EIA Practitioner Perceptions on the Role of Science in Impact Assessment

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ABSTRACT

The process of environmental impact assessment (EIA) brings together a broad raft of professional practitioners including environmental policy-makers, administrators, decision-makers, government agencies, planners, engineers, scientists, social scientists, and business and project managers as well as the public. From the diversity of these practitioners it can be anticipated that people from different backgrounds will have different expectations of how the process should function in practice. This paper presents the results of a follow-up survey of EIA practitioners in Western Australia. The purpose of the research was to examine the role of science in EIA based upon the experiences and expectations of EIA practitioners. Thirty-one EIA practitioners were interviewed. These were drawn from the Environmental Protection Authority (the peak body responsible for EIA in Western Australia) and its supporting administrative agency the Department of Environmental Protection, other government decision-making authorities, environmental consultants and project managers and environmental officers. Interviewees were also selected to represent different industry sectors (ie. planning, industrial and resource development projects) as well as urban and remote settings. Interviewees were asked about the role of science in impact prediction, monitoring activities, mitigation and management, and EIA decision-making. The results indicate that practitioners have different expectations of the role of science in EIA according to the type of project and its location (ie. urban or remote) and the stage of the EIA process. Most participants indicated that the role of science currently is greatest during the earlier pre-decision stages of EIA and provide the basis for these activities (ie. baseline monitoring, impact prediction and mitigation design). Science input in the post-decision stages of was generally perceived to be of poorer quality. Science was seen to be less important during decision-making and ongoing project management. It is kept in balance with other factors such as socio-political and economic considerations. Despite these differences, overall, good science was seen to be a hallmark for effective EIA and a greater role for science in EIA was advocated, particularly for follow-up activities.

Key words: science, environmental impact assessment, professional practice, monitoring, impact prediction, mitigation, decision-making

1 INTRODUCTION

A great deal has been written about the role of science in environmental impact assessment (EIA) over the last three decades. This work includes:

- studies of the theory and practice of EIA with respect to the role that science can or should play (eg. Beanlands and Duinker 1984, Shrader-Frechette 1985, Lemons 1994); and
- empirical studies which have examined the scientific content of EIA documents and products in a systematic and rigorous way (eg. Culhane *et al.* 1987, Bailey *et al.* 1992, Malik and Bartlett 1993)

In much of this work there is a general feeling that the level of science in EIA is wanting. Fewer studies have focussed on the perceptions of practitioners themselves on the role of science in EIA; Caldwell *et al.* (1982, Chapter 4) and Sadler (1996, Section 4.1.3) are two notable exceptions.

The research reported on here was a follow-up study that focused on practitioner perspectives on the role of science for different stages of the EIA process. The EIA stages of particular interest are as follows:

- *baseline monitoring* – the collection of information to describe the existing environment prior to implementation of a proposal;
- *impact prediction* – the process of identifying and predicting the likely consequences of a proposal. Techniques for making predictions may vary from models and other formal techniques to informal methods based on analogy and experience. This task is predominantly undertaken by proponents and the predictions are presented in environmental impact statements (EIS);
- *mitigation design* – proposing mitigation measures to minimise the occurrence or extent of predicted impacts. Mitigation may include changes to proposal design to avoid impacts outright and extend through to restoration and compensatory measures proposed for unavoidable impacts;
- *decision-making* – the principal decision point determines whether or not a proposal should be permitted to proceed. Many other smaller decisions such as planning and design decisions (Brown and McDonald 1995) are also made throughout the EIA process by proponents and regulatory agencies;
- *impact monitoring* – monitoring activities undertaken to determine the impacts or changes to the environment caused by the proposal once implemented; and
- *ongoing adaptive environmental management* – as impacts occur and the effectiveness of mitigation measures is determined (ie. from impact monitoring programs) it may be necessary to adapt project management to improve environmental protection. Ongoing project and environmental management is meant to be a flexible process of evaluation and adaption rather than a series of fixed mitigation actions.

The purpose of this follow-up study was to record practitioner perspectives on the role of science in each of these stages of the EIA process.

2 METHODOLOGY

The research was based upon practitioner perceptions. A questionnaire was presented to EIA practitioners in a taped interview. The questionnaire required a mixture of quantitative and qualitative answers in relation to the role of science in current EIA practice in Western Australia.

