INTEGRATED LANDSCAPE PLANNING AND ASSESSMENT IN THE SOUTH OKANAGAN, BRITISH COLUMBIA

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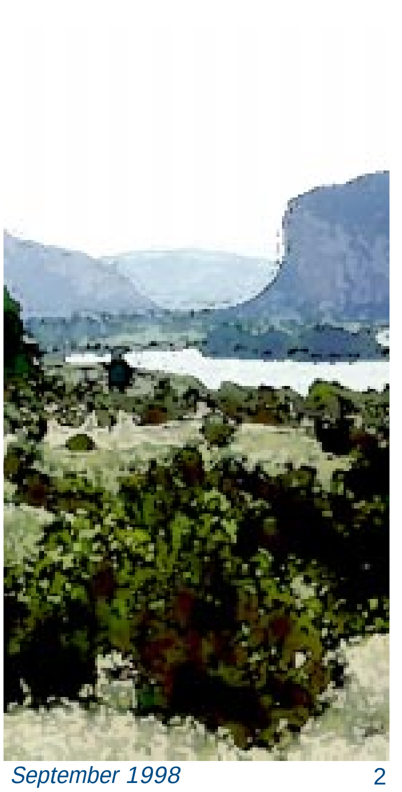
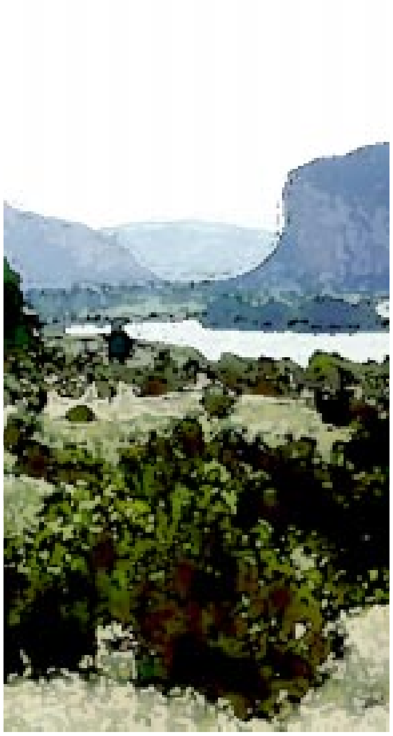
TABLE OF CONTENTS





EXECUTIVE SUMMARY

This proposal sets forth a framework for the organization and development of planning tools and techniques that support informed land use decision making. It is a proposal to provide a prototypical example of integrated landscape planning and assessment in one of the most threatened ecosystems in Canada. In doing so, the results of the study will serve as a precursor to the development of an integrated plan for the region.

The intent of the project is to examine the connections between land use activities and the consequent stresses on ecological, visual/cultural, and economic resources of the area. In order to support land use planning in the area, the study will develop a suite of computer-based simulation models which examine the multi-sectoral impacts of different future land use scenarios. A range of alternative future scenarios will identify possible regional futures, some of which represent an emphasis on single sector interests, while others seek more of a balance among interests. Scenarios will have a conservation, agriculture, or maximum urban development emphasis as well as various balanced alternatives that seek to accommodate a variety of ecological and development requirements.

The work will have two major thrusts; namely, the development of a defensive strategy of conservation and an offensive strategy of development accommodation. The defensive strategy will identify which areas must be protected, conserved and linked in order to maintain ecological integrity. The offensive strategy will identify how to best accommodate projected growth and development. In this way, both conservation and development objectives may be balanced in a manner that best meets their differing needs.

The intent of the project is to examine the connections between land use activities and the consequent stresses on ecological, visual/cultural, and economic resources.

The study will use a landscape planning approach that crosses local jurisdictional boundaries and provides pragmatic solutions that are based upon physical form (the shape, size, and configuration of both the urban and rural landscapes). The work will utilize and bridge the current planning efforts between that occurring on crown lands at the regional scale (the Land and Resource Management Plan- LRMP) and that at finer scales on private lands (the regional district Growth Management Strategy and local Municipal Development Plans).

In order to rationalize all work and to maximize the effectiveness of the project, the proposed integrated planning methodology organizes the work into several basic areas (Steinitz, 1990).

1. Representation - data that describes the existing landscape in context, space, and time. Most data will be coordinated within a computer-based Geographic Information System (GIS), in order to display and analyze the data in a spatially explicit manner.

2. Process - processes that are critical to planning will be described, including landscape functional and structural relationships. These processes will be used to construct impact and evaluation models.

3. Evaluation - the existing landscape will be evaluated. Ecological, visual/cultural, and economic criteria such as biodiversity, risk to aquatic integrity, wildfire potential/risk, visual quality, cultural resource protection, cost of public infrastructure, accommodation of projected population, etc. will be some of the metrics of evaluation. The evaluation of the existing conditions provides a baseline measure against which the impact of future change will be compared.

4. Change - A range of alternative future scenarios will identify possible future changes representing a range of sectoral emphases and balanced future objectives. The existing conditions will be mapped for comparison. Pending the availability of data, a

historical scenario representing the landscape in the 1800s will be developed as an additional measure of change.

5. Impact - the impacts of alternative future scenarios will be modeled using the same criteria used in the evaluation of the existing landscape. The measurable differences between the existing and future conditions reveals how the alternative scenarios impact (either positively or negatively) the criteria upon which land use decisions are made.

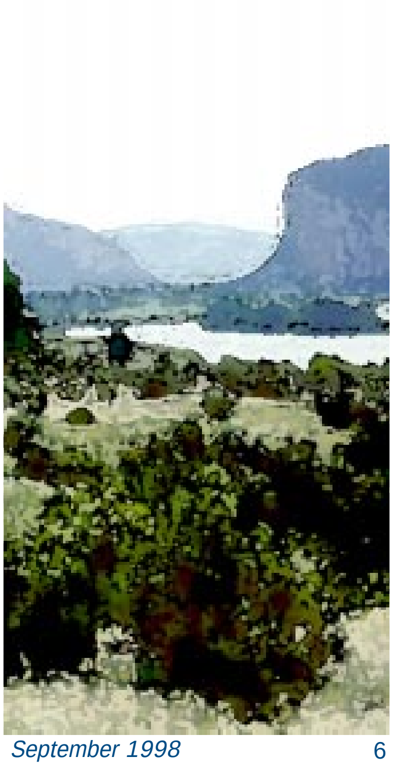
6. Decision - The actual land use planning processes will NOT be interfered with. Rather, the study seeks to support those processes by providing detailed, spatially explicit information in order to better inform decision making.

The work seeks to utilize and integrate existing data and previous work wherever possible. Efficiency of effort, identification of minimum data requirements, cost effectiveness and pragmatic, tangible results are some of the major goals of the study. There will be no duplication of the effort of others and all available sources of information, models and data will be integrated as appropriate. The project will be an example of integration, co-operation and mutual institutional support. All products and results will be available to the various planning bodies in the study area.

The study will fill an important yet currently vacant niche in planning in the region in that it addresses, simultaneously, the requirements of both conservation and development. It recognizes that success for one is dependent upon accommodation of the other. The project also bridges, utilizes and supports the efforts of the LRMP, the Regional Growth Strategy and the various municipal development plans. Successful integration of these planning levels has been exceedingly rare and the project will provide a prototypical example of how that coordination may actually be accommodated. In doing so, it will support the stated policy objectives of several federal agencies and provincial ministries as well as contributing to the protection and wise use of highly valued and nationally important landscapes.

The study will fill an important yet currently vacant niche in planning in the region in that it addresses, simultaneously, the requirements of both conservation and development.

INTRODUCTION



INTRODUCTION

The planning and management of sustainable landscapes must adopt a view that encompasses a variety of spatial extents and periods of time. In addition, planning methods must integrate a comprehensive set of ecological concerns and a wide spectrum of human interests and values. The challenge is great and examples of real success in regional planning are exceedingly rare. In response to these issues, this proposal sets forth a framework for the organization and development of planning tools and techniques that support informed decision making. It is a proposal to provide a prototypical example of integrated landscape planning in one of the most threatened ecosystems in Canada (Mosquin et al., 1995). In doing so, the results of the study will serve as a precursor to the development of an integrated plan for the region.

Recent research and past experience indicate that planning for sustainable environments has the greatest likelihood of success at the landscape level (Forman, 1995). While the landscape scale is particularly useful, differing processes require varying scales of investigation (Turner and Gardner, 1994). Therefore a hierarchy of scales is required for both description of the landscape and the examination of major processes and impacts. Many, if not most, land planning problems require solutions that cross jurisdictional boundaries. Water, species, fires, capital and humans flow freely across jurisdictional boundaries and optimal solutions are rarely found by planning the whole in parts. Currently, many finer scale plans are carried out with limited consideration of broader scale issues or the impact that local decisions may have to more regionally based concerns. Opportunities for success are greater if the area under consideration encompasses the major flows and exchanges.

Planning that fails to simultaneously address both ecological and development pressures will result in outcomes that fall far short of the requirements for either.

Only in the past 5 to 10 years have technology and theory combined to provide the opportunity to comprehensively address the complexity of landscapes within a regional context. This study proposes to work within a nested hierarchy of scales and across a number of disciplines to provide the information that decision makers require in order to make reasoned determinations. The work will have two major thrusts, namely, the development of a defensive and an offensive strategy. The defensive strategy will identify areas that must be protected, conserved and linked. The offensive strategy will identify how best to accommodate projected change; i.e. areas that are most suitable for development and the required infrastructure to support that growth. In this way, both conservation and development objectives may be balanced in a way that best meets their differing needs. Planning that fails to simultaneously address both ecological and development pressures will result in outcomes that fall far short for either.

This study seeks to utilize and integrate existing data and previous work wherever possible. Efficiency of effort, identification of minimum data requirements, cost effectiveness and pragmatic, tangible results are some of the major goals of the study. There will be no duplication of the efforts of others and all available sources of information, models and data will be utilized and integrated as appropriate. The project will be an example of integration, co-operation and mutual institutional support. Every effort will be made to ensure that local, regional, provincial, and federal planning agencies are supported by the project.

Why the South Okanagan?

- The region is one of three biodiversity hotspots in Canada with a greater than average number of endangered species.
- It provides habitat for approximately 45% of B.C. 's red and blue listed vertebrates.
- The area is experiencing dramatic growth with human populations expected to roughly double in the next twenty years.
- A considerable amount of information and research about the area and its resources has been generated, but not integrated.
- Interest in the area is high amongst both conservationists and developers.
- Integration across planning scales has not been adequately addressed.
- It is a highly valued region to both visitors and residents alike.
- There is still time to make a difference.

Note: While the overall approach of this proposal is applicable to any landscape undergoing rapid change, the details of the methodology are subject to change based upon review and input into the proposal.

BACKGROUND

In Canada, the antelope brush and sagebrush grasslands of the South Okanagan is one of three biodiversity hotspots in Canada (Mosquin, 1995) with a greater than average number of endangered species. In response to this threat, the South Okanagan Conservation Strategy (SOCS) was initiated in 1990 to prioritize management activities for the conservation of natural habitats. As a result of the SOCS efforts, many species were added to the listed of threatened or endangered by the Committee on the Status of Endangered Wildlife in Canada. In response, planning under the Committee on the Recovery of Endangered Wildlife (RENEW) began. Recovery and conservation efforts to date have focused on minimizing exposure to human activities through the establishment of networks of protected areas and limited stewardship activity and have not addressed the parallel issue of management in developed areas. The long term conservation of biodiversity in the region is highly dependent on maintaining hospitable habitats and viable populations on private lands as well as within public areas.

With the growing number of species of concern, their diversity of ecological requirements, and the location of critical habitat in a mix of both public and private ownership, it became apparent that a broader approach was needed. As a consequence, the South Okanagan Ecosystem Recovery Plan (1997) was initiated. Many, but not all, perspectives on the problem were represented and the impacts of various land use decisions was not addressed in a comprehensive manner. While the LRMP process does address many interests, it does not deal with activities on private lands or within incorporated municipalities. Regional growth management strategies initiated by the regional planning district have not been completed and local municipal development plans have not fully incorporated impact analysis. As a result, an approach to planning and analysis that fully integrates multi-sectoral interests in a spatially explicit manner would be useful.

