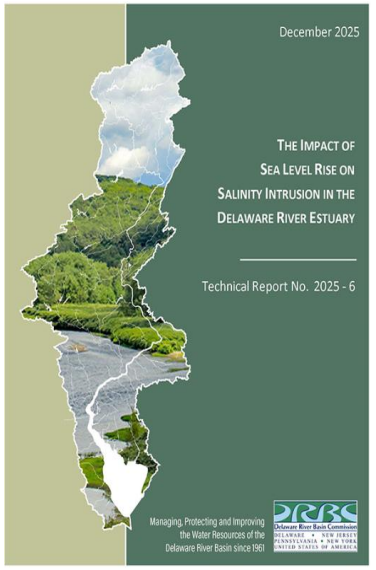








The Impact of Sea Level Rise on Salinity Intrusion in the Delaware River Estuary

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Manager of Water Resource Operations, DRBC

November 9, 2026

AWRA 2026 Annual Water Resources Conference

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Background Information

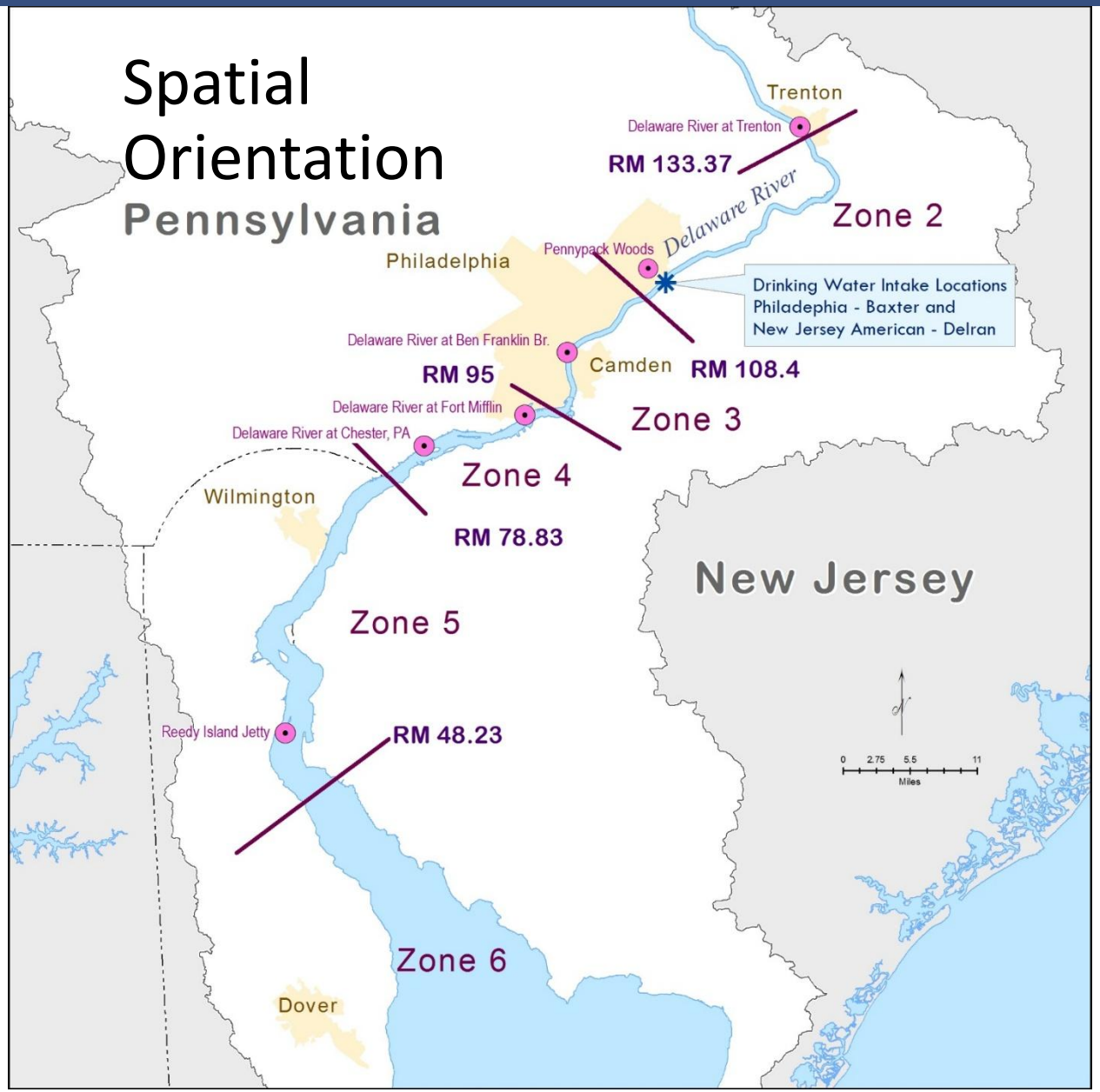


SLR Impact on Salinity



Potential Future Work

Salt Front Location and DRBC Criteria



Zone 2

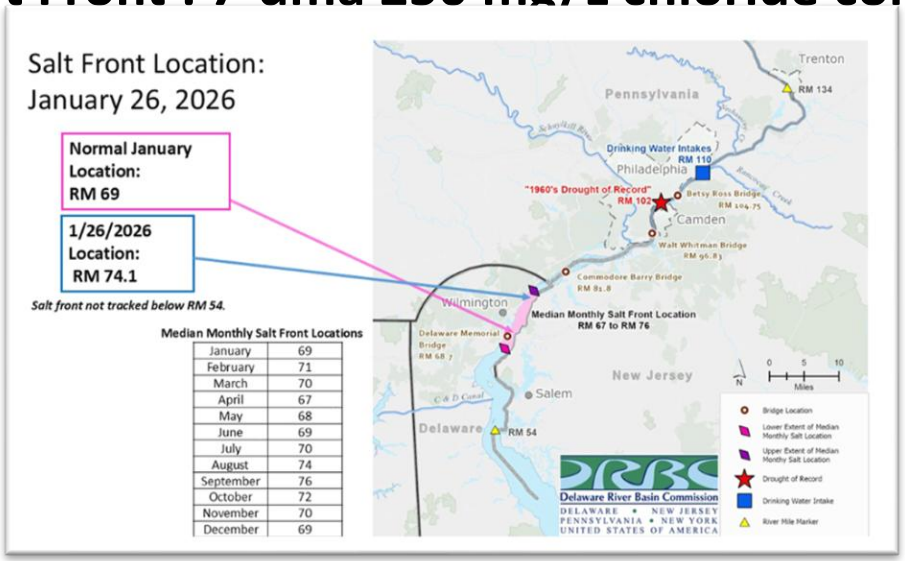
