PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Recovery Strategy for the Townsend's Mole (*Scapanus townsendii*) in Canada

Townsend's Mole



2015

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment Canada. 2015. Recovery Strategy for the Townsend's Mole (*Scapanus townsendii*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. 8 pp. + Annex.

For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the SAR Public Registry[1].

Cover illustration: Richard Forbes

Également disponible en français sous le titre
« Programme de rétablissement de la taupe de Townsend (*Scapanus townsendii*) au Canada [Proposition] »

© Her Majesty the Queen in Right of Canada, represented by the Minister of the Environment, 2015. All rights reserved.
ISBN
Catalogue no.

Content (excluding the illustrations) may be used without permission, with appropriate credit to the source.

[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

RECOVERY STRATEGY FOR THE TOWNSEND'S MOLE (*Scapanus townsendii*) IN CANADA

2015

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 *Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia* (Part 2) under Section 44 of the *Species at Risk Act.* Environment Canada has included an addition which completes the SARA requirements for this recovery strategy.

The federal Recovery Strategy for the Townsend's Mole (*Scapanus townsendii*) in Canada consists of two parts:

Part 1 – Federal addition to the *Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in Canada*, prepared by Environment Canada.

Part 2 - *Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia*, prepared by the British Columbia Ministry of Environment.

TABLE OF CONTENTS

PART 1 - Federal Addition to the *Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia*, prepared by Environment Canada

PREFACE....2
ADDITIONS AND MODIFICATIONS TO THE ADOPTED DOCUMENT....3
1. Critical Habitat....3
1.1 Identification of the Species' Critical Habitat....3
1.2 Examples of Activities Likely to Result in the Destruction of Critical Habitat....6
2. Statement on Action Plans....7
3. Effects on the Environment and Other Species....7
4. References....8

PART 2 - Recovery *Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia*, prepared by the British Columbia Ministry of Environment.

PART 1 - Federal Addition to the *Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) 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)[2] 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 recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of the Environment is the competent minister for the recovery of the Townsend's Mole and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. It has been prepared in cooperation with the Province of British Columbia (B.C.). SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Province of British Columbia led the development of the attached recovery plan for the Townsend's Mole (Part 2) in cooperation with Environment Canada.

Success in the recovery 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 strategy and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Townsend's Mole and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

ADDITIONS AND MODIFICATIONS TO THE ADOPTED DOCUMENT

The following sections have been included to address specific requirements of SARA that are not addressed in the "Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia" (Part 2 of this document, referred to henceforth as "the provincial recovery plan") and to provide updated or additional information.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery plan referring to protection of survival/recovery habitat may not directly correspond to federal requirements, and are not being adopted by Environment Canada as part of the federal recovery strategy. Whether particular measures or actions will result in protection of critical habitat under SARA will be assessed following publication of the federal recovery strategy.

1. Critical Habitat

1.1 Identification of the Species' Critical Habitat

Environment Canada accepts the description of Survival/Recovery Habitat as stated in the provincial recovery plan as the basis for critical habitat identification in the federal recovery strategy. This section provides additional information and so replaces section 7.1 of the provincial recovery plan.

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. The 2014 provincial recovery plan for this species does not identify critical habitat, but lists five survival habitat features for Townsend's Mole. The provincial recovery plan recommends developing a habitat model to delimit and map survival habitat. This modelling was completed as part of process of preparing this federal recovery strategy and the results are presented here as the geographical description component of the identification of critical habitat for Townsend's Mole in Canada. More precise boundaries may be mapped, and additional critical habitat may be added in the future if ongoing research (e.g. through work by the province, stewardship and recovery groups, university projects, or related federal Interdepartmental Recovery Fund projects) supports the inclusion of areas beyond those identified in this document. A primary consideration in the identification of critical habitat is the amount, quality, and locations of habitat needed to achieve the population and distribution objectives.

Critical habitat is identified as the area occupied by known occurrences of Townsend's Mole (which have a maximum location error of 100 m), plus an 800 m radius, i.e., the potential for above ground dispersal distances by young (Giger 1973), where biophysical attributes are present to support the species. The stated areas are estimated to encompass adequate habitat to support one or more adult territories and sufficient habitat for above ground dispersal by young from their natal nest. Within the described radius

(i.e., the critical function zone[3]), biophysical attributes that comprise critical habitat for Townsend's Mole are as follows:

1. Medium textured, deep, silt-loam soils, i.e., the Marble Hill and Ryder soils described and mapped by Luttermerding (1980). These are well drained soils not prone to flooding that support high earthworm biomass.
2. Non-forested agricultural land or lawns with grass or pasture cover with minimal disturbance.

Geospatial areas containing critical habitat were refined to exclude (1) parts of the critical function zone that contained neither Marble Hill nor Ryder soils, and (2) parts of the critical function zone that were isolated from the source occurrence location by major barriers to dispersal (e.g. highways, industrial development), in which case it could be reasonably assumed that the areas would not be reached by the Townsend's Mole. The areas containing critical habitat for Townsend's Mole are presented in Figure 1, and comprise 1821.7 ha in total. Critical habitat for Townsend's Mole in Canada occurs within the shaded yellow polygons shown on each map where the critical habitat criteria and methodology described in this section are met. The 1 km x 1 km UTM grid overlay shown on these figures is a standardized national grid system that highlights the general geographic area containing critical habitat, for land use planning and/or environmental assessment purposes. Detailed methods and decision-making processes relating to critical habitat identification are archived in a supporting document.

Critical habitat identified was evaluated against the objective to ensure continuity with populations in the United States. The largest critical habitat polygon is located in the core historical range of Townsend's Mole west of Huntingdon where the historical and extant locations are situated in suitable soils and contain extensive suitable soils within their critical function zones. Soils along the international border in this critical habitat polygon consist almost entirely of the Marble Hill type ensuring habitat connectivity with Townsend's Mole territories in bordering Washington State. It is noted that protection of critical habitat identified in border areas will be particularly crucial to the survival and recovery of this species in Canada.

The critical habitat identified is sufficient to meet the population and distribution objectives and therefore a schedule of studies is not required.

[3] The "critical function zone" distance is defined as the threshold habitat fragment size required for ensuring the growth, survival, and successful reproduction of a species such that all life history stages are supported. Existing research provides a logical basis for including a minimum critical function zone distance of 800 m as part of critical habitat for Townsend's Mole. Accounting for up to a maximum of 100 m GPS error, the default critical function zone distance is a maximum 900 m surrounding each location.

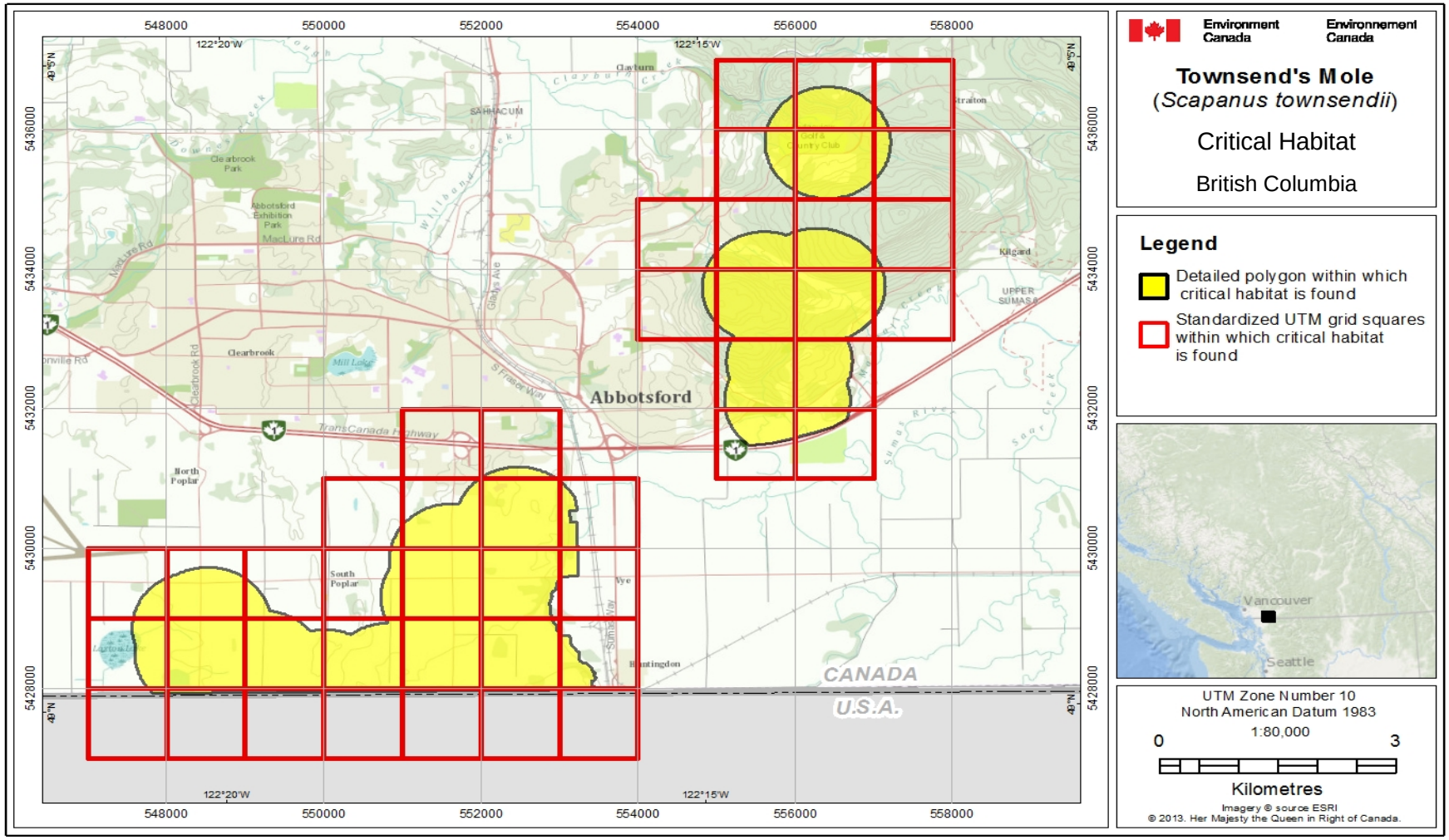


Figure 1. Critical habitat for Townsend's Mole is represented by the yellow shaded polygons (comprising 1821.7 ha) where the criteria and methodology set out in Section 1.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat in Canada; USA landbase (shaded grey) is excluded.

