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Action Plan Series

Action Plan for the Hotwater Physa (*Physella wrighti*) in Canada

Hotwater Physa

2018

Canada

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Cover illustration: Hotwater Physa (*Physella wrighti*) on *Chara* spp. Photo credit: Fisheries and Oceans Canada, Pacific Region.

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Preface

The federal, provincial, and territorial government signatories under the *Accord for the Protection of Species at Risk* (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of action plans for species listed as Extirpated, Endangered, and Threatened for which recovery has been deemed feasible. They are also required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans is the competent minister under SARA for the Hotwater Physa and has prepared this Action Plan to implement the *Recovery Strategy for Hotwater Physa (*Physella wrighti*) in Canada* (Heron 2007), as per section 47 of SARA. In preparing the Action Plan, the competent minister has considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, it has been prepared in cooperation with the Province of British Columbia's Ministry of Environment as per section 48(1) of SARA.

As stated in the preamble to SARA, success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this Action Plan and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this Action Plan for the benefit of the Hotwater Physa and Canadian society as a whole.

Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations to help achieve the population and distribution objectives identified in the recovery strategy. Implementation of this Action Plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

Fisheries and Oceans Canada (DFO) acknowledges the contributions made by those who supported the development of this Action Plan. Staff from the Province of British Columbia's Ministry of Environment (Sue Pollard, Jennifer Heron), BC Parks (Doug Biffard, Anna McIndoe) and DFO (Nadine Pinnell, Jonathan Thar, Alyssa Gerick, Sean MacConnachie, Ray Lauzier) contributed valuable information and ideas that provided the basis for the development of initial drafts of this Action Plan. These ideas helped guide the evolution of the draft action plan, and will be used to help guide the implementation of the actions identified in the plan wherever possible.

Executive Summary

The Hotwater Physa (*Physella wrighti*) was listed as Endangered under the *Species at Risk Act* (SARA) in 2003. This Action Plan is considered one in a series of documents that are linked and should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Report, Recovery Potential Assessment and Recovery Strategy.

The Hotwater Physa is a freshwater snail species endemic to Liard River Hot Springs Provincial Park, in northern British Columbia. It has a small population with narrow ecological requirements; however, there is no current or historic evidence of decline in the population (Heron 2007).

This Action Plan outlines measures that provide the best chance of achieving the population and distribution objectives for the species, including the measures to be taken to address the threats and monitor the recovery of the species. The population and distribution objectives (previously referred to as recovery goals and objectives) for the Hotwater Physa identified in the *Recovery Strategy for Hotwater Physa (*Physella wrighti*) in Canada* (Heron 2007) are as follows:

RECOVERY GOAL

Maintain and protect the population(s) of Hotwater Physa within its natural geographic range and within its current variation of abundance at the Liard River Hot Springs complex.

RECOVERY OBJECTIVES

1) to observe that the species' current distribution[1] within the Alpha and Beta pools and streams is maintained, and to refine the understanding of the current distribution to better quantify this objective by 2011; and,
2) to observe that the species' current relative abundance is maintained, and to develop methodology that increases survey precision by 2011.

Section 1.2 outlines: the measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners (Table 1), and, measures that represent opportunities for other jurisdictions, organizations or individuals to lead (Table 2). Section 1.2 measures fall under the following broad strategies: monitoring, protection, threats monitoring, knowledge gaps, and park education.

For the Hotwater Physa, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives. This Action Plan identifies critical habitat for the Hotwater Physa as their entire area of occupancy within the Liard River Hot Springs Provincial Park, including riparian areas of 30 m width, providing allochthonous[2] inputs of leaf litter and woody debris to aquatic habitats (Section 2.1).

[1] This Action Plan takes into consideration the expansion of Hotwater Physa distribution into additional locations within Liard River Hot Springs Provincial Park subsequent to the publication of Heron (2007); however, these locations are not identified herein to protect Hotwater Physa.
[2] Originating ex-situ.

It is anticipated that the protection of the species' critical habitat from destruction will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat (Section 2.1).

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

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1 Recovery Actions

1.1 Context and Scope of the Action Plan

The Hotwater Physa was listed as Endangered under Schedule 1 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA) in 2003. This Action Plan is considered one in a series of documents that are linked and should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Report (COSEWIC 2008), Recovery Potential Assessment (DFO [Fisheries and Oceans Canada] 2010), and Recovery Strategy (Heron 2007). Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. A recovery strategy also provides background information on the species and its threats and critical habitat information.

The Hotwater Physa (*Physella wrighti*) is a freshwater snail with a very small (3.25 - 9.1 mm) blackish / grey shell. It is endemic to the hot springs found in Liard River Hot Springs Provincial Park in northern British Columbia (Figure 1).

