**U.S. FISH AND WILDLIFE SERVICE**
**SPECIES ASSESSMENT**
**AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: ***Hygrotus diversipes***

COMMON NAME: **Narrow-foot Hygrotus Diving Beetle**

LEAD REGION: **R6**

LEAD REGION CONTACT: **Sarah Backsen, Regional Office, Mountain Prairie Region 6, (303) 236-4388, sarah_backsen@fws.gov**

LEAD FIELD OFFICE CONTACT: **Julie Reeves, Wyoming Ecological Services Field Office, (307) 757-3717, julie_reeves@fws.gov**

DATE INFORMATION CURRENT AS OF: **March 10, 2023**

STATUS/ACTION

___Species petitioned for listing which we have determined is not a listable entity

**x___** Species petitioned for listing which we have determined does not warrant listing (does not meet the definition of a threatened or endangered species)

___Non-listed species for which we have not received a petition but for which we have undertaken a species status assessment on our own initiative and which we have determined does not warrant listing (does not meet the definition of a threatened or endangered species)

___Listed species petitioned for delisting which we have determined does not warrant delisting

___ Listed species petitioned for downlisting which we have determined does not warrant downlisting

___ Listed species petitioned for uplisting for which we have made a warranted-but-precluded finding for uplisting (this is part of the annual resubmitted-petition finding)

___ Listed species petitioned for uplisting which we have determined does not warrant uplisting

___ New candidate
___ Continuing candidate
Date when the species first became a candidate (as currently defined): NA

___ Listing priority number change
Former LPN: ___
New LPN: ___

___ Candidate removal: Former LPN: ___
___ Taxon does not meet the Act’s definition of “endangered species” or “threatened

species” because it is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

____Taxon does not meet the Act’s definition of “endangered species” or “threatened species” because it is not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ Taxon does not meet the Act’s definition of “species.”

___ Taxon mistakenly included in past notice of review.

___ Taxon believed to be extinct.

Petition Information:

___ Non-petitioned

**__x_** Petitioned; Date petition received: **July 17, 2013**

90-day “substantial” finding FR publication date; citation: **January 12, 2016, 81 FR 1368-1375**

12-month “warranted but precluded” finding FR publication date; citation: NA

PREVIOUS FEDERAL ACTIONS:

On July 17, 2013, we received a petition from WildEarth Guardians to list the narrow-foot hygrotus diving beetle (*Hygrotus diversipes*), henceforth “diving beetle,” as an endangered or threatened species under the Endangered Species Act (Act). On January 12, 2016, we published a 90-day finding (81 FR 1368) that the petition contained substantial information indicating listing may be warranted for the species. On April 21, 2020, WildEarth Guardians filed suit (Case No. 1:20-cv-1035) to compel us to complete a 12-month finding. We subsequently agreed to submit a 12-month finding for the diving beetle to the Federal Register by August 15, 2023. This document constitutes our 12-month finding on the July 17, 2013, petition to list the diving beetle under the Act.

ANIMAL GROUP AND FAMILY/PLANT GROUP, ORDER AND FAMILY:

Group: Insects

Order: Coleoptera

Family: Dytiscidae

## ANALYTICAL FRAMEWORK

To assess the diving beetle’s viability, we conducted a species status assessment (SSA) using the three conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 306–311). Briefly, resiliency supports the ability of the species to withstand environmental and demographic stochasticity (for example, wet or dry, warm or cold years, variation in demographic rates), redundancy supports the ability of the species to withstand catastrophic events (for example, droughts, large pollution events), and representation supports the ability of the species to adapt to both near-term and long-term changes in its physical and biological environment (for example, climate change, disease). A species with a high degree of resiliency, representation, and redundancy is better able to adapt to novel changes and to tolerate environmental stochasticity and catastrophes. In general, species viability will increase with increases in resiliency, redundancy, and representation (Smith et al. 2018, p. 306). Using these principles, we identified the species’ ecological requirements for survival and reproduction at the individual, population, and species levels, and described the beneficial and risk factors influencing the species’ viability.

We use the SSA framework to assemble the best scientific and commercial data available for this species. The SSA framework consists of three sequential stages. During the first stage, we evaluate the species' needs. The next stage involves an assessment of the historical and current condition of the species' demographics and habitat characteristics, including an explanation of how the species arrived at its current condition (i.e., how threats and conservation actions have influenced the species). The final stage of the SSA framework involves assessing the species' plausible range of future responses to positive and negative environmental and anthropogenic influences. The SSA framework uses the best available information to characterize viability as the ability of a species to sustain populations in the wild over time and is used to inform our regulatory decision.

The SSA report does not represent a decision by the Service on whether the diving beetle should be listed as an endangered or threatened species under the Act. However, it does provide the scientific basis that informs our regulatory decisions, which involve the further application of standards within the Act and its implementing regulations and policies. The Species Status Assessment Report for the Narrow-foot Hygrotus Diving Beetle (*Hygrotus diversipes*) – December 2022, Version 1.0 (SSA Report) is a summary of the information we have assembled and reviewed and incorporates the best scientific and commercial data available for this species. Excerpts of the SSA Report are provided in the sections below. For more detailed information, please refer to the SSA Report (Service 2022, entire).

## BIOLOGICAL INFORMATION

Narrow-foot hygrotus diving beetles (diving beetles, hereafter) are small aquatic beetles found in central Wyoming within a specific geology of Cody Shale substrates or soils derived from Cody Shale in Fremont, Johnson, Natrona, and Washakie counties. This beetle has likely never had a wider distribution than the narrow range it currently occupies.

Diving beetles develop through egg, larval, pupal, and adult stages and rely on small, transitory, saline pools that form during the drying down of ephemeral streams in summer, with all life stages either occurring in or adjacent to these pools. Diving beetles require refugia and prey in pools and hydrologically intact areas surrounding pools, which support higher water quality and seasonally appropriate timing and quantities of water in pools. Diving beetle sites appear to function as a metapopulation, and as such, connectivity among pools is essential for diving beetles; pools need to be near enough to each other that, when local conditions in one pool become unsuitable, either adults can fly overland to another pool or that individuals at any life stages can flow downstream to another pool with suitable habitat. The frequency across years with which pools are occupied by diving beetles is also important for diving beetles; more frequently occupied pools reliably provide for the needs of diving beetles, and while infrequently occupied pools do not support diving beetles in most years, they do support diving beetles in years with extreme weather conditions that make other sites unsuitable.

