Evaluation of Biodiversity Conservation Measures in Chiba Prefecture Based on Analysis of Distribution of Threatened Plant Species

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Abstract: GIS data was utilized to compare the distribution of threatened plant species in Chiba Prefecture, Japan, with the distribution of extant protected areas, and the results were used to evaluate the effectiveness of current biodiversity conservation measures, and to identify new areas requiring protection. The distribution of threatened plant species was based on the Red-data Book of Chiba Prefecture. The Prefecture was divided up into one kilometer meshes, and each mesh was assigned a total weight based on the number and status (according to the five categories employed by the Prefecture) of threatened species found in that mesh. The distribution of extant protected areas was based on official Prefecture maps. Gap analysis was then employed to compare the distributions of endangered species data with the extant protected areas. The results showed that many of the high weight value meshes were outside the extant protected areas. In addition, the regions showing high weight values but lacking extant protection were classified according to habitat-type. Wetland and forest floor habitats were numerous. Species that inhabit rice paddies were also especially evident, indicating the importance of biodiversity conservation applied to the countryside landscape, especially to cultivated wetlands. The results of this study will hopefully be useful in identifying new areas and strategies for biodiversity conservation in Chiba Prefecture.
Keywords: biodiversity conservation, gap analysis, GIS, threatened plant species, protected areas, conservation countermeasures, countryside landscape

1. Introduction

In order to conserve world biodiversity, species of plants and animals as well as vegetation communities requiring urgent conservation are identified, and their distribution and extant protection measures are studied in detail. This same process is currently being carried out in Japan [1]. Biodiversity refers to variety of forms, and is conceived of at the genetic, species, ecosystem, and even landscape levels of organization. The goal of biodiversity conservation is to reverse the processes of biotic impoverishment at each of these levels of organization [3].

To date, biodiversity conservation countermeasures have generally been implemented at the species level, and usually only when that species shows danger of becoming extinct. This species centered approach, however, experiences many difficulties and inefficiencies, is often expensive, and tends to be narrowly focused. To broaden the focus of conservation countermeasures, an objective method for identifying areas for protection is required [3]. Recently, GAP analysis, which is capable of quickly identifying and comparing various factors related to distribution and extant protection status, has been proposed as a useful research tool for selecting new conservation areas [4]. This approach is now widely employed in geographically extensive regions such as Australia and North America, but has not been utilized in those parts of Japan where various land uses and vegetation patterns show a complex distribution within a restricted area.

This research was implemented in Chiba Prefecture, a region which shows a complex distribution of vegetation and land uses. GAP analysis was employed to compare the distribution of threatened plant species with that of extant protected areas.

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2. Objective

The purpose of this study was to utilize GAP analysis to identify areas that are rich in threatened species, but currently lack protected status. The results can then be used to suggest new areas requiring conservation measures. In addition, the threatened species were classified according to the type of habitat that they live in. Based on these results, suggestions for conservation measures in each area can be suggested, and the effectiveness of GAP analysis as a research tool for prefectural level biodiversity conservation in Japan is evaluated.

3. Study Area

Chiba Prefecture is located in central Honshu, just east of Tokyo. The north-western part of the Prefecture is contained within the greater metropolitan area, while the southern part consists of the Boso Peninsula, which projects southwards into the Pacific Ocean. Topography consists of alluvial plain and low tableland (20-40m elevation) in the north-west; and hills, with elevations of 200m-300m, on the Boso Peninsula. The Prefecture is bounded by the Edo River on the east and the Tone River on the north. The Tokyo Bay coast comprises tidal wetlands and shallow shoals, while the Boso coast consists of rocky headlands alternating with sandy beaches. Kujukuri Beach is a long stretch of sandy coast in the north-east. The total area is 5156.61km^2, and the climate is warm temperate, with relatively mild winters. Precipitation is concentrated in the summer months [5].

