

Have we seen peak water use in the Delaware River Basin?

Water withdrawals and consumptive use estimates for 1990-2017,
with projections to 2060

AWRA Mid-Atlantic Conference

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and

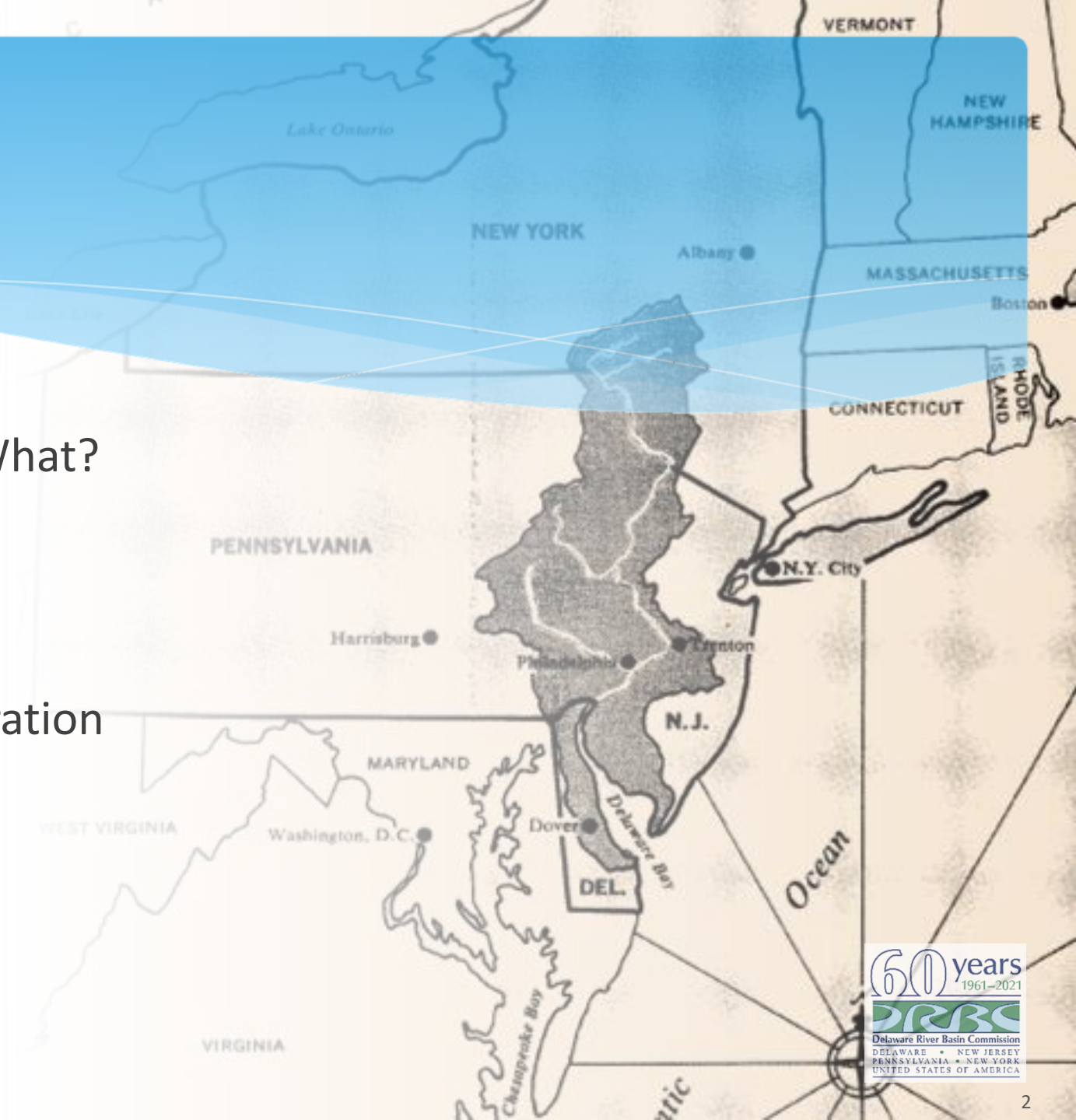
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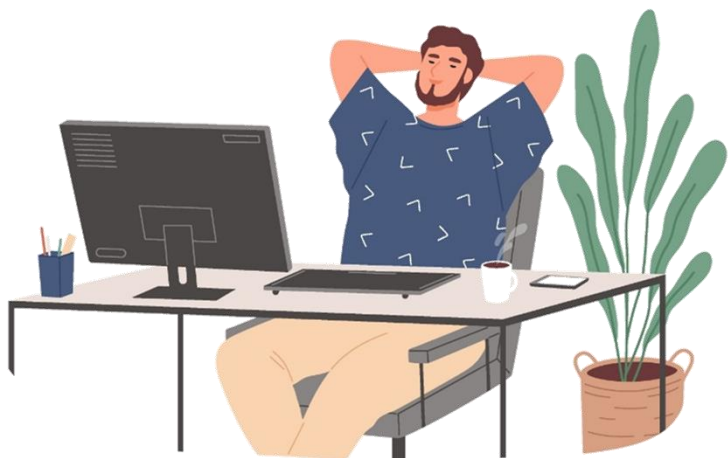


Outline

1. Water Supply Planning – Why and What?
2. Methodology
3. Results
4. Supplemental analysis: population
5. Supplemental analysis: power generation
6. Next Steps
7. Questions

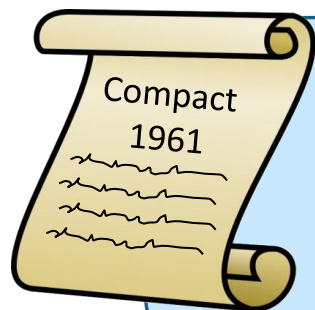


1. Water Supply Planning: Why are we projecting withdrawal data?



Is there enough water to meet future demands?

- What are the current/future demands? ←
- How does it compare against current allocations?
- What about a repeat of the Drought of Record?
- What about climate change?



DELAWARE RIVER BASIN COMPACT (1961)

3.6 General Powers.

- Conduct and sponsor research on water resources
- Collect, compile, correlate, analyze, report and interpret data on water resources and uses in the basin

1. Water Supply Planning: What are the planning objectives?

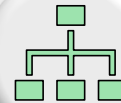


Provide projections of future average annual water use in the Delaware River Basin, through the year 2060, to be used in future planning assessments.

Represent each water use *sector* at the Basin-wide scale.



Apply GW results to the 147 sub-watersheds (Sloto & Buxton, 2006) and the sub-watersheds of SEPA-GWPA.



Apply SW results at the source level for future availability analyses.



Relate results to regulatory approvals.



2. Methodology: Primary data scale to analyze?

Analysis at the system level
(mostly)¹

Projections at a scale finer
than the system level...



Pertinent metadata is often at the system level (e.g., regulatory)



Reporting inconsistencies disguised as trends



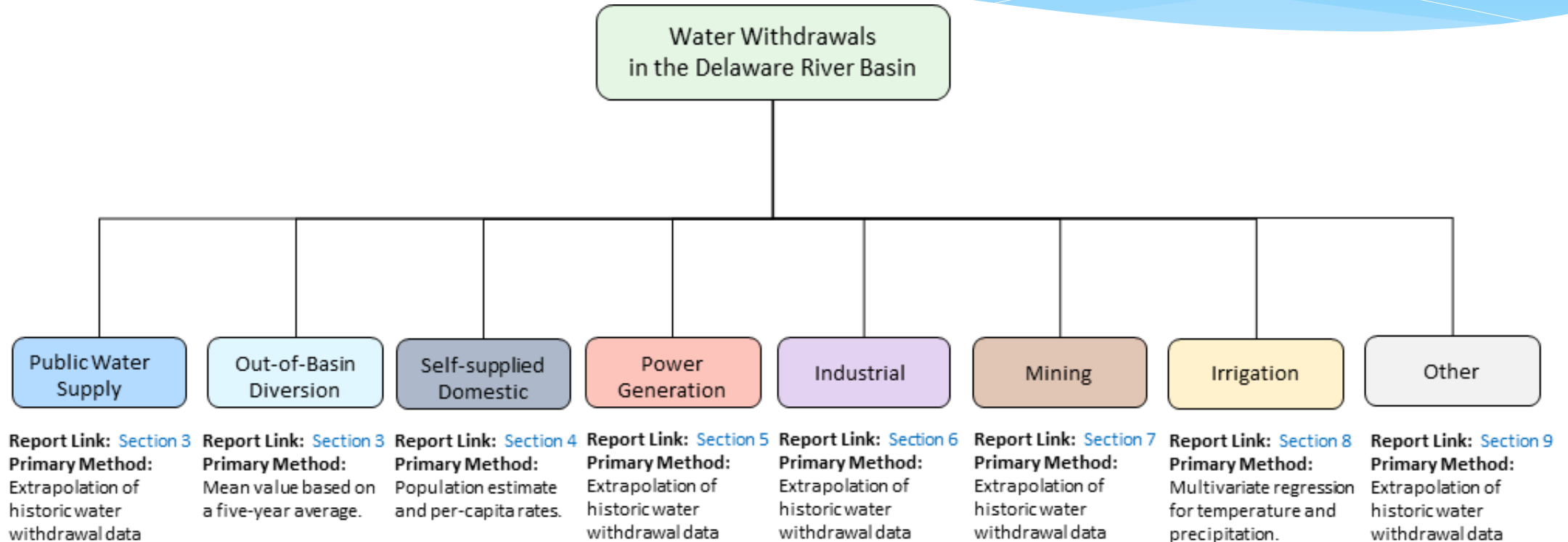
System sources show cause-and-effect relationships

