

# THE CLIMATE-BIODIVERSITY-HEALTH NEXUS PROJECT

## DOCUMENT AND SYSTEMS ANALYSES OF FOOD SYSTEMS PLANNING AND POLICY ISSUES IN THE COMOX VALLEY



University of Victoria



## **AUTHORS**

### **MOHADDESE GHADIRI**

RESEARCHER, ROYAL ROADS UNIVERSITY  
PHD CANDIDATE, SCHOOL OF PUBLIC ADMINISTRATION, UNIVERSITY OF VICTORIA

### **ROBERT NEWELL**

CANADA RESEARCH CHAIR IN CLIMATE CHANGE, BIODIVERSITY AND SUSTAINABILITY, ROYAL ROADS UNIVERSITY  
RESEARCH ASSOCIATE, FOOD AND AGRICULTURE INSTITUTE, UNIVERSITY OF THE FRASER VALLEY

### **JOFRI ISSAC**

RESEARCHER, ROYAL ROADS UNIVERSITY  
MASTER'S OF ENVIRONMENT AND MANAGEMENT STUDENT, ROYAL ROADS UNIVERSITY

## **COLLABORATING ORGANIZATIONS**

FOOD AND AGRICULTURE INSTITUTE, UNIVERSITY OF THE FRASER VALLEY  
ROYAL ROADS UNIVERSITY  
UNIVERSITY OF VICTORIA  
ISLAND HEALTH

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## 1. Introduction

Food systems are highly vulnerable to the effects of anthropogenic climate change and environmental degradation. At the same time, food systems contribute to the production of greenhouse gases that spur climate change, adversely impacting human and environmental well-being. There is a clear need for transitioning to sustainable food systems. At the local level, a way to make progress toward food system sustainability, while recognizing the complexity and diversity of these systems, is to engage in integrated community sustainability planning (Issac et al., 2022).

Nexus frameworks, such as the water-energy-food nexus, have the potential to support integrated planning by stimulating thinking about how different planning areas and priorities are interconnected (Sperling et al., 2017). Integrated approaches to planning and policy are critical for making progress toward local sustainability and resilience (Alrøe et al., 2016), and nexus frameworks can help researchers, planners, and decision-makers take such approaches to address local, place-based sustainability issues. Additionally, participatory and inclusive planning processes that involve people that have knowledge about, and relationships with, a local area are important when making and using these framework. Such participatory processes can leverage collective knowledge, while also serve to develop common language and thinking when discussing ideas and strategies.

Newell (2023) recently introduced a new nexus framework: the climate-biodiversity-health (CBH) nexus. The CBH nexus focuses on goals and objectives related to climate action, biodiversity conservation, and community health. The CBH nexus was applied in a research project in the Comox Valley region (British Columbia), which engaged local government and stakeholders in an exploration of the complexities around local food systems issues and strategies. The research was conducted in multiple phases, with the first phase using semi-structured interview methods to explore how climate change, biodiversity, and health form relationships to food systems issues (and with each other). Findings from the first phase confirmed that local planning should take integrated approaches and be based on a holistic understanding a community's issues and needs (see Ghadiri et al., 2022).

The findings from the first phase of the research informed the development of systems maps, which can be used as tools for integrated food systems planning in the Comox Valley. These systems maps provide holistic pictures of how issues and strategies affect each other, directly and indirectly. When looking at these systems, there appears to be a clear need for diverse groups and organizations to plan, coordinate, and work together due to how strategies in different planning areas interact. The systems maps serve as visual tools that can improve understanding about how different actions relate to one another, and such insights can be used to improve future planning and strategies. The tools can also be used to examine potential effects and current level of integration of existing programs and strategies.

Following the first phase of the research, an analytical framework was developed and applied to the plans of the communities in the Comox Valley region in a study that examined the plans' areas of integration and gaps in integration. The plans analyzed in this work include one regional-scale plan and five local-level (i.e., municipality or community) plan. Although developed for this research, the analytical framework can also be adapted to other cases and communities.

Additionally, systems and network analyses techniques were applied to better understand how local and regional food system relate to the CBH nexus. This analysis revealed how different components of the food and CBH system of the Comox Valley region 'cluster' in terms of forming strong relationships with one another. The results of this work can inform how to engage in integrated planning to effectively address the complex issues related to different system components.

This report presents the outcomes of the research done following the first phase of the CBH nexus project. Details on the first phase of the research project can be found in Ghadiri et al. (2022). This report begins with a discussion on the document analysis study and its findings. Then, the report presents the systems analysis work and its findings.

## 2. Document Analysis

The research examined six plans in the Comox Valley area: one Regional Growth Strategy, four Official Community Plans, and one Comprehensive Community Plan (see Table 1).

