

Action Plan for the Vancouver Lamprey (*Entosphenus macrostomus*) in Canada

Vancouver Lamprey



2019

Recommended citation:

Fisheries and Oceans Canada. 2019. Action Plan for the Vancouver Lamprey (*Entosphenus macrostomus*) in Canada. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 39 pp.

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: Adult Vancouver Lamprey. Photo credit: Joy Wade.

Également disponible en français sous le titre
«Plan d'action pour la lamproie de Vancouver (*Entosphenus macrostomus*) au Canada»

© Her Majesty the Queen in Right of Canada, represented by the Minister of Fisheries and Oceans, 2019. All rights reserved.

ISBN 978-0-660-28190-2

Catalogue no. CW69-21/57-2019E-PDF

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

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 Vancouver Lamprey¹ and has prepared this action plan to implement the recovery strategy, as per section 47 of SARA. In preparing this 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 environmental non-government organizations, industry and species experts as detailed in Appendix B, First Nations (Cowichan Tribes), and the Province of British Columbia's Ministry of Environment, 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 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 the Vancouver Lamprey 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 Fisheries and Oceans Canada 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 Alyssa Gerick (Fisheries and Oceans Canada (DFO)), with contributions from Sean MacConnachie (DFO), and Joy Wade (Fundy Aqua Services). Participants of the Action Planning Workshop (Appendix B) contributed valuable information and ideas toward the development of this action plan.

¹ The species is also known as Cowichan Lake Lamprey (*Entosphenus macrostomus*).

Executive summary

Based on COSEWIC's recommendation, the scientific name for the Vancouver Lamprey changed from *Lampetra macrostoma* to *Entosphenus macrostomus* on Schedule 1 of the *Species at Risk Act* (SARA) in August 2019. This action plan uses the new scientific name (*Entosphenus macrostomus*) throughout the document, with the exception of the reference section that refers to the former name (*Lampetra macrostoma*).

The Vancouver Lamprey (*Entosphenus macrostomus*) was listed as threatened under the 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 (COSEWIC 2008), the recovery potential assessment (RPA) research document (Harvey 2015), and the *Recovery Strategy for the Vancouver Lamprey (Entosphenus macrostomus) in Canada* (VLRT 2007).

The Vancouver Lamprey is a freshwater fish endemic to the Cowichan valley watershed in southern Vancouver Island, British Columbia. It is a scaleless, eel-like, jawless fish with a circular-shaped mouth, distinguished from similar species through variations in tooth patterns (COSEWIC 2008).

This action plan outlines measures that provide the best chance of achieving the population and distribution objectives and broader recovery goal for the species, including the measures to be taken to address the threats and monitor the recovery of the species. The population and distribution objectives for the Vancouver Lamprey (previously referred to as recovery goals and objectives) identified in the recovery strategy are as follows:

Recovery goal

The recovery goal for Vancouver lamprey is to ensure its long-term viability within its natural range. It is likely that this species will always remain at some level of risk due to its extremely limited distribution.

Recovery objectives²

1. Maintain a self-sustaining population of Vancouver lamprey within Cowichan³ and Mesachie⁴ lakes that is resilient to short-term habitat perturbations
2. Maintain, and where possible enhance, the ecological integrity of habitat for Vancouver lamprey
3. Increase scientific understanding of Vancouver lamprey through additional investigation of its taxonomic status, natural history, critical habitat and threats to the species' persistence
4. Foster awareness of Vancouver lamprey and its conservation status, and encourage active local involvement in stewardship and habitat protection

² The geographic extent of these objectives applies to the species' known distribution, which includes additional locations to those initially described in VLRT (2007). Refer to section 1.1 for further details on the Context and Scope of the action plan.

³ Includes Bear Lake and the lower 100 m of streams flowing into Cowichan Lake and Bear Lake.

⁴ Includes Mesachie Creek and the lower 100 m of Halfway Creek.

Section 1.2 outlines the measures to be taken under the following strategies, as per the species' recovery strategy (VLRT 2007):

1. Establish and support a Recovery Implementation Group (RIG) or alternative working group for Vancouver lamprey
2. Address information gaps that inhibit conservation of Vancouver lamprey
3. Clarify and address threats to Vancouver lamprey
4. Conduct studies to help define critical habitat for Vancouver lamprey
5. Develop and implement a long-term monitoring program
6. Establish water quality and water use objectives for Cowichan and Mesachie lakes
7. Develop a comprehensive water management plan for each basin
8. Inform and educate stakeholders and the general public about the species and general biodiversity values
9. Work with local governments, land developers, and others to improve and encourage watershed stewardship
10. Develop sound protocols for scientific investigations (for example, limit number of fish collected each year, etc.)

Section 33 of SARA prohibits the damage or destruction of a species' residence. A detailed description of Vancouver Lamprey's residence is provided in section 2 of this action plan and is also available on the Species at Risk Public Registry.⁵

For the Vancouver Lamprey, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives. This action plan identifies critical habitat for Vancouver Lamprey as (section 3.1):

- a) Cowichan, Bear, and Mesachie lakes
- b) Mesachie Creek (flowing between Bear and Mesachie lakes)
- c) eight tributaries flowing into Cowichan Lake (Meade's Creek north; two unnamed streams in the "Old Motel" area; Miracle, Sutton, Shaw, and Nixon creeks; Robertson River) from their deltas to 100 m upstream
- d) Halfway Creek (flowing into Mesachie Lake), from its delta to 100 m upstream
- e) riparian areas of 15 to 30 m width⁶ extending inland from the high water mark of streams described in b), c) and d), and portions of Cowichan Lake in the Hawes Bay and "Old Motel" areas

It is anticipated that the protection of the species' 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 3.3).

An evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation is provided in section 4.

⁵ http://www.sararegistry.gc.ca/sar/recovery/residence_e.cfm.

⁶ Exact critical habitat riparian widths for particular areas are delineated in Appendix C.

Table of contents

Preface	i
Acknowledgments.....	i
Executive summary.....	ii
1. Recovery actions.....	1
1.1 Context and scope of the action plan	1
1.2 Measures to be taken and implementation schedule.....	3
2. Residence	9
2.1 Location of the species' residence	9
2.2 Structure, form and investment	9
2.3 Occupancy and life-cycle function.....	9
3. Critical habitat	9
3.1 Identification of the species' critical habitat	9
3.1.1 General description of the species' critical habitat.....	9
3.1.2 Information and methods used to identify critical habitat	10
3.1.3 Identification of critical habitat	10
3.2 Examples of activities likely to result in the destruction of critical habitat.....	15
3.3 Proposed measures to protect critical habitat.....	22
4. Evaluation of socio-economic costs and benefits	22
4.1 Benefits of implementing this action plan	22
4.2 Socio-economic costs of implementing this action plan.....	23
5. Measuring progress.....	23
6. References.....	24
Appendix A: effects on the environment and other species	25
Appendix B: record of cooperation and consultation	26
Appendix C: riparian critical habitat maps	27

1. Recovery actions

1.1 Context and scope of the action plan

The Vancouver Lamprey (*Entosphenus macrostomus*) was listed as threatened under the *Species at Risk Act* (SARA) in 2003. This action plan is part of a series of documents regarding the Vancouver Lamprey, including the Committee on the Status of Endangered Wildlife in Canada COSEWIC (COSEWIC 2008) status report,⁷ the RPA research document (Harvey 2015),⁸ and the *Recovery Strategy for the Vancouver Lamprey (Entosphenus macrostomus) in Canada* (VLRT 2007)⁹ 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 a recovery strategy for the species. A recovery strategy also provides background information on the species, its threats, and critical habitat.

The Vancouver Lamprey is a parasitic fish that is eel-like in appearance: it is scaleless and jawless, with a circular-shaped mouth, distinguished from similar species through variations in tooth patterns (COSEWIC 2008). It is endemic to the Cowichan valley watershed in southern Vancouver Island, British Columbia. Specifically, its distribution includes: Cowichan, Bear, and Mesachie Lakes, Mesachie Creek, and the lower reaches of streams flowing into the occupied lakes (figure 1).

Robust abundance estimates do not exist for Vancouver Lamprey; however, MacConnachie and Wade (2016) summarize sampling studies from the 1980's to 2015 that suggest a potential decline. Further research, particularly into the relationship between prey availability and lamprey abundance, is required to confirm abundance estimates and trends.

Anthropogenic threats identified in the recovery strategy include: water and land use impacting habitats; recreation impacting habitats or individuals; degradation of water quality;¹⁰ alteration of prey base; and, climate change.¹¹

⁷ http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=1794

⁸ http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2015/2015_061-eng.html

⁹ http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=1343

¹⁰ No current water quality concerns are known, therefore this is considered a potential threat (VLRT 2007; COSEWIC 2008).

¹¹ Beyond the scope of the recovery strategy and action plan.

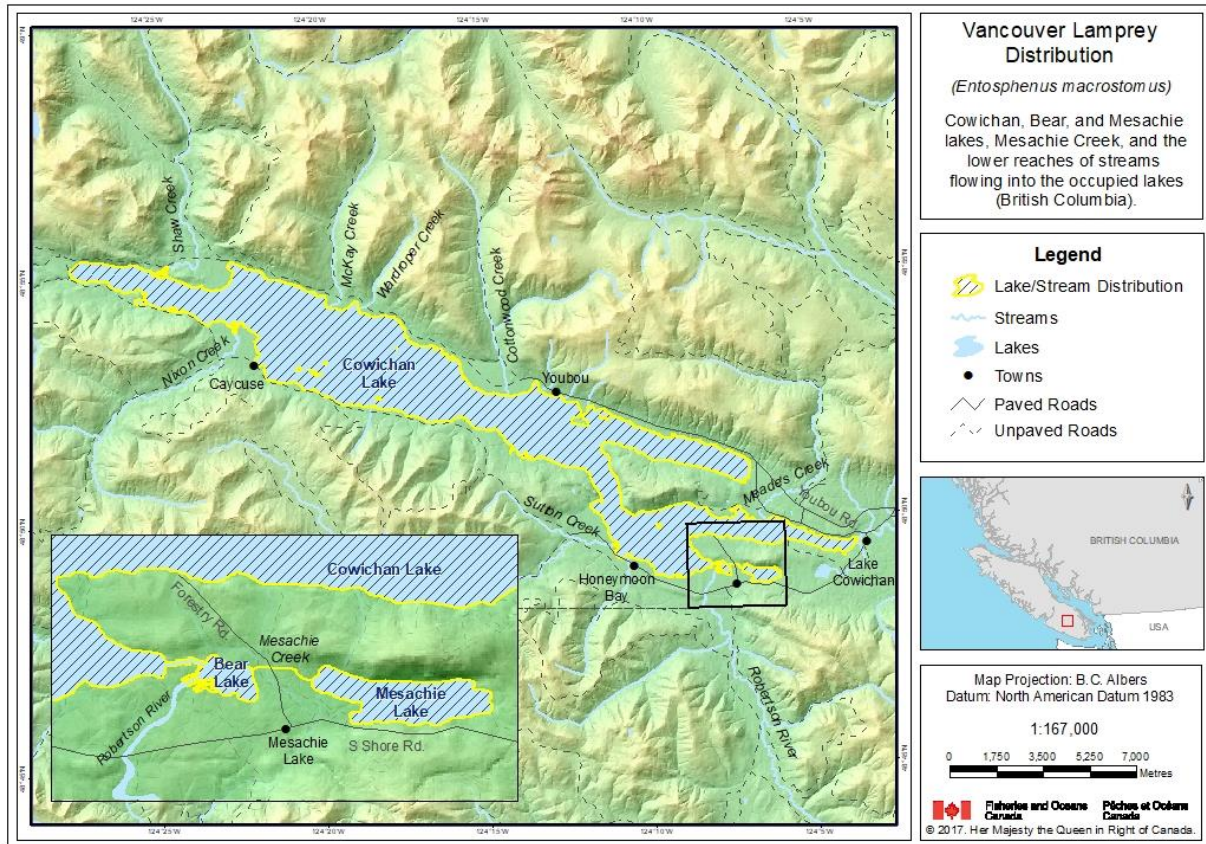


Figure 1. Distribution of Vancouver Lamprey

The recovery strategy identified population and distribution objectives (previously referred to as recovery goals and objectives) for the Vancouver Lamprey as follows:

Recovery goal

The recovery goal for Vancouver Lamprey is to ensure its long-term viability within its natural range. It is likely that this species will always remain at some level of risk due to its extremely limited distribution.

