Stream nutrient concentrations before and after timber harvest in Mica Creek, Idaho

Presented by:

John A. Gravelle

Contributors/Acknowledgments

- Timothy E. Link
- George Ice
- Diana Cook
- Terrance W. Cundy
- Dale J. McGreer

Potlatch

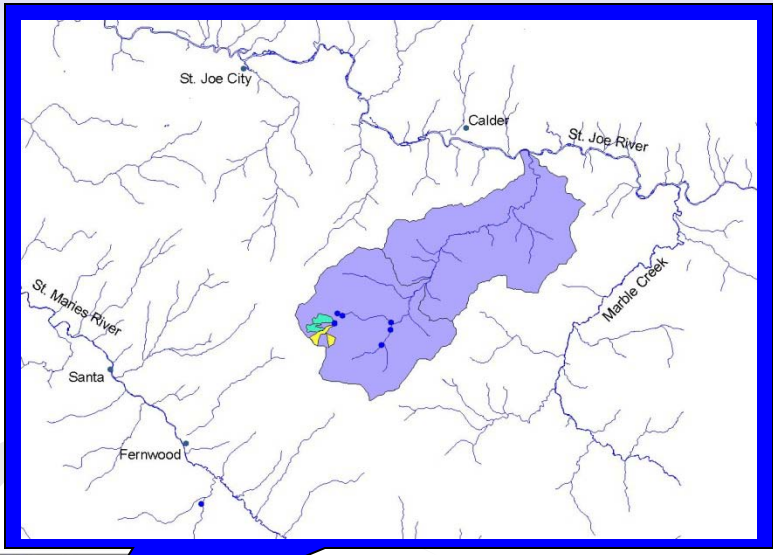
ncasi
National Council for Air and Stream Improvement, Inc.

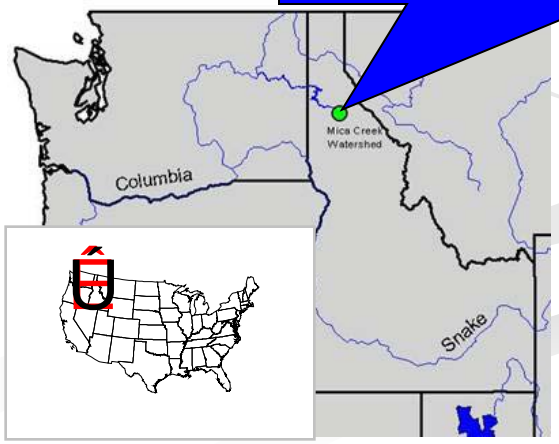
University of Idaho

Mica Creek Experimental Watershed

Northern Idaho

- Collaborative opportunity between the timber industry and university research.
- Potlatch Corporation initiated the study in 1990.
- Study area privately held by Potlatch Corporation.





Mica Creek Experimental Watershed

Potlatch Corporation initiated the project to:

- Evaluate cumulative effects of contemporary timber harvest practices
- Evaluate effectiveness of Idaho FPA regulations

Objectives:

- Assess effects of contemporary timber harvest practices on:
  - Flow
  - Sediment
  - Temperature
  - Nutrients
  - Macroinvertebrates
  - Fish

- Clear cut, thinning, cumulative effects
- Determine specific mechanisms producing responses

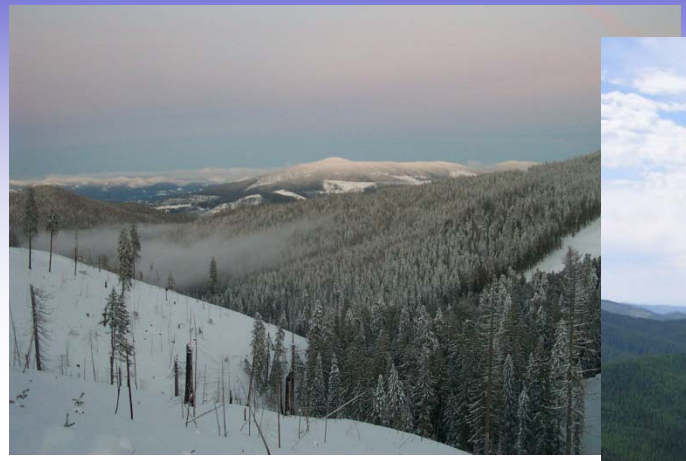
Motivation

- Forest managers need to balance:
  - Resource extraction
  - Environmental sustainability
- Contemporary BMPs have not been adequately assessed

Research and Management Needs

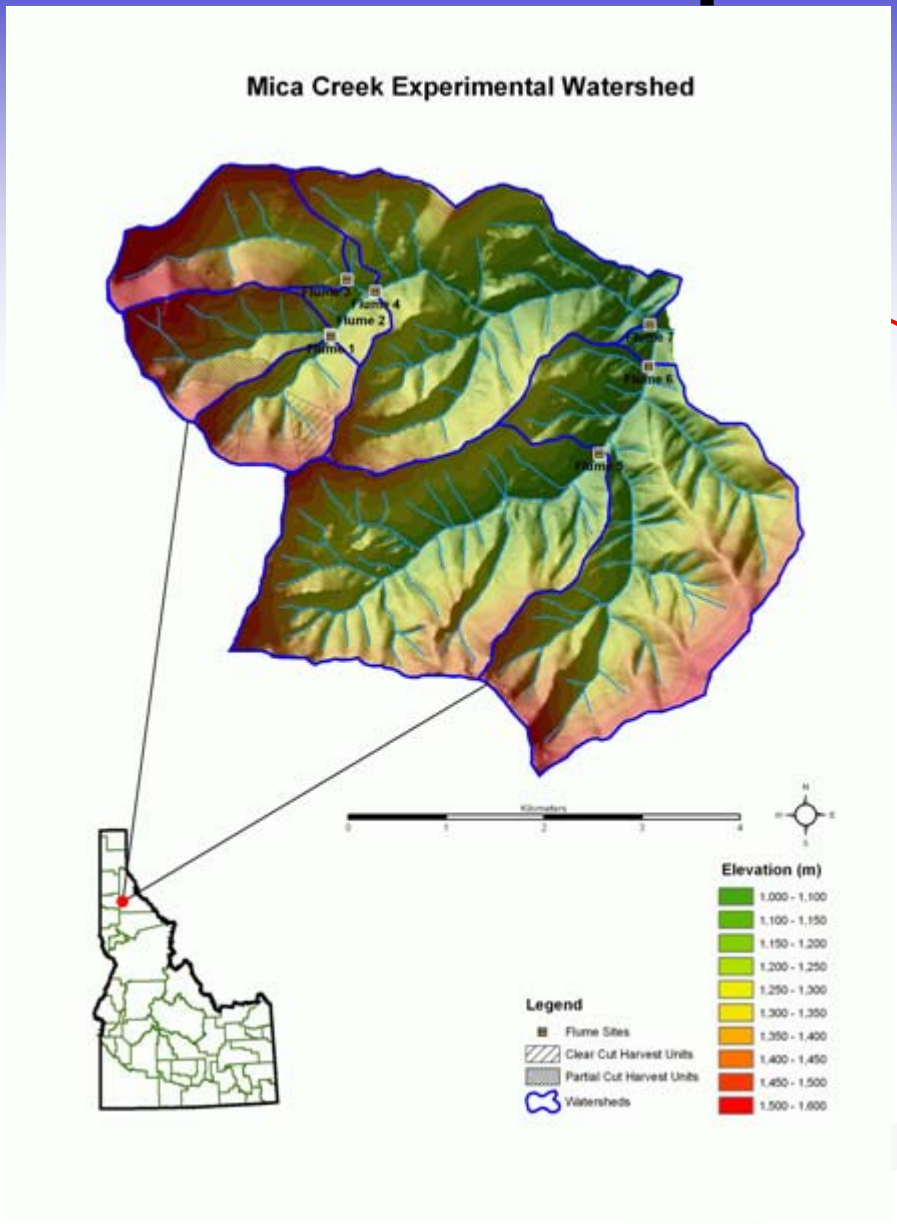
- Data from “typical” managed forestlands
  - Second growth
  - Contemporary management practices
  - Watershed scale
  - Multiple response variables
  - Inland northwest under-represented
- Mechanistic understanding of processes
- Integrated, spatially-explicit management tools

Site Characteristics



- Tributary of St. Joe River
- Size: 27 km^2 (10.5 mi^2)
- Elevation: 1000 – 1625m (3200 – 5240 ft)
- Precipitation: 1440 mm yr^{-1} (~57 in/yr)
- Vegetation: 70-80 yr. old mixed conifer
- Geology: Gneiss, quartzite

Mica Creek Experimental Watershed

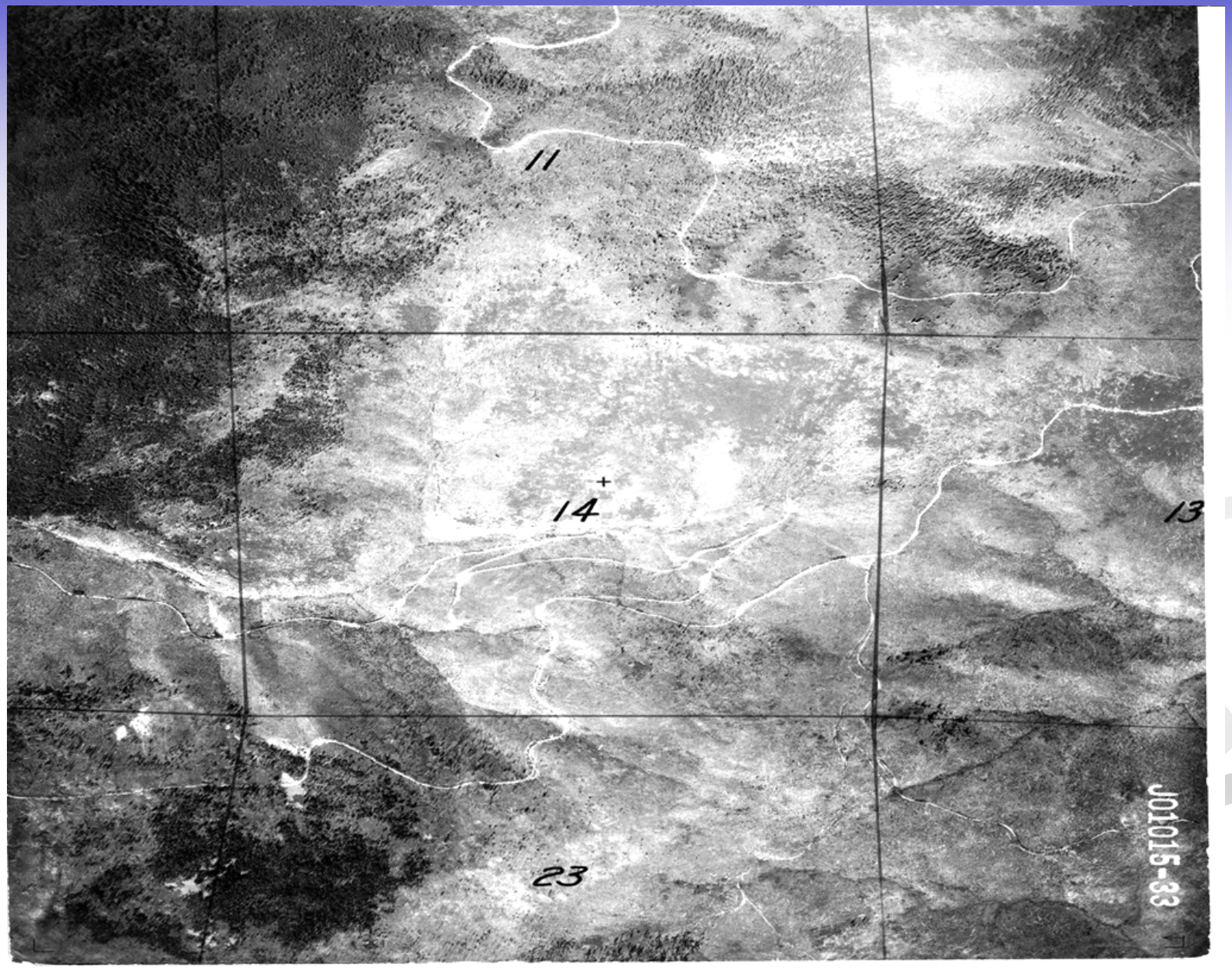


- Continental/Maritime climate region
- Rocky Mountains BUT influenced by Pacific Ocean

Historical Context

- Extensive logging
  - 1920-1930's
- Limited anthropogenic disturbance since that time

