A PRELIMINARY ASSESSMENT OF THE INITIAL IMPACT OF BLACK ARMY CUTWORM IN THE PRINCE GEORGE FOREST REGION

by

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ABSTRACT

Black army cutworm, Actebia fennica (Taucher), defoliation to newly planted seedlings in 1984, as measured in 1985, caused reductions in leader and overall seedling heights, leader and seedling mortality and leader deformations. At 5 sites with active infestations inspected in 1985, densities of 1-13 larvae and/or pupae per m^2 of duff sample resulted in 0-71% of the seedlings being defoliated.

Succulent herbaceous vegetation such as Indian hellebore, Veratum viride Ait., were preferentially defoliated by larvae over other vegetation. Natural mortality of black army cutworm at 4 locations ranged from 44-54% and the impact of parasites varied per location. Development of a reliable and operational "defoliation hazard index" will require further field sampling in many locations.

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A PRELIMINARY ASSESSMENT OF THE IMPACT OF BLACK ARMY CUTWORM IN THE PRINCE GEORGE FOREST REGION

I. INTRODUCTION

The black army cutworm, Actebia fennica (Taucher), (Fig. 1a), was considered an agricultural pest in British Columbia until 1973 (Allen and Wood 1973). Since then, infestations of various magnitudes in forest plantations have been recorded in the Prince Rupert, Prince George (Fig. 1b), Cariboo, Kamloops and Nelson Forest Regions. Defoliation has occasionally caused considerable damage to new plantations of the spruces, Picea glauca (Moench) Voss, P. engelmannii Parry, P. glauca x engelmannii, and other conifers including lodgepole pine, Pinus contorta Dougl., and Douglas-fir, Pseudotsuga menziesii, (Mirb.) Franco.(Ross and Ilnytzky 1977).

Damage has been of most concern on newly planted clearcuts which have been recently logged and broadcast burnt. In most locations the defoliating larvae have appeared in late May or early June after a broadcast burn during the previous 1 or 2 years (Ross and Ilnytzky 1977). South-facing hillsides seem to be the preferred egg-laying sites and, therefore, defoliation usually occurs there first.

Sites suffering heaviest damage have often been broadcast burned in the spring or early summer of the previous year prior to egg deposition by immigrant moths in late July or August. The following year, if herbaceous vegetation is sparse because of the severity of the burn, black army cutworm (BAC) damage to newly planted seedlings may be severe. Such developments occurred at Cutting Permit (CP) 345

Fig. 1a. Black army cutworm, Actebia fennica (Taucher), 6th instar larvae and pre-pupae, 1.7 X.

Fig. 1b. Black army cutworm defoliation at CP 134-7 (Prince George West Forest District) in early July 1984. Note defoliated southern aspects.

in the Prince George East Forest District during 1985-86.

BAC feeding has caused seedling mortality, bud damage, and delayed planting schedules. In a BSF thesis, Blackstock (1985) reviewed BAC damage to forest plantations in British Columbia from 1971 to 1984. Wood and Van Sickle (1986) outlined BAC damage in the Prince Rupert, Prince George and Cariboo Regions in 1985.

Blackstock (1985) attempted to develop methods to estimate future conifer seedling damage based on present damage to both herbaceous vegetation and seedlings. This report will not review the above thesis work here, but will outline some Ministry of Forests follow-up studies conducted in the summer of 1985.

The objectives of the project were:

1. To determine the impact of BAC defoliation in 1984 upon the current (1985) growth, form and survival of spruce seedlings.

2. To determine the severity of damage in 1985 to herbaceous vegetation and newly planted seedlings on the same site based on:
   a) the number of larvae and/or pupae per square metre (m^2), and
   b) the percent coverage and species of herbaceous vegetation on site

3. To rank herbaceous vegetation in order of palatability or preference to BAC on a per area basis.

4. To measure natural mortality of BAC in certain locations as caused by parasites, predators and other factors.

5. To make preliminary operational recommendations for management of BAC based on the above findings.

II. METHODS

A. Impact of Seedling Defoliation from 1984

A total of 27 (50 m^2) circular plots established by Blackstock (1985) in 1984 near Bear Lake on Cutting Permits C.P.'s 134-7 and 135-2 (Fig. 2) were re-measured. Spruce seedlings on both C.P.'s had suffered various degrees of defoliation (74-92%) and bud damage (27-56%) from BAC in 1984 (Table 1) (Fig. 1b).