The Tokyo Bay coastline has been intensively landfilled and developed as port and industrial infrastructure, while much of the plain and tableland region of the northwest is now devoted to suburban residential towns. The coast and hills of the Boso Peninsula, which contain rich natural scenery yet are within day-trip range of the metropolitan area, have been developed as tourist attractions and golf courses [5].

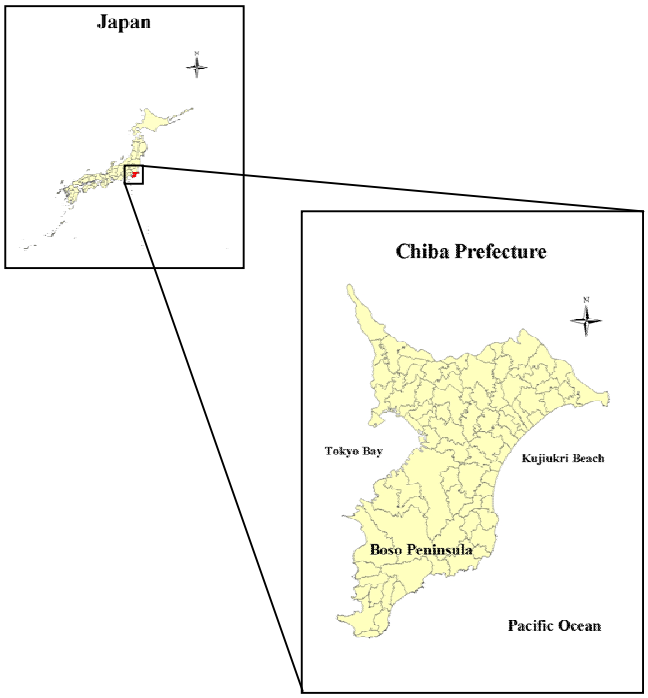

Fig. 1. Map of Study Area

4. Methods

The distribution of threatened plant species was based on the current Red-data Book of Chiba Prefecture. The Prefecture was divided up into one kilometer meshes, and the number of threatened species was totaled for each mesh. The distribution of extant protected areas was obtained from the Chiba Prefecture Nature Conservation Map (Chiba Prefecture Nature Conservation department 2003). These extant protected areas are shown in Fig. 2 and Table 1. Next, each mesh was a assigned an overall score for threatened species by weighing each threatened species according to its status as designated by the Prefecture. The status and weight factor were as follows: Extinct (Status Unknown) x5; Critical x4; Near-Critical x3; Important x2; General x1.