¹ Self-supplied domestic and Irrigation used different methodologies

2. Methodology: Breakdown by sector



The primary method is extrapolation of historic reported withdrawal data

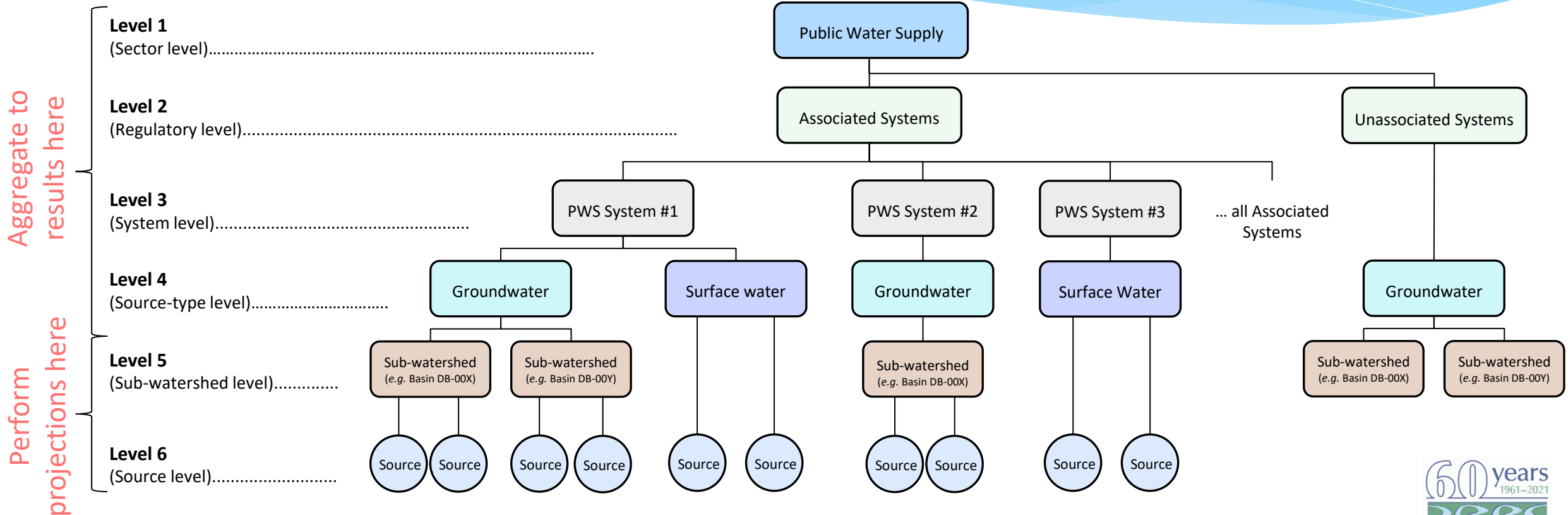


2. Methodology: A plan for projecting data?

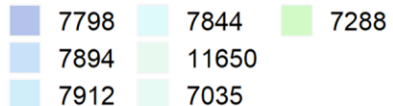
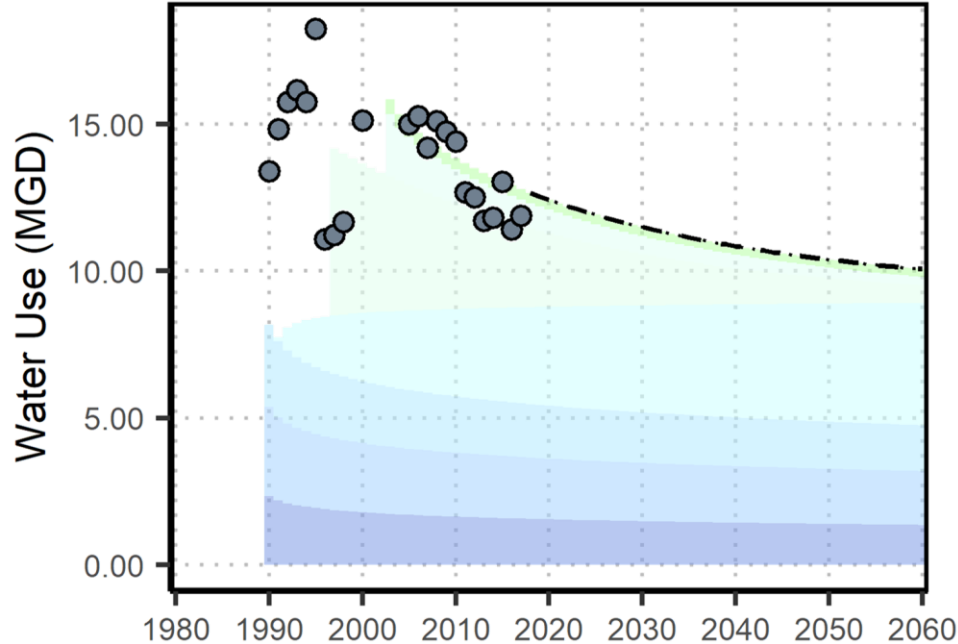


Where do we start?

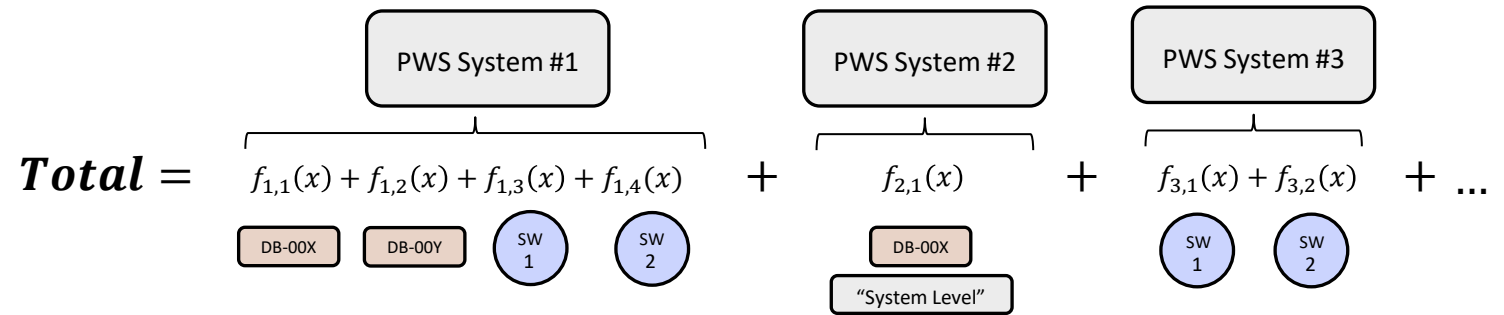
Time-series hierarchy



2. Methodology: How do you aggregate projections?



“Bottom-up approach”



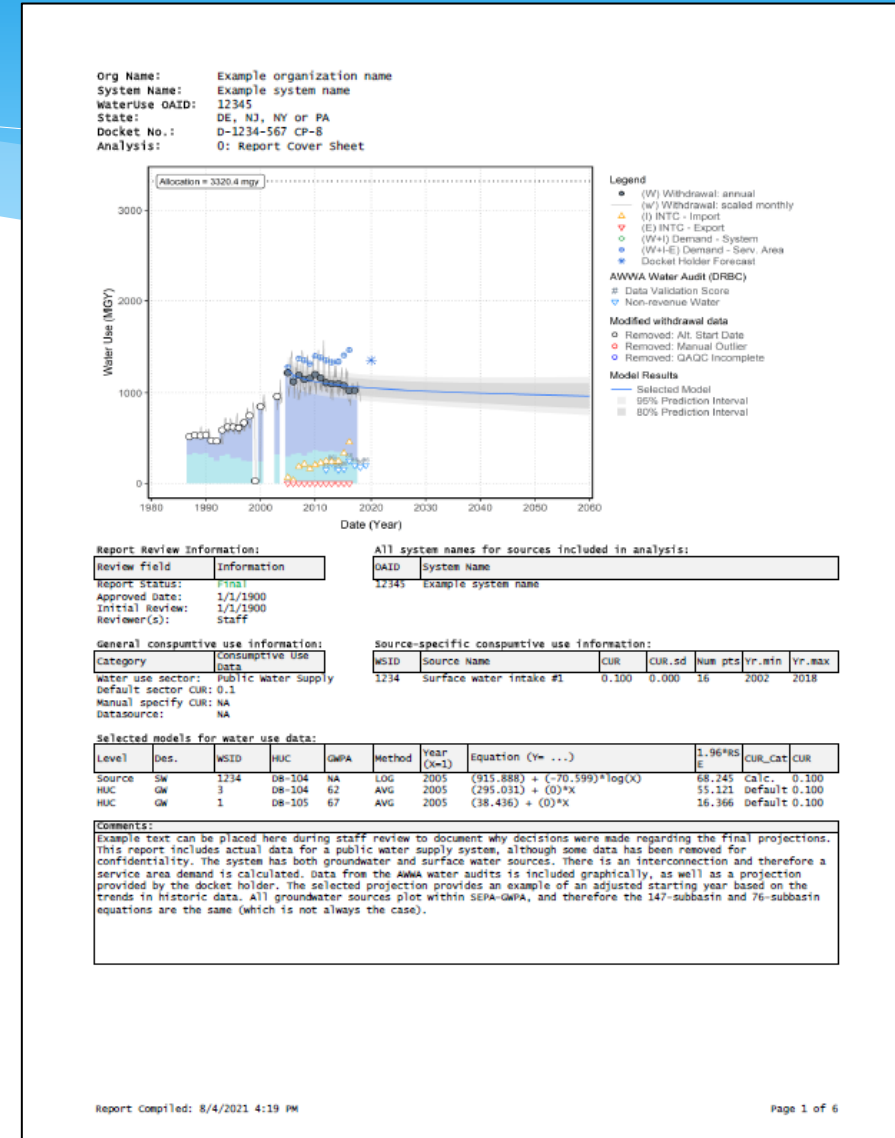
2. Methodology: A plan for projecting data?

The model is based on extrapolating historic withdrawal data.

- Significant QAQC of historic data
- 600+ system reports
- 1,100+ equations

Method	Associated		Unassociated		Subtotal	
	GW	SW	GW	SW		
Mean Value	218	71	147	0	436	
OLS	Exponential	72	17	36	0	125
	Linear	83	11	11	0	105
	Logarithmic	250	74	69	0	393
Other	62	48	4	0	114	
Subtotal	685	221	267	0	1,173	

- OLS = Ordinary Least Squares
- Associated means system operate above review thresholds and has allocation regulatory approval.
- Does not include agriculture and self-supplied domestic analyses

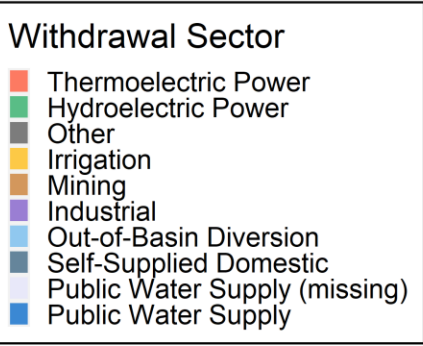
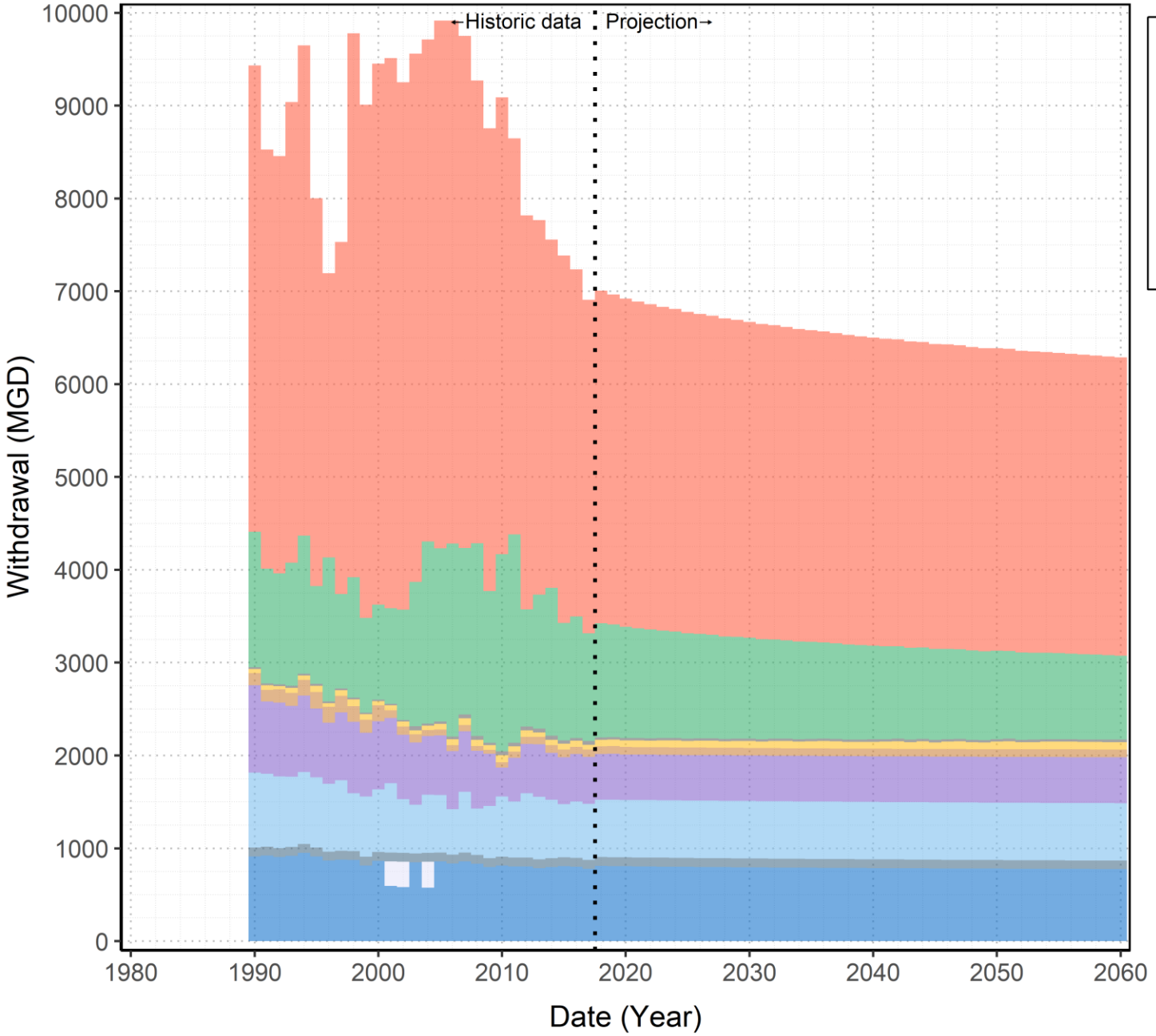


