14 Lakes/ Green Valley Forest Habitat Enhancement Project Plan

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1.0 PROJECT AND SITE DESCRIPTION

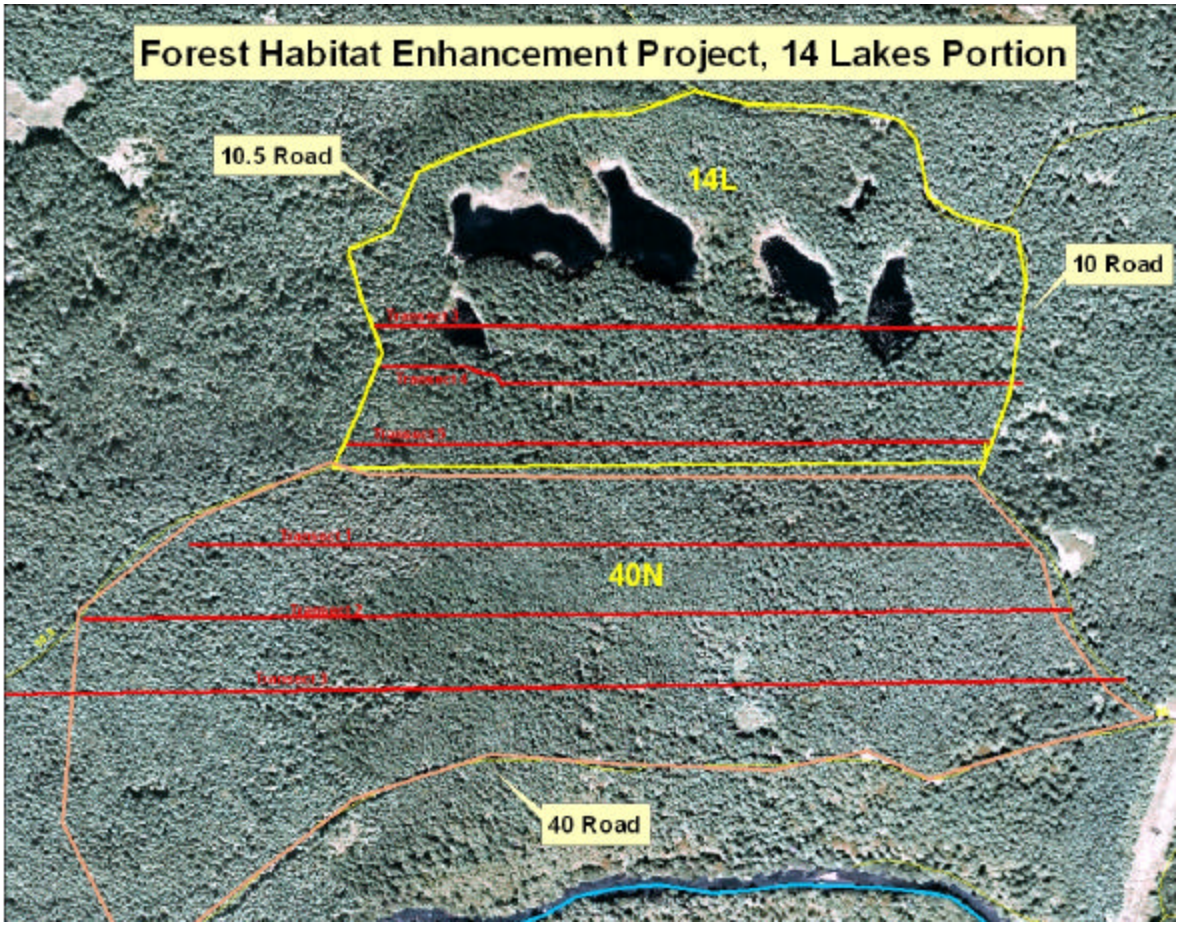
The BPA Habitat Plan project, funded by the BPA mitigation settlement, consists of two components. The first is development of a general long-term habitat plan for the BPA right-of-way and all surrounding lands. The second component is an on-the-ground forest habitat enhancement project, described in this project plan. An interdisciplinary team was formed to work on both the BPA Habitat Plan and habitat enhancement project. After reviewing all available data (including a variety of remotely-sensed image data as well as forest inventory data), we agreed that the two highest priority areas for habitat enhancement were the forest surrounding the five 14 Lakes ponds and the forest in the Green Valley. These forests differ, so are described separately in sections 1.1 and 1.2.

1.1 14 Lakes Forest

The 14 Lakes portion of the project area is bounded on the east and north by the 10 road, on the north and west by the 10.5 road and on the south by the 40 road (Figure 1). This project area (approximately 260 acres) is subdivided into two units (14L and 40N) and contains both riparian and upland forest as well as a wetland complex. The wetland includes five ponds that differ in size, water depth, slopes, and vegetative character. The ponds are located less than one mile east of the Rock Creek wetland complex and less than one mile north of the Cedar River and thus are an important link for many wildlife species that use wetland habitats. The ponds do not support any fish species and consistently have the heaviest density of amphibian breeding in the lower Cedar River Municipal Watershed (CRMW). In 2006 over 1,500 red-legged frog egg masses were documented there. Other amphibian species breeding at 14 Lakes include Pacific treefrogs, roughskin newts, northwestern salamanders, and long-toed salamanders.

The forest surrounding the ponds was harvested in the early 1900's and subsequently burned, as shown in 1912 archival photos. The forest is currently dominated by Douglas-fir, but many areas have a good diversity of tree species. There are numerous big-leaf maple trees to the north of the ponds (along the 10 and 10.5 roads in the forest between the roads and the ponds), some of which are fairly large (12-15 inch dbh, 60 ft tall). Many of these trees are currently overtopped by Douglas-fir trees and it appears they are receiving insufficient light to persist for long. The southern portion of the project area (south of the ponds) is subject to periodic wind events, and has some patchy canopy gap and snag development. This area also has generally good species diversity.

