

# Citizen Science: Eyes on the Sound

**“There’s always that inquisitive part of me. I always want to know a little bit more. I am always after the story... even when I’m going out to film a creek, I’m a reporter in the water interviewing the fish. I want to know their story, their take on things.”**

**JOHN BUCHANAN, CITIZEN SCIENTIST, SQUAMISH<sup>1</sup>**

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Citizen scientists are critical “eyes on the Sound” and keen explorers, advocates and ambassadors for Howe Sound’s nature and health. For example, research work by the Marine Life Sanctuaries Society led to the successful extension of Halkett Bay Provincial Park in 2016 to include offshore glass sponge gardens and bioherms.<sup>2</sup> Mapping of herring spawn by Squamish-based citizen scientist John Buchanan is used as evidence by advocacy groups to respond to the design and location of the Woodfibre LNG plant.<sup>3</sup> In 2016, citizen science groups and individuals alerted the public, researchers, and agencies to the record low number of bald eagles wintering in the Squamish area,<sup>4</sup> the upsurge of orca visits to Howe Sound,<sup>5</sup> and the surprising abundance of anchovy in outer Howe Sound<sup>6</sup> that may be related to the best recreational Chinook fishery in decades.<sup>7</sup>



Volunteers and biologists surveying intertidal life on Bowen Island under the Coastal Scene Investigation program run by Dr. Shannon Bard. (Photo: Bob Turner)

# Why is Citizen Science Important?

Citizen science is a global movement through which scientists and non-scientists work in partnership to conduct scientific research.<sup>8</sup> It engages hundreds, and sometimes thousands, of people of all ages, occupations, and locations, and helps scientists accomplish tasks that could not otherwise be undertaken. Non-scientists also set up research projects that ask questions of local importance that may be too small or isolated to be initiated by scientists alone.<sup>9</sup> They range from one day ‘bioblitzes’ (an intense period of biological surveying in an attempt to record all the living species within a designated area) to multi-year breeding bird surveys. The most important characteristic is public participation in genuine scientific research.<sup>10</sup>

Citizen science projects bring science and scientists into the public eye and increase local appreciation and understanding of science.<sup>11</sup> Individuals are motivated to engage in citizen science largely to help the environment or their community, to contribute to scientific knowledge or to learn, develop scientific skills, or be outdoors.<sup>12</sup>

The degree of community member involvement in citizen science projects varies.<sup>13</sup> “Contributory” projects are designed by scientists while members of the public contribute data. In “collaborative” projects community participants also collect data and some help to refine project design, analyze data, and/or disseminate findings. “Co-created” projects are designed by scientists and members of the public together, and some community participants are involved in most or all steps of the scientific process, as described in Table 1. The highest levels of community engagement are in self-created projects, run by lay people with advanced scientific knowledge and the skills to develop and manage studies on levels equal to those of professional scientists.

TABLE 1: STEPS IN THE SCIENTIFIC PROCESS

<b>Steps in the Scientific Process<sup>10</sup></b>	
<b>1.</b>	<b>Identify and define questions for study</b>
<b>2.</b>	<b>Gather information and make observations</b>
<b>3.</b>	<b>Develop hypotheses about possible answers to questions</b>
<b>4.</b>	<b>Design experiment and data collection methods</b>
<b>5.</b>	<b>Collect data</b>
<b>6.</b>	<b>Analyze data</b>
<b>7.</b>	<b>Interpret data and draw conclusions</b>
<b>8.</b>	<b>Communicate conclusions, discuss results and ask new questions</b>

## What is the connection to First Nations?

First Nations artists have long interpreted and communicated the natural world to others with a sense of place that may be similar to today's citizen scientists.



Squamish pictograph found in Howe Sound near **Ēnwilh Spálh̄xen** (Furry Creek).  
(Photo: Gary Fiegehen)

“Artistry has always been widespread in the Squamish culture. Men carve and women weave. Women weave healing and protecting powers into the items they make. Carved tools were adorned with designs depicting the owner’s spirit helpers. A beautifully carved halibut hook, for example, honoured and pleased the fish, which brought the fishermen good luck.

The Squamish Nation has more than 250 registered artists working in a range of mediums: jewelers, printmakers, wood carvers, stone and bone carvers, sculptors, potters, glassworkers, fashion designers and textile and beading artisans.

