PROPOSED

Species at Risk Act
Management Plan Series
Adopted under Section 69 of SARA

Management Plan for the Mountain Beaver (*Aplodontia rufa*) in Canada

Mountain Beaver

2014

Canada

Recommended citation:

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For copies of the management plan or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry (www.sararegistry.gc.ca).

Cover illustration: Jarred Hobbs

Également disponible en français sous le titre
« Plan de gestion du castor de montagne (*Aplodontia rufa*) au Canada [Proposed] »

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MANAGEMENT PLAN FOR THE MOUNTAIN BEAVER (*Aplodontia rufa*) IN CANADA

2014

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the "Management Plan for the Mountain Beaver (*Aplodontia rufa*) in British Columbia" (Part 2) under section 69 of the *Species at Risk Act.* Environment Canada has included an addition which completes the SARA requirements for this management plan.

The federal management plan for the Mountain Beaver (*Aplodontia rufa*) in Canada consists of two parts:

Part 1 - Federal Addition to the "Management Plan for the Mountain Beaver (*Aplodontia rufa*) in British Columbia", prepared by Environment Canada.

Part 2 - "Management Plan for the Mountain Beaver (*Aplodontia rufa*) in British Columbia", prepared by the B.C. Ministry of Environment.

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Part 1 - Federal Addition to the “Management Plan for the Mountain Beaver (*Apoldontia rufa*) in British Columbia”, prepared by Environment Canada

PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed Special Concern species and are required to report on progress within five years.

SARA section 65 requires the competent Minister, which is the federal Minister of the Environment in this case, to prepare a management plan for all listed special concern species. SARA section 69 allows the Minister to adopt all or part of an existing plan for the species if the Minister is of the opinion that an existing plan relating to a wildlife species includes adequate measures for the conservation of the species.

The attached provincial management plan (Part 2 of this document) for the species was provided as science advice to the jurisdictions responsible for managing the species in British Columbia. Environment Canada has prepared this federal addition to meet the requirements of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this management plan and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Mountain Beaver and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

ADDITIONS AND MODIFICATIONS TO THE ADOPTED DOCUMENT

The following section has been included to address a specific requirement for federal recovery documents, which is not addressed in the "Management Plan for the Mountain Beaver (*Apoldontia rufa*) in British Columbia".

Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the plan itself, but are also summarized below.

Negative impacts to the environment and other species are not anticipated. Actions to conserve and manage Mountain Beaver (e.g., inventory, monitoring, population viability analysis, threat mitigation, habitat conservation, education) will promote the conservation of other species using those habitats, including SARA-listed species (e.g., Coastal Giant Salamander [*Dicamptodon tenebrosus*], Coastal Tailed Frog [*Ascaphus truei*], Tall Bugbane [*Actaea elata* var. *elata*]).

Part 2 - “Management Plan for the Mountain Beaver (*Apoldontia rufa*) in British Columbia”, prepared by the B.C. Ministry of Environment.

Management Plan for the Mountain Beaver (*Aplodontia rufa*) in British Columbia

Prepared by Ministry of Environment

BRITISH COLUMBIA | Ministry of Environment

February 2013

About the British Columbia Management Plan Series

This series presents the management plans that are prepared as advice to the Province of British Columbia. Management plans are prepared in accordance with the priorities and management actions assigned under the British Columbia Conservation Framework. The Province prepares management plans for species that may be at risk of becoming endangered or threatened due to sensitivity to human activities or natural events, or species where management is required to meet population targets for ecosystem management, human uses, or ecological services.

What is a management plan?

A management plan identifies a set of coordinated conservation activities and land use measures needed to ensure, at a minimum, that the target species does not become threatened or endangered or is being managed for use, ecosystem goals, or ecological services. A management plan summarizes the best available science-based information on biology and threats to inform the development of a management framework. Management plans set goals and objectives, and recommend approaches appropriate for species or ecosystem conservation.

What's next?

Direction set in the management plan provides valuable information on threats and direction on conservation measures that may be used by individuals, communities, land users, conservationists, academics, and governments interested in species and ecosystem conservation.

For more information

To learn more about species at risk recovery planning in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

Management Plan for the Mountain Beaver (*Aplodontia rufa*) in British Columbia

Prepared by the Ministry of Environment

February 2013

Recommended citation

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Cover illustration/photograph

Jared Hobbs

Additional copies

Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Disclaimer

This management plan has been prepared by the B.C. Ministry of Environment, as advice to the responsible jurisdictions and organizations that may be involved in managing the species.

This document identifies the management actions that are deemed necessary, based on the best available scientific and traditional information, to prevent Mountain Beaver populations in British Columbia from becoming endangered or threatened. Management actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and management approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this management plan. The B.C. Ministry of Environment encourages all British Columbians to participate in the conservation of Mountain Beaver.

ACKNOWLEDGEMENTS

Les Gyug (Okanagan Wildlife Consulting) wrote/completed this document under contract to the BC Conservation Foundation with funding from Ministry of Environment. Leah Westereng (B.C. Ministry of Environment) formatted this document and provided technical review. Doug Ransome (BC Institute of Technology), graciously provided access to his unpublished data and observations on Mountain Beaver. This document follows the B.C. guidance for recovery planning (Ministry of Environment 2010a).

An earlier version of this document was funded by the Okanagan College (OC) in 2005, which was written by Les Gyug. Howie Richardson (OC) and Bryn White (OC) oversaw the administration of these funds. Revisions and input were provided by Orville Dyer (B.C. Ministry of Forests, Lands and Natural Resource Operations).

EXECUTIVE SUMMARY

The Mountain Beaver (*Aplodontia rufa*) is a semi-fossorial rodent limited in range to the Pacific Northwest states and British Columbia (B.C.). It was designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) because its range has decreased following habitat destruction through forestry and urbanization. It is listed as Special Concern in Canada on Schedule 1 of the *Species at Risk Act* (SARA). Based on recent genetic analyses the two previously recognized subspecies (*A. rufa rufa and A. rufa rainieri*) have been combined into one northern subspecies (*A. rufa olympica*). Mountain Beaver is ranked S3 (special concern) by the Conservation Data Centre and is on the provincial Blue list. The B.C. Conservation Framework ranks the Mountain Beaver as a priority 1 or 2[1] under goal 2 (prevent species and ecosystems from becoming at risk).

About 5% of the global range of this species occurs in the southwestern corner of B.C., which is the only Canadian province in which it is found. The extent of occurrence (minimum convex polygon encompassing known locations) in British Columbian is currently (2012) estimated at 12,990 km^2, but within that range the occupied area is estimated at 8123 km^2. The current population exists in five subpopulations. The main subpopulation ranges over 7881 km^2 and extends from the Fraser Valley to the interior. In addition there are four subpopulations isolated from the main population by unsuitable habitat: two subpopulations in the lower Fraser valley, Sumas Mountain (65 km^2) and Chilliwack Mountain (5 km^2); and two subpopulations on the east side of the range, Mount Pike (129 km^2) and Missezula Mountain (43 km^2).

Threats to this species are habitat destruction through soil compaction and disturbance by heavy machinery during forestry activities and urbanization (including road building) for locations in the lower Fraser Valley.

The management goal is to maintain the current distribution of all subpopulations in B.C., and to maintain or improve the current abundance of each Mountain Beaver subpopulation in B.C.

The following are the management objectives:

1. To protect[2] and/or maintain Mountain Beaver habitat within its occupied range.
2. To assess and mitigate the impacts of ongoing threats, particularly timber harvest/silviculture, and residential urban development and road building.
3. To address identified key knowledge gaps for Mountain Beaver including population abundance, locations of suitable habitat, and population viability.

[1] Priorities for *A. rufa rainieri* and *A. rufa rufa*, respectively, assigned when there were thought to be two subspecies.

[2] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: May 2012
Common Name (population): Mountain Beaver
Scientific Name: *Aplodontia rufa*
COSEWIC Status: Special Concern
Reason for Designation: The range of this species in Canada has contracted by 29% in the last 50 years and expansion into new habitat is constrained by large rivers. Within its range, habitat loss from urban development continues, and soil compaction caused by heavy machinery limits the use of otherwise suitable habitat. Climate change may further affect this species because it requires humid microclimates and low ambient temperatures. Rescue effect potential is limited by the short dispersal rates of the species and areas of unsuitable habitat along the border with the United States.
Canadian Occurrence: BC
COSEWIC Status History: Designated Not at Risk in April 1984. Status re-examined and designated Special Concern in April 1999. Status re-examined and confirmed in November 2001 and May 2012.

