Land Management Effects on Runoff Water Quality in Swift Current Creek Watershed

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Methods

- Three 5 ha (11 ac) instrumented watersheds at SPARC
- Runoff quantity from 1962 to date
- Intermittent water quality data since 1971
  - Sediment
  - Nitrate
  - Ortho P
  - Ammonium
  - Dissolved organic carbon
  - Herbicides

Snowmelt Runoff (mm) From Fallow 1995-2002

Runoff	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Days	39	58	39
Mean Daily	1.8	3.9	4.0

- No-Till significantly more runoff in some years due to snow trapped in chem fallow
- Other differences consistent with known watershed behaviour

Snowmelt Runoff (mm) From Stubble 1995-2002

Runoff	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Days	39	42	22
Mean Daily	1.91	1.82	3.53

- Any differences consistent with known watershed behaviour

Snowmelt Sediment (ppk) From Fallow 1995-2002

Sediment	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	0.45	12.94	0.09
Range	0 - .9	0 - *109*	0 - 0.2

- Water erosion was not a serious problem in these years but was significantly greater from chem fallow
- Other differences consistent with known watershed behaviour

Snowmelt Sediment (ppk) From Stubble1995-2002

Sediment	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	0.24	0.42	0.74
Range	0 - 3.1	0 – 1.9	0 - 0.45

- Any differences consistent with known watershed behaviour
  - Organic only fall tilled as necessary

Snowmelt nitrate (ppm) From Fallow 1995-2002

Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	1.28	0.74	1.77
Range	0.37 - 4.70	0.23 - 7.30	0.56 - 6.44

- Nitrate losses from green manure fallow was significantly greater than other fallows in 2 years

Snowmelt nitrate (ppm) From Stubble1995-2002

Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	0.13	0.31	0.36
Range	0 – 1.5	0.03 – 3.3	0.07 – 2.0

- Any differences consistent with known watershed behaviour

Snowmelt ortho-P (ppm) From Fallow 1995-2002

Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	0.22	0.13	*0.32*
Range	0.08 - 0.74	0.04 - 1.28	*0.13 - 1.38*

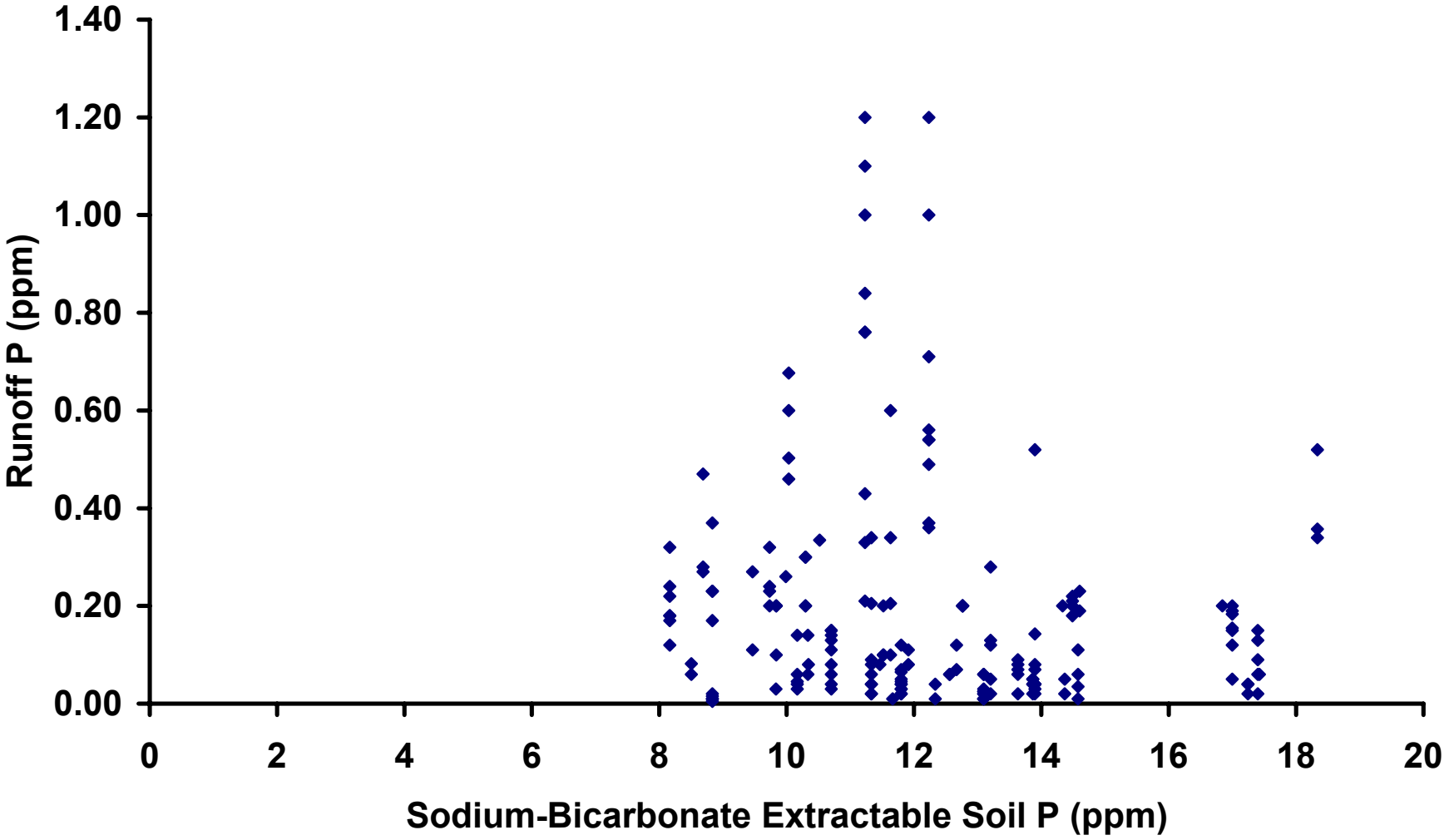
- No differences among watersheds although "organic" system hand no P additions since 1991
- Alberta aquatic guideline for ***Total P*** is 0.05 ppm
- AB guideline unachievable in these watersheds

