

eDNA Expeditions biodiversity survey of Everglades National Park

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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, by filtering up to 1800 ml of seawater through filter cartridges with a 0.8 μm pore size. 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. DNA from these samples was extracted and amplified, and then sent to the sequencing facility.

2 Results

Sequencing of the DNA from 11 samples resulted in over 20 million sequence reads. From these reads we were able to collect 12,507 unique sequences or ASVs. Matching those sequences with reference sequences in public databases, we were able to detect 194 species. A total of 2566 are known from Everglades National Park in the OBIS database. Of the 193 species detected, 77 are not known from the park in OBIS.

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

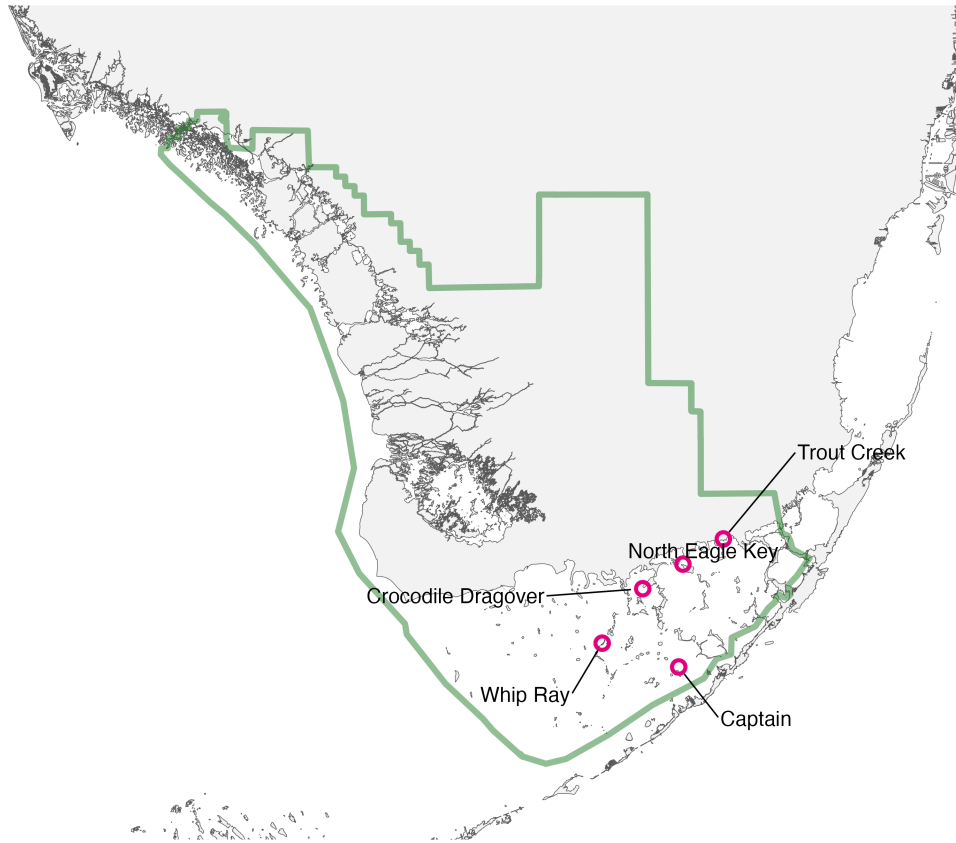


Figure 1: Map of eDNA sampling locations

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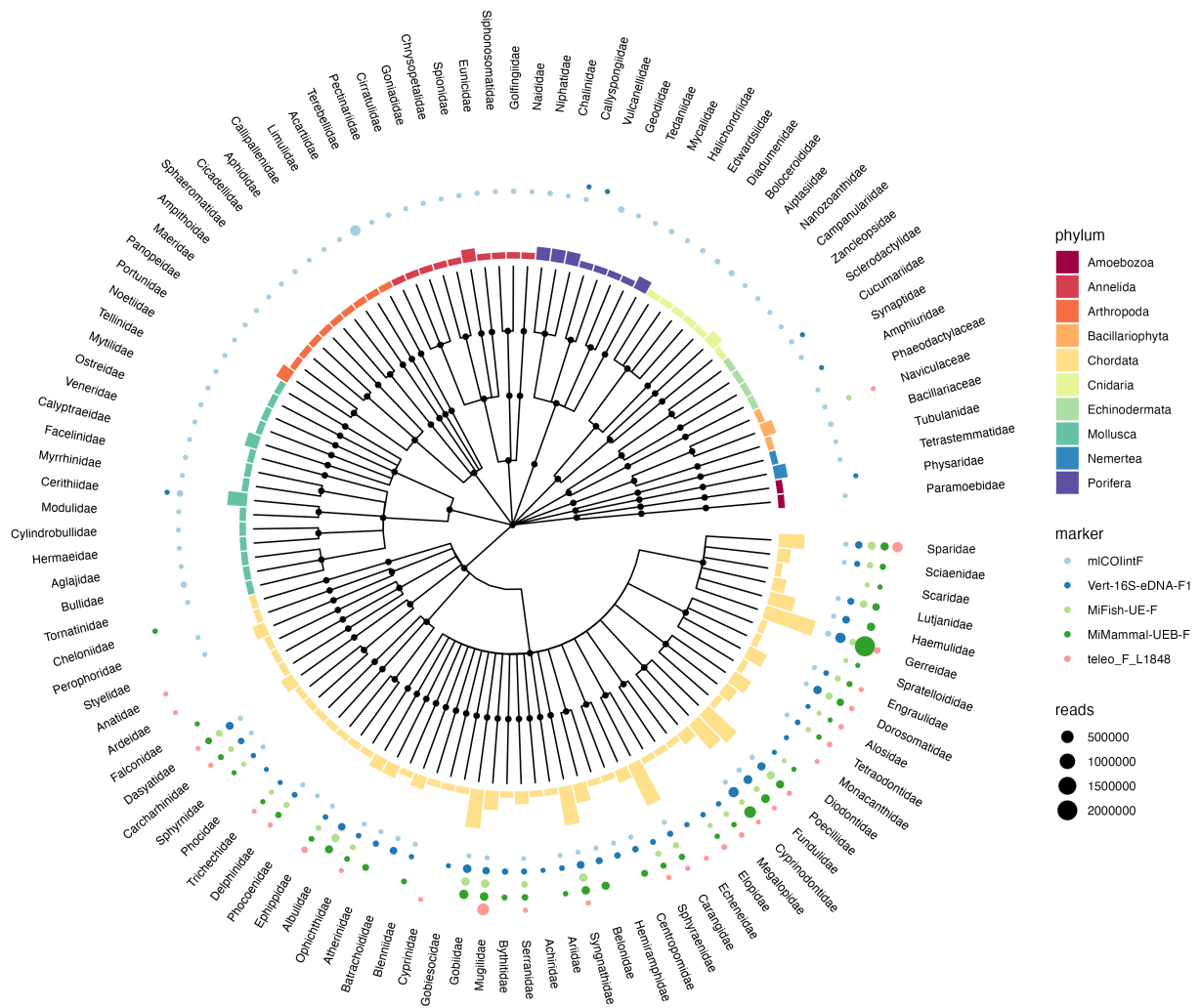


Figure 2: Number of DNA reads and species detected by family

3 Species list

phylum	class	species	category	new	vernacular
Amoebozoa	Discosea	Neoparamoeba aestuarina		yes	
Amoebozoa	Myxogastrea	Craterium leucocephalum		yes	
Annelida	Clitellata	Thalassodrilides gurwitschi		yes	red rock worm
Annelida	Polychaeta	Marphysa sanguinea			
Annelida	Polychaeta	Bhawania goodei		yes	
Annelida	Polychaeta	Glycinde multidentis		yes	
Annelida	Polychaeta	Polydora websteri			
Annelida	Polychaeta	Prionospio steenstrupi			
Annelida	Polychaeta	Timarete caribous		yes	ice cream cone worm
Annelida	Polychaeta	Pectinaria gouldii			medusa worm
Annelida	Polychaeta	Loimia medusa			
Annelida		Golfingia (Golfingia) elongata			
