ASSESSMENT OF BIODIVERSITY IN ENVIRONMENTAL IMPACT ASSESSMENT IN WA

Report to the Environmental Protection Authority on Key Issues from a Workshop held on 16 - 17 May 2000

and Recommendations on a Way Forward

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Context

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(Extract from Reith Lectures 2000, second lecture given by Dr Tom Lovejoy, Chief Biodiversity Adviser for the World Bank. Reproduced in full in Appendix 1).

"The structure of ecosystems is made up of diverse kinds of plants, animals and micro-organisms, and their combined metabolisms constitute ecosystem function."..

"..the key consists of maintaining two elements -- measurable elements -- that are characteristic of the particular ecosystem. One is maintenance of ecosystem functions.. and the other is maintenance of the biological diversity of the ecosystem."..

"Biological diversity integrates the effects of all environmental problems affecting an ecosystem. This is essentially the fundamental, if often unrecognized, principle on which all environmental science and management is based. It applies everywhere not just in freshwater."..

"Taken at the level of the entire globe, the Ruth Patrick Principle, means that biological diversity can be considered the single measure of how humanity is affecting the environment. Think of that: instead of contemplating the welter of impacts society is generating, we now can measure the sum in a single number - a real measurable key to achieving and recognizing sustainability."..

(Lovejoy, 2000)

1. INTRODUCTION

The Environmental Protection Authority (EPA) regards biological diversity as a key environmental factor when carrying out environmental impact assessment and is required under the *Environmental Protection Act (1986)* to ensure that biodiversity and ecosystem function are protected.

The EPA is mindful of the international significance of Western Australia's flora and fauna and of agreements at the International level, such as the United Nations *Convention on Biological Diversity* and National and State strategies, agreements and legislation, including the *InterGovernmental Agreement on the Environment* and *The National Strategy for the Conservation of Australia's Biodiversity.*

The EPA has recently carried out a number of assessments on land clearing and other proposals where the provision of advice to the Minister for the Environment has required considerable work on biodiversity issues to enable the EPA to be able to form a judgement about the potential environmental impact. Major projects where biodiversity is/was a significant consideration include:

- the Derby Tidal Power proposal (significance of loss of mangroves);
- Cockburn Cement removal of shell sand in Owen Anchorage (significance of loss of seagrass);
- Yarloop sand mining (significance of loss of vegetation associations);
- limestone mining in Cape Range (stygofauna and troglobytic fauna);
- expansion of Kemerton industrial area (significance of loss of vegetation associations under-represented in Bushplan);
- West Angelas to Cape Lambert railway (associated with West Angelas iron ore mine) (National Park and mulga issues);
- land clearing near Mt Lesueur;
- Warrdage coal mine proposal; and
- expansion of sand mining and land swap D'Entrecasteaux National Park.

The EPA also has before it various assessments, including several where biodiversity is a major consideration (eg. the Ord Stage 2 proposal which involves the clearing of 35,000 hectares of native vegetation). It is recognised that biodiversity is increasingly becoming an issue for all proposals of any size.

The EPA has also been asked to provide advice on the Dieback Protocol. Dieback has significant implications for biodiversity protection and management in WA, particularly in the south west.

The EPA believes firmly in the importance of open-ness and transparency in its processes with the public and in being accountable for the advice it provides. The advice should be

readily understood by professionals and the public. There is often benefit in developing assessment approaches and protocols involving interaction with relevant experts and stakeholders, particularly for complex issues where information may be lacking.

The EPA as a five member mostly part-time Authority depends very much on the goodwill of Government Departments in providing service and advice so that the EPA can undertake its array of functions in a meaningful manner.

The Workshop on Biodiversity held on 16 & 17 May 2000 had several objectives:

i) to assist the EPA refine and articulate a clear, operational understanding of biodiversity in relation to the EPA's functions and responsibilities;

ii) to provide advice to the EPA on how the EIA process can be modified to incorporate the consideration and assessment of biodiversity;

iii) to provide biodiversity experts with the opportunity to experience the kind of information and questions that the EPA has to address in forming its judgements and providing advice on biodiversity (an educative function);

iv) through participating in the Workshop all participants would come to a better understanding of the legitimacy of EPA's role in biodiversity; and leading to a hope that

v) the co-operation at the Workshop would extend beyond to a willingness to continue to be engaged in assisting the EPA on matters involving biodiversity.

The Biodiversity Workshop included selected people from the Department of Conservation and Land Management, the CSIRO, Murdoch, Curtin and Edith Cowan Universities, the Environmental Protection Authority, the Department of Environmental Protection and several environmental consultants (see list of attendees in Appendix 2).

A Discussion Paper to stimulate thinking was circulated to participants prior to the Workshop (Robinson, 2000). This document contained a wealth of material and posed "thought starters" for people to consider. A collation of all responses to the thought starters is provided in Appendix 3.

The current involvement of the EPA in biodiversity assessment has developed in an ad hoc manner in response to the requirement to consider biodiversity as a factor in environmental impact assessment (EIA). However, EPA has a strong history of providing leadership in biodiversity dating back to the 1970's when the Conservation Through Reserves initiative commenced which led to the EPA "greenbook" and "redbooks" which divided the State into "Systems" and made recommendations for the promulgation of many new, formal reserves which have been progressively implemented.

Although the EPA's functions under the EP Act pertain to both policy development and EIA, the focus of this workshop was on EIA because of the perceived urgency to improve biodiversity assessment in EIA. It was not the aim of this workshop to address the broader, more strategic or policy issues as it is intended that these be managed at another time through a different workshop design.

The EPA Chairman introduced the specific task for the Workshop as to obtain an operational understanding of biodiversity, determining how it can be measured and how best to judge the acceptability of its removal or modification, noting there are two parts to

biodiversity - the individual species and aggregations (communities and associations) of species and also biodiversity as an ecosystem driver.

Workshop participants were encouraged to consider several key questions throughout the proceedings including:

1. How much biodiversity is enough?

2. How much breeding stock is enough?

3. Over what area should this impact be considered?

4. How environmentally significant is this impact? Does it constitute a "fatal flaw"?

5. How much data are enough?

6. Who should be responsible for collection of data, particularly at the regional scale?

7. How to get data (especially proponent data) into useful, accessible data bases.

8. how does the EPA respond to a proposal (for example an Ord Stage 2), in the context of the Commonwealth's expectations and the State being a signatory to the National Strategy for the Conservation of Australia's Biodiversity?

2. PARTICIPANTS' EXPECTATIONS OF THE WORKSHOP

A selection of participants' expectations directly relevant to the EPA's requirements is reproduced here:

- To come up with an agreed definition of biodiversity.
- Look at levels of biodiversity and discuss how we can develop indicators for them (provide EPA with indicators that are measurable).
- Develop a more formulated way of EPA getting advice.
- To find ways to ensure DEP has more contact with experts.
- The EPA has to be smart in the way it interacts with experts and ask precise questions rather than proving a generic document.
- Recognise the importance of establishing protocols and common standards.
- Raise biodiversity to a higher level when considering development proposals. The continent can no longer tolerate any more loss of biodiversity.
- Generate an environment in which the EPA feels that is has good access to good advice.

- Recognise that there are practical limits to considering biodiversity at an operational level - too narrowly focused on too few taxa, focus is on the wrong taxa and on the wrong level of taxa. Need to consider biodiversity at the ecosystem level.
- Develop a biodiversity assessment process for the EPA.
- Determine what environmental areas can really benefit from further research (eg student projects).
- Develop an assessment and environmental accounting approach that is not flawed and that takes account of services provided by ecosystems not just plant species.
- Recognise that biodiversity can be dealt with in a more formal and quantitative way. Move towards trying to supply survey data in such a way that it gives decision-makers a more quantitative means of assessing biodiversity.
- Cement the idea that it is reasonable to ask proponents to examine biodiversity in the same way that we would ask them to provide physical models.
- Need to have protocols in place.
- For setting level of assessment, need to have some standards in place so that best decisions can be made and ultimate advice to Government is defendable.

3. CASE STUDIES

A summary of the outcomes from the case studies run at the workshop is provided in Appendix 4.

4. SOME MAIN POINTS OF AGREEMENT

4.1 Dynamic Nature of Ecosystems

Guidelines should require proponents to set their proposal in the regional context. Proponents must be prepared to consider their proposals in a regional context.

Regardless of level being looked at, biodiversity is the product of what is happening in the environment. Thus no need to get stuck on what level should we be looking at. Important to look at the bio-geographic level at the same time.

Ecosystem processes are the key. First need to look at the processes to see what impact change would have on them. If a disturbance will affect processes, then in all likelihood the intrusion will change the species.

Managing processes, including evolutionary aspects, involves describing the system (at function level, or at genetic, species, morphology etc) from the viewpoint of the organisms living there, as well as a description of the system (quantitative or conceptual) to which you can relate your processes and identify the ecosystem "drivers". One way of looking at species assemblages is that they are defined by all of the gradients that intersect at a particular point at that time.

Process in terms of species congruence in geographical space is important but one has to start with something specific (either species composition or functional morphology).

As there are significant differences in the terminology and use of definitions it would be useful to define the terms species, taxa, priority, rare, endangered and restricted and to standardise use.

4.2 How to Handle Species Diversity

All species are not equal. Some are more important than others, but we do not necessarily know which these key species are.

Big framework biodiversity surveys (such as that done by Norm Mackenzie for the Salinity Action Plan) would allow EPA to make better judgements.

The important wetlands are the undisturbed ones but we do not know them all yet.

We need the experts on systems to provide an interpretation of what a species list is telling us about overall environmental condition and environmental change.

Proponents should have to have other consultants look at this aspect (the interpretation) not just the people who did the surveys and compiled the species lists.

Best solution would be to equip the decision-makers and the DEP officers with a very good understanding of the patterns of diversity within as many groups as possible, for as many ecosystems as possible and also patterns of trends in organisms in relation to a variety of disturbances. If you have a framework of patters then you should be able to slot data into the framework.

More species does not equal better.

5. KEY CONCLUSIONS FROM THE WORKSHOP

5.1 EPA has a clear and legitimate role in biodiversity in Western Australia as an environmental "watchdog". EPA has roles that CALM does not have such as Environmental Protection Policies, Position Statements, Guidance Statements. Furthermore EPA can comment at a broader level, for example about the rangelands or wheatbelt as a whole.

5.2 Need a re-statement of the philosophical position from which the EPA operates and the "world" within which it operates. It was stated at the Workshop that Biodiversity is an ecosystem driver and also has an intrinsic value both morally and ethically which means that we all have the responsibility, (but in particular members of the EPA and the institution of the EPA) to ensure that it is not reduced or put at risk.

5.3 We must use the Commonwealth definition of biodiversity which defines biological diversity as being:

"*The variety of life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity.*" (Commonwealth of Australia, 1996a, p.50).

and

"*Biodiversity is all forms of life - the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form a part.*" (Commonwealth of Australia, 1996b, p.4-4).

