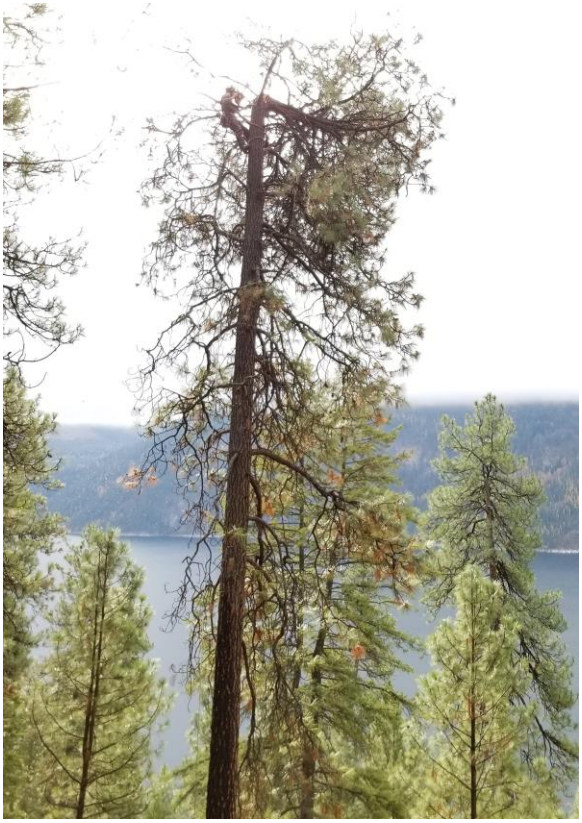
Kootenay 2018 Wildlife Tree Creation Project

(Contract # GS19NLE064)

Final Report – 6 December, 2018



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Background and Treatment Areas

Wildlife trees provide critical nesting, denning, roosting, feeding and perching habitat to over 70 species of birds, mammals and amphibians in British Columbia (Fenger et al. 2006). These include some species which are considered at risk provincially and federally. Dependent on the age, condition and disturbance history of the forested landscape, wildlife trees can be in short supply in some areas. This is the case at most of the 2018 treatment sites located in the west Kootenay region of southeastern BC (Figure 1): Broadwater NDT-4 ER, Coleman Ranch, Grey Wolf, Tulip Creek and Marsden. These areas have high habitat capability for cavity-dwelling wildlife but currently lack complex stand structural attributes and a sufficient supply of wildlife trees in moderate-advanced stages of decay. Increasing stand structural complexity and old growth forest-like attributes, including the abundance of wildlife trees (i.e., large live trees with internal decay and dead trees) are recommended objectives for these areas.

Wildlife tree enhancement treatments were conducted at the above five sites in October 2018, and are expected to increase nesting, roosting and feeding habitat supply for a variety of cavity dependent wildlife species, including Lewis's Woodpecker (*Melanerpes lewis*), Williamson's Sapsucker (*Sphyrapicus thyroideus nataliae*), Flammulated Owl (*Psiloscops flammeolus*) and Western Screech-Owl (*Megascops kennicottii macfarlanei*).

Project Goal and Objectives

The overall goal of this project was to enhance wildlife tree habitat supply and quality in the project area. The advantages and benefits of using fungal inoculation as a wildlife tree creation technique have been described by various researchers in the Pacific Northwest (Bull and Partridge 1986; Parks et al. 1996; Lewis 1998; Brandeis et al. 2002; Manning 2008; Manning 2009; Manning 2010; Manning 2011; Bednarz et al. 2013; Hennon and Mulvey 2014; Manning 2014; Manning and Manley 2014).

Specific project objectives in 2018 were:

i) to enhance overall wildlife tree habitat supply in areas which currently lack wildlife trees; and

ii) to increase the abundance of wildlife trees in areas with high habitat capability for Lewis's Woodpecker, Williamson's Sapsucker, Flammulated Owl, Western Screech-Owl and other cavity-dependent wildlife [e.g., Pileated Woodpecker (*Dryocopus pileatus*), Northern Flicker (*Colaptes auratus*)].

