Vertebrates Associated with Riparian Habitats on British Columbia's Mainland Coast

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1.0 Scope

In this report we summarize broad features of habitat use by terrestrial vertebrates that show strong affinities for riparian habitat. Species treated are those that breed along the mainland coast of British Columbia, north of Bute Inlet, or on smaller offshore islands, plus Haida Gwaii. Many of these species also occur on Vancouver Island, but Vancouver Island has some unique taxa that are not included. No riparian species occur on Haida Gwaii that do not also occur on the mainland coast. Habitat relations summarized here are thus similar to those that would be specific for Haida Gwaii, but include more species.

Studies relating vertebrates to riparian habitat often define riparian habitat on the basis of distinctive vegetative patterns rather than distance from water, particularly for birds. Associations reported here represent an association with vegetation near water, rather than a particular distance from water. Species exploiting marine environments are an exception (the majority of nests were within 50 m of the ocean). We recognize three broad kinds of riparian habitat: 1) marine, 2) wetlands, and 3) rivers, streams, and lakes. Rivers, streams, and lakes were grouped together, because in most instances forest-dwelling vertebrates make little distinction among them.

Our emphasis is on forest-dwelling species. The species noted as preferring wetlands, prefer wetlands, such as bogs and fens, in forested environments. Marine species included ('M' in Appendix I) seek ocean shores and may not require forest cover, but do use forested areas. Some terrestrial vertebrates use riparian habitat to meet a specific need, sometimes adjacency to water (e.g., beaver and river otter). Others use riparian habitat simply because it typically is both productive and structurally diverse. Because species use riparian areas for a wide range of reasons, it is difficult to discern the strength of association individual species have with riparian habitat. This report includes two broad groups of species. The first group includes species for which statistical tests of riparian association were possible, usually using multi-year data. The association of these species with riparian is designated "Y" in the appendix. The second group includes species which are frequently reported as riparian associates, but for which statistical tests were not possible (usually because of the fashion in which data were reported). Those species are designated "A" (anecdotal) in Appendix I.

In the sections following we provide an overview of the terrestrial vertebrate fauna using riparian areas, note their habitat affinities, and summarize management implications derived from those affinities.

2.0 The vertebrate fauna of riparian areas

About 90 terrestrial vertebrates on the mainland coast show close relationships with some form of riparian habitat during the breeding season. We believe the relationships are strong enough for these species that modification of riparian habitat would influence their success. Additional species are potentially present as breeding populations. For example, numerous records of the solitary sandpiper exist for the area, but no nest sites have been reported.

2.1 Distribution within biogeoclimatic zones

All but one of the 89 confirmed species occur in the Coastal Western Hemlock zone (CWH). The water vole, *Microtus richardsoni,* is generally restricted to the Mountain Hemlock zone (MH) but during peak years may descend to lower elevations. The Mountain Hemlock zone is less rich and hosts 56 species. Appendix I provides more specific habitat relationships for each species. The broad distribution across biogeoclimatic (BEC)[1] zones is summarized in Table 1.

Table 1. **Numbers of riparian-associated vertebrates on British Columbia's central and north coast.**

BEC Zone	Amphibians	Reptiles		Birds	Mammals
CWH	6	3	56		24
MH	3	3	29		21

2.2 Provincial "listings" of riparian associates

Species are "listed" when their current status merits either restorative action or further investigation. The Ministry of Environment, Lands, and Parks recognizes two broad categories: red-listed and blue-listed. Red-listed species include native taxa (species or subspecies) or populations that have been formally designated as "threatened" or "endangered", or are considered potential candidates for such designation because they run the risk of extirpation or extinction. An *endangered* species is any native taxon (species or subspecies) that is threatened with imminent extinction or extirpation throughout all or a significant portion of its range in BC. *Threatened* taxa include native species or subspecies that are likely to become endangered if factors affecting their vulnerability are not reversed. Blue-listed species usually are "sensitive" or "vulnerable " species that currently are not threatened but could become so. Some species are blue-listed primarily because there is little knowledge of their status in British Columbia.

