

1. Introduction

Many herbaceous plants are threatened with extinction due to decrease in grassland in Japan. The communities dominated by native herbaceous plants were mostly in soils with low available phosphate in northern Kanto area, where Andisols have developed (Hiradate et al., 2008). Available phosphate is usually limited in Andisols due to high aluminum contents, and its increases promote invasion and luxuriance of exotic herbaceous plants. We investigated the factors affecting herbaceous plant communities in Towada, Aomori, northern part of Japan, where Andisols have developed.

2. Materials and Methods

We conducted vegetation surveys at 63 locations around the fields, ski sites, roadside slopes, and took soil samples for chemical analysis. Available phosphate was estimated by Bray II that modified for Andisols. Available nitrogen was evaluated by hot water extraction (Uezono et al., 2009). Total carbon and total nitrogen contents were determined by dry combustion. Factors affecting number of herbaceous plants were examined by stepwise multiple regression analysis.

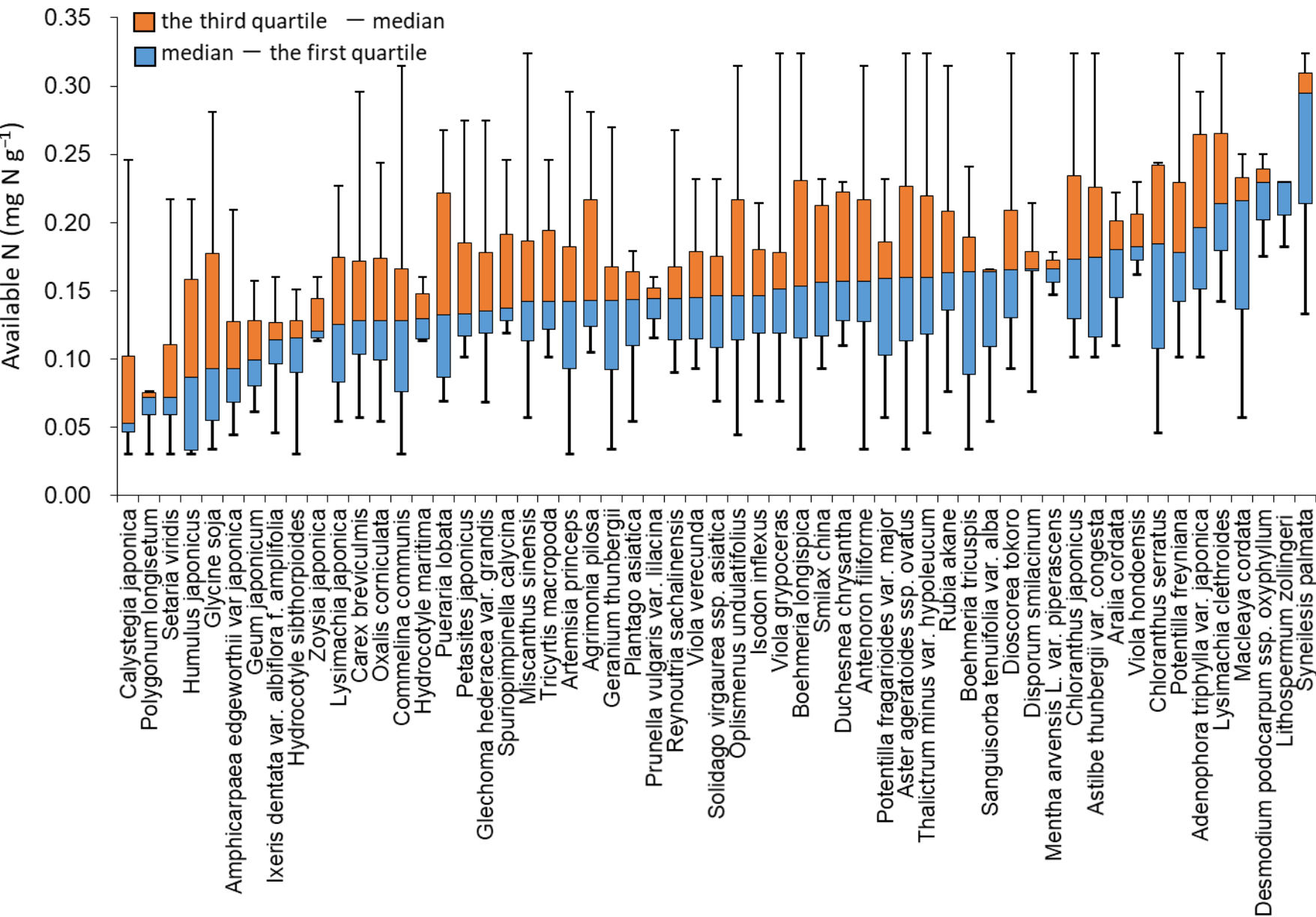


Figure 1. Available nitrogen contents of soils in which each herbaceous plant grew

Table 1: Factors affecting number of herbaceous plants

	Standardized partial regression coefficient			
	All sites (63)	Periphery of field (20)	Ski sites (23)	Vairous ¹ (20)
Number of exotic plants	—0.235	—0.268		
Coverage of exotic plants	—0.580	—0.632	—0.385	—0.397
Available N (mg N g ⁻¹)	0.377			0.462
Available P (mg P ₂ O ₅ kg ⁻¹)			—0.373	—0.383
Water content (%)				0.303
pH (NaF)	0.224			0.316
C/N ratio ²	0.165			
N/P ratio ³		0.367		
Coefficient ⁴	0.659***	0.595***	0.262*	0.827***

1: Slopes of roadside, sides of irrigation canal, and so on
2: Total carbon content / Total nitrogen content
3: Total nitrogen content / Available phosphate content
4: Adjusted coefficient of determination
Values in parenthesis are number of sites



Thalictrum minus
var. hypoleucum



Lithospermum
zollingeri

3. Results

Many herbaceous plants, including *Thalictrum minus* var. *Hypoleucum*, grew in both low and high nitrogen content soils. Some herbaceous plants grew within a certain range of available nitrogen content, such as *Polygonum longisetum* grew in low available nitrogen content but *Lithospermum zollingeri* in high soil (Fig. 1).

The number of native plant species was 2 to 22, with an average of 11 species. The mean number of native plant species was 8 at periphery of field, 11 at roadside slopes, and 13 at ski sites, respectively.

Overall, the coverage of exotic plants was the most influential factor, and it decreased the number of native plants (Table 1). Available nitrogen was the second most influential factor and positively affected. Available nitrogen affected the number of native plants at roadside slopes. At this place, the number decreased with available phosphate. This was also true at ski sites.

4. Discussion and Conclusion

Invasion of exotic herbaceous plants decreased the number of native plants in Towada, Aomori. Since increases in available phosphate promote invasion of exotic herbaceous plants, it affected negatively. On the other hand, available nitrogen increased the number of native plants. Based on quadratic regression equation, the number of species tended to decrease when available nitrogen exceeded 0.27 mg g⁻¹. Therefore, it is important to manage not to exceed this available nitrogen amounts.