

eDNA Expeditions biodiversity survey of Everglades National Park

Saara Suominen, Pieter Provoost, Ward Appeltans

November 27, 2023

1 Introduction

Environmental DNA Expeditions is a global, citizen science initiative that will help measure marine biodiversity, and the impacts climate change might have on the distribution patterns of marine life, across UNESCO World Heritage marine sites.

Ocean species shed DNA into the water around them. The genetic material from waste, mucus or cells in one liter of water can determine the species richness in a given area, without the need to actually extract organisms from their environment. The cost effective,

ethical nature of eDNA sampling has the potential to revolutionize knowledge about ecosystems and species diversity and to inspire the next generation of ocean researchers.

eDNA sampling was conducted in Everglades National Park in April 2023. 20 samples were collected at five locations in the park: Trout Creek, North Eagle Creek, Crocodile Dragover, Whip Ray, and Captain. From these 20 samples, a first batch of 11 samples covering all sites has been processed.

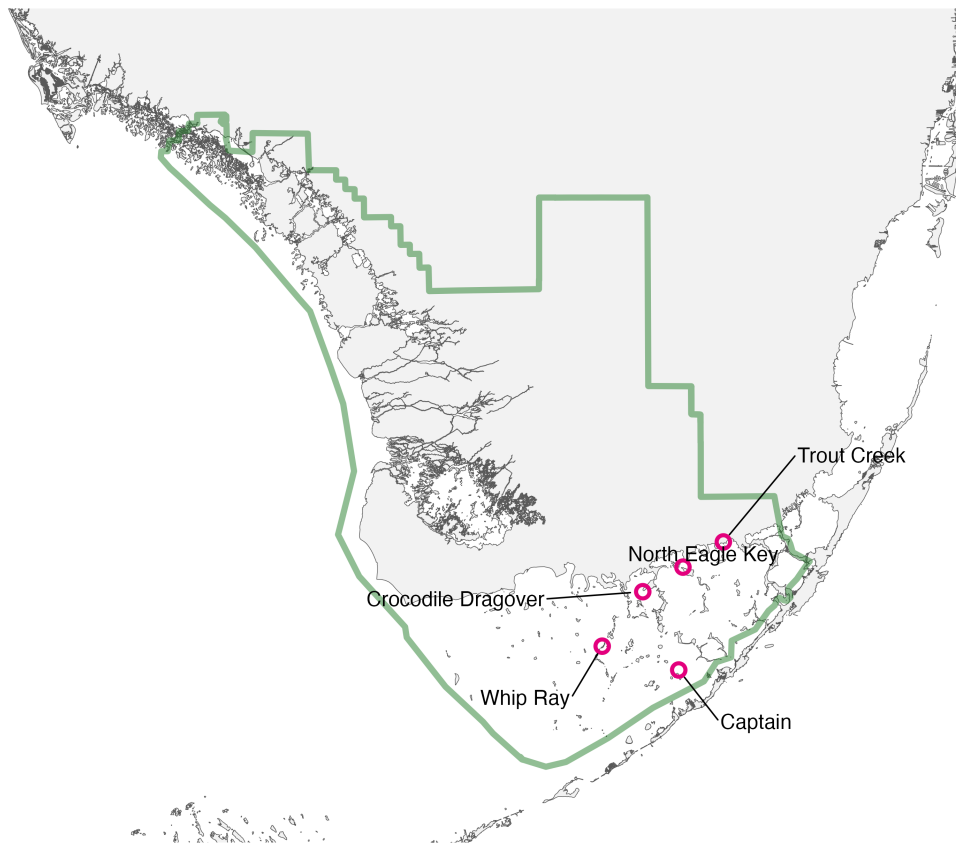


Figure 1: Map of eDNA sampling locations

2 Results

| reads | species | asvs |
|----------|---------|-------|
| 20627859 | 194 | 12507 |

| locality | materialSampleID | reads | species | asvs | sampleSize |
|--------------------|------------------|---------|---------|------|------------|
| Captain | EE0386 | 1715884 | 33 | 1261 | 1500 |
| Captain | EE0391 | 1504564 | 77 | 5480 | 1800 |
| Captain | EE0402 | 1768280 | 73 | 5873 | 1800 |
| Crocodile Dragover | EE0389 | 1542386 | 64 | 5174 | 1500 |
| Crocodile Dragover | EE0390 | 2070296 | 67 | 5042 | 450 |
| North Eagle Key | EE0388 | 1586226 | 43 | 2831 | 1500 |
| Trout Creek | EE0403 | 1854506 | 86 | 3590 | 1500 |
| Whip Ray | EE0387 | 2902938 | 78 | 3101 | 1800 |
| Whip Ray | EE0404 | 2195910 | 97 | 5838 | 1800 |
| Whip Ray | EE0405 | 1994942 | 97 | 4808 | 1800 |
| Whip Ray | EE0406 | 1491927 | 103 | 4685 | 1800 |