**Table 1. Features of local and regional plans in the Comox Valley region**

| Plan names  | No of pages | Policy areas  |  | Plan Bylaw No. |
|---|-------------|---|--|----------------|
| <b>Town Of Comox Official Community Plan</b><br>(Oct 20, 2021)                  | 209         | <ul style="list-style-type: none"> <li>Land use (housing, mixed-use, institutional, parks, agriculture and aquaculture)</li> <li>Age-friendly planning</li> <li>Environment</li> </ul>  | <ul style="list-style-type: none"> <li>Infrastructure (transportation, utilities, water, sewer, stormwater)</li> <li>Economic strategy</li> <li>Historical and cultural resources</li> <li>Inter-jurisdictional planning</li> </ul>          | 1976           |
| <b>City of Courtenay Official Community Plan</b><br>(June 27, 2022)             | 279         | <ul style="list-style-type: none"> <li>Street and transportation</li> <li>Building and landscape</li> <li>Affordable housing</li> <li>Natural environment</li> <li>Parks and recreation</li> </ul>  | <ul style="list-style-type: none"> <li>Municipal infrastructure</li> <li>Social infrastructure</li> <li>Arts, culture and heritage</li> <li>Food systems</li> <li>Local economy</li> </ul>   | 3070, 2022     |
| <b>Village of Cumberland Official Community Plan</b><br>(Oct 3, 2022)           | 183         | <ul style="list-style-type: none"> <li>Future land use</li> <li>Housing, growth management</li> <li>Heritage preservation</li> <li>Municipal infrastructure</li> <li>Transportation</li> <li>Sand and gravel extraction</li> <li>Tourism</li> </ul> | <ul style="list-style-type: none"> <li>Local food production</li> <li>Environmental conservation</li> <li>Views and landscapes</li> <li>Climate change adaptation</li> <li>Wildfire urban interface</li> <li>Recreation and parks</li> </ul> | 990, 2014      |
| <b>K'ómoks First Nation Comprehensive Community Plan</b><br>(Oct31, 2021)       | 77          | <ul style="list-style-type: none"> <li>Governance and administration</li> <li>Lands</li> <li>Housing</li> <li>People</li> <li>Education</li> </ul>  | <ul style="list-style-type: none"> <li>Environment and wildfire</li> <li>K'ómoks estuary</li> <li>Infrastructure</li> <li>Economic development</li> </ul>  | Version 1.0    |
| <b>Comox Valley Regional District Regional Growth Strategy</b><br>(Dec18, 2018) | 132         | <ul style="list-style-type: none"> <li>Housing</li> <li>Ecosystems, Natural Areas &amp; Parks</li> <li>Local Economic Development</li> <li>Transportation</li> </ul>  | <ul style="list-style-type: none"> <li>Infrastructure</li> <li>Food Systems</li> <li>Public Health and Safety</li> <li>Climate Change</li> <li>Growth management</li> </ul>  | 120, 2010      |
| <b>Rural Comox Valley Official Community Plan</b><br>(Nov 24, 2020)             | 197         | <ul style="list-style-type: none"> <li>Natural environment</li> <li>Sensitive ecosystems</li> <li>Parks and greenways</li> <li>Climate change</li> <li>Natural hazards</li> <li>Economy and industry</li> </ul>                                     | <ul style="list-style-type: none"> <li>Transportation</li> <li>Infrastructure, cultural heritage resource</li> <li>Housing</li> <li>Land uses</li> </ul>   | 337, 2014      |

### 2.1 The Local and Regional Plans

#### 2.1.1 Comox Valley Regional Growth Strategy

The Comox Valley Regional Growth Strategy (RGS) was developed through a collaboration between the Comox Valley Regional District, the City of Courtenay, the Town of Comox, and the Village of Cumberland. The primary goal of the RGS is to establish a shared vision among local governments for future land use and to facilitate the development of policies over the next two decades, as required by the Local Government Act. The RGS aims to shape future growth based on local priorities and provincial government objectives, thereby aligning provincial programs, regulations, and mandates with community-based priorities. The RGS acts as a framework for making future decisions related to land use, with the overarching aim of preserving the region's quality of life (Comox Valley Regional District, 2018).

The RGS consists of three key components: (1) a vision statement for the Comox Valley region's future over a 20-year period, (2) projections for population and employment in the region, and (3) actions for addressing challenges such as housing, ecosystems, natural spaces, parks, local economic growth, transportation, infrastructure, food systems, public health and safety, and climate change.

The RGS is organized into five parts. The first two parts introduce the RGS process and context and provide a brief explanation of the challenges on which the RGS focuses. The third part outlines eight RGS goals, each accompanied by relevant policies. Part four contains guidance on managing growth through distinct regional land use designations. The fifth part of the document provides detailed information on implementing and monitoring the RGS.

### **2.1.2 Rural Comox Valley Official Community Plan**

The Rural Comox Valley Official Community Plan (OCP) was developed in November 2014 and adopted in November 2020. It captures shared values and goals of the rural residents of the Comox Valley region. The OCP contains policies to guide the actions (in terms of acceptable future development) of community members, developers, elected officials, real estate agents, and other regional actors. Along with the RGS, the Rural Comox Valley OCP provides direction for growth and change in the three electoral areas of the Comox Valley Regional District (Comox Valley Regional District, 2020).

The plan geographically targets the majority of the Comox Valley region's lands and waters, with the exceptions being the areas within municipal boundaries, Denman and Hornby Islands (which governed by Islands Trust), and the K'ómoks First Nation's lands. The OCP applies to rural settlement areas, electoral area commercial nodes, and resource lands. The plan also applies to certain coastal waters; however, there are jurisdictional overlaps, such as with Fisheries and Oceans Canada, the Integrated Land Management Bureau, and the K'ómoks First Nation, as well as a protocol agreement with Islands Trust for waters between Denman and Hornby Islands.

The Rural Comox Valley OCP consists of three parts: (1) community vision and context, (2) objectives and policies related to the natural environment, sensitive ecosystems, parks and greenways, climate change, natural hazards, economy and industry, transportation, infrastructure, cultural heritage resource, housing, and land uses, and (3) the administration of the region.

### **2.1.3 Town of Comox Official Community Plan**

The Town of Comox OCP is organized into five parts. Part 1 contains a vision statement, background information, the legal context of the OCP, the process for updating the OCP, the OCP's structure, the regional context statement, community values, and definitions of terms used in the OCP. Part 2 describes planning objectives and the relevant policies. Part 2 is divided according to different land use categories, and it includes considerations around residential and affordable housing, environmental health, transportation (both motorized and non-motorized), planning strategies for an aging population, and infrastructure services (e.g., water, sewage, and waste management). Part 2 also covers considerations around economic development, historical and cultural resources, prospective expansion of boundaries, and collaborative efforts between jurisdictions.

Part 3 of the OCP discusses Development Permit Areas (DPAs). A total of 18 types of DPAs are described; seven of these serve to protect natural environment and ecosystems, nine address the design and character of various developments, and one serves to protect developments from hazards. Part 4 of the OCP provides the mechanisms for implementing and monitoring progress toward achieving the OCP's objectives. Part 5 contains maps relevant to the OCP, such as maps that display the locations of DPAs.

### **2.1.4 City of Courtenay Official Community Plan**

The City of Courtenay OCP was developed through a collaborative process, which involved community members in how the city's future will be shaped over the next decade and beyond. The OCP describes strategies for achieving a vision, and it contains details on key challenges and priorities, including climate change, social inequity, community well-being, and relationships between Indigenous and non-Indigenous communities (City of Courtenay, 2022).

