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Delineating the Southwest British Columbia bioregion for food system design and planning: A practical approach

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Abstract

In light of climate change, resource depletion and environmental degradation, food system vulnerability, and food insecurity, the potential to address issues of food system sustainability on local and regional scales is being increasingly recognized and pursued. Bioregions, generally defined as areas that share similar topography, plant and animal life, and human culture, represent an appropriate and consistently applicable scale and framework for sustainable food system analysis, design, and planning. As such, for a southwest British Columbia (SWBC) bioregion food system design and planning project, our first task was to delineate

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K. Mullinix conceptualized and is the principal investigator for the Southwest British Columbia Bioregional Food System Design project, and contributed substantially to the writing of this manuscript. For the project, G. Harris led the work to determine the bioregion and the writing of this manuscript. D. Nixon contributed to the manuscript and prepared all maps. L. Newman contributed to the manuscript.

our bioregion. We report on the process, deliberations, and practical considerations that contributed to the determination of the SWBC bioregion for subsequent study. In addition to a complex biogeographic landscape that includes mountains, a major river system and delta, and a marine ecosystem, SWBC's multicultural and urban/suburban/rural character is further compounded by its proximity to Vancouver Island, as well as by an international border with the Pacific Northwest United States; all represented important considerations in determining the dimensions of the bioregion. Bioregional-scale food system design and planning brings to the forefront the interdependency between human economy and community and the biophysical landscape with which they interact. In this reflective essay, we share our experience in the hope that it will inform the work of other communities in effectively delineating bioregions for food system design and planning that better align human communities and their economy with their environment. We believe the methodology presented has potential for widespread adaptation.

Keywords
Bioregion; Ecoregion; Agriculture; Food Systems; Planning; Life Place; British Columbia; Canada

Introduction

The production-paradigm agriculture and food system that dominates North America has been subject to substantial criticism in recent years. Limitations that are widely recognized include an unsustainable dependence on fossil fuels as well as environmental and social transgressions, notably the failure to address global food insecurity (Food and Agriculture Organization of the United Nations [FAO], International Fund for Agricultural Development [IFAD], & World Food Program [WFP], 2015; Hassebrook, 2006; Kimbrell, 2002; Patel, 2007; Roberts, 2008; Strange, 1988). Around the globe, governments and communities alike are exploring and investing in alternative food system strategies and action to address these issues (British Columbia Ministry of Agriculture and Lands, 2006; Colasanti & Hamm, 2010; FAO, 2015a, 2015b; Getz, 1991; Horst & Gaolach, 2015; Metcalf & Widener, 2011; Peters, Bills, Wilkins, & Fick, 2009).

There is emerging recognition that it may be most appropriate to approach sustainable food system planning locally or regionally. Such efforts have adopted various scales (Eaton, Hammond, & Laurie, 2007) because notions of local and regional are inherently value-laden: what is local or regional to one is not to another (Ackerman-Leist, 2013). In British Columbia, for example, local has been operationally defined as ranging from a 160 km (100 mile) radius (Smith & MacKinnon, 2007), to the entire 944,735 km^2 (364,764 miles^2) province (B.C. Ministry of Agriculture and Lands, 2006). Others delineate local or regional variously, including at a national scale, a state or province scale, a substate or subprovince (conglomerate of counties or municipalities) scale, a county or municipality scale, and a city scale (Cowell & Parkinson, 2003; Galzki, Mulla, & Peters, 2015; Griffin, Conrad, Peters, Ridberg, & Tyler, 2015; Pradhan, Lüdeke, Reusser, & Kropp, 2014; Zumkehr & Campbell, 2015).

The boundaries used in food system studies commonly follow some geopolitical or other arbitrary boundaries. Kloppenburg, Hendrickson, and Stevenson (1996) suggested the "foodshed," analogous to a watershed, as an appropriate unit of food system study and planning. It has been used as both a heuristic for analyzing and understanding the flow of food to a city or other defined area, and as a framework for envisioning alternative food systems (Getz, 1991; Kloppenburg, Lezberg, De Master, Stevenson, & Hendrickson, 2000; Peters, Bills, Wilkins et al., 2009; Peters, Bills, Lembo, Wilkins, & Fick, 2009; Peters, Bills, Lembo, Wilkins, & Fick, 2012). Foodsheds may be defined by the extent of their associated region, by political boundaries, or by a predetermined radial distance around a metropolitan area, and thus are arbitrary and variable (Metcalf & Widener, 2011).

The lack of an appropriately consistent convention and protocol for local/regional delineation hampers comparative and cumulative food system study, analysis, and planning (Horst & Gaolach, 2015; Peters, Bills, Lembo, Wilkins et al., 2009). Sustainable agriculture and food systems—a human enterprise and cultural construct—should

be fully linked to and be reflective of the ecology and environmental capacity of where they occur (Berry, 1997; Thackara, 2015; Thayer, 2003). For these reasons we were motivated to adopt a bioregional framework for our food system study in SWBC, Canada.

Bioregions as an Appropriate Food System Framework

Bioregions are generally defined as areas that share similar topography, plant and animal life, and human culture; they are not just geographical areas delineated by lines on a map but are conceptual entities as well (Berg, 2002). There are three major principles of bioregionalism (Dodge, 1981; Gray, 2007; Thayer, 2003; Tuan, 1974; Woolstencroft, 2003):

1. The centrality of "life place," i.e., the strong connection between human communities and the land that is associated with sustainable attitudes and practices, good health, identity, and sense of belonging;
2. The most appropriate boundaries for political organization and planning are natural ones; and
3. Decentralization of governance; bioregional communities should be more self-governing and regulating.

Bioregionalism embodies the notion that human settlement and land-use patterns must be viewed as integral and functional components of ecosystems, rather than as separate and unrelated entities (Leitão & Ahern, 2002). As such, it offers a framework with which to marry ecological and human components of the landscape. Bioregionalism provides an appropriate biogeographical context to restore and maintain natural systems, practice sustainable ways to satisfy basic human needs, and address regional issues of sustainability (Berg, 2002; Eaton et al., 2007; Hutchinson, 1996). Accordingly, a food system organized around bioregional boundaries would provide an ecological context to align this foundational dimension of the human economy with "life place."