<u>Habitat and Life History</u>

Diving beetles occupy small, transitory, saline pools that form during the drying down of ephemeral streams in summer, with all life stages either occurring in or adjacent to these pools; however, adults are able to fly overland. These pools are typical of ephemeral prairie streams, which are the result of water remaining in a series of low areas with high concentrations of dissolved salts and being fed by shallow groundwater, springs, and seeps (Tronstad 2014, p. 4), and occur in the warmest locations in Wyoming (Swanson 2012, p. 2). Typically, snowmelt and spring precipitation recharge the groundwater that supports these pools throughout the spring and into the summer as pools dry (Tronstad 2015, p. 6). Water flow can be highly variable and prone to late-spring and summer flooding events, with a single rainstorm sometimes transforming a dry bed to a flowing stream. These flooding events are typically highly localized, and other nearby pools may continue to provide conditions that meet the needs of adult diving beetles, which can seek refuge by flying, as described below (Tronstad 2022a, pers. comm.). Because pool conditions can be variable throughout a season or among years, the proximity of other pools that can provide refuge is likely an important aspect of diving beetle habitat.

Diving beetles have complete metamorphosis, with egg, larval, pupal, and adult life stages. To the extent possible, we applied the limited information available on larval and adult stages and habitat use by diving beetles, including observations from recent diving beetle surveys. Where information is not available about the exact timing, duration, and habitat use of each life stage or the specifics of the population dynamics for diving beetles, we applied information for related species. In the SSA report, we provide a thorough discussion of our assumptions and uncertainties and note where information from other species or anecdotal observations from recent diving beetle surveys has been extrapolated to inform our description of diving beetles' life history and habitat (Service 2022, pp. 6–18).

Based on the life cycle of other *Hygrotus* species, diving beetles likely live only one year with adults overwintering and mating the following spring and summer in pools (Mead 1993, p. 2; Tronstad 2022a, pers. com.). After mating, females lay eggs in the pools, and these eggs hatch and rapidly develop through three larval instars (phase between two periods of molting). The duration of each instar stage is likely determined by water temperature (Tronstad and Lindsteadt 2021, p. 4) and food availability (as in *H. curvipes*, Mead 1993, p. 25), with the final instar size also dependent upon food availability (Tronstad 2022b, pers. comm.). The final instar larvae crawl to land to develop into pupae at the water's edge and emerge from pupa casing as adults. These newly emerged adults hunt and scavenge before fall temperatures cool. Adults overwinter on land and either return to their natal pool to breed or disperse and colonize pools in the spring when temperatures warm. Diving beetles can fly, and, like other dytiscid adults, they are likely strong flyers that can disperse overland to other breeding pools, find overwintering areas, or leave areas as conditions become unfavorable, for example, as pools dry in the summer (Tronstad 2017 p. 3) or to avoid areas with high rates of parasitism, predation, and competition for resources (Liao 2021, p. 16).

Adaptations to variations in moisture and temperature, particularly hot and dry conditions, throughout the life stages of the diving beetle may help it survive the fluctuating conditions within the pools where it occurs. Larval adaptations appear to include rapid development in the shallow, warm waters of pools (Tronstad and Lindstead 2021, p. 35). For adults, flying may be an important adaptation to relocate to suitable habitat when pools dry, similar to other dytiscids (Bilton 2014, pp. 387–407). For dytiscid beetles, the adult life stage is considered to be the most desiccation-tolerant life stage, with adults of some species found in moist microhabitats below rocks or leaf litter during hot, dry periods of summer (Boulton 1989, p. 26). Adult diving beetles have been captured in similar refugia in stream beds and shallow pools during the warmer months (May through September) (Tronstad 2022a, pers. comm.). Members of Dytiscidae have been known to burrow 27 to 35 in (70 to 90 cm) into streambeds during seasonal droughts, likely contributing to their high survival rates after a drought (Fenoglio et al. 2006, p. 39). Additionally, it is possible that diving beetles may be able to survive prolonged drought, similar to *Agabus disintegrates*, a Californian dystiscid whose adults can survive dormant for up to five months during drought-like conditions (Garcia and Hagen 1987, p. 267).

The ability of diving beetle adults to fly allows individuals to relocate to suitable habitat and colonize new habitats (Tronstad 2017 p. 3). Although we do not know how far adults can fly, diving beetles have potential to travel relatively long distances based on flight distances from other, related species. For example, *Hydaticus bowringii* and *Hydaticus grammicus* can travel up to 12.43 miles (mi) (20.01 kilometers (km)) and 7.82 mi (12.58 km), respectively, in a single flight (Matsushima and Yokoi 2020, p. 335). The idea that the diving beetle can travel similar distances is further supported by the long distances between many of the known sites; the shortest distance between two diving beetle sites is approximately 1.5 mi (2.4 km) and the longest distance between nearest neighboring sites is over 50 mi (80 km)). Although direct flight between pools may be possible, the stream channel and adjacent areas may function as a main pathway for adult dispersal; 90 percent of other adult aquatic insects have been found within 33 to 66 ft (10 to 20 m) of stream corridors (Petersen et al. 2004, p. 934). Diving beetles may move among sites by swimming along stream channels, similar to how other aquatic beetles disperse by following agricultural ditches (Rolke et al. 2018, pp. 477–478), or by flying along dry channels in search of suitable habitats, preferring these to overland flights, similar to other aquatic invertebrates, including other dytiscids (Bogan and Boersma 2012, p. 1138).

