DETECTING ECOLOGICAL IMPACTS

Concepts and Applications in Coastal Habitats

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CHAPTER 14

THE ART AND SCIENCE OF ADMINISTRATIVE ENVIRONMENTAL IMPACT ASSESSMENT

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A fundamental goal of "environmental protection" in the administrative review of planned developments is to ensure that features of the natural world considered important by the public are not unduly degraded. Detecting ecological impacts after they have occurred is not a desired mechanism for achieving such protection. The ideal, of course, is to accurately forecast adverse effects of a proposed intervention before they occur, and to modify the project design at the planning stage to avoid or minimize anticipated impacts. These principles are central to the administrative environmental review process, which is a legal mandate for proposed development projects in most industrialized countries. The presumption is that comprehensive planning involving appraisal of potential impacts ("environmental impact assessment" or EIA) will result in developments that are consistent with policy designed to protect the public's interest in the natural environment (for a recent discussion, see Hildebrand and Cannon 1993). Because the process is designed to weigh the often diametric concerns of various interested parties, an intended outcome is to reduce conflict and engender consensus (Lester, Chapter 17). Hence, the process is conceived as a vehicle to achieve balanced decisions that promote expeditious development of environmentally sensible projects, and prohibit ventures that are perceived to be deficient in this regard.

There can be little dispute that administrative environmental review generally has served its intended purposes since its inception in the late 1960s (but see Wenner 1989). What can be disputed is the degree to which the process has protected the environment from substantial impact (e.g., Ambrose et al., Chapter 18), and, as a corollary, its success in reducing conflict and facilitating expeditious development (e.g., Lester, Chapter 17). Often, public response to a

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proposed development is shaped by perceptions of attendant environmental risks (Ruckelshaus 1983, Lester Chapter 17). A fundamental issue, then, is how well administrative environmental review—and more specifically legislated environmental impact assessment—reduces uncertainty in our understanding of potential effects of development. Surprisingly, there have been few comprehensive evaluations of the EIA process that address this issue (see Ambrose et al., Chapter 18). This situation exists in part because of structural features that hinder our ability to verify administrative findings through subsequent scientific evaluation (e.g., Piltz, Chapter 16; Ambrose et al., Chapter 18). As a consequence of limited feedback between administrative and scientific findings, it is difficult to determine in other than the most general sense whether the planning and review process should be made more effective, and if so, how.

Here we explore the interface between the "art" of administrative environmental review and the "science" of impact assessment research. The intent is to highlight some of the more prominent issues that limit the contribution of science to the review process, as well as to point out some of the consequences of this limitation. We describe the administrative environmental review process and explore some of the types of scientific information and analyses typically collected for such paper assessments. Subsequent chapters in this volume (Carney, Chapter 15, Piltz, Chapter 16, Lester, Chapter 17, Ambrose et al., Chapter 18) explore in detail related aspects, all of which are drawn from such contentious developments as offshore oil and gas activities and nuclear power generating stations.

Insights arising from examination of these controversial developments are far-reaching. For reasons that are both scientific and socio-political, administrative environmental review often fails to decrease uncertainty to a level acceptable to the public. Failure of environmental review policy is most evident for contentious developments where prolonged conflict not only obviates expeditious decisions, but can lead to adjudication by entities—the judiciary—poorly equipped to assess technical information (Lester, Chapter 17). Much of the cause for such dissension is rooted in the imperfect nature of the "factual" evidence upon which decisions are based (see Ruckelshaus 1983). It perhaps is less well appreciated that these imperfections exist to some extent in the deliberations of all proposed developments, irrespective of public response. This again underscores the need to more fully evaluate a basic premise of administrative environmental review, that the process protects the environment from meaningful impact.

