Planning for Biodiversity: the Role of Ecological Impact Assessment

YAEL MANDELIK,*§ TAMAR DAYAN,† AND ERAN FEITELSON‡

*Department of Zoology, Tel-Aviv University, Tel-Aviv 69978, Israel
†Department of Zoology & Institute for Nature Conservation Research, Tel-Aviv University, Tel-Aviv 69978, Israel
‡Department of Geography, the Hebrew University of Jerusalem, Mount Scopus, Jerusalem 91905, Israel

Abstract: *Environmental impact assessment (EIA) is the process of identifying potential environmental effects of proposed development and the required mitigation measures. It is one of the most widely used planning tools today, but its ability to promote biodiversity conservation is largely unexplored. We studied the ecological component of the Israeli EIA system by reviewing a representative sample of 52 environmental impact statements (EISs) produced since 1995 and their corresponding guidelines issued by the Ministry of the Environment. Quality of both EISs and guidelines was determined using a simple scoring approach. Lack of quantitative data, meaningful analyses, and ecosystem perspective was apparent throughout. Many EISs failed to perform field surveys and their qualitative nature hampered meaningful impact prediction. Most EISs concentrated on aesthetic mitigation measures and did not assess their feasibility and likely success. Most of these flaws reflect poor standards rather than true scientific limitations. Guideline quality scores were the most important factor determining the quality of EISs; second was the involvement of an ecological consultant in preparing the EIS. We found a decreasing trend of EIS quality scores over time. Improvements in EIA procedures, particularly in ecological guidelines and the incorporation of ecological consultation, are important for upgrading ecological impact assessment so that the potential of EIA to advance biodiversity conservation can be realized.*

Key Words: conservation planning, Israel, Israeli environmental impact assessment, spatial effects

Planificación para la Biodiversidad: El Papel de la Evaluación de Impacto Ecológico

Resumen: *La evaluación de impacto ambiental (EIA) es el proceso de identificación de efectos ambientales potenciales de las propuestas de desarrollo y las medidas de mitigación requeridas. Es una de las herramientas de planificación más ampliamente utilizada, pero su habilidad para promover la conservación de biodiversidad esta mayormente inexplorada. Estudiamos el componente ecológico del sistema de EIA Israelí mediante la revisión de una muestra representativa de 52 manifestaciones de impacto ambiental (MIA) producidos desde 1995 y las correspondientes directrices emitidas por el Ministerio del Ambiente. La calidad de las MIA y las directrices fue determinada utilizando un método de evaluación simple. La carencia de datos cuantitativos, análisis significativos y perspectiva de ecosistema fueron una constante. Muchas MIA no realizaron muestreos en el campo y su naturaleza cualitativa obstaculizó la predicción significativa de impacto. La mayoría de las MIA se concentraron en medidas de mitigación estética y no evaluaron su factibilidad y posible éxito. La mayoría de estos defectos son reflejo de estándares pobres, en lugar de verdaderas limitaciones científicas. Las evaluaciones de la calidad de las directrices fueron el factor más importante en la determinación de la calidad de la MIA; seguidas por la participación de un consultor ecológico en la preparación de la MIA. Encontramos una tendencia decreciente en las evaluaciones de calidad de las MIA en el tiempo. Mejoras en los procedimientos de las MIA, particularmente en las directrices ecológicas y la incorporación de consultoría ecológica, son*

§*Current address: Department of Ecology and Evolutionary Biology, Guyot Hall, Washington Road, Princeton University, Princeton, NJ 08544, U.S.A., email yaelm@princeton.edu.*
Paper submitted July 15, 2004; revised manuscript accepted September 13, 2004.

Conservation Biology 1254–1261

DOI: 10.1111/j.1523-1739.2005.00079.x

importantes para enriquecer las evaluaciones de impacto ambiental para que se pueda realizar el potencial de la MIA para que la conservación de la biodiversidad progrese.

Palabras Clave: efectos espaciales, evaluación de impacto ambiental Israelí, Israel, planificación de la conservación

Introduction

Environmental impact assessment (EIA) is the main tool used today to identify the potential environmental effects of proposed development and the possible measures to mitigate these effects (Glasson et al. 1999). It is usually required by decision makers before allowing certain projects to proceed (Sutherland 2000). Generally, an EIA involves a three-step procedure, starting with a screening process for identifying projects that require an EIA. Then a scoping process is performed to identify the main issues that need to be addressed. The last step is preparing the EIA and presenting its findings in an environmental impact statement (EIS) (Glasson et al. 1999).

