Overview of the DESC basins

Jim Buttle

- 22 headwater basins (3.4 ha – 190.5 ha)
- monitored by the Ontario Ministry of the Environment beginning in 1976; discontinued for many basins in 1990s
- goal: to estimate water and nutrient yields to lakes to predict shoreline development effects on lake trophic status in central Ontario and to understand basin and lake response to acidic deposition through the Acid Precipitation in Ontario Study
- goal was not to monitor/understand hydrology of Shield basins (***this has been a useful byproduct!***); implications for ability to extrapolate from basins to larger landscape

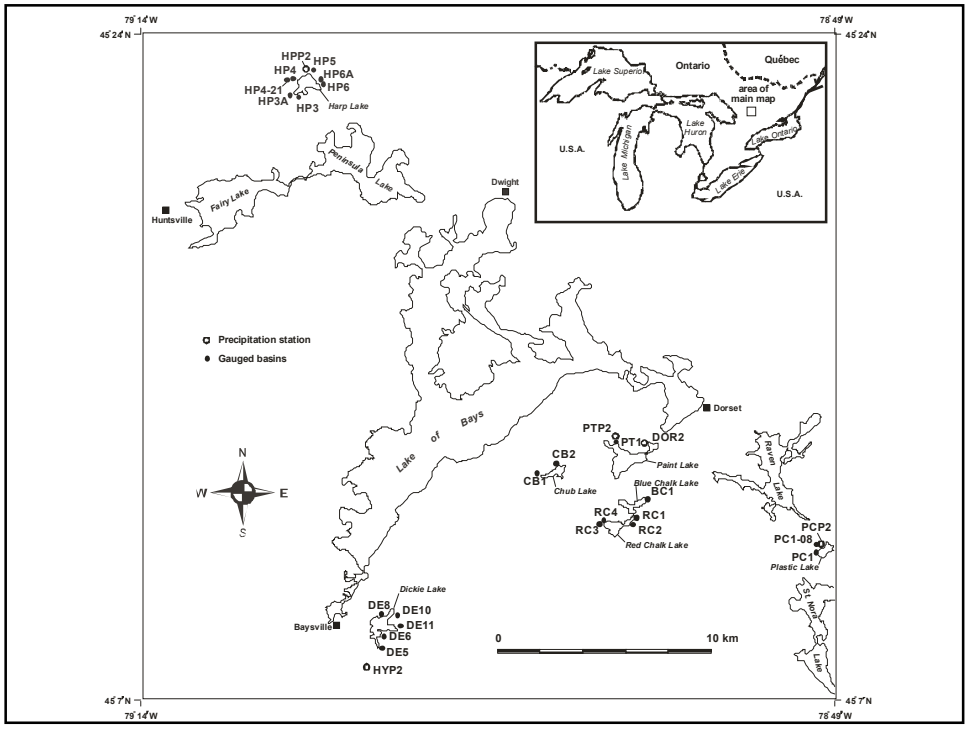
• granitized biotite and hornblende gneiss; brunisols, podzols (uplands), gleysols, histosols (valleys); coniferous → mixed → deciduous forest cover

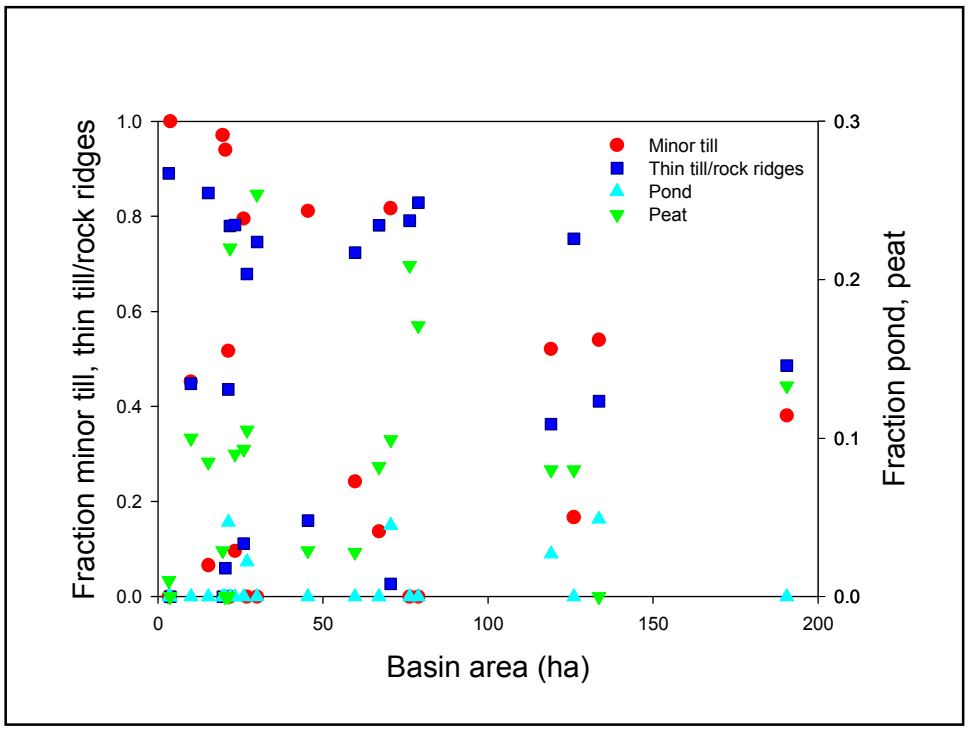
• average July and January temperatures are 18.7° and 11.1° C, respectively