Annelida		Siphonosoma cumanense		yes	
Arthropoda	Copepoda	Acartia (Acanthacartia) tonsa			
Arthropoda	Hexapoda	Rhopalosiphum padi		yes	
Arthropoda	Hexapoda	Macrosteles quadrilineatus		yes	
Arthropoda	Malacostraca	Cymadusa compta			
Arthropoda	Malacostraca	Elasmopus nkjaf		yes	
Arthropoda	Malacostraca	Neopanope packardii			Florida grassflat crab
Arthropoda	Malacostraca	Callinectes sapidus			blue crab, crabe bleu
Arthropoda	Malacostraca	Portunus sanguinolentus		yes	blood-spotted swimming crab
Arthropoda	Malacostraca	Paracerceis caudata			
Arthropoda	Merostomata	Limulus polyphemus			horseshoe crab
Arthropoda	Pycnogonida	Callipallene brevirostris	VU		
Ascomycota	Dothideomycetes	Cladosporium herbarum		yes	
Ascomycota	Eurotiomycetes	Aspergillus versicolor		yes	
Bacillariophyta	Bacillariophyceae	Cylindrotheca closterium		yes	
Bacillariophyta	Bacillariophyceae	Haslea crucigera		yes	
Bacillariophyta	Bacillariophyceae	Navicula minima		yes	
Bacillariophyta	Bacillariophyceae	Phaeodactylum tricornutum		yes	
Bryozoa	Gymnolaemata	Bugula rochae		yes	
Bryozoa	Gymnolaemata	Amathia evelinae		yes	
Cerczoa	Chlorarachnea	Chlorarachnion reptans		yes	
Chlorophyta	Mamiellophyceae	Dolichomastix tenuilepis		yes	
Chlorophyta	Mamiellophyceae	Micromonas pusilla			
Chordata	Ascidiacea	Ecteinascidia styeloides		yes	Black synascidia , Synascidie noire
Chordata	Ascidiacea	Botrylloides niger		yes	
Chordata	Ascidiacea	Botrylloides simodensis		yes	
Chordata	Aves	Anas poecilorhyncha		yes	
Chordata	Aves	Ardea cinerea		yes	
Chordata	Aves	Falco sparverius		yes	
Chordata	Elasmobranchii	Negaprion brevirostris	VU		lemon shark
Chordata	Elasmobranchii	Sphyrna tiburo	EN		bonnethead
Chordata	Elasmobranchii	Hypanus americanus	NT		
Chordata	Elasmobranchii	Hypanus rudis	CR	yes	

