

Appendix VII. Watershed Analysis

**Final Report
Hydrologic Effects Forest Harvesting
Sundance Forest Industries Forest Management Area**

**Report Prepared for:
Sundance Forest Industries
Edson, Alberta**

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DISCLAIMER

The assessment of hydrological impacts of harvesting presented in this report reflects the output from hydrologic simulation models and does not necessarily reflect actual impacts that may be observed. Ultimately, the reliability of estimates produced using WRENSS and other hydrological models depends on the availability of representative climatic/hydrometric data, and regional forest growth and yield data, and harvesting plans. In this context, Watertight Solutions has evaluated the hydrometric data used in this analysis and considers these data to be a reliable reflection of hydrologic conditions for the analysis. Limitations or errors due to deviation in actual forest growth rates from provincial average growth rates or limitations imposed by spatial/temporal scale of analysis are outside the author's control. In particular, the spatial distribution of harvested blocks, as well as the presence of additional disturbances (fire, insects, etc.) will also affect water yields.

Furthermore, it is re-emphasized that the WRENSS model projects average annual water yield changes over time based on un-routed flow (generated runoff), assuming average climatic/hydrologic conditions in the region and the rate of stand regeneration. Therefore, changes in annual water yield due to disturbance will vary from simulations based on the actual variability in climate and the degree of departure from average climatic conditions.

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Executive Summary

The effects of a forest harvesting plan on annual water yield, maximum daily flows and hydrologic recovery were assessed for Sundance Forest Industries (SFI) using the WRENS model. The proposed harvest was for a 20 year period (2007-2026) in SFI's forest management area (FMA) located south of the town of Edson, Alberta.

The FMA exists as two separate blocks, with one located in the Pembina River and Brazeau River watersheds and the other in the McLeod River watershed immediately south of the town of Edson. Harvesting is planned for the period 2007-2026, with most occurring in the southern block of the FMA. Forest cover in these watersheds includes pure to mixed stands of aspen (*Populus tremuloides*), white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*) and poorly drained wetlands with black spruce (*Picea mariana*).

Twenty-four sub-watersheds were selected in this area for simulations. These watersheds ranged in size from 10 to 103 km² (Table 1 Figure 4). Four sub-watersheds selected for simulations in the northern block ranged in size from 25 to 252 km². Harvest levels ranged from < 1% to 47 % of watershed areas for both blocks.

Results of the assessment were as follows.

Water Yield

- ▶ Simulated increases in annual water yield of 11.1%- 17.8% were significantly greater than representative flows on 10 of 24 watersheds. Most of these watersheds were located in the Low Elevation South Block of the FMA where water yield was lowest.
- ▶ These increases may exceed the upper limits of natural variability for water yield for the region based on experience elsewhere. An analysis of flow variability for the region is needed to confirm this observation.
- ▶ These increases in water yield were attributed to high levels of harvesting which removed 30% - 47% of forest cover in the watersheds.
- ▶ On the remaining 14 watersheds water yields were not significantly different from representative flows with simulated increases ranging from <1% – 8.5%. Forest cover removal in these watersheds varied from <1% - 29%.
- ▶ Low responses in water yield in watersheds with harvest levels of 20%-29% were the result of a mix of historical harvesting prior to the proposed harvest for 2006-2026. Hydrologic recovery of historical blocks was advanced which moderated water yield increases.

Hydrologic Recovery

- ▶ Hydrologic recovery, the time for water yield increases to disappear or approach “pre-harvest levels”, was assumed to occur when increases in water yield were ≤ 5%.
- ▶ Hydrologic recovery, averaged 14 years for all watersheds, with minimum and maximum values of 0- 41 years.
- ▶ Hydrologic recovery for watersheds with significant increases in water yield averaged 23 years, with minimum and maximum values of 16 and 41.
- ▶ Hydrologic recovery in watersheds with no significant increase in water yield averaged 4 years, with minimum and maximum values of 0 and 15.

- ▶ Watersheds with zero years for recovery occurred in watersheds with harvesting < 10% of watershed area, or where increases in water yield were $\leq 5\%$.

% Watershed ECA

- ▶ Watershed Equivalent Clearcut Area (ECA) was based on the return of increased water yield to “pre-harvest” conditions.
- ▶ %ECA for watersheds with significant increases in water yield averaged 23% with minimum and maximum values of 16% and 31%.
- ▶ %ECA for watersheds with no significant change in water yield averaged 11% with minimum and maximum values of 1% and 26%.

Peak Flows

- ▶ The largest simulated increases in maximum daily flows for the 2-year and 5-year events occurred in watersheds with high levels of harvesting (41%-47%).
- ▶ Increases for the 2-year and 5 year events varied from 8.3%-11.1% and 8.3% - 11.5% respectively.
- ▶ Increases in watersheds with less harvesting (1.3%-21.7%) for the 2-year and 5-year events ranged from <1% - 4.7%.
- ▶ Increases in peak flows showed a decreasing trend with an increase in recurrence intervals. The trend varied from strong for watersheds with high levels of harvesting to weak or nonexistent for watersheds with less harvesting.
- ▶ Increases for maximum flows were judged to fall within the range of natural variability

In conclusion the simulated increases in water yield and peak flows for the proposed harvesting by SDI are considered small to moderate in magnitude and duration. The high levels of harvesting in watersheds with maximum increases were moderated by the existence of historical harvesting. Based on current knowledge and experience no adverse impacts on water quality and aquatic habitat are expected, contingent upon the application of existing ground rules.

Increases in water yield and peak flows can be managed by rescheduling and reducing in the level of harvesting. This is not necessary for the current plan, but future harvesting should include considerations for hydrologic recovery to minimize the potential for cumulative impact on water yield and peak flows. Frequent entries into a watershed will sustain water yield increases and delay hydrologic recovery.

The current plan also includes strategies to minimize the impacts and spread of anticipated mountain pine infestations by harvesting a large component of mature pine stands in watersheds. The simulated changes in water yield and peaks for this plan are modest when compared to potential impacts if stands are attacked and destroyed by mountain pine beetles (Love 1955; Troendle and Nankervis 2000; Unil et al 2006; Forest Practices Board 2007).

Final Report

Hydrologic Effects of Forest Harvesting

In Sundance Forest Industries Forest Management Area

Introduction

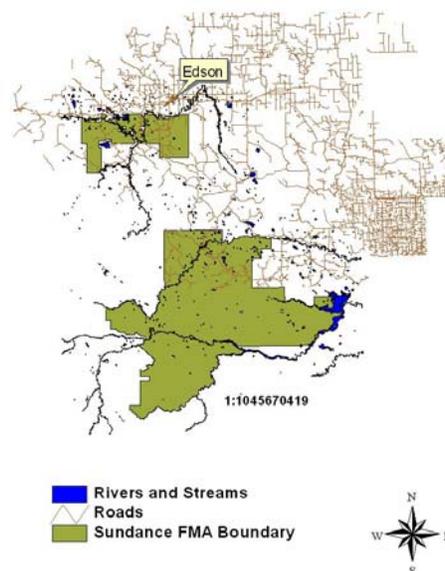
The objective of this report was to assess the hydrologic effects forest harvesting in Sundance Forest Industries (SFI) forest management area. This report addresses the effects of forest harvesting on water yield, maximum daily flow and hydrologic recovery.

SFI's forest management area (FMA) is located south of the town of Edson (Figure 1). The FMA exists as two separate blocks, with one located in the Pembina River and Brazeau River watersheds and the other in the McLeod River watershed immediately south of the town of Edson. Harvesting is planned for the period 2007-2027, with most occurring in the southern block of the FMA. Forest cover in these watersheds includes pure to mixed stands of aspen (*Populus tremuloides*), white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*) and poorly drained wetlands with black spruce (*Picea mariana*).

Hydrologic assessment of harvesting was done as follows:

1. Prepare a hydrologic land-base for the FMA
2. Identify 3rd order basins and consolidate into watersheds 50-100 km² in size
3. Assemble and prepare harvest schedule data for analysis
4. Assemble hydro-meteorological data for the region
5. Run hydrologic simulations (WRENSS) of proposed harvesting
6. Analyze and report results.

Figure 1 Sundance forest management area is located south of Edson



Methods

Hydrologic Land Base

A hydrologic land-base defines the number and extent of watersheds within a FMA. Hydrologic assessments are ideally done on a watershed basis, which includes all of the historical and proposed forest harvesting (i.e. disturbances) that can affect water flows. This is not always possible as FMA boundaries are seldom watershed based.

The hydrologic land-base prepared for SFI was done by identifying 3rd order basins in the region (Figure 2), which were consolidated into larger basins of 50-100 km² (Figure 3) which were used for simulations (Figure 4). Attempts were made to limit watershed sizes to < 100 km² which is a scale commonly used in forest planning. Furthermore, the effects of forest harvesting on water flows becomes small or obscured on large watersheds (> 200-300 km²) because the extent on harvesting in relative terms is less and the mix of newly harvested sites, unharvested sites and regenerated sites moderates flow responses.

Harvest Data

Harvest data and scheduling used in these assessments was prepared by The Forestry Corp. Primary data included were: harvest block area, year of cut, harvest block aspect, species to be harvested, and species to be regenerated and site quality (Appendix 1).

Most of the proposed harvesting is located in southern block of the FMA. Twenty-four sub-watersheds were selected in this area for simulations. These watersheds ranged in size from 10 to 103 km² (Table 1 Figure 4). Four sub-watersheds selected for simulations in the northern block ranged in size from 25 to 252 km². Harvest levels ranged from < 1% to 47 % of watershed areas for both blocks.

Hydro-Meteorological Data

Streamflow and precipitation data were downloaded from web sites of the Meteorological Service of Canada and Water Survey of Canada. Precipitation data were obtained from “2002 CDCD WEST CD” (Environment Canada 2002) for Western Canada. Streamflow data were obtained from HYDAT-CD ROM (Environment Canada 2003) which contains flow data for all of Canada. Most of the precipitation and hydrometric stations for forested regions in Alberta obtained from these sources are provided in WRENSS model as “look up tables” that allow specific stations to be input into the program.

Streamflow data for the Embarras River, Rat Creek and Brown Creek rivers were used in hydrologic simulations (Table 2) as representative watersheds. These were three hydrometric stations in the region with long term data. These watersheds are large compared to those selected for hydrologic assessment (218-648 km² vs 10-252 km²). The ideal would be to select watersheds similar in size, vegetation and topography to those for assessment.

Figure 2 Third order watersheds defined for the regions south of Edson. These sub-watersheds were used as a base to define a hydrologic land-base for the SFI's FMA and to select watersheds for simulation.

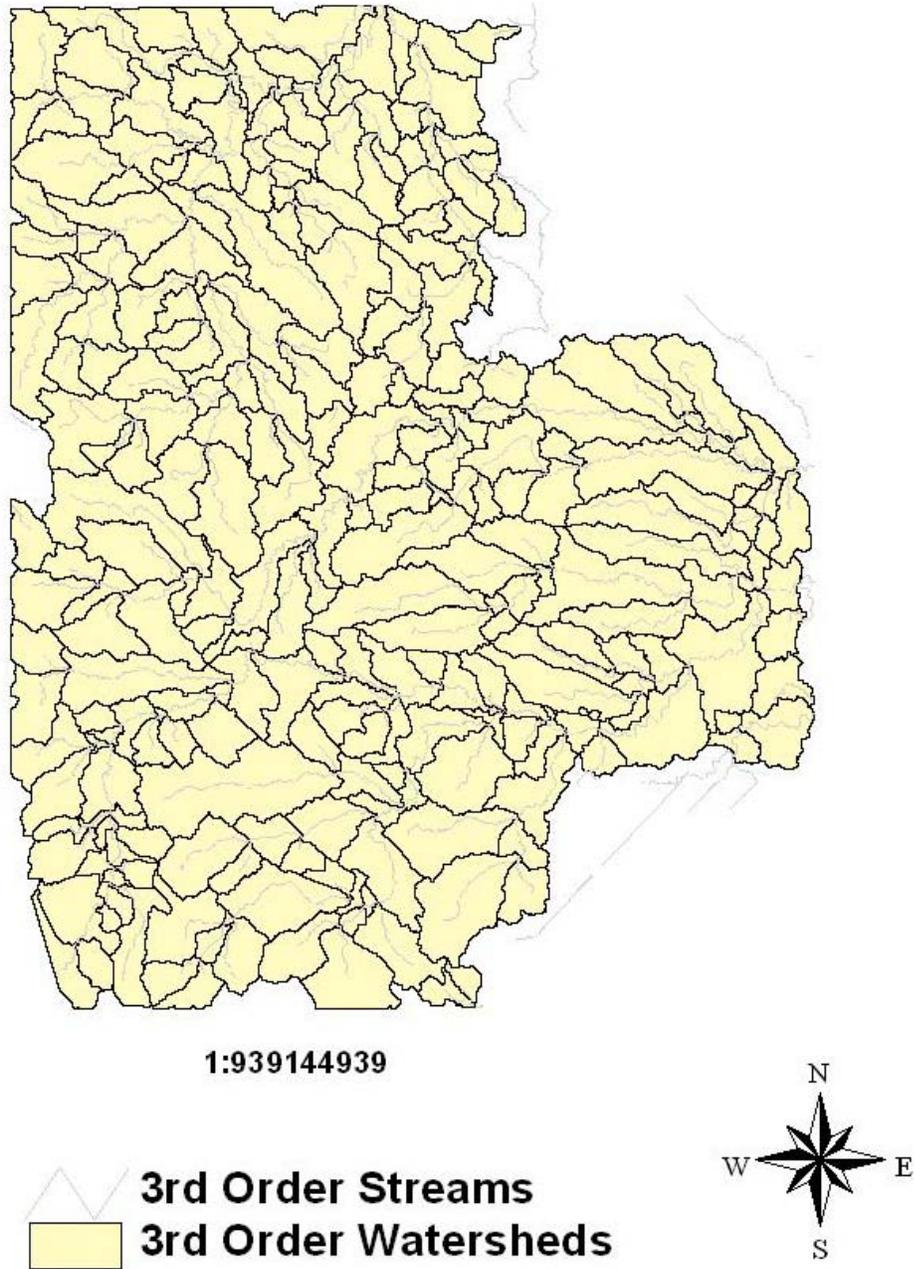
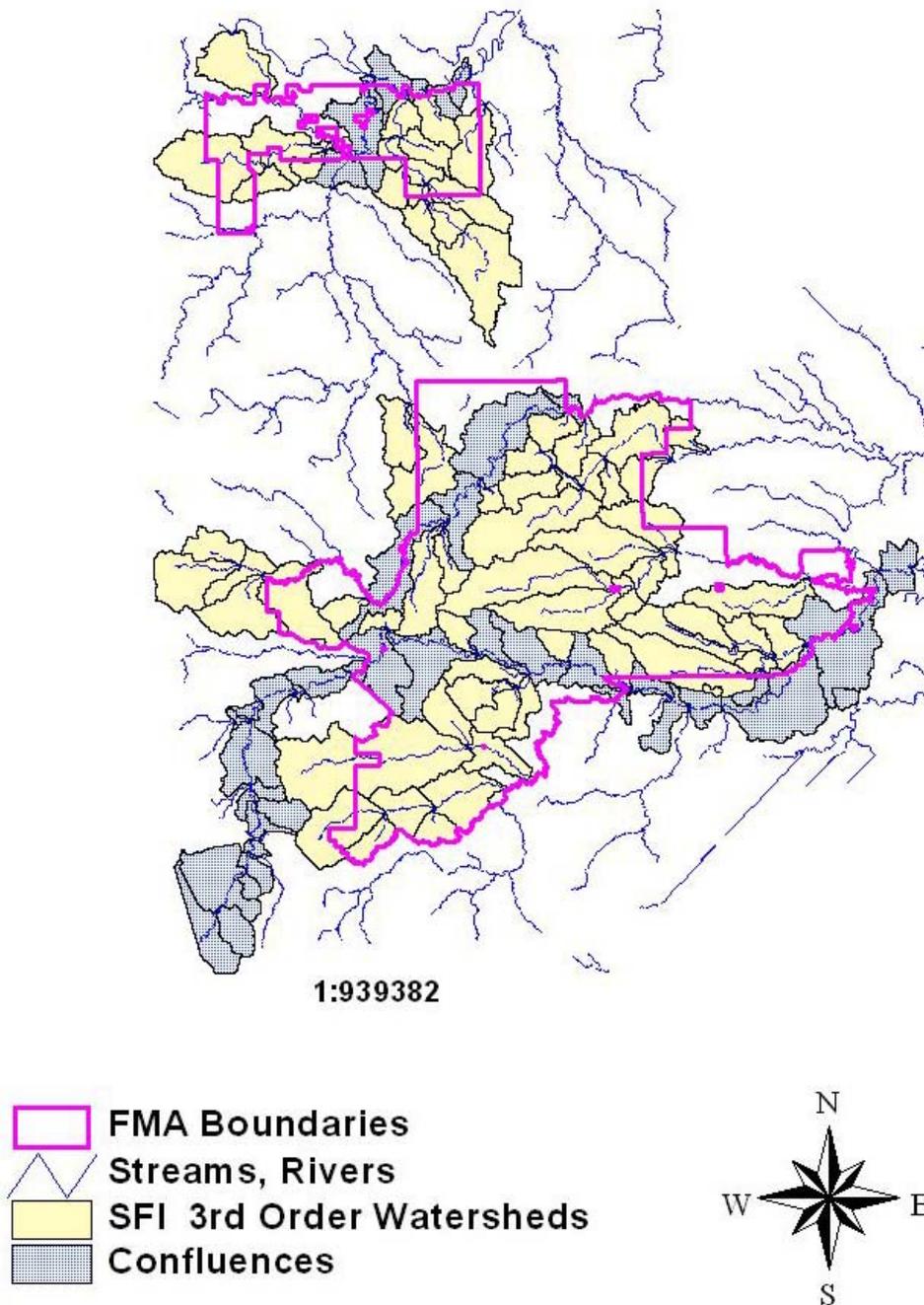
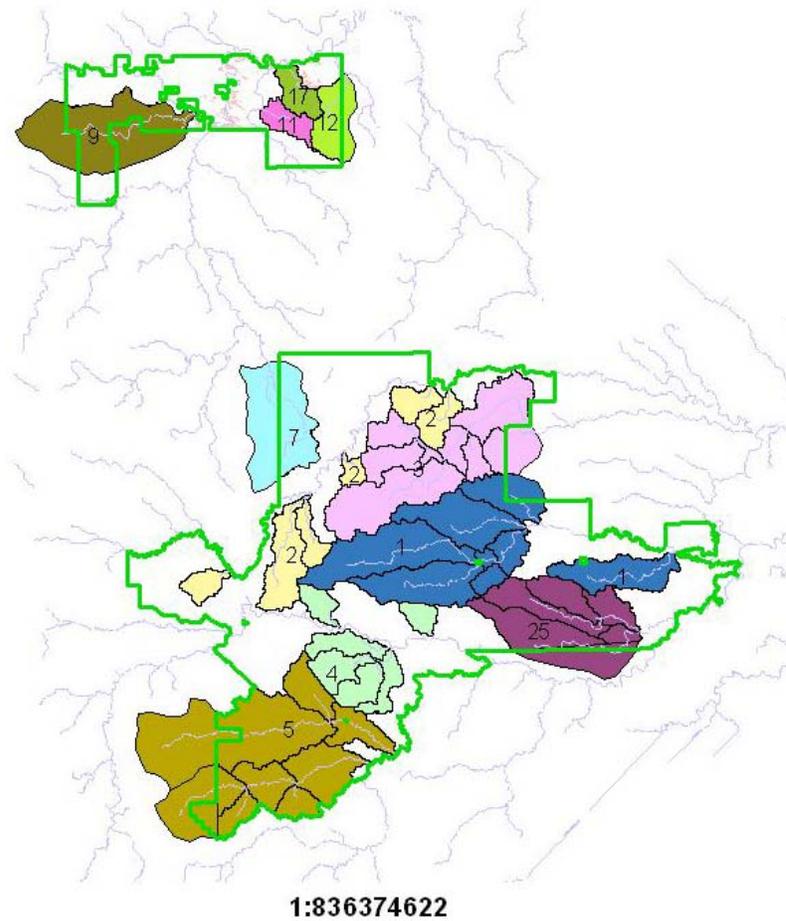


Figure 3 SFI's hydrologic land base was formed by consolidation of smaller 3rd order sub-watersheds. These watersheds ranged in size from 6 – 121 km² (Table 1). No watersheds in the confluence zones were identified because they were usually small (< 3rd order) and not easily identified.



+Figure 4 Selection of watersheds for simulation was based on watershed size ($\leq 100 \text{ km}^2$) and regions where harvesting was concentrated on the FMA.



 **FMA Boundaries**
 **3 order streams**



Table 1 Harvest levels in watersheds selected for harvesting.

Watershed Number	Area km²	Hectares Harvested	% Watershed Harvested
North Block			
1100	251.6	1134	4.5
1200	48.4	465	9.6
1700	24.6	859	35
9000	83.3	263	3.2
South Block –High Elevation			
4001	95.6	3154	33
4002	24.9	725	29.1
5001	87.8	69	0.8
5002	190.9	499	2.6
South Block – Low Elevation⁴³⁶			
1001	69.6	3310	47.6
1002	57.5	1233	21.5
1003	102.8	4843	47.1
1004	67.3	2777	41.3
1005	45.4	1005	22.2
2001	54.3	1807	33.3
2002	21.2	672	31.7
2003	24.3	720	29.6
2004	10.1	436	43
2501	48.1	1648	34.3
2502	81.2	1395	17.2
3001	54.1	2111	39
3002	94.3	3899	41.4
3003	14.7	407	27.7
7001	35.6	44	1.3
7002	63.8	1524	23.9

The selection of representative watersheds for the simulations is important as their long term average water yield (area-mm) is used to calculate percent increases in water yield. Most of the available hydrometric data is for large watersheds, whose water yields are usually smaller than those of tributary sub-watersheds ($\leq 100 \text{ km}^2$) which are normally candidates for simulations. When this occurs the most likely outcome is that simulated changes in water yield are likely to overestimated.

The Sundance FMA was divided into three water yield zones based on available data (Figure 5). The Embarras River was used as a base yield for watersheds in the north block of the FMA. The southern block was divided into two zones with Brown Creek as a base flow in the higher elevation zone and Rat Creek for the lower elevation zone to the east (Figure 5). Higher percentage flow increases can usually be expected in areas with lower water yield compared to areas of higher water yield. The lower water yield boundary in each zone was used to calculate percentage increases.

Table 2 Hydrometric stations used in WRENSS simulations

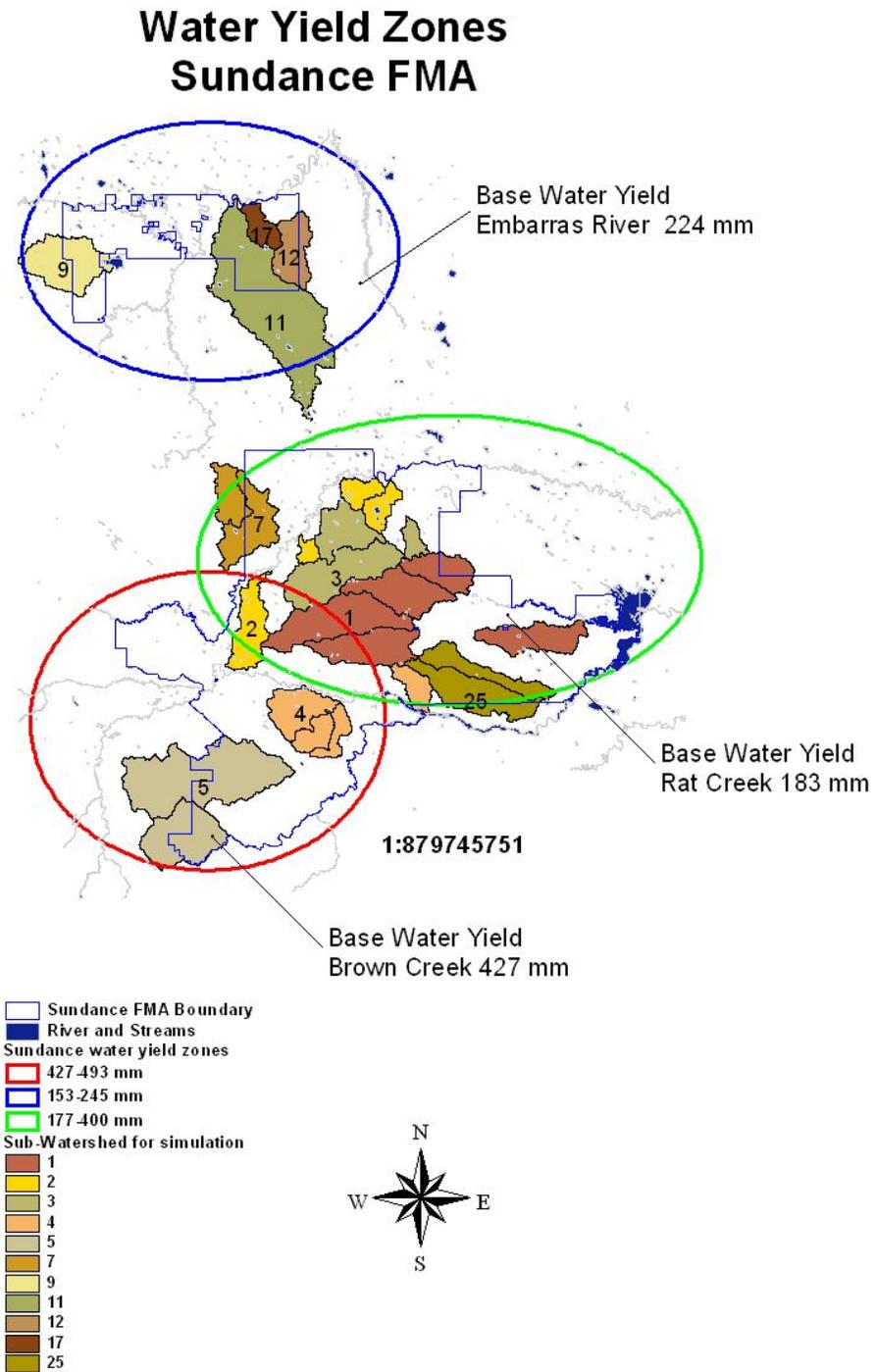
Watershed	Area km ²	Years of Record	Annual Water Yield mm		
			Avg	Max	Min
Embarras River	647.7	19	223.7	330.5	95.0
Rat Creek	606	31	183.7	363.2	76.5
Brown Creek	218.0	29	426.7	763.8	149.0

Annual and monthly precipitation records are required for WRENSS. Data of this nature are difficult to find in forested regions. Data from the Edson and the Nordegg Ranger Station were used in the simulations (Table 3).

Table 3 Annual precipitation at Edson and Nordegg Ranger Station

Station	Years Record	Annual	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sept	Oct	Nov	Dec
Edson	10	532.1	27.5	24.8	18.5	26.7	63.1	67.1	112.3	72.3	47.8	31.7	19.0	21.3
Nordegg R.S.		585.5	27.8	16.0	27.0	34.8	70.5	99.8	101.4	78.7	59.4	28.0	20.8	21.5

Figure 5 Water yield zones were constructed to account for differences in flow in the FMA. The lower boundary in each zone was used to calculate percent increases in water yield.



Hydrologic Simulations

WRENSS

Simulations were done using WRENSS (Water Resource Evaluation for Non-Point Silvicultural Sources) which was developed by the U.S. Forest Service and the U. S. Environmental Protection Agency (EPA 1980). WRENSS was designed to be used as an operational tool for forest planning. It is relatively simple in concept and has modest data requirements. It is not a “high end” research model designed to simulate daily flows (i.e. routed runoff).

Swanson (2000, 2005) prepared a computer version of the procedure (WRENSS) for Alberta conditions and modified it by linking climate and flow databases to the program. Outputs from WRENSS include:

- Increase in annual water yield
- Hydrologic recovery
- Equivalent clear-cut area
- Increases in maximum annual daily flows and maximum annual instantaneous flows for 2, 5, 10, 20 50 and 100 year recurrence intervals

Estimated changes in annual water yield are based on seasonal water balance calculations of generated runoff (GRO), which is water that will eventually become runoff but has not reached the stream channel. Increases in water yield (ΔQ) are a change in evapotranspiration (ΔET) resulting from the removal of forest cover. Increases in water yield are obtained by taking the difference between harvested and unharvested conditions.

Increases in water yield in WRENSS are expressed as area-millimeters (area-mm) and percentages. Area – mm is the volume of increased flow (or reduced ET) expressed as a uniform depth over a watershed. Increases in water yield are expressed as percents of the mean annual water yield (i.e. base yield in WRENSS) for the watershed being analyzed or a nearby representative watershed, which is of similar size, forest cover and climate (i.e. precipitation).

Increases in water yield should be considered as relative changes (e.g. small, medium, and large). Few if any models are capable of providing exact, absolute changes. Furthermore, annual water yields are highly variable among watersheds and hydrologic regions. For example, annual yields in some years in boreal forest watersheds can be 0-100 mm, while in the Rocky Mountains water yields can be 400-800 mm. An increase of 40 mm in a Rocky Mountain watershed would be a small percentage compared to a similar increase in a boreal forest watershed. Percentages must be carefully interpreted.

Hydrologic recovery is an estimate of the time required for increased water yield to disappear as trees grow back on harvest blocks to full occupancy of the site or a condition similar to pre-harvest conditions. WRENSS uses basal area as a surrogate for leaf surface area. Hydrologic recovery is assumed to occur with the time of maximum leaf area or the recovery of evapotranspiration to pre-harvest levels. Stand basal area is used as a surrogate for leaf surface area in WRENSS. This provides a very conservative estimate of hydrologic recovery as the time for basal area to return to a “mature stand level can be very long (e.g. 80-100 years).

Leaf surface area and by association hydrologic recovery is thought to occur earlier than the time to maximum basal area. Brabender (2005) reports maximum LAI for lodgepole pine around 25 years and a strong relationship between maximum LAI and periodic annual increment (PAI). Silins (2000) utilized these relationships to estimate ECA and hydrologic recovery in a modified version of WRENSS (i.e. ECA-Alberta). Based on the above, hydrologic recovery in this assessment was assumed to occur when simulated increases in water yield were $\leq 5\%$. This approach gives estimates comparable to the values reported in the literature (Brabender 2005, Lieffers et al 2002).

Equivalent Area Clearcut (ECA) is an index of hydrologic recovery. It is a measure of the disturbed area (i.e. harvest blocks) in a watershed that is in a condition to contribute extra water to streamflow. ECA is at a maximum at the time of harvest and then decreases with the regeneration of harvest blocks. The physical model supporting ECA is that vegetation removal changes water yield in rough proportion to the leaf surface area or basal area removed from a site (Ager and Clifton 2005).

ECA is defined in this assessment as the area (hectares) harvested times a reduction factor that describes the recovery of evapotranspiration losses. ECA estimates in WRENSS are provided in terms of basal area recovery and recovery of water yield. ECA_Q based on water yield recovery was used in this assessment. It is considered a more direct and realistic estimate of hydrologic recovery. ECA_Q is expressed in hectares of “harvested area” and as a percent of the watershed area.

WRENSS also estimates increases in maximum daily and instantaneous flows due to harvesting for return periods of 2, 5, 10, 20, 50 and 100-year events. WRENSS uses watershed area to estimate peak flows ($Q_{\text{peak-area}}$) for all return periods in the unharvested condition. The difference between the mean March to September streamflow in the unharvested and harvested condition is used to estimate the change in peak flow ($Q_{\text{peak mean flow}}$) caused by harvesting for each return period. The difference in $Q_{\text{peak mean flow}}$ between the harvested and unharvested conditions is added to $Q_{\text{peak-area}}$ to obtain the maximum flow for a given return period. (A more detailed description of WRENSS is provided in Appendix 1).

Simulations

Hydrologic simulations were done for 100 years (2006-2106) for each watershed with a 1 year time step. Percent increases in water yield were determined using the Embarras River, Rat Creek and Brown Creek as representative watersheds (i.e. base yield). The hydrologic region used was the New England/Boreal. Peak flows equations were for the Edson region. Specific data requirements for WRENSS simulations are shown in Appendix 2. Watersheds selected for simulations and the extent of harvesting and basin order are described in Table 1

Statistical Assessments

Increases in water yield were assessed by comparing increased water yields to those of nearby representative watersheds. Annual water yield increases were compared to the long term mean annual/seasonal flows of representative watersheds 10 years or more of flow record. If a simulated increase in water yield exceeded the upper 95% confidence limit for the mean annual flow of its representative watershed it was considered a significant increase in water yield.

Statistically the ideal situation for evaluating water yield increases would be to have long term streamflow record for the watershed being assessed. This seldom occurs, other than on experimental watersheds. The approach adopted in WRENSS is based on the assumption that nearby watersheds of similar size, forest cover, topography and climatic regimens represent a reasonable benchmark upon which managers can evaluate potential changes in water yield.

The Embarras River, Rat Creek and Brown Creek were used as representative watersheds in the these simulations. Confidence limits for mean water yield were calculated as: $\bar{O} \pm (t) (s_0)$ where \bar{O} = mean water yield, t = t value and s_0 = standard error of the mean = $\sqrt{(s^2/n)}$.

Confidence limits for each watershed were:

Embarras River ---- $224 \text{ mm} \pm (2.093 * 12.417) = 25.988 \text{ mm}$ ---- $(25.988/224)*100 = 11.6\%$
Upper 95% confidence limit = $224 + 25.998 = 249.98 \text{ mm}$

Rat Creek ---- $183 \text{ mm} \pm (2.457 * 9.804) = 24.088 \text{ mm}$ ---- $(24.088/183)*100 = 13.16\%$
Upper 95% confidence limit = $183 + 24.088 = 207.08 \text{ mm}$

Brown Creek ---- $427 \text{ mm} \pm (2.462 * 17.735) = 43.663 \text{ mm}$ ---- $(43.663/427)*100 = 10.2\%$
Upper 95% confidence limit = $427 + 43.663 = 470.66 \text{ mm}$

Simulated water yield increases greater than 11.6%, 13.16% and 10.2% were considered significant increase in comparisons made with Embarras River and Rat Creek and Brown Creek respectively. Significant increases in water yield were assumed to contribute to higher seasonal flows in affected watersheds.