For the Squamish Nation, our art, songs, and stories have spiritual significance because the maker of the art has connections to the land and seas. Consequently, we hold all artists — whose art we believe comes from dreams, visions or other spiritual connections — in high regard.”<sup>14</sup>

# What is the current state?

A broad range of citizen science activities are currently underway in Howe Sound (Table 2). Some are year round; others follow the seasonal rhythms of nature. The number of citizen science activities and participation seems to be increasing with five new activities started since 2010; however, more than half of the activities listed have been occurring regularly since before the turn of this century (Table 2). Citizen science is not new, but it may be growing

in its sophistication, as well as in recognition and acknowledgement of the benefits. We highlight three differing citizen science enterprises to illustrate the range of community engagement in Howe Sound. Other citizen science activities have contributed elsewhere in this report (e.g., see Bald Eagles article, Marine Birds article, and Annapolis article).

**TABLE 2: SELECT CITIZEN SCIENCE ACTIVITIES IN HOWE SOUND**

ACTIVITY	ORGANIZATION	LOCATION	MARINE SPECIES	ROLES OF CITIZEN SCIENTISTS AND SCIENTISTS	LEVEL OF INVOLVEMENT	START OF PROGRAM
<b>Christmas Bird Count Outer Howe Sound</b>	Lighthouse Park Preservation Society in collaboration with local birding groups	West Vancouver to Anvil Island to Gibsons	all birds including marine species	Volunteers observe, record, and report. Organizers coordinate count, compile and submit results to Audubon Society. Results available on line.	about 50 persons in 2015	2003
<b>Christmas Bird Count Squamish</b>	Squamish Environment Society	Squamish area	all birds including marine species	Volunteers observe, record, and report. Organizers coordinate count, compile and submit results to Audubon Society.	19 in 2015	1980
<b>Christmas Bird Count Sunshine Coast</b>	Sunshine Coast Natural History Society	includes west shore of Howe Sound from Port Mellon to Gibsons	all birds including marine species	Volunteers observe, record, and report. Organizers coordinate count, compile and submit results to Audubon Society.	N/A	1971
<b>Eagle Count, Brackendale Art Gallery and Squamish Winter Eagle Festival</b>	Brackendale Art Gallery and Squamish Environment Society	Lower Squamish River and tributaries	Bald Eagles	Volunteers observe, record, and report. Organizers coordinate count and compile results.	N/A	1985
<b>Monthly Bird Count Squamish Estuary</b>	Squamish Environmental Society	Squamish estuary	all birds including marine species	Volunteers observe, record, and report to eBird. Results available on line.	5 to 10	1991
<b>Monthly Bird Count Lighthouse Park</b>	Lighthouse Park Preservation Society	Lighthouse Park, West Vancouver and adjacent marine waters	all birds including marine species	Volunteers observe, record, and report to eBird. Organizers coordinate count.	5 to 8 each count	2004