1.2 Examples of Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. The provincial recovery plan provides a detailed description of limitations and potential threats to Townsend's Mole. Activities described in Table 1 are examples of those likely to cause destruction of critical habitat for the species; destructive activities are not necessarily limited to those listed.

Table 1. Examples of activities likely to result in destruction of critical habitat for Townsend's Mole. IUCN Threat numbers are in accordance with the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (CMP 2010).

Description of Activity	Description of Effect	Additional Information
Development and conversion of agricultural lands to residential, commercial, or industrial properties.	Loss of suitable soils and pasture land required for supporting adult mole territories and dispersal habitat for young.	Related IUCN Threat # 1.1, 1.2; must occur within the bounds of critical habitat to cause destruction; direct loss, effects can be cumultive
Cultivation or tilling of pasture-land for crop production	Loss of suitable soils and pasture land required for supporting adult mole territories and dispersal habitat for young; destruction of tunnels and nests.	Related IUCN Threat # 2.1, 7.3; must occur within the bounds of critical habitat to cause destruction; direct loss, effects can be cumulative
Construction of large-scale greenhouses on agricultural land	Loss of suitable habitat for digging and construction of tunnels and nests.	Related IUCN # Threat 2.1; must occur within the bounds of critical habitat to cause destruction; direct loss, effects can be cumulative
Construction of new gravel pits	Removal of topsoil essential for digging and construction of tunnels and nests results in direct loss of critical habitat.	Related IUCN Threat # 3.2; must occur within the bounds of critical habitat to cause destruction; direct loss, effects can be cumulative
New road or highway construction	Fragmentation of habitat creating barriers to dispersal (i.e. for digging or tunnel construction) such that Townsend's Mole populations are isolated.	Related IUCN Threat # 4.1; must occur within the bounds of critical habitat to cause destruction; direct loss, effects can be cumulative
Use of pesticides or herbicides	Pesticides and herbicides may contaminate soils and kill earthworms (resulting in reduced earthworm populations), which is the major prey and food source for Townsend's Mole	Related IUCN Threat # 9.3; may occur inside or outside the bounds of critical habitat to cause destruction (i.e., by local application or by pesticide/herbicide drift); direct loss, effects can be cumulative

Activities that will destroy critical habitat of Townsend's Mole are related to development or agricultural practices. The conversion of agricultural land to residential, commercial, or industrial property was identified as a significant imminent threat in the provincial recovery plan. A single large development within the core range could destroy a significant portion of the critical habitat identified for Townsend's Mole. Of the agricultural practices that can destroy critical habitat, cultivation or tilling of pasture lands is the greatest threat to critical habitat including existing tunnels and nests of Townsend's Mole. The threat is ongoing particularly with the trend to convert pasture land used for forage production and dairy farming to berry crop production. Similar activities occurring outside the bounds of identified critical habitat (for example adjacent connecting habitat in the United States) may affect the survival and recovery of Townsend's Mole in Canada, and the ability of critical habitat identified to support the species. Likewise destruction activities occurring in Canadian border areas that result in isolation of continuous connective habitat with United States populations would have particularly negative consequences.

2. Statement on Action Plans

One or more action plans will be posted on the Species at Risk Public registry by 2019.

3. 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*[4]. 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 and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[5] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies 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 strategy itself, but are also summarized below in this statement.

The provincial recovery plan for Townsend's Mole contains a section describing the effects of recovery activities on other species (i.e., Section 9). Environment Canada

[4] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[5] http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

adopts this section of the provincial recovery plan as the statement on effects of recovery activities on the environment and other species.

4. References

Glendenning, R. 1959. Biology and control of the coast mole, *Scapanus orarius orarius* True, in British Columbia. Can. J. Animal Sci. 39:34-44.

COSEWIC 2003. COSEWIC assessment and update status report on Townsend's Mole (*Scapanus townsendii*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 24 pp. <http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=184

Luttmerding, H. A. 1980. Soils of the Langley-Vancouver map area. Report No. 15. B.C. Soil Survey. Vol. 1. Soil map mosaics and legend, lower Fraser Valley (scale 1:25 000). B.C. Min. Environ., Assessment and Planning Div. Kelowna, BC.

Sheehan, T., and C. Galindo-Leal. 1996a. Status report on the Townsend's Mole *Scapanus townsendii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 44 pp.

Sheehan, T., and C. Galindo-Leal. 1996b.Townsend's Mole (*Scapanus townsendii*) in the Lower Fraser Valley: Distribution, habitat, densities and habitat management. Centre for Applied Conservation Biology, Univ. British Columbia, Vancouver, BC. 56 pp.

PART 2 – Recovery *Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia*, prepared by the British Columbia Ministry of Environment

Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia



Prepared by B.C. Ministry of Environment

BRITISH COLUMBIA | Ministry of Environment

June 2014

About the British Columbia Recovery Strategy Series

This series presents the recovery documents that are prepared as advice to the Province of British Columbia on the general approach required to recover species at risk. The Province prepares recovery documents to ensure coordinated conservation actions and to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada* and the *Canada–British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a provincial recovery document?

Recovery documents summarize the best available scientific and traditional information of a species or ecosystem to identify goals, objectives, and strategic approaches that provide a coordinated direction for recovery. These documents outline what is and what is not known about a species or ecosystem, identify threats to the species or ecosystem, and explain what should be done to mitigate those threats, as well as provide information on habitat needed for survival and recovery of the species. This information may be summarized in a recovery strategy followed by one or more action plans. The purpose of an action plan is to offer more detailed information to guide implementation of the recovery of a species or ecosystem. When sufficient information to guide implementation can be included from the onset, all of the information is presented together in a recovery plan.

Information provided in provincial recovery documents may be adopted by Environment Canada for inclusion in federal recovery documents that the federal agencies prepare to meet their commitments to recover species at risk under the *Species at Risk Act*.

What's next?

The Province of British Columbia accepts the information in these documents as advice to inform implementation of recovery measures, including decisions regarding measures to protect habitat for the species.

Success in the recovery of a species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this document. All British Columbians are encouraged to participate in these efforts.

For more information

To learn more about species at risk recovery in British Columbia, please visit the B.C. Ministry of Environment Recovery Planning webpage at:
<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

Recovery Plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia

Prepared by B.C. Ministry of Environment

June 2014

Recommended citation

B.C. Ministry of Environment. 2014. Recovery plan for the Townsend's Mole (*Scapanus townsendii*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 23 pp.

Cover illustration/photograph

Richard Forbes

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>

Publication information

978-0-7726-6810-3

Disclaimer

This recovery plan has been prepared by British Columbia Ministry of Environment, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The B.C. Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Cana*da, and the *Canada–British Columbia Agreement on Species at Risk*.

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover Townsend's Mole populations in British Columbia. Recovery 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 recovery 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 on the recovery team.

Success in the recovery 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 plan. The B.C. Ministry of Environment encourages all British Columbians to participate in the recovery of Townsend's Mole.

ACKNOWLEDGEMENTS

Dave Nagorsen (Mammalia Biological Consulting) updated this management plan to its current state with funding from Environment Canada – Canadian Wildlife Service. An earlier version of the plan in 2005 was funded by the Habitat Conservation Trust Fund through the Abbotsford Land Trust. Direction and support for the previous version came from the former Townsend's Mole Recovery Team (Caroline Astley, Langley Environmental Partners Society; Lisa Fox, Abbotsford Land Trust Society; Sylvia Letay, B.C. Ministry of Forests, Lands and Natural Resources Operations; Dave Nagorsen; Valentin Schaefer, consultant and Department of Environmental Studies, University of Victoria; Tim Sheehan, consultant) and the former B.C. Ministry of Water, Land and Air Protection. Ian McTaggart-Cowan (retired UBC professor, now deceased) provided early historical information on Townsend's Mole on the former Racey farm site, Huntingdon, B.C. The Canadian Museum of Nature supplied copies of field notes from Hamilton Mack Laing's 1927 mammal survey of Huntingdon. Susan Jessop (BC Conservation Foundation) prepared the map for Figure 3. Joe Materi (Ursus Environmental), Chris Lee (AquaTerra Environmental Ltd.), and Ken Summers (KS Biological Services) provided observations and locations of Townsend's Mole diggings.

