Species at Risk Act
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Adopted under Section 69 of SARA

Management Plan for the Vivid Dancer (*Argia vivida*) in Canada

Vivid Dancer

2022

Government of Canada
Gouvernement du Canada
Canada

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For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: © Jeremy Gatten. Male Vivid Dancer; Beasley, British Columbia, July 10, 2020.

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

MANAGEMENT PLAN FOR THE VIVID DANCER (*Argia vivida*) IN CANADA

2022

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the *Management Plan for the Vivid Dancer (*Argia vivida*) in British Columbia and Alberta* (Part 2) under Section 69 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this management plan.

The federal management plan for the Vivid Dancer in Canada consists of two parts:

Part 1 – Federal Addition to the *Management Plan for the Vivid Dancer (*Argia vivida*) in British Columbia and Alberta*, prepared by Environment and Climate Change Canada.

Part 2 – *Management Plan for the Vivid Dancer (*Argia vivida*) in British Columbia and Alberta*, prepared by the British Columbia Ministry of Environment and Climate Change Strategy.

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Part 1 – Federal Addition to the *Management Plan for the Vivid Dancer (*Argia vivida*) in British Columbia and Alberta*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] 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 management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Vivid Dancer and has prepared the federal component of this management plan (Part 1), as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with British Columbia (B.C.) Ministry of Environment and Climate Change Strategy as per section 66(1) of SARA. SARA section 69 allows the Minister to adopt all or part of an existing plan for the species if the Minister is of the opinion that an existing plan relating to wildlife species includes adequate measures for the conservation of the species. The Province of B.C. provided the attached management plan for the Vivid Dancer (Part 2) as science advice to the jurisdictions responsible for managing the species in British Columbia and Alberta. It was prepared in cooperation with Environment and Climate Change Canada and the Parks Canada Agency.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada and/or the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Vivid Dancer and Canadian society as a whole.

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

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

Additions and Modifications to the Adopted Document

The following section has been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Management Plan for the Vivid Dancer (*Argia vivida*) in British Columbia and Alberta* (Part 2 of this document, referred to henceforth as "the provincial management plan") and/or to provide updated or additional information.

Under SARA, prohibitions regarding the protection of species and their habitat do not apply to species of special concern. Conservation measures in the provincial management plan dealing with the protection of individuals and their habitat still are adopted to guide conservation efforts but would not result in federal legal protection.

1. Measuring Progress

The provincial recovery plan contains a statement on measuring progress, i.e., "Section 7 Measuring Progress" that outlines performance measures toward achieving nine management objectives that are set out in that plan (i.e., Part 2, section 5.3). Environment and Climate Change Canada adopts this content, with the inclusion of the following performance measures toward meeting the overarching management goal (as stated in Part 2, section 5.1):

- The persistence of Vivid Dancer has been maintained at all extant sites (and any new sites); and
- At all extant sites (and any new sites), the quantity and quality of suitable habitat has been maintained within a 500 m distance of any aquatic habitat associated with species records.

2. Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[3]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[4] goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning

[3] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[4] www.fsds-sfdd.ca/index.html#/en/goals/

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 management plan itself, but are also summarized below in this statement.

The provincial management plan for Vivid Dancer contains a section describing the effects of management activities on other species (i.e., section 8). Environment and Climate Change Canada adopts this section of the provincial management plan as the statement on effects of management activities on the environment and other species. Management planning activities for Vivid Dancer will be implemented with consideration for all co-occurring species at risk, such that there are no negative impacts to these species or their habitats. Some management actions for Vivid Dancer (e.g., inventory and monitoring, threat mitigation, habitat conservation, education, and research) may promote the conservation of other species at risk that overlap in distribution and rely on similar habitat attributes.

Part 2 – *Management Plan for the Vivid Dancer (*Argia vivida*) in British Columbia and Alberta*, prepared by the British Columbia Ministry of Environment and Climate Change Strategy

Management Plan for Vivid Dancer (*Argia vivida*) in British Columbia and Alberta

Prepared by the British Columbia Ministry of Environment and Climate Change Strategy

BRITISH COLUMBIA

November 2020

About the British Columbia Management Plan Series

This series presents the management plans that are prepared as advice to the Province of British Columbia. The Province prepares management plans for species that may be at risk of becoming endangered or threatened due to sensitivity to human activities or natural events.

What is a management plan?

A management plan identifies a set of coordinated conservation activities and land use measures needed to ensure, at a minimum, that the target species does not become threatened or endangered. A management plan summarizes the best available science-based information on biology and threats to inform the development of a management framework. Management plans set goals and objectives, and recommend approaches appropriate for species or ecosystem conservation.

What's next?

Direction set in the management plan provides valuable information on threats and direction on conservation measures that may be used by individuals, communities, land users, conservationists, academics, and governments interested in species and ecosystem conservation.

For more information

To learn more about species at risk recovery planning in British Columbia, please visit the B.C. Recovery Planning webpage at:

< http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning >

Management Plan for Vivid Dancer (*Argia vivida*) in British Columbia and Alberta

Prepared by the British Columbia Ministry of Environment and Climate Change Strategy

November 2020

Recommended citation

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Cover illustration/photograph

Alan Harris (with permission)

Additional copies

Additional copies can be downloaded from the B.C. Recovery Planning webpage at:

http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning/recovery-planning-documents

Disclaimer

The British Columbia Ministry of Environment and Climate Change Strategy has prepared this management plan in collaboration with the Parks Canada Agency and Environment and Climate Change Canada, as advice to the responsible jurisdictions and organizations that may be involved in managing the species.

This document identifies the management actions that are deemed necessary, based on the best available scientific, community, and Indigenous knowledge, to prevent Vivid Dancer subpopulations in British Columbia and Alberta from becoming endangered or threatened. Management actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and management approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions, damselfly specialists, land managers, and landowners had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals who provided input to this management plan.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this management plan. The B.C. Ministry of Environment and Climate Change Strategy, Environment and Climate Change Canada, and the Parks Canada Agency encourage all British Columbians and Albertans to participate in the conservation of Vivid Dancer.

ACKNOWLEDGEMENTS

This management plan was written by Jennifer Heron (B.C. Ministry of Environment and Climate Change Strategy [ENV]). Scientific information on Vivid Dancer, specific with certain areas of the species Canadian range, was provided from Orville Dyer (ENV), Claudia Copley (Royal British Columbia Museum [RBCM]), Leah Ramsay (retired; B.C. Conservation Data Centre [CDC]), Lea Gelling (CDC), Darren Copley (RBCM), Robert A. Cannings (Curator Emeritus, RBCM), Richard J. Cannings (Penticton), Diane Casimir (Parks Canada Agency [PCA]), Pippa Shepherd (PCA), Jeremy Gatten (LGL Limited) and Syd Cannings (Canadian Wildlife Service). Orville Dyer and Leah Ramsay participated in the updated threats assessment. Resource Conservation staff in the Parks Canada Agency provided review: Bryan Chruszcz in Mount Revelstoke and Glacier national parks; Shelley Humphries, Anne Forsher, Seth Cherry, Todd Keith and David Clark in Banff (north), Yoho and Kootenay national parks; Bill Hunt and Mark Taylor in Banff National Park (south); and Diane Casimir (National Office). Sue Cotterill (Alberta Conservation Information Management System) provided review. Susan Dain-Owens (B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development [FLNRORD]) provided information on thermal springs in the South Coast. Lea Gelling and Katrina Stipec (CDC) provided occurrence information. Malissa Smith (FLNRORD) provided advice on the BC *Water Sustainability Act*. Rob Foster, Al Harris and Jennifer Heron took the photographs in the management plan. Distribution map was produced by Josh Chan (FLNRORD) and Emily Cameron (ENV). Karen Stefanyk (ENV), Excedera St. Louis (ENV) and Alanah Nasadyk (ENV) provided review and editorial support. Thank you to Eric Gross and Matt Huntley (Environment and Climate Change Canada – Pacific Region [ECCC-CWS]), Medea Curteanu (ECCC-CWS-Prairie Region) and Paul Johanson (ECCC-National Capital Region) for thoughtful reviews of this document. Tracey Hooper provided editorial review.

EXECUTIVE SUMMARY

Vivid Dancer (*Argia vivida* Hagen) is a medium-sized (body length 29.5–35.0 mm), bright blue to violet damselfly with black markings. In Canada, Vivid Dancer ranges from Banff, Alberta west through the southern half of British Columbia (BC) to the westernmost occurrence at Meager Creek outside of Pemberton.

Vivid Dancer was designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in May 2015, and was listed under Schedule 1 of the federal *Species at Risk Act* (SARA) in February 2019. In British Columbia, Vivid Dancer is ranked S2S3 (imperiled-special concern and vulnerable to extirpation or extinction) and is on the provincial Blue List. In Alberta, Vivid Dancer is ranked as S2 (imperiled). The species is the only documented odonate adapted to breed in geothermal springs in North America, and many of its Canadian subpopulations are associated with thermal springs. However, in the hot valleys of the Okanagan and the Fraser River canyon, and one spring in Banff National Park, it is also found in cool, spring-fed creeks. As of 2020, Vivid Dancer had been recorded from a total of 33 subpopulations in Canada; 27 extant, 4 historical, and 2 unconfirmed. There are multiple sites in Banff National Park, some of which are unconfirmed and historical, however the overall subpopulation is extant. There is little information on subpopulation size or abundance of each extant subpopulation.

Vivid Dancer has three life stages (i.e., egg, nymph, and adult) and a life cycle that is partly aquatic and partly terrestrial. Vivid Dancer begins its life as an egg that has been laid within an aquatic environment. The egg hatches into a small gill-breathing nymph that lives for up to 3 years in its aquatic environment (nymphs grow faster in warmer water habitats). During this time, the nymph moults up to a dozen times; each time it gets a little bigger until its last moult, during which it emerges as a teneral adult with fully developed wings. Adults are aerial/terrestrial foragers and emerge from their aquatic environment from late April through mid-October, during which time the adults mate. The females lay fertilized eggs in aquatic habitats, and the life cycle begins again.

The predominant threats to extant subpopulations in British Columbia are habitat loss and degradation at most thermal spring habitats. The species is threatened by intensive recreational use of thermal springs (e.g., bathing, water diversion for pool creation), livestock trampling at cool springs, and potential predation by introduced aquatic species. Subpopulations are also vulnerable to infrastructure construction for tourism development (e.g., hotel complexes) and changes in springs caused by events such as droughts. In Alberta, all Vivid Dancer subpopulations are within Banff National Park and receive protection under the *Canada National Parks Act*. Most of the Vivid Dancer sites in Banff National Park are within areas that are permanently closed, which reduces the number of threats that have to be to be mitigated.

The management (subpopulation and distribution) goal is to improve the redundancy of Vivid Dancer at all extant subpopulations (some with multiple sites) in Canada (including any additional sites that may be identified in the future) by ceasing or mitigating human-caused threats that result in the loss of area, extent, and/or quality of suitable habitat.

The short-term statements towards meeting the management goal are:

1. to maintain the persistence of Vivid Dancer at all extant sites (and any new sites) in Canada; and
2. to prevent any further loss in the quantity or quality of remaining suitable habitat within the dispersal distance (i.e., up to 500 m from a site) of the aquatic habitat of all known records at all extant sites (and any new sites).

The management objectives for Vivid Dancer in both British Columbia and Alberta are:

1. to confirm the distribution of the species within its Canadian range;
2. to estimate abundance at each extant subpopulation;
3. to assess the extent of threats to each extant subpopulation and reduce their impacts;
4. to address knowledge gaps (e.g., aquatic requirements, life history); and
5. to increase public knowledge of the species and its associated aquatic springs.

Additional management objectives for Vivid Dancer in Alberta are:

6. to develop and implement a monitoring program at known and newly identified subpopulations and sites;
7. to continue protection of the species under the *Canada National Parks Act*; and
8. to mitigate any new threats that are identified.

Additional management objectives for Vivid Dancer in British Columbia are:

9. to secure protection for extant subpopulations.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Assessment Summary: May 2015
Common Name: Vivid Dancer
Scientific Name: *Argia vivida*[a]
Status: Special Concern
Reason for Designation: This damselfly is found in southern British Columbia and Banff, Alberta. Through much of its Canadian range it is restricted to thermal springs, but in the hot valleys of the Okanagan and the Fraser it is also found in cooler, spring-fed creeks. Habitat loss and degradation at most sites suggest subpopulations have declined. The species is threatened by intensive recreational use of thermal springs, livestock trampling at cool springs, and introduced fish. Sites are also vulnerable to potential tourism development and changes in springs caused by events such as droughts, earthquakes, and landslides.
Occurrence: British Columbia, Alberta
Status History: Designated Special Concern in May 2015.

* Committee on the Status of Endangered Wildlife in Canada.
[a] Common and scientific names reported in this management plan follow the naming conventions of the B.C. Conservation Data Centre (2020).

2 SPECIES STATUS INFORMATION

Vivid Dancer[a]			
Legal Designation:			
B.C. FRPA:[c] No	OGAA:[c] No	AB *Wildlife Act:*[b] No B.C. *Wildlife Act:*[d] No	SARA:[e] 1-SC (2019)
Conservation Status[f]			
B.C. List: Blue **B.C. Rank**: S2S3 (2015) **AB Rank:** S2 (2020)			
Canada National Rank: N2N3 (2015) **Global Rank:** G5 (2015) **United States National Rank:** N5 (2015)			

AB = Alberta; B.C. = British Columbia
[a] Data source: B.C. Conservation Data Centre (2020) unless otherwise noted.
[b] No = not listed as one of the species assessed by Alberta's Endangered Species Conservation Committee (Alberta Environment and Sustainable Resource Development. 2014).
[c] No = *Forest and Range Practices Act*; not listed in one of the categories of wildlife that requires special management attention to address the impacts of forestry and range activities on Crown land under the *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002) and/or the impacts of oil and gas activities on Crown land under the *Oil and Gas Activities Act* (OGAA; Province of British Columbia 2008).
[d] No = not designated as wildlife under the B.C. *Wildlife Act* (Province of British Columbia 1982).
[e] Schedule 1 of *Species at Risk Act* as Special Concern (SC) (SARA; Government of Canada 2002).
[f] S = subnational; N = national; G = global; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 5 = demonstrably widespread, abundant, and secure; NR = not ranked; U= unknown. Data source: NatureServe (2020) and B.C. Conservation Data Centre (2020).

3 SPECIES INFORMATION

3.1 Species Description

Vivid Dancer (*Argia vivida* Hagen) damselfly has three life stages and is both aquatic (freshwater) and terrestrial, depending on the life stage. Typical of all damselflies, the species begins its life cycle as an egg in freshwater habitat. The egg hatches into a free swimming nymph which is predatory and grows through a series of up to a dozen moults. When large enough, the nymph crawls out of its aquatic habitat and metamorphoses into its terrestrial adult form (Corbet 1999). The details of Vivid Dancer morphology and life history are summarized below. For a more detailed morphological description and additional life history, see Westfall and May (1996), Paulson (2009), and the COSEWIC (2015) status report.

Adults (Figure 1 and Figure 2) are medium sized (body length 29.5–35.0 mm) and have a robust body. Females have multiple colour forms and can be bright blue to brownish-violet, greenish-grey, brown, blue, or a mix of blue and brown to orange or red-brown. The males are typically bright blue and can resemble the same female blue form colouration. Both females and males (all forms of both sexes) have black markings on their thorax and abdomen (Westfall and May 1996; Paulson 2009). Newly emerged immature adults (teneral adults) are pale grey, tan, or cream-coloured (Conrad and Pritchard 1989; Westfall and May 1996; Paulson 2009). Both sexes also experience a temperature-related physiological colour change; i.e., individuals are *dark phase* at ambient shade temperatures below approximately 20 °C and change to a more vivid-coloured *bright phase* at temperatures above 20–24 °C, particularly when basking (Conrad and Pritchard 1989). Wings of both sexes are clear (typical form) to slightly smoky (Westfall and May 1996).

