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SOME ASPECTS OF WESTERN RED CEDAR REGENERATION IN THE COASTAL FORESTS OF BRITISH COLUMBIA

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INTRODUCTION

Western red cedar (Thuja plicata) has a very wide occurrence throughout the coastal forests of British Columbia, growing in mixture primarily with Douglas fir (Pseudotsuga menziesii), Western hemlock (Tsuga heterophylla), Amabilis fir (Abies amabilis) and Sitka spruce (Picea sitchensis). Much of this forest is regarded as a cedar-western hemlock climax.

The ideal climax forest normally should have an abundance of advance regeneration, consisting of those species forming the upper canopies of the stand. Although there is usually abundant advance regeneration of Western hemlock and Amabilis fir, most of these forests have insignificant amounts of cedar regeneration, even in cases where the main stand consists largely of this species. Such a condition is not in accord with the accepted views associated with the climatic climax theories and, accordingly, an effort was made to obtain information concerning the regeneration habits of cedar in the forest.

REVIEW OF LITERATURE

Among other reports referring to cedar regeneration, Hanzlik (6) has noted that cedar reproduces only from seed, with good seed-crops occurring at three- to four-year intervals. This report further mentions that cedar requires considerable moisture for germination and seedling establishment, and reproduces best with protection from sunlight and drying winds. Sudworth (10) describes cedar as a prolific seed-producer with heavy seed-years and states that the seedlings can survive under dense shade, although reproduction does not occur readily where fires have materially reduced the soil moisture. Baker (2), and Toumey and Korstian (11) classify cedar as a very shade-tolerant tree.

In seed-collecting studies in coastal British Columbia, Pickford (8), Garman (4), and McMinn (7) give a quantitative appraisal of cedar seed-crops. The average annual crop usually varies between 100,000 and 1,000,000 seeds per acre in stands with up to 25 per cent cedar. The heaviest annual seed-crop reported 15 million seeds per acre in a stand made up of 67 per cent cedar. Germination percentage was usually between 10 and 50 per cent, but with very light seed-crops it was less than 10 per cent.

In regeneration surveys of logged lands, Allen (1), Garman and Barr (5), and Stoodley (9) indicate that cedar can establish itself readily after logging with or without an accompanying slash burn.

The few publications concerning the regeneration of this important species, however, contribute little information concerning its ability to regenerate in undisturbed forest.

ADVANCE REGENERATION OF CEDAR IN NATURAL FORESTS

Information was available from measurements and observations recorded during field examination of temporary ecological plots. These plots were located in many types of coastal stands growing over a wide range of habitat conditions from sea level to elevations of over 4000 feet. They were established on all aspects, on a great variety of soil types in localities on Vancouver Island, the Queen Charlotte Islands, and in the forests adjacent to Terrace and Kitimat on the Mainland.

A preliminary examination of the data from all plots containing cedar showed that most stands under 200 years of age have very little advance regeneration of any species, presumably because of high stand-density. Subsequent analysis was confined to data from stands in excess of 300 years where advance regeneration from one or more species could normally be expected.

The distribution of cedar in all size-classes was examined and it was found that the data could be divided into two distinctive groups, each having a characteristic diameter-distribution curve. The first group consisted of stands where diameter distribution of cedar could be regarded as normal for a shade-tolerant species, i.e., the maximum number of trees occurred in the smaller-diameter and younger-age classes.

