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Doctoral Thesis （要約）

Contextualizing Urban Biodiversity Conservation:

Landscape Perception and Habitat-type Irreplaceability

(都市における生物多様性保全の概念化：

ランドスケープ評価とハビタートの非代替性に着目して)

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ABSTRACT

The field of biodiversity conservation originated from the standpoint of minimizing human contact with relatively-pristine ecosystems. However, increasing habitat loss, and the realization that current protected areas are ineffective in halting species decline have cast spotlight on the possibility of utilizing urban areas for biodiversity conservation. Maintaining biological diversity in urban areas also allows for adequate niche-level redundancy to maintain or boost the benefits that urban-green spaces provide to humans (regulatory, cultural and to a certain-extent, provisioning ecosystem services).

In order to maximize conservation goals and ecosystem service provision in urban areas, the conservation success of red-list species can be used as an indicator for the conceptualization of biologically viable and ecologically contextualized native landscapes. Current urban red-list species conservation measures originate from developed countries in the global North and are broadly applied to cities throughout the world despite their unique socio-ecological characteristics. These measures promote red-list species conservation through increasing percentage land area allocated to "green-spaces" within urban areas, while simultaneously targeting a decrease in the degree of fragmentation of such spaces. Such practices work on the prevailing assumption that urban "green-spaces" (which usually refer to manicured landscapes) are uniformly effective for red-list species conservation in cities throughout the world. This thinking may prove problematic in cities where red-list species richness of natural and urban areas differs significantly.

Furthermore, there has been limited focus on how social perception of urban green-spaces fit together with conservation goals. Previous studies on urban biodiversity conservation have mostly been conducted from the ecological standpoint of quantifying general rural-urban species change or surrogate taxa studies. Research on the social perception of nature at a landscape level remains divided between elucidating that landscape preference is predominantly driven by either nature conservation attitudes, or scenic aesthetic appreciation. Therefore, though well-meaning, most current red-list species conservation policies tend to result in the creation of uniform urban landscapes that vary in social and ecological effectiveness by location.

This study aims to provide recommendations for the contextualization of green-space creation and red-list species conservation through consideration of the inter-relationships between the ecological and social factors of (1) habitat-type irreplaceability of red-list species and (2) landscape-level nature conservation intent and scenic aesthetic landscape preference (collectively termed as landscape perception) of urban dwellers. Cities chosen for analysis are three highly urbanized centers (population densities of more than 5,200 people per km^2): Singapore, Tokyo (23 Wards) and Vancouver. Although situated in different ecological zones [Singapore: Tropical, Tokyo (23 Wards): Warm Temperate; Vancouver: Cold Temperate], the three cities have adopted similar strategies for urban red-list species conservation. Consistent with initial measures originating from the global North, these strategies center on targeting a broad increase in manicured green-space cover.

The methodologies associated with the abovementioned aims are: (1) categorizing occurrence records of red-list species from five taxa (vascular plants, mammals, amphibians, reptiles and birds) according to terrestrial landscapes with varying degrees of human modification. (2) Random distribution of a landscape perception questionnaire quantifying the correlation between components of landscape perception (the intent to preserve nature at a landscape level and scenic aesthetic landscape appreciation) and respondent demographic factors. In addition a land-use analysis at the neighborhood scale on four randomly selected 0.3 x 0.3 decimal degree grids was conducted to ascertain differences in a typical urban dwellers' potential exposure to different types of green-spaces on a daily basis. Results would then be used to draw theoretical implications and practical recommendations for urban biodiversity conservation that are sensitive to the socio-ecological uniqueness of each study site.

Beyond this empirical aim, the results obtained in this thesis would be used to discuss the need for a 'mindset change' in conservation biology. From the outset of preserving relatively-intact natural areas, to the recent development of acknowledging urban areas as a fallback option for conservation and ecosystem service provision, urban biodiversity conservation has merely been seen as a back-up option to rural conservation efforts. However, this thesis aims to show that biodiversity conservation in socially accepted landscapes within urban areas is a feasible option. Furthermore, it can potentially become a powerful tool to re-connect humans with nature (and, subsequently, inspire a wider sense of environmental protection), when properly combined with an understanding of the way urban-dwellers perceive and appraise their surrounding landscapes.

Results of the categorization of post-2000 records of red-list species from five taxa in each study site reveal that Singapore, a tropical study site, was found to harbor the highest number of red-list species (1,116 species), followed by Tokyo (23 Wards) with 967 red-list species and Vancouver with 301 red-list species. Results also reveal a decreasing gap between the number of unique red-list species found in naturalistic landscapes (primary vegetation and secondary vegetation) and urban manicured landscapes in Singapore, followed by Tokyo (23 Wards), then Vancouver. 696 unique red-list species from the five investigated taxa can be found in naturalistic landscapes and not in urban landscapes in Singapore. This difference decreases to 211 red-list species in Tokyo (23 Wards) and 173 in Vancouver. Habitat-type irreplaceability of manicured landscapes and urban areas for all five taxa was found to exhibit the same pattern [0.329 in Vancouver, 0.310 in Tokyo (23 Wards) and 0.188 in Singapore on a scale of 0: completely replaceable to 1: completely irreplaceable]. Landscape types that were found to contain the highest conservation potential also differed between the three sites. The highest habitat-type irreplaceability value corresponded to a collection of natural and manicured landscapes in Vancouver (0.329), a combination of primary and secondary vegetation in Tokyo (23 Wards) (0.342) and primary vegetation in Singapore (0.360). The ecological analysis conducted in this study emphasizes that conservation of red-list species within manicured urban greens is comparably less effective in Singapore, followed by Tokyo (23 Wards), but is relatively effective in Vancouver. However, it also shows that urban areas hold promise for conserving at least a quarter (about 20%) of the total red-list species, even in tropical areas.

