Allocating Scarce Resources for Conservation in a Species-rich Environment: Guidelines from History and Science

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Abstract: British Columbia is one of the most species-rich areas in north temperate regions. Its size, location, and topography encourage small incursions of species that are more abundant elsewhere. Given this richness, the province faces formidable challenges in the allocation of limited resources to conservation. The importance of making wise decisions is revealed by recent reviews of North American recovery expenditures that suggest that about 50% of efforts have failed. Fortunately, lessons from history and science can help formulate guidelines. Part of history's lesson is that we begin too late, and that more resources should be allocated to preemptive measures. We consider criteria to prioritize species and four classes of action appropriate to conditions in British Columbia that can be used to guide the allocation of resources in a cost-effective fashion. For example, about 93% of global bird extinctions since the 1600s have been island endemics. British Columbia hosts at least 90 endemic taxa, of which about 66% are island dwelling. Because centers of endemism are concentrated, preemptive monitoring plans based on a frequency that reflects natural history characteristics and known threats are possible. From a review of natural history characteristics, we have collated lists of species that are appropriate to specific conservation actions (summarized here) and provide a checklist that should precede development of a recovery plan for any specific taxon.

Key Words: British Columbia, conservation priorities, stewardship responsibility, monitoring, endemic taxa, recovery planning

Introduction

In an ideal world, we could allocate conservation resources to all species; however, current resources for conservation are less than ideal. Thus, we have two main choices regarding the allocation of our limited conservation resources: the species on which to expend resources and the conservation actions to take. Our challenge is to choose wisely, to ensure we meet our local and global conservation goals. Our major purpose in this paper is to outline a process to guide the allocation of conservation resources that exploits lessons learned from science and history. We first review general problems that have resulted during more than two decades of recovery effort in Canada and the U.S.. We then address conditions specific to British Columbia (B.C.) that may exacerbate these general challenges. We discuss criteria to assign conservation priority to species

and relate these to conservation actions. We believe that the use of such a priority-setting system for species in Canada and British Columbia would be a more cost-effective way to achieve the overall goal of biodiversity conservation.

The Generic Problem

Recent analyses of recovery spending in the United States reveal an ugly lesson. Most simply, of the more than U.S.$3.6 billion invested in species recovery since 1985, very few species have been deemed 'recovered'. For example, of 1354 species listed as Threatened or Endangered in the United States between 1966 and 1992, only 19 species have been removed from the lists, including 8 that were listed in error (GAO 1992; Winckler 1992). Despite the very best intentions and efforts of those involved, 7 species went extinct and only 4 have been recovered. In more than 99% of the instances, the investment of time, effort, and resources failed to attain delisting. Population trends are a more accurate measure of the effectiveness of recovery efforts than the number of delisted species (GAO 1988; Clark et al. 2002). One reason for this is that U.S. regulations require evidence that adequate protection will be provided to a taxon once it is delisted. Because it often is only the *Endangered Species Act* that provides protection, Doremus and Pagel (2001) observed that listing in the United Sates may be "forever". Still, when population trends are used to measure the success of recovery efforts, these reveal that efforts have resulted in stable or improving populations for only half of listed species (GAO 1988; Schultz and Gerber 2002).

The situation in Canada is little better. We estimate that of 425 taxa listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened, or Special Concern, 26 have been delisted or downlisted but only 6 (1.4%) as a result of recovery plans (data from COSEWIC website www.cosewic.gc.ca). The remaining 20 were downlisted because additional information revealed that their populations were more extensive than was known at the time of listing. For example, the eastern North American population of the harlequin duck (*Histrionicus histrionicus*) was listed by COSEWIC as endangered in 1990 based on evidence that it was disjunct, declining, and comprised of no more than 1000 adults. Recent work has revealed that birds from eastern North America are part of a much larger population of harlequin ducks that winter on the southwest coast of Greenland.

There are no regulations that limit delisting in Canada; however, most listings have been made only within the past few years so the number of delistings is likely as inaccurate a measure of recovery effectiveness as it is in the United States. The use of population trends to evaluate effectiveness of recovery efforts reveals results remarkably similar to those for the United States. Spending on recovery in Canada has not been tracked as well as in the United States; however, RENEW provides species-by-species yearly estimates of expenditures, which are probably minimum amounts, but fairly accurately reflect the disproportionate allocation of spending among species. Only 20 taxa have received funding prior to 1998 and each year since. Spending on these

20 taxa accounts for 65% of the more than $101 million spent on species recovery in Canada since 1988 (data compiled from a review of RENEW reports to date, available online at http://www.speciesatrisk.gc.ca/publications/default_e.cfm). Of these 20 taxa, 7 have stable or increasing populations, 7 still have decreasing populations, and the population status of the other 6 is unknown. Thus, in the U.S. and Canada, about 50% of spending on species recovery, about U.S.$2 billion, has not resulted in population improvement.

