LITERATURE REVIEW OF RIPARIAN HABITAT REQUIREMENTS FOR AQUATIC AND TERRESTRIAL WILDLIFE AND ITS APPLICATION TO HABITAT RESTORATION PROJECTS: A CASE EXAMPLE IN THE SOUTH OKANAGAN-SIMILKAMEEN VALLEYS, BRITISH COLUMBIA

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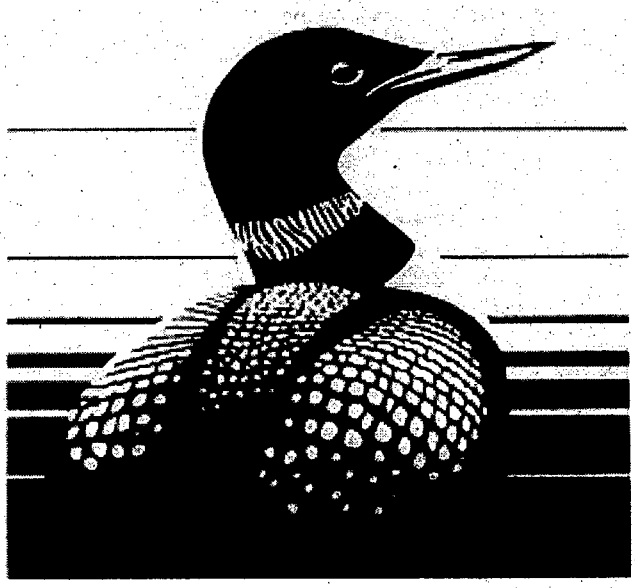

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EXECUTIVE SUMMARY

The purpose of this literature summary is to report on current scientific findings that could aid in directing the design and evaluation stages of riparian fencing projects planned for lowland riparian habitats in the south Okanagan and lower Similkameen watersheds of British Columbia's southern interior. However, many of these findings have applicability to protection of riparian habitat in general. The objective of planned riparian fencing projects in the South Okanagan-Similkameen Conservation Program (SOSCP) area is to exclude livestock from lowland riparian areas to facilitate the rehabilitation and long-term conservation of degraded, native riparian communities. This literature search summary focuses specifically on:

1. Determining if there are established, science-based guidelines for critical and optimal riparian corridor widths, related to livestock exclusion projects, for the conservation of:
   a) Water Quality;
   b) Aquatic habitat for native fish (especially native salmonids) and aquatic invertebrates; and
   c) Terrestrial wildlife habitat and wildlife movement corridors (with particular focus on using Yellow-breasted Chat habitat requirements as an indicator of critical and optimal riparian corridor width in the SOSCP area).
2. Make recommendations on the use of avian focal species as part of habitat-based, scientific monitoring protocols designed to evaluate the efficacy of riparian fencing treatments. Known habitat requirements and associations are provided for seven priority avian focal species, with particular focus on the Yellow-breasted Chat.
3. Develop recommendations for Best Management Practices Guidelines for riparian fencing projects in the SOSCP area, based on existing scientific literature.

A review of current scientific literature presents a range of empirical results and recommended guidelines for riparian corridor widths established to protect (or attempt to protect) water quality and aquatic fish habitat values. There are no guidelines for critical or optimal riparian corridor widths empirically proven to protect viable, terrestrial riparian wildlife communities. However, there are studies that attempt to empirically document riparian bird-habitat relationships as a means of quantifying the response of riparian communities to grazing pressure.

The use of a Focal Species Approach is recommended as a means of determining site-specific riparian fencing project objectives. A Focal Species Approach, involving the monitoring of changing bird population trends and productivity status relative to improving riparian habitat conditions, is also recommended as an effective and efficient means of evaluating fencing project efficacy. Known habitat requirements and associations are provided for seven priority avian focal species, with particular focus on the Yellow-breasted Chat. A summary of Brown-headed Cowbird management-related recommendations from the scientific literature is also provided.

This review provides interim direction for imminent riparian fencing or restorations projects, and recommends a course for further research. As a result of the lack of suitable empirical results within the reviewed scientific literature, recommendations for further research and best management practices guidelines offer only 'best-estimates' interim riparian corridor width guidelines that will require rigorous scientific testing to confirm their viability. The findings of this summary also highlight the need for objective-specific and site-specific riparian protection design and evaluation measures that strive to utilize standardized protocols wherever possible.

RÉSUMÉ

Cette revue de littérature a pour but de mettre à jour les découvertes scientifiques concernant la protection de l'habitat riverain. Elle pourrait orienter la préparation et l'évaluation des programmes de clôturage des zones riveraines prévues dans la partie sud intérieure de la Colombie-Britannique, plus spécifiquement des bassins versants du sud de l'Okanagan et des basses terres de la Similkameen. L'objectif des programmes de clôturage des zones riveraines du Programme de conservation de la région du sud Okanagan-Similkameen (South Okanagan-Similkameen Conservation Program (SOSCP)) est d'exclure le bétail des basses terres des régions riveraines afin de faciliter la réhabilitation et la conservation à long terme des communautés indigènes dégradées. Cette recherche de revue de littérature sommaire a comme objectifs spécifiques de :

1. Déterminer l'existence de normes scientifiques pour des largeurs minimales et optimales de corridors riverains reliées aux programmes d'exclusion du bétail pour la conservation de:
   a) la qualité de l'eau,
   b) l'habitat aquatique pour les espèces de poissons indigènes (particulièrement les salmonidés) et les invertébrés aquatiques,
   c) l'habitat de la faune terrestre et leurs corridors de déplacement (avec une attention particulière sur les besoins requis de l'habitat de la paruline polyglotte comme espèce indicatrice de largeurs minimales et optimales de corridors riverains du programme du SOSCP)
2. Faire des recommandations sur la façon dont les espèces aviaires indicatrices utilisent les habitats de base et élaborer des protocoles scientifiques de suivi afin d'évaluer l'efficacité des applications de clôturage des zones riveraines. Les besoins connus en habitat et les associations végétales correspondantes sont fournis pour sept espèces aviaires indicatrices prioritaires avec une attention particulière pour la paruline polyglotte.
3. Présenter des recommandations sur les meilleures normes d'aménagement applicables pour les programmes de clôturage des zones riveraines dans la région du SOSCP en se basant sur la littérature scientifique existante.

Une récente revue de littérature présente une gamme de résultats empiriques. Elle recommande des normes établies concenant la largeur des corridors riverains pour protéger (ou tenter de protéger) la qualité de l'eau et l'habitat des poissons. Il n'y a par contre pas de normes expérimentées de largeurs minimales ni optimales de corridors riverains qui ont démontré une protection viable pour les communautés d'espèces fauniques terrestres près des rives. Cependant, certaines études tendent à démontrer, de façon empirique, la relation entre les habitats riverains et les oiseaux comme étant un moyen de quantifier la réaction de l'habitat aux dommages causées par le broutage aux communautés riveraines. L'utilisation d'une méthode avec des espèces indicatrices est recommandée comme étant un moyen de déterminer des sites spécifiques reliés aux objectifs des programmes de clôturage des zones riveraines. Dans le but d'évaluer l'efficacité d'un programme de clôturage des zones riveraines à l'aide d'espèces indicatrices et ayant comme objectif d'améliorer les conditions des habitats riverains, il est recommandé de faire un suivi des fluctuations des populations d'oiseaux et de leur productivité. Les besoins connus en habitat et leurs associations sont fournis pour sept espèces aviaires indicatrices prioritaires avec une attention particulière sur la paruline polyglotte. Des recommandations sur les pratiques d'aménagement reliées au vacher à tête brune sont également retrouvées dans cette revue de littérature.

Cette synthèse ne procure qu'une orientation provisoire pour les programmes de clôturage ou de restauration des zones riveraines à cause du manque de résultats expérimentaux adéquats contenu dans la littérature scientifique. Cela met en évidence la nécessité d'effectuer davantage de recherche car la recommandation d'établir des directives de pratiques d'aménagement n'offrent seulement que de

"meilleurs estimés" provisoires aux normes de largeur de corridor qui demanderont de rigoureux essais scientifiques pour confirmer leur viabilité. Les trouvailles faites dans ce résumé mettent en évidence le besoin d'établir des objectifs et de cibler des sites spécifiques pouvant servir de modèle de protection riveraine ainsi que des moyens d'évaluation servant à démontrer, dans la mesure du possible, la nécessité d'utiliser des protocoles standardisés.

CRITICAL AND OPTIMAL RIPARIAN CORRIDOR DIMENSIONS

The following section summarizes the results reported in recent scientific literature regarding the establishment, restoration, or conservation of riparian corridors for the protection of water quality, aquatic habitat, and terrestrial riparian habitat, with particular focus on tested or recommended corridor dimensions.

Water Quality

From a water quality perspective, the establishment, restoration, or conservation of 'riparian corridors' (also referred to as 'vegetated buffer strips' or 'vegetated buffer zones') has been recommended as a means of allowing "natural physical and biological processes to reduce, convert, or store pollutants on the land before they enter the aquatic system" (Osborne and Kovacic 1993, p. 244). Both forested and grass riparian corridors have been shown to significantly reduce the negative impacts of anthropogenic pollutants or contaminants on water quality (Muscutt *et al.* 1993; Osborne and Kovacic 1993). There has been considerable scientific effort directed toward determining critical and optimal width and composition of riparian corridors for the protection of water quality (Muscutt *et al.* 1993; Osborne and Kovacic 1993). Both Osborne and Kovacic (1993) and Muscutt *et al.* (1993) provide summaries of results from scientific literature regarding the effectiveness of various widths of vegetated buffer zones in reducing contaminant inputs to surface water. Both sources conclude that vegetated riparian buffer zones show potential as contaminant filters, but do not provide recommendations for riparian corridor widths. Results reported by Johnson *et al.* (1997) suggest that the protection of riparian buffer strips ('land-water ecotones') may be less effective in reducing nutrient/sediment concentrations in streams than management of dominant land uses within a given catchment. All sources agree that many questions about the critical and optimal dimensions, composition, and effectiveness of riparian corridors as nutrient/sediment filters remain unanswered. A number of sources suggest site-specific conditions and objectives will ultimately determine the viability of local riparian corridors as contaminant filters for the improvement of water quality (Muscutt *et al.* 1993; Osborne and Kovacic 1993; Johnson *et al.* 1997; Todd and Elmore 1997).

- The following references report results of studies on non-point source pollution, in-stream and groundwater contaminant levels, and the effects of nitrogen pollution, but do not report riparian corridor width guidelines:

  Baird 1996
  Hooda *et al.*1997
  Paterson and Schnoor 1993
  Randall *et al.* 1997
  Rouse *et al.* 1999
  Spalding and Snow 1989
  Spalding and Exner 1993

- The following websites provide information on BC water quality standards, standardized riparian assessment procedures, and range resources assessment procedures. Only the Riparian Assessment and Prescription Procedures website suggests riparian corridor widths for streams based on Forest Practices Code of BC standards (see Table 3, p. 11):

  Riparian Assessment and Prescription Procedures, Watershed Restoration Technical Circular No. 6, 1999. Compiled and edited by C.W. Koning. (website version). Watershed Restoration Program, BC MOF, BC MOELP.
  http://srmwww.gov.bc.ca/frco/programs/wrp/rapp/tc6/

  Welcome to water quality. Water BC: our vital resource (website)
  BC Ministry of Environment, Lands and Parks
  http://wlapwww.gov.bc.ca/wat/wq/
  - includes provincial water quality standards

  Remedial Measures Primer, Pilot Version 1.0, DRAFT. 1997. BC Ministry of Forests, Forest Practices Branch, Range Section.
  http://www.for.gov.bc.ca/hfd/pubs/docs/fpb/Rmp-01.htm
  - provides basic instructions for using the Remedial Measures Model (RMM)
  - Riparian Utilization Guidelines:
  http://www.for.gov.bc.ca/hfd/pubs/docs/Fpb/Rmf01/RMf-4038.htm#E11E65
    - do not include guidelines for riparian corridor widths.
    - suggest that guidelines "need to be adapted to each area and situation based on management objectives."
    - suggest "Proper utilization guidelines can only be derived over time through trial and error by monitoring, analyzing, and evaluating the results."

    Range Use Plan Guidebook. October 2000. Forest Practices Code of British Columbia.
    http://www.for.gov.bc.ca/TASB/LEGSREGS/FPC/FPCGUIDE/RANGE/Httoc.htm
    - provides information on Range Use Plans and Crown Range Developments

The following table provides a summary of results from recent scientific literature:

Table 1. Summary of results and discussion: riparian corridors and water quality.

Results/Findings	References
"...forested VBS [vegetated buffer strip] reduced N in groundwater by 68-100% and in surface runoff by 78-98%" but is ..."dependent on initial concentrations of N in subsurface and surface water before passing through the VBS, the width of the VBS, and the soil type."	Petersen et al. 1992 *cited in* Osborne and Kovacic 1993, p.246
"...N reductions of 40-100% in subsurface waters due to forested VBS."	Osborne and Kovacic 1993, p.246

Table 1 con't. Summary of results and discussion: riparian corridors and water quality.

