Fisheries and Oceans Canada / Pêches et Océans Canada
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Science Response 2018/001

RECOVERY POTENTIAL ASSESSMENT FOR SHORTFACE LANX (*FISHEROLA NUTTALLI*)

Context

After the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses an aquatic species as Threatened, Endangered or Extirpated, Fisheries and Oceans Canada (DFO) undertakes a number of actions required to support implementation of the *Species at Risk Act* (SARA). Many of these actions require scientific information on the current status of the wildlife species, threats to its survival and recovery, and the feasibility of recovery. Formulation of this scientific advice has typically been developed through a Recovery Potential Assessment (RPA) that is conducted shortly after the COSEWIC assessment. This timing allows for consideration of peer-reviewed scientific analyses into SARA processes including recovery planning.

Shortface Lanx (*Fisherola nutalli*) was assessed by COSEWIC in the spring of 2016 as Endangered (COSEWIC 2016). In Canada, Shortface Lanx are confined to the Canadian portion of the Columbia River; globally, they are only found in the Columbia River system (Frest and Johannes 1995, 1997, 2000). Very little is known about this species. The state of knowledge is found within a few text books, field reports and the COSEWIC assessment. Normally when a RPA is undertaken a working paper is developed and a regional peer review is held. Given the paucity of data and lack of both internal and external expertise, the Science Response format was chosen to summarize the information and respond to the elements of the terms of reference in the most efficient and effective way possible.

In support of listing recommendations for Shortface Lanx, DFO Science has been asked to undertake a RPA, based on the national RPA Guidance. The advice in the RPA may be used to inform both scientific and socio-economic aspects of the listing decision, development of a recovery strategy and action plan, and to support decision making with regards to the issuance of permits or agreements, and the formulation of exemptions and related conditions, as per sections 73, 74, 75, 77, 78 and 83(4) of SARA. The advice in the RPA may also be used to prepare for the reporting requirements of SARA s.55. The advice generated via this process will update and/or consolidate any existing advice regarding Shortface Lanx.

This Science Response Report results from the Science Response Process of February 2017 on the Recovery Potential Assessment – Short Face Lanx.

Analysis and Response

Objectives

The RPA provides up-to-date information and discusses associated uncertainties of the 22 elements of the terms of reference under the following categories:

- Biology, life history, abundance and distribution
- Habitat and residence requirements

- Threats and limiting factors to survival and recovery
- Recovery targets
- Scenarios for mitigation of threats and alternatives to activities
- Allowable harm

Biology, Abundance, Distribution and Life History Parameters

Element 1: Summarize the biology of Shortface Lanx

Shortface Lanx (*Fisherola nutalli*) is within the Family Lymnaeidae, subfamily Lancinae (freshwater limpets) (Thorp and Covich 2010). They are a native lithophile and cold water stenotherm of the Columbia River (Frest and Johannes 2000). It is a freshwater limpet with an acentric conical shell up to 1.2 cm long, 1.0 cm wide, and 0.5 cm high (Neitzel and Frest 1989). The shell is small, solid, roundly ovate, slightly broader posteriorly, high-arched, apex posterior and finely concentrically striated. (Hannibal 1912).

Shortface Lanx are hermaphroditic and lay transparent, suboval gelatinous egg masses containing between 1-12 eggs (Coutant and Becker 1970). Taylor (1982) reports that they deposit 7-8 eggs in a jelly-like mass on the lower lateral surfaces of rocks. In the Washington state portion of the Columbia River, egg laying occurs from April to June (Coutant and Becker 1970). They lack a free-swimming larval stage, and hatch as young snails, anatomically complete except for the reproductive system (Hyman 1967). The life span is believed to be about a year (Coutant and Becker 1970; Neitzel and Frest 1993).

Results of laboratory studies and detailed collection at sites with measured parameters suggest that this species may not reproduce successfully in water warmer than 17.3^{o}C (Coutant and Becker 1970). Also, Coutant and Becker (1970) note that live Shortface Lanx have not been observed at field locations with water temperatures exceeding 17.0^{o}C.

Growth rates increase as the availability of food and temperatures rise (Coutant and Becker 1970). Shortface Lanx diet consists largely of diatoms and epiphytic algae (Neitzel and Frest 1992).

