FIDS REPORT

DEFOLIATOR DAMAGE ASSESSMENT AND DETECTION AND MAPPING OF INSECT EPIDEMICS, QUEEN CHARLOTTE ISLANDS AND MAINLAND COAST, 1989

Pacific and Yukon Region

Forest Insect and Disease Survey

Forestry Canada Forêts Canada

Canada

DEFOLIATOR DAMAGE ASSESSMENT

AND

DETECTION AND MAPPING OF INSECT EPIDEMICS,

QUEEN CHARLOTTE ISLANDS AND MAINLAND COAST,

1989

Prepared for:

South Moresby Forest Replacement Account (SMFRA)

Prepared by:

C. Wood and R. Garbutt

Forestry Canada
Forest Insect and Disease Survey (FIDS)
Pacific Forestry Centre,
506 West Burnside Road,
Victoria, B.C.
V8Z 1M5

TABLE OF CONTENTS

Summary

Surveys of western hemlock forests on the Queen Charlotte Islands, recently defoliated by western blackheaded budworm, Acleris gloverana, and hemlock sawfly, Neodiprion sp., were carried out by Forestry Canada, Forest Insect and Disease Survey (FIDS), August 1 to 9, 1989. The objectives were:

1. To record levels of defoliation and tree mortality in 10 damage appraisal plots on South Moresby and adjacent east coastal islands, established by FIDS in 1985, and extract increment cores from and re-mark plot trees.

2. To detect, map, and assess active insect populations on the Queen Charlotte Islands and coastal areas of the Prince Rupert Forest Region, south of Kitimat.

Defoliation, which was first detected in 1985 and affected all age classes of western hemlock over 44 360 ha in 1986, collapsed in 1988 and was not present in 1989. Tree mortality in 1989 resulting from successive years of severe defoliation was 42% in one of ten study plots; the plot contained the youngest (avg. 45 years) and the smallest diameter trees (avg. 31 cm). Tree mortality in 1988 mapped in non-plot areas averaged 20% of primarily second-growth western hemlock over 7145 ha; this followed two or more successive years of severe defoliation. In 1989, cumulative years of tree mortality were mapped in 28 patches over 1220 ha on South Moresby and adjacent east coast islands; an additional 81 patches totaling 3155 ha were mapped on Graham Island. Height growth was significantly reduced by top-kill which affected 44% of the plot trees in 1985, and increased to 72% in 1986. The length of top-kill in 1986 averaged 7.4 m, an increase from 1.3 m in 1985. Tree mortality occurred in areas where both blackheaded budworm and hemlock sawfly were epidemic. This was attributed to the combined feeding habits of the two insects, with the budworm consuming new foliage and the sawfly feeding primarily on older foliage. Radial growth increments averaged 30% less during the outbreak than during the five years prior to defoliation in 1985.

Insect populations on the Queen Charlotte Islands and coastal areas south of Kitimat in the Prince Rupert Forest Region in 1989 were endemic, with no evidence of larval feeding or foliar discoloration.

Surveys were funded by the South Moresby Forest Replacement Account (SMFRA), to provide the following:

- a history and analysis of insect outbreaks including tree mortality and growth loss

- to maintain the records of the aerial surveys in a geographic information system

Introduction

Western hemlock is the preferred host of the blackheaded budworm and sawfly but true firs, spruce and Douglas-fir have been hosts to budworm populations. Populations are characterized by periodic rapid increases followed 2 to 3 years later by rapid declines. Factors influencing population fluctuations are not fully understood; however, population declines have been influenced by natural control factors including climate, parasites, predators, disease and starvation.

History of defoliator infestations - Queen Charlotte Islands, 1931-1989

Defoliation of hemlock by **western blackheaded budworm** on the Queen Charlotte Islands was first recorded in 1931, when western hemlock were severely defoliated from Lyell Island to Masset Inlet on Graham Island. Infestations occurred periodically thereafter from 1943 to 1944, between 1952 and 1955, 1972 to 1974 and most recently, from 1985 to 1988. Tree mortality caused by budworm feeding was first documented on the Islands in 1973-74, when 67% of the western hemlock were killed in patches on Kwaikans Island in Masset Inlet.

Hemlock sawfly populations were first recorded in high numbers on the Queen Charlotte Islands in 1961. However, defoliation was significant only during the most recent outbreak with blackheaded budworm from 1985 to 1988.

Other less damaging forest pests occasionally have caused defoliation of hemlock-cedar forests on the Islands or have reached potentially damaging numbers. These include **green-striped forest looper**, Melanolophia imitata, which defoliated western hemlock and western red cedar on Graham Island over 16 400 ha in 1963-64. Populations increased in 1969 but declined in 1970 and have remained at endemic levels since then. High numbers of **saddleback looper**, Ectropis crepuscularia, larvae occurred periodically on the Queen Charlotte Islands from 1969 to 1971, and 1979 to 1980, but defoliation was not apparent. **Western hemlock looper**, Lambdina fiscellaria lugubrosa, was collected for the first time on the Islands in 1959, but very rarely since in potentially damaging numbers.

History of blackheaded budworm and hemlock sawfly infestations on the Queen Charlotte Islands, 1985-1988

The blackheaded budworm and hemlock sawfly outbreak which began in 1985 was not anticipated. Standard FIDS three-tree beating samples on Graham and Moresby islands in 1984 had not shown any increase in budworm or sawfly larval populations. Sampling of the southern coastal areas of Moresby Island by float plane had been discontinued in 1982. Defoliation was first noticed by forest industry personnel in the late summer of 1985.

Most of the defoliation in 1985 which covered 28 600 ha including 3800 ha of severe (Table 1), occurred along the east and west coast of Moresby Island, south of Louise Island (Map 1). Most of the moderate defoliation over 19 100 ha was mapped in Masset Inlet, particularly in the Dinan and McClinton bays and Awun Lake areas, and the remainder south of Louise Island. Light

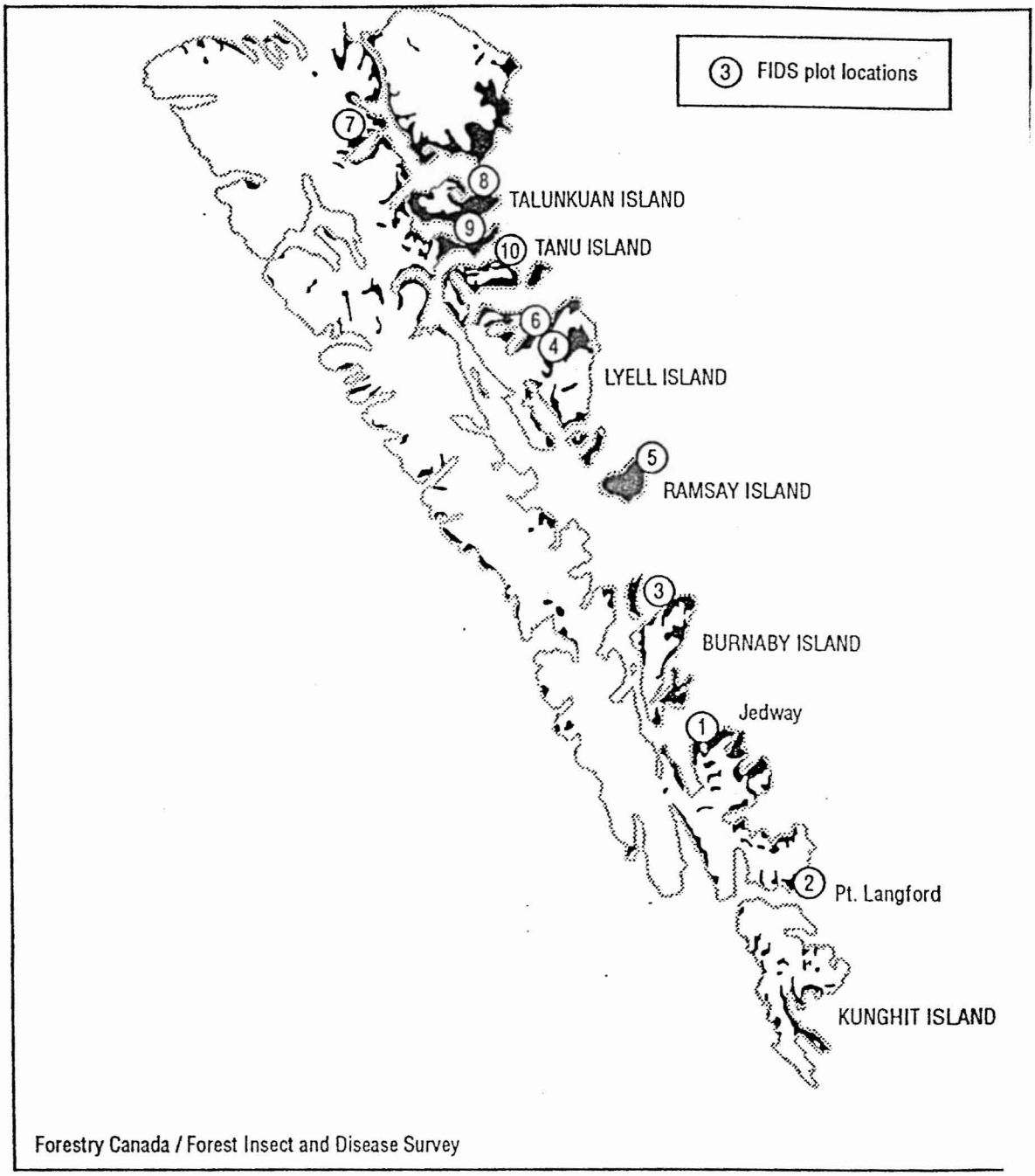
defoliation over 5700 ha was patchy throughout the remaining hemlock stands, including areas on both sides of the east narrows of Skidegate Channel. On the coastal mainland, western hemlock were lightly defoliated over 2200 ha along Douglas Channel from Bowbyes Creek near Kitimat, south to Hawkesbury and Gribbell islands and into Alan Reach along the Gardner Canal.

Table 1. Defoliation of western hemlock by western blackheaded budworm and hemlock sawfly, Queen Charlotte Islands, 1985-89.

		Area of defoliation (ha) and no. of infestations ( )				
Location	Severity*	1985	1986	1987	1988	1989
Moresby Island	Light	4885 (123)	9090 (180)	1495 (39)	670 (7)	-
	Moderate	11965 (127)	10840 (171)	2895 (73)	210 (1)	-
	Severe	3750 (35)	4535 (37)	75 (2)	-	-
	Grey	-	-	160 (3)	-	1220 (28)
	Total**	20600 (285)	24465 (388)	4465 (114)	880 (8)	1220 (28)
Graham Island	Light	800 (14)	6235 (53)	1400 (26)	4290 (27)	-
	Moderate	7150 (83)	12000 (64)	5730 (49)	2000 (13)	-
	Severe	50 (1)	1600 (8)	2505 (32)	190 (2)	-
	Grey	-	-	-	3155 (18)	-
	Total**	8000 (98)	19835 (125)	9635(107)	6480 (42)	-
Queen Charlotte Islands	Total**	28600 (383)	44300 (513)	14100(221)	7360 (50)	1220 (28)

* = Light = 1-25% defoliation; moderate = 26-65%; severe = 66% +.
** = Grey not included in total.

In October 1985, blackheaded budworm egg mass samples were collected during the establishment of 10 long-term damage appraisal study plots. On the basis of egg counts at the plots, severe defoliation was predicted at 9 of the 10 sites, but only light defoliation at the other. At Talunkwan Island and the Tangil Peninsula where much of the hemlock was severely defoliated, high numbers of hemlock sawfly eggs and empty pupal cases were collected along with blackheaded budworm eggs. These indicated increasing populations and potentially increased severity of defoliation in 1986.



Map 1. Areas of western henlock defoliated by western blackheaded budworm and hemlock sawfly, 1985-88, and location of Forestry Canada (FIDS) plots, South Moresby and archepelago, 1989.

In 1986, infestations expanded to cover 44 300 ha on the Queen Charlottes and 11 900 ha on the mainland coast. The increases in area were mostly due to expansion of existing populations from previously infested areas, and few new infestations were recorded. Areas of severely defoliated hemlock totaling 4400 ha, were limited primarily to the east coast of Moresby Island and archipelago from northern Lyell Island to central Louise Island, and most of Talunkwan Island and the Tangil Peninsula. South of these areas defoliation intensity declined despite indications from high egg counts the previous year. Severe defoliation also occurred in Skidegate Inlet, where damage had been light the previous year, and on Wathus Island in Masset Inlet. Light defoliation over 15 350 ha and moderate over 22 000 ha were mapped in most hemlock stands on Moresby Island, southern Graham Island, and in the western areas of Masset Inlet.

Hemlock sawfly populations continued to increase in 1986, intensifying damage throughout most of the budworm-infested area. Damage was attributed primarily to sawfly feeding in young planted stands over 300 ha near South Bay and over 1000 ha in the Honna River drainage. High sawfly populations which equaled or exceeded blackheaded budworm populations, were recorded on Talunkwan Island, Skidegate Channel and Wathus Island.

South of Kitimat on the mainland, infestations of blackheaded budworm expanded over 11 900 ha. Severe defoliation occurred over less than 5% of the area in small pockets between Bowbyes Creek and Emsley Cove. There was no evidence of hemlock sawfly populations in the area.

In late 1986, blackheaded budworm egg samples from 33 sites throughout the Islands and mainland infestations forecast only trace or light defoliation at 25 of the sites. Severe defoliation was predicted only near South Bay on Moresby Island. Hemlock sawfly egg samples, however, predicted severe defoliation at 5 of 25 sample locations on the Queen Charlotte Islands, including three sites on Graham Island at Honna Road branch 182, and at Wathus and Harrison islands, at South Bay on Moresby Island and at Thurston Harbour on Talunkwan Island.