The BC Conservation Data Centre has red-listed only one of the riparian-associated vertebrates in Table 1, a bat – Keen's long-eared myotis. Its potential association with riparian areas is actually unknown, but other *Myotis* show preferences for riparian habitat, particularly while foraging. Six species have been blue listed: tailed frog, red-legged frog, great blue heron, sandhill crane, grizzly bear, and fisher. The presence of fisher is not confirmed, but expected. Subspecies of the western screech owl and water shrew are listed, but listed subspecies do not occur in the area considered here.

[1] For a description of biogeoclimatic zones see Meidinger and Pojar (1991).

2.3 Federal "listings" of riparian associates

Of the species summarized in Table 1, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) considers four species to be of "Special Concern". The category *Special Concern* includes species that COSEWIC has determined are neither "endangered" nor "threatened", but which have characteristics that make them particularly sensitive to human activities or natural events. The four species considered to be of special concern by COSEWIC are the tailed frog, great blue heron, Keen's long-eared myotis, and grizzly bear. All listed species occur in the Coastal Western Hemlock zone. The tailed frog, grizzly bear, and (probably) Keen's myotis occur in the Mountain Hemlock zone as well. Relationships of listed species with riparian areas differ, and are discussed separately for each species under management implications.

3.0 Habitat relations of riparian-associated vertebrates

We consider habitat relations of riparian-associated vertebrates in four broad ways. First, we consider the extent to which these species may seek wintering and breeding habitat in riparian areas. Second, we examine their apparent preference for particular age classes of forest. Third, we summarize the relations these species have with specific habitat elements (e.g., dying and dead trees or shrubs), because these relations determine the structure of riparian habitat sought. Finally, we consider the degree to which these species seek out or avoid edges. These four ways of viewing habitat relations help describe the nature of habitat sought.

3.1 Breeding and wintering habitat

While many species use riparian areas as both breeding and wintering habitat, others tend to concentrate their movements within riparian areas during either breeding season or winter. The reptiles that show preference for riparian habitat are all snakes and become inactive during the winter. Winter dens, or hibernacula, may be upslope and away from water, but rarely great distances removed from water. The amphibians showing preference for riparian habitat include three frogs and three salamanders. Like reptiles, amphibians become inactive during the winter. The three frogs and the northwestern salamander breed in water, while the clouded salamander and ensatina breed on land. The aquatic-breeding species do not stray far from their breeding sites, and both terrestrial-breeding salamanders show a preference for riparian areas during their active period. Although mammals often shift their ranges seasonally, those shifts do not appear to be in response to riparian habitat. Among the mammals, only the bats show long distance migrations. Winter biology of most bats occurring in coastal BC is poorly understood. Only the hoary bat is known to migrate. Some are known to winter in BC (e.g., California and little brown myotis); other species have been found hibernating in Washington or Oregon (e.g., Western long-eared and Yuma myotis). Most species use caves or mine shafts during winter hibernation. Among coastal species, only the silver-haired bat is known to hibernate in trees.

The most marked differences between breeding and winter habitat use occur among the birds. We recognize three broadly different migratory patterns: 1) neotropical migrants that winter in Central America or farther south (N in Appendix I), 2) resident species (R or (R) in Appendix I), and 3) short-distance migrants (S in Appendix I). There is considerable variation among short-distance migrants, and some of these species may winter farther south on the BC coast. Of the 56 bird species considered to breed preferentially in riparian habitat, 13 continue to use riparian habitat during winter. Nine species, including such species as ancient murrelets, Cassin's auklets,

and Harlequin ducks, winter in marine environments and some, such as hooded and common mergansers, concentrate in estuaries. More importantly, species such as the greater scaup and American widgeon that do not breed on the coast and are not listed in Appendix I, also concentrate in estuaries. Similarly, at least 15 bird species that either breed in upland areas or farther inland use coastal riparian areas over winter (e.g., western grebe, redhead, palm warbler). In short, when both winter and breeding habitats are considered, riparian areas make major contributions to sustaining vertebrate populations, including some species that do not breed in riparian habitat and are thus not thought of as riparian-associates.

3.2 Associations with forest age

We recognize five broad associations with forest age: generalist, early-seral, mid-seral, mid- plus late-seral and late-seral (Table 2).

Table 2. Preference of riparian-associated terrestrial vertebrates for broad forest age-classes.

