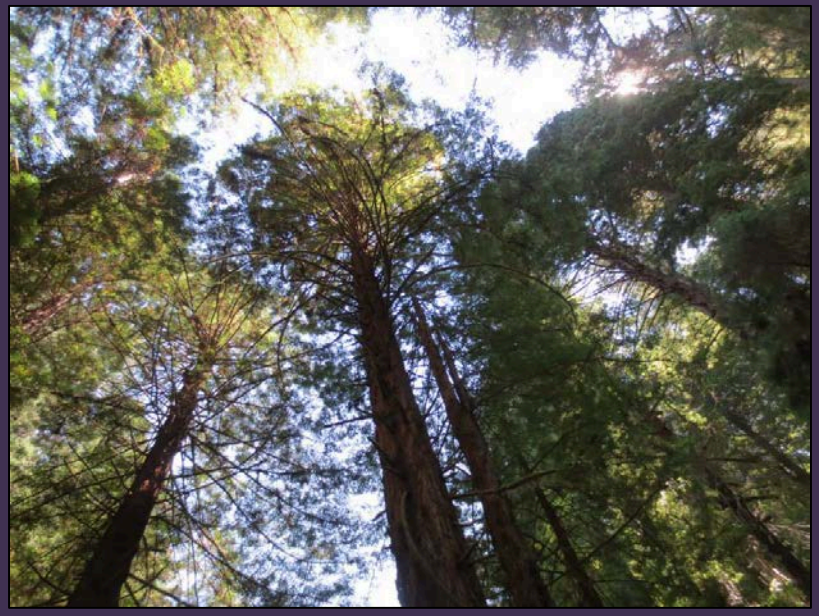
The Hydrologic Value of Trees

presentation to the Lake Forest Park City Council
November 6, 2016



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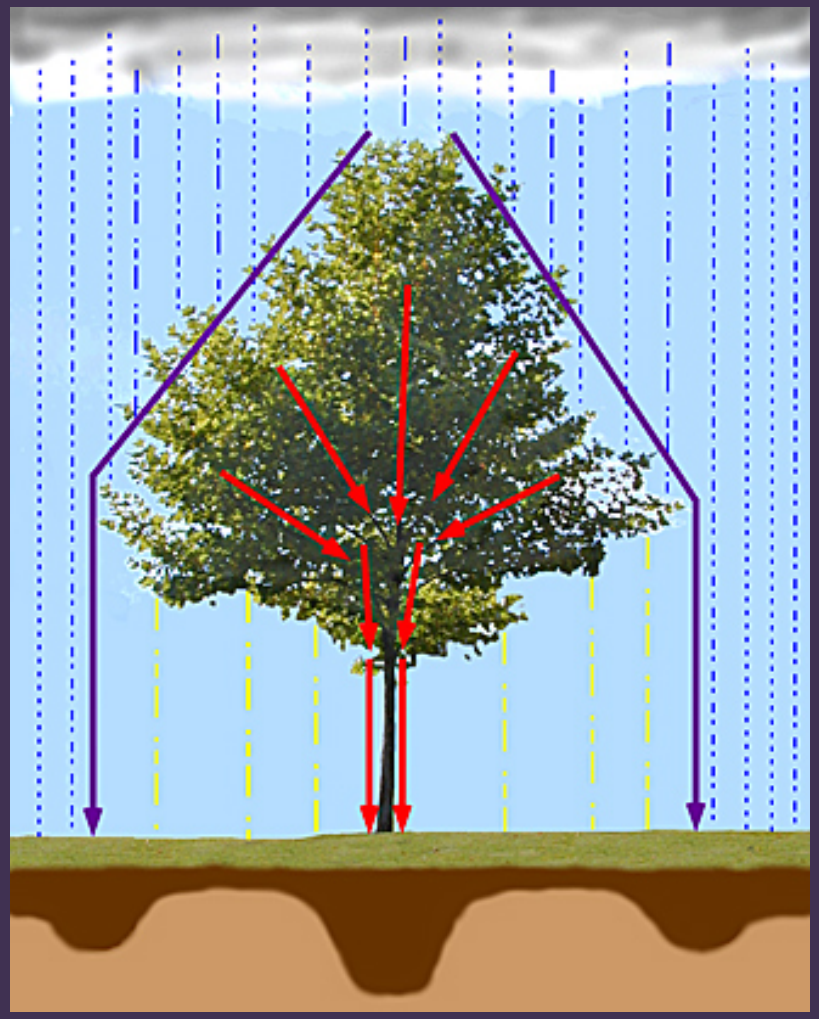
More Trees =

- Increased interception of precipitation
  - Decreased stormwater runoff
  - Increased infiltration of rain into soil
    - Increased groundwater recharge
      - higher groundwater levels
      - maintains wetlands
      - higher base levels for streams
    - Less flashy flows in streams
      - less flooding
      - less channel erosion
    - Higher quality of groundwater and streams
      - Healthier ecosystems, greater biodiversity
      - More salmon

Interception!



Interception

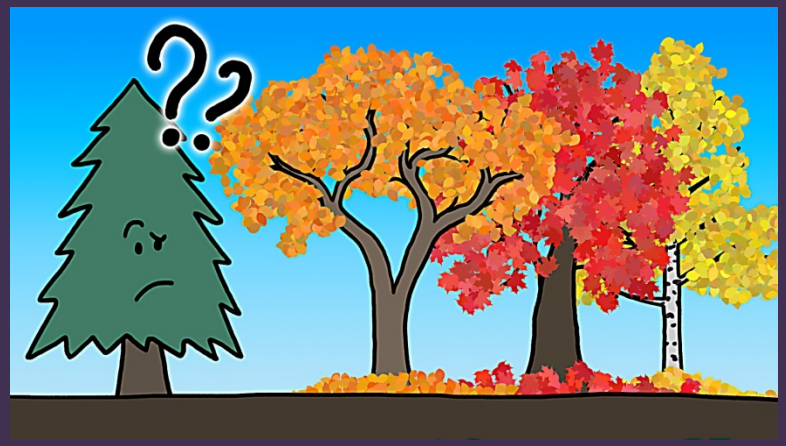
Portion of precipitation caught by plants and other surface cover which is evaporated back to the atmosphere without getting into the soil

