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Role of Ecologists as Consultants in Urban Planning and Design

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A methodology is described for the utilization of ecosystem concepts in land-use issues of urban development and urban design. The issues are discussed of utilizing science specialists to develop in-depth understanding of ecosystem structure and function, synthesizing the information into usable form, and communicating the ecosystem knowledge to engineers, architects, landscape architects, and planners. Case studies from Ontario and New York illustrate some of the difficulties and opportunities in this kind of interprofessional work. The issue of identifying who is an ecologist and the related matter of professionalization are then discussed.

INTRODUCTION

The shift in emphasis from wilderness preservation to a preoccupation with birth control, trash, and automobile exhaust suggests that a significant shift in the environmental battleground has taken place: from rural to urban issues, and to issues likely to affect the individual's personal life style. However, urban land-use decisions, upon which focus questions of open space, density, and environmental standards, are decisions still remaining in the professional hands of civil engineers, architects, landscape architects, and planners. In this paper, I will try to demonstrate how ecological, i.e., environmental science, concepts can be integrated into urban land-use decisions.

The major obstacle to a professional working relationship between the ecologist and the design and engineering professions is the traditional attitude adopted by the ecologist, a kind of motherhood belief, that all development is unacceptable, unnecessary, or "immoral." Since these other professions deal with change and receive their fees for such advice, the "thou shalt not" stance is

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outside the frame of reference for them. If ecologists can accept that the landscape change can be either constructive or destructive, depending on the professional knowledge brought to bear on the problem and depending on the resolution of professional attitudes about these problems, then professional ecological involvement in urban land-use decisions is wide open.

To adopt an offensive environmental posture recognizes not only that change will occur but also that change can be a device for conserving unique or functionally significant ecosystems and a device for rebuilding or reconstructing degraded natural environments from their present baseline condition. Such reconstruction of degraded ecosystems may be justified in geochemical terms, in bioenergetic terms, in terms of diversity, or in terms of reconstruction of durable subclimax stands, stream banks, etc. If these environmental improvements are delineated and are followed, all urban or suburban construction and development would then, in theory, have a net positive environmental effect.

The professional ecological expertise, knowledge, and guidance required to attain this net positive objective, both in theory and in practice, are for the ecological consultant to provide. Just as a surgeon can measure his success or failure in terms of body function restored or maintained, the ecologist can measure his success as a practitioner in terms of restoration and/or maintenance of ecosystem function. If in the ecologist's opinion the objective of restoring or maintaining environmental function cannot be attained by the urban planning and design effort, then the development can be delayed or prevented until adequate space, money, pollution abatement procedures, etc., are available.

This simple objective of "net" environmental improvement following development is not as difficult to achieve as it may sound, as most urban or urbanizing areas in eastern and central North America have terrestrial and aquatic ecosystems badly degraded by many centuries of abusive land-use practices. With knowledge, imagination, and interprofessional cooperation, these areas can be rebuilt into better-quality natural environments. In a microlandscape sense, Wells (1971), using an "architectural value scale," described how to rate and to enhance environmental function for single building sites through innovative design and engineering.

METHODS

The methods used for analyzing the natural environment and interpreting and integrating this information into the decision-making framework must be carefully thought through. Too complex a methodology is overly expensive and obscure to other professionals and nonprofessionals, who then become suspect of the information; too simple a methodology misses important threshold effects and more complex interactions, making the analysis and conclusions vulnerable to criticism by other scientists and knowledgeable people.

To avoid some of these pitfalls, we have found the geographical ecosystem concept of Crowley (1971) useful. Very simply, his framework is based on a hierarchial series of landscape units, from large to small, starting with the geomorphological area, e.g., a spillway, a till plain, or a lacustrine plain, and then subdividing this area into soil types (available from soil maps), integrated through the device of the soil catena, which expresses the variable of drainage as well drained, imperfectly drained, poorly drained, etc. Each soil type in the catena then can be related to a particular kind or kinds of potential natural vegetation, such as a well-drained Waterloo Sandy Loam having a red oak - white pine forest which will convert in time to a hard maple - beech ecosystem. Since many soil maps identify land units at a minimum of 3 acres, we have a physical and biological "surface" at this scale of detail related to geomorphology and soils on which to conceptualize the past, present, and future biological and man-made processes. This system must be interpreted in a historical land-use context, because man-made changes, such as tile drainage, ditches, roads, and selective logging, modify the natural ecosystems and thereby affect the existing biological surface and its potential to adapt to new changes. This Crowley method is simpler than the analytical framework of Hills (1961), although the two methods have strong similarities.

Field studies, described in the following section on case studies, demonstrate this methodology. For those used to regional geographical studies or natural-resource studies (Christiansen, 1970) which describe climate, soils, animal and plant life, etc., the difference between the ecosystem approach, which integrates and synthesizes, and this older more classical descriptive approach should be kept in mind. Hopefully, another ecologist using any of these several methodologies should get similar results.

