EPA Urban Heat Island Initiative

Beating the Heat from Urban Runoff

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Global warming is:

- aggressively researched
- international news
- fodder for Hollywood movies

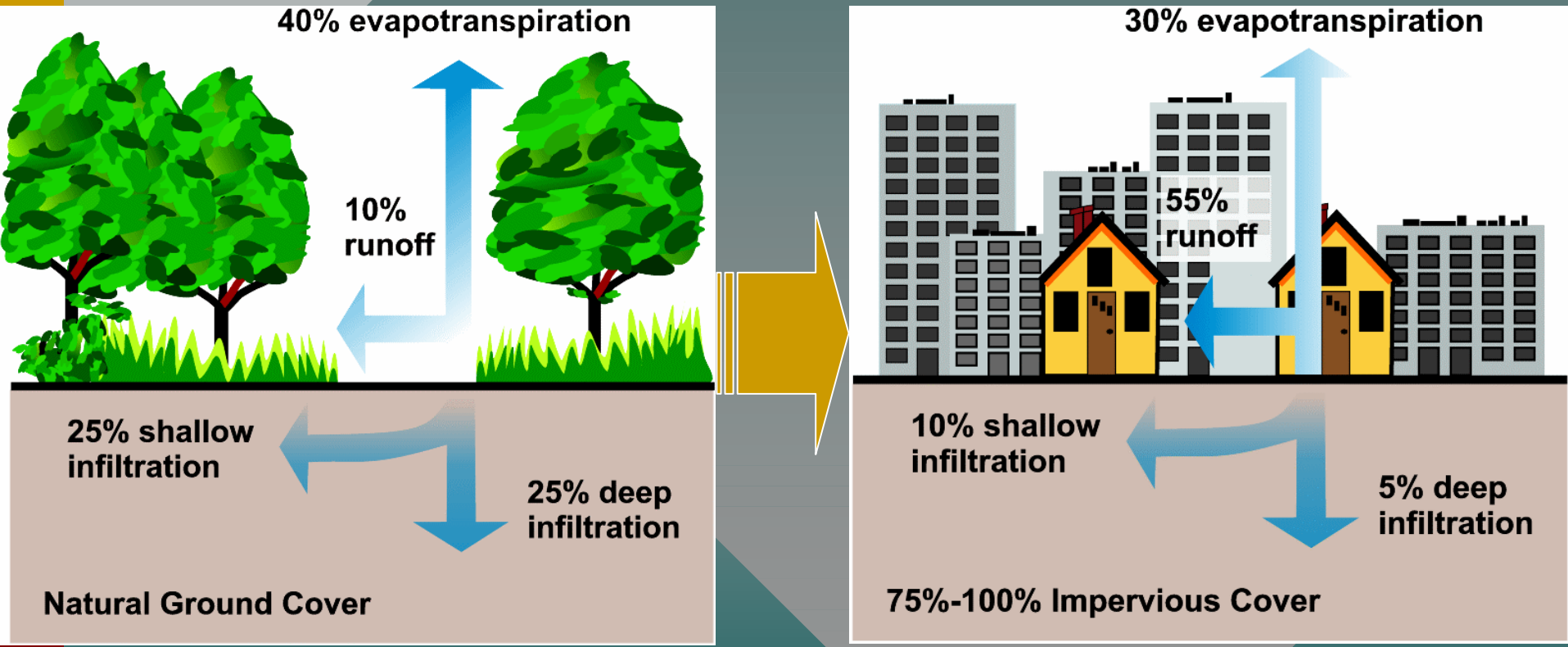
Thermal impacts to streams from urbanization is:

- Under-monitored & reported
- under-researched
- easily proven

Water Temperature:

- Affects all aspects of aquatic life, especially metabolism & reproduction
- Range determines which species can survive