Interception

- Interception Storage
  - varies with form, density, and surface texture of cover
- Canopy Interception vs Litter Interception

  13-30% of ppt 2-10% of ppt
- Deciduous vs Conifers
  - Conifers 10-15% more interception

Deciduous vs. Coniferous Trees



	Number of observations	Median canopy interception (%)
Deciduous forest		
All data	10	13
Coniferous forest		
Rainfall only	11	22
Rain and snow	26	28
European data	9	35
North American data	27	27
Taiwan	1	8

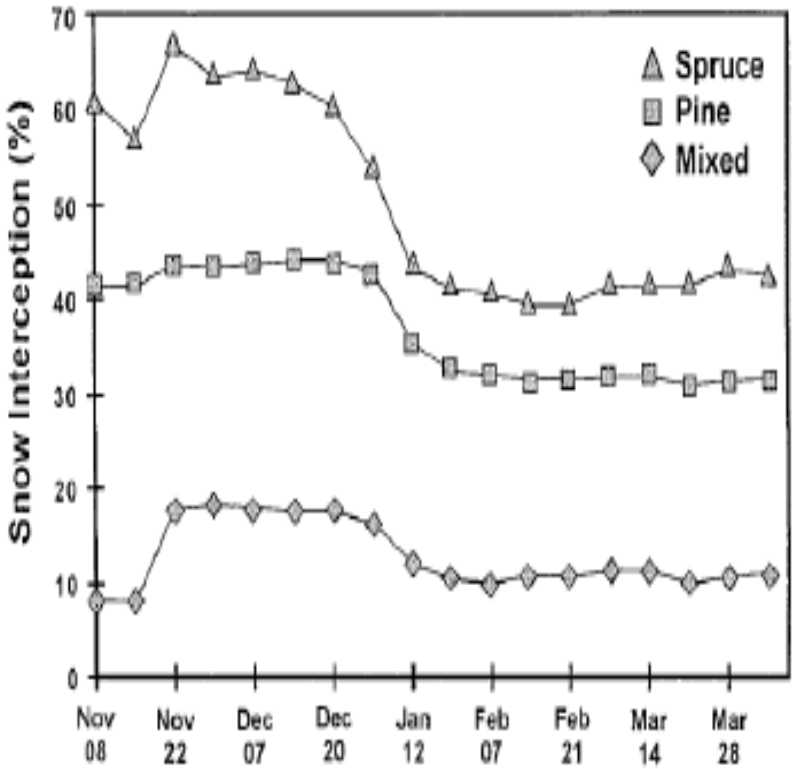
Dunne and Leopold (1978, Table 3-1)

Vegetation	Storage capacity (mm)
Oak	0.8 to 1
Sitka Spruce	2 to 3
Eucalyptus	0.2 to 0.6
Douglas fir	2.4
Cypress	0.5 to 0.8
Slash pine	0.38 to 0.5
Heather	1.1
Lowland tropical	0.74 to 1.15

