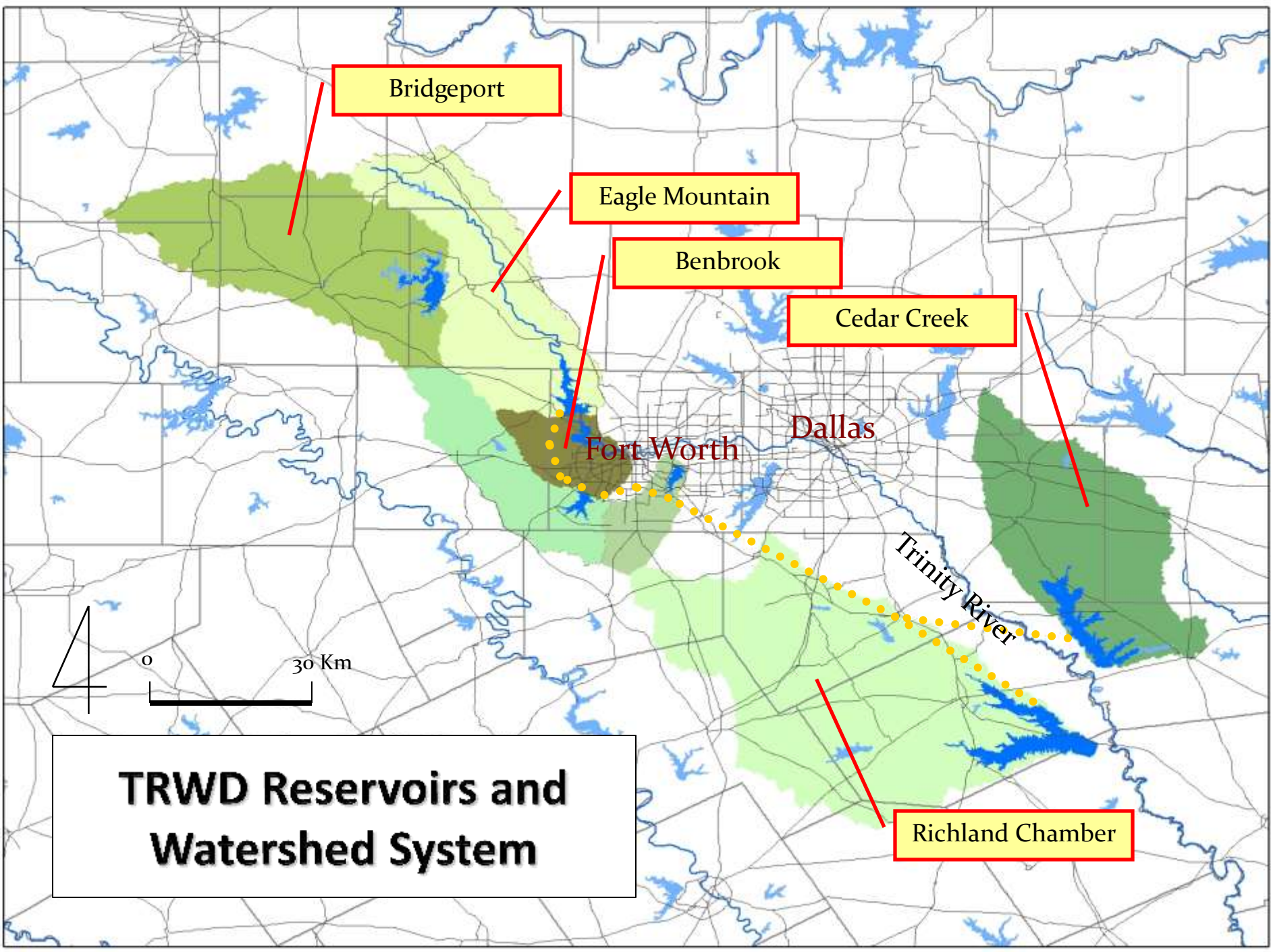


Cost-effective multiple BMPs to reduce total phosphorous level in a reservoir

Taesoo Lee
Spatial Science Laboratory,
Texas A&M University

Introduction

- Tarrant Regional Water District (TRWD)
- Serves 1.6 million people: 11 counties in and around Dallas and Fort Worth, TX
- Expect to serve a population of 2.6 million by 2050
- Water quality in the lakes has been degraded (Chlorophyll-a has been increased at 3.85% annually)
- 5 major reservoirs: Cedar Creek, Eagle Mountain, Richland-Chambers, Bridgeport and Benbrook



Bridgeport

Eagle Mountain

Benbrook

Cedar Creek

Fort Worth

Dallas

Trinity River

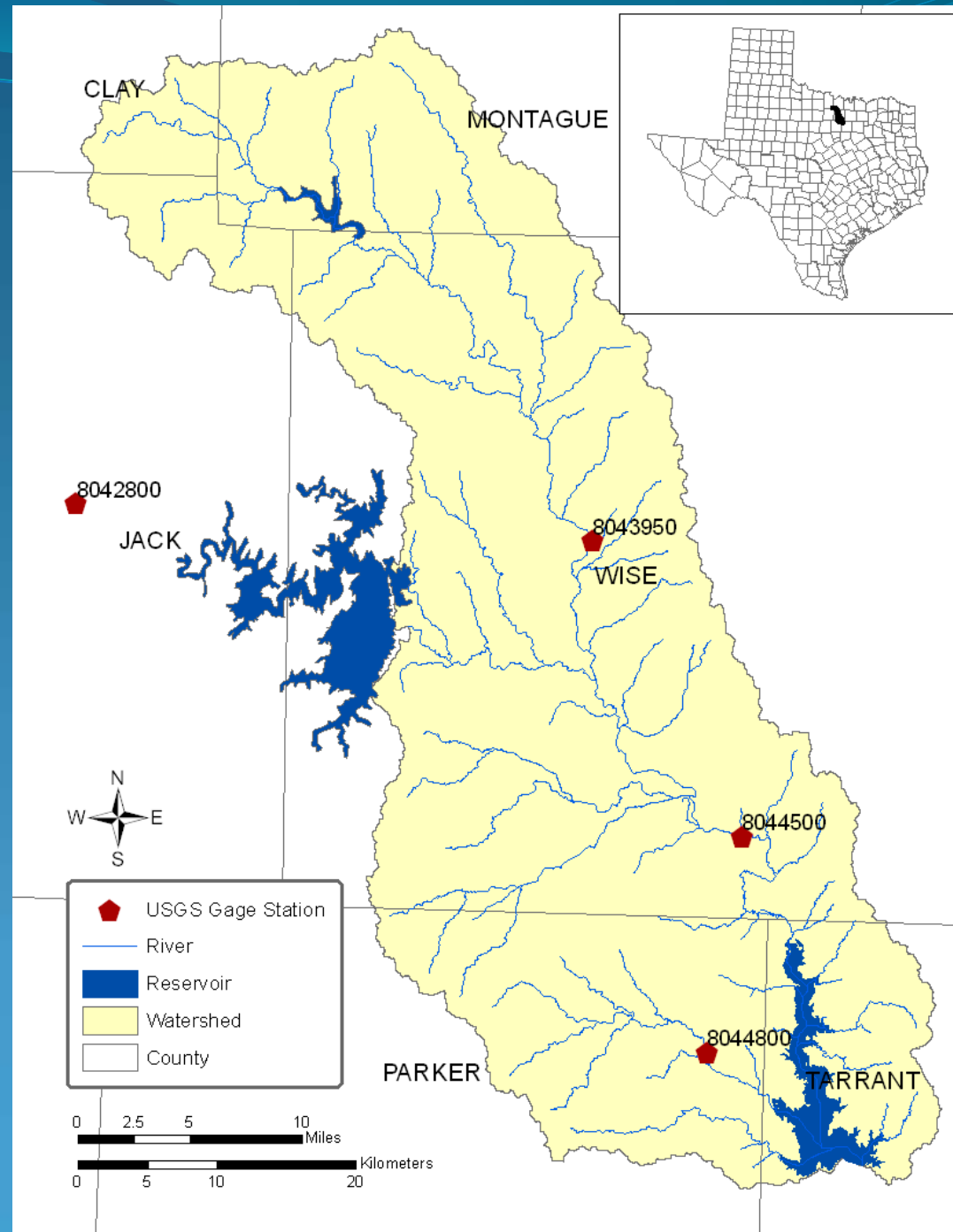
Richland Chamber



TRWD Reservoirs and Watershed System

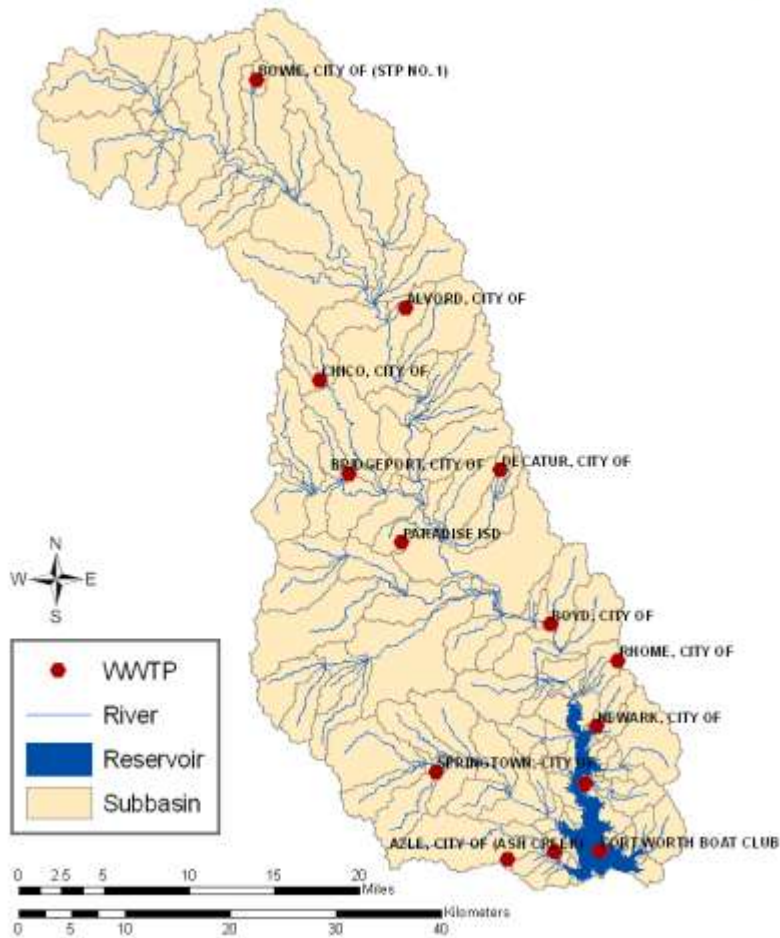
Eagle Mountain Watershed

- Watershed size – 2,200 Km²
- Lake Surface area – 35 Km²
- Mean Depth – 6.4m
- Maximum Depth – 17m
- Shoreline – 135 Km
- Bridgeport Watershed

