Silvicultural Systems

Compiled by Ryosuke KATO

Japan International Forestry Promotion
and Cooperation Center

1997

Forest:

Grow naturally without interference by humans and still produce timber. Ecologically, biogeocoenosis which has dynamic equilibrium.

Forestry:

Manage the forest to produce wood material, non wood material, environmental material, gene pool, amenity effect and others.
To create the desired kinds of forests in order to realize these materials by using a knowledge of silvics and an understanding of the forest as plant community.

Management of the forest:

Classify the forest to conserve or harvest and manage it to fullfile the function of the forest by selection of conservation type and silvicultural system.

Silviculture:

Science and art of continuously reproducing and managing the forest through the application of silvics.

Silvicultural characteristics:

To handling a particular forest type or species.

1. Degree of tolerance to shade.
2. Windfirmness of root system.
3. Ability to grow in pure or mixed stands.
4. Growth in even-aged. all-aged or uneven-aged stands.
5. Relative easiness or difficulty of obtaining reproduction.

Silvicultural treatment:

To do the different treatments to obtain the desired results according to the economic object of forest owners based on the determining factors such as forest type. forest size, species composition, and silvicultural characteristics.

Silvicultural measures:

Two major groups to be applied to immature stands by using intermediate cuttings and to be followed in harvesting mature stands by using silvicultural systems.

Intermediate cuttings in immature stands

Intermediate cuttings:

Cutting from the time of its formation until ready for harvesting.

1. Measures:

To be designed to improve the stand to increase the rate of growth of the residual trees in the stand.

2. Practice:

Intermediate cuttings include timber stand improvement, Weeding or cleanings, release or liberation cuttings including salvage cuttings, sanitation cuttings, thinnings, and pruning.

3. Purpose :

To achieve the proper growing space for the best trees in the forest by favoring them and limiting competition.

Sllvicultural systems used in harvest cuttings.

Background:

A number of silvicultural systems has originally developed in Europe. Properly managed forest by proper silvicultural system can produce much greater volumes of better quality wood over the long run than unplanned logging. It is the reason why we need the proper silvicultural system to manage the forest.

The objective of a silvicultural system:

To permit the harvesting of the mature timber crop while providing for the regeneration of the forest.

Basically, silvicultural techniques fall into two broad groups:

Area management system: removes all merchantable trees by clearcutting.

Individual tree management system: selects only marked trees for removal.

1. Area management system: Clearcutting is done in strips or blocks and is followed by natural sprouting in hardwoods or by planting conifers. It is mainly useful in even-aged stands of intolerant forest types.
2. Individual tree management systems: include the seed tree method and the shelterwood system for even-aged forests and the selection system for uneven-aged and all-aged forests.

These silvicultural systems that are described may not always fit every situation:

1. Variations using several systems are frequently employed to fit timber type and species combination, topography, and local market conditions.
2. Each system must be considered a theoretically ideal procedure, needing modification in actual practice on the ground.
3. Natural reproduction, if inadequate, is often supplemented by planting young trees in open spaces.

The choice of the proper harvesting method depends upon a number of factors, of which the following are of major importance:

1. It must fit the peculiar characteristics and silvicultural requirements of the forest type and species.
2. It must supply a sufficient volume of forest products to permit efficient logging and favorable marketing.
3. It should result in prompt restocking of desirable species and have a beneficial result on all valuable residual trees on the land. An exception to this last factor is the several clearcutting systems that do not leave any residual trees of value.
4. As a practical matter, the kind of silvicultural system to be followed on any tract should be chosen to obtain restocking at the earliest possible time after cutting, or to do the least damage and give the greatest stimulus to residual trees; but if the area does not restock naturally, supplemental planting may be required.

The following description of each method shows the types and species to which it is best suited, its advantages and disadvantages, and other pertinent information.

Clearcutting systems

The variations of this method described below are usually applied to forest situations that meet one or more of the following conditions:

1. Intolerant trees that need full sunlight for germination of the seed and development of the seedlings.
2. Shallow-rooted species or those growing in exposed places where there is danger of the whole stand being thrown by the wind.
3. Even-aged stands of species that must develop uniformly in order to provide merchantable growing stock.
4. Success can be achieved only where there are light-seeded species easily windborne into the cutover areas.