BEC Zone[1]	Generalist	Early seral	Mid seral	Mid & Late seral	Late seral
CWH	47	14	2	12	14
MH	22	12	2	10	10

Most species that are generalists with respect to stand age occur with similar abundance in all ages of stands (e.g., deer mouse). Some generalist species may seek out habitat elements that occur more commonly in late-successional forests, but do not require a stand of older trees. Cavity-nesting waterfowl, for example, require a single tree with heart rot and a cavity but they are not influenced by age, or even presence, of adjacent trees. For great blue herons, a cluster of larger trees is important, but these need not be old. The proportion of species seeking riparian habitats that are generalists with respect to forest age is higher than in the forest-dwelling vertebrate fauna as a whole. Typical proportions for generalists over a large forested area are 17 to 25% (Bunnell et al. 1999). Among species strongly associated with riparian habitat, about twice as many, 39% (MH) and 53% (CWH), are generalists with respect to forest age. The pattern suggests that whatever species seek in riparian areas, it is not strongly age-related. That makes sense, because a considerable portion of the richness and productivity in riparian areas appears to be caused by the frequent natural disturbances there (Pollock et al. 1998; Bunnell et al. 1999). The lower proportion of generalists in the Mountain Hemlock zone may reflect the lower rates of natural disturbance in that zone (Bunnell 1995).

Early-seral stages are open areas dominated by grasses, forbs, and shrubs (forest age-class 1). In the 12 broad forest types of the province, the proportion of forest-dwelling vertebrates preferring early-seral stages ranges from 16% (Coastal Douglas-Fir) to 26.5% (Spruce Willow Birch), with most types being around 20 to 22% (Bunnell et al. 1999). Values for riparian-associated species are somewhat lower: 15.7% (CWH) and 21% (MH). That may simply reflect the fact that riparian areas are so productive that open areas do not remain open long. In riparian habitat, most early-seral species are birds (8 species in the CWH and 6 in the MH). Half of these bird species are shrub nesters (4 species; Appendix I).

Many mid-seral stands are densely stocked with little understory, typically forest age-classes 4 to 5. Because of this lack of structural diversity, they are the least rich of all broad age classes. Two species, Wilson's warbler and yellow warbler, prefer mid-seral stands *provided* they are primarily deciduous (e.g., alder and willow). Both bird species prefer deciduous trees and dense shrubbery. Once the stands become old enough to break up, or become dominated by conifers, they are less favourable to these species.

Older stands represent a gradient in amounts of various habitat elements that occur more commonly in old or late-seral stands (e.g., snags, large and downed wood). Because vertebrates do not respond to the age of the stand but rather to stand structures, there are no tidy limits associated with stand age. No vertebrate in BC is limited to forest age-class 9 (at least 250 years old). Some, that we have termed late-seral, appear to be more abundant in age-classes 8 and 9 (at least 140 years old). About the same number of species (Mid & Late seral in Table 2) appear to be about equally abundant in stands 100 to 140 years of age (age-classes 6 and 7) as in older stands. It is important to appreciate that stand age itself is not the most significant variable. Stand structure is more significant, but stand age often is the only extensively available surrogate for structure. Table 3 summarizes associations with stand and forest attributes for the 26 species believed to show preference for stands at least 100 years old. Group I includes species that occur about equally across forest cover age-classes 100 years or older. Group II includes species that are more abundant in age-classes 8 and older (140 years plus). The proportion of Group II species (14/89, or 16%) is lower than expected within forests as a whole for a BEC zone. Values are typically about 35% but range from 18 to 54% (Bunnell et al. 1999). The lower value in coastal riparian habitat may simply reflect that riparian areas are more frequently disturbed than upslope areas and contain a higher proportion of generalist species (Table 2).

