# New York City Economic Development Corporation
# Financial District and Seaport Climate Resilience Plan

# Biological and Habitat Sampling Report
# October 2020 Sampling Event


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# A. INTRODUCTION

The New York City Economic Development Corporation ("NYCEDC"), on behalf of the City and in collaboration with the Mayor's Office of Recovery ("MOR"), is conducting a climate resilience master planning effort in the Financial District and Seaport of Lower Manhattan ("Financial District and Seaport Climate Resilience Master Plan," or "FiDi Seaport Climate Resilience Plan"). The FiDi Seaport Climate Resilience Plan, initiated in October of 2019, is part of the Lower Manhattan Coastal Resiliency project. The FiDi Seaport Climate Resilience Plan project comprises a 0.9-mile portion of the Manhattan shoreline along the East River from just south of the Brooklyn Bridge to the Battery, including South Street Seaport and the Wall Street Financial District, extending out to the pierhead line ("Project Area").

The East River is a tidal strait connecting Upper New York Bay and Long Island Sound that provides habitat for plankton, benthic invertebrates, marine, estuarine and anadromous fish and is used as a migratory pathway by endangered Atlantic sturgeon and possibly by the endangered shortnose sturgeon. Threatened or endangered sea turtles may also occur in the East River as occasional transient individuals. In-water components to be considered in the development of the FiDi Seaport Resilience Plan, such as extending the shoreline, have the potential to affect existing aquatic resources within the Project Area and in the adjacent portion of the lower East River. Because recent information characterizing the aquatic resources within the Project Area and the lower East River is limited, as part of the FiDi Seaport Climate Resilience Plan, NYCEDC is conducting a biological and habitat sampling study to characterize these resources.

The study area for this biological sampling comprises the Project Area and the lower East River from approximately the Battery to the south to Montgomery Street to the north, opposite the western boundary of the Brooklyn Navy Yard, a distance of approximately 1.8 miles and spanning the width of the River (**Figure 1**). The sample universe is subdivided into six zones bisected by the Brooklyn Bridge and reflecting locations relative to the Project Area and water depth. Zones (as indicated in **Figure 1**) are defined as:

1) "Primary Study Area" - the Primary Study Area along the northern shoreline of the East River from the White Hall Ferry terminal (Staten Island Ferry) to the Brooklyn Bridge, also referred to as the Project Area;
2) "Adjacent East" - the shallow, off-channel area along the northern shoreline adjacent to the Project Area and east of the Brooklyn Bridge;
3) "Channel" - the deep, river channel south of the Primary Study Area;
4) "Channel East" - the deep, channel east of the Brooklyn Bridge;
5) "Opposite Shore" - the shallow, off-channel area along East River shoreline in Brooklyn across the river from the Primary Study Area; and
6) "Opposite Shore East" - the shallow, off-channel area along the East River shoreline of Brooklyn east of the Brooklyn Bridge.

The study area is further subdivided into three habitat strata based on proximity to shoreline structure and water depth and are defined as: 1) shoreline ($\leq$ 1 meter depth), 2) nearshore (within the pierhead line, generally 1 to 5 meters depth), and 3) channel (beyond the pierhead line at depths of 5 to 12 meters). This stratified-random sampling design is intended to provide pre-construction biological and habitat data on the aquatic community in the Primary Study Area (Zone 1) that can be compared with data collected in similar shoreline habitat and deep-water areas of the East River, adjacent to, and east of, the Project Area (Zones 2-6).

## B. SUMMARY OF SAMPLE COLLECTION

This report summarizes biological and habitat sampling conducted in the East River during October 2020. NYCEDC conducted the sampling following the September 2020 Biological and Habitat Sampling Plan ("Sampling Plan") approved by the Aquatic Resource Advisory Committee established for the FiDi Seaport Climate Resilience Plan. As outlined in the Sampling Plan, the October sampling event comprised the following described in greater detail below:

- sampling with a 0.05-$m^2$ Ponar grab sampler **(Figure 2)** to characterize invertebrate abundance and biodiversity, sediment composition, and total organic carbon;
- sampling with an otter trawl, seine net, baited fish traps, and Adaptive Resolution Imaging Sonar ("ARIS") to characterize fish abundance and biodiversity;
- sampling with a conductivity, temperature and depth ("CTD") instrument to measure water quality parameters (i.e., temperature, salinity, dissolved oxygen and pH), which was conducted concurrently with the benthic and fish sampling; and
- measurements of current velocity.

In accordance with the Sampling Plan, NYCEDC did not sample for plankton for the October sampling event. NYCEDC will sample for plankton in July, August and September 2021.

NYCEDC collected a total of 118 biological samples at randomply selected locations within each zone of study area, along with water quality measurements, in October. **Table 1** summarizes the number of samples collected by gear type, zone and stratum.


**Figure 1 –** Zones for biological and habitat sampling in the East River.

**Table 1 – Samples collected by zone, study area and habitat stratum.**

| Type of Sampling | Zone | Study Area | Stratum | No. Samples |
|---|---|---|---|---|
| **Benthic Invertebrates and Substrate** | | | | |
| Macroinvertebrate and Sediment Grab | 1 | Primary Study Area | Shoreline/Nearshore | 5 |
| | 2 | Adjacent East | Shoreline/Nearshore | 5 |
| | 3 | Channel | Channel | 5 |
| | 4 | Channel East | Channel | 5 |
| | 5 | Opposite Shore | Shoreline/Nearshore | 5 |
| | 6 | Opposite Shore East | Shoreline/Nearshore | 5 |
| | | | **Total** | **30** |
| **Fish Community** | | | | |
| Seine Net | 1 | Primary Study Area | Shoreline | 2 |
| | 2 | Adjacent East | Shoreline | 2 |
| | 5 | Opposite Shore | Shoreline | 5 |
| | 6 | Opposite Shore East | Shoreline | 5 |
| | | | **Total** | **14** |
| Bottom Trawl | 3 | Channel | Channel | 5 |
| | 4 | Channel East | Channel | 5 |
| | | | **Total** | **10** |
| Baited Fish Traps (Paired) | 1 | Primary Study Area | Shoreline | 3 |
| | | | Nearshore | 1 |
| | 2 | Adjacent East | Shoreline | 2 |
| | | | Nearshore | 2 |
| | 3 | Channel | Channel | 4 |
| | 4 | Channel East | Channel | 4 |
| | 5 | Opposite Shore | Shoreline | 2 |
| | | | Nearshore | 2 |
| | 6 | Opposite Shore East | Shoreline | 3 |
| | | | Nearshore | 1 |
| | | | **Total** | **24** |
| Mid-Water Trawl (Spring) | 3 | Channel | Channel | -- |
| | 4 | Channel East | Channel | -- |
| | | **Total** | | **--** |
| Remote Sensing | 1 | Primary Study Area | Shoreline | 5 |
| | | | Nearshore | 5 |
| | 2 | Adjacent East | Shoreline | 5 |
| | | | Nearshore | 5 |
| | 5 | Opposite Shore | Shoreline | 7 |
| | | | Nearshore | 3 |
| | 6 | Opposite Shore East | Shoreline | 4 |
| | | | Nearshore | 6 |
| | | | **Total** | **40** |

**Note:** Only 2 shoreline seine sample could be collected from Zones 1 and 2 due to the lack of suitably shallow shorelines.

## C. BENTHIC GRAB SAMPLING

**Figure 1** shows the 30 locations sampled for sediment and benthic macroinvertebrates. NYCEDC collected samples in each of the six zones.

### BENTHIC INVERTEBRATE COMMUNITY

The benthic invertebrate community was dominated by polychaete and oligochaete worms, gastropod snails, and amphipod crustaceans at the sampled locations (**Table 2 and Figures 3a, 3b, and 3c)**. Species richness (i.e., the number of species collected) and overall biomass (i.e., weight of organisms collected per sample location) were highest in the channel zones (Zones 3 and 4), followed by the inshore zone on the Manhattan shoreline east of the Primary Study Area (Zone 2) (**Tables 2 and 3**). The Primary Study Area (Zone 1) and the Opposite Shoreline (Zone 5) had the lowest species richness and biomass, possibly due to bottom disturbance caused by vessels in heavily trafficed areas around the ferry terminals and ferry landings. As another indicator of the low number of species, the number of taxa making up at least 90 percent of the total number of individuals collected—which could be the species, family, or class that could be identified for a particular invertebrate—was lowest in the Primary Study Area (Zone 1) and

Opposite Shoreline (Zone 5), and approximately twice as high in the nearshore/shoreline zones upriver of the bridges (Zones 2 and 6) and in the Channel (Zone 3).

Oligochaete worms were the most abundant benthic invertebrates in the study area and were most abundant in the Channel adjacent to the Primary Study Area. Within Zone 1, the Primary Study Area, the polychaete worm *Mediomastus ambiseta*, oligochaete worms, and the gastropod snail *Japonactaeon punctostriatus* were the most abundant benthic taxa.

In Zone 2, on the Manhattan shoreline east of the Primary Study Area, benthic invertebrates were highly abundant, species rich, and had a unique species composition consisting of the amphipod crustaceans *Caprella penantis*, *Apocorphium acutum*, and *Unicola serrata* and the polychaete worms *Polycirrus* sp. and *Sabellaria vulgaris*. The amphipod crustacean *Caprella penantis,* which was one of the dominant invertebrates collected in Zone 2, was not abundant in any of the other zones. The polychaete worm *Sabellaria vulgaris*, which was uniquely abundant in upstream locations adjacent to the primary study area, is a reef building species. With the exception of the amphipod crustacean *Caprella penantis*, these taxa were not found in high abundance in the other five zones.

In the channel, Zones 3 and 4, oligochaete and polychaete worms and the gastropod snail *Japonactaeon punctostriatus* dominated the benthic invertebrate community. The sea anemone *Diadumene leucolena* was abundant in Zone 3 but not elsewhere within the study area.

**Figure 2** – Benthic grab sampling in the East River.

**Table 2 – Summary of important benthic taxa from five grab samples per zone during sampling in the lower East River, NY.**

| | Primary study area | Adjacent upstream | Channel | Channel upstream | Opposite shoreline | Opposite upstream |
|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| 5 Most Abundant Taxa | *Mediomastus ambiseta* Polychaete worm | *Caprella penantis* Amphipod crustacean | Oligochaeta Oligochaete worm | *Streblospio benedicti* Polychaete worm | *Japonactaeon punctostriatus* Gastropod snail | *Streblospio benedicti* Polychaete worm |
| | Oligochaeta Oligochaete worm | *Polycirrus* sp. Polychaete worm | *Japonactaeon punctostriatus* Gastropod snail | Cirratulidae Polychaete worm | Oligochaeta Oligochaete worm | *Heteromastus filiformis* Polychaete worm |
| | *Japonactaeon punctostriatus* Gastropod snail | *Sabellaria vulgaris* Polychaete worm | *Diadumene leucolena* Sea anemone | Oligochaeta Oligochaete worm | *Acteocina canaliculata* Gastropod snail | Oligochaeta Oligochaete worm |
| | *Streblospio benedicti* Polychaete worm | *Apocorophium acutum* Amphipod crustacean | *Streblospio benedicti* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | *Glycinde solitaria* Polychaete worm | *Japonactaeon punctostriatus* Gastropod snail |
| | *Pectinaria gouldii* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | *Heteromastus filiformis* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | *Caprella penantis* Amphipod crustacean |
| Total Individuals | 1,045 | 3,701 | 1,467 | 2,049 | 1,294 | 1,492 |
| % of Total | 69 | 54 | 56 | 64 | 76 | 46 |
| Number of Taxa Representing 90% of Total | 14 | 27 | 27 | 21 | 13 | 30 |

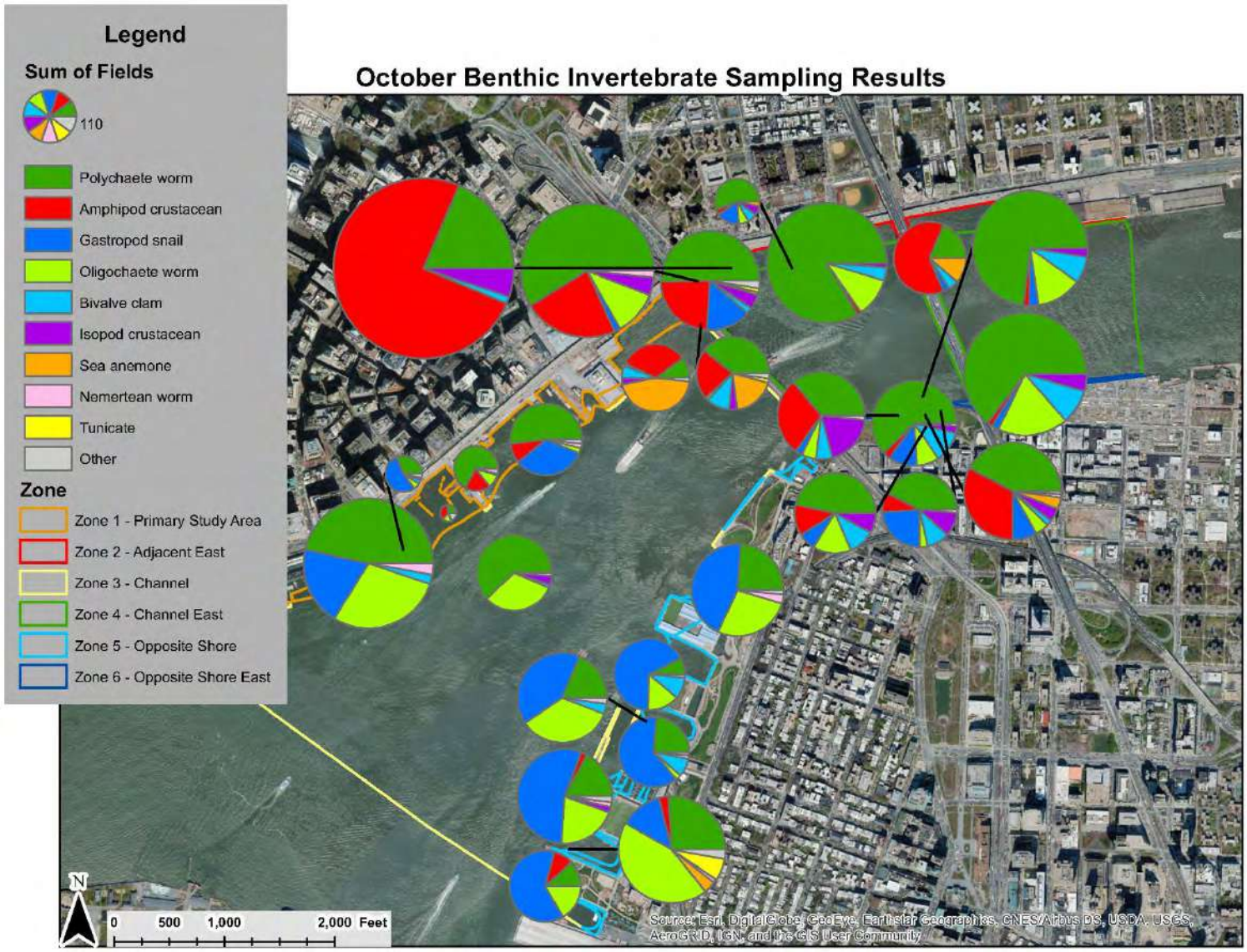


**Figure 3a –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the East River. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

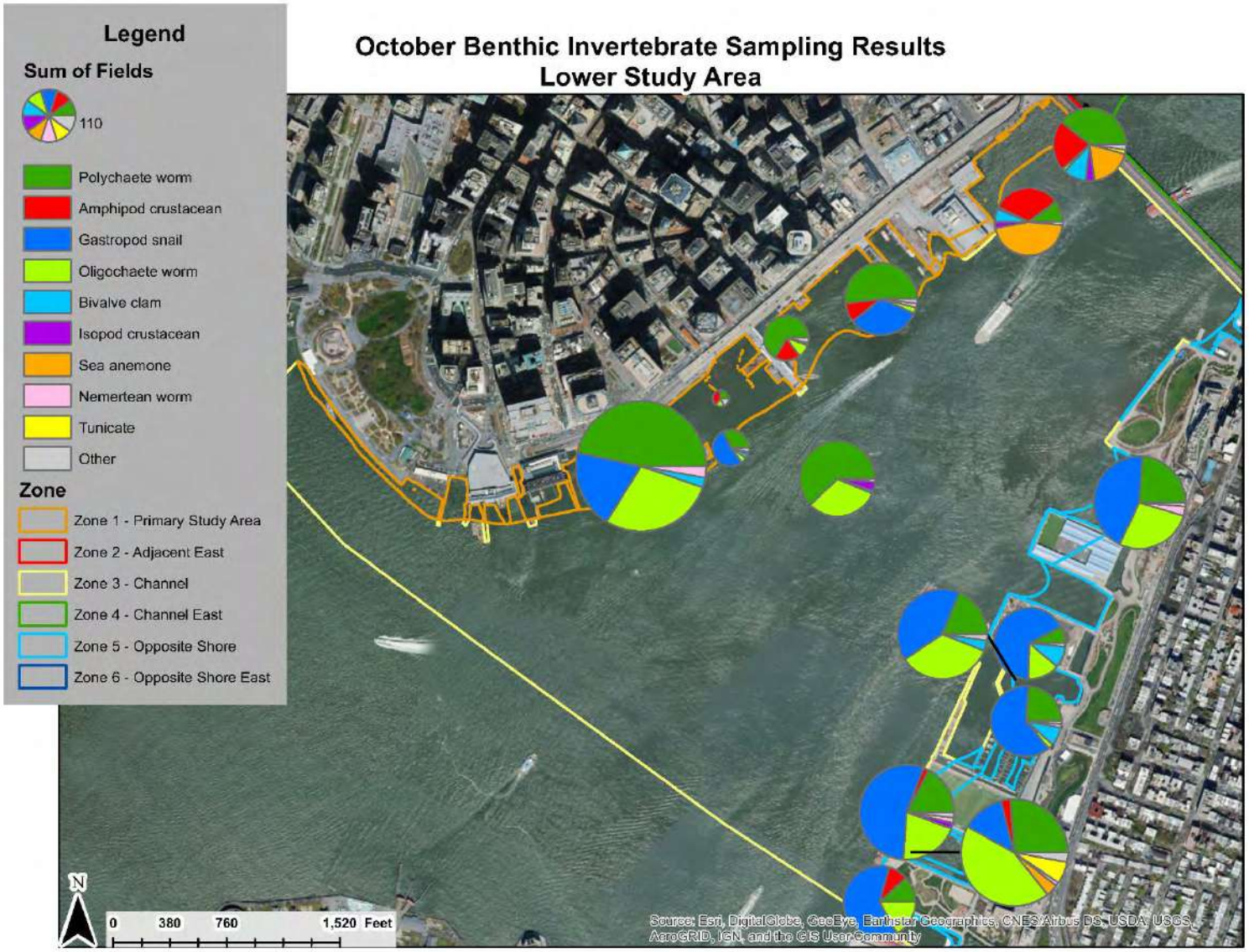


**Figure 3b –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the lower half of the study area. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

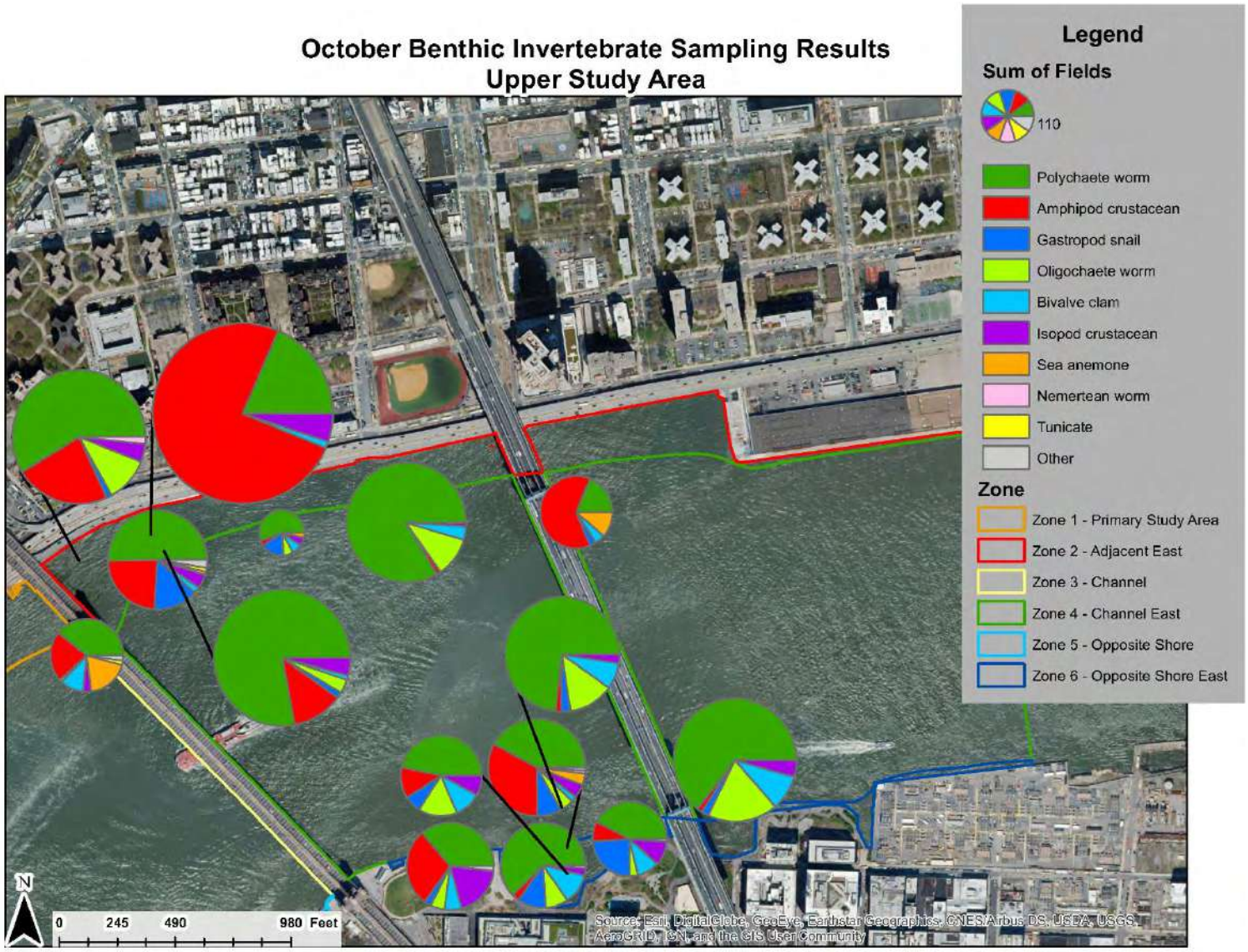


**Figure 3c –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the upper half of the study area. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

**Table 3 – Average biomass, plus or minus 2 standard errors, of benthic invertebrates collected in each sampling zone during October 2020 in the lower East River, NY.**

| Zone | Biomass |
|---|---|
| Zone 1 – Primary study area | 0.06 ± 0.03 |
| Zone 2 – Adjacent upstream | 0.72 ± 0.64 |
| Zone 3 – Channel | 1.69 ± 2.52 |
| Zone 4 – Channel upstream | 1.05 ± 0.84 |
| Zone 5 – Opposite shoreline | 0.53 ± 0.88 |
| Zone 6 – Opposite upstream | 0.19 ± 0.07 |

## SEDIMENT COMPOSITION AND TOTAL ORGANIC CARBON

Total organic carbon (TOC) was generally similar among zones and between strata, with median values ranging from 16 to 18 grams of organic carbon per kilogram of sampled substrate (g/kg) (**Figure 4**). With the exception of Zone 5, the interquartile ranges of all zones overlapped, indicating that the distribution of TOC measurements was generally similar among zones. The median TOC in Zone 5 was was 11 g/kg, which was less than in the other zones. The median TOC in the channel stratum (i.e., Zones 3 and 4) was 17.5 g/kg, which was greater than in the shoreline/nearshore stratum (15.0 g/kg), but the interquartile ranges of the strata overlapped, indicating that the distribution of TOC measurements was similar between zones.

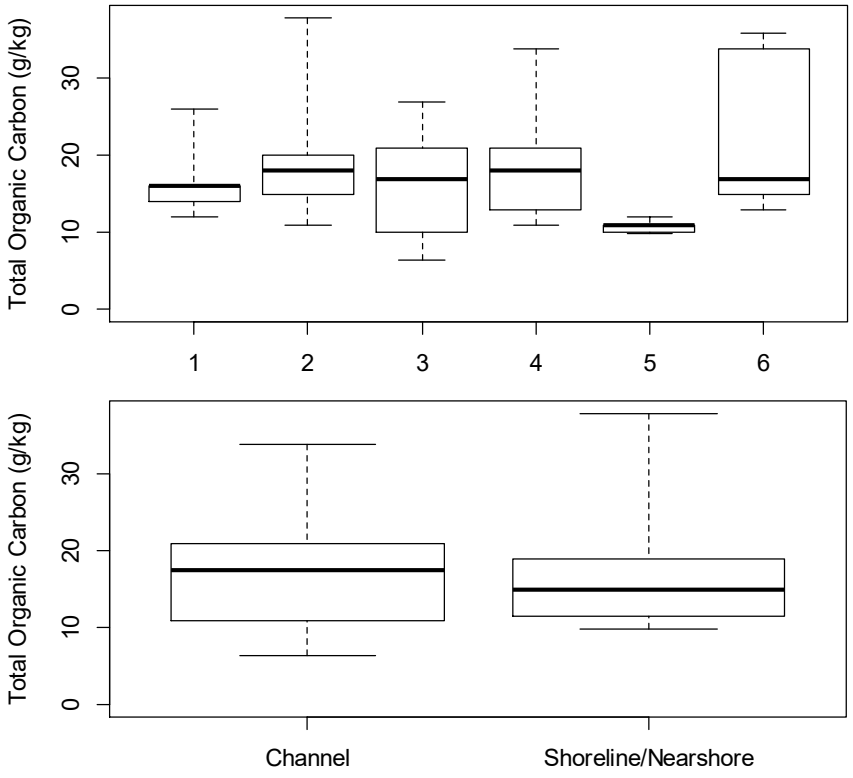


**Figure 4** – Boxplots of total organic carbon content observed across zones (top panel) and strata (bottom panel) in benthic grab sampling of the East River. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values.

NYCEDC measured Total nitrogen ("TN") at the surface and bottom of the water column at each of the 30 benthic grab sites. TN concentration was low (< 0.5 mg/L) for nearly all (58 of 60) measurements. The shoreline/nearshore stratum of Zone 2 (54 mg/L) on the Manhattan shoreline east of the Primary Study Area and the shoreline/nearshore stratum of Zone 6 (1.1 mg/L) on the opposite shore of the East River in Brooklyn had the highest TN concentrations.
NYCEDC processed 20 of the 30 benthic grab samples for grain size analysis. The remaining 10 samples had insufficient volume for analysis. NYSDEC will collect sediment samples from these 10 locations during the winter sampling event. Sediment composition of the two Brooklyn shoreline/nearshore areas, Zones 5 and 6, were distinctly different. Sediment in Zone 5 westof the Brooklyn Bridge was primarily silt and clay. Sediment in Zone 6 east of the Brooklyn Bridge was mostly sand (**Figure 5**). Sediment samples collected in the Channel generally had a higher sand composition than sediment samples collected along the shoreline. The sediment sample collected in the channel in Zone 3 consisted of more than 75% sand. Gravel comprised less than 0.1% of the sediment in most of the samples.

## D. FISH SAMPLING

**Figure 6** shows the locations of the fish samples by sampling gear—seine, trawl, and trap. **Figure 7** shows the locations of fish samples collected by remote sensing.

- NYCEDC collected a total of 14 out of the planned 20 beach seine samples (**Figure 8a**) along shorelines in Zones 1, 2, 5 and 6. Limited availability of shallow shoreline habitat in Zones 1 and 2 reduced the number of beach seines that could be collected.
- NYCEDC collected all ten of the planned bottom trawl samples in channel Zones 3 and 4 (i.e., five trawls in each zone). **Figure 6** shows the location, orientation, and length of each of the bottom trawl transects.
- NYCEDC collected all 24 baited fish trap samples (**Figure 8b**) as planned; four samples from each of the six zones.
- NYCEDC surveyed all 40 of the planned remote sensing transects during this sampling event. Ten samples were collected (**Figure 8c**) in shoreline and nearshore habitats in Zones 1, 2, 5 and 6. **Figure 9** presents several examples of ARIS data collected during remote sensing.

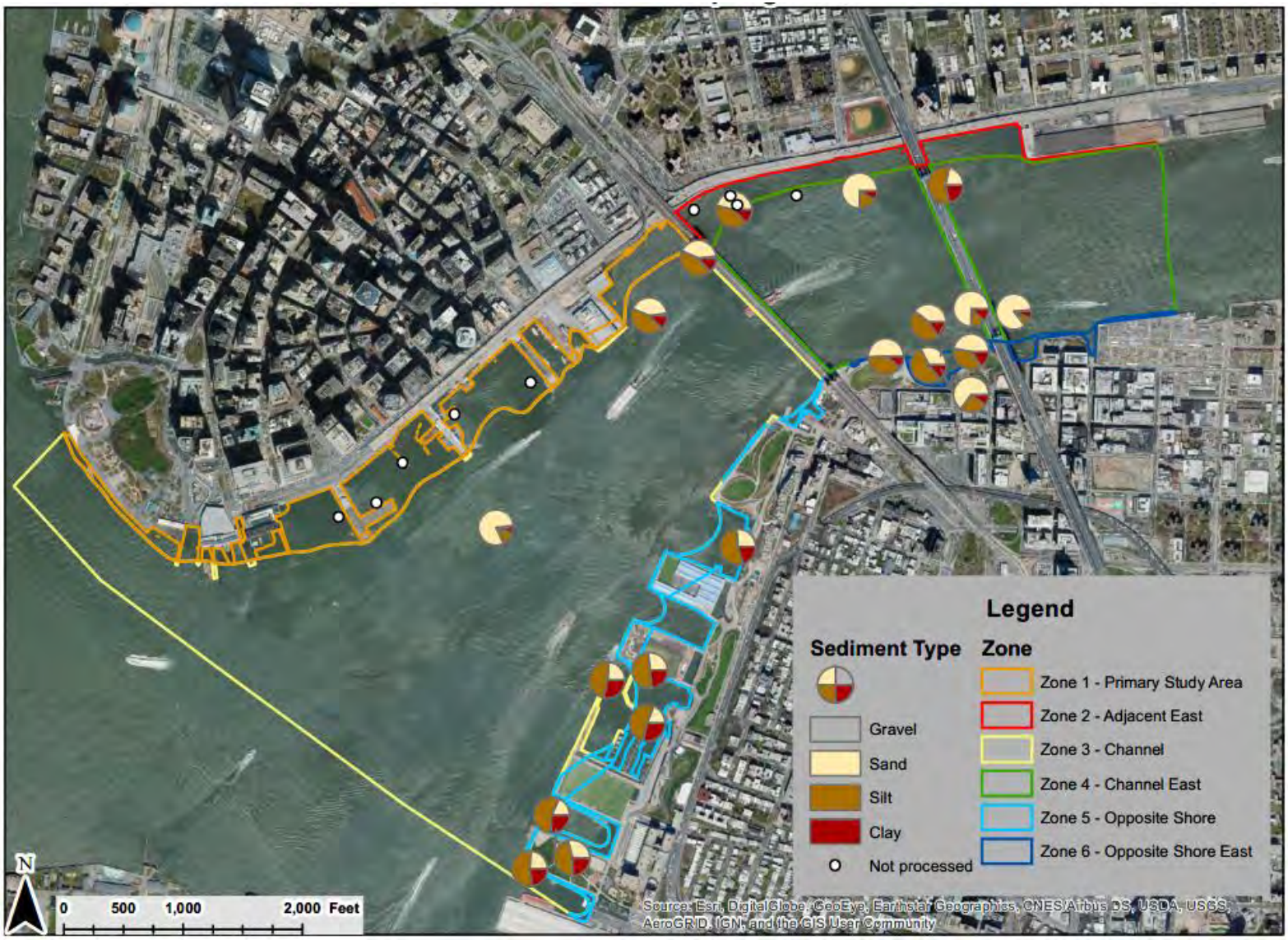


**Figure 5 –** Sediment composition in grab samples collected in the East River.

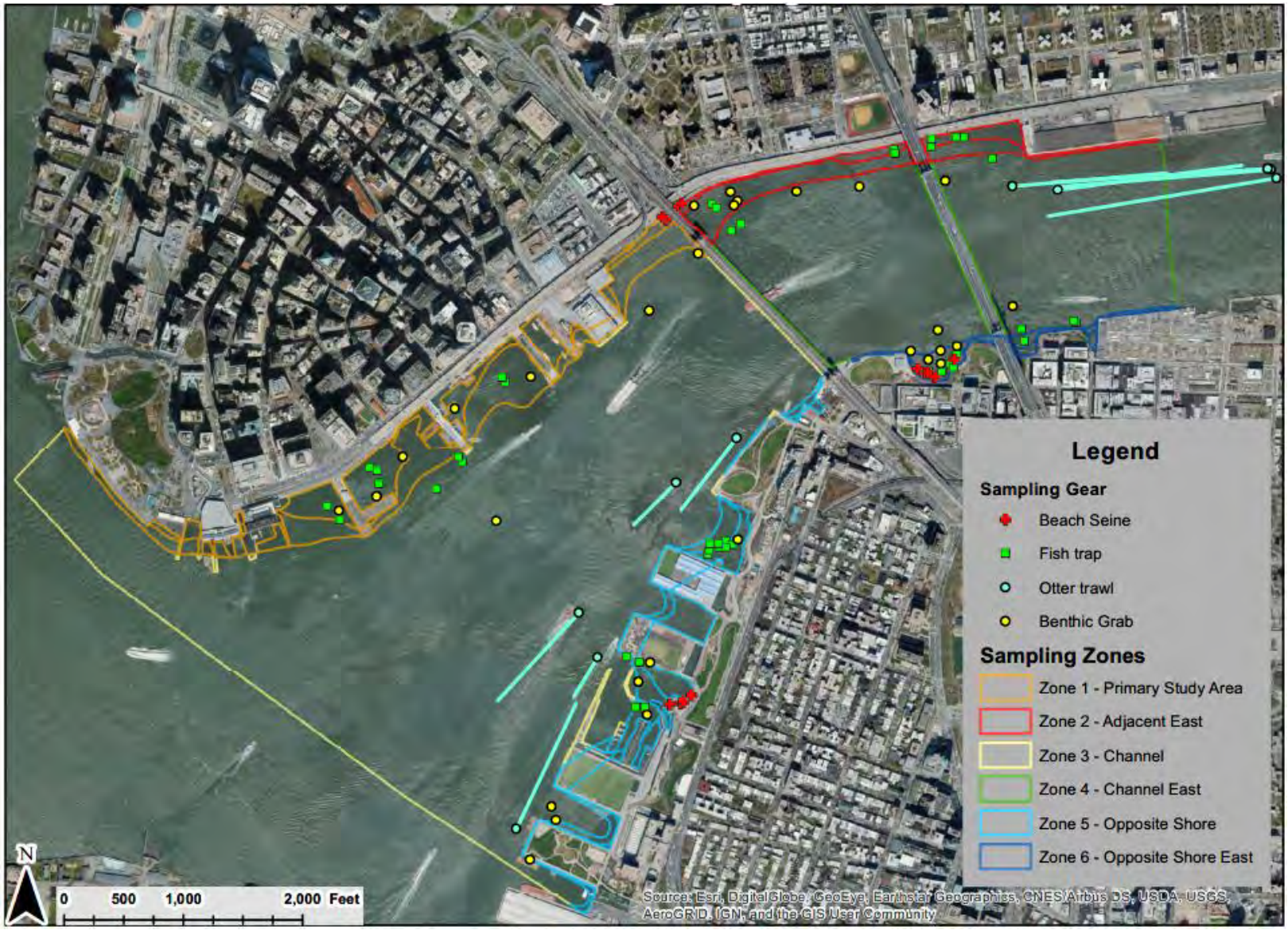


**Figure 6 –** Locations for fish and benthic grab sampling conducted in the East River.

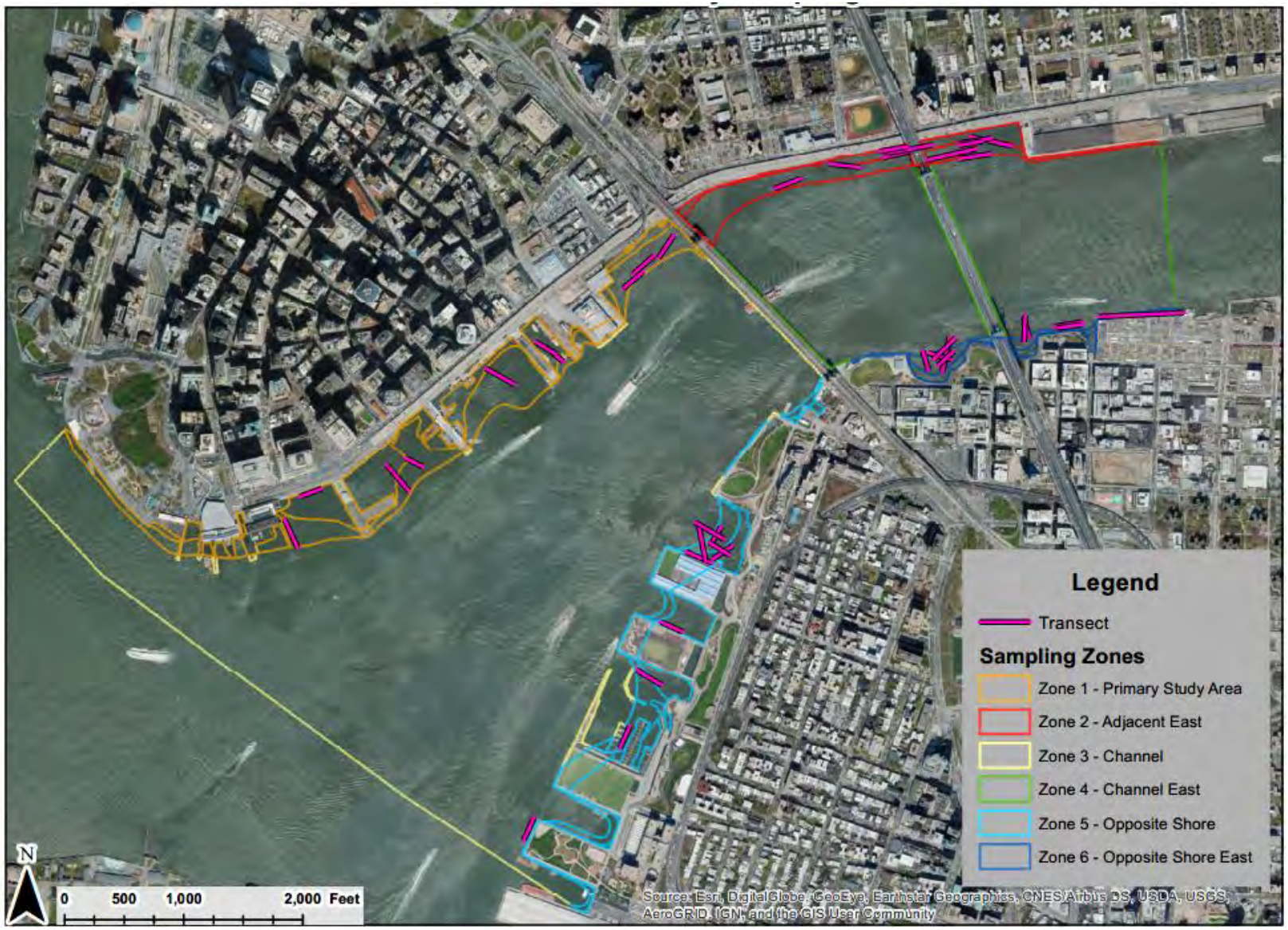


**Figure 7 –** Locations of remote sensing transects for fish conducted in the East River.


**Figure 8 –** Fish sampling by (a) beach seine, (b) baited trap, and (c) remote sensing in the East River.

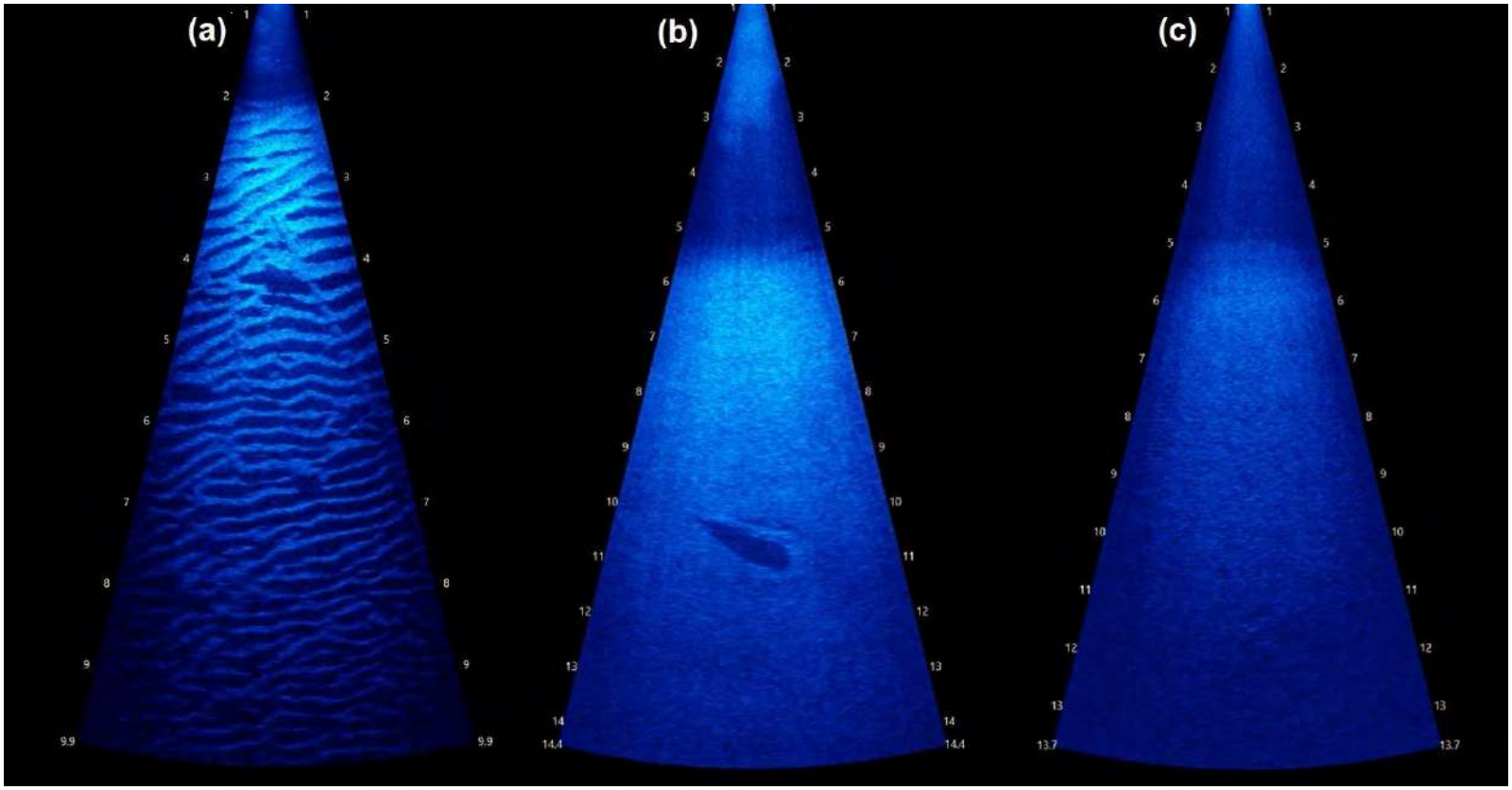


**Figure 9 –** Examples of ARIS data collected in the East River. Images include (a) medium benthic fish, (b) large benthic fish, and (c) schooling midwater fish.

## FISH ABUNDANCE AND BIODIVERSITY

*BEACH SEINE*

Atlantic silverside was the most abundant species collected in October beach seines and accounted for approximately 99% of the total catch (**Figure 10**). It was commonly observed across sampling locations, and was collected in more than 90% of samples of samples (**Figure 10**). Alewife, Atlantic menhaden, bay anchovy, bluefish, striped bass, and winter flounder were also collected in one to three samples per species. Atlantic silverside predominated the catch in each of the sampled zones (**Figure 11**). The highest number of species was observed in Zone 5 on the Brooklyn shoreline opposite the Primary Study Area (**Figure 11)**.

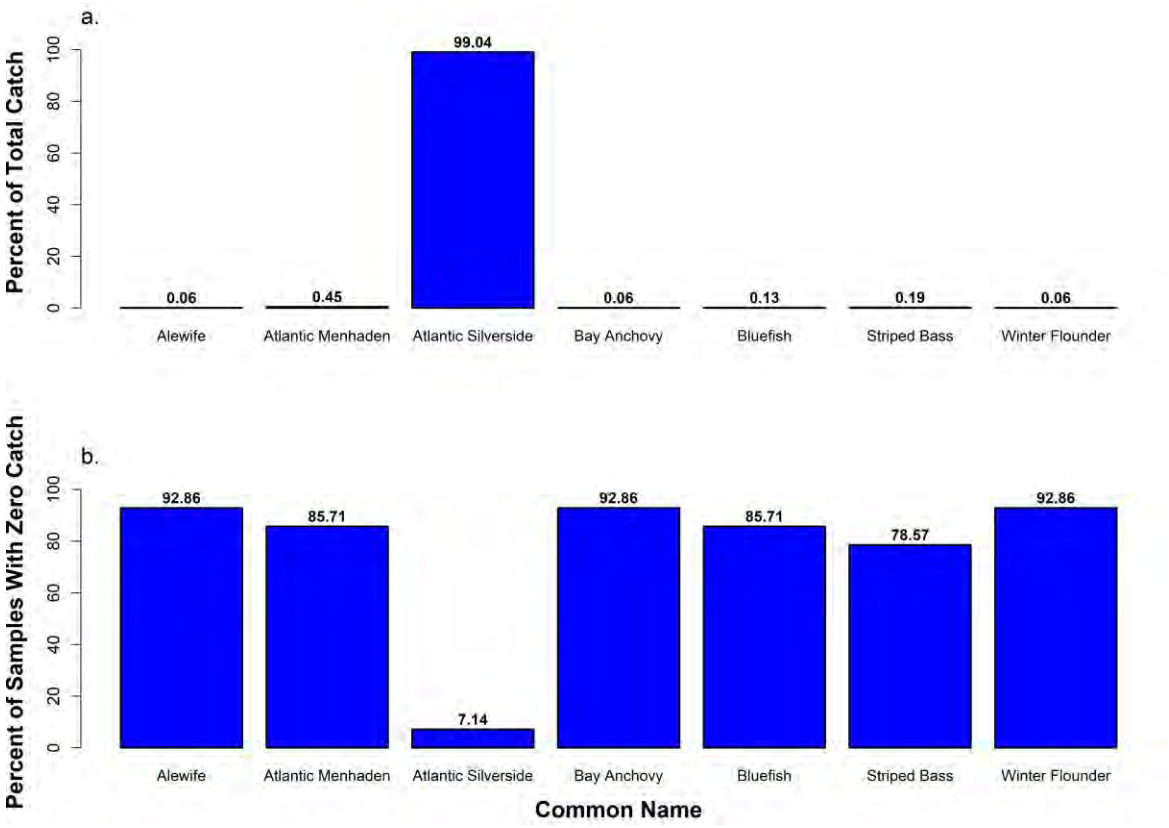


**Figure 10 –** Catch of finfish species during the beach seine survey in the East River during this sampling event.


**Figure 11 –** Species composition of fish collected during the October beach seine survey.

*BAITED FISH TRAPS*

The bated fish traps collected seven fish and five crabs during this sampling event. Although the traps were designed to target finfish, the most abundant species was a macroinvertebrate, portly spider crab, which accounted for 41.7% of the total catch (**Figure 11**). The traps collected the following finfish species: oyster toadfish, tautog and white perch, each accounting for 16.7% of the total catch; and black sea bass, which accounted for 8.3% of the total catch. Each of the finfish species were absent from at least 95% of trap samples, indicating that none of these species are ubiquitous throughout the study area (**Figure 11**). Consistent with this, oyster toadfish and tautog were the only finfish species observed in multiple trap samples, and trapping efforts in Zones 1 and 6 failed to capture any finfish species (**Figure 12**).

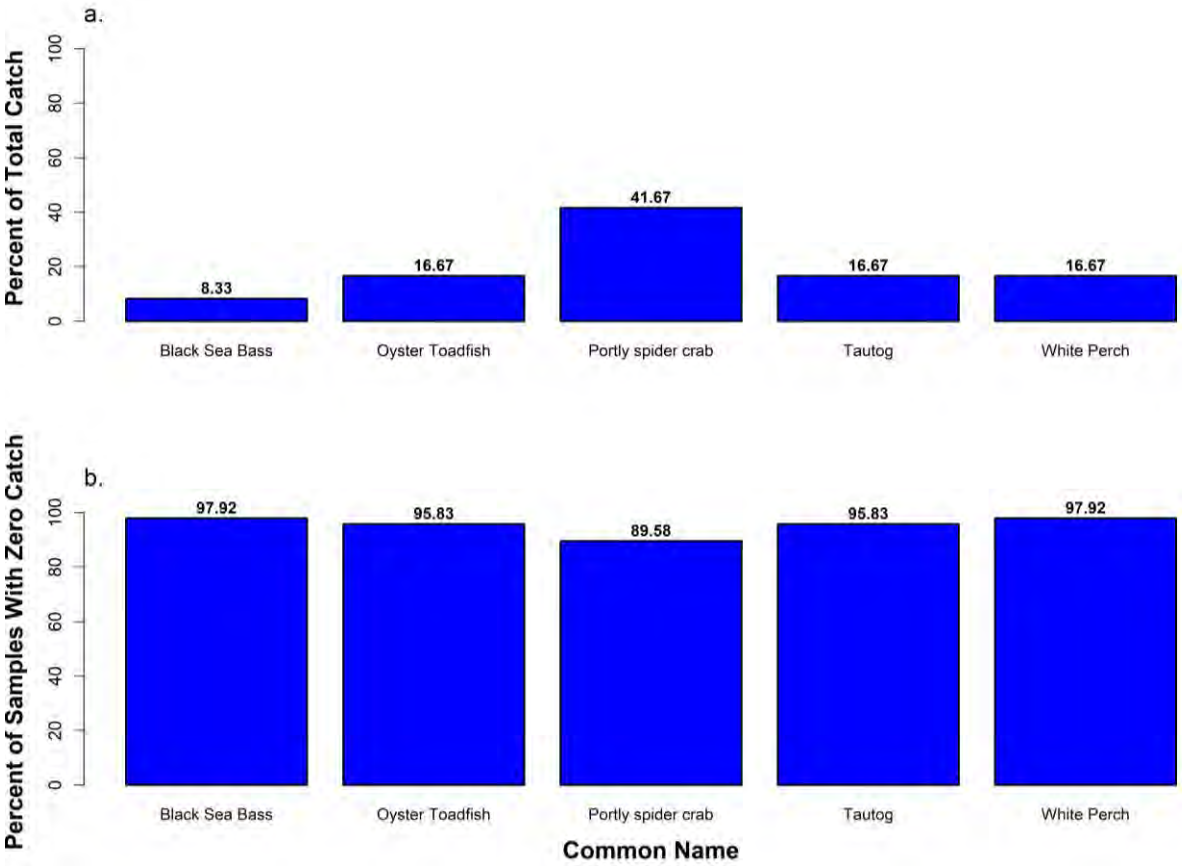


**Figure 12 –** Fish and crab species collected during the fish trapping survey of the East River.


**Figure 13** – Species composition of fish and crabs collected during the October fish trapping survey.

*REMOTE SENSING*

During remote sensing transects in October 2020, a total of 249 of fish were observed within a sampled volume of 21,366 $m^3$ in the nearshore stratum, and a total of 565 fish were observed in a sampled volume of 11,259 $m^3$ in the shoreline stratum (**Table 4**). Fish densities were highly variable, between strata and among sample sites (**Figure 14**). Fish densities in nearshore and shoreline habitats were generally highest in the Primary Study Area, but the highest mean density was observed along the shoreline within Brooklyn Bridge Park in Zone 5. The lowest fish densities were observed in the nearshore and shoreline habitats on the Manhattan shoreline east of the the Primary Study Area in Zone 2.

**Table 4 – Total counts and density for finfish detected in the October 2020 remote sensing survey**

| Stratum | Location | No. Transects | Total Volume Sampled ($m^3$) | Total Count | Density (1,000 per $m^3$) |
|---|---|---|---|---|---|
| Nearshore | Zone 1 - Primary Study Area | 5 | 2,892 | 97 | 33.5 |
| | Zone 2 - Adjacent East | 5 | 8,038 | 3 | 0.4 |
| | Zone 5 - Opposite Shore | 3 | 4,317 | 30 | 6.9 |
| | Zone 6 - Opposite Shore East | 6 | 6,119 | 119 | 19.4 |
| | **All** | **19** | **21,366** | **249** | **11.7** |
| Shoreline | Zone 1 - Primary Study Area | 5 | 2,212 | 166 | 75.0 |
| | Zone 2 - Adjacent East | 5 | 5,135 | 1 | 0.2 |
| | Zone 5 - Opposite Shore | 7 | 2,995 | 367 | 122.5 |
| | Zone 6 - Opposite Shore East | 4 | 917 | 31 | 33.8 |
| | **All** | **21** | **11,259** | **565** | **50.2** |

Densities of fish detected during remote sensing transects were classified into four different categories on the basis of size and location within the water column: small-bodied, benthic less than 200 mm long, medium-bodied, benthic 200to 500 mm long, large-bodied, benthic greater than 500 mm long and small-bodied, midwater less than 200 mmlong. The magnitude of densities and the patterns in densities among strata and locations differed among these categories (**Figure 15**). Midwater fish, which include species that school in large numbers, were much more abundant than benthic fish. Midwater fish were most abundant along shorelines in the Primary Study Area (Zone 1) and along the Opposite Shore (Zone 5). Small- and medium-bodied benthic fish were most abundant along the Brooklyn shoreline east of the Brooklyn Bridge (Zone 6) and were much less abundant elsewhere. Large-bodied benthic fish were most abundant in the nearshore and shoreline habitats in Zone 2 along the Manhattan shoreline east of the Primary Study Area and in Zone 5 alont the Brooklyn shoreline west of the Brooklyn Bridge, but were generally much less abundant than the other categories of fish.