In addition to the usefulness of this geographical ecosystem approach to spatially organize the area under study, the following items are those ones which the ecologist should be considering, as sites which can vary in size from 3 acres to a county are analyzed: (a) conceptualize the new man-made values for the postconstruction ecosystems, rather than their present values; (b) determine the renovation feasibility of the ecosystems deteriorated from past land-use practices; (c) prevent, anticipate, or reduce deleterious effects of construction on unique soil, water, vegetative, and animal resources; (d) integrate aesthetics, microclimate, and educational opportunities on the site with the natural resources; (e) assess potential damage to buildings and roads from settling, slipping, gas leakage, general geological formation, and high water tables; (f) reduce construction, engineering and landscape maintenance costs through an understanding of the thresholds and the tolerances of the natural ecosystems; (g) protect and enhance property values for home buyers and the short-term and long-term property tax base of the county or municipality; (h) adjust the time, whenever possible, needed for field analysis to fit the clients' timetable, clearly communicating the analytical difficulties and errors that may occur because of insufficient time or seasonal environmental effects that cannot be measured; (i) communicate these environmental opportunities and values to the client, appropriate decision-makers, the press, and the public in keeping with the confidentiality required of the project.

These items represent an amalgam of ecological, economic, educational, social, and aesthetic goals. Further, they present an environmental strategy of multiple dimensions necessitating an involvement with a wide range of scientific professional disciplines as well as involvement with a number of social science and design professionals.

THE PROFESSIONAL FOCUS FOR AN URBAN ECOLOGICAL CONSULTANT

In my experience, the professional ecologist who can fulfill a consulting role in urban ecosystem problems must be socially motivated, a scientist as interested in people as in plants or animals. In addition, some understanding of the philosophy, methodology, and goals of the design- and engineering-oriented professions–architecture, landscape architecture, planning, civil engineering–is vital. Few ecologists with this broad training, or interest, now exist. Moreover, few earth or natural scientists have found urban and urbanizing environments, and the problems of urban settlements, interesting to them either as academics, as civil servants, or as consultants. And few are equipped with the necessary interdisciplinary skills to work effectively in these areas.

Compounding this problem, few chairmen of biology departments place a high priority on the hiring, promotion, or graduate training of socially motivated ecologists oriented toward urban ecosystem research. The few ecologists in Canada at least who work with urban environments do so principally from a planning-school base (Dorney, 1970; Coleman and MacNaughton, 1971; Holling and Goldberg, 1971; Kitchen, 1971) or an institute base (Dansereau, 1970). In time and with stimulus from granting agencies and from consulting practices, the present emphasis in ecology on studying natural environments may be extended to include the urban or suburban environment in which the majority of people in the industrial societies live.

With ecological manpower of this type relatively scarce, there is evolving a group of "suitcase environmental specialists" moving across the continent. Because each local area has many variables and constraints in the natural and man-modified ecosystems–at even a simplistic level–it would seem to be preferable to see regional teams of ecosystem analysts evolve. In addition, the efficiency of having a local team with a local library and with access to qualified regional specialists would give such local teams strong political, scientific, and financial clout. For this reason, I believe that locally based, ecological practitioners should be encouraged, just as is the case with engineering firms and veterinary practitioners.

One other aspect of professionalism will soon confront the ecologist: whether to join a construction or engineering firm, to associate with more kindred souls in the design professions of planning, landscape architecture, and architecture, or to keep his practice "pure" environmental science. The few ecologists with whom I have talked who work in engineering firms suggest that they feel philosophically isolated; they would prefer to offer advice as subconsultants outside the direct control of such firms. Those few ecologists working intimately with the design professions find no such philosophical gap, as long as they reject the philosophy of some conservationists that all change is "bad."

Traditionally, many wildlife and fishery biologists are in tune with the kind of urban ecology under discussion here, since these biologists must relate human goals to environmental management to be effective in their work. Some physical geographers, landscape architects, soil scientists, and foresters also have relevant technical training and academic orientation which, if applied or adapted to urban ecosystem problems, would increase the potential manpower pool of urban ecologists. However, to work effectively with professional engineers, designers, and planners, the flexible environmental team approach rather than the "lone consultant approach" has distinct advantages.

The flexible or variable team approach, which is what our practice has used almost exclusively, has a small permanent core to which are added a range of special talents as are needed for each particular problem. This approach, very much like the "ad-hocracy" of Toffler (1970), combines high-quality expertise with a low operating overhead. For the team to be effective, the coordinator or project leader(s) must be a specialist-generalist: understanding the separate technical pieces, asking the relevant questions of his environmental specialists, and then communicating these to the client, who makes the ultimate investment or design decision. This role of team leader may become the focus for professional ecologists, since the availability of the technical knowledge in geology, soils, limnology, plant ecology, and animal ecology is not the limiting factor for its use. What is demanded of the role is the synthesis of a spectrum of data and the professional tailoring of information to fit the issue under discussion.

THE FLEXIBLE TEAM APPROACH TO URBAN ECOLOGICAL CONSULTING

Since the surficial geology-soils base of an area and its climate determine the actual and potential plant and animal life of an area, an understanding of ecosystem structure and function necessitates starting with scientists who have experience in earth science, and in some cases climatology. In our consulting work, we add to this earth science (and climatology) base, plant ecology, supplemented by aquatic biology, animal ecology, hydrology, computer sciences, planning, and aesthetics as needed. We hope thereby to cover significant interactions which likely will occur among slope (aspect), soils, water table, vegetation, animal populations, the soil-water interface (since it affects surface water quality), and significant historical and archeological aspects of the site.

