

## **Biodiversity in the CIT Region**

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Biological diversity within the CIT region is far greater than previously thought. While bears, salmon, and big trees are integral ecosystem components, less conspicuous species such as lichens, fungi and soil fauna comprise the majority of species in the region and play key ecological roles in the Pacific Coastal forest (Marcot 1997). Estimates of number of species in the CIT region for some major groups are approximately 50 terrestrial mammals, 20 marine mammals, 200-250 birds, 600 fungi, 700 lichens, 500-600 bryophytes, 800 vascular plants, and as many as 10,000 invertebrates. Of the species in the CIT region, the BC Conservation Data Centre (CDC) lists 9 bird species or sub-species, 5 mammal species or sub-species, and 75 vascular plant species or sub-species as endangered, threatened, or at risk. A number of invertebrate and lichen species are also endangered, threatened, or at risk in the region. Forest management is cited as a threat to a number of these species due to specific issues such as loss of tree cavities for roosts, loss of old-growth areas for foraging, and loss and fragmentation of low and mid-elevation mature and old-growth forest. The CDC also lists 21 plant communities in the CIT region as endangered, threatened, or at risk.

The ecosystem-based management framework (Coast Information Team 2003) invokes maintenance of ecological integrity and biological diversity as a guiding principle. Biological diversity includes genes, populations, species, ecosystems, and the interactions among these elements. To maintain ecological integrity we must identify these elements, or at least their key features and functions, and we must focus special attention on the elements of greatest conservation concern. This has traditionally been done by developing lists of rare, endangered, threatened, and vulnerable species and some ecosystems. However, this is only a first step in biodiversity conservation. Identifying and listing species and ecosystems at risk is a means to an end, not an end in itself. The goal is conservation of biological richness and ecosystem services, and maintenance of ecological integrity.

### ***Public and scientific mandates***

British Columbia and Canada list and try to protect species and ecosystems primarily because biologists and the rest of the public are concerned about their decline and loss. All legal and policy initiatives, such as the federal Species At Risk Act (SARA), Parks Canada ecological integrity policy, and British Columbia's Identified Wildlife Management Strategy (IWMS), derive from aesthetic/moral and utilitarian/scientific rationales, and ultimately reflect public concern.

### ***Coast Information Team (CIT) mandate***

Listing biodiversity elements of conservation concern also helps achieve the goals of the "joint solutions" project, in particular the implementation of ecosystem management. Listing can accomplish this by (Bunnell and Campbell 2002):

- contributing to estimates of the status of species and ecosystems in the CIT region—and beyond;
- focussing attention on elements of conservation concern;
- helping rank the allocation of resources to conservation programs;
- influencing management actions.

## ***Biodiversity conservation at the Species Level***

### *Existing processes for listing rare, threatened or endangered species.*

The focus of threatened/endangered legislation, policies, and programs is on species, for several legitimate reasons. The new *Species at Risk Act* (SARA) mandates protection of all wildlife species (and their “critical habitat”), and sometimes subspecies or varieties, listed as “at risk” nationally, but has no provisions for natural communities or ecosystems. Similarly the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) evaluates the status of wildlife species and some infraspecific taxa in Canada, but does not deal with communities or ecosystems.

Species are but one, albeit major, element of biodiversity. Society is also concerned about genetic and population diversity, and ecosystem or habitat diversity. Genotypes, populations, and ecosystems, as well as species, can be at risk. I have gone on at length elsewhere about the pitfalls of preoccupation with species (Pojar 2000).

Further to this: *“In most countries, environmental impact processes evaluate the likelihood that development will affect any threatened species. Most environmental regulations are implemented in a way that assumes development activities are benign, until proven otherwise. This policy places the burden of proof on stakeholders who seek to protect public good or public values. Threatened species lists are one of the few tools at the disposal of regulatory agencies and the public to limit adverse environmental impacts of development. When a proposed development action is judged to increase risks to threatened species, that activity might be modified or postponed. ... and society might naively believe that this process is adequate for biodiversity protection. ... An alternative approach is to consider the impact of developments on a much wider array of elements of biodiversity at a site and ask the question: are any of those impacts, or the cumulative impacts across all species, unacceptably large”* (Possingham and others 2002).