A striking feature of riparian-associates that are more abundant in older forest age-classes is that most associations with riparian are based on anecdotal evidence.[2] Of the 26 species, only 5 (19%) show statistically significant associations with riparian habitat. Many of these 26 species are relatively common, so the lack of a strong association with riparian habitat is unlikely to result from lack of data. Of the 12 Group I species, four are cavity nesters. Only one is a strong excavator, and the other three require natural cavities or those excavated by other birds. Of the 14 Group II species preferring age-classes over 140 years old, a greater proportion seek dead and dying trees: one is a weak excavator seeking well-rotted wood, and seven seek natural cavities (Table 3). Larger dying and dead trees are more abundant in older age-classes so it is not unexpected that 12 of 26 species seeking older age-classes use cavities. Dying and dead trees, however, are usually more abundant on upslope sites than in riparian areas (Bunnell et al. 1998), so there is little reason to expect cavity users to concentrate in riparian areas. Within the CWH as a whole, 50 species use cavities but only 22 of these favour riparian areas (see Table 4). Similarly, only 1 of the 26 riparian associates in Table 3 commonly uses downed wood – the fisher, for den sites. Again, the proportion is much lower than within the CWH as a whole, where 32 species seek out downed wood (16% of the entire vertebrate fauna). A relatively high proportion (8/14, or 57%) of the late-seral riparian associates require dying or dead trees, but a greater number of species seeking dead wood use upslope areas away from riparian influence.

[2] Many of the assumed late-seral associations are equally anecdotal.

Table 3. Vertebrate species showing a preference for both riparian habitat and older stands during breeding.

Common Name[1]	Reg[2]	CWH[3]	MH[3]	L[4]	Neo[5]	Shr[6]	Cavity[7]	Dec.[8]	Con.[8]	R[9]	Edg.[10]	Int.[11]
Group 1 Mid-and late-seral												
Tailed Frog	M	X	X	B	R					Y		
Northern Pygmy-Owl	M	X	X		R		Sec		Y	A	Y	
Western Screech-Owl	M	X			R		Sec	Y		A	Y	
Red-breasted Sapsucker	MHG	X	X		S		P	Y		A		
Hammond's Flycatcher	M	X	X		N				Y	A	R+	
Varied Thrush	MHG	X	X		(R)				Y	A		Y
Swainson's Thrush	MHG	X	X		N	H		Y		A		
Red-eyed Vireo	M	X			N	H		Y		A		
Cassin's Vireo	M	X	X		N	M				A		
Townsend's Warbler	MHG	X	X		N				Y	A		
Pine Grosbeak	MHG	X	X		R					A		
Douglas' Squirrel	M	X	X		R		Sec		Y	A		
Group 2 Late-seral												
Bald Eagle	MHG	X			(R)					Y		
Merlin	M	X			S					A	R+	
Ancient Murrelet	MHG	X			R					Y		
Pacific-slope Flycatcher	MHG	X	X		S					A		
Chestnut-backed Chickadee	MHG	X	X		R		wP			A		Y
Golden-crowned Kinglet	MHG	X	X		(R)				Y	Y		Y
Western Tanager	M	X	X		N				Y	Y		
Hoary Bat	M	X	X		S		Sec			A		
Keen's Long-eared Myotis	MHG	X	X	R	?		Sec		Y	A		
Little Brown Myotis	MHG	X	X		(R)		Sec	Y		A	Y	
Silver-haired Bat	MHG	X	X		R		Sec			A		
Western Long-eared Myotis	M	X	X		(R)		Sec			A		
Yuma Myotis	M	X	X		(R)		Sec	Y		A		
Fisher (unconfirmed)	M	X	?	B	R		Sec		Y	A		Y

[1] Species are ordered alphabetically by common name within families presented in conventional taxonomic order.

[2] "Reg" indicates the coastal region where the species breeds; M = Mainland, HG = Haida Gwaii/Queen Charlotte Islands.

[3] Biogeoclimatic zones in British Columbia are described by Meidinger and Pojar (1991). CWH = Coastal Western Hemlock, MH = Mountain Hemlock

[4] "L" indicates species status in the province of British Columbia; "R" denotes red listed; "B", blue listed; as determined by the Conservation Data Centre from the B.C. Ministry of Environment; last updated May 2000.

[5] "N" = species is a neotropical migrant; "R" = species is resident; "(R)" = species is resident in parts of its BC range: S = short-distance migrant.

[6] Shrub nester: "H" indicates high requirement of shrubs for nesting; "M" indicates medium requirement of shrubs for nesting; Ehrlich et al. (1988); Campbell et al. (1990 a, b; 1997).

[7] P = Primary Cavity Nester, wP = Weak Primary, Sec = Secondary Cavity Nester (obligate).

