Technical Report No. 26

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION, A CONCEPT AND SYMPOSIUM

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PREFACE

The following report relates to the organization, conceptual development and execution of a symposium held at the Pacific Science Association Inter-Congress in Guam, May 20-25, 1973. The symposium theme, NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION, has a direct bearing on the international relationships of the ISLAND ECOSYSTEMS IRP of the U. S. IBP. Looking beyond our current involvement with ecosystems research in the Hawaiian Islands, it becomes increasingly necessary to develop a framework within which our results can be extrapolated to other areas in the Pacific. The Guam symposium provided a platform for initiating such a framework on an international level.

ABSTRACT

This report presents the concept and proceedings (in form of abstracts) of an international symposium of the Ecology Section of the Scientific Committee on Pacific Botany held at the Second Inter-Congress of the Pacific Science Association in Guam, May 20-25, 1973.

The concept for a natural area system in the Pacific Region is developed through a brief problem analysis, a statement of objectives, an assessment of the criteria for natural areas to be included in the system and through proposing a hierarchical system for assembling the necessary information. The symposium theme is structured into six subthemes concerned with (1) Conceptual aspects, (2) Geographic and climatic analyses of natural areas in different Pacific countries, including a show of maps, (3) Analyses of community- and habitat-variation within major reserves, (4) Biogeographic similarity- and difference-evaluation between ecological reserves, (5) Human influences and protection status of each area, and (6) The need for additional areas to be considered in the system. Twenty-two abstracts are enclosed from participants in South America, New Zealand, Australia, New Caledonia, Fiji, Indonesia, Singapore, Malaysia, Thailand, Taiwan, Japan, California and Hawaii.

An international orientation towards developing a natural area system and with this, a scientific basis for the extrapolation of results of ecosystems research in the Pacific Region falls into the broader objectives of the ISLAND ECOSYSTEMS IRP of the U. S. International Biological Program. A follow-up program is suggested for the 13th Pacific Science Congress in Vancouver, August 18-30, 1975.

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ESTABLISHED 1920

PACIFIC SCIENCE ASSOCIATION

Honolulu, Hawaii
November 3, 1972

Pacific Science Association Inter-Congress Meeting in Guam, May 20-25, 1973

PROGRAM OF ECOLOGY SECTION

OF STANDING COMMITTEE ON PACIFIC BOTANY

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

1. THE CONCEPT OF A PACIFIC NATURAL AREA RESERVES SYSTEM: brief introduction, why a system of natural areas or ecological reserves, i.e., to establish the criteria for reserves and for national and regional adequacy, defining of ecological regions.

2. GEOGRAPHIC AND CLIMATIC ANALYSES: Part A, geographic analysis; a show of ecological reserves on National overview maps by country (mean scale 1 : 1 million, but ranging from 1 : 500,000 to 1 : 5 million, depending on availability), extending coverage by "UNESCO resume of Parks" as produced by IUCN, also by IBP/CT checksheet information summary of Pacific research areas as far as available. Part B Climatic and environmental stress factor analysis; (1) establishment of the macroclimate of each ecological reserve through climatic data inventory and representation in form of climate diagrams. At least one for each natural area should be prepared. Second emphasis on climatic extremes, (2) the same for each country as an overview of its climatic diversification.

3. ANALYSES OF COMMUNITY- AND HABITAT-VARIATION WITHIN SELECTED ECOLOGICAL RESERVES: by use of aerial photographs, presentation of large scale (1 : 5,000 to 1 : 50,000) vegetation maps, floristic sample stand analyses in tabulated form, analysis of environmental correlations; presentation of large scale environmental maps, where available; topographic and other kinds of vegetation and habitat profiles as a means of area and map interpretation.

4. BIOGEOGRAPHIC SIMILARITY- AND DIFFERENCE- EVALUATION BETWEEN ECOLOGICAL RESERVES: by checklists of species of plants and animals with identification of their life forms, designation of dominant species and rare and endangered species, with extension through IUCN "Red Book" data.

5. HUMAN INFLUENCES AND PROTECTION STATUS OF EACH AREA: identification of stress factor extremes (natural and man-made). Tie-in to the additional objectives of the MAB program of UNESCO, establishment of priorities.

6. NEED FOR ADDITIONAL AREAS TO BE CONSIDERED IN THE SYSTEM: definition of a balanced system.

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION: A CONCEPT[1]

INTRODUCTION

At this moment in history we are still fortunate in enjoying the coexistence of a relatively large array of natural areas in the Pacific Region. However, the time has come in which the future existence of many scientifically important natural landscape units or ecosystems is threatened by land development for the material progress of mankind. We are here to take positive steps that this progress in land development will not destroy at least those natural areas that we consider from an ecological viewpoint essential for future maintenance.

We envision a SYSTEM of natural areas for the Pacific region. This implies the establishment of a GEOGRAPHIC NETWORK of natural areas or ecological reserves. The network idea carries the charge of searching for natural area relationships in a meaningful ecological and scientific context. Included in this system would be small oceanic islands, natural (i.e., relatively unmodified) areas of defined limits on larger oceanic and continental islands and ecological reserves on the continental fringes of the Pacific Region. The Pacific Region extends over a hemisphere of ocean with widely and variously separated terrestrial aggregates. Establishment of a natural areas reserves system in this region is a task for which we can make an important start, but which will hardly ever be completed. This is so because as we begin to study the relationships between and within Pacific areas, we come to discover more and more unknown elements of ecogeographic importance. It is particularly for this reason, that we need to begin now to systematically secure an adequate number and geographic distribution of natural areas, because these areas and their comparative analyses represent a resource of

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[1]Introductory paper to Natural Area Symposium presented at the Pacific Science Association Inter-Congress Meeting in Guam, May 20-25, 1973.

knowledge that will never be depleted, if we are able to secure their protection now.

THE PROBLEMS AND METHODS IN DEVELOPING A SYSTEM

The problems in developing a system of natural areas fall into two groups:

(a) political and administrative problems

(b) scientific problems

There was a time when field biologists had to be concerned only with the scientific problems because there was no imminent danger that natural areas of interest for scientific study would disappear. However, this situation has changed. Now, scientists have to be concerned also with political and administrative problems if a natural area system is to be developed.

For this reason, our symposium contains a mix of political-administrative and scientific addresses. This combination may not entirely satisfy either the purely scientifically minded or the more administratively oriented person, and one could think of perhaps divorcing the two aspects into two separate meetings. However, this would surely be unwise as we need very definitely the closest intercommunication of administratively able and scientifically interested minds to establish a natural area system for the Pacific Region.

Such a combined method is used also by the three International organizations that so far have been most active in promoting the natural area concept in the Pacific Region. These are IUCN (International Union for the Conservation of Nature and Natural Resources), UNESCO and IBP (the International Biological Program). Each of these organizations has produced published accounts that are of immediate concern to the efforts of this symposium. These are in the same order:

1. The IUCN draft for the Island for Science Convention published in the 1971 yearbook of IUCN.

Using the United Nations as a mechanism, the Convention intends to establish a

"List of Islands of International Importance to Science" that will come under the legal protection and scientific management of an Advisory Committee. This Advisory Committee would be elected by the Nations having the sovereignty over these islands. The Committee also would examine and rule on proposals for scientific research to be undertaken.

This convention was drafted at the South Pacific Regional Symposium on Conservation of Nature-Reefs and Lagoons in Noumea, New Caledonia, August 1971. It was discussed at the 12th Pacific Science Congress in Canberra and again at the UN Conference on the Human Environment in Stockholm, June 1972. Subsequently, the draft was circulated to all member nations for comment.

At this time, the outcome of the draft convention is not yet known. However, it seems clear that other methods involving the thought-coordination of scientists of the International Pacific community must be tried simultaneously if a Pacific Natural Area System is to be established.

2. The UNESCO program of MAB (Man and the Biosphere).

This emerging UNESCO program, which can be considered the successor of IBP, has included among its 13 projects described in the Final Report of February 1972 as Project No. 8 "Conservation of natural areas and of the genetic material they contain; and (also of considerable concern to the oceanic region of the Pacific) Project No. 7 "Ecology and rational use of island ecosystems."

Thus, our efforts are very closely complementary to essential parts of the MAB program and we can be assured that our deliberations are of interest to UNESCO.

3. The IBP with its CT (Conservation of Terrestrial Ecosystems) Section under the chairmanship of Mr. E. M. Nicholson.

Efforts of this group include a "Checklist of Pacific Oceanic Islands" compiled by Gina Douglas (1969). This checklist is of considerable interest and will be an important reference for the development of a natural area system for the Pacific Region.

OBJECTIVES FOR ESTABLISHING A SYSTEM

Much has been said in recent years on the value of and need for maintaining and protecting natural areas. Three objectives stand out as more or less generally accepted (e.g. see Doty et al. 1969, Franklin et al. 1972, Moir 1972):

(1) The use of natural areas as controls or baselines for comparing the effect of man's influence on the commercially utilized portion of the same landscape.

(2) The use of natural areas as reserves of locally adapted species and for the maintenance of their diversity for possible future genetic exploitation.

(3) The use of natural areas for continued study of as yet unknown or insufficiently known processes and species interactions that may further elucidate management practices and provide deeper insights into the principles that govern life on earth.

However, the matrix of objectives is increased several times if we consider the values gained from comparative analyses of natural areas in different geographic locations, i.e., from their use as a system. Here I would like to restate, only slightly modified, ten objectives that appeared in an earlier publication by Doty, Fosberg and Mueller-Dombois (1969) as a preparation for IBP study sites in the Pacific Region. A system of natural areas will permit the elucidation of such important scientific and practical questions as:

1. The origin and adaptation of the peoples in the Pacific Basin.
2. The origin and evolution of the faunas and floras.
3. The origin and selection of the principal economic species and their ecological tolerances and adaptability.
4. The origin, development and stability relations of the major ecosystems in the Pacific Region.

5. The comparative utilization of environmental resources of structurally similar biotic communities occurring at different geographic points in the Pacific Region.
6. The comparative utilization of the environmental resources of recent volcanic and ancient physiographic environments by their biotic communities.
7. The adaptive strategies of ecologically similar species groups (i.e., functional groups) in ecosystems belonging to different biogeographic provinces or occurring in differing degrees of geographic isolation.
8. The comparative energy pathways and production efficiencies of ecosystems in similar climatic regimes but occurring in different biogeographic sections of the Pacific.
9. The comparative suitability of the principal Pacific Region ecosystems as human habitat.
10. The approaches to conservation of these ecosystems, both as wholes and as particular components especially important to man.

The list of specific objectives could easily be extended and refined, but it may be clear from the examples cited that a very great potential of new scientific and practical information can be uncovered through comparative analyses of selected natural areas in the Pacific Region once these are known and safeguarded as a system.