Results

Water Yield

The largest simulated increases in annual water yield were in the Low Elevation - South Block. Increases ranged from 13.9% to 17.8% in watersheds where the percent area harvested varied from 39% to 47% (Table 4). Volumetric increases were an extra 20 to 33 mm of water. All of these increases were significant with respect to the representative watershed (Rat Creek). Increases in the remaining 5 watersheds were not significant, ranging from < 1% to 8.5%. The extra water generated in these watersheds was 1- 16 mm.

Simulated water yield increases in the North Block of the FMA ranged from a significant increase of 12.2% in watershed 1700 to no significant changes in the remaining watersheds (1.2-3.4%). Extra water generated by harvesting ranged from a high of 27 mm to lows of 3-8 mm.

Simulated water yield increases in the High Elevation – South Block were not significant. Percent increases ranged from 0.6 – 5.2%. Extra water generated by harvesting varied from 1- 22 mm.

Hydrologic Recovery and % ECA

Hydrologic recovery for all watersheds averaged 14 years with maximum and minimum values of 0 and 41 years (Table 4). Zero values were in watersheds with low to nil harvesting and very low increases in annual water yield. The maximum time for recovery was in watershed 1001 where the increase in water yield and percent harvesting was 17.8% and 47.6% respectively.

Maximum % Watershed ECA, a measure of disturbance or recovery of evapotranspiration, varied from lows of 1%-5% for watersheds with little harvesting to highs of 27%-31% for watersheds with large water yield increases and harvest levels > 40%.

Peak Flows

The largest increases in simulated maximum daily flows occurred in the Low Elevation South Block where harvesting was greatest and more frequent (Table 5). Increases for the 2-yr to 5-yr recurrence interval events¹ varied from 8.6% to 11.1% and 8.5% to 11.5% in watersheds 2004, 1003 and 3002. The percent area harvested in these watersheds varied from 41% to 47%. Low increases ranged from 0.2% to 4.7% with harvest levels of 1.3% to 21.7%.

Simulated increases in peak flows for most of the watersheds showed a weak decreasing trend with an increase in recurrence intervals. The reason for this is the volume of extra water generated by forest cover removal in a watershed is relatively constant volume. Increases for the 2-year events varied from <1% - 11.1% compared to <1% - 7.6% for the 100 year events. The low response of peak flows was in large part a reflection of small increases in annual water yield.

¹ Recurrence interval is the average period of time expected to elapse between successive occurrence of events of given size or larger. For example an event with a recurrence interval of 2-years can be expected to be equaled or exceeded once every 2 years, or to occur 50 times in 100 years

Table 4 Simulated increases in annual water yield, % maximum watershed ECA and hydrologic recovery in SDI's forest management area. Watersheds in each block are sorted by maximum to minimum % increase in water yield. Medium and low disturbances represented by yellow and blue shading respectively. Asterisks indicate significant increase in water yield with respect to representative watersheds.

Watershed Number	Area km ²	% Watershed Harvested	Yield Increase mm	% Increase Yield	Maximum % Watershed ECA	Hydrologic Recovery years
North Block						
1700	24.6	35	27.2	12.2*	19	17
9000	83.3	3.2	2.7	1.2	5	0
1100	251.6	4.5	3.8	1.7	26	0
1200	48.4	9.6	7.6	3.4	2	0
High Elevation South Block						
4001	95.6	33	21.8	5.1	16	0
4002	24.9	29.1	22.2	5.2	14	0
5001	87.8	0.8	0.9	0.2	1	0
5002	190.9	2.6	2.6	0.6	1.8	0
Low Elevation South Block						
1001	69.6	47.6	32.7	17.8*	29	41
1003	102.8	47.1	31	16.9*	27	34
1004	67.3	41.3	30	16.4*	24	36
2004	10.1	43	29.1	15.9*	31	23
3002	94.3	41.4	27	14.7*	23	29
3001	54.1	39	25.5	13.9*	24	20
2001	54.3	33.3	22.7	12.4	22	21
2002	21.2	31.7	21.7	11.8	19	16
2003	24.3	29.6	20.9	11.4	20	16
2501	48.1	34.3	20.4	11.1	16	31
7001	35.6	1.3	1.1	0.6	1	0
2502	81.2	17.2	11.5	6.3	8	5
1002	57.5	21.5	13	7.1	11	9
1005	45.4	22.2	13.9	7.6	12	13
3003	14.7	27.7	14.2	7.7	13	12
7002	63.8	23.9	15.7	8.5	15	15

Table 5 Simulated Increases in maximum daily flows generated by forest harvesting in SDI's forest management area. Medium (5% - 15%) and low increases (<5%) are shown yellow and blue shading respectively.

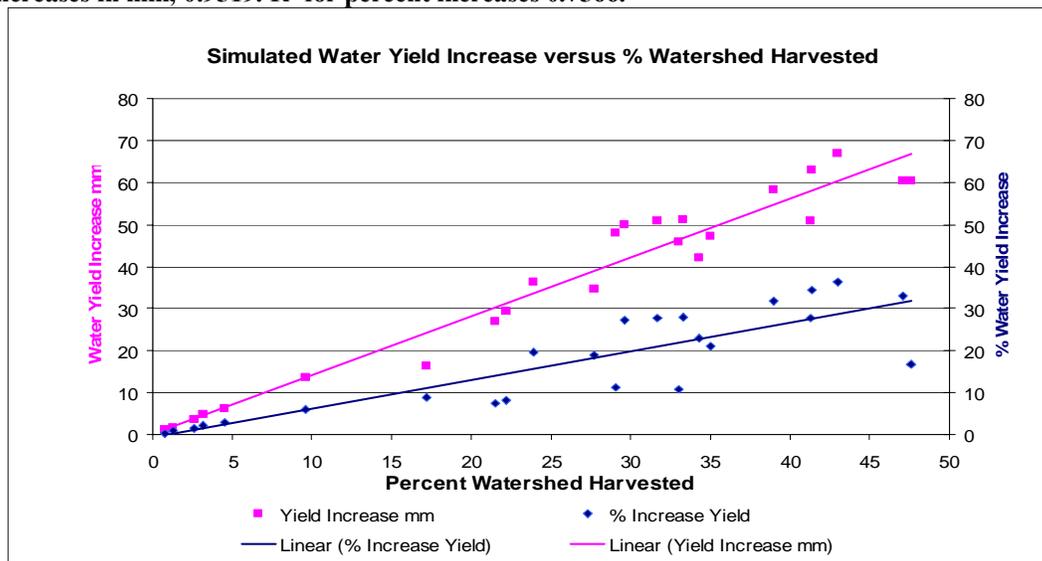
Watershed	Area km ²	% Watershed Harvested	Recurrence Interval – Years						Maximum % Watershed ECA	% Increase Water Yield
			2	5	10	20	50	100		
North Block of FMA										
1700	24.6	35	8.3	8.4	8.4	7.2	5.7	4.9	19	12.2
1200	48.4	9.6	2.6	2.6	2.6	2.1	1.7	1.5	5	3.4
1100	251.6	4.5	1.3	1.3	1.3	1.2	1.1	1.0	26	1.7
9000	83.3	3.2	0.9	0.9	0.9	0.7	0.6	0.5	2	1.2
South Block – High Elevation										
4001	95.6	33	7.8	8.7	8.4	6.4	4.9	4.1	16	5.1
4002	24.9	29.1	6.2	6.9	6.5	5	3.9	3.3	14	5.2
5002	190.9	2.6	1.0	1.2	0.8	0.6	0.5	0.4	1	0.6
5001	87.8	0.8	0.1	0.1	0.1	0.1	0.1	0.1	18	0.2
South Block – Low Elevation										
2004	10.1	43	11.1	11.5	9.7	7.7	6.1	5.2	29	15.9
1003	102.8	47.1	9.6	9.5	9.5	9.4	8.7	7.6	27	16.9
3002	94.3	41.4	8.6	8.5	8.5	8.4	7.6	6.6	24	14.7
2002	21.2	31.7	8.5	8.7	8.0	6.4	5.1	4.4	31	11.8
3001	54.1	39	8.3	8.3	8.3	8.3	7.1	6.1	23	13.9
2003	24.3	29.6	7.7	7.9	7.6	6.1	4.8	4.2	24	11.4
2501	48.1	34.3	7.2	7.2	7.2	7.2	5.9	5.1	22	11.5
1004	67.3	41.3	6.8	6.8	6.8	6.8	6.8	6.8	19	16.4
2001	54.3	33.3	6.7	6.8	6.8	6.8	6.0	5.2	20	12.4
1005	45.4	22.2	5.3	5.4	5.4	4.6	3.7	3.2	16	7.6
1002	57.5	21.5	4.7	4.7	4.7	4.7	3.9	3.4	1	7.1
3003	14.7	27.7	4.4	4.5	4.5	4.6	4.1	3.6	8	7.7
7002	63.8	23.9	4.4	4.4	4.4	4.4	4.4	3.8	11	8.5
2502	81.2	17.2	4.4	4.4	4.4	3.8	3.1	2.7	12	6.3
1001	69.6	47.6	4.0	4.0	4.0	4.0	4.0	4.0	13	17.8
7001	35.6	1.3	0.2	0.2	0.2	0.2	0.2	0.2	15	0.6

Discussion

Water Yield Increases

Increases in water yield are determined primarily by the extent and frequency of harvesting and watershed size. Harvesting that exceeds 30% - 40% or more of a watershed can be expected to increase water yield above “acceptable levels” (Figure 6). Large increases in water yield and peak flows can also be expected when harvesting is concentrated in a short period of time (<5 years) or sustained for long periods (Figures 7, 8). This was the case for 10 of the 24 watersheds assessed in this report where harvesting varied from 29.7%-47%.

Figure 6 Simulated water yield increases in versus percent of watershed harvested. R^2 for increases in mm, 0.9519. R^2 for percent increases 0.7566.



Experience in other regions of Alberta (Watertight Solutions 2005) suggests increases greater than 20%-25% exceed the natural variability² of flows with recurrence intervals less than 5 years. Flow events of these magnitudes and frequencies are considered sensitive to disturbance because of the smaller size and greater frequency. Percent increases in smaller flows are often bigger than for larger and less frequent events. Furthermore, the greater frequency of occurrence of small events (i.e. recurrence intervals < 5 years) may have greater cumulative effects in terms of energy to shape and change stream channel morphology (and aquatic habitat) may be greater in the long term than single large events.

The interaction of watershed size and area harvested will also influence water yield responses. Small watersheds usually show larger responses in water yield than larger watershed with a similar level of harvesting. For example, harvesting 1649 ha in watershed 2501(48 km²) produced a maximum water yield increase of 11.1%, while harvesting 1396 ha in watershed 2502 (81 km²) increased water yield by 6.6%. The lower response in 2502 is attributed to its greater size and less disturbance (maximum % ECA 14% vs 30%). Larger watersheds will often have a mix of newly harvested areas, old harvest areas and uncut areas that moderate water yield increases.

² Natural variability is defined as long term mean annual flow ± 2 standard deviations.

Figure 7 Simulated increases in annual water yield for watershed 2501, Sundance Industries FMA. Watershed size 49.1 km², % harvested 34.3%, max water yield increase 11.1%, max% ECA 16%, hydrologic recovery 31 years. Arrow indicates time of hydrologic recovery ($\Delta Q \sim 5\%$).

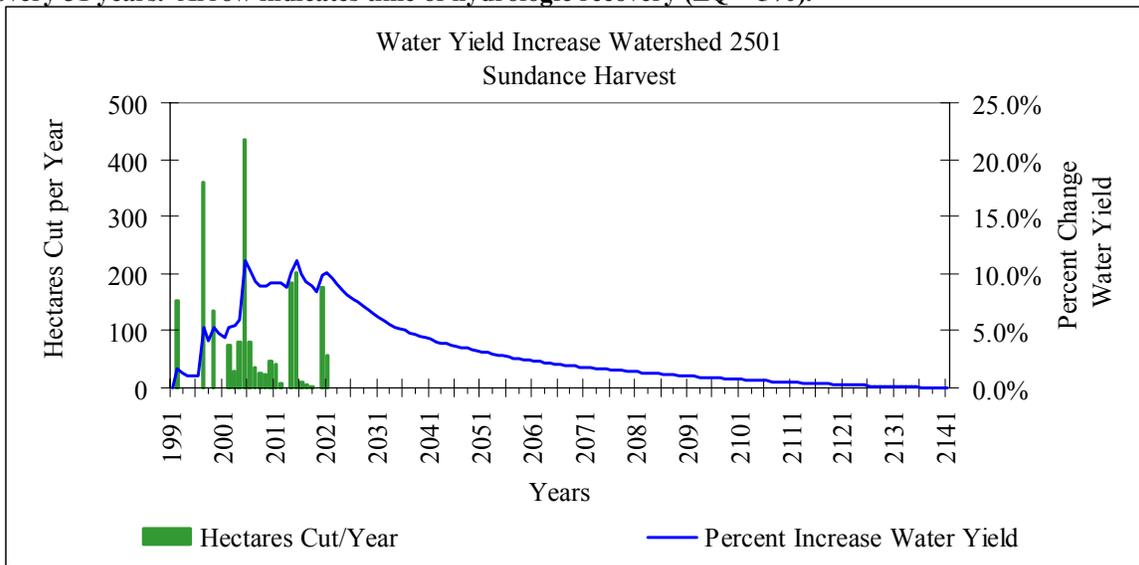
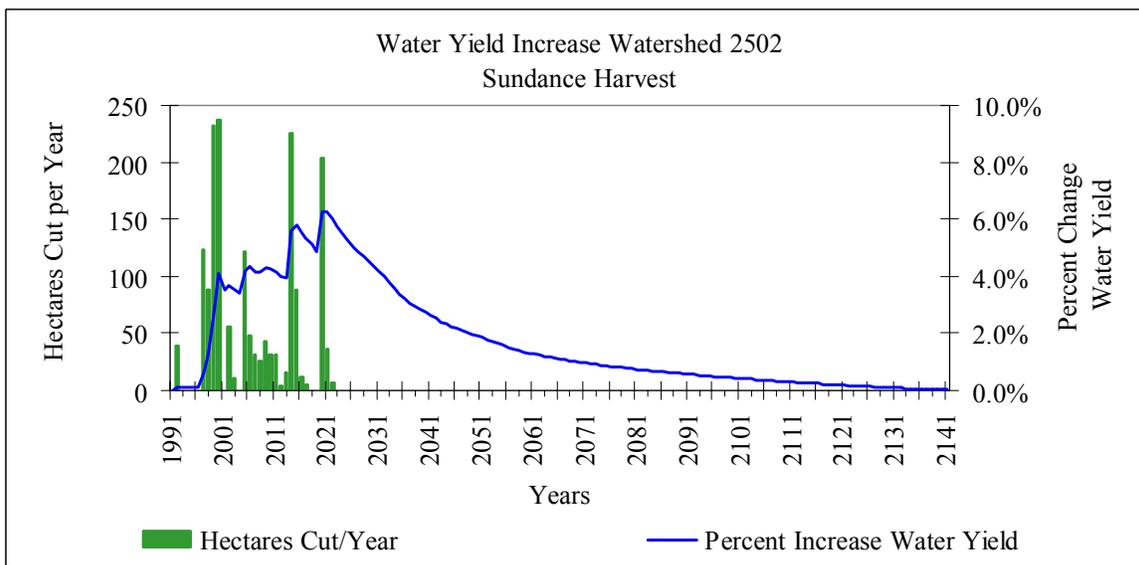


Figure 8 Simulated increases in annual water yield for watershed 2502, Sundance Industries FMA. Watershed size 81.2 km², % harvested 17.2%, max water yield increase 6.3%, max% ECA 8%, hydrologic recovery 5 years. Arrow indicates time of hydrologic recovery ($\Delta Q \sim 5\%$).



It should be noted that flow responses in WRENS simulations are strongly affected by the choice of representative watersheds used as a base to calculate percent increase. The Embarras River, Rat Creek and Brown Creek were representative watersheds in these simulations. These watersheds are bigger in area than the most of the watersheds assessed. Water yields from smaller watersheds are often greater than those of larger watersheds because the volume of flow is expressed on an areal basis. The significance of this is that the water yield increases from these simulations could be “over estimates”. Because of this it is best when interpreting these results to consider changes in flow in relative terms (low, med, high or acceptable unacceptable) and not as absolute numerical values.

Another point to consider is that watersheds or regions characterized by low annual flows will usually produce higher percentage increases in flow than those with high annual flow. This is evident for the south block-low elevation where Rat Creek with an annual flow of 183 mm was used compared to 224 and 427 for the Embarras River and Brown Creek. Ideally representative watersheds should be of similar size, topography vegetation and climate. This is often not possible. An effort was made to account for this by stratifying flows within the FMA, but there is no substitute for good data. Access to flow data for small to medium sized watersheds would make simulations more reliable.

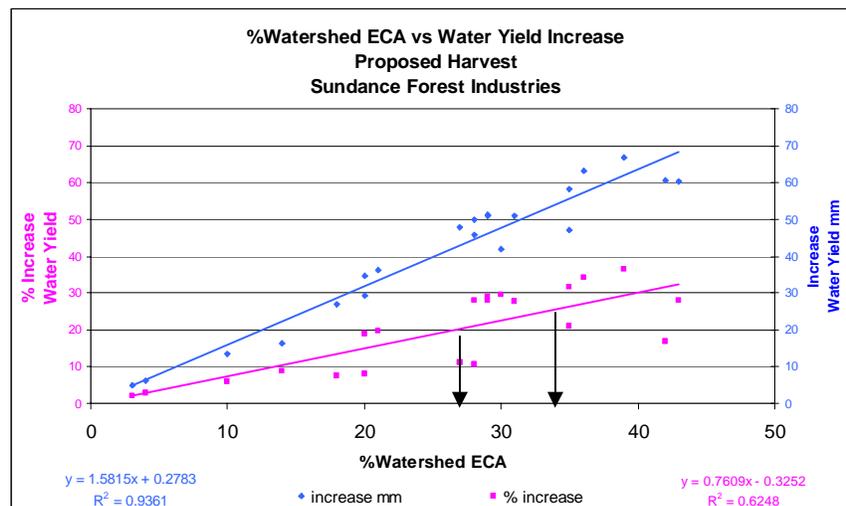
Hydrologic Recovery and %ECA

Hydrologic recovery is primarily controlled by the magnitude of water yield increases or the area and frequency of harvesting in a watershed (Figures 7, 8). Recovery will usually be shortest for a single harvest in a watershed followed by a period of no harvesting. Sustained or frequent harvesting will prolong the time for hydrologic recovery, with water yield elevated for long periods of time.

Hydrologic recovery in the watersheds averaged 14 years with minimum and maximum values of 0 and 41 years. These results appear to be reasonable but should also be used in relative terms (short, medium, long) and not as absolutes because of the uncertainty of methods and data used to estimate recovery.

Percent ECA may be a better metric than hydrologic recovery for planning purposes as it is based on sampled growth and yield data or simulated output supported by such data. However to be a useful tool ECA values should be based or referenced to “acceptable” levels of change for water yields and peak flows. Figure 9 illustrates how %ECA and water yield increases can be compared and used for planning purposes. For example, if water yield increases of 20-25% were considered “acceptable” %ECA levels of 27-37% could be used as targets/limits for watershed disturbance.

Figure 9 Regression of water yield increases on %Watershed ECA for harvest proposed by Sundance Forest Industries.

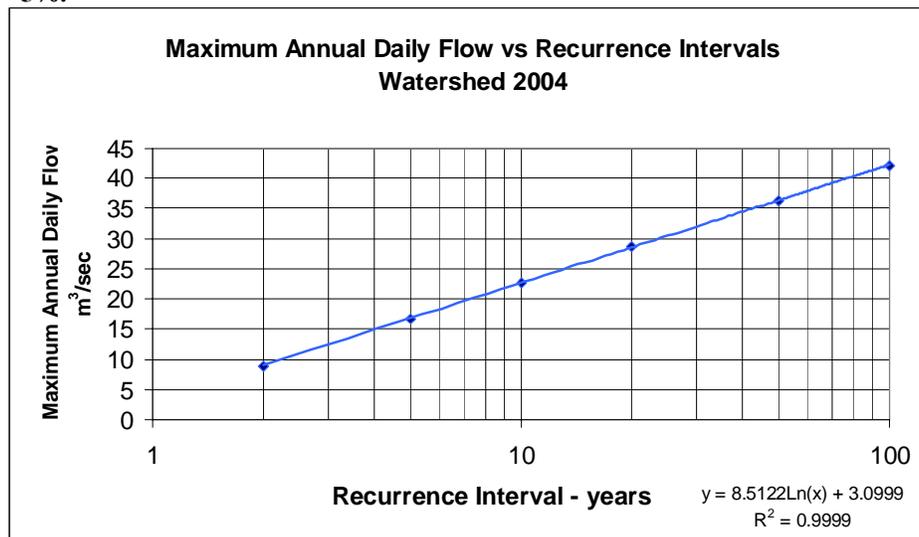


Peak Flows

Increases in peak flows following forest harvesting are also determined by the extent and frequency of forest harvesting and the climate and hydrology of a watershed. Increases in the magnitude and frequency of 2-5 year recurrence interval peaks are of concern. Recent literature suggests that sustained increases of $\geq 50\%$ in bankfull discharge³, which is defined equivalent to the 1.5-2 year recurrence interval events, can contribute to permanent changes in stream channel morphology and aquatic habitat (Guillemette et al 2005; Verry 2004). Such changes are slow to develop and are usually expressed by widening, deepening and loss of sinuosity in stream channels along with attendant changes in aquatic habitat. Such changes are slow to develop, possibly taking 60-100 years to become noticeable.

The largest increase in simulated maximum annual daily flow in these simulations was 11.1% ($8.9 \text{ m}^3/\text{sec}$ to $9.88 \text{ m}^3/\text{sec}$) for the 2 year event in watershed 2004. The change in frequency for the “new” 2-year event was 5% (Figure 10). What this means is that prior to harvesting a flow of $9.88 \text{ m}^3/\text{sec}$ could be expected to occur 45 times per 100 years. After harvesting, as the new 2-year event, it can be expected to occur 50 times per 100 years. This assumes that the variability and distribution of the population has not changed.

Figure 10 Maximum annual daily flow versus recurrence intervals Watershed 2004. 2-year event = $8.9 \text{ m}^3/\text{sec}$ was increased by 11.1% to $9.88 \text{ m}^3/\text{sec}$. Recurrence interval prior of harvesting for a flow of $9.8 \text{ m}^3/\text{sec}$ was 2.22 years, which means such a flow can be expected ~ 45 time/100 years. Following harvesting as the new 2-year event it can be expected to occur ~ 50 times/100 years. Its frequency of occurrence has increased by $0.50 - 0.45 = 0.05 \sim 5\%$.



The increases in magnitude shown for these simulations fall short of the 50% threshold level suggested in the literature (Guillemette et al 2005; Verry 2004). Based on experience elsewhere in the province, the larger increases will likely exceed the range of natural variability of peak flows for the region. An analysis of annual maximum daily flows in the Grande Prairie region indicated increases $\geq 12\%$ - 23% could exceed the “natural variability” of 2-4 year events (Watertight Solutions 2005).

³ Bankfull discharge is the flow that completely fills a stream channel to the tops of its banks. The recurrence interval of bankfull discharge is assumed to be 1.5-2 years.

Summary and Conclusions

Hydrologic assessment of a proposed harvest plan by Sundance Forest Industries indicated the following:

Water Yield

- ▶ Simulated increases in annual water yield of 11.1%- 17.8% were significantly greater than representative flows on 10 of 24 watersheds. Most of these watersheds were located in the Low Elevation South Block of the FMA where water yield was lowest.
- ▶ These increases may exceed the upper limits of natural variability for water yield for the region based on experience elsewhere. An analysis of flow variability for the region is needed to confirm this observation.
- ▶ These increases in water yield were attributed to high levels of harvesting which removed 30% - 47% of forest cover in the watersheds.
- ▶ On the remaining 14 watersheds water yields were not significantly different from representative flows with simulated increases ranging from <1% – 8.5%. Forest cover removal in these watersheds varied from <1% - 29%.
- ▶ Low responses in water yield in watersheds with harvest levels of 20%-29% were the result of a mix of historical harvesting prior to the proposed harvest for 2006-2026. Hydrologic recovery of historical blocks was advanced which moderated water yield increases.

Hydrologic Recovery

- ▶ Hydrologic recovery, the time for water yield increases to disappear or approach “pre-harvest levels”, was assumed to occur when increases in water yield were $\leq 5\%$.
- ▶ Hydrologic recovery, averaged 14 years for all watersheds, with minimum and maximum values of 0- 41 years.
- ▶ Hydrologic recovery for watersheds with significant increases in water yield averaged 23 years, with minimum and maximum values of 16 and 41.
- ▶ Hydrologic recovery in watersheds with no significant increase in water yield averaged 4 years, with minimum and maximum values of 0 and 15.
- ▶ Watersheds with zero years for recovery occurred in watersheds with harvesting < 10% of watershed area, or where increases in water yield were $\leq 5\%$.

% Watershed ECA

- ▶ Watershed Equivalent Clearcut Area (ECA) was based on the return of increased water yield to “pre-harvest” conditions.
- ▶ %ECA for watersheds with significant increases in water yield averaged 23% with minimum and maximum values of 16% and 31%.
- ▶ %ECA for watersheds with no significant change in water yield averaged 11% with minimum and maximum values of 1% and 26%.

Peak Flows

- ▶ The largest simulated increases in maximum daily flows for the 2-year and 5-year events occurred in watersheds with high levels of harvesting (41%-47%).
- ▶ Increases for the 2-year and 5 year events varied from 8.3%-11.1% and 8.3% - 11.5% respectively.
- ▶ Increases in watersheds with less harvesting (1.3%-21.7%) for the 2-year and 5-year events ranged from <1% - 4.7%.
- ▶ Increases in peak flows showed a decreasing trend with an increase in recurrence intervals. The trend varied from strong for watersheds with high levels of harvesting to weak or nonexistent for watersheds with less harvesting.
- ▶ Increases for maximum flows were judged to fall within the range of natural variability

In conclusion the simulated increases in water yield and peak flows for the proposed harvesting by SDI are considered small to moderate in magnitude and duration. The high levels of harvesting in watersheds with maximum increases were moderated by the existence of historical harvesting. Based on current knowledge and experience no adverse impacts on water quality and aquatic habitat are expected, contingent upon the application of existing ground rules.

Increases in water yield and peak flows can be managed by rescheduling and reducing in the level of harvesting. This is not necessary for the current plan, but future harvesting should include considerations for hydrologic recovery to minimize the potential for cumulative impact on water yield and peak flows. Frequent entries into a watershed will sustain water yield increases and delay hydrologic recovery.

The current plan also includes strategies to minimize the impacts and spread of anticipated mountain pine infestations by harvesting a large component of mature pine stands in watersheds. The simulated changes in water yield and peaks for this plan are modest when compared to potential impacts if stands are attacked and destroyed by mountain pine beetles (Love 1955; Troendle and Nankervis 2000; Unil et al 2006; Forest Practices Board 2007).

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Appendix 1 WRENS

WRENS

WRENS (Water Resource Evaluation for Non-Point Silvicultural Sources) was developed by the U.S. Forest Service and the U. S. Environmental Protection Agency (EPA 1980). WRENS was designed to be used as an operational tool for forest planning. It is relatively simple in concept and has modest data requirements. It is not a “high end” research model designed to simulate daily flows (i.e. routed runoff).

Swanson (1997) prepared a computer version of the procedure (WRENS) for Alberta conditions and modified it by linking climate and flow databases to the program. WRENS uses long-term monthly precipitation, annual flow data from representative watersheds, GIS-generated harvest data, watershed characteristics, and growth functions to estimate changes in annual water yield. Swanson also included methods for estimating changes in peak flows for 2, 10, 20, 50 and 100 year recurrence intervals. Estimates of watershed disturbance in terms of equivalent clear-cut area (ECA) (Ager A. A. and C. Clifton. 2005) based on recovery of basal area or water yield increases are included in WRENS. Version 3.0 of WrnsEcaAb (Swanson 2000) was used in this assessment.

Estimated changes in annual water yield are based on seasonal water balance calculations of generated runoff (GRO), which is water that will eventually become runoff but has not reached the stream channel. Increases in water yield (ΔQ) are a change in evapotranspiration (ΔET) resulting from the removal of forest cover. Increases in water yield are obtained by taking the difference in GRO before and after harvesting.

$$\text{Eq.1 } \text{GRO} = \text{Input} - \text{Losses} = P - ET \pm \Delta S$$

P = precipitation
ET = evapotranspiration losses
 ΔS = change in watershed storage.

$$\text{Eq.2 } \Delta Q \sim \Delta ET = (P_{\text{after harvest}} - \text{GRO}_{\text{after}}) - (P_{\text{before harvest}} - \text{GRO}_{\text{before}}), \text{ where precipitation before and after harvest is assumed to be the same.}$$

GRO is strongly affected by watershed storage and in the short term may not equal actual flow (Q_A). Over the long-term however $\text{GRO} = Q_A$ as average annual change in watershed storage approaches zero ($\Delta S \sim 0$). Long term precipitation and streamflow data are essential for the application of WRENS.

Increases in water yield in WRENS are expressed as area-millimeters (area-mm) and percentages. Area – mm is the volume of increased flow (or reduced ET) expressed as a uniform depth over a watershed. Increases in water yield are expressed as percents of the mean annual water yield (base yield in WRENS) for the watershed being analyzed or a nearby representative watershed, which is of similar size, forest cover and climate (i.e. precipitation).

Percent increases should be considered as relative changes (e.g. small, medium, and large). Few if any models are capable of providing exact, absolute outputs. Furthermore, annual water yields are highly variable among watersheds and hydrologic regions. For example, annual yields in some years in boreal forest watersheds can be 0-100 mm, while in the Rocky Mountains water yields can be 400-800 mm. An increase of 40 mm in a Rocky Mountain watershed would be a small percentage compared to a similar increase in a boreal forest watershed. Percentages must be carefully interpreted.

Water responses provided by WRENSS are cumulative in that they can show both water yield increases and the rate of hydrologic recovery, which is the time for evapotranspiration and water flows to return to pre-harvest levels. Hydrologic recovery in WRENSS is estimated in two ways. The first is the traditional approach based on the recovery of basal area to pre-harvest conditions with the establishment of forest regeneration. Recovery occurs when current basal area equals maximum basal area for a given site. The second is based on the recovery of simulated water yield increases to pre-harvest or undisturbed conditions ($\Delta Q \sim 0$). Hydrologic recovery based on water yield was defined as the time required for the maximum increases in annual flow (or peak flows) to decrease to levels equal to or less than 1%. The time required for hydrologic recovery is a function of the amount and frequency of harvesting in a watershed, and the occurrence and rate of growth of forest regeneration.

Equivalent Area Clearcut (ECA) is an index of hydrologic recovery. It is a measure of the disturbed area (i.e. harvest blocks) in a watershed that is in a condition to contribute extra water to streamflow. ECA is at a maximum at the time of harvest and then decreases with the establishment and growth of regeneration. The physical model supporting ECA is that vegetation removal changes water yield in rough proportion to the leaf surface area or basal area removed from a site (Ager and Clifton 2005).

ECA is defined as the area harvested times a reduction factor that describes the recovery of evapotranspiration losses. ECA estimates in WRENSS are provided in terms of basal area recovery (Eq.3) and recovery of water yield (Eq.4). ECA is expressed in hectares of harvested area and as a percent of the harvested area. %ECA in this assessment was reported as a percent of watershed area, which is hydrologically more informative.

$$\text{Eq.3} \quad ECA_{BA} = \frac{BA_{\text{current}}}{\text{Max } BA} \times \text{Harvest Area}$$

Max BA = maximum basal area possible for a given site
 BA_{current} = basal area for year -n of a specified time series

$$\text{Eq.4} \quad ECA_Q = \frac{\Delta \text{Yield}_{\text{current}}}{\Delta \text{Yield}_{\text{max } Q}} \times \text{Harvested Area}$$

$\Delta \text{Yield}_{\text{max } Q}$ = maximum water yield increases in a given time series
 $\Delta \text{Yield}_{\text{current}}$ = water yield increase for year- n in a given time series

It should be noted that hydrologic recovery based on ECA_Q includes both recovery of basal area and the effects of snow redistribution in harvest blocks (i.e. snow scour/sublimation). Hydrologic recovery based on maximum water yield increase can be shorter by half the number of years obtained with basal area. ECA_Q is considered a more direct and realistic estimate of hydrologic recovery, and was used in this report.

WRENSS also estimates increases in maximum daily and instantaneous flows due to harvesting for return periods of 2, 5, 10, 20, 50 and 100-year events. WRENSS uses watershed area to estimate peak flows ($Q_{\text{peak-area}}$) for all return periods in the unharvested condition. The difference between the mean March to September streamflow in the unharvested and harvested condition is used to estimate the change in peak flow ($Q_{\text{peak mean flow}}$) caused by harvesting for each return period. The difference in $Q_{\text{peak mean flow}}$ between the harvested and unharvested conditions is added to $Q_{\text{peak-area}}$ to obtain the maximum flow for a given return period.

In WRENSS the maximum change in peak flow attributable to the effects of forest harvesting is constrained by the maximum reduction in daily evapotranspiration rate (i.e. the volume of extra water made available by harvesting), estimated by WRENSS for a completely undisturbed watershed.

In some situations (e.g. high precipitation) the change in peak flow can exceed the daily maximum evapotranspiration rate. When this occurs it is area weighted with respect to the amount of disturbance in the watershed. For example, if the maximum evapotranspiration was 5.0 mm/day and 47% of the watershed was undisturbed, it would be reduced to 2.65 mm/day (e.g. $5.0 \text{ mm/day} \cdot (1 - 0.47) = 2.65 \text{ mm/day}$ or $4.13 \text{ m}^3/\text{sec}$). The adjusted value would then be added to the estimated peak flow (i.e. $Q_{\text{peak-area}}$).