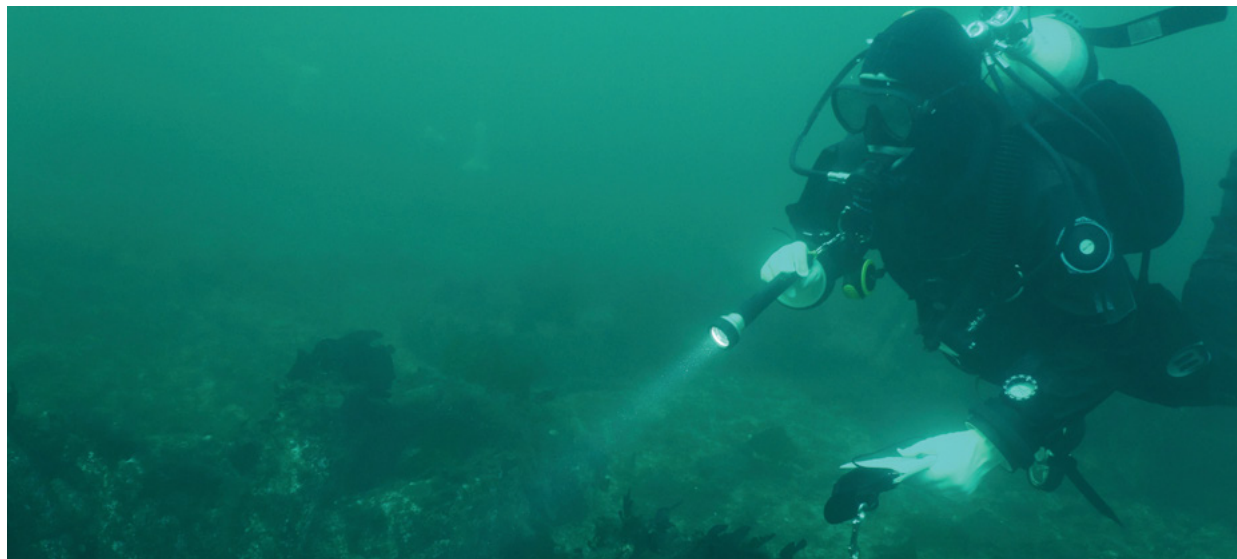
ACTIVITY	ORGANIZATION	LOCATION	MARINE SPECIES	ROLES OF CITIZEN SCIENTISTS AND SCIENTISTS	LEVEL OF INVOLVEMENT	START OF PROGRAM
Spawning Salmon Counts	Squamish Streamkeepers Society	streams and spawning channels from Furry Creek to upper Squamish River valley	salmon (chum, coho, pink)	Volunteers are responsible for specific streams. This includes stream maintenance and enhancement, counts of spawning salmon. Some enumeration by underwater video recording.	16	2000
Streamkeeping and stewardship, ocean shoreline stewardship and eelgrass and kelp planting	West Vancouver & Squamish Streamkeepers, West Vancouver Shoreline Preservation Society, Future of Howe Sound Society, Cheakamus Center, Squamish River Watershed Society, Bowen Island Fish and Wildlife Club	throughout Howe Sound and Squamish River watershed	salmon (coho, chum, pink, Chinook), herring, forage fish, marine mammals, riparian vegetation, invasive plant species, eelgrass, kelp	Volunteers are involved in habitat protection and restoration, habitat assessments, liaison with local and senior governments and First Nations, salmonid enhancement, projects with primary and secondary schools.	500	most during mid 1990s
Terminal Creek Hatchery, Bowen Island	Bowen Island Fish and Wildlife Club with DFO Salmon Enhancement Program	Bowen Island	salmon (chum, coho, pink)	Volunteers prepare, operate, maintain facilities for incubation, rearing and release of salmon fry. Volunteers assist with taking of brood stock and eggs.	10	1982
Intertidal diversity studies	Coastal Scene Investigation by Dr. Shannon Bard ( <a href="http://ecotoxicology.ca">ecotoxicology.ca</a> )	Tunstall Bay (Bowen Island), Port Mellon and Chaster Beach, Lions Bay, Porteau Cove, Darrel Bay, Britannia Beach	intertidal life	Scientists train volunteers to identify species and conduct surveys. Scientists supervise work.	30	1990-93; 1997; 1998; 2004; 2005; 2012-2016
Whale, dolphin, porpoise sightings	BC Cetacean Sightings Network (Vancouver Aquarium and Fisheries & Oceans Canada)	all marine waters in Howe Sound, as well as elsewhere	whale, dolphin, porpoise	Volunteers observe, record, and report via smartphone app (WhaleReport), web form ( <a href="http://www.wildwhales.org">www.wildwhales.org</a> ), log book, or toll-free number.	100 observers reported 141 sightings in 2015	2000
Lingcod egg mass survey	Vancouver Aquarium Marine Science Centre	Howe Sound and B.C. coast wide	lingcod	Volunteer divers observe, record and report data from personal dives.	88 divers in 2016	1994
Rockfish survey	Vancouver Aquarium Marine Science Centre	Howe Sound and B.C. coast wide	rockfish	Volunteer divers observe, record and report rockfish abundance during personal dives. Supplemented with Aquarium staff surveys.	30-40 divers/year	2006
Fish and invertebrate Surveys	Vancouver Aquarium and Reef Environmental Education Foundation ( <a href="http://reef.org">reef.org</a> )	Howe Sound and worldwide	invertebrates and fish	Volunteer divers take identification course run by Aquarium. Divers observe, record and report data from personal dives. Dive data available at <a href="http://reef.org">reef.org</a>	40-50 volunteers trained every 2-3 years	2015