Recovery objectives¹²

1. Maintain a self-sustaining population of Vancouver Lamprey within Cowichan¹³ and Mesachie¹⁴ lakes that is resilient to short-term habitat perturbations
2. Maintain, and where possible enhance, the ecological integrity of habitat for Vancouver Lamprey

¹² Refer to footnote 2.

¹³ Refer to footnote 3.

¹⁴ Refer to footnote 4.

3. Increase scientific understanding of Vancouver Lamprey through additional investigation of its taxonomic status, natural history, critical habitat and threats to the species' persistence
4. Foster awareness of Vancouver 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 Vancouver Lamprey, including measures to be taken to address threats to the species and monitor its recovery, to guide not only activities to be undertaken by Fisheries and Oceans Canada, 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. Fisheries and Oceans Canada strongly encourages all Canadians to participate in the conservation of the Vancouver Lamprey through undertaking measures outlined in this action plan. The measures fall under strategies, as per the species' recovery strategy (VLRT 2007) and are reflected in the following tables.

Table 1 identifies the measures to be undertaken by Fisheries and Oceans Canada to support the recovery of the Vancouver Lamprey. First Nations and Indigenous organizations have identified interest in supporting DFO, as appropriate, with table 1 activities.

Table 2 identifies the measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners, other agencies, organizations or individuals. Implementation of these measures will be dependent on a collaborative approach, in which Fisheries and Oceans Canada 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 for the recovery of the species.

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.

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	Strategy	Priority ¹⁵	Threats addressed	Timeline ¹⁶
1.	Develop a monitoring plan to provide for a clear indication of progress towards securing the species' long-term viability within its natural range and maintaining a self-sustaining population within the Cowichan watershed. Monitoring efforts may include lamprey distribution and a relative index of lamprey abundance.	Develop and implement a long-term monitoring program.	Medium	All	Short-term
2.	Continue to investigate use of tributary and littoral habitats throughout the Cowichan watershed.	Conduct studies to help define critical habitat for Vancouver lamprey.	High	Water and land use impacting habitats	Short-term
3.	Develop allowable harm estimates and collection guidelines for Vancouver Lamprey, which encourage the use of minimally invasive sampling and handling techniques.	Develop sound protocols for scientific investigations (for example limit number of fish collected each year, etc.).	Low	Mortality or harm to individuals	Short-term

¹⁵ 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.

¹⁶ Short-term, Medium-term, and Long-term timelines refer to measures to be initiated within 0 to 5, 6 to 10, and 10 plus years respectively from the date of posting the action plan as a final document on the Species at Risk Public Registry; some of these measures may be ongoing.

Table 2. Measures¹⁷ to be undertaken collaboratively between Fisheries and Oceans Canada and its partners

#	Recovery measures	Strategy	Priority ¹⁸	Threats addressed	Timeline ¹⁹	Partner(s)
4.	Implement the monitoring plan for Vancouver Lamprey.	Develop and implement a long-term monitoring program.	Medium	All	Medium-term	Stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations
5.	Confirm locations of suspected suitable spawning habitats (and lamprey species) in occupied water bodies. This may be partially achieved by underwater videography.	Address information gaps that inhibit conservation of Vancouver lamprey.	High	Water and land use impacting habitats	Short-term	Stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations
6.	Map the bathymetry of occupied water bodies, particularly in nearshore areas, to assist in determining impacts of altered water levels.	Address information gaps that inhibit conservation of Vancouver lamprey.	High	Water and land use impacting habitats	Short-term	Stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations
7.	Investigate the role of lacustrine riparian habitats in Vancouver Lamprey life processes. If deemed significant, conduct an assessment of appropriate potential riparian critical habitat widths surrounding the entirety of occupied lakes.	Conduct studies to help define critical habitat for Vancouver lamprey.	Medium	Land use impacting habitats	Medium-term	Academia, stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations

¹⁷ The Strategy to “Establish water quality and water use objectives for Cowichan and Mesachie lakes” is not included in table 2 as water quality objectives for Cowichan Lake are included in technical reports published by the Province of British Columbia (Province of British Columbia n.d.), and are considered sufficient for application to Mesachie Lake, which is a less intensively used lake.

¹⁸ Refer to footnote 15.

¹⁹ Refer to footnote 16.

#	Recovery measures	Strategy	Priority ¹⁸	Threats addressed	Timeline ¹⁹	Partner(s)
8.	Conduct research to define specific parameters of existing critical habitat attributes in instances where this information may assist in mitigating threats to Vancouver Lamprey.	Conduct studies to help define critical habitat for Vancouver lamprey.	Low	Water, land use, and recreation impacting habitats; degradation of water quality	Medium-term	Academia, stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations
9.	Investigate preferred prey, their abundance and abundance trends. Initial work may consist of compiling existing data on catch rates of potential prey species, such as Cutthroat Trout.	Clarify and address threats to Vancouver lamprey.	High	Alteration of prey base	Short-term	Academia, stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations
10.	<p>Identify and evaluate land and water management options to satisfy both conservation and stakeholder needs, for example by:</p> <ul style="list-style-type: none"> • compiling data on existing water use in tributaries emptying into Cowichan and Mesachie lakes • considering existing and ongoing research on long-term drought patterns (for example Cowichan Tribes and Cowichan Watershed Board in prep.) • considering species specific needs in the development, implementation, and updating of the Cowichan Basin Water Management Plan, land use plans, official community plans, by-laws and management guidelines. 	Work with local governments, land developers, and others to improve and encourage watershed stewardship.	High	Water and land use impacting habitats	Short-term	Academia, stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations

Table 3. Measures²⁰ that represent opportunities for other jurisdictions, organizations or individuals to lead

#	Recovery measures	Strategy	Priority ²¹	Threats or objective addressed	Suggested other jurisdictions or organizations
11.	Participate in a group that supports the conservation and protection of the species, and undertake watershed-based stewardship initiatives that increase understanding and awareness of the species (for example, promotion and adoption of best practices).	Establish and support a Recovery Implementation Group (RIG) or alternative working group for Vancouver lamprey.	Medium	All	Academia, stewardship groups, local, provincial, or regional governments, industry, recreational anglers, First Nations and Indigenous organizations
12.	<p>Develop educational materials and host educational events with an emphasis on:</p> <ul style="list-style-type: none"> encouraging live release of lamprey when caught in recreational fisheries reducing stigma associated with parasitism, and false associations with invasive lamprey located elsewhere the importance of maintaining nearshore habitats developing a system to report lamprey bycatch and scarring observations <p>In addition to the general public, target audiences should particularly include recreational fishers (for example fish and game associations, local tackle shops, fishing derbies), First Nations, and landowners.</p>	Inform and educate stakeholders and the general public about the species and general biodiversity values.	Low	All	Academia, stewardship groups, local, provincial, or regional governments, industry, recreational anglers, First Nations and Indigenous organizations

²⁰ The Strategy to “Develop a comprehensive water management plan for each basin” is not included in table 3 as Westland Resource Group Inc. (2007) developed a Cowichan Basin Water Management Plan on behalf of the Cowichan Valley Regional District. While this document does not specifically address Vancouver Lamprey, it does address the maintenance of aquatic habitats, and conservation of salmonids (potential prey). In 2010, the Cowichan Watershed Board reported on the status of the Water Management Plan, and provided recommendations on future actions (CWB 2010); future updates to this plan are addressed by recovery measure #10.

²¹ Refer to footnote 15.

#	Recovery measures	Strategy	Priority ²¹	Threats or objective addressed	Suggested other jurisdictions or organizations
13.	Identify and evaluate land and water management options to satisfy both conservation and stakeholder needs, for example by: <ul style="list-style-type: none"> • evaluating the potential impacts of future water licensing • considering a water conservation license under the provincial <i>Water Sustainability Act</i> • evaluating short- and long-term water level impacts of adjusting Cowichan Lake weir operation 	Work with local governments, land developers, and others to improve and encourage watershed stewardship	High	Water and land use impacting habitats	Academia, stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations
14.	Develop best practices for land development, specifically emphasizing the nuances between salmonid and lamprey habitat requirements, and species-specific needs.	Work with local governments, land developers, and others to improve and encourage watershed stewardship	Medium	Land use impacting habitats	Industry, stewardship groups, local, provincial, or regional governments, First Nations and Indigenous organizations

2. Residence

Section 33 of SARA prohibits the damage or destruction of a species' 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)]. The following (the residence statement) is a description of a residence for Vancouver Lamprey.

2.1 Location of the species' residence

Vancouver Lamprey construct nests in or near tributary deltas of streams flowing into either Cowichan or Mesachie lakes, or in Cowichan, Bear, or Mesachie lakes themselves. A biophysical description of nest site attributes is found in the first row of Table 5. Specific nesting or spawning locations have not been identified in Cowichan Lake, although one location has been identified in Mesachie Lake near the delta of Halfway Creek (Beamish and Wade 2008). The presence of extremely small ammocoetes²² in tributary deltas in Cowichan Lake suggests spawning or nesting locations are in very close proximity.

2.2 Structure, form and investment

Both sexes participate in building a nest before depositing and fertilizing eggs. Vancouver Lamprey construct nests by excavating a small depression by vibrating their bodies and carrying individual pebbles short distances using their oral disc.

2.3 Occupancy and life-cycle function

Adults die following spawning, and fertilized eggs remain in the nest until they hatch. The nests that Vancouver Lamprey construct are therefore considered residences under SARA while they are supporting the essential life-cycle processes of spawning (from mid-May to late August with a peak in mid-June) and subsequent egg incubation.

3. Critical habitat

3.1 Identification of the species' critical habitat

3.1.1 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." [s. 2(1)]

Also, SARA defines habitat for aquatic species as "... spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or

²² Larval lamprey.

indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced.” [s. 2(1)]

For the Vancouver Lamprey, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives.

This action plan identifies critical habitat for Vancouver Lamprey as: Cowichan, Bear, and Mesachie lakes; Mesachie Creek (flowing between Bear and Mesachie lakes); the lower 100 m of eight tributaries flowing into Cowichan Lake; the lower 100 m of Halfway Creek flowing into Mesachie Lake; and, riparian widths of 15 to 30 m extending inland from aforementioned streams and two specific areas of Cowichan Lake.

The critical habitat identified in this action plan is sufficient to achieve the species' population and distribution objectives. Remaining information gaps with respect to the extent of tributary habitat usage, the role of lacustrine riparian habitats in lamprey life processes, and specific parameters of existing critical habitat attributes are addressed by recovery measures 2, 7 and 8 respectively. Completion of these recovery measures may result in identification of additional areas or further refinement of critical habitat in the future.

3.1.2 Information and methods used to identify critical habitat

Critical habitat identification for Vancouver Lamprey has been informed by the publicly available research document *Information in support of the identification of critical habitat for the Cowichan (Vancouver) Lamprey* (*Entosphenus macrostomus*) (MacConnachie and Wade 2016) and *Review of the information to support the identification of critical habitat for the Cowichan (Vancouver) Lamprey* (MacConnachie and Wade in prep.), both of which reflect the outcomes of a related peer review process undertaken through DFO's Canadian Science Advisory Secretariat. In order to define the width of riparian components of critical habitat the *Riparian Areas Regulation* (RAR; B.C. Reg. 376/2004) methods were applied to a sub-set of in-flowing streams and two lacustrine areas where extremely small ammocoetes were found (inferring either spawning locations, or close proximity to spawning locations). Riparian critical habitat areas resulting from the RAR analysis range in width, depending on site characteristics.

