

**Forest Management in Hinkle Creek Watersheds:  
Evaluation of Baseline Seasonal Stream Water Nutrient Concentrations and Soil Resources**

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**Relevance to program mission**

This research addresses the need to obtain baseline data for both stream chemistry and soil resources for the North and South Forks of the Hinkle Creek Paired Watershed Study. Current forest management practices are designed to promote sustainable silvicultural systems on these paired watersheds, which are productive for timber, water, fish, and wildlife resources. A solid representative database for both stream and soil nutrients in these watersheds would provide a model upon which to help gauge the effects of current and expected intensive forest management practices on industrial forest land.

**Objectives**

1. To obtain monthly water nutrient concentration data for two consecutive years in six headwater streams, and in the North and South Forks of Hinkle Creek. Stream nutrients to be measured include: total N, P, and base cations (Ca, K, Mg, Na), dissolved organic N (DON), and inorganic N (DIN), plus stream pH, collected monthly.
2. To obtain data for soil resources and geomorphology on these watersheds, including soil physical properties (bulk density), pH, soil texture, soil C, N, S, and cation exchange capacity. This research is designed to integrate with the Hinkle Creek Paired Watershed Study on Hydrology and Water Quality being led by Arne Skaugset, OSU Forest Engineering Department.

**Overview**

Oregon has highly productive forests growing on soils that can be effectively managed for timber resources while maintaining stream water quality suitable for fish and wildlife resources. In addition to maintaining productive forests, one goal of current forest management is to maintain stream water of high quality for fish and wildlife. The same nutrients essential in adequate quantities for tree growth (N, P, and base cations, plus micronutrients) also are required by both fish and wildlife species. This project would provide a valuable initial database of stream nutrient concentrations and soil resources.

**Approach**

To accomplish the first objective for obtaining seasonal nutrient concentration data, collect samples

directly from streams monthly for the first year and seasonally afterwards, while minimizing disturbance to stream sediment. Samples will be transported in coolers on ice and taken within 24 hours to the Co-operative Chemical Analytical Laboratory at OSU for water analysis. The second objective, to collect soil samples in riparian zones and upslope forest areas, is being accomplished using recently published soil survey maps as a guide to select representative locations within the overall watershed. In addition, representative soil pits are being dug to obtain soil descriptions and underlying parent materials, and to check soil map accuracy.

### **Project Results to Date**

In September, 2002, two control and four treatment watersheds were selected for stream sampling for chemical analysis, in addition to sites just above the confluence of the North and South Forks. Since the original 8 sampling points were described, samples also are being taken from 3-4 other locations directly below clearcuts completed in 2001 and with subsequent intensive vegetation control measures in place, seeking to determine where the higher nitrate totals found in BB Creek originate and what water quality effects occur below a fresh clearcut. The tributaries sampled above BB Creek proper are ephemeral, but subsurface flow from these aquifers provides much of the summer low flow. Clay Creek also is being sampled directly above a clear-cut, and then sampled again after passing through it, to ascertain any stream water chemistry changes that might be attributed to the clear-cut.