The antelope brush and sagebrush grasslands of the South Okanagan is one of the three biodiversity hotspots in Canada (Mosquin, 1995) with a greater than average number of endangered species.

PROJECT INTENT & OBJECTIVES

This project supports the activities of a future land use scenario study for the South Okanagan. The intent of the project is to examine the connections between land use activities and the consequent stresses on ecological, visual/cultural, and economic resources of the study area. The project will conduct a future scenarios study which is intended to identify the range of potential futures for the area and their associated impacts. A set of simulation models will be assembled that may be used by regional and local planners to model the potential impacts of future plans as they change and evolve. Therefore, the overriding objective is to provide a suite of planning methods and tools that may be used to support future planning in the area and that will provide a prototypical example for other landscape planning projects in the country.

The major objective of the study is to provide a framework for integrating current research, conservation and planning efforts in the study area by spatially articulating and quantitatively evaluating the impacts of alternative land use scenarios.

Consideration of past and plausible future landscape trajectories for the region will require researchers and stakeholders to explicitly characterize how the study area has changed over time and to examine how proposed agents of change interact to produce different impacts under alternative futures. Future alternatives are based upon differing emphasis on varying sectoral interests and will help to identify detailed land pattern objectives as well as to identify areas of potential coincidence or conflict of objectives.

Areas where historical shifts in both land use and natural processes are most evident will be identified and used to assess potential impacts in other areas. Locations within the study area that are likely to experience significant land use transformation in the future will be identified and targeted for more detailed study.

The major objective of the study is to provide a framework for integrating current research, conservation and planning efforts in the region. The impacts of alternative land use strategies will be articulated spatially and quantitatively, providing valuable input to planners in the region.

The general objectives of the project are:

- To assemble a digital geographic information system (GIS) database to support landscape planning in the highly threatened antelope-brush and sagebrush grasslands of the South Okanagan.

- To provide a framework for the integration of existing and future cross disciplinary and multiple institutional efforts.

- To develop a set of planning tools (models and methods) that are based on sound principles of ecosystem management, landscape ecology, conservation biology, urban development and economics.

- To identify existing or develop new ecological, visual, cultural, and socio-economic models that can be used to evaluate alternative futures (extending to the year 2020).

- To develop descriptions and specifications for alternative landscape designs.

- To contribute to the conservation of the ecological, cultural, and economic resources of the area.

The suite of analysis, simulation, and design tools that will be developed will be the main product of the project. As new proposals for landscape change are developed and planned they can be evaluated with these tools and the cumulative effects of multiple interventions considered.

THE NEED FOR INTEGRATED LANDSCAPE ECOLOGICAL PLANNING

Natural habitats are under severe and widespread stress, primarily from the loss, alteration, and degradation of natural ecosystems due to direct and indirect effects of human activities. While the rate of decline in worldwide biological diversity has become a major public concern, only a few studies have attempted to systematically and quantitatively assess risk to biodiversity at the regional landscape scale in an integrated landscape planning process.

Many factors, other than purely ecological, will most certainly influence the plan. However, the ecology of the landscape must be fully considered if desired future conditions are to be sustainable. While landscape has been defined in many ways, the following concept of landscape will be used throughout the study:

"a mosaic where a cluster of local ecosystems is repeated in similar form over a kilometers wide area. (A specific object with recognizable boundaries)" (Forman, 1995)

Although there are no formal size limits, landscapes generally range from at least a few kilometers in diameter to several hundred kilometers in extent. Landscape ecology concentrates on the structure and pattern of the landscape, its function in terms of flows of energy, materials and organisms between elements, and the change occurring within the heterogeneous landscape mosaic over time (Forman and Godron, 1986). It is distinguished from ecology by its emphasis on spatial pattern, heterogeneity (Turner et al, 1991), and by the specific inclusion of human activities.

As a transdisciplinary science landscape ecology is particularly well suited to the study, analysis and planning of diverse land systems (Zonneveld and Forman, 1990).

As a transdisciplinary science (Zonneveld and Forman, 1990), landscape ecology is particularly well suited to the study, analysis and planning of diverse land systems. Landscape ecological investigations such as pattern and structure analysis, corridor studies, identification of critical thresholds and studies of landscape change over time are directly applicable to the project area. The changes, flows, and spatial relationships of species, energy and nutrients across the landscape is of great importance to sustainable landscape planning.

There is increasing recognition "that all ecological processes occur within a spatial context" (Turner et al, 1991) and that there are important correlations between spatial patterns and landscape processes. Structural characteristics may be correlated to such variables as fire dynamics, suitability of habitat for wildlife, water quality and quantity, biodiversity, pest populations, as well as the productivity and availability of renewable resources. Landscape structure is used here as:

"the spatial relationships among the distinctive ecosystems or "elements" present - more specifically, the distribution of energy, materials, and species in relation to the sizes, shapes, numbers, kinds, and configurations of the ecosystems" (Forman and Godron, 1986).

Understanding the ecological principles that give rise to landscape patterns over space and time should inform human interventions in the area. Such interventions need to consider the dynamic nature of the shifting landscape mosaic. Landscape planning will not be informed unless processes (disturbance regimes, nutrient cycling, physiographic constraints, successional trajectories, recovery times, population dynamics, etc.) operating at varying spatial and temporal scales are understood and incorporated into decision making.

STUDY APPROACH

The work will take a landscape ecological view and adopt a long term strategy by examining the history and processes that underlie landscape function in the region and by projecting potential scenarios into the future. Understanding the natural range of variability historically present in the landscape and designing patterns of human intervention that compliment natural processes will be central to the work.

The project strategy is based on the hypothesis that the major stressors causing biodiversity change are related mainly to urbanization and agricultural development. As population increases and development spreads, habitat is lost due to residential and other commercial development as well as conversion of natural habitats to both intensive and extensive agricultural operations. There are also indirect, secondary, and cumulative effects on vegetation by development through changes to the hydrologic and fire regimes. These affect habitat and ultimately biodiversity. The study will emphasize the understanding of ecological processes and the impacts that human interventions and natural disturbances have on both landscape structure and function. The delineation of analysis and operational units at all scales will be based primarily upon ecological criteria. A standardized ecological land classification of the study area and a characterization of the landscape patterns and processes within a nested hierarchy of scales will be fundamental to the study. However, while the initiative of this study stems from a ecological question, the issues of biodiversity are not limited to scientific inquiry. Cultural and socio-economic factors play an integral role in the project development and inquiry.

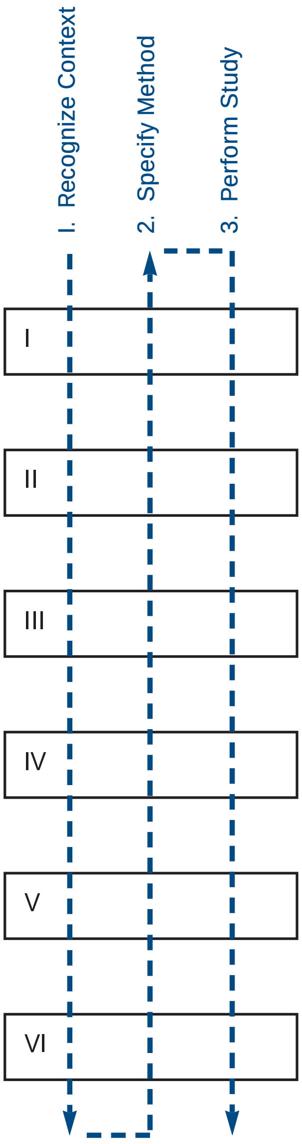
It is assumed at this time that the Terrestrial Ecosystem Mapping (TEM) units will be used as the common spatial language to be shared by models in different sectors including, among others, evaluations of impact on wildlife habitat and biodiversity, visual quality and socio-economic conditions. Some additional classes will be added in order to properly represent the range of anthropogenic uses. Most of the methods and analytical techniques used in the study will be derived from the fields of landscape ecology, conservation biology and ecosystem management.

The research strategy is based on the hypothesis that the major stressors causing biodiversity impoverishment are related mainly to urbanization and agricultural development.

Project Framework

The study is complex and multifaceted. It is therefore necessary to provide a framework to organize the various tasks and models which need to be completed. The framework directs all actions in support of necessary decision making by investigating a realm of scientific, social, and economic questions. It helps to ensure that decisions are based upon clearly defined principles and measurable criteria. The methodology must be open, modular and adaptive. Open, in the sense that evaluation criteria must be explicit and transparent to careful public examination. Modular and adaptive, in order to allow models to be updated as ecological understanding of landscapes increases and societal demands change over time.

The following framework, borrowing heavily from Steinitz (1990) and Steinitz et al. (1996), has been used to organize the various aspects of the work (Figure 1). The framework is used at three stages in the study and structured with six levels of inquiry and models. The six levels of inquiry are described in the detailed description of the project framework section. The three stages of study are as follows:



Stage One: Recognize Context

The first stage of the process is used to provide a reconnaissance survey of the major issues and context of the study. At this point, the direction of use is from top to bottom. The existing description and representation of the region is examined and a very general knowledge of how the landscape works is obtained. Obvious problems, known potential plans and interventions, the possible impacts of those interventions, as well as an understanding of how and upon what criteria decisions are made, are determined during this overview stage.

