COSEWIC
Assessment and Status Report

on the

Shortface Lanx
Fisherola nuttallii

in Canada

ENDANGERED
2016

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2016. COSEWIC assessment and status report on the Shortface Lanx *Fisherola nuttallii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 37 pp. (http://www.registrelep-sararegistry.gc.ca/default_e.cfm).

Production note:
COSEWIC would like to acknowledge Stephanie Clark and Jochen Gerber for writing the status report on Shortface Lanx in Canada. This report was prepared under contract with Environment Canada and was overseen by Dwayne Lepitzki, Co-chair of the COSEWIC Molluscs Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Patelle géante du fleuve Columbia (*Fisherola nuttallii*) au Canada.

Cover illustration/photo:
Shortface Lanx — Photo: Dr. J. Gerber.

Catalogue No. CW69-14/739-2016E-PDF
ISBN 978-0-660-05684-5

COSEWIC
Assessment Summary

Assessment Summary – May 2016

Common name
Shortface Lanx

Scientific name
Fisherola nuttallii

Status
Endangered

Reason for designation
This limpet-like freshwater snail is globally confined to the Columbia River basin. Historically known from the 1800s, the first recent evidence of the species in Canada was the discovery of a broken shell in the Columbia River near Trail, British Columbia, followed by live individuals being found in the same area in 2009 and 2010. Searches in 2014 confirm the species still exists in this short, free flowing section of the Columbia River. It requires flowing, clean, well-oxygenated, cold water, but the numerous dams on the Columbia River and its major tributaries have converted much of this habitat into reservoirs. The species is exposed to a variety of threats from natural system modifications caused by the dams, pollution from urban and industrial sources, invasive and problematic native species, and climate change.

Occurrence
British Columbia

Status history
Designated Endangered in April 2016.

COSEWIC
Executive Summary

Shortface Lanx
Fisherola nuttallii

Wildlife Species Description and Significance

Shortface Lanx, *Fisherola nuttallii* (Haldeman, 1841), is a small limpet-shaped (i.e., like a cone volcano) freshwater snail that reaches about 12 mm in length, 10 mm in width and 6 mm in height. It is readily distinguished from all other freshwater snails living in the Columbia River drainage of Canada and the US by its shell shape. The genus *Fisherola* currently contains a single species but is closely related to the genus *Lanx,* found in southern Oregon and northern California and a third yet to be described species, the "Banbury Lanx," known from four springs in southern Idaho. Given its requirements for flowing, well-oxygenated, cool (less than 20°C) rivers, Shortface Lanx could be a potential sensitive species for monitoring aquatic environments.

Distribution

Shortface Lanx is endemic and restricted to the Columbia River drainage in Canada and the US. It has been recorded from the Columbia River in Washington and Oregon, the Snake River in Idaho and Oregon, the Salmon River in Idaho, the Deschutes, John Day and Imnaha rivers in Oregon and the Okanogan, Methow and Spokane rivers in Washington. In Canada, Shortface Lanx is known only from the free-flowing portion of the Columbia River in southeastern British Columbia extending about 14 km upstream and 6 km downstream of the City of Trail. There is a historical record from 1863 from the "River Kootanie East" (= Kootenay River) but no further specimens have been located from that river.

Habitat

Shortface Lanx is typically found on the underside and sides (rarely on top) of relatively smooth rocks in large flowing rivers. The maximum depth at which the species can occur is unknown. The deepest the report writers have been able to find the species is about 0.5 m in both Canada and the US. However, it almost certainly occurs deeper, beyond the reach of searchers except those using snorkel or SCUBA.

Biology

Relatively little is known of the biology or life history of Shortface Lanx. It is a hermaphrodite (both sexes in same individual) and lays transparent, suboval gelatinous egg masses containing between 1-12 eggs. In the Washington State portion of the Columbia River, egg laying occurs from April to June, and is correlated with water temperature rising from the winter lows of 4-6°C to 17-20°C in the summer. Growth rates increase as the availability of food and temperatures rise. The life span is about a year; adult mortality increases rapidly after egg laying and temperatures rise above 17°C.

Population Sizes and Trends

There are no quantitative data on numbers of individuals in the Columbia River in Canada.

Threats and Limiting Factors

Shortface Lanx is threatened by natural system modifications through the effects of dams, invasive and other problematic native species, pollution from urban and industrial sources, and the effects of climate change and severe weather although water flow patterns are controlled by dams. Given its known limited distribution, it is susceptible to toxic spills caused by train derailment or truck accidents in close proximity to the river. The construction of dams throughout the Columbia River drainage both in Canada and the US has resulted in the formation of extensive stretches of lacustrine (lake) conditions which do not provide suitable habitat for Shortface Lanx and limit opportunities for dispersal.

Protection, Status and Ranks

In Canada, Shortface Lanx is not currently listed under the *Species at Risk Act*. In the US, it is not listed under the *Endangered Species Act* nor is it listed individually by any US state. However, it is listed as a candidate species by the state of Washington. NatureServe gives a global rank of imperilled (G2); individual provincial/state ranks are: Alberta (SNR, not ranked), British Columbia (S1, critically imperilled), Saskatchewan (SNR); Idaho (S2, imperilled), Montana (SH, possibly extinct), Oregon (S1S2, critically imperilled to imperilled), Utah (SNR), Washington (S2), Wyoming (SNR). The current ranks for Alberta and Saskatchewan are probably in error and are being reviewed.

None of the currently known sites for Shortface Lanx in Canada occur in protected areas.

TECHNICAL SUMMARY

Fisherola nuttallii

Shortface Lanx

Patelle géante du fleuve Columbia

Range of occurrence in Canada: British Columbia.

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2011) is being used)	About one year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown. No quantitative data available
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown. No quantitative data available
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence	56 km^2 (calculated EOO = 54 km^2)
Index of area of occupancy (IAO) (Always report 2x2 grid value).	56 km^2
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. Yes

Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	1-4
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, inferred (historical decline probable, continuing decline uncertain)
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred (historical decline probable, continuing decline uncertain)
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, inferred (historical decline probable, continuing decline uncertain)
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Yes, inferred (historical decline probable, continuing decline uncertain and assumes that there is more than one location)
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, recent decline in habitat quality observed and inferred but more recent mitigations have most likely improved habitat quality although various threats are still present; there has also been loss of suitable habitat due to past dam construction and the resultant reservoirs
Are there extreme fluctuations in number of subpopulations?	Unknown
Are there extreme fluctuations in number of “locations”?	Unknown
Are there extreme fluctuations in extent of occurrence?	Unknown
Are there extreme fluctuations in index of area of occupancy?	Unknown

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Columbia River	No quantitative data available
Total	Unknown

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	No quantitative data available

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* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term.

Threats (direct from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes

i. While having a scope of “pervasive”, severity for the following threats was scored as “unknown” due to insufficient knowledge and no recent trend data on subpopulations or distribution resulting in a calculated impact of “unknown”:

Natural system modifications (IUCN Threat 7),
Invasive and other problematic species and genes (IUCN Threat 8),
Pollution (IUCN Threat 9),
Climate change and severe weather (IUCN Threat 11).

ii. The following were assessed as having a “negligible” impact:

Residential and commercial development (IUCN Threat 1),
Energy production and mining (IUCN Threat 3),
Transportation and service corridors (IUCN Threat 4),
Human intrusions and disturbance (IUCN Threat 6),
Geological events (IUCN Threat 10).

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	NatureServe ranks: Idaho (S2), Montana (SH), Washington (S2)
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	Potentially
Are conditions deteriorating in Canada?[+]	Uncertain
Are conditions for the source population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	Unknown
Is rescue from outside populations likely?	Unlikely as the Canadian population is upstream of the US.

Data Sensitive Species

Is this a data sensitive species? No.

Status History

COSEWIC: Not previously assessed.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Status and Reasons for Designation:

<table>
<tr><td>Status:
Endangered</td><td>Alpha-numeric codes:
B1ab(iii)+2ab(iii)</td></tr>
<tr><td colspan="2">Reasons for designation:
This limpet-like freshwater snail is globally confined to the Columbia River basin. Historically known from the 1800s, the first recent evidence of the species in Canada was the discovery of a broken shell in the Columbia River near Trail, British Columbia, followed by live individuals being found in the same area in 2009 and 2010. Searches in 2014 confirm the species still exists in this short, free-flowing section of the Columbia River. It requires flowing, clean, well-oxygenated, cold water but the numerous dams on the Columbia River and its major tributaries have converted much of this habitat into reservoirs. The species is exposed to a variety of threats from natural system modifications caused by the dams, pollution from urban and industrial sources, invasive and problematic native species, and climate change.</td></tr>
</table>

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. The number of mature individuals is unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii). Both the EOO and IAO (56 km^2 each) are well below the thresholds for Endangered (<5,000 km^2 and 500 km^2, respectively), there are fewer than 5 locations (a), and there is an observed and inferred continuing decline in quality of habitat (biii) caused by a variety of threats.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Number of mature individuals is unknown.
Criterion D (Very Small or Restricted Population): D1 is not applicable because the number of mature individuals is unknown. D2 Threatened is applicable because while the continuous IAO (56 km^2) is above the typical 20 km^2 threshold, the number of locations is below the typical threshold (5 or fewer) and the species is prone to the effects of human activities or stochastic events in an uncertain future that once they occur, means the species will rapidly meet the thresholds for critically endangered within 1 or 2 generations (1-2 years) or become Extirpated. Although D2 Threatened was met, the species’ status was determined to be more at risk and Endangered under criterion B.
Criterion E (Quantitative Analysis): Not applicable as analyses have not been done.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2016)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

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Fisherola nuttallii

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2016

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Kingdom: Animalia

Phylum: Mollusca

Class: Gastropoda

Order: Basommatophora

Family: Lymnaeidae

Scientific name: *Fisherola nuttallii*

Common name:

English:	Shortface Lanx previously referred to as the Great Columbia River Limpet or Greater Columbia-River Limpet
French:	Patelle géante du fleuve Columbia

Shortface Lanx was first described by Haldeman (1841) as *Ancylus nuttallii* with the type locality being Oregon (specific waterbody not provided); he re-described it based on the same specimen as *Ancylus crassus* (Haldeman 1844). A couple of decades later, Baird (1863) described *Ancylus kootaniensis* from specimens collected by J.K. Lord, who was the naturalist on the British North American Boundary Commission from 1858-1862 (Figure 1). Baird stated that the specimens came from the “Rivers Kootanie and Spokane, British Columbia”. Hannibal (1912) then placed *Ancylus nuttallii* in the genus *Lanx* Clessin, 1881 and described a new genus and species, *Fisherola lancides,* for specimens from the Snake River, Idaho. Hannibal (1914) later considered *Lanx* and *Fisherola* to be members of his new family Laevapecidae and described a new subfamily Lancinae as he considered the dextral orientation of the animals of *Lanx* and *Fisherola* meant that they did not belong to the sinistrally oriented Ancylidae. *Fisherola* was then synonymized under *Lanx* by Pilsbry (1925) based on a number of shell and anatomical characters and raised Lancinae to family-level, Lancidae. He also thought that *kootaniensis* and *lancides* were synonyms of *nuttallii*. Baker (1925) conducted a detailed anatomical study of *Lanx alta* from the Klamath River, Klamathton, California and showed that anatomically *Lanx* is very close to *Lymnaea* and that if it was not for the shell differences he would place the species in the Lymnaeidae.

