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Application of Management System with Sub-working Groups Varying in Rotation for Mountainous Forests in Japan

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The purpose of this paper is to examine the possibility of application of the management system with sub-working groups varying in rotation for mountainous forests. This management system has been devised on the basis of the German "fliegende betriebsklasse". The forests under this system are divided into several subdivisions termed "sub-working groups", and one of the sub-working groups is regarded as a "sustainable production facility" on an appropriate rotation basis, and the others are regarded as "maintenance facilities" varying in rotation according to damage conditions. If the damage occurs in such forests, the forest manager interchanges the damaged stands in the sub-working group regarded as the sustainable production facility with sound stands in the sub-working groups regarded as the maintenance facilities in order to reduce the disorder of the system caused by the damage. Judging from the application methods of this system to the Kyushu Electricity Inc. Forest, this system will be able to apply to sugi plantations suffering from wind damage under clear-cutting system in Japan.

INTRODUCTION

Mountain forests in inaccessible areas of Japan have been rapidly and intensively converted into plantations of conifers such as sugi (Japanese cedar) and hinoki (Japanese cypress) without concerning for any supporting techniques. Consequently, these plantations have been extensively damaged by wind, frost, snow and animals. The total area damaged during a specified planned period of operation in a relatively small area such as a working group may be forecast on the basis of usual damage conditions, but it is difficult to forecast which of many individual stands will be damaged, and when and how the damage will occur.

A useful management system for such plantations that would incorporate unforecastable damage to stands was devised on the basis of the Germam "fliegende betriebsklasse" (Imada, 1993), which was applied to the German "kiefer" plantations damaged by insects and fungi (Katayama, 1932; Trebeljahr, 1923). The purpose of this study is to examine the possibility of application of this system to sugi plantations damaged by wind in Japan.

STUDY AREA

The study area is 1,782-hectare plantation of sugi (Japanese cedar) which is part of the Kyushu Electricity Inc. Forest, 4,452 hectares in area, and is located in nothern Kyushu, southern Japan.

This sugi plantation is composed of 11 age-classes from the l-5 through the 51-55, and was actually damaged by typhoons in 1991 (Kyushu Rinsan Inc., 1993).

The areas damaged in this plantation were 107 hectares in total, which occupied 6% of this plantation. The age-classes greatly damaged were 21-25 to 46-50 age-class.

APPLICATION OF THE SYSTEM

Arrangement of sub-working groups

We assume that the 1,782-hectare plantation is a working group. When applying the present management system to the working group, it is necessary to create a subdivision termed a "sub-working group" (Imada, 1993) within the working group. The procedures for arranging the system are as follows.

First, the appropriate rotation under undamaged conditions for the 1,782-hectare plantation should be determined. In this study, we determine this rotation to be 60 years on the basis of the management plan of the Kyushu Electricity Inc. Forest (Kyushu Rinsan Inc., 1992).

Second, the number of years in an age-class under this system should be defined. Though 5 years are in common use, 10 years seem advisable for this system, in which clear-cut stands may often be interchange between sub-working groups as described later, because of reduction in the number of age-classes in the 1,782-hectare plantation, thereby simplifying the above interchange. Defining the number of years to be 10, the 1,782-hectare plantation is composed of six age-classes from the 1-10 through the 51-60 age-class, as shown in Figure 1. Then, the number of years in the planned period of this forest operation coincides with this number of years (10 years).

Third, the youngest age-class heavily damaged by wind should be forecast on the basis of usual damage conditions, and thereafter, rotation shorter than the appropriate one (60 years) should be assumed. In this study, this youngest age-class suffering from heavy damage is forecast to be 21-30 on the basis of the wind damage data in this plantation (Kyushu Rinsan Inc. 1993), and consequently, three different rotations (30, 40

Sub-working group (SWG)	Rotation (years)	Areas (hectares) per age-class						
		1～10	11～20	21～30	31～40	41～50	51～60	Total
SWG_{60}	60	240	240	240	240	240	[240]	1440
SWG_{30}	30	37	37	[37]				111
SWG_{40}	40	39	39	39	[39]			156
SWG_{50}	50	15	15	15	15	[15]		75
Total	—	331	331	331	294	255	240	1782

Fig. 1. Age-class distribution figure for the 1,782-hectare plantation of sugi.

and 50 years) are assumed, as shown in column 2 of Figure 1.