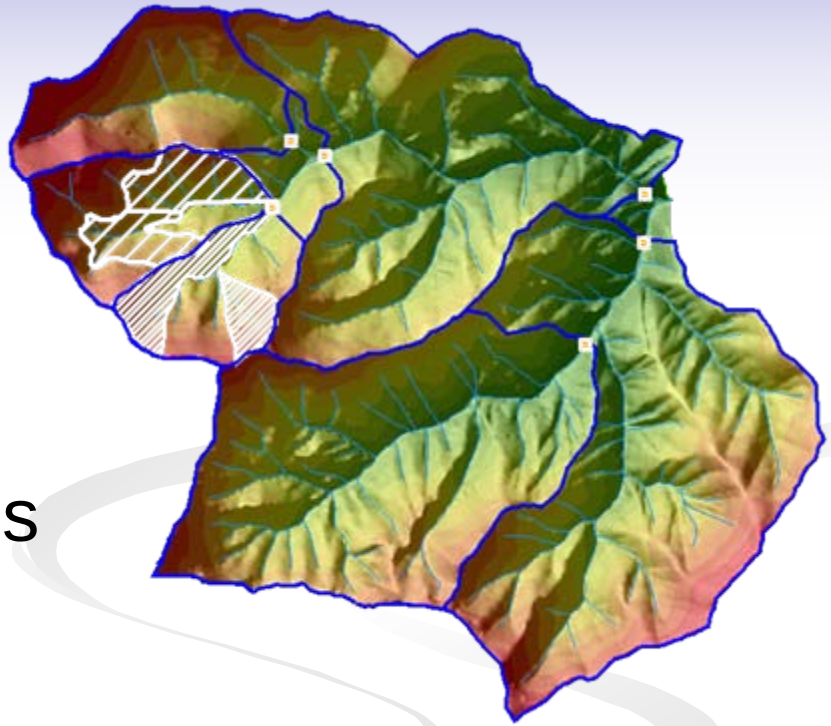
Historical Context (1933)



Post-road (2000)

MCEW Study Design

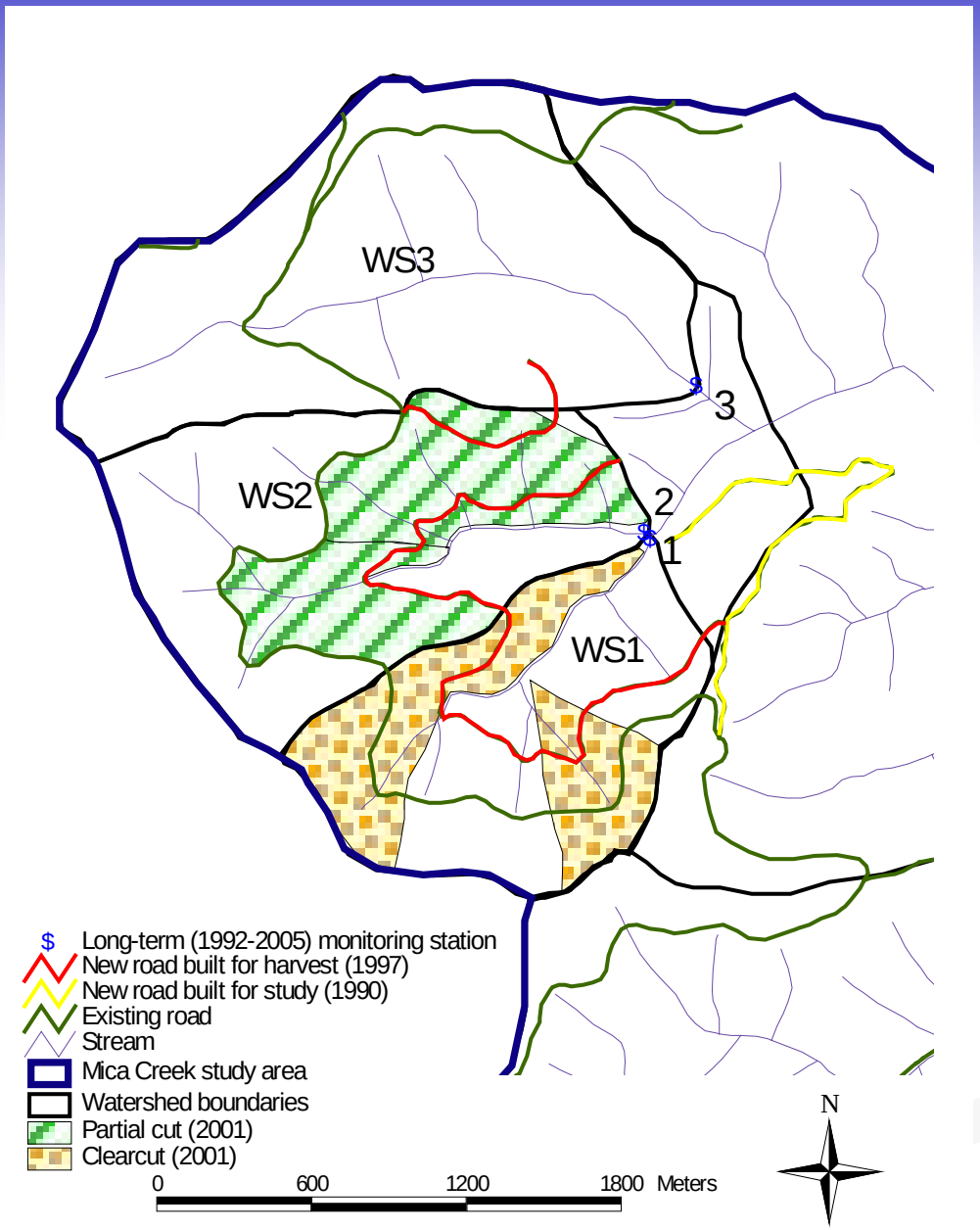
- Initiated 1990
- 6 years calibration period
- 4 years post-roads
- 5+ years post-harvest
- Paired & nested watersheds

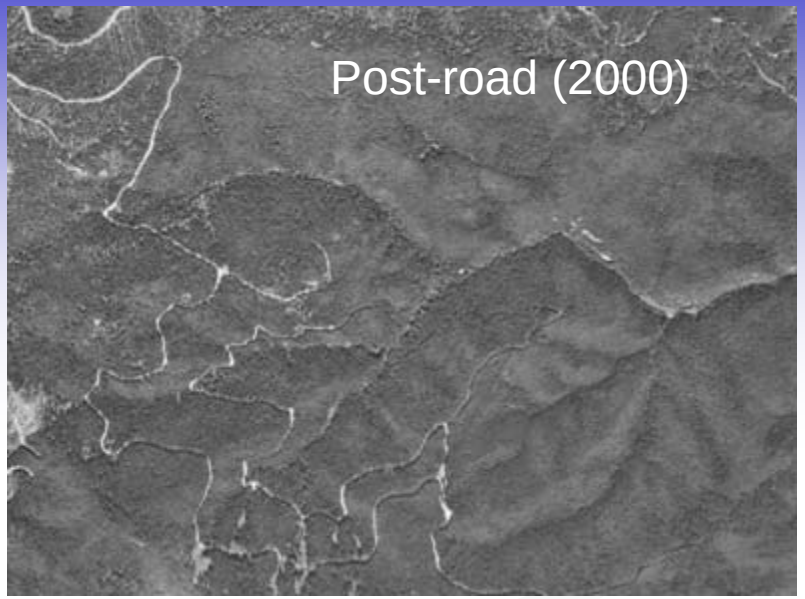


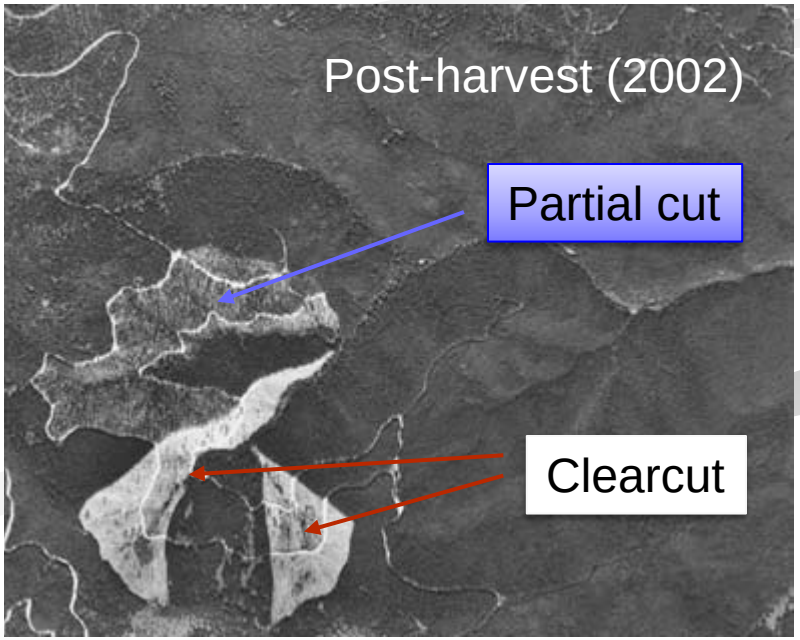
Treatment Activity

- Roads constructed in fall of 1997.
- Harvesting took place in Class II (non-fish bearing) catchments with combinations of line skidding and tractor skidding.
- Three headwater drainages on the West Fork used for harvest:
  - Watershed 1: 50% clearcut in 2001, broadcast slash burn and replanting in May 2003
  - Watershed 2: 50% partial cut (with 50% canopy removal) in the fall of 2001, final log hauling in early summer of 2002
  - Watershed 3: Control

Treatment Area





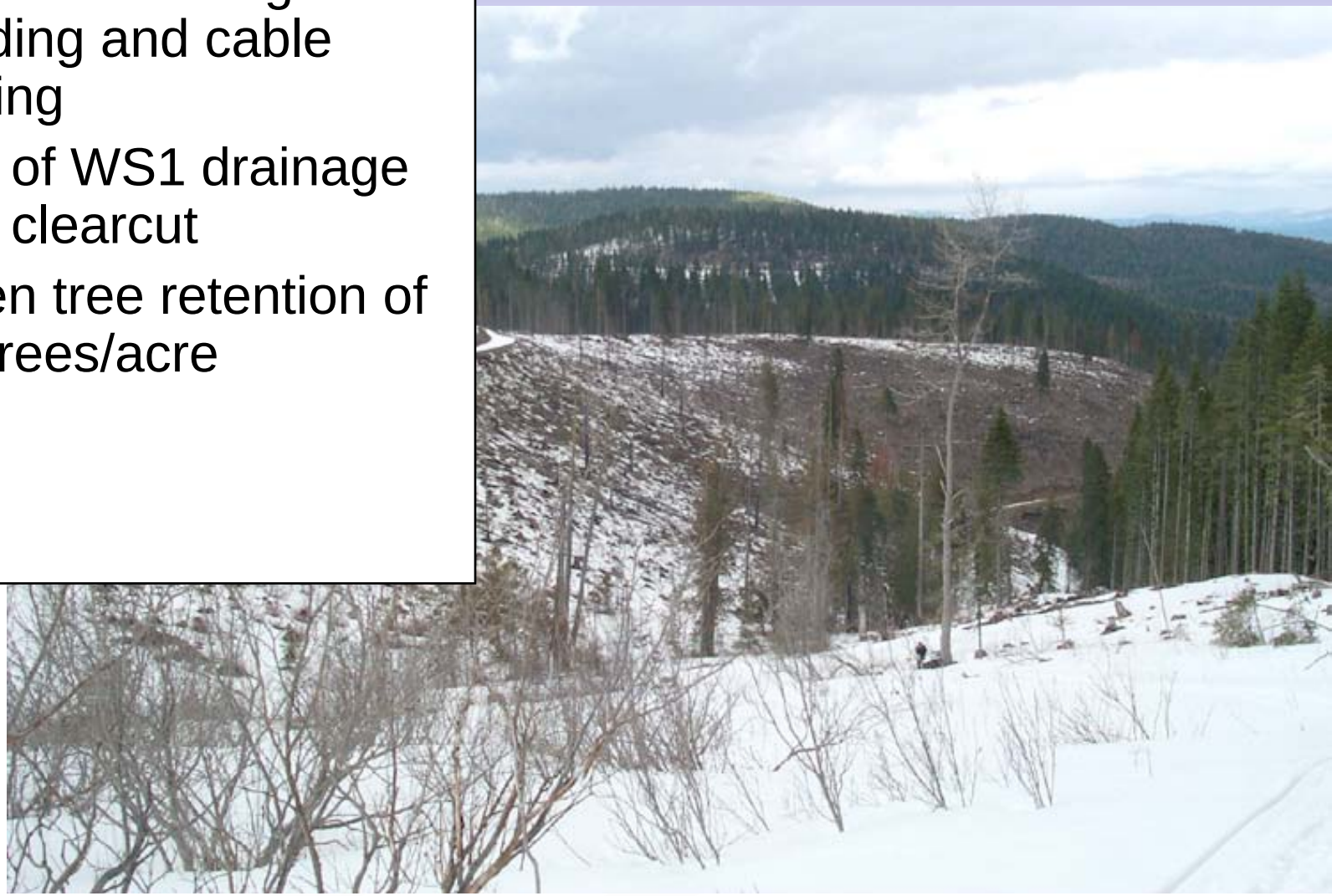


Idaho Forest Practices Act Stream Protection Zone (SPZ) Regulations

- Class I Streams: used for domestic water supply or important for the migration, rearing, and spawning of fish (fish-bearing).
  - Class I SPZ must be >=75 feet (22.9m) on each side of the ordinary high water mark.
  - 75% of current shade must be left intact.
- Class II Streams: non-fish bearing streams
  - Class II SPZ is 30 feet (9.1m) on each side of the ordinary high water mark.
  - SPZ is an equipment exclusion zone.
  - All merchantable trees can be removed.

