

# Action Plan for the Western Brook Lamprey – Morrison Creek Population (*Lampetra richardsoni*) in Canada

## Morrison Creek Lamprey



2018

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For copies of the Action Plan, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, recovery strategies, and other related recovery documents, please visit the [Species at Risk Public Registry](#).

**Cover illustration:** Western Brook Lamprey – Morrison Creek population (*Lampetra richardsoni* var. *marifuga* [top] and undetermined life history type [bottom]). Photo credit: Joy Wade.

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## 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 action plans for species listed as extirpated, endangered, or threatened for which recovery has been deemed feasible. They are also required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans is the competent minister under SARA for the Western Brook Lamprey – Morrison Creek population and has prepared this Action Plan to implement the Recovery Strategy, as per section 47 of SARA. In preparing the Action Plan, the competent minister has considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this Action Plan has been prepared in cooperation with the Morrison Creek Streamkeepers and the Sport Fishing Advisory Committee, the forest industry, Vancouver Island University, Lake Trail Middle School, the City of Courtenay, the Comox Valley Regional District, and the Province of British Columbia as per section 48(1) of SARA.

As stated in the preamble to SARA, 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 and actions set out in this Action Plan and will not be achieved by Fisheries and Oceans Canada (DFO) or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this Action Plan for the benefit of Western Brook Lamprey – Morrison Creek population and Canadian society as a whole.

Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines recovery measures to be taken by DFO and other jurisdictions and/or organizations to help achieve the population and distribution objectives identified in the Recovery Strategy.

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

## Acknowledgments

This Action Plan was prepared by Mike Waters (DFO) and Joy Wade (Fundy Aqua Services Inc.), with contributions from DFO's Martin Nantel, Sean MacConnachie, Alyssa Gerick, Nadine Pinnell, and Jonathan Thar.

## Executive Summary

The Western Brook Lamprey – Morrison Creek population (*Lampetra richardsoni*) was listed as Endangered under the *Species at Risk Act* (SARA) in 2003. This Action Plan is considered one in a series of documents that are linked and should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, the Recovery Strategy, and the Canadian Science Advisory Secretariat (CSAS) Science Advisory Reports and Research Documents.

The Western Brook Lamprey – Morrison Creek population is a freshwater fish endemic to the Morrison Creek watershed in Courtenay, British Columbia. It is a relatively small (10 –18 cm), scaleless, eel-like jawless fish with a circular-shaped mouth. The Western Brook Lamprey – Morrison Creek population exhibits a rare life history in which both a non-parasitic (*L. richardsoni*) and a parasitic (*L. richardsoni* var. *marifuga*) type are produced.

This Action Plan addresses both life history types of Western Brook Lamprey – Morrison Creek population, which are collectively referred to as “Morrison Creek Lamprey” hereinafter. It outlines measures that provide the best chance of achieving the population and distribution objectives for the population, including the measures to be taken to address the threats and monitor the recovery of the population. The population and distribution objectives for the Morrison Creek Lamprey (portrayed as recovery goals and objectives in the Recovery Strategy) are to:

1. secure its long-term viability within its natural range;
2. resolve the species taxonomic uncertainties for the purposes of its effective protection and recovery;
3. maintain a self-sustaining population within Morrison Creek;
4. maintain, and where possible enhance, the ecological integrity of habitat for the species;
5. increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence; and,
6. foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.

The Recovery Strategy (Section 9, Table 1) outlines the measures to be taken under the following broad strategies:

1. establish and support a Recovery Implementation Group or alternative working group for Morrison Creek Lamprey;
2. address information gaps that inhibit conservation of Morrison Creek Lamprey;
3. clarify and address threats to Morrison Creek Lamprey;
4. conduct studies to help define critical habitat for Morrison Creek Lamprey;
5. develop a watershed-scale sustainability plan;
6. develop and implement a long-term monitoring plan;
7. establish water quality and water use objectives for Morrison Creek;
8. inform and educate stakeholders and the general public about the species and general biodiversity values;
9. work with local government, land developers, and others to improve and encourage watershed stewardship; and,
10. develop sound protocols for scientific investigations.

For the Morrison Creek Lamprey, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support its life-cycle processes. This Action Plan identifies critical habitat for the Morrison Creek Lamprey as Morrison Creek and Arden Creek, and a riparian area of 10 – 25 metres width surrounding the wetted perimeter of both sides of these water bodies. Additionally, the identified critical habitat includes the wetlands and their interconnecting waterways within and immediately adjacent to the Morrison Creek watershed boundaries, a riparian area width of 30 metres surrounding the wetlands' wetted perimeter, and a riparian area of 10 – 25 metres width surrounding the wetted perimeter of both sides of the interconnecting waterways (Section 2.1.3). It is anticipated that the protection of the Morrison Creek Lamprey critical habitat from destruction will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat (Section 2.1.3).

An evaluation of the socio-economic costs of the Action Plan and the benefits to be derived from its implementation is provided in Section 3.

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# 1 Recovery Actions

## 1.1 Context and Scope of the Action Plan

The Western Brook Lamprey (*Lampetra richardsoni*) is a non-anadromous, non-parasitic, freshwater-resident species commonly found in streams of British Columbia, and elsewhere in western North America. It is a relatively small, scaleless, eel-like jawless fish with a circular-shaped mouth (COSEWIC 2010). The Morrison Creek population of Western Brook Lamprey is found only in the Morrison Creek watershed on Vancouver Island in the vicinity of Courtenay (Figure 1). This population exhibits a rare life history in which both a non-parasitic (*L. richardsoni*) and a parasitic (*L. richardsoni* var. *marifuga*) type are produced (Beamish et al. 1999). This Action Plan addresses both life history types, which are collectively referred to as Morrison Creek Lamprey.<sup>1</sup>

The non-parasitic life history type is recognized by its dark colouration, smaller stature, and blunt teeth as adults, whereas the parasitic type is characterized by dark pigmentation with silvery sides, a white under-belly, delayed sexual maturation and sharp adult teeth (COSEWIC 2010; Beamish 1985). The two types are indistinguishable as ammocoetes (also known as larvae); only following metamorphosis can they be distinguished (COSEWIC 2010). Very little difference exists genetically between the two (Beamish et al. 2016). It is hypothesized that some unknown environmental trigger enables the parasitic *marifuga* type to be expressed (Youson 2004). The lifespan of Morrison Creek Lamprey is unknown but the generation time is believed to range between approximately 4 – 9 years (COSEWIC 2010).

No quantitative population estimates exist for Morrison Creek Lamprey; however, Beamish (2013) summarizes the catch and biological information of survey efforts from the late 1970s and 1980s. Comparing these data to more recent catch studies (Wade and MacConnachie 2014) indicates catch rates of the parasitic type of Morrison Creek Lamprey have decreased over the past 30 years. The taxonomic relationship between the Morrison Creek population and other lampreys is currently unclear.

Further details on the taxonomical uncertainty, morphological and other biological and genetic similarities and differences of the two life history types are described elsewhere (Beamish 1985, 1987, 2013; COSEWIC 2000, 2010; National Recovery Team for Morrison Creek Lamprey 2007; DFO 2015; Wade et al. 2015).

The Morrison Creek Lamprey was listed as Endangered under the *Species at Risk Act* (SARA) in 2003. This Action Plan is part of a series of documents regarding Morrison Creek Lamprey, including the COSEWIC Status Report (COSEWIC 2010) and the Recovery Strategy (National Recovery Team for Morrison Creek Lamprey 2007), that should be taken into consideration together. Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The recovery strategy also provides background information on the species and its threats and critical habitat information.

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<sup>1</sup> In Schedule 1 of SARA, this species is officially listed as “Western Brook Lamprey – Morrison Creek Population (*Lampetra richardsoni*).” In this document, the common name “Morrison Creek Lamprey” is used throughout to maintain consistency with the Recovery Strategy (National Recovery Team for Morrison Creek Lamprey 2007), and includes the two life history types.



Key anthropogenic threats identified in the Recovery Strategy include unsustainable land use and water use, degraded water quality, reduction in prey base, climate change, excessive take of individuals for research, and recreational activities (National Recovery Team for Morrison Creek Lamprey 2007).

The general approaches to achieving survival or recovery for Morrison Creek Lamprey are to:

- establish and support stewardship initiatives;
- undertake specific research activities to fill knowledge gaps and clarify threats;
- delineate and protect key habitats;
- minimize impacts from land and water use within the context of a broader watershed development plan; and,
- design and implement sound monitoring programs (National Recovery Team for Morrison Creek Lamprey 2007).