In essence, this not only brings the depth of working and research experience in the various specialized sciences and social sciences to bear on specific issues but also prevents professional embarrassment and error by the ecologist, who as a synthesizer must make collective recommendations on urban design and construction which withstand the scrutiny of other professionals. A comparable situation exists in medicine, where a practitioner has a wide range of medical and paramedical specialists to assist in diagnosis, treatment, and prevention of illness. We too are diagnosing healthy environments and treating "sick" or deteriorated environments as well as engaging in the preventive side of land management. The lone ecologist pursuing his work without such technical support and data will find his credibility in jeopardy.

The value of a team approach becomes apparent when confrontations develop between interest groups or between professions. In a few cases, we have been asked to rewrite sections of our consulting reports because our recommendations disagreed with solutions generated by engineering consultants. The solution we have found to this dilemma is to thoroughly analyze past engineering documents and assumptions, usually the hydrological calculations. In two cases, we hired a civil engineer to explain the engineering assumptions to the environmental science team before meeting to sort out the differences with the client and the engineering firm, or city engineer. Since most civil engineers have limited experience with ecology or environmental science, such confrontations establish very quickly, for decision makers, the enormous range of knowledge available in a team approach, and many reveal the inadequate or narrow technical base on which past solutions have been proposed by a single profession. The wider implications of ecological analysis as part of an environmental decision-making framework are examined by Craik (1972).

CASE STUDIES

At this point, examples from three of our studies conducted by interdisciplinary teams should clarify how these studies differ from many previous resource management studies, differ from what are recognized as more classical "ecological studies" by biological scientists dealing with a much narrower environmental focus, usually a single species.

A New Town

The site of the New Town near Toronto, in Ontario, is a land assemblage of approximately 9000 acres; some aspects have been discussed previously (Dorney, 1970). My involvement, as a thesis supervisor, was to study the natural features and ecosystem structure of the site to see how this knowledge could be articulated to the civil engineers, architects, landscape architects, planners, and the developers. The flexible team and information paradigm used in this study and in later studies is shown in Fig. 1. An editor or communications specialist we have found to be essential to "translate" the technical language of the specialists into a general level of usage clearly understood by other professionals, the client, and the public.

The difficulty in a study such as this is not only to balance the time needed for the study with the scale of fieldwork (degree of detail) and with the available budget but also to make the client recognize the importance of these elements. For example, soils and some geomorphology (surficial geology) information was available from published agricultural soils information (Fig. 2). As this information was, of course, designed for agricultural land-use, it needed substantial reinterpretation in terms of limitations for various urban uses (Table I). In addition, the scale of detail used for agriculture field mapping (1 inch to 1320 ft) missed small but critical soil parcels under 3 acres in size, which are important in determining road patterns and subdivision design at the lot level

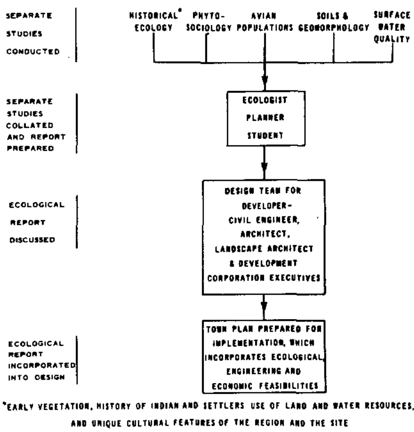


Fig. 1. Scenario for preparing an ecological report on a new town site.

Table I. Soil Characteristics Affecting Land Use

		Flooding	Erosion	Structural support	Slippage	Wetness	Permeability	Slope
Brockport	(Bkc)	L	M	H	H	L	L	M
Bottomland	(B.L.)	H	H	L	H	H	L	L
Chinguacousy	(Ch)	L	M	H	L	M	L	M
Cooksville	(Ck)	L	M	H	M	M	L	M
Fox	(F)	L	L	L	L	L	H	M
Jeddo	(J)	H	L	H	L	H	L	L
Lockport	(Lo)	L	M	H	H	L	L	M
Oneida	(O)	L	H	H	M	L	L	H
Trafalgar	(Tr)	L	M	H	M	M	L	M
Tuscola	(Tus)	L	M	M	L	M	M	M
Brady[a]	(Br)	L	L	L	L	M	H	M
Granby[a]		H	L	L	L	H	H	L
Mississauga	(Mi)	H	L	L	L	H	L	L
Muck[a]		H	L	H	L	H	L	L

[a]Additional soil types not included in the original county soil data but identified as a result of the detailed soil survey. H, high; M, medium; L, low.