First implemented in the United States in 1969, EIA has gradually become an integral feature of planning systems in more than 100 countries (Glasson et al. 1999). Moreover, its use is expected to expand in light of requirements of international lending agencies such as the World Bank to perform EIAs for projects as a prerequisite for funding (Morgan 1998) and the requirement in the Convention on Biological Diversity to apply EIA to projects with potentially adverse impacts on biodiversity (Treweek 1999). Today EIA is the most commonly used method worldwide for site-specific planning. In many cases this is the only phase in the planning process in which ecological consequences of local development actions are considered. Hence, the conservation role of EIA is critical in countries subject to intense, piecemeal development pressures.

The practice of EIA, however, has encountered considerable criticism. Reviews of EIAs conducted in Australia (Buckley 1991; Warnken & Buckley 1998), Canada (Dickman 1991), Mexico (Bojórquez-Tapia & García 1998), the United Kingdom (Lee & Brown 1992), Ireland (Lee & Dancey 1993), and other European Union states (EC 1996) often demonstrated poor quality, low impact prediction, and poor scientific rigor, although some improvement has been recorded with time (Barker & Wood 1999). Conceptually, the fact that EIA is mostly a site- and project-specific process, disregarding cumulative, cross boundary, and long-term effects, limits its predictive value (Treweek 1996). Moreover, EIA is usually performed at an advanced stage of the planning process, thus limiting the ability to make significant modifications (Sutherland 2000).

The ecological component of EIA, ecological impact assessment, is the process of identifying and evaluating potential impacts on ecosystems and their components (Treweek 1999). The inherent complexity of ecosystems, lack of basic scientific knowledge, and limited resources restrict the ability to predict potential ecological impacts with certainty (Mangel et al. 1996). These problems have hampered the development of ecological impact assessment and its integration within the EIA process (Treweek 1996). Reviews of ecological assessments performed in the United Kingdom (Thompson et al. 1997; Gray & Edwards-Jones 1999; Byron et al. 2000), United States (Atkinson et al. 2000), Australia (Warnken & Buckley 1998), and Japan (Tanaka 2001) revealed serious shortcomings throughout the process.

In Israel EISs have been used since the early 1980s as one of the main land-use planning tools under the Planning and Building Law (Brachya 1996). Their numbers increased sharply over the years, from an annual average of 7 EISs in the 1980s to an annual average of 32 EISs in the 1990s, demonstrating an increased reliance of the planning authorities on this tool. Israel, 21,000 km^2 (not including the West Bank and Gaza) and a global hot spot of biodiversity (Yom-Tov & Tchernov 1988), is undergoing exceptionally rapid development, driven in part by a population growth rate that is higher than that of other developed countries. Subsequently, urbanization, suburbanization, and infrastructure development are jeopardizing the existence of Israel's Mediterranean and arid ecosystems (Perevolotsky & Dolev 2002). Future trajectories indicate Israel will become one of the most densely populated countries in the world (Central Bureau of Statistics 1997). Hence, Israel can be viewed as representing a wide array of cases where development pressures stress both arid and Mediterranean ecosystems. An analysis of the ability of the Israeli EIA system to advance biodiversity conservation can be instructive for other societies where development pressures have not yet reached those of Israel.

The Israeli EIS system is based on a mandatory scoping process, performed by the Ministry of the Environment, in consultation with experts from relevant governmental and nongovernmental organizations (Ministry of the Environment 1997). Specific binding guidelines are prepared for each project for which an EIS is required. These guidelines are specifically tailored for the proposed project at its proposed location and take the form of a detailed checklist in which the issues, scales, and methods to be used are specified. In this aspect the Israeli system differs from that of the United States and many European countries, where scoping is based on public hearings or on a general outline of guidelines without preparation of case-specific guidelines by the authorities (Brachya & Marinov 1995). The scoping process is expected to have major effects on the preparation and quality of the EIS (Treweek 1999). Hence, the Israeli EIS system offers an important case study not only for investigating the role of EIA in promoting biodiversity conservation but also for assessing the effect of a case-specific scoping process on achieving this goal.

We investigated the ecological component of the Israeli EIS system to address the following questions: (1) What are the scientific standards of EISs (i.e., their ecological quality)? (2) What is the role of case-specific scoping in determining the ecological quality of EISs? (3) Are there other factors affecting EISs ecological quality? We then identified the major drawbacks in the EIA process in order to improve biodiversity conservation through use of this widely practiced tool.

Methods

The Sample

We reviewed 52 EISs produced from 1995 to 2002, representing about 30% of all EISs produced in Israel during this period. Most types of development are represented proportionally to their occurrence, excluding projects located inside urban or industrial centers. Residential development projects were slightly overrepresented in the sample (19% of the sample and 12% of total EISs in this period). This overrepresentation, however, may somewhat counter the systemic bias identified by Feitelson (1996) whereby residential projects are less likely to be required to submit EISs than are all other categories. Within each development category, EISs were selected randomly. All EISs referred to terrestrial habitats; 12 also referred to aquatic habitats.