Adults emerge from their aquatic habitats from late April through mid October (COSEWIC 2015; B.C. Conservation Data Centre [BC CDC] 2020). After emergence, teneral adults typically rest until their cuticle hardens, typically on emergent aquatic vegetation or within forests adjacent to their aquatic habitats (Corbet 1999). The duration of time to maturity is unknown but is estimated to be less than 1 day. Mature males perch on vegetation or rocks adjacent to their aquatic habitats and wait for passing females. Copulation and tandem flight (female and male remain attached or nuptial) lasts from 1½ to 2 hours before the female oviposits (with the male still grasping the female) within the aquatic habitat (Conrad and Pritchard 1988, 1990). At night, adults roost in riparian vegetation, including shrubs, trees, and their canopies (Paulson 2009).

Vivid Dancer eggs are cream-coloured when first oviposited and shortly thereafter turn black (Leggott and Pritchard 1985a). The eggs are pointed at one end and approximately four times wide as long. Eggs are laid singly just below the water level and on the stems of emergent and aquatic vegetation (Leggott and Pritchard 1985a; Paulson 2009). In Banff National Park, oviposition sites have been directly into the water in outflow streams (although it is unclear if the eggs sink or float), wet vegetation, a stick (Lepitzki and Lepitzki, unpubl. data, 1996–2014), and beds of stonewort (A.D. Kortello, pers. comm., 2013, cited in COSEWIC 2015). Oviposition was observed within a hot spring drainage channel about 20 cm wide and 2–3 cm deep at Kuskanax Creek (Nakusp Hot Springs) in British Columbia and described as follows: “the tandem pair landed on a sedge stem 3 cm above the stream surface and for 30 seconds the female repeatedly dipped her abdomen into the water” (Harris and Foster 2013).

Vivid Dancer nymphs reach a maximum length of 17 mm, including the terminal gills (4.5 mm) (Walker 1953). The nymphs are thickset, shorter, and more elongate than other cylindrical nymphs within the same genera (Walker 1953). Vivid Dancer nymphs look similar to Emma’s Dancer (*Argia emma*) nymphs, although their gills (caudal lamellae) are smaller and have acute rather than round tips (Walker 1953). Both species have been recorded at cool and thermal spring[1] habitats, although this is not common, nor does the presence of one species indicate the presence of the other.

[1] A thermal spring is a spring produced by the emergence of geothermally heated groundwater that rises from the interior of the Earth. There is debate in the literature regarding the minimum temperature for a spring to be considered a thermal spring (see Pentecost et al. 2003). For the purposes of Vivid Dancer habitat, a thermal spring is a point of ground water discharge whose temperatures exceeds the regional average air temperature by more than 5 °C: for cold (0-9 °C), cool (10-19 °C), warm (20-29 °C), and hot (>30 °C) springs (definitions edited from Bow Valley Naturalists 2020).

The duration of time Vivid Dancers spend as a nymph may depend on water temperature (Leggott and Prichard 1985b). Studies of captive nymphs collected from Banff National Park springs recorded 12–14 instars, with each instar approximately 1.24 times larger than the previous one (Leggott and Pritchard 1985a,b). The length of time spent as a nymph has been recorded as 1 year (Cave and Basin National Historic Site [NHS], AB) to 3 years (Albert Canyon, B.C.). Water temperatures at the Albert Canyon site fluctuate from 5 °C in the winter to 20 °C in the summer (Leggott and Pritchard 1985b; Pritchard 1989). The adult life span of Vivid Dancer is unknown; however, other damselflies live 1–3 weeks (Paulson 2009).

Figure 1. Teneral Vivid Dancer adult at Ram Creek Ecological Reserve, July 24, 2015 (Jennifer Heron).

Figure 2. Vivid Dancer adult at Ram Creek Ecological Reserve, July 24, 2015 (Jennifer Heron).

3.2 Subpopulations and Distribution

Vivid Dancer ranges in western North America from the southern tip of the Baja Peninsula in Mexico north through the western United States to south-central British Columbia (Paulson 2009; Abbot 2020; COSEWIC 2015). The global range is approximately 3,000,000 km^2; however, occurrences are discontinuous and distribution is patchy due mainly to the species' specific aquatic habitat needs. In Canada, Vivid Dancer ranges from Banff, Alberta, west through the Kootenays and southern half of British Columbia to the westernmost occurrence at Meager Creek outside Pemberton (**Error! Reference source not found.**). Approximately 3% of the species' global range is in Canada (COSEWIC 2015).

In Canada, 33 subpopulations[2] of Vivid Dancer have been documented: 27 extant, four historical, and two unconfirmed (Figure 3). The separation distance[3] between subpopulations for riverine damselflies is 5 km of suitable and/or unsuitable habitat between records (NatureServe 2020). A subpopulation can have multiple sites[4] within the 5 km separation distance. Vivid Dancer dispersal ability is unknown, although it is assumed that if there are nearby thermal spring habitats, the species may occupy those habitats within a three-generation[5] (9 years) or 10-year[6] assessment time frame unless survey data and/or other data confirm the habitat is unsuitable.

There are 27 extant subpopulations of Vivid Dancer in Canada. Extant subpopulations are defined as subpopulations with records less than 40 years old, confirmed on-site breeding (i.e., at least one of the following: mating pairs, territorial males, ovipositing females, nymphs, or exuviae[7]), evidence the habitat is likely intact, and/or no documented habitat loss or destruction. See Table 1 for a complete list of extant subpopulations.

An unconfirmed subpopulation has little or no information on the associated habitat or confirmation of breeding. The subpopulations at Radium Hot Springs (#10) and East of Nelson (#13) are both unconfirmed (see Table 1).There are two sites within the subpopulation at Banff National Park (#1) where only tenerals or mature adults have been observed and on-site breeding has not been confirmed (#1b and 1i) (**Error! Reference source not found.**). These sites are unconfirmed until evidence of breeding is confirmed.

Historical subpopulations are defined as follows: “known from only historical records but there is still some hope of rediscovery. There is evidence that the species may no longer be present but not enough to state this with certainty. The following are examples of such evidence: (1) a species has not been documented for more than 40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) a species or ecosystem has been searched for unsuccessfully but not thoroughly enough to presume that it is no longer present in the jurisdiction” (definition modified from NatureServe 2020). Four subpopulations of Vivid Dancer are historical (#2, 5, 6 and 7). One site within Banff National Park (#1a) is historical although Banff National Park is considered an extant subpopulation.

Vivid Dancer appears to require a minimum water temperature for breeding, and this may partly determine the northern limits of the species’ range (Leggot and Pritchard 1986). The northernmost historical record of Vivid Dancer is 51.4°N at Field, B.C. (#5) (Walker 1953). Vivid Dancer is recorded from an elevation of 280–1620 metres above sea level in Canada (Table 1). The Glacier National Park record (#7) is for a site at 1829 m, although this record is

[2] A subpopulation is defined as a geographically distinct group of individuals in the population (i.e., the entire Canadian population) between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less) (IUCN 2001).
[3] Adjacent springs and associated outflows with a separation distance of less than 5 km of unsuitable or suitable habitat are also considered a single subpopulation (e.g., there could be multiple discrete ponds, streams, or other aquatic habitats with damselfly larvae all within the 5-km habitat). The distance is based on the minimum separation distance and justification for estimating this distance as recommended for Vivid Dancer by NatureServe (NatureServe 2020). In summary, “The combination of breeding dispersal in the range of one to a few km with the potential for periodic long distance dispersal providing landscapes are not fragmented has led to the somewhat arbitrary assignment of separation distances at 5 km (unsuitable and suitable) for riverine damselflies”. Full text available at https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.119280/Argia_vivida (Accessed July 24, 2020).
[4] A site is a water feature and/or habitat where Vivid Dancer could occur within 150 m of adjacent sites.
[5] Vivid Dancer has a 1–3 year generation time. The species is assessed over a 10-year or three-generation time frame, whichever is the longest and taking the longest generation time; therefore, the assessment time frame is 10 years.
[6] COSEWIC reassesses species every 10 years.
[7] Minimum criteria for an occurrence as defined by NatureServe 2020.

more than 100 years old and the specific collection site is unknown. Vivid Dancer subpopulations in the Okanagan valley (#18–28), the Fraser River canyon (#14–17) and one site in Banff National Park (#1i) occur at cool springs. The remaining subpopulations occur at thermal springs (see Table 1). Vivid Dancer is recorded from cool springs in southern portions of its range in the United States (Paulson 2009; Abbot 2020).

Most Vivid Dancer subpopulations can be grouped into six main watersheds within the species' Canadian range (Table 1):

1) The South Coast Rivers – the coast range northwest of Whistler and Pemberton near Meager and Pebble Creeks
2) The Fraser River canyon near Lytton
3) The Okanagan valley from Summerland south to the international border, including one record near Vernon (e.g., BX Creek) that is a northern outlier
4) The Columbia River for the sites within the Revelstoke area
5) The Upper Kootenays to the eastern side of the Rocky Mountains
6) The Bow River Basin for the Banff National Park subpopulations

British Columbia subpopulations: There are 26 extant, four historical (#2, 5, 6, 7), and two unconfirmed (#10, 13) in British Columbia (Table 1; Figure 3). Two of the historical subpopulations, Field (#5) and Glacier (#7) (both supported by specimens), are at sites where there are no documented thermal springs, the specific collection localities are unknown, and there have been no recent searches at either site. The historical subpopulation at Fort Steele (#6) is on private land, habitat suitability is unknown, and there has been no recent inventory for this subpopulation. The historical subpopulation at Lussier (Whiteswan) Hot Springs (#2) occurs within British Columbia's Whiteswan Lake Provincial Park; it has no recent records, although associated hot springs habitat remains. The Radium Hot Springs subpopulation (#10) is considered unconfirmed: it is on private land, no recent information is available, and there is little/no information based on a specimen or collection locality.

Alberta subpopulations: There is one subpopulation of Vivid Dancer in Alberta, entirely within Banff National Park (#1) (Figure 4). This subpopulation is comprised of nine sites (one historical [#1a]; two unconfirmed [#1b and 1i] and six extant [#1c-h]) and overall is considered extant because sites fall within a 5 km separation distance[3] (Table 1). In past publications, the springs within the park were not consistently named or mapped, which has led to some confusion regarding Vivid Dancer distribution. For the purposes of this management plan, the Alberta sites are consistent with the naming used in the COSEWIC (2015) status report.

Vivid Dancer adults were first collected at the Cave and Basin NHS (#1c) in 1908 (Walker 1912), and nymphs were first collected in 1970 (Pritchard 1971). Adults have been recorded at both Vermilion (#1i) and Alpine Hut (#1b), although no nymphs or exuviae have been observed, and these sites are not considered suitable breeding habitat (Hornung and Pacas 2006); therefore these subpopulations are considered unconfirmed. The Banff Springs Hotel subpopulation (#1a) is considered historical due to habitat loss (COSEWIC 2015).

Saskatchewan: There is a record from Saskatchewan, dated 2003; however, the source and collection locality of the record is unknown (A. Benville, pers. comm., 2020; J. Kusch, pers.

comm., 2020). The Saskatchewan Conservation Data Centre does not have a record of Vivid Dancer (D. Halstead, pers. comm. 2020) and the Royal Saskatchewan Museum does not have Vivid Dancer specimens from Saskatchewan (C. Sheffield, pers. comm., 2020). Further enquiries with provincial odonate specialists did not confirm a record for the species in the province (D. Halstead, pers. comm., 2020). The Saskatchewan report of Vivid Dancer is not considered part of the Canadian distribution.

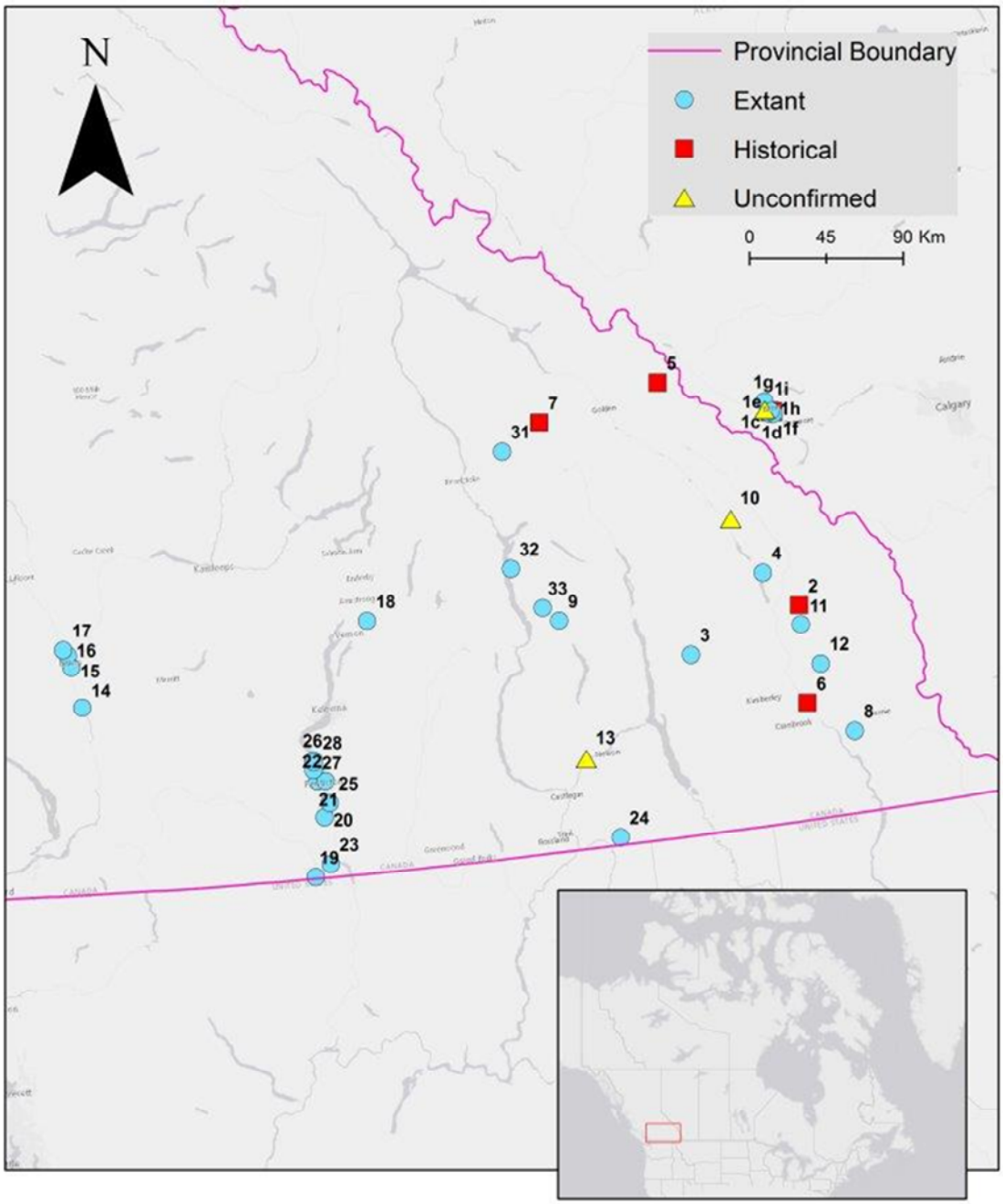

Figure 3. Vivid Dancer distribution and subpopulations in Canada (BC Ministry of Environment and Climate Change Strategy 2020)**.**