CRITERIA FOR NATURAL AREAS TO BE INCLUDED IN THE SYSTEM

A definition

A natural area can be defined as a site or unit of landscape containing biological populations or species that arrived on this site by natural means and where technological man had no major direct influence on the spacing, sociological interaction and composition of the species. This definition excludes plantations,

gardens, lawns, agricultural crop fields and such like. However, when an agricultural field is abandoned, it will revert into a natural area unless it is recultivated. Old-field vegetation, like forests reestablished after logging, are so-called "secondary" vegetations. These usually do not provide for prime examples of natural areas.

Preferred as natural areas, because of their much higher multiple scientific use-value, are areas with "primary" or original vegetation. However, such areas are extremely rare and we may therefore modify the idea of "preferred" natural areas as harboring those vegetations and associated biota that are of relatively long-term stability within a particular climatic zone. Such vegetations can be called climax communities or zonal vegetations. But different kinds of stable vegetations are usually found in one climatic zone and all of these may be desirable as natural area examples. Transitory, or changing vegetations may also be of value for more special purposes, but attempts to arrest certain successional communities may require knowledge and management.

We may therefore say that the more generally valuable natural areas are those that contain relatively stable biological communities, which are in balance with the prevailing natural factors (climate, soil, native animals under natural control) and on which the influence of technological man is and has been at a minimum.

Categories and Sizes

We found it useful in the Hawaiian Islands to consider two categories of natural areas:

(a) representative

(b) unique

(a) A representative natural area would be a sample of a more wide-spread larger type of ecosystem that may still or may have once existed in the general

area. Samples of zonal vegetation would fall into this category.

An ecosystem sample to remain representative must be large enough to contain the typical structure, species composition and the home range of the principal animal species. Preferably, the area should be surrounded by a buffer zone to avoid erosion of the features for which the area was selected. The actual minimum size required depends, on the home range of the principal animals, such as forest birds, on the species/area relationship and on the self-maintenance or stability parameters of the ecosystem. Some such areas may be as small as 200 acres (80 ha) or smaller.

(b) A unique natural area would be an area containing species or groups of species that occur only in this particular area. Unique natural areas may be established for the purpose of protecting an endangered species. Such areas, to protect a rare plant species, may be as small as an acre or even less. Others, to protect a unique large mammal, may require a minimum size of 10,000 ha (*i.e.*, 10 km x 10 km).

Number and distribution

A good natural area system should have samples of all principal ecosystems that belong to the geographic network under consideration. There is no limit on the number of areas to be considered. At least each bioclimatic zone should contain an example of the zonal vegetation. Ideally, each major landscape unit or drainage basin should have a protected natural area, if the first purpose--that of its function as a baseline or control area--is to be fulfilled. In mountainous terrain it appears most efficient to select natural areas in the form of wide belt-transects that cut through a maximum of altitudinal variation. The same applies to lowland areas in which a gradual shift in the physical environment, such as a rainfall gradient or an edaphic gradient, produces a corresponding shift in the natural vegetation cover.

Of course, it may not always be possible to include natural areas in continuous belt transects. An alternative is the layout of smaller natural areas along major gradients. This idea can be applied at all geographic scales. For example, in considering the Pacific Region as a whole, we may look for natural areas along transects or gradients, which at this scale would include major biogeographic as well as climatic gradients. Beyond these considerations, provision should be made for a balanced geographic distribution of natural areas that can be considered representative for the region as a whole.

Protection status

A more practical criterion for natural areas to be included in the system is whether the area in question can receive a reasonable degree of protection. Some areas may be immediately disregarded on this basis, while others may receive major attention and a combined effort from our group, UNESCO and IUCN may be necessary to achieve its recognition for governmental protection. There is little point in establishing an ideal system of natural areas if many of the areas have a totally uncertain future. Of course, this is the major reason for this symposium, i.e., not merely to establish the value of natural areas, but to work towards developing a system, of which the individual areas should receive the international and national recognition necessary that local governmental action will eventually result in their safeguarding for permanence.

A HIERARCHICAL SYSTEM FOR ASSEMBLING THE INFORMATION

Perhaps the most powerful tool for arranging a natural area system for the Pacific Region are maps on which the natural areas are shown. A great deal of official recognition may be obtained once natural areas or ecological reserves are mapped on official topographic maps. In the meantime, working through subregional

or individual Pacific country and National Committees for establishing a natural area system, we can advance the process by the preparation of a "shopping list" of natural areas.

For recognizing a collection of Pacific natural areas as a system, we must be able to present them at different levels of geographic scale. The following four levels appear to be sufficient:

Level 1: Very small-scale maps for general overview.

This scale would include standard wall- and atlas maps of the Pacific Region, which range in scale from 1:50 million to 1:10 million. The Denoyer-Geppert wall map of the Pacific Region (shown here) is an example. Its scale is 1:15,000,000 (i.e., 1 cm on the map represents 150 km in nature). An ecological map in this scale range is the one of Fosberg (1960) entitled "Natural Areas of Micronesia as indicated by Vegetation and Physiography." This map (FIG. 1) is published at the scale of 1:29.5 million (i.e., 1 cm corresponds to 295 km in the field). On Fosberg's 1960 map all mappable islands of Micronesia are considered as natural areas. This may pose a question that I will attempt to answer below. The map includes introductory ecological information on Micronesia. It shows which island group is in a more or less continuously wet climate and in which direction the climate becomes seasonal or dryer. It also shows which island group is affected by the Monsoon climate. Moreover, several significant geomorphological zones are shown, such as, islands on elevated limestone, others on metamorphic rock (Yap); it shows an age separation of volcanic materials in the Marianas and a significant vegetation boundary with regard to the occurrence of swordgrass (*Miscanthus floridulus*), which appears to be restricted to the Marianas.

The example of Fosberg's map shows that useful ecological information can be conveyed already from very small scale maps. For the development of a natural area system for the Pacific Region such maps can be further refined, for example,

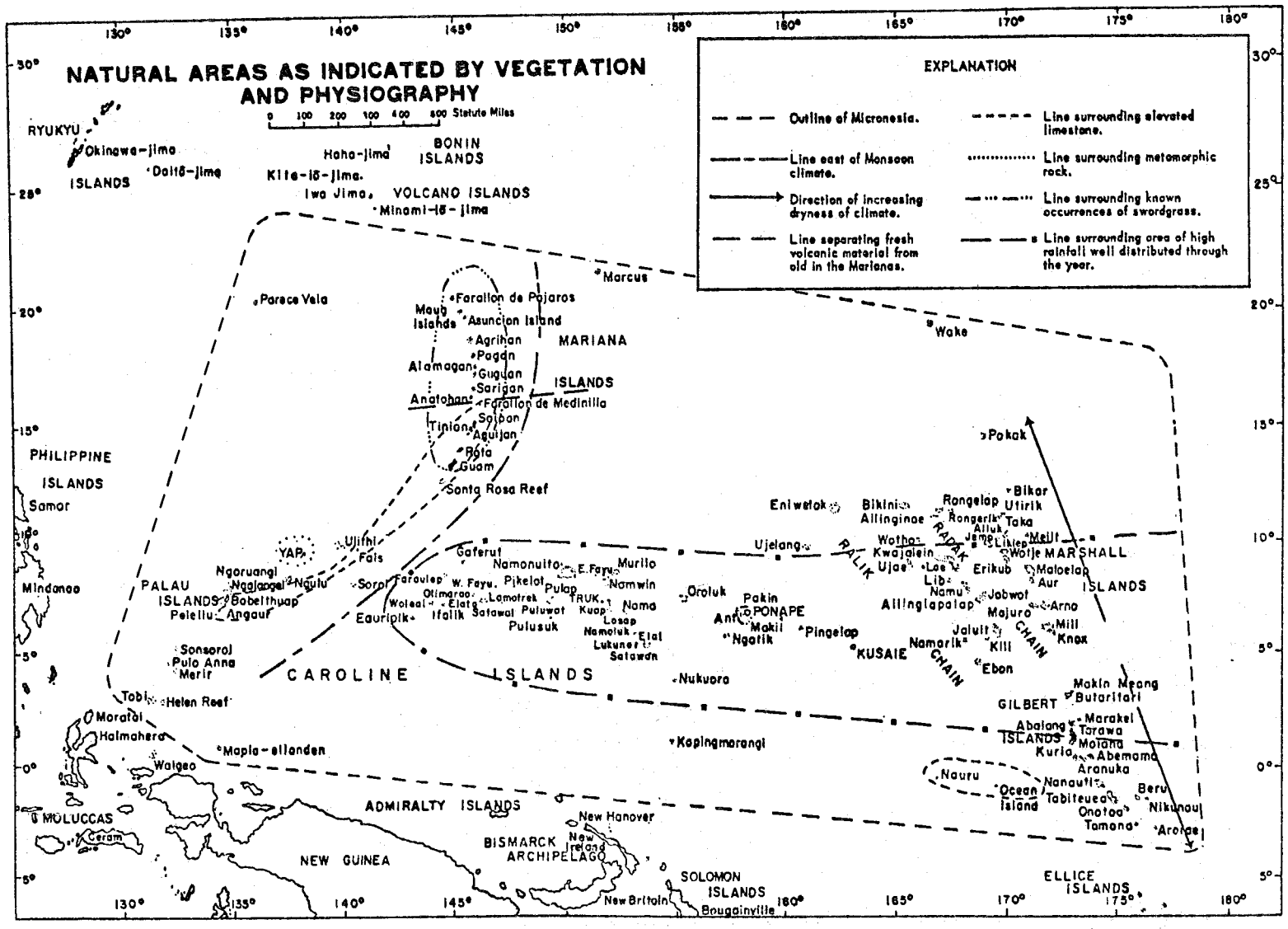

FIG. 1. Natural areas of Micronesia as indicated by vegetation and physiography. (Xeroxed with permission from Fosberg 1960).

by plotting climate diagrams according to the method of Walter (1957, 1960*, 1971) and by marking more complete vegetation zones and phenological information. A second map would be required that shows protected natural areas. For this we may have to develop a classification expressing the kind and degree of protection given to the natural area in question.

Level 2: Small scale maps for a more detailed overview, i.e., individual country or island-group maps.

The map scale for these would range from 1:10 million to 1:1 million. This scale is generally used for mapping vegetation zones, i.e., areas of potential natural vegetation. An example is Krajina's (1969) map of the "Biogeoclimatic Zones of British Columbia," published at the scale of 1:5.5 million (i.e., 1 cm on the map corresponds to 55 km). This map shows 11 ecological zones. Another example is Knapp's (1965) map of the Hawaiian Islands, which shows 7 ecological zones. This map is published at the scale of 1:2.5 million (for Hawaii) and 1:1.7 million (for the other large islands).