Predicated upon the idea that a bioregional framework may help achieve major food system sustainability goals, the Institute for Sustainable Food Systems at Kwantlen Polytechnic University initiated a multidisciplinary food system design and planning project to explore and elucidate the economic, environmental stewardship, and food self-reliance potentials of a bioregional food system in SWBC, Canada (Institute for Sustainable Food Systems, 2016). We chose SWBC for this study because it is our "life place," a highly productive and important Canadian agriculture area, one of Canada's largest and fastest-growing metropolitan areas, and a place similar to other North American jurisdictions where agricultural and food system capacity is severely threatened by urban and industrial-neoliberal economic interests.

The project's goals included:

1. Determine the boundaries of the SWBC bioregion.
2. Catalyze community and local government action around shared food system values and vision.
3. Estimate the potential of each of the following in a regional food system:
   a. Bioregional food self-reliance;
   b. Income generation, job creation, and small to medium-sized business opportunities;
   c. Requirements for food system processing, storage and distribution; and
   d. Greenhouse gas emissions reduction, balancing nitrogen and phosphorous generation (from animal manures) with crop need, and integrating ecologically beneficial farmscape features.

The first, and a surprisingly formidable, challenge of this project was to aptly delineate the Southwest British Columbia bioregion. It is that objective that is reported on here. In what follows, we present the pertinent aspects we considered and our deliberations in doing so. Our purpose is to illustrate a methodology for, and thought process around, bioregion delineation for food system design and planning so that others might consider and test its application. Other specific project findings, per the objectives above, will be reported in subsequent papers.

Delineating a Bioregion

A review of the literature on delineating bioregions reveals a range of approaches that draw from diverse sources, including the natural sciences, anthropology, historical accounts, traditions, and socio-cultural characteristics as far ranging as "spirit places" (Berg, 2002; Dodge, 1981).

Watersheds commonly are regarded as providing the most appropriate natural boundaries for bioregions (Dodge, 1981). This approach makes good ecological sense because it recognizes that biological communities within a watershed are interconnected and function as part of a whole system, where an event or action in one part of the system may have both direct and indirect implications for another. However, watershed boundaries are relatively sharp, while bioregional boundaries can be less distinct, or even "fuzzy" (Sale, 2000). Neighboring bioregions may—or may not—share a common boundary, depending on human occupancy patterns, or boundaries may overlap where two or more adjacent bioregions share environmental resources.

Alexander (1996) summarized four possible criteria for, or approaches to, bioregion delineation:

1. Ecological determinism (nature determines culture): Within a specific region, bioregions are defined by one or more environmental criteria such as hydrology, climate, and vegetation, each of which will yield a different geographic area.
2. Nature and culture influence each other to an equal degree: This is based on the premise that the bio-geoclimatic conditions of the landscape influence the socio-cultural practices of the human inhabitants as much as humans influence and shape their environment.
3. Culture is the principal determinant: The environment sets limits to certain resources, but the cultural attributes of the bioregion dominate the decision-making process.
4. Cultural determinism (culture alone determines the boundaries): A bioregion is determined by culture alone, but it requires that people re-orient themselves to an ecological focus. Precise boundaries are unimportant and do not match any specific natural boundary.

These varied approaches highlight the significant challenge of selecting determinants to delineate bioregions. For example, the approach that argues for purely natural criteria is difficult to uphold, because in order to effectively weave human activity into sustainable interactions with natural systems, human inhabitation must be recognized as one of the defining parameters (Aberley, 1993). Similarly, in regard to the perspective that nature and culture influence each other equally, it is challenging to demonstrate that such a dual cause-and-effect relationship exists.

While a bioregion may be characterized broadly by natural boundaries, the inclusion of human components such as municipal, regional and electoral districts, transport routes, land use patterns, traditional hunting and gathering areas, and others is necessary to delineate boundaries that are meaningful to bioregional inhabitants in the context of their "life place". This is exemplified by Indigenous communities whose ways of living and sustainable land management strategies practiced for millennia are closely aligned with the natural landscape. The shared boundaries of Indigenous territories are not precisely defined lines, but are associated with natural features of the landscape and the history of inhabitation, human activity, and interactions with the natural environment (Thom, 2005). As such, Indigenous culture and knowledge offers valuable insight into bioregion delineation emanating from a perspective consistent with the bioregional principle regarding the connectivity between people and "place" (Cajete, 2000; Mullinix, 2015).

Meredith (2005), a strong proponent of cultural determinism, sees the development of bioregions as both a historical and ongoing, deep-rooted process referred to as "sequent occupance." This viewpoint recognizes that many geographic regions have experienced multiple episodes of human inhabitation by people of different origins and cultures, and that the resultant cumulative interactions between these groups are what shape the bioregion more dominantly than natural boundaries. Others suggest that bioregion

determination should not be restricted by abstract, theoretical definitions and constraints, but instead be defined through the ongoing practice of the three major bioregional principles mentioned earlier (Dodge, 1981; Gray, 2007). Alexander (1996) suggests that ultimately it is "up to us" as the bioregional inhabitants to decide which criteria are most useful, considering ecological, political, and cultural viewpoints.

Marine environments represent another challenge for defining boundaries. Their inclusion is consistent with bioregionalism because these environments are an important component of the "life place" of human communities and in determining how sustainable they are in regard to food, transport and other activities (Dybas, 2005; Tirado, 2008). Where bioregions include a marine component, there are a number of factors to consider in determining the seaward extent of the bioregion. Marine ecoregional boundaries, seabed characteristics, water depth, habitat of keystone marine species, fishing grounds, and more, should all be used to guide decision-making (Forst, 2009).

Thus a bioregion can be considered to be a biogeographic unit for food system design and planning that is delineated according to what the human inhabitants perceive as meaningful with respect to the balanced interactions they have with the natural landscape that sustains social and economic stability and self-reliance (Alexander, 1996; Hutchinson, McIntyre, Hobbs, Stein, Garnett, & Kinloch, 2005).

