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Pacific Region

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RECOVERY POTENTIAL ASSESSMENT FOR HOTWATER PHYSA (*PHYSELLA WRIGHTI*)

Figure 1: Photo courtesy of S. Davis.

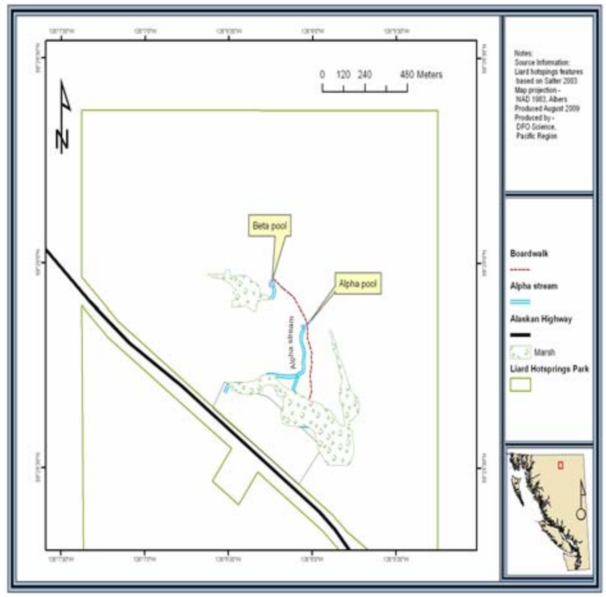

Figure 2: Laird Hotsprings Provincial Park based on Salter (2003).

Context :

In April 1998, Hotwater Physa was designated Endangered by COSEWIC. The reason for designation was because the species is a small endemic population with narrow ecological requirements occurring in an extremely restricted area subject to threats resulting from human use of hot springs pools. In 2003 the species was listed under SARA. A Recovery Strategy (Heron, 2007) is posted on the Sara Public Registry. When a species is listed under SARA a recovery potential assessment (RPA) is undertaken by DFO to provide science-based advice on current status, the likely impact of human activities on the potential for recovery, and options to mitigate human threats to achieve recovery objectives. The advice is an important component of recovery action plans. A peer review of scientific information in support of the RPA for hotwater physa was conducted by the Pacific Scientific Advice review Committee (PSARC) in June 2009.

SUMMARY

- Hotwater Physa is found within the hot springs complex of the Liard River Hot Springs Provincial Park. The snail is present in two hot springs pools known as the Alpha and Beta pools, the outlet of the Alpha pool (Alpha stream) and a warm-water swamp.
- Survey estimates of population size are likely biased low and the true population abundance potentially is in the tens of thousands.

- The semelparous life history strategy, short generation time and evidence from other freshwater snail species implies that the productivity is moderate to high.
- The species requires an aquatic environment that maintains a water temperature between 23-40ºC year round. The snails are found on substrates both above and below the water level. The preferred habitat is *Chara sp.* mats but they also are found on mats of green alga, woody debris (logs, bark, leaves), and soil/stream bed substrates.
- Factors affecting snail habitat represent the main threats to the hotwater physa population. Recreational activities pose the greatest present threat through habitat impacts and direct mortality to individual snails. Bathers in the hot springs pools may also contribute to population decline by exposing the snails to foreign substances such as soaps, lotions, and oils. The risk posed by recreational activities is considered moderate given that the population has persisted at least since 1973 when the Provincial Park opened.
- The introduction of invasive species to this endemic population is likely to have grave consequences and represents a high conservation risk.
- A collapse of the dam or weir structure in Alpha Pool would cause a change in the flow regime of the water entering the Alpha stream and on the water level of the Alpha pool. A flash flood of water could have a devastating effect on the snail population. Although a flash flood would cause a high impact, the likelihood of occurrence is considered to be low.
- Large scale changes to the water flow through the region would occur if the proposed Liard River Hydroelectric Project was initiated. The project would flood the entire hot springs complex with cooler water and therefore the impact of the threat is high. The likelihood of the threat depends on policy direction but presently the power proposals are dormant.
- Drilling activities during oil and gas exploration outside the park could potentially interfere with the underground thermal source. The source of the hot springs has not been clearly identified but it is believed to be located outside of the park boundaries. Drilling into the source water may affect the flow of hot water within the Park. Without knowledge of the boundaries of the thermal source the impact of drilling is considered to be high.
- Efforts to inform and educate park users of the ecological sensitivity of the area would help reduce the threats to habitat as well as the population of hotwater physa. This information could be in the form of better signage, interpretive programs, and greater monitoring by park staff at the pool.
- Assuming the intrinsic rate of growth r_m ranges from 0.2-0.5 per year and an equilibrium population size of 10,000 mature snails suggests a precautionary, sustainable removal rate of roughly 5-15% or 500-1500 animals per year.

