응용생태연구 8(1) : 11~26, 1994

# 우리나라에서 보전우선순위를 위한 입지 및 식물종 선정의 평가기준 : 개관 [1]

김용식 [2] · 마이클 모운더 [3]

# Evaluation Criterias of Site and Plant Species for Conservation Priorities in Korea : An Overview [1]

Yong-Shik Kim [2], Michael Maunder [3]

## 요 약

우리나라에서 앞으로 적용가능한 식물의 서식처 및 종의 선정에 대한 보전평가기준 특히 식물적 가치에 대한 기준을 마련하기 위하여 1969년부터 1986년 사이에 발표된 야생동물의 보전가치의 평가에 관련된 논문에 발표된 기준을 재 정리하였다. 희귀성, 다양성, 크기 및 정도 및 자연성 등은 대부분의 논문에서 사용되고 있는 기준이었다. 위와 같은 내용을 우리나라의 상황과 비교하여 서식처의 크기를 고려하여 16개의 요인을 정리하였다. 인간의 간섭, 생태적 분쇄성 및 희귀성 등은 서식처의 규모가 비교적 좁은 경우에 고려되어야 할 요인인 반면, 지역, 생태적 및 지리적 단위내에서의 다양성 위치 및 자연성 등은 입지의 규모가 큰 지역에 고려되어야 할 요인으로 판단되었다. 유일성, 전형성, 연구 및 교육적 가치 등은 규모의 크기 여하를 불문하고 고려되어야 할 요인으로 판단되었다. 본 기준이 우리나라에서 실제로 적용되어 앞으로 적용가능한 평가기준이 될 수 있도록 해야 하는 과제가 남아 있기는 하지만, 장차 우리나라에서 마련되어야 할 보호지역 및 특정식물의 평가기준을 위한 지침이 될 수 있으리라 판단된다.

주요어 : 평가기준, 보전가치, 식물종, 서식처

## ABSTRACT

The criteria which have been used for the assessment of wildlife conservation values and particularly botanical values during the last decade, 1969~1986, were reviewed in order to select an appropriate set of criteria applicable for Korea. Fifteen studies, including studies of particular sites reviews of ecological evaluation are reviewed. Four criteria, rarity, diversity, size & extent and naturalness were used in more than half of these studies reviewed. The sixteen components were arranged with the scale of the sites, in view of the Korean situation. The human interference, ecological fragility, as well as rarity, etc. were major components to be considered at small scale sites. In the contrary, area, diversity position in

* 본 연구는 한국과학재단과 영국문화원의 연구비지원을 받아 수행되었음. This research was supported by the Korean Science and Engineering Foundation and the British Council, 1992.

1 접수 7월 15일 Recieved on Jul. 15, 1994

2 영남대학교 농축산대학 College of Agriculture & Animal Science, Yeungnam University, Kyongsan 712-749, Korea

3 영국 리치먼드 왕립 큐 식물원 Conservation Unit, Living Collections Department, Royal Botanic Gardens, Kew, Richmond, TW9 3AB, England

ecological and geographical unit, and naturalness, *etc.* considered the major components at larger scale sites. The components such as uniqueness, typicalness, research and educational, *etc.* were considered both applicable. Although this criteria should be tested by applications in the field and amended thereafter, it will be one of the first-step to evaluate of the protected areas, as well as specific plant species in the future.

*KEY WORDS : EVALUATION CRITERIAS, CONSERVATION VALUES, PLANT SPECIES, HABITATS*

## INTRODUCTION

Korea is a peninsula country, geographically an extension of the Asian continent, it is bounded by the East Sea to the east and the Yellow Sea to the west. More than 60% of the total land area is classified as mountainous. In relation to its relatively small area of, South Korea, of 99, 020km$^2$ the flora of the country is relatively diverse with 2,898 vascular plant species, approximately 14% of these are endemic. The vegetation can be divided into three main zones; sub-tropical, temperate and alpine. The last century has been episodes of rapid and large-scale forest clearance, these have been associated with the Japanese colonial rule, World War II and the Korean War(Woo, 1990). Since the 1960s government policy has encouraged the development of protected areas(Natural Parks Law, 1960) and large scale afforestation. The human interference, such as hiking, illegal collecting or cutting plant materials were major threat to the conservation of protected areas for specific plants or populations, although it have been strongly supported by the various kinds of law(Kim & Kim, 1990; Koh *et al.*, 1991). The assessment of the conservation value of any particularsite is difficult, and in many cases based upon the specific interests of the assessor(Usher, 1986). However, there are no systematic guidelines for evaluating those species or areas for conservation values in Korea, and it had not been managed by the established standard criterias(Kim & Kim, 1990), and also in case of the conservation policies have been focused mainly in the taxonomic concerns in Korea.

As natural habits are widely threatened despite strong government legislation, there is increaasing evidence for habitat degradation and species loss. Accordingly there is an urgent need to develop a standardinised criteria to assist the development of a national conservation strategy. In particular guidelines for selecting and amanaging protected areas for botanical conservation Kim & Kim(1990) discussed criteria for the designation of rare and endangered plant species in Korea.

The present paper reviews published papers on the evaluation and prioritisation of potential protected plant and areas. There is a recognised need to develop and adopt a realistic and pragmatic set of guidelines to assist Korea in planning and managing for the conservation of both species and habitats.

## BIOLOGICAL CONSERVATION AND ECOLOGICAL EVALUATION

Human activities continue to modify or destroy areas of wild land, accordingly it is becoming a matter of global concern to establish protected areas and undertake species conservation programmes(Mack *et al.*, 1983). It is a major challenge to find practical and workable solutions to secure conditions for the long term survival of both humanity and other species sharing the earth(Prescott-Allen, 1984). The establishment of new protected areas need to be established within the context of sustainable development, plants need to be ecologically sound and supported by socially acceptable and financially viable straties.

Conservation programmes, although a matter of the great contemporary urgency(refer to

reviews, by Soule & Simberloff, 1986; Western & Paul, 1989), are not new. Korea has a very long tradition of nature conservation. During the reigh of King Chinhung(540~576 AD) of the Shilla Dynasty, the "Hwarang" systems of government promoted the value of scenic landscapes and included in its "Five Rules of Practice" that people should "cherish all living things". During the reign of King Sejo(C 15) strict regulation controlled the felling of pine trees. The modern protected area network that currently covers circa 5% of the earth surface has its origin in the establishment of the Yellowstone National Park(U. S. A.) in 1872. The objectives of this network include the represenation of species, ecosystems and geological features within protected areas. The criteria used for selecting protected areas may utilise biological properties of factors, or they may utilise political or economic factors.