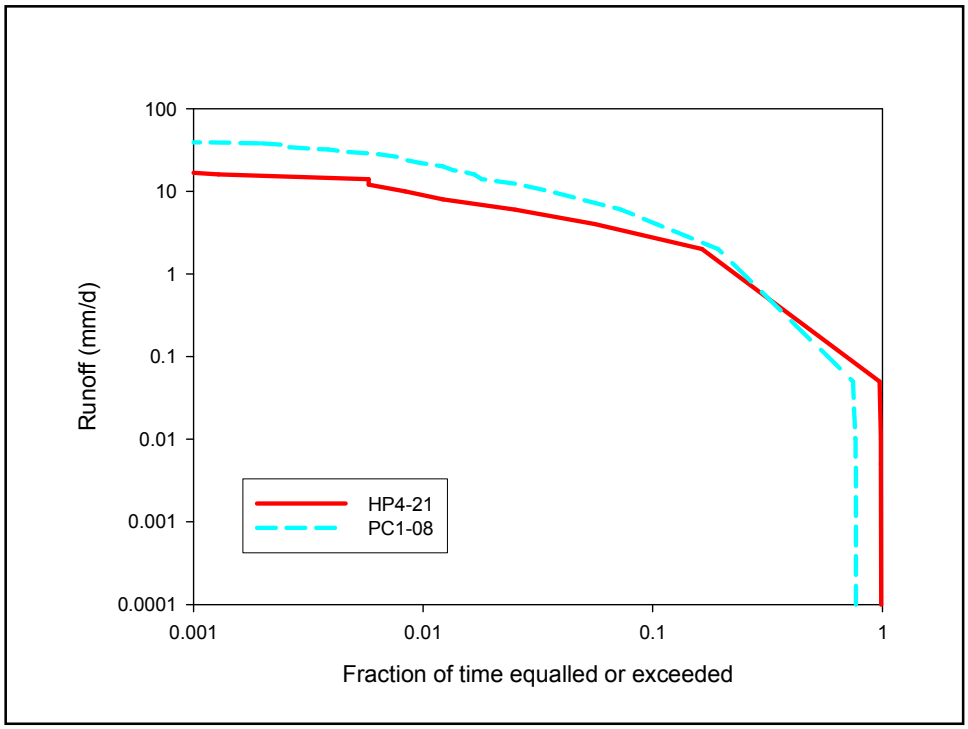
• mean annual temperatures range from 3.6°C (1993/1994) to 7.6°C (2001/2002)

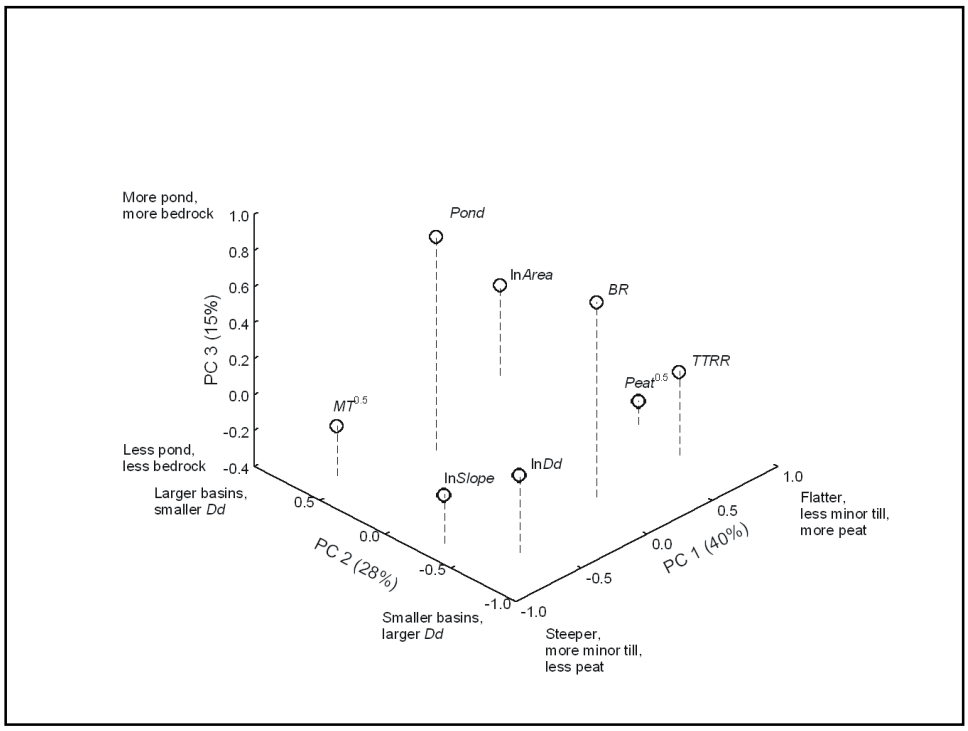
• annual precipitation at the DOR2 precipitation station for the period 1976–2001 ranged from 803 mm (1987) to 1278 mm (1980), with about 30% falling as snow