IWMS volumes include a few examples of red-listed ecosystems, but the underlying coverage by the B.C. Conservation Data Centre is incomplete, for the most part including neither non-forested nor the really rare ecosystems.

The official federal and provincial lists are logical places to start, but don't stop there. None of the handful of B.C. vascular plant species ranked nationally as endangered by COSEWIC occurs in the CIT region. This is not reassuring, for all of the 20 or so COSEWIC-listed vascular plant species occur in extreme southern British Columbia, have the bulk of their distribution in the U.S. Pacific Northwest or elsewhere, and are peripheral species in our province. Not that they don't warrant conservation concern, especially in the aggregate, as part of Garry oak or antelope brush or sagebrush—steppe ecosystems. But are these peripheral populations as worthy of protection as, for example, *Geum schofieldii*, which is a globally (not just regionally) rare species, and is endemic to the CIT region?

The CDC tracks provincial lists of red and blue species. If the CDC doesn't include a particular red-listed element for the CIT region or a part of it (such as the North Coast Forest District), that means there is no verified record of the element from the area. It doesn't necessarily mean that the element doesn't occur there. There is a scarcity of data for element occurrence data on much of the B.C. Coast (Coast Information Team 2003). In addition, the data that do exist are biased by uneven surveying effort. For example, a spatial analysis for the coast region (CIT 2003) found that the majority of element occurrence data was on Haida Gwaii, and that many of the occurrence points are near roads. In such cases local knowledge is very important.

CDC also does not deal with some locally/regionally rare or at-risk elements, for example *Chimaphila menziesii* on Haida Gwaii (Stockton and others 2002), and maybe it shouldn't (see below). But knowledge of and management for some of these elements could very well be a conservation concern in the area, or could be a component of a monitoring program, or could be an objective of a higher level plan. It behooves planners and resource managers to find out if such information exists and if it is significant.

### *Problems with existing rare species processes*

Possingham and others (2002) provide a timely review of how lists of threatened/endangered species are used or misused. They identify four common uses:

- to set priorities for allocation of resources for conservation;
- to inform the design of systems of reserves or protected areas;
- to contribute to state-of-the-environment reporting;
- to constrain development and resource exploitation.

The lists were not designed for any of these purposes, and can be used inappropriately. Possingham and others (2002) conclude that it is “naïve and counterproductive from all points of view to use threatened species lists alone to allocate resources for recovery, to guide reserve planning, or to constrain the use of the natural environment.” Moreover, “... the high profile application of threatened species lists to constrain development affects the listing process itself.” Lists of species at risk can and should contribute information to these processes, but the lists should be applied judiciously and in combination with other criteria and decision tools.

Atwood (1994) and Bunnell and Campbell (2002), among others, have also identified several problems with the methods of listing, many of which are summarized below.

#### *Inconsistent and ill-defined terminology*

COSEWIC assigns species under assessment to seven categories: *data deficient*, *not at risk*, *special concern*, *vulnerable*, *threatened*, *endangered*, and *extirpated* (no longer exists in the wild in Canada but persists elsewhere). The last four are the “at risk” categories that SARA will address.

CDC uses red and blue lists, and the categories of *unrankable*, *apparently secure*, *vulnerable*, *imperilled*, *critically imperilled*, *historical*, and *presumed extirpated or extinct*. The Red List includes native species or subspecies/varieties considered to be *extirpated*, *endangered*, or *threatened* in British Columbia. The Blue List includes any native species or subspecies/variety considered to be of special concern (vulnerable) in British Columbia. The B.C. Red rank is sort of equivalent to COSEWIC extirpated or endangered or threatened. Blue-listed taxa are at risk (vulnerable), but not extirpated, endangered, or threatened. Six factors—occurrence, abundance, range in BC, trend, protected occurrences, threats—are combined to arrive at a ranking (Harcombe 2000), but rarity appears to be the dominant criterion (see Harding and McCullum 1994). Rarity by virtue of political boundaries is often a hollow distinction, but it also appears that CDC emphasizes local and regional rarity.