Diving beetle larvae and adults are generalist predators and scavengers, opportunistically feeding on smaller organisms and carrion in pools. Similar to other dytiscid larve, diving beetle larvae are likely voracious predators, focusing on larval stages of other aquatic insects like mosquitos (as in *Laccophilus fasciatus rufus*; Bofill and Yee 2019, pp. 201–202 and 208) and other small, live food items such as ostracods and amphipods (Mead 1993, p. 24). Dytiscids are capable of feeding on zooplankton, insects, and decaying animal carcasses (Culler et al. 2014, pp. 366–367). Both larvae and adults may resort to cannibalism when other food resources become scarce, as observed in *H. curvipes* (Mead 1993, p. 24). These opportunistic traits indicate the variety of mechanisms that may allow diving beetle individuals to persist under a variety of ecological conditions and ensure development in potentially fast-drying, temporary pools.
In the SSA report, we provide a thorough discussion diving beetles' life history and habitat, including the key resource needs for the species at the individual, population, and species levels (Service 2022, pp. 4–21).

Historical and Current Range/Distribution

The diving beetle is known from 16 sites in central Wyoming within three main river basins: Powder River, Wind River, and Big Horn River, hereafter referred to as "Basins," in Fremont, Johnson, Natrona, and Washakie counties, Wyoming (Figure 1). The Powder River Basin includes 13 known sites, the Wind River Basin includes 1 known site, and the Big Horn River Basin includes 2 recently discovered sites. Diving beetles were first collected in 1964 at Dugout Creek in the Powder River Basin (Leech 1966), and between 1985 and 2021, have been observed at 15 additional sites. The increase in the number of known sites in more recent years is likely attributed to more intensive survey efforts targeting suitable habitat. The current range of the diving beetle is narrowly distributed within the specific geology of Cody Shale substrates or soils derived from Cody Shale (Tronstad and Lindstead 2021, p. 32), suggesting that the diving beetle has likely never had a wider distribution than it currently occupies.

Across the diving beetle range, sites appear to act as a single metapopulation, supported by patterns of occupancy at individual sites and by the distance between nearest neighboring sites being within a reasonable dispersal distance for diving beetles. The best available information suggests that diving beetle sites function as an interconnected, dynamic network that supports persistence of the whole metapopulation even when individual sites are extirpated, characteristic of a metapopulation (Hanski 1998, p. 43). Observed occupancy from sites that have been surveyed over multiple years indicates that it is typical for sites to support diving beetles in some years but not others, with the apparent absence of diving beetles one year indicating that a site is temporarily unoccupied, rather than extirpated, and is likely to be recolonized in following years. For example, in Dugout Creek, where diving beetles were first observed in 1964, was surveyed in twelve consecutive years between 2010 and 2021 and diving beetles were only observed four of these years. Negative surveys (there is high confidence that negative surveys are absences) in at least four consecutive years from 2010 to 2013 (no 2009 survey) were followed by confirmed occurrence in 2014 and 2015. Since 2015, the site has oscillated between negative surveys and observations of diving beetles at Dugout Creek. Patterns of site occupancy appear to depend on local weather conditions; some sites that are not typically occupied in years with average water availability are occupied during unusually dry or unusually wet years (Tronstad and Lindsteadt 2021, p. 35; Tronstad 2022a, pers. comm.). For more detail on the supporting evidence for treating diving beetle sites as a single metapopulation, see the SSA (Service 2022, pp. 12–13, 20–21).

## FACTORS INFLUENCING THE STATUS

The Act directs us to determine whether any species is an endangered species or a threatened species because of any factors (or threats) affecting its continued existence (i.e., whether it meets the definition of a threatened species or an endangered species). We use the term “threat” to refer in general to actions or conditions that are known to or are reasonably likely to negatively affect individuals of a species. The term “threat” includes actions or conditions that have a direct impact on individuals, as well as those that affect individuals through alteration of their habitat or required resources. The term “threat” may encompass—either together or separately—the source of the action or condition, or the action or condition itself.

However, the mere identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an “endangered species” or a “threatened species.” In determining whether a species meets either definition, we must evaluate all identified threats by considering the expected response by the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, then analyze the cumulative effect of all of the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Secretary determines whether the species meets the definition of an “endangered species” or a “threatened species” only after conducting this cumulative analysis and describing the expected effect on the species now and (if evaluating whether a species is a threatened species) in the foreseeable future.

### Threats

We reviewed the historical, current, and future stressors and conservation measures potentially affecting the viability of diving beetles in an SSA (Service 2022, pp. 22–33, 48–58). The following sections include summaries of the primary threats affecting diving beetles at the site or species level. We incorporated all of the stressors described in this section into an influence diagram that models the cumulative effects of stressors and their sources on the habitat and demographic factors influencing the resiliency of diving beetle sites (Figure 1). We considered the potential for all factors described in the Act to be threats to the species, including Factors A and E on which we were petitioned; we also considered the impacts of existing regulatory mechanisms (Factor D) and their effect on the identified threats and status of the species. We conducted a comprehensive review of all potential sources and stressors but did not include in our viability analysis those that did not elicit a demographic response from diving beetles or for which there was no evidence of a species-level effect, thus a response could not be modeled (Service 2022, Appendix D). Throughout the following sections, we refer to weather and climate information from approximately the 1971 to 2000 as historical and after 2010 as current. Information used in our analysis also spans into the future, based on downscaled global climate model outputs (Hegewisch and Abatzoglou 2022, unpublished).

