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# Effects of Deforestation Practice on the Distribution and Abundance of Herpetofauna in Mt. Gariwang, South Korea

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## Abstract

To know if deforestation practice affects the distribution and abundance of herpetofauna in Mt. Gariwang, South Korea, we conducted field surveys over 12 times both at deforested (n=9 sites) and un-touched (control, n=12 sites) forest areas from March to October, 2017. Each survey site was approximately 100 m long×20 m wide area, which in the middle of the site, mountain road presented. During each survey, we recorded the species and the number of amphibians and reptiles which identified. To compare environments between the two areas, we analyzed eight environmental variables, extracted from digital sources. Overall, we found one amphibian and four reptile species at deforested area, while each five amphibian and reptile species at un-touched area. The number of amphibian species significantly tended to be smaller at deforested area. The number of the survey sites where amphibians found and the number of amphibian individuals showed the same trend. For reptiles, although the number of reptile individuals showed some increases, all variables investigated were not significantly changed by deforestation practice. Our results imply that deforestation practice negatively affects amphibians, but effects of that on reptiles are not evident.

**Key Words:** amphibian, reptile, deforestation, Mt. Gariwang, forest management

## Introduction

Forest managements such as lumbering and harvesting various forest resources are inevitable and important in South Korea because mountain forests accounts for more than 67% of the country. Various positive and negative impacts have reported following the practice of forest managements (deMaynadier and Hunter 1995; Pike et al. 2011; Demarais et al. 2017). In particular, deforestation practice generally changed forest structures and often generated fragmented forest areas, subsequently resulting in various negative impacts on biological diversity (Hunter 1999). To effectively and sustainably conduct forest managements while minimizing negative impacts on forest wildlife understanding on how such deforestation practices affect ecological aspects of forest wildlife is critical.

Amphibians and reptiles play a key role in mountain forest ecosystems. They require and use both aquatic and terrestrial habitats depending on developmental stages and different seasons. From a view of food chain, amphibians

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such as salamanders and frogs consume various arthropods and insects, but on the other hand, they are important prey for reptiles, birds, and small mammals (Lee and Park 2016). Unlike amphibians, reptiles mainly consume small mammals such as mountain mouse and in part, amphibians (Kim and Oh 2014; Choi et al. 2017). In South Korea, studies on the distribution and ecological function of amphibians and reptiles in forest ecosystems are very few, excepting recent several studies on how different tree stands affect the distribution of amphibians and reptiles and on the status of herpetofauna in several national forests (Kim et al. 2011; Park et al. 2014; Choi et al. 2017; Kwon et al. 2017; Park et al. 2017). Nevertheless, whether or not forest managements such as deforestation practice affects herpetofauna in mountain forests is not studied.

In this study, we investigated if deforestation practice affects the distribution and abundance of herpetofauna in Mt. Gariwang, located at Pyeongchang-gun, Kangwon-do, South Korea. Our results could be useful to prepare efficient forest management plans to conserve biological diversity in Korean forests.

## Materials and Methods

For amphibian and reptile surveys, we arbitrary selected 9 and 12 survey sites for each deforested and un-touched (control) forest areas, respectively, which in the middle of the sites, mountain road presented. The size of each survey site was approximately 100 m long and 20 m wide. To prevent biased sampling, we did not include any sites adjoined mountain streams, in particular which have a debris barrier where amphibians could often breed. We surveyed all survey sites at total 12 times from March to October in 2017. Two men slowly walked throughout the survey site for approximately 20 min while recording the species and the number of each amphibians and reptiles identified. Although we also found some eggs and tadpoles of *Bombina orientalis*, we only used the number of adults for conversion difficulty of such data into the number of individual.

To compare environmental conditions between deforested and un-touched forest areas, we first extracted four environmental variables; altitude, slope, and aspects (raw data, four cardinal and intercardinal directions, and right angles) from the Digital Elevation Model (DEM) of Korea Forest Research Institute, and the distance from the nearest mountain stream from the Water Management Information System (WAMIS) of K Water. Because available stock map of Mt. Gariwang does not reflect recent deforestation practices, we calculated the percentage of tree stand, grass stand, mountain road, and deforested areas to total survey areas for each survey site using Google Earth images.

Because most data were not normally distributed, we conducted non-parametric statistical analyses. We used Mann-Whitney U test to compare the number of species identified per site, the number of individuals counted per site, and eight environmental variables measured between deforested and un-touched forest areas. Difference in the number of the sites where we found amphibian and reptiles was compared between the two areas using Fisher exact test due to its small sample size.

## Results and Discussion

Overall, we found one amphibian (*B. orientalis*, n=43) and four reptile species (*Takydromus amurensis, Elaphe dione, Gloydius brevicaudus, G. ussuriensis*, n=23) at deforested area, while each five amphibian (*Karsenia koreana, Onychodactylus koreanus, B. orientalis, Rana huanrenensis, R. dybowskii*, n=125) and reptile (*Takydromus amurensis, Amphiesma vibakari, Elaphe dione, Gloydius saxatilis, G. ussuriensis*, n=21) species at un-touched area. Out of eight environmental variables, only percentage of tree stand (74.7% for un-touched and 25.4% for deforested areas; $Z=3.69$, $n=21$, $p<0.001$) and percentage of deforested areas (0.0% for un-touched and 53.9% for deforested areas; $Z=4.12$, $n=21$, $p<0.001$) were different between deforested and un-touched forest areas, indicating that any differences in herpetofauna between the two areas could be mainly by deforestation practice.

