

The Canadian Field-Naturalist

SUPPLEMENTARY MATERIALS:

Combining current and historical biodiversity surveys reveals order of magnitude greater richness in a marine protected area

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Figure S1. Intertidal survey habitats at Porteau Cove Provincial Park, British Columbia, Canada. a. Typical cobble-beach habitat (looking south along Howe Sound from the riprap above sites Cob1-2, Cob 2-2). b. Typical riprap habitat (site R1-4, on the south side of the emergency ferry pier, from the riprap above the beach). c. Sandy beach north of the ferry pier surveyed for Purple Mahogany Varnish Clam, *Nuttallia obscurata*. Photos: Catherine Gerstle.

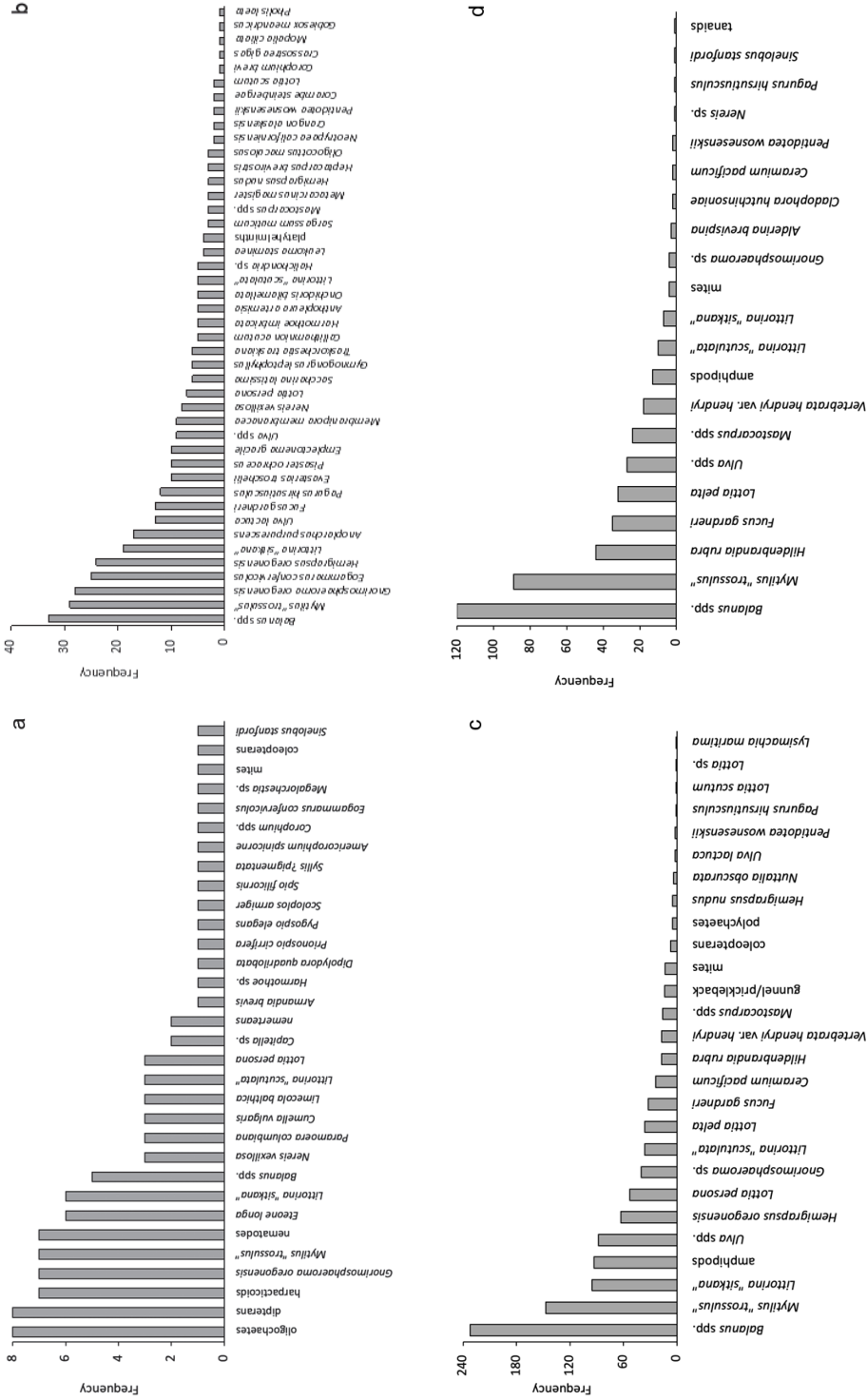


FIGURE S2. Rank-order frequency curves for taxa found in four intertidal biodiversity surveys at Porteau Cove Provincial Park, British Columbia. Frequency is number of quadrats in which each species was observed. Y-axis maxima are total number of quadrats sampled in each survey. Surveys are a. Sediment survey (Sed) by Levings and McDaniel (1976); b. Cobble beach survey (Cob1) by Birch *et al.* (1990); c. Cobble beach survey (Cob2) in our study; d. Riprap survey (Rip) in our study.