This constraint is built into the WRENSS program. The assumption inherent in this constraint is that the increase in peak flow generated by harvesting “alone” is controlled by the maximum reduction in daily potential evapotranspiration. Under these conditions the increase in maximum daily flows attributable to harvesting can be similar for a range of return periods, and persist for sustained periods until evapotranspiration recovers with regrowth of harvested areas. When this occurs, a plot of peak flow increases will appear to be flat or truncated.

WRENSS simulations can be based on average, maximum or minimum precipitation conditions. For average conditions, estimated changes in flow are what can be expected in an “average” year. WRENSS cannot provide an estimate of the effects of climatic variation on water yield and peak flows. Simulations for maximum or minimum conditions can provide an estimate of the effects of climatic extremes. In years of high precipitation flow changes would be larger and in years of low precipitation smaller. Precipitation inputs are constant for the length of a simulation and conditions being simulated.

WRENSS does not estimate flow for ungauged basins and does not produce routed stream flow (i.e. it does not indicate how much water will flow on a given day). It also does not carry over surpluses or deficits from one year to the next. The reliability of results from WRENSS can only be as good as the precipitation and flow data used. If precipitation data is representative, accurate and of sufficient duration, then WRENSS will provide an estimate of average annual water yield that is generally within 10% of measured water yield (Swanson 2000). However, it is important to remember that most precipitation data is usually under estimated.

Appendix 2 Data requirements for WRENSS Simulations

To run a WRENSS simulation two files are required. The first is a “control” file containing information describing a watershed and the streamflow data and precipitation data to be used in the simulation (Table 1). The second is a unit file containing information for each harvest clock to be harvested in the watershed (Table 2)

Table 1 – Watershed data for WRENSS simulations (Control File)

Field name	Type	Size	Dec	Description
SCENARIO	C	100		Joint identifier to link this table with the harvested blocks in tbl_Units. This name must be the same as the one used for all of the harvested blocks in any given scenario, usually a watershed.
AREA_CUT	N	20	5	Total area of the scenario or watershed in km ² .
WS_STATION	C	100		The name or identifier of a stream gauging station in the Foothills Model Forest Area. Can be supplied at run time.
WS_YIELD	N	20	5	Supplied by link to WS_STATION at run time.
WS_STAT	C	6		Unless specified as Max or Min, defaults to Avg at run time.
WS_PERIOD	C	9		Supplied by link to WS_STATION at run time.
WS_REGION	C	100		The name of the type of analysis used in peak flow determinations, Instantaneous Max or Daily Max. Can be supplied at run time.
REGION	C	5		WRENSS regions CM or RM only. Can be supplied at run time.
WX_SOURCE	C	100		The name or identifier of a weather station in the Foothills Model Forest Area. Can be supplied at run time.
WX_STAT	C	6		Unless specified as Max or Min, defaults to Avg at run time.
WX_PERIOD	C	9		Supplied by link to WX_STATION at run time.
ANNUAL_PPT	N	20	5	Supplied by link to WX_STATION at run time.
BASE_YEAR	N	6	0	Default of 1-year prior to earliest year in the BLK_YRCUT field in tbl_Units is supplied by WrnsSdr at run time. Any year earlier than the first year cut can be supplied by the user.
START_YEAR	N	6	0	Default of 1-year prior to earliest year in the BLK_YRCUT field in tbl_Units is supplied by WrnsSdr at run time. Any year earlier than the first year cut can be supplied by the user.
END_YEAR	N	6	0	Default of 100-years after the START_YEAR is supplied by WrnsSdr at run time. This default of 100 years can be changed in the WrnsSdr Global Options form. Any year later than the first year cut can be supplied by the user.
RECORDNO	N	10	0	The user should not enter any information into this field. It is used internally within WrnsSdr.

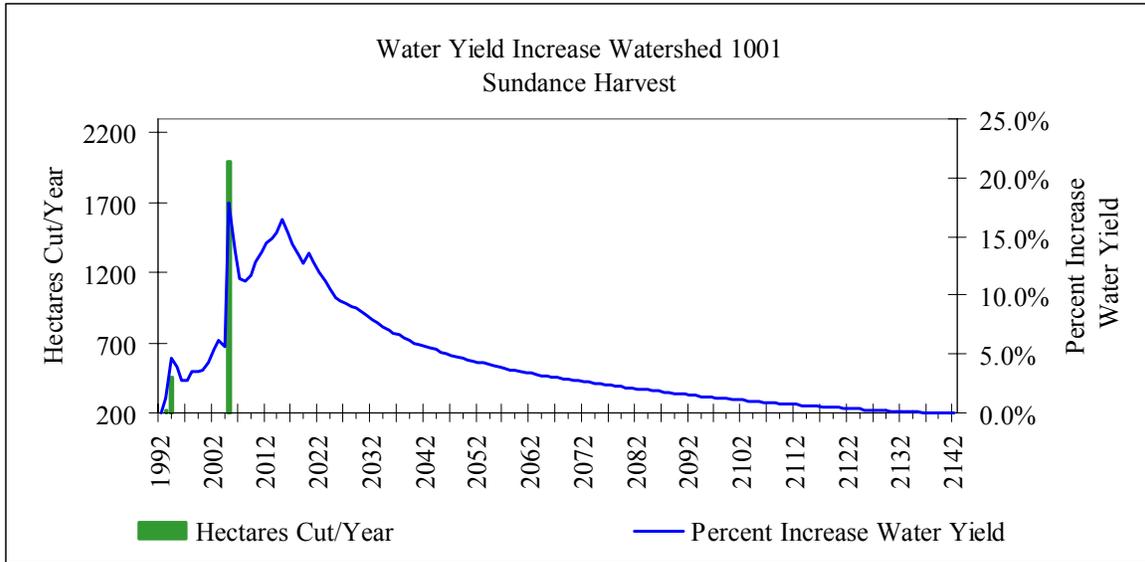
Table 2 – Harvest data for WRENSS simulations (Unit file)

SCENARIO	Title of scenario being tested.
AREA CUT	Area of harvested unit in hectares
NUMBLOCKS	Number of blocks comprising the harvested unit. This field and the BLKSIZE field allow the grouping of several blocks of similar size, species, aspect and year of harvest into one area. The Total area of all of these similar blocks goes into AREACUT field, and either the number of blocks comprising that area go into this field or the average size of the individual block goes into the BLKSIZE field.
BLKSIZE	The size of individual blocks in hectares
BLK YRCUT	The year the block or group of blocks was cut in yyyy format.
BLK ELEV	The average elevation of the block or group of blocks in meters. Used in WRNSSDR-MF to adjust precipitation data from a different elevation to that the cut blocks being analyzed.
BLK ASPECT	The average aspect of the block as N, S, or EW. Aspect is used in conjunction with precipitation to estimate potential evapotranspiration. Maximum potential ET on south aspects and minimum on north aspects.
BLK REGEN	The species that the block is to be regenerated on a block. Lodgepole Pine, White Spruce or Deciduous are the only appropriate choices.
BUF SPECIES	The species of the surround stand, again LPP or WS or Deciduous are the only appropriate choices. Used to estimate species harvested on existing cut blocks.
BUF BA	The basal of the surrounding stand in m ² /ha. Used to estimate basal on existing cut blocks.
LUT BASEBA	The anticipated basal area of regeneration on the site at maturity, or the number of years in the rotation. Represents maximum basal area in ratio to adjust ET upwards or downwards.
LUT BAYEAR	The anticipated number of years to reach the basal area at maturity or the number of years in the rotation.
IN BAFUNCT	The name of the basal area growth function for regeneration in the unit. This is assigned during operation of WRNSSDR-MF.
BUF HT	The height of the surrounding stand in meters. Used to estimate redistribution effects of snow movement in cut blocks and surrounding stands.
LUT BASETH	The anticipated height of the regeneration on the site at maturity or at the end of the rotation.
LUT THYEAR	The anticipated number of years to reach the height of maturity, of the number of years in the rotation.
IN THFUNCT	The name of the height growth function for regeneration in the unit. This is assigned during operation of WRNSSDR-MF.
IN RECORD	Block ID. This may be changed to a 15 character wide field if necessary to identify your blocks. This is not used in WRNSSDR-MF runs.

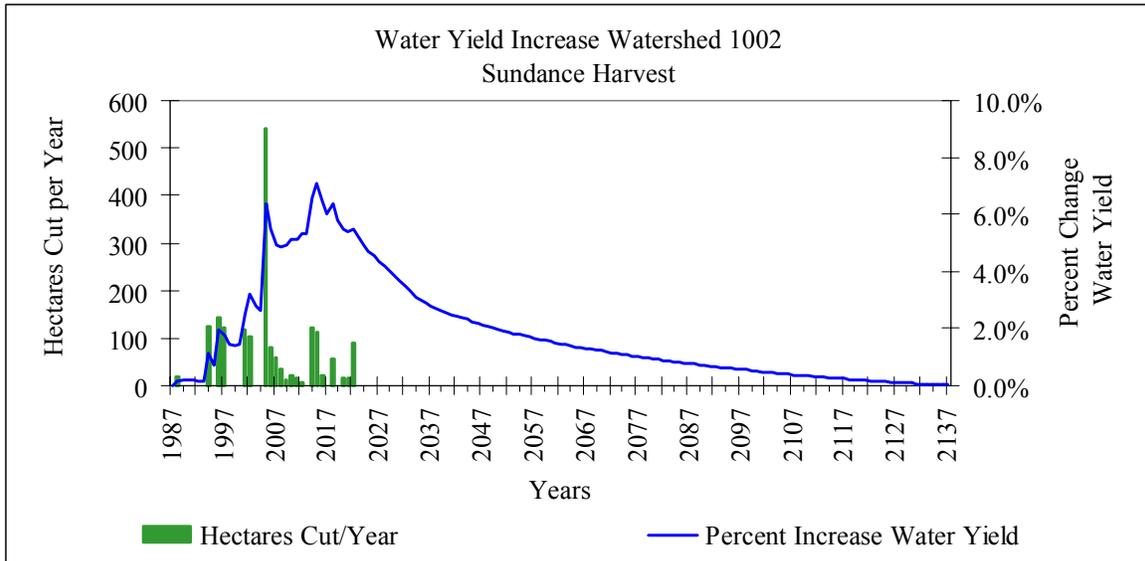
Appendix 3 WRENSS Water Yield Responses to Harvesting

The content of this appendix includes plots of annual water yield increases and hectares harvested per year for each watershed simulated.

