Environmental Auditing: Artificial Waterway Developments in Western Australia

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In recent years, environmental auditing has emerged as a means of examining the effectiveness of past environmental impact assessment in an attempt to identify ways of improving the utility and efficiency of future assessments. In this paper, an environmental audit of a range of artificial waterway developments in Western Australia is reported. In particular, three types of audit are reported: a compliance audit in which an assessment is made of whether the conditions established by statutory bodies for mitigating the environmental impacts of the developments have been implemented and enforced; a prediction audit in which the nature and accuracy of impact predictions is evaluated; and an EIA procedures audit to evaluate the effectiveness of the overall EIA process.

The results of the audit reported here are encouraging in so far as the level of compliance and prediction accuracy are concerned, although problems with the lack of monitoring data, which have beset earlier audits, prevented follow-up on many impact predictions.

Keywords: environmental audit, artificial waterways, Western Australia.

1. Introduction

Environmental impact assessment (EIA) is a process which is used to predict the potential environmental impacts of developments and to identify and prescribe mitigating measures to manage these impacts. The information generated by EIA assists decision-makers responsible for granting or denying development approval. In Western Australia, EIA has become an established component of the Government's decision-making process, and is administered by the Environmental Protection Authority (EPA).

The central document in environmental impact assessment is commonly known as an environmental impact statement (EIS), and is prepared by the proponent of the proposal. An EIS contains a series of predictions that forecast how the proposed development will or will not affect the physical, biological and social environmental components during and following project implementation. Commitments to manage these impacts should also be made.

In Western Australia at the time of this audit, three types of EIS were in use: notice of intent (NOI), public environmental report (PER) and environmental review and management programme (ERMP).

The EIA process in Western Australia has been described in detail by Bailey (1989). In brief, the EIS document forms part of the information base available to the EPA who determines whether or not a project is environmentally acceptable and, if so, makes recommendations as to appropriate environmental conditions. The Environmental Protection Authority then reports to the Minister for Environment. Prior to the proclamation in February 1987 of the Environmental Protection Act 1986, this EPA report was advisory only, although the recommendations contained within could be accepted by decision-making authorities and imposed under their legislation. Since 1987, the Minister for Environment, informed by the EPA's report and recommendations and in consultation with decision-making authorities, including other relevant Ministers, makes the final decision as to whether the project should proceed, and imposes appropriate environmental conditions for the prevention and management of the potential impacts. These conditions are contained in a statement issued by the Minister for Environment, and are legally binding.

Considerable time and resources are required to undertake an EIA, and so it is desirable to have some form of feedback loop in the system which enables a learning from experience process to occur. In recent years, environmental auditing has emerged as a means of examining the effectiveness of individual EIAs in an attempt to identify ways of improving the utility and efficiency of future assessments. Environmental auditing is a relatively new field, with few comprehensive studies reported to date. Previous auditing studies have been

reviewed by Munro *et al*. (1986) and Tomlinson and Atkinson (1987*b*). Many of these early studies were concerned with only one or two development projects. However, Bisset (1984) and Culhane *et al*. (1987) have undertaken audit studies in the U.K. and U.S., respectively, in which four and 29 developments were investigated. More recently, an audit of 19 developments within Australia has been completed by Buckley (1989), while Luecht *et al*. (1989) reported on an audit of 44 projects within the U.S. Environmental Protection Agency's Region 5. Mention should also be made of the 1985 conference on "Follow-up Audit of EIA Results" held at the Banff Centre, Canada (Sadler 1987*a,b*).

The present paper reports the results of an environmental audit of 15 artificial waterway developments in Western Australia. Although many previous studies focussed on the nature and accuracy of impact predictions, it was suggested in Bailey and Hobbs (1990) that precise prediction of impacts is less important than having in place mitigating measures that can be applied to the actual impact. In recognition of this suggestion, the aim of this study was to undertake an environmental audit with the following objectives:

1. To assess whether the conditions established by statutory bodies for mitigating the environmental impacts of developments have been implemented and enforced (compliance audit).
2. To identify the nature and accuracy of impact predictions, and to evaluate the role of impact prediction in the management of environmental impacts of developments (prediction audit).
3. To use the auditing programme to evaluate the effectiveness of the overall EIA process in order to identify areas that could usefully be revised or refocussed (EIA procedures audit).

A fuller report, including a detailed discussion of the methodology used, can be found in Hobbs *et al*. (1990).