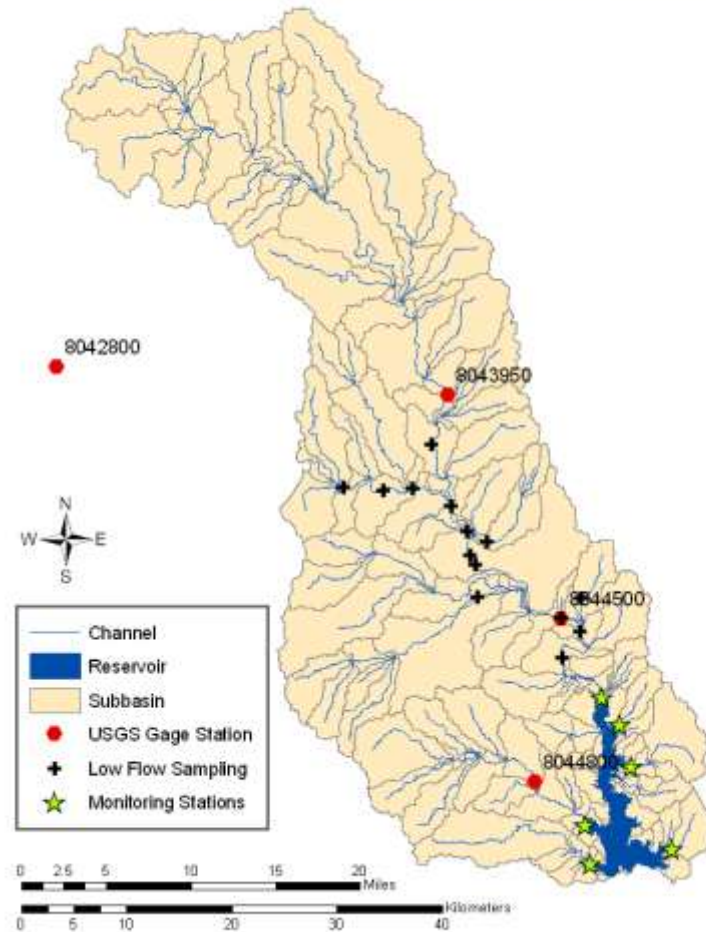


Point Sources and Monitoring Sites

Eagle Mountain Watershed WWTPs



Eagle Mountain Monitoring Sites

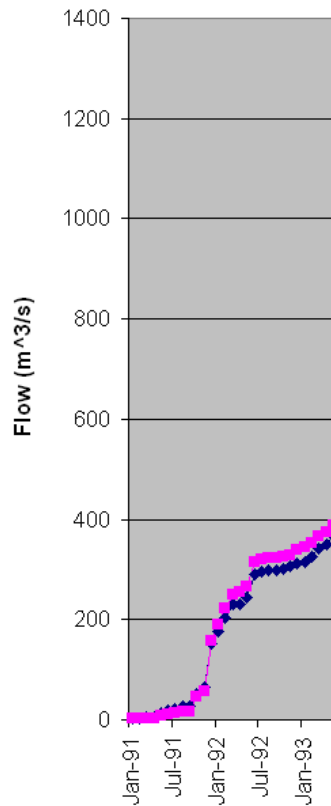


Data and Model

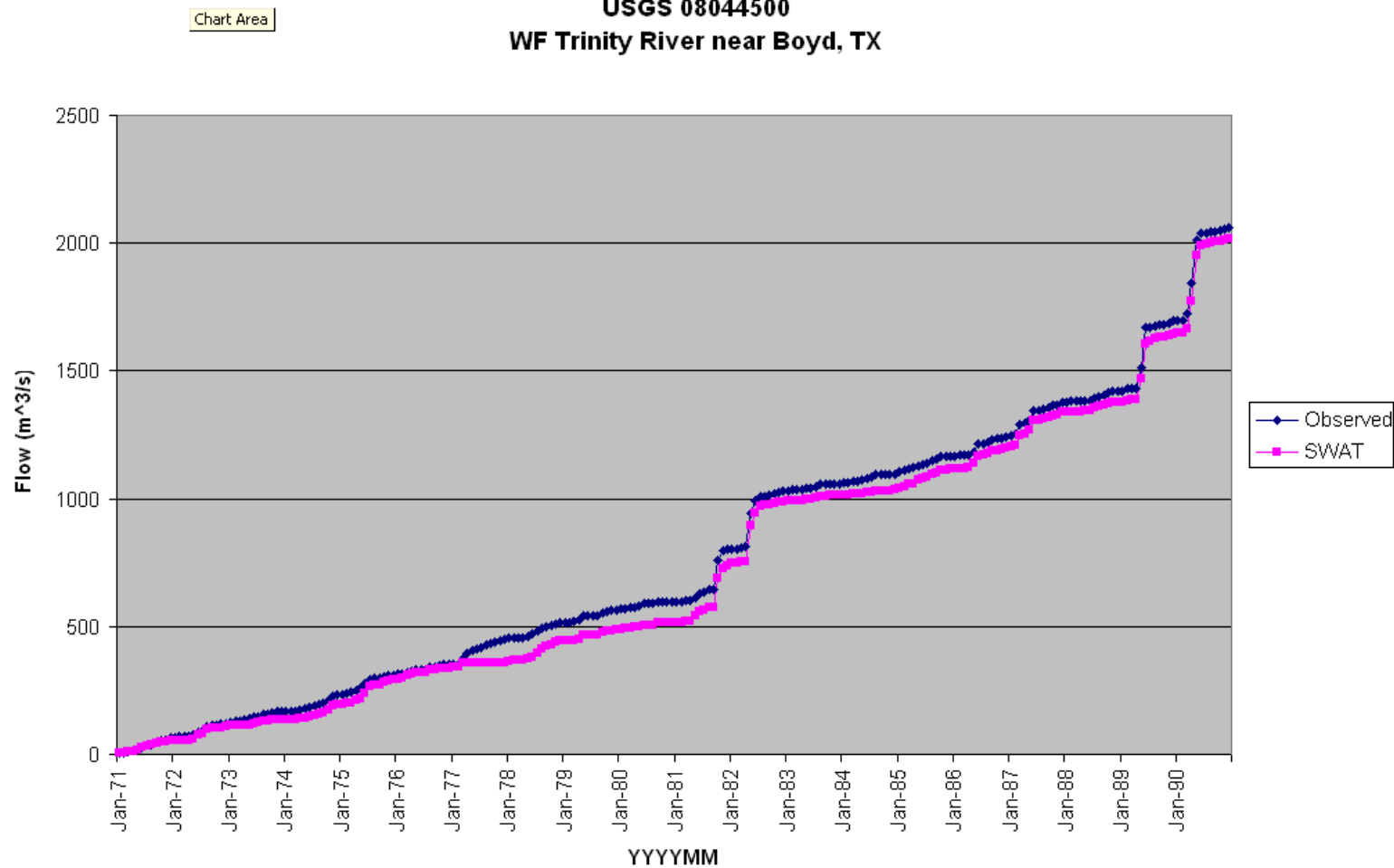
- GIS Data
 - 30m DEM
 - Weather: NCDC and NEXRAD
 - Landuse: NLCD (1992) + Urban (2001)
 - Soil: SSURGO
- Flow: USGS Gage stations
- Sediment: TWDB
- Nutrients: TRWD
- SWAT 2005

