MRRI 2022 Water Quality Report

2018-2022 5-year trends

1. Introduction

Water quality samples has been retrieved from the lower Hackensack River estuary by Meadowlands Research & Restoration Institute (MRRI) since 1993. In total, 14 different sites (HR 1, HR 2, HR 3, HR 4, HR 5, PHC 6, SMC 7, BC 8, MC 9, CKC 10, CKC 11, OPC 12, KM 13, and KM 14) are sampled each season during the low tide periods. The locations of the 14 monitoring sites along the Hackensack River are showed in Figure 1.

2. Methods and Materials

Water samples have been processed and analyzed based on EPA and Standard methods, NJDEP-certified procedures, and MRRI Standard Operating Procedure (QAPP). All the total and dissolved metals are analyzed by Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) (Agilent 7700X, Palo Alto, CA) based on EPA Method 200.8. All anions including fluoride, chloride, bromide, nitrate, nitrite, phosphate, and sulfate are measured using ion chromatography (Metrohm 881 Pro Compact IC) by EPA Method 300.1. All major cations including sodium, potassium, calcium, magnesium, and ammonia are analyzed by Metrohm 881 Pro Compact IC with Metrosep C4 150 column. Total trace mercury in water samples are analyzed by Brooks Rand total mercury analyzer MERX-T with the Model III Atomic Fluorescence detector based on EPA method 1631E. Biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), and total suspended solids (TSS) are analyzed according to the Standard Methods SM5210B, SM5220C, SM2540C, and SM2540D. Fecal coliform is analyzed by by using Membrane Filter Technique and modified EPA Method 1103.1 (mTEC). Turbidity, temperature, specific conductance/Salinity, pH, and dissolved oxygen (DO) are analyzed by YSI 6920 V2-2 multi-parameter sonde.

