

## Introduction

Recent studies have shown that small water bodies are far more abundant than previously understood. Ponds are known to have both positive and negative impacts on stream networks.

“Constructed” ponds of human origin are rapidly proliferating in many regions, yet their abundances are largely undocumented and their increasing ecological impact remains poorly understood.

## Objectives

- Compare the **current distribution** of ponds in relation to stream networks and population density (in Chester County, southeast PA, during 2005)

- Trace the **history** of pond appearance, disappearance and net proliferation (within the Brandywine Creek Watershed, 1970-2005)

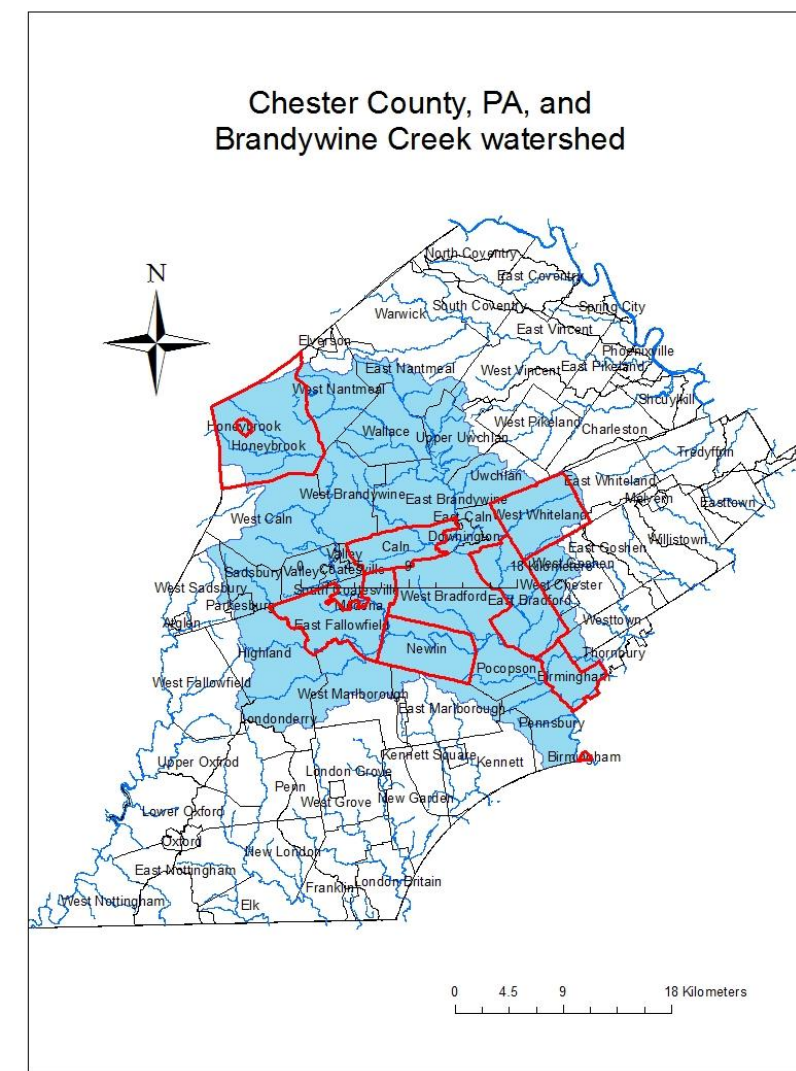


Fig. 1. Chester County, southeast Pennsylvania, with the Brandywine Ck watershed (in blue), and 7 municipalities targeted for historical analysis (outlined in red).

## Methods

### Current Pond Distribution

- Pond polygons were created from aerial photos using ArcGIS
- Analyses of 73 municipalities in Chester County, southeast PA
- Ponds evaluated in terms of
  - ♣ size frequency distribution
  - ♣ “landscape position” (e.g., articulation with streams)
  - ♣ relationship of pond density to population density

### Pond History

- Changes in pond abundance recorded from 1937-2005 in 7 municipalities within the Brandywine Creek watershed
- Computed annual rates of change in
  - ♣ new pond construction
  - ♣ pond disappearance
  - ♣ net change in density
- Annual rates of change were related to population density

# History and Distribution of Ponds in an Urbanizing Landscape

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## Results - Current Pond Distribution

Pond abundances were related to size (Fig. 2). Ponds > 0.1 ha were identified with high accuracy; smaller ponds were progressively more difficult to distinguish from aerial photos. Analyses were restricted to ponds > 0.1 ha.