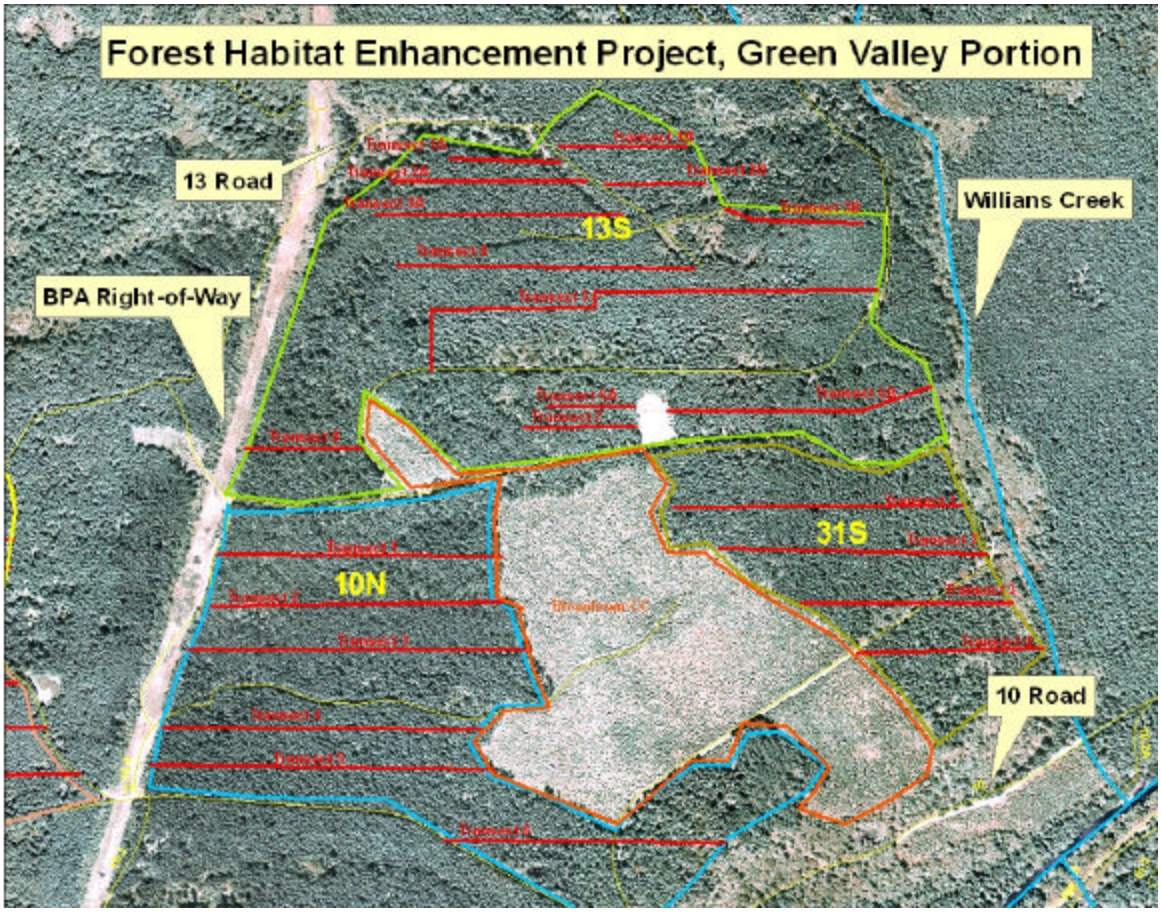
Figure 1. 14 Lakes portion of the project area, with transects illustrated in red. Note: transects 1 and 2 in the 14L section are not illustrated. They consist of the 10 and 10.5 roads north of the 14 Lakes ponds.



1.2 Green Valley Forest

The Green Valley portion of the project area is bounded on the south by the 10 road, on the east by Williams Creek, on the north by the 13 road, and on the west by the BPA right-of-way (Figure 2). This approximately 400-acre area was subdivided into three units (13S, 10N, and 31S). It consists of approximately 70 year-old second-growth conifer forest that was simplified to Douglas-fir trees by commercial thinning in the early 1980s. There is generally poor tree species diversity throughout this portion of the project area. There is some western hemlock scattered throughout the area, but western redcedar and deciduous species are extremely limited or absent in most of the area. There are few canopy gaps, although there is some uprooting of small patches of trees from previous wind events. Understory varies but is predominantly salal, with patches of red huckleberry and vine maple. There are limited numbers of snags and variable amounts of downed wood throughout this project area. There is a moderate amount of the invasive species, English holly, scattered throughout this portion of the project area.

Figure 2. Green Valley portion of the forest habitat enhancement project area, with transects illustrated in red



2.0 PROJECT GOALS AND OBJECTIVES

The overall goals for the entire habitat enhancement project are to enhance current wildlife habitat, increase plant species diversity, and accelerate development of more complex forest structure. Specific objectives for the two portions of the project are listed in sections 2.1 and 2.2.

2.1 14 Lakes Forest

The primary objective for the 14 Lakes portion of the forest habitat enhancement project is to maintain existing tree species diversity and enhance individual tree growth of the target species. The method to achieve this will be to provide increased light by cutting Douglas-fire trees around existing big-leaf maples, western redcedar, and other uncommon native tree species that are currently being suppressed by neighboring Douglas-fir trees. We will ensure the cut trees will not fall on the target species by directionally felling them away from the desired trees

Other objectives (with recommended methods to achieve the objectives shown in bullets) are:

1. Enhance habitat for snag dependent species
    - Create snags in appropriate locations by girdling trees, either at dbh or just under the lowest live canopy

2. Provide refuge and forage habitat for amphibians and other wildlife species within the forest
    - Fell trees $\geq$ 16" dbh
    - Direct the larger diameter trees toward the ponds
3. Enhance forest floor habitat and soil development
    - Leave all wood on forest floor
4. Enhance forest structural complexity
    - Create small canopy gaps where appropriate by either cutting or girdling trees

2.2 Green Valley Forest

The primary objective for the Green Valley potion of the forest habitat enhancement project is to enhance native plant species diversity by planting native trees and shrubs in created and natural gaps and removing invasive species such as English holly.

Other objectives (with recommended methods to achieve the objectives shown in bullets) are:

1. Enhance habitat for snag-dependent species
    - Create snags in appropriate locations by girdling trees
2. Enhance forest structural complexity
    - Create small canopy gaps where appropriate by either cutting or girdling trees
3. Maintain existing native species diversity and enhance the growth of individual trees of target species (where they exist)
    - Provide light by cutting Douglas-fire trees around existing western redcedar and any deciduous trees that are currently being suppressed by neighboring Douglas-fir trees
    - Ensure the cut trees will not fall on the target species by directionally falling them away from the desired trees
4. Enhance forest floor habitat and soil development
    - Leave all wood on forest floor

3.0 PROJECT JUSTIFICATION

Most of the project area (both 14 Lakes and Green Valley) has been identified by the synthesis project as a high or medium synergy area because of its connectivity among habitats (wetland, high quality forest habitat) and proximity to riparian areas and wetlands. The area is a particularly important link for species using the well developed second-growth forest habitat in the lower Taylor River drainage to the south, the riparian forest near Williams Creek to the east, and the riparian forest near Rock Creek and the Rock Creek Wetland to the west.

The ponds at 14 Lakes provide some of the most important habitat for pond breeding amphibians in the lower CRMW. Adult and juvenile amphibians migrate from the breeding ponds to upland forest habitat upon completing annual breeding or reaching metamorphosis. These animals navigate between upland forest and the ponds during both spring months and drier summer months (juveniles). Larger diameter logs directed towards the ponds provide cover and retain moisture to enhance the habitat for amphibians during these movements between habitat types.

Existing tree species diversity in the 14 Lakes area is high, so enhancing the diversity by planting will not be necessary. Maintaining the existing diversity by cutting neighboring trees will

benefit numerous wildlife species, including forest bat species such as hoary bat, birds (including a variety of warblers and flycatchers), and small mammals such as Douglas squirrel. Big-leaf maple is an important part of the existing tree species diversity near 14 Lakes. Many of the maples are overtopped, however, and will require increased light to persist over the longer term. Maples are used by a large variety of insects, birds, and mammals, as well as providing a substrate for unique flora. Increasing forest structural complexity through canopy gap, snag and downed wood creation will benefit the entire range of species that utilize late-successional forest habitat conditions (including 10 forest bat species, 6 woodpecker species, 5 owl species, many invertebrate species, and 11 small mammal species).