EXECUTIVE SUMMARY

The Townsend's Mole (*Scapanus townsendii*) was designated as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). There are only about 450 mature individuals in a single British Columbian (B.C.) population with a range of 13 km^2 adjacent to a small area of occupied habitat in the United States. Threats to the population include trapping by pest-control companies and property owners. The habitat continues to be degraded through fragmentation and urbanization. No surveys have been completed since the 2003 COSEWIC status report; therefore it is unknown whether the population has also declined since that time. It is uncertain whether immigration across the international border may rescue the B.C. population. The Townsend's Mole is listed as Endangered in Canada on Schedule 1 of the *Species at Risk Act* (SARA). In B.C., the Townsend's Mole is ranked S1 (critically imperiled) by the Conservation Data Centre and is on the provincial Red list. The B.C. Conservation Framework ranks the Townsend's Mole as a priority1 under goal 3 (maintain the diversity of native species and ecosystems). It is protected from capture and killing, under the B.C. *Wildlife Act.* Recovery is considered to be biologically and technically feasible.

The recovery (population and distribution) goals are (1) to maintain the abundance of Townsend's Mole at all known extant occurrences, and any new locations within its range in B.C., and (2) to prevent the isolation of the B.C. population by maintaining connectivity with source populations in the United States.

The following are the recovery objectives:
1. Protect Townsend's Mole from direct persecution in B.C.
2. Prevent loss[1] of Townsend's Mole habitat in B.C.
3. Determine and maintain habitat/population connectivity across the Canada–U.S. border for Townsend's Mole.
4. Address knowledge gaps relating to interspecific competition between the Coast Mole and Townsend's Mole and effects on Townsend's Mole due to reduced earthworm densities from tilling/ploughing and use of pesticides.

RECOVERY FEASIBILITY SUMMARY

The recovery of Townsend's Mole in B.C. is considered technically and biologically feasible based on the criteria outlined by the Government of Canada (2009):

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

   Yes. In B.C., Townsend's Mole consists of a single population that was estimated in 2003 at 420–490 mature animals capable of reproduction. The generation time of one year should produce an adequate pool of animals to maintain or increase the population.

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

Though probably limited, some level of rescue effect may be possible from populations in bordering Whatcom County of Washington State.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

   Yes, sufficient suitable habitat is currently available to support the species. The distributional area in B.C. is approximately 20 km^2 with the area of occupancy about 13 km^2. Most of the occupied habitat is agricultural land within the Agricultural Land Reserve (ALR) and protected from immediate residential or industrial development.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

   Yes. The primary threats to the species include direct killing by landowners or pest-control companies, and agricultural practices that affect soil conditions or destroy active tunnels and nests. These can be mitigated with outreach programs to encourage stewardship on private land. The potential threat of rezoning ALR land to allow residential or commercial development may be mitigated with an outreach program directed at local politicians and the public.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

   Yes. Monitoring programs, stewardship programs, and translocation studies could be designed and implemented with existing knowledge.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii
EXECUTIVE SUMMARY iv
RECOVERY FEASIBILITY SUMMARY iv
1 COSEWIC* Species Assessment Information 1
2 SPECIES STATUS INFORMATION 1
3 SPECIES INFORMATION 2
3.1 Species Description 2
3.2 Populations and Distribution 3
3.3 Habitat and Biological Needs of the Townsend's Mole 5
3.4 Limiting Factors 7
4 THREATS 7
4.1 Threat Assessment 8
4.2 Description of Threats 10
5 RECOVERY GOALS AND OBJECTIVES 13
5.1 Recovery (Population and Distribution) Goals 13
5.2 Rationale for the Recovery (Population and Distribution) Goals 13
5.3 Recovery Objectives 14
6 APPROACHES TO MEET OBJECTIVES 14
6.1 Actions Already Completed or Underway 14
6.2 Recovery Planning Table 16
6.3 Narrative to Support Recovery Planning Table 18
6.3.1 Habitat Protection and Private Land Stewardship 18
6.3.2 Species and Population Management 19
7 INFORMATION ON HABITAT NEEDED TO MEET RECOVERY GOAL 19
7.1 Description of Survival/Recovery Habitat 19
8 MEASURING PROGRESS 20
9 EFFECTS ON OTHER SPECIES 20
10 REFERENCES 21

LIST OF TABLES

Table 1. Threat classification table for Townsend's Mole. 9
Table 2. Recovery planning table for Townsend's Mole. 16

LIST OF FIGURES

Figure 1. Townsend's Mole. (Photo courtesy of Richard Forbes) 2
Figure 2. Townsend's Mole distribution in North America (COSEWIC 2003). 3
Figure 3. Townsend's Mole occurrences in British Columbia (2010)..... 4

1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Assessment Summary: May 2003
Common name: Townsend's Mole **
Scientific name: *Scapanus townsendii***
Status: Endangered
Reason for designation: There are only about 450 mature individuals in a single Canadian population with a range of 13 km^2 adjacent to a small area of occupied habitat in the United States. Threats to the population include trapping by pest-removal companies and property owners. The habitat has been degraded through fragmentation and urbanization. There is no evidence of decline over the last 10 years. It is uncertain whether immigration across the international border may rescue the Canadian population.
Occurrence: British Columbia
Status history: Designated Threatened in April 1996. Status re-examined and uplisted to Endangered in May 2003. Last assessment was based on an update status report.

* Committee on the Status of Endangered Wildlife in Canada.
** Common and scientific names reported in this recovery plan follow the naming conventions of the British Columbia Conservation Data Centre, which may be different from names reported by COSEWIC.

2 SPECIES STATUS INFORMATION

Townsend's Mole[a]	
Legal Designation:	
FRPA:[b] No OGAA:[b] No	B.C. *Wildlife Act:*[c] Schedule A SARA:[d] Schedule 1 - Endangered (2005)
Conservation Status[e]	
B.C. List: Red B.C. Rank: S1 (2010) National Rank: N1 (2012) Global Rank: G5 (1996)	
Other Subnational Ranks:[f] Washington: S5; Oregon: S4; California: SNR	
B.C. Conservation Framework **(CF)**[g]	
Goal 1: Contribute to global efforts for species and ecosystem conservation.	Priority:6[h] (2013)
Goal 2: Prevent species and ecosystems from becoming at risk.	Priority: 6 (2013)
Goal 3: Maintain the diversity of native species and ecosystems.	Priority: 1 (2013)
CF Action Groups:	Compile Status Report; Planning; List under *Wildlife Act*; Send to COSEWIC; Habitat Protection; Habitat Restoration; Private Land Stewardship; Species and Population Management

[a] Data source: B.C. Conservation Data Centre (2013) unless otherwise noted.
[b] No = not listed in one of the categories of wildlife that requires special management attention to address the impacts of forest and range activities on Crown land under the *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002) and/or the impacts of oil and gas activities on Crown land under the *Oil and Gas Activities Act* (OGAA; Province of British Columbia 2008).
[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] Schedule 1 = found on the List of Wildlife Species at Risk under the *Species at Risk Act* (SARA).
[e] 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.
[f] Data source: NatureServe (2013).
[g] Data source: B.C. Ministry of Environment (2010).
[h] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

3 SPECIES INFORMATION

3.1 Species Description

The largest mole in North America, Townsend's Mole has a long, nearly naked snout; minute eyes; no visible ears; and a short, nearly naked tail (Figure 1). Its front feet are broad (palms wider than long) and shovel-like with long, flat claws; the hind feet are not enlarged and have short, weak claws. Its fur is short, soft, and velvety; the fur colour ranges from blackish-brown to grey with animals appearing paler in summer pelage. The total length of adults including tail is about 205 mm. Adult males average 138 g; adult females average about 114 g.

Townsend's Mole is restricted to the Huntingdon area of southwestern British Columbia. Two other moles occur in this area: the Shrew Mole (*Neurotrichus gibbsii*) and the Coast Mole (*Scapanus orarius*). The Shrew Mole is easily distinguished from Townsend's Mole by its shrew-like appearance; long, thick scaly tail; a front foot that has palms longer than wide; and its much smaller size (average total length 112 mm, average weight 11 g). The Coast Mole is similar to the Townsend's Mole in external appearance, but adults can be identified by their smaller size (total length < 175 mm, tail length < 24 mm, weight < 90 g). Although immature Townsend's Moles, at dispersal age at 30 days, are within the size range of adult Coast Moles, Townsend's Moles can be identified by their larger front feet and claws. Illustrated keys for identifying the three moles in B.C. are in Nagorsen (1996, 2002).

Unlike Townsend's Mole and the Coast Mole, the Shrew Mole does not construct molehills. The molehills and tunnels of the Coast Mole and Townsend's Mole also differ. According to Sheehan and Galindo-Leal (1997), molehills greater than 15 cm high, 40 cm wide, with shallow tunnel diameters greater than 4.5 cm are usually from a Townsend's Mole.