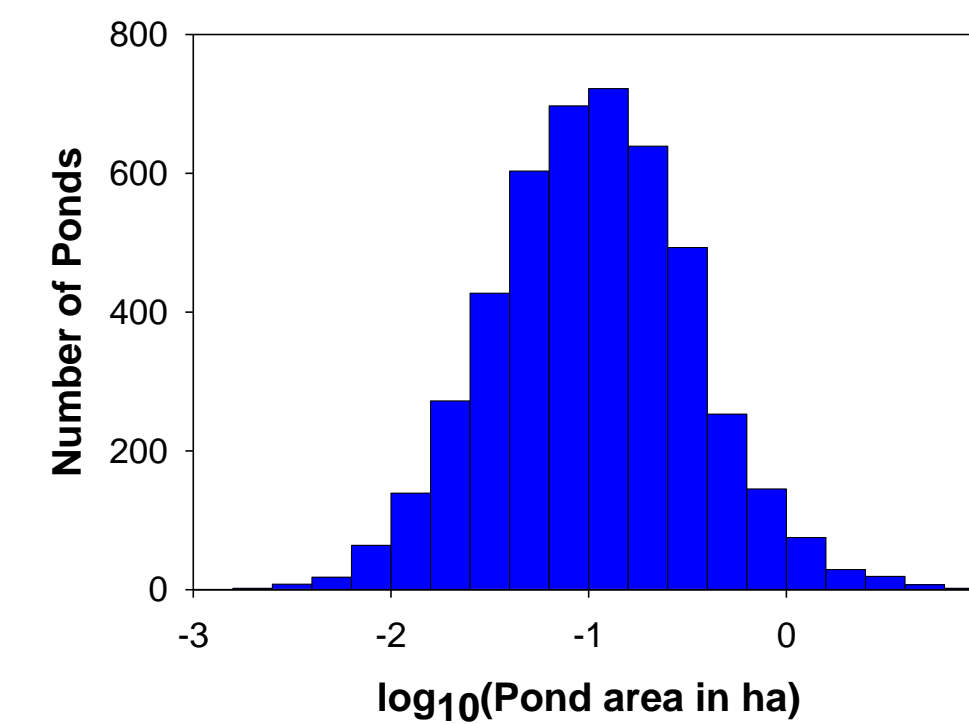


Fig. 2. Size distribution of ponds in Chester County, PA.

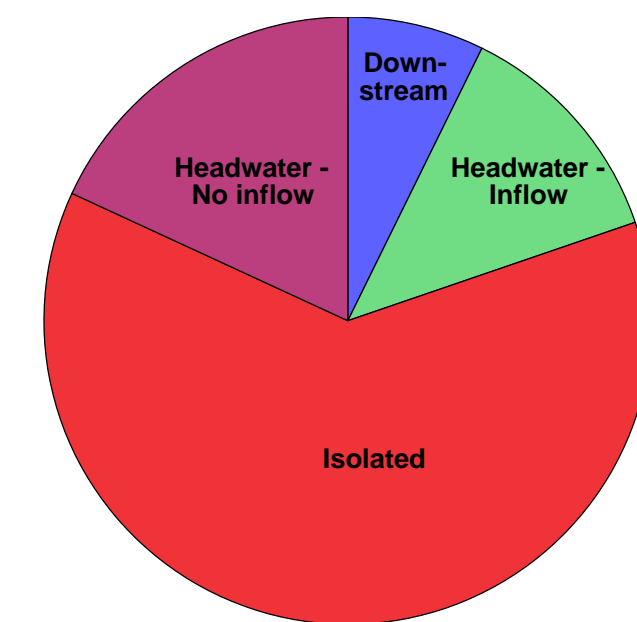


Fig. 3 Landscape Positions

Based on available GIS stream data, ponds (Fig. 3) were

- “isolated” (unconnected to streams by permanent surface flow)
- the sources (no inflow) for “headwater” (first order) streams
- headwater ponds receiving inflow
- “downstream” ponds impounding  $\geq 2^{\text{nd}}$  order streams

Based on yr-2000 aerial photos and census data, pond densities were significantly lower ( $p < 0.001$ ) in municipalities with higher population densities (Fig. 4).