5. Where whole stands are overmature, clearcutting is needed to utilize the merchantable material without wasting it.
6. Where opening up the site does not encourage a growth of shrubs before valuable tree seedlings become established.

Clearcutting of any type has the disadvantages of:

1. Overexposing some sensitive sites to drying out by the sun and wind,
2. Heavily spoiling natural reproduction (often resulting in planting costs).
3. Leaving large areas of slash that are a fire hazard.
4. Leaving the soil susceptible to erosion.

In spite of these disadvantages, which at first appear quite serious, the method can be useful when it is properly applied and modified in the following ways.

Clearcutting in Strips or Blocks:

1. In order to avoid some of the disadvantages resulting from clearcutting large areas, some forest types may be handled by cutting alternate strips or blocks and patches.
2. Areas of uncut timber on the side of the prevailing winds are left standing for a long enough time to reseed the cut over areas. after which they are cut.
3. For species that reproduce easily, such as pine and larch, the clearcutting method in strips or blocks that are not too large to allow for the quick salvage of blowdown, is sn acceptable forestry practice.
4. Livestock must be kept out of young seedling areas for 8 to 10 years to avoid serious losses.

The Seed-Tree Method:

1. This variation of the clearcutting system leaves scattered windfirm

trees at intervals close enough to provide adequate seeding for establishment of the new crop of trees.

2. It has the disadvantage of loss of seed trees by blowdown and difficulty of salvage of the seed trees after the new growth has started because of the damage caused in logging.
3. In some of the Japanese pine forest, the seed-tree method has been tried without much success because of heavy invasion of brush and sasa bamboo.
4. It is essential that sound, large-crowned windfirm trees should be left standing if maximum seeding is to be obtained. Seed trees may be left singly or in small groups in order to have the advantages of mutual protection.
5. The required number of seed trees depends upon the species and its ability to produce seed. In most cases 15-25 trees per ha are the minimum needed. They should be left for at least 5 years, or until adequate reproduction is established.

Clearcutting and Planting:

1. Some species do not reproduce very quickly and are soon prevented from doing so by the invasion of brush.
2. If clearcutting is practiced, the only sure way of obtaining reproduction with this situation is to follow immediately with planting.
3. In some forest types it is more satisfactory and economical to plant immediately after cutting because of the time saved in establishing the new forest and the assurance of the proper density of stocking.

The Coppice System:

1. This system of silviculture is applicable only to species that sprout easily from both the stumps and roots.
2. Essentially, it is a variation of the clearcutting method except that sprout reproduction is relied upon entirely to bring about the next stand.
3. The coppice method is successful in the oak type forest in Japan. It

has been found that better sprouting takes place on winter-logged areas than on those where summer logging has been followed.

The Selection System (Selective Cutting)

Cutting is called selective when each tree cut is chosen with regard to its present position in the stand and future possibilities for growth. This system is naturally suited to all-aged and uneven-aged wood lands. especially the hardwoods.

Clearcutting, high-grading (removing the best and leaving the poorest trees) and diameter-limit cutting (cutting all trees above an certain diameter and leaving all other below, regardless of quality, condition, or position in the stand) are usually a drastic shock to the forest, where as properly conducted selective cutting merely works with nature by removing the older trees to make room for the younger ones.

The selection system has many silvicultural advantages:

- It affords good site protection, windfall is kept to a minimum, reproduction is easy and certain, fire hazard is kept low and slash is scattered, and cutting can be adjusted to fit market conditions.

Its main disadvantages are economic:

1. Logging costs may increase because light volumes are removed at frequent intervals and heavy investments in growing stock are required.
2. Furthermore, damage to residual trees may be severe at times.

Selective cutting is very simple in a well-stocked, all-aged forest:

1. The older and larger trees are marked and cut as they reach maturity.
2. The growth of younger adjacent trees is accelerated while the

seedlings readily develop in the small openings made by cutting.

