The relationship between stream temperature and air temperature in Maryland streams

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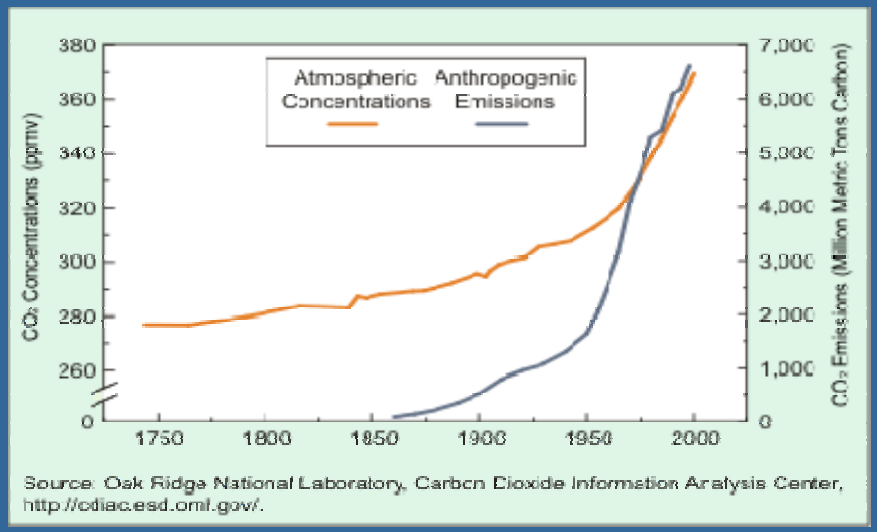
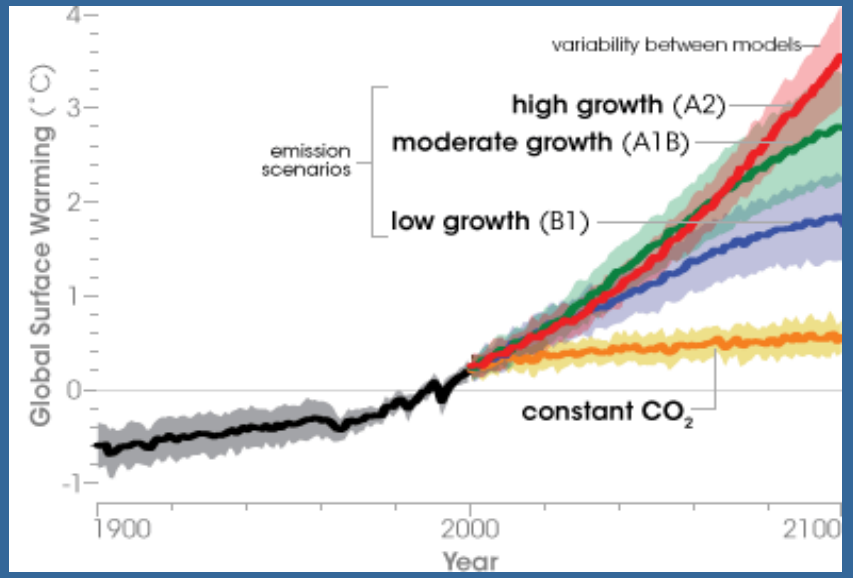
Global climate change

- Greenhouse gases
  - CO_2 has increased globally by 100 ppm (36%) over the last 250 years
  - Fastest rate from 1995 – 2005
- Temperature
  - Global mean surface temperature has risen 0.74°C over the last 100 years
  - 1998 and 2005 warmest years on record





Potential impacts on aquatic biota

- Rates of many chemical & biological processes - function of temperature
- Reductions in biodiversity; loss of some cold and cool water species
- Lethal thermal limit may be exceeded for other aquatic species – extreme droughts and heat waves
- Range expansions/new invasions of invasive species

Stream/air temperature studies

- Midwest
  - Pilgrim et al. 1998
  - Mohseni and Stefan 1999
- West
  - Neumann et al. 2003
- Nationwide
  - Easton and Scheller 1996
  - Mohseni et al. 2003
  - Bogan et al. 2003

Primary question

How will a projected increase in air temperature impact stream water temperatures in Maryland?

