Forecasting Reported Water Withdrawals – A Comparison of the Tidal and Non-Tidal Potomac

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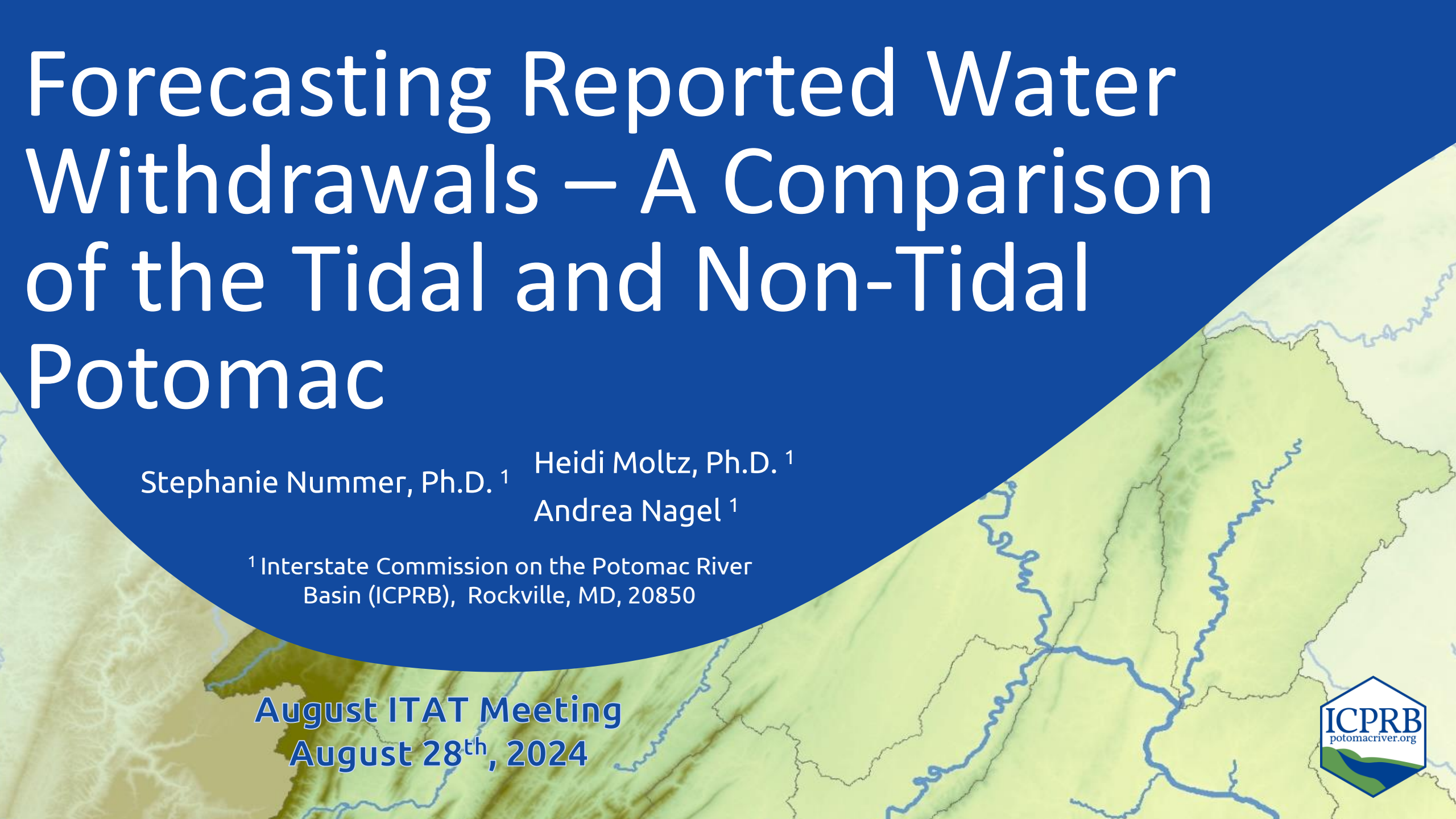
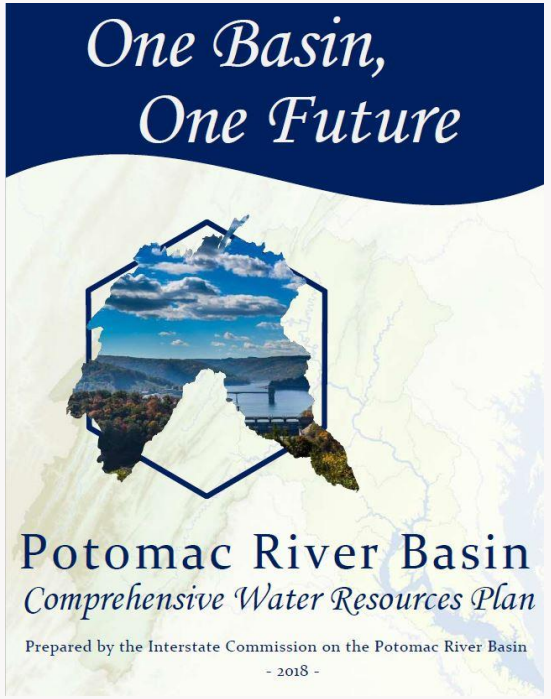


August ITAT Meeting
August 28th, 2024

Reported Water Withdrawals

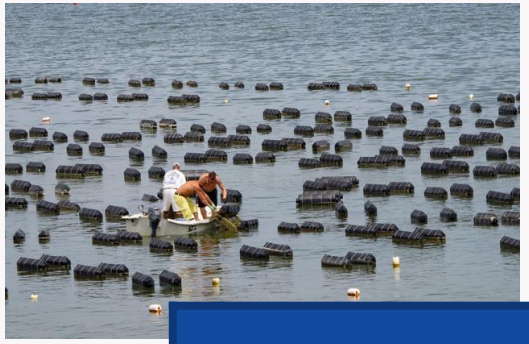
- Recommendation from the Comprehensive Plan is partially addressed with
  - Reported Withdrawal and Consumptive Use Trend Analysis
    - Trend analysis of reported data
    - Projected withdrawals
    - Associated projected consumptive use



Reported Water Withdrawals
Withdrawal and Consumptive Use (WCU) Database

- WCU database
  - Collected withdrawal data from basin jurisdictions
  - Compiled into one database with universal format
  - First published in Ducnuigeen et al. (2015) and updated in 2021

Reported Water Use Sectors



Sectors	
Aquaculture	Commercial
Irrigation	Hydroelectric
Livestock	Industrial
Mining	Other
Self-supplied domestic	Public water supply
Thermoelectric	