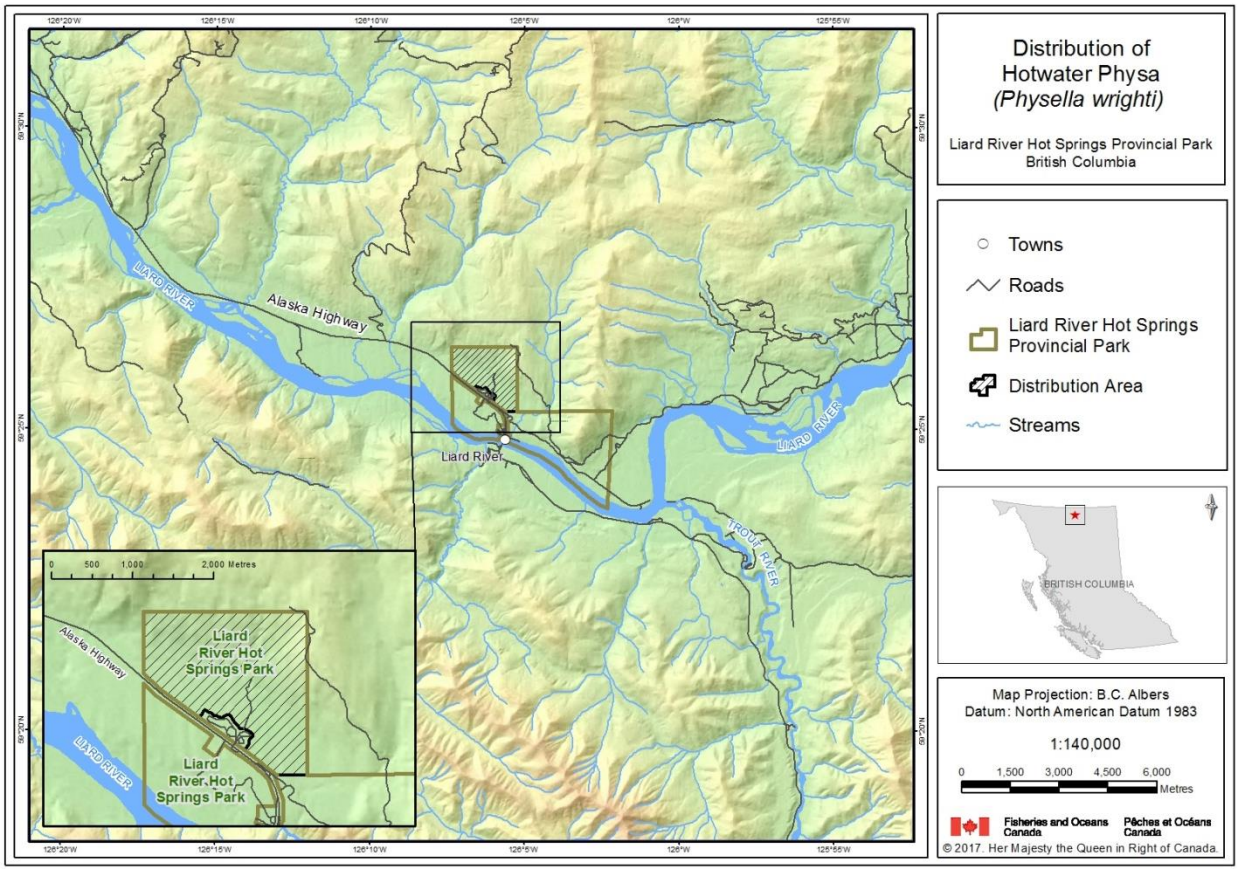

Figure 1. Distribution of the Hotwater Physa

As described in the *Recovery Strategy for Hotwater Physa (*Physella wrighti*) in Canada* (Heron 2007), there is no current or historic evidence of a decline in the population of Hotwater Physa.

Potential threats to Hotwater Physa include: changes to the flow regime as a result of human activities, including weir maintenance, recreational activities, drilling activities for oil and gas exploration, and hydroelectric development; introduction of deleterious substances; physical habitat destruction or alteration; introduced species; and collecting. The Recovery Strategy also identifies broad strategies for achieving the population and distribution objectives: population and distribution monitoring; protection; threats monitoring; filling knowledge gaps; and park education.

The population and distribution objectives (previously referred to as recovery goals and objectives) for the Hotwater Physa identified in the *Recovery Strategy for Hotwater Physa (*Physella wrighti*) in Canada* (Heron 2007) are as follows:

RECOVERY GOAL

Maintain and protect the population(s) of Hotwater Physa within its natural geographic range and within its current variation of abundance at the Liard River Hot Springs complex.

RECOVERY OBJECTIVES

1) to observe that the species' current distribution[3] within the Alpha and Beta pools and streams is maintained, and to refine the understanding of the current distribution to better quantify this objective by 2011; and,
2) to observe that the species' current relative abundance is maintained, and to develop methodology that increases survey precision by 2011.

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

[3] This Action Plan takes into consideration the expansion of Hotwater Physa distribution into additional locations within Liard River Hot Springs Provincial Park subsequent to the publication of Heron (2007); however, these locations are not identified herein to protect Hotwater Physa.

1.2 Measures to be Taken and Implementation Schedule

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

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

Table 1 identifies the measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners, other agencies, organizations or individuals. Implementation of these measures will be dependent on a collaborative approach, in which Fisheries and Oceans Canada is a partner in recovery efforts, but cannot implement the measures alone. As all Canadians are invited to join in supporting and implementing this Action Plan, Table 2 identifies remaining measures that represent opportunities for other jurisdictions, organizations or individuals to lead for the recovery of the species. If your organization is interested in participating in one of these measures, please contact the Species at Risk Pacific Region office at sara@pac.dfo-mpo.gc.ca.