Administrative Environmental Review

The Policy, Legislative and Legal Setting

Administrative review, including environmental impact assessment (EIA), is mandated for most proposed developments by legislation that sets out the prescription for the process. In the United States, developments carried out or

approved by the Federal government fall under the National Environmental Policy Act (NEPA). Public and private projects developed under the purview of individual states are governed by comparable state legislation; examples include the California Environmental Quality Act (CEQA), and the State of Washington's Environmental Policy Act. Administrative environmental review in other industrialized countries also is governed by similar legislation, such as the Environmental Planning and Assessment Act for Australia (Fairweather 1989; for a listing by country, see Westman 1985).

The National Environmental Protection Act (NEPA) and equivalent state laws (e.g., CEQA) have two main purposes. The first is to specify a uniform framework within which decision makers are provided information and facts about the environmental impacts of a proposed development. The second is to provide full public disclosure of the information and reasons leading to decisions, as well as obligations for mitigation by the applicant and enforcement of permit conditions by relevant agencies. Thus, laws such as NEPA stipulate *how* environmental review is to be conducted, and *what* information must be considered in that deliberation.

NEPA sets policy aimed at achieving broad environmental objectives, such as allowing beneficial uses of the environment that do not result in degradation, preserving the quality of renewable resources, and protecting the environment for enjoyment by future generations. However, NEPA and comparable state laws do *not* specify standards as to what does or does not constitute an acceptable level of environmental perturbation from a proposed development. How, then, are the broad environmental objectives of NEPA achieved? NEPA simply requires that the policies and programs of the Federal government be consistent with NEPA's broad environmental aims. Conformity rests on the regulatory system, also predicated in Federal law, that provides specific policies, standards, limitations and restrictions with which developments must comply. Hence, such Federal legislation as the Clean Water Act, Clean Air Act, and Endangered Species Act not only sets out environmental objectives that are more specific than—but consistent with—those of NEPA, it also provides the foundation for specific regulatory policy and the regulatory machinery.

Environmental review conducted under NEPA or equivalent state laws produces an informational record (document) for a proposed development that applicable regulatory authorities use to determine whether to issue discretionary permits. As the name implies, a discretionary permit is one where the decision to issue hinges on the judgment of the relevant agency whether the action conforms with stated policy. (By contrast, an administerial permit is issued based solely on whether an action will meet explicit requirements, such as discharge standards for an ocean outfall.) While a single agency typically has primary responsibility for conducting the environmental review, approval of a proposed project can require separate consent from a number of different permitting authorities (see below). It should be noted that permitting agencies have latitude in their interpretation of policy, and that environmental policies often must be balanced

against other, potentially conflicting mandates of an agency (e.g., Lester, Chapter 17). Possible environmental impact is but one of a number of issues to be considered in making a decision about a proposed development. Consequently, it is quite possible for various authorities to reach different permitting decisions for the same proposed development.

The following example illustrates the jurisdiction of various agencies and the regulatory filters for a proposed development of moderately high complexity. In the mid-1980s, Atlantic Richfield Company (ARCO) submitted a proposal to develop oil and gas leases in State waters (≤ 3 miles offshore) off Santa Barbara County, California. The proposed development, entitled the "Coal Oil Point Project," was to consist of 3 new offshore production platforms in State waters, new onshore processing and storage facilities, and new onshore and offshore pipelines for oil and gas transport. Because the State of California has jurisdiction over projects in its onshore environs and in "tideland" waters (to 3 miles offshore), the State Lands Commission of California conducted the administrative environmental review as required by the California Environmental Quality Act (CEQA). However, the proposed project included the placement of permanent obstructions in navigable waters of the United States (i.e., the platforms), and approval for such actions rests with the U.S. Army Corps of Engineers under the Federal Rivers and Harbors Act. Hence, the Coal Oil Point Project also was subjected to administrative review under the National Environmental Policy Act (NEPA), in this case conducted by the Army Corps of Engineers.