(about 1/5 acre). For example, the original soils map (Fig. 2) was reinterpreted by additional field mapping to a scale of 1 inch to 400 ft (Fig. 3). Certain significant soils and geomorphological features associated with the slope (just above lower right corner) which indicated possible construction difficulties related to erosion and slippage (Brockport and Lockport Soils) were not shown in their proper locations on the original agricultural map. An environmental consultant who used the agricultural soils map for urban design purposes could cause client losses on the order of a quarter million dollars, the approximate value of construction if it were to slip into the valley or if it required expensive engineering structures to prevent slippage. As well, he himself could be liable legally for inappropriate professional advice. For new town design—i.e., the

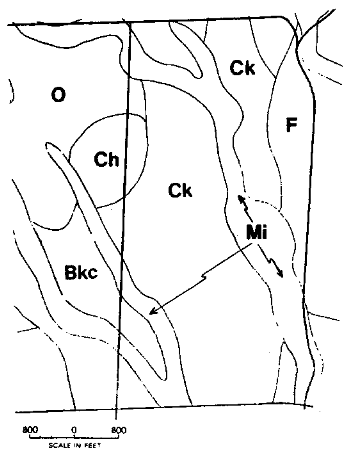


Fig. 2. Original soil survey done at a scale of 1 inch to 1320 ft intended for agricultural use.

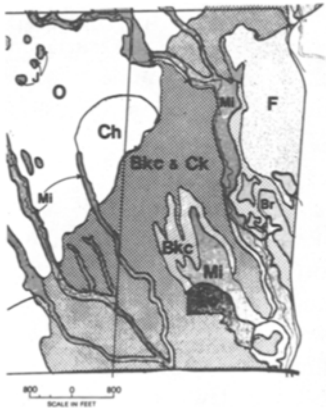


Fig. 3. Detailed soil survey mapped at a field scale of 1 inch to 400 ft.

locations of the town center, industrial areas, parks—the agricultural soils and geology maps may be adequate. The point is that the reliability of such soil maps should be understood before they are used in design decisions, unless the client assumes full responsibility for any difficulties which may ensue.

Also useful is knowledge of existing forest vegetation, in terms of its floristic structure, successional dynamics, and ability to withstand various types of intensive human use or construction. We have found that knowledge of past forest use (grazing, logging, burning), proposed drainage, and grade changes is imperative before alternatives of preservation, renovation, or tree removal on lots can be made. In this regard, the potential vegetation of each soil type is helpful in comparing the present vegetation against the potential vegetation. We generally rate tree stands according to their ability to withstand various construction changes, as well as their other potential uses, so that the designers can use this information in the office as they analyze alternative urban layouts (Table II).

Table II. Qualitative Evaluation of Woodland Sectors for Various Activities [a]

Stand No.	1	2	3	4	5	6	7	8
Hiking, viewing	G	G	F	Ex	P	F	G/Ex	Ex
Nature education	G/Ex	G	P/F	G/Ex	G	G/Ex	G	G
Ecological uniqueness	G/Ex	G	P/F	G/Ex	G	G/Ex	G	G
Ability to withstand wind damage	G	Ex	Ex	G/Ex	P	P	F	P
Ability to withstand drainage change or construction	F	F	G/Ex	G	P	P	P/F	P
Mosquito production	High	Low	Low/ Med.	Low/High		Low	Low	Med.
Picnicking use	G	G	G/Ex	G/Ex	P	P	G/Ex	P
Landscape maintenance cost if left undeveloped	Low	Low	Low/ Med.	Low	Med.	High	Med.	Med.

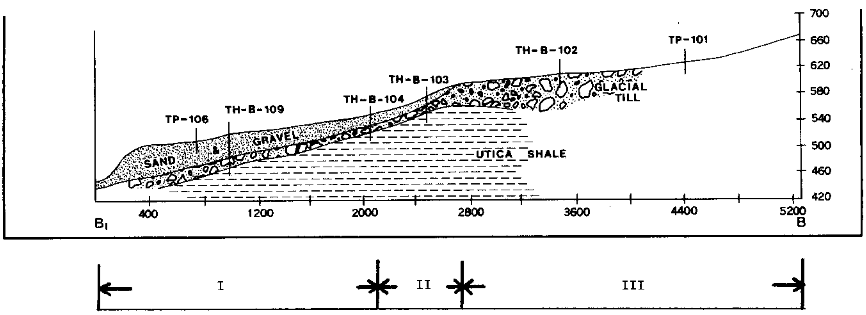
[a] Kitchen (1971).

On a new site, surface water quality can be of considerable importance. In this particular project; some upstream pollution was verified and potential difficulties with eutrophication in impoundments were projected.

A New University Campus

Ecological studies can prove useful for special-use areas, such as a zoo or a new university campus (Dorney, 1971; Twiss, 1966). Improper location and siting of buildings can result in serious deleterious effects on nearby vegetation and soils because of drainage problems, microclimatic changes, and erosion, as well as create additional costs where the sites are unsuitable because of the presence of boulders, natural gas, quick conditions, slope, higher water table, or silt and clay content of soils. If alternative sites can be found which are equally suitable, considerable savings are possible. Soils surveys (Olson, 1964) which integrate geomorphology (surficial geology) knowledge obtained from bore-hole and land-form information can provide a detailed earth science base. In addition, on such intensively used sites the high aesthetic value of trees makes phytosociological studies useful if maintenance and restoration are to be done on forested areas. Here again, knowledge of soils (*p*H, permeability, water table) explains present and potential plant communities and allows predictions to be made on what future plant community structure will evolve if planned changes in drainage and construction are carried out.