The number of amphibian species per site tended to be different ($Z=1.92$, $n=21$, $p=0.055$) between deforested and un-touched areas as mean 0.4 and 1.1 species per site, respectively (Fig. 1). Although the number of the sites where amphibians found (44.4%, 81.8% for deforested and un-touched areas, respectively) and the number of individuals per site (4.8 inds, 11.4 inds, respectively) showed

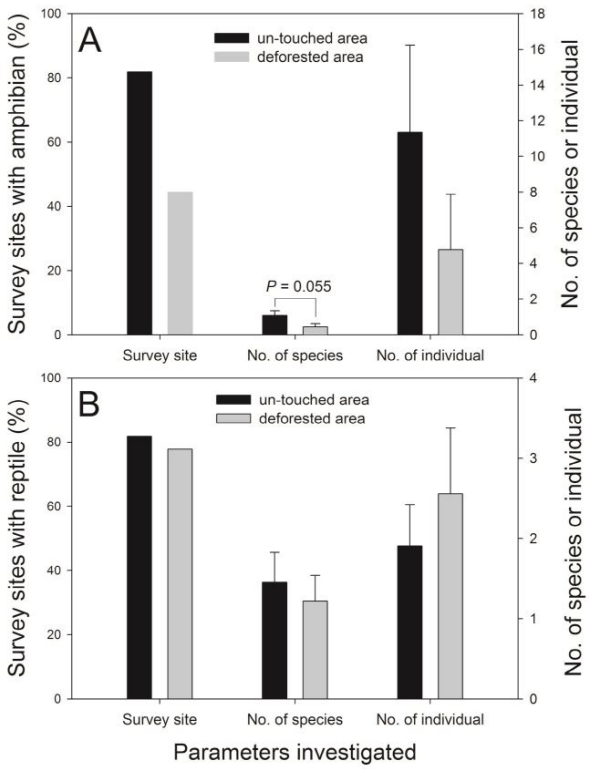


**Fig. 1.** Deforestation practice likely, negatively affected amphibian communities, in special for the number of amphibian species identified (A), while it did not evidently affect reptile communities although the number of reptile individuals showed some increases in deforested areas (B).

same trend, the differences were not statistically significant ($ps > 0.05$, Fig. 1). For reptiles, the number of the sites where reptiles found and the number of species per site showed some decreases and the number of individuals per site showed some increases in deforestation areas, but such changes were not statistically significant ($ps > 0.05$, Fig. 1).

Deforestation practice might negatively affect amphibian communities in Mt. Gariwang. In forest ecosystems, amphibians generally breed in mountain streams or in temporal ponds, formed along the ditches of mountain roads (Lee and Park 2016) and during non-breeding season they use forest floors as microhabitat. Deforestation practice resulted in decreased water levels in mountain streams or fully drying the streams due to the loss of water holding capacity of forests, but it also caused frequent flooding of the streams during a raining season (Likens et al. 1970). Also, deforestation practice removes the trees which provide appropriate canopies for amphibian microhabitat, causing decreased quality of forest microhabitat for amphibians (Hunter 1999). Therefore such changes in the deforested areas of Mt. Gariwang could be responsible for fewer amphibian species detection compared to that in un-touched, preserved, forest areas. In this study, we only found *B. orientalis* at deforested areas, but found five different species at un-touched areas. The abundance of amphibians also showed same trend. These results suggest that deforestation practice could negatively impact amphibians in mountain forests.

Unlike amphibians, negative impacts of deforestation practice might be trivial for reptiles, at least at the current time window of the deforestation. Deforestation practice has been known to change insect communities at forest floors (Paquin and Coderre 1997; Park et al. 2016) and subsequently negatively affect the abundance of lizards in forest ecosystems (Scott et al. 2005). Related studies to discuss are not currently available in South Korea. On the other hand, at certain time window after deforestation, deforested condition could increase small mammals in the areas (McLeod and Gates 1998; Kang et al. 2013). In forests, it has been known that reptiles mainly forage small mammals although they also consume some amphibians (Choi et al. 2017). So, increased preys by deforestation practice could positively affect the presence of reptiles in deforested areas. In addition, deforestation practice could provide more basking sites for some reptiles (Hunter 1999). Within forests, snakes often use canopy gaps or edges of mountain roads as basking sites (Choi et al. 2017). Such changes by deforestation could be in part beneficial for some reptiles (McLeod and Gates 1998; Pike et al. 2011) such as *G. ussuriensis* and *T. amurensis* identified in this study. Impacts of deforestation practice on reptiles could be greatly changed along the time window after initial deforestation. Therefore, to know exactly how deforestation practice affects reptile fauna, long-term monitoring studies should be done using a pre- and post-deforestation experimental design.

Our results imply that deforestation practice negatively affects amphibians, but effects of deforestation practice on reptiles are not evident. Considering ecological importance of amphibians and reptiles as both preys and predators and the function of organic and inorganic cycling in mountain forests, how forest managements affect the distribution and abundance of herpetofauna should be further investigated,

in special through a long-term monitoring study.

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