2. The artificial waterway developments

Fifteen artificial waterway developments were analysed during the study. These developments ranged from some of the earliest types of artificial waterways in Western Australia, constructed as early as 1972, to others that were under construction at the time of this analysis. EIA procedures have varied considerably during this time, and the developments studied included projects that were constructed prior to statutory EIA, projects that were assessed under the Environmental Protection Act 1971, and projects that were assessed under the present 1986 Act. Current EIA procedures provide for several levels of assessment of proposals and all levels were represented by the developments studied.

Eight of the developments were operational or nearing completion at the time of the audit, and are referred to here as the "completed" developments. Two of these developments, Waterside Mandurah and Murray River Waterfront, are residential canal estates. Sorrento Boat Harbour, Ocean Reef Boat Launching Facility and Two Rocks Marina are coastal marinas, while Mindarie Keys is a commercial and residential development based around an excavated inland harbour. The Fremantle Inner Harbour Deepening Project is an extension to the existing commercial harbour, included here because of the common issue of water quality. Another residential canal estate, Yunderup Canals, was built before statutory EIA, and there is no pre-implementation documentation available. Most of the analyses relating to the "completed" developments therefore refer to the first seven of these developments only. Two Rocks Marina was also built before statutory EIA, but a document similar in content to an ERMP was, nevertheless, produced.

A brief summary of the legal status of the environmental conditions associated with each of these developments is of relevance. The Two Rocks project is the subject of a legal agreement between the developers and the State which covers *inter alia* environmental matters. The Murray River Waterfront Development provided an interesting case in that it was assessed and rejected by the EPA in the first instance, only to be approved on a subsequent appeal made by the proponent to the Town Planning Appeal Tribunal. The development was then subject to various legally binding conditions under the Town Planning and Development Act 1928. The Fremantle Inner Harbour Deepening Project was assessed under the Environmental Protection Act 1986, and was therefore subject to legally binding conditions. All of the other "completed" developments referred to above either pre-dated statutory EIA (i.e. Yunderup Canals) or were assessed under the 1971 Act, and the associated environmental conditions have no legal force.

A further seven projects for which development had not yet commenced, or which had advanced only a short way, were also included to increase the sample size for some of the analyses that related only to pre-implementation documentation. These were: Halls Head Waterways and its revised form Port Mandurah (a canal estate), Secret Harbour Project and Westport Project (excavated harbours combining residential and commercial developments), Rockingham Marina (a small boat marina), Geraldton Foreshore Redevelopment (a marina and associated onshore development) and a proposed extension to Yunderup Canals.

3. Methodology of the study

There is no uniform methodology for environmental auditing, although Tomlinson and Atkinson (1987*a*) have proposed a standardized terminology, which we used in modified form in this study. Three of the seven specific types of audit proposed by Tomlinson and

Atkinson-compliance audit, prediction audit and EIA procedures audit-were adopted in the present study.

The methodology used in this study is discussed fully in Hobbs *et al.* (1990) and was based upon that described in Bailey and Hobbs (1990). Briefly, the methodology is centred upon a database comprising four files: "actions", "conditions", "predictions" and "impacts". These files can be described in the following ways: The methodology used in this study is discussed fully in Hobbs *et al.* (1990) and was based upon that described in Bailey and Hobbs (1990). Briefly, the methodology is centred upon a database comprising four files: "actions", "conditions", "predictions" and "impacts". These files can be described in the following ways:

Actions file: records the specific components of a project's design and any subsequent changes thereto.

Conditions file: records any commitment or recommendation for a mitigating action proposed by the proponent or other body, its legal status and data on subsequent compliance therewith.

Predictions file: records any statement that predicts a change, or no change, to any part of the biophysical or social environment as a result of project implementation, the characteristics of these predictions and their auditability and accuracy.

Impacts file: records any change in the biophysical or social environment identified as a result of project implementation and any management response thereto.

Within each database file, individual "actions", "conditions", "predictions" or "impacts" are identified as separate records. Each record consists of several fields which include both extensive memo type fields to store detailed information and summary fields to categorize the record.

During the process of applying the methodology of Bailey and Hobbs (1990) to the artificial waterways, several important modifications to the file fields were found to be convenient. Those changes of most significance are discussed below.

There were no major modifications made to the "actions" file. However, in the "conditions" file, the "type of condition" field was replaced by two new fields: "origin of condition" and "legal status". The "compliance" field was amended and a "present status" field added.

