Land Use Change and Other Factors Affecting Water Temperature in the Johnson Creek Watershed

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Data Sources

Environmental Services, City of Portland:
Johnson Creek Watershed
Streams, Rivers, Lakes
JC Impervious Areas
Urban Growth Boundary
JC Storm Links

USGS:
Land Use Raster (1992)
Water Quality Data

NOAA
Land Use images (1996 and 2001)

RLIS
10 m DEM

Special Thanks To

Mark Liebe and Kevin Ramey

Environmental Services
City of Portland

Study Area:

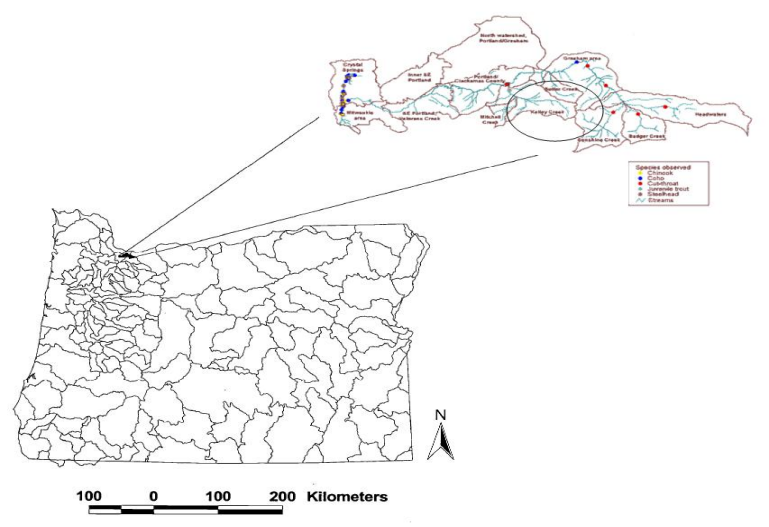
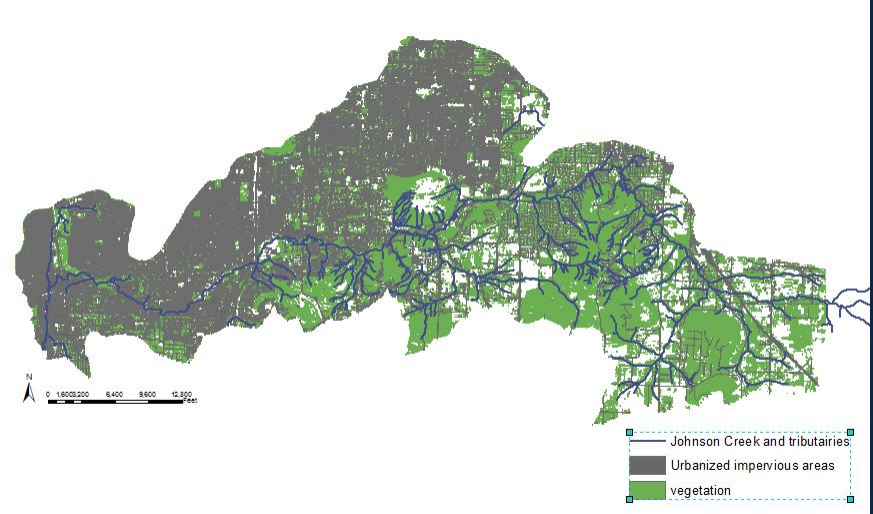
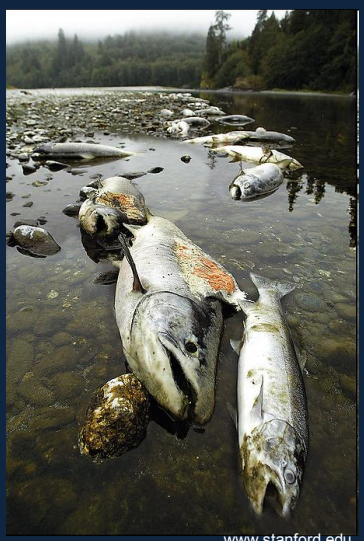


Fig. 1 – Johnson Creek Watershed (Sonoda et al., 2001).