The Ecological Evaluation Process

We developed an evaluation form that was used to review all 52 EISs. The form reflected the ecological aspects that should be addressed, based on existing scientific knowledge and on similar studies (Thompson et al. 1997; Atkinson et al. 2000; Byron et al. 2000). It comprised 64 detailed criteria grouped into seven categories:

(1) Ecological baseline information: taxonomic groups referred to and kind of information presented (e.g., detailed species lists, rarity and endangerment level, quantitative data, ecological requirements).
(2) Sources of the ecological data: scientific rigor of the data presented. We examined whether new field surveys were conducted, what methods were used, and whether the relevant scientific literature was referenced as key determinants of this factor.
(3) Ecological impact assessment: key impacts identified, quantification of these impacts, and evaluation of ecological significance.
(4) Ecosystem-level considerations: perspective (spatially and conceptually) taken in evaluating the significance of the project (i.e., were ecosystem-level considerations made in both baseline and impact predictions?). In particular, we asked whether ecosystem structure and function (i.e., succession, biomass, productivity), ecological interactions, biodiversity, and broad spatial scales (regional/national) were included in the EIS.
(5) Ecological mitigation and monitoring: proposed mitigation measures, consideration of expected impacts, and assessment of mitigation efficacy and feasibility. We examined whether ecological monitoring was proposed and what parameters and scales were addressed.
(6) Alternatives: consideration of ecological aspects when examining the project's location and design alternatives.
(7) Communication of ecological information: comprehensibility of the ecological data and evaluations to both ecologists and nonecologists. Specifically, we examined whether the major ecological findings were presented in the executive summary, whether limitations and uncertainties were clearly defined, whether clear illustration measures were used, and the use of consistent and defined terminology.

To test the robustness of our evaluations, 15 EISs (29% of the sample) were reviewed twice by two independent reviewers. Because all their results were highly consistent, it seems our evaluation process was indeed robust.

Determinants of Ecological Quality

We assessed the ecological quality of each EIS and its corresponding guidelines with a simple and straightforward scoring technique. A priori we chose a subset of 28 core criteria from the evaluation form to be used as indicators of ecological quality (Table 1). For each criterion we examined whether the required information was presented and scored it accordingly: 1 for adequate reference, 0.5 in cases of serious omissions, and 0 for no reference. This analysis emphasized four major components of the EIA process: baseline information, impact assessment, mitigation measures, and ecosystem perspective. We used a stepwise multiple regression on arc-sine transformed EIS quality scores to quantitatively test the following potential explanatory variables: year of preparation of the EIS and its corresponding guidelines, involvement of ecological consultant (yes/no), proportion of EIS devoted to ecological aspects in terms of writing space (arc-sine transformed), and the quality of ecological guidelines issued by the Ministry of the Environment (arc-sine transformed).

Table 1. The categories and 28 detailed criteria used for determining the quality score of environmental impact statements and guidelines.

Category	*Detailed criteria*
Baseline information	reference to fauna and flora
	reference to species of special concern (rare, endangered, endemic)
	reference to habitats
	reference to nature reserves, critical habitats
Ecosystem perspective	reference to ecosystem structure and function
	reference to biotic and abiotic interactions*
	reference to biodiversity
	regional and national perspective
Ecological impacts	reference to habitat loss
	reference to habitat fragmentation
	reference to habitat deterioration
	reference to direct death or removal of species
	reference to species introduction
	reference to indirect effects
	reference to cumulative effects
Mitigation measures	reference to landscaping and planting
	reference to design alterations
	reference to animal passages
	reference to transplantations or translocations*
	reference to habitat rehabilitation or recreation*
Ecological monitoring	is there clear reference to ecological monitoring?
Field survey	was a field survey preformed?
Scientific literature referred to	were any references made to the relevant literature, data bases?
Ecological aspects in the alternatives	were any ecological aspects taken into consideration in the alternative discussion?
Communicating the information	are clear illustration measures presented?

Two separate criteria presented together.

Guidelines quality scores were determined by the same method as the EIS quality score, based on the 28 core criteria specified in Table 1. To evaluate temporal changes in the quality of EISs and guidelines, we grouped them into two equal time periods: those prepared between 1995 and 1998 and those prepared between 1999 and 2002. We excluded from the quality analysis one incomplete EIS (because some of the chapters were not requested by the Ministry of the Environment).