It looks like CIT via Nature Conservancy is using the categories *imperilled*, *endangered*, *threatened*, and *special concern*. It is unclear to me how “imperilled” differs from “endangered” or “threatened.” “Species of special concern” fit one or more of the following subcategories: declining, endemic, disjunct, peripheral, vulnerable, focal, species aggregations.

#### *Over-emphasis on peripheral populations*

Most of CDC’s 271 red-listed vascular plant species occur peripherally in B.C., as is clear from their distributions. Only 29 of the 251 extant plant taxa are considered globally rare or globally important (Douglas and others 2002). Bunnell and Campbell (2002) maintain that 60% of the 87 species and subspecies of birds deemed “at risk” in B.C. have been included because “their geographic ranges transcend political boundaries and marginally enter British Columbia (e.g., Burrowing Owl, White-headed Woodpecker, and Sage Thrasher).” Unfortunately such listing tends to focus conservation attention and allocation of scarce resources on what can be unrewarding or ineffective efforts (Hunter and Hutchinson 1994; Possingham and others 2002; Scudder 2003), and to divert funding from “species for which the province has a global responsibility (Bunnell and Campbell 2002).”

Bunnell and Campbell (2002) recommend that conservation efforts (listing, tracking and recovery) for species in British Columbia address seven criteria, drawing on the priority-setting approach of Canadian Partners in Flight (Dunn and others 1999).

- Endemics (species and subspecies/varieties)
- Significant world populations in B.C.
- Significant world ranges in B.C.
- Population trends

- Species' vulnerability
- Geographically marginal (disjunct) populations
- Ecologically marginal populations.

According to this scheme, species for which B.C. has a large stewardship responsibility and that are declining or vulnerable, would be assigned a high conservation priority in the province. Mere rarity could be enough to get a species onto the lists, but wouldn't automatically confer high conservation priority.

Lists of known red and blue species and subspecies/varieties of Plants, Animals, Fungi, and Plant Associations are available on <http://srmwww.gov.bc.ca/atrisk/toolintro.html>. For the most part, these are conventional lists developed largely from CDC and related information. When using them, please bear in mind the preceding discussion about such lists. A review of CDC's and NatureServe's mandate and methods is badly needed, but is beyond the scope of this report.

### Endemic species

Endemic taxa are native to, and restricted to, a particular place or geographic region. Island endemics seem to be most vulnerable. Thus "the highest priority for listing in British Columbia must include endemic forms on islands (Bunnell and Campbell 2002)." Note that such a recommendation is easier to make for vertebrates and other well-known, generalist groups. If one considers groups with lots of localized endemics of poor dispersability and with specialized habitat requirements, such as forest canopy invertebrates (Winchester 1998), the implementation and implications of the recommendation would be much more difficult and sobering in coastal B.C.

There are no endemic species of terrestrial vertebrates in the CIT region, although the extinct Dawson Caribou of Haida Gwaii (Queen Charlotte Islands) could have been. Several endemic subspecies of birds do occur. For example, subspecies of the Northern Saw-whet Owl (*Aegolius acadicus brooksi*), Hairy Woodpecker (*Picoides villosus picoideus*), and Steller's Jay (*Cyanocitta stelleri carlottae*) are found only on Haida Gwaii. Similarly the Queen Charlotte Ermine (*Mustela erminea haidarum*) is a mammal subspecies endemic to Haida Gwaii (Reid and others 1999; Fleming and Cook 2002). Several other small mammal subspecies (e.g., *Microtus townsendi cowani*, *Peromyscus maniculatus triangularis*=*P. keeni*?) are coastal B.C. endemics. Among the vascular plants we have seven species or subspecies endemic to the CIT region. The taxonomic status of some of these infraspecific taxa is unclear, but they should not be consigned to synonymy (as has happened to several former QCI endemic vascular plant subspecies; see Appendix 1) until their relationships are understood. As Bunnell and Campbell (2002) note, "the disappearance of island forms does not mean that they will be replaced by mainland forms. Moreover, a discrete pool of genetic variability, the fundamental reason for sustaining biological diversity, is lost."