- Chlorides - Maximum 15-day average 50 mg/L

Zone 3

- Chlorides - Maximum 30-day average 180 mg/L at RM 98
- Sodium - Maximum 30-day average 100 mg/L at RM 98

DRBC Water Quality Regulations (2022):
https://www.nj.gov/drbc/library/documents/WQregs.pdf

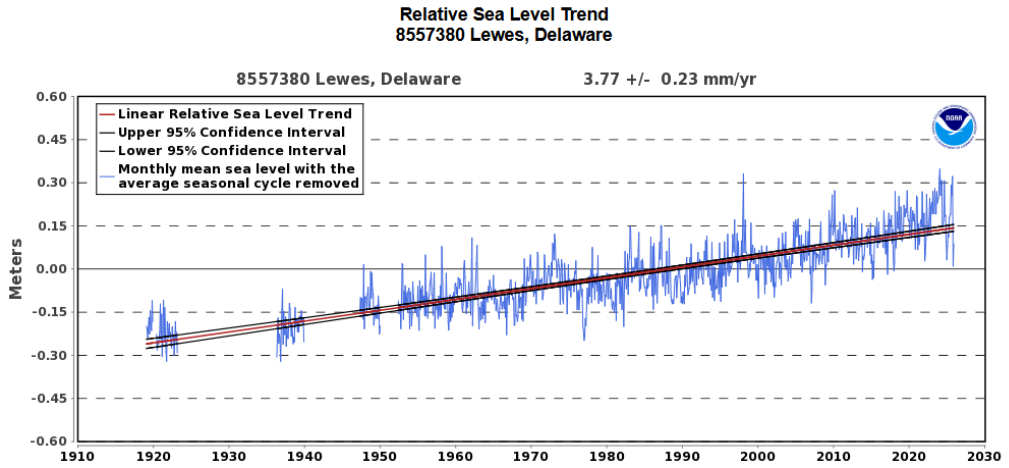
Salt Front : 7-dma 250 mg/L chloride concentration



The updated daily SF location are available on hydrosnap.drbc.net

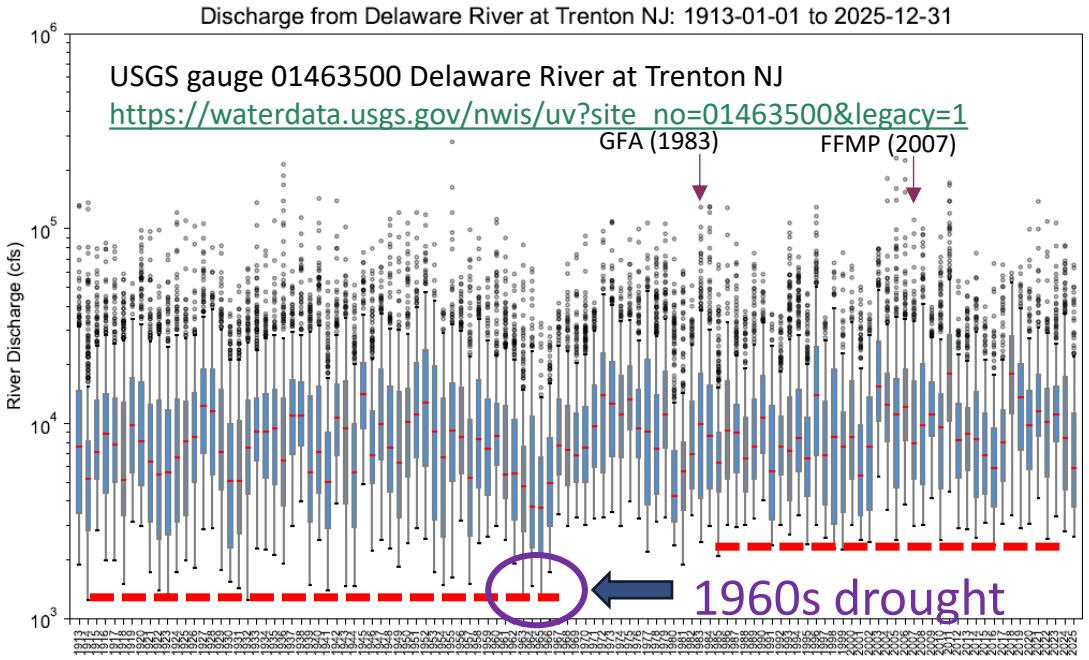
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Status of SLR for the Delaware Estuary