Areas of actually existing zonal vegetations can be marked by stars or points on such maps. In this way a natural area system for each Pacific Subregion or country and island group could be prepared.

Level 3: Intermediate-scale maps for closer regional or subregional orientation.

Their scale range would be from 1:1 million to 1:100,000 (1 cm on the map = 1 km in the field). Such maps may permit already mapping of structurally and broadly floristically defined vegetation units. An example is the "Generalized Vegetation Map of Ruhuna National Park, Ceylon" (Mueller-Dombois 1972) published at 1:138,000. Another example is the "Vegetation Zones of Hawaii" map of Ripperton and Hosaka (1942), published at the scale of 1:370,000 (for island of Hawaii) and

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* A climate-diagram map for the Pacific Region is available at 1:50 million as part 7, 2 of the Walter & Lieth Klimadiagramm Weltatlas.

at 1:225,000 (for other large islands). Maps at this scale may be useful for local natural area administration as they can be used to show administrative subunits in a local natural area system, such as for example, strict natural reserves, research natural areas, wildlife sanctuaries, natural areas for public recreation and general access without permit, etc.

Level 4: Large-scale maps for within-natural area analysis and comparisons. These maps are usually established for research purposes and detailed inventories. They include maps at the scale of 1:100,000 to 1:10,000 (1 cm on map = 100 m in the field). Such maps require months or years for preparation, and when established may show the diversity and distribution of plant communities and habitats within specific nature reserves of natural areas. Such maps are extremely important starting points for all kinds of biological research and management. An example is the 1:32,000 vegetation map of Ruhuna National Park, Ceylon (Mueller-Dombois 1967) that was used for periodic animal activity surveys, location of floristic and permanent sample plots, soil surveys, etc. Such maps are often easier to interpret, if supplied with profile diagrams.

As an action program of the Ecology Section, we may proceed with mapping Pacific natural areas at these 4 different levels of geographic scale. However, because of the urgency for developing a Natural Area System for International Recognition and legal safeguarding, we may give at this time higher priority to natural area map preparation at the smaller scales.

The most important mapping scale for the development of a Pacific Natural Area System appears to be that at Level 2, i.e., ecological zone maps for individual countries or island groups between 1:10 million to 1:1 million. From these we can develop a "shopping list" of natural areas to be presented to local or regional governments for legal protection. These maps can also serve to compile a Natural Area System map for the Pacific Region as a whole, which by necessity must be

prepared at the much smaller scale range of Level 1 (i.e., 1:10 million to 1:50 million).

If we acknowledge the high priority for the development of a Natural Area System for the Pacific Region, we should concentrate from now to the 1975 Vancouver Congress on the preparation and refinement of Level 2 and Level 3 maps of ecological zones in our own geographic region together with an identification of all natural areas that we consider essential for safeguarding. Preparation of these maps should involve a thorough literature survey and an effort to integrate previous attempts into a logical ecological zonation scheme that have a maximum of information value.

ESTABLISHED 1920

PACIFIC SCIENCE ASSOCIATION

Honolulu, Hawaii
March 30, 1973

Pacific Science Association Inter-Congress Meeting in Guam, May 20-25, 1973

PROGRAM OF ECOLOGY SECTION

OF STANDING COMMITTEE ON PACIFIC BOTANY

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

(Third and Final Announcement: Sequence of speakers and topics. An asterisk indicates that the person will probably be present. See further explanation below)

Theme 1. THE CONCEPT OF A PACIFIC NATURAL AREA RESERVES SYSTEM

A *D. Mueller-Dombois (USA, Hawaii) Conceptual introduction

A *Harold J. Coolidge (USA) Future role of parks and ecological reserves on Pacific islands as a natural area system (Abstract promised)

A *Mildred E. Mathias (USA, California) Natural areas for teaching and research (Abstract received)

A M. Numata (Japan) Development of a natural area system in Japan (Dr. Numata will send a summary)

J. B. Alvarez (Philippines) The national park system concept in the Philippines

Theme 2. GEOGRAPHICAL AND CLIMATIC ANALYSES (A SHOW OF MAPS)

A Thelma Richmond (Fiji) Geography and climatic relationships of nature reserves in Fiji (Abstract received)

A *Kuswata Kartawinata (Indonesia) Geographic and climatic analysis of a nature reserve system in Indonesia (Abstract received)

A R. E. Soeriaatmadja (Malaysia) Natural reserves in Malaysia and their development into a system (Abstract received)

A V. J. Chapman (New Zealand) Scientific reserves in New Zealand and its outlying islands (Abstract received)

A = Abstract enclosed

A *Willem Meijer (USA) A natural areas development system for Sabah-Malaysia (Abstract received)

A *A. T. Abbott (USA, Hawaii) Geomorphic landmarks as natural areas in the Hawaiian islands (Abstract promised)

A *V. T. Liu (Taiwan) The natural area reserves of Taiwan and their relation to the Pacific natural area reserve system (Abstract expected soon)

J. A. R. Anderson (UK) Nature reserves and their ecological relations in Sarawak (Did not yet respond to Second Announcement of January 18, 1973)

Theme 3. ANALYSES OF COMMUNITY- AND HABITAT-VARIATION WITHIN MAJOR RESERVES

A V. J. Chapman (New Zealand) Ecological variation within major research areas of New Zealand (Abstract received)

A *A. N. Rao (Singapore) Environmental limitations as related to growth, reproduction and maintenance of forest vegetation in Singapore (Abstract received)

A *T. Jaffre (New Caledonia) Floristic and structural variation in the Boulinda Mountain range, New Caledonia (Suggested by M. Schmid to come in his place as representative of ORSTOM)

J. A. Bullock (UK) The IBP-PT study of tropical lowland rain forest in West Malaya (Did not yet respond to Second Announcement of January 18, 1973)

L. J. Webb (Australia) Natural area classification problems in Australia (Very tentative)

Theme 4. BIOGEOGRAPHIC SIMILARITY- AND DIFFERENCE-EVALUATION BETWEEN ECOLOGICAL RESERVES

A *M. H. Sachet and F. R. Fosberg (USA) The Marquesas in Pacific biogeography (Abstract received; Dr. Fosberg will not be present)

A *C. K. Wang (Taiwan) Biogeographic relationships of the rare strand vegetation of Taiwan (Abstract received)

A *Tem Smitinand (Thailand) Biogeographic comparison of ecological reserves in Tailand (Abstract received)

A Kai Curry-Lindahl (UNESCO) Zoogeography in the Pacific region and the function of ecological reserves (Abstract received; Dr. Curry-Lindahl will not be present)

A J. D. Ovington (Australia) On the measurement of diversity in different ecological situations (Abstract received)

Theme 5. HUMAN INFLUENCES AND PROTECTION STATUS OF EACH AREA

A *C. H. Lamoureux (USA, Hawaii) A comparison of human influences and protection status of ecological reserves in Indonesia and Hawaii

A Maria Buchinger (Argentina) Remnant natural areas along the South American Pacific Coast and the human impact problem (Abstract received)

Otto Soemarwoto (Indonesia) The conflict between development and conservation in Indonesia: How can this be resolved? (Did not yet respond to Second Announcement of January 18, 1973)

*T. Hosokawa (Japan) Protection status of nature and human influenced vegetation remaining against land utilization for industry in Kyushu, Japan

Theme 6. NEED FOR ADDITIONAL AREAS TO BE CONSIDERED IN THE SYSTEM

A *W. L. Theobald (USA, Hawaii) The U. S. National Park Service program in the Pacific

*D. Mueller-Dombois (USA, Hawaii) Conclusions

EXPLANATIONS

1. Present indications are that at least 15 speakers will participate at the Guam workshop, namely those indicated by an asterisk.

2. We hope that one or two of the remaining tentative participants will come to the meeting. However, it would be unrealistic to expect several more because of the unusually poor funding situation for Pacific Science activities at this time.* Nevertheless, the program was left as complete as possible since we intend to use it as a basis and workshop-preparation for the 13th PACIFIC SCIENCE CONGRESS currently planned for August 18-30, 1975 in Vancouver, Canada.

3. Timing considerations. - I enclose for your information a xerox copy of a SECOND INTER-CONGRESS TENTATIVE OUTLINE PROGRAM OF MEETINGS dated August 20, 1972 that was sent by Dr. Ian McTaggart-Cowan (President of the Pacific Science Association) to Dr. Maxwell S. Doty (Chairman of the Scientific Committee on Pacific Botany, our chairman). I just received a letter (dated March 22) from Dr. L. G. Eldredge (Chairman of the Organizing Committee for the Guam Meeting). He informs me that three blocks of time are set aside for Botany Committee activities: Tuesday afternoon for a "formal" Committee meeting. Wednesday and Thursday afternoons especially for our NATURAL AREA SYSTEM program. (Thursday morning could also be set aside for us).

4. Scheduling.

A. Preliminary

Sunday, May 20th	Arrival and Registration	2-4:30 p.m.
Monday, May 21st	Inaugural Meeting	10 a.m.

* In all, 15 speakers participated in the Guam Symposium, i.e. those whose names are marked with an asterisk.

B. Formal meeting of Scientific Committee on Pacific Botany
Tuesday, May 22nd 2-4:30 p.m.
This afternoon meeting will be under the chairmanship of Dr. M. S. Doty. You are urged to attend this meeting, which will be an information session on current affairs and future plans of the Scientific Committee on Pacific Botany.

C. NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION. - Our workshop meeting will be scheduled for Wednesday afternoon and Thursday all day. This is based on the premise that each speaker will have 20 minutes (plus-minus time) for his presentation and 10 minutes for discussion, a total of 30 minutes time per speaker. The schedule will be as follows:

Wednesday, May 23rd - Afternoon session 2:00 - 4:30 p.m.
Theme 1 . . . . 3 or 4 speakers
Theme 2 . . . . 1st speaker

Thursday, May 24th - Morning session 9:00 - 12:30
Theme 2 . . . . continued with 4 or 5 more speakers
Theme 3 . . . . we may have no speaker on this, but will have a brief discussion on Theme 3
Afternoon session 2:00 - 5:00 p.m.
Theme 4 . . . . probably 3 speakers
Theme 5 . . . . probably only 1 speaker + Hosokawa
Theme 6 . . . . 2 speakers

Note: Minor changes in scheduling can easily be arranged in Guam. For example, we could start at 8:30 a.m. on Thursday morning if the need for more time arises.

5. Meeting room. - Dr. Eldredge has reserved a room for our workshop meeting which holds twenty-five or more seats. Projectors, as needed, will be made available. The room can be completely darkened. There should also be some wall-space for hanging up of maps; furthermore a blackboard and chalk should be in the room. You will be advised on the location and room number during the first or second day of your arrival at the University of Guam.