Many of these insular endemic taxa probably result from isolation and survival in Pleistocene glacial refugia, as on Haida Gwaii and the Brooks Peninsula (Warner and others 1982; Hebda and Haggarty 1997). Biogeographic evidence supporting a Haida Gwaii refugium comes from mammals (Foster 1965), birds (Cowan 1989), insects (Kavanaugh 1989), bryophytes (Schofield 1989), vascular plants (Taylor 1989), and lichens (Brodo 1995). Molecular evidence for distinct west coast lineages of Black Bear (Byun and others 1997) Marten and Weasel (Byun and others 1999), as well as patterns of genetic differentiation among several coastal vascular plants (Soltis and others 1997), are consistent with the refugium hypothesis. However, some of the insular forms and variations, for example stickleback fish and ground beetles, appear to be the result of rapid evolution in recent, postglacial time (Moodie and Reimchen 1976; Clarke and others 2001).

I agree with Bunnell and Campbell (2002) that all endemic species and subspecies "restricted in range to British Columbia should be afforded special status" and should be listed and tracked. Even if they are not rare and not presently listed, as for example *Sinosenecio newcombei*. This very distinctive (phenetically and phylogenetically) plant is now the only vascular species still known only from Haida Gwaii, where though common it (and most other understory plants) suffers from grazing by introduced and rampant deer (Pojar 2003).

### Significant world populations and ranges in British Columbia

In addition to the endemics, coastal British Columbia supports significant world populations, or contributes a large part of the breeding or wintering range, of more than a dozen species of birds (see Bunnell and Campbell 2002). For example,

seabirds – Ancient Murrelet, Marbled Murrelet, Cassin's Auklet, Rhinoceros Auklet

Black Oystercatcher, Barrow's Goldeneye, Bald Eagle, Great Blue Heron, Trumpeter Swan, Varied Thrush; also other vertebrates, such as Tailed Frog.

Similarly significant plants include such familiar species as *Thuja plicata* (western redcedar), *Picea sitchensis* (Sitka spruce), *Harrimanella pyroliflora* (copperbush), *Oplopanax horridus* (devil's-club).

Although coastal B.C. makes a major contribution to sustaining these species, most are not listed because they are not rare. An argument, deriving from major stewardship responsibility, can be made for listing and monitoring such species.

### Population Trends

Trends are important for assessing whether management intervention is needed, and in developing an early warning system and preventive measures for declines in ecological integrity. Lists emphasizing marginal species can divert attention away from more common species whose populations show increasing (e.g., Northwestern Crow, Pacific-slope Flycatcher) or declining (Blue Grouse, Barn Swallow, Steller's Sea Lion) trends provincially or globally (Bunnell and Campbell 2002). Parallel plant examples could be the increasing *Gaultheria shallon* (salal) and the declining *Chamaecyparis nootkatensis* (yellow-cedar).

### Vulnerability

Rarity contributes to vulnerability, but vulnerability can also be a function of life cycle features, such as seasonal aggregations. Species that have proven vulnerable in similar habitats elsewhere, should be considered potentially vulnerable in B.C. (Bunnell and Campbell 2002).

### Marginal populations

There is a continuing debate about the conservation value of marginal or peripheral species (compare Bunnell and Williams 1980; Hunter and Hutchinson 1994; Fraser 2000; Bunnell and Campbell 2002). The conservation value of geographically marginal (disjunct) populations depends on their degree of genetic divergence from other conspecific populations (Lesica and Allendorf 1995).

Potential benefits of conserving ecologically marginal populations include: full complement of genetic diversity; ecological role; local values; umbrella species (Hunter and Hutchinson 1994). The obvious danger is misallocation of funds and conservation effort.

