Study on biodiversity measuring method for Japanese urban secondary forest

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1. Introduction

Urban secondary forests in Japan are becoming increasingly important with respect to biodiversity conservation. After the World War II, however, these forests are gradually decreasing due to urban expansion. To conduct proper evaluations of these forests is, therefore, essential from the perspective of biodiversity conservation.

As one of the biodiversity conservation policies, in recent years, biodiversity offset and banking systems have been introduced in several countries, such as the USA or Australia (Medeiros & Torezan 2013; Kipson et al 2011; ROJAS & Stephenson 2012; Allen 2009; Brochure 2013). Under the systems, the variety of assessment techniques have been developed in each system and have practically been used for evaluating biodiversity conditions. The various kinds of maintenance and restoration methods were applied for biodiversity conservation in order to compensate for the loss of biodiversity with forest development activities. Therefore, appropriate methods for evaluation of the loss and gain in biodiversity, arisen from deforestation or conservation activities, are crucial for biodiversity conservation policy (Quetier & Lavorel 2011). In addition, the simple methods are better for the perspective of practical implementation (BBOP, 2012), and these assessment methods should be able to rapidly and flexibly select indicator species.

In Japan, however, there is no legal requirement of biodiversity offset. In a report published by the Japanese Central Environmental Council in 2010, it was pointed out that there is a necessity of further collecting information on new types of biodiversity conservation measurement techniques including biodiversity offset. Biodiversity offset system is now in the stage of discussion as an environmental policy tool in Japan (IDEA 2011). In addition, the evaluation technique for forest biodiversity is still under development in environmental policy level. Simple and practical biodiversity evaluation technique is thus necessary. Consequently, the lessons learned from other country's experiences are important for further examination of biodiversity offset system in Japan.

In this study, we applied the Bio-Banking Assessment Methodology (BBAM; DESCCW 2012) and the Habitat Hectare (HH; DSE 2012) method, which are implemented in Australian states, to urban secondary forest in Japan. One reason why we selected the methods is that the methods focus on forest sector which is one of the biggest sectors for the need of biodiversity management in Japan. We tested applicability of the methods in urban secondary forests in Japan based on intensive field survey. In addition, we examined the issues related to implementation of these methods into Japanese secondary forest.

2. Site description

The study was conducted in Nagoya city, Aichi prefecture, Japan (Figs. 1-2). We selected three sites: site A and B that are located inside the campus of Nagoya University and site C that is located in Shiroyama shrine, which lies 1.5 km north-west of the site B. We set a 20 m x 20 m plot in each site for measuring. We also set a 50 m x 20 m investigation area in each site for several BBAM survey items. The survey was conducted from May to September 2012.

'IAIA13 Conference Proceedings'
Impact Assessment *the Next Generation*
33rd Annual Meeting of the International Association for Impact Assessment
13 – 16 May 2013, Calgary Stampede BMO Centre | Calgary, Alberta, Canada (www.iaia.org)

