UNESCO environmental DNA (eDNA) Expeditions in marine World Heritage sites

Biodiversity survey for Península Valdés

Interim Results
Not for public distribution

About eDNA Expeditions

UNESCO's eDNA Expeditions is a global, citizen science initiative that is conducted with the intention to measure marine biodiversity and predict the impact climate change on marine community composition across UNESCO World Heritage marine sites.

eDNA is a cost effective and minimally invasive method to measure biodiversity in any given area. Marine species continuously shed DNA into the water around them in the form of waste, mucus, or cells. By extracting this DNA from water samples, and subsequently multiplying and sequencing specific regions within these DNA strands, a wide variety of species can be detected without removing any organisms from their environment. The regions in the DNA targeted for sequencing are selected depending on the scope of the study: while some markers are suitable to obtain a broad overview of biodiversity across many groups of species, other markers are particularly suited to get high resolution insight for a more specific taxonomic group such as fish. The UNESCO eDNA Expeditions initiative combines a number of markers tailored for marine vertebrates (fish, mammals, and turtles). A general marker was added to also allow detection of species from other groups such as invertebrates, which can give a broader insight in the marine species diversity in a given area.

Between September 2022 and May 2023, UNESCO organized eDNA sampling campaigns in 21 marine World Heritage sites across 17 countries around the world. At every World Heritage site, about 20 samples were collected from different habitats. Over 250 young people participated in the local sampling expeditions. They were guided by local experts and park management staff, using protocols and eDNA sampling equipment provided by UNESCO.

Biodiversity inventories generated from the samples are being combined with existing species distribution data from public biodiversity databases such as the Ocean Biodiversity Information System (OBIS) in view of obtaining a comprehensive overview of marine life across marine World Heritage sites. Through the use of climate scenarios and species distribution models, an estimate will be made of the impact of climate change, in particular rising temperatures, on local biodiversity and its potential future distribution patterns.

More information about the initiative and a press kit are available on the UNESCO website: https://www.unesco.org/en/edna-expeditions.

Results

Sampling and sample processing

eDNA sampling was conducted in Península Valdés in July 2023. A total of 20 samples were collected at 5 locations in the park covering different habitats: valdes_station_1, valdes_station_2, valdes_station_3, valdes_station_4, and valdes_station_5 (Figure 1). Up to 1,800 mL of seawater was filtered through filter cartridges containing a filter with a 0.8 µm pore size. After sampling, the filter cartridges were flushed with preservation liquid and shipped to UNESCO. DNA from the samples was extracted and amplified, and subsequently sent to the sequencing facility at KU Leuven in Belgium, a specialized university eDNA lab contracted by UNESCO for this work. PCR amplification was done using five primer pairs selected to capture as much biodiversity as possible in the target groups of the study: fish, mammals, and turtles.

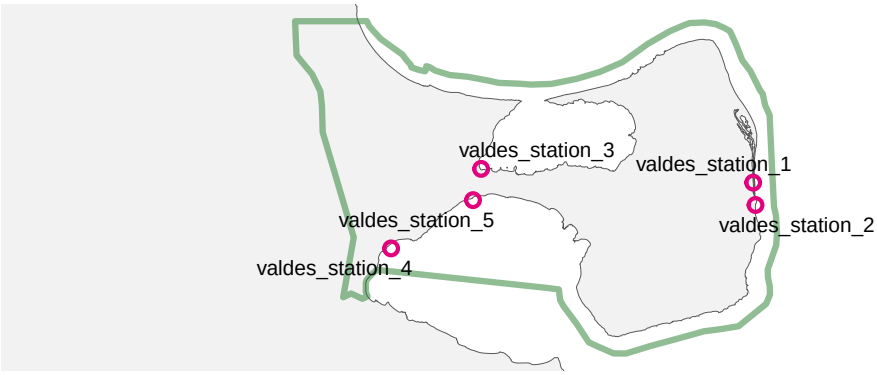

Figure 1: Map of the sampling locations.

