

eDNA Expeditions biodiversity survey of Everglades National Park

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Highlights

With 50% of the samples analysed we can share the following highlights: 17.5l of water, roughly two buckets, contained:

- **12,500 unique sequences**
- DNA from **194 identifiable species** of which 77 species were not previously reported in the Everglades. The Everglades is home to over 2,500 marine species (source UNESCO/Ocean Biodiversity Information System OBIS).
- DNA of the following **threatened species**: TO BE ADDED

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.

Results

Sampling and DNA sequencing

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

group	obis_species	edna_species	fraction
fish	643	97	0.15
mammal	13	4	0.31
turtle	6	1	0.17

category	obis_species	edna_species	fraction
CR	15	1	0.07
EN	12	1	0.08
NT	27	2	0.07
VU	35	8	0.23

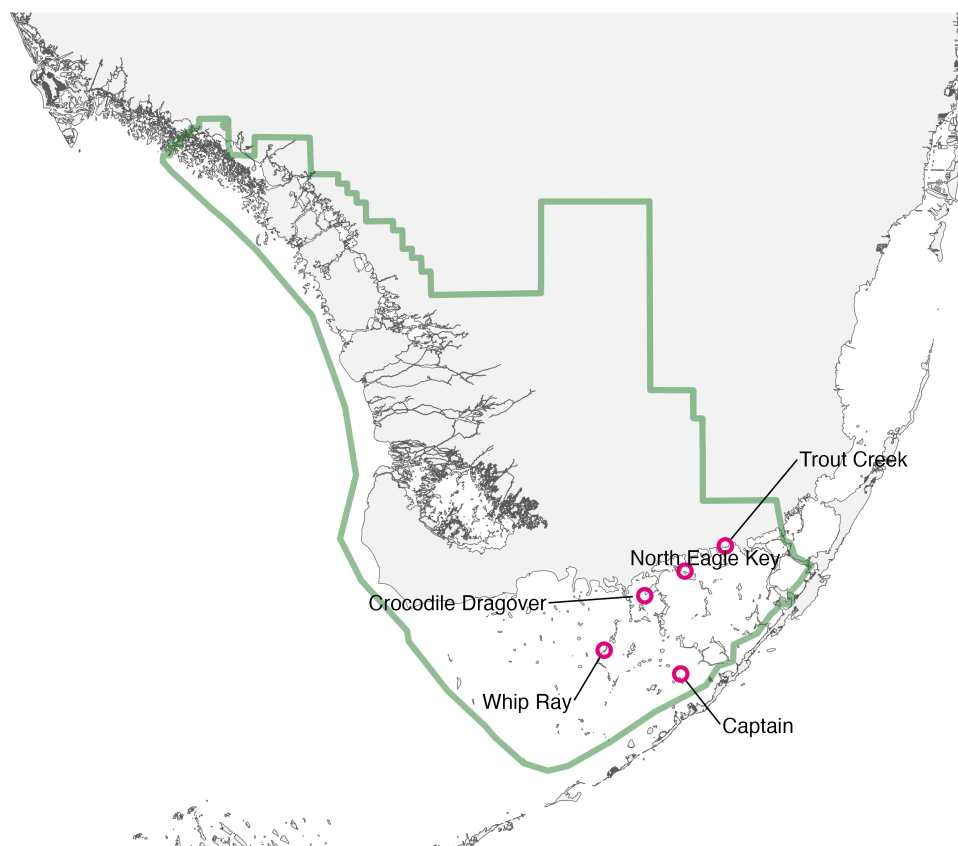


Figure 1: Map of eDNA sampling locations

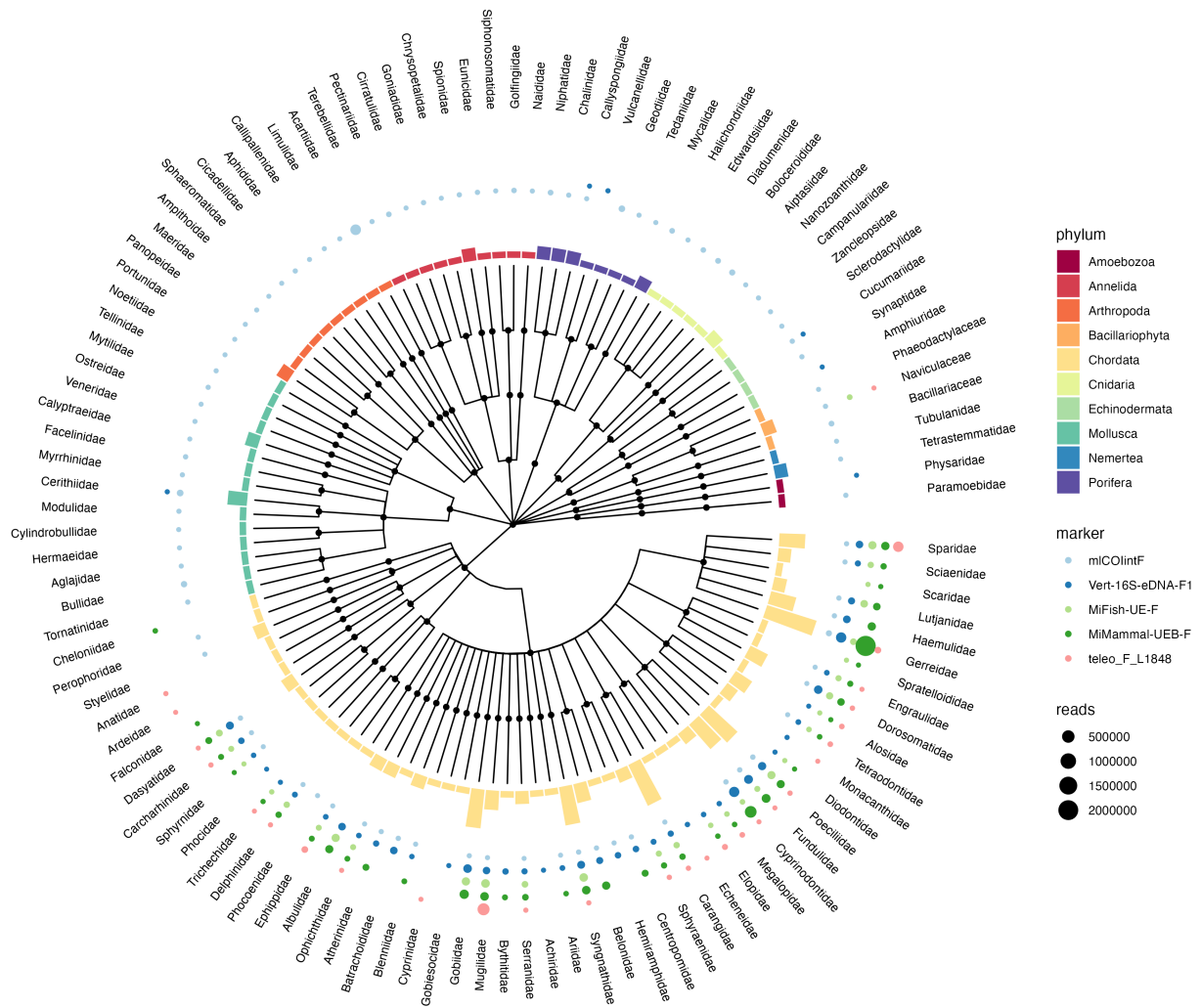


Figure 2: Number of DNA reads and species detected by family

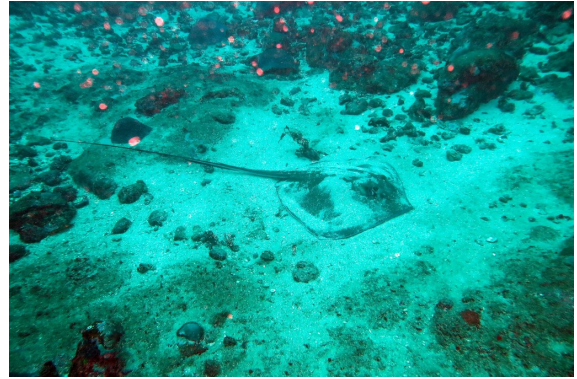
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amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat 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.