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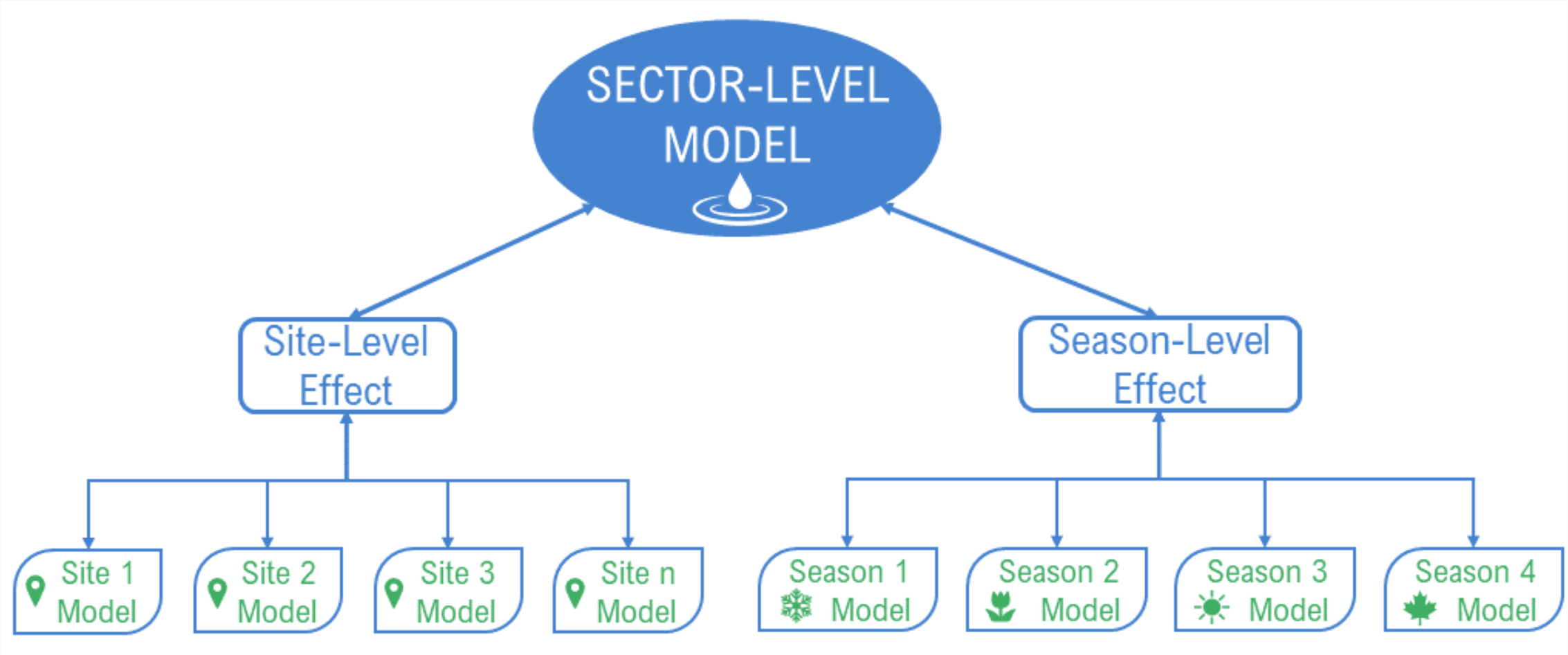
Reported Water Withdrawals

Trend Analysis & Projections

- Monthly data used to model withdrawals over time
  - For each withdrawal location
- Estimated location-specific models were used to predict future withdrawals

Hierarchical Model



Hierarchical Model – Equation

$$y_{ijk} = \alpha_{jk} + \beta_{jk}\,(Monthly\ Timestep_{ijk})$$

y_i = withdrawal (or log-withdrawal) in MGD
j = location
k = season
α = y-intercept
β = unit change/monthly timestep

Season	Month
1	Dec., Jan., Feb.
2	Mar., Apr., May
3	June, July, Aug.
4	Sept., Oct., Nov.

Basin-Wide Withdrawals (MGD)

Sector	2025	2030	2035	2040	2045	2050
Aquaculture	28.48	27.70	27.59	28.57	29.56	30.55
Commercial	8.51	8.32	8.24	8.23	8.28	8.38
Hydroelectric	1,222.39	1,222.39	1,222.39	1,222.39	1,222.39	1,222.39
Industrial	21.95	21.92	21.97	22.11	22.32	22.62
Irrigation	22.82	22.75	22.71	22.68	22.67	22.67
Livestock	0.58	0.59	0.60	0.61	0.63	0.64
Mining	52.75	57.16	61.57	65.98	70.39	74.80
Other	88.79	66.26	43.72	21.19	3.04	0.24
Thermoelectric	2,098.50	2,098.42	2,098.39	2,098.37	2,098.37	2,098.37
Public Water Supply	676.05	696.43	723.11	756.55	797.53	847.04
Self-Supplied Domestic	0.15	0.14	0.14	0.14	0.14	0.13
Basin Total	**4,220.97**	**4,222.08**	**4,230.43**	**4,246.82**	**4,275.32**	**4,327.83**