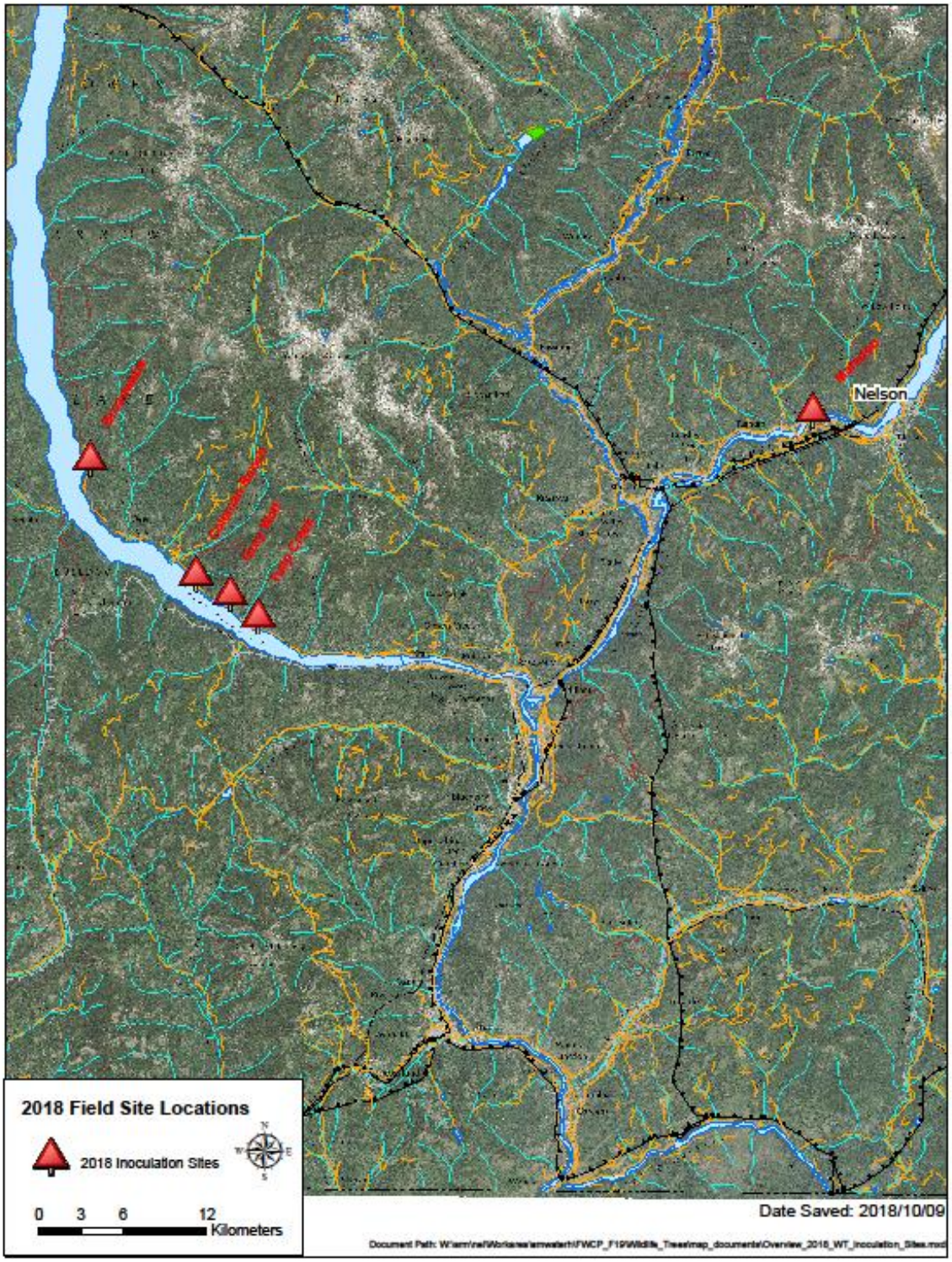

Figure 1. Location of the 2018 fungal inoculation treatment sites (Broadwater, Coleman Ranch, Grey Wolf, Tulip Creek and Marsden) in the west Kootenay region of British Columbia.