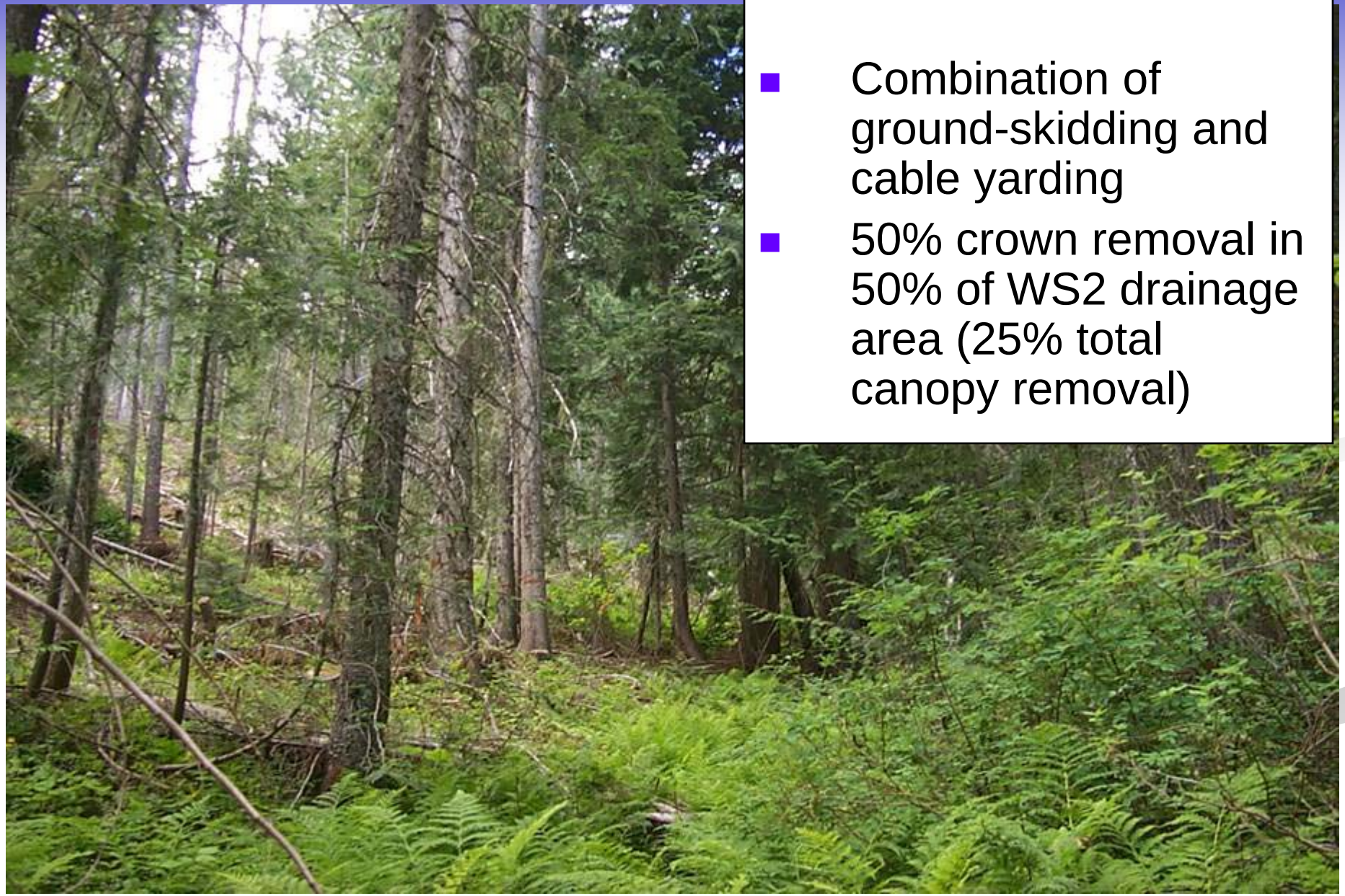
WS1: Clearcut

- Combination of ground-skidding and cable yarding
- 50% of WS1 drainage area clearcut
- Green tree retention of 2-3 trees/acre



WS2: Partial cut

- Combination of ground-skidding and cable yarding
- 50% crown removal in 50% of WS2 drainage area (25% total canopy removal)



Broadcast burning

- May 2003, clearcut harvest units only
- Low intensity burn
- Did not burn through riparian area, replanted to full stocking immediately following burn

Monitoring Infrastructure

Parameter	Timing
Biology/Geochemical	
Macroinvertebrates	Once annually
Fish	Once annually
Nutrients	Once monthly
Geomorphology	
Suspended sediment	Variable (based on discharge, storm events)
Channel cross-sections	Once annually
Particle size	Once annually
Hydrology	
Stream discharge	30-minute
Water temperature	30-minute
Meteorology	
Air temperature	30-minute
Precipitation	Daily
Snow Water Equivalent (snowpack)	Daily

Nutrients

- Nutrient loads of water draining forested watersheds generally lower than other land uses.
- Concern over alteration of chemical properties of headwater streams as well as downstream effects from forest management activities.
- Understanding stream chemistry, nutrient cycling, and nutrient loading important knowledge for comprehensive watershed management.

Nutrients

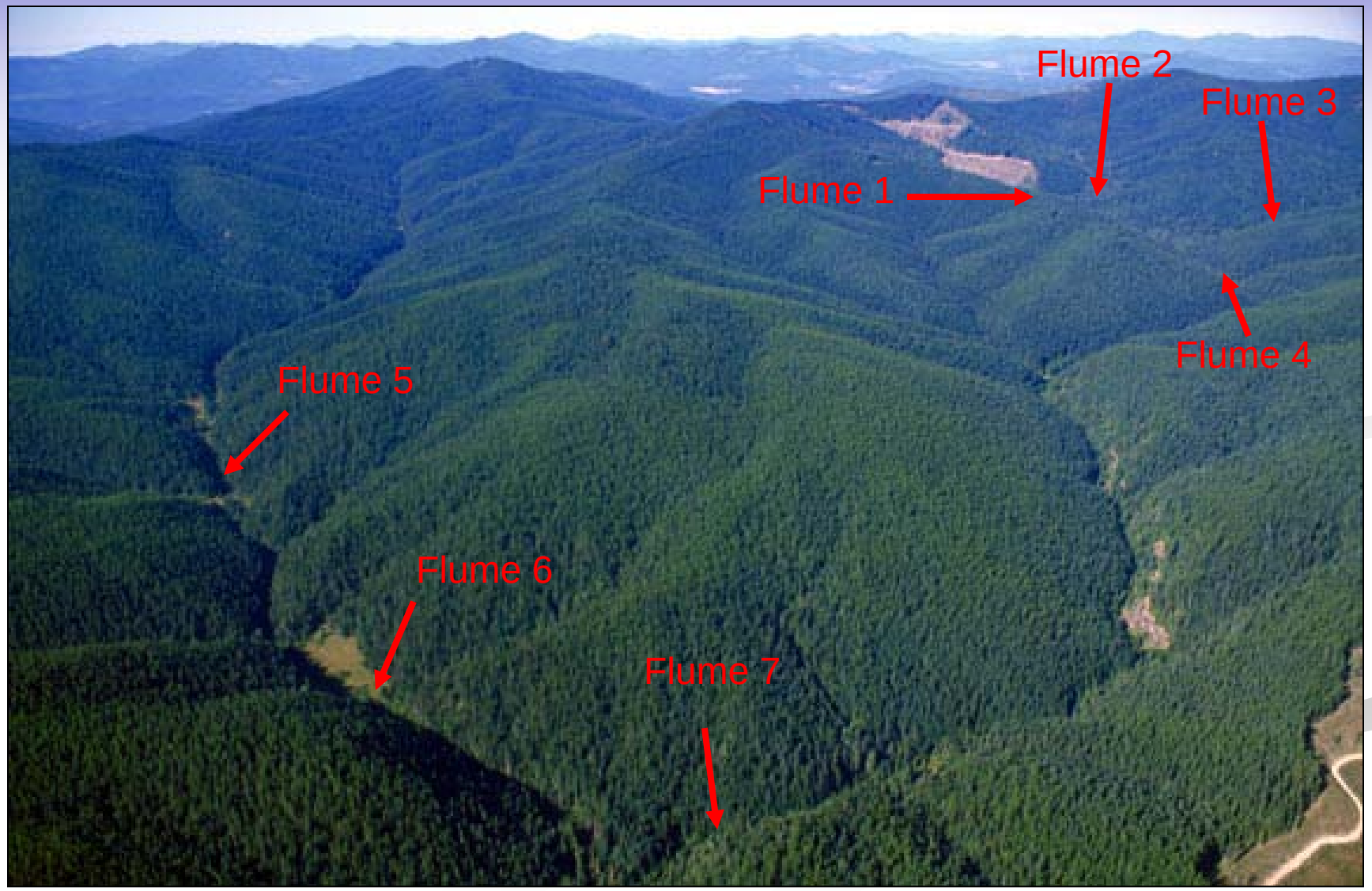
At MCEW, opportunity existed to:

- Assess general changes in N and P concentrations before and after timber harvest.
- Gather information on background nutrient concentrations in a relatively undisturbed forested watershed (before road construction and harvest).
- Provide representative nutrient concentration dynamics for intensively managed forested watersheds.
- Isolate effects of road construction component from tree removal.

Data Collection

- Grab samples taken monthly upstream of each Parshall flume (1-7).
- Year-round sampling began in 1992.
- National Council for Air and Stream Improvement (NCASI) analyzed the water samples for:
  - Total Kjeldahl Nitrogen (TKN)
  - Total Ammonia Nitrogen (TAN) [beginning in 1999]
  - Nitrate+nitrite (NO_3+NO_2)
  - Total Phosphorus (TP)
  - Orthophosphate (OP)

Mica Creek Experimental Watershed

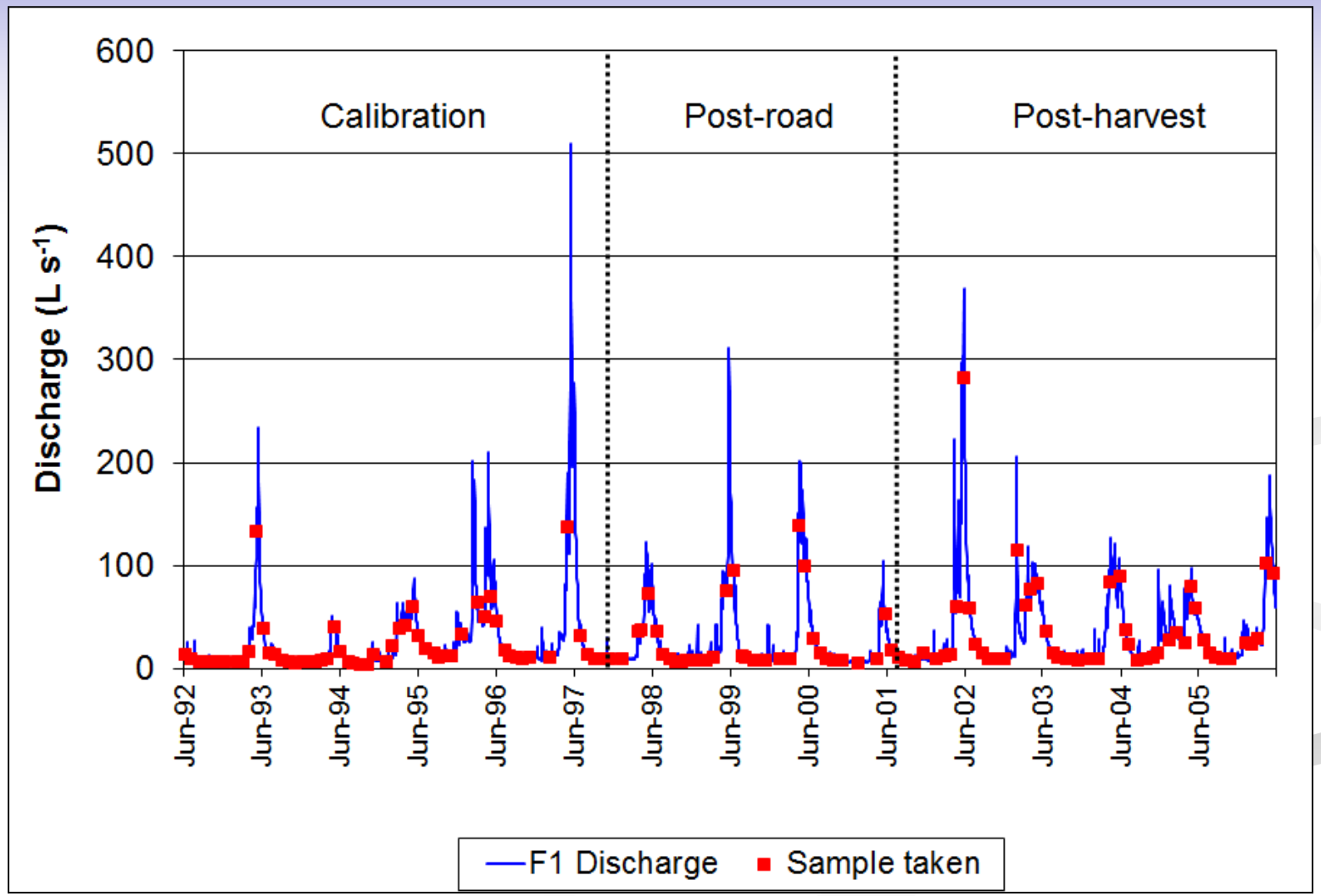


Data Analyses:

- Laboratory results from each of the flume sites were used in a Before-After/Control-Impact design.
- Student's t-tests were used for comparison between actual and predicted values for post-treatment data.
- Treatment periods used:
  - Calibration: Jun 1992-Aug 1997
  - Post-road: Sep 1998-Jun 2001
  - Post-harvest: Jul 2001-May 2006