The history of each C.P. was:

C.P. 134-7

- logged winter of 1981-82
- broadcast burned in September 1982
- planted in summer of 1983 with 211* + 1 PBR spruce

C.P. 135-2

- logged in winter of 1981-82
- broadcast burned in September 1982
- planted in spring of 1984 with 2+0 BR spruce

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* 211 cm^3 styroblock

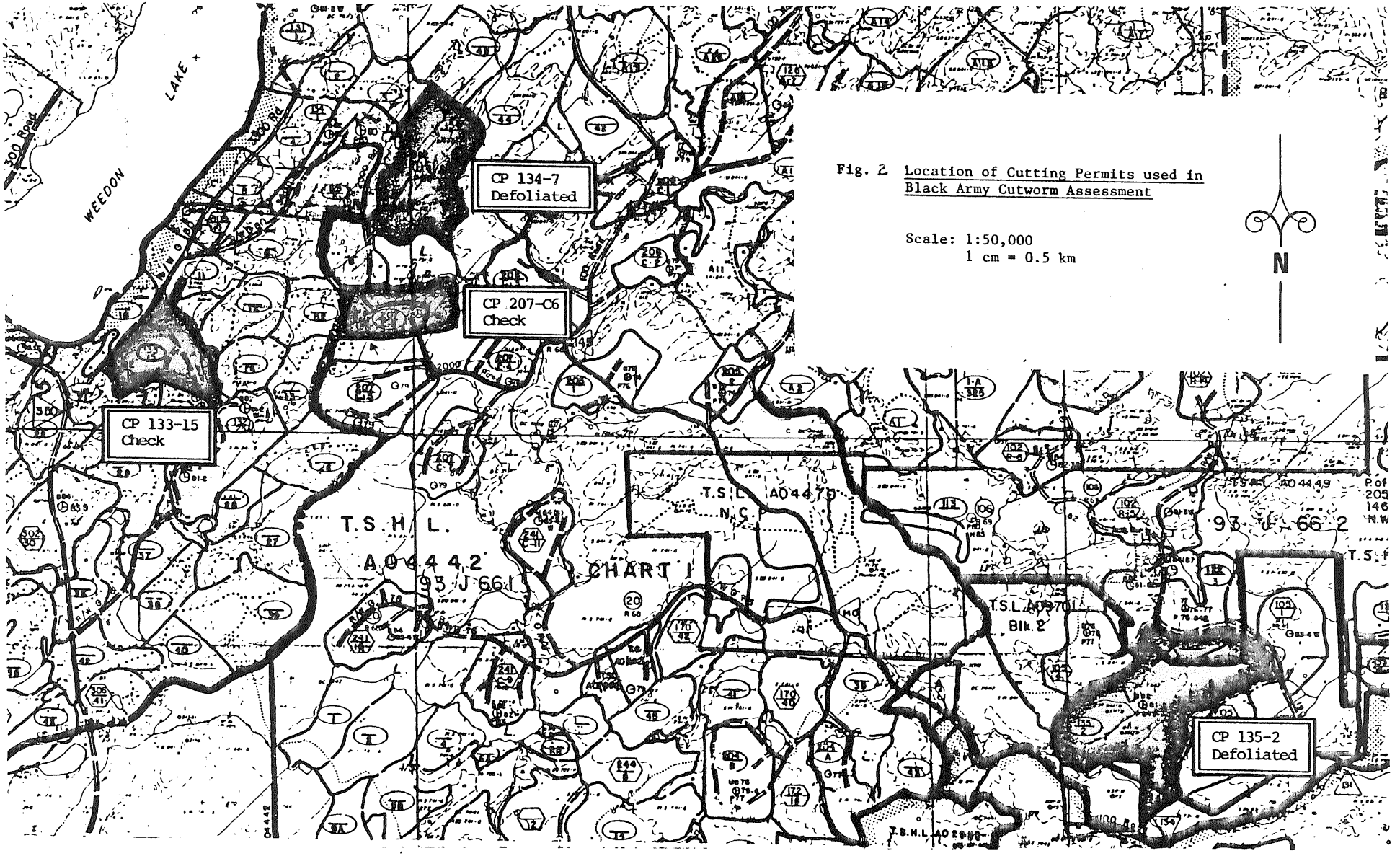

Fig. 2. Location of Cutting Permits used in Black Army Cutworm Assessment

Scale: 1:50,000
1 cm = 0.5 km

Table 1. Impact of black army cutworm damage in 1984 to seedling leader and height growth as measured in 1985

C.P.	Number of Seedlings Tallied	No. Stems per ha	Mean B A C Damage to Planting Stock in 1984		Mean Seedling Height (cm) in 1985[c]	% Difference in Seedling Heights	Mean Leader Height (cm) in 1985[c]	% Difference in Leader Heights
			% Buds Damaged[a]	% Defoliation[b]				
134-7	64	1600	27%	74%	32.8 ± 9.5		6.4 ± 6.4	
						9%		29%
207-C6*	89	2967	0%	0%	36.1 ± 8.7		9.0 ± 5.6	
135-2	82	820	56%	92%	20.0 ± 5.6		1.5 ± 1.6	
						18%		38%
133-15*	69	1980	0%	0%	24.4 ± 5.0		2.4 ± 2.0	

* Check C.P.'s (non-defoliated)

[a] Mean percent of buds damaged per C.P.