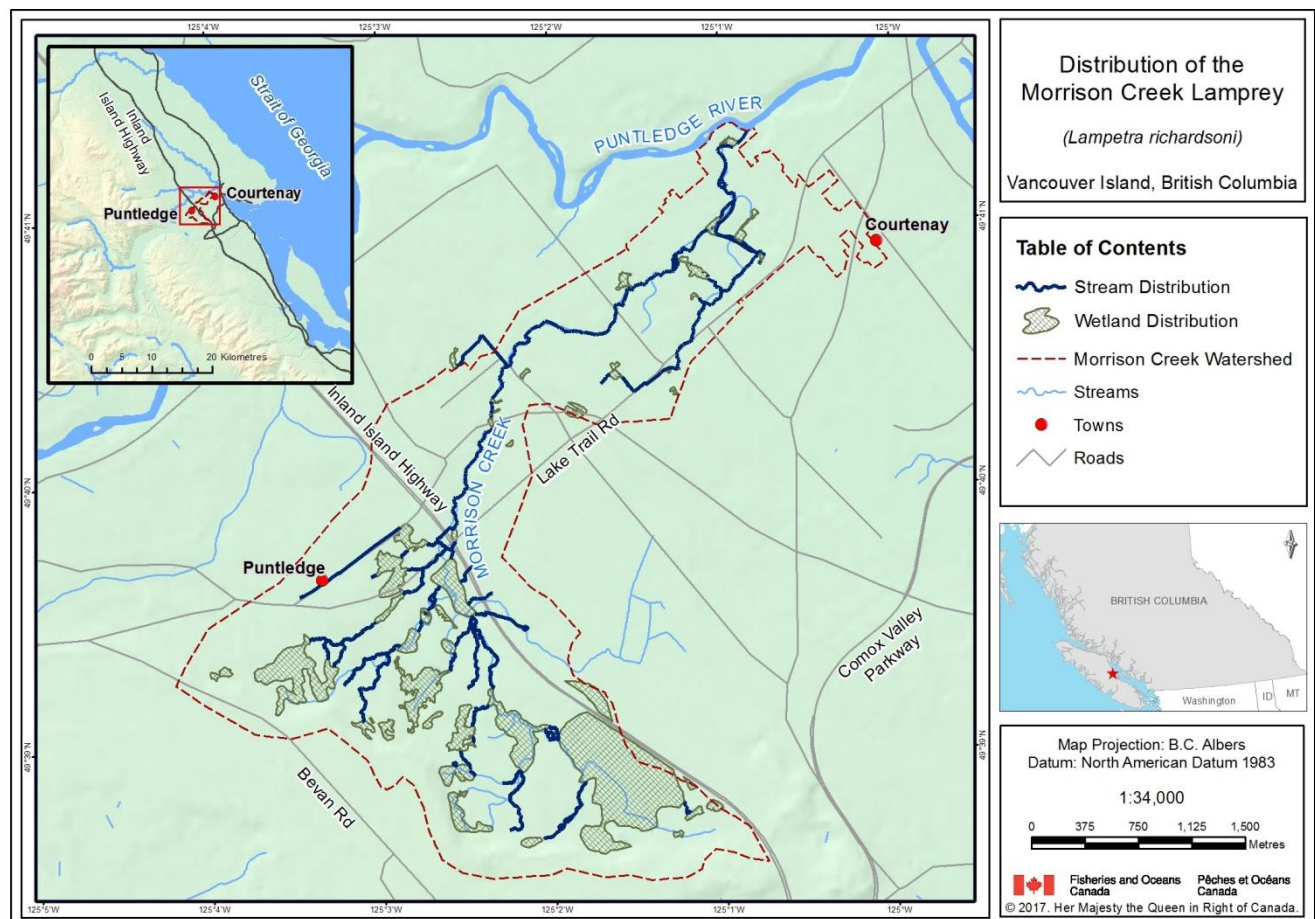


Figure 1. Distribution of Morrison Creek Lamprey



The population and distribution objectives (portrayed as recovery goals and objectives in the Recovery Strategy) for Morrison Creek Lamprey are to:

1. secure its long-term viability within its natural range;
2. resolve taxonomic uncertainties related to Morrison Creek Lamprey for the purposes of its effective protection and recovery;
3. maintain a self-sustaining population of Morrison Creek Lamprey within Morrison Creek;
4. maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey;
5. increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence; and,
6. foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.

Under section 47 of SARA, the competent minister must prepare one or more action plans based on the recovery strategy. Therefore, action planning for species at risk recovery is an iterative process. The Implementation Schedule in this Action Plan may be modified in the future depending on the progression towards recovery.

## 1.2 Measures to be Taken and Implementation Schedule

Success in the recovery of this species is dependent on the actions of many different jurisdictions; it requires the commitment and cooperation of the constituencies that will be involved in implementing the directions and measures set out in this Action Plan.

This Action Plan provides a description of the measures that provide the best chance of achieving the population and distribution objectives for Morrison Creek Lamprey, including measures to be taken to address threats to the population and monitor its recovery, to guide not only activities to be undertaken by DFO but those for which other jurisdictions, organizations and individuals have a role to play. As new information becomes available, these measures and the priority of these measures may change. DFO strongly encourages all Canadians to participate in the conservation of Morrison Creek Lamprey through undertaking measures outlined in this Action Plan.

The Recovery Strategy (Section 9, Table 1) outlines the measures to be taken under the following broad strategies:

1. establish and support a Recovery Implementation Group or alternative working group for Morrison Creek Lamprey;
2. address information gaps that inhibit conservation of Morrison Creek Lamprey;
3. clarify and address threats to Morrison Creek Lamprey;
4. conduct studies to help define critical habitat for Morrison Creek Lamprey;
5. develop a watershed-scale sustainability plan;
6. develop and implement a long-term monitoring plan;
7. establish water quality and water use objectives for Morrison Creek;
8. inform and educate stakeholders and the general public about the species and general biodiversity values;
9. work with local government, land developers, and others to improve and encourage watershed stewardship; and,
10. develop sound protocols for scientific investigations.

Table 1 identifies the measures to be undertaken by DFO to support the recovery of Morrison Creek Lamprey.

Table 2 identifies the measures to be undertaken collaboratively by DFO and its partners, other agencies, organizations or individuals. Implementation of these measures will be dependent on a collaborative approach, in which DFO is a partner in recovery efforts, but cannot implement the measures alone.

As all Canadians are invited to join in supporting and implementing this Action Plan, Table 3 identifies the remaining measures that represent opportunities for other jurisdictions, organizations or individuals to lead in the recovery of the population. If your organization is interested in participating in one of these measures, please contact the Species at Risk Pacific Region office at [sara@pac.dfo-mpo.gc.ca](mailto:sara@pac.dfo-mpo.gc.ca).

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

**Table 1. Measures to be undertaken by Fisheries and Oceans Canada**

#	Recovery Measures	Broad Strategy	Priority <sup>2</sup>	Objectives Addressed	Timeline
1	Continue to investigate presence and distribution of the population in the Upper Morrison Creek watershed, and in the natural and artificial side channels and tributaries of Morrison Creek and Arden Creek.	Address information gaps that inhibit conservation of Morrison Creek Lamprey.	High	Increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence.	2018 - 2022
2	Develop allowable harm estimates and collection guidelines for Morrison Creek Lamprey, which encourage the use of minimally invasive sampling and handling techniques.	Develop sound protocols for scientific investigations.	Medium	Secure its long-term viability within its natural range. Maintain a self-sustaining population of Morrison Creek Lamprey within Morrison Creek watershed.	2018 - 2022

<sup>2</sup> "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "High" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species.
- "Medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species.
- "Low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats.