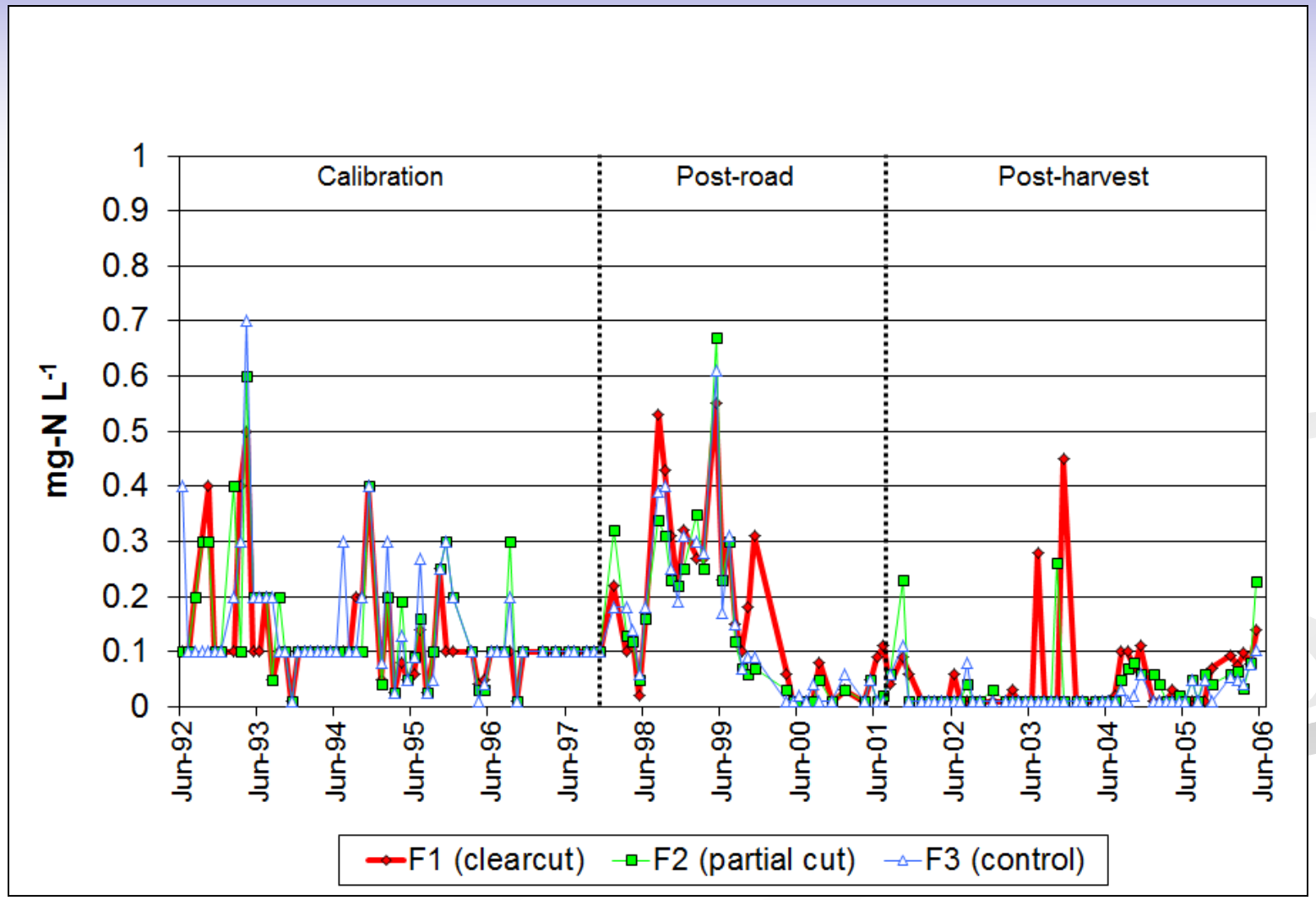
Methods: Monthly Samples

All treatment periods



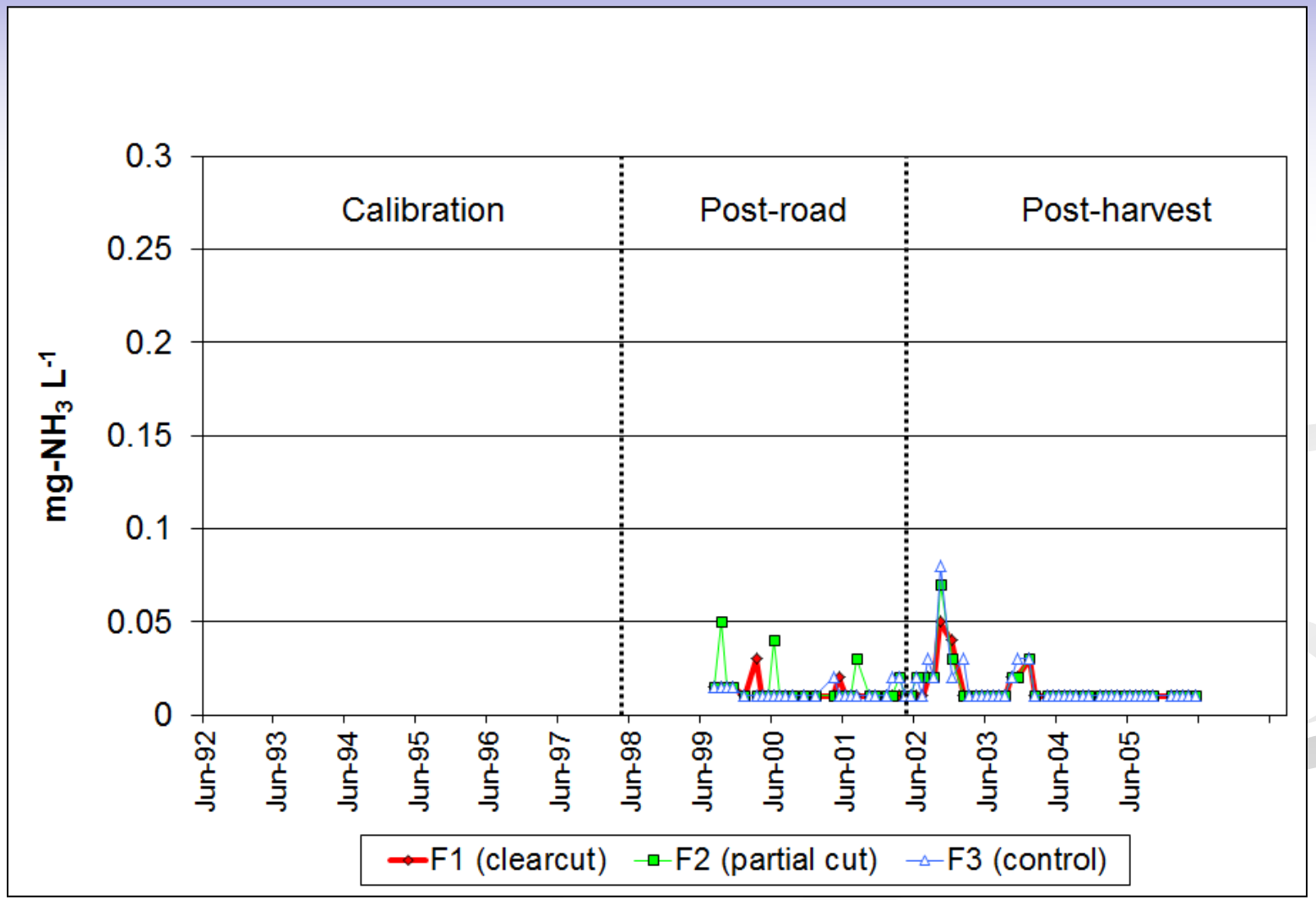
Results: Total Kjeldahl Nitrogen

Headwater sites



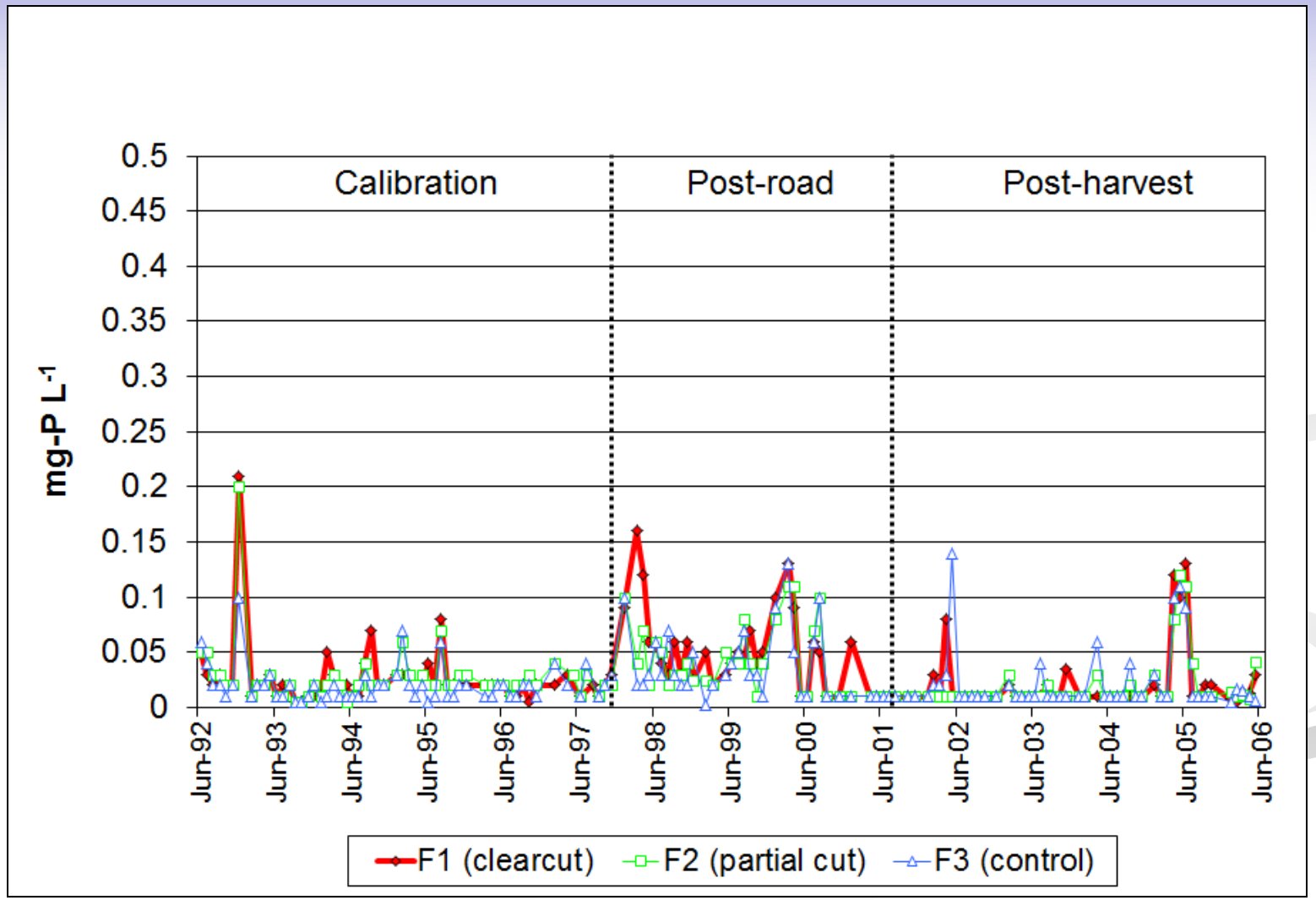
Results: Total Ammonium Nitrogen

Headwater sites



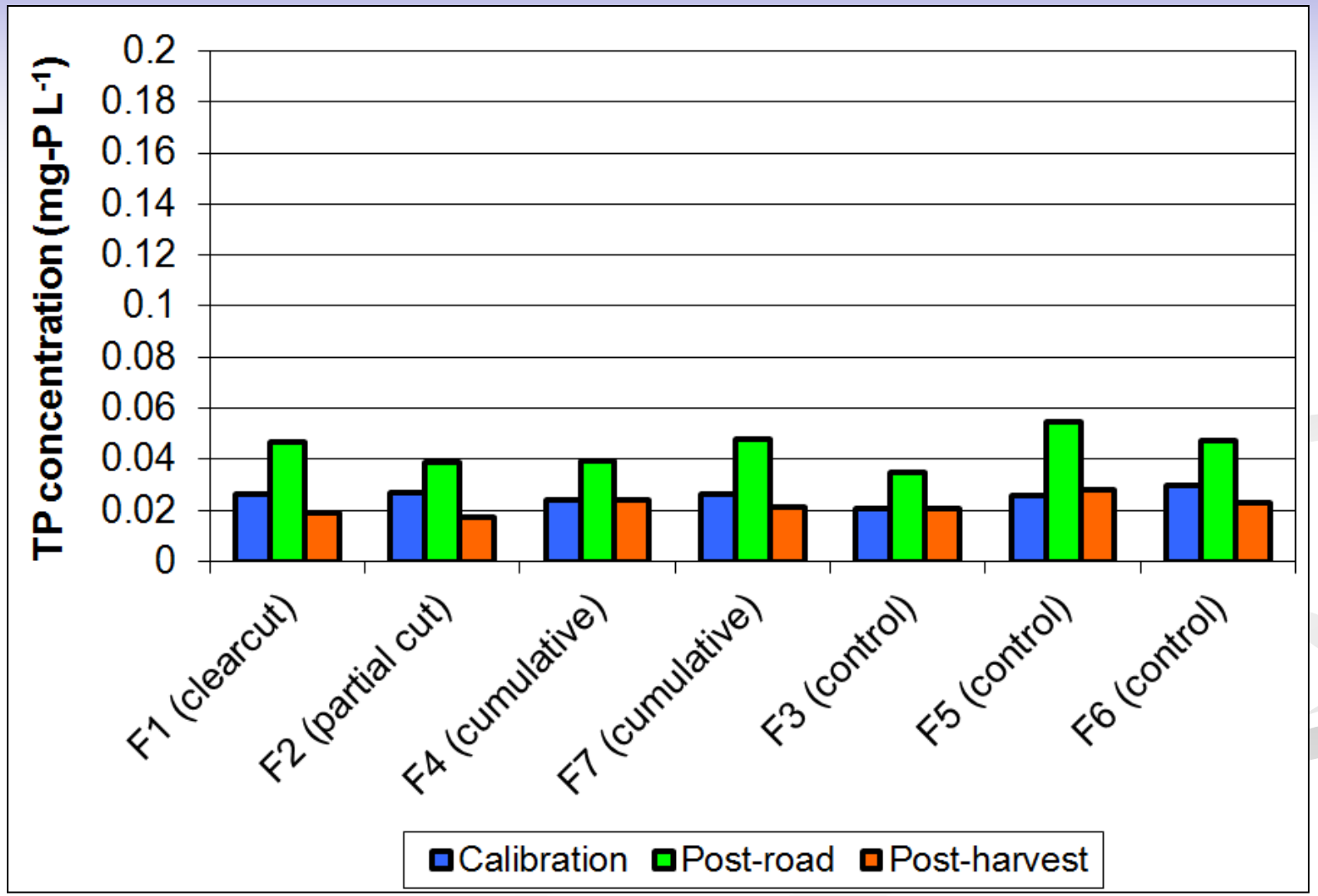
Results: Total Phosphorus

Headwater sites



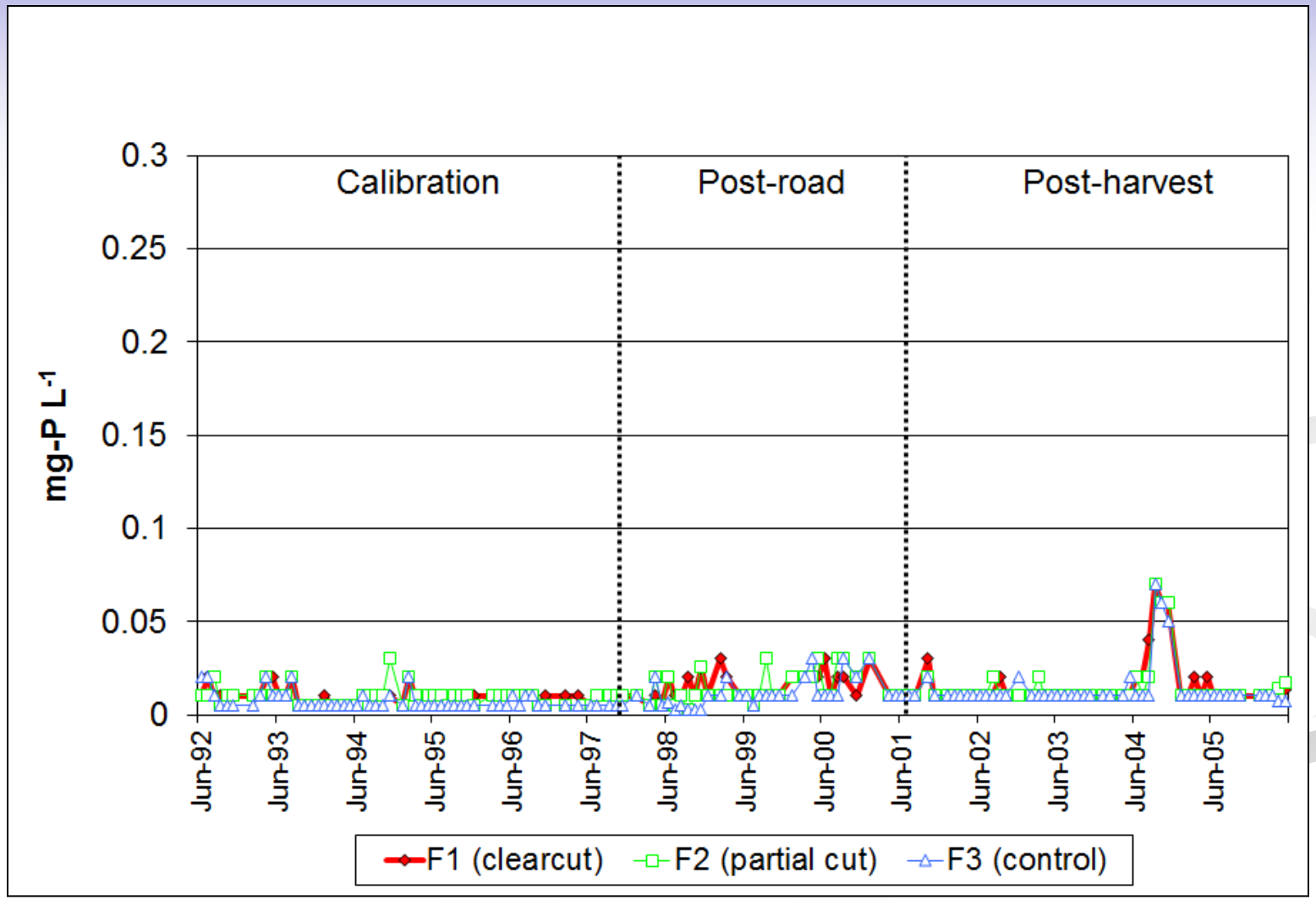
Results: Total Phosphorus

Trends by treatment period



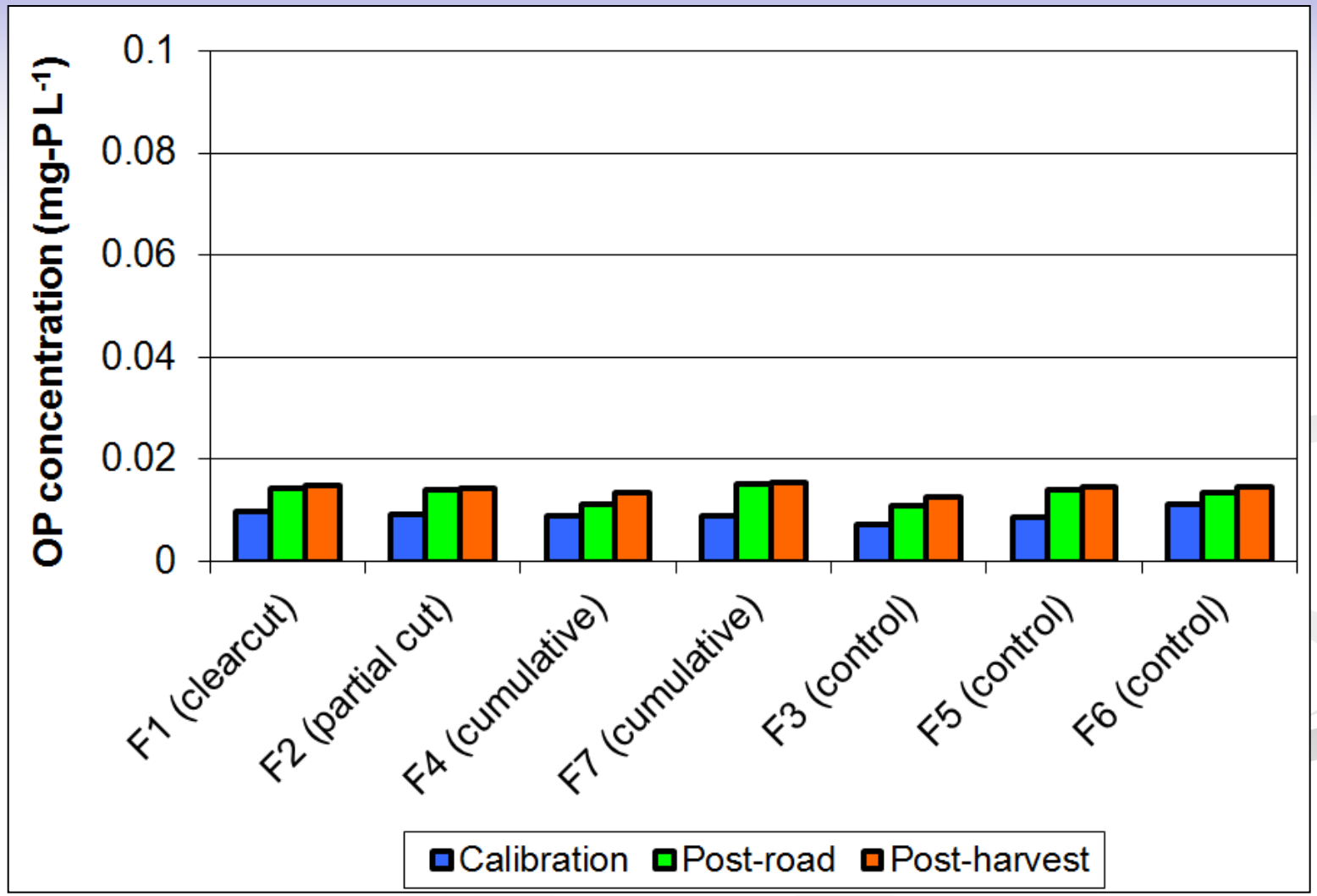
Results: Orthophosphate

