The Colville National Forest CFLRP[1] In NE Washington's Forests & Wood Products Economy

Report #3 in a series

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[1] Collaborative Forest Landscape Restoration Project

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Executive Summary

NE Washington is covered with a typical Rocky Mountain coniferous forest managed by a diversity of forest owners. These owners have a wide variety of management objectives so there are both wood commodity and significant non-commodity usages. Most of the ecological forest types generate significant annual volume growth. From a timber sustainability perspective, harvest rates are lower than expected on most ownerships. Private forests appear to be well-stocked while some public forests are over-stocked.

The Colville National Forest CFLRP project area (Vision 2020 lands) is sited mostly in Ferry County. It is serviced by both the Republic and Three Rivers Ranger Districts. Historically, all of its stewardship timber sales have been to Vaagen Brothers Lumber in Colville. Vaagen harvests timber and simultaneously engages in non-harvest restoration objectives. As the Vaagen mill technology has narrow log specifications, they resell some CFLRP logs and biomass to other entities.

From a wood resources standpoint, these forests supply logs to a variety of solid wood processing facilities. CFLRP average harvests account for slightly less than 5% of the regional harvest with most of the cutting occurring in the Ferry County portions.

Primary wood mills are concentrated in Stevens County. Ferry County does have a cedar specialty mill located on its border with Stevens County. Pend Oreille County has a sawmill and a pulp and paper mill, but their log supplies are linked more to local and Idaho forests. Their dependence on the CFLRP timber resource is secondary and distance limited.

The three counties are unique in their economic structures and trade flows. Even so, they all have proportionally strong wood products sectors. The wood sector contribution to the economic base ranges from Pend Oreille County's 22% to Ferry County's 35%. However, Stevens County's wood products sector contributes 26% to an economy 3.6 times larger. A surprise finding is that none of these counties appears to have a secondary wood products sector that would use solid wood and fiber produced within the region.

The wood sector concentration in Stevens County mirrors the concentration of other regional economic sectors within the Kettle Falls--Colville regional trade center (discussed in FEI report #2). This suggests that both log flows and trade hierarchies are spatially relocating the potential economic effects of CFLRP activities and direct expenditures into the Stevens County economy. Tests of this hypothesis will be reported in FEI report #4.

Our Analytical Process

FEI's ultimate objective is to assess the job and income effects of the Colville National Forest CFLRP[3] (Collaborative Forest Landscape Restoration Project) as a basis for further monitoring. Our first step was to collect, correct, and augment regional and county economic data (phase 1). We then used this updated information to generate updated and more accurate sector-by-sector profiles of the potentially affected local county economies (phase 2). These phases are complete and both reports are available.[4]

Phase 3 has three parts: (A) to describe the forestry sector context that the CFLRP operates within; (B) to calculate the direct effects of CFLRP activities within the local wood products sector; and (C) to estimate the indirect and induced effects of CFLRP direct effects to an existing economic structure.

This report addresses the first two parts (A & B) of phase 3. It describes information necessary to understand and quantify both the region's forest resources and the local wood products sector that uses them. From that data set, we then calculate the rates at which various CFLRP activities could generate marginal changes in that sector.

A subsequent fourth report covers part C and describes the results of using our proprietary input-out (I/O) models to estimate total local employment and income effects. During this project we built three tailored models of the affected county economies to track secondary effects throughout the other sectors of those economies.

Our models demonstrate how CFLRP activities produce secondary economic impacts in each county and where they occur. Given knowledge of any specific forest activity or policy change, the same models could be adapted to test the expected economic effects. The relative change of the policy, in this case the existence of a collaborative restoration project, can then be isolated from the background economy.

As the existence of the Colville CFLRP is a forest resources sector based policy effect, we found it necessary to assess many detailed parameters of that entire sector to understand the marginal role of the relevant CFLRP portion.

CFLRP Resources in the Context of NE Washington Forests

A forested region spreads across the northern tier of Eastern Washington, Northern Idaho, and Western Montana. It is often referred to as the "Inland Empire." We analyzed the three northeastern Washington counties that should be most influenced by CFLRP activities. These are Ferry, Pend Oreille, and Stevens Counties. Their combined forested area is 3.22 million acres[5] spread over mostly mountainous terrain with a few agrarian valleys. The forest splits relatively evenly across the three counties with slightly higher concentrations in Ferry Co. (39.6%) and Stevens Co. (36.9%). The Colville National Forest CFLRP is located mostly in the northern part of Ferry Co. with a smaller portion in Stevens Co.

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[3] The Omnibus Public Land Management Act of 2009 authorized CFLRP's across the federal land base to encourage forest health and sustainability leveraging joint private and public involvement and resources. Details of the national program at www.fs.fed.us/restoration/CFLRP

[4] FEI. 9/25/2015. " Northeastern Washington Economic Data Sets: Calibrated Corrected Augmented" and FEI. 10/26/2015. Economic Profiles of Northeast Washington Counties

[5] USDA-Forest Service Forest Inventory & Analysis (FIA). 2014. www.fia.fed.us

Regional forested lands are managed by various private and state entities. There are 3,134.3 thousand acres of managed forests. The timberland component is generally productive with 98% of the acres having high enough growth rates (>20 cu ft/acre/year) to be considered commercially feasible. Growing conditions are productive, but only 9% could be considered highly productive (>120 cu ft/acre/year).[6]

The regional forest ownership distribution is shown in table 3-1. About half (55.3%) of NE Washington forests are privately owned. The commercial structures of private forests vary considerably. There are industrial tracts, large private holdings[7], tribal forests, and small non-industrial private forests (NIPF). The USDA-Forest Service is responsible for managing most of the remaining forest lands (36.2%). Of this, 89.9 thousand acres are reserved.

Table 3-1: NE Washington Forest Area by County & Ownership

In acres from USFS FIA 2014

Ownership (%)	Ferry Co	Pend Oreille Co	Stevens Co	TriCo Σ
USFS (36.2%)	453,358	469,663	210,486	1,133,506
BLM (0.9%)	4769	0	23,740	28,509
WA state (7.4%)	32,693	16,096	182,025	230,814
Local (0.3%)	3,227	6,141	0	9,368
Private (55.2%)	747,025	246,275	738,833	1,732,134
Total (100%)	**1,241,072**	**738,175**	**1,155,084**	**3,134,331**

The ownership profile is an important dimension of forests' potential economic contribution as management objectives can vary significantly between ownerships. Private sector REIT's & TIMO's are entirely timber production oriented. Only 49% of Washington's non-industrial private forest owners hold their forests for timber production.[8] In the public sector, state forests are managed by the Washington Department of Natural Resources (WA DNR). State law requires these forests to efficiently generate income for the state's school endowment funds. Finally, on the dominant federal ownership, commodity timber production has become a smaller consideration of national forest management. Not considered here are three active timber management Native American tribes as their operations are not well identified in secondary data sets. These tribal forests include: the Colville tribal forest in Ferry County, the Spokane tribal forests in Stevens County and a small Kalispel tribal forest in Pend Oreille County.