Figure 1. Townsend's Mole. (Photo courtesy of Richard Forbes)

3.2 Populations and Distribution

Townsend's Mole inhabits the Pacific coastal regions of the United States (northern California, Oregon, Washington), and in Canada only in southwestern B.C. (Figure 2). In B.C., where this species is at the northern edge of its range, it has a very limited distribution confined to a localized area around Huntingdon and Abbotsford adjacent to the international border and is evidently absent from other agricultural lands on the north and south sides of the Fraser River (Figure 3). The extent of occurrence in B.C. is about 20 km^2 and the area of occupancy is only 13 km^2 (COSEWIC 2003). Most known occurrences are south of Highway 1 from Short Road east to Sumas Way and Huntingdon (Figure 3). The first known occurrence of Townsend's Mole north of Highway 1 was in 1986 when two moles were trapped at the Ledgeview Golf Course (Sheehan and Galindo-Leal 1996a). There are now several records from this area. These observations may represent a recent population or possibly earlier surveys such as Glendenning (1959) simply failed to search this area. It is also possible that the recorded moles are transients. Nonetheless the nearest source location in the Huntingdon population is about 3 km away, well beyond the dispersal distance of Townsend's Mole, and separated by a major highway and residential development. Nothing is known about its early historical range in B.C. (i.e., before the first documentation in 1927) and no data exist on long-term distributional changes in B.C. The distributional area in B.C. represents less than 5% of this species' global range.

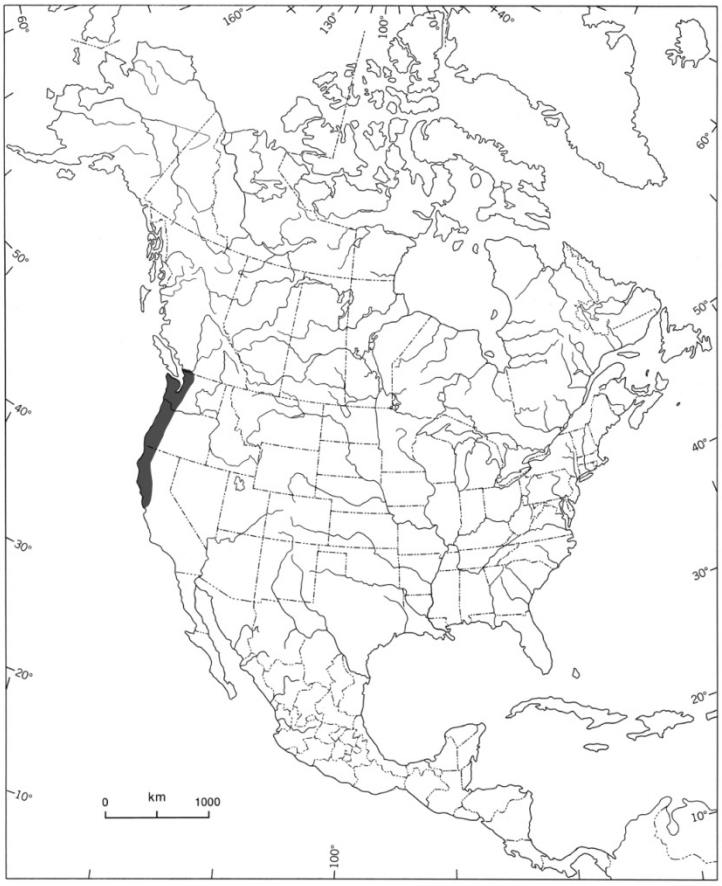


Figure 2. Townsend's Mole distribution in North America (COSEWIC 2003).

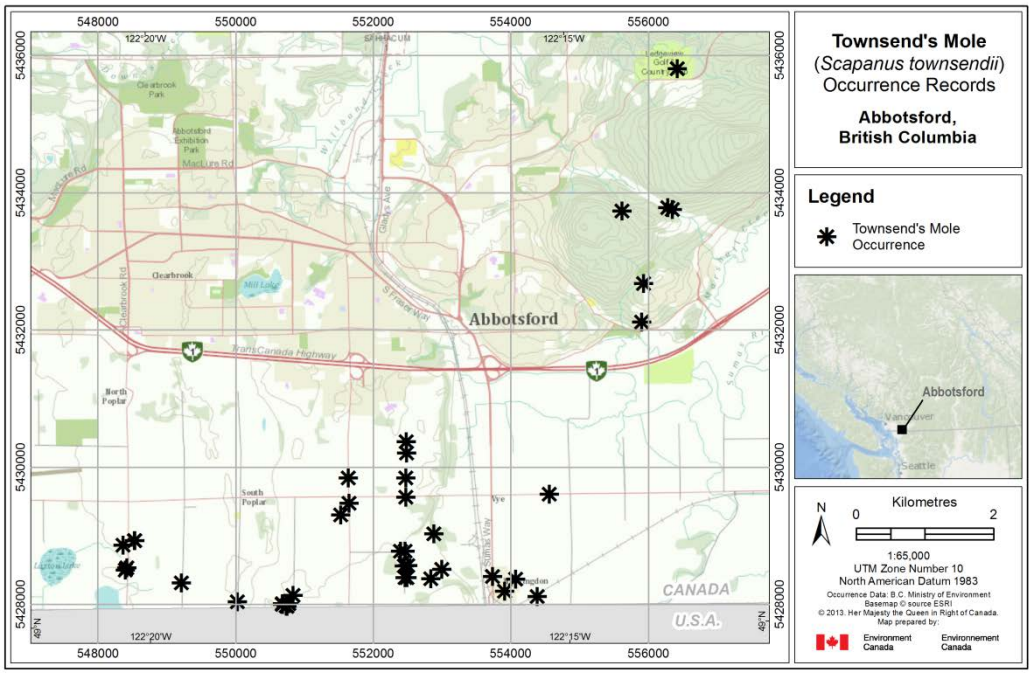


Figure 3. Townsend's Mole occurrences in British Columbia (2010).

With forest clearing in the mid-1800s (Boyle *et al.* 1997) and the introduction of earthworms (Schaefer 1978; Nagorsen 1996), it is possible that this mole only expanded its distribution to B.C. relatively recently. However, historical information on the mammals of the lower Fraser River valley is limited. The only published information on the status of small mammals in this region in early historical time was the review by Allan Brooks (Brooks 1902), a renowned naturalist–artist who did extensive small mammal collecting in the Chilliwack area in the late 1880s (Laing 1979). Brooks (1902) reported that Townsend's Mole was "common in portions of the valley not affected by Fraser floods." As no mention was made of the more common Coast Mole, it is likely that Brooks (1902) had misidentified his mole specimens and was referring to the Coast Mole. A series of museum specimens taken in the late 1890s by Brooks from "Sumas" (probably the Sumas Prairie) are now identified as Coast Moles.

The first documented evidence of Townsend's Mole in B.C. were five museum specimens (deposited in the Canadian Museum of Nature, Ottawa) collected in 1927 by Hamilton Mack Laing (Laing 1927) on the Racey farm west of Sumas Way in Huntingdon. To this day, Townsend's Moles occupy this property. Ken Racey subsequently collected 12 specimens of Townsend's Mole (deposited in the Royal Ontario Museum and the Beaty Biodiversity Museum, University of British Columbia) around Huntingdon during the 1930s and 1940s. According to Ian McTaggart-Cowan (pers. comm., 2005), even in the 1930s and 1940s Townsend's Mole in the Huntingdon area was uncommon with a localized range. In his major review of the Coast Mole in B.C., Glendenning (1959) described the Canadian range of Townsend's Mole as a 13 km^2 area at Sumas near the U.S.–Canada border, a distribution that closely matches the current range. Cowan and Guiguet (1965) described a similar distributional area for this mole. Sheehan and Galindo-Leal (1996b), who surveyed various locations in Agassiz, Aldergrove, Abbotsford,

Chilliwack, and Mission, found no Townsend's Moles outside of the Huntingdon-Abbotsford area.

A major consideration in the conservation of Townsend's Mole in B.C. (and Canada) is the potential rescue effect from Townsend's Moles inhabiting the Sumas area of Washington State. According to COSEWIC (2003) suitable habitat occurs there in lowlands associated with Johnson Creek and the Sumas and Nooksack rivers, in Whatcom County, Washington State. However, Sheehan and Galindo-Leal (1996b), who surveyed 50 locations with molehills in Whatcom County near the international border, found only 1 location with Townsend's Mole. It was close to the border about 2 km west of Sumas. In contrast, the Coast Mole was present at a number of locations in Whatcom County. In May 2002, surveys did not find any Townsend's Mole molehills in Sumas, but three territories were found on Highway 546, about 3 km south of Huntingdon, B.C. (COSEWIC 2003). Given the limited movements of Townsend's Mole, these data suggest that the B.C. population may be isolated, with limited (though as yet unknown) potential for rescue effect from neighbouring occurrences in the United States.