## **Biodiversity at Community and Ecosystem Levels**

The CDC lists over 200 rare plant associations (aka "community types") or ecosystems in British Columbia, many of which represent commercially valuable old-growth forests, or mature forest and grassland ecosystems besieged by agricultural and urban development, especially in the southern one-third of the province.

A red-listed ecosystem is considered by the CDC as "imperiled provincially because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation or extinction." A red-listed ecosystem typically has fewer than 20 high-quality occurrences within the province. A blue-listed ecosystem may have from 21 to 100 occurrences and is considered vulnerable to either large-scale disturbance or small-scale but chronic, human-caused disturbance. Both red and blue-listed ecosystems can be either naturally rare, or depleted and rare due to human activities.

Lists of Red and Blue plant associations, based on CDC information, plus other "unofficial" lists of associations and ecosystems (based on expert opinion) can be found at <http://srmwww.gov.bc.ca/atrisk/> .

CDC has a handful of red-listed ecosystems for the CIT region. Typically they are represented by productive riparian plant associations. In many cases, these red-listed floodplain ecosystems adjoin blue-listed ecosystems, either in the riparian zone or at alluvial/colluvial fans and toe slopes. A second major

group of blue-listed ecosystems occur in salt-spray zones along windward shores or in brackish shoreline habitats.

There are several other rare, sensitive, or threatened ecosystems that CDC doesn't list:

#### **A) forested ecosystems**

- productive stands of yellow-cedar – old-growth stands with healthy trees of good form and height class 4 & 5
- forests on recent, postglacial volcanic landforms; e.g., Lake Island, Kitasu Hill, Crow Lagoon
- karst forest ecosystems on the northern mainland coast; i.e., in Central Coast and North Coast districts; karst is relatively frequent on northern Vancouver Island and on Haida Gwaii, nevertheless all karst is sensitive and some specific systems on the islands are rare and very significant ecologically and culturally.

Karst ecosystems include the typically very productive forest above ground, and the subterranean component, with sinkholes, caves, disappearing streams—and peculiar cave invertebrates, plus bat roosts/hibernacula.

Note that freshwater molluscs in caves (and hot springs) include several rare/endangered species; the habitats themselves are considered endangered (Scudder 1996).

#### **B) non-forested ecosystems**

- seabird islands
- marine mammal rookeries and haul-outs
- estuaries and other tidal wetlands

-all estuaries are unique and exceptionally biologically productive, like powerful batteries or the mammalian heart, with a tidal systole and diastole. They are keystone ecosystems in the true ecological sense of “keystone” (i.e., with an impact disproportionately large relative to their size and abundance).

-all estuaries are important, but some are more important than others

-for more information and some ranking, see the Protected Areas Strategy reports for the Central Coast (Lewis and others 1997) and the Prince Rupert Region (Prince Rupert RPAT 1996), and an estuary report by MacKenzie, Remington, and Shaw (2000)

<http://www.for.gov.bc.ca/research/becweb/subsite-wrec/reports-northcoastestuaries.htm>

- sand beaches

-intrinsic rare type of ecosystem on the mainland coast; more frequent and extensive on northern Vancouver Island and Haida Gwaii

-beaches and their organisms sensitive to disturbance and marine pollution

- rich fens and marshes

-uncommon and rarely extensive

-exceptional occurrences at Tlell pontoons, east end of Owikeno Lake

- hot springs

-note roosting colony of Keen's Myotis on Hot Spring Island, Haida Gwaii; only one known in B.C.

-unusual invertebrates; Archaeobacteria

#### **Introduced Species**

*Directly from the Compendium:*

Introduced species pose one of the greatest threats to ecological integrity over the globe (Mack and others 2000) and in BC (Holt and others 2003). Introduced animals can cause extinction of native species; introduced plants can alter ecological processes; many introduced species can hybridise with native species (Mack and others 2000). Control of established invaders is rare (Mack and others 2000).