This OCP was developed and approved by the City Council in compliance with the Provincial Local Government Act. It serves as a policy framework for guiding decisions about growth, development permissions, and other community concerns such as housing and infrastructure. The OCP is effective until 2031, and an increase of around 4,500 new residents in Courtenay is anticipated in this timeframe.

City of Courtenay OCP consists of five parts: (1) foundations, (2) growth management, (3) objectives and policies in street and transportation, building and landscape, affordable housing, natural environment, parks and recreation, municipal infrastructure, social infrastructure, arts, culture and heritage, food systems, and local economy, (4) implementation, and (5) local area plans.

### **2.1.5 Village of Cumberland Official Community Plan**

The Village of Cumberland OCP is the product of a comprehensive restructuring and enhancement of the municipality's previous 2004 OCP. The primary goal of developing the new OCP was to establish a framework of objectives, goals, and policies to direct land use planning and future land management decisions in Cumberland. The OCP provides guidance for translating vision, goals, objectives, and policies into actionable steps and initiatives (Village of Cumberland, 2022).

The OCP is organized into four parts. Part 1 provides an overview of the plan, explaining its purpose, scope, and connections to other plans. Part 1 also discusses the demographics of Cumberland and the consultation process used to develop the plan. Part 2 presents the community's long-term vision, goals, and objectives. Part 3 describes policies in the areas of land use, housing, heritage preservation, transportation, environmental conservation, and others. Part 4 discusses the implementation of policies, community engagement, monitoring strategies, and regulations for DPAs and heritage conservation areas.

### **2.1.6 K'ómoks First Nations Comprehensive Community Plan**

The K'ómoks First Nation Comprehensive Community Plan (CCP) was developed to articulate the community's aspirations, desires, needs, and visions for progress towards independence and self-determination. The CCP emphasizes the need to embrace and incorporate diverse viewpoints in planning and to exercise care and compassion within the relationships involved in planning. The CCP is intended to be a guide for the community's future, and it is complemented with a Community Action Plan (CAP) that outlines concrete steps for achieving goals. Both the CCP and CAP emphasize the importance of language, culture, and collective goals (K'ómoks First Nation, 2014).

The CCP has four parts. The first three parts respectively focus on (1) reflecting on the past, (2) understanding the present, and (3) envisioning the future. The final part of the CCP contains the CAP, which focuses on actions toward implementing the plan and achieving community goals.

## **2.2 Analysis and Results**

The analytical framework used in this research was prepared as a matrix that can be applied to examine areas of integration and gaps in planning and policy documents. The matrix displays the relationships that form between food systems, climate change, biodiversity, and community health issues, strategies, and considerations. The framework can be downloaded from the project website:

[www.triaslab.ca/cbh-nexus#tools](http://www.triaslab.ca/cbh-nexus#tools)

The application of the analytical framework to the Comox Valley plans resulted in two types of data: (1) the types of food-CBH systems elements that are present in each plan, and (2) the interactions and relationships found among these elements as identified in the plans. The results of the analysis are organized thematically and summarized in Table 2.

In all plans, the theme of *land and infrastructure* demonstrated notably high numbers of references and relationships with respect to those seen in the analytical framework. The analysis found that this theme formed numerous systems relationships with elements/nodes in the *biodiversity conservation practices* and *climate action and risks* themes, demonstrating the close associations and interconnections among these planning and policy areas.

