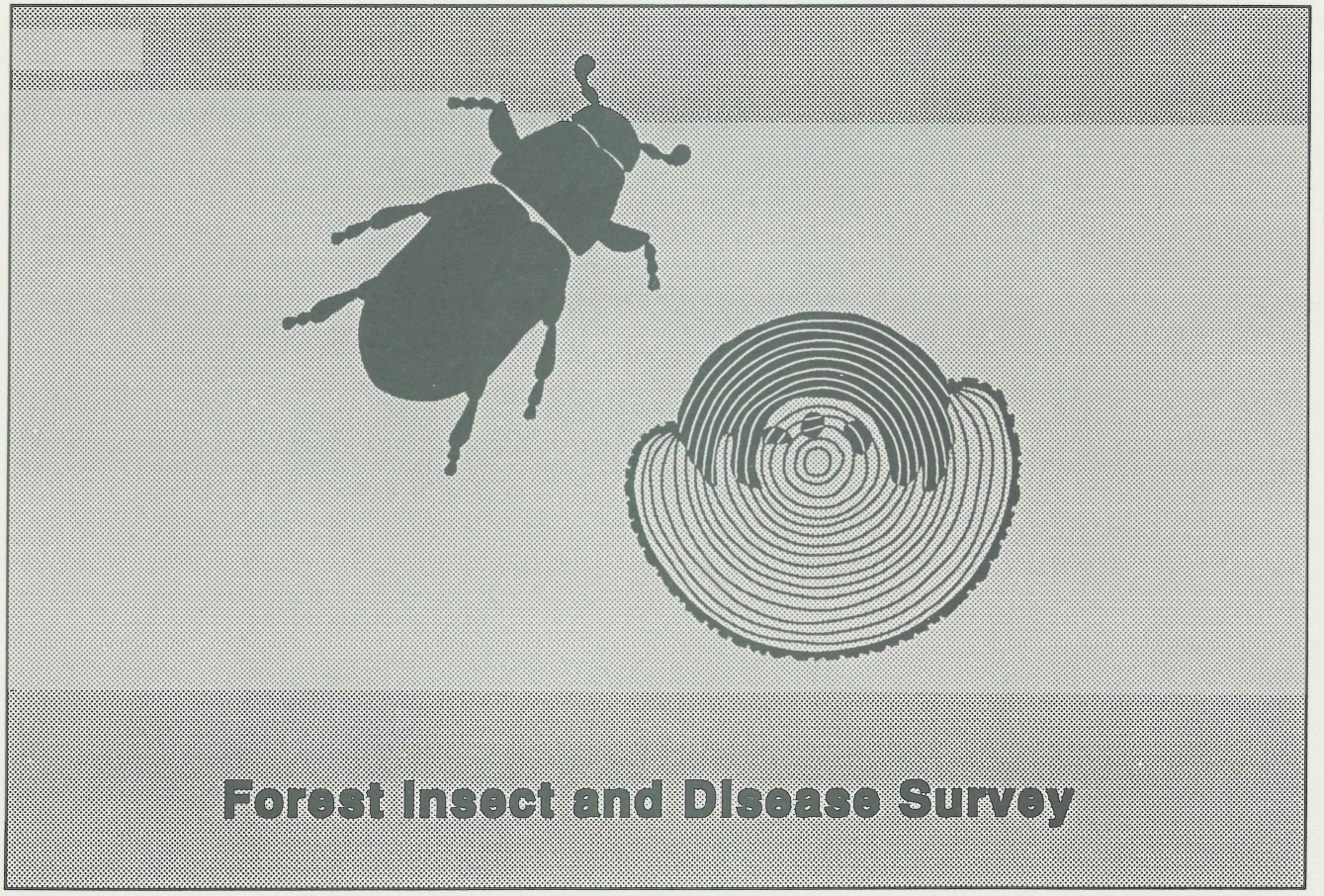
WESTERN FALSE HEMLOCK LOOPER IN BRITISH COLUMBIA 1947 - 1991

FIDS Report 92 - 9

R. I. Fennis

Pacific and Yukon Region



Forest Insect and Disease Survey

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WESTERN FALSE HEMLOCK LOOPER IN BRITISH COLUMBIA 1947 - 1991

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ABSTRACT

Western false hemlock looper, Nepytia freemani Munroe, is an important forest defoliator in British Columbia. Outbreaks have occurred periodically in the Interior Douglas-fir biogeoclimatic zone in the Kamloops and Nelson forest regions since 1947. Periodic population increases persist for 1 to 3 years, and then decline. When defoliation is severe for two or more consecutive years tree mortality and top-kill may occur.

The Forest Insect and Disease Survey detects and appraises defoliator populations annually, using three-tree beating samples to monitor larvae; ground and aerial detection surveys to record and photograph defoliation, top-kill and tree mortality. An average of 8 larva per three-tree beating sample indicates possible defoliation.

Damage varies from trace defoliation with no significant damage, through defoliation causing growth loss;too mortality in the stand. Natural control by the nuclear polyhedrosis virus is the most common method of control but spraying with Bacillus thuringiensis and DDT have been used successfully.