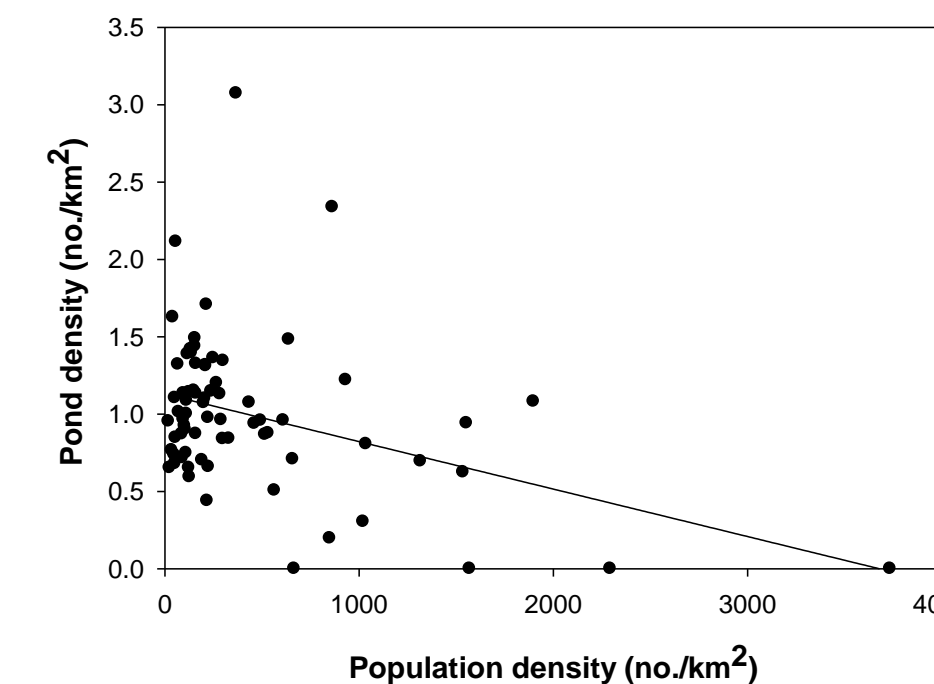


Fig. 4. Pond density vs. population density in 73 Chester County municipalities in 2000.

## Results - Pond History

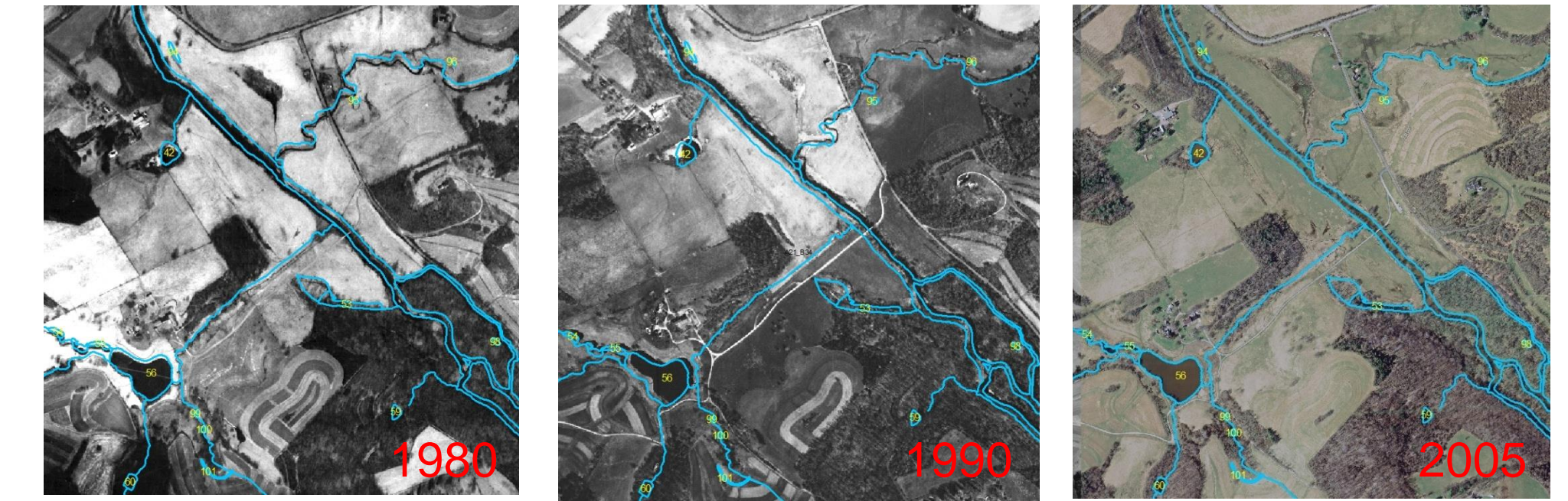


Fig. 5a-c. Aerial photos of a 2.2 km<sup>2</sup> portion of East Bradford Township, Chester County, PA

Pond appearances and disappearances were often related to changes in land use (Fig. 5a-c).