3. Frequent light cuttings at 5 or 10-year intervals tend to keep up to the quality of the growing stock.

For unmanaged and neglected wood lands:

1. They often contain some trees of inferior species, as well as deformed, diseased, and partly decayed trees. Trees may be too scattered or be so crowded that their growth has almost stopped.
2. Selective cutting in such cases offers excellent opportunities for harvesting wood while at the same time improving the spacing and increasing the rate of growth.
3. Under careless cutting, which removes the best trees and leaves the worst, the forest would cease to be an efficient wood producer.
4. The aim of selective cutting is just the opposite: such poor material as can be used should be taken **along** with good quality materials.
5. How far this should be carried depends on the kind of forest, on the availability of markets and on the need for improving the forest in order to improve future yields in both quality and quantity.
6. Proper cutting in an overcrowded forest releases the best trees and improves their growth. Cutting too heavily so as to leave only a few trees exposed has just opposite effect. They receive a shock from which they may not recover.
7. Trees need the protection of other trees removed by heavy cuttings may be blown over by the wind or injured by frost or sun scald.
8. A high wind can uproot shallow-rooted species or trees growing on shallow or wet soil; prolonged exposure to wind may weaken or kill them gradually by weakening their foliage.
9. Slender tall trees with brittle wood (such as spruce or fir), break **off** easily.
10. As a result of all of these reasons the partial cuttings such as group selection and patch cutting is desirable.

The following rules will be helpful in choosing the right trees in selection cuttings:

1. Mark for harvest all over mature trees that are making little growth.
2. Immature, thrifty, fast-growing trees of better species should be left standing.
3. In clumps of trees growing too thickly, remove the poorer specimens and inferior species.
4. Aim for proper spacing even if it means leaving a few trees that should ordinarily be cut. This will as sure continuation of proper forest conditions.
5. Removed defective, poorly formed trees of valuable species for which there is a market. Leave two or three per ha (or girdle but leave standing) for den, nesting, or wildlife food.
6. Try to release the maximum number of thrifty young saplings and poles without too sudden an overexposure to sun and wind.
7. Make light cuts at frequent intervals (5 or 10 years). This will encourage regular growth acceleration and greater growth rate. Heavier cuts at long intervals disturb a forest more severely.

The Shelterwood System

This method combines some of the features of clearcutting with those of selective cutting and is applied to even-aged stands or uneven-aged stands with large trees in the majority:

1. Some of the more shade tolerant species such as fir and spruce need to have some shade during their first years, and a partial cover can supply this.
2. Under the shelterwood method, the stand is removed in two, three, or more cuts several years apart, with the poorest timber being taken first.
3. The best trees that are left may put on some fast growth for a period but, more important, they continue to supply seed so as to assure an adequate growth of seedlings on the ground.

4. The system is used mainly in beech forest types in Japan. It is also being tried in even-aged northern hardwoods.

The series of shelterwood cuttings is divided into three phases: preparatory cutting, seeding cutting, and removal cutting.

1. The preparatory cutting removes only the most mature, defective, and other trees whose absence will benefit the residual stand.
   Openings are created that are not so large as to encourage undesirable brush, but large enough to allow enough light to stimulate seedling growth.
   Usually not more than one-third to one-fourth of the volume in the largest trees is removed in the preparatory cut. The residual trees serve as continual sources of new seed to assure adequate restocking.
2. The seeding cutting is the heaviest harvest cutting and is usually timed right after a good seed year so as to encourage the most abundant reproduction in the additional open space made available. The trees marked in a seeding cutting include all of the remaining slower growing and intermediate trees, while the very best windfirm dominant are left to stand. About 30 to 60 percent of the remaining volume is taken in this cutting.
   Natural regeneration can often be greatly stimulated by mechanical scarification of the soil that improves the seed bed and reduces brush invasions.
3. The final or removal cutting takes place after reproduction is well established. All merchantable timber is cut from the area.

The shelterwood system has several advantages.

1. Brush and undesirable hardwoods can be kept fairly well under control while seedlings start up.
2. Reforestation is accomplished by nature.
3. Seedlings develop from the choicest seed trees, thereby giving some control over the quality of the new forest.

4. The change in forest conditions is gradual, not sudden, so the seedlings and the soil can adapt themselves more readily to the change in the forest environment.
5. Finally, the trees left standing after the first and second cuts will accelerate in growth and produce wood more rapidly as a result of increased light and lessened competition for moisture and soil nutrients.

The shelterwood system's disadvantages are that it takes considerable skill, reproduction may be damaged in the second and third cut, prices and markets may not fit silvicultural timing, and logging may be more expensive.