We expect Canada to have a better track record on species recovery than the United States for several reasons. Given that Canada is not nearly so densely populated, nor so intensely developed as the United States, populations in Canada likely experience less extinction pressure from habitat loss (e.g., Diamond 1984; Hayes 1991; Abbitt and Scott 2001). As well, Canada has engaged in the recovery process more recently than the United States and has listed far fewer taxa. Canada has committed only about 2.8% of the funding that has been expended on species recovery in the United States; however, we estimate that funded, listed species in Canada receive about 3.5 times more per capita government spending than those in the United States (53¢ vs. 15¢ per person per taxon). Each person is the United States spent about $1.79 on 1193 taxa (of 1260 listed) in 2000 while a person in Canada spent about 57¢ on 108 taxa (of 429 listed) in 2002–2003 (data compiled from USFWS 2003; RENEW 2003).

Why do we fail at least half of the time? We are aware of no reviews of the recovery process in Canada, but at least seven reviews are available for the United Sates (e.g., Stafford 1995; Kirkland and Ostfeld 1999; Abbitt and Scott 2001: Elphick et al. 2001; Restani and Marzluff 2001; Clark et al. 2002; Taylor et al. 2003). These reviews describe failings that can be overcome. We summarize four major lessons:

1. Most funding has not been spent on acquiring the habitat necessary to facilitate recovery. A higher level of success was achieved when suitable habitat was available in most of the surrounding area, not simply in one direction (e.g., to east or south).
2. Recovery goals have not reflected the biology of the organism being recovered, and threats to species have rarely influenced monitoring and recovery tasks.
3. Recovery was most successful when it began while populations and geographic ranges were at higher proportions of historic levels.
4. Expenditure has not followed priority-ranking systems. A few species whose recovery has led to litigation due to conflicts with economic development (i.e., the spotted owl [*Strix occidentalis*]) have dominated recovery budgets.

Although troubling, we can easily accept that too little funding has been spent on acquiring habitat. Habitat acquisition is a greater challenge in the United States, where far more of the land is privately held than in Canada. It is far more distressing to accept that billions of U.S. dollars have been spent collecting detailed demographic data on a few species instead of on recovery actions that address the reasons why species are threatened. Of 98 recovery plans examined by Schemske et al. (1994), not one of them included “sufficient biological information to assess the

dynamics…of the species concerned." That may be because populations were too small to allow easy and cost-effective collection of adequate data. The third lesson emphasizes the importance of habitat and appears obvious from either common sense or general principles of conservation biology. We know that, despite their frequent adaptability, all organisms require a place to live and smaller populations are more susceptible to extinction. An obvious corollary of the third broad lesson is that we are not nearly as proactive as we should be. Elphik et al. (2001) observed "that variables relating to the circumstances under which populations were listed could explain almost all of the variance in recovery population goals, and that biological traits of the endangered birds explained little of the variance." Apparently, we intuitively recognize the issue and set recovery goals higher when the population's abundance at the time of writing the recovery plan is higher. When the population is very small we tend to set recovery levels so low that it may be impossible for the population to attain viability. Finally, the allocation of funding to recovery efforts has not followed the U.S. priority-ranking system (Restani and Marzluff 2001). As the pigs in *Animal Farm* observed, "All animals are equal but some animals are more equal than others." That condition also exists in Canada. Since 1988, about 93% of all funding spent on species at risk has been spent on birds and mammals, and 50% of the total has been spent on just 7 taxa. Further, about 25% of all recovery funding in Canada since 1988 ($25 million) has been spent on peripheral species. Our system for ranking focuses on the ranking of localized threat, and we have no system to assign conservation priorities. As a result, we also allocate our funding to relatively few species.

Our major purpose in this paper is to provide an approach to guide allocation of conservation funding that exploits such lessons learned from science and history. Because we have considered these lessons specifically as they apply to British Columbia, it is useful to first consider issues specific to the province.