In the third year of the outbreak in 1987, most of the defoliation over 14 110 ha occurred on both sides of Skidegate Inlet and near the west end of Masset Inlet. Populations on the mainland near Kitimat dropped to near endemic levels. Larval sampling on Graham Island found that hemlock sawfly larvae outnumbered blackheaded budworm by 2.7:1, and on Moresby Island and archipelago by 1.4:1. The combination of budworm feeding on the new foliage and sawfly feeding on the old, resulted in more complete defoliation which contributed to increased top-kill and tree mortality.

An aerial overview survey in 1987 mapped accumulated tree mortality over 3670 ha, entirely on Moresby Island. The tree mortality was equally in stands of 20-100 years and over 100 years; tree mortality in stands younger than 20 years was negligible.

Branches collected in the fall of 1987 at 36 locations throughout the infestation were examined for both hemlock sawfly pupal cases and blackheaded budworm eggs. The examinations indicated high sawfly populations would severely defoliate hemlock at two locations on either side of Skidegate Inlet, with moderate defoliation predicted at nine locations at Skidegate Inlet,

Masset Inlet and south-central Graham Island along the Honna Main access road. Almost half of the sawfly pupal cases were parasitized, indicated by the frequency of small parasite emergence holes and unemerged pupae. Blackheaded budworm eggs were far less numerous, indicating only moderate defoliation along Honna Main and on Harrison Island in Juskatla Inlet. Other counts indicated trace or light defoliation in the same areas and at Skidegate Inlet.

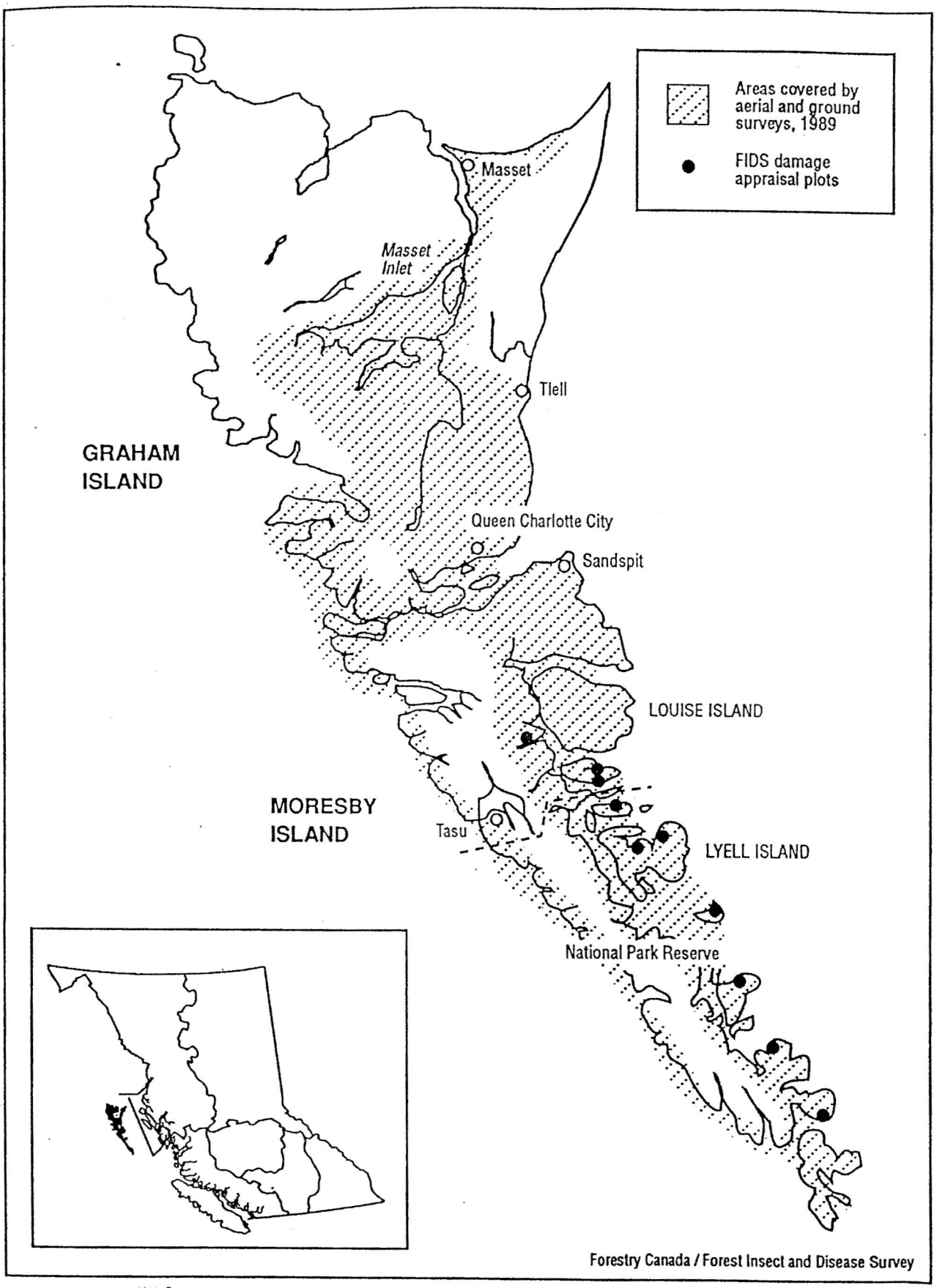
In 1988, blackheaded budworm populations, as predicted, largely collapsed and almost all of the defoliation over 7360 ha was caused by high numbers of hemlock sawfly. Less than 3% of the area was severely defoliated in a few patches along the southern shore of Masset Inlet. Elsewhere, areas of light and moderate defoliation over about 5000 and 2000 ha, respectively, occurred at Masset Inlet, southern Graham Island and near the north shore of Moresby Island. This declining trend in budworm and sawfly populations was indicated also by high levels of pupal parasitism and overall reduction in numbers of hemlock sawfly cocoons, and the low numbers of blackheaded budworm in standard FIDS beating samples.

In 1989, there was no evidence of current defoliation visible during aerial surveys, and there were no budworm larvae collected in standard beating samples during ground surveys in early August, when most hemlock sawfly had pupated. Defoliation of hemlock by sawfly was seen in an immature stand near South Bay but was only trace and only low numbers of cocoons were found. No change is forecast in 1990, when populations are expected to remain at endemic levels.

Damage Appraisal Plot Assessments, South Moresby, 1985-1989

In response to reports from the forest industry of foliar damage on western hemlock on South Moresby Island and adjacent archipelago, a Forestry Canada, FIDS survey team established 10 long-term permanent damage study plots in western hemlock stands in the Fall of 1985 (Map 2). Plots were established where significant current defoliation had been mapped by industry personnel and the B.C. Forest Service, from Sewell Harbour in the north to Forsyth Point on the southern tip of Moresby Island. Plot selection was influenced by helicopter accessibility and plots were therefore located in defoliated stands adjacent to beaches or logging roads.

The sites were selected to assess the impact of successive years of severe defoliation. Selected stands had been moderately or severely defoliated, and had a range of age classes (Table 2). Western hemlock plot trees were selected to reflect the average size range within the stand, and which had all crown levels visible permitting assessment of defoliation by crown levels. Trees were selected at random, and ranged from 10 to 25 per plot with an average of 14 (Appendix A). Trees were numbered and the diameter measured at breast height. Defoliation was estimated and recorded by percentage by crown third. Foliage from adjacent 'off-plot' felled trees was sampled for overwintering eggs to forecast population trends for 1986. A section of the felled stem was cut from each of three 'off-plot' trees at breast height to determine tree age, and to try to determine the presence and possible impact of previous defoliator outbreaks.



Map 2. Western blackheaded budworm and hemlock sawfly, Queen Charlotte Islands 1985-1989

Table 2. Status of western hemlock in 1989, defoliated by western blackheaded bu and hemlock sawfly in 1985-86, at Forestry Canada (FIDS) plots on South Moresby Island (Queen Charlotte Islands).

Plot no.	Location	No. of trees	DBH (avg. cm)	Age (avg. year)	Defoliation (avg. %) 1985	1986	1989	No. trees Healthy	Dead	Not found	Dwa mist
1	Jedway	14	65	137	68	79	7	4	***1	4	5 (
2	Forsyth Pt.	11	56	122	63	81	24	1	0	3	7 (
3 *	Burnaby I.	10	103	52	46	51	5	0	0	0	10 (
4	Lyell I. (Powrivco Bay)	15	36	60	70	24	17	6	0	0	9 (
5 *	Ramsay I.	17	65	90	65	77	<5	0	0	0	17 (
6	Lyell I. (Atli Inlet)	13	42	93	68	42	19	6	***1	0	6 (
7	Sewell Inlet	12	60	110	20	66	16	2	***1	2	7 (
8 **	Talunkwan I. (Thurston Hbr.)	35	(38	30	61	80)	-	2	33	-	
9	Talunkwan I. (South shore)	25	34	42	87	92	15	15	10	-	
10 *	Tanu I.	10	64	139	50	-	9	1	-	-	****
Total		162			60	60	12	37	46	9	6

[1] No. of trees and average % of crowns infected

* Plot trees not located; trees randomly selected in 1989
** Alternate site; original site inaccessible; original plot data in brackets
*** Dead from unknown causes
**** Two trees with top-kill including one with hemlock dwarf mistletoe

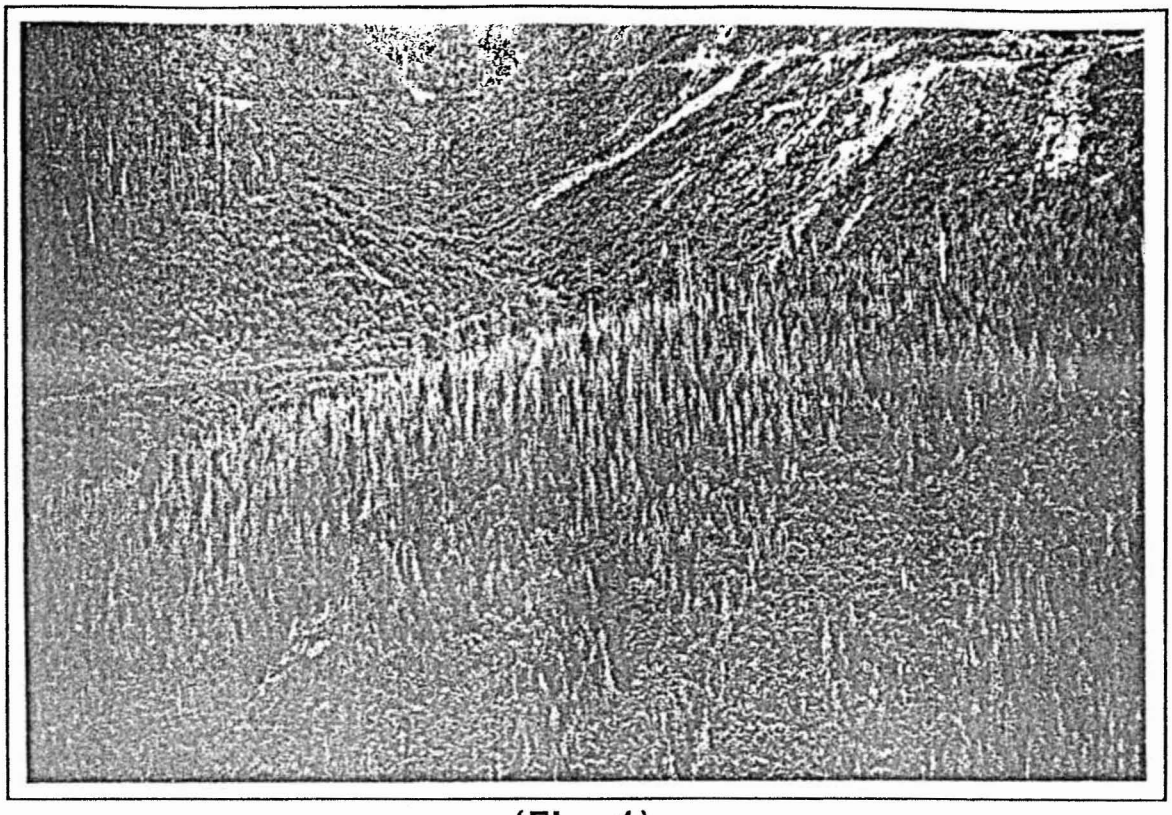
Forest industry representatives provided valuable information, air, water and ground transportation to sites, and assistance in falling representative sample trees.

In August 1989, two years after the collapse of the main infestation, the 10 plots were revisited by a Forestry Canada, FIDS crew to assess damage and tree recovery. Due to changes in the four years since the plots were established, trees at three plots (3, 5 and 10) could not be found. Alternate western hemlock in the same stand were selected and assessed. At a fourth site (plot 8), dense alder regeneration prevented a safe helicopter landing and an assessment was not possible. An alternative site about two kilometers away, in a stand that had sustained a high level of mortality due to severe defoliation by budworm and hemlock sawfly feeding, was assessed. However, data from this stand were not representative and were not included in the survey results.