Field Methods

Trees intended for treatment were selected, measured and marked prior to or concurrent with the wildlife tree creation treatments. Three types of wildlife tree creation treatments were applied to these trees. The first treatment is termed 'window' treatment (Figure 2) – this involves limbing (pruning) a 2-3 m section in the mid-upper portion of the bole (approx. 7-15 m above ground), then applying two ½ circumference stem ring girdles (intended to stress the tree but not kill it, and more importantly to reduce sapflow and sapwood moisture content in the portion of the stem between the girdles) – this section of the stem is then inoculated with the native heart rot fungi *Fomitopsis officinalis (*ponderosa pine and western larch) or *Phellinus pini* (on Douglas-fir), which were previously cultured in the lab on 8 cm x 1.3 cm wooden doweling. In addition, the stem is "scarred up" with a chainsaw in order to further stress the tree and to provide a visual stimulus to cavity excavators that this part of the tree is potentially damaged/decayed.

The second treatment called 'dead top' involves removing the original live tree top (growth leader) and leaving a 2-4 m partially limbed section as the remaining top (Figure 3); a full-ring stem girdle is applied immediately beneath this section in order to kill the upper part of the tree; this upper section is then inoculated with *Ganoderma applanatum* which is a heartrot fungi that can colonize dead woody tissue in deciduous and coniferous trees (Allen et al. 1996).

The third treatment, called 'tall stub' treatment (Figure 4), was applied to some of the larger diameter conifers (i.e., generally >50 cm dbh), particularly those which had few existing limbs in the lower ½ of the tree bole. The 'tall stub' treatment consisted of full-girdling the tree below the lowest live limbs and inoculating above this point with *G. applanatum*. As well, these trees were topped at approximately 10-15 m height. Tall stubbing is intended to kill the tree, leaving a moderate height snag (i.e., a "stub tree") which will quickly develop heartrot decay as well as natural sap rot in the outer sapwood – the result is an ecologically useable snag in the near term (resembling a natural class 6 tree[1] in appearance), providing woody substrate for feeding and excavation of nest cavities.

Trees were inoculated three times for the dead top treatments and six times for the window treatments (i.e., inserted 3 or 6 cultured dowels in conjunction with the respective topping or stem window treatments). The tall stub tree treatments were inoculated six times. All inoculation points were located within a 3-4 m vertical spread on the east or north sides of each tree bole.

For additional information concerning field methods, refer to Manning and Manley (2014).

[1] The BC MFLNRORD Forest and Range Evaluation Program (FREP) stand-level biodiversity monitoring protocol (http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/integrated-resource-monitoring/forest-range-evaluation-program/frep-monitoring-protocols/biodiversity) uses a 9-class coniferous tree classification system. Tree class 6 is a standing dead tree where approximately 1/3 to 1/2 of the original tree height has broken away. Stem wood condition in natural class 6 trees exhibits moderate to advanced decay.

Figure 2. Applying a window treatment in a Douglas-fir at Coleman Ranch (Oct. 2018). This type of treatment is intended to introduce heart rot decay into the middle portion of the tree stem.

Figure 3. Dead top treatment in a ponderosa pine at Coleman Ranch (Oct. 2018).

Figure 4. Ponderosa pine tall stub treatment, Coleman Ranch, Oct. 22, 2018.

Results

In total, 86 trees [30 Douglas-fir (*Pseudotsuga menziesii*), 37 ponderosa pine (*Pinus ponderosa*), 14 western larch (*Larix occidentalis*) and 5 trembling aspen (*Populus tremuloides*)] were inoculated and mechanically modified in order to enhance or create wildlife tree habitat at the five west Kootenay treatment sites between October 17-24, 2018.

Twenty-two trees received dead top treatments, 47 received window treatments and 17 trees received tall stub treatments. A summary of the treatment statistics is shown in Table 1. A full data summary of the treated trees, including tree number, species, diameter at breast height, treatment type and associated inoculant fungus, and tree locations (UTM coordinates), is provided in

Appendix 1 (separate document). All trees were live and appeared to be relatively healthy with no major visible stem damage or evidence of root disease at the time of pre-treatment.

Pre-treatment tree heights were variable, but ranged from approximately 15-35 m. Median tree diameter at breast height (dbh outside bark, all trees) was 60.0 cm, with diameters ranging from 35.0 – 110.0 cm.