* Committee on the Status of Endangered Wildlife in Canada.

2 SPECIES STATUS INFORMATION

Mountain Beaver[a]		
Legal Designation:		
Identified Wildlife:[b] No	*B.C. Wildlife Act:*[c] Schedule A	SARA Schedule: 1– SC (2003)
Conservation Status[d]		
B.C. List: Blue	B.C. Subnational Rank: S3 (2006)	National Rank: N3 (2011) Global Rank: G5T4 (1996)
B.C. Conservation Framework (CF)[f]		
		Subspecies[g]: *rufa / rainieri*
Goal 1: Contribute to global efforts for species and ecosystem conservation.		Priority:[h] 4 / 5 (2010)
Goal 2: Prevent species and ecosystems from becoming at risk.		Priority: 1 / 2 (2010)
Goal 3: Maintain the diversity of native species and ecosystems.		Priority: 2 / 3 (2010)

[a] Data source: B.C. Conservation Data Centre (2012) unless otherwise noted.
[b] Identified Wildlife under the *Forest and Range Practices Act*, which includes the categories of species at risk, ungulates, and regionally important wildlife (Province of British Columbia 2002).
[c] Schedule A = designated as wildlife under the B.C. *Wildlife Act*, which offers it protection from direct persecution and mortality (Province of British Columbia 1982).
[d] S = subnational; N = national; G = global; T = refers to the subspecies level; B = breeding; X = presumed extirpated; H = possibly extirpated; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable.
[e] Data source: NatureServe (2011).
[f] Data source: Ministry of Environment (2010b).
[g] Recent information indicates that there is only one subspecies in B.C. See Section 3.1
[h] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority). Note that conservation framework has not been updated to reflect that there is only likely one subspecies in B.C.

3 SPECIES INFORMATION

3.1 Species Description

The Mountain Beaver (*Aplodontia rufa*) is a small- to medium-sized, forest-dwelling rodent. This semi-fossorial rodent is the only living member of its family, Aplodontidae, and is also the most primitive living rodent (Hall 1981). There were seven recognized subspecies (Hall 1981), two of which occurred in British Columbia (B.C.): *A. rufa rufa* south of the Fraser River from Hope to Langley, and *A. rufa rainieri* east of Hope with overlap in the Cascade Mountain foothills (Nagorsen 2005). However, the differences used to characterize the two subspecies were "feebly marked" and based mostly on size (Taylor 1918; Dalquest and Scheffer 1945). There have been recent genetic analyses of *Aplodontia* including specimens from B.C. indicating there is only one subspecies in B.C.[3] (proposed as *A. rufa olympica*), and this is the only subspecies north of the Columbia River (Piaggio *et al.* 2009, Piaggio *et al.* 2012).

3.2 Populations and Distribution

3.2.1 Distribution

Global range

Currently, Mountain Beavers are only found within and to the west of the Cascade and Sierra Nevada mountain ranges of western North America, from central California north to near Merritt in B.C. (Hall 1981; Gyug 2000). The total estimated size of the Mountain Beaver range is about 200,000 km2 (IUCN 2010).

B.C. (Canadian) range

In Canada, the Mountain Beaver occurs only in B.C. with the mainland of southwestern B.C. as the northern limit of its range (Cowan and Guiguet 1965). It occurs from Abbotsford in the lower Fraser Valley south of the Fraser River, eastwards to the Princeton and Hedley areas and northwards to the Lytton and Merritt areas (Gyug 2000, 2001; Ransome 2003). The current extent of occurrence in Canada was estimated at 12,120 km2 in 2012 (Figure 1) (COSEWIC 2012). Approximately 1600 recently occupied den locations are known with GPS locations (Figure 1).

The current population exists in five subpopulations that are assumed to be separated genetically by unsuitable habitat. There is a main subpopulation of 7881 km^2 that extends from the Fraser Valley to the interior; two subpopulations in the lower Fraser valley isolated by unsuitable habitat converted to agriculture or urban/suburban development, Sumas Mountain (65 km^2) and Chilliwack Mountain (5 km^2); and two subpopulations on the east side of the range isolated by unsuitable dry and hot valleys, Mount Pike (129 km^2) and Missezula Mountain (43 km^2).

[3] As such, information and management recommendations in this document apply to all Mountain Beavers found in B.C.

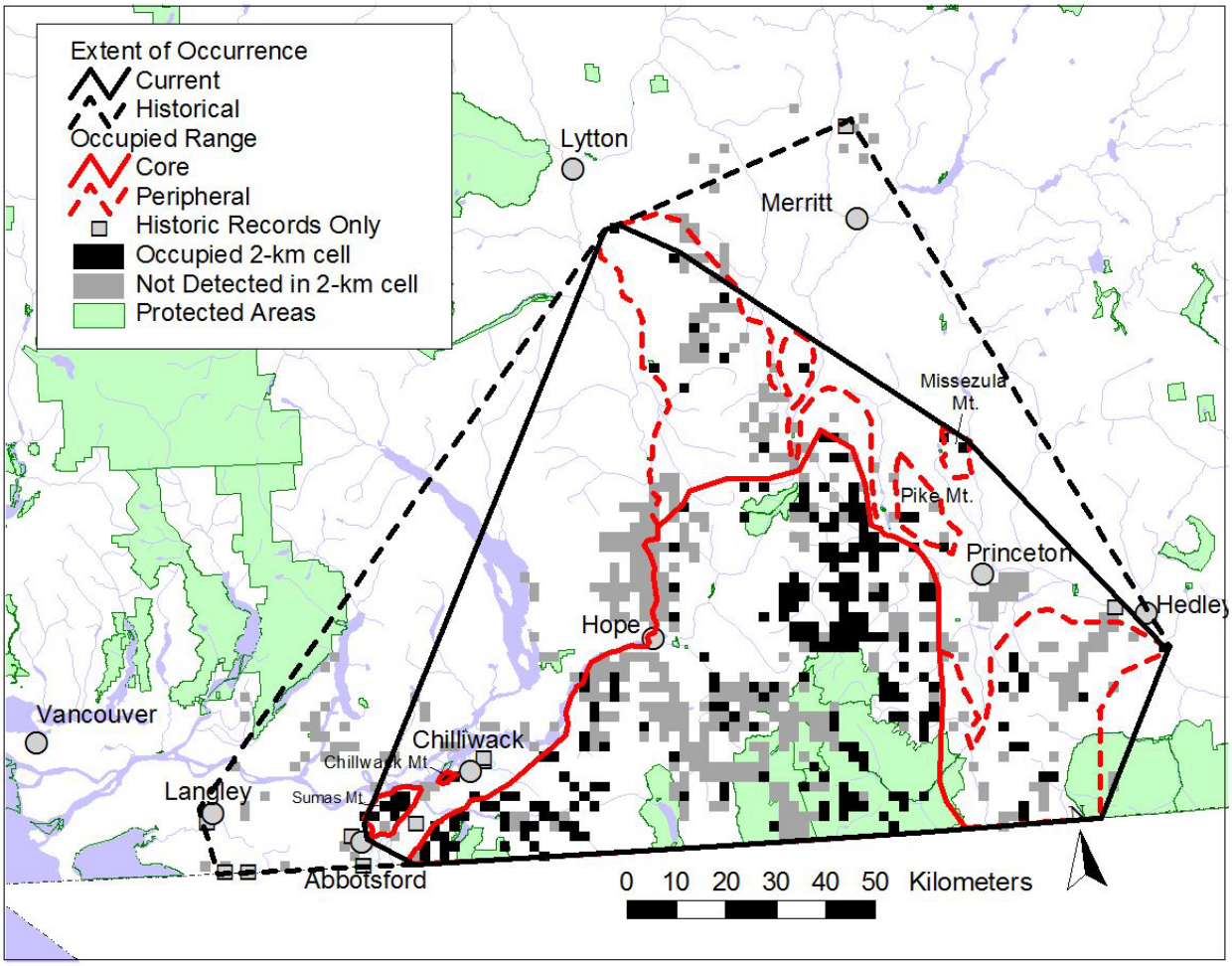

Figure 1. Mountain Beaver extent of occurrence and occupied range in B.C. showing historic records and all recently known locations summarized into location by 2 × 2 km cells.
Map has been updated since COSEWIC (2012) to include the recently discovered location southeast of Hedley.