Results

Evaluation of the Ecological Input

We found a generally high percentage of EISs that referred to vegetation and vertebrates (Fig. 1): 98% of EISs referred to perennials characterizing the area, and about 75% referred to most of the vertebrates expected to inhabit the area. Most references, however, were merely a general acknowledgment of the potential existence of the taxa in the area. Only a relatively small fraction of EISs gave detailed species lists or any quantitative data (i.e., abundance, population density, coverage), especially regarding the fauna. An average of 42% of EISs presented these data for the flora, but fewer than 25% did so in describing the fauna. Reference to species of special importance from a conservation perspective (rare, endangered, or endemic) was generally high (77%).

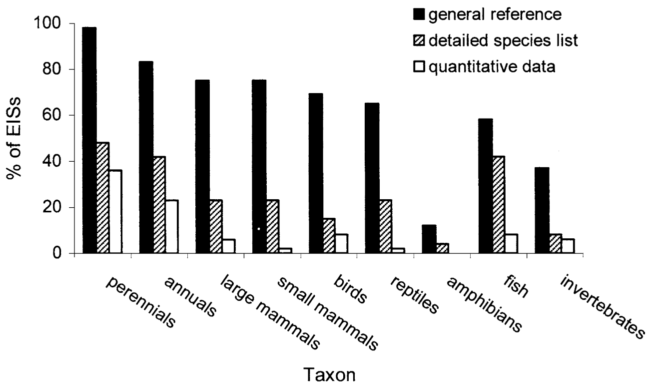

Figure 1. Baseline information in environmental impact statements (EISs): reference to different taxonomic groups. Percentages do not total 100 because EISs addressed more than the one taxon, and some gave both species lists and quantitative data. Fish data are from 12 relevant EISs.

Most EISs (71%) referred to ranges of no more then 1 km from the project site when addressing ecological aspects of habitats, fauna, and flora. There were no apparent differences between the development categories in the spatial ranges addressed.

About 60% of EISs performed new vegetation surveys, but only about half included systematic counts of richness and abundance. The rest were based only on casual observations (Fig. 2). Only 21% of these surveys were performed during the spring (March-May), when the majority of plant species can be identified. The rest either failed to specify the timing of the survey (42%) or performed surveys at suboptimal (early winter, 9%) or inappropriate times (summer, 27%). Fewer than 20% performed new field surveys of vertebrates, almost all of which were based on casual observations. From the details presented it was not possible to evaluate the temporal and spatial extent of faunal field surveys. Only 10% of EISs performed invertebrate surveys, all in aquatic habitats.

Although 79% of EISs made clear reference to zoological and botanical literature, mostly local field guides and encyclopedias, only 6% referred also to ecological literature of a more scientific nature, such as papers, reviews, or text books.

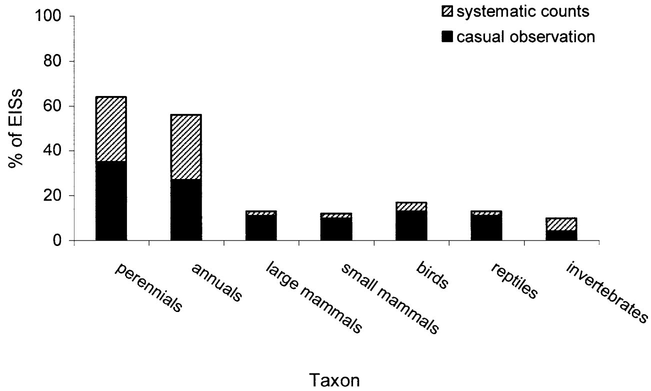

Figure 2. Sources of ecological information in our study of environmental impact assessments. Percentages do not total 100 because some EISs contained results of several field surveys based on both casual observations and systematic counts.

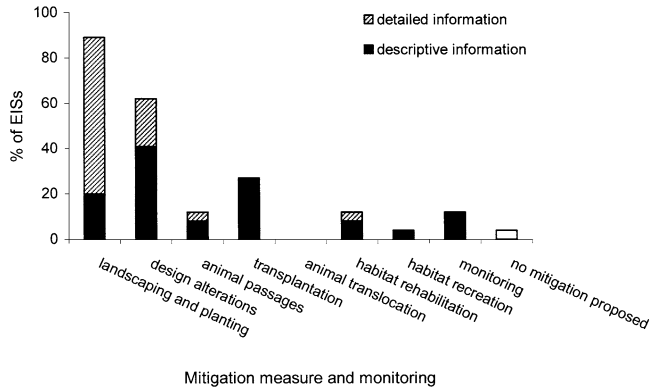

Figure 3. Quality of ecological mitigation measures and monitoring information in environmental impact statements (EISs) examined. Percentages do not total 100 because some EISs proposed several mitigation measures, and percentages are of 51 EISs (1 incomplete EIS was excluded from this analysis).