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phylum	class	species	category	new	vernacular
Chordata	Mammalia	Mirounga leonina		yes	southern elephant seal
Chordata	Mammalia	Tursiops truncatus			bottlenose dolphin, grand dauphin
Chordata	Mammalia	Neophocaena phocaenoides	VU	yes	Indian dolphin, marsouin aptere
Chordata	Mammalia	Trichechus manatus	VU		West Indian manatee
Chordata	Teleostei	Chaetodipterus faber	VU	yes	Atlantic spadefish
Chordata	Teleostei	Albula glossodonta	NT		roundjaw bonefish
Chordata	Teleostei	Albula vulpes			bonefish
Chordata	Teleostei	Myrophis punctatus			speckled worm eel
Chordata	Teleostei	Myrophis vafer		yes	Pacific worm eel
Chordata	Teleostei	Atherinomorus stipes			hardhead silverside
Chordata	Teleostei	Opsanus beta			Gulf toadfish
Chordata	Teleostei	Opsanus tau			oyster toadfish
Chordata	Teleostei	Strongylura notata			redfin needlefish
Chordata	Teleostei	Strongylura timucu			timucu
Chordata	Teleostei	Tylosurus crocodilus			houndfish
Chordata	Teleostei	Chriodorus atherinoides			hardhead halfbeak
Chordata	Teleostei	Chasmodes bosquianus			striped blenny
Chordata	Teleostei	Centropomus undecimalis			common snook
Chordata	Teleostei	Sphyræna barracuda			great barracuda
Chordata	Teleostei	Sphyræna jello		yes	pickhandle barracuda
Chordata	Teleostei	Caranx crysos			blue runner, carangue couballi
Chordata	Teleostei	Caranx hippos			common jack, carangue crevalle
Chordata	Teleostei	Caranx ignobilis		yes	giant trevally
Chordata	Teleostei	Caranx latus			horse-eye jack
Chordata	Teleostei	Oligoplites saurus			leatherjack
Chordata	Teleostei	Selene vomer			lookdown
Chordata	Teleostei	Trachinotus carolinus			pompano
Chordata	Teleostei	Echeneis naucrates			sharksucker
Chordata	Teleostei	Brevoortia tyrannus		yes	mossbunker
Chordata	Teleostei	Harengula jaguana			scaled sardine
Chordata	Teleostei	Opisthonema oglinum			Atlantic thread herring
Chordata	Teleostei	Anchoa mitchilli			bay anchovy
Chordata	Teleostei	Jenkinsia lamprotaenia			dwarf herring
Chordata	Teleostei	Carassius auratus		yes	goldfish, gible
Chordata	Teleostei	Cyprinodon variegatus			sheepshead minnow
Chordata	Teleostei	Floridichthys carpio			goldspotted killifish
Chordata	Teleostei	Fundulus confluentus			marsh killifish
Chordata	Teleostei	Fundulus grandis			Gulf killifish
Chordata	Teleostei	Fundulus xenicus			
Chordata	Teleostei	Lucania goodei		yes	rainwater killifish
Chordata	Teleostei	Lucania parva			pike killifish
Chordata	Teleostei	Belonesox belizanus			mosquitofish
Chordata	Teleostei	Gambusia affinis			eastern mosquitofish
Chordata	Teleostei	Gambusia holbrooki			mangrove gambusia
Chordata	Teleostei	Gambusia rhizophorae			