In Oregon State, estimates of population density range from 0.42 to 12.4 moles per hectare depending on habitat (Kuhn *et al.* 1966; Giger 1973). Sheehan and Galindo-Leal (1996b) estimated population densities of 5.2 and 3.2 Townsend's Moles per hectare for two fields near Huntingdon, B.C. Using a conservative density of 0.5 moles per hectare, Sheehan and Galindo-Leal (1996a) estimated the total Canadian population to be less than 700 animals. The number of mature animals (i.e., number of individuals capable of breeding) in B.C. is estimated at 420–490 (COSEWIC 2003). Nothing is known about the population trends in B.C.

3.3 Habitat and Biological Needs of the Townsend's Mole

Townsend's Mole is a specialized, fossorial mammal that spends most of its life in underground tunnels and burrows. Its body form (e.g., enlarged front feet, lack of external ears, minute eyes) is highly modified for living underground. The diet is mostly earthworms that are captured in its tunnels. Socially, adult Townsend's Moles appear to be solitary and highly territorial, although there is some overlap in their tunnel systems.

Habitat

In the United States, this species occupies natural habitats such as prairies, river floodplains, wet lowland meadows, and shrub thickets (Carraway *et al.* 1993; Verts and Carraway 1998). However, agricultural pastureland and grassy fields are probably the best, most ideal habitat. Pedersen (1963) noted that clearing of forests and the drainage of wetlands for agriculture in Oregon State in relatively recent historical time may have increased habitat favoured by Townsend's Mole. Generally, Townsend's Mole is absent from forested habitats, although in Washington State, an isolated subspecies of Townsend's Mole in the Olympic Mountains occupies subalpine meadows (Johnson and Yates 1980). Dalquest (1948) reported it common in fir forests but absent from deciduous forests in Washington.

In B.C., Townsend's Mole inhabits farmland, lawns, and golf courses in the Fraser River valley (Nagorsen 1996; COSEWIC 2003). Sheehan and Galindo-Leal (1996a, 1996b) found that all captures in British Columbia were associated with Lynden or Alderwood Silt Loam soils; they

found no Townsend's Moles in the Lynden Gravelly Silt Loam or Munroe Clay soil types. The Lynden and Alderwood Silt Loam soils are equivalent to the Marble Hill and Ryder soils of Luttermerding (1980). They found no occurrences in low sites prone to flooding or with a high water table. Sheehan and Galindo-Leal (1996a) also noted that most sites with Townsend's Moles were pastureland with grass cover. However, at the Ledgeview Golf Course where mole kill trapping was done for 10 years, Townsend's Moles evidently reinvaded the lawns from bordering habitats of thick bush dominated by alder according to Sheehan and Galindo-Leal (1996b).

It is noteworthy that these anthropogenic habitats were created after European settlement of the Fraser Basin in the mid to late 1800s (Boyle *et al.* 1997) with forest clearing and the introduction of earthworms.

Tunnels and Nests

Townsend's Mole constructs several types of tunnels (Pedersen 1963; Kuhn *et al.* 1966). Shallow (5–15 cm below the ground) surface tunnels are used for foraging and possibly locating mates in the breeding season. Deeper tunnels, usually 10–20 cm below the surface but sometimes as deep as 1–3 m, may be constructed under roads, buildings, and fencerows. Soil from excavation is deposited as conical mounds above these runway systems. In the breeding season, females construct spherical nursery nests in underground cavities where they give birth and raise their young (Pedersen 1966; Kuhn *et al.* 1966). The nest chambers are situated 15–20 cm below ground and average about 23 cm in diameter and 15 cm in depth. Dirt from excavating these chambers is usually deposited on the surface in a large mound 70–130 cm in diameter and 30–45 cm high. Some nursery nests are used only one year, others may be reused for several breeding seasons. Until a female gives birth, she will readily abandon her nest if disturbed (Pedersen 1966).

Movements

Captures of marked Townsend's Mole (Giger 1973) suggest that subterranean movements of adults with established burrow systems are limited with distances between capture sites ranging from 3 to 116 m and the average distance between captures about 40 m. Long distance movements beyond 100 m may be undertaken in the dry months of summer in poor habitats where earthworms are scarce. Young-of-the-year Townsend's Moles disperse above ground from their natal nest. Dispersal distances are generally short (165 m) but long distance movements may reach 800 m (Giger 1973).Townsend's Moles displaced artificially have successfully returned to their original locations from distances up to 450 m (Giger 1973).

Diet

The diet is predominately earthworms. Several studies of Oregon State populations (Wight 1928; Pedersen 1963; Whitaker *et al.* 1979) revealed that 70 to 90% of the prey is earthworms, based on stomach contents. Small amounts of other invertebrates (e.g., centipedes, millipedes, snails, slugs, insects) and a few small mammals (shrews or mice) have also been identified in stomach remains. Vegetation (e.g., bulbs, roots, grass, carrots, parsnips, oats, beans) is also eaten.

Reproduction

In Oregon, the breeding season begins in early winter (Moore 1939; Pedersen 1963; Verts and Carraway 1998). Males with enlarged testes have been found as early as November. By mid-March males are no longer in breeding condition. Pregnant females have been first observed in mid-March; no pregnant females were found after mid-April. Female Townsend's Moles produce only one litter per year with a litter size of one to four with three most common. The gestation period has not been determined for this species but it is assumed to be 4–6 weeks. Newborn Townsend's Moles are naked and lack teeth and distinguishable eyes; weight for newborns is about 5 g (Kuhn *et al.*1966). Within a month of weaning at about 30 days, the young begin to leave their mother's nest and disperse. In Oregon State, dispersal of the young takes place in May and June. Townsend's Moles breed in their first winter after birth.

Reproductive data for the B.C. population consist of anecdotal information from a few museum specimens. According to Nagorsen (1996), a male with enlarged testes was taken 24 March and a female with a foetus about 20% developed was captured 27 April. These data suggest that the breeding season in British Columbia may be nearly a month later than Oregon State, with young dispersing from their natal nest sometime in July.

3.4 Limiting Factors

With its dependence on earthworms and requirements for digging, Townsend's Mole is significantly limited by specific soil types. Because most of its activity is underground and its body form limits this species' ability to move on the surface, Townsend's Mole has very limited dispersal abilities and is highly vulnerable to habitat fragmentation. Producing only one litter per year and delaying reproduction until the winter after birth, Townsend's Mole has a low reproductive potential compared with most small mammals.

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 (global, national, or subnational) (Salafsky *et al.* 2008). For purposes of threat assessment, only present and future threats are considered.[2] 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.[3]

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

[2] 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).

[3] 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.

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.

4.1 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 Townsend's Mole were assessed for the entire province (Table 1).

Table 1. Threat classification table for Townsend's Mole.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
1	Residential & commercial development	Medium	Restricted	Serious	Moderate
1.1	Housing & urban areas	Medium	Restricted	Serious	Moderate
1.2	Commercial & industrial areas	Low	Small	Serious	Moderate
1.3	Tourism & recreation areas	Not Scored	Not Scored	Not Scored	Low
2	Agriculture & aquaculture	High-Medium	Pervasive	Serious-Moderate	High
2.1	Annual & perennial non-timber crops	High-Medium	Pervasive	Serious-Moderate	High
2.3	Livestock farming & ranching	Low	Small	Slight	High
3	Energy production & mining	Low	Small	Extreme	High
3.2	Mining & quarrying	Low	Small	Extreme	High
4	Transportation & service corridors	Low	Restricted	Slight	High
4.1	Roads & railroads	Low	Restricted	Slight	High
5	Biological resource use	High-Medium	Pervasive	Serious-Moderate	High
5.1	Hunting & collecting terrestrial animals	High-Medium	Pervasive	Serious-Moderate	High
7	Natural system modifications	Unknown	Unknown	Unknown	High
7.3	Other ecosystem modifications	Unknown	Unknown	Unknown	High
8	Invasive & other problematic species & genes	Low	Pervasive	Slight	High
8.1	Invasive non-native/alien species	Low	Pervasive	Slight	High
8.2	Problematic native species	Unknown	Pervasive	Unknown	High

[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 3-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 ≥ 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 Very High to High.[4] Major threats include agriculture, biological resource use, and residential development (Table 1). Details are discussed below under the Threat Level 1 headings.

IUCN-CMP Threat 1. Residential & commercial development
Any permanent habitat loss will increase fragmentation of this species' limited distributional area. This threat results in the loss of suitable soils and pastureland required for supporting adult mole territories and dispersal habitat for young.

1.1 Housing & urban areas

The most significant imminent threat identified in the COSEWIC status report (COSEWIC 2003) was habitat loss from urban development. Population growth for the Fraser Valley Regional District from 2001 to 2011 was 8%; projected population growth from 2011 to 2036 is more than 35% (BC Stats 2011). A single large development could destroy a significant portion of the habitat for Townsend's Mole given that the range distribution of this species in B.C. is very limited. Habitat north of Highway 1 is more at risk of being lost due to conversion to residential development as all but a small portion of this land falls outside of the provincial Agricultural Land Reserve (ALR).

Of the habitat around the area occupied by historical and recent occurrences of Townsend's Mole in the Huntingdon-Abbotsford area (i.e., within 900 m of given location), approximately 60% is within the ALR (B.C. Ministry of Agriculture, unpubl. data, 2012). It is unlikely that development will occur in these areas within 10 years or 3 generations as land must first be removed from the ALR. Although it is difficult to remove land from the ALR, this has occurred in the past in nearby areas. Only the Agricultural Land Commission has the legal authority to review applications that are put forward by the local government and remove land from the ALR.