3. Results



Wing Dam on The Delaware River
Lambertville New Jersey on the left and
New Hope Pennsylvania on the right.
Credit: © James Loesch
Used with permission

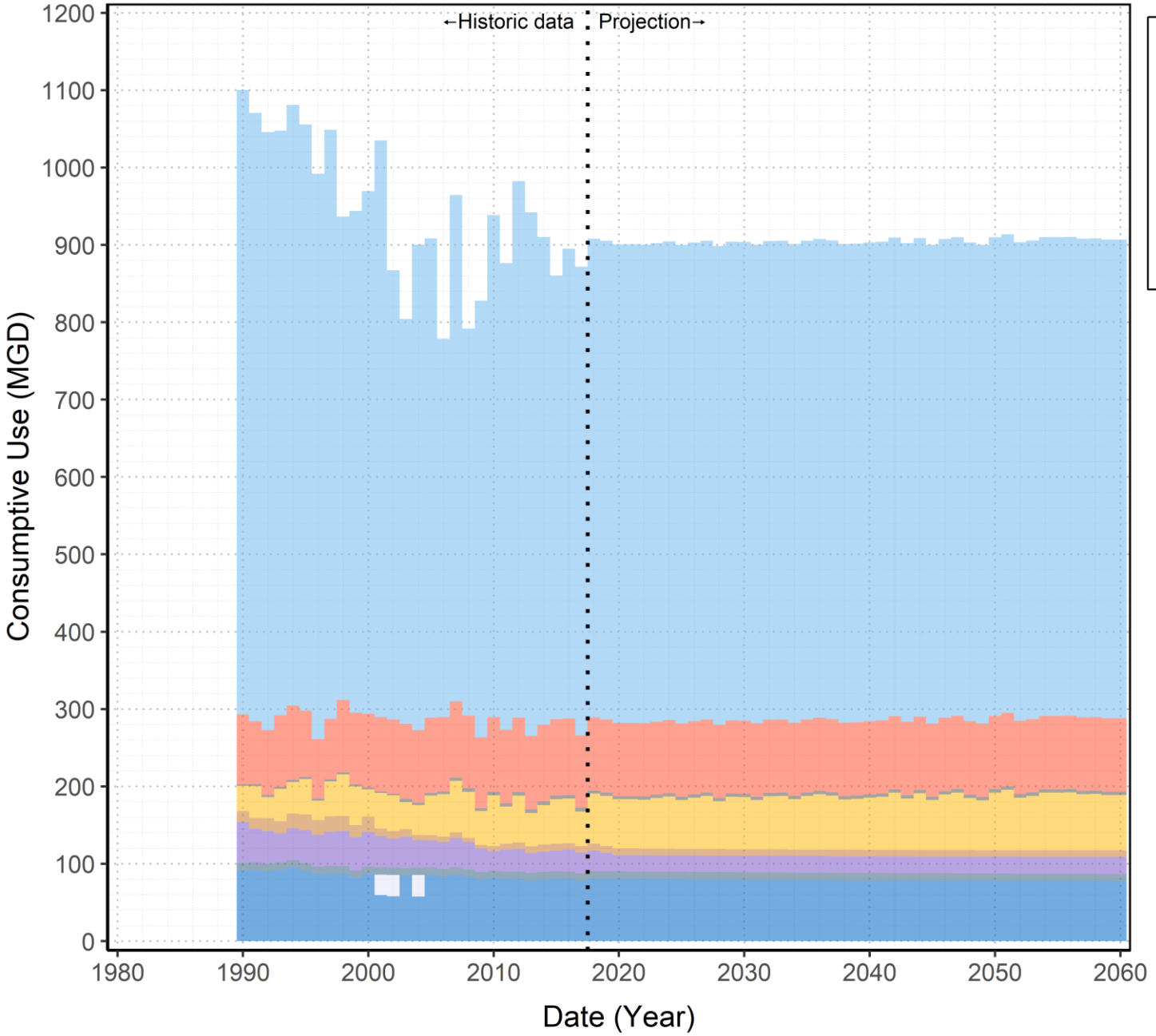
Historic and projected water withdrawals from the Delaware River Basin



- **Peak withdrawals have occurred**
- **Thermoelectric** decreases since 2007 will plateau as coal-fired facilities using once-through are limiting
- **Public Water Supply** has shown and projects decreases despite historic and projected growing in-Basin population
- **Hydroelectric** withdrawals are significant; however, no consumptive use
- **Industrial** withdrawals historically decrease, but plateau



Historic and projected consumptive water use in the Delaware River Basin

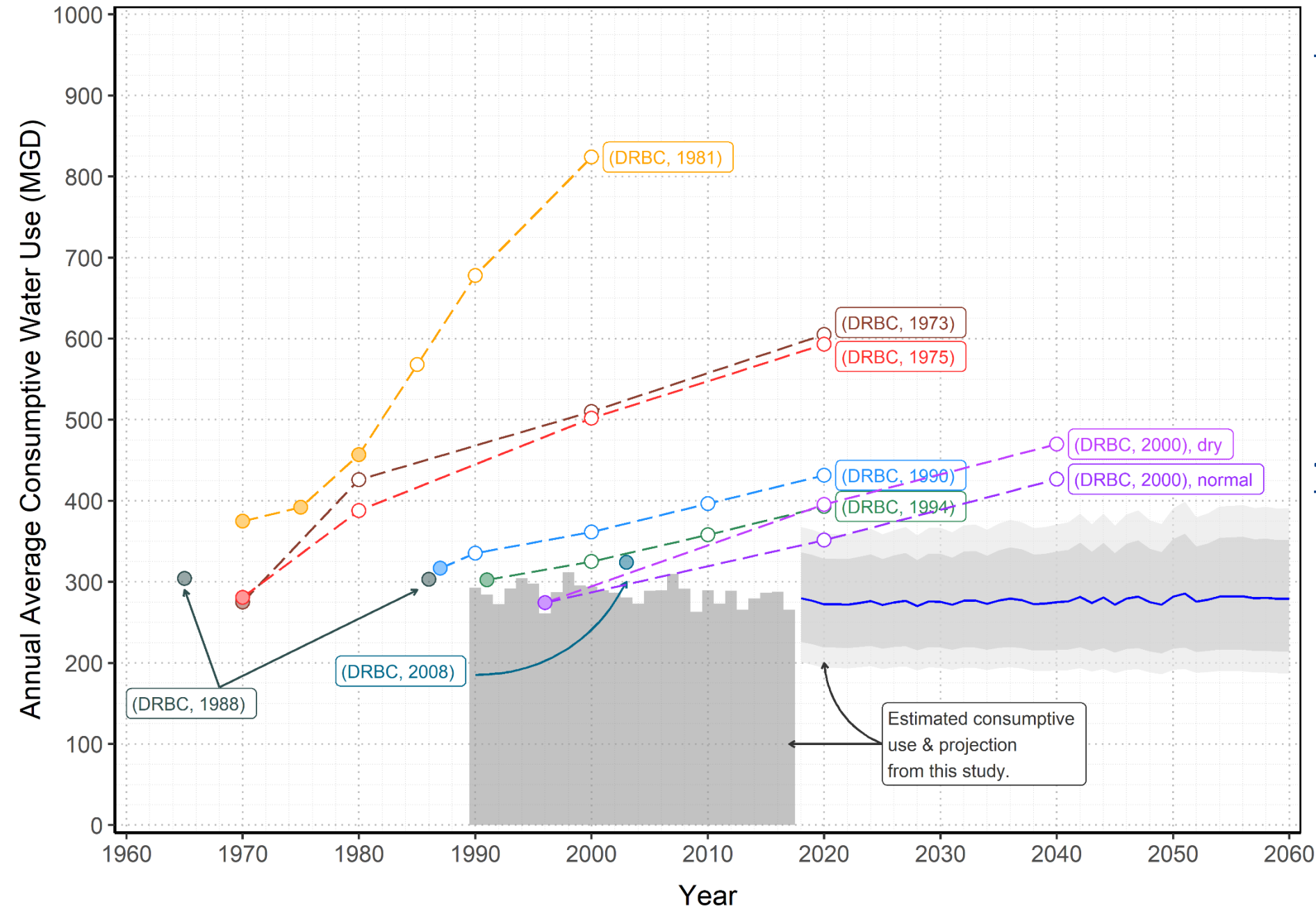


- **Consumptive use projected to remain relatively constant**

- **Largest consumptive use is Out-of-Basin Exports under a U.S. Supreme Court Decree**
- **Thermoelectric** consumptive use constant despite decreased withdrawals due to changes in technology
- **Irrigation** is significant and shows slight increases related to projected changes in climatic variables
- Significant **spatial variation** in terms of both withdrawal and consumptive use
- Comparison against previous DRBC estimates (next slide)



Previous DRBC projections of Basin-wide consumptive water use (comparison)



