Status and Impact Assessment of Invasive Alien Plant Species (IAPS): A Case Study from Galyang Municipality, Syangja Nepal

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Abstract

Invasive alien species are non-native species of plants or animals which spread and dominate new areas and are believed to cause harm to the environment, ecosystems and human well-being. Present study was conducted in Ward 11 of Galyang Municipality in Syangja district of Nepal to document the status of invasive alien plant species (IAPS) and find out the impact of such IAPS to local livelihoods through ecological assessment, household survey and regeneration survey in different land use types. A total of sixteen different IAPS were recorded, but were dominated by *Ageratum houstonianum, Bidens pilosa, Chromolaena odarata*. The present study showed that the diversity of IAPS was inversely proportional to altitude and dense forest stand. The regeneration density of desired species was found to be 5107/ha in invaded areas and 11556/ha in non-invaded areas. Fallow land and rangeland were observed to be most invaded land use types with greatest economic loss in rangeland. In case of forest, the impact on regeneration was high in open canopy and areas having high levels of grazing impact. Local people are responding to increasing invasion through hand removal and use of IAPS biomass as mulch and fuel wood for controlling the invasion in the study area.

Keywords: Ecological assessment, Invasive alien plant species (IAPS), Regeneration density, Land use type, Syangja

Introduction

Invasive Alien Species (IAS) are understood as those non-native species of plant or animal origin, having a tendency to spread and dominate in a new area and are believed to cause harm to the environment, ecosystems and human well-being (Ehrenfeld, 2010). The introduction of alien species to a new location can either be accidental or intentional (Enserink, 1999). Accidental introductions are propagated by travel across countries and continents and import of various items such as timber, food grains, fodder etc. (Shimono & Konuma, 2008). Intentional introductions are for a variety of purposes such as agriculture, horticulture, forestry and ornamental plant cultivation (Cremer, 2003).

Non-native invasive plants species are also known as exotic pest plants or invasion exotics. These exotic pest plants alter the structure and function of an ecosystem resulting in major threats to native plant communities and cause major changes in vegetation at global levels (Vitousek et al., 1996; Mack et al., 2000). Invasive plants usually possess traits that make them effective invaders, such as short life cycles, high growth rate, large number of seeds with good dispersal ability, and good colonizing capacity (Bisht et al., 2016). The globalization of trade, travel, and transport is greatly increasing the diversity and number of IAPS around the world, as well as the rate at which they are moving. At the same time, changes in climate and land use are rendering some habitats more susceptible to biological invasions (Meyerson & Reaser, 2003).

Since 17th century, IAPS have been the agents for nearly 40 percent of different animal extinctions for which cause is known (CBD, 2002). The CBD (1992) has set global priorities, and guidelines on collecting information and on coordinating international actions on invasive alien species. The fifth IUCN World Park Congress in 2003 underlined the need for managing IAPS as an “emerging issue”, which was further emphasized at the sixth World Park Congress in 2014. Nepal, being a signatory of the Convention on Biological Diversity (CBD), is required to prevent the introduction of IAPS and to control or eradicate those IAPS that threaten ecosystems, habitats and species (CBD, 1992).

Large numbers of invasive plant species have been recorded in Nepal due to its diverse altitudinal, climatic and geographic features. There are at least 219 alien species of flowering plants found in Nepal (Tiwari, 2005; Siwakoti, 2012). An assessment of invasive alien plant species (IAPS) was undertaken the first time by IUCN Nepal during 2002/2003 and reported 21 naturalized (i.e. alien species with self-sustaining population) flowering plant species to be invasive in Nepal (Tiwari, 2005). Most of these species are found in the Terai, the Siwalik and the Mid-hills of Nepal. Among the 100 worst invasive plant species of world, 11 plant species are found in Nepal (Lowe et al., 2000). Of these, seven most invasive species are on the list of Asia Pacific Region and these include *Ageratina adenophora,*

Ageratum conyzoides, Chromolaena odorata, Eichhornia crissepes, Lantana camara, Mikania micrantha and Parthenium hysterophorus (Sankaran et al., 2005). However, limited research has been carried out in Nepal based on the status and impact assessment of invasive alien plant species on different ecosystems. Galyang Municipality also has noticeable invasion by such plant species over the past few years; however, no systematic study has been conducted on the status of such species. Therefore, this study has been proposed to list such IAS, find out the status, and assess the impact on regeneration in Galyang Municipality. The study also intends to evaluate the perception of local people on such invasive species and suggests management options to control these identified species in the study area.