Results/Findings	References
"...limited information on grass VBS reveals N reductions of 10-60%."	Osborne and Kovacic 1993, p.246
"Forested VBS 30-50 m in width reduced nitrate concentrations in surface runoff by 79-98%, while grass buffers 4.6-27 m in width reduced nitrate concentrations by 54-84%."	Osborne and Kovacic 1993, p.246
"Forested VBS 16-50 m in width reduced P concentrations in surface waters by 50-85% while grass VBS 4.6-27 m in width reduced P concentrations by 61-83%."	Osborne and Kovacic 1993, p.246
"In North America VBS [vegetated buffer strip] widths between 10-30m have been shown to maintain effectively stream temperatures."	Osborne and Kovacic 1993, p.245
"Several plot studies in the USA have suggested that grass buffers are effective sediment filters with sediment retention of over 80% often reported"	Muscutt *et al.*1993, p.64
"...82% and 61% retention of ammonium and nitrate in surface runoff across alderwood buffer strips below fertilized fields in Schleswig-Holstein, Germany."	Knauer and Mander 1989 *cited in* Muscutt *et al.*1993, p.65
"Mean annual concentrations of N and P in surface runoff [in a Maryland catchment] were reduced by 83% and 81% respectively with the major proportion removed in the first 19 m of the forest [riparian buffer zone]."	Peterjohn and Correll 1984 *cited in* Muscutt *et al.*1993, p.65
A model designed for conditions found in North Carolina suggested that buffer width should be 15-80 m.	Phillips 1989 *cited in* Muscutt *et al.*1993, p.70
"Hartung and Kress (1977) provided a table of strip-width recommendations based on logging areas versus municipal areas and percent slope. Recommendation ranged from 25 ft in logging areas with 0% slope, to 450 ft in municipal areas with maximum slope to protect water quality."	Waters 1995, p.150
A study of the "effect on invertebrates and buffer strips in logging operations, 62 northern California streams with different buffer strip widths were sampled for invertebrates. Four categories of streams were sampled: no buffer strips, buffer strips less than 30 m wide, buffer strips 30-60 m wide, and controls (no logging);" benthos diversity was the same in control streams and streams with wide buffers; lower diversity in streams with no buffers or narrow buffers; streams without buffers strips still showed lower diversity after 10 years.	Erman *et al.* 1977 and Roby *et al.* 1977 cited in Waters 1995.
"In studies where more than one buffer width was investigated, proportionately greater retention of nutrients was often observed in the wider buffers."	Doyle *et al.* 1977 and Dillaha *et al.* 1989 *cited in* Muscutt *et al.*1993, p.65
Pollutants in surface runoff, particularly sediment and sediment-associated pollutants, are more likely to be removed via sediment deposition in riparian buffer zones with higher density vegetation.	Muscutt *et al.*1993, p.71
Unknowns: - what is the most effective composition and width of a VBS for specific regions and conditions; - long-term effectiveness of VBS (do they become saturated with nutrients or sediments?).	Osborne and Kovacic 1993, p.247
"There are currently no widely accepted procedures for design of buffer zones."	Muscutt *et al.*1993, p.70

Table 1 con't. Summary of results and discussion: riparian corridors and water quality.

Results/Findings	References
"...several important and fundamental questions regarding their [vegetated buffer strips] efficiency, composition, necessary width, and structure still need to be addressed."	Osborne and Kovacic 1993, p.245
"Gough (1988) argued that efforts by many land managers to establish singular, generic standards for VBS [vegetated buffer strip] widths are inappropriate as they are based on an over-simplification of complex physical processes."	Osborne and Kovacic 1993, p.245

Aquatic Habitat

The natural physical and biological functions of healthy riparian corridors have been demonstrated to be essential for the maintenance of healthy fish (particularly salmonid) populations (Rinne 1988; Stevens *et al.* 1995). The commercial importance of freshwater and anadromous fish, coupled with well-documented declines in western fish stocks, has led to the rapid development of best management practices guidelines and legislative directives for the establishment of riparian corridor buffer zones. Established guidelines and directives have been designed to protect aquatic habitat and restore populations of native aquatic species (Forest Practices Code of BC 1995 website; Stevens *et al.* 1995; Koning 1999).

Forest Practices Code of British Columbia

Riparian Management Areas

The Forest Practices Code of British Columbia, Riparian Management Area Guidebook (1995), provides standard approaches and methodologies for the identification, classification, and mapping of all water bodies in British Columbia, but particularly for streams, wetlands, and lakes on Crown lands that may be impacted by timber harvesting operations. Although the Forest Practices Code focuses on specifying planning and operational guidelines for all phases of timber harvesting operations on Crown lands, some of these guidelines may be useful for guiding range management practices in lowland riparian areas on private lands, particularly if evaluated using rigorous scientific methods.

The most relevant feature of the Code to riparian fencing projects is the Code's provision for Riparian Management Areas (RMAs). Each RMA consists of a mandatory, 'inviolate' Riparian Reserve Zone (RRZ) and an additional neighbouring Riparian Management Zone (RMZ), within which management regimes may be modified to achieve the site-specific objectives of the RMA. The minimum width of each Riparian Reserve Zone and neighbouring Riparian Management Zone, and hence the total minimum width of the RMA, bordering each water body is determined by the physical and biological attributes of that water body and its adjacent terrestrial ecosystem (based on the ecosystem's biogeoclimatic classification). For example, for streams, the minimum RMA widths for both sides of a given stream reach vary depending on the average channel width of the reach, stream gradient, community watershed use, and fish presence (Stevens *et al.* 1995). Note that the figures listed for each RRZ, RMZ and RMA in Table 3 (p. 11) apply to each side of a potentially impacted waterbody. Thus an S3 stream would have a total RMA corridor width (both sides inclusive) of 80 m. The Forest Practices Code and the Department of Fisheries and Oceans Canada, currently consider the presence of fish species to be the most important attribute of water bodies and their adjacent riparian habitats (Forest Practices Code of BC 1995). In some watersheds, the Community Watershed

designation emphasizes the high importance of water quality, primarily for human consumption. Therefore the Code's water body classification system and associated RMA guidelines have been designed to minimize negative impacts to fish habitat and water quality.
However, RMA guidelines may or may not be designed to protect critical terrestrial wildlife habitat and movement corridor needs. Although studies like Gyug (2000) and Kinley and Newhouse (1997) have attempted to determine the efficacy of RMA guidelines in their ability to protect viable, terrestrial riparian wildlife populations in forested ecosystems, there have been few projects designed to test RMA guidelines in riparian habitats of the dry grassland/shrubsteppe ecosystem that dominates the lowlands of the SOSCP area.
The following tables, modified from the Forest Practices Code of BC (1995) and Stevens *et al.* (1995), provide a summary of Riparian Management Area guidelines currently utilized on crown lands in the province of British Columbia:

Table 2. Definition of riparian classes.
(Forest Practices Code of BC 1995 and Stevens *et al.* 1995).

Class	Definition
Streams or portions of streams that are fish streams or are in community watersheds	
S1 (large rivers)	≥ 100 m wide
S1 (except large rivers)	> 20 m wide
S2	5 ≤ 20 m wide
S3	1.5 ≤ 5 m wide
S4	≤ 1.5 m wide
Streams outside of community watersheds, which are not fish streams	
S5	> 3 m wide
S6	≤ 3 m wide
Wetlands	
W1	> 5 ha in area
W2	between 1 and 5 ha in the PP, BG, IDF (very dry subzones), CDF or CWH (very dry maritime, dry maritime, or dry submaritime subzones)
W3	between 1 and 5 ha in any biogeoclimatic unit other than above
W4	between 0.25 and 1 ha in PP, BG, IDF (very dry subzones), or between 0.5 and 1 ha in CDF or CWH (very dry maritime, dry maritime, or dry submaritime)
W5	2 or more individual wetlands with a combined size of 5 ha or larger, having overlapping riparian management areas
Lakes	
L1	> 5 ha or designated by the forest district manager
L2	between 1 and 5 ha and in the PP, BG, IDF (very dry subzones), CDF or CWH (very dry maritime, dry maritime, or dry submaritime subzones)
L3	between 1 and 5 ha in any biogeoclimatic unit other than above
L4	between 0.25 and 1 ha in PP, BG, IDF (very dry subzones), or between 0.5 and 1 ha in CDF or CWH (very dry maritime, dry maritime, or dry submaritime)

Table 3. Management widths for riparian classes.
(Forest Practices Code of BC 1995 and Stevens *et al.* 1995)

Class	Average Channel Width (m)	Riparian Reserve Zone (m)	Riparian Management Zone (m)	[Total] Riparian Management Area (m)
S1 (large rivers)	≥ 100 m	0	100	100
S1	> 20 m	50	20	70
S2	5 < 20 m	30	20	50
S3	1.5 < 5 m	20	20	40
S4	< 1.5 m	0	30	30
S5	> 3 m	0	30	30
S6	≤ 3 m	0	20	20
W1 / W5		10	40	50
W2		10	20	30
W3 / W4		0	30	30
L1		10	established by forest district manager	established by forest district manager
L2		10	20	30
L3 / L4		0	30	30

Fish stream or community watershed Not a fish stream and not in a community watershed

The following excerpt was found during a search for the keywords "riparian zone width" on the BC Ministry of Forests "Search the Ministry's Internet Site":
http://www.for.gov.bc.ca/pab/publctns/westland/table10.htm
The original source has not been obtained, and thus precludes interpretation of the suggested guidelines. It is unlikely that these guidelines would be applicable to the conservation of lowland riparian communities in the SOSCP area.

Table 4. Riparian corridor width guidelines for Western Australian streams.
(http://www.for.gov.bc.ca/pab/publctns/westland/table10.htm)

"Table 10: Riparian zone width guidelines - Western Australia (Source: Western Australia Department of Conservation and Land Management, 1992)"

Stream Order	Width Either Side metres (Approx.)	Total Width metres (Approx.)	Minimum Width Either Side metres
First	30	60	20
Second	30	60	20
Third	30	60	20
Fourth	75	150	50
Fifth upwards	200	400	100

Stevens *et al.* (1995, Figure 5, p.23) suggest that the cumulative effectiveness on streams of Litter Fall, Shading, Root Strength, and Source of Large Organic Debris are maximized at 100% when the riparian zone is as wide as the height of 1 tree. Although not explicitly defined, it is assumed that the '1 tree height' represents the average height of the tallest species of mature riparian tree. By this logic, a riparian corridor 15 m wide on either side of a stream (total corridor width of 30 m), based on a average height of the tallest mature riparian tree of 15 m, is sufficient to maintain the essential

structure and function of a riparian forest for the 4 factors mentioned above. It is not clear, however, whether this provides sufficient habitat for the full range of terrestrial wildlife species.
Stevens *et al.* (1995, Figure 6, p.24) further suggests that the cumulative effectiveness of riparian microclimate factors such as Soil Moisture, Radiation, Soil Temperature, Air Temperature, Relative Humidity, and Wind Speed are maximized at 100% when the riparian zone is as wide as the height of 3 trees. It is more likely, but not supported by sufficient data, that a riparian corridor as wide as 3 tree heights would be more effective in providing sufficient habitat for the full range of terrestrial wildlife species.

Community Watershed Guidebook Standards
(Range Use, Fertilizer-free and Pesticide-free Buffer Zones)

Chapter 10 of the Forest Practices Code of British Columbia's Community Watershed Guidebook website (October 1996) established buffer zone requirements pertaining to Crown range operations. The following is a modified excerpt from the website:
http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/watrshed/water7.htm

Requirements:

Livestock must be removed from Crown range in a community watershed and not allowed to re-enter the community watershed, if their previous use has caused the water quality to fail to meet the objectives established by BC Water, Land and Air Protection. If the district manager and designated environment official agree that sufficient remedies have been taken to prevent the reduction of water quality from recurring, livestock may re-enter the community watershed.
Livestock must not be allowed to use riparian areas of community watersheds if the use would result in fecal deposits, trampling of vegetation, or exposure of mineral soil to an extent that the district manager determines to be detrimental.

- Range developments in community watersheds must not be placed to encourage livestock use within 50 m of a stream.
- Range cabins and outhouses must not be within 50 m of a stream. This is to prevent fecal contamination of water. Previously constructed cabins are not subject to this regulation, but removing or relocating them is encouraged.
- Corrals should be as far from streams as is practical, and must not be within 50 m of any stream. Drainage from corrals should not flow into any stream, lake, or other water body. Drainage should be directed to a vegetated area away from water bodies, to percolate into the soil.
- Salt blocks are not permitted within 50 m of a stream. Place them as far as possible (ideally more than 400 m) from reservoirs and streams.
- Livestock watering facilities must not be within 50 m of a stream. For information on suitable watering facilities, see the British Columbia Livestock Watering Manual, available from the Ministry of Agriculture, Food, and Fisheries.
- Roads and trails for range management must not be within 50 m of a stream except where they are needed to cross these areas. Roads and trails must be built to the standards in the Forest Road Engineering Guidebook. The district manager must approve any constructed livestock trail crossing a stream in a community watershed. Where a trail must cross a stream, select a stream-crossing location with a stable channel and banks to minimize

channel and bank disturbance. Crossings should be on culverts or bridges, or on fords approved by the district manager.

- Plan fence locations to ensure that cattle are not drawn into and trapped in the riparian area. Where a fence right-of-way must cross a riparian area, use barricades to discourage livestock access to the stream.
- Riparian areas within 1 km of the [Community Watershed] intake should be restricted to light occasional use. A 30-m wide band on each side of the stream, for a distance of 1 km above the intake, should be managed to prevent contamination from cattle defecating directly into the stream or from runoff of fecal deposits close to the stream. The 30-m zone should be widened where site conditions would contribute to direct runoff into the stream. Examples are steep, wet slopes directly above the stream, floodplains with soft alluvial sediments and high water tables, and areas with very sparse riparian vegetation cover.
- Dead livestock must be moved a minimum of 100 m from a stream within 24 hours of discovery.