expressed as mm depth over the area covered by the crown

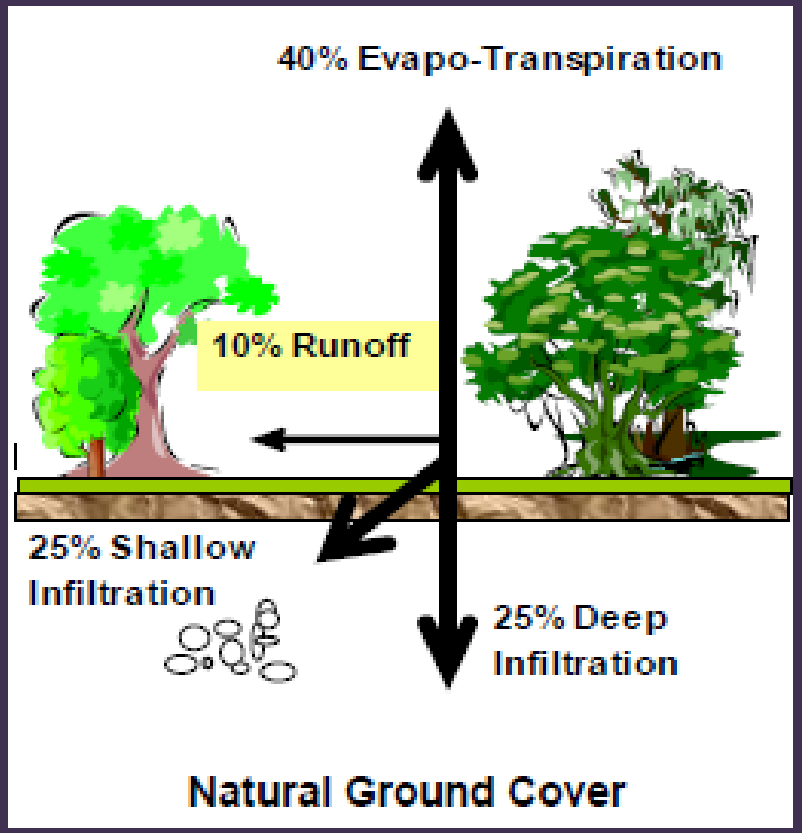
Deciduous vs. Coniferous Trees

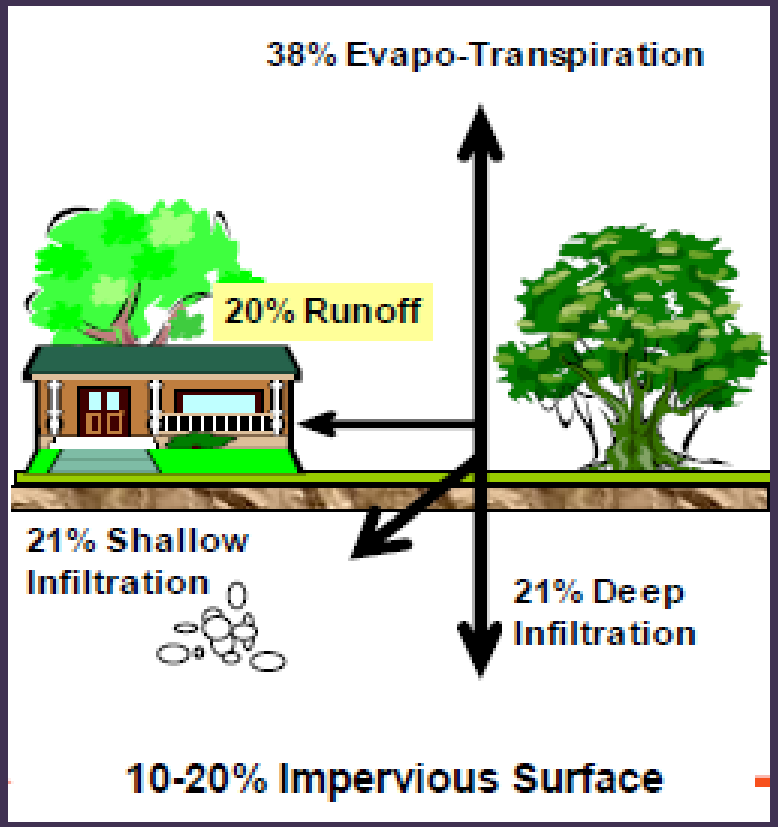
The influence on snow is even greater



Buttle JM, Creed IF, Pomeroy JW. 2000. Advances in Canadian forest hydrology, 1995-1998. *Hydrological Processes* 14: 1551-1578

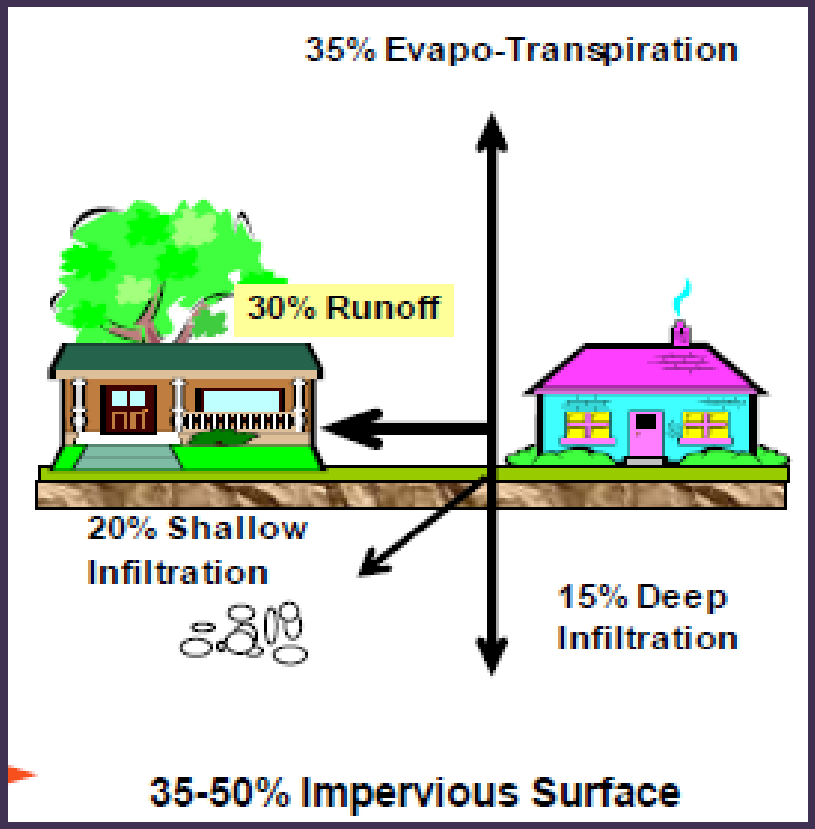
Influence of Urbanization on Runoff and Infiltration

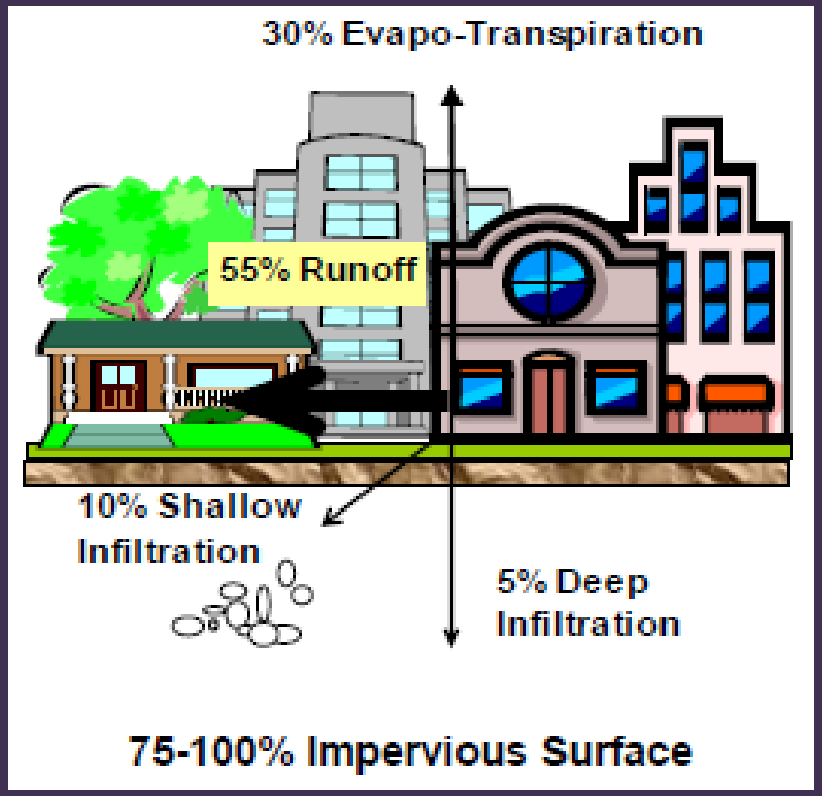




From Ruby, E (2006). How Urbanization Affects the Water Cycle. California WALUP Partnership. https://www.coastal.ca.gov/nps/watercyclefacts.pdf