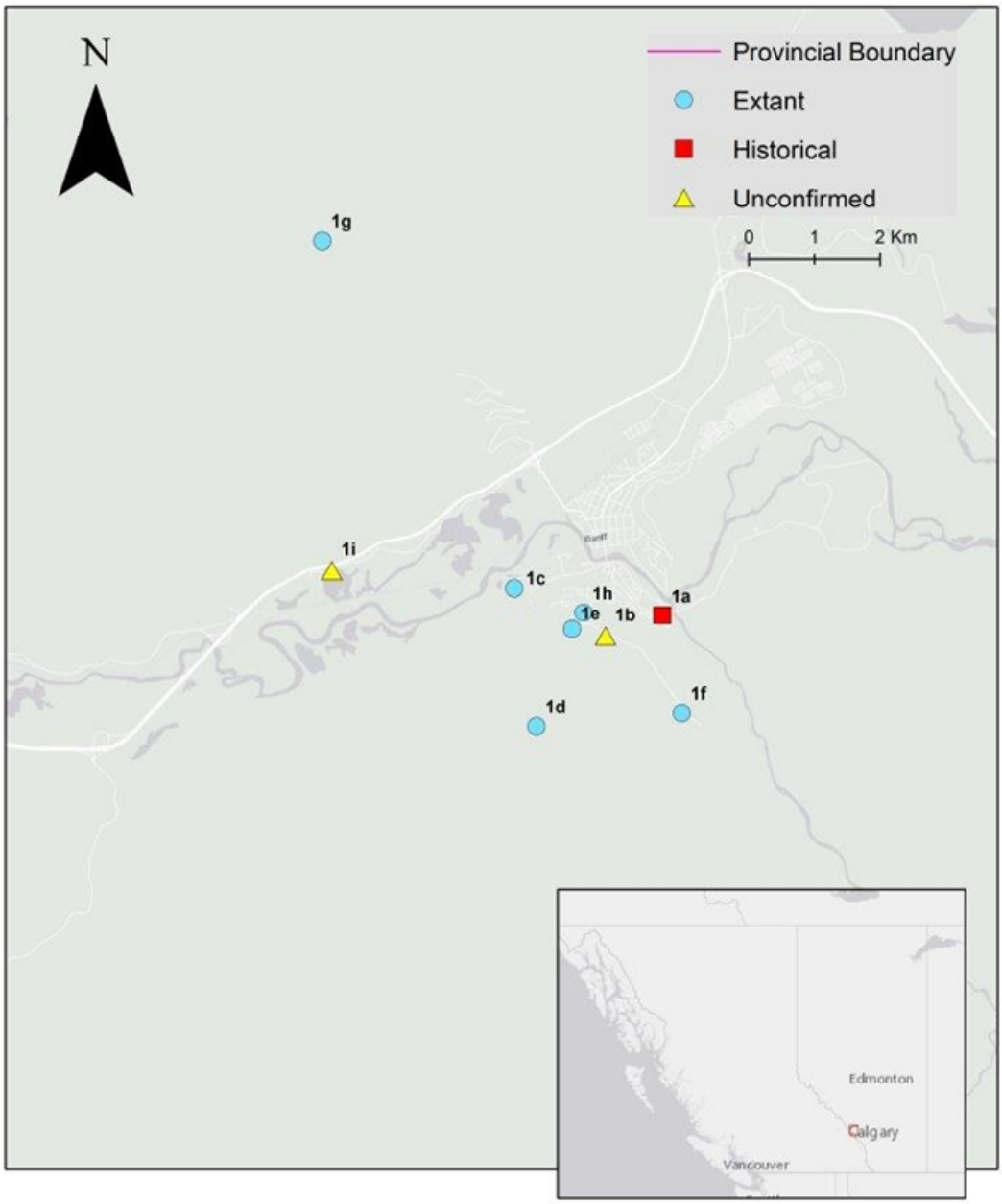

Figure 4. Vivid Dancer distribution and subpopulations in Alberta (BC Ministry of Environment and Climate Change Strategy 2020).

Table 1. Status and description of Vivid Dancer subpopulations (SP) in Alberta and British Columbia.

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
AB	Bow River Basin	1a	Banff Springs Hotel	–	Historical Unknown	No habitat remaining.	Federal; Banff National Park
AB		1b	Banff, above Middle Springs (Alpine Hut)	SF 2208	Unconfirmed; 2002; 2002	No recent habitat information. Breeding unconfirmed at this site.	Federal; Banff National Park
AB		1c	Banff, Sulphur Mountain Springs - Cave and Basin National Historic Site	SF 2208	Extant; 2013; 2013	Four separate springs: Cave, Basin, Upper Cave and Basin, and Lower Cave and Basin, and associated outflow streams. Cave Spring (circular 12 m in diameter) has no Vivid Dancer habitat and the artificial pool outside the cave is surrounded by cement walls with no natural riparian habitat. The remaining areas have good habitat.	Federal; Banff National Park
		1d	Banff, Sulphur Mountain Springs - Kidney Spring	SF 2205	Extant; 2002; 2002	Spring surfaces and runs into a cement cistern.	
		1e	Banff, Sulphur Mountain Springs - Middle Springs (Lower, Gord's, Upper, West Cave, and associated outflows)	SF 2206	Extant; 2008; 2008	Shallow pools (10–20 cm deep) fed by small streams of similar depth in small forest gaps (approximately 10 m wide) and little submerged or emergent vegetation. Benthic substrata are typically tufa and/or travertine rock formations[8] with organic matter and some plant detritus.	
		1f	Banff, Sulphur Mountain Springs – Upper Hot Springs	SF 2207	Extant; 2008; 2008	Surface stream flow and flows into a public bath house.	

[8] Tufa is defined as a variety of limestone formed when carbonate minerals precipitate out of ambient-temperature water. Geothermally heated hot springs sometime produce similar (but less porous) limestone carbonate deposits known as travertine.

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
AB		1g	Banff, Forty Mile Creek	–	Extant; 2013; 2013	Warm spring with abundant woody debris (COSEWIC 2015).	Federal; Banff National Park
AB		1h	Banff, Middle Springs Bog	–	Extant; 2003; 2003	Area of warm water seeps and tufa and/or travertine[d] deposits located downstream from the Middle Springs between residential area and road (COSEWIC 2015).	Federal; Banff National Park
AB		1i	Banff, Vermilion Cool Springs	SF 2209	Unconfirmed; 2002; 2002	Cool springs and pools ≥ 20 cm deep with submerged/emergent vegetation in a grassy area lacking trees. Bordered by Vermilion Lake Drive and the Trans-Canada Highway. Breeding unconfirmed at this site.	Federal; Banff National Park
BC	Columbia River	2	Lussier (Whiteswan) Hot Springs	–	Historical; Unknown; Unknown	Thermal springs are still present; habitat unknown.	Crown; provincial park
BC	Columbia River	3	Dewar Creek	EO 8905	Extant; 2001; 2001	Shallow, rubbly, rectangular area measuring about 10 m long and 1–2 m wide. It is created as a result of the very hot outflow (82°C) mixing with a cool spring. There is a constant flow during winter and summer. Modifications have been made to the streams and pools, and there has been trampling above the ponds; near a hiking trail and walk-in campsite.	Crown; provincial park
BC	Columbia River	4	Fairmont (Indian Tubs) Hot Springs	EO 3758	Extant; 2013; 2013	Herbaceous, palustrine wetland fed by small stream from hot springs; habitat greatly altered, with little appropriate habitat left (1991).	Private
BC	Columbia River	5	Field	–	Historical; 1905; Unknown but within the past 20 years (R.A. Cannings,	Spring-fed creek at Field, and speculation that the species may have been breeding in artificially warmed drainage ditches from the railway roundhouse (Walker 1953). “May have been locally abundant.” (Whitehouse 1941).	Federal; Yoho National Park

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
					pers. comm., 2017)		
BC	Columbia River	6	Fort Steele	–	Historical; 1981; 1981	No habitat information available.	Crown; provincial (Reserve/Notation)
BC	Columbia River	7	Glacier	–	Historical; 1905; Unknown but within the past 20 years (R.A. Cannings, pers. comm., 2017)	A single male was collected in 1902 "over a stagnant pool in a small mountain meadow at an altitude of 6000 ft" (1829 m) (Osburn 1905).	Federal; Glacier National Park
BC	Columbia River	8	Little Sand Creek (Jaffray)	EO 8882	Extant; 1999; 2013	Small, meandering, sand-bottomed creek with some rocky edges and marsh; outflow creek from shallow lake with extensive wetland and fish; bottom from cobbles to deep mud; little vegetation: some grass, sedge (*Carex* sp.), common stonewort (*Chara vulgaris*), and water milfoil (*Myrophyllum* sp.).Undeveloped area, some logging, low vehicle-use road nearby. Subpopulation appeared viable and unthreatened in 1999. None observed in 2013, but beaver activity had extensively modified the habitat.	Crown; provincial
BC	Columbia River	9	Little Wilson Lake (Wilson Lake/Creek) Warm Springs	EO 8908	Extant; 2001; 2013	Two main hot springs (both of which have been modified to form pools) emerge at least 100 m up a steep, talus-covered slope from an abandoned logging trail running parallel to creek. There is also a third spring approximately 150 m downhill. Wilson Creek thermal springs does not have high recreational use (the spring is considered difficult to access), but artificial pools have still been built. The site has been logged.	Crown; forest licence

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
BC	Columbia River	10	Radium Hot Springs	–	Unknown; unknown; unknown	There is little information to support this occurrence, including the date and/or habitat information.	Federal; Kootenay National Park
BC	Columbia River	11	Ram Creek Hot Springs Ecological Reserve	EO 8902	Extant; 2015; 2015	Fairly high-gradient, spring-fed stream and pool system that was destroyed by a landslide in mid July 2012. Bathers have rebuilt larger pools and lined them with plastic, but smaller, natural spring-fed pools remain higher up on adjacent slope. Abundant poison ivy (*Toxicodendron rydbergii*). There is habitat degradation from increased use by bathers. There is an ecological reserve direction statement (see British Columbia Ministry of Water, Land and Air Protection 2004)	Crown; provincial ecological reserve
BC	Columbia River	12	Wild Horse Hot Springs (Wildhorse Creek)	–	Extant; 2002; 2013	The site consists of a series of small pools along a stream on a mossy hillside in forest opening. Some of the pools have been created or modified by bathers.	Crown; provincial
BC	Columbia	13	Nelson, east of	Not mapped	Extant; 2020; 2020	First observed in 2019 and again in 2020; observed in private residence driveway; no information on habitat; further information about habitat is needed (J. Gatten, pers. comm., 2020).	Private
BC	Fraser River	14	Boston Bar, north of	EO 8884	Extant; 2006; 2006	A stream that came from a seep in a bank along the side of the highway near an airfield.	Provincial (transportation utility corridor) borders Federal; IR: INKAHTSAPH 6 and north of provincial Agricultural Land Reserve; also, the airstrip is on provincial Crown Land

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
BC	Fraser River	15	Lytton, 2 km south of	EO 8885	Extant; 2007; 2007	A stream in an area with forest and limited development.	Unknown ownership (018506593); suspect Crown but with tenure for quarry north of site (PID: 016408501) - tenure for a quarry
BC	Fraser River	16	Lytton, 4.25 km north of	EO 8887	Extant; 2007; 2007	Unknown; however, air photos show the stream through a forested area with some cleared fields in the area.	Crown; provincial bordered by federal Indian Reserve: Inkluckcheen
BC	Fraser River	17	Lytton, 8.9 km north of	EO 8888	Extant; 2007; 2007	Dry creek bed. Orthophotos show mainly forested land and a nearby area of cleared land.	Crown; provincial
BC	Okanagan River	18	BX Creek, Vernon	–	Extant; 2006; 2013	Urban stream through a residential area of Vernon, with a recreational trail adjacent to the stream.	Private
BC	Okanagan River	19	Chopaka	–	Extant; 1997; 1997	Small, spring-fed stream flowing into small, marshy pond. The habitat has not changed since this time.	Crown; provincial
BC	Okanagan River	20	Kearns Creek (White Lake)	EO 2510	Extant; 2014; 2014	Small, low-gradient, meandering creek that winds through dry grassland and ponderosa pine north of White Lake, then enters narrow valley just northeast of the lake. Several springs feed the creek and "The Hole" pond, and there are several emergent plant communities dominated by *Berula erecta* and common cattail (*Typha latifolia*). Cattle have been using the creek and trampling the vegetation at the crossing. The other portions of the creek appear to be fenced off (Cannings et al. 1998).	Federal
BC	Okanagan River	21	Madeline Lake, near Penticton	EO 3383	Extant; 1997;	Small stream along the road between the lake and the spring-fed marsh below Madeline	Crown; provincial

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
					1997	Lake. The habitat includes a small, spring-fed stream between the complex of small marshes below the lake; vegetation is dominated by mare's tail (*Hippuris vulgaris*) and small rushes (*Juncus* sp.). Along small, spring-fed stream draining Madeline Lake, along west side of road immediately south of the lake.	
BC	Okanagan River	22	Okanagan Lake (Penticton Yacht Club)	EO 4119	Extant; 1997; 1997	Small, spring-fed stream above a common cattail marsh at base of a glaciolacustrine silt bluff.	Municipal
BC	Okanagan River	23	Richter Pass	EO 4338	Extant; 1991; 1991	Gully in sagebrush (*Artemisia* spp.) steppe at the roadside leading up to Mount Kobau; no larval habitat observed.	Private
BC	Okanagan River	24	Rosebud Lake	–	Extant; 1999; 2013	South and west sides of sandy-bottomed, shallow lake; relatively bare shoreline; few aquatic plants.	Crown and private; wildlife refuge
BC	Okanagan River	25	Skaha Lake, East Side	EO 3851	Extant; 1997; 1997	Spring-fed marsh in silt-bottomed pond at base of a glaciolacustrine silt bluff. Pond surrounded by a band of common spike-rush (*Eleocharis palustris*) and has dense stands of bulrush (*Scirpus* spp.) and common cattail at the north end (Cannings et al. 1998).	Crown; provincial
BC	Okanagan River	26	Summerland (Crescent Beach)	EO 1504	Extant; 2011; 2011	Silt bluffs, adjacent to large lake. There is no obvious spring at the site, but there are springs scattered to the south.	Private
BC	Okanagan River	27	Summerland (Kevin Brook/ Munroe Ave Marsh)	EO 5408	Extant; 1997; 1997	Highly altered spring-fed stream confined to ditches along property lines, roads, and a railway bed. Ditch lined with bulrush (*Scirpus* spp.), purple loosestrife (*Lythrum salicaria*), common cattail, and birch (*Betula* sp.).	Private
BC	Okanagan River	28	Summerland (Switchback Road)	–	Extant; 2011; 2011	Unknown.	Private

Prov.	Water-shed	SP no.	SP name/(site)[a]	EO/SF no.[b]	Status[c]; most recent year observed; most recent year surveyed	Habitat description	Land tenure
BC	South Coast Rivers	29	Meager Creek Hot Spring, near Pemberton	EO 5273	Extant; 2020; 2020	Hot springs within creek bed.	Crown; provincial
BC	Fraser River	30	Pebble Creek (Lillooet River, Keyhole) Hot Spring	EO 8916	Extant; 2020; 2020	The source water temperature is 54°C. There are pools that go from benches above the river to the edge of the river. The lower pools are inundated in times of high water on the Lillooet River and do not have *Argia vivida* present; the upper pools and stream do. The site has had diversions and blocking of the streams that have resulted in temperatures that are too high for nymph survival. In 2003, a spur road was built from the logging road, making access easier.	Crown; provincial
BC	Upper Kootenays	31	Albert Canyon (Canyon Hot Springs)	EO 956	Extant; 1998; 2013	Small, spring-fed creek with moderate gradient. Small-flowered bulrush (*Scirpus microcarpus*), white-watered buttercup (*Ranunculus aquatilis*), and non-native watercress (*Nasturtium officinale* and *N. microphyllum*) present. Collected downstream via 2 km of piping into a pool located at Canyon Hot Springs Campground (Cannings and Cannings 1998).	Crown, transportation utility corridor
BC	Upper Kootenays	32	Halcyon Hot Springs	–	Extant; 1986; 1986	Hot spring-fed stream is too hot in upper reaches but is suitable for an 85-m reach below the confluence with a small cold tributary and before it empties into a much larger cold stream; water depth is 15–20 cm.	Private
BC	Upper Kootenays	33	Kuskanax Creek (Nakusp Hot Springs)	EO 388	Extant; 1994; 2013	Open mossy hot spring terrace in clearing with multi-channel creek and seeps that flow < 100 m into adjacent Kuskanax Creek; surrounded by Douglas-fir and hemlock forest.	Municipal

AB = Alberta; BC = British Columbia; SP. no. = subpopulation number

[a] Adjacent springs and associated outflows are considered one site if within approximately 150 m of each other. Subpopulations are defined as sites within a 5-km radius.

[b] EO no. =Element Occurrence number from B.C. Conservation Data Centre for British Columbia occurrences. SF = Source Feature (e.g., observations of the species) as assigned by Alberta Conservation Management System (2017) for Alberta occurrences. COSEWIC 2015.