Fourth, the areas damaged in the planned period (10 years) should be forecast for each age-class from 21-30 through 41-50, on the basis of the wind damage data. In this study, these damaged areas were forecast to be 37 hectares for the 21-30 , 39 hectares for the 31-40 and 15 hectares for the 41-50 age-class as shown by the cross-hatched areas in Figure 1 (Kyushu Rinsan Inc., 1993). At this stage, it is difficult and therefore unnecessary to forecast which of many individual stands in this 1,782-hectare plantation will be damaged, and when the damage will occur.

Fifth, the same areas forecast for each age-class in the preceding stage are allocated to the corresponding younger age-classes. Through the above processes, three stand groups operated on 30, 40 and 50-year rotations shorter than the appropriate one (60-year) are established in Figure 1.

Sixth, the remaining area (1,440 hectares) obtained by subtracting the total area (342 hectares) of three groups for the preceding rotations from the whole area (1,782 hectares) is regarded as the area operated on an appropriate 60-year rotation. This remaining area is evenly divided into each age-class on a 60-year rotation, as shown in Figure 1.

Through the series of procedures described above, four different stand groups, a 111-hectare group on a 30-year rotation to a 1,440-hectare group on a 60-year rotation, are arranged in the age-class distribution figure (Figure 1) by calculating the age-class areas on the basis of the forecast areas damaged in the 10 years. At this stage, these stand groups are not established in the actual 1,782-hectare plantation, and hence the individual stands that will belong to each stand group are also unlocated in the actual plantation. Accordingly, each of these stand groups, despite being on a different rotation, is not regarded as a normal working group with well-defined boundaries. Such stand groups within a working group under this management system are termed "sub-working group" (abbreviated to SWG in Figure 1), as stated earlier (Imada, 1993).

Locating stands of the oldest age-class

At this stage, these sub-working groups are arranged only in an age-class distribution figure. However, both the sub-working group structure and the age-class distribution in which the relatively older age-class areas decrease stepwise from 331 to 240 hectares, as seen in figure 1, constitute the normative framework within which the forest manager would like to bring his 1,782-hectare plantation under this management system.

When operating this system for the plantation, only the oldest age-class stands in each sub-working group, that is, the stands to be clear-cut during the planned period (10 years) should be actually located in the plantation at the start of the planned period. That is, the 37-hectare stand on a 30-year rotation to the 240-hectare stand on a 60-year one squared in the Figure 1 should be located in the 1,782-hectare plantation. Of course, these stands are located assuming that none of them will be damaged during the planned period.

However, result of locating the stands of the oldest age-class in Figure 1 is not represented in this paper.

Interchange of clear-cut stands between sub-working groups

When damage to stands occurs during the process of forest operation under this system, the forest manager will need to interchange these damaged stands with sound stands between the sub-working groups in order to reduce the disorder of this system caused by the damage.

If the damage occurs within the stands designated for clear-cutting in each sub-working group at the start of the planned period, clear-cutting will, of course, take precedence over the sound stands initially designated. Thus, in this case, it is unnecessary to interchange the stands actually clear-cut between the sub-working groups.

If the damage occurs outside the stands initially designated for clear-cutting in each sub-working group, the forest manager will need to interchange the actually clear-cut stands.

As mentioned earlier, this 1,782-hectare plantation was heavily damaged by the typhoons in 199 1 during a planned period. The damage in this plantation occurred outside the stands initially designated for clear-cutting as shown in Figure 2. In this study, interchange of clear-cut stands between sub-working groups is carried out for this wind damage in Figure 2.