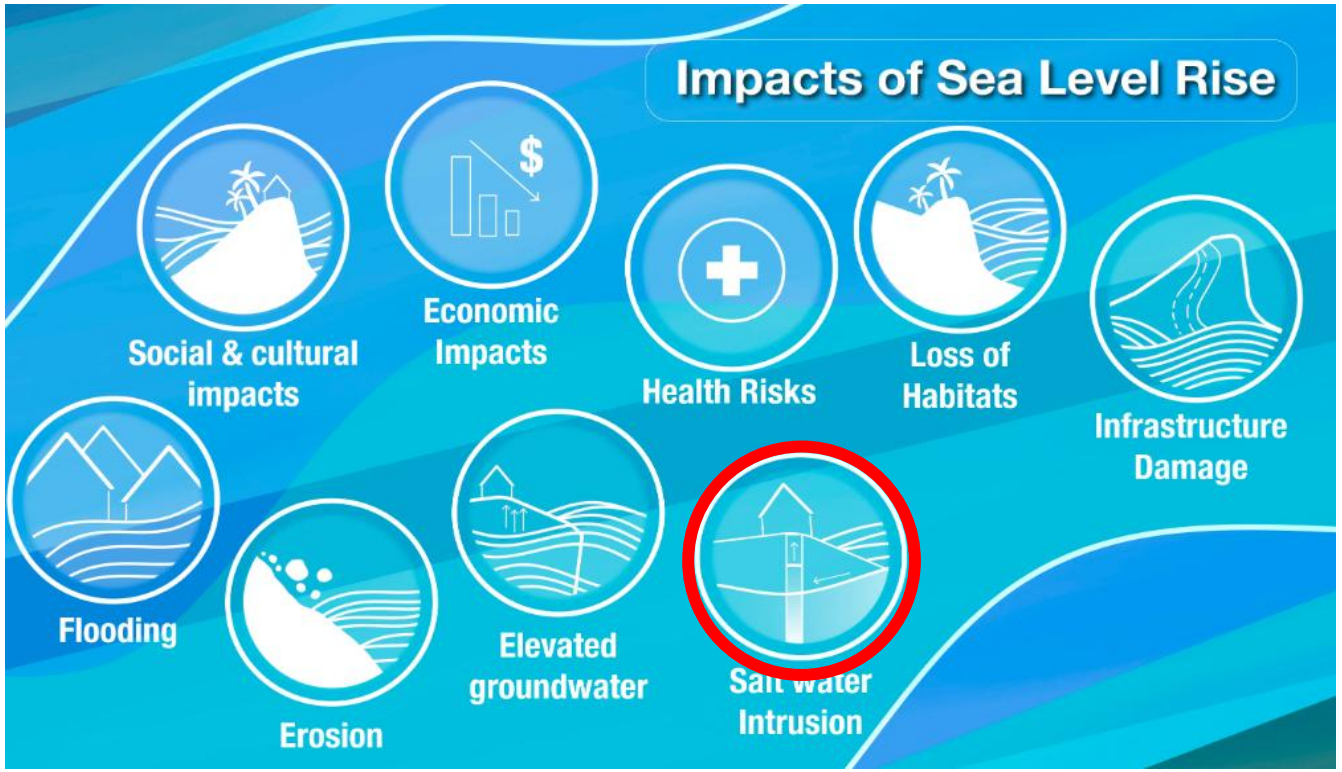


Sea level trend near Delaware Coast

NOAA tide gage at Lewes, DE.
https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8557380



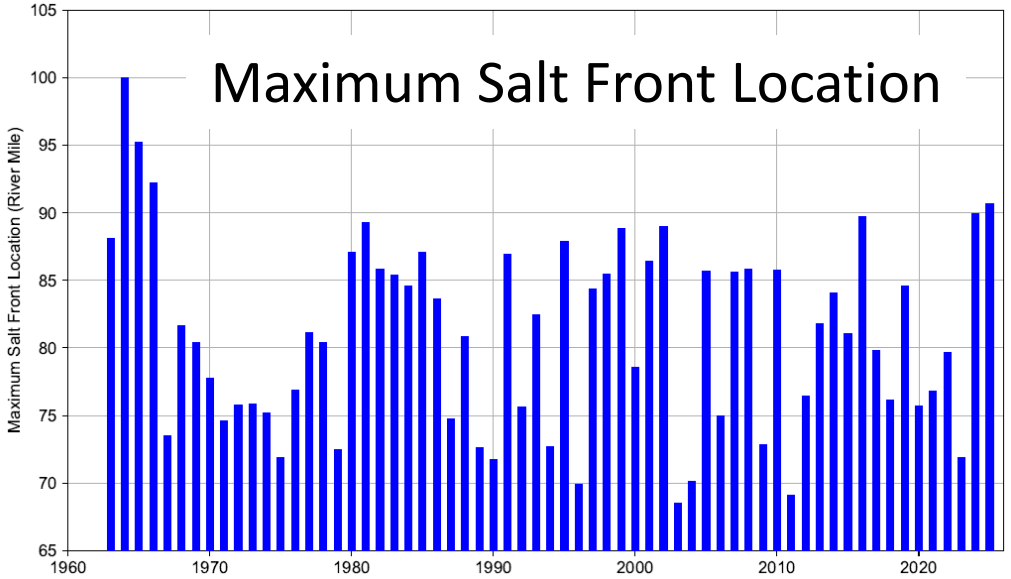
Flow on the Delaware River at Trenton, NJ