Element 2: Evaluate the recent species trajectory for abundance, distribution and number of populations

There are no quantitative data on numbers of individuals in the Columbia River in Canada, therefore, trajectories of recent abundance cannot be produced.

Shortface Lanx is endemic and restricted to the Columbia River drainage in Canada and the US (Frest and Johannes 1995, 1997, 2000).

Throughout its range, it was reported to be widespread in the lower Columbia River, Snake River and a few major tributaries in Washington, Oregon, Idaho, Montana and British Columbia (Frest and Johannes 1995, 1997, 2000). Stagliano *et al* (2007) however report a presumed extirpation of the species in the state of Montana as no sightings have been reported in the past 50 years and other extirpations of known sites reported in the literature. COSEWIC (2016) questions this assertion and reports a 1992 collection from the Clark Fork River below Thompson Falls, Montana.

Populations in the lower Columbia River are likely extirpated due to the installation of dams and impoundments (Frest and Johannes 1995); some still survive in areas near the Bonneville Dam, lower Deschutes River and the John Day River in Oregon, Methow and Okanogan Rivers in Washington (Frest and Johannes 1995; Neitzel and Frest 1993). Recent studies have confirmed that Shortface Lanx is no longer found in Hanford Reach (Newell 2003; Queen 2008; Tiller 2015) where they were once abundant (Neitzel and Frest 1993).

In Canada, Shortface Lanx is known only from the free flowing portion of the Columbia River, south-eastern British Columbia, extending about 14 km upstream and 6 km downstream of the city of Trail (COSEWIC 2016).

The number and extent of separate populations within the currently known distribution in Canada are unknown. Gene flow among populations would most likely only be possible with natural downstream transport, as adults or subadults become dislodged from the substrate. The distance and speed of transportation by natural water flow are unknown.

Element 3: Estimate the current or recent life-history parameters for Shortface Lanx.

Shortface Lanx is hermaphroditic and lay between 1-12 eggs (Coutant and Becker 1970) or 7-8 (Taylor 1982) eggs in a jelly-like mass. It lacks a free-swimming larval stage, and hatch as young snails, anatomically complete except for the reproductive system (Hyman 1967). The life span is estimated to be about a year (Coutant and Becker 1970; Neitzel and Frest 1993).

Results of field studies and detailed collection at sites with measured parameters (temperature and flow) demonstrate that this species may not reproduce successfully in water warmer than 17.3^{o}C (Coutant and Becker 1970). Also, Coutant and Becker (1970) note that live Shortface Lanx are never found at field locations with water temperatures exceeding 17.0^{o}C.

Habitat and Residence Requirements

Element 4: Describe the habitat properties that Shortface Lanx needs for successful completion of all life-history stages. Describe the function(s), feature(s), and attribute(s) of the habitat, and quantify by how much the biological function(s) that specific habitat feature(s) provides varies with the state or amount of habitat, including carrying capacity limits, if any.

There is no information available which describes specific habitat requirements for different life stages for this species. Any inferences which are made regarding habitat requirements are therefore based on the premise that the habitat required is equal to the habitat in which they were reported. The limitations of this assumption are noted but due to limited knowledge it is the best information available (Table 1).

It is also assumed that based on a short life span (approximately 1 year), no larval stage and limited dispersal methods (small gastropod) that habitat properties will apply to all/any life stages. Any features or attributes which are known would also apply to all life stage functions.

Originally believed to be restricted to relatively large streams, inhabiting rapids and rapid edges (Clarke1976; Taylor 1982,1985) Neitzel and Frest (1990) report collecting live specimens of Shortface Lanx from two locations in Methow River, WA where the stream is less than 100m wide. In 1992, this was considered the smallest stream in which Shortface Lanx was reported (Neitzel and Frest, 1992). The species is present year round but is not active in the winter (Stagliano et al 2007).

The species avoids the most turbulent areas and rapids but has been found, in rapids' edges or immediately downstream in areas with suitable substrate (Neitzel and Frest 1992). Neitzel and Frest (1990) conclude that stream size is not a limiting factor for the species as long as the stream is relatively unpolluted, cold, and well oxygenated with a permanent flow and cobble-boulder substrate. It is proposed that they require highly oxygenated water because they have neither a lung nor gill but rather, absorb oxygen from a vascularized mantle bordering the foot (Taylor 1982).