ARCO's proposed Coal Oil Point Project highlights the number and diversity of regulatory agencies that can be involved in the approval process of a project. ARCO needed no less than 27 permits or approvals from 15 Federal, State and County agencies (Table 14.1). The NEPA and CEQA environmental reviews for the Coal Oil Point Project, therefore, had to address the information requirements of these 15 permitting authorities. As "Lead Agencies," the State Lands Commission and Army Corps of Engineers were responsible for ensuring that the environmental documents were prepared in accordance with regulations of each applicable agency. Ultimately, the California State Lands Commission set aside ARCO's application (a *de facto* denial) on the grounds that the State first needed to formulate a master policy plan for development of California's tidelands. ARCO litigated this action (*ARCO vs California State Lands Commission and County of Santa Barbara*), and the Court sided with the State. ARCO subsequently dropped its appeal of the lower court's decision.

The judiciary plays several important roles, not the least of which is refining the administrative process of environmental review (Westman 1985, Hildebrand and Cannon 1993). As illustrated by the Coal Oil Point example above, parties affected by an agency's decision have recourse through the legal system. However, it is difficult to challenge a particular decision when it is generally consistent with stated policy. For example, NEPA and CEQA do not require that the most environmentally preferable project alternative be adopted, only that it be identified (quite often the "No Project" alternative will be so identified). Hence,

Table 14.1. Responsible Agencies and Permit Approvals for an Oil and Gas Development Proposed by ARCO in Santa Barbara County, California

Responsible agency	Permit or approval
Federal agencies	
U.S. Army Corps of Engineers	Section 10 of the Rivers and Harbors Act for Activities and Structures in Navigable Waters
	Section 404 of the Clean Water Act for Fill in Waters of the United States
Environmental Protection Agency	Spill Prevention Control and Countermeasure Plan
U.S. Coast Guard	Oil Spill Contingency Plan
	Approval of Aids to Navigation
Federal Aviation Administration	Approval of Heliport Operation Communication License
Federal Communication Commission	Communication License
State agencies	
State Lands Commission	Development Plan
	Land Lease for Pipeline Rights of Way
California Coastal Commission	Coastal Development Permit
	Coastal Plan Amendment
Regional Water Quality Control Board	NPDES Permit for Waste Water Discharge
Department of Fish and Game	Sections 1601—1603 Fish & Game Code: Stream or Lake Crossing Agreement
Department of Oil and Gas	Safety System Permit
	Permit to Conduct Well Operations
Department of Transportation	Right of Way Permit
	Encroachment on State Highway Permit
	Encroachment on State Highway Permit
Santa Barbara County agencies	
Resource Management Department	Development Plan
	Coastal Development Permit
	Conditional Use Permit
Environmental Health Division	Water Well Permits
	Water System Permits
	Hazardous Materials and Waste
Air Pollution Control District	Authority to Construct
	Permit to Operate
Department of Public Works	Permits for Onshore Facilities
	Excavation Permits

Note: Adopted from Environmental Impact Report / Statement Volume I, ARCO Coal Oil Point Project, State Lands Commission et al. 1986.

an agency's decision not to choose the most environmentally preferred alternative in and of itself provides no grounds for judicial relief. By contrast, failure to adhere to NEPA or CEQA *procedures* is subject to challenge in the courts. Included in this context is the adequacy of the environmental document in forecasting environmental impacts of project alternatives. Indeed, it is not an uncommon practice to litigate on the grounds that available information was insufficient to support the decision made (for some consequences, see Lester, Chapter 17). To the extent that scientific uncertainty contributes to this circumstance, the application of science can have a fundamental role in enhancing the effectiveness of administrative environmental review.

The Process of Administrative Environmental Review

Hildebrand and Cannon (1993) recently have discussed the National Environmental Policy Act (NEPA) in detail. Here the process of administrative environmental review is described in general, with specifics taken from the California Environmental Quality Act. (Except for details, the CEQA process is identical to that prescribed by NEPA. For example, NEPA requires the preparation of an Environmental Impact Statement (EIS), whereas the same document prepared under state legislation is termed an Environmental Impact Report (EIR)).