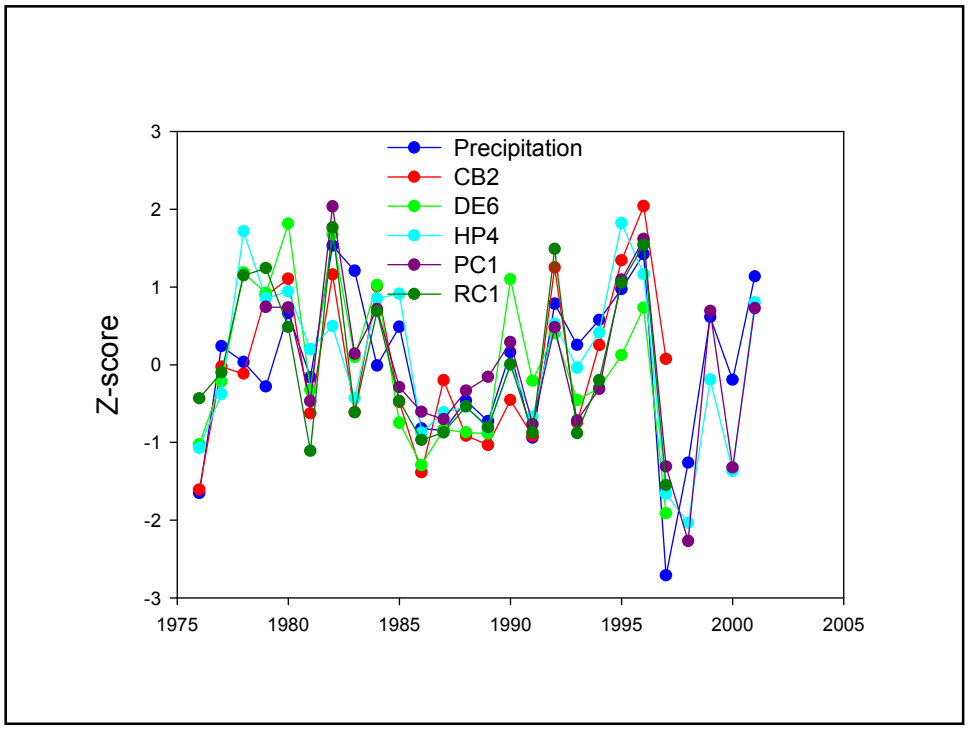
• annual runoff for the DESC region is 400–500 mm (49–77% on average delivered during Spring snowmelt)