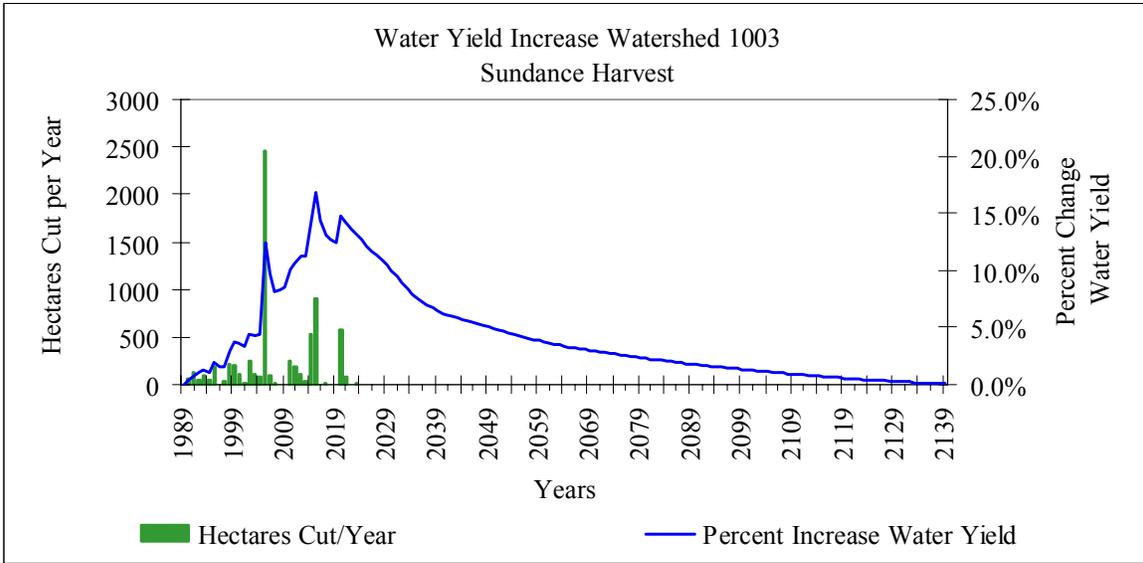
Watershed 1001



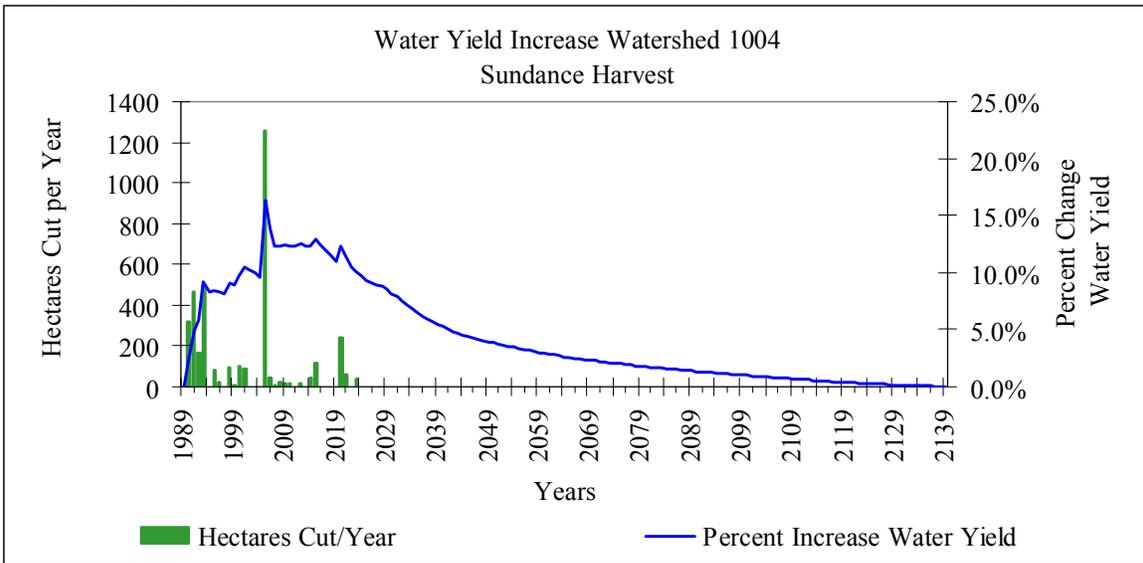
Watershed 1002



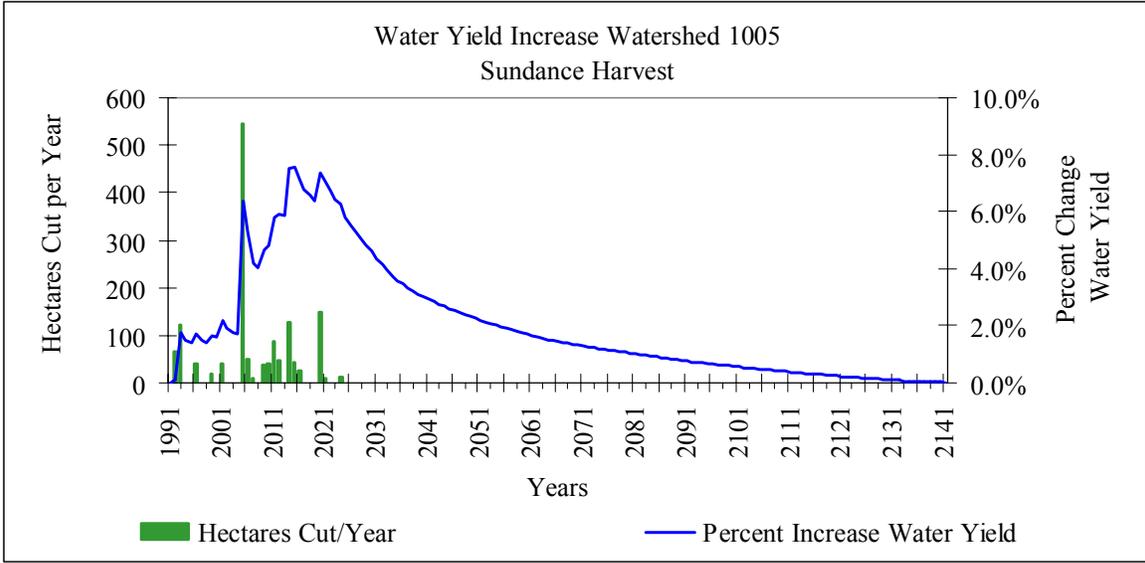
Watershed 1003



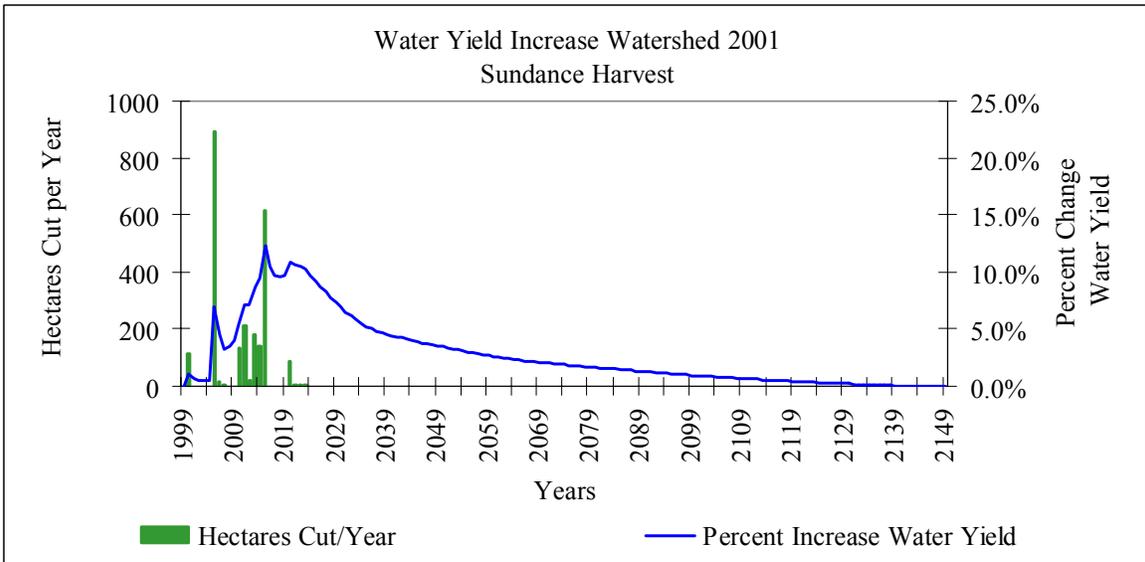
Watershed 1004



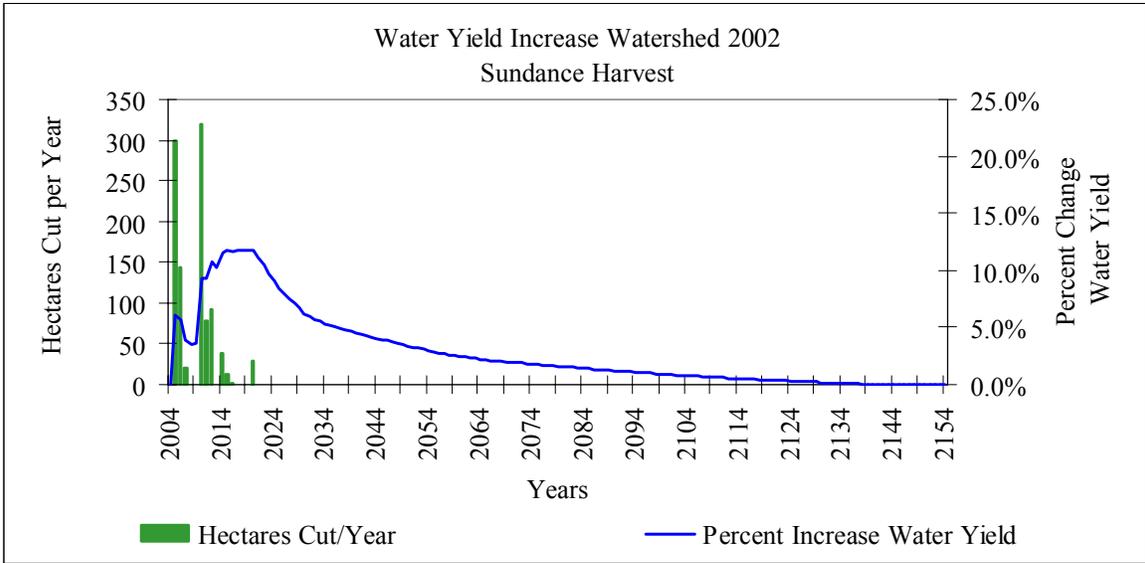
Watershed 1005



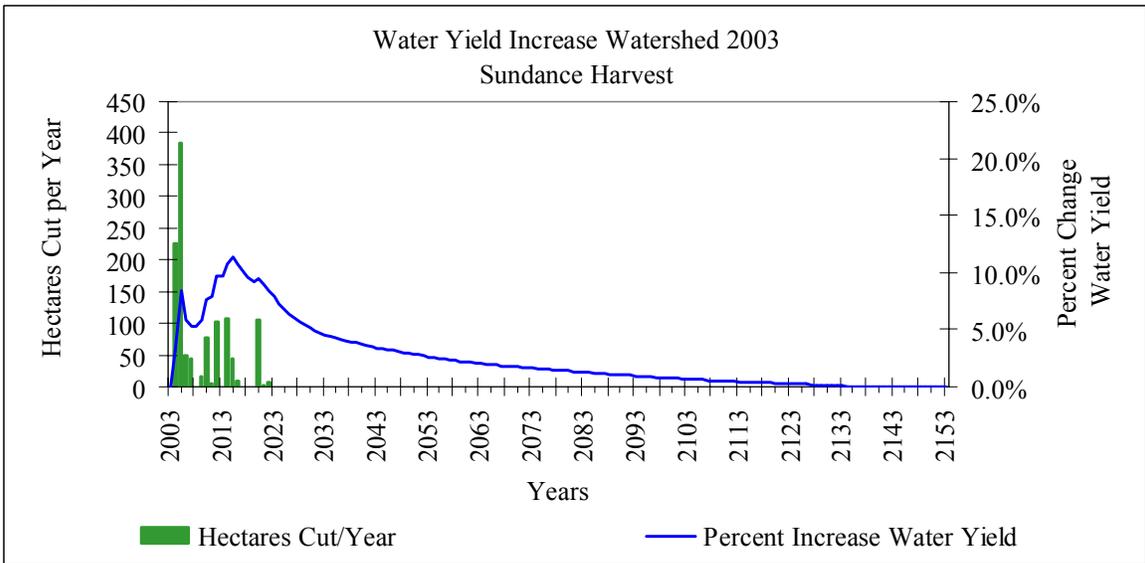
Watershed 2001



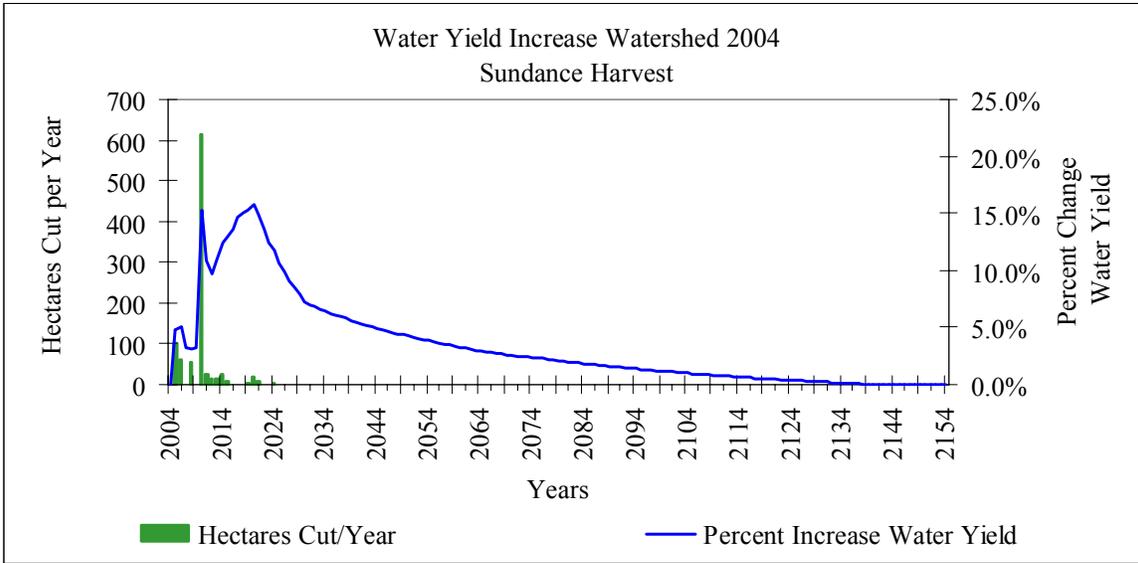
Watershed 2002



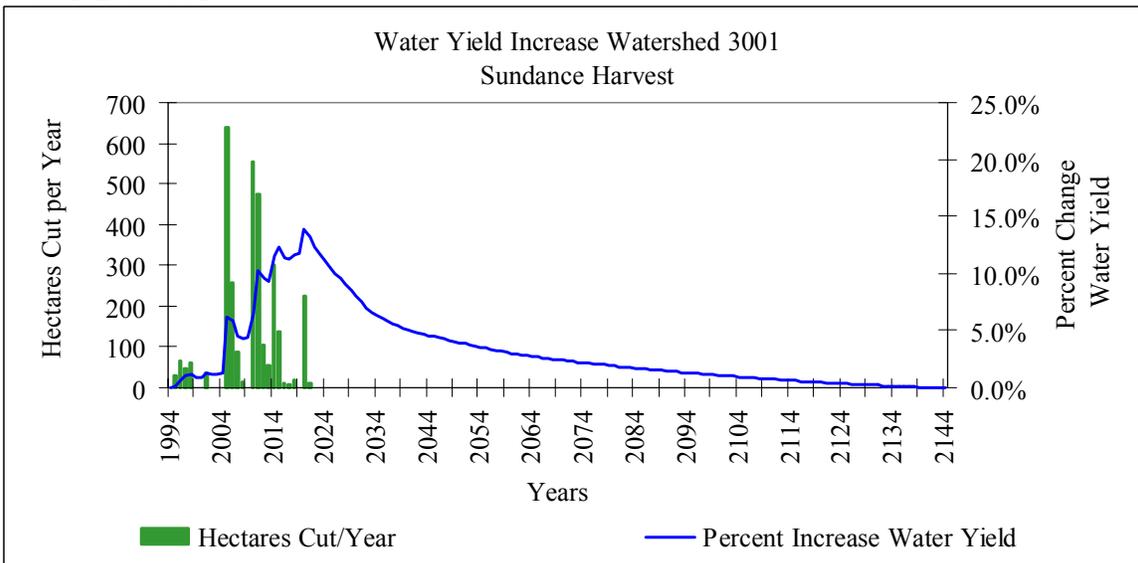
Watershed 2003



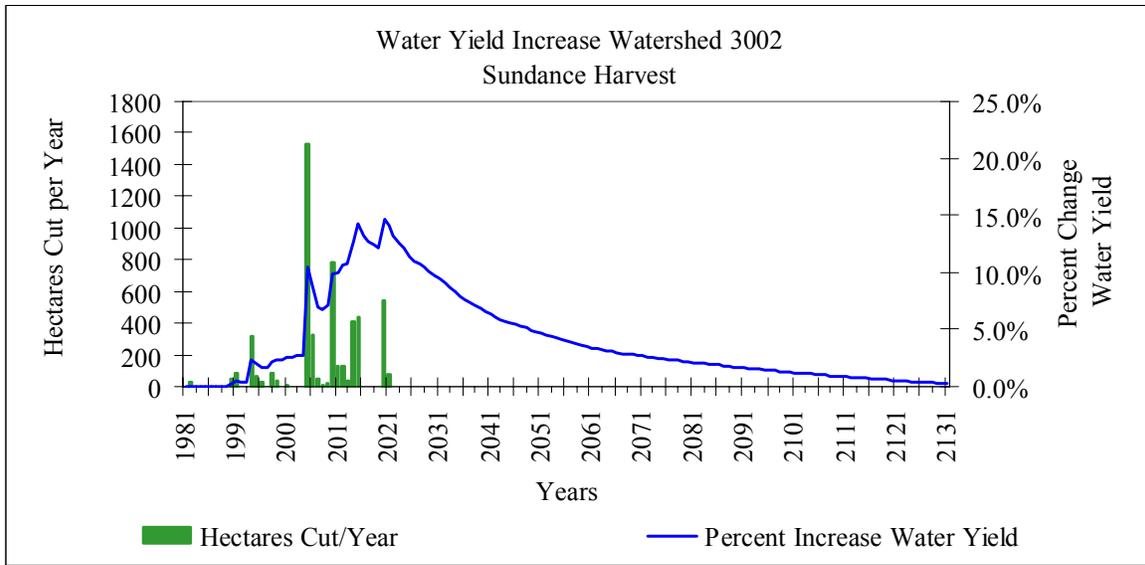
Watershed 2004



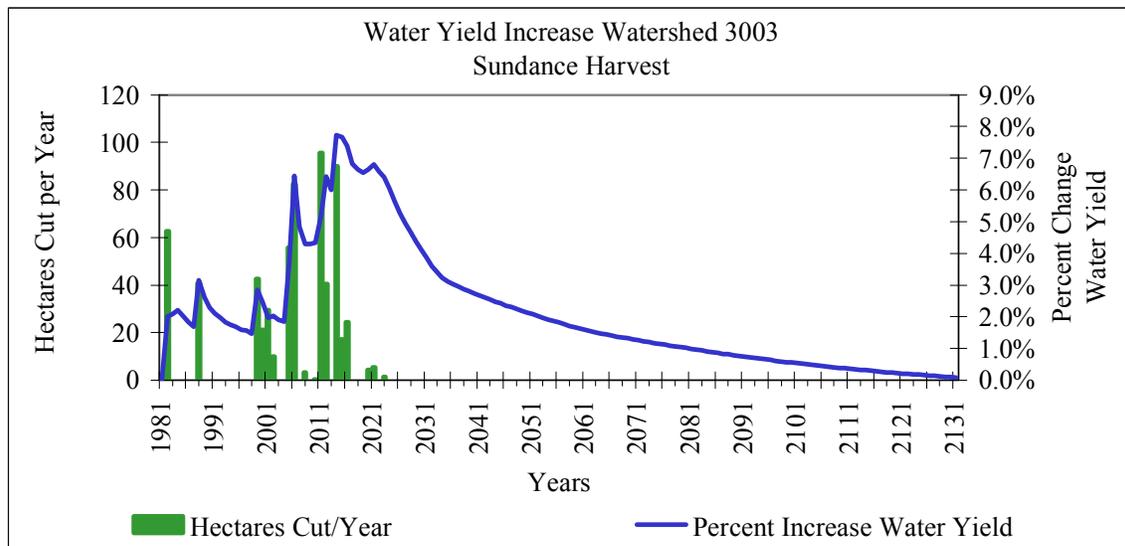
Watershed 3001



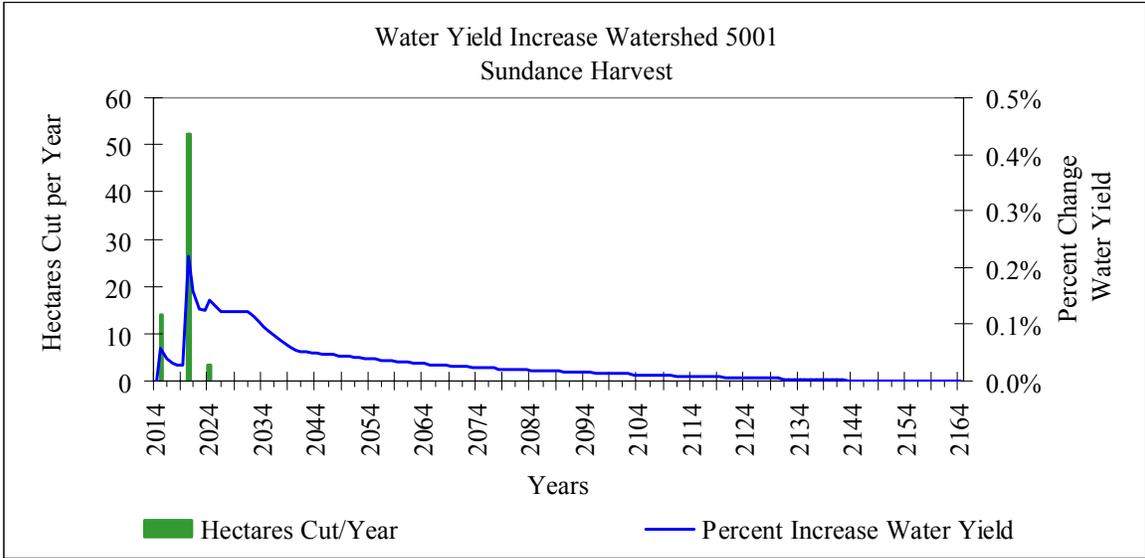
Watershed 3002



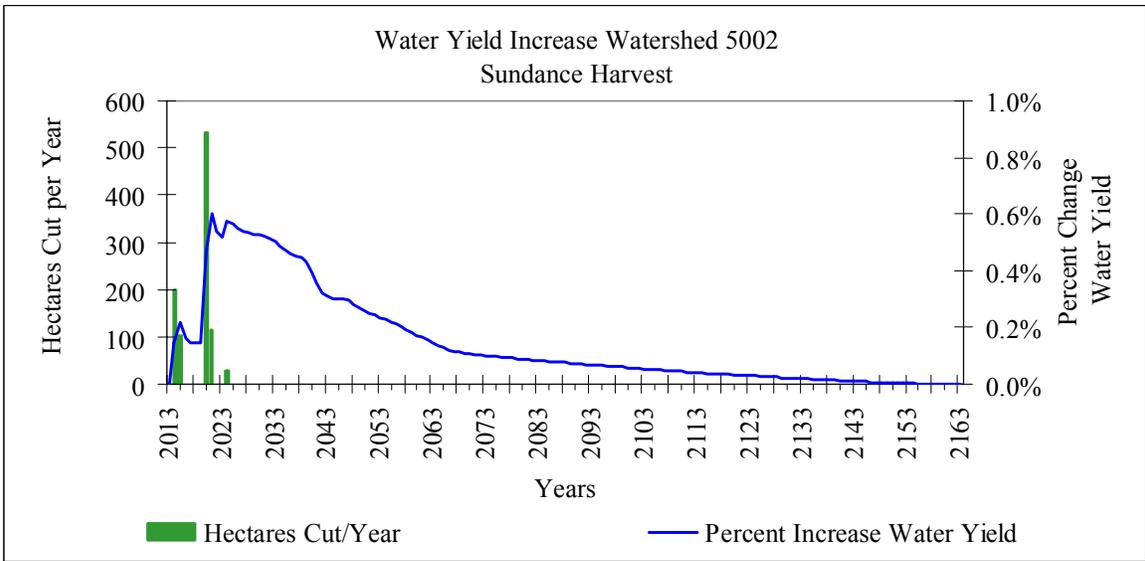
Watershed 3003



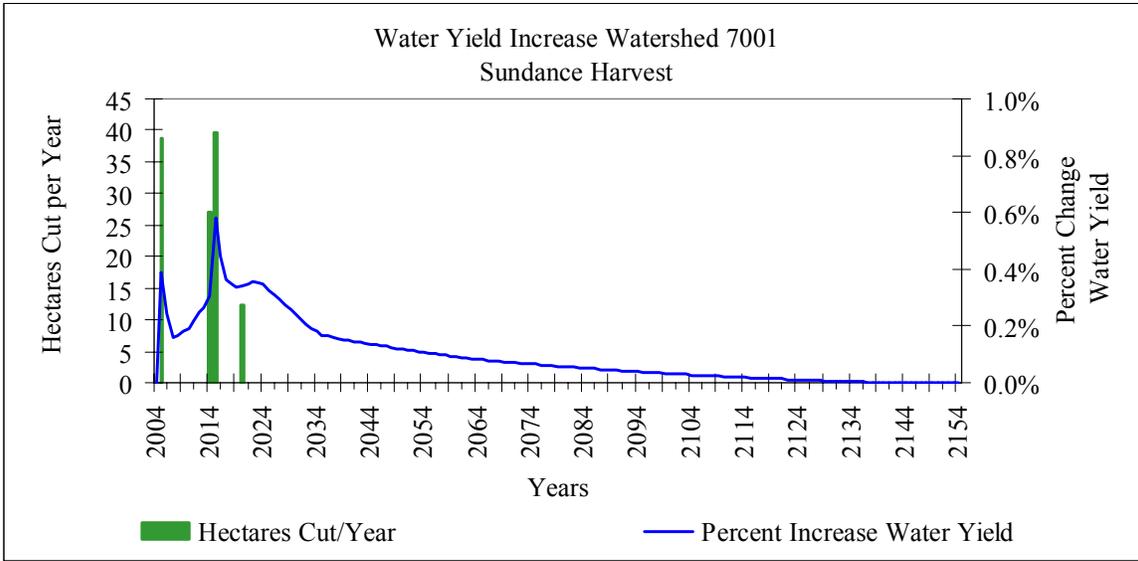
Watershed 5001



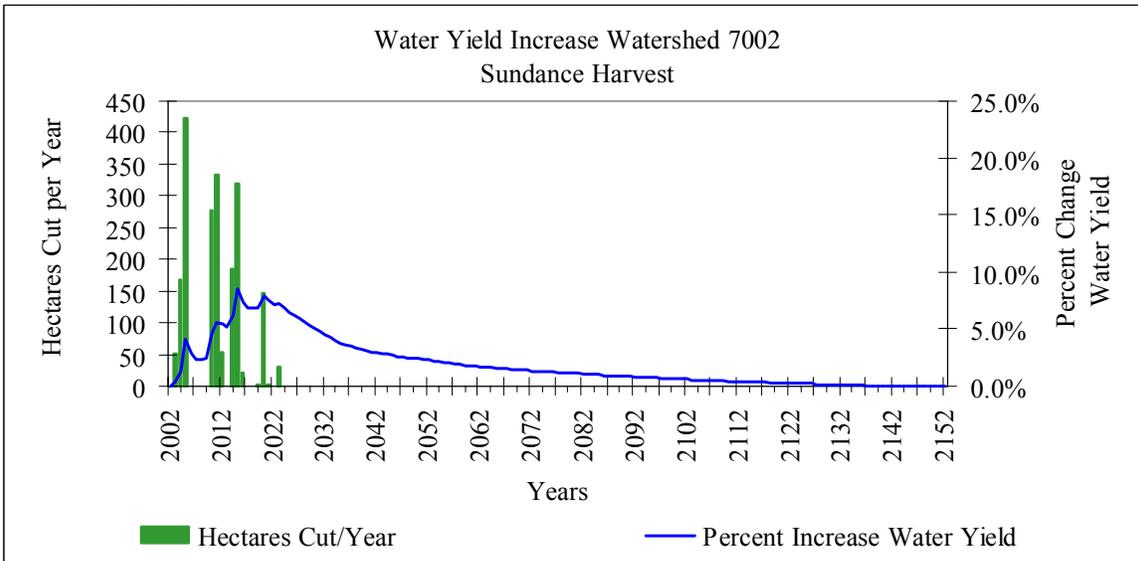
Watershed 5002



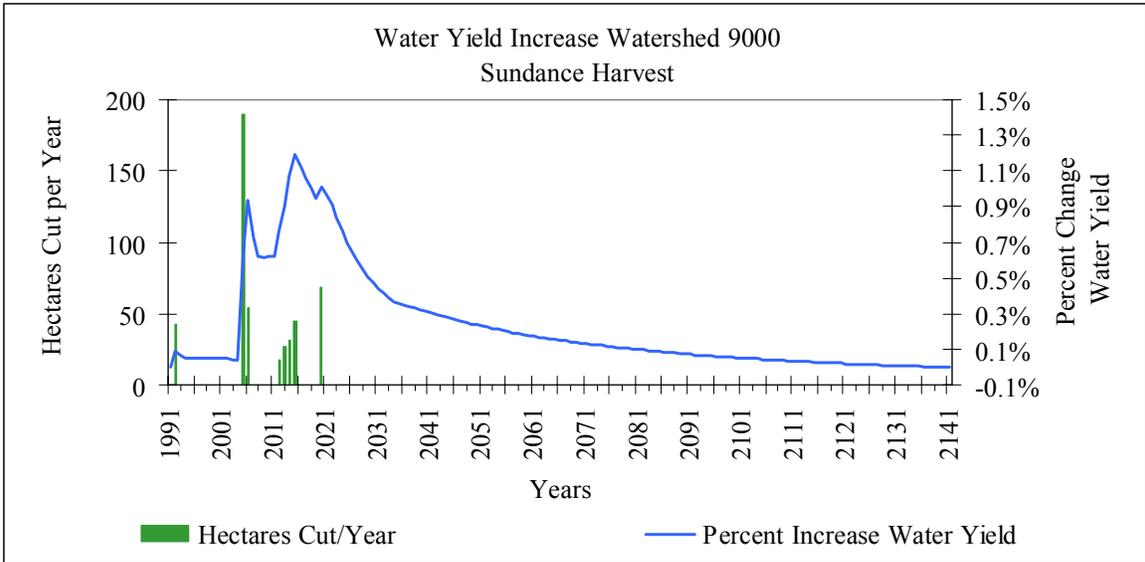
Watershed 7001



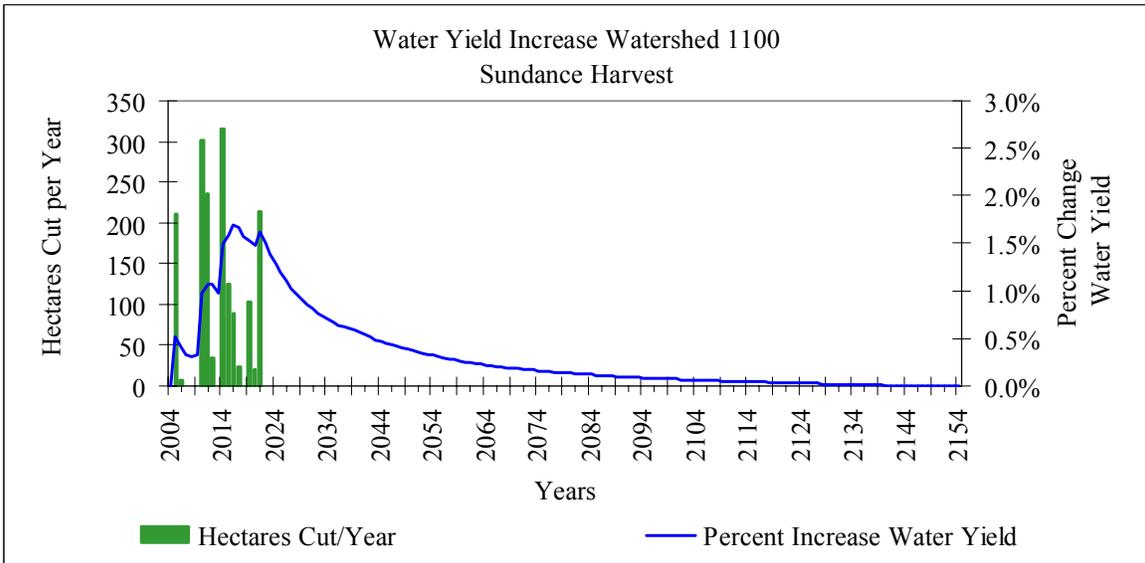
Watershed 7002



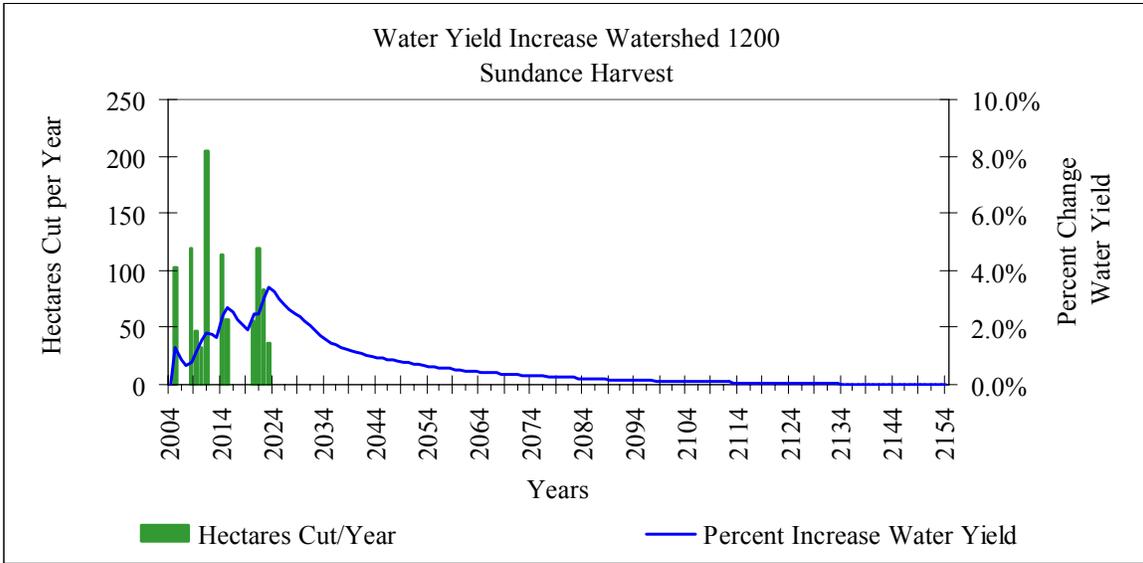
Watershed 9000



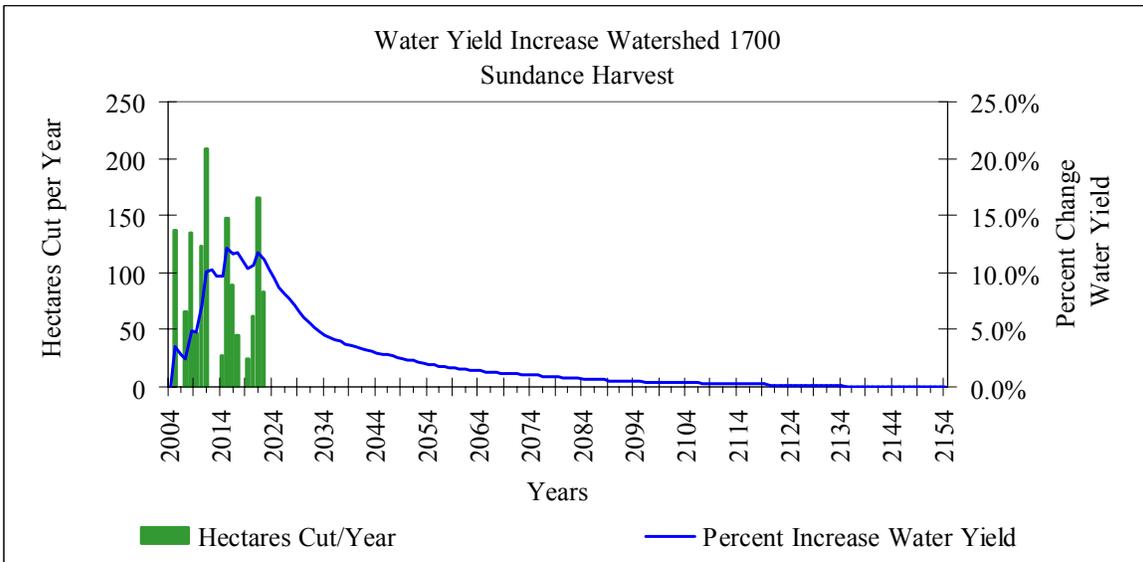
Watershed 1100



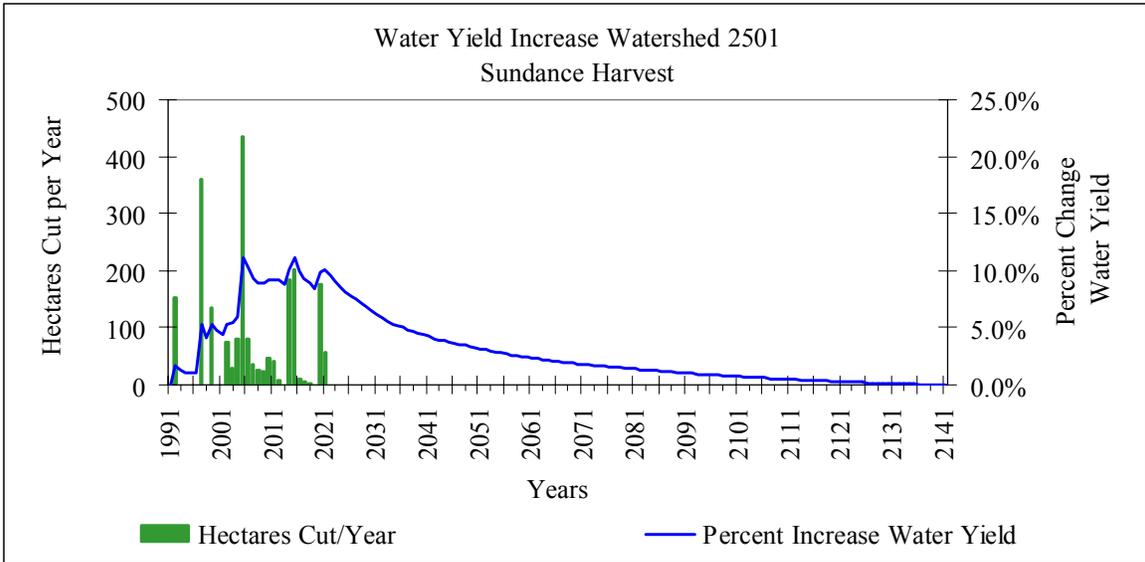
Watershed 1200



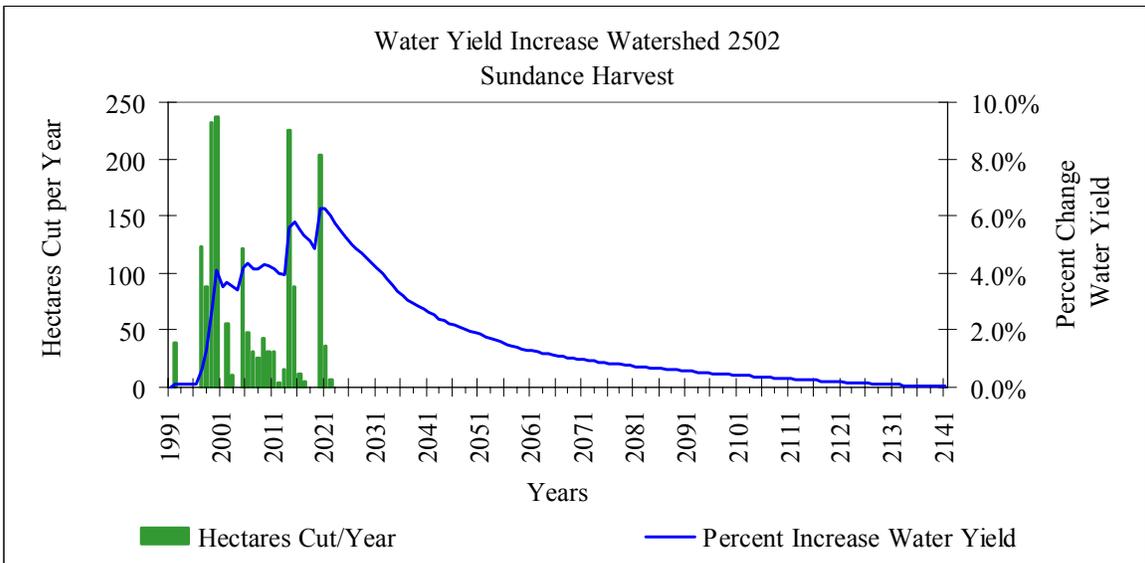
Watershed 1700



Watershed 2501



Watershed 2502

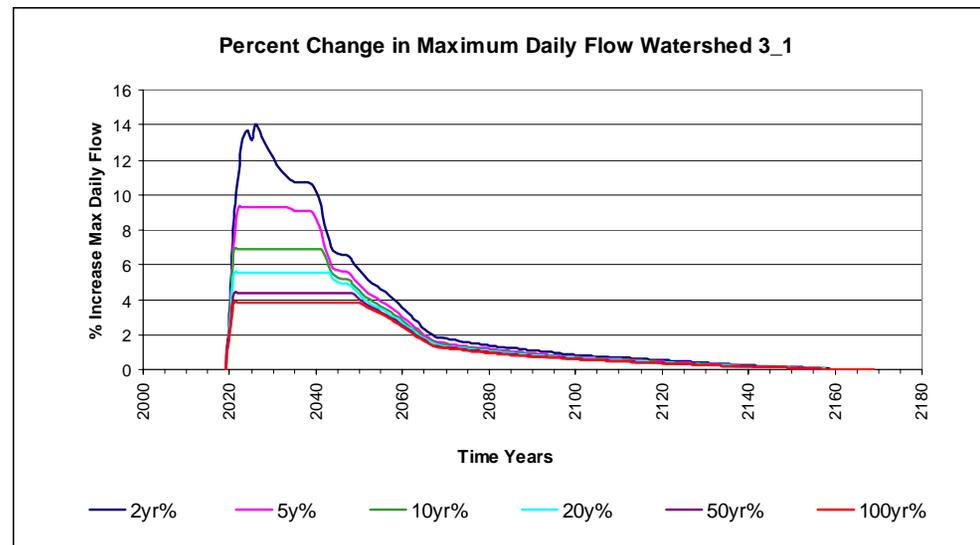


Appendix 4 WRENS Input and Output

Contents of this appendix includes

1. Inputs for scenario
2. Maximum water yield increases
3. %ECA for disturbed areas based on water yield “recovery”¹
4. %ECA for disturbed areas based on basal area “recovery”¹
5. Predicted annual daily maximum flows with and without harvesting

1. %Watershed ECA is obtained by dividing ECA in hectares by watershed area in hectares. Values for ECA in text are expressed on a watershed basis. The shape and timing for curves will be the same for disturbed area and watershed area, but magnitudes will be different (i.e. less for watershed because of its greater area).
2. Peak flow changes are estimates of the contribution of forest harvesting to peak flows, which cannot exceed the maximum daily evapotranspiration (ET) rate calculated by WRENS. When this occurs (i.e. $Q_{\text{peak}} > ET_{\text{daily max}}$) peak flows are constrained by an area-weighted reduction in maximum daily ET for a watershed. In other words, the extra water generated by harvesting that contributes to increased peak flows becomes constant for a given period of time until evapotranspiration rates have recovered where a reduction in flows can occur. The figure below illustrates how this constraint the magnitude of changes in peak flows. Peak flow changes on watersheds can remain elevated (i.e. constrained) for periods of 5-30 years depending on the extent of harvesting



Watershed 1001

Run Scenarios in database with individual Blocks

Select Scenario: **r11** Run Scenario Return to Main

Simulate Each Unit From **1993** for **150** years with **1** year time steps

Watershed Area, km²: **69.6** Total Area Cut, ha: **3309.9** Percent Watershed Cut: **47.6%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress:

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress:

Statistic **AVG** Period **1965-1992** Annual Ppt. mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** Table View

Annual Harvest Data, Operational Unit		Surrounding Stand Data	
Cut, ha	8.2	Year Cut	1993
# Blks	1	Blk Size, ha	11.4
Aspect	N	Block Elev. m	1237.0
Regeneration Sp	CONIFEROUS	Stand Species	CONIFEROUS
Basal Area Func	LPP FAIR BA	Stand BA	46.0
Tree Height Func	LPP FAIR TH	Stand TH	19.0
		Regional (Base) Silvicultural Data	
		Base BA	35.0
		Years To Base BA	130
		Base TH, m	20.0
		Years To Base TH	160

Record: 14 | 1 | 334

Results Scenario r11

Year	Yield, mm	%
1992	0.0	0.0%
1993	2.4	1.3%
1994	8.4	4.6%
1995	7.1	3.9%
1996	5.2	2.8%
1997	5.0	2.7%
1998	6.4	3.5%
1999	6.5	3.6%
2000	6.7	3.6%
2001	7.9	4.3%
2002	9.9	5.4%
2003	11.3	6.1%
2004	10.4	5.7%
2005	32.7	17.8%
2006	25.5	13.9%
2007	21.0	11.4%

MAX Yield Increase, mm: **32.7** Calibration value: **0.998**

MAX Percent Increase: **17.8%** Base Yield, mm: **183.7**

Year of MAX: **2005** Precipitation, mm: **621.1**

Scenario Name: **r11** Region: **New England/Boreal**

Buttons: Save Yield Data, ECA Mature Ba, ECA Max Yld, Max Day's Analysis, Peak Flow Analysis, Return

r11 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1992	0.0	0.0%
1993	139.6	4.2%
1994	509.4	15.4%
1995	431.0	13.0%
1996	312.2	9.4%
1997	302.8	9.1%
1998	387.2	11.7%
1999	399.1	12.1%
2000	407.1	12.3%
2001	483.3	14.6%
2002	599.2	18.1%
2003	698.7	21.1%
2004	641.0	19.4%
2005	2003.2	60.5%
2006	1542.9	46.6%
2007	1268.4	38.3%
2008	1250.1	37.8%
2009	1313.4	39.7%
2010	1418.8	42.9%
2011	1517.7	45.9%
2012	1597.2	48.3%
2013	1641.1	49.6%
2014	1700.1	51.4%

Maximum Eca, ha: **2003.2** Max Eca, %: **60.5%**

Year of max Eca: **2005**

Scenario: **r11** Region: **New England/Boreal**

Buttons: About Eca Max Yield, Save Data to Excel, Return

r11 ECA based on Mature Basal Area

Year	ECA, ha	ECA, %
1992	0.0	0.0%
1993	142.7	4.2%
1994	551.2	15.4%
1995	636.9	18.5%
1996	629.6	18.1%
1997	631.8	18.2%
1998	698.0	20.2%
1999	715.9	20.8%
2000	706.8	20.5%
2001	735.6	21.3%
2002	828.9	24.1%
2003	948.9	27.3%
2004	955.6	27.6%
2005	2348.2	68.4%
2006	2421.7	71.3%
2007	2440.9	72.1%
2008	2410.4	71.1%
2009	2385.4	70.4%
2010	2453.5	72.6%
2011	2502.5	74.1%
2012	2498.3	73.9%
2013	2475.7	73.2%
2014	2518.6	74.6%

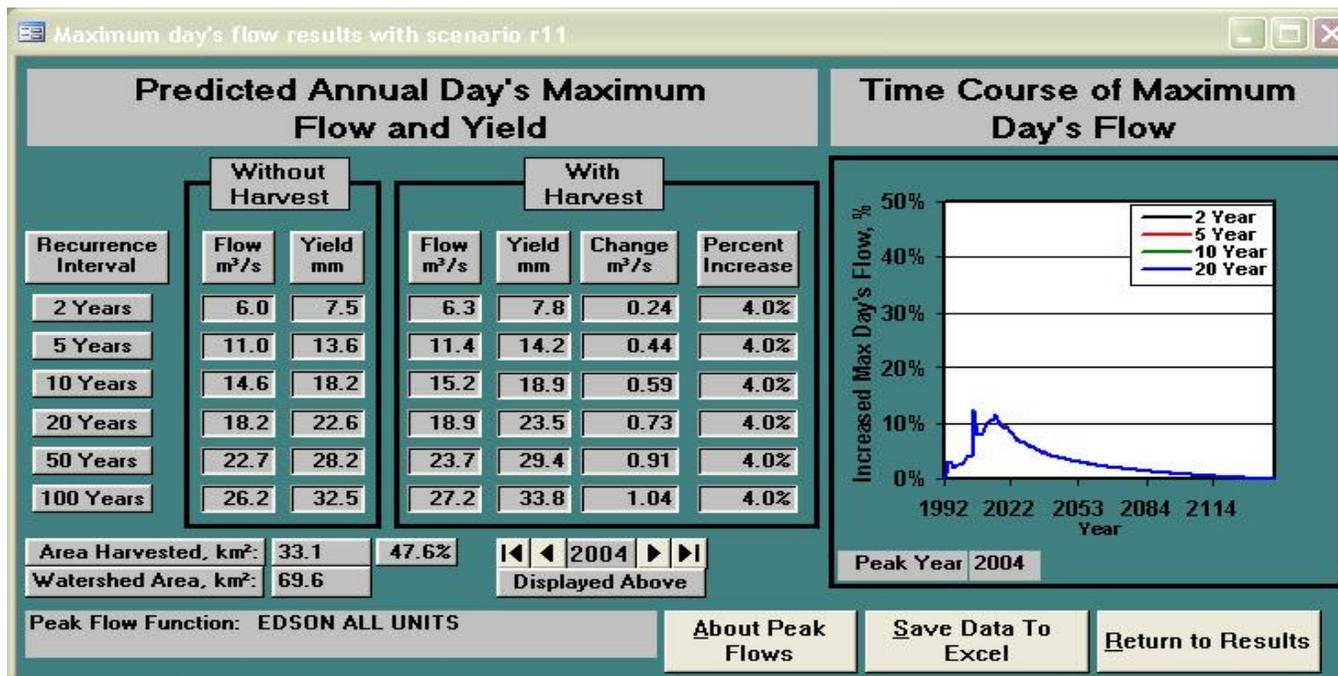
Maximum Eca, ha: **2634.8** Max Eca, %: **79.6%**

Year of max Eca: **2015**

Scenario: **r11** Region: **New England/Boreal**

Buttons: About Eca Ba Mature, Save Data to Excel, Return

Watershed 1001..continued



Watershed 1002

Run Scenarios in database with Individual Blocks

Select Scenario: **r12** Run Scenario Return to Main

Simulate Each Unit From **1988** for **150** years with **1** year time steps

Watershed Area, km²: **57.5** Total Area Cut, ha: **1233.2** Percent Watershed Cut: **21.4%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: frmRunScenarios, Individual Blocks Table View

Annual Harvest Data, Operational Unit		Surrounding Stand Data	
Cut, ha	18.0	Year Cut	1988
# Blks	1	Blk Size, ha	18.0
Aspect	N	Block Elev, m	1023.0
Regeneration Sp	DECIDUOUS	Stand Species	DECIDUOUS
Basal Area Func	DECID FAIR BA	Stand BA	25.5
Tree Height Func	DECID FAIR TH	Stand TH	16.0
Regional (Base) Silvicultural Data		Base BA	20.0
		Years To Base BA	80
		Base TH, m	20.0
		Years To Base TH	80

Record: 1 of 150

Results Scenario r12

Year	Yield, mm	%
1987	0.0	0.0%
1988	0.3	0.2%
1989	0.3	0.2%
1990	0.4	0.2%
1991	0.3	0.2%
1992	0.3	0.2%
1993	0.3	0.2%
1994	2.1	1.1%
1995	1.4	0.7%
1996	3.6	1.9%
1997	3.3	1.8%
1998	2.6	1.4%
1999	2.6	1.4%
2000	2.7	1.5%
2001	4.7	2.5%
2002	5.9	3.2%

MAX Yield Increase, mm: **13.0** Calibration value: **0.995**
 MAX Percent Increase: **7.1%** Base Yield, mm: **183.7**
 Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r12** Region: **New England/Boreal**

Save Yield Data ECA Mature Ba ECA Max Yld Max Day's Analysis Peak Flow Analysis Return

r12 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1987	0.0	0.0%
1988	15.8	1.3%
1989	16.6	1.3%
1990	18.0	1.5%
1991	16.2	1.3%
1992	14.7	1.2%
1993	13.5	1.1%
1994	105.1	8.5%
1995	69.2	5.6%
1996	163.7	13.3%
1997	150.8	12.2%
1998	123.1	10.0%
1999	119.2	9.7%
2000	125.5	10.2%
2001	225.5	18.3%
2002	280.7	22.8%
2003	243.4	19.7%
2004	231.2	18.8%
2005	580.0	47.0%
2006	490.6	39.8%
2007	435.5	35.3%
2008	434.5	35.2%
2009	438.0	35.5%

Maximum Eca, ha: **633.1** Max Eca, %: **51.3%**
 Year of max Eca: **2015**

Scenario: **r12** Region: **New England/Boreal**

About Eca Max Yield Save Data to Excel Return

r12 ECA based on Mature Basal Area

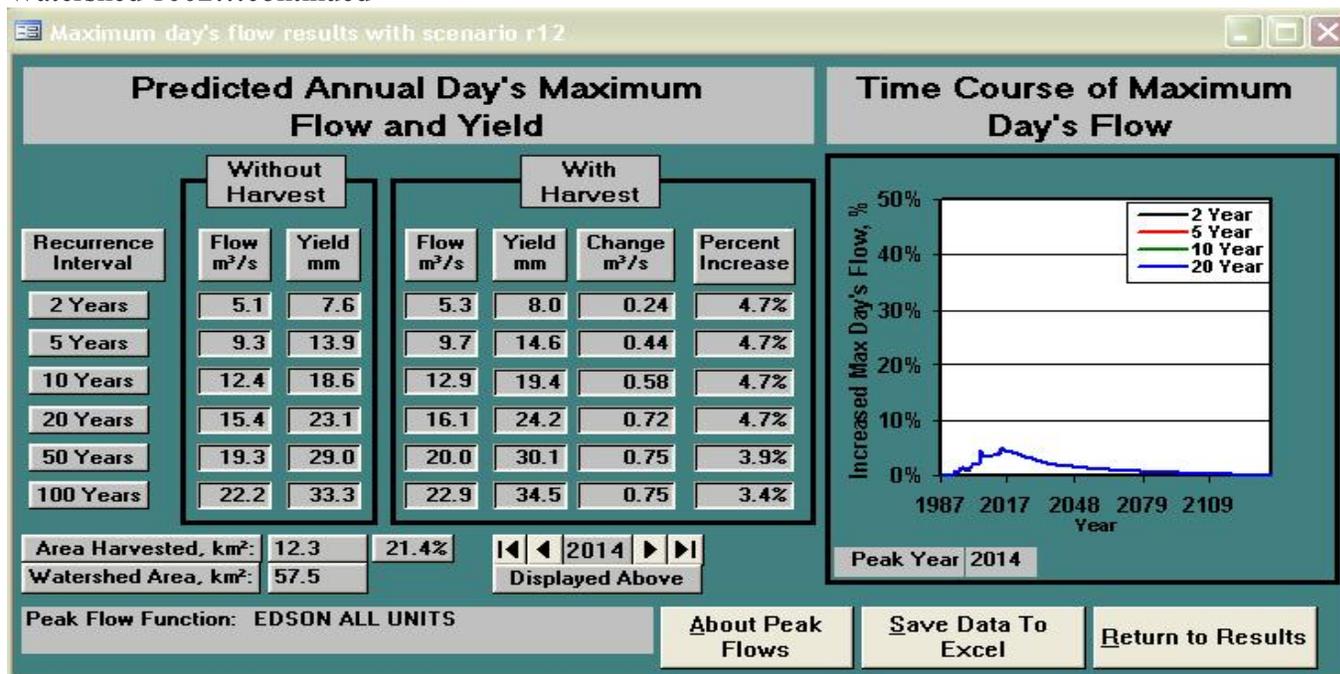
Year	ECA, ha	Eca, %
1987	0.0	0.0%
1988	18.0	1.3%
1989	17.9	1.3%
1990	17.6	1.3%
1991	17.3	1.3%
1992	16.9	1.3%
1993	16.6	1.3%
1994	109.0	8.5%
1995	107.6	8.5%
1996	220.7	17.0%
1997	245.8	19.1%
1998	242.8	19.0%
1999	239.8	18.8%
2000	236.7	18.6%
2001	325.3	25.5%
2002	404.5	31.9%
2003	399.4	31.5%
2004	394.2	31.1%
2005	737.3	58.2%
2006	770.7	60.9%
2007	793.8	62.8%
2008	800.2	63.3%
2009	795.3	62.9%