Headwater sites



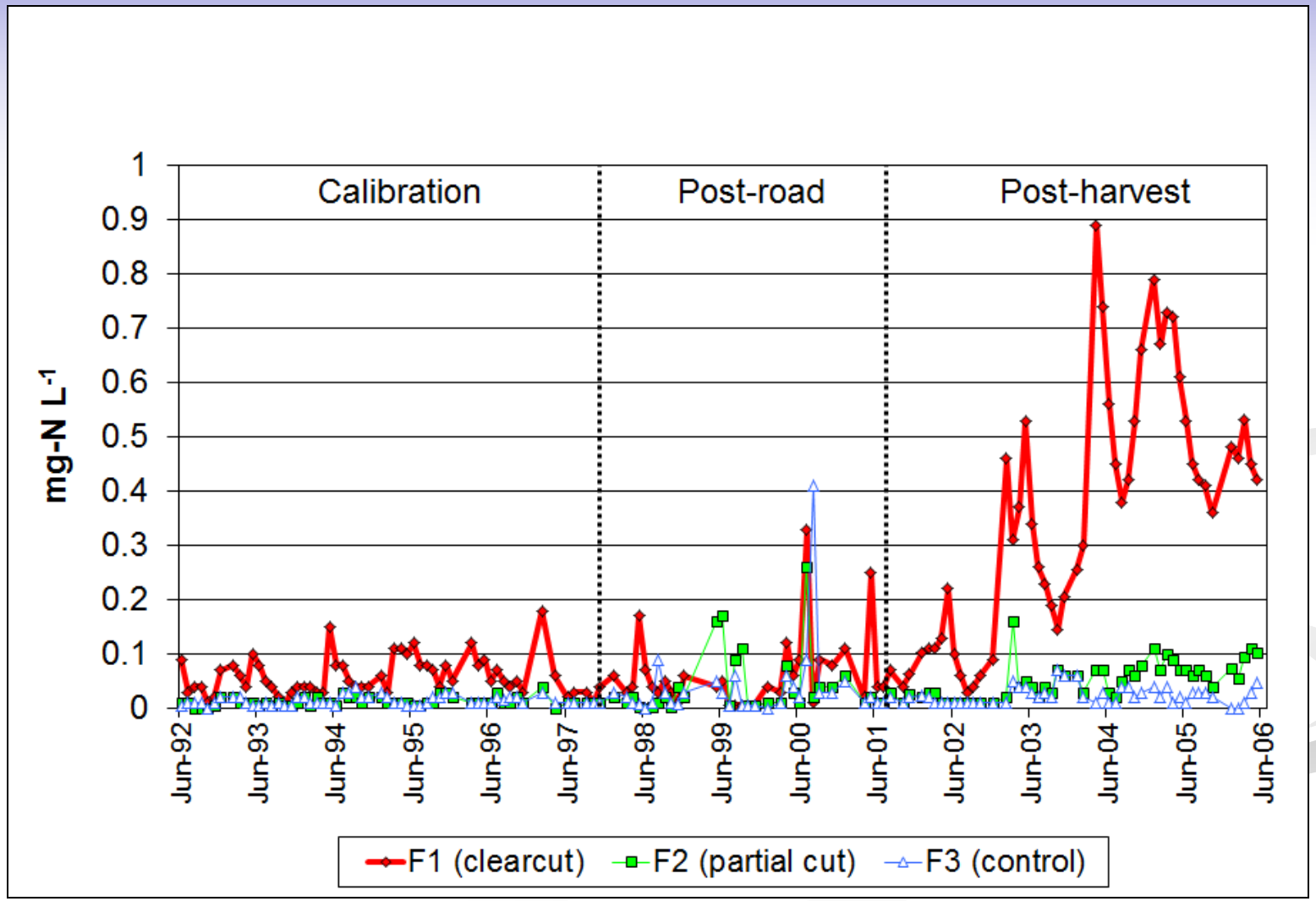
Results: Orthophosphate

Trends by treatment period



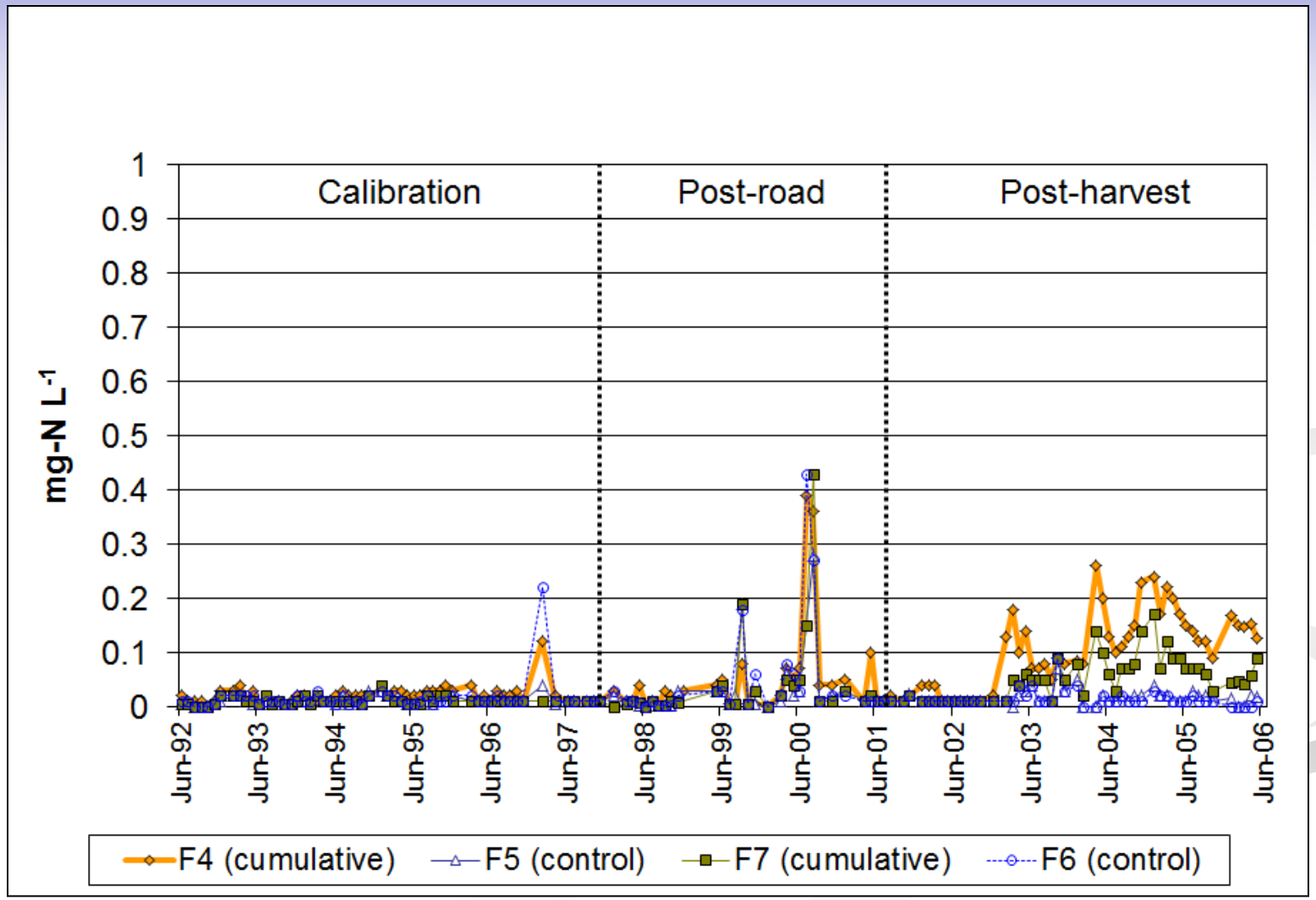
Results: Nitrates+Nitrites

Headwater sites



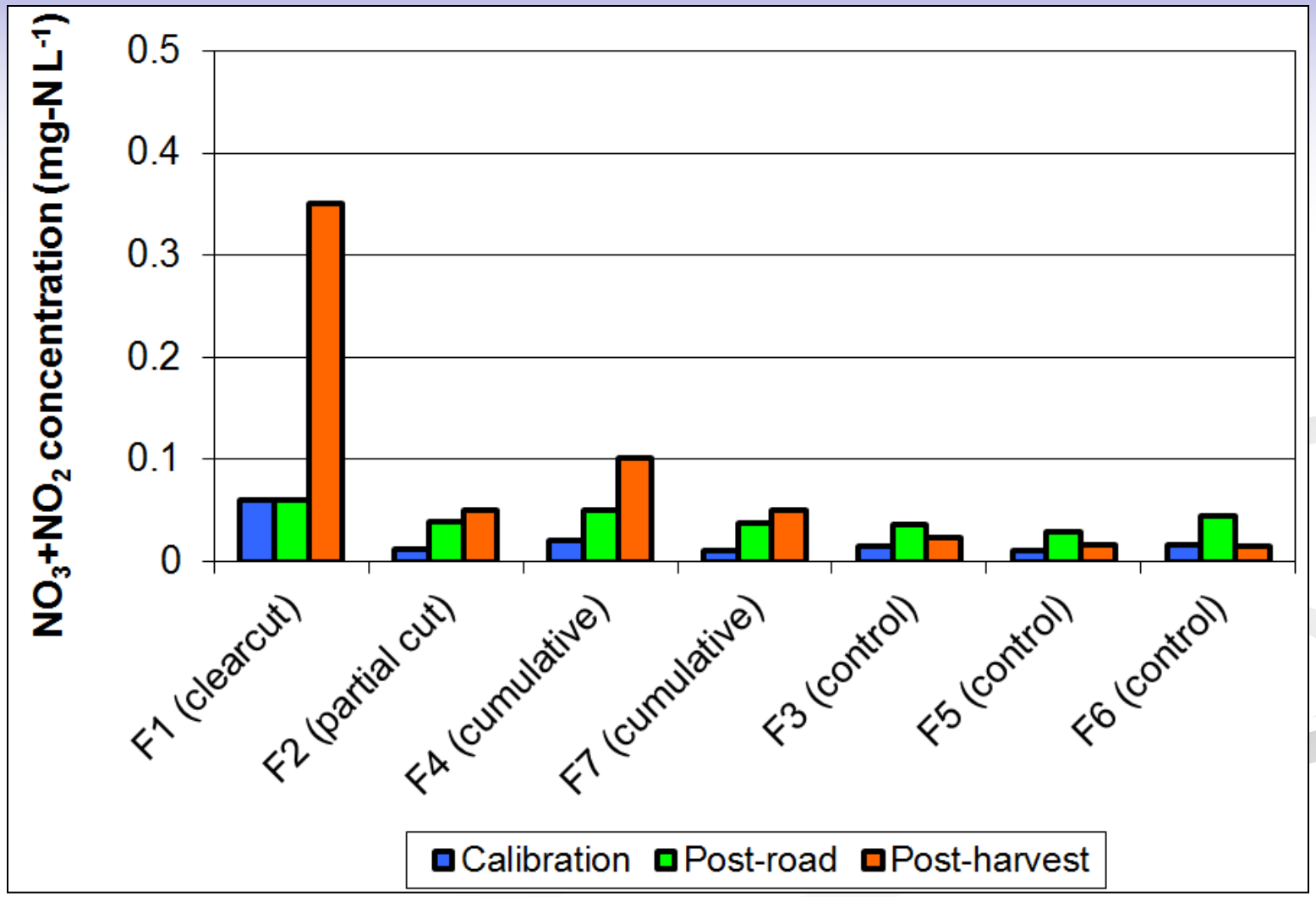
Results: Nitrates+Nitrites

Downstream sites

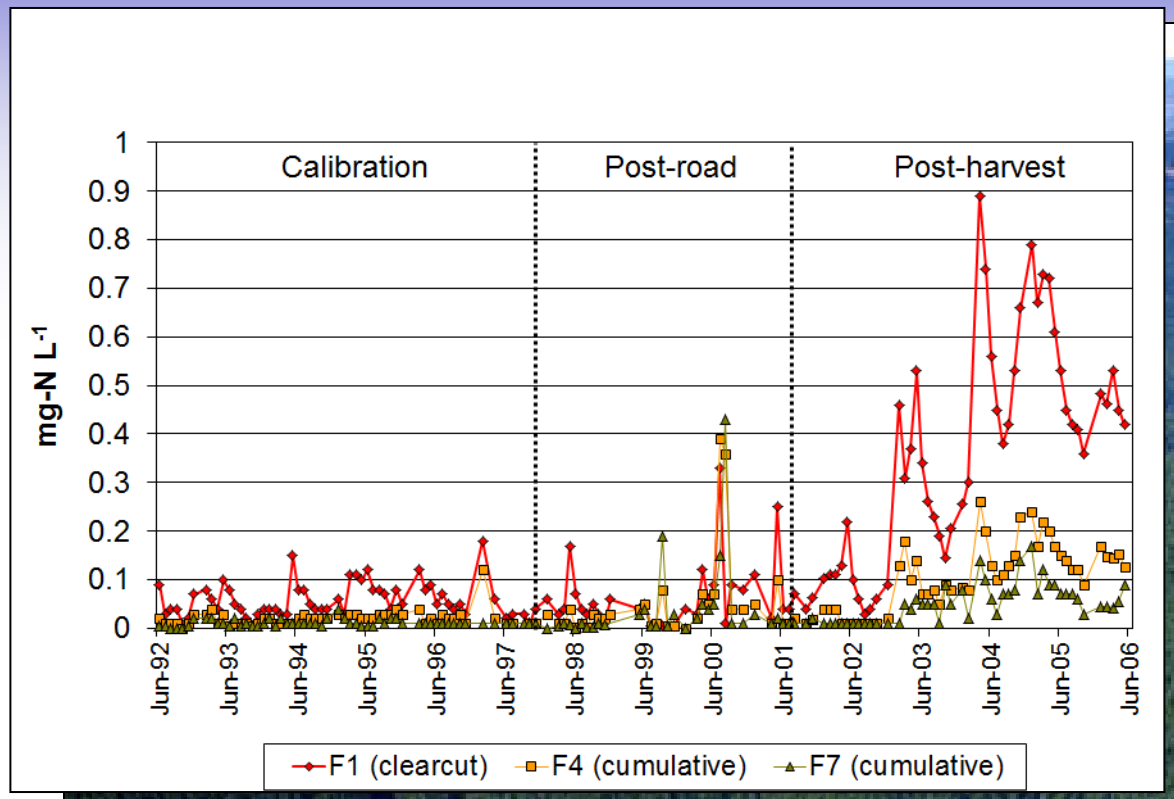


Results: Nitrates+Nitrites

Trends by treatment period

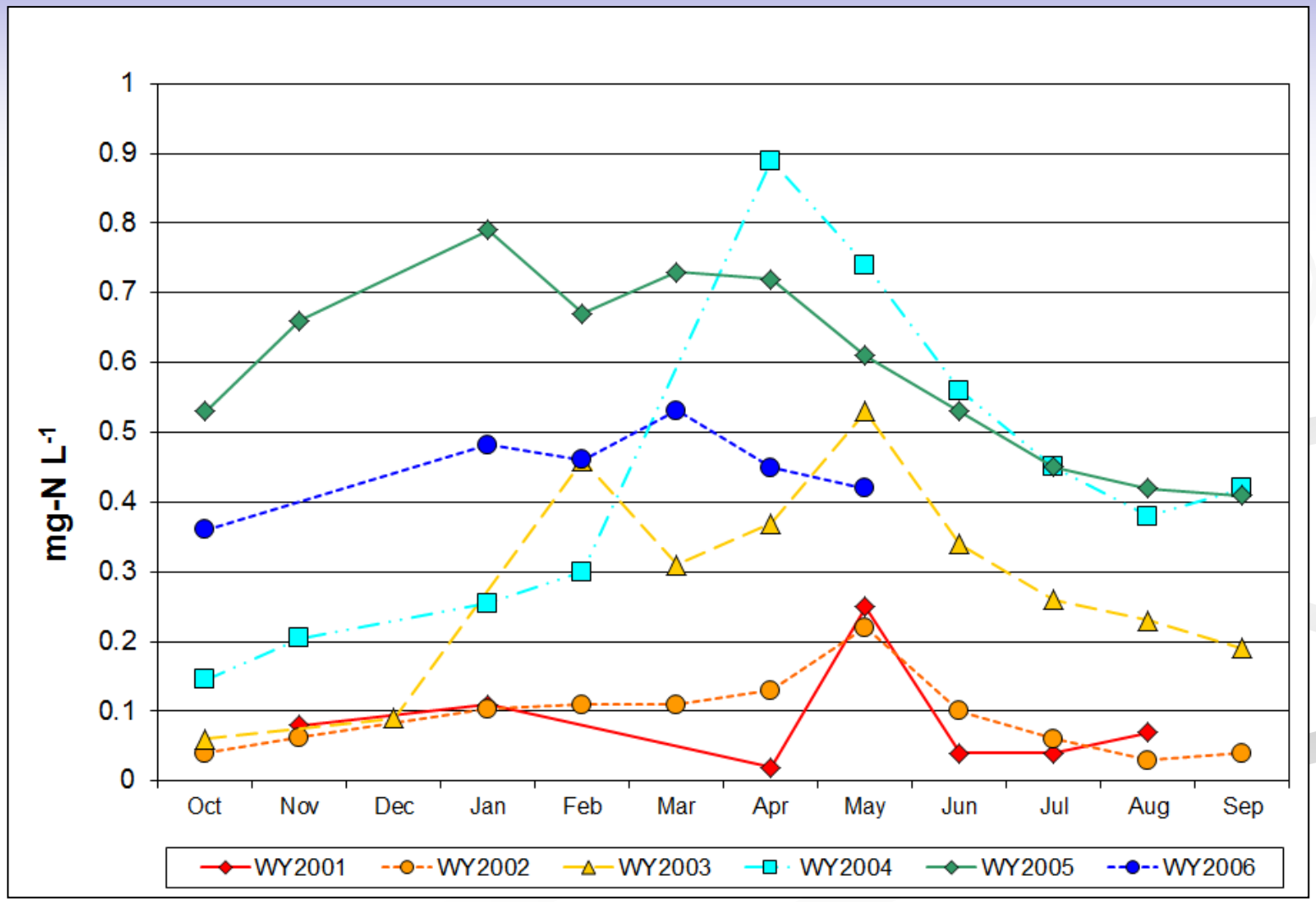


Results: Nitrates+Nitrites



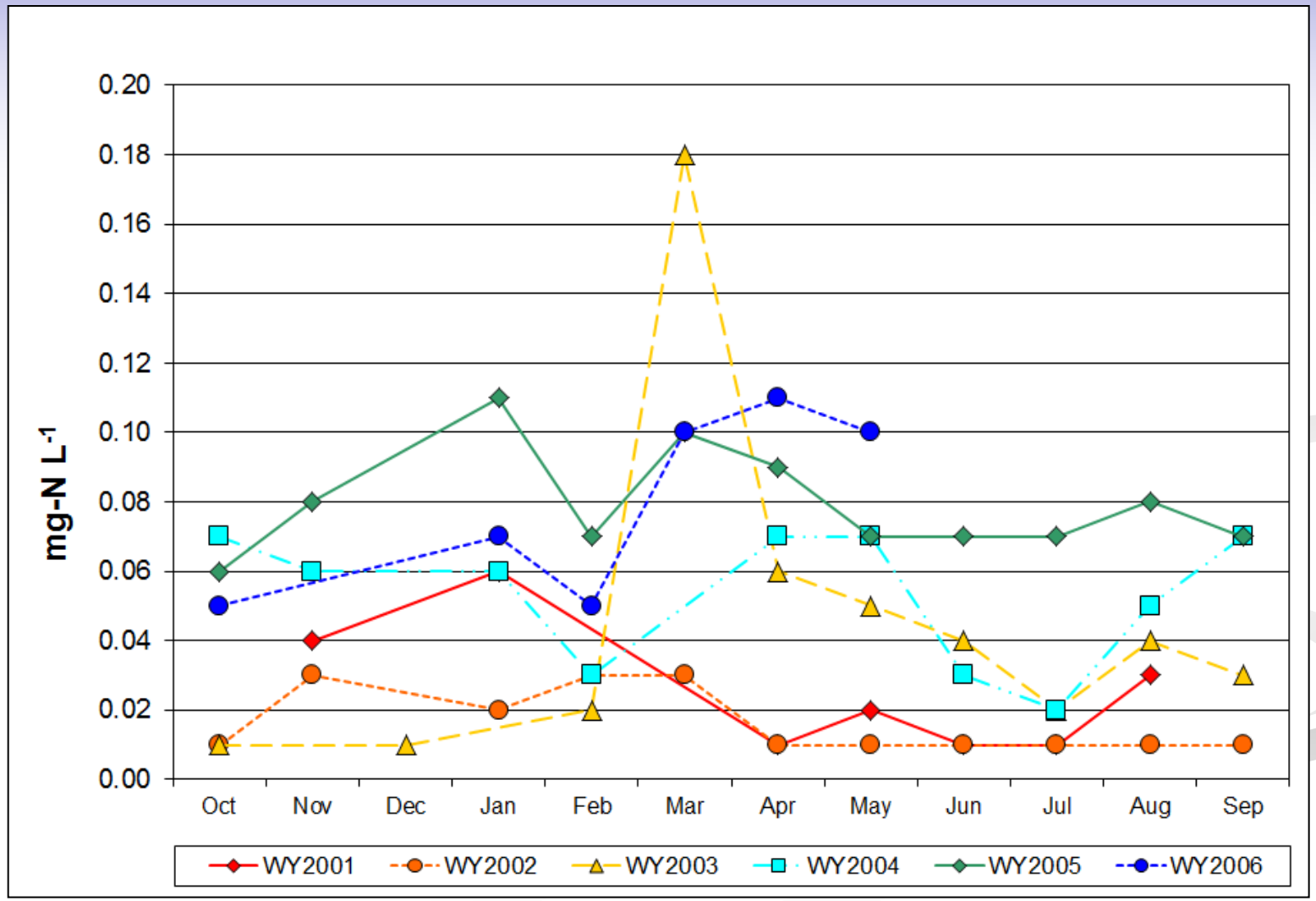