Primary indicators of forests' financial potential are the timber growing stock inventory and the rate it is harvested, as long as growth rate is not exceeded. Net growing stock is typically measured by the total net volume of harvestable trees in cubic feet per acre. Table 3-2 shows extreme concentrations of growing stock ownership. The NE Washington forest inventory is evenly split between USFS (47.3%) and private ownership (44.2%), with other owner classes being marginal.

[6] USDA-Forest Service FIA opus cit

[7] These consist of industrial forests, real estate investment trusts (REIT's) and Timber Investment Management Organizations (TIMO's)

[8] USDA-Forest Service. 2006. National Woodland Owner Survey. www.fia.fs.fed.us/nwos/

Table 3-2: NE Washington Forest Growing Stock by County & Ownership
In millions of cubic feet from USFS FIA 2011

County (%)	USFS	Other Fed	State & Lcl	Private	Total
Ferry (38.3%)	1,147.0	9.8	50.5	1,493.3	2,700.7
Pend Oreille (30.0%)	1,602.6	4.1	76.2	432.4	2,115.2
Stevens (31.7%)	582.0	86.1	374.2	1,186.2	2,228.5
TriCo Σ (100.0%)	**3,331.6**	**100.0**	**500.9**	**3,111.9**	**7,044.4**

Most of the USFS growing stock is in Ferry Co. (34.4%) where the Colville CFLRP is located, and in Pend Oreille Co. (48.1%). Private growing stock is split between Ferry Co. (48.0%) and Stevens Co. (38.1%). The average growing stock density is quite high on federal lands, where the density is 2,939 cubic feet per acre (16.2 MBF/acre[9]). We do not have CFLRP specific density data. In these forest types, this density is high and suggests that the age class distribution must be weighted by older age classes. Private forest growing stock density is considerably lower at 1,797 cu. ft/acre (9.9 MBF/ac) which suggests a younger definition of stand maturity and a more uniform distribution of age classes.

Considering only the physical location of these forests and their timber inventory can be misleading. Our analyses demonstrate that the location of economic effects derived from their use is driven by many other factors.

A Spatially Concentrated Wood Processing Sector

Local milling capacity experienced two sharp contractions over the last 4 decades. An extreme federal timber supply reduction in the late 1980's caused a log supply constraint that almost tripled input log prices. Then a housing market collapse between 2005 and 2009 created a wood output product price depression. These two combined economic forces led to numerous wood mill closures across the three counties. There are only a few surviving mills that process NE Washington timber and their production capacity is spatially concentrated

Most of the solid wood mills are located within the NE Washington timbershed, but the wood fiber mills tend to lie on the economy's periphery or are sited well outside of it. The 2012 Washington mill survey[10] reported that there were 5 sawmills within the Inland Empire. Most of these are concentrated in Stevens Co. There is one large mill (>250 MBF/shift), two medium mills (120-250 MBF/shift) and two smaller mills. Together, they consume 194.8 MMBF-LS[11] of logs annually and produce 288.3 MMBF-LT of lumber[12] along with chips and other residues. The lumber sells into a regional/ national market. The residues are mostly consumed locally.

[9] Eastside scale conversion from Oester, Paul and Steve Bowers. 2009. Measuring timber products from your woodland. Woodland Workbook EC1127. Oregon State University extension.
[10] Washington Dept. of Natural Resources. 2014. Washington Mill Survey 2012
[11] MMBF is millions of board feet of wood. MMBF-LS is Scribner log scale, but MMBF-LT is a different measure of lumber talley.
[12] Based on a surveyed 148% average overrun factor

Modern high speed mills use a technology designed around uniform smaller logs. Of the total log volume consumed, 94.3% is smaller than 20" diameter, and 45.6% are smaller than 10" diameter. This has significant implications for regional silviculture. Private forests have to grow smaller trees on a shorter rotation to meet these specifications. The size class distribution of standing timber on public forests is already skewed toward larger trees, many of which have become locally unusable. In public forest restoration such as on the CFLRP, however, usually only smaller trees are removed in thinnings, while trees with diameters >20" are frequently retained.

The logs species mix of logs utilized reflects what is locally available. Stud and construction lumber mills tend to use the 46.9% of logs that are Douglas-fir, western larch, and true firs. There are specialty pine mills that concentrate on the 44.6% of logs that are mostly ponderosa pine and a small amount of lodgepole pine. The Columbia Cedar specialty mill uses 11.8 MMBF of western red cedar from the vicinity and imports the balance of their cedar logs from northern Idaho. All the CFLRP harvests have historically been bought by Vaagen Brothers Lumber in Colville. Even though an estimated 22% logs are resold, these sales are mostly to mills located within Stevens Co.[13]

The most important mill residues are 119.3 MBDT[14] of chips to pulp mills, 55.7 MBDT of chips and shavings sent to board mills, and 103.1 MBT of fuel wood and bark. There is no mention of the large Boise-Cascade veneer/plywood operation in Kettle Falls. This is an active mill and a primary destination for larger diameter logs (5.7% of harvest) that could be peeled.

Three pulp and paper mills also use NE Washington fiber. Considering Colville as the regional economic node for residual chip supplies, all three are located at some distance. The semi-chemical pulp mill is 65 miles away at Usk, WA, a ground wood mill is at Spokane, WA, 71 miles off, and a sulfate mill at Walula, WA, is 220 miles distant. Distance is economically important because of high hauling costs for a bulky, low-valued raw material.

While pulp mills use 878.6 MBDT of furnish annually, only 43.3 % is from sawmill residues. The rest is chipped round wood from two chipping mills within the timbershed and recycled fiber. Only 46.6 % of the wood furnish comes from Washington. Another 34.1% comes from Oregon (sent mostly to the Walula mill). The remaining 19.4% is from Idaho, Montana, and British Columbian chips that are routed to the other two mills.