Critical Habitat was identified based on best available science and includes tributary deltas and surrounding nearshore lake habitat, stream habitat, pelagic lake habitat, and riparian habitat features (Table 5). Critical habitat for Vancouver Lamprey has been identified using the bounding box approach, which is described in more detail below.

3.1.3 Identification of critical habitat

Geographic information

For the Vancouver Lamprey, critical habitat (figures 2 through 12) is identified as:

- a) Cowichan, Bear, and Mesachie lakes
- b) Mesachie Creek (flowing between Bear and Mesachie lakes)
- c) eight tributaries flowing into Cowichan Lake (Meade's Creek north; two unnamed streams in the "Old Motel" area; Miracle, Sutton, Shaw, and Nixon creeks; Robertson River) from their deltas to 100 m upstream

- d) Halfway Creek (flowing into Mesachie Lake), from its delta to 100 m upstream
 e) riparian areas of 15 to 30 m width²³ extending inland from the high water mark of streams²⁴ described in b), c) and d), and portions of Cowichan Lake²⁵ in the Hawes Bay and Old Motel areas

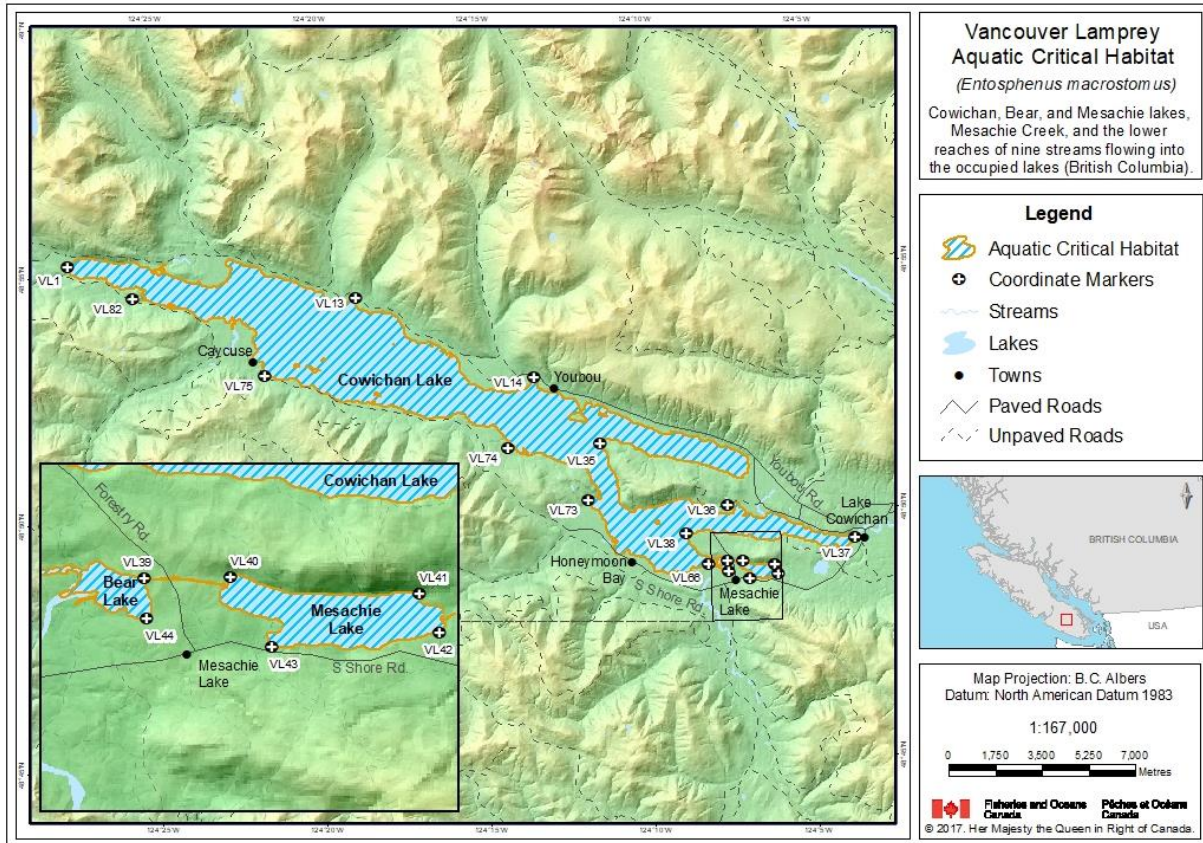


Figure 2. Geographic extent of aquatic critical habitat for Vancouver Lamprey (for riparian components of critical habitat refer to Appendix C)

The location(s) 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(s) and the function(s) it

²³ Exact critical habitat riparian widths for particular areas are delineated in Appendix C.

²⁴ The *Riparian Areas Regulation's* Schedule of Assessment Methods (B.C. Reg. 376/2004) 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." In some instances, high water marks were interpreted via air photo interpretation.

²⁵ The *Riparian Areas Regulation's* Schedule of Assessment Methods (B.C. Reg. 376/2004) defines the high water mark for ungauged lakes as "where the presence and action of annual flood waters area [sic] so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the body of water a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself and includes areas that are seasonally inundated by floodwaters."

supports occur, as described in Table 5. The approximate total area within which aquatic critical habitat is found is 613 hectares.

Table 4. Geographic coordinates associated with the critical habitat coordinate markers in figure 2.

ID	Longitude	Latitude
VL1	-124.459019	48.920229
VL13	-124.312697	48.907773
VL14	-124.222675	48.879544
VL35	-124.189966	48.856587
VL36	-124.125404	48.834871
VL37	-124.060959	48.823175
VL38	-124.146903	48.825699
VL39	-124.126046	48.816079
VL40	-124.118666	48.816223
VL41	-124.102519	48.814778
VL42	-124.100799	48.811457
VL43	-124.115142	48.810213
VL44	-124.125834	48.812654
VL66	-124.136023	48.815118
VL73	-124.196508	48.837582
VL74	-124.236628	48.855762
VL75	-124.359977	48.882297
VL82	-124.426009	48.909128

Biophysical functions, features and attributes

Table 5 summarizes the best available knowledge of the functions, features and attributes for each life stage and for each geographic location of the Vancouver Lamprey (refer to section 4.3 of the recovery strategy on 'Needs of the species' for full references). Note that not all attributes in Table 5 must be present in order for a feature to be identified as critical habitat. If the features as described in Table 5 are 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, and attributes of critical habitat necessary for Vancouver Lamprey survival

Life stage	Function ²⁶	Feature(s) ²⁷	Attribute(s) ²⁸
Eggs	Incubation	Tributary deltas and surrounding nearshore lake habitat (nest sites) Stream habitat	<ul style="list-style-type: none"> • Pebbles \leq 1 cm diameter • Embedded sediment covered with small pebbles (approximately 1 cm in diameter) and sediment • Minimum water depth (0.2 m; Beamish 1998) • Adequate flowing water • Sufficient substrate depth for nest excavation (6 to 140 mm; Stone 2006) • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants • Sedimentation levels within the natural range of variation
Ammocoetes	Feeding and rearing	Tributary deltas and surrounding nearshore lake habitat Stream habitat	<ul style="list-style-type: none"> • Low to medium water flow • Loose silt, sand or mud substrate • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Adequate supply of detritus for food • Few or no added pollutants • Sedimentation levels within the natural range of variation

²⁶ Function: A life-cycle process of the listed species taking place in critical habitat (for example, 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 the species at risk.

²⁷ 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 how 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.

²⁸ 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.

Life stage	Function ²⁶	Feature(s) ²⁷	Attribute(s) ²⁸
Adults	Spawning	Tributary deltas and surrounding nearshore lake habitat (nest sites) Stream habitat	<ul style="list-style-type: none"> • Pebbles \leq 1 cm diameter • Embedded sediment covered with small pebbles (approximately 1 cm in diameter) and sediment • Minimum water depth (0.2 m; Beamish 1998) • Adequate flowing water • Sufficient substrate depth for nest excavation (6 to 140 mm; Stone 2006) • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants • Sedimentation levels within the natural range of variation
Adults	Feeding	Lake habitat (pelagic)	<ul style="list-style-type: none"> • Prey availability (exact species unknown; salmonids) • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants
All	All	Riparian area around streams, lakes, and tributary deltas	<ul style="list-style-type: none"> • Stable banks • Terrestrially supplied food and nutrients • Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation) • Stable shade cover for stream habitat • Large and small woody debris and overhanging bank vegetation for shelter

The following anthropogenic features are excluded from the critical habitat: any human-made infrastructure (for example buildings, docks, marinas, the weir between Cowichan River and Cowichan Lake).

Summary of critical habitat relative to population and distribution objectives

These are areas that, based on current best available information, the Minister of Fisheries and Oceans considers necessary to achieve the species' population and distribution objectives required for the survival of the species. Additional critical habitat may be identified in future updates to the action plan.

3.2 Examples of activities likely to result in the destruction of critical habitat

The following examples of activities likely to result in the destruction²⁹ of critical habitat (Table 6) 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 5 of the recovery strategy. The absence of a specific human activity does not preclude or restrict the Department's ability to regulate that activity under the 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 reliable and available. 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 of tolerance to disturbance from human activities is lacking and must be acquired.

²⁹ 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
Water use impacting habitats	Excessive water extraction, or alteration of lake level and natural stream flow regime	Reduction in water levels in occupied lakes, streams, and tributary deltas thereby reducing access to aquatic habitats	Spawning Egg incubation	Tributary deltas and surrounding nearshore lake habitat Stream habitat	<ul style="list-style-type: none"> • Pebbles \leq 1 cm diameter • Embedded sediment covered with small pebbles (approximately 1 cm in diameter) and sediment • Minimum water depth (0.2 m; Beamish 1998) • Adequate flowing water • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation
Water use impacting habitats	Excessive water extraction, or alteration of lake level and natural stream flow regime	Reduction in water levels in occupied lakes, streams, and tributary deltas thereby reducing access to aquatic habitats	Ammocoete feeding and rearing	Tributary deltas and surrounding nearshore lake habitat Stream habitat	<ul style="list-style-type: none"> • Low to medium water flow • Loose silt, sand or mud substrate • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Adequate supply of detritus for food
Land use impacting habitats	Work in or around critical habitat with excessive riparian vegetation removal, or improper sediment and erosion control	Riparian vegetation removal may: <ul style="list-style-type: none"> - reduce bank stability; - reduce terrestrially supplied food, nutrients, and woody debris; - alter surface run-off rates; - increase sunlight penetration, thereby enhancing algal production and altering water quality and temperature; - increase sedimentation rates; alter sediment size; 	Spawning Egg incubation	Tributary deltas and surrounding nearshore lake habitat Stream habitat	<ul style="list-style-type: none"> • Pebbles \leq 1 cm diameter • Embedded sediment covered with small pebbles (approximately 1 cm in diameter) and sediment • Minimum water depth (0.2 m; Beamish 1998) • Adequate flowing water • Sufficient substrate depth for nest excavation (6 to 140 mm; Stone 2006) • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants • Sedimentation levels within the natural range of variation

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
		<p>increase turbidity</p> <p>Improper sediment and erosion control may:</p> <ul style="list-style-type: none"> - reduce bank stability; - increase sedimentation rates <p>Increased sedimentation rates may:</p> <ul style="list-style-type: none"> - alter aquatic substrate composition; <p>alter water quality</p>			
<p>Land use impacting habitats</p>	<p>Work in or around critical habitat with excessive riparian vegetation removal, or improper sediment and erosion control</p>	<p>Riparian vegetation removal may:</p> <ul style="list-style-type: none"> - reduce bank stability; - reduce terrestrially supplied food, nutrients, and woody debris; - alter surface run-off rates; - increase sunlight penetration, thereby enhancing algal production and altering water quality and temperature; - increase sedimentation rates; alter sediment size; increase turbidity <p>Improper sediment and erosion control may:</p>	<p>Ammocoete feeding and rearing</p>	<p>Tributary deltas and surrounding nearshore lake habitat</p> <p>Stream habitat</p> <p>Lake habitat (pelagic)</p>	<ul style="list-style-type: none"> • Loose silt, sand or mud substrate • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Adequate supply of detritus for food • Few or no added pollutants • Sedimentation levels within the natural range of variation