Source: https://earth.gov/sealevel/about-sea-level-change/impacts/the-basics/

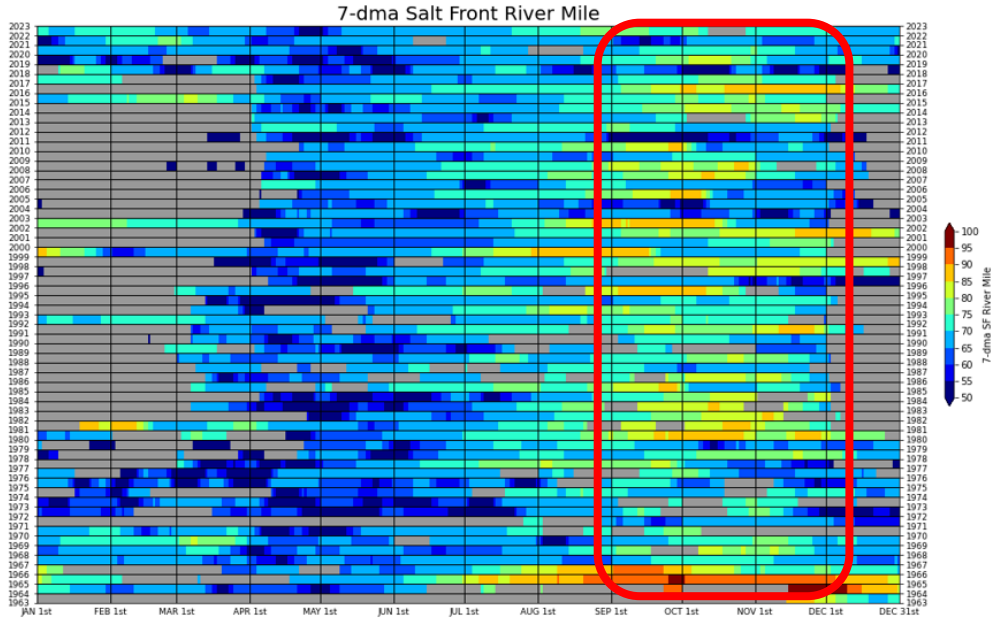
Salinity intrusion is driven primarily by two competing forcings:
Flow from upland and Tidal water level (Pressure)

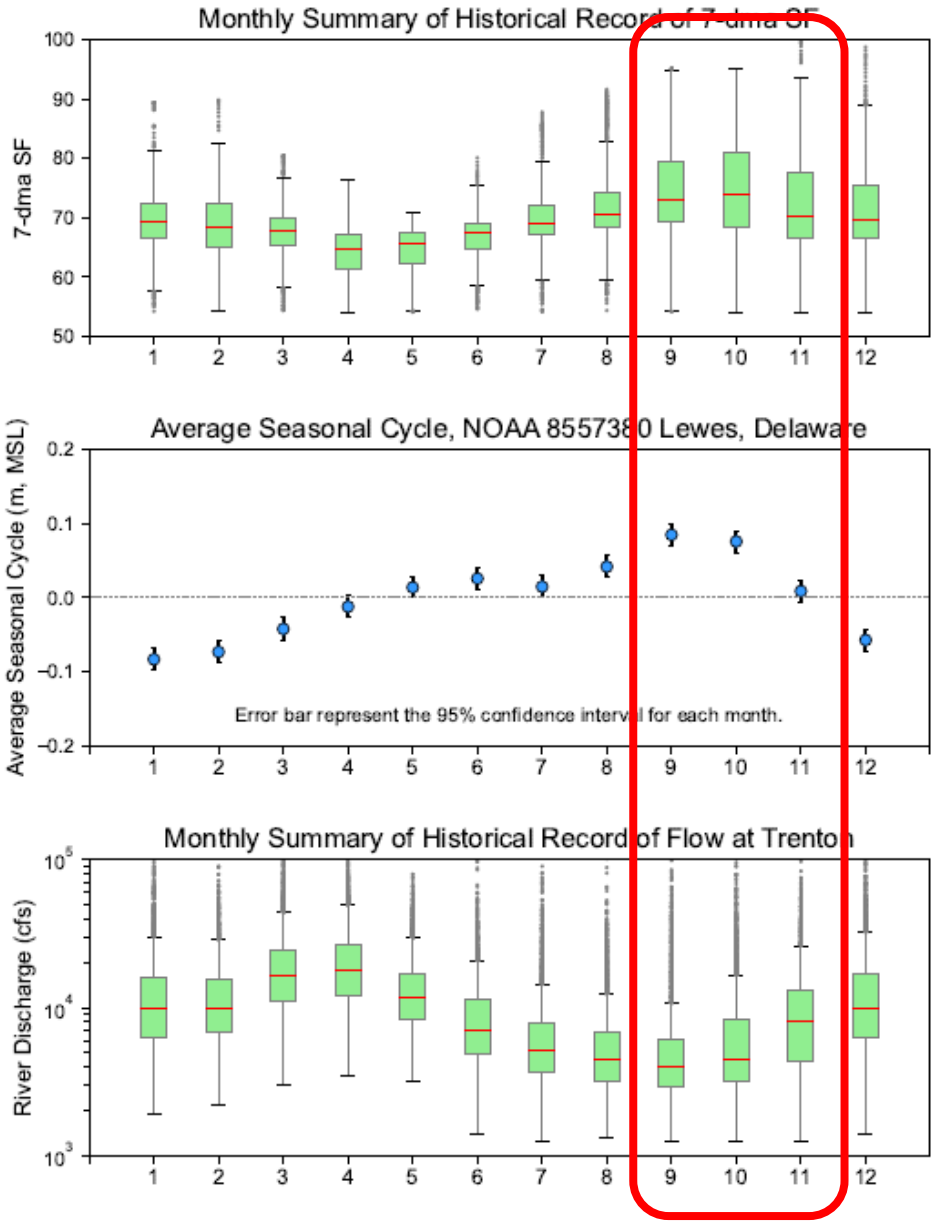
Historical Data of the Salt Front: 1963 - 2025



