UBC Social Ecological Economic Development Studies (SEEDS) Student Report

# Assessing the Sustainability of the UBC Campus

**Katherine Cheng, Ina Gershtein, Sarah Hewko, Katie Martinolich, Kirsten Pinkerton, Jana Sivapatham, Jenny Su**

**University of British Columbia**

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**Group 18**
Katherine Cheng
Ina Gershtein
Sarah Hewko
Katie Martinolich
Kirsten Pinkerton
Jana Sivapatham
Jenny Su

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## Executive Summary

The UBC food system is a microcosm of the greater global food system, reflecting the way in which food is often processed, transported, viewed, purchased, eaten, and how wastes are handled on a global scale. The group has developed a tool by which sustainability of the UBC campus may be periodically assessed. Six indicators have been selected from three categories: ecological, social, and economic. Each indicator is described in terms of importance and measurability. The selected indicators include recycling, composting, ecological footprint, food miles, nutrition, and food affordability. It is hoped that the tool will be useful to future sustainability researchers on UBC campus, in particular the UBC Sustainability Office, which is continuously working towards the goal of improving campus sustainability.

## Introduction

Having been asked to develop a model with which future researchers at UBC may evaluate the overall sustainability of the UBC campus, we, the members of Group 18, asked ourselves just what it is that makes a system sustainable. The term sustainability has as many different definitions; the Bruntland Commission defined "sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'" At a conference attended by a variety of individuals from the alternative farm/food community, it was determined that the "participants envisioned a sustainable food system as relational, proximate, diverse, ecologically sustainable, economically sustaining, just/ethical, sacred, knowledgeable/communicative, seasonal/temporal, healthful, participatory, culturally nourishing, and sustainably regulated" (Francis *et al*, 2001).

The UBC food system is a microcosm of the greater global food system, reflecting the way in which food is often processed, transported, viewed, purchased, eaten, and how waste is handled on a global scale. Food and the Earth's resources are increasing viewed as nothing more than a commodity. Our separation from food in time, space and mind disconnects our cultural and historical relationships with food and effects our food security, through a decrease in knowledge and awareness of where our food is from, what is in our food, and how to make healthy food choices (Francis *et al*, 2001). Furthermore, our ecological impact is increasing as our ability to consume resources and produce waste outstrips the carrying capacity of the Earth (Wackernagel, 1994). Thus, based on our definition of the problem in the UBC food system, the indicators of sustainability that we have chosen to include in our model fall into three categories: ecological, economic, and social. The list of indicators that could be used to assess sustainability is lengthy; as a group we selected six that we feel would be representative of the overall sustainability of the campus food system. The model we propose is very flexible in that the relative weighting of indicators and the number of indicators used can be changed according to the values and needs of the individuals using the model.

We have chosen a scale from 1-7, with 1 being unsustainable and 7 being sustainable. The specific indicators we have chosen are:

Ecological – recycling, composting, ecological/food footprint, food miles

Social – nutritional composition, food miles

Economic - affordability

Our group felt that ecological indicators are the most powerful indicators of sustainability, but that social and economic indicators are more likely to change the behaviour of individuals, because they may be promoted for the sake of immediate self-interest. For example, nutrition and affordability are very relevant in the day to day physical and financial health of individuals. As students, we are particularly susceptible to financial concerns.

Below, we have described each indicator in detail. Each section describes the rationale behind the selection of the indicator, suggestions for evaluating the indicator, and specific criteria, which can be used to place UBC on the scale.

**Value Assumptions**

Our group took a community-biocentric approach in choosing indicators to assess the sustainability of UBC's food system. Because humans, in every way, can effect the move away from or towards sustainability, by perpetuating unsustainable practices or by implementing more sustainable ones, some of our indicators, such as ensuring healthy food choices and improving food affordability, reflects a weak anthropocentric view. We believe that the UBC community should have access to affordable and nutritious foods, as part of food security for UBC. We also believe that students are often forced to choose foods based on price. Any practice that seeks to improve sustainability must therefore be economically viable, such that students may fully participate in efforts to increase sustainability at UBC.

However, the overriding belief of our group is that food should be a part of a community's cultural, social, and historical identity. Food should be connected to a place, and a community should have a sense of reciprocity and responsibility for the land it relies on for food and the necessities of life. This is reflected in our choice of indicators, such as food miles, recycling, composting, and the Ecological Food Print, and on our emphasis on ecological indicators. However, some group members felt that social and economic indicators should not be given less weight than the ecological indicators. Thus, each category of indicators, social, ecological, and economic, would be given equal weight. This arose through our different perspectives and backgrounds in animal science, global resources, food science, and dietetics. Our group resolved this issue by giving each individual indicator, such as recycling, food affordability and so on, equal weight to reflecting our community-biocentric approach[redacted]

## Ecological Indicators

### *Recycling*

Sustainability is to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (Iverson & Cornett, 1994). Recycling is the process of collecting, processing, and reusing used or waste materials. Recycling is an indicator of sustainability in that it reduces the amount of waste produced and therefore the burden on the Earth and future generations.

UBC generates approximately 12 tonnes and 2,900 tonnes of waste material daily and annually, which are exported and reallocated to landfills (UBC Sustainability Coordinator Program, 2002). The landfills are overflowing and as these buried waste materials decompose, environmentally hazardous materials are generated [redacted] Recyclable waste materials at UBC include paper, disposable containers, toner cartridges, ink-jet cartridges, batteries, polystyrene chips, chemicals, office furniture, and wood and metal (UBC Waste Management, 2003).