DNA sequencing

Sequencing of the DNA from 20 samples resulted in over 46 million sequence reads, from which we collected 31,774 unique sequences or ASVs (Tables 1 and 2).

reads	asvs
46668935	31774

Table 1: Reads, ASVs, and species across all samples.

Species identification

The marker sequences obtained from sequencing were matched with sequence reference databases built using public data available from the National Center for Biotechnology Information (NCBI). This resulted in the identification of 215 species, including 34 fish species, 9 mammalian species, and 9 turtle species (Table 3). Species from other groups, such as algae, cnidarians, crustaceans, molluscs, and worms, were also detected (Figures 2 and 3). This number of species detected represents about 36% of the 617 species known from Península Valdés in the OBIS database. Of the 215 species detected, 135 are not among the species previously reported from Península Valdés to the UNESCO OBIS database. 6 of the detected species are listed as threatened on the IUCN Red List (Table 4). A full list of species is added at the end of this report.

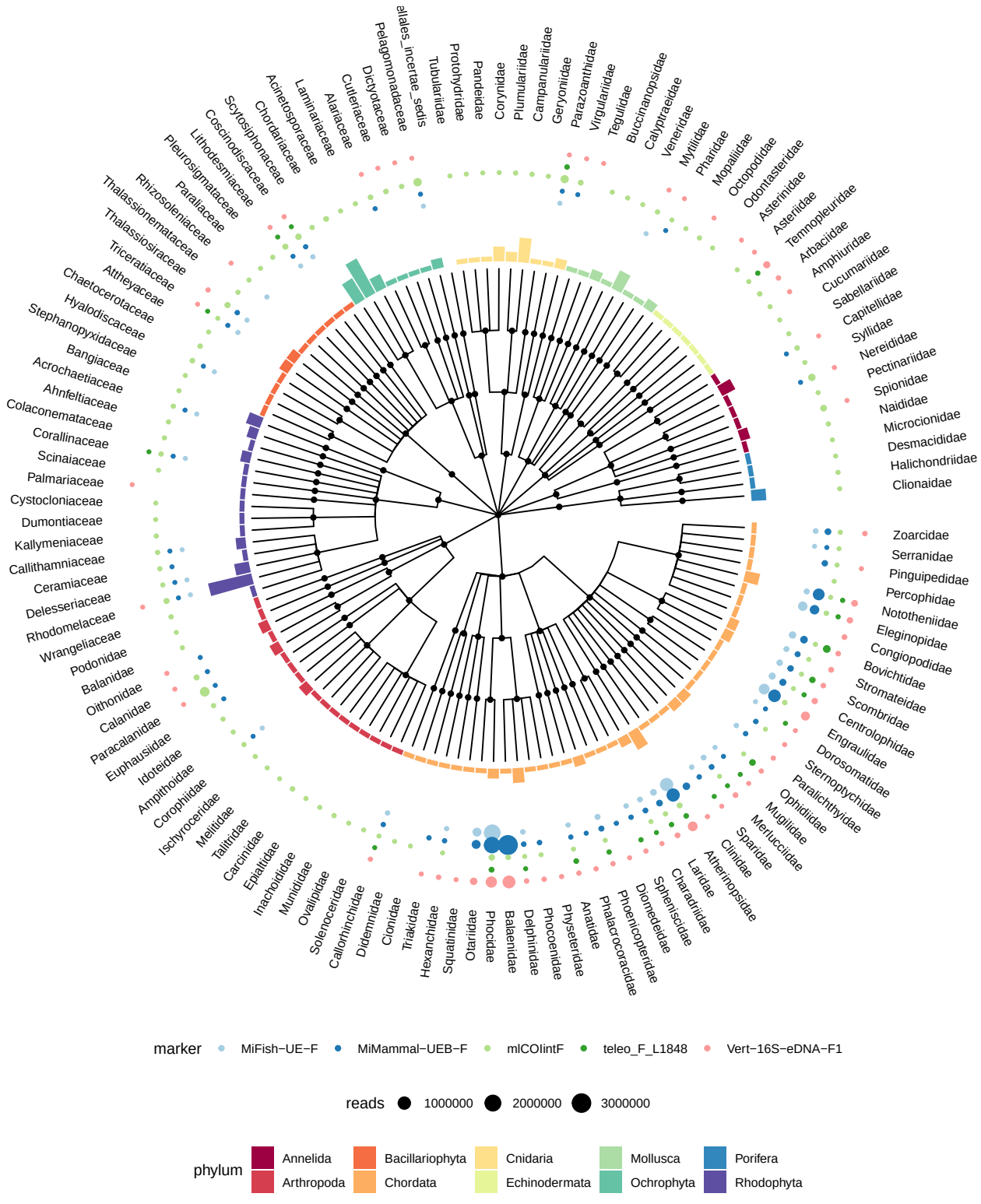

Figure 2: Number of DNA reads (bubbles) and species detected (bars) by family.

locality	materialSampleID	sampleSize	reads	asvs	species
Peninsula Valdès	EE0199	1800	1914672	8113	107