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amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

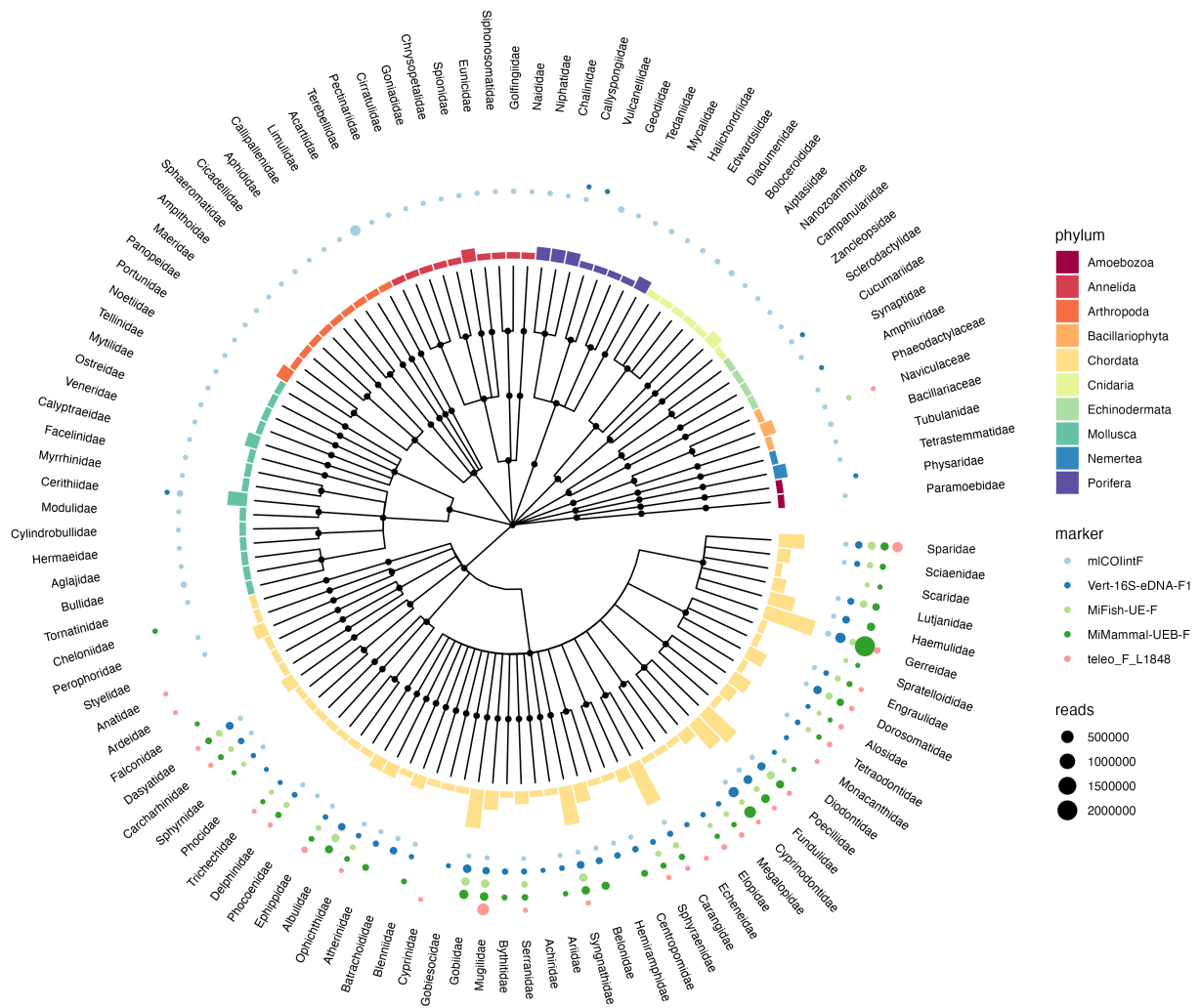


Figure 2: Number of DNA reads and species detected by family

3 Species list

| phylum | class | family | species | category |
|-----------------|-------------------|--------------------|-----------------------------|----------|
| Amoebozoa | Discosea | Paramoebidae | Paramoeba aestuarina | |
| Amoebozoa | Myxogastrea | Physaridae | Craterium leucocephalum | |
| Annelida | Clitellata | Naididae | Thalassodrilides gurwitschi | |
| Annelida | Polychaeta | Eunicidae | Marphysa sanguinea | |
| Annelida | Polychaeta | Chrysopetalidae | Bhawania goodei | |
| Annelida | Polychaeta | Goniadidae | Glycinde multidentis | |
| Annelida | Polychaeta | Spionidae | Polydora websteri | |
| Annelida | Polychaeta | Spionidae | Prionospio steenstrupi | |
| Annelida | Polychaeta | Cirratulidae | Timarete caribous | |
| Annelida | Polychaeta | Pectinariidae | Pectinaria gouldii | |
| Annelida | Polychaeta | Terebellidae | Loimia medusa | |
| Annelida | | Golfingiidae | Golfingia elongata | |
| Annelida | | Siphonosomatidae | Siphonosoma cumanense | |
| Arthropoda | Copepoda | Acartiidae | Acartia tonsa | |
| Arthropoda | Hexapoda | Aphididae | Rhopalosiphum padi | |
| Arthropoda | Hexapoda | Cicadellidae | Macrostes quadrilineatus | |
| Arthropoda | Malacostraca | Ampithoidae | Cymadusa compta | |
| Arthropoda | Malacostraca | Maeridae | Elasmopus nkjaf | |
| Arthropoda | Malacostraca | Panopeidae | Neopanope packardii | |
| Arthropoda | Malacostraca | Portunidae | Callinectes sapidus | |
| Arthropoda | Malacostraca | Portunidae | Portunus sanguinolentus | |
| Arthropoda | Malacostraca | Sphaeromatidae | Paracerceis caudata | |
| Arthropoda | Merostomata | Limulidae | Limulus polyphemus | VU |