Influence of Urbanization on Runoff and Infiltration





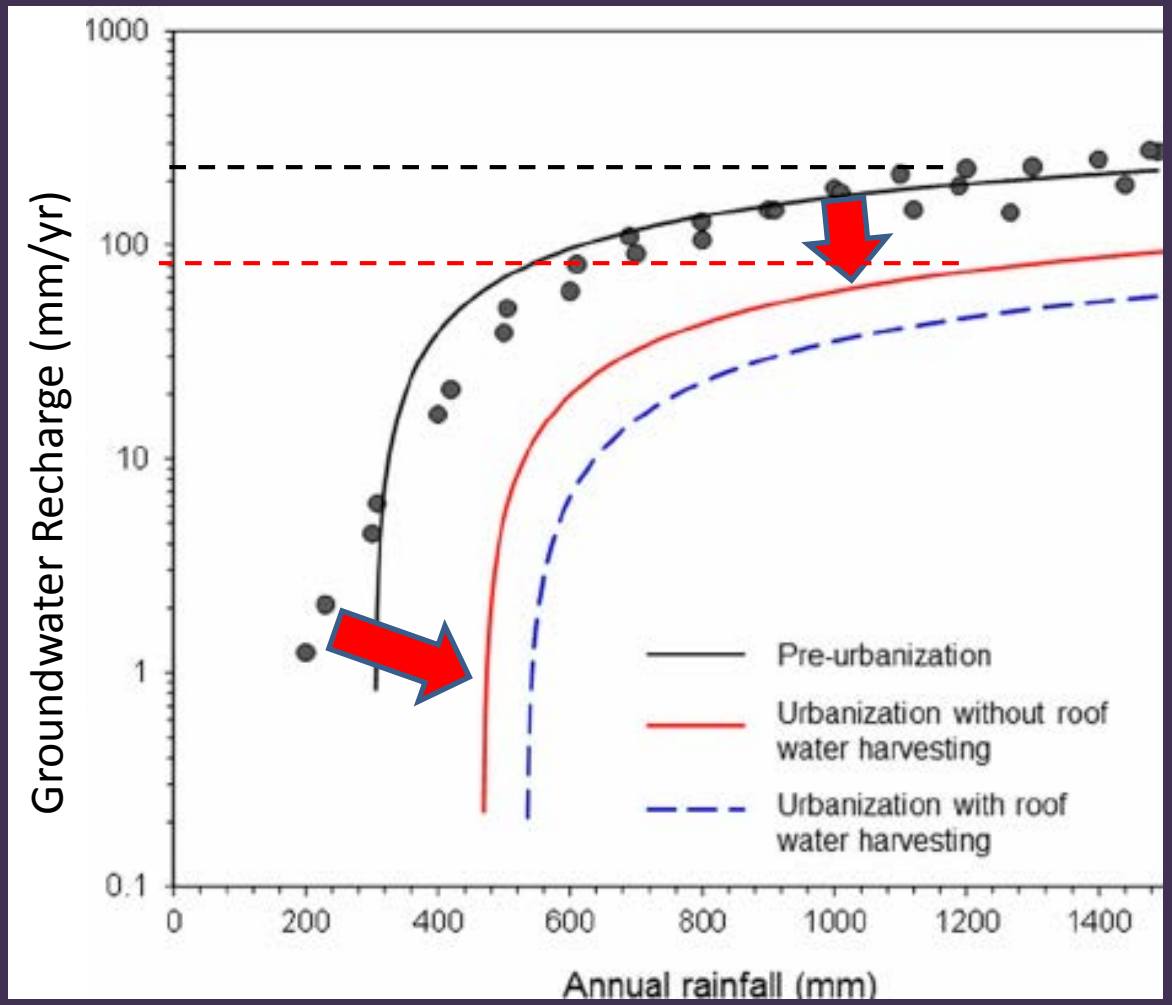
From Ruby, E (2006). How Urbanization Affects the Water Cycle. California WALUP Partnership. https://www.coastal.ca.gov/nps/watercyclefacts.pdf

Lake Forest Park Canopy Cover (2010)

Residential Lot Size	Area (Ac.)	Canopy Area (sq. m.)*		Avg. Tree Canopy
1/4 Acre (10,890sf) or more	1,220.4	2,632,415		53%
Less than ¼ Acre (10,889sf)	107.6	138,862		32%
			Total Residential	52%
Business Zone	**Area (Ac.)**	**Canopy Area (sq. m.)***		**Avg. Tree Canopy**
Neighborhood Business	3.7	2,086		14%
Neighborhood Commercial	9.6	9,909		25%
Town Center	19.3	3,070		4%
			Total Business	11%
Other Uses	**Area (Ac.)**	**Canopy Area (sq. m.)***		**Avg. Tree Canopy**
Public Parks & Open Space	59.8	157,026		65%
Road ROWs	372.6	425,280		28%

