2014 - 2020

7-Year Trends in Summer Water Quality

About MERI

The Meadowlands Environmental Research Institute (**MERI**) was created in 1998 to provide the knowledge and research necessary to understand, conserve, protect, and manage the ecosystems of the 30.4-square-mile Hackensack Meadowlands District, and to promote sharing of information and resources. MERI is the scientific arm of the New Jersey Sports and Exposition Authority (NJSEA), the regional planning and zoning agency for the District.

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Executive Summary

MERI staff collects seasonal water quality data at 14 sampling sites within the Hackensack Meadowlands District (District). Sites 1 through 5 are stationed in the Hackensack River, and Sites 6 through 14 are at tributaries (creeks) (**Figure 1**). This report contains the summer water quality data for all sites over the past seven years (2014 to 2020).

Since the summer of 2014, we have been successfully collecting summer samples from each site at low tide. We then processed and analyzed the water samples based on NJDEP-certified standard procedures.

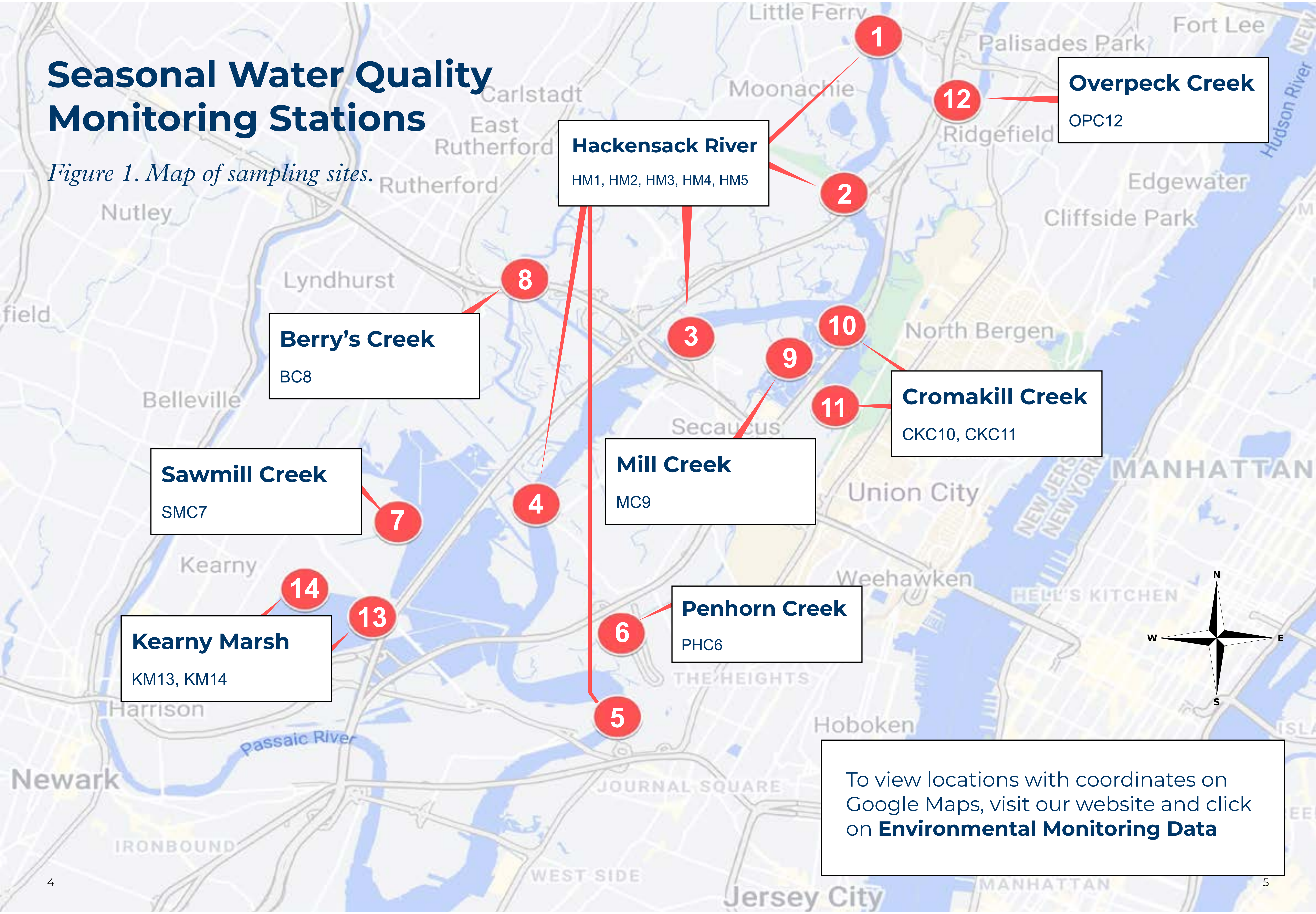
Our concerns about water quality in the District are the increasing levels of water temperature, fecal coliform, ammonium, turbidity, and phosphates, with a corresponding decrease in dissolved oxygen (DO) (**Table 4**). With climate change, water temperatures have been rising. Higher temperatures result in lower levels of DO, and especially during the summer, DO drops below the critical level (4 mg/L). This decrease in DO threatens the lives of fish and other organisms in the water.