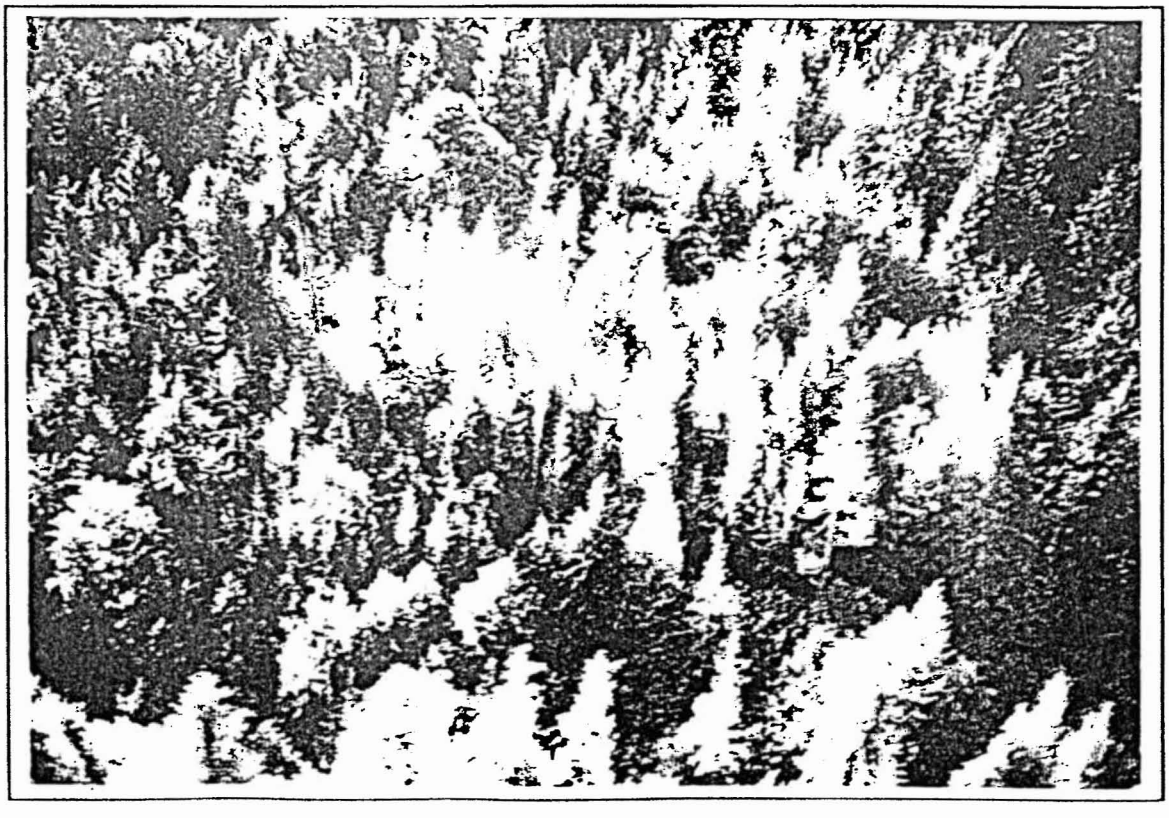
In the six original plots, western hemlock were reassessed for general condition, foliage complement, tree mortality, top-kill, and the level of dwarf mistletoe infection (Table 2). An increment core was extracted from each living plot tree at each site. Growth increments were later measured with the aid of a 'Digi-Mic' at the Pacific Forestry Centre, Victoria. This was to determine growth loss attributable to the recent infestation.

Concurrent with the plot surveys, a limited aerial survey of the Queen Charlotte Islands was completed (Map 2). The survey concentrated on previously infested areas, but found no evidence of current defoliation. Representative areas of top-kill were photographed (Figs. 1-4). A fixed-wing aerial survey to detect any defoliator activity in the area of Kitimat and south along the Douglas Channel, found no evidence of current defoliator activity.

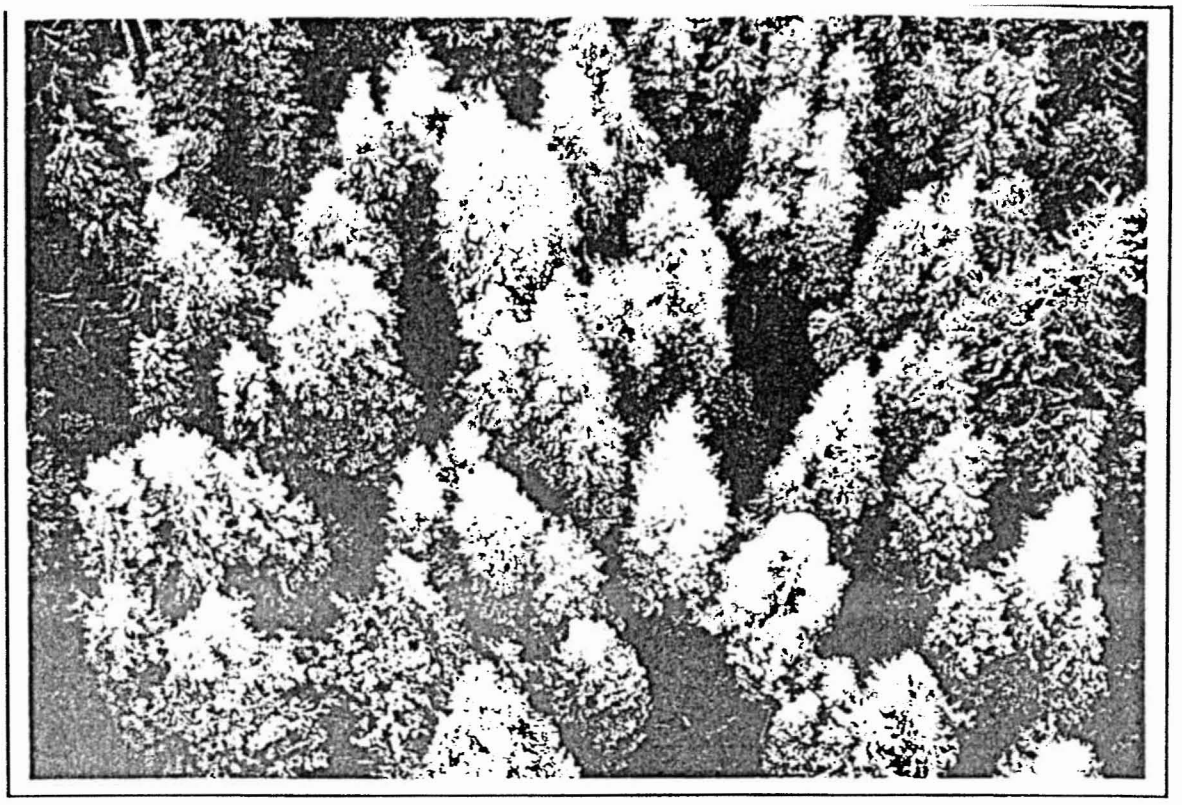
Figs. 1-4, Western hemlock in 1989, defoliated, top-killed, and killed by western blackheaded budworm and hemlock sawfly, South Moresby, Queen Charlotte Islands, 1985-88



(Fig. 1)



(Fig. 2)



(Fig. 3)

(Fig. 4)

Results

Defoliation

Defoliation in the ten damage appraisal plots during 1985-1988 range from an average of 20% at Sewell Inlet (plot 7) to 87% at Talunkwan Island (plot 9) in 1985, and from an average of 24% at Lyell Island to 92% at plot in 1986, (Graph). In 1989, 5 to 24% of the crowns were not fully refoliated. There was no apparent correlation of defoliation with age class or crown complement in 1989.

Top-kill

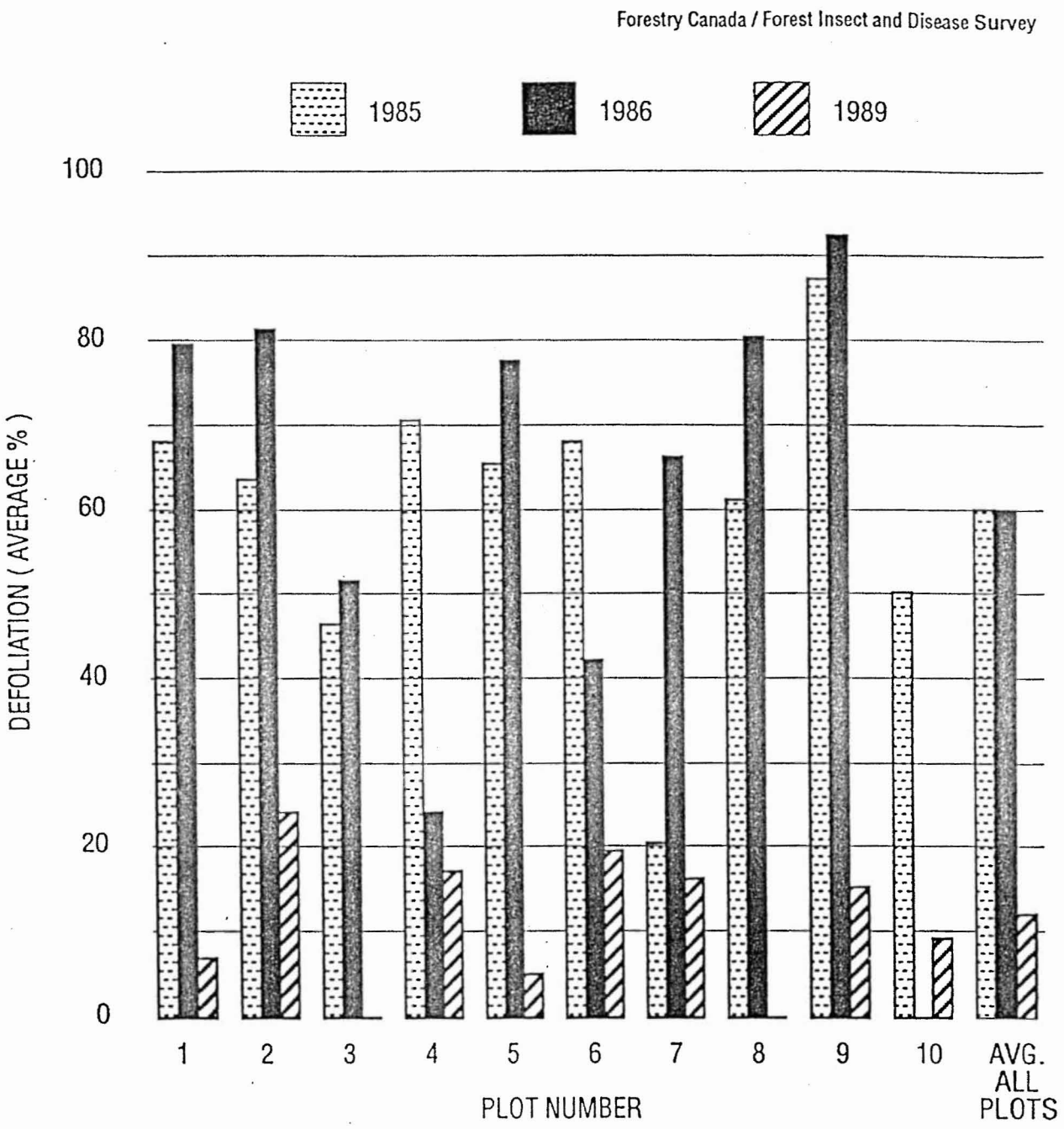
Top-kill affected an average of 44% of the trees in ten plots in 1985. This increased in 1986 and was present on an average of 72% of the trees. The length of top-kill also increased in affected trees in 1986 to an average of 7.4 m from 1.3 m in 1985. The absence of top-kill on trees in 1989 in the six original plots, where top-kill on 60% of the trees in the sam plots averaged 5.8 m in 1986, was attributed to recovery or new crowns maskir dead tops. Top-kill at plot 9 on Talunkwan Island in 1986, where 10 of 15 trees were dead in 1989, averaged 14 m. This was the most severe reported at any of the plots in 1986, and full tree mortality had not occurred.

Tree mortality

Tree mortality in the ten plots, directly attributable to successive years of severe defoliation by both blackheaded budworm and hemlock sawfly occurred only at plot 9, on Talunkwan Island, where 40% of the trees were killed. The plot trees were the youngest, the smallest diameter and the only dwarf mistletoe-free trees sampled in the survey. Defoliation in the plot averaged 87% in 1985 and 92% in 1986, 16% higher than any other plot, and 10 of the 25 trees were dead. The average tree age was 45 years, and the dbh ranged from 23 to 46 cm. The average diameter of the dead trees was 31 cm compared with an average of 36 cm for the survivors. Four of five plot trees less than 30-cm dbh were killed, and four of five trees over 40-cm dbh survived.

The high numbers and severity of larval feeding and the immaturity of the stand contributed to the high incidence of tree mortality. In previous defoliator outbreaks, more immature and understory hemlock have been killed, largely because fewer numbers of larvae are required to completely strip the foliage. In the 1985-1988 outbreak on the Queen Charlottes, an average of 2 of the hemlock was killed over an estimated 3670 ha, about half of which was in stands classified as less than 100 years old. This was based on aerial observations in 1987.