Species detection



(a) *Sphyrna tiburo*



(b) *Hypanus rudis*



(c) *Epinephelus itajara*

Figure 3: Some of the detected fish species.

Appendix: species list

phylum	class	species	group	category	new	vernacular
Amoebozoa	Discosea	Neoparamoeba aestuarina			yes	
Amoebozoa	Myxogastrea	Craterium leucocephalum			yes	
Annelida	Clitellata	Thalassodrilids gurwitschi			yes	
Annelida	Polychaeta	Marphysa sanguinea				red rock worm
Annelida	Polychaeta	Bhawania goodei			yes	
Annelida	Polychaeta	Glycinde multidentis				
Annelida	Polychaeta	Polydora websteri			yes	
Annelida	Polychaeta	Prionospio steenstrupi				
Annelida	Polychaeta	Timarete caribous			yes	
Annelida	Polychaeta	Pectinaria gouldii				ice cream cone worm
Annelida	Polychaeta	Loimia medusa				medusa worm
Annelida		Golfingia (Golfingia) elongata				
Annelida		Siphonosoma cumananse			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				
Arthropoda	Malacostraca	Callinectes sapidus				Florida grassflat crab
Arthropoda	Malacostraca	Portunus sanguinolentus			yes	blue crab, crabe bleu
Arthropoda	Malacostraca	Paracerceis caudata				blood-spotted swimming crab
Arthropoda	Merostomata	Limulus polyphemus				
Arthropoda	Pycnogonida	Callipallene brevis		VU		horseshoe crab
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	
Cercozoa	Chlorarachnea	Chlorarachnion reptans			yes	
Chlorophyta	Mamiellophyceae	Dolichomastix tenuilepis			yes	
Chlorophyta	Mamiellophyceae	Micromonas pusilla				
Chordata	Asciacea	Ecteinascidia styeioides			yes	Black synascidia , Synascidia noire
Chordata	Asciacea	Botrylloides niger			yes	
Chordata	Asciacea	Botrylloides simodensis			yes	
Chordata	Aves	Anas poecilorhyncha			yes	
Chordata	Aves	Ardea cinerea			yes	
Chordata	Aves	Falco sparverius			yes	
Chordata	Elasmobranchii	Negaprion brevirostris	fish	VU		lemon shark
Chordata	Elasmobranchii	Sphyrna tiburo	fish	EN		bonnethead
Chordata	Elasmobranchii	Hypanus americanus	fish	NT		
Chordata	Elasmobranchii	Hypanus rudis	fish	CR	yes	

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

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

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phylum	class	species	group	category	new	vernacular
Chordata	Teleostei	Syngnathus scovelli	fish			Gulf pipefish
Chordata	Teleostei	Chilomycterus schoepfii	fish			striped burrfish
Chordata	Teleostei	Stephanolepis cirrifer	fish		yes	File fish
Chordata	Teleostei	Stephanolepis hispidus	fish			
Chordata	Teleostei	Sphoeroides maculatus	fish			puffer
Chordata	Teleostei	Sphoeroides parvus	fish		yes	least puffer
Chordata	Teleostei	Sphoeroides spengleri	fish			bandtail puffer
Chordata	Teleostei	Caretta caretta	turtle	VU		loggerhead sea turtle, tortue Caouanne
Cnidaria	Anthozoa	Exalptasia diaphana				
Cnidaria	Anthozoa	Boloceroideus mcmurricchi			yes	
Cnidaria	Anthozoa	Diadumene leucolela			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				
Echinodermata	Holothuroidea	Sclerodactyla briareus			yes	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				channeled barrel-bubble, bulle cannele
Mollusca	Gastropoda	Crepidula convexa				convex slippersnail
Mollusca	Gastropoda	Learchis poica			yes	
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	
Myozoa	Dinophyceae	Amphidinium massartii			yes	
Nemertea	Hoploneurtea	Tetrastemma elegans			yes	four-eyed nemertean
Nemertea	Hoploneurtea	Tetrastemma wilsoni			yes	
Nemertea	Palaeonemertea	Tubulanus riceae			yes	
Phoronida		Phoronis psammophila			yes	

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phylum	class	species	group	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	