Urbanization in the watershed



Stream degradation through thermal pollution



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The optimal water temperature range for most cold-water fish species ranges from 12-14^{o}C, while lethal levels ranging from 23-29^{o}C.

Increased water temperatures influence fish growth rate, egg survival, migration cues, level of disease resistance and ultimate survival when lethal limits are reached. (Brazier and Brown, 1973; Rounds, 2007).

Objectives:

i. Detect the land cover changes that have occurred within the Johnson Creek Watershed and assess the spatial pattern of the change.

ii. Analyze available data to determine how land use may be leading to increases in stream water temperature.

Methods:

Land Cover Classification	
Urban	Includes all residential, commercial/industrial, paved areas and public open space.
Agriculture	Includes all cultivated areas and grasslands
Forest	Includes forested areas
Shrub/ Scrub	Includes areas that present mainly shrub or secondary vegetation.
Wetland	Low areas saturated with water
Bare land	Unvegetated areas
Water	Lakes, streams and man-made reservoirs.

Using the combine tool, we calculated the changes from 1992-1996 and 1996-2001. The resulting change matrix was use to calculate the percent change using the following equation (Long *et al*., 2007; Long *et al*., 2008):

$$Ch_i = (p_{i.} - p_{.i}) / p_{.i} * 100$$

where Chi = change of LULC in row *i* relative to previous year, pi. = row total of category, and p.i = column total of category*i*

We then divided Johnson Creek Watershed into subwatersheds using the hydrology tools in Spatial Analyst.

Using the resulting polygons, we then used zonal statistics to calculate extent of factors for each subwatershed for 2001.

Buffering:

100 ft buffer around stream to calculate amount of riparian vegetation around streams (BES, 2005).

- 300 ft buffer – calculate land use near the stream.

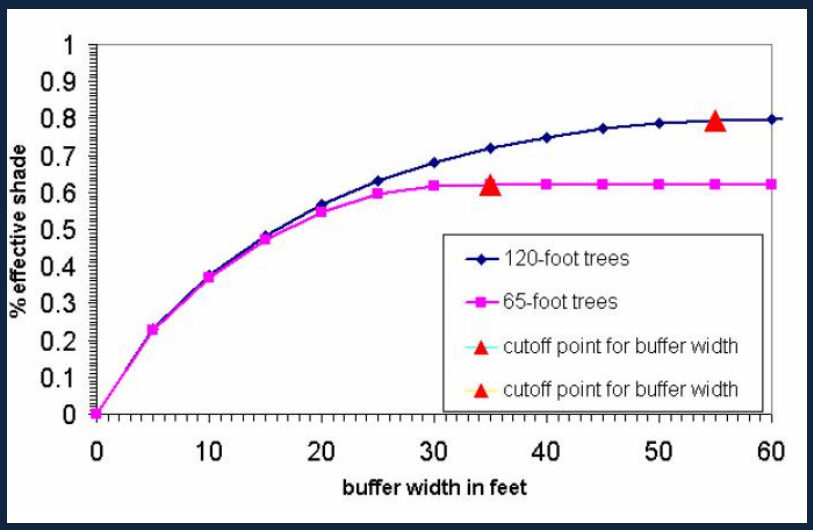
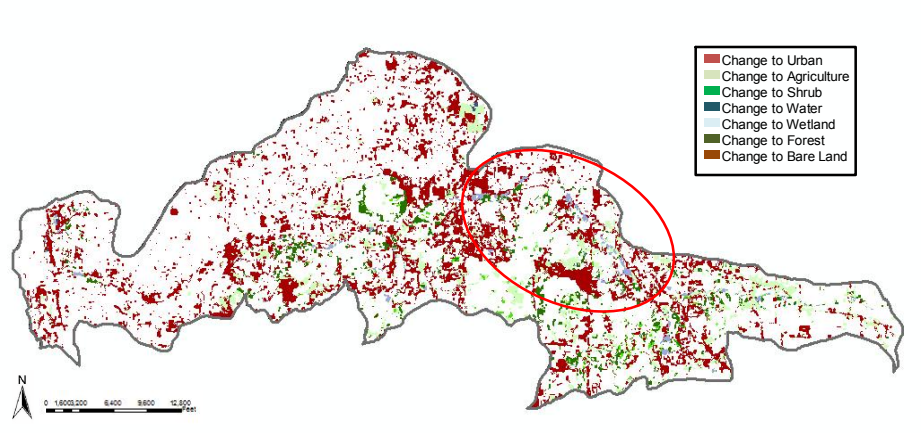