#	Recovery Measures	Broad Strategy	Priority <sup>2</sup>	Objectives Addressed	Timeline
3	<p>Develop a sufficiently robust monitoring plan to provide for a clear indication of the progress achieved towards securing the population's long-term viability within its natural range and maintaining a self-sustaining population within the Morrison Creek watershed.</p> <p>Monitoring efforts may include:</p> <ol style="list-style-type: none"> <li>1) lamprey presence, distribution, habitat use, nest distribution, spawning site locations, specific critical habitat attributes, and trends;</li> <li>2) water quality parameters such as oxygen, temperature, flow and pH;</li> <li>3) population and distribution of the watershed's aquatic communities (ecological dynamics, particularly prey-predator relationships); and,</li> <li>4) aquatic invasive species presence.</li> </ol>	Develop and implement a long-term monitoring plan.	Medium	<p>Secure its long-term viability within its natural range.</p> <p>Maintain a self-sustaining population of Morrison Creek Lamprey within Morrison Creek watershed.</p> <p>Increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence.</p>	2018 - 2022

**Table 2. Measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners, other agencies, organizations or individuals**

#	Recovery Measures	Broad Strategy	Priority <sup>3</sup>	Objectives Addressed	Timeline <sup>4</sup>	Collaborators
4	Identify Morrison Creek Lamprey prey preference, feeding rates, and estimate prey abundance and trends.	Address information gaps that inhibit conservation of Morrison Creek Lamprey.	High	Increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence.	Short-term	Stewardship groups, researchers (e.g. academic institutions, consultants), industry, local or provincial government.
5	Implement the monitoring plan for Morrison Creek Lamprey.	Develop and implement a long-term monitoring plan.	Medium	Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey. Foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.	Long-term	Stewardship groups, recreational users, local or provincial governments, industry, schools.
6	Assess and identify physical barriers to Morrison Creek Lamprey movement and potential areas for habitat restoration.	Clarify and address threats to Morrison Creek Lamprey.	Medium	Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey.	Long-term	Stewardship groups, recreational users, local or provincial governments, industry.

<sup>3</sup> Refer to footnote 2.<sup>4</sup> Short-term = 2018-2022, medium-term = 2023-2027, long-term = beyond 2028.

#	Recovery Measures	Broad Strategy	Priority <sup>3</sup>	Objectives Addressed	Timeline <sup>4</sup>	Collaborators
7	Conduct studies to assess connectivity in key headwater areas and geospatially assess the hydrological properties of Morrison Creek and its headwaters (including wetlands). This may include groundwater measurements using previously drilled monitoring wells in headwater areas.	Develop a watershed-scale sustainability plan that includes: 1) identification of key habitat, flow, and water quality values for lamprey, and 2) guidelines to avoid localized and watershed-scale impacts, which can be incorporated into effective decision making.	High	Increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence.	Medium-term	Researchers (e.g. academic institutions, consultants), industry, local or provincial governments.
8	Develop tools that would enable definitive identification of ammocoetes as either the non-parasitic or parasitic type of Morrison Creek Lamprey.	Develop a watershed-scale sustainability plan that includes: 1) identification of key habitat, flow, and water quality values for lamprey, and 2) guidelines to avoid localized and watershed-scale impacts, which can be incorporated into effective decision making.	Medium	Increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence.	Long-term	Researchers (e.g. academic institutions, consultants), industry, provincial governments.

#	Recovery Measures	Broad Strategy	Priority <sup>3</sup>	Objectives Addressed	Timeline <sup>4</sup>	Collaborators
9	<p>Identify and evaluate water management options to satisfy both conservation and stakeholder needs in the following ways:</p> <ul style="list-style-type: none"> <li>- Share information on Morrison Creek Lamprey; and,</li> <li>- engage relevant agencies about conservation and water management options.</li> </ul>	Develop a watershed-scale sustainability plan that includes: 1) identification of key habitat, flow, and water quality values for lamprey, and 2) guidelines to avoid localized and watershed-scale impacts, which can be incorporated into effective decision making.	Medium	<p>Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey.</p> <p>Foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.</p>	Medium-term	Local and provincial governments.
10	Develop water quality objectives that address the population's biological needs and parameters that affect the quality of its habitat.	Establish water quality and water use objectives for Morrison Creek	Medium	Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey.	Medium-term	Researchers (e.g. academic institutions, consultants), industry, local or provincial governments.



**Table 3. Measures that represent opportunities for other jurisdictions, organizations or individuals**

#	Recovery Measures	Broad Strategy	Priority <sup>5</sup>	Objectives Addressed	Contributors
11	Remediate barriers and conduct in-stream habitat restoration / creation / complexification projects to attenuate high and low water flows which may affect lamprey movement.	Clarify and address threats to Morrison Creek Lamprey.	Medium	Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey. Foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.	Potentially stewardship groups, recreational users, local or provincial governments, industry, schools, other agencies, groups or individuals.
12	In new and existing developments, install and maintain oil separators in potentially high-risk drains and explore options for disposal of waste materials.	Clarify and address threats to Morrison Creek Lamprey.	Medium	Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey. Foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.	Potentially local or provincial governments, land owners, developers.
13	Define discharge levels in Morrison Creek and Arden Creek throughout the year to better inform potential water conservation options.	Clarify and address threats to Morrison Creek Lamprey.	Medium	Increase scientific understanding of Morrison Creek Lamprey through additional investigation of its natural history, critical habitat and threats to its persistence.	Potentially stewardship groups, researchers (e.g. academic institutions, consultants), industry, local or provincial governments.

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<sup>5</sup> Refer to footnote 2.

#	Recovery Measures	Broad Strategy	Priority <sup>5</sup>	Objectives Addressed	Contributors
14	Share information about Morrison Creek Lamprey and encourage landowners and relevant levels of governments to consider the population in the development, implementation, and updating of land use plans, official community plans, by-laws and management guidelines.	Work with local government, land developers, and others to improve and encourage watershed stewardship.	Medium	Foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.  Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey.	Potentially stewardship groups, recreational users, local or provincial governments, schools, other agencies, groups or individuals.
15	Participate in a group that supports the conservation and protection of the population, and undertake watershed-based stewardship initiatives that increase understanding and awareness of the population. For example: <ul style="list-style-type: none"> <li>- promote and adopt best practices; and,</li> <li>- explore options for conservation of important headwater habitats outside of critical habitat.</li> </ul>	Establish and support a Recovery Implementation group (RIG) or alternative working group for Morrison Creek Lamprey; inform and educate stakeholders and the general public about the species and general biodiversity values	Medium	Foster awareness of Morrison Creek Lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection.  Maintain, and where possible enhance, the ecological integrity of habitat for Morrison Creek Lamprey.	Potentially stewardship groups, recreational users, local or provincial governments, industry, schools, other agencies, groups or individuals.

#	Recovery Measures	Broad Strategy	Priority <sup>5</sup>	Objectives Addressed	Contributors
16	Sample other Western Brook Lamprey populations and compare them to Morrison Creek Lamprey to determine the genetic relationship within and between the populations.	Establish and support a Recovery Implementation group (RIG) or alternative working group for Morrison Creek Lamprey; inform and educate stakeholders and the general public about the species and general biodiversity values	Low	Resolve taxonomic uncertainties related to Morrison Creek Lamprey for the purposes of its effective protection and recovery.	Potentially stewardship groups, provincial government, researchers (e.g. academic institutions, consultants).

## 2 Critical Habitat

### 2.1 Identification of the Species' Critical Habitat

#### 2.1.1 General Description of the Species' Critical Habitat

Critical habitat is defined in SARA as “...*the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or in an action plan for the species.*” [section 2(1)]

Also, SARA defines habitat for aquatic species at risk as “... *spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced.*” [section 2(1)]

For Morrison Creek Lamprey, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support its life-cycle processes. The critical habitat identified in this Action Plan is sufficient to achieve the Morrison Creek Lamprey's population and distribution objectives.

This Action Plan identifies critical habitat for Morrison Creek Lamprey as Morrison Creek and Arden Creek, including a riparian area of 10 – 25 metres width surrounding the wetted perimeter of both sides of these water bodies, and the wetlands and their interconnecting waterbodies within and immediately adjacent to the Morrison Creek watershed boundaries, including a riparian area width of 30 metres surrounding the wetlands' wetted perimeter, and a riparian area of 10 – 25 metres width surrounding the wetted perimeter of both sides of the interconnecting waterways.

#### 2.1.2 Information and Methods Used to Identify Critical Habitat

Critical habitat identification for Morrison Creek Lamprey has been informed by the publicly available research document *Information to support the identification of critical habitat for the Morrison Creek Lamprey* (Wade et al. 2015) and *Review of the information to support the identification of critical habitat for the Morrison Creek Lamprey* (DFO 2015), both of which reflect the outcomes of a related peer review process undertaken through DFO's Canadian Science Advisory Secretariat.

Potential critical habitat for Morrison Creek Lamprey has been identified using the bounding box approach. Recent DFO guidance on critical habitat identification using the bounding box approach, which is described in more detail below, has clarified that critical habitat includes the biophysical features and attributes within an area frequented by the species that provide the functional capacity for the species to carry out its life-cycle processes (DFO 2015). The critical habitat area recommended by Wade et al. (2015) and DFO (2015) was thus adjusted to reflect this departmental guidance.