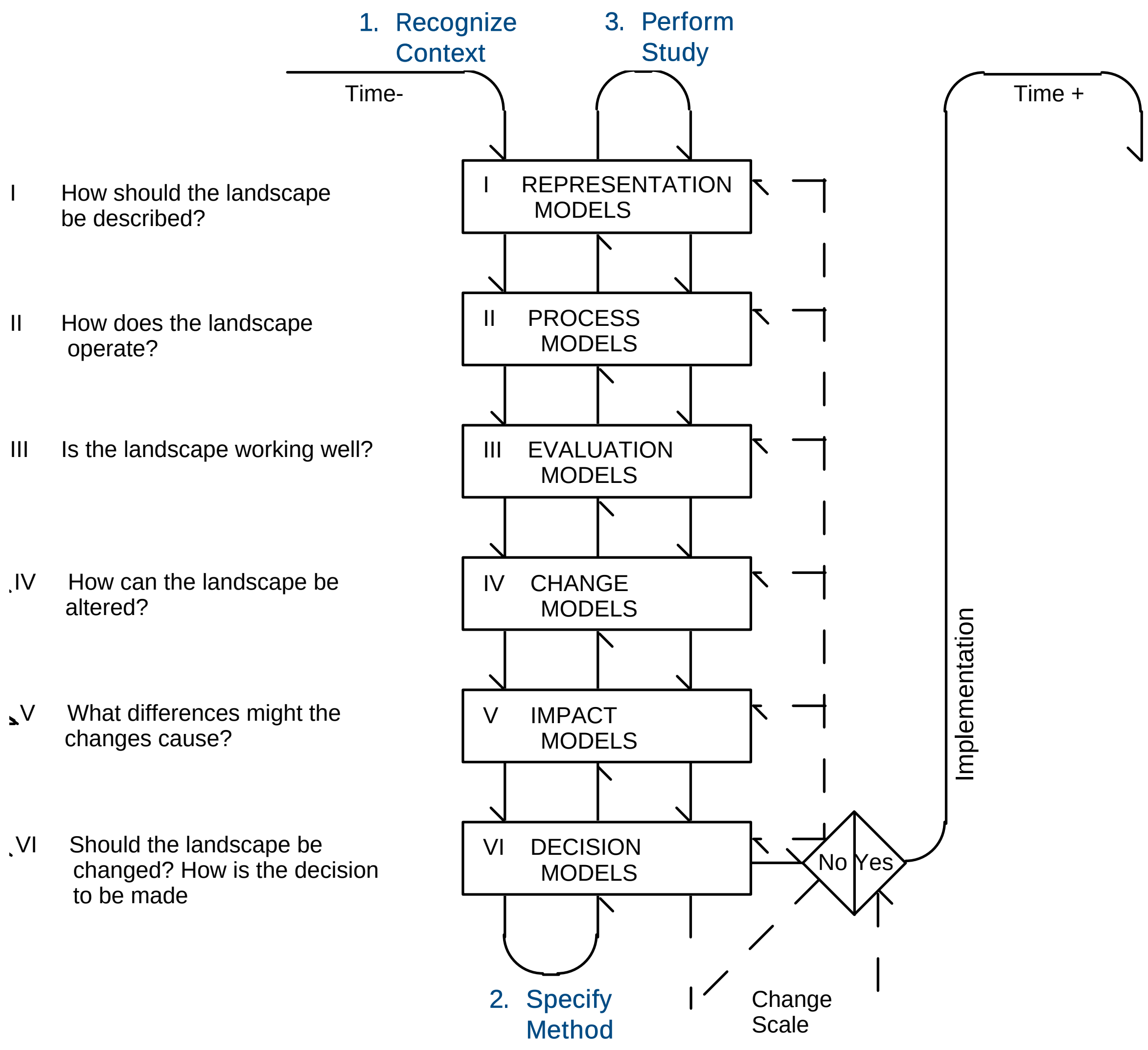
Stage Two: Specify Method

In the second stage, the framework is used to fully detail the method to be employed in the study. It ensures that each stage feeds directly into the next and eliminates redundant data gathering. It also encourages the development of rational evaluation criteria. At this stage, the framework is used from the bottom up with the rationale that the place to start in developing a methodology is not to gather data. Rather, it is in understanding how decisions to change the landscape are made. Those decisions are based upon impact criteria that decision makers, and those that they represent, are interested in. The impacts (positive or negative) are caused by changes to the landscape; either projected by trends or through designed interventions. However, before changes are made, the existing landscape conditions must be evaluated. In order to understand if the region is functioning well, the structural and functional relationships that influence various landscape processes have to be known. Once those processes are understood, landscape data and minimum representational requirements can be identified (i.e. surveys, maps, plans, three dimensional digital models, sections, reports etc.).

Stage Three: Perform Study

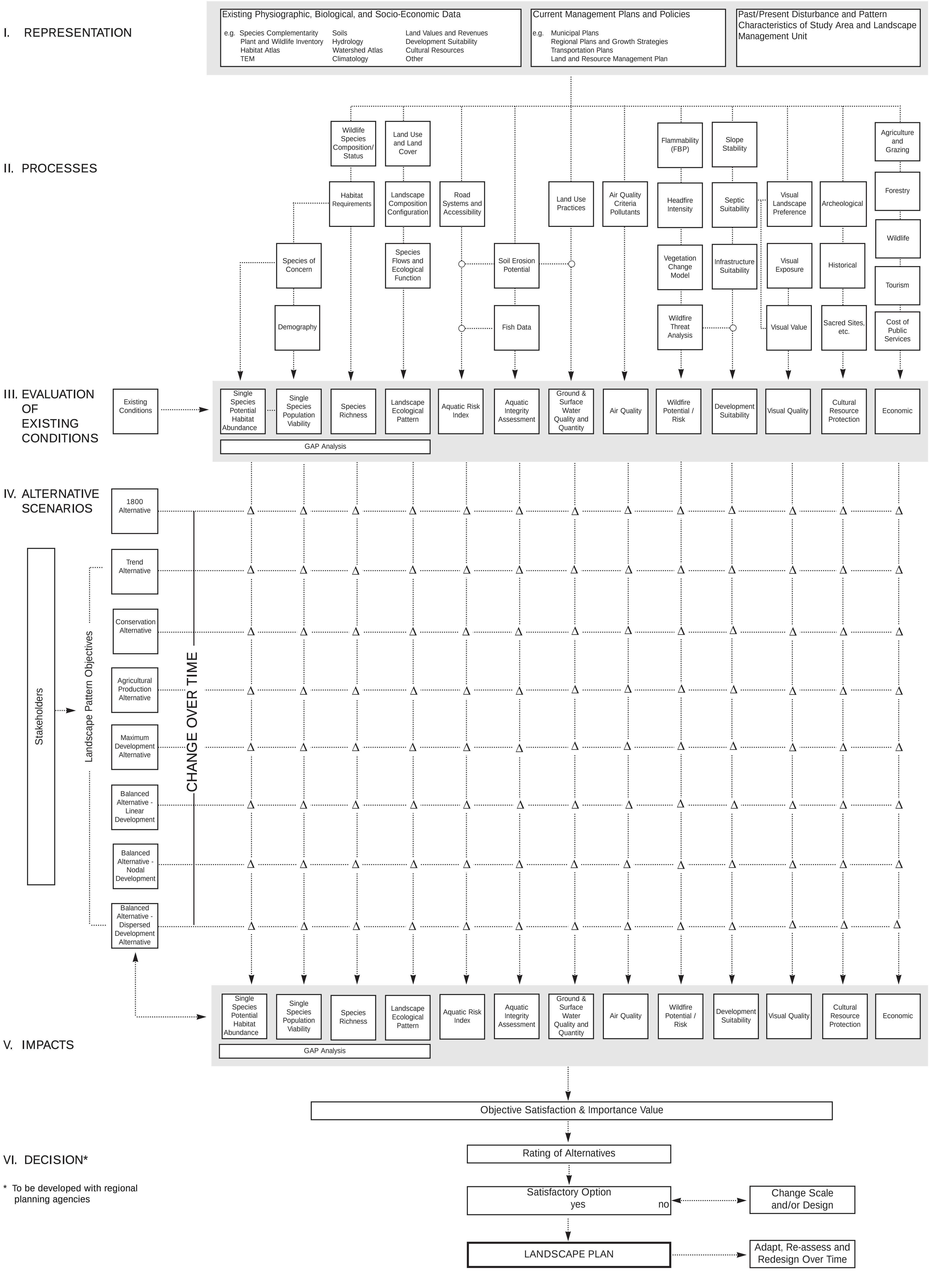
The third stage in which the framework is used is when the project is actually carried out. Here the approach is again from the top down. The data is gathered and represented in a format that can be used in the following steps; the process models are constructed, the existing landscape is evaluated, various alternative future projections or designs are produced, the impacts of those changes are determined and a decision is made whether or not to accept the change or if a redesign or a change of scale is required.

Figure 1: Project Framework

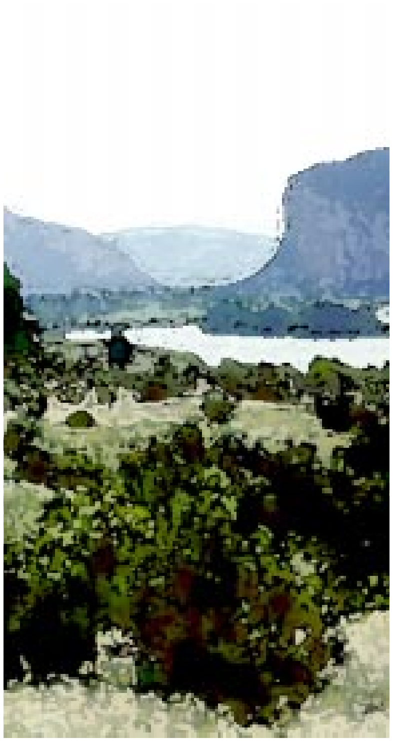


(adapted from Steinitz, 1990)

Figure 2: South Okanagan Landscape Planning Framework



PROJECT CONTEXT AND METHODS

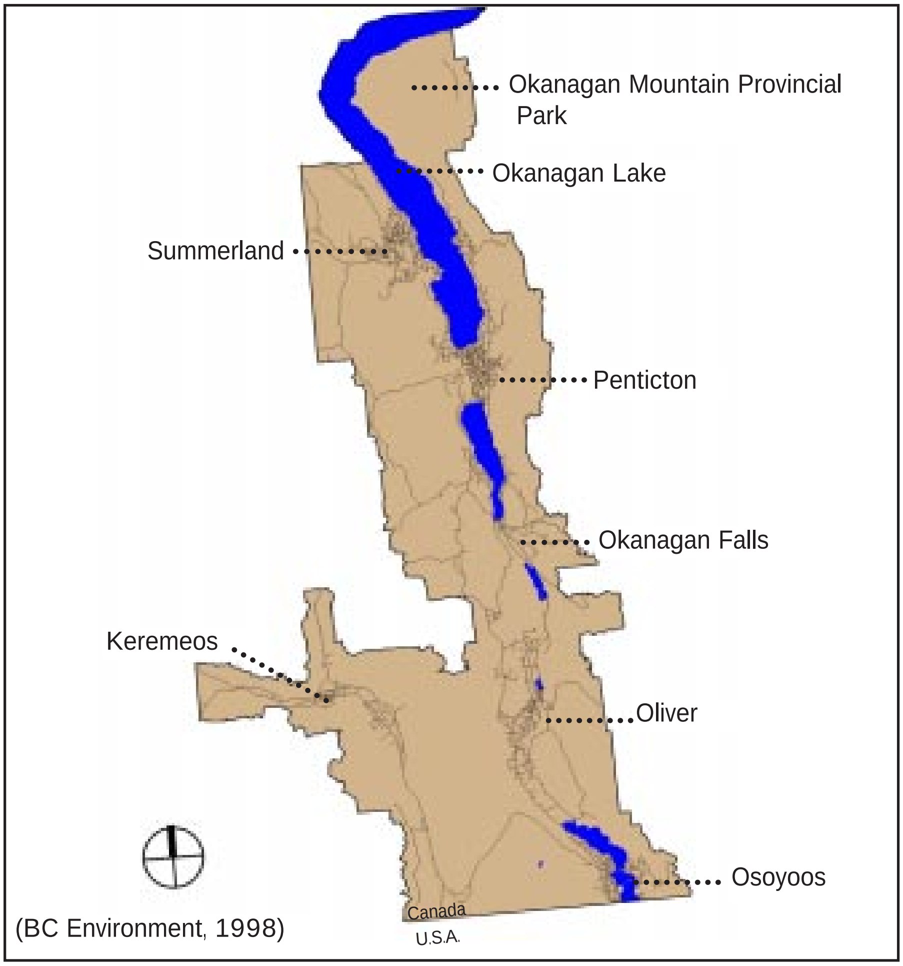


STAGE ONE: CONTEXT

As an initial reconnaissance survey, stage one identifies the existing conditions and issues that must be addressed in the study framework. Recognition of both the spatial (landscape) and political (policy) components of the area are used at this stage to determine the study area boundary, planning scale, and political structure within which the results of the study will operate.

STUDY AREA

The study area encompasses approximately 1200 square kilometers. Its boundaries have been defined by the limits of the South Okanagan Habitat Atlas prepared by the B.C. Ministry of the Environment Wildlife Habitat Branch (see study area map). This data set includes the South Okanagan basin as well as the lower reaches of the Similkameen Valley and lands lying between the valleys. It does not extend into the higher elevation areas to the west and east as originally identified in the South Okanagan Conservation Strategy. While certain processes such as regional connectivity may need to be addressed at a broader scale, the bulk of the modeling efforts will be limited to the core study area for which substantial data exists. This is the area undergoing the most dramatic change and, given the likelihood of limited resources, it will be the focus of the study. In addition, by limiting the study to the lower elevations, the complex issue of forest management in the area will only be addressed peripherally. While this is an important issue in the area, it is recommended that this study focus on the lower elevation lands where urbanization and agriculture are the predominant elements of change.



Study Area

POLICY AND PLANNING CONTEXT

Existing land use and future change are guided to a large degree by policy guidelines and planning structures. An important component of stage one is the identification of the relationship between the types of planning carried out in the area and how this project would integrate with and complement those processes.

In 1992, British Columbia passed the *Commissioner on Resources and Environment Act* in response to a growing demand for an improved land use planning system for the province. As a result, an independent Commission on Resources and Environment (CORE) was established to develop for public and government consideration, a provincial wide strategy for land use and related resource and environmental management. Through extensive public consultation, CORE developed a Provincial Land Use Strategy describing the fundamental principles of environmentally, economically, and socially sustainable land use, and an integrated set of goals and policies to guide the land use planning process throughout British Columbia.