The Specific Problem

The generic problem is simple: we need to find ways to allocate our conservation efforts more effectively and to increase our delisting rate beyond the national average of about 1.5% and the current provincial rate of 0%. British Columbia faces specific challenges but may benefit from specific opportunities. We see four large challenges:

- remarkable species richness
- a budget misaligned with the task
- a plethora of peripheral populations, and
- no clear system to assign priority for conservation

Remarkable Species Richness

Among north temperate regions, British Columbia is uncommonly rich in species on land, in freshwater, and in the adjacent ocean (Bunnell and Williams 1980; Bunnell 1990; Bunnell and Kremsater 1990). The reasons are simple: located at the nexus of three continental climate regions, B.C.'s rugged topography creates highly variable terrain, much of it oriented to prevailing weather systems. The result is that vegetation draped over a large elevation gradient varies from temperate rainforest to desert. The province also has about 30,000 km of an uncommonly diverse nearshore environment. The diversity of habitat encourages an equally rich heritage in species that is striking when compared to the rest of Canada. For example, 30% of Canada's amphibian species and 40% of Canada's hardwood tree species are found only in British Columbia (www.forestbiodiversityinbc.ca). This richness delights those who enjoy natural history, and challenges policy makers who must devise approaches to sustain it all.

Budget Misaligned With the Task

Were development equal across the country, we would expect COSEWIC to list more taxa in British Columbia than in any other jurisdiction simply because it has the highest taxonomic richness. We also might expect that more federal funding for species recovery would be allocated to British Columbia. These expectations are met. Of the taxa or populations listed by COSEWIC in only one jurisdiction that have received recovery funding since 1988, the number funded in B.C. (37) far exceeds the number in other jurisdictions (2 or 3), except Ontario (28). Similarly, with respect to the amount spent in only one jurisdiction since 1988, B.C. has received $4 million more than all other jurisdictions combined ($18.7 million vs. $14.9 million; data compiled from a review of RENEW reports since 1988. Available from http://www.speciesatrisk.gc.ca/publications/default_e.cfm). To this point, the budget appears aligned with the task.

B.C. received about $9.2 million of the funding that was spent only in one jurisdiction in 2002–2003. If we allocated this amount equally across all taxa or populations in the province that have been listed by COSEWIC, it would approximate $66,583 per taxon. The B.C. Conservation Data Centre (CDC) has designated 501 taxa as red-listed in the province. If we chose to spend money on all these, and the budget for recovery did not decline from 2002–3 levels, the amount spent would be about $18,000 per taxon. Compared with longer established programs, this budget is triflingly small. Moreover, the success rate has been very low even when expenditures were very much higher. Given some public impressions of low investment, recovery budgets actually are surprisingly high. We expect they are unlikely to show major growth. There are lessons from others' experience (summarized above) that suggest that recovery efforts do need focus. For example, many of the taxa red-listed in the province do not merit recovery efforts (see next sections and Bunnell and Squires 2005). One point is perfectly clear: if we cannot spend very

much more we must spend much more smartly. We need a system to allocate conservation priorities that aligns our budget with appropriate tasks.

A Plethora of Peripheral Populations

The topography of British Columbia creates gateways for small incursions of species that are much more abundant to the south, east, or north. These gateways include the Puget Sound lowlands, the Okanagan Valley, the Rocky Mountain Trench, the Peace River lowlands, and the Tatsenshini-Alsek triangle. The gateways are used. At least 1401 taxa occur peripherally in the province, each with no more than 10% of their range within provincial boundaries and occurring over less than 30% of the province. Of these, 915 or 65% are red- or blue-listed by the province, and 66 or 5% are listed as Endangered, Threatened, or Special Concern by COSEWIC (Bunnell and Squires 2005). We need a strategy to deal with peripheral species. Do we assign them the same effort as we would endemic taxa that have 100% of their range in B.C. or those species for which we have 50% or 75% of the world's population either year-round or in specific seasons? Of those taxa with 50–99% of their global range in B.C., only 27% are red- or blue-listed, and only 10 of them are listed by COSEWIC.

No Clear Strategy

The province has no system to prioritize species for recovery. This condition is unnerving given the still relatively undeveloped state of the province, the richness of species present, the growing number of listed species, the existence of a potentially misaligned budget, and the confusion generated by so many peripheral species. In the following two sections we provide criteria and approaches that would help develop a strategy for dealing with these issues. It is our hope that such a strategy would help us allocate our resources for conservation wisely and effectively.

Although the challenges specific to British Columbia are significant, conditions in the province also offer major opportunities not found in many other regions. British Columbia has been relatively slow to develop compared with much of the western world. For instance, we still have all the large carnivores and their prey that were here 5000 years ago. The vast majority of our land is public land, which provides greater opportunity for enacting conservation measures than does private land; however, most of this land also is forested and threats to species from forest practices pale in comparison to those from agriculture (including grazing), urbanization, and various modifications to freshwater systems. Because much remains to be developed, we have more time to learn from history and think about our actions. The task and the responsibility of the B.C. CDC is to determine the provincial status of taxa. It accomplishes that superbly, particularly given its budget. But regional status is not the same as regional priority. To allocate

our limited funds more effectively we need a credible way of assigning priorities. We offer suggestions in the following section.

