Predicting the extent of damage to conifer seedlings by the pine weevil (*Hylobius abietis* L.): a preliminary risk model by multiple logistic regression

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**Application.** The study indicates that it should be possible to build a predictive model of weevil damage from a relatively limited number of forest-related variables. The four variables identified in the present model also suggest that it may ultimately be possible to regulate weevil damage by targeting pest suppression at high risk areas and developing appropriate silvicultural strategies for others. Risk assessment is likely to be a central component in integrated management of the pine weevil in plantation forests.

**Abstract.** Damage to conifer seedlings caused by the pine weevil, *Hylobius abietis*, was estimated within eighty-two forest sites in Northern Ireland. A wide range of environmental variables were compared with the variation in damage between study sites using multiple logistic regression. Although 45 explanatory variables were considered only four were identified as significant within the final model. The four variables were the size of the planted area, the age of the planting, whether the majority of seedlings were self-seeded or planted, and if the site had been previously planted or was a newly planted area. The identification of these four variables indicates that it is possible to build a model identifying areas at risk to weevil damage. Further, although three of the factors have been recognised as significant influences on weevil damage for some time, they still remain important variables within British Isles forestry, suggesting that there is further scope for more precise targeting of weevil control measures.

**Introduction**

The pine weevil *Hylobius abietis* breeds in the stumps and roots of recently felled conifers emerging after diapause to feed on the bark of young trees (Scott and King 1974). The weevil is a widely-dispersed native of the European pine forests, although until the advent of extensive clear-felling (cutting), accompanied by an increase in the availability of breeding sites, the weevil was not considered a pest species. Within Northern Ireland damage is highly variable. On some sites damage by weevils may be minimal, on others weevils may ring bark (girdle) and kill up to 90% of newly planted saplings (R. Schaible, pers. comm.). Methods of limiting weevil damage in Northern Ireland are primarily of a general nature (e.g., pesticide dipping of all plants...
prior to planting). Specifically targeted control measures are employed on a reactive rather than a predictive basis. This form of control suffers from serious disadvantages. General treatment is expensive both economically and environmentally due to its wide application over both, “at risk”, and “safe” areas. Furthermore, reactive treatment requires that damage must occur before protective measures can be taken. Thus, there are substantial benefits to be accrued from the development of a risk assessment model capable of accurately predicting the damage caused by weevil activity. Some progress with similar species (Hylastes and Hylobius) has been made in North America (Pendrel 1990) but in Europe there have been few attempts to predict damage with any precision at either regional or local level.

Relatively small scale studies (Heritage et al. 1989; Långström 1982; Selander and Immonen 1991, 1992; Welty and Houseweart 1985) have indicated a wide range of variables which affect either weevil densities or the level of damage which they inflict. Height of vegetation cover (Stadnitskii 1978; Eidmann 1979), soil scarification (Christiansen and Sandvick 1974; Huser 1979; Österström and Andersson 1975; Söderström 1976; Söderström et al. 1978; Turchinskaya 1983), mounding (Söderström 1977; Söderström et al. 1978) and fertilization (Selander and Immonen 1991, 1992) are all site factors or treatments which result in more or less weevil damage, without necessarily directly influencing weevil density. The distinction between weevil density, and activity which results in damage is a significant one (Elton et al. 1964). Nordlander (1987) observed a close relationship between weevil numbers and damage later in the season, but failed to find an equally clear relationship between numbers and early season damage. Most recently the support for separate estimates of weevil numbers and damage came from a large scale study by Wilson and Day (1994). Although there was a moderate correlation between relative weevil densities and damage levels, the correlation rarely exceeded 0.5, implying that a significant degree of the variation in damage remained unexplained.

The present study attempts to build a risk assessment model of recent weevil damage by comparing various environmental variables, relative weevil densities and damage over 82 forest sites scattered throughout Northern Ireland.

Methods

Assessment of damage and weevil numbers

Eighty two recent (1991–1993) Sitka spruce Picea sitchensis plantations were selected from forests in all six counties of N. Ireland. The forest compartments