6. Field trip. - A field trip is planned as a "hike" for Saturday, May 26th to either Sella Bay (site of controversial Ammo Wharf) or Mt. Lamlam and surrounding ridge trails. The Guam Science Teachers Association will lead the trip.

7. Pre-registration. - Those of you intending to come and who have not already pre-registered, please write immediately to:

Dr. L. G. Eldredge
University of Guam
P.O. Box EK
Agana, Guam 96910, USA

There is a $10 registration fee required which must be paid upon arrival in Guam.

8. Abstracts. - Your abstracts will be duplicated and available for distribution to program participants in Guam. Papers presented will not be published

at this time. Instead, we intend to develop the themes and topics into publishable contributions for the 13th Pacific Science Congress in August 1975. At that time the papers should be ready as preprints.

9. I will be away from Hawaii from April 9 through May 2, 1973. If in the meantime you have any urgent question, please write to:

Dr. Maxwell S. Doty
Department of Botany
University of Hawaii
Honolulu, Hawaii 96822, USA

Honolulu, March 30, 1973

Dieter Mueller-Dombois
Vice Chairman for Ecological Affairs
Professor of Botany

Theme 1. THE CONCEPT OF A PACIFIC NATURAL AREA RESERVES SYSTEM

Pacific Science Association Inter-Congress Meeting in Guam, May 20-25, 1973

PROGRAM OF ECOLOGY SECTION OF SCIENTIFIC COMMITTEE ON PACIFIC BOTANY:

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 1. The Concept of a Pacific Natural Area System

ABSTRACT by Dieter Mueller-Dombois, Professor, Department of Botany, University of Hawaii, Honolulu, Hawaii 96822, USA

CONCEPTUAL INTRODUCTION

At this moment in history we are still fortunate in enjoying the coexistence of a relatively large array of natural areas in the Pacific Region. However, the time has come in which the future existence of many scientifically important natural landscape units or ecosystems is threatened by land development for the material progress of mankind. We are here to take positive steps that this progress in land development will not destroy at least those natural areas that we consider from an ecological viewpoint essential for future maintenance.

We envision a SYSTEM of natural areas for the Pacific region. This implies the establishment of a GEOGRAPHIC NETWORK of natural areas or ecological reserves. The network idea carries the charge of searching for natural area relationships in a meaningful ecological and scientific context. Included in this system would be small oceanic islands, natural (i.e. relatively unmodified) areas of defined limits on larger oceanic and continental islands and ecological reserves on the continental fringes of the Pacific Region. The Pacific Region extends over a hemisphere of ocean with widely and variously separated terrestrial aggregates. Establishment of a natural area reserves system in this region is a task for which we can make an important start, but which will hardly ever be completed. This is so because as we begin to study the relationships between and within Pacific areas, we come to discover more and more unknown elements of ecogeographic importance. It is particularly for this reason, that we need to begin now to systematically secure an adequate number and geographic spread of natural areas, because these areas and their comparative analyses represent a resource of knowledge that will never be depleted, if we are able to secure their protection now.

The conceptual framework for a Pacific natural area reserves system will be discussed further with regard to the following points:

1. The problems and methods in developing a system
2. Objectives for establishing a system
3. Criteria for natural areas to be included in the system
4. A hierarchical framework for assembling the information

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 1. The Concept of a Pacific Natural Area System

ABSTRACT by Harold J. Coolidge, Honorary Life Fellow of the Pacific Science Association, 38 Standley Street, Beverly, Massachusetts 01915

FUTURE ROLE OF PARKS AND ECOLOGICAL RESERVES ON PACIFIC ISLANDS AS A NATURAL AREA SYSTEM

In the recent development of world concern for safeguarding samples of ecosystems through such land use practices as establishing parks and reserves which can serve as gene banks for future generations, governments have set aside over 1400 continental areas as noted in the United Nations World List of National Parks, but up to now islands have been largely neglected. In the South Pacific the International Union for the Conservation of Nature at their Noumea Conference, in association with the South Pacific Commission (1971) and the C. T. Section of the International Biological Program in their Palau Declaration (1969), developed positive action proposals to aid in Pacific Island environmental planning.

Islands are, in many environmental respects, very different from continental areas and seem to have special patents that make them particularly vulnerable to the development programs related to accomodating fast growing tourism, as well as the exploitation of mineral, phosphate and coral resources which usually cause extensive pollution and often result in serious culture changes for Pacific Islanders.

It is to be hoped that the Islander's approach, especially to new Marine Park developments, will lead to the establishment of measures stemming from their grass roots knowledge which will be more applicable to island environmental problems then some of those now emanating from western oriented continental areas. It is proposed that Islanders can play an increasing role in maintaining the ecological viability of their island habitats against the growing outside forces leading to harmful pollution by setting up conservation councils for park systems planning and coordination of governmental activities affecting their environment.

Encouraging recent legislation relating to parks and natural areas has been adopted by the Congress of Micronesia, the government of Fiji, and is pending in other Pacific Island territories. While a federation of Island Conservation Councils may hopefully develop in the years ahead, there is a strong value in also maintaining "diversity" appropriate to the irreplaceable historic cultures of Polynesia, Melanesia and Micronesia.

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 1. The Concept of a Pacific Natural Area System

ABSTRACT by Mildred E. Mathias, Professor of Botany, University of California, Los Angeles, Botanic Gardens-Herbarium, Los Angeles, California 90024

NATURAL AREAS FOR TEACHING AND RESEARCH

Natural areas have long been used for teaching and research. Their availability has varied both in space and time and, in recent years, with increasing concentrations of urban areas, those remaining have either become relatively more inaccessible or increasingly altered by man. Organizations such as The Nature Conservancy have acquired a number of areas, some to preserve a rare species, others to protect an endangered environment. These properties are available for teaching and research although some are either too small or too fragile for general use. Federal and state agencies have protected large areas under a number of rubrics such as parks, monuments, forests, etc. Many of these are primarily used for recreation and provide open space, often preserving unique scenery, geology, archeology and other natural features. Because of often intense recreational use they are inappropriate and essentially unavailable for teaching and research. An occasional short term study is possible but any long term investigation involving instrumentation, exclusion plots, or other protection is endangered by the multiple uses to which the area is subject. The California Natural Areas Coordinating Council has indentified over 600 natural areas under various private and public ownerships in the state of California but for many of these there is no assurance that their natural qualities can or will be maintained.

In reply to the increasing pressures on natural areas for teaching and research the University of California in 1965 established the Natural Land and Water Reserves System, the purpose of which is to provide a series of reserves encompassing the diversity of California's natural habitats, both aquatic and terrestrial, for teaching and research use. Special use reserves, such as archeological sites and geologic formations, are to be included. The development of this system, and its increasing value and use provides a model for other regions.

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 1. The Concept of a Pacific Natural Area System

ABSTRACT from M. Numata, Professor, Dept. of Biology, Chiba University, Yayoi-cho, Chiba, Japan

DEVELOPMENT OF A NATURAL AREA SYSTEM IN JAPAN

(abstracted by D. Mueller-Dombois from M. Numata's paper)

Dr. Numata provides a brief history of conservation efforts in Japan. Already in ancient Japan, before the Meiji Era, regulations existed to preserve characteristic landscapes, natural forests, wildlife, precious trees, etc. Modern conservation efforts were begun by the Japanese Forest Service in 1915 with establishment of a system of "Protected National Forests for Scientific Use", which included 188 scientific reserves in various National Forests. However, the protection status of these reserves was not legally secured. In 1918, a Wildlife Protection Law was established, which restricted hunting in game preserves. In 1919, a law for the preservation of historical and natural monuments and beautiful scenery was created. One of the results was the establishment of 114 natural areas with characteristic vegetation types. Through a Forest Law (probably also before 1920) 3,555 National Protection Forests were established. But these are of a more general category, which may mean that plantation forests are included. Cutting is prohibited within 1.7 million ha of the total 6.8 million ha Protection Forest.

A National Parks Law in 1931 and a Nature Parks Law in 1957 were created to secure further land for the preservation of scenic beauty and for recreation. The Nature Parks have become important centers of nature conservation, within which "Strict Reserves" and "Special Areas" have been set up. In 1959, the Ecological Society of Japan recommended to the Government the establishment of 10 characteristic climax forest reserves while at the same time it asked the Government to change its policy of expanding man-made forests.

A resolution of the 11th Pacific Science Congress in Japan in 1966 that emanated from the Special Symposium on "Nature Conservation of Alpine and Subalpine Areas", gave a strong impetus to Government awareness for the need of natural area conservation. After that the CT section of the Japanese IBP recommended establishment of a number of specific reserves and recommended to stop clear-cutting of natural forests in Japan.

Currently the Ecological Society is preparing a list of secondary forests, grasslands, moors, rivers and coastal areas for reserve status. Japan now has a Department of Nature Conservation in both the Governmental Agency for the Environmental and the Agency for Cultural Affairs. These agencies prepared vegetation maps at 1:200,000 (based on physiognomy) for all natural monuments in all prefectures.

The Nature Conservation Society, a non-governmental agency, was established in 1951. This society has been instrumental in basic surveys of natural areas in Japan. It also has stimulated the establishment of other local and central conservation groups.

In 1972 a new law was established, the Natural Environment Conservation Law. Its purpose is a more systematic selection of natural areas for conservation. Along its guidelines is the establishment of choice natural areas not for scenic beauty, recreational use, monumental value, etc., but only for their scientific value and use. Along with the law was created the concept of a "Natural Environment Conservation Area", which is divided into a wilderness area or strict nature reserve, an ordinary area and a prefectural area. The wilderness area can be considered a strict research area for scientific use.

Theme 2. GEOGRAPHICAL AND CLIMATIC ANALYSES (A SHOW OF MAPS)

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PROGRAM OF ECOLOGY SECTION OF SCIENTIFIC COMMITTEE ON PACIFIC BOTANY:

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by Thelma de Ausen Richmond, Lecturer in Biology, The University of the South Pacific, School of Natural Resources, P.O. Box 1168, Laucala Bay, Suva, Fiji

GEOGRAPHY AND ECOLOGICAL RELATIONSHIPS OF NATURE RESERVES IN FIJI

There are five nature reserves in Fiji at present. Four are found on the largest island of Viti Levu and the fifth is found on the third largest island of Taveuni. Three of the nature reserves in Northcentral Viti Levu are extensive in acreage and represent forest types found at elevations ranging from 457 m (1,500 ft.) to 1,323 m (4,341 ft.) in steeply dissected country. Rainfall in the area averages about 3,810 mm (150 in.) per year, continuously wet for the greater part of the area except at Nandarivatu where there is a moderate dry season. The mean annual temperature is about 20.2°C (68.4°F). The soils are steepland derivatives of latosols developed on olivine basalt rocks of Pleistocene age. Nandarivatu Nature Reserve comprises an almost pure stand of Agathis vitiensis (a gymnosperm, family Pinaceae). Nanggaranimbulati Nature Reserve supports a pole forest dominated by Myrtaceae spp. and Calophyllum spp. The highest peak in Fiji, Tomaniivi or Mt. Victoria, is found on the third reserve, Tomaniivi Nature Reserve, which is the most extensive reserve of the three on Viti Levu. This supports mixed forest of Calophyllum spp., Myristica spp., and Myrtaceae spp. The fourth reserve in Viti Levu is comprised of three low islands near Suva, the capital city: Cave Island, Snake Island and Admiralty Island.