Towards a Solution—Conservation Priorities

Our thinking about conservation priorities was stimulated by a workshop on the northern goshawk (*Accipiter gentilis*) in February 2000. Much of the workshop focused on the subspecies *laingi*, which is a dubious taxonomic distinction since it is based on a single, immature specimen (contrary to current convention in systematics). The workshop found that at both the species and 'subspecies' level, the northern goshawk is a generalist in its selection of forest type, is opportunistic in its selection of food type, and apparently is productive. Its populations are also widespread and show no evident trend. Nonetheless, *A.g. laingi* is red-listed by the B.C. CDC. We were aware that this designation had resulted in expenditures for survey efforts in the range of several hundred thousand dollars. We juxtaposed our awareness of this fact with our awareness of endemic species and species with persistent declining trends, too locally common to be anything other than yellow-listed. For example, B.C. has at least four endemic mammalian subspecies for which there is good evidence of their distinctiveness. None are ranked at the subspecific level and all are yellow-listed at the species level. These all occur on islands off the coast of B.C. and include subspecies of the mink (*Mustela vison evagor*), American marten (*Martes americana nesophila*), and two subspecies of the Townsend's vole (*Microtus townsendii laingi* and *M.t. tetramerus*) (Thomas and Beckenbach 1986; Nagorsen 1990). Such discrepancies stimulated our efforts to provide guidelines for more effective allocation of conservation resources.

Those guidelines were applied to vertebrates and presented at a workshop in Victoria in September 2000 (Bunnell and Campbell 2000). In April 2003, the B.C. Ministry of Sustainable Resource Management recognized potential value in the approach and requested that it be extended to other groups of organisms. We included lichens, mosses, vascular plants, Odonata, butterflies, and freshwater fish. The principles did not change, and are summarized here (except for peripheral species—see Bunnell and Squires 2005).

Our goal was to create an approach to guide the allocation of conservation resources to species and conservation actions (e.g., tracking or recovery) that would incorporate lessons from history and science, and be as proactive as possible. The result draws on our own research and work of Dunn et al. (1999) and others who have developed a priority-setting method for landbirds as part of the North American Partners in Flight program. The five criteria for conservation priority are

1. endemics (species and subspecies),
2. significant world populations in British Columbia,
3. significant world ranges in British Columbia,
4. population trends, and
5. species vulnerability and threats.

These criteria represent two major issues: 'stewardship responsibility' and 'concern'. Responsibility assesses whether a species is concentrated in the area for which ranks are being prepared (e.g., British Columbia). High levels of concentration reflect high levels of stewardship responsibility. 'Concern' encompasses vulnerability, threat, and population trends. Combined, these two broad features of a taxon's status can be used to determine its priority for conservation actions. A high priority taxon is one that is declining or under threat and one for which the province has high stewardship responsibility. Using this system, few of B.C.'s red-listed taxa are of high priority because levels of stewardship responsibility are ignored in the ranking system used by the CDC. Bunnell et al. (2003) presented the rationale in detail. We summarize it briefly for each citerion here.

Endemics (Species and Subspecies)

Because endemic taxa are "exclusively confined to a particular place", that place has exclusive responsibility for maintaining the taxon. Globally, many endemic taxa are restricted to islands; the pattern in British Columbia is no different. Of the freshwater and terrestrial taxonomic groups tracked by the CDC, 60% are restricted to islands. Since the 1600s, 93% of the bird taxa that have become extinct were island endemics (King 1980). Moreover, about 46% of currently threatened bird species are endemics (Collar and Andrew 1988). For these reasons, the International Council for Bird Preservation identified long-term monitoring of endemic island species as a conservation priority (Johnson 1988). Vulnerability conferred by endemism also is evident in plants, mammals, reptiles, molluscs, and other groups examined (Diamond 1989; Case et al. 1992; Lowry 1998; Bunnell et al. 2003).

To acknowledge this global extinction pattern, any conservation priority ranking system must consider island-dwelling endemics. Islands of the north Pacific coast previously hosted 7 species and 67 subspecies of endemic mammals (Cook and MacDonald 2001). Among these, the Dawson caribou (*Rangifer tarandus dawsoni*) is extinct and the Vancouver Island marmot (*Marmota vancouverensis*) is endangered in British Columbia. Several island populations of beaver and marten have suffered extinction in southeast Alaska (MacDonald and Cook 1996). No bird species are confined to islands off British Columbia's coast, but larger islands contain endemic subspecies (e.g., white-tailed ptarmigan [*Lagopus leucurus saxatilis*], Steller's jay [*Cyanocitta stelleri carlottae*]). Marine organisms off the province's coast are inadequately sampled, but appear to include several species endemic to B.C. waters (Austin 2000). There are 96 endemic taxa in B.C. among the taxonomic groups tracked by the CDC (Table 1). The taxonomic status of some of these taxa is unclear, but physical differences are apparent for many, which may reveal more than different environments. Of the 96 taxa, only 21 (22%) are listed by COSEWIC (75 have not been assessed), and 48 (50%) appear on the provincial Red and Blue Lists. No endemic Odonata, amphibians or reptiles are known from British Columbia.