Figures 4 and 5 demonstrate the trade-offs between aesthetics, engineer-



Rating For:	I	II	III
Aesthetics	3	2	1
Microclimatic Comfort	1	1	1
Engineering Suitability	1	2	3
Construction Costs (?)	1	2	3
Ecological Suitability	1	2	3

#1=Optimum, #2 Satisfactory, #3 Undesirable

Fig. 4. Geological cross-section on a north to south orientation (north is to the right) of the SUNY Utica university site. The three site sectors (I, II, III), comparatively rated for five environmental factors, demonstrate the trade-offs between locating the campus building complex on the various sectors. Sector I, except for optimizing aesthetics, clearly was the best location. The aesthetic restraints were amenable to improvement by relocating a factory nearby.

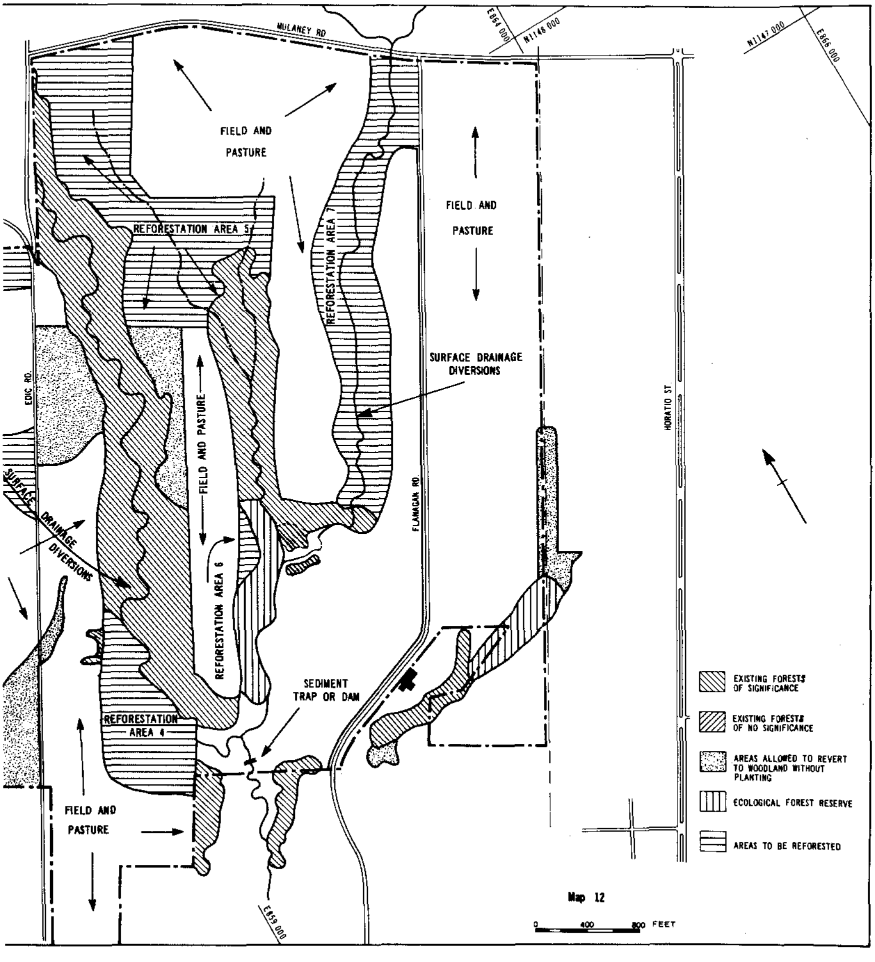


Fig. 5. Proposed land-use layout for the eastern sector of the campus site.

ing, and site ecology when a northern upper slope area (No. III in Fig. 4, which is located just south of Mulaney Road, midway betweed Edic and Flanagan Roads in Fig. 5), a midslope area (No. II in Fig. 4), and a southern lower slope area (No. I in Fig. 4, which is located about 800 ft west of Flanagan Road at the point where it curves to the west) are contrasted. Siting on the upper slope, although providing a better view, would entail expensive drainage of the compact till to prevent frost-heaving of roads, paved surfaces, and sidewalks. Subsurface drainage alteration, increased storm water runoff, reduction in side slope seepage, and the expected warming effect from buildings and asphalt parking lots would have, in our opinion, severely damaged the unique but vulnerable hemlock stands in the central valleylands (adjacent to reforestation area 5 in Fig. 5). These stands are dependent on cool-air drainage for survival—in our judgment, a threshold situation.

The final accepted solution between the client, architect, landscape architect, and engineering consultant was to locate the major buildings on the lower slopes (Fig. 6), where the deep alluvial sands and gravels provided better drainage and where the surrounding hardwood stands could benefit from or adjust to any upward thermal shift (Thompson, 1971). The midslope area (No. II in Fig. 4) was rejected for heavy building construction since the Utica shale lying near the surface necessitates expensive foundation construction—an engineering cost constraint. After avian populations, a most sensitive environ-