Materials and Methods

Study Area

The study was conducted in Galyang Municipality of Syangja district which is located in central mid-hill region of Nepal covering the area of 122.69 km^2 (Figure 1). Within the municipality, intensive study was conducted in Ward 11, Tulsibhanjyang area. The area was selected for the study due to topographic and elevational variation, high level of out-ward migration, expanse of degraded forest and fallow land and record of invasion from the past. It is located between latitudes 27.93°N, and longitudes 83.63° E. This area includes rivers like the Kaligandaki and the Aadhikhola. The elevation of the area ranges from 385-1085m from sea level and variation in elevation coupled with topography has contributed to occurrence of riverine forest dominated by *Acacia catechu* and tropical mixed deciduous forest dominated by *Shorea robusta.*

Sample Design

The distribution of the IAPS differs by aspect, elevation ranges, and land use type; thus in order to cover all aspects, the research was conducted by stratifying the study site into 200 m elevation range wise strata as shown (Figure 2). Sample locations were situated in each stratum at an interval of about 1km in such a way that those plots could cover all the land use types, elevation ranges and aspect. Altogether, 23 sample plots were selected for data collection.

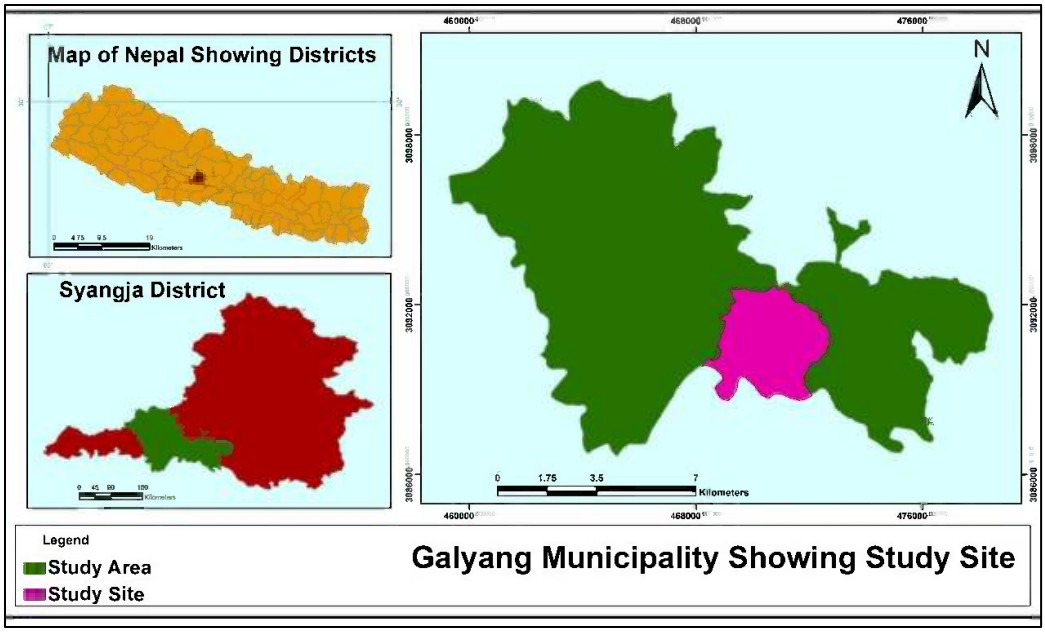

Figure 1 *Map of Nepal showing the study area*

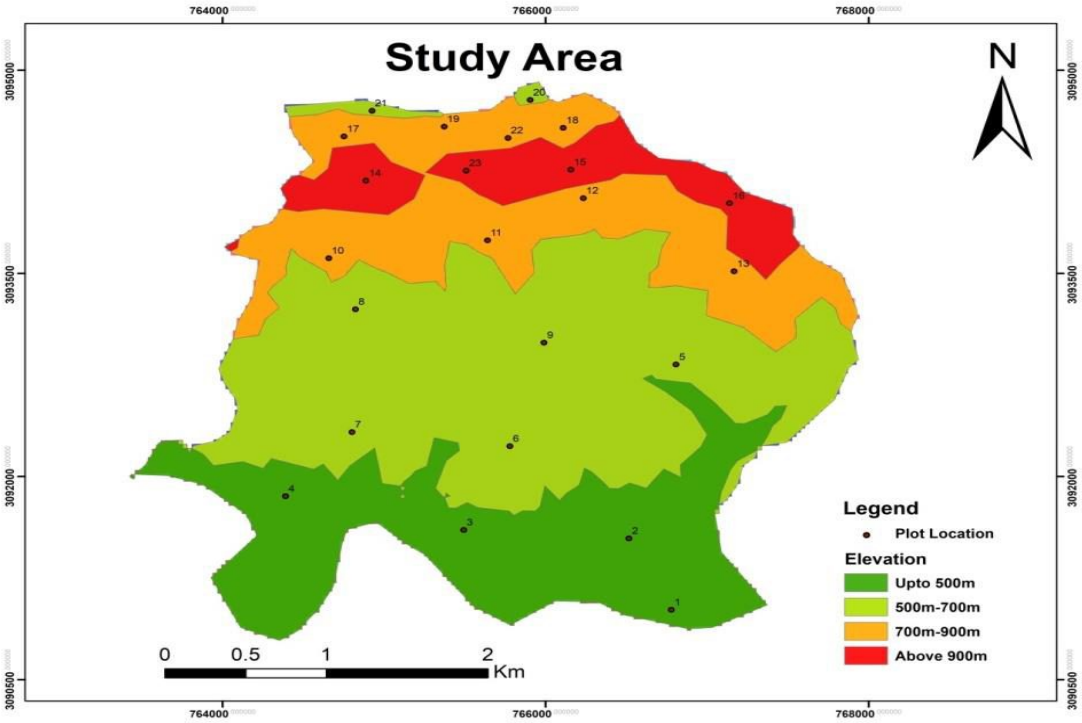