Table 1. Numbers and proportions of endemic taxa in British Columbia which appear on the provincial Red and Blue Lists or are listed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada).[a]

Group	*COSEWIC*[b]	*B.C.*[c]	*Endemic*[d]	*% Endemic*[e]	*Island-dwelling*[f]
Mosses	0	6	6	100.0	4
Vascular plants	2	9	11	81.8	8
Odonata			0		
Butterflies	1	2	5	40.0	2
Fish	15	14	20	70.0	10
Amphibians			0		
Reptiles			0		
Birds	0	6	6	100.0	6
Mammals	3	11	48	22.9	29

[a]Extinct taxa are not included.

[b]Number of endemic taxa in B.C. listed by COSEWIC as Endangered, Threatened, or Special Concern.

[c]Number of red- and blue-listed endemic taxa.

[d]Total number of endemic taxa.

[e]Percent of endemic taxa that are red- or blue-listed.

[f]Number of endemic taxa restricted to islands.

Endemic species do not migrate. They must survive where they now occur. Many also live in forested environments that can and will be altered. These observations, coupled with historical trends, suggest that the risk of extinction is high. The disappearance of island forms does not mean replacement by mainland forms. Moreover, a discrete pool of genetic variability, a fundamental reason for sustaining biological diversity, is lost.

Significant World Populations and Ranges in British Columbia

Both population and range are important. The relative proportion of populations present in an area is frequently used to designate the importance of a site to migratory birds that can be effectively counted (e.g., RAMSAR Convention, Important Bird Areas Program). For most organisms, the proportion of range occupied is an approximate surrogate for population and our most common representation of favorable habitat.

British Columbia hosts the majority, or near majority, of some species, or contributes major portions to species' ranges. Some of these species must live out their lives in the province (e.g., mosses, lichens, vascular plants, molluscs, and fish restricted to particular streams or lakes). Others are capable of long movements, but remain resident (e.g., Cassin's auklet [*Ptychoramphus aleuticus*], California bighorn sheep [*Ovis canadensis californiana*][1], mountain goat [*Oreamnos*

[1]According to the BC Species and Ecosystem Explorer (September 2004) and NatureServe Explorer (version 4.0, July 2004), recent taxonomic changes do not recognize the subspecies California bighorn sheep (*Ovis canadensis californiana*). It is now referred to as bighorn sheep (*Ovis canadensis*).

americanus]). Other species concentrate in British Columbia during particular seasons. During winter, B.C. supports a sizeable portion of the world's populations of about a dozen bird species, including the trumpeter swan (*Cygnus buccinator*), Barrow's goldeneye (*Bucephala islandica*), and surf scoter (*Melanitta perspicillata*). A majority of the world's population of other bird species dwells in the province for short periods during migration (e.g., black swift [*Cypseloides niger*]). Tidal flats along the coast and wetlands throughout the interior of the province provide critical foraging and staging areas for many species during migration (e.g., sandhill crane [*Grus canadensis*]). These migratory species do not pass through unaffected by the state of habitat here.

We estimate that B.C. hosts at least 30% of the global population during some season or 30% of the global range year-round of at least 598 taxa (Table 2). Most of these are mosses (177 taxa) and vascular plants (145 taxa), but representatives of most groups that are well documented are also included. Less than half (235 taxa) are red- or blue-listed. COSEWIC has not assessed the status of 560 of these taxa, but has determined that 8 are not at risk and 30 are designated Endangered, Threatened, or Special Concern (Table 2). Although B.C. has a major responsibility for sustaining these taxa, many do not show up on Red or Blue Lists because they are not sufficiently rare within the province. Our choice of 30% as a significant portion of the global population or global range is obviously arbitrary. Had we chosen > 50%, the total number of taxa would be 138; for > 75% (excluding endemics) the number would be 67.

Table 2. Numbers and proportions of taxa with a large proportion of their global range (> 30%) in British Columbia and which appear on the provincial Red and Blue Lists or are listed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada).[a]

Group	*COSEWIC*[b]	*B.C.*[c]	*Large range*[d]	*% Large range*[e]
Mosses	3	116	177	65.5
Vascular plants	3	72	145	49.7
Odonata	0	2	4	50.0
Butterflies	1	13	56	23.2
Fish	5	8	22	36.0
Amphibians	3	2	10	20.0
Reptiles	0	0	4	0
Birds	5	10	100	10.0
Mammals	10	12	80	15.0

[a]Extirpated taxa are not included.