Peninsula Valdès	EE0200	1620	2479262	9947	85
Peninsula Valdès	EE0201	1620	1617107	8397	106
Peninsula Valdès	EE0202	1800	1084262	7145	101
Peninsula Valdès	EE0203	1800	2590116	11322	107
Peninsula Valdès	EE0204	1620	1992504	6964	63
Peninsula Valdès	EE0205	1620	2872400	9043	79
Peninsula Valdès	EE0206	1800	1982831	5724	54
Peninsula Valdès	EE0216	1620	1788227	11899	86
Peninsula Valdès	EE0217	1680	2118418	8878	87
Peninsula Valdès	EE0218	1800	3173178	12267	104
Peninsula Valdès	EE0219	1800	1992877	6248	52
Peninsula Valdès	EE0220	1800	2936534	6523	45
Peninsula Valdès	EE0231	1800	2720070	10721	97
Peninsula Valdès	EE0232	1800	2464578	5454	45
Peninsula Valdès	EE0233	1800	3043986	11671	101
Peninsula Valdès	EE0234	1680	2040817	8712	90
Peninsula Valdès	EE0235	1800	2533015	6488	51
Peninsula Valdès	EE0236	1800	2655433	7434	50
Peninsula Valdès	EE0252	1800	2668648	6496	60

Table 2: Reads, ASVs, and species by sample.

group	eDNA species	total species	fraction
fish	34	92	0.37
mammals	9	26	0.35
turtles	0	1	

Table 3: Number of species in the three target groups, from the OBIS database and from eDNA sampling.

category	eDNA species	total species	fraction
CR	1	4	0.25
EN	1	5	0.20
VU	4	13	0.31

Table 4: Number of species by IUCN Red List category, from the OBIS database and from eDNA sampling.

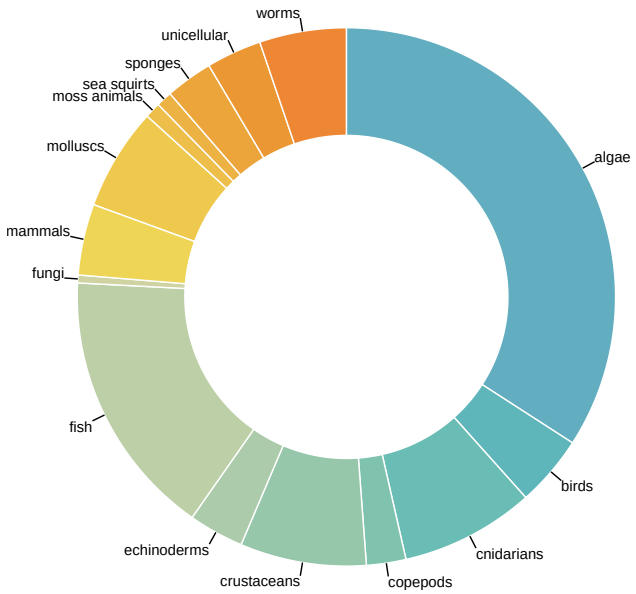

Figure 3: Distribution of detected species across groups.