The first stream samples were collected on October 24, 2002, with subsequent samples collected monthly continuing through October, 2003 and then seasonally. Complete stream chemistry results are available for October 2002 through April 2004. The averages are presented in Table 1. Statistical analysis of the data is being conducted. Results are given for the following analyses: dissolved organic total N (DON), dissolved total N, unfiltered total P, dissolved total P, dissolved  $\text{PO}_4\text{-P}$ , alkaline  $\text{HCO}_3\text{-C}$ , conductance,  $\text{NO}_3\text{-N} + \text{NO}_2\text{-N}$ ,  $\text{NH}_4\text{-N}$ , dissolved Si, dissolved Na, dissolved K, dissolved Ca, dissolved Mg, dissolved  $\text{SO}_4\text{-S}$ , dissolved Cl, suspended sediment, and pH. Discharge data is available from December of 2003 until the present and is being used to calculate mean monthly export of stream nutrients. Continuous precipitation data collected in a gauge at the front gate of the Hinkle Creek Study will be used to calculate average discharge for the stream chemistry samples collected prior to the available discharge data using regression techniques. All stream water N concentrations are low, except for some higher  $\text{NO}_3\text{-N}$  concentrations for two partially treated watersheds, Clay and BB Creeks. These small watersheds were partially cut over about 20% of their areas in 2001, prior to initiation of the integrated Hinkle Creek Study in 2002. Results for  $\text{NH}_4\text{-N}$  show that this inorganic form of N is present in low concentrations in all of these watersheds. Organic N, as both particulate, unfiltered total N, and as dissolved total N, also occurs in low concentrations. Phosphorus are lower than those observed for Watershed #10 on the H.J. Andrews LTER for an old-growth Douglas-fir forest that was growing on volcanic derived soils (Sollins et al., 1980). However, P concentrations are higher at Hinkle Creek than those sighted for several Environmental Protection Agency (EPA) ecoregions in the USA (NCASI, 2001; Ice and Binkley, 2003). Among base cations, Ca is present in higher concentrations than K or Mg. Suspended sediment was low during the dry season and higher during winter flows, as would be expected.

When comparing stream chemistry data between Hinkle Creek and the H. J. Andrews LTER

small watersheds, (Tables 2 and 3), we found that results for many of the analyses are broadly similar, especially for N and P. Cation concentrations were higher for Ca and Mg in the Hinkle Creek watersheds than for the H. J. Andrews watershed #10 (Sollins et al., 1980). More recent H. J. Andrews LTER stream chemistry data from Vanderbilt et al. (2002) show that both inorganic N and organic N concentrations are low (Table 3), and are comparable to the Hinkle Creek watersheds. Work done on the Alsea River basin watersheds (Brown et al., 1973) shows generally higher concentrations for NO<sub>3</sub>-N (Table 4) than for Hinkle Creek, except for the BB Creek watershed and the South Fork of Hinkle Creek in November - December, 2002 and December, 2003, (Figures 4 and 5) which are similar to Alsea Basin NO<sub>3</sub>-N concentrations. Forest soils in the Oregon Coast Range generally have higher concentrations of soil N and C (Rothe et al., 2002), and thus, may have higher stream NO<sub>3</sub>-N concentrations even on undisturbed control sites (Table 5) (Brown et al., 1973; Compton et al., 2003).

Newly published soil surveys were used to establish a methodology for sampling the representative Hinkle Creek soil resources. Fifteen main soil types were mapped, representative soil pits dug in accordance with the location of the mapped soils, and standard soil survey descriptions created. Twenty-seven soil pits were dug during summer 2003, their descriptions recorded, and locations noted. These soil pits were revisited during late winter and spring 2004, and soil cores taken from different depths. This information has been used to create an estimate of total soil C and N resources, and other soil physical and chemical properties noted above are being examined. To date, soil cores from 4 different depths in 24 pits have been collected and dried for storage. They have been sieved and the soil fraction less than <4mm has been ground. The samples have been analyzed for total C, N, and S. The soil pH and possibly CEC will also be analyzed in the near future. Estimates of kg/ha of the C, N, and S pools are being created and very preliminary estimates are shown for the 4 most common soil types in Table 6. The coarse fragment percentage has been subtracted on a volumetric basis. The total acreages of the different soil types will be used to compute total basin values. A soil map detailing soil location is also being created. The total percentage range of soil C, N and S from the different soil pits dug in the same soil series is shown in Tables 7, 8, and 9. The fall of 2004 will be spent filling in any perceived gaps in the soil resources data, by digging a more pits, and sampling soils of interest. Figures 1 and 2 show the location of the grab sampling points for stream nutrients and soil pits already in place. Figures 3, 4, and 5 show seasonal trends in NO<sub>3</sub>-N fluxes.

Timeline: Spring/summer 2005 - finish stream and soil collections and data analysis;  
fall/winter/spring 2005/2006 - finish theses/dissertation, submit final report and write manuscripts based on these results.

