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Status of the glass sponge reefs in the Georgia Basin**Sarah E. Cook^{a,*}, Kim W. Conway^b and Brenda Burd^c**^a 1170 Cherry Rd., Victoria, British Columbia, V8Z 7G3^b GSC Pacific (Sidney), Natural Resources Canada, 9860 West Saanich Road,
Sidney, British Columbia, V8L 4B2^c Ecostat Research Ltd., 1040 Clayton Rd., N. Saanich, British Columbia,
Canada, V8L 5P6**Abstract**

The purpose of this paper is to describe the status and general faunal composition of sponge reefs in the Georgia Basin (GB), British Columbia, Canada. Fourteen distinct deep water glass sponge (Hexactinellid) reefs have been mapped using multibeam bathymetry and sidescan sonar in the GB. Seven of these have been surveyed visually using video from Remotely Operated Vehicles (ROVs). Analysis of video data indicated that three reefs were undamaged, two were damaged and the other two were damaged but potentially recovering. The nature of the damaged reefs, with large areas of scattered dead sponge skeleton fragments and few live reef-building sponges (*Aphrocallistes vastus* and *Heterochone calyx*), as well as video evidence of tracks suggest they were damaged mechanically by mobile fishing gear.

* Corresponding author. Tel.: (250) 381-8206
Email address: sarah_cook@shaw.ca (S.Cook).

22 Relative abundance of the megafauna associated with the reefs is discussed in the
23 context of oceanographic conditions, such as sediment accumulation and organic flux, as
24 well as overall reef status. Of particular interest for fisheries conservation efforts in the
25 area was the fact that one undamaged reef in the southern GB showed higher taxonomic
26 richness and abundance of rockfish (*Sebastes* spp.), both adult and juvenile, compared
27 to an adjacent damaged reef. This result suggests that undamaged reefs may act as
28 refugia for these endangered stocks.

29
30
31 *Keywords:* Georgia Basin; Continental shelf; Glass sponge reefs; Hexactinellida; Multibeam;
32 Sidescan sonar; Effects – bottom trawling; Megafauna; Relative abundance; Reef status;
33 Rockfish

34 1. Introduction

35 Glass sponge reefs built by sponges of Class Hexactinellida, Order Hexactinosida, are
36 found along the continental shelf of the Pacific Northwest. Sponges of this order have a
37 skeleton of fused silica spicules that remains remarkably intact after the death of the
38 sponge (Krautter et al., 2006) and that can be used by sponge larvae for settlement.
39 These large, suspension-feeding animals act as baffles that slow currents at the seabed,
40 causing entrained sediment to drop out of suspension (Krautter et al., 2006). This
41 process results in the development of three-dimensional mound structures composed of
42 massive, clay-rich sediments and siliceous sponge skeletons, with live reef-building
43 sponges attached to exposed sponge skeletons on the reef surface (Conway et al.,
44 2005a; Krautter et al., 2006). Individual reef mounds grow with time, and aggregations of
45 these mounds form large reef complexes, which have been identified off British
46 Columbia, Canada, discontinuously covering over 700 km² of the continental shelf in the
47 Queen Charlotte Basin (QCB) (Conway et al., 1991; Krautter et al., 2001). A number of
48 smaller complexes have also been described in the Georgia Basin (GB) (Conway et al.,
49 2004; Conway et al., 2005a; Conway et al., 2007), and these are the focus of this paper.
50
51 The Strait of Georgia, which forms a large part of the Georgia Basin, is an enclosed body
52 of water with moderately strong tidal currents and large fresh water input from the Fraser
53 River. The Fraser River strongly influences sedimentation rates and organic flux in the
54 GB (Burd et al., this issue; Hill et al., this issue). Multibeam mapping, geophysical
55 surveys and textural data from grab samples indicate a complex pattern of sediment
56 accumulation, transport and erosion in the southern strait (Barrie et al., 2005). The

57 oceanographic and geologic settings of the reef complex on the Fraser Ridge (reef 1) and
58 the McCall Bank complexes (reefs 2 – 4) (see Fig. 1 for locations) in the GB are
59 described by Conway et al. (2004) and Conway et al. (2005a), respectively. The geologic
60 setting of the reef complexes near the entrance to Active Pass in the GB is described by
61 Conway et al. (2007).

62
63 The QCB reef complexes support diverse communities that are distinct from surrounding
64 shelf communities and play a role as nursery habitats for rockfish (*Sebastes* spp.) (Cook,
65 2005). Rockfish are commercially important and have been subject to conservation
66 efforts in recent years (DFO, 2006). Juvenile rockfish have been found at abundances
67 five times higher on live reefs than on adjacent dead reef and off-reef areas in the QCB
68 (Cook, 2005). Dead portions of the reefs, which are less structurally complex and mainly
69 consist of sponge skeleton rubble, were also found to have significantly lower taxonomic
70 richness and abundance of invertebrate fauna than live reef areas (Cook, 2005). There
71 have not yet been any studies characterizing the community associated with the reef
72 complexes in the GB.