INTRODUCTION

The purpose of the report is to compile and summarize published and unpublished data on western false hemlock looper in British Columbia since its discovery near Chase in 1942. Information in this report is based on file reports of Forestry Canada's, Forest Insect and Disease Survey (FIDS), Pacific and Yukon Region, Victoria, B.C.

There have been four infestations recorded (Table 1), the largest near Columbia Lake in 1947 where about 10 000 ha were lightly to severely defoliated. Additional information on histories of outbreaks was presented by Harris et al. (1985).

BIOLOGY

Distribution and Taxonomy

The western false hemlock looper, Nepytia freemani Munroe is a native defoliator of Douglas-fir. It is found in British Columbia in the Interior Douglas-fir biogeoclimatic zone of the Kamloops, Nelson and southern Cariboo Forest Regions. It also occurs in southwestern Alberta and northwestern United States. FIDS collections from 1981 indicate a northerly expansion[1] to near Williams Lake.

In British Columbia during 1947 and 1948 a species of Nepytia was recorded as "false hemlock looper." It was suspected to be Nepytia canosaria Wlk. but was identified as a previously undiscovered species. Dr. T.N. Freeman separated the species in the Canadian National Collection and formed the opinion that it represented a new species. (Munroe 1963)

Hosts

Western false hemlock looper is a pest of regeneration, immature and semi-mature Douglas-fir. Larvae are occasionally found on western hemlock, Engelmann spruce, alpine fir and ponderosa pine. Infestations usually occur in almost pure stands of Douglas-fir on dry, rocky sites and often near developed areas. The host is seldom killed during the first year of defoliation but mortality may occur if the outbreak continues.

Description

Egg: about 0.5 mm diameter; elliptical, truncate at one end; translucent green when laid, changing to pearly within a few weeks, becoming darker in the winter.

Larva: young larvae are pale brown; mature larvae are 24 to 32 mm long; square tan head with black dots, and pale yellow front; slender body marked by alternating tan and yellow stripes with black margins, changing to light green in prepupal stage.

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[1] Infobase; 1982. Forest Insect and Disease Survey Computer Listings of Three-tree Beating Larvae Collections By Drainage. Forestry Canada, Pacific Forest Centre, Victoria, B.C.

TABLE 1

HISTORY OF INFESTATIONS BY GEOGRAPHIC REGIONS

YEAR	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92
LOCATIONS																								
NELSON REGION																								
Invermere TSA																								
Windermere Lake-S.		XXXX													XXXXXX					XX				
Windermere Lake-N.		XXXX													XXXXXX									
Sinclair		XXXX																	XX					
Columbia Lake		XXXX																						
Arrow TSA																								
Nakusp														XX										
KAMLOOPS REGION																								
Okanagan TSA																								
Chase										XXXX					XXXX				XXXX					
Sunnybrae														XXXX				XXXXXX						
Celista														XX										
White Lake														XX				XXXX						
Salmon Arm														XX	XX				XX					
Enderby														XXXXXX					XX					
Mara														XXXX										
Gleneden														XXXX										
Canoe														XX					XX					
Grinrod														XX				XX						
Lavington														XXXXXX										
Armstrong															XX									
Vernon															XX									
Monte Lk.															XX									
Larkin															XX									
Herald-Paradise																		XX						
Kamloops TSA																								
Pritchard															XX									
Barriere															XXXX									
Jamieson Cr.															XX									
Heffley Cr.															XX									
Westsyde															XX									
Vinsulla														XX										

Description

Pupa: about 15 mm long; initially light green, changing to light brown with dark brown markings.

Adult: moth, wing expanse 25 to 35 mm grey-white with two deeply scalloped transverse black lines on the forewings; one on the hindwings. The body is grey; antennae of males plumose.

Life History and Habits

Eggs are laid from August to October, singly or in groups of up to 13 (average 4), usually on the undersides of the host needles. However, when defoliation is severe, eggs may be found on bud scales, twigs or in bark crevices. Eggs hatch the following spring. Young larvae begin to feed on new foliage in the upper crowns of the trees during late May, progressing to the older foliage and dropping to the lower branches on silken threads where they feed until about mid-August. Although the larvae are solitary feeders, they tend to congregate in loosely webbed enclosures among the needles and twigs to pupate. Pupation occurs in late July or August and adults emerge from August to October. The moths are nocturnal fliers.

DETECTION

Egg Sampling

Egg sampling is used to determine population status and to predict expansion or collapse of infestations. Two 45 cm branches taken from ten trees per location from the mid-crown are collected in September and washed (Appendix 1) to remove the eggs. The eggs are counted and the number of healthy eggs per m^2 of foliage calculated. This data is interpreted as:

Number of Eggs per m^2 foliage	Predicted Defoliation
0	none
1-299	light
300-699	moderate
700+	severe

This information was developed from a preliminary study to better determine useful prediction thresholds.

As eggs are often laid on the needles of partially defoliated twigs, the resultant larvae may quickly consume new adventitious foliage, causing twig mortality.