An ecological advisor was consulted in 60% of EISs. The eight most frequently hired ecological consultants (accounting for 68% of the EISs that involved consultation) were all with relevant academic and practical backgrounds (academic degree in life sciences and EIS-related working experience).

Most EISs indicated some potential ecological impact. The most common impacts mentioned were habitat loss (67%), direct death or removal of individuals (63%), and habitat deterioration (39%). Most EISs that referred to habitat loss also quantified it (94%). This, however, was the only impact quantified. About a quarter of all EISs referred to the potential threats of habitat fragmentation and exotic species introduction (25% and 23%, respectively). We found reference to cumulative effects (i.e., effects that accumulate over space or time) and indirect effects such as cascading effects of habitat alterations in 23% and 40% of EISs, respectively.

We found limited evidence for application of an ecosystem-level perspective in EISs. Reference to ecosystem structure and function was made in 38% of EISs. Fewer than 20% of EISs referred to ecological interactions and the possibility of their disruption (inter/intraspecific interactions, 15%; species-habitat interactions, 19%). Reference to biodiversity and broad spatial perspective (regional/national) was made in about one-third of all EISs (33% and 29%, respectively).

The overwhelming majority of EISs (96%) proposed some kind of mitigation measures (Fig. 3). The most common measures proposed were landscaping (89%) and project design alterations (62%). Background information for these measures (e.g., reasoning for choosing this measure, estimated effectiveness, detailed implementation protocol) was presented in 78% and 34% of EISs that referred to these measures, respectively. Other measures were advanced only rarely, in 4–27% of all EISs. Animal translocation was never mentioned. Only 12% of EISs referred to the need for ecological monitoring and none provided a detailed monitoring plan.

Seventy percent of EISs referred to ecological aspects in reasoning their choice of alternative, including damage to habitats or species (39%), fragmentation (22%), proximity to nature reserves (20%), and the size of area taken (12%). Because the reasons for reducing the area allotted for the project were not specified, however, it was not possible to assess whether the choice was indeed because of ecological concerns.

All EISs referred to ecological findings in the executive summary, although in more than 40% serious omissions were found (e.g., not all impacts were indicated). Seventy-nine percent of EISs indicated the information sources used and presented reference lists. Complex jargon and terminology were not used. All EISs used illustrative measures (maps, aerial photographs).

Determinants of Ecological Quality

The stepwise multiple regression model (Table 2) accounted for 81% of EIS quality score variation ($r = 0.9$). Guideline quality score was the most influential factor in determining EIS quality scores, accounting for 64% of their variation ($r = 0.8$) (Table 2, Fig. 4). The involvement

Table 2. Stepwise multiple regression analysis on arc-sine transformed environmental impact statements quality scores.

Explanatory variable	B	*SE*	p
Guidelines quality score	0.974	0.144	<0.001
Ecological advisor involved	3.104	0.756	<0.001
Percentage of ecological aspects	0.153	0.050	0.003
Guidelines preparation period (1995–1998 compared to 1999–2002)	−0.216	0.084	0.014

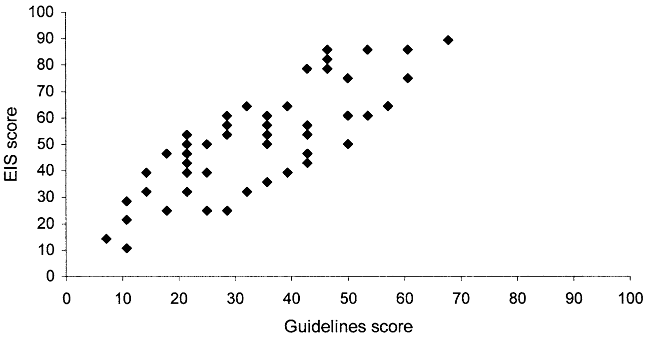

Figure 4. Correlation between environmental impact statements and guideline quality scores. For illustration, scores were converted from a scale of 0–28 to a scale of 0–100.

of an ecological advisor was the second most influential factor in determining EIS quality scores. The percentage of the EIS (in terms of writing space) devoted to ecological aspects was significantly and positively correlated with EIS quality scores; EISs containing larger ecological chapters scored higher. As a stand-alone variable it accounted for 50% of the variation in the quality scores ($r = 0.709$, $n = 51$, $p < 0.001$). Additionally, the period in which the guidelines were prepared (1995–1998 compared with 1999–2002) had a significant effect on an EIS's quality. Surprisingly, EISs for which guidelines were prepared in the later period had significantly lower quality scores ($B = -0.216$). In contrast, the period in which the EIS was prepared did not have a significant effect on quality and therefore was not included in the regression model. This insignificance might be explained by the 10 EISs that were prepared in the latter period (1999–2002) but for which the guidelines were prepared in the first period.