The fifth nature reserve at Ravilevu, Southeast Taveuni, has extremely high rainfalls of about 5,080 mm (200 in.) per year. The mountainous terrain is steeply dissected by many streams, making access even by foot very difficult. Soils in the area are steepland, highly erodible clay soils derived from olivine basalt flows of Pleistocene age. The forest is of mixed species composition, mainly Myrtaceae spp. and Calophyllum spp. with no Agathis vitiensis.

A wider range of ecosystems needs to be placed on reserve status. Several areas have been suggested and include mangrove land, pole forest at high altitudes, cycad stands, lowland rainforest, and gymnosperm forests. Reserve status is also being asked for smaller areas where rare or endangered species of plants and animals need to be protected. Consideration is being given to dispersing reserves in a greater number of islands instead of concentrating them on the larger islands. A separate submission for marine parks has been made.

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Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by Kuswata Kartawinata, Program Manager, Tropical Forest Biology, Regional Center for Tropical Biology (BIOTROP), P.O. Box 17, Kebun Raya, Bogor, Indonesia

GEOGRAPHIC AND CLIMATIC ANALYSIS OF THE NATURE RESERVES SYSTEM IN INDONESIA

According to the record of the office of the Nature Conservation and Wildlife Management, in Indonesia, there are 142 established nature reserves scattered throughout the islands, covering the area of 2,709,975.33 hectares. The majority of them occur in Java (75) and Sumatra (36). Recently 68 new sites with the total area of 1,157,333.2 hectares, have been added and approved by the government as new reserves and are now pending legislative enactment. Three of these new sites are the extensions of the previously established reserves.

The 210 reserves, including the new ones, are classified as strict nature reserves (156), wildlife refuges (39), hunting parks (8) and recreational parks (7).

The climate of Indonesia may be divided into three climatic types: ever-wet, mid-year dry (summer dry) and mid-year drought (summer drought). The ever-wet type climate prevails over the largest part of the Indonesian territory, then follows the mid-year dry and the mid-year drought types in that order. The extent of the ever-wet and mid-year dry type climate corresponds roughly with that of the tropical rain forests, and most of the reserves occur in these two climatic types. The mid-year drought type climate, whose extent corresponds closely to that of the seasonal forests, savannas and dry-grasslands, occur mainly in East Java, Lesser Sunda Islands and South and Southeast Celebes. About 20 percent of the total number of the nature reserves occur in this climatic type.

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Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by R. E. Soeriaatmadja, Professor of Botany, Universiti Kebangsaan Malaysia, 1124, Jalan Pantai Baru, Kuala Lumpur, Malaysia

NATURAL RESERVES IN MALAYSIA AND THEIR DEVELOPMENT INTO A SYSTEM

A large percentage of primary forests in Malaysia is under serious ecological changes due to the land development scheme at federal as well as state levels. The natural primary forests of Malaysia actually have been a subject of human influences, especially at the lowland areas, in the past. But the fantastic progress in land development programs throughout the country -- under the five year Malaysia plan -- may appear to be significant in changing the ecology of primary forests in the years to come. Natural forest communities will be replaced by man-made ecosystems ranging from agricultural lands (especially rubber and palm oils) to industrial areas. A nature conservation system based on ecological considerations must be established immediately for at least the following purposes:

a) conserving the natural primary forest types

b) conserving the genetic stocks of plant and animal forest species

c) conserving the plant and animal resources for reclamation of degraded areas in the future

d) conducting basic ecological research for understanding the role of the primary forest communities for the long range of human existence on earth

e) maintaining the ecological balance of the areas inhabited by human settlement

f) providing a place for man's understanding of nature.

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Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by V. J. Chapman, Professor of Botany, Department of Botany, The University of Auckland, Private Bag, Auckland, New Zealand

SCIENTIFIC RESERVES IN NEW ZEALAND AND ITS OUTLYING ISLANDS

The area is regarded as comprising New Zealand and its off-shore islands together with the Cook and Tonga Islands for which New Zealand has some responsibility. In New Zealand maps are given to illustrate the reserves which fall into the following categories: A) 42 islands or groups of major importance. B) 43 islands of lesser importance. C) 41 islands of still less significance. D) Islands of minor value or ones which have not yet been investigated. E) Reserves in the N and S islands of New Zealand which occur from sea level up to 7000 feet. Proposals are also afoot for two submarine parks in the North Island. In the Cook Islands only Suwarrow is relatively free from man's influence and access is controlled. In the Tonga group many islands are unoccupied but there appear to be no biological reports for them. This is a group which should be investigated to determine what reserves, if any, should be established.

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Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by Willem Meijer, Associate Professor of Botany, University of Kentucky, College of Arts and Sciences, Lexington, Kentucky 40506

A NATURAL AREAS DEVELOPMENT SYSTEM FOR SABAH-MALAYSIA

The crucial decision about 10 years ago by the Forest Department in Sabah that representative areas of all forest types would be set aside as nature reserves meant the start of a program that we might call now a natural areas development system. It meant that the Forest Botanist had to find out what the different types of forest were, how they relate to differences in soils, altitude and local climate, how large these areas should be and what measures should be taken for effective demarcation and protection of these areas.

With growing pressures for land development and timber exploitation, the reservation of such reserves had to be justified also by keeping up an active program of ecological botanical research demonstrating that such areas were really needed for purposes of research, demonstration and in some cases as green zones around some of the cities. Where possible, it was tried to argue that water catchments near the larger towns could serve at the same time as nature reserves, and extensive mountainous areas were designated as protective forests as hydrological reserves. The most positive events were the continued protection of Sepilok Forest Reserve 15 miles west of Sandakan since 1955 as Research Forest, the gazetting of Mt. Kinabalu National Park (275 square miles) in 1964, and the establishment of Virgin Jungle Reserves within timber concession areas, some as large as 1400 acres, others only 200-300 acres. Some very rich botanical areas in private hands near Sandakan (Kebon, China) and Beaufort Hill were protected through agreements with their owners. Thousands of trees were numbered along trails inside these botanical reserves and in many places ecological sample plots with permanently labeled trees were layed out.

We were not everywhere successful. Through political pressure we lost the chance to preserve forest along the West Coast hills near Sipitang, we lost the water catchment area of Lahad Datu and a copper mine made a large encroachment in the Kinabalu National Park. At the positive side, we can state that the Forest Department was made aware of the need of nature conservation, the conservator even became himself National Park Warden after retirement; that the cooperation was acquired of timber companies for the setting aside of Virgin Jungle Reserves inside their concession areas; and that a series of roadside reserves and a good program for protective forest reserves was incorporated into the Labuk valley development plan.

How this all worked out recently-- how much is going to be added or subtracted from our initial efforts--recent reports don't tell. Much depends often from the

drive and enthusiasm of a few nature conservationists and Forest Research Staff is not always vocal and influential enough to get something done in the field of forest conservation.

Maps will show how the various natural areas under protection represent the variability of altitude, geology, soils and local climates in Sabah.

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Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by Agatin T. Abbott, Professor of Geology, Department of Geology and Geophysics, University of Hawaii, Honolulu, Hawaii 96822

GEOMORPHIC LANDMARKS AS NATURAL AREAS IN THE HAWAIIAN ISLANDS

The islands of the Hawaiian chain present exceptionally good examples of the variety of geomorphic features that result from an interaction of natural processes in a mid-oceanic environment. These events begin with the construction of the primary volcanic island.

Other significant controls that influence the ensuing development of land forms on individual islands or in specific regions of a single island are: elevation of the area above sea level, exposure to prevailing winds and waves, climatic and microclimatic history, rainfall, later volcanic activity, rock structure, and age.

The set of geomorphic forms resulting from an interplay of these processes provides a residence for the biota that will populate the area. Consequently, it is reasonable and appropriate to emphasize designation of geomorphic features as natural landmarks in Hawaii and point out the dual role they play as geologic features and biologic havens.

This kind of approach exposes a close dependency between the landscape and its occupants.

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Contribution to Theme 2. Geographical and Climatic Analyses (A Show of Maps)

ABSTRACT by Valiant T. Liu, Senior Specialist, Department of Forest Biology, Taiwan Forestry Research Institute, 53, Nanhai Road Taipei, Taiwan, Republic of China

THE NATURAL AREA RESERVES OF TAIWAN AND THEIR RELATION TO THE PACIFIC NATURAL AREA RESERVE SYSTEM

A natural area reserve system may be defined as a kind of natural features information system or library of a region for research and education. It appears that a great variation of natural features packed into a small area will mean greater convenience for research and education purposes than do large uniform or widely separated areas.

There are various natural features concentrated in Taiwan. Particularly, vegetational features are more concentrated than at any other place in the Pacific region. Therefore, the natural area reserve system being established in Taiwan will be of great significance to the Pacific region as a whole.

A natural area reserve system for Taiwan is proposed in this paper. The characteristic natural features are stated. Important points relating to Taiwan's vegetation are the antiquity of vegetation history, the richness of various vegetation communities, the richness of phytogeographical elements, and the richness of epibiotic species. In addition to the vegetation, aspects of Taiwan's zoology, geology and climatology are discussed.

Theme 3. ANALYSES OF COMMUNITY- AND HABITAT-VARIATION WITHIN MAJOR RESERVES

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 3. Analyses of Community- and Habitat-Variation Within Major Reserves

ABSTRACT by V. J. Chapman, Professor of Botany, Department of Botany, The University of Auckland, Private Bag, Auckland, New Zealand

ECOLOGICAL VARIATION WITHIN MAJOR RESEARCH AREAS OF NEW ZEALAND

Major research areas in New Zealand are available from the sub-tropical volcanic Kermadec Islands 500 miles to the north of North Cape, at North Cape itself, mainly at sea level in a warm temperate climate, thence in the central volcanic plateau up to the limit of perpetual snows, with lava, volcanic ash or pumice as the soil substrate and also with major thermal areas. White Island in the Bay of Plenty is a regularly active volcano and provides special habitats, including those rich in sulphur. At the other extreme are the sub-antarctic islands and the Antarctic New Zealand sector. There is also a range from the very wet westland areas of the South Island (200 in./yr.) to the dry Canterbury Plains and the Rangipo desert on the east slopes of the National Park Volcanoes of the North Island (20 in. or less/yr.). Vegetationally the following major communities are represented in reserves available for research: Agathis australis forest, Podocarp forest, mixed Podocarp-broadleaf forest, Southern beech rain forest, tall and short tussock grassland, scrub tussock, alpine vegetation, scree vegetation, bogs (both lowland and acid spagnum), swamps (neutral or alkaline), estuarine areas, rivers and lakes (both natural and man-made), hot pools and streams, crater lakes, bird sanctuaries, dunes (stable, mobile, siliceous and titanic), salt marsh, mangrove swamp, sea cliff, shingle and shell beaches. For its size New Zealand probably offers the widest possible range of ecological variation in its potential research areas.