At the remaining plots tree mortality was limited: a single dead 69-cm dbh tree in plot 1 defoliated 78% in 1985 and 92% in 1986, may have di as a result of the defoliation; in plot 6 a single dead tree, however, had broken off in a wind; a dead tree in plot 7 had been moderately defoliated i both years and was very heavily infested with dwarf mistletoe. Mistletoe infections, prevalent in almost all plots, constituted a chronic stress agen



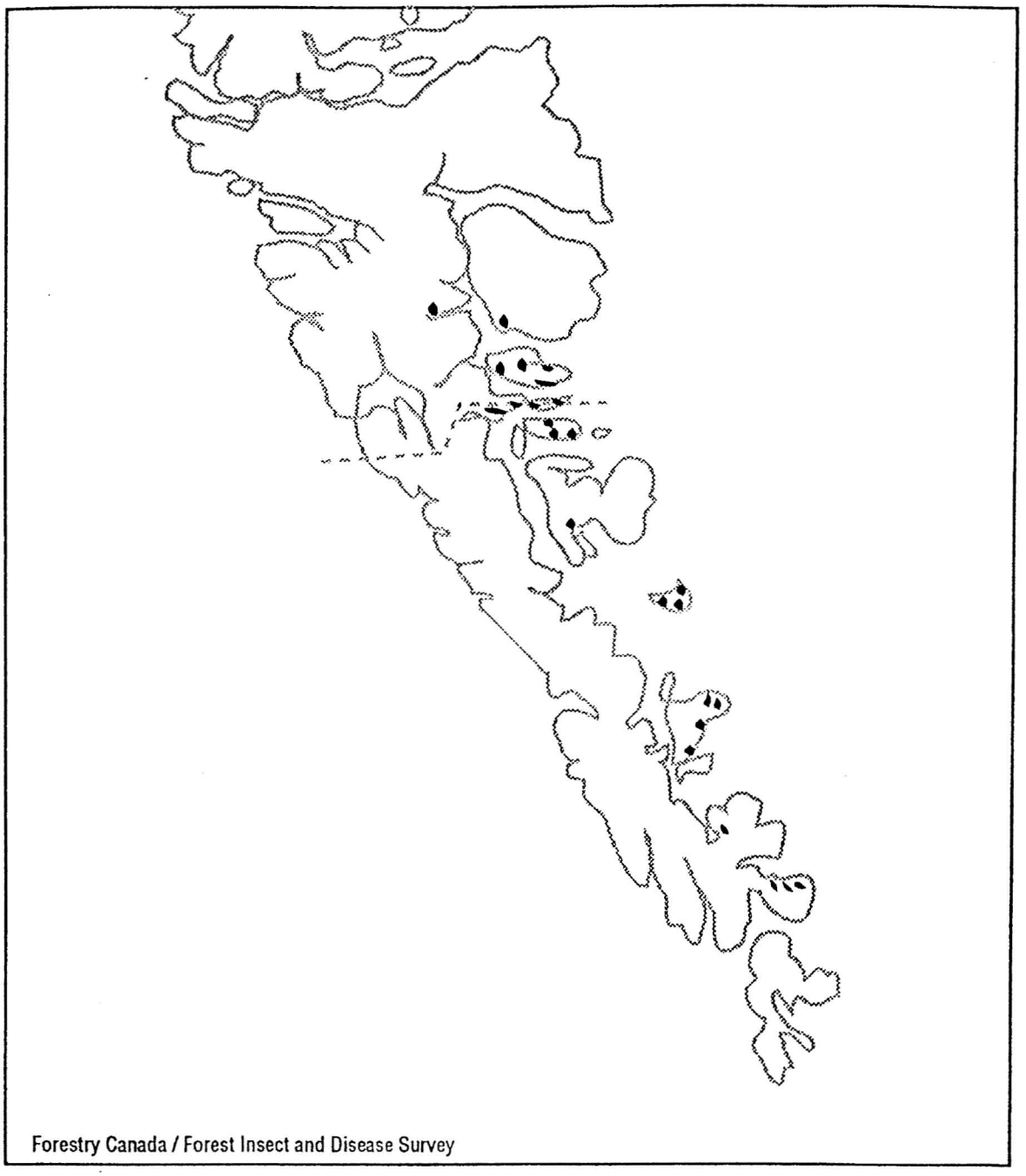
Graph: Defoliation of western hemlock in FIDS plots , South Moresby, Queen Charlotte Islands, 1985, 1986 and 1989

and as such will probably have delayed recovery of the tree from the effects of defoliation.

In 1989, cumulative years of tree mortality were mapped in 28 patches over a total of 1220 ha on South Moresby and adjacent east coast islands. An additional 18 patches of recently killed trees totaling 3155 ha were mapped on Graham Island (Map 3). Tree mortality exceeded 75% in most patches, which included most mapped also in 1987. This information and records of defoliation mapped during the outbreak on 1:250 000 topographic maps, is filed in the Geographic Information System (GIS) at the Pacific Forestry Centre in Victoria.

Radial increment loss

Core measurements from living trees at 9 of the 10 plots clearly showed a decline in growth following the onset of the infestation (Appendix B). Radial increments for the five years of the outbreak, 1985-1989, averaged 30% less than the average increment during the five years prior to 1985 (Figs. 5 and 6). Radial growth continued to decline at 7 of the 9 plots in 1988. The decline continued in 1989 at 8 of 9 plots but the growing season may not have yet been quite completed by the sampling period in early August.



Map 3. Areas of western hemlock killed by defoliation by western blackheaded budworm and hemlock sawfly, 1985-88, South Moresby and archipelago, 1989

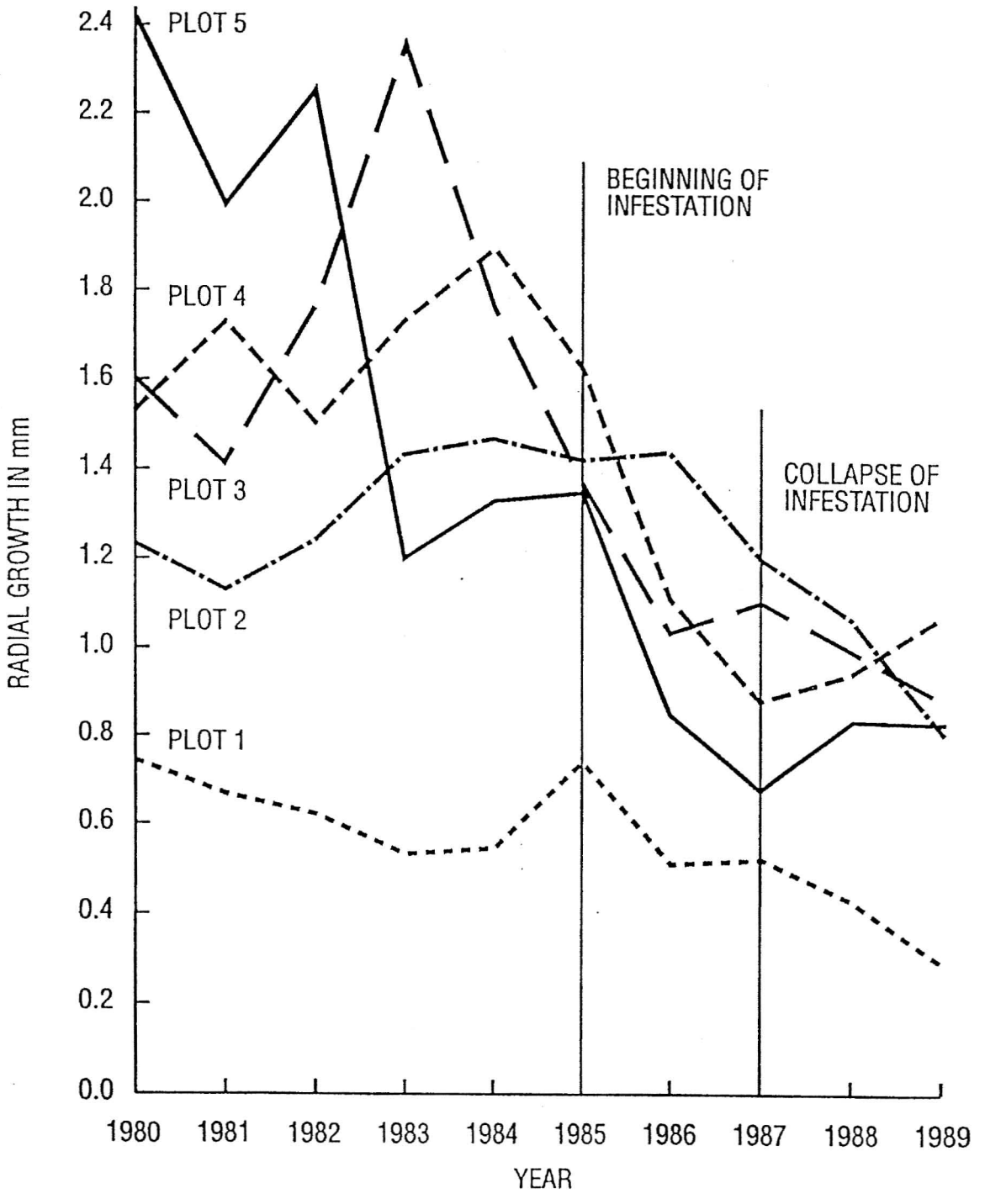


Figure 5. Radial growth of western hemlock in FIDS plots defoliated by western blackheaded budworm and hemlock sawfly in the Queen Charlotte Islands, 1989

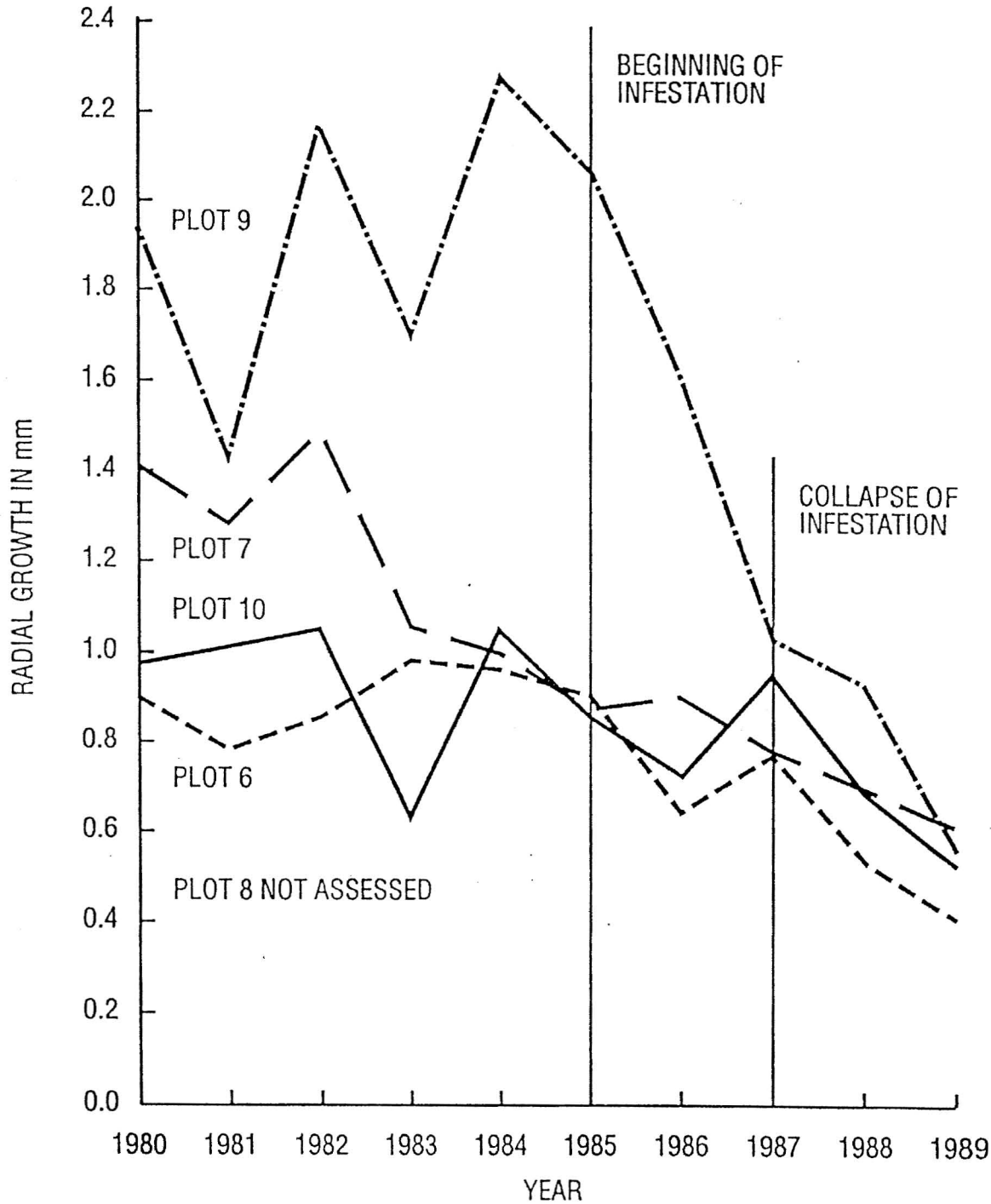


Figure 6. Average annual increment in FIDS plots defoliated by western blackheaded budworm and hemlock sawfly in the Queen Charlotte Islands, 1989

In the early 1970s, a growth impact analysis of a blackheaded budworm infestation on northern Vancouver Island, where western hemlock were lightly defoliated in 1971, severely defoliated in 1972 and lightly defoliated again in 1973, was completed. Based on the examination of western hemlock cut at Jeune Landing shortly after the last infestation, the average radial growth from 1972 to 1974 was 69% less than pre-infestation growth. During recovery (1975-76), average radial growth still averaged only 55% of previous rates (Fig. 7).

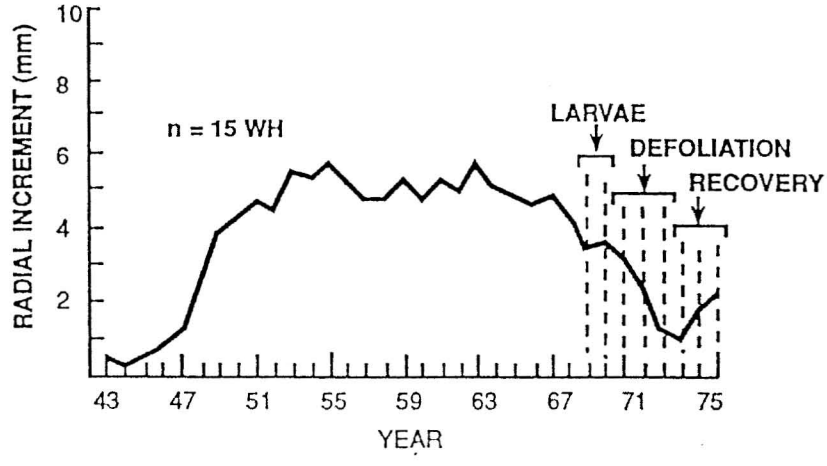


Fig. 7: Radial increment of western hemlock defoliated by western blackheaded budworm, Jeune Landing, Vancouver Island, 1971 - 1973.

There are no precedents with which to accurately predict the rate of increment recovery due to defoliation involving hemlock sawfly. This is because the level sawfly feeding, which contributed largely to the severity of the recent infestation on the Queen Charlotte Islands, is unique in documented infestations in British Columbia.