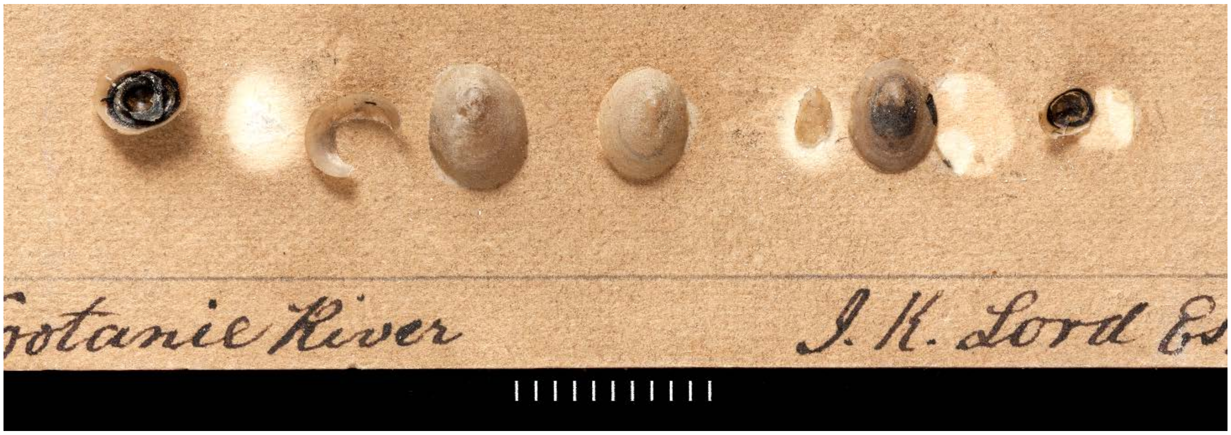

Figure 1. Syntypes of *Ancylus kootaniensis* BMNH 1863.2.4.16 from the “Kootanie River”. Photo British Museum, 2014.

Lanx and *Fisherola* are currently placed (Burch and Tottenham 1980; Neitzel and Frest 1993; Turgeon *et al*. 1998; Bouchet and Rocroi 2005) in the subfamily Lancinae, in the family Lymnaeidae. Numerous authorities including the first three just cited as well as Clarke (1981) and Johnson *et al*. (2013) have consistently misspelled *nuttallii* with one “i” instead of two (i.e., ii) as first used by Haldeman (1841) although La Rocque (1953) correctly used two, as in “ii”. Recent DNA and anatomical analyses support the separation of *Lanx* and *Fisherola*, their placement in the Lymnaeidae and that there is a single species of *Fisherola* in the Columbia River system in the US (D. Campbell pers. comm. 2015).

Morphological Description

The shell is patelliform (i.e., limpet-shaped or similar to a cone volcano), roughly oval in shape, and in adults is about 12 mm in length, 10 mm in width and 6 mm in height (Figure 1). Juveniles resemble adults and hatch from eggs. The apex is close to the anterior edge and positioned along the midline. The apex is smooth. The anterior slope is relatively short and straight or concave. The posterior slope is longer, convex and tapering to the posterior margin. The external colour is variable, from light tan to brown, with Canadian specimens darker than those from Idaho and Oregon (S. Clark pers. obs.). The internal colour is brown to dark brown getting lighter towards the edge. The internal muscle scar forms an almost complete circle but has a small but distinct gap on the right side towards the anterior margin. The shell is sculptured with coarse to fine concentric growth lines (description modified from Clarke 1981).

The animal is pigmented greyish black and has short triangular-shaped tentacles (Figure 2).

Figure 2. A live individual of *Fisherola nuttallii* from the Salmon River, Idaho, October 2014. A. showing the head, foot and mantle. B. close up of head showing the triangular tentacles and position of the eyes (small black dot at base of tentacle). Photos S. Clark, 2014.

Population Spatial Structure and Variability

There is no information on population spatial structure or variability.

Designatable Units

Available genetic data (D. Campbell pers. comm. 2015) are limited and insufficient to indicate if there is more than one designatable unit (DU) in Canada. Therefore a single DU is proposed. It occurs in COSEWIC’s Pacific National Freshwater Biogeographic Zone.

Special Significance

Shortface Lanx is endemic to the Columbia River basin and one of only four species of patelliform lymnaeids known in the world. Given its requirements for flowing, well-oxygenated, cool (less than 20°C) rivers, Shortface Lanx could be a potential sensitive species for monitoring aquatic environments.

No Aboriginal Traditional Knowledge was available for this species.

DISTRIBUTION

Global Range

Shortface Lanx is restricted to the Columbia River drainage in Canada and the US (Figure 3). In the US, it has been recorded from the Columbia River in Washington and Oregon, the Snake River in Idaho and Oregon, the Salmon River in Idaho, the Deschutes, John Day and Imnaha rivers in Oregon and the Okanogan, Methow, Grande Ronde and Spokane rivers in Washington and Idaho (Burch and Tottenham 1980; Neitzel and Frest 1989, 1993).

Stagliano *et al.* (2007) refer to historical collections of Shortface Lanx in the Clark Fork River, Montana and that these are now extirpated. However, based on the literature they cite, no such collections exist; their error may be from incorrectly referring to information in Neitzel and Frest (1989, 1993). Neitzel and Frest (1989) suggested that 27 sites that might contain suitable habitat along the Clark Fork River should be searched; when these sites were searched, no Shortface Lanx was found (Neitzel and Frest 1993). The first and currently only known collection of Shortface Lanx from Montana was sent to Deixis Consultants for identification around 1993-1994; it was collected from the Clark Fork River below Thompson Falls, Montana in 1992 (T. Frest pers. comm. 2007).

Figure 3. Global distribution of Shortface Lanx (*Fisherola nuttallii*). The yellow background shows the Columbia River Basin and the purple highlighting shows the Columbia River itself. Thick black river sections indicate known subpopulations of Shortface Lanx recorded in the past 30 years while the white sections are pre-1900. The pink dot on the Kootenay River southeast of Cranbrook, BC, indicates the area of Tobacco Plains, the possible site for the historical record attributed to “River Kootanie East”. Map drawn by S. Clark using known records from Neitzel and Frest (1989, 1993) and reference collections of the Royal British Columbia Museum, Field Museum of Natural History, Deixis Consultants and Invertebrate Identification.

Canadian Range

In Canada, Shortface Lanx is currently known only from a free-flowing stretch of the Columbia River, in southeastern British Columbia (BC), from about 14 km upstream to about 6 km downstream of the City of Trail (Figures 3 and 4). Adults and juveniles of various sizes were observed at Sites 5, 6, 7 and 9 in October 2014 (see **Search Effort**) (Table 1; Figure 4). Most of the individuals were relatively small (about 3-5 mm in length) and are probably juvenile while a small number of larger (9-10 mm) adult specimens were found. A small number of old, mostly large dead shells were found at Sites 5-7 and one was found at Site 9. These occupied sites are very near the sites where the species was collected in 2009 and 2010 (see below). Besides the records from 2009, 2010, and October 2014, the species has been detected one other time. In October 2012, Hawes *et al*. (2014) found three specimens of Shortface Lanx at a single reference site on the eastern shore of the Columbia River about 1.5 km upstream from the uppermost section of Site 7, where it was observed in October 2014 (Figure 4) (see **Search Effort**). The uppermost and most northern site known (site 5) is about 24 km downstream of the Hugh Keenleyside Dam, which is on the Columbia River about 10 river km west of Castlegar (Figure 5) and was built in 1968 (Harvey and Brown 2011). The Brilliant Dam, on the Kootenay River, is just to the east of Castlegar and just upstream of where the Kootenay flows into the Columbia (Figure 5) and was built in the 1940s (Harvey and Brown 2011).

Table 1. List of collecting sites (9-11 October 2014) and approximate numbers of Shortface Lanx observed (obs.). Length searched is a linear measurement along the river. Searches at Sites 8, 10-11 were mostly of river drift along the shoreline with the occasional boulder being turned and examined. Collector initials: SC – Stephane Clark; JG – Jochen Gerber; DL – Dwayne Lepitzki and BL – Brenda Lepitzki; SFL – Shortface Lanx. Note the time spent at each site is the actual time and not person-hours e.g., for Site 7 four people searched for 6 hours each or 24 person-hours of searching. [Editorial note: This table has been modified to remove precise location information. Please contact the COSEWIC Secretariat if you require this information.]