[b]Number of taxa with large portion of global range in B.C. listed by COSEWIC as Endangered, Threatened, or Special Concern.

[c]Number of red- and blue-listed taxa with a large portion of their global range in B.C.

[d]Total number of taxa with a large portion of their global range in B.C.

[e]Percent of taxa which have large ranges in B.C. and are red- or blue-listed.

Population Trends

Trends are far more useful as an early warning system and preventive measure than they are once recovery actions are required. Unfortunately, trend estimation is difficult (e.g., Urquhart et al. 1998; Dunn 2002). Establishing trends for rare species is especially costly because of the difficulty in encountering and sampling the species. Nonetheless, where they can be credibly estimated, trends of broad groups can reveal habitats that are most at risk. For example, the proportion of grassland and shrubland birds in North America showing declines is about three times higher than the proportion of forest-dwelling birds (Askins 1993, 1994). Similarly, the majority of shorebird populations are in decline (Howe et al. 1989; Page and Gill 1994; Morrison 2001).

Throughout North America, the absence of summaries of declining (and increasing) species based on analyses of Breeding Bird Surveys or other monitoring programs is a major weakness in most regional lists of imperiled birds (Atwood 1994; Dunn et al. 1999). Provincial lists emphasize local rarity thereby diverting attention away from more common species whose populations exhibit declining trends either provincially or regionally. Because these latter species often are common and widespread, they may indicate the 'health' of our environment in local areas, and may serve as early warnings that particular ecosystems are degrading in some way. For example, the yellow warbler (*Dendroica petechia*) and killdeer (*Charadrius vociferus*) appear to be declining in south coastal areas of the province, even though they are doing well elsewhere. Declines in yellow warbler numbers may indicate a loss of riparian areas, while declines in killdeer numbers appear to be a product of increasing urbanization. Simply recording status without trend can be misleading. For example, blue-listing of the caspian tern (*Sterna caspia*) based on its few occurrences ignores the fact that it is increasing both on the coast and in the interior of the province. Similarly, the double-crested cormorant (*Phalacrocorax auritus*) is red-listed, but shows no trend in coastal areas and is increasing in the interior.

Where trend data are available or can be acquired, they contribute more than just an assessment of the need for intervention. Trend evaluation has the advantage of being proactive rather than reactive, and public contribution toward conservation efforts can be solicited (e.g., naturalist club involvement in Breeding Bird surveys, Frogwatch). Robust trend data always will be difficult to acquire, but in some instances may be critical in determining the need for intervention. In other instances, such data may provide sufficient warning that small remedial steps can be taken early. Such steps should be guided by knowledge of the species' vulnerability.

Species' Vulnerability and Threats

Both vulnerability (or threat) and trend contribute to 'concern'. We use vulnerability differently than Dunn et al. (1999). They defined vulnerability as a composite of global abundance, based on The Nature Conservancy's global abundance score (e.g., Master 1991) and spatial extent of breeding and wintering range. (Although the Nature Conservancy's global

abundance score includes consideration of spatial extent and population trend [i.e., it is not simple abundance], the highest scoring species are always ones that are rare, so it is primarily an indicator of overall abundance [TNC 1988; Dunn et al. 1999]).

Relative abundance or rarity, however, is not the only factor, or even the major factor, contributing to vulnerability. This is recognized in the ranking system developed by the Nature Conservancy and used by the B.C. CDC. The actual or potential threats facing a species or its habitat are used as one of seven ranking factors. It is useful to distinguish between vulnerability and threat. Vulnerability may be conferred simply by localized abundance, whereas threat represents an activity that can be modified. Vulnerable species may be relatively abundant, but have some feature in their life cycle, such as seasonal concentrations, that confers vulnerability. For example, most of the province's nesting tufted puffins (*Fratercula cirrhata*) are vulnerable during a narrow window each spring as they aggregate around nesting colonies. Concentrations also may occur during migration. Although there are relatively few sandhill crane staging areas during spring migration within the province, all cranes passing through the interior of the province use them. Such areas can be delineated and potential harmful activities restricted.