Figure 2 *Study Area showing sampling plots*

Ecological Assessment

In each plot, quadrat dimensions of 10m*10m was used for the inventory of the invasive plant species and within the same location two quadrats of 1m*1m for IAPS with heights of less than 1meter and 2m*2m for species with heights of more than 1 meter were laid (Fig.3). Rapid ecological assessment was carried out in different sites as per different aspects, ecosystems, elevation ranges and location.

Household Survey

In order to find the status, impact of invasive plants on biodiversity, socio-economy of locals, household survey was conducted at different sites of the study site. A total of 45 households were surveyed through questionnaire and information were collected from people belonging to different sex, age group, caste, family status, education status etc.

Regeneration Survey

Regeneration survey was carried out in invasive plant invaded and few non-invaded regions from forest and rangeland ecosystems selected with a circular plot of radius 1.78m.

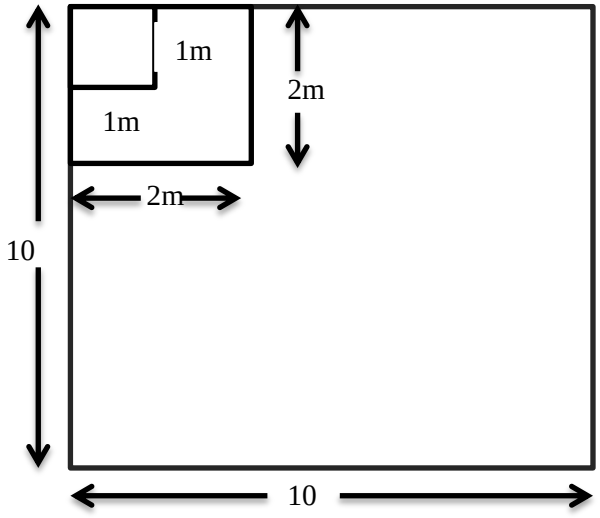

Figure 3 *Quadrat dimension*

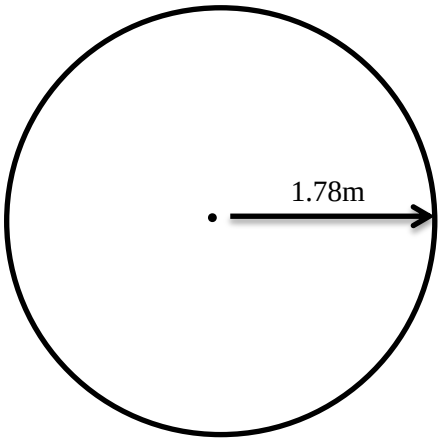

Figure 4 *Circular plot*

Data Analysis

Data was analyzed by both quantitative and qualitative methods. Quantitative methods were used to find the current status of IAPS, regeneration analysis. Analysis of species distribution was carried out through Important Value Index (IVI) method (Cottam & Curtis, 1956) which was introduced for