ACTIVITY	ORGANIZATION	LOCATION	MARINE SPECIES	ROLES OF CITIZEN SCIENTISTS AND SCIENTISTS	LEVEL OF INVOLVEMENT	START OF PROGRAM
Glass sponge surveys	Vancouver Aquarium Marine Science Centre	Defence Islands	glass sponges	Volunteer divers photograph and video glass sponge reef/gardens and reference markers during personal dives and submit online. This provides repeated observations of one reef.	6 to 10	2013
Annapolis Biodiversity Index Study	Vancouver Aquarium Marine Science Centre	Annapolis wreck dive site, Halkett Bay, Gambier Island	invertebrates and fish	Volunteer divers observe, record and report data from personal dives. Temperature logger has been installed.	N/A	2015
Howe Sound sponge reef studies	Marine Life Sanctuaries Society of BC	throughout Howe Sound from Defence Islands in north to Passage Island in south	glass sponges, rockfishes	Volunteers build deep sea survey equipment, design studies, gather data using bathymetric mapping, drop camera, depth sounders, and seafloor instruments including temperature logging and collaborate with scientists from DFO and Vancouver Aquarium.	15	1998
Exploratory dives and seafloor technical assistance	Underwater Council of BC	Dive sites at Lions Bay, Pam Rocks, Anvil Island, Bowen Island and elsewhere	glass sponges, rockfish	In collaboration with Vancouver Aquarium and Marine Life Sanctuaries Society, volunteer divers explore, record, and install seafloor monitoring instruments such as temperature loggers.	N/A	2013
Herring spawn surveys	Squamish Streamkeepers Society	upper Howe Sound including Squamish estuary and Woodfibre area	herring	Volunteers map extent and character of herring roe along intertidal zone during herring spawn. Principal surveyor John Buchanan posts results on YouTube.	12	2006
Beach sampling for forage fish spawn	Sea Watch Society (Ramona de Graaf) and BC Shore Spawners Alliance	Gibsons to Langdale, Sunshine Coast, Bowen Island	forage fish (surf smelt, Pacific sandlance)	Volunteers collect samples, analyze for presence of forage fish eggs, coordinated by marine scientist Ramona de Graaf.	40	2008
Marine mammal counts	Sewells Marina Sea Safari with Pacific Wildlife Foundation	outer Howe Sound	all marine mammals	Sewells Marina SeaSafari boat tour guides, with help from guests, observe and report wildlife sightings to Pacific Wildlife Foundation	daily boat tours April to October	2014

**Table 2 Sources of Information:** Christmas bird counts;<sup>15,16,17</sup> Eagle Count — Brackendale Winter Eagle festival;<sup>18</sup> Monthly bird counts in the Squamish estuary;<sup>19</sup> and Lighthouse Park;<sup>13</sup> Spawning salmon counts, Squamish Streamkeepers;<sup>20</sup> Howe Sound streamkeeping and stewardship, ocean shoreline stewardship and eelgrass and kelp planting;<sup>21</sup> Terminal Creek Hatchery, Bowen Island;<sup>22</sup> Intertidal diversity studies;<sup>23</sup> Whale, dolphin and porpoise sightings;<sup>31</sup> Ling cod egg mass, rockfish, fish and invertebrate, and glass sponge, surveys;<sup>30</sup> and Annapolis Biodiversity Index Study;<sup>30</sup> Howe Sound sponge reef studies;<sup>31</sup> Exploratory dives and seafloor technical assistance;<sup>24</sup> Herring spawn surveys;<sup>25</sup> Beach sampling for forage fish spawn;<sup>26</sup> Marine mammal counts.<sup>27</sup>

# What is being done?

## Spotlight #1: Coastal Ocean Research Institute (CORI), Vancouver Aquarium: scientist-directed citizen science



Volunteer diver collecting data. (Photo: Donna Gibbs)

The Vancouver Aquarium supports a number of citizen science activities in Howe Sound.<sup>28</sup> The B.C. Cetacean Sightings Network allows the public to provide information on their sightings of whales and dolphins by phone call, online app, or through the website. In 2015, 100 observers reported 141 cetacean sightings in Howe Sound.<sup>29</sup> Volunteer divers, many organized through the Underwater Council of B.C., gather data on marine life for CORI researchers. In 2016, 88 divers were involved in the lingcod egg mass survey during February and early March. A second volunteer dive survey from August to October records rockfish abundance and usually involves 30-40 divers. Volunteer divers also survey sponge reefs near the Defence Islands.<sup>30</sup> Markers placed on the reef locate photos and videos

provided by divers and allow repeated observations of specific locations. In 2015, the Aquarium launched the Annapolis Biodiversity Index Study that uses photographs and videos by volunteer divers to document the colonization by marine species of the Annapolis artificial reef in Halkett Bay (see Annapolis article).