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

Table 1. Measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners

#	Recovery Measures	Priority[4]	Threats addressed	Collaborators	Timeline
Broad Strategy: Population and Distribution Monitoring					
1	Establish, refine, and implement standardized protocols for Hotwater Physa:				
	• population monitoring at index sites; and	High	All.	DFO, BC MOE[5] (Ecosystems), BC MOE (Parks).	Short-term[6]
	• habitat occupancy and distribution surveys (including areas where the species is not known to occur).	High	All.	DFO, BC MOE (Ecosystems), BC MOE (Parks).	Medium-term[6]
Broad Strategy: Threats Monitoring					
2	Develop and implement a threats monitoring plan to provide for a clear indication of the progress towards maintaining and protecting the population(s) of Hotwater Physa within its natural geographic range and within its current variation of abundance at Liard River Hot Springs. Monitoring efforts may include: • water quality parameters (e.g. oxygen, temperature and pH); • population trends and distribution of the hot springs complex aquatic communities (ecological dynamics); • introductions of invasive / exotic species; and, • physical changes to critical habitat.	High	All.	DFO, BC MOE (Ecosystems), BC MOE (Parks), BC MFLNRO.[7]	Short-term

[4] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

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

[5] British Columbia's Ministry of Environment.

[6] Implementation must consider and address the potential impacts on Hotwater Physa habitat and individuals; consequently, surveys should not occur more frequently than once every five years.

[7] British Columbia's Ministry of Forests, Lands and Natural Resource Operations.

Table 2. Measures that represent opportunities for other jurisdictions, organizations or individuals to lead

#	Recovery Measures	Priority[8]	Threats addressed	Contributors
Broad Strategy: Knowledge Gaps				
3	Identify, prioritize, and address a list of knowledge gaps for Hotwater Physa. This may include, but is not limited to, activities derived from technical reports (e.g. Salter 2001), peer-reviewed literature, or operational documents, for example: • specific parameters of existing critical habitat attributes; • potential parasites (e.g. leeches) and predators (e.g. ducks, geese, toads) of Hotwater Physa; • effectiveness of artificial substrates as habitat; • Hotwater Physa natural history (e.g., reproduction, growth rates, population cycles, feeding preferences, and behavior); and, • systematics and taxonomy of Hotwater Physa and related species.	High	All.	BC MOE (Ecosystems), researchers (e.g. academic institutions, consultants).
4	Conduct a detailed hydrogeological and geomorphological survey to refine knowledge about the geothermal source of Liard River Hot Springs and its pathways, which specifically: • characterizes shallow and deep groundwater regimes; and, • assesses short and long term risks of any modification to these groundwater regimes and geological structures, and their subsequent influence over the recharge zone.	Medium	Change to the flow regime as a result of human activities; physical habitat destruction or alteration.	BC MOE (Ecosystems), BC MFLNRO, researchers (e.g. academic institutions, consultants).
Broad Strategy: Threats Monitoring				
5	Monitor park users' behaviour for activities that are detrimental to Hotwater Physa or its critical habitat. Record and report any incidents to DFO.	High	Physical habitat destruction or alteration; introduction of deleterious substances.	BC MOE (Parks).

[8] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

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

#	Recovery Measures	Priority[8]	Threats addressed	Contributors
Broad Strategy: Protection				
6	Evaluate the necessity for and implement the means to regulate recreational activities within Liard River Hot Springs Provincial Park.	High	Change to the flow regime as a result of human activities; introduction of deleterious substances; physical habitat destruction or alteration.	BC MOE (Parks).
7	Monitor the dimensions of upper and lower Alpha Pool to ensure that bankside erosion is minimal, and that contours, size, shape and dimensions of the pools are maintained.	High	Change to the flow regime as a result of human activities; physical habitat destruction or alteration.	BC MOE (Parks), BC MOE (Ecosystems).
8	Consider incorporation of provisions regarding Hotwater Physa management and protection outlined in this Action Plan into: • the Liard River Hot Springs Provincial Park Master Plan when it is updated; • any park policy or management documents developed in the future (including facility maintenance, compliance, and enforcement practices); and, • any land use planning documents that would affect the park area.	Low	All.	BC MOE (Parks), local governments, industry.
9	Investigate, and apply as appropriate, mechanisms for the protection[9] of the hot springs' recharge zone and the potential groundwater pathways between the recharge zone and the hot springs (outside of Liard River Hot Springs Provincial Park).	Medium	Change to the flow regime as a result of human activities; introduction of deleterious substances; physical habitat destruction or alteration.	BC MFLNRO, BC MOE (Ecosystems).[10]

[9] The British Columbia's Ministry of Natural Gas Development established a Resource Review Area (RRA) in 2014 under the *Petroleum and Natural Gas Act*. The RRA is established through direction from the statutory decision maker and may be removed in a similar manner in the future.

[10] Other provincial ministries, such as British Columbia's Ministry of Energy and Mines, may become involved as required.