BACKGROUND

Hotwater physa (*Physella wrighti*) are a small (5 mm) black/grayish snail (Figure 1). They are classified as physids and are pulmonate snails, meaning that they have a vascularised pulmonary cavity that acts as a lung to extract oxygen from water or air. They graze on algal and microbial growth.

The hotwater physa are found in the Liard River Hotsprings Provincial Park (LRHPP) complex of northern British Columbia (Figure 2). It occurs within an extremely restricted habitat as it is only found around the margins of two pools (Alpha and Beta pools), an outlet stream from Alpha Pool and the warm-water swamp. The species requires a constant and unaltered flow of geothermal water and suitable substrates near the water/air interface. This recovery potential assessment (RPA) was developed using existing DFO guidelines (DFO, 2007).

ASSESSMENT

Phase I: Assess current/recent species status

Range and number of populations

Hotwater Physa are found within the hot springs complex of LRHPP which consist of six separate thermal pools, streams and two warm-water swamps. Of these six pools the snail is present in two pools known as the Alpha and Beta pools, and the outlets of Alpha pool (Alpha stream) and Beta pool (Beta stream) as it empties into warm-water swamps. The largest population of snails is along the margins of the outlet of the Alpha stream. There is no permanent water connection between the Alpha and Beta pools and therefore they are considered to be separate and isolated from each other. Passive migration through movements of wildlife and humans may occur. Flood events from the Beta pool, located at a higher elevation, may have also contributed to migration into the Alpha pool. The Beta pool may serve as a refuge for snails in other habitats because it is generally too hot for recreational use and has limited access.

The snail was first documented along a 34m stretch of the Alpha stream in 1973 during a scientific survey of the area. Since that time a number of surveys have been conducted and have extended the range for more than 200m and into the warm-water swamp. At approximately 150m the Alpha stream splits into two, with one branch heading west towards the camping area and the other heading south towards the warm swamp. Snails have been observed along the west branch.

Abundance

Nine surveys were conducted between 1997 and 2008. Some surveys have simply re-confirmed the snails' presence at particular reference points along the stream. Six surveys have attempted to estimate abundance. The counts along the Alpha stream have ranged from 1426-7000 individuals. Surveys were completed using different assessment methods and at different times of the year, which may represent different stages of the snail's lifecycle. Some surveys also attempted to provide an estimate of habitat availability as well as population estimates. In a survey conducted by Fisheries and Oceans Canada in September 2008, a number of factors contributed to large differences in survey counts. These include disturbances caused by the stream measurement and orientation activities during the survey and differences in habitat configurations. Due to the cryptic nature of the snail in different types of habitat, they are difficult to count. Thus, determination of the preferred types of habitats is difficult due to the potential for high measurement errors during the surveys. Snails have been found hidden within the *Chara sp.* mats and it is likely these mats are the preferred habitat. Examinations of the *Chara sp.* mats in 2008 determined that the methods used to survey snails in that habitat only dislodged approximately 1/3 of the snails. Due to the cryptic nature of the snail in different types of habitat, it is difficult to determine the preferred types of habitats due to the potential for high measurement errors during the surveys. Snails have been found hidden within the Chara mats and it is likely to be the preferred habitat. Examinations of the *Chara* mats in 2008 determined that the methods used to survey snails in that habitat only dislodged approximately 1/3 of the snails hence representing a potential for large negative biases in population estimates.