[b] Mean percent of defoliation per tree per C.P.

[c] Mean seedling and leader heights on defoliated seedlings were significantly different from their respective checks at the 0.05 level (± standard deviations) (Two sample t test, Snedecor and Cochran 1972)

A total of 146 seedlings on these C.P.'s were re-measured and the following data collected:

i) number of stems per hectare (ha)

ii) seedling heights

iii) leader lengths

iv) number of seedlings that were dead or those with no leaders, dead leaders or club tops (multiple laterals).

Neither BAC or defoliation could be detected on these sites in 1985.

For comparison purposes, an additional 158 seedlings on 13 plots were assessed on 2 adjacent non-defoliated (check) CP's. The western portion of CP 207-C6 was chosen as a check for CP 134-7 because of its identical history, planting stock, similar site conditions and lack of defoliation in 1984. CP 135-15 was chosen as a check for CP 135-2 for the same reasons (Fig. 1).

B. Impact of Defoliation on Seedlings and Herbaceous Vegetation in 1985

A total of 40 (50 m^2) plots were examined in areas of active BAC defoliation in the Prince George West, Prince George East and McBride Forest Districts as indicated in Table 2. Most plots were sampled between June 3-25, 1985 and the data was recorded on the BAC sampling sheet (Appendix 1) which included:

Table 2. Locations sampled in 1985 for determination of black army cutworm impact

District	Location	No. Plots	Sample Date	Mean BAC Development Stage *
P. G. West	FL A02449 CP 603-6	10	June 24-25	pupae
P. G. East	FL A18165 CP 341	15	June 3-11	late 6th instar
	TFL 30 CP 7	5	July 23	emerged pupae
McBride	FL A1543 CP 400	5	June 18	40% 6th instar 60% pupae
	FL A1543 CP 007	5	June 19	late 6th instar
		Total = 40		

* Mean development per CP based on larval/pupal samples per m^2 of duff per plot

1. plot location
2. sample date
3. site history
4. slope position and aspect
5. percent defoliation to seedlings and species of herbaceous vegetation per plot
6. percent cover of herbaceous vegetation species per plot
7. number of larvae and/or pupae per m^2
8. mean stage of development of BAC
9. depth of duff (L-F-H layer)
10. sampling time per plot

Plots were established within defoliated areas on compass lines every 50 m. Seedlings and herbaceous vegetation were assigned symbols listed in a vegetation key and plotted onto the sampling sheet (Appendix 1). A randomly selected m^2 of duff within each of the 50 m^2 circular plots was examined for BAC larvae and/or pupae. Soil was carefully excavated with a hand rake to a depth of approximately 15 cm and virtually all BAC specimens were found within the upper 10 cm of soil.

C. Black Army Cutworm Vegetation Preference Ranking

On the 40 sample plots, herbaceous vegetation was recorded by: 1) species; 2) percent coverage of the total vegetation on site; and 3) percent defoliation as per the code on the sampling sheet (Appendix 1). Plot data was pooled for the 5 areas and the mean percent plant species coverage per plot was obtained. Herbaceous

vegetation was then ranked per area according to its palatability/preference to BAC as based on percent defoliation.

D. Natural Mortality of Black Army Cutworm

BAC larvae and pupae were collected from randomly chosen, various sized duff samples in the 4 locations listed in Table 3; samples from the Bear Lake area and in the Bowron River drainage were taken on May 23-24 and those from Valemount on June 20, 1985. Collections were placed in rearing cages with 4 cm of soil and, where larvae were included, appropriate quantities of fresh herbaceous vegetation were added. Pupae placed in rearing cages were lightly covered with 1 centimeter (cm) of soil to simulate field conditions. Fresh vegetation was added on a daily basis until all larvae entered pupation. Soil humidity was maintained by occasionally sprinkling water through the overhead screening.

Once all moths had died, cages were opened and rates of mortality determined. Emergent parasites were pinned and sent for identification to the Forest Insect and Disease Survey Unit of the Canadian Forestry Service in Victoria.

III. RESULTS

A. Impact of Seedling Defoliation from 1984

Data was collected after bud-set from July 25 to August 16, 1985. The check CP's had a considerably higher number of stems per ha than their respective defoliated CP's (Table 1). While this may have complicated comparisons of bud and defoliation

Table 3. Mortality of black army cutworm in the Prince George Forest Region in 1985

Location	Reared: No. Larvae	Reared: No. Pupae	Reared: Total	No. Moths Successfully Emerged	No. Unemerged Pupae/Larvae Killed by: Ichneumonids	Tachinids	Unknown Causes	Percent Mortality
Valemount CP's 400, 402, 007	11[a]	5	16	9[b]	1[c]	2[d]	4	44%
Bear Lake CP 603-6	65	25[e]	90	43[f]	8[g]	5[h]	34	52%**
Bowron CP 341*	100	0	100	46	7[j]	1[k]	45	54%
	100	0	100	47	1[g]	0	52	53%

[a] included 6 unknown Noctuid larvae

[b] 5 Actebia fennica, 4 Noctuid moths

[c] Eutanyacra sp.

