Part III: Ecological Footprint

This is a section of a larger report. Visit galianoconservancy.ca/oneisland/ for the full version

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Galiano Conservancy Association

Background

Those who have frequented it know that the library at the Galiano Conservancy Association (GCA) office is a treasure trove of diverse titles relating to ecology and sustainability. Browsing the shelves, an attentive reader might come across a worn copy of a book entitled "Our Ecological Footprint: Reducing Human Impact on the Earth." This book, which introduced the concept of the Ecological Footprint to popular audiences for the first time, was published in 1996 on Gabriola Island, just a handful of kilometres to the north of Galiano Island. The concept has since been applied to municipalities, cities, states, countries, and the planet as a whole, but never - we note with some irony - to one of the islands from which it took flight.

It has, however, been applied to a small island at least once before.[1] Taking inspiration from the small island of Helgoland off the northwest coast of Germany, we attempt here to present an Ecological Footprint analysis for Galiano Island.

In their 1996 book, Dr. William Rees and his student Mathis Wackernagel defined the Ecological Footprint as "the land (and water) area that would be required to support a defined human population and material standard indefinitely."[2] In other words, it is an estimate of **how much biologically productive land and water area a population is depending upon to produce all the resources it consumes and to absorb the wastes it generates**. Like **Biocapacity**, the **Ecological Footprint** is assessed in **global hectares** (gha), a unit of measurement representing the productivity of an average bioproductive hectare on earth[3] (for a further discussion of this topic, see Part II of this report). Based on current global population figures and Biocapacity estimates, an average of 1.6 gha is available for each person on the planet if resources were distributed equitably *and* if human beings appropriated the totality of the annual bioproductivity of the planet.[4]

The Ecological Footprint has emerged as an important tool for communities to organize around to address climate change, and has been employed by many communities throughout British Columbia,

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[1] See Ratter, B., & Petzold, J. (2012). From Ecological Footprint to Ecological Fingerprint - sustainable development on Helgoland. In Larsen, K. T. (Ed.), *From One Island To Another - A Celebration of Island Connections* (pp. 191-204). Centre for Regional and Tourism Research.

[2] Rees, W., & Wackernagel, M. (1996). *Our ecological footprint: Reducing human impact on Earth*. New Society Publishers.

[3] The Global Footprint Network defines "productivity" as the amount of biological materials useful to humans that is generated in a given area. Productivity that isn't useful to humans is not taken into account. See Global Footprint Network. (2022). Glossary. https://www.footprintnetwork.org/resources/glossary/#:~:text=It%20is%20the%20ratio%20of,primary%20product

[4] In other words, this figure of 1.6 gha leaves no Biocapacity for non-human species, and is therefore a minimum threshold for sustainability.

including Vancouver,[5] Saanich,[6] and Powell River.[7] It is used to collect and frame useful baseline data at a community scale, allowing community members, organizations, and governments to work together to develop and measure progress towards priority climate actions. **Consumption data is grouped into five main categories**: food systems, buildings & stationary energy, consumables & waste, transportation, and water.

An important note regarding Ecological Footprint analysis: water infrastructure is assessed, but **water *availability* is not accounted for in this methodology**. We understand availability of freshwater to be of critical interest to small island communities in the Salish Sea, and were surprised to learn that it would not be considered within the analysis. As such, we have included a section on water that provides a summary of key points from recent reports on the topic produced by the Islands Trust, including the Aquifer Conceptualization Report,[8] Recharge Potential Mapping Report,[9] and Southern Gulf Islands Groundwater Availability Assessment Report.[10]

Methods

Community Gathered Data - "Bottom-up"

No municipal government exists on Galiano Island, making it difficult to obtain data about the community. Early on in the process, we identified lack of locally-relevant data as the most significant barrier to small island communities participating in Ecological Footprinting. To overcome this barrier, we created community surveys to fill data gaps that we identified with CHRM Consulting and the **BCIT Centre for Ecocities**, our project partners for the Ecological Footprint analysis. This "bottom-up" approach generates crucial data that would not otherwise be available, but is time-consuming and is generally considered to result in underestimates.

Surveys were made available digitally and in physical survey packages. Three local businesses, the Galiano Conservancy Association's office at the Millard Learning Centre, and the Galiano Saturday Market

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[5] BCIT, Cora Hallsworth Consulting. (2018). *ecoCity Footprint Tool Pilot - City of Vancouver.* https://commons.bcit.ca/ecocitycentre/files/2020/04/EcoCity-Footprint-Tool-Vancouver-Summary-Report-REV-MAR-18.pdf

[6] BCIT, Cora Hallsworth Consulting. (2018). *ecoCity Footprint Tool Pilot - City of Saanich.* https://www.saanich.ca/assets/Community/Documents/Saanich%20ecoCity%20Pilot%20Summary%20Report%20final.pdf

[7] BCIT, Cora Hallsworth Consulting. (2018). *ecoCity Footprint - City of Powell River*. https://powellriver.civicweb.net/document/75517/

[8] GW Solutions. (2021). *Islands Trust Area Aquifer Conceptualization Model.* *https://islandstrust.bc.ca/document/islands-trust-area-aquifer-conceptualization-report-ver-2021/*

[9] GW Solutions. (2021). *Islands Trust Area Groundwater Recharge Potential Mapping.* *https://islandstrust.bc.ca/document/islands-trust-groundwater-recharge-mapping-potential-project-report-ver-2021/*

[10] GW Solutions. (2021). *Islands Trust Area Groundwater Availability Assessment.* https://islandstrust.bc.ca/document/southern-gulf-islands-groundwater-availability-assessment-report-ver-2021/

served as pick-up and drop-off locations for survey packages. QR codes linking to the digital version of the Community Mail-Out survey were posted on poster boards across the island.

The following four surveys were created specifically for this project:

Odometer Survey

This two-part survey was designed to gain an understanding of how many kilometres Galiano Island residents drive both on-island and off-island on an annual basis. The survey launched on January 8th, 2021 and closed on August 3rd, 2021. In the first part of the survey, we asked island residents to provide a dated odometer reading on each vehicle they owned, vehicle make and model, and how many days a week they typically spend on Galiano Island. The second part of the survey was open from Sept ,1 2021 to Oct 9, 2021, and followed up with participants from the first survey to obtain updated odometer readings for each of their vehicles. Results were averaged over the length of the survey (based on dates and odometer values provided by each participant), extrapolated to obtain annual values, sorted by vehicle type, and then applied proportionately to vehicle ownership data for Galiano Island that we obtained from ICBC. Copies of both odometer surveys can be found in Appendix E.

Food Diary Survey

This detailed survey was designed to gain an understanding of the diets and food sourcing patterns of Galiano Island residents. In it, we asked participating households to track everything they ate over the course of one week. Food categories were listed with specific serving sizes, and participants had to identify whether the portions originated from off-island, or were grown, hunted, fished or foraged on-island. This survey ran twice, once in the spring and once in the summer of 2021, in order to account for seasonal shifts in local food consumption patterns. Surveys were accepted from April 4th, 2021 to Oct 15, 2021. Once we obtained the data, we adjusted for occasional inconsistencies due to labeling confusion (e.g. locally produced chocolate and bread were sometimes incorrectly assumed to be of "on-island" origin). Copies of the spring and summer surveys can be found in Appendix E.

Waste Tracker Survey

This survey was designed to gain an understanding of the material consumption and waste patterns of Galiano Island residents. In it, we asked participating households to separate and weigh any and all waste that they produced over the course of two weeks. Waste was divided into three major categories: "garbage," "recycling & compost," and "waste that you plan to burn". These categories were broken down into more specific subcategories. This survey ran twice, once in the spring and once in the summer of 2021, in order to account for seasonal shifts in local consumption patterns. Surveys were accepted from April 4th, 2021 to Oct 15, 2021. Copies of the spring and summer surveys can be found in Appendix E.

Community Mail-Out Survey

This brief survey was designed to solicit basic information from as large a number of Galiano Island residents as possible. The survey included questions about transportation, energy, water, waste, food, boat ownership and use, and attitudes about sustainability. Some questions covered topics related to

the other data collection initiatives. This survey was mailed out to the entire community on June 8th, 2021 and remained open until October 15, 2021. A copy of this survey can be found in Appendix E.

Public and Private Data Sources - "Top-down"

We also compiled data that is collected by Federal and Provincial governments, local NGOs and businesses, and regional governments. Some of this data was publicly available, and some was provided on request. Sources included:

- Statistics Canada - Population and private dwelling occupancy statistics for 2016 and 2021.
- ICBC - Make and model of all vehicles registered on Galiano Island in 2020.
- Galiano Island Recycling and Resources (GIRR) - Monthly weights for each recycling material category for the year 2019.
- Garbage Gals (private on-island garbage collection business) - Weight of garbage removed from the island to landfill in 2021.
- BC Hydro - Annual averages of electricity use on Galiano Island (2014-2020).
- Superior Propane - The weight of propane delivered to Galiano Island (V0N 1P0) in 2020.
- Salish Sea Renewable Energy Co-op (SSREC) - Estimates of how much electricity is generated locally by Galiano Island residents on an annual basis.
- Islands Trust - Publicly available GIS data layers for Built Area and Zoning.
- Seair Seaplanes- Annual averaged fuel used for seaplane landing in Montague Harbour.

ecoCity Footprint Tool

We provided both the "bottom-up" and "top-down" data we collected to our Ecological Footprint project partners, CHRM Consulting and the BCIT Centre for Ecocities. All additional data required for this analysis was supplied by these partners, and may not be publicly available.