The area occupied by Mountain Beavers (Figure 1) was separated into two areas of different relative density: the core range and the peripheral range. Within the core range, it was relatively commonly encountered and within the peripheral ranges was relatively infrequently encountered. Within the core range, multiple active dens (usually >5), would be typically found in a single day search of 1-2 km^2 of apparently suitable habitat. Within the peripheral range, a single day of searching of 1-2 km^2 of apparently suitable habitat would find no active dens, 1-2 active dens, or a small group of <5 in only one small site.

Since population numbers were unknown and the proportion of the population could not be assigned to different types of land tenure, the areas occupied were used as a surrogate after adjusting for the relative density (core/peripheral) (Table 1). The largest portion of the occupied range (80%) is on Provincial Crown Forest, with the next largest portion (17%) in provincial protected areas including both provincial parks and ecological reserves. Only 2.3% of the entire occupied range is on private lands and 0.2% on First Nations reserves.

Table 1. The area of occupied Mountain Beaver range in B.C. as of 2012 by Ministry of Environment regions[a], land tenure and relative density (core or peripheral); see Figure 1).

Land tenure	Core range		Peripheral range	
	Area (km^2)	% of total range	Area (km^2)	% of total range
Lower Mainland[a] Total[b]	**3926**	**48**		
Lower Mainland Subtotals	**3813**	**47**	**112**	**1**
Provincial Crown Forest	2488	31	64	<1
Provincial Protected Areas[c]	1145	14	47	<1
Private	148	2	0.5	<0.1
First Nations Reserve	12	<1	1.0	<0.1
Crown - Federal	20	<1	0	0
Provincial Crown Licence of Occupation	0.9	<0.1	0.1	<0.1
Thompson-Nicola[a] Total	**1476**	**18**		
Thompson-Nicola Subtotals	**118**	**1**	**1359**	**17**
Provincial Crown Forest	117	1	1355	17
Provincial Protected Areas[c]	0.3	<0.1	1	<0.1
Private	0.1	<0.1	1	<0.1
First Nations Reserve	0	0	1	<0.1
Crown - Federal	0	0	0	0
Provincial Crown Licence of Occupation	1	<0.1	1	<0.1
Okanagan[a] Total	**2718**	**34**		
Okanagan Subtotals	**1257**	**11**	**1461**	**18**
Provincial Crown Forest	1115	9	1336	16
Provincial Protected Areas[c]	130	1	93	1
Private	12	<1	23	<1
First Nations Reserve	0	0	3	<0.1
Crown - Federal	0	0	0	0
Provincial Crown Licence of Occupation	0.2	<0.1	6	<0.1
Occupied Range Subtotals	**5188**	**57**	**2932**	**43**
Occupied Range Grand Total	**8120**	**100**		

[a] This corresponds with the Ministry of Environment regions. See map at http://www.env.gov.bc.ca/main/regions.html.
[b] The total includes both the area of the core and peripheral range of Mountain Beaver.
[c] Includes provincial parks and ecological reserves.

Percent of global distribution in B.C. (Canada)

The percentage of the global distribution that occurs in B.C. is estimated to be about 6% (i.e., 12,990 km^2 of 200,600 km^2).

3.2.2 Distribution Trend

The distribution of Mountain Beaver is not known to be increasing anywhere. The Fraser River forms the northern range boundary east of the Cascade Mountains despite an abundance of apparently suitable habitat north of the Fraser River. Eastward distribution is limited by dry habitats that are unsuitable for Mountain Beaver. The range boundaries in California for two of

the seven subspecies appear to be decreasing with the isolated Point Reyes subspecies losing 60% of its remaining populations in one fire in 1995 (Collins 1995) and the isolated Point Arena subspecies listed as endangered (U.S. Fish and Wildlife Service 1991).

The distribution of Mountain Beavers in the lower Fraser Valley is diminishing. The extent of occurrence of the B.C. range was 17,149 km^2 in the 1960s prior to habitat losses (COSEWIC 2012) but was estimated at 12,990 km^2 in 2012 (Figure 1). This loss of habitat, first from agriculture and then due to urban development, along with major highways, has effectively completely isolated subpopulations on Chilliwack and Sumas mountains by 6–7 km from the main population (Figure 2). There are no known trends for the other two isolated subpopulations at the eastern side of the range at Mount Pike and Missezula Mountain (Figure 1).

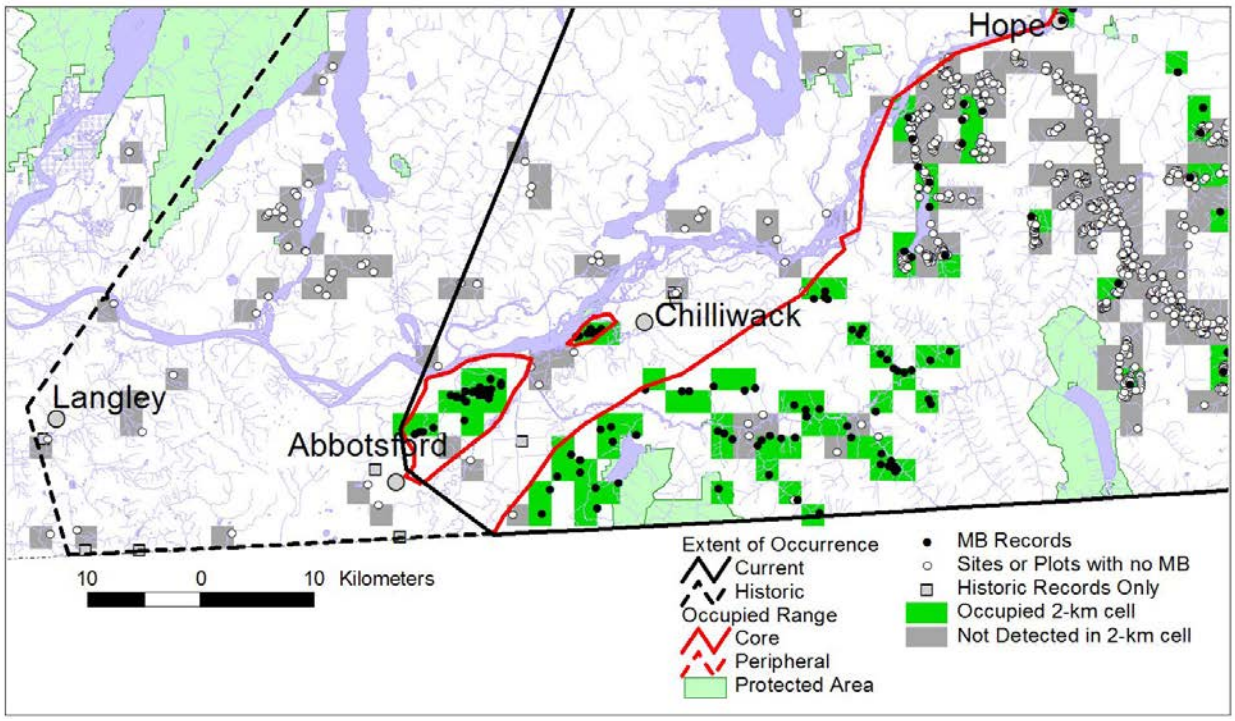

Figure 2. Mountain Beaver (MB) occurrence records and sites or plots where it was not detected in the lower Fraser valley up to 2010. The two smaller occupied core ranges indicate the isolated subpopulations on Chilliwack and Sumas Mountains.

There is one museum specimen from Langley but the Langley location has been unoccupied for at least 10 years (A. Harestad, pers. comm. to D. Ransome, 2003). As of 2010 (COSEWIC 2012) the furthest west that the species was routinely found was Abbotsford, 32 km east of Langley (Gyug 2000; Ransome 2003). Ransome (2003) did find one animal in the unoccupied area near Aldergrove 26 km west of Abbotsford, but it was live trapped < 250 m north of the U.S. border, and was seen departing in the direction of the border. No sign was found there indicating a resident population, so it was assumed that this animal was resident in the U.S. and not in Canada.