[d] Mericia ampelus

[e] included 19+ unknown Noctuid pupae

[f] 24 A. fennica, 19 Noctuid moths

[g] 1 Erigorus sp., 4 Eutanyacra sp.

[h] included 2 Nowickia latigena

[j] Erigorgus sp.

[k] Nowickia latigena

* 1st collection from upper slope
2nd collection from mid-upper slope

** no viral infections detected in dead larvae/pupae

Identification of parasites and causes of mortality determined by the Canadian Forestry Service, Pacific Forestry Centre, Victoria

damage per tree between CP's, the larger number of trees on the checks were not crowded to the point where height and leader growth would be affected within this early growth period.

On BAC-damaged sites, overall seedling heights were reduced by 9-18% and leader heights were reduced by 29-38% (Table 1). Most of the reductions in overall seedling heights were likely caused by, and reflected in, the reductions in leader heights. While one may not have been justified in separating overall bud damage from needle defoliation, a 27% rate of bud damage on CP 134-7 in 1984 resulted in a 9% loss of overall seedling height in 1985. Interestingly enough, a similar ratio of 3:1 existed on CP 135-2, that is, a 56% rate of bud damage in 1984 resulted in an 18% loss of overall seedling height in 1985. The rates of needle defoliation likely stressed the seedlings and contributed to the above growth losses.

BAC-damaged seedlings on CP's 134-7 and 133-15 also suffered various degrees of leader mortality and deformities when compared with the check areas. On defoliated CP's, approximately 13-18% of seedlings had no leaders, 8-15% were dead or had dead leaders, and 13-18% had "club tops" of multiple laterals competing for apical dominance (Table 4). Aside from seedling mortality, leader mortality and club topping are undoubtedly more serious than a simple reduction in leader and tree heights, particularly where aggressive and competitive vegetation invades the plantation.

Table 4. Impact of black army cutworm damage in 1984 to leader condition and form in 1985

C.P.	Number of Seedlings Examined	No. of Seedlings Examined with: No Leader	Dead Leader[b]	Club Top	Adjusted Percent Damage to Seedlings because of B.A.C. Feeding[c] No Leader	Dead Leader**	Club Top
134-7	64	16	5	9	12.6%	7.8%	13.0%
207-C6[a]	89	11	0	1	--	--	--
135-2	82	23	16	19	17.9%	15.2%	17.5%
133-15[a]	69	7	3	4	--	--	--

[a] Check plots

[b] Includes dead seedlings

[c] Adjusted by Abbott's formula for natural mortality/deformations

Such competitive vegetation would be better able to overtop seedlings suffering leader deformations than seedlings with no damage. There have been no studies to date on the impact of competitive vegetation on BAC-defoliated seedlings.

B Impact of Defoliation on Seedlings and Herbaceous Vegetation in 1985

Data in Table 5 illustrates the impact of BAC damage in 1985 to spruce seedlings and herbaceous vegetation in 5 locations sampled within 3 Forest Districts. The mean number of larvae and/or pupae per m^2 ranged from 1.0 $\pm$ 1.0 to 12.8 $\pm$ 14.0, and the mean percent coverage of herbaceous vegetation per plot ranged from 15-86%. Mean percent defoliation on herbaceous vegetation ranged from 1-49%, and from 0-71% of seedlings were defoliated to various degrees.

It is interesting to note that CP 7 and CP 007 had relatively similar densities of larvae and/or pupae per m^2 (1.0-1.8), similar percent coverage of herbaceous vegetation (68-86%), and similar percent seedling defoliation (18-27%). Other CP's had more varying levels of BAC densities, quantities of herbaceous vegetation, and levels of seedling defoliation.