| Arthropoda | Pycnogonida | Callipallenidae | Callipallene brevirostris | |
| Ascomycota | Dothideomycetes | Cladosporiaceae | Cladosporium herbarum | |
| Ascomycota | Eurotiomycetes | Trichocomaceae | Aspergillus versicolor | |
| Bacillariophyta | Bacillariophyceae | Bacillariaceae | Cylindrotheca closterium | |
| Bacillariophyta | Bacillariophyceae | Naviculaceae | Haslea crucigera | |
| Bacillariophyta | Bacillariophyceae | Naviculaceae | Navicula minima | |
| Bacillariophyta | Bacillariophyceae | Phaeodactylaceae | Phaeodactylum tricornutum | |
| Bryozoa | Gymnolaemata | Bugulidae | Bugula rochae | |
| Bryozoa | Gymnolaemata | Vesiculariidae | Amathia evelinae | |
| Cercozoa | Chlorarachnea | Chlorarachniaceae | Chlorarachnion reptans | |
| Chlorophyta | Mamiellophyceae | Dolichomastigaceae | Dolichomastix tenuilepis | |
| Chlorophyta | Mamiellophyceae | Mamiellaceae | Micromonas pusilla | |
| Chordata | Ascidiacea | Perophoridae | Ecteinascidia styeloides | |
| Chordata | Ascidiacea | Styelidae | Botrylloides niger | |
| Chordata | Ascidiacea | Styelidae | Botrylloides simodensis | |
| Chordata | Aves | Anatidae | Anas poecilorhyncha | |
| Chordata | Aves | Ardeidae | Ardea cinerea | |
| Chordata | Aves | Falconidae | Falco sparverius | |
| Chordata | Elasmobranchii | Carcharhinidae | Negaprion brevirostris | VU |
| Chordata | Elasmobranchii | Sphyrnidae | Sphyrna tiburo | EN |
| Chordata | Elasmobranchii | Dasyatidae | Hypanus americanus | NT |
| Chordata | Elasmobranchii | Dasyatidae | Hypanus rudis | CR |
| Chordata | Mammalia | Phocidae | Mirounga leonina | |
| Chordata | Mammalia | Delphinidae | Tursiops truncatus | |
| Chordata | Mammalia | Phocoenidae | Neophocaena phocaenoides | VU |
| Chordata | Mammalia | Trichechidae | Trichechus manatus | VU |