In the CIT region, introduced species have had substantial impacts on the ecological integrity of Haida Gwaii (Martin and Gaston 2003). The impact of introduced deer is especially dramatic: greatly reduced understory vegetation in both upland and floodplain forests, threatened endemic and rare flora, and disrupted succession (e.g. Pojar 1999, Pojar 2002). Introduced beavers have altered hydrospheric processes. More than ten other mammal and about a quarter of the plant species in Haida Gwaii are introduced. Japanese knotweed and broom have already spread widely and dominated sites; a long list of other introduced plants are successful in disturbed habitats (Pojar 2002). Introduced species also affect other areas of the coast.

Many of the species that turn into “problem species” are strong competitors in disturbed areas. Roads are corridors of invasion. Seeding of roadcuts and disturbed areas with non-native mixes contributes to the spread of introduced vegetation. Forestry, through silvicultural trials, harvesting operations and road-building, has contributed to the introduction and spread of introduced species. Young production forests help support the high population of deer on Haida Gwaii (Pojar 2002).

Because it is difficult to identify a problem species until it is well established, and because control of established invaders is rare, precaution dictates that all introduced species are considered harmful. Some species remain at low levels for decades before their population explodes (Sakai and others 2001). Knowledge of local exotics and how they spread is important. Tracking of key exotics is prudent.

### ***High ecological value landscapes***

Using the Ecosystem-Based Management (EBM) approach outlined in the EBM Handbook, varying risk targets for management would be applied at the watershed and landscape levels, with an average of low risk to ecological integrity at the sub-regional or territorial level. In areas with high conservation value, the application of high risk targets is inappropriate.

The Ecosystem Spatial Analysis (ESA) produced by the CIT maps conservation values across the CIT region. The ESA considered the interaction between conservation value and human impact by grouping analysis units and landscapes into three conservation tiers based on conservation value and matrix condition. Under this framework, areas ranked as intact or modified that also hold high conservation value, or intact areas with medium conservation value, were ranked as Tier 1. Tier 2 areas have high conservation value but are highly impacted, have low value but are intact, or fall within the mid-range of both criteria (medium value/ modified condition class). Tier 3 represents those analysis units or landscapes that are developed and have a medium or low conservation value. The application of high risk EBM targets is least appropriate in Tier 1 areas.

### **Literature Cited**

- Atwood, J.L. 1994. A century of avifaunal change in western North America: endangered small landbirds of the western United States. *Studies in Avian Biology* 15: 328-339.
- Brodo, I.M. 1995. Lichens and lichenicolous fungi of the Queen Charlotte Islands, British Columbia, Canada. 1. Introduction and new records for B.C., Canada and North America. *Mycotaxon* LVI: 135-173.
- Bunnell, F.L. and R.W. Campbell. 2002. The not so common loon: why and how we list species ... We can do better. Unpublished ms/Publication M-15, Centre for Applied Conservation Biology, University of British Columbia, Vancouver, B.C.