[8] Strongly associated with deciduous (Dec.=Y) or coniferous (Con.=Y); Hagar et al. (1995); Campbell et al. (1990 a, b; 1997)

[9] Y = Riparian 'obligate'; statistical preference; A = riparian associate, anecdotal information.

[10] Y = Statistically increasing near edge; R+ = responds positively to edges; data inadequate for statistical tests.

[11] Y = 'interior species'; statistically avoids edges.

Requirements for dead wood may account for some, but not the majority, of species believed to be associated with older riparian stands (Table 3). For example, five of the species believed to be more abundant in older stands have strong associations with edge.[3] Hammond's flycatcher, for instance, was believed to be "old-growth dependent" (Manuwal 1991), but responds positively to thinning and creation of openings in young stands (Hagar et al 1996). In part, the lack of any strong pattern reflects the anecdotal nature of associations with both riparian habitat and age of stand. In part, it also reflects the variety of reasons for which either riparian or older age classes are sought. Old stands naturally have openings or edges to which species like the merlin or Hammond's flycatcher respond, but openings also can be created in younger stands. For many species in either Table 1 or Table 3, there is no clear reason why they are associated with riparian habitat or older stands.

The most intriguing group of late-seral riparian associates are those designated as "forest interior" species. Conservation biologists define forest interior species as those whose abundance or productivity decreases near the edge of stands. The four "interior" species of Table 3 were all found to have statistically fewer individuals near stand edges. These species, thus should prefer larger contiguous tracts of older forest. Riparian habitat, however, is naturally narrow and linear, often defined on the basis of recognizable edges, and thus should not host "interior" species. It is unclear which relation is weakest – the preference for riparian areas or the avoidance of edge – but three of the four species have only anecdotal information supporting their preference for riparian areas. The fisher, for example, is simply too wide-ranging to be limited to riparian habitat. Similarly, the chestnut-backed chickadee's apparent preference for riparian habitat may reflect only its preference for deciduous trees as nesting sites. The simplest way to view these species is that they prefer larger tracts of older forest containing riparian habitat. None of them is restricted to older forest or to riparian habitat.

3.3 Associations with habitat elements

Table 3 summarizes relationships with habitat elements among riparian associates that are presumed to show a preference for older forests. Table 4 summarizes associations with habitat elements of all riparian associates. Most of the vertebrate species summarized in Table 4 use riparian areas containing forests that provide productive timber (designated 'F' in the Appendix). Generally, vertebrates using forested riparian areas around rivers, streams, or lakes make no strong distinction among those. Nor have we. A few species, such as sandhill crane,

Table 4. Use of habitat elements by forest-dwelling vertebrates preferring riparian habitats.

		Number of species restricted to or favouring:					
BEC Zone	Total	Cavities	Down Wood	Shrubs	Deciduous	Edge	Interior
CWH	89	22	7	13	29	32	4
MH	56	15	5	8	18	21	3

[3] There may be more, because *Myotis* bats are poorly understood and many *Myotis* species forage around edges.

Bonaparte's gull, and solitary sandpiper, enter productive forests but prefer open, unproductive forest around bogs and other wetlands (designated 'W' in the Appendix). Some species nest within forests, but close to the seashore. These include some colonial nesting seabirds (e.g., ancient murrelet, Cassin's auklet, and rhinoceros auklet), and the peregrine falcon, which nests close to colonial seabirds. They are designated 'M' in the Appendix. No matter what form of riparian habitat they use, vertebrates show strong associations with specific habitat elements such as snags, shrubs, or downed wood.

Species seeking riparian habitat show different preferences for habitat elements than those shown by the vertebrate fauna as a whole (see Bunnell et al. 1999). Among those species preferring riparian habitat, the proportions of species using cavities or responding positively to downed wood are somewhat lower, but the proportions of species seeking shrubs and deciduous trees are markedly higher. These differences are expected. Dead wood generally is less abundant in riparian areas than upslope, but both shrubs and hardwoods are more common in the riparian. These factors reflect the greater productivity of riparian areas and lower rates of tree mortality, as well as the greater frequency of natural disturbance. Disturbances are typically of low intensity (e.g., flooding), but they do serve to stimulate a richer vegetation, primarily shrubs and deciduous trees, and an associated greater richness of vertebrates.

