THE PROCESS OF
ECOSYSTEM-BASED CONSERVATION PLANNING

The Process: Multiple Spatial Scales

Ecosystem-based conservation planning is applicable at the full range of spatial scales from large sub-continental and regional landscapes to small watersheds and individual patches or ecosystem types. In order to protect ecosystem health and biodiversity at all scales through time, ecosystem-based conservation planning needs to begin with as large a landscape as possible. The reason for this is to ensure that ecological processes are maintained throughout the region as planning proceeds to landscapes of multiple watersheds, to individual watersheds, and eventually to patches or individual ecosystem types.

Silva develops ecosystem-based conservation plans so that the protected networks of ecosystems designed at each scale nest within those designed for larger areas. This approach not only provides for the most effective way to protect ecosystem health and biodiversity, but also results in an efficient planning system in terms of data interpretations, field assessments, map design, and structuring planning tools like geographic information systems and aerial photo interpretation.

Note: The terms *protected networks of ecosystems* and *networks of ecological reserves* are interchangeable and have the same meaning.

The design of protected networks of ecosystems or networks of ecological reserves employs the same set of six **primary (key) variables** at each spatial scale:

1. **Representation**

   . . . included because the natural pattern and range of ecosystem types need to be protected to maintain a wide range of ecosystem functions.

   - vegetation types
   - enduring features
   - successional phases with reference to range of natural variability

2. **Unique or special features**

   . . . included because these areas are infrequent and, therefore, provide important ecological functions across a planning area.

   - rare ecosystems and species (natural and anthropogenically rare)
   - habitats like bear dens, caribou calving areas, heron rookeries
   - deep, rich soils

3. **Focal species**

   . . . included to provide the range of habitats needed for a range of species to persist.

   - needs of a group of representative species. This group should reflect the diversity of species found in the planning area, and thus reflect the range of habitats found in the planning area. For example, the group should include wide ranging species like

grizzly bears and wolverines; dispersal-limited organisms like salamanders and frogs; ungulates like caribou and deer; diverse birds like songbirds and raptors; and small mammals like pine marten and flying squirrels.

4. **Ecological sensitivity**

   . . . included because many human activities easily degrade ecological integrity in ecologically sensitive areas and in adjacent areas.

   - areas with ecological limits, like very dry areas, very wet areas, shallow soils, cold soils, steep slopes, and broken terrain.

5. **Connectivity**

   . . . included because undisturbed/unmodified landscapes had few restrictions to movement of plants, animals, and microorganisms. Therefore, in managed landscapes we need to provide at least minimal levels of connectivity at each planning scale.

   - designed for a species or group of species
   - adequate unmodified habitat types across scales
   - riparian ecosystems at all scales
   - few/no barriers to movement for the species anticipated to use linkage

6. **Natural disturbance regimes**

   . . . included because the type, frequency, location, and characteristics of natural disturbances determine how ecosystems function over short and long periods of time. Natural disturbances include fire, wind, insects and decay.

   - Range of natural variability shows how frequently different disturbances change vegetation cover and associated ecosystem composition, structure, and function.
   - Frequency and size of natural disturbances determine the minimum size of core reserves that are necessary to maintain ecological integrity and biological diversity following extensive disturbance(s).

The expression of each of these six primary variables varies, depending upon the scale of planning. For example, at the large landscape level, an entire watershed may be a unique feature because it is the last unmodified area with the full range of grizzly bear habitat. At the patch level, large snags and fallen trees of a particular species may be unique features. Along with the six primary variables listed above, each ecosystem-based conservation plan utilizes specific variables that reflect the characteristics of the planning area and the overall objectives of the plan.

Designs for protected networks of ecosystems/ecological reserves at each scale are developed from a combination of interpretation of various databases, field assessments, and expert opinion. Each design is subject to modification based upon a field assessment and peer review of the design.

The three **primary scales** that we employ in the ecosystem-based conservation planning process are described below. However, the reader is cautioned that there are often intermediate scales, where plans are produced that fall between these primary scales. The precise structure of a multiple spatial scale ecosystem-based conservation plan depends upon the ecological characteristics of the area being planned and the objectives for the plan.

Scale 1: Sub-continental & regional/large landscapes: Protected Areas Network (PAN)

A protected areas network (PAN) consists of **core reserves** and **linkages** that provide for connectivity between core reserves and throughout the landscape being planned. Core reserves and linkages need to be spatially well distributed across the planning area, and be inclusive of the six primary variables listed above.

If the planning area is large, consisting of multiple landscapes, a PAN may be developed for the entire area, with finer scale PANs developed for landscapes within the large planning area.

The common scales for analysis and map production of PANs range from 1:500,000 to 1:200,000.

Scale 2: Landscapes and multiple watersheds: Protected Landscape Network (PLN)

A protected landscape network (PLN) is designed for a medium-size landscape that will be modified by human activities. The design of a PLN is followed by development of human use areas for the landscape and design of an economy for the planning area.

Considering the six primary variables described above, specific components of a PLN include:

- old growth or late successional forests;
- riparian ecosystems, from large to ephemeral features;
- wetlands and wetland complexes;
- ecologically sensitive areas;
- naturally rare ecosystem types;
- linkages or corridors that provide connectivity between and within ecosystems, groups of ecosystems, and ecological communities;
- ecosystems that provide habitat for rare, threatened, endangered genetic strains, species, and ecosystem types often termed biodiversity nodes; and
- ecological communities that are representative of the landscape.

The common scales for analysis and map production of PLNs range from 1:200,000 to 1:20,000.