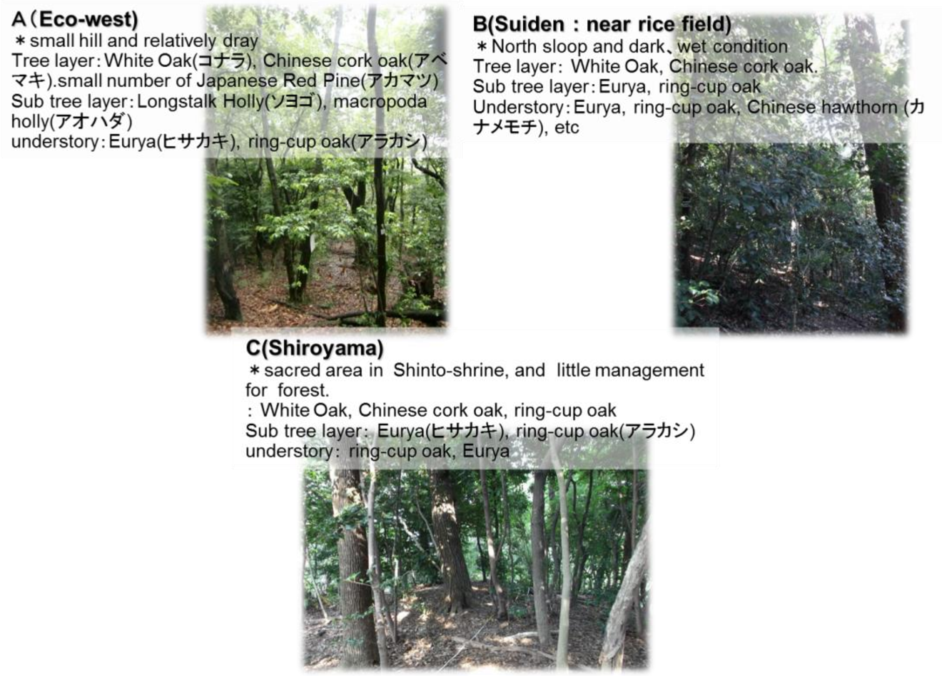

Fig.1 Survey Sites and main plant species

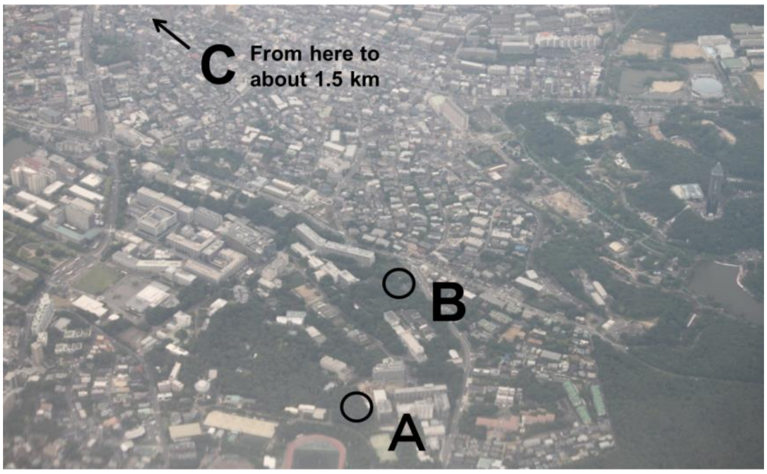

Fig.2 Survey Sites location in Nagoya city

3. Methods of Bio-Banking Assessment Methodology (BBAM) and Habitat Hectare (HH)

The BBAM and the HH consist of assessing site value and landscape value (Fig.3). In the BBAM, in addition, threatened species assessment is included. We set a benchmark site as a reference to compare target sites in both the BBAM and the HH. The site value assessment of the BBAM includes ten survey items (e.g., tree layer, sub tree layer, shrubs; see Table1). The weights of overstorey, seedling, non-native species, and tree hollow are higher than the other survey items. The site value assessment of the HH contains seven survey items (Table 2). Each item has both quantitative and qualitative assessment components. The weights of middle- and under-storey, large trees, and seedling growth are higher among survey items. The landscape value assessment comprises the following main items (see Table 3);

- Patch size
- The percentage of native vegetation cover (e.g., within the 100 ha circle, 1,000 ha circle)
- The connectivity of the site's vegetation
- Distance to core area

In addition, number and species of plants and aboveground biomass were also surveyed in each site.