3.4 Associations with forest edges

Riparian habitat is defined by edges – either as distinctive vegetation at the water's edge or as a specific distance from the water's edge. As expected, species preferring riparian habitat more commonly show a preference for edge than does the vertebrate fauna as a whole. Among the riparian vertebrate fauna, 36% of the species prefer edges in the Coastal Western Hemlock zone and 37.5% prefer edges in the Mountain Hemlock zone (Table 4). When entire vertebrate faunas are considered, the value is only 20%.

Conservation biologists define "forest interior" species not on the basis of the size of intact forested tract they seek, but on their response to edges (their numbers or productivity declines near edges). Only three of the 89 species known to be present have been reported by at least one source as avoiding edges. The fisher may be present, and also appears to avoid edge. The remaining 60% of the vertebrate species preferring riparian habitat show no evident response to edge. All three species known to be present and reported to avoid edges are birds: chestnut-backed chickadee, golden-crowned kinglet, and varied thrush. None of these three species is restricted to riparian habitat. Both the kinglet and the varied thrush show a strong preference for conifers and are more abundant in coniferous stands than in deciduous or mixed stands. The chickadee is a weak cavity nester and seeks deciduous trees that are more prone to natural cavities than are conifers. The fisher, if present, naturally ranges widely and is not confined to riparian habitat. It does seek riparian habitat during the breeding season, possibly to find the large natural cavities that occur in cottonwoods or older spruce.

4.0 Management implications

Along the coast of BC from Bute Inlet to the Portland Canal, about 90 species of terrestrial vertebrates show strong affinities for riparian areas during the breeding season. These riparian-associations represent about 53% of the vertebrate species in the area. Current data suggest that these 90 species would be significantly reduced in numbers and productivity if riparian habitat was unavailable. The total number of species using riparian habitat is actually greater than 90,

because during winter some upland and inland species migrate to coastal riparian habitat. In total, more than 100 species of terrestrial vertebrates are, to varying degrees, dependent upon riparian habitat on BC's mainland coast.

Riparian habitat hosts a great richness of fauna because of its productivity and the fact that it is subject to frequent, relatively gentle disturbance. A remarkably high portion of the riparian fauna is either generalist with respect to age or prefers early seral stages: 68.5% in the Coastal Western Hemlock zone and 61% in the Mountain Hemlock zone (Table 2). Although many species are generalist with respect to stand age, they do show strong affinities to particular habitat elements. Almost half of the species in both the Coastal Western Hemlock and Mountain Hemlock zones show strong preferences for deciduous trees or shrubs (47 and 46%, respectively; Table 4). Most of these species are birds, and were classified as preferring shrubs or deciduous trees only when at least two-thirds of recorded nest sites were in shrubs or deciduous trees. The preference for shrubs and deciduous trees is thus pronounced. Both the generalist nature of the fauna and the preference for deciduous cover reflect the frequent low intensity disturbances in riparian habitat (e.g., Naiman et al, 1993; Spackman and Hughes 1995; Bunnell et al. 1998; Pollock et al. 1998). Somewhat over one third of the species in each zone responds positively to small openings or edges. Combined, these features of the fauna suggest that for terrestrial vertebrates partial cutting in riparian areas is more likely to have a beneficial than a harmful effect. Studies elsewhere suggest that 50% of the basal area can be removed without reducing bird species richness (e.g., Darveau 1995; see review in Bunnell et al. 1998).

The observation that many riparian species respond positively to partial cutting applies to those species breeding in productive forests ('F' of Appendix I). Wetland species tend to seek forests that already are open (and unproductive). Several of the marine species nest in burrows underground (e.g., Cassin's auklet, ancient murrelet) and would be disturbed and possibly evicted by logging activities. The marine riparian species are typically colonial and in most instances the colonies are identified and can be avoided.

The common preference for deciduous cover suggests that successful efforts to convert hardwoods to conifer cover in riparian areas would work to the detriment of many terrestrial species. It also suggests that, from a terrestrial vertebrate's perspective, deciduous vegetation or dense shrubs provide a convenient delineation of the width of riparian habitat. Not all species showing a preference for riparian habitat, however, also show preference for deciduous cover or hardwoods. At least 15 species (17%) show preference for conifer cover when breeding. Moreover, most species wintering in riparian areas seek out conifer cover during winter, even if they show a strong preference for deciduous cover during the breeding season. Conifers and hardwoods occur naturally intermixed in riparian areas. Given the predominant preference riparian species show for deciduous or hardwood cover, intentional conversion to conifer cover will harm more terrestrial vertebrates than it will benefit.