An analysis of 52 predictions (Table 2) made during the 1972-1976 infestation indicated that:

1) Defoliation over a large area was predicted correctly 75% of the time.

Table 2. Defoliation predictions of Douglas-fir from egg samples of western false hemlock looper, 1972-1976, Kamloops Forest Region.

Location	Defoliation 1972 (Aerial Surveys)	Predicted Defoliation 1973 (# eggs/45 cm branch)	Defoliation 1973 (Aerial Surveys)	Predicted Defoliation 1974 (# eggs/45 cm branch)	Defoliation 1974 (Aerial Surveys)	Predicted Defoliation 1975 (# eggs/45 cm branch)	Defoliation 1975 (Aerial Surveys)	Predicted Defoliation 1976 (# eggs/45 cm branch)	Defoliation 1976 (Aerial Surveys)
Blind Bay	L	L (4.7)	0	-	0	-	0	-	0
S.W. Carlin	M	H (180.0)	L	-	0	-	0	-	0
Skimikin	0	L (2.3)	0	-	0	-	0	-	0
Mobley Rd.	L	H (79.0)	0	-	0	-	0	-	0
Sunnybrae Mi. 4	H	M (42.0)	L	L (12)	L	L (5)	0	-	0
Sunnybrae Mi. 6	H	M (46.8)	0	L (8)	0	L (1)	0	-	0
Broadview	M-H	H (61.8)	0	-	0	-	0	-	0
Enderby (Glennary)	0	L (4.3)	M-H	M (44)	0	M (28)	0	-	0
Enderby	0	-	M-H	L-M (24)	M	L (13)	0	-	0
Enderby W.	0	-	0	L (5)	0	-	0	-	0
Brash Cr. Mi. 4	0	0 (0.3)	0	L (5)	0	-	0	-	0
Brash Cr. Mi. 1	0	L (8.7)	0	-	0	L (1)	0	-	0
Jamieson Cr.	0	-	M	L (1)	H	H (66)	0	-	0
Westside	0	-	M	L (9)	H	-	0	-	0
McGillivray L. Rd.	0	-	M	M (42)	0	M (44)	0	-	0
Niskonlith L.	0	-	L	L (17)	L	H (79)	0	-	0
Chase (W.)	0	-	L	H (74)	M	H (118)	0	-	0
Chase (S)	0	-	L	H (80)	H	H (110)	0	-	0
Little Shuswap L.	0	-	M	M (41)	H	H (197)	0	-	0
Gleneden	0	-	H	M (37)	M	M (51)	0	-	0
Canoe	0	-	M-H	L (19)	0	L (6)	0	-	0
Canoe - McLeod Rd.	0	-	L	L (7)	0	-	0	-	0
Mara Lake	0	-	M	L (4)	0	-	0	-	0
Grindrod	0	-	M-H	H (54)	H	M (25)	0	-	0
Whiteman Cr.	0	-	0	L (7)	0	L (1)	0	-	0
Beau Park	0	-	0	L (10)	0	L (5)	0	-	0
Glenemma	0	-	0	L (3)	0	L (1)	0	-	0
Lavington	0	-	M-H	H (70)	L	H (197)	L-M	-	0
Monte Lake	0	-	0	-	0	L (4)	L-M	-	0
Louise Cr.-Barriere	0	-	0	-	0	M (33)	L-M	-	0
Larkin	0	-	0	-	M	-	L-M	L	0
Pritchard	0	-	0	-	0	-	L-M	L	0

L - Light defoliation, 1 - 25% of the foliage eaten, predicted from < 25 eggs/18" branch.
M - Moderate defoliation, 26 - 50% of the foliage eaten, predicted from 25-54 eggs/18" branch.
H - Heavy defoliation, 51% - 100% of the foliage eaten, predicted from > 54 eggs/18" branch.
0 - No defoliation
- - No information

2) Defoliation and specific location were predicted correctly at 33% of the areas.

3) The defoliation severity level and specific location were predicted correctly by 16% of the samples.

These predictions were made from the average number of eggs washed from 45 cm branch samples. Out of the four years predictions were made, three had defoliation the following year. It appears that the prediction of level of severity and specific location from egg counts are inaccurate as they were predicted correctly only 16% of the time. A prediction of general defoliation in the area is more accurate with 75% predicted correctly.

Larvae Sampling

Larvae are sampled during their peak active period in June and July. Sampling is done at Permanent Sampling Stations (PSS) and in infestation areas during the larval feeding period. About 150 PSS are sampled yearly for a variety of defoliating insects including western false hemlock looper. The PSS are determined by:

i) accessibility
ii) amount of forest area and important forest types
iii) insect and disease hazard rating, i.e., does the area have chronic or periodic pest problems.
iv) the area should remain undisturbed for a minimum of five years.

The standard FIDS sample consists of a three-tree beating. The foliage of conifers of the same age and species representing more than 35% of the stand composition are sampled about 20 m apart. Branches are beaten with 2.5 m pole over a 2 x 3 m white sheet. The larvae are counted, with a subsample sent to the Insectary for identification and further study. Sampling data is recorded on a standard FIDS sample form.