phylum	class	species	group	category	new	vernacular
Amoebozoa	Discosea	Parvamoeba rugata	unicellular		yes	
Amoebozoa	Discosea	Pseudoparamoeba pagei	unicellular		yes	
Amoebozoa	Discosea	Squamamoeba japonica	unicellular		yes	
Annelida	Clitellata	Paranais litoralis	worms		yes	
Annelida	Polychaeta	Boccardia proboscidea	worms			
Annelida	Polychaeta	Capitella capitata	worms		yes	gallery worm
Annelida	Polychaeta	Capitella nonatoi	worms		yes	
Annelida	Polychaeta	Capitella teleta	worms		yes	Capitella sp. I
Annelida	Polychaeta	Cistenides ehlersi	worms		yes	
Annelida	Polychaeta	Laeonereis culveri	worms		yes	
Annelida	Polychaeta	Phragmatopoma moerchi	worms		yes	
Annelida	Polychaeta	Rhynchospio glutaea	worms		yes	
Annelida	Polychaeta	Trypanosyllis zebra	worms		yes	
Arthropoda	Branchiopoda	Podon intermedius	crustaceans		yes	
Arthropoda	Copepoda	Calanoides carinatus	copepods		yes	
Arthropoda	Copepoda	Oithona nana	copepods		yes	
Arthropoda	Copepoda	Oithona similis	copepods		yes	
Arthropoda	Copepoda	Paracalanus brasiliensis	copepods		yes	
Arthropoda	Copepoda	Paracalanus quasimodo	copepods		yes	
Arthropoda	Malacostraca	Ampithoe valida	crustaceans			
Arthropoda	Malacostraca	Carcinus maenas	crustaceans			green crab, crabe enragé
Arthropoda	Malacostraca	Euphausia lucens	crustaceans		yes	
Arthropoda	Malacostraca	Grimothea gregaria	crustaceans			
Arthropoda	Malacostraca	Idotea balthica	crustaceans			Baltic isopod
Arthropoda	Malacostraca	Jassa slatteryi	crustaceans		yes	
Arthropoda	Malacostraca	Leucippa pentagona	crustaceans			
Arthropoda	Malacostraca	Leurocyclus tuberculosus	crustaceans			
Arthropoda	Malacostraca	Melita palmata	crustaceans			
Arthropoda	Malacostraca	Monocorophium acherusicum	crustaceans		yes	
Arthropoda	Malacostraca	Monocorophium insidiosum	crustaceans			
Arthropoda	Malacostraca	Orchestia gammarellus	crustaceans			common shore-skipper
Arthropoda	Malacostraca	Ovalipes trimaculatus	crustaceans			three-spot swimming crab
Arthropoda	Malacostraca	Pleoticus muelleri	crustaceans			Argentine red shrimp, Salicoque rouge d'Argentine
Arthropoda	Thecostraca	Balanus glandula	crustaceans			
Bacillariophyta	Bacillariophyceae	Attheya longicornis	algae		yes	
Bacillariophyta	Bacillariophyceae	Chaetoceros socialis	algae		yes	
Bacillariophyta	Bacillariophyceae	Coscinodiscus granii	algae		yes	
Bacillariophyta	Bacillariophyceae	Ditylum brightwellii	algae		yes	
Bacillariophyta	Bacillariophyceae	Odontella regia	algae		yes	
Bacillariophyta	Bacillariophyceae	Paralia sulcata	algae			
Bacillariophyta	Bacillariophyceae	Pleurosigma inscriptura	algae		yes	
Bacillariophyta	Bacillariophyceae	Podosira stelligera	algae		yes	
Bacillariophyta	Bacillariophyceae	Rhizosolenia delicatula	algae		yes	
Bacillariophyta	Bacillariophyceae	Stephanopyxis turris	algae		yes	
Bacillariophyta	Bacillariophyceae	Thalassionema nitzschioides	algae		yes	
Bacillariophyta	Bacillariophyceae	Thalassiosira profunda	algae		yes	
Bacillariophyta	Bacillariophyceae	Thalassiosira rotula	algae		yes	
Bacillariophyta	Bacillariophyceae	Triceratium intricatum	algae		yes	
Bryozoa	Gymnolaemata	Austrothoa yagana	moss animals		yes	
Bryozoa	Gymnolaemata	Neothoa patagonica	moss animals		yes	