Flow Calibration

1991-2004
USGS 08044500



1971-1990
USGS 08044500
WF Trinity River near Boyd, TX



Sediment Calibration

Sediment Loads by Overland Flow

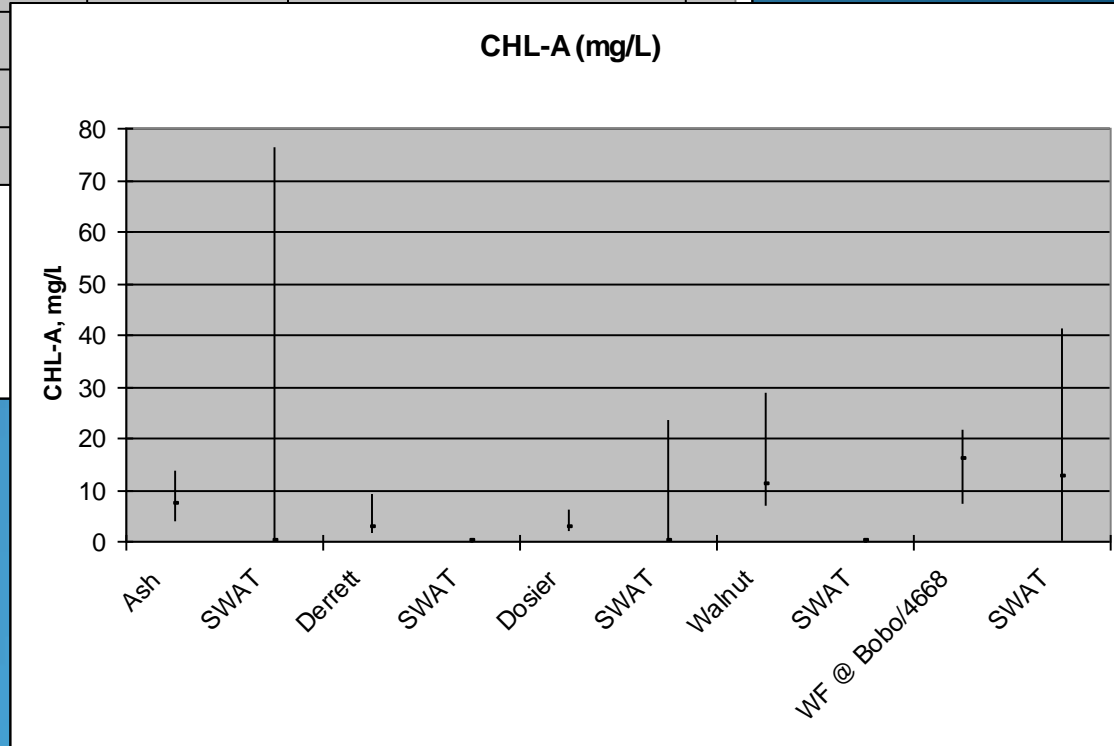
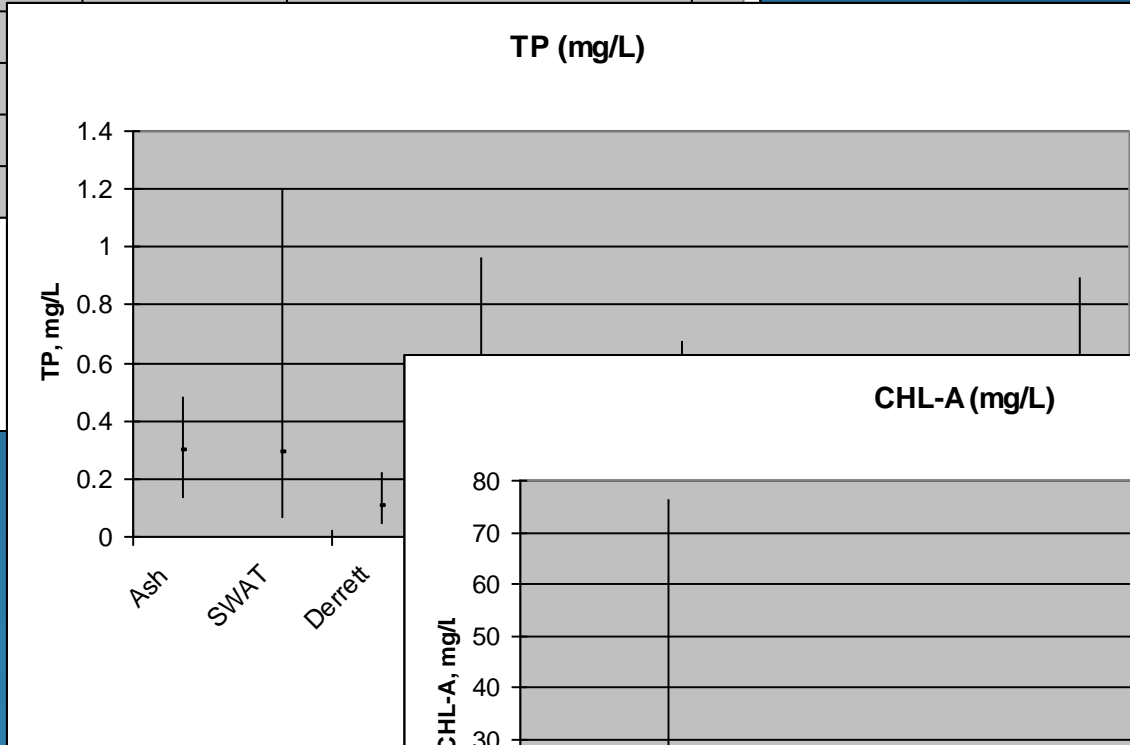
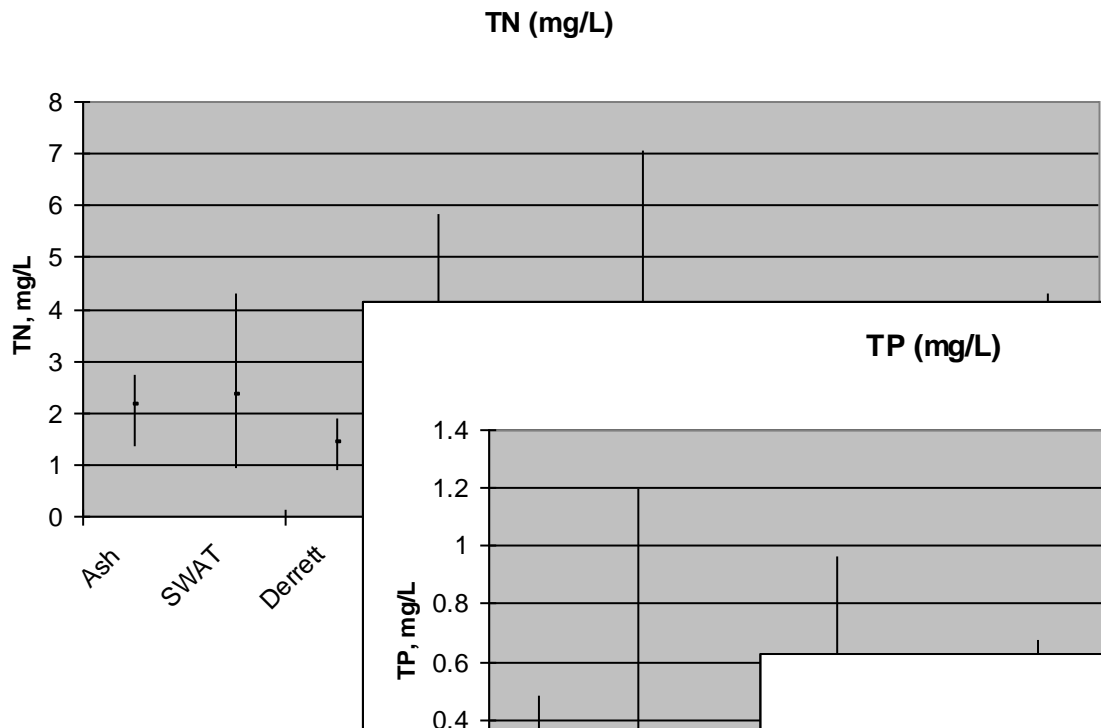
Period	Observed (metric ton)	Modeled (metric ton)	Differences (%)
Total (Annual average)		196,909	-0.2%
Calibration (1994 – 2004)	197,313	206,294	+4.6%
Validation (1970 – 1990)		191,748	-2.8%

Sediment Calibration

Sediment Loads at Reservoir

Period	Observed (Metric ton)	Modeled (metric ton)	Differences (%)
Total (Annual average)		296,400	+0.2%
Calibration (1994 – 2004)	295,822	263,827	-10.8%
Validation (1970 – 1990)		324,880	+9.8%

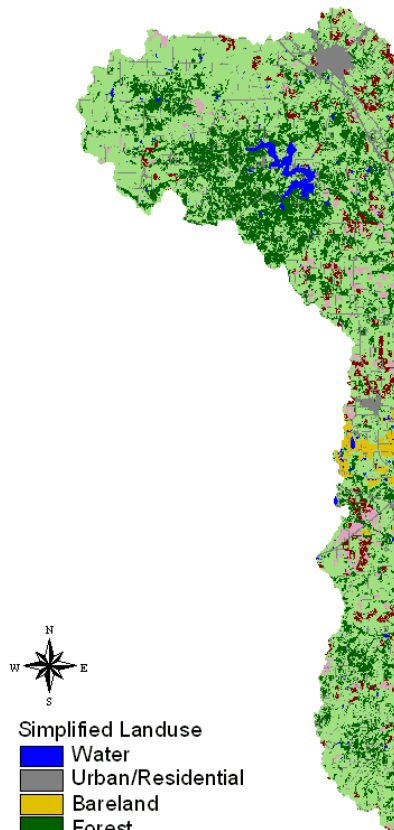
Nutrients Calibration



Loading by Landuse

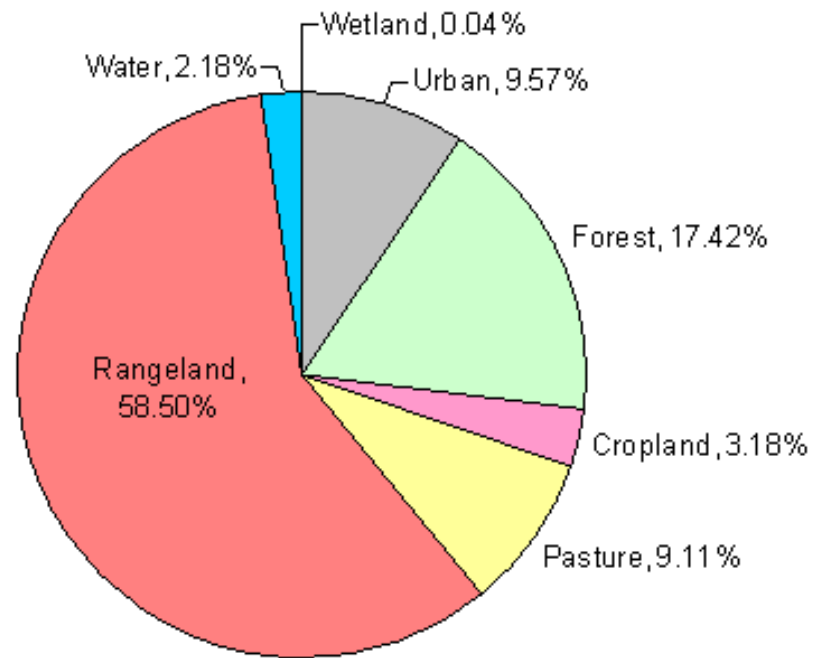
Landuse Distribution

Simplified Landuse



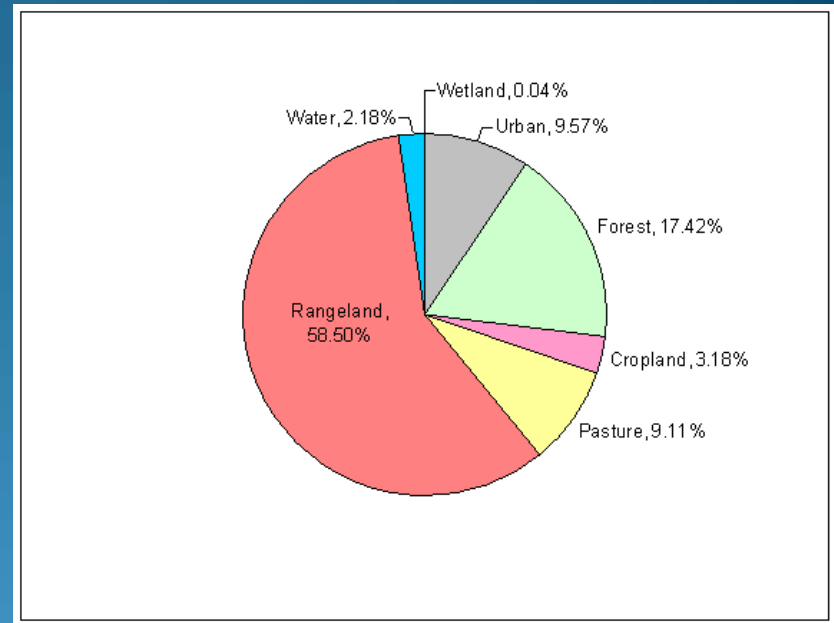
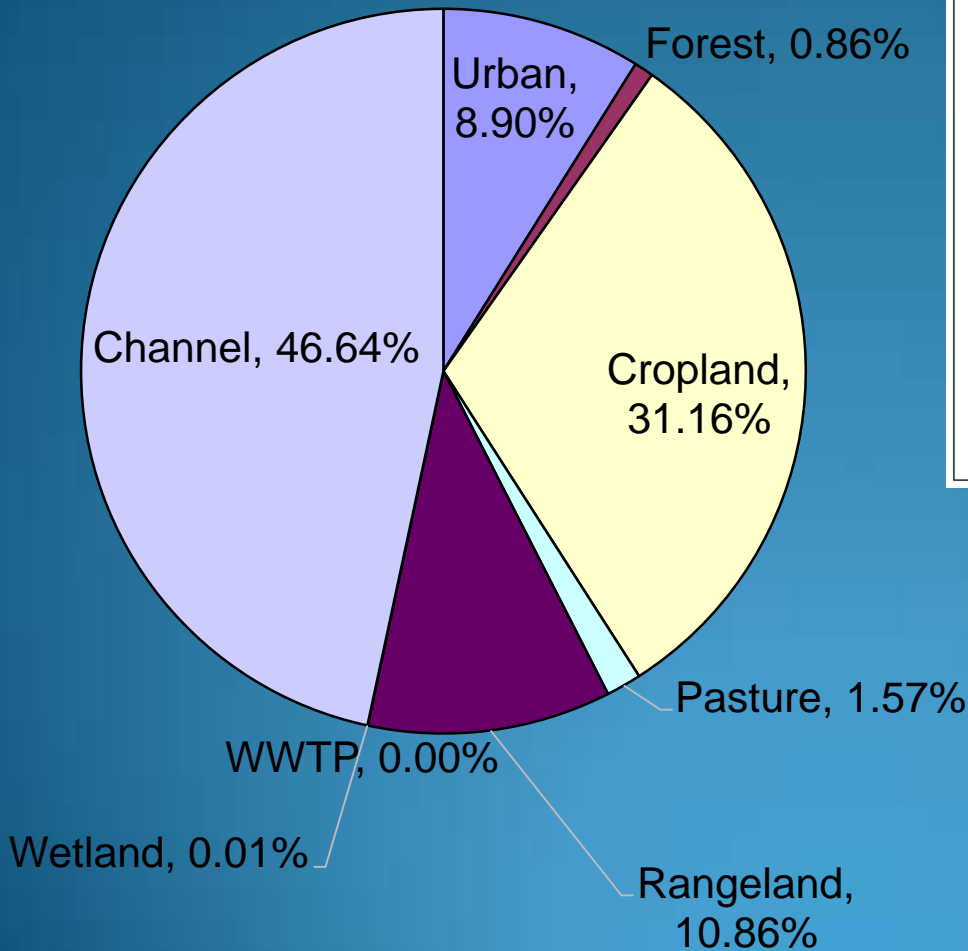
- Simplified Landuse
- Water
 - Urban/Residential
 - Bareland
 - Forest
 - Rangeland
 - Pasture
 - Cropland
 - Wetland