Although it is known as that the conception of the word 'value' is extremely difficult to define (Goldsmith, 1975), the aim of an evaluation is to determine the conservation requirements of a species, or it could be to access the impact resulting from a change in land status (Spellerberg, 1981). Ecological evaluation can be undertaken as an assessment of ecosystem qualities *per se*, or can include additional socio-economic reviews to assess economic and social implications. In addition, it is not clear in the semantic differences between ecological value and conservation value, but conservation value should invlove the assessment of the system's stability under examination, as well as its carrying capacity for various activities, the probability of demands made for changes in land-use and the effort required to make desirable ecological change. The measurement of ecological value must involve the use of criteria agreed by ecologists(Goldsmith, 1975).

Ecological evaluation may be devided into two groups; (1) ecological evaluation as an assessment of ecosystem qualities *per se*, and (2) ecological evaluation as a socio-economic procedure to estimate the functions of the natural environment for human society(Ploeg & Vlijm, 1978). The application of ecological evaluation can be examining the topic at different levels as one might also examine ecology, for example at the species level, habitat level and community level. There were efforts to preserve and protect certain groups of wildlife and also natural land areas (Given, 1976; Wright, 1977). More recently there have been attempts to devise a combination of both quantitative and qualitative informations for evaluation which help to elucidate the conservation needs or the degree of threat experienced by certain animal and plant species. As important as the ecological evaluation of a species is the development of techniques and methods for the complex habitat evaluation and priority ranking of natural areas.

The evaluation of a species to propose some form of biological conservation, such as the conservation of rare and endangered plant species may be one of the most important and also the most common objectives.

## EVALUATION OF NATURAL AREAS AND PLANT SPECIES FOR CONSERVATION VALUES

Historically the national estaes of conservation areas have developed in an *ad hoc* manner that has not taken into account the representation of viable samples of biodiversity rather it has often focused on scenic landscapes and areas not required for agricultural development. To guide planners Ratcliffe(1977) discussed the issues of quantified and subjective review of criteria for the selection of conservation areas. Since then an enermous body of often controversial and contradictory literature has developed.

The following table reviews the criteria used in 15 studies;

1. We should include the paper by Gotmark & Nilsson in Conservation Biology(1992)
2. Put country where criteria used under author name
3. Does extent = size, if so we should adopt a standard terminology

Table 1. The criteria used in fifteen studies on the assessment of conservation potential and ecological value.

| Author and Location | Criteria |
|---|---|
| Helliwell(1969) Enghand | 1. Size(including buffer zone), 2. Habitat attributes(Diversity, rarity, etc.)<br>3. Species attributes(Diversity, rarity, distribution, population)<br>4. Use(Education, research and amenity), 5. Acessibility, 6. Cash value of crop /product |
| Ranwell(1969) England | 1. Size(including buffer zone), 2. Habit attributes(Diversity, rarity, etc.)<br>3. Species attributes(Diversity, rarity, distribution, population)<br>4. Use(Educational and research, amenity), 5. Degree of disturbance /naturalness<br>6. Proximity to other sites, 7. Unknown factor |
| Ratcliffe(1971) England | 1. Extent, 2. Naturalness, 3. Richness, 4. Diversity, 5. Fragility, 6. Representativeness<br>7. Research and educational value, 8. Recored history, 9. Potential value |
| Tubbs & Blackwood (1971) England | Unsown vegetation, plantation woodland and agricultural land were used to define mappable classes. These were assesses by:<br>1. Habitat rarity, 2. Features of outstanding scientific value, 3. Wildlife reservoir potential, 4. Habitat deversity |
| Tans(1974) U. S. A. | 1. Size, 2. Diversity, 3. Educational and research potential 4. Naturalness<br>5. Threat of human inference, 6. Availability |
| Gehlbach(1975) U. S. A. | 1. Naturalness, 2. Educational suitability, 3. Species significance(e. g., rarity, uniqueness)<br>4. Community representation e. g., diversity), 5. Extent, 6. Imminence of human |
| Goldsmith(1975) England | Land use, vegetation structure and the presence of streams were used to define six habitat classes. These were assessed by:<br>1. Extent, 2. Rarity, 3. Species richness |
| Ratcliffe(1977) England | 1. Size, 2. Diversity, 3. Naturalness, 4. Rarity, 5. Fragility, 6. Typicalnes<br>7. Recorded history, 8. Position in ecological /geographical unit, 9. Potential value, 10. Intrinsic value |
| Wright(1977) England | 1. Scientific appraisal(e. g., diversity, naturalness rarity,recorded history, threat of interference and representativeness),<br>2. Management appraisal(e. g access,tenure,costs, liabilities, security) 3. Potential amenity use, 4. Potential educational use |
| van der Ploeg & Vlijm(1978) Holland | 1. Area, 2. Diversity, 3. Species, 4. Number of plant alliances, 5. Number of plant structural formations, 6. Rarity, 7. Uniqueness, 8. Vulnerability, 9. Replaceability |
| Austin & Miller(1978) Australia | 1. Area, 2. Representativeness, 3. Degree of human disturbance, |
| Everett(1978) England | 1. Species richness, 2. Naturalness, 3. Acessibility, 4. Typicalness,<br>5. Previous studies, 6. Species or habitats which contri- butes to the character of an area,<br>7. Species or habitats which contributed to past art work |
| Adamus & Clough(1978) U. S. A. | 1. Suitability<br>(1) Site tenacity (2) Seasonal mobility (3) Area size needs (4) Spatial distribution<br>2. Desirability<br>(1) Relative scarcity (2) Status change (3) Endemicity( ') Peripheality<br>(5) habitat specialization(6) Habitat scarcity (7) Susceptability to immediate human presence<br>(8) Other unusual or unique scientific values (9) Aesthetic amenities and use |
| Everett(1979) England | 1. Richness, 2. Naturalness, 3. Rarity, 4. Acessibility, 5. Previous studies 6. Typicalness<br>7. Capacity, 8. Species cropped from the wild, 9. Wild relatives of domestic species<br>10. Species which function in a similar way to man, 11. Species with known medical uses<br>12. Attractive and simulating species<br>13. Species or habitats which contributed to past art works<br>14. Species or habitats which contributes to the, 15. Species which affect the production of a<br>16. Alternate food /host sources for agents used in production |
| Usher(1986) England | 1. Diversity, 2. rarity, 3. Naturalness, 4. Area, 5. Human influence |

4. Ranwell(1969), what is the unknown factor?
5. Ratcliffe(1971), what is the difference between"richness" and "diversity"?
6. Tubbs & Blackwood(1971), do we need text before the criteria ?
7. Goldsmith(1975), number of criteria ?
8. Ploeg & Vlijm(1978), does rarity refer to species or habitat, same for uniqueness ?
9. Adamus & Clough(1978), what is site tenacity ?