Chapters 12 and 13 establish fertilizer application-free and pesticide-free zones adjacent to riparian areas. The following are modified excerpts from the website:
http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/watrshed/water8.htm#13.3.3

- Maintain a 10 m fertilizer-free zone (FFZ) around all streams observable from the air.
- Maintain a minimum 10 m pesticide-free zone, except for bacterial pesticides such as Bt, around all streams, lakes, and other water bodies in a community watershed. This regulation applies to all streams, whether flowing with water or not, within the treatment area.
- In community watersheds, all streams greater than 1.5 m in width have a riparian reserve zone wider than 10 m. In order to maintain the vegetative composition of the riparian reserve zone, do not apply pesticides within the reserve unless it is necessary for insect or disease control.
- Do not apply pesticides within 100 m upslope of a community water supply water intake. This zone is a general "no-activity" zone (including no timber harvesting and no road building).
- Applicators are responsible for creating adequate buffers to maintain the 10 m pesticide-free zone adjacent to all streams and lakes. The values shown in "Table 9" are the recommended minimums for various application techniques.
- Do not apply pesticides directly to the buffer zone. Some off-target contamination may occur in the buffer zone, but should not occur in the pesticide-free zone or the waterbody. When determining the size of the buffer zone, consider the characteristics of the pesticide, application equipment, terrain, soil, and weather conditions at the time of the applications.
- Use non-toxic marking materials to clearly mark the boundaries of the buffer zone before and during pesticide application.

Table 5. Width of buffer zone required for various pesticide applications equipment (http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/watrshed/water8.htm#13.3.3).

Equipment		Width of buffer (m)
individual tree treatment	hack/squirt, frilling, notching, drilling, lance injection	5
mistblower	backpack	5
	truck mounted	5
powerhose	truck mounted	5
granular spreader	helicopter	50
	fixed-wing	50
boom sprayer	truck mounted	5
	helicopter	100
	fixed-wing	200

"Table 9. Width of buffer zone required for various pesticide application equipment "

Terrestrial Habitat

Design and management of riparian corridors that restore water quality and maintain fish habitat should also incorporate the habitat and movement needs of terrestrial wildlife, allowing for the restoration of entire self-sustaining riparian communities. However, not until fairly recently has there been inquiry into the critical and optimal dimensions, composition, and management regimes for vegetated riparian corridors for the conservation of native terrestrial wildlife populations (Dobkin *et al.* 1998). Much of the habitat-based riparian wildlife research has used riparian birds as indicator species to explore riparian bird-habitat associations, often in relation to timber harvesting, grazing, or other anthropogenic factors that influence riparian habitat fragmentation and degradation (Taylor 1986; Sedgwick and Knopf 1987; Knopf *et al.* 1988; Schulz and Leininger 1991; Douglas *et al.* 1992; Croonquist and Brooks 1993; Hafner and Brittingham 1993; Rushton *et al.* 1994; Zeeman 1997; Dobkin *et al.* 1998; Lynn *et al.* 1998; Skagen *et al.* 1998; Popotnik and Giuliano 2000)). A few studies have used small mammals as indicator species (Kauffman and Krueger 1984; Schulz and Leininger 1991; van Woudenberg 1994). Herpetofauna sampling has also been used to study species diversity in grazed versus ungrazed northern grasslands; however, existing sampling methods may not be as rigorous or efficient as established sampling methods for birds or small mammals (van Woudenberg 1994).

Unfortunately, few studies have engaged in rigorous, systematic testing of riparian corridors or buffers of varying widths for their ability to conserve viable productivity and survival of terrestrial habitat and species (Popotnik and Giuliano 2000). A search of recent scientific literature failed to reveal established standards or best management guidelines for riparian corridor widths for the protection of viable riparian wildlife communities. There appears to be a need for rigorous, systematic, site-specific testing of riparian corridors of varying widths within the northern Great Basin, to gauge their viability for protecting indigenous riparian communities.

The following is a summary of findings from a number of scientific studies that attempted to use riparian birds as focal species, indicator species, or response guilds as a means of empirically

evaluating the effects of grazing, or livestock exclusion, on riparian communities. Many of the following studies utilize ungrazed riparian habitats or livestock exclosures as control sites:

Table 6. Summary of results and discussion: riparian corridor widths and riparian avifauna response to grazed/ungrazed treatments.

Results/Findings	References
"...species sensitive to disturbance did not occur unless an undisturbed corridor >25 m in width for each bank was present" [in a formerly forested ecosystem in central Pennsylvania].	Croonquist and Brooks 1993, p.69
"45 % reduction in the average number of birds in agricultural areas that did not have fencerows approximately 100 m from the stream." [in a formerly forested ecosystem in central Pennsylvania].	Croonquist and Brooks 1993, p.69
"...vegetated riparian corridors > 125 m were needed to support the full complement of bird communities that approached reference [control] conditions, although protecting at least 25 m of riparian habitat provided both dispersal and breeding opportunities for avian communities" [in a formerly forested ecosystem in central Pennsylvania].	Croonquist and Brooks 1993, p.69
Positive relationship between nest density and increased riparian corridor width.	Best and Stauffer 1980 *cited in* Popotnik and Giuliano 2000 ; Popotnik and Giuliano 2000 .
No relationship between zone width and avian abundance or richness (but maximum 40 m width used in the study of a forested ecosystem may have been under a necessary threshold width).	Popotnik and Giuliano 2000
Decreased cover and vegetative complexity along grazed streams versus ungrazed streams.	Tubbs 1980 *cited in* Popotnik and Giuliano 2000; Knopf *et al.* 1988; Hafner and Brittingham 1993; Popotnik and Giuliano 2000; .
Positive association between cover availability and avian abundance and richness.	Knopf *et al.* 1988; Wiens 1989 *cited in* Popotnik and Giuliano 2000; Croonquist and Brooks 1993; Popotnik and Giuliano 2000.
Positive relationships between spatial heterogeneity of vegetation and avian abundance and richness.	Willson 1974, Wiens 1989, and Naiman *et al.* 1993 *cited in* Popotnik and Giuliano 2000; Popotnik and Giuliano 2000.
Increased numbers of nesting species are probably the result of greater cover and spatial heterogeneity of vegetation.	Knopf *et al.* 1988; Croonquist and Brooks 1993; Willson 1974, Wiens 1989, and Naiman *et al.* 1993 *cited in* Popotnik and Giuliano 2000; Popotnik and Giuliano 2000.
Positive relationship between successful nest sites and increased stem density.	Best and Stauffer 1980 *cited in* Popotnik and Giuliano 2000; Popotnik and Giuliano 2000 .
The number of nesting species and nest density were higher on control (ungrazed) sites.	Popotnik and Giuliano 2000
Nest destruction from livestock was lower on control (ungrazed) sites.	Popotnik and Giuliano 2000
Avian richness and abundance increased with greater shrub heights and increased shrub volume.	Taylor 1986

Table 6 con't. Summary of results and discussion: riparian corridor widths and riparian avifauna response to grazed/ungrazed treatments.

Results/Findings	References
Birds and shrubs both decreased with grazing.	Taylor 1986
Cattle grazing has adverse effects on riparian willows and other shrubs. Willows recover when grazing is modified, reduced, or eliminated.	Ames 1977, Winegar 1977, Duff 1979, Knopf and Cannon 1981, and Rickard and Cushing 1982 *cited in* Taylor 1986.
"Fencing of streams and associated riparian habitats in pastures is a method of protecting these areas in farmlands".	Knopf *et al.* 1988; Hafner and Brittingham 1993; Belding *et al.* 2000 *cited in* Popotnik and Giuliano 2000, p.981; Popotnik and Giuliano 2000.
Fenced riparian areas may act as habitat traps by providing easy access to nests for predators.	Ratti and Reese 1988 *cited in* Popotnik and Giuliano 2000.
Yellow-breasted Chat, Veery and Western Wood-Pewee "occurred at sites with a high representation of riparian habitat in the surrounding landscape...It is suggested then, that these species in particular, preferentially select sites which are linked to extensive areas of riparian habitat."	Zeeman 1997, p.17
Stenotypic (habitat specialist) species will likely respond first to habitat perturbations; therefore, stenotypic species can serve as "guild indicators" or "ecological indicators" on which a management plan is based. For cottonwood bottomlands (in the Great Plains), the Yellow-breasted Chat (a stenotypic species) would be a good indicator of grazing pressure.	Sedgwick and Knopf 1987
"Species richness increased from 17 to 45 species nine years after removal of livestock [in Oregon]."	Winegar 1977 *cited in* Fleischner 1994, p.631
"Herbaceous cover of grazed plot less than half that of ungrazed plot [in Arizona]".	Szaro an Pase 1983 *cited in* Fleischner 1994, p.631
"Shrub canopy coverage increased 5.5 times, willow canopy coverage 8 times after removal of livestock."	Schulz and Leininger 1990 *cited in* Fleischner 1994, p.631
"Species composition altered by grazing; densities of 1/3 of species differed significantly between heavily and lightly grazed sites - -2/3 of these were higher on lightly grazed sites [in Montana]."	Mosconi and Hutto 1982 *cited in* Fleischner 1994, p.632
"Species richness decreased on grazed sites [in SE Oregon]."	Taylor 1986 *cited in* Fleischner 1994, p.632
"Abundance [of Willow Flycatcher] increased from 0 to 30 when grazing intensity reduced by 4 times [in SE Oregon]."	Taylor and Littlefield 1986 *cited in* Fleischner 1994, p.632
"Abundance [of Yellow Warbler] increased by 8 times when grazing intensity reduced by 4 times [in SE Oregon]."	Taylor and Littlefield 1986 *cited in* Fleischner 1994, p.632
"Flycatching guild, ground-foraging thrush guild and foliage-gleaning insectivore guild affected [by grazing]; bark-foraging guild unaffected [in short-term]."	Mosconi and Hutto 1982 *cited in* Fleischner 1994, p.633
"...wider corridors are always assumed to be more effective [in protecting edge-sensitive species] since they have an "interior" component free of edge effect."	Loney and Hobbs 1991, p.301

Considerable effort has been directed toward quantifying the negative effects of grazing on riparian avian richness and abundance. The results of these studies leave little doubt that richness and abundance of stenotypic, riparian-obligate bird species, in both forested and grassland ecosystems, is greater in riparian areas that are excluded from cattle grazing, as compared to control sites. Yet there is less evidence linking increased riparian-obligate bird productivity to livestock exclusion from

riparian areas. Furthermore, there is insufficient evidence linking increased bird richness, abundance, or more importantly, productivity to riparian corridor width in northern grassland/ shrubsteppe ecosystems of western North America. Insufficient data on this topic has resulted in the inability to derive empirical riparian corridor width standards or guidelines (for either critical or optimal corridor widths) that, if implemented, would protect viable native bird populations in the riparian zones of the south Okanagan and lower Similkameen watershed.

Within British Columbia there has been some effort to establish habitat protection guidelines for a wider range of taxa and specific species of particular conservation interest. The Forest Practices Code of BC (1999b, Attachment), recommends the following interim zones for Wildlife Habitat Areas (WHAs) for protection of critical habitat of 'identified' riparian-associated wildlife (Table 7).

Table 7. Recommended interim zones for Identified Wildlife (modified from: Forest Practices Code of BC 1999b, Attachment).

Species	Habitat Attribute	Interim Zone (~ha)	Interim Zone (m)
Red-listed Species			
Night Snake	hibernaculum	0.3	30 m radius
Yellow-breasted Chat	nest site	up to 5	n/a
Blue-listed Species			
Great Basin Gopher Snake	hibernaculum	0.3	30 m radius
Racer	hibernaculum	0.3	30 m radius
Rubber Boa	hibernaculum	0.3	30 m radius
American Bittern	nest site	0.8	50 m radius
+ Sandhill Crane	nest site	0.8	50 m radius
Long-billed Curlew	nest site	up to 5	n/a
Lewis's Woodpecker	aggregation	up to 3	100 m radius
Bobolink	nest site	up to 12	200 m radius

+ = Extirpated from the SOSCP area as a breeding species.

More recently, attempts have been made to estimate the biologically relevant size of core habitats surrounding wetlands for semi-aquatic amphibians and reptiles. Semlitsch and Bodie (2003) summarized data from the literature on the use of core terrestrial habitats by primarily adult amphibians and reptiles associated with wetlands (Table 8). Core terrestrial habitat for amphibians studied for all species combined, ranged from 159 to 290 m from the edge of aquatic sites studied. Overall core terrestrial habitat for reptiles studied for all species combined, ranged from 127 to 289 m from the edge of the aquatic sites studied (Table 8). The authors argue this data reflects the size of terrestrial habitats that are biologically necessary for the conservation of amphibian and reptile diversity at individual wetlands, and that riparian buffers 15–30 m wide, the amount typically used to protect wetland species in many states, are inadequate for protecting the critical (minimum) core habitat of amphibians and reptiles.

Table 8. Mean minimum and maximum core terrestrial habitat for amphibians and reptiles.*

Group	Mean minimum (m)	Mean maximum (m)
Frogs (19 spp.)	205	368
Salamanders (13 spp.)	117	218
Amphibians (32 spp., representing 1363 individuals)	159	290
Snakes (5 spp.)	168	304
Turtles (28 spp.)	123	287
Reptiles (33 spp., representing 2245 individuals)	127	289
Herpetofauna (65 spp.)	142	289

* Values represent mean linear radii extending outward from the edge of aquatic habitats compiled from summary data presented in Appendices I and II in Semlitsch and Bodie 2003.