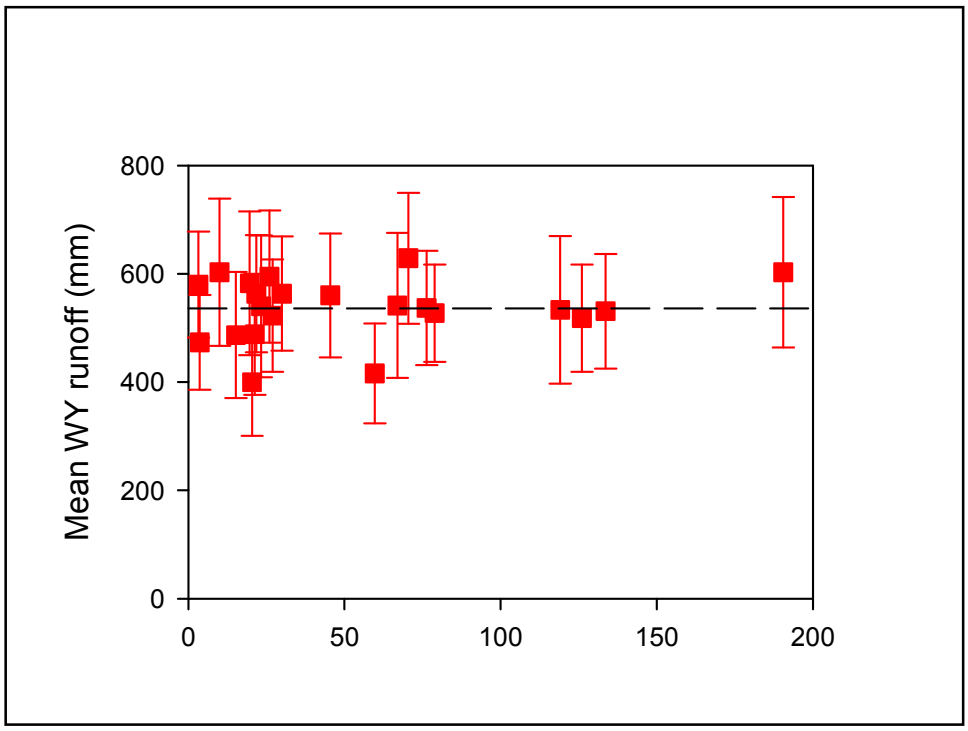


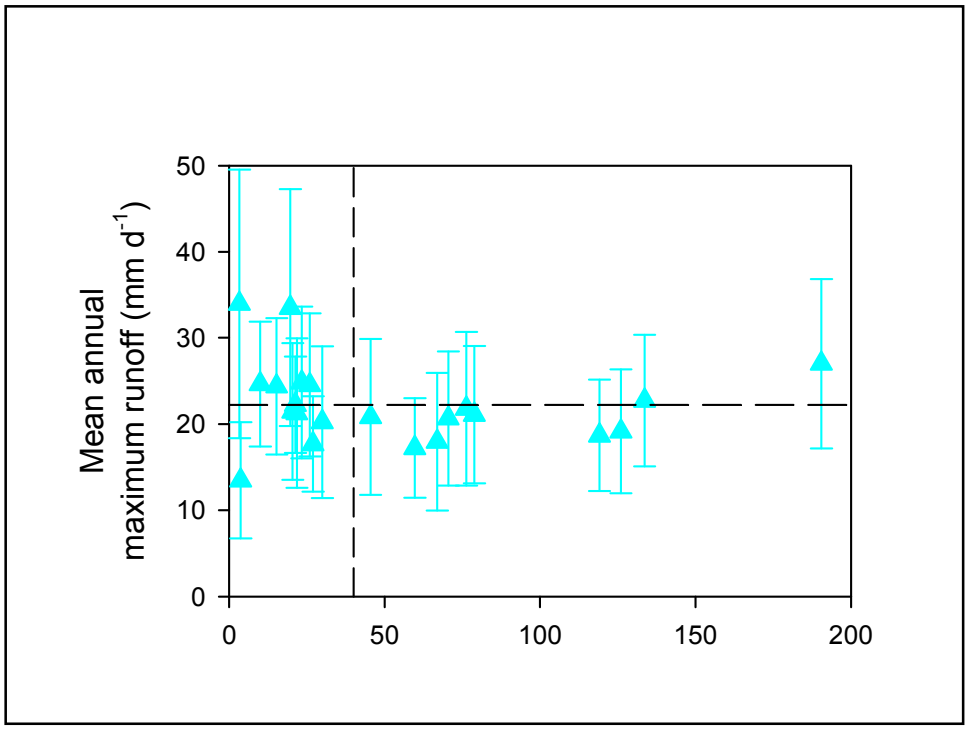

Fraction minor till, thin till/rock ridges
Fraction pond, peat
Basin area (ha)
Minor till
Thin till/rock ridges
Pond
Peat
1.0
0.8
0.6
0.4
0.2
0.0
0.3
0.2
0.1
0.0
0
50
100
150
200

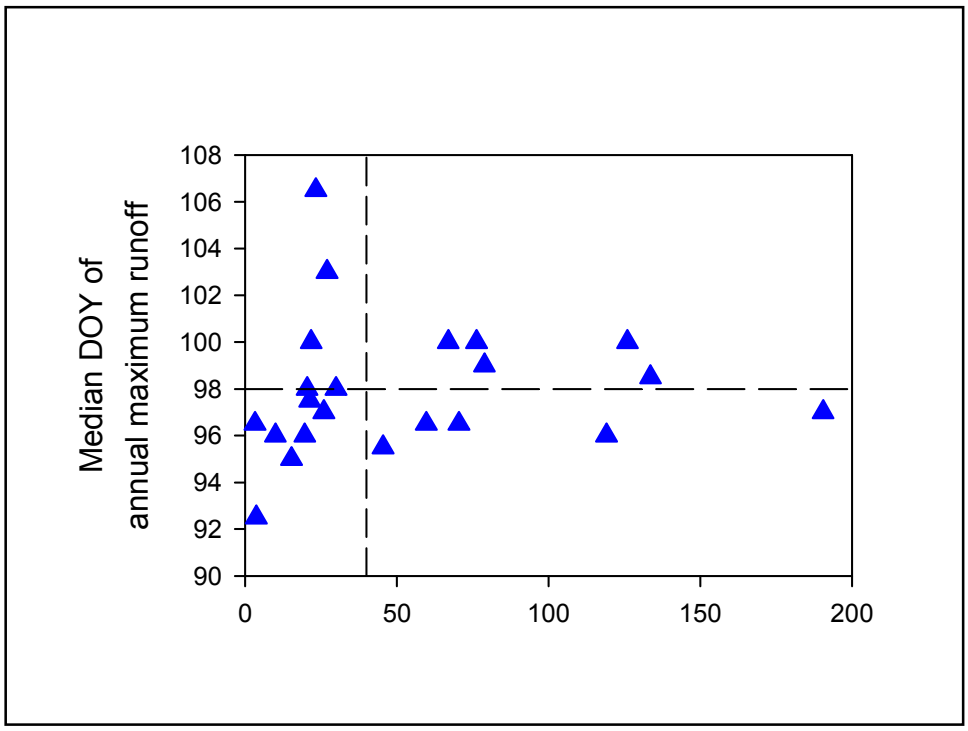

Runoff (mm/d)
Fraction of time equalled or exceeded
HP4-21
PC1-08
100
10
1
0.1
0.01
0.001
0.0001
0.001
0.01
0.1
1