Fig. 2 - Percent effective shade of riparian vegetation as a function of buffer width (BES, 2005)

Results

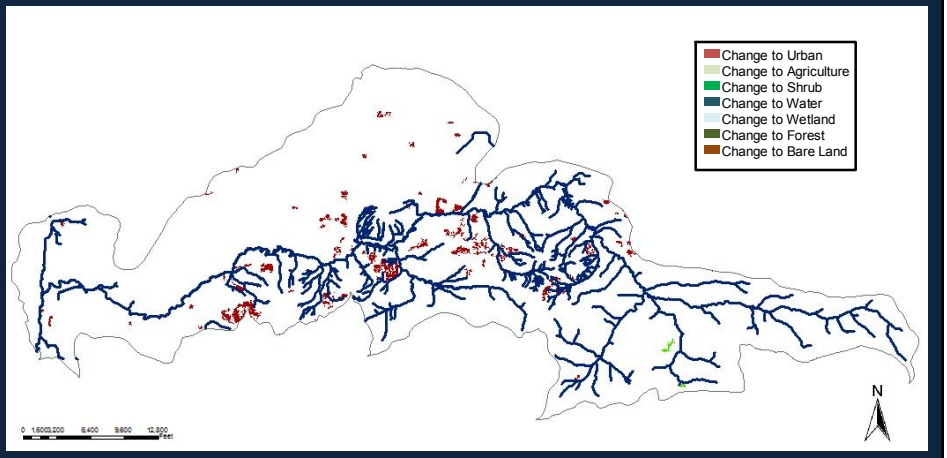
Changes from 1992 to 1996



Change matrix 1992-1996

		1996								
		Urban	Agriculture	Forest	Shrub	Wetland	Bare Land	Water	Total	Percent change
1992	Urban	62964	3070	2328	225	179	1	33	68800	35.74
	Agriculture	10047	22972	2622	393	459	0	11	36504	-12.30
	Forest	15528	4980	19854	662	808	4	41	41877	-40.23
	Shrub	4121	600	136	27	34	0	6	4924	-73.33
	Wetland	95	29	54	1	17	0	0	196	674.49
	Bare Land	604	350	32	4	6	0	25	1021	-99.51
	Water	31	13	2	1	15	0	78	140	38.57
	Total	93390	32014	25028	1313	1518	5	194	153462	