For the quantitative responses interviewees were asked to rate on a 7-point Likert scale answers to a series of questions concerning the current quality, current importance and expected importance of science for the six stages in the EIA process (questions 1-3 in Table 1). Towards the end of the interview, participants were asked to rate the extent to which the current quality of science in EIA in Western Australia met their expectations of the process on a similar Likert scale (question 4). With respect to the questions concerning the 'quality of science' in EIA, interviewees were directed to freely interpret the phrase for themselves, but to explain their answer. With respect to the questions concerning the importance of the role of science in EIA, interviewees were asked to consider how much weight was given to scientific factors in comparison to other factors (eg. socio-political) for each particular stage of EIA.

Inclusion of the Likert scale questions enabled statistical analysis of the responses to be performed. The Wilcoxon signed-rank test (or Wilcoxon T-test) was used to compare individual responses to two different questions. The Wilcoxon test statistic (Z score) was calculated by ranking the pooled observations of the two samples and obtaining the sum of ranks. The mean ranks were used for comparison. For comparisons of Likert scale questions against the background information on EIA practitioners, the Mann-Whitney test was used. The Mann-Whitney U statistic is based on the sum of ranks.

Table 1 Interview Questions With Quantitative Responses

Interview Question	Range on Likert Scale*
1. How good is the current quality of science utilised in… • baseline monitoring? • impact prediction? • mitigation design? • decision-making? • impact monitoring? • ongoing adaptive management?	very good (1) – very poor (7)
2. How important currently is the role of science in… • baseline monitoring? • impact prediction? • mitigation design? • decision-making? • impact monitoring? • ongoing adaptive management?	very important (1) – not at all important (7)
3. How important should be the role of science in… • baseline monitoring? • impact prediction? • mitigation design? • decision-making? • impact monitoring? • ongoing adaptive management?	very important (1) – not at all important (7)
4. To what extent does the current quality of science in EIA overall meet your expectations of the process?	highly satisfied (1) – highly unsatisfied (7)

* On the Likert scale the number 1 position always represented the most positive rating declining to a neutral position in the number 4 position. Numbers 5-7 represented a negative rating gradient with the 7 position representing the most negative rating.

Qualitative information was obtained by asking interviewees to justify their responses to the quantitative questions and to provide examples. Two open-ended questions were asked towards the end of the interview:
- What factors do you believe have determined the level of science utilised in EIA in Western Australia?
- How would you improve the scientific integrity of EIA in Western Australia (if at all)?

The expressions 'level of science' and 'scientific integrity' were used to encapsulate both the quality of science and the level of importance attached to it in EIA. Interviewees were encouraged to answer these two questions in this context.

Background information on EIA practitioners was also recorded including their:
- current role in EIA (ie. consultant, proponent, EIA regulator or other government agency regulator);
- length of involvement with EIA in Western Australia;
- the types of projects that they normally work with (ie. industry or fixed plant, planning and land development, or resource extraction/management); and
- the normal geographical location of these projects within the state (eg. city/urban and environs, marine/coastal, remote/isolated).

A similar approach was utilised by Caldwell *et al.* (1982, Chapter 4) in their survey of EIA practitioners. The purpose of collecting this information was to determine whether a practitioner's role in EIA affected their perceptions of the process. Geographical location was considered to determine whether there is variation in response for proposals in more remote locations where less environmental information is available compared to the more heavily populated urban areas (>80% of the population of Western Australia lives in or around the capital city of Perth and many parts of the state are remote from the capital and are sparsely populated).

3 RESULTS

Interviews were carried out with 31 EIA practitioners in Western Australia whose current role was recorded as:
- proponents or project managers (6);

- environmental consultants (10);
- EIA regulatory authority (7); and
- other government regulatory agencies (8). (A key role of the other government agencies is to comment on EIA proposals, and in some cases to issue regulatory approvals to proponents and monitor their compliance that are separate to the formal EIA process itself. In Western Australia, an approval from another government agency cannot be issued, though, until environmental approval under the EIA process has been granted).