Other Aspects of Harvest Cutting

Marking Mature Timber for Harvest

1. Proper selection of the trees to be cut and those to be left under any partial cutting system is one of the most critical forest jobs. It should be done with care, well in advance of cutting, and by experienced personnel.
2. The importance of proper marking is so great that the time it requires certainly should be considered well invested.
   It takes the forest many years to replace wasted timber.
3. The trees to be cut a remarked by axe blazes or spotted with paint on the trunk and on the butt (to serve as a check on loggers).

The external evidences of trees to be marked are:

1. Dead branches on the top of the tree.
2. Sparse and yellowish foliage.
3. Abnormally rough bark.

4. Large size (growth rate should be checked).
5. Crown of tree thinning out noticeably.

The other trees that must be considered in timber cutting operations are the damaged or defective trees. These are trees that have been damaged by grazing, fire, disease, or injured by some other cause such as lightning or previous logging.
Some of the things to look for are:

1. The presence of shelf fungus (fruit body of fungus, conks) or decay on the trunk.
2. Rotten spots, or hollows, at the base of the tree trunk.
3. Many dead branches near the top.
4. Swollen areas on the trunk of the tree indicating internal defect.
5. Holes in the trunk.
6. Hollow trunk (can be determined by pounding on the trunk).
7. Loose bark or other indications of injury.
8. Frost cracks and fire-scarred butt.

Defective or damaged trees should be given first consideration in timber harvesting so that they can be removed while there is still a chance to obtain sound logs above or below the point of damage.
Also, the removal of defective or damaged trees makes more room for sound, vigorous trees that will produce high returns in future growth.

Keep the following factors in mind when selecting trees to be harvested under partial cutting systems:

1. Leave the forest borders as dense as possible. This reduces wind damage to trees in the woods and provides cover for wildlife.
2. Remember that cutting too heavily will open the woods to drying sun and wind and which may cause mortality.
3. Remember that the condition of the tree, and not its size, should be the first consideration as to whether to cut it or leave it.

4. If the stand is understocked, the volume of timber cut in any one period should be slightly less than the net growth for the same period. This method of cutting will ensure continuous timber crops.
5. Except for stands with undergrowth, it is preferable to mark while the trees are in leaf, so that dead and dying trees can be easily recognized.
6. But be sure to leave occasional nesting and den trees to maintain a good ecological balance between trees and wildlife.
7. To control the volume and species of wood to be marked for cutting from an area, the trees should be tallied, according to their size and species, as they are marked.

Preparation of the Soil for Natural Reproduction

Skidding logs (mechanically dragging out logs) in many types of forest with an open soil free of brush before cutting will make a perfect seedbed for germination of seeds.

A number of measures have been developed to eliminate brush and open up the soil for reception of tree seeds.
Just prior to or immediately following logging (if slash is not too abundant), it has been found that disking the cutover areas with a large bull disk pulled by an crawler tractor will turn up subsoil essential for a good seed bed while setting brush back quite effectively. This is called mechanical scarification.

Clearcutting-When, Where, How Large?

Clearcutting is the simplest (and crudest) harvesting method:

1. It requires no special skill in selecting trees for future growth, seed source, nor careful planning of roads to protect the watershed and natural environment.

2. Clearcutting in large areas is the most destructive logging method because it completely disrupts the delicately balanced forest ecosystem through severe soil disturbance and drastic change in plant-animal relationships and habitat.
3. It is usually followed by even-aged stands of a single species as all new growth begins at the same time and is much more susceptible to attack by insects and diseases.

A very violent controversy has stormed against the use of clearcutting for several decades that gives little sign of abating:

1. Yet this method is appropriate for shade-intolerant types as pointed out earlier.
2. But the question still unsettled is how large should the clearcut be?
3. Generally speaking, the smaller the clearcut area, the less likely it will disturb the forest ecosystem, wildlife **relationships**, and watershed quality.

How small is small?:

1. Scientific studies are not available on optimum size of clearcut areas.
2. The great advantage claimed for large clearcuts is that they are less costly to administer, allow the use of highly mechanized (and energy consumptive) logging equipment, and produce wood at low unit costs.
3. No one claims silvicultural or environmental benefits from large clearcuts, and not much forestry expertise is needed.