Fluctuations in the population counts are likely related to the lack of a standardized survey protocol, and disturbance/displacement during the surveys, as well as natural variation in abundance. The amount of survey time, search area and time of year varied among the surveys. For these reasons it is difficult to compare survey results in terms of the numbers of snails observed. Despite the inconsistencies, the surveys do suggest that the population is relatively stable and may have seasonal fluctuations.

Life history parameters

There are no available estimates of fecundity, maturity or recruitment for hotwater physa. Life history parameters are assumed to be comparable to other physid species. Physids are oviparous hermaphrodites that lay eggs in the spring. Eggs develop directly into substrate-dependent, crawling juveniles. The adult snails die after they lay eggs and the generation time is within one year. Evidence suggests that longevity may be accelerated in a warmer environment. Temperature has been shown to directly affect life history traits such as growth rate, age of maturity and fecundity.

The semelparous life history strategy, short generation time and evidence from other freshwater snail species implies that the productivity of hotwater physa is moderate to high compared to other life history types. Estimates of the intrinsic rate of population growth r_m for tropical snails (*Indoplanorbis sp.*) was reportedly in the range of 0.2-0.5 per year (Parashar and Rao 1991). This is consistent with the range of r_m suggested by Froese and Pauly (2008) for moderate to high productivity values based on a large number of aquatic species.

Habitat requirements and habitat use patterns

Hotwater physa use both terrestrial and aquatic habitats but due to their high temperature requirements they are found only a few centimetres away from the waters edge. Physids are aquatic snails that require air to breathe and therefore they occupy substrate near the water/air interface. They require an aquatic environment that maintains a water temperature between 23-40ºC year round. The snails can be found on substrate both above and below the water level. This substrate includes mats of green alga, *Chara sp.*, woody debris (logs, bark, leaves), and soil/stream bed substrates.

Hotwater physa require a secure anchoring surface in areas of little or no water flow, although the exact flow rate parameters that they can tolerate are not known. Consistent flow rates and water levels are important for species that inhabit the margins of streams and pools. Sudden changes in water levels may expose hotwater physa to the ambient air or may dislodge them from the streambed substrate.

Hotwater physa may have a wide tolerance for changes in dissolved oxygen levels. The percent saturation of dissolved oxygen varies from 39.6% in the Alpha Pool to 80.4% in the Alpha stream. In the Alpha pool the water is relatively stagnant. The water in the stream becomes aerated as it moves over and through the weir and over the riffles and structures of the stream bed, resulting in higher dissolved oxygen levels. Hotwater physa normally inhabit waters with extremely high dissolved mineral levels. The water in the hot springs is slightly alkaline and contains high amount of calcium sulphate.

There may be seasonal migrations of snails above and below the water line, depending on the ambient air temperature. In an August 2006 survey, most snails and egg cases were observed above the water/air interface when the ambient temperature was 20°C compared to observations of mostly submerged snails in September 1997 when the ambient temperature was much cooler. Thus, adult and egg stages appear to be distributed at optimal temperatures to facilitate their life history requirements.

The riparian zone of the pools and stream are likely an important feature of the terrestrial habitat. The extent of the effect and the importance of the riparian vegetation and shade it provides has not been closely studied or quantified. Vegetation provides woody debris and leaf matter to the stream. Once this material enters the stream it becomes a substrate for algal and bacterial growth. In September 2008, aggregations of snails were observed grazing on semi-submerged leaf matter at many sites, especially at the lower end of the stream. At present the light reaching the outlet stream and the margins of the warm-water swamp where the snails are found can be described as deep shade to dappled shade. The effect of direct sunlight from an open tree canopy on the snails is not known.