The forests in the Green Valley were simplified to a Douglas-fir overstory during commercial thinning in the early 1980s. Enhancing species diversity through planting and creating structural complexity through gap, snag, and downed wood creation will help create habitat conditions that can be used by numerous birds, bats, and small carnivores. Snags are generally deficient in this area, and existing snags are heavily used by a variety of woodpeckers (downy, hairy, pileated, northern flicker). Creating additional snags will provide forage (insects) not only for the woodpeckers, but also for a variety of other birds. The canopy gaps should also provide sufficient light to the forest floor for development of a more complex understory community. This should provide forage for species like deer, elk, and cover and forage for many species of birds and small mammals.

4.0 PROJECT DESIGN AND PRESCRIPTIONS

Teams of two ecosystem staff members (wildlife biologists and forest ecologists) established transects throughout the project area, approximately 250 - 300 feet apart (see figures 1 and 2). We established eight transects throughout the 14 Lakes forest. Transect #1 runs along the 10 road from the 10/40 junction to the 10/10.5 junction. Transect #2 runs along the 10.5 road from the 10/10.5 junction for approximately 0.3 mile. The six remaining transects run due east/west, three in the southern portion of the 14L unit and three in the 40N unit. All transects in 14L were completed in fall/winter of 2005. After walking two of the transects in 40N, it was determined that the forest in 40N was sufficiently diverse and this unit was dropped from the project. In the Green Valley forest we established 18 transects, 13 of which were completed in 2005. Remaining transects were completed in the summer of 2006.

One staff person (Sally Nickelson, wildlife biologist) was present on all transects to provide continuity with adjacent habitat. Most transects were run due east/west and were marked frequently with flagging so they can be easily relocated. The goal was to simulate a natural disturbance pattern while maintaining easy to retrace transects for contractors to cut and girdle trees and to plant native species. Stations were established at irregular intervals along each transect. Each station consisted of a variable number of trees marked for either snag creation (girdle) or immediate downed wood (cut) that were at various distances and directions from the transect. Station location was determined by the staff members after evaluating the surrounding forest habitat. We collected species, diameter at breast height, distance along the transect, and distance and direction from the transect for each marked tree. We also made notes whether the gap would be planted and suggested appropriate species for planting. The location and approximate size of all created gaps will be mapped onto a GIS layer, so the pattern can be analyzed and used in future project planning.

In order to complete the project within the approved BPA Habitat Plan budget, the majority of snags will be created by girdling at DBH. This will create a short-lived snag usable for foraging, although some created snags may persist longer and be usable as nesting sites. Numerous snags were created by topping in the adjacent ROW, some larger naturally formed snags exist within the forest, and some of the girdled snags should persist long enough to become nesting sites, so creating snags by topping in this area is not critical. The short-lived snags are expected to fall in random patterns, enhancing the variability and structural complexity in the forest and providing logs that will be used by a variety of wildlife species. If additional funding becomes available, we will create some snags by climbing and girdling the tree just below the lowest live limb. This girdling will likely serve as a breakage point and should provide much longer-lasting snags that potentially could be used for nesting, because the breakage may serve as an entry point for heart-rot fungus.

Because existing tree species diversity and number of snags was already generally good in the 14 Lakes portion of the project area, approximately 75% of the trees were marked to cut. These were identified in locations to help maintain existing species diversity or enhance individual tree growth for desired tree species such as big-leaf maple or cedar. We chose not to girdle these trees to ensure that they would not fall on the desired trees that we want to maintain. We marked approximately 25% of the trees for snag creation to supplement snags in the area.

In the Green Valley portion of the project area there was poor existing species diversity and snags were generally lacking. Consequently many gaps were identified for future planting and over 75% of the trees were marked for snag creation. The 25% of trees marked for cutting were in the few areas that did have existing tree species diversity (e.g., cedar) that we wanted to maintain or enhance their growth.

Approximately 620 trees will be killed over both portions of the project area, either by snag creation or cutting for log creation. This will affect a small proportion of the project area, likely less than five acres scattered in small canopy gaps throughout the area. In the 14 Lakes portion, we hypothesize that the creation of small gaps will be sufficient to maintain existing tree species diversity. In addition, supplementing existing canopy gaps formed by wind disturbances, and existing snag habitat should enhance habitat for numerous wildlife species. In the Green Valley created gaps will be generally larger than those in 14 Lakes, and often will enlarge an existing gap. This is designed to provide sufficient light to support planting a variety of native trees and shrubs, to enhance the species diversity.

5.0 EVALUATION OF POTENTIAL NEGATIVE EFFECTS

We do not anticipate any negative ecological effects from this project. The created canopy gaps will be small and should not facilitate significantly more windthrow than would naturally occur. All downed wood will be left *in situ* to provide forest floor habitat and enhance soil development. The larger diameter downed wood may provide substrate for native Douglas-fir beetles, but we expect that they will add a small number of snags which will benefit forest diversity. It is extremely unlikely this small amount of downed wood will facilitate a major population increase.

To ensure worker safety, we will time the snag creation as close as possible to the planting in the created or natural gaps. Girdling is expected to occur in November-December 2006 and planting completed by early spring, 2007. The girdled trees should retain green leaves and remain stable for six to 12 months, giving a wide safety margin.

6.0 EVALUATION OF COSTS VERSUS BENEFITS

6.1 Options Considered

We evaluated three primary options for the forest habitat enhancement project. The first was a general thinning, which would have involved heavy equipment and yarding logs. The second was a small gap creation/ snag creation/ planting project. The third was a no treatment option. After evaluating existing data, we decided that a general thinning was not ecologically justified because the tree density had already been reduced by an earlier commercial thinning. In addition, this would have been a costly and logistically difficult option and would have resulted in some negative environmental impacts such as soil compaction from the heavy machinery. The data did indicate that a small gap creation/ snag creation/ planting project would significantly enhance the forest habitat because the canopy was generally uniform, snags were not abundant, and tree species diversity was generally low in many areas. This option would be simple and relatively inexpensive to implement, with no adverse environmental impacts, and would significantly improve the habitat over the no treatment option. Consequently, option number two is our preferred option.

6.2 Costs of Preferred Option

Evaluation of the forests and establishing the transects will be completed by Ecosystem staff for a cost of approximately $18,000 and is being funded by the BPA Habitat Plan budget. We expect that it will take two Operations Section staff members approximately 2-3 days to complete the tree felling along the 10 and 10.5 roads in spring of 2006 (~$3,000 allocated in the approved BPA Habitat Plan budget). The remainder of the felling and snag creation will be completed by a combination of Operation section staff and contractors in the fall of 2006. Approximately $18,000 has been allocated for this work in the approved BPA Habitat Plan budget. Planting in the designated canopy gaps will be completed in winter of 2006-07 and will be funded by the HCP Planting budget. A detailed planting budget and schedule will be developed during the summer of 2006.