The process of administrative environmental review under CEQA is stipulated in enabling legislation and subsequent amending bills, which state:

> The purpose of an environmental impact report is to identify the significant effects of a project on the environment, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided.

Thus, CEQA involves the preparation of documents that provide information about the impacts on the environment of a particular project, and how those impacts can be avoided or reduced. The process consists of mandated steps to generate the information needed for applicable agencies and the public at large, all of which must be completed—and a decision reached—in a specified period of time (e.g., 1 year for CEQA). While such time limitation is designed to protect the interest of the applicant, it greatly constrains the types of new scientific information that can be gathered (see below).

The first step in the process is to determine if a particular development is subject to environmental review as a number of statutory and categorical exemptions from review have been granted (e.g., construction, replacement or demolition of single family residences or existing schools, emergency repairs to existing freeways; for NEPA, actions deemed in the interest of national security). Once it is determined that an EIA review applies to a particular proposal, the agency in charge then determines (within 30 days) if the application is complete (i.e., it contains all information needed to begin review of potential impacts of the proposed development). Once deemed complete, the time "clock" for reaching a decision begins.

The agency then determines whether an environmental impact report (or statement) (EIR/S) will need to be prepared, a decision which hinges on whether the proposed project may have any significant environmental effects. This is accomplished by cursory comparison of the project against criteria established by the agency for such "issue areas" as air quality, biological resources, groundwater resources and so forth. One possible outcome is that the proposed project may be judged not to have any significant adverse environmental effects. In this case, an informational document, termed a Negative Declaration, will be prepared; if adopted, the necessary permits will be issued and the project can proceed without further environmental review. Alternatively, the preparation of an EIR/S may be deemed necessary if significant impacts appear possible. In this case, a Notice of Preparation is made public and sent to other permitting agencies to initiate the process of defining the scope of the impending review. The "scoping" process serves to identify relevant issues, general concerns, and regulatory requirements that need to be addressed in the EIR/S.

The next phase is the preparation of the Environmental Impact Report (or Statement), which is released in draft form to the public and applicable agencies for comment. The EIR/S typically includes a description of the project, a summary of the environmental "setting" in which the project is to be developed, and some description of predevelopment—or "baseline"—environmental conditions. This information provides the local context for assessing potential impacts of the proposed development. The core of the EIR/S document is the "analysis" of potential impacts that may arise from the construction, operation and decommissioning of the proposed project. In essence, this is an exercise in predictive risk assessment, although evaluation of effects almost always is qualitative and without explicit estimates of uncertainty. Project- and site-specific information is coupled with data gathered previously for other situations to theorize possible impacts. In addition to the applicant's "Preferred Project" design, other feasible designs ("Project Alternatives") also are considered to determine if they reduce or eliminate potentially significant impacts, even if they do not allow the applicant to meet the full objectives of the project. In addition to effects that might arise expressly from the proposed project ("project-specific impacts"), "cumulative impacts" also are considered. Cumulative impacts are the combined environmental effects that arise from all developments and activities in a region, and to which the proposed project will contribute.

Once possible project-related and cumulative effects have been identified, their importance is determined by comparing effects against "significance" criteria. For legally protected habitats (e.g., wetlands) or organisms (e.g., endangered species; marine mammals), any adverse effect may be judged a substantial impact regardless of its magnitude or duration. Except for such mandated situations, assessment of an effect's significance is an opinion derived from "best professional judgment." In general, environmental effects will be classified into four categories: substantial adverse impact that cannot be mitigated; substantial adverse impacts that can be mitigated to insignificance; insignificant impacts