Many EIA practitioners had had experience in more than one role and consequently some interviewees were able to provide a variety of perspectives on the EIA process based on their professional backgrounds. It appears that most EIA practitioners in Western Australia change roles at least once during their careers. For example, several environmental officers working for proponent companies and several of the consultants interviewed had previously worked for the Department of Environmental Protection (responsible for EIA in Western Australia). Similarly, some of the government employees had previously worked for private consultant or proponent companies. Two consultants also served on the membership of the Environmental Protection Authority (EPA) on a part-time basis in addition to their full-time consulting positions and a third had formerly been a member of the EPA. In Western Australia, the EPA is an independent statutory authority which determines EIA procedures and level of assessment of proposals and is a key decision-making body that makes recommendations to the Minister for the Environment on whether proposals are environmentally acceptable. The final approval decision and setting of legally binding approval conditions is the responsibility of the Minister. Whilst the EPA plays an important figure-head and decision-making role in the EIA process, day to day administration rests with the Department of Environmental Protection.

Interviews were conducted in two major resource development centres in Western Australia (mining and mineral processing operations) located some 500km and 1,500km from the capital city, as well as in the capital itself. This ensured that people with experience in both remote and urban settings were included. Many of the consultants and EIA regulators, whilst based in the capital, indicated that they worked on projects in all parts of the state. Only two participants (6%) interviewed had less than 5 years experience working in EIA; 12 participants (40%) had 11-20 years experience and 7 (22%) had >20 years experience.

In the following discussion, the results are presented for the six stages of EIA identified previously. However, discussion of impact monitoring has been paired with baseline monitoring, and ongoing adaptive environmental management paired with mitigation design to avoid repetition.

3.1 Environmental Monitoring

Ratings of the current quality of science utilised in baseline monitoring by EIA practitioners ranged from 2–6 on the Likert scale with some 58% of participants giving a positive response (ie. position 2 or 3 on the scale), 23% in the neutral position and 19% negative (ie. position 5 or 6). Several participants suggested that monitoring, fundamentally, was a scientific activity which may explain this overall positive response. A frequent comment was that money and time constraints place limitations on the scientific integrity of baseline monitoring programs. Lemons and Brown (1990) and Antcliffe 1999 give examples of monitoring programs being designed according to the available budget which negatively impacts on their scientific integrity.

Ratings of the current quality of science utilised in impact monitoring ranged from 2–6 on the Likert scale and were generally lower than that for baseline monitoring, although this was not statistically significant (39% positive, 32% neutral and 29% negative). However, the quality of science utilised in impact monitoring was rated significantly poorer than that used in mitigation design ($P=0.009$), and that used in EIA decision-making ($P=0.012$). It appears that monitoring programs in the post-decision stage of EIA are not as strong as the pre-decision stages with respect to the quality of scientific input. Many participants strongly considered impact monitoring to be poorly conducted. This was largely because proponents are keen to win approvals for their projects so are more likely to engage in baseline monitoring to satisfy the public and regulatory agencies in the lead up to decision-making, but subsequently neglect these activities once the project was operational. Similarly, Lemons (1994) suggests that one of the reasons why use of more adequate scientific knowledge has been constrained in EIA in the US is because little attention is given to post-EIS monitoring. Conversely though, a small number of participants did suggest that impact monitoring was better than baseline monitoring because it was more focussed on specific issues of concern identified during the EIA process (eg. emissions monitoring). But these respondents were far out-weighed by those with previously discussed viewpoints.

Differences in the scientific integrity of impact monitoring programs compared to baseline monitoring were noted with respect to development project type. For large resource developments (eg. mining operations) several participants noted that often inappropriate personnel were engaged to undertake impact monitoring programs. Instead of engaging experts for monitoring tasks, often environmental officers employed in proponent companies who do not have training in specialist areas (eg. hydrogeology) are expected to undertake sampling programs and data analysis or otherwise workers employed in laboring tasks (eg. sinking boreholes) are relied on to collect samples. In both situations, either through sample contamination or lack of training and experience in sampling and data analysis, the scientific integrity of such programs was considered to be inadequate.

For land development projects, proponents tend to quickly move onto new projects once land has been subdivided and the lots have been sold. There is no continuity in project management and monitoring as responsibility transfers to local and state government agencies, plus multiple land owners are bound up in the development (eg. compared to a single project owner/operator in a mining project). Consequently impact monitoring either does not occur or is not carried out to a high technical standard (eg. it may be incompatible with baseline monitoring carried out originally by the proponent).

