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Impact of Forest Management on Grade Changes in the Ecological and Natural Map of Korea

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ABSTRACT

This study analyzes objections to the Ecological and Natural Map submitted to the National Institute of Ecology from 2014 to 2024 to evaluate the impacts of forest management on changes within the Ecological and Natural Map. Among 958 objection cases, 178 (18.58%) were related to forest management, accounting for 31.23% of the total objection area. Sites subjected to forest management showed notable decreases in Grade 1 areas (33.15%) and increases in Grade 3 areas (43.21%), indicating that forest management can reduce ecological value and accelerate downgrading within the Ecological and Natural Map. Some cases also revealed intentional management to induce map changes for development purposes. In response, the Ministry of Environment revised the 2024 guidelines to defer map re-evaluation for five years in managed areas; however, this may be insufficient considering longer forest recovery periods. The study provides empirical evidence linking forest management to ecological degradation and offers insights for policy improvement and sustainable land management.

Keywords: Ecological and Natural Map, Environmental impact assessment, Environmental policy, Forest management, Objections to the Ecological and Natural Map

Introduction

The natural environment provides the essential resources for human life, such as food, clothing, and shelter, and serves as the foundation for economic activities (Moon, 2015). However, human activities aimed at increasing convenience and improving living standards have led to resource depletion and expanded environmental destruction. This has become not only a national issue but also a global one (Park & Park, 2008). Globally, urban expansion and cropland displacement have been shown to contribute to both direct and indirect forest loss, and research has confirmed that human activities can accelerate the destruction of tropical forests (Davis *et al.*, 2020; van Vliet, 2019). In Korea, to prevent indiscriminate development of natural environments, the use of Ecological and Natural Map (ENM) is mandated in the development and environmental planning processes. The ENM is a map that classifies Korea's natural environment based on ecological value, naturalness, and landscape value (Korea Legislation Research Institute, 2024) (Fig. 1). The grades of the ENM are categorized into Grade 1, Grade 2, Grade 3, and separate management areas, based on the Natural Environment Conservation Act and guidelines for creating the ENM. Grade 1 areas are for the conservation and restoration of natural environments, Grade 2 areas for the conservation and minimization of damage due to use and development, and Grade 3 areas for areas where systematic development and use are possible (Korea Legislation

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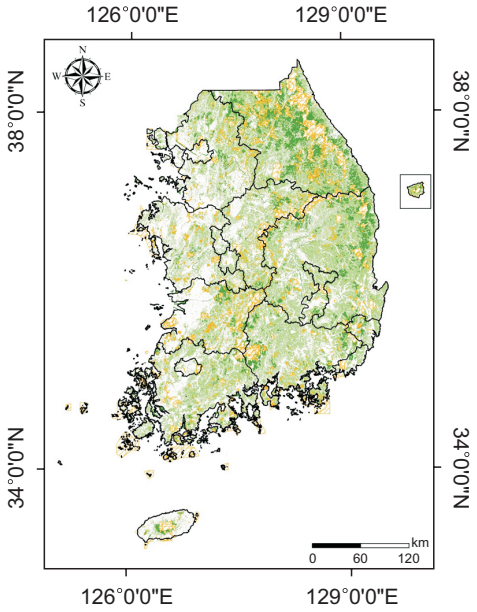

Fig. 1. ENM of Korea (green: ENM 1st Grade, light green: ENM 2nd Grade, white: ENM 3rd Grade, orange: separate management areas). ENM, Ecological and Natural Map.

Research Institute, 2024). These grades make it easy to understand the current state of the natural environment, and they are highly significant for land development. Especially, Grade 1 areas, which are of high ecological and scenic value and function as habitats for endangered wildlife, have very high conservation value, and development in these areas is strongly discouraged to prevent damage to the environment. This has led landowners and developers to view the classification as a regulatory and restrictive measure, and it has become a common cause for objections to the ENM (Ahn *et al.*, 2015). When Grade 1 areas are included in a proposed development site, authorities such as the national government or local governments often recommend excluding these areas from the development plan or reject the proposal. Landowners and developers then request changes to the grade of the ENM to facilitate development (Jung *et al.*, 2017). Since it was legislated in 1998 and first announced in 2007, the ENM has been continuously revised to reflect the latest natural environmental survey data. Requests for changes in the grades of the ENM have consistently occurred since 2007 (Ahn *et al.*, 2015; Jung *et al.*, 2017; Oh *et al.*, 2023). If the grade does not change, repeated requests for grade modifications are made, or efforts are made to degrade the environment in order to induce a lower grade (Jung *et al.*, 2017; Oh *et al.*, 2023). According to the guidelines for creating the ENM, if a natural environment is unlawfully damaged, the grade is maintained for ten years. However, no penalties are imposed for non-illegal environmental damage. Therefore, after receiving approval for forest management activities, such as forest thinning, some request grade changes based on the altered natural environment.