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 3. Analyses of Community- and Habitat-Variation Within Major Reserves

ABSTRACT by A. N. Rao, Department of Botany, University of Singapore, Singapore

ENVIRONMENTAL LIMITATIONS AS RELATED TO GROWTH, REPRODUCTION AND MAINTENANCE OF FOREST VEGETATION

As the principal center of botanical activity of the Malaysian region for more than a century, the vegetation of Singapore Island has been very well studied and the details recorded. Data on the annual rainfall, humidity and soil moisture are well documented and easily accessible. Taxonomic studies predominated for well over 60 years and the ecological studies started and progressed in the last two decades. In spite of the intensive human activities and the urbanization program, part of the island is covered with forests of one type or the other. The important plant communities of these forests are described. Certain parts of the island are best suited to study the forest regeneration and the species composition of these areas are given. The major part of the regenerated vegetation is the result of the past agricultural malpractices. The regenerating community supports a greater number of species as well as individual plants than the regenerating high forest. The influence of the different environmental factors on the growth, reproduction and other phenological aspects of these forest species will be discussed.

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 3. Analyses of Community- and Habitat-Variation within Major Reserves

ABSTRACT by T. Jaffré, Laboratoire de Botanique Centre ORSTOM, B. P. A5, Noumea-Cedex, New Caledonia

STRUCTURE AND FLORISTIC COMPOSITION OF THE VEGETATION OF THE BOULINDA MASSIF AS AFFECTED BY EDAPHIC AND ALTITUDINAL FACTORS

The Boulinda massif of ultrabasic rocks is comparatively isolated and dominates the west coast of New Caledonia near the southern limit of the northern half of the island. It covers 150 km^2 between the altitudes of 50 m and 1300 m. Mining has only begun recently and climax plant associations still exist at all levels. The flora, almost entirely endemic, is particularly rich and contains elements characteristic of both the northern and southern parts of the island. It varies according to climatic and edaphic factors, the latter being in turn determined by the altitude and the topography (brown soils at the base, ferralitic soils at intermediate altitudes and organic "rankers" at the summit. Three groups of associations may be recognized.

I. Vegetation of hypermagnesian soils at low altitudes.

This is composed of shrubs associated with serpentine and magnesian soils. The best represented families are Myrtaceae, Cyperaceae, Apocynaceae, Euphorbiaceae, and Rubiaceae. The herb layer (Cyperaceae) is scanty. Included are:

- An association with Acacia spirobis (highly dominant) and Plectronia paradoxa found on mixed more or less hydromorphic soils.
- An association of sclerophyllous plants including Styphelia cymbulae, Mooria canescens, and Phyllanthus montrouzieri but without dominant species found on stony eroded brown soils.
- An association poor in species dominated by Casuarina chamaecyparis and found on brown soils rich in humus and more or less eroded.

II. Vegetation on ferralitic soils.

This is very varied in structure and contains numerous species of poor more or less acid soils. The main families are Myrtaceae, Cyperaceae, Cunoniaceae, Orchidaceae, Epacridaceae and ferns.

1) Vegetation of ferralitic soils with gravel or ferruginous concretions in the upper horizon, the shrub layer being scattered and the herbaceous layer absent. Included are:

- An association on gravelly ferralitic plateaux between 250 m and 750 m dominated by Tristania guillainii. The flora is rather poor in species. Acacia spirorbis becomes co-dominant below 350 m.
- An association with Styphelia macrocarpa, Styphelia sp. and Araucaria rulei on gravelly or concretionary ferralitic plateaux between 600 m and 1000 m characterized by a very scattered tree layer of Araucaria rulei dominating a low and discontinuous shrub layer. Important floristic variations occur above 900 m.

2) Vegetation of hydromorphic ferralitic hard-pan soils, consisting of the Dicranopteris linearis and Grevillea gillivrayi association which is characterized by a continuous herb layer, dominated by Dicranopteris linearis and a low (20 cm - 50 cm) shrub layer covering at most 15% of the surface.

3) Vegetation of ferralitic soils with an upper clay loam horizon, characterized by a more or less continuous shrub layer and a well-developed herb layer (Cyperaceae), containing:

- An association with Hibbertia altigena, Homalium kanalense and Costularia nervosa on slopes between 400 m and 1000 m, distinguished by a low (20 cm - 150 m) scattered shrub layer, rich in rock plants.
- An association with Styphelia pancheri, Hibbertia lucens, Garcinia neglecta and Casuarina glaucescens on piedmont soils about 500 m, distinguished by a tall (2 m - 8 m) dense shrub layer including subsciaphilous transitional forest species.

4) Forest on humus-rich ferralitic soils (well represented above 900 m).

- Forest mainly of Myrtaceae, Lauraceae and Podocarpaceae in some gullies and on some difficultly accessible slopes between 700 m and 1100 m.
- Nothofagus forest with a monospecific tree layer in some gullies and heads of valleys between 700 and 1000 m.
- Araucaria montana forest on some ridges and slopes exposed to the wind between 900 m and 1100 m (dense thickets below tall Araucaria montana).

III. The Vegetation of organic "rankers".

A low forest of peculiar aspect, with abundant mosses, lichens and filmy ferns, occurs above 1150 m where the climate is particularly cloudy.

The Boulinda massif is of exceptional interest both by its geographical position at the center of a highly varied floristic region and by its richness in biotopes that are as yet little affected by human activity. At a time when attention is focussed on preservation of the natural environment in the Pacific Islands, of which New Caledonia is undoubtedly one of the most remarkable, measures (reserves, fire protection, control of mining) should be taken to protect this massif against degradation provoked too often by carelessness rather than by pressing economic needs.

Theme 4. BIOGEOGRAPHIC SIMILARITY- AND DIFFERENCE-EVALUATION BETWEEN ECOLOGICAL RESERVES

Pacific Science Association Inter-Congress Meeting in Guam, May 20-25, 1973

PROGRAM OF ECOLOGY SECTION OF SCIENTIFIC COMMITTEE ON PACIFIC BOTANY:

NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 4. Biogeographic Similarity- and Difference-Evaluation Between Ecological Reserves

ABSTRACT by Marie-Hélène Sachet and F. R. Fosberg, Department of Botany, Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560 U.S.A.

THE MARQUESAS IN PACIFIC BIOGEOGRAPHY

The Marquesas Archipelago is centrally placed along the eastern side of the Polynesian triangle. Certain elements in the Marquesan flora show interesting affinities with other island groups in the Pacific. Generally, the "usual" Indo-Pacific and Pacific distributions of plants show a gradual attenuation in genera and species numbers eastward, with many elements ending in the Marquesas, Henderson Island or Hawaii. Of interest are the patterns which are exceptions to this "normal" one. A few groups show the characteristic Pacific type but do not include the "continental" islands in the Western Pacific basin. The Marquesas have plant groups in common with Hawaii, the Society Islands, Cook Island, Raja, Fiji, New Hebrides and the Galapagos, occasionally skipping intermediate island groups where they might be expected. Conversely, there are patterns in the eastern and Central Pacific which skip the Marquesas. Such peculiar patterns may be of importance in the ultimate unravelling of the floristic history of the Pacific.

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Contribution to Theme 4. Biogeographic Similarity- and Difference-Evaluation Between Ecological Reserves

ABSTRACT by Chung-K'uei Wang, Professor of Biology, Department of Biology, Tunghai University, Taichung, Taiwan, Republic of China

BIOGEOGRAPHIC RELATIONSHIPS OF THE RARE STRAND VEGETATION OF TAIWAN

No portion of the vegetation on the island of Taiwan has received so much attention as that which is much more narrowly restricted to the low-lying west coast at the southern extremity of the island. This is a type of primeval vegetation that consists chiefly of the so-called strand plants of the tropics.

This type of rare strand vegetation on the island of Taiwan may be recognized by its narrow but sharply demarked vegetation zones principally demonstrated by two distinctive formations, the littoral scrub and the supralittoral forest, lying side by side along the seacoast. The former is dominated by the dwarf shrub *Pemphis acidula* and the latter is predominated by *Barringtonia asiatica* and *Hernandia peltata* associated with a large number of tree species that are mostly characteristic of the sea shores.

The component flora is very rich, and the species that form the great bulk of the flora are mostly typical members of the so-called strand plants of the tropics. The known range of these species suggests the possibility of the occurrence of such a type of vegetation on the tropical coasts of the Old World. Therefore the strand forest in this case appears to be the outpost representative of the so-called *Barringtonia* formation. The island of Taiwan in this connection tends to mark the northernmost limit of distribution for such a paleotropical formation.

However, the representation of the rare strand vegetation in particular on the island of Taiwan is indicative of a strong relationship between the coastal flora of the tropics and that of the island, which is more with the Old World than the New. Among the neighboring regions of the island it shows a close affinity with that of the Philippines but nearly no relation to that of Japan, though it seems controversial when the island flora on the whole is concerned.

Likewise, it is the presentation of this type of strand vegetation at the southern tip of the island that leads to the conclusion, in short, that the Wallace's line, which runs between Taiwan and Botel Tobago in this part of the world, should be again reviewed with reference to the floristic relationship of Hengchun Peninsula.

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 4. Biogeographic Similarity- and Difference-Evaluation Between Ecological Reserves

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BIOGEOGRAPHIC COMPARISON OF ECOLOGICAL RESERVES IN THAILAND

As national parks and game sanctuaries have been recently promulgated in Thailand, these will serve as ecological reserves.

Although no thorough study in ecological view-point has yet been undertaken, attempts have been made to expound the floristic-geographic nature of existing national parks, which cover a rather wide range of physiographic diversity.

Brief descriptions of some national parks are given; the floristic diversity of such ecological reserves is shown in a table.

The floristic components in the lowland have no marked difference, but the higher the elevation the more variable is the plant life resulting in local endemism.