73
74 The reef-building sponge species in the GB are *Aphrocallistes vastus* and *Heterochone*
75 *calyx*. The reef-building species are found on gravel and rock substrates, such as glacial
76 till ridges (Krautter et al., 2006), which can be found in very close proximity to the Fraser
77 River on the Fraser Ridge (see Fig. 1) (Conway et al., 2004). The GB reef complexes
78 are found in water depths of 90-300 m where bottom currents prevent sediment from
79 accumulating (Conway et al., 2005a). The GB reefs grow in linear patterns along ridges,

80 sometimes forming distinctive 'chevron' (Conway et al., 2007) or wave-form shapes
81 (Conway et al., 2005a). The reef mounds in the GB have been recorded to heights of 14
82 m above the sea-floor (Conway et al., 2004; Conway et al., 2005a).

83
84 Sidescan sonar and video surveys in the QCB undertaken between 1991 and 2002
85 revealed that damage had been done to some of the reef complexes in areas heavily
86 fished by bottom trawlers (Krautter et al., 2001; Conway et al., 2001). Fisheries and
87 Oceans Canada closed the QCB reefs to bottom trawling in July 2002 in recognition of
88 their susceptibility to the effects of fishing gear and is considering designating them as
89 Marine Protected Areas (Jamieson and Chew, 2002).

90
91 Conway et al. (2007) qualitatively described the health of the sponge reef complexes
92 (healthy or unhealthy) in the GB; however, this was not a systematic description from the
93 video and the terms 'healthy' and 'unhealthy' were not defined. This study builds upon
94 that work with the goals of using a systematic analysis of the ROV video surveys to make
95 a preliminary assessment of the status, or condition, of the surveyed sponge reef
96 complexes in the Georgia Basin, and of characterizing the megafaunal communities
97 associated with each. Possible reasons for status and differences in associated fauna
98 among reef complexes will be discussed.

99

100 **2. Materials and methods**

101 *2.1. Reef status*

102 Sponge reefs in the GB were originally mapped using multibeam bathymetry and
103 sidescan sonar collected and analyzed to determine possible locations and extents of
104 sponge reef complexes in the GB (Conway et al., 2005a). In this paper, the status of the
105 reefs and their associated megafaunal organisms were assessed using video transects
106 collected by the Pacific Geoscience Centre between 2002 and 2006 (see Table 1).

107 These transects were collected using a digital video camera mounted on either a
108 Phantom HD2 Remotely Operated Vehicle (ROV) or the Remotely Operated Platform for
109 Ocean Science (ROPOS). Both vehicles had laser pointers mounted 10 cm apart that
110 were visible in the video. The remotely operated vehicle transects ranged from 420 to
111 5718 m in length, and the compiled video segments provide a transect for each complex.

112
113 The categories of reef status are: undamaged, damaged, damaged and possibly
114 recovering, and unknown. Observations of the condition of the reef-building sponges
115 were made along the on-reef portions of each transect, by recording estimates of percent
116 alive or dead as well as the condition of the dead sponge (standing or fragmented and
117 broken). Status was assigned based on the condition of the majority (>50%) of the
118 transect. An undamaged reef consists mainly of areas of live reef-building sponges (Fig.
119 2a) (*Aphrocallistes vastus* and *Heterchone calyx*) and areas of standing dead sponge
120 (Fig. 2b) growing on mounds of dead sponge skeletons and skeletal fragments in a
121 sediment matrix. A damaged reef consists mainly of areas of broken and fragmented
122 dead sponge, possibly with small areas of standing dead sponge (Fig. 2c), and few
123 isolated live reef-building sponges. A damaged and possibly recovering reef consists of
124 mostly broken and fragmented dead sponge, but with widespread areas where young

125 reef-building sponges are colonizing the fragmented, dead sponge skeletons (Fig. 2d).
126 Unknown status indicates that the reef complex has been identified but not yet surveyed
127 using video techniques.

128

129 *2.2. Associated Fauna*

130 The whole of each transect was viewed, and all visible megafauna were identified to the
131 lowest taxonomic level possible aided by digital photos taken by ROPOS (see Table 2).
132 Reef 4 was not included in this analysis, because the video became corrupted after the
133 reef status was determined. Each transect was divided into sections based on whether
134 the video was on-reef or off-reef. The abundance of organisms was recorded for the on-
135 reef sections in a semi-quantitative way, either by counting the number of individuals, or,
136 if the number of individuals was difficult to establish due to visibility, complex terrain or
137 very high abundance, by estimation. Counts and estimates were converted into a
138 measure of relative abundance (Few<Some<Many) for each reef complex, in recognition
139 of the fact that accurately quantifying some organisms was not feasible (criteria for the
140 conversion to relative abundance are described below; Table 2). The relative abundance
141 of different taxa is useful for comparing differences in faunal composition among reefs.