Site	Location	Length (m)	No. SFL Obs.	Time (min)
1	N. side of Lower Arrow Lake, E. of Scotties Marina (SC, JG)	ca. 120 m	0	ca. 60
2	N. side of Columbia River, W. of Castlegar (SC, JG)	ca. 150 m	0	ca. 80
3	S. side of Kootenay River below Brilliant Dam (SC, JG)	ca. 100 m	0	ca. 80
4	W. side of Columbia River at Millennium Park, Castlegar (SC, JG)	ca. 400 m	0	ca. 90
5	W. side of Columbia River at Genelle (SC, JG)	ca. 200 m	30+	ca. 90
6	W. side of Columbia River at Riverdale (SC, JG)	ca. 90 m	20+	ca. 60
7	E. side of Columbia River at Trail (SC, JG, DL, BL)	ca. 600 m	200+	ca. 1440
8	E. side of Columbia River near “Rock” island, Waneta Junction (DL, BL)	ca. 350 m	0	ca. 120
9	E. side of Columbia River at mouth of Bear Creek, Waneta Junction (DL, BL)	ca. 35 m	2	ca. 54

Site	Location	Length (m)	No. SFL Obs.	Time (min)
10	E. side of Columbia River near Beaver Creek, Beaver Creek Provincial Park (DL, BL)	ca. 300 m	0	ca. 122
11	E. side of Columbia River, Beaver Creek Provincial Park (DL, BL)	ca. 80 m	0	ca. 30
12	E. side of Columbia River S. of Beaver Creek Provincial Park (SC, JG)	ca. 100 m	0	ca. 60

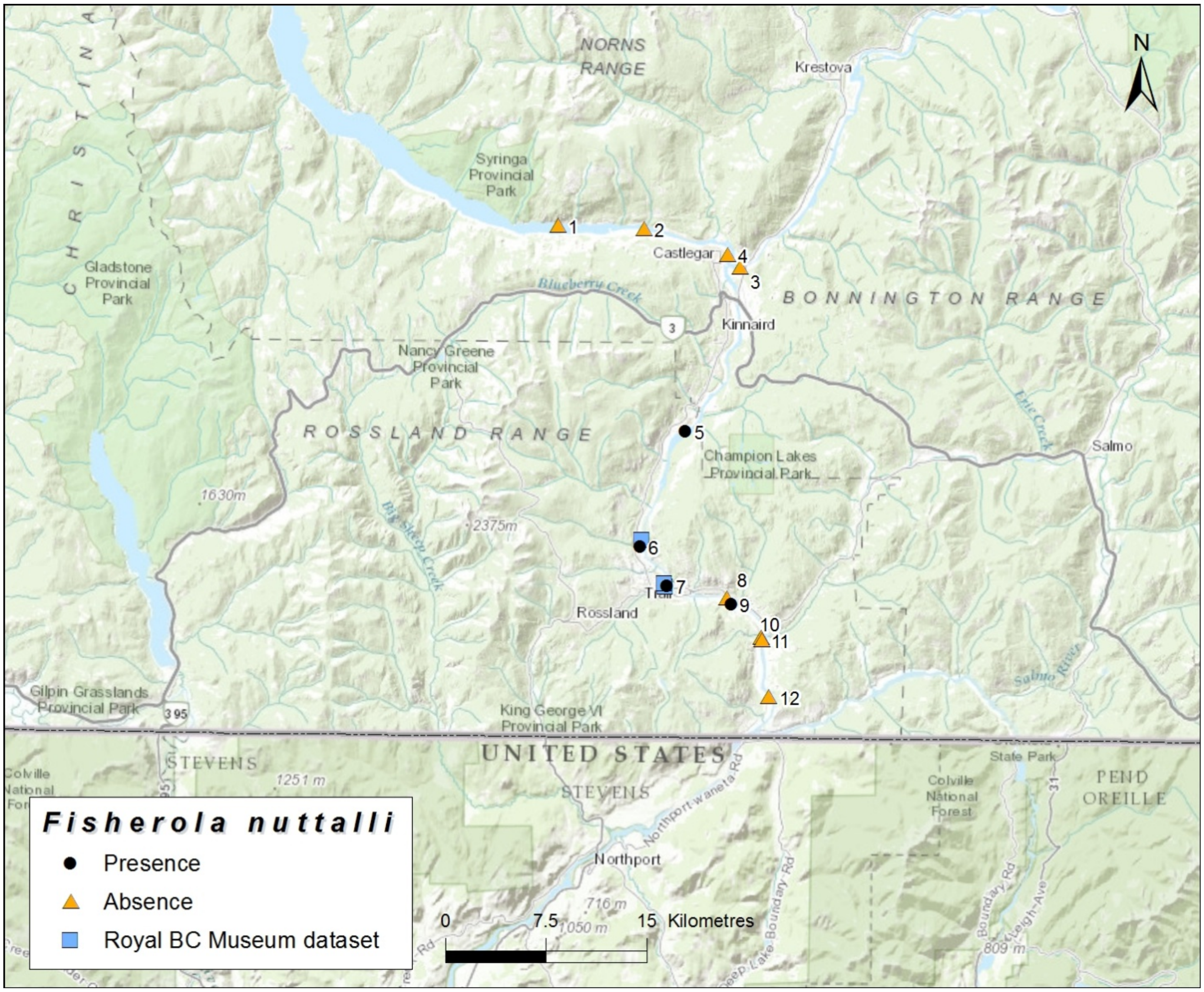

Figure 4. Canadian distribution of Shortface Lanx (*Fisherola nuttallii*). The numbers are the 2014 survey sites. Beaver Creek flows into the Columbia at survey site 10. Hugh Keenleyside Dam is just west of survey site 2 while Brilliant Dam is on the Kootenay River northeast of survey site 3.

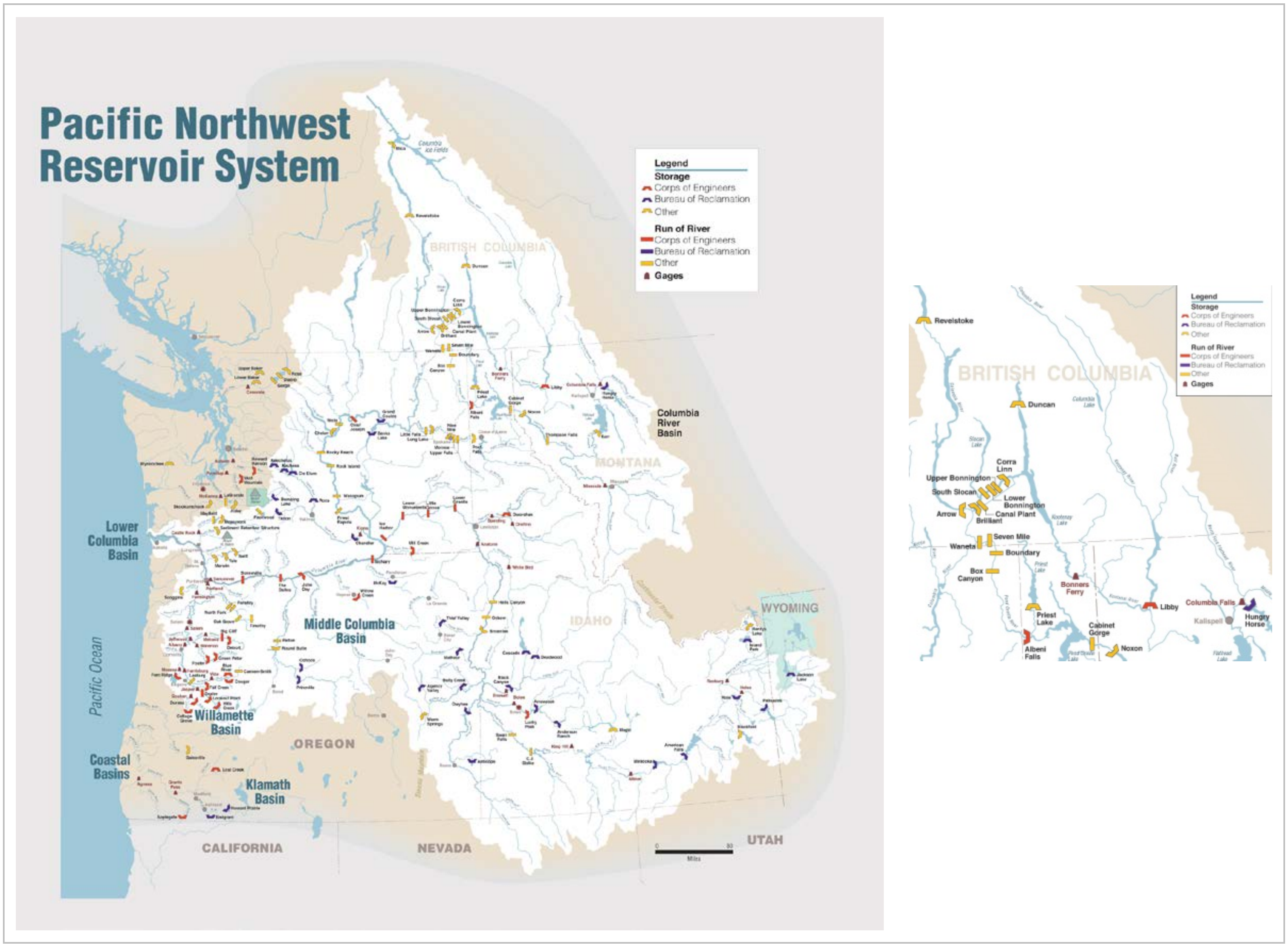

Figure 5. Dams of the Columbia River drainage in Canada and the US. Maps produced by the Portland District Visual Information, United States Army Corps of Engineers in 2010, downloaded from Wikipedia 26 September 2015. Hugh Keenleyside Dam is labelled “Arrow” on both the larger and inset maps.