Materials that should be recycled are ending up in landfills. In 2001, UBC used 106 million sheets of paper. (UBC Sustainability Coordinator Program, 2002). At UBC Food Service outlets, up to 40% of the waste materials produced is composed of disposable plates and cups (WasteFree UBC, 2002). Toner and ink-jet cartridges require 1,000 years to decompose. However, 12,000 tonnes of empty ink-jet cartridges were sent to landfills; and only 15% of used cartridges are recycled in 2002 (UBC Sustainability Coordinator Program, 2002). Furthermore, the decomposition of buried waste materials generates environmentally hazardous materials. For example, 20% of materials in batteries are hazardous; one of the primary hazardous materials is mercury. When mercury and other toxins are released into the environment they affect the balance of the ecosystem and the food chain (UBC Sustainability Coordinator Program, 2002). With recycling, we can save natural resources, conserve energy, and reduce the amount of harmful by-products being generated during decomposition.

The UBC Waste Management Office has programs and campaigns that are aimed at increasing the percentage of recycled materials each year since the late 1980's. The 50% per capita waste reduction target established by the Provincial Government has been achieved (UBC Waste Management, 2002). Each year UBC recycles approximately 850 tonnes of office paper, 450 tonnes of cardboard, 65 tonnes of containers, and 14 tonnes of florescent lights (UBC Waste Management, 2002). UBC Waste Management offers a blue bin recycling program that recycles paper products, cans and bottles and collects toner and ink-jet cartridges monthly (UBC Waste Management, 2003). The Department of Health, Safety and the Environment collects batteries and chemicals and the Surplus Equipment Recycling Facility collects office furniture, equipment and other items (UBC Waste Management, 2002).

We propose that an indicator of the sustainability of the UBC food system is a measure of the fraction of waste being recycled to the total amount of the waste generated. Therefore, the percentage of waste that has been recycled equals the amount of recycled materials/ total amount of recyclable waste materials

***In general or specifically food waste?***

To assess the percentage of waste that has been recycled, a scale that scores from 1 to 7 is used.

1- No recyclable materials are recycled
2- 0-14% of recyclable materials are recycled
3- 15-28% of recyclable materials are recycled
4- 29-57% of recyclable materials are recycled
5- 58-71% of recyclable materials are recycled
6- 72-86 % of recyclable materials are recycled
7- 87-100 % of recyclable materials are recycled

***Composting***

Composting is a process where organic matter is turned into humus through microbial degradation (Compost Council of Canada, 2003). It is a very important process in nature that is used to recycle nutrients after they have been incorporated into an organism or as waste products (Compost Council of Canada, 2003). Once these organic materials are decomposed, the leftover material makes an excellent fertilizer which can be used in gardens and places where commercial fertilizers would normally be used (UBC Waste Management, 2002). Compost has more benefits than commercial fertilizers, because organic matter in humus is very important for soil structure and all of the organisms that live and grow in the soil (Heimlich *et al*, 1999).

There are many other reasons to compost besides using the compost to improve soil conditions. Compostable materials make up a large portion of the garbage in our landfills. When these materials are recycled instead of dumped in the landfill, fewer harmful emissions are created (UBC Waste Management, 2002), and less garbage is exported to landfills.

Compost also releases emissions, as the microbes break down the organic matter; methane, a very potent green house gas, is produced. This emission can be positive when processed in a large composting facility; this offers an opportunity to collect methane emissions and use this gas as a fuel source that can be burned to power generators (UBC Waste Management, 2002).

There are many different materials that can be composted such as "food waste, animal bedding, animal waste, wood, yard waste," sawdust and ash (UBC Waste Management, 2002). These products currently make up approximately 70% of the waste produced at UBC (UBC Waste Management, 2002).

Composting is an excellent ecological indicator for sustainability at UBC; it is beneficial to soil, plant, and animal life. Large scale composting in an enclosed facility can also increase the ecological sustainability at UBC because it provides a method for UBC to reduce the green house gas emissions from campus by collecting and using the gas produced. It is a practical indicator because the amount of compostable waste produced on campus and the amount of this waste composted is easily measured.

We recommend that this indicator be measured on a scale of one to seven, where one is completely unsustainable and seven is completely sustainable.

1 – No wastes produced at UBC are composted
2 – 1-20% of compostable wastes produced at UBC are composted
3 – 21-40% of compostable wastes produced at UBC are composted
4 – 41-60% of compostable wastes produced at UBC are composted
5 – 61-80% of compostable wastes produced at UBC are composted
6 – 81-100% of compostable wastes produced at UBC are composted
7 – 81-100% of compostable wastes produced at UBC are composted plus, the methane emissions are being collected and used as a biogas

***Ecological Footprint***

The Ecological Footprint measures the load imposed by an individual, community, population, or country on the Earth through its resource consumption and subsequent waste production (Wackernagel, 1994). The Ecological Footprint indicates of the amount of land that would be required to support our current lifestyle forever. Because people rely on nature for resources such as food and clean water, we must ensure that nature's productivity and renewal systems are not outpaced by our utilization of resources and generation of waste (Wackernagel, 1994). As a result, the Ecological Footprint may not only increase our awareness of the current level of sustainability, but it may also demonstrate how and what we may do in order to decrease our impact on nature by examining the choices we make (Wackernagel, 1994).

The Ecological Footprint also illuminates issues of equity (Wackernagel, 1997). It "reveals the extent to which wealthy people and countries have already 'appropriated' the productive capacity of the biosphere" (Wackernagel, 1997). According to studies, wealthy nations consume ¾ of all the world's resources and occupy a footprint as large as the entire biological capacity of Earth (Wackernagel, 1997). With a growing population, it becomes less likely that a reasonable quality of life may be secured for everyone (Wackernagel, 1997).