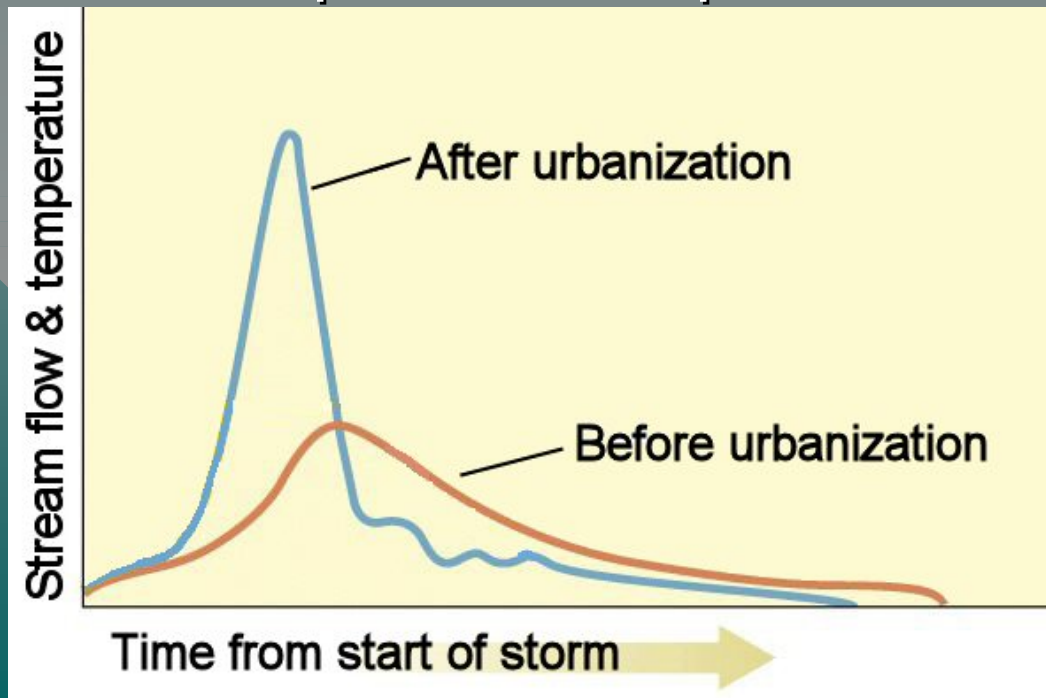
Relationship between Impervious Cover and Surface Runoff



Impervious cover in a watershed results in increased surface runoff volume, heat, and other urban pollutants

Species Tolerate Gradual Change Better than Rapid Change

- Change of 5°F in 5 hours can induce stress in most desirable species
- Time of concentration is much quicker as imperviousness increases
- Changes of +8 °F in < 1hour after summer squalls in many ultra-urban streams



Effects of Thermal Impacts

- Species diversity decreases.
- Game fish species (e.g., trout) disproportionately affected

- Salmon & shad species are especially vulnerable due to their anadramous migrating pattern.

large-scale “mystery” fish kills correspond with migration of anadramous fish into urban fresh water streams. (state agency fish kill files)

True or False:

The Clean Water Act addresses heat pollution

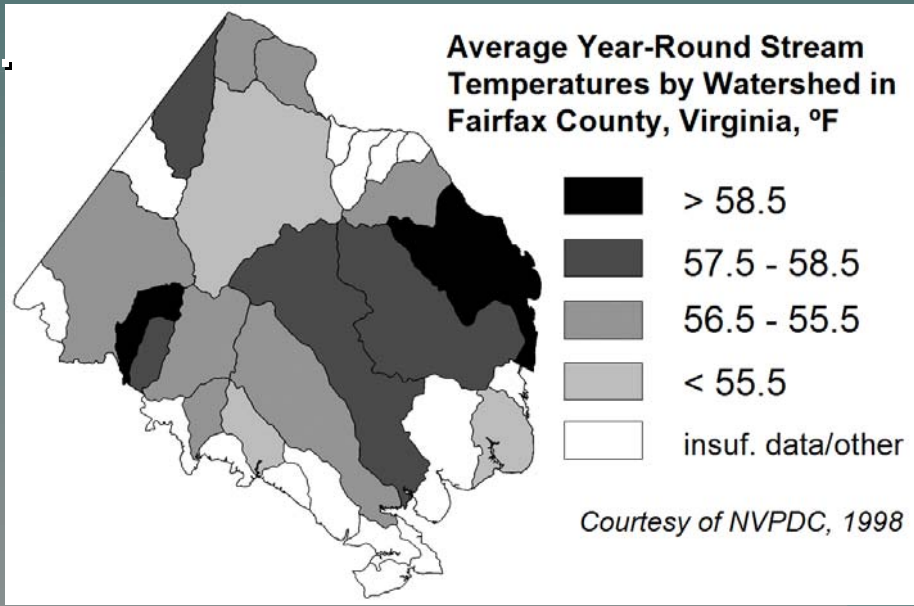
True!