Scale 3: Ecological communities and patches: Protected Ecosystem Network (PEN)

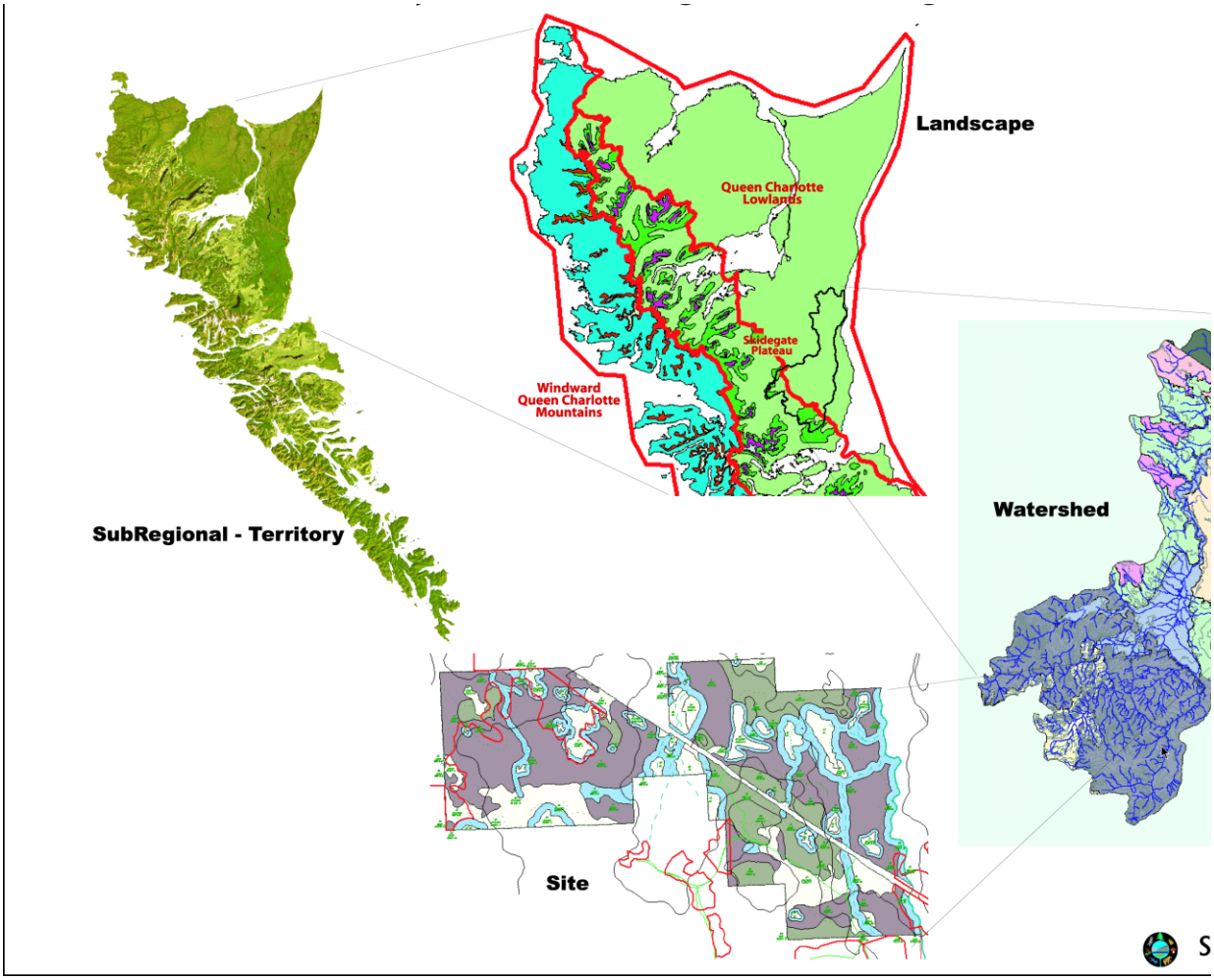
A protected ecosystem network (PEN) is designed at the community or patch level to maintain ecosystem composition, structure, and function in areas modified by human resource extraction and/or other forms of human development. The design of a PEN is part of the development of a prescription for human use in a particular ecological community or patch.

Considering the six primary variables described above, specific components of a PEN include:

- large living and dead tree structures,
- small ecologically sensitive areas,
- ephemeral streams and wetlands, and
- linkages between structures.

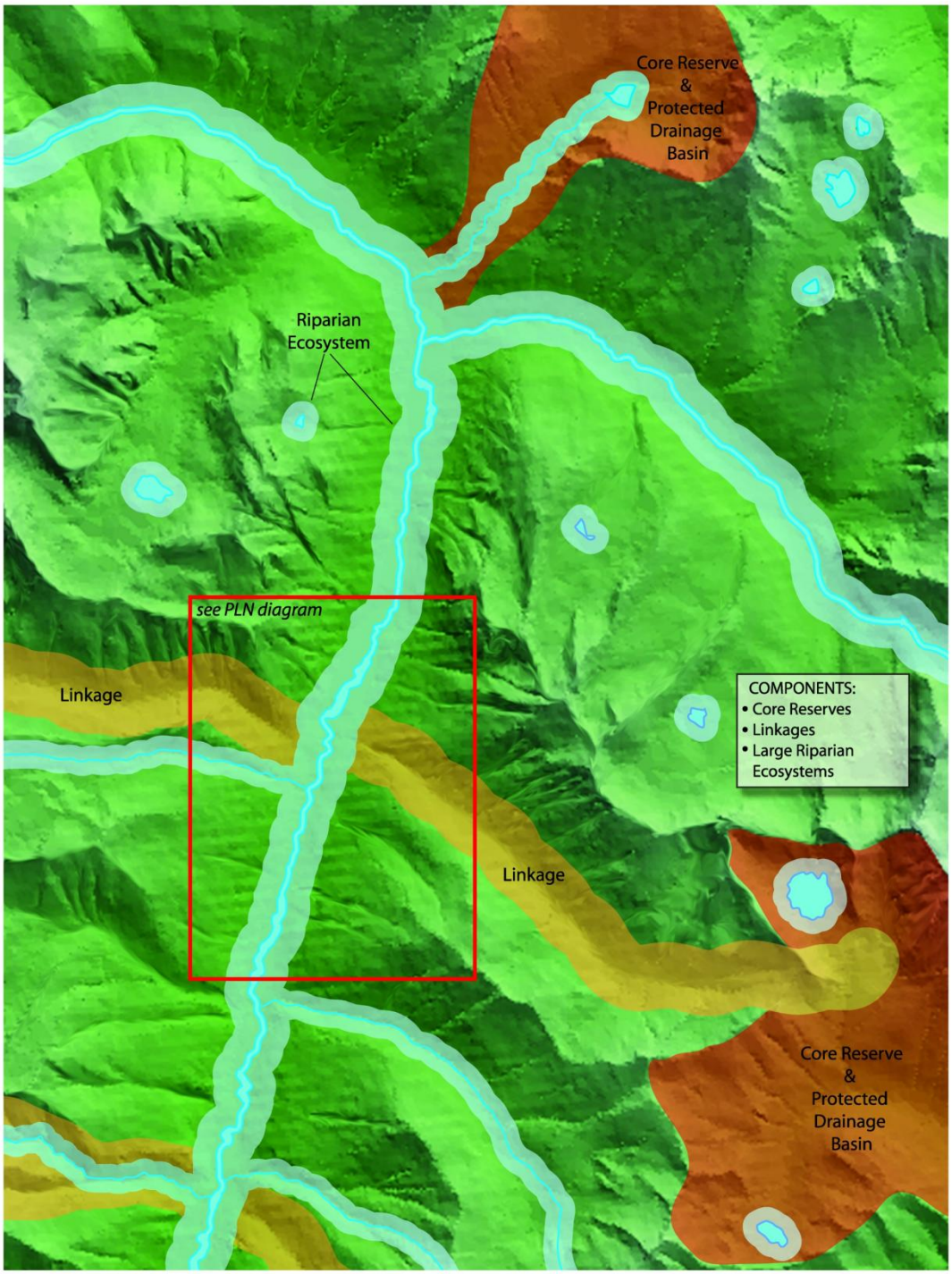
The common scales for analysis and map production for PENs range from 1:20,000 to 1:500.