Two of the outermost records of Mountain Beavers on the east side of the B.C. range are from museum specimens in areas that appeared to be currently unoccupied (isolated sites north of Merritt and near Hedley in Figure 1) (Gyug 2000; Gyug, pers. observation, 2000, 2001, and 2003). However, recent information (A. Rupp, pers. comm., July 2012) indicated that there was a location occupied for only the past two years (and not occupied in the 40–50 years prior to that based on the informant's personal experience) in the Similkameen valley bottom near Bradshaw Creek that was not considered occupied in COSEWIC (2012). This extends the extent of occurrence 7.5 km southeast of Hedley (Figure 1).

3.2.3 Population Abundance

Global abundance

There is no published estimate of the total abundance of Mountain Beavers in their global range. However, NatureServe (2011) lists the species as G5, globally widespread, abundant and secure, and the two subspecies found in B.C. as G4, apparently secure.

B.C. (Canadian) abundance

No range-wide population survey has been completed. The B.C. population is estimated at > 10,000 individuals based on extrapolation of limited census data in relation to available ecosystem and habitat mapping (Gyug 1999, 2000, 2001, 2005; Ransome 2003).

Percent of global abundance in B.C. (Canada)

The percent of global abundance in B.C. is unknown as there is no global population estimate. However, based on the percentage of the global range in B.C., it is estimated to be about 5%.

3.2.4 Population Trend

The only historical evidence of a decline for any Canadian population of Mountain Beavers is in the lower Fraser Valley near Chilliwack and Abbotsford as documented by Gyug (2000) and confirmed by Ransome (2003). There are 43 museum specimens from about 10 different locations (not all specimens had reasonably accurate location information) in areas that are no longer occupied by Mountain Beaver in the lower Fraser Valley (Gyug 2000).

Mountain Beaver may also be declining in numbers on the forested low hills in and around the lower Fraser Valley where land is being subdivided and developed (Gyug 2000). Mountain Beavers no longer occur on Mount Shannon (an isolated hill in the Fraser Valley lowlands at Chilliwack), and very few individuals appear to still live in the Mount Tom and Ryder Lake area in the foothills south of Chilliwack where populations once were thriving. Populations still exist on Sumas Mountain and Chilliwack Mountain (Ransome 2003); however, these subpopulations are on isolated hills rising in the Fraser Valley lowlands at Abbotsford and Chilliwack. The nearest part of the contiguous Mountain Beaver population is at least 6 km away to the south on Vedder Mountain in the Fraser Valley foothills.

It is assumed that throughout the main subpopulation numbers are generally stable in the absence of any major habitat alterations. Within the main subpopulation accurate locations of occupied sites has only been available recently. Therefore, it is not possible to make an accurate assessment of population trends outside of the Fraser Valley lowlands.

3.3 Needs of the Mountain Beaver

3.3.1 Habitat and Biological Needs

The 2012 COSEWIC status report has described the habitat and biological needs of Mountain Beavers as follows:

Mountain Beavers need soils that allow tunnel, runway, and burrow construction; a cool and moist microclimate within tunnels and burrows; and suitable food within 50 m of the den (Martin 1971; Carraway and Verts 1993). Subsurface drainage that keeps most tunnels and burrows wet, even to the point of having water trickling through them, appears ideal (Beier 1989; Carraway and Verts 1993; Gyug 2000). While runways and tunnels may be quite wet, underground den sites must still be dry and above the water table. Deep soils appear to be a prerequisite to establish dens and tunnel systems (Camp 1918).

Mountain Beavers occur in forests of any age but appear to prefer early to mid-seral stages where herbaceous food is abundant (Neal and Borrecco 1981; Carraway and Verts 1993). An important feature is the presence of permanent openings associated with streams and seepage zones (Gyug 2000). In forested portions of the lower Fraser Valley, Mountain Beavers commonly occur at sites ranging in age from recent clearcuts to 15-year-old sites with either moist seepage sites or areas dominated by lush vegetation (Ransome, unpubl. data). Coastal populations may attain peak densities in areas of early- to mid-seral stages vegetated by young (i.e., 20 year old) second-growth trees, shrubs, and forbs (Scheffer 1929; Dice 1932; Svihla and Svihla 1933; Hooven 1973, 1977).

In the eastern Cascades, the highest densities of Mountain Beaver are in seepage areas of upper elevation coniferous forests dominated by Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and amabilis fir (*Abies amabilis*) (Gyug 2000). These sites were fine-grained mosaics of sub-hygric to hygric forest interspersed with small meadows where the water table was either at, or close to, the surface. Most foraging appeared to take place in wet meadows, which were criss-crossed with runways; dens were usually found under tree root masses within adjacent forests.

Dens were located immediately adjacent to seepage areas on lower slopes or alluvial fans where parent materials originated from moraines, but not in valleys of large streams or rivers with well-developed gravel or cobble floodplains dominated by coarse glacio-fluvial parent materials (e.g., the Skagit Valley of B.C.) (Gyug 2000, 2005). Mountain Beavers tend to occur on smaller streams at higher elevations rather than in more flood-prone, higher-order, lower-elevation streams (Beier 1989; Gyug 2000). Dens have been found at elevations from sea level to 1925 m (Gyug 2000; Ransome, unpubl. data), and on slopes up to 73% (Gyug 2000).

3.3.2 Ecological Role

The Mountain Beaver's high annual losses of 40% to predation (Arjo *et al.* 2007) indicates that it is a small- to medium-sized herbivore at the base of the food chain for a number of direct predators including raptors, mustelids, bobcats, and coyotes (Carraway and Verts 1993; Arjo *et al.* 2007).

The Mountain Beaver has a function in soil-mixing, decompacting, and aeration similar to pocket gophers and other ground-dwelling sciurids. These other fossorial or semi-fossorial rodents use drier areas while Mountain Beavers are the only ones routinely found in wet and moist sites.

Mountain Beaver burrows and tunnels are frequently co-opted by Red Squirrels (*Tamiasciurus hudsonicus*) or Douglas's Squirrels (*T. douglasii*) for use as ground denning sites and for cone caches (Gyug, pers. observations). Other small rodents probably make use of unoccupied Mountain Beaver burrows and dens as well.

Mountain Beavers have four species of fleas for which they are the specific host species, and these fleas are virtually never found on other hosts (Lewis 1994; Lewis and Lewis 1994). This group includes the largest flea and one of the most primitive flea species known.

3.3.3 Limiting Factors

The Mountain Beaver is acknowledged as the most primitive living rodent. It is the only living species of the formerly recognized suborder of rodents Protogomorpha, the group to which the earliest known rodents belonged (Hall 1981). The Mountain Beaver is now considered part of the squirrel suborder Sciuromorpha but has maintained its position as first in the taxonomic list, i.e., considered most primitive, member of the Sciuromorpha (Wilson and Reeder 2005). Mountain Beavers have a very primitive renal anatomy that cannot produce concentrated urine and therefore they must consume large amounts of water, either directly or in their food. This limits them to living in areas with a cool and humid microclimate (Carraway and Verts 1993) as does their poor thermoregulatory capabilities with hyperthermia reported at ambient temperatures of 29°C (Johnson 1971).

Mountain Beaver have low reproductive potential compared to many rodents, having an average of only 2.5 young per year (Carraway and Verts 1993). They also appear to have relatively poor dispersal capabilities. Juvenile Mountain Beavers disperse from the birth den at the end of the first summer to establish their own den sites since adults live solitary lives. They may establish in unoccupied dens or excavate new dens. Only two studies have examined juvenile dispersal with dispersal movements of 400 m recorded for one subadult male, and 570 m for one subadult female (Martin 1971), and average dispersal distance of 148 m (n = 7, maximum 326 m; Arjo *et al.* 2007). Dispersal across major rivers appears to be very limited as the Fraser forms the northern limits of the species and the Columbia forms subspecies boundaries.