Based on the principles of the ecological footprint, a 'food footprint' may be calculated to determine the sustainability of UBC's food system. The Ecological Footprint is expressed in hectares (or acres); it represents the biologically productive land area required to maintain resource and waste flows (Rees *et al*, 1999). A food footprint includes the area of land required to graze animals, fish, and grow food, as well as the energy necessary to process and transport the food. As a result, plant based diets are considered more ecologically sustainable because they require less land, energy, and resources. The typical plant based diet averages 0.78 global hectares per ton of food compared to an animal based diet, which averages 2.1 global hectares per ton of food (Rees *et al*, 1999).

The first step in determining an ecological footprint is to estimate the per capita land appropriated (aa) for the production of food, indicated by an 'i.' This is done by dividing the average annual consumption of food ['c,' in kg/capital] by the average annual productivity or yield ['p,' in kg/ha] per hectare to produce the equation $aa_i = c_i/p_i$ (Rees *et al*, 1999). The ecological footprint ($EF_p$) of food for UBC is the per capita footprint multiplied by population size (N): $EF_p = N(aa_i)$ (Rees *et al*, 1994). Direct fossil fuel energy consumption used in producing food is calculated by estimating the area of carbon-sink forest that would be required to sequester the carbon dioxide emissions associated with burning fossil fuels in order to process and transport food; it is calculated as: [carbon emissions/capital]/[assimilation rate/hectare] (Rees *et al*, 1994). Data on annual food consumption for both animal and plant based products at UBC, the distance food travels, and the population at UBC would be collected and analysed through available spreadsheets and calculators to determine the Ecological and Food Footprints of colleges and households; these may be found at:

www.bestfootforward.com and www.esb.utexas.edu/drnrm/WhatIs/ecofootprint.htm.

The ecological footprint of the average Canadian for energy consumption and agricultural land use for food production is 0.4 hectares per capita and 0.9 hectares per capita respectively, resulting in a total of 1.3 hectares per capita (Wackernagel, 1994). This value produces a footprint three times greater than what is sustainable for the Earth. In other words, 3 Earths would be required if every person ate like the average Canadian (Wackernagel, 1994).

We recommend that the food footprint indicator be measured on a scale of one to seven, where one is completely unsustainable and seven is completely sustainable.

1- Total food footprint greater than 1.3 hectares (ha)/capita.
2- Total food footprint between 1.09 ha/capita and 1.3 ha/capita.
3- Total food footprint between 0.88 ha/capita and 1.08 ha/capita.
4- Total food footprint between 0.66 ha/capita and 0.87 ha/capita.
5- Total food footprint between 0.43 ha/capita and 0.65 ha/capita.
6- Total food footprint less than 0.43 ha/capita.
7- Total food footprint less than 0.43 ha/capita plus an overall ecological footprint less than 1.6 ha/capita.

***Food Miles***

Only a couple decades ago, farmers produced food for their families and the surrounding communities. With the occurrence of the Green Revolution and globalization, our perception of food production has changed. Currently, crops produced locally are most likely exported out of the area. Many of these crops travel great distances to get to their final destinations. A food mile is the distance food travels from where it is grown or raised to where it is ultimately purchased by the consumer or end-user (Pirog, 2001). The distance that food travels before it reaches UBC consumers is an important indicator of both social and ecological sustainability.

UBC campus has cafeterias, snack bars, residence dining rooms, Sage Bistro, Mini-Marts, a Bread Garden, Subway Sandwiches, Starbucks Coffee kiosks (UBC Food Services, 1997), and many more varieties of food services; many of which serve ethnically diverse products. Having a variety of food choices means that most of the ingredients and produce are imported to the UBC campus from regional, national or international sources. In the past 30 years there has been a significant global increase in fossil fuel use, which has corresponded with the increased use of trucks to transport goods (Pirog, 2001). Prolonged traveling time of food also contributes to the production of green house gases (GHG), such as $CO_2$, and thus contributes to overall air pollution. The global consumption of fossil fuels is estimated to release 22 billion tones of carbon dioxide ($CO_2$) into the atmosphere every year (Government of Canada, 2002).

Despite the fact that fossil fuels are a non-renewable source of energy, they currently supply about 85% of the world's total energy (Lal, 2001). Increased distance and travelling time for food products decreases the efficiency of energy use; it requires less energy consumption to transport foods that are produced locally. The longer food travels to get to UBC, the more unsustainable the food system.

In a study conducted by Iowa State University, it was estimated that the average food product produced by farmers and sold to institutional markets, such as local hospitals and restaurants, traveled an average of 44.6 miles to reach its destination; this was then compared with an estimated 1,546 miles for food items that arrived from conventional national sources (Pirog, 2001). In order to assess whether the UBC food system is ecologically sustainable, the food mileage may be used as an indicator and may be measured on a scale of 1 to 7. Assuming that, on average, food will travel similar distances as determined in the study above, 1 will represent a food system where all food is imported to campus from outside Canada, and "7" will represent a food system where all of the food is produced locally [redacted]

1- Food mileage is more than 2,544. All food imported from outside the continent.
2- Food mileage is 2,044-2,544 miles. Most food imported from North America.
3- Food mileage is 1,544-2,044 miles. Most food imported from other provinces.
4- Food mileage is 1,044-1,544 miles. Most food imported from BC.
5- Food mileage is 544-1044 miles. Most food imported from the Lower Mainland.
6- Food mileage is 44-544 miles. All food imported from the city of Vancouver.
7- Food mileage is less than 44 miles. All food imported produced on campus.