0 3 6 9 12 Kilometers



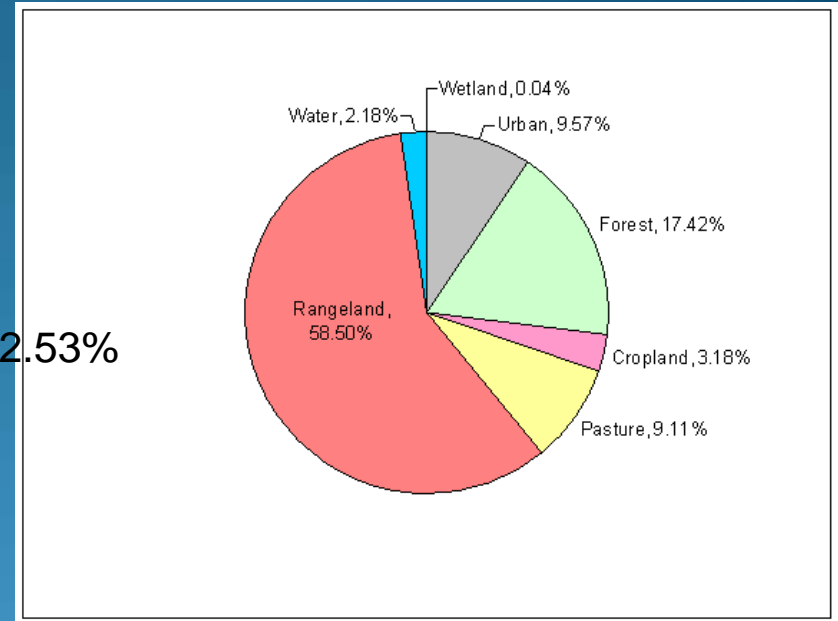
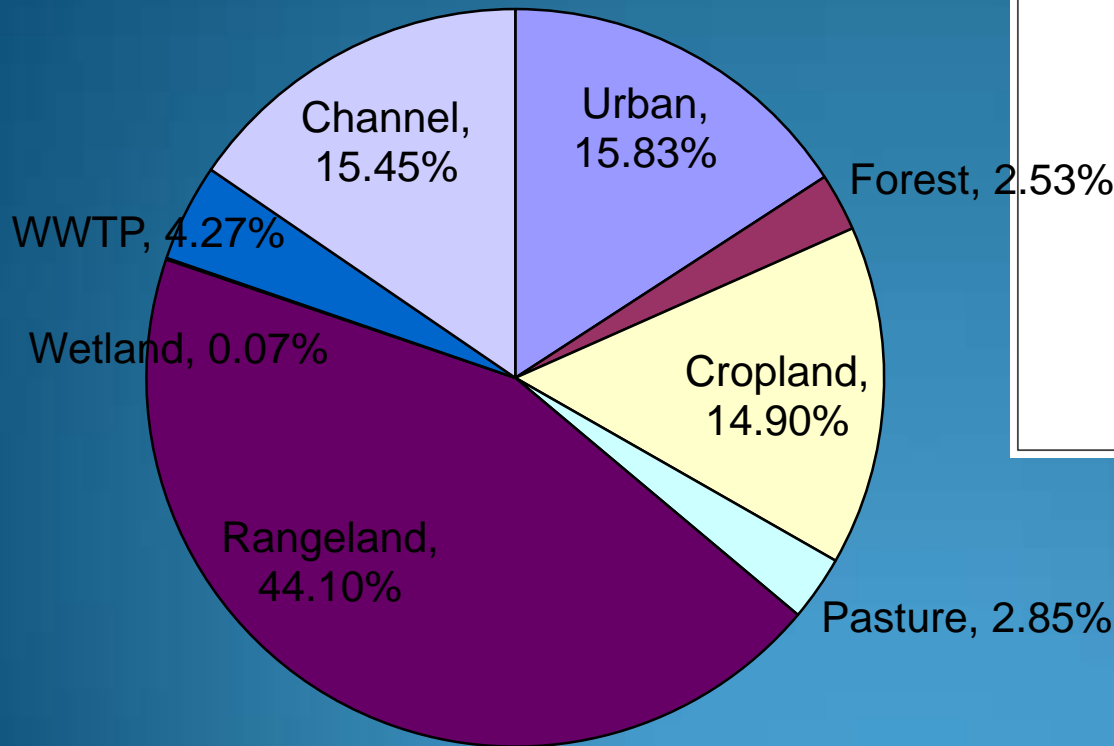
Sediment Yield by Landuse

Sediment Yield by Landuse



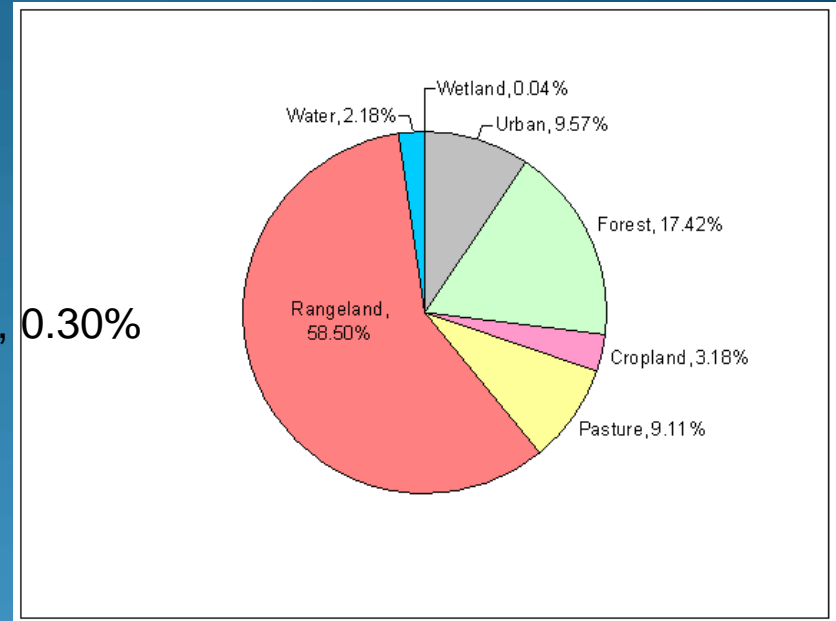
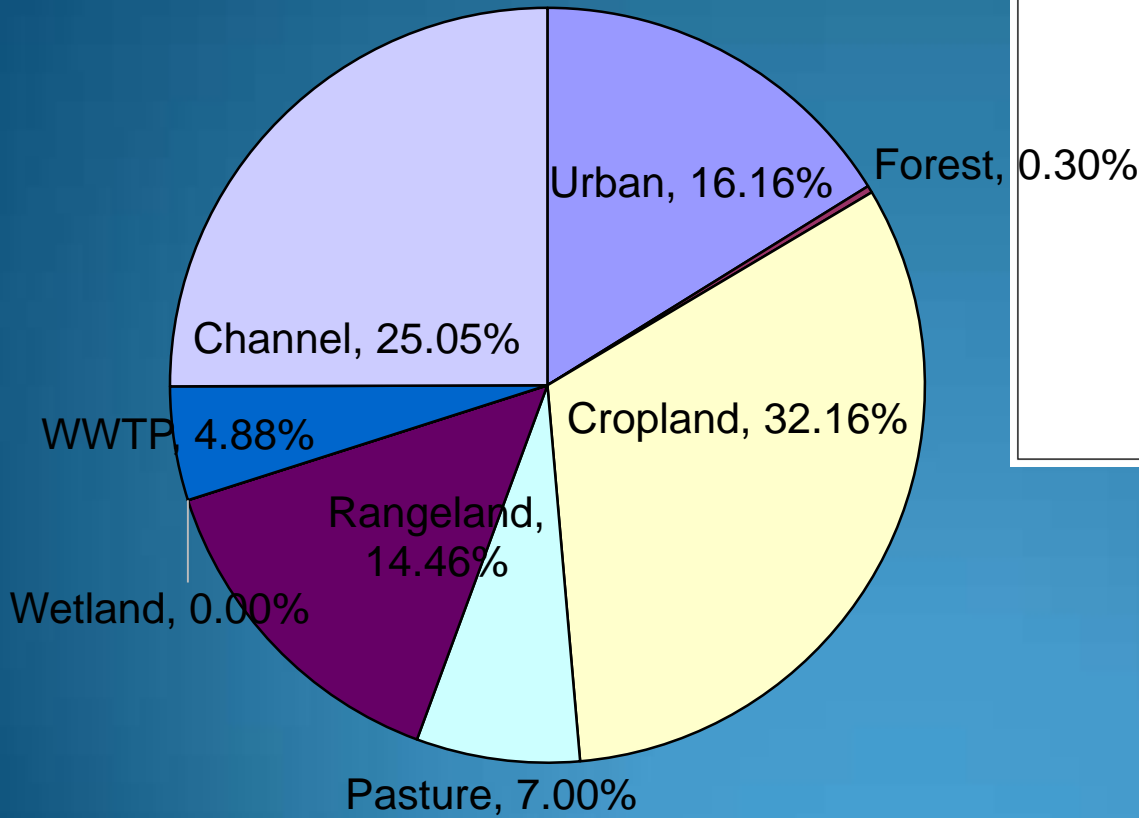
TN Loading by Landuse