Habitat availability for this species has likely changed with the construction of the weir and dam structure and the creation of the lower and upper Alpha pool. It is difficult to know what the available habitat was before alteration of the pools and construction of the weir and dam, but the most likely scenario is that the weir and dam have provided moderating flows to the outlet stream reducing the frequency and magnitude of streamflow fluctuations that would be harmful to the snail. The log dam also provides a barrier to hot spring bathers that may be tempted to wade in the small outlet stream.

Population and distribution targets

This is not a recovery situation, instead it is an attempt to protect and preserve a unique small population with a very limited and restricted distribution within LRHPP. Maintaining the current variation of abundance in the area of occupancy in the park is consistent with the goal of population persistence.

Expected population trajectories and time to recovery

There is no evidence that the snail population has declined. The expected population trajectory would be to maintain the population abundance within the current range of natural variation. This would serve to protect a unique population that exists within an area of periodically intense human use.

Residence requirements

The term residence – as defined in *SARA* s.2(1) is “a dwelling-place or 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”. This concept of residence is not applicable in this situation.

Phase II: Scope for management to facilitate recovery

Probability that the recovery targets can be achieved

There is no evidence of population decline and the population may be at or near the maximum habitat capacity. Focusing on protecting the habitat within the species’ natural geographic range is the key to maintaining population persistence. This should insure the current level of abundance is maintained.

Magnitude of each major potential source of mortality

Recreational Use

Recreational activities pose the greatest present threat to hotwater physa through both direct and indirect mortalities. Bathers may contribute to population decline by inadvertently exposing the snails to foreign substances. These include mosquito repellent, shampoo, body lotions, antibacterial soap and alcohol. The presence of these substances on the waters surface may limit the snail's access to air and/or coat them with materials that could interfere with life processes, such as egg-laying. Direct mortalities may be caused by park users playing with logs found within the pools. Bathers have been seen to send logs into the sides of the pools potentially crushing or dislodging snails. These actions may also cause the snails to become stranded above the waters surface. Visitor's venturing off the boardwalk and trampling the habitat within the Alpha stream and swamp area of the park could also crush or remove snails from their substrate and increase mortality rates. Alcohol consumption by bathers was evident during the September 2008 survey. The amount of alcohol consumed and the time bathers are in the pool, as well as the number of children in the pool are contributing risk factors. Heavy use of the Alpha pool by bathers at peak times may represent a periodic high source of stress for snails not only residing in the lower Alpha pool, but also in the outlet Alpha stream. The risk of recreational activities to population persistence is considered moderate given that the population has persisted since 1973 when the Provincial Park opened. Collection of snails by visitors would remove individuals from the breeding population, but this is most likely a low risk event.

Invasive species

An invasive species could disrupt the delicate ecology of the LRHPP and the potential risk to the endemic hotwater physa population would be very high. The introduction of a mosquito fish (Gambusia affinis) into Banff hot springs for mosquito control resulted in the extinction of the Banff longnose dace (Rhinichthys cataractae smithi) in 1987. Two known introductions of turtles have taken place in the past in LRHPP. Fortunately the animals were found and quickly removed.

Diversion of or fluctuations in the outflow of Alpha stream

Since the development of the Alpha pool in 1973, the abundance of hotwater physa appears to have been stable in the pool and stream habitat. It is not clear if any modifications to the weir or dam would result in any further improvement in habitat. The implementation of a weir and dam maintenance schedule is a proactive preventative measure to maintain the integrity of the Alpha pool and stream. The development of a weir maintenance schedule, the inclusion of this schedule in the Park Master Plan could minimize the likelihood of structural failure. Structural failure of the weir or dam would cause large mortality in the snail population. A sudden flash flood could dislodge individuals, while a sudden drop in flow could expose the snail to ambient air temperature that might be lethal during the winter.