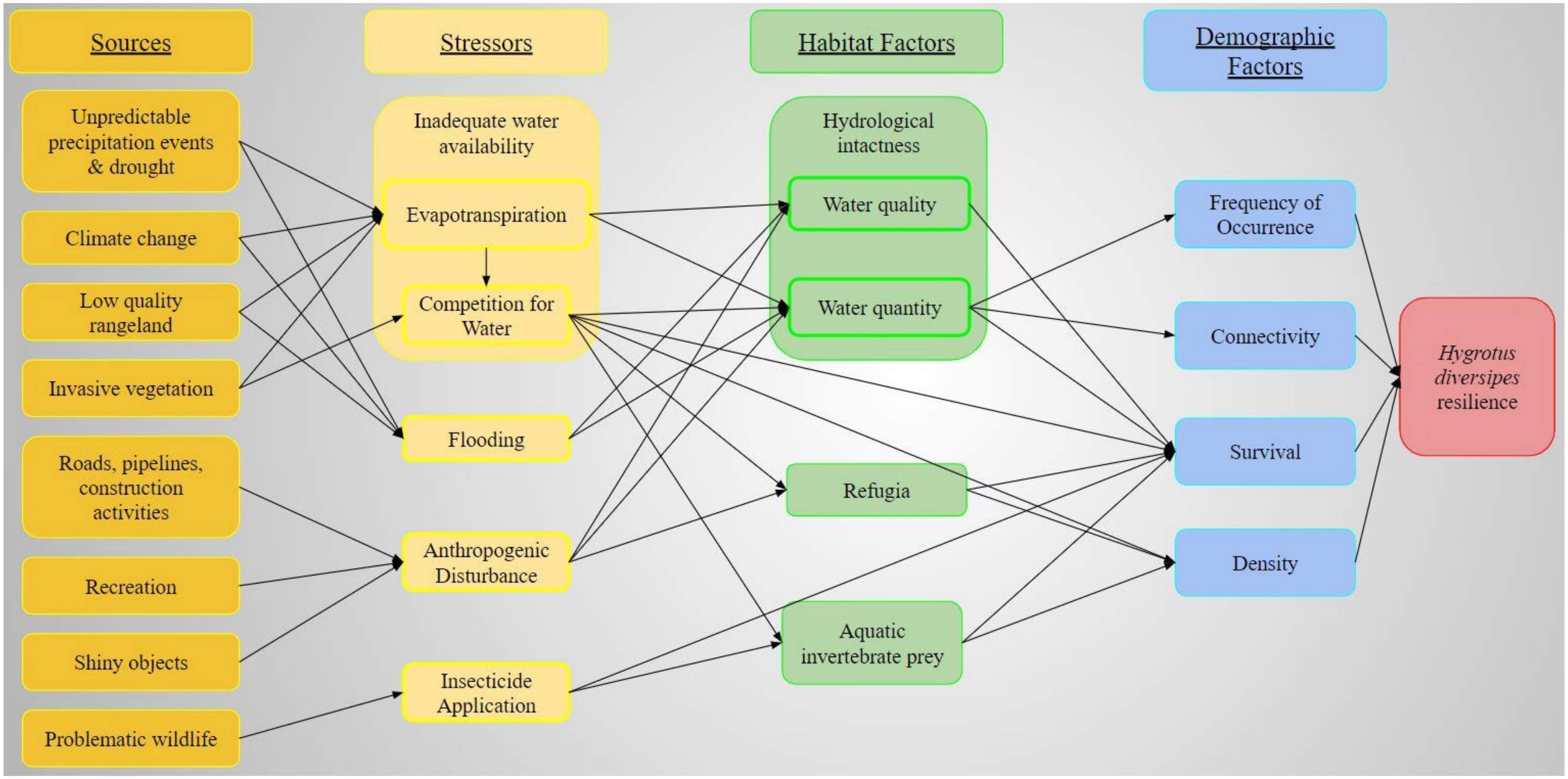

Figure 2. Conceptual diagram of how stressors and their sources influence diving beetles' habitat and demographic factors.

*Inadequate Water Availability*

Periodic droughts and variability in spring and summer precipitation are historically common within the range of diving beetles, but inadequate water availability can reduce the suitability, number, and colonization of diving beetle sites. Unpredictable precipitation events, sod-bound and compacted soils, and competition with invasive vegetation, all of which are exacerbated by climate change, can alter the amount and timing of water in pools, thereby reducing habitat quality or removing pool habitats for diving beetles.

Compared to historical conditions, shifts in precipitation timing and amounts and increased temperatures have led to an increased frequency, intensity, and duration of droughts with potential effects on water availability at diving beetle pools. For example, changes in precipitation and temperature affecting evapotranspiration rates have shifted an annual average water deficit of approximately 28.0 to 34.0 inches (in) (77.2 to 83.1 centimeters (cm)) in the 1990s to a currently modeled annual water deficit between 30 and 36 in (76.2 and 91.4 cm; Hegewisch and Abatzoglou 2022, unpublished). Droughts also can reduce the number of sites that are suitable for the diving beetle, either because of water levels that are too low year-round, drawdown that is too fast for a diving beetle to complete its life cycle, or because water quality becomes unsuitable (Tronstad et al. 2018, p. 335). Climate change may also shift the amount, timing, and duration of precipitation (Hegewisch and Abatzoglou 2022, unpublished), which may cause pools to not fill as much or as quickly in the spring and early summer and dry out faster without being recharged throughout the late summer and fall (Tronstad 2014, pp. 7–10). Currently, less precipitation falls as snow in the spring compared to historical amounts, which may reduce the groundwater recharge that supplies diving beetle pools with appropriate amounts of water throughout the summer (Tronstad and Lindsteadt 2021, p. 33). The frequency and severity of prolonged drought is likely to increase with future changes in climate.

Non-native, invasive plants and grazing, which can compact soils and exacerbate the prevalence of non-native, invasive plants, alter upland vegetation throughout the range of diving beetles, including near several pools on Bureau of Land Management (BLM) lands that are managed for grazing, and can reduce ground water recharge and water availability in pools. Intensive grazing over a long period can result in a sod-bound state, where native blue grama (*Bouteloua gracilis*) and threadleaf sedge (*Carex filifolia*) dominate the area with dense, shallow root systems that prevent water infiltration and lead to runoff (Abdel-Madig et al. 1987, p. 307; Wittkop 2021, pers. comm.). Further, excessive vegetation litter may develop in low-quality rangelands and reduce hydrological function of the soil (Printz et al. 2014, p. 76A). Non-native, invasive plants typically have shallower root systems and higher transpiration rates than native plants in central Wyoming (Owens and Moore 2007, p. 555), and the increased transpiration-related water loss from non-native, invasive plants may cause pool drawdowns earlier in the season, preventing diving beetle individuals from completing their aquatic life stages before pools dry. Although further changes in upland vegetation from non-native, invasive species and grazing are plausible, we are not aware of changes in grazing management plans or invasive vegetation management plans that would expand or intensify these threats.