Since the end of 1960's, a very diverse evaluation criteria have been invented and applied to evaluate the identity and significance of the natural or potential areas and were summarized in Table 1. Among them, Ratcliffe(1977) discussed explicitly the issues of quantification and subjectively and stated the assumptions underlying the method chosen. The criteria of evaluation of specific plant species and natural areas have been very complicated, and this means that the evaluation of the ecosystems and related plant species are very difficult to apply with one established criterias. The enermous kinds of criterias which used by scientists means that it is not so easy to evaluate the specific sites, as well as specific plant species for conservation purposes, just because the ecosystem varied by the geographical localities.

Table 2 summarises the criteria in the reviewed papers and illustrates the most commonly utilised criteria. Great emphasis is given to the rarity of habitat /ecosystems, followed by biological diversity and the area of the proposed protected area. Criteria such as size and naturalness will be of particular importance when selecting large reserves in areas of relatively undisturbed habitat with low human populations in contrast fragility will be important in areas subject to habitat degradation. For example, in Sweden and Australia, conservation planners can still plan for ecosystem scale conservation this is not the case in densely populated countries such as the United Kingdom or the Netherlands.

Table 3 shows the criteria divided into three sequential orders in England for nearly 10 years and have been slightly modified in the Nature

Table 2. Criteria used in 15 selected evaluation systems based on table 1.

| Criteria | Number of Used | Type of Criterion |
|---|---|---|
| Rarity | 13 | Biotic, Abiotic |
| Diversity | 12 | Biotic, Abiotic |
| Size (& Extent) | 10 | Biotic, Abiotic, Planning & Management |
| Naturalness | 8 | Biotic, Abiotic |
| Representativeness (Typicalness, Uniqueness) | 7 | Biotic, Abiotic |
| Education Value | 7 | Cultural |
| Threat | 5 | Planning & Management |
| Scientific Value | 5 | Planning & Management |
| Assessibility | 5 | Planning & Management |
| Richness | 5 | Biotic |
| Potential Value | 5 | Biotic, Abiotic |
| Fragility | 3 | Biotic, Abiotic |
| Recreational Value (Amenity) | 3 | Cultural |

Table 3. The valuation criterias in sequential order.

| Principal Criteria (in Order of Importance) | Ancillary Criteria | Criteria to Determine Number of Sites |
|---|---|---|
| 1. Typicalness | Recorded History | Rarity |
| 2. Naturalness | Position in an ecological Unit | Fragility |
| 3. Diversity | Potential Value | |
| 4. Size | Intrinsic Appeal | |

Source : Goldsmith (1983)

Conservancy Council document on the selection of Sites of Special Scientific Interest(Goldsmith, 1983). Thus the approach adopted involved a different evaluation method and criteria for different ecosystem or habitat types(Goldsmith & Theberge, 1987).

The most important strategies for the conservation of biodiversity *in situ* is the selection of viable protected areas containing samples of Korea's plant communities and areas of greatest species diversity. Scott *et al.*(1987) advocates focusing on the protection of species rich areas

Table 4. The relative interest of different sites.

| Most frequently used | | | Less frequently used |
|---|---|---|---|
| Diversity | Area | Potential value | Replaceability |
| Rarity | Naturalness | Wildlife reservoir potential | Amenity value |
| Representativeness | Threat of interference | Management factors | Recorded history |
| Uniqueness | Scientific value | Position in ecological geographical unit | Educational value |
| Ecological fragility | | | Availability |

Source : Margules (1980)

as a means of obtaining "the most efficient and cost effective way to retain maximal biological diversity in the minimal areas", however this may encourage an over emphasis on species rich areas at the expense of less diverse areas that represent ecologically viable landscape units. Work by Rebelo & Siegfried(1992) has shown that in the Republic of South Africa the incidence of rare species(both naturally rare species and those influenced by man) is positively correlated with species richness.

As the Korean natural areas are widely faced with increasing destructions of natural habitats, as well as specific species, such as rare and endangered plant species, number of civilian, as well as governmental institutions have been tried to establish programmes for protecting the specific species or habitats since the mid of 1960's. There are various kinds of objects of the protected areas in Korea whose primary purpose is the protection of rare and endangered species. Major protected areas could be included such as natural reserves, natural ecosystems, protected areas, natural parks, wildlife sanctuaries, protection forests, and biosphere reserves. The designated total areas of the twenty national parks, for example, is 6,113. 250 $km^2$ including marine areas of 2,348. 370 $km^2$(Woo, 1990; Kim, 1993). The criteria for designation as the natural monument for plant species in Korea is insufficient under the base of ecological conceptions and are included such as (1) unique plants and it's living sites and habitats, (2) rare and precious plants and it's sites required special conservation measures, (3) scientifically of value old trees, big trees and legendary trees, (4) representative wildnerness, nature forests, alpine plant zones and unique forests, and (5) natural habitats(Woo, 1990).

Table 5. Evaluation criterias of different sites scales to be suggested for korea.

| Small Scale Sites | Both Applicable | Large Scale Sites |
|---|---|---|
| Human Interference | Uniqueness | Area |
| Ecological Fragility | Research & Educational | Diversity |
| Rarity | Typicalness | Position in Ecological /Geographical Unit |
| Assessibility | Surrounding Vegetation | Naturalness |
| Possibility of Reintroduction | Recorded History | Representativeness Species Richness |

Table 5 illustrates the proposed basic scheme for evaluation of botanical sites in Korea. They are related to the scale of the proposed conservation area. Although the critical discussions must be made before in practical uses in the wild, the basic schemes for evaluation criteria of site and plant species selections for conservation values in Korea is suggested in Table 5. Since the Korea does not have an established strategy for evaluation of the conservation sites, as well as biotic components, the needs for the criteria are strongly awaited to be appeared. It is generally recognised that conservation targets in Korea are divided into three categories: 1) individual trees, 2) small populations with one dominant species to be protected, and 3) large populations existing with mixed species. All of the species within this categories are existed in the forests or as an isolated. The human

interferences such as hiking, as well as illegal collecting or cutting is the most important criterias to be considered (Kim & Kim, 1990; Koh *et al.*, 1991).