Results: Nitrates+Nitrites

F1 (clearcut), post-harvest



Results: Nitrates+Nitrites

F2 (partial cut), post-harvest

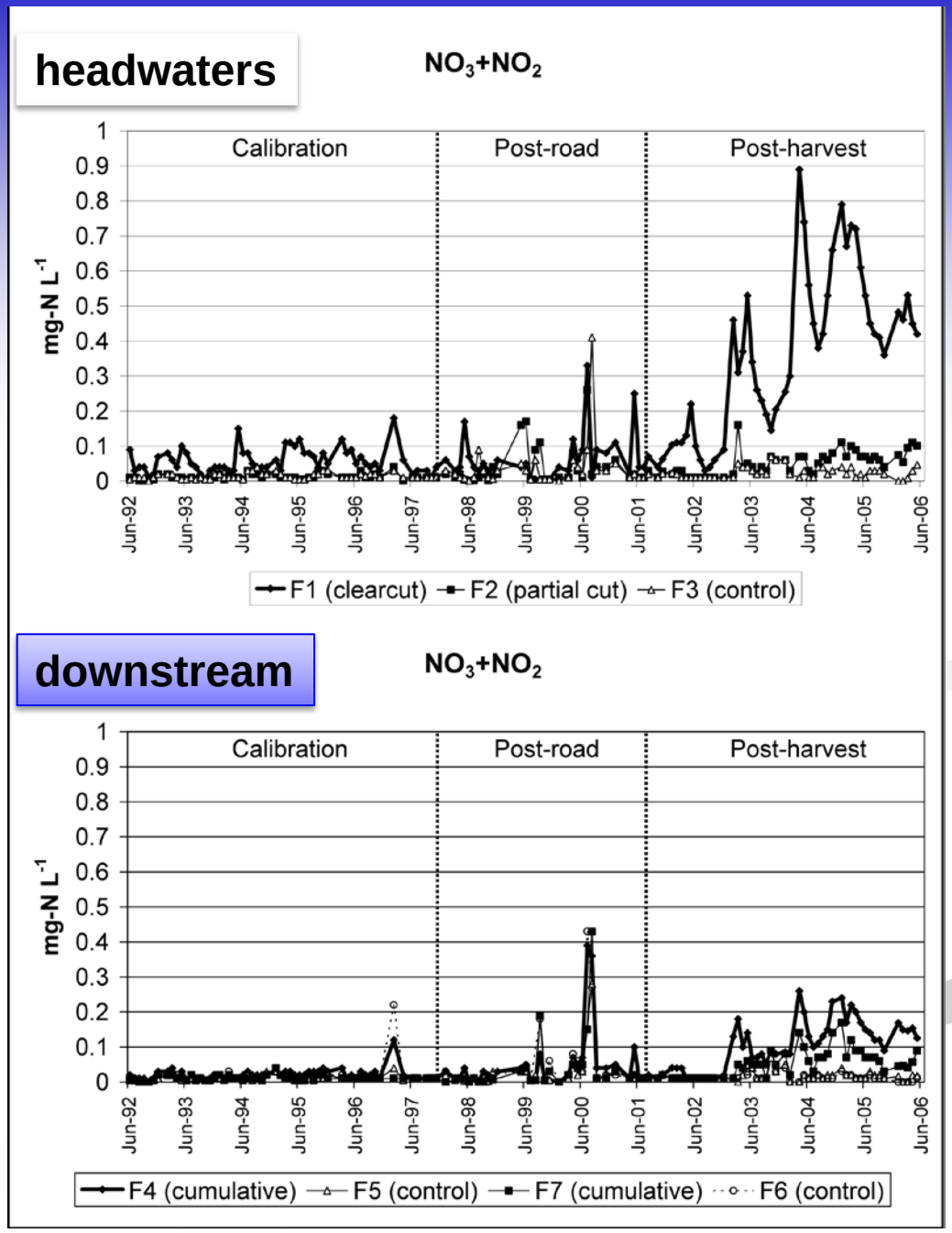


Results: Summary

- All treatment sites showed statistically significant changes ($p<0.001$) in nitrate+nitrite (NO_3+NO_2) concentrations following timber harvest.
- Little (<0.01 mg L^{-1}) or no changes were found in TKN, TAN, TP, and OP concentrations.
- Mica Creek, like many other forestland streams, has low nutrient concentrations when compared to other land uses.