There is a historical record from the “River Kootanie East” (= Kootenay River) (Carpenter 1864) but no further specimens have been reported to date. In Baird’s (1863) original description he states that the specimens came from the “Rivers Kootanie and Spokane, British Columbia”. Given that the Spokane River does not flow in Canada and that the US spelling for the “Kootanie” River is consistently used in the early literature and on the original label (Figure 1), it is very likely that an error occurred in labelling the specimens as being from BC instead of the US. However, the British North American Boundary Commission survey (Lord 1866) did cover the area where the Kootenay River first flows into the US near Tobacco Plains, just north of present-day Roosville, BC, southeast of Cranbrook (Figure 3). This section of the Kootenay River is now under Lake Koocanusa, a reservoir flooded by the construction of the Libby Dam (Figure 5) in 1972 (US Army Corps of Engineers 2005) and is unsuitable habitat for Shortface Lanx.

If indeed the six specimens (Carpenter 1864) from the “River Kootanie East” were actually from the US part of the river, then the first actual Canadian specimen would be the broken shell found by Dr. Leonard Kalas from the Columbia River at Trail (Clarke 1981). However, the whereabouts of his material is unknown. In November 2009, living specimens were found in the Columbia River at Trail (two lots or collections) and about 4 km upstream of Trail (one lot) by William Duncan. Two of these lots consist of three individuals each while the other lot has six snails. An additional collection of 50 live snails was made at Trail by W. Duncan in April 2010. All these specimens are deposited in the Royal British Columbia Museum.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO), calculated by the COSEWIC Secretariat using the minimum convex polygon, is 54 km^2. The continuous index of area occupancy (IAO) is 14 (2 km x 2 km) grids, or 56 km^2 while the discrete IAO is 20 km^2. By COSEWIC convention, the EOO cannot be smaller than the IAO so is increased to 56 km^2 to match the continuous IAO.

Search Effort

Because the first definitive and recent Canadian collections of Shortface Lanx were from the Columbia River at Trail and to maximize time available for field verification, targeted searches for this status report concentrated on the free-flowing section of the Columbia River in the vicinity of Trail. The Kootenay River at Tobacco Plains, which would be equivalent to “River Kootanie East”, was not searched as it now lies under Lake Koocanusa.

In October 2014, approximately 2500 m of the shoreline of the Columbia and Kootenay rivers in BC was searched at 12 separate sites from about 4 km upstream of the Hugh Keenleyside Dam to just above the US border (Figures 4, 5, and 6); these sites included one on the Kootenay River below Brilliant Dam before it flows into the Columbia River (Table 1, Figure 6B). Sites are defined as definitive areas of various shore lengths (Table 1) that were actively searched for Shortface Lanx. The most intensive search occurred at Trail, where approximately 600 m of the eastern shoreline of the Columbia River (Figure 6A) - from about 200 m south of the boat ramp upstream to the northern edge of Gyro Park - was searched by four people for six hours. In total, approximately 38 person-hours (Table 1) were spent searching in October 2014. Shortface Lanx was found at 4/12 (30%) of the sites searched in 2014.

Figure 6. A. Columbia River, looking upstream of the boat ramp at Trail, with S. Clark (foreground) and J. Gerber examining the underside of rocks (*Fisherola nuttallii* present). B. Kootenay River looking upstream to Brilliant Dam, east of Castlegar (*Fisherola* not present). The rocks visible in the foreground are similar to those on which *Fisherola* were found elsewhere. The clarity of the water makes it look deceptively shallow but within 1 m from the shore it dropped rapidly to more than 2 m in depth and was fast flowing. Photos: A.D. Lepitzki. B.S. Clark.

The most reliable method to find Shortface Lanx is to turn rocks by hand; snorkelling or SCUBA diving were not used in October 2014 so the search was limited by arm length. The maximum size of rock that could be lifted and turned over was between 30 and 40 cm in length. The Columbia and Kootenay rivers are large and access is often difficult (e.g., steep banks, deep water, limited road access, few crossing points or restricted by private property). In some areas where access to the river was possible, what appeared to be more suitable habitat was on the opposite bank, or in a side bay that was not in the main flow of the river and therefore did not provide suitable habitat. The site just upstream of the mouth of the Kootenay River (Table 1, Figure 6B) had what appeared to be suitable habitat for Shortface Lanx. None were found there, although all the other species of molluscs that had been found with Shortface Lanx at the other sites (see **Interspecific Interactions**) were present in good numbers, suggesting that Shortface Lanx should be there as well. However, the water depth increased rapidly from the shoreline and many potentially suitable rocks were beyond reach. While the best time to find larger numbers of adult Shortface Lanx would be late spring/early summer, access to the river would be more difficult and dangerous as the water level would be substantially higher due to snow melt.

Since the discovery of living individuals of Shortface Lanx at Trail in 2009 and 2010, there appears to have been no further sampling targeting the species until October 2014. However, Hawes *et al.* (2014) have measured water quality and sampled aquatic organisms including invertebrates using both Eckman dredges and modified surber kick samples along the Columbia River. Eckman dredges are typically used to sample soft-bottomed substrates, which would be unsuitable habitat for Shortface Lanx so this method would not be expected to detect this snail. Their technique of modified-surber kick samples should have been able to detect Shortface Lanx: rocks were picked up and washed or scrubbed by hand dislodging gastropods and other clinging organisms that were carried by the flowing water into and captured by a large net immediately downstream of the quadrat (Hawes and Tinholt pers. comm. 2016). The sampling technique at the reference site where they detected Shortface Lanx and at most of the other reference sites was stated as “other” (Hawes *et al.* 2014); “other” was done when low water velocities may not have carried organisms into the downstream net after being dislodged from the rocks and involved sweeping the water column within the sampling quadrat with another net (Hawes pers. comm. 2016). In total, they sampled for aquatic invertebrates using the modified surber kick (or “other”) methods at two erosional reference sites upstream of the Trail smelter (see **Habitat Trends**) and at five erosional exposure habitat sites downstream of the smelter, in an area extending from Birchbank (approximately 4.5 km downstream of site 5 at Genelle, Figure 4) to near the confluence with the Pend d’Oreille River near the Canada-US border. Each of the sampling sites of Hawes *et al.* (2014) had five nearby subsites for a total of 35 sampling sites. Five modified surber/kick samples were taken at each of the 35 sampling sites.

Shortface Lanx has been reported from several of the major tributaries of the Columbia River in the US (Figure 3). However, with the exception of the Kootenay River which joins the Columbia at Castlegar, there are no other similar large tributaries to the Columbia River in BC. The Slocan River, originating in Slocan Lake, joins the Kootenay River upstream of the confluence with the Columbia but if potentially suitable habitat exists and if it did harbour additional subpopulations, they would be isolated from the mainstem Columbia by a series of dams (Figure 5). The potential historical site on the Kootenay River before it initially flows into the US is under the Lake Koocanusa reservoir. It is expected that more searches might reveal more pockets containing Shortface Lanx but only within the known range.

HABITAT

Habitat Requirements

Coutant and Becker (1970) found that the Washington State population of Shortface Lanx they studied required clean, well oxygenated, flowing water with an annual temperature range of 4-20°C. Shortface Lanx is most frequently found on the underside and sides (rarely on top) of relatively clean and smooth rocks of varying sizes (Figure 6) in flowing water; these rocks are not buried in mud or other fine sediments. The maximum water velocity they can tolerate and depth they inhabit are unknown but specimens have been dredged from about 10 m in Washington State (Coutant and Becker 1970). Shortface Lanx is not found in areas of little or no current such as bays and side channels, in frequently turbid rivers such as those with glacial silt, or in areas where there is a lot of sediment and aquatic plant growth. As algal and other accumulations/aggregations begin to build up on rocks, Shortface Lanx becomes increasingly harder to detect; when rocks are heavily encrusted or embedded in sediments, Shortface Lanx is not present. Likewise, populations of the other associated native snails (*Fluminicola*, *Physella* and *Stagnicola*) (see **Interspecific Interactions**) are also substantially reduced or eliminated. As one searched downstream and approached the US border, fewer and fewer individuals of Shortface Lanx as well as the other species of freshwater snails were observed.

Habitat Trends

No part of the Columbia River where Shortface Lanx is currently known to occur is pristine: there are dams, urban centres, heavy industry (a lead-zinc smelter at Trail and a pulp mill at Castlegar), and human-altered, eutrophic tributary streams. Runoff from the small cities of Castlegar and Trail and Town of Genelle also add to the nutrient loads and contaminants carried downstream by the Columbia River. While overall river health has improved since the early 1990s, there are “historical legacy issues and occasional problems related to industrial spills” (CRIEMP 2005). Some of the best available information on habitat trends in the Columbia River is contained in recent COSEWIC status reports or Recovery Potential Assessments for freshwater fishes.

The probable or continuing decline in habitat quality factored into the status of Special Concern for Columbia Sculpin (*Cottus hubbsi*) and Shorthead Sculpin (*Cottus confusus*) (COSEWIC 2010a,b). While "both the pulp mill at Castlegar and the smelter at Trail have discharged effluent into the Columbia mainstem for decades", the adverse effects of this pollution or operation of Keenleyside Dam on Columbia Sculpin were stated as being "unknown" although the "continuing flow regulation on the Columbia River causes fluctuations in availability and quality of habitat" (COSEWIC 2010a). Pollution and introduced species in the mainstem of the Columbia River were listed as threats for Shorthead Sculpin while excess eutrophication in Beaver Creek was listed as a potential threat. Both these fishes have a much wider range in Canada than does Shortface Lanx and are found not just in the mainstem of the Columbia where Shortface Lanx is confined. They also occupy other major tributaries such as the Slocan River and tributaries to the Kootenay River above the Brilliant Dam and Kettle River, which flows into the Columbia River south of the US-Canada border (Figure 5). Columbia Sculpin is also found in the Similkameen River that joins the Okanagan River to eventually flow into the Columbia south of the border.