TN Loading by Landuse



TP Loading by Landuse

TP Loading by Landuse



BMP Implementation

Baseline

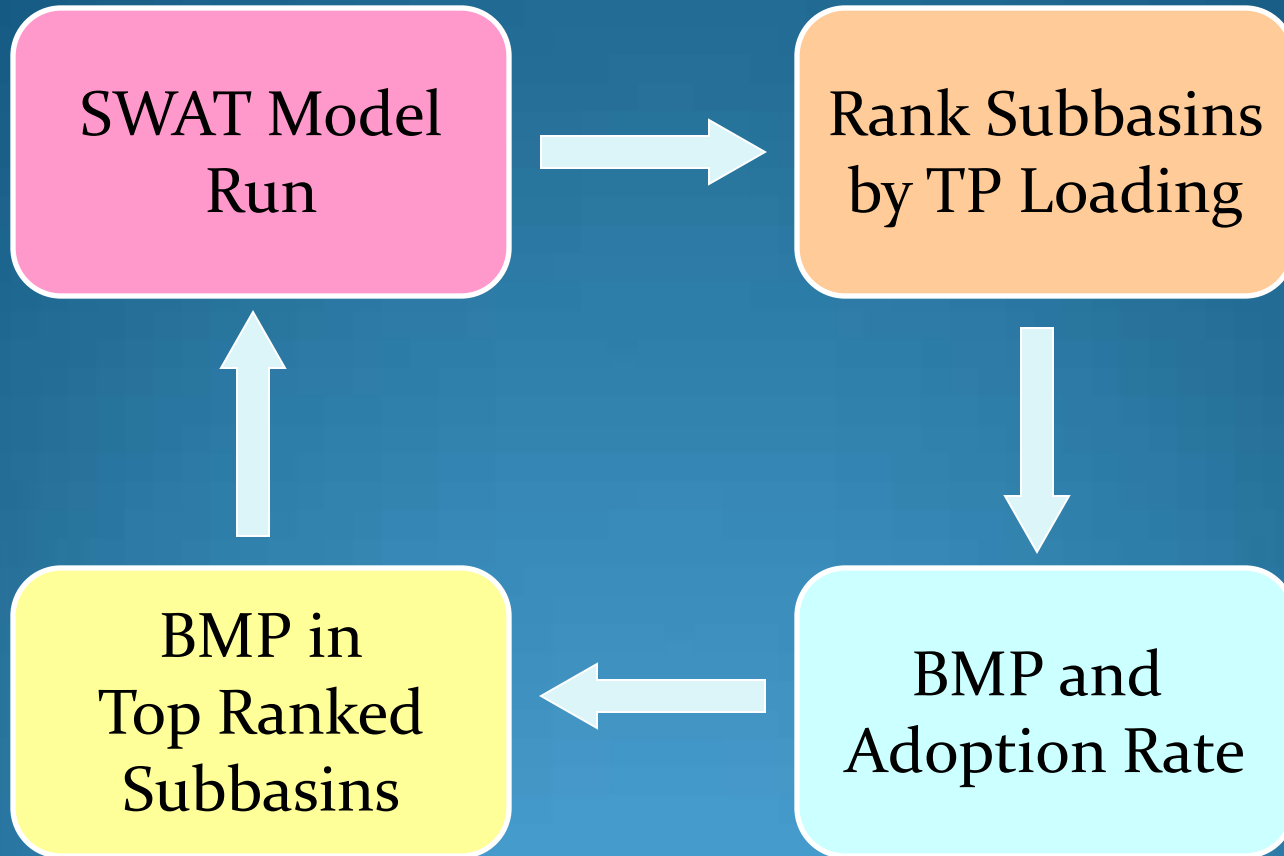
Sediment (t/y)	TN (kg/y)	TP (kg/y)
296,400	1,055,220	173,020

100 % Adoption Rate

BMPs	P Red. (%)
Conversion of Cropland to Grass – Pasture Planting	15.2
Filter Strips (15m width)	12.7
Terrace (Cropland with \geq 2% slope)	6.8
Contour Farming (Cropland with \geq 2% slope)	6.5
2,000 Ft Buffer	5.1
Ponds (17 new ponds)	4.4
Grade Stabilization Structures (with \geq 3% slope)	4.0
Riparian Buffer (All Channels)	3.3
Grassed Waterways (Subbasin with more than 10% of cropland)	3.1
Prescribed Burning (20% adoption)	1.8

Economic Analyses

Description	\$/kg of P red.
Grassed Waterway	\$6.08
Filter Strip	\$6.39
Herbicide Application to Riparian Corridor	\$21.35
Grade Stabilization - gulley plugs	\$21.68
Terracing	\$26.16
2000 ft. buffer - strips around the reservoir	\$27.06
Conversion of Cropland to Grass	\$57.82
Hypolimnetic Aeration	\$62.43
Prescribed Burning	\$72.62
FP Sites - 17 New Ponds	\$109.33



SUBBASIN	HRU	LANDUSE	HRU Area	Rank by TP
1	1	GRSG	9.22	3
2	1	GRSG	11.67	1
3	1	GRSG	0.33	15
3	2	GRSG	0.60	15
4	1	GRSG	0.51	9
4	2	GRSG	1.49	9
4	3	GRSG	2.29	9
5	1	GRSG	2.17	14
5	2	GRSG	1.25	14
5	3	GRSG	3.06	14
6	1	GRSG	0.62	7
6	2	GRSG	1.02	7
6	3	GRSG	1.30	7
6	4	GRSG	0.76	7
7	1	GRSG	1.69	5
7	2	GRSG	8.13	5
8	1	GRSG	0.16	2
8	2	GRSG	0.24	2
8	3	GRSG	0.70	2
8	4	GRSG	0.27	2
11	1	GRSG	7.21	8
12	1	GRSG	1.66	4
12	2	GRSG	3.82	4
17	1	GRSG	0.70	19
21	1	GRSG	3.50	10
21	2	GRSG	1.80	10

Example of TP Ranking:

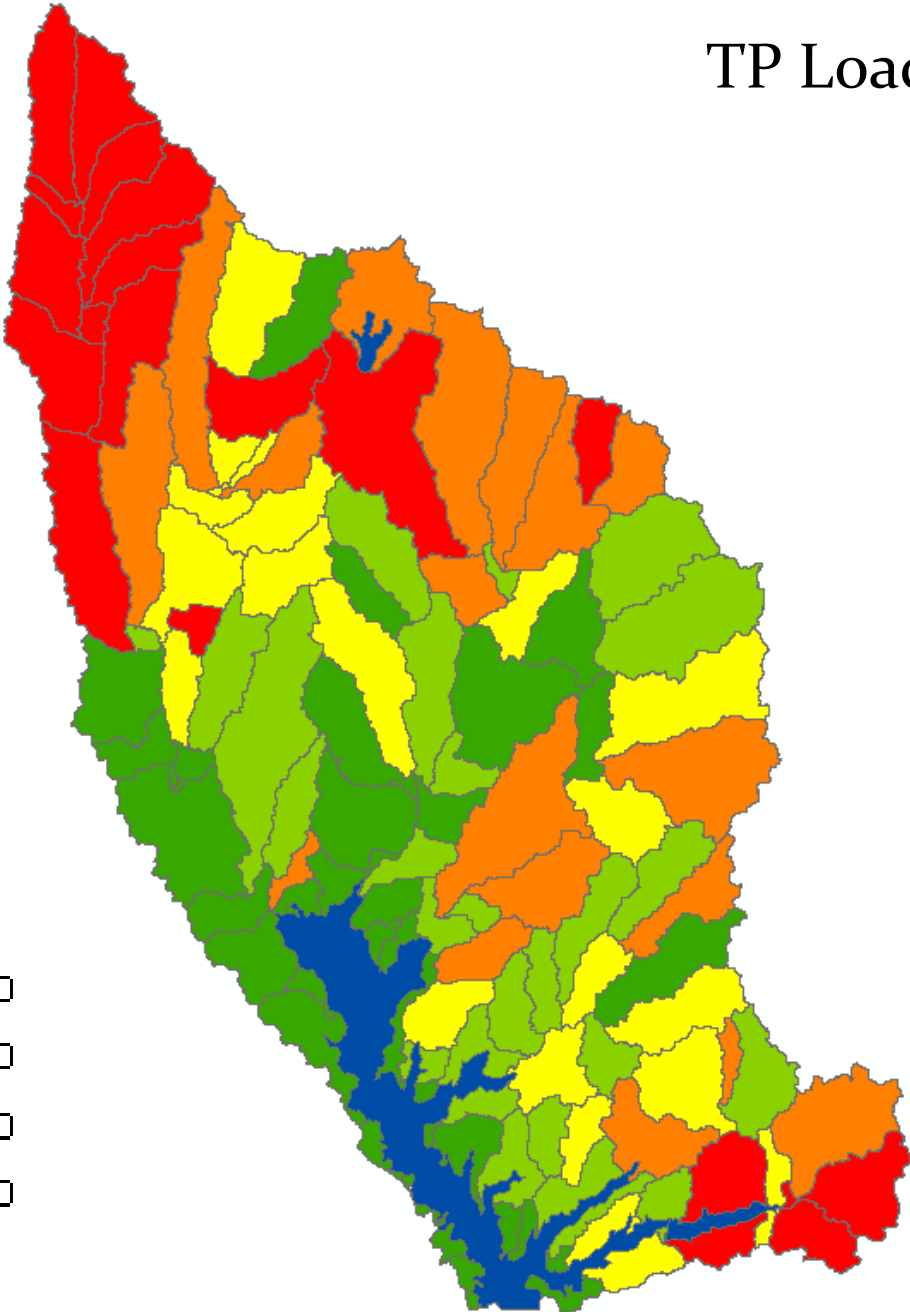
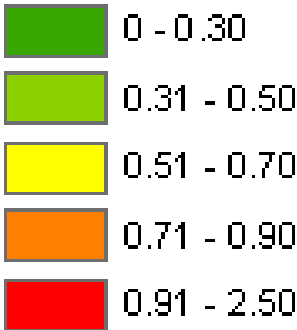
For Filter strips (50% adoption rate)