The provincial land use strategy includes:

- Principles, goals and policies to guide regional and local planning
- Sub-regional planning processes to establish broad land use zones
- Local planning processes to provide more detailed direction

Integral to the proposed Land Use Strategy was the incorporation of three levels of planning: provincial principles, goals, and policies; regional and subregional strategies and plans; and community-based or local plans. The scope of each level is described as follows:

Provincial:
Provincial level policies and directives provide guidance to all the other levels of decision-making in the land use planning system. Provincial policies, goals, and strategies for the protection and use of the province's natural resources are approved by Cabinet in response to social preference and broad-scale economic and environmental considerations.

The provincial commitment outlined in the draft Land Use Charter states "*the Government of British Columbia is committed to protecting and restoring the quality and integrity of the environment, and securing a sound and prosperous economy for present and future generations.*"

Regional/Sub-regional:
Regional and sub-regional level plans provide a vision and goals for the allocation and use of public lands and resources for broad land use zones. British Columbia currently has four regional plans and numerous sub-regional plans in various stages of completion. The primary form of a sub-regional plan is a Land and Resource Management Plan (LRMP). In the absence of a regional plan, LRMPs serve as the primary zoning and allocation tool and can specify management guidelines to implement the intent of provincial and regional policies and plans. The study area lies within the Okanagan/Shuswap LRMP process and that plan is currently in a draft phase. It will provide substantial direction to this study.

Local:
Local level plans are generally at the size of a watershed or series of watersheds. Decisions at this level are concerned with designing a pattern of use that considers local ecological conditions as well as economic and social implications. Local or regional managers of participating resource management agencies generally approve local plans. The most recent focus in local integrated planning has been in the development of "landscape unit planning" which places resource

management decisions in the context of biophysical units at the landscape level. Private land use planning is directed by the Municipal Act that enables local governments to prepare official community plans and regional growth strategies. The regional growth strategy for the district has not been completed to date.

While the land use planning system for British Columbia is described as having a hierarchical or sequential structure, within which each level of planning provides direction to subsequent, more detailed levels for various organizational, political, financial, etc. reasons; planning within the province often occurs independently of and with little integration of other levels.

Planning within the study area occurs at the subregional (LRMP) level as well as at the municipal or electoral district level . The LRMP for Okanagan/Shuswap is currently under way. The overall intent of the LRMP is to provide strategic direction and broad land use zoning for crown lands. The zoning of private lands is the responsibility of municipalities and the regional district. The management of private lands within the study area is currently addressed through a variety of bylaws, government policies and provincial and federal regulations. As noted, the Growth Management Strategy for the Regional District of Okanagan - Similkameen level has not been completed. This project should provide substantial support to that plan upon its initiation. The LRMP is likely to have been largely completed by the time this project is under way. The efforts of that work shall be incorporated into this study.

The Land Use Coordination Office has stated that "*the development of further regional plans is not currently a priority for integrated planning - integrated planning emphasis will be concentrated for the foreseeable future on completing scheduled and priority plans at the sub-regional and local levels*" (LUCO, 1998a). This project meets that emphasis.

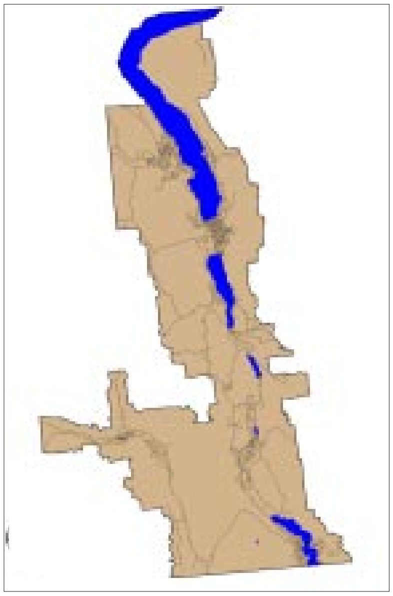
The proposed study will utilize work developed in the LRMP process and will provide a prototypical example of its incorporation into finer scales of planning. The latter two levels of planning (sub-regional and local) are particularly important in successfully directing development towards ecologically appropriate forms. It is at these scales that the actual physical form of development can be described with a level of resolution that matches development activity *and* the spatial requirements of detailed ecological impact models. This project will bridge development and ecological modeling as well as providing a practical linkage across planning scales.

SPATIAL HIERARCHY AND PLANNING SCALES

Due to substantial data and computational requirements for analyzing large areas of land, issues of scale and required data need to be carefully considered. The level of aggregation of information appropriate for planning varies with the process under consideration, and indeed, more than one scale of analysis is often necessary. In order to engage the various issues and interest groups in the study area, the project is organized to address a nested hierarchy of geographic scales.

Biodiversity and human interactions cannot be independent of one another. Given a variety of development conditions and habitat types, the level of impact and influence on biodiversity is complex. For example, using a broad scale approach to planning for biodiversity, areas with aggregated vegetation data may be used to develop optimal patterns across very large areas at the scale of the landscape or the region. Wide ranging species may also require a very broad regional scale of analysis in order to determine impacts of landscape change. Issues of fragmentation are not always dealt with adequately at finer scales and need to be addressed at a broader level. On the other hand, a finer scale approach, addressing a particularly sensitive target species with specific requirements, may demand very detailed vegetation data. In such a case, interventions or conservation may be at the stand or project level. Assessment of the rarity of species and habitats may require a combination of very detailed information over the entire extent of landscape.

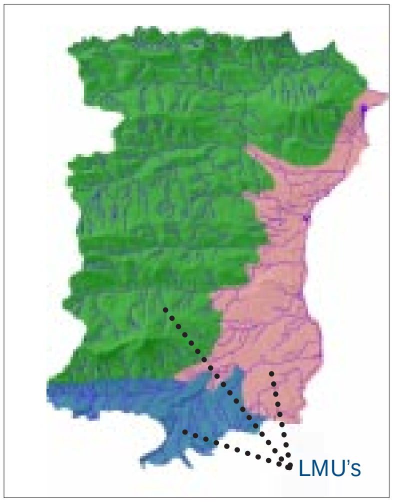
Three levels of geographic scale will be addressed in the project.



Study Area

Study Area

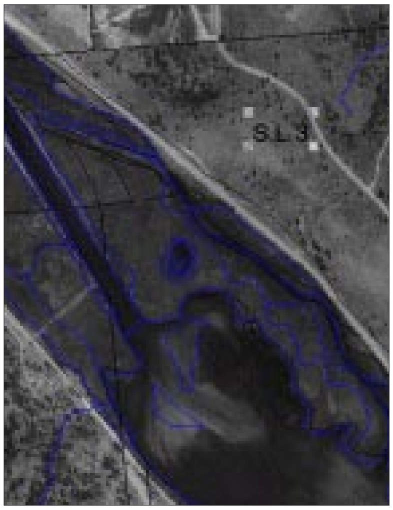
The study area includes the entire project boundary. Alternative scenarios will be developed at this scale indicating the integration and general configuration of residential development, agriculture, transportation and infrastructure, protected lands and other wildlife habitat. Issues of connectivity of natural areas will be addressed at this scale. Regional land pattern objectives will be established.



Landscape Management Unit

Landscape Management Unit

A landscape management unit or LMU is a contiguous and heterogeneous area in which the pattern of local ecosystems or land uses is repeated in similar form throughout an area that is generally at least a couple of kilometers in diameter (after Forman and Godron, 1986). It may coincide with a physical land class boundary, an ecological unit, a sub-basin, a viewshed from a high point of land or, if appropriate, an administrative or political boundary. Wherever possible, compartments will be delineated on the basis of ecological boundaries and the containment of the major flows and elements of interaction. In most cases, this will result in analytical units that cross public and private land boundaries. LMUs are defined in large part by the pattern of local landscape elements and therefore are not strictly ecologically based but rather, specifically include human activities. Thus, a landscape management unit may be a regional park, town, village or an agricultural area. Landscape pattern objectives will developed for each LMU.



Development Parcel or Protected Area

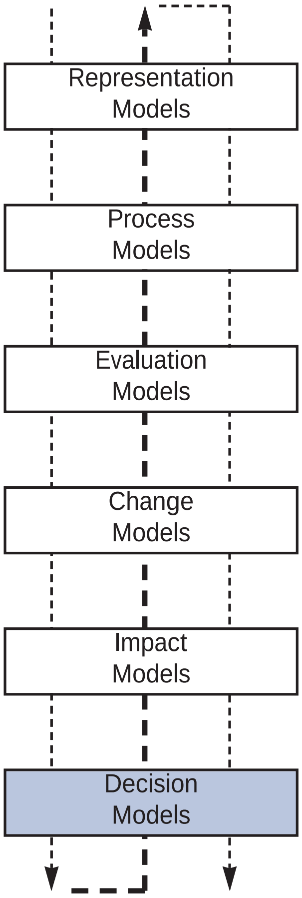
Development Parcel or Protected Area

This fine scale would be project specific and may include site-specific habitat improvement, natural reserve or protected area, small subdivision or other rural development.

STAGE TWO: METHOD

The following are the proposed methods of investigation for the project. The discussion follows the six models of the general planning framework displayed in Figure 1. The order of discussion is from the bottom up, which follows the direction of stage two in the methodology. Figure 2 shows how the component data and models of this project program are linked via an expanded planning framework.

DECISION MODELS



The way in which decisions to change or conserve the spatial pattern and management of the landscape are made is critical to the planning process and the development of the methodology. Questions such as who will make land use decisions and upon what criteria will alternatives be judged are central to the entire plan. The actual process of decision making and decision model development will not be addressed in this project. However, future development of decision models will be aided by the tools developed. Analysis, simulation, and alternative development scenarios may be used by decision makers to assess and identify the type of decision model that would best suit their criteria and objectives. Keeney and Raiffa (1993) and Ralls and Starfield (1995) are among several options for structured decision model types.

Criteria by which choices are assessed will vary among individuals and groups who hold different interests. Judging the importance of these is the responsibility of the people and jurisdictions that will be influenced by future development. As a result, major decision makers, planning bodies, and the decision making structure must be identified.

The decision process may be influenced and directed by two main types of input. First is the major decision makers and review bodies that direct policies, have regulatory capabilities and make final decisions. The second set of input is via stakeholders, organizations, and non-regulatory agencies. This group does not set policies and regulations, but can influence the final decision process through recommendations. It can include local interest groups, private land owners, provincial, and federal agencies.

The following have been identified as potential proponents in decision making and input into the project.