Responding to the challenges associated with delineating and mapping bioregions, Aberley (1993) suggests a map layering process that incorporates human elements of the landscape, such as census districts, Indigenous territories, and human resources including, for example, medical and social-service locations. Using Northwest British Columbia as a model, he presented what is arguably the most detailed and practical approach to describing and mapping bioregions. It can be summarized as follows:

1. Selection of a suitable base map to provide a foundational context to visualize the bioregion.

2. Creation of separate map layers showing historic and current political boundaries; internal boundaries used by various government agencies; watersheds; physiographic regions; climate; ecoregions and bio-geoclimatic zones; other natural boundaries (e.g., vegetation and wildlife, including keystone species, geology, etc.); Indigenous territories; current use; and special locations or features.

3. Soft boundary delineation.

4. Single line (final) delineation.

In effect, each of the map layers described represent a bioregional parameter which, when overlaid onto the base map and each other, together serve to define the physical dimensions and shape of the bioregion. However, Aberley provides no objective methodology for prioritizing the various boundary layers and, like Alexander (1996), leaves it up to the subjective analysis of the inhabitants to make such determination and draw boundary lines. This flexibility is practical, since the priorities deemed pertinent for one bioregion may not be pertinent to others.

The Southwest B.C. Context

Southwest British Columbia presents a challenging landscape in which to delineate a bioregion. The proximity of both an international border and a large island housing the provincial capital are of particular interest in the deliberations regarding the size and extent of the bioregion.

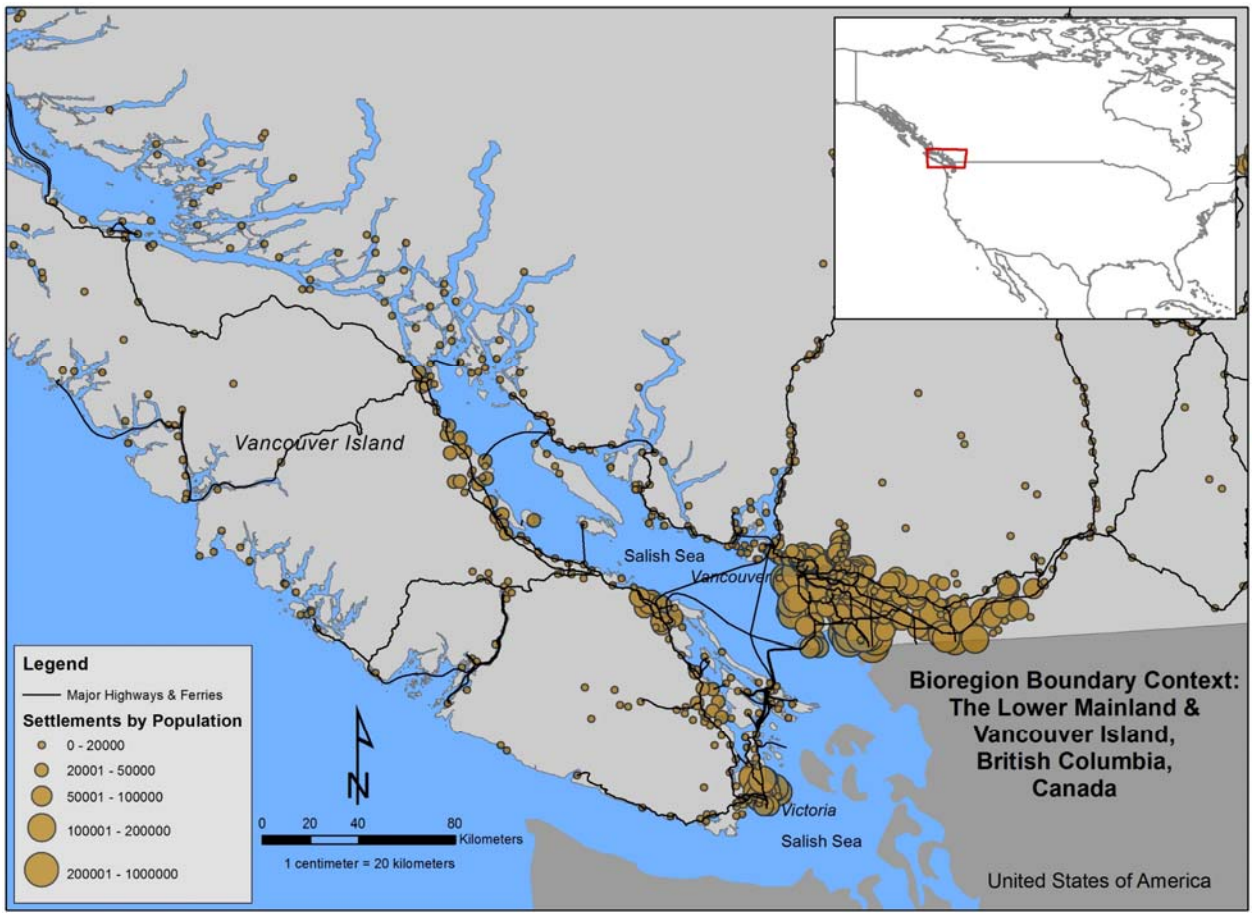
The SWBC Lower Mainland (approximately 41,380 km^2 or 15,977 miles^2) contains the province's major urban centers and most productive agricultural lands. SWBC is within the Pacific Maritime Ecozone, which has relatively mild temperatures, copious precipitation (typical of the coastal northwest), and highly productive deltaic and alluvial agricultural soils (Agriculture and Agri-Food Canada, n.d.-b; Ecological Stratification Working Group, 1995). The Strait of Georgia (part of the Salish Sea) separates nearby Vancouver Island and other proximal, smaller islands from the Lower Mainland (Figure 1) and is a

major shipping route for international trade. The "Island" also has significant agriculture resource and capacity. To the south, the 49th parallel marks the international land boundary between Canada and the United States.