Historical Data for Salt Front

Year → 1963 - 2025





Salt Front

Tide

Average Seasonal Cycle

Trenton Flow

Historical data: *https://drbc.net/Sky/hydro/saltfront.html*

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Background Information

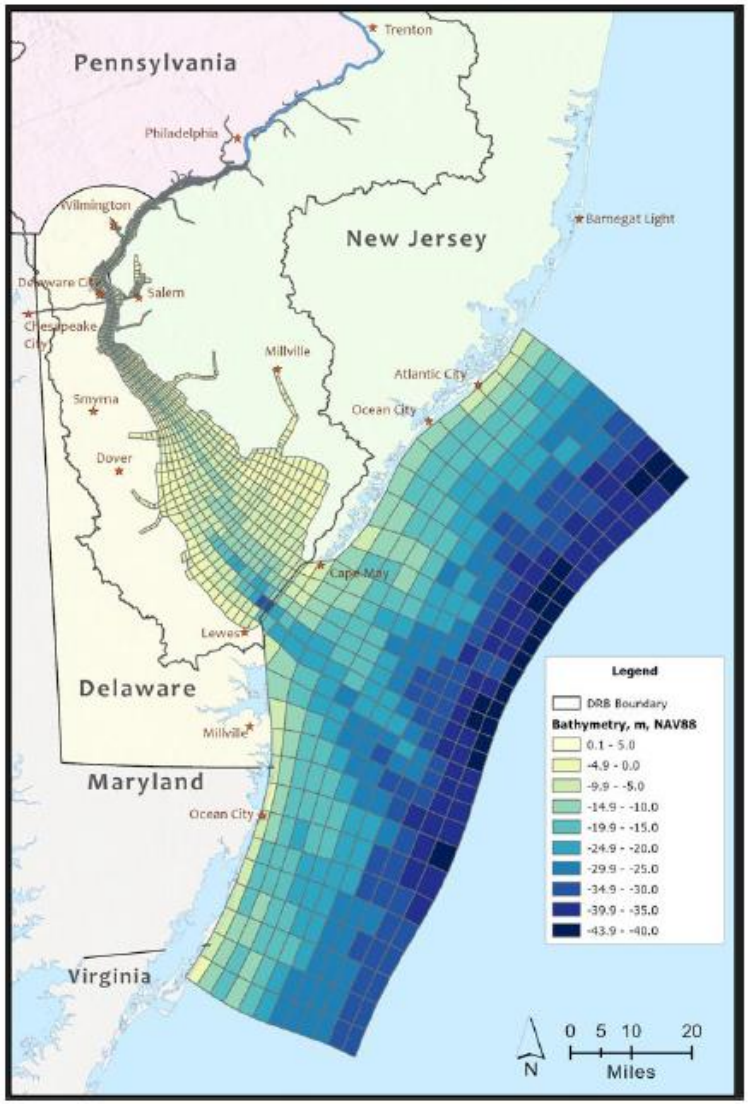


SLR Impact on Salinity



Potential Future Work

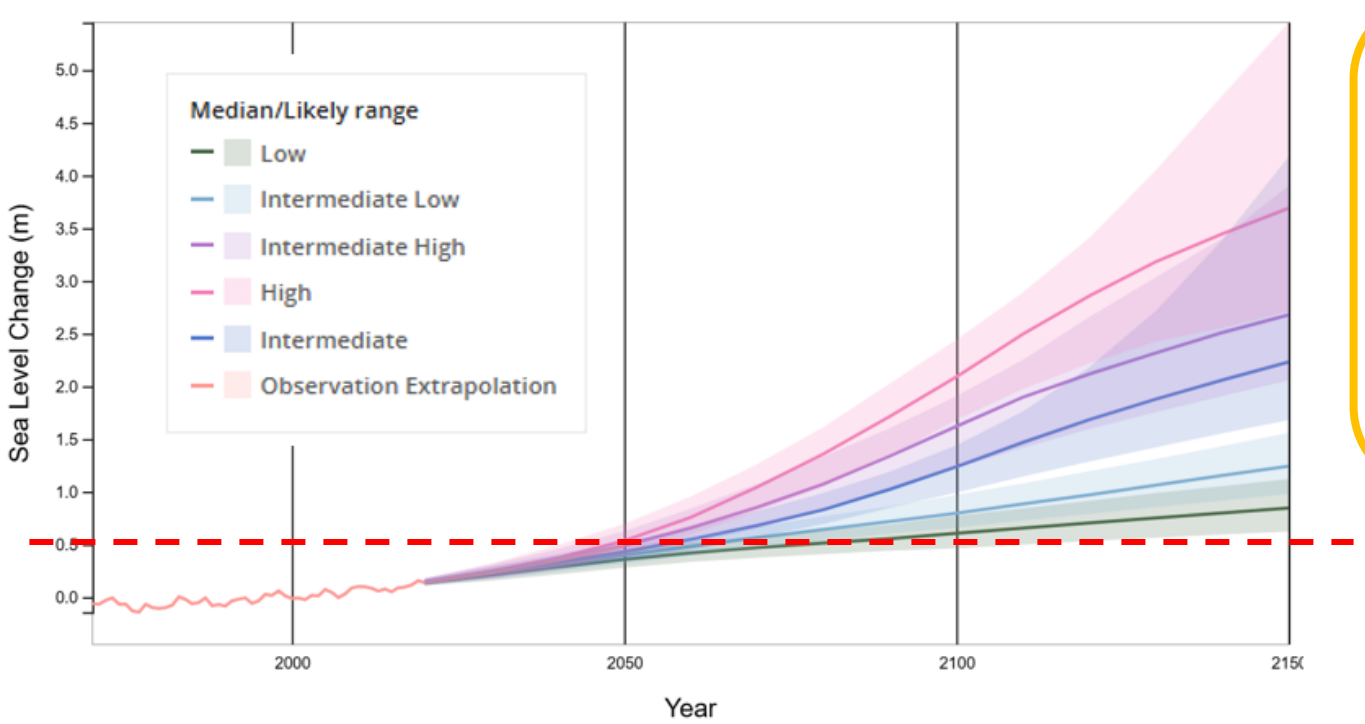
Modeling Approach



- SM3D hydrodynamic Model
- Literature review of SLR projections
- Multiple values of SLR to account for different planning scenarios, time horizon, and probability of occurrence
- Diagnostic analysis:
  - SLR
  - Bathymetry (dredging) and shape (marsh inundation)
  - Ocean surface temperature
- Multiple years simulation approach
- Conceptual analysis – managing actions

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SLR Projections for the Delaware Estuary (NOAA 2022 Study)



SLR Projections for Lewes, DE (8557380), based on NOAA 2022 Study

Imprecise Exceedance Probability

If SSPs lead to 2 to 4 C global warming

	>98%	50-97%	2- 23%	1 – 2%	<1%
scenario	Low	Int. Low	Int	Int. High	High
2020	0.135	0.144	0.146	0.147	0.146