The *current* importance of the role of science in baseline and impact monitoring was rated lower than the perceived importance that this role *should* be for both types ($P<0.001$ in both tests). Clearly EIA practitioners have higher expectations for the role of science in environmental monitoring programs than is apparent in practice, a viewpoint well articulated by others (eg., Preston 1985, Duinker 1989, Fairweather 1989, Underwood 1991 Antcliffe 1999, Benkendorff 1999). In an international survey of 324 EIA practitioners, 48% of participants rated the extent to which the state of the science limited the ability of practitioners to establish monitoring schemes that are able to detect significant development-induced effects as 'somewhat limiting', and 19% rated this factor as 'very limiting' (Sadler 1996, p81). In an earlier survey of approximately 400 EIA practitioners Caldwell *et al.* (1982, pp345-348) asked participants to rate the availability and quality of scientific data and the state-of-the-art of specific studies and systems modelling with respect to how much these four factors limited their ability to respond to EIA requirements in the US. While this study did not single out monitoring programs as such, the results are broadly comparable as the information or data referred to would come predominantly from baseline monitoring programs and supporting literature studies. For each question, responses ranged from 10.6% – 25.2% as 'very limiting' and 53.0% – 68.7% as 'somewhat limiting'. Each of these studies suggests that monitoring is an area of EIA that could be greatly improved.

The finding is also supported by recent empirical research into the scientific integrity of monitoring programs for six case studies that had undergone EIA in Western Australia. In this study Morrison-Saunders (1997) classified EIA monitoring activities with respect to the use of formal scientific techniques such as before/after control/impact (BACI) monitoring in the manner advocated by Green (1979) ranging down to programs based upon ad hoc sampling and observation only. For two of the case studies there were no examples of BACI monitoring and the best level recorded was 38% for an ocean wastewater outfall project and this was substantially higher than the other projects (Morrison-Saunders 1997). But even in this project, numerous problems with the integrity of monitoring were recorded for the key issue of water quality monitoring including; unsuitable spatial distribution of sampling sites, a five year period when sampling was conducted on a single annual basis only, no replication of sampling and contamination of a so-called 'control' site located in the impact zone of the outfall (Morrison-Saunders 1996). Combined with various other deficiencies of environmental monitoring programs for these six case studies, Morrison-Saunders and Bailey (1999) concluded that the monitoring programs largely failed to meet scientific expectations of the EIA process.

3.2 Impact Prediction

Ratings of the current quality of science utilised in impact prediction were similar to those for impact monitoring and ranged from 2–6 on the Likert scale (39% positive, 39% neutral and 22% negative). Similarly, the quality of science utilised in impact prediction was rated significantly poorer than that used in mitigation design ($P=0.016$), and that used in EIA decision-making ($P=0.025$). Practitioner comments indicated that much of the information required for making impact predictions came from baseline monitoring programs and suffered similar time and money constraints which prohibited high quality scientific studies from being undertaken.

The perceived importance *currently* of the role of science in impact prediction was seen to be less than it *should* be ($P<0.001$). As with the case for environmental monitoring, EIA practitioners in Western Australia believe that greater emphasis should be placed on scientific methods and approaches during impact prediction. This finding is consistent with the views of many EIA commentators, particular those advocating that impact predictions should be derived in a scientifically rigorous manner and presented as testable hypotheses (eg. Beanlands and Duinker 1984, Environmental Resources Limited 1985, Duinker and Baskerville 1986, Clark 1994, Epp 1995). Duinker (1985) maintains that decision-makers are more likely to pay attention to and use impact predictions when they are derived in a scientifically rigorous manner, are stated quantitatively and are measurable. Empirical research both in Western Australia (Bailey *et al.* 1992, Morrison-Saunders 1999) and internationally (eg. Bisset 1984, Culhane *et al.* 1987, Bernard *et al.* 1993, Eddlemon *et al.* 1993) has confirmed that the scientific integrity of impact predictions could be substantially improved. Finally 53% of EIA practitioners surveyed by Sadler (1996, p81) rated the extent to which the state of the relevant science limits the ability of practitioners to make accurate predictions 'somewhat limiting' and 24% rated it as 'very limiting'.