In proposing critical habitat for Morrison Creek Lamprey, Wade et al. (2015) and DFO (2015) considered, among others, the relatively small size of the drainage (entire watershed is 890 ha), the population's extreme endemism, the varied habitat features believed to be required by

different life stages, and the distribution of these habitats throughout the waterbodies where the population is found. Furthermore, potential development pressure in the Morrison Creek watershed was also considered as it could result in significant impacts to habitat and population levels through changes to stream flow, negative impacts to water sources, degradation of riparian vegetation and the introduction of pollutants to the watershed.

Sufficient aquatic critical habitat has been identified, based on occurrence data, to support all life stages of the parasitic type of Morrison Creek Lamprey. Moreover, sufficient aquatic critical habitat has also been identified to support all life stages of the non-parasitic type since it may spawn and produce eggs that could subsequently metamorphose into the parasitic type.

Riparian areas play an important part in preserving and contributing to the characteristics of aquatic ecosystems. In order to define the width of the riparian component of critical habitat, the British Columbia *Riparian Areas Regulation* (RAR; B.C. Reg. 376/2004) method was applied to Morrison Creek. The results of this analysis led to critical habitat riparian areas of 10 - 30 metres width surrounding the wetted edges, depending on the area of the stream and its characteristics.

For greater certainty, note that the critical habitat areas, features, functions and attributes identified in this Action Plan apply to both non-parasitic and parasitic types of Morrison Creek Lamprey (*L. richardsoni* and *L. richardsoni* var. *marifuga*) in Morrison Creek as these fish cannot be differentiated until after metamorphosis.

### 2.1.3 Identification of Critical Habitat

#### ***Geographic Information***

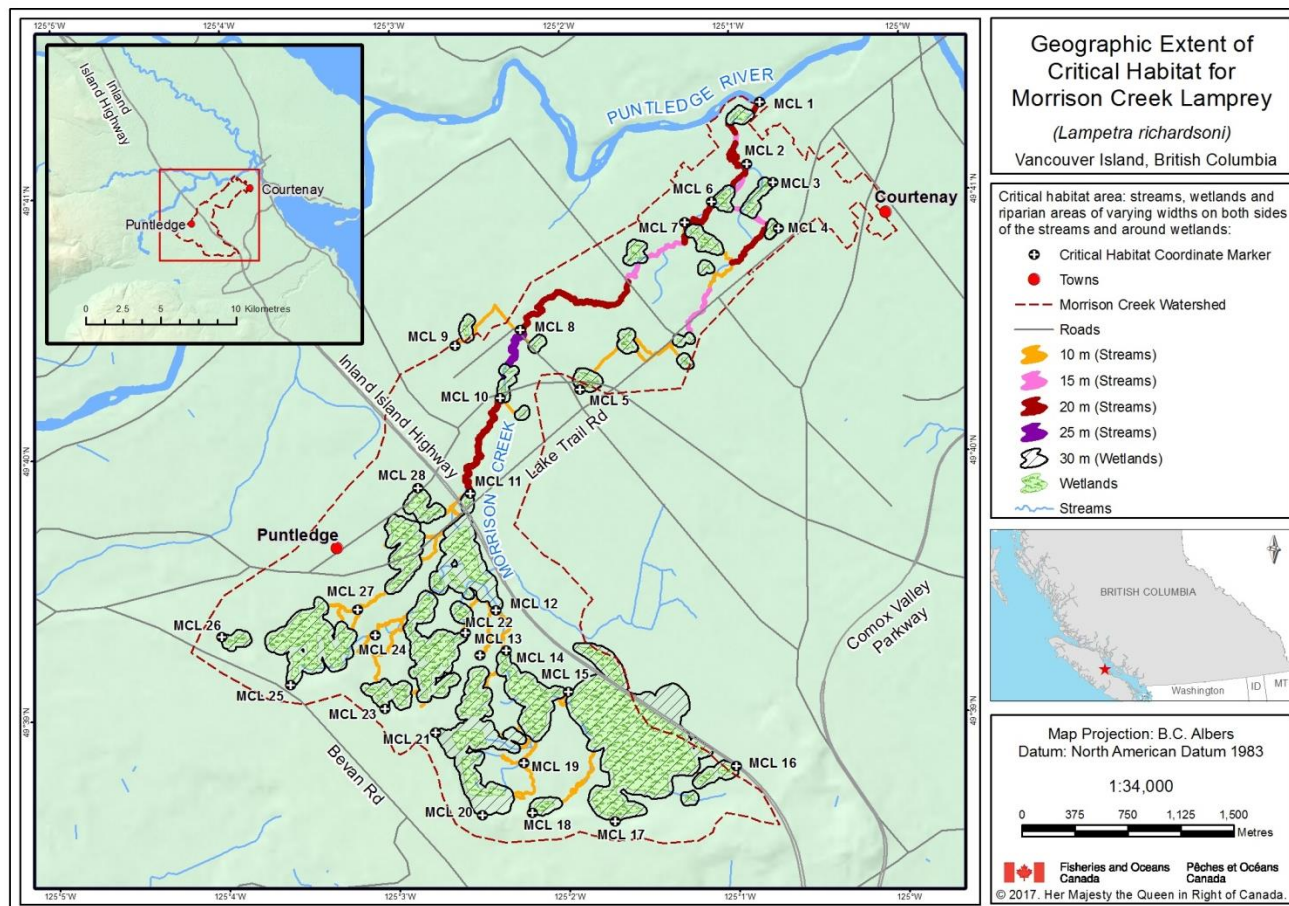
For Morrison Creek Lamprey, critical habitat is identified (Figure 2) as:

- Morrison Creek and Arden Creek, and a riparian area of 10 – 25 metres width surrounding the wetted perimeter of both sides of these water bodies.
- The wetlands and their interconnecting waterways within and immediately adjacent to the Morrison Creek watershed boundaries, a riparian area width of 30 metres surrounding the wetlands' wetted perimeter, and a riparian area of 10 – 25 metres width surrounding the wetted perimeter of both sides of the interconnecting waterways.

The wetted perimeter of the streams and wetlands is to be interpreted on the ground as the high water mark for streams and wetlands, respectively, as defined in the *Riparian Areas Regulation's* Schedule of Assessment Methods (B.C. Reg. 376/2004).<sup>6</sup>

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<sup>6</sup> The *Riparian Areas Regulation's* Schedule of Assessment Methods defines the high water mark for streams as "the visible high water mark of a stream where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the stream a character distinct from that of its banks, in vegetation, as well as the nature of the soil itself, and includes the active floodplain". The *Riparian Areas Regulation's* Schedule of Assessment Methods defines the outer edge of wetlands as follows: "from an ecological perspective, either an abundance of hydrophytes or hydric soil conditions is generally sufficient to indicate a wetland ecosystem. The boundary or high water mark of the wetland is identified by changes in vegetation structure, loss of obligate hydrophytes, and absence of wetland soil characteristics."



**Figure 2. Geographic extent of critical habitat for Morrison Creek Lamprey (refer to Table 4 for bounding box coordinates)**

The geographic extent of the critical habitat follows the contour of the upland boundaries of the riparian areas surrounding the streams and wetlands identified as critical habitat. For greater clarity, these riparian areas are found on both sides of these streams and around these wetlands, and vary in width as per the symbology and colours of the Legend in Figure 2.

The locations of the critical habitat's functions, features and attributes have been identified using the Bounding Box approach. This means that the critical habitat is not comprised of the entire area within the identified boundaries but only those areas within the identified geographical boundaries where the described biophysical feature and the function it supports occur, as described in Table 5. The approximate area of critical habitat (hectares) is: stream (3), stream riparian (38), wetlands (108), wetland riparian (120), total (269).