1. Major Decision Makers/Review Bodies

Municipal Planning Governments

- Incorporated Settlements
  - Oliver
  - Osoyoos
  - Penticton
  - Summerland
  - Keremeos

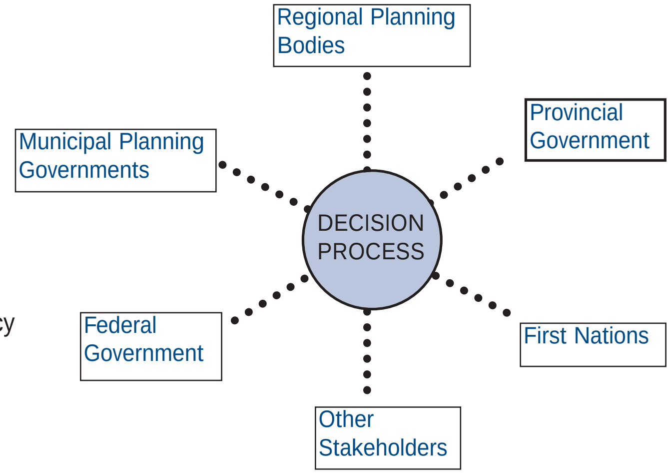
- Unincorporated Settlements
  - Kaledan
  - Okanagan Falls
  - Naramata

Regional Planning Bodies

- Regional Planning District
- Electoral Districts

Provincial Government Ministries

- Ministry of Agriculture, Fisheries and Food
- Ministry of Environment, Lands, and Parks
  - BC Environment
    - Environmental Protection Department
    - Fisheries Branch
    - Habitat Protection Branch
    - Pollution Prevention and Pesticide Management
    - Water Quality Branch
    - Wildlife Branch
    - Watershed Branch
  - BC Lands
    - Lands and Water Management
    - Water Management Division
    - Water Resources Branch
  - BC Parks
    - Parks Department Services
    - Parks and Ecological Reserves
- Ministry of Employment and Investment
- Ministry of Forests
- Ministry of Small Business, Tourism, and Culture
  - Heritage Branch
  - Archeological Branch
- Ministry of Transportation and Highways



Federal Government

- Fisheries and Oceans Canada
- Environment Canada
  - Canadian Wildlife Service
  - Canadian Environmental Assessment Agency
  - Environmental Protection Service
- National Research Council of Canada
- Natural Resources Canada
  - Canadian Forest Service

First Nations

- Osoyoos Band
- Penticton Band
- Upper Similkameen Band
- Lower Similkameen Band

2. Organizations, Agencies, Programs and Stakeholders

Provincial and Federal Governments

- Agriculture and Agri-foods Canada - Federal
- BC Government Resource Inventory Committee (RIC) - Provincial
- Committee on the Recovery of Endangered Wildlife (RENEW) - Federal (South Okanagan Ecosystem Recovery Team)
- Ecological Monitoring and Assessment Network (EMAN) - Federal
- Canadian Wildlife Service - Federal
- Forest Renewal B.C. - Provincial
- Land Resource Management Plan (LRMP) - Provincial

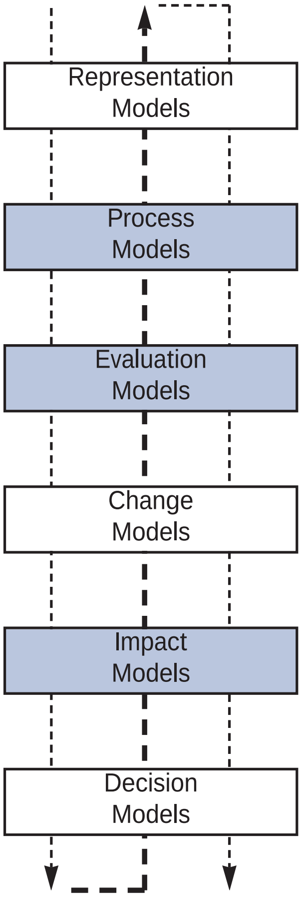
Other Interest Groups

- BC Cattlemen's Associations
- BC Fish and Game Association
- BC Wildlife Federation
- Chamber(s) of Commerce
- Developer/ Realtor association(s)
- Economic Development Commissions
- Ecotourism Association
- Federation of BC Naturalists
- Fruit growers/ Vinters
- Guide Outfitters of BC
- Land Use Coordination Office
- Local Forest Industries
- Nature Trust of BC
- National Wildlife Trust
- Okanagan-Similkameen Tourism Association
- Osoyoos Desert Society
- Outdoor Recreationalists
- Regional NGO's
- Resource-based industries (Non-renewable such as aggregate, quarries)
- Salmon River Watershed Roundtable
- South Okanagan Critical Areas Program (SOCS)
- South Okanagan/ Penticton Naturalists
- Tourism and Hotel Associations
- Trappers, anglers and hunter associations
- Water Supply Association of BC
- Private Landowners

The study consists of a diverse group of decision makers, stakeholders, agencies, and interest groups. The criteria upon which each group judges future alternatives is central to the plan.

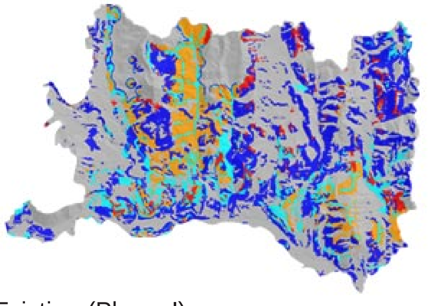
EVALUATION AND IMPACT MODELS

Decisions to change the landscape should be rationally based upon clearly stated and measurable criteria. Whether the evaluation is of the existing landscape or of the impacts of alternative future scenarios, decision makers must identify the criteria that they use to judge one condition over another. In this proposal, criteria that future decision makers are likely to use have been anticipated to establish the set of evaluation and impact models. In order to ensure that the study is cost effective, only criteria which are likely to affect decision making will be modeled. This project is subject to change based upon proposal review, comment, and funding.

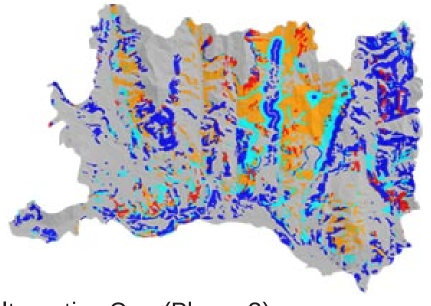


Modeling or direct sampling is required to quantify the impacts and to identify the measurable differences future landscape changes may cause. An initial evaluation of the existing conditions provides a baseline measure against which changes from the past can be assessed and impacts of future change can be compared. The same models are run on both the existing conditions and the future alternatives. The measurable differences between the existing and future conditions reveals how the alternative scenarios impact (either positively or negatively) the criteria upon which decisions are made.

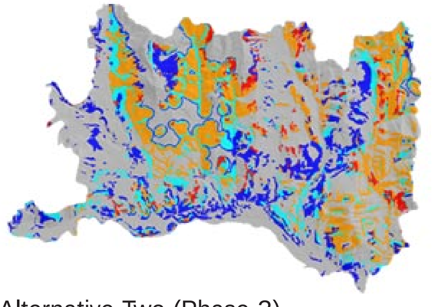
The results of evaluation and impact models will be represented by one or more thematic maps. A thematic map represents a conditional state as a result of the type of input model applied. Interpretations of change between existing condition maps, past, and alternative future scenarios will be done both visually and quantitatively. Colors are used to identify different categories and spatial arrangements of land use/land cover types for a given map allowing for comparisons. The associated map legend will reference the area that is in the map category. Quantitative measures will be indicated in “change” bar charts which show the gain or loss of a map category between the exiting conditions and various scenarios.



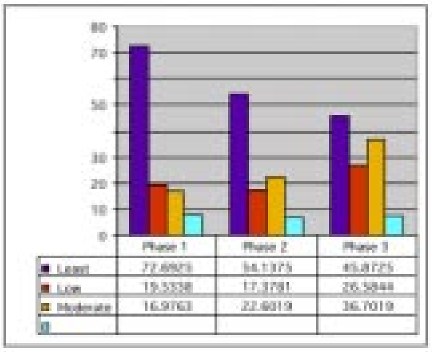
Existing (Phase I)



Alternative One (Phase 2)



Alternative Two (Phase 3)



The spatial arrangement of land use/cover is represented spatially on maps. Differences in amount of cover between various land use/cover types can be determined between the existing conditions and alternative scenarios.

An accompanying bar chart provides quantitative measures of change by area for each land use/cover type.

Evaluation and impact models must be spatially explicit; be able to be constructed from available data and describe the conditions within acceptable limits of certainty. For this study, the following three categories of evaluation and impact models have been developed:

1. Ecological Models
2. Visual/ Cultural Models
3. Economic Models

Within these categories, individual models will be developed to serve as a suite of impact measures. As opposed to the decision stage of planning which is entirely value laden, the evaluation and impact models are as value free and objective as possible. The impacts of various alternatives are judged in the decision process where the priorities of the models, as well as their importance to various landscape management units, are identified. As noted, the decision process is not the focus of the study. Rather, this work is intended to support existing decision making and planning systems.

Integral to the development of evaluation and impact models is the understanding of the processes operating within the landscape (including the functional and structural relationship among its elements). The following discussion describes the evaluation and impact models and their associated processes.


Ecological Models


Visual/Cultural Models


Socio-Economic Models

1. ECOLOGICAL EVALUATION AND IMPACT MODELS

Several ecological models will be developed including those relating to biodiversity, wildfire risk, aquatic integrity, surface and ground water quality, air quality and development suitability. Maps and graphs will be produced for most model results which indicate the change between the current and future conditions.

Biodiversity Modeling

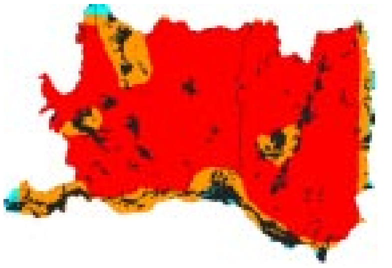
Five general approaches to modeling the effects of landscape change on biodiversity are proposed. These are:

- Single Species Potential Habitat Abundance
- Single Species Population Viability
- Species Richness
- Landscape Pattern Protection
- GAP Analysis

While each approach has its merits, none cover all of the requirements for biodiversity conservation. It is posited that pattern protection may indeed capture species richness and critical amounts of single species habitat. However, this is relatively untested and an evaluation of the effectiveness of "indispensable" (Forman,1995) pattern identification and subsequent protection will be an important aspect of the study. As detailed single species modeling is often beyond the budgets of most planning bodies, the possibility of planning essential landscape configurations at a coarse scale is very appealing if it captures other elements of ecological integrity.

i. Single Species Potential Habitat Abundance

The single species/habitat abundance models map the potential habitats of selected vertebrates based on food and cover requirements. Single species impact models have been integrated into the biodiversity study for several reasons. First, several species in the study area are on Federal threatened or endangered lists resulting in the need for impact assessments, mitigation, or recovery management strategies for individual species. Second, species that are in danger of extreme habitat loss can be identified which may indicate the need for more detailed species specific planning and management. Third, some species have requirements for specific landscape conditions or elements and may be particularly susceptible to changes in the environment; thereby serving as indicators of environmental change that may indicate concerns for other species. Fourth, over thirty-four single species models have been developed as part of the South Okanagan Habitat Atlas which will provide a foundation for model development.

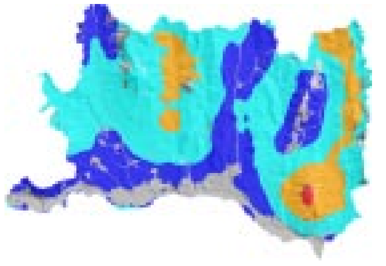


Example of potential habitat within the daily foraging area of a grizzly sow with cubs (Red indicating high value and orange moderate value).

Single species analysis will consist of:

- Habitat associations and requirements
- Species area requirements (e.g. minimum patch size)
- Habitat suitability indices (HSI) (for selected species only)

It will not be practical to model the requirements of all 34 species for every iteration of the alternatives. Priorities must be set and a range of species will be selected which represent one or more of the following criteria:

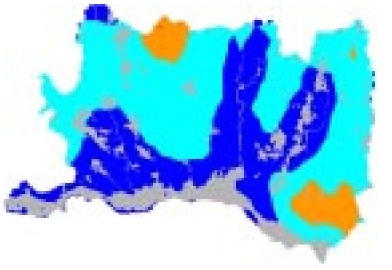


Existing effective habitat of a grizzly sow with cubs once access and land use influences have be considered. (Red indicating high, orange moderate, light blue low, and dark blue least value.

- Threatened or endangered species
- Multiple habitat species
- Large home range species
- Habitat edge species
- Interior habitat species
- Wetland species
- Riparian old growth species
- Species of agronomic concern
- Species of special management concern
- Ecosystem specific species (i.e. Antelope brush species)
- Species of social or economic importance
- Sensitivity to human land use activities and habitat alterations
- Sensitivity to changes in hydrology and riparian vegetation
- Dependence on disturbances (e.g. fire) and early successional, habitat types
- Dependence on late successional, old growth habitat types
- Knowledge of species habitat requirements for the area

It is expected that the following species may be included in the single species modeling:

•	Short Horned Lizard	*Phrynosoma douglassii*
•	Sage Thrasher	*Oreoscoptes montanus*
•	Yellow Breasted Chat	*Icteria virens*
•	White Headed Woodpecker	*Picoides albolauvatus*
•	Swainson's Hawk	*Buteo swainsoni*
•	Pallid Bat	*Antrozous pallidus*
•	California Bighorn Sheep	*Ovis canadensis californianus*
•	Fisher	*Martes pennanti*
•	Cougar	*Felis concolor*
•	Tiger Salamander	*Ambystoma tigrinum*
•	Antelope Brush	*Purshia tridentata*



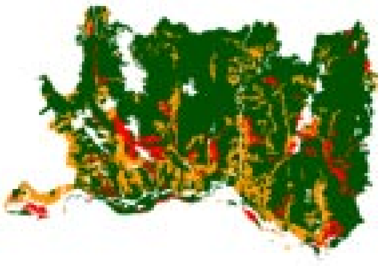
Future effective habitat of a grizzly sow with cubs once access and land use influences have be considered.