EPA's Phase II Stormwater Rule

- Nearly 5,000 urbanized communities (localities, DOTs, & others) must have a stormwater discharge permit for their "MS4s"
- Temperature is cited as one of EPA's "Pollutants of Concern"
- No specific monitoring is required
- Temperature may be addressed through Phase II permits where TMDLs have been developed

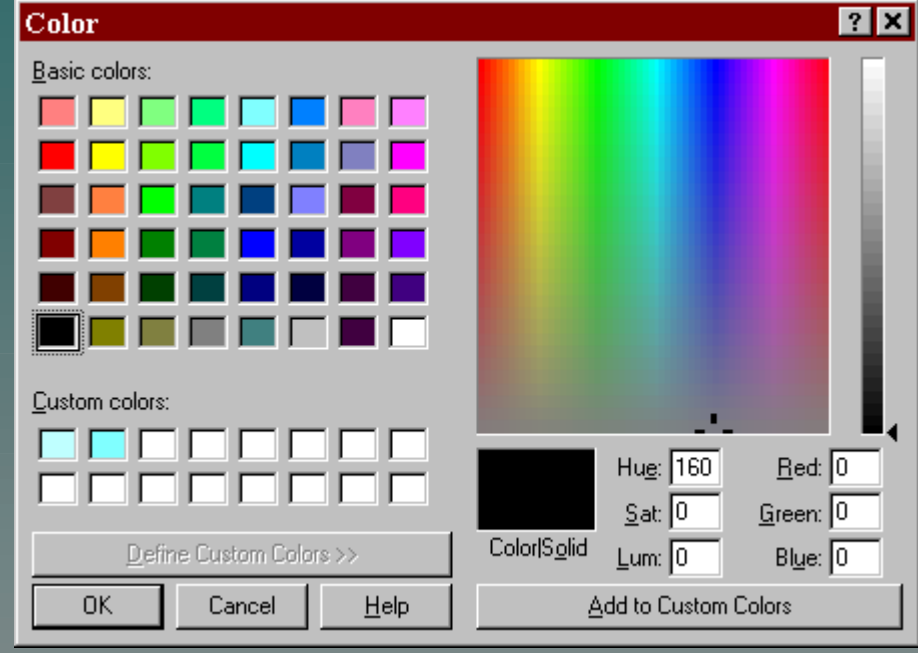
Temperature research

- ...is very limited in the U.S. Most focuses on impacts from cooling towers and forestry.
- New research is coming out of Great Lakes region.



- NVPDC (Waye, 1998) analyzed suburban Washington, DC streams and determined:
  - Avg. **summer** stream temps. increase by **0.11 °F** for every **1%** increase in imperviousness;
  - Year-round temps. also increase, but less dramatically.