comparison of species dominance. The IVI provides a quantitative basis for the classification of community, which reflects the overall importance of a species; the IVI for a species is calculated as the sum of its relative frequency, relative density and relative abundance, as follows:

IVI= Relative Frequency (%) + Relative Density (%) + Relative Abundance (%)

Results and Discussion

Status of IAPS

A rapid ecological assessment identified sixteen different IAPS from the sites, which are among the 219 IAPS found in Nepal. Listing of those invasive plants as per aspect, elevation, land use types with respect to study site are shown in Table 1.

Table 1 *Listing of IAPS of Study Area*

Invasive Plant Species of Study site with Local Name	**Naturalized IAPS found in Study Site**	**Aspect**	**Elevation (m)**	**Land use types**
Chromolaena odarata (Seto Banmara)	*Chromolaena odarata*	S	385-1085	F, FL, RL
Ageratina adhenophora (Kalo Banmara)	*Ageratina adhenophora*	N	500-1085	F, Ag, FL, RL
Ageratum houstonianum (Nilo Ganne)	*Ageratum houstonianum*	S,N	385-1085	Ag, FL
Ageratum conyzoides (Gandhe)	*Ageratum conyzoides*	S,N	385-1085	Ag, FL
Parthenium hysterophorus (Pati Jhar)	*Parthenium hysterophorus*	N	500-1085	F, Ag, FL, RL
Bidens pilosa (Kalo Kuro)	*Bidens pilosa*	S, N	385-1085	F, Ag, FL, RL
Rubus elliptius (Aaiselu)		S, N	385-1085	F, RL
Amaranthus spinosus (Kande Lude)	*Amaranthus spinosus*	S	385-1085	AG, FL
Argemone mexicana (Thakal)	*Argemone mexicana*	N	500-1085	FL, RL
Senna tora (Tapre)	*Senna tora*	S	385-700	FL
Senna occidentalis (Panwar)	*Senna occidentalis*	S, N	385-700	FL
Hyptis suaveolens (Ban Tulsi)	*Hyptis suaveolens*	S	385-700	F, FL
Mimosa pudica (Lajjawati)	*Mimosa pudica*	S	385-1085	FL,
Oxalis latifolia (Chari amilo)	*Oxalis latifolia*	S	385-1085	FL
Xanthium stromarium (Bhende Kuro)	*Xanthium stromarium*	S	385-700	FL, RL
Urena lobata (Nalu Kuro)		S	385-700	F, FL, RL

Where, N = Northern Aspect; S = Southern Aspect; F = Forest; Ag = Agriculture land; FL = Fallow Land; RL = Range Land

Among the 100 worst IAPS of world (Lowe et al., 2000), 14 worst species are prevalent in Nepal, and among them, five species were recorded in Tulsibhanjyang, Ward-11 of Galyang Municipality. Similarly, among seven worst invasive alien plant species of Asia Pacific regions (Sankaran et al., 2005), five (*C odarata, A adhenophora, A conyzoides, P hysterophorous, R ellipticus*) were recorded from the

study site. Based on household survey response, invasive plant species like *Ageratum conyzoides, Oxalis latifolia, Amaranthus spinosus* were present from the past, but, *C odatata* is reported to have recently appeared and most widely impacting the site. About half of the surveyed people responded that *C odarata* appeared around only 20 years ago, while only a few respondents said that it appeared around 10 years ago. Among the 21 important IAPS of Nepal, those that were present in Syangja district were *Ageretina adhenophora, Mimosa pudica, Amaranthus spinosus and Oxalis latifolia* (Tiwari, 2005). in addition to this, ten more invasive species that are under 25 important IAPS (Shrestha et al., 2016) of Nepal were recorded in this study and those include *C. odarata, B. pilosa, P. hysterophorus, A. conyzoides, A. mexicana, S. tora, S. occidentalis, H. suaveolens, X. strumarium, A. houstonianum* .