Ecosystem-based Conservation Planning—multiple spatial scales



Protected Areas Network - Sub-Region and Large Landscapes

to maintain biological diversity in large landscapes



Key Factors: *Ecosystem Representation, Unique Features, Focal Species Habitat, Connectivity, Ecological Sensitivity, Ecological Diversity, Rare Ecosystems and Species*

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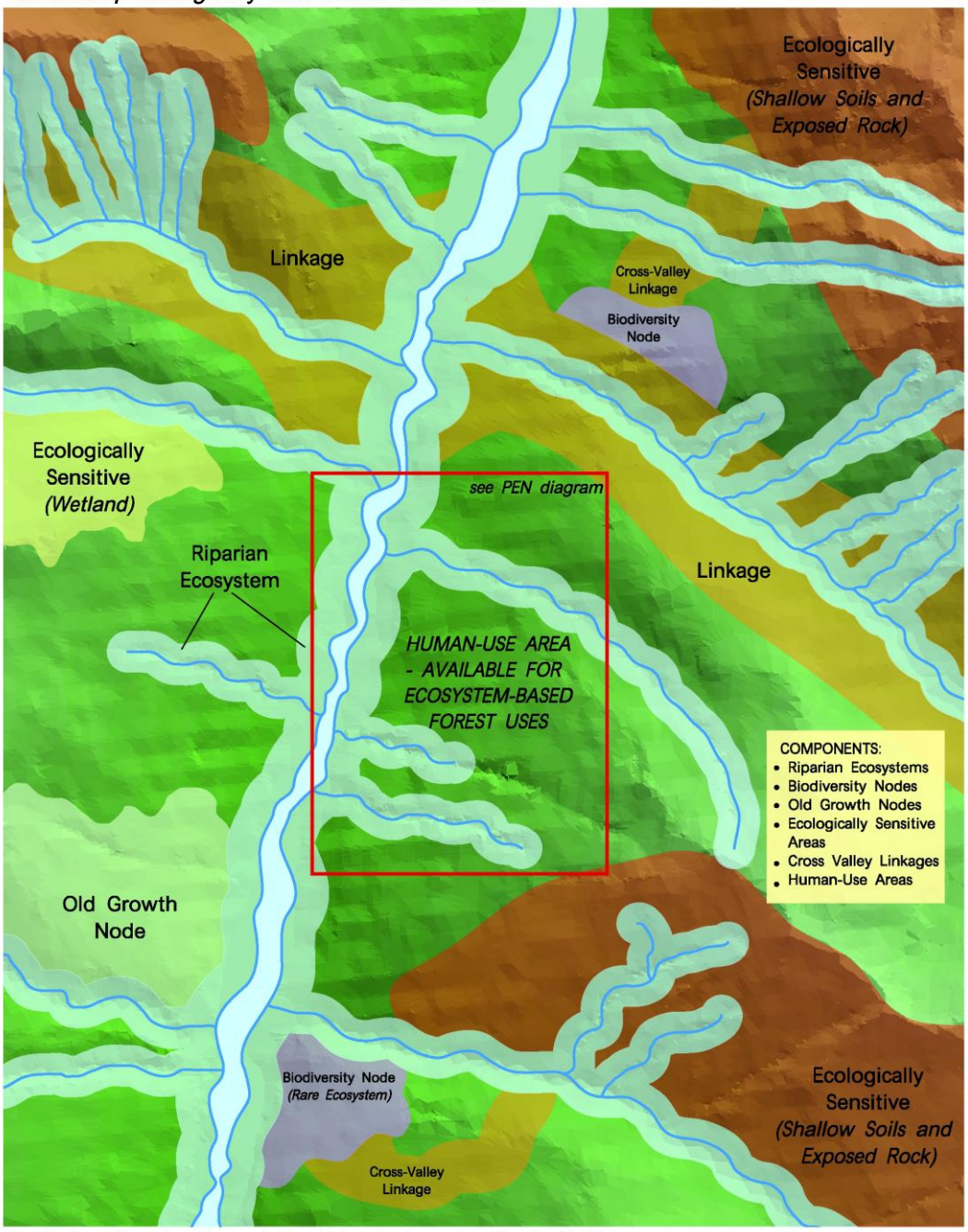
Protected Landscape Network (PLN)

*to maintain ecological integrity in **Small Landscapes** and **Watersheds**, and to develop ecologically sustainable economies*



Key Factors: *Ecosystem Representation, Unique Features, Focal Species Habitat, Connectivity, Ecological Sensitivity, Ecological Diversity, Rare Ecosystems and Species*