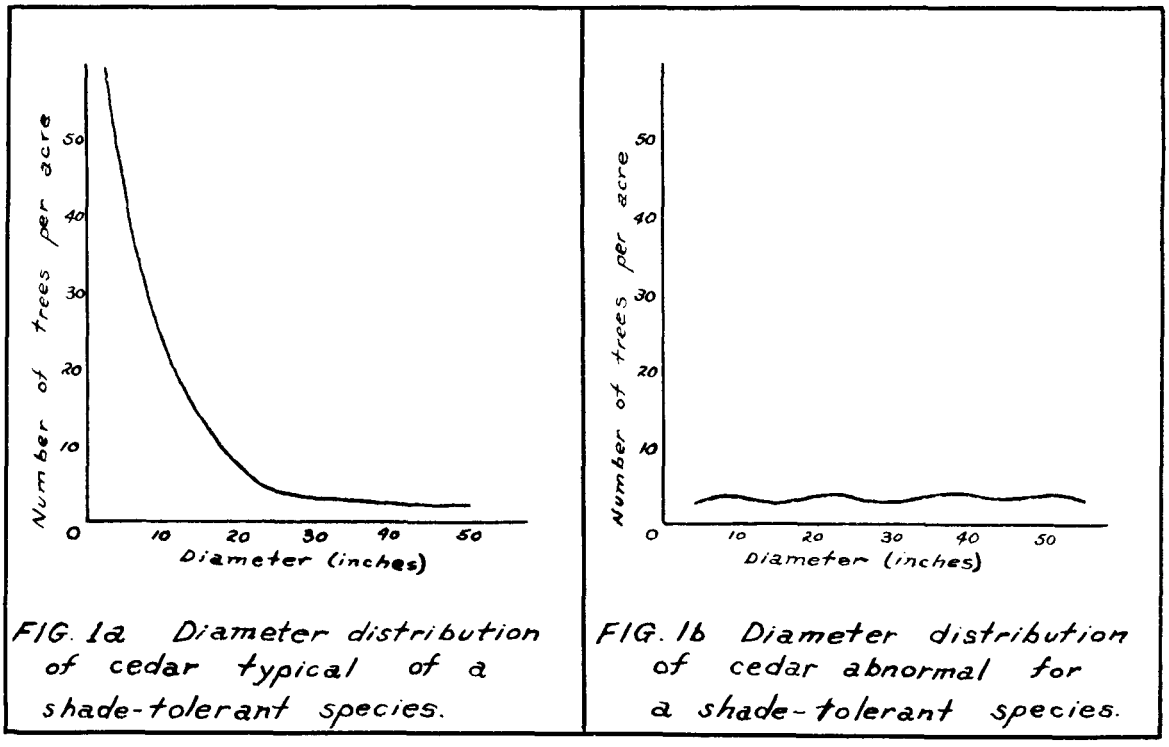

FIG. 1a Diameter distribution of cedar typical of a shade-tolerant species.

FIG. 1b Diameter distribution of cedar abnormal for a shade-tolerant species.

Fig. 1a illustrates this condition. The second group contains stands where the diameter-distribution curve of cedar cannot be considered normal for a shade-tolerant species. Stands were characterized by a noticeable lack of advance cedar regeneration as evidenced by the low number of trees in the smaller d.b.h. classes in Fig. 1b.