Similarly, the COSEWIC-threatened Umatilla Dace (*Rhinichthys umatilla*) is found in the Similkameen and Kettle rivers and along the Columbia River below the Hugh Keenleyside Dam to the US border; it is also found upstream and downstream of the Brilliant Dam on the Kootenay River as well as in the Pend D'Oreille River (COSEWIC 2010c). The highest densities are consistently along the Columbia River below the Hugh Kennleyside and Brilliant dams (COSEWIC 2010c) although this species accounted for less than one percent of the 795 small-bodied fishes electrofished by Hawes *et al.* (2014) over a 4-day period in May 2013. The various effects of hydroelectric development and dams as well as invasive aquatic species were considered the biggest threats in the Columbia River portion of this fishes' Canadian range (COSEWIC 2010c). Although Harvey and Brown (2011) stated that habitat conditions have improved during the last decade, they cautioned that historical slag deposition (see below) will continue to infiltrate downstream substrates and that a reduction in water quality and possibility of decline in fish health were threats; they also suggested a high possibility of smelter effluent spills.

The most recent study examining the water quality of the Columbia River in Canada (Hawes *et al*. 2014) was done in association with the lead-zinc smelter at Trail, a facility in operation since 1906 (Zhang 2007) or 1896, and the world's largest non-ferrous lead and zinc smelter (COSEWIC 2010c). From 1906 to mid-1995 up to 145,000 tons of waste was discharged annually into the Columbia River from the smelter (Zhang 2007); this dumping of slag was the reason for a US lawsuit against the company. The smelter company was fined $325,000 for depositing mercury into the Columbia River and allowing a leachate to overflow into Stoney Creek in September and October 2010 (Environment Canada 2014). Stoney Creek flows into the west side of the Columbia River just north of the smelter at Trail. On 29 February 2016, the same company pleaded guilty and was fined $3.0 million for three offences which resulted in the discharge of approximately 125 million litres of effluent into the Columbia River between 28 November 2013 and 5 February 2015 (Environment and Climate Change Canada 2016); site improvements to prevent future spills are expected to cost the company $50 million. Most recently, a 90 litre spill of heavy-metal contaminated water into Stoney Creek was reported on 13 April 2016 (CBC News 2016).

Hawes *et al.* (2014) reported that there have been some improvements in environmental variables such as depositional sediment quality, where they observed lower concentrations of ten different metals between 2003 and 2012. Hawes *et al.* (2014) also give the permitted volumes of various effluent discharges (Table 2) into the Columbia River for 13 domestic and industrial sources that total over 490,000 m^3/day (= 5.67 m^3/s). The three largest sources are the City of Castlegar (4,328 m^3/day), the Castlegar pulp mill (177,000 m^3/day) and the Trail smelter (296,000 m^3/day). The pulp mill was convicted of depositing effluent into the Columbia River in November 2008 (Lindsay 2012). In addition to these permitted discharge volumes provided by Hawes *et al.* (2014), there is urban storm runoff from Trail, Rossland, and Warfield via Trail Creek and an unknown quantity of discharge from highways, roads, railways and transmission lines (Hawes *et al*. 2014). In comparison, the discharge of the Columbia River measured at the Birchbank Station (08NE049) in July 2014, November 2014, June 2015, and September 2015 was approximately 3400 m^3/s, 1400 m^3/s, 2300 m^3/s, and 2800 m^3/s, respectively (Government of Canada 2015). Therefore, the volume of permitted effluent would only be 0.41% of the lowest flow rate measured recently at Birchbank (5.67 / 1400 = 0.41%).

Table 2. Summarized permitted effluent discharges to the lower Columbia River (LCR) as of 2006 (modified from Hawes *et al*. 2014).

General location of discharge	**Discharge Description**	**Approximate Discharge (m^3/day)**
Between Hugh Keenleyside Dam and Castlegar	Zellstoff-Celgar pulp mill – final industrial effluent	177,000
	Lion's Head Inn – 2^o treated domestic effluent	20
	City of Castlegar – treated effluent	2,728
	Pope and Talbot Ltd – treated effluent	>10
	City of Castlegar – treated domestic effluent	1,600
	Selkirk College - 2^o treated domestic effluent	536
Kootenay River upstream of LCR confluence	Skanska-Chant Joint Venture	14.5
	Kootenay Mobile Home Park – domestic effluent	43.6
LCR – Trail, BC	Teck Smelter – industrial effluents, cooling water	296,000
LCR – downstream of Trail, BC	Kootenay Regional District - 2^o treated effluent	10,500
	Village of Montrose - 2^o treated effluent	640
Beaver Creek	Village of Fruitvale - treated effluent	910
	Village of Salmo - treated effluent	455

According to the 2011 census, Castlegar (7816 people) and its surrounding area has a population of 13,382 people while Trail (7681 people) and its surrounding area totals 19,223 people (Columbia Basin Rural Development Institute 2012). Castlegar and its surrounding area and Trail and its surrounding area experienced human population increases of 6.8% and 3.2%, respectively, from 2006 to 2011, while British Columbia saw a 6.5% increase during the same period. The Canadian Pacific Railroad and Provincial Highway 3 (paved, mostly two lane) follow the north shore of the Kootenay River northeast of Castlegar before crossing the Columbia River and following its west shore to Trail, with Highway 2 becoming Highway 22 and 22A before crossing the Columbia River. The maximum daily number of vehicles crossing the bridge at Trail over 3 days in July 2012 was 21,893 (BC MoT 2012). At Trail, Highway 22A follows the eastern shore of the Columbia, joined by another railroad which crosses the US-Canada border. Volumes of highway and railway traffic are expected to increase with increased human population growth.

Blooms of the native diatom *Didymosphenia geminata*, commonly known as Didymo, were first noticed in rivers of Vancouver Island in the late 1980s (Bothwell *et al*. 2014) and also occur in the Columbia and Kootenay rivers (BC MoE 2015). Given the **Habitat Requirements** of Shortface Lanx, the thick brown mucilaginous mats formed by Didymo would not be suitable habitat. A very low soluble phosphorus level (below ~ 2 ppb) is now believed to be the proximate cause of these blooms but the ultimate causes are large-scale human interventions in climatic, atmospheric and edaphic processes that favour this ultra-oligotrophic species (Bothwell *et al.* 2014). In particular it is hypothesized that atmospheric deposition of reactive nitrogen from urbanization and burning of fossil fuels, shifts in snowmelt and growing seasons from climate change, nitrogen-enrichment of terrestrial landscapes from agriculture and silviculture, and a decline in marine-derived nutrients from spawning salmon decrease phosphorus inputs into aquatic environments. This is because increased nitrogen leads to increased assimilation of phosphorus which reduces its availability for runoff (Bothwell *et al.* 2014). While all these sources of increased nitrogen probably occur within the range of Shortface Lanx, the Trail Smelter may prevent Didymo formation in the localized area, as suggested by Bothwell *et al.* (2014) who propose that local-scale factors that potentially alter phosphorus concentrations might explain small-scale spatial variability of Didymo blooms. Total phosphorus within the initial dilution mixing zone (IDZ) of effluent receiving waters from the Trail smelter, particularly in the shoreline samples, was elevated (0.0032 – 0.0164 mg/L = 3.2 – 16.4 ppb) during low flow conditions (Hawes *et al.* 2014); however, the maximum level, recorded well below the downstream end of the IDZ at Waneta (15.8 km downstream of the smelter and just upstream of the confluence with the Pend d’Oreille River), cannot be ascribed to the smelter (Hawes and Tinholt pers. comm. 2016).

Since the late 1880s when the first major dam was built on the Willamette River, Oregon, the Columbia River drainage has become highly regulated with hundreds of dams including 60 major ones such as the Grand Coulee and Hugh Keenleyside (Figure 5). These dams control flooding, generate power, provide irrigation water, allow navigation for barges and recreational activities such as fishing and boating and create vast expanses of lacustrine conditions. Dams regulate about 96% of the flow of the Columbia River at the Canada-US border (CRIEMP 2005).The dams and their resultant reservoirs have modified large sections of the watershed into a series of lakes with sometimes no free-flowing portions between dams, such as the Kootenay River from the Brilliant Dam upstream to the Corra Linn Dam, creating lacustrine conditions almost to Creston, BC (Figure 5). As Shortface Lanx is not found in lacustrine conditions, the large number of dams and their associated reservoirs has resulted in a loss of potential habitat and led to the isolation of the known subpopulations from each other. While all the Canadian records are downstream of dams, US records for Shortface Lanx are both downstream and upstream of dams (Figures 3 and 5).

The free-flowing portion of the Columbia River where Shortface Lanx is currently known to occur in BC is completely surrounded by large tracts of unsuitable lacustrine habitat created by the following four dams: in Canada, Hugh Keenleyside Dam, the Brilliant Dam, and the Waneta Dam (built in 1954 on the Pend-d'Oreille River, just upstream of its junction with the Columbia River just north of the US border); and in the US, the Grand Coulee Dam (built in 1941 on the Columbia River at Grand Coulee, Washington), about 230 km downstream from the mouth of the Pend-d'Oreille River (Figure 5). The lakes formed by these dams do not provide suitable habitat for the Shortface Lanx and therefore act as very effective barriers to prevent genetic exchange and the expansion of the Canadian population above the Hugh Keenleyside, Brilliant and Waneta dams or from below the Grand Coulee Dam in the US, even if upstream migration was possible (see **Dispersal and Migration**). Likewise, if there are individuals of Shortface Lanx in the free-flowing portions of the Columbia River above the Hugh Keenleyside Dam or the two further dams between there and its headwaters (Revelstoke and Mica, Figure 5), they will not be able to expand their range downstream. Similarly for the Kootenay River above the Brilliant Dam or the five other dams between there and where the river turns south and crosses into the US before encountering the Libby Dam. Fragmentation, isolation, and limited dispersal caused by dams also apply to the Pend-d'Oreille River above Waneta Dam, as there is another dam before the river crosses into the US, and six further dams between there and its source in Montana.

There are no quantitative survey data on habitat trends for the US portion of the range of Shortface Lanx.