142

143 **3. Results**

144 *3.1. Reef distribution and status*

145 Fig. 1 shows the locations of reef complexes in the Georgia Basin as identified from
146 analysis of multibeam swath bathymetry data (Conway et al., 2007). Table 1 lists the reef
147 complexes by number, with geographic location, dive number, date surveyed and current

148 status as determined from video analysis. The reefs are numbered in order of their
149 discovery (after Conway et al., 2007). Seven of the 14 identified reef complexes in the
150 GB have been surveyed visually.

151
152 Four of the seven surveyed reefs (3, 6, 9 and 13) were classified either as damaged (3
153 and 9), or as damaged and possibly recovering (6 and 13), based on video surveys. The
154 remaining three (1, 4 and 7) were classified as undamaged.

155

156 3.2. Associated fauna

157 Table 2 presents the reef complexes on which each taxon was present. Only four taxa
158 were found on all six classified reef complexes for which there was usable video: spot
159 prawns (*Pandalus platyceros*), squat lobsters (*Munida quadrispina*), blood stars (*Henricia*
160 sp.) and ratfish (*Hydrolagus colliei*), which are all common species in British Columbia's
161 subtidal coastal waters (Cook, unpublished data from video surveys of B.C. coast). The
162 reef complex with the highest number of observed taxa (24) was undamaged reef 7. Six
163 of the taxa at this reef complex were species of rockfish (*Sebastes* spp.). The lowest
164 number of taxa (8) was observed at reef complex 1 (undamaged). The damaged reef in
165 the southern part of the GB (reef 9) had 12 taxa, and the damaged reefs in the northern
166 GB (3, 6 and 13) had between 15 and 20 taxa each.

167

168 Table 3 includes relative abundance data for each of the taxonomic groups identified in
169 Table 2 for each reef complex. The northern group of reefs (3 (damaged), 6 and 13
170 (damaged and possibly recovering)) had the highest relative abundance of lysaccine

171 sponges and demosponges, and was the only set of reefs where shortspine thornyheads
172 (*Sebastolobus alascanus*) were present. Brittle stars and sea urchins were only
173 observed at high relative abundance at reef 9 (damaged). Reef complex 7 (undamaged)
174 had the highest relative abundance of rockfish (*Sebastes* spp.). All other reefs had
175 relatively few rockfish. For example, 176 juvenile and adult rockfish were observed on
176 reef 7 (undamaged), and only 4 rockfish were observed on reef 9 (damaged). Corals,
177 mostly large Gorgonians, were observed on reefs 1 and 7 (both undamaged) in the
178 southern GB, although the highest abundance of corals was on reef 13 (damaged and
179 possibly recovering) in the northern GB.

180

181 **4. Discussion**

182 *4.1. Reef distribution and status*

183 Glass sponge reefs are distributed across a diverse range of oceanographic conditions
184 and depths in the Georgia Basin; however, more than half of the surveyed reef
185 complexes in the GB have been damaged. Reef-building glass sponges are brittle and
186 prone to fragmentation with physical contact. The nature of damaged reefs surveyed in
187 this study, with highly fragmented dead sponge skeleton and little or no standing dead
188 sponge, suggests that the reef complexes were damaged mechanically. It is well
189 documented that certain forms of fishing, such as bottom trawling, can cause this type of
190 damage to large sessile benthic fauna, including glass sponges on sponge reefs
191 (Krautter et al., 2001), other megafaunal sponges (Freese et al., 1999) and deep-water
192 corals (Hall-Spencer et al., 2002; Fosså et al., 2002; Reed et al., 2005). Sidescan sonar
193 data from damaged reef complex 3 shows relatively continuous and frequently parallel

194 tracks or marks on the seabed (Fig. 3), which were likely left by mobile fishing gear, such
195 as heavy net doors on otter trawls. These marks have been described on reef
196 complexes in QCB in areas where the trawl fisheries are or have been active (Conway et
197 al., 2001; Krautter et al., 2001).