Unfortunately, most of the data used to generate the figures in Table 8 are from amphibian and reptile species not found in the South Okanagan-Similkameen watersheds, and may have life history requirements that differ greatly from those of locally indigenous species. Therefore, utilization of the minimum and maximum distances listed in Table 8 may not be defensible for riparian restoration projects in the SOSCP area. However, Table 9 summarizes some of the source data used by Semlitsch and Bodie (2003) to calculate the figures from Table 8, listing only amphibian and reptile species known to be indigenous to the South Okanagan and Similkameen watersheds.

Table 9: Literature summary of terrestrial migration distances from aquatic sites for amphibians and reptiles (Semlitsch and Bodie 2003) – restricted to species known to also exist in the South Okanagan and Similkameen watersheds.

Species	Study Area	Distance in meters (sample size)	Data Source
Frogs			
Bufo boreas	Colorado	mode=900	Campbell 1970
	Wyoming	maximum = 101	Carpenter 1954
Hyla regilla	Oregon	mode=92; maximum=240	Jameson 1956
Rana catesbeiana	New York	mean=406; mode=1046 (n=22)	Ingram and Raney 1943
Rana pretiosa	Montana	range=41-443	Hollenbeck 1976
	Wyoming	maximum=46	Carpenter 1954
	Wyoming	range=369-462	Turner 1960
Salamanders			
Ambystoma tigrinum	South Carolina	162 (n=1)	Semlitsch 1983
	South Carolina	mean=215; range=112-450 (n=4)	Semlitsch *et al.*, unpubl. data
	New York	mean=60; range=0-286 (n=27)	Madison and Farrand 1998
Turtles			
Chysemys picta	Idaho	mode=200; maximum=600	Lindeman 1992
	Michigan	mean=60.4; range=1-164 (n=185)	Congdon and Gatten 1989
	Quebec	mean=90.4; range=1-621 (n=51)	Christens and Bider 1986

Semlitsch and Bodie (2003) propose stratification of terrestrial habitats adjacent to wetlands, including both lentic (pond) and lotic (stream) systems, into three different management zones:

(1) a first terrestrial zone immediately adjacent to the aquatic habitat, which is restricted from use and designed to buffer the core aquatic habitat and protect water resources;

(2) starting again from the wetland edge and overlapping with the first zone, a second terrestrial zone that encompasses the core terrestrial habitat defined by semiaquatic focal-group use (e.g., amphibians 159–290 m; Table 8); and
(3) a third zone, outside the second zone, that serves to buffer the core terrestrial habitat from edge effects from surrounding land use (e.g., 50 m).

However, more research is required to determine the dispersal distances and core habitat needs of indigenous amphibians and reptiles in a local context before viable buffer widths can be proposed for the SOSCP area.

A number of sources suggest that "singular, generic standards" for riparian corridor widths for the protection of water quality or terrestrial wildlife habitat are inappropriate, as they are based on an over-simplification of complex physical processes (Budd *et al.* 1987 *cited in* Croonquist and Brooks 1993; Gough 1988 *cited in* Osborne and Kovacic 1993, p.245). The complexity of site-specific physical processes combined with other site-specific environmental and cultural factors result in high variability, both spatially and temporally, in a riparian corridor's ability to support viable, whole riparian communities. The response of species, even conspicuous, easily detected taxa such as birds, to vegetative changes can be difficult to define and quantify, and can be inconsistent between different sites (Wiens and Dyer 1975 *cited in* Knopf *et al.* 1988), particularly between forested and grassland ecosystems.

Both critical (minimum) and optimal riparian corridor widths depend upon "the objective of the corridor, the ecology and movements of the target species [focal species or indicator species], and the [unique] structure of the landscape in which the corridor is located" (Bennett 1990, p.24). Even within the south Okanagan and lower Similkameen watershed, riparian habitats adjacent to lotic and limnic systems of varying size, elevation, aspect and hydrology, etc., will vary in their ability to support viable riparian wildlife communities. There is no way of empirically knowing the local viability of riparian corridors of varying widths without systematic study of individual riparian systems (or groups of systems with very similar characteristics) in the SOSCP area (Bennett 1990).

Nevertheless, knowledge of the habitat requirements of focal species (indicator species), particularly locally stenotypic riparian-obligates such as the Yellow-breasted Chat, Veery, and Yellow Warbler, could be used to approximate critical and/or optimal riparian corridor widths for lowland riparian systems in the south Okanagan and lower Similkameen – at least until systematic study can empirically prove or disprove the viability of approximated interim corridor widths. **Any suggested 'interim' corridor widths outlined in this report, based on current incomplete knowledge of the specific habitat requirements of focal species, should be rigorously tested in the field for viability.** To be consistent with adaptive management principles, developing knowledge regarding the critical and optimal habitat requirements of selected focal species, and other members of local riparian communities, should serve to modify interim riparian corridor width recommendations.

Focal Species Approach

Generally, the high level of complexity involved in identifying and quantifying the unique critical and optimal habitat needs of all species present in a specific riparian environment has prevented the complete understanding of whole riparian communities. Understanding the needs of an entire community of species in relation to complex ecological changes (e.g., climate change, cumulative anthropogenic impacts, natural evolutionary processes, etc.) is even more difficult, and may simply be unattainable. Unable to understand and manage all the individual elements of natural communities, ecologists and land managers have sought to protect these communities based on the needs of individual 'umbrella' species (single species approach), or simply by attempting to protect broader landscape or ecosystem units (landscape or ecosystem approach). Both single species-based approaches and ecosystem approaches have been criticized for their inability to direct conservation action that must provide for the unique habitat needs of a diverse community of species across the landscape (Lambeck 1997).

Utilization of a habitat-based 'focal species approach' is proposed as a means of directing riparian fencing project objectives and evaluating the effectiveness of riparian fencing projects in achieving the restoration and protection of viable riparian wildlife communities (Lambeck 1997; Partners in Flight BC/Yukon 2003). This approach focuses on restoring or protecting the critical habitat needs of a limited suite of focal species, which combined, theoretically represent the habitat attributes (composition, quantity, structure, and function) and associated management regimes necessary to sustain the broader riparian community. An avian focal species approach to conservation action implementation and evaluation may also represent one part of a broader riparian community monitoring program.

Canada's Great Basin Landbird Conservation Plan (Partners in Flight BC/Yukon 2003) identifies seven suitable focal species for lowland and montane riparian habitats in the south Okanagan and lower Similkameen watersheds: **Red-naped Sapsucker** (*Sphyrapicus nuchalis*), **Pacific-slope Flycatcher** (*Empidonax difficilis*), **Western Screech-Owl** (*Megascops kennicottii macfarlanei*), **Lewis's Woodpecker** (*Melanerpes lewis*), **Veery** (*Catharus fuscescens*), **Yellow Warbler** (*Dendroica petechia*) and **Yellow-breasted Chat** (*Icteria virens auricollis*). These seven birds represent stenotypic riparian species whose critical habitat requirements are most imminently threatened by anthropogenic influences.

Riparian areas in the SOSCP area will differ in their capacity to support various focal species. While some sites may be capable of supporting productive Yellow-breasted Chats (e.g., Osoyoos Oxbows/Okanagan River dike area), other riparian areas (e.g., Park Rill) may not provide the conditions necessary to support productive chat nesting habitat. However, sites not capable of supporting chats may be capable of supporting other focal species that require the desired condition of restored riparian habitat. Site-specific assessments and prescriptions, prepared by qualified personnel, should consider what the habitat objectives are for each site (i.e., desired habitat composition, structure, density, quantity); this is also known as the Desired Plant Community or DPC at Proper Functioning Condition (PFC). The DPC should be based on the Potential Natural Community (PNC) the site is capable of supporting. Focal species should be selected for each site, according to the similarity of their habitat requirements to the DNC at PFC. It should also be recognized that different sections, or reaches, of a stream may support different PNCs. Fencing assessments and prescriptions and the selection of focal species should take this type of variation into account.

In the absence of suitable data on viable, site-specific riparian corridor widths, and until such data can be obtained, known avian focal species habitat requirements and associations may be useful in approximating interim critical riparian corridor widths for imminent implementation of riparian fencing projects. However, it should be noted that approximations of this sort are based on incomplete empirical understanding of the specific habitat requirements of species, and as such should be rigorously tested in the field for viability.

The following data (adapted from Partners in Flight BC/Yukon 2003) summarizes the population status and habitat requirements reported in existing literature for the seven riparian-associated birds proposed as focal species for riparian habitat restoration projects in the South Okanagan – Similkameen Conservation Program area. All data originates from the following sources unless cited otherwise:

[a] Partners in Flight database (Panjabi *et al.* 2001) and/or Partners in Flight BC/Yukon Southern Interior Workshop (March 1999).
[b] Population status from British Columbia Conservation Data Centre (srmwww.gov.bc.ca/atrisk/toolintro.html) and Environment Canada (www.speciesatrisk.gc.ca/search/default_e.cfm).
[c] Population trends from Breeding Bird Survey data from 1976 – 2000 for the Southern Interior Ecoprovince (SOI), and on the longest run of data for the Great Basin Bird Conservation Region (GB). Anecdotal information from Cannings (pers. comm. 2000). BC listing from BC Ministry of Sustainable Resource (2001) and Canadian listing from Committee on the Status of Endangered Wildlife in Canada (May 2001).
[d] See Partners in Flight BC/Yukon 2003 for methods and description of accuracy ratings for population objectives derived for BC portion of the Great Basin (GB) Bird Conservation Region.
[e] Other data sources include: Birds of the Okanagan Valley, British Columbia (Cannings *et al.* 1987); Rare Birds of British Columbia (Fraser *et al.* 1999); Birds of British Columbia, v.1 & v.2 (Campbell *et al.* 1990), v.3 (Campbell *et al.* 1997) & v.4 (Campbell *et al.* 2001); Habitat atlas for wildlife at risk: south Okanagan and lower Similkameen (BC Env., Lands, and Parks 1999); Riparian Bird Conservation Plan (RHJV 2000); Siddle and Davidson 1991; Orville Dyer (pers. comm. 2000); Dick Cannings (pers. comm. 2000; unpubl. data 2003); Rick Howie (pers. comm. 2000); Christine A. Bishop and Tawna Morgan (unpubl. data 2003); Birds of North America accounts: Yellow-breasted Chat (Eckerle and Thompson 2001); Veery (Moskoff 1995); Western Screech-Owl (Cannings and Angell 2001); Yellow Warbler (Lowther *et al.* 1999); Pacific-slope Flycatcher (Lowther 2000); Lewis's Woodpecker (Tobalske 1997). COSEWIC Status Reports and Updates: Yellow-breasted Chat (Cannings 2000); Western Screech-Owl (Chaundy-Smart 2001).

Red-naped Sapsucker

Sphyrapicus nuchalis

Photo: Andy M. Bezener

Population Data

Status [b]:
BC: Yellow (Not at Risk)
CAN: Not Assessed
Trend [c]:
BC GB: No BBS trend.
Size Estimate [d]:
60,000 [accuracy rating – fair][d]
Population Objective [d]:
Increase current BC GB population by 50%.

Conservation Focus [a, e]

MONTANE RIPARIAN:
Deciduous trees and snags, especially aspen, birch, small cottonwoods and alder, below 1300 m elevation.

Photo: Andy M. Bezener

Habitat Description [e]

Excavates nest cavities in large, preferably live, aspen, birch, alder, cottonwoods and other deciduous trees, with a dbh of >23 cm (Campbell *et al.* 1990).

Important Habitat Features [e]

- territory size: habitat patches > 0.5 ha with high density of trees and a few exposed edges; 0.48 ha in Colorado aspen stands with an average of 685 trees/ha (Crockett and Hadow 1975).
- live deciduous trees for nesting (91% of nests in deciduous trees; only ~20% of deciduous nest trees were dead; 63% of nest trees have dbh of 23-30 cm):
  - Water Birch (*Betula occidentalis*)
  - Black Cottonwood (*Populus balsamifera trichocarpa*)
  - Trembling Aspen (*Populus tremuloides*), especially those with heart-rot fungus (*Fomes spp.*)
  - Mountain Alder (*Alnus incana*).
- nest trees often at forest edges.
- live deciduous trees for foraging (i.e., sap wells):
  - Water Birch
  - Mountain Alder Trembling Aspen Black Cottonwood
  - Saskatoon (*Amelanchier alnifolia*).

Pacific-slope Flycatcher

Empidonax difficilis

Photo: Andy M. Bezener

Population Data

Status [b]:
BC: Yellow (Not at Risk)
CAN: Not Assessed
Trend [c]:
BC GB: -3.9%/yr
(-11.1 to 3.9).
Size Estimate [d]:
30,000 [accuracy rating – poor][d]
Population Objective [d]:
Increase current BC GB population by 50%.

Conservation Focus [a, e]

MONTANE RIPARIAN:
Moist and shady low-mid elevation riparian habitat.

Photo: Andy M. Bezener

Habitat Description [e]

Nests on ground or in low vegetation, especially on sheltered ledges, in moist, shady riparian areas (Campbell *et al.* 2001).

Important Habitat Features [e]

- territory size: undetermined in BC interior; average size 2.5 ha (range = 1 to 3.5 ha, n=7), with territory length of 150 m on BC's Queen Charlotte Is.
- moist, shady, and structurally complex riparian woodlands with both deciduous and coniferous trees and an open airway for foraging between the canopy and understory shrub layer. Typical plants include:
  - Interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*)
  - Western Hemlock (*Tsuga heterophylla*)
  - Wester Redcedar (*Thuja plicata*)
  - Lodgepole Pine (*Pinus contorta* var. *latifolia*)
  - Ponderosa Pine (*Pinus ponderosa*)
  - Black Cottonwood
  - Trembling Aspen
  - Mountain Alder
  - Water Birch
  - Red-osier Dogwood (*Cornus stolonifera*)
  - Tall Oregon-Grape (*Mahonia aquifolium*)
  - Snowberry (*Symphoricarpos alba*)
  - Saskatoon
  - Choke Cherry (*Prunus virginiana*)
  - Wild Roses (*Rosa* ssp.)
- sloping ravines with uneven ground, sheltered ledges, small waterfalls, or deeply undercut banks that provide suitable nesting sites.