BIOLOGY

Life Cycle and Reproduction

Relatively little is known of the biology or life history of Shortface Lanx. It is a hermaphrodite and lays transparent, suboval gelatinous egg masses containing between 1-12 eggs (Coutant and Becker 1970). Coutant and Becker (1970) reported egg laying from April to June in the Washington State portion of the Columbia River, which was correlated with water temperate rising from the winter lows of 4-6°C to 17-20°C in the summer. They also noted that growth rates increased as the availability of food and temperature increased. Coutant and Becker (1970) also found that the life span was about a year, with adult mortality increasing rapidly after egg laying and after the temperatures increased above 17.3°C. Water temperature observations at the Birchbank gauging station on the Columbia River, between Trail and Genelle, from June 2014 to March 2015 are similar to those noted by Coutant and Becker (1970) as being conducive for growth and reproduction (Figure 7).

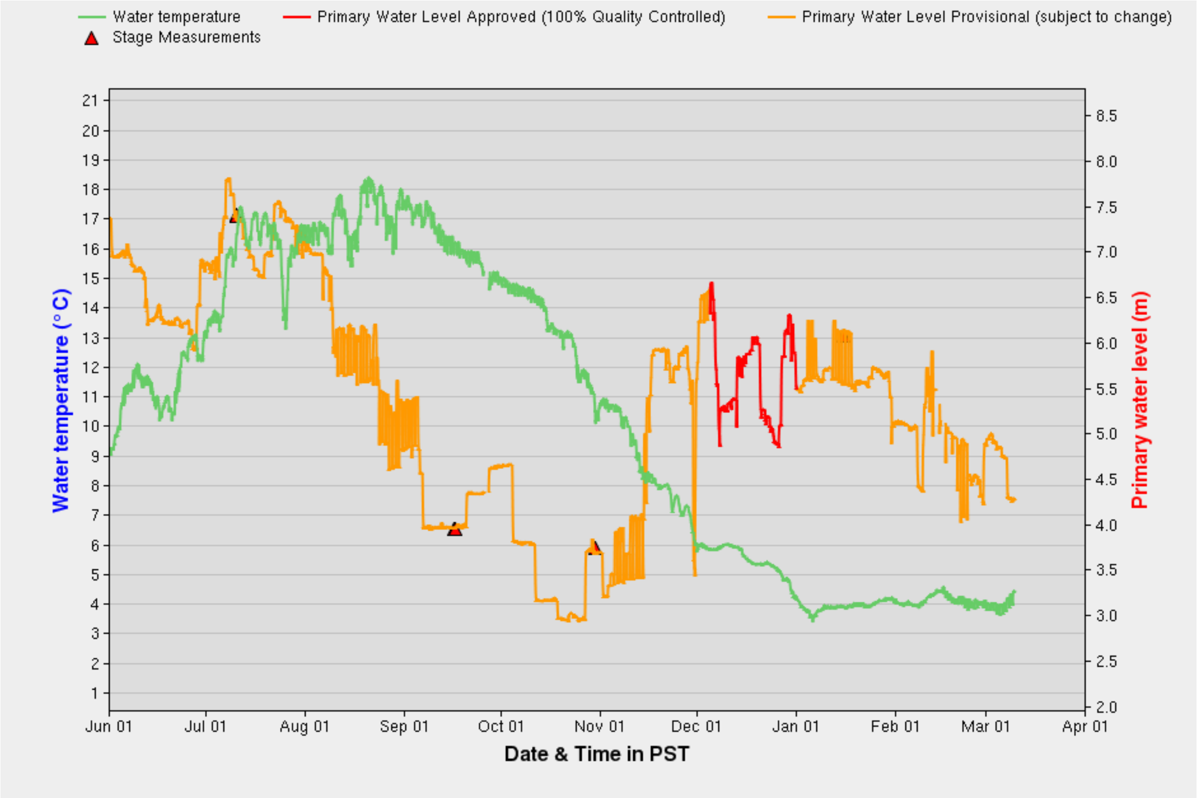

Figure 7. Water temperature and water level data from June 2014 to March 2015 at the Birchbank gauging station on the Columbia River between Trail and Genelle, British Columbia (Government of Canada 2015).

The bulk of the individuals observed in October 2014 were small with very few large adults present and no sign of any egg capsules, which would suggest that the Canadian population of Shortface Lanx has an annual life cycle. This finding is similar to Coutant and Becker's (1970) observations for the population of Shortface Lanx they studied from the Columbia River in Washington State.

Physiology and Adaptability

There are no studies of the physiology or adaptability for Shortface Lanx or other closely related species. However, Coutant and Becker (1970) reported a significant increase in mortality as water temperatures rose above 17.3°C.

Dispersal and Migration

There is currently no information available on the dispersal abilities for Shortface Lanx. Dispersal by birds (van Leeuwen and van der Velde 2012) is highly unlikely; the habitat requirements for Shortface Lanx do not readily overlap that of dabbling ducks. Based on limited observations of a few living individuals from the Salmon River, Idaho, in the lab for about a week (in October 2014), they move relatively slowly from rock to rock (S. Clark pers. obs.). It is assumed, based on the above observations, that they would be able to move from rock to rock either upstream or downstream for short distances. Given the flow rate of the Columbia River (see **Habitat Trends**), downstream migration would be much more likely than upstream.

Interspecific Interactions

There is no information on the interspecific interactions of Shortface Lanx with other species of mollusc. At the sites where Shortface Lanx occurred in October 2014, it was found in association with three to four other species of native snail; a species of *Physella* (Physidae), a species of *Stagnicola* (Lymnaeidae) and possibly two species of *Fluminicola* (Lithoglyphidae): *Fluminicola fuscus* and a possibly undescribed species in that genus. These species appear to have similar habitat requirements to Shortface Lanx and thus their presence could be used as an indicator that Shortface Lanx may also be present.

Potential predators would include fish, birds, freshwater leeches and freshwater crayfish. Trematode parasites have been observed in specimens of the related genus *Lanx* from California and Oregon (S. Clark pers. obs.) thus it is possible that Shortface Lanx could also act as an intermediate host.

Shortface Lanx most likely uses the periphyton found on smooth rocks and other hard surfaces it may crawl over as its major food source.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The methods used in October 2014 (see **Search Effort**) are more conducive to determining presence/not detected than providing abundance estimates; no efforts were made to quantify abundance other than recording time expended during searches (Table 1).

Abundance

There are no quantitative or qualitative data on the abundance of Shortface Lanx at individual sampling sites or from the Canadian and US portions of the range. However, when individuals of Shortface Lanx were encountered on a rock, there were typically 1-2 specimens, infrequently 4-6, with the most being 25 on a single turnable rock from the BC portion of the Columbia River in October 2014. The largest number, over 200 individuals, was observed during 1440 survey minutes, within the City of Trail (Table 1).

Fluctuations and Trends

There are no quantitative or qualitative data on population fluctuations or trends for Shortface Lanx for either the Canadian or US portions of the range. Given Shortface Lanx is not found in lacustrine conditions and the first collections of the species were made before there were any dams in the Columbia River drainage, it is reasonable to assume that the original pre-European settlement range of Shortface Lanx has been reduced since dam construction began (see **Habitat Trends**), which has most likely resulted in an overall global population decline.

Rescue Effect

Rescue from the US is unlikely. Presumably there are no means for this species to travel upstream over great distances, even if there were no dams in place. The next nearest known subpopulation is in the lower Okanagan River (Figure 3), which joins the Columbia River downstream of the Grand Coulee Dam on the mainstem Columbia River, which is itself 230 km downstream of the US-Canada border (Figure 5).

THREATS AND LIMITING FACTORS

Threats

The IUCN Threats Calculator (Master *et al.* 2009) (Table 3) determined the impacts from residential and commercial development (IUCN Threat 1), energy production and mining (IUCN Threat 3), transportation and service corridors (IUCN Threat 4), human intrusions and disturbance (IUCN Threat 6), and geological events (IUCN Threat 10) were “negligible” (<1% population reduction expected in the next 10 years), largely based on the scope (proportion of the Canadian population exposed to the specific threat in the next 10 years) being scored as “negligible” (<1%). However, while the scope of the threats from natural system modifications (IUCN Threat 7, specifically the threat from dams and water management/use), invasive and other problematic species and genes (IUCN Threat 8), pollution (IUCN Threat 9), and climate change and severe weather (IUCN Threat 11) were all scored as “pervasive” (meaning 71-100% of Shortface Lanx would be exposed to the threat in the next 10 years), there was insufficient knowledge and no recent trend data on subpopulations or distribution to score the severity (percent reduction in the population caused by the threat in the next 10 years) of the threats except as “unknown”, which resulted in a calculated impact of “unknown”. The timing of all these threats was scored as “High”, meaning that they are currently occurring and are expected to continue to occur in the future. Because of the five “negligible” and four “unknown” impact threats (Table 3), the overall threat impact on Shortface Lanx was calculated as “unknown”; however, the various threats still continue to reduce the habitat quality of this short stretch of the Columbia River occupied by the species.

Table 3. Threats assessment for Shortface Lanx.

Species Scientific Name	Shortface Lanx *Fisherola nuttallii*			
Date :	17 August 2015			
Assessor(s):	Assessors: Stephanie Clark (writer), David DeRosa (Teck Metals, Trail), David Fraser (BC), Andrew Hebda (Molluscs SSC), Dwayne Lepitzki (facilitator and Molluscs SSC co-chair), Remi Odense (BC); COSEWIC Secretariat: Bev McBride.			
References:	draft COSEWIC status report			
			Level 1 Threat Impact Counts	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	0	0
	D	Low	0	0
Calculated Overall Threat Impact:				
Assigned Overall Threat Impact:	U = Unknown			
Impact Adjustment Reasons:				
Overall Threat Comments	Generation time 1-2 years. A number of potential threats, but no trend data. Population likely reduced from historical times but because it was just rediscovered in 2009 no trend information is available to assist with assigning severity.			