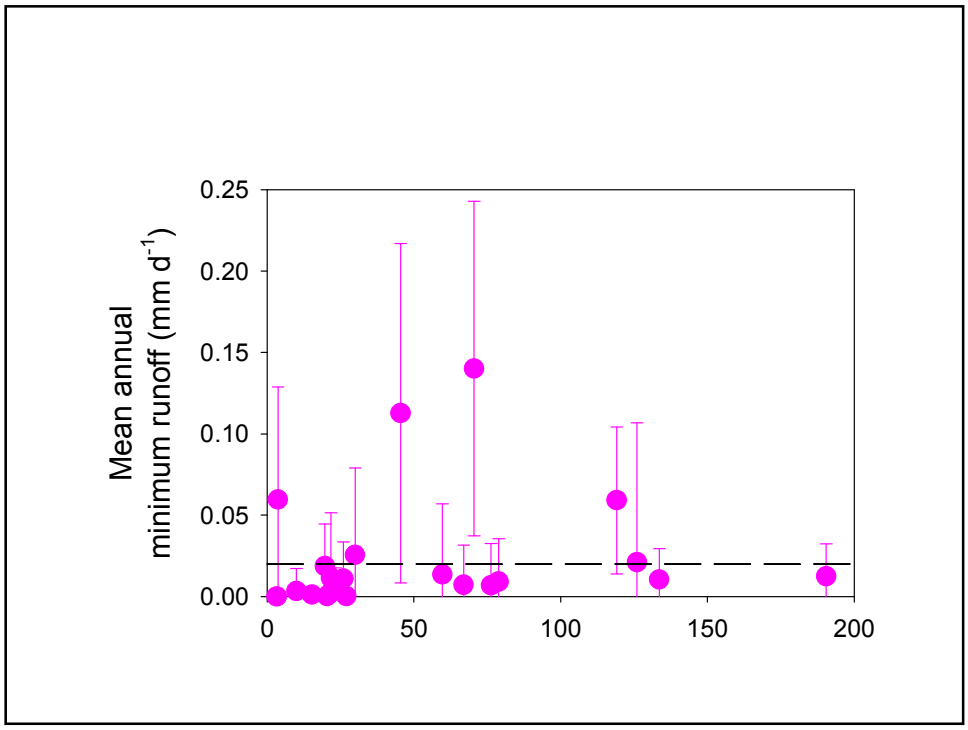

More pond,
more bedrock
Less pond,
less bedrock
PC 3 (15%)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
Pond
lnArea
BR
Peat^0.5
TTRR
MT^0.5
lnSlope
lnDd
Larger basins,
smaller Dd
Smaller basins,
larger Dd
PC 2 (28%)
0.5
0.0
-0.5
-1.0
Steeper,
more minor till,
less peat
PC 1 (40%)
Flatter,
less minor till,
more peat

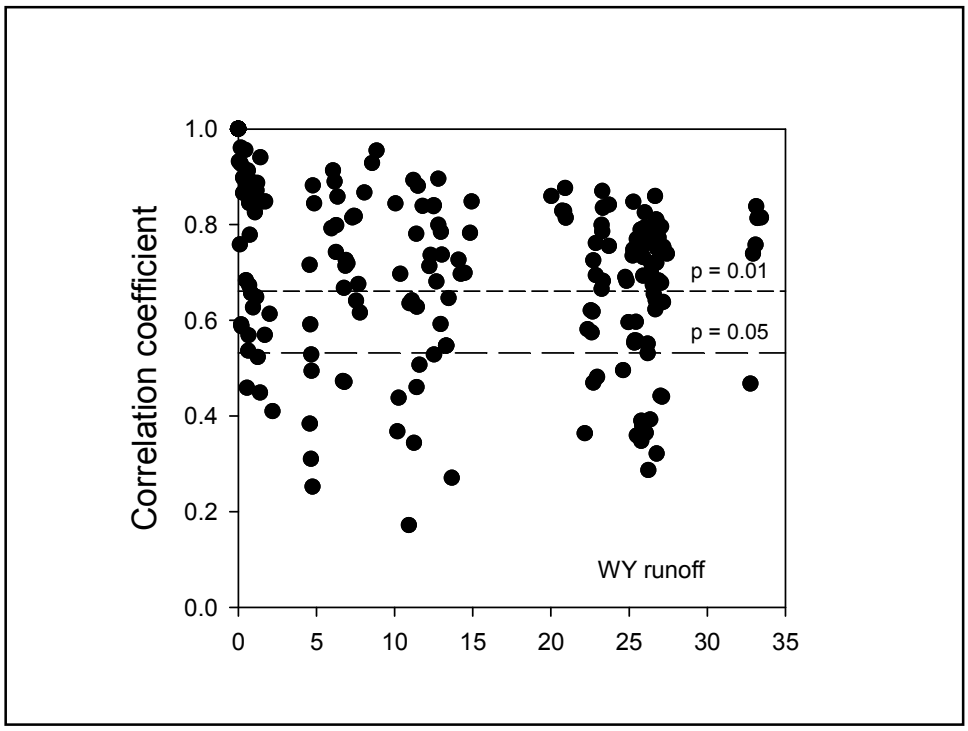

Z-score
3
2
1
0
-1
-2
-3
1975
1980
1985
1990
1995
2000
2005
Precipitation
CB2
DE6
HP4
PC1
RC1