Maximum Eca, ha: **999.3** Max Eca, %: **81.0%**
 Year of max Eca: **2018**

Scenario: **r12** Region: **New England/Boreal**

About Eca Ba Mature Save Data to Excel Return

Watershed 1002...continued



Watershed 1003

Run Scenarios in database with Individual Blocks

Select Scenario: **r13** Run Scenario Return to Main

Simulate Each Unit From **1990** for **150** years with **1** year time steps

Watershed Area, km²: **102.8** Total Area Cut, ha: **4842.4** Percent Watershed Cut: **47.1%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** Table View

Annual Harvest Data, Operational Unit

Cut, ha: **28.3** Year Cut: **1990**

Blks: **1** Blk Size, ha: **28.3**

Aspect: **N** Block Elev, m: **1204.0**

Regeneration Sp: **DECIDUOUS**

Basal Area Func: **DECID FAIR BA**

Tree Height Func: **DECID FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **32.0** Stand TH: **13.0**

Regional (Base) Silvicultural Data

Base BA: **20.0** Years To Base BA: **80**

Base TH, m: **20.0** Years To Base TH: **80**

Record: **14** of 489

Results Scenario r13

Year	Yield, mm	%
1988	0.0	0.0%
1990	0.7	0.4%
1991	1.4	0.8%
1992	1.9	1.0%
1993	2.3	1.2%
1994	1.9	1.0%
1995	3.5	1.9%
1996	2.8	1.5%
1997	2.8	1.5%
1998	5.4	2.9%
1999	7.0	3.8%
2000	6.7	3.6%
2001	6.2	3.4%
2002	8.2	4.4%
2003	8.0	4.3%
2004	8.1	4.4%

Record: **14**

MAX Yield Increase, mm: **31.0** Calibration value: **1.011**

MAX Percent Increase: **16.9%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r13** Region: **New England/Boreal**

Save Yield Data ECA Mature Ba ECA Max Yld Max Day's Analysis Peak Flow Analysis Return

r13 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1988	0.0	0.0%
1990	57.2	1.2%
1991	109.6	2.3%
1992	150.1	3.1%
1993	190.6	3.9%
1994	154.9	3.2%
1995	279.2	5.8%
1996	225.6	4.7%
1997	224.9	4.6%
1998	414.1	8.6%
1999	556.0	11.5%
2000	529.8	10.9%
2001	493.9	10.2%
2002	665.2	13.7%
2003	653.2	13.5%
2004	678.6	14.0%
2005	2031.0	41.9%
2006	1568.7	32.4%
2007	1295.0	26.7%
2008	1306.6	27.0%
2009	1370.2	28.3%
2010	1615.7	33.4%
2011	1701.3	35.1%

Maximum Eca, ha: **2745.9** Max Eca, %: **56.7%**

Year of max Eca: **2015**

Scenario: **r13** Region: **New England/Boreal**

About Eca Max Yield Save Data to Excel Return

r13 ECA based on Mature Basal Area

Year	ECA, ha	ECA, %
1988	0.0	0.0%
1990	64.9	1.2%
1991	126.6	2.3%
1992	169.2	3.1%
1993	233.9	3.9%
1994	234.8	3.2%
1995	374.8	5.8%
1996	370.5	4.7%
1997	393.4	4.6%
1998	588.0	8.6%
1999	789.5	11.5%
2000	850.0	10.9%
2001	859.6	10.2%
2002	1030.0	13.7%
2003	1071.3	13.5%
2004	1136.9	14.0%
2005	2506.0	41.9%
2006	2539.8	32.4%
2007	2526.3	26.7%
2008	2497.8	27.0%
2009	2465.8	28.3%
2010	2649.9	33.4%
2011	2717.3	35.1%

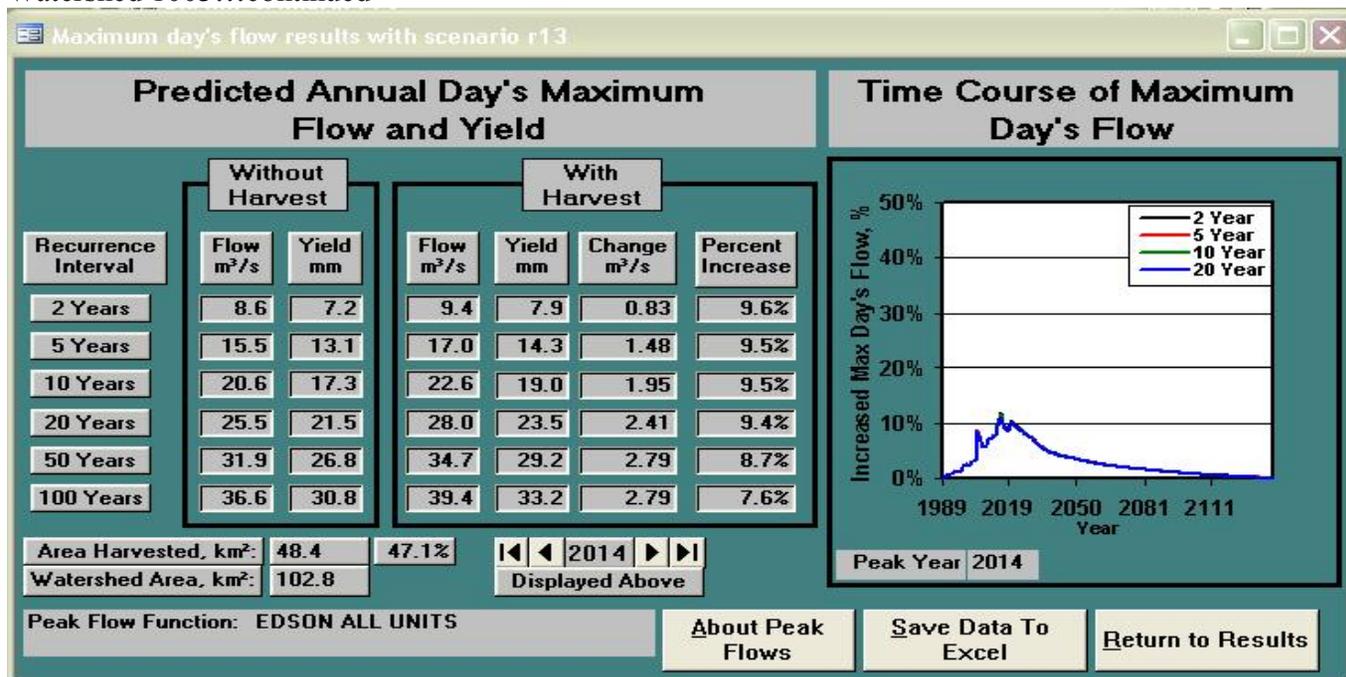
Maximum Eca, ha: **4048.0** Max Eca, %: **83.6%**

Year of max Eca: **2021**

Scenario: **r13** Region: **New England/Boreal**

About Eca Ba Mature Save Data to Excel Return

Watershed 1003...continued



Watershed 1004

Run Scenarios in database with Individual Blocks

Select Scenario: **r14** [Run Scenario] [Return to Main]

Simulate Each Unit From **1990** for **150** years with **1** year time steps

Watershed Area, km²: **67.3** Total Area Cut, ha: **2776.6** Percent Watershed Cut: **41.3%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **25.3** Year Cut: **1990**

Blks: **1** Blk Size, ha: **25.3**

Aspect: **EW** Block Elev, m: **1240.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **46.0** Stand TH: **19.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: 1 of 260

Results Scenario r14

Year	Yield, mm	%
1988	0.0	0.0%
1990	4.4	2.4%
1991	9.0	4.9%
1992	10.8	5.9%
1993	16.9	9.2%
1994	15.2	8.3%
1995	15.4	8.4%
1996	15.2	8.3%
1997	15.0	8.2%
1998	16.5	9.0%
1999	16.4	8.9%
2000	18.0	9.8%
2001	19.2	10.5%
2002	18.8	10.3%
2003	18.3	9.9%
2004	17.7	9.6%

MAX Yield Increase, mm: **30.0** Calibration value: **1.004**

MAX Percent Increase: **16.4%** Base Yield, mm: **183.7**

Year of MAX: **2005** Precipitation, mm: **621.1**

Scenario Name: **r14** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r14 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1988	0.0	0.0%
1990	240.5	8.7%
1991	475.7	17.1%
1992	547.1	19.7%
1993	873.6	31.5%
1994	767.6	27.6%
1995	782.7	28.2%
1996	772.5	27.8%
1997	766.5	27.6%
1998	849.2	30.6%
1999	845.4	30.4%
2000	924.0	33.3%
2001	970.2	34.9%
2002	949.9	34.2%
2003	917.5	33.0%
2004	883.7	31.8%
2005	1624.3	58.5%
2006	1339.1	48.2%
2007	1156.9	41.7%
2008	1153.9	41.6%
2009	1166.7	42.0%
2010	1153.5	41.5%
2011	1157.3	41.7%

Maximum Eca, ha: **1624.3** Max Eca, %: **58.5%**

Year of max Eca: **2005**

Scenario: **r14** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r14 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1988	0.0	0.0%
1990	254.9	8.7%
1991	575.5	17.1%
1992	733.0	23.5%
1993	1160.9	38.5%
1994	1149.9	38.1%
1995	1204.3	40.1%
1996	1212.0	40.3%
1997	1198.8	39.9%
1998	1261.6	41.2%
1999	1251.8	41.0%
2000	1329.6	43.2%
2001	1392.7	45.8%
2002	1376.7	45.1%
2003	1360.3	44.6%
2004	1343.8	44.1%
2005	2098.0	75.9%
2006	2107.9	76.0%
2007	2088.6	74.7%
2008	2085.0	74.6%
2009	2073.0	74.2%
2010	2054.0	73.2%
2011	2026.7	71.3%

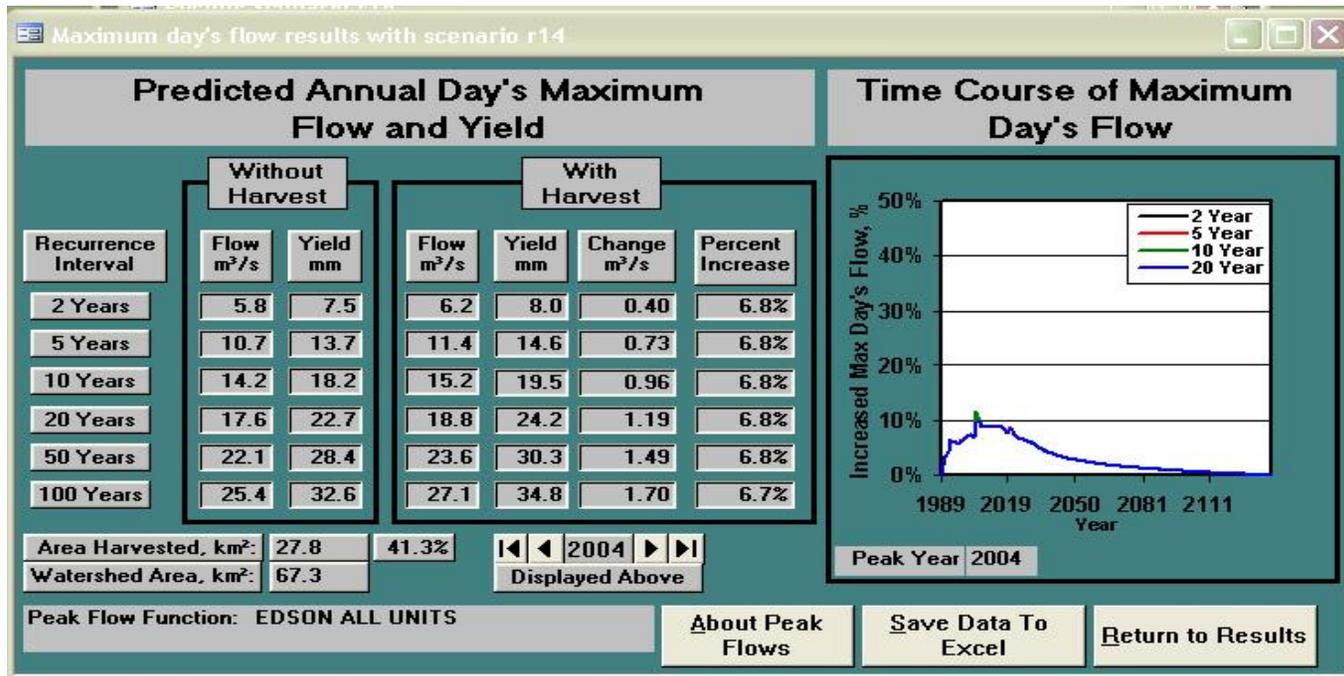
Maximum Eca, ha: **2107.9** Max Eca, %: **75.9%**

Year of max Eca: **2006**

Scenario: **r14** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 1004...continued



Watershed 1005

Run Scenarios in database with Individual Blocks

Select Scenario: **r15** [Run Scenario] [Return to Main]

Simulate Each Unit From **1992** for **150** years with **1** year time steps

Watershed Area, km²: **45.4** Total Area Cut, ha: **1007.1** Percent Watershed Cut: **22.2%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **6.3** Year Cut: **1992**

Blks: **1** Blk Size, ha: **32.0**

Aspect: **S** Block Elev, m: **1248.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **46.0** Stand TH: **19.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: **14** of 136

Results Scenario r15

Year	Yield, mm	%
1991	0.0	0.0%
1992	0.2	0.1%
1993	3.2	1.8%
1994	2.8	1.5%
1995	2.6	1.4%
1996	3.2	1.7%
1997	2.8	1.5%
1998	2.6	1.4%
1999	3.0	1.7%
2000	2.9	1.6%
2001	4.0	2.2%
2002	3.5	1.9%
2003	3.3	1.8%
2004	3.1	1.7%
2005	11.7	6.4%
2006	9.8	5.3%

Record: **14**

MAX Yield Increase, mm: **13.9** Calibration value: **1.019**

MAX Percent Increase: **7.6%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r15** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r15 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1991	0.0	0.0%
1992	7.5	0.7%
1993	114.4	11.4%
1994	95.1	9.4%
1995	87.1	8.6%
1996	109.0	10.8%
1997	96.4	9.6%
1998	88.9	8.8%
1999	103.2	10.3%
2000	100.4	10.0%
2001	138.1	13.7%
2002	122.2	12.1%
2003	113.1	11.2%
2004	108.5	10.8%
2005	449.5	44.6%
2006	362.9	36.0%
2007	282.9	28.1%
2008	274.0	27.2%
2009	319.9	31.8%
2010	328.6	32.6%
2011	408.7	40.6%
2012	414.8	41.2%
2013	411.3	40.8%

Maximum Eca, ha: **529.9** Max Eca, %: **52.6%**

Year of max Eca: **2014**

Scenario: **r15** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r15 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1991	0.0	0.0%
1992	7.5	0.7%
1993	121.7	11.4%
1994	120.7	11.3%
1995	119.1	11.2%
1996	143.5	13.4%
1997	141.6	13.2%
1998	139.7	12.9%
1999	152.7	14.4%
2000	150.6	14.1%
2001	189.7	17.6%
2002	187.0	17.3%
2003	184.3	17.0%
2004	181.5	16.7%
2005	525.4	49.8%
2006	567.1	53.0%
2007	568.8	53.1%
2008	561.5	52.3%
2009	586.8	55.2%
2010	595.0	56.0%
2011	662.0	62.2%
2012	663.8	62.3%
2013	654.6	61.5%

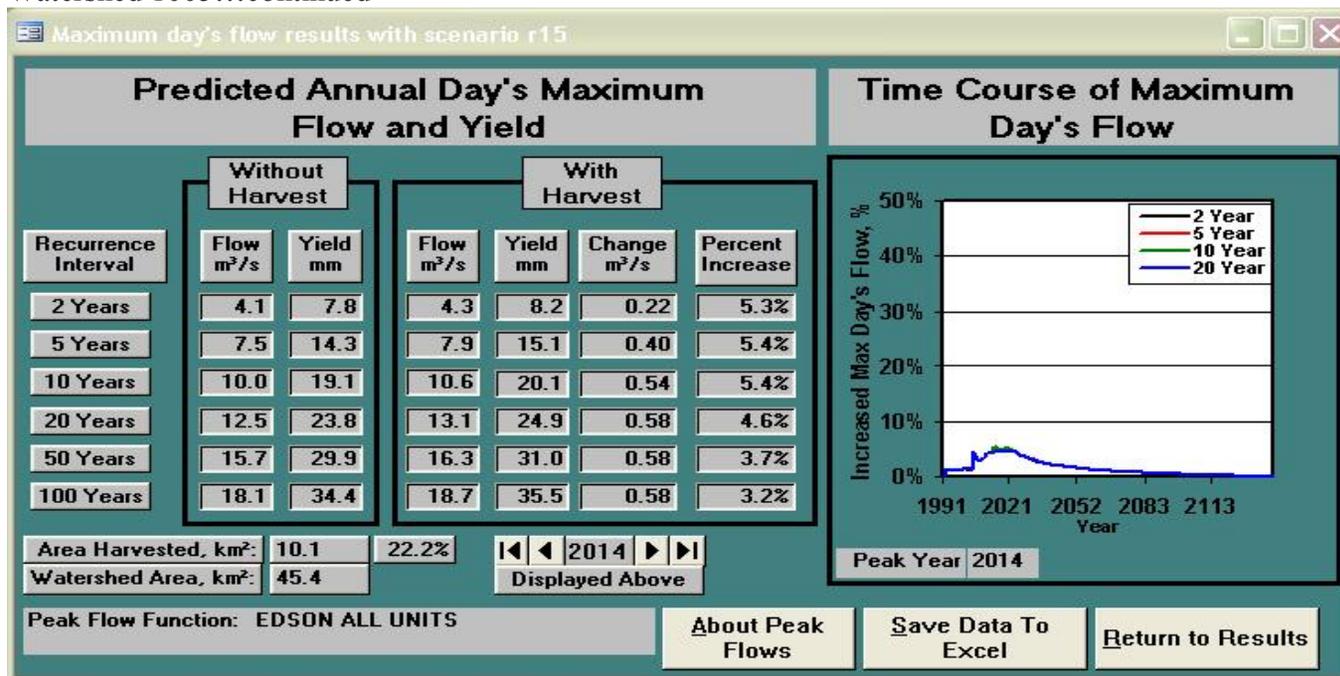
Maximum Eca, ha: **821.7** Max Eca, %: **81.6%**

Year of max Eca: **2020**

Scenario: **r15** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 1005...continued



Watershed 2001

Run Scenarios in database with Individual Blocks

Select Scenario: **r21** [Run Scenario] [Return to Main]

Simulate Each Unit From **2000** for **150** years with **1** year time steps

Watershed Area, km²: **54.3** Total Area Cut, ha: **1806.8** Percent Watershed Cut: **33.3%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: frmRunScenarios, Individual Blocks [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **1.7** Year Cut: **2000**

Blks: **1** Blk Size, ha: **1.8**

Aspect: **N** Block Elev, m: **1310.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **37.5** Stand TH: **10.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: 14 of 123

Results Scenario r21

Year	Yield, mm	%
1999	0.0	0.0%
2000	2.0	1.1%
2001	1.3	0.7%
2002	0.8	0.5%
2003	0.8	0.5%
2004	0.9	0.5%
2005	12.7	6.9%
2006	8.3	4.5%
2007	6.1	3.3%
2008	6.5	3.5%
2009	7.4	4.0%
2010	9.9	5.4%
2011	13.0	7.1%
2012	13.0	7.1%
2013	15.9	8.7%
2014	17.5	9.5%

Record: 14 of 123

MAX Yield Increase, mm: **22.7** Calibration value: **0.962**

MAX Percent Increase: **12.4%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r21** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r21 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1999	0.0	0.0%
2000	97.4	5.4%
2001	60.8	3.4%
2002	41.1	2.3%
2003	41.0	2.3%
2004	44.1	2.4%
2005	711.7	39.4%
2006	454.4	25.2%
2007	325.5	18.0%
2008	352.0	19.5%
2009	405.7	22.5%
2010	530.2	29.3%
2011	695.9	38.5%
2012	702.6	38.9%
2013	865.3	47.9%
2014	934.7	51.7%
2015	1215.7	67.3%
2016	1027.5	56.9%
2017	941.6	52.1%
2018	936.4	51.8%
2019	942.0	52.1%
2020	1032.8	57.2%
2021	1011.6	56.0%

Maximum Eca, ha: **1215.7** Max Eca, %: **67.3%**

Year of max Eca: **2015**

Scenario: **r21** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r21 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1999	0.0	0.0%
2000	97.4	5.4%
2001	96.4	5.3%
2002	95.3	5.2%
2003	94.3	5.1%
2004	93.2	5.0%
2005	757.5	40.3%
2006	762.9	40.6%
2007	757.4	40.3%
2008	748.6	39.8%
2009	739.7	39.3%
2010	823.2	43.1%
2011	969.2	50.0%
2012	972.3	50.5%
2013	1130.8	57.6%
2014	1244.5	63.4%
2015	1586.8	87.8%
2016	1567.0	86.9%
2017	1547.4	85.6%
2018	1527.1	84.3%
2019	1506.5	83.0%
2020	1572.3	87.2%
2021	1555.8	85.5%

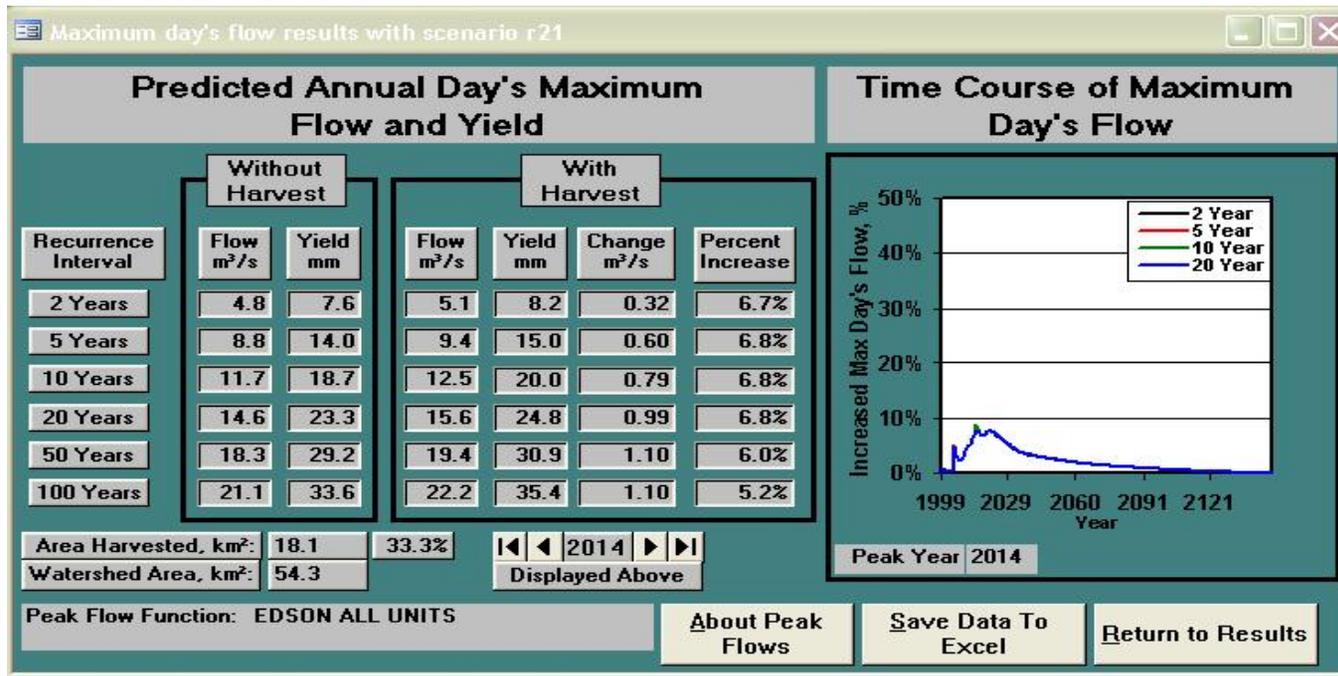
Maximum Eca, ha: **1586.8** Max Eca, %: **87.8%**

Year of max Eca: **2015**

Scenario: **r21** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 2001...continued



Watershed 2002

Run Scenarios in database with Individual Blocks

Select Scenario: **r22** [Run Scenario] [Return to Main]

Simulate Each Unit From **2005** for **150** years with **1** year time steps

Watershed Area, km²: **21.2** Total Area Cut, ha: **671.9** Percent Watershed Cut: **31.7%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit		Surrounding Stand Data	
Cut, ha	25.5	Year Cut	2005
# Blks	1	Blk Size, ha	25.5
Aspect	EW	Block Elev, m	1150.0
Regeneration Sp	CONIFEROUS	Stand Species	CONIFEROUS
Basal Area Func	LPP FAIR BA	Stand BA	25.6
Tree Height Func	LPP FAIR TH	Stand TH	7.0
		Regional (Base) Silvicultural Data	
		Base BA	35.0
		Years To Base BA	130
		Base TH, m	20.0
		Years To Base TH	160

Record: **14** of 61

Results Scenario r22

Year	Yield, mm	%
2004	0.0	0.0%
2005	11.2	6.1%
2006	10.4	5.6%
2007	7.2	3.9%
2008	6.3	3.5%
2009	6.6	3.6%
2010	17.0	9.3%
2011	17.1	9.3%
2012	19.7	10.7%
2013	18.9	10.3%
2014	21.2	11.6%
2015	21.5	11.7%
2016	21.3	11.6%
2017	21.6	11.8%
2018	21.7	11.8%
2019	21.6	11.8%

MAX Yield Increase, mm: **21.7** Calibration value: **0.964**

MAX Percent Increase: **11.8%** Base Yield, mm: **183.7**

Year of MAX: **2018** Precipitation, mm: **621.1**

Scenario Name: **r22** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r22 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2004	0.0	0.0%
2005	211.1	31.4%
2006	197.3	29.4%
2007	135.6	20.2%
2008	120.1	17.9%
2009	125.8	18.7%
2010	324.7	48.3%
2011	323.5	48.1%
2012	368.2	54.8%
2013	353.0	52.5%
2014	390.9	58.2%
2015	396.8	59.1%
2016	393.9	58.6%
2017	401.0	59.7%
2018	403.6	60.1%
2019	401.8	59.8%
2020	402.3	59.9%
2021	380.3	56.6%
2022	355.5	52.9%
2023	329.7	49.1%
2024	304.3	45.3%
2025	279.3	41.6%
2026	260.9	38.8%

Maximum Eca, ha: **403.6** Max Eca, %: **60.1%**

Year of max Eca: **2018**

Scenario: **r22** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r22 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2004	0.0	0.0%
2005	211.1	31.4%
2006	274.8	41.1%
2007	278.0	41.2%
2008	274.9	40.9%
2009	271.7	40.6%
2010	467.2	69.1%
2011	518.3	76.7%
2012	592.6	87.5%
2013	585.8	86.5%
2014	615.2	90.8%
2015	614.6	90.7%
2016	608.5	89.5%
2017	600.8	88.3%
2018	592.9	87.2%
2019	584.9	86.1%
2020	585.3	86.2%
2021	577.1	84.9%
2022	568.8	83.6%
2023	560.4	82.3%
2024	552.0	81.0%
2025	543.5	79.7%
2026	535.0	78.4%

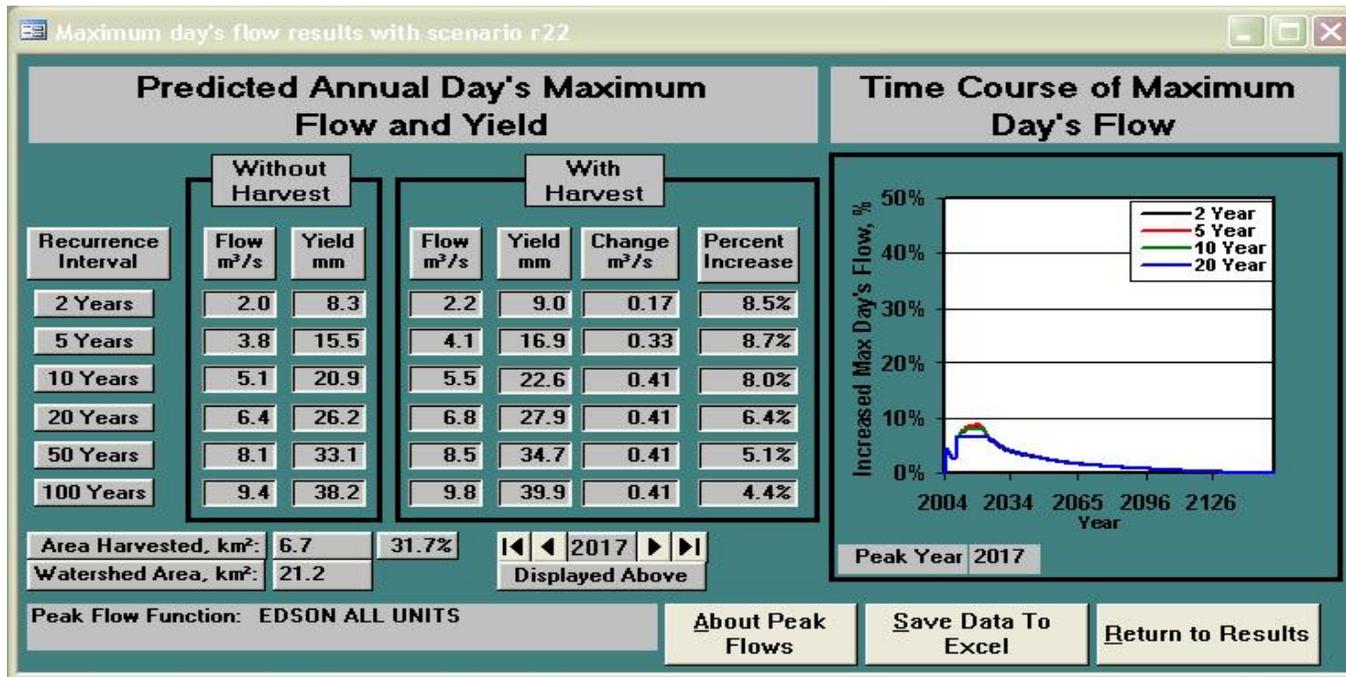
Maximum Eca, ha: **615.2** Max Eca, %: **91.6%**

Year of max Eca: **2014**

Scenario: **r22** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 2002...continued



Watershed 2003

Run Scenarios in database with Individual Blocks

Select Scenario: **r23** [Run Scenario] [Return to Main]

Simulate Each Unit From **2004** for **150** years with **1** year time steps

Watershed Area, km²: **24.3** Total Area Cut, ha: **719.5** Percent Watershed Cut: **29.6%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **138.7** Year Cut: **2004**

Blks: **1** Blk Size, ha: **219.7**

Aspect: **EW** Block Elev, m: **1181.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **43.3** Stand TH: **16.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: 1 of 75

Results Scenario r23

Year	Yield, mm	%
2003	0.0	0.0%
2004	5.7	3.1%
2005	15.5	8.4%
2006	10.7	5.8%
2007	9.8	5.3%
2008	9.6	5.3%
2009	10.6	5.8%
2010	14.0	7.6%
2011	14.5	7.9%
2012	17.8	9.7%
2013	17.9	9.7%
2014	19.8	10.8%
2015	20.9	11.4%
2016	19.8	10.8%
2017	18.6	10.1%
2018	17.7	9.6%

MAX Yield Increase, mm: **20.9** Calibration value: **0.984**

MAX Percent Increase: **11.4%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r23** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r23 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2003	0.0	0.0%
2004	146.3	20.3%
2005	363.8	50.6%
2006	248.6	34.6%
2007	225.0	31.3%
2008	224.9	31.3%
2009	249.6	34.7%
2010	317.7	44.2%
2011	334.6	46.5%
2012	408.1	56.7%
2013	413.0	57.4%
2014	460.5	64.0%
2015	474.4	65.9%
2016	446.8	62.1%
2017	419.4	58.3%
2018	399.0	55.5%
2019	380.1	52.8%
2020	382.0	53.1%
2021	362.0	50.3%
2022	340.6	47.3%
2023	315.9	43.9%
2024	289.3	40.2%
2025	267.6	37.2%

Maximum Eca, ha: **474.4** Max Eca, %: **65.9%**

Year of max Eca: **2015**

Scenario: **r23** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r23 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2003	0.0	0.0%
2004	146.3	20.3%
2005	423.2	60.6%
2006	442.6	63.1%
2007	472.9	67.3%
2008	467.5	66.5%
2009	471.2	67.0%
2010	517.6	73.7%
2011	515.0	73.3%
2012	559.4	79.3%
2013	552.2	78.5%
2014	590.7	84.1%
2015	618.9	87.4%
2016	620.1	87.5%
2017	611.5	86.3%
2018	602.7	85.1%
2019	593.8	84.0%
2020	606.1	85.7%
2021	600.3	84.8%
2022	594.2	84.4%
2023	584.8	83.2%
2024	575.2	81.6%
2025	565.6	80.0%