**Table 4. Geographic Bounding Box coordinates of critical habitat for Morrison Creek Lamprey.**

<b>ID</b>	<b>Latitude</b>	<b>Longitude</b>
MCL 1	49°41'20" N	125°00'49" W
MCL 2	49°41'06" N	125°00'54" W
MCL 3	49°41'02" N	125°00'45" W
MCL 4	49°40'51" N	125°00'43" W
MCL 5	49°40'15" N	125°01'54" W
MCL 6	49°40'58" N	125°01'07" W
MCL 7	49°40'53" N	125°01'16" W
MCL 8	49°40'29" N	125°02'15" W
MCL 9	49°40'25" N	125°02'38" W
MCL 10	49°40'13" N	125°02'22" W
MCL 11	49°39'51" N	125°02'33" W
MCL 12	49°39'24" N	125°02'25" W
MCL 13	49°39'14" N	125°02'31" W
MCL 14	49°39'15" N	125°02'21" W
MCL 15	49°39'05" N	125°01'60" W
MCL 16	49°38'48" N	125°01'01" W
MCL 17	49°38'36" N	125°01'44" W
MCL 18	49°38'38" N	125°02'13" W
MCL 19	49°38'49" N	125°02'16" W
MCL 20	49°38'37" N	125°02'31" W
MCL 21	49°38'56" N	125°02'47" W
MCL 22	49°39'19" N	125°02'36" W
MCL 23	49°39'02" N	125°03'05" W
MCL 24	49°39'19" N	125°03'08" W
MCL 25	49°39'08" N	125°03'38" W
MCL 26	49°39'19" N	125°04'02" W
MCL 27	49°39'25" N	125°03'14" W
MCL 28	49°39'53" N	125°02'52" W

### ***Biophysical Functions, Features and Attributes***

Table 5 summarizes the best available knowledge of the functions, features and attributes for each life stage of Morrison Creek Lamprey (refer to Section 2 of the Recovery Strategy - 'Description of Needs of the Species'). Note that not all attributes in Table 5 must be present in order for a feature to be identified as critical habitat. If a feature as described in Table 5 is present and capable of supporting the associated function(s), the feature is considered critical habitat for the species, even though some of the associated attributes might be outside of the range indicated in the table.



**Table 5. General summary of the biophysical functions, features, attributes and location of critical habitat necessary for the recovery of Morrison Creek Lamprey<sup>7</sup>**

Geographic location	Life stage	Function <sup>8</sup>	Feature <sup>9</sup>	Attribute <sup>10</sup>
Morrison Creek and Arden Creek	Eggs and yolk-sac larvae	Egg incubation and rearing	Stream habitat	<ul style="list-style-type: none"> <li>• Hard substrate covered with small pebbles/sediment</li> <li>• Pebbles no greater than 1 cm diameter for building nests</li> <li>• Cool, free flowing water available year round</li> <li>• Low water flow (0.1 to 0.7 m/s)</li> <li>• Water depth within the natural range of variation</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Sedimentation levels within the natural range of variation</li> </ul>
Morrison Creek and Arden Creek	Ammocoetes	Feeding and rearing	Stream habitat	<ul style="list-style-type: none"> <li>• Low to medium water flow</li> <li>• Loose silt, sand or mud substrate in which to burrow</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Adequate food supply</li> </ul>

<sup>7</sup> For greater certainty, the critical habitat areas, features, functions and attributes apply to both non-parasitic and parasitic types of Morrison Creek Lamprey (*L. richardsoni* and *L. richardsoni* var. *marifuga*) in Morrison Creek as these fish cannot be differentiated until after metamorphosis.

<sup>8</sup> Function: A life-cycle process of the listed species taking place in critical habitat (e.g. spawning, nursery, rearing, feeding and migration). The function informs the rationale for its protection. The identification of critical habitat must describe how the functions support a life process necessary for the survival or recovery of species at risk.

<sup>9</sup> Feature: Every function is the result of a single or multiple feature(s) which are the structural components of the critical habitat. Features describe *how* the habitat is critical and they are the essential structural component that provides the requisite function(s) to meet the species' needs. Features may change over time and are usually comprised of more than one part, or attribute. A change or disruption to the feature or any of its attributes may affect the function and its ability to meet the biological needs of the species.

<sup>10</sup> Attribute: Attributes are measurable properties or characteristics of a feature. Attributes describe how the identified features support the identified functions necessary for the species' life processes. Together, the attributes allow the feature to support the function. In essence, attributes provide the greatest level of information about a feature, the quality of the feature and how the feature is able to support the life-cycle requirements of the species.

Geographic location	Life stage	Function <sup>8</sup>	Feature <sup>9</sup>	Attribute <sup>10</sup>
Morrison Creek and Arden Creek	Adults	Spawning	Stream habitat	<ul style="list-style-type: none"> <li>• Hard substrate covered with small pebbles/sediment</li> <li>• Pebbles no greater than 1 cm diameter for building nests</li> <li>• Cool, free flowing water available year round</li> <li>• Low water flow (0.1 to 0.7 m/s)</li> <li>• Water depth within the natural range of variation</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Sedimentation levels within the natural range of variation</li> </ul>
Morrison Creek and Arden Creek	Adults	Feeding	Stream habitat	<ul style="list-style-type: none"> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Small boulders and overhanging banks, or muddy or silty substrates for shelter</li> </ul>
Morrison Creek and Arden Creek	Metamorphosing adults	Metamorphosis	Stream habitat	<ul style="list-style-type: none"> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Small boulders and overhanging banks, or muddy or silty substrates for shelter</li> </ul>

Geographic location	Life stage	Function <sup>8</sup>	Feature <sup>9</sup>	Attribute <sup>10</sup>
Wetlands within and immediately adjacent to the Morrison Creek watershed boundaries	Ammocoetes;  Metamorphosing adults;  Adults	Feeding and rearing;  Metamorphosis;  Feeding	Wetland habitat	<p>The following attributes support all identified functions of each identified life stage:</p> <ul style="list-style-type: none"> <li>• Terrestrially supplied food and nutrients</li> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Stable shade cover for wetland habitat</li> <li>• Muddy or silty substrates for shelter</li> <li>• Plant litter to contribute to detritus</li> <li>• Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation)</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> </ul>
Morrison Creek and Arden Creek, and wetlands within and immediately adjacent to the Morrison Creek watershed boundaries	Eggs and yolk-sac larvae;  Ammocoetes;  Adults and metamorphosing adults	Egg incubation and rearing;  Feeding and rearing;  Feeding and metamorphosis	Riparian area surrounding wetted perimeters of streams and wetlands	<p>The following attributes support all identified functions of each identified life stage:</p> <ul style="list-style-type: none"> <li>• Stable banks</li> <li>• Terrestrially supplied food and nutrients</li> <li>• Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation)</li> <li>• Stable shade cover for stream and wetland habitat</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Plant litter to contribute to detritus</li> </ul>

***Summary of critical habitat relative to population and distribution objectives***

These are areas that the Minister of Fisheries and Oceans considers necessary to achieve the Morrison Creek Lamprey's population and distribution objectives required for the survival or recovery of the population.

**2.2 Examples of Activities Likely to Result in Destruction of Critical Habitat**

The following examples of activities likely to result in the destruction<sup>11</sup> of critical habitat (Table 5) are based on known human activities that are likely to occur in and around critical habitat and would result in the destruction of critical habitat if unmitigated. The list of activities is neither exhaustive nor exclusive and has been guided by the threats described in Section 3 of the Recovery Strategy. The absence of a specific human activity in Table 6 does not preclude or restrict the Department's ability to regulate that activity under SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition, and does not mean the activity will inevitably result in destruction of critical habitat. Every proposed activity must be assessed on a case-by-case basis and site-specific mitigation will be applied where it is available and reliable. Where information is available, thresholds and limits have been developed for critical habitat attributes to better inform management and regulatory decision making. However, in many cases knowledge of a species and its critical habitat's thresholds or tolerance to disturbance from human activities is lacking and must be acquired.

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<sup>11</sup> Destruction occurs when there is a temporary or permanent loss of a function of critical habitat at a time when it is required by the species.