#	Recovery Measures	Priority[8]	Threats addressed	Contributors
10	Develop and apply appropriate standards and guidelines to mitigate potential impacts from oil and gas, mineral and geothermal exploration and extraction activities to the geothermal source of the hot springs.	Medium	Change to the flow regime as a result of human activities; introduction of deleterious substances; physical habitat destruction or alteration.	BC MEM, BC MNGD,[11] BC OGC,[12] industry.
Broad Strategy: Park Education				

11	Promote Liard River Hot Springs Provincial Park regulations and best practices to park users, and encourage them to avoid:
	• actions that could result in introductions that may harm individuals or their habitat, for example:
	  ○ use of personal care products (e.g. sunscreen or insect repellent, perfumes, shampoo, soap, etc.);
	  ○ spilling of beverages or other substances;
	  ○ introducing copper (e.g. tossing pennies);
	  ○ introduction of non-native exotic species such as carp, fairy shrimp, turtles or other aquarium trade species;
	• actions that could result in changes to water quality, levels or flows; and,
	• harm to individual Hotwater Physa.
		High	Change to the flow regime as a result of human activities; introduction of deleterious substances.	DFO, BC MOE (Parks).

12	Ensure that park staff and any other relevant staff from provincial ministries are aware of the presence of Hotwater Physa within the park, its status under SARA and any relevant provisions from the Hotwater Physa Recovery Strategy and this Action Plan intended to protect the species and its habitat.	High	All.	BC MOE (Parks).

[11] British Columbia's Ministry of Natural Gas Development.
[12] British Columbia Oil and Gas Commission.

2 Critical Habitat

2.1 Identification of the Species' Critical Habitat

2.1.1 General Description of the Species' Critical Habitat

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

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

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

This Action Plan identifies critical habitat for the Hotwater Physa as the species' entire area of occupancy, allowing for "seasonal and annual variation in temperature, high uncertainty in abundance estimates and the desire for [connectedness] between habitats" (DFO 2010). This includes riparian areas of 30 m width, providing allochthonous inputs of leaf litter and woody debris to aquatic habitats.

The critical habitat identified in this Action Plan is sufficient to achieve the species' population and distribution objectives. The Schedule of Studies defined in the Recovery Strategy (Section 1.6.1; Heron 2007) outlined the research required to acquire more detail about the identified critical habitat, and is complemented by the research activities found in Tables 1 and 2 of this Action Plan.

2.1.2 Information and Methods Used to Identify Critical Habitat

The geographic locations and biophysical functions, features and attributes of the critical habitat were identified using the best available information. This information is contained in *Hotwater Physa (*Physella wrighti*) research at Liard River Hotsprings Provincial Park – 2012 and 2013* (BC MOE 2015), summarized in the *Recovery Potential Assessment for Hotwater Physa (*Physella wrighti*)* (DFO 2010), and supplemented by BC MOE staff members' expertise.

The following locations of the critical habitat functions, features and attributes for Hotwater Physa have been identified using the bounding box approach. This means that critical habitat is not comprised of the entire area within the identified boundaries but only those areas within the identified geographical boundaries where the described biophysical feature and the function it supports occur, as described in Table 3.

2.1.3 Identification of Critical Habitat

Geographic Information

For the Hotwater Physa, critical habitat (Figure 2) is identified as their entire area of occupancy within the Liard River Hot Springs Provincial Park, including:

- Alpha pool and the remainder of the Alpha complex (streams and marsh areas) downstream from the pool (DFO 2010);
- other pools, streams and marsh areas within the hot springs complex that contain Hotwater Physa, which are not open to the public; and,
- a riparian[13] area of 30 metre width[14] surrounding the wetted perimeter of each marsh,[15] pool and stream[16] described above.

Figure 2 shows the boundaries and coordinates of the bounding box that contains critical habitat features, functions and attributes for Hotwater Physa. This critical habitat map is only meant to provide geographical information related to critical habitat.

[13] Hotwater Physa are found "centimetres away from the [water's] edge" (DFO 2010). Additionally, riparian areas surrounding Hotwater Physa's aquatic habitat include both coniferous and deciduous tree growth, as indicated by georeferenced air photos taken in 2014. DFO (2010) also notes that Hotwater Physa graze on submerged leaf matter, and that woody debris serves as a substrate for algal and bacterial growth.

[14] In the absence of an assessment conducted by a qualified professional, a 30 m riparian width has been identified based on best available information consistent with the Riparian Areas Regulation's (RAR; B.C. Reg. 376/2004) Schedule of Assessment Methods (simple assessment) and riparian widths for other aquatic species at risk in British Columbia.

[15] The wetted perimeter of marshes is to be interpreted on the ground as the high water mark for wetlands as defined in the RAR's Schedule of Assessment Methods (B.C. Reg. 376/2004): "from an ecological perspective, either an abundance of hydrophytes or hydric soil conditions is generally sufficient to indicate a wetland ecosystem. The boundary or high water mark of the wetland is identified by changes in vegetation structure, loss of obligate hydrophytes, and absence of wetland soil characteristics."

[16] The wetted perimeter of streams and pools is to be interpreted on the ground as the high water mark for streams as defined in the RAR's Schedule of Assessment Methods (B.C. Reg. 376/2004): "the visible high water mark of a stream where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the stream a character distinct from that of its banks, in vegetation, as well as the nature of the soil itself, and includes the active floodplain."