	Threat	**Impact (calculated)**	**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	**Residential & commercial development**	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
1.1	Housing & urban areas					
1.2	Commercial & industrial areas					
1.3	Tourism & recreation areas	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Expansion of the Waterloo Eddy boat launch south of Castlegar is possible. Dirt and gravel launch being upgraded to gravel.
2	**Agriculture & aquaculture**					
2.1	Annual & perennial non-timber crops					
2.2	Wood & pulp plantations					
2.3	Livestock farming & ranching					
2.4	Marine & freshwater aquaculture					
3	**Energy production & mining**	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling					

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.2	Mining & quarrying	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Rock gathering out of the river for fire pits and landscaping occurs, but is likely minimal because it is mostly restricted to the dry area of river bed.
3.3	Renewable energy					
4	**Transportation & service corridors**	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	City of Trail is replacing the old bridge at Trail in a new location.
4.2	Utility & service lines					No new pipeline crossings of Columbia River are planned.
4.3	Shipping lanes					
4.4	Flight paths					
5	**Biological resource use**					
5.1	Hunting & collecting terrestrial animals					
5.2	Gathering terrestrial plants					
5.3	Logging & wood harvesting					
5.4	Fishing & harvesting aquatic resources					
6	**Human intrusions & disturbance**	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Some impacts expected at Genelle from people fishing (wading and walking along islands).
6.2	War, civil unrest & military exercises	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	Some infrequent aquatic or amphibious military exercises have occurred and are expected.
6.3	Work & other activities	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Searches for Shortface Lanx; monitoring fisheries, water quality and benthic invertebrates.
7	**Natural system modifications**	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression					
7.2	Dams & water management/use	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Changes in water regime from dams. Water is released from a variety of depths in the reservoir. Temperature changes in the water. Water levels can fluctuate daily depending on power demands. Some of the water level conditions are governed by international treaty with the USA. Fluctuations have been moderated since the 1990s. Regulation of the water levels could be beneficial during droughts. Water released from the reservoirs carries very little silt and could be nutrient poor.
7.3	Other ecosystem modifications	Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Compensation commitments to create shallow water habitat for salmonids could have impacted Shortface Lanx. Recontouring has occurred to prevent fish strandings. Aquatic plants likely do not affect the Shortface Lanx habitat.
8	**Invasive & other problematic species & genes**	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	The potential predators Tench (*Tinca tinca*), basses (*Micropterus* spp.), Carp (*Cyprinus carpio*), Walleye (*Sander vitreus*), and Northern Pike (*Esox lucius*) are in the system that pass through the area. Introduced Dreissenids likely not an issue. Shortface Lanx most likely vulnerable at night when foraging.
8.2	Problematic native species		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Didymo (*Didymosphenia geminata*) is found in the area. White Sturgeon (*Acipenser transmontanus*) populations (potential predator) have been enhanced through stocking.
8.3	Introduced genetic material						
9	**Pollution**		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Cumulative effects of effluents and airborne pollution
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Trail and Castlegar have sewage treatment plants. The other smaller communities have septic systems.
9.2	Industrial & military effluents		Unknown	Large (31-70%)	Unknown	High (Continuing)	Trail smelter has 3 permitted outfalls and a groundwater plume that enters the river. The area where the plume is is close to the highest density of Shortface Lanx and most vulnerable during drought periods. The discharge area has lower levels of Didymo. A treatment plant, currently being tested, is anticipated in 2016 that will lower effluent in the groundwater upwelling into the river. Placer mining and gravel extraction close to river banks may result in siltation in Columbia River, mostly downstream of Trail. Potential for increased tannins in water due to floating logs at Castlegar pulpmill.
9.3	Agricultural & forestry effluents						Beaver Creek is the only agricultural area in the drainage, but there are no Shortface Lanx known that far downstream.
9.4	Garbage & solid waste		Unknown	Small (1-10%)	Unknown	High (Continuing)	Small amount of garbage pushed over the river bank.
9.5	Air-borne pollutants		Unknown	Large (31-70%)	Unknown	High (Continuing)	Stack from the smelter.
9.6	Excess energy						There is a potential effect with changes in water temperature. See 7.2.
10	**Geological events**		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Flash flooding creates rilling into the Columbia mainstem and can be a source of siltation.
11	**Climate change & severe weather**		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	11.2, 11.3, and 11.4 in combination. Air temperature in the Columbia Basin has increased; Columbia River average temperature is suspected to have increased.
11.1	Habitat shifting & alteration						
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						

Natural system modifications, Dams and water/management use (IUCN Threat 7.2 – impact “unknown”)

It is not clear whether the operating procedures at Hugh Keenleyside and Brilliant dams pose a threat to the Canadian population of Shortface Lanx. It is possible that sudden changes in water levels and temperatures (water can be released from a variety of depths) at critical stages in the life history of the snail might adversely impact its reproductive success and growth. In contrast, seasonal changes in scouring, flows and temperatures are less extreme and the effects of extreme precipitation events are reduced in regulated river systems.

Invasive and other problematic species and genes (IUCN Threats 8.1 and 8.2 – impact “unknown”)

McPhail and Carveth (1993) indicate 13 introduced exotic fish in the lower Columbia River system (Arrow Lakes downstream to US border) but do not subdivide this list into flowing riverine or non-flowing waters. There are a variety of non-native fish species currently in the Columbia River itself, which could be a threat (Table 3). While DFO (2013) suggested that habitat conditions were suitable and the probability of invasion and risk to the environment for the introduction of dreissenid mussels (Zebra or Quagga mussels, *Dreissena polymorpha* and *D. bugensis,* respectively) were high in the Columbia River watershed, they would most likely not be found in great abundance in the fast-flowing, main channel inhabited by Shortface Lanx if introduced. Dreissenids are much more common and problematic in lentic (standing water) systems and need fairly stable habitats to remain attached to surfaces; their populations will only be very dense in headwater lakes and impoundments should they get introduced. While the threat is plausible, the impact from dreissenids is “unknown”. If the introduced fish forage at the same time as Shortface Lanx are active (Table 3), the latter could be consumed. Similarly, increases in sturgeon populations could increase predation pressure on Shortface Lanx, given the foraging habitats of the fish and microdistribution of the snail. Mats of Didymo would most likely render habitat unsuitable for Shortface Lanx.

Pollution (IUCN Threat 9 – impact “unknown”)

The Columbia River receives pollution from a variety of sources including households, urban areas, the Castlegar pulpmill, and both aerial and water impacts from the Trail smelter (Table 3). The toxic chemical spills from the smelter at Trail and pulpmill at Castlegar since 2008 are discussed in **Habitat Trends.** Pollution from agriculture along Beaver Creek was not applicable as no Shortface Lanx was found this far downstream. Hawes *et al.* (2014) used box plots to compare six standard invertebrate metrics (abundance, species richness, EPT [Ephemeroptera, Plecoptera, and Trichoptera] richness and percent EPT, percent Chironomidae, and Simpson and Hilsenhoff Biotic indices) in both depositional and erosional habitats upstream (reference) and downstream (exposure) of the Trail smelter. Because benthic invertebrate abundance and diversity varied by an order of magnitude among sites within reference and exposure habitats, statistical comparisons are difficult. Overall species richness and diversity (Simpson's Index) were similar in erosional habitats upstream and downstream of the smelter but it appears that mean EPT richness and % EPT were higher downstream of the smelter. They suggested the higher preponderance of EPT resulted in a lower mean Hilsenhoff Biotic Index in erosional sites downstream of the smelter than upstream in reference sites indicating that there were more organic pollution intolerant species downstream of the smelter. The applicability of these general benthic invertebrate results to Shortface Lanx is uncertain.

Heavy metal contamination is an ongoing problem in the Columbia River but Hawes *et al*. (2014) show that there has been a reduction in heavy metal concentrations between 2003 and 2012, although downstream depositional levels of copper, lead, and zinc in sediments were still two standard deviations above levels from upstream reference sites. In 2012, downstream total dissolved solid levels of zinc, lead, copper, and arsenic in depositional areas still exceeded possible effect level concentrations (the lower limit usually associated with potential adverse effects). Heavy metal concentrations were not measured in erosional habitat, which would probably be more suitable for Shortface Lanx. Hawes *et al.* (2014) do state that sediments are confined to small depositional areas in the Columbia River but are also found to a "much lesser extent" in the interstices between cobbles in erosional areas. Interestingly, studies along a 22 mile stretch of the Coeur d'Alene River in northern Idaho show that populations of another freshwater snail, *Physella columbiana* (Rotund Physa or Columbia River Physa), are more robust in the heavy metal (lead, zinc, cadmium) polluted lakes than in reference sites in neighbouring drainages, a potential consequence of decreased trematode parasite loads because the parasites have a lower tolerance to heavy metals (Lefcort *et al.* 2004, 2008). Clarke (1981) suggests *P. columbiana* is restricted to the Columbia River system.

Another complex interaction may be occurring with effluents from the Trail smelter. Shortface Lanx re-discovered in 2009 were on the rock island on the west side of the Columbia River at Trail, adjacent to the smelter. This island is right at Metallurgical Outfall C-III (Hawes *et al.* 2014), a site that could not be reached during the surveys of 2014 for this report. An apparent lack of Didymo at this site could be partly due to scour, which commonly prevents benthic algae blooms in streams (Bothwell *et al.* 2014); however, it is now known that Didymo only forms mats under very low phosphorus, oligotrophic conditions (Bothwell *et al.* 2014). The discharge from the Trail smelter has an elevated phosphorus component (Hawes *et al.* 2014) (see **Habitat Trends**) and this could be preventing the Didymo from growing in mat form where phosphorus levels are elevated. The closing of the Sullivan Mine in Kimberly BC caused a Didymo bloom in the Kootenay River following the drop in phosphorus loading (Bothwell pers. comm. 2014). Didymo is found in the area (Table 3; Hawes *et al.* 2014; BC MoE 2015) but it is uncertain if detailed maps of its microdistribution in the Columbia River are available.