CP 400 contained a slightly higher mean of 2.0 larvae and/or pupae per m^2, but herbaceous vegetation covered only 15% of the

Table 5. Impact of black army cutworm damage in 1985 to spruce seedlings and herbaceous vegetation in the Prince George Forest Region

Forest District	C.P. or Location	No. Plots	Mean No. of Larvae/Pupae per m^2	Mean Percent Coverage of Herbaceous Vegetation	Range of Defoliation on Herbaceous Vegetation	Mean No. Seedlings per Plot	Mean Percent of Seedlings Defoliated
P. G. West	CP 603-6	10	2.8 ± 2.3*	82%	1-24%	7.8 ± 1.8*	0%
P. G. East	CP 341	14	12.8 ± 14.0	19%	25-49%	6.6 ± 2.0	14%
	TFL 30	5	1.8 ± 1.5	86%	25--49%	5.6 ± 1.1	27%
McBride	CP 400	5	2.0 ± 1.6	15%	1--24%	4.2 ± 1.9	71%
	CP 007	5	1.0 ± 1.0	68%	1-24%	4.4 ± 0.9	18%

* Standard deviations included (n-1 weighting)

sampled area. Therefore, in the absence of an adequate BAC food source (other factors being equal), it is not surprising that 71% of the seedlings suffered defoliation. Figure 3a illustrates BAC defoliation on CP 400 in July 1985.

CP 341 had a considerably higher mean of 12.8 larvae/pupae per m^2, and the minimal herbaceous vegetation on site (19% cover) consequently suffered a higher degree of defoliation (25-49%) than 3 of the 4 other CP's. It is noteworthy that only 14% of the seedlings here were defoliated, perhaps because Indian hellebore, Veratum viride Ait. comprise 29% of the vegetation and was preferred by BAC over 7 of 11 other species (Table 6). Figure 3b illustrates Indian hellebore defoliated by BAC.

CP 603-6 had a slightly higher mean number of larvae and/or pupae per m^2 than CP 7, but both plots had similar levels of herbaceous ground cover. However, on CP 603-6, BAC defoilation occurred only on herbaceous vegetation - not on seedlings.

False Solomon's-seal, Smilacina racemosa (L.) Desf., was BAC's preferred food source on both CP 603-6 and CP 7 (Tables 7, 8). On CP 7 where S. racemosa was relatively scarce (5.2% of vegetation), percent seedling defoliation was relatively high (27%); on CP 603-6 where S. racemosa was relatively abundant (12.5 % of vegetation), percent seedling defoliation was nil. Although other site factors undoubtedly influenced defoliation rates, the above

Fig. 3a. Black army cutworm defoliation on CP 400 (McBride Forest District) on June 18, 1985.

Fig. 3b. Indian hellebore, Veratum viride Ait., partially defoliated by black army cutworm.

Table 6

Black Army Cutworm Vegetation Preference Ranking

Forest District Prince George East

CP or Location CP 341

No. Plots Sampled 14

Mean Percent Coverage of Herbaceous Vegetation per Plot 19%

Range of Defoliation on Herbaceous Vegetation per Plot 50-74%

Plant Species	Mean % Plant Species Occupation per total Vegetation per Plot	Ranking of BAC Feeding Preference
Indian hellebore, Veratum viride	29.4 ± 27.0	1
red swamp currant, Ribes triste	17.0 ± 20.8	1
bracken fern, Pteridium aquilinum	14.6 ± 9.5	4
wood horsetail, Equisetum sylvaticum	13.2 ± 23.8	3
slender wheat grass, Agropyronon trachycaulum	6.8 ± 12.0	4
cordydalis, Cordydalis sempievirens	5.4 ± 15.9	4
fireweed, Epilobium angustifolium	5.0 ± 8.3	1
valerian, Valeriana dioca	4.5 ± 8.4	1
willow sp., Salix spp.	3.2 ± 12.0	4
dandelion, Taraxacum officinale	1.4 ± 5.3	1
western meadow-rue, Thalictrum occidentale	0.5 ± 1.3	2
Hooker's fairybells, Disporum hookeri	0.1 ± 0.3	3

Table 7

Black Army Cutworm Vegetation Preference Ranking

Forest District Prince George West

CP or Location CP 603-6

No. Plots Sampled 10

Mean Percent Coverage of Herbaceous Vegetation per Plot 82%

Range of Defoliation on Herbaceous Vegetation per Plot 1-24%

Plant Species	Mean % Plant Species Occupation per total Vegetation per Plot	Ranking of BAC Feeding Preference
fireweed, Epilobium angustifolium	48.5 ± 24.5	2
false Solomon's-seal, Smilacina racemosa	12.5 ± 17.4	1
red swamp currant, Ribes triste	11.0 ± 6.6	2
trembling aspen, Populus tremuloides	10.2 ± 18.0	2
raspberry, Rubus ideaus	6.2 ± 11.4	2
slender wheat grass, Agropyronon trachycaulum	4.0 ± 9.7	2
dandelion, Taraxacum officinale	3.4 ± 10.8	2
black twinberry, Lonicera involucrata	1.5 ± 3.4	2
Hooker's fairybells, Disporum hookeri	0.6 ± 1.5	1
western meadow-rue, Thalictrum occidentale	0.4 ± 0.8	2
devil's club, Oplopanax horridus	0.3 ± 0.9	2
three-leaved foamflower, Tiarella trifoliata	0.1 ± 0.3	2
cordydalis, Cordydalis sempievirens	0.1 ± 0.3	3