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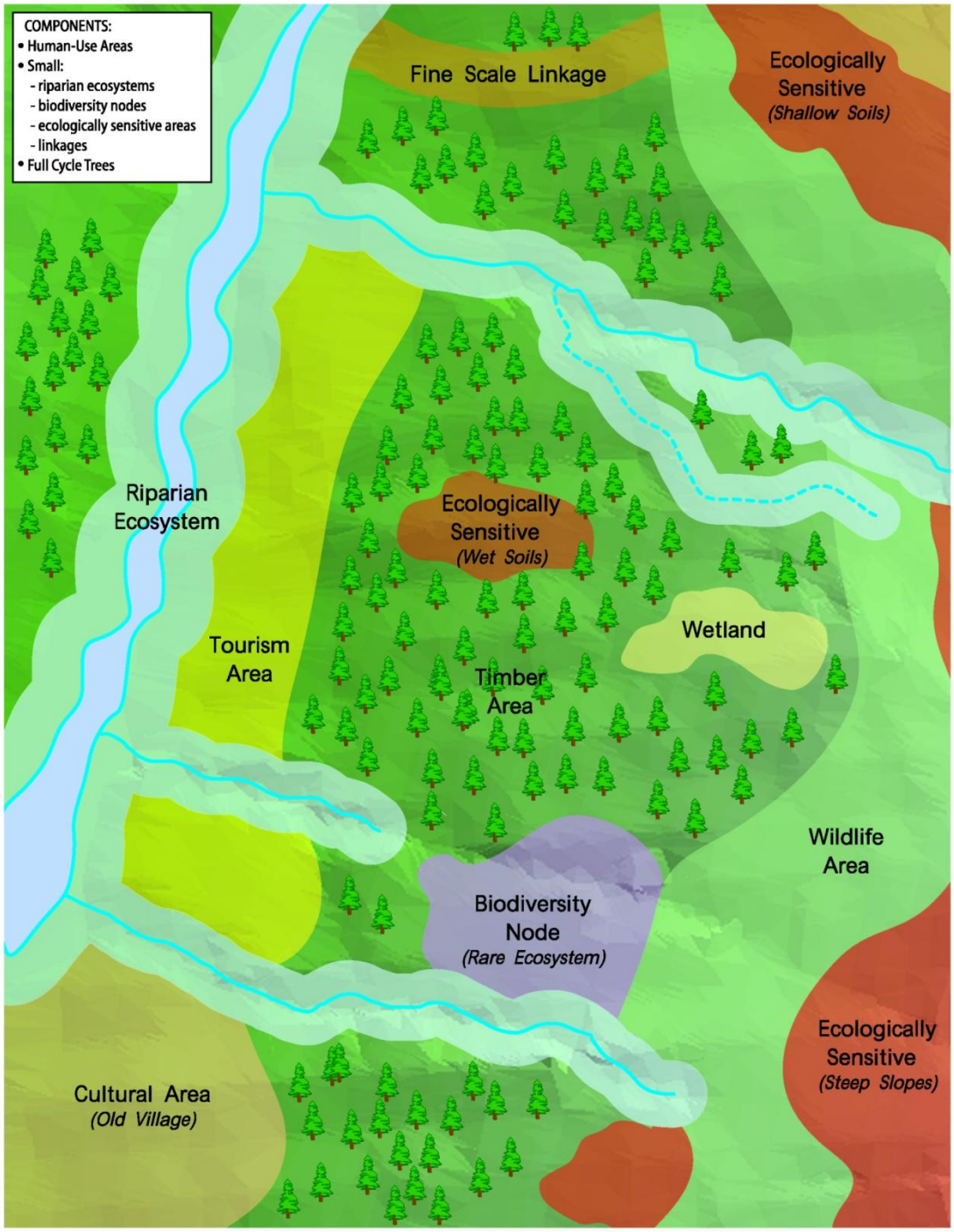
Protected Ecosystem Network (PEN)

*to develop ecologically sustainable economies, while maintaining ecological integrity within **Sites** or **Stands***



Key Factors for Reserve Design: *Ecosystem Representation, Unique Features, Focal Species Habitat, Connectivity, Ecological Sensitivity, Ecological Diversity, Rare Ecosystems and Species*

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The Process: Major Steps

First Nations and local communities are full participants in the process described below. Accommodation of First Nations aboriginal title and rights is a major factor in designing and implementing an ecosystem-based conservation planning process. Community interests that participate in an ecosystem-based conservation planning process are required to have a significant constituency, a clear means of regularly communicating with their constituency, and a clear means of being held accountable to their constituency and to the broader community. Industrial interests, along with other interests, need to be comfortable with, and adopt the philosophy and principles of an ecosystem-based approach to planning.

STEP 1: Describe the *character* and *condition* of the planning area, including:

- **the ecological landscape, and**
- **the human communities within or dependent upon the ecological landscape.**

The **character** of the ecological landscape refers to the natural[1] composition, structure, and function at all scales of the landscape. In other words, describing the character of the landscape means describing what it is and how it works. The character of human communities can be described in a similar way by understanding the residents, or composition, institutions or structures, and means of operation or functioning.

The **condition** of the ecological landscape refers to how the natural ecological composition, structure, and function have been modified or impacted as a result of human modification from resource exploitation, settlement, and other human activities. Similarly, the condition of human communities may be described by a variety of indicators, including: distribution of resources among community members and groups; meeting needs as opposed to acquiring wants; and whether people have meaningful and satisfying work.

STEP 2: Identify what to leave—what parts of the landscape need to be protected—by:

- **Determining *ecological sensitivity* and identifying *ecological limits*.**

Species, ecosystems, and landscapes, which are easily degraded or perturbed are **sensitive to disturbance.** Certain animal species, for example, are sensitive to disturbance because they have very specific habitat requirements. Soil communities on steep, wet slopes are also sensitive to disturbance because they are likely to slump or slide, resulting in soil erosion and stream siltation. The **ecological sensitivity** of these species and systems is determined by assessing biophysical characteristics such as slope gradient, slope complexity, moisture regimes, and overall soil depth, or by assessing habitat requirements and population dynamics.