The **ecoCity Footprint Tool**[11] approach to the Ecological Footprint also includes and incorporates both territorial and consumption-based greenhouse gas (ghg) emissions inventories. The **Territorial Emissions Inventory** captures emissions sources from within a given geographic area; the **Consumption-based Emissions Inventory** (CEBI) quantifies all ghg emissions attributable to a given population, regardless of where those emissions occur geographically. Greenhouse gas emissions are measured in **Tonnes of Carbon Dioxide Equivalent (tCO_2e)**, which expresses the impact of different ghgs in terms of the amount of CO_2 (carbon dioxide) that would create the same amount of warming if released into the atmosphere. This enables reporting of total greenhouse gas emissions in one measurement.[12] To view BCIT's methodology, see their report at www.galianoconservancy.ca/oneisland.

[11] See https://www.bcit.ca/centre-for-ecocities/tools/ and https://www.ecocityfootprint.org/#home

[12] Methane, for example, is a potent ghg that is at the time of this report *not* included in Ecological Footprint accounting, but is captured by emissions inventories.

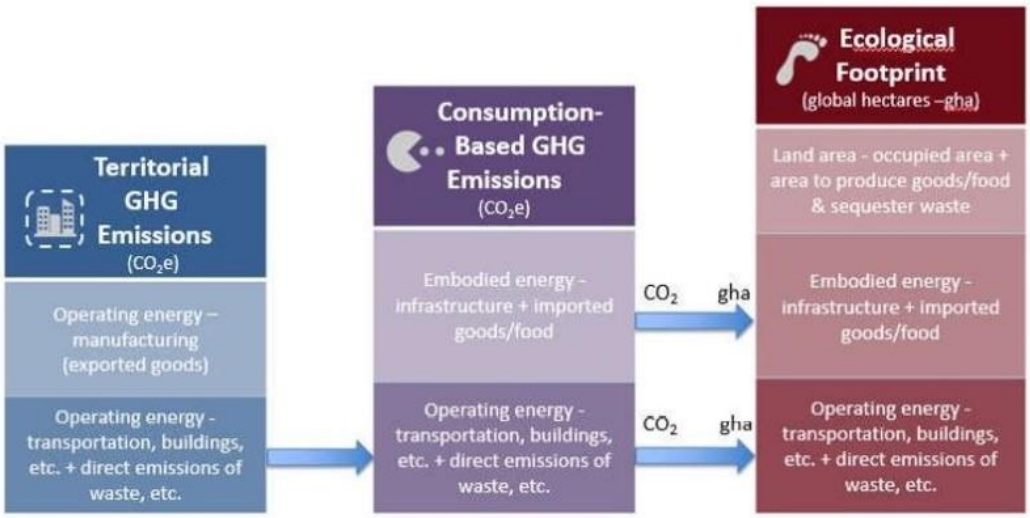

Figure 8. Comparison of the GHG Emission Inventories and Ecological Footprint Approach

Ecological Footprint of Galiano Island

The following is our summary of Ecological Footprint results provided to us by the BCIT Centre for Ecocities; for their technical report, which includes additional scenarios and a discussion of the CEBI, please visit www.galianoconservancy.ca/oneisland.

Overview

We present the results of our Ecological Footprint analysis for the Galiano Island community in two distinct scenarios:

The **Baseline Scenario** is a snapshot of the Galiano Island community's Ecological Footprint circa 2017-2021. It includes the combined footprint of all full-time residents, the 'on-island' footprint of part-time residents and tourists (including ferry and seaplane transportation to Galiano Island), and a portion of part-time resident flights taken globally. **Senior government services** are included.[13]

The **One Planet Scenario**, on the other hand, is an illustrative example of measures that could be taken collectively to reduce the Ecological Footprint of the Galiano Island community to a size that is sustainable and equitable from a planetary perspective. The actual reductions would need to be greater to account for senior government services and to include setting aside land for nature.[14]

[13] Services provided by Federal and Provincial governments to the citizenry; in Canada, this includes military, health care, administrative, and other high-level services that aren't accounted for at the local level.
[14] We note that this scenario was provided to us by CHRM Consulting and the BCIT Centre for Ecocities as one possible route to achieve **"One Planet Living"** on Galiano Island, and should not be viewed as prescriptive. For our summary and recommendations from this project, see Part V of this report.

Baseline Scenario

Results

We found that **the Ecological Footprint of the Galiano Island community is 18,600 global hectares, or 6.8 gha/ca**. This means that, if everyone on the planet lived according to average Galiano Island standards, the equivalent of **4.3 earths would be required** to support this lifestyle at a global scale. Included in this analysis are 1,396 full-time residents[15] and 1,327 full-time equivalent seasonal residents, a composite population based on our estimate of the number of part-time residents on the island[16] and the total estimated person-days of the approximately 80,000 tourists[17] that visit the island annually. **Roughly half of the footprint is attributable to full-time residents** (9,700 gha) and the other half is attributable to part-time residents and tourists (8,900 gha). This result reflects the true cost of a local economy that specializes in goods and services provided to the seasonal population.

Discussion

Like most - if not all - communities in Canada, **the Galiano Island community uses a disproportionate amount of the Earth's surface area** to support its current standard of living, relative to both its population *and* the Biocapacity of the island itself. We estimate that **the community uses 29% more Biocapacity than the lands and waters that comprise Galiano Island offer** back to the biosphere (14,373 gha). It is important to remember that this is an *indirect* comparison, as the community no longer relies on local ecosystems to produce the vast majority of the resources it requires to live.[18]

It is also important to note that **this footprint includes senior government services** that are provided to all Canadians by the Provinces and the Federal government, including health care, military, and administrative services. These services are a critical piece of the Galiano Island community's footprint, but are beyond the control of the local community. When these services are excluded from the analysis, we are left with a total of 11,100 gha, or **4.1 gha/ca that are responsive to community action** (i.e., over which the community can exert some level of influence). It would take **2.6 earths to support the global population at this local standard**, excluding senior government services.

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[15] Statistics Canada. (2021). *Census Profile - Galiano Islands Trust Area.* https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=V0N%201P0&DGUIDlist=2021A0006590004&GENDERlist=1&STATISTIClist=1&HEADERlist=0&fbclid=IwAR2FY6x-CnYKMQFb7xmnnUkMo43VCVQPqkUe14NljQ8xPvegNNlYQrD9Pxc

[16] This estimate is based on our comparison of different values for "Private Dwellings Occupied by Usual Residents," and "Total Private Dwellings" on Galiano Island from 2021 census data. We assumed that dwellings that are not occupied by "usual residents" belong to part-time residents, and based our estimates for average part-time resident household size and occupancy rates (i.e., annual days on the island) on data from our Community Mail-Out Survey.

[17] This value for annual visitation is from 2007. We assume an average of four days on the island per tourist. See Ecoplan international. (2008). *Southern Gulf Islands Community Tourism Part 1: Tourism Profile.* https://www.crd.bc.ca/docs/default-source/salt-spring-island-ea-pdf/cedc/part_one-tourism_profile.pdf?sfvrsn=2

[18] See Part IV of this report for a detailed discussion of the trend away from reliance on local resources.

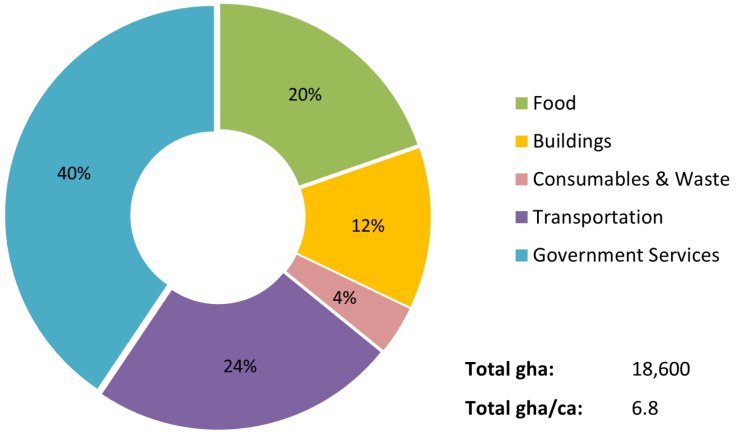

Figure 9. Galiano's Baseline Ecological Footprint, 2021

Data Visualizations

The ecoCity Footprint Tool presents results for the Ecological Footprint alongside a Consumption-based Emission Inventory (CBEI). The emissions inventory is included in (i.e., directly informs) the footprint results, but also captures some emissions not accounted for by Ecological Footprint analysis, including methane emissions. Some impacts have larger relative contributions to the footprint, and some have larger relative contributions to the emissions inventory, allowing for a comparison of relative impact. For each category, we will present the **footprint on the left**, and the **emissions inventory on the right.**

Ecological Footprint | BASELINE SCENARIO | GHG Emissions Inventory

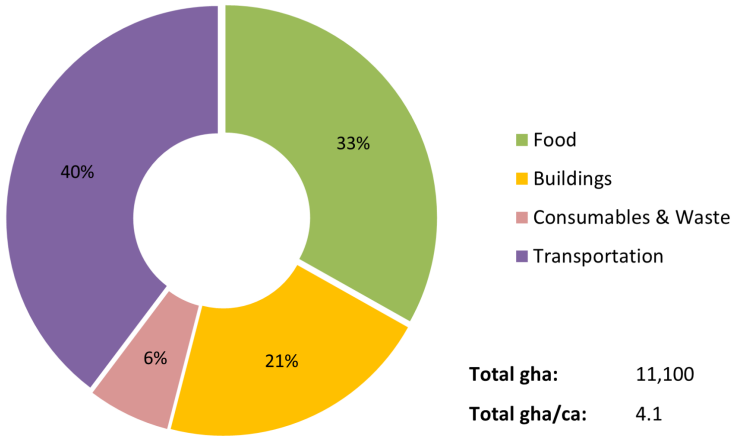

Figure 10. Galiano's Baseline Ecological Footprint, minus national and provincial government services, 2021

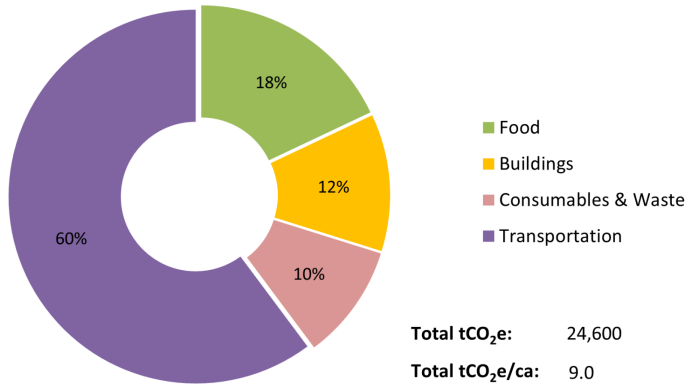

Figure 11. Baseline GHG Emissions Inventory, minus national and provincial government services, 2021

Figure 12. Galiano's Ecological Footprint, including national and provincial government services, 2021

Figure 13. Galiano's Ecological Footprint, excluding government services, 2021

How Many Earths?