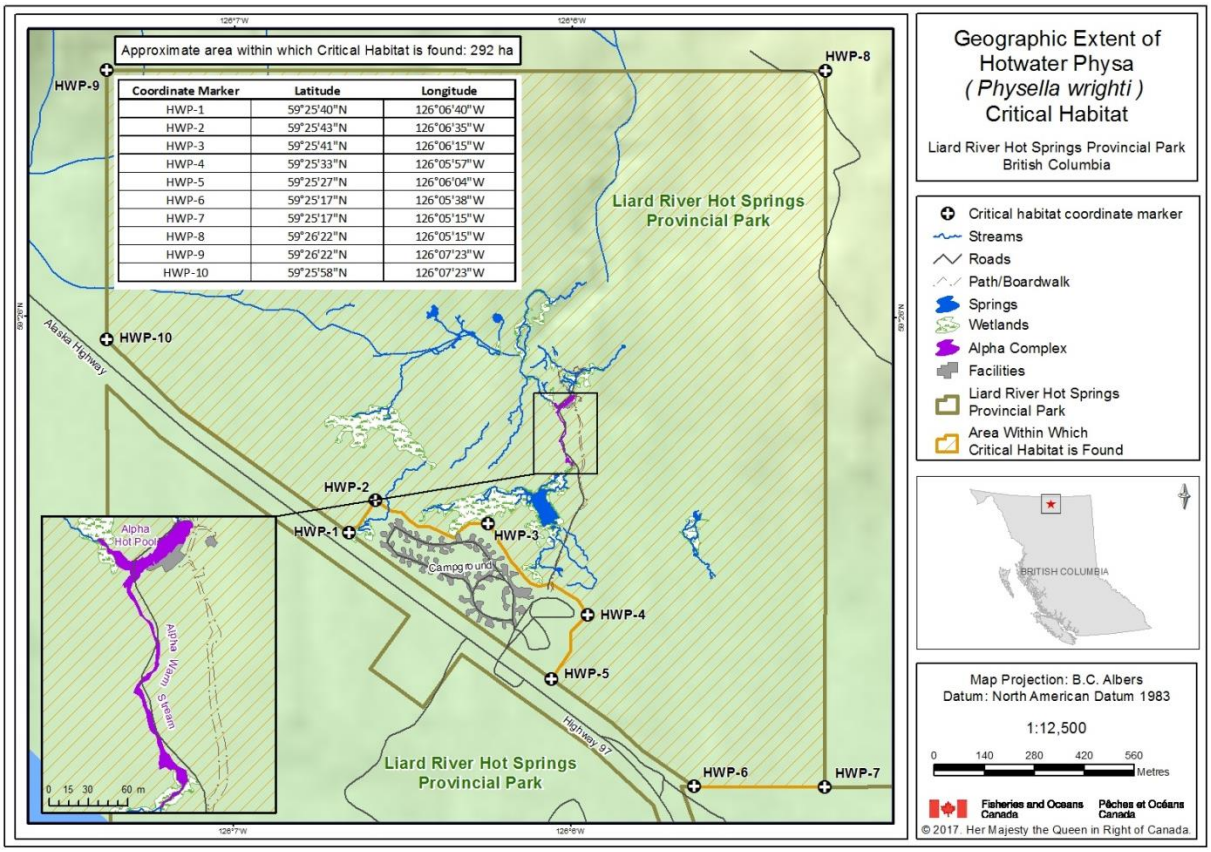

Figure 2. Geographic Extent of Critical Habitat for the Hotwater Physa (riparian critical habitat not mapped)

Note: In Figure 2 diagonal hashing represents the area within which critical habitat is found. The Alpha Complex inset map represents an area occupied by the species that is known to, and frequented by, the public; however, the remainder of Hotwater Physa's area of occupancy is not mapped to protect the species (refer to footnote three).

Biophysical Functions, Features and Attributes

Table 3 summarizes the best available knowledge of the functions, features and attributes for each life stage of the Hotwater Physa. Note that not all attributes in Table 3 must be present in order for a feature to be identified as critical habitat. If the features described in Table 3 are present and capable of supporting the associated function(s), the feature is considered critical habitat for the species, even though some of the associated attributes might be outside of the range indicated in the table.

Table 3. General summary of the biophysical functions,[17] features,[18] attributes[19] and location of critical habitat necessary for the Hotwater Physa's survival

Geographic location	Life stage	Function	Feature(s)	Attribute(s)
Liard River Hot Springs complex	Adults, Juveniles and Eggs	Feeding, rearing, reproduction and incubation	Pool, stream and marsh habitats	• Access to the air-water interface (i.e. absence of surface films, which may limit access to air and/or coat them with materials that interfere with life processes) • Constant supply of geothermally-heated water between 18 and 40 degrees Celsius • Low water velocity • Consistent water levels (i.e. preventing desiccation/dislodgement) • Water with no or low levels of pollutants • Water with high levels of dissolved minerals (minimum conductivity of 1000 µS/cm) • Alkaline water • Adequate amounts of substrate (both submerged, and within 5 cm above the air-water interface) including: the stream bed and banks, mats of green alga, *Chara* spp., and allochthonous inputs from vegetation (e.g. logs, branches, twigs, bark, leaves) • Physically stable foreshore environment (i.e. stable banks) • Adequate supply of algal and bacterial growth

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

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

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

Geographic location	Life stage	Function	Feature(s)	Attribute(s)
Liard River Hot Springs complex	Adults, Juveniles, and Eggs	Feeding, rearing, reproduction and incubation	Riparian areas of 30 m width surrounding wetted perimeters of pools, streams, and marshes	• Adequate supply of allochthonous inputs from vegetation • Soils, rocks, and vegetation extending 15 cm inland from the wetted perimeter of streams, pools, and marshes

The following anthropogenic features are excluded from critical habitat: all human-made infrastructure, such as stairs into the water, buildings, changing areas, boardwalks, rocks and tar paper installed for structural support, the dam, and the weir.