The list is not finalized and species will be added or deleted as the project develops.

ii. Single Species Population Viability

Subsequent to spatial mapping of species potential habitat abundance, single species population viability evaluation and impact models will be developed to determine the ability of the species to persist in a given environment. As an extension of demographic and genetic variability analyses, the population viability analysis will predict the number of animals needed (minimum viable population) to ensure a sustainable rate of persistence over a given time period.

The minimum dynamic area (MDA) of suitable habitat necessary for maintaining the minimum viable population will be determined for a given set of species. The spatial representation of the potential habitat abundance will provide a measure for evaluation between the potential habitat present in each scenario versus that which is needed to maintain a viable population.



Existing

Future

Example of Avian Species Richness Mapping indicating change over time (Red = high).

iii. Species Richness

The species richness approach examines the spatial distribution of the set of species (e.g. birds, mammals, reptiles, amphibians, invertebrates) known to reside in the area. This is a fairly simple model in that it relates vegetation or land cover and patch size to the wildlife habitat requirements of a potential resident. Changes in habitat abundance between the present and future is measured for each species. The total number of potential species in the landscape and per pixel or polygon can also be calculated. Results will be summarized by various categories, e.g. taxa, COSEWIC listed etc.

The species richness approach does not focus on any particular species. Rather, it is an indicator of the properties of the set of all species associated with a pattern of vegetation. It does not consider interspersion or the configuration of landscape elements. However, hotspots adjacent to protected areas will be specifically examined.

Wildlife Habitat Relation (WHR) models will be used to associate species with each habitat type within the study area. Data requirements for the WHR models will include the identification of habitat associations of species and habitat area requirements. Models will be developed for terrestrial vertebrates, invertebrate species (insects and arachnids), aquatic species, and plant species. WHR process models are also used in the GAP analysis, which is the second component of the Impact and Evaluation Model for Species Richness.

iv. Landscape Ecological Pattern

The fourth major approach is the protection of landscape patterns. This analysis will examine the structure and configuration of landscape elements at different scales. The patch-corridor-matrix model of Forman (1986, 1995) proposes that an ecologically viable landscape must contain several indispensable patterns to provide for critical landscape functions. These include large patches of natural vegetation, species movement connectivity between large patches, vegetated corridors along major streams and rivers, and small patches scattered across a less suitable matrix to function as stepping stones for movement. The evaluation of the landscape ecological pattern is based on the hypothesis that there are spatial patterns of landscape elements that will conserve the majority of natural processes in any landscape.

The focus of the landscape ecological pattern analysis is the relationship between the spatial structure of the landscape and critical landscape functions. Both the characteristics of the patterns and the degree of protection afforded important landscape ecological configurations and processes will be quantified. More specifically, analysis and comparative evaluation will be based upon:

Existing

- Degree of protection or enhancement of "indispensable" landscape ecological patterns:
  - Large natural vegetation patches
  - Connectivity for movement among and between large natural patches
  - Small patches (stepping stones) and corridors through altered landscapes
  - Protection of the stream/lake influence zones

Future

- Degree of protection or enhancement of important ecological locations:
  - Sensitive, endangered, threatened, rare and unique landscape elements e.g. wetlands, unusual soils, species rich areas etc.
  - Large nodes in networks, connections, and other strategic points in the landscape

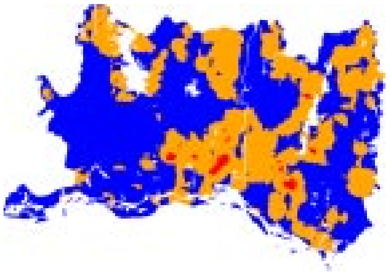
- Degree of species movements over the landscape (connectivity)
  - Major routes through the landscape
  - Connectivity of the matrix
  - Landscape resistance to species flows
  - Known local extinctions and recolonization of meta populations
  - The potential for spread of exotic species

- Degree of mosaic adaptability and stability based on:
  - Resistance to catastrophic fire and pest outbreaks (refer to fire risk)
  - Structural diversity (variation in size and shape) and compositional diversity (variety of types of landscape elements and diversity of pattern) as related to the range of natural variability
  - amount and distribution of seral stages in various landscapes and throughout the region

Examples above indicate changes in disturbance patch size, while below illustrates vegetation composition diversity alteration over time.

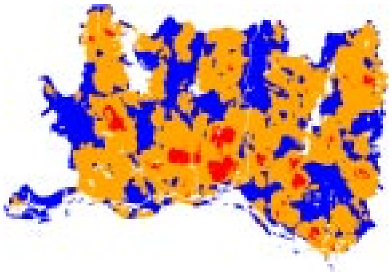
v. GAP Analysis

GAP analysis will be used to systematically evaluate the protection afforded important habitats and locations, e.g. areas of species richness, unique and rare elements, critical habitats etc.. The method locates those areas in which individual species and/or groups of species are found and determines if they fall within areas of active management plans. Protection may be afforded by land consolidation or through land use policy and management intervention.



Existing

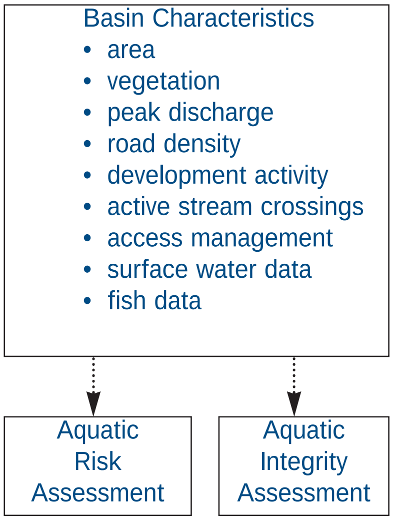
For example, areas with active management plans for conserving biodiversity are considered relatively stable environments for species. Areas with high species richness values but without active management plans for biodiversity are considered "gaps." GAP analysis consists of several primary investigations: the distribution of actual vegetation cover and land cover; the protection and management status of public and private property; distributions and richness of species as predicted in WHR models; important elements or configurations identified in the landscape ecological pattern analysis etc.. A central assumption of GAP analysis is that mapped vegetation accurately represents the spatial distribution of terrestrial species.



Future

Aquatic Risk Assessment

The hydrological and biological integrity of aquatic ecosystems depends critically on human activities that affect land use and land cover both along stream margins as well as throughout the catchment or sub basin. It is proposed that watershed issues in the sub basins of the study area be addressed by developing a risk assessment procedure based, in part, upon the Interior Watershed Assessment Procedure (IWAP) used in the B.C. Forest Practice Code. The procedure is used to take spatial data (i.e. the type and distribution of vegetation, land use, transportation systems etc.) and develop a score card rating of risk to aquatic ecosystems.



Watershed analysis will be conducted independent of landscape management unit boundaries. Policies or actions specific to those portions of the watershed falling within an LMU may be identified but analysis of the fluvial related process will be conducted on the sub-basins under consideration. It is anticipated that the "pour points" on the Okanagan, Vaseux, and Osoyoos Lakes and the Similkameen River will be used to delineate sub-basins. The sub basins indicated in the BC Watershed Atlas will be used. Fisheries management objectives may also be used to identify sub basin priorities for management. The following characteristics will be calculated for the basin and will be used to produce a watershed report card (after BC Environment, 1995):

- area of basin
- vegetative and land use cover of basin
- vegetative and land use cover of riparian zones
- peak discharge at point of interest
- road density in the basin
- road density in first order stream drainages
- portion of area of first order stream drainages that has been developed
- levels and areas of potential erosion
- density of roads on erodible sites
- density of roads less than 100 meters from a stream
- density of roads on erodible sites less than 100 meters from a stream
- active stream crossings in the basin
- access management within the basin
- portion of streams that have been developed within 100 meters of a stream
- portion of fish bearing reaches that have been developed within 100 meters
- data for other aquatic organisms

Changes to the stream morphology resulting from landscape change will not be modeled at this time.

i. Soil Erosion Potential

As erosion potential figures prominently in the watershed risk assessment, areas of potential soil erosion need to be delineated. While soil erosion is only one aspect of loss of soil fertility, only erosion will be dealt with in this study. Soil erosion potential will be calculated by using the Universal Soil Loss Equation. The USLE states:

$$A = R \cdot K \cdot L \cdot S \cdot C \cdot P$$

where
A = soil loss ha-1 yr -1
K = the soil erodibility factor (range: 0-1)
L = the slope length factor
R= the rainfall factor
(ca 1/2 mean annual rainfall in mm)
S = steepness factor
P = the support practice factor
C = the cover factor (range: 0-1)

ii. Road Systems and Accessibility

Accessibility is a major concern throughout the region and is required as part of the watershed risk assessment. Road densities and types of access (roadway type, active stream crossings, utility rights-of-way and seasonal trails, motorized vs. non motorized) as well as seasonality of access will be calculated for both the LMU's and study area scales. The accessibility analysis will be used in several other areas particularly the habitat effectiveness models relating to single species and fishing pressure on fish bearing reaches.

iii. Fisheries

Effects of land use change on a watershed. Drainage converted to agriculture.

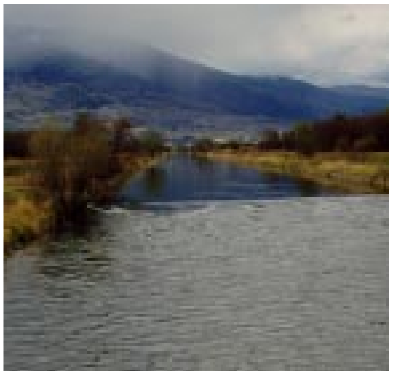
Fish bearing reaches and "hotspots" are required in the watershed analysis and will be mapped in coordination with the B.C. Fisheries Branch. This will include species distribution, significant sites (spawning, overwintering, aggregations by species), and known reaches of seasonal fish movement. Key fisheries in the region will be identified. Since the early 1960s, fish populations have been seriously affected due to dams, diversions, channeling, draining, and pollution. Increased population numbers and tourism to the area has placed additional demand on fish stocks and their associated habitats.

Impact on fish bearing stream reaches is generally due to changes in :

- flow and seasonal discharge
- sedimentation
- stream gradient and stream morphology
- temperature
- amount of woody debris in the stream
- contiguity of the stream (i.e. lack of culverts and other blockages to fish passage)
- quantity and quality of the streamside vegetation

Important factors to consider regarding fisheries include:

- significant sites such as spawning and over-wintering
- fish distribution and seasonal movement
- stream contiguity (location and effect of dams, diversions, and channels)
- flow and seasonal discharge (quantity); stream gradient, morphology, and temperature; and water quality (sediment/nutrient/chemical intrusion)
- flow and seasonal discharge
- stream gradient and morphology
- water temperature influences/impacts
- quantity and quality of streamside vegetation
- degree of protection of important streams and lakes
- fishing pressure



Loss of riparian vegetation and alteration of a stream corridor

Aquatic Integrity Assessment

An assessment of biological integrity will be conducted for aquatic organisms (e.g. fish, benthic invertebrates) at the sub basin scale using a multimetric index (e.g. Hughes et al., 1998, Karr and Chu, 1998) and/or a multivariate analysis approach (e.g. Reynoldson et al., 1997). Results will be compared to the aquatic risk assessment of the sub basin. Quantitative relationships between sub basin characteristics and aquatic integrity may also be explored. Roth et al. (1996) found that regional land use upstream from a site was the primary determinant of stream biotic integrity in an agricultural and urbanizing watershed in southeastern Michigan."