[c] 33 subpopulations: 27 extant subpopulations; 4 historical; 3 unconfirmed. *Extant*: springs with confirmed breeding (e.g., presence of nymphs, exuviae). If confirmed breeding is more than 40 years previous and subsequent surveys have not confirmed the species presence, yet the habitat appears suitable. It is assumed the species is still present based on the suitable habitat and the occurrence is still considered extant. Adjacent springs (less than approximately 150 m apart) and associated outflows are also considered a single site. *Historical*: no recent field information, site has been destroyed, or no surveys verifying the continued existence of the occurrence for 20 years.

3.3 Habitat and Biological Needs of Vivid Dancer

The following habitat description is summarized from the COSEWIC (2015) status report.

3.3.1 General habitat

Vivid Dancer habitat in Canada is associated with thermal springs (Leggott and Pritchard 1985ab) and low-elevation cool springs (Table 1) (BC CDC 2020). There is a debate in the literature regarding the minimum temperature for a spring to be considered a thermal spring (see Pentecost *et al.* 2003). In terms of Vivid Dancer habitat, a thermal spring is a point of groundwater discharge whose temperature exceeds the regional average air temperature by more than 5 °C for cold springs (0–9 °C), cool springs (10–19 °C), warm springs (20–29 °C), and hot springs (> 30 °C) springs (definitions edited from Bow Valley Naturalists 2020). The habitat notes associated with the historical occurrences at Field (#5), Glacier (#7), East of Nelson (#13) and Richter Pass (#23) do not note the presence of a spring (Table 1); however, habitat information for these subpopulations is not well documented. Table 2 is a summary of essential functions, features, and attributes of Vivid Dancer habitat in Alberta and British Columbia.

3.3.2 Oviposition sites

Vivid Dancers begin their life cycle as an egg. Mating pairs remain in tandem during oviposition. Females oviposit in the water and below the water's surface in areas with thick, lush emergent and aquatic vegetation (Leggott and Pritchard 1985a; Hornung and Pacas 2006; Paulson 2009) and/or in water within dense sedge beds, as well as on under the water and on emergent vegetation (Paulson 2009). Egg development appears to require a minimum of 11.25 °C (Pritchard 1989).

3.3.3 Nymphal habitat

Once the egg has been laid on an oviposition site, it hatches into a gill-breathing nymph which continues to grow and develop in small spring-fed streams and pools, medium-sized streams, and spring runs[9] (Paulson 2009; BC CDC 2020). Nymphs are known to move into stream currents, which suggests that they may require higher oxygen concentrations than other similar species of damselflies (Pritchard 1991; Corbet 1999). At thermal springs in the southern Canadian Cordillera, discharge rates are usually low (1–50 liters per second [L/s]); however, higher flow rates occur at Meager Creek (#29) (up to 500 L/s). Damselfly nymphs are not observed within high-velocity areas of springs (Fairbank and Faulkner 1992; Grasby and Hutcheon 2001); they are found instead within the surrounding low-flow and marshy areas.

Data on nymphal development temperature thresholds in Canada are limited and variable. The minimum temperature needed for nymphal development is likely similar to egg development (11.25 °C [Pritchard 1989]), and although nymphs have been recorded at higher temperatures, the minimum, maximum and threshold for optimal development are unknown. Nymphs have

[9] A "spring run" is a defined point at which groundwater reaches the surface and the flowing channel (sometimes braided) is fed by the spring. Usually spring runs are short and join other spring runs, a stream, a spring pond, or a spring lake (text edited from Wisconsin Department of Natural Resources 2019).

been observed year-round at Cave and Basin NHS (#1c) (22–30 °C), Albert Canyon (#31) (5 °C in winter to 20 °C in summer) (Leggott and Pritchard 1985b), and Dewar Creek (#3) (9–32 °C) (Salter 2003). Larval habitat downstream from the main hot water discharge vents is air-cooled or cooled by the influx of water from cooler streams. At Little Wilson Lake (#9), when measured in October the water temperature air-cooled from 34 to 21 °C (Salter 2003) and at Dewar Creek (#3) the water temperature cooled from 82 °C (spring outlet) to 28 °C at the larval collection site (Salter 2003). As is common with thermal springs, water temperatures reach a maximum during winter when cooler water inflow is lowest (e.g., Banff National Park # 1) (Grasby and Lepitzki 2002; COSEWIC 2008).

At Cave and Basin NHS (#1c), nymphs were observed hiding in lush aquatic vegetation, including pondweed (*Potamogeton* spp.), water cress (*Nasturtium* spp.), and some non-native plant species (Pritchard 1971). Nymphs have also been observed hiding in woody vegetation and under rocks (Paulson 2009; J. Heron, pers. obs. at Ram Creek #11).

3.3.4 Adult foraging habitat

Vivid Dancer adults are aerial predators, and both sexes hunt within the terrestrial habitat adjacent to their springs habitat. Damselflies consume a wide variety of insects, mostly while on the wing. As is typical of many odonates (Foster and Soluk 2006), female Vivid Dancers tend to disperse farther away from the aquatic springs, and into the terrestrial habitat, more frequently than do males (Kortello and Ham 2010). Both teneral males and females forage widely to build up energy reserves for reproduction and to avoid conspecific competition (Kirkton and Schultz 2001; Bried and Ervin 2006).

The spatial extent of damselfly foraging patterns is generally not well studied. When defining damselfly element occurrences, NatureServe's (2004a,b, 2020) delineation of terrestrial foraging habitat includes a 500-m distance surrounding freshwater habitat where breeding and/or oviposition has been observed and/or nymphs, exuviae, and teneral adults have been observed. This parameter is based on odonate territorial (mating) and foraging studies for New England Bluet (*Enallagma laterale*) (Briggs 1993), Black-tailed Skimmer (*Nesciothermis nigeriensis*) (Corbet 1999), Copper Demoiselle (*Calopteryx haemorrhoidalis*) (Corbet 1999; Beukeman 2002), and Martha's Pennant (*Chorolestes tessalatus*) (Samways and Steytler 1996). More recent studies of a threatened dragonfly species in Europe, the Ruddy Darter (*Sympetrum depressiusculum*) (Dolný *et al*. 2014), suggest that areas of dense vegetation are important for prey production, and that disturbances to the surrounding terrestrial habitat have an impact on subpopulations.

Foraging habitat for adult Vivid Dancers also includes the aerial areas above the freshwater springs oviposition habitat. The spatial area of freshwater habitat, aerial height to which damselflies will fly, distance travelled during foraging, and horizontal area that adult damselflies patrol are difficult to quantify and require further study.

3.3.5 Perching, roosting, and mating habitat

Vivid Dancer adults require perching and roosting habitat within which to take cover and rest both at night (to slow the radiant loss of heat) (Kortello and Ham 2010) and during the day.

Perching and roosting are most commonly observed within riparian habitat, and trees or large shrubs and plants are required for roosting (Conrad and Pritchard 1988; Pritchard and Kortello 1997; Paulson 2009). In both British Columbia and Alberta, Vivid Dancer adults (both sexes, teneral and mature) have been observed perching or resting on rocks, logs, bare ground, brush piles, and boardwalks (COSEWIC 2015; BC CDC 2020).

Vivid Dancer's minimum thoracic temperature for flight is approximately 26 °C (Legott and Pritchard 1986), which may partially explain its association with thermal springs. The species' association with cool springs within the Okanagan valley (#18–28) and Fraser River (#14–17) canyon may be due to the high summer temperatures in these regions. Although the discharge temperature of the springs[10] in both these areas is higher than the regional average air temperature by more than 5 °C. The average daily summer temperatures can reach 30 °C in the Okanagan valley (high of 38°C in Summerland in 1998) and 29 °C in the Lillooet area (high greater than 41 °C in 1998). Vivid Dancer flight activity is less frequent on overcast days (Leggott and Pritchard 1986), and the species is frequently observed basking in sunlit patches (Pritchard and Kortello 1997). Nocturnal resting behaviour is difficult to observe, which makes it difficult to document the specific habitat features necessary for this activity (Kortello and Ham 2010). In Banff National Park (#1), adults have been observed nocturnally resting on trees (adjacent to and within the surrounding forest), including spruce (*Picea* spp.), lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), trembling aspen (*Populus tremuloides*), and willow (*Salix* spp.) (Ham and Kortello 2005; Kortello and Ham 2010). This same perching/roosting habitat is also used by copulating pairs.

General habitat descriptions of Vivid Dancer sites and the terrestrial plant communities adjacent to them are not well documented. Terrestrial habitat differs substantially across the species' wide geographic range, and it is likely that the structure and function of the habitat is more important than vegetation composition for roosting, mating, and maintaining the aquatic habitat (e.g., riparian vegetation prevents siltation and shoreline erosion). Habitat descriptions for all subpopulations are a knowledge gap.

[10] For the purposes of Vivid Dancer habitat, a thermal spring is a point of ground water discharge whose temperatures exceeds the regional average air temperature by more than 5 °C: for cold (0-9 °C), cool (10-19 °C), warm (20-29 °C), and hot (>30 °C) springs (definitions edited from Bow Valley Naturalists 2020).

Table 2 .Summary of essential functions, features, and attributes of Vivid Dancer habitat in Alberta and British Columbia.

Life stage	Function[a]	Feature(s)[b]	Attributes[c]
Adult	Foraging, breeding, cover, perching, and roosting	Open forest and shrub vegetation with sunlit patches; rocks, emergent vegetation, and woody debris at the water edges and/or emergent from shallow waters.	Minimum ambient temperature for insect movement is 12 °C; sites where there is more sun and ambient temperatures reach more than 12 °C are likely to be favoured; sites include rocks, logs, bare ground, brush piles, boardwalks, and other similar structures. As well, vegetation in this area provides forage habitat (e.g., prey populations).
Egg	Oviposition (tandem males and females) and incubation	Clear, permanent, well-oxygenated, freshwater thermal or cool springs habitat.	Minimum ambient temperature for insect movement is 12 °C; for insect mating and oviposition, the temperature would need to be at this minimum. Minimum temperature 5 °C in winter, 9–32 °C in summer (Salter 2003), although additional data on the specific temperature where eggs have been recorded need to be collected (e.g., eggs are not likely to survive in 32 °C water). Water chemistry parameters (e.g., nitrogen, oxygen, pH, conductivity) are unknown. Eggs are oviposited onto stems of emergent and aquatic vegetation within thick lush emergent vegetation below the waterline (Hornung and Pacas 2006) and dense sedge beds (Paulson 2009).
Nymphs (during adult emergence)	Adult emergence	Clear, permanent, well-oxygenated, freshwater thermal or cool springs habitat.	Minimum temperature is 5 °C in winter, 9–32 °C in summer (Salter 2003), although additional data on the specific temperature where nymphs have been recorded need to be collected (e.g., nymphs are not likely to survive in 32 °C water). Structures in the aquatic environment that nymphs can crawl upon and emerge are required (e.g., sedges and rushes, rocks, emergent sticks, dense sedge beds) (Paulson 2009).
Nymph (all stages)	Feeding, foraging	Clear, permanent, well-oxygenated, freshwater thermal or cool springs habitat.	Minimum temperature is 5 °C in winter, 9–32 °C (Salter 2003) in summer, although additional data on the specific temperature where nymphs have been recorded need to be collected (e.g., nymphs are not likely to survive in 32 °C water). Water chemistry parameters are unknown. The stream flow rate is also unknown; however, based on field observations, the streams are slow moving and calm and the stream bottom is muddy.

[a] Function: a life cycle process of the species.
[b] Feature: the essential structural components of the habitat required by the species.
[c] Attribute: the building blocks or *measurable* characteristics of a feature.

3.4 Ecological Role

In general, odonates play several important ecological roles as predators, prey items, and indicators of ecosystem health.

- *Top predators*. During the adult (terrestrial) and nymphal (aquatic) life stages, odonates are generalist predators of many other invertebrates. The composition of prey items consumed

depends on the abundance of prey items within an environment, ease of capture, and prey size/habits (Corbet 1999).

- *Prey items.* Odonates are prey items for numerous aquatic amphibians (both the adults and immature forms), birds, lizards, bats, and fish (damselfly nymphs) (Corbet 1999).

- *Indicators of ecosystem health.* Odonates are used as indicators of aquatic ecosystem health. For example, they are used in combination with other macroinvertebrate taxa as indicators of water quality (e.g., dissolved oxygen levels, floodplain indices, and presence of temporary/permanent water bodies [Cordoba-Anguilar 2008]), sediment erosion (e.g., sediment makes aquatic habitat cloudy and limits the ability of nymphs to find prey, and can suffocate eggs and nymphs), and pollution, including fertilizer runoff and agricultural chemicals.

3.5 Limiting Factors

Limiting factors make the species less likely to respond to management or conservation efforts but are generally not human-induced. Limiting factors specifically for Vivid Dancer are not well documented and need further research.

- *Thermal and cool springs habitat.* Vivid Dancer is restricted to these specific habitat types (see Section 3.3). The water quality attributes at these sites, such as temperature, water flow, dissolved oxygen, pH, and dissolved nutrients, can affect the development of damselfly nymphs. Aquatic habitat attributes, such as the spatial area of suitable muddy-bottomed larval burrowing habitat, as well as suitable oviposition, emergence, and terrestrial foraging habitat can also limit the subpopulation size and persistence at a spring. Water quality parameters appear to limit the species' distribution and subpopulations throughout its Canadian range, but further research on specific parameters is needed.

- *Limited dispersal ability*. Damselflies are not typically strong fliers nor are they known to travel long distances (Corbet 1999). Adults are likely to remain within close proximity to their natal thermal/cool springs habitats. In general, commuting flight between reproductive, foraging, and/or roosting sites is less than 200 m and up to 1 km (Corbet 1999).

- *Weather patterns and ambient temperature*. Weather can affect odonate activity. Vivid Dancer adults have a short life span (unknown but estimated to be 1–3 weeks). Adult damselflies can fly during inclement weather; however, if unseasonably cool ambient temperatures occur or there is a higher frequency of severe storms (both heavy wind and rain), adults will be unable to fly and mate.

- *Small subpopulation size and genetic isolation.* The thermal and cool springs habitats where Vivid Dancer has been recorded are separated by large distances, and it is unlikely that adult damselflies move between subpopulations.

4 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (subpopulation, species, community, or ecosystem) in the area of interest (global, national, or subnational) (adapted from Salafsky *et al*. 2008). For the purposes of threat assessment, only present and future threats are considered. Threats presented here do not include limiting factors (see Section 3.5).

For the most part, threats are related to human activities, but they can also be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., introduction of invasive species). Effects of natural phenomena (e.g., fire, flooding) may be especially important when the species is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al*. 2012). As such, natural phenomena are included in the definition of a threat, though they should be considered cautiously. These stochastic events should be considered a threat only if a species or habitat is damaged from other threats and has lost its resilience. In such cases, the effect on the subpopulation would be disproportionately large compared to the effect experienced historically (Salafsky *et al*. 2008).

4.1 Threat Assessment

The threat classification in Table 3 is based on the International Union for the Conservation of Nature–Conservation Measures Partnership (IUCN-CMP) unified threats classification system and is consistent with methods used by the B.C. Conservation Data Centre. For a detailed description of the threat classification system, see the Open Standards website (Open Standards 2014). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat “impact” is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2012) and the table footnotes for details. A description of the threats included in Table 3 are described in Section 4.2 and are updated from the COSEWIC (2015) status report.

Table 3. Threat classification table for Vivid Dancer in British Columbia and Alberta.