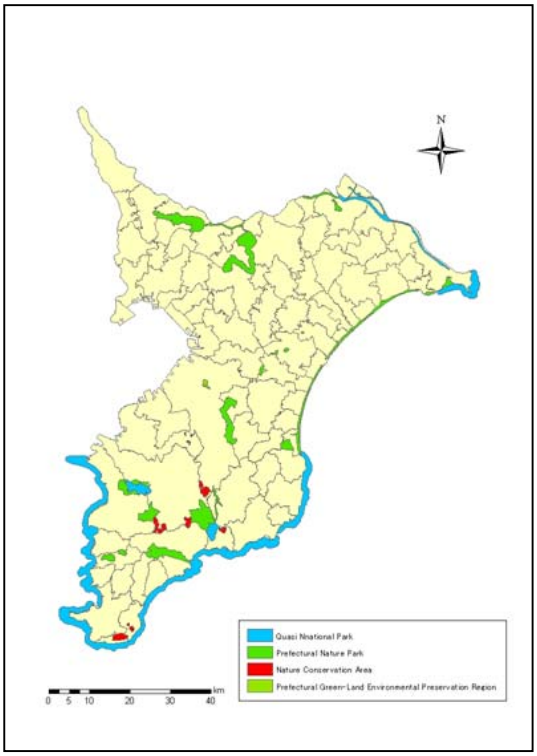

Fig. 2. Distribution of Protected Areas in Chiba Prefecture

Table 1. Date of Establishment and Area (ha) of Protected Areas

Protected Area	Date	Area(ha j
Suigoutsukuba Quasi-National Park	March 3, 1959	3145
Minamibousou Quasi-National Park	August 1, 1958	5690
Prefectural Youroukeikokuokukiyosumi Natural Park	August 9, 1935	2790
Prefectural Kujukuri Natural Park	August 9, 1935	3253
Prefectural Inbatega Natural Park	October 24, 1952	6606
Prefectural Takagosan Natural Park	August 9, 1935	2342
Prefectural Mineokasannkei Natural Park	August 9, 1935	1574
Prefectural Toyama Natural Park	March 3, 1951	676
Prefectural Otone Natural Park	July 5, 1935	503
Prefectural Kasamoritsurumai Natural Park	March 8, 1966	1948
Shirahama Nature Conservation Area	August 22, 1975	294.12
Umegasekeikoku Nature Conservation Area	January 9, 1976	236.64
Takatsukayama Nature Conservation Area	January 9, 1976	66.34
Zizoudou Ｅabukasekitai Nature Conservation Area	January 9, 1976	23.14
Motokiyosumisan Nature Conservation Area	May 7, 1976	295.37
Gakechisyokusei Nature Conservation Area	January 23, 1979	11.11
Uchiurayama nature Conservation Area	May 11, 1984	147.04
Seiwa Nature Conservation Area	November 10, 1992	596.13
Daifukuyamahokubu Nature Conservation Area	March 31, 1998	103.86
Yamakuradamusyuhen Green Nature Conservation Area	April 19, 1977	77.3

GAP analysis was then used to compare the weighted threatened species scores with the distribution of extant protected areas, seeking to identify mesh with high weighted scores but no extant protection [3]. An outline of he GAP analysis methodology is shown in Fig. 3 Finally, the mesh with high weighted scores but no protection were selected, and the Handbook of Japanese Vegetation [2] was used to determine the type of natural habitat that the threatened species in each mesh depend on.