An average number of 8 larvae per three-tree beating for all drainages usually indicates a potential for defoliation the current or following year (Tables 3, 4). A summary of regional beating data from computer records shows defoliation years preceded by collections of 2.1 to 15 larvae/plot; with an average of 7.3 larvae/plot. (Infobase, 1982) Drainage divisions near Salmon Arm and Columbia Lake were included to see if there is a relationship between a specific area and larvae numbers. The data on table 3 and 4 indicates that prediction is more difficult over a smaller area. Severity of defoliation generally increases with the number of larvae. However, population fluctuation is great enough that predictions of level of severity from larval counts would be inaccurate.

The percentage positive collection in the year before an infestation ranges from 20 to 31 percent and in years with no infestation ranges from 4 to 44 percent. The percentage of positive collections gives an indication of how widespread western false hemlock looper is in the Region but has no obvious relationship to defoliation (Table 3 and 4).

Table 3. Average number of false hemlock looper larvae per standard FIDS beating collection and percent collection containing larvae, Nelson Region 1949-1981.

Year	Avg. No. of larva/collection all drainages	% Positive Collections	Avg. No. larva/collection DD 721[1]	Remarks[2]
1949	2.6	21	-	0
50	1.6	8	-	0
51	1.8	10	-	0
52	2.8	15	-	0
53	3.8	21	-	0
54	2.6	15	-	0
55	3.1	12	-	0
56	1.8	8	-	0
57	1.9	7	-	0
58	1.8	7	-	0
59	3.4	10	-	0
60	2.0	9	-	0
61	2.0	12	-	0
62	2.2	8	-	0
63	4.0	19	6.9	0
64	4.9	14	9.3	0
65	2.8	18	3.6	0
66	1.5	14	1.0	0
67	1.7	13	1.0	0
68	1.9	9	0	0
69	1.2	4	0	0
70	1.8	14	0	0
71	2.9	19	1.3	0
72	2.1	20	2.5	0
73	8.4	33	8.0	S. defoliation
74	7.2	12	8.0	L. defoliation
75	98.5	10	145.2	M. defoliation
76	1.9	11	1.5	0
77	1.7	9	1.0	0
78	1.3	13	1.0	0
79	2.8	20	1.5	0
80	-	-	0	0
81	-	-	4.5	0

[1] DD Drainage Division near Columbia Lake

[2] L - Light
M - Moderate
S - Severe
0 - No defoliation
- - No information

Table 4. Average number of false hemlock looper larvae per standard FIDS beating collection and percent collections containing larvae Kamloops Region, 1949-81.

Year	Avg. No of larva/collection all drainages	% Positive collection	Avg. No. larvae/collections DD 637[1]	Remark[2]
1949	2.0	2	-	0
50	2.2	11	-	0
51	2.5	18	-	0
52	6.6	44	-	0
53	6.1	43	-	0
54	3.7	44	-	0
55	2.7	17	-	0
56	3.7	18	-	0
57	2.1	22	-	0
58	3.0	39	-	0
59	3.8	18	-	0
60	2.3	22	-	0
61	4.2	24	-	0
62	8.5	31	-	alert
63	16.8	53	36.9	M-S defoliation
64	19.3	64	49.8	M-S defoliation
65	3.7	37	1.8	0
66	1.6	13	2.8	0
67	1.6	15	1.0	0
68	2.7	6	2.0	0
69	2.4	13	2.7	0
70	3.2	10	3.0	0
71	9.1	26	14.0	alert
72	16.2	23	80.4	L-S defoliation
73	33.9	39	41.1	L-S defoliation
74	22.5	37	51.8	L-S defoliation
75	25.3	46	42.5	L-S defoliation
76	4.8	12	14.0	0
77	1.6	8	1.5	0
78	1.7	6	2.0	0
79	2.2	6	1.6	0
80	-	-	7.0	alert
81	-	-	19.3	L defoliation

[1] Drainage Division near Salmon Arm

[2] L - Light
M - Moderate
S - Severe
0 - No defoliation
- - No information

Aerial Survey

The defoliation is recorded by aerial survey. Aircraft are used by FIDS for; photography, detection, sketch mapping and appraisal of infestations. This is usually done in mid to late summer when discoloration is most evident. Defoliation is interpreted as:

Light: discolored foliage barely visible from the air, some branch tip and upper crown defoliation.

Moderate: pronounced discoloration, noticeably thin foliage, top third of many trees severely defoliated, some completely stripped.

Severe: bare branch tips and completely defoliated tops, most trees more than 50% defoliation.

The intensity and area of defoliation on Tables 3 and 4 were mapped during aerial and ground surveys. From 1947 to 1948 defoliation, scattered mortality and top-kill occurred over 10 000 ha between Columbia Lake and Radium. Moderate to severe defoliation occurred near Chase in 1963 and 1964. Light to severe defoliation occurred over 5 600 ha near Chase, Lavington and the North Thompson Valley from 1972 to 1975. Light defoliation occurred over 350 ha near Shuswap Lake from 1981 to 1983 (Table 1). Occasionally Nepytia freemani occurs with Orgyia pseudotsugae causing defoliation. Both insects infest similar habitats and are capable of severely defoliating the stand.