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phylum	class	species	group	category	new	vernacular
Chlorophyta	Mamiellophyceae	Bathycoccus prasinos	algae		yes	
Chlorophyta	Mamiellophyceae	Micromonas pusilla	algae		yes	
Chlorophyta	Pyramimonadophyceae	Pycnococcus provasolii	algae		yes	
Chordata	Ascidiacea	Ciona robusta	sea squirts			
Chordata	Ascidiacea	Lissoclinum perforatum	sea squirts		yes	
Chordata	Aves	Haematopus palliatus	birds	LC		American oystercatcher, huîtrier d'Amérique
Chordata	Aves	Lophonetta specularioides	birds	LC		crested duck, Canard huppé
Chordata	Aves	Phalacrocorax brasilianus	birds			neotropical cormorant, Cormoran vigua
Chordata	Aves	Phoenicopterus chilensis	birds	NT		Chilean flamingo
Chordata	Aves	Phoenicopterus ruber	birds	LC	yes	greater flamingo, flamant des Caraïbes
Chordata	Aves	Spheniscus magellanicus	birds	LC		Magellanic penguin, Manchot de Magellan
Chordata	Aves	Sterna hirundinacea	birds	LC		South American tern, sterne hirundinacée
Chordata	Aves	Sterna vittata	birds	LC	yes	Antarctic tern, Sterne couronnée
Chordata	Aves	Thalassarche melanophris	birds	LC		black-browed albatross
Chordata	Elasmobranchii	Galeorhinus galeus	fish	CR		tope, requin-hâ
Chordata	Elasmobranchii	Notorynchus cepedianus	fish	VU		broadnose sevengill shark, requin à sept branchies
Chordata	Elasmobranchii	Squatina guggenheim	fish	EN	yes	
Chordata	Holocephali	Callorhinchus callorynchus	fish	VU		plownose chimaera, masca
Chordata	Mammalia	Eubalaena australis	mammals	LC		southern right whale, baleine du Cap
Chordata	Mammalia	Lagenorhynchus obscurus	mammals	LC		dusky dolphin, dauphin obscur
Chordata	Mammalia	Lobodon carcinophagus	mammals			crabeater seal
Chordata	Mammalia	Mirounga leonina	mammals	LC		southern elephant seal
Chordata	Mammalia	Otaria byronia	mammals	LC		South American sea lion
Chordata	Mammalia	Phocoena spinipinnis	mammals	NT		Burmeister's porpoise, marsouin de Burmeister
Chordata	Mammalia	Physeter macrocephalus	mammals	VU		sperm whale, cachalot à dents pointues
Chordata	Mammalia	Stenella coeruleoalba	mammals	LC	yes	striped dolphin, dauphin bleu et blanc
Chordata	Mammalia	Tursiops truncatus	mammals	LC		bottlenose dolphin, grand dauphin
Chordata	Teleostei	Acanthistius patachonicus	fish	DD		
Chordata	Teleostei	Austrolycus laticinctus	fish			
Chordata	Teleostei	Bovichtus argentinus	fish			
Chordata	Teleostei	Congiopodus peruvianus	fish	LC		
Chordata	Teleostei	Eleginops maclovinus	fish			
Chordata	Teleostei	Engraulis anchoita	fish	LC		Argentine anchovy, anchois d'Argentine
Chordata	Teleostei	Genypterus blacodes	fish			pink cusk-eel
Chordata	Teleostei	Harengula jaguana	fish	LC	yes	scaled sardine
Chordata	Teleostei	Maurolicus muelleri	fish	LC	yes	Muller's pearlsides, maurolique de Müller
Chordata	Teleostei	Merluccius hubbsi	fish			Argentine hake, merlu d'Argentine
Chordata	Teleostei	Mugil curema	fish	LC	yes	silverside mullet
Chordata	Teleostei	Mugil liza	fish	DD		liza
Chordata	Teleostei	Myxodes viridis	fish	LC	yes	
Chordata	Teleostei	Odontesthes argentinensis	fish			
Chordata	Teleostei	Odontesthes incisa	fish	LC		
Chordata	Teleostei	Odontesthes nigricans	fish			
Chordata	Teleostei	Odontesthes smitti	fish		yes	
Chordata	Teleostei	Pagrus pagrus	fish	LC		red porgy, pagre commun
Chordata	Teleostei	Paralichthys patagonicus	fish	VU		
Chordata	Teleostei	Patagonotothen ramsayi	fish	DD	yes	cod icefish
Chordata	Teleostei	Patagonotothen sima	fish			
Chordata	Teleostei	Patagonotothen tessellata	fish	DD	yes	
Chordata	Teleostei	Percophis brasiliensis	fish			

