Natural regeneration within the Coillte estate

I Occurrence and extent with respect to species and association with site factors

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Abstract

A study was conducted in 1998 and 1999 on the occurrence and extent of natural regeneration within the Coillte estate. Natural regeneration was found on 0.4% (1,975 ha) of the estate. Three species: birch (*Betula* spp.), Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and lodgepole pine (south coastal) (*Pinus contorta* var. *contorta*) accounted for over 80% of this area. Natural regeneration occurred most frequently on brown earths and podsols. Sites of low fertility status had the highest occurrence of natural regeneration. It occurred most frequently at elevations below 100 m, on sheltered sites and on sites with good natural drainage.

Keywords: elevation, exposure, natural regeneration, soil type, species, site fertility.

Introduction

To date, the vast majority of forest stands in Ireland have been managed under a clearcutting silvicultural system; reforestation after felling uses nursery-grown planting stock. However, with forest owners aiming to achieve and retain forest certification, there is increasing interest in silvicultural systems other than clearcutting. These alternatives, in most instances, rely on natural regeneration for reforestation. While spontaneous natural regeneration occurs, especially of Sitka spruce (*Picea sitchensis* (Bong.) Carr.), mainly in the Wicklow area, and of lodgepole pine (*Pinus contorta* Dougl.) in many areas, it has, until recently, been considered more of a problem than an opportunity. The difficulty associated with predicting its density and speed (Harmer 1995) and its more demanding silvicultural requirements (Harmer *et al.* 1997) may account for this.

In response to the limited knowledge of natural regeneration in Ireland and of the potential for silvicultural systems other than clearcutting, a study was initiated in November 1998, which had as an objective an assessment of the extent of natural regeneration within the Coillte estate using existing inventory data. This paper reports the main findings.

Methods

All subcompartments within the Coillte estate containing natural regeneration were identified from the company's computerised inventory records. The presence of up to four separate tree species are recorded on any one subcompartment. The percentage of the total canopy cover of the subcompartment comprised of each species is also recorded. The minimum value that can be recorded for any one species is five percent of the total canopy cover. If one or more of the species arises from natural regeneration the subcompartment is

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tagged with the letter W on the database. All subcompartments thus tagged were selected and their inventory data copied to an Excel™ file. The database classified each subcompartment according to soil type, fertility class (OCarroll 1975), elevation, exposure and drainage. Data were not available for all of the factors in each subcompartment. In these instances the term 'unknown' was assigned to the missing datum. Using these data, an analysis of the occurrence and extent of natural regeneration within the Coillte estate was conducted (O'Leary 2000).

The area and number of naturally regenerated (NR) stands within the Coillte estate were categorised according to a number of factors, including the number of subcompartments found to contain naturally regenerated stands, their area and their regional distribution. The total area of the Coillte estate was also categorised according to these factors to indicate possible marginal effects. The species that were regenerating naturally were also identified.

Results

Of 121,767 subcompartments (SC) within the Coillte estate, 2,568 were identified as containing natural regeneration (as defined in Methods). These amounted to 1,975 ha of natural regeneration from a total Coillte forest area of 442,296 ha.

Species composition of natural regeneration

Twenty-one tree species were found to have regenerated naturally within the 2,568 subcompartments. Birch (*Betula spp.*) was found on the greatest number of subcompartments while Sitka spruce comprised the greatest area of regeneration (Table 1).

Table 1: *Occurrence and extent of natural regeneration within the Coillte estate.*

Species	*Area within the Coillte estate ha*	*Natural regeneration*	
		Number of subcompartments	*Area ha*
Sitka spruce (*Picea sitchensis* (Bong.) Carr.)	247,394	188	588
Birch (*Betula* spp.)	3,937	1,103	559
Lodgepole pine (south coastal) (*Pinus contorta* var. *contorta*)	51,221	748	473
Ash (*Fraxinus excelsior* L.)	3,106	300	102
Oak (*Quercus* spp.)	3,716	68	24
Other species	132,922	161	229

Five species (ash, birch, lodgepole pine, oak and Sitka spruce) occurred on 94% of those subcompartments with natural regeneration, and accounted for 88% of the total area of natural regeneration.

Association between location and site factors and the occurrence and extent of natural regeneration

Results are presented below for the association between a number of location and site factors and the occurrence of natural regeneration. No cause-effect is implied in the presentations. Furthermore, higher or lower occurrences may be an artefact of the extent of occurrence of a particular level of the variable in the Coillte estate. Marginal effects are not presented here but are explored in the Discussion.

Location – Coillte Regions

The Coillte estate is divided into six Regions. The Midlands Region was found to have the greatest number of subcompartments containing natural regeneration (Table 2). The North-Western and Western Regions contained the smallest number of subcompartments with natural regeneration. When examined on an area basis, the Eastern Region had the largest area of natural regeneration.