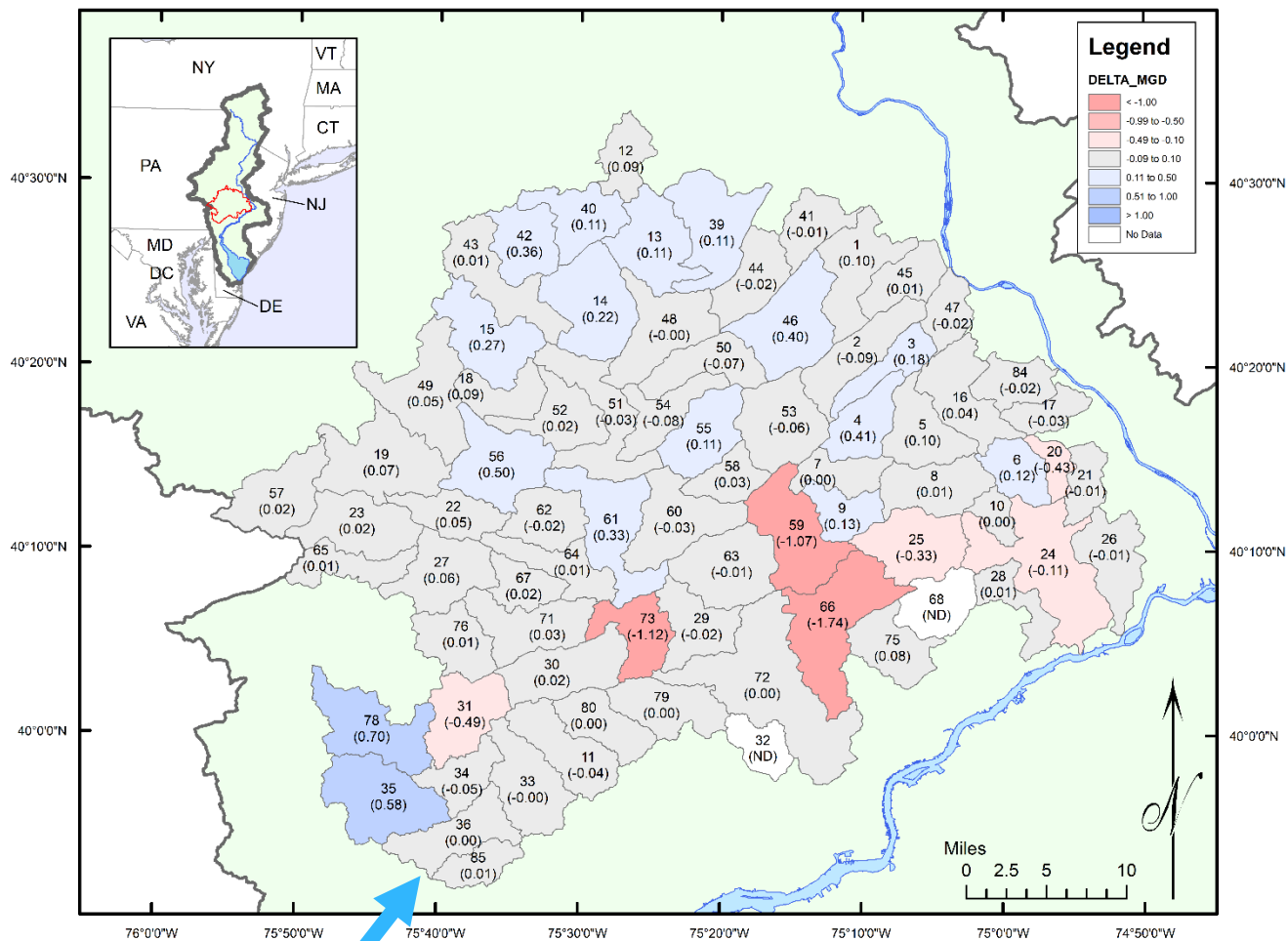
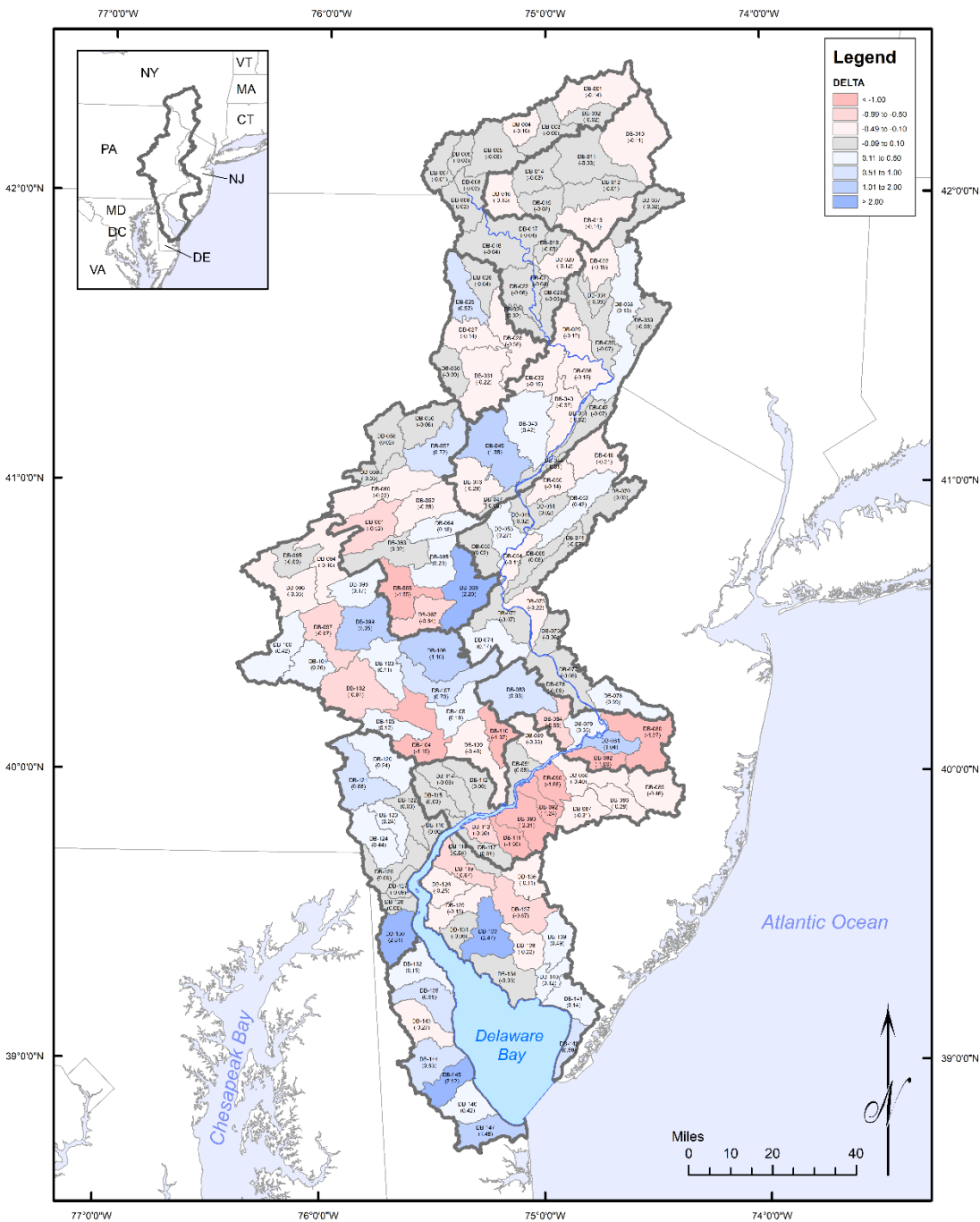
Prior projections often:

- Work from one estimated year of withdrawal data
- Are performed indirectly (e.g., applying population projections)
- May have considered/ accounted for planned facilities (e.g., power)

This study:

- Almost 30 years of data
- Aligns with previous estimates
- Most conservative projection





SEPA-GWPA:

- Decreasing ($\Delta < -0.10$ MGD) 7 subbasins (-5.273 MGD)
- Neutral ($-0.10 < \Delta < 0.10$ MGD) 51 subbasins (+0.325 MGD)
- Increasing ($\Delta > 0.10$ MGD) 16 subbasins (+4.629 MGD)

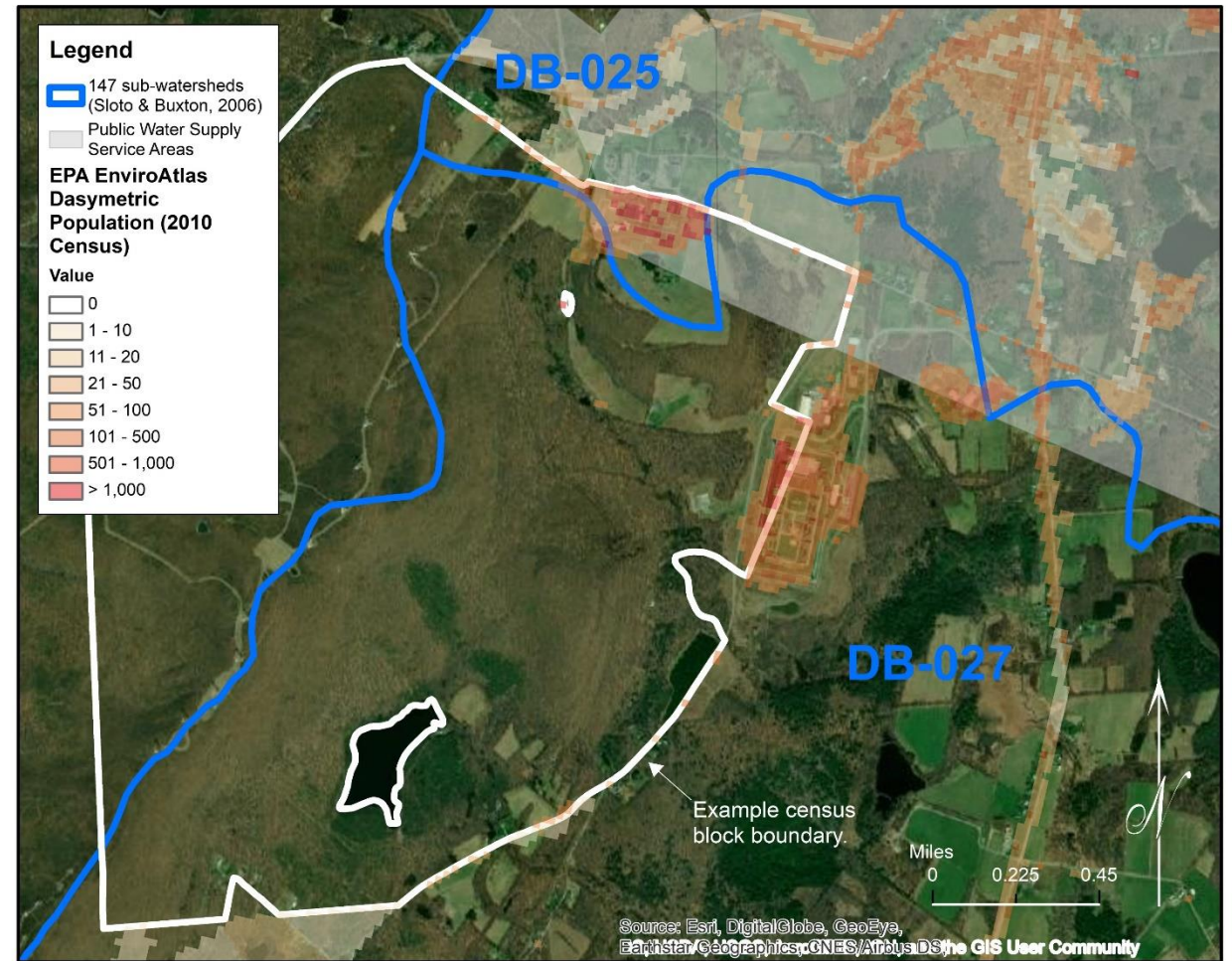
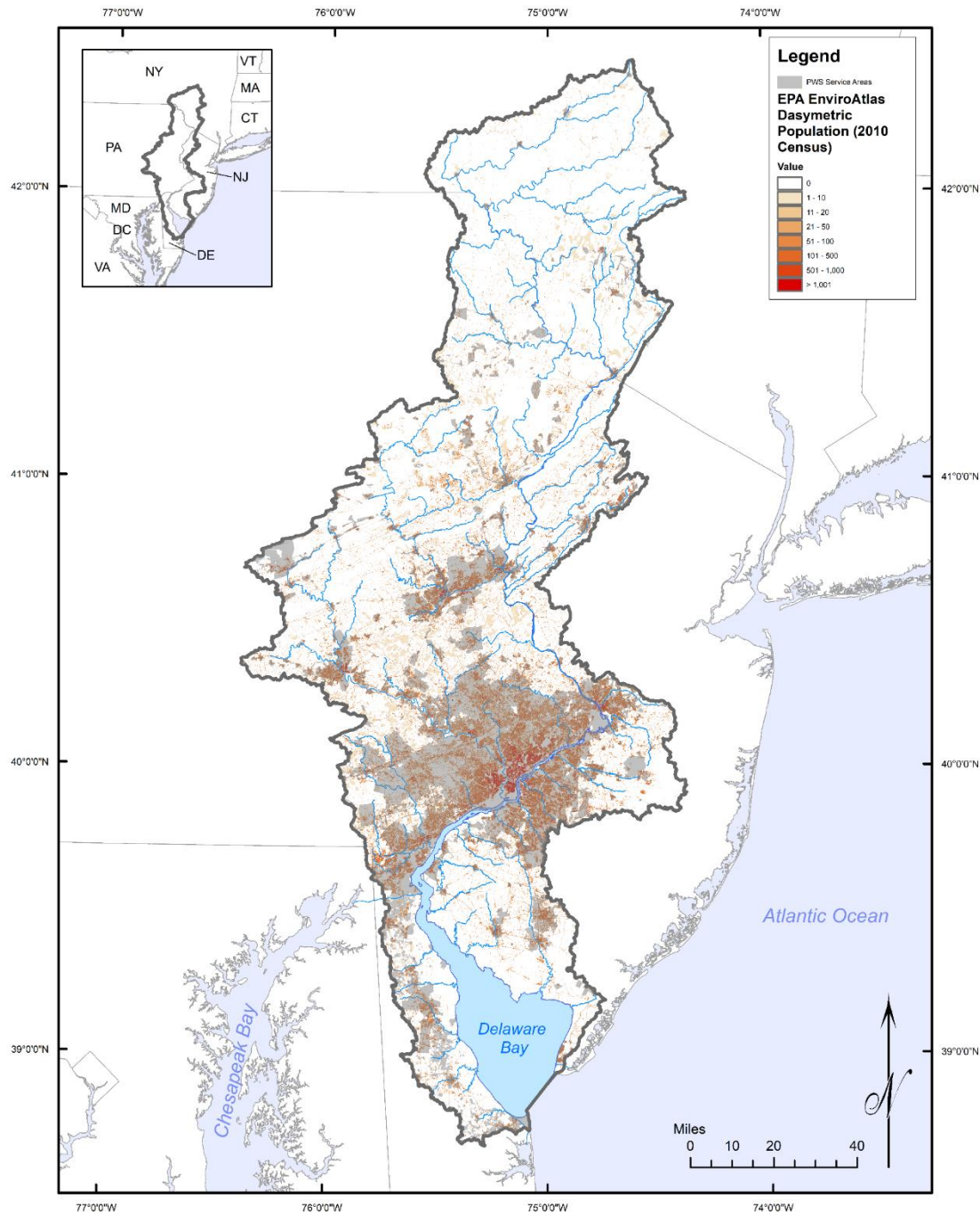
147 Subbasins:

- Decreasing ($\Delta < -0.10$ MGD) 51 subbasins (-26.500 MGD)
- Neutral ($-0.10 < \Delta < 0.10$ MGD) 56 subbasins (-1.451 MGD)
- Increasing ($\Delta > 0.10$ MGD) 40 subbasins (+26.930 MGD)

4. Supplemental analysis: population

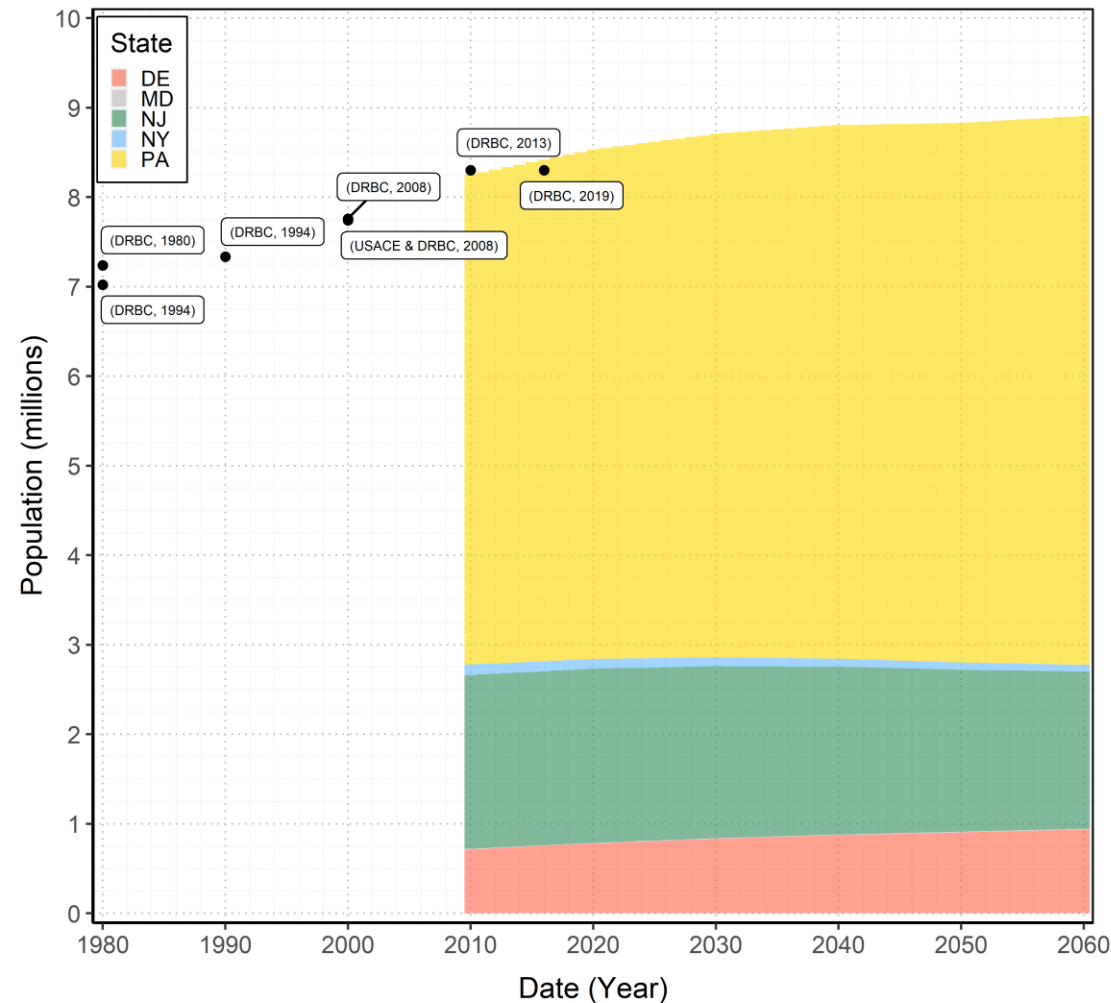


The Delaware River flowing under the Benjamin Franklin Bridge with the Philadelphia skyline behind.
Credit: © Chris Boswell
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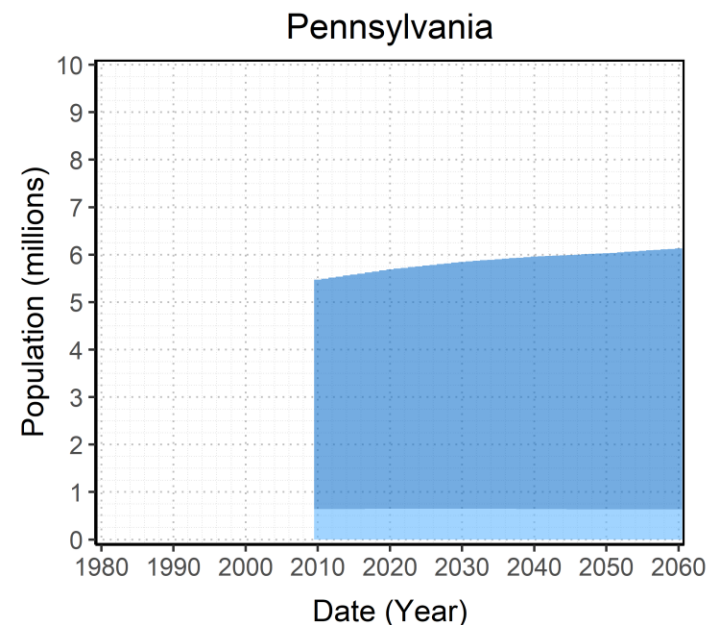
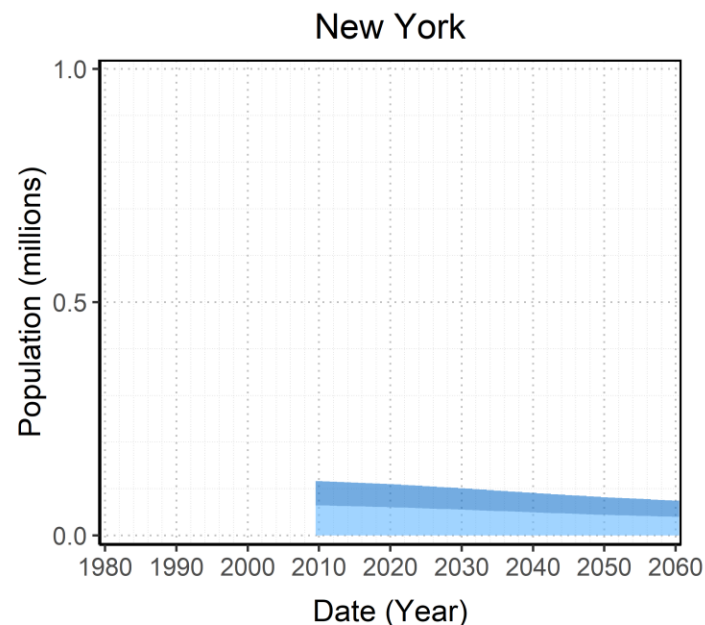
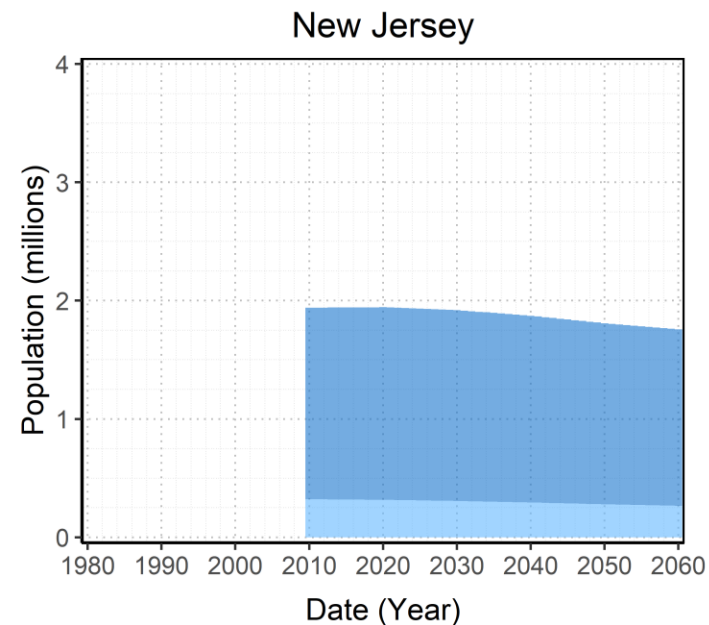
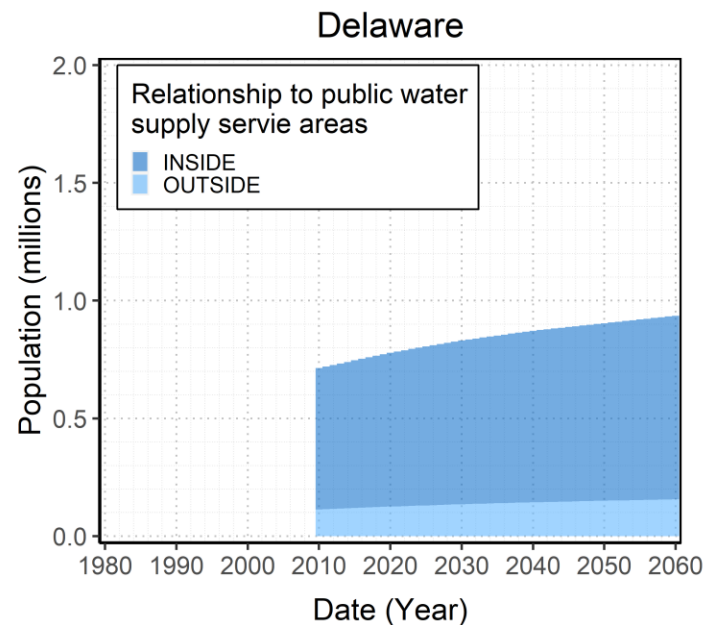
- EPA EnviroAtlas dasymetrically mapped 2010 population to 30x30m pixels
- Public water supplier service areas
- Raster analyses show 2010 population: ~8.252 MM people
 - 1.146MM (~14%) reside outside services areas

Delaware River Basin population estimate (2010) and projections based on Hauer & CIESIN, 2021 (scenario SSP2)