The "origin of condition" field indicates the body which proposed each condition. The options distinguish between voluntary commitments made by the proponent in its EIA documentation, EPA recommendations, additional conditions contained in the Minister for Environment's statement, and, finally, other conditions.

The "legal status" field records whether the condition is legally binding under the Environmental Protection Act 1986 (i.e. a Ministerial condition), legally binding under other legislation or not legally binding. Another option covers those proposals that were still undergoing assessment at the time of the audit.

The amended "compliance" field records the extent of compliance by the responsible body with each condition at the time of the audit. The options available are largely as described in Bailey and Hobbs (1990), with the addition of a "yes in part" option and the deletion of another which was relocated into the new "present status" field. This field summarizes the status of compliance with the condition by recording whether the implementation of the condition was completed or ongoing at the time of the audit, or if the condition was not yet applicable.

In the "predictions" file, an "issue category" and "nature of impact" field were added in order to rate predictions according to their perceived importance and beneficiality.

The "issue category" field rates the importance of the predicted impact as perceived by the EPA at the time of its assessment, and the "nature of impact" field records the predicted impact's adverse or beneficial nature as perceived by the author of the prediction (usually the proponent). It is important to note that the data recorded in both of these fields were derived from interpretation of the EIA documentation, not from our interpretation of the significance or nature of the predicted impact.

The "issue category" field is used to record the extent to which each prediction addressed key issues identified for the particular project. The key issues for each development were drawn from the EPA's report, and are based on the points identified and highlighted by the EPA as being important or significant at the time. Predictions were assigned a rating of 1, 2 or 3 as follows:

Issue category 1: prediction directly addresses a key issue.

Issue category 2: prediction indirectly addresses a key issue.

Issue category 3: prediction does not address a key issue.

A similar field, with the exception of category 2, was also used in the "impacts" file to rate the importance of impacts. The "nature of impact" field records the beneficiality of each predicted impact as perceived by the author of the prediction. Each prediction was assigned to one of three categories: a potential impact was determined to be either "adverse", "beneficial" or "neutral". Where the authors of the prediction stated explicitly that the impact would be adverse or beneficial, their judgement was used. Otherwise, adverse impacts were defined as those that would cause a deterioration, or a change that was not stated to be beneficial, in the existing environmental quality for that component of the environment. "Neutral" impacts were defined as those impacts that would result in no change in environmental quality.

This approach can be compared to that of Culhane *et al.* (1987) who classified predictions that forecast no change in the environment as beneficial. These authors based their classification of adverse/beneficial on the way they perceived that the writers of predictions meant a passage to be read. Under their definition, a statement that predicts that an adverse impact will not occur would be recorded as beneficial.

Finally, three fields in the "predictions" file concerned with the question of auditability were rationalized into two fields.

In the "impacts" file, the only modification of importance was the merger of the two fields concerned with predictive success. It is worth noting that the "impacts" file contains three types of observed impacts: impacts that were expected to occur (impacts predicted accurately), impacts that were contemplated but predicted not to occur (inaccurate predictions) and impacts that were completely unforeseen (impacts not predicted). Some predictions contained in the "predictions" file have no corresponding record in the "impacts" file because they are accurate predictions that no impact will occur. A similar comment could be made for inaccurate predictions.

4. Results and discussion

This section presents the results of the study under the headings of compliance audit, prediction audit and EIA procedures audit. Where reference is made to "all projects", this refers to the 14 developments for which pre-project documentation was available. The "completed" projects discussed under the "actions", "conditions" and "predictions" files comprise the seven operational developments for which there was pre-project documentation. The impacts file also includes Yunderup Canals, making a total of eight "completed" developments.

The database was analysed in two main ways. First, the distribution of records within the categories of each field was summarized in tabular form to provide an overview of the data. Second, where association between different fields was believed to be a possibility (for example between the level of accuracy of a prediction and the sophistication of its underlying predictive method), a chi-squared analysis was performed to test for significance of association. Only the more important of the results are reported here; for a fuller coverage, the reader is referred to Hobbs *et al.* (1990).

4.1. COMPLIANCE AUDIT

Table 1 lists compliance for the seven "completed" projects. The compliance audit could not be finalized for many of these projects, however, because implementation of many conditions was still ongoing or not yet applicable at the time of the audit.