- Bunnell, F.L. and R.G. Williams. 1980. Subspecies and diversity—the spice of life or prophet of doom. Pages 246-259 in R. Stace-Smith, L. Johns, and P. Joslin, editors. Threatened and endangered species and habitats in British Columbia and the Yukon. British Columbia Ministry of Environment, Fish and Wildlife Branch, Victoria, B.C.
- Byun, S.A., B.F. Koop, and T.E. Reimchen. 1997. North American black bear mtDNA phylogeography: implications for morphology and the Haida Gwaii glacial refugium controversy. *Evolution* 51: 1647-1653.
- Byun, S.A., B.F. Koop, and T.E. Reimchen. 1999. Coastal refugia and postglacial recolonization routes: reply to Dembowski, Stone, and Cook. *Evolution* 53: 2013-2015.
- Byun, S.A., B.F. Koop, and T.E. Reimchen. 2002. Evolution of the Dawson caribou (*Rangifer tarandus dawsoni*). *Canadian Journal of Zoology* 80: 956-960.
- Clarke, T.E., D.B. Levin, D.H. Kavanaugh, and T.E. Reimchen. 2001. Rapid evolution in the *Nebria gregaria* group (Coleoptera: Carabidae) and the paleogeography of the Queen Charlotte Islands. *Evolution* 55: 1408-1418.
- Coast Information Team CIT. September 22, 2003. An Ecosystem Spatial Analysis for Haida Gwaii, Central Coast and North Coast British Columbia. Draft.
- Cowan, I.M. 1989. Birds and mammals on the Queen Charlotte Islands. Pages 175-186 in G.G.E. Scudder and N. Gessler (editors). The outer shores. Queen Charlotte Islands Museum Press. 327 p.
- Douglas, G.W., D. Meidinger, and J.L. Penny. 2002. Rare native vascular plants of British Columbia. 2d edition. Province of British Columbia, Conservation Data Centre/ Ministry of Forests, Victoria, B.C.
- Dunn, E.H., D.J.T. Hussell, and D.A. Welsh. 1999. Priority-setting tool applied to Canada's landbirds based on concern and responsibility for species. *Conservation Biology* 13: 1404-1415.
- Fleming, M. and J.A. Cook. 2002. Phylogeography of endemic ermine (*Mustela erminea*) in southeast Alaska. *Molecular Ecology* 11: 795-807.
- Foster, J.B. 1965. The evolution of the mammals of the Queen Charlotte Islands, British Columbia. Occasional Papers of the British Columbia Provincial Museum Number 14, Victoria, B.C.
- Fraser, D.F. 2000. Species at the edge: the case for listing of "peripheral" species. Pages 40-53 in L.M. Darling, editor. At Risk: Proceedings of a conference on the biology and management of species and habitats at risk. 15-19 February, 1999, Kamloops, B.C. British Columbia Ministry of Environment, Lands, and Parks, Victoria, B.C.
- Harcombe, A.P. 2000. The Conservation Data Centre: for the greatest about the least. Pages 13-17 in L.M. Darling, editor. At Risk: Proceedings of a conference on the biology and management of species and habitats at risk. 15-19 February, 1999, Kamloops, B.C. British Columbia Ministry of Environment, Lands, and Parks, Victoria, B.C.
- Hebda, R. and J. Haggarty. 1997. Brooks Peninsula: an ice age refugium on Vancouver Island. Occasional Paper Number 5, Royal British Columbia Museum, Victoria, B.C.
- Harding, L.E. and E. McCullum, editors. 1994. Biodiversity in British Columbia. Our changing environment. Ministry of Supply and Services, Ottawa, Ontario.
- Holt, R.F., Utzig, G., M. Carver and J. Booth. 2003. Biodiversity Conservation in BC: Ranked Impacts and Conservation Gap Analysis. A report prepared for MWLAP.