## References

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Figure 1

# Hinkle Creek Experimental Forest

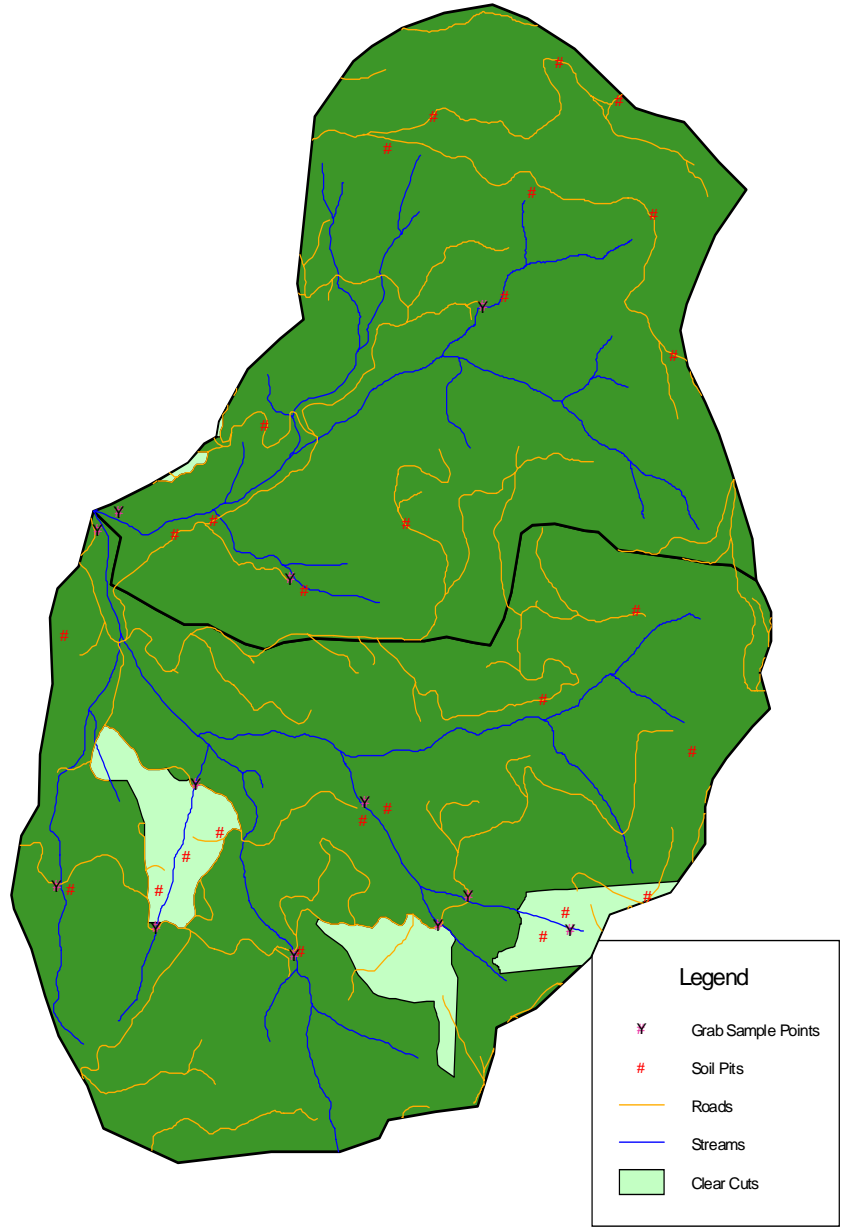
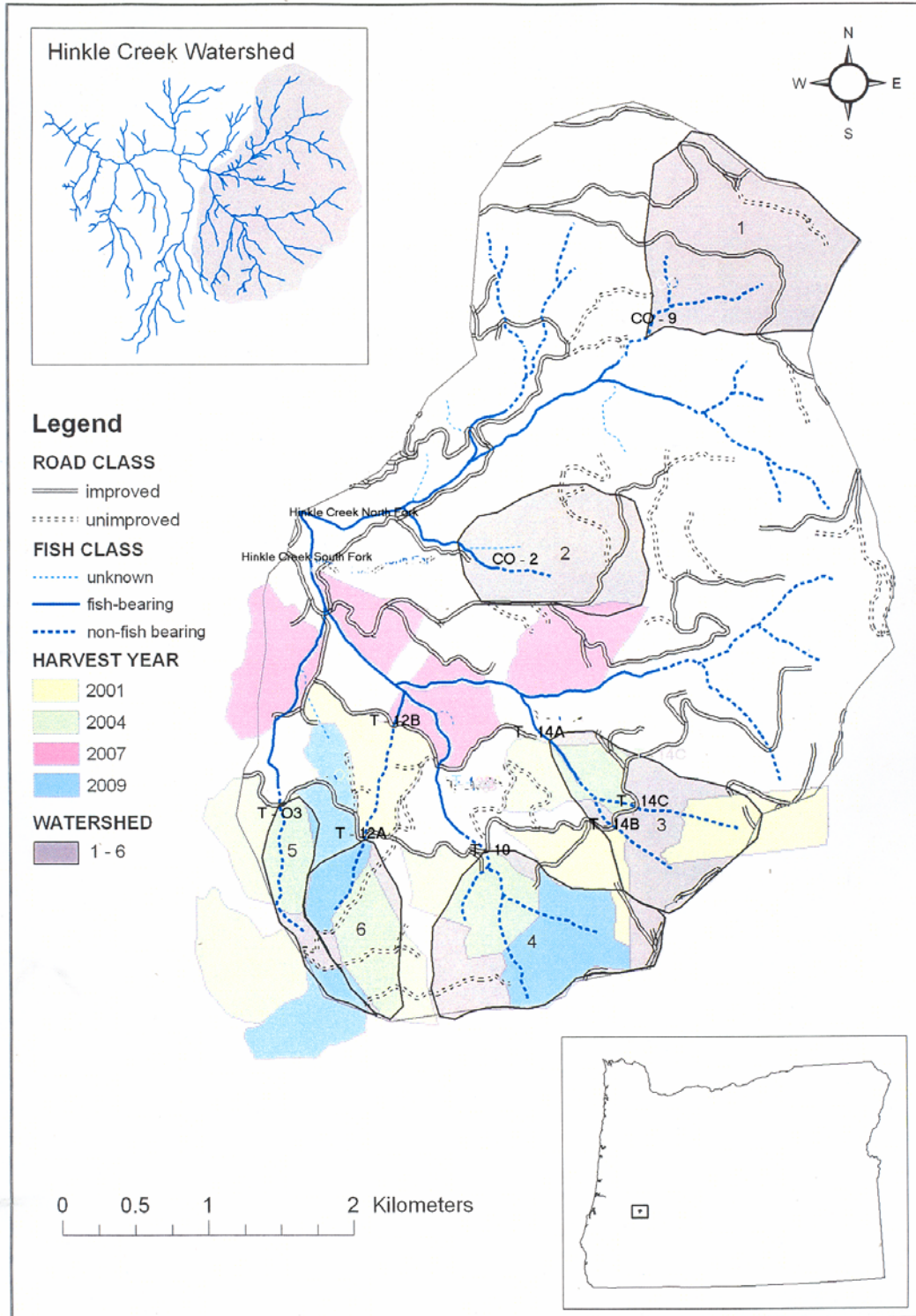