198
199 The presence of young reef-building sponges on damaged reefs 6 and 13 is evidence
200 that re-colonization can occur. Individual reef-building sponges were often observed
201 growing on bedrock or glacial till substrate adjacent to the damaged reefs (Fig. 4)
202 (Conway et al., 2007), and these off-reef areas could provide a source of larvae for re-
203 colonization. Possible recovery time for a reef complex can only be suggested based on
204 growth rates and size of the reef complexes. The reef-building sponge *Aphrocallistes*
205 *vastus* has a calculated mean growth rate of 1 cm per year and a maximum rate of 7 cm
206 per year (Krautter et al., 2001, calculated from data in Levings and McDaniel, 1974). The
207 size of the reefs makes it likely that recovery would occur on a time scale of hundreds of
208 years (Conway et al., 2005b). Lyssacine glass sponges, such as *Acanthascus*
209 (*Rhabdocalyptus*) *dawsoni*, and encrusting and erect forms of demosponges, such as
210 *Vulcanella* sp. or *Desmacella* sp., also colonize dead sponge skeleton (Cook, 2005;
211 Lehnert et al., 2005). These taxa were observed on most of the damaged reefs,
212 suggesting that these sites are still capable of sustaining a large suspension feeding
213 community. It appears that lyssacine sponges can be primary colonizers of dead reefs,
214 which is not surprising since *Acanthascus* (*Rhabdocalyptus*) *dawsoni* has twice the mean
215 growth rate of *Aphrocallistes vastus* (Leys and Lauzon, 1998). However, there is

216 currently no literature available on the progression of colonization on dead sponge
217 fragments.

218

219 Reef complex 1 (undamaged) is unique in that it is beneath the buoyant particulate plume
220 of the Fraser River. Although the ridge at reef complex 1 is a remnant glacial feature
221 rising above the sedimented basin, it is in an area with an unusually high sedimentation
222 rate (see Table 1 and Burd et al., this issue). Leys et al. (2004) and Farrow et al. (1983)
223 suggest that high sedimentation rates are associated with lower abundance of glass
224 sponges, since a sediment veneer can negatively affect the ability of glass sponges to
225 become established. In the case of reef complex 1, tidal currents are sufficiently strong
226 to keep sediment in suspension and the ridge surface non-depositional (Conway et al.,
227 2004), allowing glass sponges to colonize the gravel substrate. The reef mounds on the
228 ridge enlarge as growing sponges baffle the tidal currents and trap suspended sediment
229 (Krautter et al., 2006). The reef-building sponges on reef 1 were observed to be more
230 tube-shaped, with narrower oscula compared to the reef complexes in the QCB (Conway
231 et al., 2004) and to the other reefs in the GB. According to evidence from the fossil
232 record, a narrower osculum can compensate for increased sedimentation rates and
233 reduce the amount of sediment trapped in the sponge cavity. This adaptation helps to
234 prevent sediment from overwhelming cleaning mechanisms, which can cause the death
235 of the sponge (Conway et al., 2004). The presence of a healthy sponge reef beneath the
236 Fraser River plume shows that these organisms can adapt to unusual sedimentation
237 conditions, if current regime, seabed sediment transport rates, temperature, and
238 dissolved oxygen and silica levels are suitable (Leys et al., 2004; Whitney et al., 2005).

239
240 The most recently discovered reef complex (14 in Howe Sound, see Fig. 1 for location)
241 was identified by Natural Resources Canada personnel (unpublished data, 2008),
242 subsequent to the publication of the discovery of the other sponge reefs by Conway et al.
243 (2007). Reef complex 14 appears to be undamaged; however, ROV survey videos of
244 that reef have not yet been analyzed and further work will be required to assess the
245 status of this reef complex and its associated faunal community.

246

247 *4.2. Associated fauna*

248 Reef-building sponges appear to be foundation species, as defined by Dayton (1975),
249 since they are organisms that create habitat for other organisms, and thereby exert a
250 disproportionately large influence on community structure. Therefore, fauna associated
251 with the reefs could be affected by changes to the status of the reef. To determine the
252 effect of reef status on the associated community, a comparison was made between
253 reefs 7 (undamaged) and 9 (damaged) in the southern basin, which are located close
254 together (~8 km apart) and were surveyed only days apart. The higher number of taxa
255 and greater abundance of both adult and juvenile rockfish at reef 7 (undamaged) is
256 consistent with published results that link increased habitat complexity, or structural
257 heterogeneity, to increased taxonomic richness and abundance of individuals (Crowder
258 and Cooper, 1982; Diehl, 1992; Garcia-Charton and Perez-Ruzafa, 1998; Wyda et al.,
259 2002; Garcia-Charton et al., 2004). It is therefore likely that undamaged sponge reefs in
260 the GB can provide refugia for adult rockfish and a nursery habitat for juveniles, as found
261 in the QCB (Cook, 2005). However, it should be noted that the other undamaged reef

262 where fauna were assessed (reef 1), had the lowest number of taxa of all the surveyed
263 reefs. This result seems inconsistent with the supposition that sponge reefs in the GB
264 are refugia supporting enhanced bio-diversity. However, as mentioned in section 4.1,
265 this reef complex is in a unique oceanographic setting, with a high concentration of
266 suspended sediment and a high sedimentation rate, which may be less than ideal for the
267 settlement of other sessile species typically associated with the reefs. Regional
268 variations in physical and biological factors have been shown to affect the distribution and
269 abundance of fish assemblages (Garcia-Charton et al., 2004); the same may be true for
270 invertebrate fauna. A statistically rigorous comparison of reef fauna between damaged
271 and undamaged reefs was not possible using this dataset; however these results provide
272 a preliminary basis for more in-depth assessment of the reefs in the future.