Table 1. Summary of tree inoculation treatments (n=86) conducted in the west Kootenay Region in 2018.

Location	Treatment Type			Tree Species[2]				Total
	Dead Top	Window	Tall Stub	Fd	Py	Lw	At	
Broadwater	4	16	4	12	8	4	0	24
Coleman Ranch	2	11	3	1	2	10	3	16
Grey Wolf	3	0	5	1	7	0	0	8
Tulip Creek	1	0	3	2	2	0	0	4
Marsden	12	20	2	14	18	0	2	34
Total	**22**	**47**	**17**	**30**	**37**	**14**	**5**	**86**

[2] Fd = Douglas-fir; Py = ponderosa pine; Lw = western larch; At = trembling aspen

Discussion

Overall, the window treatment was applied to 55% of the treated trees, with the remainder receiving dead top (25%) or tall stub (20%) treatments. These varied treatments will produce different types of wildlife trees over time. For example, trees with the window treatment remain alive and provide habitat value for many years since the onset and progression of internal decay is much lengthier than in the other treatments. Dead top and tall stub treatments on the other hand, result in effective killing of treated stemwood via full girdling; as such the heartwood decay process is accelerated (Manning and Manley 2014, Manning 2011).

The tall stub treatments are effectively dead trees post-treatment, and will start to decay relatively soon with natural saprot beginning in a few months, particularly on ponderosa pine; these stub trees, while not providing the same habitat longevity as the other inoculation treatments, provide very important shorter term habitat value (e.g., 2-15 years), mimic natural dead stub trees which are often uncommon in many forest stands (e.g., class 6 and 7 wildlife trees which have broken off due to previous stem injury/decay or wind-snap), and are used for feeding and as cavity-nesting substrates by species such as Lewis' Woodpecker and Northern Flicker which prefer "softer trees" with more advanced internal decay. Tall stub treatment trees are being shown to receive use by wildlife within a relatively short time after treatment. For

example, in a limited survey of trees which had been previously inoculated and mechanically modified in 2011 at Foosey Pasture (E. Kootenay region, BC), Manning (unpublished observations, July 2018) found some tall stub treatments in Douglas-fir had received substantial wildlife use within the past seven years since treatment (Figure 5). Similar observations of nesting cavity excavation on ponderosa pine tall stubs which were treated in 2010 at Dutch-Findlay (E. Kootenay region, BC) were documented by Manning and Manley (2014). In addition, Manning (unpublished observations Oct. 2018) observed recent and extensive woodpecker foraging excavations on a ponderosa pine (Figure 6) which had received a tall stub treatment in 2014 at Deer Bay (W. Kootenay region, BC).

Dead top treatment trees also provide cavity nesting habitat opportunities relatively quickly. Manning and Manley (2014) documented nest cavity construction by a Pileated Woodpecker in a dead top treatment ponderosa pine at Pine Butte (E. Kootenay region, BC) within three years post-treatment. The ecological benefits of both tall stub and dead top treatments are provision of dead-wood habitat structure within a short period of time (Manning and Manley 2014). This is particularly important in locations where "standing dead wood structure", particularly larger diameter stems, are scarce due to past or forecasted removal (e.g., areas logged or cleared for timber harvesting, agriculture, hydro development, urban-rural interface, wildfire-impacted areas).

Figure 5. Douglas-fir tall stub treatment, Foosey Pasture (E. Kootenay region, BC), July 3, 2018. This tree had been inoculated and mechanically modified as a tall stub in 2011. Seven woodpecker nesting cavities were observed in this tree. Red arrows show location of two recent nest cavities.

Figure 6. Ponderosa pine tall stub treatment, Deer Park (W. Kootenay region, BC), Oct. 22, 2018. This tree had been inoculated and mechanically modified as a tall stub in 2014. Note the large, deep feeding excavation (at red arrow) in the upper part of the stem. Brown cubical wood tissue is also evident at this position which indicates extensive decay in the heartwood of this tree. Photo: Eric Gross.