Summary:

- NO_3 + NO_2
  - +0.29 mg L^{-1} (CC)
  - +0.03 mg L^{-1} (PC)
  - + downstream
- TKN (no change)
- TAN (no change)
- TP (no change)
- OP (no change)
  - +~0.01 mg L^{-1}
    Cumulative site



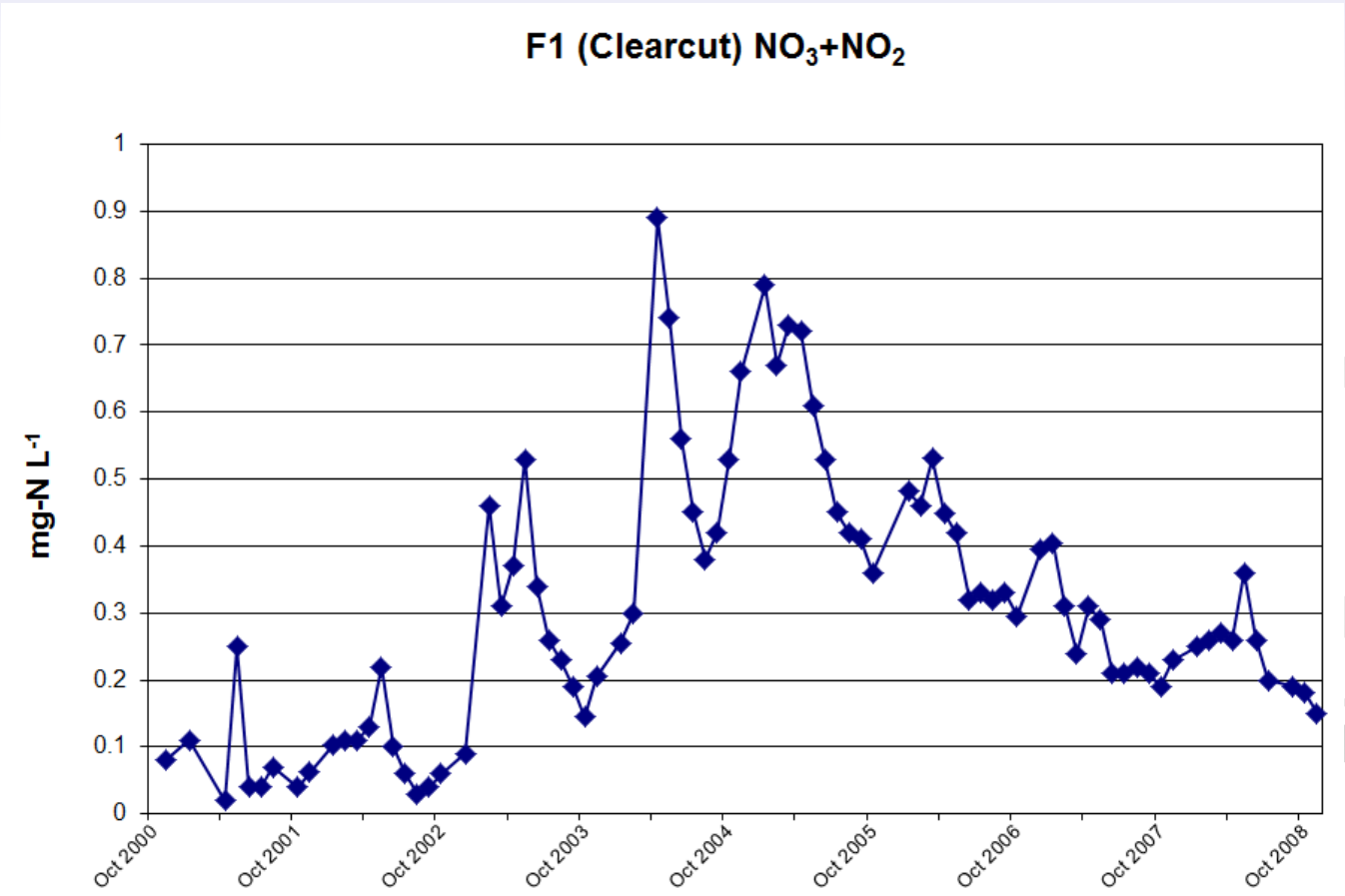
MCEW Nutrients: Summary

For further information:

Gravelle J. A., G. Ice, T. E. Link, and D. Cook. 2009. Nutrient concentration dynamics in an inland Pacific Northwest watershed before and after timber harvest, *Forest Ecology and Management, 257: 1663-1675.*