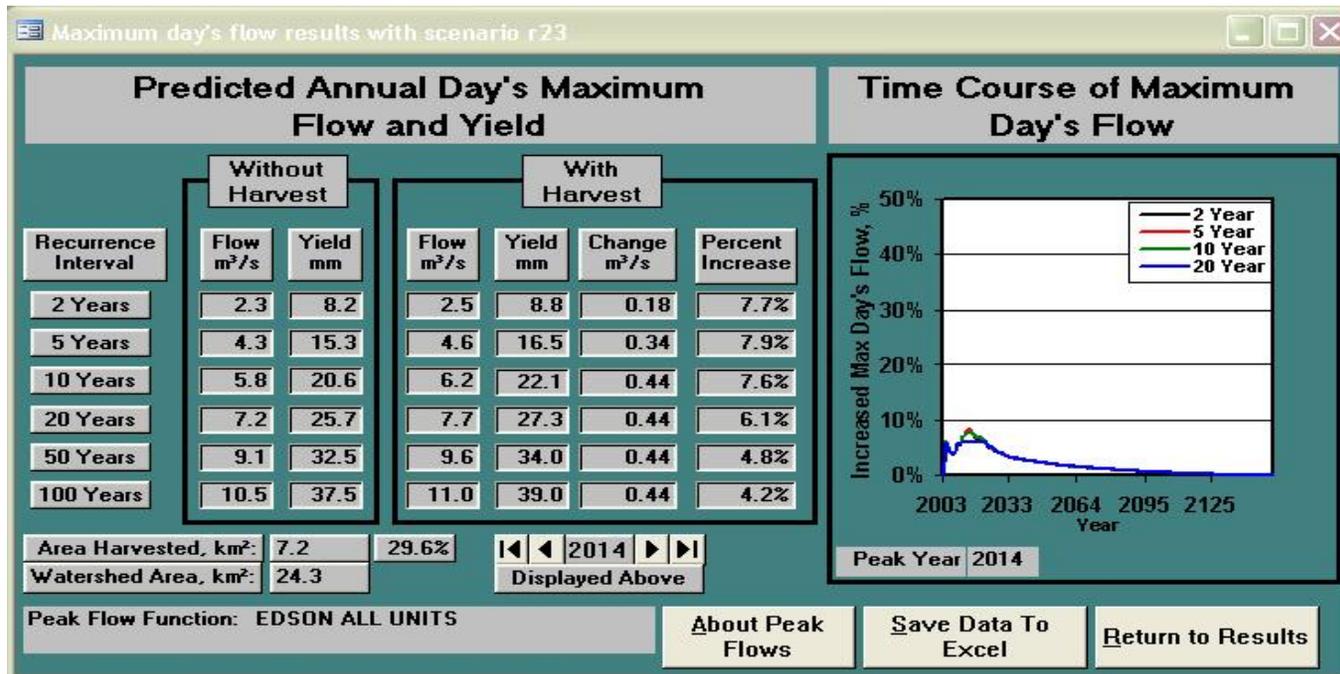
Maximum Eca, ha: **620.1** Max Eca, %: **86.2%**

Year of max Eca: **2016**

Scenario: **r23** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 2003...continued



Watershed 2004

Run Scenarios in database with Individual Blocks

Select Scenario: **r24** [Run Scenario] [Return to Main]

Simulate Each Unit From **2005** for **150** years with **1** year time steps

Watershed Area, km²: **10.1** Total Area Cut, ha: **435.8** Percent Watershed Cut: **43.0%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: frmRunScenarios, Individual Blocks [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **32.1** Year Cut: **2005**

Blks: **1** Blk Size, ha: **37.2**

Aspect: **N** Block Elev, m: **1202.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **28.8** Stand TH: **10.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: **14** of 26

Results Scenario r24

Year	Yield, mm	%
2004	0.0	0.0%
2005	8.8	4.8%
2006	9.2	5.0%
2007	5.9	3.2%
2008	5.8	3.1%
2009	6.0	3.3%
2010	28.0	15.2%
2011	19.9	10.8%
2012	17.8	9.7%
2013	19.9	10.8%
2014	23.0	12.5%
2015	23.8	12.9%
2016	25.0	13.6%
2017	26.9	14.7%
2018	27.5	15.0%
2019	28.0	15.3%

Record: [Navigation]

MAX Yield Increase, mm: **29.1** Calibration value: **0.956**

MAX Percent Increase: **15.9%** Base Yield, mm: **183.7**

Year of MAX: **2020** Precipitation, mm: **621.1**

Scenario Name: **r24** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r24 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2004	0.0	0.0%
2005	87.9	20.2%
2006	89.6	20.6%
2007	57.0	13.1%
2008	56.8	13.0%
2009	59.1	13.6%
2010	306.8	70.4%
2011	212.1	48.7%
2012	183.4	42.1%
2013	206.8	47.5%
2014	240.4	55.2%
2015	251.6	57.7%
2016	267.5	61.4%
2017	291.3	66.8%
2018	298.1	68.4%
2019	303.2	69.6%
2020	310.2	71.2%
2021	290.6	66.7%
2022	265.9	61.0%
2023	244.1	56.0%
2024	227.7	52.3%
2025	206.4	47.4%
2026	189.5	43.5%

Maximum Eca, ha: **310.2** Max Eca, %: **71.2%**

Year of max Eca: **2020**

Scenario: **r24** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r24 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2004	0.0	0.0%
2005	87.9	20.2%
2006	123.3	29.2%
2007	121.9	28.8%
2008	127.3	29.8%
2009	125.8	29.4%
2010	368.7	87.2%
2011	367.9	86.6%
2012	375.8	87.8%
2013	379.8	88.1%
2014	384.2	88.4%
2015	380.3	87.0%
2016	375.4	85.5%
2017	370.4	83.8%
2018	365.4	82.2%
2019	362.8	81.0%
2020	373.7	83.0%
2021	372.3	82.0%
2022	366.8	79.8%
2023	361.3	77.5%
2024	359.6	76.6%
2025	353.9	74.0%
2026	348.2	71.2%

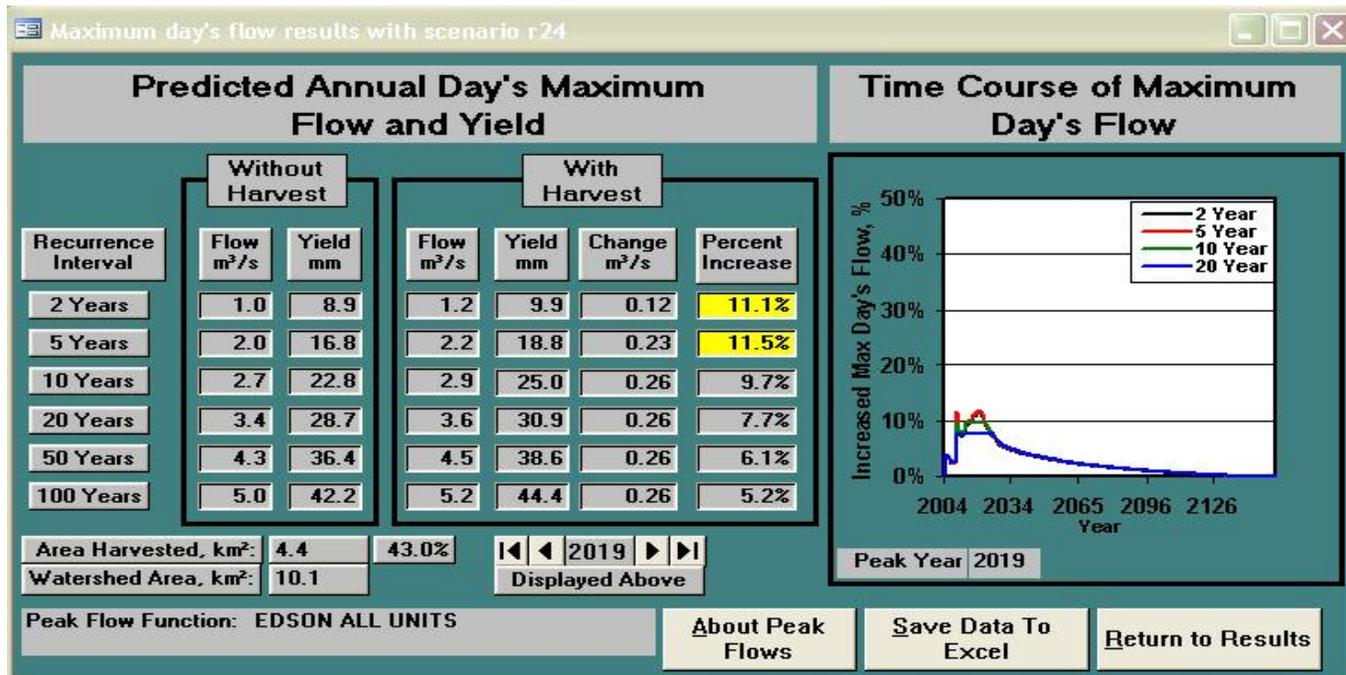
Maximum Eca, ha: **384.2** Max Eca, %: **88.2%**

Year of max Eca: **2014**

Scenario: **r24** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 2004...continued



Watershed 3001

Run Scenarios in database with Individual Blocks

Select Scenario: **r31** [Run Scenario] [Return to Main]

Simulate Each Unit From **1995** for **150** years with **1** year time steps

Watershed Area, km²: **54.1** Total Area Cut, ha: **2111.5** Percent Watershed Cut: **39.0%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: frmRunScenarios, Individual Blocks [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **3.8** Year Cut: **1995**

Blks: **1** Blk Size, ha: **3.8**

Aspect: **N** Block Elev, m: **1286.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **WS FAIR BA**

Tree Height Func: **WS FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **42.0** Stand TH: **22.0**

Regional (Base) Silvicultural Data

Base BA: **30.0** Years To Base BA: **140**

Base TH: **20.0** Years To Base TH: **170**

Record: **14** of 179

Results Scenario r31

Year	Yield, mm	%
1994	0.0	0.0%
1995	0.3	0.2%
1996	1.3	0.7%
1997	1.9	1.0%
1998	2.1	1.1%
1999	1.6	0.9%
2000	1.6	0.8%
2001	2.4	1.3%
2002	2.2	1.2%
2003	2.2	1.2%
2004	2.4	1.3%
2005	11.4	6.2%
2006	10.7	5.8%
2007	8.3	4.5%
2008	8.0	4.3%
2009	8.2	4.5%

MAX Yield Increase, mm: **25.5** Calibration value: **0.970**

MAX Percent Increase: **13.9%** Base Yield, mm: **183.7**

Year of MAX: **2020** Precipitation, mm: **621.1**

Scenario Name: **r31** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r31 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1994	0.0	0.0%
1995	10.5	0.5%
1996	59.2	2.8%
1997	87.3	4.1%
1998	95.8	4.5%
1999	74.6	3.5%
2000	70.1	3.3%
2001	109.1	5.2%
2002	102.3	4.8%
2003	103.0	4.9%
2004	110.2	5.2%
2005	588.8	27.9%
2006	540.6	25.6%
2007	412.2	19.5%
2008	396.8	18.8%
2009	411.0	19.5%
2010	598.5	28.3%
2011	976.7	46.3%
2012	914.1	43.3%
2013	876.1	41.5%
2014	1095.1	51.9%
2015	1152.2	54.6%
2016	1069.3	50.6%

Maximum Eca, ha: **1304.2** Max Eca, %: **61.8%**

Year of max Eca: **2020**

Scenario: **r31** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r31 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1994	0.0	0.0%
1995	11.9	0.7%
1996	65.0	4.1%
1997	110.6	6.8%
1998	143.9	8.9%
1999	142.5	8.8%
2000	141.0	8.7%
2001	175.2	10.8%
2002	173.3	10.6%
2003	171.4	10.5%
2004	169.5	10.4%
2005	639.9	39.8%
2006	771.8	47.9%
2007	785.6	48.9%
2008	790.6	49.2%
2009	781.3	48.6%
2010	946.8	58.4%
2011	1343.8	82.5%
2012	1413.3	87.5%
2013	1444.1	89.2%
2014	1642.0	100.0%
2015	1742.8	106.1%
2016	1722.4	105.2%

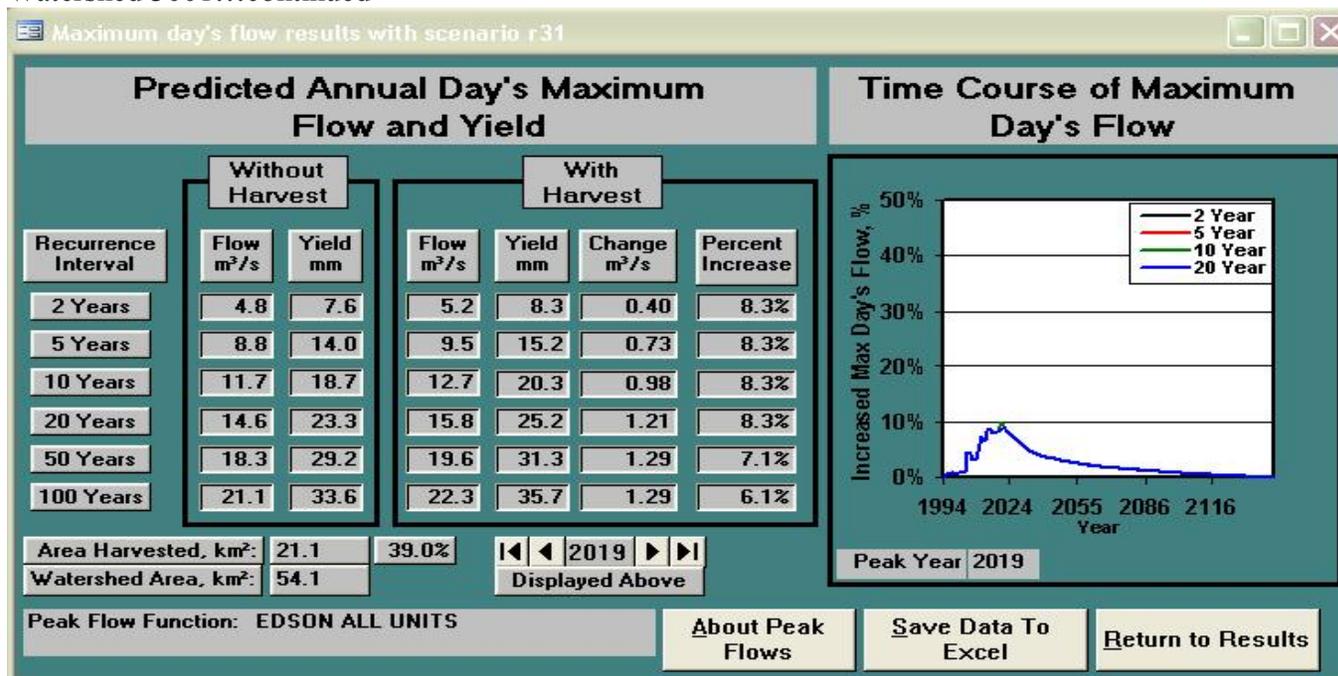
Maximum Eca, ha: **1847.1** Max Eca, %: **87.5%**

Year of max Eca: **2020**

Scenario: **r31** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 3001...continued



Watershed 3002

Run Scenarios in database with Individual Blocks

Select Scenario: **r32** [Run Scenario] [Return to Main]

Simulate Each Unit From **1982** for **150** years with **1** year time steps

Watershed Area, km²: **94.3** Total Area Cut, ha: **3899.3** Percent Watershed Cut: **41.4%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **1.8** Year Cut: **1982**

Blks: **1** Blk Size, ha: **27.7**

Aspect: **EW** Block Elev, m: **1196.0**

Regeneration Sp: **DECIDUOUS**

Basal Area Func: **DECID FAIR BA**

Tree Height Func: **DECID FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **46.0** Stand TH: **19.0**

Regional (Base) Silvicultural Data

Base BA: **20.0** Years To Base BA: **80**

Base TH, m: **20.0** Years To Base TH: **80**

Record: **14** of 345

Results Scenario r32

Year	Yield, mm	%
1981	0.0	0.0%
1982	0.0	0.0%
1983	0.0	0.0%
1984	0.0	0.0%
1985	0.0	0.0%
1986	0.0	0.0%
1987	0.0	0.0%
1988	0.0	0.0%
1989	0.0	0.0%
1990	0.4	0.2%
1991	0.9	0.5%
1992	0.7	0.4%
1993	0.6	0.3%
1994	4.4	2.4%
1995	3.6	2.0%
1996	3.0	1.7%

Record: [Navigation icons]

MAX Yield Increase, mm: **27.0** Calibration value: **0.985**

MAX Percent Increase: **14.7%** Base Yield, mm: **183.7**

Year of MAX: **2020** Precipitation, mm: **621.1**

Scenario Name: **r32** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r32 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1981	0.0	0.0%
1982	1.6	0.0%
1983	1.7	0.0%
1984	1.8	0.0%
1985	1.6	0.0%
1986	1.5	0.0%
1987	1.3	0.0%
1988	1.2	0.0%
1989	1.1	0.0%
1990	25.1	0.6%
1991	67.8	1.7%
1992	51.4	1.3%
1993	42.7	1.1%
1994	352.2	9.0%
1995	277.6	7.1%
1996	228.7	5.9%
1997	223.6	5.7%
1998	301.3	7.7%
1999	313.6	8.0%
2000	321.9	8.3%
2001	350.5	9.0%
2002	360.6	9.2%
2003	369.0	9.5%

Maximum Eca, ha: **2214.6** Max Eca, %: **56.8%**

Year of max Eca: **2020**

Scenario: **r32** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r32 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1981	0.0	0.0%
1982	1.8	0.0%
1983	1.8	0.0%
1984	1.7	0.0%
1985	1.7	0.0%
1986	1.7	0.0%
1987	1.6	0.0%
1988	1.6	0.0%
1989	1.6	0.0%
1990	39.9	1.0%
1991	82.5	2.2%
1992	82.0	2.2%
1993	81.5	2.2%
1994	401.6	10.8%
1995	432.9	11.5%
1996	442.6	11.8%
1997	438.5	11.7%
1998	509.4	13.7%
1999	520.0	13.9%
2000	515.2	13.7%
2001	515.8	13.7%
2002	510.7	13.5%
2003	505.5	13.2%

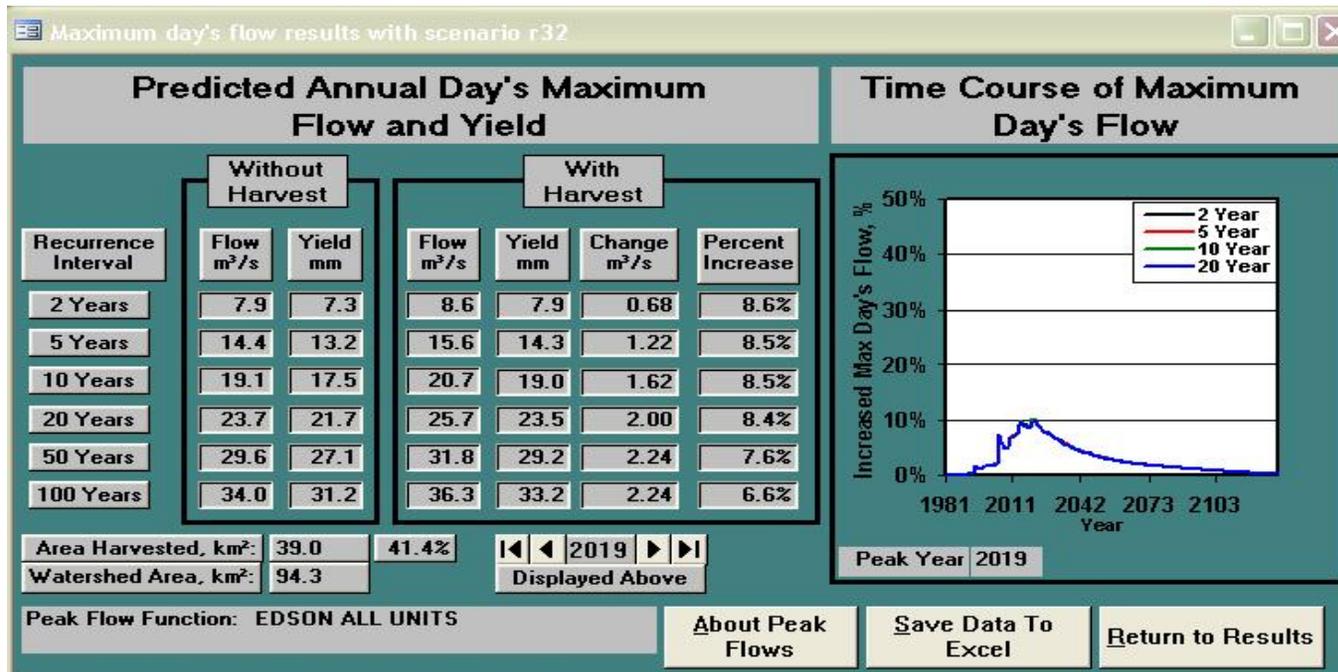
Maximum Eca, ha: **3337.1** Max Eca, %: **85.6%**

Year of max Eca: **2021**

Scenario: **r32** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 3002...continued



Watershed 3003

Run Scenarios in database with Individual Blocks

Select Scenario: **r33** [Run Scenario] [Return to Main]

Simulate Each Unit From **1982** for **150** years with **1** year time steps

Watershed Area, km²: **14.7** Total Area Cut, ha: **406.5** Percent Watershed Cut: **27.6%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **8.8** Year Cut: **1982**

Blks: **1** Blk Size, ha: **14.2**

Aspect: **N** Block Elev, m: **1157.0**

Regeneration Sp: **DECIDUOUS**

Basal Area Func: **DECID FAIR BA**

Tree Height Func: **DECID FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **46.0** Stand TH: **19.0**

Regional (Base) Silvicultural Data

Base BA: **20.0** Years To Base BA: **80**

Base TH, m: **20.0** Years To Base TH: **80**

Record: **14** of 47

Results Scenario r33

Year	Yield, mm	%
1981	0.0	0.0%
1982	3.7	2.0%
1983	3.8	2.1%
1984	4.1	2.2%
1985	3.7	2.0%
1986	3.4	1.8%
1987	3.1	1.7%
1988	5.8	3.1%
1989	4.8	2.6%
1990	4.2	2.3%
1991	3.9	2.1%
1992	3.6	2.0%
1993	3.4	1.8%
1994	3.2	1.8%
1995	3.1	1.7%
1996	2.9	1.6%

Record: **14**

MAX Yield Increase, mm: **14.2** Calibration value: **0.940**

MAX Percent Increase: **7.7%** Base Yield, mm: **183.7**

Year of MAX: **2014** Precipitation, mm: **621.1**

Scenario Name: **r33** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r33 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1981	0.0	0.0%
1982	43.9	10.8%
1983	45.5	11.2%
1984	48.4	11.9%
1985	44.0	10.8%
1986	39.9	9.8%
1987	36.8	9.0%
1988	73.4	18.1%
1989	59.9	14.7%
1990	51.9	12.8%
1991	47.8	11.8%
1992	45.1	11.1%
1993	42.4	10.4%
1994	41.0	10.1%
1995	39.9	9.8%
1996	37.8	9.3%
1997	37.5	9.2%
1998	35.2	8.7%
1999	71.5	17.6%
2000	60.5	14.9%
2001	48.0	11.8%
2002	50.0	12.3%
2003	47.3	11.6%

Maximum Eca, ha: **191.2** Max Eca, %: **47.0%**

Year of max Eca: **2014**

Scenario: **r33** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r33 ECA based on Mature Basal Area

Year	ECA, ha	ECA, %
1981	0.0	0.0%
1982	48.4	11.9%
1983	49.0	12.1%
1984	47.2	11.8%
1985	46.3	11.6%
1986	45.4	11.4%
1987	44.5	11.2%
1988	84.2	21.0%
1989	82.8	20.9%
1990	81.3	20.7%
1991	79.8	20.4%
1992	78.2	20.1%
1993	76.7	19.8%
1994	75.1	19.4%
1995	73.5	19.0%
1996	71.9	18.6%
1997	70.3	18.2%
1998	68.6	17.7%
1999	105.8	27.1%
2000	110.3	28.0%
2001	108.7	27.6%
2002	112.3	28.6%
2003	110.2	28.0%

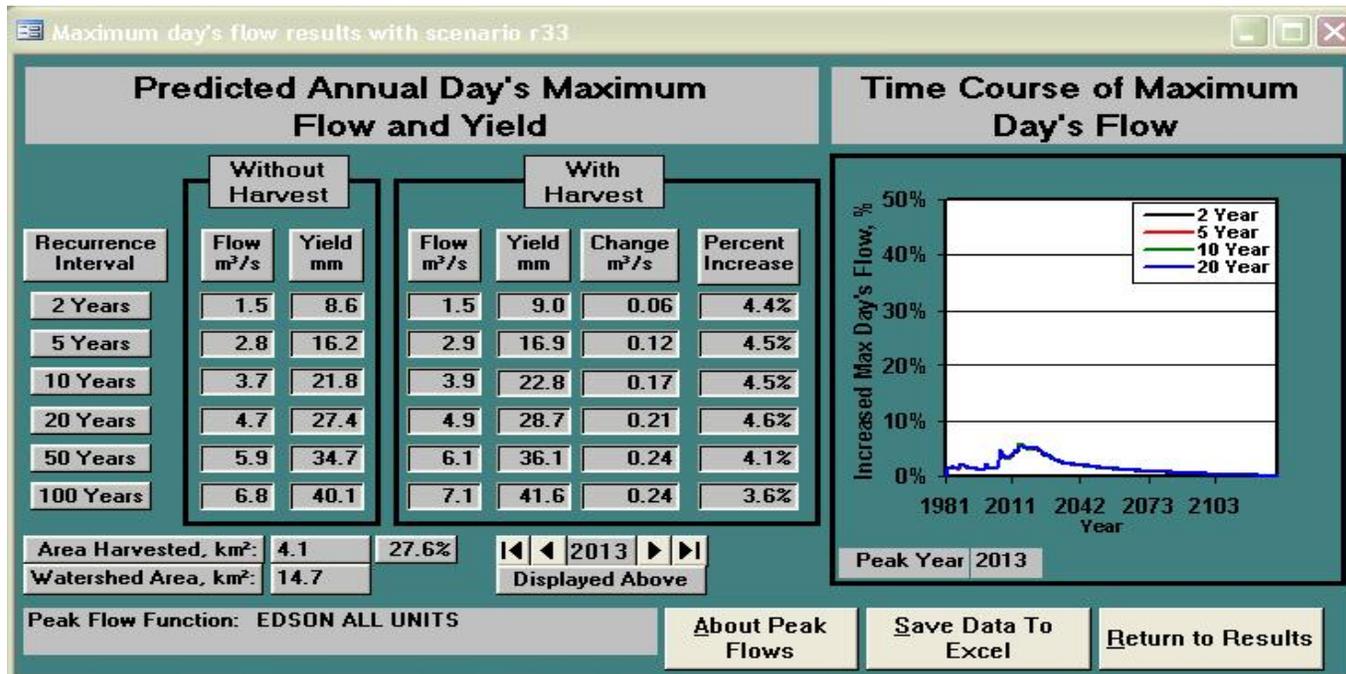
Maximum Eca, ha: **319.7** Max Eca, %: **78.7%**

Year of max Eca: **2016**

Scenario: **r33** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 3003..continued



Watershed 4001

Run Scenarios in database with Individual Blocks

Select Scenario: **r41** [Run Scenario] [Return to Main]

Simulate Each Unit From **1995** for **150** years with **1** year time steps

Watershed Area, km²: **95.6** Total Area Cut, ha: **3152.4** Percent Watershed Cut: **33.0%**

Appropriate Forest and Unit Group: **ROCKY-CLEARWATER UNITS R1 TO R4** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **BROWN CREEK AT FORESTRY ROAD** Year Progress

Statistic **AVG** Period **1974-1998** Yld, mm: **426.7** Area, km²: **218**

Precipitation Data Source: **NORDEGG** Units Progress

Statistic **AVG** Period **1915-1955** Annual Ppt, mm: **538.6**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **27.9** Year Cut: **1995**

Blks: **1** Blk Size, ha: **27.9**

Aspect: **EW** Block Elev, m: **1174.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **28.8** Stand TH: **10.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: **14** of 313

Results Scenario r41

Year	Yield, mm	%
1994	0.0	0.0%
1995	6.2	1.5%
1996	5.3	1.2%
1997	5.5	1.3%
1998	4.8	1.1%
1999	4.6	1.1%
2000	4.3	1.0%
2001	4.0	0.9%
2002	3.9	0.9%
2003	7.8	1.8%
2004	7.9	1.8%
2005	14.0	3.3%
2006	12.0	2.8%
2007	10.5	2.5%
2008	10.6	2.5%
2009	10.2	2.4%

MAX Yield Increase, mm: **21.8** Calibration value: **1.569**

MAX Percent Increase: **5.1%** Base Yield, mm: **426.7**

Year of MAX: **2015** Precipitation, mm: **538.6**

Scenario Name: **r41** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r41 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1994	0.0	0.0%
1995	418.1	13.3%
1996	357.1	11.3%
1997	367.3	11.7%
1998	324.6	10.3%
1999	306.9	9.7%
2000	287.2	9.1%
2001	263.1	8.5%
2002	260.0	8.2%
2003	544.2	17.3%
2004	549.8	17.4%
2005	971.7	30.8%
2006	833.2	26.4%
2007	729.5	23.1%
2008	737.3	23.4%
2009	708.5	22.5%
2010	824.5	26.2%
2011	917.6	29.1%
2012	878.6	27.9%
2013	853.6	27.1%
2014	1163.3	36.9%
2015	1495.5	47.4%
2016	1292.7	41.0%

Maximum Eca, ha: **1495.5** Max Eca, %: **47.4%**

Year of max Eca: **2015**

Scenario: **r41** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r41 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1994	0.0	0.0%
1995	418.1	13.3%
1996	464.5	14.6%
1997	555.3	17.5%
1998	548.7	17.2%
1999	541.8	17.0%
2000	534.8	16.7%
2001	527.7	16.5%
2002	520.5	16.3%
2003	797.8	24.8%
2004	870.3	26.8%
2005	1351.1	41.3%
2006	1361.5	41.6%
2007	1343.7	41.0%
2008	1371.5	41.6%
2009	1366.2	41.4%
2010	1516.3	45.2%
2011	1673.7	50.0%
2012	1703.2	50.8%
2013	1705.5	50.8%
2014	2017.8	58.3%
2015	2458.7	70.7%
2016	2427.5	69.4%

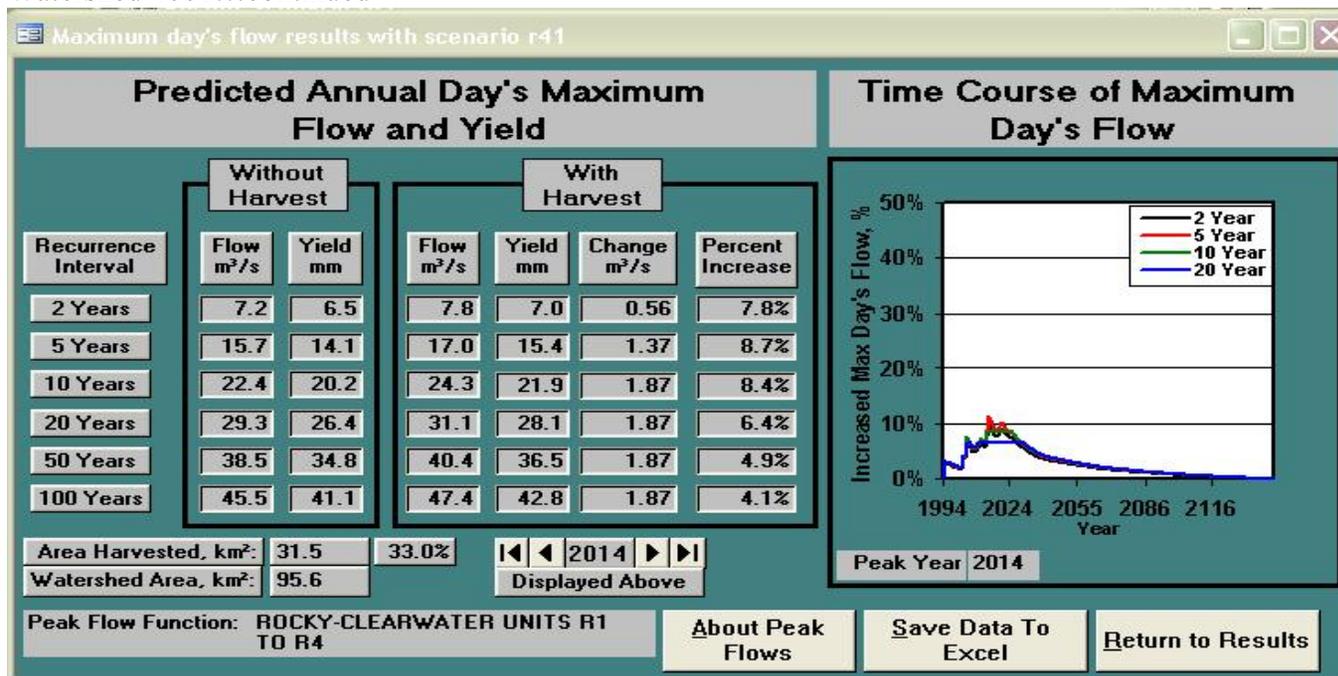
Maximum Eca, ha: **2620.2** Max Eca, %: **83.1%**

Year of max Eca: **2021**

Scenario: **r41** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 4001...continued



Watershed 4002

Run Scenarios in database with Individual Blocks

Select Scenario: **r42** [Run Scenario] [Return to Main]

Simulate Each Unit From **1998** for **150** years with **1** year time steps

Watershed Area, km²: **24.9** Total Area Cut, ha: **724.8** Percent Watershed Cut: **29.1%**

Appropriate Forest and Unit Group: **ROCKY-CLEARWATER UNITS R1 TO R4** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **BROWN CREEK AT FORESTRY ROAD** Year Progress

Statistic **AVG** Period **1974-1998** Yld, mm **426.7** Area, km² **218**

Precipitation Data Source: **NORDEGG** Units Progress

Statistic **AVG** Period **1915-1955** Annual Ppt, mm: **538.6**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha **13.6** Year Cut **1998**

