





DESCRIPTIVE NOTES

The San Juan Archipelago-Southern Gulf Islands seafloor-mapping effort is an ongoing mapping program focused on the characterization of marine benthic habitats and the mapping of geology within the Salish Sea. The Salish Sea has suffered a severe decline in several species of bottom fish over the past several decades likely due to environmental degradation and overfishing (Puget Sound Ambient Monitoring Program, 2002; Fisheries and Oceans Canada, Rockfish Conservations Areas, 2006). The primary objective of this mapping effort is to characterize potential marine benthic habitats and geology. The final product includes interpretive maps that can be used to identify rockfish (Sebastes sp.) habitats, which then can be used by both Canada and the US to manage, conserve and sustain economically significant fisheries (considered outcomes) in the Transboundary region. A mechanism that has been developed to address fisheries conservation and sustainability is the establishment of Marine Protected Areas (MPAs) and voluntary or mandatory no-take zones whose evaluation as a benthic habitat can be done using potential habitat maps. Therefore, a secondary objective of this mapping effort is to provide data where assessment, and if necessary modification, of established MPAs, and the establishment of new MPAs, can be made. Additional mapping objectives that evolved from this project include the identification of specific deep-water foraging habitats such as dynamic bedforms that harbor sand lance (Ammodytes hexapterus) and potential siliceous sponge reefs (hexactinellid), although these are not specifically identified in the maps as characterization of these specific habitat types is continuing.

The San Juan Archipelago-Georgia Basin region is an active tectonic province whose physiography and geomorphology reflect both Mesozoic to Cenozoic convergent (subduction/accretion) plate tectonic processes and Pleistocene glaciation (glacial scouring/deposition). These processes have juxtaposed and deformed Jurassic-Cretaceous metamorphic rocks with Tertiary-Quaternary sedimentary rocks producing a complex of fjords, grooved and polished bedrock outcrops, and erratic boulders and moraines. Banks of till and glacial advance outwash deposits have also formed and contribute to the variety of relief within the region. Present day tidal action has fashioned much of the relic glacial-marine sediments into dynamic bedforms consisting of sand and gravel wave and dune fields. Modern day sedimentary deposits (sand and mud banks) represent materials being supplied to the region by the Fraser River of British Columbia, Canada.

This tectonic province can be divided into two distinct zones based on bedrock types: a northern sedimentary bedrock zone and a southern metamorphic rock zone separated by the Haro fault (see map sheets 2 and 3). Both zones provide good hard bedrock exposures, however the sedimentary rock type is differentially eroded, thus forming ledges and overhangs while the metamorphic bedrock are highly fractured and faulted forming cracks, crevices, and blocky boulder aprons. The severity and variety of tectonic, geologic and physical processes active in the province are directly responsible for forming the large variety of potential marine benthic habitat types mapped in the region.

The habitat classification was done following an existing habitat classification code, which was established to distinguish habitat types for species of interest and to facilitate ease of use and queries in GIS and other database programs. The code used in this map is modified from the scheme developed by Greene et al. (1999, 2007) for deep-water habitat characterisation.

The seafloor imagery interpretation and habitat type delineation were based on knowledge of the geology of the seafloor and seafloor processes in the study area (Thompson, 1981, Mosher et al., 2000; Barrie et al., 2005; 2009). Geological processes, structure and morphology depicted in the imagery were used to distinguish distinct potential habitat types. Resolution of the seafloor interpretation varied with the type of MBES systems that were used in the various surveys. However, for most of the area, seafloor features such as bedrock types (e.g., sedimentary, metamorphic, volcanic, and granitic rocks), structures (e.g., faults, folds, scours, and landslides), and bedforms of unconsolidated sediments were easily distinguished. To differentiate pinnacle and/or boulders (lh(b)/p) habitat from simple bedrock habitat, a specific rule was assigned where any known bedrock polygons with a surface area smaller than 500 m² became identified with

The Transboundary region covered by this map series has been divided into four quadrants and this sheet (Sheet 1 of 4; Haro Strait) covers most of Haro Strait located between southern Vancouver Island (Victoria), B.C. Canada and San Juan Island, WA USA and part of north central Straits of Juan de Fuca. Habitat types here are predominantly composed of hard faulted and fractured metamorphic rocks, boulders and dynamic bedforms. Strong currents in Haro Strait

sweep the bedrock clean and produce sediment waves and dune fields.

¹ "Potential" is used here to indicate that the habitat mapped on the basis of morphology and substrate type may not have a known species or assemblage of organisms that are identified to use the habitat.

REFERENCES

Barrie, J.V. and Hill, P.R., Conway KW., Iwanowska, K. and Picard, K., 2005. Environmental Marine Geoscience 4: Georgia Basin. Seabed features and geomarine geohazards: Geoscience Canada, 32(4), p. 145–156. Barrie, J.V., Conway, K. W, Picard, K. and Greene H.G., 2009. Large-scale sedimentary bedforms and sediment dynamics on a glaciated tectonic continental shelf. Examples from the Pacific margin of Canada: Continental Shelf Research 29, p. 796–806.