Species, ecosystems, and landscapes that are sensitive to disturbance have biophysical, climatic, or abundance thresholds. Serious ecological degradation,

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[1] *Natural* is defined as the composition, structure, and function of ecosystems before industrial modification of landscapes and their component ecosystems. Therefore, in North America, *natural* conditions would be defined largely as the period before European contact. Note that *natural* does not mean without human modification and includes Indigenous Management Systems.

including species loss, may occur if these thresholds or **ecological limits** are exceeded by human activity. For example, inappropriate timber cutting in forests growing on cold and/or thin soils will result in long-term loss of habitat and degraded nutrient cycling. Similarly, excessive harvesting of a mammal or fish population will result in catastrophic decline or extinction. Ecological limits can be identified by the presence of characteristics such as cold climates, cold soils, terrain with steep and/or broken slopes, very wet or very dry moisture regimes, heavy snow packs, low numbers of a naturally occurring species, and the habitat requirements for a particular species.

Ecological sensitivity and ecological limits of species, ecosystems, and landscapes define areas that require high levels of protection at all spatial and temporal scales.

- **Identifying naturally or ecologically rare ecosystems.**

  Within any landscape there are unique ecosystem types that comprise only small portions of the landscape and/or occur very infrequently in dispersed patterns, throughout the landscape. Rare or unique ecosystem types require protection, from the patch to the large landscape level, in order to maintain ecological integrity.

- **Identifying landscape pattern, representative ecosystem types and natural disturbance regimes.**

  The landscape pattern or mosaic is defined by the distribution, frequency, size, and shape of the **ecosystem-types** comprising the landscape. Ecosystem types are commonly defined by variability in vegetative communities in combination with topographic features. Homogeneous patterns and heterogeneous patterns within the planning landscape result in identifying different representative ecosystem types, and ultimately in designing different protected networks of ecosystems/ecological reserves. The nature, size, frequency, and shape of natural disturbances determines how the landscape pattern changes through time. Protected networks of ecosystems/ecological reserves need to be designed to accommodate these changes without loss of ecological integrity.

- **Defining a protected areas network (PAN), consisting of core reserves and linkages or corridors between reserves.**

  The design of the PAN, including the location, size, and configuration of core reserves and linkages/corridors, needs to consider:

  i. *The character of the landscape*. . .Core reserves and linkages/corridors need to be well distributed across the landscape, need to encompass special features and naturally rare ecosystem types, need to contain good representation of ecosystem types, need to meet the needs of focal species, and need to anticipate natural disturbance frequency and patterns. These aspects of core reserves and linkages/corridors are determined from the description of the character of the landscape, and theme maps developed during this description.

  ii. *The condition of the landscape* . . . as much as possible, core reserves and linkages/corridors need to be unmodified by industrial human development. However, if key ecosystems and/or key geographical areas have been modified, these areas need to be included in an ecosystem-based conservation plan as

large landscape reserves and/or linkages/corridors, with the provision that active restoration will occur in these areas.

iii. *Keystone and/or umbrella species* . . . large landscape reserves and linkages/corridors need to ensure, within the limits of our understanding of ecosystem functioning, persistence (as opposed to mere existence) of keystone and umbrella species. **Keystone species** provide unique functions within ecosystems. Without keystone species, key aspects of ecosystem functioning, like nutrient cycling and photosynthesis, are damaged. **Umbrella species** are those whose health (i.e. population and condition of population) reflect the condition of a broad range of species in both individual ecosystem types and large landscapes. Large landscape reserves and linkages/corridors need to accommodate the needs of both keystone species and umbrella species.

iv. *Rare, threatened, and endangered genetic strains, species, and ecosystems* . . . refers not only to *naturally rare* genetic strains, species, and ecosystem types, but also to genetic strains, species, and ecosystem types which have *been made rare, threatened, or endangered* by human modification of ecosystems and landscapes. Necessary habitat for rare, threatened, and endangered genetic strains, species, and ecosystem types need to be accommodated by large landscape reserves and linkages/corridors.

- **Test for the habitat needs of a range of species**.

At this point in developing an ecosystem-based conservation plan, a network of protected ecosystems/ecological reserves is emerging. Depending upon the size of the area being planned, this network will be a PAN, a PLN, or a PEN. In order to ensure that the network maintains composition, structure, and function at the spatial scale it has been designed for, the network of protected ecosystems/ecological reserves needs to be tested to ensure that the needs of various species are met. Population data and habitat needs for a variety of species, a **group of species,** are used to test the effectiveness of the protected network of ecosystems/ecological reserves to identify "holes" or flaws in the design. The wider the range of species and the greater the number of species that can be used to test the protected network, the more confidence the planner can have that the ecosystem-based conservation plan will protect and maintain ecosystem composition, structure, and function at all scales through time.

Note: The process outlined in STEP 2 above is generally followed for the development of protected landscape networks (PLNs), as well as PANs.
The primary difference is that design of PLNs requires a finer network of protected ecosystems than a PAN. For example, riparian ecosystems and old growth forest nodes appear in a PLN, but not in a PAN, while core reserves are central to a PAN, but are not usually designed in a PLN. Also, the linkages/corridors in a PLN are smaller and more frequent than the linkages/corridors in a PAN.

The process to define a protected ecosystem network (PEN) is a finer scale version of the process to define a PLN, and also depends upon the characteristics of the specific patch or ecosystem type where human activities are planned. For example, instead of defining old growth nodes, as in a PLN, a PEN defines individual trees, snags, and fallen trees for inclusion in the PEN.

As described in STEP 3 below, the design of PLNs and PENs is an integral part of developing an ecologically sustainable economy.

STEP 3: Develop diverse, ecologically sustainable community-based economies by:

- **Defining *Protected Landscape Networks* in landscapes that will be modified by ecologically responsible human use.**