Objectives

- Examine the relationship between air and water temperatures in unimpaired Maryland watersheds
- Determine how stream water temperatures can be explained by air temperatures

Temperature relationships

- Physiographic region

  Highland, Eastern Piedmont, Coastal Plain

- Stream order

  1st, 2nd, 3rd

- Drainage area

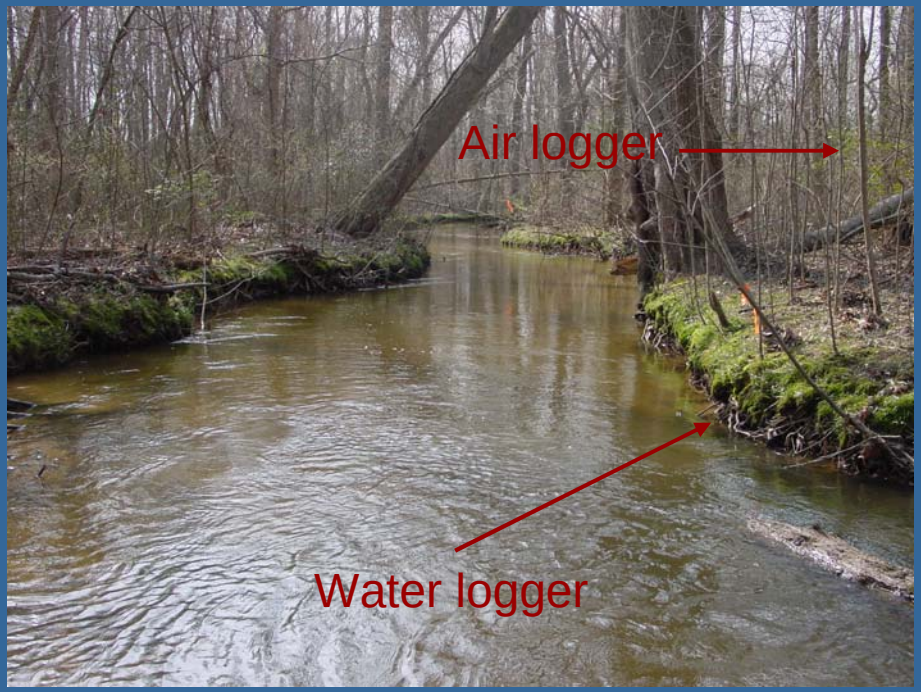
  <1000 acres, 1000-5000 acres, 5000-10000 acres, >10,000 acres