The density of ponds (>0.1 ha) in 7 townships within the Brandywine Creek watershed increased steadily from 1971 – 2005 (Fig. 6), and averaged 0.02 new ponds/km<sup>2</sup>/yr.

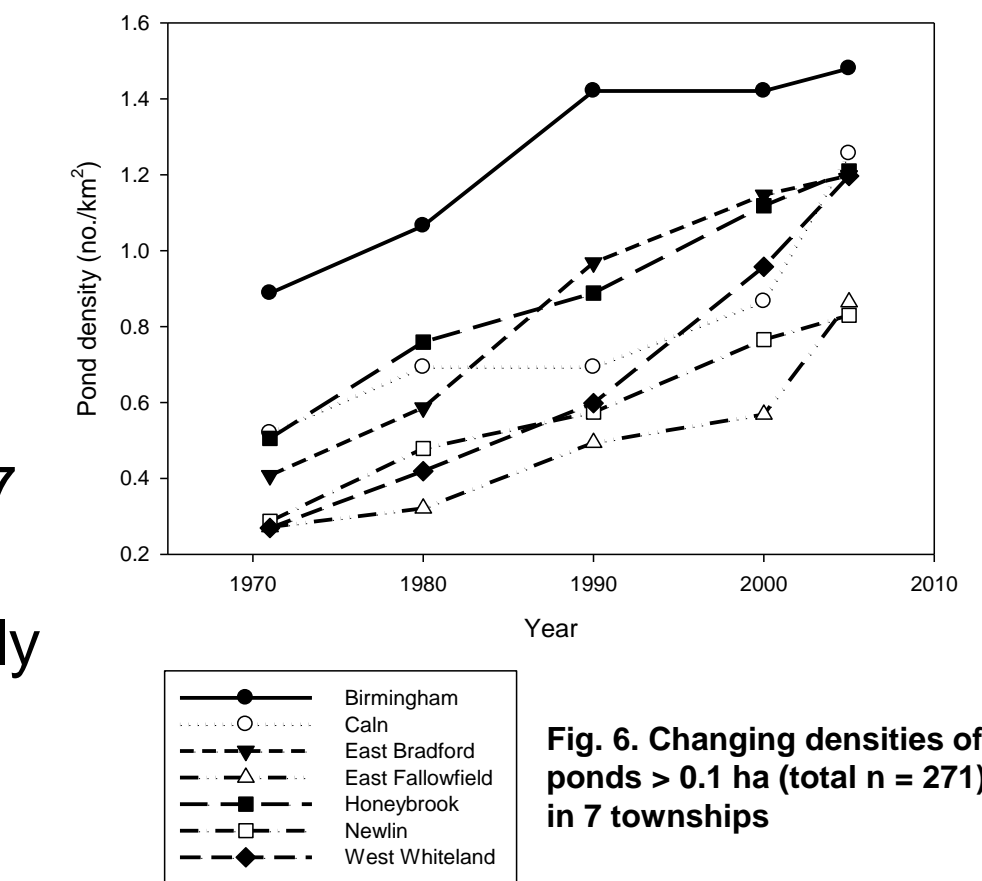


Fig. 6. Changing densities of ponds > 0.1 ha (total n = 271) in 7 townships

## Conclusions

- GIS analysis of aerial photography is an effective way of determining the distribution and historical trends of ponds > 0.1 ha.
- Approximately 61.6% of ponds were currently considered “isolated” from streams; however, available stream data layers fail to include very small, often intermittent, pond outflows.
- Whereas ponds historically were typically “downstream” impoundments, only 5.7% of current ponds are in downstream locations.
- Densities of ponds have been steadily increasing over recent decades in southeast PA, but are reduced in municipalities with very high population densities
- associated with housing and road construction are increasing in number.
- Based on known ecological effects of individual ponds, and their increasing prevalence in regional landscapes, the aggregate impact of pond proliferation on stream networks is likely to be substantial.