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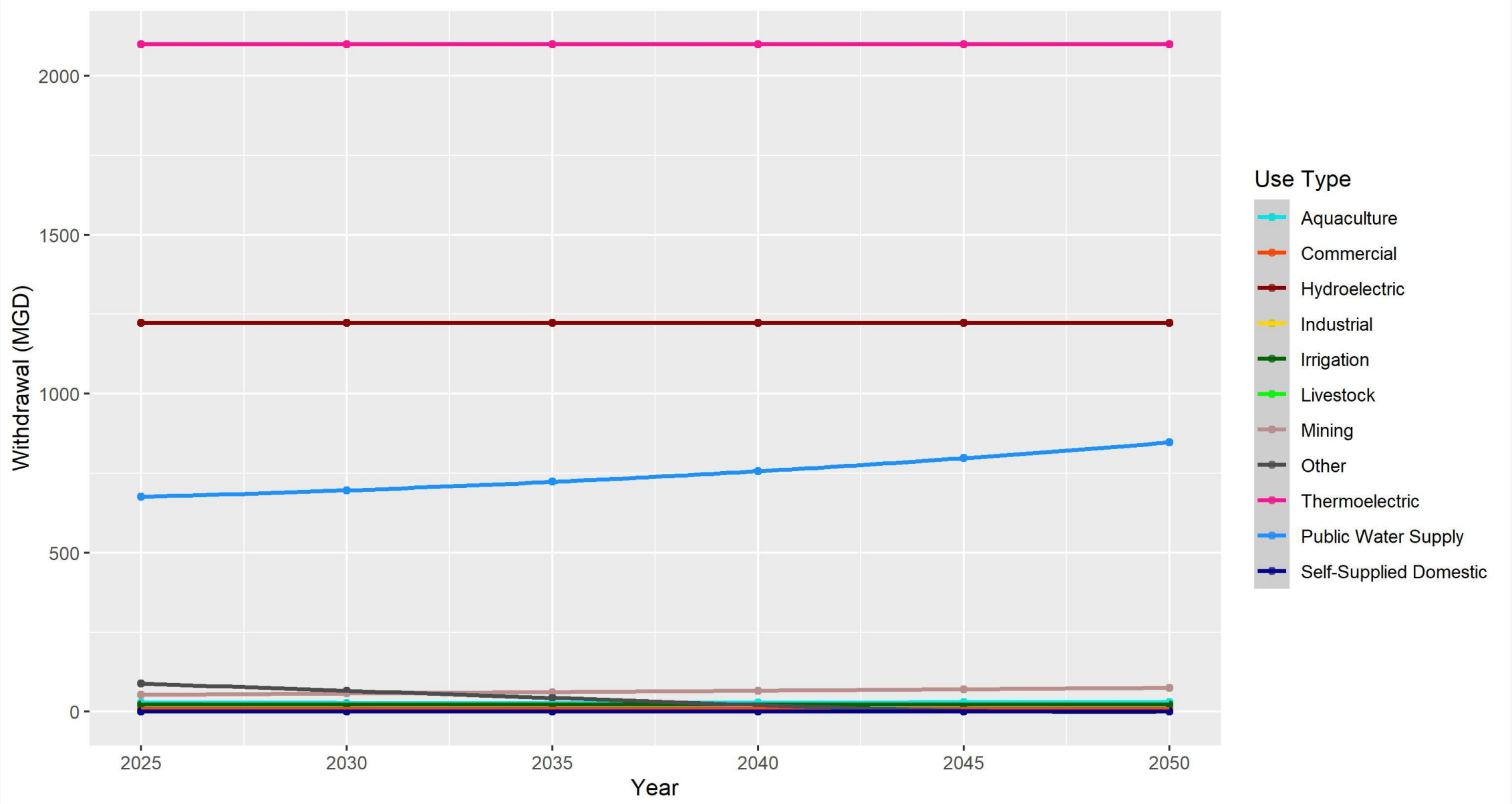
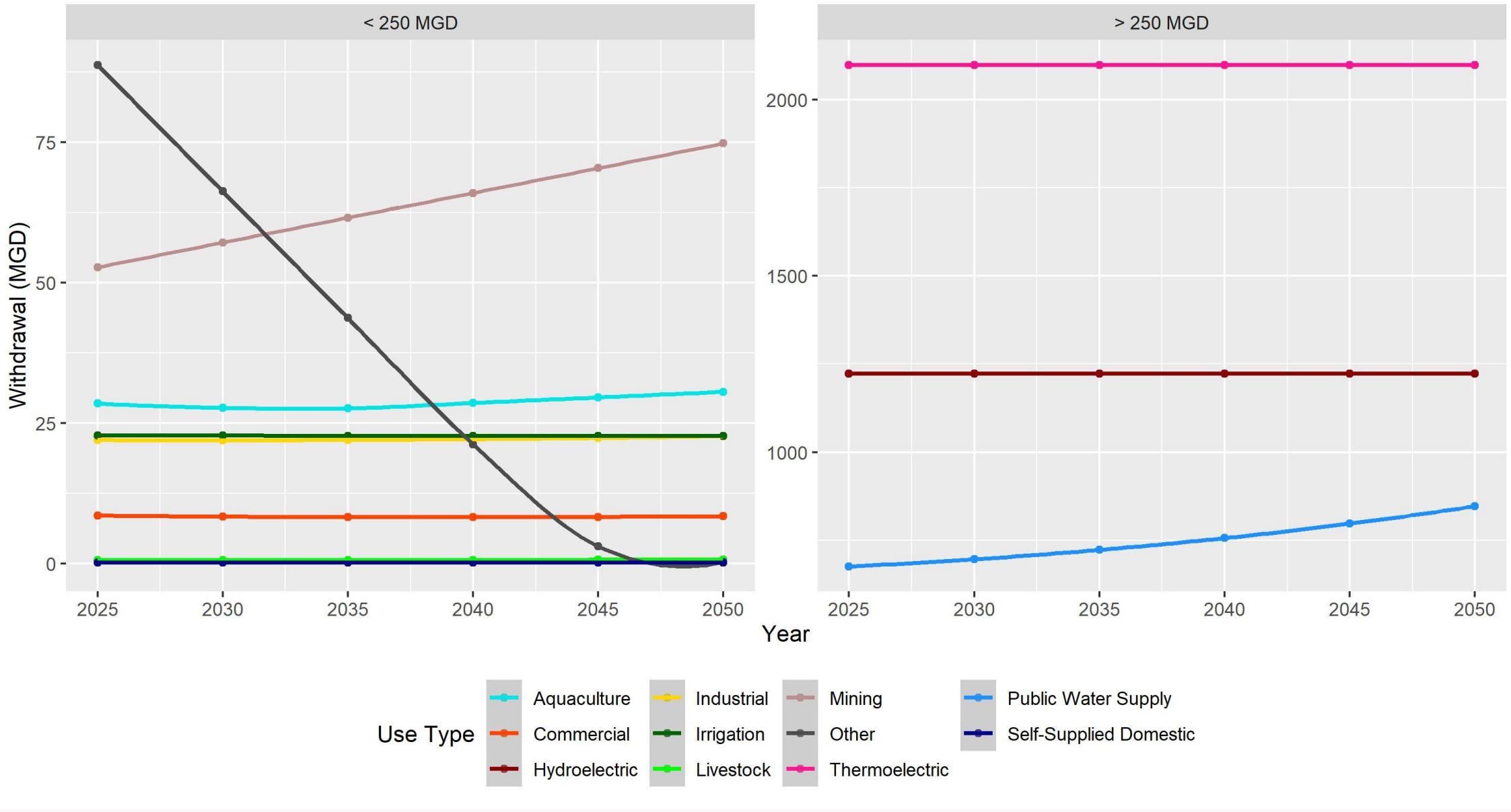
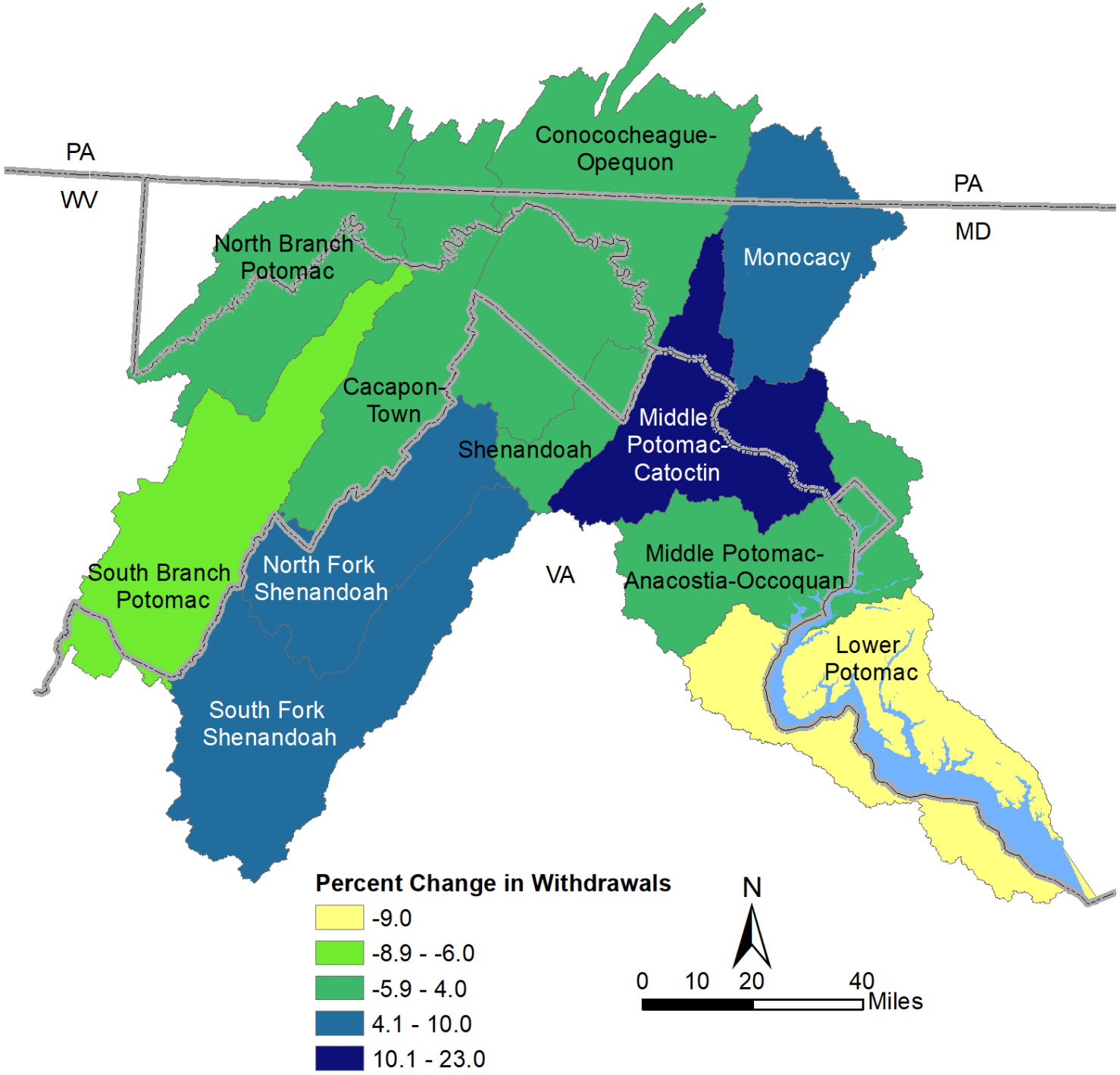
Potomac Withdrawals by Sector