The majority of SWBC's approximately 1,500 km² (579 mile²) of agricultural land is protected by the provincially legislated Agricultural Land Reserve (ALR) (Dorward, Smukler, & Mullinix, 2016; Government of British Columbia, 2013). SWBC is a major center for the production of dairy, egg, turkey, broiler chicken, cranberry, blueberry, raspberry, greenhouse sweet pepper and tomato, and various other field horticultural crops (British Columbia Ministry of Agriculture, n.d., 2013).

Southwest B.C. is the traditional territory of the Coast Salish peoples, comprising over 50 tribes and/or Nations (Thom, 2005). Within SWBC there are five regional districts and 34 municipalities with a combined population of more than 3 million (Statistics Canada, 2014). A groundswell of organizations has mobilized within the bioregion around the themes of food, land, culture, and ecological sustainability. Examples include organizations sponsored by municipal governments, such as the Langley Environmental Partners Society and Vancouver Food Policy Council, and social-sector organizations such as Farm Folk City Folk, Society Promoting Environmental Conservation, the B.C. Food Systems Network, and the Sustainable Food Systems Working Group.

Figure 1. The Southwest British Columbia Context. The biogeographic region of SWBC showing major population centers and transport routes of the mainland in relation to the Canada-USA border, the Salish Sea and Vancouver Island.

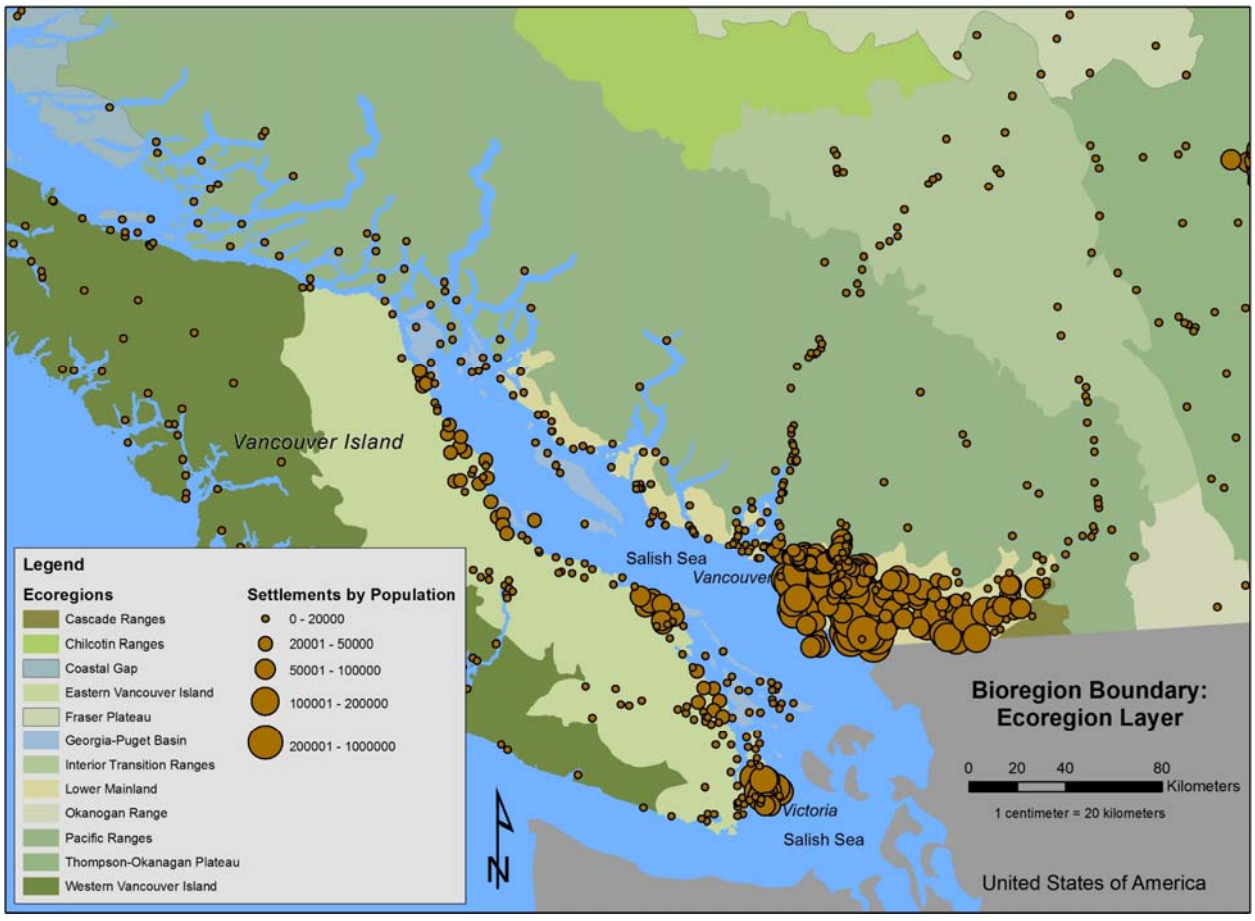


Delineating the SWBC Bioregion

The approach we used to delineate and map the SWBC bioregion was an adaptation of the process put forth by Aberley (1993).

1. Using geographic information systems (GIS), we first selected a base map of the SWBC region that included the SWBC mainland, northwest Washington state, Vancouver Island, and the Salish Sea. The base map with a simple coastal outline was established from the GIS Ecoregion data set from the National Ecological Framework for Canada (Agriculture and Agri-Food Canada, n.d.). Onto this we overlaid map layers showing major settlements and transport routes (Natural Resources Canada, n.d.) to produce the SWBC context map (Figure 1).
2. Additional GIS map layers were then selected from readily available data sources: Level 3 Ecoregion data set (Figure 2) to reveal areas with similar ecological communities and reflecting similar climate (Agriculture and Agri-Food Canada, n.d.); major water drainage areas (Figure 3) and geopolitical boundaries (Figure 4) representing regional districts and their component municipalities (B.C. Statistics, 2011). These layers represent major attributes of both the natural and human elements of the landscape and also incorporate many of the finer-grain attributes. For this reason, they may be considered to be key bioregional indicators. The Level 3 Ecoregion data set, for example, not only identifies areas with distinct ecological communities, but also reflects the unique combination

Figure 2. Ecoregions (Level 3 Classification). Ecoregions show areas with distinct ecological communities and also reflect similar climate, geology, and soil conditions.