Temperature data

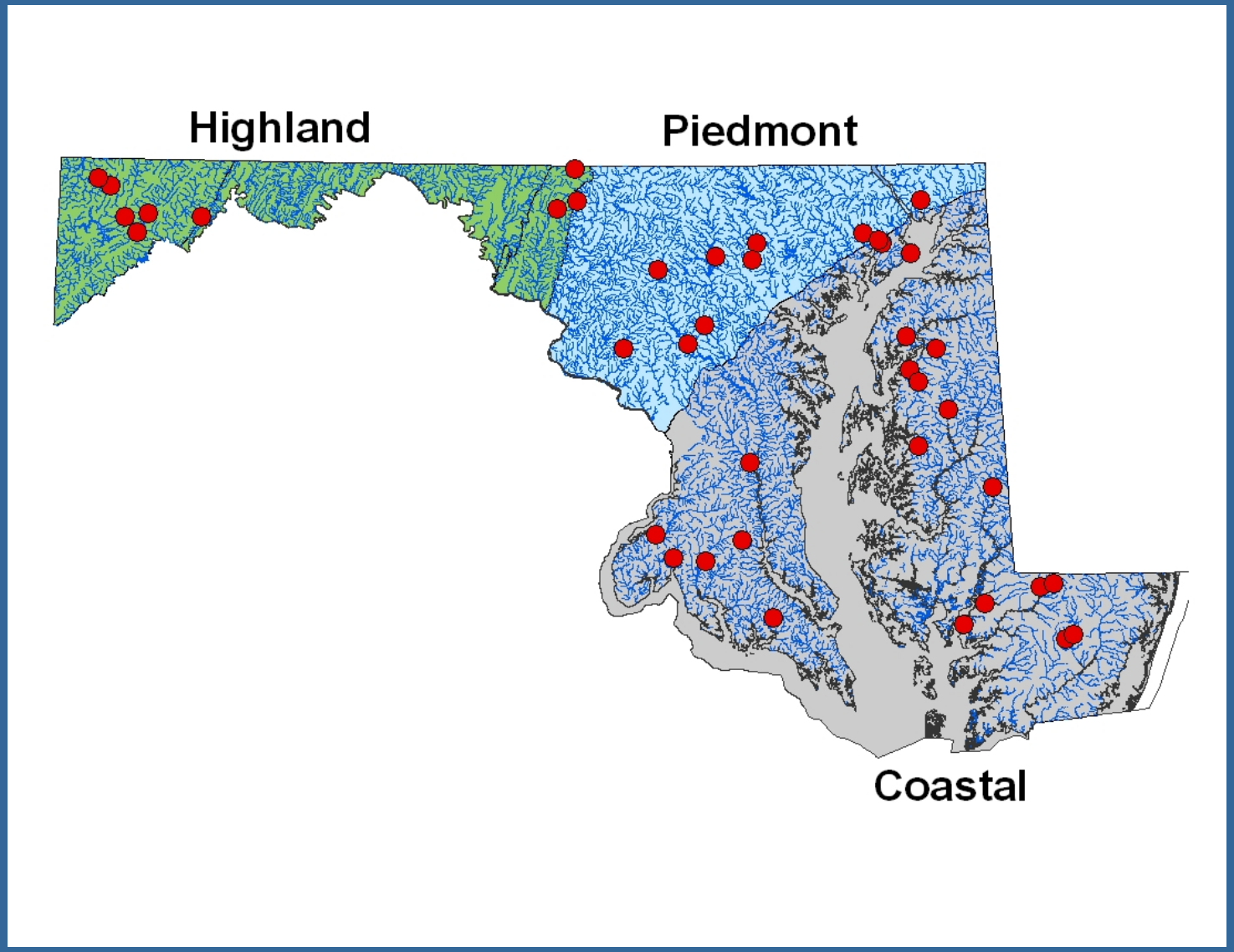
- Collected from 29 MBSS sites (20 Sentinel Sites)
- Unimpaired watersheds
  - % Development
    - Mean - 3.1%
  - % Impervious surface
    - Mean – 0.2%

Temperature data

- Temp logger data from June-August
- Average 3 day temperature
- Years (2005-2007)
- Water and air temp logger placed at each site