Research on the ENM has included studies on the economic value of Grade 1 areas (Shin & Min, 2005), complaints regarding the ENM (Ahn *et al.*, 2015; Jung *et al.*, 2017; Oh *et al.*, 2023), factors influencing grade downgrades (Choi *et al.*, 2019; Kang *et al.*, 2023), and the status of Grade 1 areas in the ENM (Yoon *et al.*, 2024). Additionally, while some studies have explored the impact of artificial damage on the ENM grades (Choi *et al.*, 2019), this study have only compared data before and after the regular assessments, and no studies have examined the impact of forest management on objections. This study aims to investigate the influence of forest management on objections by analyzing cases of objections filed after forest management activities.

Materials and Methods

We analyzed objections cases submitted to the National Institute of Ecology from 2014 to 2024. All submissions—including approved, withdrawn, and rejected cases—were considered. Specific analyses included:

Objections trends: To examine the cases of objections filed after forest management, the number of objections received over the past 10 years and the number of those related to forest management were reviewed. The distribution of all objection areas and the areas where forest management was identified were analyzed. The analysis of objections cases included all submissions, including those processed normally, withdrawn, or rejected.

Grade changes: Comparison of ENM grades before and after forest management in objection areas using ArcGIS-based spatial analysis (ArcGIS 10.8.; ESRI, Redlands, CA, USA). However, objections regarding cancellation, rejection, and the designation or removal of separate management zones were not included in the area comparison analysis, as they are unrelated to changes in grade.

Results

Trends in objections

The total number of objections filed over the 11-year period from 2014 to 2024 was found to be 958. The highest number of objections was recorded in 2018 with 177 cases, followed by 131 cases in 2021, 107 cases in 2019, 91 cases in 2022, 85 cases in 2017, 82 cases in 2020, 76 cases in 2023, 64 cases in 2024, 52 cases in 2014, 51 cases in 2016, and 42 cases in 2015. From 2014 to 2021, the number of objections showed a gradual increase, but from 2021, a decreasing trend was observed. During the same period, 178 objections related to for-

est management were identified. The highest number of these was recorded in 2019 with 32 cases, followed by 24 cases in 2018, 21 cases in both 2020 and 2021, 15 cases in both 2017 and 2024, 13 cases in both 2022 and 2023, 12 cases in 2016, 7 cases in 2014, and 5 cases in 2015 (Table 1). An analysis of objection cases related to confirmed forest management by region revealed the following distribution: 53 cases in Gangwon Special Self-governing Province, 31 in Gyeonggi-do, 30 in Gyeongsangnam-do, 21 in Chungcheongnam-do, 17 in Gyeongsangbuk-do, 9 in Jeonbuk Special Self-governing Province, 5 in Ulsan, 4 in Jeollanam-do, 4 in Busan, 3 in Chungcheongbuk-do, and 1 in Incheon (Table 2).

Table 1. Annual number of cases to total objections and objection after forest management

Year	Total case	Forest management case
2014	52	7
2015	42	5
2016	51	12
2017	85	15
2018	177	24
2019	107	32
2020	82	21
2021	131	21
2022	91	13
2023	76	13
2024	64	15

Types of forest management

The forest management types were classified into five categories. Clear-cutting included areas where only partial clear-cutting was carried out within the objection regions. Among the types, clear-cutting accounted for the highest proportion with 117 cases, followed by thinning with 42 cases, pest control with 13 cases, pruning with 4 cases, and others with 2 cases (Table 3).