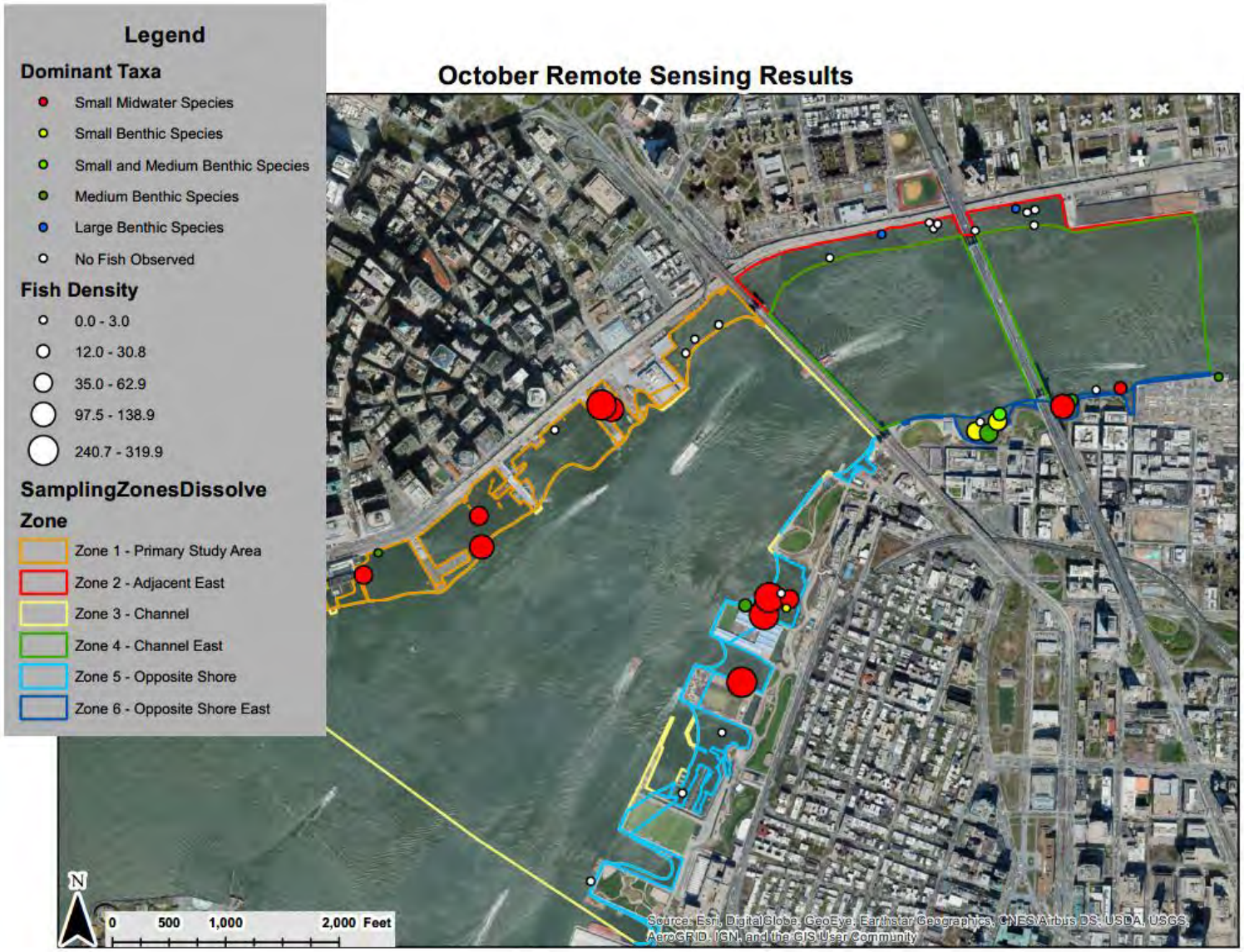


**Figure 14** – Distribution and density of fish assemblages observed during the October remote sensing survey.

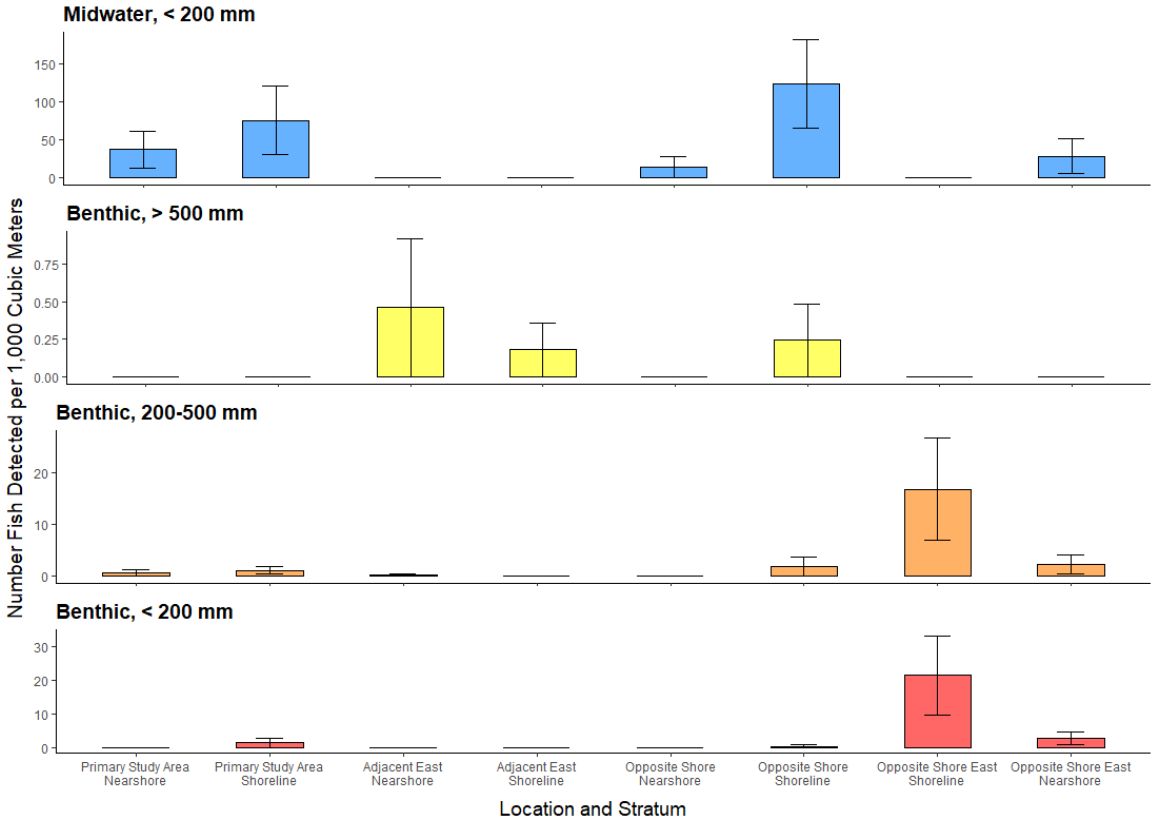


**Figure 15** – Densities of four categories of finfish detected among locations and strata during remote sensing transects of nearshore and shoreline habitats of the East River.

## E. WATER QUALITY AND CURRENT VELOCITY

NYCEDC collected water quality samples at the surface and bottom of the river concurrent with each of the 117 biological samples (**Figure 16**; **Table 5**). Water quality data were not logged at one of the 118 sample sites. Bottom samples were collected at a mean depth of 17.9 feet (5.5 meters).

### WATER QUALITY CHARACTERISTICS

Four water quality parameters (i.e., temperature, salinity, dissolved oxygen (DO) and pH measured during sampling of the East River in October 2020 are summarized by zone and habitat stratum in **Table 5**. For each of the parameters, the overall mean and range were similar between the surface and bottom. **Figure 17** provides an example of depth profiles for water quality parameters.


**Figure 16 –** Locations of water quality profiles associated with October biological sampling in the East River.

**Table 5 – Water quality parameters measured in East River surface and bottom waters during biological and habitat sampling in October 2020**

| Position | Zone | Stratum | N | Depth (ft) | Temperature (C) | | Salinity (PSU) | | DO (mg/L) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Surface | 1 | Nearshore | 6 | 1.0 | 16.7 | 16.5 - 16.9 | 24.9 | 24.7 - 25.7 | 6.8 | 6.2 - 8.9 | 7.8 | 7.7 - 8.0 |
| | | Shoreline | 9 | 0.9 | 16.8 | 16.6 - 17.2 | 25.2 | 24.7 - 26.4 | 7.0 | 6.2 - 8.9 | 7.8 | 7.7 - 7.9 |
| | | Shoreline/Nearshore | 5 | 1.0 | 20.6 | 20.6 - 20.7 | 25.4 | 25.1 - 25.7 | 7.0 | 7.0 - 7.1 | 7.9 | 7.8 - 7.9 |
| | 2 | Nearshore | 7 | 1.0 | 16.9 | 16.8 - 17.1 | 25.0 | 24.5 - 26.3 | 6.8 | 6.2 - 8.9 | 7.8 | 7.8 - 7.9 |
| | | Shoreline | 8 | 1.0 | 16.9 | 16.7 - 17.5 | 25.1 | 24.5 - 25.9 | 6.9 | 6.2 - 8.9 | 7.9 | 7.7 - 8.0 |
| | | Shoreline/Nearshore | 5 | 1.0 | 20.8 | 20.7 - 20.8 | 24.4 | 24.2 - 24.7 | 6.8 | 6.7 - 7.0 | 7.7 | 7.7 - 7.8 |
| | 3 | Channel | 14 | 1.0 | 18.7 | 17.1 - 20.4 | 25.1 | 24.1 - 25.8 | 8.1 | 7.7 - 8.9 | 7.8 | 7.6 - 7.9 |
| | 4 | Channel | 14 | 1.0 | 18.5 | 16.8 - 20.8 | 25.0 | 24.2 - 25.7 | 7.3 | 6.6 - 8.8 | 7.7 | 7.6 - 7.9 |
| | 5 | Nearshore | 5 | 1.0 | 16.7 | 16.3 - 17.8 | 24.9 | 24.5 - 25.5 | 7.1 | 6.2 - 8.8 | 7.9 | 7.7 - 8.0 |
| | | Shoreline | 13 | 0.8 | 16.7 | 16.2 - 17.8 | 24.8 | 23.8 - 25.5 | 7.2 | 6.1 - 9.1 | 7.9 | 7.7 - 8.0 |
| | | Shoreline/Nearshore | 5 | 1.0 | 20.2 | 20.2 - 20.3 | 25.1 | 24.8 - 25.3 | 8.1 | 7.9 - 8.2 | 7.7 | 7.6 - 7.7 |
| | 6 | Nearshore | 7 | 1.0 | 16.6 | 16.5 - 17.4 | 24.4 | 24.2 - 25.9 | 6.4 | 6.0 - 7.8 | 7.9 | 7.7 - 8.0 |
| | | Shoreline | 12 | 0.8 | 16.7 | 16.5 - 17.5 | 25.1 | 24.1 - 26.1 | 7.4 | 6.2 - 8.9 | 7.9 | 7.7 - 8.0 |
| | | Shoreline/Nearshore | 5 | 1.0 | 20.4 | 20.4 - 20.5 | 24.6 | 24.4 - 24.7 | 8.1 | 8.1 - 8.2 | 7.7 | 7.7 - 7.7 |
| | **All** | | **115** | **1.0** | **17.9** | **16.2 - 20.8** | **24.9** | **24.1 - 26.3** | **7.3** | **6.0 - 9.1** | **7.8** | **7.6 - 8.0** |
| Bottom | 1 | Nearshore | 6 | 11.3 | 16.7 | 16.5 - 16.9 | 24.9 | 24.7 - 25.7 | 6.8 | 6.1 - 8.9 | 7.8 | 7.7 - 8.0 |
| | | Shoreline | 9 | 12.1 | 16.8 | 16.5 - 17.1 | 25.3 | 24.7 - 26.6 | 7.0 | 6.1 - 8.9 | 7.9 | 7.8 - 8.0 |
| | | Shoreline/Nearshore | 5 | 13.4 | 20.6 | 20.5 - 20.7 | 25.4 | 25.1 - 25.7 | 7.0 | 6.9 - 7.1 | 7.9 | 7.8 - 7.9 |
| | 2 | Nearshore | 7 | 20.3 | 16.9 | 16.8 - 17.1 | 25.1 | 24.6 - 26.4 | 6.7 | 6.1 - 8.7 | 7.8 | 7.8 - 7.9 |
| | | Shoreline | 8 | 21.8 | 16.9 | 16.6 - 17.3 | 25.2 | 24.6 - 26.1 | 6.8 | 6.1 - 8.7 | 7.9 | 7.7 - 8.0 |
| | | Shoreline/Nearshore | 5 | 8.0 | 20.8 | 20.7 - 20.8 | 24.4 | 24.2 - 24.9 | 6.8 | 6.6 - 7.0 | 7.7 | 7.7 - 7.8 |
| | 3 | Channel | 14 | 35.7 | 18.6 | 17.1 - 20.3 | 25.6 | 25.1 - 26.4 | 8.0 | 7.6 - 8.8 | 7.8 | 7.6 - 8.0 |
| | 4 | Channel | 14 | 34.9 | 18.5 | 16.7 - 20.8 | 25.0 | 24.2 - 25.8 | 7.2 | 6.4 - 8.7 | 7.7 | 7.6 - 7.9 |
| | 5 | Nearshore | 5 | 16.0 | 16.7 | 16.3 - 17.4 | 25.2 | 24.8 - 26.1 | 7.0 | 6.1 - 8.8 | 7.9 | 7.7 - 8.0 |
| | | Shoreline | 13 | 7.8 | 16.7 | 16.3 - 17.3 | 25.1 | 24.5 - 26.3 | 7.1 | 6.1 - 9.1 | 7.9 | 7.7 - 8.0 |
| | | Shoreline/Nearshore | 5 | 19.4 | 20.3 | 20.2 - 20.3 | 25.6 | 25.4 - 25.8 | 8.0 | 8.0 - 8.2 | 7.7 | 7.7 - 7.7 |
| | 6 | Nearshore | 7 | 11.3 | 16.6 | 16.5 - 17.4 | 24.4 | 24.2 - 25.9 | 6.3 | 6.0 - 7.7 | 7.9 | 7.7 - 8.0 |
| | | Shoreline | 12 | 7.1 | 16.7 | 16.5 - 17.5 | 25.2 | 24.1 - 26.1 | 7.3 | 6.1 - 8.9 | 7.9 | 7.7 - 8.0 |
| | | Shoreline/Nearshore | 5 | 6.0 | 20.4 | 20.4 - 20.5 | 24.6 | 24.4 - 24.7 | 8.1 | 8.0 - 8.1 | 7.7 | 7.7 - 7.7 |
| | **All** | | **115** | **17.9** | **17.8** | **16.3 - 20.8** | **25.1** | **24.1 - 26.6** | **7.2** | **6.0 - 9.1** | **7.8** | **7.6 - 8.0** |

**Note:** Samples collected in the "shoreline/nearshore" stratum are all from benthic grab sampling.

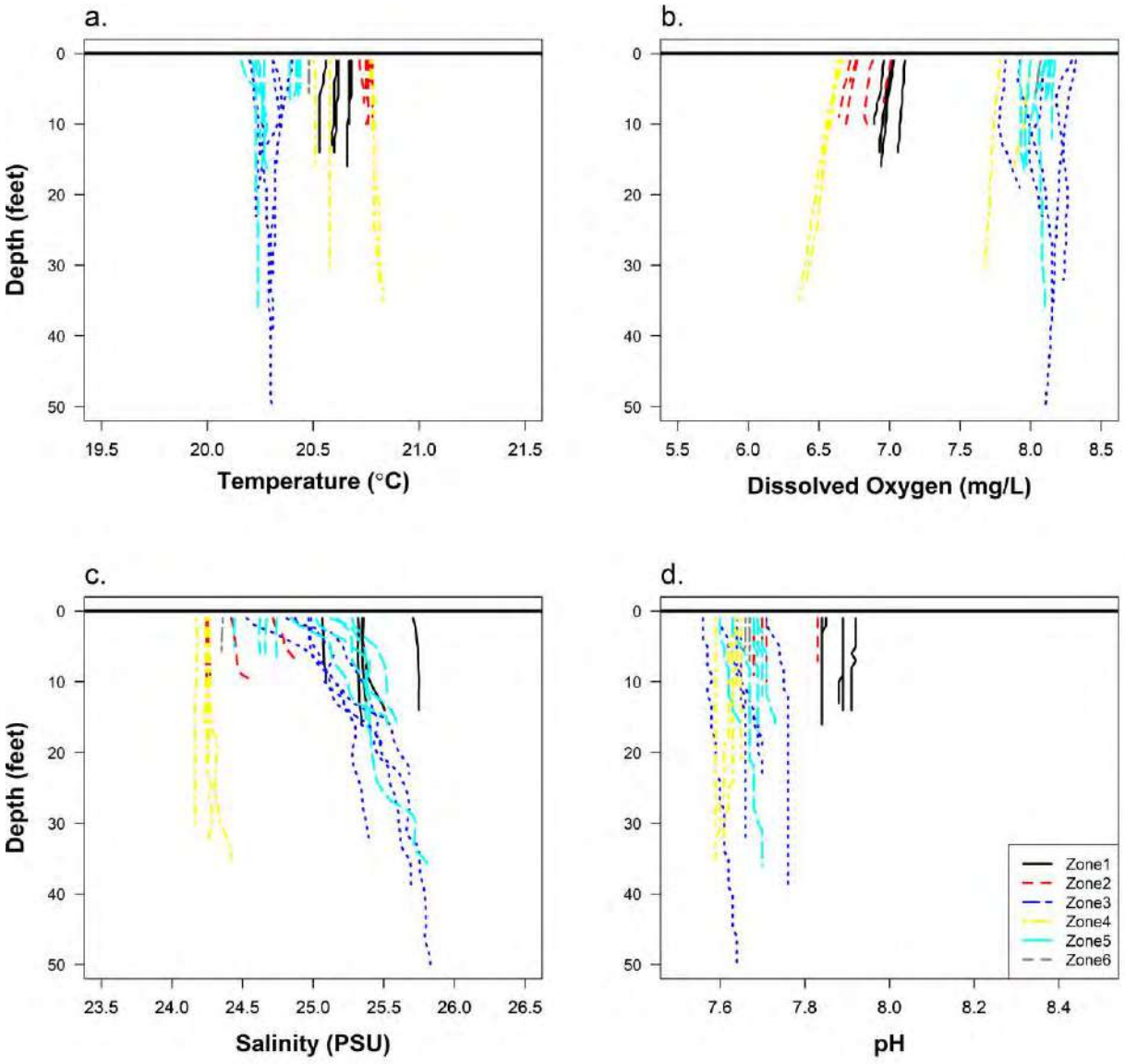


**Figure 17** – Depth profiles of water quality parameters measured during benthic grab sampling. Similar water quality profiles were acquired to complement biological samples collected with each of the sampling gears.

## CURRENT VELOCITY

NYCEDC collected a total of 78 current velocity measurements during grab sampling (30 samples), bottom trawls (10 samples), beach seines (14 samples) and fish trapping (24 samples). Current velocity ranged from 0.001 to 0.98 meters per second ("m/s") (0.003 to 3.22 feet per second ["ft/s"]) and averaged 0.23 m/s (0.75 ft/s) (**Figure 18**). Most of the current velocity measurements were less than 0.20 m/s (0.66 ft/s). Bottom depth measurements ranged from 3 to 50 feet (0.9 to 15.2 meters) and averaged 17 feet (5.2 meters) (**Figure 18**). **Figure 19** illustrates the observed increases in water depth and current velocity moving from from the shoreline to nearshore to channel habitats, and the differences in water depth and current velocity among sampling zones.

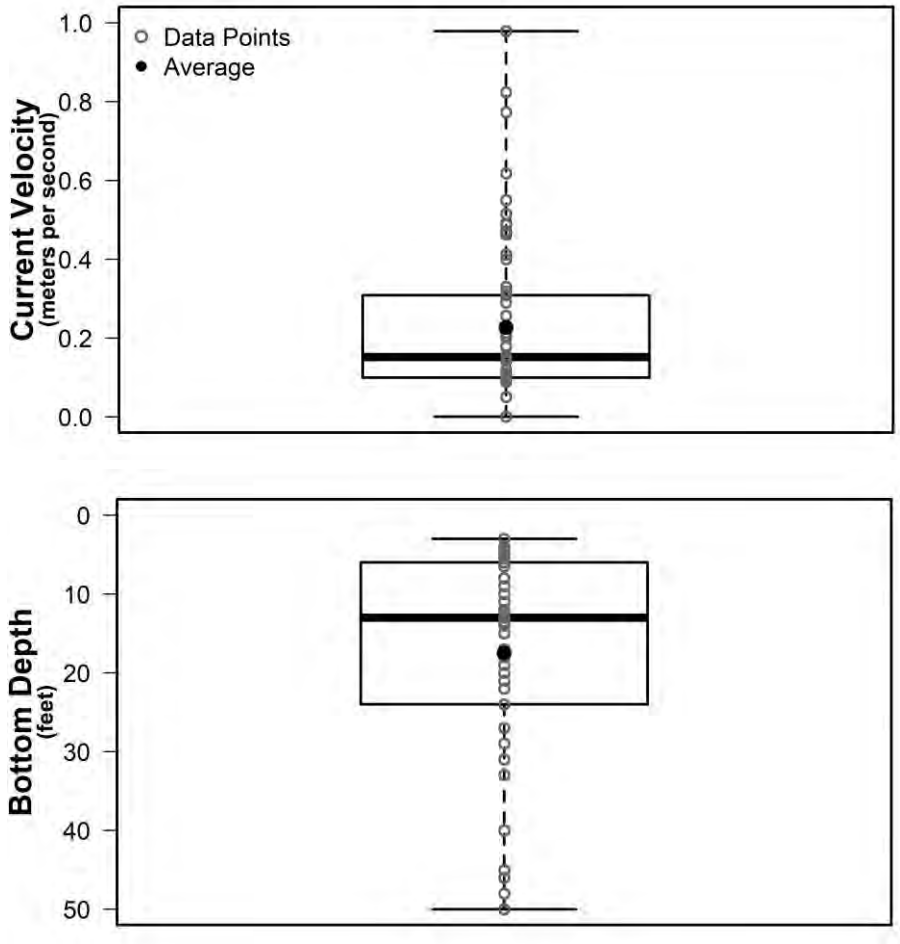


**Figure 18** – Current velocity and water depth measurements taken at sample sites in the lower East River during October 2020. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

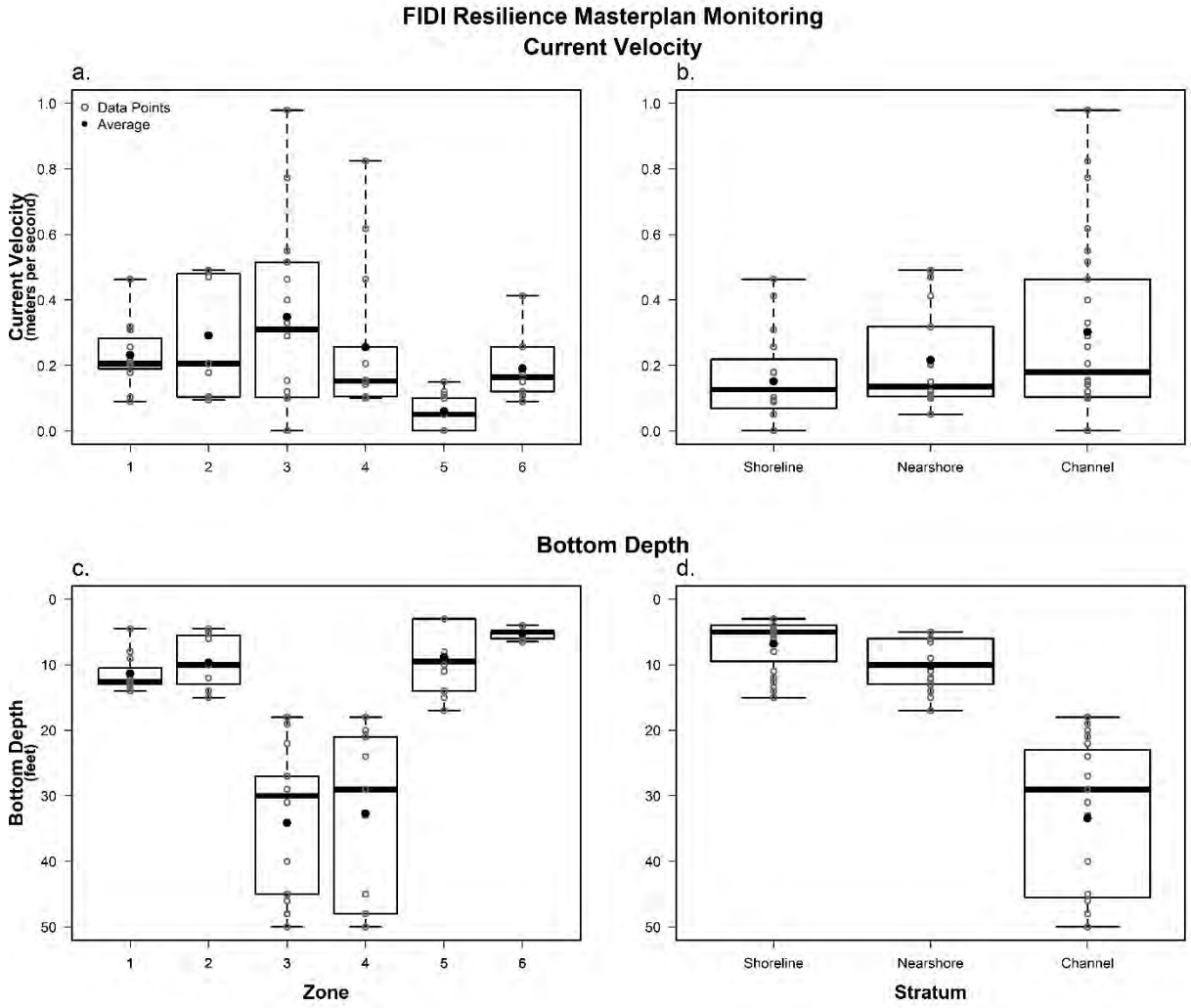


**Figure 19** – Current velocity and water depth measurements taken at sample sites in the lower East River during October 2020. Data are plotted to compare and contrast among zones and habitat strata. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

# New York City Economic Development Corporation
# Financial District and Seaport Climate Resilience Plan

# Biological and Habitat Sampling Report
# January 2021 Sampling Event

**Prepared by**

New York City Economic Development Corporation
AKRF, Inc.
Normandeau Associates, Inc.

**April 9, 2020**

# Table of Contents

# A. INTRODUCTION

The New York City Economic Development Corporation ("NYCEDC"), on behalf of the City and in collaboration with the Mayor's Office of Recovery ("MOR"), is conducting a climate resilience master planning effort in the Financial District and Seaport of Lower Manhattan ("Financial District and Seaport Climate Resilience Master Plan," or "FiDi Seaport Climate Resilience Plan"). The FiDi Seaport Climate Resilience Plan, initiated in October of 2019, is part of the Lower Manhattan Coastal Resiliency project. The FiDi Seaport Climate Resilience Plan project comprises a 0.9-mile portion of the Manhattan shoreline along the East River from just south of the Brooklyn Bridge to the Battery, including South Street Seaport and the Wall Street Financial District, extending out to the pierhead line ("Project Area").

The East River is a tidal strait connecting Upper New York Bay and Long Island Sound that provides habitat for plankton, benthic invertebrates, marine, estuarine and anadromous fish and is used as a migratory pathway by endangered Atlantic sturgeon and possibly by the endangered shortnose sturgeon. Threatened or endangered sea turtles may also occur in the East River as occasional transient individuals. In-water components to be considered in the development of the FiDi Seaport Resilience Plan, such as extending the shoreline, have the potential to affect existing aquatic resources within the Project Area and in the adjacent portion of the lower East River. Because recent information characterizing the aquatic resources within the Project Area and the lower East River is limited, as part of the FiDi Seaport Climate Resilience Plan, NYCEDC is conducting a biological and habitat sampling study to characterize these resources.

The study area for this biological sampling comprises the Project Area and the lower East River from approximately the Battery to the south to Montgomery Street to the north, opposite the western boundary of the Brooklyn Navy Yard, a distance of approximately 1.8 miles and spanning the width of the River (**Figure 1**). The sample universe is subdivided into six zones bisected by the Brooklyn Bridge and reflecting locations relative to the Project Area and water depth. Zones (as indicated in **Figure 1**) are defined as:

1) "Primary Study Area" - the Primary Study Area along the northern shoreline of the East River from the White Hall Ferry terminal (Staten Island Ferry) to the Brooklyn Bridge, also referred to as the Project Area;
2) "Adjacent East" - the shallow, off-channel area along the northern shoreline adjacent to the Project Area and east of the Brooklyn Bridge;
3) "Channel" - the deep, river channel south of the Primary Study Area;
4) "Channel East" - the deep, channel east of the Brooklyn Bridge;
5) "Opposite Shore" - the shallow, off-channel area along East River shoreline in Brooklyn across the river from the Primary Study Area; and
6) "Opposite Shore East" - the shallow, off-channel area along the East River shoreline of Brooklyn east of the Brooklyn Bridge.

The study area is further subdivided into three habitat strata based on proximity to shoreline structure and water depth and are defined as: 1) shoreline ($\leq$ 1 meter depth), 2) nearshore (within the pierhead line, generally 1 to 5 meters depth), and 3) channel (beyond the pierhead line at depths of 5 to 12 meters). This stratified-random sampling design is intended to provide pre-construction biological and habitat data on the aquatic community in the Primary Study Area (Zone 1) that can be compared with data collected in similar shoreline habitat and deep-water areas of the East River, adjacent to, and east of, the Project Area (Zones 2-6).


**Figure 1 –** Zones for biological and habitat sampling in the East River

## B. SUMMARY OF SAMPLE COLLECTION

This report summarizes biological and habitat sampling conducted in the East River during January 2021. NYCEDC conducted the sampling in accordance with the Biological and Habitat Sampling Plan ("Sampling Plan") approved by the Aquatic Resource Advisory Committee established for the Project and finalized in September 2020. As outlined in the Sampling Plan, the January sampling event comprised the following described in greater detail below:

- sampling with an otter trawl and Adaptive Resolution Imaging Sonar ("ARIS") remote sensing to characterize fish abundance and biodiversity;
- sampling with a conductivity, temperature and depth ("CTD") instrument to measure water quality parameters (i.e., temperature, salinity, dissolved oxygen and pH), which was conducted concurrently with the benthic and fish sampling; and
- measurements of current velocity.

In accordance with the Sampling Plan, sampling during January 2021 focused on deterimining the use of the lower East River by overwintering striped bass and winter flounder. NYCEDC did not conduct plankton sampling, fish trapping, or fish seining during the January sampling event. The full complement of sampling gears will be deployed again during April and July 2021 sampling. Although benthic grab samples were not planned for the winter sampling event, benthic grab samples were collected for sediment analysis in Zones 1 and 2 during January 2021 due to inadequate samples volumes in sediment grab samples collected in those Zones during the October 2020 sampling.

During January 2021, NYCEDC collected a total of 80 biological and habitat samples at randomly selected locations within each Zone of study area, along with water quality measurements. **Table 1** summarizes the number of samples collected by gear type, zone and stratum.

**Table 1 – Samples collected by Zone, study area and habitat stratum.**

| Type of Sampling | Zone | | Stratum | No. Samples |
|---|---|---|---|---|
| Sediment Grab | 1 | Primary Study Area | Shoreline/Nearshore | 5 |
| | 2 | Adjacent East | Shoreline/Nearshore | 5 |
| | | | **Total** | **10** |
| **Fish Community** | | | | |
| | 3 | Channel | Channel | 15 |
| | 4 | Channel East | Channel | 15 |
| | | | **Total** | **30** |
| Remote Sensing | 1 | Primary Study Area | Shoreline | 6 |
| | | | Nearshore | 4 |
| | 2 | Adjacent East | Shoreline | 4 |
| | | | Nearshore | 6 |
| | 5 | Opposite Shore | Shoreline | 5 |
| | | | Nearshore | 5 |
| | 6 | Opposite Shore East | Shoreline | 2 |
| | | | Nearshore | 8 |
| | | | **Total** | **40** |

**Note:** Sediment grabs were re-sampled in Zones 1 and 2 in January 2021 due to inadequate sample volumes in sediment grab samples collected in those Zones in October 2020

### SEDIMENT COMPOSITION

Because grab samples collected from Zones 1 and 2 during October 2020 sampling had insufficient volumes for grain size analysis,. NYCEDC collected new grabsamples from these locations during the January sampling event and processed them for inclusion in this report. Complete results of the fall sediment sampling survey, including the 10 samples collected in January 2021, are presented in **Figure 2**. Sediment samples collected in Zones 1 and 2 consisted mostly of silt and sand. Samples from the channel and upstream of the bridges (Zones 3, 4, and 6) were generally sandier than the other Zones. Sediment in Zone 5 across the river from the Primary Study Area was primarily silt and clay and the least sandiest of the Zones. Gravel comprised less than 0.1% in most of the samples.

## C. FISH SAMPLING

**Figure 3** shows the location, orientation, and lengths of each of the bottom trawl transects. **Figure 3** also shows the locations of fish samples collected by remote sensing.

- NYCEDC collected all 30 of the planned bottom trawl samples in channel Zones 3 and 4 (i.e., fifteen trawls in each zone) during the winter sampling event.
- NYCEDC collected all 40 of the planned remote sensing samples during the winter sampling event. Ten samples were collected in nearshore and shoreline habitats in Zones 1, 2, 5 and 6. **Figure 4** presents several examples of ARIS data collected during remote sensing.


**Figure 2 –** Sediment composition of grab samples collected in the East River. Samples in Zones 3 through 6 were collected in October 2020; samples in Zones 1 and 2 were collected in January 2021.

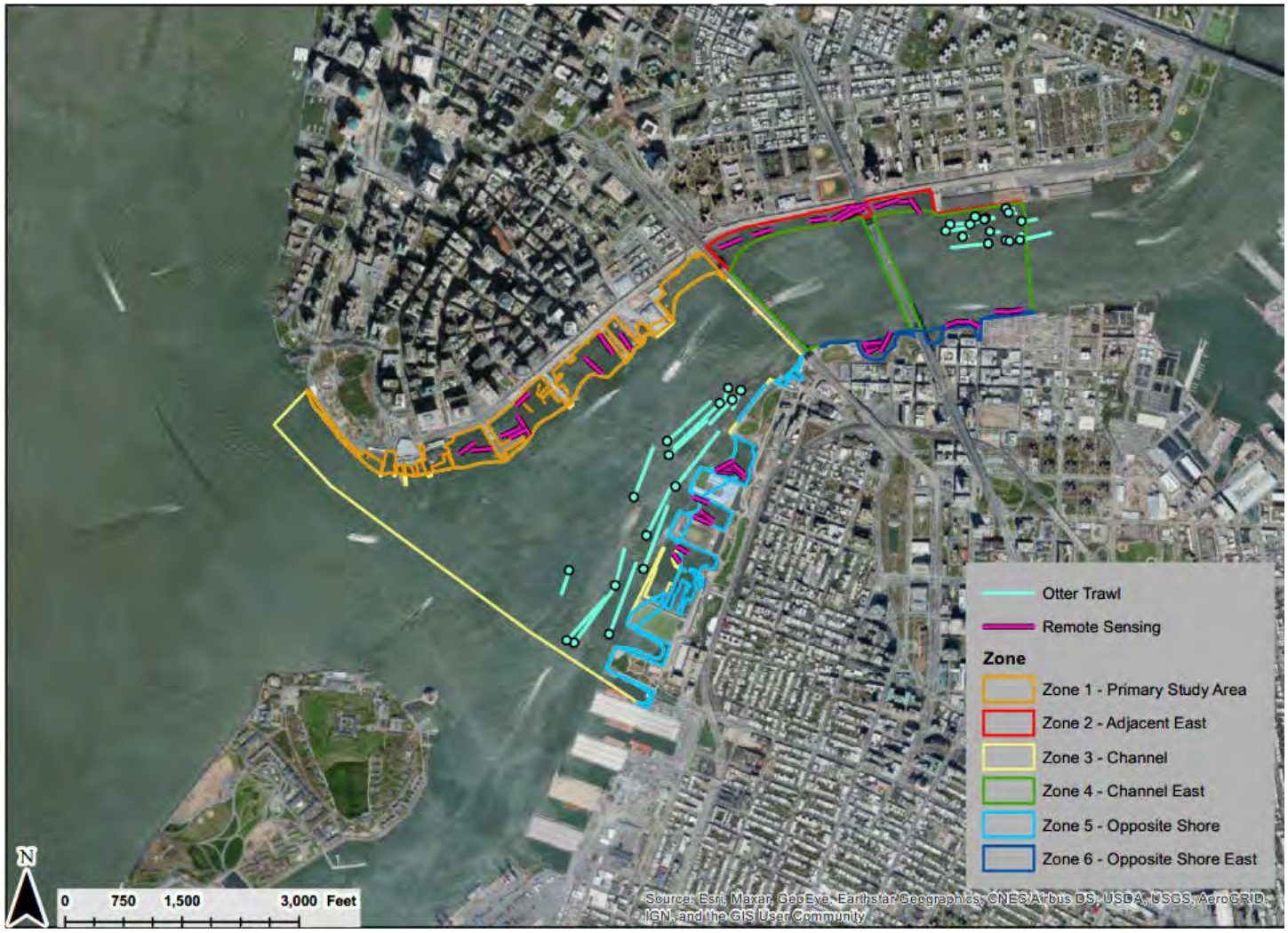


**Figure 3 –** Locations for fish trawl sampling and remote sensing conducted in the East River during January 2021.

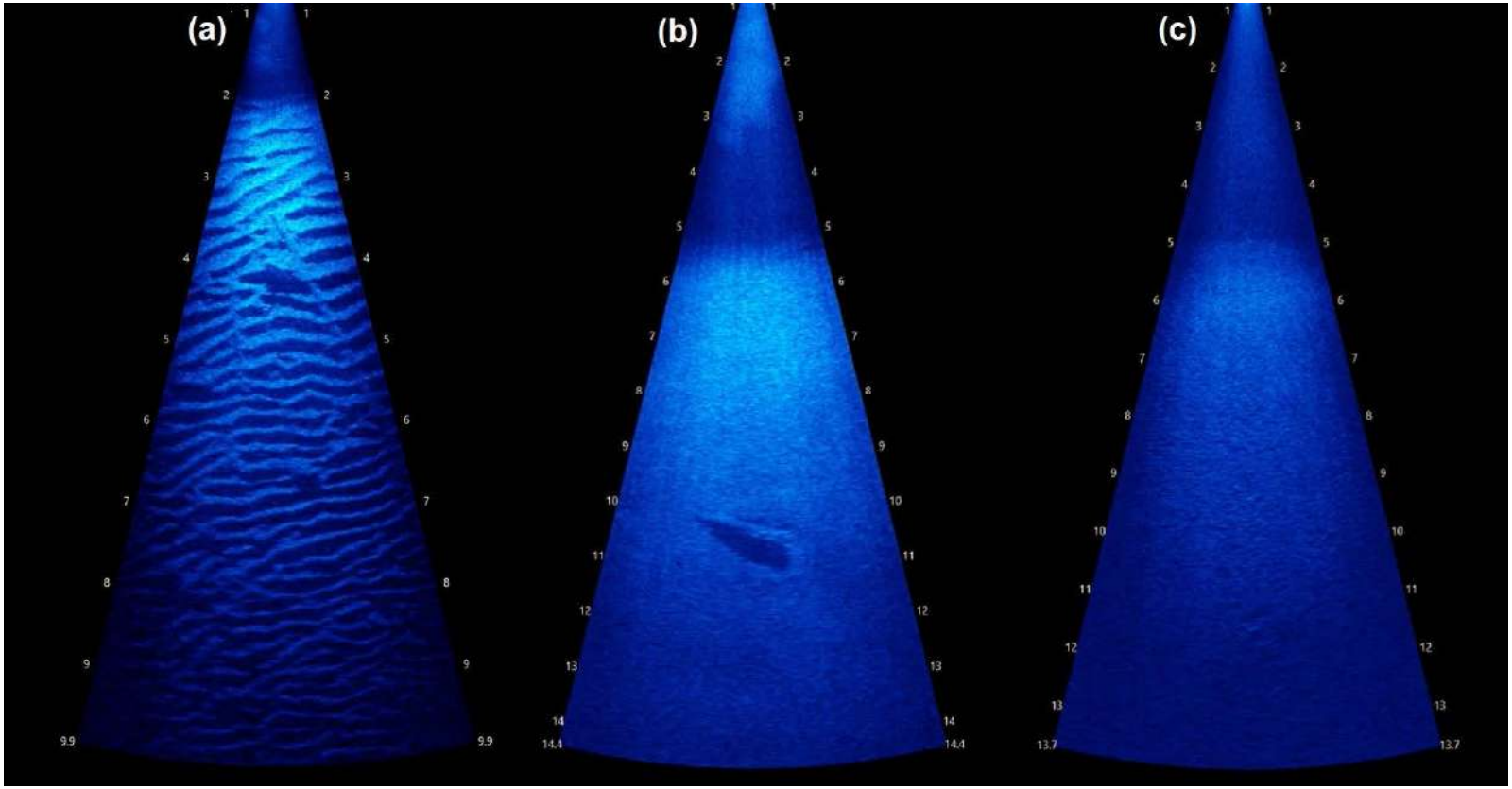


**Figure 4 –** Examples of ARIS data collected in the East River during the Biological and Habitat Sampling program. Images include (a) medium benthic fish, (b) large benthic fish, and (c) schooling midwater fish.

## FISH ABUNDANCE AND BIODIVERSITY

*BOTTOM TRAWL*

A total of 205 fish were collected in bottom trawls during the winter survey. Spotted hake and striped bass were most abundant, accounting for approximately 91% and 7% of the total catch, respectively (**Table 2**). Five other fish species were uncommonly collected (i.e., 1 or 2 individuals) including Alewife, Atlantic croaker, Atlantic menhaden, blueback herring and silver hake were also collected but only as 1 or 2 indiduals during the January trawl sampling event.

**Table 2 – Counts of finfish collected in samples during the January 2021 bottom trawl survey**

| Site ID | Alewife | Atlantic croaker | Atlantic menhaden | blueback herring | silver hake | spotted hake | striped bass |
|---|---|---|---|---|---|---|---|
| 1 | . | . | . | . | . | 33 | 1 |
| 4 | . | . | . | . | . | 3 | . |
| 5 | . | . | . | . | . | 3 | . |
| 6 | . | . | . | . | . | 12 | 2 |
| 9 | . | . | . | . | . | . | . |
| 10 | . | . | . | . | . | . | . |
| 15 | . | . | . | . | . | . | . |
| 16 | . | 1 | . | . | . | 4 | . |
| 19 | . | . | . | . | . | 1 | . |
| 21 | . | . | . | . | . | . | . |
| 22 | . | . | . | . | . | 1 | . |
| 27 | . | . | . | . | . | 1 | . |
| 28 | . | . | . | . | . | 3 | . |
| 30 | . | . | . | . | . | . | . |
| 33 | . | . | . | . | . | 18 | 2 |
| 34 | . | . | . | . | 1 | 29 | 5 |
| 35 | . | . | . | . | . | 43 | 1 |
| 39 | . | . | . | . | . | . | . |
| 40 | . | . | . | . | . | 2 | . |
| 41 | . | . | . | . | . | 21 | 2 |
| 44 | . | . | . | 1 | . | 3 | . |
| 45 | . | . | . | . | . | 1 | . |
| 46 | . | . | . | . | . | . | . |
| 50 | . | . | 1 | . | . | . | . |
| 51 | . | . | . | . | . | . | . |
| 52 | . | . | . | . | . | . | . |
| 56 | . | . | . | . | . | 1 | . |
| 57 | . | . | 1 | . | . | 2 | . |
| 59 | . | . | . | . | . | 2 | . |
| 60 | 1 | . | . | . | . | 2 | 1 |
| **Total** | **1** | **1** | **2** | **1** | **1** | **185** | **14** |

*REMOTE SENSING*

Only three fish were observed during remote sensing transects in January.Two fish were observed within a sampled volume of 17,085 $m^3$ in the nearshore stratum, and 1 fish was observed in a sampled volume of 11,087 $m^3$ in the shoreline stratum (**Table 3**). Fish densities were low across all strata sample sites.

**Table 3 – Total counts and density for finfish detected during the January 2021 remote sensing survey**

| Stratum | Location | No. Transects | Total Volume Sampled ($m^3$) | Total Count | Density (1,000 per $m^3$) |
|---|---|---|---|---|---|
| Nearshore | Zone 1 - Primary Study Area | 4 | 2,177 | 1 | 0.46 |
| | Zone 2 - Adjacent East | 6 | 6,087 | 0 | 0.00 |
| | Zone 5 - Opposite Shore | 5 | 2,506 | 1 | 0.40 |
| | Zone 6 - Opposite Shore East | 8 | 6,315 | 0 | 0.00 |
| | **All** | **23** | **17,085** | **2** | **0.12** |
| Shoreline | Zone 1 - Primary Study Area | 6 | 2,450 | 0 | 0.00 |
| | Zone 2 - Adjacent East | 4 | 5,339 | 0 | 0.00 |
| | Zone 5 - Opposite Shore | 5 | 2,840 | 1 | 0.35 |
| | Zone 6 - Opposite Shore East | 2 | 458 | 0 | 0.00 |
| | **All** | **17** | **11,087** | **1** | **0.09** |

Densities of fish detected during remote sensing transects were classified into four different categories on the basis of size and location within the water column: benthic small-bodied (less than 200 mm long), benthic medium-bodied (200 to 500 mm long), benthic large-bodied (greater than 500 mm long), and midwater small-bodied. Fish densities were low across all strata and sample sites for each of these categories during the January sampling (**Figure 5**). Of the three fish observed during the remote sensing, one was a small-bodied midwater fish, one was a small-bodied benthic fish, and one was a medium-bodied benthic fish.

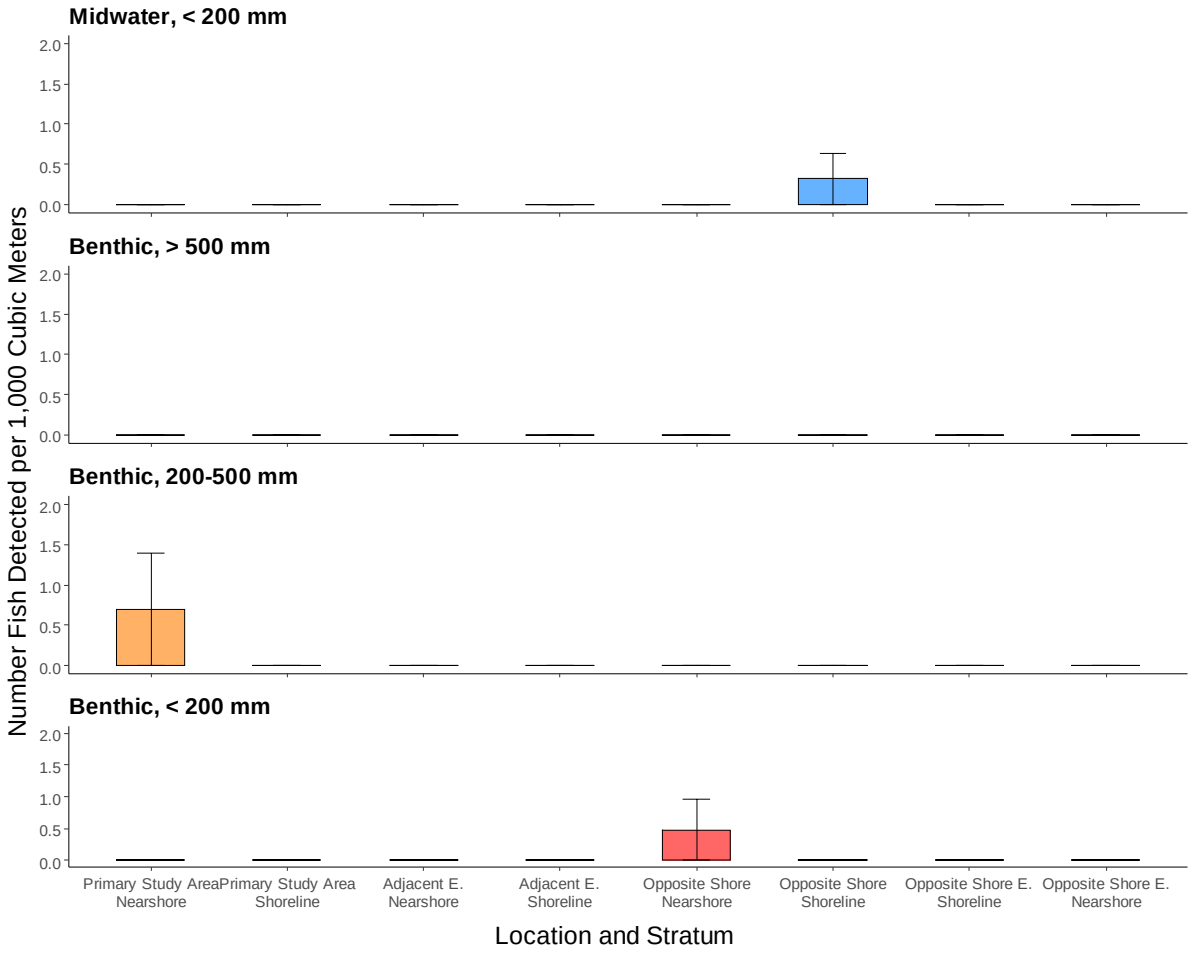


**Figure 5** – Densities of finfish detected among locations and strata during remote sensing transects of nearshore and shoreline habitats of the East River during the January 2021 survey.

## D. WATER QUALITY AND CURRENT VELOCITY

NYCEDC collected water quality samples at the surface and bottom of the river concurrent with each of the 70 biological samples (**Figure 6**; **Table 4**). Bottom samples were collected at a mean depth of 21.0 feet (6.4 meters).

### WATER QUALITY CHARACTERISTICS

**Table 4** summarizes water temperature, salinity, dissolved oxygen [DO] and pH measured during sampling of the East River in January 2021 by zone and habitat stratum. For each of the parameters, the overall mean and range were generally similar between the surface and bottom. However, salinity measurements collected at the bottom were lower than those collected at the surface. **Figure 7** provides an example of depth profiles for water quality parameters.


**Figure 6 –** Locations of water quality profiles associated with winter biological sampling in the East River during January 2021.

**Table 4 – Water quality parameters measured in East River surface and bottom waters during biological and habitat sampling in January 2021**

| Position | Zone | Stratum | N | Depth (ft) | Temperature (C) | | Salinity (PSU) | | DO (mg/L) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Surface | 1 | Nearshore | 4 | 1.0 | 5.0 | 4.9 - 5.0 | 24.2 | 24.1 - 24.4 | 9.7 | 9.7 - 9.8 | 8.1 | 8.0 - 8.1 |
| | | Shoreline | 6 | 1.0 | 5.0 | 4.9 - 5.0 | 24.2 | 24.0 - 24.4 | 9.7 | 9.7 - 9.8 | 8.1 | 8.1 - 8.1 |
| | 2 | Nearshore | 6 | 1.0 | 4.8 | 4.7 - 5.0 | 23.9 | 23.8 - 24.0 | 9.8 | 9.8 - 9.9 | 8.1 | 8.1 - 8.2 |
| | | Shoreline | 4 | 1.0 | 4.6 | 4.6 - 4.7 | 23.8 | 23.8 - 23.8 | 9.9 | 9.9 - 9.9 | 8.2 | 8.2 - 8.2 |
| | 3 | Channel | 15 | 1.0 | 4.5 | 4.1 - 4.9 | 21.1 | 19.0 - 22.0 | 10.4 | 9.8 - 10.8 | 8.1 | 8.1 - 8.2 |
| | 4 | Channel | 15 | 1.0 | 4.6 | 4.1 - 5.3 | 23.6 | 23.2 - 24.8 | 10.2 | 10.0 - 10.2 | 8.2 | 8.0 - 8.2 |
| | 5 | Nearshore | 5 | 1.0 | 4.3 | 4.0 - 4.6 | 22.6 | 21.3 - 23.4 | 9.9 | 9.7 - 10.1 | 8.1 | 8.0 - 8.1 |
| | | Shoreline | 5 | 1.0 | 4.3 | 4.0 - 4.4 | 22.4 | 21.1 - 23.0 | 10.0 | 9.8 - 10.5 | 8.0 | 8.0 - 8.1 |
| | 6 | Nearshore | 8 | 1.0 | 4.6 | 4.5 - 4.6 | 23.3 | 23.1 - 23.4 | 9.8 | 9.7 - 9.8 | 8.1 | 8.1 - 8.2 |
| | | Shoreline | 2 | 1.0 | 4.6 | 4.6 - 4.6 | 23.3 | 23.3 - 23.4 | 9.7 | 9.7 - 9.7 | 8.1 | 8.1 - 8.1 |
| | **All** | | **70** | **1.0** | **4.6** | **4.0 – 5.3** | **23.2** | **19.0 - 24.8** | **9.9** | **9.7 - 10.8** | **8.1** | **8.0 - 8.2** |
| Bottom | 1 | Nearshore | 4 | 12.5 | 5.0 | 5.0 - 5.0 | 24.4 | 24.1 - 24.6 | 9.7 | 9.7 - 9.8 | 8.1 | 8.1 - 8.1 |
| | | Shoreline | 6 | 10.7 | 5.0 | 4.9 - 5.0 | 24.3 | 24.0 - 24.5 | 9.7 | 9.7 - 9.8 | 8.1 | 8.1 - 8.1 |
| | 2 | Nearshore | 6 | 17.0 | 4.8 | 4.7 - 5.0 | 23.9 | 23.8 - 24.1 | 9.8 | 9.8 - 9.9 | 8.1 | 8.1 - 8.2 |
| | | Shoreline | 4 | 20.8 | 4.7 | 4.7 - 4.7 | 23.8 | 23.8 - 23.8 | 9.8 | 9.8 - 9.8 | 8.1 | 8.1 - 8.2 |
| | 3 | Channel | 15 | 46.7 | 5.1 | 4.2 - 6.3 | 24.5 | 21.8 - 28.1 | 10.0 | 9.3 - 10.4 | 8.2 | 8.1 - 8.2 |
| | 4 | Channel | 15 | 46.2 | 4.7 | 4.1 - 5.4 | 23.7 | 23.3 - 25.3 | 10.2 | 10.0 - 10.3 | 8.2 | 8.1 - 8.2 |
| | 5 | Nearshore | 5 | 15.6 | 4.6 | 4.5 - 4.7 | 23.6 | 23.3 - 24.0 | 9.8 | 9.7 - 9.8 | 8.1 | 8.0 - 8.1 |
| | | Shoreline | 5 | 15.4 | 4.6 | 4.4 - 4.8 | 23.7 | 23.2 - 24.5 | 9.8 | 9.7 - 9.9 | 8.0 | 8.0 - 8.1 |
| | 6 | Nearshore | 8 | 17.1 | 4.6 | 4.5 - 4.6 | 23.3 | 23.2 - 23.4 | 9.8 | 9.7 - 9.8 | 8.1 | 8.1 - 8.2 |
| | | Shoreline | 2 | 8.0 | 4.6 | 4.6 - 4.6 | 23.3 | 23.3 - 23.4 | 9.7 | 9.7 - 9.7 | 8.1 | 8.1 - 8.1 |
| | **All** | | **70** | **21.0** | **4.8** | **4.1 - 6.3** | **23.9** | **21.8 - 28.1** | **9.8** | **9.3 - 10.4** | **8.1** | **8.0 - 8.2** |

**Note:** Samples collected in the “shoreline/nearshore” stratum are all from benthic grab sampling.

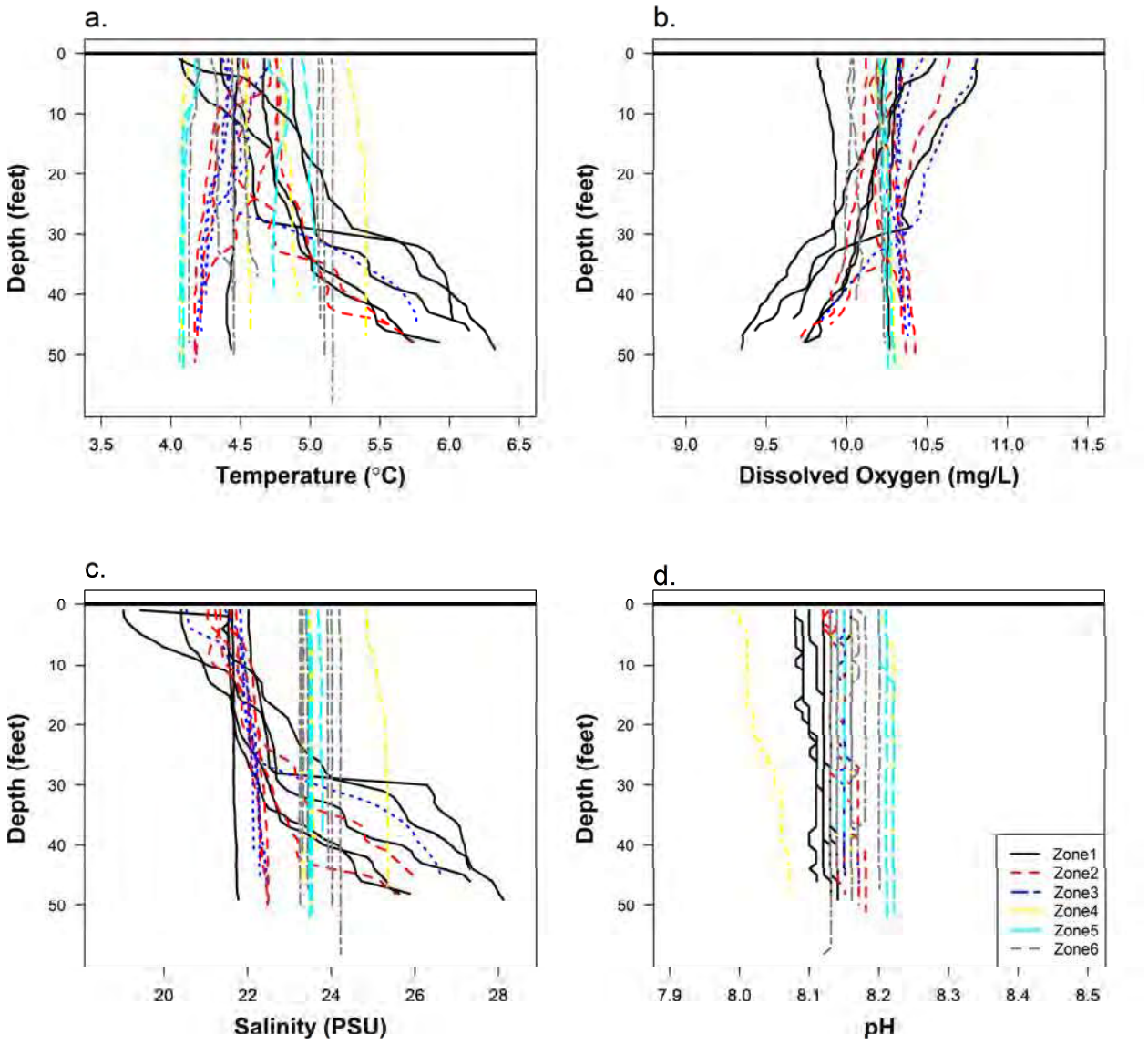


**Figure 7** – Depth profiles of water quality parameters measured during trawl monitoring in January 2021. Similar water quality profiles were acquired to complement biological samples collected with each of the sampling gears.