Western Screech-Owl

Megascops kennicottii macfarlanei

Photo: Andy M. Bezener

Population Data

Status [b]**:**
BC: Red-listed
CAN: Endangered
(*macfarlanei* ssp.)

Trend [c]**:**
BC GB: No BBS trend.

Size Estimate:
~50-300 birds: most in Okanagan Valley (Dick Cannings, unpubl. data 2003) [accuracy rating - fair][d]

Population Objective [d]**:**
At minimum, maintain current distribution and habitat until data deficiencies (i.e., population size and habitat requirements) are determined.

Conservation Focus [a, e]

LOWLAND RIPARIAN:
Large cottonwood snags and trees below 1000 m elevation.

Photo: Andy M. Bezener

Habitat Description [e]

Nests in existing cavities in large live trees or snags, especially cottonwoods. May forage in adjacent shrubsteppe or open dry woodland habitat (Campbell *et al.* 1990).

Important Habitat Features [e]

- territory size: undetermined in BC; estimated to be >6 ha; in s. Idaho, the nearest-neighbour distances for 34 nests ranged from 205 to 8475 m (mean 3054 ± 481SE) (Rains 1998 *in* Cannings and Angell 2001).
- nests in live and standing dead Black Cottonwood trees >25 cm dbh (mean = 61.5 cm dbh).
- nest cavities located 1.2 to 12.2 m above ground (n=43); cavities measured in BC were 30 to 36 cm in depth (n=3) with interior bowl up to 15 cm in diameter; entrance diameter of measured cavities = 15 cm (n=2), although cavities 7 cm in diameter are thought to be preferred.
- 8 of 24 nests documented in BC were in cavities excavated by Northern Flickers or Pileated Woodpeckers; 16 were in natural, non-woodpecker cavities.
- individuals nesting in narrow riparian zones may forage and roost in adjacent shrubsteppe or open forest habitat of Ponderosa Pine and Interior Douglas-fir.

Lewis's Woodpecker

Melanerpes lewis

Photo: Andy M. Bezener

Population Data

Status [b]**:**
BC: Blue-listed
CAN: Special Concern
Trend [c]**:**
BC GB: No BBS trend; Slow anecdotal decline.
GB: ↓
Size Estimate:
700-1200 (Siddle and Davidson 1991)
[accuracy rating - moderate][d]
Population Objective [d]**:**
Increase current BC GB population by 50%

Conservation Focus [a, e]

LOWLAND RIPARIAN:
Large cottonwood snags and trees adjacent to open areas below 1100 m elevation.

Photo: Andy M. Bezener

Habitat Description [e]

Nests in large-diameter black cottonwood snags and trees, especially those with dead tops or heartrot (Campbell *et al.* 1990).

Important Habitat Features [e]

- territory size: undetermined in BC; estimated at 4 ha; 1 to 6.1 ha in Blue Mtns. of Washington and Oregon; foraging home ranges larger and may overlap.
- open country with large live and standing dead trees (>30 dbh; preferrably >50 cm dbh; mean dbh = 60 cm) with ~25% canopy closure, especially of the following species:
  Black Cottonwood, live or dead
  Ponderosa Pine, especially live trees with dead tops.
- prefers previously excavated holes, but will excavate in large trees, especially Ponderosa Pine and Black Cottonwood with decaying centres.
- requires shrubsteppe and/or open dry woodland habitat with a shrubby understory for foraging adjacent to nest site (e.g., nest tree patches with 10-40% canopy closure adjacent to open patches with <20% tree canopy closure).

Veery

Catharus fuscescens

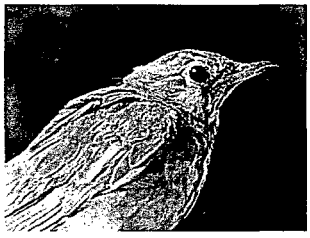

Photo: Andy M. Bezener

Population Data

Status [b]:
BC: Yellow (Not at Risk)
CAN: Not Assessed
Other: Declining globally
Trend [c]:
BC GB: ↑
Size Estimate [d]:
100,000 [accuracy rating – fair][d]
Population Objective [d]:
Increase current BC GB population by 10%.

Conservation Focus [a, e]

LOWLAND RIPARIAN:
Native riparian thickets – especially cottonwood understory.

Photo: Andy M. Bezener

Habitat Description [e]

Nests on or near the ground in dense, moist and shady undergrowth of deciduous riparian woodlands (Campbell *et al.* 1997; Moskoff 1995).

Important Habitat Features [e]

- territory size: 0.1 to "a few" ha/territory in North America (Bertin 1975 *cited in* Moskoff 1995); 0.25 ha in Ontario (Martin 1960 *cited in* Moskoff 1995).
- requires shady riparian woodlands; associated with a tree canopy dominated by Black Cottonwood with a dense shrub understory of native shrubs including:
  - Water Birch
  - Red-osier Dogwood Snowberry Willow (*Salix spp.*)
  - Tall Oregon Grape
  - Wild Rose.
- "preference for sites with understory," especially wild rose; maximum edge vegetation, complexity of vertical structure, and relatively high proportion of riparian habitat at the landscape level (20-60%, avg. = 32.7%) (Zeeman 1997, p.16).
- "Sites associated with human habitation were avoided" (Zeeman 1997, p.16).

Yellow Warbler

Dendroica petechia

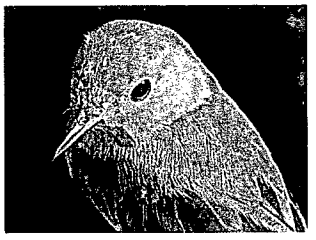

Photo: Andy M. Bezener

Population Data

Status [b]**:**
BC: Yellow (Not at Risk)
CAN: Not Assessed
Trend [c]**:**
BC GB: -3.1%/yr
GB: ↓
Size Estimate[d]**:**
100,000 [accuracy rating - fair][d]
Population Objective [d]**:**
Double current BC GB population.

Conservation Focus [a, e]

LOWLAND RIPARIAN:
Native riparian thickets, especially wild roses and willows, below 900 m elevation.

Photo: Andy M. Bezener

Habitat Description [e]

Nests in dense deciduous riparian vegetation, especially short trees or tall shrubs, particularly wild roses and willows, usually adjacent to a source of water (Campbell *et al.* 2001).

Important Habitat Features [e]

- territory size: ranges from 0.2-1.5ha/territory in North America.
- dense, narrow strips of large, structurally complex riparian shrubs bordering rivers, streams, and wetlands, especially along oxbows.
- Shrubs used for nesting include:
  - Wild Rose
  - Willow
  - Snowberry
- Other dominant shrubs within territories include:
  - Water Birch
  - Red-osier Dogwood.
- abundance positively related to width of riparian vegetation, number of tree and shrub species, presence of willow and shrub height in California (RHJV 2000).
- will breed in remnant willow thickets and small riparian patches of native vegetation; high association with narrow riparian tracts with edge habitat (Zeeman 1997).

Yellow-breasted Chat

Icteria virens auricollis

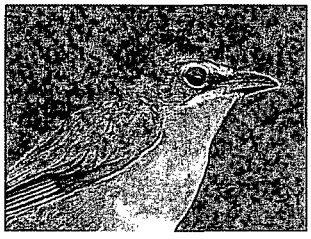

Photo: Andy M. Bezener

Population Data

Status [b]**:**
BC: Red-listed
CAN: Endangered (*auricollis* ssp. - BC population)

Trend [c]**:**
BC GB: No BBS trend

Size Estimate:
30-35 breeding pairs in South Okanagan watershed (C.A. Bishop and T. Morgan, unpubl. data 2003) [accuracy rating - good][d]

Population Objective [d]**:**
Adopt population recovery objective from Recovery Action Plan (*in prep*).

Conservation Focus [a, e]

LOWLAND RIPARIAN:
Native riparian thickets, especially wild rose, below 800 m elevation.

Photo: Andy M. Bezener

Habitat Description [e]

Nests in dense, impenetrable wild rose thickets, often within lowland cottonwood or water birch woodlands (Cadman and Page 1994; Campbell *et al.* 2001).

Important Habitat Features [e]

- territory size: 1 to 2 ha/territory in Canada (Cadman and Page 1994); 0.5 to 1 ha in Virginia (Dennis 1958); 1.24 ha in Indiana (Thompson and Nolan 1973).
- nests in very dense, more-or-less impenetrable, riparian shrub thickets, especially of wild rose, along streams and oxbows.
- most nests built in dense shrubs, averaging 1.25 m tall with some shrubs as high as 3.5 m (Gibbard and Gibbard 1992); nests may be built in the following shrubs:
  - Prickly Rose (*Rosa acicularis*)
  - Baldhip Rose (*Rosa gymnocarpa*)
  - Nootka Rose (*Rosa nutkana*)
  - Prairie Rose (*Rosa woodsii*)
  - Snowberry.
- wild rose thickets within the larger territory should be a minimum of 9 m wide by 9 m long (81 m^2) by 1.5 to >2m high, and should occupy 30 to 50% of the territory (Gibbard and Gibbard 1992; Johnston and Rockwell 2000).
- intermittent canopy 8 to 15 m high should be composed of one or more of the following species:
  - Water Birch
  - Black Cottonwood
  - Trembling Aspen
  - * Gibbard and Gibbard (1992) suggest a tree canopy height of no more than 6 m, and Zeeman (1997) suggest a positive association with tree heights >13 m at the site level.
  - * further research is recommended to determine the effects of tree canopies (i.e., canopy influence on Brown-headed Cowbird parasitism rates) on YBCH productivity.

- other important plants (Gibbard and Gibbard 1992; Johnston and Rockwell 2000) that may be present in territories include, but are not necessarily limited to:
  - Willow
  - Blue Elderberry (*Sambucus caerulea*)
  - Black Hawthorn (*Crataegus douglasii*)
  - Mountain Alder
  - Snowberry Saskatoon (*Amelanchier alnifolia cusickii*)
  - Red-osier Dogwood Poison Ivy (*Rhus radicans*)
  - White Clematis (*Clematis ligusticifolia*)
  - Various native grasses and forbs.
- may also nest in hillside hawthorn and sumac thickets.
- maximal continuity of riparian habitat at the landscape level (10-50%, avg. = 40%) (Zeeman 1997).
- "Pesticide use (Cannings 1995) may contribute to an absence from sites having orchards or related agricultural land use" (Zeeman 1997, p.17).

Additional Data

A partial field inventory of potential Yellow-breasted Chat habitat in the South Okanagan Valley in 2000 by Johnston and Rockwell included estimations of 12 occupied chat territories. An occupied chat territory being defined as a patch or area of potentially suitable chat breeding habitat that was occupied, and thus assumed to be defended by, a single singing male chat. Territory length and width dimensions (the height dimension was not measured) were estimated visually, in metres, or with the aid of a rangefinder (Johnston and Rockwell 2000).

Table 10. Estimated patch-size of Yellow-breasted Chat territories in the South Okanagan, British Columbia (Johnston and Rockwell 2000).

Estimated Patch Size	Length (m)	Width (m)	Area (m^2)	Area (ha)
Minimum Estimated Patch Size	50	20	1000	0.1
Maximum Estimated Patch Size	600	400	240000	24
*Average Estimated Patch Size	205	123	25215	2.5
+Average Estimated Patch Size			48950	4.9

* Average Estimated Patch Size based on Average Length x Average Width (from Table 1)
+ Average Estimated Patch Size based on Average Area (from Table 1)

Table 11. Vegetation on sites where Yellow-breasted Chats were observed. (from Johnston and Rockwell 2000).

Chat site	Suitability	Number of Chats	Rose sp%	Salix %	Saskatoon %	Snowberry%	Blue Elderberry%	Sumac%	Poison Ivy %	Red Alder %	Cotton Wood %	Hawthorne%	Red Osier Dogwood%	Knapweed%	Grasses %	Forbes %	Water Birch%	Hazel Nut/Chinese Elm %	Water%	Length of site (m)	Width of site (m)	Area of site (square m)
PIR	high	1	45	5	5	5			5		10			5		20				300	150	45000
RR1	high	1	20	7	7	4	5	5	10		20		4	3	5	5	5			50	20	1000
RR2	high	2	30	5	4	3	5		5	2	10	2	9	3		15	7			180	100	18000
RR3	mod	1	25	8	15	7			10	5	17				8			5		100	20	2000
IPP	high	2	40	8	7	5			7		15				12		6			600	400	240000
22N4	high	1	35	15			2								25		13		10	70	60	4200
22N3	high	2	30	21			1		10			5	10		3		20			110	60	6600
22N2	high	1	25	7		5			8		15		5	2		21	12			100	65	6500
22N1	high	2	30	40			2				13					5	10			60	65	3900
BSR	high	1	20	20				10	2						15		23		10	600	400	240000
22S1	high	1	15	5				30	5						15		30			120	55	6600
IRD	mod	2	20	10	6	5			8	7			6	4	13		21			170	80	13600
Total		17	365	172	44	34	16	45	80	14	100	12	44	17	99	66	167	5	20	2460	1475	587400
Average			30.4	14.3	3.67	2.83	1.33	3.75	6.67	1.17	8.33	1	3.67	1.42	8.25	5.5	13.9	0.42	1.67	205	123	48950

Based on their preliminary report of field estimations, Johnston and Rockwell (2000) suggest singing male Yellow-breasted Chats (assumed to be defending suitable breeding territory) occupied territories no smaller than 1000 square metres or 0.1 ha. The smallest territory was estimated to be 50 metres in length, with a width of approximately 20 metres. Note that their methods of territory delineation require further clarification (their estimations may or may not reflect the actual dimensions of defended territories), and that there is no indication of the productive status (or viability) of these approximated territories. Johnston and Rockwell's estimation of a minimum observed territory size of 0.1 ha does not constitute a critical (minimum) territory size, unless corroborated with further field investigation and confirmation of territory viability (i.e., a 0.1 ha territory is capable of supporting the fledging of young chats). Nor is there any confirmed evidence that the maximum estimated territory size of 24 ha (600 m long x 400 m wide) represents a single defended and productive chat territory. It is possible that this estimated territory, as large as it is, may not be viable. Conversely, it is possible that such a large area may support a number of defended and productive chat territories, based on reports of the Yellow-breasted Chat's potentially 'semi-colonial,' but monogamous breeding habits (Dennis 1958).