Plot volume and volume loss

An estimated 155 m3/ha (42% of the stand volume), was lost at plot 9 on Talunkwan Island, where 40% of the plot trees were killed as a result of successive years of severe defoliation by western blackheaded budworm and hemlock sawfly, during the 1985-1988 outbreak on the Queen Charlotte Islands.

The average tree volumes at the other nine sample sites, based on #5 (BAF 5) prism sweeps ranged from 372 to 1080 m3/ha (average 620 m3/ha). Stand composition was about 83% western hemlock (66% of the volume), 14% (24% of the volume) Sitka spruce, and the remainder were western red cedar.

Dwarf mistletoe

Mature and overmature western hemlock in 8 of 10 plot areas surveyed were infected by western hemlock dwarf mistletoe, Arceuthobium tsugense.

There was no evidence of infection on the plot trees killed by defoliation on Talunkwan Island. Infection by dwarf mistletoe was predominantly on branches, with an average of 25% of the branches per tree with brooms on 60-year-old trees at one site and to 42 to 50% (avg. 45%) at five sites. The heaviest was on 120-140- year-old trees at Jedway and Forsyth Point with 62% and 80% of the branches infected.

Conclusions

The major objectives of the 1989 damage appraisal plot survey, to estimate tree recovery, document mortality and take increment core samples, were largely met within the allotted 12 hours of helicopter flying.

Sufficient data were collected from trees at six plots and from alternate trees to determine that tree mortality is likely to occur in stands less than 35-cm dbh when severely defoliated by both western blackheaded budworm and hemlock sawfly for two or more successive years. Data also demonstrated that a 30% increment reduction occurs in the five years following the onset of larval feeding compared with the previous five years. A data file on the history of the infestation has been summarized and infestation maps are maintained within the Geographic Information System at the Pacific Forestry Centre, Victoria.

A more detailed survey to monitor increment recovery, when trees may have recovered from the effects of defoliation, has been proposed. For a valid statistical analysis of increment loss and recovery, 30 or more increment cores per site would be needed along with about 10 from non-host species such as western red cedar as controls.

References

Forest Insect and Disease Survey. 1989. Maps of major forest insect infestations. Prince Rupert Forest Region, 1922-1988. FIDS Rep. 89-8. 27 p.

Garbutt R.; Stewart, A. 1989. Forest insect and disease conditions, Prince Rupert Forest Region 1988. FIDS Rep. 89-5. 51 p.

Koot H.P. 1980. Western blackheaded budworm. For. Can. Pac. For. Cent., Pest Leaflet 24. 4 p.

Stewart, A. 1987. Current defoliation of western hemlock and predictions for 1988 on the Queen Charlotte Islands, B.C. FIDS Pest Report. Dec., 1987. 7 p.

Unger, L.; Humphreys, N. 1982. History of population fluctuations and infestations of important forest insects in the Prince Rupert Region, 1914-1981. FIDS File Rep. 1982.

Unger, L.; Stewart, A. 1986. Forest insect and disease conditions, Prince Rupert Forest Region 1985. FIDS Rep. 86-5. 39 p.

Unger, L.; Stewart, A. 1987. Forest insect and disease conditions, Prince Rupert Forest Region 1986. FIDS Rep. 87-5. 50 p.

Unger, L.; Stewart, A. 1988. Forest insect and disease conditions, Prince Rupert Forest Region 1987. FIDS Rep. 88-5. 54 p.

Wood.C.S.; Van Sickle, G.A. 1987. Forest insect and disease conditions, British Columbia and Yukon 1986. Info. Rep. BC-X-287. 35 p.

****

Appendix A, Forestry Canada, (FIDS) plot data, defoliator damage assessment, South Moresby, Queen Charlotte Islands 1985, 1986, 1989.

Plot 1 - Jedway - 01.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	86	57	80	not found	-	
2	69	78	92	dead	-	dead
3	53	73	83	5	none	
4	59	53	70	5	none	
5	63	60	80	not found	-	
6	69	67	63	5	75	
7	51	53	70	15	60	
8	98	57	67	15	80	
9	60	67	73	10	50	
10	71	73	63	not found	-	
11	30	77	87	0	none	bumpy conk
12	42	77	90	not found	-	
13	106	77	87	5	none	
14	61	80	95	0	4	
Avg.	65	68	79	6.5%	62%	

Other

Egg counts: 1985 - 186/sample = severe defoliation; 1986 - 6/ sample = light

* = Bumpy growth on branches

Dwarf mistletoe - 5 trees with 45-50% (avg. 60%) of branches with swellings

Top-kill - 1 m top-kill on 10% of adjacent regeneration

Dead - 1 tree - 69 cm dbh

Prism sweep (#5) : wH - 7 ; wrC - 2; sS - 2; range 45-250 cm dbh

Plot 2 - Forsyth Point - 01.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	62	67	77	not found	-	
2	41	67	93	"	-	
3	56	53	80	"	-	
4	60	62	90	20	95	
5	96	50	78	20	95	
6	36	67	72	30*	95	
7	48	65	80	20*	90	sapsucker damage
8	52	65	78	65	70	
9	48	70	88	0	50	
10	52	65	85	20*	70	
11	64	63	73	20"	80	
Avg.	56	63	81	24	80	

Other

Egg counts: 1985 - 135/sample = severe defoliation; 1986 - 6 = light;
1987 - >1 = no defoliation

*Defol. in upper 50% of crown

Prism sweep (#5): sS - 9; range 35-90 cm dbh

Plot 3 - Burnaby Island - 01.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	98	52	67	<5	50 br	-
2	53	23	7			
3	82	50	73			
4	80	47	57			
5	148	52	58			
6	120	52	57			
7	128	52	57			
8	107	45	50			
9	95	42	4			
10	18	45	42			
Avg.	103	46	51	<5	50%	

Other

Randomly selected trees: original plot trees not located, averaged 45 cı

Egg counts: 1985 - 117/sample = severe defoliation

Prism sweep (#5): wH = 8; wS = 8; average 30-180 cm dbh

Plot 4 - Lyell Island, Powrivco Bay - 02.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	45	85	50	20	50	
2	38	92	23	10	35	
3	38	78	27	20	30	
4	41	82	33	10	5	
5	42	62	13	10	50	twin top
6	34	67	53	30	0	
7	38	57	13	10	50	'bumps'
8	38	60	17	5	0	
9	30	47	17	10	0	
10	32	45	7	5	0	
11	38	70	27	15	50	
12	37	67	20	0	0	good recovery
13	32	67	10	5	0	good recovery
14	40	77	15	10	25	
15	36	77	40	0	60	
Avg.	36	70	24	17	39	

Other

Egg counts: 1985 - 71/sample = severe defoliation; 1986 - 6/ sample = light

Prism sweep (#5): wH - 15; range 35 - 90 cm dbh

Plot 5 - Ramsay Island - 01.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	81	72	77	<5	50	
2	42	73	72			
3	87	77	73			
4	20	68	67			stem swellin
5	60	72	86			" random #4
6	104	57	75			
7	57	68	73			
8	43	67	80			top-kill to
9	99	47	67			1.0 m on 5-1
10	58	50	82			regen around
11	78	72	86			egg sample t
12	81	77	90			
13	73	63	75			bumps on low
14	66	63	88			all branches
15	44	72	75			most trees
16	56	68	83			
17	77	63	68			
Avg.	65	65	77	<5	50	

Other

Randomly selected trees; plot trees not located

Prism sweep (#5): wH = 14, (range 35-75 cm dbh); wrC = 2, (average 120 cm
sS = 1, (120 cm dbh)

Plot 6 - Lyell Island, at the Inlet - 02.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	75	78	35	30	50	
2	47	63	28	25	50	
3	38	72	50	dead	-	broken @ 4 m
4	46	70	48	30	50	
5	40	65	45	25	50	
6	32	63	35	20	25	
7	37	58	45	10	none	
8	29	55	33	10	none	
9	41	72	48	10	none	
10	84	73	53	15	25	
11	32	80	50	15	25	
12	30	65	23	15	none	
13	19	70	48	15	none	
Avg.	42	68	42	19	39	

Other

Egg counts: 1985 - 21/sample = light defoliation

Prism sweep (#5): wH =12 (range 25-110 cm dbh); sS = 3 (average 100 cm dbh)

Plot 7 - Sewell Inlet - 03.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	45	38	85	not found	-	
2	64	25	52	dead	-	
3	39	23	43	35	35	
4	64	27	86	30	65	
5	70	18	72	10	none	
6	97	7	47	2	none	
7	42	25	70	25	20	
8	76	22	65	not found	-	
9	70	12	60	10	65	
10	54	18	63	5	65	
11	59	7	65	2	20	
12	42	17	86	25	65	
Avg.	60	20	66	16	48	

Other

Egg counts: 1985 - 123/sample = severe defoliation; 1986 - 19/ sample = lig
1987 - <1/ sample = no defoliation

Larvae in standard FIDS samples: 1986 - HSF/WBHB - 470/625; 1987 - 600/10C
1988 - 0/0

Dead mature wH in area with mistletoe.

Prism sweep - N/A

Plot 8 - Talunkwan Island, Thurston Harbour - 02.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989[1]	Mistletoe	Other
1	23	62	77	)		
2	33	53	85	)		
3	32	65	90	) FIDS site not accessible; alternate site		
4	28	73	93	) accesssed from shoreline, east of FIDS		
5	34	68	90	) plot BCFS plot numbered: Strip 11, Plot 3,		
6	29	75	75	) 372, 373, 1983.		
7	61	68	77	)		
8	42	60	73	) Of 35 wH tagged in plot, 33 were killed;		
9	38	55	78	) all less than 40 cm dbh; two living trees		
10	47	52	83	) were 45 and 50 cm dbh.		
11	49	57	80	)		
12	30	52	72	)		
13	36	58	78	)		
14	42	57	75	)		
15	48	58	77	)		
Avg.	38	61	80			

Other

Egg counts at original plot: 1985 - 219/sample = severe defoliation;
1986 - 11/sample = light

Larvae in standard FIDS sample at original plot: HSF/WBHB, 1987 = 1050/440

Plot 9 - Talunkwan I. (South Shore) - 03.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986	1989	Mistletoe	Other
1	27	88	100	dead	negative in	
2	33	90	73	20	plot trees	
3	32	93	100	85		
4	45	85	77	5		
5	31	85	-	-		spruce
6	37	57	70	0		
7	36	90	80	5		
8	35	80	77	10		
9	23	93	100	dead		
10	29	92	100	dead		
11	27	85	100	dead		15′ stump
12	32	92	100	dead		50′ stump
13	41	77	93	0		
14	32	78	95	dead		
15	36	93	90	dead		
16	31	95	90	dead		
17	26	90	97	30		
18	46	92	97	30		dead top 3m
19	44	90	100	dead		
20	31	93	100	dead		
21	30	92	98	5		
22	35	90	98	5		
23	42	92	98	5		
24	37	83	98	5		
25	38	85	90	5		
Avg.	34	87	92	15		

Other

10 trees dead in plot: 8 died in 1986, 2 in 1989

NB - No mistletoe

Plot 10, Tanu Island - 03.08.89 - C. Wood, R. Garbutt

Tree #	DBH (cm)	Defoliation % (avg) 1985	1986*	1989**	Mistletoe	Other
1	47	43	-	10	15	
2	37	53		10	35	top-kill 2 m
3	78	68		5	50	
4	56	67		0	50	
5	82	60		15	none	(immature)
6	48	50		2	60	
7	64	48		10	60	
8	80	48		25	75	
9	69	30		0	60	
10	76	30		10	none	top-kill 0.5 m
Avg.	64	50	-	9	50	

Other

* Not visited in 1986

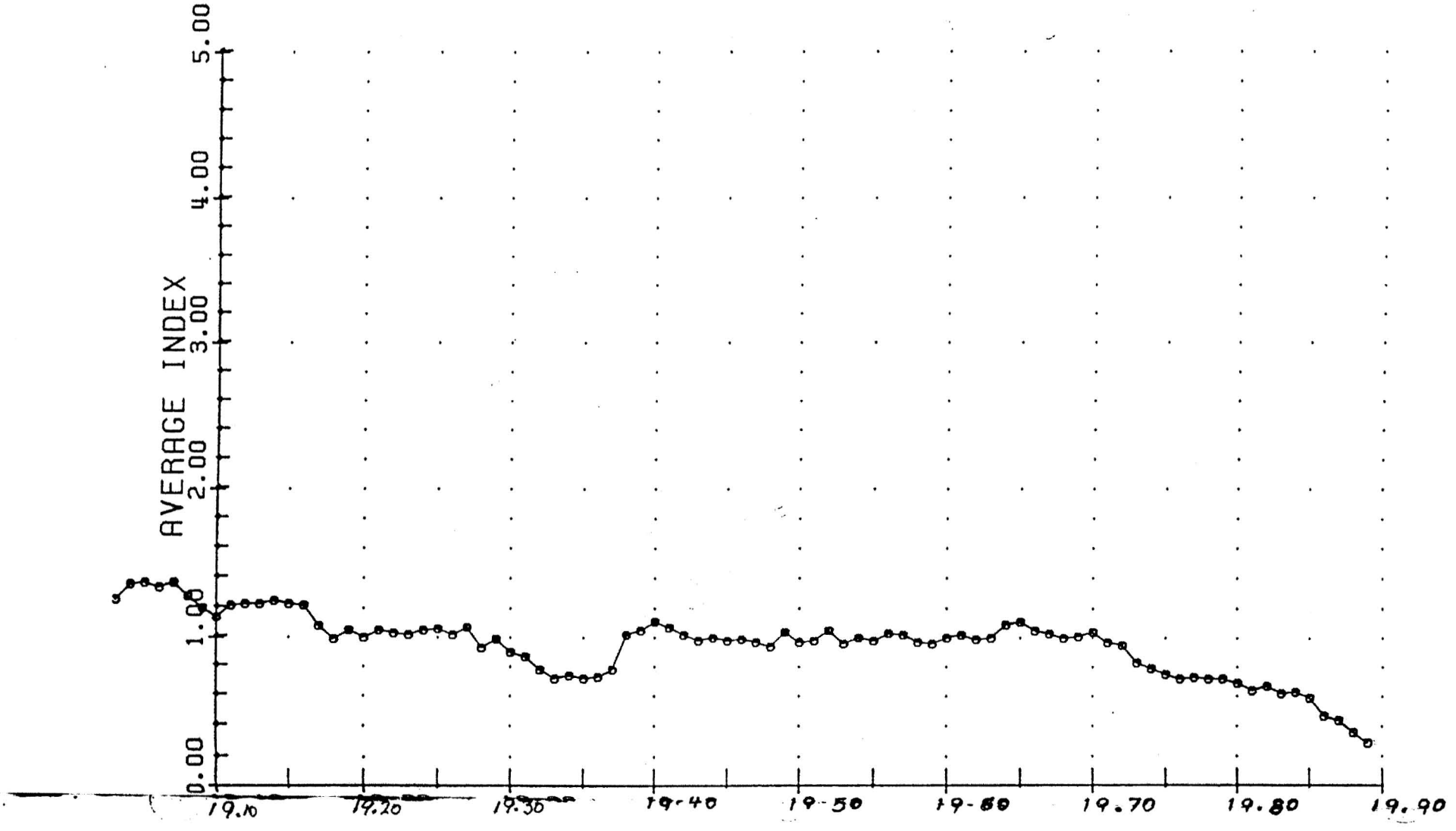
** Randamly selected trees; plot trees not located.