Small clearcuts however have these advantages:

1. Slash and logging debris are less likely to become fire hazards because more rapid decay will result in protection against drying wind and sunshine.
2. Seed from the adjacent uncut forest is more abundantly spread over smaller area and results in natural reproduction-thus making

replanting unnecessary.

3. More total edge effect is created, which is valuable to wildlife.
4. Instead of recreating extensive even-aged new forest as with large clearcuts, small patch cuts carried out over the same area over the same period of years will result in a series of age class stages of greater diversity for wildlife, and a more pleasing landscape.
5. Small clearcuts can be handled by self-employed loggers with less total investment in heavy machinery and less damage to the surviving **understory** of young trees.
6. Small clearcuts can be blended more effectively into the landscape and are less offensive to recreational viewers.
7. Thus when there is a choice between large area clearcuts and smaller ones, the latter should be preferred unless salvage of fire killed, diseased, or wind thrown timber becomes necessary.
8. This preference should not limit large timber sales but rather restrict the size of patches to be cut each year so that the timber is harvested in stages over several years to avoid the disadvantages of extensive clearing as indicated above.

Silvicultural systems for natural forest in Japan.

Forest management in national forest in Japan.

The present forest management system in Japan has put in practice by Forest Agency in 1973 considering natural and social conditions of Japan. The outline of management system are as follows:

Clearcutting system.

Area for clearcutting system:

1. Areas where are practiced by clearcutting system are limited to the man-made forests which are expected to have comparatively higher forest productivity than that of the forests managed by another systems.
2. The higher forest productivity means that the mean annual increment at the final cutting stage is at least higher than 5 m^3/ha. In general, it is said that the mean annual increment in case of natural forest stands in Japan is around 3 m^3/ha, while in case of man-made forests it is expected to be more than 5 m^3/ha.
3. In Japan, around 40 % of the forest area is man-made forest and main species of man-made forest are *Cryptomeria japonica* (Sugi), *Chamaecyparis obtusa* (Hinoki), *Larix leptolepis* (Karamatsu), *Pinus densiflora* (Akamatsu), *Abies sacharinensis* (Todomatsu) and others. Almost all these man-made forests have been managing by clearcutting system.
4. It should be considered from the viewpoints of natural conditions such as climate, topography, altitude, soil, and forestry technological situation to apply the clearcutting system to the forest. And at present, the conversions from pure man-made forests to mixed and multi-storied forests are trying in order to realize the forests which will have more diversity and sustainable productivity than the pure forest.

Management in the clearcutting system:

1. The cutting area must be scattered all over the forest area as much as possible. The area of one stand is limited to less than 5 ha in case of protection forests and to less than 20 ha in ordinary forests.
2. The stands adjacent to new plantation may be cut over after the crown of the new plantation is closed in case of protection forest. but in case of ordinary forest it may be cut over soon after the time when the closure of crown is expected.
3. The shelter belt must be established actively at the ridge or along the stream of valley of clearcutting area. and the width of the belt will be almost over 30 m on flat land and 40 m on slope land.
4. Useful natural young seedlings in planting areas are preserved.
5. Planting must be done within 2 years after the cutting of natural forests, and in case of man-made forests the area must be planted within 1 years after cutting.
6. Thinning must also be done appropriately in order to keep the stands vigorous and also improve commercial value of harvesting timbers.

Seed tree system and strip clearcutting system.

These systems are applied mainly to *Pinus densiflora* (Akamatsu).
Fagus crenata (Buna) in Tohoku.
Management in these systems is as follows:

1. Standard number of reserved seed trees is less than 50 trees per ha, although this depends on the crown size of seed trees, the range of scattering seeds, quantity of seeds and so on. The detail of these matters will be mentioned latter.
2. In the case of a strip clearcutting system, the first step in it's implementation is the determination of the width of the strips. For Akamatsu, it is said that the width of 50 m is suitable for strips clearcutting system.

Shelterwood system.

This system is applied to the forest of *Abies sacharinensis* (Todomatsu), *Picea jezoensis* (Ezomatsu), *Thujopsis dolabrata* (Hiba) and others. They are treated in the same way as explained in the forestry textbooks. Cutting are carried on with preparatory, seeding and removal cutting as a general rule.

Selection cutting system.

This system is applied when the stands are aimed at high productivity with the inducement of a multi-storied forest type. However, in the forest of Japan, located in the temperate zone, a single tree selective cutting system is almost impossible because of luxuriant weeds, so group selection (patch cutting or partial cutting) is adopted as a rule.