The definition of Lovejoy (2000) is also relevant and is not restricted sole to all forms of life:

"*The totality of this diversity from the genetic level, through organisms to ecosystems and landscapes is termed collectively biological diversity.* "

5.4 In assessing biodiversity it will have to be done on a case by case basis as it is unlikely that a broad based approach will ever be practical. There will be some cases where this will need to include the genetic level of diversity.

5.5 It was recognised that it is important for a proposal to be looked at in its local and regional environmental context and for strategic and cumulative impacts to be considered as well (such as the Pilbara iron ore mines and railways).

5.6 Government should be responsible for driving the collection of regional biodiversity information and can do so by lining up money, services and kind, and approaching companies to assist. There is probably a role for the EPA in setting the framework for obtaining regional environmental information. CALM recommended using an open architectural design approach which leads to increasing knowledge base rather than an information dead end.

5.7 There is a need to identify the priority areas for regional work. This needs to take account of both development nodes and other interests. An ideal is to have

ecological maps (as equivalents to vegetation maps) which could show distribution of groups (eg invertebrates) or a number of layers such as geology, soils, vegetation, fauna as ecozones similar to the approach used to map Kruger National Park.

5.8 It was noted that setting level of assessment is a key step in the assessment process and often insufficient time was allocated to the task of obtaining advice from experts, for example on biodiversity, prior to setting the level of assessment. In general, very little information is sought, other than that provided by DEP officers.

5.9 It is as important to define what you do not want (in terms of environmental quality) as it is to define what you do want. For example, it is a case of not wanting an unnatural assemblage even thought it would keep salinity levels down.

5.10 We have clear indicators of what is an unacceptable system and also need to have clear indicators of what is an acceptable system (ie functioning, regional, undisturbed etc)

5.11 A key question is to what extent are we able to keep the naturalness of a system? An indicator of change (acceptable/unacceptable) may then be a measure of difference from what is/was natural compared to what is there now or would result from a proposal. (this can be done quantitatively or may be qualitative where we are dealing with the public expectation of the retention of a degree of naturalness).

6. KEY ELEMENTS REQUIRED FOR EPA ASSESSMENT OF BIODIVERSITY

6.1 EPA needs to be clear about why it is protecting biodiversity. Is it because of ecological processes and ecological function or for its own sake (bearing in mind that different assemblages of organisms can provide equivalent ecological function).

6.2 It must be remembered that the community expects a degree of naturalness in our environment.

6.3 A systems approach to assessments is essential. There are currently problems with the definition of an environmental factor (too reductionist the whole system is greater than the sum of the parts). The environmental factor should be the ecosystem as a whole not divided into bits as at present. There is a need to move to proper consideration of environmental systems as the key focus of assessing change. The system should replace components of systems as the environmental factors. This will need revision of the Heathcliffe Table and EIA approach, but is consistent with the work already substantially progressed by the Chairman, former Deputy Chairman (Sally Robinson) and Colin Murray in September 1999.

6.4 Need better advice at the setting of level of assessment. Chairman needs to be able to access key biodiversity experts (those with knowledge of environmental systems) from outside the DEP to assist with this.

6.5 The key questions to ask when setting level of assessment and throughout the assessment process are:

- what are the ecosystems that would be affected by this development?
- what is the area of the ecosystem that would be affected?
- what is the estimated magnitude of change to biodiversity in that ecosystem?
- what is the ratio of this area to be affected compared to the area of this ecosystem remaining pristine?

6.6 Biodiversity should be properly considered at the stage of "Quick Yes" and "Quick No".

6.7 Develop a way for the EPA to be able to access better biodiversity advice at several stages in the assessment process, in particular setting level of assessment, development of guidelines, determining suitability of proponent documentation for review, assessment by the EPA.

6.8 The EPA can do better in its development of the Guidelines for proponents for large projects. Small external groups could be used to develop guidelines at least in some instances (not just for ERMP's), to ensure that issues are properly scoped and addressed. In the case of biodiversity this would need to cover sampling strategies, strategic approach to collecting information, data analysis requirements etc.

6.9 EPA needs assistance in identifying key issues and questions so there is a need to be able to access experts to nominate the things they think the EPA should know about for particular assessments in particular areas.

6.10 EPA should ensure that the information on biodiversity in proponent documentation is adequate for the assessment. In part this relates back to the guidelines and EPA/DEP getting its expectations right at an early stage. At present, DEP circulates parts of drafts to other agencies but if inadequacies are identified this is addressed during the response to submissions. However, this prejudices the ability of the public to have a meaningful document on which to make comment. Inadequacies should be corrected prior to public review. This will hold up release but should signal to proponents to improve their game on biodiversity work and surveys.

6.11 Proponents should be able to identify hotspots and avoid them whenever feasible. This was the intent of the Position Statement on "Special Areas".

6.12 Develop measurable indicators of biodiversity for the EPA to use.

6.13 EPA should ensure that information provided by proponents is valid and accurately presented in review documentation.

6.14 Establish standard data collection and survey protocols for key information required for assessments.

6.15 EPA needs to be more targeted and specific in framing the questions to which it wants answers from biodiversity and other experts in assessment.

6.16 EPA needs to have ongoing access to the Workshop group and to a wider group of biodiversity experts. This can be done through compilation of a directory of the key topics, various experts etc as a database cross linked to find the best people to consult. The list should be bigger rather than smaller. It is important to know who

has the right information. There could be a head of the group to round up the information.

6.17 EPA should address the issue of biodiversity in a broader context than EIA on a case by case basis for individual projects.

6.18 EPA should address cumulative assessment in the context of biodiversity?

7. OUTSTANDING KEY ISSUES REQUIRING FURTHER CONSIDERATION

7.1 How can EPA address the issue of biodiversity in a broader context than EIA on a case by case basis for individual projects?

7.2 How should EPA address cumulative assessment in the context of biodiversity?

7.3 Who (and how) should data bases be set up to ensure that all proponent data is collected in a manner that will allow for comparison and is incorporated in the State database?

7.4 There is an urgent need for DEP to develop and maintain its expertise in biodiversity assessment. There is a need for training of DEP staff by biodiversity experts and for this to be on-going training.

7.5 There is a need to move to proper consideration of environmental systems as the key focus of assessing change. The system should replace components of systems as the environmental factors. This will need revision of the Heathcliffe Table, and approach to EIA but consistent with the work already substantially progressed by the Chairman, former Deputy Chairman (Sally Robinson) and Colin Murray in September 1999.

7.6 The opportunity exists for work to be done relatively inexpensively on areas identified by the EPA as priority areas. The Universities collectively carry out over 120 student projects each year and are keen to have these be real and useful wherever possible. These can be focused by the EPA and carried out for very low cost (generally sufficient to cover travel and accommodation). Several university staff raised that they would like to have the opportunity to brief the EPA on last year's student projects and seek input on priority areas for the coming year.

8. CONSULTANT'S RECOMMENDATIONS

8.1 EPA has a clear and legitimate role in biodiversity in Western Australia as an environmental "watchdog". EPA has roles that CALM does not have such as Environmental Protection Policies, Position Statements, Guidance Statements and EPA can comment at a broader level.

8.2 The EPA should re-state the philosophical position from which it operates and the "world" within which it operates. It was stated at the Workshop by the EPA Chairman that Biodiversity is an ecosystem driver and also has an intrinsic value both morally and ethically which means that we all have the responsibility to ensure that it is not reduced or put at risk.

8.3 EPA should make a clear and public statement (eg in the Annual Report) about why it is protecting biodiversity. Is it because of ecological processes and ecological function or for its own sake (bearing in mind that different assemblages of organisms can provide equivalent ecological function).

8.4 From a strictly "living things" perspective the EPA should use the Commonwealth definition of biodiversity which states that biological diversity is:

"The variety of life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity." (Commonwealth of Australia, 1996a, p.50).

and

"Biodiversity is all forms of life - the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form a part." (Commonwealth of Australia, 1996b, p.4-4).

However, it should be noted the biodiversity and biological diversity are not inter-changeable terms (see also 8.5)

8.5 The definition of biodiversity of Lovejoy (2000) is fuller as it includes landscape and life (see below). This makes a systems approach to assessments essential if biodiversity is to be properly considered by proponents and the EPA.

"The totality of this diversity from the genetic level, through organisms to ecosystems and landscapes is termed collectively biological diversity. " (Lovejoy, 2000).

8.6 It is recommended that as there are significant differences in the terminology and use of definitions it would be useful to reach common understanding of the terms species, taxa, priority, rare, endangered and restricted and to standardise use, at least within WA, and to consider the definitions of "Biodiversity" and "Biological diversity" as in recommendations 8.4. and 8.5.

8.7 It is recommended that the EPA accept the key elements identified in Section 6 of this report and develop its approach to assessment of biodiversity in EIA accordingly.

8.8 It is recommended that Guidelines should require proponents to set their proposal in the regional context.

8.9 The EPA should establish a means of being able to obtain the best advice from a broad range of experienced professionals on biodiversity and other important environmental issues it is considering in assessment of proposals. Groups and individuals such as used for the Workshop form a good starting point for the issue of biodiversity. The people who attended the workshops on Special Areas as well as others can also provide a useful resource singly and in combination. Although such experts would be likely to be used in an occasional and ad hoc manner, it may be appropriate for the EPA to allocate a portion of its budget to cover costs and a small fee for those providing advice.

8.10 All species are not equal. Some are more important than others, but we do not necessarily know which these key species are. It is therefore recommended that proponents and the EPA manage uncertainty within a framework of lack of sufficient knowledge, through use of the Precautionary Principle and other approaches such as application of the ASTEC guidelines for carrying out research in World Heritage and other environmentally sensitive areas.

8.11 The review of approach to assessment commenced in September 1999 be completed, with a view to replacing the current approach to assessment with a systems approach. This would necessitate a change of emphasis from the small element environmental factors as currently expressed in the "Heathcliffe Table" to an environmental factor being defined as the system(s) being affected by a proposal.

8.12 It is recommended that as the Workshop held on 16-17 May 2000 focused on the EPA, biodiversity and environmental impact assessment, a second workshop be held focusing on the policy and broader strategic roles of the EPA in biodiversity in all environmental systems in Western Australia. Biodiversity provides a useful focus from which more generalised approaches for other statewide environmental issues may be extrapolated at the policy and strategic levels.

8.13 The workshop was beneficial in re-establishing positive working relationships between the DEP/EPA and CALM as well as in establishing new links. It is recommended that a similar workshop approach, involving 1.5 to 2 days and including an overnight stay and dinner, be used to improve linkages and working relationships with other key agencies, individuals and stakeholder groups to think-tank issues and approaches to other significant environmental topics. Examples would include water resource development, catchment management, natural resource management, salinity, marine and coastal management, greenhouse etc.

8.14 It is recommended that the EPA establish several student scholarships to cover the transport and accommodation costs of projects of benefit to the EPA. These may initially be in the area of biodiversity but may be extended to include other expertise areas. The EPA could consider establishing an annual student prize project similar to that run by the Australian Water Association.

9. REFERENCES

Commonwealth of Australia, 1996a, National Strategy for the Protection of Australia's Biological Diversity.

Commonwealth of Australia, 1996b, State of the Environment Australia 1996.