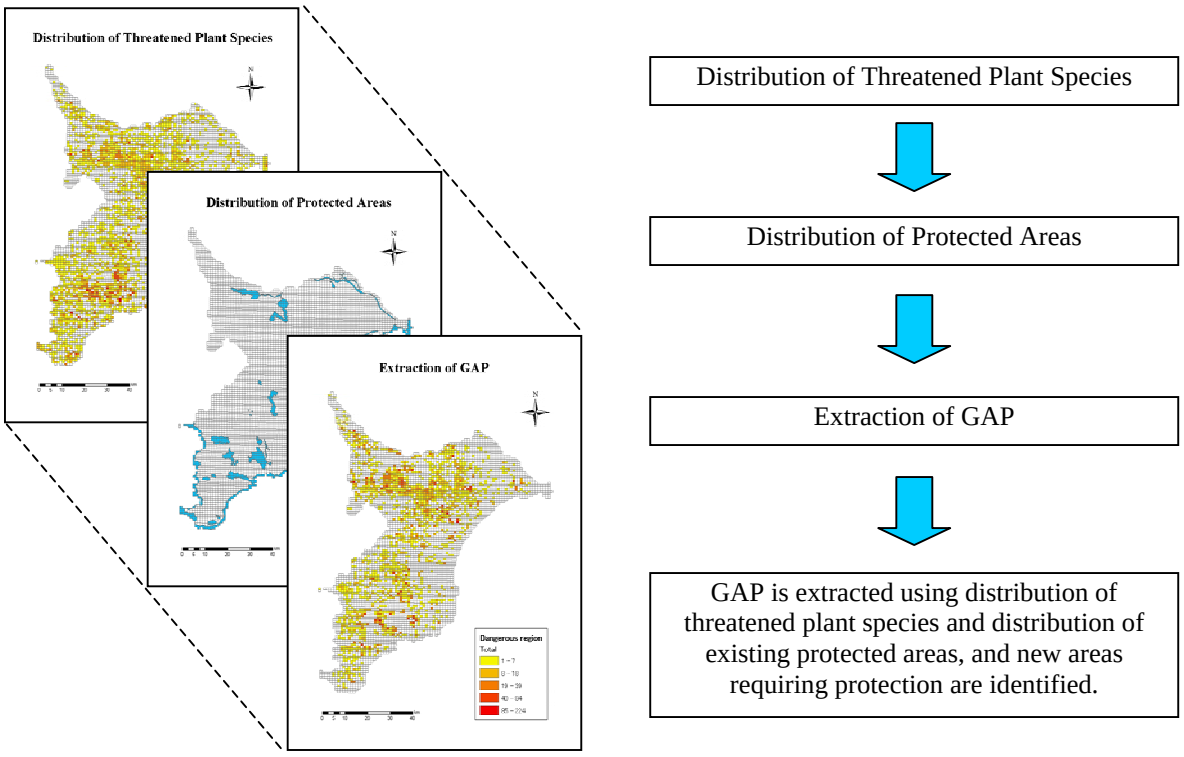

Fig. 3. Outline of Gap Analysis

5. Results

The results of the un-weighted total number of threatened plant species is mapped against the distribution of extant protected areas in Fig. 4 As can be seen, in the north central part of the Prefecture, the scale of protected areas is small, and many of the mesh showing high numbers of threatened species are outside the protected areas. In the southern Boso Peninsula, on the other hand, the number and size of the protected areas are larger, and many of the high value mesh are within the protected areas.

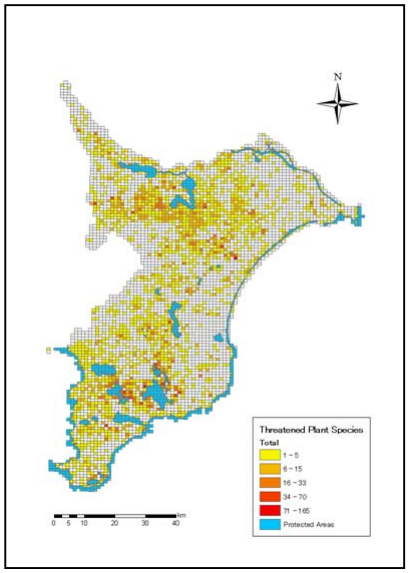

Fig. 4. Distribution of Protected Areas and Threatend Plant Species

In Fig. 5, GAP analyses was used to compare the weighted scores for each mesh with the distribution of protected areas. Each mesh was then evaluated as to the degree to which the need for protection (weighted score) matches the extant protection status. Mesh with good matching are illustrated in shades of blue, and those with poor matching in shades from yellow through red. The degree of matching can be interpreted as a measure of the suitability of extant protection measures. The highest suitability category, in which a large weighted score of threatened species are found in protected areas, totaled 1.08% of the total mesh. The lowest suitability category, in which a large weighted score of threatened species is found in non-protected areas, totaled 0.32% of the total mesh. As can be seen, areas with high suitability are concentrated in the southern region; while those of low suitability are in the north.

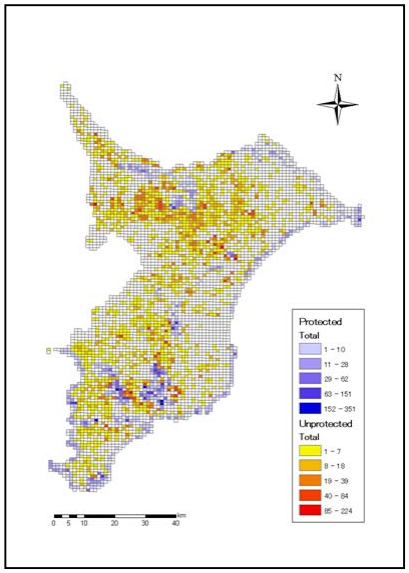

Fig. 5. Suitability of Extant Protected Areas. Weighted Score of Threatened Plant Species in Protected Area (blue) and Unprotected Areas (yellow red)

The results of the habitat classification for the low suitability region in the north are shown in Table 2. By far and away the highest number of threatened species (71) was found to inhabit wetland habitats, which include natural marshes and shallow lakes as well as rice paddies. Forest habitats, which include both natural and semi-managed woodlands, held 22 species, and grasslands 16 species. The plant species designated in the Critical status are listed in Table 3, along with the total number of places where these species have been confirmed. The number of confirmed places in protected and unprotected areas is also listed, and used to calculate the proportion of habitats protected for each species. As can be seen, protection coverage is very low for most of the critical species.

