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Beginning in the spring of 1995 the Canadian Forest Service Forest Health Network (FHN), in co-operation with the Forest Ecosystem Processes Network, conducted a forest pest survey of plots established at eight sites under the Coastal Forest Chronosequence project. The plots had been established in the early 1990s to study the effects of the conversion of old-growth forests to young managed forests on southern Vancouver Island. Four of the sites were located in the Douglas-fir (*Pseudotsuga menziesii*) dominated very dry Coastal Western Hemlock biogeoclimatic subzone (CWHxm1) on the east side of Vancouver Island, and four in the western hemlock (*Tsuga heterophylla*) dominated very wet Coastal Western Hemlock subzone (CWHvm1) on the west side of Vancouver Island. The purpose of the FHN survey was to document the occurrence and impact of forest pests in four seral stages at each site to aid in future cause and effect analyses. The four stages were: (1) R - regeneration (3-9 years); (2) I - immature (32-43 years); (3) M - mature (66-99 years); and (4) O - old growth (>200 years). The survey results are summarized in Table 1, and are detailed in an unpublished report (Garbutt and Humphreys 1997) entitled "Forest Insect and Disease Conditions in Eight Chronosequence Plots on Southern Vancouver Island", on file in the library at the Pacific Forestry Centre.

The forests of Vancouver Island were among the first in British Columbia to be industrially converted from a complex old-growth and largely climax mosaic, to the relative uniformity of young planted and naturally regenerated stands. Prior to man's influence, major disturbances were scattered and infrequent, limited primarily to the forces of wind and fire, and damaging insect infestations. By the beginning of the 1990s less than 45% of the original mature forest remained, much of it in the high elevation, wetter, Mountain Hemlock zone (MacKinnon 1993). Between 1946 and 1996, forest pest activity on Vancouver Island and elsewhere in the province was surveyed and recorded by the Forest Insect and Disease Survey (FIDS) group of the Canadian Forest Service, and the information was published in annual reports. These reports document a steady reduction in populations and subsequent damage by defoliating insects and bark beetles, among the most destructive pests of mature and over-mature stands. As these traditional pests declined we witnessed a concurrent increase in damage caused by such insects as weevils and adelgids, and diseases such as root rots and needle casts, which proliferated in the increasing proportion of young and middle-aged stands (Thies and Sturrock 1995, Allen et al. 1996, Turnquist and Alfaro 1996).

Temporal patterns of destructive pest activity can be broadly characterized as being either chronic or periodic. Chronic pest damage is either ongoing and progressive, or repeated annually over an extended period. Periodic activity, in contrast, can occur on a regular or irregular cycle, often with many years between outbreaks. Significant periodic damage in old-growth stands on Vancouver Island was most often caused by infestations of: 1) defoliators like the western blackheaded budworm (*Acleris gloverana*), greenstriped forest looper (*Melanolophia imitata*), and western spruce budworm (*Choristoneura occidentalis*), and 2) bark beetles like the Douglas-fir beetle (*Dendroctonus pseudotsugae*). Defoliator epidemics would last for two or three years and then collapse as the pest population itself became host to a range of diseases, parasites, and predators; succumbed to climatic influences; or starved due to depletion of the food source (unpublished FIDS reports). Defoliator infestations would recur following a predictable period of population recovery. The bark beetle bred successfully in stressed or freshly killed Douglas-fir following windthrow events or periods of drought, and then attacked healthy timber. The periodicity of beetle outbreaks was therefore irregular and largely event-dependent.

A notable exception to the domination of periodic pests in old-growth stands is hemlock dwarf mistletoe (*Arceuthobium tsugense*), a chronic pest of all age class stands but one that causes much greater damage in terms of growth loss in older trees (Thomson et al. 1984). The prevalence of this disease is evidenced by its occurrence in all five hemlock leading plots (Table 1), primarily in the over-mature plots. Red ring rot (*Phellinus pini*) conks were common in the vicinity of the two Victoria Watershed plots (Table 1) and, though these conks were not seen on the plot trees, blind conks and hollow boles suggested prolonged infection of some of the largest over-mature Douglas-fir. Trees infected with a chronic heart rot such as red ring rot normally live for many years because the disease progresses slowly, but the lethal effects of the disease are most often expressed in trees that are long past maturity, and so can also be seen as natural agents of senescence and subsequent renewal.