Prior to the discovery of hotwater physa in 1973, the Alpha pool was modified to accommodate bathers. Cool water from a creek was diverted into the lower Alpha pool to moderate the water temperature. Alpha pool was artificially created through the installation of a dam and weir. The weir separates the water into the upper and lower Alpha pools. The log dam holds back the water in the lower Alpha pool at the outlet to the Alpha stream. It is difficult to assess how these past modifications have altered the habitat and distribution of Hotwater physa, but the moderated temperature of the lower Alpha pool and outlet to the Alpha stream is well within the temperature tolerance of hotwater physa. A collapse of the dam or weir structure would cause a change in the flow entering the Alpha stream and on the water level of the Alpha pool. A flash flood of water could have a devastating effect on the population of hotwater physa and therefore represents a high impact but with a low likelihood of occurrence.

Land-use of the surrounding area

Large scale changes to the water flow through the region would include potential development of the Liard River Hydroelectric Project (Devil's Gorge Project). This project would flood the entire hot springs complex with cooler water. The impact of the threat is high. The likelihood that this project would be initiated is considered to be low, but this is dependent upon future policy direction. At present the power proposals are dormant.

Drilling activities during oil and gas exploration outside the park could potentially interfere with the underground thermal source. The source of the hotsprings is unknown but it is believed to be located outside of the park boundaries. Drilling into the source water may affect the flow of hot water within the Park. Without knowledge of the boundaries of the thermal source the impact of drilling is considered high.

Magnitude by which current threats to habitats have reduced habitat quantity and quality

The Liard River hot springs have been used for bathing since prospectors and trappers first came to the area at the end of the 19th century and during the building of the Alaskan Highway during World War II. In 1957 the area was set aside as a provincial park in order to manage the continued public use of an ecologically unique area. There are no pre-development hotwater physa population estimates, habitat quantity or quality estimates, nor are there any hotwater physa distributional data from the source springs, streams and warm-water swamps. The weir and dam were installed to create the lower and upper Alpha pools by altering the flow, shape, and depth of the hot springs to accommodate bathers. It is not possible to measure the impact these activities had on hotwater physa before it was discovered and before any population monitoring was in place. Anecdotal accounts suggest that in the early years as a Provincial Park and during the construction of the Alaskan Highway individuals using the pools often washed with soaps and shampoos.

Likelihood that the current quantity and quality of habitat is sufficient

Despite the pool development activities and associated human recreational use, the continued presence of hotwater physa in the hot springs complex shows that it has been able to survive and persist despite the reduction to habitat quantity and quality. Studies of the evolutionary processes of hotwater physa have suggested that it has adapted to the hot water environment by losing their tolerance to cold water. This implies that the species has little tolerance for water colder than 23°C. Recommended boundaries of potential critical habitat are the present area of occupancy, including occupied pools, the Beta and Alpha streams and the marsh downstream of Alpha stream within an 18-40°C temperature gradient. It also includes a lateral area of 15 cm horizontal from the top of each stream bank.

Phase III: Scenarios for mitigation and alternatives to activities

Inventory of mitigation measures

Recreational Use

Habitat destruction, disruption or deterioration can be avoided by providing and maintaining elevated boardwalks, establishing and enforcing a maximum bathing capacity, and preventing the expansion of the camping facilities within LRHPP. Improved signage would inform the public that the hot springs are vulnerable to human misuse. Signage requesting that visitors not put on mosquito repellent before entering pools would be helpful. Closer monitoring of the Alpha pool by park staff during peak use times would advise park managers on the risk of exceeding suggested or recommended maximum bathing capacity. The LRHPP Master Plan proposes that interpretation programs be developed for park users. Implementation of these proposals could foster stewardship by park users. It would be ideal to have all bathers shower in freshwater before entering the pools, but given the remote location of the park and the lack of running water this is not a feasible option at this time. Park users are requested not to use soaps and shampoos within the pools. Some of the risk to the snails from deleterious material may be alleviated by the relatively high volume of water being flushed through the Alpha pool, but the dilution effect on the snails is unknown.