3.3 Mitigation and Ongoing Adaptive Environmental Management

Previously it was noted that the current quality of science utilised in mitigation design was significantly greater than that for impact prediction and impact monitoring. A similar statistically significant relationship existed between the perceived importance currently of the role of science in mitigation design compared with ongoing adaptive management (P=0.020). Based on mean values, the current role of science was considered to be more important in mitigation than in ongoing adaptive management. Again, the pre-decision stages of EIA appear to command greater attention with respect to scientific input than the post-decision stages for comparable activities.

The supporting qualitative responses provide two explanations for this finding. Firstly many practitioners suggest that the key focus for most proponents in EIA is to obtain approvals. Consequently they are more likely to devote time and resources to pre-decision activities (eg. project design, investigative studies and EIS preparation) compared to the post-decision stages of a project unless a significant environmental problem is encountered or they are prevailed upon by regulators or public pressure (eg. Morrison-Saunders 1998). Similarly regulatory agencies pay less attention to projects in the post-decision stages of projects. Interviewees advocated a greater role for EIA follow-up (eg. audits, impact monitoring and management activities). Secondly, for major resource development projects (eg. mining and mineral processing) it is difficult to make modifications to fixed plant even if there were good environmental reasons to do so due to the costs involved. Greater investigation and planning is likely to be invested in the pre-decision engineering design stages of projects compared to ongoing project operations. The emphasis on engineering design aspects of projects was seen by participants to be grounded in scientific method.

For planning and land development projects (ie. where engineering design considerations are not so rigid), the tendency for proponents to quickly move on to new projects means that there is typically no continuity in project management. Thus here too there is minimal opportunity for adaptive environmental management initiated by proponents to occur. In these projects management responsibility ends up with individual land owners and local governments; interviewees indicated that there is typically little or no ongoing environmental management or monitoring programs put in place. Clark *et al.* (1987) have previously stated that monitoring and auditing (which are important steps in adaptive management) are long-term commitments and that it would be best if personnel establishing a monitoring program were to remain to carry it out in order to maintain consistency. For land development projects where this continuity cannot be guaranteed, it seems that any adaptive management is likely to arise from external regulatory or public pressure rather than from the organisations responsible for monitoring and management programs.

The extent to which the state of science limits the ability of practitioners to custom-design successful mitigation measures was rated as 'somewhat limiting' by 58% of participants in Sadler's (1996, p81) international survey and 'very limiting' by 12%. These findings are largely supported by the work of Bailey *et al.* (1992), Bailey (1997) and Morrison-Saunders and Bailey (1999) who similarly found relatively low levels of science evident in EIA compared to international expectations.

3.4 Decision-Making

As mentioned previously, the quality of science utilised in decision-making was rated higher than that in several other stages of the EIA process. These results imply that EIA practitioners are generally satisfied with the *quality* of scientific input available to decision-makers. However different results were apparent for the *importance* placed on the role of science in decision-making. The perceived importance of science in EIA decision-making was compared to the perceived importance of science in baseline monitoring, impact prediction, mitigation design, impact monitoring and ongoing adaptive management (ie. question 3 in Table 1). It was found to be significantly less important in all cases (P ranged from 0.038 to 0.001). Interviewees frequently indicated that science was only one of several factors that EIA decisions should be based upon, whereas science should form the basis of the other stages of EIA. For example several participants suggested that it was impossible to undertake environmental monitoring programs without some scientific background or process, but that this is not the case for decision-making.

Participants were prompted to identify the other factors that influence EIA decision-making. In Western Australia the ultimate responsibility for decision-making and issue of project approvals rests with the Minister for the Environment. Consequently social, economic and political considerations influence the decision-making process along with the environmental considerations and these were frequently identified by participants. Other factors such as precedent, experience, intuition, common sense, anecdotal information and emotions all influence EIA decision-making processes were also mentioned. Consequently the role of science was perceived to be less here than for other stages of the EIA process. A similar finding was recorded by Walsh (1998) concerning the role of science in the formulation of environmental policies in Western Australia. In a survey of 22 practitioners involved in environmental policy initiatives, he found that science played a key role in the early stages of policy formulation including raising awareness, influencing values and 'underpinning' or providing a sound basis for environmental policies. Beyond this though, non-scientific considerations were generally considered to have shaped policy and in situations where high levels of conflict were evident, the role of science was seen to be secondary to political considerations (Walsh 1998, p134).