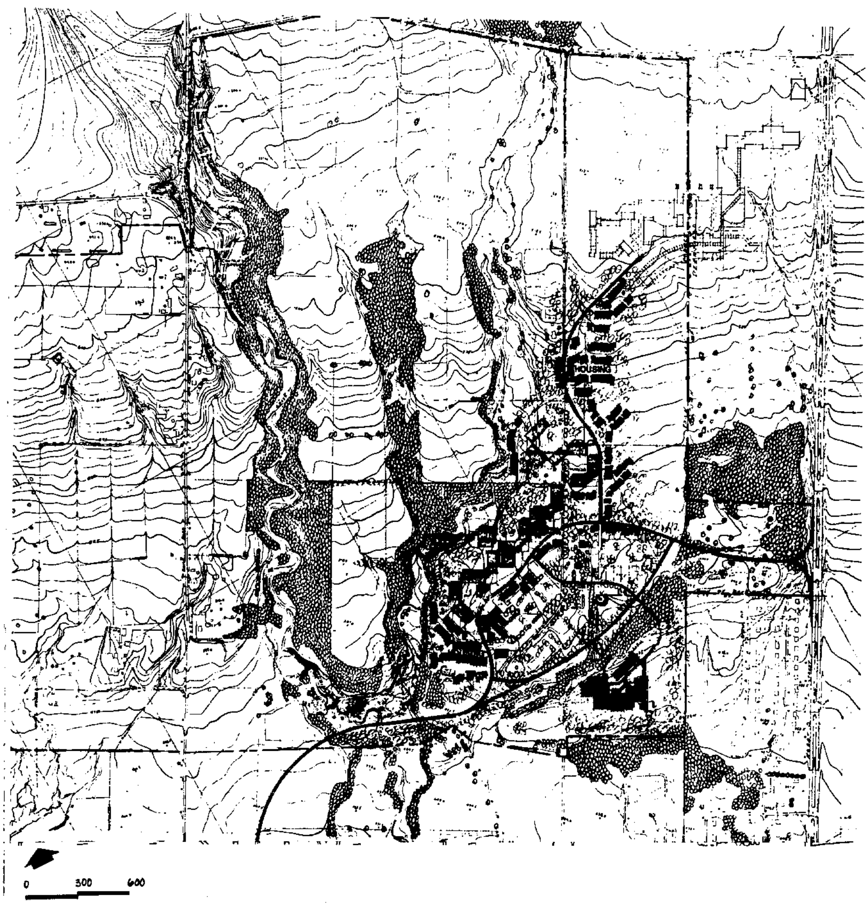


Fig. 6. Comprehensive campus building and site plan for the initial phase of construction (to 1980).

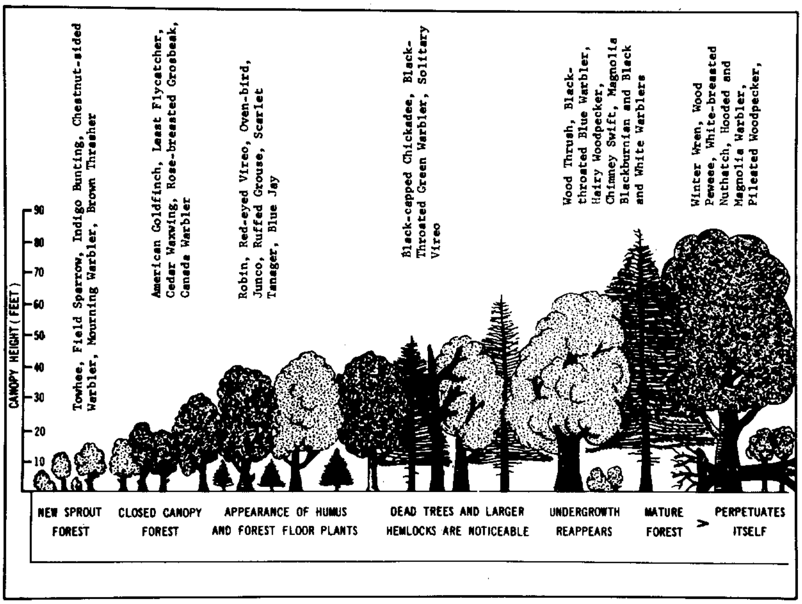


Fig. 7. Characteristic shifts in bird species resulting from natural succession following clear-cutting of the original maple-beech-hemlock forest (adapted from Saunders, 1936).

mental indicator, were measured in representative forest stands, pastures, and open fields (Fig. 7), it was then possible to talk meaningfully about potential ecosystems on the site—their reconstruction, preservation, and management.

The proposed land-use management plan (Fig. 5) preserves the unique raptor and other upper-level food-chain consumers on the site and preserves unique ecosystems (ecological forest reserves), while at the same time it diversifies the site in terms of reforestation of previous destroyed ecosystems, in this case oak-hickory, and increases the extent of field-forest edges. The sediment trap (Fig. 5) can later be converted to a pond or marsh after providing for on-site retention of any soil lost during construction. In this particular site design, we felt that substantial environmental improvement in forests, wildlife, and water quality could be attained within the context of a new type of land use.