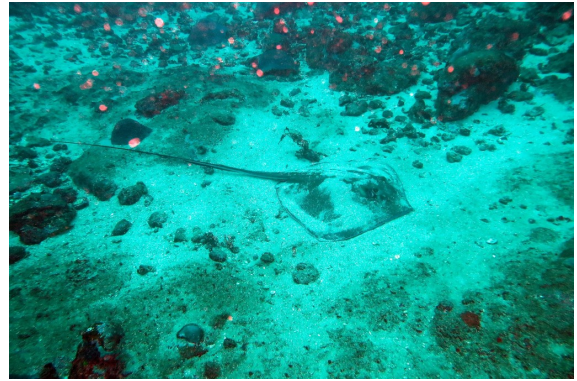
| | | | | |
|----------|-----------|-----------------|---------------------------|----|
| Chordata | Teleostei | Ephippidae | Chaetodipterus faber | |
| Chordata | Teleostei | Albulidae | Albula glossodonta | VU |
| Chordata | Teleostei | Albulidae | Albula vulpes | NT |
| Chordata | Teleostei | Ophichthidae | Myrophis punctatus | |
| Chordata | Teleostei | Ophichthidae | Myrophis vafer | |
| Chordata | Teleostei | Atherinidae | Atherinomorus stipes | |
| Chordata | Teleostei | Batrachoididae | Opsanus beta | |
| Chordata | Teleostei | Batrachoididae | Opsanus tau | |
| Chordata | Teleostei | Belonidae | Strongylura notata | |
| Chordata | Teleostei | Belonidae | Strongylura timucu | |
| Chordata | Teleostei | Belonidae | Tylosurus crocodilus | |
| Chordata | Teleostei | Hemiramphidae | Chriodorus atherinoides | |
| Chordata | Teleostei | Blenniidae | Chasmodes bosquianus | |
| Chordata | Teleostei | Centropomidae | Centropomus undecimalis | |
| Chordata | Teleostei | Sphyraenidae | Sphyraena barracuda | |
| Chordata | Teleostei | Sphyraenidae | Sphyraena jello | |
| Chordata | Teleostei | Carangidae | Caranx crysos | |
| Chordata | Teleostei | Carangidae | Caranx hippos | |
| Chordata | Teleostei | Carangidae | Caranx ignobilis | |
| Chordata | Teleostei | Carangidae | Caranx latus | |
| Chordata | Teleostei | Carangidae | Oligoplites saurus | |
| Chordata | Teleostei | Carangidae | Selene vomer | |
| Chordata | Teleostei | Carangidae | Trachinotus carolinus | |
| Chordata | Teleostei | Echeneidae | Echeneis naucrates | |
| Chordata | Teleostei | Alosidae | Brevoortia tyrannus | |
| Chordata | Teleostei | Dorosomatidae | Harengula humeralis | |
| Chordata | Teleostei | Dorosomatidae | Harengula jaguana | |
| Chordata | Teleostei | Dorosomatidae | Opisthonema oglinum | |
| Chordata | Teleostei | Engraulidae | Anchoa mitchilli | |
| Chordata | Teleostei | Spratelloididae | Jenkinsia lamprotaenia | |
| Chordata | Teleostei | Cyprinidae | Carassius auratus | |
| Chordata | Teleostei | Cyprinodontidae | Cyprinodon variegatus | |
| Chordata | Teleostei | Cyprinodontidae | Floridichthys carpio | |
| Chordata | Teleostei | Fundulidae | Adinia xenica | |
| Chordata | Teleostei | Fundulidae | Fundulus confluentus | |
| Chordata | Teleostei | Fundulidae | Fundulus grandis | |
| Chordata | Teleostei | Fundulidae | Lucania goodei | |
| Chordata | Teleostei | Fundulidae | Lucania parva | |
| Chordata | Teleostei | Poeciliidae | Belonesox belizanus | |
| Chordata | Teleostei | Poeciliidae | Gambusia affinis | |
| Chordata | Teleostei | Poeciliidae | Gambusia holbrooki | |
| Chordata | Teleostei | Poeciliidae | Gambusia rhizophorae | |
| Chordata | Teleostei | Poeciliidae | Poecilia latipinna | |
| Chordata | Teleostei | Poeciliidae | Poecilia sphenops | |
| Chordata | Teleostei | Elopidae | Elops saurus | |
| Chordata | Teleostei | Megalopidae | Megalops atlanticus | VU |
| Chordata | Teleostei | Gerreidae | Diapterus auratus | |
| Chordata | Teleostei | Gerreidae | Eucinostomus argenteus | |
| Chordata | Teleostei | Gerreidae | Eucinostomus gula | |
| Chordata | Teleostei | Gerreidae | Eucinostomus jonesii | |
| Chordata | Teleostei | Gerreidae | Eucinostomus melanopterus | |
| Chordata | Teleostei | Gerreidae | Eugerres plumieri | |
| Chordata | Teleostei | Gerreidae | Gerres cinereus | |