Discussion

Results of our review of ecological impact assessments in Israel show that despite 20 years of experience and the expectations for growing professionalism, major flaws in the identification and analysis of ecological impacts abound, thereby limiting the value of the EIA process for conservation. These findings raise two questions: To what extent do our findings reflect the potential of EIA to advance biodiversity conservation? What should be done to improve the assessment of ecological impacts of development at the project level? To address these questions we first discuss the conservation implications of our findings and the ways in which the ecological practice in EISs could be improved. Then we discuss the reasons for the evident failure to use the best practices available.

Baseline information comprised mainly descriptive, nonquantitative data on vascular plants and vertebrates expected to inhabit the project area and its immediate vicinity. The value of these taxa as biodiversity or disturbance indicators is questionable (Caro & O'Doherty 1999; Hilty & Merenlender 2000). Similar results have emerged in the United Kingdom (Thompson et al. 1997; Byron et al. 2000) and the United States (Atkinson et al. 2000), suggesting that reference to fauna, especially to potential indicator taxa, is a weakness in most EISs. Recent developments in the field of rapid biodiversity assessment could be beneficial to the EIA process. Standardized inventories based on indicator taxa, higher-level taxa, and morphospecies reduce the time and expertise needed (Oliver & Beattie 1996; Kerr et al. 2000) and put these inventories within reach of most EISs. At the broad spatial scale, biodiversity assessments can be based on landscape parameters such as habitat diversity, rarity, and connectivity (Duelli 1997), readily accessible in the GIS era. Most EISs, however, did not refer to these methods or try to systematically evaluate species and ecosystem diversity. Field surveys exhibited low ecological standards, disregarded spatial and temporal variations, and failed to apply scientifically based sampling techniques (e.g., Sutherland 2000). Therefore, data collected in EISs are not useful for long-term monitoring or for local capacity building.

Ecosystem and landscape perspectives in conservation planning are critical for the long-term protection of biodiversity (Simberloff 1998). This perception is manifested in the programs of leading conservation organizations (Redford et al. 2003) and should be reflected in EIS practice as well. Ecological impact statements should address not only single species but also communities, ecosystems, and ecological interactions. Most EISs referred merely to the localized impact area of the project, not going beyond the single-species level. Thus, currently the contribution of EISs to an integrative evaluation of the significance of development on ecosystems and communities is limited.

We rarely found reference to the major threats to biodiversity (i.e., habitat loss, fragmentation, alien invasive species). When they were referenced, they were mostly descriptive and disregarded temporal and spatial scales of impacts. Although there are scientific limitations to impact prediction (Warnken & Buckley 1998), the quality of impact prediction we found was poor. Reluctance to refer to habitat fragmentation caused by a new road or the possibility of introducing alien invasive species into a reserve because of the construction of a nearby settlement are a matter of negligence rather than true scientific barriers. Additionally, most EISs did not refer to existing ecological stressors and did not provide the data for predicting cumulative effects, critical for a comprehensive evaluation of the project (Harte 2001).

Ecological significance of major effects can be evaluated against several benchmarks, including species-specific measures such as extinction risk, population and metapopulation viability analyses, or habitat and home-range requirements (Ralls & Taylor 1997; Hoopes &

Harrison 1998) and ecosystem-level measures such as diversity, rarity, and representativeness of species and habitats in the area (Bibby 1998). Such evaluations were rarely performed in the EISs we analyzed.

Because implementing avoidance measures is usually restricted by the advanced planning stage in which EIA comes into play (Sutherland 2000), there is usually need for minimization and compensation measures such as wildlife passages or translocation of plants and animals. Most EISs referred to landscaping and planting as compensation measures, but all references were exclusively focused on visual aspects, with dubious ecological value. Over half of EISs suggested design alterations, but these were mostly aesthetic measures such as alterations of the project design to avoid damaging old trees (a positive action, but of little ecological value when considering a few trees left in a developed area). In fact, some "cosmetic" measures may be more harmful than beneficial because they convey a false appearance that ecological aspects have been addressed.

Monitoring is the Achilles' heel of the EIA process, but it is essential for validating impact prediction and the effectiveness of mitigation measures and important for establishing spatial and temporal baseline variations in ecosystems (Thompson et al. 1997). Only a few EISs suggested ecological monitoring, and none provided a plan.