Robinson, S. J., 2000, "Biodiversity??" A Working Paper to Stimulate Discussion at a 2 Day Workshop to be Held May 16 - 17 2000 for the Environmental Protection Authority.

APPENDIX 1

Reith Lectures 2000

Respect for the Earth - Can Sustainable Development be Made to Work in the Real World?

Reith Lectures 2000, Lecture # 2 Biodiversity - Dr Tom Lovejoy (Chief Biodiversity Adviser for the World Bank)

From the moment of our birth we grow up in a world of difference. Very early we learn we share this world not just with our family but with other living things. "Every child has its bug period" as the great Harvard biologist E. O. Wilson says. We discover that not only are there different kinds of plants and animals-- which scientists call species --but also that there can be lots of difference between individuals of any one kind.

This genetic variation we discover first in our parents. And unless we live in an urban setting far from a park, we soon learn that different kinds of animals and plants live together in different places: camels in deserts, whales in the seas, gorillas in tropical forests. The totality of this diversity from the genetic level, through organisms to ecosystems and landscapes is termed collectively biological diversity.

I chose to come to California to give this lecture rather than somewhere else, because of an exciting experiment with biological diversity. I believe it may well help us in the global quest to maintain the biological underpinnings of sustainability, but I will turn to the story of the California Gnatcatcher later in this talk.

It is another fact of life that no organism can exist without affecting its environment. To be alive requires energy so all organisms need to eat: even green plants which use the energy of the sun have to take in nutrients to both live and grow. Similarly all organisms produce wastes. While they are biodegradable -- and it is nothing short of astonishing what some organisms will "feed" upon -- the wastes do alter the environment and potentially affect other organisms.

Consequently the choice confronting humanity is not whether it affects the environment or does not. Rather the choice is about how we affect the environment, that is, in what ways and to what extent. Our planet is very much a living planet and it's incredibly rich web of life is central to how it functions and therefore to sustainability of the human enterprise. Understanding and attaining sustainability is therefore very complex and does not admit of many simple solutions.

At the moment it is clear that we are far from sustainability. We are in deep trouble biologically and already into a spasm of extinction of our own making unequalled since the one which took the dinosaurs. It is not a peaceable kingdom. The rate at which species disappear is about 1,000 to 10,000 times normal, and a quarter or more of all species could vanish within a couple of decades. There is a major problem with biological diversity. That really is a given. What is far more important is to recognize why it is happening and how we might arrange our lives so our grandchildren can enjoy a sustainable existence on a biologically rich planet.

Biological diversity lies at the heart of sustainable development. The quality of our lives is entwined with it so much more deeply than most of us ever notice, that our fate depends on how well we provide for the future of other forms of life. This goes way beyond the obvious and essentials of food, fiber and shelter, to medicines and complex industrial processes. Biological diversity is essentially an incredibly vast library for the life sciences which is drawn upon to improve critical biologically based enterprises like agriculture and medicine.

Just recently, a sample from a Zambezi riverbank of an obscure group of organisms called slime molds yielded promising new compounds to fight tumors resistant to taxol. Taxol, a key element in the arsenal against breast, ovarian and lung cancer, loses effectiveness in some cases. Taxol itself originally came from the Pacific Yew, considered by foresters just a few years ago to be a trash tree in the forests of the northwest United States. The effective molecules in both cases came from natural defenses of the two wild species in interactions with other species. Sometimes the link is less direct but nonetheless very real as, for example, the development of the ACE inhibitors for treating high blood pressure they arose from the discovery of a unknown system of regulation of blood pressure in the course of a study of the venom of a tropical viper.

The structure of ecosystems is made up of diverse kinds of plants, animals and micro-organisms, and their combined metabolisms constitute ecosystem function.
In this day of quick resort to technological fixes, it is notable that New York City elected to restore the ecosystem function of its degrading watershed rather than construct a water treatment plant. When I grew up in that city it was famous for the quality of its water: when I would return after being away I remember noticing how delicious the water tasted. It even won in blind tastings over fancy European bottled waters. But changes in land use in the watershed led to deteriorating water quality until our Environmental Protection Agency was about to require the city to build a multi billion dollar water treatment facility. Instead a bond issue at a tenth the cost made it possible to restore the watershed, its biological diversity, and therefore its functions. It was a natural and a permanent solution.

What we often call natural disasters are not always natural. They often happen where a little recognized ecosystem service, namely that of disaster prevention has broken down. The horrifying floods and mudslides Hurricane Mitch brought Honduras and the even more ghastly events in December following heavy rains in Venezuela demonstrate this well. Equally heavy rains in Venezuela in 1952 had much lesser consequence because the poor - the ultimate victims -- had not then deforested critical slopes. In Honduras there are anecdotes of adjacent hillsides in which the one with intact forest remained stable and also released less floodwater. Often characterized as "natural disasters" these are only partly so, and the devastating humanitarian and economic blows make a strong argument for maintenance of ecosystems and their services. And, right now we are seeing this happen once again in Madagascar.

About 50 years ago, American freshwater ecologist Ruth Patrick began a line of research subsequently recognized by the U.S. National Medal of Science. Ruth, has been essentially a den mother for a couple of generations of scientists and is in my personal Pantheon. Fifteen years ago when I chose her to speak at a particularly important meeting on the environment, someone asked me "Why did you choose someone so old?". My reply: "When your grandmother tells you have cooties or head lice, you take it more seriously."

Ruth Patrick began a systematic study of rivers and their biological diversity which demonstrates that the numbers and kinds of species in a river -- its biological diversity in our current parlance -- reflect the basic ecology of the river and the environmental stresses to which it is subject. In other words, biological diversity integrates the effects of all environmental problems affecting an ecosystem. This is essentially the fundamental, if often unrecognized, principle on which all environmental science and management is based. It applies everywhere not just in freshwater.

Taken at the level of the entire globe, the Ruth Patrick Principle, means that biological diversity can be considered the single measure of how humanity is affecting the environment. Think of that: instead of contemplating the welter of impacts society is

generating, we now can measure the sum in a single number - a real measurable key to achieving and recognizing sustainability.

At the scale of an ecosystem such as South Florida, the coastal sage scrub of California's five southern counties, or even as ambitious a one as the Amazon basin, the key consists of maintaining two elements -- measurable elements -- that are characteristic of the particular ecosystem. One is maintenance of ecosystem functions, such as the sheet flow of water in South Florida, and the other is maintenance of the biological diversity of the ecosystem. The latter can be thought of as managing so that the species list a hundred or five hundred years from now will be pretty much the same as it is today. It certainly does not mean that this has to be true of every spot within the ecosystem although there do need to be areas of strict preservation. There certainly can be locations (cities for example) where there is very intense use and low biological diversity. It does mean enough wild places and enough connections between them so all the species can make it in the long term.

These two measurable goals provide an operational definition for sustainable development within that piece of geography. It is, of course, seriously challenging because it means taking on all environmental problems intrinsic to the area as well as those like acid rain and climate change which are extrinsic. While this might seem to ignore the social and economic elements of sustainability, in the end it certainly does not, because otherwise they will begin to affect the two measurable standards: ecosystem function and biological diversity. Consequently the other aspects of this lecture series, for example good governance and health, are also vital for success. If not applied late in a history of environmental degradation, this ecosystem management approach allows for considerable flexibility and creativity in addressing human aspirations.

South Florida provides an instructive case. A large ecological unit, it extends from the Kissimmee River and Lake Okeechobee about half way up the Florida peninsula down through the Everglades Park and includes Florida Bay, the Florida Keys and the coral reef beyond. It is essentially a single system dependent upon the sheet flow of water from north to south known as the "River of Grass". Over a half century or more individual isolated decisions -- each presumably reasonable in their own context and time -- for flood control, water supply, and agricultural purposes, have drastically altered the flow. Not a drop of water flows naturally without a valve being turned, and only a quarter to a half of the natural flow reaches Florida Bay depending on the year. Subterranean flow through the limestone underpinnings is so reduced the freshwater upwellings in Florida Bay have ceased. The result is a degrading ecosystem, reproductive failure of water birds, endangered species, hypersalinity in Florida Bay, loss of seas grass beds, algal blooms and additional stresses on an already stressed reef system. Ecosystem function and biological diversity are measurably impaired. I had no inkling of this when I first visited the Everglades as a teenager and the problems were not blatantly obvious at that point. In 1993, however, when I served as Science Advisor for the Department of the Interior, the problems were so obvious I could pick out some of them on satellite images of the peninsula.

If the above is the consequence of ad hoc and uncoordinated decision making, then the resolution of such problems, or better yet their avoidance, depends on the converse: on integrated and consultative decision making that integrates society's decisions within the ecosystem framework. When it works best it takes the decision making back to where people live. This is the essence of the multibillion dollar program to restore the natural plumbing of south Florida as much as possible. It will take decades and makes a good case for avoiding such problems to begin with. It also is not easy with so many players with differing vested interests. For example the state recently refused to implement part of the plan, namely to buy out people who had encroached on some sensitive areas. Scientifically

the plan needs some significant improvement. Nonetheless, the degradation is beginning to be reversed and the overall trend seems positive.

Southern California where we are tonight presents a different example. Home to Los Angeles, San Diego and some of the worst urban/suburban sprawl in the United States, its native habitat had become reduced to the point, that America's most powerful environmental legislation, the Endangered Species Act was invoked on behalf of a jaunty little bird, the California gnatcatcher -- which just happens to inhabit some of the priciest real estate in the nation. The powers of the Endangered Species Act have tended to be used only once a species is listed (an indication that its habitat and constituent biological diversity was on the verge of being endangered itself). So the exercise was not just about the gnatcatcher but an array of other species like a tiny arboreal salamander, a lizard known as the orange-throated whiptail and the San Diego Thornmint. Southern California , in fact, has a concentration of species found nowhere else: you are all living in this biodiversity "hotspot". If nothing is done until a species reaches the brink of endangerment, inevitably there are economic interests squared off against a species with an obscure name. So even though this really is a signal that the region is beginning to unravel biologically, the situation is easily caricatured as people vs. biological esoterica. A famous example is the Tellico Dam in Tennessee is a little minnow called the snail darter.

So when I was at the Department of the Interior, the situation here was turning into a classic test case for a new approach. I came out to California and thanks to colleagues at the Department of Natural Resources, I had the chance to see the situation firsthand, from the air, on the ground and with the people seeking a resolution. This time the state of California together with the federal agencies and the five county governments undertook to deal with the problem proactively while there was still some flexibility biologically and legally. Industry and civil society, especially the Nature Conservancy, were active participants. The idea was to plan conservation of entire natural communities before it was so late that costs and consequences became impossibly high. Large landowners such as the Irvine Company, were major players, agreeing to land exchanges which worked for both nature and their business interests. At Camp Pendelton in San Diego County the United States Marine Corps worried that the military might have to shoulder a particular heavy burden and were delighted to discover that when all engaged in the plan this was not so. The Commandant even took particular pride in beach management to favor a nesting seabird.