The removal of logs from the lower Alpha pool on a regular basis would reduce mortality rates and minimize the damage that can be caused by bathers playing with the logs. Large logs that blocked the weir are thought to have been a problem in the past.

Diversion of or fluctuations in the outflow of Alpha stream

Since the development of the Alpha pool in 1973, the hotwater physa population appears to have stabilized. It is not clear if any modifications to the weir, dam, or diverted cool water inlet stream would result in any positive habitat restoration or enhancement. The implementation of a weir and dam maintenance schedule is a proactive preventative measure to maintain the integrity of the Alpha pool and stream. The development of a weir maintenance schedule and inclusion of this schedule in the Park Master Plan could minimize the likelihood of structural failure. Structural failure of the weir or dam could cause a large mortality event. A sudden flash flood could dislodge individual snails, while a sudden drop in flow could expose the snail to ambient air temperature that might be lethal during the winter.

Land-use of the surrounding area

An assessment to determine the source and route of the geothermally heated water to the hot springs would provide greater certainty in assessing the level of risk associated with the source location. It is likely that the underground source of the hot springs is located outside the Provincial Park boundary. This information would help inform decisions about future drilling proposals.

Alternatives to human activities and threats habitat

Threats to hotwater physa are more related to factors affecting snail habitat than to threats that cause individual snail mortality. Efforts to inform and educate park users of the ecological sensitivity of the area would help reduce the threats to habitat as well as to individual snails within the population. This information could be in the form of better signage, interpretive programs, and greater monitoring by park staff at the pool.

As reported, estimates of population size are highly uncertain and very likely biased low, possibly by a factor of three. The true abundance of snails in the park likely exceeds 10,000 mature animals and therefore is greater than the theoretical minimum viable population size of 7,000 animals suggested by Reed et al. (2003); albeit for vertebrates. This implies that there is scope for allowable harm under SARA. Assuming the intrinsic rate of growth r_m ranges from 0.2-0.5 and assuming an equilibrium population size of 10,000 mature snails suggests a precautionary, sustainable removal rate of roughly 5-15% or 500-1500 animals per year (Froese and Pauly 2008).

CONCLUSIONS AND ADVICE

Habitat and population assessments of hotwater physa inhabiting LRHPP are highly uncertain because of the limitations of the survey data. Key life history parameters can only be inferred from other snail species. Although abundance estimates are highly uncertain, mature snails likely number in the tens of thousands. Much of what is known about population size is based on a series of surveys beginning in 1997. The objectives of the surveys have varied and are fraught with serious logistical and design issues that have prevented a systematic assessment of population abundance. The surveys have also posed threats to the snails and their habitats. Although survey methods are beyond the scope of an RPA, the information could be useful when developing recovery action plans. It is recommended that future survey designs for population estimation be linked to assessments of human impacts and that a cautious approach is adopted due to the potential impact. Recommended survey methods could include mark-recapture experiments and would depend on the objectives and where absolute population estimates are desirable. Surveys to assess presence/absence could be done to assess persistence in known areas but if there was no application for incidental harm (i.e. research) then survey intensity could be minimal (i.e. foot surveys) if abundance estimates are not important. The frequency of future surveys again would depend on the objectives.

Based on information available for other, better studied snail species, estimates of allowable harm are in the range of 500-1500 snails per year. The entire area of occupancy including the Alpha and Beta pools, the Alpha and Beta streams (with a lateral area of 15 cm horizontal from each stream bank) and the marsh (18-40°C gradient) downstream from the Alpha stream are recommended as potential critical habitat. This would take into consideration the seasonal and annual variation in temperature, the high uncertainty in abundance estimates and the desire for connectiveness among habitats. Genetic studies to assess rescue potential from other local physa populations would also be useful.

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