## CURRENT VELOCITY

NYCEDC collected a total of 70 current velocity measurements during the bottom trawl (30 samples) and remote sensing (40 samples) surveys. Current velocity ranged from 0.05 to 1.4 meters per second ("m/s") (0.17 to 4.59 feet per second ["ft/s"]) and averaged 0.40 m/s (1.3 ft/s) (**Figure 8**). Bottom depth measurements ranged from 6 to 54 feet (1.8 to 16.5 meters) and averaged 29.5 feet (9.0 meters) (**Figure 8**). **Figure 9** illustrates the observed increases in water depth and current velocity from the shoreline to the nearshore to the channel habitats, and the differences in water depth and current velocity among sampling zones.

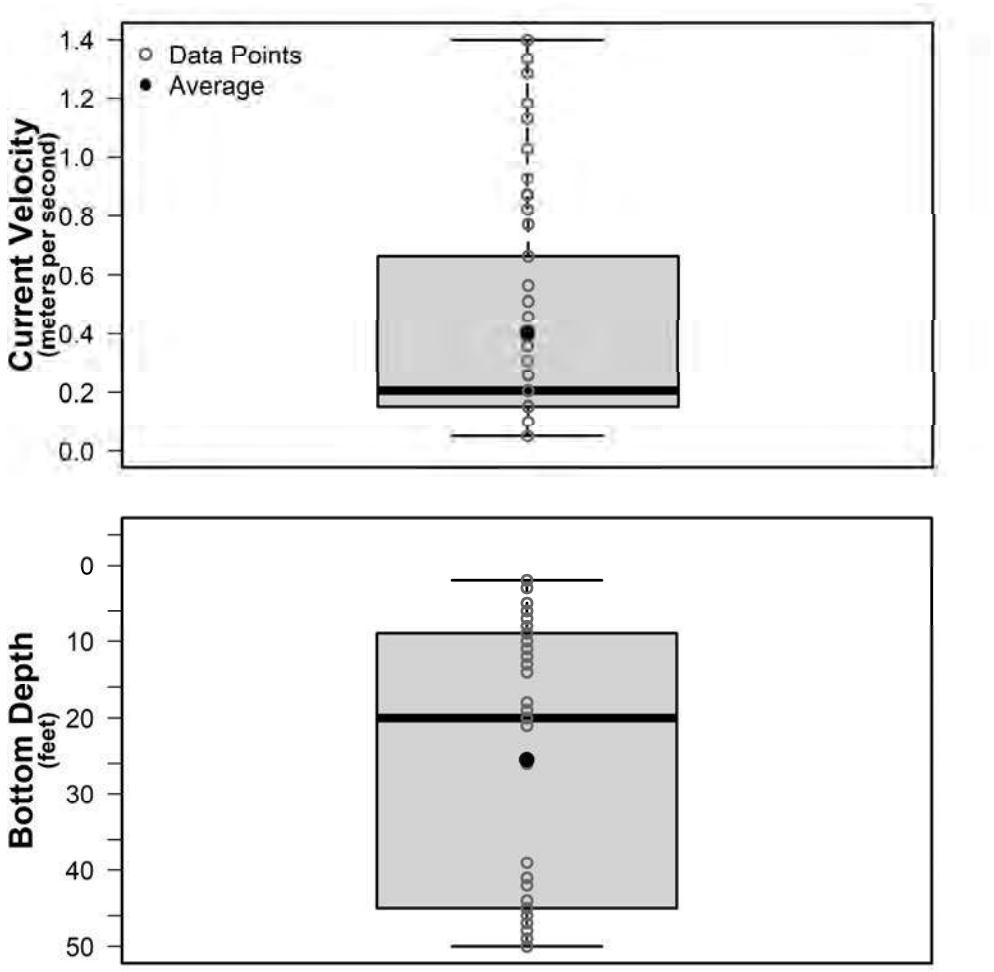


**Figure 8** – Current velocity and water depth measurements taken at sample sites in the lower East River during January 2021. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

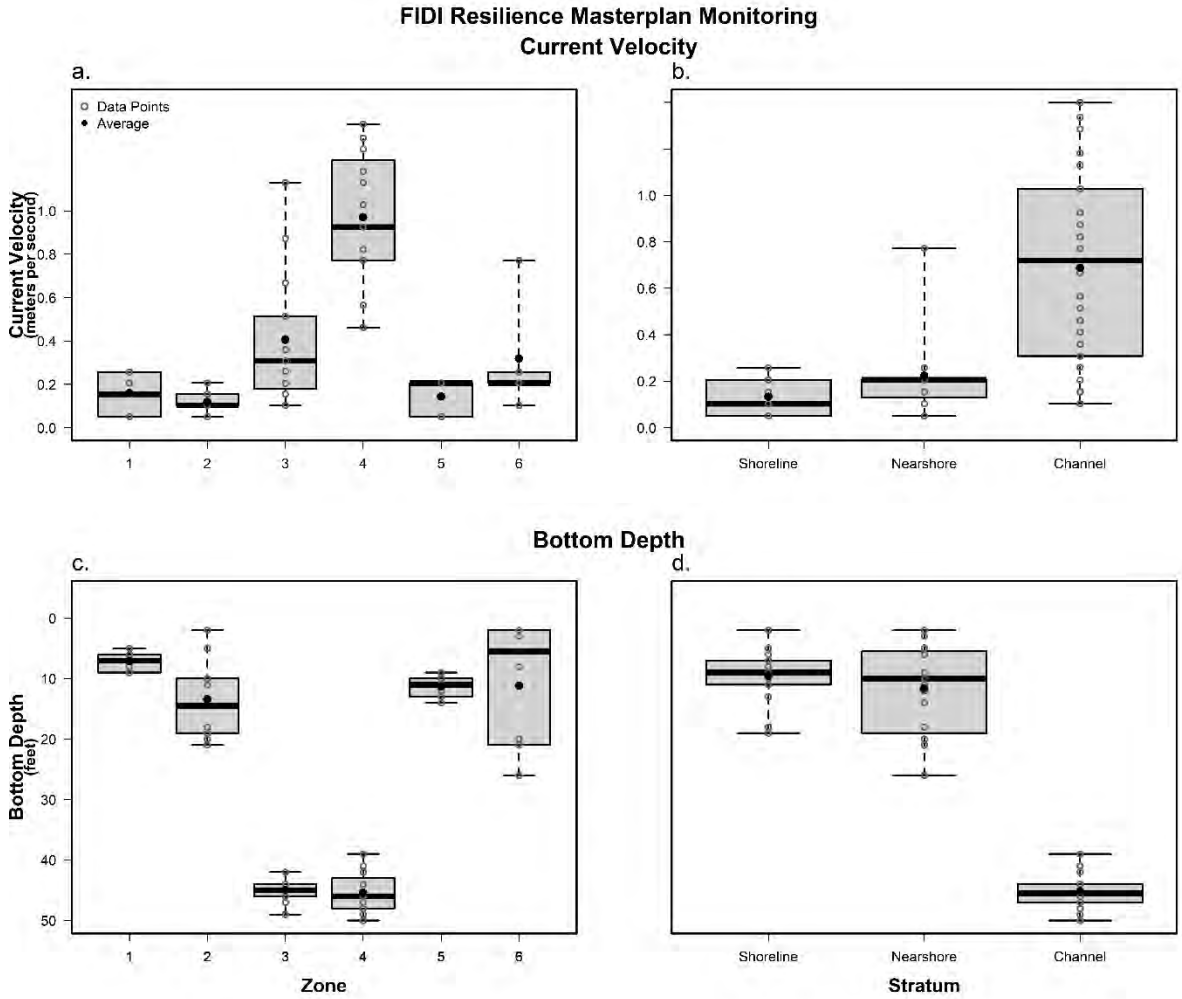


**Figure 9** – Current velocity and water depth measurements taken at sample sites in the lower East River during January 2021. Data are plotted to compare and contrast among zones and habitat strata. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

# New York City Economic Development Corporation
# Financial District and Seaport Climate Resilience Plan

# Biological and Habitat Sampling Report
# April 2021 Sampling Event


**Prepared by**

New York City Economic Development Corporation
AKRF, Inc.
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**July 30, 2021**

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# A. INTRODUCTION

The New York City Economic Development Corporation ("NYCEDC"), on behalf of the City and in collaboration with the Mayor's Office of Recovery ("MOR"), is conducting a climate resilience master planning effort in the Financial District and Seaport of Lower Manhattan ("Financial District and Seaport Climate Resilience Master Plan," or "FiDi Seaport Climate Resilience Plan"). The FiDi Seaport Climate Resilience Plan, initiated in October of 2019, is part of the Lower Manhattan Coastal Resiliency project. The FiDi Seaport Climate Resilience Plan project comprises a 0.9-mile portion of the Manhattan shoreline along the East River from just south of the Brooklyn Bridge to the Battery, including South Street Seaport and the Wall Street Financial District, extending out to the pierhead line ("Project Area").

The East River is a tidal strait connecting Upper New York Bay and Long Island Sound that provides habitat for plankton, benthic invertebrates, marine, estuarine and anadromous fish and is used as a migratory pathway by endangered Atlantic sturgeon and possibly by the endangered shortnose sturgeon. Threatened or endangered sea turtles may also occur in the East River as occasional transient individuals. In-water components to be considered in the development of the FiDi Seaport Resilience Plan, such as extending the shoreline, have the potential to affect existing aquatic resources within the Project Area and in the adjacent portion of the lower East River. Because recent information characterizing the aquatic resources within the Project Area and the lower East River is limited, as part of the FiDi Seaport Climate Resilience Plan, NYCEDC is conducting a biological and habitat sampling study to characterize these resources.

The study area for this biological sampling comprises the Project Area and the lower East River from approximately the Battery to the south to Montgomery Street to the north, opposite the western boundary of the Brooklyn Navy Yard, a distance of approximately 1.8 miles and spanning the width of the River (**Figure 1**). The sample universe is subdivided into six zones bisected by the Brooklyn Bridge and reflecting locations relative to the Project Area and water depth. Zones (as indicated in **Figure 1**) are defined as:

1) "Primary Study Area" - the Primary Study Area along the northern shoreline of the East River from the White Hall Ferry terminal (Staten Island Ferry) to the Brooklyn Bridge, also referred to as the Project Area;
2) "Adjacent East" - the shallow, off-channel area along the northern shoreline adjacent to the Project Area and east of the Brooklyn Bridge;
3) "Channel" - the deep, river channel south of the Primary Study Area;
4) "Channel East" - the deep, channel east of the Brooklyn Bridge;
5) "Opposite Shore" - the shallow, off-channel area along East River shoreline in Brooklyn across the river from the Primary Study Area; and
6) "Opposite Shore East" - the shallow, off-channel area along the East River shoreline of Brooklyn east of the Brooklyn Bridge.

The study area is further subdivided into three habitat strata based on proximity to shoreline structure and water depth and are defined as: 1) shoreline ($\leq$ 1 meter depth), 2) nearshore (within the pierhead line, generally 1 to 5 meters depth), and 3) channel (beyond the pierhead line at depths of 5 to 12 meters). This stratified-random sampling design is intended to provide pre-construction biological and habitat data on the aquatic community in the Primary Study Area (Zone 1) that can be compared with data collected in similar shoreline habitat and deep-water areas of the East River, adjacent to, and east of, the Project Area (Zones 2-6).

## B. SUMMARY OF SAMPLE COLLECTION

This report summarizes biological and habitat sampling conducted in the East River during April 2021. NYCEDC conducted the sampling following protocols described in the September 2020 Biological and Habitat Sampling Plan ("Sampling Plan") approved by the Aquatic Resource Advisory Committee that has been established for the FiDi Seaport Climate Resilience Plan. As outlined in the Sampling Plan, the April sampling event comprised the following described in greater detail below:

- sampling with a 0.05-$m^2$ Ponar grab sampler **(Figure 2)** to characterize invertebrate abundance and biodiversity, sediment composition, and total organic carbon;
- sampling with an otter trawl, seine net, baited fish traps, and remote sensing using an Adaptive Resolution Imaging Sonar ("ARIS") to characterize fish abundance and biodiversity;
- sampling with a mid-water trawl in the channel stratum to estimate the abundance of migrating anadromous fish (i.e., clupeids and striped bass);
- sampling with a conductivity, temperature and depth ("CTD") instrument to measure water quality parameters (i.e., temperature, salinity, dissolved oxygen and pH), which was conducted concurrently with the benthic and fish sampling; and
- measurements of current velocity.

In accordance with the Sampling Plan, NYCEDC did not sample for plankton for the April sampling event. NYCEDC will sample for plankton in July, August and September 2021.

NYCEDC collected a total of 138 biological samples at randomly selected locations within each zone of study area, along with water quality measurements, in April. **Table 1** summarizes the number of samples collected by gear type, zone and stratum.


**Figure 1 –** Zones for biological and habitat sampling in the East River.

**Table 1 – Samples collected by zone, study area and habitat stratum.**

| Type of Sampling | Zone | Study Area | Stratum | No. Samples |
|---|---|---|---|---|
| **Benthic Invertebrates and Substrate** | | | | |
| Macroinvertebrate and Sediment Grab | 1 | Primary Study Area | Shoreline/Nearshore | 5 |
| | 2 | Adjacent East | Shoreline/Nearshore | 5 |
| | 3 | Channel | Channel | 5 |
| | 4 | Channel East | Channel | 5 |
| | 5 | Opposite Shore | Shoreline/Nearshore | 5 |
| | 6 | Opposite Shore East | Shoreline/Nearshore | 5 |
| | | | **Total** | **30** |
| **Fish Community** | | | | |
| Seine Net | 1 | Primary Study Area | Shoreline | 2 |
| | 2 | Adjacent East | Shoreline | 2 |
| | 5 | Opposite Shore | Shoreline | 5 |
| | 6 | Opposite Shore East | Shoreline | 5 |
| | | | **Total** | **14** |
| Bottom Trawl | 3 | Channel | Channel | 5 |
| | 4 | Channel East | Channel | 5 |
| | | | **Total** | **10** |
| Baited Fish Traps (Paired) | 1 | Primary Study Area | Shoreline | 3 |
| | | | Nearshore | 1 |
| | 2 | Adjacent East | Shoreline | 2 |
| | | | Nearshore | 2 |
| | 3 | Channel | Channel | 4 |
| | 4 | Channel East | Channel | 4 |
| | 5 | Opposite Shore | Shoreline | 2 |
| | | | Nearshore | 2 |
| | 6 | Opposite Shore East | Shoreline | 3 |
| | | | Nearshore | 1 |
| | | | **Total** | **24** |
| Mid-Water Trawl (Spring) | 3 | Channel | Channel | 10 |
| | 4 | Channel East | Channel | 10 |
| | | **Total** | | **20** |
| Remote Sensing | 1 | Primary Study Area | Shoreline | 4 |
| | | | Nearshore | 6 |
| | 2 | Adjacent East | Shoreline | 4 |
| | | | Nearshore | 6 |
| | 5 | Opposite Shore | Shoreline | 7 |
| | | | Nearshore | 3 |
| | 6 | Opposite Shore East | Shoreline | 4 |
| | | | Nearshore | 6 |
| | | | **Total** | **40** |
| | | | **Grand Total** | **138** |

**Note:** Only 2 shoreline seine samples could be collected from Zones 1 and 2 due to the lack of suitably shallow shorelines.

## C. BENTHIC GRAB SAMPLING

**Figure 3** shows the 30 locations sampled for sediment and benthic macroinvertebrates during the April sampling event. NYCEDC collected five sediment and benthic macroinvertebrate grab samples in each of the six zones (**Table 1**).

### BENTHIC INVERTEBRATE COMMUNITY

The benthic invertebrate community in the study area during April was dominated by bivalve mussels and clams, polychaete and oligochaete worms, and gastropod snails (**Table 2 and Figures 4a, 4b, and 4c)**. Abundance of benthic invertebrates was highest in Zone 2 along the Manhattan shoreline adjacent to the Primary Study Area (Zone 1) and was at least 45 percent higher compared to all other zones. Lowest abundance was observed along the Brooklyn shoreline (Zones 5 and 6) and was an order of magnitude lower in Zone 5 compared to the other Zones. Moderate abundances of benthic invertebrates were collected in the Primary Study Area (Zone 1) and in the Channel zones (Zones 3 and 4).

Species richness (defined here as the number of benthic invertebrate species that represent 90% of all individuals collected in each zone) was highest in Zone 5; however, the total number of individuals and overall average biomass (i.e., weight of organisms collected per sample) of benthic invertebrates were lowest in Zone 5 (**Tables 2 and 3**). Average biomass was highest in the shoreline, nearshore, and channel habitats in Zones 2 and 4 upriver from the Primary Study Area (**Table 3**).

The bivalve mussel, *Mytilus edulis*, was the most abundant benthic invertebrate taxon in the study area and was most abundant in all zones during April except the Opposite Shoreline (Zone 5). Within the Primary Study Area (Zone 1), the four other taxa that were among the five most abundant included the polychaete worm, *Mediomastus ambiseta*, oligochaete worms, and the polychaete worms, *Streblospio benedicti* and *Ampharete oculata*. These taxa were also among the most abundant benthic taxa collected in the other Zones during April.

The tube-forming, reef-building polychaete worm, *Sabellaria vulgaris* (**Figure 5**), was not among the most abundant benthic taxa, but was present in all zones except Zone 5. This species was most abundant in Zone 2 (277 total individuals collected) compared to elsewhere (i.e., 180 total individuals in all other zones combined). Based on observations of this habitat-forming species during the sampling and testing program, and the potential value of worm-reef habitat as structure for other aquatic organisms, a single field reconnaissance event will be conducted during the August or September field event in an effort to confirm the presence of worm reefs in the study area. A drop camera will be used at several locations where *Sabellaria* worms have been collected in high abundance and where benthic features have also been observed during remote sensing. Results of the drop camera survey will be included in a future report.

**Figure 2** – Benthic grab sampling in the East River.

**Table 2 – Summary of important benthic taxa from five grab samples per zone during April sampling in the lower East River, NY.**

| | **Primary study area** | **Adjacent upstream** | **Channel** | **Channel upstream** | **Opposite shoreline** | **Opposite upstream** |
|---|---|---|---|---|---|---|
| | **Zone 1** | **Zone 2** | **Zone 3** | **Zone 4** | **Zone 5** | **Zone 6** |
| 5 Most Abundant Taxa | *Mytilus edulis* Bivalve mussel | *Mytilus edulis* Bivalve mussel | *Mytilus edulis* Bivalve mussel | *Mytilus edulis* Bivalve mussel | *Mya arenaria* Bivalve clam | *Mytilus edulis* Bivalve mussel |
| | *Mediomastus ambiseta* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Acteocina canaliculata* Gastropod snail | *Mediomastus ambiseta* Polychaete worm |
| | Oligochaeta Oligochaete worm | *Polycirrus* sp. Polychaete worm | Oligochaeta Oligochaete worm | *Ampharete oculata* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | Oligochaeta Oligochaete worm |
| | *Streblospio benedicti* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | *Mya arenaria* Bivalve clam | *Japonactaeon punctostriatus* Gastropod snail | *Streblospio benedicti* Polychaete worm |
| | *Ampharete oculata* Polychaete worm | Terebellidae Polychaete worm | *Ampharete oculata* Polychaete worm | Oligochaeta Oligochaete worm | *Mulinia lateralis* Bivalve clam | *Ampharete oculata* Polychaete worm |
| Total Individuals | 5,287 | 9,595 | 6,547 | 6,597 | 504 | 3,010 |
| % of Total | 67 | 47 | 65 | 55 | 33 | 56 |
| Number of Taxa Representing 90% of Total | 32 | 32 | 29 | 33 | 63 | 46 |

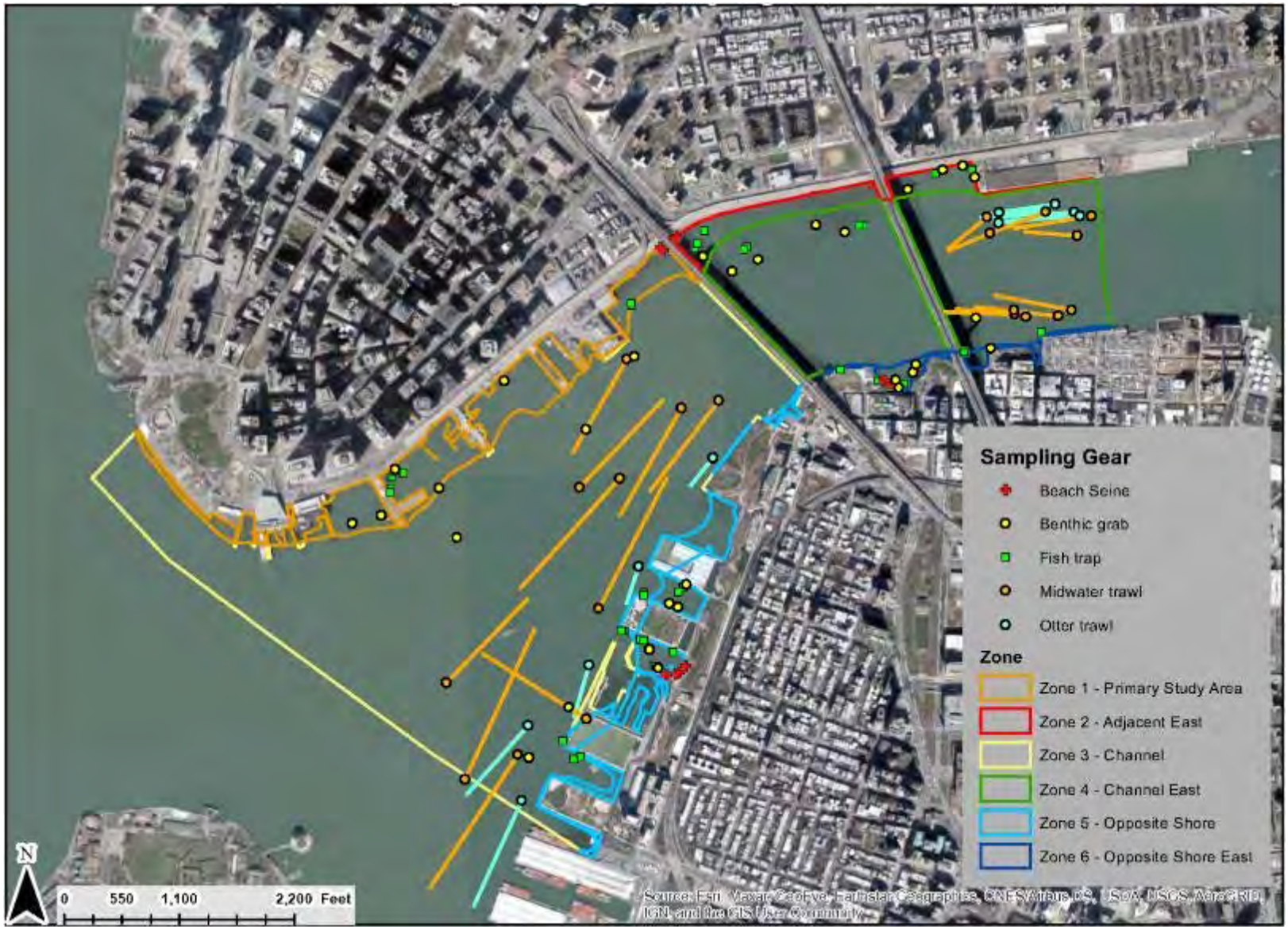



**Figure 3 –** Locations for fish and benthic grab sampling conducted in the East River.

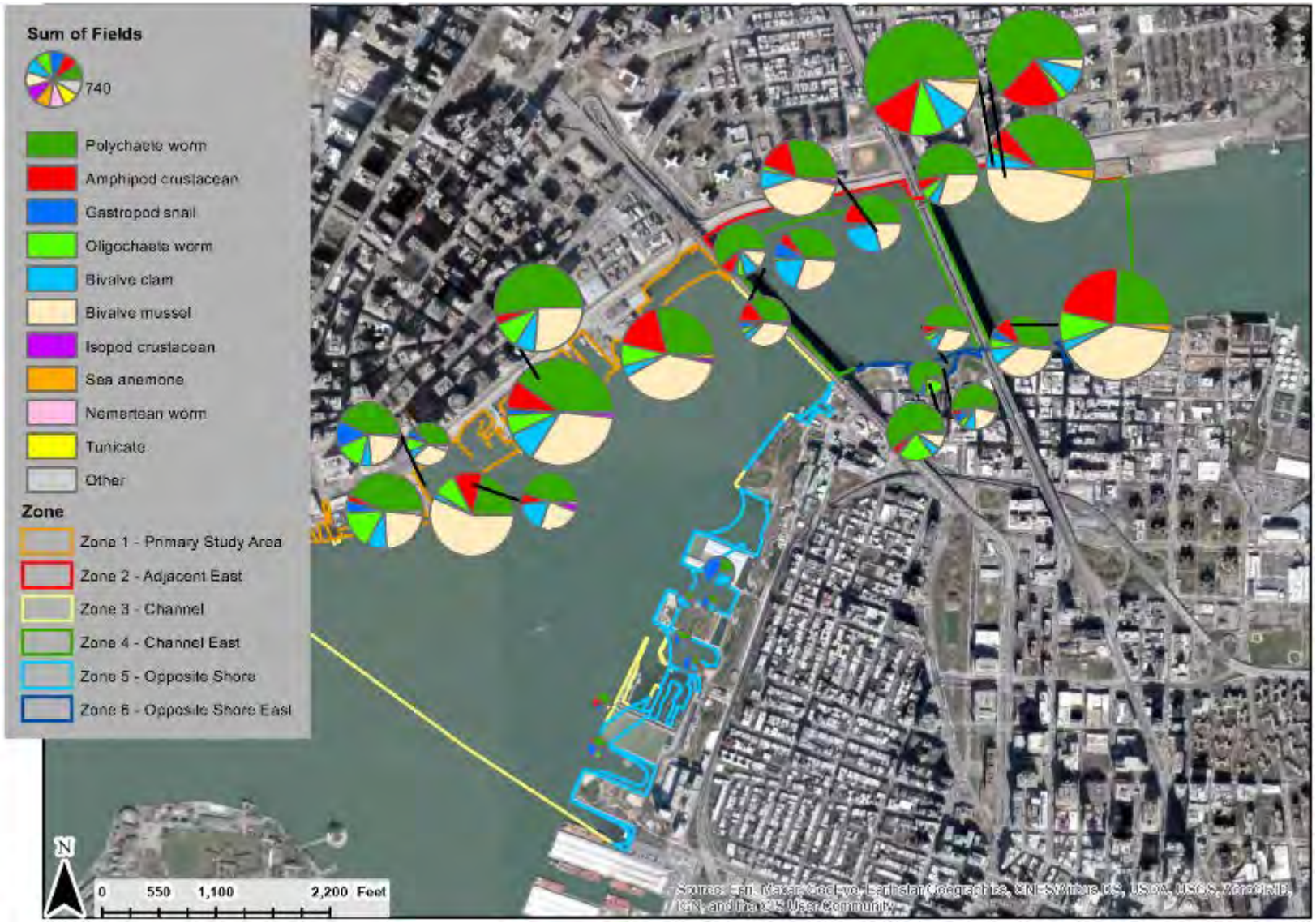



**Figure 4a –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the East River. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

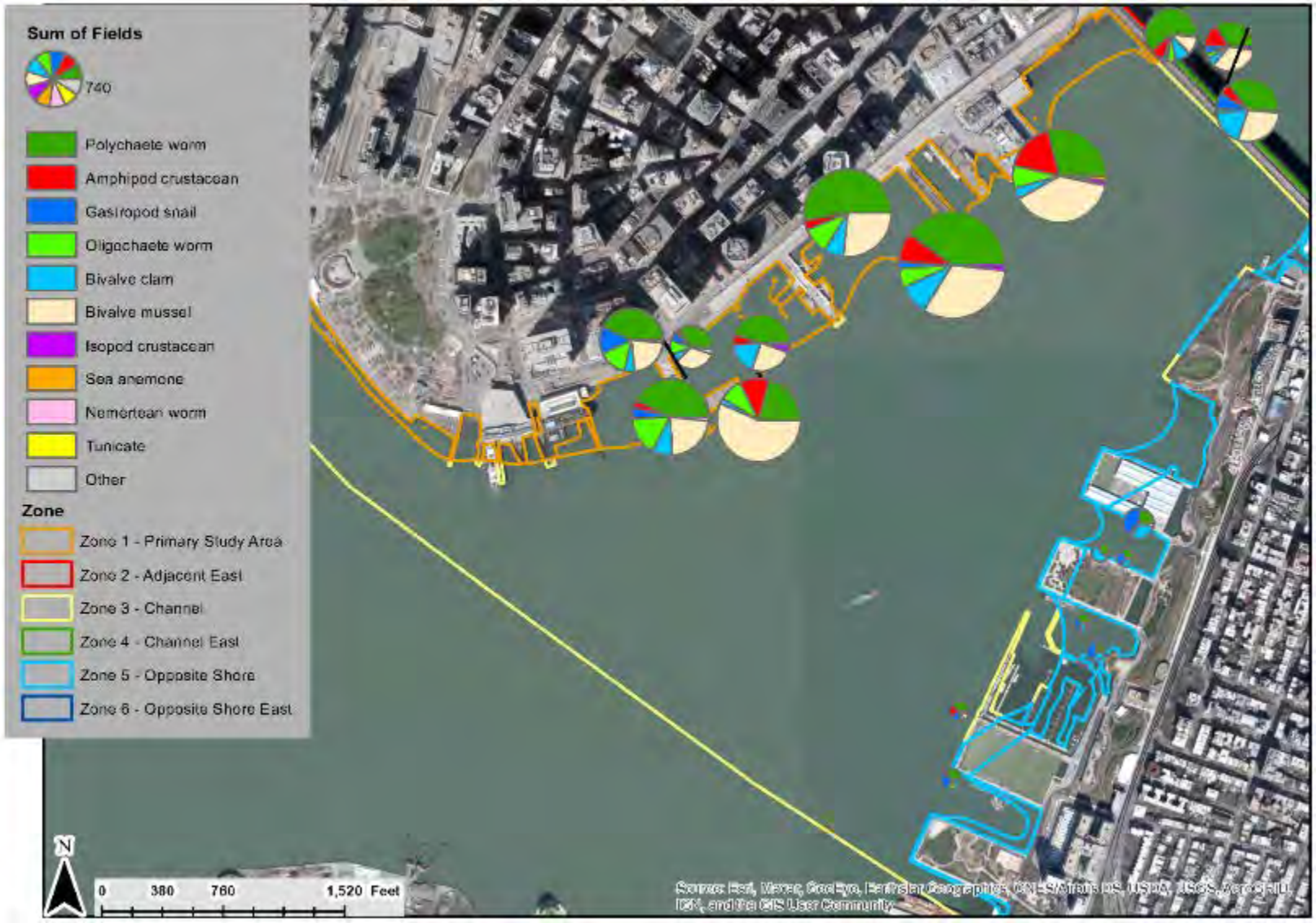



**Figure 4b –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the lower half of the study area. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

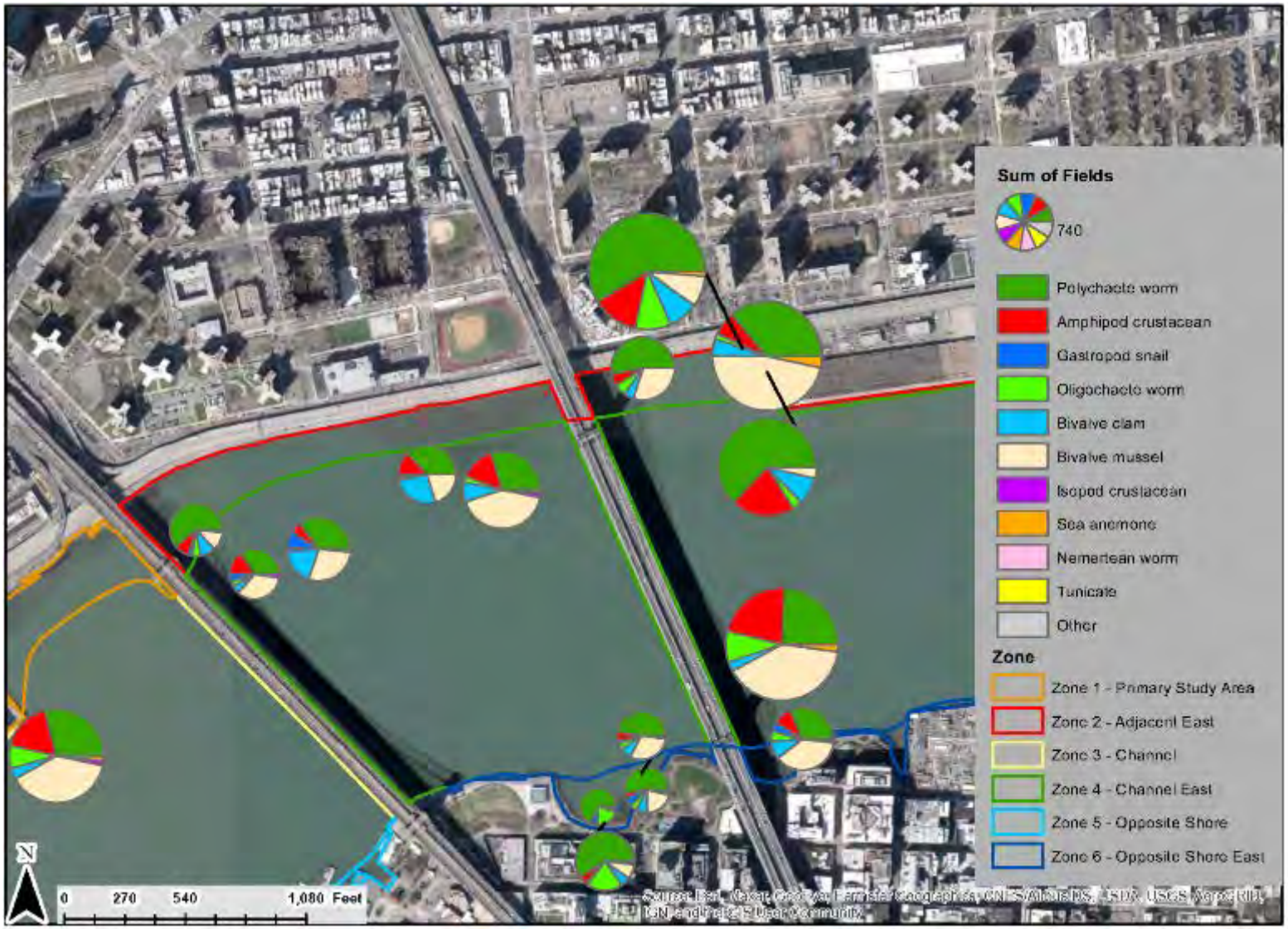



**Figure 4c –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the upper half of the study area. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

**Table 3 – Average biomass, plus or minus 2 standard errors, of benthic invertebrates collected in each sampling zone during October 2020 in the lower East River, NY.**

| Zone | Biomass |
|---|---|
| Zone 1 – Primary study area | 1.87 ± 1.41 |
| Zone 2 – Adjacent upstream | 3.50 ± 1.58 |
| Zone 3 – Channel downstream | 2.45 ± 1.02 |
| Zone 4 – Channel upstream | 4.23 ± 2.37 |
| Zone 5 – Opposite shoreline | 0.89 ± 0.72 |
| Zone 6 – Opposite upstream | 0.91 ± 0.61 |

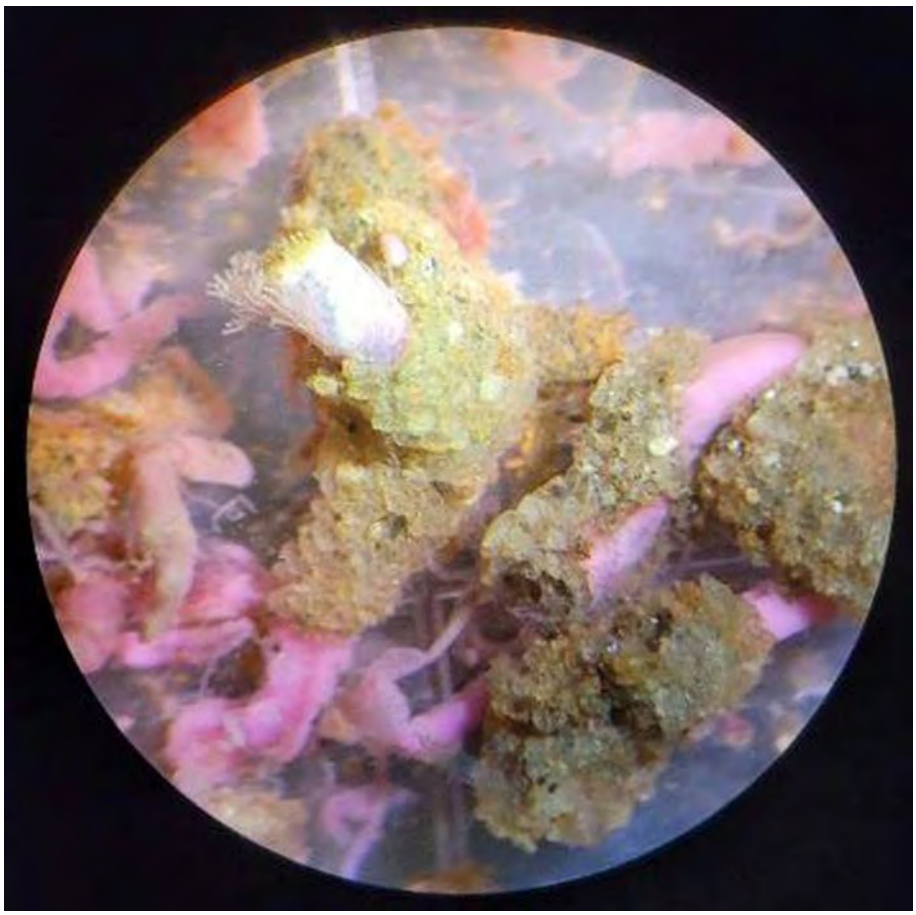


**Figure 5** – Photograph of *Sabellaria vulgaris* (tube-forming, reef-building polychaete worms) from a benthic grab sample collected during April in the East River. This image was taken under the sorting scope during processing in the lab.

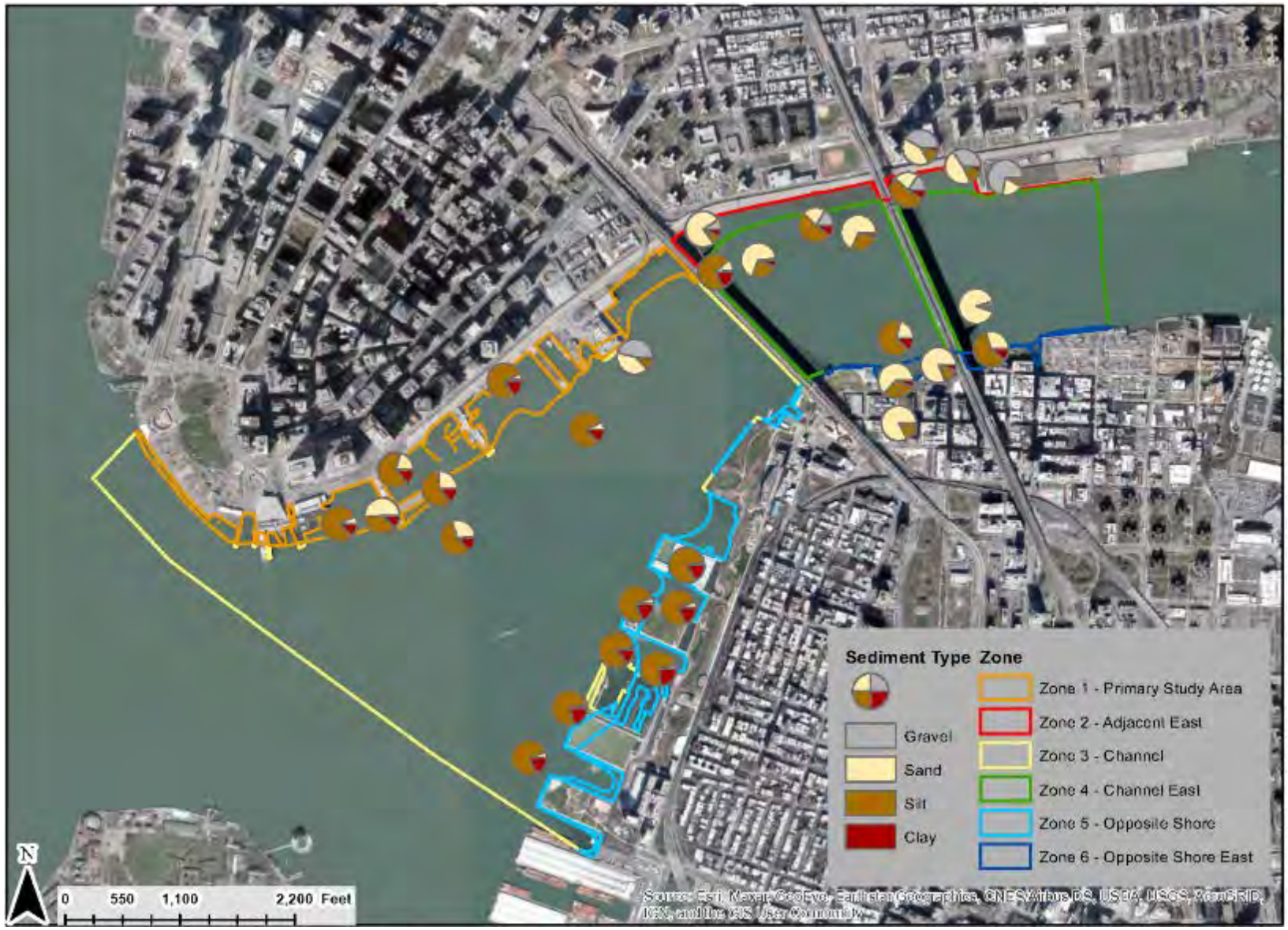



**Figure 6 –** Sediment composition in grab samples collected in the East River.

## SEDIMENT COMPOSITION AND TOTAL ORGANIC CARBON

Sediment composition along the Manhattan shoreline/nearshore area (Zones 1 and 2) was distinctly different between zones. Sediment in Zone 1 west of the Brooklyn Bridge was primarily silt with smaller amount of sand and minimal clay, whereas sediment in Zone 2 east of the Brooklyn Bridge was primarily sand (**Figure 6**). Similarly, along the Brooklyn shoreline/nearshore area (Zones 5 and 6), sediment in Zone 5 west of the Brooklyn Bridge was primarily silt and clay, while sediment in Zone 6 east of the Brooklyn Bridge was primarily sand (**Figure 4**). The pattern of higher silt content on the riverbed west of the Brooklyn Bridge and higher sand content east of the Bridge was also observed in the channel (Zones 3 and 4); samples collected in Zone 3 west of the Brooklyn Bridge generally consisted mostly of silt, whereas half of the sediment samples collected in Zone 4 east of the Brooklyn Bridge consisted of mostly sand, and the other half consisted mostly of silt. Gravel comprised less than 0.1% of the sediment in most of the samples. However, there were high proportions of gravel (approximately 20% to 70%) observed in one of the samples in the channel in Zone 3 and in most of the samples collected along the shoreline east of the Brooklyn Bridge in Zone 2.

Total organic carbon (TOC) was similar among Zones 1, 2, 3, and 5, which had median TOC concentrations ranging from 9 to 12 grams of organic carbon per kilogram of sampled substrate (g/kg) and had minimal variation among samples. By contrast, Zones 4 and 6 had considerably higher median concentrations of 16 and 20 g/kg, respectively, and had higher variation among samples (**Figure 7**). The median TOC concentration in the channel stratum (i.e., Zones 3 and 4) was 12.5 g/kg, which was slightly greater than in the shoreline/nearshore stratum (11.5 g/kg). There were several samples in the channel stratum that had much higher TOC concentrations than the median, including a sample with a TOC concentration of 74 g/kg (**Figure 7**).

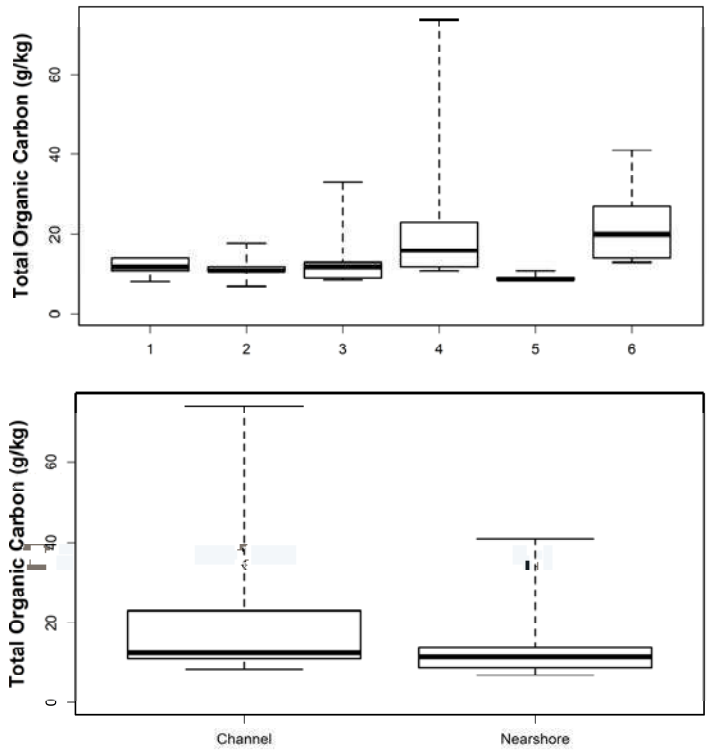



**Figure 7** – Boxplots of total organic carbon content observed across zones (top panel) and strata (bottom panel) in benthic grab sampling of the East River. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values.

## D. FISH SAMPLING

**Figure 3** shows the locations of the fish samples by sampling gear—beach seine, baited fish trap, bottom trawl, and mid-water trawl. **Figure 9** shows the locations of fish sampling conducted using remote sensing.

- NYCEDC collected a total of 14 out of the planned 20 beach seine samples (**Figure 8**) along shorelines in Zones 1, 2, 5 and 6. Limited availability of shallow shoreline habitat in Zones 1 and 2 limited the number of beach seines that could be collected.
- NYCEDC collected all 10 of the planned bottom trawl samples in channel Zones 3 and 4 (i.e., 5 trawls in each zone).
- NYCEDC collected all 24 baited fish trap samples (**Figure 8**) as planned; four samples from each of the six zones.
- NYCEDC collected all 20 of the planned mid-water trawl samples in channel Zones 3 and 4 (i.e., 10 trawls in each zone).
- NYCEDC surveyed all 40 of the planned remote sensing transects during this sampling event. Ten samples were collected (**Figure 9**) in shoreline and nearshore habitats in Zones 1, 2, 5 and 6. **Figure 10** presents several examples of ARIS data collected during remote sensing.

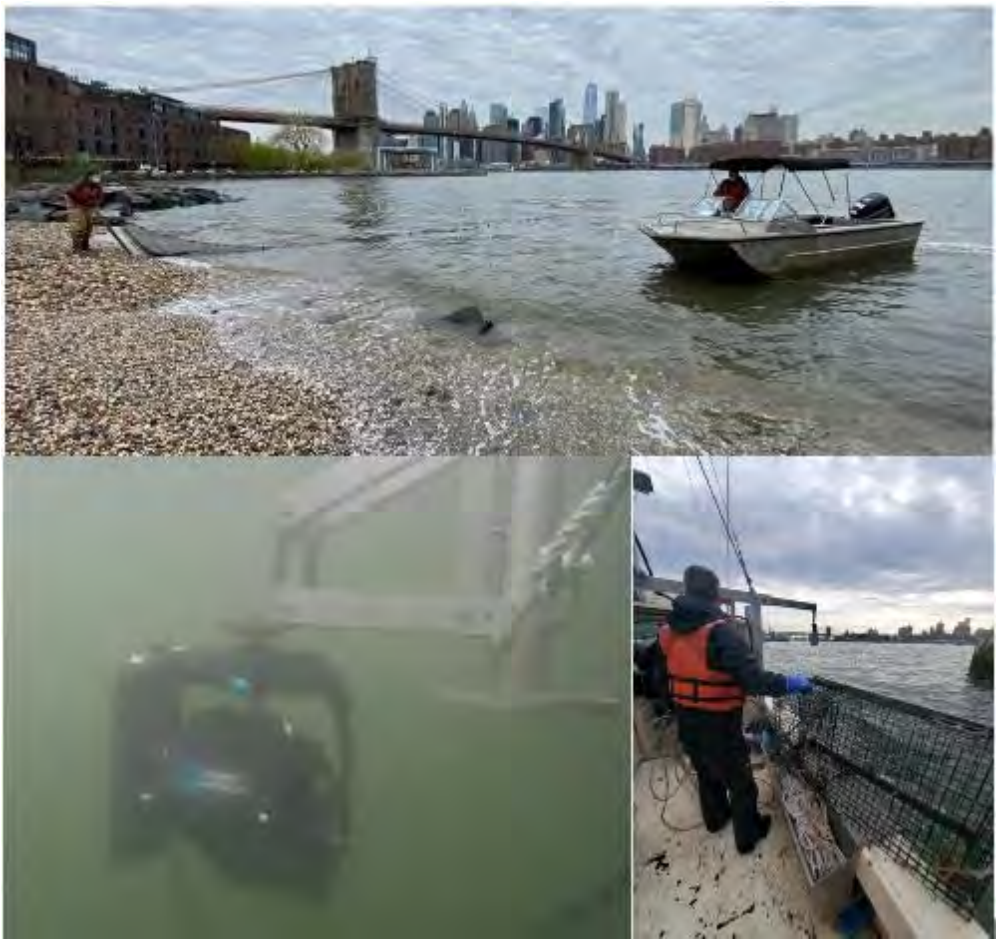


**Figure 8 –** Fish sampling by beach seine (top), remote sensing (bottom left), and trap (bottom right) in the East River.

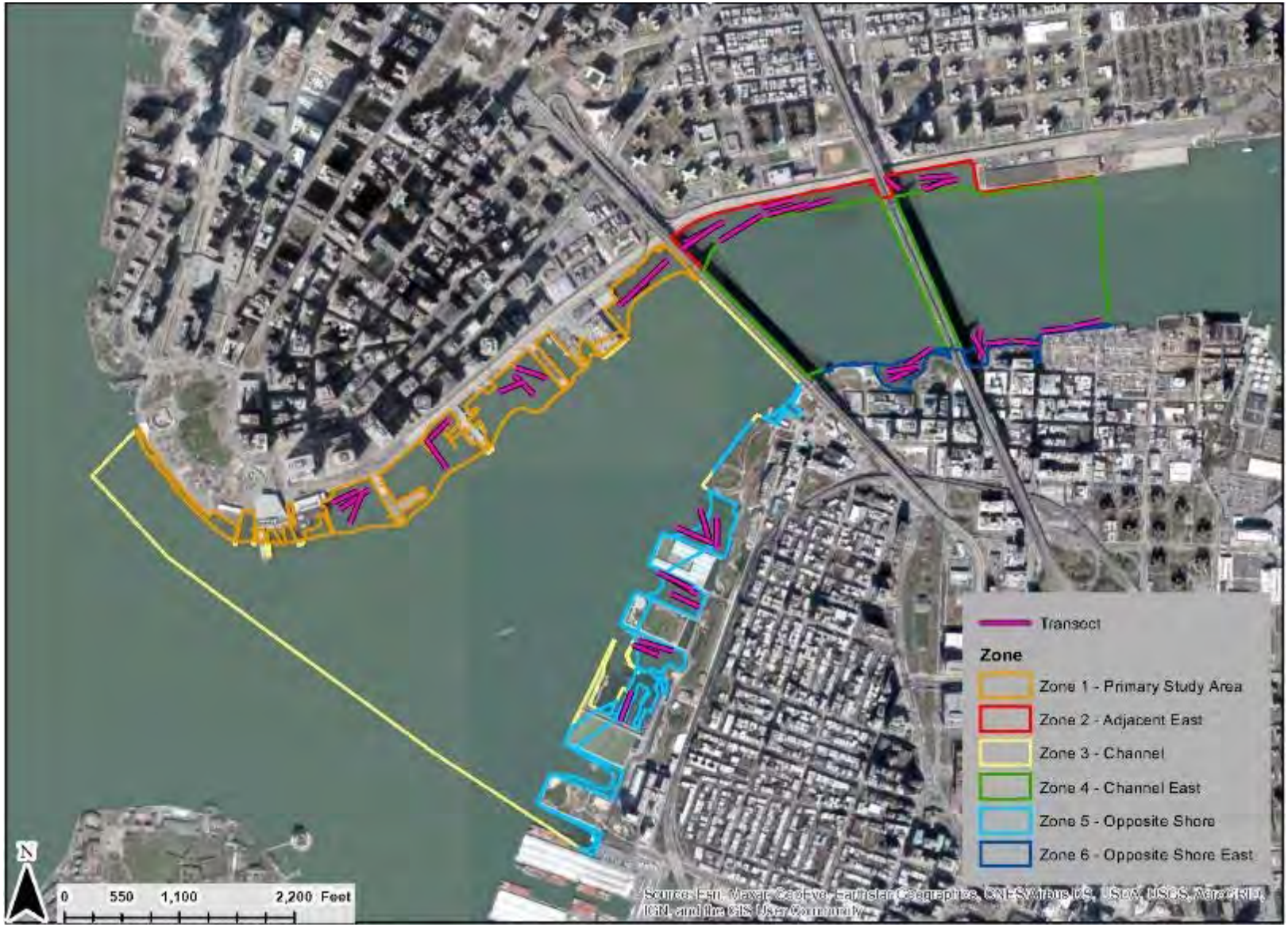



**Figure 9 –** Locations of remote sensing transects for fish conducted in the East River.

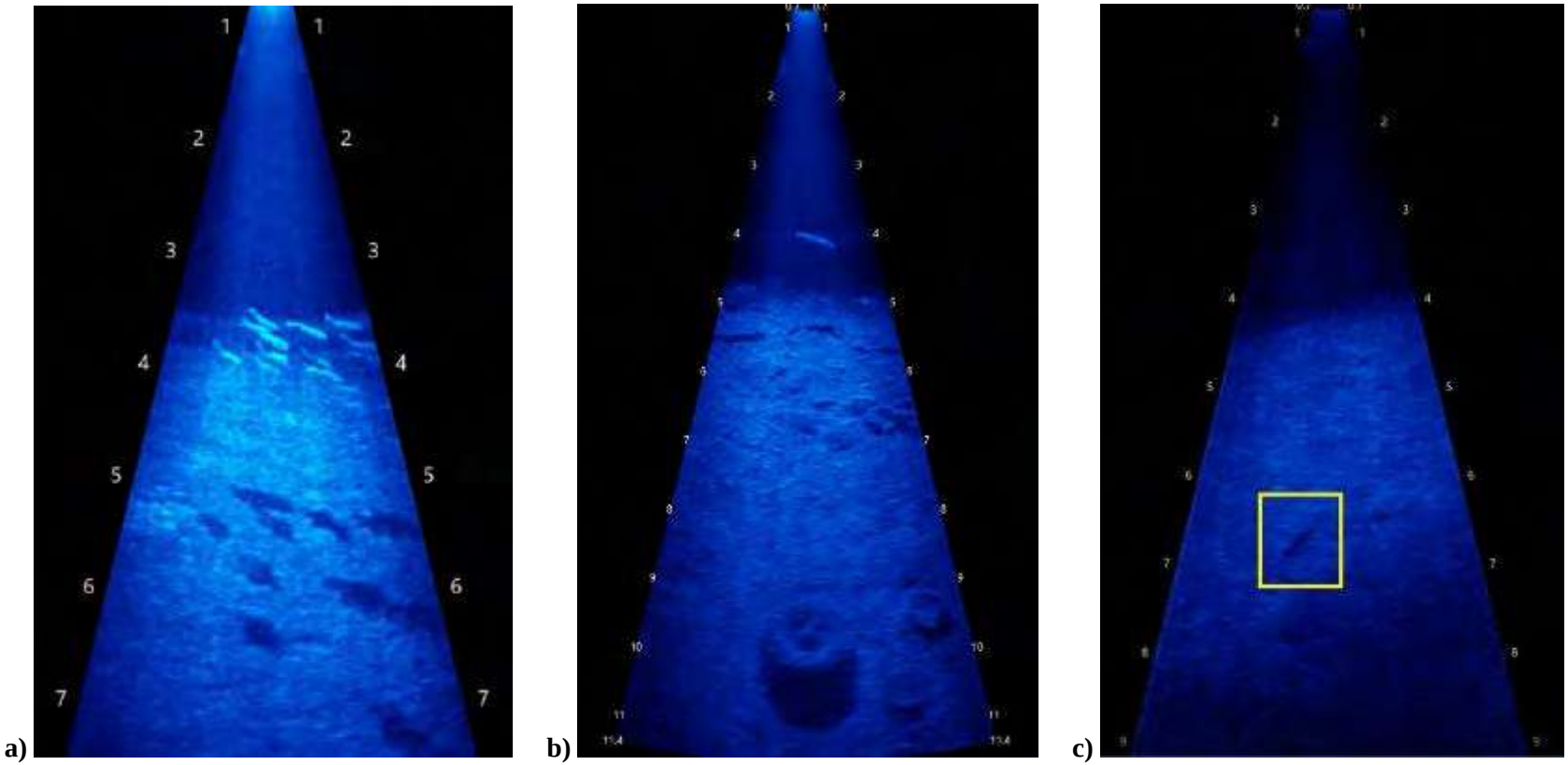


**Figure 10 –**ARIS remote sensing data collected in the East River during April sampling. Images include: a) medium-bodied, schooling, midwater fish, b) large-bodied midwater fish, and c) medium-bodied, benthic fish.