6.3 Expected Benefits

The expected benefits of this project include greater species diversity, greatly increased snags and logs, and increased forest structural complexity, all of which will significantly improve the habitat for numerous wildlife species (as described in Section 3.0).

7.0 COORDINATION WITH OTHER PROJECTS

This project will complement two riparian habitat restoration projects at 14 Lakes. The first involved felling trees into the ponds to create sites for amphibian egg mass attachment and to serve as migration corridors. The second focuses on removing invasive plant species around the ponds (primarily Eurasian blackberry) and planting native trees and shrubs in the areas where the invasive plants were removed.

This project will also complement the gap creation/planting project in the forest near the ROW south of the Cedar River, as well as the BPA ROW clearing plan in which numerous snags were created, log piles were created, and down wood retained.

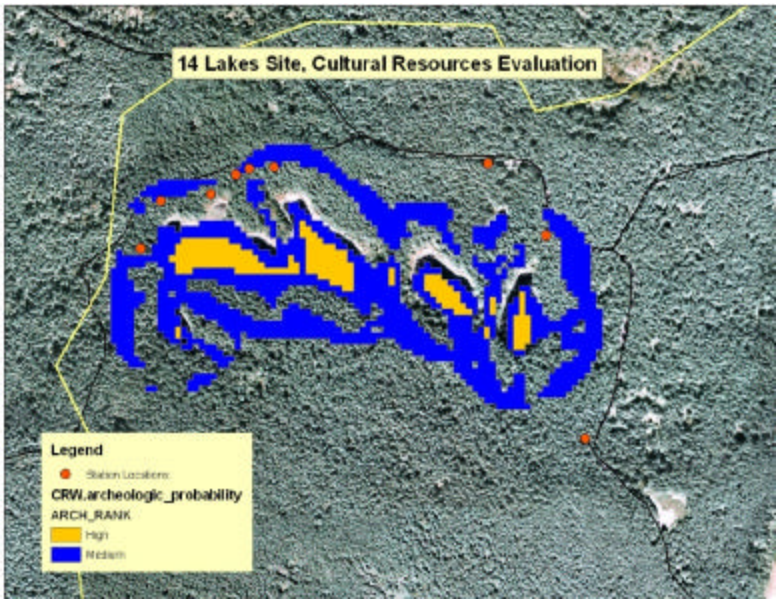
8.0 PERMITTING AND APPROVALS

A forest practice application is not required to implement the spring 2006 cutting along transects 1 and 2 in the 14 Lakes portion of the project area. Washington DNR has provided an informal conference note that documents we have consulted them and they determined a permit is not required. They requested that we consult with them separately for the fall 2006 implementation. At that time they determined that a forest practice application would not be required for the remainder of the project (the southern part of the 14 Lakes area and the entire Green Valley area) because no logs would be yarded.

9.0 CULTURAL RESOURCES EVALUATION

The only areas with moderate or high probability of containing cultural resources are in or adjacent to the 14 Lakes ponds (figure 3). A small number of stations fall within the moderate probability areas, with none in the high probability. The remainder of the project area is considered to be low probability. The Public Programs manager reviewed this plan and concluded the stations along transects 1 and 2 in the 14 Lakes portion would cause no significant impact on cultural resources. Therefore, the spring implementation (see section 10.0) will proceed as planned. He evaluated the remainder of the project in the summer of 2006 prior to fall implementation and concluded that the remainder of the project would cause no significant impact on cultural resources. A Work Planning Checklist was completed for the spring implementation, with a separate checklist prepared for the fall implementation.

Figure 3. All areas considered to be moderate or high probability of the presence of cultural resources.



10.0 IMPLEMENTATION

Spring 2006 - The Watershed Services Division, Operations section will assign two people to cut 57 trees in nine stations along the 10 and 10.5 roads north of the ponds. One staff is an expert tree feller, while the other will be a trainee. All of these stations are designed to increase light for existing big-leaf maple trees and to provide downed wood habitat for amphibians and other wildlife species.

Fall/Winter 2006 –Watershed Services Division, Operations section staff, will cut or girdle all marked trees in the remainder of the project area (the southern part of 14 Lakes south of the ponds and the Green Valley portion of the project area) for all stations that have at least one tree designated to be cut. Girdling technique will be two narrow chainsaw rings that penetrate through the entire cambium and circle the entire circumference of the tree. Stations with trees marked only to girdle will not be treated.

Winter/Spring 2006-07 – Two different contractors will create snags at all stations with trees marked only to girdle, by girdling at DBH or climbing and girdling just below the lowest live limb. Girdling technique will be to remove the bark and cambium in a wide (>12 inch) band around the entire tree circumference using either a chainsaw or ax. Contractors will also plant the identified planting gaps with native tree and shrub species. In addition, as time permits, they will dig out invasive plant species (primarily English holly) found along the transects.

11.0 ADAPTIVE MANAGEMENT AND MONITORING

Monitoring will focus on the following areas:

1. Survival of the existing big-leaf maple trees north of the 14 Lake ponds (in the forest between the 10 and 10.5 roads and the ponds). This will simply consist of an evaluation of the success of thinning around the maples to increase light and therefore longevity of these trees in nine areas along the 10 and 10.5 roads. The maples at the nine stations will be evaluated at years 5 and 10. If the maples do not survive, we will determine at that time whether we will expand the canopy gap and replant the gap to big-leaf maple.

2. Success of various methods of snag creation. This will consist of percent mortality by creation type and contractor. Two basic creation types will be used: 1) two narrow parallel lines through the bark and cambium using a chainsaw; 2) completely removing a wide gap of bark and cambium (12 inches minimum) either at DBH or climbing to the lowest live limb, usually using an ax rather than a chainsaw to remove the bark.

3. Survival of planted stock in selected planting gaps in the Green Valley forest. Monitoring these gaps will include established photo points and a species list and number of surviving plants in the gap. The selected gaps will be monitored at 3 and 6 years after planting. If there is less than 50% survival of the planted stock at 5 years and few native species have seeded into the gap, we may supplement the planting at that time. Route to monitoring gaps will be identified such that staff will not have to walk near girdled trees to reach the selected gap.

4. Monitoring wildlife use of selected created snags. Snags of each creation type will be added to the ongoing snag creation study. Number and location of monitored snags will be determined once the project is complete.

12.0 2007 CANOPY GAP/SNAG CREATION AS-BUILT

Unit 40N was deleted from the project in the summer of 2006 after walking two of the three transects and observing that the current forest was already species diverse and structurally patchy.

All units, transects and stations were mapped using ArcGIS, with information in the associated attribute table for each station, including number of trees by treatment, if planting occurred, whether holly was present, etc. See Figures 1-4 for a summary of all treatments for each unit.