Threat no.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Subpopulation no.(s)[f]
1	Residential & commercial development	Low	Small (1–10%)	Extreme – Moderate (11–100%)	Moderate (possibly in the short term, < 10 yr)	
1.1	Housing & urban areas	Low	Small (1–10%)	Extreme – Moderate (11–100%)	Moderate (possibly in the short term, < 10 yr)	AB: not a current threat (historical threat at 1h). BC: 13, 18, 21, 22, 26, 27, 28, undocumented springs
1.2	Commercial & industrial areas	Unknown	Unknown	Extreme – Moderate (11–100%)	Moderate (possibly in the short term, < 10 yr)	AB: not a current threat (historical threat). BC: 10, 22, undocumented springs
1.3	Tourism & recreation areas	Low	Small (1–10%)	Extreme – Serious (31–100%)	Moderate (possibly in the short term, < 10 yr)	AB: 1 BC: 4, 22, 31, 32, 33, undocumented springs
2	Agriculture & aquaculture	Low	Restricted – Small (1–30%)	Moderate – Slight (1–30%)	High (continuing)	
2.1	Annual & perennial non-timber crops					Not applicable in AB or BC.
2.2	Wood & pulp plantations					Not applicable in AB or BC.
2.3	Livestock farming & ranching	Low	Restricted - Small (1–30%)	Moderate – Slight (1–30%)	High (continuing)	AB: Not applicable. BC: 15, 16, 17, 19, 20, 21, 23
2.4	Marine & freshwater aquaculture					Not applicable in AB or BC.
3	Energy production & mining	Unknown	Small (1–10%)	Unknown	Moderate (possibly in the short term, < 10 yr)	
3.1	Oil & gas drilling					AB: Not applicable. BC: Undocumented springs.
3.2	Mining & quarrying	Unknown	Small (1–10%)	Unknown	Moderate (possibly in the short term, < 10 yr)	AB: Not applicable. BC: 15; Undocumented springs.
3.3	Renewable energy	Unknown	Small (1–10%)	Unknown	Moderate (possibly in the short term, < 10 yr)	AB: Not applicable. BC: potentially 9, 12, 29 and 30
4	Transportation & service corridors	Low	Restricted	Slight	High	

Threat no.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Subpopulation no.(s)[f]
4.1	Roads & railroads	Low	Restricted (11–30%)	Slight (1–10%)	High (continuing)	AB: 1 BC: 4, 13, 14, 20, 22, 23, 25, 27, 28, 30
4.2	Utility & service lines					Not applicable in AB or BC.
4.3	Shipping lanes					Not applicable in AB or BC.
4.4	Flight paths					Not applicable in AB or BC.
5	Biological resource use	Unknown	Small (1–10%)	Unknown	Moderate (possibly in the short term, < 10 yr)	
5.1	Hunting & collecting terrestrial animals					Not applicable in AB or BC.
5.2	Gathering terrestrial plants					Not applicable in AB or BC.
5.3	Logging & wood harvesting	Unknown	Small (1–10%)	Unknown	Moderate (possibly in the short term, < 10 yr)	AB: Not a threat BC: 8, 9
5.4	Fishing & harvesting aquatic resources					Not applicable in AB or BC.
6	Human intrusions & disturbance	Medium – Low	Large (1–30%)	Moderate – Slight (1–30%)	High (continuing)	
6.1	Recreational activities	Medium – Low	Large (1–30%)	Moderate – Slight (1–30%)	High (continuing)	AB: 1h, 1i BC: 2, 3, 4, 9, 10, 11, 12, 15, 22, 26, 29, 30, 31, 32, 33
6.2	War, civil unrest, & military exercises					Not applicable in AB or BC.
6.3	Work & other activities	Negligible	Small (1–10%)	Negligible (< 1%)	High (continuing)	AB: 1
7	Natural system modifications	Low	Small	Slight	High	
7.1	Fire & fire suppression	Negligible	Small (1–10%)	Negligible (< 1%)	Unknown	All subpopulations in BC and AB. BC: However, subpopulations in Fraser River canyon (14, 15, 16, 17), South Coast (29, 30) and Okanagan valley (18–28) have a greater wildfire risk.
7.2	Dams & water management/use	Low	Small (1–10%)	Slight (1–10%)	High (continuing)	AB: 1 BC: Undocumented subpopulations.
7.3	Other ecosystem modifications	Unknown	Pervasive (71–100%)	Unknown	High (continuing)	All subpopulations in AB and BC.

Threat no.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Subpopulation no.(s)[f]
8	Invasive & other problematic species, genes & diseases	Unknown	Small (1–10%)	Unknown	High (continuing)	
8.1	Invasive non-native/alien species/diseases	Unknown	Small (1–10%)	Unknown	High (continuing)	AB: 1. BC: 24, 31; unknown but possible at all subpopulations.
8.2	Problematic native species/diseases	Unknown	Small (1–10%)	Unknown	High (continuing)	AB : Not applicable. BC: 21
8.3	Introduced genetic material					Not applicable in AB or BC.
9	Pollution	Unknown	Restricted	Unknown	High	
9.1	Domestic & urban waste water	Unknown	Restricted (11–30%)	Unknown	High (continuing)	AB: 1 BC: 2, 3, 4, 9-12, 24, 29, 30, 32, 33
9.2	Industrial & military effluents	Unknown	Small (1–10%)	Unknown	High (continuing)	AB: 1 BC: 4, 10, 31
9.3	Agricultural & forestry effluents	Unknown	Small (1–10%)	Unknown	High (continuing)	AB: Not applicable. BC: 10, 15, 16, 17, 18, 19, 21, 22, 23, 25, 26, 27, 28
9.4	Garbage & solid waste	Negligible	Small (1–10%)	Negligible (< 1%)	High (continuing)	AB: Not applicable. BC: 2, 3, 9-12, 19, 24, 29, 30, 32, 33
9.5	Air-borne pollutants					Not applicable in AB or BC.
9.6	Excess energy					Not applicable in AB or BC.
10	Geological events	Unknown	Unknown	Unknown	Moderate	
10.1	Volcanoes					Not applicable in AB or BC.
10.2	Earthquakes/tsunamis	Unknown	Unknown	Unknown	Moderate (possibly in the short term, < 10 yr)	AB: 1 BC: 18, 30
10.3	Avalanches/landslides	Unknown	Unknown	Unknown	Moderate (possibly in the short term, < 10 yr)	AB: Not applicable. BC: 11, 23, 29
11	Climate change & severe weather	Unknown	Small	Unknown	High	
11.1	Habitat shifting & alteration					Not applicable in AB or BC.
11.2	Droughts	Unknown	Small (1–10%)	Unknown	High (continuing)	All subpopulations in AB and BC.
11.3	Temperature extremes					Not applicable in AB or BC.
11.4	Storms & flooding	Unknown	Small (1–10%)	Unknown	High (continuing)	All subpopulations in AB and BC.

AB = Alberta; BC = British Columbia

[a] Threat numbers are provided for Level 1 threats (i.e., whole numbers) and Level 2 threats (i.e., numbers with decimals).

[b] Impact – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on severity and scope rating and considers only present and future threats. Threat impact reflects a reduction of a species subpopulation. The median rate of subpopulation reduction for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75%), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment time (e.g., timing is insignificant/negligible [past threat] or low [possible threat in long term]); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[c] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' subpopulation in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[d] Severity – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or 3-generation time frame. For this species, a 10-year time frame was used. Severity is usually measured as the degree of reduction of the species' subpopulation. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit $\geq$ 0%).

[e] Timing – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

[f] As described in Table 1.

4.2 Description of Threats

Specific threats to Vivid Dancer individuals and habitat at subpopulation sites are not well documented. Land ownership and activities at a site greatly influence the type of threat imposed on the thermal or cool spring where Vivid Dancer larvae reside and adults patrol. At some subpopulation sites, land ownership or tenure adjacent to the thermal or cool spring habitat is not known (e.g., recreational property, permanent residence, commercial property, recreational park).

The overall rangewide threat impact for this species is High–Medium. This new threats assessment is based on the COSEWIC (2015) status report and is updated with additional new information. The more recent assessment takes into account additional local knowledge of each subpopulation and the linkages between known causal versus proximal threats for each site, and is further explained under each threat heading.

The overall threat impact considers the cumulative impact of multiple threats which vary between subpopulations. The primary threats to Vivid Dancer are recreational activities; trampling, urination, and defecation by livestock that have access to cool springs habitats; dams and water management; and invasive non-native alien species. The ongoing cumulative alteration, degradation, and loss of thermal springs habitats, including the wetland edges and waterways flowing in and out of the springs area, affect nymphal development sites and water quality. Details are discussed below under the threat headings. Threats with unknown impact are also described because of the uncertainty they impose upon the overall impact on the species, given the pervasive scope of those threats.

Threat 1. Residential and commercial development (Low impact)

1.1 Housing & urban areas (Low impact)

British Columbia: There is widespread and ongoing development throughout the Okanagan valley (Bezener *et al*. 2004; COSEWIC 2012); however, at present, no housing or urban development has been proposed specific to known Vivid Dancer habitats. There is some urban development within 500 m (potential terrestrial foraging territory) of BX Creek (#18), Madeline Lake (#21), and around the Yacht Club site along Okanagan Lake (#22), Summerland – Crescent Beach (#26), Summerland – Kevin Brook/Munroe Ave Marsh (#27), and Summerland – Switchback Road (#28). In the event of development within foraging habitat, additional proximate threats could occur (e.g., increased sedimentation of aquatic habitats from surface runoff, pollution of waterways from garbage and other materials and increased nitrogen from wastewater and septic tank systems).

This threat is potentially applicable to undocumented cool springs within the region. However, under the provincial *Water Sustainability Act*, there are provisions to prevent the destruction of cool springs habitats.

Alberta: The threat of housing or urban development is not applicable to subpopulations in Banff National Park (#1). Historical residential development occurred at Middle Springs Bog (#1h)

(Marsh 1974; Hornung and Pacas 2006); however, there has not been any subsequent residential development nor is there likely to be in the future (COSEWIC 2015). Unless new subpopulations in AB are documented, this threat does not apply.

1.2 Commercial & industrial areas (Unknown impact)

British Columbia: The installation of water extraction structures at cool springs for commercial spring water extraction is a growing threat to undocumented cool springs. The installation of water extraction structures involves the clearing or channeling of water and drawing down water to install the mechanical structure, and potentially the construction of an access road to the site. Although water extraction requires permits under the provincial *Water Sustainability Act*, it is possible for permits to be approved without knowing that Vivid Dancer is present. Currently, inventory for the damselfly is not a permit requirement, but even if it were, it must be conducted at the appropriate time of year and for a number of years to determine if Vivid Dancer is present at a spring and/or the impact that water extraction has on the subpopulation.

Alberta: The threat of commercial or industrial development for water extraction purposes is not applicable to subpopulations in Banff National Park (#1).

1.3 Tourism & recreation areas (Low impact)

The threat of hotel and thermal springs bath development was documented under Threat 1.2 in the COSEWIC (2015) status report but is categorized under Threat 1.3 in this document in order to separate the commercial extraction of spring water from development for tourism purposes.

British Columbia: Historical construction of hotels, bath houses, and pools has altered numerous thermal springs that support Vivid Dancer subpopulations (Albert Canyon [#31], Fairmont [#4], Halcyon [#32], Kuskanax Creek [#33]) and may have eliminated the Radium Hot Springs subpopulation [#10] (although information on this site is lacking and the subpopulation is unconfirmed). Expansion of this commercial infrastructure is possible at all historically developed sites with Vivid Dancer subpopulations, as well as undeveloped thermal springs due to a growing interest by development companies (J. Heron, pers. comm., 2017; G. Wilson, pers. comm., 2017). Habitat quality appears to have been adversely impacted at Kuskanax Creek (Nakusp Hot Springs) (#33), Fairmont (#4), and potentially Halcyon (#32) due to the continued diversion of water for the bathing facilities (R. Foster, pers. comm., 2013, cited in COSEWIC 2015).Vivid Dancers continue to breed at the spring source at Fairmont (#4) (mossy pools, tufa, and/or travertine mounds and free-running streams) (J. Heron, pers. comm., 2017) and Albert Canyon (#31) (COSEWIC 2015). There is the potential to expand the footprint of the buildings, marina, and infrastructure at the Penticton Yacht Club (#22), but the timing of it is unknown.

There is extensive alteration and diversion of water by recreational users at non-commercially developed springs. This is further discussed and scored under Threat 6.1.

Alberta: All subpopulations are located within Banff National Park (#1), where commercial development is essentially capped, and all maintenance and recapitalization projects are carefully implemented to the highest standards to ensure the maintenance of ecological integrity and

protection of species at risk. The developed footprint at the Cave and Basin (#1c) remains unchanged, and other sites have virtually no impacts from tourism and recreation. All of the Kidney and Middle Spring sites are in a complete area closure where human use is prohibited.

Threat 2. Agriculture & aquaculture (Low impact)

2.3 Livestock farming & ranching (Low impact)

British Columbia: Livestock grazing (cattle and horse ranching) occurs at Kearns Creek (#20), Richter Pass (#23), and Chopaka (#19) (Cannings and Cannings 1998; Cannings 2002; R. A. Cannings, pers. comm., 2017) and likely at some of the Lytton subpopulations (#15–17). Direct threats to Vivid Dancer individuals and their aquatic habitat from livestock grazing include trampling of nymphs and aquatic vegetation (used by nymphs for refuge and by adults for emergence and resting). Urination and defecation affect water quality through the input of nutrients, and trampling affects water quality through sedimentation.

In both the Pemberton (#29, 30) and Lytton areas (#15–17), the springs used by Vivid Dancer are on provincial land, First Nations reserves or the ownership is unknown. Within the Lytton and Okanagan areas, the identified Vivid Dancer habitats are cool springs on provincial land. If these springs are in areas that are used as rangelands, they could be disturbed by cattle if access to the springs is not prevented (e.g., if the spring is not fenced off). Livestock grazing potentially affects additional undocumented subpopulations at cool springs in the Okanagan valley, Lytton, and elsewhere.

Alberta: Not applicable.

Threat 3. Energy production & mining (Unknown impact)

3.1 Oil & gas drilling and 3.2 Mining & quarrying (Unknown impact)

British Columbia: Many of the thermal springs throughout the province have not been inventoried for Vivid Dancer. These springs are within areas where oil, gas, and mining exploration are ongoing, and the work involved (e.g., blasting, drilling) could impact the underground thermal springs water sources and pathways. This threat is applicable at a site in Lytton (#15) due to a tenure for a quarry, but rangewide, the threat is unknown and needs further study.

Alberta: Not applicable.

3.3 Renewable energy (Unknown impact)

British Columbia: Geothermal power development is a potential threat to numerous thermal springs throughout the province (J. Heron, pers. comm., 2017; G. Wilson, pers. comm., 2017). Within the Vivid Dancer's range, there is a demonstration plant near South Meager Creek (CanGEO 2013). Altered spring water discharge likely impacts the hydrogeology of Meager Creek (#29).

Alberta: Not applicable.

Threat 4. Transportation & service corridors (Low impact)

4.1 Roads & railroads (Low impact)

In general, odonates are susceptible to road mortality (Rao and Girish 2007; Catling and Kostiuk 2008). Following emergence, teneral and adult dragonflies and damselflies forage within the adjacent terrestrial habitat. Numerous extant Vivid Dancer subpopulations are adjacent to highways, provincial Forest Service roads, and/or narrow rights-of-way where vehicles may either drive over resting adults and/or collide with flying adults. Vehicles that travel at speeds in excess of 50 km/h have the potential to harm or kill odonates; the upper limit to which odonates can avoid collision is 50km/h (Brunelle 2010). Following vehicular collision, odonates experience shock and drop to the ground. At that point, they may revive and fly away, become vulnerable to predation by birds or other predators, or be run over by road traffic (Rao and Girish 2007).

British Columbia: The Okanagan valley is experiencing human population growth and increased tourism. Road widening and expansion has the potential to destroy habitat and impact Kearns Creek (#20) (R. A. Cannings, pers. comm., 2011) and Skaha Lake, East Side (#25). Road kill is a potential threat at subpopulations that are near potential roads or parking lots (#4, 14, 18, 21, 23–28).

Alberta: Road kill is a potential threat to subpopulations that are adjacent to the roads through Banff National Park (#1b, 1h).