With regards to the social acceptance of landscape types which would contribute to maximal red-list species conservation in urban areas, findings of the landscape perception survey was not completely optimistic. Survey response rates were 29% (88/300) in Singapore, 16% (313/2000) in Tokyo (23 Wards) and 11% (110/1000) in Vancouver. Although respondents significantly valued the preservation of nature over its utilization regardless of location, landscapes that were widely preferred were not always those which supported maximal red-list species conservation. The majority of the respondents were found to significantly prefer visually non-complex landscapes. This resulted in manicured landscapes being increasingly preferred over naturalistic landscapes in the order of Singapore to Tokyo (23 Wards) to Vancouver.

Accordingly, Vancouverites exhibited a "best case scenario" whereby preferred landscapes coincided with landscapes with the highest habitat-type irreplaceability values (natural and manicured landscapes). Tokyoites' and Singaporeans' preferences were less consistent and inconsistent with habitat-types best suited for conservation (Tokyo: secondary and manicured landscapes; Singapore: manicured landscapes). From open-ended questionnaire answers and interview responses, reasons driving landscape selection were given to be predominantly aesthetic in all three cities, with the exception of Vancouverites citing biodiversity conservation as an additional motivator. Furthermore, results of a land-use analysis on the amount of manicured and naturalistic landscapes present at a neighborhood-level in the three study sites revealed no overall significant differences, thereby excluding *potential* exposure as an explanatory driver of landscape perception.

In summary, social and landscape results show that respondents in all three study-cities significantly value the preservation of nature over its utilization (landscape level) but have a landscape preference which is generally confined to visually non-complex landscapes. Therefore, there is a possibility that nature conservation intent functions less as a predictor of landscape preference than scenic aesthetics in tropical and warm temperate cities like Singapore and Tokyo (23 Wards). This could be due to the existence of a landscape "complexity preference limit" inherent in urban dwellers, where landscapes having too much biodiversity are deemed as visually chaotic and potentially unpleasant. The ecological results presented in this thesis highlights the natural baseline characteristic of extremely high red-list species-richness within natural tropical landscapes and the relatively lower species-richness in cool and warm temperate natural landscapes. Accordingly, across all three cities, preferred, non-complex landscapes were those that contain moderately high levels of unique red-list species (around 300 unique red-list species). However, this does not mean that conservation within default landscape preference is in conflict with ecological goals. In cold temperate cities (e.g. Vancouver), and to a certain extent, warm temperate cities [e.g. Tokyo (23 Wards)], non-complex habitat types included natural landscapes with significant habitat-type irreplaceability values.

The results of this study support city-specific social and ecological uniqueness. In accordance with prevailing social preference and habitat-type irreplaceability, it is easier to naturalize urban landscapes and conserve red-list species by default in Vancouver, as compared to Tokyo (23 Wards) and Singapore (most difficult). This result shows that current urban biodiversity conservation methods of increasing manicured landscape cover in cities can be effective in

temperate zones but highlights the need for contextualized urban biodiversity conservation, especially in Singapore and Tokyo (23 Wards). Some recommendations are provided as follows:

A) Encourage a mindset change among policy-makers and practitioners towards realizing the potential of urban areas for conservation.
B) Maintain existing urban landscape aesthetics while increasing conservation capacity through micro-habitat modification especially in Singapore and Tokyo (23 Wards).
C) Consider the inclusion of non-invasive exotic species in non-complex landscapes insofar as they aid in the stabilization of microclimates. In some cases, non-invasive exotic species are already widely accepted by the general public [(e.g. Ginko trees in Tokyo 23 Wards)] and can be used as a focal point to increase acceptance of a more biodiversity city.
D) Encourage habitat-connectivity between parks and natural landscapes, instead of just between manicured landscapes.
E) Among survey respondents who indicated preference for both naturalistic and manicured landscapes, policy-targetable factors for increasing acceptance of naturalistic landscapes are conservation education in Singapore and encouraging frequent park-going behavior in Tokyo (23 Wards). A positive feedback spiral could then exist between promoting (A to E) and E as positive correlations were also found between experience of biodiversity, younger age, intent to preserve nature and naturalistic landscape choice. No significant correlating factors were found in Vancouver as the majority of respondents already had a preference for both naturalistic and manicured landscapes.

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