Ecological Footprint results are often expressed in terms of the number of "Earths" that would be required to support the global human population at the material standard of a specific community at a specific point in time. This illustrative metric is derived from dividing the gha/ca for a community by the estimated gha/ca available to everyone at a planetary scale. At the time of writing, there is an estimated **1.6 gha/ca available to support human life on Earth.** At 6.8 gha/ca, the Galiano Island community is living at a standard that would require **4.3 "Earths" to support at a global scale**; of this, the community is **directly responsible for 2.6 Earths**, or about 4.1 gha/ca.

It is important to emphasize that the target of 1.6 gha/ca (a) does not leave any Biocapacity for wildlife, and (b) is a moving target that shrinks with increasing global population and Biocapacity losses.

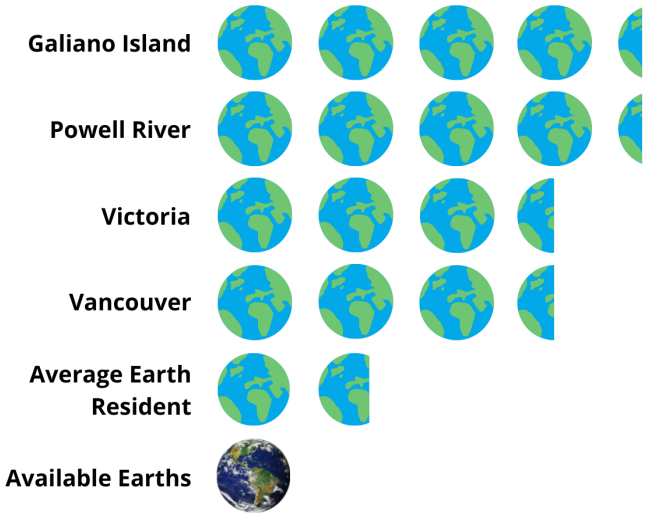

Figure 14. BCIT completed Ecological Footprints of nearby municipalities using the same methodology in 2018. This figure includes national and provincial government services.

How Do We Compare?

Ecological Footprints have been calculated in many other jurisdictions, including the City of Calgary, Alberta.[19] Footprint results should be compared with caution, as different methodologies may include or exclude specific components. Senior government services are often excluded at the municipal level but are included at the Provincial and national level. The Ecological Footprint is still evolving, and new components are constantly being added. It is a snapshot in time, which is why the City of Vancouver has performed three successive Ecological Footprint assessments. According to the **Global Footprint Network**, **the Earth's human population uses the equivalent of 1.75 Earths** at the time of writing.

[19] See https://www.footprintnetwork.org/2015/04/10/calgary/

Food

Results

Food contributes an estimated **3,700 gha (33%)** to the Ecological Footprint - **lower than the Canadian average**. The food survey results demonstrate that Galiano Island residents consume, on average, less meat and more legumes than the Canadian population as a whole. The addition of the tourist population to the analysis increased the contribution of meat and meat products to the footprint, as we assumed an average Canadian diet for visitors.[20] Animal products are very resource intensive to produce relative to comparable foods, and **meat and dairy products are by far the biggest contributors** to the footprint - despite the Galiano Island community's apparent reduced reliance on these foods relative to the average. An exception to this rule is locally-harvested seafood and venison,[21] which have negligible impact on the food footprint.[22]

Food transportation has a very low impact relative to the energetic and spatial demands of industrial-scale food production. **Food waste plays a major role** - it is estimated that over half of the food that is grown is wasted at some point along the supply chain and in households.[23] We found that on-island production of fruits, vegetables, and eggs plays a significant role in reducing the food footprint by eliminating **food miles** and waste that would otherwise occur in the supply chain.

Discussion

The Galiano Island community's diet and **efforts to produce local food are reflected in the below-average footprint of food**, and likely have an even greater impact than what we've captured here.[24] Our Food Diary results suggest that, by weight, **13.5% of the food consumed on Galiano Island was produced locally** in 2021, including 32% of the fruits and vegetables and 50% of the eggs. Our Community Mail-Out Survey results suggest that the average food-producing garden size is 5707 ft^2 for full-time residents and 1918 ft^2 for part-time residents, while 23% of survey participants stated that they are currently facing barriers to starting a garden or expanding their existing garden. Lack of time and capacity, lack of knowledge, cost, and access to contractors and trades workers were the most common barriers. A remarkable 71% of participants stated that they preserve their own food, and 21% stated that they hunt and fish locally. Efforts to reduce the footprint of food on Galiano Island should focus on reducing food waste, which can include expanding local food production and harvesting. Reducing consumption of imported meat and dairy products is also beneficial.

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[20] Agriculture and Agri-Food Canada. (2015). *An Overview of Canadian Food Loss and Waste Estimates.*
[21] From a greenhouse gas perspective, it is arguably beneficial to harvest local deer from the landscape, as deer emit methane as a byproduct of their digestion - a trait they share in common with other ungulates such as cattle.
[22] However, fossil fuels may be used to power the boats or vehicles used to access these animals.
[23] National Zero Waste Council. (2022). *Food Waste.* https://lovefoodhatewaste.ca/
[24] This is because locally-grown fruit, vegetables, and eggs were still assumed to have a material and production footprint equivalent to that of industrial agriculture, due to lack of relevant data on small-scale production.