Table 2. List of Threatened Plant Species by Habitat Type

Habitat	Threatened Plant				
Wetland	*Rotala hippuris*	*Myriophyllum ussuriense*	*Carex omiana var. omiana*	*Drosera indica*	*Drosera peltata*
	Swertia tosaensis	*Fimbristylis kadzusana*	*Pecteilis radiata*	*Rhynchospora fujiiana*	*Habenaria flagellifera*
	Salomonia ciliata	*Ludwigia ovalis*	*Schoenoplectus lacustris*	*Pogostemon yatabeanus*	*Mentha japonica*
	Mitrasacme indica	*Centranthera cochinchinensis subsp. lutea*	*Deinostema violaceum*	*Utricularia bifida*	*Utricularia caerulea*
	Utricularia uliginosa	*Lobelia sessilifolia*	*Aster rugulosus*	*Cirsium sieboldii*	*Hypoxis aurea*
	Eriocaulon parvum	*Eleocharis tetraquetra*	*Rhynchospora rugosa*	*Rhynchospora faberi*	*Rhynchospora faberi*
	Rhynchospora fauriei	*Scleria caricina*	*Scleria parvula*	*Habenaria linearifolia*	*Platanthera hologlottis*
	Pogonia japonica	*Persicaria hastatosagittata*	*Triadenum japonicum*	*Drosera rotundifolia*	*Drosera spathulata*
	Sium sisarum	*Dopatrium junceum*	*Inula britannica subsp. japonica*	*Inula linariifolia*	*Sagittaria aginashi*
	Lilium leichtlinii var. tigrinum	*Eriocaulon hondoense*	*Sparganium erectum*	*Carex maculata*	*Eleocharis attenuata*
	Bletilla striata	*Scutellaria dependens Maxim*	*Tephroseris pierotii*	*Dimeria ornithopoda*	*Fimbristylis complanata*
	Schoenus apogon	*Schoenoplectus mucronatus var. tataranus*	*Sparganium subglobosum*	*Scirpus fuirenoides*	*Inula salicina var. asiatica*
	Prenanthes tanakae	*Ceratophyllum demersum*	*Alisma plantago-aquatica var. orientale*	*Trapa incisa*	*Monochoria korsakowii*
	Utricularia minor	*Nuphar japonica*	*Myriophyllum verticillatum*	*Utricularia aurea*	*Utricularia vulgaris var. japonica*
	Ottelia alismoides				
Forest	*Isodon effusus*	*Iris gracilipes*	*Adonis ramosa*	*Taeniophyllum glandulosum*	*Polystichum retrosopaleaceum*
	Japanobotrychium strictum	*Botrychium virginianum*	*Dennstaedtia wilfordii*	*Coptis japonica var. major*	*Cephalanthera erecta*
	Epimedium grandiflorum var. thunbergianum	*Monotropa uniflora*	*Swertia japonica*	*Cephalanthera falcata*	*Gastrodia elata*
	Goodyera schlechtendaliana	*Parnassia palustris var. palustris*	*Aster fastigiatus*	*Calanthe discolor*	*Bulbostylis densa*
	Botrychium nipponicum	*Clematis patens*			
Grassland	*Liparis paradoxa*	*Pulsatilla cernua*	*Scabiosa japonica*	*Erigeron thunbergii subsp. thunbergii*	*Polygonatum humile*
	Gentiana thunbergii	*Iris ensata var. spontanea*	*Crotalaria sessiliflora*	*Patrinia scabiosifolia*	*Koeleria cristata*
	Ranunculus japonicus	*Allium thunbergii*	*Calamagrostis hakonensis*	*Scrophularia buergeriana*	*Anaphalis margaritacea*
	Mitrasacme pygmaea				