Therefore, a more detailed, empirical study of Yellow-breasted Chat territories is required, and should attempt to include a standardized assessment of territory productivity. Until further empirical evidence is obtained, it is difficult to draw conclusions regarding critical or optimal chat territory

dimensions and characteristics in the South Okanagan and Lower Similkameen Valleys. Nevertheless, the exclusion of livestock from 5 ha-sized areas of potentially suitable chat habitat, as is currently recognized, may be a useful guideline for imminent riparian fencing projects in parts of the SOSCP area.

The Yellow-breasted Chat is considered to be a stenotypic species (habitat specialist) whose breeding habitat is sensitive to the impacts of grazing pressure (Washington & Oregon Partners In Flight 2000; Zeeman 1997; Sedgwick and Knopf 1987). The British Columbia population of Yellow-breasted Chat is considered to be endangered, owing to extremely small population size and imminent loss of its native riparian thicket breeding habitat in the main lowland valleys of the South Okanagan and Lower Similkameen watershed (Forest Practices Code of BC 1999a; BC Environment, Lands and Parks 1999; COSEWIC 2000). Riparian fencing projects with the objective of rehabilitating extensive areas of native riparian thickets within the main lowland valleys of the South Okanagan and Lower Similkameen could be evaluated with the use of the Yellow-breasted Chat as a focal species (Sedgwick and Knopf 1987; Zeeman 1997; Washington & Oregon Partners In Flight 2000).

Brown-headed Cowbird Brood Parasitism Effects

The following is a summary of findings on the effects and status of Brown-headed Cowbird (*Molothrus ater*) brood parasitism in the SOSCP area:

Table 12. Summary of results and discussion: Brown-headed Cowbird Brood Parasitism Effects on riparian birds.

Results/Findings	References
"Our data suggest that habitat loss and perhaps cowbird parasitism have been factors in the near extirpation of Warbling Vireos at low elevations in the Okanagan Valley..." "...Warbling Vireos on the floor and middle elevations of the Okanagan Valley are part of a sink population maintained by emigration from source populations at higher elevations or from other areas."	Ward and Smith 2000b, p.34"
"Parasitism levels have been found to vary considerably among years within a host population."	Smith and Arcese 1994 *cited in* Vander Haegen and Walker 1999, p.3"
"Cowbirds appear to select breeding habitats with high host densities."	Thompson *et al.* In press *cited in* Goguen and Mathews 1999, p.1"
"...an average frequency of parasitism of 23 % was insufficient to have a detectable influence on Willow Flycatcher population growth in eastern Oregon."	Sedgwick and Iko 1999 *cited in* Smith 1999, p.106
Proposed rule of thumb for cowbird management program": "Managers should consider initiating cowbird management programs when the frequency of parasitism in a sample of 30 or more nests gathered in a locality in each of two or more years, consistently exceeds 6"%."	Smith 1999, p.107
Cassin's Vireo, Warbling Vireo, Red-eyed Vireo, and the Yellow-breasted Chat are species of conservation interest most likely to be influenced by cowbird nest parasitism [in the Okanagan Valley].	Smith 2000
Weed management and habitat quality improvements [for host species] are preferred long-term solutions to cowbird control compared to expensive, sustained cowbird trapping programs.	Smith 200"
"The species with the most severe parasitism [in the Okanagan Valley] are Warbling Vireo, Yellow Warbler, Black-headed Grosbeak, and Song Sparrow."	Ward and Smith 2000a, p.215

Table 12 con't. Summary of results and discussion: Brown-headed Cowbird Brood Parasitism Effects on riparian birds.

Results/Findings	References
"The species of greatest concern are those cowbird hosts that are restricted to habitat islands far from, or in the absence of, sources of colonists. One such species [in the SOSCP area] is the Yellow-breasted Chat, *Icteria virens*."	Ward and Smith 2000a, p.218
"...human-induced disturbance..." and "...the loss of riverine woodland habitat may be placing several species like chats and Willow Flycatchers in increasing jeopardy through habitat fragmentation and loss. Increasing levels of cowbird parasitism in such a situation could cause rapid population extinctions, and active management of such as cowbird removal might be considered. In the absence of significant habitat restoration measures, however, cowbird control might merely postpone the extinction of such species."	Ward and Smith 2000a, p.218
"...parasitized Yellow-breasted Chat nests were less concealed from below than unparasitized nests were."	Averill 1996 *cited in* Staab and Morrison 1999, p.22
Analysis showed that "...parasitized nests [of 4 common host species] had less ground cover immediately below them, and that shrubs were farther away when compared to unparasitized nests."	Averill 1996 *cited in* Staab and Morrison 1999, p.22
"Unparasitized nests had greater vegetation volume and shorter distance to concealing vegetation below the nest."	Staab and Morrison 1999, p.21
"Nest site selection, nesting success, and frequency of cowbird parasitism at Yellow-breasted Chat nests appear to be influenced by patch size."	Burhans and Thompson 1999, p.214
Some individual Yellow-breasted Chats (in Missouri) are capable of rejecting (via recognition and ejection) Brown-headed Cowbird eggs, while others accept foreign eggs.	Burhans and Freeman 1997

A 1997 study of bird-habitat associations in the South Okanagan by Aubrey Zeeman reported the following habitat associations for Brown-headed Cowbirds:

- "Logistical regression analyses suggest that cowbirds favour areas with more extensive areas of riparian habitat"; higher abundance of birds (potential hosts) in riparian areas relative to adjacent upland habitats may attract Brown-headed Cowbirds to riparian areas (Zeeman 1997, p.14).
- The presence of the Brown-headed Cowbird "does not reflect a healthy riparian ecosystem, but rather a threat to rare riparian-obligates such as the Yellow-breasted Chat" (Zeeman 1997, p.14/15);
- "while Brown-headed Cowbirds may indicate a more extensive area of riparian habitat, their presence poses a threat to rare riparian-obligates" (Zeeman 1997, p.17).

Dr. James Smith (2000) indicates the need for long-term monitoring of Brown-headed Cowbird parasitism effects prior to consideration of cowbird management programs. He further suggests there is currently insufficient data on the effects of cowbird parasitism on the endangered BC population of Yellow-breasted Chat. Such data would be useful in assessing if cowbird management is required in conjunction with habitat restoration initiatives focused on chats in the SOSCP area.

Other Potential Indicator Species

Other potentially suitable indicator species for riparian fencing project evaluation studies, as suggested in recent literature, include Willow Flycatcher (Lynn *et al.* 1998), Western Wood-Pewee (Zeeman 1997), Warbling Vireo (Lynn *et al.* 1998; Ward and Smith 2000b), Song Sparrow (Lynn *et*

al. 1998) and Common Yellowthroats (Sedgwick and Knopf 1987).

RIPARIAN FENCING BEST MANAGEMENT PRACTICES GUIDELINE RECOMMENDATIONS

Fencing Treatment Criteria

It is recommended that the following criteria form the framework for planned riparian fencing treatments in the SOSCP area:

- Riparian areas to be considered for fencing treatment must be privately owned.
- Site dynamics must support fencing as the best management option to eventually sustain a viable endemic riparian community, including selected Focal Species, at the desired successional stage (i.e., Desired Plant Community at Proper Functioning Condition).
- Priority sites for riparian fencing treatment must score above a to-be-selected threshold for the Site Prioritization process described on pages 38-39.

Site Selection Protocol

Pre-field Assessment

General Protocol

Remnant riparian areas are often narrow strips along watercourses. Most map coverages are at a scale of 1:20,000. The ability to conduct site selection from orthophotos and map coverages has limitations at this resolution. Furthermore, habitat condition is inferred from structural stage interpretations with limited field sampling, and land use is not identified. Analysis for potential sites will use these coverages as a guide, but ultimate selection will be dependent on site-specific field assessments. The following is a list of resources to be used in the site selection process:

- **TEM, TRIM and Orthophoto:** water emphasis mapping.
- **YBCH model:** depict habitat areas.
- **Historic suitable habitat:** model and add to YBCH habitat.
- **YBCH sightings:** overlay sightings observations; compare model to sightings.
- **Land tenure overlay:** select private and conservation holdings; develop landowner database.
- **Summary of Previous Contacts:** landowner database will be appended with a summary of previous contact information.
- **Field Evaluation:** conduct field evaluation of first cut map to determine whether sites would benefit from riparian fencing. Map any additional areas that mapping/model did not identify.

Site Prioritization

A matrix should be developed to rate/rank the suitability of each site for fencing treatment based a variety of considerations. The following categories (A to E) provide an example of how such a matrix might be structured. Sites with the highest score (derived from the sum of the ranks from all five categories) would be given highest priority. All sites that score above a selected threshold would be included in a list of priority sites that would be investigated through landowner contacts.

Note: - the rank value (or weight) of the options in a category may be modified if it is deemed that a category represents a higher set of priorities.
- finalization of rankings, particularly for categories B and E, will be contingent upon landowner contact and a field assessment.

Category A: Focal Species Rankings (1 to 9):

Ranked from lowest priority (1) to highest priority (9) are sites that have:

1. no potential for any Focal Species habitat based on current field assessments and assessments of the historical capability of the site; however, fencing treatment would provide protection for other conservation values:
   - migratory bird stopover site or movement corridor for wildlife;
   - important terrestrial habitat for species other than Focal Species (e.g., snake hibernaculum, bat roost, nesting habitat for non-focal species, birthing grounds, etc.);
   - important aquatic habitat;
   - maintained or improved water quality.
2. no potential for YBCH habitat, and no existing remnants of habitat for another Focal Species (pp. 26-31), but habitat creation for another Focal Species may be possible with intensive habitat reclamation efforts (i.e., based on historical suitability of site).
3. no potential for YBCH habitat, but potentially suitable breeding habitat for another Focal Species (pp. 26-31) (productive status undetermined; some habitat remnants existing, but habitat enhancement or restoration required).
4. no potential for YBCH habitat, but existing breeding habitat for another Focal Species (pp. 26-31) (productive status undetermined).
5. no potential for YBCH habitat, but existing productive breeding habitat for another Focal Species (pp. 26-31).
6. no existing remnants of YBCH habitat, but habitat creation may be possible with intensive habitat reclamation efforts (i.e., based on historical suitability of site).
7. potentially suitable YBCH breeding habitat (productive status undetermined; some habitat remnants existing, but habitat enhancement or restoration required).
8. existing YBCH breeding habitat (productive status undetermined).
9. existing productive YBCH breeding habitat.

Category B: Site Size and Corridor Width (1 to 9):

Ranked from lowest priority (1) to highest priority (9) are sites:

1. < 1 hectare in size, with an average fencing setback of < 15 metres.
2. 1 to 5 hectares in size, with an average fencing setback of < 15 metres.
3. > 5 hectares in size, with an average fencing setback of < 15 metres.
4. < 1 hectare in size, with an average fencing setback of 15 to 30 metres.
5. 1 to 5 hectares in size, with an average fencing setback of 15 to 30 metres.
6. > 5 hectares in size, with an average fencing setback of 15 to 30 metres.
7. < 1 hectare in size, with an average fencing setback of > 30 metres.
8. 1 to 5 hectares in size, with an average fencing setback of > 30 metres.
9. > 5 hectares in size, with an average fencing setback of > 30 metres.

Category C: Site Connectivity (1 to 4):

Ranked from lowest priority (1) to highest priority (9) are sites that:

1. are relatively isolated (greater than 1 km) from existing or planned conservation holdings.
2. are within close proximity (within 1 km) of existing or planned conservation holdings.
3. are adjacent to a single existing or planned conservation holding.
4. link two or more existing or planned conservation holdings.

Category D: Adjacent Threats (1 to 3):

Ranked from lowest priority (1) to highest priority (9) are sites that have:

1. planned or existing adjacent large-scale threats (e.g., intensive agriculture, pesticide or herbicide application, waste disposal, intensive resource extraction).
2. planned or existing adjacent small-scale threats (e.g., domestic cats, utility corridor, lightly-used transportation corridor [permeable or impermeable surface], seasonal livestock use).
3. no planned or existing adjacent small-scale or large-scale threats.

Category E: Landowner Interest (1 to 4):

Ranked from lowest priority (1) to highest priority (9) are sites owned by persons:

1. *not currently interested in riparian fencing or other riparian protection options (*in such a situation, where other rankings are high, land ownership status should be monitored by SOSCP stewardship co-ordinators in case a change in ownership brings new interest in riparian conservation initiatives).
2. not interested in riparian fencing, but interested in other riparian protection options.
3. interested in riparian fencing and agrees to sign all recommended landowner agreements, except establishment of a conservation covenant.
4. interested in riparian fencing and agrees to sign all recommended landowner agreements, including establishment of a conservation covenant.