Recommendations

In order to improve the overall efficacy of future wildlife tree creation treatments and accompanying fungal inoculation techniques, new recommendations are suggested below. These are based upon: i) observations of previously treated trees recently visited by Manning in July and October, 2018; ii) recent discussions with Strategic Resource Solutions' arborists concerning treatment tree "wound reaction characteristics" (e.g., amount of sap flow at stem girdles, callousing of sapwood/cambial layer at stem girdles); and iii) an improved understanding of heartwood fungi – tree host susceptibility to decay in relation to inoculation treatment type (e.g., tall stub vs. window) and selection of fungal inoculant species.

1) Monitor future tree condition and wildlife use (i.e., stem breakage, presence of nest cavities, feeding excavations or fungal conks) of a sample of treated trees at 5 years post-treatment (ca. 2023 for the 2018 treatment cohort).

2) When conducting wildlife tree creation and inoculation treatments, the following treatment parameters and variables should be followed:

   a) TALL STUBS - based on current treatment effectiveness monitoring results, tall stub treatments have received the most use by cavity excavating wildlife. Tall stub treatments should be increased in frequency at locations where there is a lack of current or anticipated standing dead trees. Such trees provide readily available nesting, roosting, denning and foraging substrate for a variety of wildlife species, and dependent on the selected tree species and its diameter, tall stubs will provide suitable habitat in as little as 3-5 years and lasting as long as 20 years or more. Candidate trees for tall stub treatments should have the following characteristics:

      i) Ponderosa pine, Douglas-fir, white spruce, lodgepole pine, black cottonwood, balsam poplar and trembling aspen are recommended tree species
      ii) Larger diameter trees will persist longer as tall stubs. Minimum dbh for tall stubs is 50 cm, except trembling aspen is 40 cm
      iii) Height after tall stub treatment should be in the 8-15 m range
      iv) The minimum application height of the full-stem-girdle should be 5 m above ground
      v) Ensure the full stem girdle is cut sufficiently wide and deep to permanently sever the active cambium and adjacent conductive sapwood. Can also modify the girdling technique on species resilient to girdling (eg: *Populus spp*.) to a “stacked double-girdle” with approximately 30 cm vertical spread between the two full girdles
      vi) All live foliage (branches) above the full-stem-girdle should be removed
      vii) All tall stub treatment trees should be inoculated <u>at least six times</u> with the appropriate heart rot decay fungus

   b) DEAD TOPS

      i) Ponderosa pine, Douglas-fir and western larch are recommended tree species
      ii) Dead top length should be increased to 4-6 m
      iii) All live foliage (branches) above the full-stem-girdle should be removed
      iv) Be sure the full stem girdle is cut sufficiently wide and deep to permanently sever the active cambium and adjacent conductive sapwood
      v) All dead top treatment trees should be inoculated <u>at least four times</u> with the appropriate heart rot decay fungus

   c) WINDOWS – window treatments are maintained as full height live trees, and are intended to create future longitudinal and relatively extensive internal decay columns within the trunk of

treatment trees. As such, these treatments should provide long-term nesting and foraging habitat for cavity excavators such as Williamson's Sapsucker.

i) Western larch is most suitable to application of window treatments. This is because of the lengthy internal stem decay columns (caused most often by the heart rot decay fungus *F. officinalis*) which tend to naturally occur in live, mature and old larch trees (Figure 7). Such trees provide highly important nesting substrate for various primary cavity excavators, particularly Williamson's Sapsucker
ii) The vertical span of the stem window (between upper and lowermost girdles) should be 3-5 m in length
iii) Apply four partial stem girdles (1/2 circumference) within the vertical span of the window
iv) Be sure the partial girdles are cut sufficiently wide and deep to permanently sever the active cambium and adjacent conductive sapwood
v) All live foliage (branches) should be removed within the span of the stem window
vi) Douglas-fir can also be selected for window treatments. In this case the native heart rot fungus *Phellinus pini* should be used as the inoculant
vii) Trees selected for window treatments should be larger size, generally >50 cm dbh and >20 m height
viii) All window treatment trees should be inoculated <u>at least eight times</u> with the appropriate heart rot decay fungus

3) Application of bat micro-habitat features and other mechanical stem damage.

i) Vertical and slightly spiraling cuts (a.k.a. bat slits, Figure 8) and what are termed "undercut bat flanges" (Figure 9), as well as superficial "stem scuffs and scars", can be applied to any trees which receive tall stub, dead top or window treatments. Bat slits and flanges provide potential immediate habitat for roosting bats, and are generally 1-2 cm wide, 10-20 cm depth into the stem, and variable in length (i.e., 50-100 cm). Stem scuffs serve as visual indicators/stimulants for primary cavity excavators of potential stem damage and internal decay at this position within the tree trunk
ii) Trees which are specifically selected to enhance bat roosting habitat should usually be located near natural forest openings or riparian areas, where bats routinely forage for airborne insect prey.