Table 1. Compliance with environmental conditions for the seven "completed" developments

Compliance	Number
Total Yes	121
Yes in detail	93
Yes in effect	9
Yes in part	19
No	22
Not relevant	43
No information	7
Total	193

Compliance was generally very high, with only 22 out of a total of 193 conditions not complied with. No difference in compliance was found between different subject categories.

The largest subject category, with approximately half the total number of conditions, was management. That is, proponents and the EPA focus upon project management as a means of controlling environmental impacts. Culhane *et al.* (1987) also report that most mitigating measures were complied with for their respective studies.

Slightly more than one quarter of all conditions were legally binding. Compliance was proportionally higher for those conditions that were legally binding under legislation other than the Environmental Protection Act 1986, and was proportionally lower for conditions that were not legally binding ($\chi^2 = 6{\cdot}814$, $P < 0{\cdot}05$, df = 2). This result is essentially as would be expected. Only seven conditions were Ministerial conditions, i.e. were imposed under the Environmental Protection Act 1986, and these displayed the statistically expected distribution of compliance. There was no difference in compliance between the non-binding conditions that originated as voluntary commitments by the proponent, and those that originated as EPA recommendations.

4.2. PREDICTION AUDIT

A total of 665 predictions were identified from the 14 developments for which pre-project documentation was available. Of these, 311 predictions refer to the seven "completed" projects. In our analyses of the records in the "predictions" file, we used all of the available data when investigating the nature of the documented predictions, and the data for the seven "completed" projects alone when investigating prediction auditability and accuracy.

The majority of predictions addressed impacts in the physical component of the environment. This result is contrary to that of Culhane *et al.* (1987) who found that the majority of predictions addressed socio-economic issues. Within the physical environment category, the greatest number of predictions addressed water quality impacts. The majority of the biological predictions were concerned with the impacts on the aquatic ecology of the artificial waterways themselves and their adjoining waters. Of the predictions concerning the social component of the environment, most fell into the category which addressed the potential impacts of the developments on the existing human environment adjacent to the project site.

Slightly more predictions addressed important issues directly than either indirectly or not at all. However, approximately one third of all predictions did not concern matters identified as the key issues during project assessment. Nevertheless, a comparison of the key issues for each development with the details of the predictions made showed that, in general, most of the important issues were covered by predictions.

Proportionally more of the predictions that addressed important issues directly were perceived as "adverse" by the author of the prediction and fewer were perceived as "beneficial". Conversely, predictions that addressed minor or unimportant issues were more likely to be perceived as "beneficial" and less likely to be perceived as "adverse" (χ^2=69·93, *P*<0.001, df=4). A closer look at the "beneficial" predictions revealed that many were statements of advocacy for the project, as recorded in the proponents' documents. This suggests that many of the predictions which do not address important issues are included in proponents' EIA documents in order to present the proposed developments in a more favourable way.

The vast majority of predictions (91%) did not indicate a timescale in which the predicted impact was expected to occur. Similarly, most predictions (88%) were expressed in qualitative rather than quantitative terms. This finding is of the same general order as that of Culhane *et al.* (1987) who reported that approximately 24% of predictions were quantified.

Approximately one third of all predicted impacts had a probability of "certain to occur". Half of all predicted impacts were expressed as certain events, either "certain to occur" or "certain not to occur". The probability with which an impact was predicted was related to whether the proponent perceived it as "adverse" or "beneficial"; "beneficial" predictions were more likely to be predicted with a high or certain probability, while impacts predicted with a low probability were usually seen as adverse (χ^2= 115·34, *P<0·001,* df=8). These results together suggest that the authors of predictions (mostly obtained from the proponents' documents) end to stress the positive aspects of the proposal and attempt to alleviate any fears people may have regarding a development by including discussions of potentially adverse impacts that were not expected to eventuate.

Nearly two thirds of all predictions (62%) were formulated using predictive methods based upon a general knowledge of the subject or local experience and/or literature review. Similar findings were reported by Culhane *et al.* (1987). Fewer predictions were based upon models, but proportionally more of these predictions were found to address important issues directly, whereas predictions utilizing only general knowledge as the predictive method addressed proportionally more non-key issues (χ^2= 69·57, *P*<0.00l, df= 8). This suggests that the issues proponents make the most effort to research and predict with care are the same issues that the EPA consider to be important. Therefore, early advice to proponents as to the nature of these issues should at least enable an appropriate concentration of prediction effort to occur. Such advice could be provided through the publication by the EPA of generic guidelines for individual classes of development, providing that sufficient flexibility remains for each case to be assessed on its individual merits.