4 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (globe, nation, or subnation). For purposes of threat assessment, only present and future threats are considered[4]. Threats presented here do not include biological features of the species or population such as inbreeding depression, small population size, and genetic isolation; or likelihood of regeneration or recolonization for ecosystems, which are considered limiting factors.[5]

For the most part, threats are related to human activities, but they can be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., invasive species introduction). Effects of natural phenomena (e.g., fire, hurricane, flooding) may be especially important when the species or ecosystem is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al.* 2009). As such, natural phenomena are included in the definition of a threat, though should be applied cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its resilience, and is thus vulnerable to the disturbance (Salafsky *et al.* 2008) so that this type of event would have a disproportionately large effect on the population/ecosystem compared to the effect they would have had historically.

[4] Past threats may be recorded but are not used in the calculation of Threat Impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2009).

[5] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts.

4.1 Threat Assessment

The threat classification below is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system and is consistent with methods used by the B.C. Conservation Data Centre and the B.C. Conservation Framework. For a detailed description of the threat classification system, see the CMP website (CMP 2010). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat "impact" is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2009) and table footnotes for details. Threats for the Mountain Beaver were assessed for the entire province (Table 2).

Table 2. Threat classification table for Mountain Beaver.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
1	Residential & commercial development	Low	Small	Serious	High
1.1	Housing & urban areas	Low	Small	Serious	High
1.2	Commercial & industrial areas	Negligible	Negligible	Serious	Low
2	Agriculture & aquaculture	Not Calculated	Not Scored	Not Scored	Negligible (past threat)
2.1	Annual & perennial non-timber crops	Not Calculated	Not Scored	Not Scored	Negligible (past threat)
3	Energy production & mining	Low	Small	Moderate	Moderate
3.2	Mining & quarrying	Low	Small	Moderate	Moderate
3.3	Renewable energy	Negligible	Negligible	Moderate	Low
4	Transportation & service corridors	Low	Small	Serious	High
4.1	Roads & railroads	Low	Small	Serious	High
4.2	Utility & service lines	Low	Small	Slight	High
5	Biological resource use	Medium	Restricted	Serious	High
5.3	Logging & wood harvesting	Medium	Restricted	Serious	High
7	Natural system modifications	Negligible	Negligible	Slight	High
7.1	Fire & fire suppression	Negligible	Negligible	Slight	High
10	Geological events	Negligible	Negligible	Slight	Low

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
10.3	Avalanches/landslides	Negligible	Negligible	Slight	Low
11	Climate change & severe weather	Negligible	Negligible	Slight	Low
11.1	Habitat shifting & alteration	Negligible	Negligible	Slight	Low
11.2	Droughts	Negligible	Negligible	Slight	Low
11.3	Temperature extremes	Negligible	Negligible	Slight	Low

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.
[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).
[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit $\underline{>}$ 0%).
[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

The overall province-wide Threat Impact for this species is High.[6] The overall threat considers the cumulative impacts of multiple threats. The current primary threat is habitat destruction through soil compaction and disturbance by heavy machinery during forestry activities, followed by urbanization and road building for locations in the lower Fraser Valley, and the potential for the opening/reopening of mines within the occupied range in the near future (Table 2). Details are discussed below under the Threat Level 1 headings.

IUCN-CMP Threat 1. Residential and commercial development

In the lower elevations of the Fraser River valley, habitat loss through urbanization and agriculture (see Threat #2) is probably the major cause of downward trends in Mountain Beaver populations. Areas that they previously occupied on the valley floor of the lower Fraser Valley now appear to be devoid of Mountain Beavers. In the Chilliwack and Abbotsford areas of the lower Fraser Valley, suburban development is now focusing on private land holdings in the foothill areas because valley bottom areas are already highly developed, are very expensive closer to Vancouver, or have been placed in B.C.'s Agricultural Land Reserve. Suburban development is also occurring in other areas occupied by Mountain Beaver in the Lower Fraser valley such as near Hope. Commercial and industrial developments do not target the foothill areas where Mountain Beavers remain in the lower Fraser Valley and therefore are not considered a current threat to Mountain Beaver habitat.

The greatest impacts of development are likely to be on the isolated subpopulations on Sumas and Chilliwack Mountains with areas of 65 km^2 and 5 km^2, respectively. About 50% of Sumas Mountain and 80% of Chilliwack Mountain are in private land holdings and part of future development lands. In these areas, population viability is a concern as population size is unknown but likely small, and any rescue effect by immigration is unlikely because of isolation from the nearest source population by 6–7 km.

Threats that may result in direct habitat loss, and the reduction of habitat suitability related to development include (1) fragmentation including disruption of migration corridors by roads, (2) the interruption of groundwater flows by buildings and roads drying out areas that were previously suitable, (3) increased runoff from impervious areas inundating sites that were previously only moist, (4) the modification of natural plant communities and introduction of non-palatable or invasive plants and weeds during development, and (5) the increasing harassment and predation by human pets or other carnivores now closely associated with human settlement such as coyotes. It is not certain if Mountain Beaver populations can successfully persist in the midst of urban/suburban development. The largest effect is likely to be from direct habitat loss to development with the other factors contributing much more indirectly or less significantly to habitat unsuitability.

[6] The overall threat impact was calculated following Master *et al.* (2009) using the number of Level 1 Threats assigned to this species where Timing = High or Moderate. This includes 0 Very High, 0 High, 1 Medium, 3 Low, and 0 Unknown (Table 2).

About 2.3% of the Mountain Beaver occupied range in Canada is in private land holdings, and approximately 100 km^2 of potential Mountain Beaver habitat is zoned for future development in the City of Abbotsford (2005), in the City of Chilliwack (1996, 2007), and in Electoral Area "G" of the Fraser Valley Regional District (2008). Given that these areas are often higher quality habitat than steeper slopes or mountains, they may contain a disproportionately higher amount of the actual population. However, the maximum effect of development of all of these lands is still unlikely to affect more than 5% of B.C.'s Mountain Beaver population.

IUCN-CMP Threat 2. Agriculture and aquaculture

Virtually all the Mountain Beaver habitat (~ 700 km^2 of Mountain Beaver former range; Gyug 2000) on the floor of the lower Fraser Valley has already been lost to agriculture including the draining of Sumas Lake. It is assumed that most of this area would have been occupied before agricultural development but after agricultural development only very small pockets of occupied habitat remained. As the potential agricultural land base has been almost completely put into agricultural uses, this is a past impact and no further impacts are expected over the next 10 years.

IUCN-CMP Threat 3. Energy production and mining

Within the footprints of open pit mines, expected impacts due to direct mortality and habitat loss would be severe. At underground mines the impacts would not be as severe as the footprints would be expected to be smaller. Long-term impacts need not be severe as long as sites are rehabilitated. For example, Mountain Beavers have reoccupied old mine excavations and operating sites at Treasure Mountain wherever these have been taken over by alder but they have not reoccupied highly altered open pits and spoil piles that have not revegetated (Gyug, pers. observations).

There are very few mines within the range of Mountain Beavers in B.C. The mine at Treasure Mountain is scheduled to be re-opened but with a very limited footprint as much of the mine will be underground. A magnetite mine may be planned at Olivine Mountain in an area known to be occupied by Mountain Beavers. There is an open pit coal mine near Coalmont/Granite Creek that is less than 10 years old, which now appears abandoned and has not been rehabilitated. Although Mountain Beavers formerly occurred in that general area, it is not known whether there were occupied sites at the actual mine site prior to the opening of the mine.

Possible run-of-river electrical generation on streams or in areas occupied by Mountain Beaver would be expected to affect Mountain Beaver habitat only in the small areas affected by the operational footprint, i.e., plant, or along associated transmission corridors. Removing or altering stream flows is likely to have little effect on Mountain Beavers as ground water and very small streams appear to be more important habitat determinants than the larger streams or rivers that would normally be used for run-of-river power generation.

IUCN-CMP Threat 4. Transportation and service corridors

Either permanent or temporary resource road construction can cause direct mortality and long-term habitat loss. The cumulative amount of this loss is unknown although the scope would be expected to be small in the next 10 years, or in any 10-year period. Mountain Beaver activity has been observed in resource road banks so habitat loss from unpaved resource roads may only be limited to the traveled surface, and direct mortality would be expected to be very small as these roads receive very little night-time use when Mountain Beavers are most active.