Surface Water Quality, Quantity, and Timing

As part of the watershed analysis, surface water quality and peak flows must be assessed. Changes in these characteristics are likely to occur as the result of landscape change. The hydrological regime is defined in terms of both single events and long-term patterns. The single-event perspective describes surface water runoff levels that result from a rainstorm of certain intensity, duration, and frequency that falls in a drainage basin. The long term perspective encompasses the precipitation from many storms and examines the daily or monthly fluctuations in soil moisture and stream flow. The effects of land use change on both need to be determined. In addition to the score card index listed above, the following hydrological processes will be modeled and calculated for several priority basins (basins to be determined):

- Stream hydrographs
- Peak discharges
- Frequency of flood events
- Sensitivity analysis of the above to landscape change
- Amount, source, and known impacts of sedimentation and chemical pollutants

The hydrologic models that will be considered for the analysis include: WRENS, TR-20 and HEC-1. This area is still under investigation and collaborators need to be identified.

Land use activities and change may impact the watershed due to loss of vegetation, increased runoff, sedimentation, etc.

Ground Water Quality and Quantity

Ground water quality and quantity is influenced by urban growth and agricultural development both directly and indirectly. Water quality can and historically has been affected by contamination from urban runoff, agricultural pesticides and fertilizers, home maintenance chemicals, and septic systems. In addition, increased demands on the aquifer for withdrawals of potable water and irrigation present quantity issues. Groundwater analysis and modeling will address the impacts of the various alternatives on potable water, contamination levels, and aquifer recharge.

There is a considerable database maintained by the B.C. Ministry of Environment, Water Management Branch of well locations and water quality. Some impact evaluation and modeling has been carried out that may be appropriate for strategic planning but further investigation is required. Details of the methods of ground water modeling in response to alternative futures are in progress.

Ground water quality and quantity is influenced by urban growth and agricultural development both directly and indirectly.

Air Quality

Impacts to air quality, due to increased development and agricultural waste burning, is being experienced north of the study area around Kelowna. A similar trend has been identified in the study area, therefore, analysis and modeling of existing and future impacts to air quality are included within this study. Due to the current lack of data and limited precedence for air quality modeling, details of the methodology will be developed later in the process. However, the following air quality criteria pollutants may be considered for modeling and/or monitoring:

- Sulphur Dioxide
- Carbon Monoxide
- Ozone
- Lead
- Nitrogen Oxides
- PM10 particulate matter which includes:
  - Wind-blown dust from dry, open areas
  - Entrained road dust
  - Fugitive dust emissions
  - Agricultural waste burning
  - Pesticide and fertilizer application
  - Exposed soil from fallow fields
  - Wood smoke from fireplaces
  - Fossil fuel burning
  - Chemical reactions of primary pollutants

Wildfire Potential/Risk

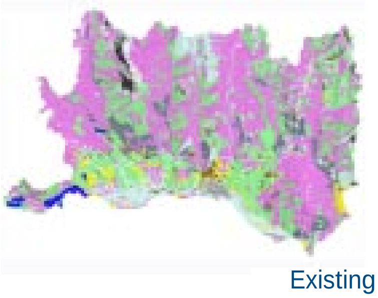
Fire is a critical process in many plant communities and periodic fire events are necessary to the long term survival of some native plants species, communities and their associated wildlife. The alteration of historic fire regimes through fire suppression has resulted in changes to the successional trajectories of many plant communities and can alter species composition in both the medium and long term. In addition, fire management and the threat of wildfire to human settlements must consider the increased fuel loads that have accumulated in many areas due to suppression activities. The urban wildland interface may be configured in many ways and the resultant wildfire threat may vary considerably. A measure of wildfire (or lack of fire) impacts and the relationship to the long-term survival of native plant species and communities as well as the risk to urban development must be understood.

The urban/wildland interface may be configured in many ways and the resultant wildfire threat may vary considerably.

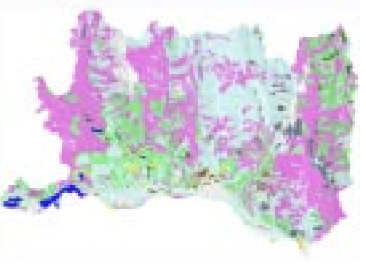
Many aspects of the Spatial Fire Management System (SFMS) work now ongoing both by the Ministry of Forests (MOF) in Penticton as well as by the Canadian Forest Service (CFS) in Victoria and Edmonton will be utilized. Analysis of wildfire potential and threat analysis will involve the following models.

i. Flammability (FBP Fuel Types)

Vegetation will be classified to reflect the fuel class according to the Canadian Forest Service system. This classification is based largely on vegetation type and structure (e.g. coniferous, deciduous, ladder fuels, crown density, canopy closure and surface fuels).



Existing



Future

Wildfire process models will map existing and future conditions for flammability, headfire intensity, vegetation change, and wildfire threat.

ii. Headfire Intensity

Using the SFMS, maps will be developed to indicate the potential intensity of wildfires. This model utilizes fuel type, topography, and climate, and can be used to identify the spatial distribution of varying levels of intensity of headfires. This indicates potential "hotspots" or areas which should be targeted for action in order to protect values at risk.

iii. Vegetation Change Model

Changes in vegetation due to alteration of historical or inherent disturbance regimes must be understood and factored into alternative futures for the area. The work of Steve Taylor and Greg Baxter from the CFS will be used. This includes either the Woodstock model to assist in fire treatment prioritization on a landscape basis, or their work on the Forest Vegetation Simulator (previously called Prognosis) which provides a stand approach for predicting forest structure, fuel loading, and fire behavior changes over time.

iv. Wildfire Threat Analysis

Using the SFMS from the Decision Support Systems research group of the CFS in Edmonton and the work of Brad Hawkes (CFS) and Judy Beck (MOF), the alternatives will be evaluated for wildfire threat.

2. VISUAL/ CULTURAL EVALUATION AND IMPACT MODELS

The Land and Resource Management Planning process (LRMP) has carried out substantial cultural assessment and issue identification. This work will be used for many portions of the study.

The degree of current protection and future risks to cultural resources will be assessed.

Visual Quality

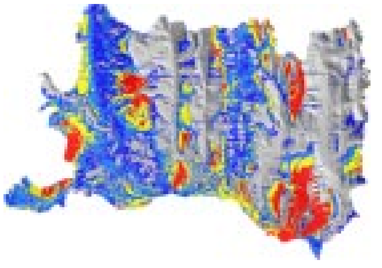
People understand their environment largely through what they see around them. The changes that increased growth will bring to the area may result in a significant devaluing of one of the most important resources that brought people to the area in the first place. The importance of the scenic quality and visual value of the area should not be underestimated. The study therefore includes a model of the impact of future change on visual quality. Process models will include:

i. Visual Landscape Preference Model

A landscape preference model will be developed based on evaluation of key landscape types, treatment, and elements. Evaluation will be based upon public input via a visual preference survey.

ii. Visual Exposure Model

Levels of exposure in terms of the extent that landscapes are visible from all major transportation routes in the study area.



Visual preference and visual exposure outputs will be combined to produce a map of visual landscape value.

iii. Visual Value Model

Visual preference and visual exposure outputs are combined to define levels of visual landscape value. For example, areas indicated as the most preferred and most visually sensitive will have the highest visual value rating.

Cultural Resource Protection

The degree of current protection and future risks to sacred sites, archeological, heritage, and other significant cultural resources will be assessed. Process models will use available data as no new field work is anticipated to be necessary.

i. Heritage/ Archeological Resource Model

Archeological and heritage resources are protected under the Heritage Conservation Act as “Provincial Heritage Sites”. This model will map recorded sites that have been identified to date and may include an assessment of potentially important sites or locales.

ii. Traditional Use Study (TUS)

Traditional use sites are “any geographically defined sites (land or water) used traditionally by one or more groups of First Nations people for some type of activity”. These sites may lack physical evidence artifacts or structures, yet maintain cultural significance to a living community of people. Information about traditional use sites is recorded in Traditional Use Sites databases maintained by individual First Nations.

3. ECONOMIC EVALUATION AND IMPACT MODELS

The Land and Resource Management Planning process (LRMP) has carried out substantial issue identification and social values assessment. This work will be used for many portions of the study. In addition, a strategic overview of the economic impact of various alternatives is required. Ecological systems need to be analyzed in such a way as to reflect the interdependence of economic well being and ecosystem health (Ervin and Berrens, 1994). In addition to resource use and non use, non market goods and services must be considered if tradeoffs are to be reasonably assessed.

Following Ervin and Berrens, (1994), evaluation of the effects of future landscapes must reflect:

- Direct use values (agricultural production, residential development, recreation)
- Indirect use values (watershed protection, biodiversity protection)
- Option values (the value of potential use of the area)
- Bequest value (the importance of intergenerational bequesting)
- Existence value (for its own sake and independent of any use of the resource)

Ecological systems need to be analyzed in such a way as to reflect the interdependance of economic well being and ecosystem health.

The following are seen as important aspects of the economy that should be considered in the evaluation of the alternatives and may form the basis for a more detailed terms of reference for economic modeling.

- Agriculture / Horticulture
  - production
  - loss of agricultural land to urban conversion
  - revenues
  - employment opportunities

- Forestry
  - tax and stumpage revenues
  - harvested wood volume (cubic meters and dollars)
  - fire suppression costs
  - employment opportunities

- Grazing
  - stocking levels (Animal Unit Months) and revenues
  - employment opportunities (including number of ranchers, hands, etc)

- Tourism
  - ecotourism
  - remote visitation (incl. guiding and outfitting) and revenues
  - vehicular based visitation and revenues
  - willingness to pay for naturalness, wilderness and scenic quality
  - employment opportunities
  - recreational opportunities
  - diversity of recreational opportunities
  - areal extent of recreation lands
  - taxation revenues

- Fishing, Hunting and Trapping and Wildlife Viewing
  - revenues
  - employment opportunities (incl. guiding and outfitting)
  - number of participants
  - cost of wildlife depredation

• Non Renewable Resource Economics
  - resource revenues
  - employment opportunities

• Other
  - other commercial opportunities
  - seasonality and temporality of economic benefits
  - diversity of the local and regional economy
  - taxation returns
  - land costs
  - non market values
    - watershed Protection Value
    - biodiversity Value

• Cost of Public Action/Services
  - capital requirements of major infrastructure (sewer, schools, water, and roads)
  - public costs related to development (urban, rural, and exurban)
  - infrastructure operating costs
  - public service staffing and operational requirements

Urban/Wildland interface and the risk of wildfire

Condemned property due to slope instability

Development Suitability

Development suitability and evaluation models examine physical land constraints to residential and infrastructure development (roads, sewer, water and septic). Suitability criteria have been identified for the area based upon risks to public health and safety, as well as cost and degree of difficulty of construction. These include slope stability, wildfire risk, surficial geology and soils.

i. Slope Stability Model

Soil type and property data will be combined with topography to determine relative slope stability and potential for failure.

ii. Wildfire Risk/Hazard Model

(As previously described)

iii. Septic Suitability

Areas of potential development that lie outside of existing central sewer systems will be assessed for septic suitability. Provincial regulations and standards will guide the analysis of soils types and structure and their capability of supporting septic systems.

iv. Infrastructure Suitability

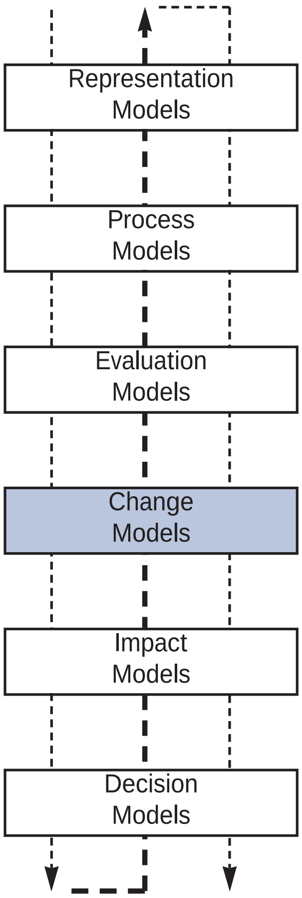
Surficial geology will be examined in order to identify areas of bedrock outcrops or other unsuitable soils etc. which would limit or dramatically increase the cost of infrastructure development.