2030	0.211	0.227	0.235	0.244	0.246
2040	0.286	0.313	0.330	0.356	0.374
2050	0.358	0.399	0.432	0.489	0.535
2060	0.420	0.482	0.548	0.657	0.757
2070	0.470	0.565	0.680	0.853	1.044
2080	0.514	0.643	0.830	1.073	1.360
2090	0.555	0.718	1.024	1.339	1.715
2100	0.606	0.796	1.238	1.621	2.091
2110	0.655	0.884	1.468	1.898	2.495
2120	0.704	0.970	1.684	2.117	2.858
2130	0.751	1.062	1.878	2.316	3.182
2140	0.799	1.155	2.060	2.510	3.447
2150	0.845	1.242	2.232	2.678	3.691

Source: NOAA (2022 projections, decadal median values are shown)
https://sealevel.nasa.gov/task-force-scenario-tool?psmsl_id=224

DRBC Modeling Study Selected Scenarios:
0 (baseline), 0.3, 0.5, 0.8, 1.0, 1.6 m,
all referenced to baseline 2000

All SLR amounts are relative to the baseline of the year 2000 (1991-2009 epoch)

Details on the scenario projections and uncertainty ranges are provided in the 2022 Sea Level Rise Technical Report, https://earth.gov/sealevel/us/resources/2022-sea-level-rise-technical-report.

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Simulated Salt Front Location: 10-year Ensemble Results

(1965, 2001 to 2002, 2011 to 2013, and 2016 to 2019)