Figure 2.



**Stream Legend and Sampling Locations**

C-O9 = DeMearsmen Creek  
 C-O2 = Myers Creek  
 T-03 = Fenton Creek  
 T-12 = Clay Creek  
 T-10 = Russell Creek  
 T-14 = BB Creek

**Table 1. October 2002 – April 2004 Hinkle Creek Watershed Stream Chemistry Data. Average Concentrations.**

<b>October 2002 – April 2004</b>	<b>Control DeMear sman Creek</b>	<b>Control Myers Creek</b>	<b>Hinkle Creek North Fork Confl.</b>	<b>Hinkle Creek South Fork Confl.</b>	<b>Treat. Fenton Creek</b>	<b>Treat. Russell Creek</b>	<b>Treat. Clay Creek</b>	<b>Treat. BB Creek</b>
Total DON-N mg/L	0.033	0.027	0.040	0.038	0.025	0.020	0.028	0.031
Dissolved Total- N mg/L	0.054	0.040	0.059	0.144	0.049	0.045	0.066	0.528
Unfiltered Total - P mg/L	0.028	0.023	0.019	0.020	0.046	0.023	0.029	0.021
Dissolved Total - P mg/L	0.024	0.017	0.017	0.018	0.039	0.019	0.021	0.018
Dissolved PO <sub>4</sub> -P mg/L	0.015	0.010	0.009	0.009	0.031	0.012	0.013	0.011
Alkaline HCO <sub>3</sub> - C mg/L	5.879	8.481	6.694	5.499	5.713	6.285	5.477	6.439
Conductance $\mu$ s/cm	51.28	70.40	57.86	48.35	50.31	54.05	48.37	59.31
NO <sub>3</sub> -N + NO <sub>2</sub> - N mg/L	0.012	0.009	0.015	0.100	0.016	0.021	0.027	0.488
NH <sub>4</sub> - N mg/L	0.009	0.005	0.004	0.006	0.009	0.004	0.011	0.009
Dissolved Si mg/L	8.648	8.896	8.058	8.085	9.511	8.447	7.536	7.922
Dissolved Na mg/L	4.035	4.079	4.026	3.163	4.583	3.140	3.143	3.309
Dissolved K mg/L	0.490	0.291	0.469	0.347	0.575	0.259	0.399	0.251
Dissolved Ca mg/L	4.722	8.191	5.765	5.011	4.219	5.989	5.073	60647
Dissolved Mg mg/L	1.334	2.502	1.658	1.349	1.162	1.434	1.201	1.738
Dissolved SO <sub>4</sub> – S mg/L	0.182	0.110	0.150	0.126	0.194	0.130	0.136	0.156
Dissolved Cl mg/L	1.558	1.583	1.854	1.396	1.512	1.652	1.448	1.556
Suspended sediment mg/L	2.949	2.579	2.248	1.911	8.369	3.151	5.933	1.675
pH	7.45	7.66	7.57	7.50	7.47	7.51	7.50	7.57

\* Dissolved SO<sub>4</sub> – S and Dissolved Cl are from Oct. 2002 – Feb. 2003 only

Figure 3. Inorganic N concentrations in Clay Creek A above clear-cut and Clay Creek B below clear-cut (Oct. 2002 – April 2004).