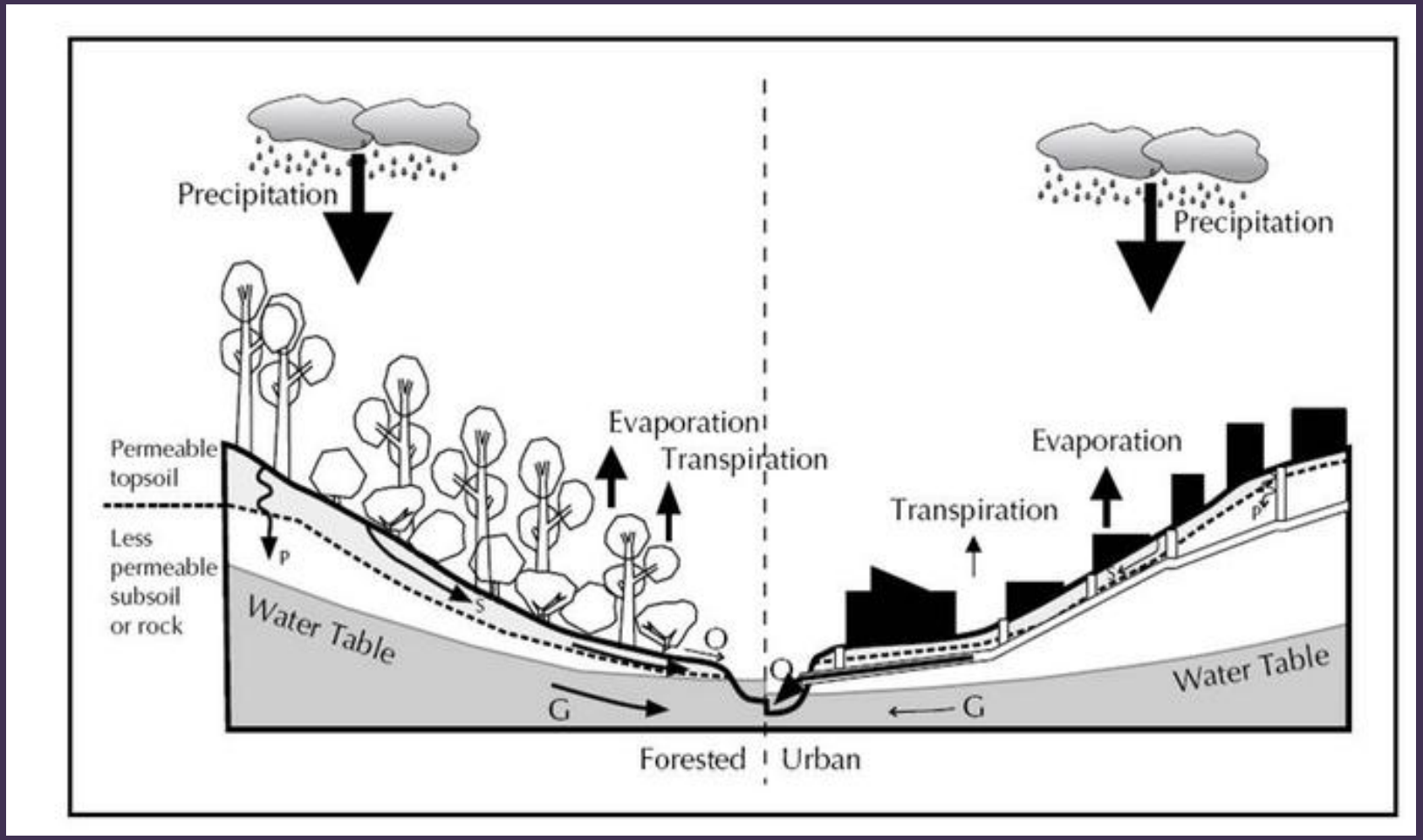
Community Forest Management Plan - http://www.cityoflfp.com/DocumentCenter/Home/View/369

Influence of Urbanization on Groundwater Recharge



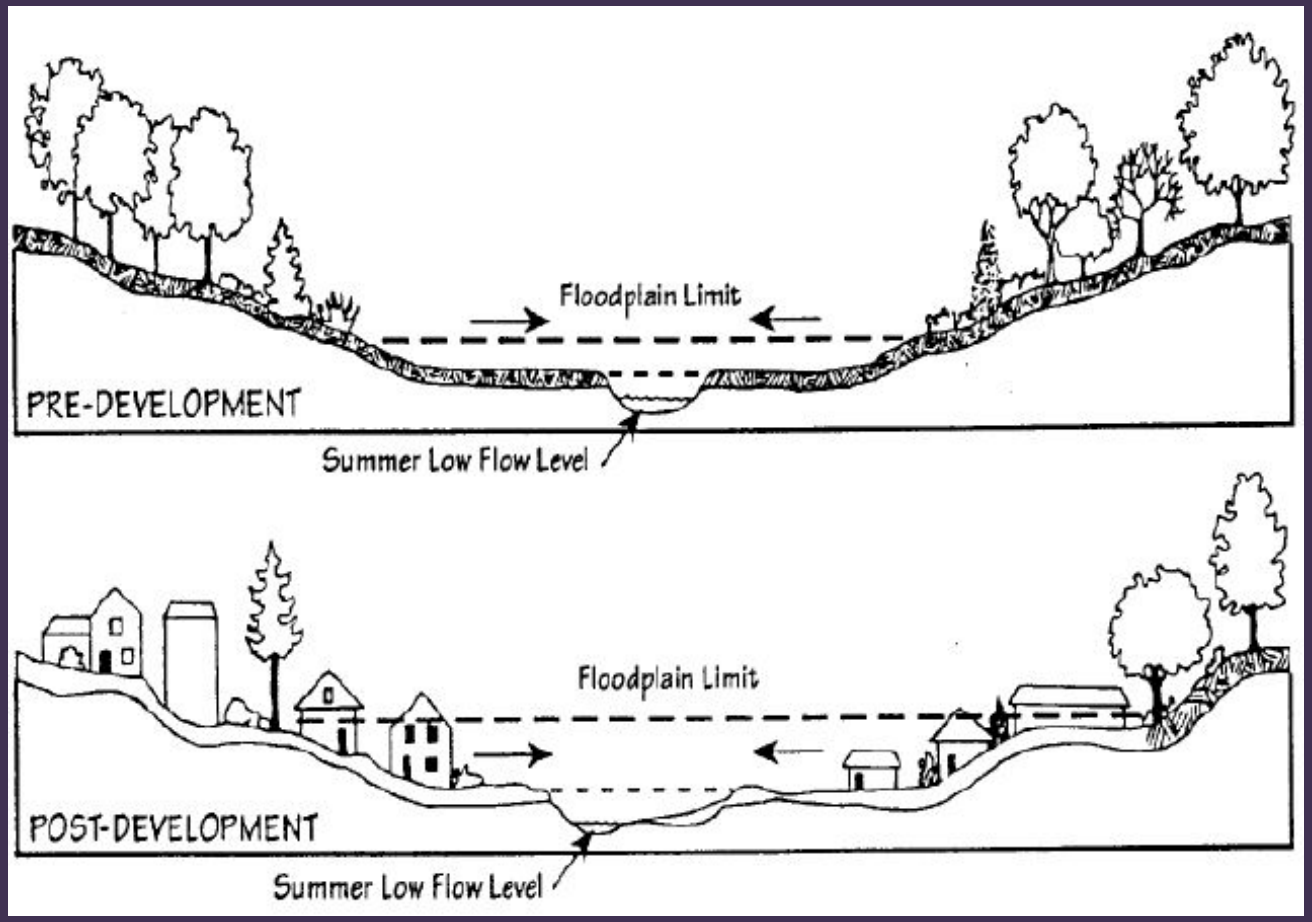
https://www.researchgate.net/figure/265913254_fig5_Fig-5-Effect-of-urbanization-with-and-without-roof-water-harvesting-on-rainfall

