Yellow-cedar Decline in Young-growth on Kupreanof Island

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While on Kupreanof Island for another field project, we detected dead and dying yellow-cedar trees in a 64-acre second-growth stand (FACTS ID: 4470200001) harvested in 1981 and pre-commercially thinned in 2009. The stand was not particularly wet (as would be expected in a declining stand), but appeared steep, rocky, and shallow to bedrock. As on wet sites, shallow, rocky soils could also lead to shallow rooting and vulnerability to yellow-cedar decline freezing injury. A rock pit adjacent to the stand offered a view of the soil profile and bedrock. Salmonberry, blueberry, dwarf dogwood, bracken, oak and deer fern were common, with skunk cabbage and devil's club in drainages.

Tree observations

We collected tree attributes (dbh, crown fullness, crown color), location information, and described the surrounding shrub and forb vegetation for 20 yellow-cedar trees in the stand (Table 1). Trees ranged from 3.6 to 9.7in dbh (mean 5.7in). Four of the twenty trees had recently died (trees 4, 5, 16, and 19). Some trees with full crowns were significantly or completely discolored (e.g., trees 4, 6, 13, 16, 18, and 19), indicating rapid symptom development and/or tree death (Fig. 1). Some trees had thin crowns (e.g., tree 1, 2 ,5, 15) and varying amounts of crown discoloration, indicating a relatively slower decline process (Fig. 2). Other monitored trees were healthy (e.g., trees 8, 9, 10, 11, 17, and 20) (Fig 3.) or at intermediate stages of symptom development (Fig. 4). It will be informative to track crown symptom development of these trees, which could indicate whether or not yellow-cedar health in this stand is further deteriorating.

Dying trees often had signs of Phloeosinus bark beetle attack (very recent attack or extensive galleries) and Armillaria root disease; these agents are frequently associated with trees stressed by root-freezing injury. Lesions (stained discoloration) were often present on excavated roots of dead or symptomatic trees. Advanced root decay associated with Armillaria infection is uncommon in yellow-cedar, but was detected on one live tree. A sample collected from this tree has been subsequently identified as *A. sinapina*, the same species identified from a variety of hosts state-wide. It is possible that certain young-growth stand management activities, such as pre-commercial thinning or slash management, may increase impacts from Armillaria and Phloeosinus beetles, but this remains to be evaluated. To date, yellow-cedar decline symptoms in young-growth have been identified in stands aged 30-40 years old that have been thinned within the last decade.

Detection

Symptomatic yellow-cedar trees were visible from the road (Fig. 5) and from the air (Fig. 6). Therefore, road and aerial surveys offer a promising approach for monitoring other young-growth stand potentially impacted by decline. The hydrology and snow GIS layers that feed into the Cedar Suitability Index used to model yellow-cedar decline risk at present and into the future did not detect that this site would be vulnerable to yellow-cedar decline. This model is not intended to be scaled-down in this way, but this further demonstrates that the model should not be used to prioritize stands for monitoring.

Figure 1. Two examples of yellow-cedar crop trees with full, discolored crowns that appear to have died rapidly in a young-growth stand on Kupreanof Island affected by yellow-cedar decline.

Figure 2. A yellow-cedar crop tree with a thin, discolored tree crown in a young-growth stand on Kupreanof Island affected by yellow-cedar decline. Crown-thinning is a gradual response to root-freezing injury over time.

Figure 3. A healthy yellow-cedar crop tree in a young-growth stand on Kupreanof Island affected by yellow-cedar decline.

Figure 4. A yellow-cedar crop tree showing intermediate crown discoloration symptoms in a young-growth stand on Kupreanof Island affected by yellow-cedar decline.

Figure 4. Crown discoloration symptoms in a young-growth stand on Kupreanof Island affected by yellow-cedar decline as seen from the road.