Turning now to the results obtained from our investigation of prediction auditability and accuracy, only half of all predictions from the completed developments (a total of 311 predictions) could be audited (Table 2). In comparison, Bisset (1984) found that it was possible to audit only 12% of all predictions for their study.

The largest category (35%) of inauditable predictions were inauditable due to a lack of data. This figure is an indication of the extent to which monitoring programmes did not ensure that predictions could be validated or invalidated. Interestingly, the proportion of predictions inauditable due to lack of data was similar for the three issue categories, indicating that monitoring effort is not concentrated upon predictions associated with identified key issues. It can be seen from Table 2 that relatively few predictions were inauditable due to their excessively vague wording ("not auditable in theory") or because changes to the project's design made the prediction irrelevant ("project design change"). Bisset (1984) on the other hand found that 26% of all predictions were inauditable for these two reasons.

Table 2. Auditability of the impact predictions for the seven "completed" developments

Auditable in practice	Number
Yes	166
No	145
Not auditable in theory	7
Project design change	4
Not applicable yet	26
No data/insufficient data	108
Total	311

Proportionally more physical predictions and fewer biological predictions were "auditable in practice". Social predictions were found to display the statistically expected result for "auditability in practice" ($\chi^2 = 18{\cdot}482$, $P < 0{\cdot}001$, df= 2). Both physical processes and water quality predictions had around twice as many predictions that were "auditable in practice" as not. Biological and groundwater predictions, on the other hand, had over twice as many inauditable as auditable. It was found that wherever data was available from monitoring programmes, they almost exclusively addressed physical processes and water quality issues. By comparison, baseline monitoring and post-project monitoring programmes very rarely considered aquatic ecology issues.

Table 3 shows the accuracy of predictions that were able to be audited. Most auditable predictions were accurate, and the overall accuracy ratio (combining the three categories of accuracy and inaccuracy) was 78% to 22%, or approximately 3·5:1. Previous results for

prediction accuracy have ranged from a low of 30% "fairly accurate" (Culhane *et al.*, 1987) through Bisset's (1984) 47% and Buckley's (1989) 57% for the significant impacts only, to a high of 80% (Luecht *et al.*, 1989). Although such comparisons are interesting, it is unwise to attach too much importance to them, given the very variable interpretations given to the concept of "accuracy" when applied to impact predictions.

Various comparisons were made between prediction accuracy and other prediction categories to attempt to explain the reasons for the observed accuracy. It was found that the 3· 5:1 ratio applied over all comparisons and prediction accuracy was therefore not associated with any other database field. In other words, neither the type of predicted impact, its significance, the wording of the prediction, nor the basis of the prediction had any significant effect on prediction accuracy. Culhane *et al.* (1987) reported similar results, while Bisset (1984) found that significant numbers of predictions made with a high level of certainty turned out to be accurate.

Table 3. Accuracy of the impact predictions for the seven "completed" developments

Accuracy of predictions	Number
Total accurate	129
Accurate	84
Mostly accurate	17
Accurate so far	28
Total inaccurate	37
Inaccurate	19
Mostly inaccurate	9
Inaccurate so far	9
Total	166

Environmental impact assessment is, of course, principally concerned with the prediction and management of environmental impacts. In the present study, impacts were identified both from the process of validating or invalidating predictions in the "predictions" file, and also from other sources such as monitoring reports and interviews. A total of 77 impacts were recorded altogether for the full eight "completed" developments.

Approximately half the impacts were accurately predicted in advance. Of those that were not accurately predicted, approximately equal numbers of impacts were the subject of inaccurate predictions (the impact was predicted not to occur) or were not considered in any predictions. These results are very different from the proportion of accurate to inaccurate predictions (3·5:1) and demonstrate the relationship between prediction accuracy and observed

environmental impacts as previously discussed. Many of the accurate predictions were statements that an impact would not occur, and because the impact did not occur, these predictions were not reflected in the "impacts" file.

It is interesting that a relatively high proportion of impacts were not considered in any of the pre-project documentation. By comparison, Bisset (1984) reports that "a few" impacts resulting from the development were omitted from EISs, while Culhane *et al.* (1987) reports only three unanticipated impacts out of 29 projects.