Threat 5. Biological resource use (Unknown impact)

5.3 Logging & wood harvesting (Unknown impact)

British Columbia: Clearcut logging and forest thinning threaten Vivid Dancer subpopulations on provincial Crown land. The forested area around Little Wilson Lake (#9) has been severely degraded by mechanical damage and siltation from logging equipment (Salter 2003; S.P. Salter, pers. comm., 2014, cited in COSEWIC 2015). The removal of trees increases surface water runoff and siltation within waterways adjacent to logged areas, and reduces water quality for nymphal development. The removal of trees also reduces the availability of resting and mating sites for adults. The COSEWIC (2015) status report states that Kearns Creek (#20) is threatened by logging; however, this threat was inaccurately reported because these subpopulations are on federal land where no logging is conducted. There is the potential threat of logging at Little Sand Creek (#8).

Alberta: Parks Canada undertakes forest fuel modification (FireSmart) and prescribed fire activities, which have the potential to impact subpopulations. However, known sites are protected through appropriate mitigations identified in the environmental impact assessment process (e.g., following Kortello and Ham 2010).

Threat 6. Human intrusions & disturbance (Medium–Low impact)

6.1 Recreational activities (Medium–Low impact)

British Columbia: When bathers enter the water of thermal springs, residues from body oils, shampoos, soaps, suntan products, deodorants, and insect repellents wash into the water and may impact flora and fauna (Kroeger 1988; Lee and Ackerman 1999; Lepitzki and Pacas 2010; COSEWIC 2008). The impacts on water quality from these products and the cumulative impacts on Vivid Dancers or their prey are unknown. The water quality at all thermal springs subpopulations used for recreational bathing (#1h, 1i, 2- 4, 9- 13, 15, 22, 26, 29, 30-33) has likely changed due to residues from these products, but the severity is unknown. Vivid Dancer has been observed in flowing irrigation canals elsewhere in its global range (Paulson 2009); thus, the species may be tolerant of some altered water quality. Table 4 provides a summary of Vivid Dancer subpopulations with documented recreational use.

Bathers frequently modify thermal springs habitats to improve their bathing experience. This adversely impacts Vivid Dancer individuals and their aquatic habitats. Plastic liners, and wooden or concrete benches or other structures may be added to the site, and sometimes bathtubs or other pre-made pools are brought to the site and water is diverted into them. These items are eventually discarded and left at the site. Bathers also move or add rocks to the edges of the springs, remove or alter riparian vegetation, and change or divert water to maintain desired bathing temperatures, which are often higher than optimal temperatures for nymphal growth. The cumulative effects of these actions result in habitat degradation. Although some of the materials used to modify the thermal springs are eventually considered garbage (Threat 9.4), this issue is included under Threat 6.1.

Cool springs in the Okanagan valley and Fraser River canyon are less likely to be impacted by recreational bathing.

Table 4. Vivid Dancer subpopulations with documented recreational use.

Province	Subpopulation no.	Subpopulation name	Notes on recreational use[a]
BC	3	Dewar Creek	Dewar Creek has a high-temperature outflow (recorded as high as 82 °C) and has a constant flow during winter and summer. Modifications have been made to the streams and pools, and there has been trampling above the ponds. The spring is near a hiking trail and walk-in campsite.
BC	4	Fairmont	The natural portion of Fairmont is a herbaceous, palustrine wetland fed by a small stream from the hot springs. The habitat Vivid Dancer occupies has been greatly altered and is adjacent to the main parking lot for the main hotel and commercial pools. There is interpretive signage and a trail leading through the habitat, and a possibility of trampling from foot traffic through the site.
BC	2	Lussier (Whiteswan) Hot Springs	Lussier is a historical subpopulation, although habitat appears to be suitable. The thermal spring continues to receive high

Province	Subpopulation no.	Subpopulation name	Notes on recreational use[a]
			recreational use by bathers, and there is potential for water diversion activities.
BC	9	Little Wilson Lake (Wilson Lake/Creek) Warm Springs	Wilson Creek thermal springs are not highly visited sites. The site is difficult to access and the water is not very hot, However water continues to be diverted and artificial pools continue to be constructed at the site; both activities are detrimental to the survival of nymphs and eggs. Two main hot springs (both of which have been modified to form pools) emerge at least 100 m up a steep, talus-covered slope from an abandoned logging trail that runs parallel to the creek. There is also a third site approximately 150 m downhill.
BC	11	Ram Creek Ecological Reserve	Ram Creek has less use since the main access road was converted back to natural habitat and more than a 1-km hike is now required to access the site. Water diversion that causes occupied pools or shallow areas to dry out, creation of artificial pools with temperatures greater than the thresholds for nymph survival, and bathing (trampling of nymphs and emergent vegetation used as emergence sites) are detrimental to the survival of the subpopulation. There is an ecological reserve direction statement (see British Columbia Ministry of Water, Land and Air Protection 2004)
BC	12	Wild Horse Hot Springs	Wild Horse Hot Springs consists of a series of small pools along a stream on a mossy hillside in a forest opening. Some of the pools have been created or modified by bathers. There is little recent information on the site.
BC	22	Okanagan Lake (Penticton Yacht Club)	Okanagan Lake is impacted by hiking and walking over the cool springs habitat; these activities trample the site; the threat is not from bathing.
BC	30	Pebble Creek (Lillooet River, Keyhole) Hot Spring	Pebble Creek Hot Spring has a source temperature is 54 °C. There are pools that go from benches above the river to the edge of the river. The lower pools are inundated during high water levels on the Lillooet River and do not have Vivid Dancer present; however, the upper pools and stream do. Diversions made at the site and blocking of the streams have resulted in temperatures that are too high for nymph survival. In 2003, a shortcut road was created from an adjacent logging road, which has made access easier. The site is closed for recreational use; however, illegal use is ongoing.
BC	31	Albert Canyon	Albert Canyon is not a high-temperature thermal springs (20 °C in summer and 5 °C in winter). Information on recreational activities at this site are unknown; however, recreational use is expected given the proximity to recreational camp sites.
BC	32	Halcyon Hot Springs	Halcyon Hot Springs is a commercially developed hot springs; there may be some recreational use outside the developed portions of the site, although the details are unknown. The hot spring-fed stream is too hot in the upper reaches but appears suitable for an 85-m reach below the confluence with a small cold tributary and before it empties into a much larger cold stream; water depth is 15–20 cm.
BC	26	Summerland (Crescent Beach)	Summerland experiences hiking and walking over the cool springs habitat which impacts the site through trampling; the threat is not from bathing.

Province	Subpopulation no.	Subpopulation name	Notes on recreational use[a]
BC	33	Kuskanax Creek (Nakusp Hot Springs)	Nakusp Hot Springs Trail leads to the site, and there is some water diversion and recreational use by bathers.
BC	29	Meager Creek Hot Spring	Meager Creek Hot Spring was once a popular destination for bathers, although recent landslides and difficult trails limit the number of visitors. An access road was constructed in 2019 and the site is accessible now, although there is a locked gate across a portion of the road. The site is closed to all recreation. Water diversion that causes occupied pools or shallow areas to dry out, creation of artificial pools with temperatures greater than the thresholds for nymph survival, and bathing (trampling of nymphs and emergent vegetation used as emergence sites) are detrimental to the survival of the subpopulation.

[a] Source: BC CDC 2020

Alberta: The sites with extant Vivid Dancer subpopulations in Banff National Park are not used for recreational bathing, and most are in areas that are closed to the public (Kidney and Middle Springs #1def) or where swimming is actively prohibited and/or monitored daily through video surveillance (e.g., Cave and Basin #1c and portions of Middle Springs west cave #1e). In the past, significant alterations in water chemistry were detected at thermal springs in Banff National Park (#1) following swimming events (Lepitzki 1998, 1999). The main impacts from recreational activities are from accidental trampling of Vivid Dancer adults perched on boardwalks and trails (as observed by Lepitzki and Lepitzki, unpubl. data, 1996–2014), and frequent human disturbance could affect courtship behaviour and oviposition.

Recreational horseback riding is available to visitors in Banff National Park. Horses use the numerous trails adjacent to Vivid Dancer subpopulations (Cave and Basin NHS [#1c] and Middle Springs Bog [#1h]), and it is possible that they could trample adults resting on the warm open dirt along the trails. Horse excrement left along the trails may leach into the adjacent water and over long periods may affect water quality, but it may also support increased prey availability for Vivid Dancer. The overall impact from these activities in Banff National Park is thought to be negligible.

6.3 Work & other activities (Negligible impact)

British Columbia: Not applicable.

Alberta: Research and monitoring activities for Banff Springs Snail (*Physella johnsoni*) are ongoing within some of the thermal springs that Vivid Dancer occupies in Banff National Park (#1). This work aligns with protection requirements under the *Species at Risk Act* and the *Canada National Parks Act*, including minimizing impacts on other species at risk, such as Vivid Dancer.

Threat 7. Natural System Modifications (Low impact)

7.1 Fire & fire suppression (Negligible impact)

British Columbia: Wildfire is considered to be part of the natural ecosystem processes of the Southern Interior grasslands. Historically, frequent low-intensity wildfires were more common throughout these low-elevation habitats. Over the past 100 years, fire suppression programs have altered the natural fire regime, and as a result, present-day wildfires are more extensive and severe than in the past. The terrestrial foraging habitat surrounding subpopulations in the Fraser River canyon (#14–17), South Coast (#29, 30), and Okanagan valley (#20–28) is highly susceptible to wildfire. The loss of forested habitat reduces the availability of mating, roosting, foraging, and resting sites for Vivid Dancer. The loss of forested vegetation leads to increased surface water runoff into freshwater habitats and increased siltation, which reduces water quality for Vivid Dancer eggs and developing nymphs.

Alberta: Wildfire is possible in Banff National Park (#1) and would have the same impacts as those described for British Columbia. Parks Canada is currently implementing a large-scale fuel modification project in the area upwind of most of these sites, on the west side of Sulphur Mountain. This project will significantly reduce the fire risk to these springs. Known Vivid Dancer sites are protected through mitigations identified in the environmental impact assessment process (e.g. following Kortello and Ham 2010).

7.2 Dams & water management/use (Low impact)

British Columbia: Cool springs are under potential risk of development and are discussed under Threat 1.2. Thermal springs are at risk of water diversion from bathers and recreational users; this threat is discussed under Threat 6.1.

Alberta: Numerous springs within Banff National Park (#1) have been diverted by pipes into valves, which get clogged. In the past, some of the outflow streams have gone dry and nymphs did not survive. This threat is considered historical.

7.3 Other ecosystem modifications (Unknown impact)

British Columbia and Alberta: Other ecosystem modifications include threats that do not directly kill/harm Vivid Dancer but adversely impact their habitat, food source, reproduction, or other factors that cause the subpopulation to decline. The cumulative effects of fire suppression activities, natural succession, and spread of non-native/alien plants have contributed to a cumulative decline in terrestrial foraging habitat quality (e.g., reduction in prey available to Vivid Dancer adults) and availability of resting sites (e.g., for resting, mating, and cover) for Vivid Dancer.

Alberta: In an effort to reduce fuel loads in Banff National Park, forest thinning has been completed at some sites and may continue in the future. These activities can change the microhabitat along streams where Vivid Dancers could perch, mate, rest and forage, however forest thinning did not appear to impede Vivid Dancer movement (Ham and Kortello 2005). Known Vivid Dancer sites are protected through appropriate mitigations identified in the environmental impact assessment process for forest thinning work (e.g. following Kortello and Ham 2010)

Threat 8. Invasive & other problematic species/diseases and genes (Unknown impact)

8.1 Invasive non-native/alien species, genes and diseases (Unknown impact)

The non-native European Paper Wasp (*Polistes dominula*) is becoming more widespread in both British Columbia and Alberta (MacMillan 2007) and has been observed preying upon Vivid Dancer adults. In addition, California Brook Trout (*Salvelinus fontinalis*) and Rainbow Trout (*Oncorhynchus mykiss*) have been widely introduced in the Vivid Dancer's range in Canada and may consume Vivid Dancer nymphs (Scott and Crossman 1973).

British Columbia: Rainbow Trout and California Brook Trout are present at Rosebud Lake (#24) and possibly Albert Canyon (#31). Non-native aquatic plants are likely present at most sites where Vivid Dancers are found. Some of these plants grow thick rhizomatous mats, which results in reduced oxygen content of the water, changes in the pH of the water, changes in nutrients that support prey populations, reduced availability of open water for Vivid Dancer nymphs, and incremental changes to the long-term habitat quality. The severity of this threat at each Vivid Dancer subpopulation is unknown and needs further evaluation.

Alberta: Numerous non-native fish species were introduced to the springs of Banff National Park (#1), including Western Mosquitofish (*Gambusia affinis*), Sailfin Molly (*Poecilia latipinna*), Green Swordtail (*Xiphophorus helleri*), Convict Cichlid (*Cichlasoma nigrofasciatum*), African Jewelfish (*Hemichromis bimaculatus*), and Freshwater Angelfish (*Pterophyllum scalare*) (Acorn 2004), although only the mosquitofish, mollies, and jewelfish persist (Parks Canada 2014). A higher abundance of Vivid Dancer nymphs have been recorded at Middle Springs (#1b), where no non-native fish have been found, than at the Cave and Basin NHS (#1c), where non-native fish are present (Rice 2002a; Hornung and Pacas 2006).

8.2 Problematic native species/diseases (Unknown impact)

British Columbia: Natural vegetation succession within the aquatic cool springs environments is a threat at Madeline Lake (#21). The encroachment of native vegetation into the waterways reduces the amount of available aquatic habitat.

Alberta: Not applicable.

Threat 9. Pollution (Unknown impact)

9.1 Domestic & urban waste water (Unknown impact)

British Columbia: Water runoff from roadways (e.g., sediment, diluted road salt, and chemicals) has the potential to affect Vivid Dancer habitat at Halcyon Hot Springs (#32) and Lussier (Whiteswan) Hot Springs (#2), and likely other springs although further information is needed. The severity is unknown.

Alberta: Salt is not used next to the basin (#1c) nor along the boardwalks (numerous sites) although it is used along roadways and may drain into outflow streams. Best management

practices have been implemented to ensure salt does not enter the springs. A limited amount of salt is used for de-icing along roadways adjacent to Vivid Dancer subpopulations at Middle Springs Bog (#1h) and Vermilion Cool Springs #1i), but the effects of salt, or stormwater management in general (salt, sediment, hydrocarbons, etc.) on Vivid Dancer abundance and habitats are unclear.

9.2 Industrial & military effluents (Unknown impact)

British Columbia: Chlorine is used at Fairmont Hot Springs (#4), but the concentration and frequency of use are unknown, and the impacts on Vivid Dancer subpopulations have not been studied. The spillover from commercial springs into the natural remaining thermal springs habitat is also unknown. Historically, chlorine has been added at Albert Canyon (#31) and Radium Hot Springs (#10).

Alberta: Chlorine was historically added to the thermal springs in Banff National Park, particularly at Cave and Basin NHS (#1c) when it was open for bathing. However, this no longer occurs, and chlorine is no longer used. Chlorine is used in the Upper Hot Springs (#1f) in Banff National Park. The only population that could have been impacted by chlorine is the Banff Springs Hotel, which is a historical subpopulation (#1a).

9.3 Agricultural & forestry effluents (Unknown impact)

British Columbia: Agricultural fertilizers, pesticides from lawns, oil, and sediments from roads are a potential threat to some subpopulations, particularly in the Okanagan valley (#18–28), but the impacts on water quality or Vivid Dancer abundance or their prey are unknown.

Alberta: Not applicable.

Threat 10. Geological events (Unknown impact)

10.2 Earthquakes/tsunamis (Unknown impact)

British Columbia: Earthquakes can stop or alter the flow of underground thermal springs, although this is difficult to predict and/or map. This type of earthquake activity could cause local extirpation of Vivid Dancer subpopulations. Vivid Dancer subpopulations in coastal British Columbia (Meager Hot Springs #29 and Pebble Creek #30) are within areas that have a higher probability of earthquake occurrence (Natural Resources Canada 2018).

Alberta: Not applicable.

10.3 Avalanche/landslides (Unknown impact)

British Columbia: Avalanches and landslides have occurred at or near three Vivid Dancer subpopulations. At Ram Creek (#11), a large landslide in 2011 buried some pools and springs at the site, although Vivid Dancer has persisted (BC CDC 2020). In 2010, Meager Creek (#29) experienced the largest recorded landslide in Canadian history at more than 48 million cubic

metres (Guthrie *et al*. 2012). The landslide did not affect the Vivid Dancer subpopulation, although it may have affected underground water sources. At Richter Pass (#23), Vivid Dancer was observed in a sagebrush gully on the side of the road that goes up to Mt. Kobau, and the area is subject to small rock slides.