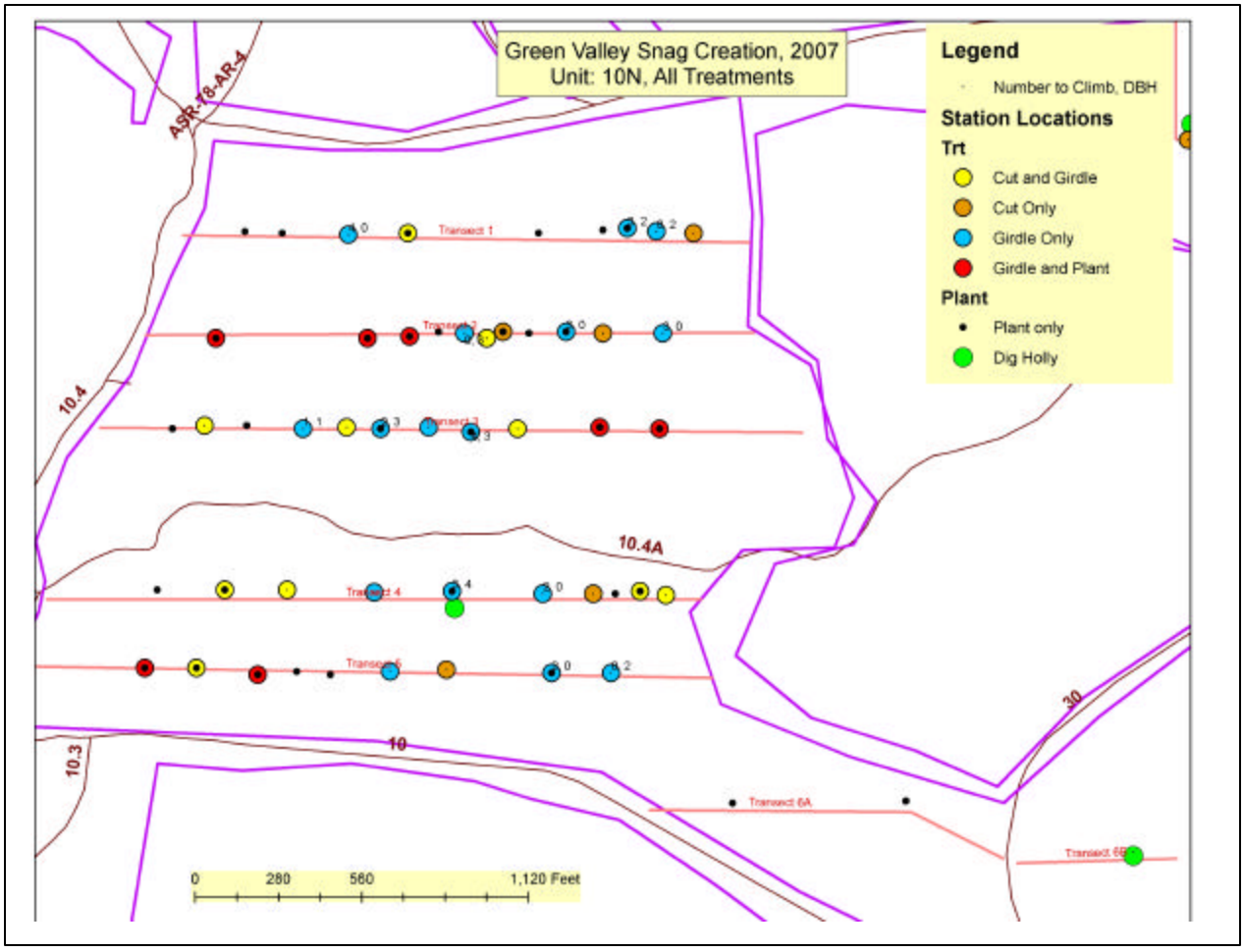


Figure 1. Summary of all treatments in unit 10N

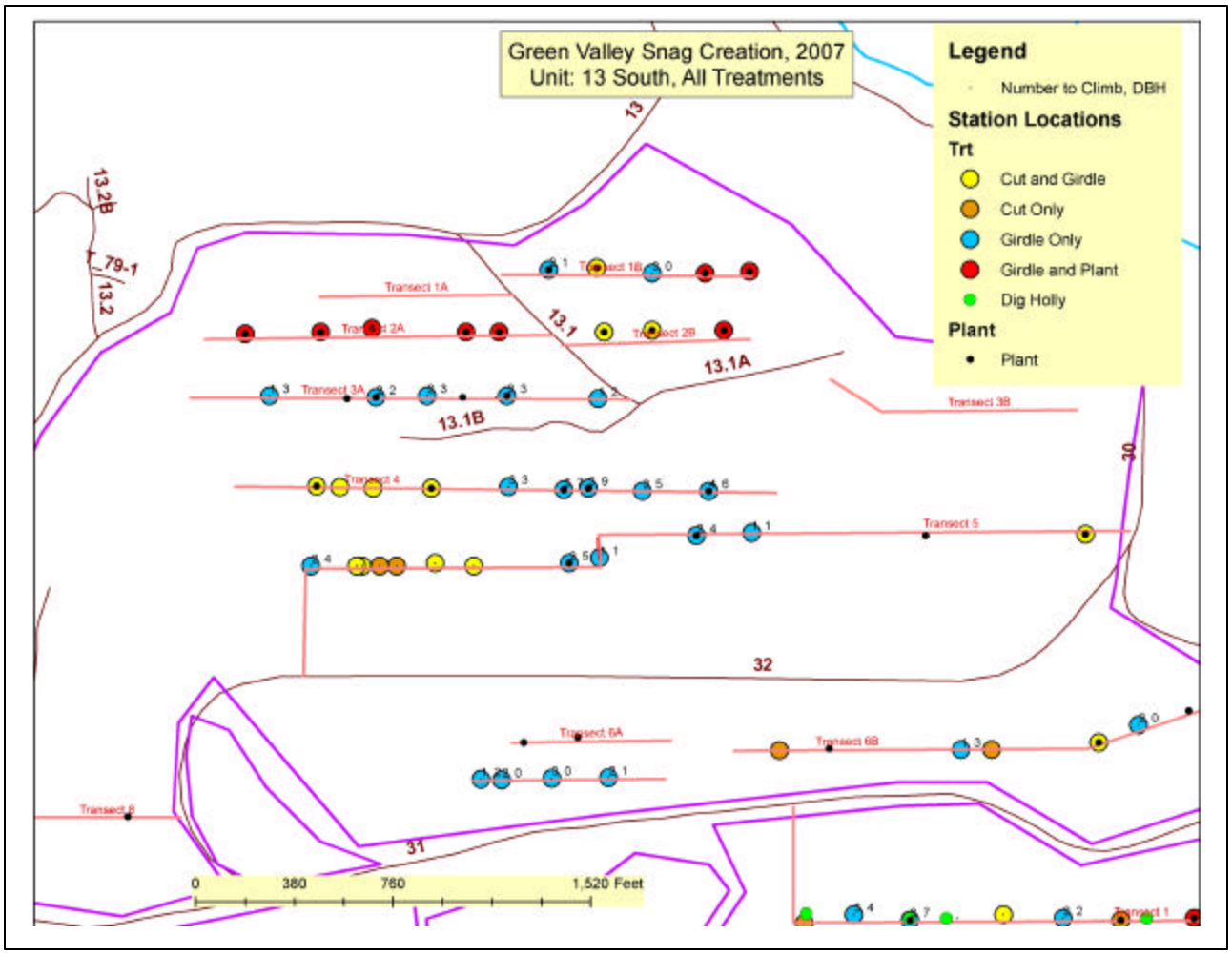