Summary of critical habitat relative to population and distribution objectives

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

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

The following examples of activities likely to result in the destruction[20] of critical habitat (Table 4) are based on known human activities that are likely to occur in and around critical habitat and would result in the destruction of critical habitat if unmitigated. The list of activities is neither exhaustive nor exclusive and has been guided by the threats described in Section 1.5 of the Recovery Strategy (Heron 2007). The absence of a specific human activity does not preclude or restrict the Department's ability to regulate that activity under SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition, and does not mean the activity will inevitably result in destruction of critical habitat. Every proposed activity must be assessed on a case-by-case basis and site-specific mitigation will be applied where it is available and reliable. Where information is available, thresholds and limits have been developed for critical habitat attributes to better inform management and regulatory decision making. However, in many cases knowledge of a species and its critical habitat's thresholds of tolerance to disturbance from human activities is lacking and must be acquired.

[20] Destruction occurs when there is a temporary or permanent loss of a function of critical habitat at a time when it is required by the species.

Table 4. Examples of activities likely to result in the destruction of critical habitat

Threat	Activity	Effect- Pathway	Function Affected	Feature Affected	Attribute Affected
Change to the flow regime as a result of human activities	Blockage, removal, or damage to the integrity of the dam, weir, pools, streams, marshes and their riparian banks,[21] where Hotwater Physa are present.	Altered water levels and flow rates could affect supply of water through pools, streams and marsh habitat. This may lead to dislodging Hotwater Physa attached to substrates, desiccation, bank erosion, or a reduction in aquatic habitat.	Feeding, rearing, reproduction and incubation	Pool, stream and marsh habitats	• Constant supply of geothermally-heated water between 18 and 40 degrees Celsius • Low water velocity • Consistent water levels (i.e. preventing desiccation/dislodgement) • Physically stable foreshore environment (i.e. stable banks)
Introduction of deleterious substances	Introduction of deleterious substances (e.g. sunscreen, insect repellent, lotion, soaps, shampoos spilled beverages, copper, and other foreign substances[22]) into the hot springs complex.	Presence of these substances on the water's surface could limit the snails' access to air and/or coat them with materials that interfere with life processes such as egg laying (DFO 2010). They may also affect the overall water quality within the hot springs complex.	Feeding, rearing, reproduction and incubation	Pool, stream and marsh habitats	• Water with no or low levels of pollutants • Water with high levels of dissolved minerals (minimum conductivity of 1000 µS/cm) • Alkaline water

[21] Such activities are prohibited under British Columbia's *Park Act*, but instances of visitors to the Liard River Hot Springs Provincial Park blocking the outflow to the lower end of Alpha Pool have been documented (Heron 2007).
[22] Also refer to Row 5 of Table 4 with respect to contamination of the hot springs' geothermal source.

Threat	Activity	Effect- Pathway	Function Affected	Feature Affected	Attribute Affected
Physical habitat destruction or alteration	In-stream wading, or walking outside of established boardwalk, trail and Alpha Pool bathing facilities.	Wave action may dislodge Hotwater Physa, affecting their ability to feed and access the air/water interface as needed. Displacement of *Chara* mats, or disruption of bacterial growth on submerged substrates. Disturbance of riparian banks, marsh areas or in-stream areas where Hotwater Physa are present.[23]	Feeding, rearing, reproduction and incubation	Pool, stream, marsh, and riparian areas of 30 m widths	• Consistent water levels (i.e. preventing desiccation/dislodgement) • Adequate amounts of substrate (both submerged, and within 5 cm above the air-water interface) including: the stream bed and banks, mats of green alga, *Chara* spp., and allochthonous inputs from vegetation (e.g. logs, branches, twigs, bark, leaves) • Adequate supply of algal and bacterial growth • Access to the air-water interface (i.e. absence of surface films, which may limit access to air and/or coat them with materials that interfere with life processes) • Soils, rocks, and vegetation extending 15 cm inland from the wetted perimeter of streams, pools, and marshes • Physically stable foreshore environment (i.e. stable banks)

[23] If visitors remain entirely on the established boardwalk, trail and Alpha Pool bathing facilities, they are unlikely to risk trampling or disturbing areas downstream in the Alpha complex, or other pool, stream and marsh areas within the park.