Table 2. *Regional distribution of the occurrence and extent of natural regeneration within the Coillte estate.*

Region	*Area*	*Natural regeneration*	
	ha	*Number of subcompartments*	*Area ha*
Eastern	44,903	434	656
Southern	93,186	501	310
Mid-Southern	99,001	537	229
Western	77,032	159	159
North-Western	76,327	148	88
Midlands	51,847	789	533

Natural regeneration and soil type

Natural regeneration occurred on thirteen different soil types[4], most commonly on brown earths and podsols (707 and 690 subcompartments respectively). It was more frequent on raised bog peats (298 subcompartments) than on blanket peats (121 subcompartments). Podsols had the highest area of natural regeneration, 743 ha, followed by brown earths (415 ha).

Table 3. *Soil type and the occurrence and extent of natural regeneration within the Coillte estate.*

Soil type	*Area within the Coillte estate*	*Natural regeneration*	
	ha	*Number of subcompartments*	*Area ha*
Brown earths	41,944	707	415
Podsols	99,937	690	743
Gleys	86,733	498	257
Raised peats	26,408	298	342
Blanket peats	167,397	121	79
Other	19,877	254	139

[4] Grouped into six categories for convenience (Table 3).

Site fertility

Subcompartments with natural regeneration were most commonly (33% or 857 subcompartments) found on sites of low fertility. These also had the greatest area (42%) of natural regeneration (Table 4).

Table 4. *Fertility class and the occurrence and extent of natural regeneration within the Coillte estate.*

Fertility class	*Area within the Coillte estate*	*Natural regeneration*	
		Number of subcompartments	*Area*
	ha		*ha*
High	26,430	174	70
Intermediate	89,608	664	603
Low	281,824	857	842
Varying	41,390	752	383
Unknown	3, 044	121	77

Elevation

Subcompartments containing natural regeneration were most commonly found at elevations above 100 m (Table 5).

Table 5. *Elevation and the occurrence and extent of natural regeneration within the Coillte estate.*

Elevation category	*Area within the Coillte estate*	*Natural regeneration*	
		Number of subcompartments	*Area*
m	*ha*		*ha*
<100	110,754	1,159	762
100-199	131,192	729	394
200-299	131,336	517	451
>299	65,923	163	367
Unknown	3,091	0	0

Exposure

Sheltered subcompartments or subcompartments that were moderately exposed contained natural regeneration more frequently than subcompartments with high or severe exposure (Table 6). This trend was true for the area of natural regeneration also.

Table 6. *Exposure and the occurrence and extent of natural regeneration within the Coillte estate.*

Exposure	*Area within the Coillte estate ha*	*Natural regeneration*	
		Number of subcompartments	*Area ha*
Severe	21,378	16	22
High	153,492	308	298
Moderate	207,817	1,247	1,056
Sheltered	56,507	876	510
Unknown	3,102	121	80

Drainage

Natural regeneration was most frequent on sites that were classified as having good drainage (Table 7). A sharp fall-off in the number of stands regenerating was noticeable as the quality of drainage decreased.

Table 7. *Drainage category and the occurrence and extent of natural regeneration within the Coillte estate.*

Drainage category	*Area within the Coillte estate ha*	*Natural regeneration*	
		Number of subcompartments	*Area ha*
Good	146,247	1,334	1,132
Moderate	159,345	786	478
Poor	124,103	284	272
Very poor	9, 493	33	14
Unknown	3, 108	121	79

Discussion

Just under 0.4% (or 1,975 ha) of the total area of the Coillte estate consists of natural regeneration. While this percentage is small, the relatively young age structure of the estate should be borne in mind. Also a limited amount of clearcutting has taken place to date. Furthermore, the majority, if not all of the existing areas of natural regeneration have occurred spontaneously, with no intervention used to favour their occurrence.

The range of coniferous and broadleaved tree species found in naturally regenerated areas was quite extensive. However, five species dominated: ash, birch, lodgepole pine, oak and Sitka spruce. These accounted for 88% of the total area of natural regeneration, while they also accounted for 70% of the total Coillte estate.