## FISH ABUNDANCE AND BIODIVERSITY

*BEACH SEINE*

Fish were collected at 5 of the 14 beach seine sites sampled during April. Three fish species were collected, including Atlantic silverside, striped bass, and northern pipefish. Atlantic silverside was the most abundant species and accounted for approximately 60% of the total catch (**Figure 11**). However, Atlantic silverside was not ubiquitous across sampling locations, as it was absent from more than 85% of samples (**Figure 11**). Northern pipefish was collected in one sample in Zone 1, striped bass was collected in two samples in Zone 2, and Atlantic silverside was collected in two samples in Zones 1 and 5 (**Figure 12**).

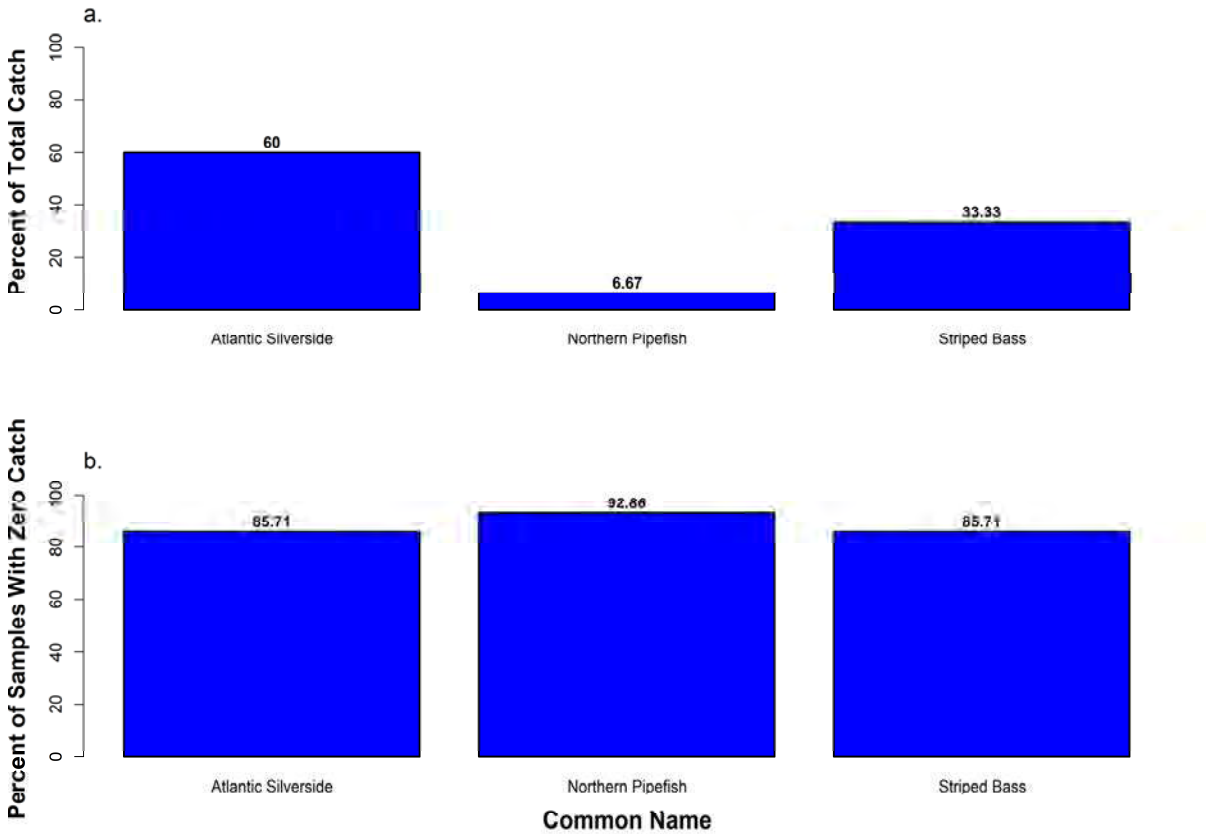



**Figure 11 –** Catch of finfish species during the beach seine survey in the East River during this sampling event.

*BAITED FISH TRAPS*

The baited fish traps collected two tautog during this sampling event, which were both collected in one trap that was set in Zone 3 (**Figure 13**). Tautog were absent from the other approximately 98% of traps that were set. No other fish were collected during trap sampling in April.


**Figure 12 –** Species composition of fish collected during the April beach seine survey.

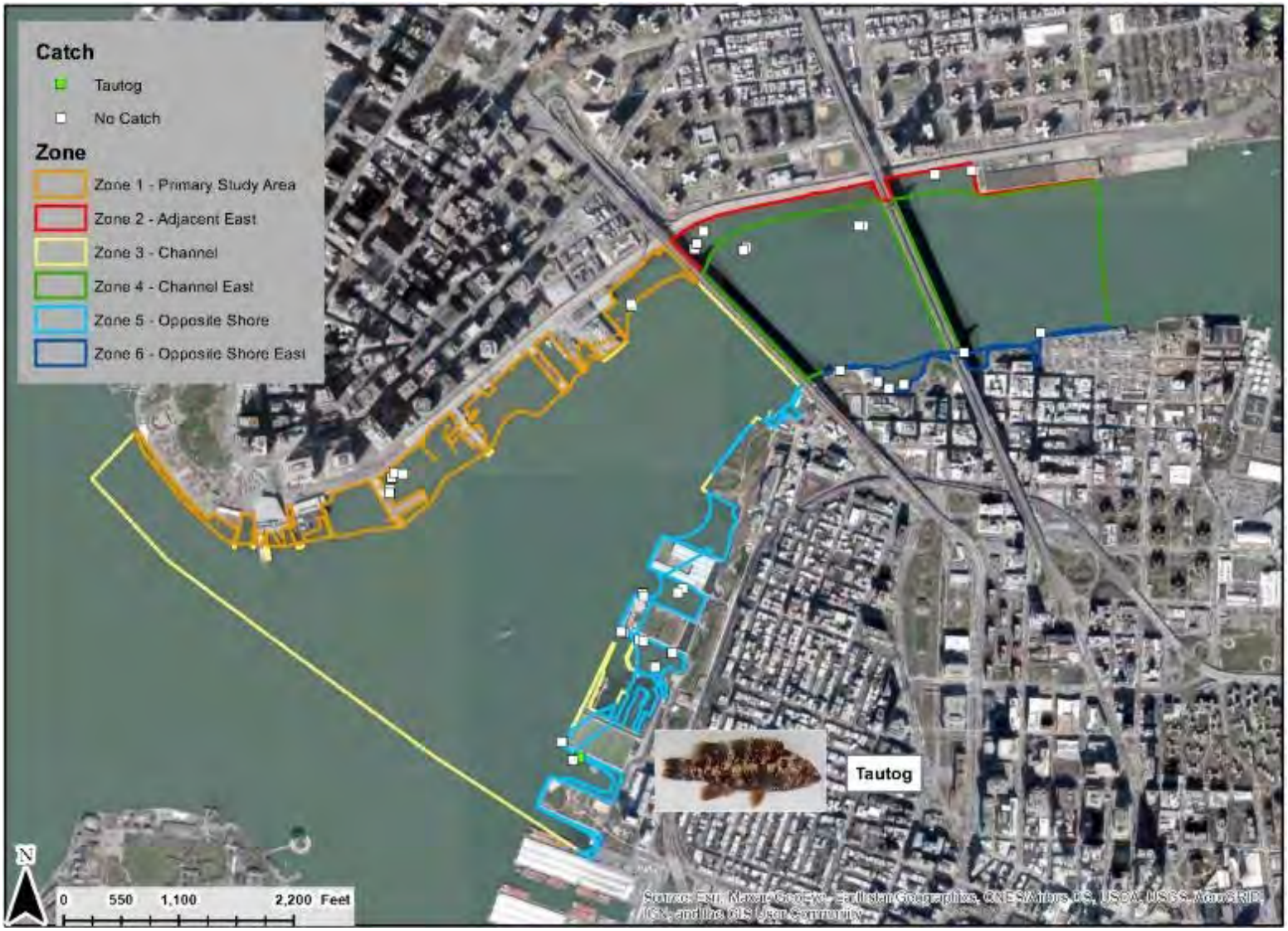



**Figure 13 –** Species composition of fish collected during the April baited fish trap survey.

*MID-WATER TRAWL*

The mid-water trawl samples collected to target migrating anadromous striped bass, shad, and herring during this sampling event did not collect any fish.

*BOTTOM TRAWL*

The bottom trawls conducted during this sampling event collected three fish representing three different species: skilletfish, spotted hake and striped bass (**Figure 14**). Each of these three species was absent from 90% of the trawls that were conducted (**Figure 14**). The striped bass and skilletfish were collected in Zone 4, and the spotted hake was collected in Zone 3 (**Figure 15)**.

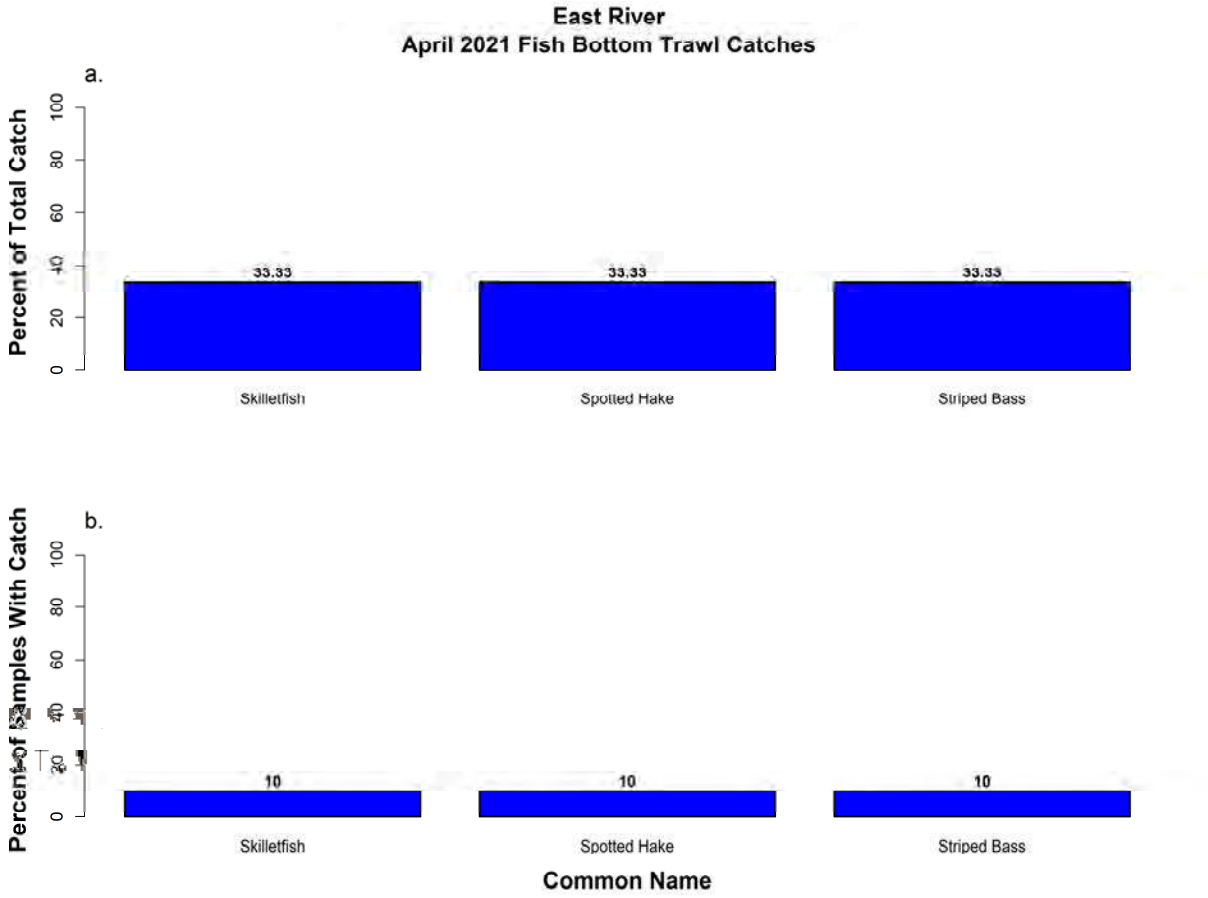



**Figure 14 –** Catch of finfish species during the bottom trawl survey in the East River during this sampling event.

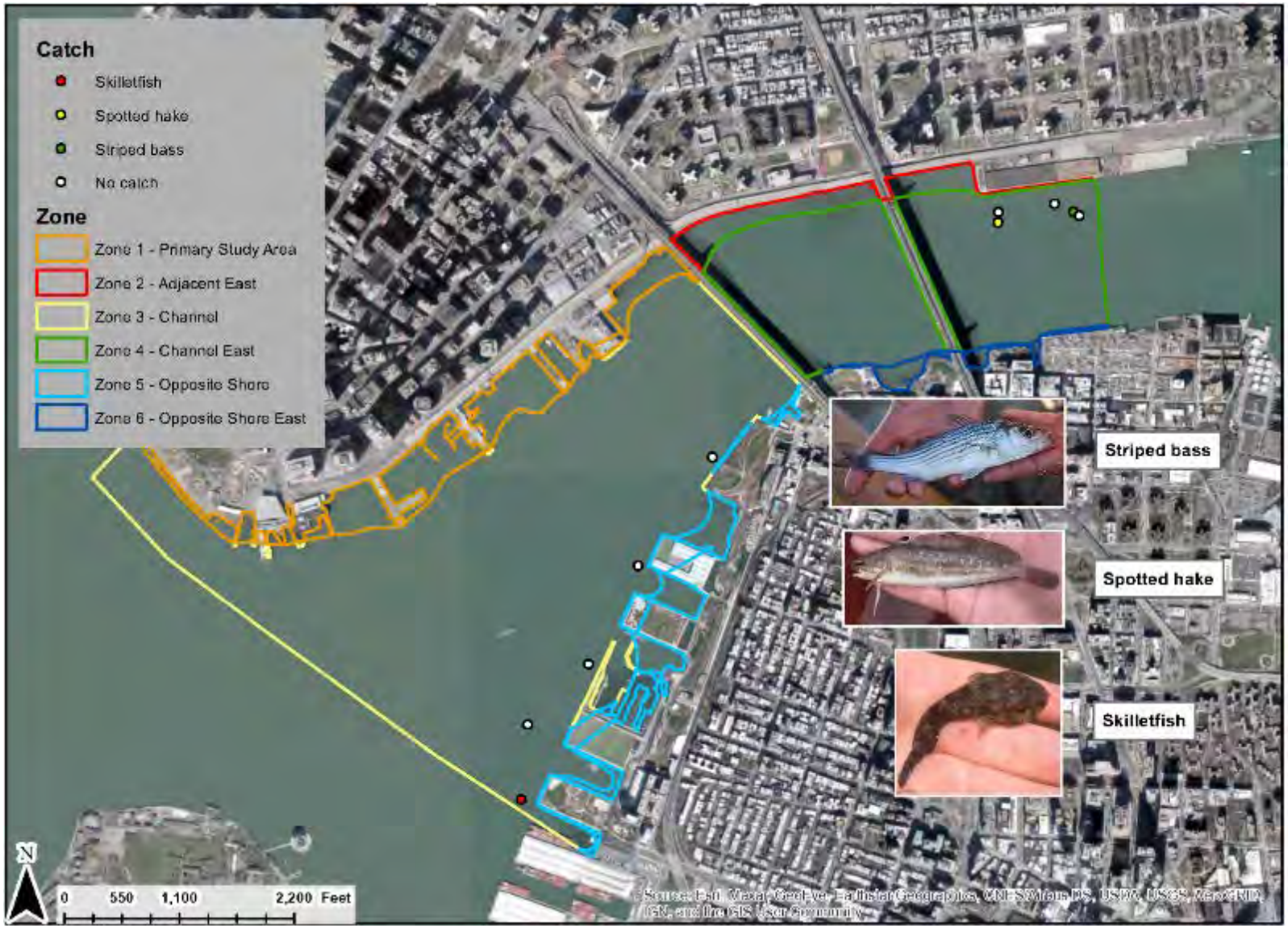



**Figure 15** – Species composition of fish collected during the April bottom trawl survey.

*REMOTE SENSING*

Fish were most abundant along shorelines in Zones 1 and 6 during remote sensing transects surveyed in April 2021 (**Table 4 and Figure 16**). A total of 44 fish were observed within a sampled volume of 25,154 $m^3$ in the nearshore stratum, and a total of 54 fish were observed in a sampled volume of 15,760 $m^3$ in the shoreline stratum (**Table 4**). Fish densities were low, but consistent among Zones in the nearshore stratum, whereas densities were higher on average, but more variable among Zones in the shoreline stratum (**Table 4**). The highest fish densities in April were observed along the shoreline in the Primary Study Area (Zone 1), and the lowest densities were observed in the nearshore habitat of Zone 1 and along the shoreline in Zone 5 across the river from the Primary Study Area.

**Table 4 – Total counts and density for finfish detected in the April 2021 remote sensing survey**

| Stratum | Location | No. Transects | Total Volume Sampled ($m^3$) | Total Count | Density (1,000 per $m^3$) |
|---|---|---|---|---|---|
| Nearshore | Zone 1 - Primary Study Area | 6 | 4,768 | 2 | 0.4 |
| | Zone 2 - Adjacent East | 6 | 9,716 | 25 | 2.6 |
| | Zone 5 - Opposite Shore | 3 | 3,157 | 5 | 1.6 |
| | Zone 6 - Opposite Shore East | 6 | 7,513 | 12 | 1.6 |
| | **All** | **21** | **25,154** | **44** | **1.7** |
| Shoreline | Zone 1 - Primary Study Area | 4 | 2,059 | 30 | 14.6 |
| | Zone 2 - Adjacent East | 4 | 5,256 | 4 | 0.8 |
| | Zone 5 - Opposite Shore | 7 | 5,789 | 0 | 0.0 |
| | Zone 6 - Opposite Shore East | 4 | 2,656 | 20 | 7.5 |
| | **All** | **19** | **15,760** | **54** | **3.4** |

Densities of fish detected during remote sensing transects were classified into three different length categories, small-bodied (< 200 mm), medium-bodied (200-500 mm), and large-bodied (> 500 mm), within each of two habitat categories, benthic (i.e., on the bottom) and pelagic (i.e., in the water column). The magnitude of densities and the patterns in densities among strata and locations differed among these categories (**Figure 17**). Midwater fish, which include species that school in large numbers, were much more abundant than benthic fish. Small-bodied, midwater fish were abundant in the nearshore stratum of the Opposite Shore East (Zone 6), but were rarely observed in other locations. Medium-bodied, midwater fish were abundant in each of the zones, with the highest abundance occurring in the nearshore stratum of the Primary Study Area (Zone 1). Large-bodied, midwater fish were commonly observed in the nearshore habitat along the Manhattan shoreline in the Primary Study Area (Zone 1) and Adjacent East (Zone 2), but at low densities. Medium-bodied, benthic fish were observed at low densities in each of the four zones and were most abundant along the shoreline of the Primary Study Area (Zone 1), but otherwise did not exhibit a clear difference in abundance between the nearshore and shoreline strata or among zones.

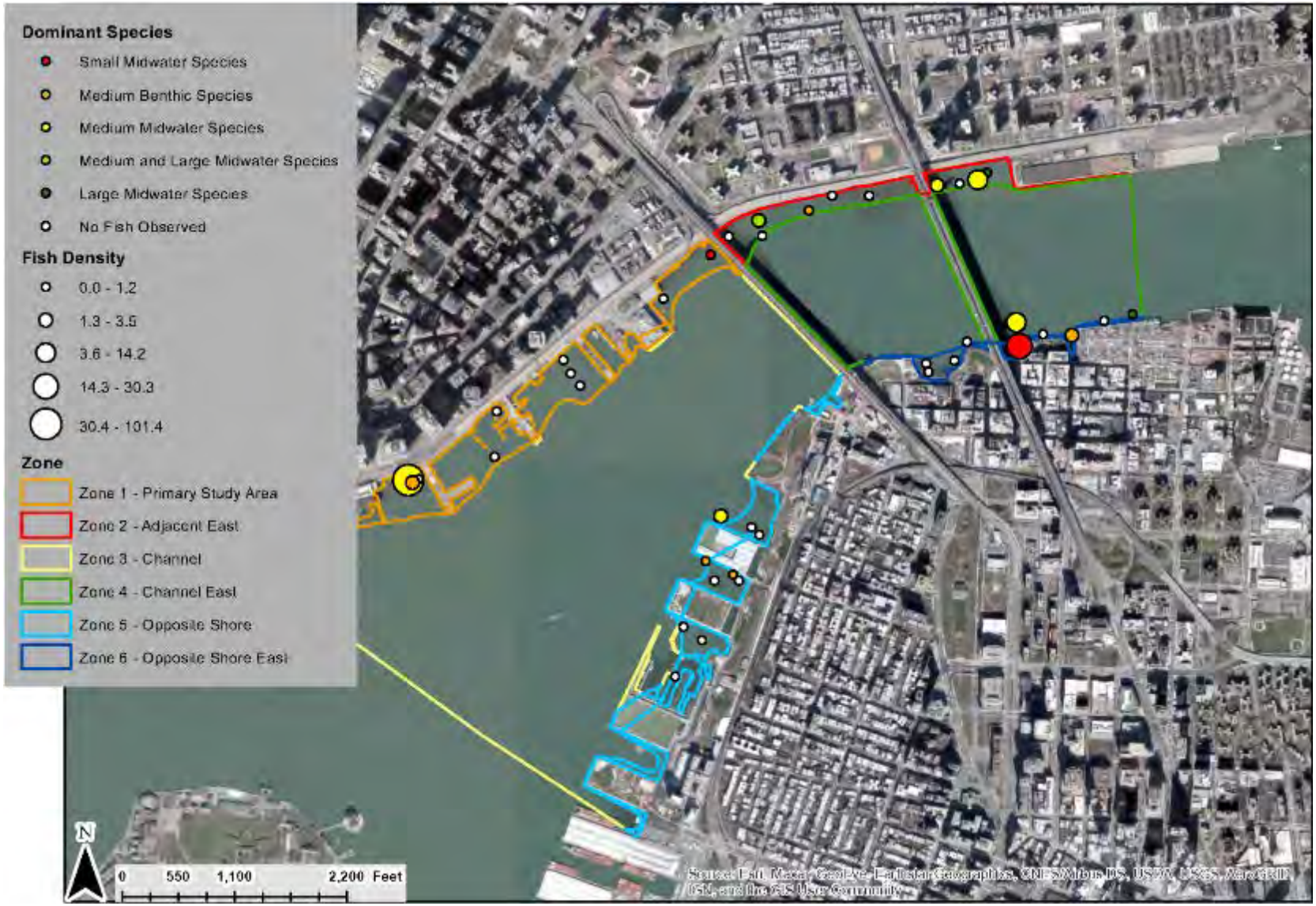



**Figure 16** – Distribution and density of fish assemblages observed during the April remote sensing survey.

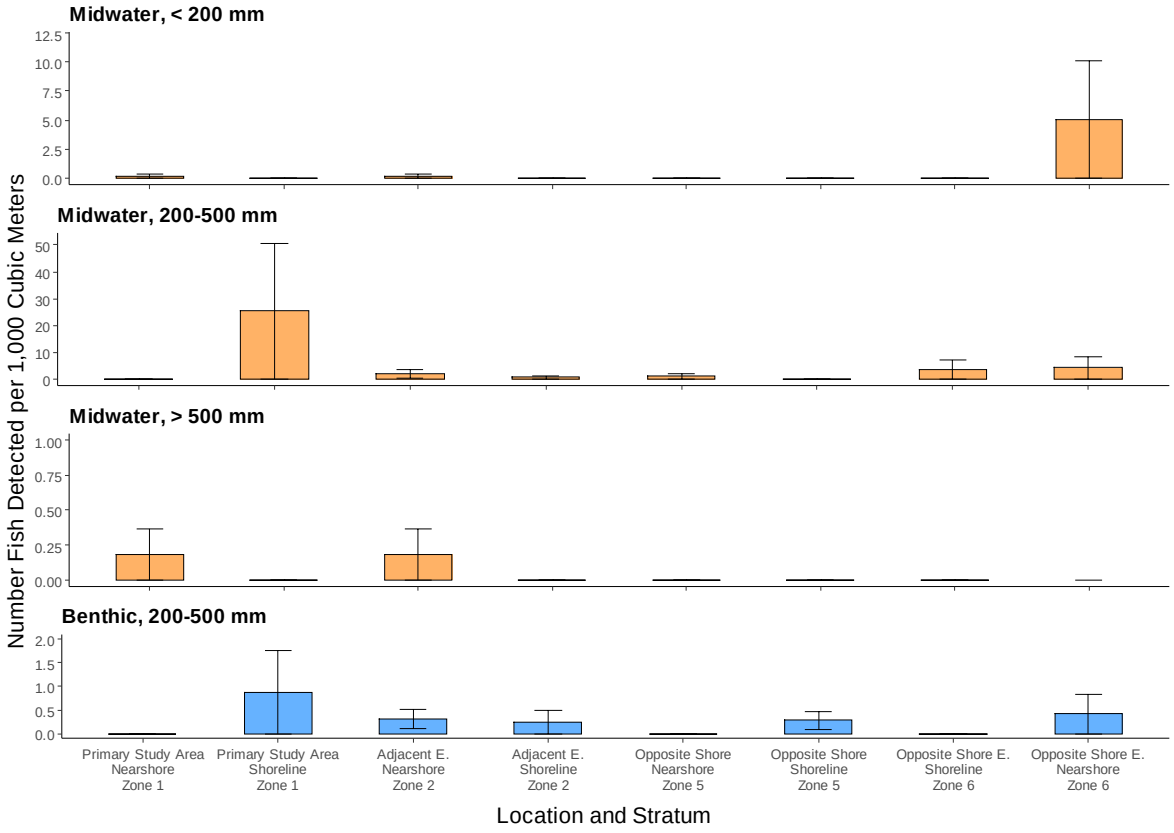



**Figure 17** – Densities of four categories of finfish observed by location and stratum during remote sensing transects of nearshore and shoreline habitats of the East River. Fish were classified from remote sensing footage as mid-water or benthic (on the bottom) and based on body size as small-bodied (<200 mm), medium-bodied (200-500 mm), or large-bodied (>500 mm).

## E. WATER QUALITY AND CURRENT VELOCITY

NYCEDC collected water quality samples at the surface and bottom of the river concurrent with each of the 138 biological samples (**Figure 18**; **Table 5**). Bottom samples were collected at a mean depth of 17.3 feet (5.3 meters).

### WATER QUALITY CHARACTERISTICS

Four water quality parameters (i.e., temperature, salinity, dissolved oxygen (DO) and pH) measured during sampling of the East River in April 2021 are summarized by zone and habitat stratum in **Table 5**. For each of the parameters, the overall mean and range were similar between the surface and bottom. **Figure 19** provides an example of depth profiles for water quality parameters.

### TOTAL NITROGEN IN THE WATER COLUMN

NYEDC measured total nitrogen ("TN") at the surface and bottom of the water column at each of the 30 benthic grab sites. The TN concentration was low (< 0.5 mg/L) in 33 out of 60 samples. Among the samples with TN concentrations greater than 0.5 mg/L, the average TN concentration was 0.87 mg/L, and the maximum TN concentration was 1.7 mg/L. Zone 1 had the most samples with TN concentrations greater than 0.5 mg/L (8 out of 10), followed by Zone 5 (7 out of 10), and Zone 3 (6 out of 10). The highest TN concentrations (1.7 mg/L) were observed in samples collected in Zones 1 and 2.

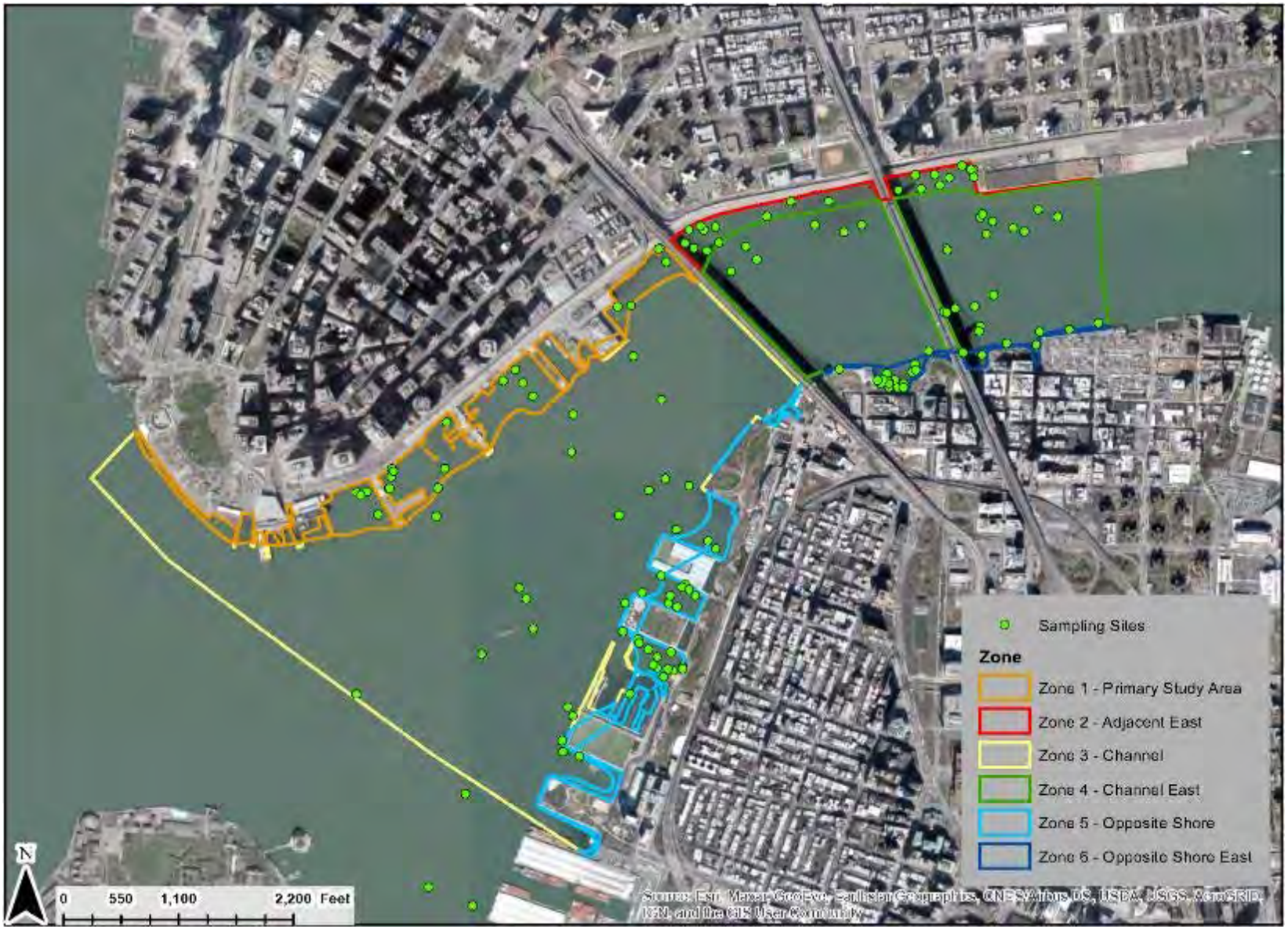



**Figure 18 –** Locations of water quality profiles associated with April biological sampling in the East River.

**Table 5 – Water quality parameters measured in East River surface and bottom waters during biological and habitat sampling in April 2021**

| Position | Zone | Stratum | N | Depth (ft) | Temperature (C) | | Salinity (PSU) | | DO (mg/L) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Surface | 1 | Nearshore | 7 | 1.0 | 9.7 | 7.9 - 10.1 | 21.7 | 21.3 - 22.6 | 8.9 | 8.7 - 9.6 | 7.9 | 7.9 - 8.0 |
| | | Shoreline | 9 | 0.9 | 9.3 | 7.7 - 10.2 | 21.8 | 20.6 - 23.7 | 9.4 | 8.4 - 11.6 | 7.9 | 7.8 - 7.9 |
| | | Shoreline/Nearshore | 5 | 1.0 | 9.2 | 9.2 - 9.2 | 23.6 | 23.3 - 23.8 | 8.7 | 8.6 - 8.8 | 7.9 | 7.9 - 7.9 |
| | 2 | Nearshore | 8 | 1.0 | 9.4 | 7.8 - 9.9 | 21.7 | 21.0 - 22.4 | 8.5 | 8.0 - 10.2 | 7.8 | 7.8 - 8.0 |
| | | Shoreline | 8 | 0.9 | 9.4 | 8.0 - 9.9 | 21.9 | 20.8 - 23.0 | 8.8 | 8.0 - 10.1 | 7.8 | 7.8 - 7.9 |
| | | Shoreline/Nearshore | 5 | 1.0 | 9.3 | 9.3 - 9.3 | 23.1 | 22.8 - 23.3 | 8.5 | 8.4 - 8.6 | 7.9 | 7.9 - 7.9 |
| | 3 | Channel | 24 | 1.0 | 9.4 | 8.0 - 10.6 | 20.0 | 14.9 - 23.7 | 8.9 | 7.6 - 10.8 | 7.9 | 7.7 - 8.0 |
| | 4 | Channel | 24 | 1.0 | 9.6 | 7.8 - 11.6 | 18.8 | 10.4 - 22.8 | 8.8 | 7.9 - 10.2 | 7.9 | 7.8 - 8.0 |
| | 5 | Nearshore | 5 | 1.0 | 9.6 | 8.3 - 10.6 | 19.5 | 19.0 - 20.0 | 9.4 | 9.0 - 10.4 | 7.9 | 7.8 - 8.0 |
| | | Shoreline | 14 | 0.8 | 9.9 | 8.3 - 10.7 | 20.9 | 18.9 - 23.2 | 9.0 | 8.4 - 11.3 | 7.9 | 7.8 - 8.0 |
| | | Shoreline/Nearshore | 5 | 1.0 | 9.6 | 9.5 - 9.8 | 19.8 | 19.3 - 20.4 | 8.8 | 8.7 - 9.0 | 7.9 | 7.9 - 7.9 |
| | 6 | Nearshore | 7 | 1.0 | 9.8 | 9.2 - 10.1 | 21.5 | 20.6 - 22.5 | 9.0 | 8.7 - 9.9 | 7.8 | 7.8 - 7.9 |
| | | Shoreline | 12 | 0.8 | 9.5 | 8.1 - 10.2 | 22.5 | 20.6 - 24.5 | 9.1 | 8.4 - 10.4 | 7.9 | 7.9 - 8.0 |
| | | Shoreline/Nearshore | 5 | 1.0 | 9.3 | 9.3 - 9.4 | 22.0 | 21.9 - 22.2 | 8.7 | 8.5 - 8.8 | 7.9 | 7.9 - 7.9 |
| | **All** | | **138** | **1.0** | **9.5** | **7.7 - 11.6** | **21.3** | **10.4 - 24.5** | **8.9** | **7.6 - 11.6** | **7.9** | **7.7 - 8.0** |
| Bottom | 1 | Nearshore | 7 | 13.6 | 9.6 | 7.9 - 10.0 | 21.8 | 21.5 - 22.7 | 8.9 | 8.7 - 9.5 | 7.9 | 7.9 - 8.0 |
| | | Shoreline | 9 | 10.7 | 9.2 | 7.7 - 10.1 | 22.2 | 21.5 - 23.7 | 9.3 | 8.4 - 11.0 | 7.9 | 7.9 - 7.9 |
| | | Shoreline/Nearshore | 5 | 16.4 | 9.2 | 9.2 - 9.2 | 24.1 | 23.5 - 24.6 | 8.7 | 8.7 - 8.7 | 7.9 | 7.9 - 7.9 |
| | 2 | Nearshore | 8 | 16.5 | 9.3 | 7.8 - 9.8 | 22.2 | 21.4 - 22.6 | 8.5 | 8.0 - 10.2 | 7.9 | 7.8 - 8.0 |
| | | Shoreline | 8 | 15.6 | 9.4 | 7.9 - 9.9 | 22.2 | 20.8 - 23.2 | 8.7 | 8.0 - 10.1 | 7.9 | 7.8 - 7.9 |
| | | Shoreline/Nearshore | 5 | 16.8 | 9.3 | 9.2 - 9.3 | 23.2 | 22.8 - 23.6 | 8.5 | 8.5 - 8.5 | 7.9 | 7.9 - 7.9 |
| | 3 | Channel | 24 | 43.5 | 9.0 | 7.6 - 10.3 | 22.3 | 20.2 - 25.2 | 8.7 | 7.5 - 10.4 | 7.9 | 7.8 - 8.0 |
| | 4 | Channel | 24 | 41.0 | 9.0 | 7.8 - 10.4 | 23.0 | 20.3 - 25.8 | 8.6 | 7.5 - 10.2 | 7.9 | 7.8 - 8.0 |
| | 5 | Nearshore | 5 | 16.6 | 9.0 | 7.8 - 9.7 | 21.7 | 21.1 - 22.7 | 9.2 | 8.7 - 10.2 | 7.9 | 7.8 - 7.9 |
| | | Shoreline | 14 | 10.4 | 9.5 | 7.8 - 10.3 | 22.3 | 20.9 - 23.3 | 8.8 | 8.3 - 10.6 | 7.9 | 7.8 - 7.9 |
| | | Shoreline/Nearshore | 5 | 15.8 | 9.4 | 9.3 - 9.4 | 21.7 | 21.4 - 22.0 | 8.7 | 8.5 - 8.8 | 7.9 | 7.8 - 7.9 |
| | 6 | Nearshore | 7 | 15.4 | 9.6 | 9.2 - 9.7 | 22.3 | 21.9 - 22.7 | 8.9 | 8.7 - 9.5 | 7.9 | 7.8 - 7.9 |
| | | Shoreline | 12 | 7.4 | 9.4 | 8.1 - 10.1 | 22.9 | 21.5 - 24.5 | 9.0 | 8.4 - 10.4 | 7.9 | 7.9 - 8.0 |
| | | Shoreline/Nearshore | 5 | 8.2 | 9.3 | 9.3 - 9.4 | 22.1 | 22.0 - 22.3 | 8.7 | 8.6 - 8.8 | 7.9 | 7.9 - 7.9 |
| | **All** | | **138** | **17.7** | **9.3** | **7.6 - 10.4** | **22.4** | **20.2 - 25.8** | **8.8** | **7.5 - 11.0** | **7.9** | **7.8 - 8.0** |

**Note:** Samples collected in the "shoreline/nearshore" stratum are all from benthic grab sampling.

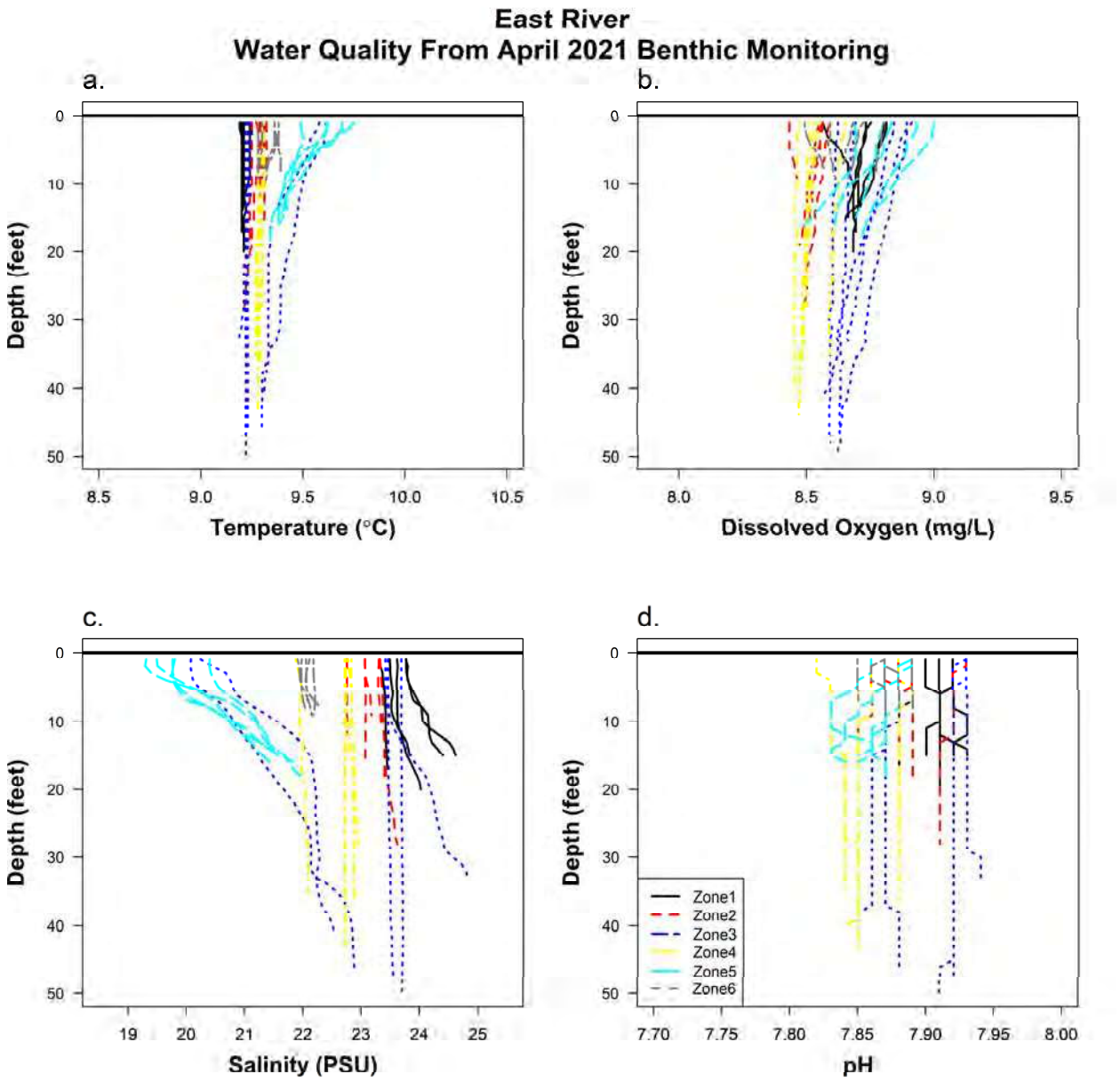



**Figure 19** – Depth profiles of water quality parameters measured during benthic grab sampling. Similar water quality profiles were acquired to complement biological samples collected with each of the sampling gears.

## CURRENT VELOCITY

NYCEDC collected a total of 78 current velocity measurements during grab sampling (30 samples), bottom trawls (10 samples), beach seines (14 samples) and fish trapping (24 samples). Current velocity ranged from 0.001 to 0.98 meters per second ("m/s") (0.003 to 3.22 feet per second ["ft/s"]) and averaged 0.23 m/s (0.75 ft/s) (**Figure 20**). Most of the current velocity measurements were less than 0.20 m/s (0.66 ft/s). Bottom depth measurements ranged from 3 to 50 feet (0.9 to 15.2 meters) and averaged 17 feet (5.2 meters) (**Figure 20**). **Figure 21** illustrates the observed increases in water depth and current velocity moving from the shoreline to nearshore to channel habitats, and the differences in water depth and current velocity among sampling zones.

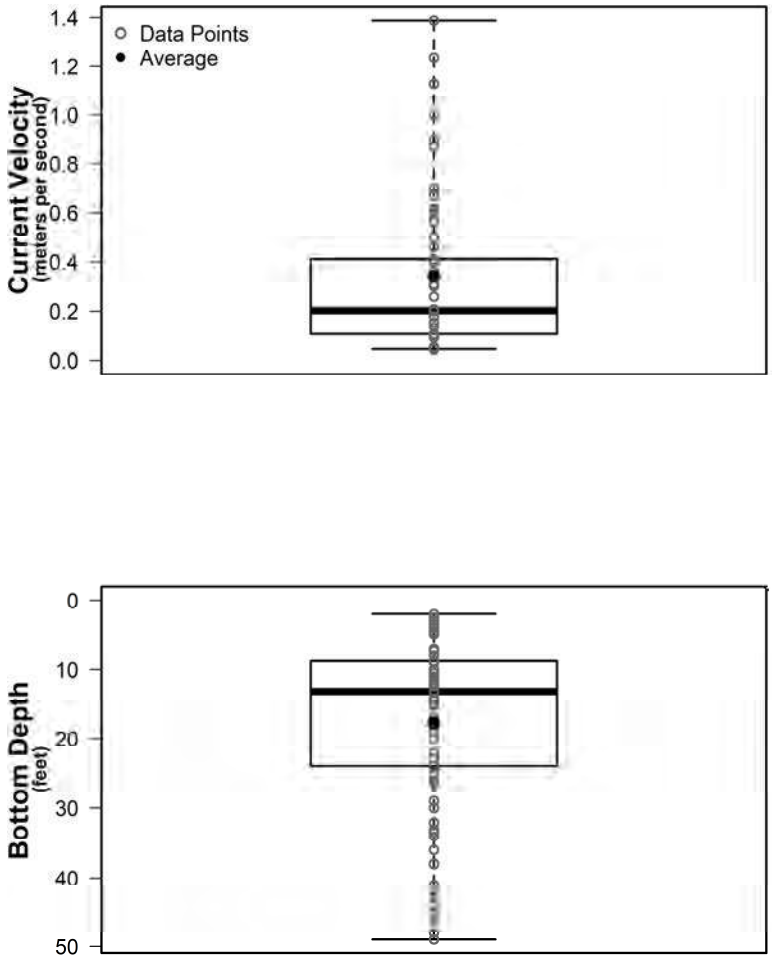



**Figure 20** – Current velocity and water depth measurements taken at sample sites in the lower East River during April 2021. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

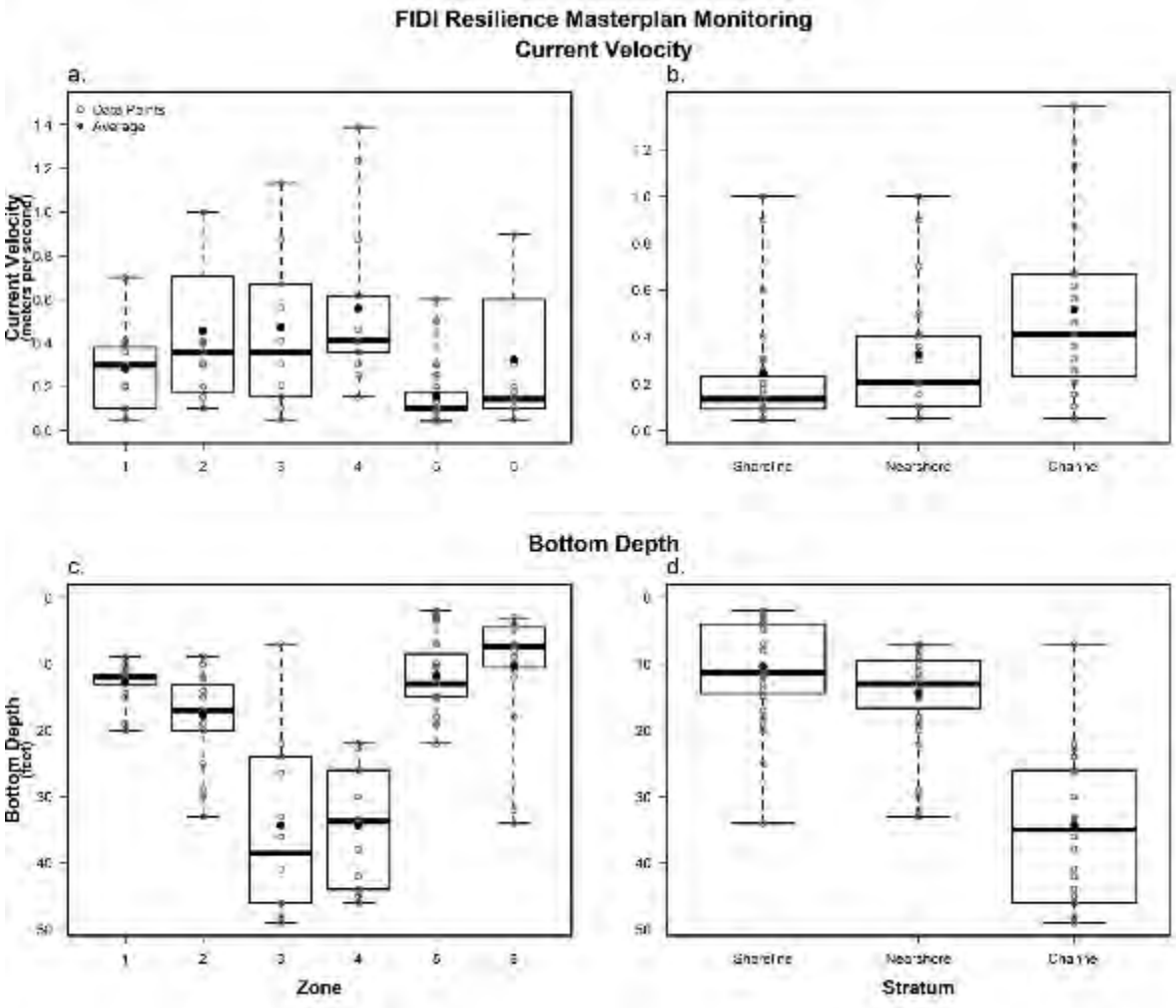



**Figure 21** – Current velocity and water depth measurements taken at sample sites in the lower East River during April 2021. Data are plotted to compare and contrast among zones and habitat strata. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

# New York City Economic Development Corporation
# Financial District and Seaport Climate Resilience Plan

# Biological and Habitat Sampling Program
# July through September 2021 Sampling Event
# and
# Year 1 Annual Report


**Prepared by**

New York City Economic Development Corporation
AKRF, Inc.
Normandeau Associates, Inc.


**January 2022**

# Table of Contents

# A. INTRODUCTION

The New York City Economic Development Corporation ("NYCEDC"), on behalf of the City and in collaboration with the Mayor's Office of Climate Recovery ("MOCR"), is conducting a climate resilience master planning effort in the Financial District and Seaport of Lower Manhattan ("Financial District and Seaport Climate Resilience Master Plan" or "FiDi Seaport Climate Resilience Plan"). The FiDi Seaport Climate Resilience Plan, initiated in October of 2019, is part of the Lower Manhattan Coastal Resiliency project ("Project"). The FiDi Seaport Climate Resilience Plan project comprises a 0.9-mile portion of the Manhattan shoreline along the East River from just south of the Brooklyn Bridge to the Battery, including South Street Seaport and the Wall Street Financial District, extending out to the pierhead line ("Project Area").

The East River is a tidal strait connecting Upper New York Bay and Long Island Sound that provides habitat for plankton, benthic invertebrates, marine, estuarine and anadromous fish and is used as a migratory pathway by endangered Atlantic sturgeon and possibly by the endangered shortnose sturgeon. Threatened or endangered sea turtles may also occur in the East River as occasional transient individuals. In-water components to be considered in the development of the FiDi Seaport Resilience Plan, such as extending the shoreline, have the potential to affect existing aquatic resources within the Project Area and in the adjacent deeper channel of the lower East River. Because recent information characterizing the aquatic resources within the Project Area and the lower East River is limited, as part of the FiDi Seaport Climate Resilience Plan, NYCEDC has initiated a Biological and Habitat Sampling Program ("Program") to characterize these resources.

The study area for this Program comprises the Project Area and the lower East River from the Battery to Montgomery Street, opposite the Brooklyn Navy Yard, a distance of approximately 1.8 miles. Within this reach, the Project Area spans the width of the River (**Figure 1**). The sample universe is subdivided into six zones bisected by the Brooklyn Bridge and reflects locations relative to the Project Area and water depth.

Zones (as indicated in **Figure 1**) are defined as:

1) "Primary Study Area" - the Primary Study Area along the northern shoreline of the East River from the White Hall Ferry terminal (Staten Island Ferry) to the Brooklyn Bridge, also referred to as the Project Area;
2) "Adjacent East" - the shallow, off-channel area along the northern shoreline adjacent to the Project Area and east of the Brooklyn Bridge;
3) "Channel" - the deep, river channel south of the Primary Study Area;
4) "Channel East" - the deep, channel east of the Brooklyn Bridge;
5) "Opposite Shore" - the shallow, off-channel area along East River shoreline in Brooklyn across the river from the Primary Study Area; and
6) "Opposite Shore East" - the shallow, off-channel area along the East River shoreline of Brooklyn east of the Brooklyn Bridge.

The study area is further subdivided into three habitat strata based on proximity to shoreline structure and water depth, which are defined as: 1) shoreline ($\leq$ 1 meter depth), 2) nearshore (within the pierhead line, generally 1 to 5 meters depth), and 3) channel (beyond the pierhead line at depths of 5 to 12 meters). This stratified-random sampling design is intended to provide pre-construction biological and habitat data on the aquatic community in the Primary Study Area (Zone 1) that can be compared with data collected in similar shoreline habitat and deep-water areas of the East River, adjacent to, and east of, the Project Area (Zones 2-6).