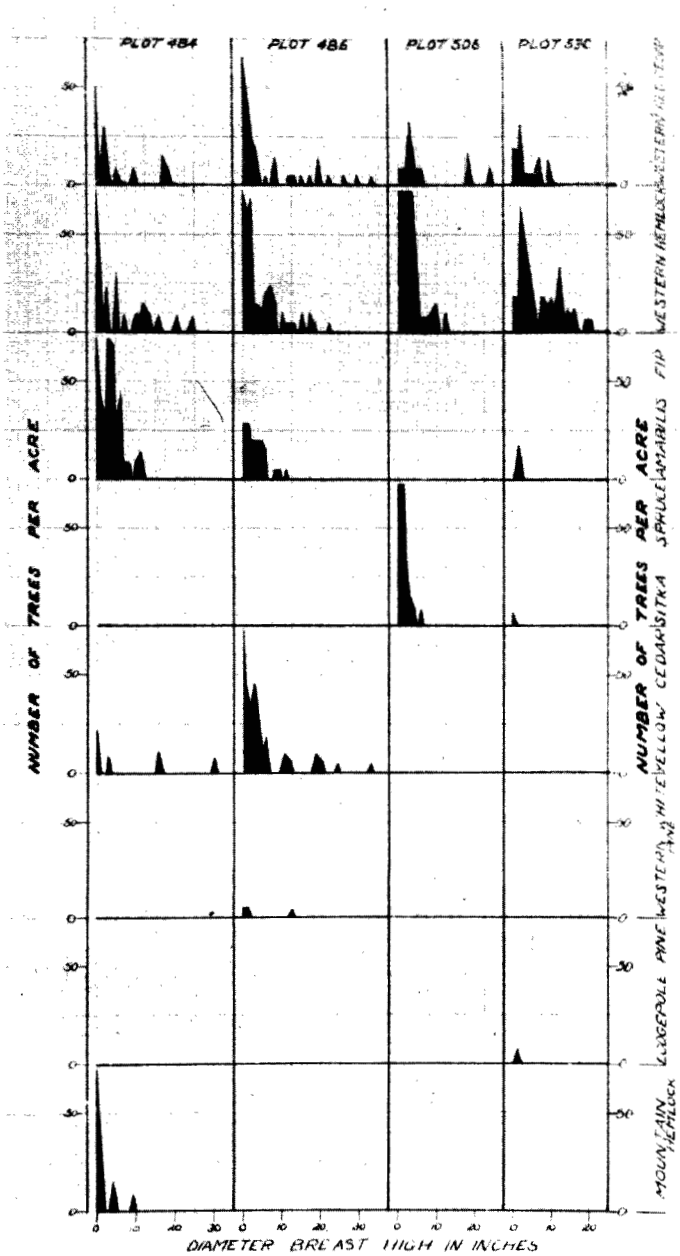

FIG. 2 THE DIAMETER DISTRIBUTION OF ALL TREES ON SAMPLE PLOTS ESTABLISHED IN OVERMATURE SCRUB STANDS.

The field data were re-examined for other distinctive features of these groups. The few plots which conformed to the curve in Fig. 1a had several features in common. They were open-grown stands of short trees on poorly drained sites of exceptionally low productivity, such stands being classified locally as cedar scrub. The diameter distributions of four such typical plots are shown in Fig. 2. Evidently conditions in these scrub stands are favourable for regeneration of a number of species.

All of the plots in which the diameter distribution of cedar was characteristic of that described in Fig. 1b were from commercial stands of medium to high stand-density, which were growing on productive forest land. The diameter distributions of all species on four typical plots of this type are shown in Fig. 3, and all these plots contain an appreciable proportion of cedar by volume.