4) Wildlife tree creation/fungal inoculation treatments can be specifically tailored toward the habitat needs of various wildlife species. A partial list of species is as follows:

a) For Lewis's Woodpecker nest trees: tall stub and dead top treatments on ponderosa pine; dead top treatments on cottonwood
b) For Williamson's Sapsucker nest trees: combination treatments (window + dead top) on large diameter western larch (>60 cm dbh); tall stub treatments on larger diameter trembling aspen (>40 cm dbh); tall stub treatments on larger diameter ponderosa pine (>60 cm dbh). <u>Note</u>: window treatments on western larch are intended to create future

extensive decay columns in the middle-bole region of the tree, while still maintaining a live and stable tree that offers long-term nesting habitat

c) For Williamson's Sapsucker foraging substrate: in areas with suitable habitat for Williamson's Sapsucker and where there is a desire to enhance foraging habitat supply for this species, consider inoculating the largest downed pieces (>30 cm large-end diameter) of ponderosa pine stems which have been removed (felled) during tall stub treatments. Inoculation of these pieces will accelerate their decay. Large pieces of downed woody debris can provide habitat for carpenter ants (*Camponotus spp*.) which are a preferred food source for sapsuckers during the nestling phase of the breeding season. These pieces should firstly have most of their branches removed so that the log can lay relatively flat on the ground as opposed to being suspended off the ground. The log can be inoculated once every two meters of log length up to the position where log diameter tapers down to <30 cm, and then be bucked at this point. Inoculation with the wood decay fungus *Fomitopsis pinicola* is recommended since it is the most ubiquitous downed wood colonizer and "slash destroyer" found in most B.C. forest stands (Allen et al. 1996)

d) For Fisher den trees: in areas with suitable or capable habitat for Fisher, create future den trees in large diameter black cottonwood or balsam poplar (ideally >60 cm dbh). Use window treatments located between 4-15 m above ground (follow guidance for "installing windows" as per Recommendation #2c above, with particular emphasis on sufficient depth and location of partial stem girdles). Future den cavity entrance courts can be initiated as simulated branch collar wounds, simulated woodpecker cavity starts (Figure 10), and simulated frost crack wounds (Figure 11); Fishers often enter tree dens through these types of natural stem openings (Figure 12). Using old natural branch stubs as loci for applying artificial branch collar and cavity start wounds is recommended.

e) For Fisher den trees: in areas with suitable or capable Fisher habitat where denning is known to occur in lodgepole pine or trembling aspen, create future den trees in large diameter specimens of these species (ideally >50 cm dbh). Use tall stub treatments with appropriate stem modifications (as described in #4d above) positioned between 4-8 m above ground on the remaining stem. Overall tall stub stem height in these situations should be 12-15 m, which is greater than the height range described for tall stubs in Recommendation #2a(iii) above.

5) Trembling Aspen treatments: in areas with mixed or pure stands of mature or old trembling aspen, wildlife tree enhancement treatments can create a relatively "quick supply" of potential nesting and foraging substrate for a wide variety of resident and migratory cavity dwelling wildlife, including woodpeckers, sapsuckers, chickadees, nuthatches, tree swallows, bluebirds, small owls, kestrels, squirrels and bats (Fenger et al. 2006). For trembling aspen use tall stub treatments as per Recommendation #2a above (Figure 13). Candidate aspen trees for treatment should be >40 cm dbh.