The treatment methods for regeneration:

1. At present, the target of this system is to realize the well stocked and all-aged forest type in general. However, the present volume per ha is almost lower than that of the goal stand. Then, the period for adjustment is established and the period is almost 2 times of cutting cycle period, and the stand concerned is led to the goal forest by repeating of weak cutting.
2. Cutting by group is done around the old tree with large diameter, so as to increase the ratio of numbers of middle and small-diameter trees, and also to promote the occurrence of good young growth.
3. After cutting, surface raking, ground preparation, weeding or supplemental planting is done where and when necessary.

Serious problem for natural regeneration in Japan.

1. In Japan, the summer season is very hot and wet and is different from

the summer season in Europe where is not so hot and wet. According to this hot and wet weather in summer season, the growth of weeds and brush is outstanding, and frequent weeding or brushing is essential to maintain the growing seedlings on the forest floor. Especially, sasa bamboo grows thick on mountainous area in Hokkaido and Tohoku.

2. Abundant sasa bamboo or bamboo grass groups on the forest floor causes serious problems for natural regeneration in Japan. The seedlings developed after selective cutting disappear within a few years if they are grown under these sasa bamboo.
Sasa bamboo group in Hokkaido consists of 4 main groups, that is *Sasa kurilensis* (Chishimazasa) group, *Sasa paniculata* (Kumaizasa) group, *Sasa nipponica* (Miyakozasa) group and *Sasa purpurascens* (Suzutake) group.

3. Overstory and shrub-stratum also intercept light and cause the early death of seedlings. Thus, the ground needs to be prepared in combination with the retention of an appropriate number of seed trees for a given period so as to obtain good seeding occurrence.

4. Ground preparation is necessary to ensure successful regeneration. The immediate objective of ground preparation is to eliminate the sasa bamboo group and shrubs which will compete with the seedlings, so it consists mainly of clearing. Subsequent weeding should be performed often.

5. However, since there are cost limitations, a minimum of 2 or 3 weeding should be made in a year. In addition to clearing and weeding by hand and with small machines (brush cutters), herbicides can be used, or the ground surface can be worked over with tractors or other heavy machinery.

6. Also, grazing cattle can be pastured in stands allowing them to eat the weeds, shrubs, and especially, the sasa bamboo group.

7. When there are areas of only a few seedling sowing to various reasons and regeneration by seed tree has not been successful, the supplemental plantings must be done to accomplish the regeneration.

some examples of silvicultural systems for natural forest in Japan.

In Japan, the silvicultural system for natural forest has been implemented mainly in Hokkaido and Tohoku districts where there are almost all the natural forest there in Japan. So here, the examples of silvicultural system in Hokkaido and Tohoku are presented.

The silvicultural system for natural forest in Hokkaido.

The system in Hokkaido is classified roughly into three types depending on the cutting method, that is shelterwood system, clearcutting system and selection system which is shown in Table 1.

Table 1. Silvicultural systems of natural forest in Hokkaido.

Silvicultural systems of natural forest

- Silvicultural system with supplemental treatment
  - Shelterwood system
    - Natural seeding class I
    - Natural seeding class II
  - Clearcutting system (Seed tree method)
    - Natural seeding class I
  - Thinning
  - Selection system
    - Natural seeding class I
    - Natural seeding class II
- Silvicultural system without supplemental treatment
  - Selection system(Tree) (Protective management)
    - Natural seeding class II
  - Cutting prohibitted forest (Special protection forest)

1. Shelterwood system:

The stand which has an abundant advanced seedlings of useful species,

but the growth of upper story tree has declined should be employed the shelterwood system to accelerate the growth of seedling.

2. Clearcutting system:

The stand which is expected to establish the broad leaved forest like oak and birch forest by conducting the soil surface treatment should be employed the clearcutting system and sometimes seed trees should be remained.

3. Induced forest by thinning:

Broad leaved secondary forest and even-aged man-made forest which will be expected to produce high quality timber in future should be thinned in order to be induced to manage like natural forest in future.

4. Selection system:

The selection system consists of individual selection system and group selection system. In these stand, if there is not enough seedlings the supplemental treatment such as scarification of soil surface, artificial sowing and planting are conducted. This regeneration method is called "natural seeding class I" and the operation method is explained latter.