1.2 Commercial & industrial areas

Industrial or commercial areas with buildings and paved parking lots eliminate Townsend's Mole habitat. The Sumas Way highway corridor in B.C. is excluded from the ALR. Several occurrence records of Townsend's Mole are in the southern portion of Sumas Way near the U.S. border in an area with industrial development.

1.3 Tourism & recreation

Tourism and recreation areas are not considered a threat at this time. Currently there is only one golf course within the distributional area of Townsend's Mole. Although as human population and urban growth expand pressure to develop agricultural lands for golf courses will increase, it is unlikely that this will occur within 10 years as land would first need to be removed from the ALR. In addition, the lawns of golf courses may provide suitable habitat for Townsend's Mole.

[4] 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 2 High-Medium, 1 Medium, 3 Low, and 1 Unknown (Table 1).The overall threat considers the cumulative impacts of multiple threats.

IUCN-CMP Threat 2. Agriculture & aquaculture

2.1 Annual & perennial non-timber crops

Tilling and ploughing break up the surface layer of the soil and may make it unsuitable for tunnel construction by the Townsend's Mole, and may result in direct mortality if animals in shallow nests cannot escape quickly enough. The shallow surface tunnels of Townsend's Mole used for foraging are only 5–15 cm below the surface, and the deeper permanent tunnels can be as shallow as 15–20 cm making them vulnerable to ploughing or tilling. Some nursery nests that are 7–50 cm below the surface (Kuhn *et al.* 1966) may also be vulnerable to damage and direct destruction of young moles.

There is a trend to convert pastureland used for forage production and dairy farming to berry crop production. Currently berry crop production is the most common use of agricultural land within the of Townsend's Mole range south of Highway 1 (B.C. Ministry of Agriculture, Food and Fisheries 2004; B.C. Ministry of Agriculture, 2012, unpubl. data). The suitability of berry crop lands for Townsend's Mole is unknown.

In parts of the Fraser Valley, greenhouses have been constructed for commercial production of vegetables resulting in loss of suitable habitat for digging and construction of tunnels and nests. A few greenhouse or mushroom farm operations exist within the range of Townsend's Mole (B.C. Ministry of Agriculture, Food and Fisheries 2004). Although conversion of agricultural land to commercial greenhouses is permitted on ALR lands, there has been no change in the greenhouse footprint in this area in the past 10 year. Greenhouses as well as quarries represent a very small fraction of the land base in this area (i.e., 3 greenhouses and 2 quarries; < 1%) (B.C. Ministry of Agriculture, 2012, unpubl. data).

2.3 Livestock farming & ranching

Although pastureland is the ideal habitat for Townsend's Mole, dairy cows occasionally trample or disturb natal nests (Pederson 1963). However, the impact of this threat is low as there are few dairy or cattle operations within the Townsend's Mole range in B.C.

IUCN-CMP Threat 3. Energy production & mining

3.2 Mining & quarrying

Gravel extraction operations that remove top soil could seriously impact habitat essential for digging and destroy existing tunnels or nests. Several locations in the Huntingdon, B.C., area have significant gravel deposits. Gravel extraction is regulated and is designated a non-farm use or activity; however, as long as a soil removal permit has been obtained, gravel pits can be constructed on land protected in the ALR (Province of British Columbia 1996). Proposals to

expand[5] or construct gravel pits have been made in the past 5 years and are expected in the future (S. Letay, pers. comm. 2014).

IUCN-CMP Threat 4. Transportation & service corridors

4.1 Roads & railroads

Dispersing young that cross roads are vulnerable to accidental mortality from vehicles. Pedersen (1963) recorded 14 road-killed Townsend's Moles in one month during his study in Oregon State. In addition to direct mortality from road kills, roads increase habitat fragmentation by creating barriers to dispersal (i.e., for digging or tunnel construction) such that Townsend's Mole populations are isolated. For example, the locations east of Abbotsford are separated from the Huntingdon core area of the range by the Trans-Canada Highway, a major four-lane highway. With the projected population growth for the Fraser Valley Regional District, more roads and road expansions can be expected.

IUCN-CMP Threat 5. Biological resource use

5.1 Hunting & collecting terrestrial animals

Although an endangered species, Townsend's Mole is a little-known small mammal in Canada. Most people are simply unaware of this mammal or confuse it with the more abundant and widespread Coast Mole, which is regarded as a pest by farmers, golf course owners, and residential, commercial and industrial landowners in the Fraser Valley due to damage caused by mole tunnels. Two pamphlets on mole control in British Columbia produced for the general public recommend kill trapping with the English scissors mole trap (Glendenning 1951; Gerber 1978). These were published before Townsend's Mole was designated by COSEWIC or listed under SARA and they make no distinction between killing the Coast Mole and Townsend's Mole. Human intolerance of moles is the underlying cause for this threat.

Mole trapping by pest-control companies or the general public/farmers on agricultural lands, golf courses, or gardens and lawns in residential areas may result in captures of Townsend's Mole (Sheehan and Galindo-Leal 1996a; COSEWIC 2003). In British Columbia, mole removal is focused on the more abundant and widespread Coast Mole. However, because the control methods are indiscriminate, any mole control within the limited distributional area of the Townsend's Mole could result in mortalities.

IUCN-CMP Threat 7. Natural system modifications

7.3 Other ecosystem modifications

Soil tilling or ploughing would be expected to reduce population densities of Townsend's Mole by reducing the biomass of earthworms (The Pennsylvania State University 2008). Schaefer and Sadleir (1981) demonstrated that abundance (measured by the number of molehills) of the Coast Mole in British Columbia was correlated with the biomass of earthworms. Given the

[5] One gravel pit within the Townsend's Mole range was expanded in the last 5 years; however no Townsend's Moles were found in the expansion footprint.

importance of earthworms as a food source for Townsend's Mole, a similar relationship would be expected.

In addition, pesticides[6] applied directly or indirectly to soils (e.g., for agricultural purposes or to maintain golf courses) may be toxic to earthworms and may reduce earthworm densities (The Pennsylvania State University 2008). More analysis is required to investigate what pesticides are being used in this area and what effects they have on earthworm populations.

IUCN-CMP Threat 8. Invasive & other problematic species & genes

8.1 Invasive non-native/alien species

Although domestic dogs and cats rarely eat moles, they are a source of mortality. Maser *et al.* (1984) reported that in coastal Oregon, dogs and cats were the main predators of moles. Dogs dig out and kill moles throughout the year. Cats mostly take juvenile Townsend's Moles when they disperse from their nursery nests above ground in summer. Pedersen (1963) reported an account from a farmer who had a cat that captured five moles within a seven-day period.

8.2 Problematic native species

Within its limited Canadian range, Townsend's Mole is sympatric with the Coast Mole, a species widespread throughout much of the Fraser River valley (Glendenning 1951; Nagorsen 1996). Of the 137 mole territories found in the Huntingdon area in 2002 (COSEWIC 2003), only 16 (10.5%) were Townsend's Mole. According to Whitaker *et al.* (1979), differences in habitat orientation, burrow depth, and body size reduce competition between the Coast Mole and Townsend's Mole in Oregon. Nonetheless, the degree of competition between Coast Mole and Townsend's Mole at the northern edge of their ranges is unknown. Given its greater abundance, the Coast Mole may exclude Townsend's Mole from some available habitats.

5 RECOVERY GOALS AND OBJECTIVES

5.1 Recovery (Population and Distribution) Goals

The recovery (population and distribution) goals are (1) to maintain the abundance of Townsend's Mole at all known extant occurrences, and any new locations within its range in B.C., and (2) to prevent the isolation of the B.C. population by maintaining connectivity with source populations in the United States.

5.2 Rationale for the Recovery (Population and Distribution) Goals

No evidence suggests that the Townsend's Mole was ever more abundant or widespread in B.C. In fact, available data indicate that this species may have colonized to B.C./Canada as recently as the 1800s with development of agricultural lands and the introduction of earthworms. As such it

[6] Although COSEWIC (2003) mentions that pesticides may kill moles directly, references or evidence to support this statement was not found (D. Nagorsen, pers. comm., 2013).

would not be appropriate to set population targets to increase numbers for a species that may have colonized as a result of human modification of the landscape.

Habitat for the Townsend's Mole continues to be degraded through fragmentation and urbanization (COSEWIC 2003) thus preventing habitat loss will be important to the goal of maintaining known occurrences. As no targeted surveys for Townsend's Mole have been completed since the status report (COSEWIC 2003), it is unknown whether there has been an accompanying population decline since that time. Without knowledge to indicate that the population is declining, maintaining the current population and preventing its decline by addressing threats is an appropriate goal.

In addition, given its small population size and small distributional area it is not likely that down-listing this species to a Threatened status will ever be achievable as it would require a substantial increase in abundance (> 2,500 mature individuals). This would require a significant trans-border rescue effect, which at this time is unknown or limited at best. There are also no large tracts of suitable habitat that is unoccupied by Townsend's Mole habitat in B.C. for this species to expand its distribution. However, maintaining habitat connectivity to adjacent areas of Washington State to encourage cross-border movements may prove to be important for maintaining B.C.'s population and so is included as part of the goal.