Table S1. Intertidal taxa found in four quantitative quadrat surveys (x) or reported as qualitative text (t) records in Porteau Cove Provincial Park (PCPP), British Columbia, Canada. The four surveys were Sed (sediment, Levings and McDaniel 1976), Cob1 (cobble beach, Birch *et al.* 1990), Cob2 (cobble beach, our study), and Rip (riprap, our study). Notes indicate: NIS, non-indigenous species; MP, taxa listed in the PCPP Master Plan (BC Parks 1990); earlier species names as reported in original surveys; condition of organisms if not alive; citations for species that were reported only in additional sources beyond the four surveys (Willem 2004 and iNaturalist records via GBIF 2023). Under Distinct, plus signs (+) indicate taxa identified as distinct for the purpose of the total taxon count.

Taxon	Common name	Historical		Current		Notes	Distinct
		Sed	Cob1	Cob2	Rip		
PORIFERA							
Demospongiae							
<i>Halichondria</i> sp.	breadcrumb sponge		x				+
CNIDARIA							
Anthozoa							
<i>Anthopleura artemisia</i>	Sand Anemone		x				+
PLATYHELMINTHES							
platyhelminthes	flatworm		x				+
MOLLUSCA							
Polyplacophora							
<i>Mopalia ciliata</i>	Hairy Chiton		x				+
Gastropoda							
<i>Lottia</i> (= <i>Notoacmea</i> = <i>Tectura</i>) <i>persona</i>	Mask Limpet	x	x	x			+
<i>Lottia pelta</i>	Shield Limpet			x	x	MP	+
<i>Lottia scutum</i>	Flat Limpet		x [†]	x		† as “Flat Limpet <i>Lottia</i> sp.”	+
<i>Lottia</i> sp.	limpet (indet. small)			x			
<i>Littorina</i> “ <i>scutulata</i> ”	“Checkered Periwinkle”	x	x	x	x	MP	+
<i>Littorina</i> “ <i>sitkana</i> ”	“Sitka Periwinkle”	x	x	x	x		+
<i>Corambe</i> (= <i>Doridella</i>) <i>steinbergae</i>	nudibranch		x				+
<i>Onchidoris bilamellata</i>	Barnacle-eating Nudibranch		x				+
Bivalvia							
<i>Mytilus</i> “ <i>trossulus</i> ”	Blue Mussel	x [†]	x [†]	x	x	† as <i>M. edulis</i> ; MP	+
<i>Magallana</i> (= <i>Crassostrea</i>) <i>gigas</i>	Japanese Oyster		x			NIS	+
<i>Limecola balthica</i> (= <i>Macoma</i> <i>inconspicua</i>)	Baltic Clam	x			t		+
<i>Leukoma</i> (= <i>Protothaca</i>) <i>staminea</i>	Littleneck Clam		x				+
<i>Mya arenaria</i>	Soft-shell Clam				t	NIS	+
<i>Nuttallia obscurata</i>	Purple Mahogany Clam			x		NIS	+
ANNELIDA							
Capitellidae							
<i>Capitella</i> sp.	–		x				+
Nereidae							
<i>Nereis vexillosa</i>	–		x	x	x		+
<i>Nereis</i> sp.	–					x	
Opheliidae							
<i>Armandia brevis</i>	–		x				+