It is clearly more important to predict accurately the significant impacts rather than the minor ones. Of the impacts that were not accurately predicted, those that represented key issues were more often the subject of inaccurate predictions, whereas those that did not represent important issues were more often not predicted at all ($\chi^2 = 10{\cdot}765$, $P < 0{\cdot}01$, df= 2). In other words, the key issues were nearly always highlighted in predictions, although they may have been predicted not to occur, whereas completely unexpected impacts were usually in areas not considered key issues during document preparation and assessment. This is an important point in that the identification of a potential impact, even if inaccurately predicted, can give rise to the imposition of an environmental condition designed to elicit an appropriate management response in the event that the impact does occur.

This relationship between impact identification and management response was explored through the analysis of the "management response" field in the "impacts" file. Around half of all the recorded impacts did not warrant any management response. These included many impacts that were an inevitable consequence of the development proceeding, such as loss of habitat, changes to landscape and acceptable turbidity plumes during construction. Such inevitable impacts can be assumed to have been judged as acceptable by the EPA during its assessment. The second largest category of management response was "none". This category covers instances where an impact has occurred and is an acknowledged problem but where no action has been taken to date. The absence of any response at the time of this audit is not necessarily a cause for concern, given that half of the instances in which there had been no response relate to Two Rocks and Yunderup Canals which pre-dated EIA.

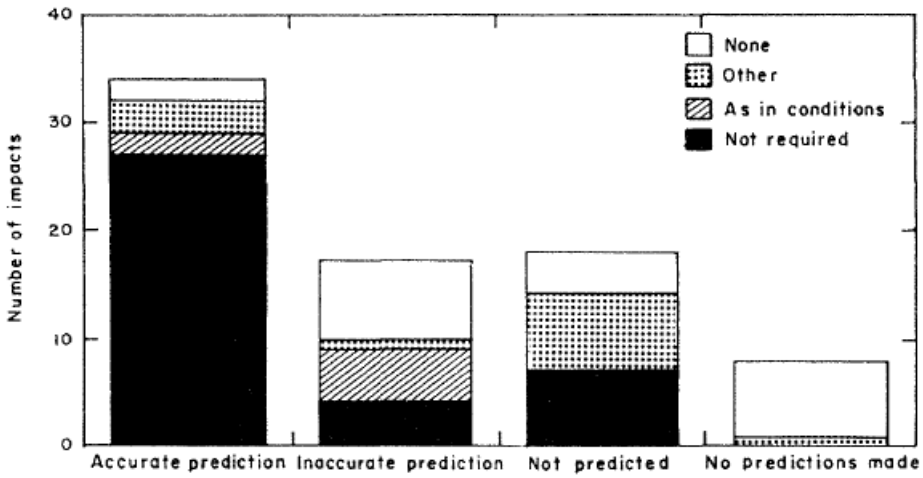
Seven impacts were responsed to as provided for in environmental conditions, while 13 impacts had a response of "other", indicating that management bodies were able to react successfully to impacts as they arose without the benefit of pre-existing mitigating measures outlined in environmental conditions.

The relationship between the success with which an impact was predicted and the management response to it is illustrated in Figure 1.

The vast majority of impacts that were predicted accurately did not require any sort of response. Many of these were either not significant enough to warrant a management response or were inevitable impacts. Of the remainder, only two had a response of "none". Other foreseen impacts were responded to either according to conditions or by some other management response.

The type of management response varied between the two categories of unexpected impacts, with responses that were determined by existing conditions applying only to those impacts that were considered but inaccurately predicted. However, of the impacts that were not considered at all, many had a management response of "other", and in fact there were fewer impacts with a response of "none" than there were for the "inaccurate" category. These results suggest that, while impact identification rather than accurate impact prediction may indeed be sufficient for the setting of conditions, management responses can be arrived at with or without conditions.

Figure 1. Association between the success of impact prediction and the management response to observed impacts (χ^2 = 50·24, P< 0·001, df= 9). The data for "no predictions made" refers to the impacts associated with the Yunderup Canals project for which there was no pre-implementation documentation.



From Figure 1, it appears that a management response can arise both for inaccurately predicted impacts (in which case the response would be governed by the relevant environmental condition), and also for unforeseen impacts where the response is initiated by the proponent together with an ongoing involvement by the regulatory agencies (principally the EPA).