TREE MORTALITY AND INCREMENT LOSS

The western false hemlock looper is a serious pest of Douglas-fir in the B.C. interior. Larvae are wasteful feeders, seldom devouring an entire needle but rather eating part of one and then moving to another. The partially consumed needles dry out and change color, producing the reddish-brown appearance of damaged trees. During an infestation, trees may be entirely defoliated in one season.

Defoliation appears in June in the upper crowns and by July or August, entire trees may be defoliated. By this time, the ground beneath heavily defoliated trees may be carpeted with partially eaten needles and frass. Extensive webbing is evident in heavily infested stands. Douglas-fir are seldom killed after only one year's defoliation, however, repeated attacks may result in top kill or tree mortality. Severe defoliation in successive years can cause considerable mortality and top-kill (Table 5 and 6). The FIDS damage appraisal section established tree mortality plots in areas of defoliation in the Kamloops Region during 1972-73 (Table 7). These indicated 51% mortality to plots with successive years of 90% defoliation (Table 5). This infestation resulted in about 10% total mortality in the stand. In addition one tree was killed after successive years of 85% defoliation. Increment loss in defoliation class 50-100% has an average of 34% growth loss and 0-50% has 19% (Table 8). The loss is noticeable in all of the defoliation categories. (Unpublished FIDS Damage Appraisal information)

Table 5. The relationship of 90% or greater defoliation to tree mortality over time, all plots, Kamloops Region, 1972-79.

No. of years of 90+% defoliation	No. Trees sampled	No. Trees dead
1	135	66 (49%)
2	39	22 (56%)
3	11	6 (55%)
cumulative	185	94 (51%)

Table 6. The relationship of 90% or greater defoliation to top-kill over time, of surviving trees, all plots, Kamloops Region, 1972-79.

No. of years of 90+% defoliation	No. of Trees Sampled	No. of Trees Top-kill
1	31	17 (55%)
2	16	6 (38%)
3	5	5 (100%)
cumulative	52	28 (54%)

Table 7. Damage appraisal plots for western false hemlock looper, Kamloops Region, 1972-1979.

Location and Plot No.	Date Established	Years Observed
1 Enderby	1973	1973-76 and 1979
2 Lavington	"	1973-79
3 Canoe	"	"
4 Gleneden	"	"
5 Sunnybrae 4 mi.	1972	1972-79
6 Sunnybrae 5.2 mi.	"	"

Table 8. Increment loss of semi-mature Douglas-fir defoliated by western false hemlock looper by defoliation class, Kamloops Forest Region 1972-73

Defoliation Class	Plot Name	Tree No.	Five Year Average Increment Growth (mm) from increment cores Before Infestation	During Infestation	After Infestation
75-100%	Enderby	4	.28	.15	.48
	Enderby	17	.41	.21	1.50
	Enderby	30	.88	.24	.38
	Enderby	38	.61	.52	.52
	Lavington	14	.47	.61	.40
	Lavington	17	1.07	.34	.37
	Canoe	16	1.67	1.25	.40
	Canoe	17	.68	1.19	.64
	Canoe	29	1.23	.16	.31
	Gleneden	4	.63	.49	.38
	Gleneden	7	.94	1.12	.63
	Gleneden	11	1.25	.28	.39
	Sunnybrae 4 mi.	5	1.56	2.01	1.14
	Sunnybrae 4 mi.	6	1.61	.60	1.47
	Sunnybrae 4 mi.	15	.98	.27	.52
	Sunnybrae 4 mi.	19	.52	.26	.29
Avg. Increment Loss			.92	.61 34%	.61
50-74%	Lavington	2	.27	.18	.32
	Lavington	9	.15	.10	.15
	Lavington	46	.70	.19	.10
	Sunnybrae 4 mile	1	1.23	.50	1.37
Avg. Increment Loss			.59	.39 34%	.63
0-50%	Sunnybrae 6 mile	6	1.77	1.00	1.64
	Sunnybrae 6 mile	10	1.36	1.59	1.58
Avg. Increment Loss			1.56	1.26 19%	1.61

CONTROLS

Insect Parasites

A number of egg parasites are associated with Nepytia freemani and occur naturally. The most common are the Trichogramma sp. and a Telenomus sp. both identified in looper populations in 1973-74. Data from 1974 egg collections (Table 9) had an average of 6% parasitism (range 0 to 50%). Parasitism this low does not indicate a significant population change. In 1975 the WFHL population collapsed at most locations; indicating that parasitism does not have a great enough influence on population to predict collapse. While egg parasitism may be useful with other factors, using it alone does not appear to give accurate population predictions.

Egg parasitism is determined when the eggs are washed from the foliage. (appendix 1) Parasitized eggs are black in color while healthy are bronze, infertile are yellow and old are opaque.