Previous Study Example

TP Loading Baseline

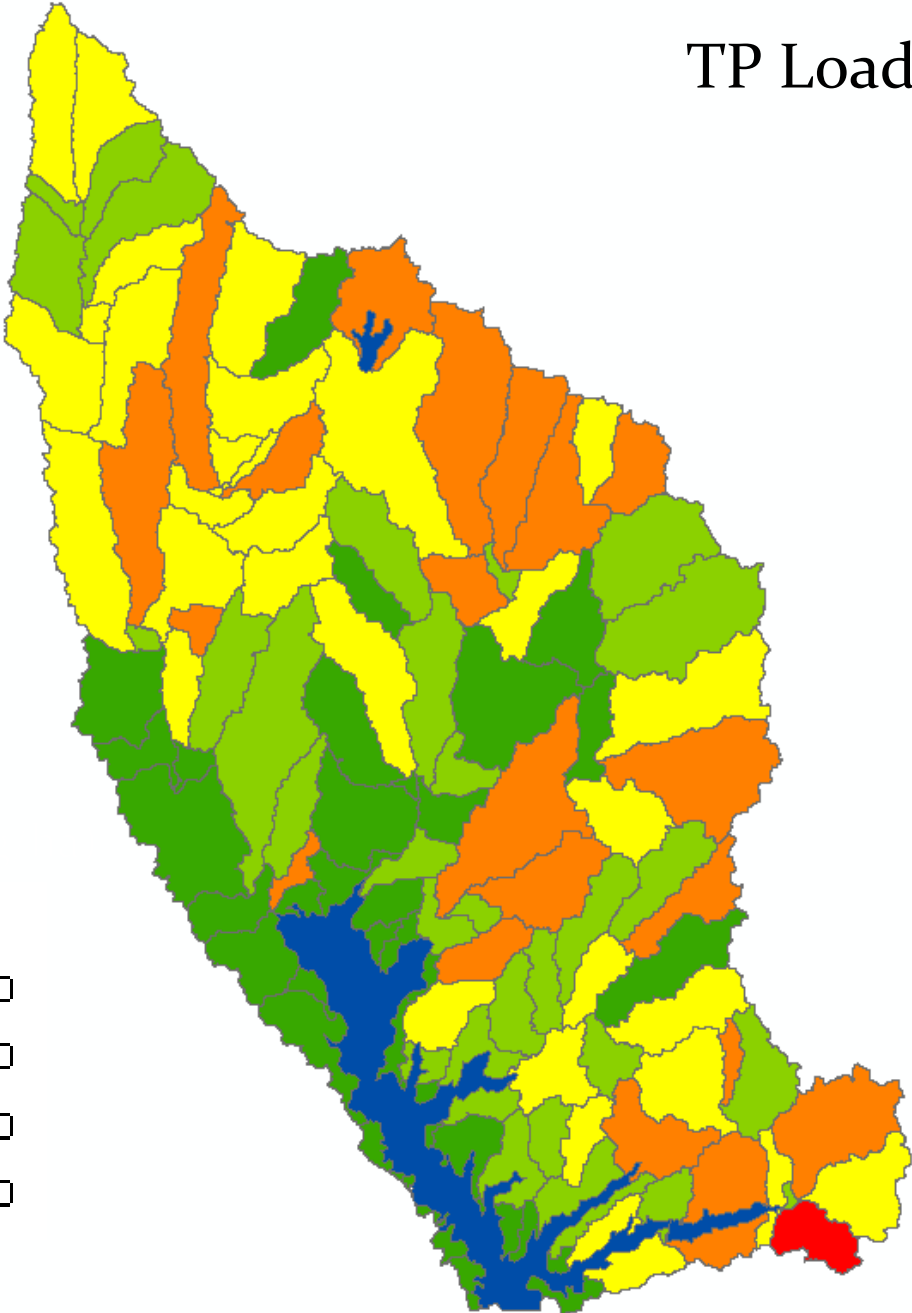
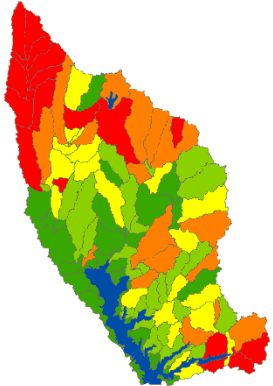


TP (t/ha)

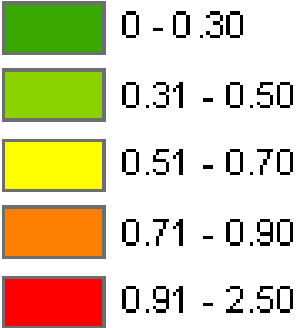


TP Loading by 1 BMP

Filter Strips



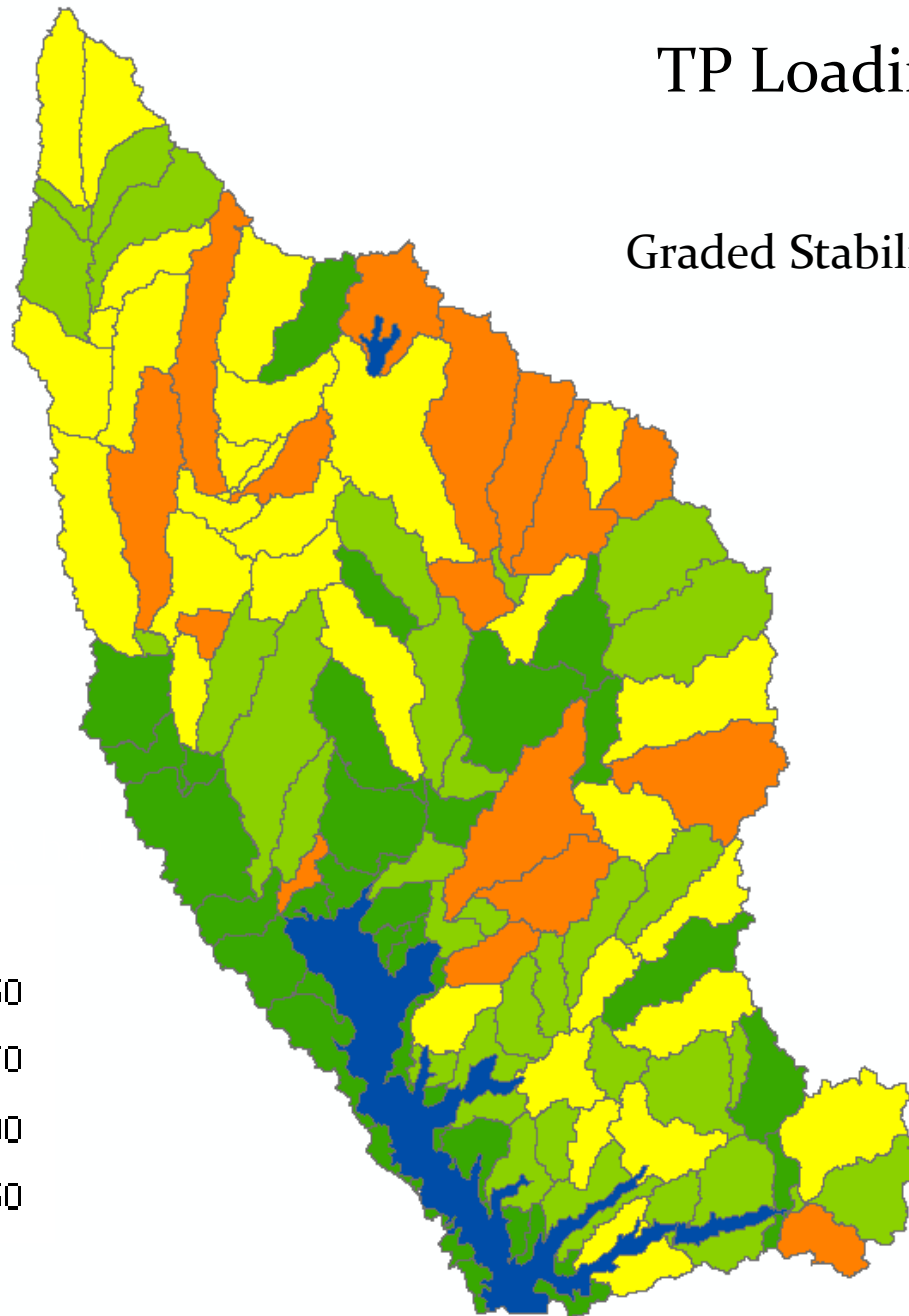
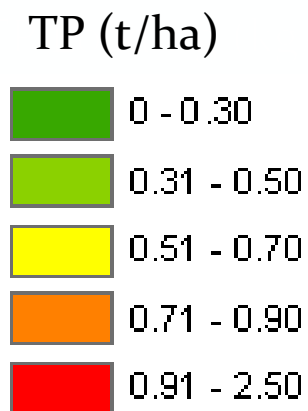
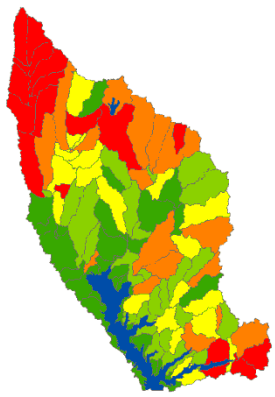
TP (t/ha)