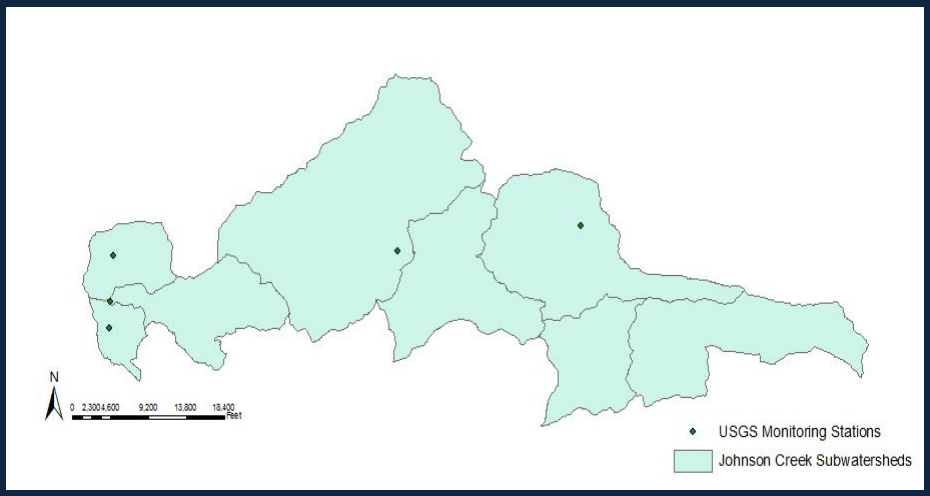
Change from 1996 to 2001



Change Matrix 1996-2001

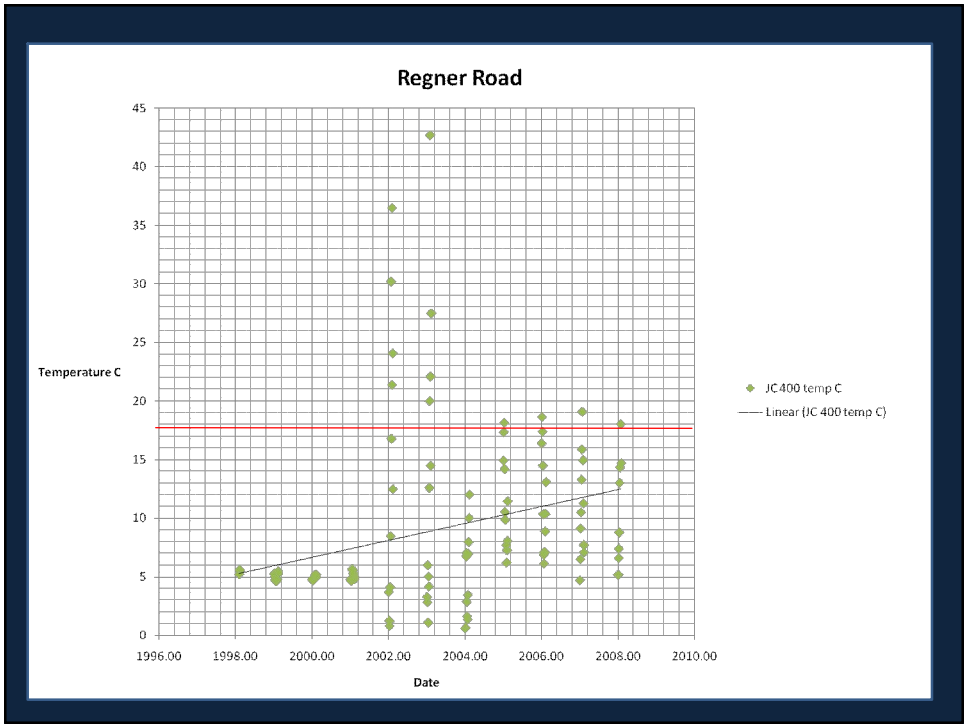
		2001								
		Urban	Agriculture	Forest	Shrub	Wetland	Bare Land	Water	Total	Percent change
1996	Urban	93751	0	0	0	0	0	0	93751	0.03
	Agriculture	2344	29974	1	70	0	0	0	32389	0.07
	Forest	239	22	24856	0	0	1	0	25118	0.01
	Shrub	7	0	0	1314	0	0	0	1321	-0.05
	Wetland	0	0	0	0	1519	0	0	1519	0.00
	Bare Land	0	0	0	0	0	5	0	5	-0.20
	Water	0	0	0	0	0	0	196	196	0.00
	Total	96341	29996	24857	1384	1519	6	196	154299	