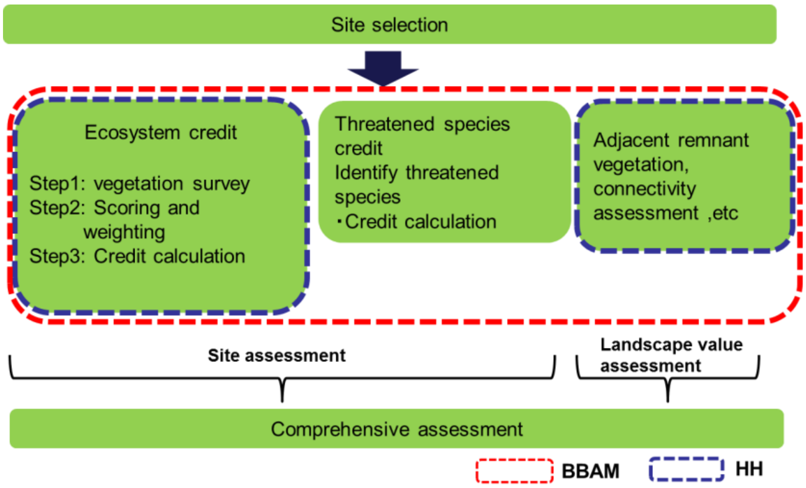

Fig.3 Framework of BBAM and HH

Table.1 BBAM survey items(source: DECSSW,2012)

BBAM survey items	The definition used this time	score
Native over - storey cover	Vegetation cover rate for tree layer (more than 10m)(%)	25
Native mid - storey cover	Vegetation cover rate for trees(1m to10m height)(%)	10
Native ground cover (Shrubs)	Understory less than 1m height	10
Native ground cover (grasses)	Understory less than 1m height	2.5
Native ground cover (others)	Others less than 1m height	2.5
Native plant species richness	Total specie number	2.5
Total length of fallen logs	Bigger than 10cm diameter	5
Proportion of over - storey spiecies occurring as regeneration	Regeneration less than 20cm height	20
Exotic plant cover	Invasive species defined by Invasive Alien Species Act(2004)	12.5
Number of trees with hollows	Number of hollows (more than 1m height) with trees more than 5cm diameter	10

Table.2 HH survey items(source: DSE,2012)

HH survey items	Evaluation criteria about quantity	Evaluation criteria about quality	score
	Definitions of this research	Definitions of this research	
Large Trees	The number of large trees beyond DBH50cm (a dead tree is also included) (a number/ha)	The leaf of the limb of each large tree is attached and it is the average value (the situation of an inferior branch is not included) of condition and a health performance (more 70% or less of 30% or more than 70%, less than 30%).	10
Tree Canopy Cover	Mature height (tree height of 15 m) Covering rate of the trees (Canopy tree) which form the tree crown of the top layer at 80% or more (tree height of 12 m or more) (Large Tree is included)	Tthe leaf of the limb of each canopy tree (Canopy tree) is attached -- condition and a health performance (Large trees -- the same)	5
Lack of Weeds	The vegetation rate of the grass plant which poses a threat to a native species	The rate of the alien species which poses especially a threat, and the kind which grows thick too much (more than nothing, 50% or less, and 50%)	15
Understorey	The number of seeds and vegetation rate (only a native species is an object) over a benchmark of each composition kind (Understorey Life forms) below Immature tree (at 5 m or more, height is less than (less than 12 m) 80% of trees of mature height (15 m))	Vegetation from which preservation is expected in consideration of recovery hope from seasonal change and periodical disturbance, etc. existence degree (are they 50% or more and less than 50%)	25
Recruitment	The number of existence of the stock of the young tree (tree height of 20 cm or more less than 1 m) which passed through the seedling of a low tree and one year or more of growth in Canopy tree and Understorey	The rate to the benchmark of the number of updating tree sorts (Are they 50% or more and less than 50%)	10
Organic Litter	The covering rate of the leaf soil layer to a benchmark	A leaf soil layer is mainly based on a native species -- do thing or not	5
Logs	The sum total length of the log to a benchmark. (A stump 10 cm or more in diameter and a 1.3 m or less (10 cm or more in diameter)-high stump are also included)	Diameter more than half of the average DBH of Large tree existence rate (are they 25% or more and less than 25%)	5

Table.3 Landscape evaluation method of BBAM and HH

+BBAM Landscape value

- The percentage of native vegetation cover within the 1000-hectare and 100-hectare assessment circles
- The connectivity of the site's vegetation with surrounding vegetation
- Total adjacent remnant area – the area of native vegetation that is not in low condition and that is linked to the next area of native vegetation.