**Table 2. Systems elements (ref.) and relationships (impacts) identified in Comox Valley plans**

| Nodes   | RGS        |            | Rural Comox OCP |            | Comox OCP  |            | Courtenay OCP |            | Cumberland OCP |            | Komox First Nations CCP |           |
|---|------------|------------|-----------------|------------|------------|------------|---------------|------------|----------------|------------|-------------------------|-----------|
|   | Ref        | Impacts    | Ref             | Impacts    | Ref        | Impacts    | Ref           | Impacts    | Ref            | Impacts    | Ref                     | Impacts   |
| 1- Biodiversity conservation practices        | 115        | 13         | 173             | 11         | 111        | 11         | 121           | 10         | 72             | 7          | 30                      | 7         |
| • Ecosystems integrity and health             | 36         | 2          | 60              | 2          | 53         | 1          | 69            | 2          | 51             | 2          | 18                      | 1         |
| • Water quantity and quality                  | 22         | 2          | 56              | 2          | 23         | 2          | 17            | 2          | 9              | 1          | 4                       | 2         |
| • Water resource management                   | 57         | 9          | 57              | 7          | 35         | 8          | 35            | 6          | 12             | 4          | 8                       | 4         |
| 2- Knowledge exchange                         | 8          | 4          | 10              | 9          | 8          | 5          | 46            | 18         | 56             | 16         | 19                      | 4         |
| • Training and education                      | 0          | 0          | 3               | 3          | 0          | 0          | 0             | 0          | 0              | 0          | 0                       | 0         |
| • Awareness improvement programs              | 8          | 4          | 4               | 4          | 2          | 2          | 27            | 11         | 51             | 13         | 19                      | 4         |
| • Community integration                       | 0          | 0          | 0               | 0          | 0          | 0          | 0             | 0          | 5              | 3          | 0                       | 0         |
| • Public awareness                            | 0          | 0          | 3               | 2          | 6          | 3          | 19            | 7          | 0              | 0          | 0                       | 0         |
| 3- Climate actions and risks                  | 231        | 31         | 132             | 31         | 173        | 45         | 284           | 56         | 179            | 37         | 27                      | 11        |
| • Crisis management                           | 25         | 5          | 33              | 10         | 14         | 6          | 22            | 8          | 43             | 12         | 6                       | 3         |
| • Emission reduction programs                 | 67         | 11         | 8               | 4          | 9          | 7          | 49            | 15         | 24             | 4          | 3                       | 2         |
| • Energy efficiency in buildings              | 14         | 3          | 1               | 1          | 10         | 6          | 45            | 10         | 5              | 2          | 0                       | 0         |
| • Green space conservation                    | 92         | 10         | 70              | 11         | 100        | 15         | 113           | 15         | 87             | 16         | 7                       | 3         |
| • Agri resilience                             | 0          | 0          | 2               | 1          | 6          | 3          | 10            | 2          | 0              | 0          | 0                       | 0         |
| • GHG emissions reduction                     | 19         | 1          | 8               | 2          | 8          | 3          | 23            | 3          | 10             | 1          | 2                       | 1         |
| • Natural disasters and climate risks impacts | 14         | 1          | 10              | 2          | 21         | 3          | 20            | 2          | 10             | 2          | 9                       | 2         |
| • Increased adoption of renewable energy      | 0          | 0          | 0               | 0          | 5          | 2          | 2             | 1          | 0              | 0          | 0                       | 0         |
| 4- Government and social support              | 16         | 5          | 30              | 11         | 19         | 10         | 69            | 22         | 49             | 14         | 7                       | 5         |
| • Governmental financial supports             | 1          | 1          | 11              | 6          | 4          | 3          | 20            | 12         | 19             | 6          | 0                       | 0         |
| • Poverty reduction programs                  | 0          | 0          | 0               | 0          | 0          | 0          | 4             | 2          | 0              | 0          | 0                       | 0         |
| • Current and comprehensive dataset           | 8          | 2          | 2               | 1          | 1          | 1          | 25            | 5          | 2              | 1          | 2                       | 1         |
| • Local economic improvement                  | 3          | 1          | 6               | 2          | 10         | 2          | 8             | 2          | 13             | 6          | 3                       | 3         |
| • Social justice and equity                   | 4          | 1          | 11              | 2          | 1          | 1          | 12            | 1          | 15             | 1          | 2                       | 1         |
| • Human and financial resources               | 0          | 0          | 0               | 0          | 3          | 3          | 0             | 0          | 0              | 0          | 0                       | 0         |
| 5- Food systems                               | 87         | 29         | 102             | 25         | 32         | 18         | 77            | 31         | 27             | 11         | 5                       | 5         |
| • Farming techniques                          | 10         | 8          | 6               | 5          | 3          | 3          | 7             | 6          | 0              | 0          | 0                       | 0         |
| • Food Justice programs                       | 0          | 0          | 0               | 0          | 0          | 0          | 8             | 5          | 0              | 0          | 0                       | 0         |
| • Shellfish farming                           | 12         | 4          | 5               | 3          | 4          | 3          | 0             | 0          | 0              | 0          | 2                       | 2         |
| • Support global food market                  | 0          | 0          | 0               | 0          | 0          | 0          | 0             | 0          | 0              | 0          | 0                       | 0         |
| • Support local food market                   | 5          | 3          | 3               | 3          | 4          | 4          | 23            | 7          | 2              | 2          | 0                       | 0         |
| • Support local foods                         | 45         | 8          | 36              | 8          | 8          | 3          | 31            | 9          | 18             | 7          | 2                       | 2         |
| • Food affordability                          | 0          | 0          | 0               | 0          | 0          | 0          | 1             | 1          | 0              | 0          | 0                       | 0         |
| • Food diet                                   | 0          | 0          | 0               | 0          | 0          | 0          | 2             | 1          | 0              | 0          | 0                       | 0         |
| • Food resilience                             | 3          | 3          | 0               | 0          | 1          | 1          | 3             | 1          | 1              | 1          | 1                       | 1         |
| • Increased local food production             | 12         | 3          | 52              | 6          | 10         | 3          | 2             | 1          | 6              | 1          | 0                       | 0         |
| • Reducing food miles                         | 0          | 0          | 0               | 0          | 2          | 1          | 0             | 0          | 0              | 0          | 0                       | 0         |
| 6- Human health                               | 47         | 8          | 5               | 3          | 8          | 3          | 35            | 8          | 27             | 9          | 6                       | 3         |
| • Community health programs                   | 9          | 3          | 4               | 2          | 8          | 3          | 7             | 2          | 9              | 5          | 1                       | 1         |
| • Health risks                                | 0          | 0          | 0               | 0          | 0          | 0          | 0             | 0          | 0              | 0          | 0                       | 0         |
| • Mental health and wellbeing                 | 18         | 3          | 0               | 0          | 0          | 0          | 17            | 4          | 9              | 2          | 1                       | 1         |
| • Physical health                             | 20         | 2          | 1               | 1          | 0          | 0          | 11            | 2          | 9              | 2          | 4                       | 1         |
| 7- Land and infrastructure                    | 308        | 45         | 282             | 35         | 284        | 43         | 501           | 58         | 291            | 44         | 42                      | 13        |
| • Affordable housing programs                 | 54         | 7          | 11              | 4          | 41         | 8          | 65            | 9          | 38             | 11         | 3                       | 2         |
| • Enhancing active transportation             | 72         | 10         | 12              | 2          | 56         | 11         | 62            | 13         | 43             | 9          | 4                       | 2         |
| • Land-use governance                         | 150        | 21         | 240             | 23         | 139        | 15         | 318           | 25         | 188            | 20         | 35                      | 9         |
| • Affordable housing availability             | 23         | 3          | 8               | 2          | 21         | 2          | 17            | 4          | 12             | 2          | 0                       | 0         |
| • Increased accessibility                     | 6          | 3          | 5               | 1          | 8          | 2          | 28            | 2          | 8              | 1          | 0                       | 0         |
| • Land availability and affordability         | 0          | 0          | 0               | 0          | 6          | 2          | 4             | 2          | 0              | 0          | 0                       | 0         |
| • Population needs and demographic changes    | 3          | 1          | 4               | 2          | 10         | 2          | 6             | 2          | 0              | 0          | 0                       | 0         |
| • Traffic congestion                          | 0          | 0          | 2               | 1          | 3          | 1          | 1             | 1          | 2              | 1          | 0                       | 0         |
| 8- Waste challenges and management            | 4          | 1          | 2               | 1          | 8          | 5          | 14            | 6          | 2              | 2          | 0                       | 0         |
| • Waste resource management                   | 4          | 1          | 2               | 1          | 6          | 3          | 14            | 6          | 2              | 2          | 0                       | 0         |
| • Waste reduction                             | 0          | 0          | 0               | 0          | 2          | 2          | 0             | 0          | 0              | 0          | 0                       | 0         |
| <b>Total</b>                                  | <b>816</b> | <b>136</b> | <b>736</b>      | <b>126</b> | <b>643</b> | <b>140</b> | <b>1147</b>   | <b>209</b> | <b>703</b>     | <b>140</b> | <b>136</b>              | <b>48</b> |



The RGS contained many elements related to the *land and infrastructure* theme, with these primarily centering on land-use governance and transportation. In contrast, the theme of *waste challenges and management* was the least featured in the RGS. This may be due to how the plan particularly focuses on considerations related to growth and development.