Furthermore, we found an increasing trend of phosphates in the creeks. Higher phosphate concentrations, along with higher water temperatures and ammonia, have the potential to create harmful algal blooms (HABs).

Therefore, it is necessary to carefully monitor water quality parameters and to reduce the import of extra nutrients, such as phosphate and nitrate, into the Meadowlands estuary.

Seasonal Water Quality Monitoring Stations

Figure 1. Map of sampling sites.



To view locations with coordinates on Google Maps, visit our website and click on **Environmental Monitoring Data**

Glossary of Terms

anion A negatively charged ion, such as chloride (Cl^-) or sulfate (SO_4^{2-})

BOD **biochemical oxygen demand**: The amount of oxygen that will be consumed by aerobic microorganisms while decomposing organic matter.

cation A positively charged ion, such as calcium (Ca^{2+}), magnesium (Mg^{2+}), or potassium (K^+)

COD **chemical oxygen demand**: The amount of oxygen that will be consumed by the chemical oxidation (breakdown) of organic pollutants in water.

dissolved metals Dissolved metals are those that can pass through a 0.45-µm filter; they, along with particulate metals, make up the number of total metals.

DO **dissolved oxygen**: The measure of how much oxygen is present in the water.

HAB **harmful algal bloom**: Occurs when colonies of algae (simple plants that live in the sea and freshwater) grow out of control and produce toxic or harmful effects.

NJDEP **New Jersey Department of Environmental Protection**

TDS **total dissolved solids**: The total concentration of dissolved substances in water, made up of inorganic salts and a small amount of organic matter.

total metals Total metal concentration includes dissolved metals plus particulate (insoluable) metals.

TNTC **too numerous to count**

turbidity The measure of the relative clarity of a liquid.

See **Typical Water Quality Parameters Explained** [PDF] for additional reference.

Wet Chemistry Parameters

Including Major Anions and Cations

Over the sampling period (2014 to 2020), anions, cations, and most wet chemistry parameters (i.e., hardness, BOD, COD, nitrate, TSS, TDS, conductivity, salinity, chloride, sulfate, fluoride, nitrite, bromide, sodium, potassium, calcium, magnesium, and pH) show an average decreasing trend during the summertime (**Table 1**). Lower salinity, pH, anions, and cations in water are related to increasing levels of precipitation during this time period.

↑	**Average increase**
↓	**Average decrease**
↔	**No difference**
ND	**Data not available**

Table 1. Average trends: wet chemistry.

	HR1	HR2	HR3	HR4	HR5	PH6	SM7	BC8	MC9	CKC10	CKC11	OPC12	K13	K14
Hardness (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓
BOD (mg/L)	↓	↓	↔	↑	↑	↔	↔	↓	↓	↓	↑	↓	↔	↓
COD (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓
NO_3^- (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓
TSS (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑
TDS (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Conductiv-ity (mS/cm)	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓
Salinity (%)	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓
Cl^- (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
SO_4^{2-} (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
F^- (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
NO_2^- (mg/L)	↓	↓	↓	↓	ND	ND	ND	↓	↓	↓	ND	↓	ND	↓
Br^- (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Na^+ (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓
K^+ (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓
Ca^{2+} (mg/L)	↓	↓	↔	↔	↑	↓	↓	↓	↓	↔	↑	↔	↓	↓
Mg^{2+} (mg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓
pH	↔	↔	↑	↓	↓	↓	↓	↑	↓	↓	↓	↔	↔	↓

Metals

From HR 1 to CKC 10, most total metals, including chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn), all show a decreasing trend (**Table 2**). However, from CKC 11 to KM 14, most total metals show an increasing trend. This increase is related to the proximity of these sites to combined sewage outflows. The average total manganese has an increasing trend in almost all samples at all sites.