Figure 2. Summary of all treatments in unit 13S

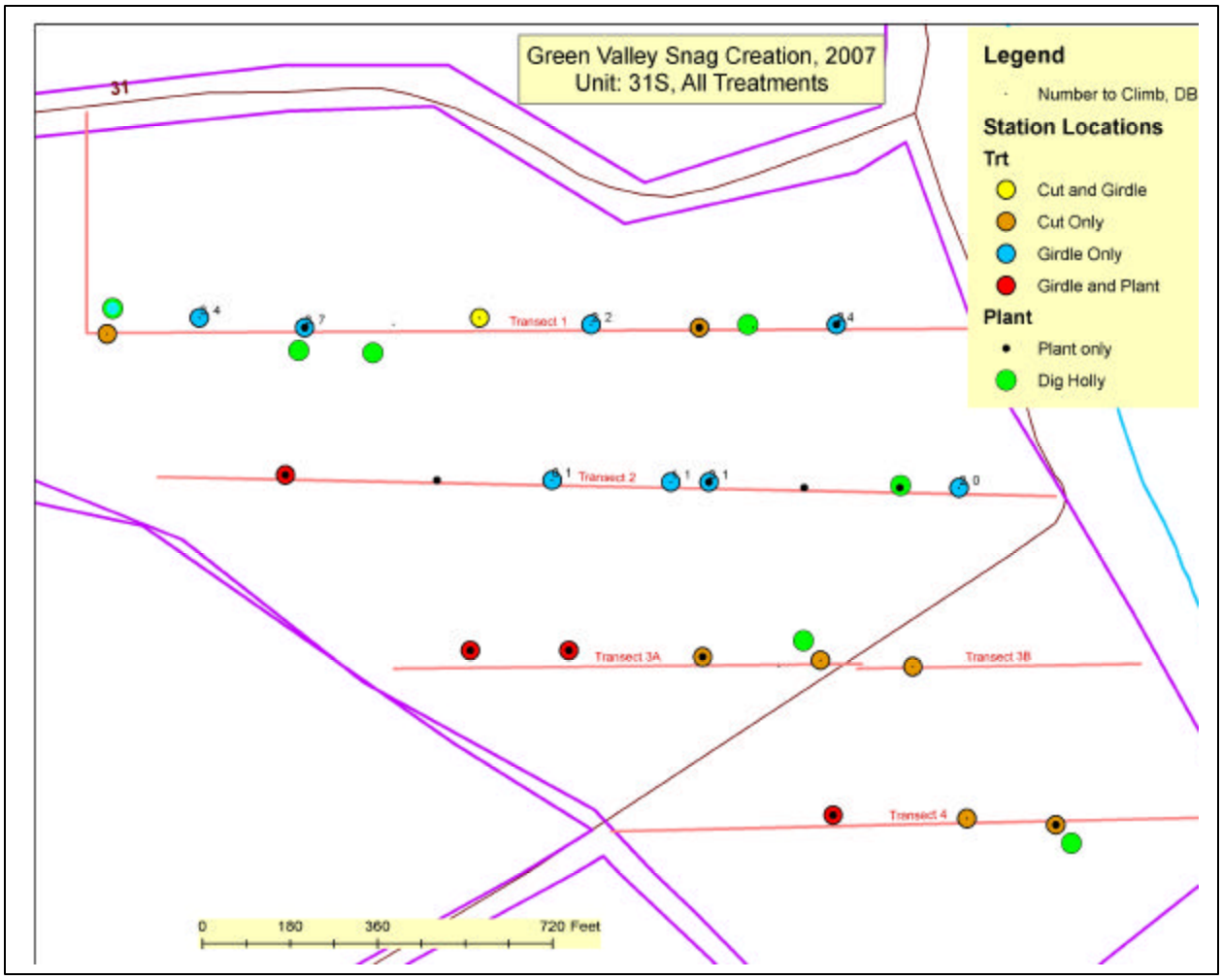


Figure 3. Summary of all treatments in unit 31S.