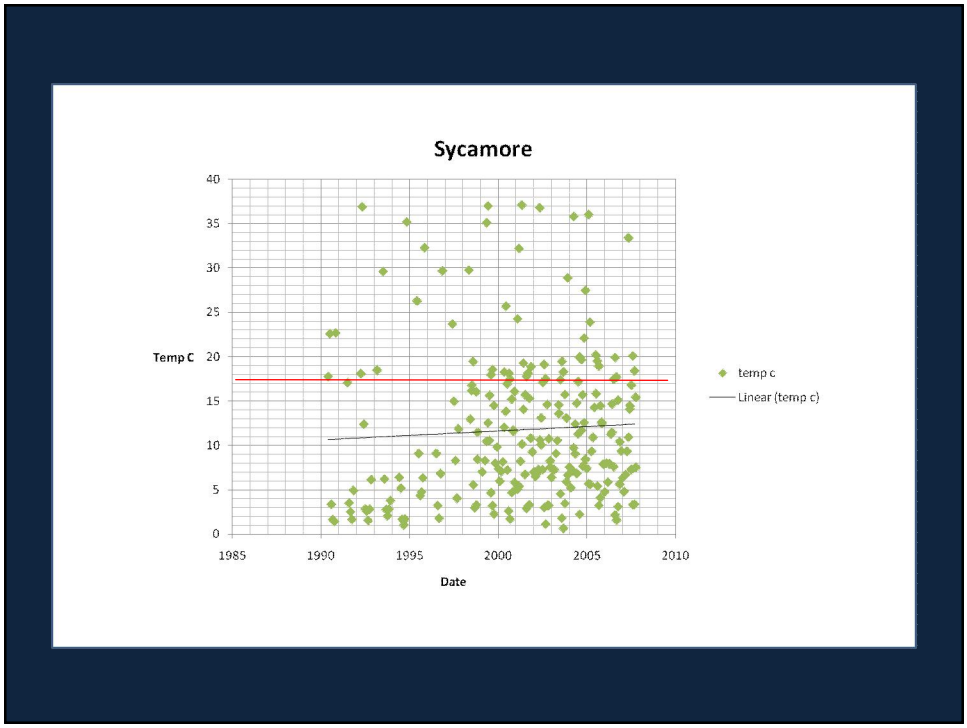
Johnson Creek Subwatersheds



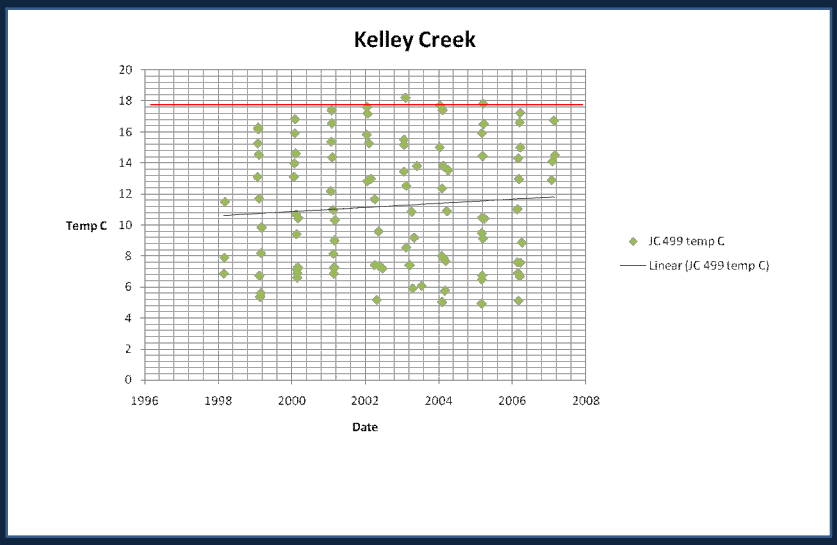
Percent Land use

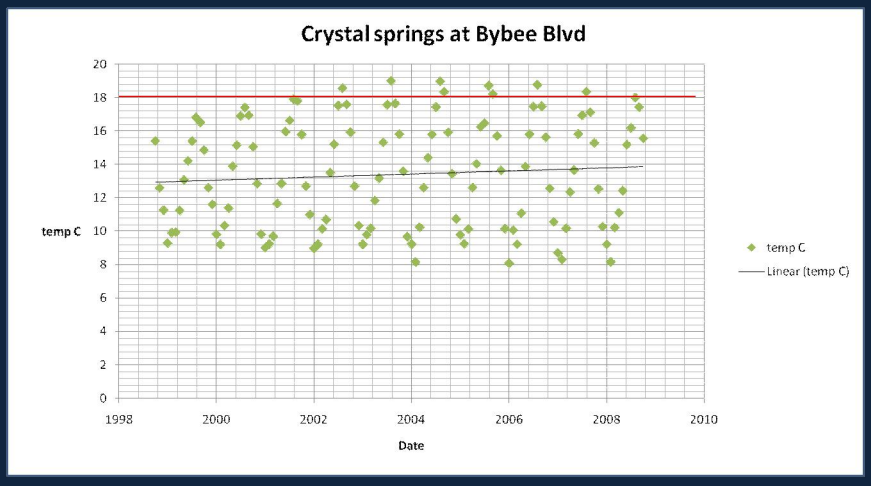
Station Name	Urban	Agriculture	Forest	Shrub	Wetland	Bare land	Water
Johnson Creek at Regner Rd at Gresham, OR	41.12%	11.73%	40.59%	1.16%	4.81%	0.01%	0.04%
Kelley Creek at 159th Drive	39.84%	29.40%	24.93%	0.99%	3.94%	0.00%	0.02%
Johnson Creek at Sycamore, OR	38.69%	9.27%	48.74%	1.13%	1.60%	0.00%	0.01%