New permanent paved roads in Mountain Beaver habitat will primarily be in areas opened up to suburban development. These result in direct habitat loss as well as a reduction in habitat suitability by fragmentation, which disrupts migration corridors. The entrainment of water flows into culverts and ditches may also disrupt habitat suitability even without any direct development within the habitat. Within the range of Mountain Beavers these impacts are expected to be limited to newly developed areas near Abbotsford, Chilliwack, and Hope.

A number of service corridors from the interior to the Lower Mainland cut through the range of Mountain Beavers in the Cascades including oil and gas pipelines and major power transmission lines. The amount of habitat loss due to existing corridors is unknown but probably minor. Another 500 kV transmission line, the Interior-Lower Mainland (ILM) is currently being built (2012–2015). There is the possibility of habitat disruption and loss during right-of-way vegetation clearing and during tower and road construction, although environmental management plans in place seek to minimize those disruptions or habitat loss. Overall the long-term effects of this new corridor are expected to be very limited in area, i.e. to the tower sites alone, and to have little to no impact on Mountain Beavers.

IUCN-CMP Threat 5. Biological resource use (5.3 Logging and Wood Harvesting)

About 80% of the Mountain Beaver range in B.C. is within provincial forest lands. Clearcutting with heavy machinery is now the primary method of timber harvest within the range of Mountain Beavers in B.C. replacing older hand-falling methods. While Mountain Beavers can be very abundant in the dense shrub and herbaceous growth that sometimes follows clearcutting, this population abundance may be limited by the effect of machinery compaction on soils. Gyug (2000) documented Mountain Beaver densities 85–95% lower on clearcut sites where heavy machinery had compacted and disturbed soils. The primary effect is soil compaction of sites by heavy machinery that kills Mountain Beavers within their dens and creates long-term loss of dens because the sites are too compacted to be re-excavated when Mountain Beavers may attempt to recolonize. Other effects include changes in soil moisture regimes as sites are purposely dried out by ditching or mounding so that conifers can be planted. There is also possible additional exposure to predators and heat through removal of overhead shrub and tree cover.

Since 2000, the riparian guidelines of the *Forest and Range Practices Act* have established at least 5-m no-machine buffers on all streams, but only about 20% of Mountain Beaver dens are found within 5 m of streams (Gyug, unpubl. data), leaving 80% of the population still vulnerable to soil disturbance and compaction. Voluntary guidelines have been developed (Gyug 2001; Gyug and Ransome 2011) that would mitigate impacts to active Mountain Beaver sites by

establishing no-machine zones around active dens and activity areas during timber harvesting and site preparation.

These guidelines were assessed using pre- and post-harvest densities and occupancy rates east of the Cascades crest by Gyug and Ransome (2011). Density decreased 1 year post-harvest but then was not significantly different from pre-harvest levels 8–13 years later, indicating that these guidelines can successfully mitigate machinery and disturbance impacts on Mountain Beavers in clearcuts. However, usually because of oversight, 30% of dens known from prior to timber harvest did have some level of disturbance or compaction. The post-harvest occupancy rate of sites with severe soil disturbance (23%) was significantly lower than for other sites (71%). Severely disturbed sites were sometimes used, but most often only for short periods as the habitat suitability was probably quite low. Some 42% of severely disturbed sites were used in either 2010 or 2011, but only 5% of severely disturbed sites were used in both 2010 and 2011 compared to 32% of mildly disturbed sites and to 45% of undisturbed sites.

Clearcutting may not have the same negative effects on Mountain Beaver in the low-elevation coastal forests of B.C. as they do on the east side of the Cascades crest Mountains. Mountain Beavers are relatively common in regenerating clearcuts in the Chilliwack Forest District (Cosco 1980; Gyug 2000; Ransome 2003). These low-elevation forest sites on the west side of the Cascade Mountains in B.C. may be more similar to low-elevation coastal forests of Washington and Oregon where Mountain Beavers seem to readily reoccupy sites after clearcutting (e.g., Hacker and Coblentz 1993). However, specific responses to soil disturbance and compaction have not been studied there. It is possible that soils are generally deeper, wetter, and more friable in coastal areas and therefore new den sites are more easily established after disturbances but this should be documented. Mountain Beaver densities may also be higher in coastal areas providing a larger pool of potential immigrants for vacated sites than on the dry east side of the Cascade Mountains but this has yet to be confirmed.

IUCN-CMP Threat 7. Natural system modifications (7.1 Fire and Fire Suppression)

Threats from fire suppression would impact long-term habitat use as canopies tend to close, limiting herbaceous forage growth and rendering sites less suitable. However, timber harvesting has largely replaced fires as an agent of forest change in resetting succession. As harvesting probably occurs at a similar overall rate in this ecosystem as fires did in the past, the resulting threat impact is negligible.

Fires may pose a short-term threat in that areas denuded of vegetation are not immediately suitable for occupancy even if animals do survive fires by going underground. Fellers *et al.* (2004) estimated < 2% of the original Mountain Beaver population of a 5000-ha burned area at Point Reyes remained after a wildfire in 1995 and even 5 years after. However, by 10 years post-fire numbers had increased to 52% of pre-fire numbers; as further successional changes took effect the prediction was that numbers would recover further (Fellers and Osbourn 2009). There is no indication that fire extent or severity in the range of Mountain Beavers in B.C. is changing from historical levels, so the overall threat impact is considered negligible.

IUCN-CMP 10. Geological events

Mountain Beavers sometimes den within snow avalanche paths in the Cascade Mountains (Gyug, unpubl. data). However, the threat posed by direct mortality when snow avalanches flow overtop the den and foraging sites is probably very small except during very large climax avalanches. Even then avalanches would only be a threat if the animals happened to be above ground at the time of the avalanche. Overall this threat was considered negligible.

IUCN-CMP 11. Climate change and severe weather

Mountain Beavers are likely sensitive to climate change because of their requirement for abundant free water, cool humid microclimates, and low ambient temperatures. Consensus climate projections for the Cascades in B.C. to 2080 are for eastward extension of the Coastal Western Hemlock zone largely eliminating the current Engelmann Spruce – Subalpine Fir and Montane Spruce biogeoclimatic zones in the eastern Cascade foothills along with upward expansion of the dry Interior Douglas-fir biogeoclimatic zone (Wang *et al*. 2012). If climates become warmer, individuals on the east side of the Cascades would be most affected as this is where their range is currently limited by aridity and high summer temperatures. For the Mountain Beaver subpopulations on Mount Pike and Missezula Mountain north of Princeton, local extirpation may occur because of climate change warming and very limited immigration potential because of isolation from other subpopulations. For example, an isolated site at similar elevation northwest of Merritt has been extirpated in the last 50 years.

So, although climate change is a concern, the threat to Mountain Beavers was assumed to be negligible over the next 10 years as the expected amount of climate change over the next 10 years is very small. These long-term projections indicate that high temperatures or drought are unlikely to affect the core range but that long-term effects on the peripheral range are expected and the peripheral range is likely to contract.

5 MANAGEMENT GOAL AND OBJECTIVES

5.1 Management Goal

The management goal is to maintain the current distribution of all subpopulations in B.C., and to maintain or improve the current abundance of each Mountain Beaver subpopulation in B.C.

5.2 Rationale for the Management Goal

This management goal is set to, at a minimum, prevent the Mountain Beaver's conservation status (Special Concern) from being upgraded to Threatened or Endangered, and at a maximum to allow for downgrading to Not at Risk. The management goals have been set so that if they are not met, then future status assessments would be likely to recommend upgrading the status. Meeting the management goals then becomes a test of whether key threats have been addressed and, if not addressed, whether these threats had the expected outcome on population and distribution.

The distribution goal including number of subpopulations, and size of Extent of Occurrence and Index of Area of Occupancy, can be quantified as the distribution is fairly well known and has been mapped (e.g. Figure 1 of this report, also COSEWIC 2012).

The population goal cannot be quantified as absolute abundance due to knowledge gaps: population numbers are unknown, insufficient information is available to complete minimum population viability analysis, and dispersal and recolonization capabilities are usually unclear. Suitable information is not currently available to quantify targets for populations and habitats, including the number of individuals and area of habitat required to maintain a viable population. Therefore, the population goal is limited to relative abundance measures that would be the basis of the estimated prior and future population trends used in the COSEWIC status assessment. There is a considerable amount of baseline information of known den locations used as a surrogate for population numbers in many census areas (e.g. Gyug 2000,Gyug 2005, COSEWIC 2012, Gyug and Ransome 2012). These, along with all other location records could form the basis of relative density indices or occupancy indices for long-term monitoring but the methods have yet to be rigorously tested for statistical power and tested against absolute population estimates.