Table 9. Defoliation prediction for 1975 based on 1974 egg counts of western false hemlock looper, Kamloops Forest District.

Location	Avg. no. eggs per 45 cm branch		% eggs parasitized		1975 defoliation prediction	1975 defoliation
	1973	1974	1973	1974		
Darfield	-	0	-	-	-	0
Chinook Cove	-	6	-	0	light	0
Louis Cr.	-	33	-	8	medium	0
Fishtrap Mtn.	-	3	-	0	light	0
Poison Cr.	-	1	-	0	light	0
Oliver Cr.	-	14	-	2	light	0
Skull Cr. S.W.	-	93	-	17	heavy	0
McLure Ferry N.	-	37	-	45	medium	0
McLure Ferry	-	11	-	0	light	0
McLure S.	-	8	-	2	light	0
Black Pines N.	-	16	-	0	light	0
Black Pines	-	6	-	36	light	0
Black Pines S.	-	5	-	0	light	0
Sullivan Range	-	6	-	6	light	0
Jamieson Range	-	7	-	9	light	0
Knouff L Rd.	-	0	-	-	-	0
Vinsulla	-	1	-	0	light	0
Vinsulla S.	-	26	-	3	medium	0
Lyons L	-	7	-	0	light	0
Heffley Cr.	-	10	-	2	light	0
Jamieson Cr. N.	-	8	-	26	light	0
Jamieson Cr. (mi. 2.5)	2	66	0	2	heavy	0
Jamieson Cr. (mi. 6.5)	-	1	-	14	light	0

(Cont'd)

Table 9. (Cont'd)

Location	Avg. no. eggs per 45 cm branch		% eggs parasitized		1975 defoliation prediction	1975 defoliation
	1973	1974	1973	1974		
Jamieson Cr. W.	-	36	-	1	medium	0
Jamieson Cr. S.	-	55	-	2	heavy	0
O'Connor L	-	66	-	1	heavy	0
Lower Dairy Cr.	9	21	4	3	medium	0
Upper Dairy Cr.	-	57	-	7	heavy	0
Rayleigh N.E.	-	5	-	0	light	0
Rayleigh	-	27	-	1	medium	0
Paul L.	0	1	-	0	light	0
Lower Campbell Range Rd.	-	5	-	0	light	0
Pinantan Rd., (mi. 5)	-	1	-	0	light	0
Whiskers Hill	-	80	-	30	heavy	0
Whiskers Hill E.	-	40	-	1	medium	0
McGillivray L Rd., mi. 3	42	44	8	17	medium	0
Niskonlith L.W.	17	79	4	4	heavy	0
Niskonlith L - Loakin Cr.	-	105	-	2	heavy	0
Loakin Cr., mi. 7	-	0	-	-	-	0
Little Shuswap L,1 mi.N.	-	197	-	6	heavy	0
Little Shuswap L, N.	41	61	9	11	heavy	0
Chase, 1 mi. S.W.	80	118	2	9	heavy	0
Chase, 1 mi. W.	74	110	2	5	heavy	0
Adams R Br.	-	56	-	0	heavy	0
Sorrento, 2.5 mi. W.	-	22	-	0	medium	0
Squilax, 1 mi. S.	-	1	-	0	light	0
Chum L	-	0	-	-	-	0
Phillips L	-	0	-	-	light	0
Skimikin L	-	0	-	-	-	0
Sunnybrae, mi. 2	-	2	-	7	light	0
Sunnybrae, mi. 4	12	5	17	0	light	0
Sunnybrae, mi. 6	7	1	12	0	light	0
Gleneden, 1 mi. N.	37	51	12	5	medium	0
Gleneden, 2 mi. S.	-	26	-	0	medium	0
Gleneden, 3 mi. S.	-	4	-	0	light	0
North Broadview	4	11	30	6	light	0
Canoe, 1 mi. S.	19	6	27	6	light	0
Grindrod, 1 mi. S.	54	25	10	14	medium	0
Brash Cr., mi. 1	5	1	3	0	light	0
Glenmary	44	28	18	1	medium	0
Enderby, 1 mi. N.	24	13	14	5	light	0
Stepney	-	1	-	0	light	0
Glenemma	1	1	0	0	light	0
MT. Rose	-	39	-	0	medium	0
Armstrong, W. mi. S.	-	0	-	-	-	0
Duck Meadow	-	0	-	-	-	0

(Cont'd)

Table 9. (Cont'd)

Location	Avg. no. eggs per 45 cm branch		% eggs parasitized		1975 defoliation prediction	1975 defoliation
	1973	1974	1973	1974		
Monte L, N.	-	4	-	4	light	0
Monte L, S.	-	24	-	1	medium	light
Pinaus L Rd.	-	4	-	0	light	0
Falkland	-	1	-	0	light	0
Silver Cr.	-	0	-	-	-	0
Yankee Flats	-	2	-	50	light	0
Deer Cr.	70	272	7	5	heavy	0
Lavington, 2.7 mi. W.	-	197	-	6	heavy	0
Lavington, 1.6 mi. E.	-	251	-	8	heavy	medium
Lavington, 2 mi. S.E.	-	207	-	14	heavy	0
Coldstream Cr.	-	11	-	5	light	0
Irish Cr.	1	0	0	-	light	0
Beau Park	10	5	11	0	light	0
Whiteman Cr.	1	1	0	14	light	0
Larkin	-	-	-	-	-	light
Pritchard	-	-	-	-	-	light
Louis Creek	-	-	-	-	-	medium
Average	25	34	9%	6%	medium	