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
		<ul style="list-style-type: none"> - reduce bank stability; - increase sedimentation rates <p>Increased sedimentation rates may:</p> <ul style="list-style-type: none"> - alter aquatic substrate composition; <p>alter water quality</p>			
Land use impacting habitats	Work in or around critical habitat with excessive riparian vegetation removal, or improper sediment and erosion control	<p>Riparian vegetation removal may:</p> <ul style="list-style-type: none"> - reduce bank stability; - reduce terrestrially supplied food, nutrients, and woody debris; - alter surface run-off rates; - increase sunlight penetration, thereby enhancing algal production and altering water quality and temperature; - increase sedimentation rates; alter sediment size; increase turbidity <p>Improper sediment and erosion control may:</p> <ul style="list-style-type: none"> - reduce bank stability; - increase sedimentation rates 	Adult feeding	Lake habitat (pelagic)	<ul style="list-style-type: none"> • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
		Increased sedimentation rates may: - alter aquatic substrate composition; alter water quality			
Land use impacting habitats	Work in or around critical habitat with excessive riparian vegetation removal, or improper sediment and erosion control	Riparian vegetation removal may: - reduce bank stability; - reduce terrestrially supplied food, nutrients, and woody debris; - alter surface run-off rates; - increase sunlight penetration, thereby enhancing algal production and altering water quality and temperature; - increase sedimentation rates; alter sediment size; increase turbidity Improper sediment and erosion control may: - reduce bank stability; - increase sedimentation rates Increased sedimentation rates may: - alter aquatic	All	Riparian area around streams, lakes, and tributary deltas	<ul style="list-style-type: none"> • Stable banks • Terrestrially supplied food and nutrients • Stable quality and quantity of surface water run-off during high rainfall conditions (within the natural range of variation) • Stable shade cover for stream habitat • Large and small woody debris and overhanging bank vegetation for shelter

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
		substrate composition; alter water quality			
Alteration of prey base	Reduction in salmonid abundance through human activities	Reduced prey availability	Adult feeding	Lake habitat (pelagic)	<ul style="list-style-type: none"> • Prey availability (exact species unknown; salmonids)
Alteration of prey base	Introduction of invasive species through human activities	Modification of predator-prey relationships	Ammocoete feeding	Tributary deltas and surrounding nearshore lake habitat Stream habitat	<ul style="list-style-type: none"> • Adequate supply of detritus for food
Alteration of prey base	Introduction of invasive species through human activities	Modification of predator-prey relationships	Adult feeding	Lake habitat (pelagic)	<ul style="list-style-type: none"> • Prey availability (exact species unknown; salmonids)
Alteration of prey base Degradation of water quality	Excessive nutrient input through groundwater and/or surface flows as the result of point- or non-point sources	Eutrophication resulting in algal blooms reducing light penetration, water clarity, changing water chemistry, increased sedimentation rates, altered food web structure	Adult feeding	Lake habitat (pelagic)	<ul style="list-style-type: none"> • Prey availability (exact species unknown; salmonids) • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants
Alteration of prey base Degradation of water quality	Excessive nutrient input through groundwater and/or surface flows as the result of point- or non-point sources	Eutrophication resulting in algal blooms reducing light penetration, water clarity, changing water chemistry, increased sedimentation rates, altered food web structure	Egg incubation	Tributary deltas and surrounding nearshore lake habitat Stream habitat	<ul style="list-style-type: none"> • Pebbles \leq 1 cm diameter • Embedded sediment covered with small pebbles (approximately 1 cm in diameter) and sediment • Sufficient substrate depth for nest excavation (6 to 140 mm; Stone 2006) • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants • Sedimentation levels within the natural

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
Recreation impacting habitats or individuals Degradation of water quality	Release of contaminants into aquatic habitats, including from surface runoff and recreational activities	Some contaminants do not readily dissolve in water but will bind with organic material and can be deposited in sediment	Egg incubation Ammocoete rearing	Tributary deltas and surrounding nearshore lake habitat Stream habitat	range of variation <ul style="list-style-type: none"> • Water quality parameters (oxygen, temperature, turbidity and pH) within the natural range of variation • Few or no added pollutants

3.3 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 the Vancouver Lamprey's 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.

4. Evaluation of socio-economic costs and benefits

The 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 (SARA 49(1)(e), 2003). 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 organizations or agents other than the federal government may be better placed for implementation of certain aspects of the plan. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. The intent of this evaluation is to inform the public and to guide decision-making on implementation of the action plan by partners.

The protection and recovery of species at risk can result in both benefits and costs. The Act 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*" (SARA 2003). 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; DFO 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.

4.1 Benefits of implementing this action plan

The impacts on Vancouver Lamprey of the recovery measures in this plan are unknown but likely positive. As indicated above, Canadians value species for a number of reasons, including non-market benefits (in other words existence, bequest and option values).³⁰ Activities that positively affect the recovery of species with non-market benefits may result in positive benefits to Canadians.

³⁰ 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).

The recovery measures for Vancouver Lamprey may also provide broader benefits to other species. For example, monitoring and research activities may provide information on other species or habitat conditions that would be useful in their management. As well, the evaluation of land and water management options in Vancouver Lamprey habitat may provide benefits to other species that also depend on those habitats, while best practices for land development may provide benefits to both Vancouver Lamprey and its prey species, such as salmonids.

4.2 Socio-economic costs of implementing this action plan

The implementation schedule separates recovery measures into three tables. Table 1 includes measures to be undertaken by DFO with the full costs borne by the Government of Canada. Table 2 includes measures to be undertaken collaboratively between DFO and partners; the costs of these measures would be borne jointly by government and partners. The measures in Table 3 provide opportunities for other jurisdictions, organizations and individuals to support the recovery of Vancouver Lamprey; these costs would be borne primarily by parties other than the Government of Canada. Government costs would come from existing allocations.

The majority of the measures in the plan are research activities, focused on gathering information on habitats and prey species. These are very low cost activities that are primarily scheduled to be conducted in the short-term (that is, first five years). The measures to develop a monitoring plan and implement the plan are very low in cost and are to be conducted in the medium- (6 to 10 years) and long-term (10+ years). The development of guidelines and strategies around allowable harm, land and water management options and best management practices for land development are very low cost measures, and would occur principally in the short-term, but also in the medium-term. The costs associated with the stewardship and education measures in Table 3 are unknown, but are likely very low cost based on similar actions for other species. These measures are anticipated for the duration of the action plan, and most costs would likely be borne by parties other than Government of Canada.

The direct annual costs of all of the measures in the action plan are anticipated to be very low (that is, less than \$50,000/year), with some additional in-kind costs likely for partners, organizations and individuals for measures identified in Tables 2 and 3. Indirect costs are not anticipated. The costs will be distributed across the short-, medium- and long-term.

5. Measuring progress

The performance measures presented in the associated 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 s. 55 of SARA) will be done by assessing progress towards implementing the strategies identified in the recovery strategy.

Reporting on the ecological and socio-economic impacts of the action plan (under s. 55 of SARA) will be done by assessing the results of monitoring the recovery of the species and its long-term viability, and by assessing the implementation of the action plan.

6. References

- Beamish, R.J., and Wade, J. 2008. Critical habitat and the conservation ecology of the freshwater parasitic lamprey, *Lampetra macrostoma*. Canadian Field-Naturalist 122(4): 327-337.
- COSEWIC. 2008. COSEWIC assessment and update status report on the Vancouver Lamprey *Lampetra macrostoma* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 39 pp.
- Cowichan Tribes and Cowichan Watershed Board. in prep. The sustainability of Cowichan River in-stream flows: tree-ring records suggest the worst droughts are yet to come. Report in progress, based on the results of Coulthard et al. (2016) and Coulthard and Smith (2015).
- CBWB (Cowichan Basin Watershed Board). 2010. Current status of Cowichan basin water management plan and recommended actions 2010. Available online at: [Current status of Cowichan basin water management plan and recommended actions 2010](#) [accessed November 2016].
- Fisheries and Oceans Canada. 2008. Estimation of the Economic Benefits of Marine Mammal Recovery in the St. Lawrence Estuary. Policy and Economics Regional Branch, Quebec 2008.
- Fisheries and Oceans Canada. 2016. Report on the progress of recovery strategy implementation for Cowichan Lake Lamprey (*Entosphenus macrostomus*) in Canada for the period 2007 – 2015. *Species at Risk Act Recovery Strategy Report Series*. Fisheries and Oceans Canada, Ottawa. iii + 12 pp.
- Harvey, B. 2015. Recovery Potential Assessment for the Vancouver Lamprey (*Lampetra macrostoma* Beamish). DFO Can. Sci. Advis. Sec. Res. Doc. 2015/061. vi + 13 p.
- Loomis, J.B. & White, D.S 1996. Economic Benefits of Rare and Endangered Species: Summary and Meta-analysis. *Ecological Economics*, 18: 197-206.
- MacConnachie, S., and Wade, J. 2016. Information in support of the identification of critical habitat for the Cowichan (Vancouver) Lamprey (*Entosphenus macrostomus*). DFO Can. Sci. Advis. Sec. Res. Doc. 2016/109. vi + 17 p.
- MacConnachie, S., and Wade, J. in prep. Review of the information to support the identification of critical habitat for the Cowichan (Vancouver) Lamprey). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/XXX.
- Province of British Columbia. n.d. Water quality objectives: West coast region. Available online at: [Water quality objectives: West coast region](#) [accessed September 2016].
- Stone, J. 2006. Observations on nest characteristics, spawning habitat, and spawning behaviour of Pacific and Western Brook lamprey in a Washington stream. *Northwestern Naturalist* 87: 225-232.
- VLRT (Vancouver Lamprey Recovery Team). 2007. Recovery Strategy for the Vancouver Lamprey (*Lampetra macrostoma*) in Canada. *Species at Risk Act Recovery Strategy Series*, Fisheries and Oceans Canada, Ottawa, ix +21 pp.
- Westland Resource Group Inc. 2007. Cowichan basin water management plan. Available online at: [Cowichan Basin Water Management Plan](#) [accessed November 2016].

Appendix A: effects on the environment and other species

In accordance with the [Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals](#) (2010), SARA recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. 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 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 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.

By promoting the recovery of the Vancouver Lamprey in the wild this action plan will benefit the environment, 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 following associated target: 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: water and land use impacting habitats; recreation impacting habitats or individuals; and, alteration of prey base. By addressing these threats, the actions will contribute to overall ecosystem health, which is likely to provide benefits to other species, such as Coho Salmon, Coastal Cutthroat Trout, and Dolly Varden, as well as ecological services to Canadians living in the area.

Vancouver Lamprey co-exist with other fish species found in the Cowichan watershed, such as salmonids. Ammocoetes filter feed on detritus and suspended organic matter, while juveniles and adults parasitize salmonids (COSEWIC 2008). Though some mortality of the host fish occurs, scarring suggests that Vancouver Lamprey mostly feed without killing the host (Beamish 1982 in COSEWIC 2008). Additionally, the species appears to have historically coexisted with a healthy population of salmonids in Cowichan and Mesachie Lakes (NatureServe 2006 in COSEWIC 2008). Though predation on Vancouver Lamprey is not highly reported, eggs are likely preyed upon by other fishes, and more mature stages are likely preyed upon by birds and mink (Scott and Crossman 1973, Close et al. 2002, Cochran et al. 1992, and Beamish 1980 in COSEWIC 2008). Significant adverse effects on other species are not anticipated as the result of the implementation of this action plan.

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

Action plans are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties and others as outlined in SARA section 48. DFO hosted an action planning workshop in the Town of Lake Cowichan, British Columbia the afternoon of September 19, 2016 to seek input on the development of this action plan. Information on participation is included below.