5.3 Management Objectives

The management plan has the following objectives:

1. To protect[7] and/or maintain Mountain Beaver habitat within its occupied range.
2. To assess and mitigate the impacts of ongoing threats, particularly timber harvest/silviculture and residential urban development and road building.
3. To address identified key knowledge gaps for Mountain Beaver including population abundance, locations of suitable habitat, and population viability.

6 APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Underway

The following actions have been categorized by the action groups of the B.C. Conservation Framework (Ministry of Environment 2010b). Status of the action group for this species is given in parentheses.

Compile Status Report (complete)

- COSEWIC report completed (COSEWIC 2001, 2012).

[7] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

Send to COSEWIC (complete)

- Mountain Beaver designated as Special Concern in 1999 and status re-examined and confirmed in November 2001 and May 2012.

Planning (in progress)

- B.C. management plan completed (this document, 2013).

Review Taxonomy and Status (in progress)

- Genetic studies have been completed to determine the nature of the subspecies relationship of *Aplodontia rufa rufa* and *Aplodontia rufa rainieri*. Doug Ransome gave B.C. samples to colleagues in the United States for a range-wide genetic evaluation. The manuscript was submitted for publication in January 2012. The conclusion was that there is only one subspecies north of the Columbia River including the entire range within both B.C and Washington State.

Habitat Protection and Land Stewardship (in progress)

- Quantitative Mountain Beaver habitat studies and post-hoc evaluation of Mountain Beaver response to clearcutting on the east (interior) side of the Cascade Mountains (Gyug 2000).
- Terrestrial Ecosystem Mapping (TEM) or Predictive Ecosystem Mapping (PEM) at 1:20,000 has been completed for about 40% of the range of Mountain Beavers including the Merritt PEM, Lillooet PEM, Chilliwack Lake TEM, Hope TEM, Dewdney TEM, BC Gas Pipeline TEM, and Okanagan TSA PEM. Mountain Beaver habitat suitability models have been developed for some of this mapping but there are no current plans to continue this or extend to other mapping or to verify the reliability of these models.
- Research on Mountain Beaver occupancy of areas before and after timber harvesting to directly determine responses to alternative timber harvesting and silvicultural methods on the east side of the Cascade Mountains. Preliminary post-harvesting results from 7 blocks as of 2001 (Gyug 2001); post-harvest evaluation of 13 blocks and controls 8–13 years after clearcutting in 2011 (Gyug and Ransome 2011). Six blocks evaluated pre-harvest in 1997–2001 have yet to be harvested.
- Best Management Practices (BMP) have been developed for timber-harvesting and silvicultural operations in areas occupied by Mountain Beavers on the east side of the Cascades.
- Surveys to determine Mountain Beaver distribution on the west (coastal) side of the Cascade Mountains (Ransome 2003).
- Census methods are being developed for coastal areas occupied by Mountain Beavers in dense shrub habitats where direct observation census techniques are insufficient (diploma students at B.C. Institute of Technology). This is ongoing (e.g., Salvador and Gravel 2010).
- Development of pamphlet and information package for forest managers and forest licensee staff for identification and conservation of Mountain Beaver on the east side of the Cascades Mountains was drafted in 2004, and updated in 2011 by the Ministry of Forests, Lands and Natural Resource Operations, Kamloops).

- Approximately 15% of the Mountain Beaver's range is found within 33 parks, recreation areas, or ecological reserves. These areas are protected from industrial resource extraction through provisions such as the *Parks Act* and the *Ecological Reserve Act*. Considering only the core range, about 22% (1150 km^2) is in 25 protected areas. The majority (99%) of the protected area within the core range is in six protected areas: E.C. Manning Provincial Park, Skagit Valley Provincial Park, Cascade Recreation Area, Coquihalla Summit Recreation Area, Cultus Lake Provincial Park, and Liumchen Ecological Reserve.
- Old-Growth Management Areas (OGMA) and Wildlife Habitat Areas (WHA) established for other species, particularly tall bugbane (*Actaea elata* var. *elata*), Grizzly Bear (*Ursus arctos*), and Coastal Tailed Frogs (*Ascaphus truei*) may provide additional habitat protection for Mountain Beaver, but the extent of potential habitat this covers has not been quantified.
- Outside of protected areas, Mountain Beavers are intended for protection under the Wildlife Habitat Features (WHF) section 70 of the Forest Planning and Practices Regulation (FPPR) of the *Forest and Range Practices Act* (FRPA; J. Psyllakis, pers. comm., 2012). Guidelines for establishment of WHFs have been developed under the original Identified Wildlife Management Strategy of the Forest Practices Code (B.C. Ministry of Forests and Ministry of Environment, Lands and Parks 1999) but these have yet to be fully adopted under the newer legislation and regulations.
- Some protection may exist through management within current Riparian Management Areas and Zones (FPPR Sections 50 and 52) and Riparian Reserves Zones (FPPR Section 51).

6.2 Management Action Table

Table 3. Management action table for Mountain Beaver.

Objective	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
3	**Population abundance and viability: isolated subpopulations** Complete inventory, mapping, and population viability analysis for Sumas Mountain and Chilliwack Mountain. Include assessment of likely rescue effect by immigration from nearby areas of the main subpopulation where threats are similar. If necessary, develop recovery plan.	1.1 Knowledge Gap	Essential
2, 3	Include as part of the population viability analysis on Sumas and Chilliwack Mountains a post-hoc study, or a more powerful but lengthier before-and-after study, of the impacts of suburban/urban development on Mountain Beaver occupancy.	1.1 Knowledge Gap	Necessary
3	Develop and apply monitoring plan for isolated subpopulations (Mount Pike and Missezula Mountain) at the east and northern edges of the range.	11.1, 5.3 (and others)	Necessary
3	**Population abundance and viability: entire range** Develop and verify new models for previously mapped areas without current Mountain Beaver models. The objective is to use mapping to estimate population abundance and viability, so will require keying relative abundance to absolute abundance.	Knowledge Gap	Beneficial

Objective	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
3	Once habitat models have been verified, estimate population numbers including confidence intervals derived from quantitative data; estimate what type of mapping will best complete coverage of entire range.	Knowledge Gap	Beneficial
3	Complete mapping identified in previous bullet of any areas in core range not currently mapped, and develop and verify modeling to estimate potential habitat. Complete population estimate for entire range.	Knowledge Gap	Beneficial
3	Monitor current distribution to determine if range is still occupied and not contracting.	1.1, 5.3, 11.1	Essential
3	Assess bioclimatic envelope of Mountain Beaver to determine possible long-term distributional responses to climate change.	11 Knowledge Gap	Essential
	Conservation of populations: all lands		
1	Once the amount of habitat needed for viable populations is known and population numbers estimated, then determine where additional protection may be needed beyond areas already protected by protected areas, OGMAs, and WHAs for other species.	Knowledge Gap; 5.3 + others	Beneficial
2	Assess impact of threats from forestry, urban development, mining, road building, and other land uses on an ongoing basis through referral and assessment processes. Avoid and/or mitigate impacts on a case-by-case basis.	3.2, 4.1	Necessary
	Conservation of populations: private land		
1, 2	Develop and implement communication strategy including Best Management Plans/Practices (BMP) brochure, community information presentation, and involvement options.	1.1, 1.2	Necessary
1, 2	Work with provincial, regional, and municipal governments to develop regulatory and planning tools for conserving habitat on private lands, including BMP and incorporation of Mountain Beaver into urban Growth Strategies, Official Community Plans, Sector Plans, Neighbourhood Plans, Development Permit areas, and/or other strategies.	1.1, 1.2	Essential
1, 2	Provide information, consult, and develop conservation agreements with landowners of suitable or occupied habitat on an as-required or as-requested basis.	1.1, 1.2, 5.3	Beneficial
	Conservation of populations: Crown land (forestry impacts)		
2	Long-term assessment of current BMPs for timber-harvesting and silvicultural operations in areas occupied by Mountain Beavers on the east side of the Cascades using existing study sites already used for short-term assessment.	5.3	Beneficial
2	In the Lower Mainland Region, collect quantitative ecology data related to impacts of forestry on Mountain Beavers in a post-hoc study, and, if impacts are found, initiate a before-and-after study.	5.3 Knowledge Gap	Essential