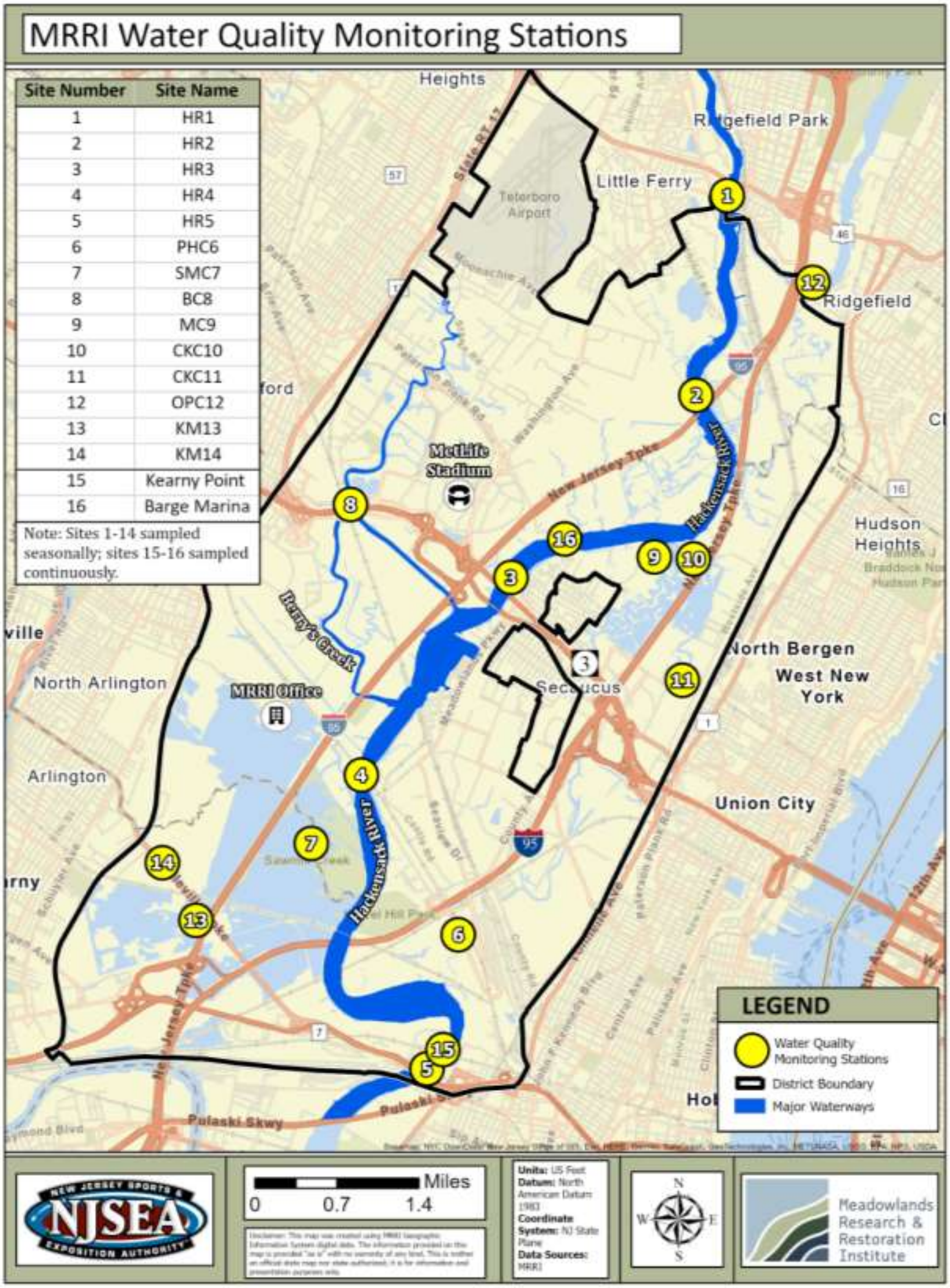

Figure 1. MRRI water quality monitoring stations along the lower Hackensack River.

3. Results and Discussion

Table 1 and Table 2 list the water quality parameters for the 5-year average and 2022. The data shows that most water quality parameters did not change significantly. The data is divided into two sections, River and Creek, with each section containing seven sites sampled. The data from each season of the past 5 years was recorded in an average and then graphed, resulting in 20 data points to identify any significant linear trend either increasing or decreasing. In addition, the available NJ Surface Water Quality Standards (SWQS) are added in the table, and all parameters were checked compared to the SWQS. All water quality parameters are in compliance with the SWQS, except for fecal coliform. According to SWQS, fecal coliform should be less than 770 MPN/100ml for saline water. However, the average fecal coliform for 2022 is 842±1307 MPN/100ml.

Most of the total metals and dissolved metals, except Mn, have lower average values in 2022 compared to the 5-year average values. This indicates that metal concentrations in the water body are lower in 2022 than in previous years. The average total trace metal concentrations in the main river are lower than those in the creeks. However, the major cations, including Na, K, Ca, and Mg, have higher concentrations in the main river than in the creeks. Moreover, most of the water quality parameters in Table 1 are also lower in 2022. However, total dissolved solids (TDS), nitrate, specific conductivity, salinity, chloride, sulfate, and bromide have higher average concentrations in 2022 than in the 5-year average. This may imply seawater intrusion in the lower Hackensack River estuary.

Table 1. The average wet chemistry parameters for the year 2022 and the entire 5 years.

		River		Creek		
Parameters	**Units**	**2022 average**	**5 years average**	**2022 average**	**5 years average**	**NJ SWQS***
Hardness	**mg/L**	1080±170	1088±340	484±135	528±198	n/a
Fecal Coliforms	**MPN/100ml**	348±471	422±1416	842±1307	638±1057	770MPN/100ml
BOD	**mg/L**	8.03±3.74	5.67±2.87	11.2±4.3	8.32±3.25	n/a
COD	**mg/L**	30.3±16.7	33.8±11.6	23.5±14.9	32.4±11.6	n/a
Ammonium	**mgN/L**	2.82±1.75	2.44±1.10	1.55±0.56	1.76±0.81	n/a
Nitrate	**mg/L**	2.35±0.87	2.28±0.66	1.91±0.29	1.89±0.76	n/a
TSS	**mg/L**	8.38±4.54	12.3±5.3	14.6±9.2	23.8±13.4	n/a
TDS	**mg/L**	7060±1527	6520±2149	3050±1581	2825±1289	n/a
Turbidity	**NTU**	7.46±3.10	12.9±5.9	11.9±2.9	20.6±10.7	30 NTU
Temperature	**oC**	14.9±10.5	16.1±9.3	15.1±9.2	16.3±9.0	29.4 oC
Specific Conductivity	**mS/cm**	12.1±2.7	10.2±3.0	4.89±1.84	4.45±1.72	n/a
Salinity	**ppt**	7.14±1.72	5.91±1.92	2.71±1.07	2.46±1.02	n/a
Chloride	**mg/L**	3405±873	3110±1090	1360±1192	1340±624	n/a
Sulfate	**mg/L**	420±128	376±136	147±80	137±80	250 mg/L (freshwater)
Fluoride	**mg/L**	0.25±0.08	0.19±0.07	0.16±0.03	0.15±0.03	n/a
Nitrite	**mg/L**	0.50±0.44	0.45±0.42	0.27±0.23	0.32±0.38	n/a
Bromide	**mg/L**	8.17±2.36	7.12±2.58	3.42±2.13	2.81±1.65	n/a
pH	**SU**	7.52±0.19	7.53±0.24	7.50±0.23	7.65±0.36	6.5-8.5
DO	**mg/L**	6.35±0.93	6.25±2.49	6.97±1.94	7.39±2.15	4 mg/L
Phosphate	**mg/L**	2.80±3.47	3.33±3.33	1.51±0.31	3.35±3.77	n/a