4.3. EIA PROCEDURES AUDIT

To undertake an EIA procedures audit is fraught with methodological difficulties, not the least of which is concerned with the demonstration that any environmental benefits were indeed the result of the application of the EIA process. Our study has not addressed itself to such issues; rather an attempt has been made to gain an improved understanding of the manner in which EIA operates. It has been claimed by many of those involved with environmental impact assessment in Western Australia that a somewhat uncommon feature of the process as practised here is its emphasis upon the management and monitoring of impacts. That is, EIA has been seen not as solely a planning tool, but more as an approach integrating the planning and management of the environmental consequences of development.

The results obtained from this initial audit of artificial waterway developments throw some light on this matter. It has been shown earlier that the EIA process in Western Australia does indeed place an emphasis upon impact management, and, most importantly, it was also shown that even inaccurately predicted impacts are often responded to in accordance with the associated environmental condition. Interestingly, a management response was found to have occurred for over one third of the unforeseen impacts which are, of course, not covered by any condition requiring a response. One can only speculate about whether these responses would have occurred in the absence of EIA, or whether the increase in awareness of a developer's environmental obligations that can be engendered through EIA is responsible.

It is also worth stressing at this point the large proportion of impact predictions that could not be audited due to a lack of sufficient monitoring data. Monitoring should be seen from the outset as an extensive and long-term management commitment by the proponent in the same way as any other management commitment. Certainly, monitoring programmes can be costly, but the accumulated information, together with that obtained from similar developments, would allow monitoring requirements to be periodically reassessed and revised so that long-term monitoring could continue at a lower, but specifically focussed, level.

Finally, it is important to be aware of the limitations of auditing. Audits only check on what is against what was intended or expected. This point is relevant when it comes to applying the results of the audits to the wider context of EIA procedures. It can be seen from the outset that it is not possible for auditing completely to answer the question "Did the EIA process work in ensuring the environment was protected?" While it is possible to show that unacceptable environmental impacts have occurred in the presence of procedures that were in place to manage them, and therefore conclude that the procedures were in some way deficient, it is impossible to ascribe unequivocally the absence of any impacts to the presence of the procedures.

5. Conclusion

In this paper, an environmental audit of a range of artificial waterway developments in Western Australia has been reported. Three types of audit were undertaken: a compliance audit in which an assessment was made of whether the conditions established by statutory bodies for mitigating the environmental impacts of the developments were implemented and enforced, a prediction audit in which the nature and accuracy of impact predictions were evaluated, and an EIA procedures audit to evaluate the effectiveness of the EIA process.

The level of compliance was high, at 63% of 193 individual conditions for seven "completed" projects. An observation of significance was that while the origin of a condition did not appear to influence compliance, those conditions which were legally binding were more likely to be complied with than those that were not. This result is to be expected.

Of the total of 665 predictions examined, 311 refer to the '"completed" projects. Of these 311, some 145 could not be audited because of one of several reasons. For the 166 auditable predictions, 129 were "accurate", "mostly accurate" or "accurate so far", while 37 were "inaccurate" to a greater or lesser extent. This approximate 3·5:1 ratio of "accurate" to "inaccurate" predictions applied over all comparisons, and prediction accuracy was not associated with any other characteristic of the prediction.

As for the impacts, 34 of the 77 impacts identified during the study were accurately predicted. Of those that were not accurately predicted, approximately equal numbers of impacts were the subject of inaccurate predictions (the impact was predicted not to occur) or were not considered in any predictions. In both cases, it was often found that a management response had occurred.

This environmental audit has shown that the EIA process in Western Australia is not one whose role is seen to end with the decision to proceed with development or not, but rather continues into the implementation phase with impact management and monitoring. Although there is still room for improvement, especially in the area of the extent and duration of monitoring, the results reported here are encouraging in so far as they tend to confirm the utility of environmental impact assessment as a tool for environmental protection. This utility lies not so much in the accuracy or otherwise of the impact predictions, but in the focus upon impact management which is a characteristic feature of the EIA system in Western Australia. Thus, impact identification and the implementation of associated environmental conditions appear to be of more significance than the generation of scientifically testable and accurate predictions. It is here that the methodology used in this study has proved of value in avoiding the pre-occupation with overly strict auditing of narrowly-defined predictions in favour of a

more operationally significant concern with EIA as a process that is of relevance from the planning through to the management of a proposed development.

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