First, the damaged 7.0%hectare stands in the 41-50-year age-class shown in Figure 2 were not included among the stands initially designated for clear-cutting. Then, the forest manager will need to interchange these damaged stands in SWG_{60} with the sound 7.03-hectare stands initially designated for clear-cutting in the 41-50-year age-class in SWG_{50}, as seen in Figure 2. At this stage, the forest manager carries out this interchange only in Figure 2. In response to this interchange, on the ground in the 1,782-hectare plantation, these damaged 7.0%hectare stands should be actually clear-cut as part of the clear-cut stands in SWG_{50}, whereas the preceding sound 7.03-hectare stands in SWG_{50} is left as part of the untouched stands in the 41-50 age-class in SWG_{60} as shown in Figure 3.

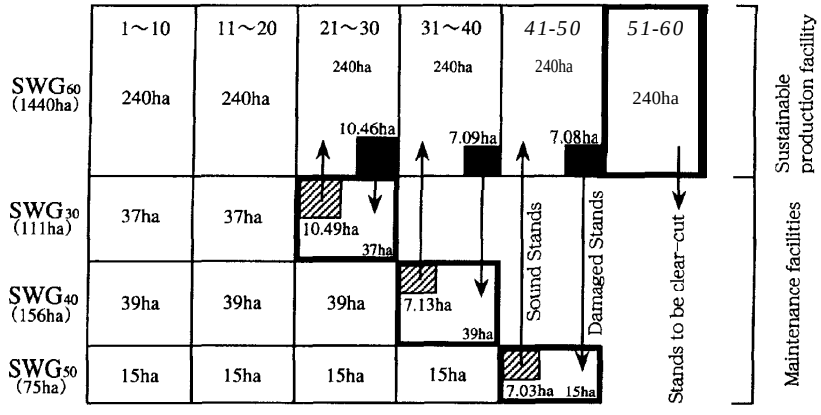

Fig. 2. Model for interchange of damaged stands with sound stands between sub-working groups.