Low grade mill residue (27,768 BDT/year) is used to fire lumber drying kilns. Much of the remainder including 74,382 BDT of bark is sent to the biomass energy plant in Kettle Falls run by Avista. As it uses up to 70 BDT per hour, local biomass supplies are insufficient. Avista reports that about 15 thousand truckloads (about 200,000 GT) are consumed annually, so over half has to be imported from Canada.[15]

Timber Harvests and Log Supplies

The three-county timbershed has generated logs from most ownerships as shown in table 3-3. The most logs (69.4%) come from private lands. Of this 37.9% comes from industrial forests, 31.1% from the REIT/TIMO's, and 31.0% from the NIPF. There is a spatial disconnect between the forest acreages and

[13] Colville National Forest. 2013 CFLRP annual report
[14] MBDT is thousands of bone dry tons of wood fiber
[15] Avista management personal communication 8/17/2015

inventories that are concentrated in Ferry and Pend Oreille Counties and the locus of harvest volumes that are concentrated in Stevens County.

Only in Ferry Co., where most of the CFLRP stewardship projects are located, is the Colville national forest harvest share significant (38.6%). We estimate that over time, 71% of this is from Ferry County portions of the CFLRP. Pend Oreille and Stevens Co. harvests are dominated by private timber suppliers. It appears that without the CFLRP activities, which average 12 MMBF/year over time, National Forest timber harvests would be scant.

Table 3-3: NE Washington 2013 Timber Harvest by County

In MBF-LS/year by WA DNR

County (%)	USFS	Other Federal	State & Local	Private	Total
Ferry (17.4%)	16,238	23	5,048	20,767	42,076
Pend Oreille (28.2%)	6,488	566	22,833	38,209	68,096
Stevens (54.4%)	3,780	2,445	16,683	108,801	131,709
TriCo Σ (100.0)	**26,506**	**3,034**	**44,564**	**167,777**	**241,881**

As shown in table 3-4, there was a slight increase in the 3-county harvests in 2014. The biggest increases were found in the federal and private forest ownerships. However, the Ferry Co. portion actually declined.

Table 3-4: NE Washington 2014 Timber Harvest by County

In MBF-LS by WA DOR

County (%)	USFS	Other Federal	State & Local	Private	Total
Ferry (12.8%)	9,888	0	2,251	20,943	33,082
Pend Oreille (27.4%)	19,858	1,560	6,501	43,013	70,932
Stevens (59.8%)	5,270	1,843	32,941	114,889	154,943
TriCo Σ (100.0%)	**35,016**	**3,403**	**41,693**	**178,845**	**258,957**

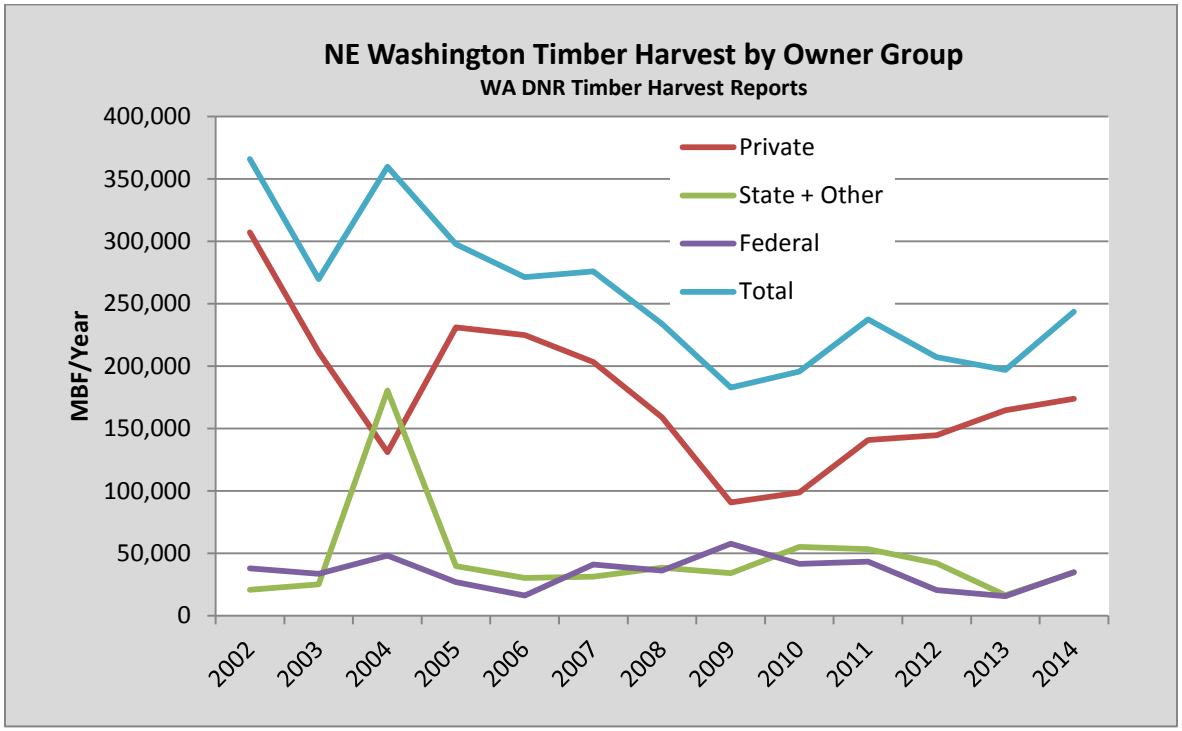
Neither table 3 nor table 4 summaries explicitly identify the significant Colville Tribal timber harvests. Two of the tribal sources[16] report that their average annual harvest sums to 55 MMBF. Of this 37% flows north and easterly into this timbershed. The rest is large Douglas-fir destined westward for the tribal veneer mill in Omak (Okanogan County).

The timbershed harvest pattern has not been stable over the longer run (see figure 3-1) due to the dynamics of wood products markets and changes in public harvest policies. The total harvest has seen a steady decline since 2002. There had been a major USFS harvest reduction in the late 20th century, but by 2002, that source had settled down to a relatively stable 30 MMBF-LS/year. The most dynamic changes are in the private sector (including large REIT/TIMO's). There was a marked positive response to high log prices during the housing boom (2005-2006) and a negative response to low log prices during the bust

[16] Colville and Kalispell Tribes

(2008-2010) with increases ever since. The most price responsive subsector was the NIPF component. The total harvest has oscillated between 200 to 250 MMBF/year ever since. Due to harvest variability years we have chosen to average 2013 and 2014 as a reference base for this analysis. It coincides with a CFLRP average expenditure pattern that stabilizes wide swings in spending.