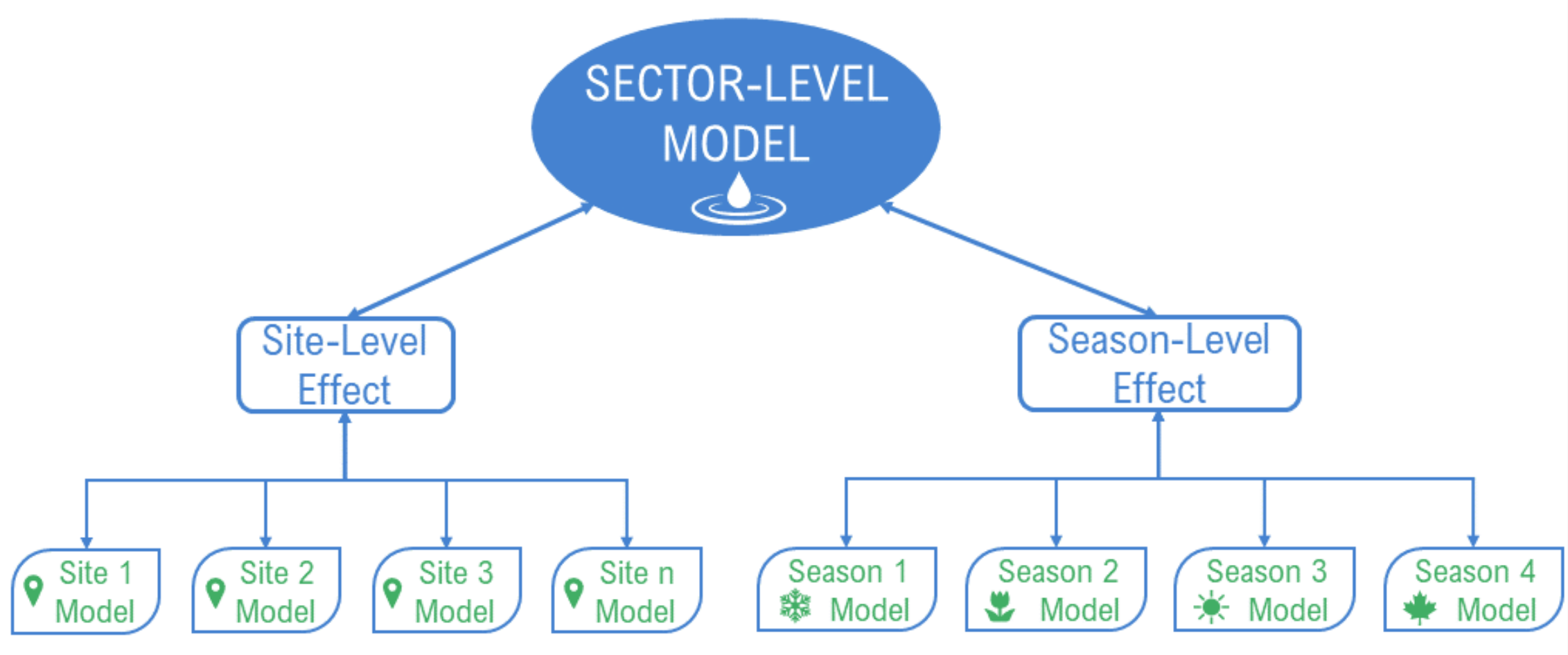
Potomac Withdrawals by Sector





Basin-Wide Withdrawals (MGD)

Hierarchical Model Flexibility



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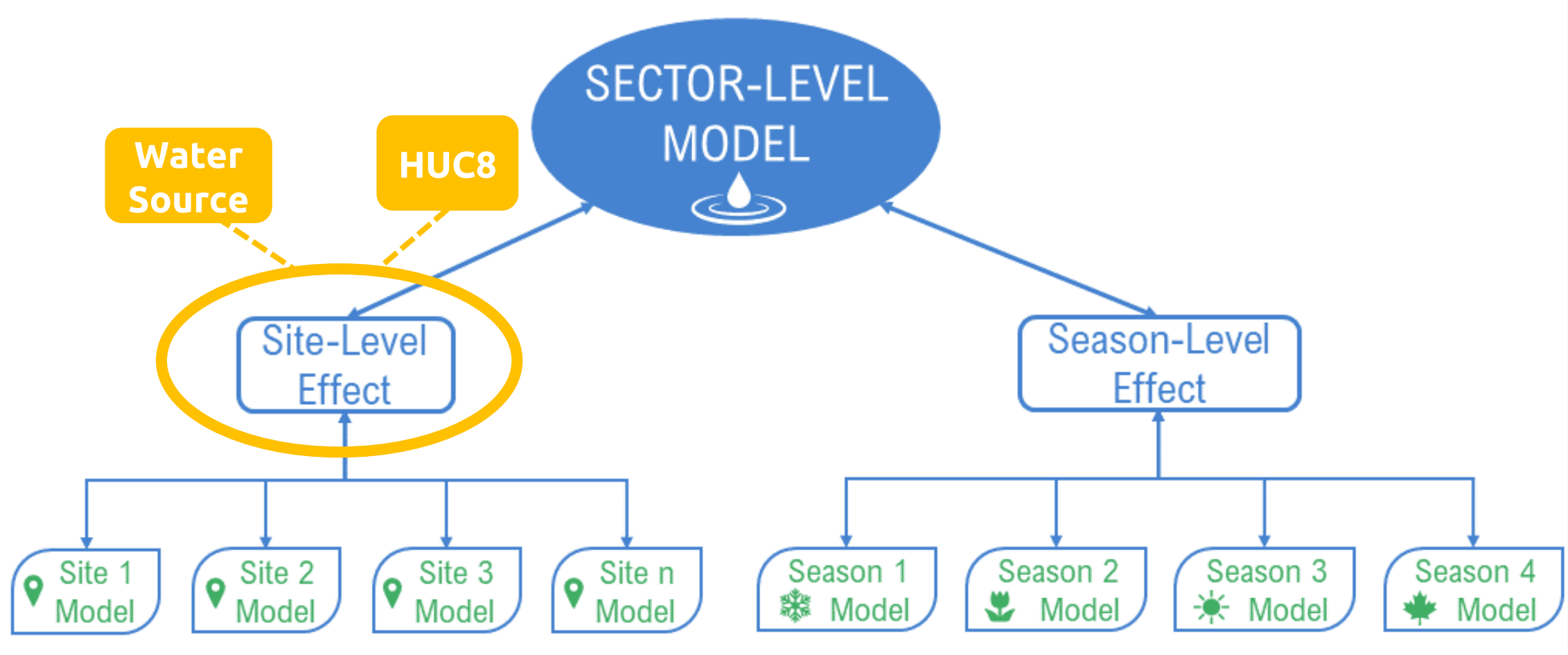

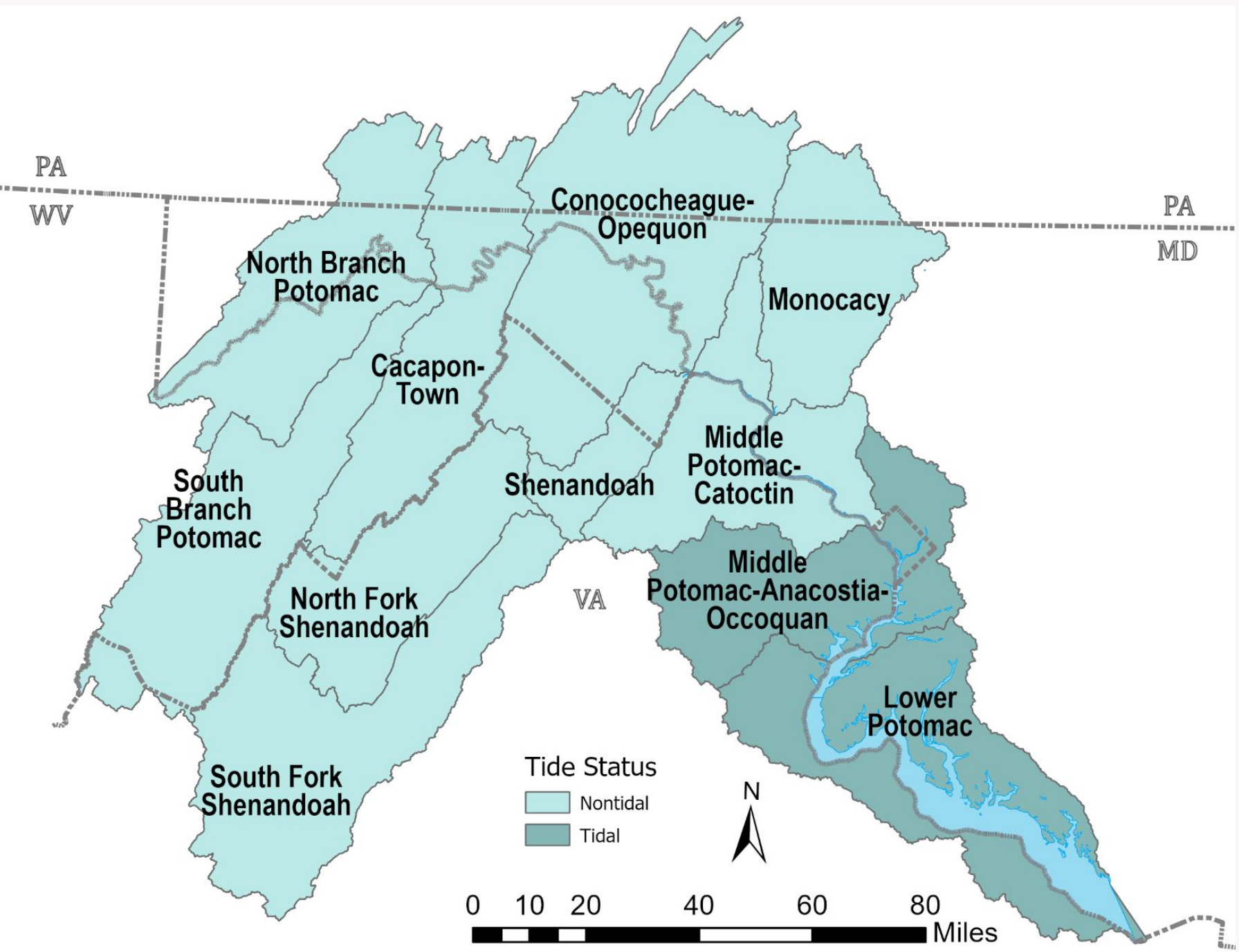

Potomac Basin Tide Status

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Nontidal vs Tidal Withdrawals (MGD)