The species is most abundant in habitats which are highly oxygenated, and have gravel to boulder substrates, but they can be found on silt or mud substrates in areas with slow flow, warm water, or massive seasonal discharges that destabilize the substrate (Neitzel and Frest 1992). They appear to avoid bare rock walls unlike other Lanx species (Neitzel and Frest 1992) and avoid areas of bedrock substrate or areas that are dredged or mined (Frest 1999). In the Canadian portion of the Columbia River near Trail they were found on cobble up to 40cm long (COSEWIC 2016).

Shortface Lanx prefer oligotrophic streams (Frest and Johannes 2000) and are not found in areas with high abundances of macrophytes or epiphytic algae (Frest and Johannes, 1995, 1997; Frest 1999). They feed by scraping algae and diatoms from the surfaces of rocks and may occasionally feed on other plant surfaces (Stagliano et al 2007). In Canada, Shortface Lanx are most frequently found on the underside and sides (rarely on top) of relatively clean (i.e., not heavily encrusted with algae and other accumulations/aggregations), smooth rocks of various sizes that are not embedded in sediments (COSEWIC 2016).

The species has often been found co-occurring with the Columbia Pebblesnail (*Fluminicola columbiana*) (Frest and Johannes 1995,1997, Neitzel and Frest 1989, 1990, 1992).

The maximum depth at which the species can occur is unknown. COSEWIC (2016) reports being able to find the species in up to approximately 0.5m depth, what other depths were sampled was not indicated. In Washington State, samples have been dredged from about 10m in depth (Coutant and Becker 1970). While the species can most likely move short distances from rock-to-rock (COSEWIC 2016), a rapid decrease in water depth could result in stranding, desiccation (or freezing) and mortality if the magnitude and rapidity of the water depth decrease exceeds the dispersal distance. Speed of short distance dispersal is unknown.

Table 1. Functions, features and attributes of Shortface Lanx habitat

Functions	**Features**	**Attributes**
All life stages	Medium to fast flowing water	Temperatures below 17°C High O_2 levels (thresholds unknown)
	Cobble to boulder habitat	Stable substrate that is mostly or totally submerged
	Oligotrophic streams	Without high abundances of macrophytes or epiphytic algae

Element 5: Provide information on the spatial extent of the areas in Shortface Lanx distribution that are likely to have these habitat properties.

There have been few studies to determine the Canadian range of the species; field studies were conducted in 2009, 2010 and 2014 in and around the Trail area (COSEWIC 2016).

Based on field observations in 2014 where Shortface Lanx were observed, the current potential habitat is approximately 38km of the main stem of the Columbia River (COSEWIC 2016). The Extent of Occurrence of the currently known occupied habitat using the minimum convex polygon method is 54 km^2 (COSEWIC 2016).

Little search effort has taken place and it is expected that this is an underestimate of the range of the species in Canada. However, it’s unlikely that the entire length of potential range will have the suitable features (described above) for Shortface Lanx.