The Aquarium also runs training courses for fish and invertebrate identification to support REEF volunteer fish and invertebrate surveys.<sup>31</sup> About 40-50 volunteers are trained every second year to identify species and use consistent survey techniques. As of 2016, the online database records species and abundance at 40 sites in Howe Sound.<sup>32</sup>



## Spotlight #2: Marine Life Sanctuaries Society: Non-Government Organization (NGO) directed citizen science

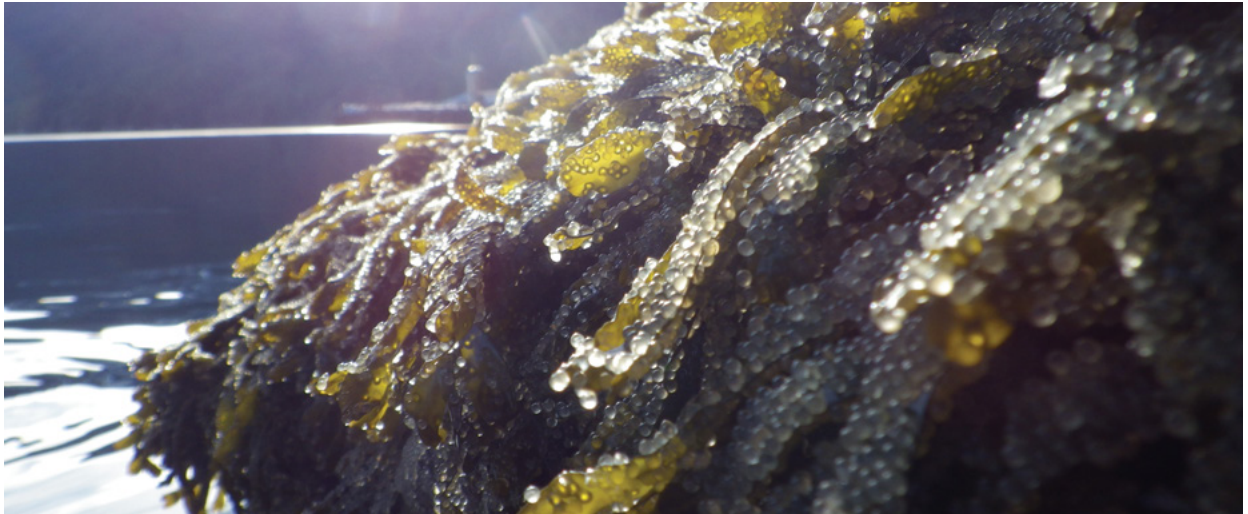


Diver installs sea floor monitoring equipment with the MLSS. (Photo: Glen Dennison)

The Marine Life Sanctuaries Society of BC (MLSS) has employed sophisticated deep water technology and survey techniques to locate and map glass sponge reefs (bioherms) in Howe Sound and document their ecology. MLSS members built a deep water drop-camera and lighting system to remotely video and photograph the seafloor, use GPS and depth sounder to create high resolution 3D maps of the seafloor, and conduct SCUBA dive team surveys to gather detailed information on the sponge reefs and to deploy instruments.<sup>33</sup> To date, the Society has identified 12 reefs at eight locations and many more sponge gardens in Howe Sound<sup>34</sup> in collaboration with divers from the Underwater Council of B.C., scientists at Fisheries and Oceans Canada (DFO) and the Vancouver Aquarium.

Much of this research is led by Glen Dennison who has been SCUBA diving in Howe Sound for over 40 years<sup>35</sup> and in 2015 alone, logged 49 days of boat work on the waters of Howe Sound. MLSS continues to discover and describe new reefs,<sup>36</sup> provide educational talks in local communities, educational beach interpretation programs, and advocate against the use of bottom contact fishing gear on sponge reefs.<sup>37</sup> Recently MLSS has initiated a project to monitor water temperatures in Howe Sound at depths between 25 and 40 metres depth at five sponge reefs and the Annapolis artificial reef. MLSS leadership led directly to the recent expansion of Halkett Bay Provincial Park into the marine environment to protect an offshore sponge garden and bioherm.<sup>38</sup>

## Spotlight #3: John Buchanan: an individual citizen scientist



Herring spawn on intertidal algae with Woodfibre, a closed pulp and paper mill, in the background. (Photo: John Buchanan)