Landowner Contact

1. Consult with SOSCP Stewardship Team chair regarding co-ordinated landowner contact protocol.
2. Initial contact: phone and make appointment.
3. Initial visit with landowner:
   a) Supply following information:
   - Species at Risk literature, including "Chats In Your Neighbourhood" (Yellow-breasted Chat/riparian landowner stewardship brochure)
   - "The Value of Riparian Habitat and How to Care for It" (Living In Nature Series brochure)
   - water quality initiatives
   - riparian fencing program
   - fisheries habitat brochure.

   b) Interview landowner about land practices and ask if a riparian fencing project would be suitable and acceptable. Discuss options for fence location and riparian corridor width options, including Department of Fisheries and Oceans 'legal imperative.' Different types of fencing (e.g. smooth wire, rail) to be offered as options.

Field Assessment and Prescription Procedures

The viable width of a riparian corridor to be excluded from livestock via fencing is variable depending on the site-specific objectives (e.g., rehabilitate riparian thicket habitat to productive capacity for one pair of Yellow-breasted Chats) and site-specific conditions (e.g., soil type, slope, vegetative cover type, local climate, etc.). Therefore, qualified personnel should complete a full field assessment and project prescription for all sites selected for fencing treatment. Ideally the assessment procedure should:

- Determine the Potential Natural Community the site is capable of supporting. Selection of the Desired Plant Community will be based on this site-specific potential.
- Consider what the habitat objectives or 'targets' are for each site (i.e., the Desired Plant Community at Proper Functioning Condition). Focal species should be selected for each site, according to the similarity of their habitat requirements to the Desired Plant Community at Proper Functioning Condition. Some sites may allow for more than one prescription option, while other sites will exclude certain options because of site limitations (e.g., some sites may not be capable of supporting productive Yellow-breasted Chat habitat).
- Recognize that different sections, or reaches, of a stream often support different Potential Natural Communities. Fencing assessments and prescriptions, and the selection of focal species, should take this type of within-site variation into account.

The Riparian Assessment and Prescription Procedures protocol (Koning 1999), established by the BC Ministry of Forests and the BC Ministry of Water, Air, Lands and Parks Watershed Restoration Program, offers a standardized methodology for forestry applications on provincial Crown land. This approach may be adapted for use with riparian fencing project field assessments and prescriptions on private lands. Ideally, the chosen protocol should provide proper project documentation and direction, and will enhance compatibility of project evaluation data with other ongoing and future riparian restoration projects in British Columbia.

Landowner Agreements

It is recommended that the following signed agreements be reached with landowners in conjunction with riparian fencing treatments in the SOSCP area:

- The landowner agrees to maintain the fence in good operational condition over a minimum period of years (to be determined through negotiation).
- The landowner agrees to permit ongoing access by program representatives for monitoring purposes.
- The landowner agrees to provide, at her or his own expense, alternate water sources for livestock.
- The landowner agrees to permit, if necessary, active restoration (e.g. plantings, weed control, etc.), by program representatives or other authorized groups, of fenced riparian areas to improve or enhance habitat integrity.
- The landowner agrees to permit, if necessary, active restoration (e.g. plantings, weed control, etc.) by program representatives or other authorized groups, of fence margins and associated construction access corridors that have been disturbed during fence installation or maintenance.
- The landowner agrees (optional) to establish a conservation covenant on the protected riparian area subjected to fencing treatment.

Landowner Costs and Considerations

The costs to landowners of livestock exclusion in riparian zones will vary from one site to another, and as such should be quantified, if possible, on a site-by-site basis. Full awareness of the costs and benefits associated with riparian fencing projects will help ranchers balance the needs of their ranching operation with the needs of viable riparian communities.

Costs will include:
- capital costs of original fencing and post material (provided to landowner)
- labour costs of fencing installation (provided to landowner)
- labour costs, as well as capital costs of replacement materials, of fencing maintenance
- cost of alternative watering source development and maintenance
- cost of lost forage production.

Benefits of riparian fencing may include:
- reduced harm to people (downstream communities), livestock, and wildlife through improved water quality, owing to reduced or eliminated contaminant inputs (i.e., reduced exposure to mobile in-stream diseases and contaminants)
- improved, productive native wildlife habitat (for game and non-game species)
- improved, productive native fish habitat (for game and non-game species)
- recovery of provincially and/or nationally endangered species
- reduced property taxes.

The value of species, especially endangered species, to landowners and the broader community should also be considered, along with the protection benefits of riparian fencing wherever possible:
- Existence Value of species (how much people value the continued existence of these organisms)
- Bequest Value (the value of leaving some of these organisms for future generations)

- Option Value (the value of having an option to do something with species in the future, even if we have no direct economic uses for them at present).

Cost-sharing incentives and technical support (e.g., alternative watering sources) provided by local communities and stewardship programs, and community exposure as a water- and wildlife-friendly operation provide additional benefit to ranchers that support riparian fencing initiatives.

Focal Species Buffer Width Recommendations

The following is a summary of interim riparian habitat buffer dimensions recommended for the conservation of riparian-obligate focal species. These species-specific recommendations, combined with the habitat composition data provided (pp. 26-35), may be used to direct habitat restoration actions in conjunction with riparian fencing treatments. These recommendations are based on the best available knowledge of local species habitat requirements; unfortunately, some information is conflicting, deficient, or simply unavailable. Therefore, these recommendations should be updated periodically based on the outcome of additional research and evaluation. The following species are listed in order of priority for guiding lowland riparian habitat restoration efforts in particular:

Yellow-breasted Chat

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone capable of supporting a 1 ha/10,000 m^2 minimum territory size (2 to 5 ha preferred), listed in order of priority:
  - 100 m wide x 100 m long
  - 50 m wide x 200 m long
  - 30 m wide x 333.3 m long
  - 25 m wide x 400 m long
  - 20 m wide x 500 m long
  - 15 m wide x 666.7 m long

Western Screech-Owl

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone capable of supporting a 6 ha/60,000 m^2 minimum territory size (10 to 60 ha preferred), listed in order of priority:
  - 200 m wide x 300 m long
  - 150 m wide x 400 m long
  - 100 m wide x 600 m long
  - 80 m wide x 750 m long
  - 60 m wide x 1000 m long

Veery

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone capable of supporting a 0.25 ha/2,500 m^2 minimum territory size (1 to 3 ha preferred), listed in order of priority:

50 m wide x 50 m long
30 m wide x 83.3 m long
25 m wide x 100 m long
20 m wide x 125 m long
15 m wide x 166.7 m long

Yellow Warbler

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone capable of supporting a 0.5 ha/5,000 m^2 minimum territory size (1 to 1.5 ha preferred), listed in order of priority:

50 m wide x 100 m long
30 m wide x 166.7 m long
25 m wide x 200 m long
20 m wide x 250 m long
15 m wide x 333.3 m long

Lewis's Woodpecker

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone, including adjacent dry woodland and/or shrubsteppe habitats capable of supporting a 4 ha/40,000 m^2 minimum territory size (5 to 10 ha preferred), listed in order of priority:

250 m wide x 160 m long
200 m wide x 200 m long
150 m wide x 266.7 m long
100 m wide x 400 m long

Red-naped Sapsucker

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone capable of supporting a 0.5 ha/5,000 m^2 minimum territory size (1 to 1.5 ha preferred), listed in order of priority:

50 m wide x 100 m long
30 m wide x 166.7 m long
25 m wide x 200 m long
20 m wide x 250 m long

Pacific-slope Flycatcher

Recommended Buffer Zone Dimensions

- recommended dimensions for a riparian buffer zone capable of supporting a 2.5 ha/25,000 m^2 minimum territory size, listed in order of priority:

150 m wide x 166.7 m long

100 m wide x 250 m long
80 m wide x 312.5 m long
60 m wide x 416.7 m long

General Fencing Treatment Guidelines

Riparian Corridor Width Guidelines

1. Where possible, the historical (pre-European influence) area of riparian habitat should be fenced to exclude livestock, to allow for the restoration of natural ecological processes and functions for the benefit of entire native riparian communities. Unfortunately, one of the long-term impacts of grazing includes the contraction (narrowing) of the riparian zone, such that the width of the currently apparent riparian corridor may be less then the historical width.

2. If it is not possible to determine the extent of the historical riparian corridor, or if it is undesirable to exclude cattle from the entire historical riparian area, riparian fencing should either:
   a) protect the apparent (existing) riparian corridor, rather than bisect existing riparian habitat, if possible; or if preferred,
   b) protect a riparian corridor of a fixed or variable width, determined by a combination of:
      - legal requirements;
      - site-specific conditions;
      - site-specific objectives (e.g., selected Focal Species habitat targets);
      - economic factors (e.g., cost of fencing, lost forage production, etc.);

   whichever option best balances the maximization of water quality and riparian habitat protection for native plants, fish, and wildlife, with the costs associated with livestock exclusion.

3. The Department of Fisheries and Oceans, Canada, in conjunction with the British Columbia Ministry of Water, Air, Lands and Parks (Chilibeck *et al.* 1992), have established a minimum 15 metre 'leave strip' guideline for riparian zone width along each stream bank or shoreline of any fish-bearing waterbody or watercourse for the protection of fish habitat. This 15 m figure represents a legal directive of the Canadian federal *Fisheries Act* that has been supported in case law, and as such should be adopted as a minimum distance for fencing setback from any fish-bearing water body. This 15 m guideline also applies to non-fish-bearing reaches and direct tributaries within one stream order of fish-bearing reaches.

4. Fencing objectives set to meet Focal Species habitat recommendations (pp. 26-35 and 42-43) may demand that fencing setbacks be widened beyond the 15 metre minimum for fish-bearing water bodies. The following should be considered when setting fencing setbacks in relation to Focal Species habitat targets:
   - Wider riparian corridors excluded from livestock are preferred to narrower corridors because they provide more 'interior' habitat and provide better protection from edge-effects for edge-sensitive riparian-obligate species (such as the Yellow-breasted Chat and Veery).
   - Wide intermittent 'core' patches of riparian habitat bordered by very narrow stretches of habitat should provide more viable 'interior' habitat than a linear corridor of moderate, continuous width with a higher edge:interior ratio. For example, a 2 to 5 ha 'clump' of unbroken, very dense riparian thicket habitat with very narrow 15 m wide 'inlet' and

'outlet' corridors may be more advantageous to edge-sensitive species than a single linear corridor 20 or 25 m wide.

5. The following options for setting riparian corridor width have been suggested by Wenger (1999) and Wenger and Fowler (2000). These following options should be considered if other recommendations suggested above are unsuitable:

Option One (variable width)

- Base width is 100 feet (30.5 metres) plus 2 feet (0.61 metres) per 1 percent of slope* of the stream valley.
- It is extended to edge of floodplain.
- It is extended by the width of wetlands that lie within or partly within the buffer (as determined by slope and floodplain width).
- Existing impervious surfaces in the riparian zone do not count toward buffer width (i.e., the width is extended by the width of the impervious surface, just as for wetlands).
- Slopes over 25 percent do not count toward the width.
- The buffer applies to all perennial and intermittent streams.
- Ephemeral streams are not protected by buffers, but their banks must be vegetated.

Option Two (variable width)

- Base width is 50 feet (15.2 meters) plus 2 feet (0.61 meters) per 1 percent of slope of the stream valley.
- Entire floodplain is not necessarily included in the buffer, although potential sources of severe contamination should be excluded from the floodplain.
- Existing impervious surfaces in the riparian zone do not count toward buffer width (i.e., the width is extended by the width of the impervious surface, just as for wetlands).
- Slopes over 25 percent do not count toward the width.
- The buffer applies to all perennial and intermittent streams.
- Ephemeral streams are not protected by buffers, but their banks must be vegetated.

Option Three (fixed width)

- Fixed buffer width is 100 feet (30.5 metres).
- The buffer applies to all perennial and intermittent streams.
- Ephemeral streams are not protected by buffers, but their banks must be vegetated.

Notes:
For all three options, buffer vegetation should consist of native forest.
Restoration should be conducted when necessary and possible.
* Percent slope is the increase in elevation per unit of width. For example, if the stream valley rises by 20 feet (6.1 metres) over a width of 100 feet (30.5 metres), slope is 20 percent.

Installation Guidelines

1. Installation of fencing should attempt to minimize disturbance to riparian wildlife (particularly nesting or breeding species), native riparian vegetation and soils along the fence margin:
   - Ideally, fencing installation should take place between November 1 and March 15 during periods of plant dormancy.

- Weed control measures should be implemented along fence margins during the first two or three years after fence installation.
- A qualified weed control specialist should be consulted to prescribe site-specific weed control measures, and possible native plant re-introduction regimes, that minimize harm to the existing riparian community and maximize native riparian plant community rehabilitation.

Grazing Variances

1. If grazing of riparian areas is necessary for part of the year to offset total losses of riparian forage production, consider:
   - adjusting the timing of riparian grazing to help meet specific objectives
     - e.g., graze in the early part of the growing season to reduce harm on woody riparian vegetation production
     - e.g., "livestock use will occur prior to mid-July in order to prevent browsing of willow shoots" (BC Ministry of Forests Remedial Measures Primer website)
   - reducing the duration of grazing pressure to help meet specific objectives
     - e.g., landowners may be willing to fence-off larger riparian areas if they can still graze portions of the riparian area, even for a short period of time (i.e., a couple of days)
     - e.g., livestock will be removed from the riparian portion of the unit when the average stubble height in the key area reaches 8 cm
   - moving supplements, alternative water sources, and shading sources away from sensitive riparian features like stream banks and thickets
     - e.g., livestock will be distributed by daily herding and by placement of salt blocks. Salt blocks will be placed no closer than 400 m from the riparian area

*These options should only be considered if short-term grazing effects do not negatively impact the habitat objectives prescribed for the riparian exclosure.