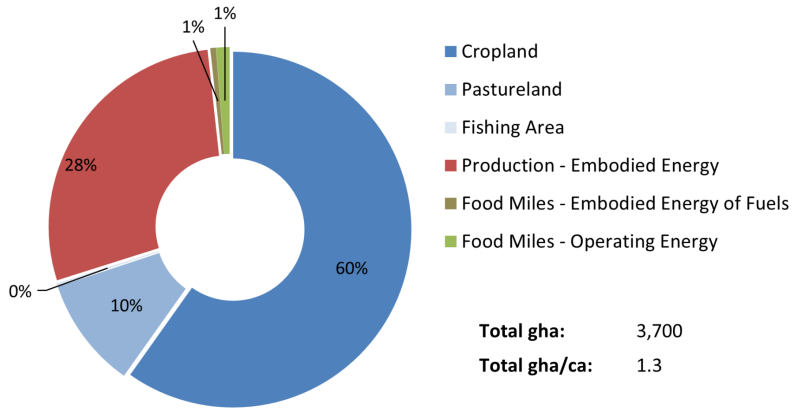

Figure 15. Galiano's Food Footprint, 2021

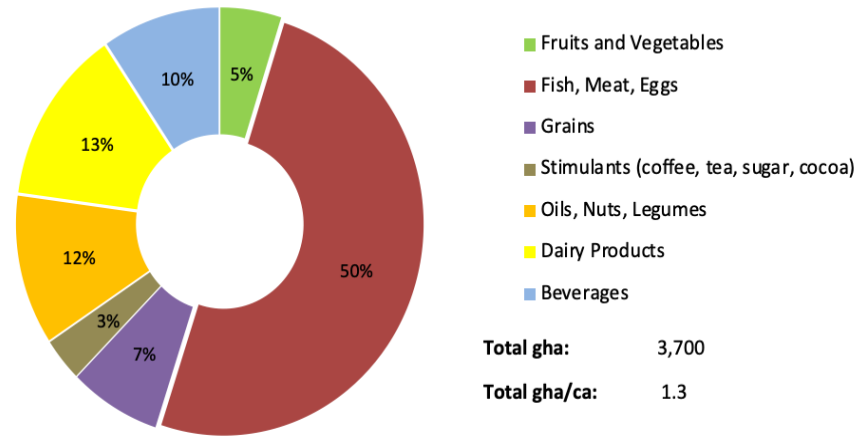

Figure 16. Galiano's Food Type Footprint, 2021

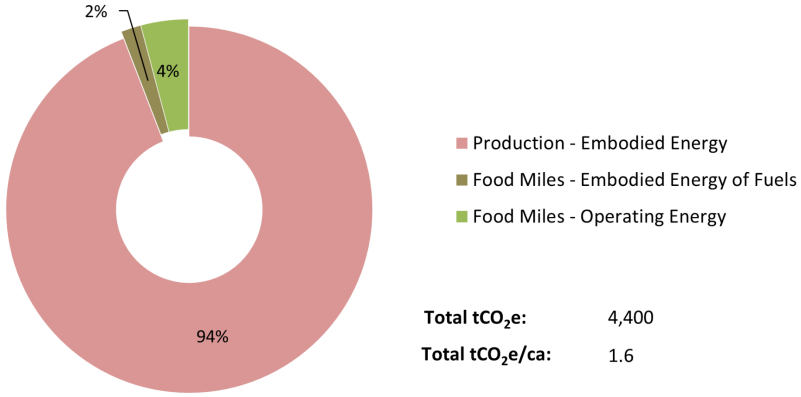

Figure 17. GHG Emissions Inventory of Food, 2021

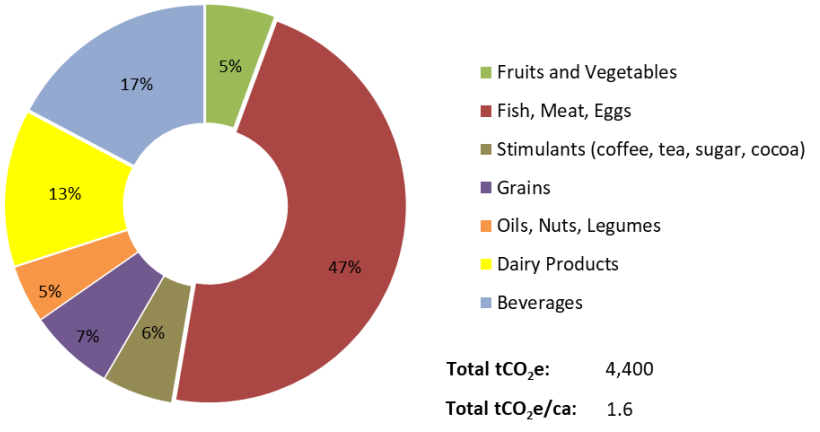

Figure 18. GHG Emissions Inventory of Food Type, 2021

Buildings & Stationary Energy

Results

Buildings and stationary energy contribute an estimated **2,300 gha (21%)** to the Ecological Footprint. The **impact of the built area is higher than BC average.** Low-density single-family homes scattered across the island are the driving cause behind the relatively high impact of the built area. **Operating emissions are below average for British Columbia**, due to relatively high electricity use and low fossil fuel use for home heating. Wood stoves, a common heat source on the island, are considered to be ghg neutral from a footprint perspective if the wood is derived from local ecosystems, but do contribute to local particulate pollution.

Discussion

The residential built area[25] is by far the biggest contributor to the footprint of buildings and stationary energy on Galiano Island, due to the **low density of the island population relative to the amount of space occupied by structures and clearings.** This is unusual, as elsewhere in British Columbia **operating energy** (energy used to power and heat buildings) is a more significant impact in relative terms. Even for smaller towns like Powell River, the built area only takes up about ¼ of the footprint of buildings and stationary energy.[26] Historically, low-density development on Galiano Island has resulted in part from concerns about limited groundwater supplies, zoning bylaws, and cultural preferences - this is discussed further in Parts IV and V of this report.

Galiano Island households typically employ a combination of wood stoves, baseboard heating, and heat pumps, although some homes are still reliant on fossil fuel for heating. **Electricity use on Galiano Island is high relative to other BC jurisdictions**, due in part to easy access to electricity relative to fossil fuels. Inefficient baseboard heaters and poorly-insulated homes are issues across BC. High electricity use has a low impact on the overall footprint because 90% of B.C. Hydro's energy production is hydroelectric.[27] From an Ecological Footprint perspective, hydroelectric dams have a much lower impact than burning fossil fuels. Nevertheless, hydroelectric dams do have negative effects on ecosystems and communities, including: flooding, negative effects on fish migration, methane production, and **embodied emissions** from concrete production.[28] At the time of writing, we estimate that **local solar installations produce more than 1.5% of the electricity used on the island.**

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[25] Built area includes areas categorized as 'Developed' and as 'Rural Settlement' in the 2021 Land-Use Map. This means that the cleared areas around homes on the island - including septic fields, gardens, and lawns - are included.
[26] BCIT, Cora Hallsworth Consulting. (2018). *ecoCity Footprint Tool Pilot - City of Powell River* https://powellriver.civicweb.net/document/75517/
[27] BC Hydro. (2022). *Generation Station* https://www.bchydro.com/energy-in-bc/operations/generation.html
[28] Cox, S. (2022, May 13). *BC Hydro lacks an appetite for green electricity. That's hurting this historic family-run plant*. The Narwhal. Retrieved May 13, 2022, from https://thenarwhal.ca/bc-hydro-lacks-an-appetite-for-green-electricity-thats-hurting-this-historic-family-run-plant/

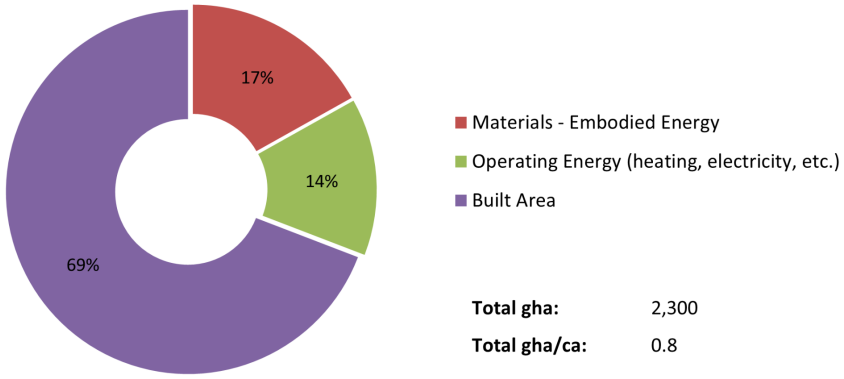


Figure 19. Galiano's Footprint Summary, 2021

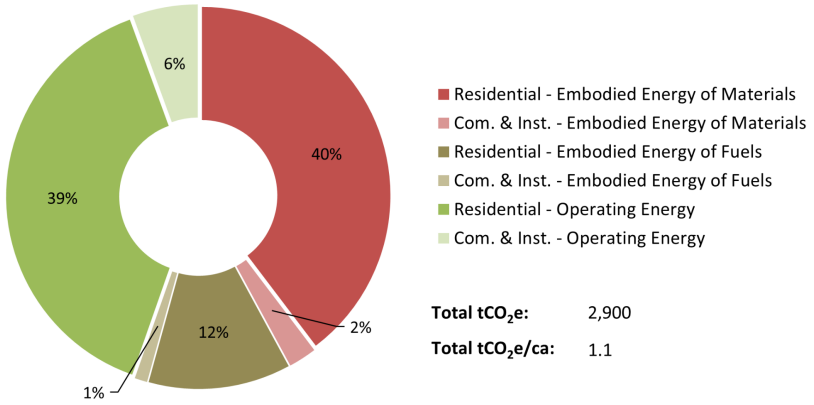


Figure 21. GHG Emissions Inventory of Buildings, 2021

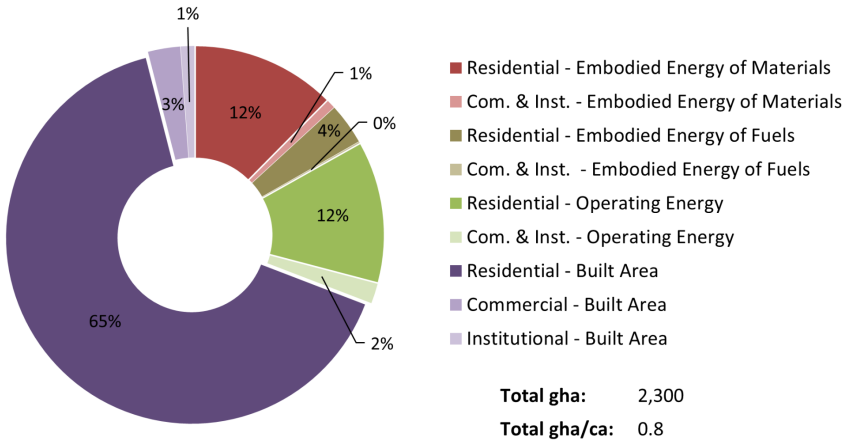


Figure 20. Galiano's Buildings Footprint Detailed, 2021

Consumables & Waste

Results

Consumer products and waste contribute an estimated **690 gha (6%)** to the Ecological Footprint - **lower than other BC juridictions**. Results from the Waste Tracker survey for the Galiano Island community were about ½ of the Capital Regional District average. These results were used for both full-time and part-time residents, while Metro Vancouver and Capital Regional District averages were used for tourists.

Recycled and disposed supply chain emissions (**embodied energy** of materials) are the largest contributors. **Direct landfill emissions and septic tank emissions (primarily methane) are not captured in the footprint**, but are accounted for in the ghg emissions inventory, where they make a significant contribution.

Discussion

The Ecological Footprint methodology accounts for the land and energy required to produce, transport, and dispose of consumer goods by examining the waste stream, with the assumption that all products eventually make their way into landfill or recycling facilities. This means that reusing, repurposing, and/or locally composting products effectively removes them from the embodied energy footprint of consumables and waste. Embodied energy accounts for the majority of the waste footprint, and originates from supply chain emissions, including extraction, processing and transport.

Of all the categories, **consumables and waste is most likely an underestimate** for several reasons. First, the Waste Tracker survey provided "bottom-up" data that is probably lower than the reality. Secondly, an unknown percentage of products purchased and disposed of by members of the Galiano Island community apparently do not find their way to landfill or recycling facilities, and are instead burned, dumped in local ecosystems, or left sitting in yards or basements due to the relatively high cost of disposal off-island.[29]

While this category is likely underestimated, there is good reason to believe that the Galiano Island community is still below Canadian average in terms of waste, due in large part to a healthy local culture of recycling and reuse, the financial disincentive of producing garbage in the first place (i.e., cost and hassle of off-island disposal), and a very high level of composting of organic wastes.[30]

Emissions from septic fields are a significant local component of the emissions inventory.