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
Aquaculture	27.96	0.52	27.18	0.52	27.07	0.52	28.06	0.52	29.05	0.52	30.03	0.52
Commercial	4.59	3.92	4.43	3.88	4.37	3.87	4.37	3.86	4.42	3.86	4.51	3.87
Hydroelectric	1,222.39		1,222.39		1,222.39		1,222.39		1,222.39		1,222.39	
Industrial	21.65	0.31	21.61	0.31	21.66	0.31	21.80	0.31	22.01	0.32	22.30	0.32
Irrigation	18.50	4.32	18.43	4.32	18.39	4.32	18.36	4.33	18.33	4.33	18.32	4.35
Livestock	0.58		0.59		0.60		0.61		0.63		0.64	
Mining	49.32	3.43	53.73	3.43	58.14	3.43	62.55	3.43	66.96	3.43	71.37	3.43
Other		88.79		66.26		43.72		21.19		3.04		0.24
Thermoelectric	1,195.45	903.05	1,195.44	902.97	1,195.44	902.95	1,195.44	902.94	1,195.44	902.93	1,195.44	902.93
Public Water Supply	572.12	103.93	592.58	103.85	619.28	103.82	652.73	103.83	693.66	103.87	743.10	103.94
Self-Supplied Domestic	0.13	0.02	0.12	0.02	0.12	0.02	0.12	0.02	0.11	0.02	0.11	0.02
Total	**3,112.69**	**1,108.28**	**3,136.52**	**1,085.56**	**3,167.47**	**1,062.95**	**3,206.42**	**1,040.42**	**3,253.00**	**1,022.32**	**3,308.22**	**1,019.61**

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Nontidal vs Tidal Withdrawals (MGD)

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
Aquaculture	27.96	0.52	27.18	0.52	27.07	0.52	28.06	0.52	29.05	0.52	30.03	0.52
Commercial	4.59	3.92	4.43	3.88	4.37	3.87	4.37	3.86	4.42	3.86	4.51	3.87
Hydroelectric	1,222.39		1,222.39		1,222.39		1,222.39		1,222.39		1,222.39	
Industrial	21.65	0.31	21.61	0.31	21.66	0.31	21.80	0.31	22.01	0.32	22.30	0.32
Irrigation	18.50	4.32	18.43	4.32	18.39	4.32	18.36	4.33	18.33	4.33	18.32	4.35
Livestock	0.58		0.59		0.60		0.61		0.63		0.64	
Mining	49.32	3.43	53.73	3.43	58.14	3.43	62.55	3.43	66.96	3.43	71.37	3.43
Other		88.79		66.26		43.72		21.19		3.04		0.24
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Nontidal vs Tidal Withdrawals (MGD)

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
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Commercial	4.59	3.92	4.43	3.88	4.37	3.87	4.37	3.86	4.42	3.86	4.51	3.87
Hydroelectric	1,222.39		1,222.39		1,222.39		1,222.39		1,222.39		1,222.39	
Industrial	21.65	0.31	21.61	0.31	21.66	0.31	21.80	0.31	22.01	0.32	22.30	0.32
Irrigation	18.50	4.32	18.43	4.32	18.39	4.32	18.36	4.33	18.33	4.33	18.32	4.35
Livestock	0.58		0.59		0.60		0.61		0.63		0.64	
Mining	49.32	3.43	53.73	3.43	58.14	3.43	62.55	3.43	66.96	3.43	71.37	3.43
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Hydroelectric	1,222.39		1,222.39		1,222.39		1,222.39		1,222.39		1,222.39	
Industrial	21.65	0.31	21.61	0.31	21.66	0.31	21.80	0.31	22.01	0.32	22.30	0.32
Irrigation	18.50	4.32	18.43	4.32	18.39	4.32	18.36	4.33	18.33	4.33	18.32	4.35
Livestock	0.58		0.59		0.60		0.61		0.63		0.64	
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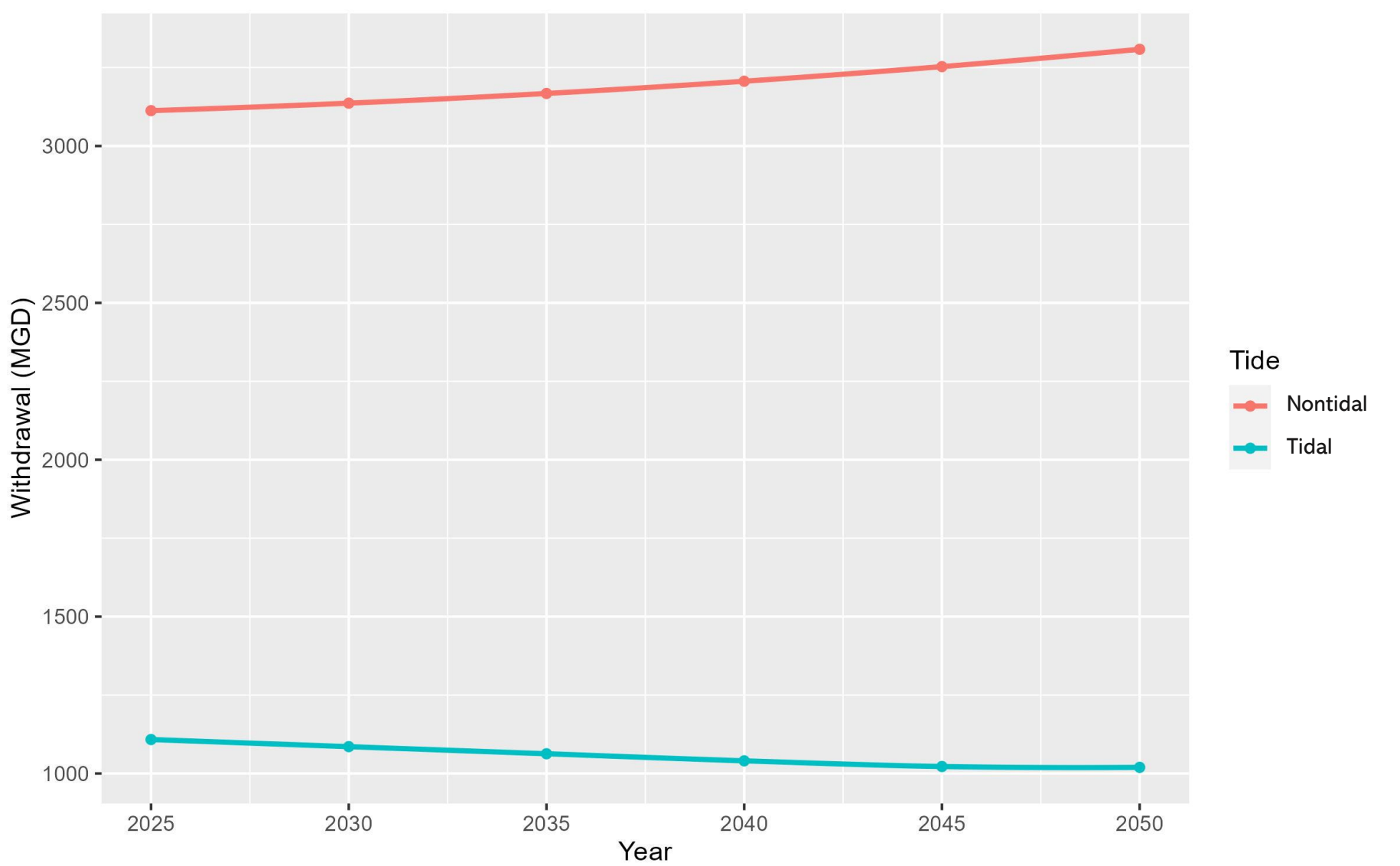
Nontidal vs Tidal Trends