Organizations represented
1. British Columbia Conservation Foundation
2. British Columbia's Ministry of Environment
3. Cowichan Lake and River Stewardship Society
4. Cowichan Stewardship Roundtable
5. Cowichan Tribes
6. Cowichan Valley Regional District
7. Fisheries and Oceans Canada
8. Fundy Aqua Services
9. Q'ul-Ihanumtsun Aquatic Resources Society
10. TimberWest

Workshop participants identified knowledge gaps and provided input on potential recovery measures addressing key threats. Discussions focused on the importance of: proponents, water managers, and landowners taking specific habitat requirements into consideration during the planning and conduct of their activities; reducing stigma (associated with parasitism and false associations with invasive lamprey) and communicating the Threatened status of the species; and, the general need for further research to inform knowledge gaps.

DFO also hosted a community open-house the same evening and in the same location as the workshop, to share information and seek input from those potentially affected by, or interested in, the action plan. Attendees were predominantly positive about Vancouver Lamprey recovery, and participated in discussions about SARA and species biology, threats, and recovery.

In February 2017 the draft action plan was circulated to Indigenous organizations, local, regional, and provincial governments, academia, environmental non-government organizations, industry, and recreational fishers for a 30-day external review. Comments resulted in minor revisions to recovery measures, and clarifications or expansions on critical habitat features and attributes.

Additional stakeholder, Aboriginal, 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. No feedback was received.

Appendix C: riparian critical habitat maps

The following maps represent widths of riparian critical habitat associated with particular areas identified as aquatic critical habitat; they should be taken into consideration along with the content of section 3 of this action plan. Riparian critical habitat widths extend inland from the high water mark of identified water bodies. The approximate total area within which riparian critical habitat is found is 15 hectares.

Refer to section 3.1.3 for a description of anthropogenic features excluded from critical habitat.

Table 7. Geographic coordinates associated with critical habitat coordinate markers in figures 3 through 13.

ID	Longitude	Latitude	Reference map
VL2	-124.415	48.91811	figure 12
VL3	-124.411	48.91992	figure 12
VL4	-124.409	48.92068	figure 12
VL5	-124.409	48.92038	figure 12
VL6	-124.41	48.91972	figure 12
VL7	-124.409	48.91749	figure 12
VL8	-124.414	48.9185	figure 12
VL9	-124.411	48.91887	figure 12
VL10	-124.412	48.91698	figure 12
VL11	-124.378	48.92001	figure 4
VL12	-124.375	48.92147	figure 4
VL15	-124.197	48.86995	figure 10
VL16	-124.196	48.87038	figure 10
VL17	-124.196	48.87068	figure 10
VL18	-124.196	48.87067	figure 10
VL19	-124.196	48.87039	figure 10
VL20	-124.195	48.87035	figure 10
VL21	-124.194	48.87096	figure 10
VL22	-124.194	48.87093	figure 10
VL23	-124.195	48.87034	figure 10
VL24	-124.194	48.87004	figure 10
VL25	-124.153	48.85996	figure 8
VL26	-124.154	48.8605	figure 8
VL27	-124.154	48.86053	figure 8
VL28	-124.153	48.85999	figure 8
VL29	-124.117	48.84519	figure 5
VL30	-124.117	48.84455	figure 5
VL31	-124.117	48.84344	figure 5
VL32	-124.118	48.84344	figure 5
VL33	-124.118	48.84451	figure 5

ID	Longitude	Latitude	Reference map
VL34	-124.118	48.84446	figure 5
VL45	-124.13	48.81377	figure 11
VL46	-124.13	48.81443	figure 11
VL47	-124.132	48.81395	figure 11
VL48	-124.13	48.81454	figure 11
VL49	-124.13	48.81468	figure 11
VL50	-124.13	48.8149	figure 11
VL51	-124.133	48.81446	figure 11
VL52	-124.133	48.81474	figure 11
VL53	-124.132	48.81531	figure 11
VL54	-124.132	48.81644	figure 11
VL55	-124.126	48.81604	figure 6
VL56	-124.126	48.816	figure 6
VL57	-124.123	48.81605	figure 6 & figure 7
VL58	-124.124	48.81626	figure 6 & figure 7
VL59	-124.123	48.81605	figure 6 & figure 7
VL60	-124.119	48.81552	figure 7
VL61	-124.119	48.81547	figure 7
VL62	-124.101	48.81254	figure 3
VL63	-124.1	48.81312	figure 3
VL64	-124.1	48.81311	figure 3
VL65	-124.101	48.81252	figure 3
VL67	-124.183	48.82306	figure 13
VL68	-124.183	48.82353	figure 13
VL69	-124.185	48.82414	figure 13
VL70	-124.185	48.82433	figure 13
VL71	-124.183	48.82385	figure 13
VL72	-124.182	48.82392	figure 13
VL76	-124.372	48.9016	figure 9
VL77	-124.374	48.9012	figure 9
VL78	-124.375	48.89838	figure 9
VL79	-124.376	48.8982	figure 9
VL80	-124.376	48.8992	figure 9
VL81	-124.375	48.90226	figure 9

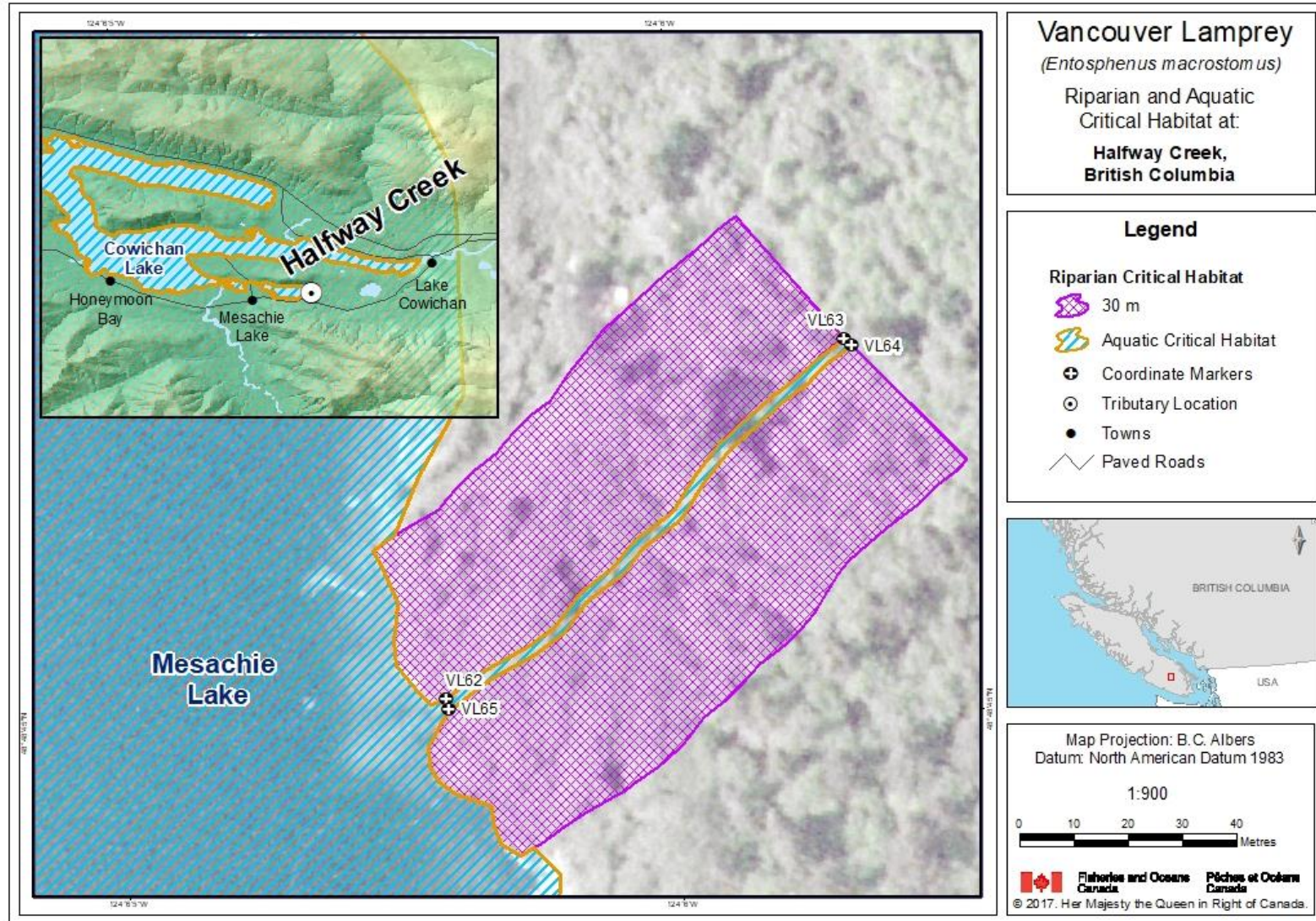


Figure 3. Geographic extent of riparian critical habitat associated with Halfway Creek

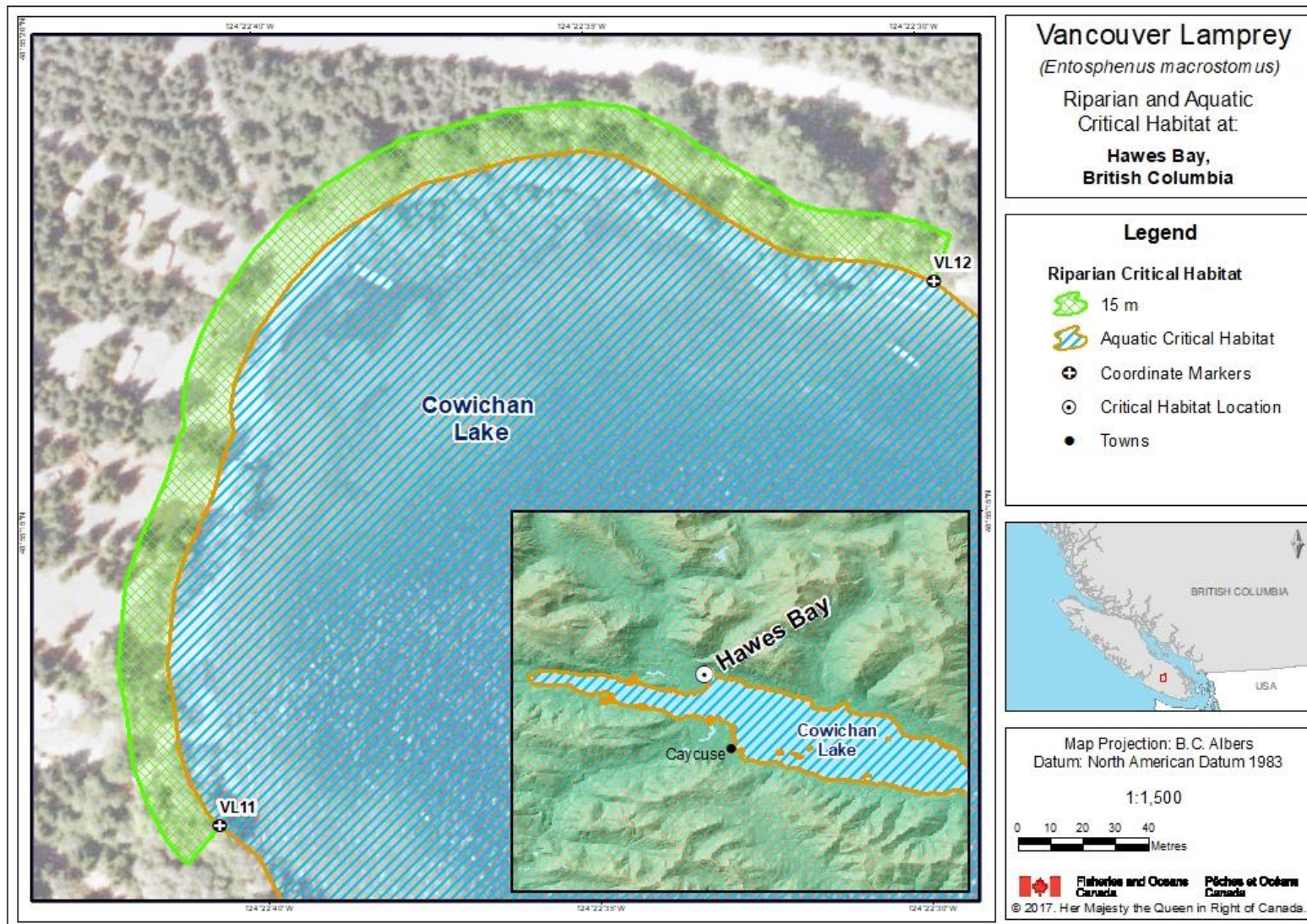


Figure 4. Geographic extent of riparian critical habitat associated with Hawes Bay