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Contribution to Theme 4. Biogeographic Similarity- and Difference-Evaluation Between Ecological Reserves

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ZOOGEOGRAPHY IN THE PACIFIC REGION AND THE FUNCTION OF ECOLOGICAL RESERVES

This paper deals with biomes and habitats of the Pacific in need of conservation programs for saving endangered vertebrates. The "Pacific region" is here understood as archipelagoes and islands in the Pacific Ocean. Hence archipelagoes and islands fringing the continents joining directly the Pacific Ocean have been included but not the continents themselves and their inner achipelagoes and islands.

Zoogeographically, the accepted pattern of continental faunal regions include associated continental islands. This means that in the Pacific there are islands belonging to not less than five continental f nal regions: the Oriental, Palearctic, Nearctic, Neotropical and Australian. In addition, there are in Oceania and also elsewhere in the Pacific Ocean, quite a number of islands and archipelagoes which are not connected with the continental shelves and, as far as vertebrates are concerned, cannot be grouped with one or another of the continental faunal regions. Therefore, in this review "Oceania" as well as other isolated islands of the Pacific are dealt with separately from islands and archipelagoes fringing the continental faunal regions of the Pacific area.

Many of these oceanic islands have their own zoogeographical profile and are, therefore, of great scientific interest, particularly in view of the fact that isolated islands, whether large or small, often produce animal species that differ from those on the continents, as well as from those on the satellites (archipelagoes and islands) of continents.

Unfortunately, few isolated islands have been left unviolated by man. Destruction and alteration of habitats often coupled with introductions of exotic species of both plants and animals have in many cases led to disastrous results for this native fauna. In the Pacific region (defined as above) 105 vertebrates have become extinct during historic time. Twenty are probably extinct and 177 are endangered by extermination. A very high proportion of these totals are represented by Oceania and other isolated islands of the Pacific, where not less than 58 vertebrates have become extinct during historic time, three are probably extinct and 88 are facing extinction.

Legislative protection of threatened vertebrates is not enough. Such measures must be combined with the establishment of ecological reserves, where habitats and biomes are allowed to remain and evolve naturally. Many habitats have to be restored to natural conditions. Only conservation oriented action, based on ecological facts, can lead to a successful safeguarding of at present endangered vertebrate species in the Pacific, as well as those which are rapidly approaching the same fatal situation.

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Contribution to Theme 4. Biogeographic Similarity- and Difference-Evaluation Between Ecological Reserves

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ON THE MEASUREMENT OF DIVERSITY IN DIFFERENT ECOLOGICAL SITUATIONS

Despite the significance and conspicuousness of spatial variation in ecosystems, it is described only fragmentally in the literature and is often ignored because of problems of scale, data gathering and representation. Failure to recognize and describe detailed ecological patterns within ecosystems reflects the tendency of researchers to generalize by combining or averaging data. Yet the spatial variability within an ecosystem and its dynamic changing pattern are essential features of particular ecosystems and the proper evaluation, management and maintenance of conservation values of ecosystems depends on a sensitive understanding of this variability. The presence and distribution of specific plants and animals within ecosystems largely reflects the changing ecological pattern and in part determines the nature of change.

The special roles of environmental diversity and factor interaction in determining community patterns are examined by descriptions for particular systems of the field relations of soils, parent materials, relief, ground water, vegetation and tree growth. The ecological significance of some organisms in producing spatial variation is illustrated and attention drawn to the gradual but significant ecological changes that occur leading in time to greater ecological diversity and accentuation of the degree of spatial variation.

Theme 5. HUMAN INFLUENCES AND PROTECTION STATUS OF EACH AREA

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 5. Human Influences and Protection Status of Each Area

ABSTRACT by Charles H. Lamoureux, Professor of Botany, Department of Botany, University of Hawaii, Honolulu, Hawaii 96822

A COMPARISON OF HUMAN INFLUENCES AND PROTECTION STATUS OF ECOLOGICAL RESERVES IN INDONESIA AND HAWAII

Indonesia contains a large land area, distributed over more than 3000 islands, mostly of a continental nature, with a diverse and harmonic native biota including many herbivorous mammals. Human occupation of the area has been continuous for several thousand years. Hawaii contains a much smaller land area, distributed among less than 100 islands, only 8 of which are more than a few square km in size, and all of an isolated oceanic nature with no past land connections to continental areas. The small disharmonic native biota includes no herbivorous mammals. Human occupation of the area extends back only about 1000 years. In both areas rapid human population increases in the 20th century have led to greatly increased demands on natural resources and increased pressures for more intensive land use.

In Indonesia ecological reserves include 157 nature reserves which have been officially designat d during the past 50 years, and some areas classified as protection forests for watershed protection. However, boundaries of many ecological reserves are unmarked (or even unknown), and effective supervision of most of them is not being practiced.

In Hawaii there are two national parks, the Hawaiian Islands National Wildlife Refuge, and a few areas under State control (e.g., Alakai Swamp Wilderness Reserve, some forest reserves, some state parks) which function as ecological reserves. The law providing for a Hawaii Natural Areas Reserve System has been passed, but the system is being established very slowly.

In both areas human influences have been both direct (clearing land for cultivation and other human uses; harvesting forest products, etc.), and indirect (effects of species of plants and animals introduced by man on native species). On the whole, the direct human influences seem to have been responsible for greatest change in the past in Indonesia, and are those now most immediately posing problems in the protection of Indonesian ecological reserves. In Hawaii, while direct human influences were of great importance up to about 100 years ago, indirect human influences seem to have been more important during the past century, and continue to be of greater importance. The reasons for these differences are related both to differences in the native biota, and to the social, cultural, and political differences between the human populations in these areas.

The different types of human influence on the protection status of ecological reserves in the two areas should lead to different solutions to the problems involved in establishment and management of ecological reserves. Although ideally a nature reserve should not be subjected to intensive management, in areas where indirect human influences on natural populations are pronounced it may become necessary to utilize intensive management practices (e.g., control or eradication of introduced plant and animal species) to maintain the natural values for which the reserve was originally established.

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Contribution to Theme 5. Human Influences and Protection Status of Each Area

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REMNANT NATURAL AREAS ALONG THE SOUTH AMERICAN PACIFIC COAST AND THE HUMAN IMPACT PROBLEM

After considering past history of nature conservation as suggested and practiced by natives, scientists and governments (mainly through the establishment of National Parks) the present situation is discussed.

Due to more ecological knowledge and world-wide awakening towards the necessity to protect natural areas, the Latin American conservationists held several meetings to find solutions to common problems and start action programs.

Examples from different countries are given to illustrate both the destructive influences as well as sound projects which tend towards the permanent protection of natural areas. Scientists and teachers wish to conserve habitats as much remains to be discovered about the flora and fauna, especially in the tropics.

In most parts of the continent the wilderness areas are difficult to reach and it is only possible to study them when roads are built or logging operations take place. It is, however, seldom that scientific teams are present at such events; at the most collectors arrive, who have to pay their way and prepare as many collections as possible, often destroying completely the most valuable and rare species. In some countries there are scientific study areas, but these are either overused by students or seldom used.

Wild animals, especially mammals and birds are among the main attractions of national parks and therefore cause a serious problem. The administrators of national parks are confronted with the dilemma to decide whether or not to permit the explosion of one or several species. Those who decide that natural explosions ensure the survival of the genetically most suitable individuals seem to be forgetting that at the same time many plants and lesser animals disappear irrevocably, especially because none exist anymore outside the park to reinvade their original habitats.

Fortunately the public in general has shown in the past decade sufficient knowledge and interest in the subject and formed conservation associations. These, or their individual and influential members, not only urge the governments to establish new national parks in valuable areas and keep the National Park concept separated from wildlife refuges, but also are aware of the need to protect smaller ecosystems (kipuka-like islands in the desert, remnant forests, habitats of endemic species) which would be too small for National Parks, or not significant enough for national Sanctuaries.

Local governments, private organizations and universities take care of these areas and recently in many cases the department of tourism protects them until the government or any other agency with expertise in resource management takes over. In November 1973 the Third International Seminar on Natural Areas and Tourism will be held in Latin America.

Theme 6. NEED FOR ADDITIONAL AREAS TO BE CONSIDERED IN THE SYSTEM

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NATURAL AREA SYSTEM DEVELOPMENT FOR THE PACIFIC REGION

Contribution to Theme 6. Need for Additional Areas to be Considered in the System

ABSTRACT by William L. Theobald, Associate Professor, Department of Botany, University of Hawaii, Honolulu, Hawaii 96822, USA

THE U.S. NATIONAL PARK SERVICE PROGRAM IN THE PACIFIC

An inventory of potential natural areas throughout the U. S., its territories, and areas under its control is presently being undertaken by the United States National Park Service. The preparation of two such surveys has recently been funded by the Park Service to the University of Hawaii with Dr. Agatin Abbott, Dr. Alison Kay, Dr. Charles Lamoureux and myself as principal investigators. These studies include a "Survey of Natural Areas in the Hawaiian Islands," and a "Survey of Natural Areas in the Pacific Islands Territories." The latter includes the Trust Territory of the Pacific Islands, Guam, American Samoa, and such other islands under U. S. jurisdiction or control. As noted in the original contracts, "The study should include a description of each significant site recommended by the contractor as a potential natural landmark including its location, physical characteristics and natural values. . . . Some sites will qualify for registry as natural landmarks and some even may warrant further study for possible inclusion in the National Park System."

CONCLUSIONS

The symposium covered a variety of related aspects. The essential results can be summarized under four subheadings:

- International-administrative cooperation
- Natural area concepts
- Geographic ecosystem analysis
- A coordinated action program

International-administrative cooperation

This aspect was particularly discussed by Dr. Coolidge in his introductory paper, which gave special weight to oceanic islands and marine parks. He stressed the growing concern in the International community for the conservation of oceanic island resources, which includes the preservation of natural areas in the form of terrestrial and marine ecosystem examples. Our 1973 Guam Symposium can be seen as a further step in this concern. An organized concern began with the UNESCO symposium on "Man's place in the Island Ecosystem" convened by F. R. Fosberg (1963) at the 10th Pacific Science Congress in Honolulu in 1961. Other platforms, where this concern was expressed were the First World Conference on National Parks in Seattle in 1962, the 11th Pacific Science Congress in Tokyo in 1966, the IUCN General Assemblies (New Delhi 1969 and Banff 1972), the IUCN-South Pacific Commission (SPC) Regional Symposium on Conservation of Nature: Reefs and Lagoons in Noumea in 1971, the 12th Pacific Science Congress in Canberra in 1971 (see Costin and Groves 1973) and the Second World Conference on National Parks in Yellowstone and Grand Teton in 1972. Dr. Coolidge also mentioned a new "International Center for Environmental Renewal," named THRESHOLD, that was created in March 1973, and of which Dr. Coolidge is one of the founders. THRESHOLD wants to create an international institution devoted to research, technical assistance, experimental management and

education. The center would also be interested in all matters relating to developing a Natural Area System for the Pacific Region.