(no mitigation needed); and positive (beneficial) effects. Other than in the broadest sense, there are no set operational criteria for making these evaluations, which therefore tends to be an *ad hoc* exercise done for each proposed project. In general, consideration is given to the species and habitats likely to be affected, the magnitude of possible impact ("effect size;" Osenberg et al. Chapter 6), and the spatial extent and duration of impact (Raimondi and Reed, Chapter 10). Because the imprecise nature of administrative impact assessment is recognized explicitly, aspects of the process make the evaluation more environmentally conservative. In particular, plausible "worst-case" scenarios are analyzed even if the probability of such events occurring is remote (but nonzero). Thus, a proposed project is evaluated on the basis of its worst possible effects on the environment, and not just its most likely or average impacts. Analyzing projects against this more stringent standard is an attempt to minimize possible environmental consequences of uncertainty in predicting impacts.

Part of evaluating whether potential project effects will be substantial is determining whether and how identified impacts could be reduced to "insignificant." This paper exercise involves exploring feasible mitigation alternatives. Since the preferred resolution is to avoid an impact altogether, methods are considered that might have this desired outcome. It often is the case that adverse effects could be minimized but not totally avoided, and additional measures may need to be sought to reduce impacts to an acceptable level. Nonetheless, there will be impacts for which no mitigation measures are known to be effective. In cases where restoration of natural resources cannot be accomplished, "out-of-kind" compensation might be contemplated.

The final phase of the administrative review is certification of the EIR/S document. This involves solicitation of comments on the Draft EIR/S from agencies and other interested parties, which can result in modification of the document. The EIR/S is certified after all requirements have been satisfied and the document is deemed adequate. By this action, it is accepted that the predicted impacts are those (and only those) the project will actually have, and that the stated mitigation actions will actually work. The "best guesses" become facts upon which decisions to issue discretionary permits are made.

Scientific Data Collection and Analyses in Environmental Impact Reports

The collection of new scientific data to assess likely impacts is a sanctioned activity in the administrative review of a proposed development. It seems inherently reasonable that acquisition of new information would reduce uncertainty for decision-makers regarding potential impacts. The question we ask is, are new data often gathered for the preparation of an EIR/S, and if so, how useful are they in assessing likely impacts? Here we examine recent environmental impact statements to explore the extent to which new field data were collected and

analyzed to help predict effects as part of the EIR/S process. Collection of new, "site-specific" data on resources at risk is the most common activity in this regard, and the general rationale given is to provide a baseline of preimpact conditions which could then be compared with future measurements. We examined 18 recent EISs for major proposed coastal developments in Australia, where the administrative environmental review process parallels that in the United States (see Fairweather 1989, Lincoln Smith 1991). While the 18 assessments are not a random selection, they were chosen without prior knowledge of the type of data and data analysis they contained. Therefore, insights provided by examining these EISs likely apply to administrative environmental assessments in general. Each EIS assessment was categorized according to: (i) the level of the biological data collected to establish baseline conditions (pre-existing data only, data from a new quantitative survey, comparative study (quantitative surveys at > 1 site or time), or experimental study), (ii) the type of "statistical" analysis performed on these data (qualitative only (e.g., species list), raw data presentation, descriptive statistics, exploratory statistics or hypothesis testing), and (iii) the nature of suggested proposals for future monitoring of effects (none, general description, some detail, specific structure).

All 18 Environmental Impact Statements included data on biological resources that were newly collected as part of the assessment, although the extent varied from mere lists of species present to detailed field surveys. None included any investigation that might be classified as an experimental study. Ten (56%) included data gathered from two or more sites or two or more time periods; however, data collections rarely extended beyond a single year, and usually involved a single time period. Because temporal variability was not (or, at best, poorly) estimated, in no case was the data collection sufficient for subsequent statistical exploration of project impacts using a Before-After-Control-Impact Paired Series (BACIPS) type of design (for general requirements of BACIPS, see Stewart-Oaten et al. 1986, Stewart-Oaten, Chapter 7; for sample size considerations, see Osenberg et al., Chapter 6).