Food miles may be estimated by using a weighted average source distance (WASD) (Carlsson-Kanyama, 1997). WASD combines information on distances from producers to consumers and the amount of food product transported. The formula for WASD is :

*WASD = $\sum (m(k) \times d(k)) / \sum m(k)$

m- amount consumed from each location of consumption origin,
k- different locations of the production origin,
d- distances form the locations of production origin to the point of consumption.

* formula adapted form Pirog, (2001). . [redacted]

Food mileage is also an indicator for social sustainability. Since travelling time can be lengthy, the produce will not be as fresh and nutritious on arrival as produce that was produced locally. The shelf life of these produce are often significantly reduced. Because consumers get their food from other countries, they have little connection with the food production process (Pirog, 2001). Reducing food miles will decrease the "distance in mind," psychological detachment from sources of food (Francis *et al*, 2001), as more food will be produced and consumed locally

[redacted]

**Social Indicator**

***Nutrition***

Clearly, the focus of the UBC campus food system is its consumers; the students, faculty, support staff and visitors that rely on the food offered at campus facilities. The system exists to provide these people with the energy and nutrients that allow them to work and to learn effectively. A healthy balanced diet is important in reducing the risk of many chronic diseases and health problems later in life, such as cardiovascular disease and diabetes (Sizer *et al*, 1997). Therefore, the nutritional quality of food provided on campus is a key indicator of the health of the UBC community, and the overall social sustainability of the system.

The nutritional integrity of the campus food system most strongly affects the many students who live in residences on campus and rely on cafeteria meal plans for all of their meals. However, it is also important for all of the thousands of people that buy, or wish to buy, food from any of the Snack Bars, Residence Dining Rooms, Sage Bistro, Mini Marts, Bread Garden, SUBWAY Sandwiches, Starbucks Coffee Kiosks, Catering Services, AMS venues, and private food providers on campus every day. The ability of students and other consumers to make positive and balanced personal food choices depends on what is made available at these venues. Therefore, in order for the campus population to have the opportunity to eat a balanced diet, the composition of foods offered on campus must be balanced accordingly.

As an indicator of the nutritional quality of this food selection, we have chosen to use the National Research Council (NRC)'s R*ecommended Dietary Allowances* (NRC, 1989) of protein, fat, and carbohydrates for healthy people. The council recommends that an average person's intake of these macronutrients make up 15%, 30%, and 55% of their total caloric intake respectively (NRC, 1989). Of course, these measures do not *specifically* reflect fibre content of the food or their content of important vitamins or minerals. However, this macronutrient variety remains a good indicator of overall nutritional value; when these measures are in balance, all other nutrients are more likely to be in balance (Gardner *et al*, 2000). Therefore, to make the analysis of nutrition a feasible part of our sustainability study on campus, we propose that the UBC Food

System be assessed according to the ideal that it provide a selection of food made up of 15% protein calories, 30% fat calories, and 55% carbohydrate calories.

Depending on the resources available, the study of this indicator may be comprehensive by measuring the total quantity of food offered in all facilities in a given day, or it could be less comprehensive through random sampling of foodstuffs purchased by consumers across food service locations and weighted according to the relative importance of those locations with respect to the quantity of food they supply. Practically, the nutrient contents of the foods studied could be measured using existing databases, such as the Nutrient Value of Some Common Foods document put out by the Government of Canada or by precise studies in laboratories on campus. Pre-packaged foods may be easily analyzed using their nutritional content labels, which directly state the fat, protein, and carbohydrate contents.

In order to apply the gathered data to our 1 to 7 scale of sustainability, we propose that the actual calorie ratios of the three macronutrients in campus food be compared to the recommended NRC ratios, and the total deviance between the values recorded. For example, if the average fat calories in campus food are found to represent 44% of total calories, we observe a 14% deviance from the 30% recommended value. The three deviance values, for fat, protein, and carbohydrates are then summed to obtain a total deviance value. To continue our example, if carbohydrate calories were found to be 46% and protein 10%, than the total deviance value would be 28%. We then match this value to the appropriate sustainability rating according to the following scale, where a perfect sustainability rating of 7 represents zero deviance, and a sustainability rating of 1 represents 170%, the highest possible deviance. ([redacted]

1- 147-170 % deviance from NRC macronutrient ratios
2- 118-146 % deviance from NRC macronutrient ratios
3- 88-117 % deviance from NRC macronutrient ratios
4- 59-87 % deviance from NRC macronutrient ratios
5- 30-58 % deviance from NRC macronutrient ratios
6- 29-57 % deviance from NRC macronutrient ratios
7- 0-28 % deviance from NRC macronutrient ratios

**<u>Economic Indicator</u>**

***Food Affordability***

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Agriculture Canada, 1999). Food affordability contributes to food security by allowing people to readily access sufficient, safe, and nutritious food. When the food is too expensive it leads to food insecurity because not everyone has access to it (Dietitian's of Canada, 2002). A situation of food insecurity is in turn a symptom of an economically unsustainable system.

Affordability of food is of great importance to UBC students, since most have a limited amount of disposable income. For instance, a full time student who is on student loan receives about $840.00 of monthly allowance. Out of this total monthly allowance, exactly $176 is allocated for food (Ministry Advanced Education, 2002). This value falls short of the amount calculated for a monthly Healthy Food Basket, which states that a person between the ages of 19-24 requires approximately $197.92 a month for food (Dietitian's of Canada, 2002).