Alberta: Not applicable.

Threat 11. Climate change & severe weather (Unknown impact)

11.2 Droughts (from COSEWIC 2015) and 11.4 Storms & flooding (Unknown impact)

The thermal spring hydrogeology of Vivid Dancer habitats in Canada is based on meteoric water circulating to depth, being heated, and then flowing back to the surface (Grasby and Hutcheon 2001). Climate change, particularly increased frequency and intensity of extreme droughts, decreased precipitation, and increased mean annual temperatures, is a potential threat to the water supply dynamics of thermal springs.

British Columbia: Unknown.

Alberta: There are five examples of springs in Banff National Park (#1)(Upper Hot, Kidney, Upper Middle, Middle West Cave, Gord's) that dried out and then were used by Vivid Dancers once the flows resumed (Lepitzki and Lepitzki, unpubl. data, 1996–2014). As a result, recolonization is thought to be possible if there are adjacent unaffected sites.

In the past, extreme low-precipitation years may have caused reduced flows at some Banff National Park thermal springs (Grasby and Lepitzki 2002). Continued flow anomalies may be expected due to climate change (Scott and Suffling 2000). Because thermal spring drying typically occurs over the winter, the aquatic nymphs that will produce the next generation of adult Vivid Dancers are the life stage that is affected.

5 MANAGEMENT GOAL AND OBJECTIVES

Vivid Dancer occurs in two provinces and within habitats owned and/or managed by different governments, agencies within those governments, and private landowners. The management goal, short-term statements towards meeting the management goal and management objectives reflect the different approaches in each province.

5.1 Management Goal

The management (subpopulation and distribution) goal is to improve the redundancy of Vivid Dancer at all extant subpopulations (some with multiple sites) in Canada (including any additional sites that may be identified in the future) by ceasing or mitigating human-caused threats that result in the loss of area, extent, and/or quality of suitable habitat.

The short-term statements towards meeting the management goal are:

1. to maintain the persistence of Vivid Dancer at all extant sites (and any new sites) in Canada; and

2. to prevent any further loss in the quantity or quality of remaining suitable habitat within the dispersal distance (i.e., up to 500 m[11] from a site) of the aquatic habitat of all known records at all extant sites (and any new sites).

5.2 Rationale for the Management Goal

There are 33 subpopulations of Vivid Dancer in Canada, 27 of which are extant. These records are the result of both targeted searches and incidental collection (i.e., random chance collections when surveying for other species) over many years.

Given the limited number of known Vivid Dancer subpopulations, the management goal and short-term statements were set to ensure the redundancy of the species at all extant subpopulations in both British Columbia and Alberta. There are a limited number of thermal and cool spring habitats in western Canada, these habitats are not easily restored nor easily created, and the ability for one subpopulation of Vivid Dancer to recolonize another is unlikely. Preventing habitat loss and degradation at habitats with extant subpopulations ensures the number of subpopulations stays above thresholds that may otherwise warrant consideration for uplisting the species.

There is little information on adult damselfly terrestrial foraging distance in habitats surrounding nymphal aquatic habitats. A foraging distance of 500 m surrounding extant aquatic sites was chosen based on related species and compiled into recommendations for Vivid Dancer by NatureServe (2004ab). The foraging distance should include the breeding site, surrounding pond and upland habitat extending 500 m in a radius from the breeding site.

Specific subpopulation targets cannot be quantified at this time because subpopulation information for Vivid Dancer is limited, incomplete, and/or outdated. Consequently, there is little information with which to measure abundance trends or to complete a minimum subpopulation viability analysis. Life span, dispersal, and recolonization capabilities are unknown, and detailed aquatic habitat requirements are unclear. Fulfilling these knowledge gaps will provide important information that will help maintain the abundance of known subpopulations and will allow the management goal to be quantified in the future.

It is unlikely that suitable habitat for Vivid Dancer was more widespread in the past, due mainly to the specificity of the species' thermal spring habitat requirements. Furthermore, because there is currently no information or evidence from historical sampling to suggest that the species' range was more widespread in the past, a management goal of actively increasing the number of subpopulations through translocation or other techniques is not recommended at this time. If additional naturally occurring subpopulations are recorded, they will be included in management planning.

[11] A foraging distance of 500 m surrounding extant aquatic sites was chosen based on related species and compiled into recommendations for Vivid Dancer by NatureServe (2004ab, 2020). NatureServe (2020) states: "The few studies determining area of adult foraging habitat surrounding breeding sites have indicated a range of 30 meters to 300 meters [see Briggs (1993) for *Enallagma laterale*; Corbet (1999) for *Nesciothemis nigeriensis* and *Calopteryx haemorrhoidalis*; Beukeman (2002) for *Calopteryx haemorrhoidalis*; and Samways and Steytler (1996) for *Chorolestes tessalatus*]".

5.3 Management Objectives

The management objectives[12] for Vivid Dancer in both British Columbia and Alberta are:

1. to confirm the distribution of the species within its Canadian range;
2. to estimate abundance at each extant subpopulation;
3. to assess the extent of threats to each extant subpopulation and reduce their impacts;
4. to address knowledge gaps (e.g., aquatic requirements, life history); and
5. to increase the public knowledge of the species and its associated aquatic springs.

Additional management objectives for Vivid Dancer in Alberta are:

6. to develop and implement a monitoring program at known and newly identified subpopulations and sites;
7. continue protection of the species under the *Canada National Parks Act*; and
8. mitigate any new threats that are identified.

Additional management objectives for Vivid Dancer in British Columbia are:

9. to secure protection[13] for extant subpopulations.

6 APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Underway

The following actions have been categorized by the action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2009). Status of the action group for this species is shown in parentheses.

Compile Status Report (complete)

- 2015 COSEWIC report

Send to COSEWIC (complete)

- Vivid Dancer assessed as Special Concern (COSEWIC 2015). Re-assessment due 2025.

Planning (in progress)

- British Columbia and Alberta Management Plan completed (this document, 2020).

[12] Taken together, the objectives will achieve the goal if successfully implemented. Objectives describe a set of specific activities that need to be accomplished to achieve the goal. Objectives focus on outcomes, but do not prescribe mechanisms or methods for achieving those outcomes. The following SMART acronym is used to describe important characteristics of objectives (e.g., **S**pecific, **M**easurable, **A**chievable, **R**elevant/results-focused/realistic and **T**ime-bound. Note that time targets are omitted from objectives and are instead specified in the section "Measuring Progress."(British Columbia Guide to Recovery Planning for Species and Ecosystems at Risk April 2016. Available at http://a100.gov.bc.ca/pub/eirs/finishDownloadDocument.do?subdocumentId=10332 [Accessed Sept. 2020])

[13] Protection can be achieved through various mechanisms, including voluntary stewardship agreements, conservation covenants, land use designations, protected areas, and sale of private lands by willing vendors. A number of subpopulations are already protected under existing legislation (e.g., #1, 2, 11, 20, 29, 30).

Inventory (in progress)
The most recent inventory for British Columbia and Alberta is detailed in the COSEWIC (2015) status report. Most of the inventory needs are within British Columbia.

British Columbia inventory:

- 1900–2020: More than 3000 person-hours of inventory for adult damselflies and dragonflies have been documented and have generated more than 18,000 records from 1200 sites across British Columbia (COSEWIC 2011; C. Copley, pers. comm., 2017).
- Non-targeted and opportunistic searches have occurred simultaneously during surveys for other aquatic invertebrates; however, Vivid Dancer has not been recorded. Although the dates, search times, and subpopulations have not specifically been recorded, the species would have been noted by specialists during those surveys (R.A. Cannings, pers. comm., 2017; C. Copley, pers. comm., 2017; D. Copley, pers. comm., 2017; O. Dyer, pers. comm., 2017; K. Needham, pers. comm., 2017; L. Ramsay, pers. comm., 2017).
- 2015: During an inventory conducted at Ram Creek Ecological Reserve (#11), approximately 10 adult specimens and at least 20 nymphs were recorded (J. Heron, pers. comm., 2017).
- 2000–2008: Dragonfly and damselfly inventories were conducted in the Okanagan and Similkameen valleys (Cannings *et al*. 1998), the Columbia Basin east of the Okanagan, central and northern British Columbia (Cannings *et al*. 2000), thermal springs near Ram Creek (#11), Dewar Creek (#3), Wildhorse Creek (#12), Pebble Creek (#30), and Wilson Creek (#9)(Salter 2003), and in the southern Caribou north of the Thompson valley (COSEWIC 2011).
- 2020: Inventory was conducted at Meager Creek (#29) on June 25 and July 9, 2020, and at Pebble Creek (Keyhole) Hot Springs (#30) on June 16, 2020. Vivid Dancer was confirmed at both these subpopulations (J. Heron, pers. obs.).
- Minimal inventory has been conducted at cool springs in British Columbia, due mainly to poor mapping of this geological feature. Cool springs that have been mapped within the Okanagan valley and Lytton/Lillooet areas have potential habitat that should be surveyed.

Alberta inventory:

- 1994–2014: Inventory confirmed the presence of breeding individuals at Forty Mile Creek (#1g) (Rice 2002b). Inventory at Vermilion Lake (#1i) and the old Alpine Hut (#1b) confirmed the presence of adults breeding remains unconfirmed (Rice 2002b; Hornung and Pacas 2006).
- 1996–2000: Seventeen separate thermal springs in Banff National Park were surveyed once every 3 weeks from January through July.
- October 1998–July 2013: Thermal springs in the Bow Valley and between Norquay and Brewster Mountains were surveyed at least four times. Vivid Dancer was not recorded during these surveys.
- There are few thermal springs in Alberta. Cool springs are not well mapped in the province, and most have not been surveyed for Vivid Dancer.

Habitat Protection, Restoration, and Private Land Stewardship (in progress)

British Columbia:

- No specific habitat protection for Vivid Dancer has been established. Existing mechanisms that could provide habitat protection for the species are listed in Table 5.
- The provincial *Water Sustainability Act* (Province of British Columbia 2020) came into effect February 29, 2016. It replaces the provincial *Water Act*, as well as components of the *Fish Protection Act*, which has been renamed the *Riparian Areas Protection Act* (Province of British Columbia 2016), with some sections repealed. The *Water Sustainability Act* includes some guidance on the protection of sensitive streams and aquatic ecosystems. For example, under Section 16, the decision-maker can require mitigation measures for, and changes in and about, a stream (including the diversion of a stream) when proposed activities are likely to have an adverse impact on an aquatic ecosystem. Additional potential protection mechanisms are included in Part 3, Division 4, which refers to "Water Sustainability Plans" (Section 65). Under this section, the Minister may designate an area for the development of a Water Sustainability Plan if the Minister considers that it will help prevent or address risks to aquatic ecosystem health.
- Components of the *Riparian Areas Protection Act* calls on local governments to protect riparian areas during residential, commercial, and industrial development by ensuring that a qualified environmental professional conducts a science-based assessment of proposed activities (Province of British Columbia 2016).
- Vivid Dancer is a candidate for listing as a "Species at Risk" under the *Forest and Range Practices Act* and *Oil and Gas Activities Act*.
- In 2015, the logging road leading to the base of Ram Creek (#11) was rehabilitated by planting conifers and seeding with native vegetation. These restoration actions were taken to prevent vehicular access to the site (both road and all-terrain vehicles).

Alberta

- All extant subpopulations of Vivid Dancer occur on federal land within Banff National Park and therefore are protected under the federal *Canada National Parks Act*.
- The Cave, Basin, Upper Cave and Basin, and Lower Cave and Basin pools are included as part of the Cave and Basin NHS (#1c), which is managed to preserve commemorative integrity (Parks Canada 1998, 2007) in accordance with the management plan for the site and the Commemorative Integrity Statement (Lepitzki and Pacas 2010), and to protect their ecological integrity because they are within Banff National Park.
- Some sections of Cave and Basin NHS (#1c) and Middle Springs (#1e), and the entire Kidney Spring (#1d) have been identified as critical habitat for Banff Springs Snail (*Physella johnsoni*) (Lepitzki and Pacas 2010) under the federal *Species at Risk Act*. These areas also protect co-occurring Vivid Dancer habitat. For example, the Sulphur Mountain Wildlife Corridor (Lower Middle [#1e]) is permanently closed to unauthorized persons, and the closure is enforced through regular patrols and electronic surveillance. Similarly, the entire Kidney Spring (#1d) is under a permanent area closure that has been implemented to protect the Banff Springs Snail. Illegal swimming at the Cave and Basin NHS pool (#1c) and Middle Springs Cave spring pool (#1e) has been reduced through signage, fencing, installation of a security system, daily staff presence, and prosecution of trespassers.

Table 5. Existing mechanisms that afford habitat protection for Vivid Dancer.

Mechanism	Threat[a] or concern addressed	Subpopulation no.
Riparian Areas Protection Act Section 12 (Province of British Columbia 2016)	1.1; 1.2; 1.3	BC: 2–33
Water Sustainability Act (Province of British Columbia 2020)	7.2; 9.1	BC: 2–33
Land Act, Section 16 Reserve; Section 17 Reserve or Notation of Interest (Province of British Columbia 1996a)	1.1; 1.2; 1.3; 2.3; 4.1	BC: 2–3
Parks Act (Province of British Columbia 1996b)	All	BC: 2, 3, 11, 20
Ecological Reserve Act and Regulations (Province of British Columbia 1996c)	All	BC: 11
Protected Areas of British Columbia Act (Province of British Columbia 2000)	All	BC: 2, 3, 11, 20
Canada National Parks Act (Canada 2000)	All	AB: 1
Forest and Range Practices Act (Province of British Columbia 2002)	2.3; 4.1; 5.3	BC: 8, 9, 12, 14, 15, 16, 17, 18, 19, 21, 23, 24, 29, 30
Oil and Gas Activities Act (Province of British Columbia 2008)	2.3; 4.1; 3.1; 3.2; 3.3	BC: 8, 9, 12, 14, 15, 16, 17, 18, 19, 21, 23, 24, 29, 30

[a] Threat numbers according to the IUCN–CMP classification (see Table 3 for details).

6.2 Recommended Management Actions

Management planning for Vivid Dancer is concurrent with management planning approaches for species that co-occur within thermal springs habitats. Because of the extensive knowledge gaps for Vivid Dancer, most of the management planning activities listed in Table 6 centre on inventory, habitat information gathering, habitat mapping, and threat clarification, particularly in British Columbia. These activities will help prioritize areas for future surveys and inform habitat protection efforts. A combined approach to conservation also includes engaging the academic, naturalist, and stewardship communities in species management projects; including inventory, natural history, and habitat information gathering. In Alberta, all subpopulations occur within Banff National Park and receive protection under the *Canada National Parks Act* and consideration under the *Species at Risk Act*. Most of the subpopulations are within areas that are permanently closed, and there are few other threats to mitigate (e.g., keeping deleterious substances out of Vivid Dancer habitat). Actions in Alberta focus on (1) development and implementation of a monitoring program, (2) continued protection of the species under the *Canada National Parks Act*, and (3) mitigating any new threats that are identified.

Table 6. Recommended management actions for Vivid Dancer.