0 - No defoliation
- - No information

Bacterial Disease

Bacillus thuringiensis (B.t.) is a naturally occurring pathogenic bacterium. It is produced commercially and is effective against many lepidopterous insects. Spray trails by the CFS and BCFS using B.t. against Nepytia freemani were conducted in 1974, at an infestation on Douglas-fir near Chase. Three 16 ha plots were larval-sampled, one was sprayed with B.t., one with juvenile hormone Altosid^{R} (methoprene) and one not treated. Two applications were made each applying 560 gm of Dipel^{R} powder (B.t.) in 19 L of water per hectare. There was greater than 77% larvae mortality with B.t. and 30% with Altosid. The percent of mortality was determined by analyzing the data with Abbot's formula. (Sheperd et al., 1974)

In 1972 spray trails with Cordyceps militaris (L. ex St. Am.) Link, near Sunnybrae by the CFS did not show significantly greater mortality in treated plots compared to control plots. (Ross, 1972) Other entomopathogens, including species of Verticillium and Beauveria also have been occasionally reported infecting N. freemani.

Viral Disease

Larva mortality caused by a nuclear polyhedrosis virus (NPV) has been recorded in N. freemani since 1948. Infected larvae usually die before pupating. The NPV is a naturally occurring virus often present in the duff and forest soil of infested stands. (Brooks et.al., 1978) The virus is ingested by larvae feeding on contaminated foliage and spreads rapidly through the population. The collections with the most mortality were made June 23, 1948 in the Windermere Valley in Nelson Region at the north corner of lot 4596 were approximately 86% of the larvae died from virus. The average mortality in the area was 78%. In 1983 75% larval mortality occurred in a infestation near Shuswap Lake. (Erickson et al., 1983)

Predators

Little has been recorded on predation of N. freemani larva. However, it is suspected that birds, rodents and insects feed on a small portion of the population.

Chemical Insecticides

In 1948, an estimated 4 400 ha between Salter Creek on the west side of Columbia Lake to a point about 16 km north of Radium was sprayed by the BCFS. A Bell 47B3 helicopter applied the spray at a concentration of one kilogram DDT per 10 liters of diesel oil at a rate of 11 L/ha. This was done to protect Christmas tree plantations in the area. The treatment along with disease almost completely wiped out the looper.

DISCUSSION

Western false hemlock looper populations have been recorded in B.C. since 1947. Outbreaks which persist for one to four years have caused top-kill and tree mortality. Four infestations have occurred; at Columbia Lake in 1947, Chase in 1964, Shuswap and Columbia lakes in 1972 and the Shuswap and Columbia lakes in 1981.

The prediction of defoliation from egg sampling is good as a gross prediction and poor for specific site and severity; indicating the significant effect of population migrations. Data from Table 2 comparing predicted defoliation at 32 sites over 4 years shows that a prediction of defoliation somewhere in a large area (e.g. defoliation in the Shuswap) is correct 75% of the time. The intensity of defoliation at a specific location (e.g. severe defoliation at Blind Bay) is predicted correctly only 16% of the time. This improves if we predict defoliation at a specific location (e.g. defoliation at Blind Bay) which is predicted correctly 33% of the time. This comparison indicates that egg sampling is good as a general prediction of defoliation.

Larva sampling is used to predict population increase to damaging levels. Data from Table 3 and 4 indicates that an average of 8 or more larvae per collection in all drainages indicates the potential for defoliation the following year, this occurred in 2 of the 4 infestations. The average larvae per collection for 2 drainages having a history of infestations had more variability. An average of 9.3 larvae was recorded without defoliation the

following year while an average of 7.0 larvae had defoliation the next year. This indicates predictions over a small area are less accurate.

Larvae sampling as a predictor of defoliation is useful as an indication of population size great enough to be damaging. It is not able to accurately predict levels of defoliation (e.g. light) or specific location (e.g. D.D. 637 near Salmon Arm)

The percent positive collection is useful for determining how widespread larvae are in the district but does not have a predictable relationship with defoliation.

Tree mortality and top-kill occurred on trees with more than 90% defoliation annually(Table 6 and 7). Mortality occurred to 51% of the sampled trees and top-kill to 54% of the surviving trees over 3 years. One tree, with successive years of 85% defoliation also died. Only with defoliation greater than 90% is mortality and top-kill a concern. Increment loss is about 35% with defoliation from 50 to 100% and about 20% with defoliation less than 50%. Light, moderate and severe defoliation would have 20, 20 and 35% increment loss respectively.