*N. J. A. C. 7:9B, Surface Water Quality Standards

Table 2. The average total metals and dissolved metals in the water samples for the year 2022 and the entire 5 years.

		River		Creek		
Parameters	**Units**	**2022 average**	**5 years average**	**2022 average**	**5 years average**	**NJ SWQS***
Total Metals	**Cd, ug/L**	<1.00	<1.00	<1.00	<1.00	H: 16
	Cr, ug/L	2.68±0.42	3.11±0.93	3.49±1.04	6.50±3.44	H: 750
	Cu, ug/L	4.82±1.17	4.17±1.69	7.26±1.63	13.8±11.2	n/a
	Fe, ug/L	785±347	693±265	1120±165	1671±876	n/a
	Mn, ug/L	264±42	261±66	338±100	383±102	H: 100
	Ni, ug/L	2.05±0.63	2.07±0.36	2.25±0.38	2.89±0.91	H: 1700
	Pb, ug/L	2.16±0.30	2.56±0.89	3.49±1.51	6.32±4.27	n/a
	Zn, ug/L	14.8±6.3	14.7±5.8	22.8±8.1	25.3±12.2	H: 26000
Dissolved Metals	**Na, mg/L**	1820±320	1750±558	733±236	757±323	n/a
	K, mg/L	69.3±11.5	66.5±20.3	28.4±10.9	29.2±11.3	n/a
	Ca, mg/L	99.2±15.6	106±25	63.1±13.7	75.2±19.7	n/a
	Mg, mg/L	203±34	201±68	79.5±29.2	85.4±38.2	n/a
	Cd, ug/l	<1.00	<1.00	<1.00	<1.00	A: 40 C: 8.8
	Cr, ug/l	1.21±0.28	1.68±1.17	1.06±0.28	1.84±1.35	n/a
	Cu, ug/l	2.74±0.96	2.91±2.37	2.93±0.61	5.40±2.74	A: 7.9 C: 5.6
	Fe, ug/l	62.0±36.3	116.86±69.79	194±158	307±210	n/a
	Mn, ug/l	248±30	230±60	323±60	288±101	n/a
	Ni, ug/l	1.51±0.19	13.4±50.7	1.68±0.15	18.9±74.6	A: 64 C: 22
	Pb, ug/l	<1.00	1.10±0.48	<1.00	1.73±0.94	A: 210 C:24
	Zn, ug/l	9.76±4.39	10.6±4.4	10.9±4.6	12.1±5.4	A:90 C:81
Total Hg	**ng/l**	18.3±4.3	22.3±9.0	28.1±10.9	47.5±21.2	A:1800 C:940 H: 51

*N. J. A. C. 7:9B, Surface Water Quality Standards; A means acute, C means Chronic, H means Human health noncarcinogen.