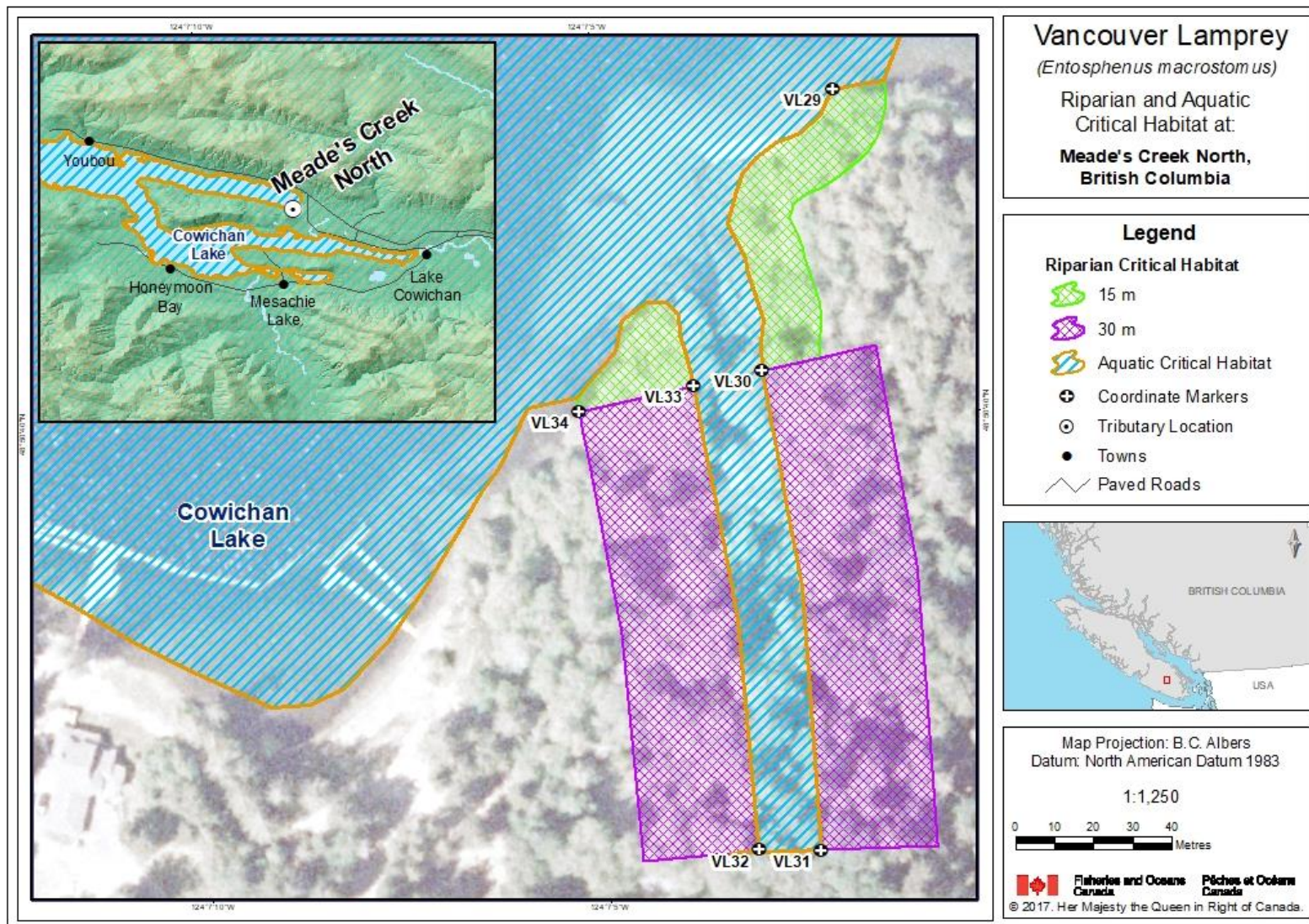


Figure 5. Geographic extent of riparian critical habitat associated with Meade's Creek North

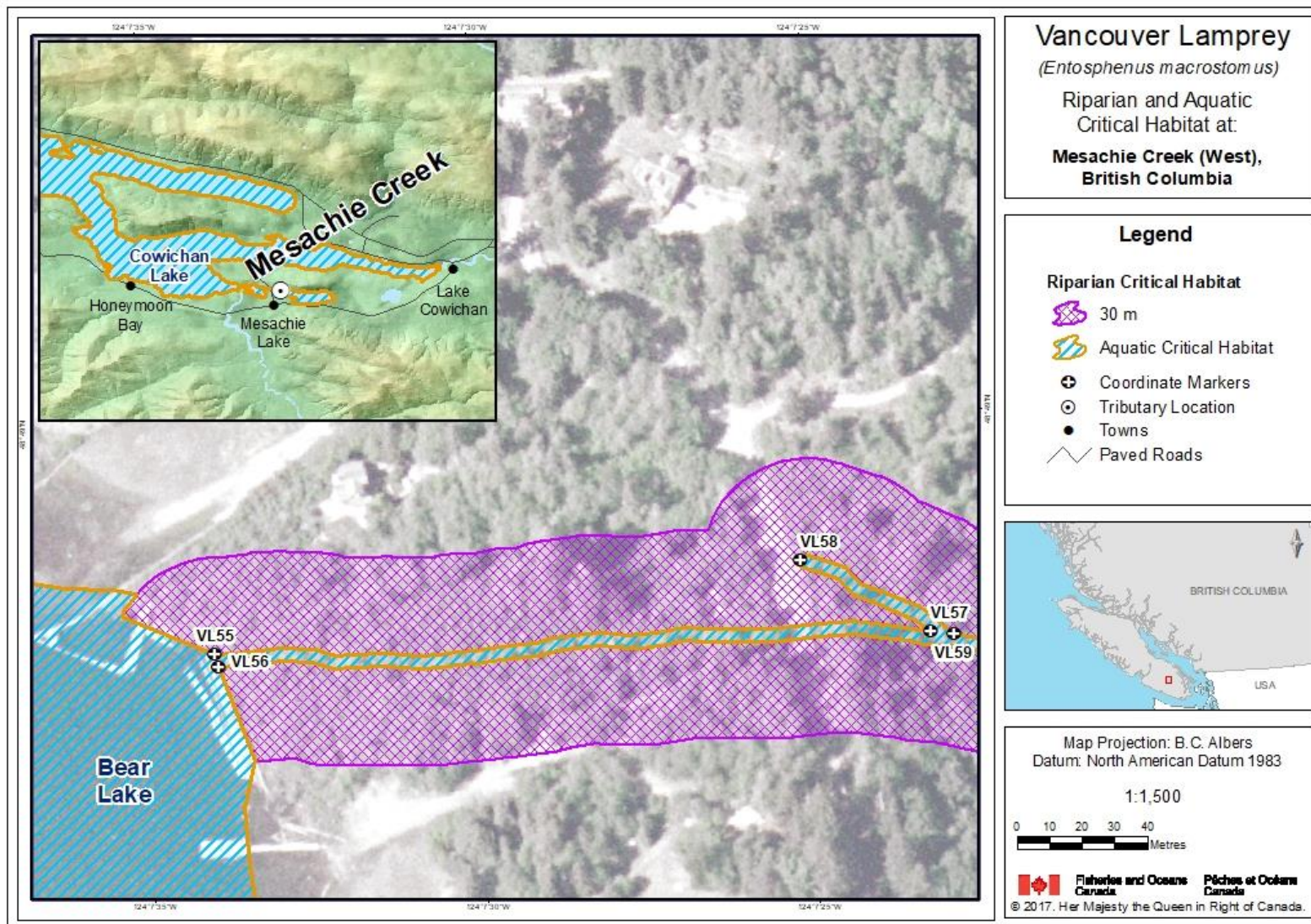


Figure 6. Geographic extent of riparian critical habitat associated with the western portion of Mesachie Creek

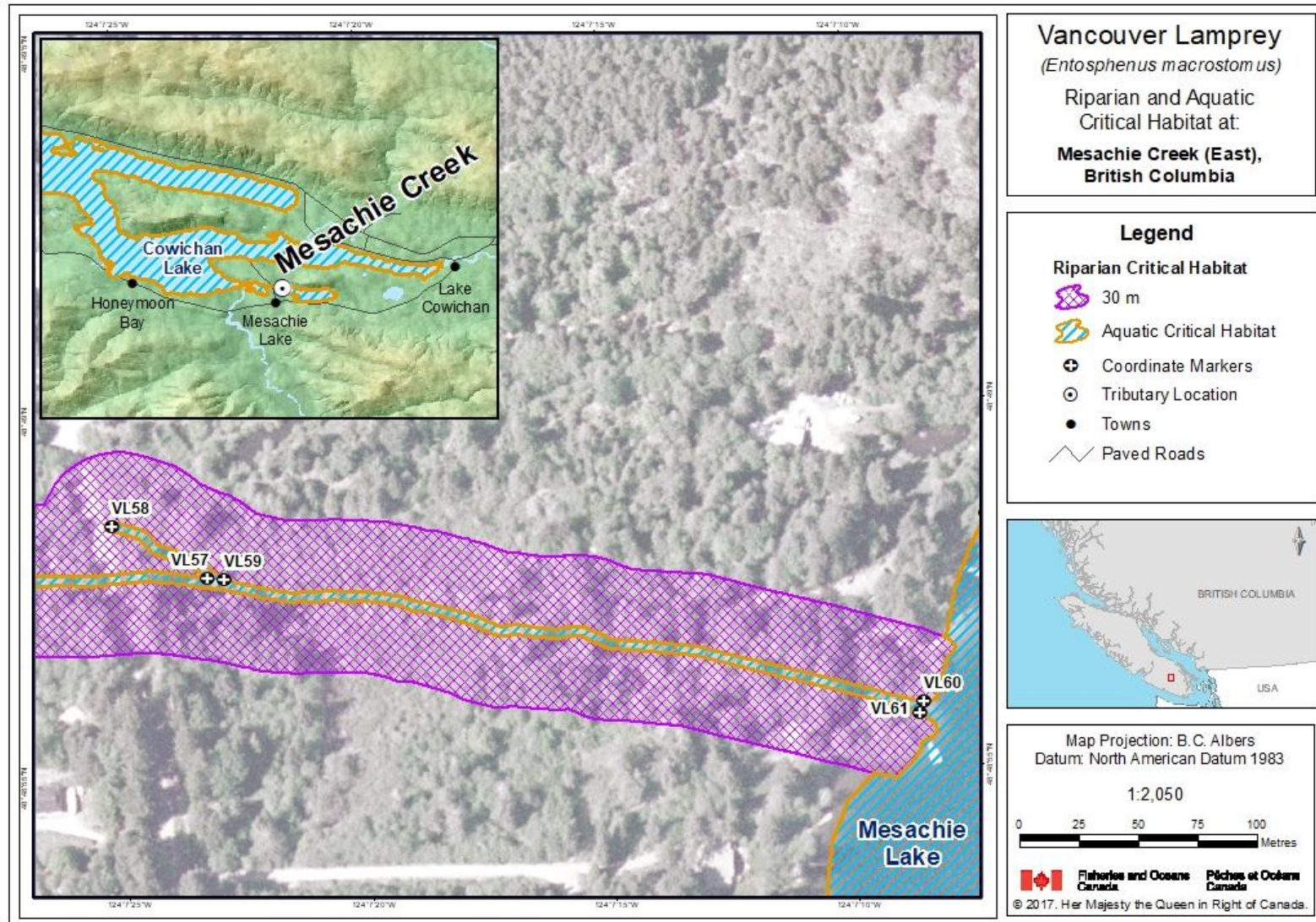


Figure 7. Geographic extent of riparian critical habitat associated with the eastern portion of Mesachie Creek