Influence of Urbanization on Stormwater Runoff, Groundwater Levels, and Stream Baseflow



From Raele, J (2016). Urban Streams, *in* Stream and Watershed Restoration. Wikispaces Classroom. https://riverrestoration.wikispaces.com/Urban+streams

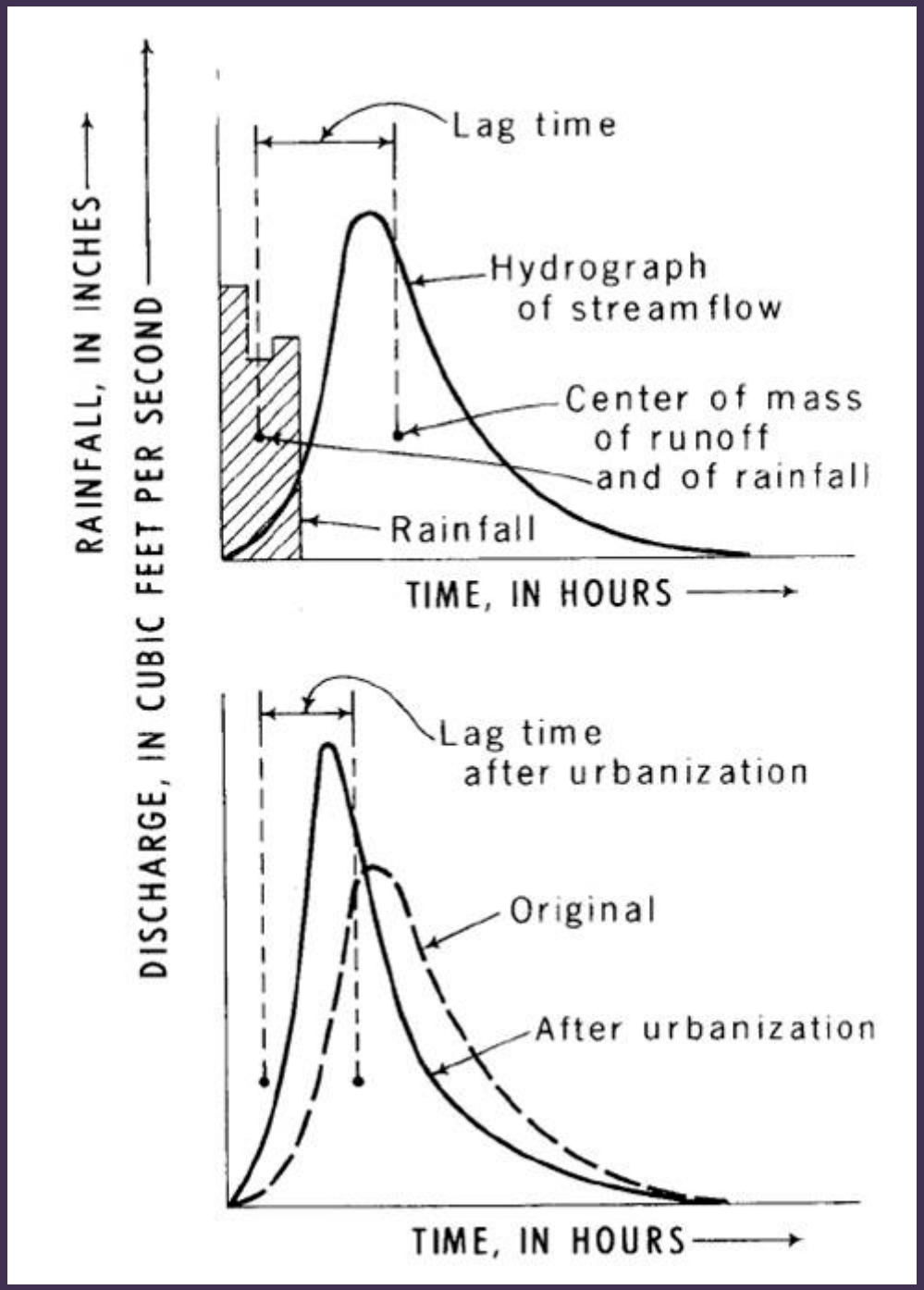
Influence of Urbanization on Stormwater Stream Baseflow, Channel Modification, and Flooding



From **Ramachandra, TV and Mujumdar, PP (2009). Urban Floods: Case Study in Bangalore.** *Journal of the National Institute of Disaster Management* , 3(2).
http://wgbis.ces.iisc.ernet.in/energy/water/paper/urbanfloods_bangalore/Floodplain_Elevations1.jpg

Influence of Urbanization on Stream Discharge

Flashy!
Discharge increases sooner and goes higher.



From Raele, J (2016). Urban Streams, *in* Stream and Watershed Restoration. Wikispaces Classroom. https://riverrestoration.wikispaces.com/Urban+streams