The most significant insect and disease pests in young and middle-aged stands on Vancouver Island tend to persist as chronic agents. Among these pests are root diseases, terminal weevils, and adelgids. The most damaging pest of Douglas-fir (and to a lesser degree, western hemlock and true firs) is laminated root rot (*Phellinus weirii*). *Phellinus weirii*, the only disease mortality within the chronosequence study (the bulk of the mortality resulted from understory suppression), recently killed two Douglas-fir trees in one of the Victoria Watershed north subplots and infected 15 others (Table 1). Though in this study the mortality occurred in a mature plot, the lethal effects of this disease are more often seen in middle-aged stands. Following infection, the fungus aggressively attacks living host tissue until the host succumbs or the fungus becomes compartmentalized by host defenses. The disease is transmitted from tree to tree via root contact, forming distinct 'centres' within which all susceptible trees are infected. But perhaps the key factors in the chronic nature of this disease are its ability to survive in dead roots and cut stumps and its ability to be transmitted through root contact to succeeding generations of trees. There is growing evidence suggesting that the establishment of monoculture Douglas-fir plantations on untreated, infected sites—a common practice until recently—has significantly increased the incidence of root disease caused by *P. weirii* (Thies and Sturrock 1995). Another factor contributing to the homogeneity of managed young stands on the east coast of Vancouver Island was, to some degree, presaged by the introduction, around 1910, of white pine blister rust *(Cronartium ribicola),* which all but eliminated western white pine as a significant component of the forest. Like Douglas-fir, white pine is a pioneer species, but unlike Douglas-fir, it is resistant to *P. weirii.*

The white pine weevil (*Pissodes strobi*), the most damaging pest of young Sitka spruce on Vancouver Island, causes chronic damage, but primarily at the stand level (Turnquist and Alfaro 1996). Successive generations of weevils attack trees within a young stand, without necessarily re-attacking the same individuals. The balsam woolly adelgid (*Adelges piceae*), an insect accidentally introduced from Europe, is now the major cause of chronic damage to young amabilis fir (*Abies amabilis*) on the Island (L. Humble pers. comm.).

Though needle diseases such as Sirococcus shoot blight (*Sirococcus strobilinus*), and cedar leaf blight (*Didymascella thujina*) do occur on older trees, they are more common, and cause more damage, in young stands (Boyce 1961). These pests are exceptions to the trend, being periodic in occurrence, with sporadic rather than cyclic outbreaks regulated by moisture conditions at the time of spore release.

The establishment of desired species plantations (notably Douglas-fir) on sites better suited to hemlock and cedar has also increased the susceptibility of even-aged young stands to the proliferation of insect and disease pests. Off-site induced stress has left the trees more susceptible to attack by a range of pests, including needle casts, root diseases, and secondary bark beetles. Within this new structure of host uniformity and some site-induced stress, landscape-level disturbances resulting from chronic attack by insects and diseases are potentially more damaging than the dis-

TABLE 1. Forest pest activity in eight chronosequences on Southern Vancouver Island.

Chronosequence (Biogeoclimatic Variant)	Stage	Sub-plot	Pest	Tree species	Remarks
Victoria Watershed South (CWHxm1)	regeneration	all	Cooley spruce gall adelgid, *Adelges cooleyi*	Douglas-fir (DF)	1% needles infested
	regeneration	all	deer	DF	light browsing
	immature	all	no pest activity	DF	
	mature	all	no pest activity	DF	
	old growth	3+4	Red ring rot, *Phellinus pini* (suspected)	DF	blind conks in 2 trees
Victoria Watershed North (CWHxm1)	regeneration	all	deer	Western redcedar (wrC)	some trees severely browsed
	immature	all	no pest activity	all	
	mature	4	Laminated root rot *(Phellinus weirii)*	DF	2 trees dead; 15 additional with crown symptoms
	old growth	2	*P. pini* (suspected)	DF+Western hemlock (wH)	blind conks on 1 tree of each species
Koksilah (CWHxm1)	regeneration	all	no pest activity	all	
	immature	2	DF cone moth, *Dioryctria abietivorella*	DF	3 attacks in superficial "dime cankers"
	mature	all	no pest activity	all	
	old growth	all	no pest activity	all	
Nanaimo River (CWHxm1)	regeneration	all	no pest activity	DF	
	immature	1	moisture stress	wH	trees stunted and unhealthy
	mature	all	wH dwarf mistletoe, *Arceuthobium tsugense*	wH	severe swellings and brooms in most trees
	old growth	all	*A. tsugense*	wH	severe swellings, brooms and stunting in most trees
Port Renfrew (CWHvm1)	regeneration	all	wH shoot blight, *Sirococcus strobilinus*	wH	negligible damage
	immature	all	*A. tsugense*	wH	common in overstory
	mature	all	*A. tsugense*	wH	common; stunted overstory
	old growth	all	*A. tsugense*	wH	common; stunted overstory
Red Granite Creek (CWHvm1)	regeneration	all	*S. strobilinus*	wH	10% of trees, negligible damage
	immature	all	no pest activity	all	
	mature	all	no pest activity	all	
	old growth	all	*A. tsugense*	wH	common - trees still growing well
Nitinat (CWHvm1)	regeneration	all	no pest activity	all	
	immature	all	no pest activity	all	
	mature	4	*P. pini* (suspected)	wH	blind conk in 1 tree
	old growth	all	*A. tsugense*	wH	common - severe symptoms in most trees
Klanawa (CWHvm1)	regeneration	all	no pest activity	all	
	immature	all	*A. tsugense*	wH	understory infected from overstory
	mature	all	no pest activity	all	
	old growth	all	*A. tsugense*	wH	common - severe symptoms in vets

turbances from periodic pests in the old-growth forests.

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