5.3 Recovery Objectives

Immediate recovery objectives should focus on preventing habitat loss and population declines within the small known range in B.C.

1. Protect Townsend's Mole from direct persecution in B.C.
2. Prevent loss[7] of Townsend's Mole habitat in B.C.
3. Determine and maintain habitat/population connectivity across the Canada–U.S. border for Townsend's Mole.
4. Address knowledge gaps relating to interspecific competition between the Coast Mole and Townsend's Mole and effects on Townsend's Mole due to reduced earthworm densities from tilling/ploughing and use of pesticides.

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 (B.C. Ministry of Environment 2010). Status of the action group for this species is given in parentheses.

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

Compile Status Report (complete)

- COSEWIC report completed (COSEWIC 2003). Update due 2013.

Send to COSEWIC (complete)

- Townsend's Mole assessed as Endangered (COSEWIC 2003). Re-assessment for this species is due.

Planning (in progress)

- BC Recovery Plan completed (this document, 2014).

6.2 Recovery Planning Table

Table 2. Recovery planning table for Townsend's Mole.

Objective	Conservation Framework action group	Actions to meet objectives	Performance measures	Threat[a] or concern addressed	Priority[b]
1	Species and Population Management	Develop an outreach program targeted at pest-control companies that trap moles and at landowners in the known range of Townsend's Mole: • Contact companies • Assess existing practices • Educate, and develop and implement measures to avoid Townsend's Mole mortality	Pest-control companies are aware of the Townsend's Mole and take measures to reduce mortalities by 2016	5.1, 7.3	Essential
1, 2	Habitat Protection; Land Stewardship; Species and Population Management	Develop an outreach program that involves all of the landowners/farmers with known Townsend's Mole territories on their land: • Development of a communication strategy for contacting land owners/farmers (e.g., extension materials, translation, native speakers to convey information, etc.) that includes dialogue with the relevant agricultural commodity association • Contact landowners/land managers • Inventory properties to identify active Townsend's Moles territories • Assess land use practices on each property with Townsend's Moles • Prioritize sites based on risk to Townsend's Mole • Develop site-specific best management practices (BMPs) that do not include kill trapping or poisoning Townsend's Moles	All landowners/farmers contacted by 2015 Known sites inventoried by 2016 BMPs are in use by 2017	1.1, 1.2, 2.1, 2.3, 3.2, 5.1, 7.3, 8.1	Essential
2	Habitat Protection	With a focus on stewardship, put in place mechanisms to protect habitat as needed.	Mechanisms to protect habitat have been initiated by 2017	1.1, 1.2, 2.1, 2.3, 3.2, 4.1	Necessary

Objective	Conservation Framework action group	Actions to meet objectives	Performance measures	Threat[a] or concern addressed	Priority[b]
		Consider the use of incentive programs.			
3	Habitat Protection; Habitat Restoration	Clarify the distribution of Townsend's Mole and potential habitat near and south of the Canadian border: • Develop a habitat model for Townsend's Mole using soil characteristics, agricultural land use, and other factors to determine potential habitat, especially in Washington near the border. • Inventory moles in Whatcom County, Washington, using the habitat model to identify potential habitats near the international border.	Habitat model developed by 2016 Mole inventory near international border completed by 2017 Level of habitat/population connectivity across Canadian/U.S. border for Townsend's Mole determined by 2018	Knowledge Gap	Necessary
4	Species and Population Management	Develop a population monitoring program for inventorying the known territories of both Townsend's Mole and the Coast Mole in the known B.C. range of Townsend's Mole.	Monitoring inventory program established by 2014	Knowledge Gap	Necessary
4	Species and Population Management	Encourage a research program that will study interspecific competition between the Coast Mole and Townsend's Mole.	Research study on competition with Coast Mole initiated by 2015	Knowledge Gap; 8.2	Necessary
4	Species and Population Management	Encourage a research program that will study indirect effects of reduced earthworm densities on Townsend's Mole population size due to pesticide/herbicide use and tilling/ploughing practices.	Research study on effects of pesticide/herbicide use initiated when possible	Knowledge Gap; 7.3	Beneficial

[a] Threat numbers according to the IUCN-CMP classification (see Table 1 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 Support Recovery Planning Table

Most of this species' range in B.C. is on private land (Figure 3). Within its known range there are only a few small parcels of federal or provincial Crown land and municipal land. In 2009, Townsend's Mole mounds were found on the Agriculture and Agri-Food Canada Clearbrook Research Substation on Clearbrook Road, a 7.5-ha parcel of federal land. The Matsqui Correctional Institution (Figure 3), with about 115 ha of federal land, is just outside the known range of this species. Tim Sheehan (pers. comm., 2005) found only Coast Moles on this property in 1996 but it may support suitable habitat. With most occurrences on high-value private property, acquiring land for protected areas will be difficult. In addition, Townsend's Mole is regarded as a nuisance or pest by most people. Any conservation recovery effort will need to be based on stewardship and public support. This is a realistic approach, as the species' distribution is so small (~20 km^2), it should be feasible. Development of a communication plan that establishes dialogue through the commodity associations on ALR will allow contact and interaction with landowners with known Townsend's Mole territories on their property.

6.3.1 Habitat Protection and Private Land Stewardship

An updated inventory is needed to determine the current distribution and location of all active territories of this species in B.C. All known Townsend's Mole sites identified in COSEWIC (2003) and by Sheehan and Galindo-Leal (1996b) as well as new territories found from 2007 to 2010 during environmental assessments and a documented occurrence in a residential area from 2010 should be re-assessed (S. Letay, pers. comm. 2014). The inventory should identify all active territories of Townsend's Mole, and landowners or property owners with Townsend's Mole.
A more long-term strategy is to identify potential habitats. A habitat model based on all known extant occurrences should be developed to identify potential habitats and assess habitat fragmentation and protection needs. Inventory in potential habitats in Washington to determine if there are unknown territories and potential unoccupied habitat near the Canadian border would help determine potential connectivity with populations in bordering Washington State.

Using the results from the inventory, all properties in B.C. with Townsend's Mole should be assessed to determine their current land use. This survey will assist in better ranking the threats found at each Townsend's Mole occurrence. It will assist with identifying farms with high risk activities and prioritize farms or landowners for outreach/education programs.

The most important group to reach are landowners (farmers, property owners in the range near Huntingdon) with known Townsend's Mole territories on their property. Because of the perception of Townsend's Mole as a pest, any interactions with landowners will require sensitivity and an emphasis on co-operation and promoting voluntary stewardship actions. The outreach program should focus on making landowners aware of the existence of an endangered species on their land and encouraging best management practices. Given the long-term objective of increasing connectivity with Townsend's Mole populations in Washington State, it is recommended that outreach/public education extends to landowners in Whatcom County, Washington, near the Canadian border with known Townsend's Mole territories.

Other audiences that need to be reached by outreach programs are the pest-control companies involved in mole eradication, the general populace of the Abbotsford area including municipal

politicians, and golf course owners/managers. At present, Townsend's Mole is essentially unknown to most of the public. With its habitat vulnerable to land use decisions that affect farmland (urban or commercial development, gravel pits, golf courses), it is essential that an education program is developed to increase the profile of this small mammal. As Townsend's Mole is known to occur on only one golf course within its known range, a focused effort could be made to promote species awareness and sensitivity in this regard.

6.3.2 Species and Population Management

A research project should be encouraged to assess interspecific competition with the Coast Mole where the two species co-occur. The research should evaluate microhabitat use by the two species, including the possible competitive exclusion of Townsend's Mole by the Coast Mole, and the effects of recovery activities on their competition.

7 INFORMATION ON HABITAT NEEDED TO MEET RECOVERY GOAL

Threats to Townsend's Mole habitat have been identified. To help meet the recovery (population and distribution) goals for this species, it is recommended that specific habitat attributes be identified for Townsend's Mole. In addition, it is recommended that locations of survival/recovery habitat are described on the landscape to mitigate habitat threats and to facilitate the actions for meeting the recovery (population and distribution) goals.

7.1 Description of Survival/Recovery Habitat

The habitat used by this species is well documented. Based on descriptions in Glendenning (1959), Sheehan and Galindo-Leal (1996a, 1996b), COSEWIC (2003), and recent observations from environmental assessments, the biophysical attributes of survival habitat for Townsend's Mole in B.C. are as follows:

1. Medium-textured, deep, silt-loam soils (i.e., the Marble Hill and Ryder soils described and mapped by Luttermerding [1980]). These well-drained soils are not prone to flooding and support high earthworm biomass.
2. Non-forested agricultural land or lawns with grass or pasture cover with minimal disturbance.

Survival/recovery habitat is described as the area occupied by known occurrences of Townsend's Mole (which have a location error of 100 m), plus an 800-m radius (i.e., the potential for above-ground dispersal distances by young; Giger 1973), where biophysical attributes are present to support the species. The stated areas are estimated to encompass adequate habitat to support one or more adult territories and sufficient habitat for above-ground dispersal by young from their natal nest. Within the described radius, only locations situated in suitable soil types (e.g., Marble Hill or Ryder soils) or with suitable soils accessible by dispersal are designated as survival/recovery habitat. Major barriers to dispersal (highways, industrial, and residential areas) are excluded.