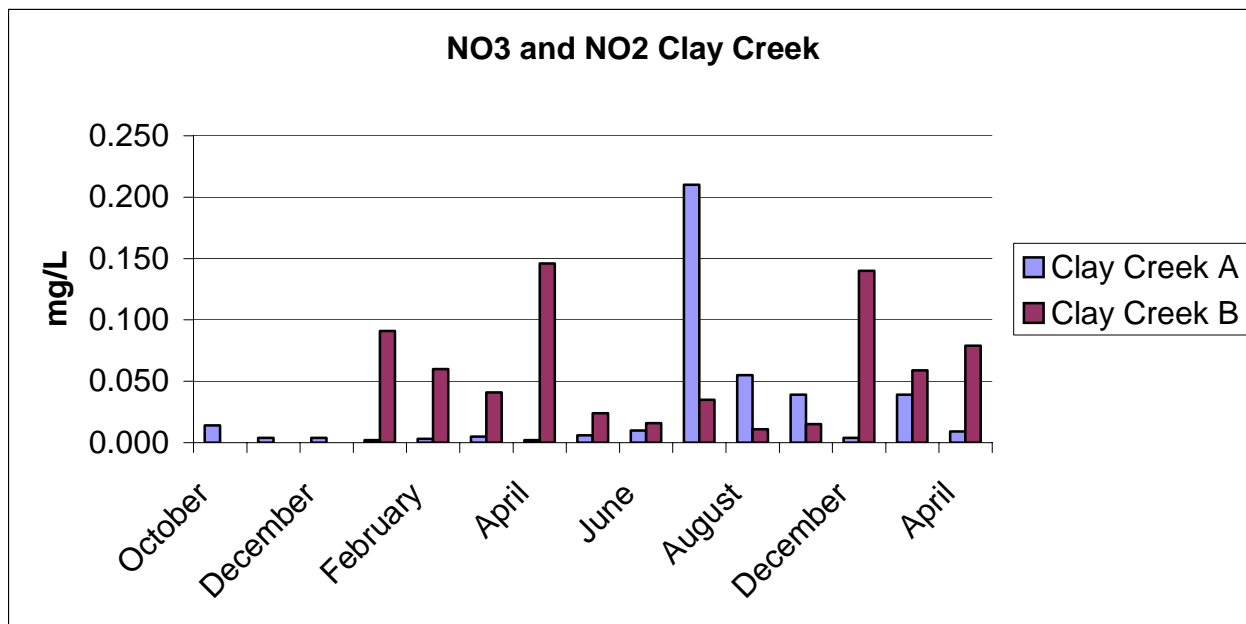


Figure 4. Inorganic N concentrations in Hinkle North and South Forks, and in BB Creek (Oct. 2002 – April 