County-Sized Land Units

In experimental academic work done on county-sized areas (Coleman and MacNaughton, 1971) in a rapidly urbanizing area, we have found that the highly sophisticated geographical ecosystem (Crowley, 1970) can be self-defeating, unless an equally sophisticated planning staff, knowledgeable in the natural and earth sciences, can interpret the data base. Until such sophisticated planners or planning staffs begin to work in local (city or county) offices in Ontario, a greater degree of generalization seems to be more effective (Dorney *et al.*, 1970). The more generalized method adapted from McHarg (1969) depicts the natural environmental resources in a three-step scale of quality (high-medium-low) and then overlays these resource features by computer or by transparent overlays to demonstrate spatial resource-quality patterns. Conflicts between development (dams, housing, roads, utility lines) and natural resources can be defined and then (hopefully) be resolved through more detailed studies. Although such an approach can be criticized as too simplistic, its low cost (3000 to 30,000 dollars depending on student labor costs) and rapid collation (3 months to 12 months) suggest that it can be the first step prior to more systematic ecosystem studies. Such regional resource studies may lead to more detailed analysis when specific issues such as designation of estate development, a garbage dump, or a new highway are proposed. They can provide justification to politicians for more detailed studies or can provide initial information for citizen groups who may dislike a development proposal but rarely have the time and professional backup to raise definitive objections or reasonable alternatives.

FINANCIAL ASPECTS OF URBAN ECOLOGICAL STUDIES

Since most scientists and clients are not aware of the costs of undertaking systematic interdisciplinary environmental studies at various scales of detail, it may be helpful to outline our costs for comparative purposes.

On an acreage basis, new town landscape analysis (as outlined in Fig. 1 using only general county soils maps and geology) costs about 4 to 6 dollars per acre. More fine-grain or detailed subdivision and special site work, such as for a park, zoo, or campus, with original geomorphology and soils mapping at 1 inch to 400 ft scale, costs about 35 dollars per acre. County-sized units cost about 1 to 10 cents per acre, including the digitizing for computer manipulation of data. Viewed in isolation, these costs may seem to be higher than the market can bear. However, as in any profession, fees must be examined in light of benefits derived—as is the case in the other professions such as medicine, architecture, planning, and law.

Urban environments are expensive environments: expensive to buy as raw land, expensive to build on, and expensive to maintain. Ecological fees viewed as a percentage of total development costs, for example, for a subdivision, represent between 0.005 and 0.3% of final market value. The other specific aspect of costs, other than as a percentage of value for urban ecology work, is represented by money saved on construction or savings because of property values protected. With such ecological interdisciplinary or team analysis, we have found that we have prevented substantial design and engineering errors from occurring in over half of the projects. Or phrased another way, we have identified the probability of certain "unforeseen" or "unperceived" acts of God occurring if particular physical changes were to take place due to development. The project engineer and the design team have then either to overcome the limitation (which costs money) or to look at other less destructive development alternatives. From our experience to date (Table III), for every dollar spent on ecological advice by various clients an average of 16 dollars in reduced construction costs or savings from potential property damage can be demonstrated.

In now appears that the present lack of professional understanding of how the natural ecosystems react to development pressure is costing developers, homeowners, or the general taxpayer large sums of money in direct costs, not to mention the long-term losses in amenities and ecosystem quality deterioration. This suggests that the design and engineering professions can improve their own practices substantially be using professional environmental insights that an ecological team can develop. Such ecological expertise in the development field can forge new areas for environmental law, since we know that many "acts of God" are the indirect or direct result of human interference in natural processes. Once these processes are identified and documented, the principle of *caveat emptor* may no longer apply.

Recent ecological, economic, and engineering comparisons of subdivisions in Waterloo, Ontario, suggest that "designing with nature" can result in substantially higher gross profit per acre, as high as 5000 dollars per acre (MacNaughton, 1971). Similarly, Clawson (1971) demonstrated that cluster development can result in substantial cost reduction as well as reduce severe environmental degradation. These dollar arguments are potent weapons in

Table III. Savings Generated by Research and Consulting Studies[a] on Ecosystems to Be Modified

	Ecosystem analysis cost (dollars)	Approximate saving (dollars)
New Town	21,000	300,000-500,000
Subdivision A	2,500	16,000
Subdivision B	800	30,000
Subdivision C	500	10,000-30,000
Park	None[b]	50,000

[a] Ecoplans Ltd.

[b] Done by graduate class, hence the cost was borne by the University of Waterloo.

regional urban planning, if a dialogue exists between ecologists, designers, planners, and engineers, and if local examples similar to the representative ones described here are documented. Unfortunately, we seem to have too few of these examples to use. More research effort on a wider variety of landscape design problems will determine whether our results are generally typical.

When the present concern about environmental quality is translated into regulations and controls, it might appear that the public will have to pay higher prices for some goods and services, since less efficient or uneconomic methods must be used. Our work in the urban ecology field suggests that costs for ecological advice will result in lower costs to government, to industry, and to the public. It suggests that the present prices for real estate and development are higher than they need to be because the correction of environmental mistakes must be paid by the developer, loaded onto the government tax bill, or paid directly by the private property owner.

From this economic perspective, our work suggests that well-documented ecological advice can give developers and governmental bodies who use it a competitive economic edge. If this is true, the acceptance and use of ecological advice could come quickly from within the industrial and financial sector and not have to be superimposed solely by government regulation. If further explorations into using ecological advice in a constructive way prove that ecology saves the investment and development community considerable amounts of money, I believe the urban development aspect of the environmental "battle" will be won easily and that this "battle" will be of much shorter duration than now envisioned.