Snowmelt ortho-P (ppm) From Stubble1995-2002

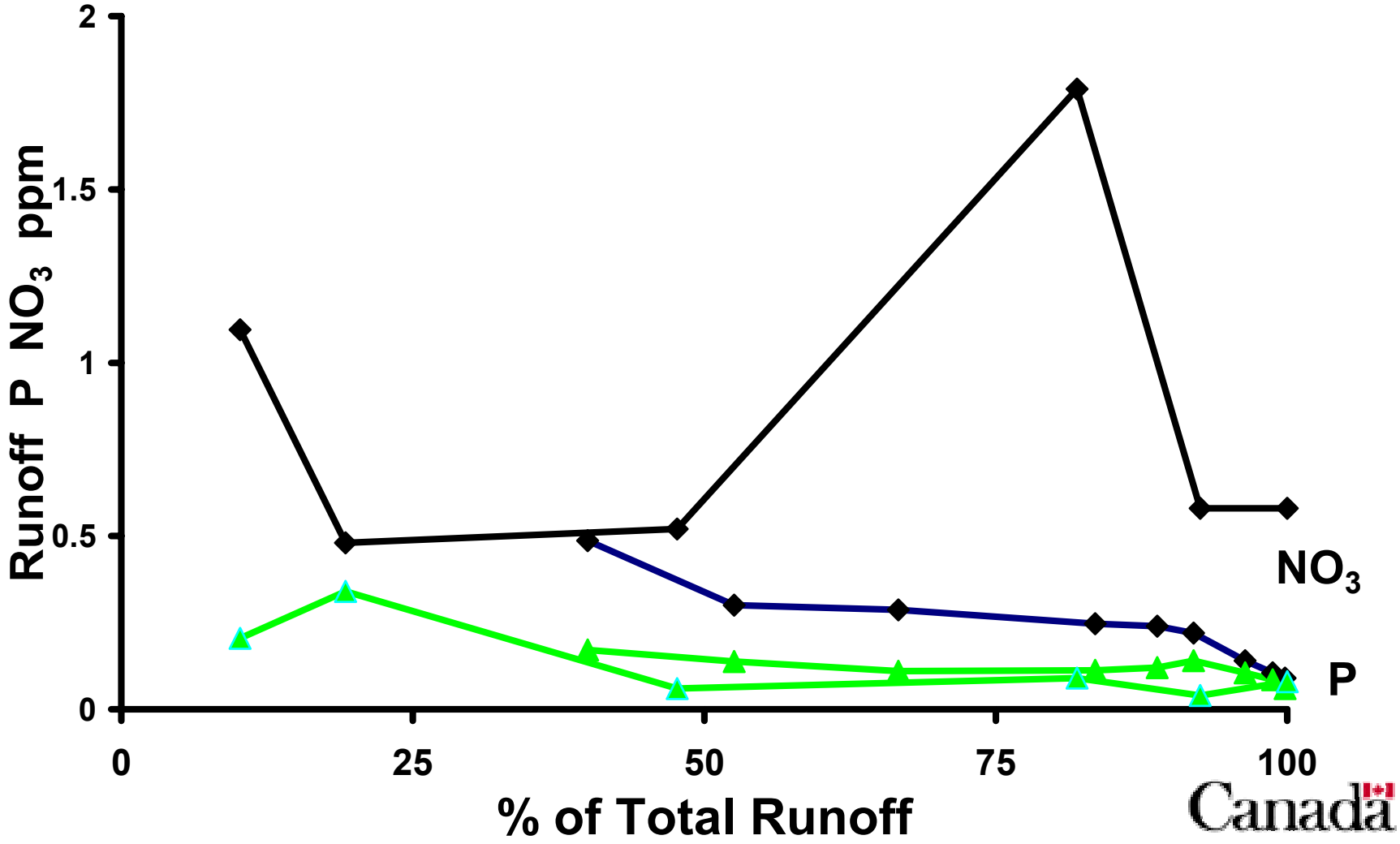
Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	0.066	0.099	0.073
Range	0 – 0.68	0 – 1.11	0 – 0.31