[29] See Part IV of this report for a discussion of the history of waste disposal and recycling on Galiano Island.
[30] 91.3% of respondents to a 2021 survey report that they compost organic wastes at home. See Nuckhady, B. (2021). *Key Findings: Understanding Household Food Consumption and Food Waste Management in Galiano Island*. https://galianoconservancy.ca/wp-content/uploads/2022/05/Galiano-Household-Consumption-Survey-results.pdf

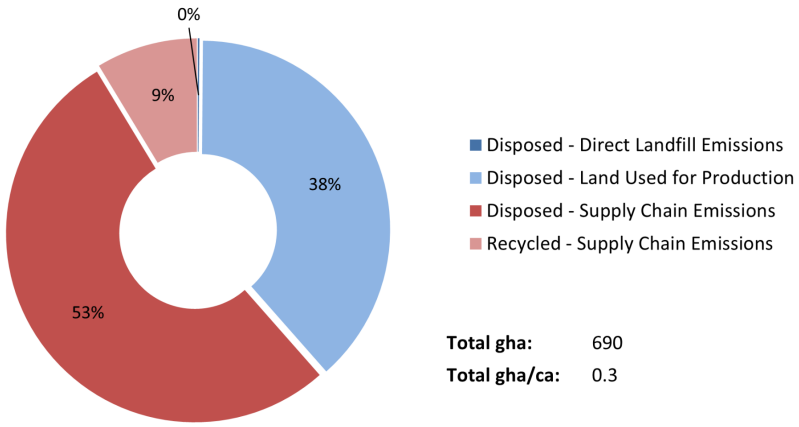


Figure 22. Galiano's Consumables & Wastes Footprint, 2021

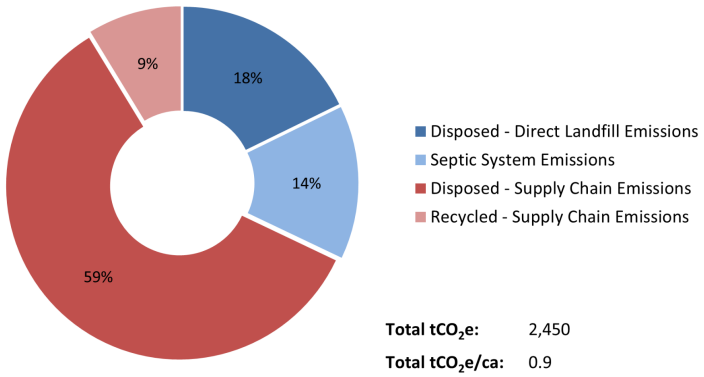


Figure 24. GHG Emissions Inventory of Consumables & Waste, 2021

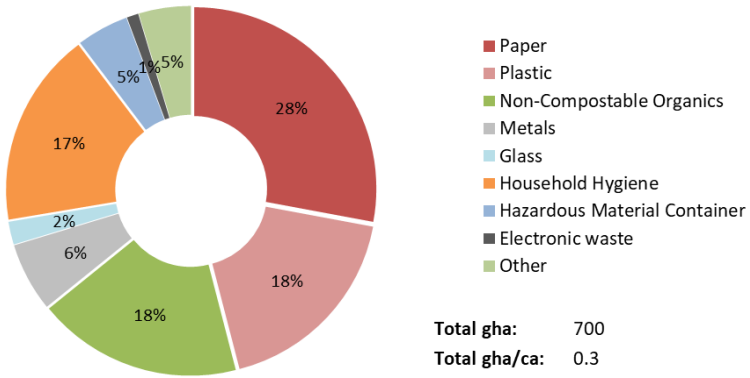


Figure 23. Galiano's Consumables Footprint Details, 2021

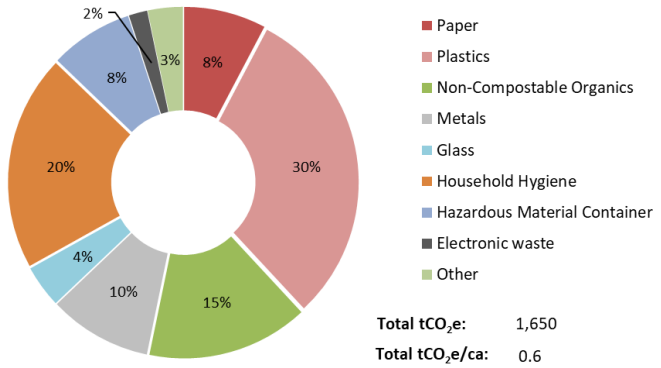


Figure 25. GHG Emissions Inventory of Consumables by Type, 2021

Transportation

Results

Transportation contributes an estimated **4,400 gha (40%)** to the Ecological Footprint - **higher than other BC jurisdictions**. Transportation is the single largest contributor to the Galiano Island community's Ecological Footprint. For full-time and part-time residents, the **transportation footprint is roughly ⅓ each of vehicle use, ferry trips and air travel.** Full-time residents **drive less and fly more than the average BC jurisdiction**. Tourists contribute significantly to seasonal increases in vehicle, ferry, and seaplane trips.[31]

While the embodied energy of paved and unpaved roads is minor, **the built area occupied by the extensive road network on Galiano Island is very high relative to other BC jurisdictions.** Galiano Island has 0.25 km^2 of paved roads *and* 2.78 km^2 of non-paved roads, many of which are legacies of the forest industry on the island but that remain clear of vegetation due to continued use or compaction.

Discussion

Compared to other BC jurisdictions, the full-time and part-time residents of Galiano Island travel **twice as much by plane, and travel ⅔ less by vehicle.** Ferry travel is a significant portion of the footprint. Daily tourist vehicle use on-island is estimated to be 3 times higher than resident use. The addition of tourists increases the impacts of both vehicle and ferry use, while somewhat masking the outsized contributions of air travel and built area to the footprint.

Despite low vehicle use relative to Provincial averages, **personal vehicles remain the primary local form of transportation.** Serious barriers to adoption of active transport were apparent from our Community Mail-Out Survey, where 57% of participants stated that they do not feel safe biking, and 28% stated that they do not feel safe walking on public roads. Nevertheless, **45% of participants who completed our Community Mail-Out survey claimed to use active transport at least occasionally** (1% - 10% of their trips). Those that felt safe biking on public roads followed up with comments such as: "Safer during the non-tourist season"; "Yes, but avoid weekends and other busy times if possible"; and "generally on the north part of the island and on weekdays."

Galiano has three public electric vehicle (EV) charging stations. Electric vehicle ownership on the island has been increasing since 2015 (from 3x in 2015 to 26x in 2020). **48% of our survey respondents stated that purchasing an EV was a lifestyle change that they would like to make**, but that it is currently out of reach. All but one participant identified cost as being the most significant barrier.

[31] For the purposes of this analysis, we assumed an average of 4 days per trip for each visitor to the island, and then created a daily vehicle use profile (based on a typical itinerary) for these trips. All seaplane use was attributed to visitors.