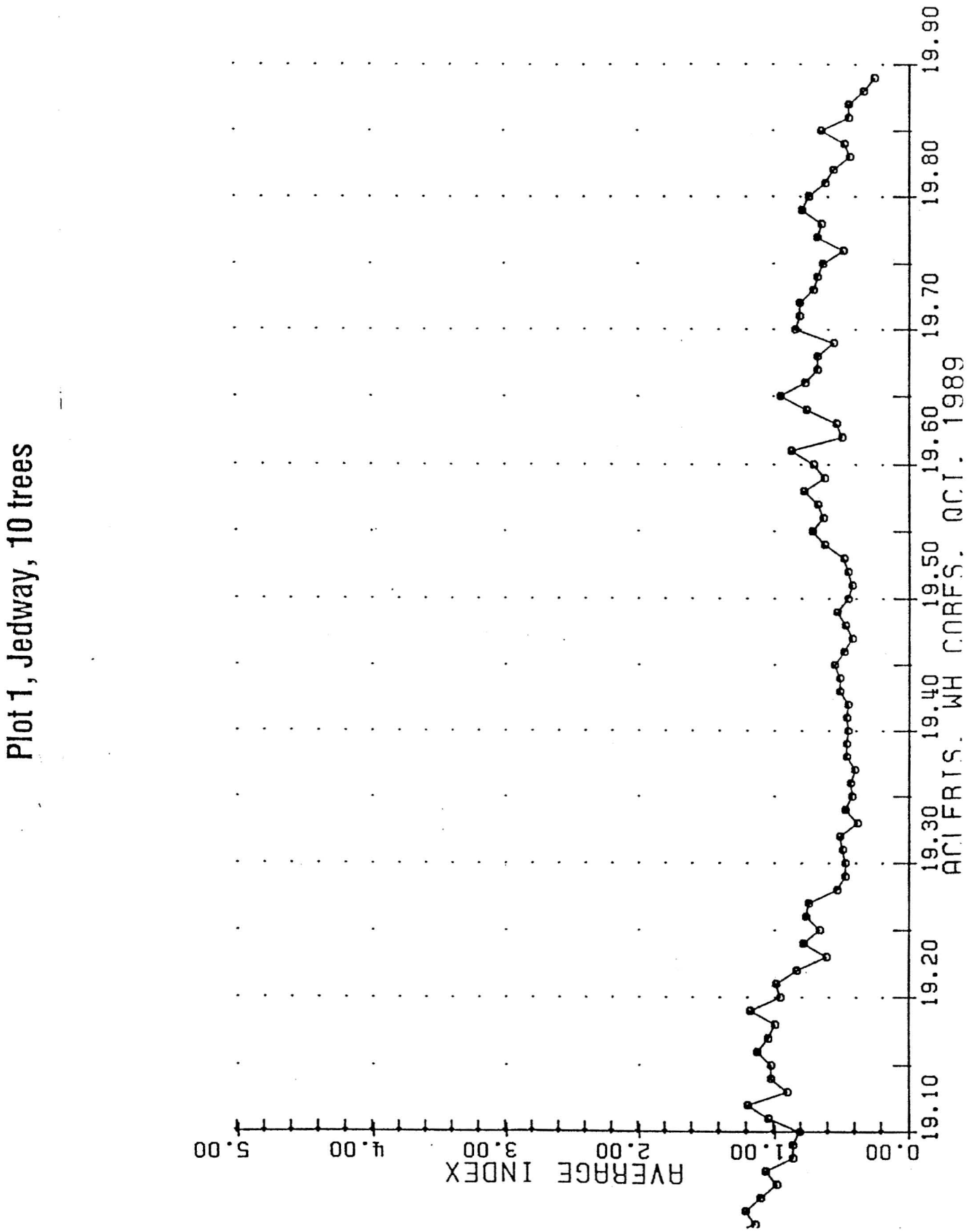
Prism sweep (#5); wH - 7, range 25-60 cm dbh; wrC - 9, average 100 cm dbh

Appendix B

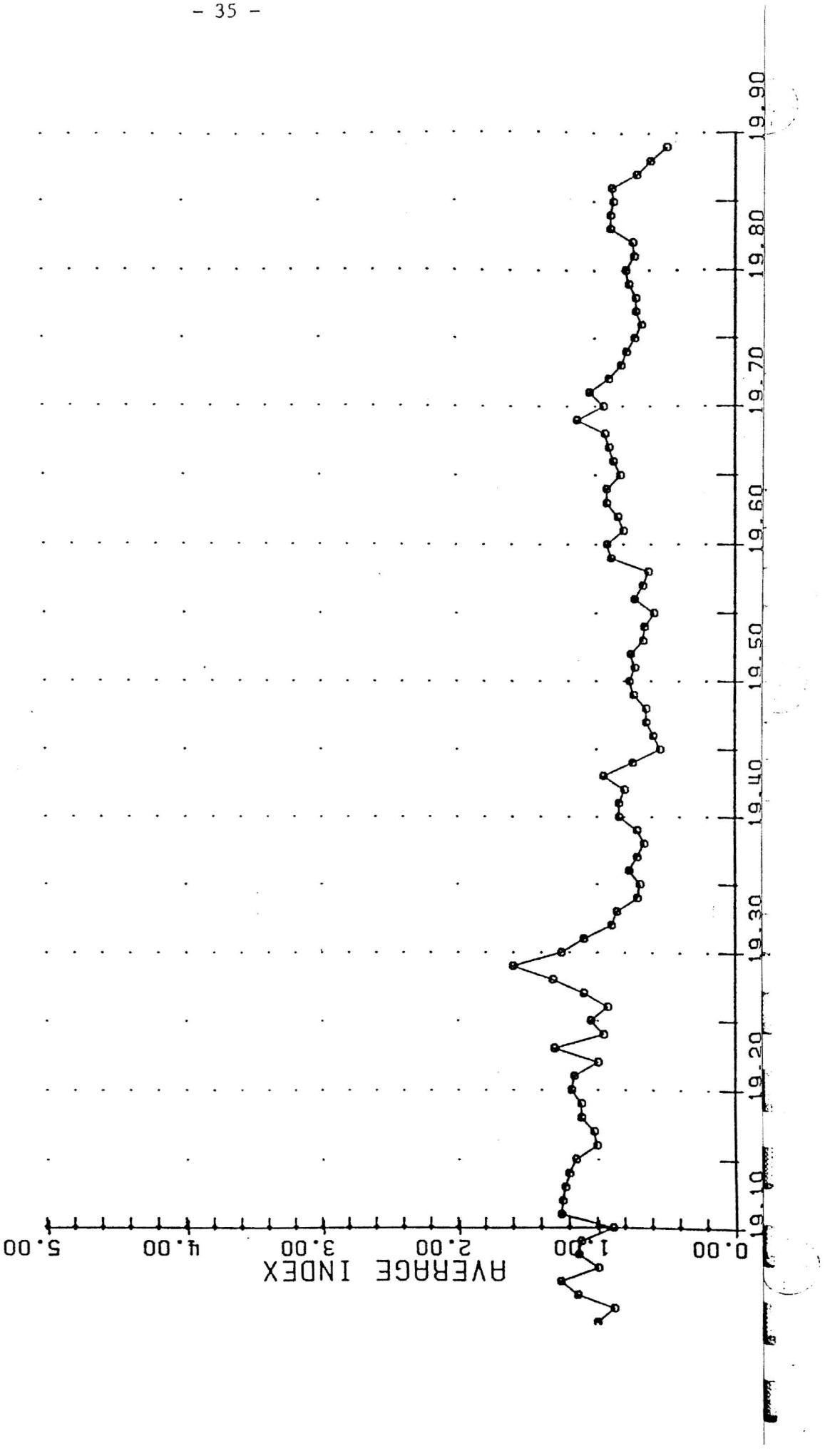
Radial growth increment of western hemlock at Forestry Canada (FIDS) plots, South Moresby, Queen Charlotte Islands, 1989