TP Loading by 2 BMPs

Filter Strips

Graded Stabilization Structures

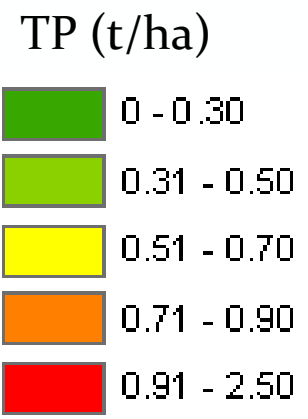
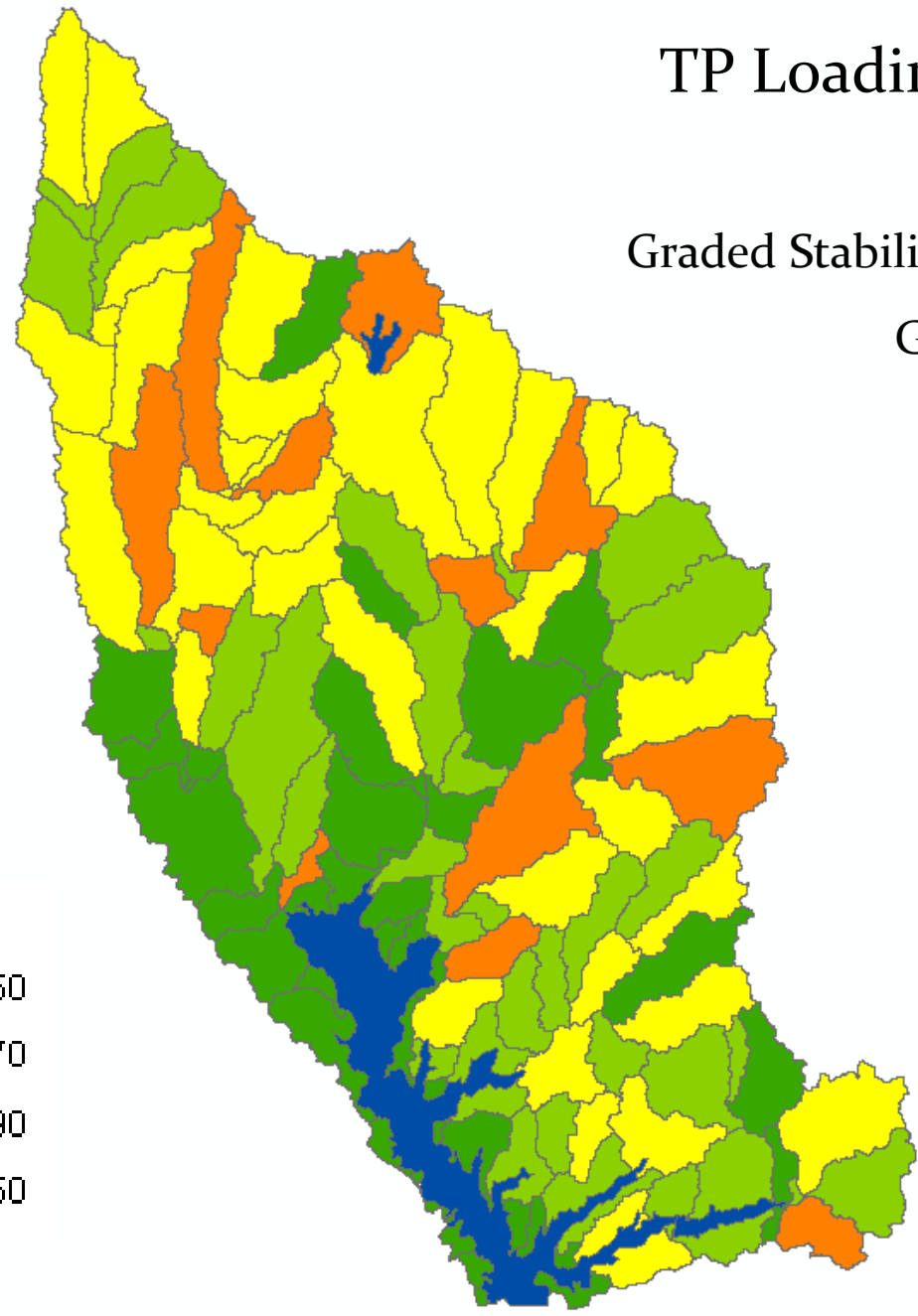
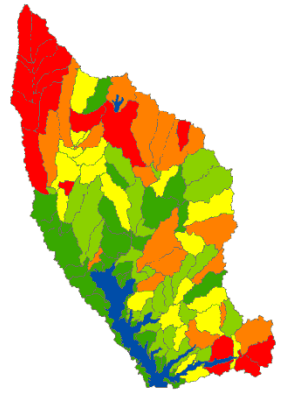


TP Loading by 3 BMPs

Filter Strips

Graded Stabilization Structures

Grassed Waterway



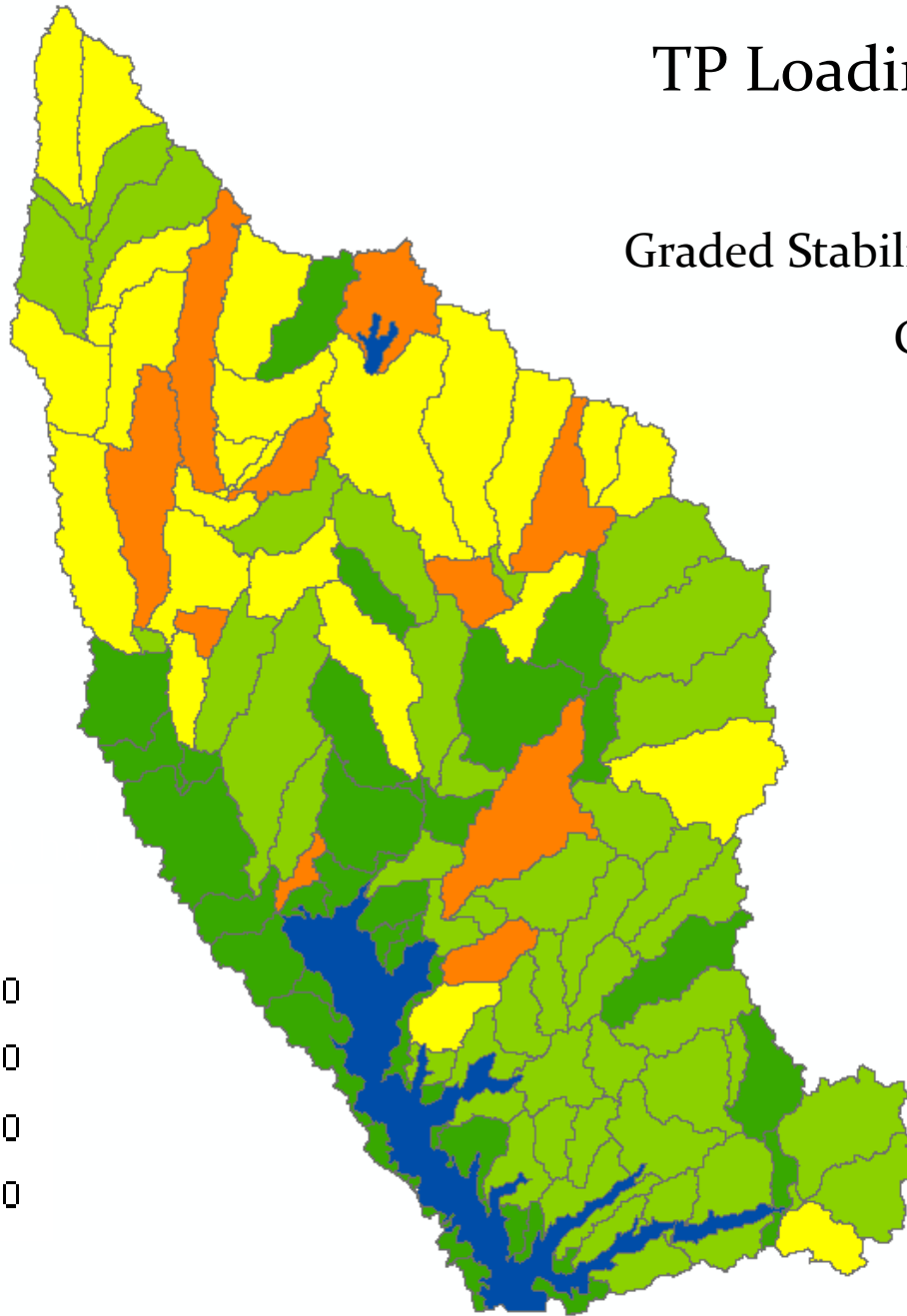
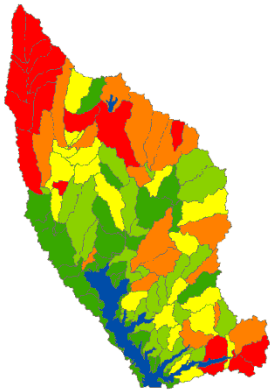
TP Loading by 4 BMPs

Filter Strips

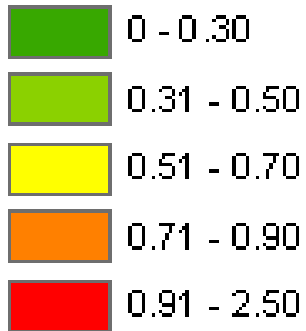
Graded Stabilization Structures

Grassed Waterway

Terrace



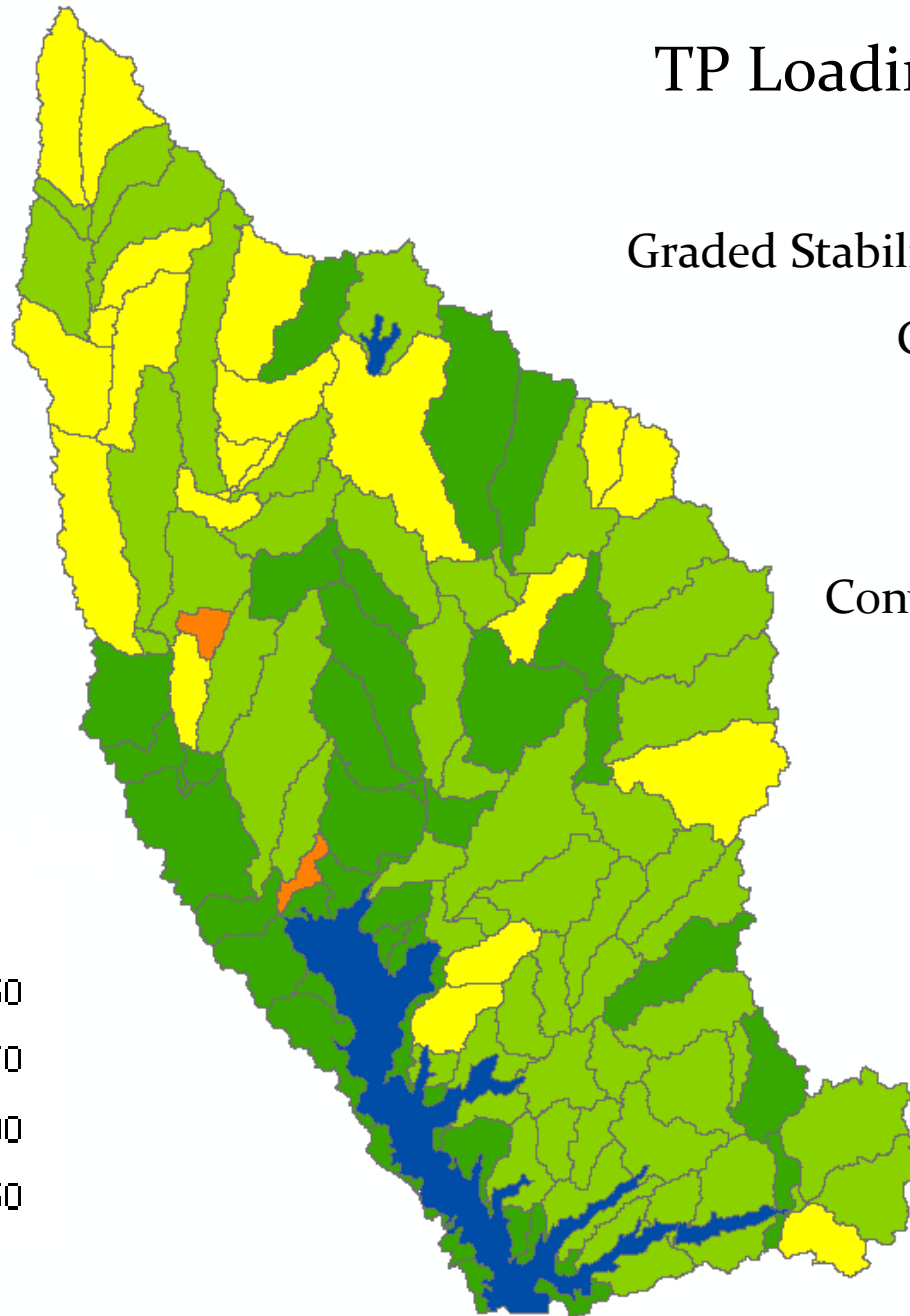
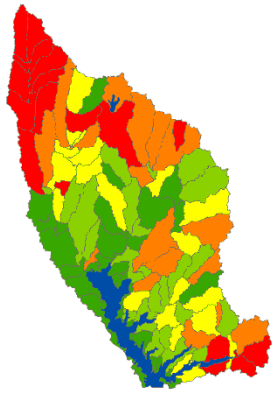
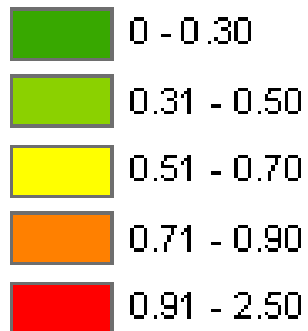
TP (t/ha)