Table 2. Average trends: total metals.

	HR1	HR2	HR3	HR4	HR5	PH6	SM7	BC8	MC9	CKC10	CKC11	OPC12	K13	K14
Cadmium (µg/L)	↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↑	↑
Chromium (µg/L)	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓	↑	↑	↑
Copper (µg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	↑	↓
Iron (µg/L)	↓	↓	↓	↔	↓	↑	↓	↓	↓	↓	↓	↔	↓	↑
Lead (µg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	↑	↑
Manganese (µg/L)	↔	↔	↑	↑	↑	↔	↑	↑	↑	↑	↑	↑	↑	↑
Nickel (µg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑
Zinc (µg/L)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

By contrast, dissolved metals show different patterns during the summer season over these 7 years. **Table 3** shows the dissolved metal trends over time. Dissolved Cu, Ni, and Zn have a decreasing trend at most sites.

Table 3. Average trends: dissolved metals.

	HR1	HR2	HR3	HR4	HR5	PH6	SM7	BC8	MC9	CKC10	CKC11	OPC12	K13	K14
Cadmium (µg/L)	↓	↑	↑	↔	↓	↑	↑	↔	↑	↑	↓	↑	↑	↔
Chromium (µg/L)	↑	↓	↑	↑	↑	↑	↑	↑	↑	↔	↑	↓	↓	↑
Copper (µg/L)	↓	↓	↓	↓	↓	↑	↓	↓	↓	↓	↑	↑	↓	↑
Iron (µg/L)	↔	↑	↑	↑	↑	↑	↑	↑	↑	↑	↓	↑	↓	↑
Manganese (µg/L)	↔	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↓	↓
Nickel (µg/L)	↔	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓
Lead (µg/L)	↑	↑	↑	↓	↓	↑	↓	↑	↑	↓	↑	↑	↑	↑
Zinc (µg/L)	↓	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Mercury (ng/L)	↑	↓	↑	↑	↑	↓	↑	↓	↑	↑	↓	↑	↑	↑

Priority Parameters

Fecal Coliform, Ammonium, Turbidity, Temperature, Phosphate, and Dissolved Oxygen

Our concerns about water quality in the District are the increasing levels of water temperature, fecal coliform, ammonium, turbidity, and phosphates, with a corresponding decrease in dissolved oxygen (DO) (**Table 4**). With climate change, water temperatures have been rising. Higher temperatures result in lower levels of DO, and especially during the summer, DO drops below the critical level (4 mg/L). This decrease in DO threatens the lives of fish and other organisms in the water.

Furthermore, we found an increasing trend of phosphates in the creeks. Higher phosphate concentrations, along with higher water temperatures and ammonia, have the potential to create harmful algal blooms (HABs).

Table 4. Average trends: fecal coliform, ammonium, turbidity, temperature, phosphate, and DO

	HR1	HR2	HR3	HR4	HR5	PH6	SM7	BC8	MC9	CKC10	CKC11	OPC12	K13	K14
Fecal Coliforms (MPN/100mL)	↓	↑	↑	↑	↑	↑	↑	↑	↔	↑	High	↑	↑	↑
NH_4 (mgN/L)	↓	↑	↓	↑	↑	↓	↑	↑	↑	↑	↑	↑	↓	↓
Turbidity (NTU)	↓	↓	↓	↑	↑	↔	↑	↓	↑	↓	↑	↓	↑	↑
Temperature (°C)	↑	↑	↑	↑	↑	↔	↑	↑	↑	↑	↑	↑	↑	↑
Phosphate (mg/L)	↑	↓	↑	↓	↓	↑	↓	↓	↓	↓	↑	↑	↑	↓
DO (mg/L)	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓

↑	**Average increase**
↓	**Average decrease**
↔	**No difference**
High	**Concentration is out of range**

River and Creek Data

The Hackensack River

At HR 1 (upstream), almost all metal concentrations decreased over time with decreasing TSS, COD, and turbidity. Fecal coliforms maintained the same level. However, we found increased levels of phosphate and water temperature, and a decreased level of DO. At HR 2, most metal concentrations also decreased over time with decreasing TSS, COD, and turbidity. Phosphate concentration maintained the same range (1 to 2.5 mg/L). From 2018 to 2020, the fecal coliform count was correlated with the increased ammonium concentration during the summer season. At the same site, we observed decreased DO concentrations in the past three years (below 4 mg/L at HR 2).