It is frequently acknowledged that non-scientific factors influence EIA decision-making. Morgan (1998, p80) argues that the traditional expectation in the scientific literature that the EIA process ought to be primarily a scientific process for making and testing predictions about human impacts on the natural environment is one-sided, and ignores the socio-political aspects of EIA. Freudenburg (1989) emphasises the political dimension of EIA and suggests that political factors typically outweigh scientific ones in the decision-making process. Sadler (1996, p16) notes that decision-making requires striking a balance between economic, environmental, social and other criteria, and thus it is a political process involving trade-offs rather than a purely scientific undertaking. There are others who suggest that it is appropriate that the EIA process is actively informed from sources other than science alone. For example, many researchers have pointed out that there is a subjective component of EIA based on value judgements and which constitutes the ‘art’ of EIA (eg. Eversley 1976, Orians 1986, Hyman and Stiftel 1988, Lemons and Brown 1990, Caldwell 1991, Hellstrom and Merle 1996). Finally, Robinson (1989) suggests that EIA comprises of politics, public and science, and that successful EIA requires all three to be in balance.

While the survey participants acknowledged the realities of non-scientific influences on EIA decision-making, it did not mean that they necessarily agreed that it should be this way. As with previous viewpoints on the *importance* of science in EIA, participants strongly indicated that science *should* play a greater role in EIA decision-making ($P<0.001$). Some participants (mainly consultants and proponents) believed it was wrong that socio-political factors should be included in EIA decision-making and one even suggested that a scientifically based decision-making process drawing solely on 'objective' data should be developed and utilised. EIA regulators and other government regulators were more accepting of the socio-political aspects of EIA decision-making. Several advocated an explicit role for economic and other social factors in EIA decision-making (a recent ruling in a legal case in Western Australia prevents the EPA from taking economic and certain social considerations into account when assessing a proposal; Bache *et al.* 1996).

Practitioners involved in planning and land development projects rated the quality of science utilised in EIA decision-making in Western Australia significantly more poorly than that of the individuals whose work did not include planning ($P=0.028$). Further to the previous comments about land development projects, several EIA regulators and consultants claimed that land developers are often small, 'one-off' proponents operating in an industry with small profit margins relative to large resource development projects. Consequently they had less resources to invest in EIA studies and less incentive to do so (eg. a long term mining company operating multiple projects has both accumulated experience and financial resources, as well as their reputation to uphold). It was widely acknowledged by participants that scientific studies during EIA (particularly baseline monitoring) are expensive undertakings. Consequently for planning and land development projects it would appear that EIA decision-makers are forced to make decisions based upon poorer quality documentation (which in turn reflects poorer quality supporting scientific studies provided by proponents).

3.5 Overall Expectations of the Science in EIA

With respect to question 4 (in Table 1), 68% of participants indicated that the current quality of science in EIA met with their expectations of the process, 10% gave a neutral response and 22% indicated dissatisfaction including one response in the 'highly unsatisfied' end of the spectrum. Given the misgivings many interviewees had with the quality and importance of science in EIA, this finding implies that practitioners' expectations are tempered by the realities of what they know to be current EIA practice. All interviewees indicated that the quality of science in EIA could be improved and that it should play a more important role in the process, but many clearly did not expect this to eventuate in practice due to the influence of other factors (eg. money, time, socio-political etc.). Levels of satisfaction with the quality of science in EIA were across all four practitioner types.

3.6 Factors Determining the Level of Science in EIA

In response to the question: What factors do you believe have determined the level of science utilised in EIA in Western Australia? the most frequent response offered (19 respondents or 61%) was increased public knowledge or expectation for environmental performance. Public pressure on proponents, consultants and regulators alike was seen to improve accountability and the quality of information used to justify approval decisions. All four types of EIA practitioners identified this factor. Previously Morrison-Saunders (1998) found that public pressure also had a major effect on environmental management outcomes in each of six case study projects examined in Western Australia. This finding highlights the importance of having an EIA process which is transparent and accountable to the public (Commonwealth Environmental Protection Agency undated, p15; Wood and Bailey 1994, Sadler 1996, p95; Morrison-Saunders and Bailey 2000).

Despite the apparent public pressure in EIA, remoteness may reduce this influence. Five of the respondents (16%) stated that there was generally less public pressure on projects located in remote parts of the state, including offshore oil and gas projects, compared to those in well populated areas. This is partly due to the vast scale of the 'outback' regions of Western Australia which are scarcely populated. It is also partly because most of the population living near major resource development projects are those that are employed in the industry themselves and they are likely to be advocates for that industry or operation.