Margules(1980) analysed that the relationsh ips between variables in pairs using regression and principal components analysis. These showed that there is no obvious overall ranking of criteria use by different assessors but that criteria can vary depending on size of site with fragility, threat and rarity being important for small sites and representativeness, area and naturalness being more important for larger sites(Figure 1).

A lot of works dealt with numerical values for several criteria and then add them together (Yapp, 1973; Given, 1976) or multiply them (Goldsmith, 1975) although most workers would now emphasize that the weighting of different criteria is not recommended and that the comparison of like-with-like is acceptable, but not like-with-unlike(Goldsmith, 1983).

The ranking system is founded on a systematic analysis of the areas to be ranked based on criteria which are grouped into four categories: (1) determinants of natural area value (biological characteristics), including quality, commonness, and community diversity, (2) physical characteristics and use value, the former including size and buffer considerations, (3) degree of threat, and (4) availability. Areas of both public and private ownership can be ranked with this system (Tans, 1974).

The conception of evaluating the significance of natural areas, as well as specific plant species for conservation or other purposes has recently evolved and has found wide application(Adamus & Clough, 1978; Margules & Usher, 1981; Goldsmith, 1983). Margules & Usher(1981), and Smith & Theberge(1986, 1987) reviewed recent major works on the evaluating criterias for natural areas, as well as specific plant species fo. conservation values.

The criteria schemes for assessing conservation value contain a plethora of criteria, concepts and values which can be grouped together, as seen in Table 1. The major criteria for ecological evaluation are discussed in below:

### 1. Area

The number of species encountered, in general, increases as the size of the area increases. The species-area relationship is widely known in biogeographic theories(Margules & Usher, 1981). The geographic similrarity between

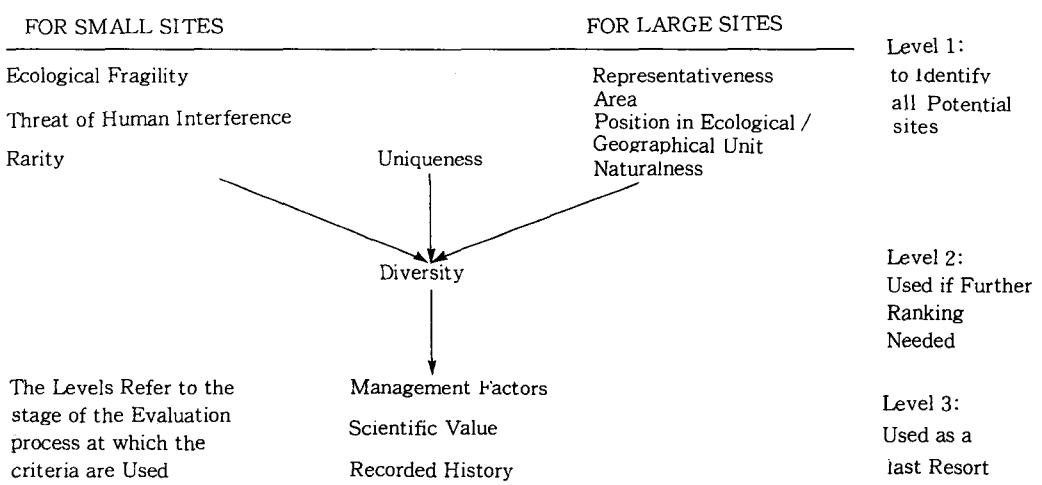


Figure 1. A hierarchy of criteria for conservation evaluation. The Levels 1, 2 and 3 refer to the stage of the evaluation process at which the criteria are used(Margules, 1980).

islands and nature reserves has lead a number of people to find important implications for the selection and design of nature reserves from studies of island biogeography(Terborgh, 1974; Diamond, 1975; Fleming, 1975; Diamond & May, 1976). Conservationists have used species-area relationships and island biogeography theory to argue for single large reserves instead of a number of smaller ones. There are practical and theoretical reasons why such arguments should be treated with caution since it may be that several small areas will contain more species between them, at least initially, than one large one.

### 2. Diversity

Diversity can refer to community, habitat or species diversity. The measurement of community diversity requires a classification of communities at a regional scale so that the number present at any site can be counted(Margules & Usher, 1981).

Habitat diversity can also be measured using widely accepted types. Species diversity can be interpreted in a number of different ways. It can mean the number of different species, the 'species richness', or it can mean a function of the number of different species and their relative abundances(abundance may be measured by the number of individuals in each species or by some measure of importance, e. g. biomass). Another meaning of diversity(Goodman, 1975) is the number of different trophic levels and the number of interconnections between species both within and between trophic levels. Smith & Theberge(1986) reported that the vegetation communities were most commonly used for assessing diversity, because their inventory requires the least field work, and other forms of diversity are correlated with community diversity.

### 3. Species Richness:

Conservationists often equate species richness with diversity, though the latter term has a broader meaning to ecologists(Johnson & Raven, 1970). Although species richness does indicate diversity, its value in isolation is limited even within a group of apparently similar sites due to the multiplicity of its causes; variation between sites may reflect differences in area, homogeneity or maturity.

Species richness can be measured simply by counting the number of species in a community. As sample size increases so does the number of species encountered, so that measures of species richness can only be used to compare two or more sites in the sample sizes are equal (Margules & Usher, 1981). Species diversity for biological conservation is most conviniently assessed by measuring species richness.

### 4. Rarity:

The problem of incorporating species quality into assessment schemes has not been satisfactorily resolved. A more objective and less restrictive method of defining selected species based on local rarity seems more appropriate(Dony & Denholm, 1985).

The protection of rare species and communities has been, to many people, the most important function of conservation. Rarity has become the focus of conservationist political activity and a major element in what is essentially a moral debate surrounding the ligitimacy of conservation.

Since small populations of wide spread species may be disjunct or isolated from the main distribution and thus have restricted range and these junct populations may differ genetically from the main populations of the species, rare species usually have peculiar ecological requirements and the areas that contain them can provide valuable natural laborotories for studies of biogeography and population regulation(Margules & Usher, 1981). Habitat alteration or destruction has been a major cause of the reduction in numbers of many species.