With SLR of 0.3 to 1.6m, SF moved farther upstream by 1.6 to 10.5 miles

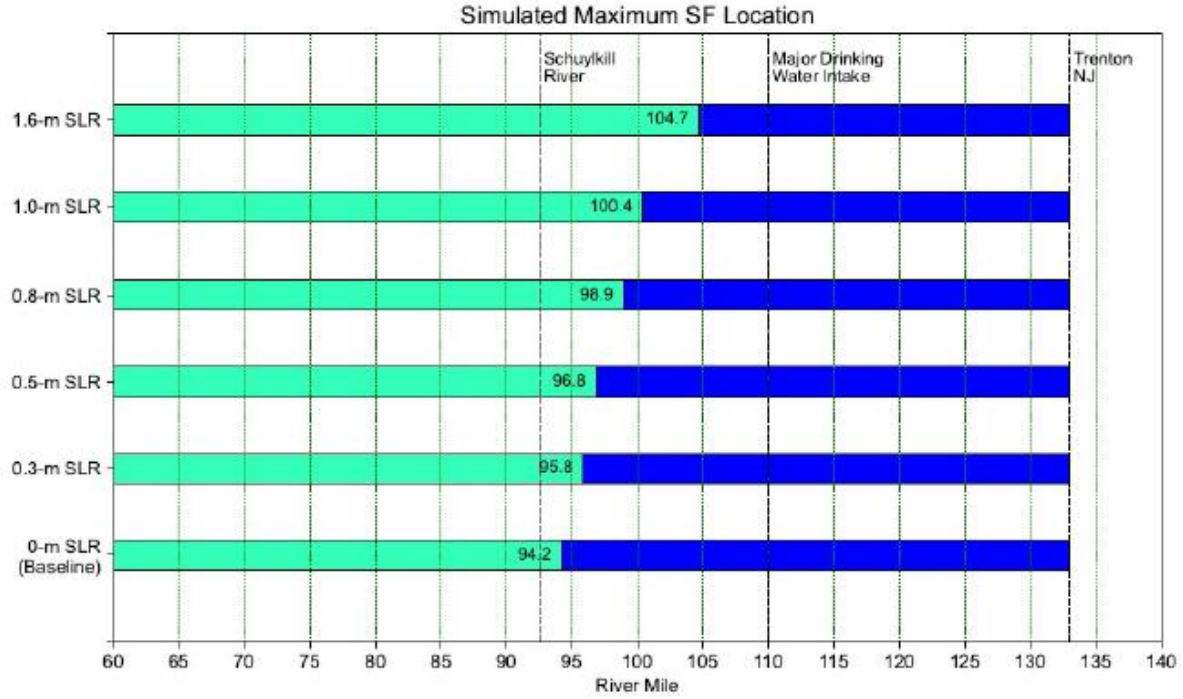


Figure 4.2-2. Simulated maximum location of the salt front with SLR during a hypothetical repeat of 1965 flows with a 2,500 cfs flow objective at Trenton, NJ.

Table G. 6. The percentage of time during the 10 simulated years that the salt front location is above RM 92.5.

0 m SLR	0.3 m SLR	0.5 m SLR	0.8 m SLR	1 m SLR	1.6 m SLR
1.6	2.8	4.0	5.8	7.1	11.3

Table 4.2-1. Simulated maximum location of the salt front with sea level rise and the normal range of the salt front location from the 10-year ensemble simulations.

Sea Level Rise (m)	Normal Range of Salt Front Location from the 10-year Ensemble (RM)	Maximum Salt Front Location (RM)	Increase in Simulated Maximum Salt Front from Baseline (RM)
0	61.6–76.5	94.2	–
0.3	62.7–77.8	95.8	1.6
0.5	63.4–78.7	96.8	2.6
0.8	64.3–80.1	98.9	4.7
1.0	64.9–81.2	100.4	6.2
1.6	66.8–84.1	104.7	10.5

The maximum location of the salt front occurred during the simulated 1965 conditions with implementation of a constant Trenton flow objective of 2,500 cfs.

Normal range:
(25 – 75 percentile range)

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Chloride Concentration: 10-year Ensemble Results

(1965, 2001 to 2002, 2011 to 2013, and 2016 to 2019)

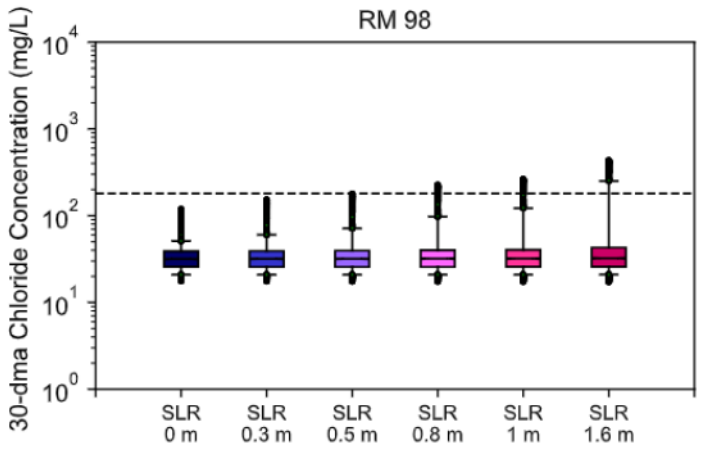


Figure 4.2-4. Simulated maximum 30-day moving average chloride concentration at RM 98 based on 10-year ensemble results.

Note: dashed line indicates the water quality standard of 180 mg/L chloride concentration at RM 98. In these ensemble simulations, a 2,500 cfs minimum flow was set on the Delaware River at Trenton to reflect the flow objective under drought conditions of 1965. Simulated years are 1965, 2001-2002, 2011-2013, and 2016-2019.

Table 4.2-2. Simulated maximum 30-dma chloride concentration at River Mile 98.

Sea Level Rise (m)	30-dma chloride concentration at Camden, RM 98 (mg/L)	Total number of days 30-dma chloride concentration exceeds 180 mg/L	Percent of time 30-dma chloride concentration exceeds 180 mg/L
0	119	0	0%
0.3	152	0	0%
0.5	178	0	0%
0.8	225	80 *	2.2% *
1.0	263	118 *	3.2% *
1.6	431	273	7.5%

Total number of days simulated = 3652.

* Simulated exceedances only occurred in 1965 with the constant 2,500 cfs flow objective at Trenton. For 1.6 m SLR, exceedances occurred in 4 years (2001, 2002, 2016, and 1965).

Sea level rise exceeding 0.5 m may result in water quality standard exceedances, and current flow objectives at Trenton may not provide sufficient salinity control.

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Sensitivity: Effects of Federal Navigation Channel Deepening

2002 low-flow hydrological condition, 45-ft channel bathymetry

Table 5.4-1. Sensitivity of salt front location to channel bathymetry and SLR.

