (K. Nielson, pers. comm., 1995). Membership by the various diving, aviation, resort, fishing and tour boat Associations is voluntary, however operators within member Associations automatically become members themselves (K. Nielson, pers. comm., 1995).

James Cook University (JCU)

In 1993 the University established a Committee for Ecologically Sustainable Development to be charged with the fulfilment of three terms of reference regarding the assessment of current operations and the establishment of strategies to make the university's operations ecologically sustainable. Unfortunately the process has as yet not gone beyond the establishment of the committee. However, in the research arena JCU is also involved in INTROMARC.

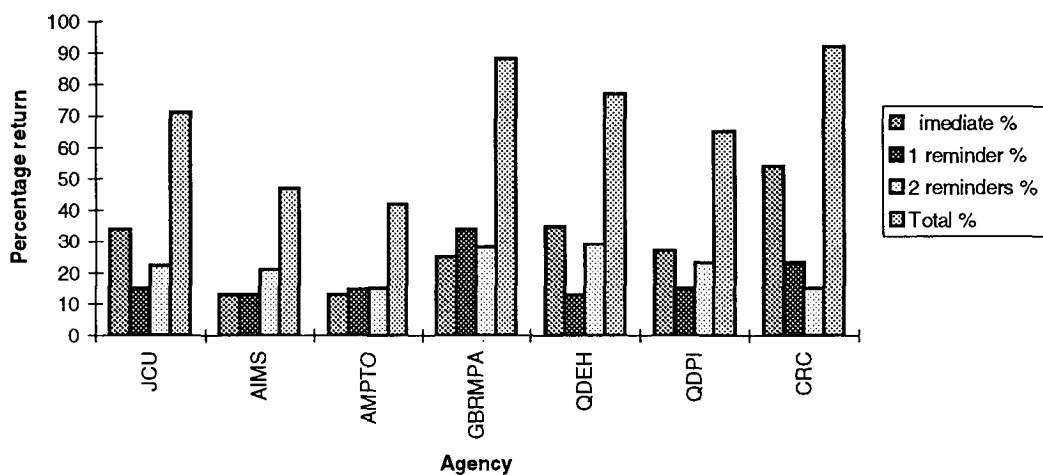
All the groups mentioned above are taking steps towards the national goal of ESD by being involved in the CRC for Ecologically Sustainable Development of the Great Barrier Reef, and also through their ratification of the 25 Year Strategic Plan for the Great Barrier Reef World Heritage Area.

Appendix 3 - Response rate analysis

Response rates

agency	initial N	immediate		1 reminder		2 reminders		no response		Total	
		#	%	#	%	#	%	#	%	#	%
JCU	41	14	34	6	15	9	22	12	29	29	71
AIMS	30	4	13	4	13	6	21	16	53	14	47
AMPTO	69	9	13	10	14.5	10	15	40	58	29	42
GBRMPA	32	8	25	11	34	9	28	4	13	28	88
QDEH	31	11	35	4	13	9	29	7	23	24	77
QDPI	26	7	27	4	15	6	23	9	35	17	65
CRC	13	7	54	3	23	2	15	1	8	12	92
Total	242	60	24.8	42	17.4	51	21	89	37	153	63.2

Questionnaire response rate



Appendix 4 - Number and percentage of respondents in all demographic groupings

Agency	Staffing Level			Occup / Expertise			Gender		Age Category				
	Senior	Middle	Operatnl	Social	Nat. Sci.	M'ment	Female	Male	18 - 25	26 - 35	36 - 45	46 - 55	> 55
GBRMPA n = 28 (")	18 64.3	9 32	1 3.6	7 25	7 25	14 50	7 25	21 75	1 4	5 18.5	15 55.5	4 15	2 7.5
AIMS/JCU n = 40 (#)	14 35	16 40	10 25	4 10	34 85	2 5	11 28	28 72	1 2.5	7 17.5	15 37.5	13 32.5	4 10
AMPTO n = 27 (* ")	18 69.2	4 15.4	4 15.4	10 37	3 11	14 52	3 11	24 89	2 8	11 42	7 27	3 11.5	3 11.5
DEH n = 24 (")	2 9	13 57	8 35	7 29	11 46	6 25	8 33	16 66	0 0	13 57	7 30	3 13	0 0
DPI n = 17	3 17.6	9 53	5 29.4	4 23.6	8 47	5 29.4	4 24	13 76	0 0	6 34	10 60	1 6	0 0
CRC n = 14 (* ')	4 36.4	0 0	7 63.6	2 18	9 82	0 0	3 25	9 75	5 42	5 42	1 8	1 8	0 0
Total N n = 148	59 41	51 35	35 24	34 23	72 49	41 28	36 24.5	111 75.5	9 6	47 32	58 39	25 17	9 6

* = missing value on staffing level

= missing value in gender

" = missing value on age category

' = missing value on expertise

Appendix 5 - Cross tabulation and Chi Square test on the eight words most commonly chosen as “one of five words most closely associated with the concept of ESD”

agency	growth		wise use		balance		preserv'n		limit		conserv'n		b'diversity		health		TOTAL
	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	
GBRMPA	29	27	75	77	61	74	21	31.9	50	48	61	64	36	36	50	26	383
AIMS/JCU	28	26	75	77	73	74	35	31.7	53	47	65	63	28	36	23	26	380
AMPTO	48	30	93	86	70	82	56	35.5	44	53	74	71	26	40	15	29	426
DEH.	21	29	79	84	88	80	29	34.4	50	51	67	68	46	39	33	28	413
DPI	24	25	82	74	82	71	18	30.4	35	45	65	60	47	34	12	25	365
CRC REEF	17	31	83	90	92	86	42	36.9	67	55	67	73	42	41	33	31	443
TOTAL	167		487		466		201		299		399		225		166		2410

Chi square homogeneity of variance test

Ho: there is no significant variation in choice of words between respondents belonging to the six agencies

Observed (O) = % of respondents choosing that word, Expected (E) = Row Total * Column Total / Grand Total

Chi square = $(O-E)^2 / E = 108.09$, Critical Chi square = 49.8 therefore $p < 0.05$ and Ho is rejected

Alpha = 0.05 DF = 35

Appendix 6 - Comments on question 1 (is ESD possible: why?)