With respect to data analysis, six (33%) EISs presented results as species lists, descriptive accounts or in other non-quantitative forms. The remaining 12 (67%) provided some descriptive statistics ranging from simple summary tables to more sophisticated measures such as diversity indices (for discussions of the utility of diversity measures for impact assessment, see Carney 1987, Chapter 15). Three EISs used a standard statistical test (analysis of variance) to identify differences between locations or habitats. This hypothesis test is not particularly relevant to impact assessment as differences between locations or habitats always are expected (if not always detected); demonstrating statistically that sites differ provides no insight into the potential impact of a project. The most sophisticated data analysis presented in the 18 EISs was associated with a proposed power station; various classification techniques, diversity indices and a mathematical model of the effect of water temperature were provided, and model predictions were compared with survey data.

With respect to proposals for monitoring of subsequent impacts, 5 (28%) EISs made no mention of monitoring either during or after development was to take place (EIR/Ss in the United States must describe mandated compliance monitoring requirements, although many of these are inadequately designed: Osenberg and Schmitt, Chapter 1). Four (22%) mentioned monitoring in general terms, 5 (28%) gave some indication of what might be monitored, and 4 (22%) provided some insight on the overall design of a monitoring program. None contained a detailed proposal for monitoring, and only two hinted at such crucial design issues as the number of samples and effect of variability that would need to be considered. None included any explicit or implicit reference to a BACIPS-type sampling design.

This brief analysis of environmental impact statements indicates that the collection of new site-specific data is a common practice in the preparation of EIR/Ss. It is not uncommon for the environmental assessment to be the first biological survey of an area, and thus the data collected are an important first step. However, as practiced, the information is most useful in describing the habitats and species at risk to a proposed project. Despite the commonly stated aim of providing a baseline for subsequent measurement of impacts, data collected specifically as part of an EIR/S appear rarely to be useful for a subsequent BACIPS-type exploration of actual impacts. Further, statistical design considerations do not play a major role in the review process, and statistical analysis of even the most rudimentary kind was noticeably absent from the majority of assessments. Where statistical tests were applied, the hypotheses tested were irrelevant to impact assessment. Further, there appears to be widespread failure to appreciate that traditional hypothesis testing approaches are not well suited to environmental impact assessment where yes/no answers have limited applicability compared with estimating the magnitude of effects (see Stewart-Oaten, Chapter 2).

At least two aspects account for the paucity in EIR/Ss of "before impact" data useful for rigorous measurement of subsequent impacts. First, the nature of most individual development proposals makes it impractical to devote the time and resources necessary to conduct the type of field surveys needed for rigorous statistical exploration of impacts. For many proposed developments, the cost to gather adequate data is far out of proportion to the value of the proposed development or its likely environmental impact. Second, the mandated time limitation for completion of the administrative review, once initiated, greatly constrains the type of new scientific inquiry that can be conducted. This mismatch in the time needed for proper scientific inquiry and that available is perhaps secondary to another structural problem: scientific efforts that could improve the process as a whole have limited benefit to the individual proponent, and typically require an investment of resources that are unrealistic for most proposed developments. In few cases where many similar (and major) projects are anticipated—for example offshore oil and gas developments—ongoing programs to conduct comprehensive environmental research have been established to provide generic

information useful in the administrative review of specific proposals. The Environmental Studies Program of the Minerals Management Service, U.S. Department of the Interior is one such example (see Carney, Chapter 15; Piltz, Chapter 16; Lester, Chapter 17). In other cases involving large developments, *ad hoc* research programs have been established that operate in parallel but independently of the EIR/S process (for an example, see Ambrose et al., Chapter 18). In general, however, there is little capacity in the EIR/S process for the provision of "before impact" monitoring data that are adequate for subsequent estimation of a project's environmental effects.