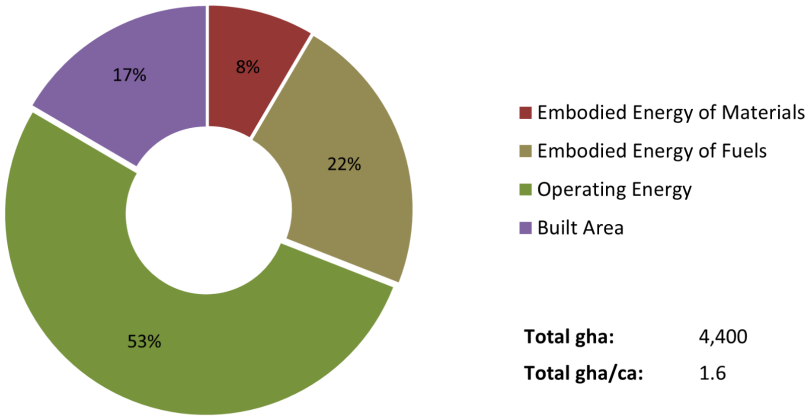


Figure 26. Galiano's Transportation Footprint Summary, 2021

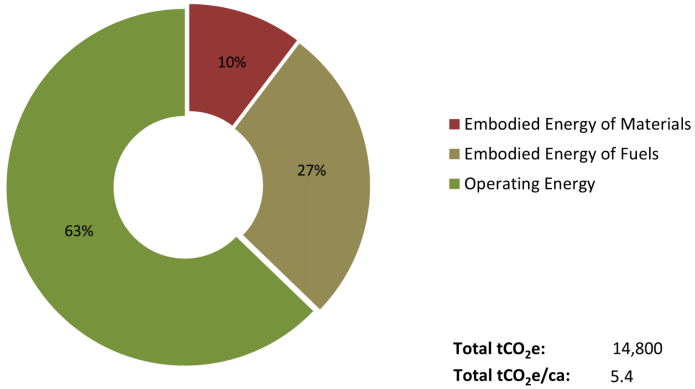


Figure 28. GHG Emissions Inventory of Transportation, 2021

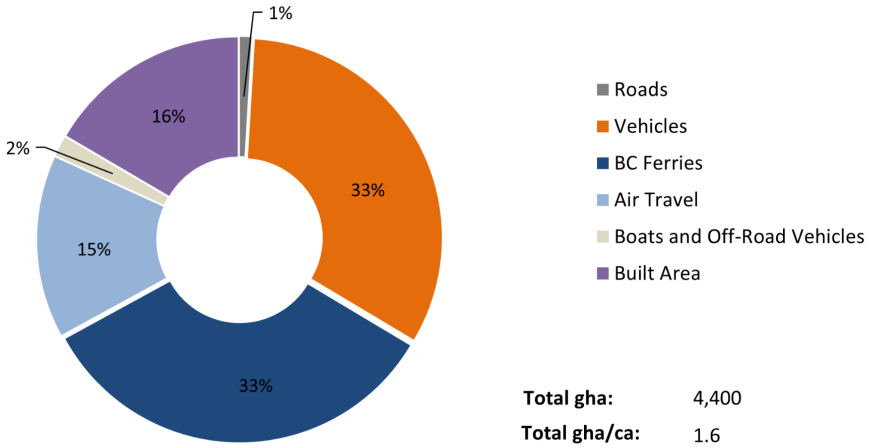


Figure 27. Galiano's Transportation Footprint by Type, 2021

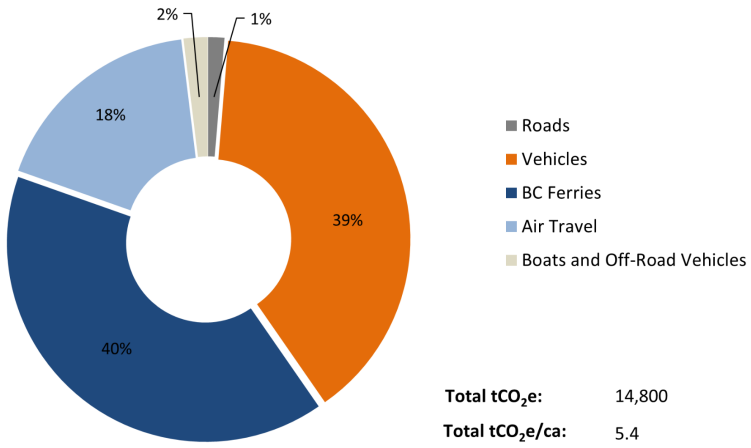


Figure 29. GHG Emissions Inventory of Consumables by Type, 2021

Water

Discussion

Water is typically included as a category in Ecological Footprint analysis, but only in terms of the land and infrastructure required to supply it to a given population. Since the Galiano Island community relies almost exclusively on private wells and rainwater harvesting infrastructure to meet its water needs, the lack of centralized water distribution systems prevented us from including water infrastructure in the Ecological Footprint results.[32]

Nevertheless, freshwater availability and accessibility is a critical component of local sustainability that deserves consideration. Accordingly, we provide a summary of ongoing, publicly available research being conducted by the Islands Trust on this topic. This brief discussion is informed by the following reports:

- Islands Trust Area Aquifer Conceptualization Report, 2021[33]
- Islands Trust Area Groundwater Recharge Potential Mapping Report, 2021[34]
- Islands Trust Groundwater Recharge Potential Mapping Appendices, 2021[35]

Arguably, water is the one remaining footprint category which the Galiano Island community remains overwhelmingly reliant on the island itself to provide. The irony is that this local reliance effectively removes water from the scope of Ecological Footprint analysis and places it squarely in the purview of island residents themselves. After reviewing the existing literature, we feel that more work needs to be done to understand water availability, water consumption and thresholds across the island, and to address local deficits. We observe that annual rainfall (between 60 and 75 centimetres on average) provides ample opportunity for reducing reliance on limited groundwater supplies.

Summary

According to Islands Trust data, groundwater wells serve as the primary water source for about 77% of island households, with surface water wells making up the remainder (~23%). Galiano's groundwater is at its lowest availability in August and September. Aquifer recharge starts in October, and Galiano's groundwater's maximum is in the winter months. The influx of seasonal residents and demand for

[32] The embodied energy of private water infrastructure could be investigated further, but was not evaluated due to its long lifespan and very low overall contribution to the footprint. The grid energy required to pump water is incorporated in the buildings and infrastructure section.

[33] GW Solutions. (2021). Islands Trust Area Aquifer Conceptualization Model. *https://islandstrust.bc.ca/document/islands-trust-area-aquifer-conceptualization-report-ver-2021/*

[34] GW Solutions. (2021). Islands Trust Area Groundwater Recharge Potential Mapping. *https://islandstrust.bc.ca/document/islands-trust-groundwater-recharge-mapping-potential-project-report-ver-2021/*

[35] GW Solutions. (2021). Islands Trust Area Groundwater Availability Assessment. https://islandstrust.bc.ca/document/southern-gulf-islands-groundwater-availability-assessment-report-ver-2021/

irrigation cause the Galiano Island community's water consumption to increase from May to September, with July and August being the most intensive. Therefore, the time of greatest groundwater need coincides with the time of lowest availability.

From 1980 to present, groundwater elevation has decreased in OW258, the Provincial observation well at the Galiano Community School. This seasonal fluctuation of 9 to 11 metres is the largest noted across all of the Southern Gulf Islands included in the study. Decreasing trends in groundwater elevation indicate aquifer discharge is greater than recharge, and may be attributed to the cumulative impacts of climate change, well density, land-use change, and development. In coastal areas, local groundwater deficits can result in salt-water intrusion into aquifers, which is a potentially non-reversible process.

For the Islands Trust Area Groundwater Availability Assessment, groundwater regions were used to compare the percentage of groundwater used to the amount of groundwater recharge across the island. The Islands Trust employs a threshold of 10%, meaning that 10% more groundwater is being used then recharged. In the "Normal" scenario (Left), the Cain Peninsula groundwater region (Red) is currently exceeding the 10% threshold. Other notable areas with 5-9% stress (Yellow) are the Montague Harbour groundwater region and the South Galiano groundwater region. When the driest scenario is projected (Right), more groundwater regions show an increase in groundwater stress. If the Southern Gulf Islands were to experience drought conditions comparable to those of 1985, groundwater recharge could be reduced by up to 50%, further exacerbating groundwater deficits.

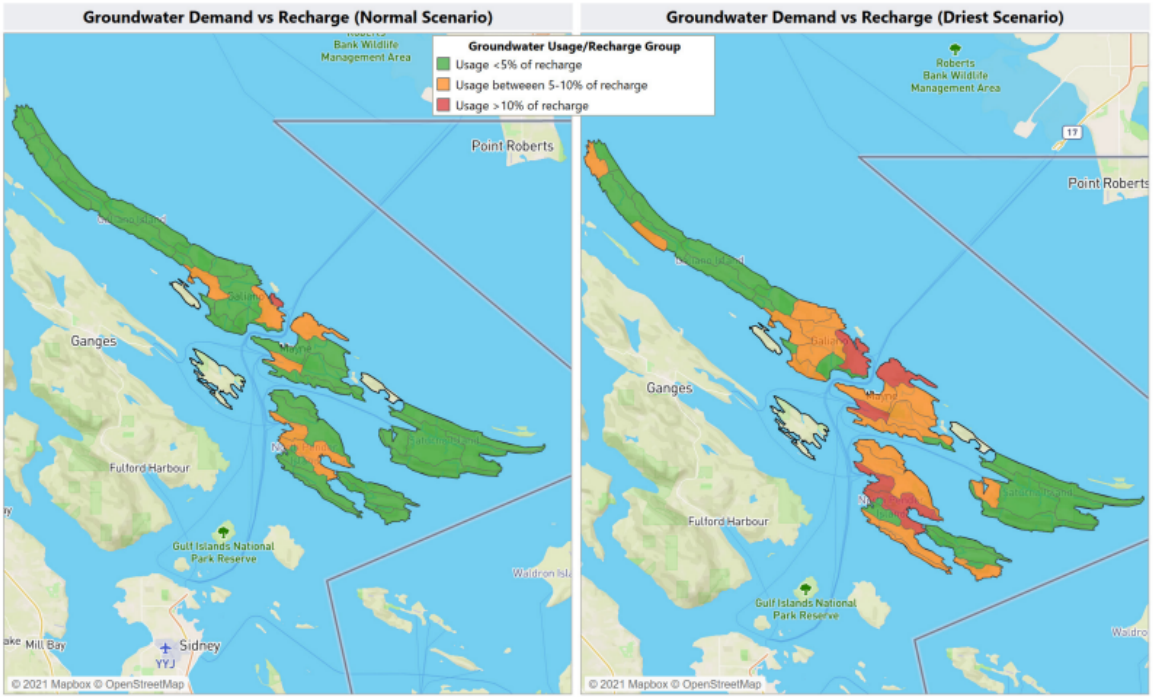


Figure 30. Groundwater recharge and groundwater use per groundwater region (normal and driest scenario) [36]

[36] GW Solutions. (2021). Islands Trust Area Groundwater Availability Assessment. https://islandstrust.bc.ca/document/southern-gulf-islands-groundwater-availability-assessment-report-ver-2021/

Reducing Reliance on Groundwater

In our Community Mail-Out Survey, 93% of households stated that a groundwater or surface water well was their primary water source, while the remaining 7% reported getting their water from rainwater harvesting or by purchasing bottled water. 20 households out of 126 indicated that their well has at one point either run out of water or gotten "extremely low."

The Galiano Island community has already started taking steps to reduce its reliance on groundwater by harvesting rainwater and/or installing water-reducing appliances. Many gardeners on Galiano Island are keenly aware of the high water demands of non-native garden plants, and many practice rainwater collection to supply at least part of their irrigation needs. Neighbouring islands such as Salt Spring have also identified water availability to be a serious issue[37] and are currently offering rebates for rainwater harvesting infrastructure.[38]

Table 4. Use of additional water conservation practices reported by participating households.