Taxon	Common name	Historical		Current		Notes	Distinct
		Sed	Cob1	Cob2	Rip		
Orbiniidae							
<i>Scoloplos armiger</i>	—	x					+
Phyllodocidae							
<i>Eteone longa</i>	—	x					+
Spionidae							
<i>Prionospio cirrifera</i>	—	x					+
<i>Pygospio elegans</i>	—	x					+
<i>Dipolydora</i> (=Polydora) <i>quadrilobata</i>	—	x					+
<i>Spio filicornis</i>	—	x					+
Syllidae							
<i>Syllis</i> ? <i>pigmentata</i> (=S. ? <i>pulchra</i>)	—	x					+
<i>Syllis adamantea adamantea</i>	—	t					+
Polynoidea							
<i>Harmothoe imbricata</i>	—		x				+
<i>Harmothoe</i> sp.	—	x					
Polychaeta							
Polychaeta: indet.	—				x		
Oligochaeta: indet.	—	x					+
NEMERTEA							
<i>Emplectonema gracile</i>	green nemertean		x				+
<i>Amphiporus</i> sp.	white nemertean				x		+
Nemertea: indet.	nemertean	x					
BRYOZOA							
<i>Membranipora membranacea</i>	bryozoan		x				+
<i>Alderina brevispina</i>	bryozoan				x [†]	† empty zooecia on rock	+
NEMATA							
Nemata: indet.	nematode	x					+
ARTHROPODA							
Cirripedia							
<i>Balanus glandula</i>	barnacle	x	x	x	x	MP	+
<i>Balanus crenatus</i>	barnacle			x	x		+
Copepoda							
Harpacticoida: indet.	harpacticoid copepod	x					+
Decapoda							
<i>Hemigrapsus nudus</i>	Purple Shore Crab		x	x			+
<i>Hemigrapsus oregonensis</i>	Green Shore Crab		x	x			+
<i>Cancer productus</i>	Red Rock Crab			t [†]		† moulted exoskeleton	+
<i>Metacarcinus</i> (=Cancer) <i>magister</i>	Dungeness Crab		x [†]	t [†]		† moulted exoskeleton	+
<i>Pagurus hirsutiussculus</i>	Hairy Hermit Crab		x	x			+
<i>Neotrypaea</i> (=Callinasa) <i>californiensis</i>	Ghost Shrimp		x				+
<i>Heptacarpus brevirostris</i>	Stout Coastal Shrimp		x				+
<i>Crangon alaskensis</i>	Northern Crangon Shrimp		x				+
<i>Crangon franciscorum</i> <i>franciscorum</i>	Bay Shrimp				t		+

Taxon	Common name	Historical		Current		Notes	Distinct
		Sed	Cob1	Cob2	Rip		
Cumacea							
<i>Cumella vulgaris</i>	–	x					+
Tanaidacea							
<i>Sinelobus</i> (= <i>Tanais stanfordi</i>)	–	x			NIS		+
tanaid indet.	–				x		
Isopoda							
<i>Gnorimosphaeroma oregonensis</i>	pillbug isopod	x	x	x	x		+
<i>Gnorimosphaeroma</i> sp.	pillbug isopod			x	x		
<i>Pentidotea</i> (= <i>Idotea</i>) <i>wosnesenskii</i>	Rockweed Isopod		x	x	x		+
Oniscidea indet.	terrestrial isopod			x			+
Amphipoda							
<i>Ampithoe valida</i>	–				x	NIS	+
<i>Ampithoe</i> sp.	–				x		
<i>Americorophium</i> (= <i>Corophium</i>) <i>spincorne</i>	–	x		x			+
<i>Americorophium</i> spp.	–			x			
<i>Corophium brevi</i>	–		x				+
<i>Corophium</i> sp.	–	x					
<i>Ligia occidentalis</i>	Western Sea Slater					GBIF	+
<i>Monocorophium acherusicum</i>	–			x	x	NIS	+
<i>Monocorophium</i> sp.	–			x	x		
<i>Eogammarus</i> (= <i>Anisogammarus</i>) <i>confervicolus</i>	–	x	x	x			+
<i>Paramoera columbiana</i>	–	x					+
<i>Melita</i> sp.	–			x	x		+
Melitidae: indet.	–				x		
<i>Pontogeneia intermedia</i>	–			x	x		+
<i>Traskorchestia traskiana</i>	–		x			MP(?)	+
<i>Paciforchestia klawei</i>	–				x		+
<i>Megalorchestia</i> (= <i>Orchestoidea</i>) sp.	–	x					+
<i>Ptilohyale plumulosus</i>	–			x	x		+
Hyalidae: indet.	–			x	x		
Hexapoda							
Diptera							
Chironomidae	chironomid midges	t					+
other	other flies	t					+
total	all flies	x					
Coleoptera							
<i>Ellychnia hatchi</i>	Pacific firefly					GBIF	+
Staphylinidae	rove beetle		t	x			+
indet.	other beetles	x					
Arachnida							
<i>Neomolgus littoralis</i>	red intertidal mite			x	x		+
Halacaridae: indet.	mites	x	t				
Araneae	spiders	t					+