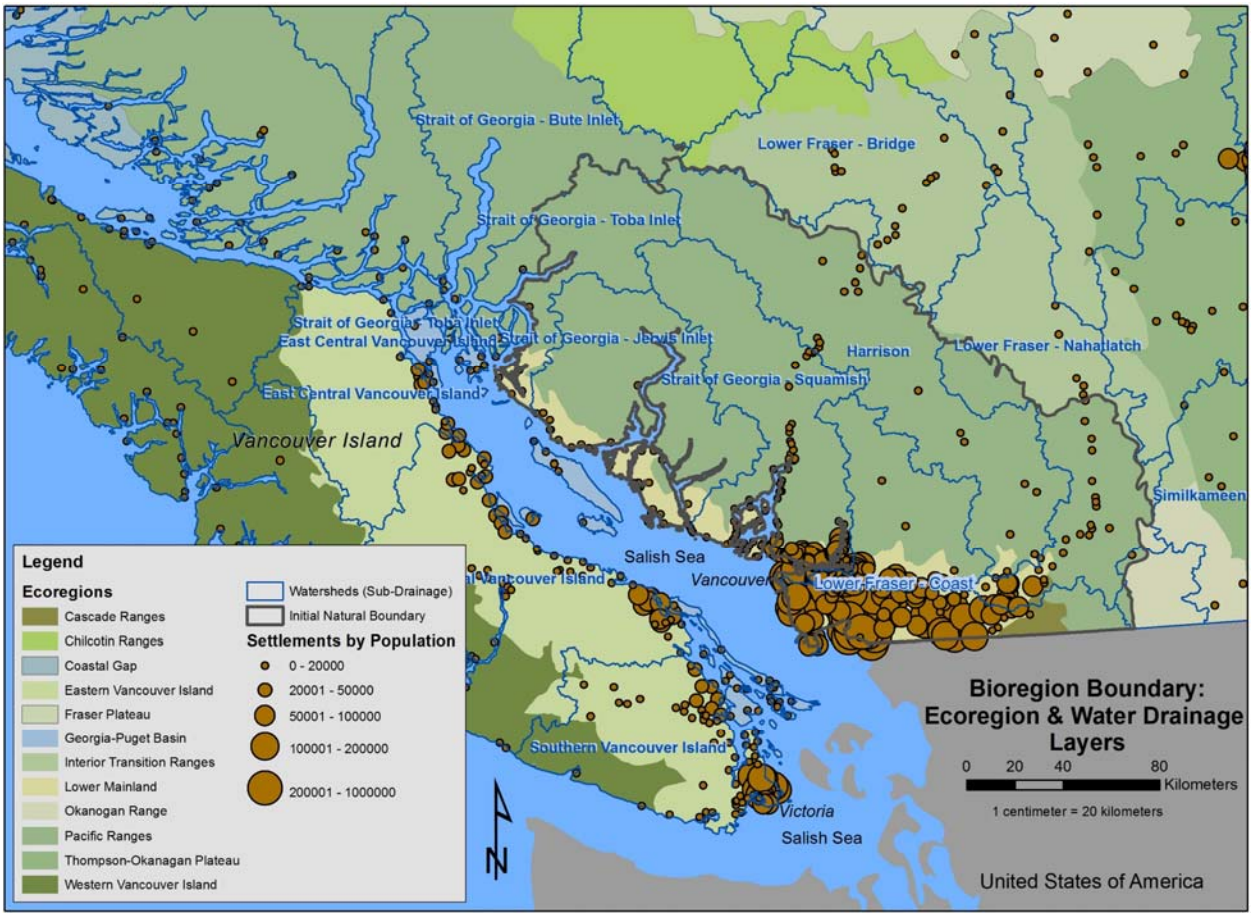
of temperature, rainfall, geology, and soil conditions associated with those communities. Our initial efforts to include additional map layers in order to do a more comprehensive analysis failed to provide a more detailed resolution of the bioregional boundary, and in fact only served to make the process unduly onerous. The layers selected here thus were considered to collectively represent a minimum but sufficient number of key natural and human elements of the biogeographic landscape recognized in the literature as important criteria for delineating bioregions. Corresponding data sets are widely available across North America and elsewhere (e.g., Australia), allowing bioregional attributes to be compared across different regions and countries.

3. Map layers were sequentially overlaid onto the base map to allow qualitative assessment of the spatial relationships between the various map components. The merits of including various components of the landscape were then discussed and evaluated in relation to project goals and practical considerations. What follows is a detailed description of how the proposed boundary of the SWBC bioregion was determined.

The Southwest B.C. Bioregion

Per Aberley (1993) and Alexander (1996), our ultimate determination of the SWBC bioregion was based on a combination of ecological, cultural, jurisdictional, and practical considerations (Figure 5). While the bioregion was very much informed by

Figure 3. Ecoregion and Water Drainage Areas. These map layers formed the basis for determining the initial natural boundary of the bioregion.