Through the regional program some 400,000 acres have been identified for eventual protection, a network of conservation which is now more than 60% complete. True, endangered species listing of the gnatcatcher in one sense drove the process, but the result was considerably better than otherwise would have been the case using regulatory powers of the Endangered Species Act alone. Just two weeks ago California voters approved a four billion dollar bond issue for securing critical conservation land, with at least $150 million of this dedicated to southern California.

I go to the Amazon with such frequency that I have given up explaining. I just say I am always on my way to the Amazon. In fact, I wrote this lecture on my laptop while I was there. As important as it is from a conservation point of view I confess I also just like to go to this place of perpetual biological surprise and listen to howler monkeys and other jungle noises from my hammock. As complex as South Florida or Southern California are, an even more complex challenge is presented by ecosystem management of the Amazon. Comprising eight nations, for none of whom the Amazon is a major priority, it nonetheless operates ecologically as a single system. In an extraordinary interaction between biological and physical elements, the Amazon literally generates half of its own rainfall. If too much forest is cleared in the wrong places, the hydrology would begin to change and affect the biology of this, the largest of the world's forests, the largest wilderness and the world's

single greatest repository of biological diversity. In its vast river system which contains 20% of all the river water in the world reside around 3000 species of fish (more than the entire North Atlantic) some of which migrate from estuary to headwaters and back in the course of their life spans.

Each Amazonian nation finds it hard enough to integrate the various elements of government decision making into a comprehensive policy resembling something like ecosystem management for their piece of the Amazon. Is there any possibility that there could be coordination at the level of the Amazon as a whole? The optimistic answer is that there is certainly a greater chance today with some enlightened national leaders and ministers. The Treaty for Amazon Cooperation provides a possible framework, but it will require leadership especially by Brazil which holds two thirds of the real estate. I believe it could happen and I know that multilateral agencies like the World Bank, the InterAmerican Development Bank , UNDP and UNEP plus civil society would jump at the chance to support such an effort. Sustainable development takes good governance as well as good science.

All three examples must be considered works in progress not final solutions because environmental problems arise continuously like dragons' teeth. One of the most important extrinsic factors for ecosystem management is that of climate change. This is in large degree because when biological diversity is protected by isolated parks and reserves, the ability of species to move and to track required ecological conditions is impeded by an obstacle course of human dominated landscapes.

All will be for naught if society fails to address the greenhouse gas problem. The threat is also much more imminent than most people realize. The world is literally melting: tropical glaciers will be gone in twenty years and new data on the Arctic ice cap indicate that it too is likely to break up in the same time period.

The good news is that there are things we can do about that right now. Some involve energy substitution and conservation. Others involve trees and forests because they play an enormous role in the global carbon cycle. A major effort to stem deforestation, reforest, and to protect natural forests will ward off further greenhouse gas emissions and also make a major contribution to conservation of biological diversity.

The moment is at hand to take the right steps to underpin a sustainable future biologically. Certainly, the challenge is highly complex, and it must work locally everywhere so that it all adds up to sustainable development. Yet it could be summed up by saying we need to live within nature rather than think of it as something which is taken care of, almost in token fashion, with fenced off areas while humanity operates without restraint in the rest of the landscape.

As powerful and imperative as I believe the practical arguments for conservation are, a change in perception and value about our place in nature could achieve vastly more. Classical conservation is not in fact enough. Honoring the Patrick Principle through ecosystem management means we have to live in ways that won't degrade the biology of areas of strict preservation, but also won't degrade that of the landscapes in which we live. That is why sustainable development is so important. It is also why it is so complex to grasp. Fortunately in biological diversity, we not only have wonderful resources we also have a very real measure of sustainability. I am frequently reminded of a long discussion with British naturalist Gerald Durrell when he turned to me with tears in his eyes and said: "There is so little time".

The natural world in which we live is nothing short of entrancing -- wondrous really. Personally, I take great joy in sharing a world with the shimmering variety of life on earth. Nor can I believe any of us really want a planet which is a lonely wasteland.

QUESTIONS FROM THE FLOOR

Gordon Labaedz - leader of the Southern Californian Sierra Club: For your overseas listeners the Sierra Club is the largest volunteer activist environmental organisation in the United States, and what we've found is that sustainable development has become a buzz word for human centred destruction of the wild planet, and if in fact sustainable development is something that's enacted it's for humans, it's to diminish air pollution and to have good drinking water etc - I would question whether or not it maybe more reasonable at least from an environmental activist point of view to look at it from the animals' and the plants' point of view rather than the humans' point of view.

Thomas Lovejoy: Well you know I think in fact that is precisely why I come down to the conclusion that you really need to have a biological measure - as to whether a piece of landscape is being treated in a sustainable fashion, because otherwise there's no real way to know whether you've actually passed certain limits or not, so I think in many senses I subscribe entirely to your point of view.

David Brower - founder of Earth Island Institute: I have the same concern about the word "development" - in my lectures I usually go for a laugh by saying I recommend open season on developers and the audience loves that. I'd like to see what you think of the word sustainable "diversity" - where I have no problem.

Thomas Lovejoy: Given the choice between using the word development or growth, I much prefer to use development because growth just seems to go on consuming forever until it in a sense consumes itself. Sustainable diversity - I mean in fact what I've been talking about in a sense could be called that - it certainly could be called that, because its measure in the end is whether the diversity survives.

Cathleen Cox - director of research at the Los Angeles Zoo: I'm also species co-ordinator for the Drill, which is one of the most endangered primates on the continent of Africa. My observation has been that when people are told they can't continue to pursue their livelihood there's a lot of resistance, for example in the centre of California the Tiger Salamander has just been declared endangered and the farmers there are being told they can't till the same soil as they did before - in Nigeria the Drill is so endangered that the local villagers are being told they can't hunt bush meat. And I think that individuals don't want to give up immediate rewards in trade for some of the potential problems in the future being alleviated and in fact in the future they may not be around - they know they have to bear the cost of the problem so my question really is - how can we make the future more important to today's population?

Tom Lovejoy: Well that question goes to the basic heart of everything about environment and a number of other issues as well - the short term versus the long term. And I think it's easier to do it if you have a larger framework, so if you're looking at a situation in a larger piece of landscape which can provide other opportunities which are not destructive of the biology then it's easier to come to some kind of resolution. In a sense you are telling somebody they can't do something but you're also giving them something else they can do. And all of that is fine and dandy but in the end it also comes down to the total number of people in a piece of landscape and you know what the impact is per individual - and that varies greatly around the world from huge impact of North Americans

as opposed to some people from the Third World, so it is a major challenge, no question about it.

Josh Muldavin - Professor in Geography and Environmental Studies, UCLA: I get the sense in terms of your judging of sustainability by this single measure of declining biodiversity that in essence you've taken an approach which places our hopes in the hands of the lead scientist, policy-makers, political leaders, captains of industry, environmental managers - and as such the answers tend to be fairly top-down in practice if not in your vision. In your lecture you talk about we, us, our - and in fact I don't think that 'we' exists and in the reality there's a vast divide between those who gain the benefits of environmental degradation and those who pay the costs which is the vast majority. So I'd like to challenge I guess this notion of biodiversity because it tends to completely obliterate what I think are much more central issues around the environment and that is who's determining what this kind of sustainable development should be? - who's paying for it? - and who's paying the costs of it?

Tom Lovejoy: Well my answer to that is in fact the first two of the three examples I talked about, I think the only reason they're working at all is because there is local participation. I mean otherwise I think it would just have exploded. Part of the reason it works is that when you have local involvement somebody who has a piece of the mosaic and gives up a little bit of his or her God-given right to what they want to do on that piece of the mosaic - in fact gains much more by being in communication with the surrounding pieces of the mosaic and in fact warding off things that might affect their piece. We're really new in this whole game of trying to take this kind of approach to land use through all levels from the Federal Government down to counties and to local people and local environmental groups and local businesses and the rest. And it's messy - it is really messy and the further the biological degradation has progressed the harder it is. But I think in the end that's the only way it's going to work.

Josh Muldavin: I understand that you want local participation but - again this is a rhetoric-versus-reality idea - you're a representative here, you're an advisor to the World Bank - not an organisation that has too much accountability to the public in general or to people in local areas and you know as an advisor to them that most of their projects environmental are about selling environmental technology - helping first world corporations sell environmental technology. It's not about solving structurally environmental problems and why degradation happens So it provides a nice technocratic problem and a technocratic solution and my fear is in that doing biodiversity as the measure you're maintaining in essence a technocratic top-down approach, although I understand that you personally view individual participation and communities as an important attribute to that.

Tom Lovejoy: Well you know I mean there's always a tension between the top-down and the local but you know an awful lot of environmental movement starts locally because of some local problem, so I don't think it's quite so simplistic as that. I didn't come here to defend the World Bank where I'm only spending two years. But there is a lot that goes on at the World Bank - it's a lot better than I thought it was - I mean really you know the bank is largely defined but its mistakes and I'm astonished to find that there's a portfolio, to use the bank word, well in excess of a billion dollars on projects that legitimately can be called biological diversity projects and there's a whole bunch of other stuff that gets labelled other kinds of things which is different from selling environmental technology.

Host, Kate Adie: Thank you - before we take more questions from this audience here in Los Angeles let's here some of the comments from people who've joined in our debate on the Internet. Over the past few weeks the BBC has had a website devoted to these Reith lectures and we've had many e-mails from around the world - such as this from Nicolas

Pringle saying " the island of Kiribas, the first place to see the dawn of the new Millennium is expected to be submerged by the sea within 50 years due to global warming. Is this not a message to us all that sustainable development is essential - if a true global nightmare is to be avoided?

Then Jo Turner from the United Kingdom makes this point: "the problem we face is not that there is too little food or too few resources but that we in the West use more than our fair share." He sums it up like this: "we must live more simply so others may simply live." And finally Paul Dolman read Dr. Lovejoy's summary of his lecture on the BBC website and wasn't very impressed. Once again he writes : "We hear the same stale techno-centric and invalid arguments from Tom Lovejoy. Can we please have some honesty in this debate? One day very soon the corporate and government decision makers are going to see through the rationalist smokescreen - people like Dr. Lovejoy perpetuate as a justification for conservation. And if we have not then begun to fight from the position that life is worthy of veneration irrespective of whether it has some material value to us, then we can kiss it all goodbye."

Tom, the thought there seems to be that nature's important for itself not just for how it can help the human race - are you about to defend your rationalist smokescreen?

Thomas Lovejoy: Well I believe I said something about a change in values is more powerful and that we really need to think of ourselves as living within nature. You can't exist without affecting nature - if we eat dinner tonight we have affected some bit of biological diversity - somehow. And it's also I just think it's incredibly important to have some kind of measure as to whether you are succeeding or not and I think it comes down to what's happening to biology on the ground.