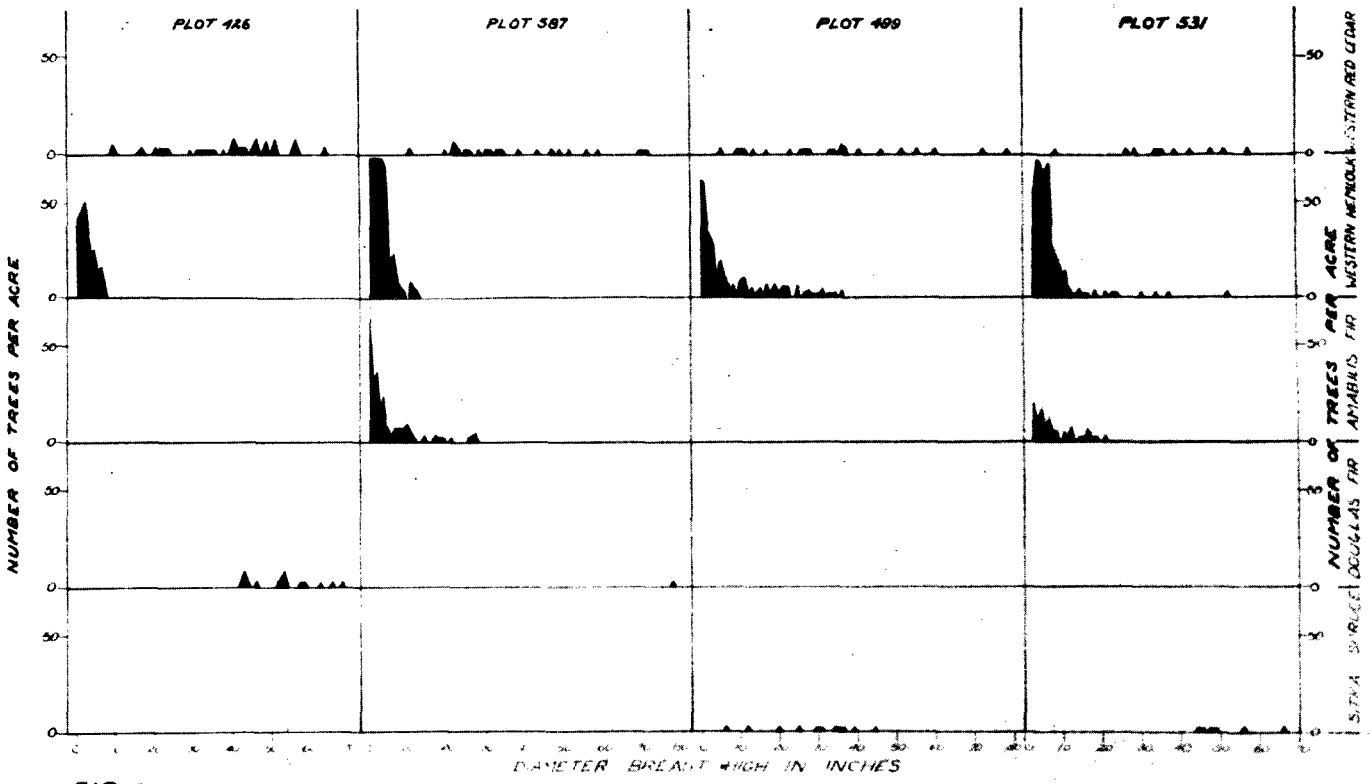

FIG. 3. THE DIAMETER DISTRIBUTION OF ALL TREES ON SAMPLE PLOTS ESTABLISHED IN MATURE AND OVERMATURE STANDS OF COMMERCIAL VALUE.

It would be expected that the greatest abundance of cedar advance regeneration would be found in stands with a high proportion of cedar by volume. Plots in which cedar was abundant were, therefore, selected for analysis, and the results are presented in Table 1.

This table indicates that a high proportion of cedar in the main stand does not guarantee an abundance of advance cedar regeneration. Plot data further indicate that the occurrence of advance cedar regeneration is most erratic, and it may take many years before individual cedar trees become successfully established. The ages of the smallest cedar

trees were counted in a number of plots, all with an abundance of cedar in the main stand. On five of these plots, the youngest trees averaged 70 years of age, while on two other plots there had been no successful regeneration of cedar for over 200 years. In these same plots, there was abundant regeneration of Western hemlock and Amabilis fir.

The advanced ages of very small trees indicates that cedar can endure suppression for a considerable length of time, and trees with a d.b.h. of 3 inches, height of 25 feet, and 200 years old are by no means exceptional. Furthermore, cedar responds well in growth rate after release from suppression. The scarcity of advance regeneration can hardly be attributed to a lack of seed supply, as this species is known to produce large quantities of viable seed. It is probably due to germination failure and seedling mortality, the causes of which are still unknown.

TABLE 1--A comparison of the species composition of advance regeneration with that of the main stand based on 28 plots.