Figure 3-1: NE Washington 3- County Timber Harvest 2002-2013
WA DNR Timber Harvest Reports



Colville CFLRP Harvest Contributions

From 2006 through 2015, there have been 9 stewardship contracts associated with the Colville NF CFLRP.[17] All of these sold to Vaagen Brothers Lumber in Colville. Although actual harvests have been concentrated into two years, we chose to stabilize the irregular sales volumes by spreading potential harvests smoothly over ten cutting years as we are attempting to define a stable reference base. This brings the average annual harvest into the vicinity of 11 to 12 MMBF/year. This amounts to 31% of federal harvests and 4% of total regional harvests. Of the total CFLRP volume, 87% was saw timber. However, as the Vaagen mill has narrow log specifications, we can expect that some of the sawtimber and all of the non-saw logs were actually resold to other local mills.[18] Except for pulp logs to Usk, rehauling costs makes other Stevens County mills the dominant destinations.

[17] Colville National Forest data compiled supplied by Chelsea McIver, University of Montana Bureau of Business and Economic Analysis (MBBER) personal communication.
[18] The FEI analysis uses percentage redistributions from the 2013 CFLRP annual report

Spatially, the CFLRP harvests were distributed 70% in Ferry County and 30% in Stevens County. This returns the county portion of timber sales funds mostly to Ferry County. There are no 25% fund distributions from stewardship sales, but there are other local effects. However, harvest locus does not control the final spatial distribution of effects. County distribution of direct salaries and indirect/induced jobs and income depends more on where workers reside rather than where they work. A good example is the other contracted stewardship services on these sales. They are provided by specialized contractors mostly from elsewhere. Less than 1% of spending is linked to Ferry County, 7% to Pend Oreille County, 24% to Stevens County, and 68% is out of region.[19] Likewise, secondary effects from manufacture accrue more where logs are processed than where they are harvested.

We had to resolve three analytical considerations before using the CFLRP harvest and other activities in the I/O models. First, as the Colville National Forest annual harvests in Ferry County are dominated by CFLRP sources, we have assumed that these volumes augmented total federal harvests there rather than shifted them from other sites. Second, non-harvest stewardship activities were justified by inclusion in the collaborative, and would not have otherwise occurred. Third, the CFLRP annual harvest is small relative to total regional harvest, so that we can also assume that they did not significantly displace harvests from other ownerships. In sum, the entire CFLRP volume is modeled as a supplemental effect within the regional wood products economy, instead of a substitution.

Timber Harvest and Tax Values

Most I-O models ignore the returns to forest proprietors, but stumpage receipts constitute a substantial income flow into this timbershed so we build them into our calculations. Calculated average stumpage values range[20] from a high of $679/MBF for scarce western red cedar while common construction species (Douglas-fir, hemlock and pines) have a tighter spread from $214 to $247/MBF. Note that federal sales revenue (a public proprietors' income) is returned to the treasury and State DNR revenue is returned to the School Endowment Fund.

This constitutes a visible local government fiscal component. We calculate these values from early 2015 area-wide estimated private stumpage values[21] applied to known 2014 harvest volumes. Table 3-5 shows that private forest gross income is significant, particularly in Stevens County. As 80% of the Washington timber excise tax is earmarked for local distribution, the direct stumpage contribution to county government is notable.

Table 3-5: NE Washington 2014 Private Gross & Net Stumpage Returns by County
Calculated from WA DOR values and volume estimates

County	Gross Taxable	Total Tax	County Amt	Net Stumpage
Ferry	$5,081,683	$254,084	$203,267	$4,827,599
Pend Oreille	$10,650,379	$532,519	$426,015	$10,117,860
Stevens	$28,605,992	$1,430,300	$1,144,240	$27,175,692
Tri County Σ	**$44,338,054**	**$2,216,903**	**$1,773,522**	**$42,121,151**

[19] Chelsea McIver MBBER ibid
[20] WA DOR Stumpage values for eastern Washington. June 2015
[21] WA DOR.2015 ibid.

Different private ownerships will have different local economic influences. The NIPF harvest receipts (46.5 %) should largely circulate through local economic sectors. Industrial harvest revenues (35.5%) may have more leakage depending on the industrial home office location. Large non-industrial ownerships (25.5%) are nationally held shares in REIT's and TIMO's. Once local management costs are subtracted, net receipts are almost entirely distributed outside of local economies.

The stumpage values of CFLRP timber are substantially lower. Across all sales, they range from $9 to $145/MBF and the 10-year average is $63/MBF. The accumulated sales value is $8.2 million over the decade. This is not surprising considering that all of the CFLRP contracts are actually stewardship sales where bidders compete on their ability to cost-effectively accomplish additional forest restoration goals that offset the net value of harvestable timber. There are no 25% fund returns to the counties for this sales type.

Washington State is unusual in that the 5% state timber severance tax is paid by harvesters, even on logs they cut from federal lands. That means that CFLRP operations have state harvest tax direct effects. Through 2015 about 70% of the CFLRP timber harvests occurred in Ferry Co. So CFLRP harvests account for just over 40% of the total taxable Ferry Co. timber harvest. That equates to an annual net timber tax income of $82 thousand. The Stevens Co. harvest tax income from CFLRP harvests are more modest at around $37 thousand per year. None of the Pend Oreille Co. harvest tax receipts are CFLRP related. These types of revenues are often omitted in I/O modeling, but are included in ours.

Sustainability of Regional Timber Supplies

In forestry decisions, sustainability is always a high priority criterion. There are many forms of sustainability, but our analysis addresses only one. From a commodity timber production stand point, the NE Washington forest resource appears to be under-utilized. Under-utilization can lead to stagnation, larger fires and forest health problems. Whether this is due to recent subpar log markets or an increasing predominance of non-timber objectives, a non-timber reorientation of many of these forests is clear in the summary statistics.

Although timber commodity orientation is actually subjective, calculating a forest's rate of inventory turn-over (ROIT) can be illustrative. An investment in natural capital, such as forested lands and timber growing stock, should generate a physical annual yield of fiber about equal to the long-run real returns (ROI) on investments from other capital assets. Viability should range between 2.5% and 3.5%. To check sustainability the ROIT should be at or below net annual growth. Table 3-6 shows exceptionally low ROIT's for all ownership classes except Washington DNR. Typical timber growth rates in these forest types are significantly higher. Data was unavailable for estimating this criterion on tribal forests.