Janet Hering - professor of environmental engineering science, Cal Tech: I applaud the several comments that have been made about the need to reduce the impact of members of developed countries and their proportional impact compared to less developed countries. And I just wonder how possible that's gonna be on the really hard things - the stuff that's close to our heart like cars. There was a study done that indicated the price of gasoline in the United States would have to be 4 or 5 dollars a gallon before people made serious decisions about fuel economy and how much they would drive and whether it was really important to have that sports utility vehicle or not. Gas prices have come close to $2 a gallon - in Southern California and people are ready to march on Washington. There's discussion of lowering the gas tax, the truck drivers are out there in force - and - and basically you see both the Democratic and Republican parties completely caving in on this issue and I think that there's - there are gonna be a lot harder things than passing a bond issue on a California State proposition that for things that sound good like safe water and parks - and we're gonna have to look at some of these hard issues, and I'd like to have your opinion on how we're gonna approach that?

Tom Lovejoy: Well let me say first of all it is important to have some way to deal with energy prices not having stability - just going up and down like this - that's very destructive. But in the long run we shouldn't be using gasoline - we just shouldn't. And I think it's a real sign of hope that the Ford Motor Company a few weeks back pulled out of the so called global climate coalition which was all the fossil fuel industries trying to pooh-pooh the idea of climate change from greenhouse gases, so there may be some things we have to give up - there are also maybe some things which really creative technology can give us much more acceptable solutions for - like hydrogen fuel cells.

Bill White - executive director of the Orang-utan Foundation International: You set a couple of alarms that I'm not sure everyone's quite hearing - one is the global

warming effect and the other is losing our rain forests. Quite frankly 250 million dollars going into Indonesia for the situation of the forests would just be a dent in the problem - so we have to find a way to have the World Bank work together with the IMF to work with other countries, to work with corporations and to work at the local level, giving these people jobs - or else you know as well as I do that they're gonna take chain saws and cut down the trees.

Tom Lovejoy: You would be astonished at how hard the President of the World Bank had to work to get the World Bank board to accept this small conservation grant programme - I mean it has taken him four years. And he finally gave 'em each a big book on hot spots and said you don't get it - go home and read this all night. Just to underscore the climate change issue - all the glaciers on top of high mountains in the tropics are melting at a rate that they're gonna be gone in 20 years and our nuclear submarine data on the thickness of the arctic ice sheet is now analysed and it lost 40% since the initial period of measurement and it is on the average only 6 feet thick and it's losing four inches a year so you can do the arithmetic - that's less than 20 years. And that begins to tie into the whole global oceanic climate influence so it's quite spooky.

Bill Christian - Atlantic Richfield Company: Put your place in the stead of a leader of the energy industry - say John Browne. What does sustainability mean to you and how would you comport yourself? - what would you do? - what sort of leadership positions would you take? - what would you have your company do in light of what you've said about sustainability and global climate change?

Tom Lovejoy: Well I mean I think the first thing I would do which I think he's started to do in fact is say we're about energy - we're not about fossil fuels. You know there will be a period when we still use fossil fuels to the extent that it's natural gas rather than coal - that's a factor-of-four improvement. And then looking at hydrogen fuels and other things of that sort. Those are the priorities - and I'd invest heavily in research.

Jeff Lin - school student, San Marino High: I was just wondering what do you see as the role of biotechnology such as genetic engineering in biodiversity?

Tom Lovejoy: So, genetically modified organisms. As a technology it's like any technology, it has pluses and it has minuses - it can be used for good and it can be used for ill. It's come on very fast, driven by sort of competition in big corporations. I think it came on too fast. On the other hand if that becomes a way to produce rice enriched with Vitamin A so that a billion people in the world don't have the threat of blindness early in their life, that is a real positive. At the same time you have to be very careful about the potential environmental affects. I think regulation and labelling is a very sensible way to go. But in the end I guess one has to say there will be biotechnology - the question is how thoughtfully and carefully will we manage it. In a sense my biggest fear about biotechnology is that it will create agricultural plants which can grow in places where you never could grow them before, so there'll be yet that much more pressure on the remaining natural habitats of the world.

Jean Rosenfeld -historian of religions: I'm aware that there's an earth spirituality ...meant that maybe a major new religion in the world in the coming generations - you have put forth a kind of - as a Jeremiah in a bow tie a scenario that is equal that I hear from my son who's an Earth Firster and I wanted to ask you whether you think the salvation so to speak of the world from this apocalyptic scenario which your last statement typified is going to rest in a technological trumping of technologically-induced problems or whether the small is beautiful idealistic utopian notion of the anti-WTO movement that is growing is the wave of the future? Do we educate ourselves to do - to have less and to work with less

each of us in a kind of Scandinavian solution so to speak? Or are we going to look for more technological solutions to solve for example putting gasoline additives to mitigate smog and then finding out that that pollutes our water system?

Tom Lovejoy: I never believed that there was a technological fix but I also believe we're going to need a lot of what technology can do for us. Anything that could improve automobile engines so that they're not generating CO2 is a big plus. But in the end I also think you know it's not gonna be a choice of whether we make do with less in the sense that if we don't really think that through the choice will be forced upon us - there won't be a choice cos we'll have run the resource base down to the point where we just have to be that way. So I really think that - it's funny in a way - the diversity of points of view in the environmental movement I think is very important - having that spiritual element, having that spread, having that lead people to make choices about how they life their lives is as important as somebody who can figure out technological ways to get us off our fossil fuel fix.

Daniel Emmett - actor and conservationist: Biodiversity clearly has to be the measure of how we're doing because - when our daisies start disappearing and our birds that's a problem. What's being done in terms of cataloguing what's out there - I think we don't even know quite what's in our forests and in our rivers and in our oceans, and if this is going to the measure as it should be - what's going on up there to really find out what we've got so we can use that to change policies and our behaviour?

Tom Lovejoy: Well thank you - thank you for that set up. It is nothing short of scandalous that we probably only know one out of every ten species on earth, let alone where they are or, various aspects of their biology, and I for one continue to try to launch a new age of exploration in which explore the biology of our earth, a lot of which would just you know blow people's minds. I mean talk about changing attitudes, that could be very valuable indeed. I keep trying to push that in Washington and periodically I get closer to it and then it ebbs away, but I think you're quite right. I mean unless we really know what there is, and where it is, we're gonna make some mistakes without even knowing we've made them.

Bob Gillespie - President of Population Communication: The population of the planet has doubled in the last 38 years and will double again in the next 50 to 60 years from 6 to 12 billion. Given that and the fact that the Untied States with 4.8% of that population produces 26% of our greenhouse gases - you know what hope is there for protecting the environment when everybody on the planet wants to live like we do?

Tom Lovejoy: I'm really glad you brought up both the population and the consumption issues together. We heard it at the beginning actually in some of the introductory remarks but I'll put it in my own way and that is there are now too many people on earth for everybody to live an American lifestyle. And there are also too many people on earth for everybody to live something closer to a hunter gatherer lifestyle, so the answer's somewhere in between and it's really complicated and it's going to be a real transformation in the history of human society.

Terence McNally: If you could stand in the future 20 or 25 years and ask yourself from that position did humanity turn it around? - do you come down on the yes or no? - and if you come down on the yes what are some of the - from that vantage point looking back - what are some of the things that turned us around?

Tom Lovejoy: I think what's going to happen is suddenly people are going to - and maybe - maybe sort of this sense of global community is gonna help us a lot and - that

millennium celebration was the first time I ever felt there was something that was truly global and if people start looking at it that way and then they look up there and see the ice cap melting and say it's time to do something - we could have one of these relatively revolutionary moments, particularly with the ballot box that would suddenly change the way things happen.

APPENDIX 2

LIST OF WORKSHOP PARTICIPANTS

Mr Frank Batini	CALM
Mr Bernard Bowen	Chairman EPA
Dr Andrew Burbidge	CALM (Woodvale)
Mr Ben Carr	DEP
Dr David Coates	CALM (Herbarium)
Dr Jenny Davis	Murdoch University (Environmental Science)
Mrs Alanna Fandry	EPA (admin support)
Dr Paul Lavery	Edith Cowan University (Natural Sciences)
Dr Ian Le Provost	Member - EPA
Dr Des Lord	Consultant (D A Lord & Associates)
Ms Melinda Macleod	DEP
Professor Jonathan Majer	Curtin University (Environmental Biology)
Dr Libby Mattiske	Deputy Chair EPA
Mr Norm McKenzie	CALM (Woodvale)
Professor Harry Recher	Edith Cowan University (Natural Sciences)
Ms Sally Robinson	Consultant (Strategic Environmental Solutions & former Deputy Chairman EPA)
Dr Denis Saunders	CSIRO (Wildlife & Ecology)
Mr Gary Whisson	DEP

Joined for afternoon session on Day 2

Mr Graeme French	Executive Officer EPA
Dr Bryan Jenkins	CEO DEP
Professor Bert Main	
Dr Barbara Main	
A/Professor Frank Murray	Member - EPA
Mr Rob Sippe	DEP (Director Policy Coordination)
Mr Kim Taylor	DEP (Director Evaluation)
Dr Paul Vogel	DEP (Director Environmental Systems)
Ms Beverley Walker	DEP

APPENDIX 3

"BIODIVERSITY??"

Responses to Thought Starters

May 2000

PERSIAN CARPET

I understand the analogy, but as I see it, it is an issue of scale. At what stage are the segments too small to be 'coherent'. For example, there are many excellent 'Persian carpet' mats that are smaller than 1 m x 1 m and complete. Edge effects are significant in nature. Add to landscape variation eg. seagrasses, woodlands. The edges provide transition zones with high gradients and many riches. In nature, edges can 'regenerate'. But it comes back to scale, and perhaps connection between the segments.

Thought Starter 1: What is our operational understanding of the term "biodiversity"; how are we going to measure it; and how do we judge the acceptability of its removal or modification as a result of a proposal?

As far as our understanding of the term biodiversity is concerned, I strongly believe that we should remain in line with the Commonwealth definition of it. However, I have a certain amount of problem with the EPA/DEP becoming heavily involved with genetic diversity – it is going to have enough trouble taking into account biodiversity at the species level, let alone at the genetic level. I do not believe that there is any possibility of DEP staff being able to measure biodiversity themselves, they will need to rely heavily on what information is available in the State and will need to make it their business to find out what information is available.

I would judge the acceptability of removal of biodiversity on the basis of what proportion of the original biodiversity is being removed and also how much of it remains. (J Majer)

A good starting point for an operational understanding of biodiversity would be to consider the three different levels that form part of most biodiversity definitions, ie. ecosystem, species and genetic.

All levels can be measured although current knowledge and resourcing in relation to the gathering of appropriate information will clearly be significant limiting factors in the measurement of biodiversity loss when assessing impact. Biodiversity indicators for the Commonwealth State of Environment Reporting could provide a starting point for determining how it could be measured.

Judging acceptability of its removal or modification depends upon the availability of sufficient baseline knowledge of the biodiversity in the area in question. There is no easy answer. However, with sufficient information it should be possible to determine whether loss of species/taxa, loss of ecosystem processes, loss of genetic diversity (ie populations of key/threatened species, significant reduction in genetic diversity of key species) will be critical in relation to overall biodiversity conservation in the area. (D Coates).