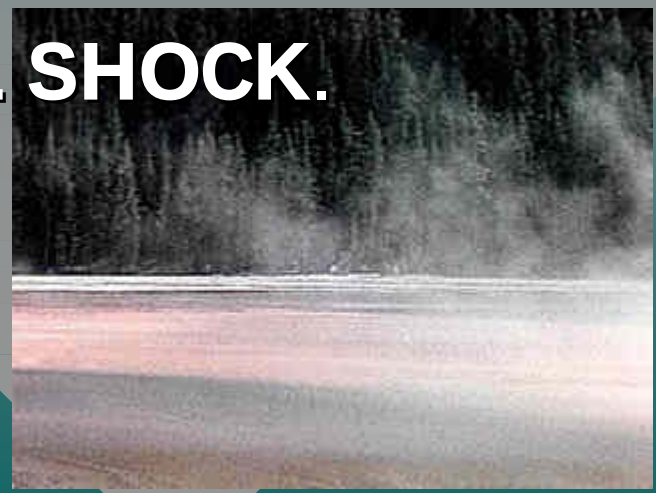
Factoids



1. Color theory: light surfaces reflect heat; dark surfaces absorb heat (& cut down on glare).
2. Water transfers heat more effectively than nearly all common liquids. (Only ammonia is more effective.)

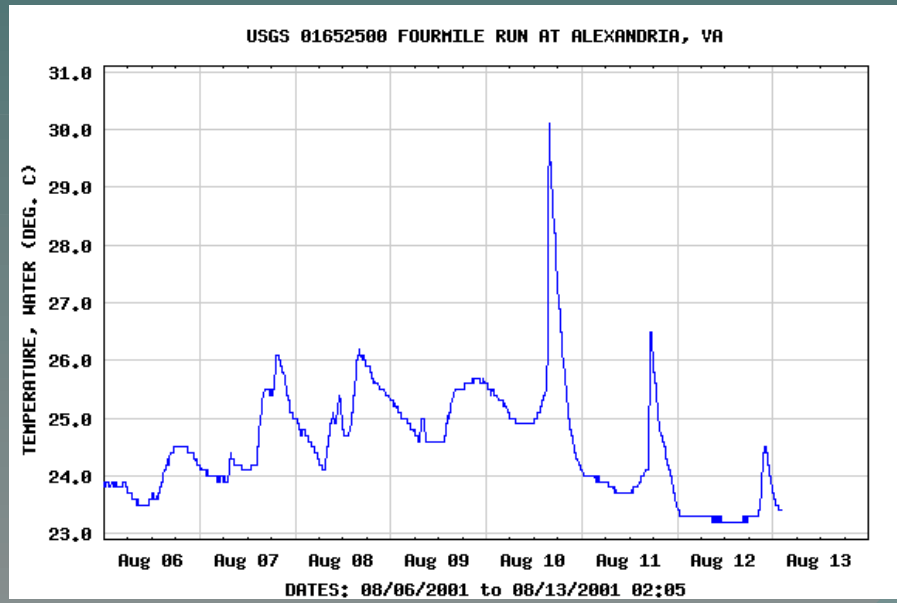
Thermal Shock; the Missing Link

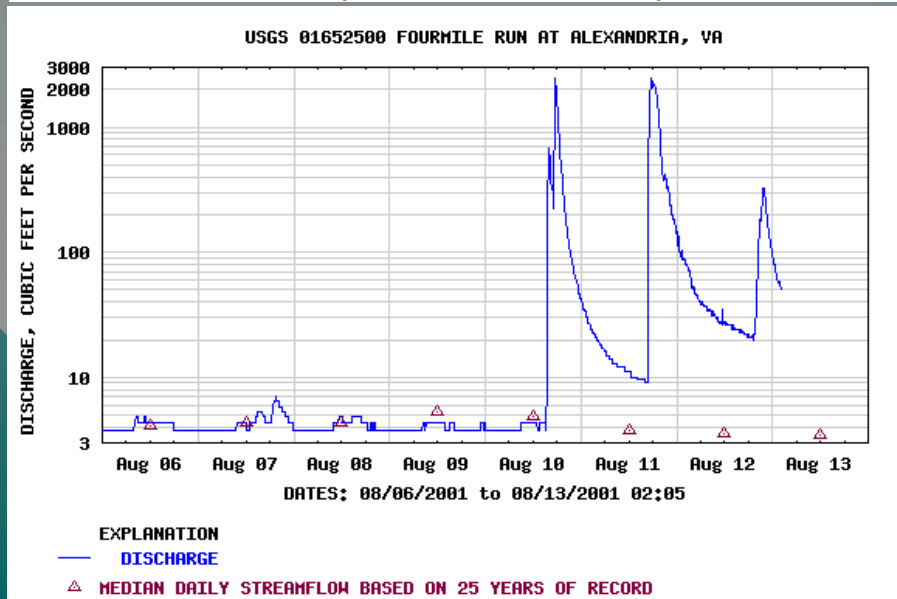
- Sun's heat is stored in parking lots & streets (esp. on warm, sunny days).
- After summer squalls, storm drains inject this heat into streams.
- The result is **THERMAL SHOCK**.