During year 1 of the Program, seasonal sampling events were conducted during the Fall (October 2020), Winter (January 2021), Spring (April 2021), and Summer (July-September 2021) seasons. A detailed description of the sampling gears and sample effort planned for each season is provided in the *NYCEDC Financial District and Seaport Climate Resilience Master Plan Revised Draft Biological and Habitat Sampling Plan*, dated September 2020 ("Sampling Plan"). Following the completion of each seasonal sampling event, a Biological and Habitat Sampling report was prepared, summarizing the results of the sampling effort during the season. The purpose of the present report is to summarize the results of the summer sampling event, conducted from July through September 2021, and to provide a synthesis of Year 1 sampling results. During the July 2021 sampling event, the full complement of sampling gears was used to collect biological and habitat data for the summer season. Sampling during August and September was limited to the collection of plankton samples. Year 2 sampling began in October 2021 and will continue to follow the protocol described in the Sampling Plan.


**Figure 1 –** Zones for biological and habitat sampling in the East River.

# B. JULY 2021 SAMPLING EVENT

## SUMMARY OF SAMPLE COLLECTION

This section of the report summarizes biological and habitat sampling conducted in the East River during July 2021. NYCEDC conducted the sampling following protocols described in the Sampling Plan approved by the Aquatic Resource Advisory Committee ("ARAC")[1] that has been established for the Project. As outlined in the Sampling Plan, the July sampling event consisted of the following activities described in greater detail below:

- sampling with a 0.05-$m^2$ Ponar grab sampler **(Figure 2)** to characterize invertebrate abundance and biodiversity, sediment composition, and total organic carbon;
- sampling with an otter trawl, seine net, baited fish traps, and remote sensing using an Adaptive Resolution Imaging Sonar ("ARIS"; **Figure 8**) to characterize fish abundance and biodiversity;
- sampling with a 100-micron zooplankton sampler to estimate abundance of zooplankton and classify the community;
- sampling with a YSI water-quality monitoring instrument to measure chlorophyll-a and fluorescence as indicators of primary productivity by phytoplankton;
- sampling with a YSI water-quality monitoring instrument to measure water quality parameters (i.e., temperature, salinity, dissolved oxygen and pH), which was conducted concurrently with each benthic, fish, and plankton sample; and
- measurements of current velocity at each sample site.

During the July sampling event, NYCEDC collected a total of 154 biological and habitat samples at randomly selected locations within each zone of the study area (**Figure 3**). **Table 1** summarizes the number of samples collected by gear type, zone and stratum.

**Figure 2** – Benthic grab sampling in the East River.

[1] Consists of agency representatives from the U.S. Army Corps of Engineers, U.S. Coast Guard, National Marine Fisheries Service, New York State Department of Environmental Protection, and NYS Department of State

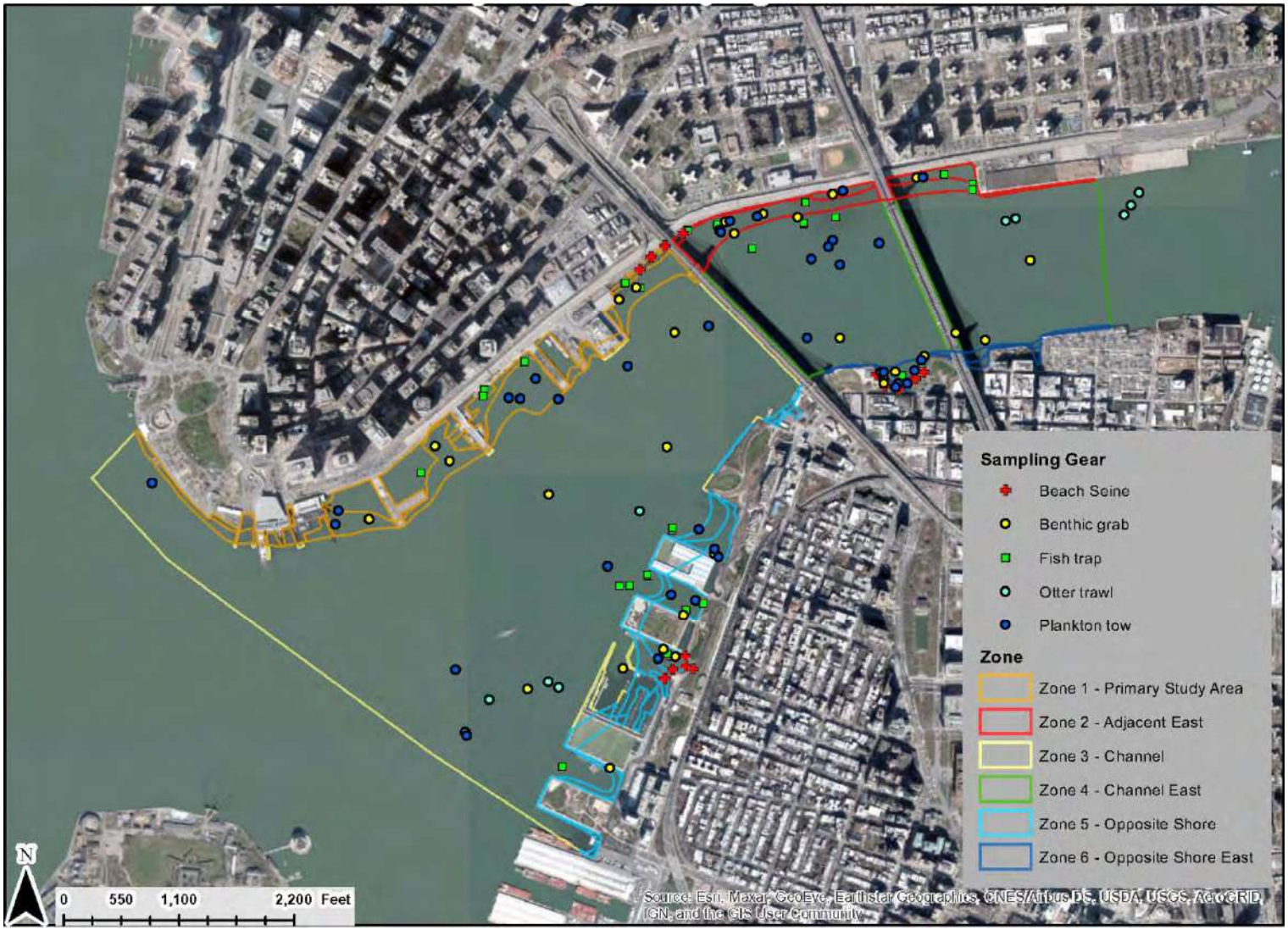



**Figure 3 –** Locations for fish, benthic grab, and plankton sampling conducted in the East River in July 2021.

## BENTHIC GRAB SAMPLING

**Figure 3** shows the 30 locations sampled with the benthic grab to collect sediment and benthic macroinvertebrates during the July sampling event. NYCEDC collected five sediment and benthic macroinvertebrate grab samples in each of the six zones (**Table 1**).

*BENTHIC INVERTEBRATE COMMUNITY*

The benthic invertebrate community in the study area during July was dominated by polychaete and oligochaete worms; amphipod crustaceans and bivalve clams were also abundant in samples collected in the interpier areas between the Brooklyn and Manhattan Bridges (**Table 2 and Figures 4a, 4b, and 4c)**. Abundance of benthic invertebrates was highest in Zone 2 along the Manhattan shoreline adjacent to the Primary Study Area (Zone 1) and was at least 30 percent higher compared to all other zones. The lowest abundance was observed in Zone 5 along the Brooklyn shoreline, where it was an order of magnitude lower compared to the other Zones. Moderate abundances of benthic invertebrates were collected in the Primary Study Area (Zone 1) and in the Channel zones (Zones 3 and 4).

Species richness (defined here as the number of benthic invertebrate species that represent 90% of all individuals collected in each zone) was highest in Zones 2 and 5; however, the total number of individuals and overall average biomass (i.e., weight of organisms collected per sample) of benthic invertebrates were lowest in Zone 5 (**Tables 2 and 3**). Average biomass was highest in the channel habitats in Zones 3, offshore of the Primary Study Area (**Table 3**).

The polychaete worm, *Mediomastus ambiseta,* and oligochaete worms were two of the most abundant benthic invertebrate taxa collected in all Zones. Within the Primary Study Area (Zone 1), three other polychaete worm taxa were among the dominant benthic invertebrates collected.

The tube-forming, reef-building polychaete worm, *Sabellaria vulgaris* (**Figure 5**), observed during the April benthic sampling, was present in all zones except Zone 5 in July. This species was most abundant in Zone 2 (311 total individuals collected) compared to elsewhere (i.e., 28 total individuals in all other zones combined). Based on observations of this habitat-forming species during the sampling and testing program, and the potential value of worm-reef habitat as structure for other aquatic organisms, a single field reconnaissance event using a drop camera was recommended to be included during the Year 2 October sampling event in an effort to determine if worm reefs are present in the study area. A drop camera was used at several locations where *Sabellaria* worms have been collected in high abundance and where unconfirmed benthic features that may be worm reefs have been observed during remote sensing. Results of the drop camera survey will be included in the October 2021 report.

**Table 1 – Samples collected by zone, study area and habitat stratum**

| Type of Sampling | Zone | Study Area | Stratum | No. Samples |
|---|---|---|---|---|
| **Benthic Invertebrates and Substrate** | | | | |
| Macroinvertebrate and Sediment Grab | 1 | Primary Study Area | Shoreline/Nearshore | 5 |
| | 2 | Adjacent East | Shoreline/Nearshore | 5 |
| | 3 | Channel | Channel | 5 |
| | 4 | Channel East | Channel | 5 |
| | 5 | Opposite Shore | Shoreline/Nearshore | 5 |
| | 6 | Opposite Shore East | Shoreline/Nearshore | 5 |
| | **Total** | | | **30** |
| Seine Net | 1 | Primary Study Area | Shoreline | 3 |
| | 2 | Adjacent East | Shoreline | 1 |
| | 5 | Opposite Shore | Shoreline | 5 |
| | 6 | Opposite Shore East | Shoreline | 5 |
| | **Total** | | | **14** |
| Bottom Trawl | 3 | Channel | Channel | 5 |
| | 4 | Channel East | Channel | 5 |
| | **Total** | | | **10** |
| Baited Fish Traps (Paired) | 1 | Primary Study Area | Shoreline | 2 |
| | | | Nearshore | 2 |
| | 2 | Adjacent East | Shoreline | 2 |
| | | | Nearshore | 2 |
| | 3 | Channel | Channel | 4 |
| | 4 | Channel East | Channel | 4 |
| | 5 | Opposite Shore | Shoreline | 4 |
| | | | Nearshore | 0 |
| | 6 | Opposite Shore East | Shoreline | 2 |
| | | | Nearshore | 2 |
| | **Total** | | | **24** |
| Remote Sensing | 1 | Primary Study Area | Shoreline | 5 |
| | | | Nearshore | 5 |
| | 2 | Adjacent East | Shoreline | 5 |
| | | | Nearshore | 5 |
| | 5 | Opposite Shore | Shoreline | 6 |
| | | | Nearshore | 4 |
| | 6 | Opposite Shore East | Shoreline | 3 |
| | | | Nearshore | 7 |
| | | | **Total** | **40** |
| Phytoplankton and Zooplankton Samples | 1 | Primary Study Area | Shoreline/Nearshore | **6** |
| | 2 | Adjacent East | Shoreline/Nearshore | **6** |
| | 3 | Channel | Channel | **6** |
| | 4 | Channel East | Channel | **6** |
| | 5 | Opposite Shore | Shoreline/Nearshore | **6** |
| | 6 | Opposite Shore East | Shoreline/Nearshore | **6** |
| | | | **Total** | **36** |
| | | | **Grand Total** | **154** |

**Note:** Fewer than the planned 5 shoreline seine samples were collected from Zones 1 and 2 due to the lack of suitably shallow intertidal shorelines.

**Table 2 – Summary of dominant benthic taxa collected from five grab samples per zone in the lower East River, NY during July 2021**

| | Primary Study Area | Adjacent Upstream | Channel | Channel Upstream | Opposite Shoreline | Opposite Upstream |
|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| 5 Most Abundant Taxa | *Mediomastus ambiseta* Polychaete worm | Oligochaeta Oligochaete worm | Oligochaeta Oligochaete worm | *Mediomastus ambiseta* Polychaete worm | Oligochaeta Oligochaete worm | *Mediomastus ambiseta* Polychaete worm |
| | Oligochaeta Oligochaete worm | *Mediomastus ambiseta* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | Oligochaeta Oligochaete worm | *Leitoscoloplos* sp. Polychaete worm | *Pygospio elegans* Polychaete worm |
| | *Polycirrus* sp. Polychaete worm | *Polycirrus* sp. Polychaete worm | Cirratulidae Polychaete worm | *Pygospio elegans* Polychaete worm | *Mediomastus ambiseta* Polychaete worm | Oligochaeta Oligochaete worm |
| | *Streblospio benedicti* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Polydora cornuta* Polychaete worm | Cirratulidae Polychaete worm | *Mya arenaria* Bivalve clam | *Ameritella agilis* Bivalve clam |
| | *Polydora cornuta* Polychaete worm | *Sabellaria vulgaris* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Streblospio benedicti* Polychaete worm | *Acteocina canaliculata* Gastropod snail | *Erichsonella filiformis* Isopod crustacean |
| Total Individuals | 2,674 | 5,772 | 2,896 | 3,906 | 311 | 4,446 |
| % of Total | 75 | 68 | 72 | 66 | 61 | 76 |
| Number of Taxa Representing 90% of Total | 17 | 23 | 17 | 18 | 23 | 15 |

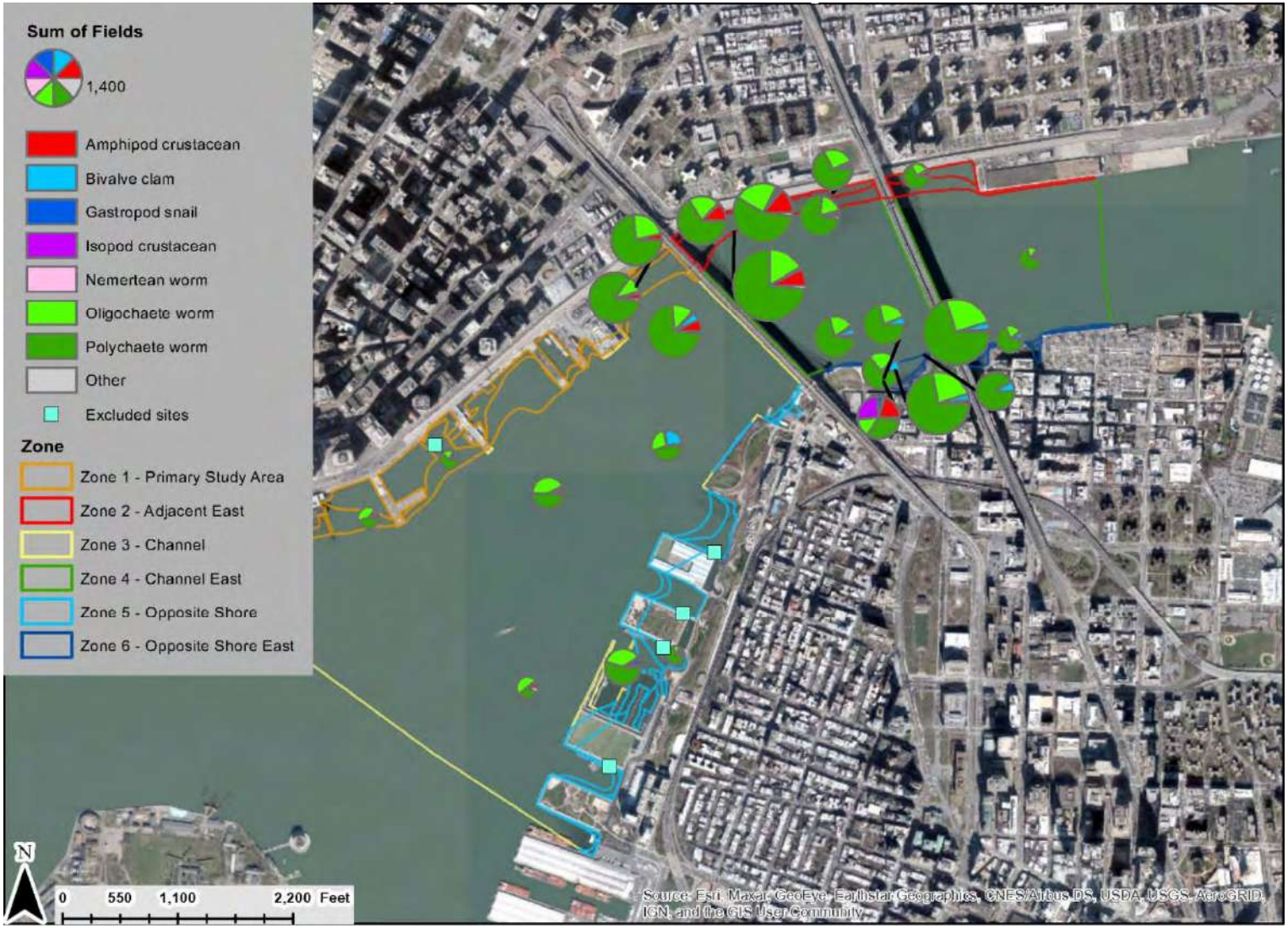



**Figure 4a –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the East River in July 2021. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location. Low abundance sites, shown as light blue squares, were excluded from this figure for mapping purposes. Data from these sites are provided on **Figure 4b**.


**Figure 4b –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the lower half of the study area in July 2021. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location. Low abundance sites excluded from **Figure 4a** are shown here.

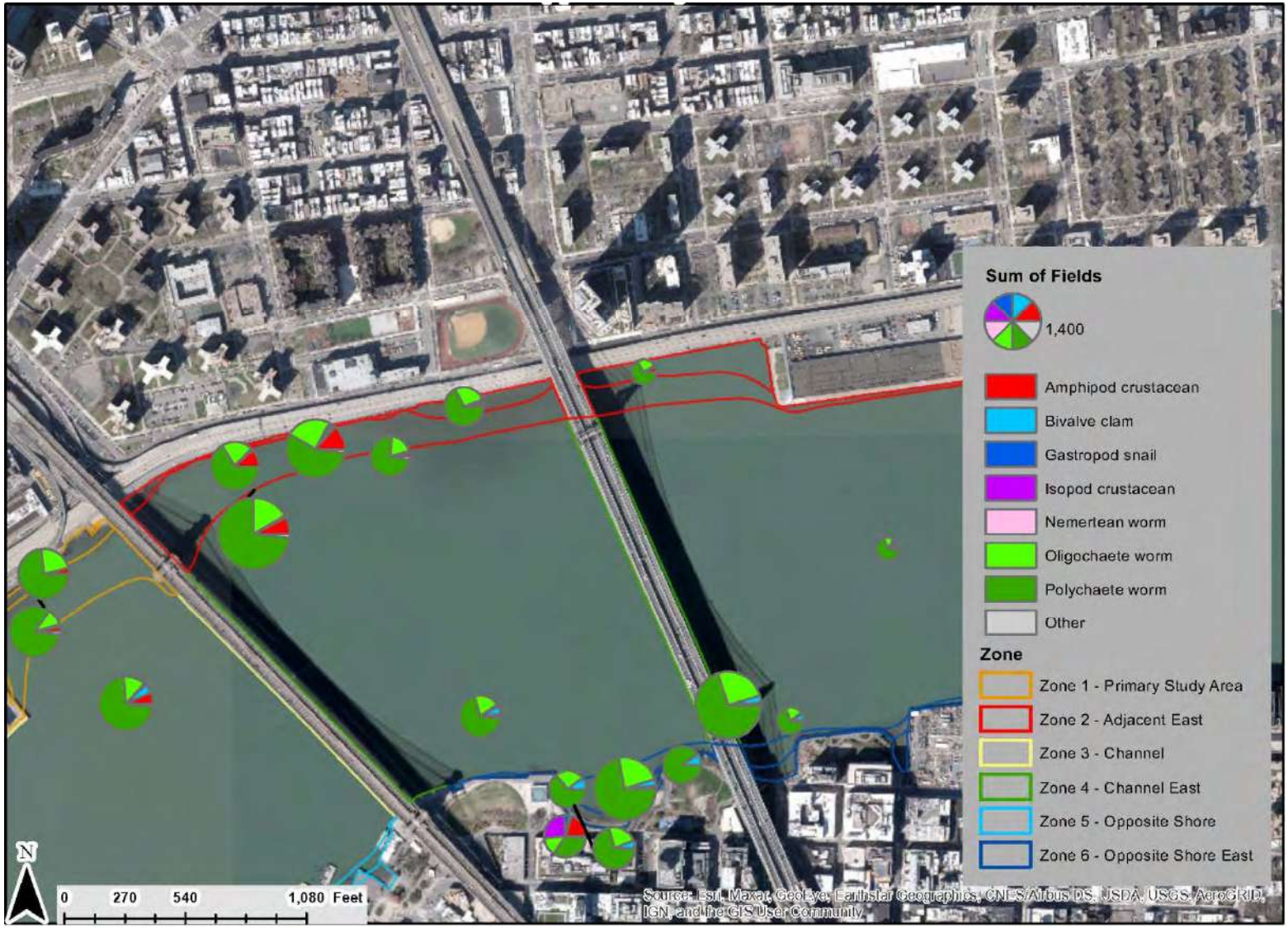



**Figure 4c –** Species composition and proportional abundance of benthic invertebrates collected during grab sampling conducted in the upper half of the study area in July 2021. The size of each pie chart is proportionate to the abundance of invertebrates collected at each location.

**Table 3 – Average biomass, ± 2 standard errors, of benthic invertebrates collected in each sampling zone during July 2021 in the lower East River, NY**

| Zone | Biomass |
|---|---|
| Zone 1 – Primary study area | 1.32 ± 1.67 |
| Zone 2 – Adjacent upstream | 2.47 ± 2.86 |
| Zone 3 – Channel downstream | 5.99 ± 6.03 |
| Zone 4 – Channel upstream | 0.65 ± 0.60 |
| Zone 5 – Opposite shoreline | 0.38 ± 0.51 |
| Zone 6 – Opposite upstream | 1.16 ± 1.94 |

**Figure 5** – Photograph of *Sabellaria vulgaris* (tube-forming, reef-building polychaete worms) from a benthic grab sample collected in the East River during April 2021. This image was taken under the sorting scope during processing in the lab. Although the occurrence of worm tubes has been confirmed from this and similar samples, the presence of larger, worm reef structures often formed by this species has not been confirmed.

*SEDIMENT COMPOSITION AND TOTAL ORGANIC CARBON*

Sediment composition along the Manhattan shoreline/nearshore area (Zones 1 and 2) was composed primarily of silt with smaller amount of sand and/or clay; greater amounts of sand and gravel were collected further upriver in Zone 2 (**Figure 6**). Most of the samples collected along the Brooklyn shoreline/nearshore area (Zones 5 and 6) were sandy with some silt. Sediment samples collected from Zone 5 also contained a relatively high proportion of clay. Sediment samples collected in the channel (Zones 3 and 4) were generally sandy with some gravel and silt, but also contained small amounts of clay. Two of the samples collected in July (Zone 1 and 6) had relatively high proportions of gravel (approximately 20% to 25%).

Total organic carbon (TOC) was similar among Zones 1, 2, 3, and 5, which had median TOC concentrations ranging from 8 to 12 grams of organic carbon per kilogram of sampled substrate (g/kg). By contrast, Zones 4 and 6 had considerably higher median concentrations of 21 and 15 g/kg, respectively (**Figure 7**). The median TOC concentration in the channel stratum (i.e., Zones 3 and 4) was 14.5 g/kg, which was slightly higher than in the nearshore stratum (12.0 g/kg). There were several samples in each stratum that had much higher TOC concentrations than the median, including a sample with a TOC concentration of 41 g/kg in the channel stratum (**Figure 7**).

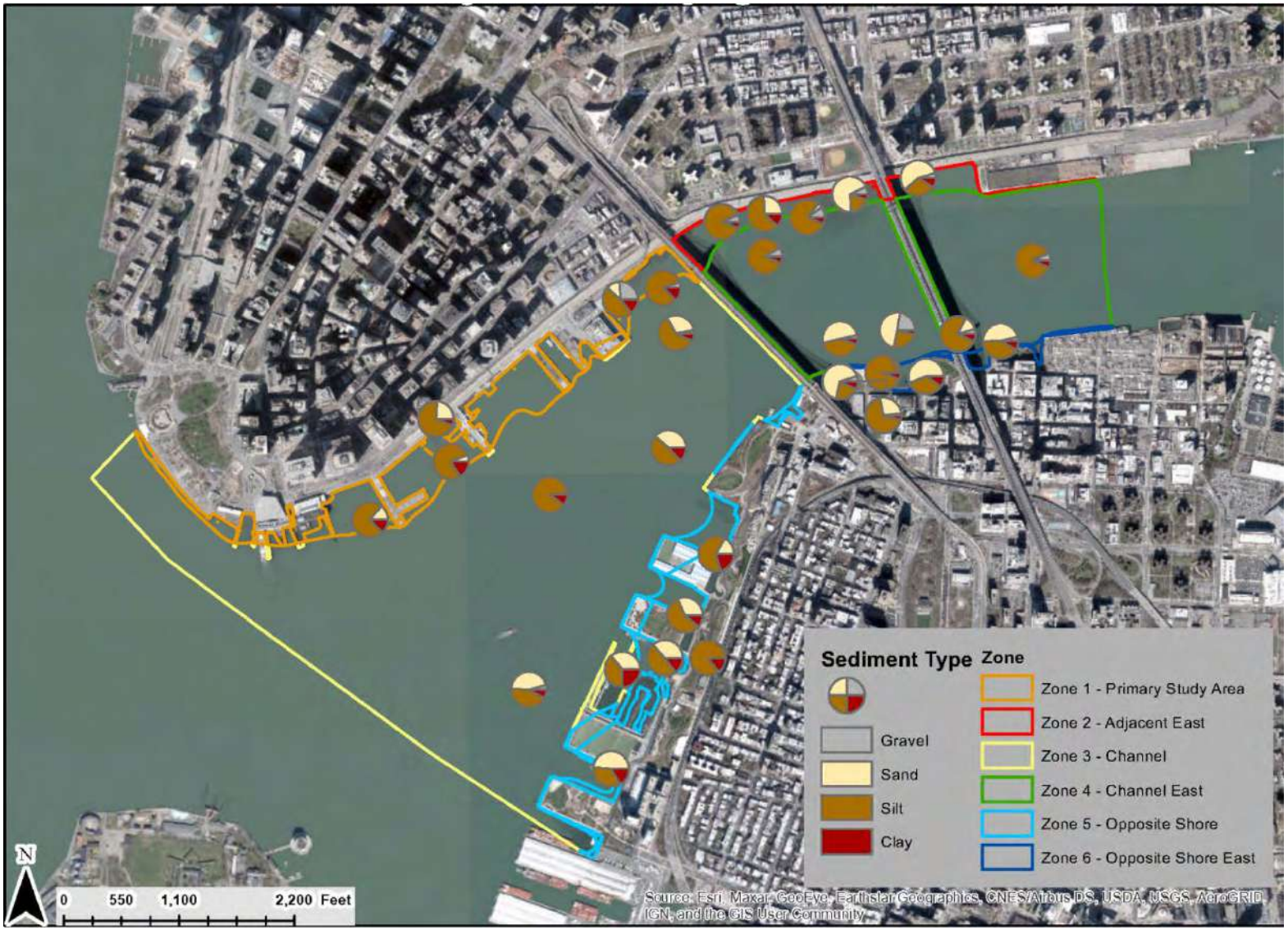



**Figure 6 –** Sediment composition in grab samples collected in the East River during July 2021.

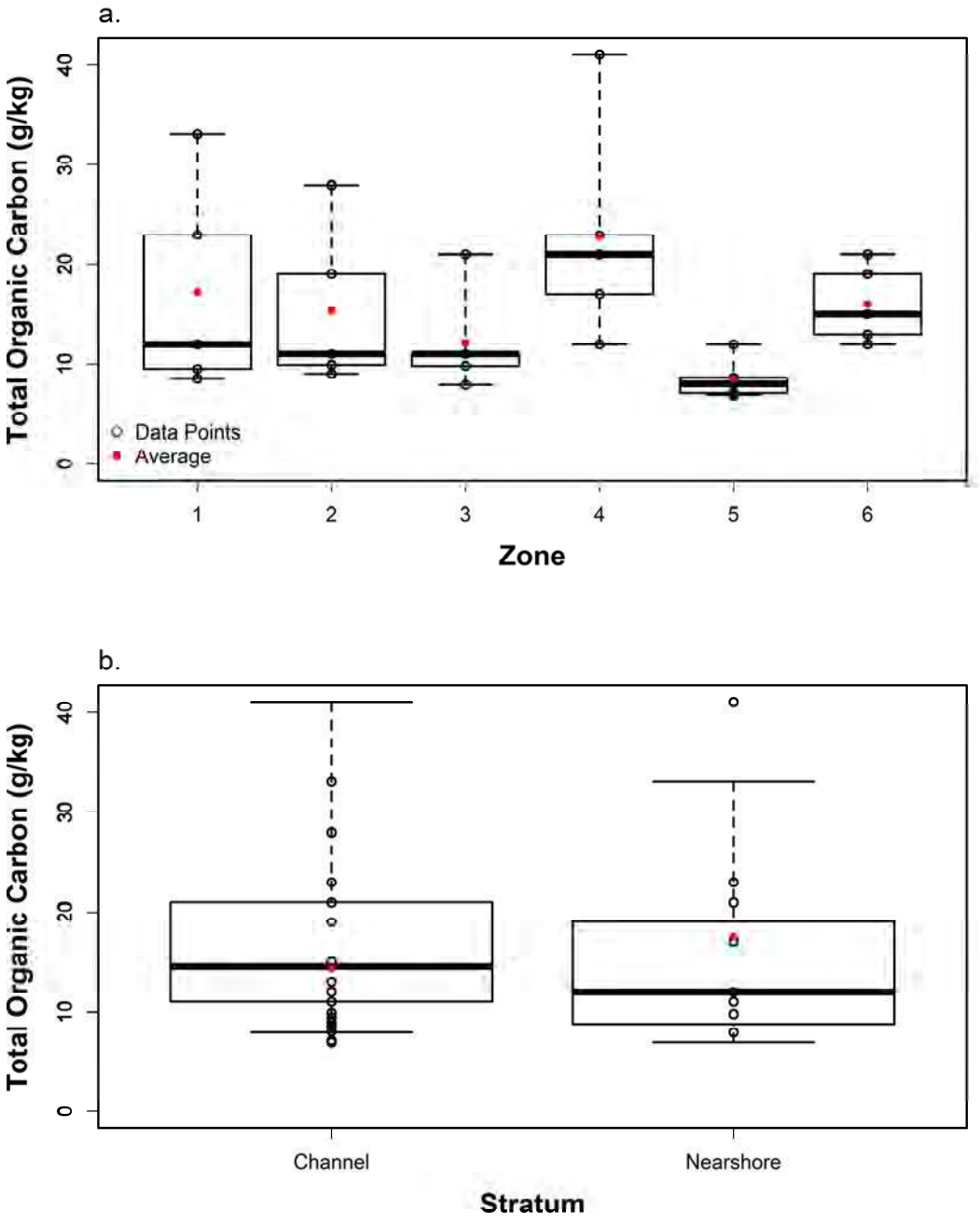



**Figure 7** – Boxplots of total organic carbon content observed across zones (top panel) and strata (bottom panel) in benthic grab sampling of the East River in July 2021. In each boxplot, the black bar represents the median (or middle value), the box depicts the middle 50% of the data distribution, and the whiskers depict the range beyond which outliers (open circles) occur.

## FISH SAMPLING

**Figure 3** shows the locations of the fish samples by sampling gear—beach seine, baited fish trap, and bottom trawl collected during July 2021. **Figure 9** shows the locations of fish sampling conducted using remote sensing.

- NYCEDC collected a total of 14 out of the planned 20 beach seine samples (**Figure 8**) along intertidal shorelines in Manhattan and Brooklyn (Zones 1, 2, 5 and 6). Limited availability of shallow shorelines in Zones 1 and 2 limited the number of beach seine samples that could be collected from those Zones.
- NYCEDC collected all 10 of the planned bottom-trawl samples in channel Zones 3 and 4 (i.e., 5 trawls in each zone). As with earlier sampling events, heavy vessel traffic and submerged obstructions constrained the deployment of bottom trawls to the areas that were sampled.
- NYCEDC collected all 24 baited fish trap samples (**Figure 8**) as planned; four samples from each of the six zones were collected.
- NYCEDC surveyed all 40 of the planned remote sensing transects during this sampling event. Ten transects per zone were surveyed (**Figure 9**) in shoreline and nearshore habitats in Zones 1, 2, 5 and 6. **Figure 10** presents several examples of ARIS imagery collected during remote sensing in July.

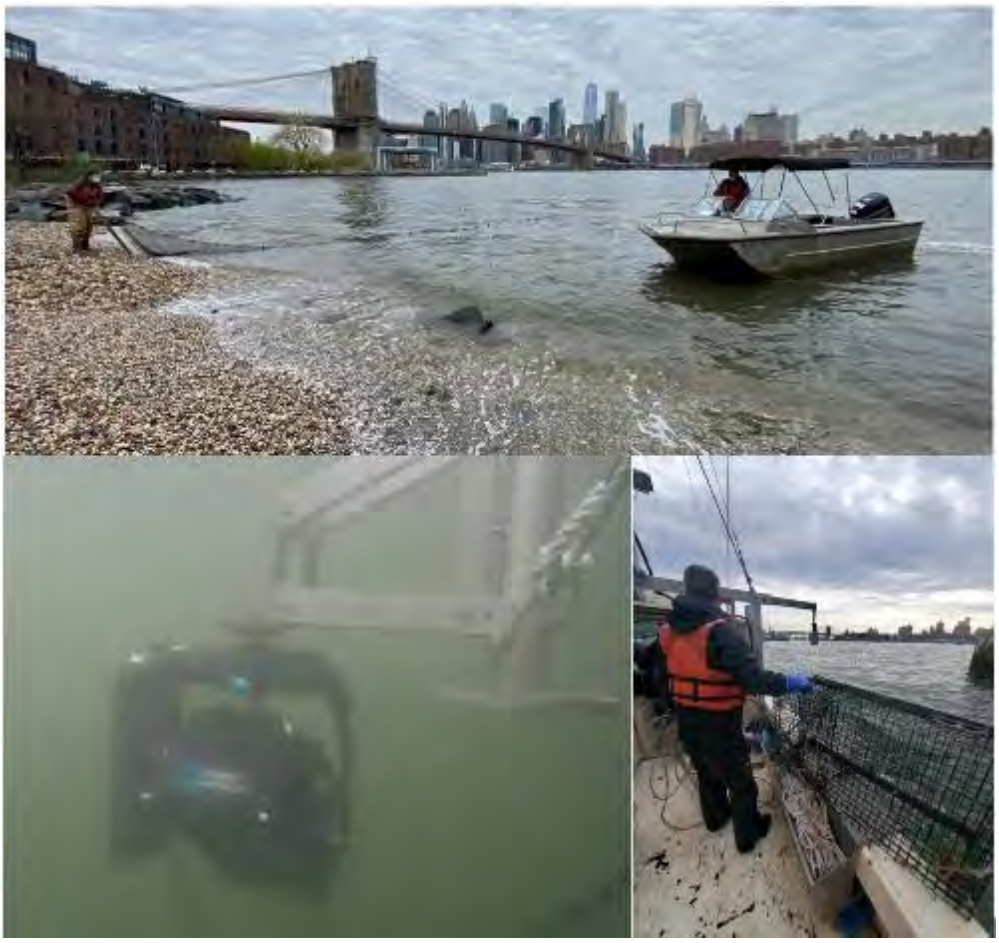


**Figure 8 –** Fish sampling by beach seine (top), remote sensing (bottom left), and baited traps (bottom right) in the East River.

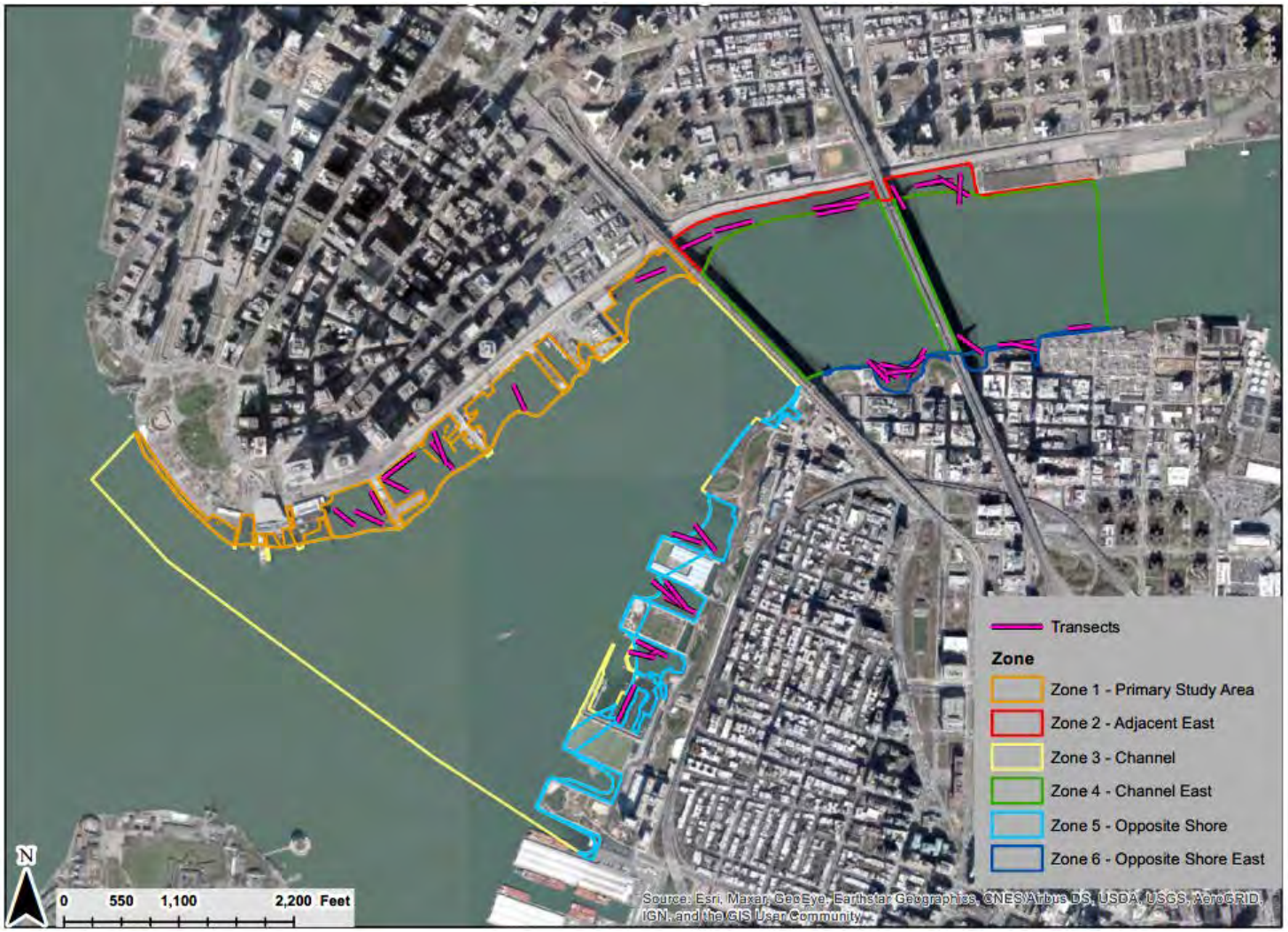



**Figure 9 –** Locations of remote sensing transects for fish conducted in the East River in July 2021.

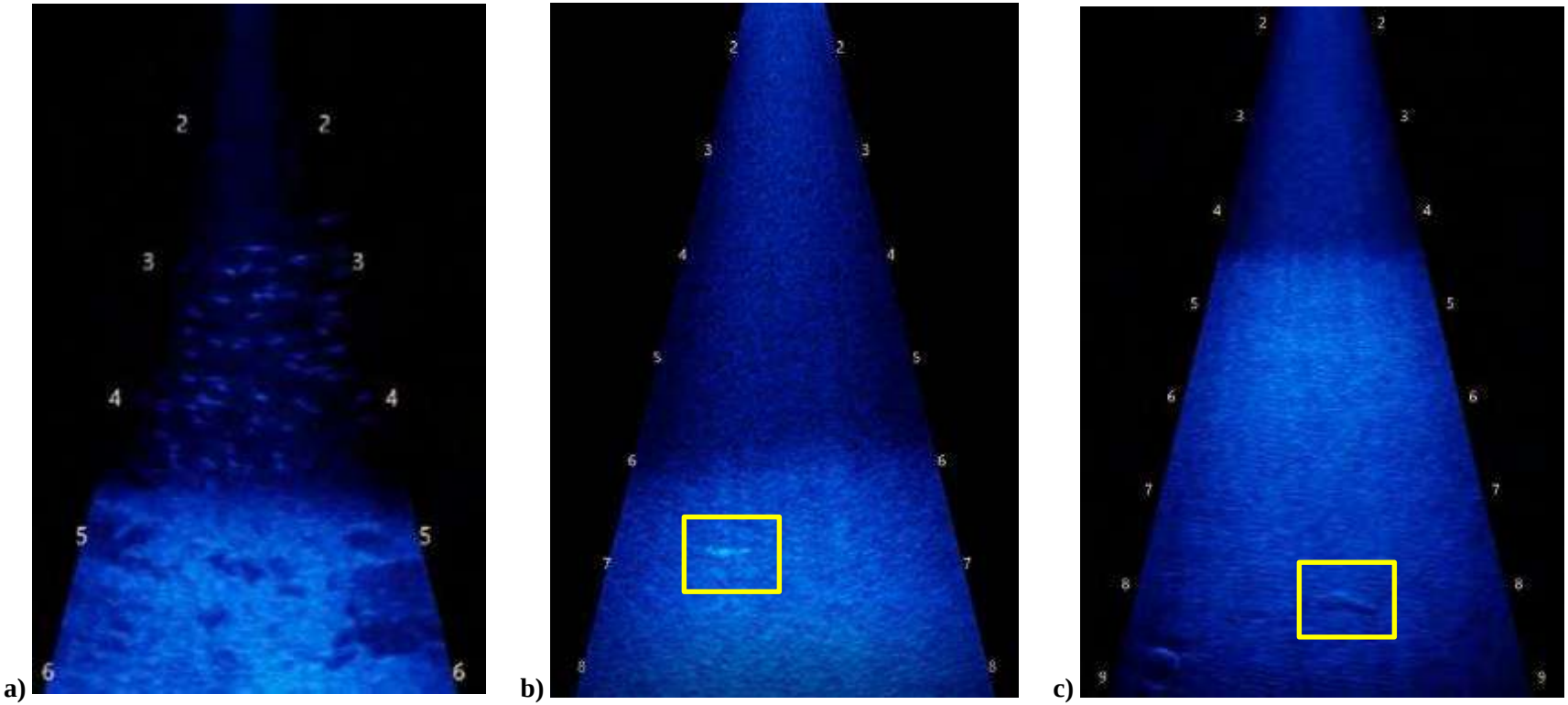


**Figure 10 –**ARIS remote sensing data collected in the East River during July 2021 sampling. Images include: a) small-bodied, schooling, midwater fish, b) a medium-bodied, midwater fish, and c) a large-bodied eel.

*FISH ABUNDANCE AND BIODIVERSITY*

*Beach seine*

Fish were collected at 7 of the 14 beach seine sites sampled during July. Six fish species were collected, including Atlantic silverside, Atlantic tomcod, bluefish, striped bass, tautog, and winter flounder. Atlantic silverside was the most abundant species and accounted for approximately 73% of the total catch (**Figure 11**). While abundant, Atlantic silverside was not ubiquitous across sample sites, as it was only collected in approximately 21% of samples (**Figure 11**). All catches using the beach seine occurred on the opposite shore in Zones 5 and 6. Striped bass was collected in three samples in Zone 6, Atlantic silverside and winter flounder were collected together in three samples in Zone 5, and Atlantic tomcod, bluefish and tautog were collected together in one sample in Zone 5 (**Figure 12**).

*Baited fish traps*

Fish were collected at 13 of the 24 baited fish traps set during July. Eight fish or crab species were collected, including American eel, blue crab, oyster toadfish, portly spider crab, striped bass, summer flounder, tautog, and white perch. Oyster toadfish was the most abundant species and accounted for approximately 57% of the total catch (**Figure 13**). While the most abundant, oyster toadfish was not ubiquitous across sampling locations, as it was only collected in 42% of samples (**Figure 13**). There was generally no catch in traps deployed along the Manhattan shoreline (Zones 1 and 2; **Figure 14**), with the exception of one trap that caught an oyster toadfish. Oyster toadfish was collected in six out of eight samples in the channel (Zones 3 and 4). Other species collected in the channel included blue crab, portly spider crab, striped bass, and tautog. Oyster toadfish was collected in three out of eight samples along the Brooklyn shoreline (Zones 5 and 6). Other species collected along the Brooklyn shoreline included American eel, striped bass, summer flounder, and white perch.

*Bottom Trawl*

Fish were collected in 6 of the 10 bottom trawl tows during July. Seven species were collected, including Atlantic tomcod, blue crab, oyster toadfish, portly spider crab, spotted hake, tautog, and weakfish. There were no dominant species during July trawl sampling. The three most abundant species, Atlantic tomcod, oyster toadfish, and spotted hake, each accounted for 20% of the total catch (**Figure 15**). None of the species were ubiquitous across sampling locations, as no species was collected in more than 20% of samples (**Figure 15**). Species collected in Zone 3 consisted of entirely finfish, including Atlantic tomcod, oyster toadfish, spotted hake, tautog, and weakfish, whereas species collected Zone 4 consisted primarily of decapod crabs, including blue crab and portly spider crab (**Figure 16**). Atlantic tomcod was the only species that was collected in both channel zones.

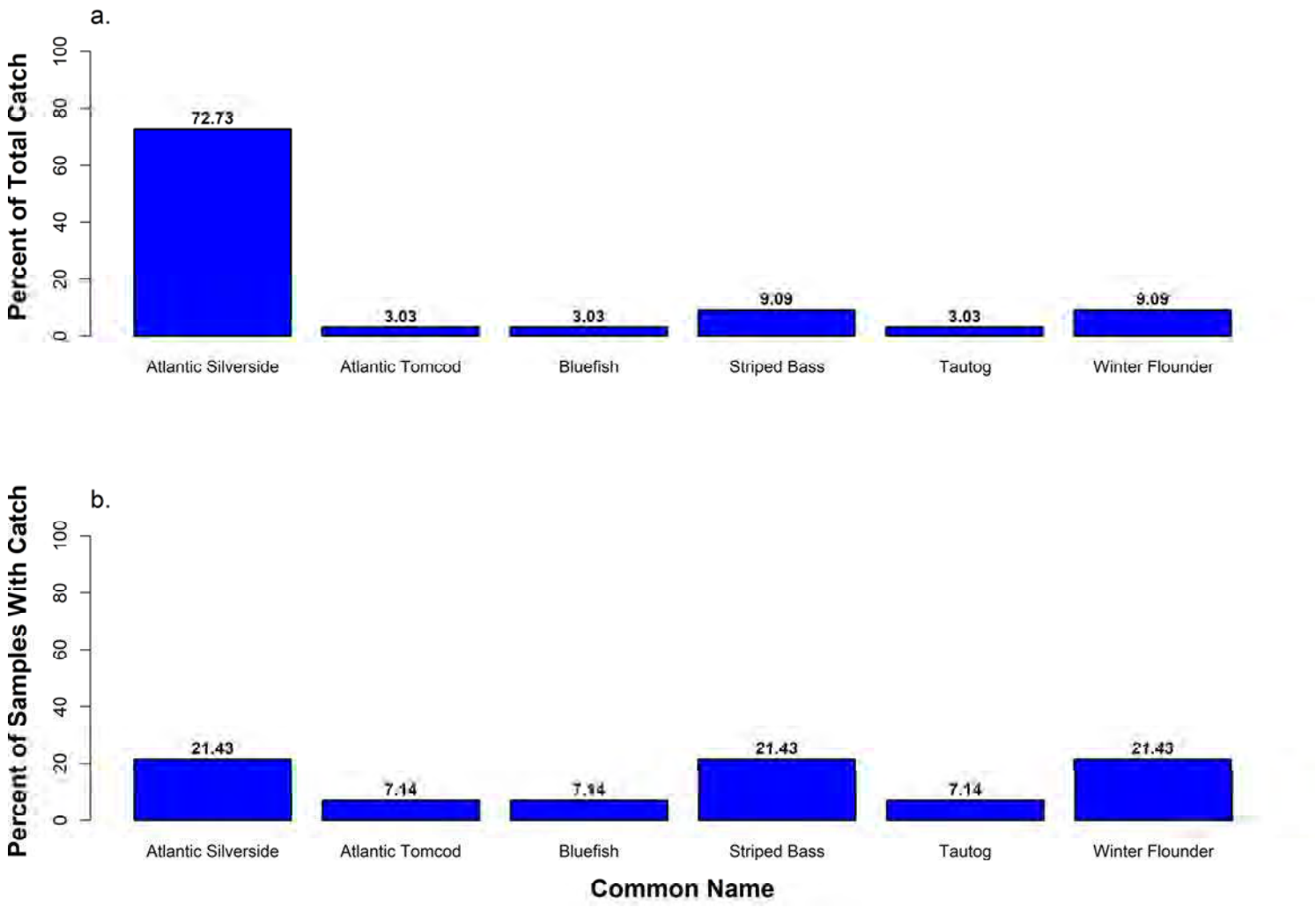



**Figure 11 –** Catch of finfish species during the beach seine survey in the East River during the July 2021 sampling event.


**Figure 12 –** Species composition of fish collected during the July 2021 beach seine survey.

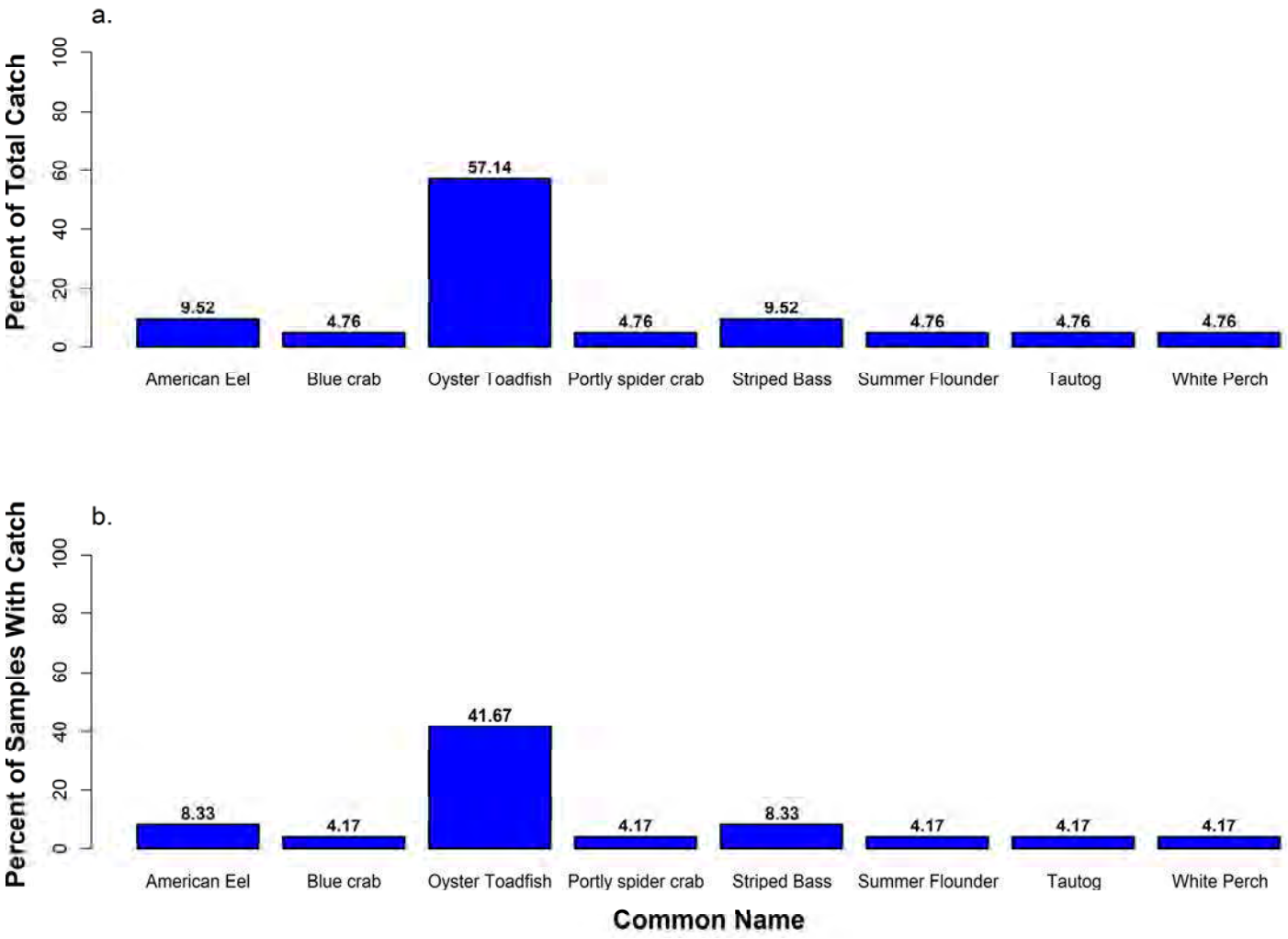



**Figure 13 –** Catch of finfish species during the baited fish trap survey in the East River during the July 2021 sampling event.