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phylum	class	species	group	category	new	vernacular
Chordata	Teleostei	Pinguipes brasilianus	fish			
Chordata	Teleostei	Raneya brasiliensis	fish	LC		
Chordata	Teleostei	Scomber colias	fish	LC	yes	chub mackerel, maquereau blanc
Chordata	Teleostei	Scomber japonicus	fish	LC		Atlantic chub mackerel, maquereaux blanc
Chordata	Teleostei	Seriolella porosa	fish			
Chordata	Teleostei	Stromateus brasiliensis	fish			
Chordata	Teleostei	Stromateus stellatus	fish	LC	yes	
Cnidaria	Anthozoa	Isozoanthus sulcatus	cnidarians		yes	
Cnidaria	Anthozoa	Stylatula elegans	cnidarians		yes	
Cnidaria	Anthozoa	Virgularia mirabilis	cnidarians		yes	elegant sea pen, pennatule magnifique
Cnidaria	Hydrozoa	Clytia gracilis	cnidarians		yes	
Cnidaria	Hydrozoa	Clytia hemisphaerica	cnidarians		yes	
Cnidaria	Hydrozoa	Coryne eximia	cnidarians		yes	
Cnidaria	Hydrozoa	Hybocodon chilensis	cnidarians		yes	
Cnidaria	Hydrozoa	Leuckartiara octona	cnidarians		yes	
Cnidaria	Hydrozoa	Liriope tetraphylla	cnidarians		yes	
Cnidaria	Hydrozoa	Obelia bidentata	cnidarians		yes	doubletoothed hydroid
Cnidaria	Hydrozoa	Obelia dichotoma	cnidarians		yes	sea thread hydroid
Cnidaria	Hydrozoa	Orthopyxis crenata	cnidarians		yes	
Cnidaria	Hydrozoa	Plumularia duseni	cnidarians		yes	
Cnidaria	Hydrozoa	Plumularia setacea	cnidarians		yes	little seabristle
Cnidaria	Hydrozoa	Protohydra leuckarti	cnidarians		yes	
Cnidaria	Hydrozoa	Sarsia striata	cnidarians		yes	
Cnidaria	Hydrozoa	Sarsia tubulosa	cnidarians		yes	clapper hydroid
Cryptophyta	Cryptophyceae	Hemiselmis andersenii			yes	
Echinodermata	Asteroidea	Anasterias antarctica	echinoderms			
Echinodermata	Asteroidea	Cycethra verrucosa	echinoderms			
Echinodermata	Asteroidea	Odontaster meridionalis	echinoderms		yes	
Echinodermata	Echinoidea	Arbacia dufresnii	echinoderms			
Echinodermata	Echinoidea	Pseudechinus magellanicus	echinoderms			
Echinodermata	Holothuroidea	Pentactella leonina	echinoderms			
Echinodermata	Ophiuroidea	Amphipholis squamata	echinoderms		yes	dwarf brittle star
Haptophyta	Coccolithophyceae	Emiliania huxleyi	algae		yes	
Haptophyta	Coccolithophyceae	Phaeocystis globosa	algae		yes	
Mollusca	Bivalvia	Ameghinomya antiqua	molluscs			
Mollusca	Bivalvia	Aulacomya atra	molluscs			
Mollusca	Bivalvia	Brachidontes rodriguezii	molluscs			
Mollusca	Bivalvia	Ensis macha	molluscs			
Mollusca	Bivalvia	Mytilus edulis	molluscs			blue mussel, moule commune
Mollusca	Bivalvia	Perumytilus purpuratus	molluscs			
Mollusca	Cephalopoda	Octopus tehuelchus	molluscs	DD		Tehuelche octopus
Mollusca	Cephalopoda	Robsonella fontaniana	molluscs			
Mollusca	Gastropoda	Bostrycapulus odites	molluscs		yes	
Mollusca	Gastropoda	Buccinastrum deforme	molluscs			
Mollusca	Gastropoda	Crepipatella dilatata	molluscs			
Mollusca	Gastropoda	Tegula patagonica	molluscs			
Mollusca	Polyplacophora	Plaxiphora aurata	molluscs			
Myzozoa	Dinophyceae	Dinophysis acuminata	unicellular			
Myzozoa	Dinophyceae	Heterocapsa rotundata	unicellular		yes	
Myzozoa	Dinophyceae	Nusuttodinium poecilochroum	unicellular		yes	