| | | | | |
|---------------|---------------|-----------------|-----------------------------|----|
| Chordata | Teleostei | Gerreidae | Ulaema lefroyi | |
| Chordata | Teleostei | Haemulidae | Haemulon aurolineatum | |
| Chordata | Teleostei | Haemulidae | Haemulon parra | |
| Chordata | Teleostei | Haemulidae | Haemulon plumierii | |
| Chordata | Teleostei | Haemulidae | Haemulon sciurus | |
| Chordata | Teleostei | Lutjanidae | Lutjanus argentimaculatus | |
| Chordata | Teleostei | Lutjanidae | Lutjanus griseus | |
| Chordata | Teleostei | Scaridae | Nicholsina usta | |
| Chordata | Teleostei | Sciaenidae | Cynoscion nebulosus | |
| Chordata | Teleostei | Sciaenidae | Pogonias cromis | |
| Chordata | Teleostei | Sparidae | Archosargus probatocephalus | |
| Chordata | Teleostei | Sparidae | Archosargus rhomboidalis | |
| Chordata | Teleostei | Sparidae | Diplodus kotschyi | |
| Chordata | Teleostei | Sparidae | Lagodon rhomboides | |
| Chordata | Teleostei | Gobiesocidae | Gobiosox strumosus | |
| Chordata | Teleostei | Gobiidae | Gobiosoma bosc | |
| Chordata | Teleostei | Gobiidae | Gobiosoma ginsburgi | |
| Chordata | Teleostei | Gobiidae | Gobiosoma robustum | |
| Chordata | Teleostei | Gobiidae | Lophogobius cyprinoides | |
| Chordata | Teleostei | Gobiidae | Microgobius gulosus | |
| Chordata | Teleostei | Gobiidae | Microgobius microlepis | |
| Chordata | Teleostei | Mugilidae | Mugil cephalus | |
| Chordata | Teleostei | Mugilidae | Mugil curema | |
| Chordata | Teleostei | Mugilidae | Mugil rubrioculus | |
| Chordata | Teleostei | Bythitidae | Ogilbia cayorum | |
| Chordata | Teleostei | Serranidae | Epinephelus itajara | VU |
| Chordata | Teleostei | Serranidae | Epinephelus lanceolatus | |
| Chordata | Teleostei | Achiridae | Trinectes maculatus | |
| Chordata | Teleostei | Ariidae | Ariopsis felis | |
| Chordata | Teleostei | Syngnathidae | Anarchopterus criniger | |
| Chordata | Teleostei | Syngnathidae | Hippocampus zosterae | |
| Chordata | Teleostei | Syngnathidae | Syngnathus floridae | |
| Chordata | Teleostei | Syngnathidae | Syngnathus fuscus | |
| Chordata | Teleostei | Syngnathidae | Syngnathus schlegeli | |
| Chordata | Teleostei | Syngnathidae | Syngnathus scovelli | |
| Chordata | Teleostei | Diodontidae | Chilomycterus schoepfii | |
| Chordata | Teleostei | Monacanthidae | Stephanolepis cirrifer | |
| Chordata | Teleostei | Monacanthidae | Stephanolepis hispidus | |
| Chordata | Teleostei | Tetraodontidae | Sphoeroides maculatus | |
| Chordata | Teleostei | Tetraodontidae | Sphoeroides parvus | |
| Chordata | Teleostei | Tetraodontidae | Sphoeroides spengleri | |
| Chordata | Teleostei | Cheloniidae | Caretta caretta | VU |
| Cnidaria | Anthozoa | Aiptasiidae | Exaiptasia diaphana | |
| Cnidaria | Anthozoa | Boloceroideidae | Boloceroideus mcmurrici | |
| Cnidaria | Anthozoa | Diadumenidae | Diadumene leucolepis | |
| Cnidaria | Anthozoa | Edwardsiidae | Edwardsia longicornis | |
| Cnidaria | Anthozoa | Nanozoanthidae | Nanozoanthus harenaceus | |
| Cnidaria | Hydrozoa | Zancleopsisidae | Zancleopsis dichotoma | |
| Cnidaria | Hydrozoa | Campanulariidae | Clytia hemisphaerica | |
| Cnidaria | Hydrozoa | Campanulariidae | Obelia bidentata | |
| Ctenophora | Tentaculata | Coeloplanidae | Vallicula multiformis | |
| Echinodermata | Holothuroidea | Synaptidae | Leptosynapta tenuis | |
| Echinodermata | Holothuroidea | Cucumariidae | Thyonella gemmata | |