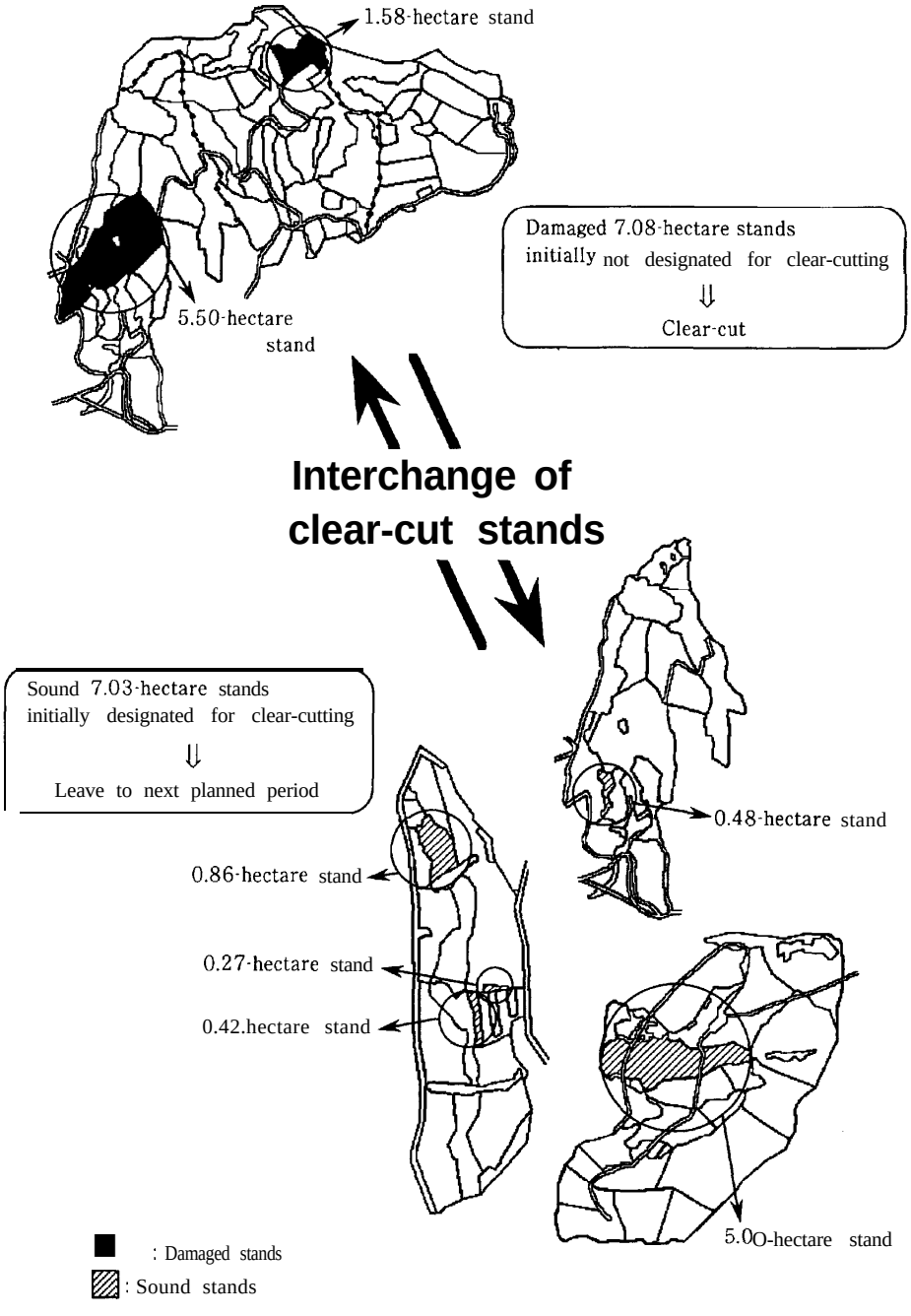

Fig. 3. Interchange of clear-cut stands.

Second, the damage to the 7.09-hectare stands in the 31-40-year age-class in Figure 2 occurred in the same manner as the above case. In this case, the damaged stands will be in either SWG_{60} or SWG_{50}, judging from Figure 2. In the process of forest operation under this system, these damaged stands are considered to occur in SWG_{60}. In the same manner as for the 41-50-year age-class case described above, the forest manager, only in Figure 2, needs to interchange these damaged stands with the sound stands between SWG_{60} and SWG,,,, as seen in Figure 2, and on the ground in the 1,782-hectare plantation, these damaged stands need to be clear-cut, whereas the sound stands is left intact.

In the case of damaged stands in the 21-30-year age-class, the forest manager needs to carry out the interchange only in Figure 2 and clear-cutting on the ground in the same way as for the damaged stands in the 31-40-year age-class, as seen in Figure 2.

DISCUSSION

As mentioned above, under this management system, a forest is composed of both a sub-working group regarded as a "sustainable production facility" on an appropriate rotation and several sub-working groups regarded as "maintenance facilities" varying in rotation for reduction the disorder of this system caused by the damage as shown in Figure 1. Furthermore, though each sub-working group in the age-class is equal in area, the forest comprising the sub-working groups is uneven, that is, becoming smaller stepwise from 331 to 240 hectares in total area in the relatively older age-class, as shown in Figure 1. Such a sub-working group structure and age-class distribution are the normative framework of the forest under this system.

In the process of forest operation under this system, the damage occurring within the stands initially not designated for clear-cutting in each sub-working group are regarded as the damage within the sustainable production facility. Consequently, the forest manager should be maintain the sustainable management system by exchanging the damaged stands in the sustainable production facility with sound stands in the maintenance facilities.

According to the series of procedures described here, this management system will be able to apply to sugi plantations suffering from wind damage under clear-cutting system in Japan. However, the following two preconditions will be needed for application of this system. First precondition is securing a market of middle and small-sized trees yielding from sub-working groups operated on a short rotation. Second precondition is preconstruction of enough forest roads to interchange the clear-cut stands.

Finally, if forest catastrophes exceeding the damage conditions forecast on the basis of the wind damage data in this plantation unfortunately occur, the operation of this system will be unavoidably disrupted.

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* The title is tentative translation from original Japanese title by the authors of this paper