*Flooding*

Flood events are naturally occurring within the diving beetle's range, suggesting that the diving beetle is adapted to some frequency and intensity of flood events (Miller 2002, p. 30; Swanson 2012, p. 8; Tronstad 2015, pp. 8–9); however, floods with larger magnitudes and durations can reduce the ability of these pools to provide habitat for diving beetles. Flooding that happens at the appropriate time of year and appropriate volume can help maintain habitat and connectivity among sites for diving beetles; however, intense flooding that scours away pools, drowns pupae, and exposes beetles to predators for an extended time can have a net negative effect on the diving beetle. Unpredictable precipitation events, drought, and sod-bound and compacted soils, and climate change can all contribute to high magnitude and duration floods. Flooding of pools can be intensified by droughts as hardened soils resist infiltration, and almost all water is transported as surface flow. The frequency and intensity of floods is likely to increase with future changes in climate.

*Anthropogenic Disturbance*

The landscape where diving beetles occur is relatively sparsely populated by humans, but the construction, use, maintenance, and presence of anthropogenic structures and objects likely influences habitat suitability and demographics for diving beetles. The construction, use, and maintenance of roadways, pipelines, oil and gas production, as well as recreation and the presence of shiny anthropogenic objects can reduce habitat quality, remove pools, and directly harm individuals.

Although construction of roads and pipelines can also alter hydrology to create habitat for diving beetles (Tronstad 2022a, pers. comm.), in other instances road or pipeline construction may fill, dry, scour, or remove pools through alteration of the geology and hydrology of the surrounding landscape (Miller 2002, p. 4). Roads also may serve as conduits for increases in disturbance if these areas become more frequently visited as the human population continues to expand (Tronstad et al. 2011, p. 9). Some dirt roads within or on the edges of diving beetle sites are used for vehicle crossing in the dry season and for recreation by off-road vehicles, both of which may crush individuals of any life stage, but most notably the pupa and adult life stages sheltering in terrestrial areas near water (Tronstad 2022a, pers. comm.). Runoff from completed roads is also expected to reduce groundwater recharge and ultimately reduce the year-round suitability of habitat for diving beetles in nearby pools. Runoff from roads and other human-created impervious surfaces can also deposit chemical contaminants and reduce the water quality of diving beetle pools. Many of the known diving beetle sites occur along roadways and pipelines, and therefore construction, use, and maintenance of roadways and pipelines may alter the hydrological intactness of the site, typically with an overall negative influence on the suitability of sites for the diving beetle.

Oil, gas, and coal bed methane production extraction occurs within the range of diving beetles and there is potential for this development near diving beetle sites. Produced water from these developments may contain dissolved mineral salts, organic compounds, and inorganic metals based on the chemistry and byproducts of the rocks in these underlying strata. If produced water is not injected into a water disposal formation or properly diluted prior to disposal overland, it may flood diving beetle sites and alter the chemistry of pool water (Tronstad et al. 2018, p. 335. Chemical spills associated with energy production and transport are known to occur within the range of diving beetles (Wyoming Department of Environmental Quality (WDEQ) 2022), but it is unknown whether any spill has reached or affected diving beetle pools. Of the 16 known sites occupied by the diving beetle, none are within waterbodies on the Section 303(d) list of impaired waters (WDEQ 2020).

Shiny anthropogenic objects can be a hazard for the diving beetle because they can attract dispersing beetles in flight. Insects respond to horizontally polarized light to find water in or near which to lay their eggs. Glass, metal, and plastic objects (e.g., vehicles, buildings with glass surfaces) can reflect horizontally polarized light so strongly that aquatic insects mistake them for bodies of water. These shiny objects thus create ecological traps where eggs are laid in non-suitable areas and adults are susceptible to death (Horvath et al. 2010, p. 1644). In Wyoming, anecdotal evidence suggests that diving beetles are attracted to and land on objects that are covered with shiny paint, but then are unable to take flight again (Wittkop and Tronstad 2022, pers. comm.).

*Insecticide Spraying*

Insecticide spraying, specifically used to control grasshoppers and Mormon crickets (*Anabrus simplex*) on rangelands, occurs throughout the diving beetle range. Although the larval stage of dytiscids typically have moderate sensitivity to pollutants compared to other aquatic invertebrates (Barbour et al. 1999, p. B-19), insecticides applied within and near diving beetle sites have the potential to kill all life stages of the beetle, depending on the chemical and exposure (Williams 2022, pers. comm.). Larval stages may be more susceptible to insecticides than adults due to their inability to leave a contaminated pool. Insecticide exposure at larval stages may kill, impair growth, and delay development, as observed in the western erete (*Eretes sticticus*), another species of dytiscid larvae (Younes 2008, pp. 349–350). While the tolerance of the diving beetle to insecticide application is unknown, it may have some tolerance given its preference for highly saline, ephemeral environments containing hyper concentrated compounds that naturally occur in drying pools. We expect that insecticide spraying will continue throughout the range of the diving beetle, but we lack information about the timing, proximity to diving beetle pools, and concentrations of insecticide applications; however, the weight of the evidence suggests negative effects to diving beetles are likely and will continue in this landscape.

<u>Conservation Measures and Existing Regulatory Mechanisms</u>

There are no official active or proposed conservation measures specifically for the protection of diving beetles. The BLM aims to protect diving beetle sites within its management area from insecticide application (Keefe 2022, pers. comm.), but they have not formalized any conservation measures for diving beetles. U.S. insecticide application practices employed by the Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) reduce the risk from non-target application of insecticide to aquatic species, and while these practices may also benefit diving beetles, these efforts are not specifically targeting diving beetles nor are the benefits to diving beetles clear.

Cumulative Effects

We note that, by using the SSA framework to guide our analysis of the scientific information documented in the SSA report, we have analyzed the cumulative effects of identified threats and conservation actions on the species. To assess the current and future condition of the species, we evaluate the effects of all the relevant factors that may be influencing the species, including threats and conservation efforts. Because the SSA framework considers not just the presence of the factors, but to what degree they collectively influence risk to the entire species, our assessment integrates the cumulative effects of the factors and replaces a standalone cumulative-effects analysis.