Threat	Activity	Effect- Pathway	Function Affected	Feature Affected	Attribute Affected
Physical habitat destruction or alteration	Extensive removal of riparian vegetation.	Altered supply of the leaves, bark and other woody debris that provide an important source of substrate for Hotwater Physa and that support algal and bacterial growth which are important for Hotwater Physa feeding.	Feeding, rearing, reproduction and incubation	Pool, stream, marsh, and riparian areas of 30 m widths	• Adequate supply of allochthonous inputs from vegetation • Adequate amounts of substrate (both submerged, and within 5 cm above the air-water interface) including: the stream bed and banks, mats of green alga, *Chara* spp., and allochthonous inputs from vegetation (e.g. logs, branches, twigs, bark, leaves) • Adequate supply of algal and bacterial growth
Change to the flow regime as a result of human activities	Drilling (e.g. associated with mineral, geothermal, or oil and gas exploration) within the hot springs' recharge zone and areas of potential pathways.	Unmitigated drilling activities in this area have the potential to interfere with the flow of heated water to the hot springs complex and / or to contribute to contamination of the geothermally-heated water that reaches the hot springs outlet (GW Solutions 2010).	Feeding, rearing, reproduction and incubation	Pool, stream and marsh habitats	• Constant supply of geothermally-heated water between 18 and 40 degrees Celsius • Alkaline water • Water with no or low levels of pollutants
Introduced species	Introduction through deliberate or inadvertent human actions potentially leading to subsequent establishment of non-native aquatic species.	Alteration of water quality within the hot springs complex. Change in vegetation community composition or structure, potentially affecting growth of alga, *Chara* spp. and bacteria. Change in the faunal community potentially impacting Hotwater Physa, either directly through increased predation or displacement, or indirectly through competition for food and resources.	Feeding, rearing, reproduction and incubation	Pool, stream and marsh habitats	• Alkaline water • Adequate amounts of substrate (both submerged, and within 5 cm above the air-water interface) including: the stream bed and banks, mats of green alga, *Chara* spp., and allochthonous inputs from vegetation (e.g. logs, branches, twigs, bark, leaves) • Adequate supply of algal and bacterial growth

2.3 Proposed Measures to Protect Critical Habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a recovery strategy or action plan. For the Hotwater Physa's critical habitat, it is anticipated that this will be accomplished through a SARA Critical Habitat Order made under Subsections 58(4) and (5), which will invoke the prohibition in Subsection 58(1) against the destruction of the identified critical habitat.

It is important to keep in mind that critical habitat can be destroyed from activities both within and outside of the geographic extent of the critical habitat.

3 Evaluation of Socio-Economic Costs and of Benefits

The *Species at Risk Act* requires that an action plan include an evaluation of its socio-economic costs, and the benefits to be derived from its implementation (SARA 49(1)(e), 2003). This evaluation addresses only the incremental socio-economic costs of implementing this Action Plan from a national perspective, as well as the social and environmental benefits that would occur if the Action Plan were implemented in its entirety, recognizing that organizations or agents other than the federal government may be better placed for implementation of certain aspects of the Action Plan. The intent of this evaluation is to inform the public and to guide decision making on implementation of the Action Plan by partners.

The protection and recovery of species at risk can result in both benefits and costs. The Act recognizes that "*wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons*" (SARA 2003). Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians. A review of the literature confirms that Canadians value the preservation and conservation of species in and of themselves. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2008). Furthermore, the conservation of species at risk is an important component of the Government of Canada's commitment to conserving biological diversity under the *International Convention on Biological Diversity*. The Government of Canada has also made a commitment to protect and recover species at risk through the *Accord for the Protection of Species at Risk*. The specific costs and benefits associated with this Action Plan are described below.

This evaluation does not address the socio-economic impacts of protecting critical habitat for Hotwater Physa. Should a SARA Critical Habitat Order be used for critical habitat protection, the development of the Order would follow a regulatory process in compliance with the Cabinet Directive for Regulatory Management (CDRM), including an analysis of any potential incremental impacts of the SARA Critical Habitat Order that would be included in the Regulatory Impact Analysis Statement.

3.1 Socio-economic Costs of Implementing this Action Plan

All actions identified in this plan will need to be undertaken in collaboration with the Province of British Columbia; potentially, other contributors may participate, or may already be involved. These partners may include other government agencies, academic institutions, researchers,

local stewardship organizations, private citizens, and industry groups. Such participation may include in-kind support in terms of staff time and resources for discussion and to attend meetings. There is a lack of detail in terms of project specifics, such as, what and when guidelines and protocols could be implemented. This precludes a full assessment of the costs to partners and stakeholders and an evaluation of the distribution of those costs.

Half of the actions in this Plan are related to research and monitoring activities. One action is related to increasing education and awareness to ensure that park users abide by existing regulations, and another is related to ensuring awareness of park staff. The remaining actions focus on the development of guidelines, protocols and protection mechanisms to mitigate threats to Hotwater Physa.

The majority of the actions (e.g. research, monitoring, education and development of guidelines and/or regulations) are expected to be initiated in the short-term with some monitoring and education continuing over the long-term. Timelines for implementation of any new protocols, guidelines, or potential regulations are not known.

Table 1 research and monitoring actions are to be undertaken collaboratively. The overall costs (financial and in-kind) of Table 1 for DFO and collaborators are expected to be low.[24] Table 2 actions include additional, likely, low financial and in-kind costs for DFO.

Several actions in Table 2 require development of guidelines, protocols or protection mechanisms. The costs of development of these types of documents are usually minimal, requiring some financial contribution and in-kind costs in terms of staff time for developing materials and to attend meetings. Of these, two actions (Action 9 and 10) include implementation of guidelines, protocols or protection mechanisms. These actions are intended to address future potential activities associated with mining, gas and geothermal industries, beyond those that may currently occur in the area. Available information indicates that there are no activities planned for the area in the near future. Implementation of these two actions could result in future costs. However, in the absence of any information on the contents of the plans, future activities that may occur, or any potential mitigation or modification requirements for such activities, it is not possible to provide an overall estimate of costs over the long-term.