Grade changes

The total area processed for objections filed between 2014 and 2024 was found to be 106,873,300 m^2. The changes in area by ENM grade before and after the objections were as follows: Grade 1-95,806,391 m^2, Grade 2-8,208,041 m^2, and Grade 3-2,858,868 m^2 before, and Grade 1-27,223,061 m^2, Grade 2-50,146,706 m^2, and Grade 3-29,503,533 m^2 after. The area of Grade 1 decreased by 68,583,330 m^2, while Grade 2 increased by 41,938,665 m^2, and Grade 3 increased by 26,644,665 m^2. The area with confirmed forest management was 33,381,020 m^2. The changes in area by grade in forest management areas were as follows: Grade 1-33,381,020 m^2, Grade 2-3,154,663 m^2, and Grade 3-314,507 m^2 before, and Grade 1-10,645,143 m^2, Grade 2-14,377,886 m^2, and Grade 3-11,827,160 m^2 after. The area of Grade 1 decreased by 22,735,877 m^2, while Grade 2 increased by 11,223,223 m^2, and Grade 3 increased by 11,512,653 m^2 (Table 4). An analysis of changes in Grade 1 area by administrative region indicates that Gangwon Special Self-governing Province experienced the largest decrease, with a reduction of 11,411,752 m^2. This was followed by Gyeongsangnam-do (2,606,440 m^2), Gyeonggi-do (2,334,458 m^2), Gyeongsangbuk-do (2,025,939 m^2), Ulsan (1,732,659 m^2), Chungcheongnam-

Table 2. Number of objections by administrative district and changes in ENM grades following forest managment

	Cases	Before objection			After objection		
		1st area (m^2)	2nd area (m^2)	3rd area (m^2)	1st area (m^2)	2nd area (m^2)	3rd area (m^2)
Gangwon Special Self-governing Province	53	20,101,590	1,642,526	61,076	8,689,838	7,379,425	5,735,929
Gyeonggi-do	31	3,133,403	298,762	48,131	798,945	1,056,053	1,625,298
Gyeongsangnam-do	30	2,894,006	383,165	184,437	287,566	2,454,066	719,976
Chungcheongnam-do	21	1,094,850	105,735	4,052	88,338	530,242	586,057
Gyeongsangbuk-do	17	2,663,654	565,450	2,644	637,715	329,442	2,264,591
Jeonbuk Special Self-governing Province	9	301,222	2,971	7,655	33,351	136,615	141,882
Ulsan	5	1,732,659	49,250	49	0	1,689,907	92,051
Jeollanam-do	4	333,646	106,804	2,597	20,311	81,724	341,012
Busan	4	760,475	0	3,836	79,410	529,649	155,252
Chungcheongbuk-do	3	363,524	0	30	9,670	190,762	163,122
Incheon	1	1,990	0	0	0	0	1,990

ENM, Ecological and Natural Map.

Table 3. Number of cases by forest management types

	Clear-cutting	Thinning	Pests and disease management	Pruning	Ohter
Number of case	117	42	13	4	2

Table 4. Changes in ENM areas due to objection to ENM

	ENM grade	Total case area (m^2)	Forest management case area (m^2)
Before objection	1st	95,806,391	33,381,020
	2nd	8,208,041	3,154,663
	3rd	2,858,868	314,507
After objection	1st	27,223,061	10,645,143
	2nd	50,146,706	14,377,886
	3rd	29,503,533	11,827,160

ENM, Ecological and Natural Map.

do (1,006,512 m^2), Busan (681,065 m^2), Chungcheongbuk-do (353,854 m^2), Jeollanam-do (313,335 m^2), Jeonbuk Special Self-governing Province (267,871 m^2), and Incheon (1,990 m^2) (Table 2).

Forest management and changes in Ecological and Natural Map grades

The areas with confirmed forest management accounted for 18.58% of the total objections filed. The area of objections related to forest management made up 31.23% of the total area of objections. Examining the changes in area by ENM grade, areas with forest management contributed to 33.15% of the decrease in Grade 1 area, 26.76% of the increase in Grade 2 area, and 43.21% of the increase in Grade 3 area.

Discussion

The ENM is used in environmental policies of the government and local authorities, as well as in environmental impact assessments for land development (Korea Legislation Research Institute, 2024). Specifically, administrative agencies use the ENM grades as a criterion for granting development permits, effectively making the grades a form of regulation. As a result, objections to the ENM are primarily filed for the purpose of land development (Ahn *et al.*, 2015; Jung *et al.*, 2017; Oh *et al.*, 2023).

According to the results of this study, the number of objections to the ENM has gradually decreased, but objections after forest management practices have remained consistent. These cases accounted for 18.58% of the total objections, and forest management accounted for 43.21% of the increase in Grade 3 areas, indicating that forest management has a significant impact on the increase in Grade 3 areas. Regionally, a relatively high number of objections following forest management were observed in Gangwon Special Self-governing Province, which has a high proportion of Grade 1 distribution, as well as in Gyeonggi-do and Gyeongsangnam-do, where land development pressure is high (Table 2).