## CURRENT CONDITION

To assess diving beetle viability, we evaluated resiliency, redundancy, and representation across all sites, with evaluation of redundancy and representation at the species level. As part of this evaluation, we applied an assessment of the 12 core attributes that drive adaptive capacity (Thurman et al. 2020, entire), primarily supporting our evaluation of representation, but also informing our evaluations of resiliency and redundancy. We considered habitat and demographic needs at the individual, site, and species levels, and described stressors influencing the viability of diving beetles. We evaluated the current resiliency of sites using a subset of the species' needs to determine site condition (Table 1). We evaluated current resiliency using information that was available related to habitat quality, water quantity, and demographic factors. Habitat quality was indicated by how hydrologically intact pools and adjacent terrestrial areas were and by a predicted aquatic habitat suitability score from previous modeling (Tronstad et al. 2018, pp. 331–335). Metrics indicating water quantity included the number of droughts per decade and spring and summer precipitation as compared to local historical averages. Demographic factors included the frequency with which diving beetles occupy a site and connectivity among pools, both of which also describe site contributions to the larger metapopulation. We developed a basis for assigning a condition category for each metric at the site level based on the available data and our understanding of diving beetle habitat needs and life history. A full description of the resiliency metrics can be found in the SSA report (Service 2022, pp. 34–43).

Table 1. Condition category table summarizing the method for assessing diving beetle resiliency using habitat and demographic factors. SD = standard deviation.

| **Factor Type** | **Habitat Factors** | | | | | **Demographic Factors** | |
|---|---|---|---|---|---|---|---|
| | **Habitat Quality** | | **Water Quantity** | | | | |
| **Name of Factor** | **Hydrological intactness** | **Modeled Suitability** | **Drought** | **Spring Precip (in)** | **Summer Precip (in)** | **Frequency of occurrence** | **Connectivity** |
| **Description of Factor** | Limited disturbance of upland around pools | Predicted occupancy probability indicates suitability of aquatic habitat | Number of droughts per decade | Precipitation available in spring | Precipitation available in summer | How often diving beetles are observed | Number of known sites within 20 km |
| High condition | 0–1 disturbance | >1 SD above average (> 0.773) | <1 per decade | Within <1 SD of historical average by Basin | Within <1 SD of historical average by Basin | >50% observation rate | 3 or more neighbors |
| Moderate condition | 2 disturbances | Within 1 SD of average (0.152 to 0.773 | 1–2 per decade | 1–2 SD of historical average by Basin | 1–2 SD of historical average by Basin | 25–50% observation rate | 1–2 neighbors |
| Low condition | 3+ disturbances | >1 SD below average (<0.152) | >2 per decade | >2 SD of historical average by Basin | >2 SD of historical average by Basin | <25% observation rate | 0 neighbors |

We evaluated the 16 known diving beetle sites within the metapopulation spanning three main river basins (Powder River, Wind River, and Big Horn River, hereafter referred to as "Basins") in central Wyoming. The first diving beetle site was documented in 1964, and we do not have evidence that diving beetles have been permanently extirpated from any of the sites where they have previously been detected. The best available information indicates that it is normal for diving beetles to shift occupancy among sites throughout their range, changing sites primarily based on local water availability. Although occupancy has not been confirmed since the mid-1990s at three sites and since 2002 at four sites, these gaps in detected occupancy could be explained for four sites by a lack surveys since that time (0-2 surveys) due to limited site access on private land. For the remaining three sites, each with 10 annual surveys since the last detection, the gap in occupancy could be explained by differences in water availability between the most recent year of detection and the following survey years. For example, the diving beetle was not found at the Conant Creek site after its 2002 discovery during an unusually dry year, until 2021, which was another unusually dry year (Tronstad and Lindsteadt 2021, p. 35). Additionally, across all seven sites with gaps in occupancy, other site conditions (e.g., level of disturbance, intactness of aquatic habitat, landscape position, connectivity with other sites) have not markedly changed since the previous detections, and it is reasonable to expect that diving beetles would likely occupy these pools in future years when water availability is similar to water availability during the last year of detection. Historical and current land uses, including road and pipeline development and grazing, have likely eliminated or reduced the quality of habitat at some sites, but we are not aware of permanent extirpation of any site.

Of the 16 sites, 7 have moderate condition and 9 have high condition resiliency scores. This species is a narrow endemic, with all known sites within an approximately 65 mi (105 km) radius in four counties in Wyoming. As a narrow endemic, redundancy is inherently low, and likely always has been, and we are not aware of any catastrophic events that have affected the diving beetle in the past nor of any range contraction. Four of the sites with high condition resiliency are occupied by the diving beetle most years and likely function as source sites near the center of the species' range. Although five of the seven sites with moderate condition resiliency are on the outskirts of the species' range, redundancy is bolstered across these parts of the range by all sites functioning together as a metapopulation; if any sites were lost, they could be recolonized as long as suitable habitat conditions return and there remains sufficient connectivity with source sites. Redundancy is supported by the geographic distribution of sites across three Basins, which represent different watersheds and across which there is variation in local conditions, including precipitation. However, there is only one site in the Wind River Basin and two sites in the Big Horn Basin, and in the event of a catastrophic event affecting the third Basin, Power River Basin, the ability of the sites in the other two Basins to maintain the species would remain relatively low. Current representation is supported by the breadth of adaptive capacity attributes the diving beetle exhibits. Evaluation of adaptive capacity attributes suggests that this species has the ability to adapt to changing conditions, such as changes in water availability, through its life history strategy and physiological and behavioral traits. For example, aquatic stages live in pools where water flow and temperature can be highly variable, and strategies such as rapid larval development, a desiccation-tolerant adult life stage, and the ability of adults to fly overland to relocate to suitable habitat, may help diving beetles survive the fluctuating conditions within the pools where it occurs. Additionally, diving beetle larvae and adults are generalist predators and scavengers, and the ability to opportunistically feed on smaller organisms in pools may allow diving beetle individuals to persist under a variety of ecological conditions and ensure development in potentially fast-drying, temporary pools. Similar to redundancy, representation is similarly supported at current levels in part by the distribution of sites across three Basins, potentially providing a diversity of habitat conditions.