Other frequently identified factors believed to have determined the level of science utilised in EIA by all four groups were:

- the requirements of EIA regulators (17 or 55%) including published guideline documents as well as the leadership provided by key personnel within the EPA and Department of Environmental Protection. These were generally seen to have had a favorable impact on the quality of scientific studies during EIA and to be a positive initiative. However, some participants felt that these guidelines were inadequate and one suggested that they reduce the flexibility of the EIA process by focussing effort onto narrowly defined issues, a concern similarly raised by Morrison-Saunders and Bailey (2000) in regard to current EIA practice in Western Australia;
- political expectations (15 or 48%) which were seen to reduce the importance placed on scientific factors as decisions were seen to be largely influenced by socio-economic and political considerations; and
- financial resources provided by proponents (14 or 45%). The cost of undertaking scientific studies during EIA was seen to be a major problem with insufficient funding being available to permit appropriate work to be carried out (eg. baseline monitoring) in many circumstances. Budget restrictions were identified by 61% of participants in Sadler's (1996, p82) international survey as being very limiting on 'best practice' EIA.

Company size was also frequently identified as a factor determining the level of science in EIA in Western Australia (12 or 39%). This factor was identified primarily by consultants and regulatory agencies only. It also relates to the financial resources provided by proponents whereby larger operators tend to have more resources available to undertake EIA studies as well as more experience in the process. However, several interviewees gave examples of small companies with minimal financial resources engaging in high quality scientific investigations during EIA.

3.7 Improving the Scientific Integrity of EIA

In response to the question: How would you improve the scientific integrity of EIA in Western Australia (if at all)?, respondents typically referred to or built upon their answers for the previous question. Three additional suggestions, common to all four types of EIA practitioner, were frequently mentioned:

- Increase the resources available to the Department of Environmental Protection (ie. the EIA regulator; 10 responses or 32%). Problems identified here included overworking/understaffing of the department combined with inadequate levels of experience or training of the staff employed. Many of the 'best' environmental professionals end up working for proponents and consultants (ie. in the 'private sector') as the pay and work conditions are more attractive here. Furthermore, people with experience in the department appear to be highly sought after by the private sector, presumably because they 'know the system' and may be able to more readily obtain project approvals for proponents. A reduced individual workload and increased expertise of staff in the department would increase the scientific integrity in EIA via provision of better advice to proponents and more opportunity to prepare guidance documents outlining the expectations of regulators;

- Increased consultation with all stakeholders early in the EIA process (10 or 32%) by proponents. This would enable regulators and the public to provide feedback on proposals before EIS documents were prepared and formal public review procedures commenced. Hence the feedback could be construed as constructive criticism rather than negative feedback as it would enable project design to be modified during the planning stages. Early public consultation would improve the scientific integrity of EIA through improved scoping and demand for greater rigor in EIA studies. Once proponents had invested in the preparation of an EIS document, they tend to be locked into a particular project design which they will only reluctantly change if forced to by regulators; and
- Subject EIA documents to peer assessment and review (9 or 29%). Similar to having early public consultation, it was felt that peer review would generally improve scientific methods and techniques used in EIA studies as well as the quality of information and reporting. If monitoring programs were subject to peer review, better programs would subsequently be designed while peer review of EISs would overcome the tendency for consultants to prepare documents of advocacy on behalf of proponents by requiring a more objective rational or scientific basis to EIA reporting. Peer review in EIA has previously been recommended by Dickerson and Montomery (1993), Lemons (1994), Morgan (1998, p83) and Benkendorff (1999) as a means of improving the scientific component of monitoring programs and EISs in particular.

4 SCIENCE IN EIA: OUTCOMES AND IMPROVEMENTS

It was clear from all practitioners surveyed that science was considered to play an important role in EIA and they generally all desired a greatly quality and use of science during EIA. Having poor quality science in EIA was mainly seen to result in a lack of information for decision-making and environmental management purposes. It might be expected that the converse would also be true; that where sound information is available, good quality science would be evident in EIA practice. There are no empirical studies to support or repute this. It is interesting to note, though, that in a recent survey of the quality of EISs in the US, Tzoumis and Finegold (2000) expected that information adequacy in EISs would improve over time due to enhancements in computer technology and increased knowledge. However, their results suggested that documents are not improving particularly in information quality and that there appears to be very little learning from previous years of EIS preparation by the agencies involved. Perhaps the same could be said about the quality of science in EIS. It is clear that factors other than knowledge and technical capability dictate the quality of science and information utilised in EIA.