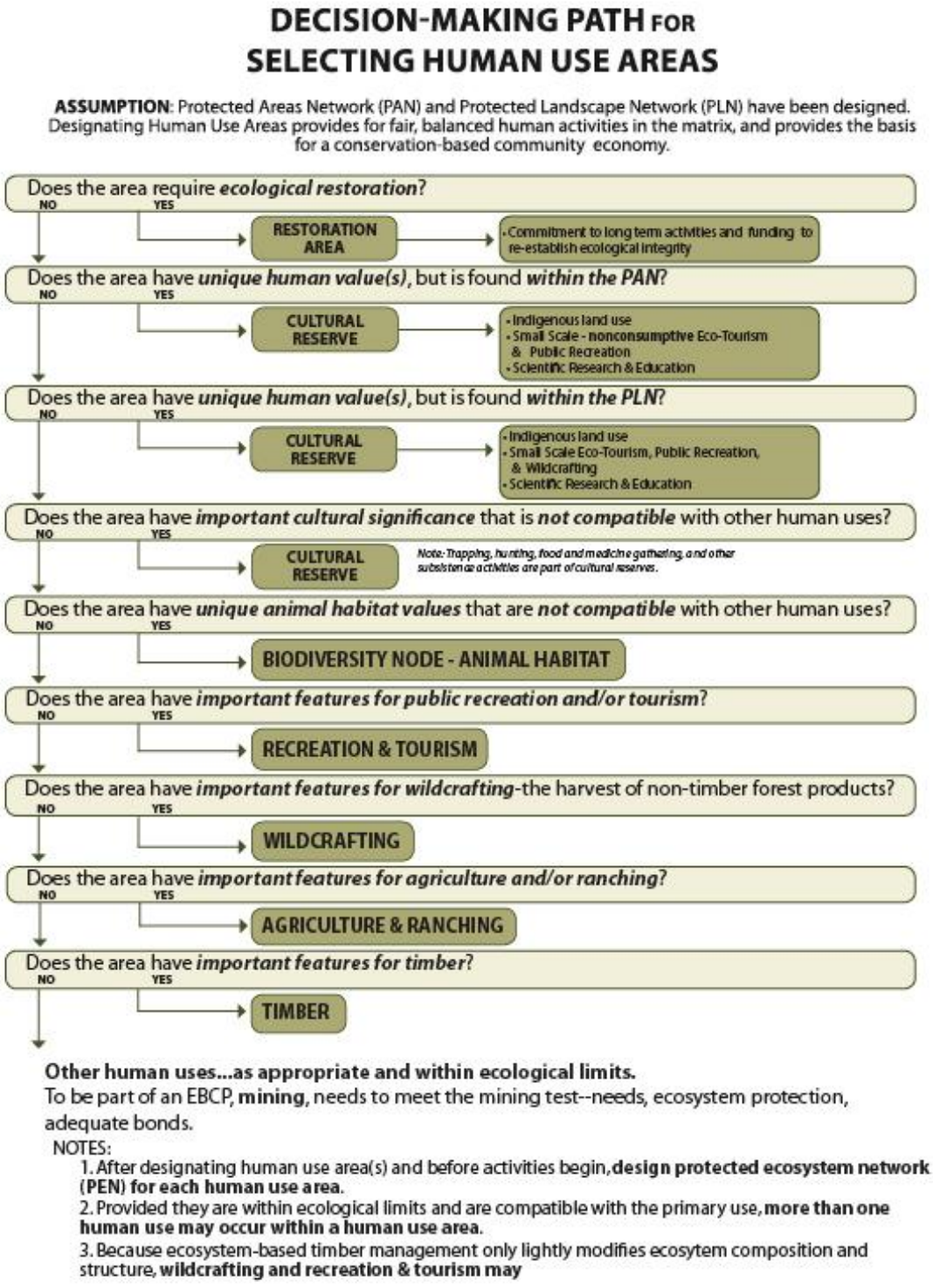
  Protected landscape networks will contain the parts described earlier in **The Process: Multiple Spatial Scales**, and will be defined through the same process as that used in defining large landscape reserves. The process of ecosystem-based conservation planning progresses from the large landscape or regional level to the small patch level where human modification for cultural and economic reasons occurs. Protected landscape networks and protected ecosystem networks maintain the composition, structure, and function of the **matrix**, the portion of the landscape actively used for human economic activities. Keeping the matrix healthy is necessary to ensure the protection, maintenance, and where necessary, the restoration of ecological health and protection of biological diversity of the entire landscape, including the PAN.

- **Establishing human use areas.**

  Respecting the PAN and PLN, communities use an inclusive, participatory process to identify areas where various kinds of human activities will be carried out. Many of these will directly contribute to economic well-being, while others will provide for social and cultural well-being.

  The least consumptive activities and the activities that depend upon essentially unmodified ecosystems are designated first to ensure that these activities are protected from more aggressive land uses. Overall, the goal is to provide for fair, balanced use of the landscape being planned, while maintaining ecological integrity. In other words, all land users are entitled to an adequate, protected landbase to meet their needs.

  Note: Step 3, paragraphs 4 through 7 describe factors that need to be incorporated into the process of selecting human use areas.



- **Defining *Protected Ecosystem Networks* in patches that will be modified by ecologically responsible human use.**

Protected ecosystem networks are small-scale versions of protected landscape networks, which ensure protection of individual trees, including snags and fallen trees; small riparian ecosystems, including ephemeral streams, wetlands, and ponds; small ecologically sensitive areas; and unique habitats in patches that are modified by human use.

- **Protecting natural capital.**

  Protecting natural capital means pursuing **ecologically responsible** economic activities that protect, maintain, and, where necessary, restore ecosystem composition, structure, and function at all scales. The first priority of these activities is to maintain natural capital (i.e. avoid causing soil degradation) and the second priority is to restore natural capital where it has been degraded (i.e. in previously logged mature forests, use techniques that assist in the restoration of snags and fallen trees to restore natural animal habitat and soil functions).

- **Developing a diversity of *ecologically responsible activities*, which focus on quality and adding value, as close to the source of resources as possible.**

  Ecosystems are diverse at all scales and, therefore, economies that are based on a diversity of ecologically responsible activities tend to be more successful in maintaining ecosystem health and biodiversity. Therefore, diverse economies are more ecologically sustainable than economies that are based on only one or a few activities. A diversity of activities also promotes economic stability by avoiding economic problems when one part of the economy is weak. Focusing on producing high quality, value-added products and services means increased employment and wealth can be generated for a given quantity of natural resources used. Thus, the production of high quality, value-added services and products, as close to the source of natural resources as possible, is a key ingredient in developing ecologically sustainable, *community-based* economies.

- **Providing for sufficiency and quality livelihoods.**

  Ecologically sustainable economies focus on fulfilling needs rather than satisfying wants, and on providing meaningful, involved, and valued work that links people to their ecosystems. Economies and jobs that produce high income levels often impair rather than protect natural capital because they are based on *consuming* unsustainable levels of resources that exceed ecological limits. Economies that meet needs and provide quality work within ecological limits, on the other hand, promote human and community well-being, and serve to protect and maintain the ecosystems that support such well-being.