**Table 6. Examples of activities likely to result in the destruction of critical habitat**

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Land-use activities which have the capacity to alter aquatic habitat directly or indirectly.	Work in or around critical habitat with excessive riparian vegetation removal, improper sediment and erosion control, incompatibility with lamprey habitat requirements, or impacts to water availability in streams, springs, wetlands, or groundwater.	<p>Impacts to riparian habitat, alteration of run-off rates or water storage capacity that impact water flow.</p> <p>Reduction in bank stability leading to an increase in sediment inputs to water, which could:</p> <ul style="list-style-type: none"> <li>- Reduce aquatic vegetation which alters food and nutrient regime as well as increase predator exposure;</li> <li>- Alter preferred substrate and water quality (sediment, turbidity, etc.);</li> <li>- Increase the amount of sunlight reaching the stream or wetland enhancing algal production and leading to temporary loss of habitat.</li> </ul> <p>Stream / wetland / riparian modifications can:</p> <ul style="list-style-type: none"> <li>- Cover or alter preferred substrates, alter water depths and flow patterns, potentially affecting turbidity, nutrient levels, water temperatures and oxygenation, and depositional areas;</li> <li>- Reduce habitat availability;</li> <li>- Reduce organic inputs into the water and alter temperatures, potentially affecting food availability.</li> </ul>	Feeding and rearing of ammocoetes	Stream habitat	<ul style="list-style-type: none"> <li>• Low to medium water flow</li> <li>• Loose silt, sand or mud substrate in which to burrow</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Adequate food supply</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Land-use activities which have the capacity to alter aquatic habitat directly or indirectly.	Work in or around critical habitat with excessive riparian vegetation removal, improper sediment and erosion control, incompatibility with lamprey habitat requirements, or impacts to water availability in streams, springs, wetlands, or groundwater.	<p>Impacts to riparian habitat, alteration of run-off rates or water storage capacity that impact water flow.</p> <p>Reduction in bank stability leading to an increase in sediment inputs to water, which could:</p> <ul style="list-style-type: none"> <li>- Reduce aquatic vegetation which alters food and nutrient regime as well as increase predator exposure;</li> <li>- Alter preferred substrate and water quality (sediment, turbidity, etc.);</li> <li>- Increase the amount of sunlight reaching the stream or wetland enhancing algal production and leading to temporary loss of habitat.</li> </ul> <p>Stream / wetland / riparian modifications can:</p> <ul style="list-style-type: none"> <li>- Cover or alter preferred substrates, alter water depths and flow patterns, potentially affecting turbidity, nutrient levels, water temperatures and oxygenation, and depositional areas;</li> <li>- Reduce habitat availability;</li> <li>- Reduce organic inputs into the water and alter temperatures, potentially affecting food availability.</li> </ul>	Adult feeding and metamorphosis	Stream habitat	<ul style="list-style-type: none"> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Small boulders and overhanging banks, or muddy or silty substrates for shelter</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Land-use activities which have the capacity to alter aquatic habitat directly or indirectly.	Work in or around critical habitat with excessive riparian vegetation removal, improper sediment and erosion control, incompatibility with lamprey habitat requirements, or impacts to water availability in streams, springs, wetlands, or groundwater.	<p>Impacts to riparian habitat, alteration of run-off rates or water storage capacity that impact water flow.</p> <p>Reduction in bank stability leading to an increase in sediment inputs to water, which could:</p> <ul style="list-style-type: none"> <li>- Reduce aquatic vegetation which alters food and nutrient regime as well as increase predator exposure;</li> <li>- Alter preferred substrate and water quality (sediment, turbidity, etc.);</li> <li>- Increase the amount of sunlight reaching the stream or wetland enhancing algal production and leading to temporary loss of habitat.</li> </ul> <p>Stream / wetland / riparian modifications can:</p> <ul style="list-style-type: none"> <li>- Cover or alter preferred substrates, alter water depths and flow patterns, potentially affecting turbidity, nutrient levels, water temperatures and oxygenation, and depositional areas;</li> <li>- Reduce habitat availability;</li> <li>- Reduce organic inputs into the water and alter temperatures, potentially affecting food availability.</li> </ul>	Spawning and egg incubation	Stream habitat	<ul style="list-style-type: none"> <li>• Hard substrate covered with small pebbles/sediment</li> <li>• Pebbles no greater than 1cm diameter for building nests</li> <li>• Cool, free flowing water available year round</li> <li>• Low water flow (0.1 to 0.7 m/s)</li> <li>• Water depth within the natural range of variation</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Sedimentation levels within the natural range of variation</li> </ul>



Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Land-use activities which have the capacity to alter aquatic habitat directly or indirectly.	Work in or around critical habitat with excessive riparian vegetation removal, improper sediment and erosion control, incompatibility with lamprey habitat requirements, or impacts to water availability in streams, springs, wetlands, or groundwater.	<p>Impacts to riparian habitat, alteration of run-off rates or water storage capacity that impact water flow.</p> <p>Reduction in bank stability leading to an increase in sediment inputs to water, which could:</p> <ul style="list-style-type: none"> <li>- Reduce aquatic vegetation which alters food and nutrient regime as well as increase predator exposure;</li> <li>- Alter preferred substrate and water quality (sediment, turbidity, etc.);</li> <li>- Increase the amount of sunlight reaching the stream or wetland enhancing algal production and leading to temporary loss of habitat.</li> </ul> <p>Stream / wetland / riparian modifications can:</p> <ul style="list-style-type: none"> <li>- Cover or alter preferred substrates, alter water depths and flow patterns, potentially affecting turbidity, nutrient levels, water temperatures and oxygenation, and depositional areas;</li> <li>- Reduce habitat availability;</li> <li>- Reduce organic inputs into the water and alter temperatures, potentially affecting food availability.</li> </ul>	All functions except spawning.	Wetland habitat	<ul style="list-style-type: none"> <li>• Stable banks</li> <li>• Terrestrially supplied food and nutrients</li> <li>• Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation)</li> <li>• Stable shade cover for stream and wetland habitat</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Plant litter to contribute to detritus</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Land-use activities which have the capacity to alter aquatic habitat directly or indirectly.	Work in or around critical habitat with excessive riparian vegetation removal, improper sediment and erosion control, incompatibility with lamprey habitat requirements, or impacts to water availability in streams, springs, wetlands, or groundwater.	<p>Impacts to riparian habitat, alteration of run-off rates or water storage capacity that impact water flow.</p> <p>Reduction in bank stability leading to an increase in sediment inputs to water, which could:</p> <ul style="list-style-type: none"> <li>- Reduce aquatic vegetation which alters food and nutrient regime as well as increase predator exposure;</li> <li>- Alter preferred substrate and water quality (sediment, turbidity, etc.);</li> <li>- Increase the amount of sunlight reaching the stream or wetland enhancing algal production and leading to temporary loss of habitat.</li> </ul> <p>Stream / wetland / riparian modifications can:</p> <ul style="list-style-type: none"> <li>- Cover or alter preferred substrates, alter water depths and flow patterns, potentially affecting turbidity, nutrient levels, water temperatures and oxygenation, and depositional areas;</li> <li>- Reduce habitat availability;</li> <li>- Reduce organic inputs into the water and alter temperatures, potentially affecting food availability.</li> </ul>	<p>All functions</p> <ul style="list-style-type: none"> <li>- Only applies to riparian vegetation removal within the defined areas around the stream and inflowing streams</li> </ul>	Riparian area surrounding wetted perimeters of streams and wetlands	<ul style="list-style-type: none"> <li>• Terrestrially supplied food and nutrients</li> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Stable shade cover for wetland habitat</li> <li>• Muddy or silty substrates for shelter</li> <li>• Plant litter to contribute to detritus</li> <li>• Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation)</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Water use activities which have the capacity to alter aquatic habitat directly or indirectly.	Water management that causes dewatering of habitat, excessive flow rates, or impacts to streams, springs, wetlands, groundwater, or riparian areas.	<p>Water fluctuations greater than natural variability could alter water availability, duration, and flow in Morrison Creek.</p> <p>Altered flow patterns could affect aquatic habitat availability, sediment deposition, alter temperatures, and integrity of riparian areas.</p>	Feeding and rearing of ammocoetes	Stream habitat	<ul style="list-style-type: none"> <li>• Low to medium water flow</li> <li>• Loose silt, sand or mud substrate in which to burrow</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Adequate food supply</li> </ul>
Water use activities which have the capacity to alter aquatic habitat directly or indirectly.	Water management that causes dewatering of habitat, excessive flow rates, or impacts to streams, springs, wetlands, groundwater, or riparian areas.	<p>Water fluctuations greater than natural variability could alter water availability, duration, and flow in Morrison Creek.</p> <p>Altered flow patterns could affect aquatic habitat availability, sediment deposition, alter temperatures, and integrity of riparian areas.</p>	Adult feeding and metamorphosis	Stream habitat	<ul style="list-style-type: none"> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• vegetation for shelter</li> <li>• Small boulders and overhanging banks, or muddy or silty substrates for shelter</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Water use activities which have the capacity to alter aquatic habitat directly or indirectly.	Water management that causes dewatering of habitat, excessive flow rates, or impacts to streams, springs, wetlands, groundwater, or riparian areas.	<p>Water fluctuations greater than natural variability could alter water availability, duration, and flow in Morrison Creek.</p> <p>Altered flow patterns could affect aquatic habitat availability, sediment deposition, alter temperatures, and integrity of riparian areas.</p>	Spawning and egg incubation	Stream habitat	<ul style="list-style-type: none"> <li>• Hard substrate covered with small pebbles/sediment</li> <li>• Pebbles no greater than 1cm diameter for building nests</li> <li>• Cool, free flowing water available year round</li> <li>• Low water flow (0.1 to 0.7 m/s)</li> <li>• Water depth within the natural range of variation</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Sedimentation levels within the natural range of variation</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Water use activities which have the capacity to alter aquatic habitat directly or indirectly.	Water management that causes dewatering of habitat, excessive flow rates, or impacts to streams, springs, wetlands, groundwater, or riparian areas.	<p>Water fluctuations greater than natural variability could alter water availability, duration, and flow in Morrison Creek.</p> <p>Altered flow patterns could affect aquatic habitat availability, sediment deposition, alter temperatures, and integrity of riparian areas.</p>	All functions except spawning	Wetland habitat	<ul style="list-style-type: none"> <li>• Terrestrially supplied food and nutrients</li> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Stable shade cover for wetland habitat</li> <li>• Muddy or silty substrates for shelter</li> <li>• Plant litter to contribute to detritus</li> <li>• Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation)</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Water use activities which have the capacity to alter aquatic habitat directly or indirectly.	Water management that causes dewatering of habitat, excessive flow rates, or impacts to streams, springs, wetlands, groundwater, or riparian areas.	<p>Water fluctuations greater than natural variability could alter water availability, duration, and flow in Morrison Creek.</p> <p>Altered flow patterns could affect aquatic habitat availability, sediment deposition, alter temperatures, and integrity of riparian areas.</p>	All functions	Riparian area surrounding wetted perimeters of streams and wetlands	<ul style="list-style-type: none"> <li>• Stable banks</li> <li>• Terrestrially supplied food and nutrients</li> <li>• Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation)</li> <li>• Stable shade cover for stream and wetland habitat</li> <li>• Supply of plant litter to contribute to detritus</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Plant litter to contribute to detritus</li> </ul>
Degradation of water quality.	<p>Release of urban and industrial deleterious substances.</p> <p>and</p> <p>Excessive nutrient input through groundwater and/or surface flows from point or non-point sources.</p>	<p>Harmful substances that affect adult feeding and metamorphosis as well as rearing of ammocoetes and egg incubation.</p> <p>and</p> <p>Eutrophication resulting in algal blooms reducing light penetration, water clarity, changing water chemistry, altered food web structure.</p>	Feeding and rearing of ammocoetes	Stream habitat	<ul style="list-style-type: none"> <li>• Low to medium water flow</li> <li>• Loose silt, sand or mud substrate in which to burrow</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Adequate food supply</li> </ul>