Overall, DFO costs (financial and in-kind) for Table 1 and Table 2 are expected to be low. Partner costs for actions in Table 1, as well as those actions related to research, monitoring and assessment, education and development of guidelines and protocols in Table 2 are also expected to be low. However, costs and distribution of costs from implementation of guidelines, protocols and protection mechanisms (Action 9 and 10) on potential future industry activities are unknown.

3.2 Benefits of Implementing this Action Plan

There are no known uses or cultural significance associated with Hotwater Physa; however, it is a unique species that contributes to biodiversity. The recovery measures in this plan are anticipated to maintain current non-market benefits associated with the species including

[24] Guidance provides scales in terms of present values, as well as annualized values. The annualized scale is: Low $0-$1 million, Medium $1-$10 million, High >$10 million (Treasury Board of Canada Secretariat 2014).

existence, bequest and option values.[25] As indicated above, Canadians value such measures for a number of reasons.

The recovery measures are also likely to provide broader benefits, as some of the threats to Hotwater Physa are common to other species that depend on the unique environment within Liard River Hot Springs Provincial Park. Consequently, this Action Plan may contribute to maintaining biodiversity in Canada and it will contribute positively to a number of goals under the Federal Sustainable Development Strategy (Appendix A).

3.3 Efforts Towards Recovery to Date

The *Report on the Progress of Recovery Strategy Implementation for the Hotwater Physa (*Physella wrighti*) in Canada for the Period 2007 – 2015* (DFO 2016)[26] outlines the recovery efforts that Fisheries and Oceans Canada has been able to document.

[25] Non-market benefits include bequest values (the value placed on conservation for future generations), existence values (the value people place on the existence of a species) and option values (the amount someone is willing to pay to keep open the option of future use of the species).
[26] http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=3030.

4 Measuring Progress

The performance measures presented in the Recovery Strategy provide a way to define and measure progress toward achieving the population and distribution objectives.

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

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

5 References

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Appendix A: Effects on the Environment and Other Species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (2010), SARA recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. The purpose of an SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the Action Plan itself, but are also summarized below in this statement.

This Action Plan will clearly benefit the environment by promoting the recovery of Hotwater Physa; maintaining biodiversity within Canada helps to encourage the resiliency of its ecosystems. As such, this Action Plan positively contributes to the FSDS': Theme III (Protecting Nature and Canadians); Goals 4 (Conserving and Restoring Ecosystems, Wildlife and Habitat, and Protecting Canadians) and 5 (Biological Resources); and Target 4.1 (Species at Risk). Specific activities identified within the Action Plan can also contribute to Theme II (Maintaining Water Quality and Availability) and Goal 3 (Water Quality and Water Availability).

The actions outlined in this plan for promoting the recovery of Hotwater Physa may also provide protection and other benefits to other species within Liard River Hot Springs Provincial Park. Actions to protect the portions of the hot springs complex that are critical habitat for Hotwater Physa will benefit other species that use and depend upon the unique environment of the hot springs. This includes the population of Lake Chub (*Couesius plumbeus*) within the hot springs complex that have adapted to this warm water environment, assessed as data deficient by COSEWIC in 2004 (COSEWIC 2004). Invertebrate species that may benefit include the plains forktail damselfly (*Ischnura damula*) and the mayfly (*Caenis youngi*). Plants found at Liard River Hot Springs Provincial Park that could benefit include the provincially blue-listed Hudson Bay sedge (*Carex heleonastes*), tender sedge (*Carex tenera*), white adder's-mouth orchid (*Malaxis brachypoda*), and Yukon lupine (*Lupinis kuschei*). As well, snake root (*Sanicula marilandica),* stinging nettle (*Urtica dioca* spp. *lyallii*) and monkeyflower (*Mimulus guttatus)* are all plants that would not normally survive at this latitude yet are present within the park due to the unique hot springs environment; they could also benefit from actions outlined in this plan for the protection of the hot springs environment.

The potential for this Action Plan to inadvertently lead to adverse effects on the environment and other species was considered. The SEA concluded that the Action Plan brings a significant net benefit to the environment and other species, and will not entail any major adverse effects.

Appendix B: Record of Cooperation and Consultation

Action plans are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties and others as outlined in SARA section 48. DFO has utilized processes for coordination and consultation between the federal and British Columbia governments on management and protection of species at risk as outlined in the *Canada-British Columbia Agreement on Species at Risk*. Information on participation is included in the Acknowledgements section of this Action Plan.

DFO conducted a 30-day external review of the draft Action Plan from October 20 to November 18, 2016. A copy of the draft Action Plan, a link to DFO's online species profile, and a comment form were mailed, faxed and e-mailed to 11 indigenous organizations, offering further discussion with DFO; no comments were submitted. Three consultants or species experts, one mining company, and the Muskwa-Kechika Management Advisory Board (representing industry, local government, and conservation, among others) were also emailed. Of these, one person submitted comments focused on the species' taxonomic status. No significant edits were made as a result of the external review.

Additional stakeholder, Aboriginal, and public input was sought through the publication of the proposed document on the Species at Risk Public Registry for a 60-day public comment period from May 10 to July 9, 2017. No comments were received during this period.