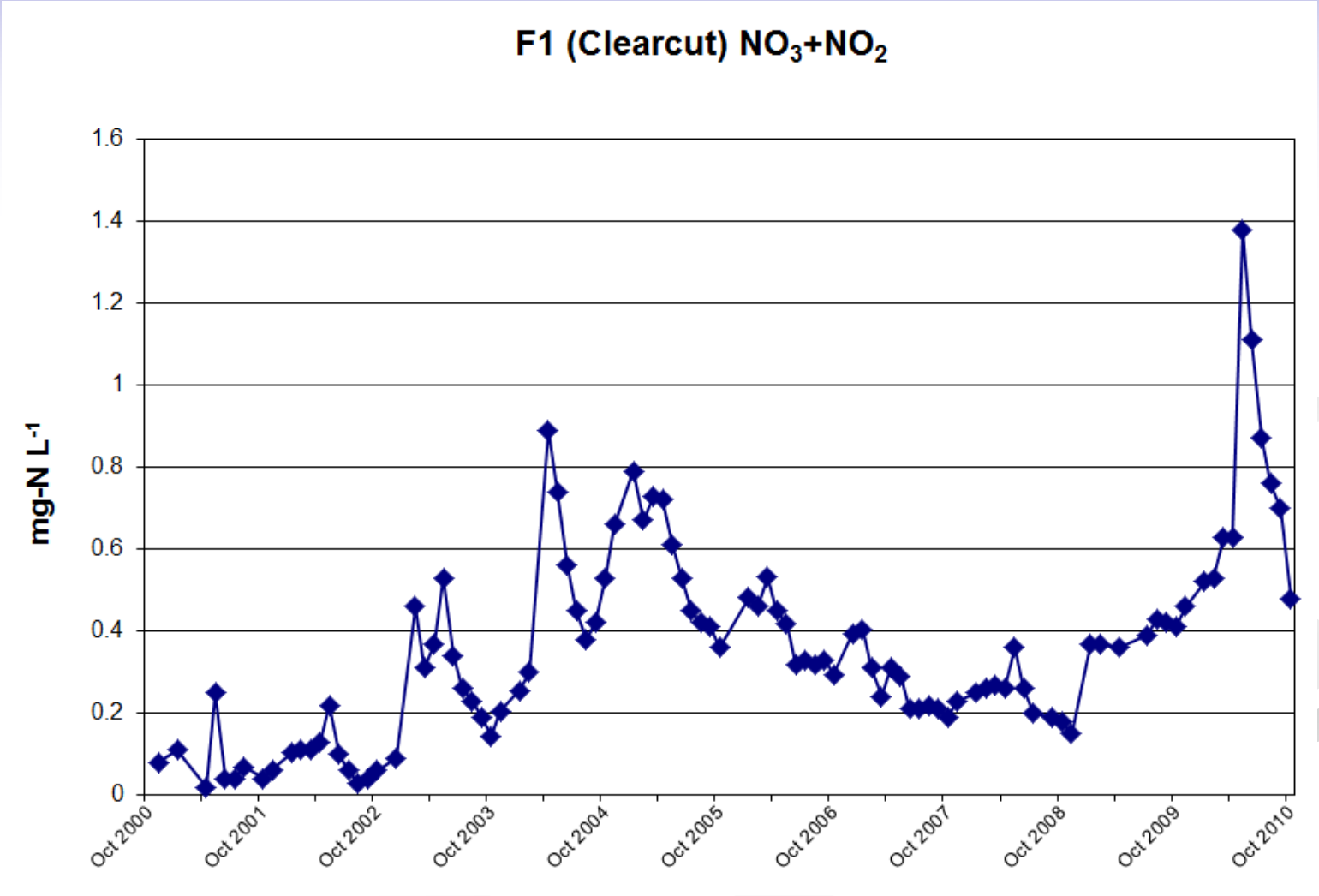
Ongoing Research

Continued monitoring at long-term sites like MCEW can be quite valuable in gaining knowledge because sometimes an apparent trend goes from…



Ongoing Research

to this!!!

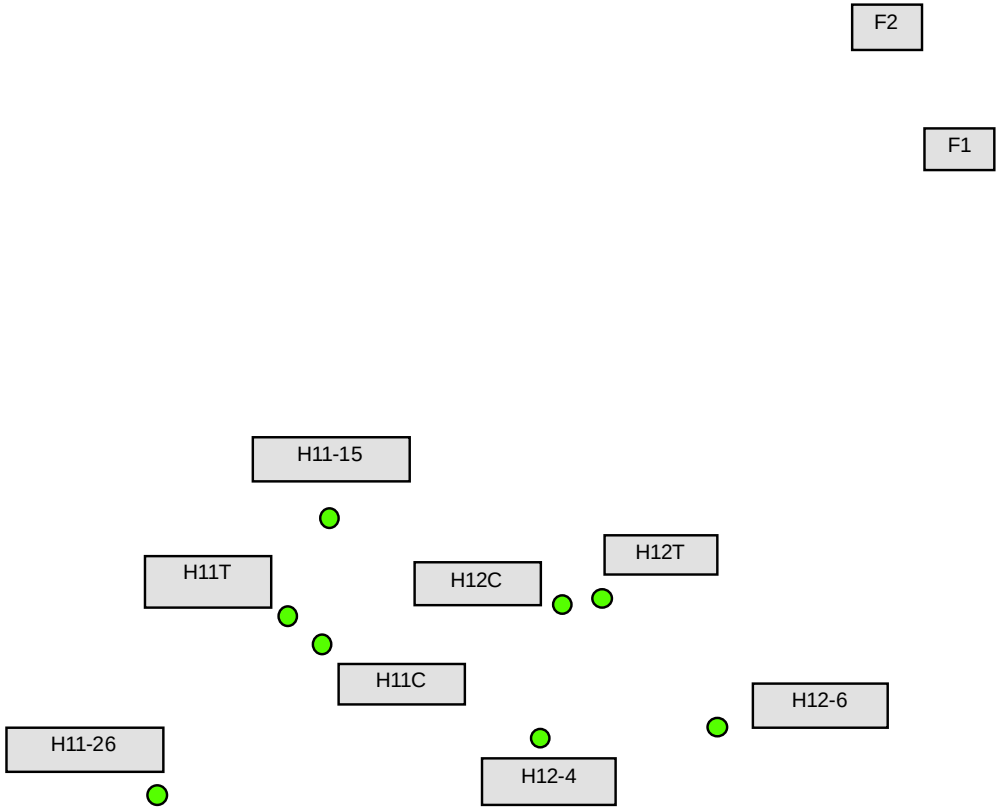


Ongoing Research

So what has happened to make nitrate+nitrite (NO_3+NO_2) concentrations go back up?

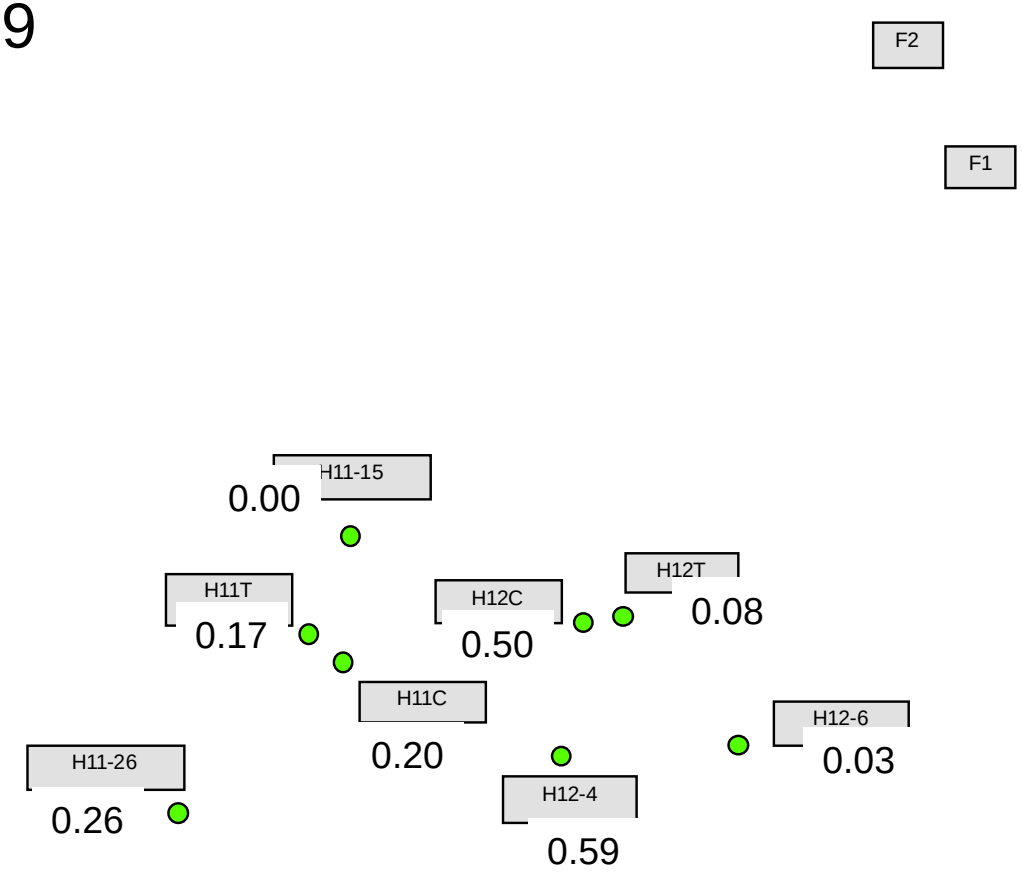
- Previous pre-harvest work showed that elevated background F1 watershed nitrate+nitrite (NO_3+NO_2) concentrations resulted from nitrogen-fixing vegetation (alder).
- Additional headwater sites were revisited in 2010.

Ongoing Research
Additional Headwater Sampling



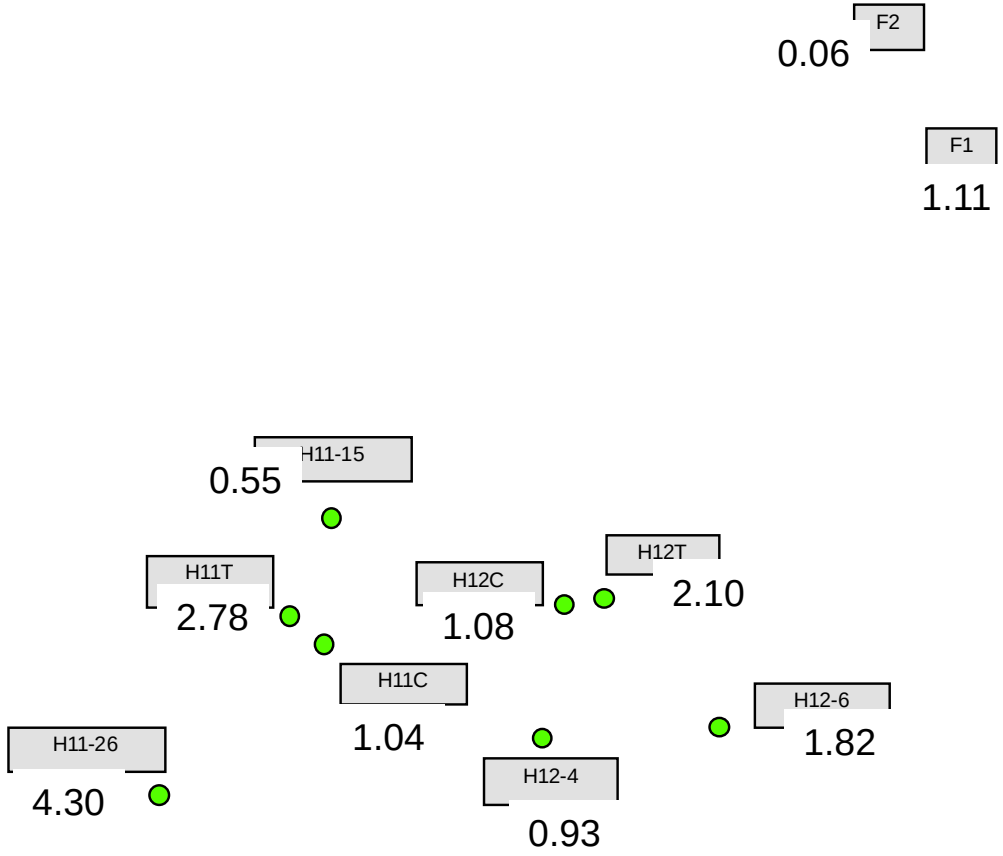
Ongoing Research
Additional Headwater Sampling

Summer 1999
(pre-harvest)



Ongoing Research
Additional Headwater Sampling

June 2010



Ongoing Research

Possible cause of nitrate+nitrite (NO_3+NO_2) concentration trend reversal.

- Increased vigor of riparian nitrogen-fixing vegetation (alder).

H11T (clearcut): Pre-harvest

H11T (clearcut): Post-harvest

Ongoing Research

Possible cause of nitrate+nitrite (NO_3+NO_2) concentration trend reversal.

- Reduced vegetative uptake from competition release spray.

Ongoing Research

We think the nitrate+nitrite (NO_3+NO_2) concentration increases observed in 2009 and 2010 are probably some combination of:

1) Reduced vegetative uptake from competition release spray.

2) Delayed effect of microbial activity and decay of organic matter (mineralization).

3) Increased vigor of riparian vegetation (alder).

Ongoing Research

Continued monitoring will assist in evaluating the current trends during:

- Additional forest management activity.
- Stand regeneration.
- Hydrologic recovery.

More results will be coming!


Thank you!
jag@pineorchard.com