Table 8

Black Army Cutworm Vegetation Preference Ranking

Forest District Prince George East

CP or Location CP 7

No. Plots Sampled 5

Mean Percent Coverage of Herbaceous Vegetation per Plot 86%

Range of Defoliation on Herbaceous Vegetation per Plot 25-49%

Plant Species	Mean % Plant Species Occupation per total Vegetation per Plot	Ranking of BAC Feeding Preference
wood horsetail, Equisetum aquilinum	26.0 ± 33.1	6
Hooker's fairybells, Disporum hookeri	25.4 ± 16.2	3
black twinberry, Lonicera involucrata	19.0 ± 5.5	4
fireweed, Epilobium angustifolium	12.4 ± 12.6	4
false Solomon's-seal, Smilacina racemosa	5.2 ± 11.1	1
queen's cup, Clintonia uniflora	3.0 ± 4.5	2
bracken fern, Pteridium aquilinum	3.0 ± 4.5	5
alder spp., Alnus spp.	1.0 ± 2.2	4
raspberry, Rubus ideaus	1.0 ± 2.2	6
slender wheat grass, Agropyronon trachycaulum	1.0 ± 2.2	6

may help explain the feeding variation between plots. BAC vegetation preference ranking is further discussed in the next Section (C).

C. Black Army Cutworm Vegetation Preference Ranking

Tables 6-10 rank species of vegetation per CP in order of their degree of defoliation from BAC. General observations indicate that:

1. Although Indian hellebore was only present on CP 341, it comprised 29% of the plot vegetation and suffered a 50-74% rate of defoliation along with a few other species of lesser density (Table 6).

2. Where the lily, false Solomon's-seal, was present (CP 603-6, CP 7), it was generally more palatable to BAC than other plant species (Tables 7, 8).

3. Hooker's fairybells, Disporum hookeri (Torr.) Nicholson, was present at every area except CP 400. This other member of the lily family was preferentially defoliated over many other plant species on CP 7 and CP 603-6, and less so on CP 341 and CP 007 (Tables 6, 7, 8, 10).

4. Fireweed, Epilobium angustifolium L., was present on all areas and was defoliated to various degrees depending on location (Tables 6-10).

Table 9

Black Army Cutworm Vegetation Preference Ranking

Forest District McBride

CP or Location CP 400

No. Plots Sampled 5

Mean Percent Coverage of Herbaceous Vegetation per Plot 15%

Range of Defoliation on Herbaceous Vegetation per Plot 1-24%

Plant Species	Mean % Plant Species Occupation per total Vegetation per Plot	Ranking of BAC Feeding Preference
fireweed, Epilobium angustifolium	76.6 ± 24.0	3
heart-leaved arnica, Arnica cordifolium	5.0 ± 1.8	4
raspberry, Rubus ideaus	5.0 ± 26.8	4
wood horsetail, Equisetum sylvaticum	4.0 ± 8.9	1
thimbleberry, Rubus parviflorus	3.2 ± 4.6	2
red elderberry, Sambucus racemosa	2.0 ± 4.5	4
dandelion, Taraxacum officinale	1.0 ± 2.2	5
red swamp currant, Ribes triste	0.4 ± 0.9	5

Table 10

Black Army Cutworm Vegetation Preference Ranking

Forest District McBride

CP or Location CP 007

No. Plots Sampled 5

Mean Percent Coverage of Herbaceous Vegetation per Plot 68%

Range of Defoliation on Herbaceous Vegetation per Plot 1-24%

Plant Species	Mean % Plant Species Occupation per total Vegetation per Plot	Ranking of BAC Feeding Preference
fireweed, *Epilobium angustifolium*	38.0 ± 12.5	1
bracken fern, *Pteridium aquilinum*	25.0 ± 7.1	2
raspberry, *Rubus ideaus*	17.0 ± 7.6	2
valerian, *Valeriana dioca*	15.0 ± 10.0	2
Hooker's fairybells, *Disporum hookeri*	2.0 ± 4.4	2
false lily-of-the-valley, *Maianthemum canadense*	2.0 ± 4.5	2

5. Western meadow-rue, Thalictrum occidentale A. Gray, was found in small quantities on CP's 341 and 603-6, but was ranked second in palatability on CP 341 (Tables 6, 7).

It was apparent from the data that succulent plants such as Indian hellebore and the lilies - false Solomon's-seal and Hooker's fairybells, where available, were preferentially defoliated by BAC over other herbaceous vegetation. With further investigation, a few such plants might serve as key indicators in integrating the various factors of site hazard rating for BAC.