One way to measure food affordability on the UBC campus is to measure the amount spent on food by a student who lives in residence when he/ she completely depends on UBC food providers. To accurately assess this indicator a study should be done to assess the affordability of foods sold on various UBC food services outlets. With adequate resources, this assessment could be very comprehensive; by randomly collecting 3 meals per day from various food outlets and residence cafeterias on campus, a reasonable estimate of average cost can be determined. This amount can then be used to estimate the monthly cost of eating exclusively at UBC. This value can then be calculated as a percentage of the overall average student income ($840.00 for those with student loans). For instance, Meal "Plan A", which caters to students who eat at residence dinning halls or on campus six to seven days a week, costs approximately $396.00 monthly. This amount deviates too far away from the allocated food allowance of $176.00 by the student loan services (Ministry of Advanced Education, 2002). If we use $396.00 to calculate the percentage of the overall average student income devoted to food, this would translate into 46% of a student's income spent on food purchases. The average BC resident spends approximately 10% of their monthly income on food while low-income residents of BC spend nearly 30% (Dietitian's of Canada, 2002). Thus, a sustainable food system is measured at 1, where students spend less than 5% of their income on food, and increases in a range of 7, which is unsustainable because students are required to spent more than 30% of their income on food. . [redacted]

1 $\geq$ 30% of income spent on food
2 $\leq$ 26-30% of income spent on food
3 $\leq$ 21-25% of income spent on food
4 $\leq$ 16-20% of income spent on food
5 $\leq$ 11-15% of income spent on food
6 $\leq$ 6-10% of income spent on food
7 $\leq$ 0-5% of income spent on food

## Conclusion

Finally, we apply the sustainability point values for each of our indicators: food miles, nutrition, affordability, ecological footprint, recycling and composting, to a calculation of overall food system sustainability. To begin, each indicator is assigned a weight, reflecting its relative importance to the system's sustainability. This weight is, of course, arbitrary, and is dependent on the value judgments of whoever performs the study. Our group, as discussed earlier, has chosen to give equal weight to each of the indicators, reflecting a greater importance for ecological factors, which are represented by at least three of the indicators, than for social or economic factors, which are each represented in only one or two. Thus, our model currently shows an equal value multiplier of 0.167 for each of our 7 indicators. (0.167 * 7 = 1) The score for each indicator, a value from 1 to 7 is then multiplied by its value multiplier, and added to the other scores to get an overall sustainability rating out of seven for the campus food system.

Using this model, a score for the sustainability of the UBC food system can be easily calculated. Scores can be compared from year to year in order to monitor the progress in creating a sustainable campus. Important to our design was the ability to use the model consistently for many years and to accurately monitor such progress despite evolving criteria. Thus, we have made the model flexible to changes in value judgements and indicator priorities. The value multipliers can be adjusted to reflect such changes, and indicators may be added or subtracted to accommodate new understandings about sustainability. By doing so, we can retroactively calculate sustainability scores for past years according to present criteria. Thus, we can create a simple picture of the evolution of our campus food system. . [redacted]

The UBC Sustainability Office currently has various programs that are underway, projects that students and instructors are collaborating on, and other programs that are in progress. For example, the SEEDS project currently has students and instructors working together on redesigning waste bins, landscaping pesticide usage, and pilot wetlands. Other projects include sustainable energy management, paper recycling and green buildings (UBC Sustainability Office, 2003).

Our project complements the goals and objectives of the Sustainability Office. The indicators that we have developed can be useful to the Sustainability Office in assessing the progress of programs that have already been implemented. For example, our indicator for food recycling may be adjusted and used to determine the effectiveness of paper and water recycling on campus. Partners of the UBC Sustainability Office, such as UBC Waste Management, may also use these indicators to assess the sustainability of the food system and the campus in general. We are confident that our model can be used to successfully judge the sustainability of the UBC food system.

Some indicators, which are not discussed in this paper, were mentioned in our group as possible indicators; more often than not, these were dismissed because they would be impractical or impossible to measure. ([redacted] These call for further research.

We feel that research should be conducted in the area of measuring the soil, water, and energy conservation at UBC as an indicator of sustainability. "A community that depends on its human neighbors, neighboring lands, and native species to supply the majority of its needs must ensure that the social and natural resources it utilizes to fulfill those needs remain healthy. A consequence of proximate self-reliance is that social welfare, soil and water conservation, and energy efficiency become issues of immediate practical concern" (Kloppenburg *et al*, 1996).

We also feel that the amount of co-operation between faculties on campus with regards to sustainability issues would be a valuable social indicator of the overall sustainability of the campus. We feel that promoting partnerships between faculties is essential; determining a way to measure the degree of interconnection on campus would make it an ideal candidate for addition to our model.

An ecological indicator that deserves further research is the impact of the UBC food system on the wildlife population and biodiversity; research would be needed to determine an appropriate way to measure this and categorize it into levels for the purposes of the model.

In summary, we feel that the model that we have designed will be a very useful tool in future years. Its flexibility and ease of use make it a practical, dynamic tool for future researchers in the area of the sustainability of the UBC food system.