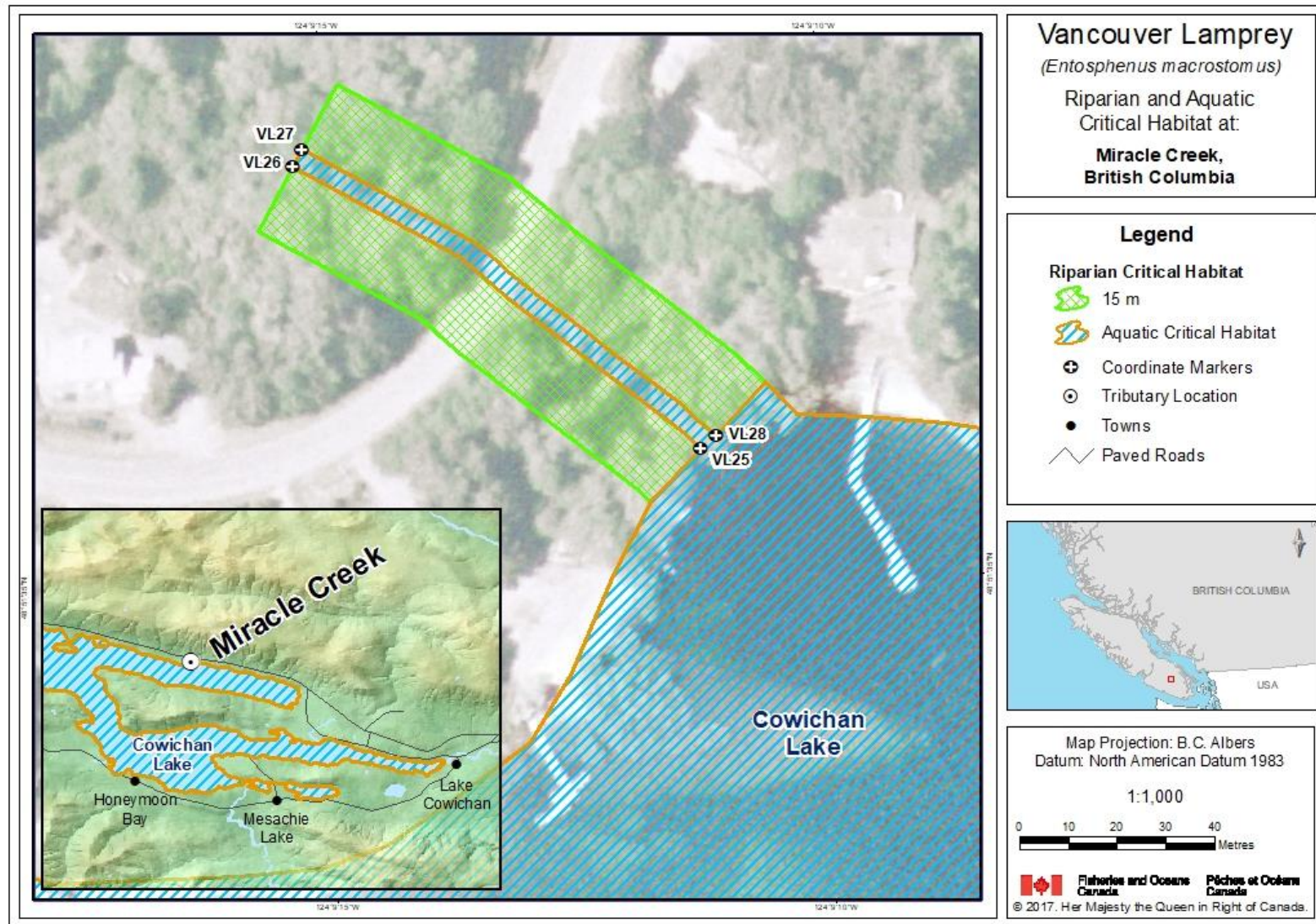


Figure 8. Geographic extent of riparian critical habitat associated with Miracle Creek

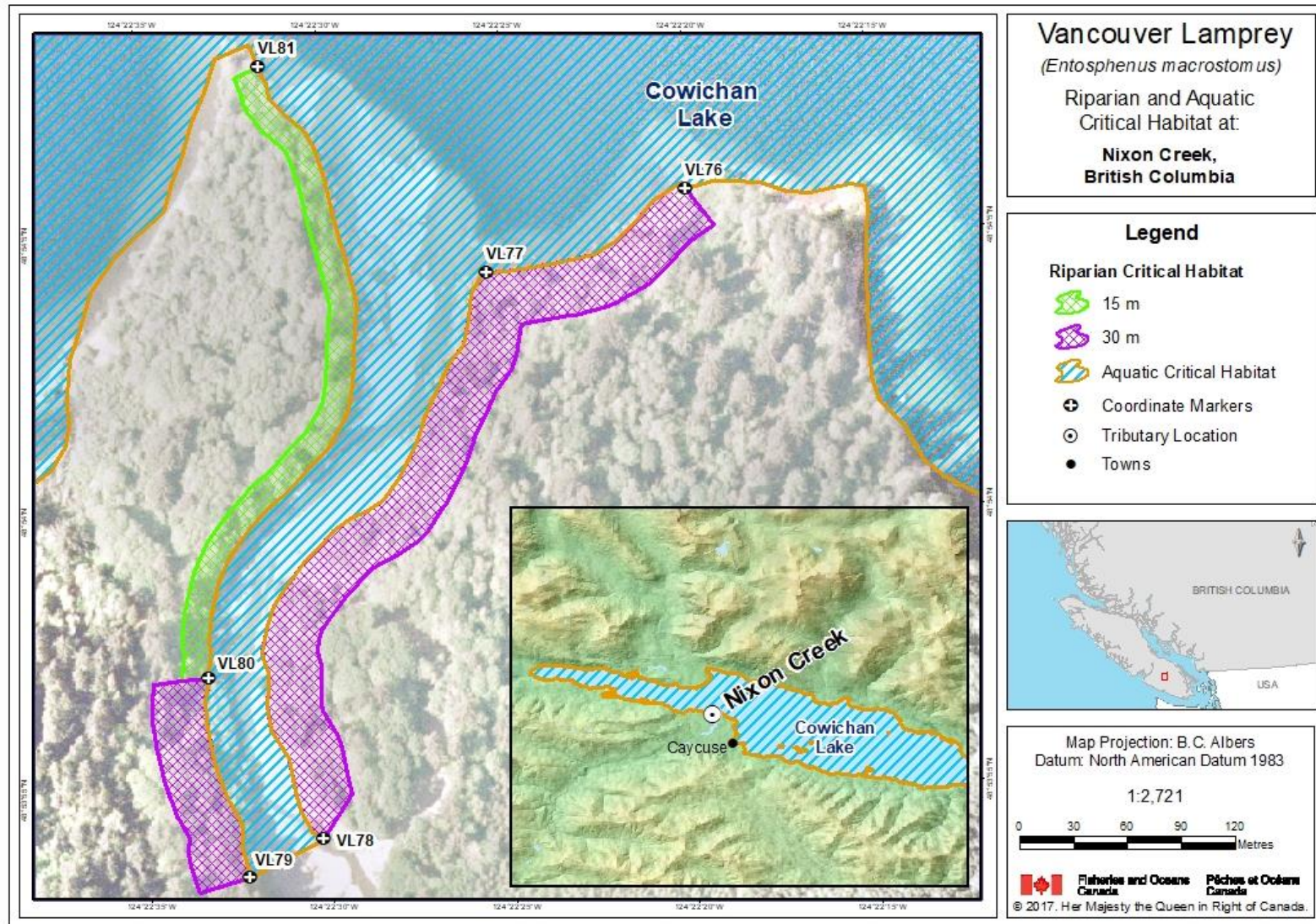


Figure 9. Geographic extent of riparian critical habitat associated with Nixon Creek

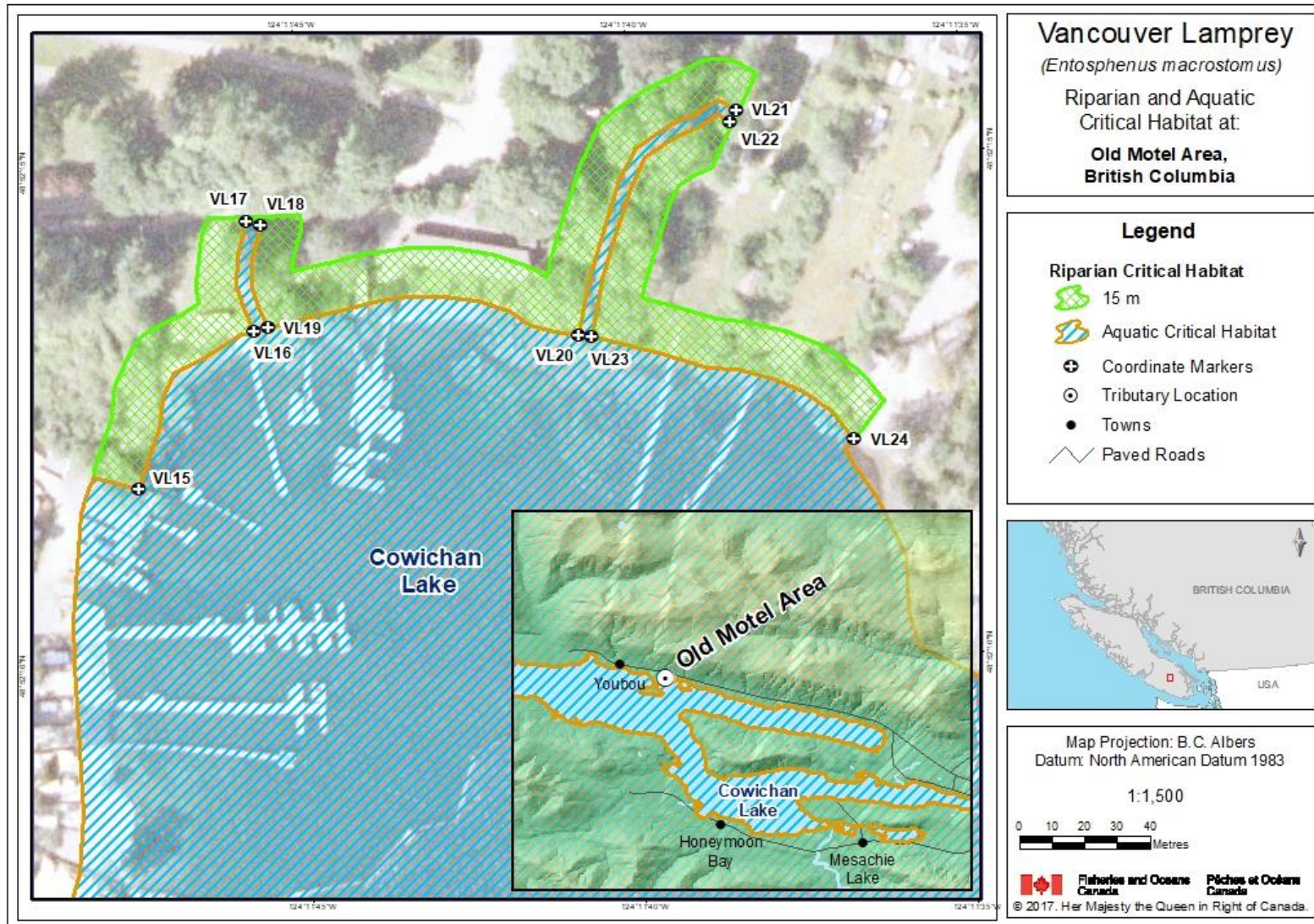


Figure 10. Geographic extent of riparian critical habitat associated with the Old Motel Area