There are several reasons for weighting sites according to the local rarity of species present. Rare species are generally most vulnerable to human pressure, and often indicate unusual ecological conditions(Ratcliffe, 1977). However, overemphasizing rarity can detract attention from

one of conservation's principle goals-maintaining communities of organisms most typical or representative of a particular habitat. Since typical sites by definition contain many common species and fewer rarities, assessment values based on rarity will usually be negatively correlated with ones that measure typicalness. Because rarity and typicalness are difficult to reconcile, rarity indices mus be interpreted with care to ensure that odditi .e not conserved at the expense of more typical species(Dony & Denholm, 1985). Consideration of rarity also introduces a problem of scale, i. e. whether rarity should be assessed at county, regional or national level. Use of the national scale(Ward & Evans, 1976) in a country as varied in climate and topography as Korea obscures distribution patterns necessary to understand a species' ecological requirements and assess its local importance to conservationists. Species that are locally frequent in a study area may be uncommon nationally, and so on(Dony & Denholm, 1985).

5. Naturalness:

The term naturalness implies the recognition of some natural condition which may be difficult to determine. It is often used in a sense that implies freedom from human influence but few, if any, communities of plants and animals are free from the influence of man(Margules & Usher, 1981). Wright(1977) discussed the criteria commonly used in critical areas. Such criteria can be useful in order to standardise the methods employed by conservation instituions to select areas and also for the collection of data needed to substantiate these selections, such as knowledge, representation, use, potential economic effects, potential conservation effects, manageability, persistence, geographic distribution, quality, variety of values and scarcity. Also Wright(1977) classified landcapes into agricultural or artificial, semi-natural, and near-natural.

The most common usage of 'natural' in the ecological literature is understood to mean a process, situation, or system free of human influence. Naturalness is a scientific concept that can be evaluated and quantified(Wright, 1990), but Anderson(1991) discussed the meaning of natural and naturalness,although it has some difficult to assessing it(Margules & Usher, 1981).

The prevalence of the use of naturalness as a criterion is linked to its use in human-dominated landscapes(Tubbs & Blackwood, 1971) and developed areas(Tans, 1974; Gehlbach, 1975). In order to evaluate of naturalness, methodologies used to evaluate small areas(Tans, 1974; Gehlbach, 1975; Wright, 1977) uses categories and scores. The characteristics which indicate an area's naturalness vary from ecosystem to ecosystem, and thus the method of assessment must vary accordingly(Tans, 1974; Ratcliffe, 1977).

6. Threat of Human Interference :

Human activities may still threaten species, and disturbances and ecological changes continue, even in protected areas(Bratton & White 1980). Human activities are destroying the natural world and its biota at an ever increasing rate (Vane-Wright *et al.*, 1991), and has been a major cause of the reduction in numbers of many species(Margules & Usher, 1981). Some of these changes may be related to preserve size and geographical relations(Willis, 1974; Terbough, 1974; Diamond, 1975), others to environmental change, natural disturbance, or community processes such as succession(Stone, 1965; Owen, 1972). No preserve is totally free of human influence(Owen, 1972; Miller & Botkin, 1974). People are attracted to preserves, in part due to their scarcity in the developed landscape. There is currently a worldwide trend for visitor pressure to increase(Brotherton, 1975; Dory, 1977).

Evaluation of human impacts and management decisions should take into account the goals for a particular area(Figure 2). If human activities continue to influence the ecosystem in such a way to prevent achievement of the desired level of sustainability, the goals need to be reexamined (Patten, 1991).

Species which are rare are often considered to

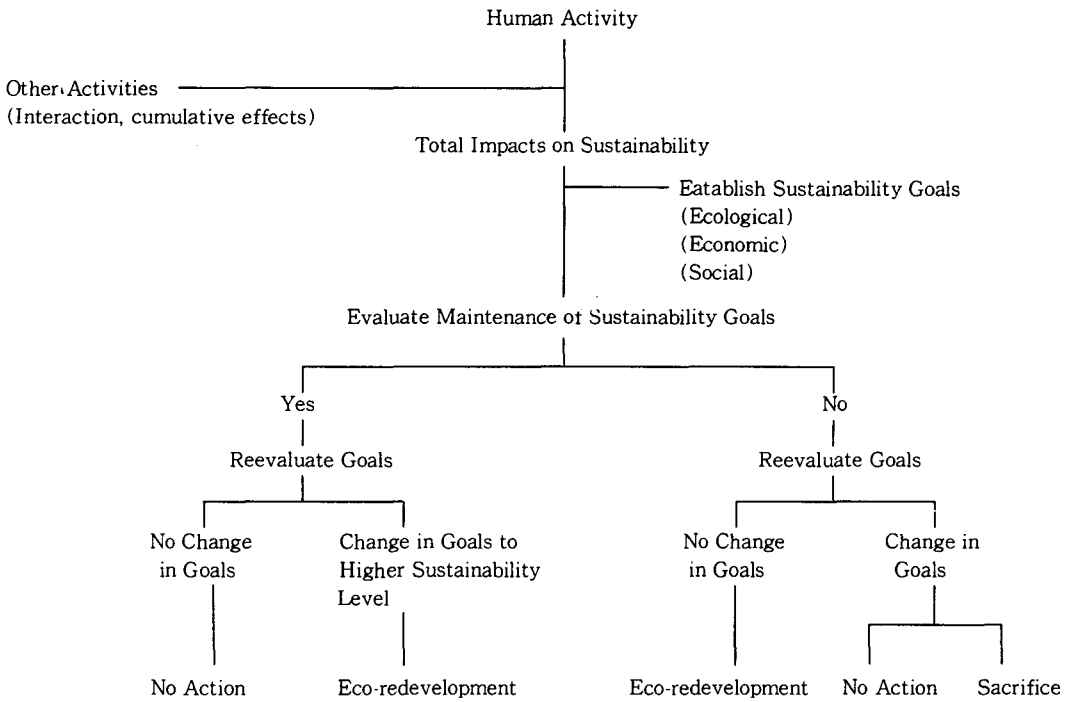


Figure 2. Steps in evaluating the consequences of human activities and needs for ecosystem redevelopment (Patten, 1991).

be under a threat of human inteference simply because they are rare. Species occuring in only one or two locations, even in some numbers, are again considered at risk because of human interference if these were counted under both the rarity and the threat of human interference criteria, the same factor would be counted twice (Margules & Usher, 1981).

### 7. Research & Educational:

A high species and habitat diversity within one area may provide a range of material which will enable more research projects to be undertaken than a less diverse area(Everett, 1979). Ratcliffe(1977) considers that accessibility, typicalness and previous studies on a site increase its value for research. Rare species and habitats, a possibility of extinction, are also of interest, as any information about them gathered through research may yield some particularly important feature which would otherwise be lost forever if extinction occured(Everett, 1979).