SLR (m)	Channel Depth (ft)	Simulated Maximum Salt Front Location (RM)	Change in Salt Front Location Due to Increased Channel Depth (mi) [1] SF45 – SF40	Change in Salt Front Location Due to SLR for 40-ft Channel (mi) [2] SF(SLR) – SF(0m)	Change in Salt Front Location Due to SLR for 45-ft Channel (mi) [3] SF(SLR) – SF(0m)	Total Change in Salt Front Location Due to SLR and Channel Depth (mi) [4]* SF(45ft,SLR) – SF(40ft,0m)
0	40	88.3		–	–	
	45	90.7	2.4	–		2.4
0.5	40	91.3		3.0		
	45	93.4	2.1		2.7	5.1
1.0	40	94.1		5.8	–	
	45	96.3	2.2		5.6	8.0
1.6	40	99.0		10.7	–	
	45	101.4	2.4		10.7	13.1

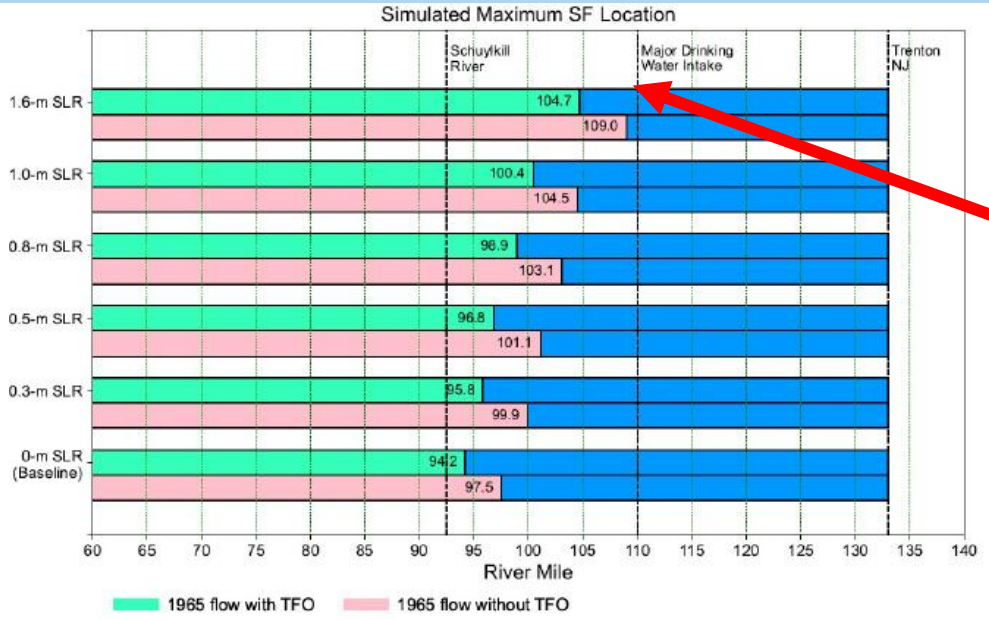
Note: the analysis was based on the 2002 hydrologic conditions. 2002 is one of the dry years.
* The total change in the salt front location with the channel deepening (45-ft channel) AND SLR compared to the SF for a 40-ft channel and 0 m SLR.

A deeper channel makes salinity intrusion farther upstream, while the SLR has a greater impact on salinity intrusion than the 5-ft channel deepening project

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Impact of Trenton Flow Objective

1965 hydrological condition, 45-ft channel bathymetry



SF is kept below RM 105 for all SLR scenarios with minimum 2500 cfs flow objective at Trenton with 1965 flow conditions.

Table 7.1-1. Simulated maximum salt front location during a repeat of 1965 flows during the 1960s drought with sea level rise: Evaluation of the Trenton Flow Objective.

Sea Level Rise (m)	Maximum Salt Front Location with Historical Flows (River Mile)	Maximum Salt Front Location with Historical Flows plus 2,500 cfs Flow Objective (River Mile)	Change in Simulated Maximum Salt Front Location (mi)
0	97.5	94.2	-3.3
0.3	99.9	95.8	-4.1
0.5	101.1	96.8	-4.3
0.8	103.1	98.9	-4.2
1.0	104.5	100.4	-4.1
1.6	109.0	104.7	-4.3

Table 7.1-3. Simulated days (percent of year) the maximum 30-dma chloride concentration at RM 98 (Camden) exceeds the water quality standard of 180 mg/L with sea level rise during a repeat of 1965 flows during the 1960s drought: Evaluation of the Trenton Flow Objective.

Sea Level Rise (m)	Historical Flows (days) [percent of year]	Historical Flows plus 2,500 cfs Flow Objective (days) [percent of year]	Difference (days)
0	43 [11.8%]	0 [0%]	-43
0.3	84 [23.0%]	0 [0%]	-84
0.5	115 [31.5%]	4 [1.1%]	-111
0.8	150 [41.1%]	91 [24.9%]	-59
1.0	160 [43.8%]	132 [36.2%]	-28
1.6	180 [49.3%]	170 [46.6%]	-10

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Background Information



SLR Impact on Salinity



Potential Future Work

POTENTIAL FUTURE WORK

Additional Analysis associate to SLR, Planning Scenarios

- Additional systematic analysis of the SF response to the tide and flows → Flow Objective with SLR → Water availability → Risk and sustainability study.
- Climate-impacted flow conditions → Climate change may alter the distribution and seasonality of inflows to the Estuary, so additional analysis of other climate-impacted flow conditions may be warranted.
- Planning scenarios → Model assumptions, non-tidal salinity, ocean temperature, future flows, and other boundary conditions, may also be factors to consider when designing detailed scenarios for future planning efforts.

Adaption, Mitigation, and Sustainability

- Protection of public health and safety: water quality, water availability and water supply sustainability.
- Impact of sea level rise on habitat and the health of aquatic life.
- Inform and improve flow and drought management programs for changing climate

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Welcome any questions, comments and suggestions







Additional information

- Report Website: https://www.nj.gov/drbc/programs/flow/SLR-impacts-report.html
- Salt Front: https://www.nj.gov/drbc/programs/flow/salt-front.html
- Salt Front Data and Data Viewer: https://drbc.net/Sky/hydro/saltfront.html

email: Fanghui.Chen@drbc.gov

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