273
274 Reef 6 (damaged, possibly recovering) had the highest number of taxa of the northern
275 GB complexes. Unfortunately, there were no undamaged reefs in the northern GB on
276 which the fauna could be assessed for this study, so it cannot be determined whether the
277 taxonomic richness observed on reef 6 was typical of the area. Reef 13 (damaged,
278 possibly recovering), also in the northern GB, had a higher relative abundance of sessile
279 filter feeders than did the other reef complexes. Hydrodynamic conditions or biological
280 factors, such as abundance of suspended food particles, may encourage settlement of
281 these sessile filter feeders at damaged reef sites.

282
283 One of the consequences of trawling damage is to decrease habitat complexity (Watling
284 and Norse, 1998; Kaiser et al., 2000). This could be especially detrimental for the juvenile

285 fish that use these complex structural habitats. For example, it was observed that the
286 shortspine thornyheads (*Sebastolobus alascanus*) on the damaged reefs in the northern
287 GB, which were almost all in the juvenile to intermediate colour phase (Love et al., 2002),
288 were frequently observed within or near the scattered areas of higher relief, such as
289 patches of standing dead sponge. Juvenile rockfish (*Sebastes* spp.) also have an affinity
290 for structurally complex habitats (O'Connell and Carlile, 1994; Cote et al., 2003; Diaz et
291 al., 2003). Rockfish are a dwindling fisheries resource throughout the Pacific Northwest
292 and have been the focus of conservation initiatives in recent years (Ralston, 1998;
293 Musick et al., 2000; Yamanaka, 2000; DFO, 2006). Protection of refugia and nursery
294 habitat, such as sponge reefs, would be consistent with this conservation strategy
295 (Yoklavich, 1997).

296

297 **5. Conclusions**

298 The sponge reefs in the GB exist in a range of bathymetric settings and oceanographic
299 conditions, and are distributed throughout the GB. Over half of the reefs that have been
300 visually surveyed show significant damage, likely by fishing activities, such as bottom
301 trawling. The damaged reefs appear to be capable of recovery, although the time
302 required for sponge and reef re-growth is unknown. Undamaged reefs appear to have
303 the potential to act as refugia and nursery habitat for commercially valuable fish species.
304 Trawl closures have been implemented as a fisheries management measure at the large
305 sponge reef complexes in the Queen Charlotte Basin in recognition of their fragile nature
306 and importance to fisheries resources; similar protection may be warranted for the
307 sponge reefs in the Strait of Georgia.

308

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1 **Figure Titles**

2
3 Fig. 1. Location of known glass sponge reef complexes in the Georgia Basin. They are
4 numbered in order of discovery by multibeam swath bathymetry surveys conducted by
5 the Geological Survey of Canada (after Conway *et al.*, 2007). Only six complexes
6 (1,3,6,7,9,13) have been surveyed using visual techniques.

7
8 Fig. 2. A) Dense live reef-building sponges (undamaged reef 7), B) Standing dead
9 sponge skeleton (damaged and possibly recovering reef 13). Crimson anemones
10 (*Cribrinopsis fernaldi*), boot sponges (Rosselid sponges) and a small reef building sponge
11 are attached, C) Fragmented dead sponge skeleton spread over the seabed (damaged
12 reef 9), D) Small reef-building sponges attached to fragmented dead sponge skeleton
13 (damaged but possibly recovering reef 6). Several tube-dwelling anemones
14 (*Pachycerianthus fimbriatus*) are also present.

15
16 Fig. 3. Sidescan sonar and interpretation from reef complex 3 (McCall Bank) showing
17 parallel lines in the reef surface that are interpreted as the marks left from the heavy
18 doors of bottom trawl gear.

19
20 Fig. 4. Reef-building sponges growing on glacial till adjacent to the reef complexes in the
21 McCall Bank area.