Typical areas are important as they can be used to demonstrate the principles of ecology and other environmental sciences. Ratcliffe(1977) points out the need for educational areas to be accessible in order to be used to any appreciable extent.

There is concern that heavy use of conservation reserves for field studies might prejudice their conservation value. All reserves have some extent of educational value which depends largely on factors such as proximity to educational institutions and accessibility(Margules & Usher, 1981).

### 8. Aesthetic:

Many species of wildlife are attractive and visually stimulating to watch. Some species attract a great deal more interest and thus have a greater aesthetic value than others (Moore, 1969; Helliwell, 1973; Racliffe, 1977; Everett, 1978). Generally the greater species and habitat diversity of an area the more

likely it is to be attractive and aesthetically pleasing to people(Everett, 1979).

9. Recorded History:

Recorded history is also a criterion which is of dubious value, because first, it cannot in any way be construed as an inherent characeristic of the site and, second, it is very difficult to measure or quantify(Goldsmith, 1983).

Recorded history is a criterion that has only limited use in site assessment(Usher, 1980). Ratcliffe(1977) states that the criterion should not be over-rated, but that it should add value to sites which would score highly on other criteria.

10. Potential Value & Intrinsic Appeal:

A reasonably accurate prediction of the course of ecological succession is needed to access potential value(Margules & Usher, 1981). Both potential value and intrinsic appeal rely heavily on the assessor's value judgements about how a site might develop or about public opinion(Usher, 1980). Intrinsic appeal is difficult to evaluate since it is concerned with the social aspects of conservation (Usher, 1980).

The potential value is essentially applied to sites which are undergoing some sort of change in land-use, and thus it would be particulraly suitable when considering such areas as qurries, some of which could bocome important conservation sites in the future (Usher, 1980). Presumably an appropriate management can increase the ecological value of a site(Goldsmith, 1983).

Ratcliffe(1977) used the criteria of 'intrinsic appeal' for site assessment and selection. Similarly, colorful wild flowers and rare orchids arouse more enthusiasm than insignificant liverworts.

## SITE SELECTION FOR THE DESIGN OF PROTECTED AREAS

The process of site selection involves three basic stages: recording the intrinsic site features; assessings comparative site quality, and choosing the national series of key sites. The following ten criteria used for site assessment and selection of reserves are size, diversity, naturalness, rarity, fragility, typicalness, recorded history, position in ecological/geographical unit, potential value and intricsic appeal(Table 1).

Evaluating and ranking natural areas in a standardinised fashion for acquisition is as essential as survey procedures and computer synthesis of survey data(Gehlbach, 1975).

In order to attain effective nature conservation, it is initially requires accurate methods of identifying sites most worthy of preservation and management as nature reserves (Dony & Denholm, 1985), and hence much recent effort by conservationists has been directed towards identifying criteria that should govern the choice of reserves (Diamond & May, 1976; Racliffe, 1977; Margules & Usher, 1981; Rebelo & Siegfried, 1992). The important physical and biotic factors affecting the growth and survival of species in natural terrestrial habitats(Table 6) are physical(site

Table 6. The major physical and biotic factors of a terrestrial plant habitat.

| |
|---|
| A. Physical (Site Characteristics) |
| 1. Photosynthetic photon flux density (light 'intensity') |
| 2. Temperature |
| 3. Soil-various chemical and physical parameters and depth |
| 4. Litter |
| 5. Natural disturbances-fire, windfalls, landslides, erosion, shoreline processes, etc. |
| 6. Topography-slope degree and aspect |
| 7. Hydrology |
| 8. Pollutants-NOx, $O_3$, $SO_2$, Hg, Pb, *etc.* |
| B. Biotic |
| 1. Other plants in the community |
| 2. Disease and insect outbreaks |
| 3. Predators |
| 4. Pollinators |
| 5. Human impacts-trampling, collecting |
| 6. Grazing, burrowing, and rooting |
| 7. Symbiotic relationships |
| 8. Exotic species |

Source: Baskin & Baskin, 1983

characteristics) and biotic (Baskin & Baskin, 1983).

The reasons for the creation of a reserve may be various: (1) the presence of one or several especially interesting communities, (2) the existence of a center of endemism, (3) the existence of a center of high species richness, (4) the imminence of extinction of a species or a group of species, (5) the presence of areas for spawning breeding or foraging, especially for migratory species, (6) the existence of beautiful landscapes of high tourist value, and (7) various political reasons (Rapoport *et al.*, 1986).

The selection of an area for preservation may also fit different criteria. We can concentrate on two main strategies: the conservation of the most typical communities or the conservation of the maximum species richness. The problem is that if the area to be preserved is relatively small, the maximum species richness is not always present in the most typical communities. Maximum diversity generally occurs in ecotones where two or more communities intergrade and where endemic or mainly ecotonal species may be present(Rapoport *et al.*, 1986).

Table 7. Principles for the choice of evaluation mehtod

| An Evaluation Method Should: |
|---|
| 1) Be based on principles and assumptions that are valid and easily illustrated |
| 2) Yield results understandable to decision makers and the public |
| 3) Make explicit subjective values and judgements |
| 4) Yield results that are repeatable given certain explicit assumptions |
| 5) Allow use of qualitative and quantitative information in a methodologically sound way |
| 6) Stimulate the imagination of decision makers and increase insight into the choice to be made |
| 7) Enable the use of information at different spatial scales |
| 8) Allow consideration of alternatives both seperately and in combination |

Source: Smith & Theberge, 1987

## Discussion and Conclusions

It is becoming increasingly apparent that species of conservation concern cannot be conserved as individual units abstracted from issues of habitat conservation and economic and social realities. Basing a strategy on the conservation of viable samples of different vegetation communities may be an efficient method of preserving the majority of species of in situ conservation(Hunter *et al.*, 1988).

To reduce the conflicts over land use and top slow or prevent the loss of species in Korea planners must become anticipatory, planning in advance of crises. A national strategy is required to safeguard the future of the most important plant habitats in the country ensuring a representative sample of habitat types and conserving endemic and threatened species.