Crystal Springs Creek at Bybee St, Portland, OR	74.98%	4.00%	9.99%	0.21%	6.63%	0.00%	3.05%
Crystal Springs Creek at Mouth, Portland, OR	85.33%	2.07%	4.42%	1.44%	3.07%	0.14%	1.67%
Johnson Creek at Milwaukie, OR	99.42%	0.00%	0.30%	0.00%	0.76%	0.00%	0.15%

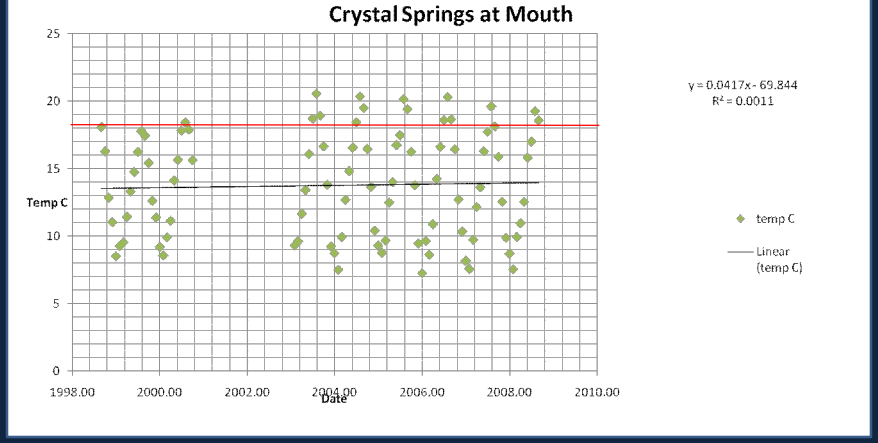

Regner Road
Temperature C
45
40
35
30
25
20
15
10
5
0
1996.00
1998.00
2000.00
2002.00
2004.00
2006.00
2008.00
2010.00
Date
JC 400 temp C
Linear (JC 400 temp C)