Blks **1** Blk Size, ha **13.7**

Aspect **S** Block Elev, m **1261.0**

Regeneration Sp **CONIFEROUS**

Basal Area Func **LPP FAIR BA**

Tree Height Func **LPP FAIR TH**

Surrounding Stand Data

Stand Species **CONIFEROUS**

Stand BA **46.0** Stand TH **19.0**

Regional (Base) Silvicultural Data

Base BA **35.0** Years To Base BA **130**

Base TH, m **20.0** Years To Base TH **160**

Record: **14** of 105

Results Scenario r42

Year	Yield, mm	%
1997	0.0	0.0%
1998	7.8	1.8%
1999	16.2	3.8%
2000	22.2	5.2%
2001	18.8	4.4%
2002	18.0	4.2%
2003	18.3	4.3%
2004	17.0	4.0%
2005	18.9	4.4%
2006	19.2	4.5%
2007	18.1	4.2%
2008	17.9	4.2%
2009	19.4	4.5%
2010	20.3	4.8%
2011	19.1	4.5%
2012	17.8	4.2%

MAX Yield Increase, mm **22.2** Calibration value **1.650**

MAX Percent Increase **5.2%** Base Yield, mm **426.7**

Year of MAX **2000** Precipitation, mm **538.6**

Scenario Name: **r42** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r42 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1997	0.0	0.0%
1998	126.4	17.4%
1999	257.7	35.5%
2000	351.6	48.5%
2001	299.7	41.3%
2002	284.8	39.3%
2003	288.1	39.8%
2004	268.1	37.0%
2005	295.1	40.7%
2006	299.9	41.4%
2007	284.7	39.3%
2008	282.2	38.9%
2009	306.9	42.4%
2010	323.1	44.6%
2011	303.0	41.8%
2012	282.3	39.0%
2013	265.6	36.6%
2014	308.3	42.5%
2015	275.9	38.1%
2016	250.4	34.6%
2017	235.2	32.5%
2018	220.8	30.5%
2019	204.9	28.3%

Maximum Eca, ha **351.6** Max Eca, % **48.5%**

Year of max Eca **2000**

Scenario: **r42** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r42 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1997	0.0	0.0%
1998	126.4	17.4%
1999	294.1	40.5%
2000	441.8	60.6%
2001	456.6	62.8%
2002	463.9	63.8%
2003	485.1	66.5%
2004	479.1	65.9%
2005	516.6	70.8%
2006	533.9	73.1%
2007	527.1	72.3%
2008	521.9	71.7%
2009	540.7	74.0%
2010	561.9	76.5%
2011	557.0	75.8%
2012	549.1	74.7%
2013	540.9	73.8%
2014	590.9	80.9%
2015	583.7	79.9%
2016	574.9	78.5%
2017	565.8	77.0%
2018	556.6	75.5%
2019	547.4	74.0%

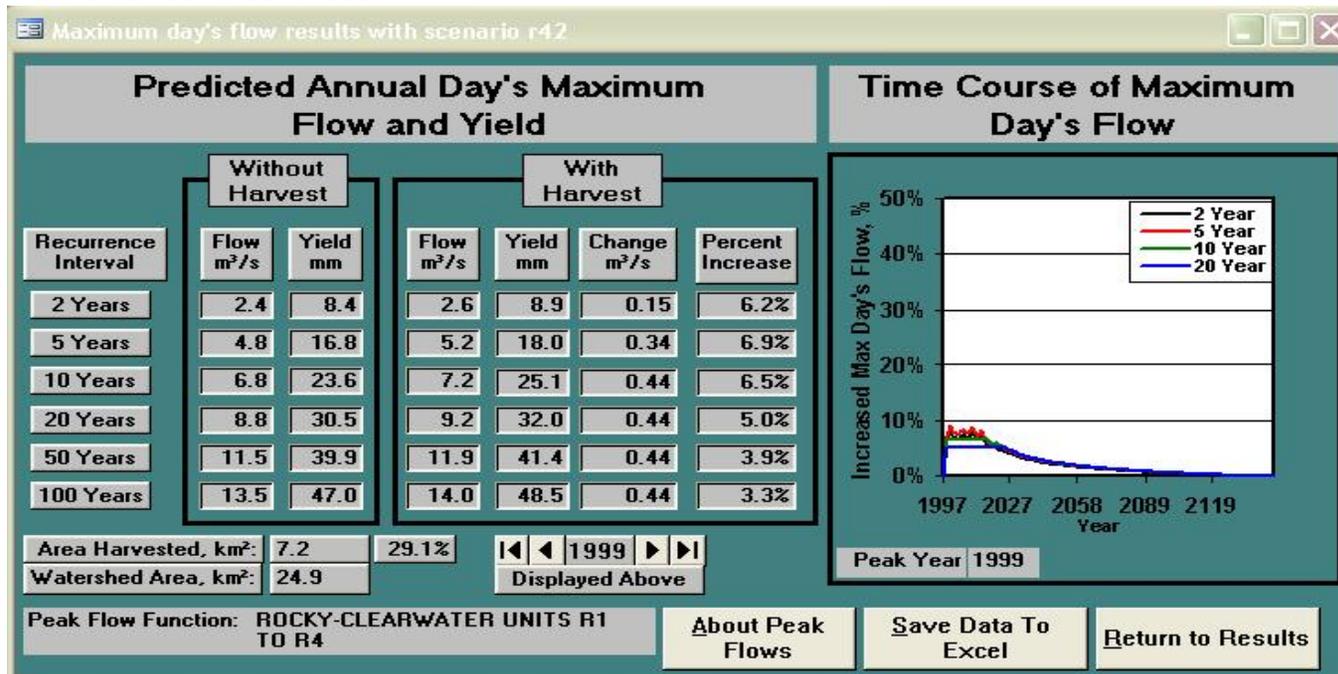
Maximum Eca, ha **590.9** Max Eca, % **81.5%**

Year of max Eca **2014**

Scenario: **r42** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 4002...continued



Watershed 5001

Run Scenarios in database with individual Blocks

Select Scenario: **r51** [Run Scenario] [Return to Main]

Simulate Each Unit From **2015** for **150** years with **1** year time steps

Watershed Area, km²: **87.8** Total Area Cut, ha: **69.4** Percent Watershed Cut: **0.8%**

Appropriate Forest and Unit Group: **ROCKY-CLEARWATER UNITS R1 TO R4** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **BROWN CREEK AT FORESTRY ROAD** Year Progress: _____

Statistic **AVG** Period **1974-1998** Yld, mm: **426.7** Area, km²: **218**

Precipitation Data Source: **NORDEGG** Units Progress: _____

Statistic **AVG** Period **1915-1955** Annual Ppt, mm: **538.6**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha	3.6	Year Cut	2015
# Blks	1	Blk Size, ha	3.6
Aspect	EW	Block Elev, m	1797.0
Regeneration Sp	CONIFEROUS		
Basal Area Func	LPP FAIR BA		
Tree Height Func	LPP FAIR TH		

Surrounding Stand Data

Stand Species	CONIFEROUS		
Stand BA	38.6	Stand TH	19.0

Regional (Base) Silvicultural Data

Base BA	35.0	Years To Base BA	130
Base TH, m	20.0	Years To Base TH	160

Record: 1 of 5

Results Scenario r51

Year	Yield, mm	%
2014	0.0	0.0%
2015	0.2	0.1%
2016	0.2	0.0%
2017	0.1	0.0%
2018	0.1	0.0%
2019	0.1	0.0%
2020	0.9	0.2%
2021	0.7	0.2%
2022	0.5	0.1%
2023	0.5	0.1%
2024	0.6	0.1%
2025	0.6	0.1%
2026	0.5	0.1%
2027	0.5	0.1%
2028	0.5	0.1%
2029	0.5	0.1%

MAX Yield Increase, mm: **0.9** Calibration value: **1,600**

MAX Percent Increase: **0.2%** Base Yield, mm: **426.7**

Year of MAX: **2020** Precipitation, mm: **538.6**

Scenario Name: **r51** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r51 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2014	0.0	0.0%
2015	14.0	20.1%
2016	9.9	14.2%
2017	7.6	10.9%
2018	7.3	10.6%
2019	7.4	10.6%
2020	58.6	84.5%
2021	42.1	60.7%
2022	33.2	47.8%
2023	32.9	47.4%
2024	37.1	53.4%
2025	34.1	49.2%
2026	32.0	46.1%
2027	31.6	45.5%
2028	32.0	46.1%
2029	32.1	46.3%
2030	32.2	46.4%
2031	32.2	46.4%
2032	30.1	43.4%
2033	27.7	39.9%
2034	25.3	36.5%
2035	23.0	33.2%
2036	21.0	30.3%

Maximum Eca, ha: **58.6** Max Eca, %: **84.5%**

Year of max Eca: **2020**

Scenario: **r51** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r51 ECA based on Mature Basal Area

Year	ECA, ha	ECA, %
2014	0.0	0.0%
2015	14.0	20.1%
2016	13.8	19.8%
2017	13.7	19.7%
2018	13.5	19.4%
2019	13.4	19.3%
2020	65.1	94.6%
2021	64.4	93.1%
2022	63.7	91.6%
2023	62.9	90.1%
2024	65.6	94.6%
2025	64.8	92.6%
2026	64.0	91.1%
2027	63.1	89.6%
2028	62.3	88.1%
2029	61.4	86.6%
2030	60.6	85.1%
2031	59.7	83.6%
2032	58.8	82.1%
2033	57.9	80.6%
2034	57.0	79.1%
2035	56.1	77.6%
2036	55.2	76.1%

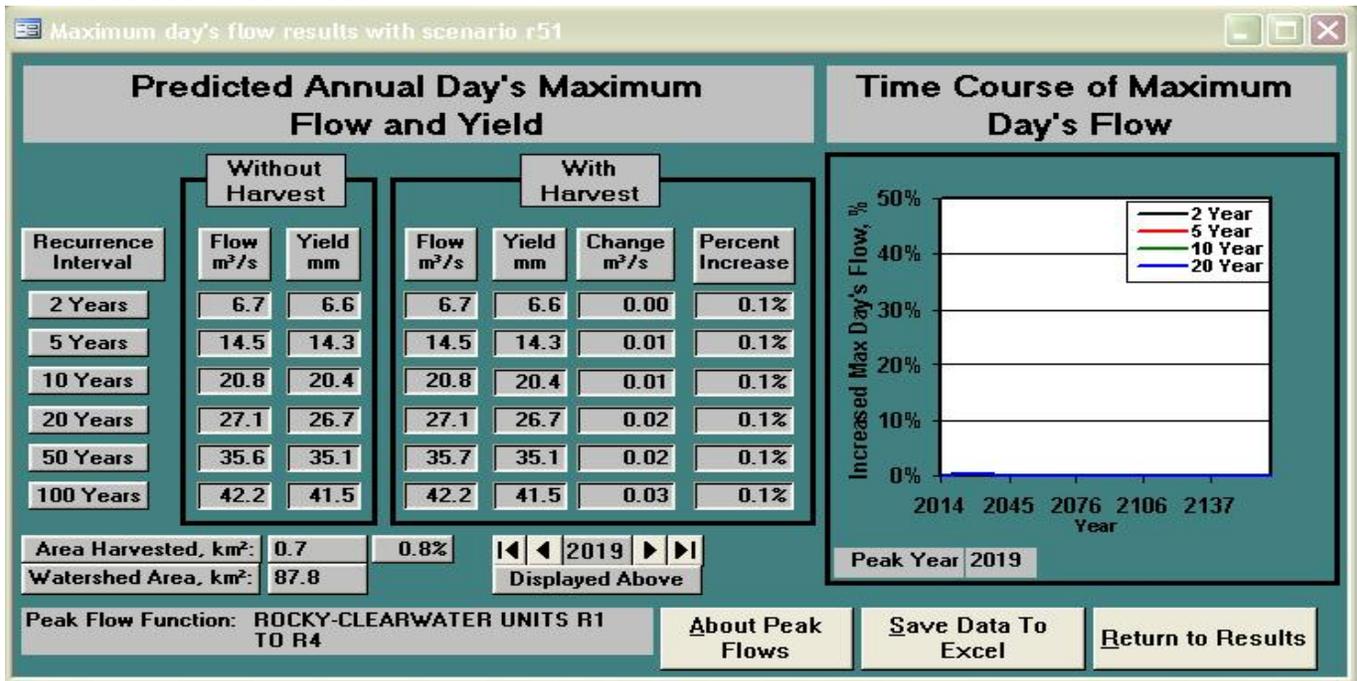
Maximum Eca, ha: **65.6** Max Eca, %: **94.6%**

Year of max Eca: **2024**

Scenario: **r51** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 5001...continued



Watershed 5002

Run Scenarios in database with Individual Blocks

Select Scenario: **r52** [Run Scenario] [Return to Main]

Simulate Each Unit From **2014** for **150** years with **1** year time steps

Watershed Area, km²: **190.9** Total Area Cut, ha: **500.5** Percent Watershed Cut: **2.6%**

Appropriate Forest and Unit Group: **ROCKY-CLEARWATER UNITS R1 TO R4** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **BROWN CREEK AT FORESTRY ROAD** Year Progress

Statistic **AVG** Period **1974-1998** Yld, mm **426.7** Area, km² **218**

Precipitation Data Source: **NORDEGG** Units Progress

Statistic **AVG** Period **1915-1955** Annual Ppt, mm: **538.6**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **22.6** Year Cut: **2014**

Blks: **1** Blk Size, ha: **38.1**

Aspect: **S** Block Elev, m: **1386.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **43.3** Stand TH: **16.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: **14** of 36

Results Scenario r52

Year	Yield, mm	%
2013	0.0	0.0%
2014	0.6	0.1%
2015	0.9	0.2%
2016	0.7	0.2%
2017	0.6	0.1%
2018	0.6	0.1%
2019	0.6	0.1%
2020	2.0	0.5%
2021	2.6	0.6%
2022	2.3	0.5%
2023	2.2	0.5%
2024	2.5	0.6%
2025	2.4	0.6%
2026	2.3	0.5%
2027	2.3	0.5%
2028	2.3	0.5%

MAX Yield Increase, mm: **2.6** Calibration value: **1.605**

MAX Percent Increase: **0.6%** Base Yield, mm: **426.7**

Year of MAX: **2021** Precipitation, mm: **538.6**

Scenario Name: **r52** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r52 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2013	0.0	0.0%
2014	93.7	16.7%
2015	126.7	25.3%
2016	93.6	18.7%
2017	82.4	16.5%
2018	84.3	16.9%
2019	81.7	16.3%
2020	262.0	52.3%
2021	343.0	68.5%
2022	302.7	60.5%
2023	289.3	57.8%
2024	320.5	64.0%
2025	316.1	63.2%
2026	305.9	61.1%
2027	299.0	59.7%
2028	297.1	59.4%
2029	295.7	59.1%
2030	294.4	58.8%
2031	292.6	58.5%
2032	286.9	57.3%
2033	277.8	55.5%
2034	268.6	53.7%
2035	260.9	52.1%

Maximum Eca, ha: **343.0** Max Eca, %: **68.5%**

Year of max Eca: **2021**

Scenario: **r52** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r52 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2013	0.0	0.0%
2014	83.7	16.7%
2015	152.5	30.5%
2016	150.9	30.2%
2017	149.3	30.0%
2018	149.2	30.0%
2019	147.5	29.5%
2020	352.4	70.5%
2021	459.4	91.9%
2022	456.8	91.4%
2023	452.1	90.5%
2024	477.7	95.5%
2025	473.7	94.7%
2026	469.7	93.9%
2027	465.6	93.1%
2028	461.4	92.3%
2029	457.2	91.5%
2030	452.9	90.7%
2031	448.6	90.0%
2032	444.2	89.3%
2033	439.9	88.6%
2034	435.4	88.0%
2035	431.0	87.5%

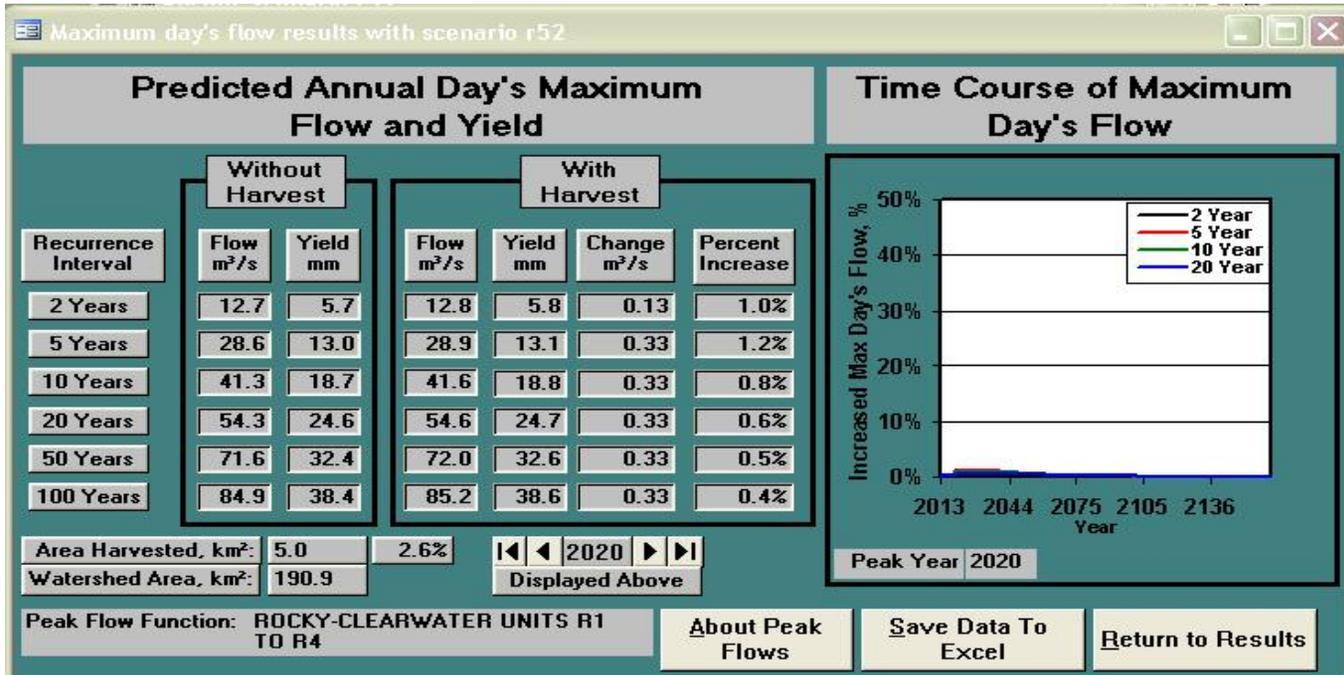
Maximum Eca, ha: **477.7** Max Eca, %: **95.5%**

Year of max Eca: **2024**

Scenario: **r52** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 5002...continued



Watershed 7001

Run Scenarios in database with Individual Blocks

Select Scenario: **r71** [Run Scenario] [Return to Main]

Simulate Each Unit From **2005** for **150** years with **1** year time steps

Watershed Area, km²: **35.6** Total Area Cut, ha: **44.5** Percent Watershed Cut: **1.3%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic **AVG** Period **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic **AVG** Period **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit		Surrounding Stand Data	
Cut, ha	5.5	Year Cut	2005
# Blks	1	Blk Size, ha	5.9
Aspect	EW	Block Elev, m	1195.0
Regeneration Sp	CONIFEROUS	Stand Species	CONIFEROUS
Basal Area Func	LPP FAIR BA	Stand BA	43.3
Tree Height Func	LPP FAIR TH	Stand TH	16.0
		Regional (Base) Silvicultural Data	
		Base BA	35.0
		Years To Base BA	130
		Base TH, m	20.0
		Years To Base TH	160

Record: 14 | 1 | 8

Results Scenario r71

Year	Yield, mm	%
2004	0.0	0.0%
2005	0.7	0.4%
2006	0.4	0.2%
2007	0.3	0.2%
2008	0.3	0.2%
2009	0.3	0.2%
2010	0.4	0.2%
2011	0.4	0.2%
2012	0.5	0.3%
2013	0.5	0.3%
2014	0.6	0.3%
2015	1.1	0.6%
2016	0.8	0.4%
2017	0.7	0.4%
2018	0.6	0.3%
2019	0.6	0.3%

MAX Yield Increase, mm: **1.1** Calibration value: **0.955**

MAX Percent Increase: **0.6%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r71** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r71 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2004	0.0	0.0%
2005	23.5	52.9%
2006	14.6	32.8%
2007	9.8	22.1%
2008	9.9	22.2%
2009	10.9	24.5%
2010	11.6	26.1%
2011	13.2	29.7%
2012	15.3	34.4%
2013	16.1	36.1%
2014	18.6	41.7%
2015	35.8	80.4%
2016	27.2	61.2%
2017	22.3	50.0%
2018	21.1	47.4%
2019	20.8	46.7%
2020	21.0	47.1%
2021	21.3	47.8%
2022	22.0	49.5%
2023	21.8	48.9%
2024	21.5	48.3%
2025	20.1	45.1%
2026	19.0	42.7%

Maximum Eca, ha: **35.8** Max Eca, %: **80.4%**

Year of max Eca: **2015**

Scenario: **r71** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r71 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2004	0.0	0.0%
2005	23.5	52.9%
2006	23.3	52.5%
2007	23.0	51.8%
2008	22.8	51.5%
2009	22.5	51.1%
2010	22.2	50.7%
2011	21.9	50.3%
2012	21.7	50.0%
2013	21.4	49.6%
2014	22.9	51.3%
2015	41.2	92.5%
2016	40.6	91.3%
2017	40.1	90.5%
2018	39.6	89.7%
2019	39.0	88.8%
2020	39.1	89.0%
2021	38.5	87.5%
2022	38.0	86.6%
2023	37.4	85.7%
2024	36.8	84.8%
2025	36.2	83.9%
2026	35.7	83.1%

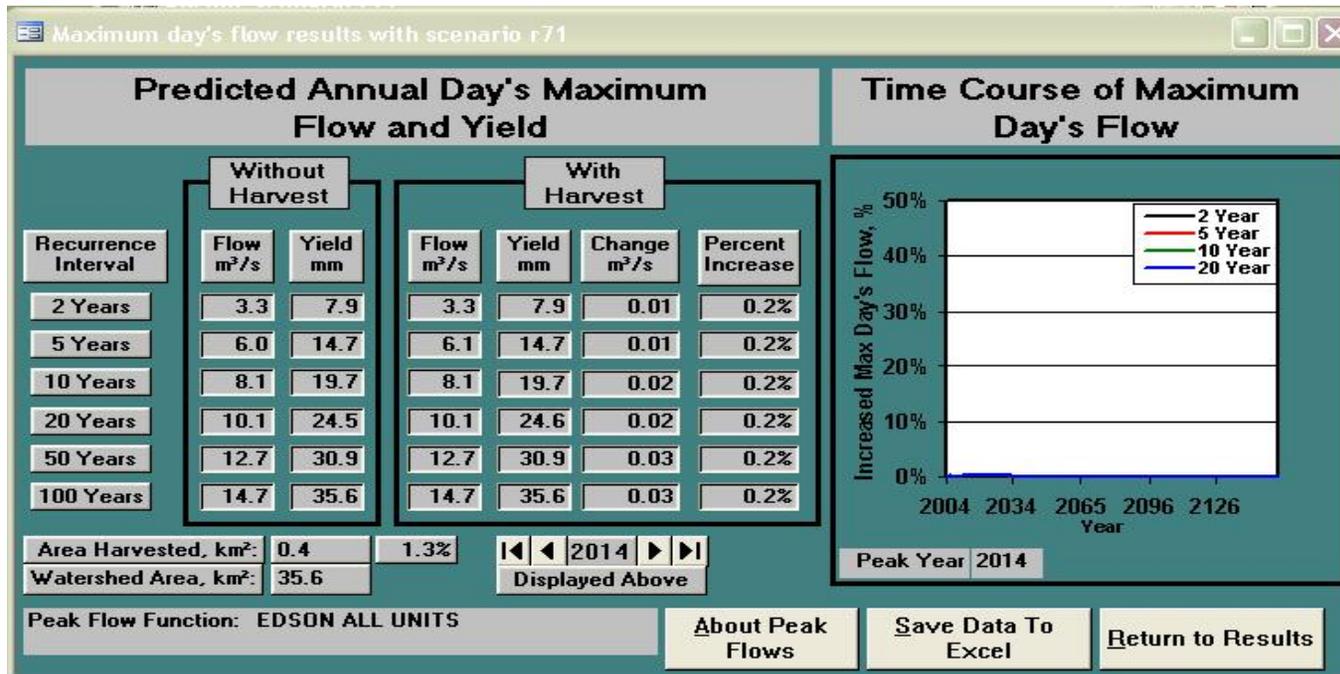
Maximum Eca, ha: **41.2** Max Eca, %: **92.5%**

Year of max Eca: **2015**

Scenario: **r71** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 7001...continued



Watershed 7002

Run Scenarios in database with Individual Blocks

Select Scenario: **r72** [Run Scenario] [Return to Main]

Simulate Each Unit From **2003** for **150** years with **1** year time steps

Watershed Area, km²: **63.8** Total Area Cut, ha: **1523.3** Percent Watershed Cut: **23.9%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **2.3** Year Cut: **2003**

Blks: **1** Blk Size, ha: **11.3**

Aspect: **EW** Block Elev, m: **1163.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **40.5** Stand TH: **13.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: 14 of 142

Results Scenario r72

Year	Yield, mm	%
2002	0.0	0.0%
2003	0.7	0.4%
2004	2.5	1.3%
2005	7.6	4.1%
2006	5.1	2.8%
2007	4.2	2.3%
2008	4.3	2.3%
2009	4.6	2.5%
2010	8.5	4.6%
2011	10.1	5.5%
2012	10.0	5.4%
2013	9.4	5.1%
2014	11.4	6.2%
2015	15.7	8.5%
2016	13.6	7.4%
2017	12.6	6.8%

MAX Yield Increase, mm: **15.7** Calibration value: **0.975**

MAX Percent Increase: **8.5%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r72** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r72 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2002	0.0	0.0%
2003	37.9	2.5%
2004	157.0	10.3%
2005	469.8	30.8%
2006	314.5	20.6%
2007	252.6	16.6%
2008	261.4	17.2%
2009	284.6	18.7%
2010	504.4	33.1%
2011	608.7	40.0%
2012	607.4	39.9%
2013	572.3	37.6%
2014	679.9	44.6%
2015	937.8	61.6%
2016	811.4	53.3%
2017	746.2	49.0%
2018	744.6	48.9%
2019	748.1	49.1%
2020	868.6	57.0%
2021	816.9	53.6%
2022	780.5	51.2%
2023	783.9	51.5%
2024	749.7	49.2%

Maximum Eca, ha: **937.8** Max Eca, %: **61.6%**

Year of max Eca: **2015**

Scenario: **r72** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r72 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2002	0.0	0.0%
2003	37.9	1.1%
2004	170.7	1.1%
2005	550.6	1.1%
2006	544.8	1.1%
2007	538.4	1.1%
2008	531.8	1.1%
2009	525.2	1.1%
2010	712.6	4.4%
2011	841.4	4.4%
2012	884.7	4.4%
2013	873.5	4.4%
2014	973.9	4.4%
2015	1261.5	6.8%
2016	1256.4	6.8%
2017	1240.8	6.8%
2018	1223.9	6.8%
2019	1208.1	6.8%
2020	1318.2	6.8%
2021	1301.5	6.8%
2022	1282.5	6.8%
2023	1293.1	6.8%
2024	1273.5	6.8%

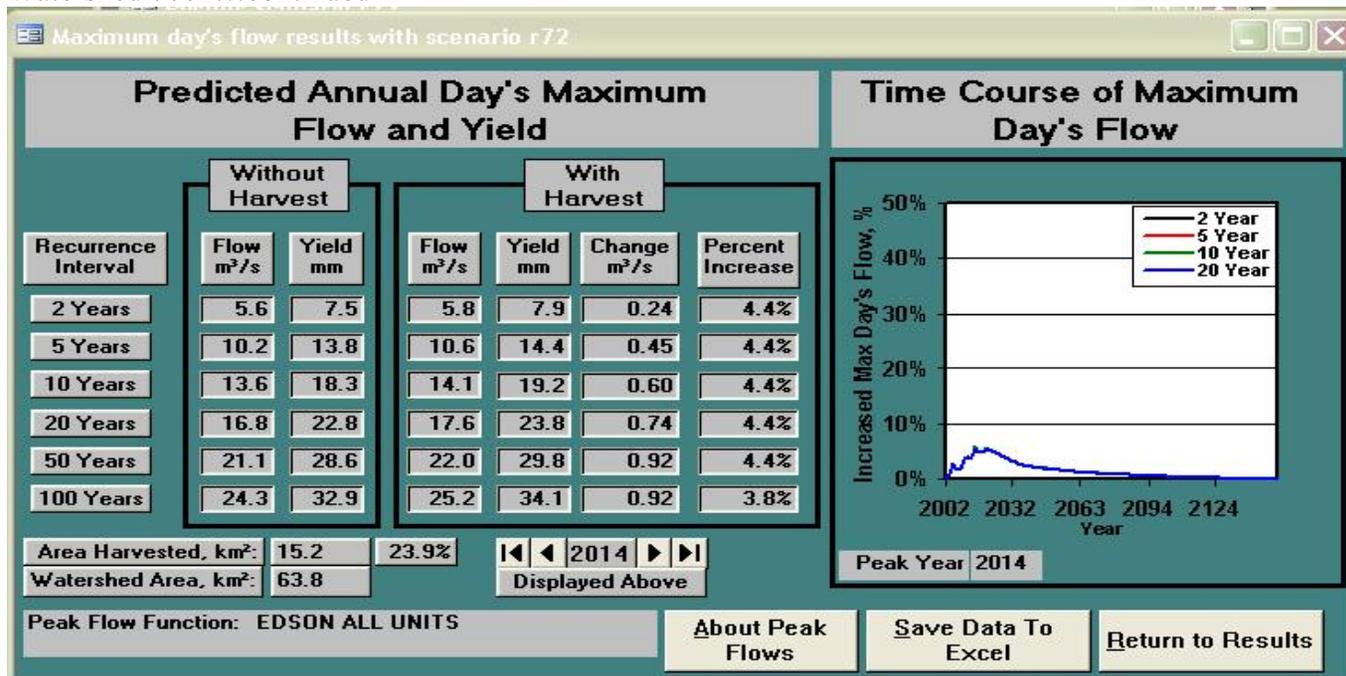
Maximum Eca, ha: **1318.2** Max Eca, %: **86.5%**

Year of max Eca: **2015**

Scenario: **r72** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 7002...continued



Watershed 9000

Run Scenarios in database with Individual Blocks

Select Scenario: **r90** Run Scenario Return to Main

Simulate Each Unit From **1992** for **150** years with **1** year time steps

Watershed Area, km²: **83.3** Total Area Cut, ha: **263.0** Percent Watershed Cut: **3.2%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **EMBARRAS RIVER NEAR WEALD** Year Progress

Statistic **AVG** Period **1984-1998** Yld, mm: **223.7** Area, km²: **647**

Precipitation Data Source: **EDSON A** Units Progress

Statistic **AVG** Period **1971-1998** Annual Ppt, mm: **556.9**

Cut Block Details: **frmRunScenarios, Individual Blocks** Table View

Annual Harvest Data, Operational Unit

Cut, ha: **1.2** Year Cut: **1992**

Blks: **1** Blk Size, ha: **19.7**

Aspect: **EW** Block Elev, m: **1072.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **46.0** Stand TH: **19.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: **14** of 11

Results Scenario r90

Year	Yield, mm	%
1991	0.0	0.0%
1992	0.2	0.1%
1993	0.1	0.1%
1994	0.1	0.0%
1995	0.1	0.0%
1996	0.1	0.0%
1997	0.1	0.0%
1998	0.1	0.1%
1999	0.1	0.1%
2000	0.1	0.1%
2001	0.1	0.0%
2002	0.1	0.0%
2003	0.1	0.0%
2004	0.1	0.0%
2005	1.4	0.6%
2006	2.1	0.9%

MAX Yield Increase, mm: **2.7** Calibration value: **1.311**

MAX Percent Increase: **1.2%** Base Yield, mm: **223.7**

Year of MAX: **2015** Precipitation, mm: **556.9**

Scenario Name: **r90** Region: **New England/Boreal**

Save Yield Data ECA Mature Ba ECA Max Yld Max Day's Analysis Peak Flow Analysis Return

r90 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1991	0.0	0.0%
1992	10.2	3.9%
1993	7.2	2.7%
1994	5.5	2.1%
1995	5.4	2.1%
1996	5.8	2.2%
1997	5.8	2.2%
1998	5.9	2.2%
1999	5.9	2.2%
2000	5.9	2.3%
2001	5.8	2.2%
2002	5.5	2.1%
2003	5.1	1.9%
2004	4.7	1.8%
2005	77.7	29.5%
2006	119.5	45.4%
2007	93.0	35.4%
2008	78.8	30.0%
2009	77.7	29.6%
2010	78.7	29.9%
2011	78.3	29.8%
2012	94.1	35.8%
2013	115.0	43.7%

Maximum Eca, ha: **145.6** Max Eca, %: **55.4%**

Year of max Eca: **2015**

Scenario: **r90** Region: **New England/Boreal**

About Eca Max Yield Save Data to Excel Return

r90 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1991	0.0	0.0%
1992	10.2	3.9%
1993	10.1	3.9%
1994	10.0	3.9%
1995	9.9	3.9%
1996	9.8	3.9%
1997	9.6	3.9%
1998	9.5	3.9%
1999	9.4	3.9%
2000	9.3	3.9%
2001	9.1	3.9%
2002	9.0	3.9%
2003	8.9	3.9%
2004	8.8	3.9%
2005	84.4	30.9%
2006	137.3	50.3%
2007	135.5	50.0%
2008	133.8	49.7%
2009	132.0	49.4%
2010	130.1	49.0%
2011	128.3	48.6%
2012	143.9	52.0%
2013	168.8	60.3%