The natural forest stand are divided into two type according to their stand condition:

1) The one is the forest stand which has an annual productivity of around 4.5m³/ha and the purpose of this stand is to get 270m³/ha in volume within 15 years of cutting cycle. These stands are managed through intensive treatment like natural seeding class I.

2) The other one is the forest stand which has an annual productivity of around 3.3m³/ha and the purpose of this stand is to get 220m³/ha in volume within 20 years of cutting cycle. These stands are managed not so intensive.

3) The forest stands where there are already plenty of advanced growth of seedling or the natural seeding is expected after cutting, any supplemental treatment is not conducted. This method is called "natural seeding class II".

Standard operation of natural seeding class I at national forest in Hokkaido.

1. The operation of silvicultural system of natural seeding class I is to combine the weeding, soil surface raking or scarification and planting in order to get sound regeneration depending on actual situation of the site.
2. Management area and operation site:
   1) Management area:
      Management area includes the lots of operation site, and is settled by using the boundary of natural geographical features or the compartment and sub-compartment.
   2) Operation site:
      Operation site belongs to the management area where the weeding, soil surface raking and planting is conducted and the size of site is more than 0.05ha.
   3) The percentage of operation site to the management area should be considered to be almost more than 20 % of the management area.
3. Standard operation and method.
   1) Weeding:
      If the site has already enough young growth, the weeding should be done especially for the site where the growth of young seedling might be prevented by sasa bamboo. Sometimes, it will be conducted by using herbicide(mainly the natrium chlorate).
   2) Soil surface raking or scarification:
      The site where natural regeneration could not be expected because of the growth of sasa bamboo and the thick accumulation of raw humus on the forest floor should be improved to be regenerated by soil surface raking or scarification. This operation should be conducted by using mechanical scarification and the burning. And also herbicide should be applied to the site depending on the situation of the site.
   3) Planting:
      In order to ensure the regeneration, planting should be done depending

on the situation of the site. The species for planting is mainly *Abies sacharinensis* (Todomatsu), but considering the micro-climate, topography, soil condition of the site, *Picea jezoensis* (Ezomatsu), *P. Glehnii* (Akaezomatsu) and their mixture will be employed.
And also nest planting (group planting) and planting around of the stump of cutted tree should be sometimes considered depending on the the situation.

Standard for group selection system at national forest in Hokkaido.

1. Group of trees to be cut:

For group selection system, after taking into consideration on the remaining of useful middle and small sized trees, the characteristics of natural seeding of the tree such as *Betula* species, and the characteristics and planting method of planting species, following tree group should be cut:

1) Tree group which mainly shows a remarkable declining growth.
2) Tree group which consists of inferior species and quality.
3) Tree group of large-sized tree which reaches the cutting age and can not expect to grow more.

2. Size of cutting coupe:

Standard size of cutting coupe is around 0.05-0.5ha. However, it should be determined after considering the stand composition of tree group, light supply for tree seedlings and climatic condition. In case there is already open area, the cutting coupe should be combined with tree group around the open area, But size of one cutting coupe must not over 0.5ha.

3. Cutting coupe:

Cutting coupe in the group selection system should be established within the area of 200 m from the forest road network on the premise that they will be treated as natural seeding class I.

4. Selection of cutting trees:

Middle and small sized tree with good quality in the cutting coupe should be remained and the other trees should be cutted.