An examination of the species occurrence data (Table 1) suggests that lodgepole pine appears to regenerate naturally more readily than Sitka spruce. One percent of the total forest area of lodgepole pine was naturally regenerated, while only 0.2% of the total forest area of Sitka spruce comprised naturally regenerated stands. Natural regeneration of Sitka spruce is dependent upon good seed years (von Ow *et al.* 1996, Dagg 1998), the periodicity of which ranges from 3-5 years (Gordon and Faulkner 1992). Lodgepole pine, on the other hand, is a consistent seed producer, producing good quantities of seed cones annually (Fowells 1965), with the best seed crops occurring at 2-3 year intervals (*ibid.*). Another possible reason for the relatively greater area of natural regeneration of lodgepole pine is that many Sitka spruce stands are clearcut before they start to produce seed, which Savill (1991) indicated to be 30-40 years of age. In contrast, lodgepole pine starts to produce seed much earlier, with maximum seed production occurring after 30 years of age (Savill 1991). Unlike Sitka spruce, the majority of lodgepole pine stands in the Coillte estate are planted on blanket peat. Competing vegetation on these soils may be more limited following clearcutting than in the case of soils, such as gleys, that are carrying Sitka spruce crops, making it more likely that lodgepole pine would regenerate naturally.

Of the broadleaves, birch showed the greatest capacity to regenerate naturally (Table 1). Of the total area of birch 3,937 ha, 559 ha were identified as arising from natural regeneration, in 1,103 subcompartments. Ash also showed a strong capacity to regenerate naturally, with 3% of the total area of ash arising from natural regeneration. Both ash and birch are pioneer species (Evans 1984) with prolific seed production (Savill 1991) and with a high capacity to regenerate naturally. The other main broadleaved species, beech and oak, which account for 53% of Coillte's broadleaved forests, have distinctive fruiting patterns, with heavy mast years for both species usually occurring in Britain every 10 years (Savill 1991).

Characteristics of sites on which naturally regenerated stands were found

The majority of naturally regenerated stands were located on brown earths and podsols (Table 3). These soils comprise 9% and 22% of the Coillte estate, respectively. It may appear surprising that brown earths were the soil type that most commonly supported natural regeneration. The normally high fertility status of these soils would make colonisation with vegetation very likely shortly after clearcutting. There is also evidence from the work reported here (Table 4) and from Britain (Brown and Neustein 1974) that natural regeneration tends to be more commonly associated with low fertility sites and poor quality soils such as podsols and peats, probably because of the slower rate of vegetation colonisation of these soils following clearcutting. However, one possible explanation for this result is that many of the oldest stands in the Coillte estate are found on brown earths. Many of the earliest state forests were the woodland areas of estates which were acquired by the Land Commission in the early part of the 20th century. In addition, during the 1930s the Forestry Division acquired better quality lands than in subsequent decades, as many farms were sold off because of the depressed state of agriculture during the Economic War. As a result, many of the forests within the Coillte estate that have reached seed-bearing-age are more likely to be located on brown-earths and podsols. Thus, the observation of high natural regeneration occurrence and extent on better quality soils may be confounded with stand age. It may also be the case that old woodland sites have seed reserves already present, or they may be located nearer to tree-seed banks than upland, formerly unenclosed, mountain sites that have been afforested.

A quarter of the total area of natural regeneration was at elevations less than 100 m (while only 13% of the entire Coillte estate was located at these elevations) (Table 5). Furthermore, over two thirds of the area of natural regeneration was on sites classified as sheltered or moderately exposed, while 60% of the Coillte estate was thus classified (Table 6). These findings are not surprising, given that the majority of natural regeneration was found on brown earths and podsols which tend to occur at lower elevations (as opposed to peats and peaty podsols at higher elevations).

Sixty-nine percent of the Coillte estate is located on sites classified as moderately or well drained (Table 7). Of the sites on which natural regeneration occurred and where drainage conditions were known, 81% were classified as being moderately or well drained. This finding would suggest a greater tendency for stands to regenerate naturally on sites where drainage is good rather than on poorly drained sites. However, all seed requires moisture to germinate. Nixon and Worrell (1999) indicate that optimum conditions are provided by a moist substrate with a high relative humidity. However, even on well drained sites lack of moisture is unlikely to limit germination in the wet, maritime climate of Ireland. Similarly, on poorly drained sites, there is a greater likelihood that the litter layer will take longer to decompose following clearcutting than on more freely draining soils, thereby making it more difficult for the radicle of the germinating seed to reach soil and for the seedling to survive. Site drainage may also influence the survival of newly germinated seedlings. For example, Vickers and Palmer (2000) found that the survival of germinants was negatively affected by excessive moisture in the seed bed. The reason is believed to be the restricted availability of soil nutrients for the growth and development of seedlings on poorly drained soils (Carlisle and Brown 1968).

Conclusion

The increased emphasis on examining silvicultural systems other than clearcutting has resulted in an increased interest in natural regeneration. However, the successful use of natural regeneration is a challenging task. A necessary prerequisite for successful implementation and management is the identification of sites where regeneration is likely to occur. The findings presented in this paper provide some information to help to identify such sites.

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