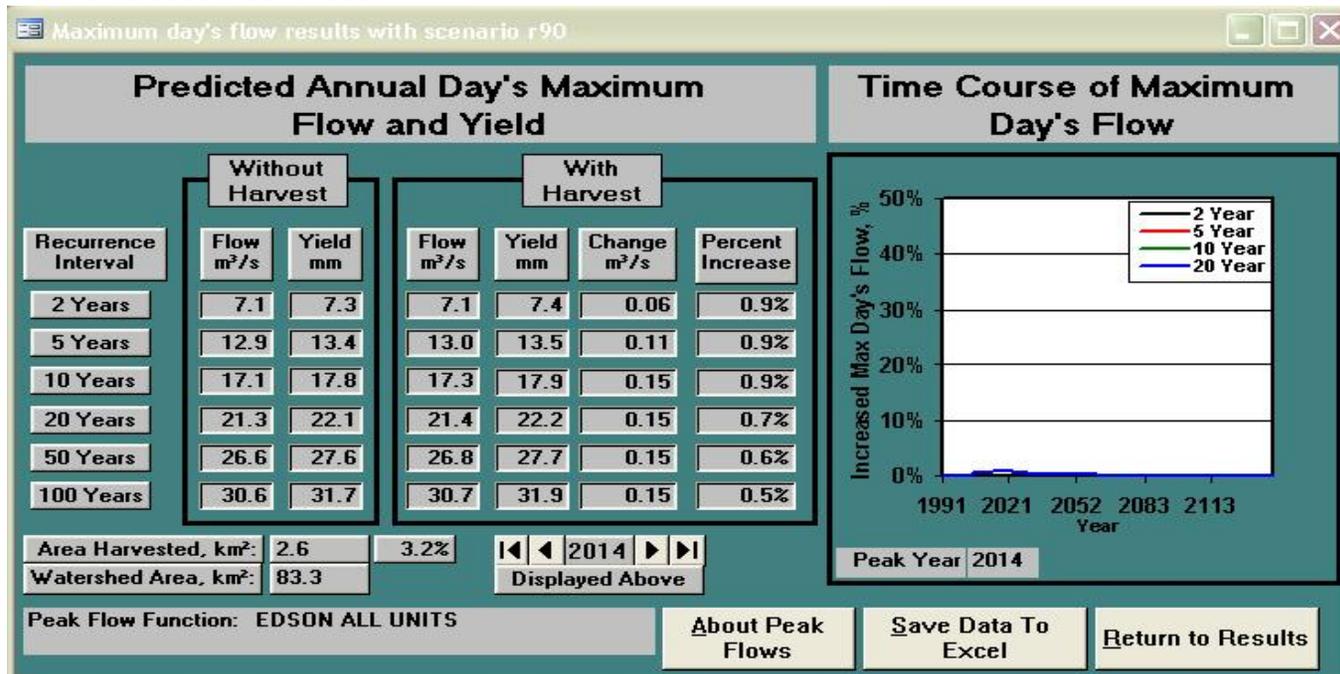
Maximum Eca, ha: **226.2** Max Eca, %: **86.0%**

Year of max Eca: **2015**

Scenario: **r90** Region: **New England/Boreal**

About Eca Ba Mature Save Data to Excel Return

Watershed 9000...continued



Watershed 1100

Run Scenarios in database with Individual Blocks

Select Scenario: **r110** Run Scenario Return to Main

Simulate Each Unit From **2005** for **150** years with **1** year time steps

Watershed Area, km²: **251.6** Total Area Cut, ha: **1133.6** Percent Watershed Cut: **4.5%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **EMBARRAS RIVER NEAR WEALD** Year Progress

Statistic **AVG** Period **1984-1998** Yld, mm: **223.7** Area, km²: **647**

Precipitation Data Source: **EDSON A** Units Progress

Statistic **AVG** Period **1971-1998** Annual Ppt, mm: **556.9**

Cut Block Details: **frmRunScenarios, Individual Blocks** Table View

Annual Harvest Data, Operational Unit

Cut, ha: **15.0** Year Cut: **2005**

Blks: **1** Blk Size, ha: **15.0**

Aspect: **N** Block Elev, m: **940.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **LPP FAIR BA**

Tree Height Func: **LPP FAIR TH**

Surrounding Stand Data

Stand Species: **DECIDUOUS**

Stand BA: **29.2** Stand TH: **19.0**

Regional (Base) Silvicultural Data

Base BA: **35.0** Years To Base BA: **130**

Base TH, m: **20.0** Years To Base TH: **160**

Record: 1 of 75

Results Scenario r110

Year	Yield, mm	%
2004	0.0	0.0%
2005	1.1	0.5%
2006	0.9	0.4%
2007	0.7	0.3%
2008	0.7	0.3%
2009	0.7	0.3%
2010	2.2	1.0%
2011	2.4	1.1%
2012	2.4	1.1%
2013	2.2	1.0%
2014	3.3	1.5%
2015	3.6	1.6%
2016	3.8	1.7%
2017	3.7	1.7%
2018	3.5	1.6%
2019	3.4	1.5%

MAX Yield Increase, mm: **3.8** Calibration value: **1.255**

MAX Percent Increase: **1.7%** Base Yield, mm: **223.7**

Year of MAX: **2016** Precipitation, mm: **556.9**

Scenario Name: **r110** Region: **New England/Boreal**

Save Yield Data ECA Mature Ba ECA Max Yld Max Day's Analysis Peak Flow Analysis Return

r110 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2004	0.0	0.0%
2005	195.9	17.3%
2006	155.5	13.7%
2007	124.3	11.0%
2008	119.1	10.5%
2009	125.5	11.1%
2010	388.7	34.3%
2011	419.4	37.0%
2012	417.6	36.8%
2013	381.2	33.6%
2014	579.2	51.1%
2015	618.9	54.6%
2016	661.0	58.3%
2017	649.9	57.3%
2018	615.3	54.3%
2019	595.4	52.5%
2020	576.7	50.9%
2021	623.6	55.0%
2022	575.3	50.8%
2023	526.2	46.4%
2024	484.1	42.7%
2025	449.1	39.6%
2026	418.0	36.9%

Maximum Eca, ha: **661.0** Max Eca, %: **58.3%**

Year of max Eca: **2016**

Scenario: **r110** Region: **New England/Boreal**

About Eca Max Yield Save Data to Excel Return

r110 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2004	0.0	0.0%
2005	200.1	17.3%
2006	206.3	17.7%
2007	204.1	17.5%
2008	201.8	17.3%
2009	199.5	17.1%
2010	464.9	40.1%
2011	536.4	46.5%
2012	564.4	48.0%
2013	556.9	47.8%
2014	774.7	66.2%
2015	845.6	72.0%
2016	918.3	77.5%
2017	925.9	78.1%
2018	911.7	76.9%
2019	919.7	77.6%
2020	924.7	77.9%
2021	1001.6	84.9%
2022	985.0	83.3%
2023	968.0	81.7%
2024	951.4	80.2%
2025	934.0	78.7%
2026	916.4	77.2%

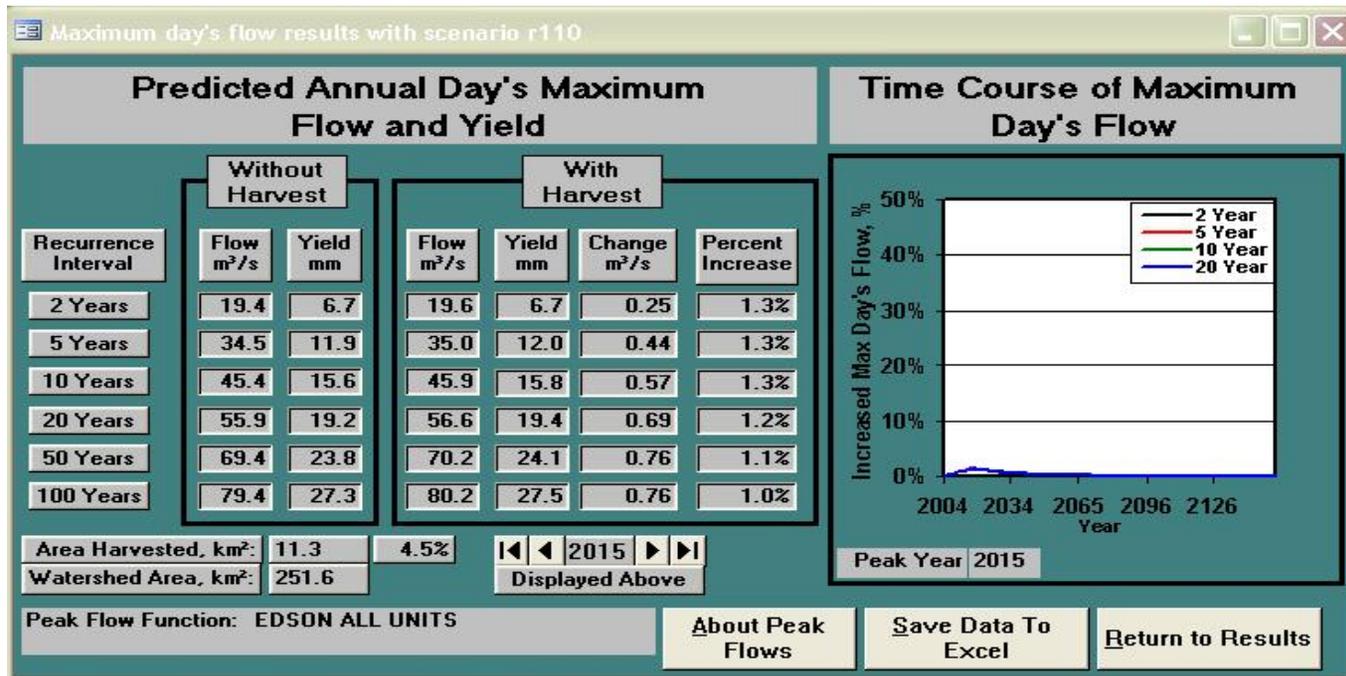
Maximum Eca, ha: **1001.6** Max Eca, %: **88.4%**

Year of max Eca: **2021**

Scenario: **r110** Region: **New England/Boreal**

About Eca Ba Mature Save Data to Excel Return

Watershed 1100...continued



Watershed 1200

Run Scenarios in database with Individual Blocks

Select Scenario: **r120** [Run Scenario] [Return to Main]

Simulate Each Unit From **2005** for **150** years with **1** year time steps

Watershed Area, km²: **48.4** Total Area Cut, ha: **464.6** Percent Watershed Cut: **9.6%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **EMBARRAS RIVER NEAR WEALD** Year Progress: _____

Statistic **AVG** Period **1984-1998** Yld, mm: **223.7** Area, km²: **647**

Precipitation Data Source: **EDSON A** Units Progress: _____

Statistic **AVG** Period **1971-1998** Annual Ppt, mm: **556.9**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit		Surrounding Stand Data	
Cut, ha	67.1	Year Cut	2005
# Blks	1	Blk Size, ha	67.1
Aspect	EW	Block Elev, m	946.0
Regeneration Sp	CONIFEROUS	Stand Species	CONIFEROUS
Basal Area Func	LPP FAIR BA	Stand BA	28.8
Tree Height Func	LPP FAIR TH	Stand TH	10.0
		Regional (Base) Silvicultural Data	
		Base BA	35.0
		Years To Base BA	130
		Base TH, m	20.0
		Years To Base TH	160

Record: 14 of 18

Results Scenario r120

Year	Yield, mm	%
2004	0.0	0.0%
2005	2.9	1.3%
2006	2.0	0.9%
2007	1.5	0.7%
2008	1.8	0.8%
2009	2.5	1.1%
2010	3.5	1.6%
2011	4.1	1.8%
2012	4.0	1.8%
2013	3.8	1.7%
2014	5.4	2.4%
2015	6.0	2.7%
2016	5.7	2.5%
2017	5.1	2.3%
2018	4.7	2.1%
2019	4.3	1.9%

MAX Yield Increase, mm: **7.6** Calibration value: **1.262**

MAX Percent Increase: **3.4%** Base Yield, mm: **223.7**

Year of MAX: **2023** Precipitation, mm: **556.9**

Scenario Name: **r120** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r120 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2004	0.0	0.0%
2005	102.0	22.0%
2006	70.6	15.2%
2007	53.2	11.5%
2008	61.8	13.3%
2009	88.0	18.9%
2010	120.7	26.0%
2011	138.3	29.8%
2012	133.7	28.8%
2013	127.1	27.3%
2014	184.8	39.8%
2015	205.0	44.1%
2016	194.0	41.7%
2017	174.5	37.6%
2018	158.9	34.2%
2019	146.3	31.5%
2020	189.6	40.8%
2021	183.2	39.4%
2022	228.4	49.2%
2023	252.5	54.3%
2024	240.6	51.8%
2025	220.6	47.5%
2026	204.4	44.0%

Maximum Eca, ha: **252.5** Max Eca, %: **54.3%**

Year of max Eca: **2023**

Scenario: **r120** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r120 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2004	0.0	0.0%
2005	102.0	22.0%
2006	100.9	21.9%
2007	99.8	21.8%
2008	107.5	23.6%
2009	130.2	28.9%
2010	160.7	35.3%
2011	182.4	39.7%
2012	180.0	39.3%
2013	177.6	38.9%
2014	244.9	54.9%
2015	264.3	59.1%
2016	260.3	58.1%
2017	256.1	57.1%
2018	251.8	56.1%
2019	247.5	55.2%
2020	298.4	65.9%
2021	313.4	69.1%
2022	378.6	84.4%
2023	409.0	88.0%
2024	402.1	86.3%
2025	394.7	84.7%
2026	387.2	83.1%

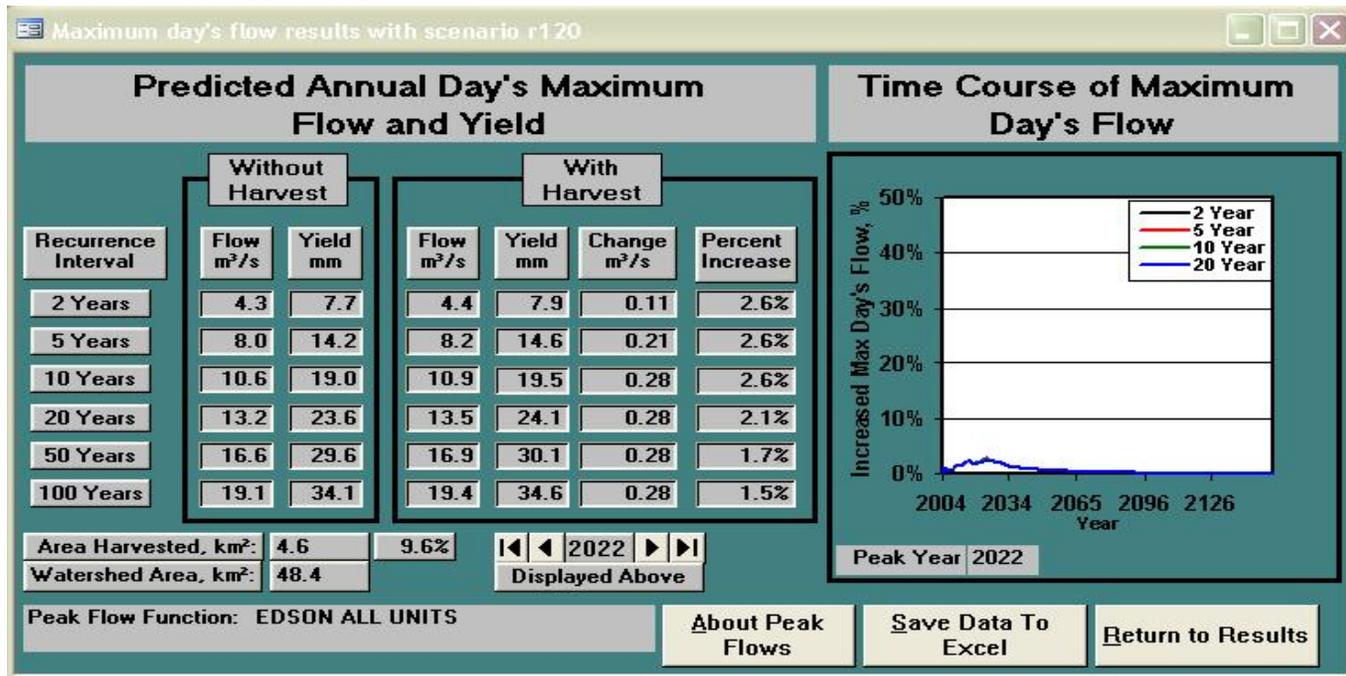
Maximum Eca, ha: **409.0** Max Eca, %: **88.0%**

Year of max Eca: **2023**

Scenario: **r120** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 1200...continued



Watershed 1700

Run Scenarios in database with Individual Blocks

Select Scenario: **r170** [Run Scenario] [Return to Main]

Simulate Each Unit From **2005** for **150** years with **1** year time steps

Watershed Area, km²: **24.6** Total Area Cut, ha: **859.3** Percent Watershed Cut: **35.0%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **EMBARRAS RIVER NEAR WEALD** Year Progress

Statistic: **AVG** Period: **1984-1998** Yld, mm: **223.7** Area, km²: **647**

Precipitation Data Source: **EDSON A** Units Progress

Statistic: **AVG** Period: **1971-1998** Annual Ppt, mm: **556.9**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **14.6** Year Cut: **2005** Surrounding Stand Data

Blks: **1** Blk Size, ha: **14.6** Stand Species: **DECIDUOUS**

Aspect: **EW** Block Elev, m: **944.0** Stand BA: **29.2** Stand TH: **19.0**

Regeneration Sp: **CONIFEROUS** Regional (Base) Silvicultural Data

Basal Area Func: **LPP FAIR BA** Base BA: **35.0** Years To Base BA: **130**

Tree Height Func: **LPP FAIR TH** Base TH, m: **20.0** Years To Base TH: **160**

Record: **14** of 35

Results Scenario r170

Year	Yield, mm	%
2004	0.0	0.0%
2005	7.7	3.5%
2006	6.3	2.8%
2007	5.4	2.4%
2008	11.1	5.0%
2009	10.8	4.8%
2010	15.8	7.1%
2011	22.6	10.1%
2012	22.8	10.2%
2013	21.7	9.7%
2014	21.7	9.7%
2015	27.2	12.2%
2016	26.0	11.6%
2017	26.5	11.8%
2018	24.6	11.0%
2019	23.1	10.3%

Record: **14**

MAX Yield Increase, mm: **27.2** Calibration value: **1.236**

MAX Percent Increase: **12.2%** Base Yield, mm: **223.7**

Year of MAX: **2015** Precipitation, mm: **556.9**

Scenario Name: **r170** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r170 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
2004	0.0	0.0%
2005	135.6	15.8%
2006	110.9	12.3%
2007	95.8	11.2%
2008	193.5	22.5%
2009	187.0	21.8%
2010	267.9	31.2%
2011	387.5	45.1%
2012	391.7	45.6%
2013	372.6	43.4%
2014	371.0	43.2%
2015	470.8	54.8%
2016	448.6	52.2%
2017	457.7	53.3%
2018	425.3	49.5%
2019	397.3	46.2%
2020	408.1	47.5%
2021	451.0	52.5%
2022	427.2	49.7%
2023	394.0	45.9%
2024	358.3	41.7%
2025	331.0	38.5%
2026	310.6	36.1%

Maximum Eca, ha: **470.8** Max Eca, %: **54.8%**

Year of max Eca: **2015**

Scenario: **r170** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r170 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
2004	0.0	0.0%
2005	137.5	1
2006	136.2	1
2007	137.8	1
2008	245.9	2
2009	265.9	2
2010	371.1	4
2011	508.9	7
2012	503.3	7
2013	496.1	6
2014	516.1	6
2015	636.4	7
2016	632.1	7
2017	667.2	7
2018	656.5	7
2019	646.3	7
2020	675.7	7
2021	748.3	8
2022	738.2	8
2023	724.4	8
2024	710.4	8
2025	696.3	8
2026	682.1	7

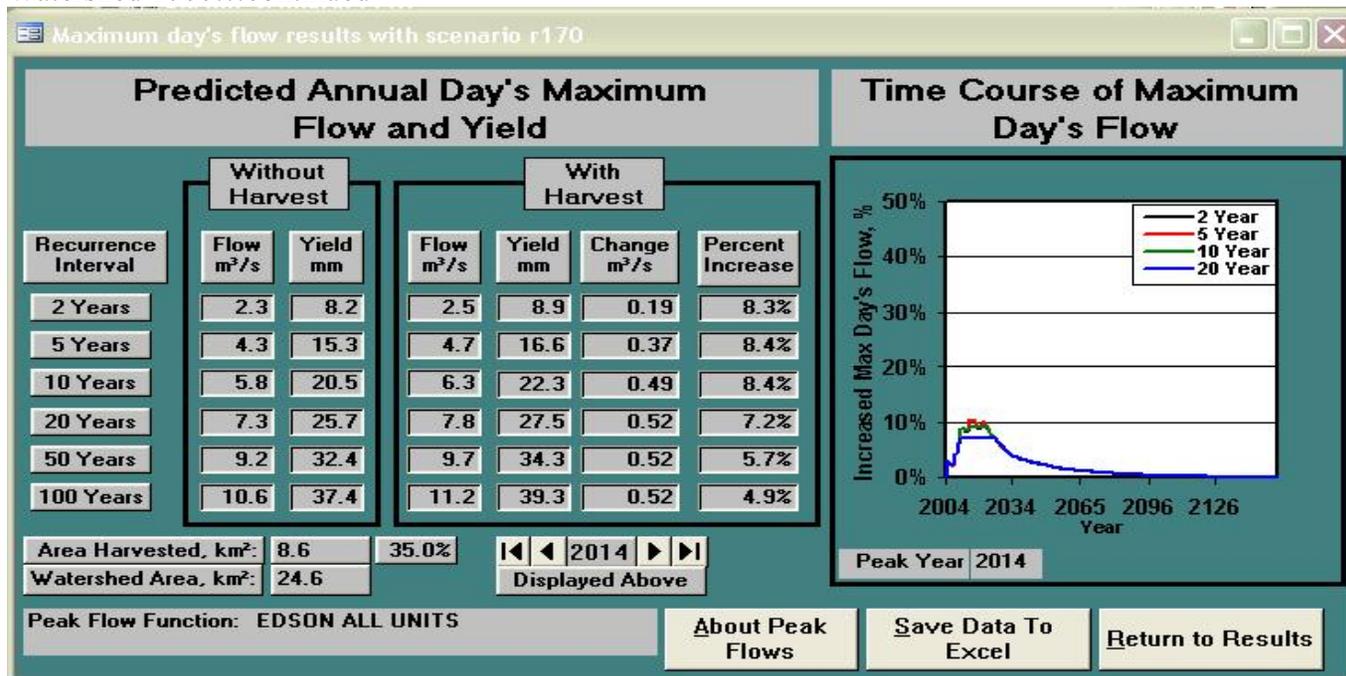
Maximum Eca, ha: **748.3** Max Eca, %: **87.1%**

Year of max Eca: **2021**

Scenario: **r170** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 1700...continued



Watershed 2501

Run Scenarios in database with Individual Blocks

Select Scenario: **r251** [Run Scenario] [Return to Main]

Simulate Each Unit From **1992** for **150** years with **1** year time steps

Watershed Area, km²: **48.1** Total Area Cut, ha: **1645.9** Percent Watershed Cut: **34.2%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress: _____

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress: _____

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: frmRunScenarios, Individual Blocks [Table View]

Annual Harvest Data, Operational Unit		Surrounding Stand Data	
Cut, ha	24.8	Year Cut	1992
# Blks	1	Blk Size, ha	26.6
Aspect	N	Block Elev, m	1038.0
Regeneration Sp	CONIFEROUS	Stand Species	CONIFEROUS
Basal Area Func	WS FAIR BA	Stand BA	35.3
Tree Height Func	WS FAIR TH	Stand TH	16.0
		Regional (Base) Silvicultural Data	
		Base BA	30.0
		Years To Base BA	140
		Base TH, m	20.0
		Years To Base TH	170

Record: 1 of 262

Results Scenario r251

Year	Yield, mm	%
1991	0.0	0.0%
1992	3.2	1.7%
1993	2.4	1.3%
1994	1.9	1.0%
1995	1.9	1.0%
1996	1.9	1.1%
1997	9.7	5.3%
1998	7.7	4.2%
1999	9.9	5.4%
2000	8.7	4.7%
2001	8.2	4.4%
2002	9.9	5.4%
2003	9.9	5.4%
2004	11.0	6.0%
2005	20.4	11.1%
2006	18.9	10.3%

Record: 1 of 262

MAX Yield Increase, mm: **20.4** Calibration value: **1.018**

MAX Percent Increase: **11.1%** Base Yield, mm: **183.7**

Year of MAX: **2015** Precipitation, mm: **621.1**

Scenario Name: **r251** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r251 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1991	0.0	0.0%
1992	114.2	6.9%
1993	82.8	5.0%
1994	65.8	4.0%
1995	65.4	4.0%
1996	67.2	4.1%
1997	374.4	22.8%
1998	289.5	17.6%
1999	370.3	22.5%
2000	325.8	19.8%
2001	306.4	18.6%
2002	380.9	23.1%
2003	378.6	23.0%
2004	417.6	25.4%
2005	788.8	47.9%
2006	722.8	43.9%
2007	648.0	39.4%
2008	624.5	37.9%
2009	626.2	38.0%
2010	644.2	39.1%
2011	647.5	39.3%
2012	641.0	38.9%
2013	621.0	37.7%

Maximum Eca, ha: **788.8** Max Eca, %: **47.9%**

Year of max Eca: **2005**

Scenario: **r251** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r251 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1991	0.0	0.0%
1992	126.5	7.8%
1993	125.5	7.7%
1994	124.6	7.6%
1995	123.6	7.5%
1996	122.6	7.4%
1997	431.1	26.8%
1998	427.0	26.5%
1999	542.6	33.6%
2000	536.3	33.2%
2001	529.9	32.8%
2002	597.9	37.5%
2003	604.5	37.9%
2004	640.2	40.1%
2005	1001.3	62.7%
2006	1039.5	64.5%
2007	1040.5	64.5%
2008	1032.8	64.1%
2009	1029.3	63.8%
2010	1055.5	65.4%
2011	1067.7	66.2%
2012	1059.9	65.7%
2013	1043.8	64.8%

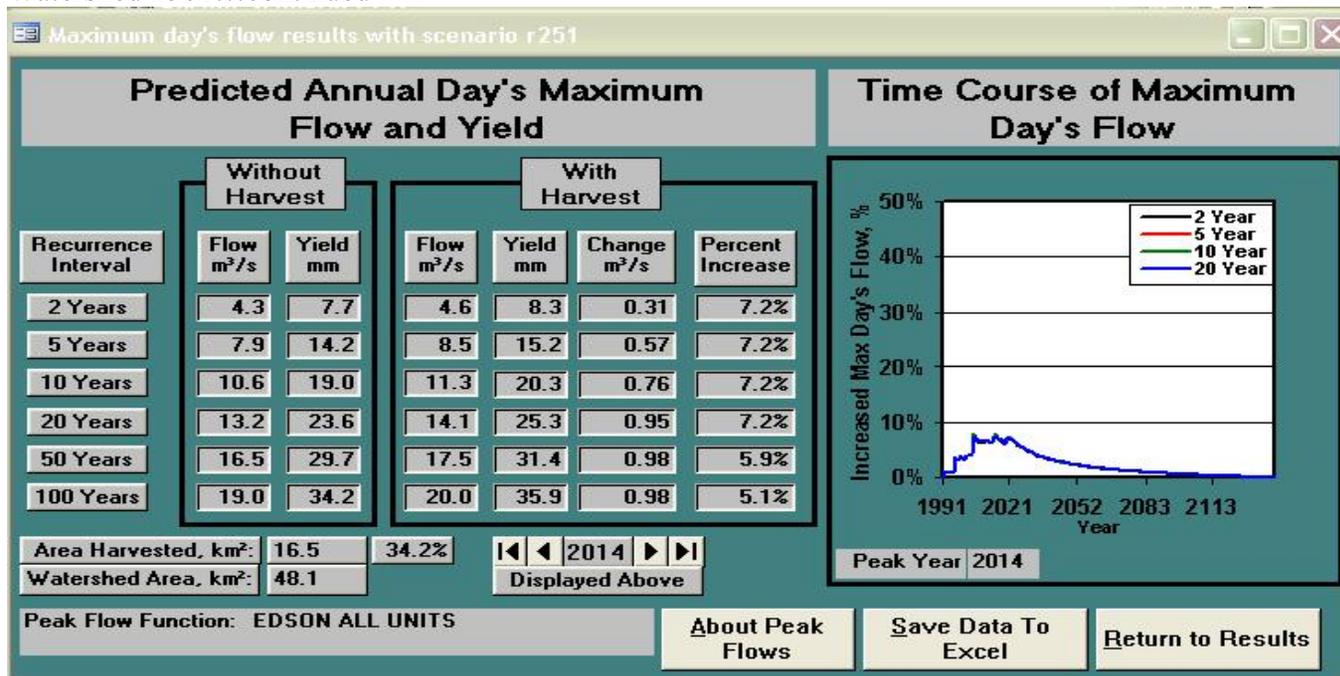
Maximum Eca, ha: **1318.8** Max Eca, %: **80.1%**

Year of max Eca: **2021**

Scenario: **r251** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 2501...continued



Watershed 2502

Run Scenarios in database with Individual Blocks

Select Scenario: **r252** [Run Scenario] [Return to Main]

Simulate Each Unit From **1992** for **150** years with **1** year time steps

Watershed Area, km²: **81.2** Total Area Cut, ha: **1395.0** Percent Watershed Cut: **17.2%**

Appropriate Forest and Unit Group: **EDSON ALL UNITS** Yield Data Selection: **Forest Unit Stations** Region: **New England/Boreal**

Watershed Yield Data Source: **RAT CREEK NEAR CYNTHIA** Year Progress

Statistic: **AVG** Period: **1972-1998** Yld, mm: **183.7** Area, km²: **606**

Precipitation Data Source: **ROBB RANGER STATION** Units Progress

Statistic: **AVG** Period: **1965-1992** Annual Ppt, mm: **621.1**

Cut Block Details: **frmRunScenarios, Individual Blocks** [Table View]

Annual Harvest Data, Operational Unit

Cut, ha: **4.7** Year Cut: **1992**

Blks: **1** Blk Size, ha: **5.7**

Aspect: **5** Block Elev, m: **1019.0**

Regeneration Sp: **CONIFEROUS**

Basal Area Func: **WS FAIR BA**

Tree Height Func: **WS FAIR TH**

Surrounding Stand Data

Stand Species: **CONIFEROUS**

Stand BA: **22.5** Stand TH: **4.0**

Regional (Base) Silvicultural Data

Base BA: **30.0** Years To Base BA: **140**

Base TH, m: **20.0** Years To Base TH: **170**

Record: 1 of 184

Results Scenario r252

Year	Yield, mm	%
1991	0.0	0.0%
1992	0.2	0.1%
1993	0.2	0.1%
1994	0.2	0.1%
1995	0.2	0.1%
1996	0.2	0.1%
1997	1.2	0.6%
1998	2.3	1.3%
1999	5.0	2.7%
2000	7.5	4.1%
2001	6.4	3.5%
2002	6.7	3.7%
2003	6.5	3.5%
2004	6.3	3.4%
2005	7.7	4.2%
2006	8.0	4.3%

Record: 1 of 184

MAX Yield Increase, mm: **11.5** Calibration value: **1.033**

MAX Percent Increase: **6.3%** Base Yield, mm: **183.8**

Year of MAX: **2021** Precipitation, mm: **621.1**

Scenario Name: **r252** Region: **New England/Boreal**

[Save Yield Data] [ECA Mature Ba] [ECA Max Yld] [Max Day's Analysis] [Peak Flow Analysis] [Return]

r252 ECA based on Maximum Water Yield Increase

Year	Eca, ha	Eca, %
1991	0.0	0.0%
1992	10.1	0.7%
1993	10.1	0.7%
1994	10.1	0.7%
1995	10.2	0.7%
1996	10.2	0.7%
1997	65.2	4.7%
1998	131.4	9.4%
1999	308.1	22.1%
2000	451.2	32.3%
2001	383.6	27.5%
2002	397.5	28.5%
2003	385.7	27.7%
2004	374.7	26.9%
2005	460.4	33.0%
2006	478.3	34.3%
2007	457.9	32.8%
2008	459.3	32.9%
2009	478.9	34.3%
2010	469.1	33.6%
2011	454.3	32.6%
2012	435.0	31.2%
2013	432.6	31.0%

Maximum Eca, ha: **675.5** Max Eca, %: **48.4%**

Year of max Eca: **2020**

Scenario: **r252** Region: **New England/Boreal**

[About Eca Max Yield] [Save Data to Excel] [Return]

r252 ECA based on Mature Basal Area

Year	ECA, ha	Eca, %
1991	0.0	0.0%
1992	13.5	1.3%
1993	13.5	1.3%
1994	13.5	1.3%
1995	13.5	1.3%
1996	13.5	1.3%
1997	74.4	7.4%
1998	161.6	16.1%
1999	344.9	34.4%
2000	542.5	54.2%
2001	536.8	53.6%
2002	574.6	57.4%
2003	571.7	57.1%
2004	564.0	56.4%
2005	648.1	64.8%
2006	684.8	68.4%
2007	688.0	68.8%
2008	699.0	69.9%
2009	728.2	72.8%
2010	748.9	74.8%
2011	754.1	75.4%
2012	747.4	74.7%
2013	752.1	75.2%

Maximum Eca, ha: **1148.3** Max Eca, %: **82.3%**

Year of max Eca: **2021**

Scenario: **r252** Region: **New England/Boreal**

[About Eca Ba Mature] [Save Data to Excel] [Return]

Watershed 2502...continued