D. Natural Mortality of Black Army Cutworm

Table 3 depicts natural mortality of BAC from larval and/or pupal collections made in 4 locations within 3 Forest Districts. Moth emergence in rearing cages began between June 17-27, and all moths and their associated parasites died between July 9-22. It should be noted that an unknown species of Noctuid* moth of similar appearance to BAC was collected and reared from collections at Valemount and Bear Lake. The unidentified Noctuid comprized 44% of the total successful moth emergence at the latter sites.

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*Identification pending by the Forest Insect and Disease Survey Unit, Canadian Forestry Service, Victoria.

Dead BAC larvae and pupae from the Bear Lake (CP 603-6) collection were checked for NPV virus infection by the Canadian Forestry Service*, but no incidence of NPV was found. Although mortality from Ichneumonid and Tachinid parasites was variable, total percent mortality at the 4 locations was fairly consistent and ranged from 44% at Valemount to 54% in the Bowron at CP 341. Such rates of late larval/pupal mortality, while perhaps not significantly reducing defoliation in 1985, will likely result in reduced overall egg deposition on adjacent cutblocks in 1986.

IV. SUMMARY AND RECOMMENDATIONS

A. Summary

1. BAC defoliation on seedlings in the Prince George West Forest District in 1984, as measured in 1985, caused:
   1) a 29-38% reduction in leader height;
   2) a 9-18% reduction in total seedling height;
   3) a 13-18% loss of leaders;
   4) a 8-15% leader or seedling mortality; and
   5) a 13-18% leader deformation or "club topping".

2. At 5 locations examined in 3 Forest Districts:
   1. BAC densities per area ranged from 1-13 larvae/pupae per m^2;
   2. mean percent cover of herbaceous vegetation per CP's ranged from 15-86%;

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* Dr. Imre Otvos, Pacific Forestry Centre, Victoria, B.C.

3. BAC defoliation on herbaceous vegetation per CP's ranged from 1-49%; and
4. the mean percent of seedlings defoliated per CP's ranged from 0-71%.

Data indicated that even on sites with relatively high concentrations of herbaceous vegetation (e.g., 68% coverage on CP 007), as few as 1 BAC larva per m^2 caused defoliation to 18% of the seedlings on site. Where alternative food sources of herbaceous vegetation were relatively sparse (e.g., 15% coverage on CP 400),as few as 2 larvae/m^2 caused damage to 71% of the newly planted seedlings. Therefore, sites with relatively sparse herbaceous vegetation and more than 1 larvae/m^2 may be subjected to BAC seedling defoliation.

3. Where succulent herbaceous vegetation was present, such as Indian hellebore and the lilies - false Solomon's-seal and Hooker's fairybells, these plants were preferentially defoliated by BAC over other vegetation. Where present, such plants might serve as key indicators in helping to predict potential seedling defoliation.

4. Although BAC mortality from Ichneumonid and Tachinid parasites was variable, total percent natural mortality of BAC at the 4 locations was fairly consistent and ranged from 44-54%. Such rates of mortality should help reduce overall egg deposition on adjacent cut-blocks in 1986.

5. Development of an operational and reliable BAC defoliation hazard index is a complicated goal and will require continued sampling and re-examination of defoliated areas in many locations.

B. Recommendations

Based on data collected in this report and previous studies, it is recommended that:

1. All south-facing upper slopes of cutblocks which have been recently logged and broadcast burnt are at risk and, therefore, should be inspected a few days prior to spring planting. If BAC larvae and/or defoliation on herbaceous vegetation is present, the affected area should be delineated and not planted until a further assessment can be made (step 2).

2. Since as few as 1 larvae/m^2 can cause serious defoliation under certain site conditions, areas with sparse or non-succulent herbaceous vegetation (e.g., less than 80% coverage) and 1 or more larvae/m^2, should not be planted until after most larvae have entered pupation. This planting delay may take several days to several weeks depending on the stage of larval instar discovered. Blackstock (1985) indicated that the cost of replanting an area because of BAC damage averaged $143.00/ha.

3. Levels of seedling defoliation should be estimated in more precise categories than that recommended by Blackstock (1985) and subsequently used in this study in 1985. Increments of 0%, 1-5%, 6-10%, 11-15%, etc., would more accurately classify defoliation and help to better correlate damage to other site parameters such as larval densities.

4. Other methods of detecting BAC are being developed by the Canadian Forestry Service for adults (via pheromone traps) and early instar larvae (via duff samples) in the year prior to larval defoliation. Attempts should be made to correlate such capture rates or samples with resulting larvae and/or defoliation the second year.

5. Timing of broadcast burning (e.g., spring, summer, fall), and consideration of drought codes and duff moisture codes should be more closely examined. Further examination of BAC defoliated cutblocks in many locations is necessary before a functional defoliation hazard index can become operational. It is recommended that an informal inter-agency committee be established to co-ordinate and identify further field studies. Such a committee should consist of two representatives of the B.C. Forest Service and one each from the Canadian Forestry Service and a Forest Licencee.