Detail analysis of IVI in the study area showed that *Bidens pilosa, Ageratum houstonianum* and *Chromolaena odarata* had high species dominance while *Xanthium stromarium, Senna tora* and *Argemone maxicana* had the lowest species dominance in the study area (Table 2).

Table 2 *Status of identified IAPS*

S.N	Species	RD (in %)	RF (in %)	RA (in %)	IVI (in %)
1	*Chromolaena odarata* (Seto Banmara)	12.93	14.29	10.71	37.93
2	*Ageratina adhenophora* (Kalo Banmara)	11.11	8.16	8.05	27.33
3	*Ageratum houstonianum* (Nilo Ganne)	20.50	14.29	8.49	43.27
4	*Ageratum conyzoides* (Gandhe)	2.68	4.08	3.89	10.65
5	*Parthenium hysterophorus* (Pati Jhar)	7.09	8.16	5.14	20.39
6	*Bidens pilosa* (Kalo Kuro)	15.90	16.33	5.76	37.99
7	*Rubus elliptius* (Aaiselu)	1.92	6.12	1.85	9.89
8	*Amaranthus spinosus* (Kande Lude)	3.83	2.04	11.11	16.98
9	*Argemone mexicana* (Thakal)	1.53	3.06	2.96	7.56
10	*Senna tora* (Tapre)	1.34	2.04	3.89	7.27
11	*Senna occidentalis* (Panwar)	1.92	5.10	2.22	9.24
12	*Hyptis suaveolens* (Ban Tulsi)	3.83	4.08	5.55	13.47
13	*Mimosa pudica* (Lajjawati)	3.64	6.12	3.52	13.28
14	*Oxalis latifolia* (Chari amilo)	8.43	3.06	16.29	27.78
15	*Xanthium stromarium* (Bhende Kuro)	1.15	2.04	3.33	6.52
16	*Urena lobata* (Nalu Kuro)	4.98	4.08	7.22	16.28

Based on people's perception from the economic point of view *C odarata, A conyzoides, A houstonianum* were most problematic. The distribution of these problematic species on different land use shows that fallow land was highly invaded by these species in natural environment followed by rangeland (Figure 5).

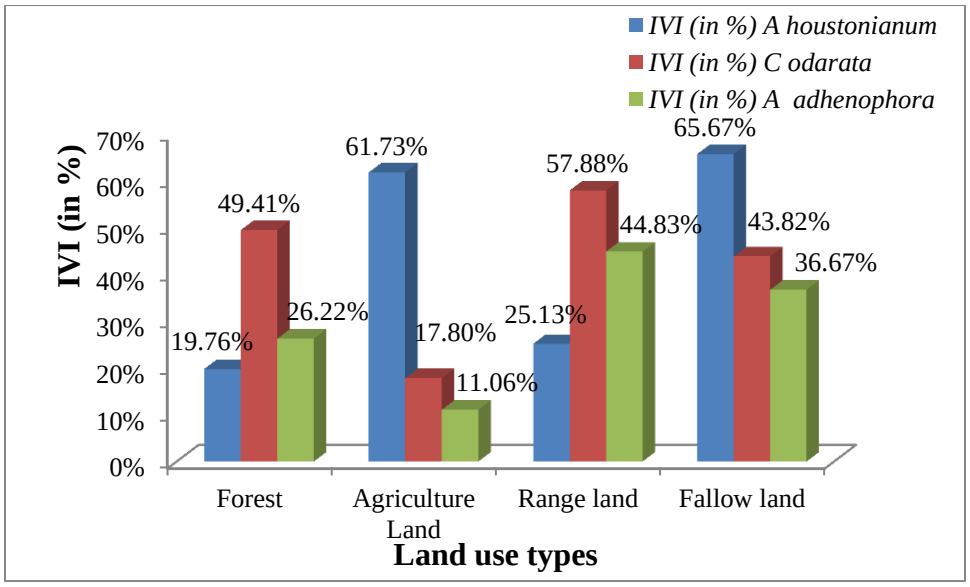

Figure 5 *The importance value index for key invasive species on different land use types*

The household survey conducted on 45 households revealed that the most invaded land use type was found to be range land followed by fallow land. This is probably because, in agriculture land tillage is carried out at least annually. Thus, there is no invasion in close canopy of forest as opposed to range land and fallow land where management activities are not carried out.