Known threats are also reasons for concern, but can be dealt with more directly. Potential weak links in the life cycle can be distilled from basic natural history data. For example, bobolink (*Dolichonyx oryzivorus*) populations in British Columbia could be improved by eliminating early spring and night mowing of hayfields (van Damme 1999). Learning from experience in other regions can be helpful, particularly from areas with similar habitats that are more populous or have a longer history of resource extraction. Species that have proven vulnerable in such areas should be considered potentially vulnerable in B.C., even if there is not yet a discernable local population decline (e.g., Huggard et al. 2000). This approach is not sufficient basis for recovery actions, but it does provide the opportunity to be proactive and preventive, which often is cheaper and more successful. Effort to assess vulnerability or threat need not be applied to all species, but there is no reason why effort cannot be applied to the species that have been identified as those of high priority based on high stewardship responsibility and a declining population trend.

Matching the Criteria to Tasks

We intended the criteria (above) to serve as a screening procedure to assign appropriate kinds of conservation action to species. This approach also is intended to be more proactive than current approaches. We propose four broad classes of action: (1) evaluation of threat, (2) monitoring, (3) evaluation of need for protected area or recovery plan, and (4) implementation of recovery plan or creation of protected area. These are treated in some detail by Bunnell et al. (2003), and are summarized here.

Evaluation of Threat

Threat cannot be evaluated for all taxa. Taxa for which B.C. has major global stewardship responsibility are initial candidates for evaluating threat (Tables 1 and 2). All terrestrial or freshwater endemic taxa enter this action category because their loss represents an irreplaceable gene pool. Endemic marine organisms may be less at risk because some reproduce by planktonic larvae that can drift considerable distances. A few are restricted to very particular habitats (e.g., a periodically anoxic fjord or single hydrothermal vent). For island endemics, evaluation should focus on known weak links and should consider loss of habitat, urbanization, introductions of alien animals, release of feral predators, research activities, resource extraction, and shooting. Other taxa for which threat should be evaluated include populations that are vulnerable due to limited local occurrence (disjunct populations would have clear priority over politically peripheral populations [Bunnell and Squires 2005]).

Among taxa for which B.C. has a major stewardship responsibility, evaluation of threat should not be limited to current conditions in British Columbia but should include threats documented elsewhere for the same or closely similar species (e.g., Huggard et al. 2000), as well as the concepts of 'keystone species' and species of 'functional importance' (*sensu* Hurlbert 1997). The latter concepts help reveal other processes or species associated with the species under review. Once threat is evaluated, some taxa will be relegated to monitoring while others receive further scrutiny.

Monitoring

All species cannot be monitored**.** Initial groups for which a monitoring plan should be developed include taxa for which B.C. has a major stewardship responsibility, including endemics; known disjunct populations (Bunnell and Squires 2005); and any species not within these groups but for which some form of trend data are available. Combined, these groups encompass many species, but the task is not as formidable as may first appear.

A first step is to define the groups (e.g., Tables 1 and 2), then determine a survey frequency that considers level of threat, degree of global responsibility, and natural history characteristics. Surveys need not be annual. Relative rarity does not imply high monitoring frequency. For example, the endemic northern pocket gopher (*Thomomys talpoides segregatus*) occupied the same small 10-km range in 1997 that it occupied when first discovered 50 years earlier (Munro 1950; Fraker et al. 1997). The taxon is vulnerable, but apparently not threatened. The frequency of monitoring could be a decade or more.

The restricted ranges of endemics facilitate both evaluation of threat and monitoring. Most endemic taxa in B.C. occupy very small areas. The monitoring of endemics is facilitated by their concentration within the province, principally on the major islands. Beneficial logistics mean that a monitoring schedule of every five years for many species is not impractical, and can be longer for species that appear unthreatened. There are practical limitations for some species.

Hydrothermal vents are difficult to sample. Similarly, reports of the Vancouver Island wolverine (*Gulo gulo vancouverensis*) and island subspecies of the ermine (*Mustela erminea*) are sufficiently rare that any attempt at monitoring is impractical.

When we identified taxa for which the province has significant global responsibility, we recorded them in population or range classes of 30–50%, 51–75%, and 76–99% (endemics were treated separately). Budgetary considerations could guide the cutoff at > 30% (598 taxa), > 50% (138 taxa), or > 75% (67 taxa excluding endemics). Again, level of threat and degree of responsibility should guide monitoring frequency. For sedentary species, such as mosses, little more than the number of occurrences can be monitored. Other organisms appear regularly on Breeding Bird Surveys, Christmas Bird Counts, Frogwatch, or other surveys for which the province has no financial obligations. All such species should be included in the monitoring summaries, whether or not they fall into specific categories of concern.

We suggest elsewhere in these proceedings that disjunct peripheral populations merit monitoring (Bunnell and Squires 2005). These represent potential new species, responses to climate change, or potential collapses towards the periphery of the range. Because ranges of these taxa are localized, the expenses of monitoring are reduced, and naturalist clubs can be encouraged to contribute.