John Buchanan has contributed greatly to the public understanding of Howe Sound's nature and environmental issues. John has lived most of his life in Howe Sound, and driven by curiosity and care, spends large portions of his free time "keeping an eye" on Howe Sound.<sup>24</sup> John surveys streams in late summer and fall for spawning salmon, using an underwater camera to get accurate counts as he moves upstream through various pools.<sup>39</sup> In February and March John is on the water in his boat, surveying the distribution of herring spawn along the shores of Howe Sound, recording the spawning activity with underwater cameras, and posting survey results on line.<sup>40</sup> John is also an opportunistic storyteller; he records what he sees while out on the water or walking streams and has posted over 250 videos of wildlife from orcas and otters to bear and sea jellies.<sup>41</sup> As a passionate advocate for a healthy Howe Sound, John flags environmental issues he encounters such as low stream flows during the drought of 2015,<sup>42</sup> shoreline debris that needs clean up,<sup>43</sup> and

questionable management practices in the Squamish Estuary.<sup>44</sup>

Though much citizen science is being done in Howe Sound, at present there is no central way to share information or coordinate the planning of these projects. A solution could be as simple as an imaginative website that serves as a forum for nature sightings and observations, citizen science conversations about Howe Sound, and networking opportunities. More ambitiously, such a site could store and share collected data, coordinate data gathering and community training, and act as a portal for researchers to Howe Sound. An example of such a hub that could be emulated and serves a subject-specific community – volcanoes – is called the VolcanoCafe.<sup>45</sup> Such a site could invigorate citizen science in Howe Sound, draw researchers' interest, and increase the accessibility of data for policy decisions by local and regional governments.

# What can you do?

SOME ACTIONS CONTRIBUTED BY CORI



## Individual and Organization Action:

- Get involved with an ongoing citizen science project in Howe Sound (Table 2).
- Share your photos and videos of Howe Sound nature on your favourite social media platform.
- Join NatureWatch ([naturewatch.ca](http://naturewatch.ca)), a partnership of Nature Canada and the David Suzuki Foundation to engage Canadians in four ongoing citizen science projects: FrogWatch, PlantWatch, IceWatch and WormWatch.
- Donate. Almost all the groups engaged in citizen science projects in Howe Sound are non-profit groups and projects depend upon donations to continue.
- Learn more about citizen science and how to do it at Citizen Science Central sponsored by Cornell University's Lab of Ornithology: [birds.cornell.edu/citscitoolkit/toolkit/steps](http://birds.cornell.edu/citscitoolkit/toolkit/steps)
- Encourage citizen science participation within your company or organization (e.g., Use citizen science participation to give back to the community, and serve as a team-building exercise).



## Government Actions and Policy:

- Continue to support and raise awareness of the ongoing citizen science projects within Howe Sound (Table 2).
- Provide and maintain a central portal of information including; citizen science project listings, data gathering, community training, and a tool-kit for best practices of designing and maintaining citizen science projects.
- Provide resources needed to enhance and continue local citizen science projects as funding permits.
- Promote closer relationships with stakeholders to citizen science projects in order to facilitate further participation and awareness.
- Increase the use of citizen science data contributing to natural resource and environmental science, natural resource management, and environmental protection and policy making.
- Develop policy to recognize and weigh citizen science, in addition to other scientific evidence and traditional knowledge, submitted for review in the environmental assessment process.
- Invite citizen scientist representation at public engagement events for policies and management to add their voice to input throughout decision-making processes.
- Partner with non-government organizations and other groups to create more citizen science projects on diverse subjects.

# Resources

John Buchanan YouTube videos:  
[youtube.com/user/sqecs2/videos](https://youtube.com/user/sqecs2/videos)

Audubon Bird Count data:  
[netapp.audubon.org/CBCObservation](http://netapp.audubon.org/CBCObservation)

B.C. Cetaceans Sightings Network  
[wildwhales.org](http://wildwhales.org)

Bowen Fish and Wildlife Club  
[bowenhatchery.org](http://bowenhatchery.org)

Bowen Island Conservancy  
[bowenislandconservancy.org](http://bowenislandconservancy.org)

Gambier Island Conservancy  
[gambier.ca](http://gambier.ca)

Howe Sound dive sites biodiversity  
[reef.org/db/reports/geo/PAC/136/](http://reef.org/db/reports/geo/PAC/136/)

Lighthouse Park Preservation Society  
[lpps.ca/volunteering](http://lpps.ca/volunteering)

Marine Life Sanctuaries Society  
[mlssbc.com](http://mlssbc.com)

Squamish Environment Society  
[squamishenvironment.ca](http://squamishenvironment.ca)

Squamish Streamkeepers  
[squamishstreamkeepers.net](http://squamishstreamkeepers.net)