At HR 3, fecal coliform counts remained level from 2014 to 2018. In the summer of 2019 we observed a noticeable increase in fecal coliform counts (360 MPN/100), and in 2020 fecal coliform counts were too numerous to count (TNTC). From 2015 to 2020, the ammonium concentration at HR 3 increased as well. Most metals, anions, cations, and TSS stayed at the same level, and COD slightly decreased over time during the summer. The water quality at HR 4 and HR 5 remained steady, except for increased levels of ammonium and turbidity.

The River vs. the Creeks

Tables 5, **6**, and **7**, along with **Figure 2**, compare the average trends in the main river with those of the creeks. In the main river, we observed increasing trends for fecal coliform, temperature, phosphate, and ammonium. The total cadmium (Cd) and mercury (Hg) also increased in the main stem of the river.

CKC 11 showed the worst water quality among all creek sites, including extremely low DO (0.39 mg/L), high concentrations of ammonium (10.2 mg-N/L), and TNTC fecal coliform. Fecal coliform, turbidity, temperature, phosphate, Cr, Mn, and Hg have increasing trends in the creeks. Most anions and cations, COD, TSS, TDS, and DO have decreasing trends.

Table 5 (top left). Average wet chemistry trends: river vs. creeks.

Table 6 (bottom left). Average trends in anions and cations: river vs. creeks.

Table 7 (bottom right). Average trends in metals: river vs. creeks.

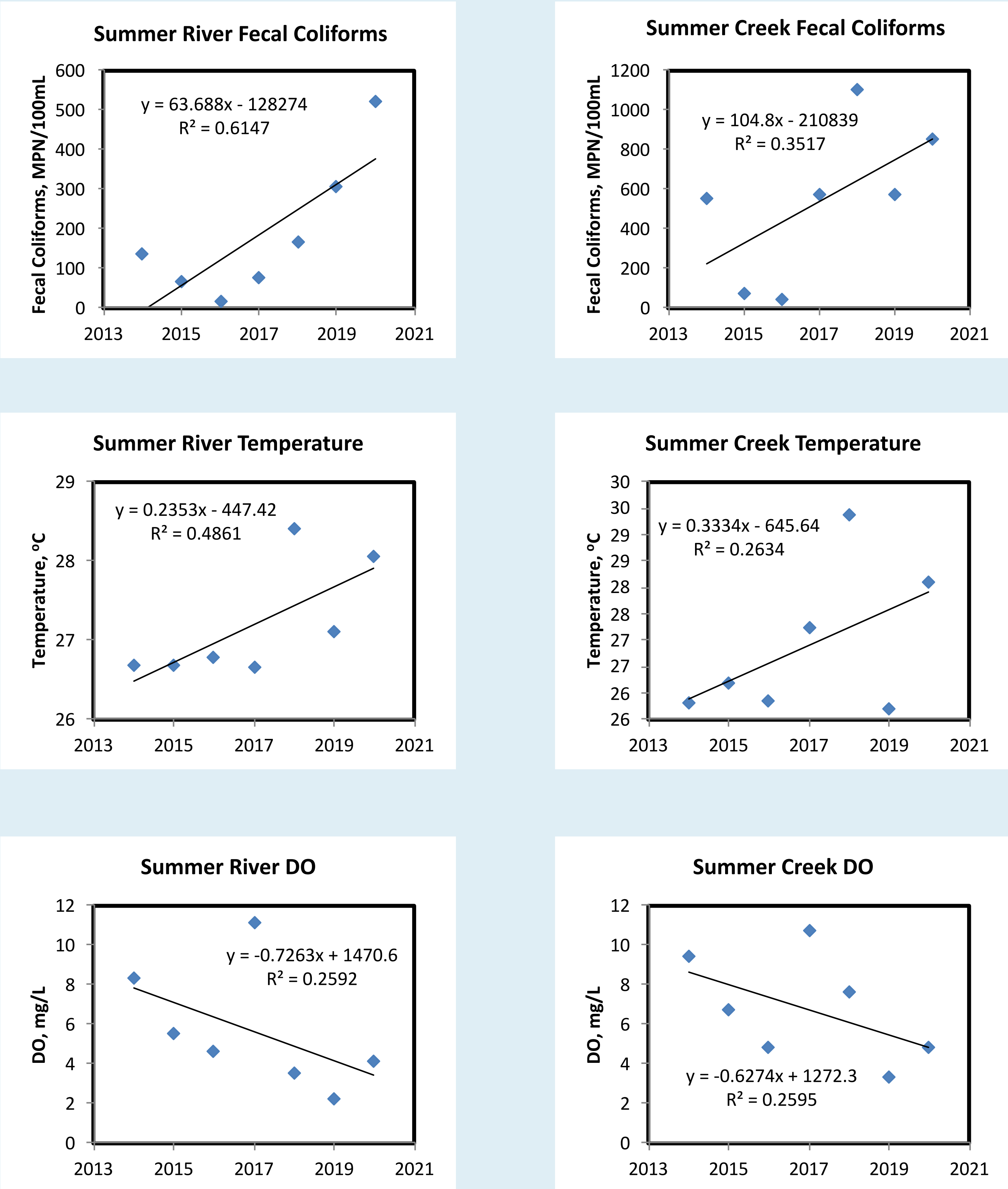
	Main River	Creeks
Hardness (mg/L)	↓	↓
Fecal Coliforms (MPN/100mL)	↑	↑
BOD (mg/L)	↓	↔
COD (mg/L)	↓	↓
TSS (mg/L)	↓	↓
TDS (mg/L)	↓	↓
Turbidity (NTU)	↓	↑
Temperature (°C)	↑	↑
Conductivity (mS/cm)	↓	↓
Salinity (ppt)	↓	↓
pH (SU)	↓	↓
DO (mg/L)	↓	↓
Phosphate (mg/L)	↑	↑
NH_4 (mgN/L)	↑	↓