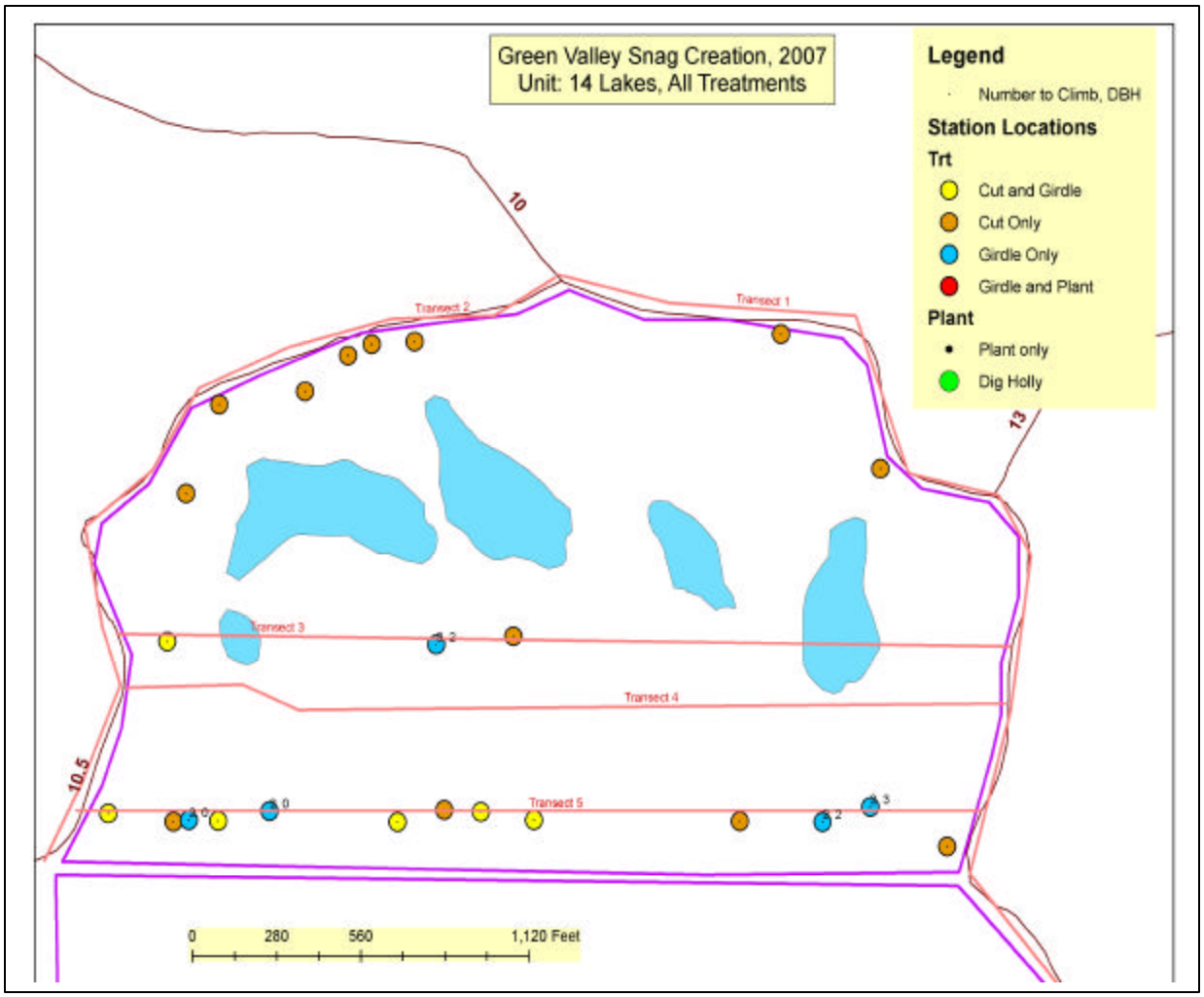


Figure 4. Summary of all treatments in unit 14L.

A total of 224 logs and 393 snags were created (Table 1). Approximately 25% (104) of the snags were created by climbing.

Table 1. Summary of Treatments, Number of Trees by Unit

Treatment	Operator	Date	Unit				
			14L	10N	13S	31S	Total
Cut	SPU	Nov-Dec 2006	86	44	57	37	**224**
Girdle, DBH, Narrow	SPU	Nov-Dec 2006	12	31	40	2	**85**
Climb and Girdle, Wide	A&R Cable	Feb-07	11	32	47	14	**104**
Girdle, DBH, Wide	A&R Cable	Feb-07	7	22	65	16	**110**
Girdle, DBH, Wide	Restoration Logistics	Apr-07	0	39	29	26	**94**
Total # canopy gaps created	All	Nov 06-Apr 09	24	38	54	20	**136**

Actual costs were approximately $5,000 more than anticipated for planning and project layout, which was covered by additional BPA mitigation funds (see Table 2 for a cost breakdown). We decided to include climbing and girdling 104 trees, which added about $6,000 to the costs. This additional expense was covered by the HCP Ecological Thinning budget.

Table 2. Breakdown of all actual project costs[1]

Expense	Task	Cost
SPU Operations Staff	Cut; Girdle DBH, narrow	$10,250
A&R Cable	Climb& girdle; Girdle DBH, wide	$13,905
Restoration Logistics	Girdle DBH, wide; Clear Holly; Planting	$7,682
SPU Ecosystems staff	Transect and Station Layout	$18,350
SPU Ecosystems staff	Planning; Project Management	$19,000
Plants		$1,068
Total		**$70,255**

[1]Note: above costs include the planting costs delineated in the planting as-built, Section 13.

13.0 2007 PLANTING IMPLEMENTATION AS-BUILT

The goal of the planting portion of the project was to increase understory tree and shrub diversity in the created gaps in the Green Valley forest. The 14L units were already sufficiently species diverse, so no planting was conducted in that unit.

Unit Areas
13 South – 219 acres
10 North – 149 acres
31 South – 69 acres

Transect Areas
The area of the three units which were planted exceeds 300 acres. Since plants were targeted in gaps along the transects, we are not considering the entire project area as planted acres. Actual planted gaps totaled approximately 5.5 acres.

Monitoring
In order to monitor the survival and effectiveness of the plantings, pin-flags were placed next to some of the plants in each unit (Table 3).

Table 3. Number of marked plants by transect and station

Transect	Station Number	Number of plants
Unit: 13 S		
2A	3	4
2A	1	24
2B	2	8
4	1	17
4	3	20
Unit: 10 N		
6A	1	24
6A	2	19
3	6	12
3	9	17
1	2	10
Unit: 31 S		
1	1	12
1	2	6
1	5	19
2	2	12
2	5	12

Costs
Costs for the planting portion of the project totaled about $11,000, with the majority for the labor to do the planting (Table 4). Planting was completed in April 2007 using labor from Restoratoin Logistics and bareroot seedlings from Fourth Corner Nursery

Table 4. Costs for Green Valley Project Planting

Expense	Total Cost	Source
Plants	$1,068.01	Fourth Corner Nursery
Labor	$7,681.60	Restoration Logistics
Project Management	$2,330.30	SPU
Total	**$11,079.91**	

Species List

Big leaf maple – 250
Hazelnut – 50
Sitka spruce – 50
Bitter cherry – 50
Red flowering currant – 100
Peaberrry rose – 50
Red elderberry – 50
Snowberry – 50
Western red cedar – 400
Cascara – 100
Total: 1,150

Details

Details about each station along each transect were provided to the contractor. These included the number (if any) of trees to girdle, whether there was any holly to dig, and number of plants to install (Table 5).

Table 5. Planting details for each transect

Unit	Transect	Station	Number to Girdle	Clear Holly	Plant	Planting Gap Area (ft2)	# Plants
31S	1	1	6		Y	2450	12
31S	1	2	0		Y		6
31S	1			Y			
31S	1	5	10	Y	Y	4000	19
31S	1	7		Y			
31S	2	2	4		Y	4500	22
31S	2				Y	4000	19
31S	2	5	5		Y	3500	17
31S	3A			Y			
31S	3A	2	0		Y		12
31S	3A	3	8		Y	4800	23
31S	3A	4	8		Y	4800	23
31S	4	1	6		Y	1400	7
31S	4	3	0	Y	Y		
10N	1	NG	0		Y	6000	29

10N	1	NG	0		Y	7475	36
10N	1	2	4		Y	3500	17
10N	1	NG			Y	8400	40
10N	1	NG			Y	2500	12
10N	1	3	5		Y	1600	8
10N	2	1	2		Y	1600	8
10N	2	2	4		Y	1200	6
10N	2	3	2		Y	4000	19
10N	2	NG			Y	4400	21
10N	2	6	0		Y	6000	29
10N	2	NG			Y	2100	10
10N	2	7	3		Y	4400	21
10N	3	NG			Y	3000	14
10N	3	NG			Y	4800	23
10N	3	4	5		Y	6000	29
10N	3	6	7		Y	2500	12
10N	3	8	10		Y	3500	17
10N	3	9	8		Y	3600	17
10N	4	NG			Y	2000	10
10N	4	1	7		Y	3000	14
10N	4	4	7	Y	Y	6000	29
10N	4	NG			Y	3000	14
10N	4	7	1		Y	1200	6
10N	5	1	5		Y	1600	8
10N	5	2	6		Y	3200	15
10N	5	3	8		Y	6000	29
10N	5	NG	0		Y	2100	10
10N	5	NG	0		Y	6000	29
10N	5	6	2		Y	2450	12
10N	6A	1			Y	5000	24
10N	6A	2			Y	4000	19
10N	6B			Y			
13S	1B	1	3		Y	1200	6
13S	1B	2	2		Y	3200	15
13S	1B	4	3		Y	1200	6
13S	2A	5	4		Y	1600	8
13S	2A	4	5		Y	1600	8
13S	2A	3	2		Y	900	4
13S	2A	2	5		Y	1600	8
13S	2A	1	2		Y	5000	24
13S	2A	NG			Y	5000	24
13S	2B	2	3		Y	3500	17
13S	2B	3	5		Y	1600	8
13S	3A	2	5		Y	1600	8
13S	3A	NG	0		Y	900	4
13S	3A	4	4		Y	1200	6
13S	3A	NG	0		Y	1000	5
13S	4	1	10		Y	3500	17
13S	4	2	7		Y	2500	12