Research Needs

1. Storm sampling of temperature is vital.
2. Causation should be isolated (surface color, impervious cover shading, stream shading, etc.).
3. Mitigation techniques should be tested.

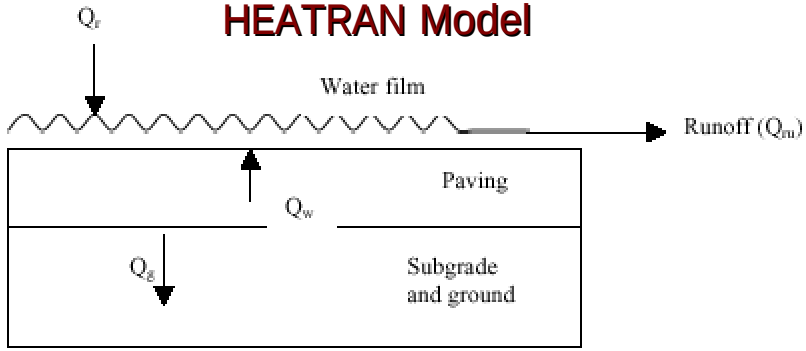




Recent Research

Dr. Bill James & Yi Li,
Univ. of Guelph (Canada),
for Kieser & Associates,
WERF Grant, Published 2004
Stormwater Thermal Enrichment in Urban Watersheds

Consolidated Drain Project, Portage, MI
HEATRAN Model



Simplified heat budget schematic during continuous rainfall, day time.

(James and ul Haq, unpublished information 2001)

Dr. Bill James, Permeable Paver Researcher

Published or co-published over 30 technical articles on permeable pavers

At least 10 focus on thermal benefits

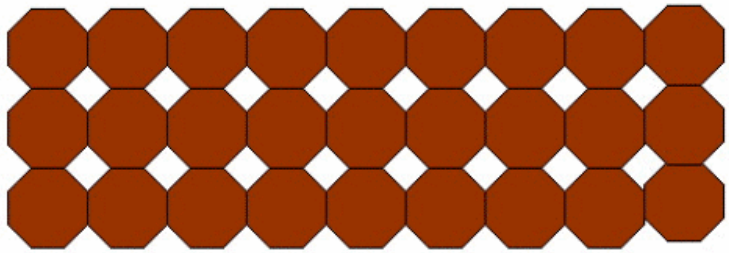


Figure 1. Schematic of Ecostone permeable concrete block paving stone pavement (Gerrits, 2001).