Influence of Urbanization on Stream Peak Flows

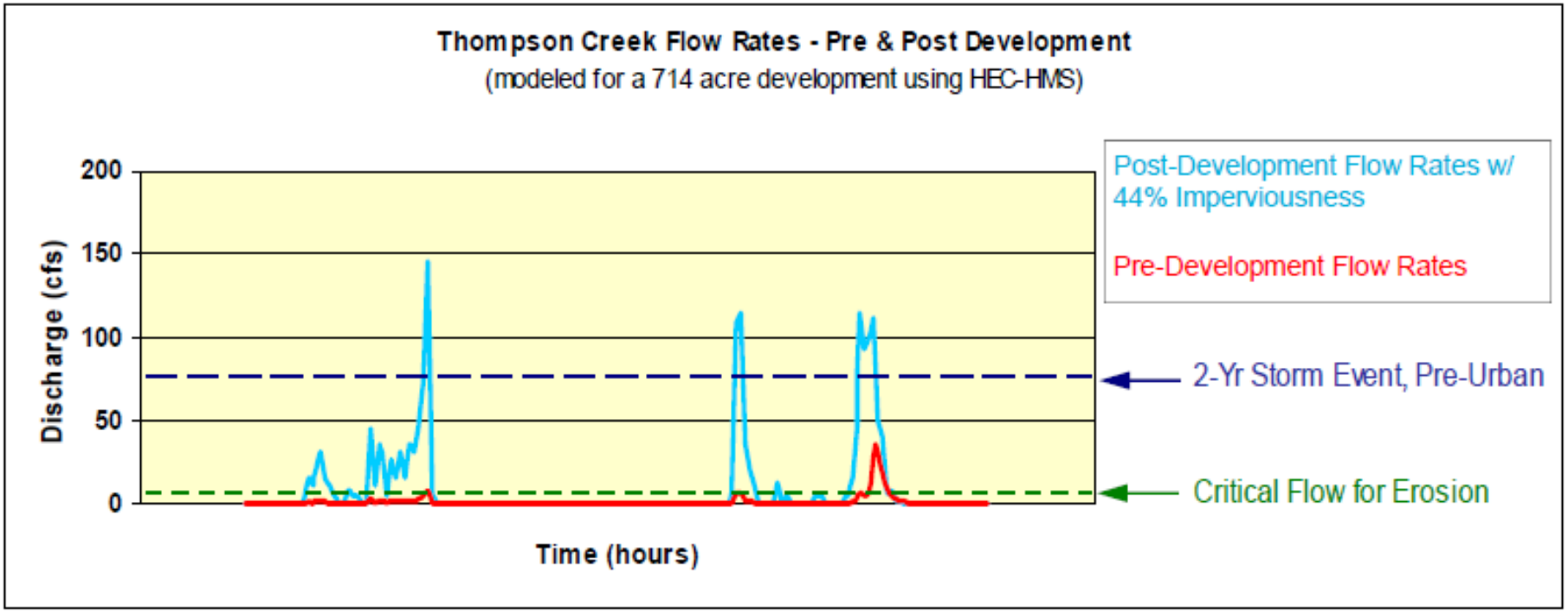


Figure 5. Comparison of Pre- and Post-Development Flow Conditions, Thompson Creek, Santa Clara Valley, CA.

From Ruby, E (2006). How Urbanization Affects the Water Cycle. California WALUP Partnership.
https://www.coastal.ca.gov/nps/watercyclefacts.pdf

Reviving Urban Streams: Land Use, Hydrology, Biology and Human Behavior (Booth, et al., 2004)

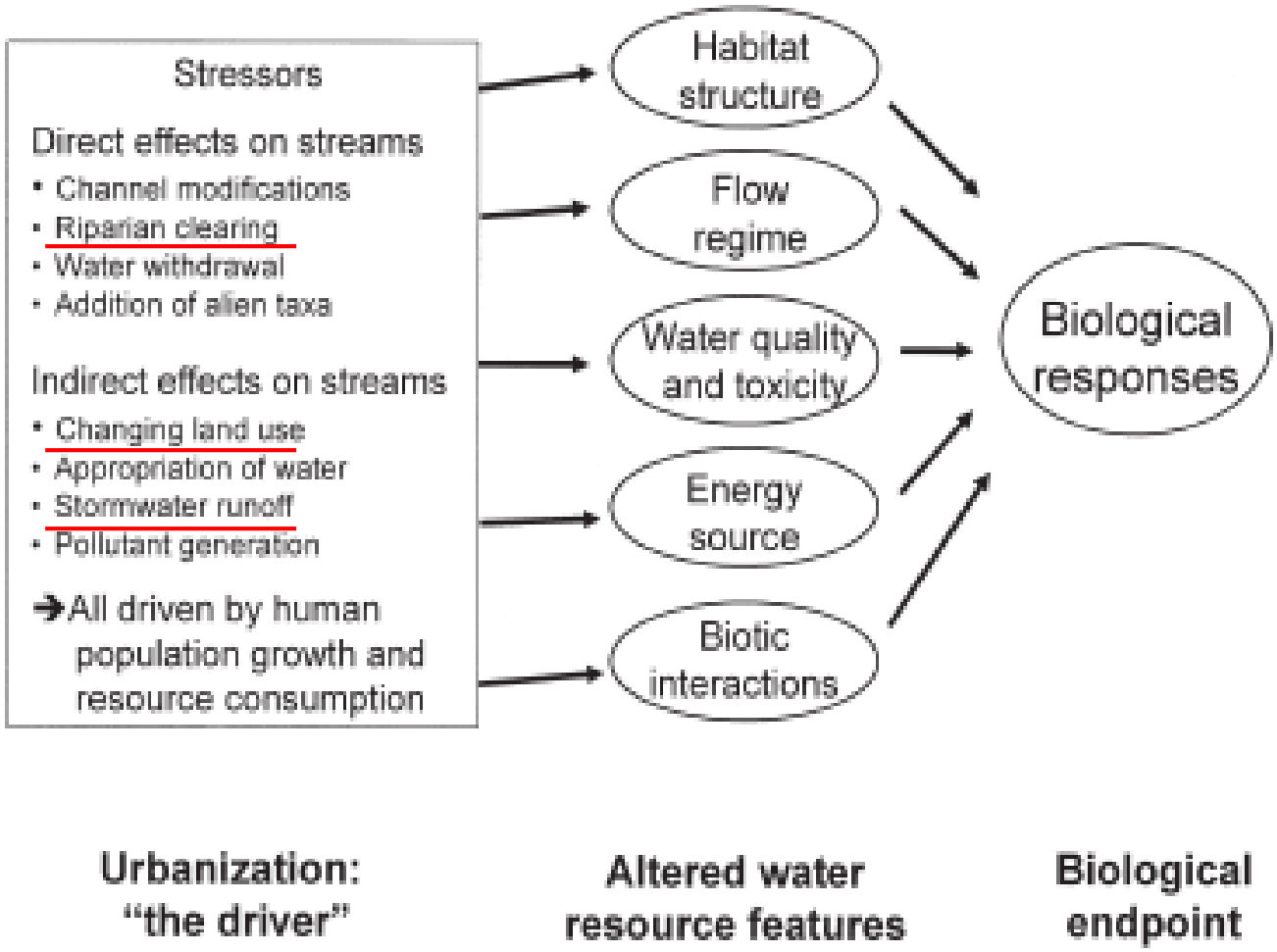


Figure 1. Conceptual Model of the Varied Stressors Resulting From Human Actions That Alter Stream Biological Condition (modified from Karr and Yoder, 2004).