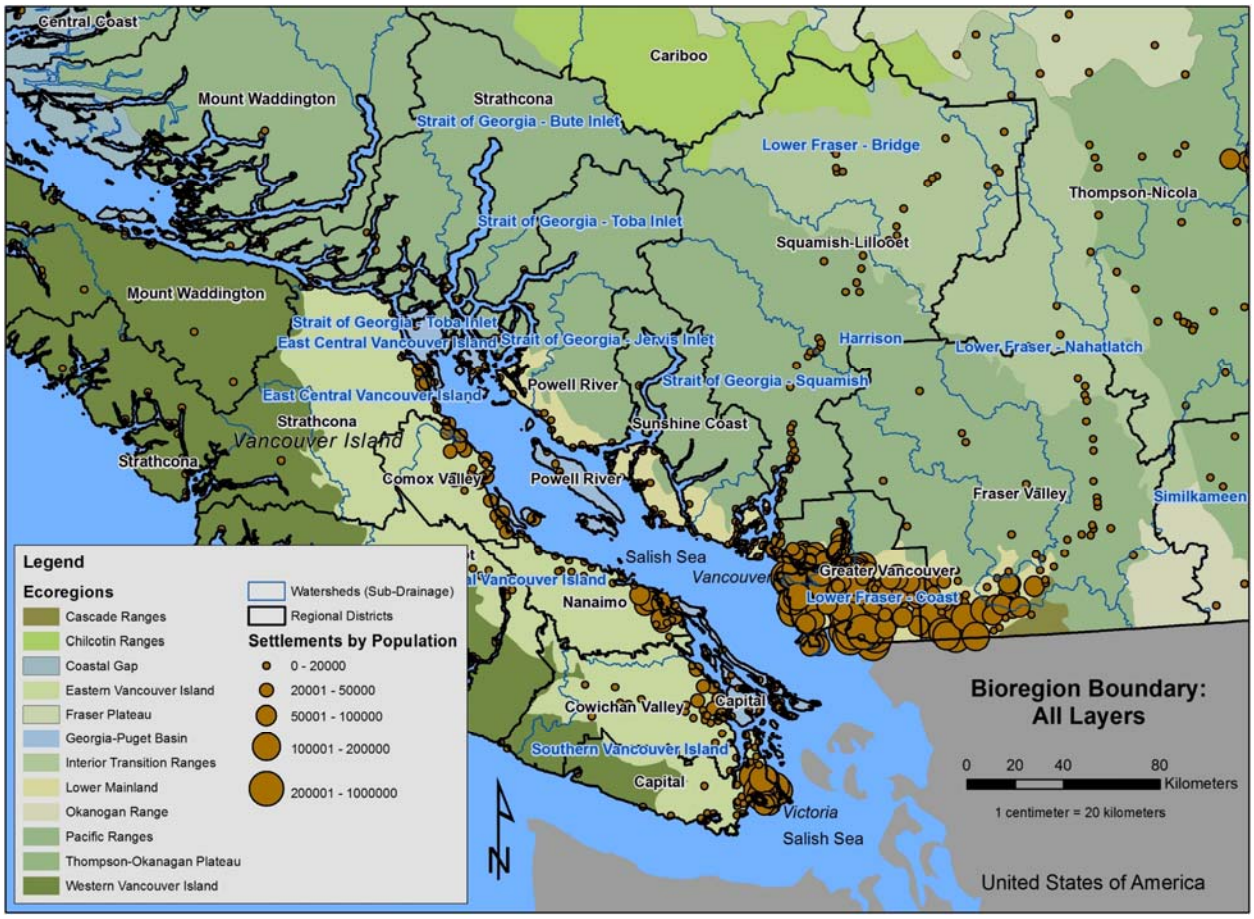
ecoregion and watershed characteristics, political boundaries limited the inclusion of some ecoregion components. Furthermore it was restricted to the terrestrial mainland, excluding nearby islands and communities, as well as marine elements. Ultimately the bioregion conformed to five contiguous regional districts (census consolidated subdivisions). From a cultural perspective it is this area (bioregion) that is identified and referred to by the resident populace as the Lower Mainland.

The following sequence of steps reflects the deliberations and organic decision-making process involved in delineating the SWBC bioregion.

1. The proximity of Vancouver Island and the Gulf Islands to the mainland (Figure 1) raised the question of whether to include them as part of the SWBC bioregion. This dilemma was highlighted by the level of contemporary social and economic interaction, as well as the volume of commuting and resource-sharing that takes place between the island and mainland.

From an ecological perspective, the presence of a large land mass, such as Vancouver Island, in close proximity to the B.C. mainland has manifested climatic modifications resulting in differences in the structure and species composition of biological communities found on the island and the mainland. As a consequence, the ecoregional classification system of Canada (Agriculture and Agri-Food Canada, n.d.) recognizes that Vancouver Island is composed of two ecoregions (Western Vancouver Island and Eastern Vancouver Island), both of which are differentiated, on the basis of climatic and biogeographic differences, from those found on the coastal mainland (Lower Mainland

Figure 4. The Southwest British Columbia (SWBC) Bioregion Layers. Composite map showing geopolitical boundaries and all other layers (except transport routes).