8 MEASURING PROGRESS

Performance indicators provide a way to define and measure progress toward achieving the recovery (population and distribution) goals and objectives. These are included in Table 2 for recommended action.

9 EFFECTS ON OTHER SPECIES

The mammal most likely to be impacted by the recovery activities is the Coast Mole. The impacts of the recovery activities on the Coast Mole are unknown; however, reducing habitat degradation and direct mortality of Townsend's Mole could potentially result in higher populations of Coast Mole. If this species has a competitive edge over Townsend's Mole, increasing its densities could potentially promote displacement of Townsend's Mole. More research on the interspecific competitive relationship of Coast Mole and Townsend's Mole is required to determine related effects.

Several other species at risk overlap with the distribution of Townsend's Mole. The Barn Owl (*Tyto alba*) – Western Population overlaps in distribution and relies on the same agricultural field – grassland habitat that Townsend's Mole requires for survival. The Pacific Water Shrew (*Sorex bendirii*), Oregon Forestsnail (*Allogona townsendiana*), and Phantom Orchid (*Cephalanthera austiniae*) also occur within the B.C. range of Townsend's Mole. Recovery planning activities for Townsend's Mole will be implemented with consideration of all co-occurring species at risk, such that there are no negative impacts to these species or their habitats.

10 REFERENCES

B.C. Conservation Data Centre. 2013. BC Species and Ecosystems Explorer. B.C. Min. Environ., Victoria, BC. <http://a100.gov.bc.ca/pub/eswp/> [Accessed February, 2013]

B.C. Ministry of Agriculture, Food and Fisheries. 2004. Farmland use in Abbotsford and the future for potential growth. Report and GIS maps B.C. Min. Agric., Victoria, BC. <http://www.al.gov.bc.ca/resmgmt/sf/gis/projects.htm>

B.C. Ministry of Environment. 2010. Conservation framework. B.C. Min. Environ., Victoria, BC. <http://www.env.gov.bc.ca/conservationframework/index.html> [Accessed February 2013]

B.C. Stats. 2011. Overview of the BC and regional population projections 2011to 2036. 8 pp.

Brooks, A. 1902. Mammals of the Chilliwack District. The Ottawa Naturalist 15:239–244.

Boyle, C., L. Lavkulich, H. Schreier, and E. Kiss. 1997. Changes in land cover and subsequent effects on Lower Fraser Basin ecosystems from 1827–1990. Environ. Manage. 21:185–196.

Carraway, L.N., L.F. Alexander, and B.J. Verts. 1993. *Scapanus townsendii*. Mammalian Species 434:1–7.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. COSEWIC assessment and update status report on Townsend's Mole (*Scapanus townsendii*) in Canada. Ottawa, ON. 24 pp. <http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=184>

Conservation Measures Partnership (CMP). 2010. Threats taxonomy. <http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies/threats-taxonomy> [Accessed February, 2013]

Cowan, M. and C.J. Guiguet. 1965. The mammals of British Columbia. B.C. Prov. Museum, Victoria, BC. 414 pp.

Dalquest, W.W. 1948. Mammals of Washington. Univ. of Kansas Publ., Museum Nat. Hist. 2:1–444.

Gerber, H.S. 1978. Mole control in British Columbia. B.C. Min. Agric., Victoria, BC. 5 pp.

Giger, R.D. 1973. Movements and homing in Townsend's mole near Tillamook, Oregon. J. Mammal. 54:648–659.

Glendenning, R. 1951. Mole control in British Columbia. Government of Canada, Min. Agric., Ottawa, ON. Processed Publication Ser., Entomology 113. 4 pp.

Glendenning, R. 1959. Biology and control of the coast mole, *Scapanus orarius orarius* True, in British Columbia. Can. J. Anim. Sci. 39:34–44.

Government of Canada. 2009. Species at Risk Act policies, overarching policy framework – draft. Min. Environ., Ottawa, ON. 38 pp. <http://dsp-psd.pwgsc.gc.ca/collection_2009/ec/En4-113-2009-eng.pdf> [Accessed February, 2013]

Johnson, M.L. and T.L. Yates. 1980. A new Townsend's mole (Insectivora: Talpidae) from the State of Washington. Texas Tech Univ., The Museum, Occas. Papers 63:1–6.

Kuhn, L.W., W.Q. Wick, and R.J. Pedersen. 1966. Breeding nests of Townsend's mole in Oregon. J. Mammal. 47:239–249.

Laing, H.M. 1927. Field notes for 1927 small mammal survey, southern British Columbia. Can. Museum Nature, Ottawa, ON. Unpubl. manuscript.

Laing, H.M. 1979. Allan Brooks: artist naturalist. B.C. Prov. Museum, Victoria, BC. Spec. Publ. No. 3. 249 pp.

Luttmerding, H.A. 1980. Soils of the Langley-Vancouver map area. Report No. 15. B.C. Soil Survey. Vol. 1. Soil map mosaics and legend, lower Fraser Valley (scale 1:25 000). B.C. Min. Environ., Assessment and Planning Div., Kelowna, BC.

Maser, C., B.R. Mate, J.F. Franklin, and C.T. Dryness. 1984. Natural history of Oregon coast mammals. Univ. Oregon, Museum Nat. Hist., Eugene, OR. 496 pp.

Master, L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NatureServe conservation status assessments: factors for assessing extinction risk. NatureServe, Arlington, VA. <http://www.natureserve.org/publications/ConsStatusAssess_StatusFactors.pdf> [Accessed 02, 2013]

Moore, A.W. 1939. Notes on the Townsend mole. J. Mammal. 20:499–501.

Moore, K.E. 1990. Urbanization in the lower Fraser Valley, 1980–1987. Can. Wildl. Serv., Tech. Rep. Ser. 120:1–12.

Nagorsen, D.W. 1996. Opossums, shrews and moles of British Columbia. Univ. British Columbia Press, Vancouver, BC. 168 pp.

Nagorsen, D.W. 2002. An identification manual to the small mammals of British Columbia. B.C. Min. Sustainable Resource Management; B.C. Min. Water, Land and Air Protection; and Royal B.C. Museum, Victoria, BC.153 pp.

NatureServe. 2013. NatureServe explorer: an online encyclopedia of life [web application]. Version 7.1. Arlington, VA. <http://www.natureserve.org/explorer> [Accessed 02, 2013]

Pedersen, R.J. 1963. The life history and ecology of Townsend's mole *Scapanus townsendii* (Bachman) in Tillamook County, Oregon. M.S. thesis. Oregon State Univ., Corvallis, OR. 60 pp.

Pedersen, R.J. 1966. Nesting behavior of Townsend's mole. The Murrelet 47:47–48.

Province of British Columbia. 1982. Wildlife Act [RSBC 1996] c. 488. Queen's Printer, Victoria, BC. <http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96488_01> [Accessed February, 2013]

Province of British Columbia. 2002. Forest and Range Practices Act [RSBC 2002] c. 69. Queen's Printer, Victoria, BC. <http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_02069_01> [Accessed February, 2013]

Province of British Columbia. 2008. Oil and Gas Activities Act [SBC 2008] c. 36. Queen's Printer, Victoria, BC. <http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_08036_01> [Accessed February, 2013]

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conserv. Biol. 22:897–911.

Schaefer, V.H. 1978. Aspects of habitat selection in the coast mole (*Scapanus orarius*) in British Columbia. Ph.D. thesis. Simon Fraser Univ., Burnaby, BC. 205 pp.

Schaefer, V.H. and R.M.F. Sadleir. 1981. Factors influencing molehill construction by the coast mole (*Scapanus orarius* True). Mammalia 45:31–38.

Sheehan, T. and C. Galindo-Leal. 1996a. Status report on the Townsend's Mole *Scapanus townsendii* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 44 pp.

Sheehan, T. and C. Galindo-Leal. 1996b. Townsend's Mole (*Scapanus townsendii*) in the Lower Fraser Valley: distribution, habitat, densities and habitat management. Centre for Applied Conservation Biology, Univ. British Columbia Press, Vancouver, BC. 56 pp.

Sheehan, S.T. and C. Galindo-Leal. 1997. Identifying coast moles, *Scapanus orarius*, and Townsend's mole, *Scapanus townsendii*, from tunnel and mound size. Can. Field Nat. 111:463–465.

The Pennsylvania State University. 2008. Earthworms. PennState College of Agricultural Sciences, Agricultural Research and Extension, University Park, PA. 10 pp.

Verts, V.J. and L.N. Carraway. 1998. Land mammals of Oregon. Univ. California Press, Berkeley, CA. 668 pp.

Whitaker, J.O., C. Maser, and R.J. Pedersen. 1979. Food and ectoparasitic mites of Oregon moles. Northwest Sci. 53:268–273.

Wight, H.M. 1928. Food habits of the Townsend's mole *Scapanus townsendii* (Bachman). J. Mammal. 9:19–33.

Personal Communications

Dr. Ian McTaggart-Cowan, retired (now deceased)

Dave Nagorsen, Mammalia Biological Consulting

Tim Sheehan, consultant and former recovery team member