Impacts on Regeneration of Desired Species:

On calculating the average regeneration per hectare, there were only 5107 individuals/ha in IAPS invaded areas and 11556 individuals/ha in non-invaded areas. Impact on regeneration of some of high value species of that area are shown in Figure 6.

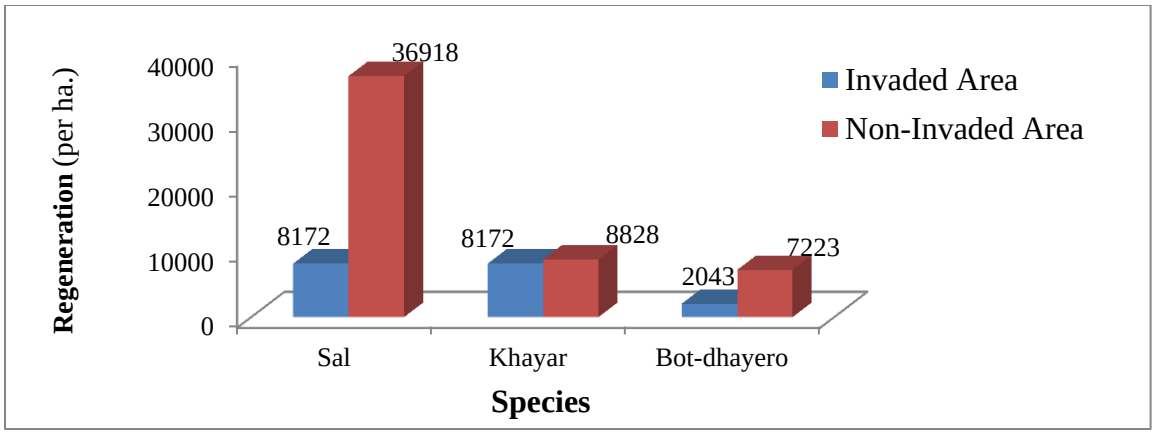

Figure 6 *Impacts on Regeneration of Desired Species*

The impact of IAPS seems to be high in degraded or open canopied forest while in case of rangeland high impact were seen in IAPS invaded region (Table 3).

Table 3 *Average regeneration in different land use*

Average Regeneration in Forest		**Average Regeneration in Rangeland**	
Open Canopy (/ha.)	Closed Canopy (/ha.)	Invaded region (/ha.)	Non-Invaded Region (/ha.)
4943	14232	5296	11938

Management of IAPS:

IAPS have both positive and negative impacts. These plants supply a variety of forest products and services including fuel wood, animal feed, soil conservation, rehabilitation of degraded lands and cultural values. But the negative impacts of IAPS are far more than those of benefits thus, these species must be managed. Management of invasive species involves three basic strategies: prevention, eradication and control (Radosevich et al., 2009). As the study area is already invaded by invasive species, prevention and eradication is not possible. Thus, the only strategy is to control them such they further they cannot invade more areas. 68.89% of respondents engage mechanical removal of IAPS; 17.78% respondents take no action for management while remaining 13.33% were observed to use chemicals to control these species

Conclusion

In the study area, a total of sixteen IAPS were recorded. Among the recorded IAPS, *Ageratum houstonianum, Bidens pilosa, Chromolaena odarata* had high species dominance. Economically *C odarata* was reported to be the most problematic with higher impact in range land, while ecologically, fallow land was found to be a highly invaded land use type. Regeneration of desired species is affected by invasion of IAPS in forest and rangeland type and in average regeneration in invaded region was 5107/ha while 11556/ha in non-invaded region. Distribution and diversity of IAPS was found higher in southern aspect compared to northern aspect. Similarly, in altitudinal variation, it was observed that the invasion of IAPS decreased with an increase in altitude. Most of the people were unaware about the IAPS and their impact on native species, so awareness among local people particularly for identification and control measure has been recommended. Mechanical control measure could be applied for removal by uprooting manage the number. Last but not least, enrichment plantation in degraded forest and open canopy has been recommended for reducing the rate of invasion as the numbers of invasive species were observed to be higher in open canopy areas.

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