Most of the *land and infrastructure* elements in the RGS appear to have systems relationships with, and exert impacts on, other systems elements related to the themes of *biodiversity and conservation practices* and *climate action and risks*. The theme of *climate action and risks* also formed numerous relationships with elements in the theme of *biodiversity and conservation practices*. Specific examples include the relationships that are seen with the RGS's goals for protecting ecosystems, natural areas, and parks.

Similar to the RGS, the *land and infrastructure* theme was most featured in all OCPs, while *waste challenges and management* and *knowledge exchange* were least featured. The OCPs also demonstrated strong integration of considerations related to the *land and infrastructure*, *biodiversity and conservation practices*, *climate action and risks*, and *food systems* themes. Examples include (1) the designation of environmentally sensitive areas and agricultural preservation in housing and land-use planning, (2) efforts around connecting transit networks to greenways for enhanced active transportation and reduced greenhouse gas emissions, (3) plans to assess greenhouse gas emissions impacts of different land-use patterns, (4) the provision of local food services and markets, (5) advocacy around reducing pesticide usage when integrating agricultural lands with other land uses to minimize potential impacts to human health, and (6) the integration of land development and food production spaces.

In the K'ómoks CCP, the theme of *land and infrastructure* also featured most prominently, while the theme of *waste challenges and management* featured the least. Once again, the analysis found that the *land and infrastructure* theme formed the most relationships with systems elements in the themes of *biodiversity and conservation practices* and *climate action and risks*. The CCP identifies the impact of land ownership and authority on environmental resources, habitat preservation, and local food production. The plan also discusses the economic significance of hunting, trapping, and fishing in the community.

The CCP emphasizes Indigenous Peoples rights to manage their land and environment, along with the importance of empowering Indigenous communities so that they can effectively manage the developed and natural areas of their lands. These are key planning and governance considerations; however, due to how the analytical framework was developed in this research (i.e., being based on the food-CBH system), such considerations were not incorporated into the matrix and captured in the analysis. This reveals a limitation of the framework, and it emphasizes the importance of adapting the framework to different place-based and cultural contexts.

## 2.3 Conclusions and Recommendations

This study demonstrated how planning in the Comox Valley captures the interconnectedness among different local development and sustainability considerations, particularly among the themes of *land and infrastructure*, *biodiversity conservation practices*, and *climate action and risks*. The analysis also revealed that far less attention was given to the areas of *knowledge exchange* and *waste challenges and management* in the plans. Accordingly, future planning could give more attention to these areas, particularly with respect to their integration with other planning areas and strategies.

Based on the findings of the study, several key recommendations are given here:

- 1) **Sections dedicated to food systems:** Create distinct sections in plans that specifically address food systems issues and priorities. These sections should outline strategies related to food systems, taking into account their implications for climate mitigation, land use, biodiversity conservation, and human health.
- 2) **Comprehensively capture interconnections among strategies:** Emphasize the importance of holistic approaches by articulating the interconnections among various strategies in the plans, particularly those related to land use, housing, food, and human health.
- 3) **Integration of local food-based economic development:** Incorporate considerations around enhancing local food economies when devising and discussing economic development strategies and objectives in plans.
- 4) **Incorporation of local knowledge:** Identify and articulate strategies for incorporating local knowledge (including that of Indigenous communities, non-governmental organizations, and community members) in the development, implementation, and monitoring of plans. This could be included in plans as distinct sections dedicated to local knowledge and inclusion.
- 5) **Stronger inclusion of waste management:** Identify and incorporate strategies related to waste management (e.g., waste diversion, recycling, upcycling, composting) into the plans to better address environmental sustainability issues and promote responsible resource usage.
- 6) **Sections dedicated to biodiversity conservation:** Include full sections in the plans that are specifically dedicated to biodiversity conservation, and in these sections, identify the relationships and tensions among land use, transportation planning, and biodiversity conservation activities and strategies.

### 3. Systems Analysis

Integrated community planning that employs systems thinking can be used for making progress toward local food systems sustainability, as such approaches to planning enable recognition and understanding of the complexity and diversity of these systems (Issac et al., 2022). In this section, we discuss research that applied systems analysis techniques to explore different components of the food system of the Comox Valley region and their relationships with the CBH nexus. The results of the analysis provide insights into the opportunities and needs for effective integrated planning that can support progress toward local sustainability and resilience.

Specifically, this systems analysis research aimed to: (1) capture stakeholder knowledge and understanding of the interconnectedness of challenges and strategies surrounding food systems planning and the CBH nexus, and (2) detect clusters or groupings of different components of the food-CBH system.

#### 3.1 Methods and Analysis

This research engaged stakeholders and applied a mixed-method approach to data collection and analysis. Interview data collected in the first phase of the research was used to develop a series of causal loop diagrams (CLD). CLDs are graphical representations of the relationships among system components and their dynamic behavior. These types of diagrams serve to improve comprehension of causality between individual components within a system and how they operate as a 'whole', that is, a set of components (Castro, 2022).

We used a similar approach to the methods employed by Gholipour et al. (2023) to create the CLDs, which involved identifying system components and their causal relationships from excerpts in the interview transcripts. We then applied network analysis techniques, namely techniques to identify clusters within the systems that form through high interconnectedness among certain system components.