Table 2. Current resiliency for the diving beetle at each site using condition categories. An overall average score of 2.33 to 3.00 = high condition; 1.67 to 2.32 = moderate condition; and 1.00 to 1.66 = low condition.

| **Factor Type** | **Habitat Factors** | | | | | **Demographic Factors** | | **Resiliency Score Calculation** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Habitat Quality** | | **Water Quantity** | | | | | | | |
| **Name of Factor** | **Hydrological intactness** | **Modeled Suitability** | **Drought** | **Spring Precip (in)** | **Summer Precip (in)** | **Frequency of occurrence** | **Connectivity** | **Total Score** | **Total Bins Known** | **Overall Average Resiliency Score** |
| **Description of Factor** | Limited disturbance of upland around pools | Predicted occupancy probability indicates suitability of aquatic habitat | Number of droughts per decade | Precipitation available in spring | Precipitation available in summer | How often diving beetles are observed | Number of known sites within 20 km | Sum of all factors | Number of factors assessed | Average Score |
| **Powder River Basin Sites** | | | | | | | | | | |
| Dugout Creek | moderate | High | moderate | High | high | high | high | 19 | 7 | 2.71 |
| Cloud Creek at 33 Mile Road | moderate | Moderate | moderate | High | high | low | high | 16 | 7 | 2.29 |
| Cloud Creek at Wild Horse Road | moderate | High | moderate | high | high | high | high | 19 | 7 | 2.71 |
| Dead Horse Creek | moderate | Moderate | moderate | high | high | high | high | 18 | 7 | 2.57 |
| Hay Draw | moderate | Moderate | moderate | high | high | unknown | high | 15 | 6 | 2.50 |
| Government Creek | moderate | Moderate | moderate | high | high | low | high | 16 | 7 | 2.29 |
| Unnamed pool by Barnum | moderate | Low | moderate | high | high | low | moderate | 14 | 7 | 2.00 |
| Flying E Creek | low | Moderate | moderate | high | high | unknown | low | 12 | 6 | 2.00 |
| Teapot Creek | moderate | High | moderate | high | high | unknown | moderate | 14 | 6 | 2.33 |
| Sand Draw | high | Moderate | moderate | high | high | unknown | low | 14 | 6 | 2.33 |
| Tributary to Murphy Creek | moderate | Unknown | moderate | high | high | high | moderate | 15 | 6 | 2.50 |
| Lone Tree Creek | high | Moderate | moderate | high | high | unknown | high | 16 | 6 | 2.67 |
| Tributary of Dead Horse Creek | high | Moderate | moderate | high | high | unknown | high | 16 | 6 | 2.67 |
| **Wind River Basin Site** | | | | | | | | | | |
| Conant Creek | high | Moderate | moderate | high | high | low | low | 15 | 7 | 2.14 |
| **Big Horn River Basin Sites** | | | | | | | | | | |
| East Fork Nowater Creek | moderate | Moderate | moderate | high | high | unknown | low | 13 | 6 | 2.17 |
| North Fork Bud Kimball | moderate | Low | moderate | high | high | unknown | low | 12 | 6 | 2.00 |

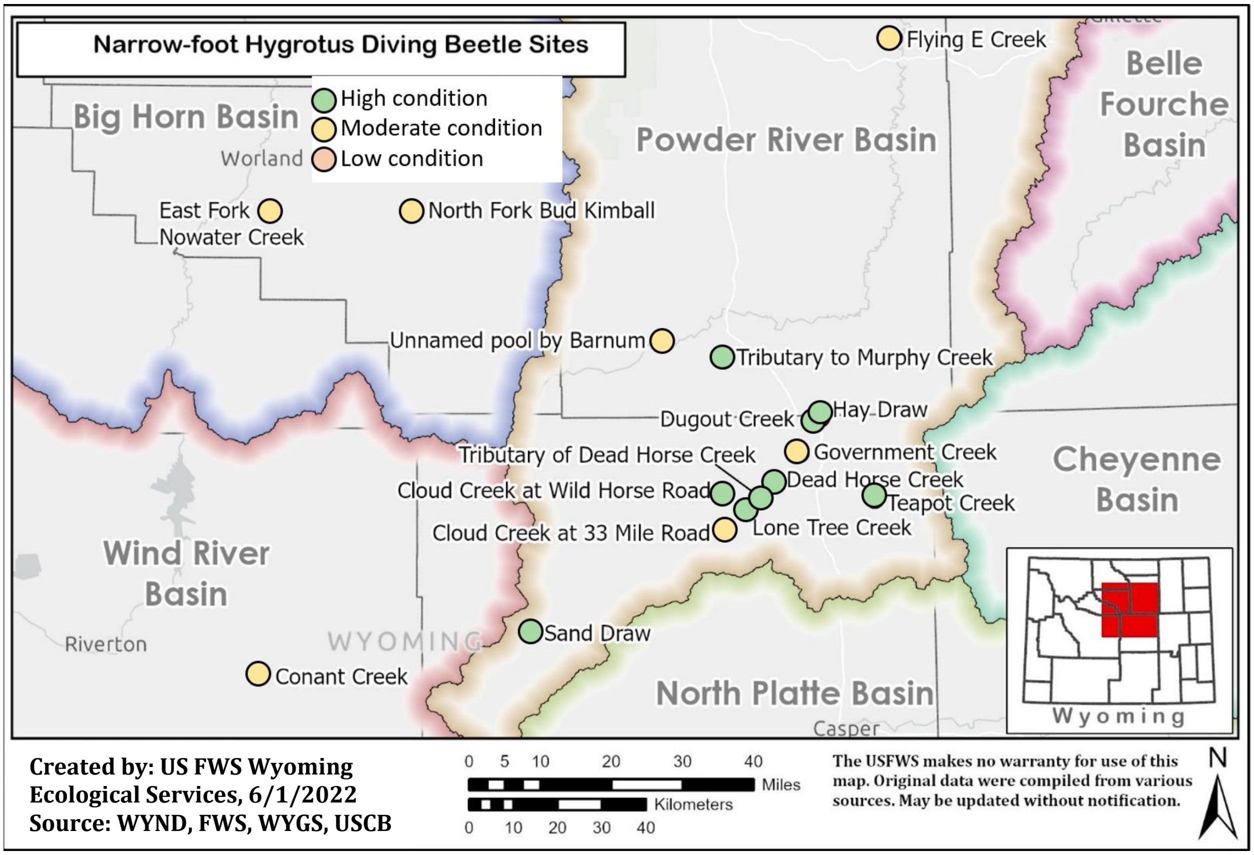


Figure 3. Map of the current resiliency for narrow-foot diving beetles by site, throughout its range in central Wyoming. Sites in high condition are displayed in green and moderate condition sites are yellow. Base map created June 1, 2022; site condition overlaid on base map.