Table 3 and Table 4 summarize the trends found for the wet chemistry parameters, including hardness, BOD, COD, nitrate, TSS, TDS, conductivity, salinity, chloride, sulfate, fluoride, nitrite, bromide, sodium, potassium, calcium, magnesium, pH, turbidity, phosphate, ammonia, fecal coliforms, temperature, and dissolved oxygen. The statistical test performed for each parameter assessed the R^2 value to determine if it was greater than 0.20 before concluding whether there is a significant trend of the parameter increasing or decreasing. However, for variables temperature and dissolved oxygen, the R^2 value for the overall 5-year graph will be small due to the data's dependence on the season. Therefore, for these parameters, the direction of the trend line will only be considered to decide whether the data shows an increase or decrease over time. The significant increasing trends for the River found in the data were for conductivity, salinity, chloride, fluoride, and temperature. The increase in specific conductivity could be due to the increase in salinity and dissolved salts in the water. The increasing trend of chloride and fluoride in the water were also observed in the river. The temperature trend shows an increase, which may be a result of the current climate changes that reflect higher temperatures. As a result of the increasing temperature, TSS or total suspended solids have reduced since more solids would be dissolved rather than suspended, which, in turn, would decrease the turbidity in the water if there were fewer suspended solids. The fecal coliform trend could have also increased due to the higher temperature since it could further support the life of more bacteria within the water while decreasing the dissolved oxygen contents over time found in the river.

Figure 2 shows the graph of the average fecal coliform amount for each season each year for both the River and the Creek. The fecal coliform data for CKC 11 were not included in the summery graph. The fecal coliform at CKC11 is always Too Numerous to Count (TNTC). The fecal coliform has higher concentration levels in the Creek than that in the River. The fecal coliform has an increase trend in the creeks and a decrease trend in the river, but the trend is not significant. The increasing trends in the Creeks were for COD and temperature. In this case, the increasing COD and temperature in combination would decrease the DO amount in the water since there will be higher oxidizable organic matter in the water overall. Similar to the turbidity of the River trend, the turbidity of the Creek trend also decreased, most likely due to the increasing temperature.

Table 3. The 2018-2022 average water quality trends of wet chemistry parameters for the main lower Hackensack River or its tributaries. (Green, decreasing trends; Blue, no visible difference; Red, increasing trends.)

Parameters	Units	River	Creek
Hardness	mg/L	↔	↔
BOD		↔	↔
COD		↔	↑
NO_3^-		↔	↔
TSS		↓	↔
TDS		↔	↔
Conductivity	mS/cm	↑	↔
Salinity	%	↑	↔
Chloride	mg/L	↑	↔
Sulfate		↔	↔
Fluoride		↑	↔
Nitrite		↔	↔
Bromide		↔	↔
Sodium		↔	↔
Potassium		↔	↔
Calcium		↔	↔
Magnesium		↔	↔
pH		↔	↔
Turbidity	NTU	↓	↓
Phosphate	mg/L	↔	↓
NH4	mg/L	↔	↔
Fecal Coliforms	MPN/100ml	↔	↔
Temperature	^oC	↑	↑
Dissolved Oxygen	mg/L	↓	↓

Table 4. The 2018-2022 average water quality trends of total metals (TM) and dissolved metals (DM) parameters for the main lower Hackensack River or its tributaries. (Green, decreasing trends; Blue, no visible difference; Red, increasing trends.)

TM	River	Creek
Cadmium	ND	ND
Chromium	↓	↔
Copper	↔	↓
Iron	↔	↔
Lead	↔	↔
Manganese	↔	↔
Nickel	↔	↓
Zinc	↔	↔

DM	River	Creek
Cadmium	ND	ND
Chromium	↔	↔
Copper	↔	↓
Iron	↓	↔
Lead	ND	ND
Manganese	↔	↔
Nickel	↔	↔
Zinc	↔	↔

Temperature variations were examined individually for each season. During the winter season, the River exhibited a noteworthy decrease, whereas the Creek showed no significant change. In the spring season, both the River and Creek displayed no significant changes. Moving to the summer season, the Creek's temperature experienced a significant decrease, contrasting with the River, which remained stable. Lastly, during the winter season, the Creek's temperature increased, while the River's temperature remained unchanged. Dissolved oxygen levels for the four seasons over the five years were also summarized. In the winter season, the River recorded a significant decrease, while the Creek did not exhibit a significant change. For the spring season, there were no significant changes in either the River or Creek. In the summer season, the River experienced a considerable increase, while the Creek did not show a significant change. Finally, during the winter season, the Creek's temperature increased, and the River's temperature remained unchanged. In general, the trends in temperature and dissolved oxygen changes for most seasons were similar between the River and Creek.