We used Gephi for this analysis, and using network analysis techniques, we examined the following characteristics of the system:

- Centrality - the level to which a system component connects other systems components through direct and indirect relationships
- In-degree - the number of relationships a system component forms with other systems components where it is being influenced/impacted by the other components
- Out-degree - the number of relationships a system component forms with other systems components where it influences/impacts the other components

The final analytical technique used in the systems analysis involved applying the Girvan-Newman algorithm to identify tightly-knit groups of systems components within the system. The results of this work revealed densely interconnected clusters (also known as 'communities') within the system.

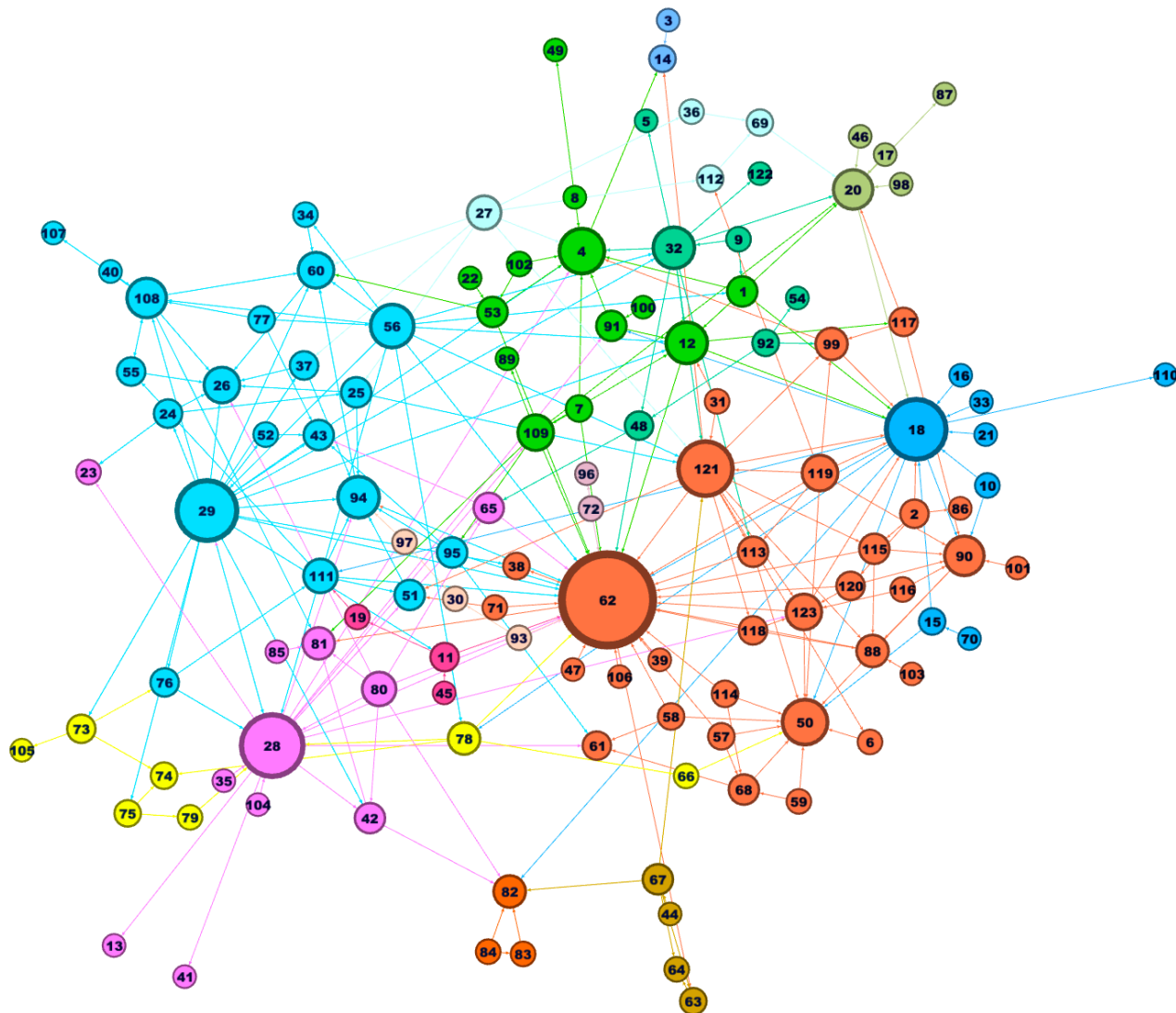
## 3.2 Results

### 3.2.1 Food Systems and CBH Nexus

The systems map produced through this work consisted of 123 systems elements (i.e., nodes) and 275 relationships (i.e., edges). Of the 123 nodes, the majority relate to food (n=48), while the others relate to climate (n=13), biodiversity (n=23), and health (n=17). An emergent category of governance (n=22) was identified through the analysis, which consisted of nodes that did not distinctly fit within the food, climate change, biodiversity, or health categories. The systems map is shown in Figure 1.

**Figure 1. Systems map of food and CBH nexus in the Comox Valley region**

Each node is assigned a identification number (see [www.triaslab.ca/cbh-nexus#tools](http://www.triaslab.ca/cbh-nexus#tools) to download the Gephi project with all the node names and identification numbers). Node clusters are identified through colours. The node sizes in the map represent their centrality values within the system.



The nodes with the highest centrality values were food availability and production, community mobilization, partnerships, climate risks, and regenerative agriculture (Table 3). Each of these high-centrality nodes formed 18 or more connections/relationships within the systems map.

A summary of key findings is presented below, organized by the categories of food, climate change, biodiversity, health, and governance.