Table 3. Protection of Critical Plant Species

Species	Family	Protected	Unprotected	Total	Proportion Protected
Linum stelleroides	*Ranunculaceae*	1	3	4	25
Asarum takaoi var. hisauchii	*Aristolochiaceae*	1	2	3	33
Carex lasiocarpa subsp. Occultans	*Cyperaceae*	0	3	3	0
Carex macrandrolepis	*Cyperaceae*	0	1	1	0
Fimbristylis kadzusana	*Cyperaceae*	0	2	2	0
Fimbristylis stauntonii	*Cyperaceae*	0	1	1	0
Rhynchospora fujiiana	*Cyperaceae*	0	3	3	0
Platycodon grandiflorus	*Campanulaceae*	3	17	20	15
Eupatorium japonicum	*Compositae*	3	20	23	13
Dichocarpum trachyspermum	*Ranunculaceae*	1	1	2	50
Pulsatilla cernua	*Ranunculaceae*	2	10	12	17
Brasenia schreberi	*Nymphaeaceae*	0	3	3	0
Stellaria filicaulis	*Caryophyllaceae*	2	0	2	100
Sciaphila nana	*Triuridaceae*	0	1	1	0
Scabiosa japonica	*Dipsacaceae*	7	0	7	100
Sparganium japonicum	*Sparganiaceae*	0	3	3	0
Sparganium subglobosum	*Sparganiaceae*	0	5	5	0
Gagea japonica	*Liliaceae*	0	1	1	0
Goodyera biflora	*Orchidaceae*	4	4	8	50
Pecteilis radiata	*Orchidaceae*	0	5	5	0
Neofinetia falcata	*Orchidaceae*	0	3	3	0
Ponerorchis graminifolia var. suzukiana	*Orchidaceae*	6	2	8	75
Taeniophyllum glandulosum	*Orchidaceae*	2	4	6	33

6. Discussion and Conclusions

The results of this research show that many of Chiba Prefecture's threatened plans species are found outside the extant protected areas. This indicates that the current system of protected areas is not sufficient to conserve biodiversity. This trend is especially strong in the north, where much of the land is characterized by suburban residential development surrounded by agricultural countryside. Protected areas in this region tend to be small and scattered, while the number of threatened species is high. The habitat classification results confirm the conclusion that many of the threatened species rely on managed and semi-managed countryside habitats such as rice paddies and coppiced woodlands.

These results indicate the need for new conservation measures in addition to the current system of protected areas. Countryside habitats, in particular, cannot be conserved by simply setting aside as nature preserves. These habitats require regular maintenance, and a system for promoting nature friendly farming practices and farmland management is thus required.

This research clearly demonstrated that GAP analysis can be used as an effective tool for analyzing biodiversity conservation measures at the prefectural level in Japan, even where a complex mixture of land use patterns is found in a restricted area.

7. References

[1] Nature Protection Department, Chiba Prefecture, 1999. Red Date Book of Plants in Chiba Prefecture, Chiba

[2] Miyawaki, A., S. Okuda, and R. Mochizuki, 1983. Handbook of Japanese Vegetation (Revised Edition), Shibundo

[3] Scott, J. M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'erchia, T. C.Edwards,Jr., J. Ulliman, and R.G.Wright, 1993. Gap analysis: a geographic approach to protectionof biological diversity, Wildlife Monograph 123:1-41.

[4] Davis, F.W., 1994, Gap Analysis of the Southwestern California Region, National Center for Geographic Information and Analysis, Technical Report 94-4

[5] **URL:** Chiba Prefectural Government: http://www.pref.chiba.jp/syozoku/b_kouhou/guidebook/location-j.html