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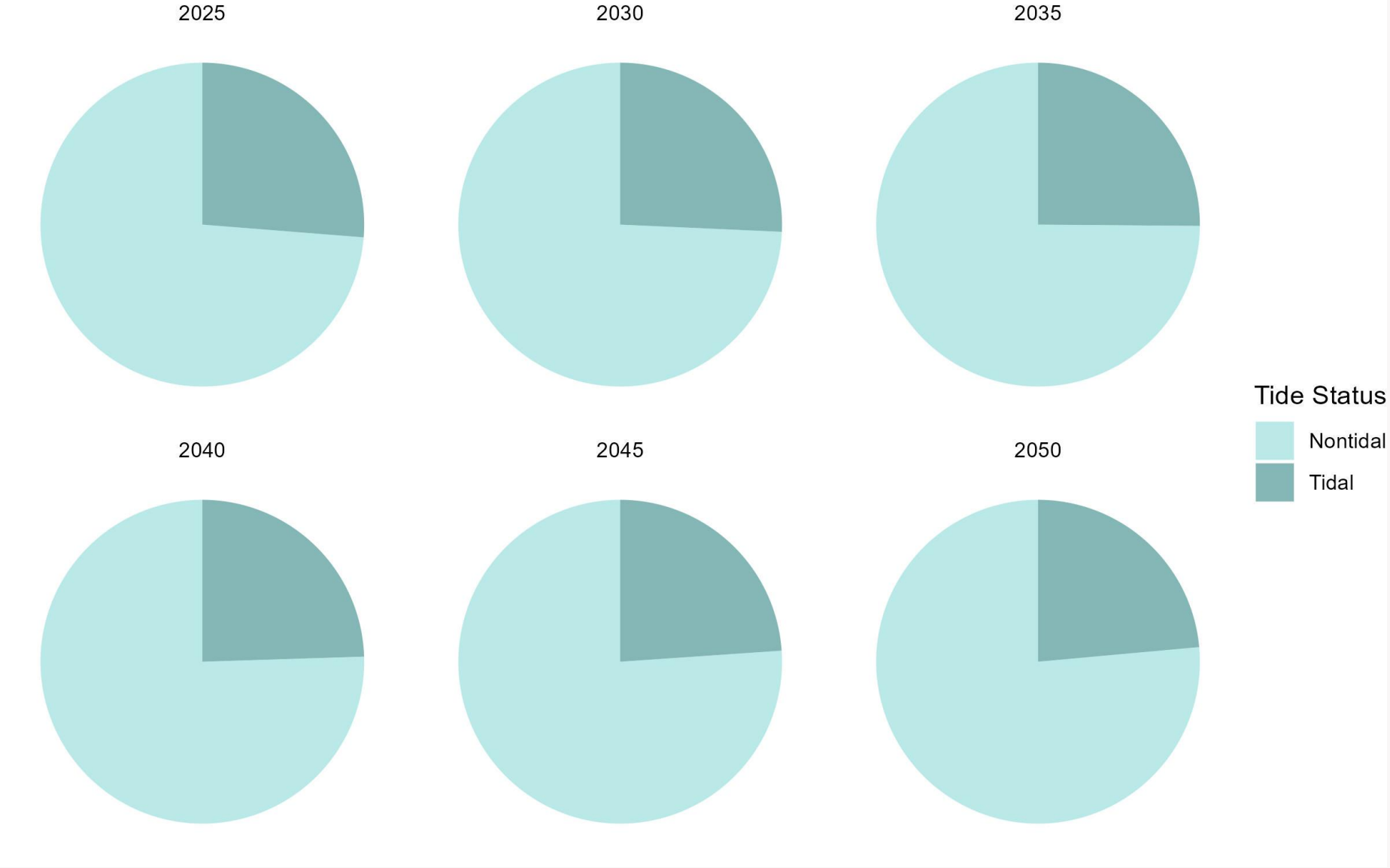
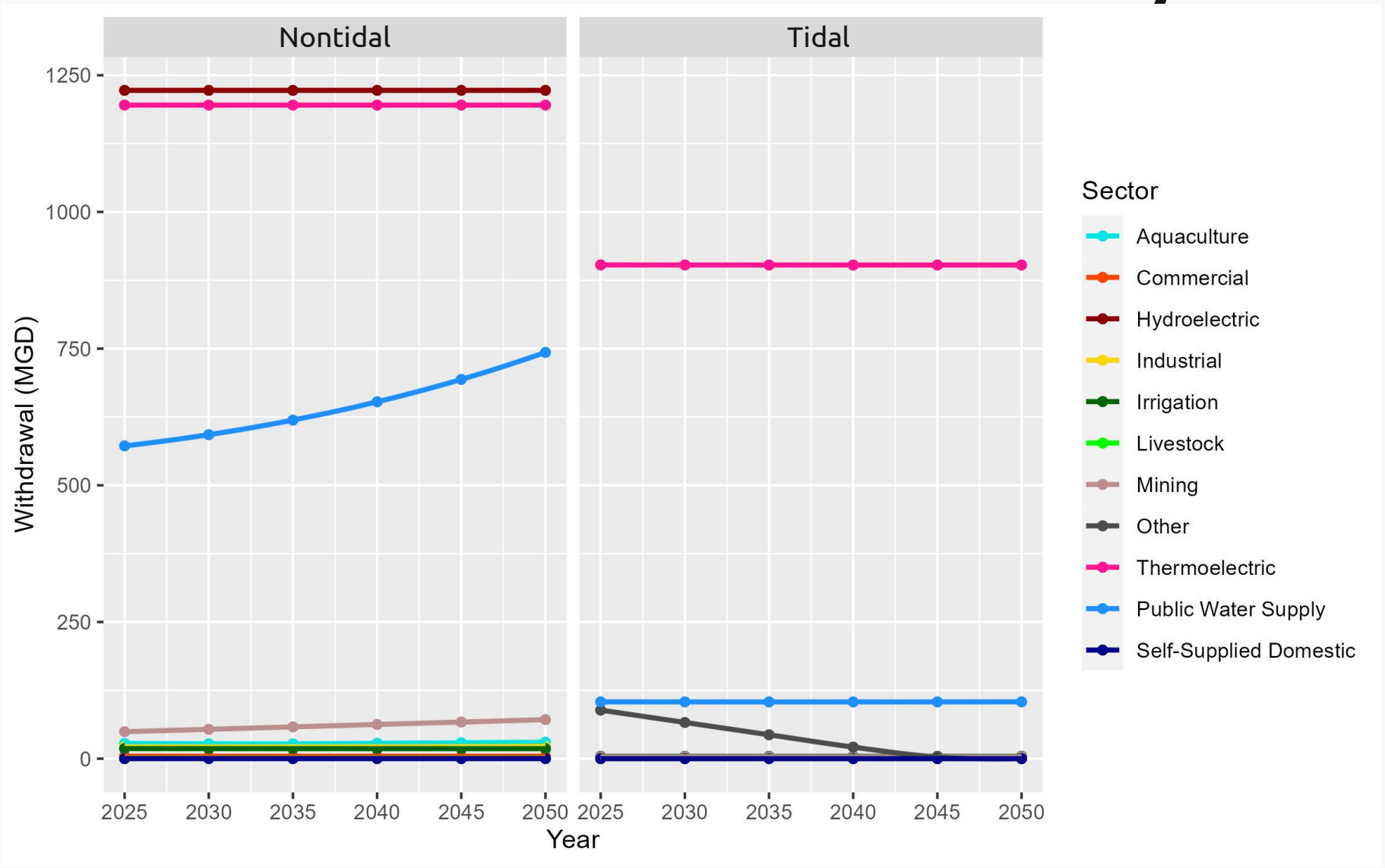