Fourteen species, or about 16% of all species preferring riparian habitat, also appear to prefer late-seral stages (140 years old plus; Table 2). Even among species preferring late-seral stages, five species also show a preference for edges or respond positively to small openings in the forest (Table 3). Most of the species preferring late-seral stages use cavities (57%; Table 3). Only one species, red-breasted sapsucker, is a strong primary excavator capable of creating cavities for other species. The cavity users are thus largely dependent on natural cavities that develop in older trees. Deciduous trees decay more readily than conifers, which accounts for some of the preference shown for deciduous cover. Conifers, however, provide more durable cavity sites, and conifer snags may remain standing for more than 100 years after dying (Daniels et al. 1997; Huggard 1999). Because heart rots necessary to create cavity sites enter conifers at older ages

than they do hardwoods (FPL 1967; Cline 1977), conifer trees suitable as cavity sites are large (typically 50 or more cm dbh or more on the coast; Bunnell et al. 2000). In their synthesis of cavity requirements, Bunnell et al. (1999) estimated that 2 to 3 large snags per ha (50 or more cm dbh) were required to maintain the full complement of cavity-using species. More smaller snags are required as foraging sites. Any efforts to use partial cutting in riparian areas to encourage overall species richness can be implemented only if snags are retained in the majority of riparian habitat.

The presence of three or four species that prefer older seral stages (100 years old and older) *and* avoid edges indicates that partial cutting in riparian areas should not be ubiquitous (see Table 3). Although associations with stand age are somewhat anecdotal for each of these species, each species has been found to avoid edges in at least one study ($p < 0.05$). The reasons for this avoidance are unclear. All, however, tend to be resident species and settle in areas where they will find food during both breeding and winter. Home ranges or territories for these species are too large to be confined to riparian areas, so the implication is that these species will do best in larger tracts of forest 10 ha or more that contain riparian habitat. The fisher is uncommonly wide-ranging but likely present in only a small portion of the area. Review of continent-wide literature suggests that the primary threat to the fisher is not habitat alteration but trapping (Bunnell et al. 1997).

For several of the listed species, specific guidelines on management can be offered. No guidance can be offered for Keen's long-eared myotis. In BC, the species is known from only nine specimens, and its single know colony is a tidal cave, heated by a natural hot spring, on Hot Spring Island. In part because live specimens of Keen's long-eared myotis are impossible to distinguish from western long-eared myotis, almost nothing is known of its natural history, including forest types used or whether it does actually show riparian affinities. Guidelines are easier to derive for other species. Heronries of the great blue heron, for example, are readily identified. Appropriate management actions include: 1) avoiding harvest in known heronries, 2) retaining riparian buffers (especially those with large hardwoods), and 3) avoiding harvest or road construction within 400 m of heronries during the courtship and pre-incubation period (March 1 through March 31).

Sandhill crane breeding sites also are localized and known, and their staging areas could be mapped. Concern for the sandhill crane centres around urbanization (farther south), draining of wetlands, and disturbance near localized staging, nesting, and summer foraging areas. Forest practices have no negative effect, *providing* wetlands are buffered and disturbance avoided (the critical period is likely prior to incubation, March 15 to April 15. Logging or road building should be avoided within 400 m of nesting or staging areas during that time. The young forage near the nesting area until late August, so activities within 400 m of the nesting area should be limited through August. Most of these areas are wetlands, in non-productive forests that should not be candidates for logging.