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phylum	class	species	group	category	new	vernacular
Myzozoa	Dinophyceae	Tripos lineatus	unicellular		yes	
Nemertea	Palaeonemertea	Cephalothrix hermaphroditicus	worms		yes	
Ochrophyta	Dictyochophyceae	Pseudochattonella farcimen	algae		yes	
Ochrophyta	Pelagophyceae	Aureococcus anophagefferens	algae		yes	
Ochrophyta	Pelagophyceae	Pelagomonas calceolata	algae		yes	
Ochrophyta	Phaeophyceae	Acinetospora crinita	algae		yes	
Ochrophyta	Phaeophyceae	Acinetospora filamentosa	algae		yes	
Ochrophyta	Phaeophyceae	Cutleria multifida	algae		yes	
Ochrophyta	Phaeophyceae	Dictyota dichotoma	algae			
Ochrophyta	Phaeophyceae	Feldmannia globifera	algae		yes	
Ochrophyta	Phaeophyceae	Leathesia marina	algae			
Ochrophyta	Phaeophyceae	Leptonematella fasciculata	algae		yes	
Ochrophyta	Phaeophyceae	Macrocystis pyrifera	algae			
Ochrophyta	Phaeophyceae	Mesogloia vermiculata	algae		yes	
Ochrophyta	Phaeophyceae	Microspongium stilophorae	algae		yes	
Ochrophyta	Phaeophyceae	Myrionema balticum	algae		yes	
Ochrophyta	Phaeophyceae	Myrionema strangulans	algae		yes	
Ochrophyta	Phaeophyceae	Papenfussiella kuromo	algae		yes	
Ochrophyta	Phaeophyceae	Petalonia fascia	algae		yes	
Ochrophyta	Phaeophyceae	Petalonia tenella	algae		yes	
Ochrophyta	Phaeophyceae	Planosiphon gracilis	algae		yes	
Ochrophyta	Phaeophyceae	Punctaria latifolia	algae		yes	
Ochrophyta	Phaeophyceae	Scytosiphon lomentaria	algae		yes	
Ochrophyta	Phaeophyceae	Scytosiphon promiscuus	algae		yes	
Ochrophyta	Phaeophyceae	Undaria pinnatifida	algae			
Oomycota	Peronosporea	Eurychasma dicksonii	fungi		yes	
Platyhelminthes		Microstomum compositum			yes	
Platyhelminthes		Microstomum septentrionale			yes	
Platyhelminthes		Promesostoma dipterostylum			yes	
Porifera	Demospongiae	Clathria (Clathria) unica	sponges		yes	
Porifera	Demospongiae	Cliona celata	sponges			boring sponge, clione jaune
Porifera	Demospongiae	Cliona chilensis	sponges			
Porifera	Demospongiae	Clionaopsis platei	sponges			
Porifera	Demospongiae	Desmapsamma anchorata	sponges		yes	
Porifera	Demospongiae	Halichondria (Halichondria) panicea	sponges		yes	breadcrumb sponge
Rhodophyta	Bangiophyceae	Porphyra mumfordii	algae		yes	
Rhodophyta	Bangiophyceae	Pyropia orbicularis	algae		yes	
Rhodophyta	Bangiophyceae	Pyropia thuretii	algae		yes	
Rhodophyta	Florideophyceae	Acrochaetium moniliforme	algae		yes	
Rhodophyta	Florideophyceae	Ahnfeltia plicata	algae		yes	
Rhodophyta	Florideophyceae	Bossiella orbigniana	algae		yes	
Rhodophyta	Florideophyceae	Callithamnion corymbosum	algae		yes	
Rhodophyta	Florideophyceae	Callithamnion tetragonum	algae		yes	
Rhodophyta	Florideophyceae	Callophyllis variegata	algae		yes	
Rhodophyta	Florideophyceae	Carradoriella denudata	algae		yes	
Rhodophyta	Florideophyceae	Ceramium secundatum	algae		yes	
Rhodophyta	Florideophyceae	Colaconema caespitosum	algae		yes	
Rhodophyta	Florideophyceae	Colaconema daviesii	algae		yes	
Rhodophyta	Florideophyceae	Dasya tenuis	algae		yes	
Rhodophyta	Florideophyceae	Dudresnaya verticillata	algae		yes	