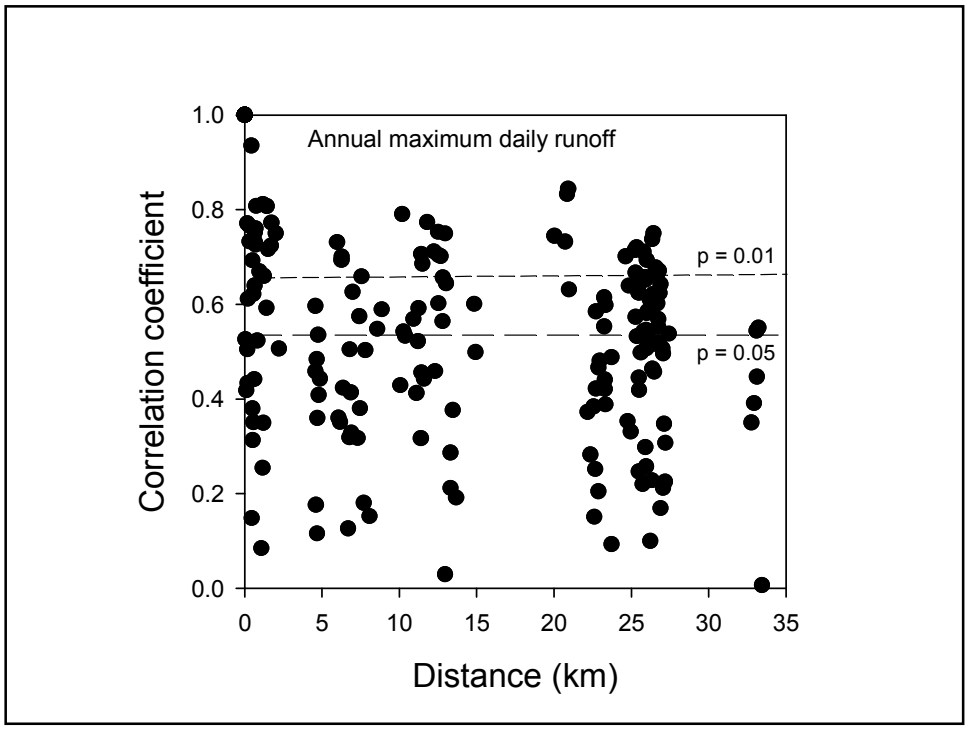

Mean WY runoff (mm)
800
600
400
200
0
0
50
100
150
200


Mean annual
maximum runoff (mm d-1)
50
40
30
20
10
0
0
50
100
150
200

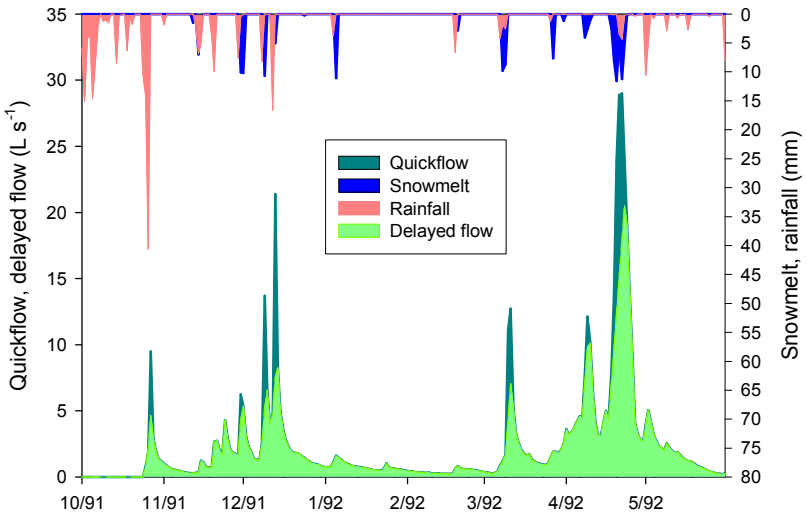

Median DOY of
annual maximum runoff
108
106
104
102
100
98
96
94
92
90
0
50
100
150
200