Y = yes M = maybe N = no

AIMS	Y - it implies a modified natural environment that is viable
AIMS	M - complex linkages
AIMS	M - but we need wilderness areas which keep people out
AIMS	Y - if population growth changes
AIMS	Y - because ESD is an abstraction, a philosophy almost and can take form as a framework for action and decision making on resource use issues
AIMS	M - seen as usage / harvest, but there is the problem of greed and ignorance to be overcome
AIMS	M - it depends on the time horizon - we don't know what effects things now will have on the future
AIMS	Y - use ecological criteria as performance indicators and legislation and education to achieve them
AMPTO	Y - if you consider each development individually (can restrict them but don't refuse them)
AMPTO	Y - because we can sell the environment and make a profit
AMPTO	Y - out of need - tourism needs the environment so it will be preserved
AMPTO	Y - it has already been achieved at some scales - eg some fisheries
AMPTO	Y - at a GBR tourism scale because the operators are keen
AMPTO	Y - because it is good for the tourism business
AMPTO	Y - we can restore previously degraded areas
AMPTO	Y - it can be done in wealthy countries because we need the environment
AMPTO	M - if expert advice is not disregarded
AMPTO	Y - if we evaluate and control impacts
AMPTO	Y - if we put the environment above greed and money
AMPTO	Y - we are regulated like any other species so we will be stopped before we go too far
AMPTO	Y - because it has to be for our survival (*3)
AMPTO	Y - if we increase research into indicators of biological and physical health
CRC	y - if we find the balance between use and renewability
CRC	N - development means growth and growth is not sustainable
CRC	Y - sustain is a relative concept, but still ESD is a useful term as it encourages ecological thinking during the development process
CRC	M - if industry is interested and willing to take advice
CRC	N - its an oxy-moron
CRC	Y - it will happen when it becomes economically and politically essential
CRC	Y - if it is planned at the short and long term scales
CRC	M - if some money making ventures are cut back (tourism and fishing)
CRC	M - problem with definition - how can we sustain an ecology that we don't know everything about
CRC	Y - there is a growing commitment to balance in Australia
DEH	M - it requires information we don't have; and the will and cooperation of the community, government and individuals
DEH	M - but it is not yet being considered by most developers
DEH	Y - but it depends on the definition
DEH	M - it must be applied to individual industry operations

DEH	N - world bank, economics, multi - nationals
DEH	N - too much people impact on all areas
DEH	M - too much need - too few resources
DEH	Y - ecosystems are dynamic and can cope with some development
DEH	Y - but we need more information on resource ecology
DEH	M - it depends on the definition of development
DEH	M - but economics, commerce and politics are overwhelming
DEH	M - we need an understanding of the environment, and social and political acceptance
DPI	M - it should be "ecologically viable development"
DPI	N - due to money, politics and economics
DPI	M - only at a local and short term scale due to population and consumption pressures
DPI	Y - its a balance between economic and environmental considerations
DPI	N - because the economy revolves around money - will make wrong decisions
DPI	M - as unlikely as maximum sustainable yield
DPI	N - we don't know enough about b'diversity, and we don't have enough social commitment to make the right decisions
DPI	N - history has shown that some things are not sustainable
DPI	M - if costs of ESD are met by funding
GB	M - but economics and the power of money are too strong and friendly technology is too slow
GB	M - it depends on politics
GB	N - we always degrade the environment - through management we can achieve partial ESD
GB	M - ESD is out of date - try ecologically sustainable use
GB	N - human overpopulation problem
GB	Y - with proper management and research
GB	M - how do we know which environmental trends are normal and which are anthropogenic?
GB	Y - because the greatest profit comes from long term planning
GB	Y - can achieve projects at the local scale without destroying local values and environment
GB	M - it depends on the scale
GB	N - its an oxymoron
GB	Y - if development means social, cultural and intellectual development
GB	M - development means utilisation of resources and that can't go on forever
GB	M - if all users have one goal - to protect the environment
GB	N - ecologically sustainable use "yes" but development cannot continue indefinitely
GB	Y - in Australia, but not globally because of the population problem
GB	M - it requires a huge attitude change and a visible difference so that users see that they are achieving something
JCU	M - on a small scale only
JCU	M - problem of population size
JCU	M - complex social, economic and environmental issue
JCU	M - what is ecologically sustainable now may not be so in the future
JCU	M - the financial consequences will be hard on the public
JCU	M - should only aim at a 25 yr time frame, its not possible beyond this
JCU	Y - but there is a limit to development

JCU	N - because of the temporal mismatch between economics and ecology and because of population growth
JCU	M - it depends on the definition
JCU	N - because we don't understand resource dynamics
JCU	M - it depends on scale and geographic, cultural and economic setting
JCU	M - not under present social and political circumstances
JCU	N - any development will change the environment
JCU	Y - people are starting to change because they see it is necessary
JCU	Y - we need to understand ecology and keep development within those limits
JCU	Y - but its a question of scale
JCU	Y - if we assess stocks of tourists and future demand
JCU	Y - the key is education, and development in ways that don't require impact
JCU	Y - if we go back to doing things within the earths means