Fire and Regeneration

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Study area
The islands of Lygra and Lurekalven, situated at 60º 42' N, and 5º 5' E, in the Lurefjorden fjord basin, Western Norway; characteristic oceanic climate with small differences between Junae and January mean temperatures (12ºC and 2ºC) a long growing season (220 days above 5ºC), abundant precipitation (1600 mm/yr) evenly distributed throughout the year, strong winds, seldom snow cover or periods of frost.

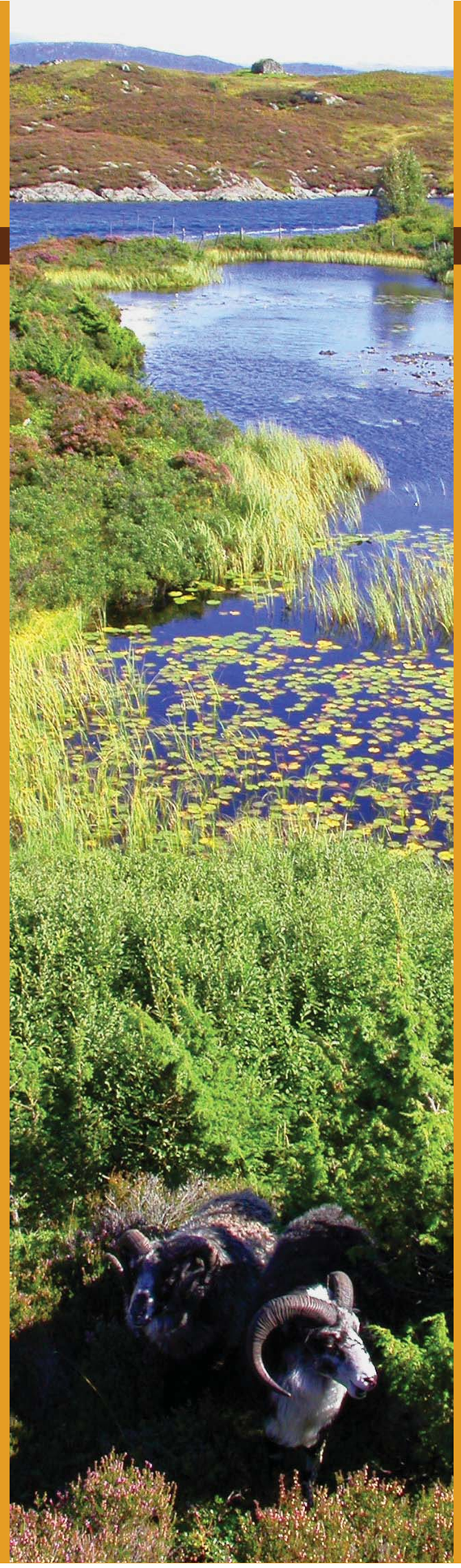
BACKGROUND

Dormant seeds in the soil serve a dual function in plant populations. They are memories of populations and communities past, and at the same time a potential for future persistence and survival. Hence, the longevity of seeds in the soil affects the resilience of plant communities.

Heathlands are influenced by many factors leading to vegetation change. Burning and grazing have been the most commonly employed management practices in Western Scandinavia. Local seed availability may be affected by e.g. seed-source density, seed production, dispersal strategy and predation, while microsite availability may be affected by e.g. competition, disturbance, and grazing. In the open heathland landscape seed-sources may be sparse, and while the availability of safe sites may be the major limitation in heavily grazed heathland areas, seed limitation may become the most important limiting factor as grazing pressure decreases. A proper understanding of how heathlands respond to disturbance must take account of seed production-, dispersal-, seed bank- and germinability dynamics. In cyclic vegetation types such as heathlands, seed banks are particularly important so that the species can survive locally with time.

We investigated the relationship between standing vegetation and soil seed bank in burnt heath of varying age (recently burnt – 30 years since last fire), using a chronosequence approach. An indirect seedling emergence technique was used to analyse the soil seed samples.