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Degradation of water quality.	Release of urban and industrial deleterious substances.  and  Excessive nutrient input through groundwater and/or surface flows from point or non-point sources.	Harmful substances that affect adult feeding and metamorphosis as well as rearing of ammocoetes and egg incubation.  and  Eutrophication resulting in algal blooms reducing light penetration, water clarity, changing water chemistry, altered food web structure.	Adult feeding and metamorphosis	Stream Habitat	<ul style="list-style-type: none"> <li>• Availability of fish (exact species unknown) as prey</li> <li>• Cool, free flowing water available year round</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Large and small woody debris and overhanging bank vegetation for shelter</li> <li>• Small boulders and overhanging banks, or muddy or silty substrates for shelter</li> </ul>
Degradation of water quality.	Release of urban and industrial deleterious substances.  and  Excessive nutrient input through groundwater and/or surface flows from point or non-point sources.	Harmful substances that affect adult feeding and metamorphosis as well as rearing of ammocoetes and egg incubation.  and  Eutrophication resulting in algal blooms reducing light penetration, water clarity, changing water chemistry, altered food web structure.	Spawning and egg incubation	Stream Habitat	<ul style="list-style-type: none"> <li>• Hard substrate covered with small pebbles/sediment</li> <li>• Pebbles no greater than 1cm diameter for building nests</li> <li>• Cool, free flowing water available year round</li> <li>• Low water flow (0.1 to 0.7 m/s)</li> <li>• Water depth within the natural range of variation</li> <li>• Water quality parameters (oxygen, temperature and pH) within the natural range of variation</li> <li>• Few or no added pollutants</li> <li>• Sedimentation levels within the natural range of variation</li> </ul>



Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Alteration of prey base.	Activities that reduce prey abundance could directly affect Morrison Creek Lamprey abundance.	Disruption of predator prey relationship leading to impacts on Morrison Creek Lamprey abundance.	Adult feeding	Stream habitat	<ul style="list-style-type: none"><li>• Availability of fish (exact species unknown) as prey</li></ul>

## 2.3 Proposed Measures to Protect Critical Habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a final recovery strategy or action plan and included in the Species at Risk Public Registry. For Morrison Creek Lamprey critical habitat, it is anticipated that this will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

## 2.4 Residence

SARA defines a residence as:

*“a dwelling place, such as a den, nest or other similar area or place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating;” [s. 2(1)].*

Both sexes of Morrison Creek Lamprey participate in building a nest before spawning, though males do much of the work (Beamish et al. 1999; COSEWIC 2010). Lamprey excavate a small depression by vibrating their bodies and carrying individual pebbles short distances using their oral disc (COSEWIC 2010). Morrison Creek Lamprey begin spawning in April. Eggs are deposited, fertilized, and incubated in nests prior to hatching (National Recovery Team for Morrison Creek Lamprey 2007; COSEWIC 2010). Dying adults have been captured, post-spawning, in downstream traps into July and August. Moreover, a laboratory study found that the majority of Western Brook Lamprey eggs from Washington State hatched within 12 - 30 days (Meeuwig et al. 2005 in COSEWIC 2010), further suggesting that lamprey nests may be in use between April and July.

Specific locations of Morrison Creek Lamprey nests are not known; however, spawned-out lamprey and nests have been found in areas of Morrison Creek with low water flow and hard substrate covered with small pebbles (Joy Wade pers. comm.). Western Brook Lamprey nests are typically constructed in sand and gravel substrate (< 2 cm diameter) near the upstream end of a riffle, in the downstream portion of pools (McPhail 2007; COSEWIC 2010). The average oral disc diameter of spawning Morrison Creek Lamprey is 1.01 cm (Beamish and Withler 1986), therefore the availability of gravel approximately 1 cm in diameter may influence nest location.

In summary, adult lamprey of both sexes make an investment in creating nests, which represent discrete dwelling places with the functional capacity to support the essential life-cycle processes of spawning and egg incubation. As such, nests are considered a residence for Morrison Creek Lamprey during the time they are under construction by adults and while eggs incubate in them throughout April to July.

### 3 Evaluation of Socio-Economic Costs and of Benefits

Section 49(1) (e) of SARA requires that an action plan include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. This evaluation addresses only the incremental socio-economic costs of implementing this Action Plan from a national perspective as well as the social and environmental benefits that would occur if the Action Plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. Its intent is to inform the public and to guide decision making on implementation of the Action Plan by partners and collaborators.

The protection and recovery of species at risk can result in both benefits and costs. The Act's Preamble recognizes that "*wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons*". Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians. A review of the literature confirms that Canadians value the preservation and conservation of species in and of themselves. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; Fisheries and Oceans Canada 2008). Furthermore, the conservation of species at risk is an important component of the Government of Canada's commitment to conserving biological diversity under the *International Convention on Biological Diversity*. The Government of Canada has also made a commitment to protect and recover species at risk through the [\*Accord for the Protection of Species at Risk\*](#). The specific costs and benefits associated with this Action Plan are described below.

This evaluation does not address the socio-economic impacts of protecting critical habitat for Morrison Creek Lamprey. Under SARA, DFO must ensure that critical habitat identified in a recovery strategy or action plan is legally protected within 180 days of the final posting of the recovery strategy or action plan. Where an Order will be used for critical habitat protection, the development of the Order will follow a regulatory process in compliance with the Cabinet Directive on Streamlining Regulations, including an analysis of any potential incremental impacts of the Order that will be included in the Regulatory Impact Analysis Statement. As a consequence, no additional analysis of the critical habitat protection has been undertaken for the assessment of costs and benefits of the Action Plan.

#### 3.1 Efforts Towards Recovery to Date

Measures to support recovery implemented prior to this Action Plan include DFO-funded research to support critical habitat identification as well as education, outreach and stewardship projects supported by DFO through the Habitat Stewardship Program. Since the 1970s, Dr. Richard Beamish has significantly contributed to knowledge of Morrison Creek Lamprey biology, taxonomy, and habitat use. Further, the Morrison Creek Streamkeepers have conducted outreach and awareness campaigns, implemented a number of stewardship and habitat restoration projects, as well as conducted research (e.g. identification of spawning sites) to support the recovery of the population. Volunteers have also contributed to Morrison Creek Lamprey field surveys. In 2015, under the federal *Fisheries Act*, DFO developed aquatic

invasive species (AIS) regulations which will benefit Morrison Creek Lamprey and other species at risk affected by AIS.