Proposals: Within the context of a national biodiversity action plan a review of sites for botanical conservation be undertaken as part of a review of Korea's protected areas in accordance with the Biodiversity Convention and Agenda 21:

1. Using a national vegetation survey plan ensure that all vegetation types in Korea are represented as viable samples within protected areas, that where ever possible rep- resent viable ecosystem units.
2. Areas of particular diversity and endemism are identified within recognised biogeographical regions and protected areas established.
3. Particular locations *e. g.* groves of historically or genetically important species such as specimen trees are protected in smaller reserves. These areas to be specifically maaanaged to promote the conservation of plant genetic resources.
4. The design and management of protected areas should take into account regional land use patterns and consider the social and economic impacts of surrounding land use.
5. The distribution and status of Korea's threatened species be identified and a national database established to support the establishemnt of an integrated national botanical conservation strategy.

Rowe(1992) states "The primary concern becomes the maintenance of landscapes and

waterscapes as complete ecosystems..... instead of sharply focusing on the productivity of individual or competing resources.

## Literature Cited


Adamus, P. R. & G. C. Clough (1978) Evaluating Species for Protection in Natural Areas. Biological Conservation 13:165-178.

Anderson, J. E. (1991) A Conceptual Framework for Evaluating and Quantifying Naturalness. Conservation Biology 5(3):347-352.

Austin, M. A. & D. J. Miller (1978) Conservation. In Landuse on the South Coast of New South Wales:A Study in Acquiring and Using Information to Analyse Regional Land Use Options. Ed. by M. P. Austin & K. D. Cocks. Vol. 4. Land Function Studies. p. 169-195. Melbourne, CSIRO, Australia.

Baskin, J. M. & C. C. Baskin (1983) Some Considerations in Evaluating and Monitoring Populations of Rare Plants in Successional Environments. Natural Areas Journal 6(3):26-30.

Beaman, J. H., Henson, D., Bourdo, E. A., Pippen, R. W., Case, F. W., Reznicek, A. A., Crispin, S. R., E. G. Voss & P. W. Thompson (1985) Endangered and Threatened Vascular Plants in Michigan. II. Third Biennial Review Proposed List. The Michigan Botanist 24 (3):99-116.

Bradshaw, M. E. & J. P. Doody (1978) Plant Population Studies and Their Relevance to Nature Conservation. Biological Conservation 14:223-242.

Bratton, S. P. & P. S. White (1980) Rare Plant Management-After Preservation What ? Rhodora 82:49-75.

Brotherton, D. I. (1975) The Development and Management of Country Parks in England and Wales. Biological Conservation 7:151-154.

Butler, G., L. Meredith & M. Richardson (1991) Conservation of Rare or Threatened Plants in Australasia. Proceedings of the Conference Protective Custody? - Ex Situ Plant Conservation in Australasia, March 1991. 211 pp.

Diamond, J. M. (1975) The Island Dilemma: Lessons of Modern Biogeographic Studies for the Design of Natural Reserves. Biological Conservation 7:129-146.

Diamond, J. M. & R. M. May (1976) Island Biogeogarphy and the Design of Natural Reserves. In Theoretical Ecology:Principles and Applications Ed. by R. M. May. pp. 163-186. Blackwell, Oxford.

Dony, J. G. & I. Denholm (1985) Some Quantitative Methods of Assessing the Conservation Value of Ecologically Similar Sites. Journal of Applied Ecology 22:229-238.

Dory, M. A. G. (1977) Covadonga National Parks, Austuria, Spain. Its History, Conservation Interest and Management Problems. Biological Conservation 11:79-85.

Drury, W. H. (1974) Rare Species. Biological Conservation 6:162-169.

DuMond, D. M. (1973) A Guide for the Selection of Rare, Unique, and Endangered Plants. Castanea 38(4):387-395.

Everett, R. D. (1978) The Wildlife Preference Shown by Countryside Visitors. Biological Conservation 14:75-84.

Everett, R. D. (1979) The Functions of Wildlife and Their Possible Use for Deriving Site Selection Components. Biological Conservation 16(3):207-218.

Fleming, C. A. (1975) Scientific Planning of Reserves. Forest and Bird 196:15-18.

Gehlbach, F. R. (1975) Investigation, Evaluation, and Priority Ranking of Natural Areas. Biological Conservation 8:79-88.

Given, D. R. (1976) A Register of Rare and Endangered Indigenous Plants in New Zealand. New Zealand Journal of Botany 14:135-149.

Goldsmith, F. B. (1975) The Evaluation of Ecological Resources in the Countryside for Conservation Purposes. Biological Conservation 8:89-96.

Goldsmith, F. B. (1983) Evaluating Nature. In A. Warren & F. B. Goldsmith (Edited). Conservation in Perspective. John Wiley & Sons, Ltd. p. 233-246.

Goodman, D. (1975) The Theory of Diversity-Stability Relationships in Ecology. Quartely Review of Biology 50: 237-265.

Gotmark, F. & C. Nilsson (1992) Criteria Used for Protection of Natural Areas in Sweden 1909-1986. Conservation Biology 6(2): 220-231.

Helliwell, D. R. (1969) Valuation of Wildlife Resources. Regional Studies 3: 41-47.

Helliwell, D. R. (1973) Priorities and Values in Nature Conservation. Journal of Environmental Management 2: 51-74.

Hooper, M. D. (1971) The Size and Surroundings of Nature Reserves. In Duffey, E. & A. S. Watt. (Edited) The Scientific Management of Animal and Plant Communities in Conservation. pp. 555-561. Blackwell Scientific Publications, Oxford.

Hunter, M. , G. L. Jacobson & T. Webb (1988) Paleoecology and the Coarse-Filter Approach to Maintaining Biological Diversity. Conservation Biology 2(4): 375-385.

Illinois Nature Reserves Commission (1973) Comprehensive Plan for the Illinois Nature Preserves System. Part. 1 and 2. Rockford, Illinois.

Johnson, M. P. & P. H. Raven (1970) Natural Regulation of Plant Diversity. Evolutionary Biology 4:127-162.

Kim, Y. S. (1994) The Neccesity of Evaluation Criteria Selections for Korean Rare and Endangered Plant Species. Journal of Korean Applied Ecology 8(1):Printing.

Kim, Y. S. & T. W. Kim (1990) The Conservation of Rare and Endangered Plants and the Role of Botanic Gardens and Arboreta in Korea. Bulletin of Kwanak Arboretum, Seoul National University 15(2-1):33-47.

Koh, K. S. , D. I. Choi, J. O. Bae, S. W. Chung, D. H. Kim, I. A. Huh, J. B. Lee & Y. M. Lee (1991) The Conservation of Legally Protected Wildlife and Plants (II). NIER No. 91-02-302. 94 pp.