Nontidal vs Tidal Trends by Sector



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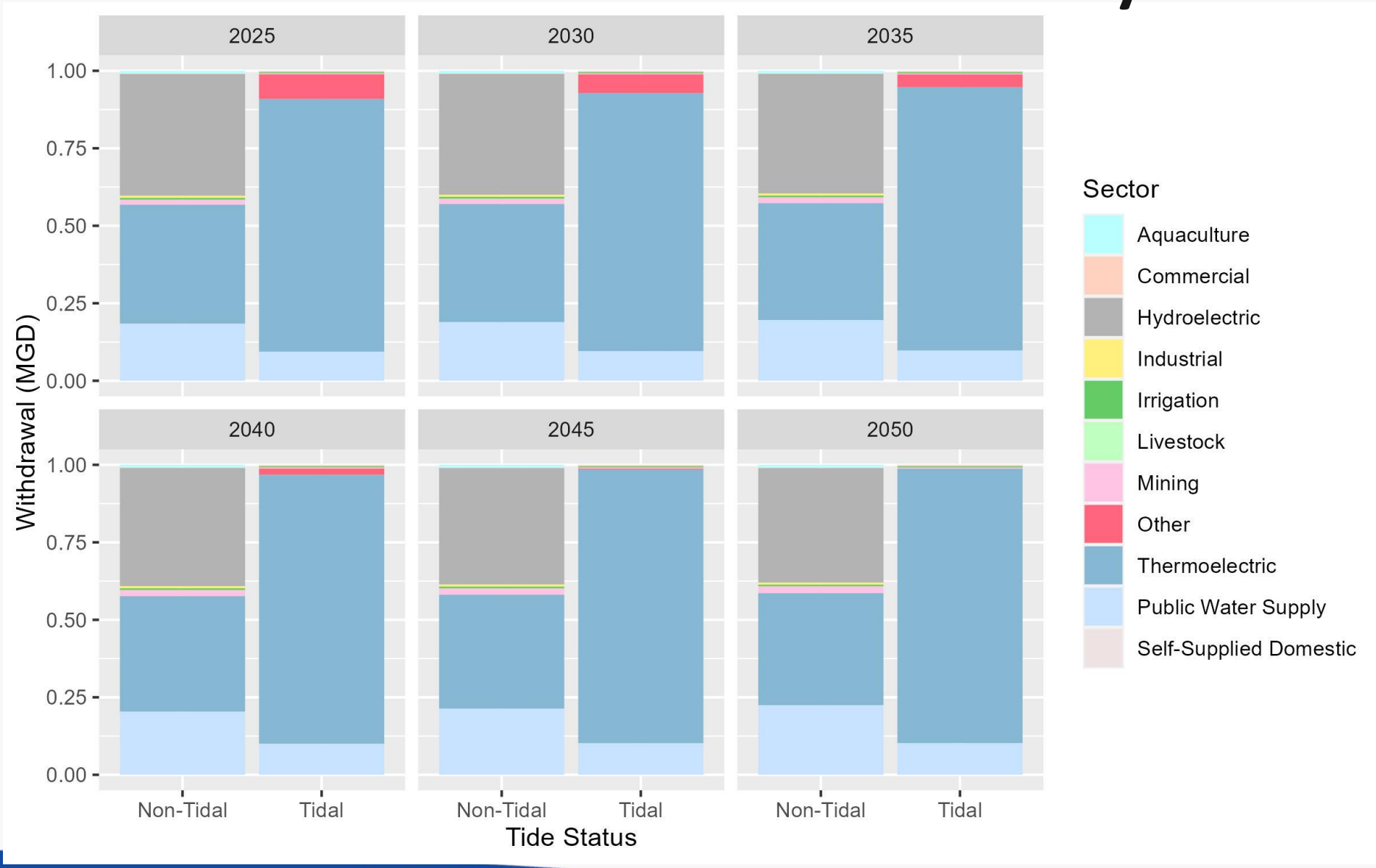
Nontidal vs Tidal Trends by Sector



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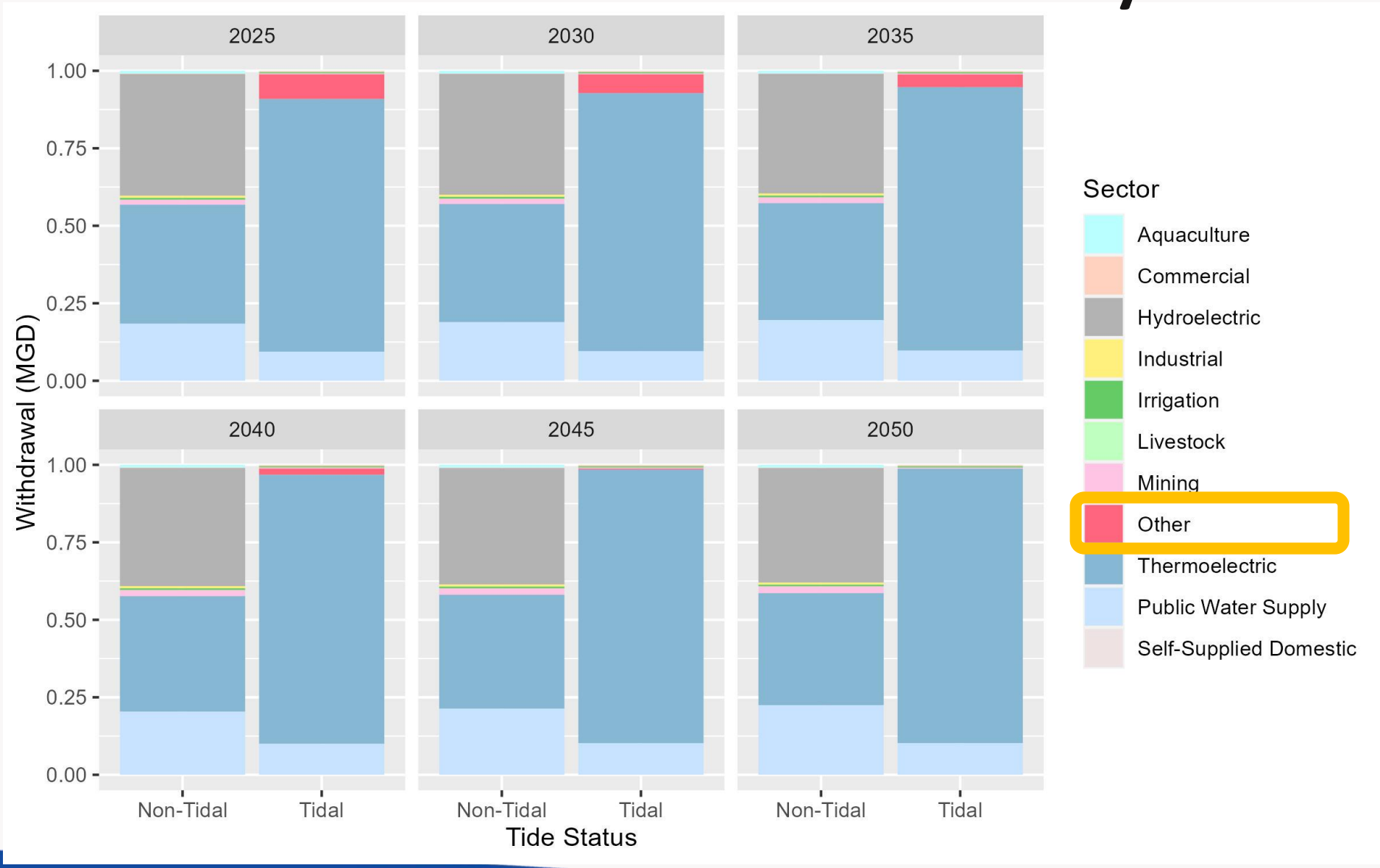