The Beaver Creek drainage receives agricultural runoff from dairy farms and orchards. In addition, the effluent from the Fruitvale and Montrose primary and secondary sewage treatment systems flow into Beaver Creek (COSEWIC 2010a,b; Hawes *et al.* 2014). Consequently this lowers water quality in Beaver Creek and leads to increased levels of eutrophication in the Columbia River downstream of the confluence with Beaver Creek at the northern end of Beaver Creek Provincial Park, which is about 3.5 km downstream of the nearest known occurrence of Shortface Lanx. It seems that this far downstream the additional agricultural effluent renders the habitat unsuitable for Shortface Lanx, potentially due to too much periphyton growth. This effect was seen even further downstream at Site 12 (Table 1, Figure 4) where only a few specimens of three species of mollusc, which were much more common at upstream sites 3, 6 and 7, were observed.

Climate change and severe weather (IUCN Threat 11 – impact "unknown")

The IUCN threat subcategories of droughts, temperature extremes, and storms and flooding have unknown impacts on Shortface Lanx (Table 3). Air temperature in the Columbia River basin has increased by 1.5°C over the past century with the change between 1971 and 2000 being equivalent to a 4.1°C/century increase (Columbia Basin Trust 2007). Average annual temperature is expected to increase relative to current conditions by 1.1ºC to 1.3ºC by the 2020s, by 2.4ºC to 3.0ºC by the 2050s and perhaps by as much as 3.3ºC to 5.0ºC by the 2080s (Columbia Basin Trust 2007). While discharge of the Columbia River has been gauged at the Birchbank station since 1937 (Government of Canada 2015), a corresponding long-term data set recording water temperature is not available; however, temperature is expected to have increased. A reduced glacier melt translates into a reduced flow of cold water into the system during the summer. Droughts and lower water flow could cause a loss of suitable habitat; temperature extremes also would be detrimental for Shortface Lanx. In addition, the regulation of flows from the dams has to be considered when discussing effects from climate change.

Cumulative Effects

The combination of the ongoing buildup of contaminants from domestic and industrial sources (see map in CRIEMP 2005 for effluent sources) and changes in water temperature and flow could have detrimental effects on the different lifestages of Shortface Lanx. These factors could also accumulate and promote changes to the structure and composition of the periphyton community that the snail uses as its food source. However, water and sediment quality does seem to be improving in the Columbia River in Canada (Hawes *et al.* 2014). These improvements may in part be due to fines, charges, and lawsuits against the various industries.

Limiting Factors

The low likelihood of upstream dispersal and dependence on relatively smooth and clean rocks of various sizes not buried in mud or fine sediments in clean, cold, free-flowing water are limiting factors for Shortface Lanx. The presence of the numerous dams also limits opportunities for downstream dispersal and genetic exchange.

Number of Locations

The number of locations for Shortface Lanx is difficult to determine. Given the distribution of the four known clusters of Shortface Lanx (Table 1, Figure 4) and the variety of plausible threats along the Columbia River, the number of locations is most likely below five. A single catastrophic event of sufficient magnitude such as a toxic spill occurring upstream of Genelle could affect the entire known Canadian range, suggesting a single location. If, however, an event was to occur at the bridge crossing the Columbia River at Trail then the portion of the range affected would be from that point downstream while the upstream portion would remain unimpacted, and therefore the minimum number of locations could be two. The number of locations could be as high as four if each known cluster within the Canadian range was subject to a different point source threat which only affected that single cluster.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Shortface Lanx is not listed under the *Species at Risk Act*. Invertebrates designated by COSEWIC as Threatened, Endangered, or Extirpated can be protected through the British Columbia *Wildlife Act* and *Wildlife Amendment Act 2004* once they are listed in the regulations; however, no timeline for the completion of the regulations is available.

Non-Legal Status and Ranks

The British Columbia Conservation Data Centre (2015) assigned Shortface Lanx a Provincial rank of S1 (critically imperilled) and a BC list rank of Red (indicating that it is a candidate for either extirpated, endangered, or threatened status in BC).

In the US, Shortface Lanx is not listed under the *Endangered Species Act*. In 1984, Shortface Lanx was a Candidate Species, Category 2 but in 1991 it became a Candidate Species, Category 3C, meaning it was removed from the Candidate Species list (U.S. Fish and Wildlife Service 1984, 1991). By 1991, the Fish and Wildlife Service had received information that suggested it was more widespread than initially thought and therefore required no further action at that time.

Shortface Lanx is not listed individually by any US state. However, the Washington Department of Fish and Wildlife (2015) lists the species as a state candidate.

NatureServe (2016) gives Shortface Lanx a global rank of G2 (imperilled, last reviewed 19 February 2008) and national ranks of N2 for the US (2 June 2000) and N1 (critically imperilled) for Canada (7 May 2013). They give the following state / provincial ranks: Alberta (SNR, not ranked), British Columbia (S1, critically imperilled), Saskatchewan (SNR), Idaho (S2, imperilled), Montana (SH, possibly extinct), Oregon (S1S2, critically imperilled to imperilled), Utah (SNR), Washington (S2), Wyoming (SNR). The American

Fisheries Society Endangered Species Committee (Johnson *et al.* 2013) listed Shortface Lanx as threatened.

The current NatureServe (2016) rankings of SNR for Saskatchewan and Alberta are erroneous and are in the process of being removed (S. Cannings pers. comm. 2016); the Columbia River does not drain either province. The reasons for the NatureServe (2016) state rankings for Utah and Wyoming are uncertain as Shortface Lanx is only known from large to very large rivers and not small tributaries and headwater streams such as those found in the very upper parts of the Snake River drainage that reach into Utah and Wyoming. These headwaters also reach into Nevada, which is not within the species' range according to NatureServe (2016).

Habitat Protection and Ownership

The Columbia and Kootenay rivers are public waters owned by the Canadian Government, but most of the land adjacent to these rivers is private. There are numerous licences for agricultural and industrial water extraction and/or effluent releases into these rivers (COSEWIC 2010a; Hawes *et al*. 2014).

None of the known British Columbian sites occur in protected areas.

Beaver Creek Provincial Park is about 3.5 km downstream of the nearest known occurrence of Shortface Lanx in the Columbia River. However, Beaver Creek, which joins the Columbia River at the northern boundary of the park, is contaminated with high levels of urban and agricultural effluent and runoff (COSEWIC 2010a,b). The added nutrient load has resulted in increased amounts of algal growth and other accretions on the rocks and other substrates in the Columbia River downstream of the junction and thus has reduced the available habitat not only for Shortface Lanx but also for the other species of molluscs commonly associated with it further upstream.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Dwayne Lepitzki helped with fieldwork, obtaining literature and editing.

Brenda Lepitzki helped with fieldwork.

Robert Forsyth offered advice and background information.

Ed Johannes, Seattle, Washington provided literature and background information.

Heidi Gartner, Collection Manager, Invertebrates, Royal British Columbia Museum, Victoria, BC provided specimen data and photos of previously collected specimens from Trail.

Jonathan Ablett, Curator of Non-marine Mollusca and Cephalopoda, Division of Invertebrates, Zoology Department, Natural History Museum, London, UK, provided photos of the type specimens of *Ancylus kootaniensis* Baird, 1863.

Jenny Wu, Scientific Project Officer, COSEWIC Secretariat, Canadian Wildlife Service, Environment Canada, Gatineau, QC, generated the EOO and IAO calculations and the distribution map.

Remi Odense, Risk Assessor, BC Ministry of the Environment, provided the initial sources for the Didymo story.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Stephanie Clark received a B.App.Sc. (Biochemistry) from the University of Technology, Sydney, New South Wales, Australia in 1990, an M.Sc. (Zoology - taxonomy and genetics) from Macquarie University, NSW in 1998 and a Ph.D. (Zoology – taxonomy and conservation) from the University of Western Sydney, NSW in 2005. Her passion for molluscs began as a child in Sydney and has continued ever since. In the late 1970s she began volunteering at the Australian Museum, Sydney. She was employed as a Technical Officer (Scientific) at the Australian Museum from 1987-1995 working with freshwater snails. In 1996 she began a consulting career conducting invertebrate surveys particularly for threatened and endangered land and freshwater molluscs both in Australia and the United States. She was an invited participant at the IUCN Red List workshop assessing the Red List status of the world's freshwater molluscs, held in London, United Kingdom, February, 2010 and served on the Status Review Panel for the US federally endangered Idaho Springsnail (*Pyrgulopsis robusta*), in Boise, Idaho, October, 2005. She has authored and/or coauthored over 100 papers and reports on the taxonomy, systematics and conservation of freshwater and terrestrial molluscs and aquatic invertebrates and is a member of the IUCN SSC Mollusc Specialist Group and a Research Associate at the Field Museum of Natural History, Chicago, Illinois.

Jochen Gerber received an MSc (Diplom) in Biology from the University of Freiburg, Germany, in 1988. In 1995 he received a PhD (Dr. rer. nat) in Biology from the University of Munich, Germany. The focus of his research is on terrestrial and freshwater molluscs. He has been studying their taxonomy, distribution, and ecology mainly in Europe, North Asia, and North America. While he is mostly studying extant faunas, he has also been involved in the analysis of mollusc faunas recovered during paleontological and archeological projects. His publication list contains more than 40 titles. In addition, he authored or co-authored ca. 20 survey reports. Since 1999 he has held the position of Collections Manager of Invertebrates of the Field Museum of Natural History, Chicago. He oversees the museum's collections of all invertebrate groups except insects, myriapods and arachnids. The collection currently comprises ca. 345,000 series of molluscs and ca. 15,000 series of non-molluscan invertebrates. From 2009 to 2012 he served as the Editor for Terrestrial Gastropods/Pulmonata for the journal *Zootaxa.* He has been a member of the Terrestrial Mollusk Team, New Pest Advisory Group, APHIS (USDA) since 2005.

COLLECTIONS EXAMINED

- Field Museum of Natural History, Chicago, Illinois, US.
- Royal British Columbia Museum, Vancouver, BC (photos of specimens sent by Heidi Gartner).
- Reference collection of Invertebrate Identification, Chicago, Illinois, US.
- Reference collection of Deixis Consultants, Seattle, Washington, US.