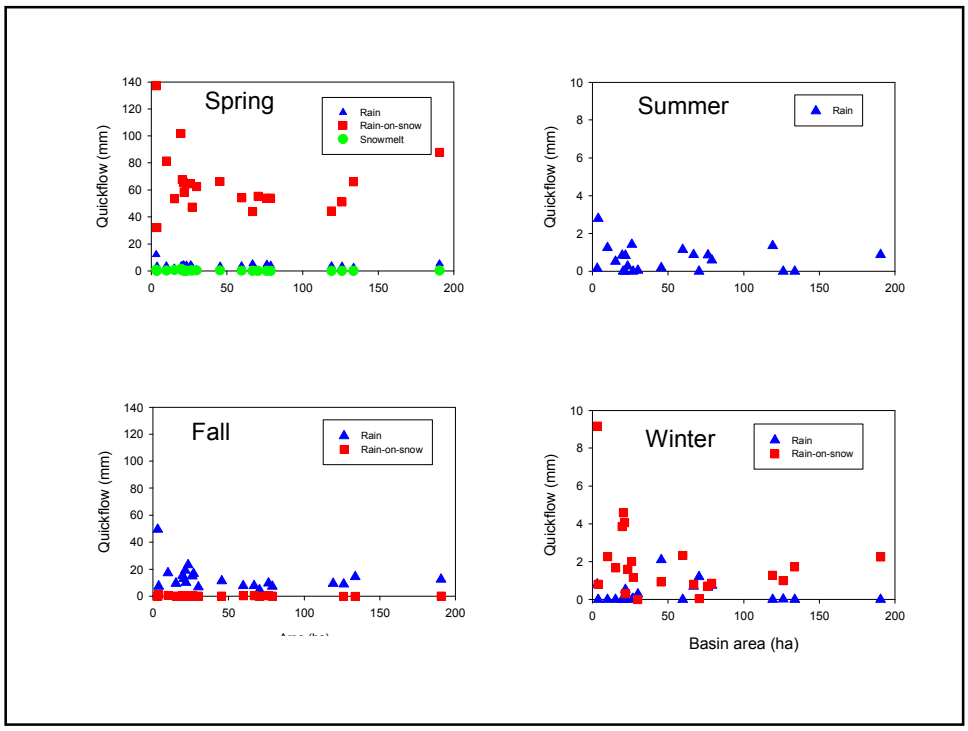

Mean annual
minimum runoff (mm d-1)
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200

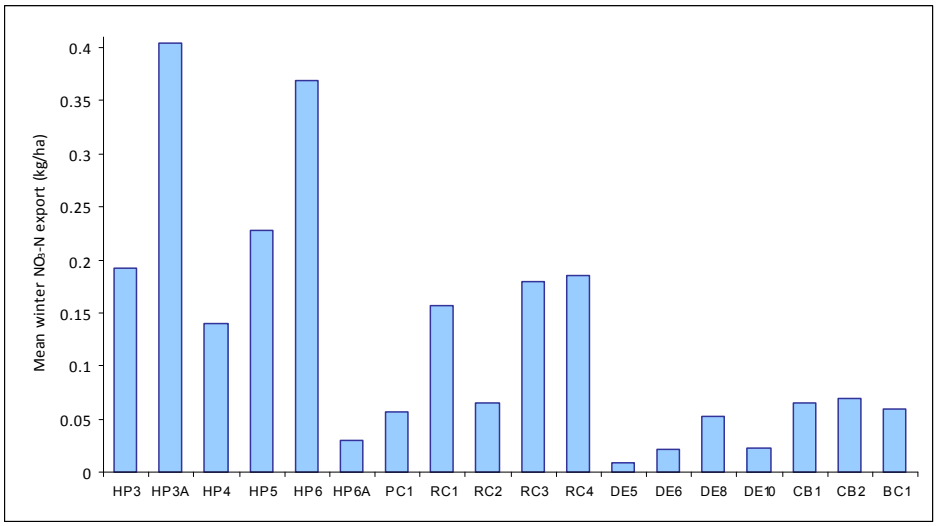

Correlation coefficient
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
p = 0.01
p = 0.05
WY runoff

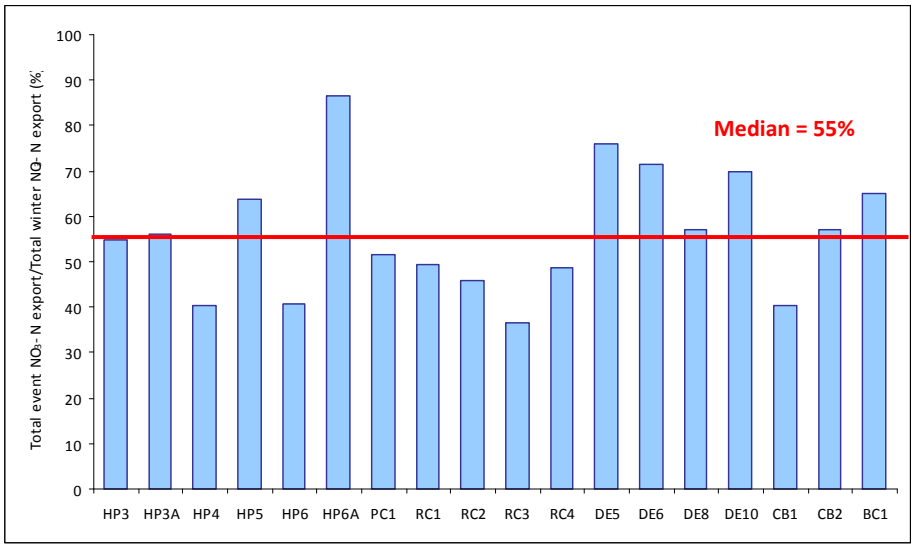

Correlation coefficient
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
Annual maximum daily runoff
p = 0.01
p = 0.05
Distance (km)