**Table 3. List of nodes with high connectivity within the food-CBH system**

\* Category codes in the table below refer to food (F), climate change (C), biodiversity (B), and governance (G)

| Id  | Node                            | Category* | Community-ID | Indegree | Outdegree | Degree (Centrality) |
|-----|---------------------------------|-----------|--------------|----------|-----------|---------------------|
| 62  | Food availability & production  | F         | 10           | 34       | 4         | 38                  |
| 28  | Community mobilization          | G         | 13           | 8        | 14        | 22                  |
| 18  | Climate risks                   | C         | 12           | 13       | 8         | 21                  |
| 29  | Partnerships                    | G         | 14           | 2        | 19        | 21                  |
| 121 | Regenerative agriculture        | F         | 10           | 7        | 11        | 18                  |
| 4   | Habitat conservation            | B         | 5            | 11       | 2         | 13                  |
| 50  | Local farms                     | F         | 10           | 13       | 0         | 13                  |
| 56  | Funding limitation              | G         | 14           | 1        | 11        | 12                  |
| 32  | Training and skill development  | G         | 4            | 3        | 8         | 11                  |
| 12  | Climate resilience              | C         | 5            | 7        | 4         | 11                  |
| 94  | Food aggregation & distribution | F         | 14           | 9        | 2         | 11                  |
| 20  | GHG emissions                   | C         | 0            | 8        | 2         | 10                  |
| 90  | Water scarcity                  | B         | 10           | 8        | 2         | 10                  |
| 108 | Housing security                | G         | 14           | 5        | 5         | 10                  |

**Food:** Factors like climate change, funding, and workforce availability impact food availability and production. Funding constraints and outdated agricultural practices hinder progress toward local food sustainability and resilience. Climate change and risks can drive interest in exploring different agricultural techniques and methods such as regenerative agriculture; however, barriers related to funding and market demand create challenges around the adoption of these techniques.

**Biodiversity:** Water scarcity and habitat conservation are key environmental concerns. Strategies like drip irrigation can (in part) address water scarcity, while scarcity becomes a more severe issue with climate change. Conservation efforts that target habitat preservation are enhanced when they involve community collaboration, such as seen with initiatives like Project Watershed. Additionally, training programs that support regenerative agriculture and sustainable agriculture practices have the potential to build resilience against climate change-induced extreme weather events, while also enhancing wildlife habitat.

**Climate change:** Climate change presents risks and disruptions to food availability and water resources, and there is a need to identify and use climate-resistant crops. In addition, new infrastructure is needed to adapt to climate change and its impacts on community health, such as building heating/cooling centres to support community members during extreme weather events. Climate change also forms systems relationships with air quality and deforestation, and concerns around these issues can stimulate research, funding, and actions in areas such as the expansion of green space.

**Governance:** Effective community mobilization can benefit food, biodiversity, and climate objectives. Partnership initiatives have the potential to enhance conservation efforts and climate resilience work. However, funding limitations and communication gaps hinder progress in such areas. Increases in government support of, and resources for, community-driven initiatives are needed.

**Health:** COVID-19 impacted/impacts physical and mental health, especially for vulnerable groups. Simultaneously, rising housing prices exerted/exert a compounding impact on mental health and people's financial ability to access to healthy food. Furthermore, there are increasing concerns about the impact of forest fire smoke on respiratory health.

### 3.2.2 Exploring the Underlying System Characteristics

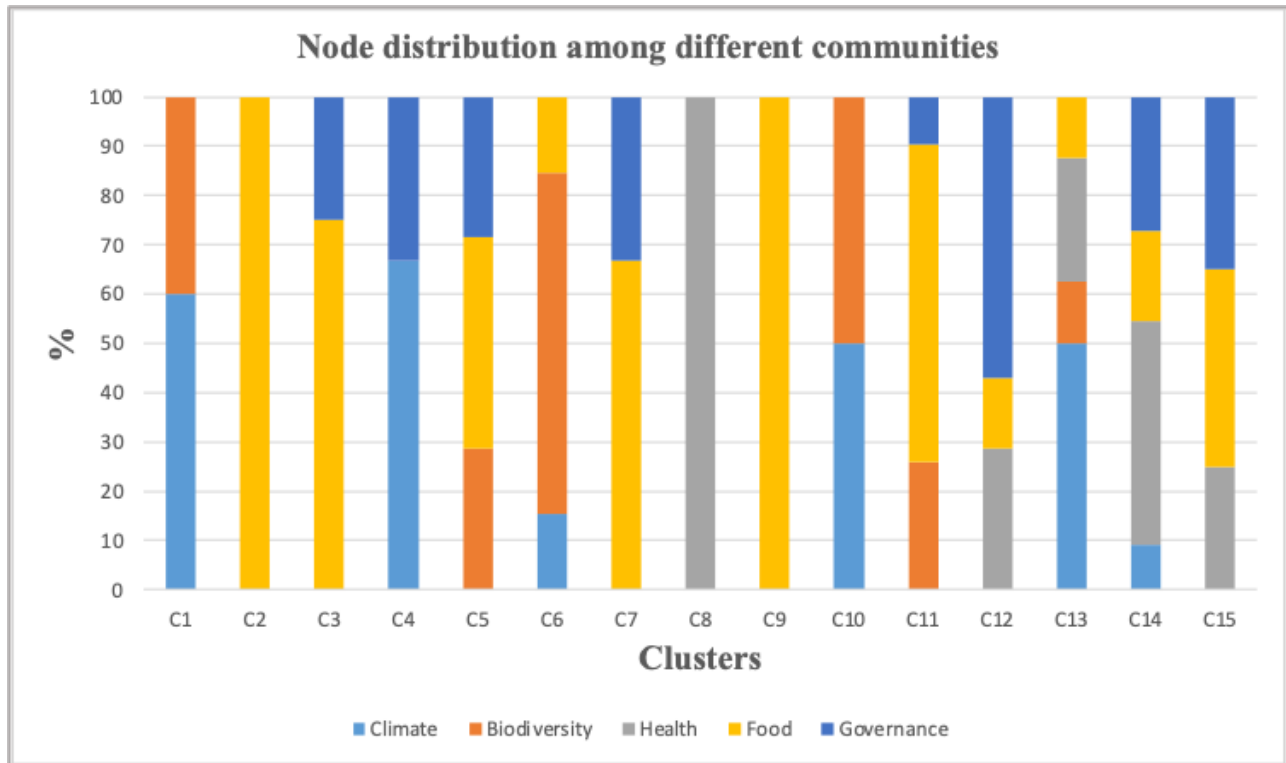
The analysis identified 15 clusters in the system, with the largest consisting of 31 nodes and the smallest having 2 nodes (Table 4). C11, C15, C6, C14, and C13 are the largest clusters in the system, and C4, C7, C8, C10, and C2 are clusters that only consist of three or fewer nodes.