- No differences among watersheds although "organic" system hand no P additions since 1991
- Alberta aquatic guideline for ***Total P*** is 0.05 ppm
- AB guideline unachievable in these watersheds

Runoff P vs Soil P



Runoff P and NO_3



Snowmelt 2,4-D(ppb) From Fallow 1995-2002

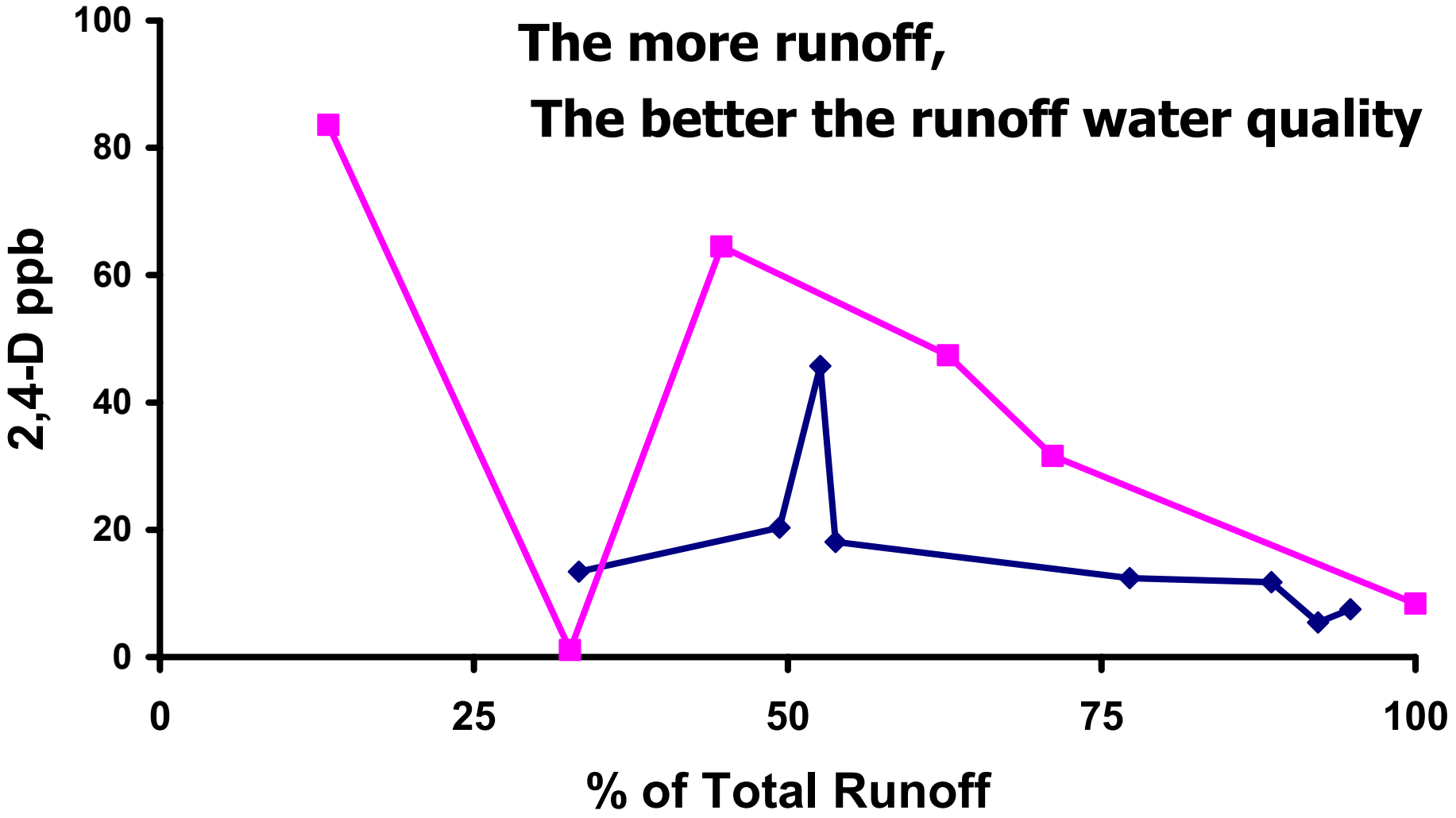
Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	14.90	7.25	3.34
Range	5.43 - 45.7	2.19 - 17.3	0.1 - 12.21