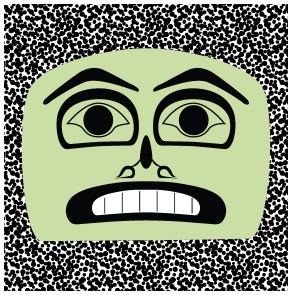
Water Reducing Practices	Survey Responses
Cistern or Water Storage Tanks	39%
Greywater system	18%
Rain Barrels	52%
Dual system toilets	17%
Composting toilets	14%

The Galiano Conservancy Association provides resources to help island residents reduce their reliance on groundwater: for more information, visit www.galianoconservancy.ca/water.

[37] Transition Salt Spring. (2021). *Climate action Plan 2020 to 2030.* https://transitionsaltspring.com/wp-content/uploads/2021/01/1.-CAP-2.0-COMPLETE-WEB.pdf

[38] See https://transitionsaltspring.com/cac-rainwater-harvesting/#:~:text=Applicants%20can%20receive%20%24250%20for,volume%20held%20meets%20the%20requirements.

One Planet Scenario



Overview

CHRM Consulting and the BCIT Centre of EcoCities provided us with a reduction scenario that examines one potential pathway to reducing the Galiano Island community's footprint to a level that is sustainable and equitable from a global perspective. It is an example of what it might take to **collectively reduce the impacts of the entire Galiano Island community to less than 1.4 gha/ca** (i.e., if everyone on the planet had an equal impact and equal share of the remaining Biocapacity, and a tiny amount was left over for wild nature). A **Sustainability Gap** of 63% of the current footprint must be addressed to achieve "**One Planet Living**." As extreme as this scenario might appear to many community members, further emissions reduction activities would likely be needed to meet climate stabilization goals. This scenario focuses on **reducing components of the Galiano Island community's Ecological Footprint that are responsive to community-led actions**. The actual reductions would need to be greater to account for **senior government services.** See Part V of this report for our recommendations.

Table 5. Reductions need to reach a One Planet Scenario.

Reduction Measures	**EF Reduction (gha)**	**GHG Reduction (tCO_2e)**
Food • 80% reduction of food waste	1,520	1,830
Buildings & Stationary Energy • 85% reduction in residential developed area, 50% in commercial/institutional • 100% conversion to renewable energy	1,640	1,320
Consumables & waste • 50% reduction of municipal solid waste (MSW) through reduced consumption and improved circularity (sharing, repair, reuse) • 50% reduction in septic system emissions	340	1,180
Transportation • 80% reduction in non-paved roads • 50% decrease in vehicle fleet • 100% conversion to electric vehicles, ferries, and personal watercraft • 80% reduction in air travel	3,840	13,330
Total Reduction	**7,340**	**17,660**

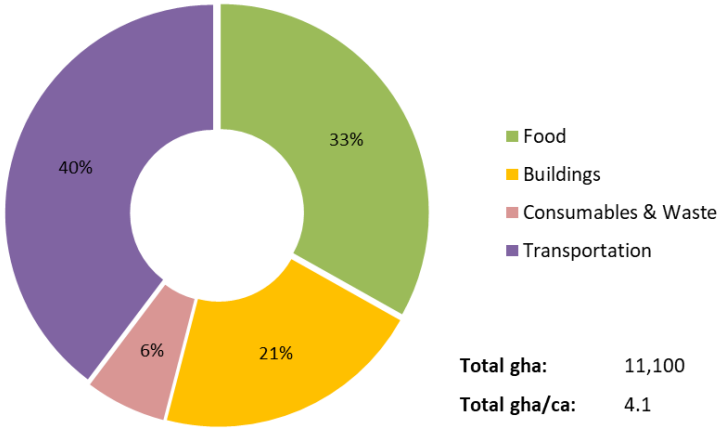


Figure 31. Galiano's Baseline Footprint Summary, 2021

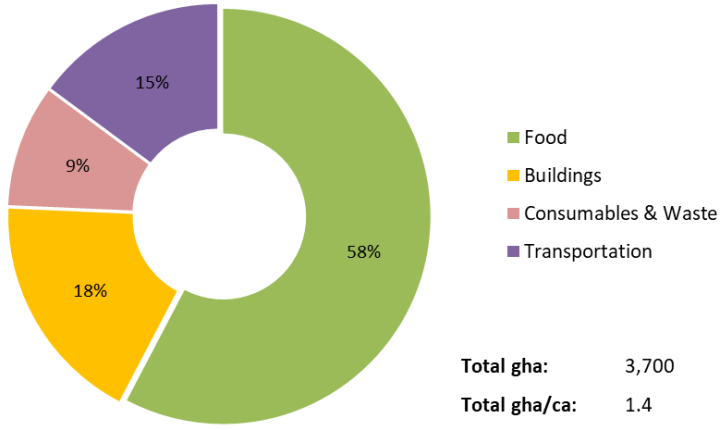


Figure 33. Galiano's One Planet Scenario Summary, 2021

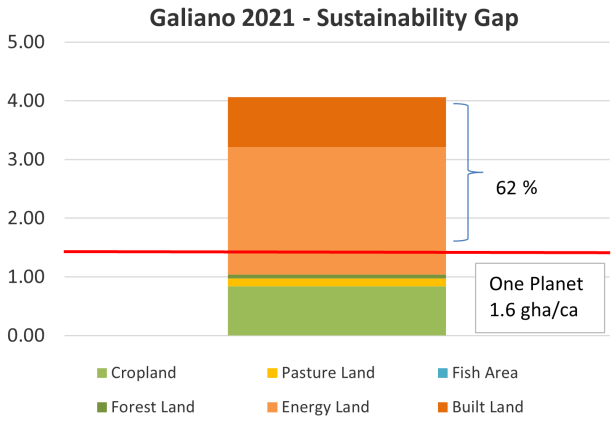


Figure 32. Galiano's Baseline Footprint Sustainability Gap, 2021

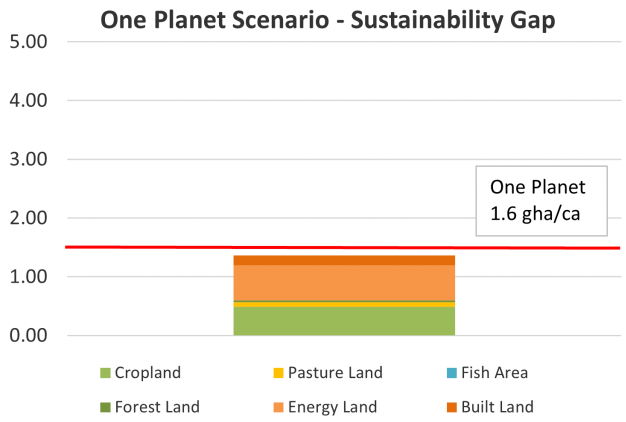


Figure 34. Galiano's One Planet Scenario Sustainability Gap, 2021

Emissions Reductions

A Matter of Degrees

The **One Planet Scenario** calls for a **66% reduction in the Ecological Footprint** and a **72% reduction in greenhouse gas emissions** attributable to the Galiano Island community. If projected to the year 2030, this target exceeds the current 2030 targets set by Canada (40% reduction from 2005 levels), the Capital Regional District (50% reduction from 2007 levels), and Transition Salt Spring (50% reduction by 2030).[39] In reality, however, **any emissions reductions that can feasibly be achieved must be attempted** across every human community if the goal is to minimize the probability of exceeding 1.5 ℃ at a planetary scale. This is because, even if achieved, the international commitments made during and since the **2015 Paris Climate Accords do not themselves provide reasonable assurance of meeting the 1.5 ℃ threshold**,[40] and - like many countries - Canada appears at the time of writing not to be on track to meet its commitments.[41]

Putting targets and probabilities aside, every ton of greenhouse gas that is prevented from entering the atmosphere mitigates against the existential threat posed by the **Climate Crisis**. While it is undesirable (and impossible) to reduce the human Ecological Footprint to zero, it *is* desirable and **essential to achieve net-zero emissions as soon as possible**. On Galiano Island, this means virtually eliminating emissions from the transportation sector, reducing food and consumer waste, electrifying home heating, and reducing septic field emissions.

Oil and Gas

According to the national inventory for 2020, the **oil and gas sector is responsible for a stunning 27% of all territorial emissions in Canada**.[42] While the majority of this report considers opportunities for the Galiano Island community to directly reduce its own footprint and emissions, we must observe that ongoing oil and gas development elsewhere in Canada cannot credibly be shown to be compatible with a livable future below the 1.5 ℃ threshold. We pause here to express gratitude to members of the Galiano Island community who are involved in efforts - whether grassroots, Indigenous-led, or institutional - to prevent further exploitation of fossil fuel resources in this country, and to emphasize that these efforts must be successful in order to meet international (and local) targets.

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[39] Transition Salt Spring. (2021). *Climate Action Plan 2020-2030*. Retrieved March 25, 2022 from https://transitionsaltspring.com/wp-content/uploads/2021/01/1.-CAP-2.0-COMPLETE-WEB.pdf

[40] R. Mackie (Personal communication. May 25, 2022).

[41] Labbe, S. (2022, May 24). *Canada's emissions plan 128 megatonnes short of 1.5 C target, says report*. Victoria Times Colonist. Retrieved May 25, 2022, from https://www.timescolonist.com/highlights/canadas-emissions-plan-128-megatonnes-short-of-15-c-target-says-report-5401327

[42] Environment and Climate Change Canada. (2022). *Canadian Environmental Sustainability Indicators: Greenhouse gas emissions*. Retrieved May 25, 2022, from www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gasemissions.html

Limitations

Survey Results

Survey results are generally considered statistically significant when 10% or more of the population has been represented.[43] We discussed using proxies from other sources in specific circumstances where survey representation was less than 10% of the island population, but concluded that using local data with lower representation was still the best method to get a snapshot of local consumption patterns.