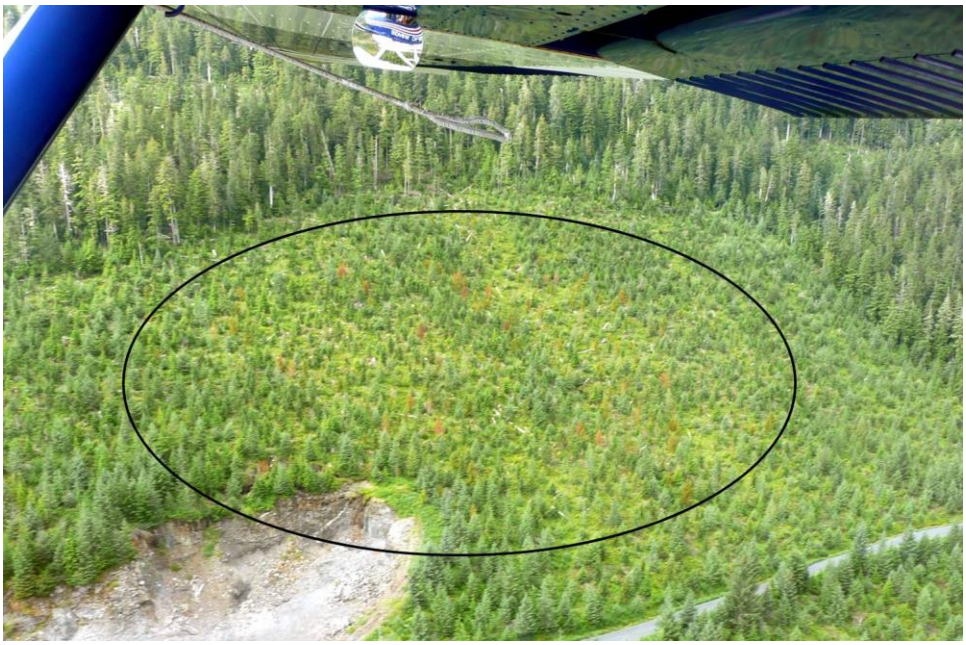

Figure 4. Crown discoloration symptoms in a young-growth stand on Kupreanof Island affected by yellow-cedar decline as seen from a float plane.

Table 1. Data collected from 20 yellow-cedar crop trees in a stand affected by yellow-cedar decline on Kupreanof Island.

Tree	Latitude	Longitude	DBH	Crown Fullness (%)	Crown Color (%)			Armillaria (1/0)	Beetles (1/0)	Other Notes	Surrounding veg/habitat[1]
					red/brown	yellow	green				
1	56.70389	-132.99488	4.1	40						Lesion near roots.	RUSP
2	56.70388	-132.99495	5.1	35						Lesion near roots. Beetle larvae didn't produce galleries.	RUSP, VAOV, VAAL
3	56.70404	-132.99499	7.9	65	0	60	40			Fuller crown, but active discoloration. 60% Chlorosis	RUSP, VAOV, VAAL, MEFE, GYDR, COCA
4	56.70412	-132.9947	7	85	100	0	0		1	Dead. Rapidly killed. Lesion near roots. Adjacent to healthy tree.	MEFE,PTER
5	56.7042	-132.99473		20	100	0	0	1	1	Dead. Rapidly killed. Phloeosnus frass & nuptual chambers.	RUSP, COCA, PTER
6	56.70424	-132.99488	5.7	95	30	20	50	1		Brown interior. Dead cambium and stained sapwood.	ADIA, MEFE, BACC, BLEC
7	56.70419	-132.99491	3.6	75	10	10	80				VAOV, VAAL, COCA, GYDR
8	56.70423	-132.99486	7.6	100	0	5	95				LYCO, MEFE, PTER
9	56.70471	-132.99403	6.8	100	3	3	94				PTER, OPHO
10	56.70432	-132.99441	5.6	100	1	1	98			Many healthy trees nearby.	GYDR, RUSP, PTER, RUSP
11	56.70429	-132.9942	2.8	100	3	0	97				PTER, MEFE
12	56.70434	-132.99387	5.4	80	15	0	85				PTER, MEFE, LYAM
13	56.70434	-132.99387	6.8	100	10	50	40		1	Fresh beetle attack and nuptual galleries.	PTER, LYAM
14	56.70431	-132.9937	5.2	80	35	60	5	1			PTER, MEFE, COCA
15	56.7044	-132.9936		50	40	10	40			Attempted beetle attack. No armillaria	MEFE, VAOV, VAAL, ADIA
16	56.7044	-132.99357	3.9	80	100	0	0	1	1	Recently killed. Near steep gully & creek.	RUSP, PTER, COCA
17	56.70435	-132.99347	5.3	100	10	5	85				RUSP, PTER, MEFE, VAOV, VAAL
18	56.70431	-132.99341	4.9	75	30	20	50			No armilllaria present.	PTER, MEFE
19	56.70431	-132.99341	5.4	95	100	0	0		1	Recently killed. Extensive Galleries	RUSP, VAOV, VAAL, PTER, LYAM
20	56.70421	-132.99358	9.7	100	0	0	100				OPHO, LYAM, VAOV, VAAL

1. RUSP- *Rubus spectabilis*, salmonberry; VAOV- *Vaccinium ovalifolium*, oval-leaved blueberry; VAAL- *Vacciunium alaskaense*, Alaska blueberry; MEFE- *Menziesia ferruginea*, falze azalea; COCA- *Cornus canadensis*, dwarf dogwood; GYDR- *Gymnocarpium dryopteris*, oak fern; OPHO- *Oplopanax horridus*, devil's club; PTER- *Pteridium* spp., bracken fern; LYAM- *Lystichiton americanus*, skunk cabbage; ADIA- *Adiantum* spp., maidenhair fern; BLEC- Blechnum spp., deer fern; LYCO- *Lycopodum* spp, creeping-cedar.