AN ECOLOGICAL PROFESSION

If our initial studies and successes in Ontario and New York are borne out by other work, a practicing ecological profession dealing with urbanizing or urbanized areas and not financially dependent on government grants, civil service personnel, or university salaries may be within reach. A substantial monetary base similar to that supporting planning, landscape architecture, architecture, and civil engineering may become available which will support the evolution of a professional cadre of regionally knowledgeable consulting ecologists. Public pressure groups and new environmental legislation, such as environmental impact statements, will assist in developing this monetary base.

Relevant to this apparent financial base is the reception such a profession might find among the other professions involved in urban environments. In most cases, we have found that consulting civil engineers, architects, landscape architects, and planners have been receptive, not resistant, to using ecological or ecosystem concepts when they are documented and are clearly communicated.

Further, these professions will use it without distortion. However, as consulting professionals we have no code of ethics to "police" the profession, set standards, and adjudicate disputes when conflicting advice is given or information is misused. This gap must be closed as soon as possible before low-quality advice causes considerable embarrassment and decreases credibility with the other professions just mentioned.

If in the near future ecologists, without having their ecological work prostituted by special interest groups, can take an independent professional posture similar to that found in medicine, dentistry, law, and veterinary medicine, we can have a solid base on which to build a practicing profession and professional ethics by which to protect the public from inexperienced ecological practitioners. A dynamic profession will encourage the smooth flow of competent young men and women into the field from biology, wildlife management, fisheries, soil science, geology, physical geography, forestry, planning, and landscape architecture. Even though there is now a wide gap between academic scientists and applied scientists, these lines of contact with the universities must be kept viable, for if they are cut both the universities and practitioners will be disadvantaged.

In my view, the present professional science societies in Canada and the United States are ready for the task of organizing such a practicing profession of ecology. If we can put aside our ecological rhetoric and enter into an honest and open dialogue with other professions, we can solve, collectively, many problems associated with the management and development of urban and urbanizing areas.

REFERENCES

Christiansen, E. A. (ed.) (1970). *Physical Environment of Saskatoon Canada,* National Research Council of Canada, Publ. No. 11378, Ottawa, Ontario.

Clawson, M. (1971). *Suburban Land Conversion in the United States: An Economic and Governmental Process,* Johns Hopkins Press, Baltimore.

Coleman, D., and MacNaughton, I. (1971). Environmental planning in Waterloo County. In McLellan, A. G. (ed.), *The Waterloo County Area Selected Geographical Essays,* Department of Geography, University of Waterloo, Waterloo, Ontario.

Craik, K. H. (1972). An ecological perspective on environmental decision-making. *Hum. Ecol.* **1:** 69-80.

Crowley, J. M. (1971). Ecoregions of South Wellington County and their implications for planning. In McLellan, A. G. (ed.), *The Waterloo County Area Selected Geographical Essays,* Department of Geography, University of Waterloo, Waterloo, Ontario.

Dansereau, P. (ed.) (1970). *Challenge for Survival: Land, Air, and Water for Man in Megalopolis,* Columbia University Press, New York and London.

Dorney, R. S. (1970). The ecologist in action. *Landscape Arch.* **60:** 196-199.

Dorney, R. S., *et al.* (1970). *An Ecological Analysis of the Waterloo-South Wellington Region,* Division of Environmental Studies, University of Waterloo, Waterloo, Ontario.

Dorney, R. S., *et al.* (1971). *An Ecological Analysis and Natural Resource Management Proposals for SUNY Upper Division College Site at Herkimer-Utica-Rome, New York,* Ecoplans Ltd., Waterloo, Ontario.

Hills, G. A. (1961). *The Ecological Basis for Land-Use Planning,* Research Report No. 46, Ontario Department of Lands and Forests, Toronto, Ontario.

Holling, C. S., and Goldberg, M. A. (1971). Ecology and planning. *Am. Inst. Planners J.* **37:** 221-230.

Kitchen, C. (1971). Ecological concepts in subdivision design. In McLellan, A. G. (ed.), *The Waterloo County Area Selected Geographical Essays,* Department of Geography, University of Waterloo, Waterloo, Ontario.

MacNaughton, I. F. (1971). An economic and physical examination of urban open space with specific reference to natural floodplain parks. M. A. thesis, School of Urban and Regional Planning, University of Waterloo, Waterloo, Ontario.

McHarg, I. L. (1969). *Design with Nature,* Natural History Press, Garden City, N.Y.

Olson, G. W. (1964). *Application of Soil Survey to Problems of Health, Sanitation, and Engineering,* Cornell University Agricultural Experiment Station, Memoir 387 (March), Ithaca, N.Y.

Thompson, Benjamin, and Associates (1971). *Comprehensive Campus Plan SUNY at Herkimer Utica-Rome,* Cambridge, Mass.

Toffler, A. (1970). *Future Shock,* Bantam Books, New York.

Twiss, R. H. (1966). *Natural Resources Study for the Santa Cruz Campus of the University of California,* Santa Cruz, Calif.

Wells, M. B. (1971). The absolutely constant incontestably stable architectural value scale. *Prog. Arch.* (March), pp. 92-97.