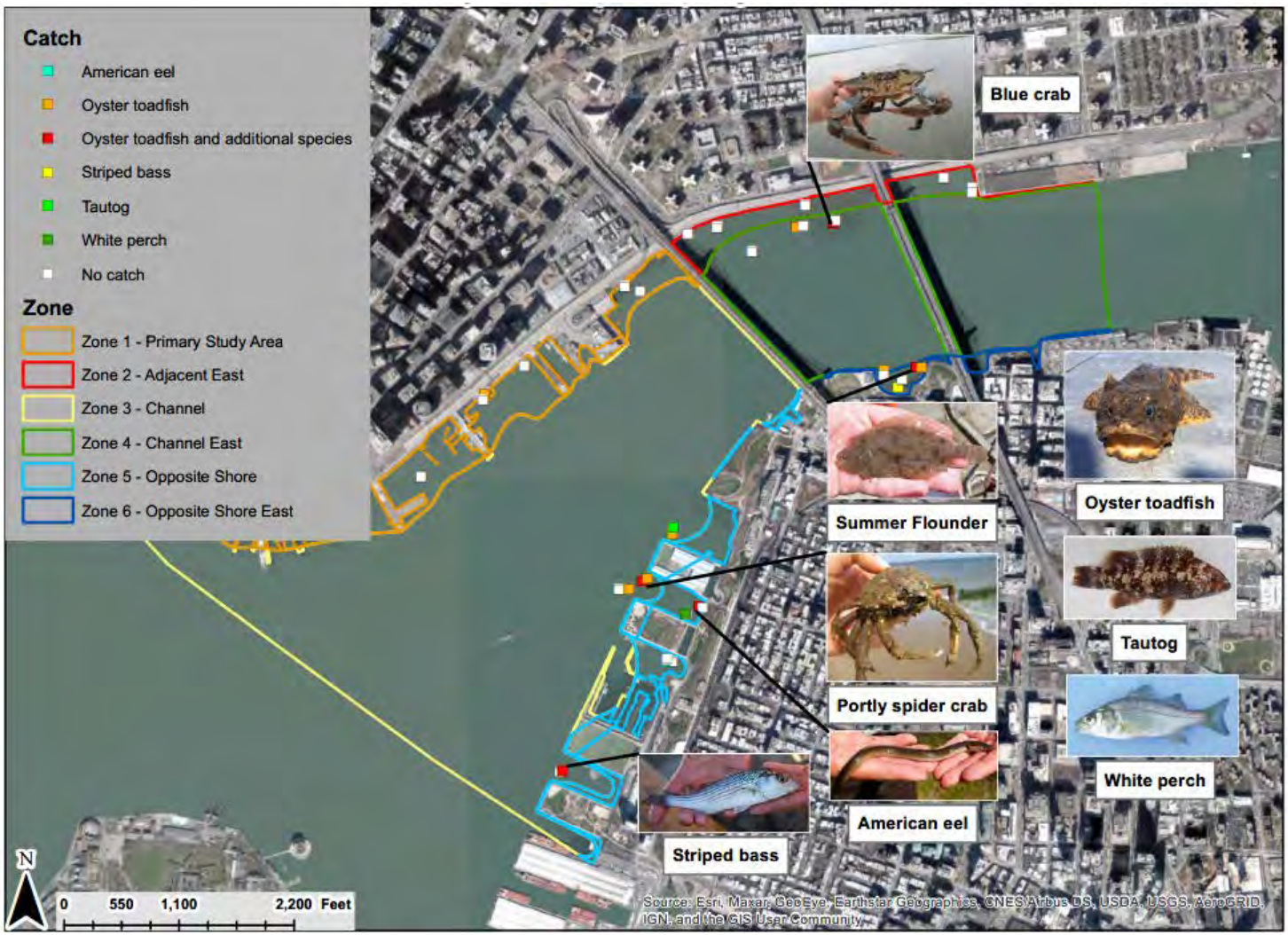



**Figure 14 –** Species composition of fish collected during the July 2021 baited fish trap survey.

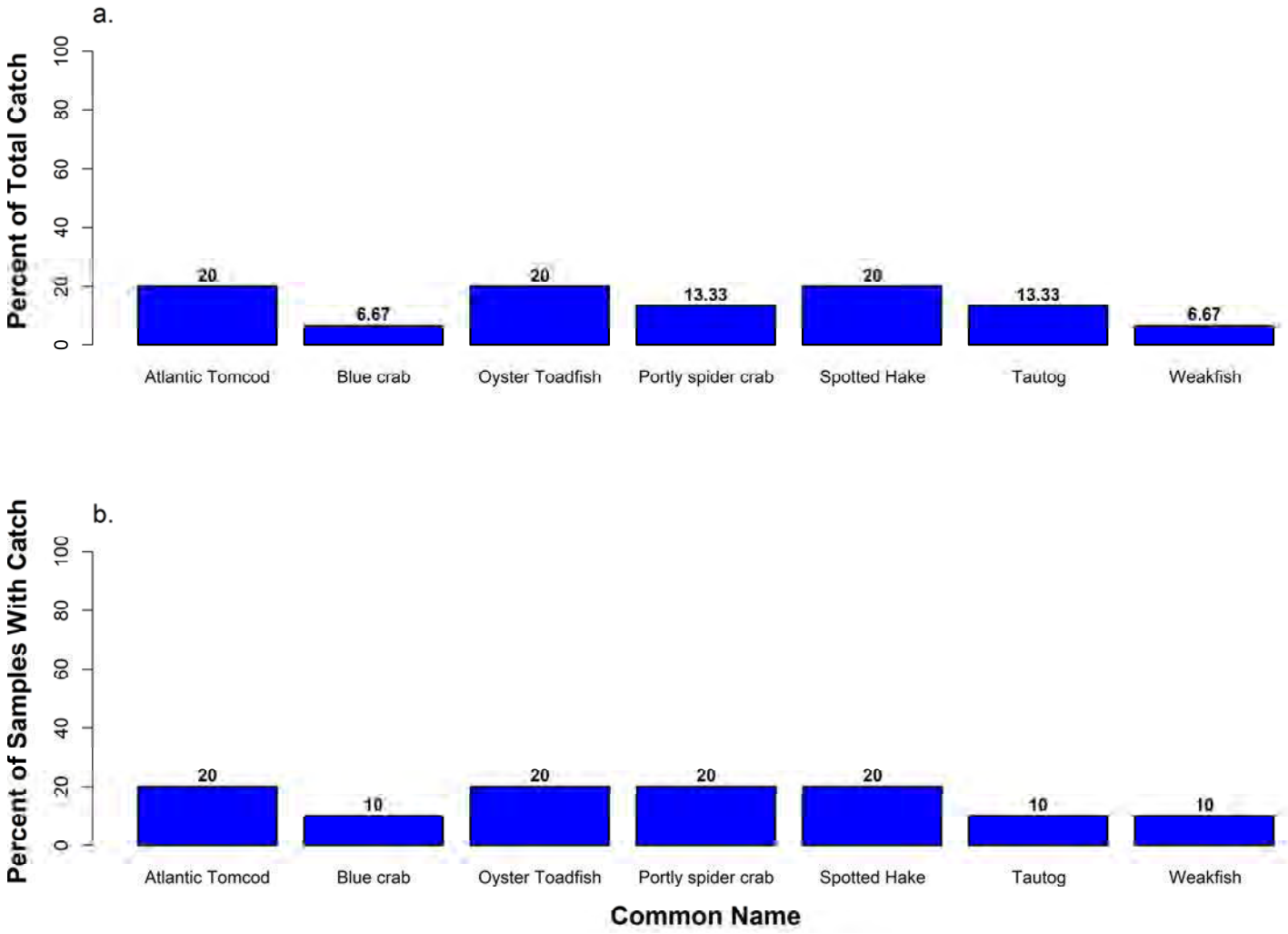



**Figure 15 –** Catch of finfish species during the bottom trawl survey in the East River during the July 2021 sampling event.


**Figure 16** – Species composition of fish collected during the July 2021 bottom trawl survey.

*Remote sensing*

Fish were most abundant in Zone 1 in the nearshore and shoreline strata during remote sensing transects surveyed in July 2021 (**Table 4 and Figure 17**). A total of 304 fish were observed within a sampled volume of 16,136 $m^3$ in the nearshore stratum, and a total of 105 fish were observed in a sampled volume of 19,524 $m^3$ in the shoreline stratum. In both strata, the highest fish densities in July were observed in the Primary Study Area (Zone 1), and the lowest densities were observed in Adjacent East Area (Zone 2).

**Table 4 – Total counts and density for finfish detected during the remote sensing survey in the lower East River, NY during July 2021**

| Stratum | Location | No. Transects | Total Volume Sampled ($m^3$) | Total Count | Density (1,000 per $m^3$) |
|---|---|---|---|---|---|
| Nearshore | Zone 1 - Primary Study Area | 5 | 2,906 | 283 | 97.4 |
| | Zone 2 - Adjacent East | 5 | 6,986 | 2 | 0.3 |
| | Zone 5 - Opposite Shore | 4 | 2,166 | 6 | 2.8 |
| | Zone 6 - Opposite Shore East | 7 | 4,078 | 13 | 3.2 |
| | **All** | **21** | **16,136** | **304** | **18.8** |
| Shoreline | Zone 1 - Primary Study Area | 5 | 2,454 | 85 | 34.6 |
| | Zone 2 - Adjacent East | 5 | 9,100 | 1 | 0.1 |
| | Zone 5 - Opposite Shore | 6 | 5,932 | 4 | 0.7 |
| | Zone 6 - Opposite Shore East | 3 | 2,037 | 15 | 7.4 |
| | **All** | **19** | **19,524** | **105** | **5.4** |

Densities of fish detected during remote sensing transects were classified into three different length categories, small-bodied (< 200 mm), medium-bodied (200-500 mm), and large-bodied (> 500 mm), within each of two habitat categories, benthic (i.e., on the bottom) and pelagic (i.e., in the water column). The magnitude of densities and the patterns in densities among strata and locations differed among these categories. Small, midwater fish, which include species that school in large numbers, was the most abundant category, followed by medium-bodied, benthic fish; other categories were observed in low densities throughout the survey area (**Figure 18**). Small-bodied, midwater fish were highly abundant in the nearshore and shoreline strata of the Primary Study Area (Zone 1), but were rarely observed in other locations, whereas medium-bodied, midwater fish were most abundant along the opposite shore (Zones 5 and 6), with the highest abundance occurring in the nearshore stratum of Zone 6 (**Figures 17 and 18**).

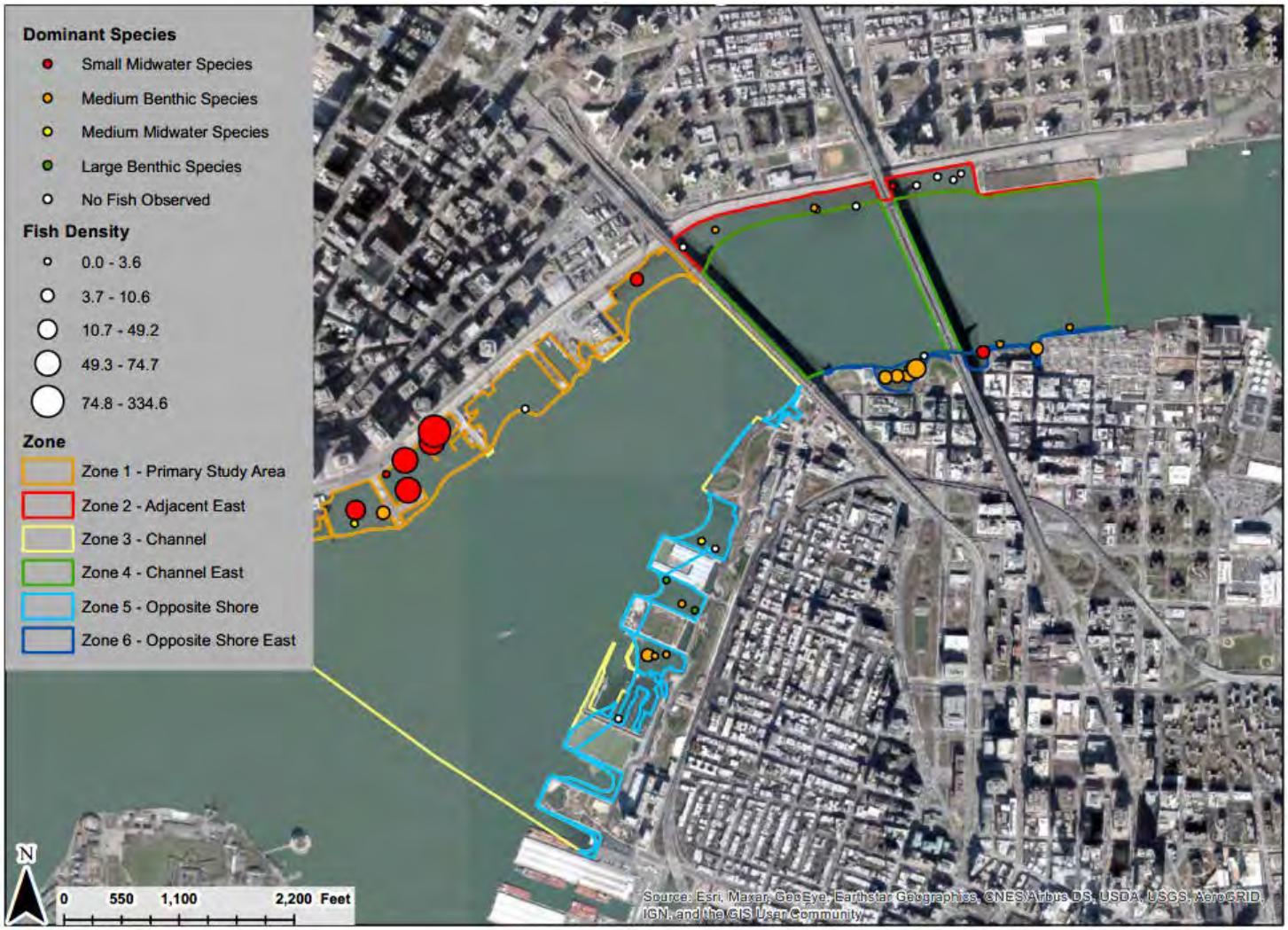



**Figure 17** – Distribution and density of fish assemblages observed during the July 2021 remote sensing survey.

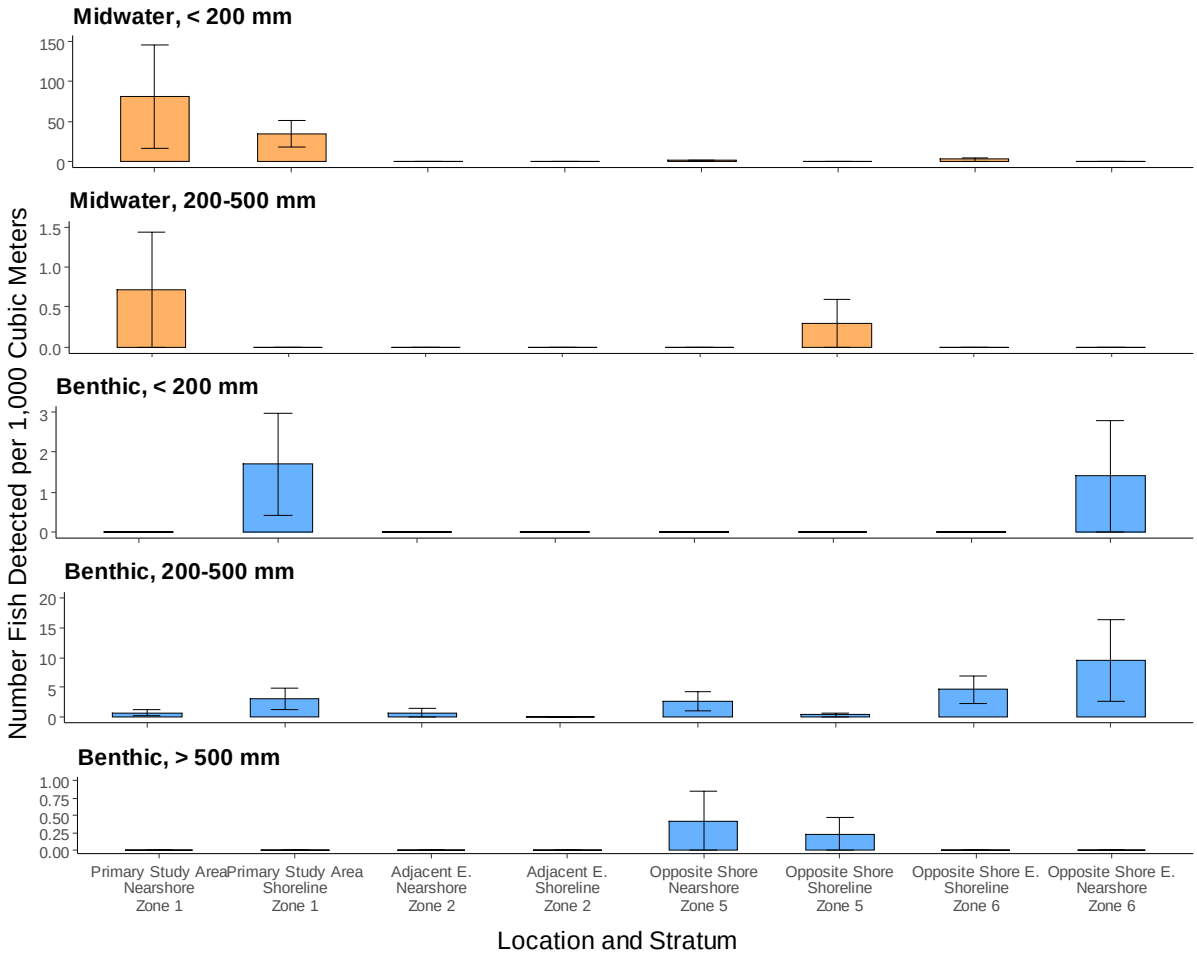



**Figure 18** – Densities of four categories of finfish observed by location and stratum during July 2021 remote sensing transects of nearshore and shoreline habitats of the East River. Fish were classified from remote sensing footage as mid-water or benthic (on the bottom) and based on body size as small-bodied (<200 mm), medium-bodied (200-500 mm), or large-bodied (>500 mm).

## PHYTOPLANKTON AND ZOOPLANKTON

**Figure 3** shows the 36 locations that were concurrently sampled for phytoplankton and zooplankton during the July sampling event. NYCEDC collected six phytoplankton and zooplankton samples in each of the six zones during July 2021 (**Table 1**).

### *PHYTOPLANKTON CHARACTERISTICS*

Chlorophyll-a and phycoerythrin (the green and red photosynthetic pigments) concentrations were measured using a YSI phosphorescence sensor as proxies for primary productivity associated with phytoplankton during sampling of the East River in July 2021[1]. **Table 5** summarizes pigment concentrations by Zone and water depth in. Primary productivity was higher along the opposite shore in Brooklyn compared to the other zones, particularly near the bottom of the water column. **Figure 19** provides a comparison of primary productivity depth profiles among zones. There were notable peaks

[1] Estimated pigment concentrations are relative estimates based on calibration of the optical sensors to Rhodamine WT calibration solution and are not absolute pigment concentration values. Based on water-quality data collected by NYCDEP and concentrations published in recent studies, these estimates are likely close to actual values.

in primary productivity observed beneath the surface of the water column in Zones 1, 5, and 6. In Zones 5 and 6 on the opposite shore, the peaks in primary productivity occurred just above the river bottom at depths of approximately 15 and 7 feet, respectively. In Zone 1 in the Primary Study Area, the peak in primary productivity occurred near the middle of the water column at a depth of approximately 13 feet. In the channel zones, primary productivity peaked near the surface and rapidly declined with depth before leveling off at a depth of approximately 10 feet.

The phytoplankton sampling conducted in July indicated limited concentrations of chlorophyll-a and phycoerythrin in the study area. The highest observed concentrations appear to be in a few localized near-bottom zones at the shallow stations along the shoreline of the river, potentially due to benthic microalgae on the river bottom.

**Table 5 – Primary productivity characteristics measured in the lower East River, NY during July 2021**

| Position | Zone | Study Area | N | Depth (ft) | Chlorophyll-a (µg/L) | | Phycoerythrin (µg/L) | |
|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range |
| Surface | 1 | Primary Study Area | 6 | 1.0 | 0.42 | 0.21 - 0.69 | 0.00 | 0.00 - 0.00 |
| | 2 | Adjacent East | 6 | 1.0 | 0.35 | 0.15 - 0.61 | 0.00 | 0.00 - 0.00 |
| | 3 | Channel | 6 | 1.0 | 0.89 | 0.45 - 1.27 | 0.36 | 0.00 - 1.05 |
| | 4 | Channel East | 6 | 1.0 | 0.60 | 0.36 - 0.96 | 0.00 | 0.00 - 0.00 |
| | 5 | Opposite Shore | 6 | 1.0 | 0.83 | 0.32 - 1.18 | 0.30 | 0.00 - 1.06 |
| | 6 | Opposite Shore East | 6 | 1.0 | 0.44 | 0.33 - 0.55 | 0.14 | 0.00 - 0.86 |
| | **All** | | **36** | **1.0** | **0.59** | **0.15 - 1.27** | **0.13** | **0.00 - 1.06** |
| Bottom | 1 | Primary Study Area | 6 | 16.2 | 0.86 | 0.38 - 2.67 | 1.24 | 0.00 - 7.04 |
| | 2 | Adjacent East | 6 | 13.8 | 0.36 | 0.14 - 0.73 | 0.00 | 0.00 - 0.00 |
| | 3 | Channel | 6 | 44.2 | 0.59 | 0.19 - 0.88 | 0.22 | 0.00 - 1.26 |
| | 4 | Channel East | 6 | 56.5 | 0.24 | 0.04 - 0.41 | 0.00 | 0.00 - 0.00 |
| | 5 | Opposite Shore | 6 | 15.8 | 2.23 | 0.57 - 3.46 | 4.89 | 0.00 - 9.45 |
| | 6 | Opposite Shore East | 6 | 7.3 | 1.42 | 0.33 - 5.97 | 1.94 | 0.00 - 11.62 |
| | **All** | | **36** | **25.6** | **0.95** | **0.04 - 5.97** | **1.38** | **0.00 - 11.62** |
| All Depths | 1 | Primary Study Area | 97 | 12.2 | 0.34 | 0.00 - 2.67 | 0.09 | 0.00 - 7.04 |
| | 2 | Adjacent East | 83 | 9.4 | 0.30 | 0.01 - 0.73 | 0.00 | 0.00 - 0.00 |
| | 3 | Channel | 265 | 24.1 | 0.57 | 0.00 - 1.39 | 0.05 | 0.00 - 1.26 |
| | 4 | Channel East | 339 | 29.2 | 0.29 | 0.00 - 0.96 | 0.00 | 0.00 - 0.02 |
| | 5 | Opposite Shore | 95 | 8.5 | 0.74 | 0.00 - 3.46 | 0.40 | 0.00 - 9.45 |
| | 6 | Opposite Shore East | 44 | 4.2 | 0.68 | 0.00 - 5.97 | 0.52 | 0.00 - 11.62 |
| | **All** | | **923** | **14.6** | **0.49** | **0.00 - 5.97** | **0.18** | **0.00 - 11.62** |

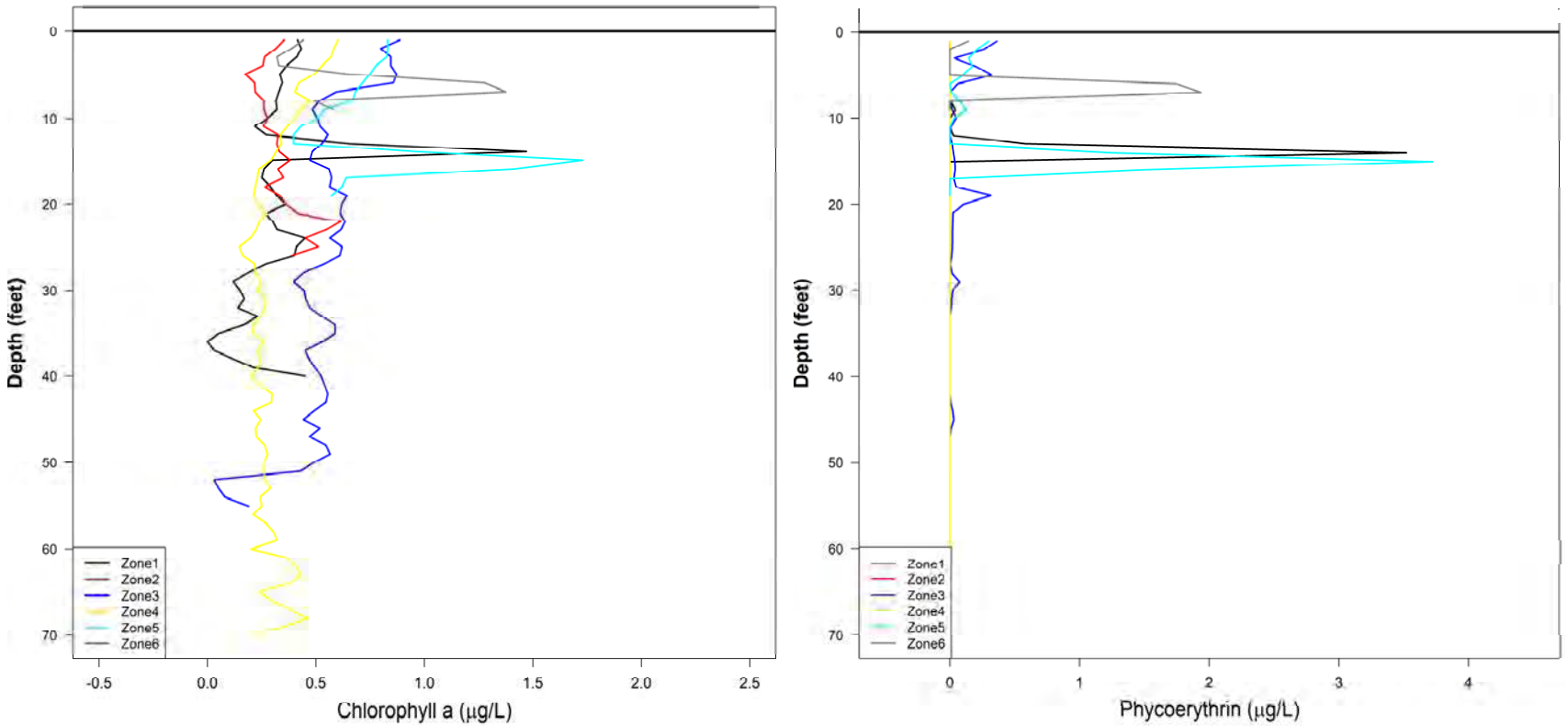



**Figure 19** – Depth profiles by Zone for two proxies of primary productivity, chlorophyll-a and phycoerythrin, measured during plankton sampling in July 2021. Chlorophyll-a and phycoerythrin were averaged across the six samples collected in each of the six zones.

*ZOOPLANKTON COMMUNITY*

The zooplankton community in the study area during July was dominated by calanoid copepods (*Acartia tonsa, Acartia* spp., *Labidocera aestiva*). Other abundant taxa included cyclopoid and harpacticoid copepods, polychaete worm larvae, and ciliates (**Table 6 and Figures 20a, 20b, and 20c**). Zooplankton abundance was highest in the channel stratum, particularly Zone 3, where abundance was an order of magnitude higher than the shoreline/nearshore Zones. The lowest zooplankton abundance was observed along the eastern portion of the Brooklyn shoreline in the Opposite Shore East study area (Zone 6). Species richness, defined here as the number of zooplankton species/taxa that represent 90% of all individuals collected in each zone, was highest in the Channel East study area (Zone 4) and lowest in the Channel (Zone 3). As with the benthic invertebrate community, the greatest diversity of zooplankton appears to be along the Manhattan shoreline and nearshore strata of Zone 2.

The calanoid copepod, *Acartia* sp., was the most abundant zooplankton taxon in the study area and was most abundant in all zones in July. In the Primary Study Area (Zone 1), the other most dominant taxa included the harpacticoid copepod, Harpacticoida and ciliates in the family Codonellidae. These taxa were among the dominant taxa in other Zones as well.

**WATER QUALITY AND CURRENT VELOCITY**

NYCEDC collected water quality samples at the surface and bottom of the river concurrent with each of the 154 biological samples collected in July (**Figure 21**; **Table 7**). Bottom samples were collected at a mean depth of 15.8 feet (4.8 meters).

*WATER QUALITY CHARACTERISTICS*

Four water quality parameters (i.e., temperature, salinity, dissolved oxygen (DO) and pH) measured during sampling of the East River in July 2021 are summarized by zone and habitat stratum in **Table 7**. For each of the parameters, the overall mean and range were similar between the surface and bottom. **Figure 22** provides an example of depth profiles for water quality parameters.

*TOTAL NITROGEN IN THE WATER COLUMN*

NYCEDC measured total nitrogen ("TN") at the surface and bottom of the water column at each of the 30 benthic grab sites. The TN concentration was low (< 0.5 mg/L) in 30 out of 60 samples. Among the samples with TN concentrations greater than 0.5 mg/L, the average TN concentration was 1.0 mg/L, and the maximum TN concentration was 2.0 mg/L. Zone 6 had the most samples with TN concentrations greater than 0.5 mg/L (8 out of 10), followed by Zone 4 (7 out of 10), Zones 2, 3 and 5 (4 out of 10), and Zone 1 (3 out of 10). The highest TN concentrations (≥ 1.2 mg/L) were observed in samples collected in Zones 3, 5 and 6.

**Table 6 – Summary of dominant zooplankton taxa collected from six plankton tows per zone in the lower East River, NY during July 2021**

| | Primary Study Area | Adjacent Upstream | Channel | Channel Upstream | Opposite Shoreline | Opposite Upstream |
|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| 5 Most Abundant Taxa | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod |
| | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | Unidentified ciliate Ciliate |
| | *Labidocera aestiva* Calanoid copepod | *Labidocera aestiva* Calanoid copepod | Spionidae Polychaete worm | *Oithona colcarva* Cyclopoid copepod | *Labidocera aestiva* Calanoid copepod | Codonellidae Ciliate |
| | Harpacticoida Harpacticoid copepod | *Oithona* sp. Cyclopoid copepod | *Labidocera aestiva* Calanoid copepod | *Pseudodiaptomus pelagicus* Calanoid copepod | Spionidae Polychaete worm | *Labidocera aestiva* Calanoid copepod |
| | Codonellidae Ciliate | *Oithona colcarva* Cyclopoid copepod | *Oithona* sp. Cyclopoid copepod | *Labidocera aestiva* Calanoid copepod | *Oithona colcarva* Cyclopoid copepod | Harpacticoida Harpacticoid copepod |
| Total Individuals | 6,156 | 7,605 | 66,878 | 29,182 | 7,365 | 2,446 |
| % of Total | 90 | 89 | 95 | 88 | 91 | 91 |
| Number of Taxa Representing 90% of Total | 6 | 6 | 2 | 7 | 5 | 5 |

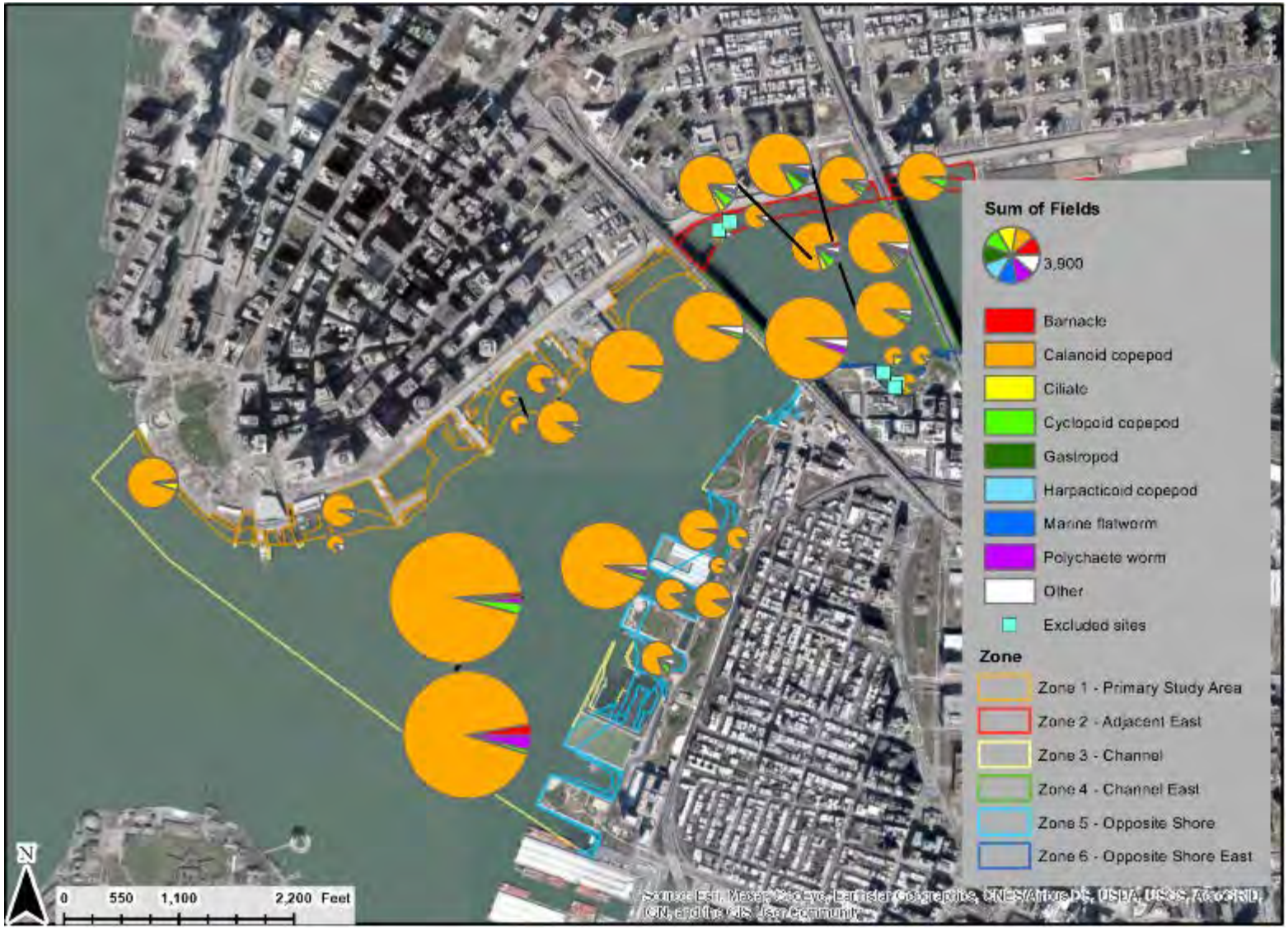



**Figure 20a –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the East River in July 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location. Low abundance sites, shown as light blue squares, were excluded from this figure for mapping purposes. Data for these sites are provided in **Figure 20c**.


**Figure 20b –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the lower half of the study area in July 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location.

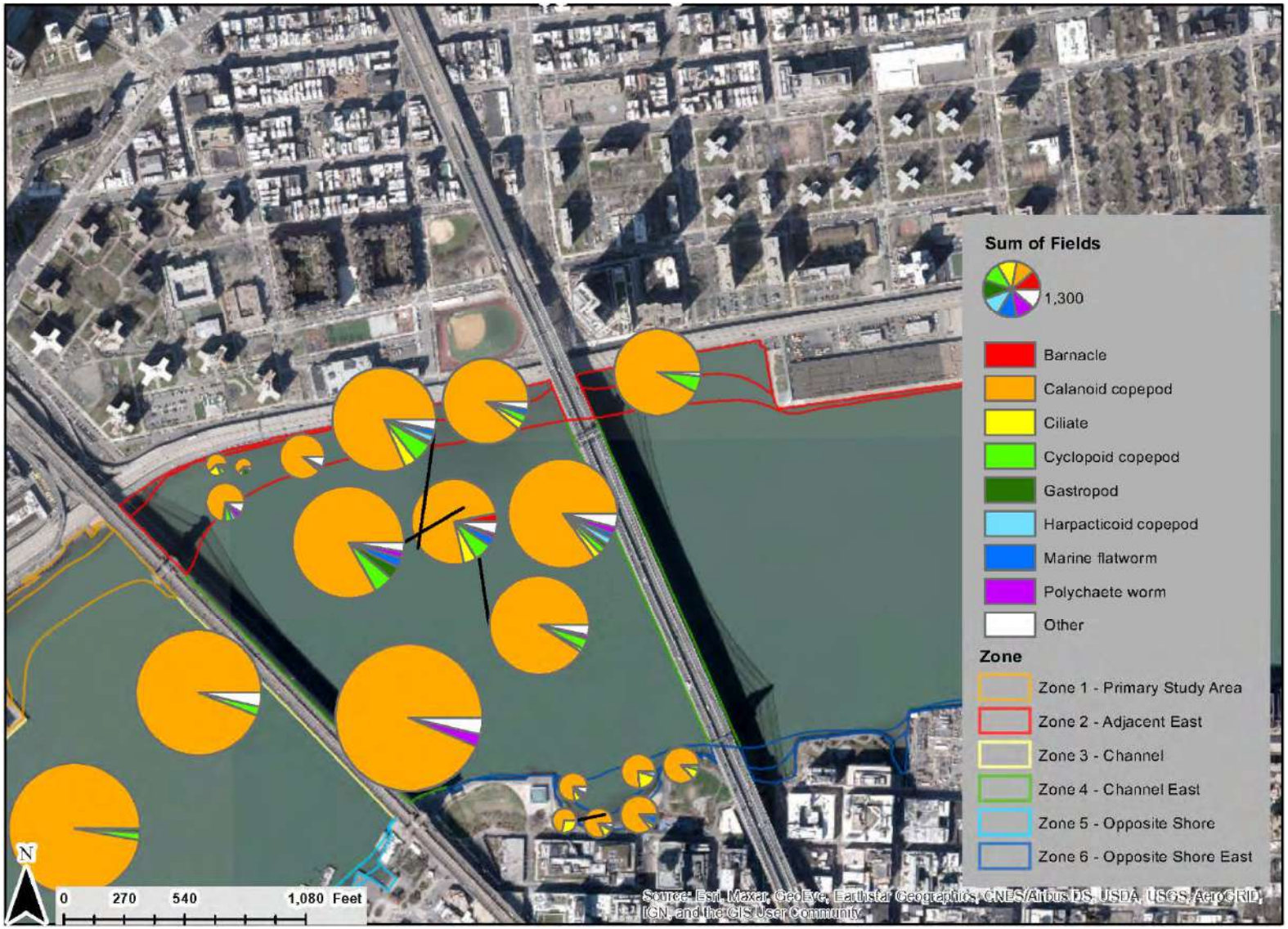



**Figure 20c –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the upper half of the study area in July 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location. Note the difference in pie chart scale compared to **Figures 20a and 20b** due to the inclusion of low abundance sites.

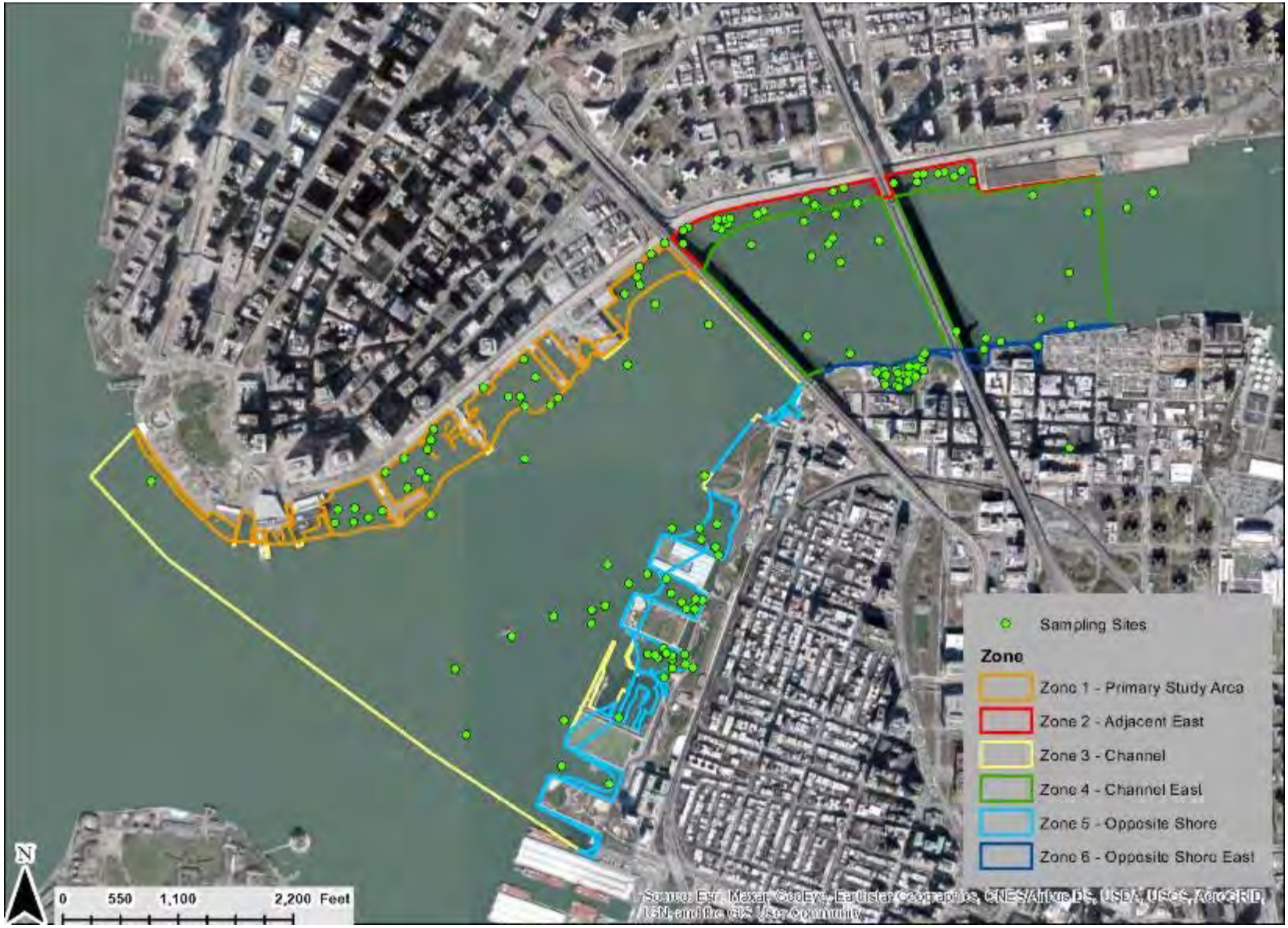



**Figure 21 –** Locations of water quality profiles collected during July 2021 biological sampling in the East River.

**Table 7 – Water quality parameters measured at surface and bottom locations in the lower East River, NY during July 2021**

| Position | Zone | Stratum | N | Depth (ft) | Temperature (C) | | Salinity (PSU) | | DO (mg/L) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Surface | 1 | Nearshore | 7 | 1.0 | 22.2 | 21.4 - 24.2 | 21.8 | 17.4 - 23.5 | 5.4 | 5.1 - 5.5 | 7.7 | 7.6 - 7.7 |
| | | Shoreline | 7 | 1.0 | 22.2 | 21.3 - 24.1 | 21.6 | 16.7 - 23.4 | 5.4 | 5.0 - 5.6 | 7.6 | 7.6 - 7.7 |
| | | Shoreline/Nearshore | 11 | 1.0 | 23.1 | 22.9 - 23.2 | 20.5 | 19.7 - 21.3 | 4.7 | 4.2 - 5.0 | 7.6 | 7.5 - 7.7 |
| | 2 | Nearshore | 7 | 1.0 | 22.2 | 21.5 - 23.9 | 22.2 | 19.1 - 23.4 | 5.2 | 5.0 - 5.4 | 7.6 | 7.6 - 7.7 |
| | | Shoreline | 12 | 0.8 | 22.2 | 21.5 - 23.9 | 23.0 | 18.6 - 24.2 | 5.3 | 5.0 - 5.7 | 7.6 | 7.5 - 7.7 |
| | | Shoreline/Nearshore | 11 | 1.0 | 23.2 | 23.1 - 23.7 | 20.5 | 19.2 - 21.3 | 4.8 | 4.1 - 5.4 | 7.6 | 7.5 - 7.7 |
| | 3 | Channel | 20 | 1.0 | 23.8 | 22.9 - 24.5 | 17.6 | 12.1 - 20.7 | 5.0 | 4.6 - 5.6 | 7.6 | 7.6 - 7.8 |
| | 4 | Channel | 20 | 1.0 | 23.8 | 23.2 - 25.0 | 19.0 | 15.2 - 21.1 | 4.8 | 4.1 - 5.5 | 7.6 | 7.4 - 7.7 |
| | 5 | Nearshore | 4 | 1.0 | 22.0 | 21.8 - 22.2 | 22.8 | 22.5 - 23.0 | 5.4 | 5.2 - 5.9 | 7.7 | 7.6 - 7.7 |
| | | Shoreline | 15 | 0.8 | 22.7 | 21.6 - 25.0 | 21.5 | 14.5 - 24.4 | 5.5 | 5.1 - 6.4 | 7.6 | 7.5 - 7.7 |
| | | Shoreline/Nearshore | 11 | 1.0 | 23.7 | 23.6 - 24.0 | 16.4 | 13.9 - 18.1 | 5.0 | 4.6 - 5.5 | 7.6 | 7.6 - 7.7 |
| | 6 | Nearshore | 9 | 1.0 | 22.2 | 21.6 - 24.1 | 22.3 | 19.1 - 23.2 | 5.0 | 4.7 - 5.3 | 7.6 | 7.5 - 7.6 |
| | | Shoreline | 9 | 0.8 | 22.6 | 21.6 - 24.2 | 22.9 | 19.3 - 24.4 | 5.7 | 4.5 - 7.3 | 7.6 | 7.6 - 7.8 |
| | | Shoreline/Nearshore | 11 | 1.0 | 23.3 | 23.2 - 23.5 | 20.0 | 19.3 - 21.1 | 4.6 | 4.3 - 5.0 | 7.6 | 7.5 - 7.7 |
| | **All** | | **154** | **1.0** | **22.8** | **21.3 - 25.0** | **20.9** | **12.1 - 24.4** | **5.1** | **4.1 - 7.3** | **7.6** | **7.4 - 7.8** |
| Bottom | 1 | Nearshore | 7 | 11.1 | 22.1 | 21.3 - 23.8 | 22.2 | 18.5 - 23.5 | 5.4 | 5.0 - 5.5 | 7.7 | 7.6 - 7.7 |
| | | Shoreline | 7 | 11.4 | 22.0 | 21.2 - 23.9 | 22.1 | 17.5 - 23.6 | 5.3 | 4.9 - 5.5 | 7.6 | 7.6 - 7.7 |
| | | Shoreline/Nearshore | 11 | 16.1 | 22.9 | 22.3 - 23.1 | 21.2 | 20.2 - 22.9 | 4.6 | 4.2 - 5.0 | 7.6 | 7.5 - 7.7 |
| | 2 | Nearshore | 7 | 14.1 | 22.0 | 21.3 - 23.8 | 22.4 | 19.7 - 23.5 | 5.2 | 5.0 - 5.5 | 7.6 | 7.6 - 7.7 |
| | | Shoreline | 12 | 12.8 | 22.0 | 21.3 - 23.8 | 23.1 | 19.7 - 24.2 | 5.2 | 4.8 - 5.6 | 7.6 | 7.5 - 7.7 |
| | | Shoreline/Nearshore | 11 | 15.5 | 23.1 | 22.7 - 23.3 | 21.0 | 20.0 - 21.8 | 4.7 | 4.0 - 5.3 | 7.6 | 7.5 - 7.7 |
| | 3 | Channel | 20 | 40.4 | 23.2 | 22.3 - 24.0 | 20.9 | 18.3 - 23.4 | 4.6 | 3.9 - 5.3 | 7.6 | 7.4 - 7.7 |
| | 4 | Channel | 20 | 42.4 | 23.4 | 22.5 - 24.0 | 20.9 | 19.4 - 22.8 | 4.5 | 4.1 - 5.3 | 7.6 | 7.4 - 7.7 |
| | 5 | Nearshore | 4 | 11.8 | 21.5 | 21.5 - 21.6 | 23.1 | 23.0 - 23.2 | 5.2 | 5.1 - 5.5 | 7.6 | 7.6 - 7.6 |
| | | Shoreline | 15 | 9.0 | 22.2 | 21.4 - 24.0 | 22.5 | 18.8 - 24.4 | 5.3 | 4.7 - 6.4 | 7.6 | 7.4 - 7.7 |
| | | Shoreline/Nearshore | 11 | 15.2 | 23.5 | 23.1 - 23.8 | 17.7 | 16.3 - 20.6 | 4.9 | 4.4 - 5.1 | 7.6 | 7.6 - 7.7 |
| | 6 | Nearshore | 9 | 9.3 | 22.1 | 21.5 - 24.1 | 22.3 | 19.1 - 23.2 | 5.0 | 4.7 - 5.2 | 7.5 | 7.5 - 7.6 |
| | | Shoreline | 9 | 4.3 | 22.6 | 21.6 - 24.1 | 22.9 | 19.3 - 24.5 | 5.7 | 4.5 - 7.2 | 7.6 | 7.5 - 7.8 |
| | | Shoreline/Nearshore | 11 | 7.9 | 23.1 | 22.5 - 23.5 | 20.7 | 19.4 - 22.7 | 4.6 | 4.3 - 4.9 | 7.6 | 7.5 - 7.7 |
| | **All** | | **154** | **15.8** | **22.6** | **21.2 - 24.1** | **21.6** | **16.3 - 24.5** | **5.0** | **3.9 - 7.2** | **7.6** | **7.4 - 7.8** |

**Note:** Samples collected in the "shoreline/nearshore" stratum are all from benthic grab sampling.

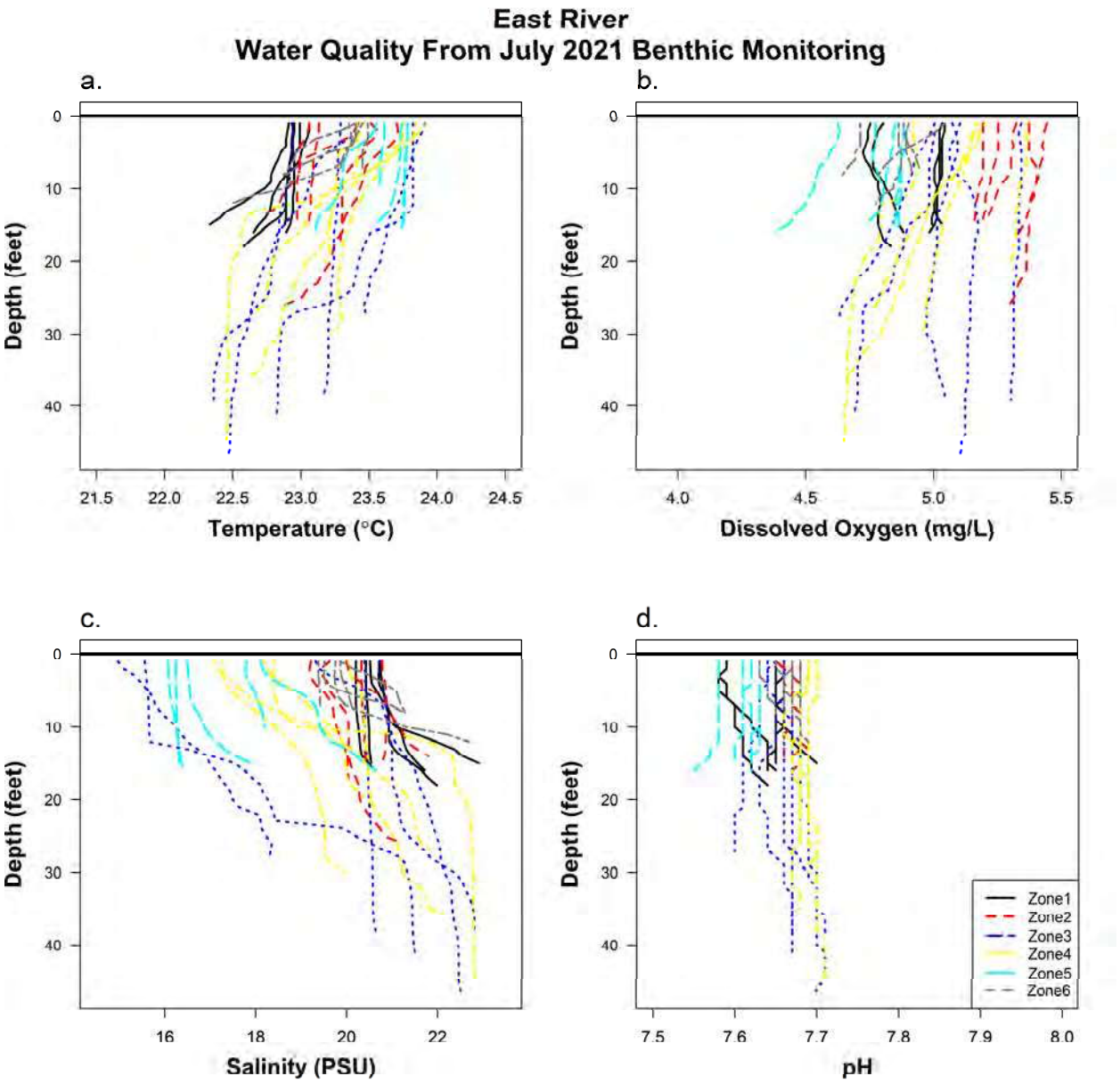



**Figure 22** – Depth profiles of water quality parameters measured during benthic grab sampling in July 2021. Similar water quality profiles were acquired to complement biological samples collected with each of the sampling gears.

*CURRENT VELOCITY*

NYCEDC collected a total of 154 current velocity measurements at biological sample sites during July 2021. Current velocity ranged from 0.051 to 1.54 meters per second ("m/s") (0.17 to 5.05 feet per second ["ft/s"]) and averaged 0.40 m/s (1.31 ft/s) (**Figure 23**). Most of the current velocity measurements (62% of all measurements) were less than 0.31 m/s (1.02 ft/s). Bottom depth measurements ranged from 1.5 to 66.8 feet (0.5 to 20.4 meters) and averaged 18 feet (5.5 meters) (**Figure 23**). **Figure 24** illustrates the observed increases in water depth and current velocity moving from the shoreline to nearshore to channel habitats, and the differences in water depth and current velocity among sampling zones.

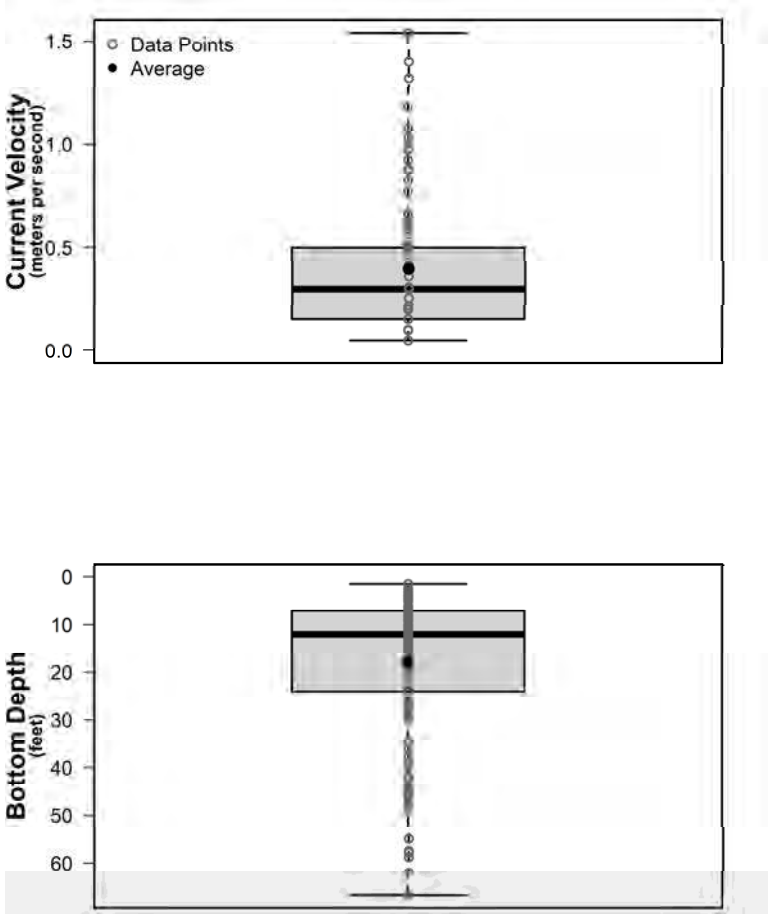



**Figure 23** – Current velocity and water depth measurements taken at sample sites in the lower East River during July 2021. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

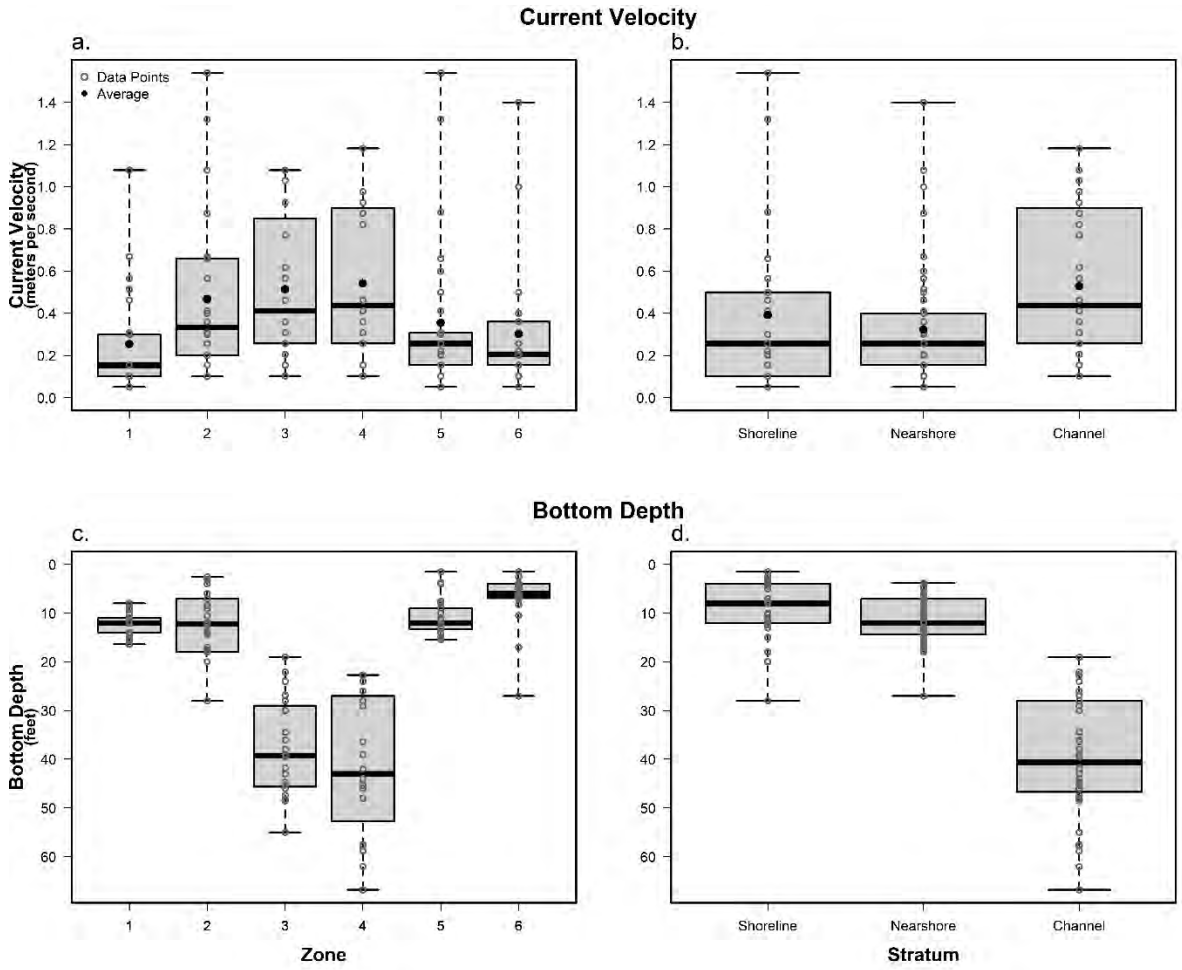



**Figure 24** – Current velocity and water depth measurements taken at sample sites in the lower East River during July 2021. Data are plotted to compare and contrast among zones and habitat strata. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

# C. AUGUST 2021 SAMPLING EVENT

## SUMMARY OF SAMPLE COLLECTION

This section of the report summarizes biological and habitat sampling conducted in the East River during August 2021. As outlined in the Sampling Plan, the August sampling event consisted of the following activities described in greater detail below:

- sampling with a 100-micron zooplankton sampler to estimate abundance of zooplankton and classify the community;
- sampling with a YSI water-quality monitoring instrument to measure chlorophyll-a and fluorescence as indicators of primary productivity of phytoplankton;
- sampling with a YSI water-quality monitoring instrument to measure water quality parameters (i.e., temperature, salinity, dissolved oxygen, and pH), which was conducted concurrently with each plankton sample; and
- measurements of current velocity at each sample site.