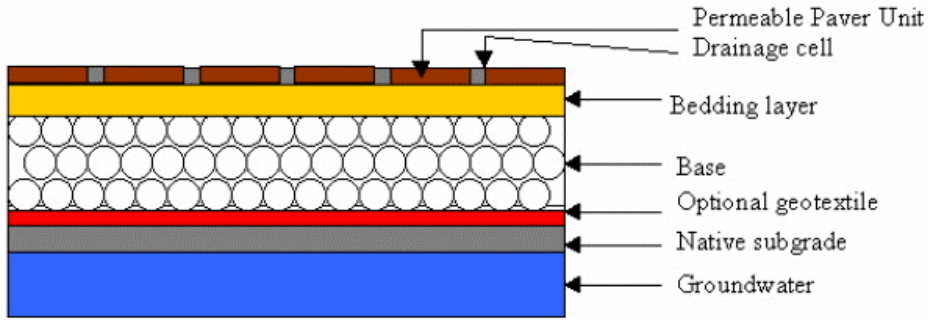


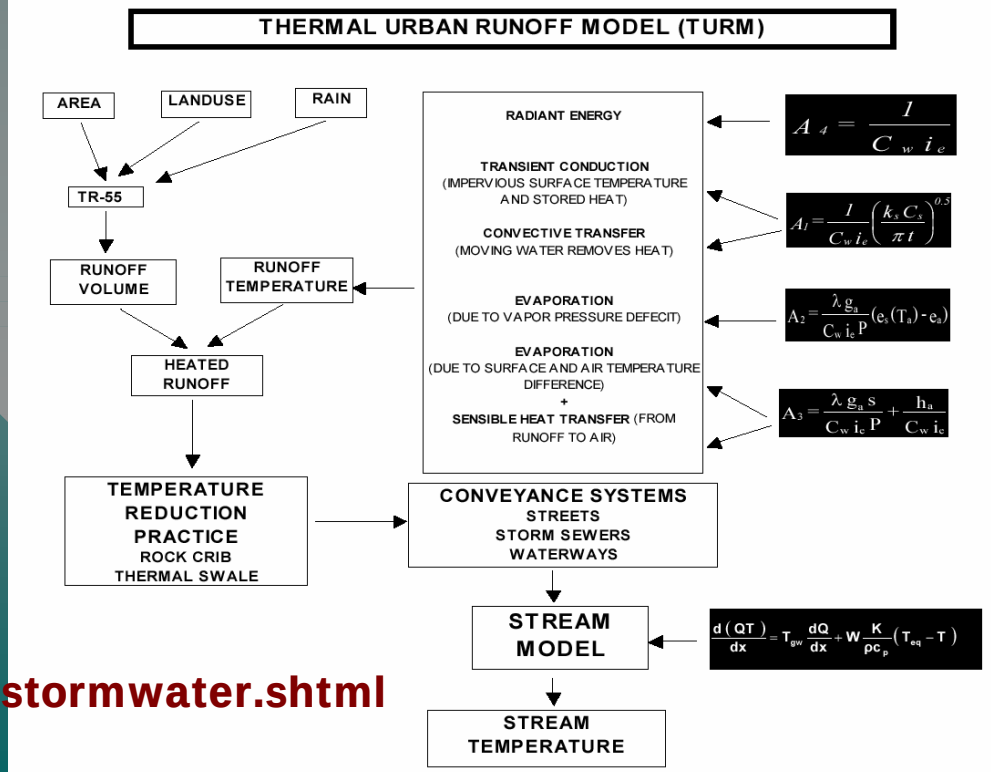
Figure 2. Sectional view of a permeable concrete block paving stone pavement (Gerrits, 2001).

Dane Co., Wisconsin

Regulates “thermally sensitive areas” with thermal runoff mitigation requirements, 2002 Stormwater Management Ordinance