Table 3-6: ROIT by Timber Ownership by County

Calculated from FIA inventory and WA DNR harvest data

County	USFS	Other Fed	State & Lcl	Private	Total
Ferry	0.26%	0.04%	1.82%	0.25%	0.28%
Pend Oreille	0.07%	2.51%	5.45%	1.61%	0.59%
Stevens	0.12%	0.52%	0.81%	1.67%	1.07%
TriCo Σ	**0.14%**	**0.55%**	**1.62%**	**0.98%**	**0.62%**

The extremely low ROIT on NE Washington federal lands is similar to national forests elsewhere. Those forests share in a national 3-decade policy shift away from commodity timber management. CFLRP restoration activities should somewhat offset an otherwise likely decline in forest condition. Only the Washington DNR seems to be managing their land base with implied timber efficiency. The real surprise is in the local private sector forests where ROIT yields are moderate at best when compared to other timber oriented regions. There must be a large portion of regional NIPF lands where non-timber ownership objectives predominate. Along the Pacific coast, retirement and lifestyle migration has had similar effects on redirecting forest objectives. We had found even lower NIPF ROIT's in California, that are explained by a combination of non-timber objectives, coupled with extremely costly private timber management regulation.

Timber efficiency is only one timbershed performance criterion. As a sustainability cross-check, we looked for growing stock mortality data to compare with growth statistics, but FIA[22] reports no mortality data for this region. An alternative check is a comparison of annual growth to harvest in recruitment-to-depletion ratios. In this criterion, a number greater than one indicates growing stock build-up while indices less than one suggest depletion. Again FIA data is insufficient for this check. Another approach is to examine land productivity. Using the mid-point productivity of each timberland site class across the entire timbershed we calculated potential annual growth as 1,321.8 MMBF/year. Comparing this to the annual harvest of 241.9 MMBF/year we find a gross inventory accumulation rate of 5.5. This indicates that growing stock should either accumulating at a rapid rate or is being heavily offset by other forces such as disease and fire.

Spatial Distribution of Raw Material Flows

Within the timbershed, logs are mobile. As such, the economic effects of wood production and processing can be spatially complicated. The logging and trucking sectors are as mobile as the logs and therefore critical to track. Economic activity occurs where the trees are cut (place of work), but the dominant job and income effects are most visible where workers live (place of residence) and at the place of business of logging and trucking companies. Production jobs and income can be more stable spatially except where significant commuting patterns are found.

This is not a closed timbershed in that logs and other fiber often cross the county political boundaries. Of particular importance are the forests of the Colville Tribe. Their large forest acreage is split between Ferry County and Okanogan County, but tribal timber enterprises are focused more westerly where they own a mill. Forests of northern Idaho also represent a resource base for mills within these three Washington counties. There are smaller volumes moving both ways into and out of Canada.

To recognize this spatial component, we constructed a log flow matrix that roughly identifies the annual spatial movement of raw materials from harvest to point of utilization. Fiber has a corollary pattern of movement. We surveyed each mill to identify annual log consumption[23] by species and type of log. That was matched to known county harvests of log volume by species and type. Depending on the technology

[22] FIA is the USDA-Forest Service--Forest Inventory and Analysis group
[23] Mill log consumption is considered proprietary data. This precludes our release of mill-specific details of the log flow model.

of each mill and the species utilized we calculated a spatial materials balance model to account for the source to use patterns.

Generalized results are no surprise. While we saw earlier that harvests are spatially dispersed, processing occurs primarily in Stevens County with some consumption, particularly of residuals, in Pend Oreille County. A spatial anomaly exists with one firm, Columbia Cedar. Their physical location is in Ferry County, but their logs are largely imported and their functional economic location is within the Kettle Falls-Colville economic core. As a result, most CFLRP logs would primarily generate Stevens Co. spatial effects. In other sectors there are non-Stevens county effects, such as in Ferry Co. federal forestry employment, some logging and trucking there, and residuals usages into Pend Oreille Co. These are discussed in a later section.

We also had to consider spatial distribution of final products. We found that rail dominates the final distribution of lumber and plywood to mostly out-of-region sales. The local consumption of wood is such a small proportion that most of the product is presumed to leave the timbershed boundaries except for cross-hauling hog fuel and residuals, and some product trucking to Spokane.

Calculating Direct Job Effects

I/O models are wonderfully flexible. Once the linkages are established, by knowing job changes income and expenditures can be deduced and vice versa. We came at direct effects input estimation using multiple approaches. First, we tried using reported job and income numbers, but as we have often found before, these are often misleading numbers that poorly represent wood products sectors. Second, we used an engineering approach that calculates an aggregation of the average labor requirements by task categories and applying known average incomes by category to derive labor income by subsector. Finally, for activities within the CFLRP, we used annual 20-20 Vision reports combined with contractor analyses by University of Montana, to spatially allocate average annual CFLRP expenditures.

Forest and Logging Jobs Calculations

Forestry services job number adjustments came from our survey of primary contractors and key industry informants. Logging jobs are typically under reported and we reality checked these numbers several ways. Published labor statistics are based on covered employment numbers by NAICS code. Logging is characterized by self-insured proprietors who are not included. We have found this sector to be as much as 80% unreported.[24] In this study, we came at estimating loggers from two directions. First, we have surveyed proprietors and estimated the average number of loggers attached permanently or temporarily to each. Second we estimate the total number of loggers required to harvest a known annual volume using production coefficients. We eventually relied on this latter technique, but it required the use of numerous assumptions.

[24] FEI and Mason Bruce and Girrard Inc. 20006. Western Oregon Plan Revision for the O&C Lands. Chapter 4, section 2 socioeconomic analysis. Contracted by the Bureau of Land Management.

Studies estimating the average number of loggers per MMBF harvested have varied between. 1.45/MMBF[25] and 3.013. The range between these numbers is too wide to rely on for local economic effects estimation. The low one is based on census numbers which often have large errors of omission and typically include log trucking within the NAICS code. The second is based on a west-wide survey of loggers and also appears to include log trucking.