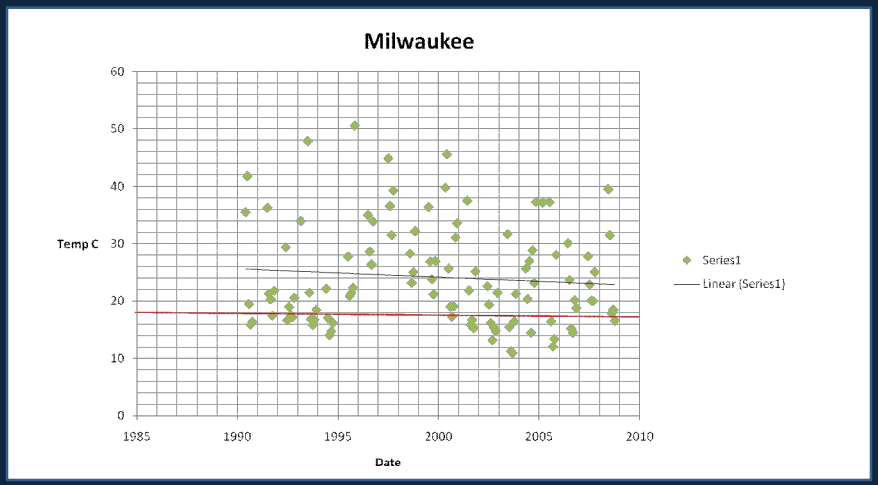

Sycamore
Temp C
40
35
30
25
20
15
10
5
0
1985
1990
1995
2000
2005
2010
Date
temp c
Linear (temp c)

Water temperatures (1999-2002)



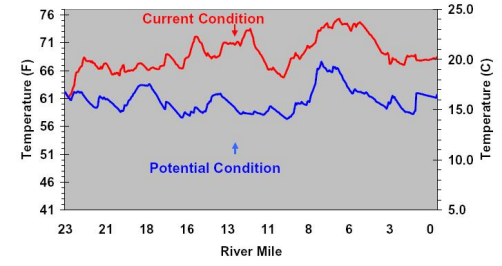


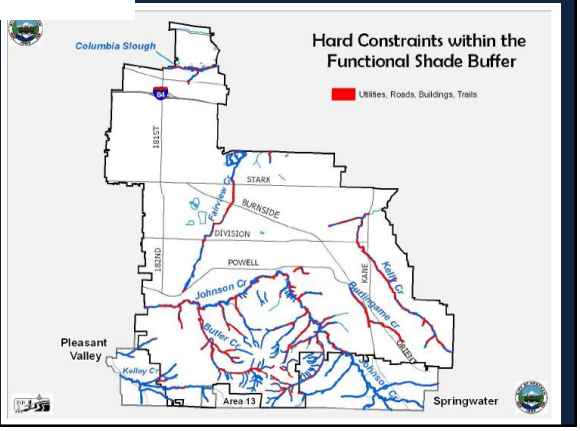

Crystal Springs at Mouth
y = 0.0417x - 69.844
R² = 0.0011
Temp C
Date
25
20
15
10
5
0
1998.00
2000.00
2002.00
2004.00
2006.00
2008.00
2010.00
temp C
Linear (temp C)


Milwaukee
Temp C
Date
60
50
40
30
20
10
0
1985
1990
1995
2000
2005
2010
Series1
Linear (Series1)

Conclusions

- The upper reaches of the watershed still present better water quality. However, these are the targeted areas for urban expansion and considering increasing water temperature trends, these areas might soon be limited to fish populations
- Other studies have concluded that as development continues and more natural and agricultural areas are urbanized, increases in water withdrawals and decreases low flows will lead to even higher water temperatures (Risley and Doyle, 1997; Risley, 1997).
- Fortunately, riparian restoration areas have shown to support populations of salmonids and cutthroat trout in recent years. GIS used in this manner can be used to target areas for restoration





(BES, 2005)

Limitations

- Different classified land cover images lead to errors in change classification.

- Lack of sufficient water quality data from the USGS.
- Data contained many errors
- Groomed line by line eliminating errors
- Interpretation errors
- Statistical analysis limited by quality of data
- Overall warming trend except at Milwaukee

Data Sample

year_nu	month_nu	mean_va
1989	10	21.5
1989	11	39
1989	12	69.6
1990	1	183.2
1990	2	160.9
1990	3	69.8
1990	4	50.4
1990	5	35.5
1990	6	41.8
1990	7	19.5

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