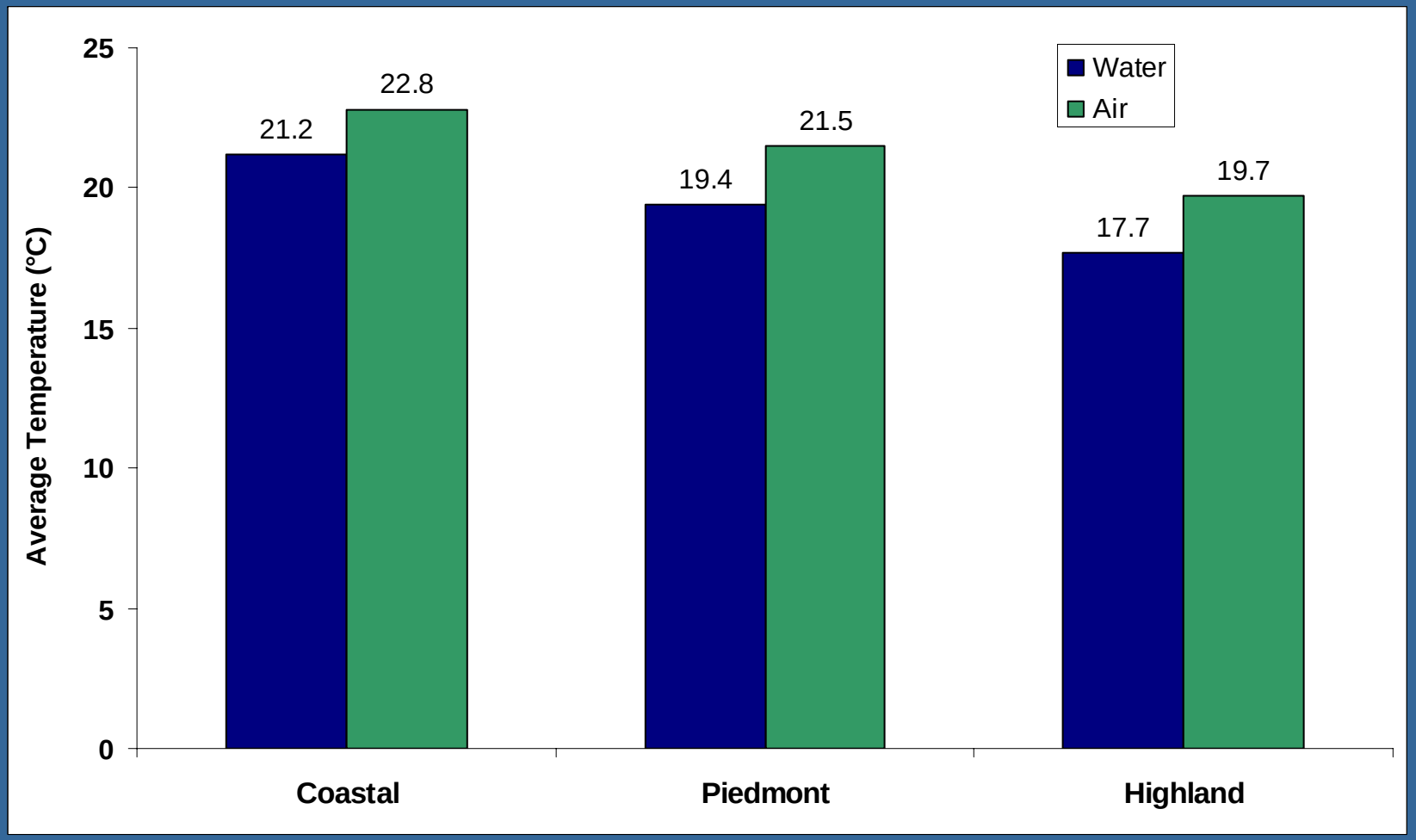


Temperature sample sites



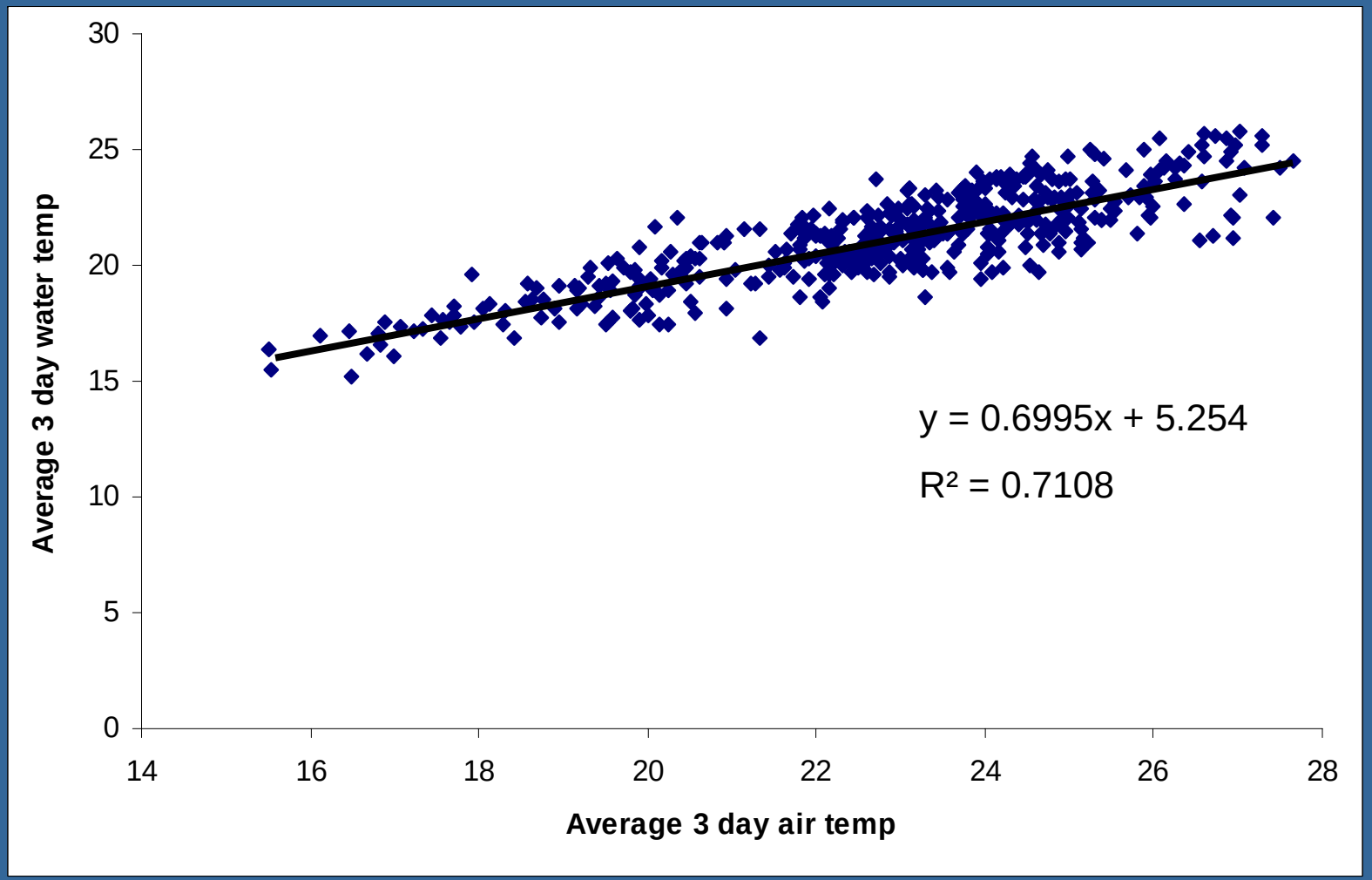
Physiographic region

Average summer air and water temperatures



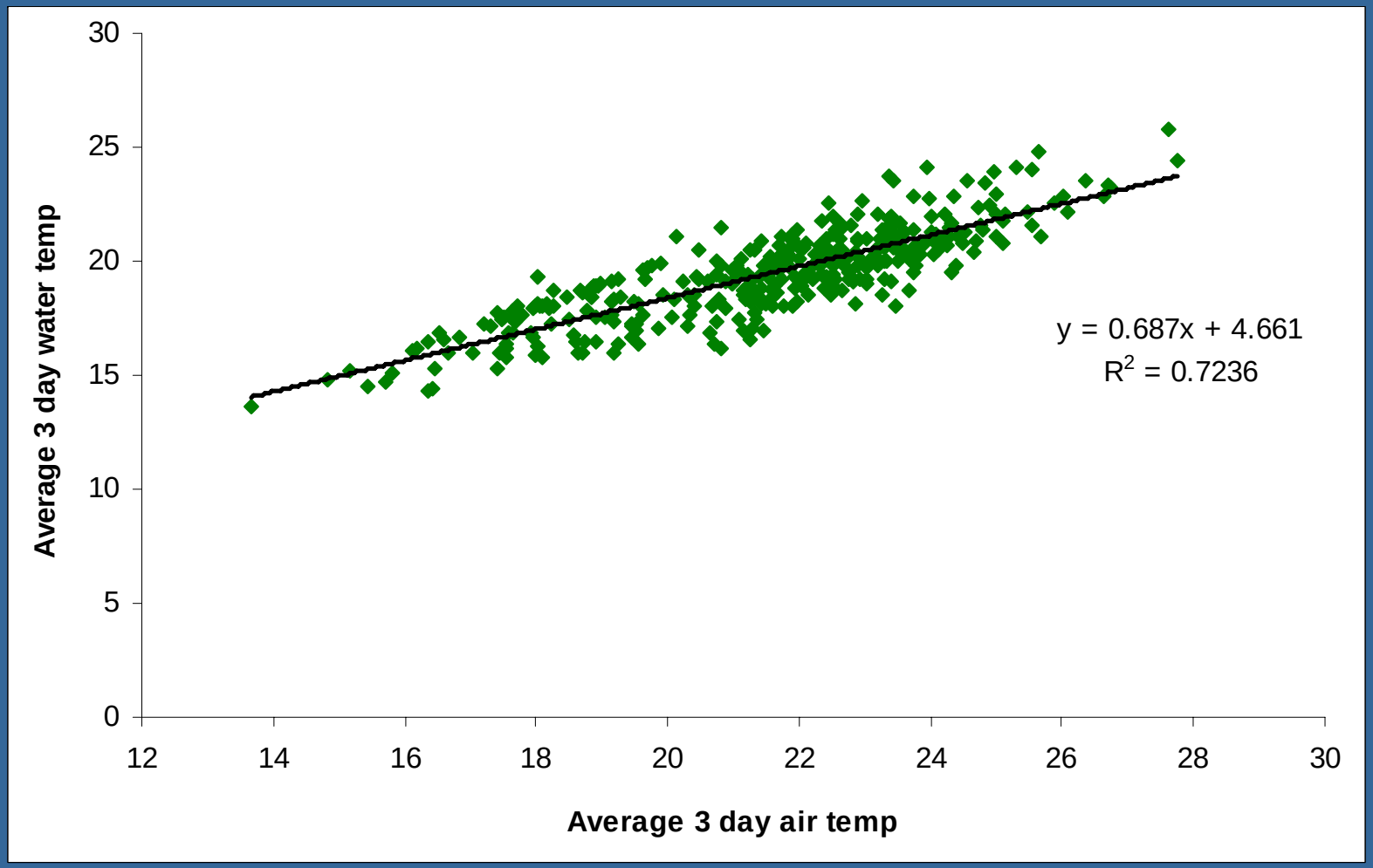
Physiographic region

Coastal – 15 pairs of data



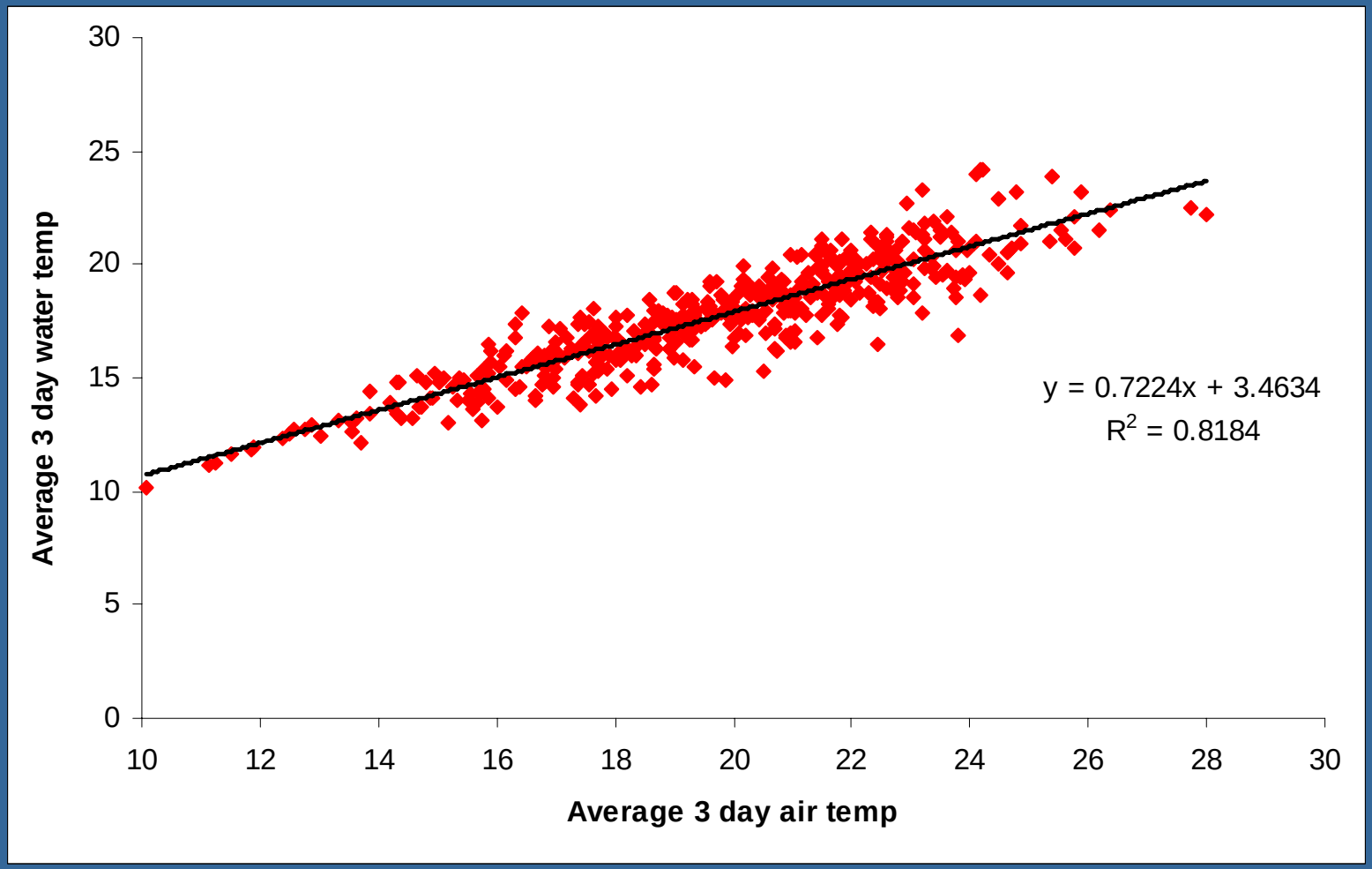
Physiographic region

Piedmont – 10 pairs of data



Physiographic region

Highland – 12 pairs of data



Physiographic region results

Region	Water temp range (°C)	Slope	R-square
Highland	10.1 - 24.1	0.722	0.818
Piedmont	13.6 - 25.8	0.687	0.723
Coastal	15.2 - 25.7	0.699	0.711

ANCOVA - No difference based on physiographic region

Stream order results

Stream order	Logger pairs	Slope	R-square
1st	18	0.781	0.802
2nd	14	0.756	0.777
3rd	5	0.908	0.874

Drainage area results

Drainage area (acre)	Logger pairs	Slope	R-square
<1,000	18	0.752	0.785
1,000 - 5,000	11	0.785	0.772
5,000 - 10,000	3	0.931	0.946
>10,000	5	0.791	0.864

General results

- Linear relationship between air and water temperatures
- Air/water temperature rate is 0.7-0.8°C in unimpacted watersheds
- No difference in air/water temperature relationship based on physiographic region
- Potential increase in air/water temperature rate with increased stream size

Current work

- Air and water temperature loggers deployed at all 2008 MBSS sites
  - Sentinel sites (1 year)
  - MBSS (6 months)
- Examine air/water temperature relationship across range of watershed landscape conditions

Acknowledge

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