The Forest Resources Development and Management Act defines forest management as a project aimed at maintaining, developing, or restoring the functions of forests (Korea Law Information Center, 2023). Forest resource management is considered a critical undertaking to create ecologically stable and disaster-resistant economic forests (Jang *et al.*, 2008; Woo *et al.*, 2012).

However, in cases where the desired grade changes are not achieved through objections to the ENM, there have been instances where objections are filed again after forest management, such as logging (Oh *et al.*, 2023). The primary goal of forest management is to promote healthy forest ecosystems, and ENM grades are not considered when implementing such activities. According to the Natural Environment Conservation Act, the ENM is intended to be used in development planning where environmental degradation is anticipated. Therefore, forest management does not fall within the scope of ENM applications. However, there have been confirmed attempts to exploit this legal loophole to intentionally lower ENM grades. The following process was identified through several cases (National Institute of Ecology, 2020; 2023) (Figs. 2, 3): First, forest management is carried out after obtaining approval for forest management. Second, objections to the ENM are filed to attempt a grade change. Third, once the grade change is completed, development projects, such as environmental impact assessments, are initiated. In particular, if the development area is below the minimum threshold for environmental impact assessment (e.g., an area of 30,000 m^2 or less), the downgrade of the ENM rating due to forest management may lead directly to development without undergoing an environmental impact assessment review. It appears that forest management is being used as a means to induce grade downgrades in the ENM.

Conclusion

Due to the identified issue of ENM grade downgrading caused by forest management projects, the Ministry of Environment amended relevant legislation in September 2024 (Korea Law Information Center, 2024). In areas where forest management has been implemented, ENM

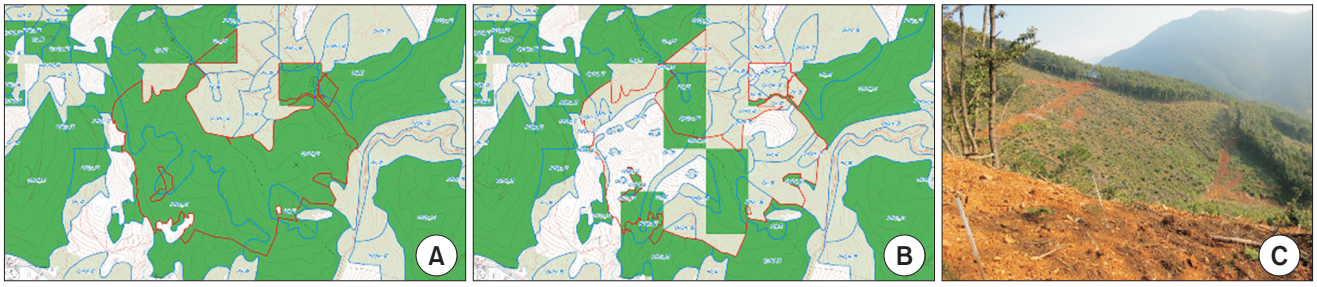

Fig. 2. Changes ENM grades after forest management (case area: Samcheok). (A) Before objections to the ENM. (B) After objections to the ENM. (C) Forest management implementation site. In this area, an environmental impact assessment for resource extraction was approved following the change in the ENM grade. Source: National Institute of Ecology (2020). ENM, Ecological and Natural Map.

Fig. 3. Changes in ENM grades after forest management (case area: Mungyeong). (A) Before objections to the ENM. (B) After objections to the ENM. (C) Forest management implementation site. In this area, an environmental impact assessment for cable car development was approved following the change in the ENM grade. Source: National Institute of Ecology (2023). ENM, Ecological and Natural Map.

grade will now be based on pre-management survey data, without reflecting new changes in the natural environment for a period of five years. However, under the current grading criteria of the ENM, vegetation older than 30 years, with high naturalness, is classified as Grade 1 (Korea Law Information Center, 2024). It is judged that five years is insufficient time for forests disturbed by forest management to recover to their previous state. An analysis of future objection cases is necessary to evaluate the effectiveness of the recent legal amendments, and in-depth research is required to ensure that the forest management and ENM system are operated in alignment with their original objectives.

Author Contributions

Data curation: WO. Funding acquisition: WO. Methodology: WO. Software: HYY. Supervision: WO. Visualization: HYY. Writing – original draft: WO. Writing – review & editing: HYY, JC.

Conflict of Interest

The authors declare that they have no competing interests.

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