

論文の内容の要旨

論文題目 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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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 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 the creation of conservation subdivisions (i.e. clustering built areas in order to maximize the percentage allocation of continuous “green-space” within development projects) or through increasing “green-spaces” within urban areas. These 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. Though well-meaning, initial 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 in three highly urbanized cities (population densities of more than 5,200 people per km²): 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. Ecological and social indicators selected for the contextualization of urban biodiversity

conservation in each study site focuses on: (1) quantifying landscape-level nature conservation intent and landscape preference (collectively termed landscape perception) of urban-dwellers, as well as investigating underlying preference drivers, (2) profiling red-list species richness by terrestrial habitat type with consideration of habitat-type irreplaceability and subsequently, (3) providing recommendations for conservation of red-list species in urban areas that are sensitive to the socio-ecological uniqueness of each study site.

The methodologies associated with the abovementioned aims are: (1) random distribution of a landscape perception questionnaire to urban dwellers in each of the study sites, in addition to a four 0.3 decimal degree grids land-use analysis to ascertain differences in potential exposure to different types of green-spaces at a neighborhood level, (2) categorizing occurrence records of red-list species from five taxa (vascular plants, mammals, amphibians, reptiles and birds) to terrestrial landscapes with varying degrees of human modification and (3) drawing recommendations for urban biodiversity conservation which are unique to each study site from results obtained through (1), (2), literature reviews and interviews with informants involved in biodiversity conservation/ urban planning.

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 obtained in from this study on 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 (1,129 species), followed by Tokyo (23 Wards) with 967 red-list species and Vancouver with 301 red-list species. Results also reveal a decreasing species-richness gap between naturalistic landscapes (primary/ old-secondary vegetation) and urban manicured landscapes in Singapore, followed by Tokyo (23 Wards), then Vancouver. 726 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 369 red-list species in Tokyo (23 Wards) and 20 in Vancouver. Habitat-type irreplaceability of manicured landscapes and urban areas for all five taxa was found to exhibit the same pattern (0.467 in Vancouver, 0.310 in Tokyo and 0.188 in Singapore on a scale of 0: completely replaceable to 1: completely irreplaceable). 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, 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 30% (90/300) in Singapore, 15.7% (313/2000) in Tokyo and 11% (110/1000) in Vancouver. Although respondents significantly valued the preservation of nature over its utilization regardless of location (Singapore: ANOVA, $df_1=2$ $df_2=3060$, $p < 0.001$; Tokyo: ANOVA, $df_1=1$ $df_2=6884$ $p < 0.001$; Vancouver: ANOVA, $df_1=1$ $df_2=217$, $p < 0.001$), landscapes that were widely preferred were not always those which supported red-list species conservation. The majority of the respondents were found to significantly prefer 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 [χ^2 , $p < 0.05$, + $((O-E)/\sqrt{E}) > 2SE$].

This is possibly 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. Accordingly, landscape-level species-richness is closely tied to landscape preference. 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. Consequently, this result can further feedback into explaining why landscape preference was found to be idealistic and unfortunately, most ecologically incorrect in Singapore due to the lack of actual experience in natural landscapes. In contrast, Tokyoites held a more realistic/experience-based perception of nature in Tokyo while Vancouver presented the “best case scenario” of a match between realism and idealism. The lower natural diversity of deciduous and cool-temperate forests in Tokyo and Vancouver meant that these natural landscapes were within the “complexity preference limit” and hence offered a higher level of practical/ on-site human-nature interaction. As evidenced from the survey results, it was found that respondents who frequently visited natural habitats in Singapore made up 21.5 percent of the dataset while this percentage was 51.8 in Tokyo and 57.8 in Vancouver. In line with Vancouverites’ idealism, they also were found to have the highest score for intention to preserve natural landscapes and had biodiversity conservation as a prominent landscape preference motivator.

A land-use analysis on the amount of manicured and naturalistic landscapes available to a typical resident 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. This further supports the discussion that urbanites would not visit natural landscapes, in-spite of them being accessible, if they had a diversity and visual complexity which exceeded the “complexity preference limit”. In the case of this thesis, results show that this “complexity preference limit” excludes tropical natural landscapes and primary cool-temperate forests in Tokyo. Therefore, in accordance with prevailing social preference, it is again easier to naturalize urban landscapes and conserve red-list species by default in Vancouver, as compared to Tokyo and Singapore (most difficult).

In totality, the results of this study support city-specific social and ecological uniqueness. This highlights the need for contextualized urban biodiversity conservation, especially in urban green-spaces (i.e. manicured landscapes) within cities like Singapore and Tokyo (23 Wards). However, on the optimistic side, results also show that urban areas are capable of harboring a sizable amount of at least 100 distinct red-list species regardless of ecological zone. This amount can be potentially increased to about 300 and 480 red-list species in Vancouver and Tokyo respectively, considering that the default landscape preference includes

natural landscapes in these two cities. Besides eco-zone dependent biodiversity (which determines landscapes that fall within the social “complexity preference limit”), landscape perception can be further shaped by the distinct urban planning movements in each study site. In light of findings in this thesis, theoretical and practical recommendations for contextualization of urban biodiversity conservation are:

- A) Encourage a mindset change among policy-makers and biodiversity conservation practitioners that urban areas are just a fallback option for biodiversity conservation. This research has shown that urban areas are home to at least 100 different red-list species regardless of location and thus, may constitute a unique ecosystem of its own. This is especially relevant in Tokyo and Vancouver, where social preference included natural landscapes in urban areas, thereby potentially increasing the total number red-list species which can be conserved within social acceptance limits in urban areas. A more positive “branding” of the biodiversity conservation capacity in cities could also serve to direct future political, economic and scientific will towards more effective research on urban ecology.
- B) Maintain existing urban landscape aesthetics while increasing conservation capacity through micro-habitat modification, in order to further improve urban red-list species conservation in Vancouver, and prompt bigger improvements in Singapore and Tokyo (23 Wards).
- C) 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 (Stepwise Forward MLR, $df=12$, $p < 0.05$) and encouraging frequent park-going behavior in Tokyo (23 Wards) (Stepwise Forward MLR, $df=9$, $p < 0.05$). No significant correlating factors were found in Vancouver as majority of the respondents already had an existing preference for both naturalistic and manicured landscapes. However, there is no completely straightforward method for ensuring acceptance of naturalistic landscapes in Singapore and Tokyo (23 Wards) as positive correlations were also found between intent to preserve nature, younger age and naturalistic landscape choice.
- D) Promote habitat connectivity with adjacent patches of primary/ old-secondary forest and secondary forests in Singapore, and primary/ old-secondary forest in Tokyo (23 Wards). This is in light of findings showing that habitat-type irreplaceability of natural landscapes is higher than manicured landscapes and urban areas in Singapore and Tokyo (23 Wards).