Table 6. Survey representation

Survey Type	Participation	Galiano Representation
Community Mail-Out Survey	135 Households (282 People)	20%
Food Diary	43 Households (88 People)	6%
Waste Tracker	41 Households (91 People)	7%
Odometer Survey	62 Vehicles	7%

It is possible that participants in our surveys were more "environmentally conscious" than the general Galiano population, as all surveys were opt-in. This may have affected our data.

Data was collected during the COVID-19 pandemic in 2021, with pandemic-related restrictions in effect throughout much of the year. This may also have affected the data (e.g. part-time resident reported length of stay). When appropriate, survey questions were framed "In a non-covid year" (e.g. flights).

Ecological Footprint

Data for the Ecological footprint came from various sources. Some data was collected at the community level ("bottom-up") and other data sets were provided from private entities and governments ("top-down"). This can make comparability between datasets difficult. We did our best to seek out other sources to double check the accuracy and scalability of our data. Most dataset were from between 2019 - 2021, although in some cases data from 2018, and 2017 were used.

The ecoCity Footprint Tool's methodology is geared towards urban centres. We worked with BCIT to adapt the methodology to accommodate data from a small, rural island community (e.g. including small-scale food production, hunting, wood stoves, ferry dependency, etc.), but in some of these areas solid data to evaluate the impacts of rural activities is not currently available.

[43] Dattalo, A. (2008). *Determining Sample Size: Balancing Power, Precision, and Practicality*. Oxford Scholarship Online

Methane, a potent greenhouse gas, is not considered in the Ecological Footprint but is considered in the GHG Emissions Inventory.

We also asked CHRM Consulting and the BCIT Centre for Ecocities to present an Ecological Footprint analysis that only considers the footprint of full-time island residents, and this assessment is included in their report. We chose not to reproduce it here because we feel that it is essential to include for the on-island footprint of visitors and seasonal residents, who we estimate account for roughly half of the person-days spent on Galiano Island, and who play a significant role underwriting the local economy.[44] This choice nearly doubles the total footprint, and affects all of the values expressed on a per-capita basis in this report. It is also likely that, since our estimate of 80,000 tourists comes from a 2007 report, we have underestimated the true contribution of the full-time equivalent seasonal resident population to the footprint.

Comparing Biocapacity to Ecological Footprint at a *local scale* should be done with caution. The Ecological Footprint methodology considers planet Earth to be a closed system for all intents and purposes, but nearly every geographically distinct community in the world is now enmeshed in a global economy that has, to greater or lesser degrees, distanced it from direct reliance on the bioproductivity of its immediate environment. The Galiano Island community simply would not exist as it currently does in the absence of regional and global supply chains providing for most of its fundamental needs.

This project is a first attempt at generating an Ecological Footprint for a small island community in North America. It was an experiment, and like all experiments it revealed lessons both through the results and through the process of generating them. Future assessments along these lines should consider how to better account for and incorporate small-scale, non-industrial production practices, infrastructure, and lifeways into footprint frameworks. Freshwater availability is also an important element of sustainability that appears to fall outside of the scope of existing Ecological Footprint methodologies.

[44] In the same way, we would not consider an Ecological Footprint analysis for the city of Fort McMurray in Alberta to be credible if it failed to account for at least a portion of the footprint of the dominant industry in the community.

Glossary

Key Terms

Biocapacity - Biocapacity represents the productive potential of an area's biologically productive land and water surface; in other words, the capacity for ecosystems to regenerate plant matter. Biocapacity is measured in global hectares (gha).

BCIT Centre for Ecocities - An arm of the British Columbia Institute of Technology with the mission "to help cities and communities close their sustainability gap."

Tonnes of Carbon Dioxide Equivalent (tCO_2e) - Carbon Dioxide Equivalence expresses the impact of each different greenhouse gas in terms of the amount of CO_2 that would create the same amount of warming when released into the atmosphere. This enables reporting total greenhouse gas emissions with one measurement.

Carbon Sequestration - A natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.

Carrying Capacity - The number of people, animals, or crops which a region can support without environmental degradation.

Climate Crisis - Refers to the planetary threat posed by continued anthropogenic emissions of greenhouse gases into the atmosphere; the term has come to replace 'climate change' and 'global warming' in discourses concerning global climate.

Consumption-based Emissions Inventory (CBEI) - A form of greenhouse gas emissions inventory that enables a region to quantify the emissions that are attributable to activities of individuals that reside within that region. CBEIs do not replace traditional 'territorial' inventories (see below), but rather they are complementary to them. CBEIs include the emissions that are generated during the production, shipping, use and disposal of all goods consumed in the region, regardless of where they are produced, as well as the impacts of residents and local businesses while they are travelling outside the community's borders.

ecoCity Footprint Tool - A tool developed by Dr. Jennie Moore, with the capacity to create multiple outputs for a community using "bottom-up" data sets: a territorial greenhouse gas emissions inventory, a consumption-based greenhouse gas emissions inventory, and an ecological footprint. See ecocityfootprint.org

Ecological Fingerprint - An evaluation of the particular attitude, self-image and intrinsic values a community adopts with respect to global resource use.

Ecological Footprint - An estimate of how much biologically productive land and water area an individual or population needs to produce all the resources it consumes and to absorb the waste it generates; in other words, the area that would be required to support a defined human population and material standard indefinitely. It is measured in global hectares (gha), where a global hectare is a biologically productive hectare with globally averaged productivity for that year.

Ecosystem Services - The direct and indirect contributions of ecosystems to human well-being. Ecosystems services including provisioning, regulating, supporting, and cultural values.

Embodied Energy - Energy used in creating and delivering a material (e.g., consumable good or infrastructure), including energy used for extraction of raw materials, manufacturing and transportation of the end product.

Embodied Emissions - Greenhouse gas emissions associated with creating and delivering a material (e.g., consumable goods or infrastructure), including those associated with energy used for extraction of raw materials, manufacturing and transportation of the end product.

Exclusive Economic Zone (EEZ) - The area of the sea in which a given nation state asserts special rights regarding the exploration and use of marine resources. In Canada, the EEZ extends 370 kilometers offshore.

Food Miles - The distance food travels from where it is grown or made to where it is purchased or consumed by the end user.

Global Hectares (gha) - A global hectare (gha) is a unit of biocapacity, representing the productivity of a bioproductive hectare on earth with average productivity. There are just over 12 billion biologically productive hectares on Earth. Global hectares are often expressed in terms of global hectares per capita (gha/ca).

Global Footprint Network - An international nonprofit organization founded in 2003 with a mission "to help end ecological overshoot by making ecological limits central to decision-making."

Islands Trust - The Islands Trust is a special purpose government mandated to preserve and protect over 450 Islands in the Salish Sea. The Province of British Columbia created the Islands Trust in 1974 in response to the potential environmental effects of dense residential subdivisions that were in development in the Gulf Islands. The mandate of the Island Trust is "to preserve and protect the Trust Area and its unique amenities and environment for the benefit of the residents of the Trust Area and of British Columbia in cooperation with municipalities, regional districts, improvement districts, First Nations, other persons and organizations and the government of British Columbia."

Net Primary Production - The difference between the energy fixed by autotrophs and their respiration; most commonly equated to increments in biomass per unit of land surface and time.

One Planet Living - A lifestyle that, if adopted by everyone, could be supported indefinitely by the regenerative capacity of Earth's ecosystems.

Operating Energy - The energy used in the function of a product, building, vehicle, etc.

Operating Emissions - The greenhouse gas emissions associated with operating energy.

Overshoot - Global overshoot occurs when humanity's demand on nature exceeds the biosphere's regenerative capacity or supply. Such overshoot leads to a depletion of Earth's life-supporting natural capital, including the buildup of waste such as ocean acidification from excessive CO_2 or climate change from greenhouse gas accumulation in the atmosphere.

Rockfish Conservation Areas - Areas designated by Fisheries and Oceans Canada where any fishing activities that impact on rockfish, lingcod, or their habitat (including activities resulting in bycatch of these species) are prohibited.

Senior Government Services - Services provided by Federal and Provincial governments to the citizenry; in Canada, this includes military, health care, administrative, and other high-level services that aren't accounted for at the local level.

Sustainability Gap - The difference between the estimated Ecological Footprint of a population and the Ecological Footprint that would achieve "One Planet Living" (see above).

Territorial Emissions Inventory - Also known as a Sectoral Inventory, a territorial inventory identifies direct greenhouse gas (GHG) emissions from all sources within a region. This is the standard type of GHG emissions inventory compiled by local, regional, provincial and federal governments.
A standardized approach to territorial inventories is prescribed by the GPC (Global Protocol for Community-Scale Greenhouse Gas Emissions Protocol).

Two-eyed seeing - According to Mi'kmaw Elder Albert Marshall: " to see from one eye with the strengths of Indigenous ways of knowing, and to see from the other eye with the strengths of Western ways of knowing, and to use both of these eyes together

Acronyms

BCIT - British Columbia Institute of Technology

CBEI - Consumption-based Emissions Inventory

CRD - Capital Regional District

CSPGS - Coast Salish Peoples of Galiano Society

CO_2/Co_2e - Carbon dioxide/Carbon dioxide equivalent

EF - Ecological Footprint

eF Tool - ecoCity Footprint Tool

EEZ - Exclusive Economic Zone

GCA - Galiano Conservancy Association

GFN - Global Footprint Network

gha - Global Hectares

gha/ca - Global Hectares per Capita (person)

ghg - Greenhouse Gas

GIRR - Galiano Island Recycling Resources

GPC - Global Protocol for Community-Scale Greenhouse Gas Emissions Protocol

ICBC - Insurance Corporation of British Columbia

MSW - Municipal Solid Waste

NPP - Net Primary Production

RCA - RockFish Conservation Area

SSREC - Salish Sea Renewable Energy Co-op