Prohibited Activities

All significant sources of aquatic contamination and degradation should be excluded from buffers. These include (Wenger 1999):

- construction resulting in land disturbance
- accessory structures and buildings, parking lots, driveways, and other impervious surfaces
- logging roads
- mining
- septic tanks or septic tank drain fields
- agricultural fields
- waste disposal sites
- receiving areas for toxic or hazardous waste or other contaminants
- stormwater detention ponds (except those designed as wetlands)
- access of livestock
- clear cutting of forests
- application of pesticides and fertilizers.

Recommendations for Research Needs and Riparian Fencing Evaluation

- All riparian fencing projects implemented in the SOSCP area should include a monitoring and evaluation program to determine the efficacy of riparian fencing treatments.

- Data collected from riparian communities subjected to fencing treatment (pre-treatment and post-treatment data) should be compared to data collected from control sites (grazed riparian sites).

- Entire bird communities or a select number of avian focal species may be used in conjunction with vegetation sampling to evaluate the overall response of the riparian community to various treatments. Comparison of pre-treatment (before fencing) data, ideally obtained from a planned fencing site over one or two years prior to fencing installation, to post-treatment data (after fencing) would allow for a robust analysis of riparian fencing efficacy.

- If collection of data one to two years prior to installation is not reasonable, data should be collected as soon as possible after installation .

- Focal species should be selected based on site-specific objectives and habitat capability (i.e., the Potential Natural Community or the Desired Plant Community). Potential priority focal species are discussed on pages 26 to 32.

- The avian and vegetation sampling methods selected will vary depending on specific research objectives. However, the following recommendations should help direct the selection of monitoring methods:
  - Avian and vegetation/habitat sampling methods should conform to Resource Inventory Committee (RIC) and Partners In Flight (PIF) design and protocol standards.
  - Decide on preferred survey intensity:
    - Use **Encounter Transects** for **Presence/Not detected** data
    - Use **Variable Radius Point Counts** for **Relative Abundance** data
    - Use **Spot Mapping** or **Distance-based Point Counts** for **Absolute Abundance (species density)** data
    - Consider measuring productivity (see Vickery *et al.* 1992); e.g., using the **Monitoring Avian Productivity and Survivorship** protocol.
  - Decide on preferred sampling intensity (minimum sample size = 30).
  - Decide on timing (time of year) and duration (how many years) of sampling.
  - Treatment (fenced) sites should be compared to 'random' control sites (no fencing treatment) if possible.
  - Consider surveying entire riparian community in addition to Focal Species.
  - Consider using extended (10 minute duration) call-playback point count surveys for Yellow-breasted Chat and Red-naped Sapsucker.

  * Standardized sampling of small mammal populations should also be considered in addition to avian and vegetation sampling.

- Where possible, research should include rigorous testing of riparian community response to fencing treatments in riparian corridors of varying widths. The following table lists examples of 'interim' riparian corridor widths that could be tested against grazed controls in various riparian

systems in the SOSCP area (sample interim riparian corridor widths are suggested based on existing Forest Practices Code of BC RMA standards and guidelines):

Table 13. Examples of interim corridor widths to test for various stream classes.

Stream Class	Average Channel Width (m)	Control Site Corridor Width (m)	Interim Riparian Corridor Widths (m)		
			Treatment #1	Treatment #2	Treatment #3
S1	≥ 100 m	0	100	200	300
S1	> 20 m	0	50	100	200
S2	> 5 ≤ 20 m	0	30	60	120
S3	1.5 ≤ 5 m	0	20	40	80
S4	< 1.5 m	0	10	20	40
S5	> 3 m	0	10	20	40
S6	≤ 3 m	0	10	20	40

The results of rigorous variable corridor width testing will further scientific knowledge related to riparian corridor viability, and will help direct future riparian restoration efforts in the SOSCP area, the broader southern interior of British Columbia, and other neighbouring jurisdictions.

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Appendix I. Lowland Riparian Species at Risk in the SOSCP area.
(modified from: Environment Canada 2000 and Forest Practices Code of BC 1999)

+ = Extirpated from the SOSCP area as a breeding species, or unknown status
* = Species that may or may not require the use of lowland riparian areas
R = Provincially Red-listed Species (Endangered)
B = Provincially Blue-listed Species (Threatened or Vulnerable)
Ex = Nationally Extirpated Species or Populations
E = Nationally Endangered Species or Populations
T = Nationally Threatened Species or Populations
SC = Species or Populations of Species Concern (Nationally)

Common Name	Scientific Name	Status
Plants		
Annual Paintbrush	*Castilleja minor* ssp. *minor*	R
Atkinson's Coreopsis	*Coreopsis tinctoria* var. *atkinsoniana*	R
Awned Cyperus	*Cyperus squarrosus*	B
Beaked Spike-rush	*Eleocharis rostellata*	B
Bearded Sedge	*Carex comosa*	B
Blackened Sedge	*Carex epapillosa*	B
Blue Vervain	*Verbena hastata* var. *scabra*	R
Booth's Willow	*Salix boothii*	B
Bristly Mousetail	*Myosurus apetalus* var. *borealis*	R
Bushy Cinquefoil	*Potentilla paradoxa*	R
Cut-leaved Waterparsnip	*Berula erecta*	R
Dotted Smartweed	*Polygonum punctatum*	B
False-pimpernel	*Lindernia dubia* var. *anagallidea*	B
Fox Sedge	*Carex vulpinoidea*	B
Giant Helleborine	*Epipactis gigantean*	B / SC
Hairy Water-clover	*Marsilea vestita*	R
Holm's Rocky Mountain Sedge	*Carex scopulorum* var. *bracteosa*	B
Hutchinsia	*Hutchinsia procumbens*	R
Little Fescue	*Festuca minutiflora*	B
Lyall's Mariposa Lily	*Calochortus lyallii*	R / T
Marsh Muhly	*Muhlenbergia glomerata*	B
Mexican Mosquito Fern	*Azolla mexicana*	R / T
Nuttall's Waterweed	*Elodea nuttallii*	B
Peach-leaf Willow	*Salix amygdaloides*	R
Porcupine Sedge	*Carex hystricina*	B
Prairie Gentian	*Gentiana affinis*	B
Purple Spike-rush	*Eleocharis atropurpurea*	R
Red-rooted Cyperus	*Cyperus erythrorhizos*	R
Regel's Rush	*Juncus regelii*	B
River Bulrush	*Bolboschoenus fluviatilis*	B
Rocky Mountain Sedge	*Carex scopulorum* var. *bracteosa*	B
Scarlet Ammannia	*Ammannia robusta*	R / E
Short-rayed Aster	*Aster frondosus*	R
Small-flowered Lipocarpha	*Lipocarpha micrantha*	R / E
Swamp Onion	*Allium validum*	R
Tall Beggarticks	*Bidens vulgata*	R
Toothcup	*Rotala ramosior*	R / E
Tweedy's Willow	*Salix tweedyi*	B
Western Centaury	*Centaurium exaltatum*	R

Appendix I con't. Lowland Riparian Species at Risk in the SOSCP area.
(modified from: Environment Canada 2000 and Forest Practices Code of BC 1999)

Common Name	Scientific Name	Status
Plant Associations		
Water Birch/Red-osier Dogwood		R
Hairy Water-clover/American Bulrush		R
Ponderosa Pine/Black Cottonwood/ Poison Ivy		R
Black Cottonwood/ Water Birch		R
Sandbar Willow/Peach-leaf Willow		R
Douglas-fir/Water Birch/Douglas Maple		R
Insects		
Vivid Dancer		R
Mormon Metalmark	*Apodemia mormo*	R / E
Behr's Hairstreak	*Satyrium behrii*	R / T
Monarch	*Danaus plexippus*	B / SC
Fish		
Umatilla Dace	*Rhinichthys Umatilla*	R / SC
Chiselmouth	*Acrocheilus alutaceus*	B
Mountain Sucker	*Catostomus platyrhynchus*	B
Mottled Sculpin	*Cottus bairdi*	B / SC
Amphibians		
Tiger Salamander	*Ambystoma tigrinum*	R / E
Great Basin Spadefoot	*Scaphiopus intermontanus*	B / T
Western Toad	*Bufo boreas*	SC
+Northern Leopard Frog	*Rana pipiens*	R / E
Reptiles		
Western Painted Turtle	*Chrysemys picta belli*	B
Western Skink	*Eumeces skiltonianus*	SC
Rubber Boa	*Charina bottae utahensis*	SC
Racer	*Coluber constrictor*	B
*Night Snake	*Hypsiglena torquata deserticola*	R / E
Great Basin Gopher Snake	*Pituophis melanoleucus deserticola*	B / T
Western Rattlesnake	*Crotalus viridis oreganus*	B / T
Birds		
American Bittern	*Botaurus lentiginosus*	B
Great Blue Heron	*Ardea herodias*	B
Turkey Vulture	*Cathartes aura*	B
Peregrine Falcon	*Falco peregrinus anatum*	R / T
+Greater Sage Grouse	*Centrocercus urophasianus*	+R / Ex
+Sharp-tailed Grouse ssp. *Columbianus*	*Tympanuchus phasianellus columbianus*	+R
+Sandhill Crane	*Grus canadensis*	+B
Long-billed Curlew	*Numenius americanus*	B / SC
Barn Owl	*Tyto alba*	B / SC
Short-eared Owl	*Asio flammeus*	B / SC
Western Screech-Owl ssp. *Macfarlanei*	*Megascops kennicottii macfarlanei*	R / E
Lewis's Woodpecker	*Melanerpes lewis*	B / SC
White-headed Woodpecker	*Picoides albolarvatus*	R / E
Yellow-breasted Chat ssp. *Auricollis*	*Icteria virens auricollis*	R / E
Bobolink	*Dolichonyx oryzivorus*	B

Appendix I con't. Lowland Riparian Species at Risk in the SOSCP area.
(modified from: Environment Canada 2000 and Forest Practices Code of BC 1999)

Common Name	Scientific Name	Status
Mammals		
Pallid Bat	*Antrozous pallidus*	R / T
Western Red Bat	*Lasiurus borealis*	R
Fringed Myotis Bat	*Myotis thysanodes*	B / SC
Spotted Bat	*Euderma maculatum*	B / SC

Appendix II: List of lowland- and montane riparian-associated breeding birds found in the South Okanagan – Similkameen Program area (Cannings et al. 1987; Zeeman 1997; Campbell et al. 1990, 1997 and 2001).

+ = Riparian obligate species
* Extirpated as breeders

* Common Loon
+Pied-billed Grebe
Red-necked Grebe
Eared Grebe
Horned Grebe
+American Bittern
+Great Blue Heron
+Canada Goose
+Wood Duck
+Green-winged Teal
+Mallard
+Northern Pintail
+Blue-winged Teal
+Cinnamon Teal
+Northern Shoveler
+American Wigeon
+Canvasback
+Redhead
+Ring-necked Duck
+Harlequin Duck
+Common Goldeneye
+Barrow's Goldeneye
+Common Merganser
+Ruddy Duck
Osprey
Bald Eagle
+Northern Harrier
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-tailed Hawk
American Kestrel
Merlin
*Peregrine Falcon
Ring-necked Pheasant
Ruffed Grouse
Blue Grouse
California Quail
+Virginia Rail
+Sora
+American Coot
* Sandhill Crane
Killdeer
+Spotted Sandpiper
Long-billed Curlew
+Wilson's Snipe
+Wilson's Phalarope
Rock Dove
Mourning Dove
Barn Owl
Short-eared Owl
Long-eared Owl
Great Horned Owl
Barred Owl
+Western Screech-Owl
Northern Saw-whet Owl
Common Nighthawk
+Black Swift
Vaux's Swift
White-throated Swift
Black-chinned Hummingbird
Calliope Hummingbird
Rufous Hummingbird
+Belted Kingfisher
Lewis's Woodpecker
Red-naped Sapsucker
Downy Woodpecker
Hairy Woodpecker
Northern Flicker
Pileated Woodpecker
Western Wood-Pewee
+Willow Flycatcher
+Pacific-slope Flycatcher
Say's Phoebe
Western Kingbird
Eastern Kingbird
Warbling Vireo
Red-eyed Vireo
Black-billed Magpie
American Crow
Tree Swallow
Violet-green Swallow
Northern Rough-winged Swallow
Bank Swallow
Cliff Swallow
Barn Swallow
Black-capped Chickadee
Mountain Chickadee
House Wren
+Marsh Wren
Western Bluebird
Mountain Bluebird
+Veery
American Robin
+Gray Catbird
European Starling
+Cedar Waxwing
Nashville Warbler
+Yellow Warbler
American Redstart
MacGillivray's Warbler
+Common Yellowthroat
Wilson's Warbler
+Yellow-breasted Chat
Western Tanager
+Black-headed Grosbeak
Lazuli Bunting
Spotted Towhee
Chipping Sparrow
Savannah Sparrow
+Song Sparrow
Lincoln's Sparrow
White-crowned Sparrow
Dark-eyed Junco
+Bobolink
+Red-winged Blackbird
+Yellow-headed Blackbird
Brewer's Blackbird
Brown-headed Cowbird
Bullock's Oriole
Cassin's Finch
House Finch
Red Crossbill
Pine Siskin
American Goldfinch
Evening Grosbeak