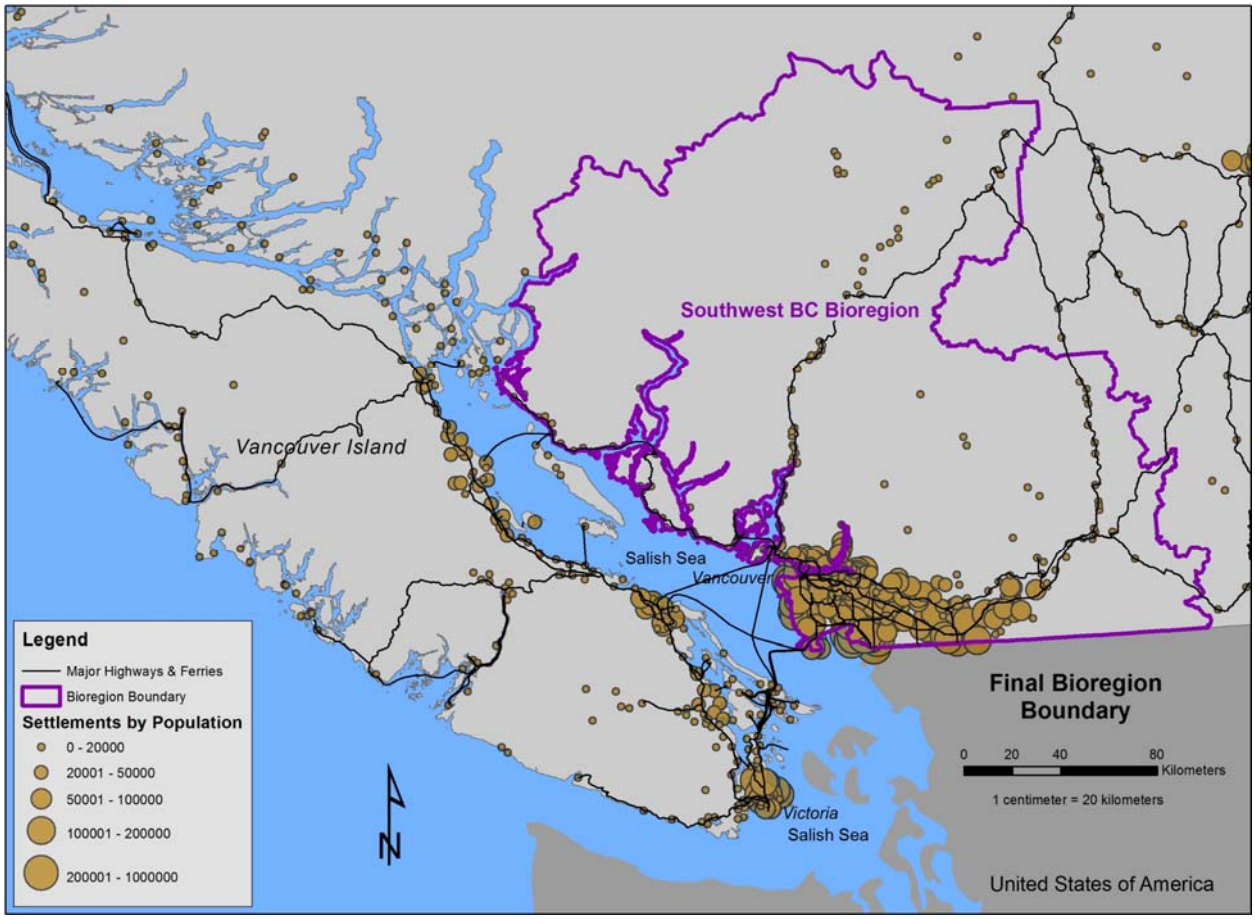
and Pacific Ranges ecoregions) (Figure 2).

In addition to the differences in ecological characteristics between the mainland and Vancouver Island, the Salish Sea separates the water drainage areas (Figure 3) and acts as a biogeographic barrier that limits the connectivity between the ecological communities in these two terrestrial regions in much the same way a mountain range would. Notwithstanding dispersal mechanisms that allow some movement of plants and animals to occur, the Salish Sea serves to isolate the terrestrial ecosystems on the island which, to a large extent, function independently from those on the mainland. This supports Vancouver Island being categorized as a separate bioregion from SWBC.

Originating as separate colonies, the early history and development of Vancouver Island was independent from those of mainland British Columbia and led to significant differences in the character and function of the major cities associated with each region. Victoria, a midsized city, is the political capital of B.C., while Vancouver, the epicenter of a major metropolitan area, is the main economic and business center (Figure 1). The Capital Regional District (on Vancouver Island) has a notably smaller population whose mother tongue is other than English or French (12%) than does the Greater Vancouver Regional District (mainland) (40%) (Statistics Canada, 2012). Furthermore, these regions rarely interact for planning and governance objectives. Such characteristic differences between these two major population centers, combined with their physical separation by the Salish Sea, further support the categorization of Vancouver Island as a separate bioregion.

The Salish Sea itself is recognized as an

Figure 5. The Southwest British Columbia Bioregion. This shows the final boundary in relation to major settlements and transport routes.



important element of the "life place" for the inhabitants of the bioregion (Barnett, 1955). Extensive areas of the mainland drain into the sea, which affords extended ecosystem services to the bioregion. Furthermore the sea contributes to the regional economy through employment opportunities and the provisioning of a significant quantity and diversity of foods. While historical Indigenous communities utilized the Salish Sea as their primary transport route, auto-mobilization in the latter 20th century, as well as privatization of the B.C. ferry service in 2003, have led many contemporary bioregional inhabitants to perceive the Salish Sea as a transport barrier between the mainland and Vancouver Island (Stewart, 2014). While the Salish Sea was considered for inclusion into the bioregion, the sheer magnitude of the SWBC Food System Design Project and the complex interrelationships between land and sea made it prudent to limit the scope to an analysis of terrestrial landscapes. Consequently, the Salish Sea was excluded for the purposes of our study.

2. Another significant issue to contend with was the proximity of the international Canada/U.S. border in southwest B.C. (Figure 1). While this latitudinal boundary does not coincide with any natural demarcation, it represents a human "life place" distinction imposed by political institutions that cannot be ignored. Despite the existence of international agreements such as the North American Free Trade Agreement (NAFTA) and the Pacific Salmon Treaty, which promote transborder trade and collaborative environmental stewardship, the preponderance of different laws, planning policies, trade, and management practices, as well as cultural viewpoints and practices, on both sides of this boundary make transborder, bioregional food system planning particularly challenging, if not practically impossible at this juncture. Owing to these political jurisdictional complications, we concluded that it would be unrealistic to attempt to incorporate elements of the U.S. into our bioregional food system study. Consequently we determined that the southern boundary of the SWBC bioregion would be marked by the international U.S./Canada (province of British Columbia/state of Washington) border.

3. Having established exclusive terrestrial and Canadian focus to the project, decisions then had to be made about the ecological dimensions of the bioregion. By overlaying maps showing the major population centers, water drainage areas, and ecoregions, we identified three ecoregions occupied by these communities: the Lower Mainland, Pacific Ranges, and to a lesser extent the Cascade Ranges (Figure 3). The northern extent of the Lower Mainland Ecoregion represents a natural boundary coinciding with local water drainage areas and with the northern limit of the Sunshine Coast Highway. For these reasons it was selected as the northern limit of the bioregion. To the east, the ecoregion demarcation between the Pacific Ranges and the Interior Transition Ranges is associated with marked changes in climate, topography, and vegetation, and in many places it is closely aligned with water drainage areas. This natural division also separates major communities influenced by their proximity to the coast versus those influenced by other factors (and considered "interior") and was thus considered to represent the most appropriate eastward extent of the bioregion. These natural divisions in the landscape were combined to form the initial natural boundary of the SWBC bioregion (Figure 3).