Increased Impervious Cover and More Runoff Leads to:	**Impervious Cover and Hydrologic Impacts to Streams**						
	Flooding	Channel Widening	Streambed Alteration	Increased Summer Stream Temperature	Water Quality Degradation	Habitat Loss	Biodiversity Loss
Increased Rain Inputs	●	●	●	●	●		
Increased Peak Flow	●	●	●			●	
Increased Peak Flow Duration	●	●	●			●	
Decreased Base Flow				●		●	●
Increased Pathogen Loading					●		●
Increased Sediment Loading	●	●	●		●	●	●

After: Urbanization of Streams: Studies of Hydrologic Impacts, EPA 841-R-97-009, 1997.

Relationships between % Urbanization and Riparian and Biotic Integrity

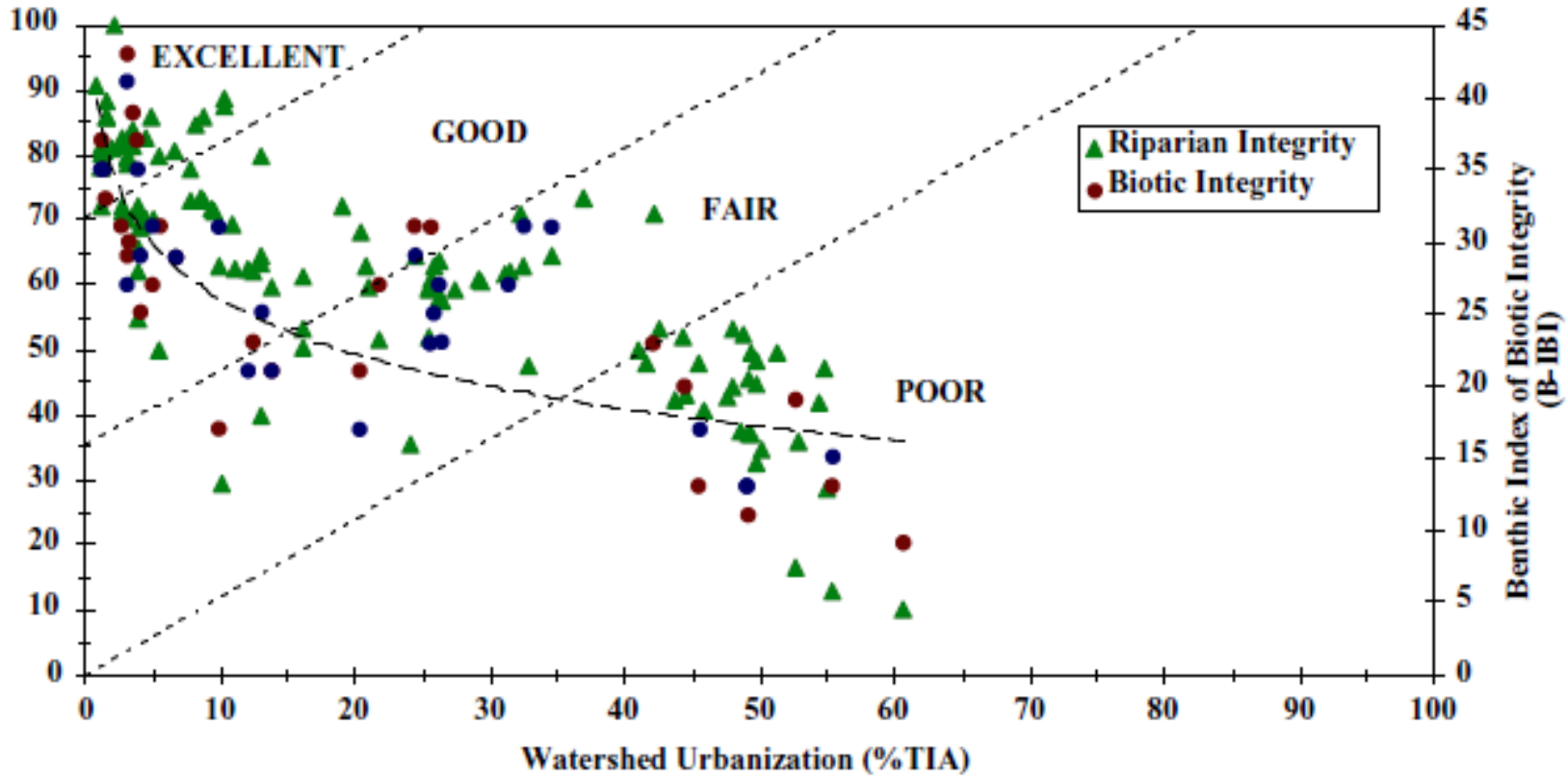


Figure 16. Relationship between basin development, riparian buffer width, and biological integrity in PSL streams.

From May, 1998. **The Cumulative Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion**

Other Key Tree Benefits

- Trees cool the landscape
  - "A mature tree canopy reduces air temperatures (in the summer) by about 5 to 10° F, influencing the internal temperatures of nearby buildings." – Lake Forest Park Community Forest Management Plan www.cityoflfp.com/DocumentCenter/Home/View/369
- Trees sequester carbon, offsetting our greenhouse gas emissions
  - "net carbon sequestration rate averaging 0.205 kg C/m^2/year" – Nowak, et al., 2013 http://www.fs.fed.us/nrs/pubs/jrnl/2013/nrs_2013_nowak_001.pdf

Other Key Tree Benefits

- Trees reduce other air pollutants
  - cooler air temperatures created by tree canopies reduce smog levels by up to 6%, producing savings in air clean-up campaigns. Finally, a mature tree absorbs from 120 to 240 lbs of the small particles and gases of air pollution." – Lake Forest Park Community Forest Management Plan www.cityoflfp.com/DocumentCenter/Home/View/369
- Trees produce oxygen
  - "A typical person consumes about 386 lb of oxygen per year. A healthy tree, such as a 32-foot tall ash tree, can produce about 260 lb of oxygen annually - two trees supply the oxygen needs of a person each year!"