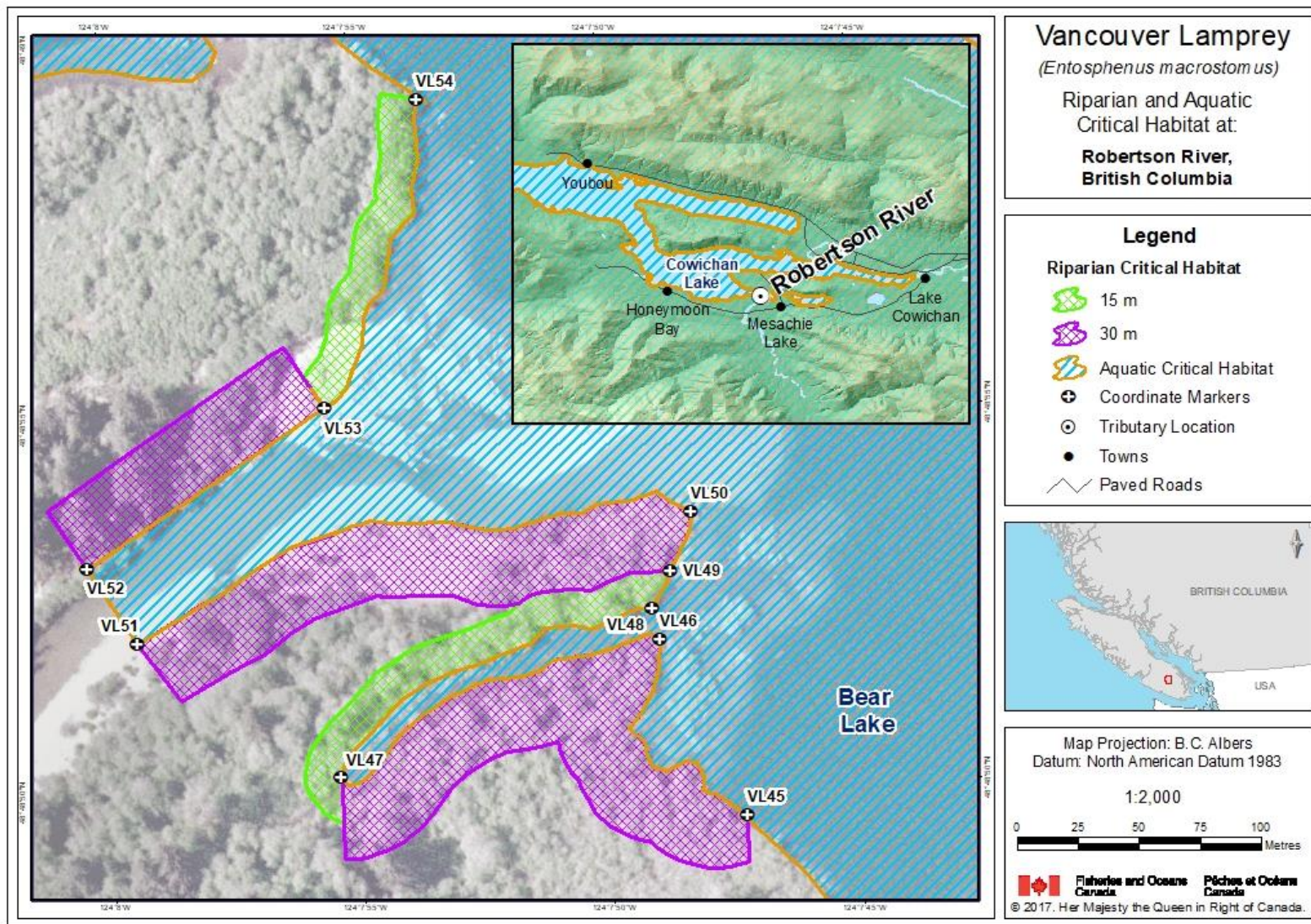


Figure 11. Geographic extent of riparian critical habitat associated with Robertson River

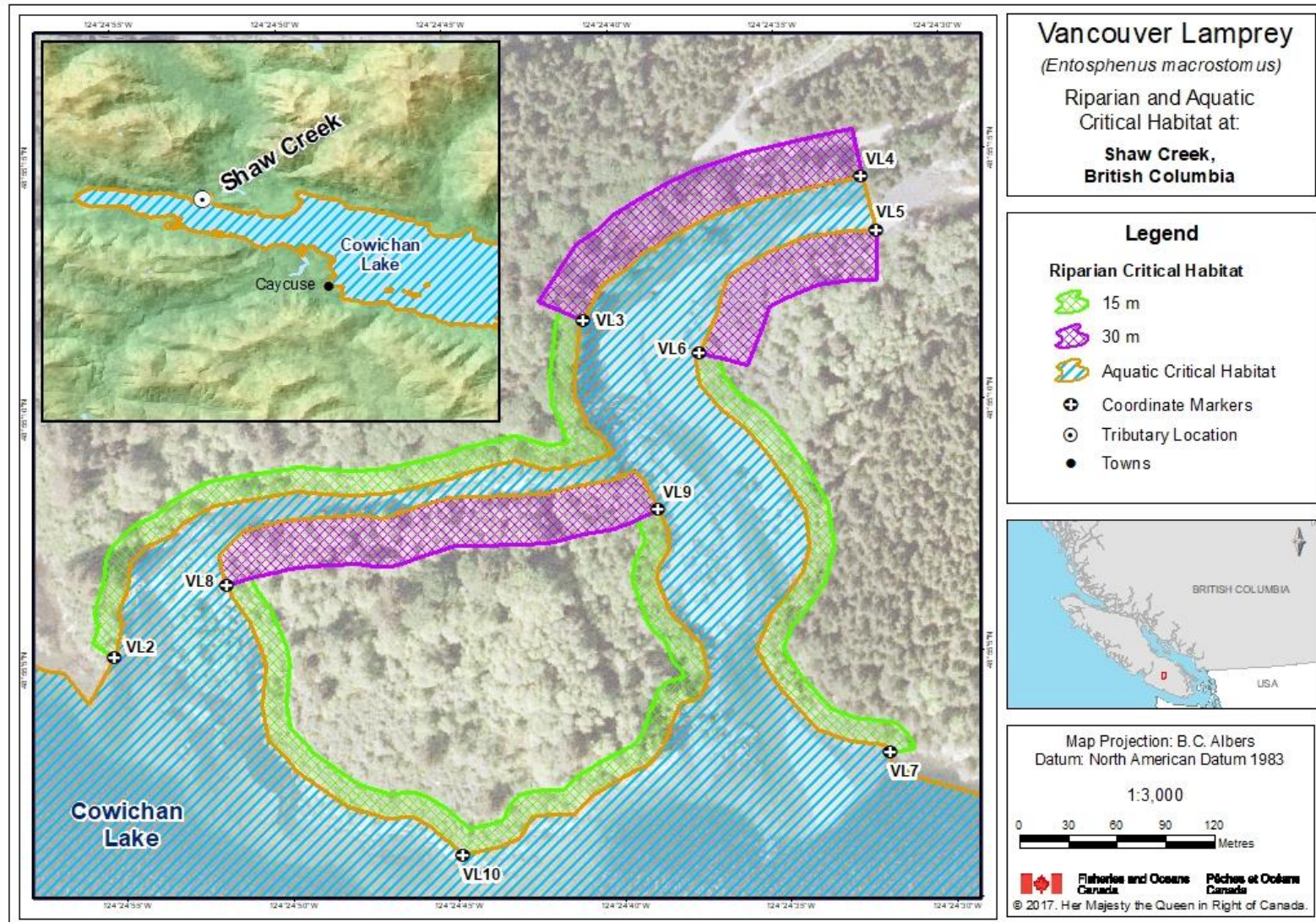


Figure 12. Geographic extent of riparian critical habitat associated with Shaw Creek

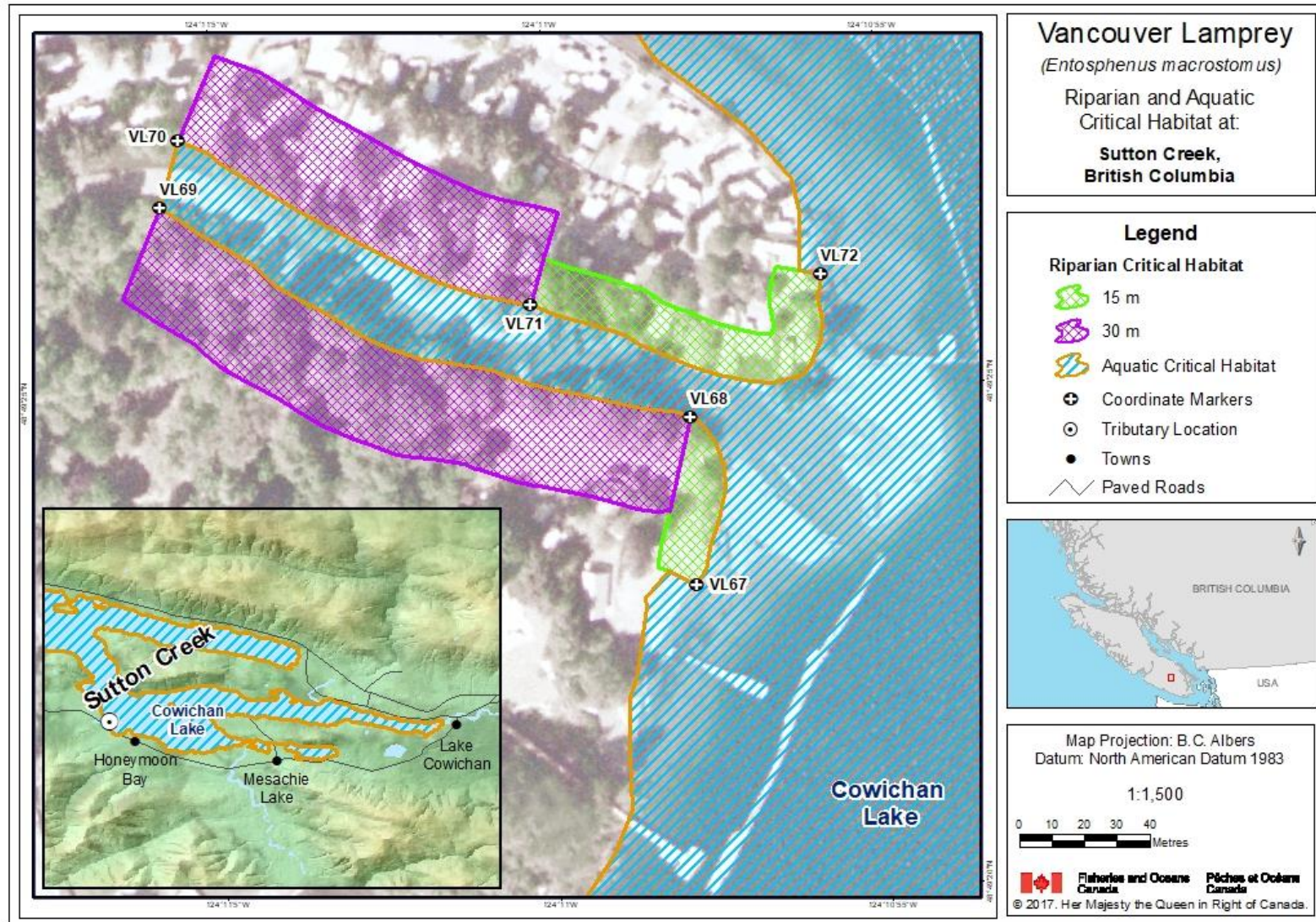


Figure 13. Geographic extent of riparian critical habitat associated with Sutton Creek