TP Loading by 6 BMPs

- Filter Strips
- Graded Stabilization Structures
- Grassed Waterway
- Terrace
- WWTP
- Conversion to Pasture

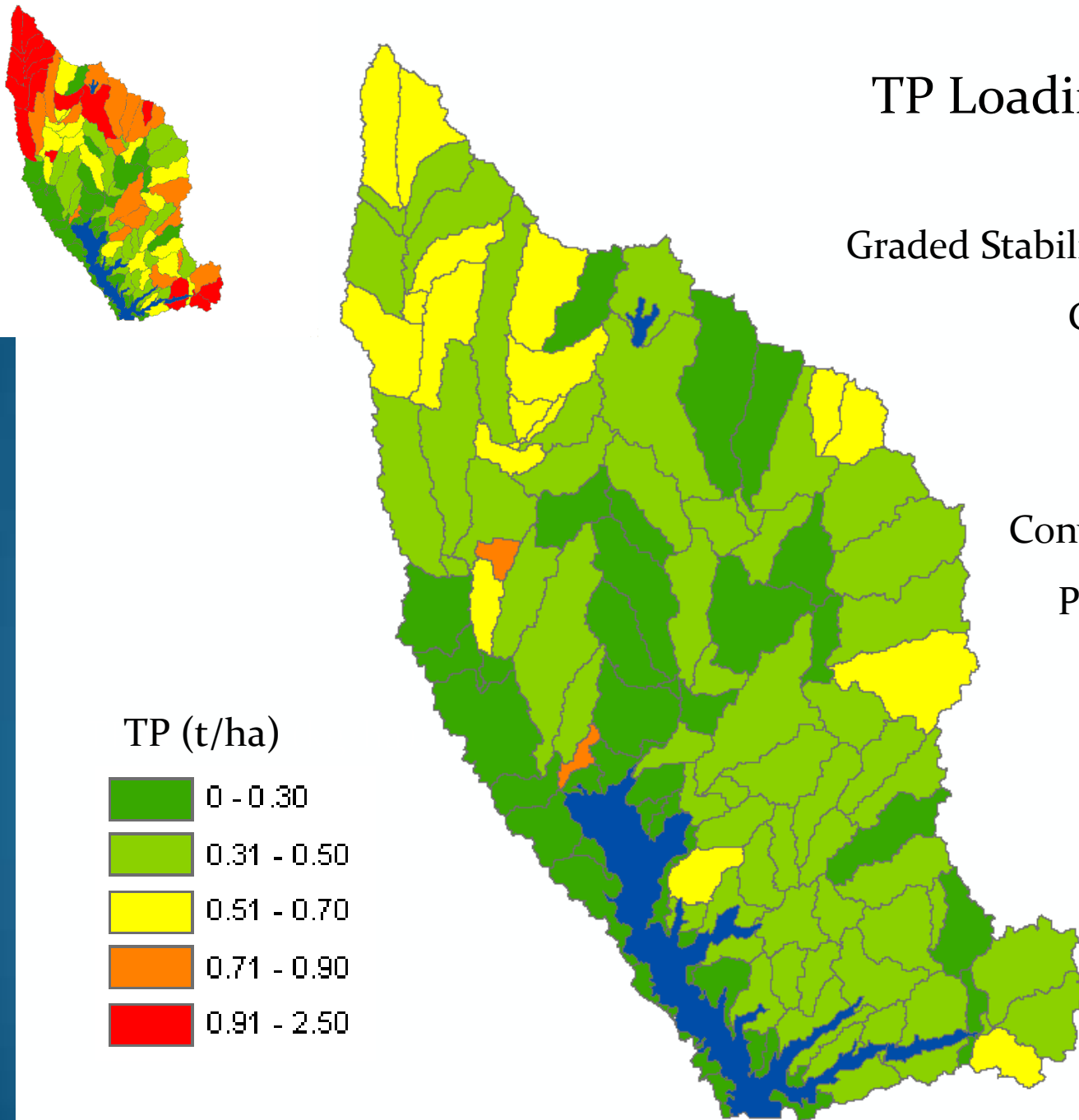
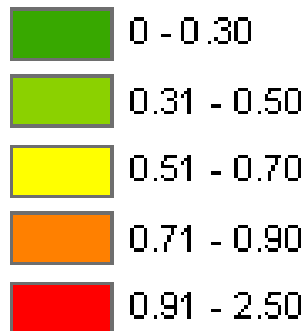
TP (t/ha)



TP Loading by 7 BMPs

- Filter Strips
- Graded Stabilization Structures
- Grassed Waterway
- Terrace
- WWTP
- Conversion to Pasture
- Prescribed Grazing

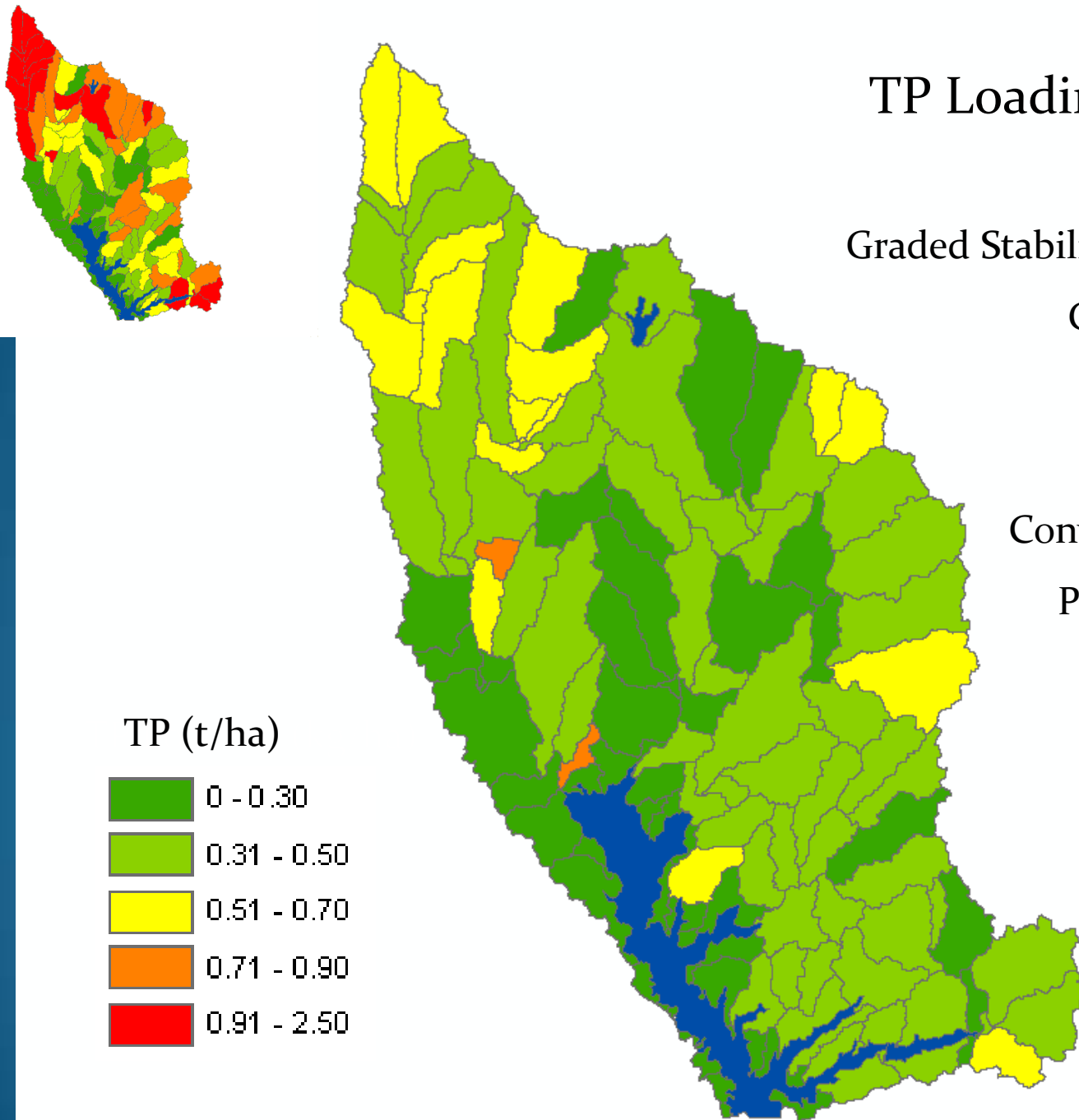
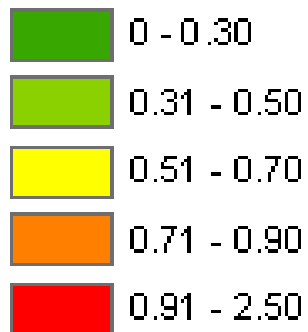
TP (t/ha)



TP Loading by 8 BMPs

- Filter Strips
- Graded Stabilization Structures
- Grassed Waterway
- Terrace
- WWTP
- Conversion to Pasture
- Prescribed Grazing
- 2000 Ft Buffer

TP (t/ha)



Question?
¿Tiene algunas preguntas?