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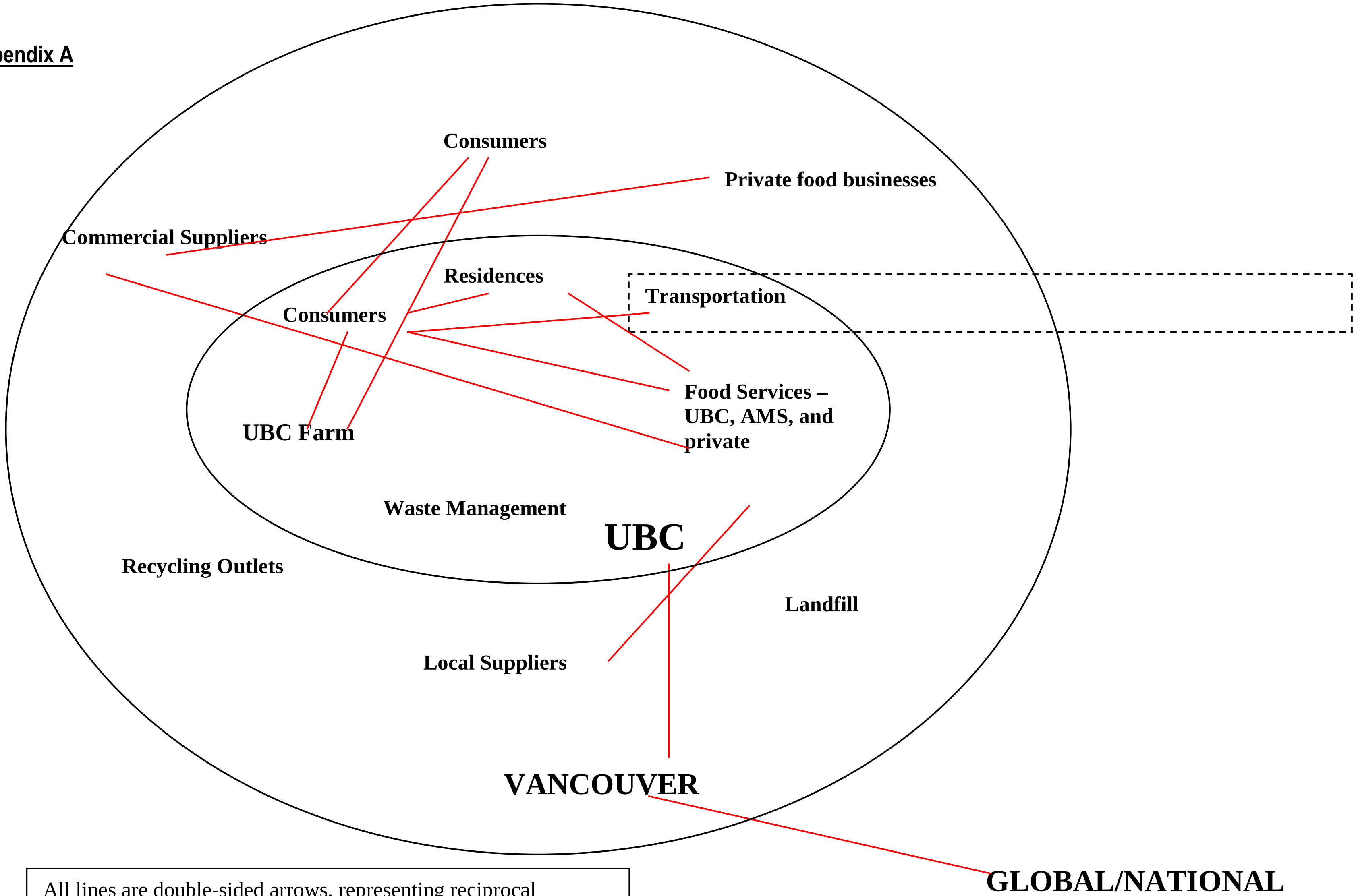
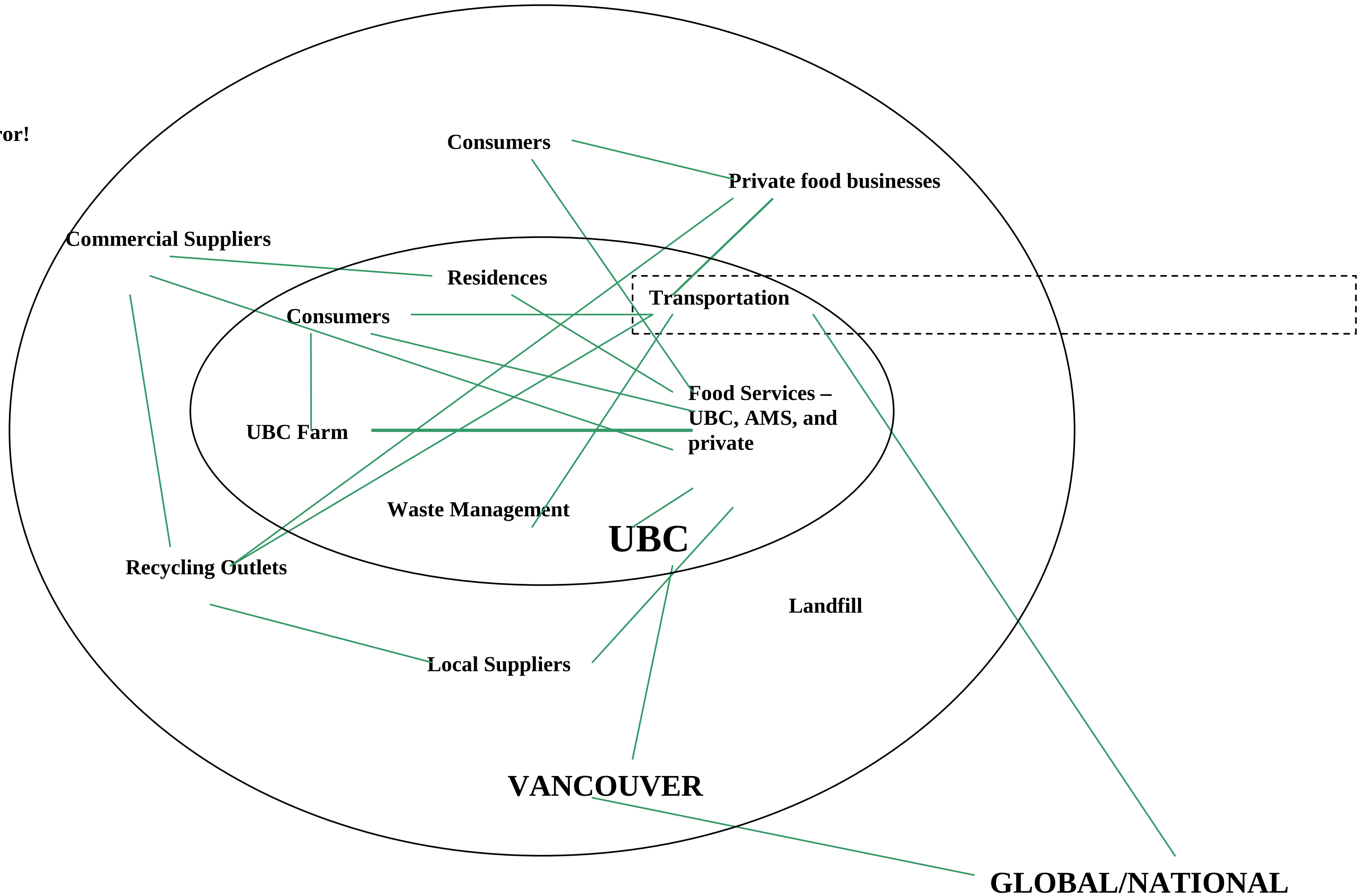
## Appendix A