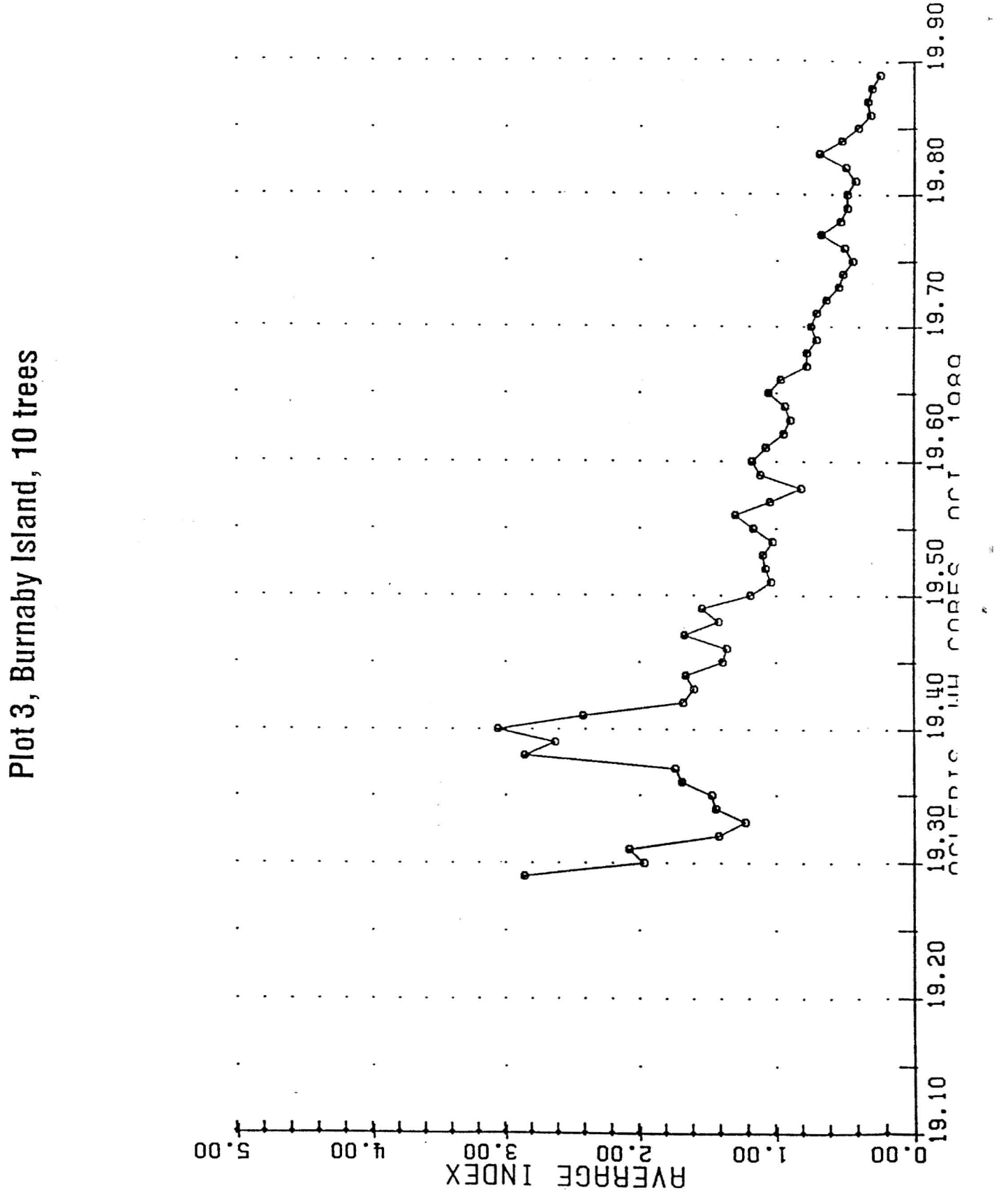
All living trees at all plots



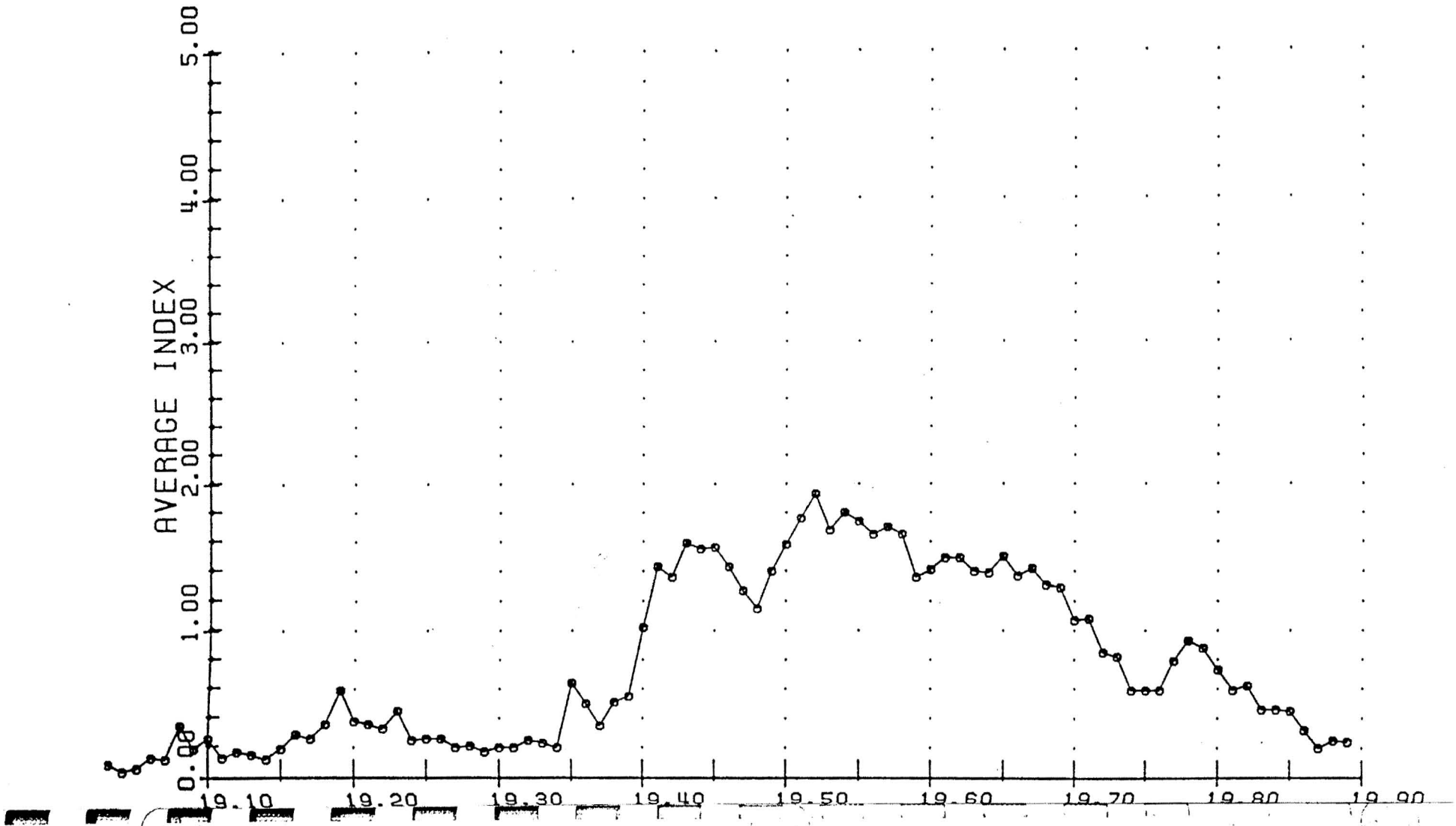

Plot 1, Jedway, 10 trees
AVERAGE INDEX
0.00
1.00
2.00
3.00
4.00
5.00
19.10
19.20
19.30
19.40
19.50
19.60
19.70
19.80
19.90
ACI FRIS. WH CORFS. OCT. 1989

Plot 2, Forsyth Point, 9 trees

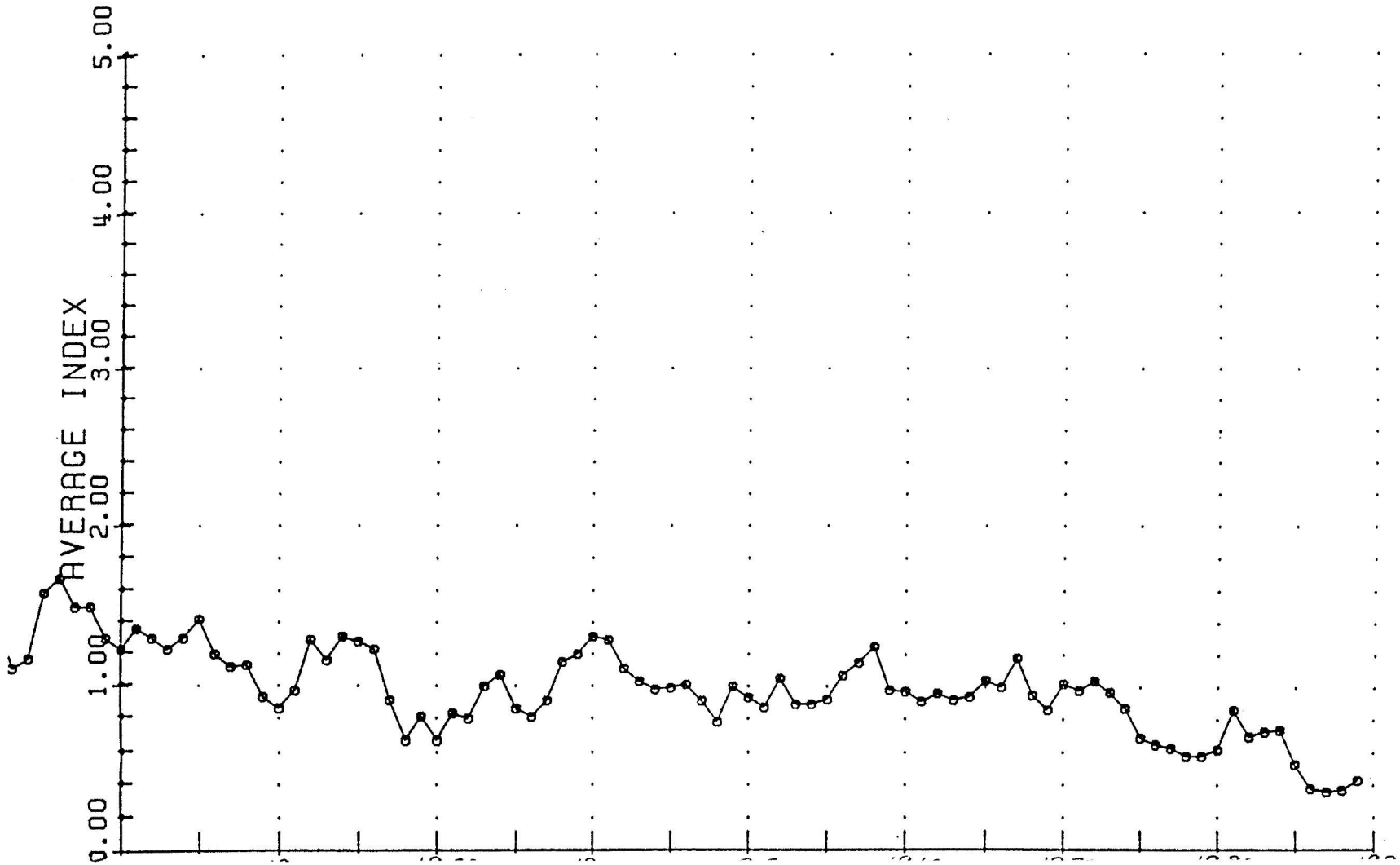


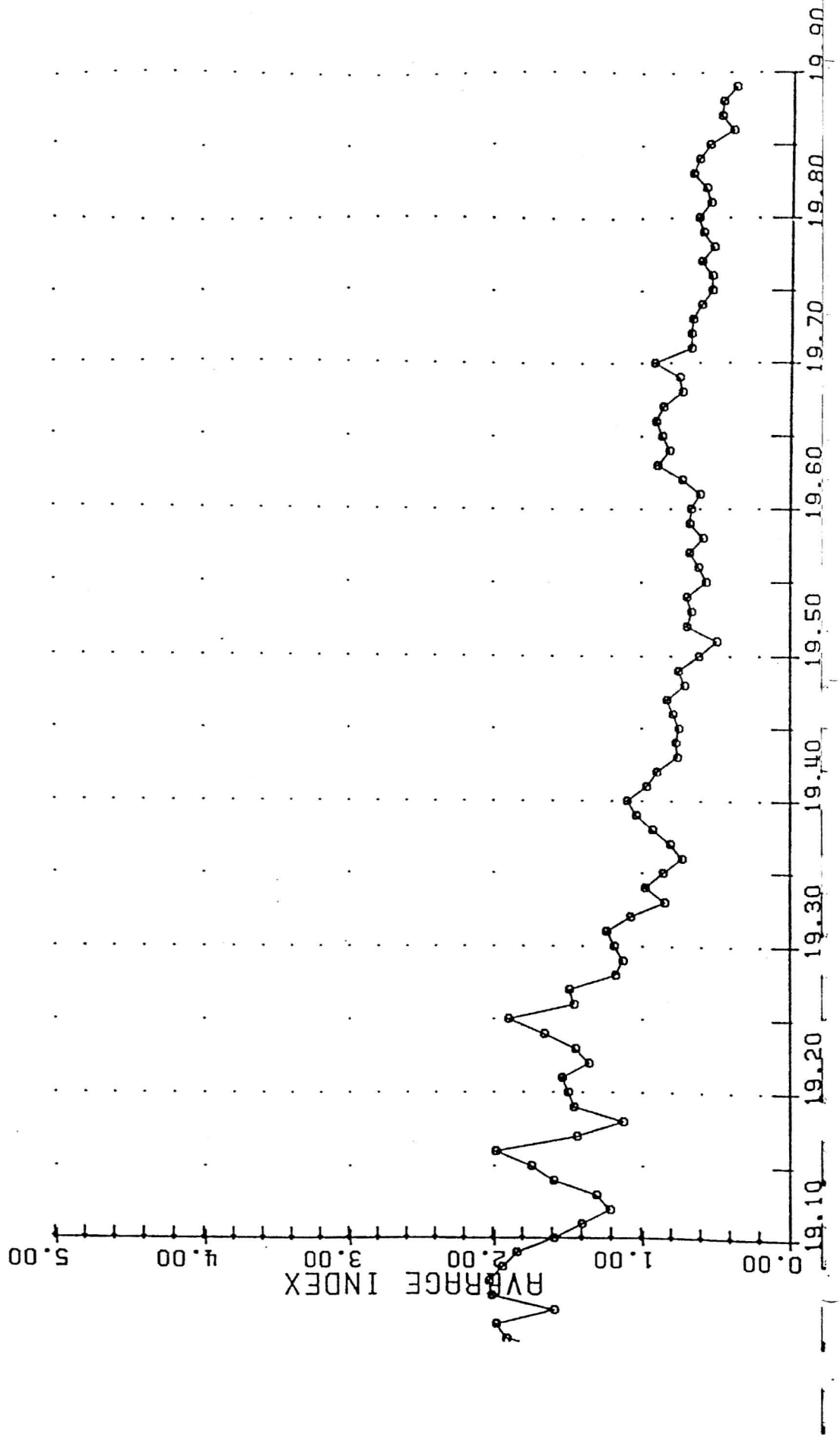

Plot 3, Burnaby Island, 10 trees
AVERAGE INDEX
0.00
1.00
2.00
3.00
4.00
5.00
19.10
19.20
19.30
19.40
19.50
19.60
19.70
19.80
19.90