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phylum	class	species	category	new	vernacular
Chordata	Teleostei	Poecilia latipinna			saifin molly
Chordata	Teleostei	Poecilia sphenops		yes	Mexican molly
Chordata	Teleostei	Elops saurus			ladyfish
Chordata	Teleostei	Megalops atlanticus	VU		tarpon
Chordata	Teleostei	Diapterus auratus			Irish mojarra
Chordata	Teleostei	Eucinostomus argenteus			silver mojarra
Chordata	Teleostei	Eucinostomus gula			Jenny mojarra
Chordata	Teleostei	Eucinostomus jonesii			slender mojarra
Chordata	Teleostei	Eucinostomus melanopterus			flagfin mojarra
Chordata	Teleostei	Eugerres plumieri			striped mojarra
Chordata	Teleostei	Gerres cinereus			yellowfin mojarra
Chordata	Teleostei	Ulaema lefroyi			
Chordata	Teleostei	Haemulon aurolineatum			tomtate grunt
Chordata	Teleostei	Haemulon parra			sailor's choice
Chordata	Teleostei	Haemulon plumieri			grunt
Chordata	Teleostei	Haemulon sciurus			bluestriped grunt
Chordata	Teleostei	Lutjanus argentimaculatus		yes	river snapper
Chordata	Teleostei	Lutjanus griseus			grey snapper
Chordata	Teleostei	Nicholsina usta			emerald parrotfish
Chordata	Teleostei	Cynoscion nebulosus			spotted weakfish
Chordata	Teleostei	Pogonias cromis			blackdrum
Chordata	Teleostei	Archosargus probatocephalus			sheepshead
Chordata	Teleostei	Archosargus rhomboidalis			Western Atlantic seabream
Chordata	Teleostei	Diplodus kotschyi		yes	
Chordata	Teleostei	Lagodon rhomboides			pinfish
Chordata	Teleostei	Gobiosox strumosus			skilletfish
Chordata	Teleostei	Gobiosoma bosc			naked goby
Chordata	Teleostei	Gobiosoma ginsburgi		yes	seaboard goby
Chordata	Teleostei	Gobiosoma robustum			code goby
Chordata	Teleostei	Lophogobius cyprinoides			crested goby
Chordata	Teleostei	Microgobius gulosus			clown goby
Chordata	Teleostei	Microgobius microlepis			banner goby
Chordata	Teleostei	Mugil cephalus			grey mullet, muge
Chordata	Teleostei	Mugil curema			silverside mullet
Chordata	Teleostei	Mugil rubrioculus			
Chordata	Teleostei	Ogilbia cayorum	VU		key brotula
Chordata	Teleostei	Epinephelus itajara		yes	itajara
Chordata	Teleostei	Epinephelus lanceolatus			giant grouper
Chordata	Teleostei	Trinectes maculatus			hogchoker
Chordata	Teleostei	Ariopsis felis			hardhead catfish
Chordata	Teleostei	Anarchopterus criniger			fringed pipefish
Chordata	Teleostei	Hippocampus zosterae			dwarf seahorse
Chordata	Teleostei	Syngnathus floridae			duky pipefish
Chordata	Teleostei	Syngnathus fuscus			northern pipefish
Chordata	Teleostei	Syngnathus schlegelii		yes	Seaweed pipefish