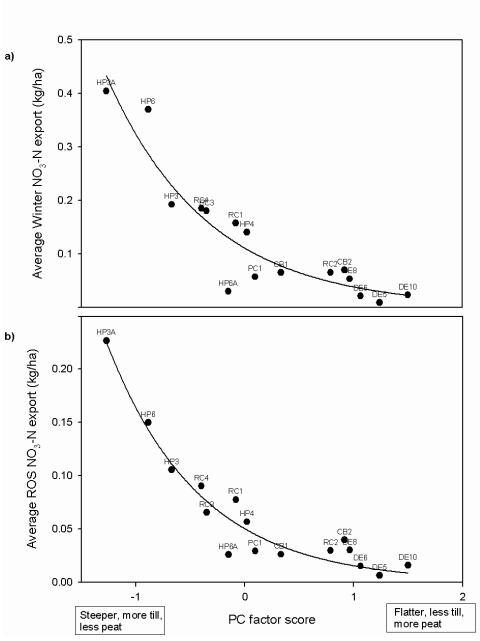
Parameter	Homogeneous trend (Mann-Kendall τ; Van Belle and Hughes χ^2 test)?	Common trend significantly different from 0?	Direction of trend?
WY runoff	Yes	No	
WY runoff/ WY precipitation	No	Yes	Decrease
Annual maximum runoff	Yes	Yes	Decrease
DOY of annual maximum runoff	Yes	No	
Annual minimum runoff	Yes	Yes	Decrease
DOY of annual minimum runoff	Yes	Yes	Increase
# of 0 flow days	Yes	No	
Date of median flow	Yes	No	

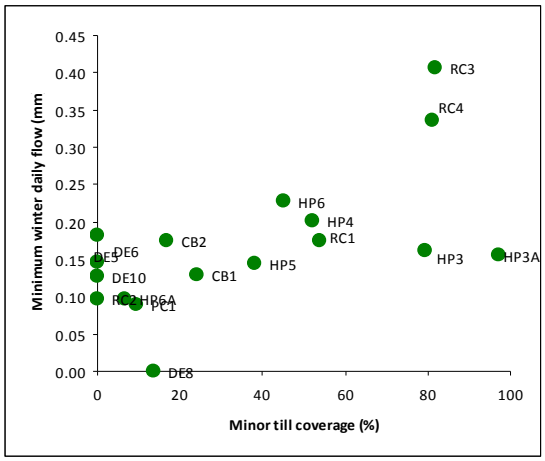



Spring
Rain
Rain-on-snow
Snowmelt
Quickflow (mm)
Summer
Rain
Quickflow (mm)
Fall
Rain
Rain-on-snow
Quickflow (mm)
Winter
Rain
Rain-on-snow
Quickflow (mm)
Basin area (ha)

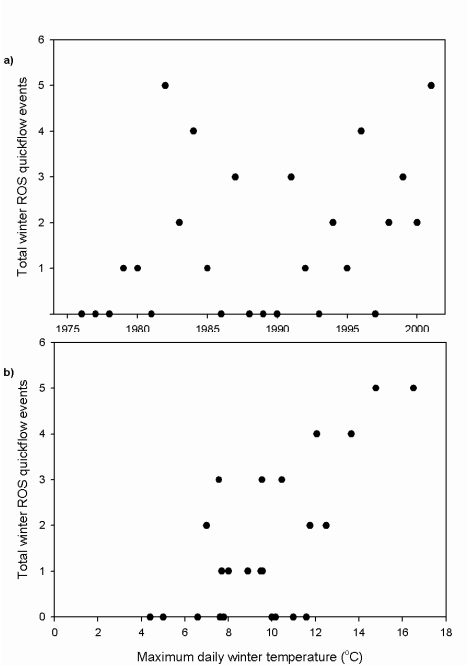

Mean winter NO3-N export (kg/ha)
HP3
HP3A
HP4
HP5
HP6
HP6A
PC1
RC1
RC2
RC3
RC4
DE5
DE6
DE8
DE10
CB1
CB2
BC1


Total event NO3- N export/Total winter NO3- N export (%)
100
90
80
70
60
50
40
30
20
10
0
Median = 55%
HP3
HP3A
HP4
HP5
HP6
HP6A
PC1
RC1
RC2
RC3
RC4
DE5
DE6
DE8
DE10
CB1
CB2
BC1


a)
Average Winter NO3-N export (kg/ha)
0.5
0.4
0.3
0.2
0.1
b)
Average ROS NO3-N export (kg/ha)
0.20
0.15
0.10
0.05
0.00
-1
0
1
2
PC factor score
Steeper, more till, less peat
Flatter, less till, more peat



- more minor till =
  - continuous hydrologic linkage between slopes and streams during winter
  - greater potential to move N from slopes to streams and out of the basin



- proportion of winter NO_3-N export attributable to ROS events is consistent across basins
  - suggests ROS events are important control on winter NO_3-N export at the landscape scale
- differences between basins in winter NO_3-N export despite similar N deposition patterns
  - physiographic and hydrologic factors?
  - biogeochemical factors?
- ROS NO_3-N export may increase in the future with increase in Winter temperatures