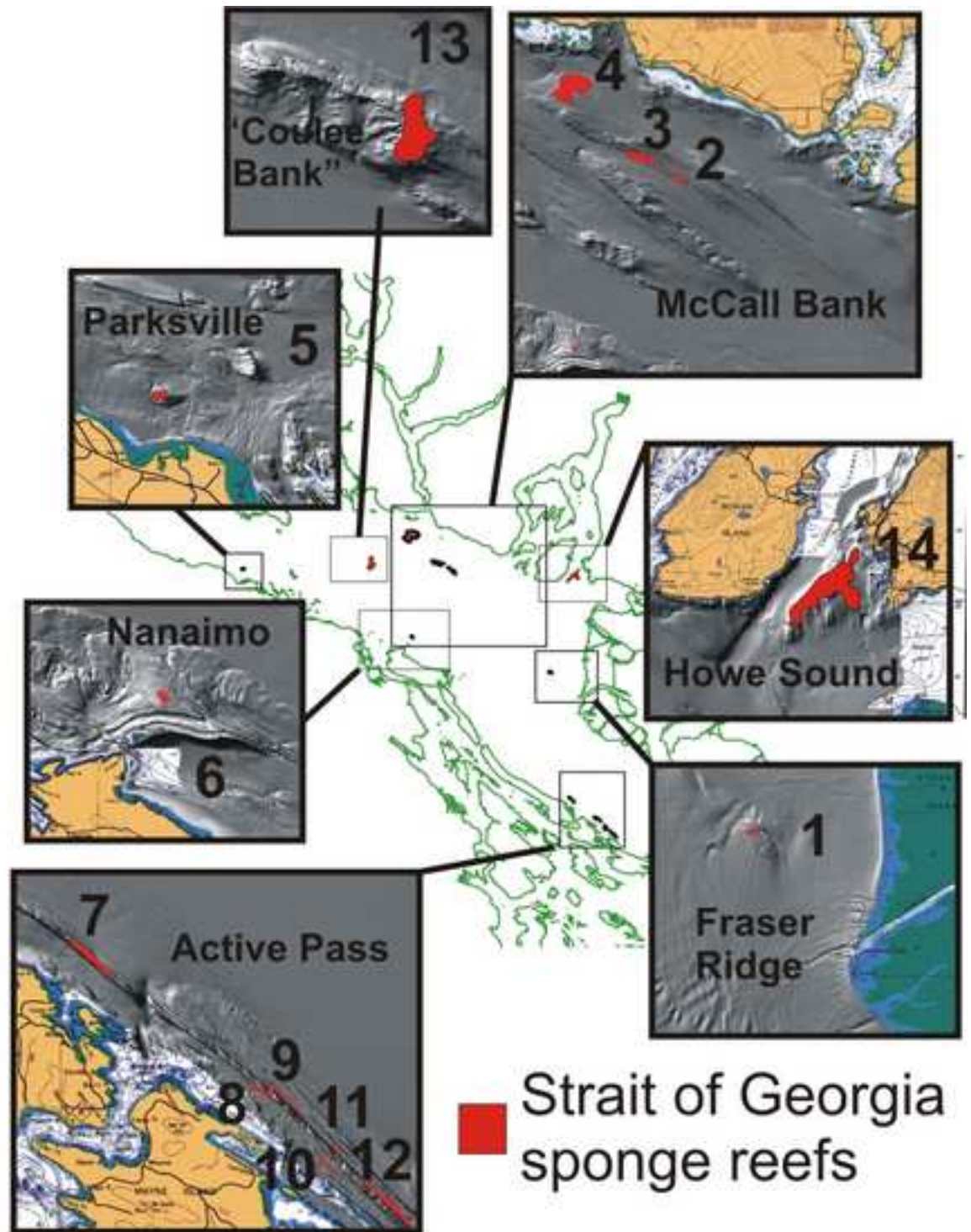


Figure1



Figure2a



Figure2b



Figure2c



Figure2d

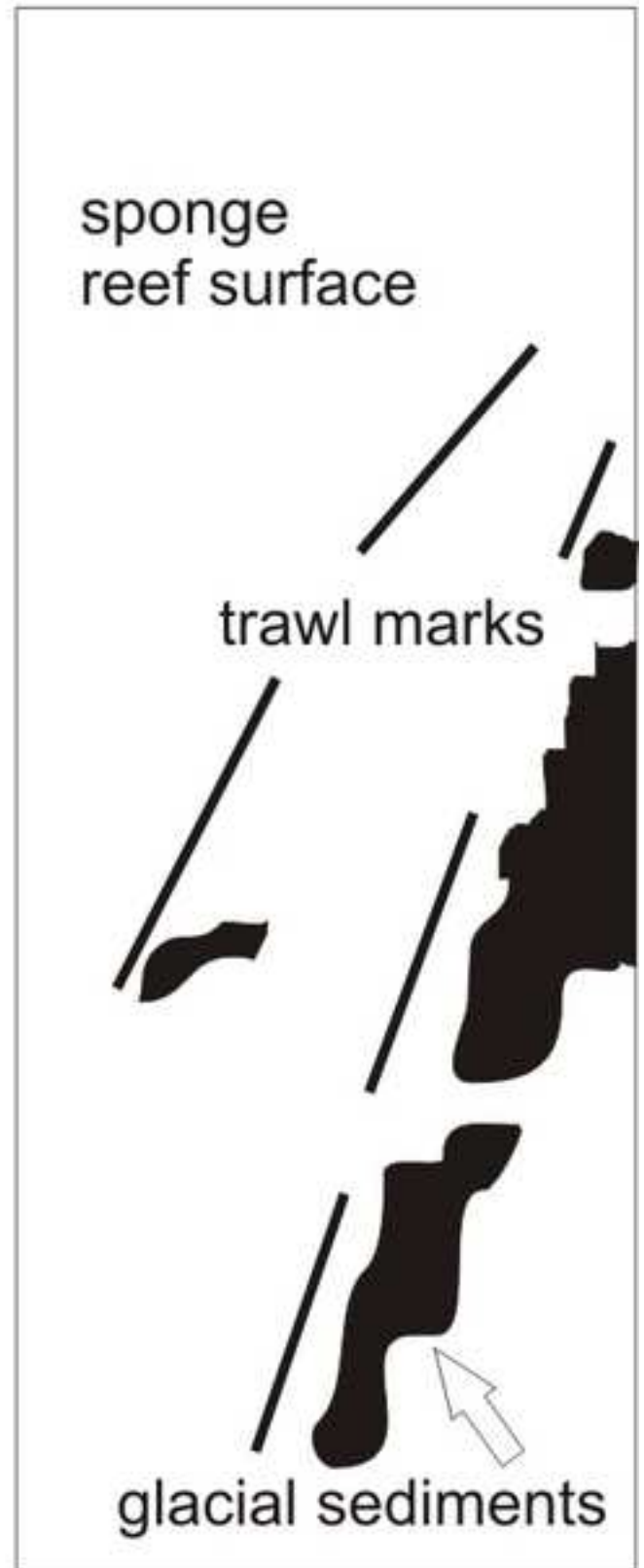


Figure3



Figure4

1 Table 1
 2 Current status of the glass sponge reefs in the Georgia Basin. The reef complexes are numbered in order of their
 3 discovery, after Conway et al. (2007).

Reef Complex	Geographic Location	Dive Number	Date Sampled (Video)	Status [†]	Depth Range (m)	Duration (min)	Distance (m)	Sedimentation Rate* (g/cm ² /yr)	Organic Flux** (mgC/cm ² /yr)
1	Fraser Ridge	PGC02004, dives 1-4	July 2002	Undamaged	150-190	371	3470	>4	>30
2	McCall Bank	N/A	N/A	Unknown	120-210			<0.75	<15
3	McCall Bank	ROPOS dive 760	October 2003	Damaged	120-210	258	3244	<0.75	<15
4	McCall Bank	ROPOS dive 761	October 2003	Undamaged [‡]	90-210	62	663	<0.75	<15
5	Parksville	N/A	N/A	Unknown	90-110			<0.75	<15
6	Nanaimo	ROPOS dive 873	November 2004	Damaged, possibly recovering	110-150	154	5718	<0.75	<15
7	Active Pass North	ROPOS dive 930	October 2005	Undamaged	95-105	171	1920	>2.5	>25
8	Active Pass South	N/A	N/A	Unknown	90-100			>2.5	>25
9	Active Pass South	ROPOS dive 931	October 2005	Damaged	120-140	154	1770	>2.5	>25
10	Active Pass South	N/A	N/A	Unknown	90-100			>2.5	>25
11	Active Pass South	N/A	N/A	Unknown	100-110			>2.5	>25
12	Active Pass South	N/A	N/A	Unknown	100-130			>2.5	>25
13	"Coulee Bank"	ROPOS dive 1029	November 2006	Damaged, possibly recovering	240-290	211	4780	<0.75	<15
14	Howe Sound	N/A	N/A	Unknown	50-160			<0.75	<10

4 [†]See section 2.2 for definitions.

5 [‡]Described as undamaged in Conway *et al.* (2005a); however the video was corrupted so faunal associations were not assessed.

6 *Estimated from figures in Burd *et al.* (this issue) and Hill *et al.* (this issue).

7 **Estimated from figure in Burd *et al.* (this issue).

8
 9

10

11 Table 2

12 All observed megafaunal fish and invertebrate taxa as identified to the lowest taxonomic level possible, rolled into higher
 13 level taxonomic groups. The reef complexes each taxon was observed on is listed.