The two listed frogs have very different habits: the red-legged frog is largely limited to shallow ponds while the tailed frog breeds only in streams. Although the red-legged frog ventures well into forest during damp conditions, it generally is limited to riparian habitat around the small, quiet pools, ponds, swamps, or ditches in which it breeds (it has been reported to breed in slow streams farther south). Forests around these ponds and streams can be productive, and the sites are not consistently buffered. The northern end of the BC range of the red-legged frog is ill-defined but probably extends north of Bute Inlet. Appropriate management actions include: 1) road construction that limits runoff into nearby ponds or slow streams, and 2) 30-m buffers around ponds or swamps on the southern third of the coastal area considered here (until the

species range is better defined). The tailed frog is widely spread along the coast, in high-elevation streams too small to receive default protection. It is of concern because tadpoles are negatively impacted by forest practices in low gradient streams over incompetent rock (e.g., sandstones). On other sites, the tadpoles benefit from logging because of higher in-stream productivity caused by increased radiation. Sensitive areas can be readily delineated from map data and streamside buffers implemented. The Centre for Applied Conservation Biology is collating recent data to indicate ways to delineate sensitive areas and designate appropriate buffer widths and densities.[4]

Both listed mammal species (fisher and grizzly bear) are wide ranging and not limited to riparian areas, though each meet important needs in riparian areas. The major mortality factor for grizzlies has been killing by humans (McLellan et al. 1999). Although hunting has ceased, the market for gall-bladders remains and other poaching will continue. Past forest practices have encouraged grizzly mortality primarily by permitting access to their habitat. In the near future, the greater effect is likely to be on grizzly productivity. Forest practices can have both positive and negative effects on productivity. Extensive openings encourage berry-producing shrubs which helps increase bear productivity, but extensive vegetative management could reduce both shrub and bear productivity. Practices that reduce either the abundance of salmon or access to salmon also reduce productivity. Appropriate management actions include: 1) managing access, 2) continued buffering of salmon-bearing streams, and 3) practices that sustain berry-producing shrubs (e.g., limited vegetation management, creation of openings).

If the fisher is present, it occurs in the northeastern parts of the costal area considered here. Riparian areas, including streams and wetlands, are important because the fisher requires large natural cavities in standing trees, snags, and logs. Suitable cavities are found in large cottonwoods and spruce, which appears to account for the fisher's preference for riparian areas during breeding. The species' range in coastal regions is ill-defined but where potentially present (northeast) class S4 streams and wetlands should receive buffers similar to those intended to sustain salmonids.

4.0 Summary

Major points emerging from this review include:

- On BC's mainland coast, about 90 terrestrial, forest-dwelling, vertebrate species are to varying degrees dependent upon riparian habitat
- Most species are generalists in their association with stand age, or seek early seral stages.
- About 14 species seek attributes that occur more commonly in stands 140 years or more of age (age-classes 8 and 9).
- Almost half of the species present seek shrubs or deciduous trees. Conversion of riparian areas to conifer cover would impact these species negatively.

[4] There will be two products: a meta-analysis of North American data, commissioned by Washington State Department of Natural Resources, and a pamphlet simply outlining tailed frog biology and appropriate conservation measures (Bunnell et al. 2001).

- Partial cutting in riparian areas is likely to have a beneficial effect for most riparian-dependent vertebrate fauna, *provided*: 1) it is not applied ubiquitously (i.e., some late-seral stands are retained); 2) does not discourage deciduous cover; and 3) retains snags.

- Specific management actions for listed species preferring riparian areas are:
  - Great Blue Heron: 1) avoid harvest in known heronries, 2) retain riparian buffers (especially those with large hardwoods), and 3) avoid harvest or road construction within 400 m of heronries during the courtship and pre-incubation period (March 1 through March 31).
  - Sandhill Crane: 1) buffer wetlands used for staging, foraging, and nesting; 2) avoid disturbance (logging and road-building) prior to incubation (March 15-April 15) within 400 m of nesting or staging areas; 4) limit activities within 400 m of the nesting areas through August.
  - Red-Legged Frogs: 1) construct any roads so as to limit runoff into nearby ponds or slow streams, and 2) provide 30-m buffers around ponds or swamps on the southern third of the area considered here (until the species range is better defined).
  - Tailed Frogs: 1) provide buffers around clusters of favourable headwater streams, with smaller buffers around selected streams between large buffers. 2) measures implemented to reduce siltation associated with road building (see Bunnell et al. 2001)
  - Grizzly: 1) manage access, 2) continue buffering salmon-bearing streams, and 3) sustain berry-producing shrubs (e.g., limit vegetation management, create openings).
  - Fisher: where potentially present (northeast) class S4 streams and wetlands should receive buffers similar to those intended to sustain salmonids.

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