4. Turning our attention to the human communities occupying this landscape, an additional map overlay showing geopolitical boundaries revealed that the bioregion as delineated thus far contained all but a small component of, and roughly approximated, five contiguous regional districts: Greater Vancouver, Fraser Valley, Sunshine Coast, Powell River, and Squamish-Lillooet (Figure 4). We also noted that, in many cases, regional district boundaries conformed closely to water drainage areas. Upon conducting preliminary research to obtain data on the characteristics and agri-food potential of the proposed bioregion, we came to realize that all available data were configured to census divisions, corresponding to regional district boundaries and other geopolitical divisions. Given that all data (soil types, arable lands, crops, yields, population, etc.) necessary for the larger project were available only on a regional district basis, and knowing that regional residents recognize the five districts as the

Lower Mainland—their "life place" (thus providing "cultural familiarity")—we decided to align the bioregional boundary with that of the five regional districts (Figures 4 and 5). What is more, using the five contiguous regional district boundaries did not eliminate any agricultural land (food production capacity) from our study area.

Thus, while not discounting the possibility of generating future data sets on the basis of natural boundaries, in order to make this bioregion food system design and planning project feasible, its initial scope was necessarily condensed to consist of the five contiguous regional districts on the southwest B.C. mainland: Greater Vancouver, Fraser Valley, Sunshine Coast, Powell River, and Squamish-Lillooet (Figure 4). This approximates the terrestrial dimensions of the ecoregions and water drainage areas that would otherwise have formed the natural boundaries of the bioregion (Figure 3). The resultant bioregion (Figure 5) is thus composed of a substantial but reasonable number (39) of municipal and regional district governments to work with and also conforms to existing units of census data collection to facilitate data acquisition and analysis that would not have been possible using alternative criteria.

Having delineated the SWBC bioregion, we turned to the project's focus on food systems. In considering the sources and quality of available data and the constraints on project resources, we further decided that the current study would be limited to an examination of the Agricultural Land Reserve (ALR) contained within the bioregion. The ALR is the result of provincial legislation (Agricultural Land Commission Act, 2002) that identifies the majority of agriculturally suitable lands in SWBC, protects them from non-agricultural use, and therefore essentially delimits the potential future extent of agriculture in this bioregion.

These criteria and decisions represent a practical division of the landscape into manageable components to address the unwieldy magnitude and enormous level of complexity of the entire project. While our delineation process reflects that put forward by Aberley (1993), the final bioregional boundary (Figure 5) was selected based on practical as well as logistical reasons. However, as the work progresses and we gain capacity as well as feedback from regional stakeholders, reconsideration and modification of the bioregional boundary may be warranted.

Conclusions

If we are to build sustainable and resilient food systems and communities that can navigate the uncertainties of climate change and post-carbon economies, it is most practical to develop food security strategies linked to localized food systems (Ackerman-Leist, 2013; Greer, 2009; Heinberg, 2003; Moreau, Moore, & Mullinix, 2012). The potential benefits of utilizing a bioregional framework as a comprehensive and relatively consistent heuristic device for food system design and planning, predicating such upon a sustainable human economy and environmental capacity of the bioregion, cannot be overstated (Jones & Atkinson, 1999). We found that the bioregional framework aligned food system planning with community and the environment in a relatively uniform and well-ordered, yet adaptable, way. It may prove likewise to others, in providing an appropriate scale and ecological context for food system planning and analysis.

To engage in and advance bioregional-scale food system study and planning, the initial challenge is to determine the dimensions of the bioregion. To achieve this, we modified the approach used by Aberley (1993). This model provides a relatively consistent framework for delineating bioregions and also offers the flexibility to allow researchers and others to evaluate and prioritize the unique biophysical and cultural attributes of a region while incorporating practical considerations into the decision-making process. All major landscape components, such as terrestrial, marine, islands, watersheds, ecoregions, geopolitical boundaries, transport routes, and culture, must be considered for inclusion. For the SWBC bioregion, these decisions were crucial to achieving project goals and contributing to the overall success of the project.

While specific, precisely defined variables, such as watersheds, may lend themselves to forthright and definitive demarcation, the many interpretations of what constitutes a bioregion preclude easy prescription. Thus the boundaries of

this area (and indeed our thinking about it) may best be left somewhat imprecise, or "fuzzy." In this way we can better acknowledge and reflect the interconnectedness of nature, ecological systems, and our communities (Bennett, 2010). In their pioneering work on bioregionalism, Berg and Dasmann (1978) referred to a bioregion as a "terrain of consciousness" to emphasize the role of culture in its delineation. Ultimately, it rests with the inhabitants' perception of what constitutes their "life place" to determine which features of the landscape will serve as their bioregional boundary.

Our methodology to delineate the SWBC bioregion employed GIS technology, which is increasingly being used to map complex elements of the landscape and analyze associated spatial data. This approach is not unduly cumbersome and requires a limited number of data sets that are freely available in Canada from government websites. Thus it has potential widespread application, enabling bioregional food systems to be compared on national and international levels.

Community consultation will be essential to explore the cultural dimensions of a bioregion and to ascertain and nurture a commitment to adopting bioregional principles. It is equally true, and important, that the ecological character and environmental capacities of our "life places" must again be central to the construct of our cultures and societies, including our agri-food systems. Both cultural considerations and environmental capacities call for a transformation of our relationships with one another as well as with the land, plants, and animals that provide us with our food and other elements of sustenance, and also provide a context for our "life place." It requires a re-orientation of our interactions with the natural landscape in a way that maintains ecosystem integrity in order to support sustainable human communities. Delineating a bioregion, practically and functionally and from both ecological and cultural perspectives, is the place to start.

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