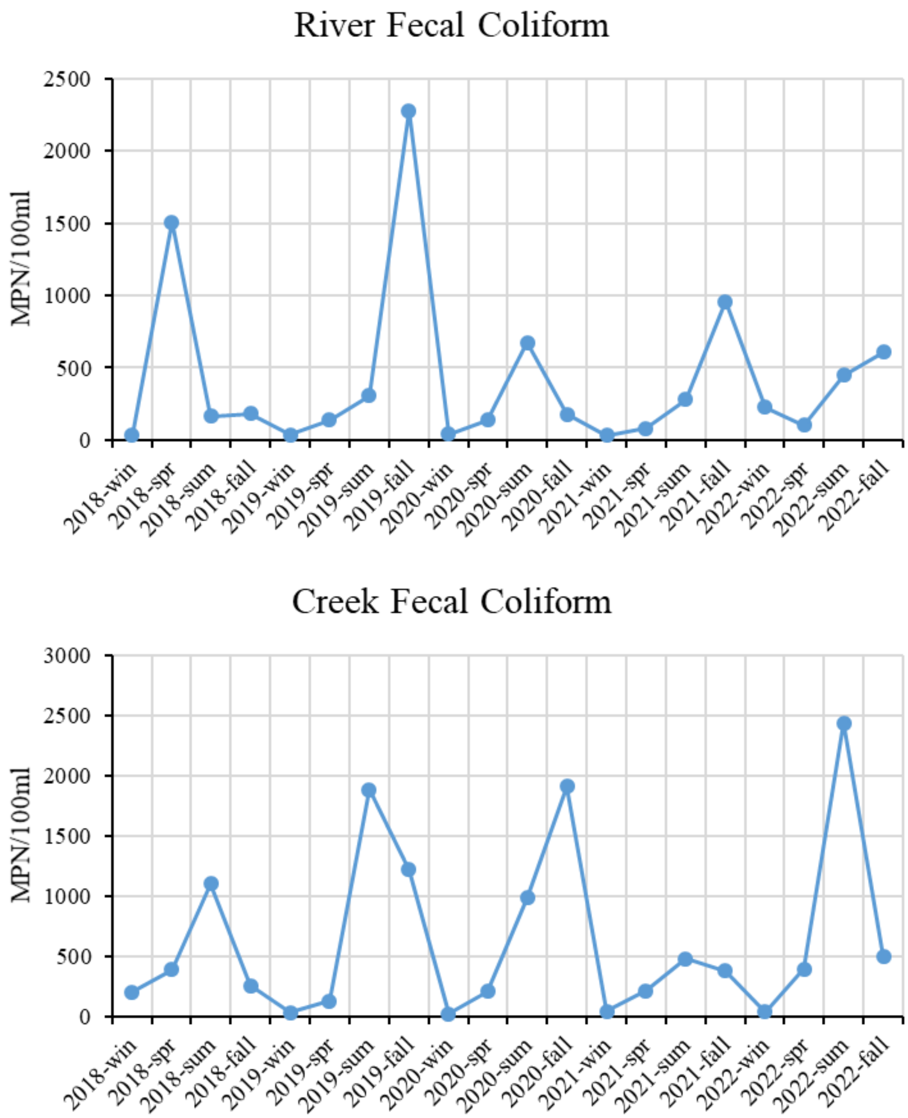

Figure 2. The 2018-2022 average fecal coliforms for the main lower Hackensack River or its tributaries.

4. Conclusion

According to water quality data collected between 2018 and 2022, there have been no significant changes in the factors influencing the water quality of the Hackensack River and its connected creeks. All water quality parameters meet the SWQS standards, except for fecal coliform. In 2022, the average fecal coliform concentration in the creeks was 842±1307 MPN/100ml, which is higher than the SWQS criterion of 770 MPN/100ml for saline water.

Additionally, the intrusion of seawater may contribute to increased salinity and dissolved solids levels in the lower Hackensack River, which could harm the aquatic ecosystem. To keep monitoring and evaluating these sites, the MRRI Lab will continue to collect water quality data throughout each season annually. This ongoing effort aims to detect any changes and evaluate their environmental impacts.

5. Acknowledgments

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