We instead relied on actual Inland Empire logger contracting experience.[26] Modern logging is efficient, particularly with capital intensive technology such as feller-bunchers. As a result, we found two divergent rates depending on the capital intensity of the project. We extrapolated from a monthly expected production rate to a typical 8-month logging year. This generated estimates of 0.56 for capital intensive operations (feller-buncher, forwarder, loader), and 2.34 jobs/MMBF for labor intensive harvests (feller, skidder, limber, loader). Neither of these estimates includes log trucking jobs.

We applied each estimate based on probable specified technology by ownership. Federal, other public and NIPF forests currently have complex silvicultural prescriptions requiring labor intensive harvest treatments. Examples include national forest restoration or NIPF forest health and aesthetics. Industrial, large REIT/TIMO, and WA DNR tend to be more timber production oriented and are well suited to use mechanical harvesting. This results in an Inland Empire weighted average of 1.79 jobs/MMBF.

The census spatial distribution of loggers was reasonably consistent with our survey results even though the job numbers varied significantly. Table 3-7 shows how we used the spatial distribution of reported census numbers to apportion the FEI implied logging demand estimates. FEI numbers are 72% higher (or Census numbers miss 42%). This is consistent with the degree of under-reporting that we have encountered in several western timbersheds.

Table 3-7: Regional Logger Estimates by Source and County

County	Census Reported	%	FEI Calculated
Ferry	23.0	11.8%	39.6
Pend Oreille	58.0	29.7%	99.9
Stevens	114.0	58.5%	196.4
TriCo Σ	**195.0**	**100.0%**	**335.9**

Log Trucking Jobs Calculations

Normally log trucking is included as generic trucking in the transportation sector. To create direct job and income effects of harvesting, we have to isolate estimate for log and wood residuals trucking alone. We used two approaches to make and cross-check an estimate. The two techniques were: (1) inspection of Washington State truck license and CDL lists; and (2) estimating the necessary truck capacity demand for

[25] Mason, Larry and Bruce Lippke. 2007. Jobs, Revenues, and Taxes from Timber Harvest: an examination of the forest industry contribution to the Washington state economy. U. of Washington Rural Technology Initiative, Seattle

[26] Bassler, Greg. 2015. Production of loggers contracted by NW Management. Moscow, Idaho. Personal communication

this system using known volumes hauled, approximate daily turns, and the technical specifications of typical log trucks.

The typical eastside log truck is a 5-axle long logger (tractor + single tongue trailer). These are limited to 80,000 GVT. The surveyed average net weight in Washington is 54,039 pounds.[27] Adding an extra "pup" trailer can increase a load weight to 70,729 pounds. We define the long logger as a standard "load" and find the load capacity using average local species log weight of 6,300 pounds/MBF.[28] So a truck load typically holds 8.6 MBF based on weight alone. This can vary considerably by diameter of logs hauled. The small diameter logs that dominated this timbershed harvest take more physical space and a height limited load may have hundreds of logs but only 5 MBF (31,500 pounds). The log flow and cross-haul volume estimates from the wood spatial distribution model were converted to annual truck demand. Annual truck demand was converted to annualized driver demand. The spatial distribution shown in table 3-8 is based on the proportions in CDL lists.

Table 3-8: Log and Biomass Trucking Job Estimates

County	Logging Trucks	Other Trucks	Trucking Total
Ferry	8	0	8
Pend Oreille	20	0	20
Stevens	39	18	57
TriCo Σ	**67**	**18**	**85**

Mill Employment Jobs

These job numbers are not based on estimates, but on actual survey responses from each of the regional wood products manufacturing firms. All participated to some degree. The survey aggregate numbers for this wood sector were reported in our report #2. We offer no detailed report of individual firm numbers. Several respondents considered this data as confidential and permitted our use of such data to build the I/O models as long as specific job and income data could not be traced back to individual firms.

Product Trucking Jobs Calculations

Where logs move by truck, we found that final products shipments are split between truck and rail. Sales to locals and to the Inland Empire region would be trucked, where sales to other destinations would be by rail. There is good railway route coverage in both main valleys. Stevens County is served by BNSF through Spokane with links north on the Kettle Falls Railway. Pend Oreille County is served by the Pend Oreille Valley Railroad that links to the BNSF in Sandpoint. Specific wood products truck and rail trucking is already a part of existing transportation sector capacity shown in our report #2.

[27] Mason, Larry. Kenneth Cassavant, Bruce Lippke, Diem Nyugen, & Eric Jessup. August 2008. The Washington Log Trucking Industry: Costs and Safety Analysis. U of Washington. Rural Technology Initiative. Seattle in cooperation with Washington State University.Transportation Research Group. Pullman

[28] Wenger, Karl (ed). 1984. Forestry Handbook 2nd ed. Table 17 p 275. For Society of American Foresters by John Wiley & Sopns. New York.

Isolating the CFLRP's Economic Contributions

An I/O model uses coefficients that link transactions between sectors. The FEI models of the three county economies identify an average base year status quo job and income pattern. By introducing a direct CFLRP expenditures change into directly affected sectors, the model generates a new indirect and induced job and income pattern across all the sectors of a spatially defined economy. The difference between the base results and new results can be attributed to the CFLRP forest restoration activities.

Expenditures Based Direct CFLRP Effects

The Colville CFLRP is one federal agency's involvement within the Northwest Forestry Coalition's 20-20 Forest Vision initiative.[29] Forest restoration activities on Colville National Forest administered lands are primarily concentrated within in the CFLRP boundaries under a memorandum of understanding with the NW Forestry Coalition. Actual forest stewardship[30] contracts there began in 2006. To date nine contracts have been let to Vaagen Lumber Company that range from specific task orders, to fuel reduction, to full stewardship contracts.

We consider that this proportion of federal harvest would not have otherwise occurred without the existence of this program and expenditures justified by it. CFLRP expenditures include funds from a number of different sources. Again, we used 2013-2014 averages as a base reference year. For the average base year there were $5.4 million of total expenses. Expense categories are generally estimated and reported by category in annual CFLRP reports, but we use some different definitions of applicable expense.

The Colville National Forest makes explicit expenditures in several forms. Individual performance contracts for specific restoration activities have been analyzed elsewhere in great detail;[31] There are other federal expenditures for agency labor, equipment and administration. The annual average that we used for these two categories was $3.0 million. The 20-20 reports identify an additional expenditure category of project spending by non-federal cooperators. In examining the types reported, and the locus of the primary activities, we assumed that most of these other activities could have occurred elsewhere within the region and being parts of existing budgets would already be incorporated in the inter-sectoral transactions matrix.