| | | | |
|-----------------|-----------------|------------------|--------------------------|
| Echinodermata | Holothuroidea | Sclerodactylidae | Sclerodactyla briareus |
| Echinodermata | Ophiuroidea | Amphiuridae | Amphipholis squamata |
| Gnathostomulida | | Gnathostomulidae | Gnathostomula axi |
| Mollusca | Bivalvia | Noetiidae | Arcopsis adamsi |
| Mollusca | Bivalvia | Tellinidae | Ameritella mitchelli |
| Mollusca | Bivalvia | Mytilidae | Brachidontes exustus |
| Mollusca | Bivalvia | Ostreidae | Crassostrea virginica |
| Mollusca | Bivalvia | Veneridae | Anomalocardia auberiana |
| Mollusca | Bivalvia | Veneridae | Chione cancellata |
| Mollusca | Gastropoda | Aglajidae | Philinopsis pusa |
| Mollusca | Gastropoda | Bullidae | Bulla arabica |
| Mollusca | Gastropoda | Tornatinidae | Acteocina canaliculata |
| Mollusca | Gastropoda | Calyptraeidae | Crepidula convexa |
| Mollusca | Gastropoda | Facelinidae | Learchis poica |
| Mollusca | Gastropoda | Myrrhinidae | Nanuca occidentalis |
| Mollusca | Gastropoda | Cerithiidae | Bittium varium |
| Mollusca | Gastropoda | Cerithiidae | Cerithium eburneum |
| Mollusca | Gastropoda | Cerithiidae | Cerithium muscarum |
| Mollusca | Gastropoda | Modulidae | Modulus modulus |
| Mollusca | Gastropoda | Cylindrobullidae | Cylindrobulla beauii |
| Mollusca | Gastropoda | Hermaeidae | Cyerce antillensis |
| Myzozoa | Dinophyceae | Amphidiniaceae | Amphidinium massartii |
| Nemertea | Hoplonemertea | Tetrastemmatidae | Tetrastemma elegans |
| Nemertea | Hoplonemertea | Tetrastemmatidae | Tetrastemma wilsoni |
| Nemertea | Palaeonemertea | Tubulanidae | Tubulanus riceae |
| Phoronida | | Phoronidae | Phoronis psammophila |
| Porifera | Demospongiae | Callyspongiidae | Callyspongia diffusa |
| Porifera | Demospongiae | Callyspongiidae | Callyspongia vaginalis |
| Porifera | Demospongiae | Chalinidae | Cladocroce burapha |
| Porifera | Demospongiae | Chalinidae | Haliclona vansoesti |
| Porifera | Demospongiae | Niphatidae | Gelliodes wilsoni |
| Porifera | Demospongiae | Niphatidae | Pachychalina tenera |
| Porifera | Demospongiae | Mycalidae | Mycale fibrexilis |
| Porifera | Demospongiae | Tedaniidae | Tedania ignis |
| Porifera | Demospongiae | Halichondriidae | Amorphinopsis fenestrata |
| Porifera | Demospongiae | Halichondriidae | Halichondria melanadocia |
| Porifera | Demospongiae | Geodiidae | Geodia neptuni |
| Porifera | Demospongiae | Vulcanellidae | Poecillastra laminaris |
| Rhodophyta | Florideophyceae | Rhodomelaceae | Polysiphonia echinata |



(a) *Sphyrna tiburo*



(b) *Hypanus rudis*



(c) *Epinephelus itajara*

Figure 3: Some of the detected fish species.