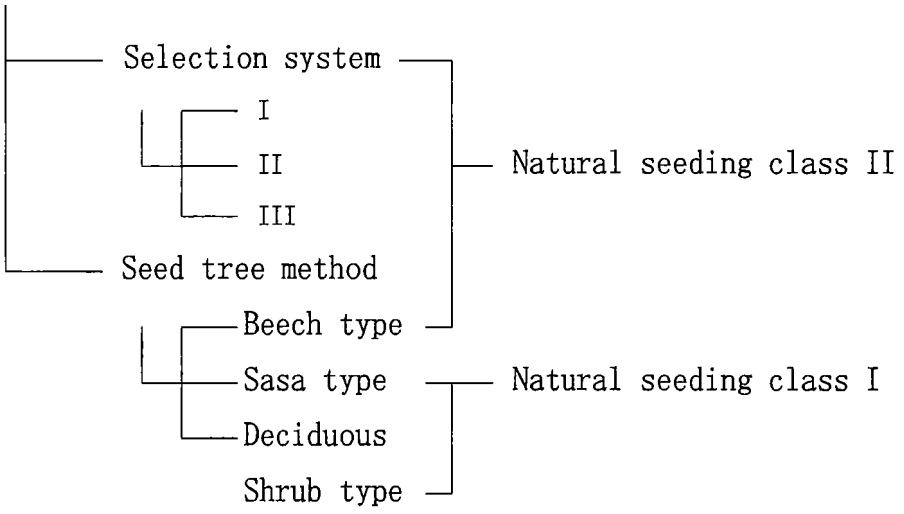
Silvicultural systems for Japanese beech natural forest in Tohoku.

Principle of silvicultural systems for Japanese beech forests:

1. They are classified into two forest stands according to their function of environmental and public benefit, the one is to aim to produce timber for general use and the other is to maintain the function of public benefit.
2. The cutting system is divided into two systems based on the above mentioned objectives and situation of succeeding seedlings, that is, seed tree method and selection system (group selection system and individual selection system).
3. The silvicultural systems for Japanese beech and other broad-leaved forest is summarized in Table 2:

Table 2. Silvicultural system for Japanese beech natural forest in Tohoku.

Silvicultural system of beech forest



Rotation age and target for timber production:

1. Rotation age is divided into two types, the one is 100 years for the stand which is nearly pure stand and thinning will be done, and the other is 130 years for the stand where the thinning will not be done.
2. The target for timber production is to aim to produce the timber for

general use, furniture, plywood, flooring board, industrial art and musical instrument.

3. The diameter class of log to be produced is to aim to get middle -sized diameter (30-40 cm).

Silvicultural systems in Japanese beech forest:

1. Seed tree method:

1) Cutting area is less than 5 ha at the protected forest and less than 10 ha at the other forest. And cutting coupe should be scattered on the management area.

2) After accomplishing the regeneration, the seed tree is harvested after 15 years of operation as the 2 times of good seed year will be expected during the period.

2. Selection system:

This system is divided into the three cutting method, that is selection system I, II and III.

1) Selection system I:

(1) This method is applied for the stand where is expected to increase the productivity. Because these stands have lots of useful natural trees including beech species and grow well.

(2) The cutting method is group selection system for the forest where beech is main component and easy to regenerate, and the area for cutting coupe is less than 0.05ha for protection forest and 0.1ha for the other forest. The other forest is conducted by individual selection system.

(3) Cutting rate of both system is less than 30%.

(4) In group selection system, the cutting should be given priority to the place having a lot of young seedlings, the trees having middle and small diameter should be reserved and the old aged trees having bigger diameter than the expected diameter (36 cm) should be cutted away.

(5) In individual selection system, cutting should be given priority to the trees having expected diameter or more.

2) Selection system II:

(1) This method is applied for the shelter belt stand.

(2) The cutting method is individual selection system and the cutting rate is 20 %. The cutting trees are weaked, damaged trees and old-aged trees having big diameter.

(3) The cutting of the stand will be done at the same time of cutting of surrounding forest stand.

3) Selection system III:

(1) This method is applied for the forest having an important role for the public benefits or low productivity owing to the severe natural condition. The weaked and damaged trees will be cutted individually not so as to give drastical change to the forest.

3. Regeneration for seed tree method:

1) The seed tree should be remained according to the vegetation type of the forest. The vegetation types are classified into Beech type, Sasa type and Deciduous shrub type.

2) The Beech type means that more than 10,000/ha of natural seedlings of useful trees including beech grow and cover more than 80 % of the stand.

3) Sasa type means that the stand are dominated by Sasa species and there are little useful natural seedlings on the floor.

4) Deciduous shrub type means that the stand are dominated by deciduous shrub and there are little useful natural seedlings on the floor.

5) The regeneration method for Sasa and Deciduous shrub type should be done by natural seeding class I, and Beech type should be done by natural seeding class II.

6) The number and size of seed tree should be decided by the vegetation type. For example, if the diameter of seed tree is 30 cm, 13-27 seed trees per ha for Beech type and 40 trees for the other type should be remained uniformely on the stand.