The summary of monitoring activities should include the year in which the taxon was last monitored to help guide allocation of resources across years. To be complete and permit proactive responses wherever possible, the summary should include all taxa for which trend data are possible, including source and level of accuracy. Furbearer data derived from trappers, for example, do not provide reliable trend data as recorded. Where data permit an evaluation of trend, the trend also should be recorded, including sources. If data revealing long-term, negative trends appear credible for taxa not yet evaluated for threat, evaluation of threat and functional importance should be undertaken.

Evaluation of Need for Protected Area or Recovery Plan

The steps described above represent a screening procedure that does not encourage the designation of a recovery plan or protected area simply because a taxon is rare in B.C. Thresholds for management intervention based on trend data have been established (e.g., IUCN considers a population decline of 80% globally over a 10-year period or 3 generations as critically endangered; the Royal Society for the Protection of Birds considers a 50% national decline over 25 years as reason for red-listing). Because they can be erratic (Dunn 2002), trends alone are insufficient to stimulate action other than scrutiny of threat. Trends should be employed to update the summary list of species monitored (‘watch list’), and to stimulate careful evaluation of threat. Trends for wide-ranging species rarely will be statistically sound, and should be viewed in the context of natural history and trends elsewhere in the global range. Because events at sea or on distant wintering grounds may be more threatening, the evaluation of vulnerability will help to

determine whether conservation actions in British Columbia can play a significant role in recovery.

The major point is that the screening procedure should be used before embarking on conservation efforts specific to a taxon. The process should allow the allocation of resources to areas or taxa where responsibility is highest and success is least likely to be sabotaged by underlying biological relations (as for ecologically marginal taxa in the 'land of the living dead' of Wolf et al. 1996; Bunnell and Squires 2005). Evaluating threat and vulnerability will reveal that there often are multiple ways in which conservation resources can be allocated. These range from specific habitat management or use standards to habitat covenants, and should be considered before embarking on costly interventions or habitat acquisition. The province should develop a checklist of questions to be asked about potential recovery efforts before they are implemented. We believe the criteria we have proposed here provide a broad outline of the checklist.

The screening process suggested also is broadly applicable to threatened or endangered ecosystems, which may represent entire constellations of organisms (some unknown). Although ecosystem classifications frequently do not cross political borders effectively, some ecosystems appear endemic while others appear politically peripheral (*sensu* Bunnell and Squires 2005). The province's well-established ecosystem classification system allows assessment of location, intensity of use, and trends in alteration. Similarly, vulnerability can be assessed. Where endangered ecosystems are known to host a number of locally rare species, habitat protection will likely be far more effective than development of a collection of individual recovery plans.

Implementation of Recovery Plan or Creation of Protected Area

Costly intervention should not be implemented on low priority species unless there are clear and valid reasons. Some current actions (e.g., for the green turtle [*Chelonia mydas*], leatherback turtle[2] [*Dermochelys coriacea*], or white-headed woodpecker [*Picoides albolarvatus*]) appear to be an opportunistic response to available funding. Opportunism is useful but is no replacement for a responsible approach to stewardship that recognizes the wealth of biological richness within the province.

We have noted that species recovery in North America does not have a good track record. Lessons from history indicate that government agencies should engage in recovery plans only with clear adherence to a system that recognizes priorities for conservation, that they should focus on habitat acquisition, and that efforts should be proactive before populations become very small or isolated.

[2]NatureServe Explorer (version 4.0, July 2004) currently does not recognize this common or taxonomic name.

Conclusions

Our track record in species recovery is a clear sign that we need to allocate our resources more effectively than we have done. A compelling distraction in British Columbia is the large number of locally rare taxa, for which < 10% of their global range occurs within the province. We estimate there are at least 1401 of such 'peripheral' taxa, and 65% (915) of these are red- or blue-listed. We address the vexing problem of conservation priorities for peripheral species in B.C. elsewhere (Bunnell and Squires 2005); however, there are hundreds of taxa for which British Columbia has significant global stewardship responsibility (Tables 1 and 2). We believe we can do better than we have at sustaining productive populations of species, but that two major steps are required. One is to assign more funding to habitat acquisition and less to study. Another is to create a system to assign priorities for conservation efforts that can be more proactive. Almost all reviews of past recovery efforts indicate that a major reason for our failures is that populations were too small by the time recovery was undertaken. The criteria we propose permit a more proactive approach to conservation actions. Those lessons emphasize the importance of avoiding the pursuit of local rarity. Worse, focus on local rarity, especially that which is ecologically marginal, undermines any attempt to meet global responsibilities and denies an ability to be proactive.

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