The Need for Better Scientific Feedback in the EIA Process

A legitimate question is whether better mechanisms to obtain adequate "before impact" data are needed in the administrative review of proposed developments. After all, the goal is to predict a project's impacts and devise means to ameliorate them. Scientific advances in "ecological risk assessment" (*sensu* Suter 1993a) show great promise for improving capabilities in this regard. While estimating environmental impacts through extensive monitoring programs will continue to be unwarranted for many proposed developments, there remain compelling reasons for more frequent monitoring of impacts as part of the administrative review process that would benefit the process as a whole. First, there have been virtually no rigorous checks on the extent to which the EIR/S process has successfully predicted the environmental effects of a development. Even when quantitative "ecological risk assessment" techniques become used more widely to predict effects, there is a crucial need to establish how well impacts are being forecast. This will not be possible unless such rigorous sampling designs such as BACIPS are used to estimate actual impacts. Results of perhaps the best quantitative audit of EIR/S predictions done to date are not comforting (Ambrose et al., Chapter 18); not only were the predicted environmental impacts highly inaccurate, real effects were not detected by the mandated compliance monitoring regime. Because such quantitative audits of environmental predictions in EIR/Ss are extremely rare, no feedback loop exists between administrative findings and scientific verification (Larkin 1984). Consequently, it is not possible to assess the extent to which current EIR/S practices protect the environment from meaningful impact.

Second, monitoring programs to estimate effects are useful in attempts to mitigate the environmental impacts of a development. They can provide quantitative estimates of the amounts of natural resources that are damaged or lost, and therefore provide a quantitative target for the levels of resources that need to be replaced. Perhaps more importantly, BACIPS-type monitoring programs can also be applied to the mitigation project to evaluate the efficacy of the mitigation actions. Currently, mandated mitigation actions are assumed to have the desired

result, and scientific confirmation is virtually nonexistent. Permitting agencies are reluctant to approve mitigation measures that are not well proven, yet there is no systematic mechanism to establish the success of either currently used or promising techniques.

Finally, there is the general issue of improving the information base to facilitate and improve future decisions. While every proposed project has novel elements (e.g., specific location and design features), most are quite similar to other projects that have been undertaken numerous times in the past. For example, a large fraction of proposed projects are extensions or modifications of existing facilities (e.g., 8 of the 18 Australian assessments examined here), or essentially are "replicates" of others but in a new location (e.g., offshore oil production platforms) (for several examples, see Fairweather and Lincoln Smith 1993). Had the impacts from these previous projects been well-studied, there would have been improved potential to accurately predict the likely impacts of the proposed projects. Despite the opportunity for empirical study, there is a rather poor understanding of the general impacts that arise from any sort of development. This largely reflects a common failure to rigorously measure actual impacts and provide case studies; attempts to do so are infrequent (see Piltz, Chapter 16), and when done, the results often are equivocal because of inadequate or misguided sampling designs (Carney 1987, Osenberg and Schmitt, Chapter 1). Because "retrospective" assessment techniques (i.e., those which lack Before data and are applied only *after* impacts have occurred) provide weak evidence at best (Lincoln Smith 1991, Suter 1993b, Osenberg and Schmitt, Chapter 1), the consistent faiure to obtain adequate Before and After impact data through comprehensive monitoring programs is a major contributor to the problem.

Conclusions

Administrative environmental impact assessment (EIA) is a public process through which decision-makers are provided with information about the possible environmental effects of a proposed development. The information record (EIR/S) is used to support the decision made. While it is inevitable that such decisions will be made on incomplete scientific information (Ruckelshaus 1983), there are structural aspects of the process that constrain the potential contributions of science in improving its execution. One notable weakness is the lack of regular feedback between administrative findings and scientific corroboration. The system for collecting (or collating) information not only should support the present decision, but also should facilitate assessment of whether the decision was justified, and should support future decisions concerning similar developments. The challenge is to integrate administrative assessments with rigorous impact monitoring programs to maximize their benefits to one another and to environmental management in general.

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