13S	4	3	12		Y	4200	20
13S	4	4	10		Y	3500	17
13S	4	6	3		Y	2500	12
13S	4	7	7		Y	3500	17
13S	4	8	2		Y	2500	12
13S	4	9	5		Y	3000	14
13S	5	1	7		Y	3500	17
13S	5	3	6		Y	2500	12
13S	5	5	7		Y	2500	12
13S	5	NG			Y	3000	14
13S	6A	NG			Y	3000	14
13S	6B	NG			Y	3000	14
13S	6B	4	1		Y	3500	17
13S	6B	NG			Y	3000	14
13S	8	1	0		Y	7000	33

TOTAL						229875	1161

14.0 2009 ADDITIONAL CANOPY GAPS AS-BUILT

In 2009 transect 2 in the 14 Lakes unit was expanded to include creating canopy gaps around additional big-leaf maples. Seven sites with 15 big-leaf maple trees were treated. A total of 49 trees were cut and 25 girdled to create snags (Table 6). Trees were marked by two SPU Ecosystem section staff on 9/17/09 and cut by two SPU Operations staff on 11/19/09. All sites were monitored for compliance and cut to specifications. Survival of the big-leaf maple will be monitored as part of the overall project monitoring.

Table 6. Summary of number of trees cut and girdled

Site	Maple #	# trees to cut	# trees to snag
1	1	4	0
	2	2	4
	3	3	2
	4	0	1
	5	2	0
2	6	2	1
	7	0	4
	8	2	0
	9	3	3
	10	3	3
3	11	3	2
4	12	9	3
5	13	10	
6	14	2	2
7	15	4	
Totals		**49**	**25**

15.0 2010 PLANT SURVIVAL MONITORING AS-BUILT

Of the 1,150 total seedlings that were planted in 2007, 216 plants at 15 stations were marked for monitoring by placing a pinflag adjacent to the seedling. The pinflags were not labeled or color coded by species. In the summer of 2010 a sample of 10 of these 15 stations was monitored for three-year survival. During the monitoring, it was found that some stations had numbers of pin flags that differed from the prescription, although most were installed as prescribed. A total of 88 plants (8% of the total number planted) were found either dead or alive. If prescriptions were accurately followed, there should have been 168 flagged seedlings at the 10 stations sampled, meaning 52% of the flagged seedlings were relocated.

We extrapolated survival by species based on the 8% sampled, assuming that plants were sampled in proportion to the ratios planted. For example, based on an 8% sample of the 400 planted western red cedar, we should have found 31 plants. However, only 17 were found alive, giving an estimated 56% survival rate. Unfortunately, for most other species either none or very few plants were found, making the estimated survival rate highly uncertain (Table 7).

Table 7. Percent survival of planted stock by species.

Species	Percent survival (number found/extrapolated number that should have been found)	Number planted (all stations)	Extrapolated number that should have been found (in flagged stations that were sampled)	Number found alive (in flagged stations that were sampled)
Big leaf maple	16%	250	19	3
Hazelnut	0	50	4	0
Sitka spruce	78%	50	4	3
Bitter cherry	0	50	4	0
Red flowering currant	0	100	8	0
Snowberry	0	50	4	0
Western red cedar	56%	400	31	17
Cascara	0	100	8	0
Red elderberry	100%	50	4	4
Peaberry rose	0	50	4	0

The surviving conifers looked healthy, with only four of the cedars having any browse damage. The shrubs found alive all had moderate to heavy browse present. This was a difficult planting site because of the dense salal. Although the goal was to target planting in areas with sparse understory, in practice many of the plants were installed amongst dense salal, where the competition for light and nutrients made survival difficult.

Lessons learned: We should have labeled or color coded the pinflags by species so that we could have obtained a more accurate estimate of survival by species. Also, we should have conducted more intensive compliance monitoring during implementation to ensure that the prescriptions were accurately followed at all stations and that the most appropriate locations were chosen for planting (i.e., more open areas with less competition from the salal).

16.0 2011 SNAG CREATION MONITORING AS-BUILT

In the fall of 2008 (approximately two years post treatment) 13 stations within unit 31S and 41 stations within unit 13S were monitored for tree mortality. A total of 231 treated trees were monitored, with data recorded by snag treatment type and operator. The narrow chainsaw double ring treatment had by far the best success, with 89% mortality (Table 8). The method of removing a wide strip of bark and cambium had moderate success when the tree was climbed (56%), but poor success when done at DBH (6% and 28%).

In February 2011 (approximately four years post-treatment) the two remaining units were sampled. We sampled 27 stations within unit 10N and 7 stations within unit 14L, with a total of 107 trees sampled. As in 2008, the narrow chainsaw double ring treatment had a high success rate (90% mortality). All three other method/operator combinations had poor success (ranging from 10% to 28%). Virtually all of the trees that had been treated but were still alive had very healthy foliage, with little evidence of yellowing.

Table 8. Amount and percent mortality by treatment type and operator.

Treatment	Number Treated	Number Dead	Percent Mortality
2 years post-treatment (Units 13S & 31S)			
Narrow Chainsaw double ring - SPU Operations	46	41	89
Climb, ax or chainsaw wide girdle - A&R Cable	57	32	56
DBH ax or chainsaw wide girdle - A&R Cable	75	21	28
DBH ax wide girdle - Restoration Logistics	53	3	6
4 years post-treatment (Units 10N & 14L)			
Narrow Chainsaw double ring - SPU Operations	31	28	90
Climb, ax or chainsaw wide girdle - A&R Cable	25	7	28
DBH ax or chainsaw wide girdle - A&R Cable	21	2	10
DBH ax or chainsaw wide girdle - Restoration Logistics	30	4	13

Nine stations that had been monitored in 2008 were re-checked in 2011 to see if any additional mortality had occurred. There was basically no change from the 2008 data, so it appeared that if the tree was going to die as a result of the treatment, it would do so within two years.

We speculate that the reason for the poor success using the wide bark/cambium removal method is that it was difficult to remove all of the cambium. Leaving even a few small channels of intact cambium appeared to be sufficient to provide the tree with needed nutrients. The wide bark removal may provide future access for insects or pathogens that may eventually weaken and kill

the tree. However, based on these data, we recommend that only the narrow chainsaw double ring method be used for future snag creation in the watershed.