Additionally two participants surveyed in the present study suggested that the absence of technical information about an environmental setting or issue could actually promote explicit requirements for scientific studies to be implemented. One participant noted that 'frontier' issues (ie. new types of developments or technologies that have not been assessed previously or proposals in environmental settings that are not well understood) often spurred interest and requirements for formal scientific investigations during EIA. Another participant noted that for the planning sector, land development is increasingly moving onto poorer quality land as all of the land with greatest suitability for urban expansion has already been developed. The result in both situations is a requirement for greater baseline studies and ongoing monitoring investigations to improve the knowledge base about the impacts of development and to improve project management. This approach to EIA is in keeping with the precautionary principle and demonstrates that the relationship between information availability and the quality of science in EIA is not necessarily simple.

The survey results clearly indicated that practitioners believe there is room for improvement in the quality of science in EIA throughout the process. It appears that the quality of science in the post-decision stages of the of the process is particularly wanting; a similar finding was report by Sadler (1996, p82). EIA follow-up activities such as monitoring and ongoing adaptive management programs clearly can be improved considerably. However some practitioners are satisfied with the available *quality* of science in EIA but do not believe that it is given sufficient *importance* in decision-making and project management. Throughout the surveys there was no suggestion that technical skills for conducting scientific studies were wanting, whereas much of the literature on this topic implies that the practice of science within EIA itself needs to be improved.

Clearly the quality and availability of science to EIA practitioners forms only part of the equation and there are other factors that influence the scientific integrity of EIA outcomes. Foremost among these are time and budget constraints to engage in scientific studies, particularly baseline monitoring upon which all other stages of EIA are based. That the quality of science in the pre-decision stages of EIA is generally perceived to be better than that in the post-decision stages indicates that the desire to win a project approval remains a key driving force in EIA, rather than maximising environmental protection.

Socio-political factors clearly have a bearing on the scientific integrity of EIA, particularly during the principal decision-making stage. It is clear that science provides only one input to decision-making along with other considerations (ie. social, economic, political etc.). To advance the scientific integrity of EIA may not require more sophisticated scientific studies and development of scientific techniques so much as better integration with these other factors. Tapping into public pressure interests and encouraging regulators to adopt more stringent guidelines and expectations for EIA practice are promising avenues to explore.

One question that still remains is: how much science is needed in EIA to ensure that the environment is protected? The practitioners surveyed in this study clearly all believed that science should play a greater role in the EIA process. But the survey did not attempt to identify a threshold for defining what is an adequate amount and/or quality of science in EIA for environmental management purposes. Participants in Sadler's (1996, p81) international survey indicated that the state of science limited the ability of practitioners to custom-design successful mitigation measures. While Bailey *et al.* (1992), Bailey (1997) and Morrison-Saunders and Bailey (1999) recorded relatively low levels of science evident in EIA compared to international expectations, they provided evidence that effective environmental management could arise in the absence of scientific rigor in EIA. For example Morrison-Saunders and Bailey (1999) concluded that neither scientific rigor in impact prediction nor prediction accuracy had any bearing on the implementation of environmental management activities. They suggested that simple issue identification during EIA may be more important than rigorous impact prediction as it would be sufficient to alert managers to issues requiring environmental management attention. They also found that environmental management activities may result in the absence of ideal rational-scientific monitoring programs. The implication here is that the environment can be protected and managed without recourse to formal scientific studies or procedures.

These findings are consistent with the viewpoint expressed by many practitioners surveyed in this study that common sense and experience play an important role in EIA practice. Whilst it must be acknowledged that to some extent science or scientific method will underlie experience and common sense factors, looking to science to improve EIA performance may be misleading. As Bisset (1988) cautioned: 'the literature concerned with the new 'scientific' thinking has a certain missionary, proselytising tone which it is necessary to treat with a degree of circumspection'. Practitioners need to look beyond advances in scientific methods alone to improve EIA practice. Similarly, follow-up activities should not focus on scientific components of EIA at the expense of the other factors that influence outcomes.

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