Main aims were; (1) to investigate the soil seed bank/ standing vegetation relationships over a post fire succession in northern European heathlands. (2) does similarity between seed bank and vegetation imply importance of seed banking in restoration? (3) how do seed bank and vegetation densities and species richness vary over the course of succession? (4) how does the key species Calluna vulgaris respond to fire, both in the way of seed germatability and regrowth in the vegetation?



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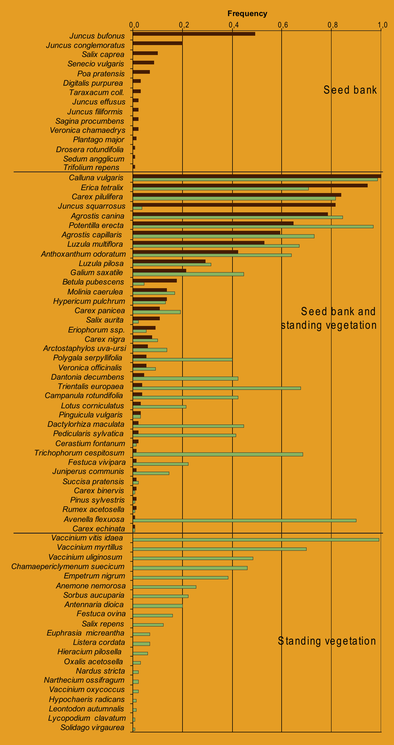
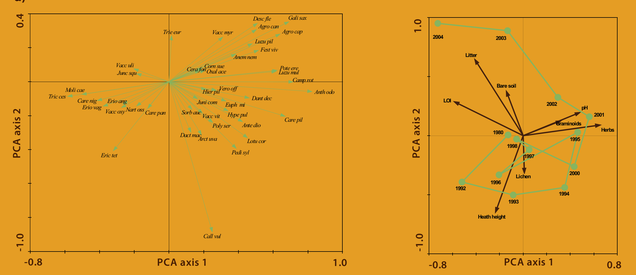


a)



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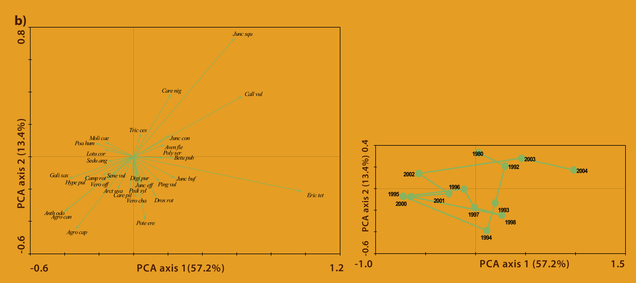
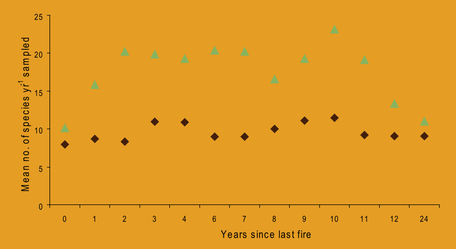