- 2,4-D applied in previous fall on conventional and no-till *only*
- Water Quality Guidelines:
  - Drinking: 100 ppb (exceeded in some runoff events here)
  - Aquatic: 4 ppb (routinely exceeded)
- Why 2,4-D on "organic" system?

Where did 2,4-D come from?

- Hill et al. (2002) analyzed precipitation across prairies including in SW SK (Neville)
- 2,4-D in rain 0 - ***3.2*** ppb at Neville
  - Higher than some prairie sites and lower than some others (9.2 ppb max observed prairie 2,4-D conc.)
- Add dry deposition (snow good scrubber) plus any local drift and 2,4-D in organic system is reasonable (?)
- (Bromoxynil and MCPA also widely observed in rain and locally can be be at much higher concentrations than 2,4-D)

Runoff 2,4-D


The more runoff,
The better the runoff water quality
2,4-D ppb
100
80
60
40
20
0
0
25
50
75
100
% of Total Runoff

Dissolved Organic Carbon (ppm) From Fallow 1995-2002

Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	13.09	12.67	16.53
Range	11.3 - 51.8	6.3 - 37.8	8.78 - 35.25

- Water Quality Guidelines:
  - Drinking: 4 ppm for chlorination

Dissolved Organic Carbon (ppm) From Stubble 1995-2002

Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	23.7	22.65	19.30
Range	14.4 - 43.6	15 - 62.7	12.5 - 36.3

- Water Quality Guidelines:
  - Drinking: 4 ppm for chlorination

Triallate(ppb) From Fallow 1995-2002

Nitrate	Conventional Wheat-Fallow	No-Till Wheat-Fallow	"Organic" Wheat-Fallow
Weighted Mean	1.52	6.83	0
Range	1.2 - 5.6	1.4 - 16.6	Not detected

- Non-incorporated triallate in no-till system significantly increased losses vs incoporated triallate in tilled system
- Water Quality Guidelines:
  - Drinking: 230 ppb
  - Aquatic: 0.24 ppb (routinely exceeded)

Rainfall Runoff

- Few events
- Initially no-till had greater runoff than expected based on past behaviour, now (2002) that does not appear to be the case
- No clear management differences on water quality
  - P concentrations can be very high (10 ppm)

Grass vs Cropland?

Grass vs Cropland (1977-1980)

Runoff (mm)	Grass	Conv. Till Wheat-Fallow
Days	154	103
Daily Mean	1.27	1.17

- Grass (in wide rows) similar to cropland

Grass vs Cropland (1977-1980)

Sediment (ppk)	Grass	Conv. Till Wheat-Fallow
Weighted Mean	0.048	0.073
Range	0 - 0.34	0 – 0.148

- Grass (in wide rows) similar to cropland

Grass vs Cropland (1977-1980)

Nitrate (ppm)	Grass	Conv. Till Wheat-Fallow
Weighted Mean	0.24	0.07
Range	0 - 0.32	0 – 0.08

- Grass (in wide rows) similar to cropland

Grass vs Cropland (1977-1980)

Ortho-P (ppm)	Grass	Conv. Till Wheat-Fallow
Weighted Mean	0.188	0.090
Range	0 - 0.34	0 – 0.24

- Grass (in wide rows) similar to cropland

Grass vs Cropland (1977-1980)

2,4-D (ppm)	Grass	Conv. Till Wheat-Fallow
Weighted Mean	4.33	22.4
Range	0-11.7	0.1-63

- Grass has less 2,4-D (not applied)
  - Shows significant atmospheric deposition

Thoughts and Summary

- Having surface water that meets all aquatic water quality guidelines not practical goal in Swift Current Creek watershed
  - Low nutrients (P) especially difficult to achieve
  - Low runoff amount can mean lower quality

Thoughts and Summary (2)

- Land management in watershed does affect water quality
  - Extra care needed since any added degradation can push water quality into more undesirable state
- Fall-applied herbicides should be discouraged on land whose runoff readily enters creek