*Office of Environment and Heritage (OEH) websites: http://www.environment.nsw.gov.au/ (2012/10/25)

+HH Landscape value

- Patch size: Criteria and scores for the area of the nominated patch: <2ha,≥ 2 but<5ha,≥ 5 but<10ha,≥ 10 but<20ha,≥ 20 ha but 'significantly disturbed',≥ 20 ha but 'not significantly disturbed'
- Neighbourhoods: This component assesses the degree of both 'linked' and 'unlinked' native vegetation in the 'neighbourhood'. A total of three 'neighbourhoods' within nested radii (i.e. 100 m, 1 km, 5 km)
- Distance to core area: estimation of the distance to the nearest 'core area'. For the purposes of this assessment, a 'core area' is defined as a block of native vegetation greater than 50 ha.(> 5 km, 1–5 km, < 1 km, Contiguous)

*Department of Primary Industries, Victoria, Australia websites: http://www.dpi.vic.gov.au/home(2012/10/25)

Table.4 Resulets of BBAM

	BioBanking	A (Eco-west)	B (Suiden)	C (shiroyama)
Site Value (BM average)	Native over – storey cover	20	20	20
	Native mid – storey cover	10	20	10
	Native ground cover (Shrubs)	5	2.5	5
	Native ground cover (grasses)	6	0	20
	Native ground cover (others)	5	0	0
	Native plant species richness	25	75	50
	Total length of fallen logs	30	20	10
	Regeneration	37.5	37.5	37.5
	Exotic plant cover	15	15	15
	Number of trees with hollows	40	20	60
	Total Percentage (site score/maximum site score*100) (BM-Max)	70.4	77.8	78.7
	Total Percentage (site score/maximum site score*100) (BM-Average)	70.4	75.9	79.6
Landscape value	Percent native vegetation cover within a 1.79km radius of the site (1,000ha)	7.2	8.8	2.4
	Percent native vegetation cover within a 0.55km radius of the site (100ha)	4.5	3.0	1.5
	Connectivity value	0.0	0.0	0.0
	Total adjacent remnant area	3.0	0.0	0.0
	Total Landscape Value	14.7	11.8	3.9
	Site value + Landscape value (max=150) (BM max)	85.1	89.6	82.6
	Site value + Landscape value (max=150) (BM average)	85.1	87.7	83.5

:best score :worst score

*Hasegawa et al. (2013)

Table.5 Resulets of HH

	Habitat Hectare	A (Eco-west)	B (Suiden)	C (shiroyama)
Site Value	Large Trees	0	0	8
	Tree Canopy Cover	4	4	5
	Lack of Weeds	15	15	15
	Understorey	25	25	25
	Recruitment	10	3	3
	Organic Litter	5	5	5
	Logs	5	2	2
	Total Site Score	64	54	63
	HH(BM-MAX)	64	54	63
	HH(BM-AVERAGE)	64	54	63
Landscape value	Criteria and scores for the area of the nominated patch	1.00	1.00	2.00
	Neighbourhood comopnent for the atand shown:Radius100km	0.75	0.75	1.13
	Radius1km	1.00	1.00	0.10
	Radius5km	0.38	0.38	0.15
	Distance to core area	2.00	4.00	2.00
	Total Landscape Value	5.13	7.13	5.38
	Site value + Landscape value (max=100) (both BM max and BM average)	69.1	61.1	68.4

:best score :worst score

*Hasegawa & Hayashi (2012)
Hasegawa & Hayashi (2013)

4. Results

The results of this study, based on the field survey, are summarized in Table 4-5. The site evaluation results were different between the BBAM and the HH. In the BBAM assessment, the score of the site C was the highest and the evaluation of hollow and native ground cover (grasses and others) were higher in the site C than in the other sites. In the HH assessment, high score items were understorey and lack of weeds (Table

5). In the highest score site (site A), the scores of recruitment and logs were higher than that of the other sites, although the evaluation of large-tree was not higher.