During the August sampling event, NYCEDC collected a total of 36 phytoplankton and zooplankton samples at randomly selected locations within each zone throughout the study area, along with water quality measurements.

## PHYTOPLANKTON AND ZOOPLANKTON

**Figure 25** shows the 36 locations that were concurrently sampled for phytoplankton and zooplankton during the August sampling event. NYCEDC collected six phytoplankton and six zooplankton samples in each of the six zones.

*PHYTOPLANKTON CHARACTERISTICS*

Chlorophyll-a and phycoerythrin (the green and red photosynthetic pigments) concentrations were measured using a YSI phosphorescence sensor as proxies for primary productivity associated with phytoplankton during sampling of the East River in August 2021. **Table 8** summarizes pigment concentrations are summarized by Zone and water depth. Similar to July, primary productivity in August was highest along the opposite shore in Brooklyn compared to the other zones, particularly near the bottom of the water column. **Figure 26** provides a comparison of primary productivity depth profiles among Zones. There were notable peaks in primary productivity observed at the bottom of the water column in Zones 1, 5, and 6. In the channel zones, primary productivity peaked near the surface and declined with depth before leveling off at a depth of approximately 10 to 20 feet.

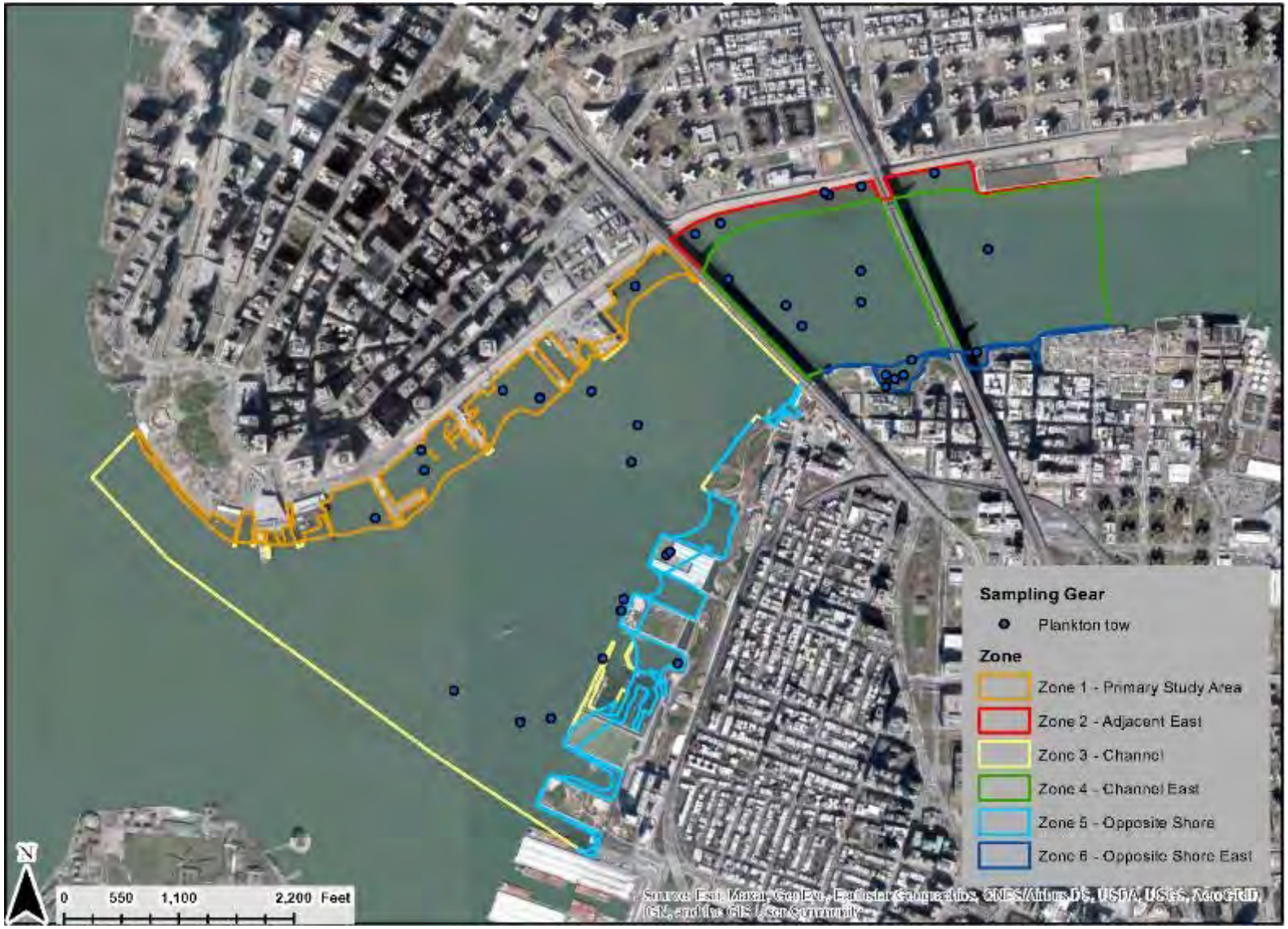



**Figure 25 –** Locations for plankton sampling conducted in the East River in August 2021.

**Table 8 – Primary productivity characteristics measured in the lower East River, NY during August 2021**

| Position | Zone | Study Area | N | Depth (ft) | Chlorophyll-a (µg/L) | | Phycoerythrin (µg/L) | |
|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range |
| Surface | 1 | Primary Study Area | 6 | 1.00 | 0.21 | 0.00 - 0.40 | 0.00 | 0.00 - 0.00 |
| | 2 | Adjacent East | 6 | 1.00 | 0.30 | 0.20 - 0.38 | 0.00 | 0.00 - 0.00 |
| | 3 | Channel | 6 | 1.00 | 0.61 | 0.35 - 0.74 | 0.00 | 0.00 - 0.00 |
| | 4 | Channel East | 6 | 1.00 | 0.46 | 0.35 - 0.56 | 0.00 | 0.00 - 0.00 |
| | 5 | Opposite Shore | 6 | 1.00 | 0.50 | 0.34 - 0.71 | 0.02 | 0.00 - 0.10 |
| | 6 | Opposite Shore East | 6 | 1.00 | 0.46 | 0.32 - 0.65 | 0.00 | 0.00 - 0.00 |
| | **All** | | 36 | 1.00 | 0.42 | **0.00 - 0.74** | 0.00 | **0.00 - 0.10** |
| Bottom | 1 | Primary Study Area | 6 | 14.33 | 0.44 | 0.13 - 1.31 | 0.24 | 0.00 - 1.45 |
| | 2 | Adjacent East | 6 | 15.67 | 0.27 | 0.10 - 0.52 | 0.00 | 0.00 - 0.00 |
| | 3 | Channel | 6 | 45.17 | 0.44 | 0.27 - 0.61 | 0.00 | 0.00 - 0.00 |
| | 4 | Channel East | 6 | 60.00 | 0.24 | 0.11 - 0.36 | 0.00 | 0.00 - 0.00 |
| | 5 | Opposite Shore | 6 | 14.67 | 1.36 | 0.53 - 3.43 | 1.78 | 0.00 - 6.48 |
| | 6 | Opposite Shore East | 6 | 9.17 | 0.86 | 0.27 - 1.93 | 0.76 | 0.00 - 3.67 |
| | **All** | | 36 | 26.50 | 0.60 | **0.10 - 3.43** | 0.46 | **0.00 - 6.48** |
| All Depths | 1 | Primary Study Area | 86 | 7.70 | 0.27 | 0.00 - 1.31 | 0.02 | 0.00 - 1.45 |
| | 2 | Adjacent East | 94 | 9.16 | 0.28 | 0.00 - 0.59 | 0.00 | 0.00 - 0.00 |
| | 3 | Channel | 271 | 24.26 | 0.41 | 0.07 - 0.84 | 0.00 | 0.00 - 0.00 |
| | 4 | Channel East | 360 | 31.26 | 0.32 | 0.00 - 0.81 | 0.00 | 0.00 - 0.00 |
| | 5 | Opposite Shore | 88 | 8.27 | 0.57 | 0.21 - 3.43 | 0.16 | 0.00 - 6.48 |
| | 6 | Opposite Shore East | 55 | 5.11 | 0.51 | 0.15 - 1.93 | 0.10 | 0.00 - 3.67 |
| | **All** | | 954 | 14.29 | 0.39 | **0.00 - 3.43** | 0.05 | **0.00 - 6.48** |

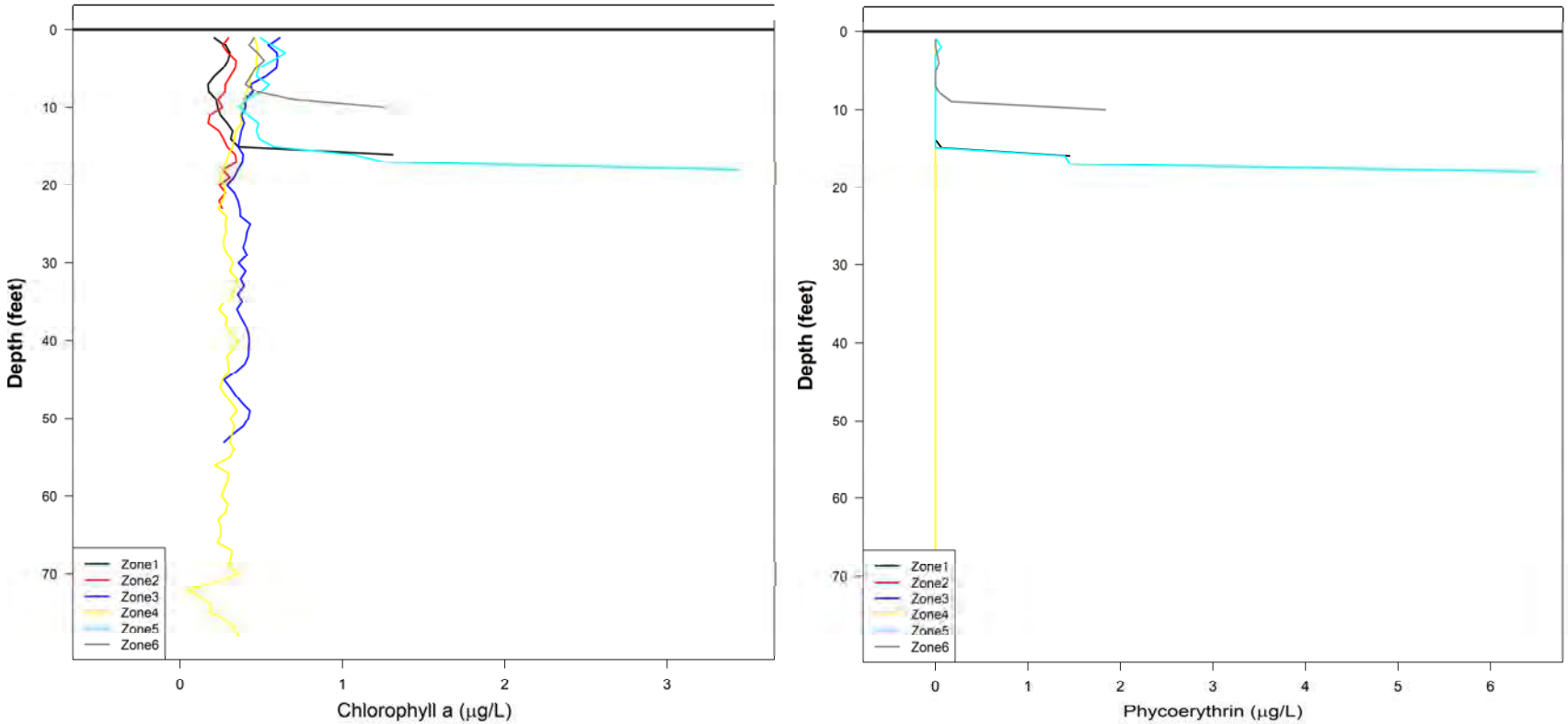



**Figure 26** – Depth profiles by zone for two proxies of primary productivity, chlorophyll-a and phycoerythrin, measured during phytoplankton sampling in August 2021. Chlorophyll-a and phycoerythrin were averaged across the six samples collected in each of the six zones. As observed in July, peak concentrations in Zones 1, 5, and 6 occurred at the bottom of the water column. Phycoerythrin concentrations in Zones 2, 3, and 4 were 0.00 µg/L.

*ZOOPLANKTON COMMUNITY*

The zooplankton community in the study area during August was dominated by calanoid copepods (*Acartia tonsa*, *Acartia* spp.), polychaete worm larvae, and rotifers. Other abundant taxa included barnacles, bivalves, and bryozoans (**Table 9 and Figures 27a, 27b, and 27c**). The highest zooplankton abundance was observed in the channel (Zones 3 and 4), where it was 4 to 10 times higher than in the shoreline/nearshore study areas. Similar to the July zooplankton results, the lowest abundance was observed along the Brooklyn shoreline (Zones 5 and 6). By contrast, species richness, defined here as the number of zooplankton species/taxa that represent 90% of all individuals collected in each zone, was highest along the Brooklyn shoreline and was considerably lower along the Manhattan shoreline (Zones 1 and 2) and in the Channel (Zones 3 and 4).

The calanoid copepod, *Acartia* sp. Was the most abundant zooplankton taxon in all zones in August. In the Primary Study Area (Zone 1), the other most dominant taxa included the rotifer, *Synchaeta* sp., the polychaete worm, Spionidae, and unidentified Bivalvia larvae.

**WATER QUALITY AND CURRENT VELOCITY**

NYCEDC collected water quality samples at the surface and bottom of the river concurrent with each of the 36 plankton samples collected in August (**Figure 28; Table 10**). Bottom samples were collected at a mean depth of 26.5 feet (8.1 meters).

*WATER QUALITY CHARACTERISTICS*

Four water quality parameters (i.e., temperature, salinity, DO, and pH) measured during sampling of the East River in August 2021 are summarized by zone and habitat stratum in **Table 10**. The overall mean and range of temperature, DO and pH were similar between the surface and bottom. The overall mean and range of salinity were higher in bottom waters compared to surface waters. **Figure 29** provides an example of depth profiles for water quality parameters.

**Table 9 – Summary of dominant zooplankton taxa collected from six plankton tows per zone in the lower East River, NY during August 2021**

| | Primary Study Area | Adjacent Upstream | Channel | Channel Upstream | Opposite Shoreline | Opposite Upstream |
|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| 5 Most Abundant Taxa | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod |
| | *Synchaeta* sp. Rotifer | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | *Balanus* sp. Barnacle | *Acartia tonsa* Calanoid copepod |
| | Spionidae Polychaete worm | Spionidae Polychaete worm | Spionidae Polychaete worm | Spionidae Polychaete worm | *Synchaeta* sp. Rotifer | *Balanus* sp. Barnacle |
| | *Acartia tonsa* Calanoid copepod | *Synchaeta* sp. Rotifer | *Balanus* sp. Barnacle | *Synchaeta* sp. Rotifer | *Electra pilosa* Bryozoan | *Electra pilosa* Bryozoan |
| | Bivalvia Bivalve | Bivalvia Bivalve | *Synchaeta* sp. Rotifer | Bivalvia Bivalve | Spionidae Polychaete worm | *Synchaeta* sp. Rotifer |
| Total Individuals | 22,342 | 12,405 | 87,217 | 84,709 | 7,857 | 6,365 |
| % of Total | 89 | 90 | 92 | 91 | 84 | 75 |
| Number of Taxa Representing 90% of Total | 6 | 5 | 5 | 5 | 8 | 11 |

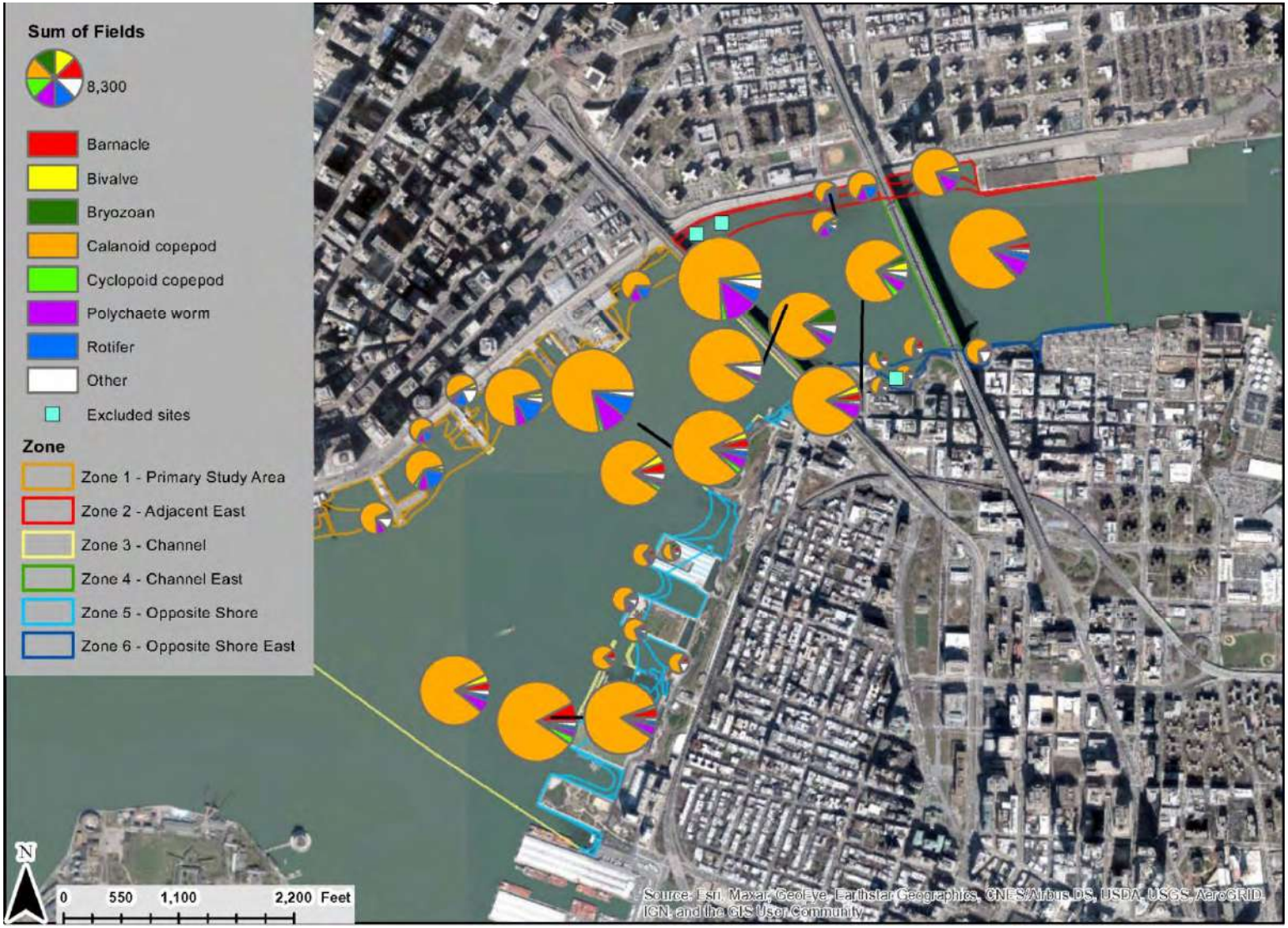



**Figure 27a –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the East River in August 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location. Low abundance sites, shown as light blue squares, were excluded from this figure for mapping purposes. Data for these sites are provided in **Figure 27c**.


**Figure 27b –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the lower half of the study area in August 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location.


**Figure 27c –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the upper half of the study area in August 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location. Note the difference in pie chart scale compared to **Figures 27a and 27b** due to the inclusion of low abundance sites.

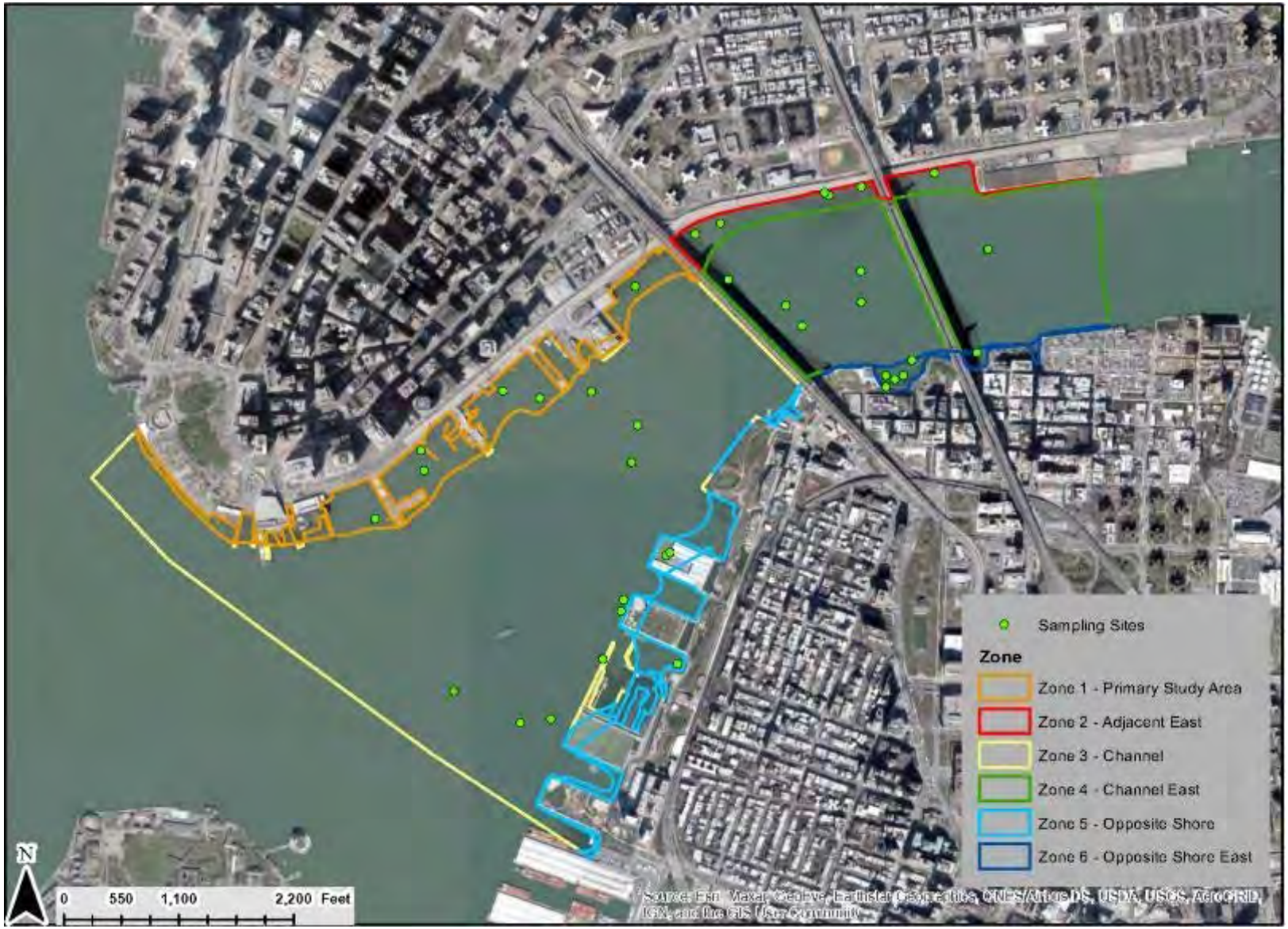



**Figure 28 –** Locations of water quality profiles associated with August 2021 biological sampling in the East River.

**Table 10 – Water quality parameters measured at surface and bottom locations in the lower East River, NY during August 2021**

| Position | Zone | Stratum | N | Depth (ft) | Temperature (C) | | Salinity (PSU) | | DO (mg/L) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Surface | 1 | Shoreline/Nearshore | 6 | 1.0 | 24.5 | 24.4 - 24.7 | 17.3 | 16.5 - 18.0 | 4.4 | 4.3 - 4.7 | 7.3 | 7.3 - 7.4 |
| | 2 | Shoreline/Nearshore | 6 | 1.0 | 24.7 | 24.5 - 24.8 | 17.2 | 16.1 - 17.9 | 4.5 | 4.3 - 4.8 | 7.4 | 7.3 - 7.4 |
| | 3 | Channel | 6 | 1.0 | 25.1 | 24.8 - 25.3 | 12.1 | 10.1 - 14.2 | 5.2 | 4.8 - 5.5 | 7.4 | 7.4 - 7.5 |
| | 4 | Channel | 6 | 1.0 | 25.0 | 24.8 - 25.1 | 13.9 | 13.1 - 15.0 | 5.2 | 5.0 - 5.3 | 7.5 | 7.4 - 7.5 |
| | 5 | Shoreline/Nearshore | 6 | 1.0 | 25.1 | 25.0 - 25.3 | 12.0 | 11.5 - 12.3 | 5.4 | 5.2 - 5.8 | 7.5 | 7.4 - 7.5 |
| | 6 | Shoreline/Nearshore | 6 | 1.0 | 24.9 | 24.5 - 25.1 | 16.4 | 15.9 - 17.7 | 5.1 | 4.8 - 5.3 | 7.5 | 7.5 - 7.5 |
| | **All** | | **36** | **1.0** | **24.9** | **24.4 - 25.3** | **14.8** | **10.1 - 18.0** | **5.0** | **4.3 - 5.8** | **7.4** | **7.3 - 7.5** |
| Bottom | 1 | Shoreline/Nearshore | 6 | 14.3 | 24.2 | 24.0 - 24.4 | 18.6 | 17.6 - 19.4 | 4.4 | 4.2 - 4.5 | 7.3 | 7.3 - 7.4 |
| | 2 | Shoreline/Nearshore | 6 | 15.7 | 24.5 | 24.2 - 24.7 | 17.9 | 16.5 - 18.9 | 4.4 | 4.2 - 4.7 | 7.4 | 7.3 - 7.4 |
| | 3 | Channel | 6 | 45.2 | 23.9 | 23.7 - 24.1 | 19.8 | 19.1 - 20.8 | 4.5 | 4.5 - 4.6 | 7.4 | 7.4 - 7.5 |
| | 4 | Channel | 6 | 60.0 | 24.0 | 23.8 - 24.4 | 19.4 | 17.1 - 20.2 | 4.6 | 4.5 - 4.8 | 7.4 | 7.4 - 7.5 |
| | 5 | Shoreline/Nearshore | 6 | 14.7 | 24.9 | 24.5 - 25.1 | 13.3 | 12.0 - 16.2 | 5.2 | 5.0 - 5.6 | 7.4 | 7.4 - 7.5 |
| | 6 | Shoreline/Nearshore | 6 | 9.2 | 24.3 | 23.9 - 24.6 | 18.2 | 17.0 - 19.7 | 5.0 | 4.6 - 5.2 | 7.4 | 7.4 - 7.5 |
| | **All** | | **36** | **26.5** | **24.3** | **23.7 - 25.1** | **17.9** | **11.9 - 20.8** | **4.7** | **4.2 - 5.6** | **7.4** | **7.3 - 7.5** |

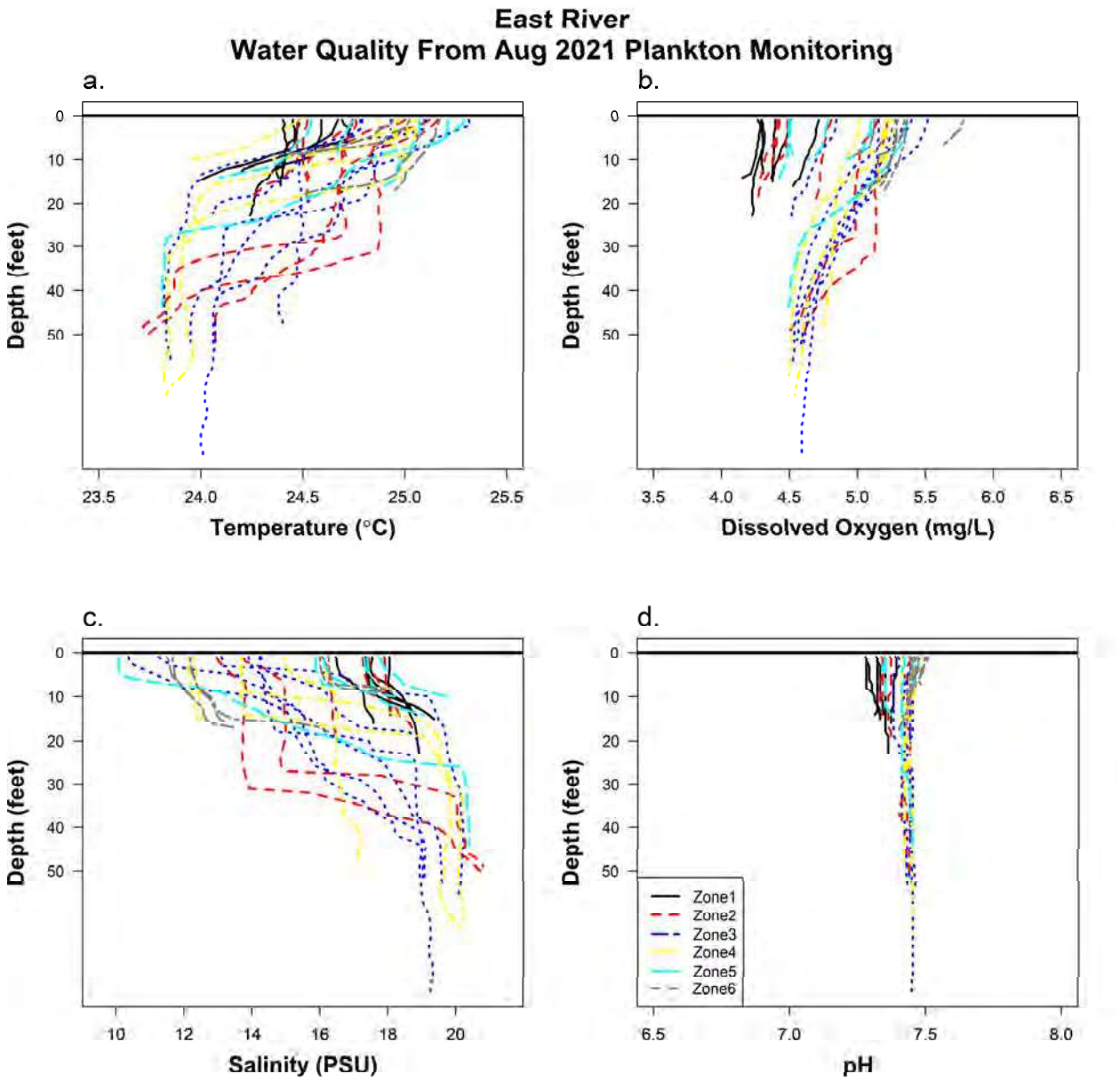



**Figure 29** – Depth profiles of water quality parameters measured during plankton sampling in August 2021.

*CURRENT VELOCITY*

NYCEDC collected a total of 36 current velocity measurements during plankton monitoring in August 2021. Current velocity ranged from 0.10 to 1.34 m/s (0.34 to 4.40 feet per second ft/s) and averaged 0.53 m/s (1.74 ft/s) (**Figure 30**). Bottom depth measurements ranged from 7.1 to 79.9 feet (2.2 to 24.4 meters) and averaged 27.0 feet (8.2 meters) (**Figure 30**). **Figure 31** illustrates the observed increases in water depth and current velocity moving from the nearshore to channel habitats, and the differences in water depth and current velocity among sampling zones.

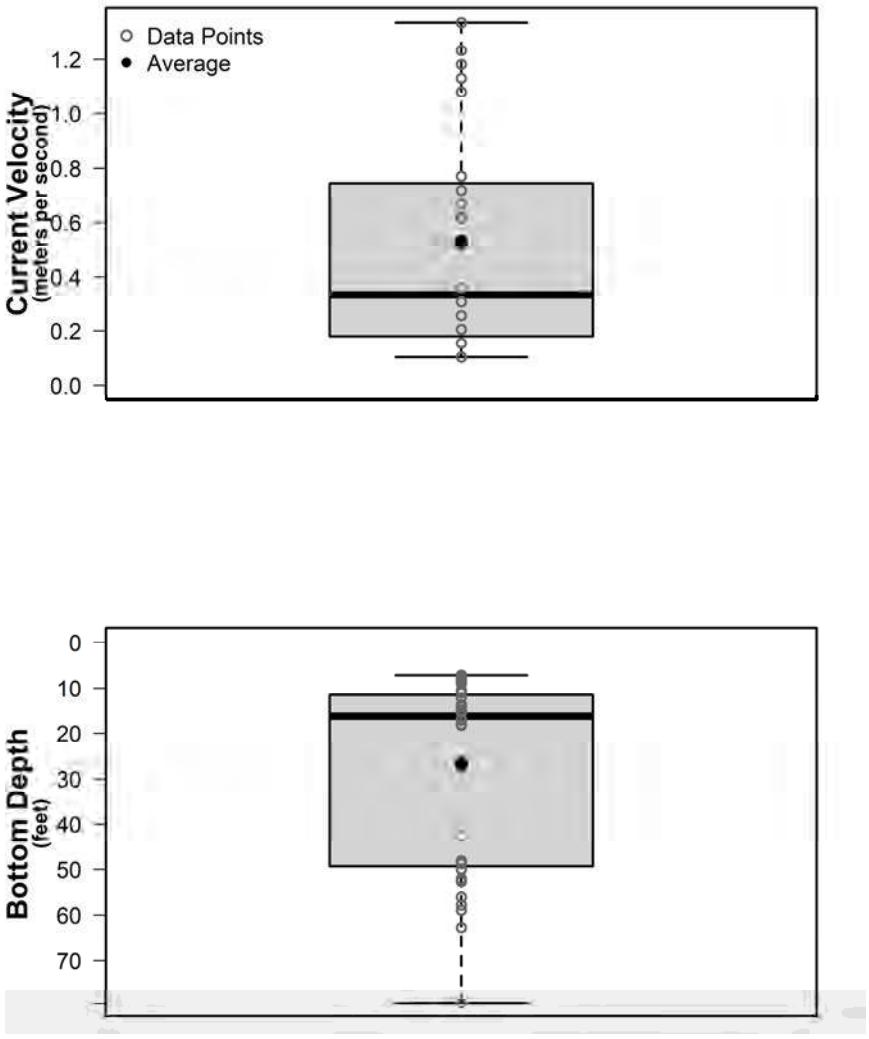



**Figure 30** – Current velocity and water depth measurements taken at sample sites in the lower East River during August 2021. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

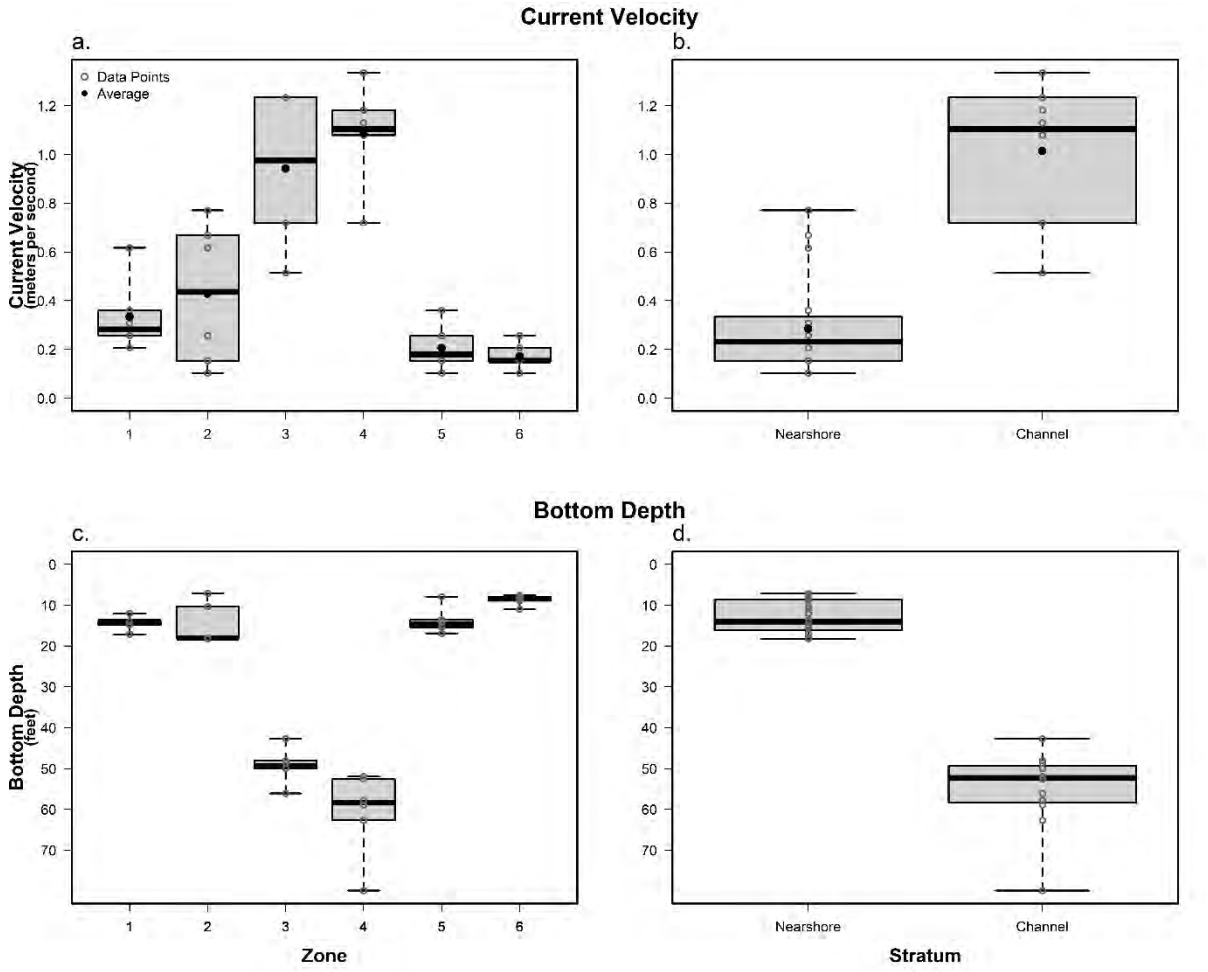



**Figure 31** – Current velocity and water depth measurements taken at sample sites in the lower East River during August 2021. Data are plotted to compare and contrast among zones and habitat strata. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

# D. SEPTEMBER 2021 SAMPLING EVENT

## SUMMARY OF SAMPLE COLLECTION

This section of the report summarizes biological and habitat sampling conducted in the East River during September 2021. As outlined in the Sampling Plan, the September sampling event consisted of the following activities described in greater detail below:

- sampling with a 100-micron zooplankton sampler to estimate abundance of zooplankton and classify the community;
- sampling with a YSI water-quality monitoring instrument to measure water quality parameters (i.e., temperature, salinity, dissolved oxygen and pH), which was conducted concurrently with each plankton sample; and
- measurements of current velocity at each sample site.

During the September sampling event, NYCEDC collected a total of 36 zooplankton samples at randomly selected locations within each zone throughout the study area, along with water quality measurements.

## ZOOPLANKTON

**Figure 32** shows the 36 locations that were sampled for zooplankton during the September sampling event. NYCEDC collected six zooplankton samples in each of the six zones.

### *ZOOPLANKTON COMMUNITY*

The zooplankton community in the study area during September was dominated by calanoid copepods (*Acartia tonsa* and *Acartia* spp.). Other abundant taxa included polychaete worms and ciliates (**Table 11 and Figures 33a, 33b, and 33c**). As was observed during zooplankton sampling in July and August, the highest zooplankton abundance occurred in the channel (Zones 3 and 4) in September, where it was an order of magnitude higher than in the shoreline/nearshore areas. The lowest abundance was occurred along the Opposite upstream shoreline (Zone 6). Species richness, defined here as the number of zooplankton species/taxa that represent 90% of all individuals collected in each zone, was considerably higher in the Primary study area (Zone 1) than in each of the other zones and was lowest in the Adjacent Upstream (Zone 2) and Channel (Zones 3 and 4).

The calanoid copepod taxon *Acartia* sp. was the most abundant zooplankton taxon in the study area and was most abundant in all Zones in September. In the Primary Study Area (Zone 1), the other most dominant taxa included the polychaete worm, Spionidae, the ciliate, *Favella ehrenbergii*, and unidentified Bivalvia.

## WATER QUALITY AND CURRENT VELOCITY

NYCEDC collected water quality samples at the surface and bottom of the river concurrent with each of the 36 plankton samples collected in September (**Figure 34; Table 12**). Bottom samples were collected at a mean depth of 26.4 feet (8.1 meters).

### *WATER QUALITY CHARACTERISTICS*

**Table 12** summarizes four water quality parameters (i.e., temperature, salinity, DO, and pH) measured during sampling of the East River in September 2021 by zone and habitat stratum in. The overall mean and range of temperature, DO and pH were similar between the surface and bottom. The overall mean and range of salinity were higher in bottom waters compared to surface waters. **Figure 35** provides an example of depth profiles for water quality parameters.


**Figure 32 –** Locations for zooplankton sampling conducted in the East River in September 2021.

**Table 11 – Summary of dominant zooplankton taxa from six plankton tows per zone in the lower East River, NY during September 2021**

| | Primary Study Area | Adjacent Upstream | Channel | Channel Upstream | Opposite Shoreline | Opposite Upstream |
|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| 5 Most Abundant Taxa | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod |
| | Spionidae Polychaete worm | Spionidae Polychaete worm | Spionidae Polychaete worm | *Acartia tonsa* Calanoid copepod | *Favella ehrenbergii* Ciliate | *Favella ehrenbergii* Ciliate |
| | *Favella ehrenbergii* Ciliate | *Favella ehrenbergii* Ciliate | *Favella ehrenbergii* Ciliate | Spionidae Polychaete worm | Spionidae Polychaete worm | Spionidae Polychaete worm |
| | *Acartia tonsa* Calanoid copepod | Bivalvia Bivalve | Gastropoda Gastropod | *Favella ehrenbergii* Ciliate | *Acartia tonsa* Calanoid copepod | *Hemicyclops* sp. Cyclopoid copepod |
| | Bivalvia Bivalve | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | Bivalvia Bivalve | *Balanus* sp. Barnacle | *Acartia tonsa* Calanoid copepod |
| Total Individuals | 16,004 | 10,023 | 104,114 | 71,547 | 14,824 | 7,506 |
| % of Total | 73 | 88 | 89 | 87 | 84 | 79 |
| Number of Taxa Representing 90% of Total | 14 | 6 | 6 | 7 | 9 | 8 |

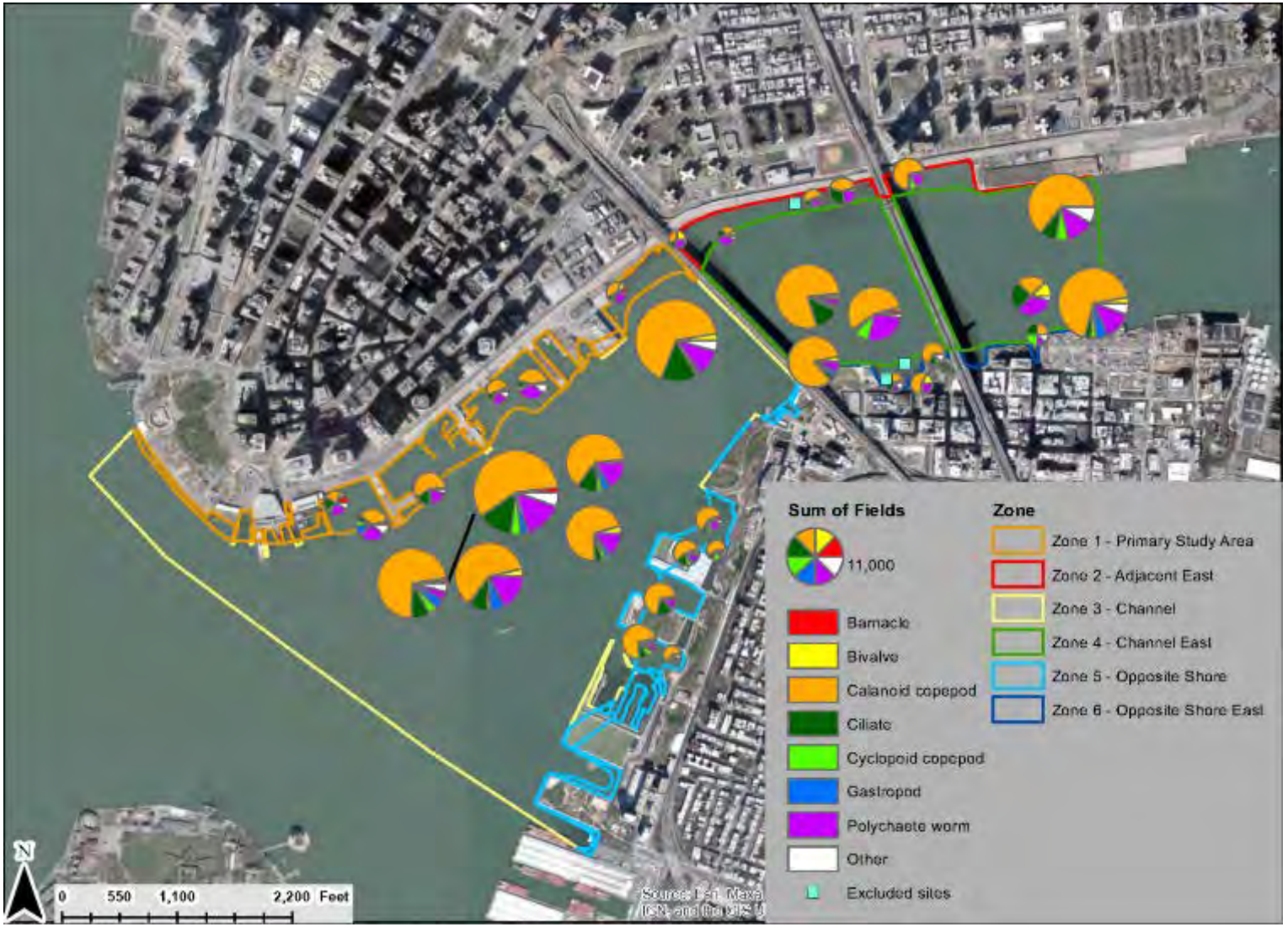



**Figure 33a –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the East River in September 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location. Low abundance sites were excluded for mapping purposes. Data from these sites are provided on **Figure 33c**.


**Figure 33b –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the lower half of the study area in September 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location.

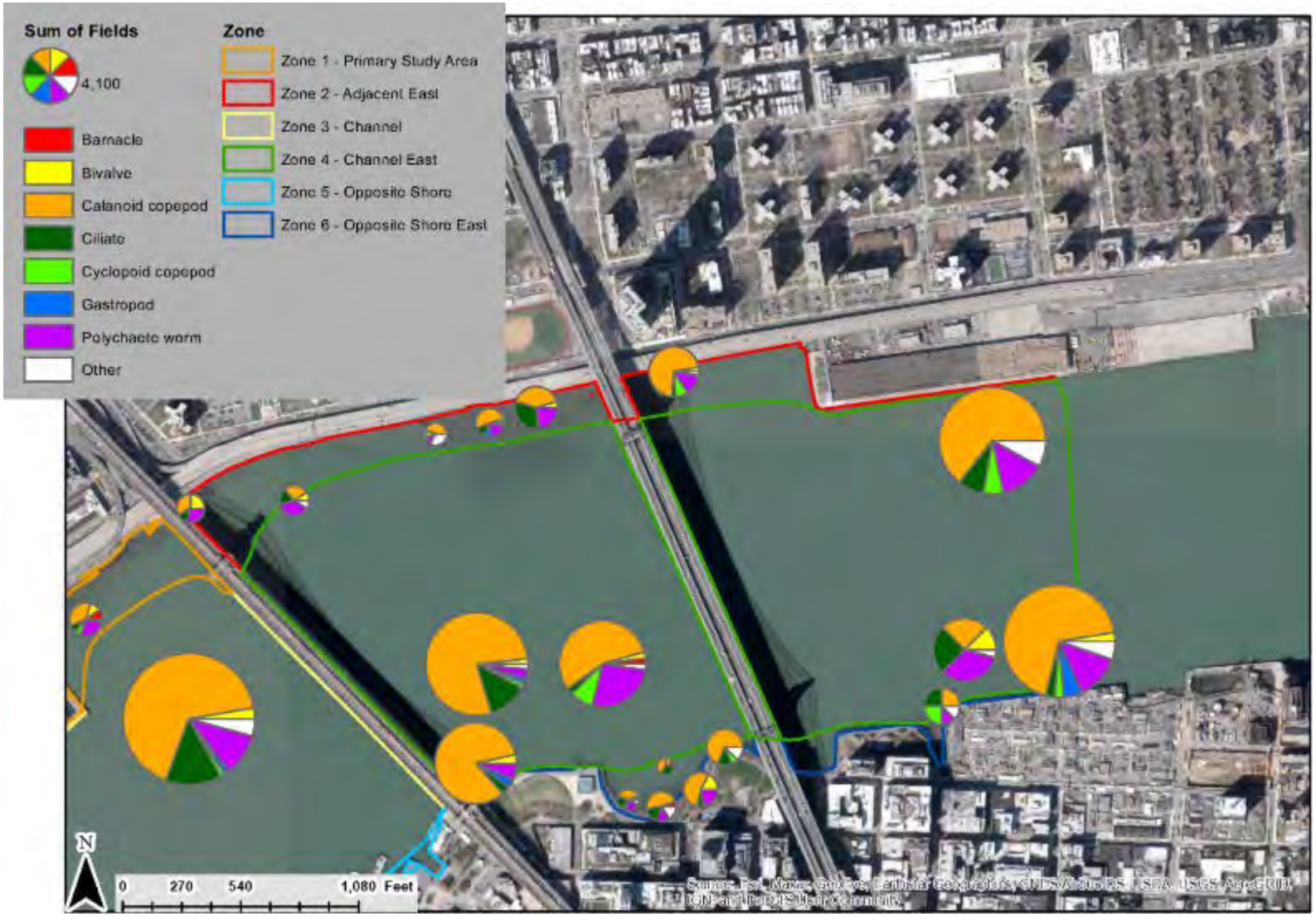



**Figure 33c –** Species composition and proportional abundance of zooplankton collected during plankton tows conducted in the upper half of the study area in September 2021. The size of each pie chart is proportionate to the abundance of zooplankton collected at each location. Note the difference in pie chart scale compared to **Figures 33a and 33b** due to the inclusion of low abundance sites

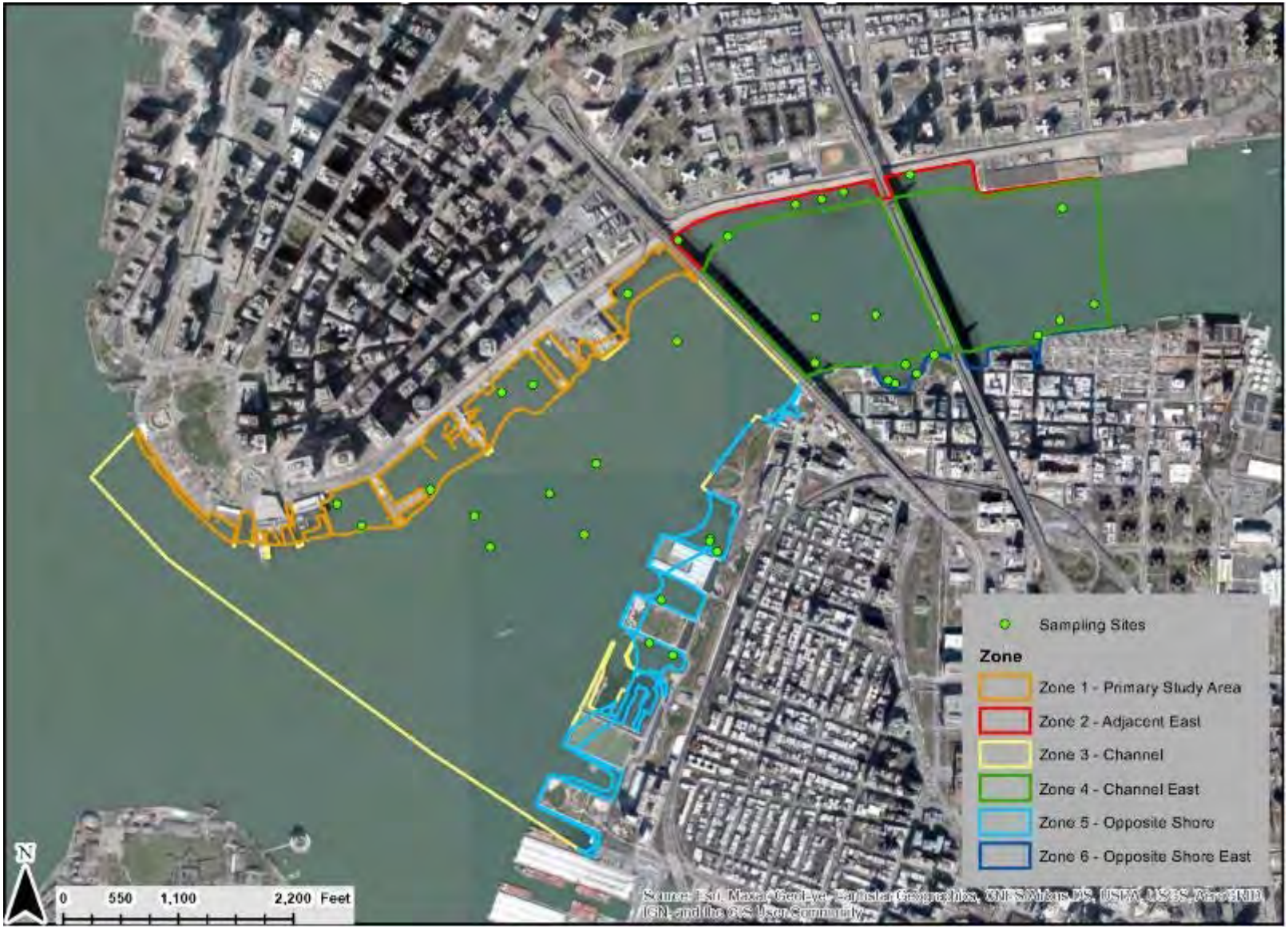



**Figure 34 –** Locations of water quality profiles associated with September 2021 biological sampling in the East River.