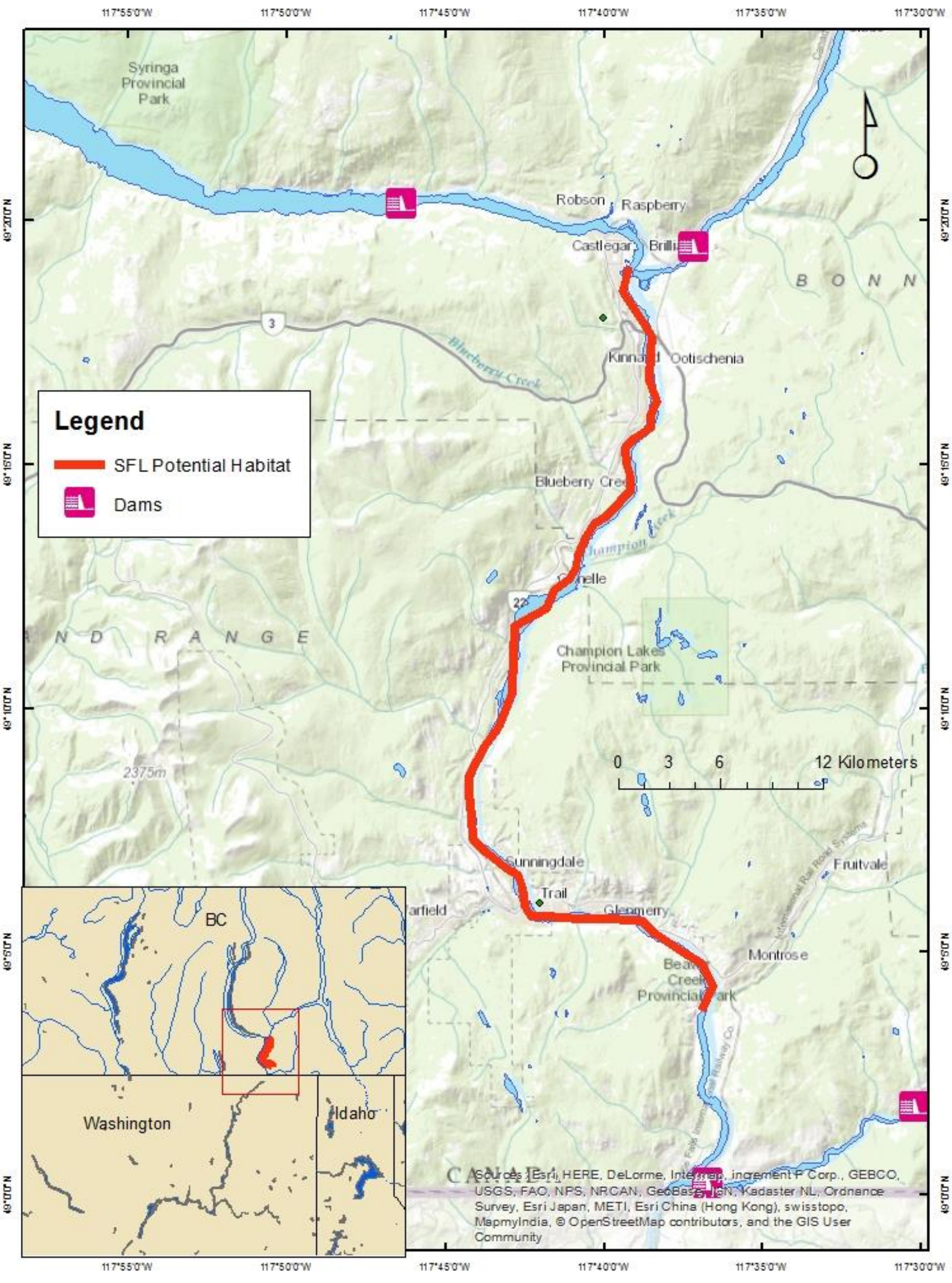

Figure 1. Areas of potential habitat for Shortface Lanx in Canada.

Element 6: Quantify the presence and extent of spatial configuration constraints, if any, such as connectivity, barriers to access, etc.

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 conditions which do not provide suitable habitat for Shortface Lanx and limit opportunities for dispersal.

In Canada, the uppermost and most northern site known is about 24 km downstream of the Hugh Keenleyside Dam which is on the Columbia River about 10 river km west of Castlegar and was built in 1968 (Harvey and Brown 2011). The Brilliant Dam is on the Kootenay River east of Castlegar and upstream of where the Kootenay River flows into the Columbia River; it was built in the 1940s (Harvey and Brown 2011).

There is only one record of a Shortface Lanx shell in southern British Columbia before the 1940s when the first dam was built and that was in the "River Kootanie East" in the 1800s. Whether this location is in Canada or not is uncertain (COSEWIC 2016). The next oldest report in Canada was the finding of a broken shell in the "Columbia River at Trail", no date is provided but the book in which it was cited was Clarke 1981 and at the time of publication, it was deemed a "recent" report.