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phylum	class	species	group	category	new	vernacular
Rhodophyta	Florideophyceae	Eutrichosiphonia paniculata	algae		yes	
Rhodophyta	Florideophyceae	Grania pectinata	algae		yes	
Rhodophyta	Florideophyceae	Leptosiphonia brodiei	algae		yes	
Rhodophyta	Florideophyceae	Melanothamnus harveyi	algae		yes	
Rhodophyta	Florideophyceae	Meridionella obtusangula	algae		yes	
Rhodophyta	Florideophyceae	Palmaria palmata	algae		yes	
Rhodophyta	Florideophyceae	Phycodrys antarctica	algae		yes	
Rhodophyta	Florideophyceae	Polysiphonia devoniensis	algae		yes	
Rhodophyta	Florideophyceae	Polysiphonia morrowii	algae			
Rhodophyta	Florideophyceae	Polysiphonia radiata	algae		yes	
Rhodophyta	Florideophyceae	Polysiphonia scopulorum	algae		yes	
Rhodophyta	Florideophyceae	Schizoseris multifoliata	algae		yes	
Rhodophyta	Florideophyceae	Scinaia capensis	algae		yes	
Rhodophyta	Florideophyceae	Spermothamnion cymosum	algae		yes	
Rhodophyta	Florideophyceae	Streblocladia camptoclada	algae		yes	