Sunshine Coast Natural History Society  
[sites.google.com/site/scnaturalhistorysoc](http://sites.google.com/site/scnaturalhistorysoc)

Vancouver Aquarium, Howe Sound Group  
[vanaqua.org/act/research/howe-sound-group](http://vanaqua.org/act/research/howe-sound-group)

West Vancouver Streamkeepers  
[westvancouverstreamkeepers.ca](http://westvancouverstreamkeepers.ca)

# Footnotes

<sup>1</sup> Foster, S. and T. Fillingham. "Exploring Britannia Creek with John Buchanan." Accessed Aug 16 2016. <http://sustainablehowesound.ca/video/>.

<sup>2</sup> Foster, S. "Citizen scientists behind reef preservation effort." North Shore News, May 4 2016, Accessed August 16, 2016. <http://www.nsnews.com/opinion/letters/letter-citizen-scientists-behind-reef-preservation-effort-1.2246446>.

<sup>3</sup> Concerned Citizens Bowen. "The Secret of Herring Spawn around Woodfibre." Accessed August 15, 2016. <http://cbowen.ca/secret/>.

<sup>4</sup> Squamish Christmas Bird Count (BCSQ) 116 (2015), Audubon Society. Accessed August 14, 2016. <http://netapp.audubon.org/CBCObservation/CurrentYear/ResultsByCount.aspx>.

<sup>5</sup> Tessa Danelesko, e-mail message to author. August 22, 2016.

<sup>6</sup> For example see Turner, B. "Great schools of anchovy in Howe Sound." YouTube. June 30, 2016. Accessed August 14, 2016. <https://www.youtube.com/watch?v=u9ePy3N5Tto>.

<sup>7</sup> Korsch, D "Predator's Pen – Saltwater Fishing Report – May 28th, 2016." May 28, 2016. Accessed August 14, 2016. <http://www.predatorcharters.ca/html/newsletters.html>.

<sup>8</sup> Miller-Rushing, A., P. Primack, and R. Bonney. 2012. The history of public participation in ecological research. *Frontiers in Ecology and the Environment* 10(6): 285–290.

<sup>9</sup> Rotman, D., J. Hammock, J. Preece, D. Hansen, C. Boston, A. Bowser, and Y. He. 2014. "Motivations Affecting Initial and Long-Term Participation in Citizen Science Projects in Three Countries." *iConference 2014 Proceedings*. Berlin. *iSchools, Illinois Digital Environment for Access to Learning and Scholarship*, 4 Mar. 2014. Accessed August 2016. [www.ideals.illinois.edu/bitstream/handle/2142/47301/054\\_ready.pdf?sequence=2](http://www.ideals.illinois.edu/bitstream/handle/2142/47301/054_ready.pdf?sequence=2).

<sup>10</sup> Miller-Rushing et al. 2012.

<sup>11</sup> Bonney, R., C.B. Cooper, J. Dickinson, S. Kelling, T. Phillips, K.V. Rosenberg, and J. Shirk. 2009. Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. *BioScience* 59(11): 977–984. doi: <http://dx.doi.org/10.1525/bio.2009.59.11.9>