### 3.2 Benefits of Implementing this Action Plan

The impacts of the recovery measures in this plan on Morrison Creek Lamprey are unknown but likely positive. As indicated above, Canadians value species for a number of reasons, including non-market benefits (i.e. existence, bequest and option values)<sup>12</sup>. Measures that positively affect the recovery of these species may result in positive benefits to Canadians.

The recovery measures may also provide broader benefits. For example, watershed based stewardship initiatives could increase public awareness of all fish species that utilize the Morrison Creek watershed. Further, information of habitat threats to Morrison Creek Lamprey and remediation of barriers to fish passage may benefit other fish species that utilize Morrison Creek watershed, such as salmonids. Consequently, many of the recovery measures identified in this Action Plan, while benefitting Morrison Creek Lamprey, may also provide overall benefits to the aquatic ecosystem within the watershed.

### 3.3 Socio-Economic Costs of Implementing this Action Plan

The Implementation Schedule separates recovery measures into three tables. Table 1 and Table 2 include all the high priority recovery measures, and some medium priority recovery measures. Table 3 consists of primarily medium priority measures, as well as some of the low priority recovery measures. Table 3 actions include four research and engagement measures, likely to be low cost<sup>13</sup>. Additionally, there are two relatively higher, but undetermined cost actions associated with habitat restoration and mitigation measures (e.g. oil separators). While the financial contribution required for recovery measures in all tables has been estimated, limited information is available on in-kind support costs and resources that may be necessary, as well as identification of participants and timelines.

The majority of activities in the plan focus on research work. Research to increase scientific understanding of Morrison Creek Lamprey natural history, identify critical habitat and clarify and reduce threats are closely linked to monitoring / assessment, as well as development and implementation of guidelines and plans. Most recovery measures will require cooperation and support from a number of partners.

The majority of the identified costs are associated with research that would be completed in the short- (i.e. <5 years) to medium-term (i.e. 5-10 years). The majority of the longer-term recovery measures (>10 years) will be associated with low cost monitoring and assessment that will occur intermittently over the anticipated timeframe of the plan (i.e., >25 years). Work to develop identification tools is also scheduled for the longer-term with low associated costs. The completion date for implementing the Action Plan is not specified.

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<sup>12</sup> Non-market benefits include bequest values (the value placed on conservation for future generations), existence values (the value people place on the existence of a species) and option values (the amount someone is willing to pay to keep open the option of future use of the species).

<sup>13</sup> Cost levels are based on those identified in the Treasury Board of Canada Secretariat "[Triage Statement Form](#)" Scales in terms of (discounted) present values over ten years and annualized values. The annualized scale is: Low \$0-\$1 million, Medium \$1-\$10 million, High >\$10 million.

All the recovery measures outlined are expected to be low cost according to the Treasury Board of Canada Secretariat's scales. The total cost estimate for Government of Canada (DFO) activities in Tables 1 and 2 are expected to be low; the majority of direct financial costs are expected to be federal government costs. Recovery measures are anticipated to be funded from existing federal resources, as well as supplemental funds from annual programs such as the Habitat Stewardship Program (HSP).

Most recovery measures for Morrison Creek Lamprey will require a collaborative approach. A number of partners and collaborators are identified including, but not limited to, other levels of government, environmental organizations, academic institutions, stewardship groups and other stakeholders who may contribute either financial and/or in-kind support. While it is possible to estimate the financial cost to undertake recovery measures, there is a high degree of uncertainty regarding the scale of in-kind cost for partners as information on specific participants and projects is not available. The inclusion of the in-kind resources and efforts would increase the total cost; however, the overall costs for Canadian partners and government (i.e. all three tables) are still expected to be low.

## **4 Measuring Progress**

The recovery measures outlined in this Action Plan reflect the objectives and broad strategies described in the Recovery Strategy. When implemented, they are expected to advance the recovery of Morrison Creek Lamprey in Canada. The performance indicators presented in the Recovery Strategy provide a way to define and measure progress toward achieving the population and distribution objectives.

Reporting on implementation of the Action Plan (under section 55 of SARA) will be done by assessing progress towards implementing the broad strategies outlined in the Recovery Strategy.

Reporting on the ecological and socio-economic impacts of the Action Plan (under section 55 of SARA) will be done by assessing the results of monitoring the recovery of the population and its long term viability, and by assessing the implementation of the Action Plan. Many measures, particularly, but not limited to, Measures 1 and 3 in Table 1 of this Action Plan will increase our understanding of the Morrison Creek Lamprey and its status, threats, and over time will contribute to monitoring this population in Canada. Data from existing monitoring efforts on Morrison Creek Lamprey, other co-occurring species, and the biotic and abiotic components of the habitat will be considered when available.

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## Appendix A: 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 and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the [Federal Sustainable Development Strategy's](#) (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of action plans may 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 Action Plan itself, but are also summarized below in this statement.

This Action Plan will benefit the environment by promoting the recovery of Morrison Creek Lamprey in the wild, thereby contributing to FSDS Theme III (Protecting Nature and Canadians), Goal 4 (Conservation and Restoring Ecosystems, Wildlife and Habitat, and Protecting Canadians). Specifically, it will help to attain the associated target of 4.1 which is to have populations of federally listed species at risk exhibit trends that are consistent with the objectives of recovery strategies and management plans.

The actions identified in this Plan address threats such as land use activities; water withdrawals or impoundments that alter the natural variability in water flow; and releases of deleterious substances into the watershed. By addressing these threats, the actions will contribute to the overall ecosystem health, which may provide benefits to other species, such as Pink, Coho, Chinook and Chum Salmon, Cutthroat, Rainbow and Steelhead Trout, Dolly Varden, and Pacific Lamprey, as well as ecological services to Canadians living in the area. No adverse effects on other species are anticipated as the result of the implementation of this Action Plan.

Morrison Creek Lamprey co-exist with other fish species found in the Morrison Creek watershed and may be parasites of, as well as prey for, some fish species such as Coho Salmon. Species-specific and predatory interactions may occur between Morrison Creek Lamprey and carnivorous benthic invertebrates or piscivorous birds, but they are not thought to be a threat to Morrison Creek Lamprey at this time.

Given the considerations outlined above, the benefits of this Action Plan to the environment and other species are expected to outweigh any adverse effects that may occur.



## Appendix B: Record of Cooperation and Consultation

The Morrison Creek Lamprey was listed as Endangered under SARA in 2003 and a Recovery Strategy was finalized in 2007. The Minister of Fisheries and Oceans Canada (DFO) is the competent minister under SARA for Morrison Creek Lamprey and prepared the Action Plan to implement the Recovery Strategy, as per section 47 of SARA. To the extent possible, it has been prepared in cooperation with the Province of British Columbia as per section 48(1) of SARA. Processes for coordination and consultation between the federal and British Columbia governments on management and protection of species at risk are outlined in the [Canada-British Columbia Agreement on Species at Risk](#).

In March 2014 an action planning workshop was held in Courtenay, British Columbia to collect information and gather input from stakeholders and rights holders on current and potential measures to include in the Action Plan for Morrison Creek Lamprey. Information on local activities and perspectives, Morrison Creek Lamprey biology and current management was provided by the Morrison Creek Streamkeepers and the Sport Fishing Advisory Committee, the forest industry, Vancouver Island University, Lake Trail Middle School, the City of Courtenay, the Comox Valley Regional District, and the Province of British Columbia as per section 48(1) of SARA.

A community open-house was also held in March 2014 at the Lake Trail School library. Five people attended the session, participating in discussions about land use around the creek and opportunities for cooperation to remove or reduce barriers to fish movement.

Open-house participants were predominantly positive about Morrison Creek Lamprey recovery. A number of respondents expressed an interest in participating in recovery actions once the Action Plan was developed, and emphasized the need for funding recovery measures.

In July 2016 the draft Action Plan was circulated to indigenous organizations, local, regional, and provincial governments, consultants, academia, environmental non-government organizations, industry, and recreational fishers for a 31-day external review. Comments resulted in minor revisions to biological descriptions, and clarifications or expansions to recovery measures.

Additional stakeholder, Indigenous, and public input was sought through the publication of the proposed document on the Species at Risk Public Registry for a 60-day public comment period. Comments resulted in minor revisions to recovery measures, and clarifications to the description and representation of critical habitat.

All comments received were considered in the finalization of the Action Plan.