6) Relative to all of the above inoculation treatment recommendations, it is imperative to select and use the most appropriate fungal decay organism. These are characterized as heart rot decay fungi and have varying preferences and selectivity for tree hosts. For example, some fungal heart rot organisms (e.g., *Fomes fomentarius, Phellinus hartigii*) are more aggressive in

colonization and eventual decay of their host tree than others (Manning 2013); some species are generalist colonizers (e.g., *Phellinus pini* affects many coniferous trees); some species are restricted to deciduous tree species hosts (e.g., *Spongipellis delectans*); others only colonize a single tree species (e.g., *Phellinus tremulae* is unique to trembling aspen), and a few are highly ubiquitous (e.g., *Fomitopsis pinicola*) (Allen et al. 1996). Table 2 shows the recommended fungal inoculant species for candidate tree species hosts and treatment types.

Table 2. Recommended fungal inoculant species for different tree species hosts and treatment types.

Host Tree Species	Recommended Fungal Inoculant	Treatment Type[3]				Comments
		TS	DT	W	C	
Western larch	*Fomitopsis officinalis*			x	x	A combination treatment (W+DT) is recommended when applying a window treatment to larch
	Fomitopsis pinicola	n	x			
Douglas-fir	*F. officinalis or Phellinus pini*[4]			x		
	F. pinicola or Ganoderma applanatum	x	x			
Ponderosa pine	*F. pinicola or G. applanatum*	x	x	n		
Lodgepole pine	*F. pinicola*	x	n	n		
White spruce	*G. applanatum or F. pinicola*	x	x	n		
Black cottonwood, Balsam poplar	*Spongipellis delectans*	x	x	x		Because of their scaffold branching form, Dead Top treatments in cottonwood and poplar involve stubbing, girdling and inoculating one or more of the large, vertical sweeping limbs. *P. populnea* is most damaging in living tree hosts and is therefore only suitable for Window treatments
	Pholiota populnea			x		
Trembling aspen	*Ganoderma applanatum or Fomes fomentarius*	x	n	n		Select aspen which do NOT have any visible fungal fruiting bodies (conks) at the time of treatment

[3] TS = tall stub; DT = dead top; W = window; C = combination (W + DT);
x = recommended treatment type; n = this treatment type not recommended for this tree species

[4] The scientific name for *Phellinus pini* has been recently changed to *Porodaedalea pini*

Figure 7. Example of a high value Williamson's Sapsucker nest tree (western larch) showing multiple nest cavities and nearby heart rot conk (*Fomitopsis officinalis*). In British Columbia, this species of fungus is most commonly found in western larch trees (Allen et al. 1996) and appears to be associated with the internal tree decay conditions amenable for development of lengthy internal decay columns and subsequent nest cavity excavation by Williamson's Sapsucker as well as other primary cavity excavating birds. This tree would be considered an extremely high value wildlife tree used for nesting by Williamson's Sapsucker and other cavity nesters over many years. Photo: Randy Waterous.

Figure 8. Vertical bat slit installed on the trunk of a large cottonwood tree (Tsay Keh Dene, BC, Sept. 2018). Photo: Ryan Murphy.

Figure 9. Undercut bat flanges installed on the trunk of a Douglas-fir tall stub treatment (Coleman Ranch, BC, Oct. 2018). These can provide immediate roosting habitat for bats. Photo: Darcie Quamme

Figure 10. Simulated “cavity start”. This artificial wound will serve as a future entrance court to the fungal decay column which has been initiated via inoculation in this part of the tree stem. Photo: Ryan Murphy.

Figure 11. Mechanical modifications and fungal inoculation applied to a large diameter cottonwood tree for creation of a future internal decay column, cavity entrance and fisher den site (Tsay Keh Dene, BC, Sept. 2018). Red arrow indicates a "cavity start"; purple arrow is frost crack simulation (natural frost cracks are often used as entrance courts to the internal decay cavity); and green arrow is the lower partial girdle applied to one side of the stem. The fungal inoculant species (*Spongipellis delectans*) was applied six times within the 3 m length of stem above the lower girdle.

Figure 12. Natural stem wound in a cottonwood leading into an internal decay cavity. These types of wounds can be initiated by stems scars from tree fall, frost cracks, wind shake and lightning strike.

Figure 13. Example of a tall stub treatment applied to a trembling aspen. Note vertically spiraling bat slit installed at red arrow. This tree had virtually no existing internal decay at the time of stubbing (Tsay Keh Dene, Sept. 2018).

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All photographs courtesy of Todd Manning, except where otherwise indicated.

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