2004). BB Creek A is the main branch below tributaries.

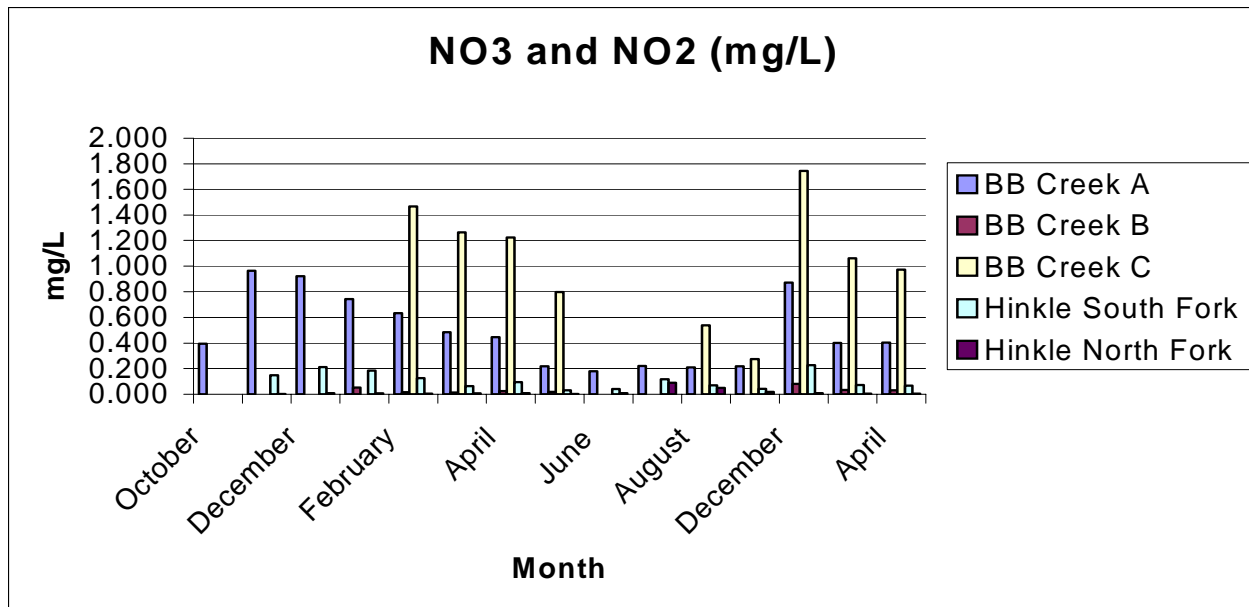
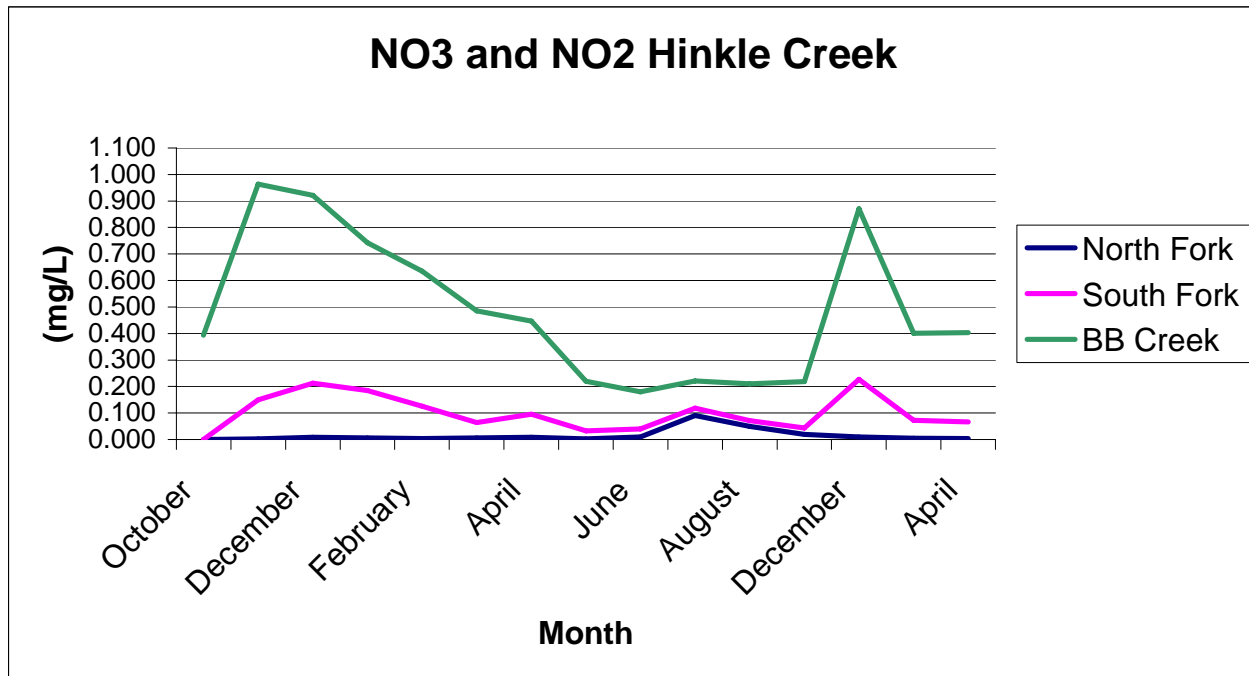