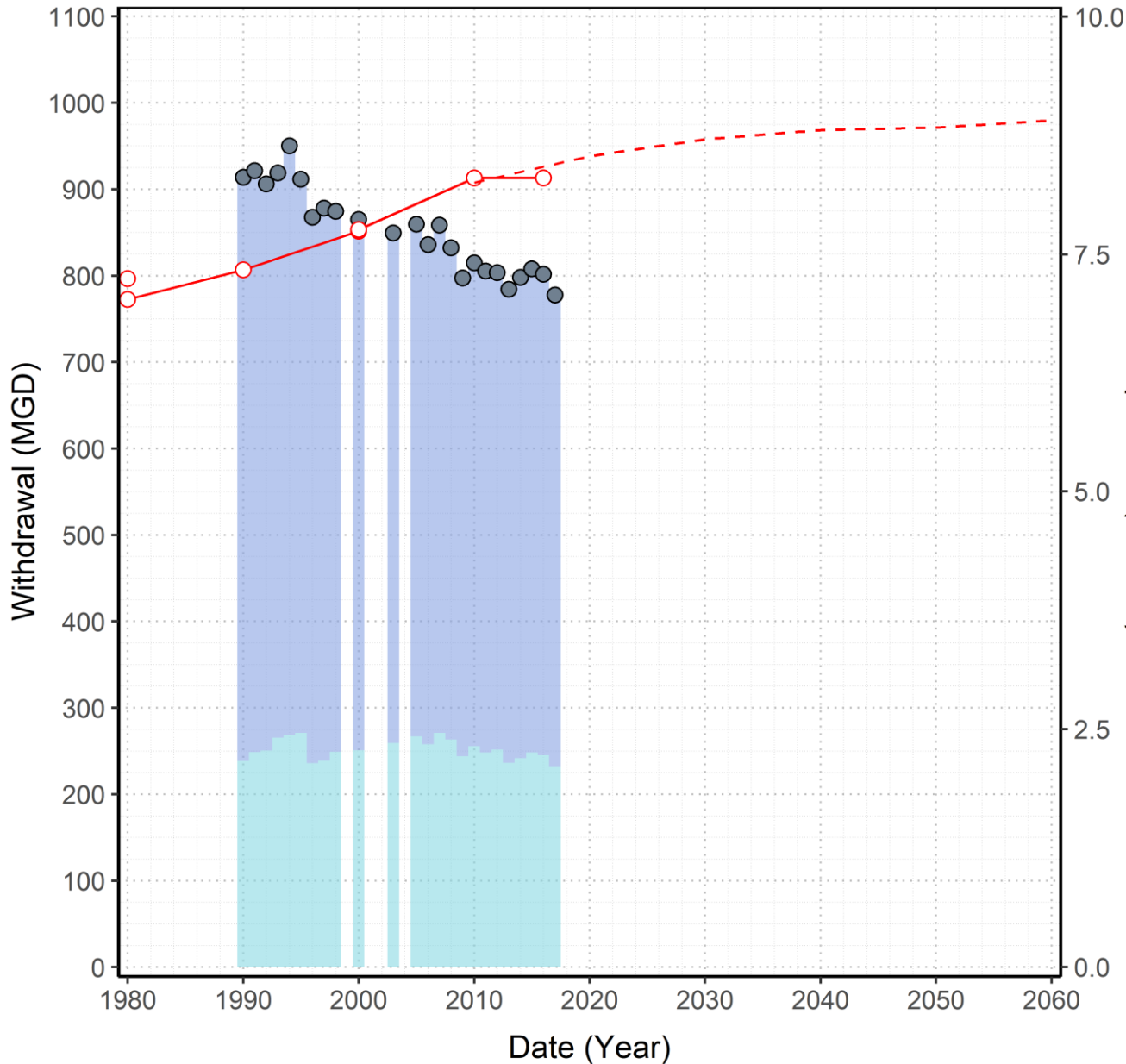


Projected populations were calculated by applying the county-level annual percent changes determined from **M. Hauer & CIESIN, 2021 ; SSP2**

Delaware River Basin state population estimates (2010) and projections based on Hauer & CIESIN, 2021 (scenario SSP2)



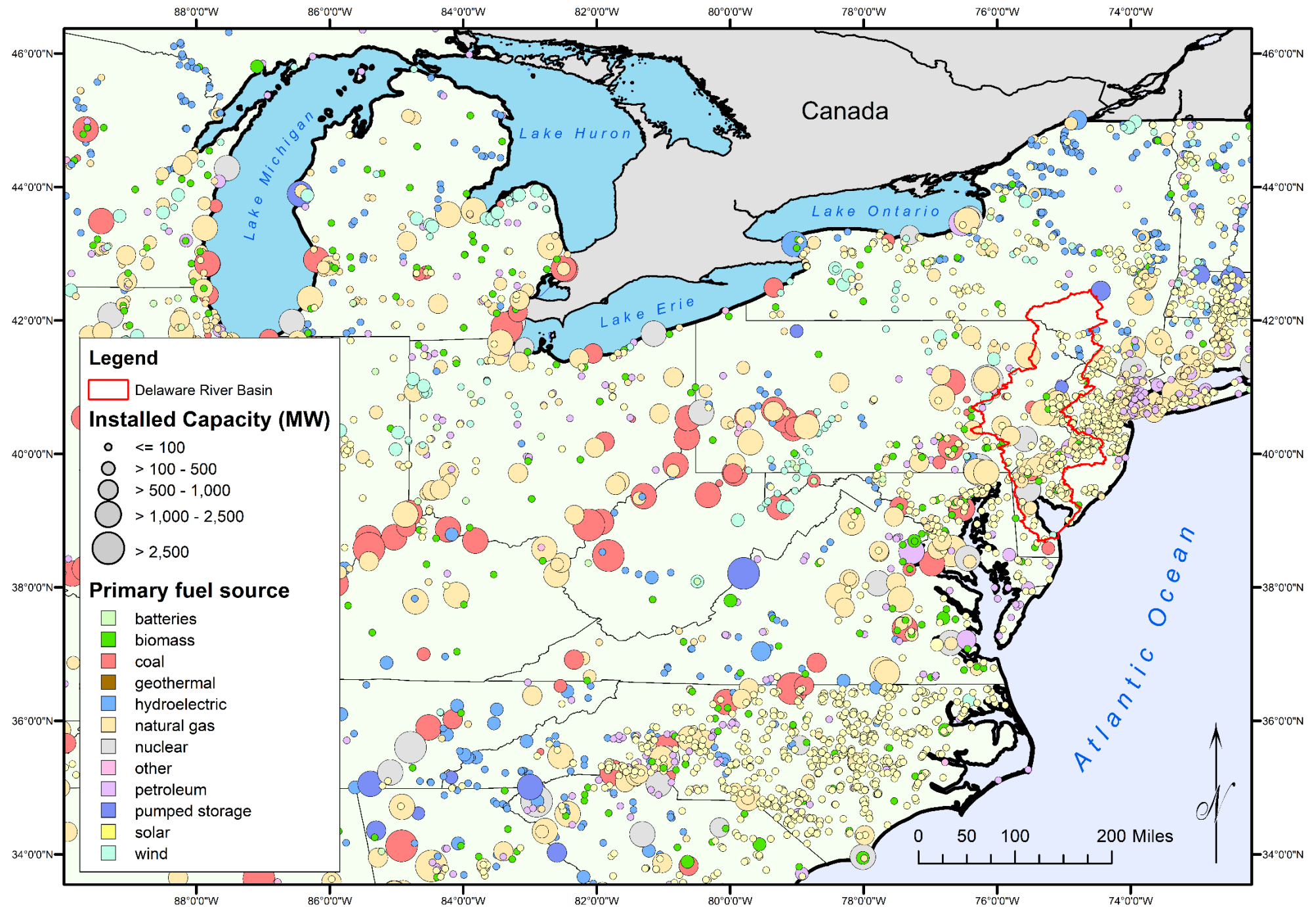
Public water supply withdrawals from the Delaware River Basin with comparison to the in-Basin population

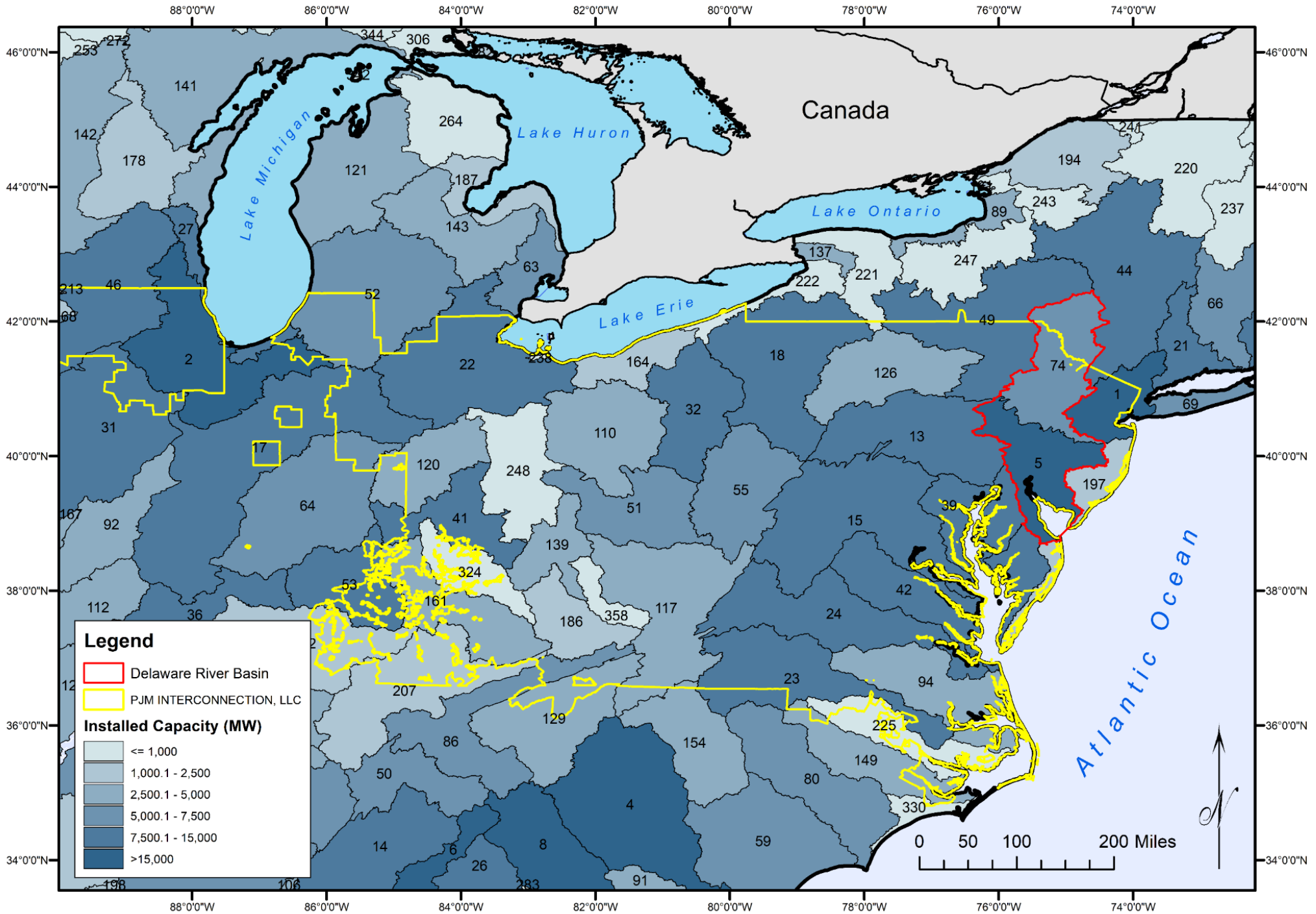


- Population had increased, projected to continue increasing.
- Withdrawals by public water suppliers have decreased, projected to continue decreasing.
- Population growth skewed in PWS service areas... consequently self-supplied projections decrease
 - Self-supplied withdrawals assumed all groundwater, calculated based on single state per-capita rates