Fisheries and Oceans Canada, 2006. Rockfish Conservation Areas, Fisheries and Oceans Canada, Pacific Region, 177 p. Greene, H.G., Yoklavich, M.M., Starr, R.M., O'Connell, V.M., Wakefield, W.W., Sullivan, D.E., McRea

Jr., J.E., and Cailliet, G.M., 1999: A classification scheme for deep seafloor habitats: Oceanologica Acta. 22(6): p. 663-678 Greene, H.G., Bizzarro, J.J., O'Connell, V.M., and Brylinsky, C.K., 2007. Construction of digital

potential marine benthic habitat maps using a coded classification scheme and its application. In Todd, B.J., and Greene, H.G., eds., Mapping the Seafloor for Habitat Characterization. Geological Association of Canada, Special Paper 47, p. 141–155. Mosher, D.C. and Johnson, S.Y. (eds.), Rathwell, G.J., Kung, R.B., and Rhea, S.B. (compilers), 2000. Neotectonics of the eastern Juan de Fuca Strait: a digital geological and geophysical atlas:

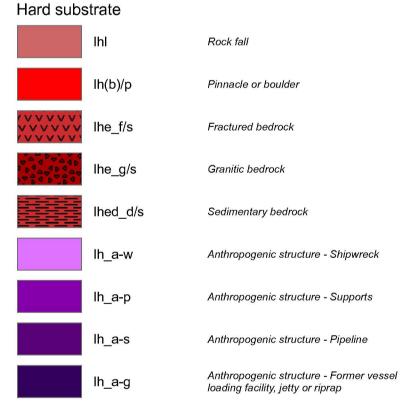
Geological Survey of Canada Open File 3931. Puget Sound Ambient Monitoring Program, 2002. 2002 Puget Sound Update: Eighth Report of the Puget Sound Ambient Monitoring Program: Puget Sound Water Quality Action Team.

Thompson, R.E., 1981. Oceanography of the British Columbia Coast: Canadian Fisheries and Aquatic Sciences, Special Publication 56: 291 p.

KEY TO HABITAT TYPES Not all units may appear on this map sheet.