Figure 5. Inorganic N concentrations in Hinkle North and South Forks and in the main branch of BB Creek (Oct. 2002 – April 2004).



**Table 2. Stream chemistry data from HJ Andrews WS#10 weir from 1973-75 (Sollins et al., 1980).**

NO <sub>3</sub> -N + NO <sub>2</sub> -N mg/L	0.19
Kjeldahl N mg/L	0.035
Na mg/L	1.96
K mg/L	0.339
Ca mg/L	3.20
Alkalinity HCO <sub>3</sub> -C mg/L	4.17
Total P mg/L	0.054
SO <sub>4</sub> -S mg/L	N/A
Cl mg/L	N/A
Mg mg/L	0.834

N/A denotes not analyzed.

**Table 3. Average inorganic and organic N concentrations for three old-growth-dominated streams at HJ Andrews (Vanderbilt et al., 2002).**

Concentration	WS #2 (1982-2001)	WS #9 (1969-2001)	WS #8 (1972-2001)
NO <sub>3</sub> -N mg/L	0.001	0.003	0.004
NH <sub>4</sub> -N mg/L	0.007	0.008	0.009
DON mg/L	0.02	0.04	0.02
PON mg/L	0.02	0.02	0.01

DON denotes dissolved organic N.  
PON denotes particulate organic N.