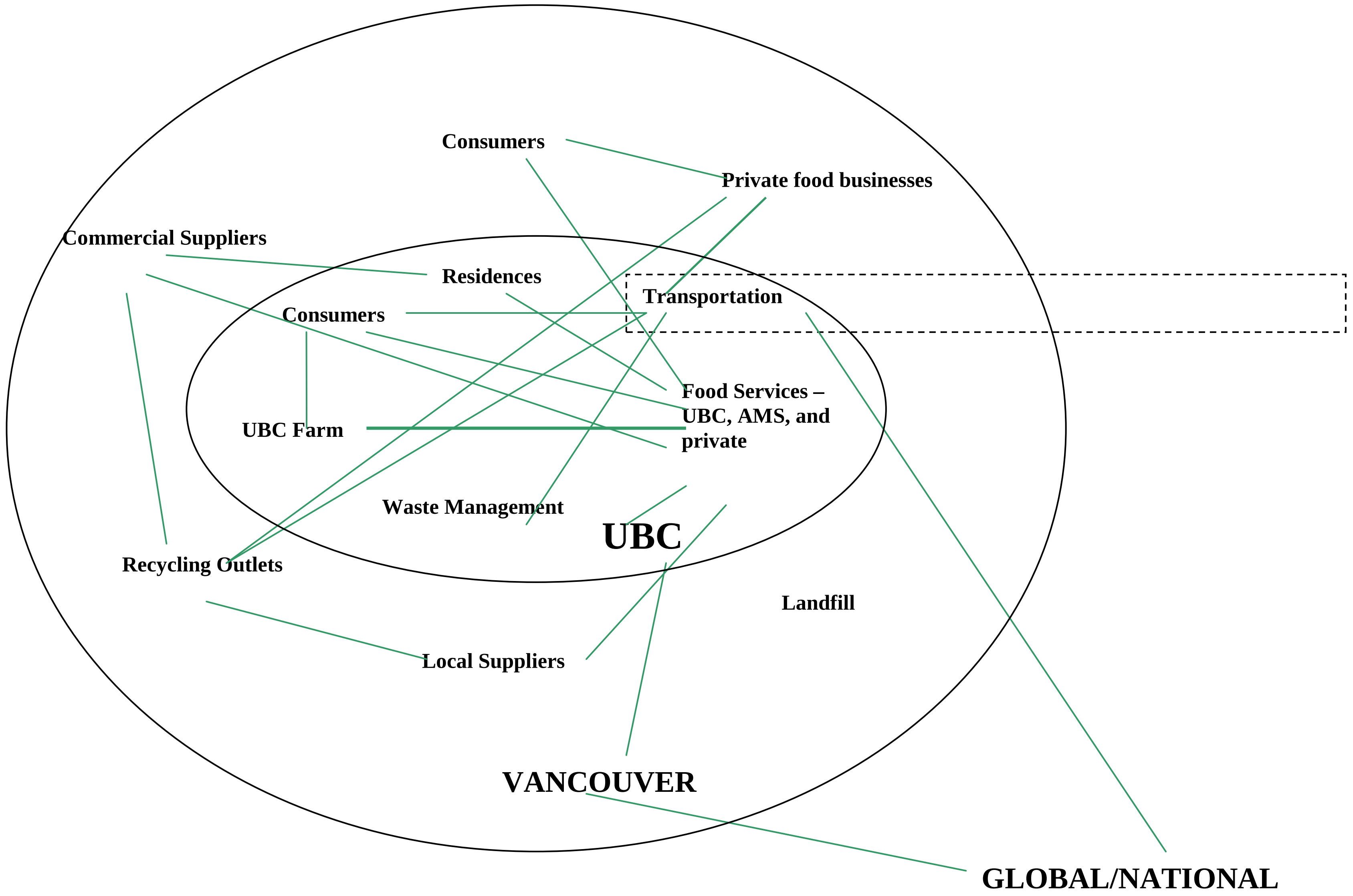



All lines are double-sided arrows, representing reciprocal interactions between the two components.
—— = social