- **Promoting the development of social capital.**

  Social capital refers to the wealth of knowledge, skills, experience, and values that individuals and communities build over time. Collectively, these are the human resources that allow individuals, organizations, and communities to understand the ecosystems they live in, to solve problems together, and to adapt when social, economic, and ecological conditions change. Social capital is developed when community members participate equally in making decisions about how ecosystems, and the natural resources provided by ecosystems, will be used; about what goods

and services will be produced; and about how those goods and services are distributed in the community or sold for individual and community revenue.

Some Large Challenges: scale, time, and restoration

1. **Scale:**

   Ecosystem-based conservation plans, need to be developed and implemented at all scales from the largest landscape to the smallest patch.

2. **Time:**

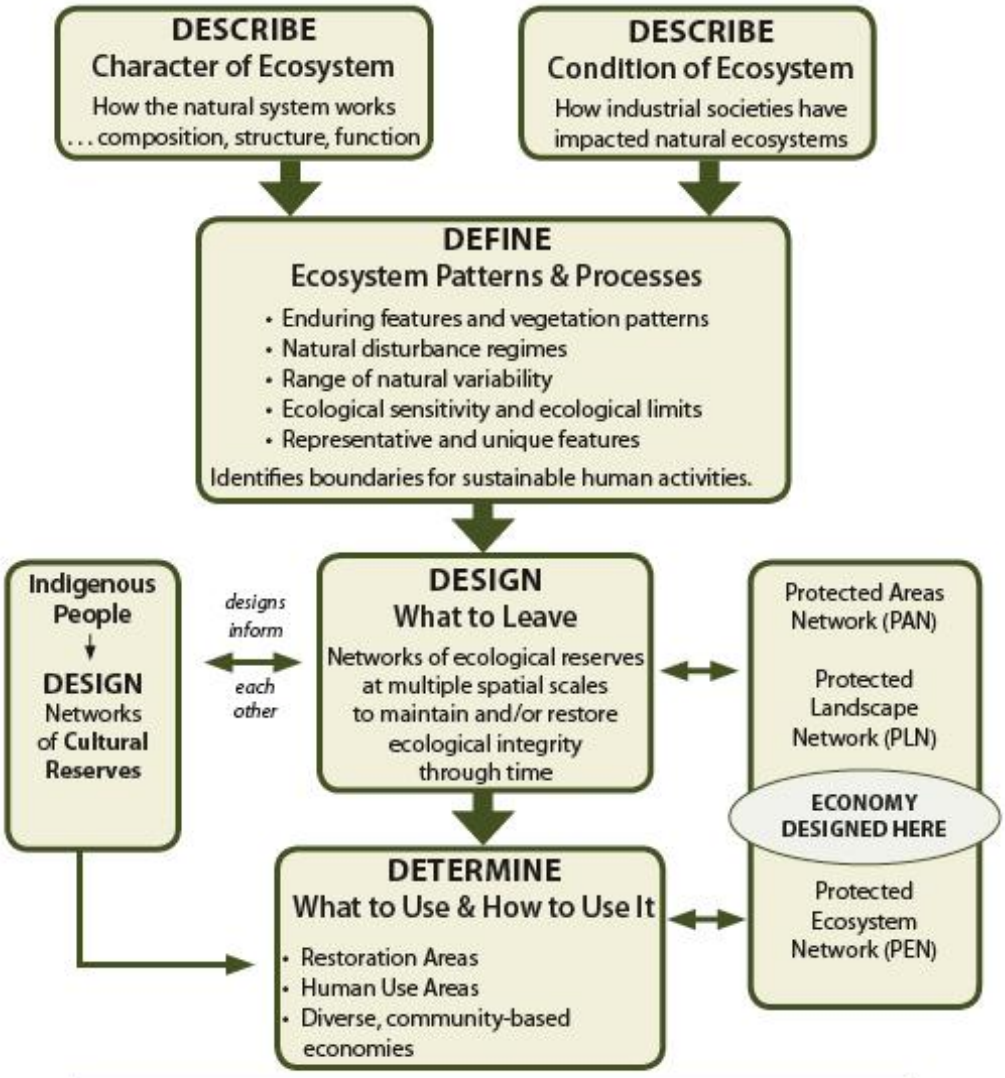
   Ecosystem-based conservation plans must, as much as possible, attempt to predict natural changes, and provide for succession and change, while maintaining the composition, structure, and function necessary to ensure the persistence of natural, healthy, and diverse ecosystems—ecological integrity. Establishing a PAN with core reserves and linkages of sufficient size to withstand large natural disturbances is a key aspect of developing ecosystem-based conservation plans that account for succession and change.

3. **Restoration:**

   Human beings have a basic obligation to work with nature to repair our ecological mistakes in exploiting ecosystems. Restoration must be understood not as a "quick fix," but as assisting nature to rebuild healthy composition, structure, and function in damaged ecosystems. Our commitment to restoration should not provide the rationalization to continue exploiting and damaging ecosystems, but should serve as a sober lesson to avoid ecological damage in our future plans and activities.

THE ECOSYSTEM-BASED CONSERVATION PLANNING PROCESS

- detailed overview -



Major Goals of Ecosystem-based Conservation Planning:

- Maintain and/or restore ecological integrity across spatial and temporal scales.
- Protect and/or restore Indigenous and community land uses.
- Establish diverse, ecologically sustainable community-based economies.

The Sequence of Logic for Ecosystem-Based Conservation Planning

General Components

This logic is applied at each spatial scale of planning.