Natural area concepts

These ranged all the way from the national park concept (Dr. Coolidge) to small one-acre (or even smaller) wilderness areas for university research and education (Prof. Mathias), and from unique geological landmarks (Prof. Abbott) to the idea of "green spaces" in urban industrial centers (Prof. Hosokawa). It should be made clear that the "green space" concept--though of unquestionable importance and value in urban planning--has little or nothing to do with the natural area concept as understood by most field biologists and ecologists. Man-made parks, picnic sites, lawns and playgrounds are purposely excluded from the definition of natural areas (see p. 7). Unique geological landmarks, e.g. textbook examples of amphitheater-headed valleys in the Hawaiian islands, etc. often cannot serve as good examples of natural areas, because they are inaccessible to the field biologist. Moreover, such areas are usually well protected through their topography so that the idea to preserve them does not necessarily deserve an urgent concern of the field biologist.

The two examples, "green spaces" and "geological landmarks" are purposely emphasized as being marginal to the "natural area" concept as seen by field biologists. However, groups of people working with these three different area-concepts in the same region should be aware of each others activities because their interests can certainly overlap in given situations. For example, a "green space" may contain a semi-natural community that is not totally man-modified and may thus lend itself to some nature-research for university class projects. Similarly, a "geological landmark" may double as a natural area useful for biological research. In such cases, a coordinated approach may greatly enhance the chances in obtaining ecological reserve status for such a double-purpose natural area.

National Parks usually provide excellent examples of natural areas for research. However, by definition, national parks are relatively large contiguous areas, usually covering several square miles of terrain. Prof. T. Tamura (Japan), the originator of the concept for an international marine parks system in the western Pacific, visualizes underwater parks that are the size of entire island groups. He has selected six island groups as most suitable for a Pacific marine parks system. These include 1) The Nansei and Ogasawara Islands of Japan, 2) Micronesia (see FIG. 1), 3) The Great Barrier Reef and New Caledonia, 4) Fiji and Samoan Islands, 5) French Polynesian-Society Islands, including the Cook Islands, and 6) The Hawaiian Islands. Tamura's (1972) suggested marine park areas may serve as a useful guide to establishing a concept of "ecological regions" in the Pacific within each of which we may distinguish a number of terrestrial ecological zones with specific natural areas for preservation.

However, the point to be stressed here is that national parks are relatively large in size and few in number. They may contain several administrative subunits, such as recreation areas, wildlife sanctuaries and strict nature reserves. As indicated by the name, recreation is given priority in the first unit and its value as a natural area for research and education may thus be limited. Wildlife sanctuaries are excellent for certain kinds of nature research, particularly for wildlife research, but they may often include management practices to increase the carrying capacity for certain kinds of wildlife. This may render such an area unsuitable as a baseline- or control-area against which the effects of management on the commercially used portion of the same landscape can be measured (i.e. objective no. 1 for natural area establishment, see p. 6). It is also obvious that national parks cannot be relied on in providing an adequate coverage of natural areas for the Pacific Region. There are far too few national parks to contain the subregionally important natural ecosystems. This point has been well clarified by Professor Mathias,

who emphasized the need for at least a minimum representation of the ecologically important biomes and communities in the California natural area system. Here, the stress is placed on the need for areas--even though small--for research and education. Similarly, Professor Numata in his historical account of the Japanese natural area movement, emphasized the present concern in Japan for natural areas serving the more limited purposes of scientific research and education.

Geographic ecosystem analysis

The scientific problems in developing a natural area system for the Pacific Region were more or less circumscribed by Themes 2 to 4 (see p. 2). However, the themes also left considerable latitude for an interpretation of various natural-area attributes in different subregions of the Pacific.

The symposium discussions brought forth a need for further coordination. A coordinated scientific input of the PSA Ecology Section could form a valuable contribution to the international cooperative efforts (of IUCN, UNESCO and its MAB program, the World National Park movement, THRESHOLD, the South Pacific Commission, including the Pacific Science Association) in establishing Natural Area Reserves in the Pacific Region. It was felt that the PSA contribution of the Ecology Section would best be focused on the problem of identifying representative ecosystems in the Pacific Region.

It was further anticipated that the identification of representative ecosystems becomes an action program of the Ecology Section for the 1975 Vancouver Congress of the Pacific Science Association. At that time, this action program should result in preprints to be presented in a symposium under the same or similar title which then would be assembled for publication in one volume.

The scientific objective of identifying representative ecosystems in the Pacific Region cannot be achieved by a mere list of parks, islands, reserves,

ecosystems or vegetation types. Instead, a hierarchical system of ecological mapping was proposed that leans on the four-level approach suggested in the introductory paper (pp. 10-15).

A coordinated action program

Resident ecologists in the different Pacific countries and others knowledgeable of specific Pacific areas or island groups would be well advised if they were to consider the following coordinated action program:

Minimum Program

1. To define and map the ecological zones of their country or island group at a small (level 2) to intermediate (level 3) scale, if possible at 1:1 million.
2. To describe the characteristic ecosystems in these zones and to mark the location of actually existing ecosystem or vegetation examples by asterisks, dots, squares or actual outlines (in the case of level 3 maps) on the same map.

Extended Program

3. To develop enlargements of selected ecosystem or vegetation examples (as determined through point 2 above) by mapping of the vegetation and/or habitats on large-scale (level 4) maps.
4. To present with these large-scale maps a fairly detailed description of the map-units in the form of a manual or monograph.

Explanation

The program elements are designed to encourage resident ecologists of as many different Pacific countries as possible to participate in this action program. Much of the information may already be available, but may need to be uncovered through a literature review. A number of methods are available to provide adequate information under each point of the program. Following are a few suggestions:

To point 1 (Minimum Program): Ecological zonations (with or without maps) are

already developed for many Pacific countries. It is necessary to rediscover these through a good literature review. In this connection it is important to discuss these earlier works in the light of the most recent knowledge of the area or region in question. There are a number of ecological zonation schemes developed in the world literature. However, it is important to observe that a good zonation scheme must contain the following parts:

(a) climatic information - A good approach is the gathering of information from climatic (particularly rainfall) stations and the presentation of this information in the form of climate diagrams (after Walter, see references on p. 13), which are thereafter plotted on small- or intermediate-scale topographic maps. From the mapped climate diagrams it is then possible to draw climatic zones as was demonstrated by Dr. Kartawinata during the Guam Symposium for the whole of Indonesia (on a 1:2.5 million map) and for Java in more detail (on a 1:1 million map). His maps would be improved by insertion of scale-adapted topographic lines. Mrs. de Ausen Richmond (who mailed her contribution to the Symposium) used the same method for the description of the climate types of the six reserves in the Fijian Islands. A necessary extension for fulfilling point 1 of the program outline would be to develop this information for several more climatic stations so that zones with similar climates can be delimited for the Fijian Island group.

It would of course also be useful to develop other climatic zonation schemes, such as those of Köppen, Thornthwaite, Gaussen, among others. However, the Walter method has the advantage that the actual climatic data are shown and that the zonation scheme is not fixed, but subject to interpretation through observations of regionally significant biotic responses (Mueller-Dombois 1968).

(b) Vegetation information - Over a geographically large terrain, major species compositions are likely to vary so that floristically different vegetation types

(at the biome or formation level) may occur in what may be recognized as the same (or uniform) climatic zone. This was pointed out for Indonesia (by Dr. Kartawinata and Prof. Meijer), where, for example, the range of Dipterocarp forests may be limited to only parts of the terrain lying in the ever-wet rain forest climate. It is thus necessary to consider also phyto- or biogeographic boundaries in delimiting ecological zones. An earlier vegetation map of van Steenis may be used in combination with Kartawinata's climate map to take care of this second important criterion (i.e. ranges of major stand-structure forming species).

(c) Physiographic information - One type of this information was already emphasized as necessary for climatic zonation maps (under a), namely to indicate major topographical variations. Similarly, geomorphological and geological information should be added in the defining (where necessary) or description of ecological zones. An example where such information adds considerably to defining of ecological zones is given by Fosberg's 1960 map of Micronesia (see FIG. 1). Prof. Meijer demonstrated the usefulness of satellite air photographs in delimiting ecological zones on Borneo by physiographic features.

To point 2 (Minimum program): It is absolutely essential that the major existing ecosystem types are marked on the ecological zone maps. A zone map indicates only certain uniform ecological conditions for each zone; it does not tell anything concrete about the actually existing ecosystems. A large segment of an ecological zone may be under urban or agricultural development. Much of the existing vegetation may be greatly modified (for example, in forest plantations) or it may be in different stages of development or recovery from disturbances (successional vegetation types). Thus, an ecological zone may contain a great mixture of vegetation types or no natural vegetation at all.

In discussing the characteristic ecosystems (as marked on the ecological zone

maps), it would be useful to relate the vegetation of these ecosystems to the UNESCO classification of world vegetation types (see Ellenberg and Mueller-Dombois 1967, also in Reichle 1970, abbreviated). This would fulfill one important function in facilitating international communication and would permit the recognition of general physiognomic-ecological similarities that may be discovered in different biogeographic provinces of the Pacific Region.

To points 3 and 4 (Extended program): A large-scale vegetation map is an important tool for natural area management and, if properly designed, can become the basic framework for all kinds of biological research to follow. The extended program requires a great deal of preparatory work. It is suggested for the 1975 Vancouver Symposium only, where such detail-work is already in progress and where it can be completed for presentation at that time. However, in such cases it is considered a very valuable contribution provided that it is developed as an extension of the minimum program.

In the mapping of vegetation types on large-scale maps it would be of value to consider two kinds of information:

(1) Mapping of vegetation according to the structural classification system of Fosberg (1967). This system has been adopted for the IBP/CT check sheet survey and should be further extended for natural area evaluation in the Pacific Region.

(2) Mapping of phytosociological vegetation units, preferably according to the system of Braun-Blanquet (1965, see also Becking 1957 or Benninghoff 1966).

The reason for suggesting these two systems for large-scale mapping is that both are easily applied and that they have application to general purposes. Moreover, they can be combined and thereby provide useful complementary information. The essential feature of Fosberg's scheme provides for mapping vegetation units

with the help of air photographs on a strictly structural basis, which does not require any detailed knowledge of the species assemblage of an area. (A generally useful mean map scale is 1:50,000). The essential part of the Braun-Blanquet method provides for a detailed floristic inventory of an area by species lists assembled in different habitats of a natural area. (A generally applied map scale is 1:10,000 to 1:25,000). It does not require a sophisticated quantitative technique of vegetation analyses, which may be required only for special purposes and investigations. Of course, other methods of natural area inventory, mapping and classification are also welcome as contributions in the Extended Program, and there should be room for a discussion of natural area classification methods.

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