Taxon	Common name	Historical		Current		Notes	Distinct
		Sed	Cob1	Cob2	Rip		
ECHINODERMATA							
Asteroida							
<i>Dermasterias imbricata</i>	Leather Star					GBIF	+
<i>Evasterias troschelii</i>	Mottled Star		x				+
<i>Pisaster ochraceus</i>	Ochre Star		x				+
Echinoidea							
<i>Strongylocentrotus purpuratus</i>	Purple Sea Urchin			t [†]		† empty test	+
CHORDATA							
Pisces							
<i>Cottus asper</i>	Prickly Sculpin					GBIF	+
<i>Gobiesox maeandricus</i>	Northern Clingfish		x				+
<i>Pholis laeta</i>	Crescent Gunnel		x				+
Pholidae & Stichaeidae	gunnels & pricklebacks				x		
<i>Anoplarchus purpurescens</i>	High Cockscomb		x				+
<i>Oligocottus snyderi</i>	Fluffy Sculpin		x				+
<i>Oligocottus maculosus</i>	Tidepool Sculpin		x				+
ALGAE							
Chlorophyta							
<i>Cladophora hutchinsiae</i>	green moss					x	+
<i>Ulva (=Enteromorpha) intestinalis</i>	Sea Intestines		x				+
<i>Ulva lactuca</i>	Sea Lettuce		x	x			+
<i>Ulva</i> spp. (<i>U. intestinalis</i> or <i>U. compressa</i> or <i>U. lathrate</i>)	–			x	x		
encrusting green	encrusting green		t				+
Phaeophyta							
<i>Fucus gardneri</i>	Rockweed		x	x	x		+
<i>Pilayella littoralis</i>	filamentous brown					Willems 2004	+
<i>Saccharina latissimi</i> (= <i>Laminaria saccharina</i>)	Broadleaf Kelp		x	t [†]		† drift specimen	+
<i>Sargassum muticum</i>	Japanese Wireweed		x			NIS	+
Rhodophyta							
<i>Callithamnion acutum</i>	–		x				+
<i>Ceramium pacificum</i>	–			x	x		+
<i>Gymnogongrus leptophyllus</i>	–		x				+
<i>Hildenbrandia rubra</i>	–			x	x		+
encrusting red	–		t				
<i>Mastocarpus</i> spp.	–		x [†]	x	x	† as <i>M. papillatus</i>	+
<i>Porphyra maculosa</i>	–		t				+
<i>Vertebrata</i> (= <i>Polysiphonia</i>) <i>hendryi</i> var. <i>hendryi</i>	–			x	x		+
VASCULAR PLANTS							
<i>Carex lyngbyei</i>	Lyngbye's Sedge		t				+
<i>Carex</i> sp.	sedge			t		MP	
<i>Distichlis spicata</i>	Spike Grass		t				+
<i>Lysimachia</i> (= <i>Glaux</i>) <i>maritima</i>	Sea Milkwort		t	x			+

Literature Cited

- BC Parks.** 1990. Porteau Cove Provincial Park master plan. Ministry of Environment and Climate Change Strategy, Victoria, British Columbia, Canada.
- Birch, G.J., N.G. McDaniel, and M.A. Quick.** 1990. Porteau Cove Provincial Park: marine bio-physical inventory and recreational assessment. Unpublished report. B.C. Ministry of Parks, Planning and Conservation, North Vancouver, British Columbia, Canada.
- GBIF (Global Biodiversity Information Facility).** 2023. Online database occurrence records. Accessed 14 March 2023. *Cottus asper* <https://www.gbif.org/occurrence/3079586697>, uploaded 5 April 2021. *Dermasterias imbricata* <https://www.gbif.org/occurrence/3124680398>, uploaded 26 May 2021. *Elychnia hatchi* <https://www.gbif.org/occurrence/1632910601>, uploaded 1 January 2017. *Ligia occidentalis* <https://www.gbif.org/occurrence/2803146655>, uploaded 21 June 2020.
- Levings, C.D., and N.G. McDaniel.** 1976. Industrial disruption of invertebrate communities on beaches in Howe Sound. British Columbia Fisheries and Marine Service Technical Report 663. Environment Canada, West Vancouver, British Columbia, Canada.
- Willems, W.** 2004. A GIS-approach to compare intertidal diversity and contaminant loading in the marine receiving environment of two pulp mills in British Columbia, Canada. M.Sc. thesis, Universiteit Gent/MareLac, Gent, Belgium.