Process carried out at MULTIPLE SPATIAL SCALES

(regions, sub-regions/territories, large landscapes, small landscapes, watersheds, sites/stands)

ASSESS . . . Obtain information . . . existing and new

CHARACTER . . . how natural system functions

CONDITION . . . impacts on natural system from industrial developments

} ☒ ECOSYSTEMS ☒ CULTURES ☒ COMMUNITIES ☒ ECONOMIES

DESIGN . . . Interpret information and develop options

* Ecological Reserve Networks at multiple spatial scales
  * Protected Areas Network (PAN)
  * Protected Landscape Network (PLN)
  * Protected Ecosystem Network (PEN)
* Healthy cultures and communities
  * community infrastructure and services
  * economic development
  * capacity building
  * institutional arrangements

INTEGRATE . . . Select design option(s) and bring together ecosystem, cultural, community, and economic information

* Select ecological reserve networks
  * Protected Areas Network (PAN): large landscape
  * Protected Landscape Network (PLN): small landscape/watershed
  * Protected Ecosystem Network (PEN): site/stand
* Select cultural reserves
* Designate human use areas: cultural protection, rediscovery, trapping, hunting, timber, non-timber forest products, subsistence, settlement, tourism, recreation . . . others as appropriate

IMPLEMENT . . . Establish networks of ecological and cultural reserves. Carry out human activities to maintain or restore full ecosystem functioning, maintain or restore cultures, and develop healthy communities and their economies.

* Determine restoration needs
* Conduct operations planning
* Fine-tune ecological reserve networks and cultural reserves
* Carry out activities that restore or maintain ecological and cultural integrity
* Monitor and evaluate results . . . adaptive management (passive and active)

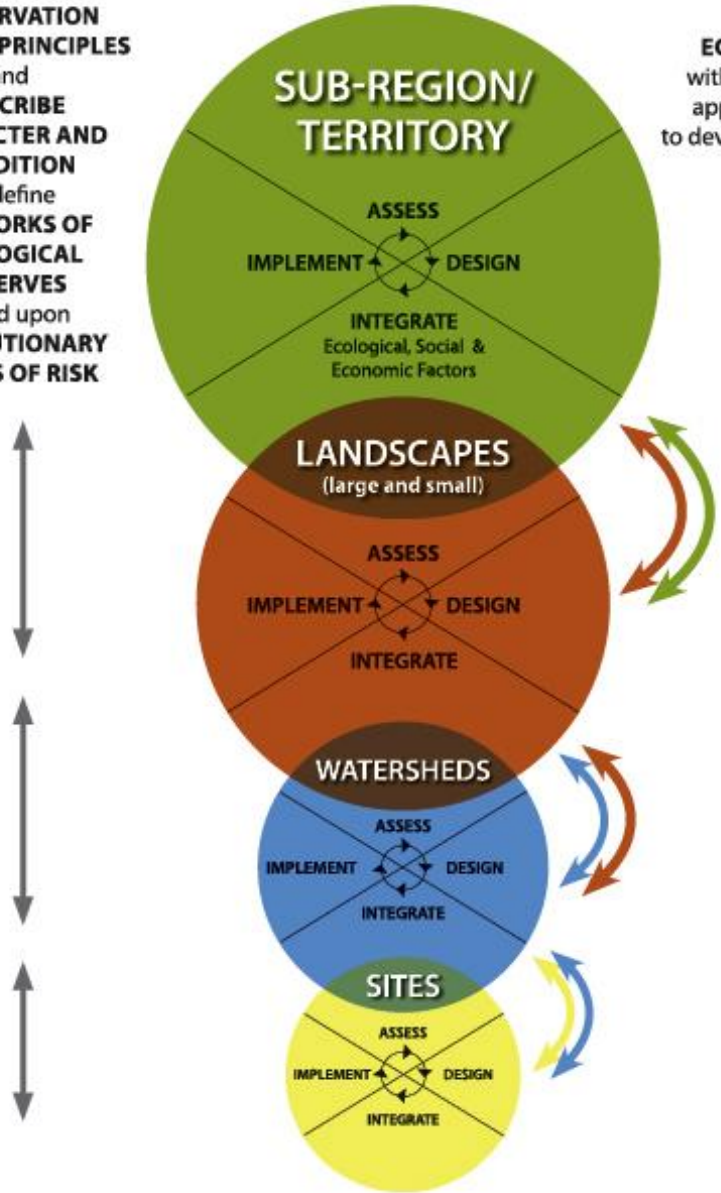
ITERATIVE NATURE OF MULTIPLE SPATIAL SCALE ECOSYSTEM-BASED CONSERVATION PLANNING

ECOSYSTEMS

APPLY CONSERVATION BIOLOGY PRINCIPLES and **DESCRIBE CHARACTER AND CONDITION** to define **NETWORKS OF ECOLOGICAL RESERVES** based upon **PRECAUTIONARY LEVELS OF RISK**

CULTURE & ECONOMIES

DESCRIBE CULTURAL and **ECONOMIC OPTIONS** within ecological limits or appropriate levels of risk to develop diverse community economies



Data Sets Useful in Ecosystem-based Conservation Planning

There is a myriad of data sets that are useful for ecosystem-based conservation planning. This section only provides the reader with a description of common data sets useful in the process of ecosystem-based conservation planning.

Several general points can be made about data sets:

- Finding success at developing an ecosystem-based conservation plan is more about having the right data, than having all of the data that exists. Thus, carefully understanding the process of ecosystem-based conservation planning, and the objectives for a specific plan are necessary to identify the most useful data sets.
- First Nations traditional ecological knowledge is very valuable, and can be used to improve the accuracy of standard data sets, as well as provide data sets that are not commonly available.
- Anecdotal data needs to be tested for reasonableness and accuracy, but often provides data sets that are not commonly available and can be quite useful in designing ecosystem-based conservation plans.
- Because of the complexity of developing ecosystem-based conservation plans, much of the analysis and design work is assisted by the use of geographic information systems (GIS). Therefore, having data sets in a digital format is important. Silva has assisted groups to prepare ecosystem-based conservation plans for small areas, however, without the use of GIS.

Data sets that are usually available and useful for ecosystem-based conservation planning include:

Note: The data sets described below need to be of an appropriate scale for the spatial scale being planned, i.e. regional or large landscape, medium landscape or multiple watersheds, watershed, ecological community or patch.

- Stereoscopic air photos
- Satellite imagery
- Vegetative and biophysical classification maps and data
- Landforms and soil maps and data
- Topographic maps
- First Nations' traditional use studies, or other eco-cultural data
- Resource inventories, including forest inventories, mineral potential, tourism potential etc., maps and data
- Animal habitat potential, and animal range maps and data
- Rare, threatened, and endangered species and ecosystems maps and data
- Resource extraction history and plans, both maps and data