The National Strategy for the Conservation of Australia's Biological Diversity provides a nationally accepted definition of biodiversity. This must be the starting point. This definition provides an approach for measuring biodiversity at 3 levels. It is recognised (and needs to be understood) that we will not be able to fully identify all elements of biodiversity except at the ecosystem level. Biological surveys provide a surrogate measure

of key or specified components of the biodiversity of an area/region using a consistent repeatable approach. We should be looking to reconstruct robust systems. (G Whisson)

There is a good understanding of the term and it is set out in the United Nations *Convention on Biological Diversity* and in *The National Strategy for the Conservation of Australia's Biological Diversity.*

Species level can be measured through traditional techniques, although this only measures the components. Not everyone can adapt this to ecosystem level thinking. Genetic level is difficult for large-scale proposals.

The EPA needs detailed reliable information to make judgements about the acceptability of removal. (M Macleod)

This is the goal of the workshop. The operational definition needs to be sensible and measurable. (D Lord)

Thought Starter 2: What is a reasonable objective(s) against which to judge the impact of a proposal on biodiversity?

The reasonable objective would be to assess the proportional loss of biodiversity in relation to an undisturbed benchmark and the area in which this loss takes place. Area can be expressed in units or, preferably, as a percentage of the area over which that community is normally found. (J Majer)

Reasonable objectives against which to judge the impact of a proposal on biodiversity should include no overall loss of biodiversity in relation to genetic diversity (number of individuals, number of populations), species diversity (including subspecies) and ecosystem diversity or perhaps more specifically ecological community diversity. (D Coates)

Impact of proposals should be considered directly in the local context and in the regional context. Objectives for the regional conservation of ecosystem diversity have been set in terms of percent protected and the concept of comprehensive, adequate and representative (CAR) conservation. At the species level, objectives have been defined in terms of protection of rare and priority species and the keystone species. Information at the genetic diversity level is very limited.

The CAR concept is in part intended to protect surrogates of genetic diversity through protecting species and ecosystems in a number of replicates throughout their normal range, and in the protection of outlying populations and refugia. Principle of no nett loss of biodiversity. (G Whisson)

'Natural' conditions at the site and area.
Loss of important species/assemblages.
Natural ranges of plants and animals affected.
Influences on system function (measured as a sum of attributes).(D Lord)

Thought Starter 3: What does the EPA say to the community and to proponents about its operational definition of biodiversity, how it will be measured and how it will be considered as an environmental factor by the EPA?

The EPA/DEP should make it clearly known that it is endeavouring to operate within the guidelines and objectives of the National Biodiversity Strategy. I believe that it will add to the credibility of the EPA/DEP's initiatives if it is seen to be operating in tandem with this Commonwealth document. (J Majer)

It is important that the EPA indicate to the community that any operational definition of biodiversity will cover not only changes in biodiversity at ecosystem, species and genetic levels but also ecological and evolutionary processes associated with the maintenance of that biodiversity. The EPA should also stress that in practice the applicability of this

definition will vary in different circumstances depending upon the current knowledge of biodiversity relating to the particular situation and the limitations (expertise, resources) in gathering additional information.

I understand there were a series of workshops held by Environment Australia in 1997 to develop a series of indicators which could be used for assessing change in biodiversity over time. Such indicators could be used by the EPA as a starting point for the measurement of biodiversity. I have the following publication re genetic indicators which might provide a basis for discussion – Brown *et al*, 1997. *Genetic Indicators for State of Environment Reporting*. State of Environment Australia. Technical Paper Series. (D Coates)

The definition should be based on the definition given in *The National Strategy for the Conservation of Australia's Biological Diversity*, but operationally recognising that suitable surrogate measures of biodiversity need to be established through standard biological survey methods. They may vary regionally depending on the information base and improving knowledge. Specific approaches will also be needed in restructured/rare ecosystems. EPA guidance statement should serve to help define the approach and the factor. (G Whisson)

Thought starter 4: To what extent should EPA be in the business of local level, short-term approaches (5-10 years) or big picture, strategic visions for a better environment (say 30-100 years). Which should EPA apply to biodiversity as an issue. Should it be even longer?

Although it is expensive and, naturally, time consuming to take the long-term approach, I believe that the information gain over long-term approaches is much greater than a range of short-term approaches. The suggested 30 to 100 year time frame seems reasonable and, having a relatively stable work force, the EPA/DEP is in a position to maintain records to enable this to be done.

As I have said earlier, the EPA and the DEP do not have the resources to be in the business of data gathering, however I do believe that they should be linked in with organisations or individuals who are maintaining long-term databases. (J Majer)

Any biodiversity conservation requires a big picture/strategic visions approach over at least the next 100 year and probably significantly longer. The ecological and evolutionary processes we currently see in our flora and fauna have developed from millions of years of evolution. I cannot see how we can realistically expect to carry out biodiversity conservation without considering long-term management options. (D Coates)

Inevitably the EPA will need to be involved at both levels. Local level / short-term through environmental impact assessment. Big picture / long-term through policy. It is very important that the EPA maintains the long-term big picture role. (G Whisson)

The long-term, strategic vision is absolutely necessary. However there is a need to consider both, as short-term thinking can often influence the flow-on effects to the long-term. Mitigation and management should be implemented that is sound for both short- and long-term protection of biodiversity. Not many people can think in time frames of greater than 100 years, so 30 to 100 year planning would be great, as long as the project / management measures are reviewed and revised routinely. (M Macleod)

Both time scales.
In principle, the longer time scale is preferable, but there is seldom the information available.
(D Lord)

<u>Thought starter 5</u>: The public appears to have a view that the EPA should be an advocate for the environment and that it should be politically neutral, there for the public and act as an environmental "watchdog". What are your views on this.

I strongly believe that the EPA/DEP should act as an environmental watchdog, if they don't, who does? (J Majer)

I agree and strongly support the EPA's role as an environmental watchdog. (D Coates)

Agree! (G Whisson)

EPA role clear in Environmental Protection Act. Role of EPA may be viewed differently by various segments of the community. For example, conservation groups may have different expectations of the community than industry groups.

Thought Starter 6: How much biodiversity is enough? How much breeding stock and genetic diversity within a species is enough?

First and foremost, we should be aiming to maintain the full range of species that used to occur in Western Australia. The EPA/DEP cannot be involved itself in measurements of genetic diversity, but staff who are concerned with environmental appraisals should be aware of all of the issues pertaining to the need to maintain genetic diversity and should consider these issues when acting upon appraisals. (J Majer)

Given the significant losses of biodiversity already apparent in this State any further loss should be considered undesirable. Any future proposed removal or modification of biodiversity should be on the basis of no further overall loss.

The question relating to minimal levels of genetic diversity for species survival has been broadly addressed theoretically and also empirically in a broad range of animal and plants. Ultimately the larger the reduction in population size the greater the loss of genetic diversity. However, this will depend on the species (life-history etc). Some generalisations are possible across certain groups of WA vascular plants where we have relatively good comparative population based genetic diversity data. In most other groups, specific genetic diversity studies on key species would be required. (D Coates)

These issues have evolved with the public and policy statements increasingly recognising the importance of biodiversity. The latest standards defined in the National Partnership Agreements for the National Heritage Trust (NHT) identify 30 % retention of an ecosystem as the level of concern, and 10 % retention as the endangered level. Issue of climate change. All biodiversity has intrinsic value. (G Whisson)

What a great question! This should be asked continuously, and even when we think we've got an answer, I hope someone is still asking it! (M Macleod)

Difficult to make a broad statement to this. Realise the difficulty faced by EPA, but presume the approach to these two matters will vary strongly on a site by site basis. (D Lord)

<u>Thought Starter 7:</u> What nature of environmental outcome would be likely to constitute a "fatal flaw"?"

- Loss of a recognised taxon (variety, subspecies, species);
- Loss of an ecological community;
- Permanent alteration of ecological processes related to ie drainage, water table. (D Coates)

"Fatal flaw" is a loaded term and we should be looking at ensuring that proposals don't overload environmental systems concept of cumulative impacts. NSW has an 8 point system. There will be a number, and it would be a mistake to attempt to fully prescribe them, but they would include:

- potential extinction of a species;
- clearing of a Threatened Ecological Community – generally recognising that loss of some small, highly constrained, poor quality examples may be acceptable (ie. not fatal flaws), provided there are environmental benefits involved and the extinction of the community is not at issue;
- loss of major populations of threatened species;
- loss of refugia;
- loss of significant areas, or ecosystems of recognised importance, or highly restricted ecosystems;

  irreversible change. (G Whisson)

- unmanageable impact on internationally, nationally or regionally recognised 'elements'
- unjustifiable proposal causing significant environmental impact
- ecosystem loss (M Macleod)

Lets think through this one. Highly variable. Could be total loss of amenity to a community with little effect on the natural effect to the loss of significant species/assemblages.(D Lord)

<u>Thought Starter 8</u>: There may be merit in regarding the Heathcliffe objectives as a starting point rather than an end point, to be refined by both the proponent and the EPA as part of the assessment process so that the final environmental objective reported on by the EPA in its report is one which is tailored to suit the actual proposal at the specific location. What are your views and suggestions on this?

Agree. Should be discussed further in detail at the workshop. (D Coates)

Some merit in this, provided this does not constitute a bidding down war by proponents/consultants. The ability to recognise and address unexpected issues that come out through the environmental impact assessment process is a positive of this approach. Standards of biological survey and interpretations are equally important issues in bringing out key values and potential impacts. (G Whisson)

The Heathcliffe Table provides a good pre-assessment starting point, but these factors should be combined before the environmental review is released, so that an ecosystem approach is reported for public comment. Definitely by the stage the EPA reports to the Minister, an ecosystem view should be taken, and the potential impacts assessed at the ecosystem, and lower, levels. (M Macleod)

Heathcliff tables useful. Need relevant application on a case by case basis. (D Lord)

<u>Thought Starter 9</u>: Should the EPA be considering genetic diversity? How practical is this and how should it do it? How can proponents carry out the necessary work and what work would you expect to see? Given that financial resources are always limited what should be the priority for proponents and the EPA to have to consider full genetic diversity.

I do not believe that it is practical to consider genetic diversity. EPA/DEP officers should be aware of the issues pertaining to genetic diversity and maybe should undertake, or have undertaken, a university unit in conservation genetics. (J Majer)

I cannot see how the EPA can consider biodiversity conservation without considering genetic diversity at some level. Genetic diversity studies and the monitoring of genetic diversity change is practical when considered in the context of the information provided in Brown *et al* 1997 cited under Thought Starter 3.

The type of work necessary in relation to monitoring and assessing genetic diversity is outlined in Brown *et al* 1997. Briefly they list the following indicators:

1. Number of sub-specific taxa
2. Population size, numbers and physical isolation
3. Environmental amplitude
4. Genetic diversity at (usually molecular) marker loci
5. Quantitative genetic variation
6. Inter-population genetic structure (using molecular marker loci)
7. Mating
8. In many cases only one or a few of the above indicators would be required for an initial assessment of genetic diversity.