Objective	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
	Include study of impacts of Mountain Beavers on silviculture in the post-hoc study similar to that already conducted on the east side of the Cascades.		
2	Based on regionally applicable data, develop BMPs for timber-harvesting and silvicultural operations in areas occupied by Mountain Beavers on the west side of the Cascades.	5.3	Essential
1, 2	Work with provincial government and forest licensees to develop regulatory and planning tools for conserving habitat within the FRPA framework; complete WHF tools for implementation; implement WHF at forest district level within occupied range of Mountain Beaver on Crown land base, and assess whether these are achieving conservation of local populations and habitats.	5.3	Essential
2	Develop information package for forest managers, licensees, and field staff for identification of Mountain Beaver sign, and incorporation of regulatory requirements as well as BMPs.	5.3	Necessary
	Conservation of populations: federal lands		
2	Assess extent of occurrence and threats on federal Department of National Defence (DND) lands at Chilliwack using existing mapping, and field verification. Develop management strategy for Mountain Beaver habitat on these lands.	1.2	Beneficial
2	Work with aboriginal groups to identify traditional knowledge and opportunities for cooperative conservation projects.	Knowledge Gap	Beneficial

[a] Threat numbers according to the IUCN-CMP classification (see Table 2 for details).
[b] Essential (urgent and important, needs to start immediately); Necessary (important but not urgent, action can start in 2–5 years); or Beneficial (action is beneficial and could start at any time that was feasible).

6.3 Narrative to Management Actions Table

The distribution of Mountain Beaver is fairly well known and has been mapped. There are however, several knowledge gaps regarding its population: population numbers are unknown, insufficient information is available to complete minimum population viability analysis, and dispersal and recolonization capabilities are usually unclear. Abundance can be tracked only at the very local level for sites where censuses have been done within the main subpopulation (see Gyug 2000; Gyug and Ransome 2011). Relative abundance or occupancy (presence/non-detection) could be quantified and used for trend monitoring but rigorous monitoring procedures have yet to be developed or applied to any of the subpopulations.

To accomplish the management goal, management is required throughout the currently occupied range. On crown forest lands, all currently occupied habitats including in the peripheral range should be conserved as these are where localities are the most vulnerable to extirpation, while broad strategies alone may be appropriate in the core range.

The broad strategy necessary would require first addressing the threat to habitat suitability of the main Mountain Beaver subpopulation from heavy machine use during timber harvesting and site

preparation, and to determining the scope and severity of this threat to coastal Mountain Beaver habitat suitability. Suitable information is not currently available to quantify targets for populations and habitats, including the number of individuals and area of habitat required to maintain a viable population. If the main or medium threats are addressed and removed, then the detailed information that would be required to estimate population viability would not be required. In that case, only relative abundance and trends need be tracked, and management could be based on this information.

Enacting the draft Wildlife Habitat Features regulations would downgrade the medium impact threat of forestry (Table 2) to low or negligible for 80% of the main subpopulation from timber harvesting and site preparation. Short- and long-term threats to the two isolated subpopulations in the lower Fraser Valley on Sumas and Chilliwack mountains are from suburban development, and the long-term threat to the two subpopulations on the east side of the range on Mount Pike and Missezula Mountain from climate change. Each of these threats is more difficult to address or remove, but apply over a very limited area.

In the four isolated subpopulations (Chilliwack, Sumas, Pike, and Missezula mountains; Figures 2 and 3), there is insufficient knowledge of abundance or local-scale distribution to conduct a population viability analysis, or to set population or habitat targets. In particular for the two subpopulations on Sumas and Chilliwack Mountains where there are short-term threats from suburban development, knowledge of population abundance, local distribution of habitat, levels of immigration, and recovery from the nearest part of the main subpopulations (and the extent or viability of this portion of the main subpopulation) are knowledge gaps. These knowledge gaps will need to be addressed and management strategies developed over the short term (i.e., within the next 5–10 years) as these populations may be very small and already at high risk of extirpation. Zielinski *et al.* (2012) give an example of how hair-snaring and genetic analyses can estimate population size and viability on the endangered Point Arena Mountain Beaver. As many people are not aware of this species` existence, the public profile will need to be raised for it to be included in the planning process. This will require development of a public education process for the public at large as well as municipal and regional planners and politicians.

For the Mount Pike and Missezula Mountain subpopulations the threats would be from timber harvesting and silvicultural operations and are less imminent or short term than for the Chilliwack and Sumas mountain subpopulations. Therefore only monitoring of these two eastern subpopulations is recommended on the short term.

Mountain Beavers are limited to areas of high humidity and moderate temperatures therefore their distribution may be impacted by climate change. While climate change scenarios are available for B.C. out to 2080, the likely distributional responses of Mountain Beaver to climate change are uncertain because their bioclimatic envelope has not been defined (e.g. Lawler *et al*. 2009).

7 MEASURING PROGRESS

The following performance indicators provide a way to define and measure progress toward achieving the management goal and objectives. Performance measures are listed below for each

objective.

Objective 1

- A monitoring plan is developed by 2014 to verify if the range, particularly at the edges, continues to be occupied, and the monitoring plan is applied according to the schedule developed within the plan.
- A population viability study including estimates of habitat and population abundance and location is initiated on Sumas and Chilliwack Mountains by 2013.
- All resource development applications are reviewed and no occupied Mountain Beaver habitat is lost to impacts (annual, initiated by 2013). Any losses are mitigated by successful habitat replacement or enhancement locally.

Objective 2

- A communication strategy aimed at private sector and municipalities is developed by 2014, delivered on an ongoing basis but evaluated annually.
- Mountain Beaver mitigation strategies and methods are included in local planning bylaws of municipalities and areas of the Lower Fraser Valley Regional District where Mountain Beaver occur (2014).
- Mountain Beaver impacts from suburban/urban development are measured in a post-hoc study that estimates existing impacts in 2013, and/or a more powerful before-and-after study of impacts that will take a number of years to complete is initiated in 2013 to determine impacts as development takes place.
- A report is completed assessing distribution and possible impacts of DND activities on Mountain Beaver on DND lands at Chilliwack by 2018.
- FRPA Regulations (e.g., WHF) conserving or maintaining Mountain Beaver habitat on provincial Crown lands are enacted by 2013.
- On the east side of the Cascades, the long-term pre- and post-harvest study of timber harvesting and silvicultural impacts of soil disturbance on Mountain Beaver is completed by 2021 (10 years after last assessment) to assess effectiveness of BMPs.
- On the west side of the Cascades, a post-hoc study of soil disturbance impacts in clearcuts on Mountain Beaver occupancy and Mountain Beaver effects on silviculture is completed by 2015.
- If significant impacts to Mountain Beaver are detected during the post-hoc study, a before-after-control-impact study of timber harvesting and silvicultural impacts and possible mitigation methods for Mountain Beaver is begun on the west side of the Cascades and the Coast Mountains by 2016.

Objective 3

- The likely distributional response of Mountain Beavers to climate change is assessed using bioclimatic envelope methods and B.C. climate change scenarios by 2014.
- Mountain Beaver habitat suitability models are developed and assessed for reliability using existing mapping by 2017. Include recommendations of whether reliable models are achievable with this mapping or whether other map products would be required.
- If the habitat suitability models can be verified, then the models are used to quantitatively predict population abundance by 2018.

- Remaining regions in the Mountain Beaver range have ecosystem or other suitable mapping completed after, or if, reliable Mountain Beaver habitat suitability models have been developed.[8]

8 EFFECTS ON OTHER SPECIES

A suite of species found in the lower Fraser Valley, some of which are COSEWIC-listed, overlap broadly in range with the Mountain Beaver. Species such as the Coastal Giant Salamander (Dicamptodon tenebrosus), Coastal Tailed Frog, and tall bugbane (Actaea elata var. elata) may share habitat with Mountain Beavers in riparian areas along streams or other areas. Conservation of habitat for these species may likely benefit Mountain Beavers, and vice versa.

[8] No date can be set since this mapping would be part of other projects and not initiated just for Mountain Beaver.

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