Other CFLRP- related expenditures are private payments to loggers and equipment that are harvesting timber under CFRLP auspices (this is not included in 20-20 reports). There are also in-kind credits to stewardship contractors (Vaagen Lumber Co.) for non-commercial activities. These are not direct transactions but are considered expenditures as credits functionally reduce the price eventually paid for logs. Based on regional logging costs, we estimated the contractor's approximate average annual logging

[29] Details on the NW Forestry Coalition and the 20-20 initiative at www.nwforestrcoalition.org

[30] Forest stewardship is a generally defined as improving forest health, sustainability, and environmental benefits. As a specific program, it takes different forms in two different US Forest Service contexts: cooperative on state and private lands, and collaborative on federal lands. The Forest Stewardship Council is a private wood products certification program.

[31] McIver, Chelsea. December 2015, Measuring the Benefits of CFLRP for Local Communities in Northeastern Washington. University of Montana. Bureau of Business and Economic Development 2012-2015

cost to be $1.98 million. Adding back in the $0.41 million Forest Service credits for non-harvest activities, brings this private expense category to $2.4 million in the averaged reference year.

Yearly CFLRP expenditures have not been stable. A good example is contractor spending. In the last four years, total claimed expenses ranged from $550 thousand in 2014 to $1,482 thousand in 2015 with an annual average of $1,053 thousand.[32] As I/O models are deterministic, they require a stable reference point. Our base year approach (2013-2014 average) uses a similar representative amount of $984 thousand. This varies only 6.5% from the 4-year average and ignores the actual extreme variability.

As we use county-specific I/O models, the spatial distribution of CFLRP expenditures is important. For direct agency administration and own projects, we positioned the Supervisor's Office (SO) oriented expenses in Colville. This includes a portion of administrative activity, and the labor and equipment based at the SO. District resource management functions were split 60% to Stevens Co. and 40% to Ferry Co. Private harvest and stewardship labor and equipment was split between Ferry Co. and Stevens Co. The additional contractor expenditures are well documented by the UM report. We include a base year variant of their results to highlight how their findings were used in our modeling.

Table 3-9: CFLRP Contractor Spatial Distribution of Expenses

From U of Montana 2015

Expense Type	Ferry Co.	Pend Oreille Co.	Stevens County	Out-of Region	Total
Capital-intensive	$0	$0	$102,327	$248,494	$350,821
Labor-Intensive	$4,171	$0	$6,112	$555,216	$565,499
Stewardship	$0	$25,448	$0	$35,925	$61,373
Technical Services	$1,462	$0	$0	$3,422	$4,884
Products	$0	$1,418	$0	$0	$1,418
Total	$5,633	$26,866	$108,439	$843,057	$983,994

The spatial consideration is that although supplemental contractors may earn this amount within this region, the locus of final effect is dominantly out-of-region. The average apparent leakage is 86%. Although this contracted labor may have had some local spending, there was no survey of labor spending patterns available for these contracts.

NE Washington Wood Sector Economic Base Conclusions

So far, we have limited the discussion of estimated CFLRP economic effects to direct effects. These direct job and income effects of regional forestry activities also generate indirect and induced effects as initial transactions cycle through other economic sectors. Total effects are generated by a proprietary input-output (I/O) model constructed by FEI. The range of total economic effects and how they are CFLRP-linked across the regional economy are discussed in report #4.

[32] Extreme variability is quantified by a very large coefficient of variability (2.26) indicating that the standard deviation is larger than the mean.

I/O modeling also enables a more detailed examination of the entire wood products sector's role in the regional economy. The CFLRP operates in the context of an extremely strong regional wood and wood processing sector. In percentage terms (table 3-10) all three counties have similar wood sector contributions to the respective economic bases. However, this is misleading as the relative strengths of the county economies vary so extensively. We had reported an initial estimate of the gross wood sectors' economic bases for each county in our report #2. Now that the I/O models are functioning, we are able to estimate the specific economic base contribution of individual forestry and wood products subsectors.

Gross findings do not vary significantly from previously reported estimates. The inferences made from them remain unchanged. The region's wood sector economic base is concentrated in Stevens County. Its absolute base is almost three times higher than either of the two other counties. Proportionally, wood is still important in Ferry County as it is a large percentage of a small economy. In Pend Oreille County wood is a smaller proportional contributor as the southern end of that county has another large export industry and income strength from Spokane commuting. Note that the proportional economic contributions are larger than for the number of jobs in all the counties as wood sector jobs tend to be both productive and better paid.

Table 3-10: Wood Sectors Economic Base by County
Calculated from FEI economic modeling

County	County Employ	Wood Employ	Wood % Employ	Economic Base $KK	Wood Base $KK	Wood % Econ Base
Ferry	2,072	517	25.0%	$294.0	$101.6	34.6%
Pend Oreille	3,276	407	12.4%	$480.0	$105.7	22.0%
Stevens	12,364	2,500	20.2%	$1,057.0	$280.4	26.5%
Trico Σ	17,712	3,424	19.3%	$1,831.0	$487.7	26.6%

The FEI model tracks the employment and economic base contributions of 49 separate subsectors that are associated with the wood sector operations. These include: forestry services, primary wood products, and secondary goods produced from wood. There are also subsectors that specialize in serving wood production, such as machinery manufacturing and log truck transportation. Part of public employment is directly linked to wood sector activities, regulation or oversight.

We compress these subsector results into 10 catagorical types for two reasons. Less individual sector detail actually facilitates the formation of inferences, plus we must avoid specific firm identification.[33] We report both the related jobs, and the imported income that constitutes the economic base. Table 3-11 shows the subsector employment findings for each county.

[33] Publishing 49 subsector detail could reveal proprietary firm level data and violate FEI's confidentiality agreements with industrial informants.

Table 3-11: Wood Subsectors Economic Base Employment by County

Wood Subsectors	Ferry Co. Jobs	Pend Oreille Co Jobs	Stevens Co Jobs	Trico Σ Jobs
Ag/forestry support/hunting	21	26	493	540
Logging/log & biomass hauling	47	64	684	795
Regen, Forest Mgmt, & Restoration	117	4	335	456
Primary Wood Mills, Pulp & Biomass	205	185	512	902
Secondary solid wood products	0	5	36	41
Secondary fiber base products	0	0	0	0
Mobile & prefab home mfg	0	0	0	0
Machine & Sector maint	2	0	48	50
Product warehouse/truck/rail	20	32	85	138
State & Federal government	104	91	307	502

In all counties there is an obvious imbalance between resource jobs, primary manufacturing, and secondary manufacturing. The first two categories are strong and the latter is practically absent. This shows that very little of the regional wood resource is manufactured into final products within the region. For example, although lumber is occasionally sold into retail markets, it is considered a primary product. Goods produced from lumber would be considered secondary. With abundant raw wood materials and an underemployed labor force, we would have expected to see many secondary manufacturing firms. There appears to be only a single small one. Many secondary industries could use the large volumes of locally produced solid or fiber primary wood as raw materials for secondary products with specialty or niche markets. Examples from other regions are pallet, truss and prefab architectural panels manufacturing. An already strong wood sector could be augmented by the local presence of such industries.