Analysis of agricultural production and associated issues such as production, revenues, employment opportunities, and loss to urbanization is one of several components for study in the economic evaluation and impact models.

EXISTING CONDITIONS AND ALTERNATIVE FUTURE SCENARIOS

The existing landscape is a mosaic of various land uses and land cover classes. The broad use/cover classes within the study area consist of residential and commercial development, agriculture, transportation and infrastructure, open space, natural vegetation areas, rock and large water bodies. Shifts in the configuration or pattern of these local landscape elements are occurring continuously.

Landscape change within the study area is influenced predominantly by population growth with its associated residential and commercial development, transformation of native vegetation by agriculture and forestry, and changes in the natural disturbance regimes (chiefly fire return intervals on upland sites and inundation frequency in riparian areas). Future alternatives for the area are guided by current trends or caused by the implementation of purposeful change via plans, designs, investments, policy and regulations. The existing conditions are not in stasis regardless of future actions. Conservation, non-action, as well as intervention will all bring about future change; with different impacts. Using existing plans, known trends, and differing sectoral emphasis together with input from decision makers and stakeholders, a range of future alternative scenarios will be developed and their associated impacts simulated.



Land Pattern Objectives

The integration of ecological and societal requirements is the most difficult task of land planning, particularly when sectoral objectives are in conflict and are described in broad policy terms. This project will differ from many others in that integration will be attempted by requiring that sectoral objectives be described in terms of land pattern requirements. Integration is achieved as a landscape configuration design solution with tradeoffs and compromises clearly measurable and legibly defined on a map.

Land pattern objectives must be set for both the entire study area as well as for individual landscape management units (LMUs). The various alternatives will be driven by and will inform land pattern objectives at both scales. Sectoral interests such as vineyard or agricultural production will be described in terms of the identification and configuration of local landscape elements that best meet industry requirements. Similarly, conservation alternatives will have priority landscape configurations that best suit ecological integrity. The requirements of all sectors will be analyzed and areas of coincidence or conflict of objectives identified.

The identification of pattern objectives for each sector and the subsequent analysis will be important inputs to the more balanced alternatives that will be the focus of the most serious work of the study.

Basic Guidelines for Alternatives

In order to evaluate the future scenarios in a similar manner as well as to reduce the complexity of the evaluation process, all alternatives (including the existing conditions) will be described with a single map and in a common spatial vocabulary. This vocabulary will be a modified version of the existing Terrestrial Ecosystem Mapping (TEM) classification with additions for more detailed anthropogenic uses. The single map which describes each alternative will be the input into most of the impact models.

In addition, the development of alternatives will follow a set of basic guidelines.

- The alternatives will use the terrestrial ecosystem mapping classification together with various classes of residential/commercial development, other urban land classes, agriculture, roads, and infrastructure, as the basic spatial vocabulary. The extent and configuration of each land use/land cover will define the variations among alternatives.

- In order to provide an understanding of various levels of impacts, as well as to help identify individual sectoral land pattern requirements, alternatives that emphasize a particular land use will be developed in addition to more balanced options.

- Future population projections for the project area are estimated to double by the ` year 2020. All future scenarios will respond to a target population number through the allotment of appropriate residential development. However, a residential development density will not be established in order to allow for flexibility between plans and an ability to meet different scenario objectives.

- Alternatives are based on the assumption that existing land use and land cover types will remain the same in the future. Factors such as drastic changes in the economy or industry will not be included in the models.

- Climate change will not be modeled.

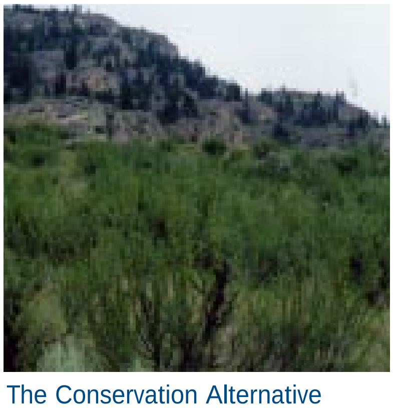
The Trend Alternative assumes that existing land uses would continue to change and that existing protection and management policies would be continued.

The Alternatives

Eight future alternatives that may be delineated for the area are proposed below. Others may be added as stakeholder involvement increases.

i. The Trend Alternative

Using current plans, zoning, and regulations, the Trend Alternative represents the most likely long term future for the study area. This alternative assumes that existing "urban" land uses such as residential, commercial, industrial, and transportation would continue to change, and that existing protection and management policies would be continued. Future land use changes will be located in the most likely areas based upon current trends and policies.



The Conservation Alternative prioritizes the conservation of ecological integrity and cultural resources.

ii. The Conservation Alternative

The Conservation Alternative prioritizes the conservation of ecological integrity and cultural resources. Agricultural land does not increase within this alternative and existing open space areas remain or are protected for ecological or cultural purposes. Residential and commercial development will be located in developable areas in a manner that minimizes conflict with conservation objectives.

iii. The Agricultural Production Alternative

Agricultural practices including orchards, vineyards, ranching, and farming are maximized within the study area. Within this alternative, all Agricultural Land Reserves (ALR's) would be utilized for agriculture along with undeveloped private lands.

iv. The Maximum Development Alternative

This alternative emphasizes residential and commercial development (including recreation and tourism) on all lands that are suitable for development.

The Agricultural Production Alternative maximizes agricultural practices such as orchards, vineyards, ranching, and farming.

v. The Balanced Alternatives

As a combination of the best solutions for future land use, the balanced alternatives project a series of development patterns representing different spatial arrangements. All balanced alternatives have critical agricultural and conservation areas identified, although substantial variation in conservation potential will be realized through varying patterns. The major difference between them will be residential and commercial development configurations. Three balanced alternatives are anticipated.

a. Linear Development Alternative
Development will occur along major roads, rivers, and lakes.

b. Nodal Development Alternative
Development will be concentrated in identified urban centers. Some new nodes may be created.

c. Dispersed Development Alternative
Development will occur in a random pattern dispersed throughout the landscape.

vi. 1800 Alternative*

By analyzing landscape history we can begin to understand how a landscape was made, where it is within its dynamic history, and what its future trajectory might be in relation to current or alternative ecological and cultural trends. As an indication of change over time, from past to present, a scenario representing the land use and land cover of the area in the early 1800s may be developed by creating a potential vegetation based upon physiographic and climatic characteristics.

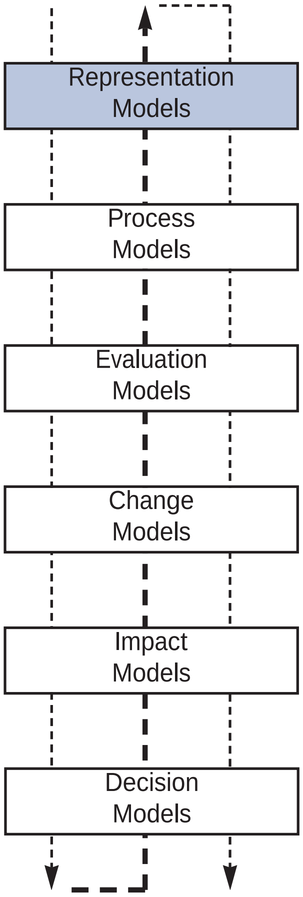
* Development and inclusion of the 1800 alternative in the study will be done pending the availability of historical data for the area.

The Maximum Development Alternative emphasizes residential and commercial development.

LANDSCAPE REPRESENTATION, AND MINIMUM DATA REQUIREMENTS

Landscape representation determines how the landscape will be described in context, space and time. In essence, landscape representation data forms the building blocks upon which all process, evaluation, and impact models are developed. Central to this is the development of a defining vocabulary and a syntax to identify those characteristics of a place relevant to the study.

Landscape representation data describes static and dynamic processes at work in the study area. Most data will be coordinated within a computer-based Geographic Information System, or GIS, as a means of displaying and analyzing data in a spatially explicit manner. The state of the landscape will be represented with maps, charts, and diagrams that are derived from the data. As data assembly is one of the costliest parts of the study, as much existing data as possible will be utilized. New data acquisition will be minimized by only acquiring data that is needed for the models identified in previous sections.



In support of Evaluation, Impact, and Process models, the following base data will be required:

- Landsat TM data - Ministry of Forests
- TRIM mapping - Ministry of. Environment., Lands, and Parks
- Administrative boundaries, plans, and regulations
- Land ownership and Land Use Mapping
- Cadastral Mapping - roads, utilities, parcels
- Terrestrial Ecosystem Mapping - Ministry of Environment
- Soils - BC Soils Information Project (Ministry of Agriculture, Fisheries and Foods)
- Wildlife Inventory data
- Capability/Suitability Species Mapping
- Species at Risk Database - Ministry of Environment, Lands, and Parks
- Ecosystem Connectivity Map - LRMP (Dr. G. Scudders)
- Biogeoclimatic Ecosystem Classification (BEC) - Ministry of Forests
- Biophysical Habitat Data and Mapping - Ministry of Environment, Lands, and Parks
- Vegetation Inventory (Habitat Atlas)
- Climatology
- Hydrology data and mapping (quantity, quality, timing)
- Fish Information Summary System (FISS) - Fisheries Branch
- Hot Spot Fisheries Inventory - South Okanagan inventory document
- Well test records - Environment Canada
- Watershed Atlas data and mapping (incl. fish distribution) - BC Environment
- Surface water sampling stations - Ministry of Environment, Lands, and Parks
- Fisheries, lakes, streams, stream reaches, overwintering and spawning locations
- British Columbia Watershed Atlas
- Geologic Hazard mapping
- Historic Fire Data - BC Forest Protection Branch
- Wildfire Threat Analysis - Ministry of Forests
- Wildfire Threat Rating System - Ministry of Forests
- Successional Modeling System (Forest Fire) - Ministry of Forests
- Visual Quality Objectives (VQO) - Ministry of Forests
- Visual Sensitivity Rating Map - Ministry of Forests
- Archeological site mapping - Heritage Branch
- Cultural heritage resources
- Tourism and recreation records and plans
- Demographic data
- Transportation plans

TECHNICAL IMPLEMENTATION

The project is designed to use a computer-based Geographic Information System (GIS) which contains digital data about the region. The GIS will be used to perform the analyses, produce maps, charts, and other graphic and tabular results. GIS is a type of database that allows descriptions of the landscape to be geographically referenced. Among many other capabilities, information such as the amount of conservation land in the study area, analysis of the spatial relationships between elements in the landscape, and queries to the location of various attributes can be accommodated by the GIS system. Further, models that use these spatially explicit data can be created to simulate natural processes. Changes to the landscape can also be modeled and assessed for potential impacts. The work would simply not be possible without the GIS. In addition to the use of the GIS for data organization, mapping and modeling, it will be used for visualization. Maps will be draped over terrain and interested parties may view the landscape data layers and alternatives in 3D stereo flythroughs. In addition other landscape visualization programs will allow near photorealistic rendering from any view or sets of views to create animations of the alternatives. These visualizations are particularly important to the understanding of the landscape by both lay members of the public as well as by professional analysts.

It is anticipated that data used for the project will be acquired from several sources and have variation in spatial resolution and accuracy. While most source data will be in digital form, some data may have to be digitized from printed originals. All data will be assembled, standardized to a common set of descriptive terms, and combined to produce the study's representation of the landscape.

Computer programs necessary for the study include:

- Analytical models – ArcInfo, ArcView (including Spatial Analyst and Network Analyst) and ERDAS Imagine
- Alternative Scenarios – ERDAS Imagine, Map Factory and ArcInfo
- Visualization - ERDAS Virtual GIS, World Construction Set,

A high end Windows NT or Unix workstation will also be required.

STAGE THREE: STUDY IMPLEMENTATION

A companion work plan document has been prepared which describes the study team, potential collaborators, timelines and budget projections. The scope and timing of the final study will depend, to a large extent, on the availability of funding. Funding in phases is a feasible strategy given the modular nature of the proposed study.

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