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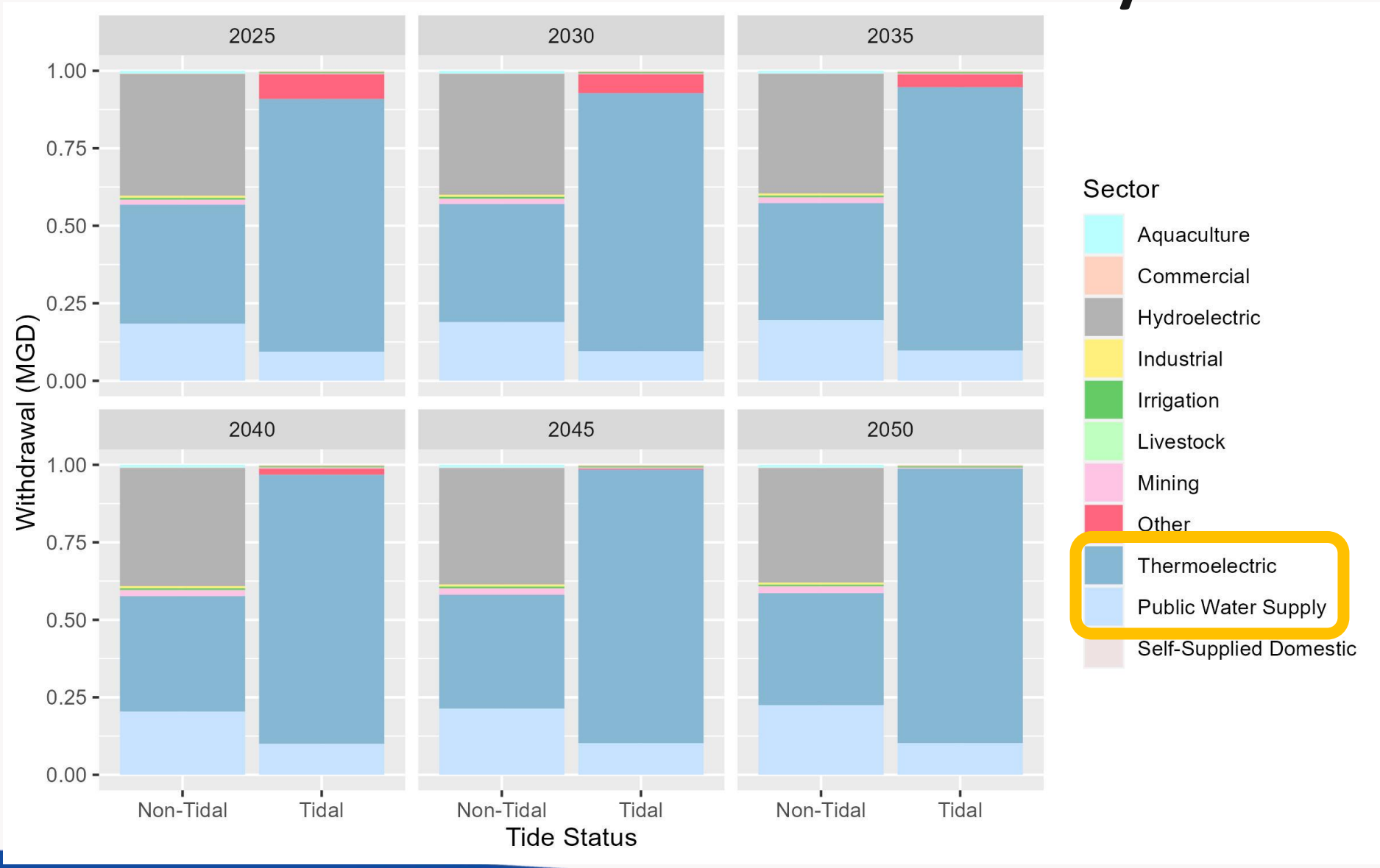

Nontidal vs Tidal Relative %

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
Aquaculture	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.1%	0.9%	0.1%
Commercial	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%
Hydroelectric	39.3%		39.0%		38.6%		38.1%		37.6%		37.0%	
Industrial	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%
Irrigation	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%
Livestock	0.02%		0.02%		0.02%		0.02%		0.02%		0.02%	
Mining	1.6%	0.3%	1.7%	0.3%	1.8%	0.3%	2.0%	0.3%	2.1%	0.3%	2.2%	0.3%
Other		8.0%		6.1%		4.1%		2.0%		0.3%		0.02%
Thermoelectric	38.4%	81.5%	38.1%	83.2%	37.7%	84.9%	37.3%	86.8%	36.7%	88.3%	36.1%	88.6%
Public Water Supply	18.4%	9.4%	18.9%	9.6%	19.6%	9.8%	20.4%	10.0%	21.3%	10.2%	22.5%	10.2%
Self-Supplied Domestic	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.003%	0.002%	0.003%	0.002%

Nontidal vs Tidal Relative %

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
Aquaculture	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.1%	0.9%	0.1%
Commercial	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%
Hydroelectric	39.3%		39.0%		38.6%		38.1%		37.6%		37.0%	
Industrial	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%
Irrigation	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%
Livestock	0.02%		0.02%		0.02%		0.02%		0.02%		0.02%	
Mining	1.6%	0.3%	1.7%	0.3%	1.8%	0.3%	2.0%	0.3%	2.1%	0.3%	2.2%	0.3%
Other		8.0%		6.1%		4.1%		2.0%		0.3%		0.02%
Thermoelectric	38.4%	81.5%	38.1%	83.2%	37.7%	84.9%	37.3%	86.8%	36.7%	88.3%	36.1%	88.6%
Public Water Supply	18.4%	9.4%	18.9%	9.6%	19.6%	9.8%	20.4%	10.0%	21.3%	10.2%	22.5%	10.2%
Self-Supplied Domestic	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.003%	0.002%	0.003%	0.002%

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Nontidal vs Tidal Relative %

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
Aquaculture	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.1%	0.9%	0.1%
Commercial	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%
Hydroelectric	39.3%		39.0%		38.6%		38.1%		37.6%		37.0%	
Industrial	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%
Irrigation	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%
Livestock	0.02%		0.02%		0.02%		0.02%		0.02%		0.02%	
Mining	1.6%	0.3%	1.7%	0.3%	1.8%	0.3%	2.0%	0.3%	2.1%	0.3%	2.2%	0.3%
Other		8.0%		6.1%		4.1%		2.0%		0.3%		0.02%
Thermoelectric	38.4%	81.5%	38.1%	83.2%	37.7%	84.9%	37.3%	86.8%	36.7%	88.3%	36.1%	88.6%
Public Water Supply	18.4%	9.4%	18.9%	9.6%	19.6%	9.8%	20.4%	10.0%	21.3%	10.2%	22.5%	10.2%
Self-Supplied Domestic	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.003%	0.002%	0.003%	0.002%

Nontidal vs Tidal Relative %

	2025		2030		2035		2040		2045		2050	
	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal	Nontidal	Tidal
Aquaculture	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.05%	0.9%	0.1%	0.9%	0.1%
Commercial	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%	0.1%	0.4%
Hydroelectric	39.3%		39.0%		38.6%		38.1%		37.6%		37.0%	
Industrial	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%	0.7%	0.03%
Irrigation	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%	0.4%
Livestock	0.02%		0.02%		0.02%		0.02%		0.02%		0.02%	
Mining	1.6%	0.3%	1.7%	0.3%	1.8%	0.3%	2.0%	0.3%	2.1%	0.3%	2.2%	0.3%
Other		8.0%		6.1%		4.1%		2.0%		0.3%		0.02%
Thermoelectric	38.4%	81.5%	38.1%	83.2%	37.7%	84.9%	37.3%	86.8%	36.7%	88.3%	36.1%	88.6%
Public Water Supply	18.4%	9.4%	18.9%	9.6%	19.6%	9.8%	20.4%	10.0%	21.3%	10.2%	22.5%	10.2%
Self-Supplied Domestic	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.004%	0.002%	0.003%	0.002%	0.003%	0.002%

Nontidal VS Tidal Predictions

- Tidal withdrawals are projected to
  - decrease by about 88 MGD from 2025 to 2050
  - Proportionally come from the Thermoelectric and Public Water Supply sectors more
- Nontidal withdrawals
  - Increase by about 195 MGD from 2025 to 2050
  - Proportionally come from the Public Water Supply sector more

Next Steps

- Scope of Work for continuous improvement of the WCU database
  - A maintenance plan
  - Public sharing protocol
  - Tabular and geospatial online querying tools for aggregate-level data
  - Update of consumptive use rates
    - By sector
    - Location-specific when possible
    - Agriculture location & crop specific
  - Information/education material

Questions?