Other surprisingly weak subsectors are the machine and mill services group. This suggests that most of such services are either internal or provided by specialty firms outside of the region, probably Spokane. Another suprising industry that was not present was modular/mobile home manufacturing or log home manufacturing. Similar studies in Oregon and Idaho find that presence of a primary wood products industry is an important contributing factor to the development of mobile/modular and log home manufacturing.

Although government subsectors is not normally thought of as wood subsectors, we find that a large amount of government employment, especially federal, is associated with the wood sector. The obvious direct jobs are those associated with agency resource management, but this total also includes other public sector jobs that would not have otherwise existed.

Wood Economic Base Highlights

- **NE Washington regional economy has a strong wood products base**
- **All counties have significant wood sector contributions**
- **Stevens County has the largest absolute wood sector base**

- **Strongest wood subsectors are forestry resources and primary manufacturing**
- **Secondary wood processing is a missing subsector**
- **Wood sector service subsectors are unusually weak**
- **The government subsector is unusually strong and concentrated in Stevens County**

An Aside: What About Wildfire's Economic Effects?[34]

Record northeastern Washington forest acreages burned during the 2015 fire season. The largest of these wildfires was the North Star fire (218,138 acres) on the Colville Tribal Forests in Ferry County. These were also another five large wildfires that burned an additional 226 thousand National Forest acres within the CFLRP influence zone.[i]

The economics of such events is complex and beyond the scope of this analysis, but there are ways to ask two fundamental economic questions. First, what is the investment return to forest restoration expenditures? Fire fighting is mitigation of a catastrophe, so from a micro-economic standpoint, wildfire management is minimization of a cost plus loss. An eastern Oregon study[35] found that $1.00 of restoration implied a $1.60 reduction in suppression costs. The answer to this question is better addressed with fire modeling in a cost-benefit format rather than using I/O.

The second question addresses the apparent local job and income effects of an unusual fire season. This type of analysis can be easily misinterpreted. From a local economic standpoint, jobs and income effects of fire fighting look positive. From a social welfare standpoint these jobs are actually negative, i.e. society would be considered better off if they didn't have to exist.

To track wildfire economic effects would require additional research. There is a significant annual pre-suppression expenditure that is relatively stable. As a result, these jobs and income are already included in on-going agency budgets and already considered as direct jobs.

The difficulty of *a priori* analysis is that individual wildfire seasons vary considerably in intensity. Additional suppression resources are purchased in unpredictable amounts; resource damages vary from year-to-year; and post fire restoration costs also vary. The volume effect of salvage harvests on local log markets can vary considerably. These are unpredictable stochastic events that would be difficult to include in a deterministic model such as input-output analysis. Even including an average could be misleading. However, it is possible to analyze a known and quantified past season in retrospect if an I/O model exists for the affected region.

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[34] FEI economic effects models have potential utility beyond the CFLRP. They are detailed mathematical descriptions of most economic linkages between the forest and wood products sector and the Northeast Washington regional economy. As such they can be used for numerous other analyses from economic development intervention to public policy evaluation. The review committee was particularly interested in the economics of wildfire. This aside was eventually developed as a separate paper on potential wildfire effects applications: "Subsequent uses for the CFLRP Input-Output model: Wildfire" dated 12/16/2015

[35] Mason, Bruce and Girrard Inc. et al. 2012. National Forest Health Restoration: An Economic Assessment of Forest Restoration on Oregon's Eastside National Forests. Report to Oregon Governor Kitzhaber

Even a retrospective analysis has limitations. Suppression resources would have varying local economic effects. Initially, this depends on where they come from. Income effects tend to occur where they are based rather than where they are used. There are few local supplemental fire crews, but local equipment can be identified and have measurable returns to local owners.

Separating local expenditures for supplies and lodging can be difficult. First, these tend to occur in high leakage sectors, and second, a fire crew purchase of fuel meals or motel room may displace tourist purchases that would have otherwise occurred. It seems clear in the unusual 2015 fire season that mega-fires with their accompanying smoke and closures effectively ended the tourist season.

There are redirections of normal expenditures. Significant wildfire damages affect the short-run expenditures on restoration, diverting budgets from their original purposes. In the longer-run, patterns of resource management activities can change as can the scheduling of timber harvests. This shifts the available resource linkages between local forests and the wood products sector that uses them. It also affects the connection to transactions that generate indirect and induced effects.

Lastly, there are micro-economic market changes that can change or redistribute economic welfare between sectors. In 2016, huge volumes of fire salvage timber will be available to a milling infrastructure of relatively fixed capacity. There is first a log price effect. Not only is burned timber of a lower grade with higher handling costs, huge shifts in log supply drive down prices quickly in a weakly competitive market structure. A rough estimate of potentially available salvage volume from the region's 2015 wildfires is over 5 times the input capacity of the existing milling and logging infrastructure. The price effect could be as much as a 40% reduction in green log prices and a significantly larger effect on private stumpage values. Typically, this oversupply of low grade salvage logs has only a two year life as standing dead timber degrades quickly.

A market redistribution effect has multiple dimensions. Previous suppliers of green logs cannot afford to harvest into glutted markets. The balance of receipts shifts from high stumpage private logs to extremely low stumpage public logs. From a tax and fiscal standpoint this would constitute a lose-lose scenario.

If Input-Output models like the ones we built for the CFLRP study are available, they can be used to help quantify the scenarios outlined above, but only as a deviation from the stable wildfire scenario presumed during model construction for the 2013-2014 data baseline.

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[i] Inciweb. 2016. These were: Kaniksu Complex (26,670 acres), Kettle Complex (73,392 acres) Tower Fire (26,120 acres), Carpenter Road Fire (63,972 acres), and Stickpin Fire (35,530 acres).