- Hunter, M.L. Jr. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally abundant, but globally common. *Conservation Biology* 8: 1163-1165.
- Kavanaugh, D.H. 1989. The ground-beetle (Coleoptera: Carabidae) fauna of the Queen Charlotte Islands: its composition, affinities, and origins. Pages 131-146 in G.G.E. Scudder and N. Gessler (editors). *The outer shores*. Queen Charlotte Islands Museum Press. 327 p.
- Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? *Conservation Biology* 5: 559-565.
- Lewis, K., J. Crinklaw, and A. Murphy. 1997. Revised study areas for the Central Coast LRMP area. Land Use Coordination Office, Victoria, B.C. 225 p.
- Mack, R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout, M., and Bazzaz, F. (2000) Biotic Invasions: Causes, Epidemiology, Global Consequences and Control. *Ecological Applications* 10:689-710.
- Martin, J.-L. and A.J. Gaston (editors). 2003. *Proceedings of a Symposium: Lessons from the Islands: Introduced species and what they tell us about how ecosystems work*. Oct. 2002, Queen Charlotte, B.C. (*in press*).
- Moodie, G.E.E. and T.E. Reimchen. 1976. Glacial refugia, endemism and stickleback populations of the Queen Charlotte Islands. *Canadian Field-Naturalist* 90: 471-474.
- Pojar, J. 1999. The effects of deer browsing on the plant life of Haida Gwaii. Pages 90-98 in G.C. Wiggins (ed) *The cedar symposium: growing western redcedar and yellow-cypress on the Queen Charlotte islands/Haida Gwaii*. British Columbia Ministry of Forests/Canada-BC South Moresby Forest Replacement Account, Victoria, BC.
- Pojar, J. 2000. Genes, species, ecosystems: is surrogacy meaningful? Pages 943-949 in L.M. Darling, editor. *At Risk: Proceedings of a conference on the biology and management of species and habitats at risk*. 15-19 February, 1999, Kamloops, B.C. British Columbia Ministry of Environment, Lands, and Parks, Victoria, B.C.
- Pojar, J. 2002. Rare ecosystems of the CWHvh2. Report for the North Coast LRMP.
- Pojar, J. 2003. Changes in vegetation of Haida Gwaii in historical time. Paper presented at Symposium: *Lessons from the Islands: Introduced species and what they tell us about how ecosystems work*. Oct. 2002, Queen Charlotte, B.C.
- Possingham, H.P., S.J. Andelman, M.A. Burgman, R.A. Medellin, L.L. Master, and D.A. Keith. 2002. Limits to the use of threatened species lists. *Trends in Ecology & Evolution* 17: 503-507.
- Prince Rupert Regional Protected Areas Team (RPAT). 1996. *The Prince Rupert Region PAS report*. Smithers, B.C. 109 p.
- Reid, D.G., F.L. Waterhouse, P.E.F. Buck, A.E. Derocher, R. Bettner, C.D. French, and C. Husband. 1999. Status and management of ermine on the Queen Charlotte Islands, British Columbia. Extension Note EN-001, British Columbia Ministry of Forests, Vancouver Region, Nanaimo, B.C.
- Sakai, A.K., F.W. Allendorf, J.S. Holt, D.M. Lodge, J. Molofsky, K.A. With, S. Baughman, R.J. Cabib, J.E. Cohen, N.C. Ellstrand, D.E. McCauley, P.O'Neil, I.M. Parker, J.N. Thompson and S.G. Weller. 2001. The population biology of invasive species. *Annual Review of Ecology and Systematics* 32:305-332.
- Schofield, W.B. 1989. Structure and affinities of the bryoflora of the Queen Charlotte Islands. Pages 109-119 in G.G.E. Scudder and N. Gessler (editors). *The outer shores*. Queen Charlotte Islands Museum Press. 327 p.
- Scudder, G.G.E. 1996. Terrestrial and freshwater invertebrates of British Columbia: priorities for inventory and descriptive research. Working Paper 9, British Columbia Ministry of Forests, Research Branch and Ministry of Environment, Lands, and Parks, Wildlife Branch, Victoria, B.C. 206 p.
- Scudder, G.G.E. 2003. Biodiversity conservation and protected areas in British Columbia. Sierra Legal Defence Fund / University of British Columbia Centre for Biodiversity Research, Vancouver, B.C.

Soltis, D.E., M.A. Gitzendanner, D.D. Streng, and P.S. Soltis. 1997. Chloroplast DNA intraspecific phylogeography of plants from the Pacific Northwest of North America. *Plant Systematics and Evolution* 206: 353-373.

Stockton, S.A., L. Bobeck, I. Buttler, and J.L. Smith. 2002. Menzies' pipsissewa, *Chimaphila menziesii*, a widespread but previously overlooked species on Haida Gwaii. Ms submitted to *Canadian Field-Naturalist*.

Taylor, R.L. 1989. Vascular plants of the Queen Charlotte Islands. Pages 121-125 in G.G.E. Scudder and N. Gessler (editors). *The outer shores*. Queen Charlotte Islands Museum Press. 327 p.

Warner, B.G., R.W. Mathewes, and J.J. Clague. 1982. Ice-free conditions on the Queen Charlotte Islands, British Columbia, at the height of Late Wisconsin glaciation. *Science* 218: 675-677.

Winchester, N. 1998. Severing the web: changing biodiversity in converted northern temperate ancient coastal rainforests. *Northwest Science* 72, Special Issue 2: 124-126.