Tree Species	Percentage species composition of entire stand by volume	Percentage species composition of advance regeneration by number of trees
Western red cedar	43.2	1.3
Douglas fir	23.7	0
Western hemlock	19.1	62.2
Amabilis fir	7.8	34.6
Other species	6.2	1.9

REGENERATION OF CEDAR FOLLOWING LOGGING

Surveys conducted by Allen (1), Garman and Barr (5), and Stoodley (9) indicate that cedar is readily established after clear cutting, even when the area has been slash burnt. Clear cutting, the usual logging method in coastal British Columbia, causes many profound environmental changes, and survey data would seem to indicate that these changes are favourable to cedar regeneration. At any rate, there is sufficient data to state positively that cedar regeneration is more prevalent on areas disturbed by logging than beneath natural undisturbed commercial stands.

THE REPRODUCTION OF CEDAR BY MEANS OF ADVENTITIOUS ROOTS

In view of the scarcity of advance cedar regeneration beneath undisturbed commercial forests, close attention was given to the small cedar trees present, and to the immediate environmental conditions. The minor disturbances created by windfalls are evidently responsible for the establishment of some advance regeneration from seed. Beneath stands having typical undisturbed soil conditions, cedar establishment from seed seems to be a failure, although many one-year-old seedlings may be found on rotten wood. For the most part regeneration depends largely upon vegetative reproduction.

Considerable versatility is shown by this species in reproducing vegetatively. Adventitious roots may develop on the low hanging limbs of an erect tree, or they may form along the trunk of a fallen, living

Fig. 4. This is a cedar branch which fell on wet soil during a windstorm, produced adventitious roots, and became self-sustaining. The foliage has already assumed an erect habit of growth.

tree; and a number of examples were found where roots had formed on living branches which had been torn off a tree by the wind and then had fallen on a wet soil surface. Adventitious roots develop most commonly on the branches of trees in a recumbent or semi-recumbent position, forming along portions of the branches which are in direct contact with the soil, where the accumulating litter maintains moist conditions. When the new roots have been established, the end of the branch becomes erect and assumes the habit of a tree. The portion of the original branch between the adventitious roots and the parent tree usually dies and the tree becomes self-sustaining. Examples of vegetative reproduction are shown by the photos in Figs. 4, 5, and 6.

Fig. 5. Two cedar trees, 14 and 22 inches in diameter, have developed from the limbs of a fallen, parent tree. The root system of the parent tree is sustaining the two trees, as they have no root systems of their own.

Fig. 6. These cedar branches producing adventitious roots were still connected to the parent tree. The branch in the upper photo is already self-sustaining, for the wood between the branch and the parent tree is dead; the branch in the lower photo is still connected to the parent tree by living tissue.

Diameter growth of cedar branches is ordinarily slow and, consequently, small trees originating vegetatively from slow-growing branches may be of a very advanced age. This may account for the great ages of many small cedar trees in the forest.

During the course of field work on Vancouver Island, adventitious rooting was also noted on Yellow cedar (Chamaecyparis nootkatensis) and Alpine fir (Abies lasiocarpa). Vegetative reproduction of Eastern White cedar (Thuja occidentalis) has been described in detail by Curtis (3).

DISCUSSION

Regeneration of cedar from seed is largely a failure beneath undisturbed commercial stands, and this is probably due to excessive mortality during germination and the early stages of seedling development. The causes remain to be investigated.

However, cedar can reproduce successfully from seed on open areas disturbed by logging, windfall, or fires.

Vegetative reproduction by means of adventitious roots is of common occurrence, and in forests of high density it may be fully as important as reproduction from seed.

Advance cedar regeneration is, however, seldom as abundant as that of Western hemlock or Amabilis fir. Once established, cedar apparently has a lower mortality rate than these two species, due to its longevity and greater resistance to diseases and insects. Consequently, within a given period, mortality among large cedar trees is less than among Western hemlock or Amabilis fir.

These observations indicate that cedar does not possess all the qualities usually associated with a very shade-tolerant species.

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