**Table 4. List of nodes clusters identified in the food-CBH system**

| Cluster | Nodes  |
|---------|--|
| C1      | GHG emissions   Measure GHG emission   Air quality<br>Promoting reuse   Transportation network plan  |
| C2      | Unsustainable consumption   Food waste diversion   |
| C3      | Colonial agriculture practices   Food justice   Indigenous food sovereignty   Policy effectiveness monitoring/updating   |
| C4      | Climate adaptation   Flooding   Regional growth strategy   |
| C5      | Training and skill development   Backyard farms   Agriculturally enabling zoning bylaws   Water stewardship   Nitrogen management   Urban agriculture<br>Rotational grazing  |
| C6      | Habitat conservation   Climate resilience   Public greenspace   Shellfish aquaculture & habitat   Coastal restoration   Watershed health   Project watershed   Plastic debris   Urban forest management plan   Increase in ocean temperature   Surface water conservation   Poor rainwater management   Community Garden   |
| C7      | Community-supported agriculture   Marketing local produce   Promote small business   |
| C8      | Physical health   Respiratory illness   Wood smoke   |
| C9      | Community organization support   Food waste   Composting   Food greening program   |
| C10     | Carbon sequestration   Forage project  |
| C11     | Food availability & production   Regenerative agriculture   Local farms   Water scarcity   Organic farming   Climate resistant crops   Soil health   Deforestation   Expensive local produce   Cover crops   Drip irrigation/Micro-irrigation   Access to local foods   Mixed livestock farm   No-tillage   Rainwater harvesting   Dugout ponds   Crop diversification   School food program   Maintenance costs   Price competition (against global chains)   Pollinator vegetation   Superstore (large chain) dominance   Hedge rows   Research and development   Uncertain market demand   Dependence on groundwater   Over pumping   Wood waste   Tree fruit replacement program   Farmland housing densification policies   Agricultural land reserve |
| C12     | Workforce shortage   Bureaucracy   Delayed action   Government <a href="#">siloes</a>   Abattoir availability   Top-down approach   Employment   |
| C13     | Climate risks   Commercial greenhouse   Water treatment plant   Heating/cooling centres   Global warming   Use of social media   Quality of life   Pest infestation  |
| C14     | Community mobilization   COVID-19   Mental health   Local produce awareness   Emergency planning & services   BIPOC participation   Climate risk awareness   Mental health services   Food and agriculture task force   Community focused projects   Creating walkable neighborhood  |
| C15     | Partnerships   Funding limitation   Food aggregation & distribution   Housing security   Access to healthy foods   Vulnerable groups   Supply chain disruption   Local food producers   Food hub   Indigenous participation   Mandate to support local farmers   Diversity and inclusion   Good food box program   Cost of living   Communication gap   Government support   Local restaurants   Coupon program   Affordable housing   Homelessness  |

Figure 2 displays how the different clusters relate to the categories of food, climate change, biodiversity, health, and governance in terms of the percentages of the nodes that pertain to each of the categories. In the following paragraphs, we describe a few of the clusters, their components, and their systems relationships and interactions.

**Figure 2. Cluster relationships to food, climate change, biodiversity, health, and governance**



The C14 cluster contains 11 nodes, and it is interesting in that these nodes pertain to a variety of different categories. The cluster includes health-related nodes, such as COVID-19, mental health, mental health services, emergency planning and services. The cluster also contains governance-related nodes, such as community mobilization and community-focused projects. Additionally, food- and climate-related nodes are found within the cluster, including local product awareness and climate risk awareness. The tight relationship among these nodes indicates a need for collaboration among local health, climate, and food specialists in planning processes to determine how to address these interconnected local and regional challenges.

The C6 cluster is another interesting example. C6 consists of 13 nodes, including those related to ecological risks (e.g., plastic debris and poor rainwater management) and those related to strategies for address such risks, including increasing public greenspace, community gardens, and surface water conservation. Community gardens have also been described as a strategy for strengthening social connectivity in a community and building civic engagement through food production; however, as noted by other researchers (Drake & Lawson, 2015), the success of community gardens requires that they are integrated with broader initiatives and objectives (i.e., rather than being isolated, one-off efforts), as well as sustained by financial resources beyond just an investment in their initial setup and establishment.

Examples of smaller clusters include C9, which consists of nodes related to food waste and strategies for reducing waste. The C7 cluster also relates to food, but with a focus on improving the local food economy. C7 consists of three nodes, these being community-supported agriculture, marketing local produce, and promoting small businesses in the Comox Valley region. The interconnectivity of these nodes suggests that a coordinated implementation of such local food strategies holds the potential to boost the local food economy and support local food markets.

As a final example, the C12 cluster captures a set of interrelated governance-related challenges, these being bureaucracy, delayed action, government siloes, top-down approach, and workforce shortage (which affects the availability of government workers). These challenges need to be considered and addressed with respect to their interconnectivity and how the issues interact and compound one another.

### **3.3 Conclusions**

This research used stakeholder knowledge to map the food-CBH system in the Comox Valley region. The systems mapping work was useful for identifying cause-and-effect relationships among different components of the food-CBH system. Food production, availability, and accessibility are foundational to food systems, and these are adversely impacted by climate change and degrading biodiversity. Such impacts result in poor community health outcomes. Local governments, community organizations, and stakeholders must collaborate to address the complex and interrelated challenges associated with food, climate change, biodiversity, and health. Good governance involves coordinating and integrating actions and efforts among these four planning and policy areas.

By visualizing and analyzing food systems components and relationships, planners and decision-makers can better understand the direct and indirect consequences of implementing certain actions and strategies. Additionally, using systems and network analysis techniques to identify clusters within the food-CBH system can reveal opportunities for collaboration, such as ways of forming partnerships between different organizations to address food system challenges that are tightly connected with issues related to other critical planning and policy areas. In this way, system mapping and analysis can be used to identify key organizations, stakeholders, and actors to be included in planning processes for developing and implementing integrated plans and strategies.



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