5. Supplemental analysis: power generation

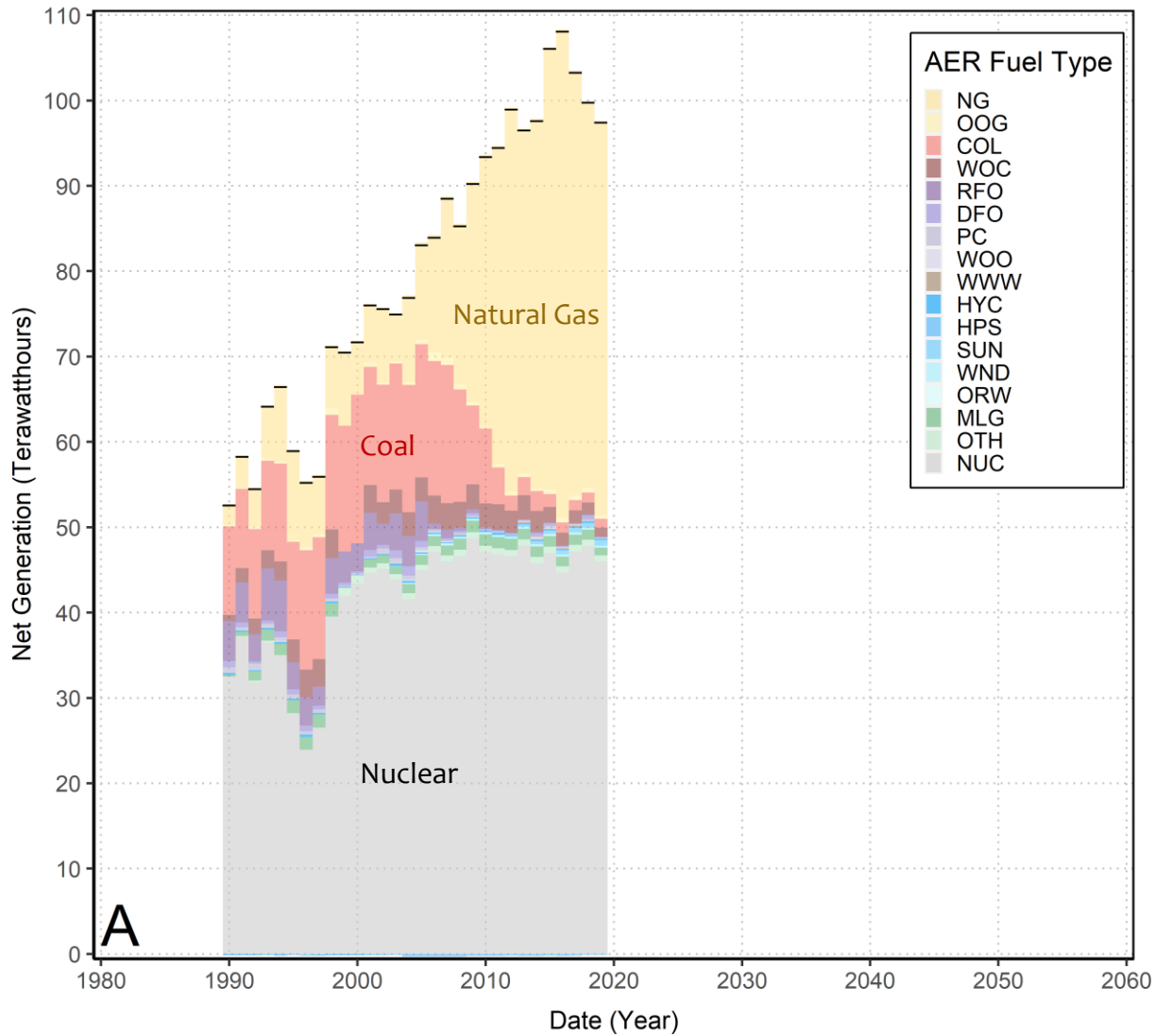




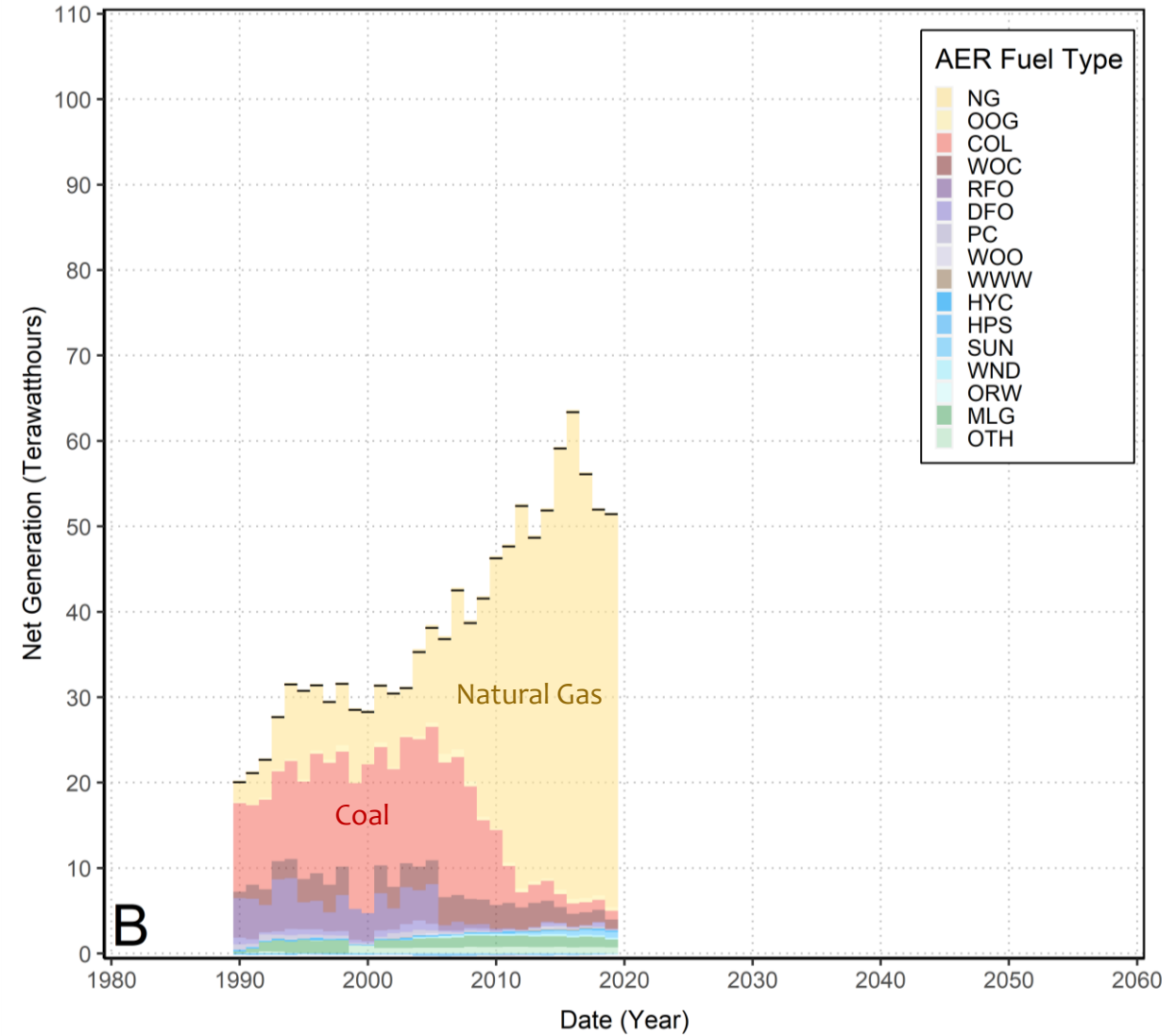


Power Facility Net Generation in the Delaware River Basin Categorized by AER Fuel Type