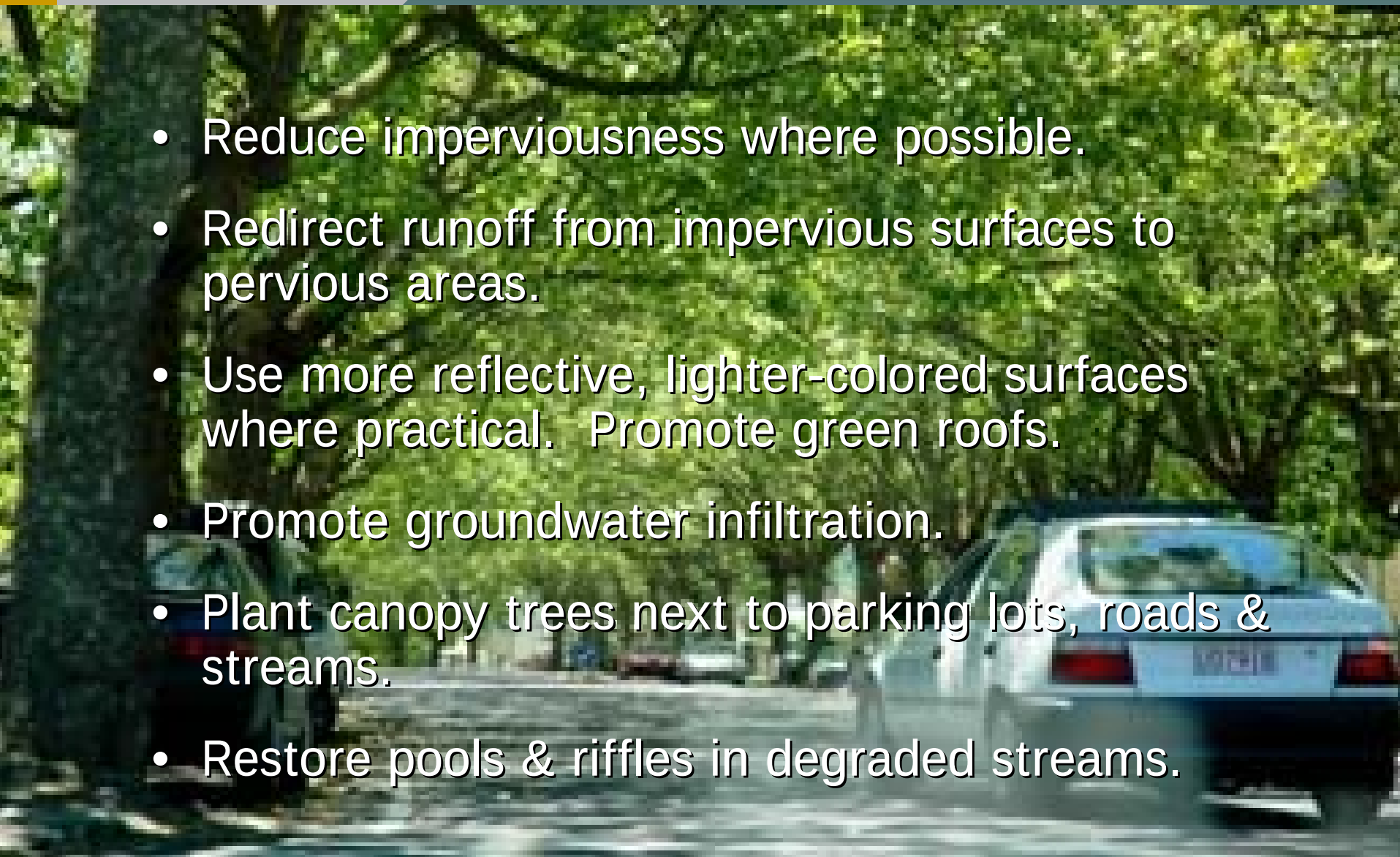
Goal: protect cold water fisheries

U. WI, Madison Excel Spreadsheet Model



www.countyofdane.com/lwrd/lakes/stormwater.shtml

Mitigation Strategies



- Reduce imperviousness where possible.
- Redirect runoff from impervious surfaces to pervious areas.
- Use more reflective, lighter-colored surfaces where practical. Promote green roofs.
- Promote groundwater infiltration.
- Plant canopy trees next to parking lots, roads & streams.
- Restore pools & riffles in degraded streams.

Mitigation Examples

Jennings-Randolph Lake & nearby Savage Reservoir in Maryland…

Army Corps of Engineers mixes water from different depths of the reservoirs & release water of uniform temperature & pH.
(to mitigate acid mine drainage)

Result…

- **Brown & Brook Trout population exploded;**
- **World-class whitewater venue created.**

Conclusions

- Heat pollution:
  - is real & measurable
  - has impacts
  - is not well regulated or enforced by statute
  - can be mitigated
- Simple, inexpensive research should be conducted:
  - to determine dominant factors
  - to develop/improve mitigation strategies

Good News & Bad News:

Thermal shock seems to be limited to urban/ suburban areas