In the BBAM landscape assessment, the site A had the highest value, whereas in the HH assessment, the site B had the highest. In the BBAM, the evaluation result of isolated forest, the site C, was very low, because of heavy weight of distance from large green area. In the HH, the difference of evaluation among sites was small because the evaluation included not only the distance to core area but also the patch size.

Total number of plant species, and aboveground biomass were the highest in the site B and followed by the site C (Table 6).

5. Discussion

The situation of Japanese urban secondary forest is different depending on forest management. This study indicated that the assessment classification and weighting technique of the BBAM and the HH can reflect the variety of situations of Japanese urban forest to some extent. According to the study, the assessment results depended on evaluation indicator employed in an assessment. For example, the overall BBAM score of the site C was the highest among three sites, but if you look at individual items, such as, total number of plant species and above ground biomass, the results were different (Table 6). According to this, the important point for biodiversity assessment is consideration of assessment purpose.

Table.6 Resaults of all indices

Site	A (Eco-west)	B (Suiden)	C (shiroyama)
●HH			
Total Site Score	64.0	54.0	63.0
Site value + Landscape value (max=100) (both BM max and BM average)	69.1	61.1	68.4
●BBAM			
Total Percentage (site score/maximum site score*100) (BM-Max)	70.4	77.8	78.7
Total Percentage (site score/maximum site score*100) (BM-Average)	70.4	75.9	79.6
Site value + Landscape value (max=150) (BM max)	85.1	89.6	82.6
Site value + Landscape value (max=150) (BM average)	85.1	87.7	83.5
●Fundamental Indices			
Total number	127	179	167
Species number	14	34	17
Above ground biomass(kg/400㎡)	4751.0	7888.4	6868.8

:best score :worst score

In the BBAM, the assessment priority of logs and hollows are higher after the total number of species, so that the BBAM methodology may successfully evaluate the native habitat of living things in secondary forest in Japan.

The BBAM focuses only on the existence of native ground cover (<1 m) (Table 2). Moreover, the height and diameter of trees are not contained in the survey item. Therefore, in this method it is difficult to appropriately evaluate young tree, seedling, and herbaceous layer. So, it is necessary to supplement it with other related evaluation items for example tree height and diameter.

The field survey of the HH may evaluate the quality of the forest habitat in detail because it includes the items like number of species, coverage of vegetation and health performance of trees. However, the evaluation of large tree and standing stock was not sufficiently included. Even though the evaluation criteria of large tree existed in the HH, we suggest that supplemental evaluation items related to large tree and standing stock should be added.

In the landscape assessment of the BBAM, the score of isolated forest was low. For instance, score of site C was the highest in the BBAM, whereas the total score was the lowest in the evaluation including landscape value. In landscape assessment of the BBAM and the HH, the distance from and contiguity with large-scale green patches are focused. However, especially in city area, isolated forest is ecologically important as stepping-stone and for the delivery of ecosystem services. It will be necessary to take the evaluation of isolation degree into consideration.

6. Conclusions

This study suggested that the state of tree and fallen leaves could evaluate properly by using the HH and the BBAM. However, several issues still remained on the following aspects: (1) improving the evaluation of the state of large trees and lower layer vegetation; (2) the evaluation of isolation of the forest; (3) the evaluation of management history of the forest; and (4) the evaluation of endangered species.

Acknowledgements

This study is granted partly by the Japan Society for the Promotion of Science through the "Funding Program for Next Generation World-Leading Researchers". The authors thank Ms Natsuko Yoshino, Mr. Kartik Malhotra, Mr. Kouhei Iwashita, Mr. Takahiro Ikeda, Mr. Shimpei Inoue, and research assistant staff for their assistance in field survey; Dr. Makoto Ooba and members of the Hayashi Lab for co-operation and assistance during the assessments.

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