In many instances a genetic diversity study on one or a few key species would cost less than species diversity or ecological community studies, and if carried out in conjunction with those studies would greatly enhance the overall assessment of biodiversity. (D Coates)

Yes where this information is available or might be expected to be an important issue. Full genetic diversity is unlikely to be a realistic expectation. CAR criteria surrogates for covering genetic range. Refugia, disjunct populations, range ends and distinctive variants should all be recognised as significant factors. (G Whisson)

Genetic diversity needs to be considered, although a proponent may not include detail in a review document if they can demonstrate that there was not the need. In the case of some assessments, genetic diversity may be specifically required, for example an assessment of a genetically modified organism. (M Macleod)

In principle, yes. Quite difficult. Looks like this will be a topic for discussion. (D Lord)

<u>Thought Starter 10</u>: To what extent should the EPA consider species diversity, given that a large number of species have not yet been described. Should it include all invertebrates and microorganisms? If so, how should EPA handle this with proponents?

I am concerned that the EPA/DEP should consider the diversity of invertebrates. This is not known in many sites, and once again officers should be aware of the available information on this topic and attempt to extrapolate to the areas under their consideration. This would also be the case for fungi, although consideration of microorganisms probably suffers from the same problem as genetic diversity, namely lack of resources to adequately consider them. (J Majer)

Species or taxon diversity is generally considered the focal point for most conservation of biodiversity programs. Inevitably some groups will be poorly represented in biodiversity estimates for some areas because taxonomic knowledge is poor or lacking. However, assessment of species/taxon diversity based on current available knowledge is probably the most readily achievable approach to estimating biodiversity values. (D Coates)

Species diversity of vertebrates and higher plants should be the minimum standard. Should be considered where specific issues require it (eg. some karst environments) or where rare species are involved, or species are expected to have a very limited distribution. Survey for invertebrate species should also be required.

The EPA process drives much of the biological survey in WA. The EPA has a role in ensuring that biological survey work is conducted to appropriate standards of collection, identification and accessibility of information. This in time improves the knowledge of species and context of significance of individual populations in project areas. The surveys need to be aware of how different groups respond to the environment to ensure that the appropriate biodiversity groups/surrogates are surveyed. Need to be aware of ecosystem processes. (G Whisson)

Is it necessary to 'measure' all aspects of a system? In assessing biodiversity, for uniformity of approach, measurements will probably need to be at the higher end eg. landscapes, major (key, dominant) relationships, and presence/abundance of larger plants/animals. (D Lord)

<u>Thought Starter 11</u>: To what extent should the EPA consider ecosystem diversity, if the definition from the National SoE is accepted whereby ecosystems represent unique combinations of genes and species? If so, how should EPA handle this with proponents?

It is essential that the EPA/DEP should consider ecosystem diversity. To enable this objective to be met, the EPA/DEP should have access to a full set of maps of Western Australian ecosystems. (J Majer)

I find the ecosystem approach a particularly difficult concept to grasp given the many and varying definitions of an ecosystem. Perhaps an ecological community approach would be more practical. For example WA now has a number of ecological communities listed as threatened etc. (D Coates)

The EPA should be considering ecosystems as a key level of biodiversity. Guidance statements for biological surveys should provide a consistent regional framework for defining ecosystems. Need to be aware of sites serving as refugia in hard seasonal times (pulse and response concept). Rare / restricted environments often the key components of the environment. Need to consider dynamics of climate change. (G Whisson)

<u>Thought Starter 12</u>: At what scale do you think it would be appropriate to consider biodiversity in carrying out an environmental impact assessment of projects that may impact on one or more of the following:

a) seagrasses (Cockburn Sound-Owen Anchorage area)
seagrass (Shark Bay area)
b) the Mt Leseuer area
c) the Stirling Range area
d) the Kimberley
e) jarrah forest
f) south west karri and tingle forests
g) salt lakes
h) mangroves

The grain of ecosystem diversity varies amongst the examples given under this Thought Starter. The size of this grain should be identified for the areas and ecosystems listed and this should dictate the scale at which biodiversity should be considered. For instance, the grain for ecosystems in the Kimberley may well be much coarser than the grain in the Stirling Range area. (J Majer)

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a) Seagrasses. Genetic diversity in the key *Posidonia* species. Species diversity and ecological community diversity.
b) Mt Lesueur area. Species diversity and ecological community diversity
c) Stirling Range. Species diversity and ecological community diversity.
d) Kimberley. Species diversity and ecological community diversity.
e) Jarrah forest. Genetic diversity in key species (ie jarrah, marri, woylie, chuditch), species diversity and ecological community diversity
f) Karri and tingle forest. Genetic diversity in key species, species diversity and ecological community diversity
g) Salt lakes. Species diversity and ecological community diversity
h) Mangroves. Genetic diversity in key species (ie mangrove species), species diversity and ecological community diversity (D Coates)

At least at the ecosystem and species level. Also at the genetic level looking at range ends, outlying populations and distinctive refugia in Mt Lesueur, Stirling Ranges and southwest Karri and Tingle forests. Consider the area of the proposal within the area/range of the ecosystem. Need to be aware of the scale of patterning of heterogeneity in the environment. This will vary with the environment and influence the scale of surveying and significance of individual areas. (G Whisson)

Good question. First look at natural processes - ranges ability to propagate/predator territory. Marine and terrestrial systems approach may be different. In marine system, the conduit of water allows for vast ranges of organisms, therefore there is seldom the threat of a genuine 'loss' of a species. Conversely effects can also have large ranges. corals at Rottnest influenced by Leeuwin Current. Effect at Abrolhos (would have to be huge) could influence coral at Rottnest. (D Lord)

<u>Thought Starter 13</u>: As ecosystems are constantly changing what should EPA be assessing? Assemblages of species, communities, ecosystems? To what extent should EPA be maintaining what is already there in a static state, as opposed to ensuring that the dynamic nature of ecosystems is maintained and focusing on continuation of ecosystems that are "healthy" and "resilient" even though they may be different from what is currently there.

Every ecologist knows that communities are dynamic. However, the changes through time are generally small compared with the changes associated with human activity in an area. I therefore believe that the EPA/DEP should consider communities as they currently exist and be flexible in their extrapolations of how they might be in the future. They should not, however, budget for major changes in community composition. (J Majer)

It is important that the focus in biodiversity conservation is not only on the preservation of what is already there but also on the dynamic nature of ecosystems. Genetic diversity provides the basis for evolutionary change resulting in new forms, species and ultimately new ecosystems. If we consider genetic diversity to be an integral part biodiversity then

evolutionary and ecosystem processes are integral parts of a system which maintains and generates biodiversity. That is we should not only aim to conserve/sustain biodiversity but also processes associated with its generation. (D Coates)

The EPA needs to consider values of the ecosystem as surveyed and place it in a regional context, to consider regional importance. Recognition should also be given to the role of the site in maintaining regional/local ecosystem processes, and the likely viability of the area. In highly cleared environments and Threatened Ecological Communities, some loss of condition should be expected without detracting from the significance of the site. These areas may still be the best remaining example of this original flora/fauna and vegetation. Weeds/feral species should not be considered a part of the dynamic nature of ecosystems. Recognise role of management in controlling threatening processes. (G Whisson)

Thought Starter 14: How can one give practical application of the Precautionary Principle (see Appendix 3) to assessment of impacts of proposals on biodiversity in general, particularly where there is inadequate information and data available?

Staff should be aware of the impact of developments on biodiversity from as wide a range of ecosystems as possible and attempt to extrapolate these changes to areas under consideration when deciding whether to adopt the precautionary principle or not. (J Majer)

The use of key threatening processes as discussed in section 6.4 seems to provide a suitable basis for the use of the Precautionary Principal. The Precautionary Principal could perhaps also be used in a broader context where threats might lead to the significant loss of a species or ecological community although not sufficient to consider them threatened. (D Coates)

Systems for standard collection, recording and storage of biodiversity information should be developed as a priority, including quality control to address over time the inadequacy of biodiversity information. The EPA has addresses the precautionary principle in the Position Statement for Cape Range. This approach should be more widely applied. (G Whisson)

Thought Starter 15: How does the EPA give proper consideration to keystone species, particularly where there may not be adequate knowledge?

It is often difficult to consider keystone species when we are still not certain which species they are. In cases where this is known, staff should enlighten themselves about impacts of keystone species and take this into account in their considerations. If the keystone species is not known, then attempts should be made to extrapolate their knowledge of similar species which are acting as keystone species in other ecosystems. (J Majer)

Keystone species have a particularly important role to play in biodiversity conservation. Measures carried out to prevent their extinction and enhance their probability of survival and recovery will inevitably benefit the ecological communities and possibly at a broader level the ecosystems in which they currently exist. (D Coates)

To the extent reasonable a precautionary approach should be considered based on professional judgement from existing/available information – recognising the characteristics of keystone species. (G Whisson)

APPENDIX 4

SUMMARY OF OUTCOMES OF CASE STUDIES

1. CASE STUDY # 1 - STYGOFAUNA CAPE RANGE

(Briefing officer : Gary Whisson)

EPA objective for subterranean fauna is:

- *to ensure that subterranean fauna are adequately protected, consistent with the provisions of the Wildlife Conservation Act (1950);*
- *to maintain the abundance, diversity and geographical distribution of subterranean fauna; and*
- *to improve understanding of subterranean fauna through appropriate research including sampling, identification, and documentation.*

Before breaking into individual groups to consider this proposal, Bernard Bowen summarised the salient aspects of the proposal as being:

- Removal of a habitat could lead to the extinction of a species.
- Cape Range has some classical cave formations, sink holes, shafts, and those systems are significant for troglobytic fauna; stygofauna are also found occupying a lot of small fissures and "islands" in the system on a very fine scale.
- it is an area of international significance as a karst province, because of the stygofauna, its geology, its morphology and characteristics of that environment;
- it is the only one of its type in Australia;
- its diversity and world significance – Cape Range now supports whole classes, orders and families of fauna that do not occur anywhere else in Australia; up there with the best of the world in terms of species diversity; it also includes a number of threatened fauna;
- What questions should we have been asking of proponents and scientists?
- What degree of sampling was necessary to provide no loss of a species?
- Do we have to find every species which is there – off-site as well?
- How much sampling would be reasonable?
- What role does the precautionary approach play in this?
- Is it sufficiently precautionary to say "no"?