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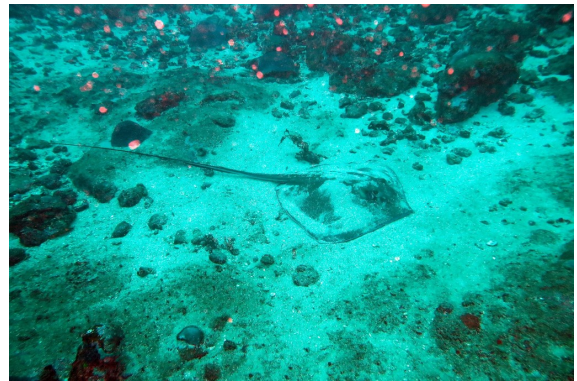
phylum	class	species	category	new	vernacular
Chordata	Teleostei	Syngnathus scovelli			Gulf pipefish
Chordata	Teleostei	Chilomycterus schoepfii		yes	striped burrfish
Chordata	Teleostei	Stephanolepis cirrifer			File fish
Chordata	Teleostei	Stephanolepis hispidus			
Chordata	Teleostei	Sphoeroides maculatus			puffer
Chordata	Teleostei	Sphoeroides parvus		yes	least puffer
Chordata	Teleostei	Sphoeroides spengleri			bandtail puffer
Chordata		Caretta caretta	VU		loggerhead sea turtle, tortue Caouanne
Cnidaria	Anthozoa	Exaiptasia diaphana			
Cnidaria	Anthozoa	Bolocerooides mcmurricchi		yes	
Cnidaria	Anthozoa	Diadumene leucolena		yes	white anemone
Cnidaria	Anthozoa	Edwardsia longicornis		yes	
Cnidaria	Anthozoa	Nanozoanthus harenaceus		yes	
Cnidaria	Hydrozoa	Zancleopsis dichotoma		yes	
Cnidaria	Hydrozoa	Clytia hemisphaerica		yes	
Cnidaria	Hydrozoa	Obelia bidentata		yes	doubletoothed hydroid
Ctenophora	Tentaculata	Vallicula multiformis		yes	
Echinodermata	Holothuroidea	Leptosynapta tenuis			slender footless sea cucumber, holothurie grle
Echinodermata	Holothuroidea	Thyonella gemmata		yes	
Echinodermata	Holothuroidea	Sclerodactyla briareus			hard-fingered sea cucumber, holothurie de Briare
Echinodermata	Ophiuroidea	Amphipholis squamata			dwarf brittle star
Gnathostomulida		Gnathostomula mediterranea		yes	
Mollusca	Bivalvia	Arcopsis adamsi			
Mollusca	Bivalvia	Ameritella mitchelli		yes	
Mollusca	Bivalvia	Brachidontes exustus			
Mollusca	Bivalvia	Crassostrea virginica			eastern oyster, hutre creuse amricaine
Mollusca	Bivalvia	Anomalocardia puella			
Mollusca	Bivalvia	Chione cancellata			cross-barred venus
Mollusca	Gastropoda	Philinopsis pusa		yes	
Mollusca	Gastropoda	Bulla arabica		yes	
Mollusca	Gastropoda	Acteocina canaliculata			
Mollusca	Gastropoda	Crepidula convexa			channeled barrel-bubble, bulle cannele
Mollusca	Gastropoda	Learchis poica		yes	convex slippersnail
Mollusca	Gastropoda	Dondice occidentalis		yes	
Mollusca	Gastropoda	Bittium varium			
Mollusca	Gastropoda	Cerithium eburneum			grass cerith
Mollusca	Gastropoda	Cerithium muscarum			ivory cerith
Mollusca	Gastropoda	Modulus modiolus			flyspeck cerith
Mollusca	Gastropoda	Cylindrobulla beauii			Atlantic modiolus
Mollusca	Gastropoda	Cyerce antillensis		yes	
Myzozoa	Dinophyceae	Amphidinium massartii		yes	
Nemertea	Hoplonemertea	Tetrastemma elegans		yes	four-eyed nemertean
Nemertea	Hoplonemertea	Tetrastemma wilsoni		yes	
Nemertea	Palaeonemertea	Tubulanus riceae		yes	
Phoronida		Phoronis psammophila		yes	

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phylum	class	species	category	new	vernacular
Porifera	Demospongiae	Callyspongia (Cladochalina) aculeata		yes	
Porifera	Demospongiae	Callyspongia (Cladochalina) diffusa		yes	
Porifera	Demospongiae	Cladocroce burapha		yes	
Porifera	Demospongiae	Haliclona (Halichoclona) vansoesti		yes	
Porifera	Demospongiae	Gelliodes wilsoni		yes	
Porifera	Demospongiae	Pachychalina tenera		yes	
Porifera	Demospongiae	Mycale (Carmia) fibrexilis		yes	yellow flabby-sponge
Porifera	Demospongiae	Tedania (Tedania) ignis		yes	
Porifera	Demospongiae	Amorphinopsis fenestrata		yes	
Porifera	Demospongiae	Halichondria (Halichondria) melanadocia		yes	
Porifera	Demospongiae	Geodia neptuni		yes	
Porifera	Demospongiae	Poecillastra laminaris		yes	
Rhodophyta	Florideophyceae	Acanthosiphonia echinata		yes	



(a) *Sphyrna tiburo*



(b) *Hypanus rudis*



(c) *Epinephelus itajara*

Figure 3: Some of the detected fish species.