Because of the lack of historical data regarding the extent of range within Canada it is difficult to determine the effects of the Hugh Keenleyside Dam or Brilliant Dam. However, there is direct evidence in the US portion of the Columbia River of the effects of dams on the distribution of Shortface Lanx (Frest and Johannes 1995). It is also uncertain how far the species' range may have extended upstream of these lowest-most Canadian dams on either or both the Columbia or Kootenay rivers. The Canadian records are the most northerly for this species.

Element 7: Evaluate to what extent the concept of residence applies to the species, and if so, describe the 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.C. 2002 c29).

The residence must support a life cycle function, there must be an element of investment in the creation or modification of the structure, and it must be occupied by one or more individuals. Shortface Lanx are deposit spawners and they do not modify their environment for the purpose of breeding, rearing, and staging. As a result the concept of residence does not apply.

Threats and Limiting Factors to the Survival and Recovery of Shortface Lanx

Element 8: Assess and prioritize the threats to the survival and recovery of Shortface Lanx

Shortface Lanx are threatened by natural system modifications through the effects of dams, invasive and other native species, pollution from urban and industrial sources, and the effects of climate change and severe weather events although water flow patterns are controlled by dams (COSEWIC 2016). Reduction in historical population range has been attributed to habitat fragmentation caused by dams and impoundments in the lower reaches of the Columbia River (Frest and Johannes 1995,1997). 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 conditions which do not provide suitable habitat for Shortface Lanx and limit opportunities for dispersal. Given its known limited distribution, they are susceptible to toxic spills caused by train derailment or truck accidents in close proximity to the Columbia River (COSEWIC 2016).

Element 9: Identify the activities most likely to threaten (i.e., damage or destroy) the habitat properties identified in elements 4-5 and provide information on the extent and consequences of these activities.

Human activities that threaten the specific habitat that supports Shortface Lanx have not been characterized mostly because of the lack of basic understanding of the species. COSEWIC did conduct a threat assessment for the species (COSEWIC 2016) but the threats are not specific to habitat. Many of the elements described in this section are included in the COSEWIC 2016 threat assessment.

Threats to the Columbia River ecosystem have been well documented for other species (i.e. Umatilla Dace, Shorthead Sculpin and Columbia Sculpin (COSEWIC 2010 a, b, c, and Harvey and Brown 2011). The greatest likely reduction in habitat quantity in the US portion of the range occurred with the building and operation of multiple dams on the Columbia River. The resulting impoundment of water resulted in the fragmentation of the distribution of the species and changes to the hydrograph. BC Hydro does have a proposed dam site upstream of Trail. As this dam is not under construction this activity is currently considered low.

The species is susceptible to temperatures exceeding their thermal tolerance (approximately 17^{o}C) (Coutant and Becker 1970). The experience gained from events in the southern portion of their American range (e.g. Tiller 2015) may include the monitoring of water temperatures in locations where Shortface Lanx have been reported as well as communication with dam operators and regulators. Similarly, a release of colder water when reproduction is normally occurring could affect the population. Rapid decreases in water levels could also exceed the ability of Shortface Lanx to disperse and remain submerged; desiccation or freezing could result, depending on the time of year.

With respect to the population within the US distribution, threats to the species have included eutrophication due to agricultural practices, pulp mill effluents, metal smelting residues and discharges (Frest and Johannes 1995). Within the area in which Shortface Lanx have been observed in Canada there is a pulp mill and a smelting operation. However, COSEWIC (2016) suggested that increased eutrophication in portions of the Columbia River downstream of Beaver Creek may limit the downstream extent of the range.

The construction of the Zellstoff Celgar pulp mill near Castlegar began in 1959 (Kootenaybiz 2015). In the 1970s, the BC Ministry of Environment conducted an air and water quality study in the Kootenay area which included investigations regarding environmental effects from what was then the Canadian Cellulose pulp mill. Although the study was limited to certain parameters, they determined that the effect of pulp mill effluent on dissolved oxygen, suspended solids and turbidity in the river was not significant (British Columbia 1979). They noted however that at low river flow, mill effluent may cause sub-lethal stress on aquatic life between the mill and the Kootenay River (BC MOE 1979).