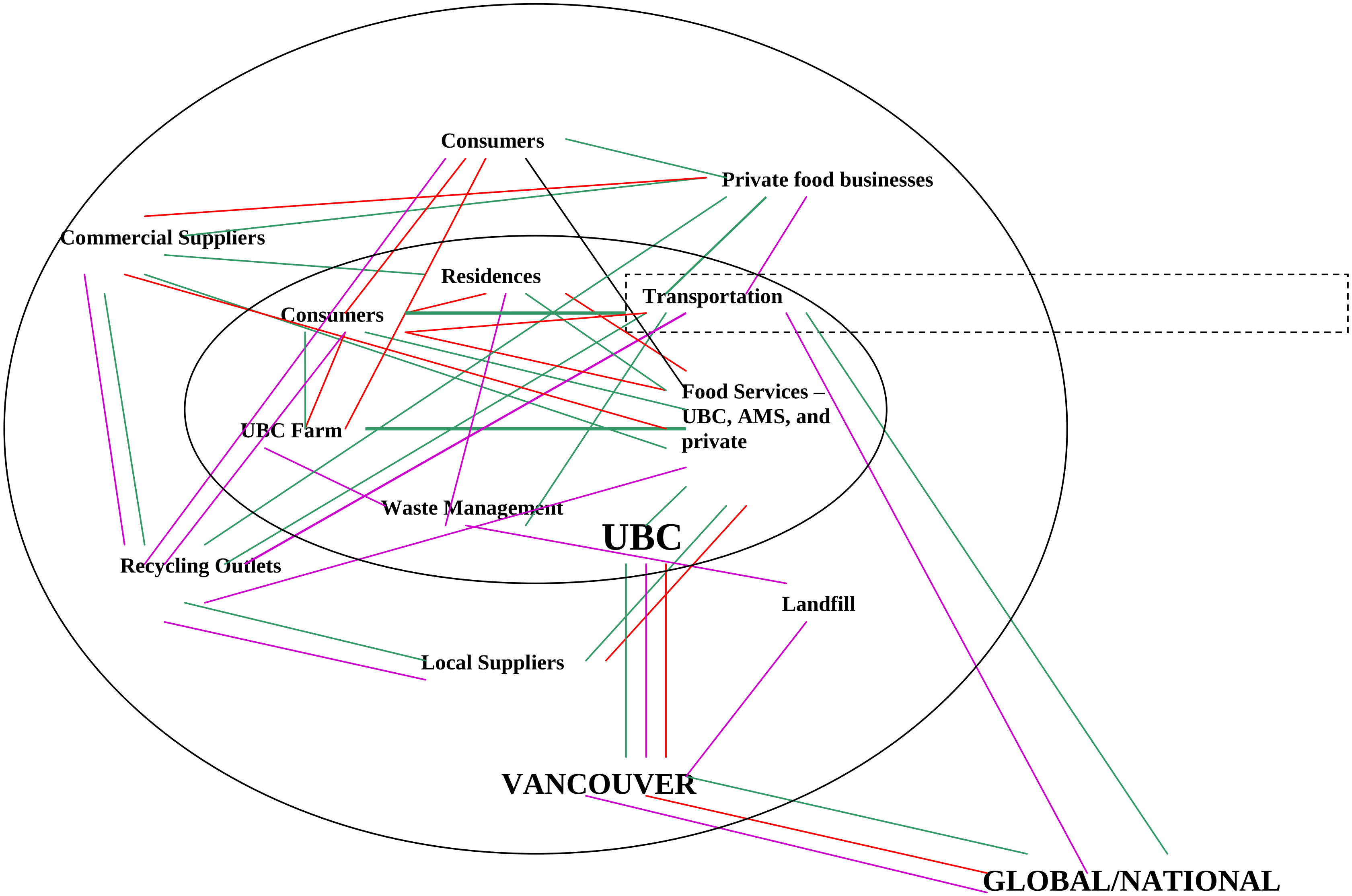
**Error!**




All lines are double-sided arrows, representing reciprocal interactions between the two components.
—— = economic




All lines are double-sided arrows, representing reciprocal interactions between the two components.
—— = economic




All lines are double-sided arrows, representing reciprocal interactions between the two components.
—— = economic
—— = ecological
—— = social

**Appendix B**

| | Measure-ment Criteria: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Enter a Value /7 | Values* Multiplier | Weighted Index Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Food Miles | Average miles traveled by UBC food: | >2,544 | 2,044 - 2,544 | 1,544 - 2,044 | 1,044 - 1,544 | 544-1044 | 44-544 | <44 | | 0.167 | - |
| Nutritional Value | Deviance from NRC macronutrient ratios: | 147 - 170 | 118 - 146 | 88 - 117 | 59 - 87 | 30 - 58 | 29 - 49 | 0 - 28 | | 0.167 | - |
| Affordability | Percent of income spent on food: | >30% | 26-30% | 21-25% | 16-20% | 11-15% | 6-10% | 0-5% | | 0.167 | - |
| Ecological Footprint | Hectares per person on campus | > 1.3 | 1.09-1.3 | 0.88-1.08 | 0.66-0.87 | 0.43-0.65 | <0.43 | <0.43 ** | | 0.167 | - |
| Recycling | Percent of recyclable material recycled | No recycling | 0-14% | 15-28% | 29-57% | 58-71% | 72-86% | 87-100% | | 0.167 | - |
| Composting | % of compost-able material composted | No composting | 1 - 20% | 19 - 40% | 41 - 60% | 59 - 80% | 81 - 100% | 81-100% *** | | 0.167 | - |
| | | | | | | | | | | **CAMPUS SUSTAINABILITY INDEX / 7:** | **0.0** |

* Adjust multiplier values for variables according to their relative importance, such that the sum of all multipliers remains 1.
** footprint less than 0.43 ha/capita plus an overall ecological footprint less than 1.6 ha/capita.
*** 87-100% of compostable wastes produced at UBC are composted plus, the methane emissions are being collected and used as a biogas