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
			Protect extant habitats			
1, 3, 7, 9	Habitat Protection, Restoration and Private Land Stewardship	BC	1. Confirm land ownership of both the aquatic spring habitat and terrestrial habitats adjacent to known Vivid Dancer subpopulations.	Compile a list of landowners for each known subpopulation and the adjacent surrounding habitat by 2025.	All threats	Essential
		BC and AB	2. Clarify the scope, severity, and timing of the threats applicable to the aquatic and terrestrial habitats of extant Vivid Dancer subpopulations. This action overlaps the conservation actions outlined under Objective 3.	AB: Threats have been accurately assessed at AB subpopulation sites. BC: Establish protocols to compare and measure subpopulation and habitat-specific threats at known subpopulations by 2025.	All threats	Necessary
		BC	3. Work with private landowners (#4–7, 10, 13, 22, 25, 26–28, 31–33) to determine appropriate stewardship measures, develop best management practice guidelines to mitigate habitat-specific threats to the aquatic springs habitats, protect habitat, and restore vegetation for use as emergence habitats.	Work toward stewardship agreements and/or covenants for known (and any new) Vivid Dancer habitats on private conservation lands and regional district and municipal lands by 2025.	1, 2.3, 6.1, 8.1, 9	Necessary
		BC	4. On undesignated B.C. provincial Crown land habitats, establish Section 15 or 16 Reserve and/or a Notation of Interest and/or Section 17 (conditional withdrawal) under the *Land Act* such that future development interest knows species-at-risk habitat occurs on the habitat.	Establish habitat polygon maps by 2025 for Vivid Dancer habitats on B.C. provincial Crown land and work toward Section 15 or 16 Reserve and/or Notation of Interest and/or Section 17 (conditional withdrawal) under the provincial *Land Act* at these habitats.	All threats	Essential

[14] B.C. Ministry of Environment, 2009. Conservation framework action groups as outlined in B.C. Ministry of Environment 2009.

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
		BC	5. Determine whether water licences have been granted within the immediate vicinity of Vivid Dancer aquatic habitats. If a water licence has been granted, assess whether it has a detrimental impact on Vivid Dancer subpopulations, and/or apply for a water licence for conservation purposes under the British Columbia *Water Sustainability Act* for all known Vivid Dancer habitats.	Compile a list of water licences within all Vivid Dancer habitats, and secure water licences for conservation purposes by 2025.	1.1, 1.2, 3.3, 7.2	Necessary
		BC	6. Recommend Vivid Dancer be a priority for listing in the category "Species at Risk" under the British Columbia *Forest and Range Practices Act* and *Oil and Gas Activities Act.*	Recommend Vivid Dancer for listing as Species at Risk under these Acts and draft an *Identified Wildlife Management Species Account* for Vivid Dancer under these Acts by 2025.	All	Necessary
		BC and AB	7. Update the park/management planning documents for confirmed subpopulations/habitats within British Columbia and Alberta owned areas (Banff National Park #1; Lussier [Whiteswan] Hot Springs (#2); White Lake (#20), Ram Creek Ecological Reserve (#11).	AB: Banff National Park planning documents are updated, and park management objectives currently include those measures to protect Vivid Dancer and its habitat. BC: Update park plans with appropriate Vivid Dancer management information; if no park planning documents are available, then draft a separate management recommendation plan for the parks specifically for Vivid Dancer by 2025.	1.3, 6.1	Necessary

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
2, 4, 6	Habitat	BC and AB	**Confirm distribution and address knowledge gaps, such as habitat requirements for each life stage** 8. Develop a standard, repeatable technique for recording baseline subpopulation abundance information at each known habitat and to monitor future trends.	Develop and test subpopulation monitoring protocols by 2025.	Knowledge gaps; all threats	Essential
	Habitat (cont'd)	BC and AB	9. Develop standardized inventory protocol for surveys at extant habitats that include the recording of habitat attributes, aquatic and terrestrial plant community information, life stage surveys (e.g., months to survey for specific life stages), water quality data (e.g., temperature, conductivity), immediate threats, and other natural history information.	Develop and test inventory protocols by 2025.	Knowledge gaps; all threats	Essential
		BC and AB	10. Using the standard inventory protocol (Action 9), compile existing information for all extant habitats.	Complete habitat descriptions for each Vivid Dancer subpopulation by 2025.	Knowledge gaps; all threats	Necessary
		BC	11. For those subpopulations associated with cool springs in the Fraser River canyon (#14–17) and Okanagan valley (#18–28), using the information obtained (Action 1–10), develop inputs to a habitat suitability model that can be mapped using geographic information system (GIS).	Complete a habitat suitability model to guide and prioritize future inventory work by 2025.	Knowledge gaps; all threats	Necessary
		BC	12. Use the outputs from the habitat suitability model (Action 11) to prioritize survey habitats in unchecked	Identify and continue to inventory additional potential habitat within	Knowledge gaps; all threats	Essential

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
			potential habitat in the Okanagan and Lillooet valleys.	the species' range and refine the habitat model (ongoing).		
		BC and AB	13. Develop a 10-year inventory schedule and landowner contact strategy for priority habitats.	AB: Monitor Vivid Dancer subpopulations at least once during the 10-year period. BC: Identify and continue to inventory additional potential habitat within the species' range and refine the habitat model (ongoing).	Knowledge gaps; all threats	Necessary
		BC	14. Work with landowners and/or land managers to identify potential Vivid Dancer habitat and survey priority habitats.	Identify and continue to inventory additional potential habitat within the species' range and refine the habitat model (ongoing).	Knowledge gaps; all threats	Essential
		BC and AB	15. Inventory priority habitats, record the standard information (above) at all habitats searched, including habitats where the species has not been recorded (e.g., null habitats).	AB: Monitor Vivid Dancer subpopulations at least once during the 10-year period BC: Identify and continue to inventory additional potential habitat within the species' range and refine habitat model (ongoing).	Knowledge gaps; all threats	Essential
		BC and AB	16. Use knowledge gained through surveys to refine the habitat model.	AB: Monitor Vivid Dancer subpopulations at least once during the 10-year period BC: Identify and continue to inventory additional potential habitat within the species' range and refine the habitat model (ongoing).	Knowledge gaps; all threats	Necessary

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
3, 6, 8	Monitor Trends	BC and AB	**Develop threats assessment and monitor extant habitats** 17. Confirm the scope, severity, and timing of all applicable threats, including new threats, to each extant Vivid Dancer subpopulation.	AB: Threats to these subpopulations are currently mitigated; new threats will be documented. BC: Complete protocols to measure and compare habitat-specific threats by 2025.	Knowledge gaps; all threats	Necessary
		BC and AB	18. In conjunction with the standard inventory protocol, develop protocols to measure and compare habitat-specific threats at each extant subpopulation.	Complete protocols to measure and compare habitat-specific threats by 2025.	Knowledge gaps; all threats	Necessary
		BC and AB	19. Develop threat monitoring protocols at known habitats (e.g., photographic monitoring, water quality monitoring) to monitor long-term habitat changes.	Implement habitat monitoring at known subpopulation habitats by 2025.	Knowledge gaps; all threats	Essential
		BC and AB	20. Evaluate the effectiveness of measures used to prevent deleterious substances from entering the water and potentially impacting larval habitat (e.g., water quality monitoring).	Implement habitat monitoring at known subpopulation habitats by 2025.	Knowledge gaps; all threats	Essential
		BC and AB	21. At extant habitats, monitor the introduction of natural sedimentation into the aquatic habitats and the changes to riparian structure adjacent to those aquatic habitats.	Implement habitat monitoring at known subpopulation habitats by 2025.	Knowledge gaps; all threats	Essential
		BC and AB	22. Document the introduction and/or presence of invasive species at extant habitats; address knowledge gaps regarding how aquatic invasive species	Implement habitat monitoring at known subpopulation habitats by 2025.	8.1	Essential

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
			(e.g., fairy shrimp, aquatic invasive plants) impact Vivid Dancer nymphs.			
5	Private Land Stewardship and Habitat Protection	BC and AB	**Increase the profile of Vivid Dancer** 23. Increase public awareness of the existence, conservation value, threats, and harm reduction measures for Vivid Dancer and associated thermal and cool springs habitats.	AB: Parks Canada has integrated Vivid Dancer into many of its public information initiatives, including information on thermal springs. BC: Develop Vivid Dancer information sheets that are specific to landowners, land stewards, managers, lease holders and the sector, and which outline the threats applicable to that sector and the stewardship actions to mitigate those threats by 2025.	All	Beneficial
		BC and AB	24. Update and/or share knowledge with regional conservation organizations about Vivid Dancer and encourage integration of the species into biodiversity planning and engagement actions currently led by these conservation organizations and associated partners. In British Columbia, these partners include the South Okanagan–Similkameen Conservation Program, BC Nature, The Nature Trust, The Nature Conservancy, The Land Conservancy, the Osoyoos Lake Water Quality Society, South Coast Conservation Program, and additional local organizations. In Alberta, these organizations include the Friends of	AB: Parks Canada has integrated Vivid Dancer into many of its current planning initiatives. BC: Develop an outreach strategy for Vivid Dancer and other species that use thermal springs and cool springs by 2025.	All	Beneficial

Objective(s)	Conservation Framework action group[14]	Province applicable	Actions to meet objectives	Performance measure	Threat[a] or concern addressed	Priority[b]
			Banff National Park and the Bow Valley Naturalists.			
		BC and AB	25. Engage local stewardship and conservation groups, such as those listed in Action 24, through the development and delivery of public education and outreach materials specific to Vivid Dancer.	a. Develop a public outreach and communications approach, as necessary, to minimize impacts from threats at known habitats (e.g., from recreational activities) by 2025. b. Develop resource materials for a workshop on damselfly natural history, conservation of damselflies and their thermal and cool spring habitats by 2025. c. Determine what additional species at risk overlap the habitats of each extant Vivid Dancer subpopulation and how conservation action(s) impact those species by 2025. d. Engage private landowners (where applicable) in participating in the Environmental Farm Plan Program.	All	Beneficial

[a] Threat numbers according to the IUCN–CMP classification (see Table 3 for details).
[b] Essential: urgent and important, needs to start immediately; Necessary: important but not urgent, action can start in 2–5 years; Beneficial: action is beneficial and could start at any time that is feasible.

6.3 Narrative to Support Management Actions Table

Recommended actions have been categorized by the action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2009).

6.3.1 Habitat Protection

Planning activities, including landscape planning and zoning to prevent the loss of thermal springs and cool springs habitats, are focused on subpopulations throughout British Columbia" or "Planning activities include landscape planning and zoning to prevent the loss of thermal springs and cool springs habitats that are used by subpopulations throughout British Columbia. Actions include identifying where the habitats are located and the land ownership of those sites; working with the landowner(s), including municipalities, on zoning and habitat protection; clarifying threats; and incorporating Vivid Dancer and its habitats into site-specific plans for localities in which the species is known to occur. Opportunities should be taken to include Vivid Dancer habitats in various planning processes, such as creating new and updated provincial park master plans and local development areas, private conservation land management plans, and other similar documents.

Listing of Vivid Dancer as Identified Wildlife under the province's *Forest and Range Practices Act* and *Oil and Gas Activities Act* is recommended to allow for various additional habitat protection mechanisms, such as the establishment of Wildlife Habitat Areas. Whenever feasible, including the species in multi-species management programs is recommended.

Subpopulations within Banff National Park already receive protection under the *Canada National Parks Act* and consideration under the *Species at Risk Act*. For example, s79 under the Species at Risk Act states requirements to identify, mitigate and monitor adverse effects to the species when conducting environmental impact assessments, which applies to species of Special Concern (i.e., Vivid Dancer). Most of the subpopulations are within areas that are permanently closed, and there are few threats to mitigate (e.g., deleterious substances are already kept out of Vivid Dancer habitat).

6.3.2 Inventory

Some thermal springs throughout the Canadian range of Vivid Dancer, primarily in British Columbia, have not been surveyed for the species, nor have unmapped and undocumented cool springs. Actions in this management plan are intended to apply a systematic approach to inventory. The first step is to conduct geographic information system (GIS) habitat suitability mapping based on thermal and cool springs biophysical mapping. Developing standard survey protocols will improve the effectiveness of surveys, and a 10-year inventory schedule will enable the systematic tracking of progress. Because of the relatively large area involved, a prioritized sampling regime is required to cover different geographic areas across the species' range.

Most thermal springs within Banff National Park have been well surveyed for Vivid Dancer; therefore, this action is not a priority there. Confirmation of breeding is needed at the Alpine Hut

(#1b) and Vermilion (#1i) sites as well as the two unconfirmed sites in British Columbia (Radium Hot Springs #10 and East of Nelson #13).

6.3.3 Ecosystem and Habitat Protection, Restoration, and Private Land Stewardship

In British Columbia, there are numerous thermal and cool springs on private lands; therefore, stewardship activities and securement through covenants and Memoranda of Understanding are an essential component of habitat protection and management. Actions include collaboration with local conservation groups that are already working with private landholders and encouraging them to protect habitat through habitat management or formal means such as conservation covenants. Under the *Agricultural Land Commission Act*, Section 22 (2), a covenant that restricts or prohibits the use of agricultural land for farm purposes has no effect until approved by the commission. Further information about entering into a covenant within the Agricultural Land Reserve may be obtained from the Agricultural Land Commission.

Actions also include raising awareness among landholders and managers about Vivid Dancer and its thermal/cool springs habitats through outreach activities conducted in partnership with governments and local conservation organizations, industry associations, farmer institutes, and/or researchers. For example, the Environmental Farm Plan Program is a voluntary and confidential program that helps farmers identify and subsequently reduce on-farm environmental risks. The program currently allows participating farmers to apply for cost-shared funding to implement beneficial management practices related to reducing impacts on air quality; improving land and water quality and enhancing or protecting biodiversity; improving management of nutrients; managing agricultural input and waste; and managing irrigation water. The Environmental Farm Plan Program can help increase the adoption of voluntary stewardship actions.

Draft recommendations for habitat restoration at thermal springs with extant subpopulations of Vivid Dancer in British Columbia where significant historical habitat alteration has occurred need to be developed for subpopulations associated with those sites.

In Banff National Park (#1), Vivid Dancer already receives habitat protection. The one historical subpopulation in Banff National Park (#1a) and four historical subpopulations in British Columbia (#2, 5–7) are not priority sites for restoration.

6.3.4 Monitoring

Owing to Vivid Dancer's small size and cryptic habits, its large geographic range, and the resources required to conduct thorough annual surveys for the species, it is not logistically feasible to monitor all sites that it occupies. Actions focus on monitoring trends in the extent and quality of habitat rather than on trends in Vivid Dancer abundance at each thermal/cool springs site, and are applicable to subpopulations in both Alberta and British Columbia. The presence of Vivid Dancer adults and nymphs recorded during site surveys indicates that the subpopulation is persisting if the habitat remains intact and threats are minimized. Actions address the development and implementation of a program for monitoring habitat trends at prioritized sampling stations in different portions of the species' range. Collaborative opportunities for incorporating monitoring into a multi-species program (e.g., under climate change monitoring,

water quality monitoring) are to be explored. At present, habitat monitoring is ongoing at some sites in Banff National Park (#1).

7 MEASURING PROGRESS

Performance measures provide a way of defining and measuring progress toward achieving the management goals and objectives. Performance measures are listed in Table 6 in Section 6.2. The management plan will be reviewed in 10 years to assess progress and identify additional approaches or changes that may be required to achieve conservation of Vivid Dancer.

8 EFFECTS ON OTHER SPECIES

Management actions for Vivid Dancer will be implemented with consideration for all co-occurring species at risk so that no negative impacts on those species or their habitats occur.

British Columbia: In addition to Vivid Dancer, numerous provincially listed species and species assessed by COSEWIC occur within thermal springs habitats (note: some COSEWIC species are also provincially listed) (BC CDC 2020). For example, at Fairmont Hot Springs, eight rare plant species, including the federally listed endangered Southern Maidenhair Fern (*Adiantum capillus-veneris*), co-occur with Vivid Dancer (Environment Canada 2013), and there is a record of Rubber Boa at Radium Hot Springs (#10). A full list of species at risk that co-occur at each thermal springs site has not yet been created; this is an action listed in Table 6. 6.

Alberta: Some of the thermal springs in Banff National Park provide habitat for the Canadian endemic Banff Springs Snail (Endangered) (COSEWIC 2008), and some sections were home to the extinct Banff Longnose Dace (*Rhinichthys cataractae smithi*), an endemic subspecies (Lanteigne 1987; Renaud and McAllister 1988). In addition, 28 species of rare mosses and three species of liverworts occur within some of the Banff area thermal springs (Krieger 2003; Lepitzki and Pacas 2010).

Protection for Vivid Dancer habitat will benefit some of these species. Many of the actions in Table 3 are concurrent with actions for other species at risk that are being implemented by the South Coast Conservation Program, South Okanagan–Similkameen Conservation Program, and other conservation initiatives in the Thompson River valley.

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