Tree mortality seldom occurs after one year of defoliation, but usually occurs following repeated years of severe defoliation.

Control of western false hemlock looper occurs largely through naturally occurring egg parasites, and larval diseases. Chemical controls have been rarely used. Bacillus thuringiensis spray trials resulted in 77% mortality of the larvae in test plots. A naturally occurring nuclear polyhedrosis virus has killed up to 86% of the larvae in infestations in the Nelson Region and is usually the major cause of collapse in N. freemani populations. D.D.T. has been used effectively against the looper, however, it is no longer licensed for use.

Appendix 1

6. Instructions for Separating Eggs from Foliage

a) Hot Water Method

This method has been successfully tested for extracting eggs of false hemlock looper. Store samples in cold room (above freezing) until ready for processing; do not leave out overnight. Trim branches to the specified length and record foliage area (length x 1/2 width) on FIDS form #101 (revised 1982). Cut up sample, place in a plastic bucket, pour water in heated to 100 C. and immerse for at least 30 seconds. Swirl the samples using tongs to shake eggs free. Pour the contents of the bucket into two stacked strainers set into a plastic funnel. The top strainer is a large mesh sieve 20-mesh, 0.841 mm and the bottom a 50-mesh, 0.297 mm. Wash the contents thoroughly with a strong jet of water to force eggs through the top sieve, to be retained by the lower one. Remove the top strainer. The lower strainer is placed upside-down in a funnel and the eggs are washed into a container. Wash the contents of the container onto filter paper using the Vacuum/Filter operation system. Count the healthy eggs and compare the total number of eggs per m^2 to the predicted defoliation. (discussed under Detection, Egg Sampling)

REFERENCES

Brooks, M.H., et al. 1978. The Douglas-fir Tussock Moth: A Synthesis. USDA Tech. Bul. 1585, p.139.

Campbell, D.K. 1948. Nepytia canosaria? Windermere Valley Outbreak - 1948. Canadian Forestry Service, Vernon, File Report, 14 pp..

Cottrell, C.B.; Koot, H.P. 1974. Western False Hemlock Looper Infestation in the Kamloops Forest District, Canadian Forestry Service, Pacific Forest Research Centre, Victoria, B.C., File Report, 7 pp.

Cottrell, C.B.; Ross, D.A. 1972. False Hemlock Looper Infestations in the Kamloops Forest District, 1972. Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C., File Report, 1 pp.

Erickson, R.D.; Ferris, R.L. 1983. Forest Insect and Disease Conditions, Kamloops Forest Region. Forestry Canada, Pacific Forestry Centre, Victoria, B.C., File Report 33 pp.

Ferris, R.L.; Woensdregt, H.A. 1983. Western False Hemlock Looper. Pacific Forest Research Centre, Victoria, Pest Leaflet 59, 4 pp.

Furniss, R.L.; Carolin, V.M. Western Forest Insects, 1977. Misc. Pub. No. 1339, U.S. Department of Agriculture, Washington, D.C.

Harris, J.W.E.; Dawson, A.F.; Brown, R.G. 1985. The western false hemlock looper in British Columbia 1942-1984. Pacific Forestry Centre, Canadian Forestry Service, Victoria, B.C., Information Report BC-X-269, 11 pp.

Ilnytzky, S.; Woods, T.A.D. 1972. Report on Experimental Spraying of the False Hemlock Looper, Nepytia freemani on Douglas-fir (Pseudotsugae menziesii) using Bacillus thuringiensis and Cordyceps militaris at Sunnybrae on Shuswap Lake near Salmon Arm, B.C. Pacific Forest Research Centre, Canadian Forestry Service, Victoria, British Columbia, File Report, 4 pp.

Koot, H.P.; Garbutt, R.W. 1982. History of Population Fluctuations and Infestations of Important Forest Insects in the Nelson Forest Region. Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C. File Report, 102 pp.

Munroe, E. 1963. A new species of Nepytia (Lepidoptera: Geometridae), of Economic Importance to Douglas-fir in British Columbia. Can. Ent., 95: 407-413.

Ross, D.A. 1972. Report for Interdepartmental Committee on Forest Spraying Operations. Western False Hemlock Looper Nepytia freemani Munroe. Pacific Forest Research Centre, Canadian Forest Service, Victoria, British Columbia, File Report, 7 pp.

Shepherd, R.F.; Carrow, J.R. 1974. False Hemlock Looper (Nepytia freemani Munroe) Aerial Spray Trials, Chase, B.C. 1974. Canadian Forestry Service, Pacific Forest Research Centre, Victoria, B.C., File Report, 2 pp.

Shore, T.L. 1984. Forest Insect and Disease Survey, Pacific Region General Instructions Manual. Canadian Forestry Service, Pacific Forest Research Centre, Victoria, British Columbia, 123 pp.

Wood, C.; Woensdregt, H. 1982. History of Population Fluctuations and Infestations of Important Forest Insects in the Kamloops Forest Region. Pacific Forest Research Centre, Canadian Forestry Service, Victoria, British Columbia. File Report, 96 pp.