Taxonomic Group	Phylum	Class	Taxa	Common Name	Reef Complexes
Anemones	Cnidaria	Anthozoa	<i>Cribrinopsis fernaldi</i>	Crimson Anemone	1,3,7,9,13
			<i>Pachycerianthus fimbriatus</i>	Tube-Dwelling Anemone	1,7,13
Corals	Cnidaria	Anthozoa	Order Gorgonacea	Gorgonian Corals	13
			Poss. <i>Lophelia pertusa</i>		1
				Hydrocorals	7
Hydroids	Cnidaria	Hydrozoa		Hydroids	6,13
Lyssacine Sponges	Porifera	Hexactinellida	Order Lyssacinosa	Boot Sponges	1,3,6,7,13
Demosponges	Porifera	Demospongiae	<i>Iophon</i> (?) sp.	Finger Sponge	3,6,13
			<i>Vulcanella</i> sp.	Plate Sponge	3,6
			<i>Stylissa</i> sp.	Trumpet Sponge	7
				White Dorid Nudibranch	3
Gastropods	Mollusca	Gastropoda	Suborder Doridacea		
			<i>Fusitriton oregonensis</i>	Oregon Whelk	7
Squat Lobsters	Arthropoda	Malacostraca	<i>Munida quadrispina</i>	Squat Lobster	All
Other Crustaceans	Arthropoda	Malacostraca	<i>Oregonia</i> sp.	Decorator crabs	3,7
			<i>Pandalus platyceros</i>	Spot Prawn	All
			<i>Lopholithodes</i> sp.	Box Crab	6,7
Seastars	Echinodermata	Asteroidea	<i>Ceramaster patagonicus</i>	Cookie Star	3,6,7,13
			Family Goniasteridae		3,6,9,13
			<i>Henricia</i> sp.	Blood Stars	All
			<i>Pteraster tesselatus</i>	Cushion Star	3,6,7,9
Sea Urchins	Echinodermata	Echinoidea	<i>Strongylocentrotus</i> sp.		7,9
Brittle Stars	Echinodermata	Ophiuroidea		Brittle Stars	9
Rockfish	Chordata	Osteichthyes	<i>Sebastes</i> sp.	Rockfish	7,9
			<i>Sebastes elongatus</i>	Greenstriped Rockfish	3,6,7
			<i>Sebastes flavidus</i>	Yellowtail Rockfish	7
			<i>Sebastes maliger</i>	Quillback Rockfish	6,7
			<i>Sebastes miniatus</i>	Vermillion Rockfish	6
			<i>Sebastes proriger</i>	Redstripe Rockfish	7
			<i>Sebastes ruberrimus</i>	Yelloweye Rockfish	3,7,9
			<i>Sebastolobus alascanus</i>	Shortspine Thornyhead	3,6,13
				Poachers	7
				Codfish	6,7,13
Thornyheads	Chordata	Osteichthyes	Family Agonidae		
			Family Gadidae	Flatfish	3,6,7,9
			Family Pleuronectidae		
			<i>Ophiodon elongatus</i>	Lingcod	6
Cartilagenous Fish	Chordata	Chondrichthyes	<i>Hydrolagus colliei</i>	Ratfish	All
			<i>Squalus acanthias</i>	Dogfish	3,6,13
			Family Rajidae	Skates	3

14

15 Table 3
 16 Relative abundance of invertebrate groups between surveyed reef complexes (F=Few<S=Some<M=Many). A line
 17 indicates none were observed. Measure indicates whether individuals were counted (C) or estimated (E). Criteria for
 18 converting estimates and counts into a relative abundance is given below the table.

Reef	Anemones	Corals	Hydroids	Lyssacine Sponges	Demosponges	Gastropods	Squat Lobsters	Other Crustaceans	Sea Stars	Sea Urchins	Brittle Stars	Rockfish	Shortspine Thornyhead	Other Bony Fish	Cartilaginous Fish
1	S	F	—	F	F	—	M	F	F	F	—	F	—	—	M
3	F	—	—	S	S	F	M	F	S	—	—	F	S	F	S
6	—	—	S	S	S	—	S	M	M	—	—	S	S	M	M
7	F	F	—	F	F	F	S	M	F	F	—	M	—	F	S
9	F	—	—	—	F	—	F	S	M	M	M	F	—	F	M
13	M	M	M	M	M	—	M	S	S	—	—	—	M	F	S
Measure	E [†]	C*	E	E	E	C	E	C	C**	C	E	C	C	C	E

20 †For all taxa where total number of individuals was estimated F=<10, S=10-50 and M=>50.

21 *For taxa where individuals were counted (except Sea Stars) F=<10, S=10-20 and M=>20.

22 **For Sea Stars F=<15, S=15-50 and M=>50; this criteria is different from the other taxa that were counted due to the higher general
 23 abundance of this taxon.