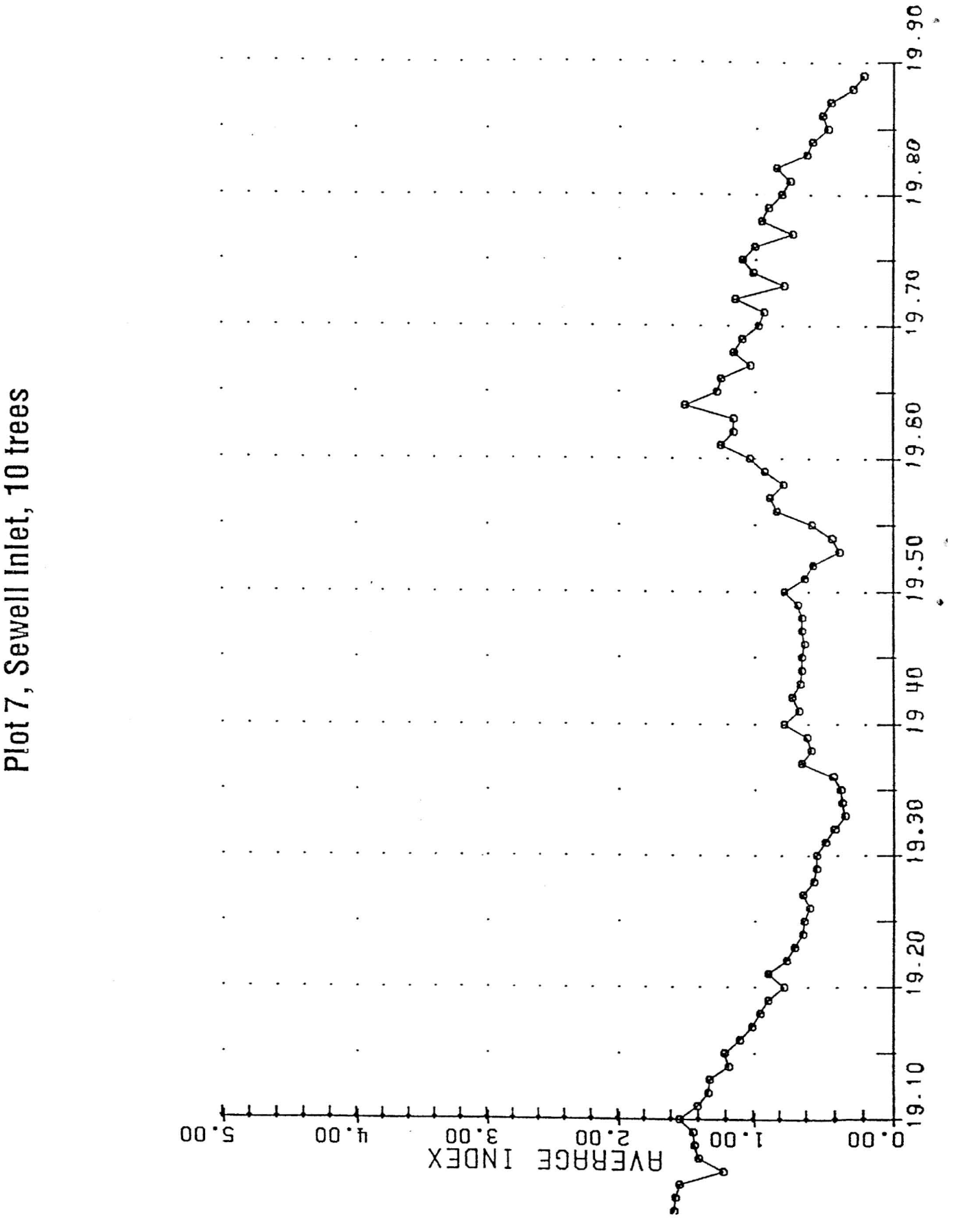
Plot 4, Lyell Island, 10 trees

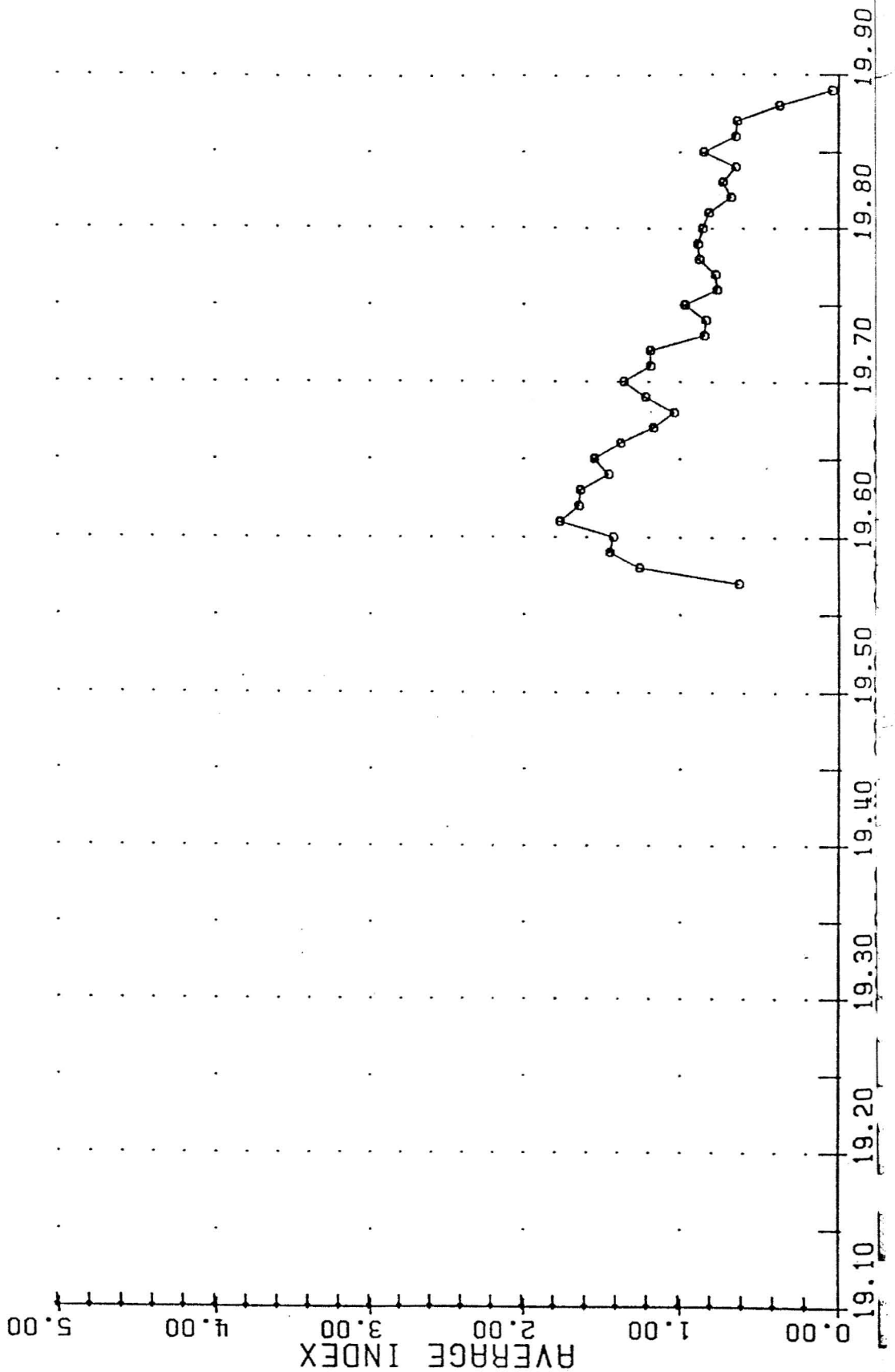


Plot 5, Ramsay Island, 9 trees

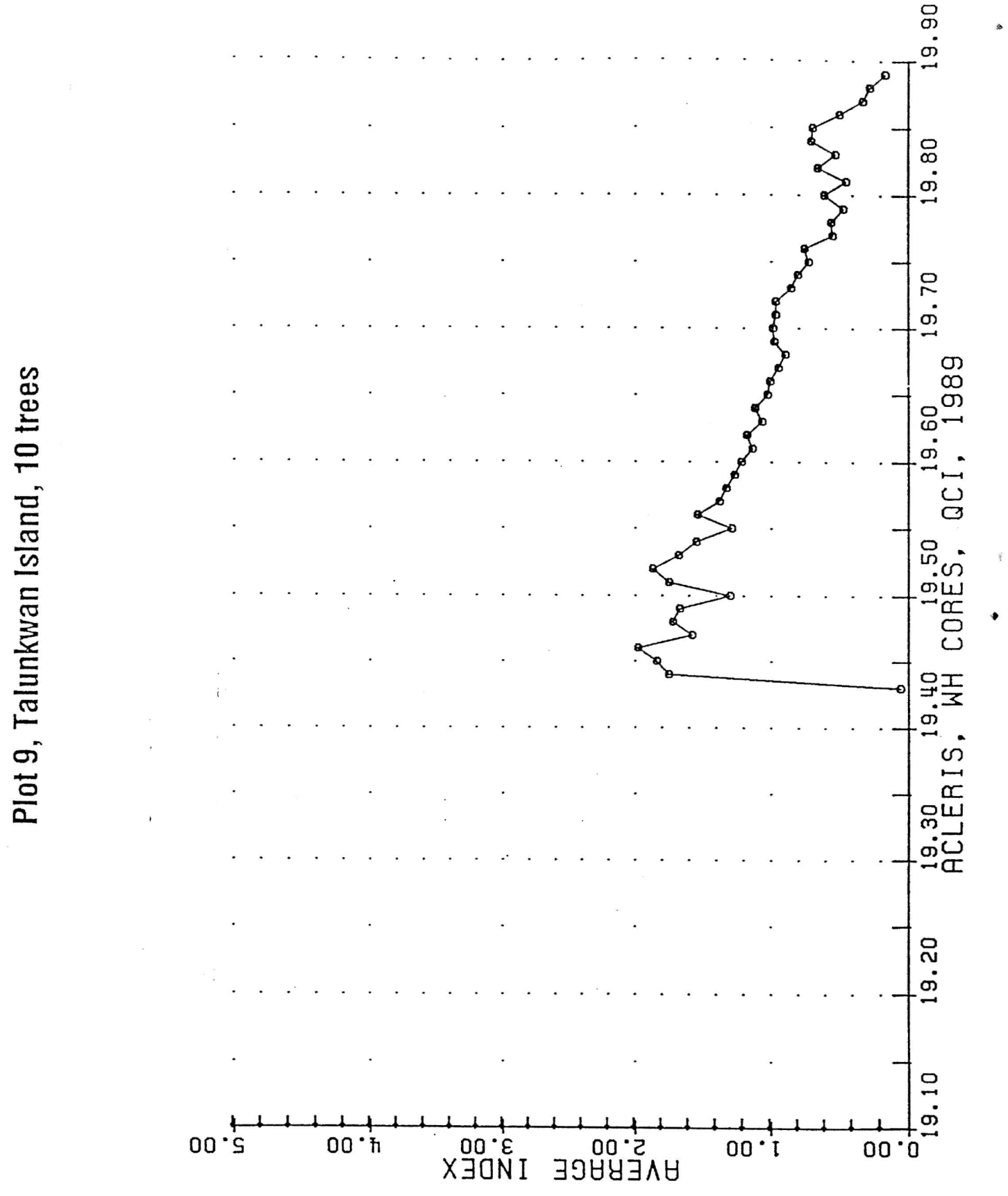


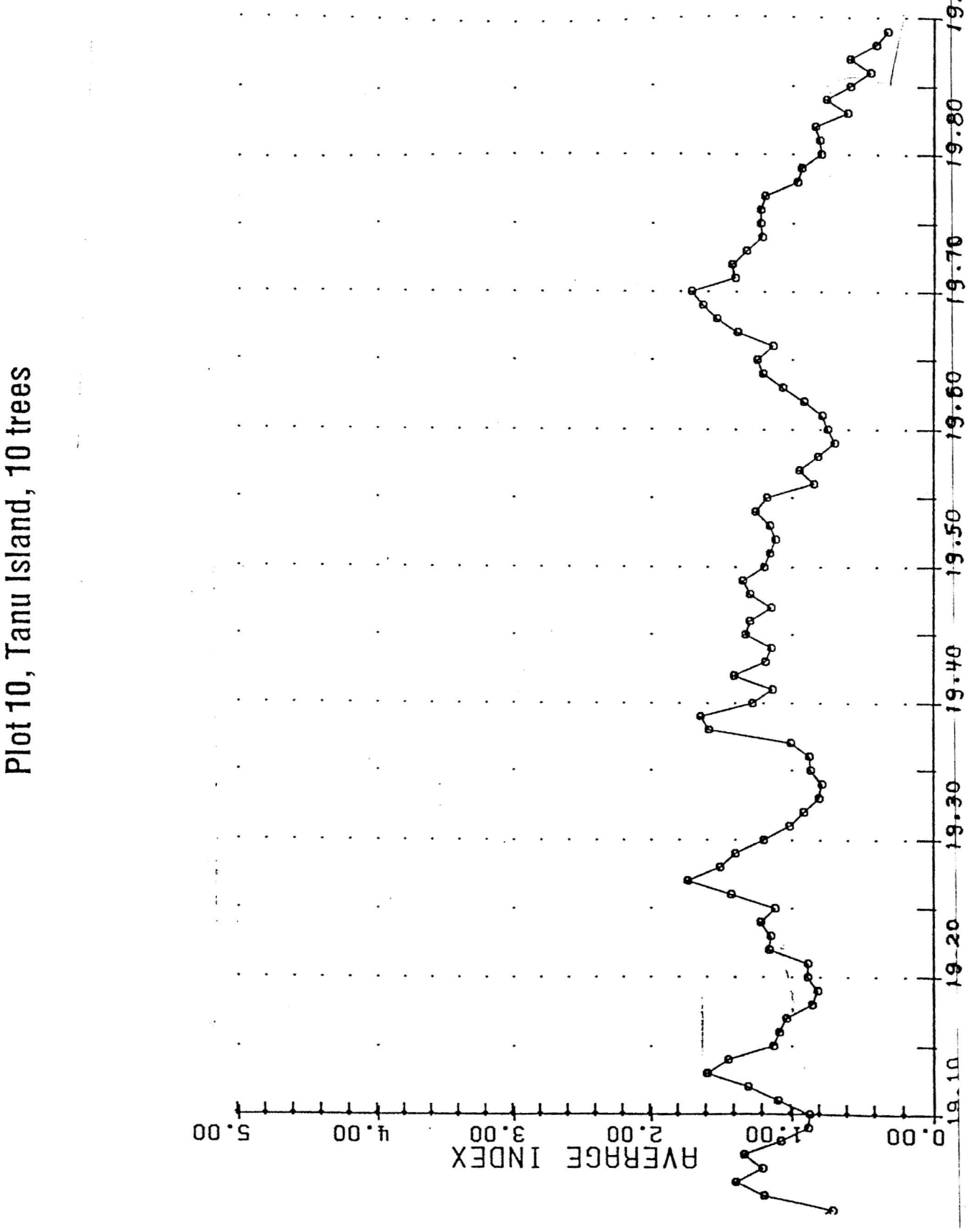

Plot 6, Lyell Island, 9 trees
AVERAGE INDEX
0.00
1.00
2.00
3.00
4.00
5.00
19.10
19.20
19.30
19.40
19.50
19.60
19.70
19.80
19.90


Plot 7, Sewell Inlet, 10 trees
AVERAGE INDEX
0.00
1.00
2.00
3.00
4.00
5.00
19.10
19.20
19.30
19 40
19.50
19.60
19.70
19.80
19.90



Plot 8, Thurston Harbour, 3 trees


Plot 9, Talunkwan Island, 10 trees
AVERAGE INDEX
0.00
1.00
2.00
3.00
4.00
5.00
19.10
19.20
19.30
19.40
19.50
19.60
19.70
19.80
19.90
ACLERIS, WH CORES, QCI, 1989


Plot 10, Tanu Island, 10 trees
AVERAGE INDEX
0.00
1.00
2.00
3.00
4.00
5.00
19.10
19.20
19.30
19.40
19.50
19.60
19.70
19.80
19.90