It is recognized that this study was limited in its scope and that the mill technology has changed significantly. For example, in the 1990s the Zellstoff Celgar pulp mill underwent a rebuild and modernization, part of which included modern power generation and environmental facilities (Celgar 1993). Additional upgrades were made in 2007 including the reduced consumption of energy and chemicals (Celgar 2007). Although efforts to modernize and green the mill have been extensive, Zellstoff Celgar was fined $150,000 for spilling millions of litres of effluent containing black liquor into the Columbia River (Environment and Climate Change Canada 2012). Black liquor is a byproduct from pulp processing used as a fuel in some pulp mills. The judge in the case however deemed that no noticeable harm was done (Canadian Broadcasting Corporation 2012).

There has been a smelter in operation in Trail since 1896, originally to treat lead and zinc ore (Turnbull 1980). In 1905 it was incorporated as the Consolidated Mining and Smelting Company of Canada (COMINCO) (Wirth 2000), it is currently referred to as Teck Mining Inc. or COMINCO. They operate a fertilizer plant and smelter.

In the 1920s the smelter caused significant air pollution in both the US and Canada which resulted in an international tribunal; litigation and settlement was negotiated in the 1940s (Wirth 2000). In 2016, Tech Metals was fined three million dollars for the discharge of 125 million litres of effluent into the Columbia River (Environment and Climate Change Canada 2016). Deleterious effluent discharges included elevated copper, cadmium, chlorine, or pH and ammonia at concentrations that were harmful to fish (Environment and Climate Change Canada 2016).

Although smelting and milling activities persist, the presence of Shortface Lanx continues even after 100 years of operation.

Treated sewage effluent from the cities, towns, and villages beginning at Castlegar also flow into the Columbia River in Canada (Hawes *et al.* 2014).

Until more information is available on the distribution and abundance of the species, conclusive advice on prioritization and severity of threats cannot be provided.

Element 10: Assess any natural factors that will limit the survival and recovery of Shortface Lanx

Natural factors which may limit the survival of the species include habitat loss and increased water temperature. It has been demonstrated in the US that the impoundment and fragmentation of the Columbia River by multiple dams has eliminated significant portions of the likely habitat that may have once supported Shortface Lanx. Although the dams themselves are not a natural factor they have bounded the area of suitable habitat for the species and given the patchiness of their known distribution, and that recolonization is unlikely, any loss to current available habitat is a limiting factor to their survival.

Shortface Lanx have an upper thermal limit of approximately 17^{o}C (Coutant and Becker 1970), exceeding this temperature would result in death and therefore limit species survival if this temperature were to persist.

Potential predation by invasive fish species have been identified as a threat to survival of the species as has predation from enhancement of White Sturgeon (*Acipenser transmontanus*) (COSEWIC 2016).

Element 11: Discuss the potential ecological impacts of the threats identified in element 9 to the target species and other co-occurring species. List the possible benefits and disadvantages to the target species and other co-occurring species that may occur if the threats are abated. Identify existing monitoring efforts for the target species and other co-occurring species associated with each of the threats, and identify any knowledge gaps.

As stated previously, in the US, dams have been shown to greatly reduce the available habitat as well as fragment habitat causing reduction in range for this species. As there are no imminent plans to build more dams within the known range of the species in Canada, the ecological impact due to dams cannot be considered. If significant changes to the operation of the current dams are proposed, the impacts on downstream habitat for the species should be considered. These impacts should include monitoring of water temperature and depth.

The ecological impacts of deleterious substances being released directly into the water or first via the air from either the pulp mill at Castlegar or the smelter/fertilizer plant at Trail pose an ongoing concern as the tolerances for such deleterious substances are not known for Shortface Lanx.

There are no known monitoring efforts for other co-occurring species of mollusks.

Recovery Targets

Element 12: Propose candidate abundance and distribution target(s) for recovery.

Population information on Shortface Lanx is limited to incidental collections and observations and thus information that could provide an understanding of lifespan, dispersal distance, and other factors is not yet available. Filling these knowledge gaps will provide important information to help maintain the population abundance for extant populations/habitats, and allow the recovery goal to be quantified in the future. As such, qualitative targets are recommended until such time further research is undertaken to develop a census of the population. In the interim, conserving and increasing (where feasible) habitat quantity and quality will serve as a surrogate for maintaining population abundance.