The groups were asked to consider the following:

- the issues considered
- information available
- its thinking about what biodiversity is and the role of the EPA
- constraint of the Heathcliffe table definitions and objectives (the source of the above objective for stygofauna)
- what it decides and why – is this a consensus or a majority decision
- any differences of views
- the weighting given to various points
- the process by which a decision was arrived at

2. REPORT BACK ON CASE STUDY # 1

2.1 Group 1: Associate Professor Jonathan Majer as Chairman

- The particular problem has arisen here because the particular fauna is well studied and has turned out to have some interesting features. This situation has not arisen elsewhere. The Peninsula has a relatively well studied stygofauna, but the actual site concerned does not appear to be as well studied as the Peninsula as a whole.
- Proposal is on a micro-biogeographic scale restricted, but not just from one trough to the next that fauna is different, but closely related; and there appear to be spots where there is a taxon with no close relative in the area.
- The area does seem to be diverse by world standards of karst – this does seem to be a site of significance.
- Therefore there is a danger that allowing the limestone mining in that site could cause either a species, which is absolutely unique to the area, being threatened with extinction, or a species which is different, but closely related to one over the next trough, being threatened with extinction. The former is more important than the latter, given the Minister's responsibility not to allow loss of species.
- There does appear to be a problem with sampling. With more sampling there may be more widespread distinction of these species.
- There is a case for stating that in terms of the stygofauna, this is a site of world significance and we suggest that possibly the proponent consider withdrawal of the proposal until and if further data becomes available to help the case for the proponent. Another alternative is to look at the possibility of exchanging this tenement with another one in a less sensitive area.
- If the proponent does go ahead with this, the EPA should probably recommend saying NO on the basis of this being a place of extreme significance.
- Problem was that the significant issue was an unseen invertebrate. If this had been another species of highly coloured butterflies, there would not have been a problem. The issue is highly visible species with some charm. It seems that perhaps these things do not occur in isolation. If had resources to put out education type material, the public might start to value the area because of the unseen fauna.
- The process which created this rich fauna may have other values; ie the stygofauna has not occurred in isolation. There is an indication that there is a need for public to appreciate invertebrates in general and in this particular case. Bill Humphreys had thought that this area was important compared with other areas he had worked on and he himself had made a distinction between this area and others. It came back to an expert opinion and one that did have a lot of credibility.
- Question: What about the two different views of the experts?

2.2 Group 2: Mr Ben Carr as Chairman

- Approach was essentially to use the precautionary principle;
- If expert advice was not available in State, go interstate or overseas;
- Taxonomic uncertainty; maybe send overseas for identification;
- Proponent could not demonstrate that the mine would not cause species extinction; so fatal flaws;
- There was a need to get the proponent to undertake regional fauna survey work to provide context;
- Invertebrates were essential to the decision-making process;
- Genetic studies of the key species should have been required;
- Were survey techniques valid or not? It appeared that the onus of proof may have actually been turned round in this case, that the EPA would have to prove there was an impact;
- Important to protect evolution/process of the area;
- Difficulties in sampling the fauna adequately;
- The objectives did not always capture the key impacts and some of the objectives of the environmental factors did not make sense;
- Group unanimously decided that there were fatal flaws in the proposal and should not be allowed;
- There was a problem in the process in that there was no process of adjusting Ministerial Conditions after the proposal had been implemented, in the light of real experience;
- On the ground that it is a unique area alone, it should not be allowed;
- Amount of information on the fauna was too limited and it was incumbent upon the proponent to provide sufficient information on which to make a judgement;
- Differences between two consultants: what is truth? If 2 people are experts, with high qualifications, presenting totally divergent views on a variety of proposals, what do we base our decision on? There is a range of "truth" in submissions from experts on a variety of matters. When have this, should seek peer assessment outside of the people who made the original submissions: look at techniques used and whether the conclusions reached were verified by the data presented;
- On different opinions by two experts – the important question is whether there was a reasonable chance that a species could become extinct, not the difference of opinion.
- It should be a requirement of the EPA that specimens, when collected, should be placed in a public institution where they can be accessed by experts and have their identification checked;
- Every time there is a mine proposed, there is an appeal saying that you have not shown that there is not a species which could be made extinct and it is a real nuisance. Maybe there should be a workshop on the topic.

2.3 Group 3: Dr Paul Lavery as Chairman

- Information needs and the elements required to give a level of confidence about making a decision:
  - published descriptions of the species which were in the area and were contributing to the biodiversity;
  - sampling to show whether those species were present outside of the area which was going to be affected and whether they were species well distributed outside the area to be impacted;
- There was a lack of attention given to ecological function of the area; both because of its importance and also if the disturbance alters the ecological functions of the area that may have an equal or more dramatic effect on the area;
- The crucial requirement was an understanding of the relative spatial scales of the disturbance and of the diversity and ecological function of the area;
- Important to know whether we can extrapolate knowledge that speciation occurring on the scale of meters is duplicated elsewhere, and therefore we can hold this assumption;
- Given that there was a lack of data for almost all of these things, we did not think you could say that there would not be an adverse effect. In the face of information that this was an important area, it required the consultants/proponent to disprove that this site was important and could be developed.

3. PLENARY SESSION ON CASE STUDY #1

Summary: Bernard Bowen as Chairman

- There is a consistent flavour from all three groups.
- How does EPA look at the experience we have now got from that area and move it across to other areas where the same questions are being asked by the same expert, "Show me". You come to the question of what are the landscapes like. But you cannot demonstrate until you have done the sampling. Maybe it should be a requirement for mining companies to carry out sampling.
- The generalisation does not have to be based on the specifics of this case. We have some suggestion of the spatial scale of biodiversity. Whereas if have a major mining project in a homogenous terrain, sampling would not have to be as detailed and as spatially fine and time consuming. If we are going to talk about spatial scales, should also talk about temporal scales. There is a strong link between high mineral potential and biodiversity.
- How should we operate at this biodiversity level? It seems to depend on what you know about the area.
- Heathcliffe table should have a section on ecosystem function.
- The difference is uniformity of landscape, rarity of species, risk to species.
- Needs to be articulated so that it is understandable to politicians and to the community.
- Consensus view that the proposal has a fatal flaw.

4. CASE STUDY #3 – COONDAWANNA FLATS AND ROBE RAILWAY

(Briefing Officer: Frank Batini)

Key questions:

- Is the biodiversity of unallocated Crown land the same as, or different from the biodiversity of reserves?
- Values: mulga, biologically significant precincts, ie on certain criteria this is seen to be a reasonably significant area.
- Various options for the rail route.
- Coondawanna west route – greater biological values than any other option; alternatively railway could duplicate existing corridor?

Company presented biological data on both options, however, this raises the following questions:

1. Are the data accurate?
2. Is the information provided valuable in making decisions?
3. Is the information provided worth basing decisions on?
4. EPA has other things to consider which go beyond advice on biodiversity impacts of the options, eg greenhouse gas.

Now ask, are there any threatening processes on the landscape which might be operating: feral species, grazing, fires, interruption of drainage flows, weeds, wind dispersal of soil.

Therefore, should the EPA focus itself just on the project and things that the project is adding, or should EPA look at obtaining some environmental gain out of this, and try to improve things.

Note that there is a need to question the data and its relevance. Also need to consider direct and indirect impacts, eg width of rail impact. These sorts of mulga are major building blocks of the Pilbara and they need to be protected. It is a key-stone species of that community, eg birds to whom there is most risk. There are more species in the mulga community in the desert than in the jarrah forest.

Need to have regional context with which to consider site specific data.

Frank asked the group the question: Are there adequate reserves of those minerals which could be developed at less environmental cost? This should be irrespective of which company has the lease. May need to change Mining Act to allow this.

May need to ask the Department of Resources Development to look at infrastructure needs in the Pilbara, and maybe shared infrastructure. Is this another case of cumulative impact? There is a predisposition for shared infrastructure by the Government.

Frank also asked the workshop participants to consider the philosophical question - "Given that there is going to be a new railway line, is it acceptable that that railway line goes through a national park?"

The groups were different from those used on Day 1 and were asked to consider the following:

- the issues considered
- information available
- its thinking about what biodiversity is and the role of the EPA
- constraint of the Heathcliffe table definitions and objectives (the source of the above objective for stygofauna)
- what it decides and why – is this a consensus or a majority decision
- any differences of views
- the weighting given to various points
- the process by which a decision was arrived at

5. REPORT BACK ON CASE STUDY # 3

5.1 Group 1:

- Information in the summary table is not adequate to make judgement. A lot of decisions are going to be couched in terms of its impact on ecosystem processes, and without knowing certain details, such as where a species is, it is difficult to make a decision.
- Major issue is water and drainage.
- Some arrangements needed to be made to get decision about using existing railway.
- If that was proven to be unfeasible, how do you minimise impact of a second line? The appropriate way would be on the existing line bed and using existing infrastructure, eg the road-bed.
- If that were taken, you would be going through 2 national parks, creating disturbance, weed infestations, etc.
- **Decision:**
  - first preference - share and build extra 60 km;
  - second preference – use route of least disturbance;
  - third preference – existing road route.
  - ie., given the lack of information, minimise disturbance.

5.2 Group 2:

Railway route:

- Major concern was that the company was able to put up a single route option, whereas it should have been an array of routes and options and costs, in order to make assessment.
- Data was limited and meaningless, so was suspect.
- There was no way to check information.
- Information needs: better assessment of the role of the mulga and vegetation communities on both routes; assessment of long term impacts, not just immediate; much more detail on biodiversity of the area and long term.
- We still do not know which route CALM prefers (clarified by Frank Batini).
- Clear need for a regional strategy and impact assessment in the Pilbara. Its a last opportunity – boundaries should be reconsidered; original ones are probably decided by pastoral leases, some surveyor, so should not be inviolate. We need a better park system and we need to be able to design corridors that do not cut through reserves.
- **Decision:** Send back to company to provide more information about options and routes. If not, choose eastern route because it seemed to have less impact than the western route.

Chichester National Park:

- NO rail service corridors in the national park as a basic principle;
- Two is worse than one, so NO.

Information:

- You do have to rely on the judgement of the person who has prepared the data report.
- More time needs to be put in up front at the guidance position, about what information needs to be made.
- Principles:
  - there should not be corridors in National Parks;
  - we need a bigger strategic study of the area in relation to future proposals (for Central Pilbara);
  - we should design a park system of the area, which represents, in the CAR sense, the region, and also we should work in other areas outside the region; eg. proposal for revision of boundary of Hamersley Range.

5.3 Group 3: Norm Mackenzie as Chairman

- Overall feeling is that there was no body of data for making optimum, rational conservation decisions in relation to rail proposals and easement proposals, an ecological study was essential.
- Looking at problem of some of the cumulative impacts:
  - minimise overall disturbance
  - who designed the categories that were addressed in the table of information?
  - comparison of data was inadequate and useless
  - was not either any relation to local scales and regional scales.
- Were concerned about what processes would be set in motion by the area of impact of the whole easement; we expected a wider than 15m impact; therefore need for best practice scale design.
- Many of the landscape units traversed would have coarse patterns so it should be possible to find an appropriate route over the easement.
- It should be possible to find an approved route which may not be either one of the proposed ones.
- Note shadow effect of the line interfering with water flows, plus potential to interfere with flow of genetic information across it - ie you may be splitting up the park into two genetic groups which may never meet again (eg non-flying invertebrates).
- Are we concerning ourselves with things which change naturally over broad distances? We do not have a basis for distinguishing localised change from natural trend - ie it is an extremely dynamic environment. The arid zones are normally boom and bust, drought and flood.
- Combinations of broad-scale effects can have an amplified effect under pinch conditions.
- Are there other things going on in the Pilbara that are more threatening - weeds, kapok, buffel, ruby dock, and most of these come in after disturbance.
- Coming out of this, there is some need for strategic and cumulative impact assessment as part of basic planning, rather than dealing with projects one by one.
- What about integrated data bases, so that more detailed regional assessments can be done - ie data base management and regional assessments etc.