All power generation facilities

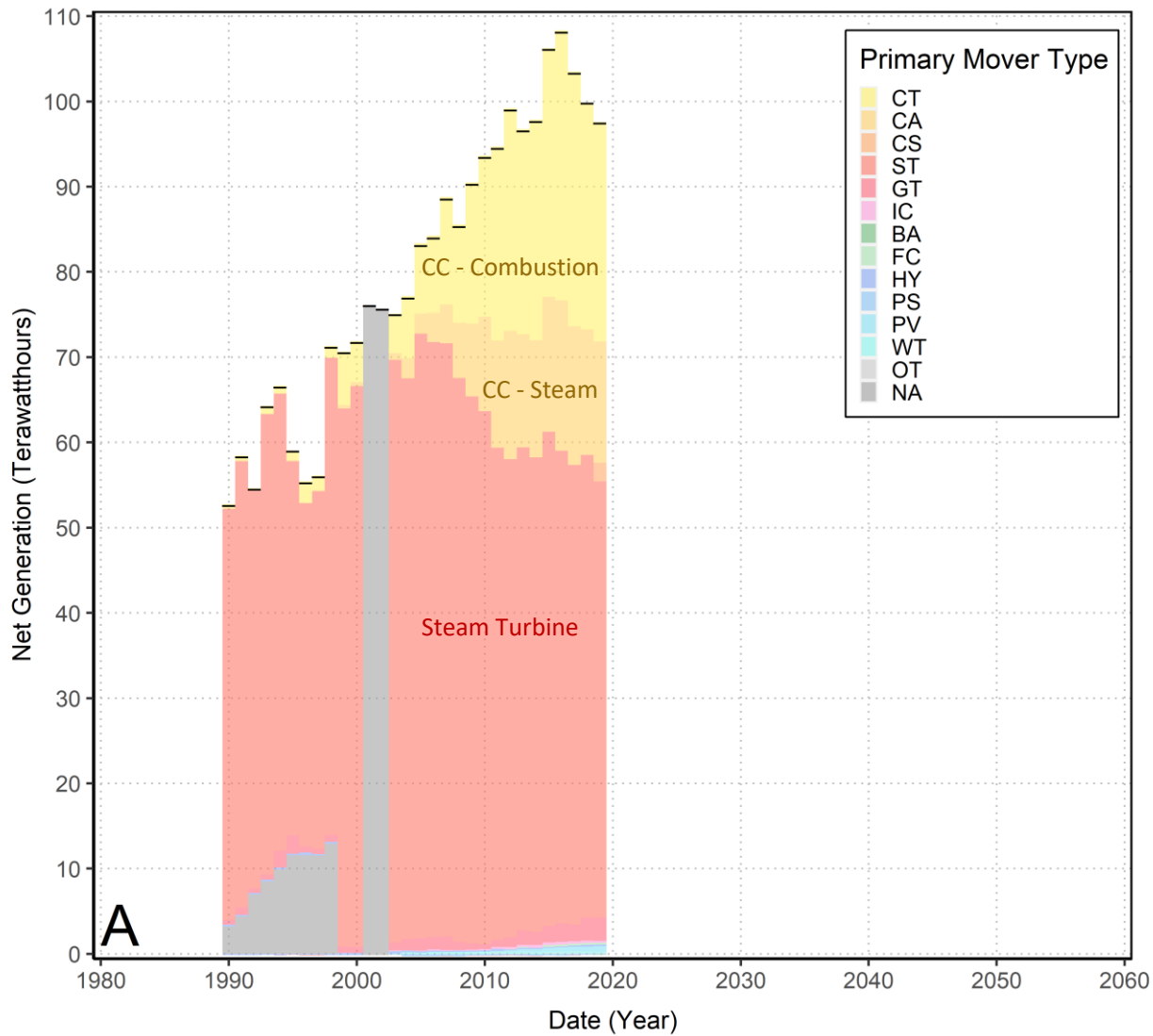


Excluding nuclear power generation facilities

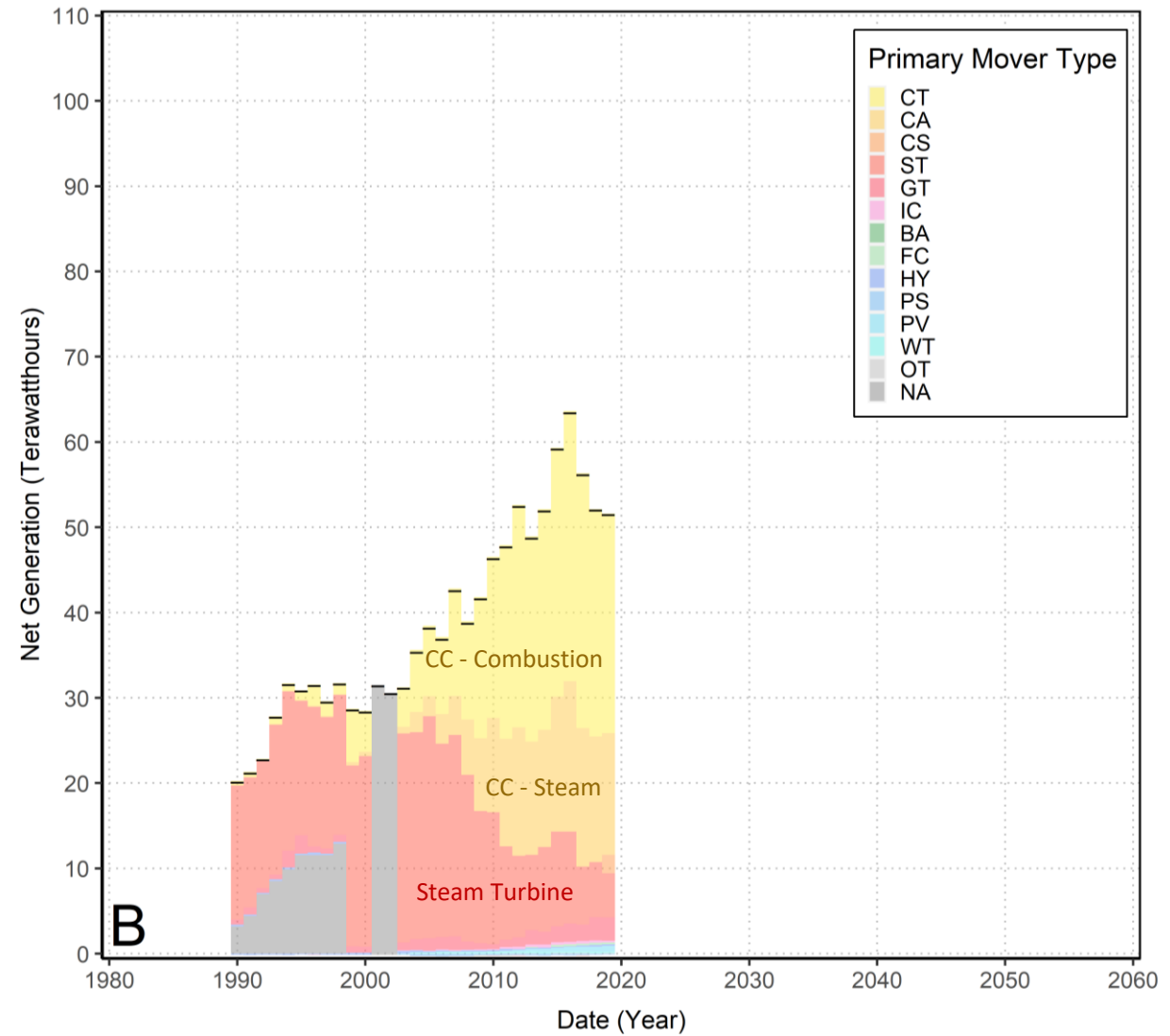


Power Facility Net Generation in the Delaware River Basin Categorized by Primary Mover Type

All power generation facilities

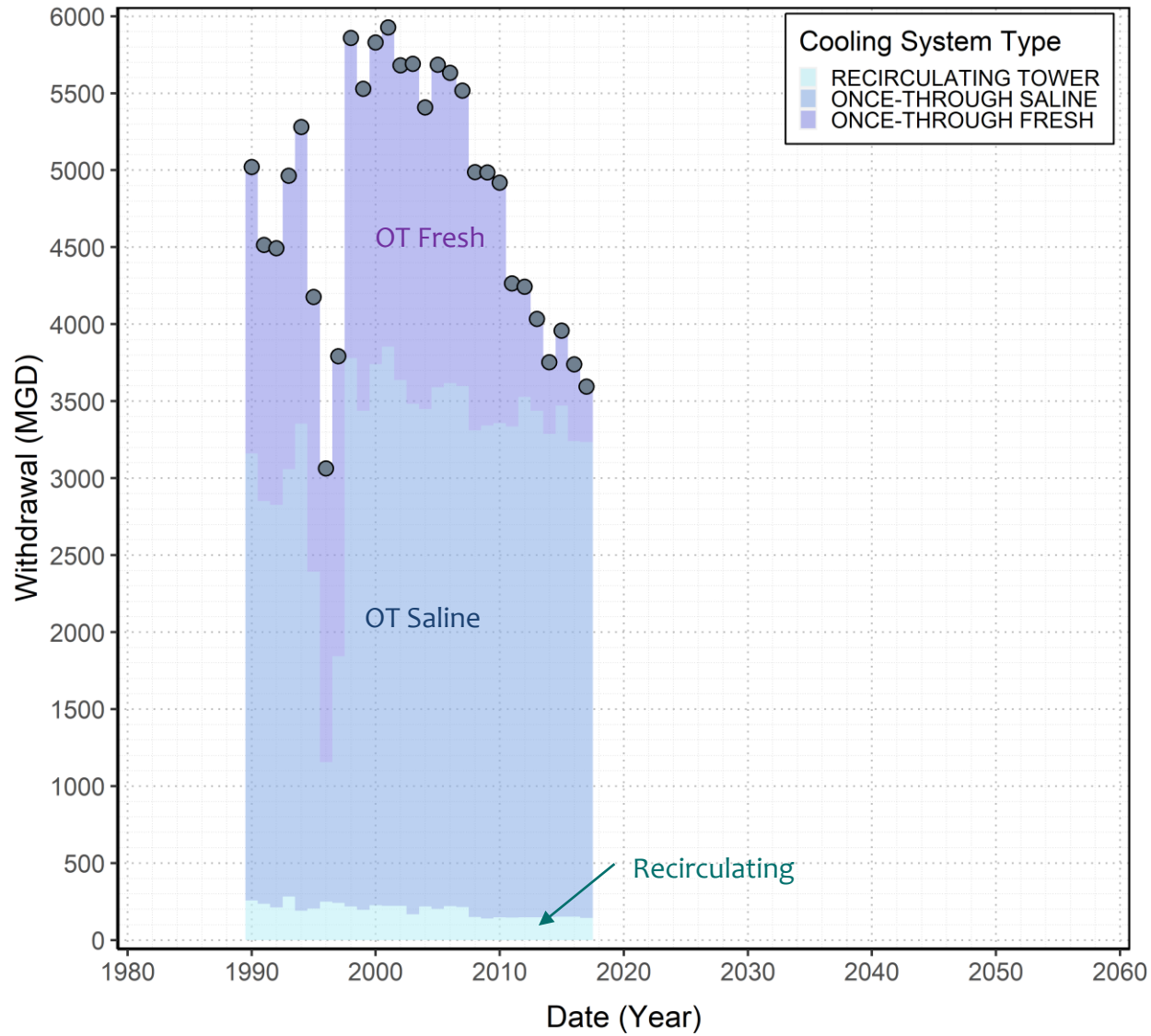


Excluding nuclear power generation facilities



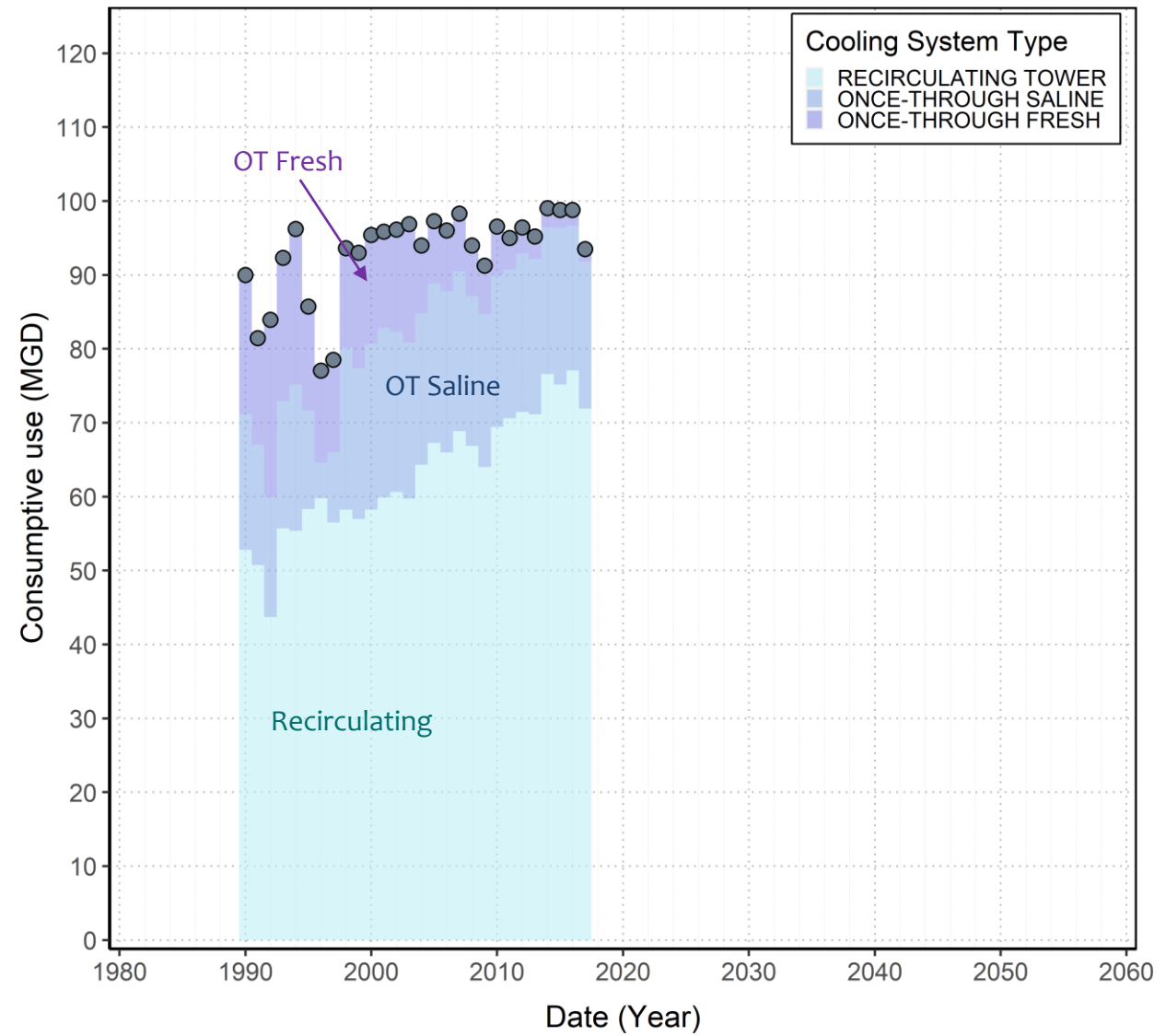
Thermoelectric water withdrawals in the Delaware River Basin

All power generation facilities



Thermoelectric consumptive use in the Delaware River Basin

All power generation facilities



6. Next Steps

- * Publish a report at the end of September with data release
- * Groundwater availability
 - * 147 HUC scale
 - * SEPA GWPA scale
- * Surface Water availability
 - * Consider effects of climate change
 - * Consider reservoir operations
 - * Consider the Drought of Record

7. Questions



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