Efforts should be undertaken to ensure that the population does not decrease from its current known population size. Further exploratory surveys could be undertaken to confirm distribution. Until such time however the distribution target is recommended as the known existing range within the Columbia river watershed.

The assessment criteria invoked by COSEWIC (2016) were B1ab(iii)+2ab(iii) where both the extent of occurrence (EOO) and index of area of occupancy (IAO) (56 km2 each) are well below the thresholds for endangered (<5,000 km^2 and 500 km^2, respectively), there are fewer than five locations (a), and there is an observed and inferred continuing decline in quality of habitat (biii) caused by a variety of threats (COSEWIC 2016). In considering recommendations for candidate targets, the newly proposed government of Canada policy on survival and recovery needs to be taken into consideration (Government of Canada 2016). Given that Shortface Lanx is likely at the northern end of its global distribution, and regardless of changes to habitat from damming the Columbia River, the species would still be below the EOO and IAO and therefore be considered historically precarious. Given that the extent of irreversible harm is so great i.e. building of the dams has permanently altered the habitat, it is unlikely that it is biologically feasible to improve the condition of the species to approach the lower end of the *historical condition, therefore* recovery could be considered not feasible (Table 2). Although survival is not technically feasible either based on proposed definitions, given their ongoing persistence of over 100 years of disturbance, survival could be considered likely.

Table 2. Feasibility of survival or recovery table.

Survival Threshold

Fundamental Species Characteristic	**Survival or Recovery Threshold** (Non-precarious Species)	**Technically and Biologically Feasible to Achieve Threshold Before Opportunity is Lost? (Y / N / unknown)**
Species Trend	Stable or increasing over 10 years or 3 generations whichever is longer (up to 100 years)	Unknown. Population was likely larger before the building of dams on the Columbia river. The construction of the dams was far longer than three generations or ten years.

Fundamental Species Characteristic	Survival or Recovery Threshold (Non-precarious Species)	Technically and Biologically Feasible to Achieve Threshold Before Opportunity is Lost? (Y / N / unknown)
Resilience	Sufficiently large to recover from periodic disturbance and avoid demographic and genetic collapse or better	Y: Given the tremendous amounts of habitat alteration and input of contaminants, the species persists
Redundancy	Enough redundancy in the number of (sub) populations or a large enough area of occupancy to prevent catastrophic loss or better	Unknown
Population Connectivity	Not severely and unnaturally fragmented	N: The likely former range of the species in Canada has been fragmented from the construction of dams. The existing likely range does not have any further barriers to downstream movement
Mitigation of Anthropogenic Threats	Significant threats avoided or mitigated to the extent that they no longer threaten the species	N: The impact from the building of the dams cannot be mitigated. Ongoing dam operations can be mitigated to reduce the impact from dewatering and change of flow rates. Impacts from pollutants from the various sources are mitigated through standard operating procedures.
Result	*If all above conditions can be met, species is above the survival threshold*	☐ ***Survival threshold met*** ☒ ***Survival threshold not met***

Minimum Recovery Threshold

Fundamental Species Characteristic	Survival or Recovery Threshold (Non-precarious Species)	Technically and Biologically Feasible to Achieve Threshold Before Opportunity is Lost? (Y / N / unknown)
Species Condition	Improved over when first assessed as at risk	Unknown. First assessment was 2016
Representation (Species presence in appropriate ecological communities)	Approximating historical condition at a coarse scale	N: Species likely had a greater range before the building of dams
Independent of connectivity with populations outside of Canada	Yes: connectivity may be important but cannot be necessary	N: Existing dams in Washington prevent upstream migration
Independent of species intervention	Yes	Y: no intervention required
Result	*If survival threshold and all above conditions can be met, recovery is feasible*	☐ ***Recovery feasible*** ☒ ***Recovery not feasible***

Element 13: Project expected population trajectories over a scientifically reasonable time frame (minimum of 10 years), and trajectories over time to the potential recovery target(s), given current Shortface Lanx population dynamics parameters.

No quantitative abundance information exists, therefore numerical targets and trajectories cannot be provided.

Element 14: Provide advice on the degree to which supply of suitable habitat meets the demands of the species both at present and when the species reaches the potential recovery target(s) identified in element 12.