**Table 4. Annual mean NO<sub>3</sub>-N (mg/L) concentrations for three streams in the Alsea River basin both before (1965-1966) and after (1967-1968) treatments (Brown et al., 1973).**

Year	Flynn Creek (uncut control)	Needle Branch (clear-cut)	Deer Creek (patch-cut)
1965	1.21	0.12	1.12
1966	1.16	0.19	0.98
1967	1.18	0.44	1.21
1968	1.18	0.43	1.12

**Table 5. Yearly flow rated average concentrations of several streams in the Oregon Coast Range in 2000 (mg/L) (Compton et al., 2003)**

Concentration	Teal Creek	Baxter Creek	Curl Creek	Bear Creek	Slick Rock	Salmon River
NO <sub>3</sub> -N (mg/L)	1.352	1.203	0.875	0.652	0.074	0.167
DON (mg/L)	0.052	0.063	0.048	0.047	0.020	0.033
Ca (ueq/L)	363	71	356	274	133	151
Mg (ueq/L)	207	85	200	192	65	92
Na (ueq/L)	638	162	291	243	110	140
K (ueq/L)	18	12	6	11	4	4

ueq/L = microequivalents per liter

**Table 6. Average kg/ha of mineral soil C/N/S depth of 0-60 cm from 4 most common soil types in the Hinkle Creek drainage**

Soil Series	C (Kg/ha) 0-60 cm	S (Kg/ha) 0-60 cm	N (Kg/ha) 0-60 cm
Orford Gravelly Loam	81844	380	3511
Honeygrove Gravelly Loam	63543	442	2826
Illahee-Mellowmoon-Scaredman Complex	130453	322	4939
Klickitat-Harrington Complex	74445	255	3468

Note: Orford Avg. 9 pits ~ 50% basin

Honeygrove Avg. 3 pits ~ 15% basin

Klickitat Avg. 4 pits ~ 25% basin

Illahee Avg. 2 pits ~ 5% basin

Note: When S values were below detection level of 0.01 %, 0.005 % used

**Table 7. Range of total % of C values for different depths of 4 most common soil types in the Hinkle Creek drainage**

Soil Series	0-15 cm (%)	15-30 cm (%)	30-60 cm (%)
Orford Gravelly Loam	0.91 – 4.89	0.81 – 4.99	0.2 – 3.17
Honeygrove Gravelly Loam	2.24 – 3.46	0.65 – 1.43	0.58 – 1.68
Illahee-Mellowmoon-Scaredman Complex	6.04 – 6.41	3.20 – 4.77	0.96 – 1.04
Klickitat-Harrington Complex	2.57 – 5.99	1.75 – 3.18	1.20 – 2.65

**Table 8. Range of total % of S values for different depths of 4 most common soil types in the Hinkle Creek drainage**

<b>Soil Series</b>	<b>0-15 cm (%)</b>	<b>15-30 cm (%)</b>	<b>30-60 cm (%)</b>
Orford Gravelly Loam	0.005 – 0.02	0.005 – 0.02	0.005 – 0.02
Honeygrove Gravelly Loam	0.005 – 0.005	0.005 – 0.01	0.005 – 0.03
Illahee-Mellowmoon-Scaredman Complex	0.01 – 0.02	0.005 – 0.01	0.005 – 0.005
Klickitat-Harrington Complex	0.005 – 0.02	0.005 – 0.02	0.005 – 0.005

**Table 9. Range of total % of N values for different depths of 4 most common soil types in the Hinkle Creek drainage**

<b>Soil Series</b>	<b>0-15 cm (%)</b>	<b>15-30 cm (%)</b>	<b>30-60 cm (%)</b>
Orford Gravelly Loam	0.04 – 0.16	0.02 – 0.17	0.01 – 0.12
Honeygrove Gravelly Loam	0.14 – 0.03	0.03 – 0.07	0.03 – 0.06
Illahee-Mellowmoon-Scaredman Complex	0.23 – 0.23	0.13 – 0.18	0.06 – 0.11
Klickitat-Harrington Complex	0.03 – 0.23	0.08 – 0.09	0.07 – 0.08