			Not al	l un
	Unconsoli	dated substrate	(mud)	
48°30'N		ls(m)_u	Unconsolidated sediments	
		ls(m)t_u	Unconsolidated sediment terrace	
		ls(m)_h/u	Hummocky unconsolidated sediments	
		ls(m)m_u	Mound	
		ls(m)h_e/u	Pockmark	
		ls(m)h_s/u	Scour depression	
		ls(m)_h/a-dd/u	Hummocky dredge or anchor disturbances	
		ls(m)g_a-dg/u	Dredge channel	
		ls(m)t_h/a/u	Sawdust terrace	
	Unconsoli	dated substrate (sand / mud)	
		ls(s/m)_u	Unconsolidated sediments	
		ls(s/m)_h/u	Hummocky unconsolidated sediments	
		ls(s/m)v/t_u	Vegetative unconsolidated sediment terrace	
		ls(s/m)m_u	Linear ridge	
		ls(s/m)i/m_u	Ice-formed mound	
		ls(s/m)h_u	Depression	
48°25 'N		ls(s/m)h_s/u	Scour depression	
		ls(s/m)g_s/u	Scour gully	
	~~~.	ls(s/m)g/w_s/u	Scour gully with sediment bedforms	
		ls(s/m)s_s/u	Current-scoured scarp	
		ls(s/m)s_u	Scarp	
		ls(s/m)_h/a-dd/u	Hummocky dredge or anchor disturbances	
	Unconsoli	dated substrate (	sand / gravel)	
		ls(s/g)_u	Unconsolidated sediments	
		ls(s/g)_h/u	Hummocky unconsolidated sediments	
	~~~.	ls(s/g)w_u	Sediment bedforms	
	~~~~	ls(s/g)w_s/u	Current-scoured sediment bedforms	
		ls(s/g)m_u	Mound or linear ridge	
	1.5	ls(s/g)i/m_u	Ice-formed mound, esker or moraine	
	1.71	ls(s/g)i/m_h/u	Hummocky ice-formed mound	
		ls(s/g)h_u	Depression	
		ls(s/g)i/h_s/u	Dropstone depression	
		ls(s/g)h_s/u	Scour depression	
		ls(s/g)g_s/u	Scour gully	
		ls(s/g)l_h/u	Hummocky landslide deposit	
		ls(s/g)s_s/u	Current-scoured scarp	
		ls(s/g)_a-dm/u	Dredge disposal	
		ls(s/g)_h/a-dd/u	Hummocky dredge or anchor disturbances	
		ls(s/g)g_a-dg/u	Dredge channel	
	0.000 g U	ls(s/_h/a-f/u	Ferry-wash scour	

Unconsolidated substrate (gravel)				
ents				
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## AUTHORS: K. Picard, C. Endris, H.G. Greene, and J.V. Barrie

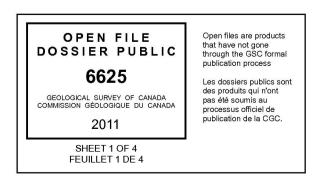
Compilation by K. Picard and C. Endris Edited by H.G. Greene and J.V. Barrie

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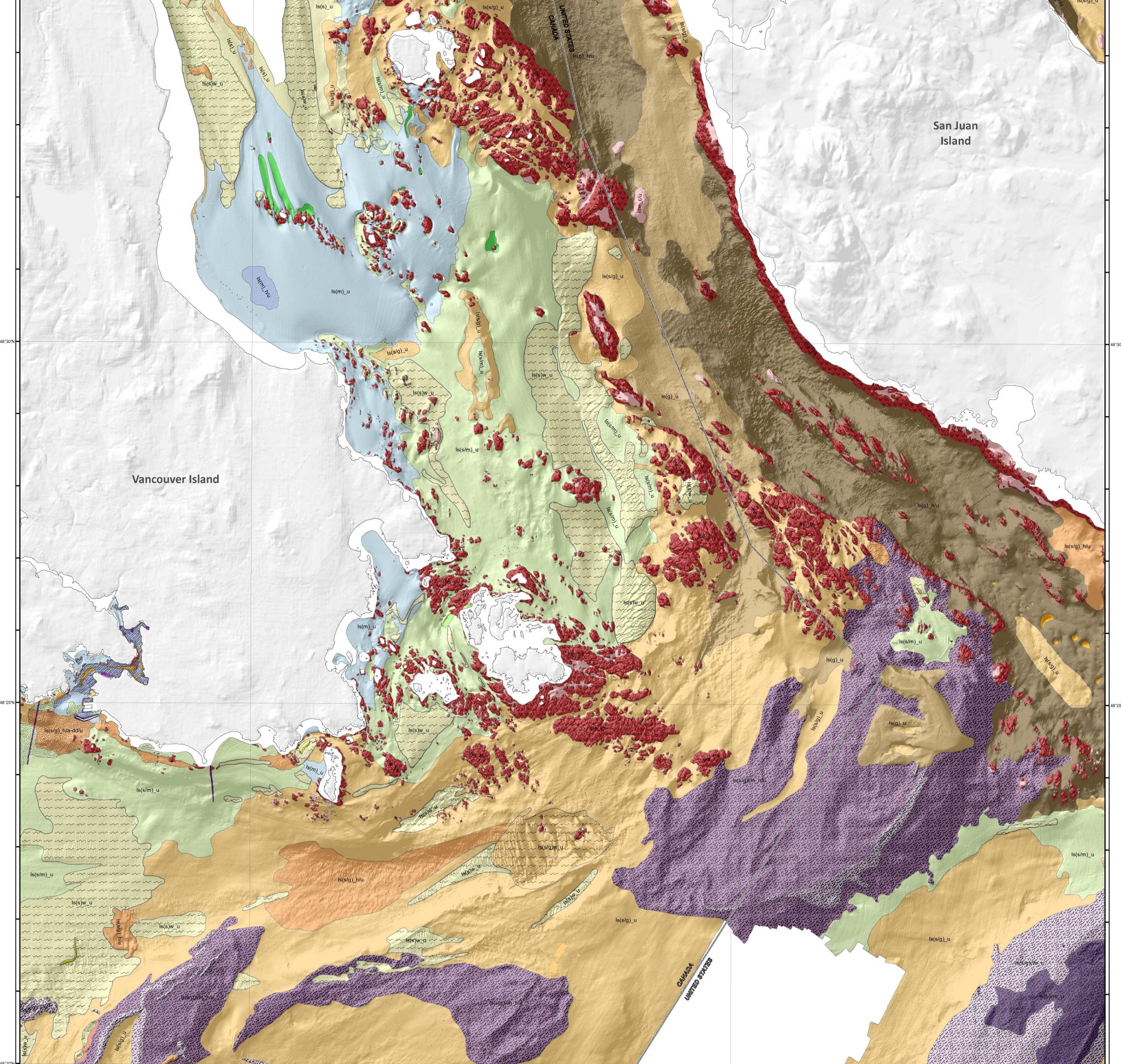
Digital Cartography by C. Endris, Center for Habitat Studies



Sheet 1 of 4, Haro Strait Picard, K.; Endris, C.

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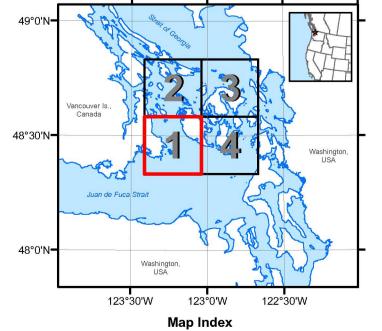
POTENTIAL MARINE BENTHIC HABITATS AND SHADED SEAFLOOR RELIEF

# SOUTHERN GULF ISLANDS AND SAN JUAN ARCHIPELAGO

CANADA AND U.S.A.

**Haro Strait** Scale 1:50 000/Échelle 1/50 000

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