The species is currently constrained to its existing range. Unless other populations are identified in other river reaches the existing supply of habitat meets the current abundance and distribution**.**

Element 15: Assess the probability that the potential recovery target(s) can be achieved under current rates of population dynamics parameters, and how that probability would vary with different mortality (especially lower) and productivity (especially higher) parameters.

Given the paucity of data on biological traits, population dynamics and abundance, population trajectories and probabilities of meeting different targets cannot be provided. A general assumption however is that existing threats and habitat limitation have been present for multiple generations of Shortface Lanx and the species continues to survive. There is significant uncertainty associated with this assumption however. Targeted research on life history parameters, abundance, and distribution would greatly increase the likelihood of being able to provide trajectories to different quantitative targets.

Scenarios for Mitigation of Threats and Alternatives to Activities

Element 16: Develop an inventory of feasible mitigation measures and reasonable alternatives to the activities that are threats to the species and its habitat (as identified in elements 8 and 10).

No feasible mitigation measures which directly address the threats can be suggested. However, a better understanding of the basic biology of the species as well as the potential impacts of pollutants from the effluent from the smelter or the pulp mill or urban areas and agriculture may aid in decision making. At present, these potential effects are unknown. Additionally, a better understanding of the potential interactions between invasive or enhanced species and Shortface Lanx may aid in management.

Element 17: Develop an inventory of activities that could increase the productivity or survivorship parameters (as identified in elements 3 and 15).

Collecting further biological and distribution information could aid in the determination of the factors regulating population abundance and individual survival. For example:

- Determine the maximum depth at which the species can survive. This information can help inform population abundance estimates.
- Determine presence or absence within the Columbia River downstream and upstream of the Hugh Keenleyside dam and in other tributaries of the Columbia River.
- Monitor water temperatures and depths in locations where species has been identified.

Element 18: If current habitat supply may be insufficient to achieve recovery targets (see element 14), provide advice on the feasibility of restoring the habitat to higher values. Advice must be provided in the context of all available options for achieving abundance and distribution targets.

The only likely means of restoring Shortface Lanx habitat to support a higher population or distribution target is the removal of the existing dams on the Columbia River and allowing the river to return to its former natural flow regime. However, removal of the dams would not necessarily result in re-colonization of presumably occupied habitat given the specific riverine features the species prefers. Dam removal is also highly infeasible.

Element 19: Estimate the reduction in mortality rate expected by each of the mitigation measures or alternatives in element 16 and the increase in productivity or survivorship associated with each measure in element 17.

Given the paucity of data on biological traits, population dynamics and abundance, population trajectories and probabilities of meeting different targets cannot be provided.

Element 20: Project expected population trajectory (and uncertainties) over a scientifically reasonable time frame and to the time of reaching recovery targets, given mortality rates and productivities associated with the specific measures identified for exploration in element 19. Include those that provide as high a probability of survivorship and recovery as possible for biologically realistic parameter values.

Given the paucity of data on biological traits, population dynamics and abundance, population trajectories and probabilities of meeting different targets cannot be provided.

Element 21: Recommend parameter values for population productivity and starting mortality rates and, where necessary, specialized features of population models that would be required to allow exploration of additional scenarios as part of the assessment of economic, social, and cultural impacts in support of the listing process.

Given the paucity of data on biological traits, population dynamics and abundance it is not possible to recommend vales for population productivity or mortality rates.

Allowable Harm Assessment

Element 22: Evaluate maximum human-induced mortality and habitat destruction that the species can sustain without jeopardizing its survival or recovery.

No quantitative advice can be provided at this time on allowable harm. Existing activities, although apparently serious, appear to not be affecting survival of existing population given the species' ongoing presence. Directed harm from scientific sampling should be undertaken in a coordinated fashion such that the least amount of animals are taken while ensuring that questions pertaining to population levels can be reached.

Conclusions

Shortface Lanx has been assessed by COSEWIC as endangered. There is very little information available to inform recovery options or listing decisions. Although recovery is considered not feasible given the historic precarious nature of the species, survival is likely under current environmental conditions. Ongoing studies are recommended to develop indices of abundance and confirmation of distribution of the species in Canada.

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