V. ACKNOWLEDGEMENTS

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Appendix 1

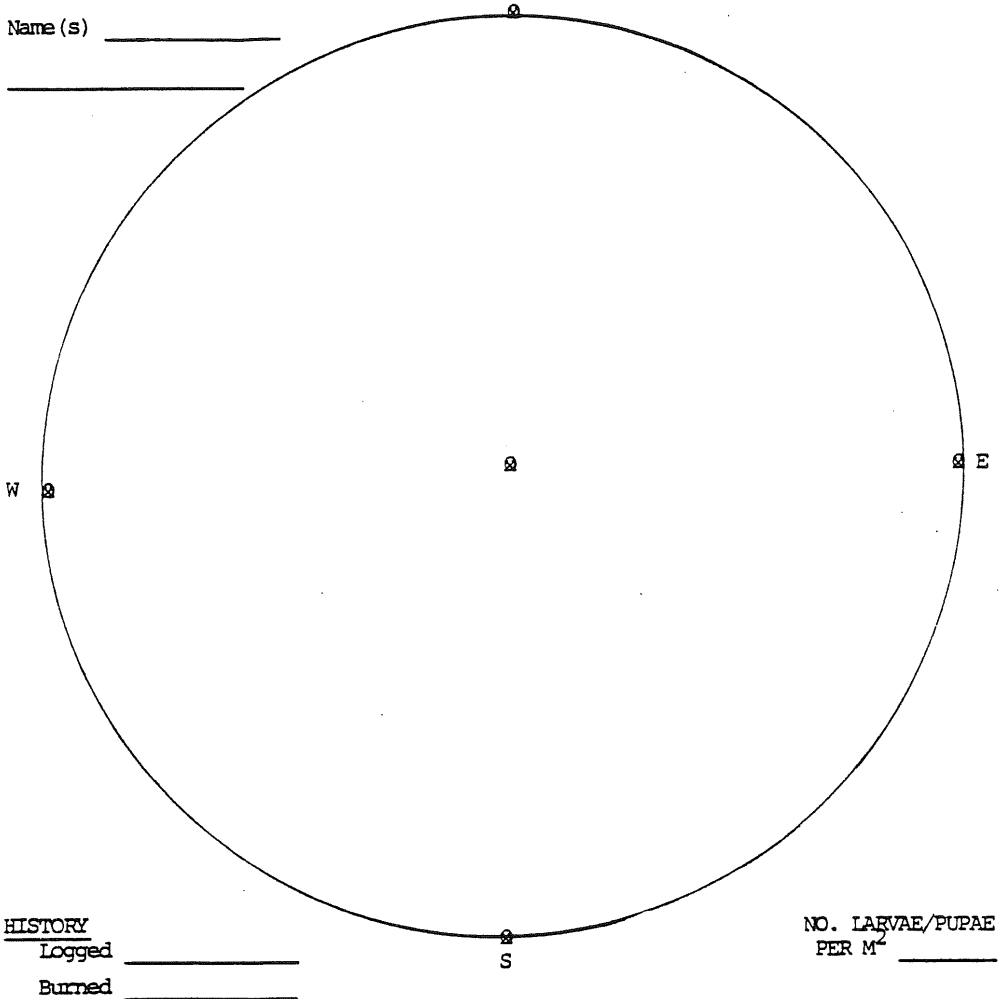
BLACK ARMY CUTWORM SAMPLING SHEET

Forest District _____ Plot Number _____

CP or General Location _____ Date _____

Name(s) _____

_____



HISTORY
Logged _____
Burned _____

NO. LARVAE/PUPAE PER M^2 _____

MEAN STAGE OF DEVELOPMENT _____

SLOPE POSITION
Upper (ridge, upper, middle)
Lower (base, lower)

ASPECT
Cool (n, w, none-base)
Warm (s, e, none-ridge)

PERCENT DEFOLIATION

1 -	90 - 100	%
2 -	75 - 89	%
3 -	50 - 74	%
4 -	25 - 49	%
5 -	1 - 24	%
6 -	0	%

SOIL INFORMATION
Depth of duff _____

SAMPLING TIME _____

VEGETATION KEY

x	spruce seedling	Co	cordydalis
▼	Indian hellebore	wh	wood horsetail
fi	fireweed	re	red elderberry
c	swamp current	☤	Devil's Club
f	fern	Ω	Queen's Cup
w	willow	u_6	
ta	trembling aspen	Tt	Tiarella trifoliata
h	hooker's fairybells	st	stellaria sp.
*	western mtn. ash	a	alder
s	birch-leaved spirea	g	geranium sp.
t	black twinberry	SS	false solomon's seal
r	western meadowrue	Bg	black gooseberry
v	valerian	Rb	raspberry