- <sup>12</sup> Alexander, B. 2016. Understanding volunteer motivations to participate in citizen science projects: a deeper look at water quality monitoring. *Journal of Science Communication* 15(03), A04.
- <sup>13</sup> Bonney, R., H. Ballard, R. Jordan, E. McCallie, T. Phillips, J. Shirk, and C.C. Wilderman. 2009. *Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education*. A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education (CAISE).
- <sup>14</sup> Reproduced with permission from “Where Rivers, Mountains and People Meet”, Squamish Líl’wat Cultural Centre.
- <sup>15</sup> Squamish Environmental Society. Monthly Estuary Bird Count. Accessed August 14, 2016. <http://www.squamishenvironment.ca/programs/squamish-birders/>.
- <sup>16</sup> Suann Hosie, email message to author, July 11, 2016.
- <sup>17</sup> Sunshine Coast Natural History Society. Christmas Bird Count. Accessed August 14, 2016. <https://sites.google.com/site/scnaturalhistorysoc/news/christmas-bird-count>.
- <sup>18</sup> Brackendale Winter Eagle Festival. Accessed August 14, 2016. <http://www.brackendaleartgallery.com/Festival.html>.
- <sup>19</sup> Squamish Environment Society. Squamish Estuary Monthly Bird Count Records. Accessed August 10, 2016. <http://squamishbirds.webs.com/countrecords.htm>.
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- <sup>21</sup> Rob Bell-Irving, email message to author, July 11, 2016.
- <sup>22</sup> Mike von Zuben, email message to author, July 16, 2016.
- <sup>23</sup> Shannon Bard, email message to author, July 13, 2016.
- <sup>24</sup> Underwater Council of BC. Citizen science. Accessed August 30, 2016. <http://underwatercouncilbc.org/projects/citizen-science.html>.
- <sup>25</sup> John Buchanan in discussion with author, June 18, 2016
- <sup>26</sup> Diane Sanford, email message to author, July 14, 2016
- <sup>27</sup> Megan Sewell, email message to author, July 14, 2016.
- <sup>28</sup> Jessica Schultz in discussion with author, June 22, 2016.
- <sup>29</sup> Danelesko, T., email message to author, August 22, 2016.
- <sup>30</sup> Vancouver Aquarium. “Diving Sponge Reefs and Gardens.” Accessed July 16, 2016. <https://www.vanaqua.org/act/research/howe-sound-group/sponges>.
- <sup>31</sup> Reef Environmental Education Foundation. “The REEF Volunteer Fish Survey Project.” REEF. Accessed July 16, 2016. <http://www.reef.org/programs/volunteersurvey>.
- <sup>32</sup> For example, see the Geographic Zone Report for Howe Sound (136). REEF. Accessed August 16, 2016. <http://www.reef.org/db/reports/geo/PAC/136/1993-01-01/2016-08-16/3>.
- <sup>33</sup> Glen Dennison, email message to author, July 15, 2016.
- <sup>34</sup> Marine Life Sanctuaries Society. Sponge Research. Accessed August 10, 2016. <https://mlssbc.com/programs/sponge-research/>.
- <sup>35</sup> Dennison, G. 2012. *Diving Howe Sound Reefs and Islands: The Complete Guide to Diving Howe Sound Reefs & Islands by Boat*, Colourcraft Ltd, 140 p.
- <sup>36</sup> Marine Life Sanctuaries Society. “MLSS Discovers Massive Sponge Bioherm in Howe Sound.” October 7, 2014. Accessed August 14, 2016. <https://mlssbc.com/2014/10/07/mlss-discovers-massive-sponge-bioherm-in-howe-sound/>.
- <sup>37</sup> Marine Life Sanctuaries Society. “Kelvin Grove glass sponges at risk from damage by fishing gear.” September 2, 2015. Accessed August 14, 2016. <https://mlssbc.com/2015/09/02/kelvin-grove-glass-sponges-at-risk-from-damage-by-fishing-gear/>.
- <sup>38</sup> B.C. Government News. “Protection of glass sponges celebrated.” May 26, 2016. Accessed August 14, 2016. <https://news.gov.bc.ca/releases/2016ENV0031-000859>.
- <sup>39</sup> For example, see McNab Creek Survey report Sept 30, 2015, by John Buchanan. October 1, 2015. Accessed August 14, 2016. [https://youtu.be/UJY\\_PdNB0LU](https://youtu.be/UJY_PdNB0LU).
- <sup>40</sup> For example, see Buchanan, John. “Report 6 Foulger Creek Herring Spawn, Howe Sound, BC April 11, 2016” April 11, 2016. Accessed August 14, 2016. <https://youtu.be/QSGjkSTXXxA>.
- <sup>41</sup> For examples, see Howe Sound John. Videos by John Buchanan. Accessed August 16, 2016. [https://www.youtube.com/user/sqecs2/videos?shelf\\_id=1&view=0&sort=dd](https://www.youtube.com/user/sqecs2/videos?shelf_id=1&view=0&sort=dd).
- <sup>42</sup> State of the Squamish area creeks in this hot weather Aug 11, 2015. August 11, 2015. Accessed August 14, 2016. <https://youtu.be/uI05qLNXZ-c>.
- <sup>43</sup> Targets for planned springtime [cleanup] Howe Sound B C, March 8, 2015. March 9, 2015. Accessed August 14, 2015. <https://youtu.be/-z-2WCDQpVc>.
- <sup>44</sup> The Good, the Bad, and the Ugly. Bridge Pond situation, Squamish River Estuary May 31, 2014. May 31, 2014. Accessed August 14, 2016. <https://youtu.be/PXE2gE7FXWg>.
- <sup>45</sup> Volcano Café. Accessed August 16, 2016. <http://www.volcanocafe.org/>.