	Main River	Creeks
Phosphate (mg/L)	↑	↑
NH_4 (mgN/L)	↑	↓
Nitrate (mg/L)	↓	↓
Nitrite (mg/L)	↓	↓
Chloride (mg/L)	↓	↓
Sulfate (mg/L)	↓	↓
Fluoride (mg/L)	↓	↓
Bromide (mg/L)	↓	↓
Sodium (mg/L)	↓	↓
Potassium (mg/L)	↓	↓
Calcium (mg/L)	↓	↓
Magnesium (mg/L)	↓	↓

		Main River	Creeks
Total Metals	**Cadmium** (µg/L)	↑	↓
	Chromium (µg/L)	↓	↑
	Copper (µg/L)	↓	↓
	Iron (µg/L)	↓	↔
	Manganese (µg/L)	↓	↑
	Nickel (µg/L)	↑	↑
	Lead (µg/L)	↓	↓
	Zinc (µg/L)	↓	↓
Dissolved Metals	**Cadmium** (µg/L)	↑	↑
	Chromium (µg/L)	↑	↑
	Copper (µg/L)	↓	↔
	Iron (µg/L)	↑	↑
	Manganese (µg/L)	↑	↑
	Nickel (µg/L)	↓	↓
	Lead (µg/L)	↓	↑
	Zinc (µg/L)	↓	↓
	Mercury (ng/L)	↑	↑

Figure 2.

The following line charts show the upward trend for **fecal coliforms** at both river and creek sites, the upward trend for **temperature** at both river and creek sites, and the downward trend for **DO** at both river and creek sites.



Summary and Conclusions

In conclusion, most anions, cations, total metals, COD, BOD, TSS, and TDS showed decreasing trends during the summers of the study period. Moreover, the water temperature, fecal coliform counts, ammonium, and phosphate increased during this period, while DO had a decreasing trend. The most affected location (CKC 11) is near a permitted combined sewage outflow. This creek has had consistently lower water quality since the beginning of the monitoring program in 1994.

The higher levels of nutrients (phosphates) observed in KM 13 are triggering harmful algal blooms (HABs). HABs have been found at KM 13 for several years, resulting in samples that are very difficult to filtrate because of the amount of algae in suspension.

Future water quality reporting will occur every season in shorter form. For more information, including real-time scientific data, visit **https://meri.njmeadowlands.gov**.

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