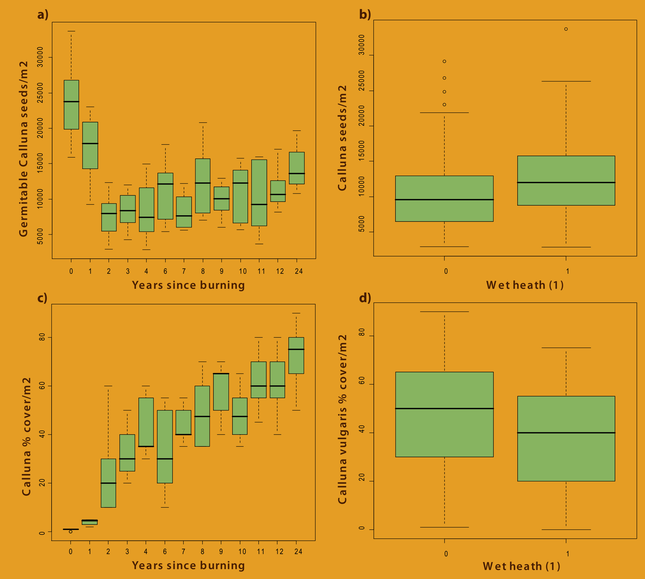
PCA ordination diagrams of environmental variables and years of the chronosequence, and species of the standing vegetation (a) and soil seed bank (b) over the post-fire succession (n=130). The compositional change from the pre-fire census (marked 1980) to recently burnt (marked 2004) is drawn as a trajectory. Trends in various environmental variables are indicated. During the first 24 years after fire the heathland vegetation progresses from open ground via species rich graminoid and herbaceous dominated vegetation to *Calluna*-dominated heath. The post-fire succession is less clearly reflected in the seed bank, as it is dominated mainly by a few very abundant species, such as *Calluna vulgaris, Erica tetralix, Juncus squarrosus* and *Carex pilulifera*.

Results

The frequency of occurrence of species registered in the 130 sampled plots as viable seeds in the soil seed bank (■) and the standing vegetation (□) found in the heathland habitat managed by traditional heather burning at Lygra and Lurekalven, Western Norway. A total of 75 taxa were identified. The 10 most commonly occurring species of the seed bank constituted 98 % of the germinated seeds. The main component of the seed bank; *Calluna vulgaris*, 48 % then *Erica tetralix*, 34 %. The Sørenson's index of similarity (Sørenson 1948) indicated a 68.4% concordance between the species composition of the seed bank and the standing vegetation.



Species richness was always higher in the vegetation in comparison to the corresponding seed banks. The species found were related largely to the localized vegetation, although some seedlings were more or less numerous than expected compared to the surrounding vegetation cover.



(a) *Calluna vulgaris* showed significantly higher germination rates the two first years following fire. Fire might cause changed chemical properties of the soil; charcoal particles deposited on the surface may absorb germination inhibitors and allelophathic chemicals, and smoke and ash may act as germination cues. Hence, increased germination rate immediately after a fire may be explained by fire-related chemical and physical changes taking effect. We have started a project to investigate this further. (b) Significantly more seedlings emerged from north facing wet heath. (c) Increase of *Calluna* cover in the standing vegetation over the course of the post-fire succession. d) There is significantly higher coverage of *Calluna vulgaris* in the south facing moderately moist sites.

Conclusions

Estimates of seed bank density and composition are dependent on the methods applied. The large, persistent soil seed stores of *Calluna vulgaris, Erica tetralix, Agrostis* spp. and *Juncus* spp., all known to have long-lived seeds, indicate that oure methods were suitable for the detection of the persistent reservoir of readily germinable seeds in this system.

The high similarity supports the thesis that in frequently disturbed communities vegetation and seed bank composition should be similar. This correspondence exists because disturbance limits community composition to early successional species with more persistent seed banks for colonization instead of later successional species that colonize by invasion. The soil seed bank is often used to assess the restoration potential of a site, in particular in fragmented landscapes where the probability of influx of viable seeds is extremely limited. The size and the quality of the viable seed bank may both be determinants of successful heathland management and restoration on successional sites.

From a management point of view, prescribed burning is successful in many aspects as it is not labour intensive or time consuming and at low cost. These findings emphasize the need for continued management measures in order to maintain northern heathlands. Our study shows that burning by rotation creates heterogeneity which in turn contributes to a dependable seed bank for revegetation of bared ground after disturbance in these coastal areas. Heathland management is dependent on some form of disturbance regime, and the response of the vegetation will thus partly depend on the composition, density and spatial distribution of the seed bank.