Mace, G. M. & R. Lande (1991) Assessing Extinction Threats: Toward a Reevaluation of IUCN Threatened Species Categories. Conservation Biology 5(2):148-157.

Mack, A. , W. P. Gregg, S. P. Bratton & P. S. White (1983) A Survey of Ecological Inventory, Monitoring, and Research in US National Park Service Biosphere Reserves. Biological Conservation 26:33-45.

Margules, C. (1980) A Study of the Assessment of Potentital Conservation Sites, Duplicated Report, Dept. of Biology, Univ. of York. 20 pp.

Margules, C. & M. B. Usher (1981) Criteria Used in Assessing Wildlife Conservation Potential: A Review. Biological Conservation 21:79-109.

Menges, E. S. (1983) Predicting the Future of Rare Plant Populations: Demographic Monitoring and Modeling. Natural Areas Journal 6 (3):13-25.

Miller, R. S. & D. B. Botkin (1974) Endangered Species: Models and Predictions. The American Scientists 62:173-181.

Moore, N. W. (1969) Experience with Pesticides and the Theory of Conservation. Biological Conservation 8: 239-250.

Morse, L. E. & M. S. Henifin (Edited) (1981) Rare Plant Conservation: Geographical Data Organization. The New York Botanical Garden, Bronx, New York, U. S. A. 370 pp.

Noss, R. F. (1977) Protecting Natural Areas in Fragmented Landscape. Natural Areas Journal 7:2-13

Owen, J. S. (1972) Some Thoughts on Management in National Parks. Biological Conservation 4:241-246.

Patten, D. T. (1991) Human Impacts in the Greater Yellowstone Ecosystem: Evaluating Sustainability Goals and Eco-redevelopment. Conservation Biology 5(3):405-411.

Peterken, G. F. (1974) A Method for Assessing Woodland Flora for Conservation Using Indicator Species. Biological Conservation 6(4) :239-245.

Ploeg, S. W. F. Van Der & L. Vlijm (1978) Ecological Evaluation, Nature Conservation and Land Use Planning With Particular Reference to Methods Used in the Netherlandes. Biological Conservation 14:197-221.

Prescott-Allen, R. (1984) Threatened Habitats: The Challenges for Humanity. In Conservation of Threatened Natural Habitats (Eds. Hall, A. V.). South African National Scientific Programmes Report No. 92. p. 16-45.

Ranwell, D. S. (1969) A Semi-quantitative Index for Comparative Biological Value of Sites. Norwich, Coastal Ecology Research Station.

Rapoport, E. H., G. Borioli, J. A. Monjeau, J. E. Puntieri & R. D. Oviedo (1986) The Design of Nature Reserves: A Simulation Trial for Assessing Specific Conservation Value. Biological Conservation 37:269-290.

Ratcliffe, D. A. (1971) Criteria for the Selection of Nature Reserves. Advancement of Science, London 27:294-296.

Ratcliffe, D. A. (1977) A Nature Conservation Review. Cambridge University Press. Vol. 1:6-10.

Rebelo, A. G. & W. R. Siegfried (1992) Where Should Nature Reserves Be Located in the Cape Floristic Region, South Africa? Models for the Spacial Configuration of a Reserve Network Aimed at Maximising the Protection of Floral Diversity. Conservation Biology 6(2) :243-252.

Rowe, R. (1992) Trochetiopsis: Towards the Conservation of the Genus (Unpublished). 66pp.

Scott, J. M., B. Csuti, J. D. Jacobi & J. E. Estes (1987) Species Richness: A Geographic Approach to Protecting Future Biological Diversity. BioScience 37(11):782-788.

Smith, P. G. R. & J. B. Theberge (1986) A Review of Criteria for Evaluating Natural Areas. Environmental Management 10(6):715-734.

Smith, P. G. R. & J. B. Theberge (1987) Evaluating Natural Areas Using Multiple Criteria: Theory and Practice. Environmental Management 11(4):447-460.

Soule, M. E. & D. Simberloff (1986) What Do Genetics and Ecology Tell Us About the Design of Nature Reserve? Biological Conservation 35:19-40.

Spellerberg, I. F. (1981) Ecological Evaluation for Conservation. Studies in Biology No. 133:1-60.

Stone, E. C. (1965) Preserving Vegetation in Parks and Wilderness. Science 150:1261-1267.

Tans, W. (1974) Priority Ranking of Biotic Natural Areas. The Michigan Botanist 13:31-39.

Terbough, J. (1974) Preservation of Natural Diversity: The Problem of Extinction Prone Species. BioScience 24:715-722.

Tubbs, C. R. & J. W. Blackwood (1971) Ecological Evaluation of Land for Planning Purposes. Biological Conservation 3(3): 169-172.

Usher, M. B. (1980) An Assessment of Conservation Values Within a Large Site of Special Scientific Interest in North Yorkshire. Field Studies 5:323-348.

Usher, M. B. (Edited) (1986) Wildlife Conservation Evaluation. Chapman & Hall, London. 393 pp.

van der Ploeg, S. W. F. & L. Vlijm (1978) Ecological Evaluation, Nature Conservation and Land Use Planning with Particular Reference to Methods Used in the Netherlands. Biological Conservation 14:197-221.

Vane-Wright, R. I., C. J. Humphries & P. H. Williams (1991) What to Protect?-Systematics and the Agony of Choice. Biological Conservation 55:235-254.

Ward, S. D. & D. F. Evans (1976) Conservation Assessment of British Limestone Pavements Based on Floristic Criteria. Biological Conservation 9:217-233.

Western, D. & M. Paul (1989) Conservation for the Twenty First Century. Oxford University Press, Oxford. 365pp.

Willis, E. O. (1974) Populations and Local Extinctions of Birds on Barro Colorado Island, Panama. Ecological Monograph 44:153-169.

Woo, B. M. (1990) Status of Management of the Protected Areas in the Republic of Korea. Paper No. 13, Delivered at FAO Conference: Regional Expert Consultation on Management of Protected Areas in the Asia-Pacific Region, 10-14 December 1990, Bangkok, Thailand. 43 pp.

Wright, D. F. (1977) A Site Evaluation Scheme for Use in the Assessment of Potential Nature Reserves. Biological Conservation 11:293-305.

Wright, D. H. (1990) Human Impacts on Energy Flow Through Natural Ecosystems, and Implications for Species Endangerment. Ambio 19:189-194.

Yapp, W. B. (1973) Ecological Evaluation of a Linear Landscape. Biological Conservation 5:45-47.