A preliminary sample of earlier EISs (produced before 1995) ($n = 10$) exhibited very low ecological standards, suggesting that a significant improvement took place during the early 1990s. Later, however, the trend was reversed. In recent years the EIA system in Israel, and in other countries (Wolsink 2003), has been under attack by development interests who argue that it unduly protracts the planning process, thereby delaying major infrastructure projects. Regardless of the validity of these allegations (Feitelson 2002), they have led to changes in planning procedures of major infrastructure projects (for which most of the EISs are prepared). These pressures may account for the unexpected decline in guideline and EIS quality.

The most significant result of our study is that the major shortcomings of ecological impact assessment in Israel are all rooted to a significant degree in the scoping process carried out by the Ministry of the Environment. This result presents a major challenge but is also a source of hope. Improving the standards of ecological guidelines might be the most potent tool in upgrading the quality of ecological impact assessment. Although it is important to bear in mind that scoping is by essence a value judgment because it is based on societal norms and is inherently political in nature (Weston 2000), there are many ways to improve this process, not least by greater use of GIS (Haklay et al. 1998).

The involvement of an ecological advisor was the second most influential factor determining EIS quality. In some instances, consultants elaborated the original guidelines and raised issues that were not referred to in the first place (personal communication with EIS practitioners and ministerial staff). This bottom-up mechanism of EIS improvement may seem surprising in light of the dependency between EIS experts and the developer who hires them (Warnken & Buckley 1998). It can be explained, however, by the professional norms of the small community of ecologists involved in the preparations of EISs, thereby demonstrating that ecologists, as an epistemic community, can have a role in improving EISs. Obligatory ecological consultation should therefore be regarded as a potential tool for upgrading the ecological quality of EISs.

Although EISs with the shortest ecological chapters tended to score lower, large volumes of ecological literature do not necessarily translate into better quality. In most cases they only augment the work load of usually short-staffed departments. Similar patterns were found in examination of other environmental aspects of EISs (Glasson et al. 1999). Well-crafted and focused guidelines, indicating a few critical parameters that need to be assessed and monitored, would reduce this problem.

In the past two decades conservation biology has developed as a quickly growing, rigorous scientific discipline. Ecological impact assessment, which should have benefited greatly from the developments in this scientific field, seems to have largely been left behind. The numerous conceptual and technical developments of conservation biology are rarely reflected in use of this tool. Clearly ecologists have a role to play in making ecological impact assessment beneficial for biodiversity conservation. We found that ecological consultants were capable of significantly improving EISs when actively involved in the process. Moreover, we found that scoping quality is key to EIS quality. Because scoping is based on societal norms, ecologists should continue in their efforts to influence these norms to the benefit of biodiversity conservation.

Acknowledgments

We thank the staff of the planning department and librarian of the Ministry of the Environment for their helpful cooperation and hospitality and D. Simberloff for his helpful comments and insights on this manuscript. This research was supported by the Beracha Foundation, the Ministry of the Environment, and the Jerusalem Institute for Israel Studies.

Literature Cited

Atkinson, S. F., S. Bhatia, F. A. Schoolmaster, and W. T. Waller. 2000. Treatment of biodiversity impacts in a sample of US environmental impact statements. Impact Assessment and Project Appraisal **18:**271–282.

Barker, A., and C. Wood. 1999. An evaluation of EIA systems performance in eight EU countries. Environmental Impact Assessment Review **19:**387–404.

Bibby, C. J. 1998. Selecting areas for conservation. Pages 176–201 in

W. J. Sutherland, editor. Conservation science and action. Blackwell Science, Oxford, United Kingdom.

Bojórquez-Tapia, L. A., and O. García. 1998. An approach for evaluating EIAs—deficiencies of EIA in Mexico. Environmental Impact Assessment Review **18:**217–240.

Brachya, V. 1996. Environmental management through land use planning in Israel. Bulletin of the International Society of City and Regional Planners, special issue 2.

Brachya, V., and U. Marinov. 1995. Environmental impact statements in Israel and other countries: a comparative analysis. Horizons in Geography **42–43:**71–78 (in Hebrew).

Buckley, R. C. 1991. How accurate are environmental impact predictions? Ambio **20:**161–162.

Byron, H. J., J. R. Treweek, W. R. Sheate, and S. Thompson. 2000. Road developments in the UK: an analysis of ecological assessment in environmental impact statements produced between 1993 and 1997. Journal of Environmental Planning and Management **43:**71–97.

Caro, T. M., and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. Conservation Biology **13:**805–814.

Central Bureau of Statistics, Israel (CBS). 1997. Projections of Israel's population until 2020. CBS, Jerusalem.

Dickman, M. 1991. Failure of an environmental impact assessment to predict the impact of mine tailings on Canada's most northerly hypersaline lake. Environmental Impact Assessment Review **11:**171–180.