**Table 12 – Water quality parameters measured at surface and bottom locations in the lower East River, NY during September 2021**

| Position | Zone | Stratum | N | Depth (ft) | Temperature (C) | | Salinity (PSU) | | DO (mg/L) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Surface | 1 | Shoreline/Nearshore | 6 | 1.0 | 22.4 | 22.4 - 22.5 | 21.0 | 20.6 - 21.4 | 5.7 | 5.5 - 5.8 | 7.6 | 7.6 - 7.7 |
| | 2 | Shoreline/Nearshore | 6 | 1.0 | 22.5 | 22.4 - 22.5 | 21.1 | 20.7 - 21.4 | 5.6 | 5.6 - 5.8 | 7.6 | 7.6 - 7.7 |
| | 3 | Channel | 6 | 1.0 | 22.5 | 22.4 - 22.5 | 21.4 | 21.2 - 21.6 | 6.0 | 5.9 - 6.2 | 7.7 | 7.7 - 7.7 |
| | 4 | Channel | 6 | 1.0 | 22.4 | 22.4 - 22.5 | 21.8 | 21.5 - 22.0 | 5.8 | 5.8 - 5.9 | 7.7 | 7.7 - 7.7 |
| | 5 | Shoreline/Nearshore | 6 | 1.0 | 22.5 | 22.5 - 22.7 | 21.5 | 21.4 - 21.5 | 5.7 | 5.6 - 5.7 | 7.7 | 7.6 - 7.7 |
| | 6 | Shoreline/Nearshore | 6 | 1.0 | 22.4 | 22.4 - 22.4 | 21.8 | 21.7 - 22.0 | 5.8 | 5.7 - 5.8 | 7.7 | 7.7 - 7.7 |
| | **All** | | **36** | **1.0** | **22.5** | **22.4 - 22.7** | **21.4** | **20.6 - 22.0** | **5.8** | **5.5 - 6.2** | **7.7** | **7.6 - 7.7** |
| Bottom | 1 | Shoreline/Nearshore | 6 | 15.8 | 22.4 | 22.4 - 22.5 | 21.3 | 20.7 - 21.5 | 5.7 | 5.4 - 5.7 | 7.6 | 7.6 - 7.7 |
| | 2 | Shoreline/Nearshore | 6 | 18.2 | 22.4 | 22.4 - 22.4 | 21.7 | 21.4 - 21.8 | 5.6 | 5.6 - 5.7 | 7.7 | 7.7 - 7.7 |
| | 3 | Channel | 6 | 49.0 | 22.3 | 22.3 - 22.3 | 22.3 | 21.9 - 22.8 | 5.8 | 5.8 - 5.9 | 7.7 | 7.7 - 7.7 |
| | 4 | Channel | 6 | 48.8 | 22.3 | 22.3 - 22.4 | 22.0 | 21.5 - 22.5 | 5.8 | 5.7 - 5.8 | 7.7 | 7.7 - 7.7 |
| | 5 | Shoreline/Nearshore | 6 | 15.0 | 22.4 | 22.3 - 22.5 | 22.0 | 21.5 - 22.2 | 5.6 | 5.6 - 5.7 | 7.7 | 7.7 - 7.7 |
| | 6 | Shoreline/Nearshore | 6 | 11.3 | 22.4 | 22.3 - 22.4 | 22.0 | 21.9 - 22.1 | 5.7 | 5.7 - 5.8 | 7.7 | 7.7 - 7.7 |
| | **All** | | **36** | **26.4** | **22.4** | **22.3 - 22.5** | **21.9** | **20.7 - 22.8** | **5.7** | **5.4 - 5.9** | **7.7** | **7.6 - 7.7** |

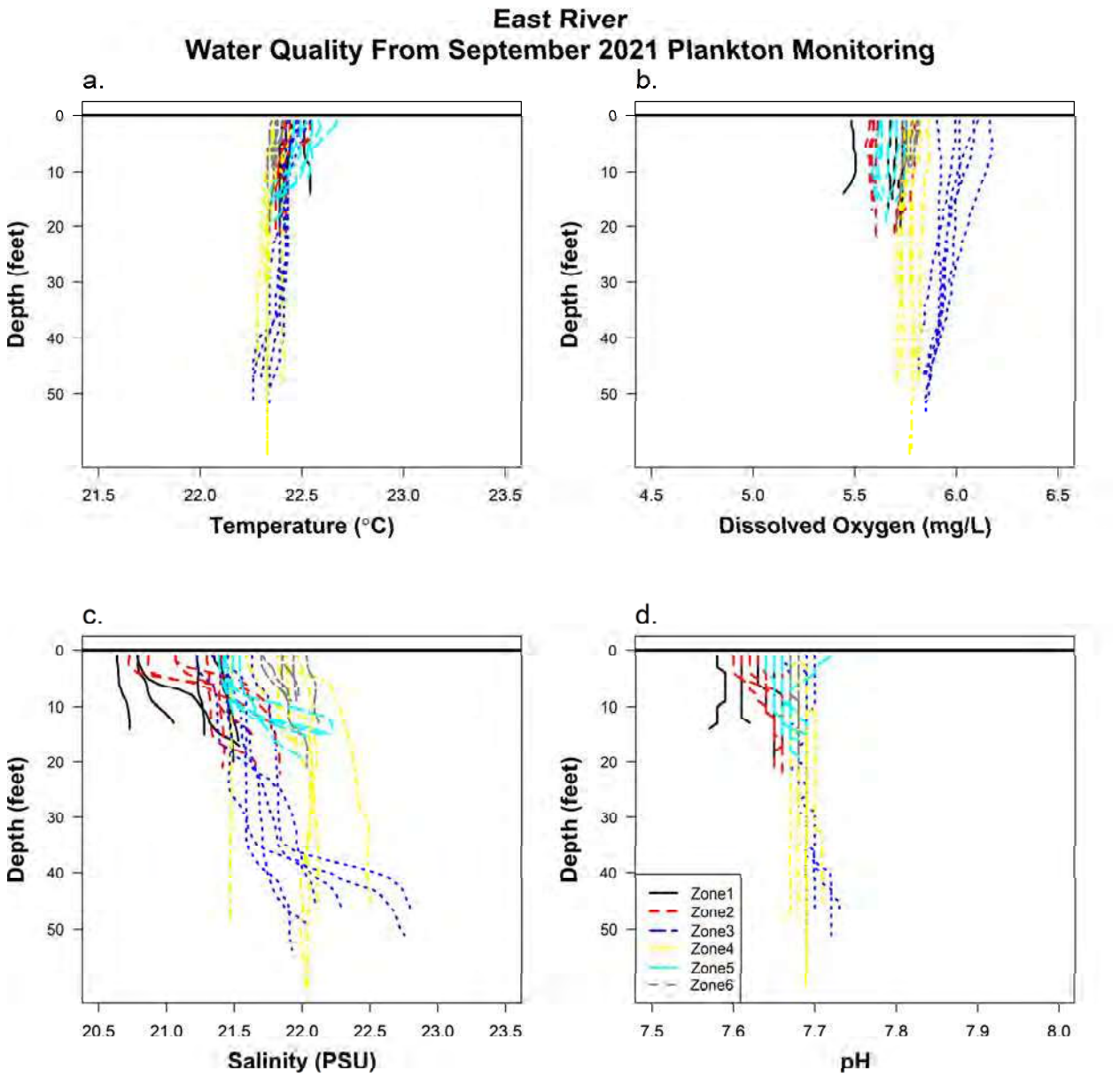



**Figure 35** – Depth profiles of water quality parameters measured during plankton sampling in September 2021.

*CURRENT VELOCITY*

NYCEDC collected a total of 36 current velocity measurements during plankton monitoring in September. Current velocity ranged from 0.051 to 1.54 m/s (0.17 to 5.05 feet per second ft/s) and averaged 0.44 m/s (1.44 ft/s) (**Figure 36**). Bottom depth measurements ranged from 8.5 to 58.0 feet (2.6 to 17.7 meters) and averaged 25.3 feet (7.7 meters) (**Figure 36**). **Figure 37** illustrates the observed increases in water depth and current velocity moving from nearshore to channel habitats, and the differences in water depth and current velocity among sampling zones.

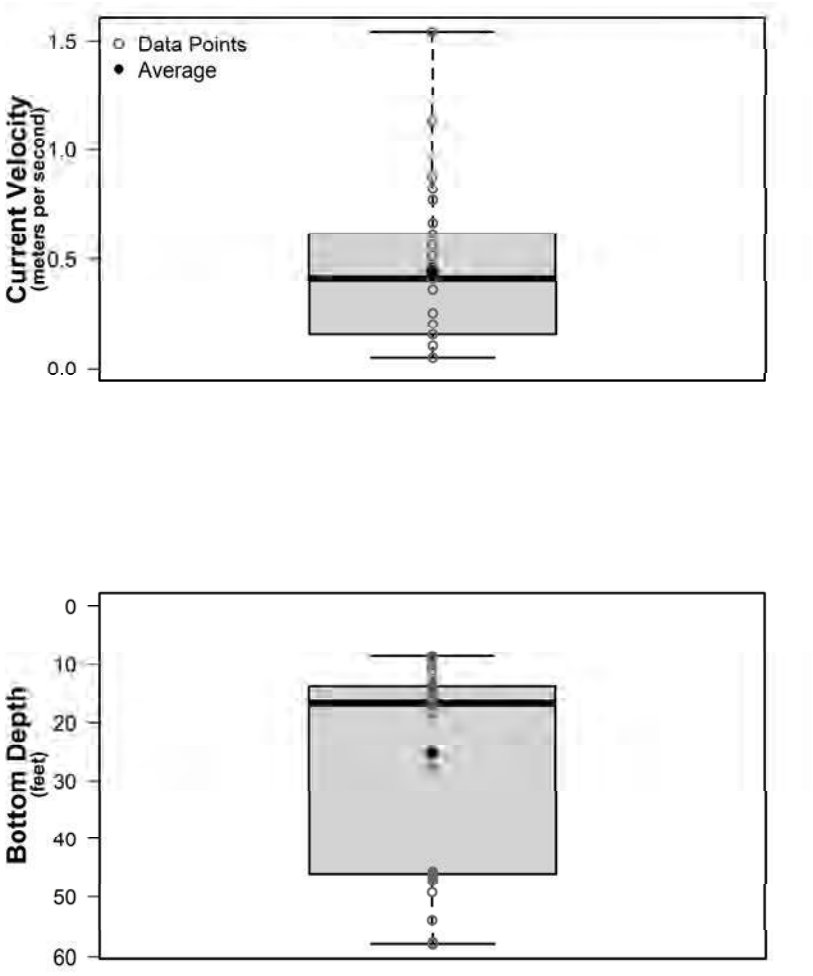



**Figure 36** – Current velocity and water depth measurements taken at sample sites in the lower East River during September 2021. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

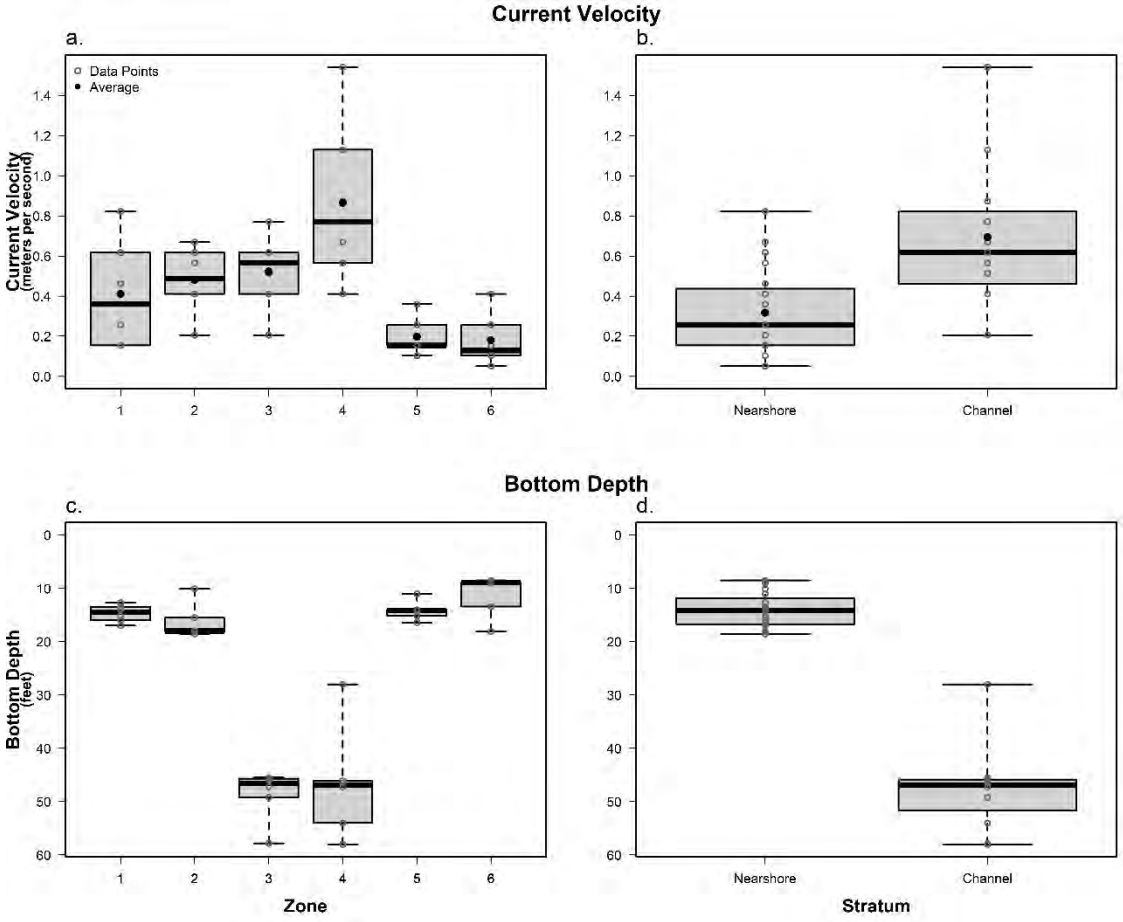



**Figure 37** – Current velocity and water depth measurements taken at sample sites in the lower East River during September 2021. Data are plotted to compare and contrast among zones and habitat strata. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

# E. SYNTHESIS OF YEAR 1 RESULTS FROM THE NYCEDC BIOLOGICAL AND HABITAT SAMPLING PROGRAM

## YEAR 1 SAMPLING EFFORT

Over four seasonal sampling events conducted from October 2020 through September 2021 during Year 1 of the Biological and Habitat Sampling Program, NYCEDC collected a total of 354 samples for finfish, including 42 seine samples, 60 bottom trawl samples, 20 midwater trawl samples, 72 baited fish trap samples (paired), and 160 remote sensing samples (**Table 13**). All finfish and shellfish collected from those sampling efforts were returned to the East River after they were documented. Further, NYCEDC collected a total of 90 benthic invertebrate and sediment grab samples and 108 phytoplankton and zooplankton samples (**Table 13**). All collected benthic invertebrate and zooplankton specimens were retained and preserved for

laboratory analysis. Water quality and current velocity samples were collected concurrent with each biological sample to provide physical habitat data at each sample site.

**Table 13 – Number of samples collected by gear type during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| Sampling Gear | Number of Samples Collected | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fall | Winter | Spring | Summer | | | |
| | Oct-20 | Jan-21 | Apr-21 | Jul-21 | Aug-21 | Sep-21 | Total |
| Seine Net | 14 | -- | 14 | 14 | -- | -- | **42** |
| Bottom Trawl | 10 | 30 | 10 | 10 | -- | -- | **60** |
| Midwater Trawl | -- | -- | 20 | -- | -- | -- | **20** |
| Baited Fish Traps (Paired) | 24 | -- | 24 | 24 | -- | -- | **72** |
| Remote Sensing | 40 | 40 | 40 | 40 | -- | -- | **160** |
| Benthic Invertebrate and Sediment Grab | 30 | -- | 30 | 30 | -- | -- | **90** |
| Phytoplankton and Zooplankton | -- | -- | -- | 36 | 36 | 36 | **108** |
| **Total** | **118** | **70** | **138** | **154** | **36** | **36** | **472** |

## PHYSICAL HABITAT

Benthic grabs for sediment samples were collected across the four sampling events. There was generally a higher proportion of sand and gravel in samples collected upstream of Pier 17 (i.e., in Zones 2, 4, and 6), and a higher proportion of silt and clay downstream of Pier 17 (i.e., in Zones 1, 3, and 5), particularly along the Brooklyn shoreline (Zone 5) where fine clays were most prevalent. In the Primary Study Area (Zone 1), benthic sediment was primarily fine silt with some clay and sand in lesser proportions.

Sediment data were used to interpolate bottom sediment throughout the study area to create a sediment map (**Figure 38**). The map shows a predominance of sandy silt throughout much of the study area with areas of finer clayey silt downstream of the Brooklyn Bridge. Upstream of the Brooklyn Bridge, silty sand is most common, with areas of sandy silt, but little clay.

Waters temperatures varied among seasons during Year 1 sampling, ranging from 4.6°C in January to 24.9°C in August, but varied minimally among zones (**Table 14**) and were 0.5 to 1.0 °C warmer in the channel zones (3 and 4) than the shoreline zones when differences occurred. Salinity exhibited more variation among seasons than among zones, ranging from 14.8 PSU in August to 25.0 PSU in October. Salinity was typically lower in the channel (Zones 3 and 4) and highest along the Manhattan shoreline (Zones 1 and 2), but was similar among zones during the late summer and fall seasons. Significant seasonal variation in DO was observed, ranging from 5.0 to 5.8 mg/L during the summer months to 10.0 mg/L during the winter; however, DO levels were similar among zones. pH did not vary within the study area, but was lowest during summer when water temperatures were warmest and highest during winter when temperatures were coolest.

Current velocity was measured during sampling with each of the gears during year 1. **Figure 39** provides a summary of the variation in current velocity measurements among zones and seasons. Current velocities were generally between 0.1 and 0.8 meters per second; an exception to this occurred in Zone 3 during January and Zones 3 and 4 during August, when the average current velocity was approximately 1 meter per second. The highest current velocity measurements were generally observed in the channel zones (i.e., Zones 3 and 4), but the difference in current velocity between the channel zones and the other zones was often small with the exception of January and August. The current velocities observed in along the Manhattan shore of the East River (i.e., Zones 1 and 2) were generally higher than those observed along the Brooklyn shore (i.e., Zones 5 and 6). The most variable current velocities were observed in Zones 2, 3, and 4.

Remote sensing data and satellite photographs were used to create a habitat map of the study area (**Figure 40**). Remote sensing data were used to identify structure on the river bottom that may serve as habitat for the aquatic community. Identified structure included cars, debris (e.g., tires, woody debris, rock), large debris, rock piles, and sand waves. Satellite photographs were used to classify the shoreline throughout the study area as bulkhead shoreline, overwater structure, and sloped shoreline. Areas characterized by the presence of complex, structured habitat occur throughout nearshore areas, interspersed by areas of homogenous, river bottom without structure. Sand wave features on the river bottom occur in the Primary Study Area (Zone 1), and in the nearshore area between the bridges on the Manhattan and Brooklyn shorelines (Zones 2 and 6).

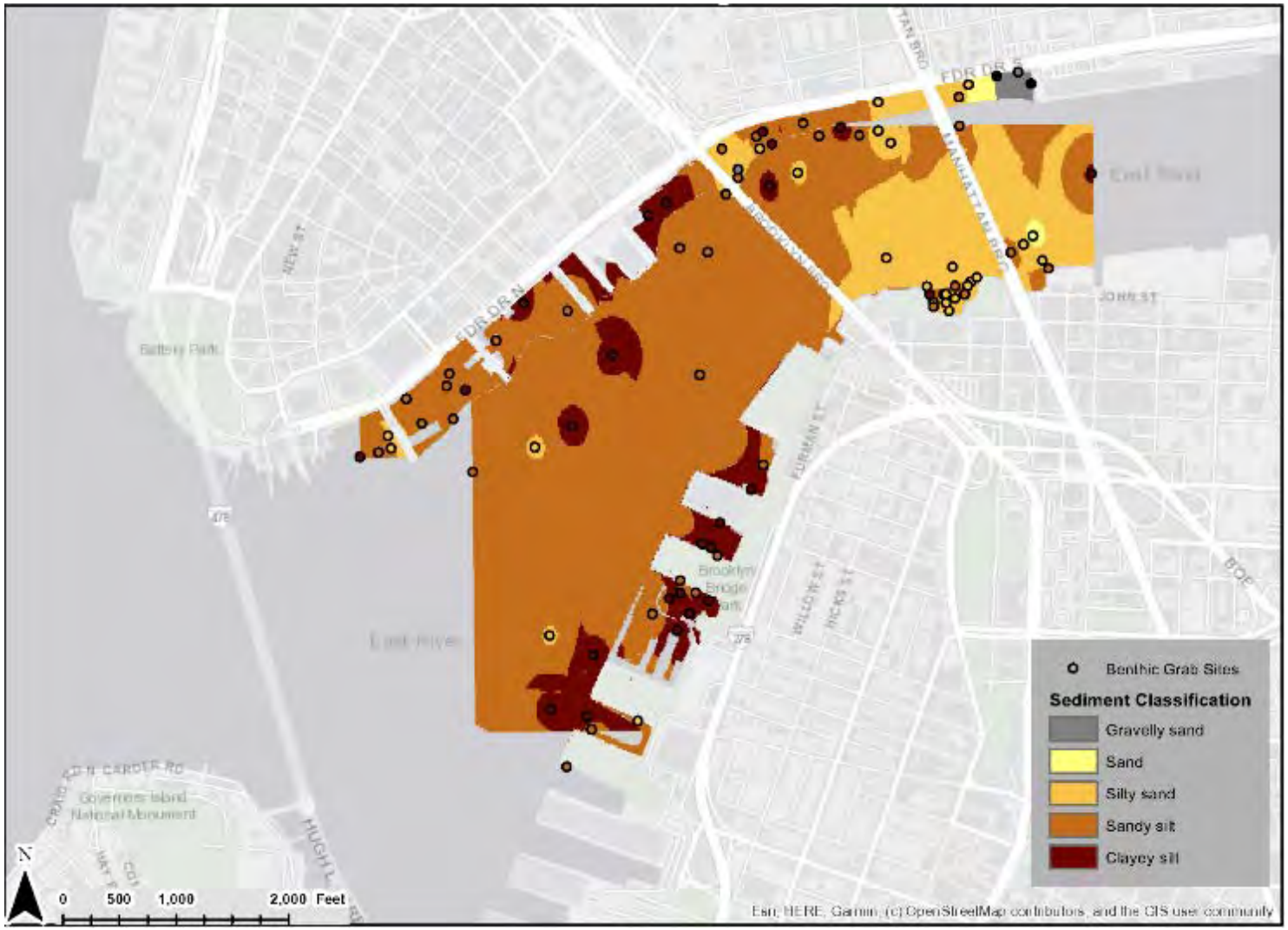



**Figure 38 –** Map showing sediment composition of benthic grab samples (indicated by circles with fill color representing sediment classification) collected during Year 1 and interpolated bottom sediment.

**Table 14 – Average water quality parameters measured at surface locations in each zone and sampling month during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| Zone | Fall | Winter | Spring | Summer | | | Average |
|---|---|---|---|---|---|---|---|
| | Oct-20 | Jan-21 | Apr-21 | Jul-21 | Aug-21 | Sep-21 | |
| **Temperature (℃)** | | | | | | | |
| 1 | 17.7 | 5.0 | 9.4 | 22.6 | 24.5 | 22.4 | 16.9 |
| 2 | 17.9 | 4.7 | 9.4 | 22.6 | 24.7 | 22.5 | 17.0 |
| 3 | 18.7 | 4.5 | 9.4 | 23.8 | 25.1 | 22.5 | 17.3 |
| 4 | 18.5 | 4.6 | 9.6 | 23.8 | 25.0 | 22.4 | 17.3 |
| 5 | 17.5 | 4.3 | 9.8 | 23.0 | 25.1 | 22.5 | 17.0 |
| 6 | 17.4 | 4.6 | 9.5 | 22.7 | 24.9 | 22.4 | 16.9 |
| **Average** | **18.0** | **4.6** | **9.5** | **23.1** | **24.9** | **22.5** | **17.1** |
| **Salinity (PSU)** | | | | | | | |
| 1 | 25.2 | 24.2 | 22.2 | 21.2 | 17.3 | 21.0 | 21.9 |
| 2 | 24.9 | 23.9 | 22.1 | 21.9 | 17.2 | 21.1 | 21.9 |
| 3 | 25.1 | 21.1 | 20.0 | 17.6 | 12.1 | 21.4 | 19.6 |
| 4 | 25.0 | 23.6 | 18.8 | 19.0 | 13.9 | 21.8 | 20.4 |
| 5 | 24.9 | 22.5 | 20.4 | 19.8 | 12.0 | 21.5 | 20.2 |
| 6 | 24.8 | 23.3 | 22.1 | 21.6 | 16.4 | 21.8 | 21.7 |
| **Average** | **25.0** | **23.1** | **20.9** | **20.2** | **14.8** | **21.4** | **20.9** |
| **Dissolved Oxygen (mg/L)** | | | | | | | |
| 1 | 6.9 | 9.7 | 9.1 | 5.1 | 4.4 | 5.7 | 6.8 |
| 2 | 6.8 | 9.8 | 8.6 | 5.1 | 4.5 | 5.6 | 6.7 |
| 3 | 8.1 | 10.4 | 8.9 | 5.0 | 5.2 | 6.0 | 7.3 |
| 4 | 7.3 | 10.2 | 8.8 | 4.8 | 5.2 | 5.8 | 7.0 |
| 5 | 7.4 | 10.0 | 9.0 | 5.3 | 5.4 | 5.7 | 7.1 |
| 6 | 7.3 | 9.8 | 9.0 | 5.1 | 5.1 | 5.8 | 7.0 |
| **Average** | **7.3** | **10.0** | **8.9** | **5.1** | **5.0** | **5.8** | **7.0** |
| **pH** | | | | | | | |
| 1 | 7.8 | 8.1 | 7.9 | 7.6 | 7.3 | 7.6 | 7.7 |
| 2 | 7.8 | 8.1 | 7.8 | 7.6 | 7.4 | 7.6 | 7.7 |
| 3 | 7.8 | 8.1 | 7.9 | 7.6 | 7.4 | 7.7 | 7.8 |
| 4 | 7.7 | 8.2 | 7.9 | 7.6 | 7.5 | 7.7 | 7.8 |
| 5 | 7.9 | 8.1 | 7.9 | 7.6 | 7.5 | 7.7 | 7.8 |
| 6 | 7.9 | 8.1 | 7.9 | 7.6 | 7.5 | 7.7 | 7.8 |
| **Average** | **7.8** | **8.1** | **7.9** | **7.6** | **7.4** | **7.7** | **7.8** |

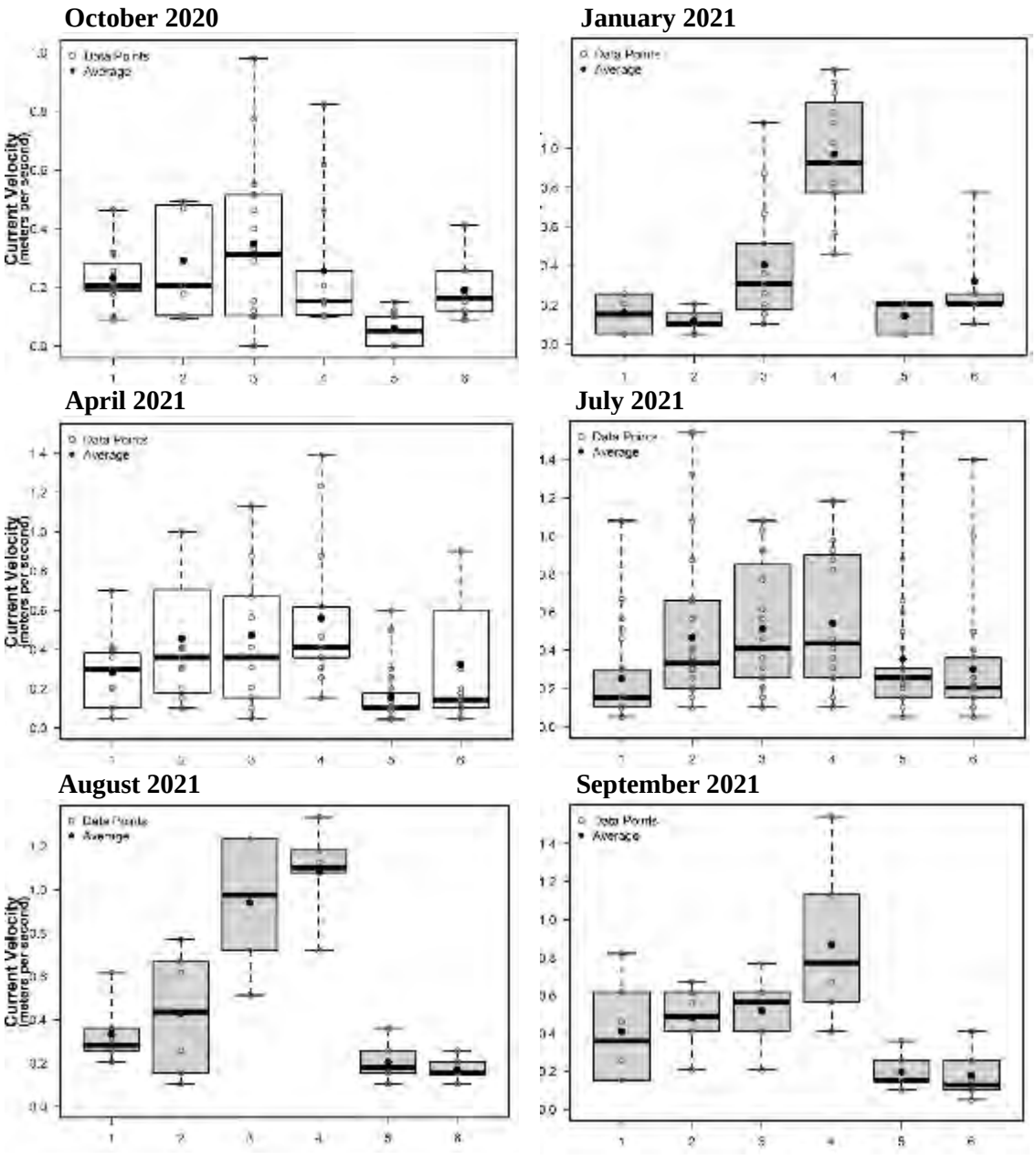



**Figure 39 –** Current velocity measurements taken at sample sites in the lower East River during Year 1. Data are plotted to compare and contrast among seasons and zones. In each boxplot, the box depicts the middle 50% of the data distribution, the black bar represents the median (or middle value), and the whiskers extend to the minimum and maximum values. Open circles represent individual measurements, while the closed circle represents the average measurement.

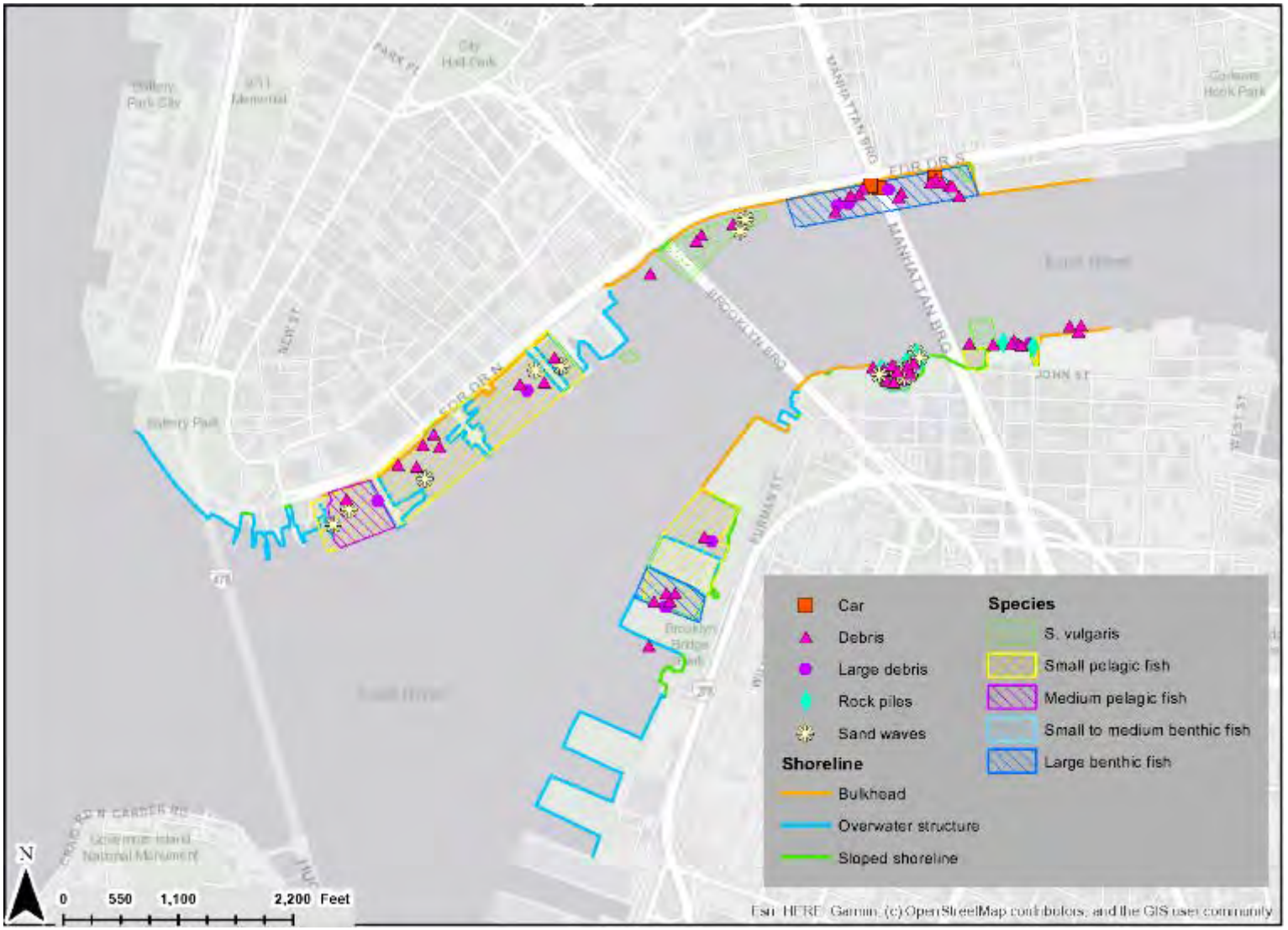



**Figure 40 –** Habitat map of the study area, based on remote sensing and satellite imagery, Year 1.

**PHYTOPLANKTON AND ZOOPLANKTON**

Primary productivity parameters, including chlorophyll-a and phycoerythrin, were measured throughout the water column during plankton sampling in Year 1. A summary of average values of those two primary productivity parameters measured at the surface, bottom, and throughout the water column is provided in **Table 15**. Primary productivity, particularly phycoerythrin, was higher at the bottom than at the surface of the water column in the three out of the four shoreline zones (i.e., Zones 1, 5, and 6). By contrast, primary productivity was higher at surface than at the bottom of the water column in the channel zones. Primary productivity was higher in the opposite shore zones compared to the other zones, particularly near the bottom of the water column.

**Figure 41** provides a comparison of primary productivity depth profiles among zones during plankton sampling in July and August 2021. There were notable peaks in primary productivity observed beneath the surface of the water column in Zones 1, 5, and 6. In these three zones, the peaks in primary productivity typically occurred just above or at the bottom of the water column at depths between 7 and 18 feet. In the channel zones, primary productivity peaked near the surface and rapidly declined with depth before leveling off at a depth of approximately 20 feet.

Abundance and species composition of zooplankton were characterized from plankton sampling data collected in Year 1. **Table 16** summarizes the total zooplankton abundance, species richness, and most abundant species observed across all sampling events in . Zooplankton abundance was an order of magnitude higher in the channel zones than in the shoreline zones. The highest zooplankton abundance was observed in the in Zone 3 (258,210), and the lowest zooplankton abundance was observed along the Opposite Shoreline (Zone 6) (16,351). Among the shoreline zones, zooplankton abundance was highest in the Primary Study Area (Zone 1). By contrast, species richness, defined here as the number of zooplankton species/taxa that represent 90% of all individuals collected in each zone, was typically higher in the shoreline zones than in the channel zones. The highest species richness (12) was observed in Zones 1 and 6, whereas the lowest species richness (5) was observed in Zone 3.

The calanoid copepod taxon, *Acartia* sp., was the most abundant taxon in all Zones during plankton sampling in 2021 (**Table 16**). In the Primary Study Area (Zone 1), the other most abundant taxa included the polychaete worm, Spionidae, the rotifer, *Synchaeta* sp., and the ciliate, *Favella ehrenbergii*.

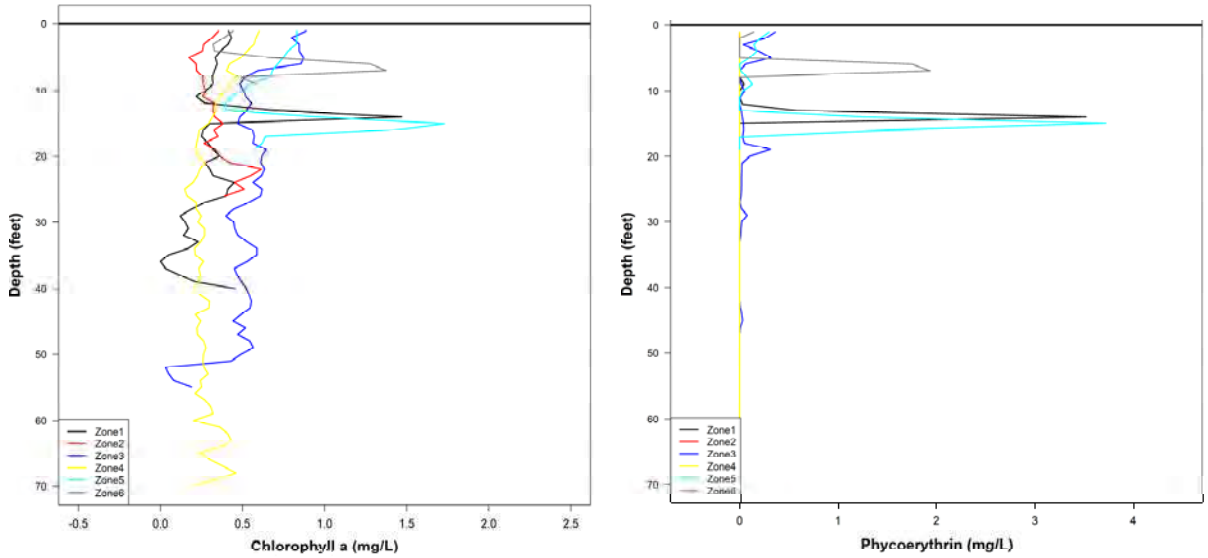
**Table 15 – Primary productivity characteristics measured within the water column during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| Position | Zone | Study Area | Chlorophyll-a (mg/L) | | | Phycoerythrin (mg/L) | | |
|---|---|---|---|---|---|---|---|---|
| | | | July | August | Average | July | August | Average |
| Surface | 1 | Primary Study Area | 0.42 | 0.21 | 0.32 | 0.00 | 0.00 | 0.00 |
| | 2 | Adjacent East | 0.35 | 0.30 | 0.33 | 0.00 | 0.00 | 0.00 |
| | 3 | Channel | 0.89 | 0.61 | 0.75 | 0.36 | 0.00 | 0.18 |
| | 4 | Channel East | 0.60 | 0.46 | 0.53 | 0.00 | 0.00 | 0.00 |
| | 5 | Opposite Shore | 0.83 | 0.50 | 0.67 | 0.30 | 0.02 | 0.16 |
| | 6 | Opposite Shore East | 0.44 | 0.46 | 0.45 | 0.14 | 0.00 | 0.07 |
| | | **Average** | **0.59** | **0.42** | **0.51** | **0.13** | **0.00** | **0.07** |
| Bottom | 1 | Primary Study Area | 0.86 | 0.44 | 0.65 | 1.24 | 0.24 | 0.74 |
| | 2 | Adjacent East | 0.36 | 0.27 | 0.32 | 0.00 | 0.00 | 0.00 |
| | 3 | Channel | 0.59 | 0.44 | 0.52 | 0.22 | 0.00 | 0.11 |
| | 4 | Channel East | 0.24 | 0.24 | 0.24 | 0.00 | 0.00 | 0.00 |
| | 5 | Opposite Shore | 2.23 | 1.36 | 1.80 | 4.89 | 1.78 | 3.34 |
| | 6 | Opposite Shore East | 1.42 | 0.86 | 1.14 | 1.94 | 0.76 | 1.35 |
| | | **Average** | **0.95** | **0.60** | **0.78** | **1.38** | **0.46** | **0.92** |
| All Depths | 1 | Primary Study Area | 0.34 | 0.27 | 0.31 | 0.09 | 0.02 | 0.06 |
| | 2 | Adjacent East | 0.30 | 0.28 | 0.29 | 0.00 | 0.00 | 0.00 |
| | 3 | Channel | 0.57 | 0.41 | 0.49 | 0.05 | 0.00 | 0.03 |
| | 4 | Channel East | 0.29 | 0.32 | 0.31 | 0.00 | 0.00 | 0.00 |
| | 5 | Opposite Shore | 0.74 | 0.57 | 0.66 | 0.40 | 0.16 | 0.28 |
| | 6 | Opposite Shore East | 0.68 | 0.51 | 0.60 | 0.52 | 0.10 | 0.31 |
| | | **Average** | **0.49** | **0.39** | **0.44** | **0.18** | **0.05** | **0.12** |

**Table 16 – Summary of dominant zooplankton taxa from six plankton tows per zone during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| | Primary Study Area | Adjacent Upstream | Channel | Channel Upstream | Opposite Shoreline | Opposite Upstream |
|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| 5 Most Abundant Taxa | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod | *Acartia* sp. Calanoid copepod |
| | Spionidae Polychaete worm | Spionidae Polychaete worm | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | Spionidae Polychaete worm | *Favella ehrenbergii* Ciliate |
| | *Acartia tonsa* Calanoid copepod | *Acartia tonsa* Calanoid copepod | Spionidae Polychaete worm | Spionidae Polychaete worm | *Favella ehrenbergii* Ciliate | *Acartia tonsa* Calanoid copepod |
| | *Synchaeta* sp. Rotifer | *Favella ehrenbergii* Ciliate | *Favella ehrenbergii* Ciliate | *Favella ehrenbergii* Ciliate | *Balanus* sp. Barnacle | Spionidae Polychaete worm |
| | *Favella ehrenbergii* Ciliate | *Synchaeta* sp. Rotifer | *Balanus* sp. Barnacle | Bivalvia Bivalve | *Acartia tonsa* Calanoid copepod | *Balanus* sp. Barnacle |
| Total Individuals | 44,503 | 30,033 | 258,210 | 185,460 | 30,045 | 16,351 |
| % of Total | 80 | 85 | 89 | 87 | 83 | 72 |
| Number of Taxa Representing 90% of Total | 12 | 6 | 5 | 7 | 10 | 12 |

**July 2021**




**August 2021**

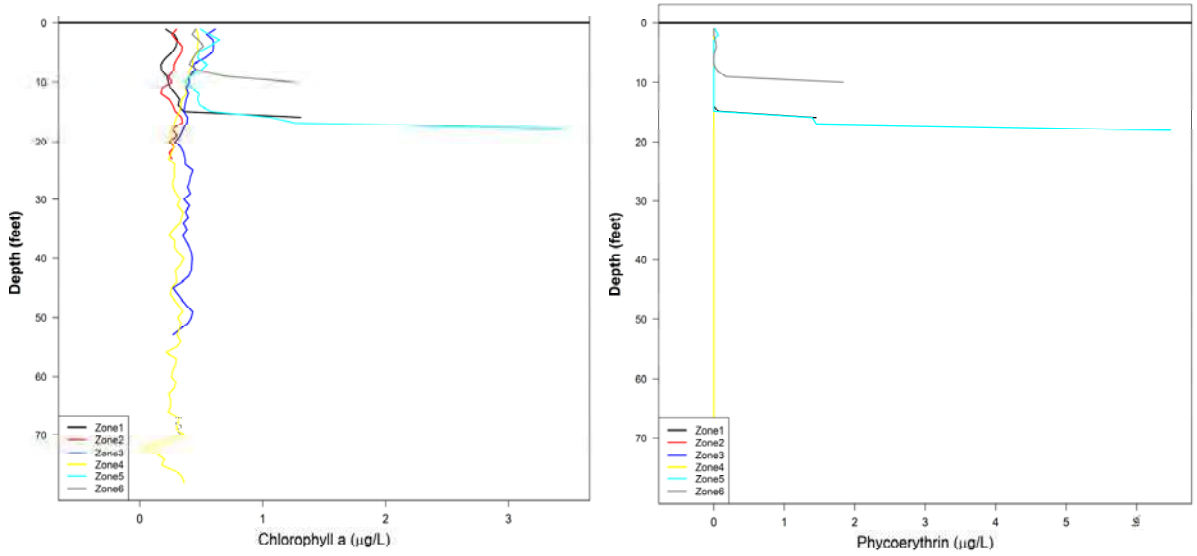



**Figure 41** – Depth profiles by zone for two proxies of primary productivity, chlorophyll-a and phycoerythrin, measured during plankton sampling in Year 1. Chlorophyll-a and phycoerythrin were averaged across the six samples collected in each of the six zones.

**BENTHIC INVERTEBRATE COMMUNITY**

The benthic invertebrate community in the study area consisted of polychaete and oligochaete worms, amphipod and isopod crustaceans, bivalve clams and mussels, gastropod snails, and sea anemones. Throughout the study area, two species of polychaete worms (*Streblospio benedicti* and *Mediomastus ambiseta*) and oligochaete worms were the most commonly collected and widely distributed benthic taxa. Seven other polychaete worm taxa were also among the most abundant, but less widely distributed. One species of reef-building polychaete worm, *Sabellaria vulgaris*, was collected in high abundance in Zone 2 during two of three seasons, but was not dominant in the other zones (**Figure 40**). *Mytilus* mussels were the most abundant benthic taxon collected during the spring, which was probably the result of an annual recruitment event of small, young mussels to the study area.

Highest abundances and greatest richness of benthic invertebrates were observed during the spring and lowest abundances during the fall (**Table 17**). Highest abundances were consistently collected in Zone 2 along the Manhattan shoreline and lowest abundances were consistently collected in Zone 5 along the Brooklyn shoreline. Despite the low abundances in Zone 5, the benthic assemblage found along the Brooklyn shoreline (Zones 5 and 6) was generally represented by a greater variety of benthic taxa than the assemblage collected in the channel and along the Manhattan side of the river. In Zones 5 and 6, the benthic assemblage was dominated by polychaete and oligochaete worms, bivalve clams and mussels, gastropod snails, and amphipod and isopod crustaceans, compared to an assemblage consisting primarily of polychaete and oligochaete worms in the other zones.

The benthic invertebrate assemblage in the Primary Study Area (Zone 1) was characterized by consistently lower abundances, similar or lower species richness, and dominance by fewer benthic taxa compared to the assemblages collected in the adjacent shoreline and nearshore habitat (Zone 2) and from the channel (Zones 3 and 4; **Table 17**). Similar to the rest of the study area, two species of polychaete worms (*Streblospio benedicti* and *Mediomastus ambiseta*) and oligochaete worms were the most commonly collected in Zone 1, but other benthic taxa, including bivalve clams and mussels, gastropod snails, amphipod and isopod crustaceans were not among the dominant taxa, indicating a relatively less diverse benthic assemblage in Zone 1 compared to the rest of the study area.

**Table 17 – Summary of benthic invertebrate taxa collected from five grabs per zone each season during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| | Fall 2020 | | | Spring 2021 | | | Summer 2021 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Zone** | **Total Individuals** | **% of Total** | **Species Richness** | **Total Individuals** | **% of Total** | **Species Richness** | **Total Individuals** | **% of Total** | **Species Richness** |
| **1** | 1,045 | 69 | 14 | 5,287 | 67 | 32 | 2,674 | 75 | 17 |
| **2** | 3,701 | 54 | 27 | 9,595 | 47 | 32 | 5,772 | 68 | 23 |
| **3** | 1,467 | 56 | 27 | 6,547 | 65 | 29 | 2,896 | 72 | 17 |
| **4** | 2,049 | 64 | 21 | 6,597 | 55 | 33 | 3,906 | 66 | 18 |
| **5** | 1,294 | 76 | 13 | 504 | 33 | 63 | 311 | 61 | 23 |
| **6** | 1,492 | 46 | 30 | 3,010 | 56 | 46 | 4,446 | 76 | 15 |

**Note:** Species richness is calculated as the number of benthic taxa representing 90% of the total organisms collected.

## FISH COMMUNITY

**Table 18** provides a comparison of fish collections among sampling zones from all gears during Year 1 sampling. The dominant species in the nearshore zones (Zones 1, 2, 5 and 6) was the small-bodied, schooling species, Atlantic silverside, which was collected in the beach seines, and was likely one of the highly abundant, small-bodied schooling species observed during remote sensing survey. The dominant species in the channel zones (Zones 3 and 4) was spotted hake, which was particularly abundant in Zone 3. Other common species in the channel zones included striped bass, oyster toadfish, and tautog. The number of fish species observed in the channel zones was generally higher than in the nearshore zones, with the exception of Zone 5 where relatively high abundances and high species richness was observed in the Brooklyn Bridge marina and adjacent nearshore habitat along the Brooklyn shoreline.

The number of species and fish abundances observed during fish sampling in Year 1 was substantially higher in October and July compared to January and April (**Table 19**). A greater number of species was observed in July (21) than in October (12), but the number of fish observed in October (2,386) was considerably greater than that observed in July (478), due to the large schools of Atlantic silversides in the beach seines and remote sensing survey.

There were substantial seasonal differences in fish abundance and number of species collected in each of the gears (**Table 19**). In particular, differences were observed between the bottom trawl survey, which is conducted in the deeper-water channel habitats, and the beach seine and remote sensing surveys, which are conducted in the shoreline and nearshore habitats. While the majority of fish were observed in October in the beach seine (97%) and remote sensing (62%) surveys, there were no fish observed in bottom trawl survey during that month. Instead, the majority of fish were observed in January in the bottom trawl survey (92%), a month in which the fewest fish were observed in the shallower water sampled in the interpier areas by the remote sensing survey. The peak in abundance in the beach seine survey in October was driven by an influx of Atlantic silverside, a small midwater species that accounted for 99% of the catch that month. Further, although fish were not taxonomically identified in the remote sensing survey, the abundance in October was dominated by small midwater species, which likely included Atlantic silverside. Atlantic silverside inhabit the shallows along the shoreline during warmer months and swim into deeper waters during the winter, which is consistent with the seasonal patterns observed in the survey. Conversely, the peak in abundance in the bottom trawl survey in January was driven primarily by spotted hake and secondarily by striped bass, which together accounted for 97% of the catch that month. Spotted hake and striped bass are known to overwinter in estuaries and tidal rivers, and the high abundance of these species in the channel in January could reflect a pattern of fish moving into deeper waters to avoid cold waters during the winter months. As the water warmed during the spring and summer months, the number of species and abundance of fish (excluding Atlantic silversides) increased in all of the sampling gears as fish moved back into the study area and throughout the variety of aquatic habitats that occur there. This is especially evident in the July samples (**Table 19**).

Distribution of fish observed during remote sensing is included on the habitat map (**Figure 40**) to illustrate fish associations with various habitat features. Small- and medium-bodied mid-water fish, likely to include schooling species such as Atlantic silversides, bay anchovy, alewife, and menhaden were commonly observed in the interpier area in Zone 1. Large-bodied fish were more commonly observed along the exposed shoreline upriver of the Brooklyn Bridge on the Manhattan side of the River, but also in the Brooklyn Bridge Park Marina where small-bodied schooling fish were also common.

**Table 18 – Number of fish collected by species and zone in all sampling gears during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| | Zone | | | | | |
|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** |
| Alewife | 0 | 0 | 0 | 1 | 1 | 0 |
| American Eel | 0 | 0 | 0 | 0 | 2 | 0 |
| Atlantic Croaker | 0 | 0 | 0 | 1 | 0 | 0 |
| Atlantic Menhaden | 0 | 0 | 0 | 2 | 4 | 3 |
| Atlantic Silverside | 748 | 384 | 0 | 0 | 402 | 45 |
| Atlantic Tomcod | 0 | 0 | 1 | 2 | 1 | 0 |
| Bay Anchovy | 0 | 0 | 0 | 0 | 1 | 0 |
| Black Sea Bass | 0 | 0 | 1 | 0 | 0 | 0 |
| Blueback Herring | 0 | 0 | 1 | 0 | 0 | 0 |
| Blue Crab | 0 | 0 | 0 | 2 | 0 | 0 |
| Bluefish | 0 | 0 | 0 | 0 | 3 | 0 |
| Northern Pipefish | 1 | 0 | 0 | 0 | 0 | 0 |
| Oyster Toadfish | 1 | 1 | 9 | 2 | 1 | 3 |
| Portly Spider Crab | 0 | 4 | 1 | 2 | 1 | 0 |
| Silver Hake | 0 | 0 | 1 | 0 | 0 | 0 |
| Skilletfish | 0 | 0 | 1 | 0 | 0 | 0 |
| Spotted Hake | 0 | 0 | 171 | 18 | 0 | 0 |
| Striped Bass | 0 | 3 | 14 | 2 | 1 | 7 |
| Summer Flounder | 0 | 0 | 0 | 0 | 0 | 1 |
| Tautog | 0 | 0 | 6 | 0 | 2 | 0 |
| Weakfish | 0 | 0 | 1 | 0 | 0 | 0 |
| White Perch | 0 | 0 | 0 | 2 | 1 | 0 |
| Winter Flounder | 0 | 0 | 0 | 0 | 4 | 0 |
| Unidentified[1] | 664 | 36 | -- | -- | 414 | 210 |
| **Total** | **1,414** | **428** | **207** | **34** | **838** | **269** |
| **Number of Species** | **3** | **4** | **11** | **10** | **13** | **5** |

[1] Fish observed in the remote sensing survey were not identified by species

**Table 19 – Number of species and fish collected by gear and season during Year 1 of the NYCEDC Biological and Habitat Sampling Program on the lower East River, NY**

| | Number of Species | | | | Number of Fish | | | |
|---|---|---|---|---|---|---|---|---|
| | **Fall** | **Winter** | **Spring** | **Summer** | **Fall** | **Winter** | **Spring** | **Summer** |
| **Gear** | **Oct-20** | **Jan-21** | **Apr-21** | **Jul-21** | **Oct-20** | **Jan-21** | **Apr-21** | **Jul-21** |
| Beach Seine | 7 | -- | 3 | 6 | 1,560 | -- | 15 | 33 |
| Bottom Trawl | 0 | 7 | 3 | 7 | 0 | 205 | 3 | 15 |
| Baited Fish Trap | 5 | -- | 1 | 8 | 12 | -- | 2 | 21 |
| Remote Sensing | -- | -- | -- | -- | 814 | 3 | 98 | 409 |
| **Total** | **12** | **7** | **7** | **21** | **2,386** | **208** | **118** | **478** |