Duelli, P. 1997. Biodiversity evaluation in agricultural landscapes: an approach at two different scales. Agriculture Ecosystems & Environment **62:**81–91.

EC (European Commission). 1996. Evaluation of the performance of the EIA process. EC, Brussels.

Feitelson, E. 1996. Some spatial aspects of environmental impact statements in Israel. Geoforum **27:**527–537.

Feitelson, E. 2002. Delays and by-passes in national infrastructure planning in Israel. Position paper. National Council for Environmental Quality, Jerusalem (in Hebrew).

Glasson, J., R. Therivel, and A. Chadwick. 1999. Introduction to environmental impact assessment. 2nd edition. UCL Press, London.

Gray, I. M., and G. Edwards-Jones. 1999. A review of the quality of environmental impact assessments in the Scottish forest sector. Forestry **72:**1–10.

Haklay, M., E. Feitelson, and Y. Doytsher. 1998. The potential of a GIS-based scoping system: an Israeli proposal and case study. Environmental Impact Assessment Review **18:**439–459.

Harte, J. 2001. Land use, biodiversity, and ecosystem integrity: the challenge of preserving earth's life support system. Ecology Law Quarterly **27:**929–965.

Hilty, J., and A. Merenlender. 2000. Faunal indicator taxa selection for monitoring ecosystem health. Biological Conservation **92:**185–197.

Hoopes, M. F., and S. Harrison. 1998. Metapopulation, source-sink and disturbance dynamics. Pages 135–151 in W. J. Sutherland, editor. Conservation science and action. Blackwell Science, Oxford, United Kingdom.

Kerr, J. T., A. Sugar, and L. Packer. 2000. Indicator taxa, rapid biodiversity assessment, and nestedness in an endangered ecosystem. Conservation Biology **14:**1726–1734.

Lee, N., and D. Brown. 1992. Quality control in environmental assessments. Project Appraisal **7:**41–45.

Lee, N., and R. Dancey. 1993. The quality of environmental impact statements in Ireland and the United Kingdom: a comparative analysis. Project Appraisal **8:**31–36.

Mangel, M., et al. 1996. Principles for the conservation of wild living resources. Ecological Applications **6:**338–362.

Ministry of the Environment. 1997. Environmental impact statements. Ministry of the Environment, Jerusalem (in Hebrew).

Morgan, R. K. 1998. Environmental impact assessment: a methodological perspective. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Oliver, I., and A. J. Beattie. 1996. Designing a cost-effective invertebrate survey: a test of methods for rapid assessment of biodiversity. Ecological Applications **6:**594–607.

Perevolotsky, A., and A. Dolev. 2002. Endangered species in Israel. Red list of threatened animals: vertebrates. Nature and Parks Authority and the Society for the Preservation of Nature, Jerusalem (in Hebrew).

Ralls, K., and B. L. Taylor. 1997. How viable is population viability analysis? Pages 228–235 in S. T. A. Pickett, R. S. Ostfeld, M. Shachak, and G. E. Likens, editors. The ecological basis of conservation: heterogeneity, ecosystems, and biodiversity. Chapman & Hall, New York.

Redford, K. H., et al. 2003. Mapping the conservation landscape. Conservation Biology **17:**116–131.

Simberloff, D. 1998. Flagships, umbrellas, and keystones: is single-species management passé in the landscape area? Biological Conservation **83:**247–257.

Sutherland, W. J. 2000. The conservation handbook: research, management and policy. Blackwell Science, Oxford, United Kingdom.

Tanaka, A. 2001. Changing ecological assessment and mitigation in Japan. Built Environment **27:**35–41.

Thompson, S., J. R. Treweek, and D. J. Thurling. 1997. The ecological component of environmental impact assessment: a critical review of British environmental statements. Journal of Environmental Planning and Management **40:**157–171.

Treweek, J. R. 1996. Ecology and environmental impact assessment. Journal of Applied Ecology **33:**191–199.

Treweek, J. R. 1999. Ecological impact assessment. Blackwell Science, Oxford, United Kingdom.

Warnken, J., and R. Buckley. 1998. Scientific quality of tourism environmental impact assessment. Journal of Applied Ecology **35:**1–8.

Weston, J. 2000. EIA, decision-making theory and screening and scoping in UK practice. Journal of Environmental Planning and Management **43:**185–203.

Wolsink, M. 2003. Reshaping the Dutch planning system: a learning process? Environment and Planning A **35:**705–723.

Yom-Tov, Y., and E. Tchernov. 1988. Zoogeography of Israel. Pages 1–6 in E. Yom-Tov and E. Tchernov, editors. The zoogeography of Israel. Junk Publishers, Dordrecht, The Netherlands.