FUTURE CONDITION

In the SSA report, we assessed the future viability of the diving beetle in terms of resiliency, redundancy, and representation using projections and plausible future scenarios to describe the stressors influencing the viability of the species out to 2050.

*Future Scenarios*

Based on our understanding of historical, current, and expected future conditions, we developed three plausible future scenarios. These scenarios represent the range of uncertainties regarding the key stressors influencing diving beetles by 2050. This timeframe enabled us to consider the threats/stressors acting on the species and to draw reliable conclusions on the species' response to those factors. The 2050 timeframe represents approximately 30 generations, and it is reasonable to assess the effects of the stressors on diving beetles out to 2050. Downscaled climate models available up to 2050 do not project substantial differences among emission scenarios. Beyond this timeframe, climate models project considerable variation in conditions among different emissions scenarios, increasing the uncertainty in both climate conditions and the species' likely response. Based on our analysis of potential stressors in the SSA report, we include climate change, inadequate water availability, flooding, anthropogenic disturbance, and insecticide spraying in these future scenarios that we used to evaluate the future condition of the species. We expect projected climate change to influence water availability and flooding for the diving beetle; thus, inadequate water availability and flooding projections in future scenarios must align with projected climate change within each scenario. The three scenarios in our SSA were: (1) Scenario 1. Least Change or Continuation in Stressors; (2) Scenario 2. Low to Moderate Increase in Stressors; and (3) Scenario 3. Substantial Increase in Stressors. The plausible future scenarios are described in detail in the SSA (Service 2022, pp. 49–60).

Table 3. Range of effects predicted for stressors influencing future resiliency of the diving beetle under three plausible future scenarios.

| **Stressor** | **Mechanism of Effect** | **Future Scenarios** | | |
|---|---|---|---|---|
| | | **Scenario 1 (Least Change/ Continuation)** | **Scenario 2 (Low to Moderate Increase in Stressors)** | **Scenario 3 (Substantial Increase in Stressors)** |
| **Climate change** | Climate Model (temperature and precipitation) | MRI-CGCM3 (RCP 4.5) | HadGEM2-CC365 (RCP 8.5) | HADGEM2-ES365 (RCP 8.5) |
| | | Near historical summer temperatures and spring precipitation | Warmer summer and wetter spring | Hot, dry summer and wetter spring |
| **Inadequate water availability** | Evapotranspiration | Evapotranspiration continues at near to current levels; sufficient number of pools continue to contain water at appropriate times | Moderate increase in evapotranspiration; moderately more pools do not fill at appropriate times or that dry too quickly | Substantial increase in evapotranspiration; Substantially more pools fill or dry too quickly; entire Basin receives too little precipitation to compensate for increased summer evaporation |
| | Competition for water from invasive vegetation | Current levels of invasives | Current levels of invasives | Increase in invasives |
| | Drought | Fewer severe or extreme droughts | Frequency of drought similar to historical | More frequent severe or extreme droughts |
| | Infiltration rates | Similar to historical infiltration rates continue | Some sod-bound sites experience lowered infiltration and recharge | Reduced infiltration and recharge due to low spring snow and sod-bound rangelands |

| Stressor | Mechanism of Effect | Future Scenarios | | |
|---|---|---|---|---|
| | | Scenario 1 (Least Change/ Continuation) | Scenario 2 (Low to Moderate Increase in Stressors) | Scenario 3 (Substantial Increase in Stressors) |
| **Flooding** | Flooding and drying regime | Flash flooding occurs at similar to or less than current frequency | Slight increased frequency of flash flooding relative to current | Flash flooding happens occasionally, but with greater intensity |
| | Linking streams/predators | Flood events and dry down link streams and predators at a similar to current rate | Flooding creates fewer pools, more flowing streams, and more access for predators | Fewer pools are connected by floods. Sudden, intense storms followed by droughts decrease absorption and increase run off |
| | Scouring floods | Current frequency and intensity of scouring/flash floods; Continues to provide sufficient connectivity and supports gene flow | Low to moderate increase in frequency and intensity of scouring/flash floods; Leads to increased connectivity and supporting gene flow; however, fewer opportunities for pool formation | Substantial increase in frequency and intensity of scouring/flash floods; Leads to increased connectivity and supporting gene flow; however, fewer opportunities for pools to be selected |
| **Anthropogenic disturbance** | Roads or pipelines can increase or decrease availability of water by changing hydrology | No new roads or pipelines, current hydrology is retained | An additional road or pipeline is located within each basin | New development leads to increased roads and human activity |
| | Recreation can lead to crushing | No negative effect from recreation | No negative effect from recreation | Recreation kills entire cohort in some pools |
| | Construction activities can remove pool habitat | No pools are removed or altered during construction activities | Pool habitat is removed during construction, but habitat returns to suitability over time | Construction vehicles kill individuals and remove pool geology so it cannot return in some pools |
| | Human-made reflective objects attract flying adults | No change in the amount of human-made objects | Slight increase in the amount of human-made objects in range | Dramatic increase in amount of human-made objects in range; cohorts lost |

| Stressor | Mechanism of Effect | Future Scenarios | | |
|---|---|---|---|---|
| | | **Scenario 1 (Least Change/ Continuation)** | **Scenario 2 (Low to Moderate Increase in Stressors)** | **Scenario 3 (Substantial Increase in Stressors)** |
| **Insecticide spraying** | Application of chemical insecticide targeting grasshoppers | Current frequency and intensity of application using current best management practices (BMPs). | Current frequency and intensity of application using current BMPs | Increased frequency and intensity of application |
| | Direct effect on diving beetle survival and health | No life stages are negatively influenced | Sufficient survival of diving beetles after spraying | Chemical is detrimental to all life stages of diving beetle |
| | Reduction of prey base | No food resources killed | Sufficient food resources retained after spraying | Substantial reduction in food resources to the extent that it is limiting for diving beetles |

Scenario 1 presents a climate scenario with the least change from historical summer temperatures and spring precipitation (Table 3); however, spring precipitation increases 5.2 to 13.1 percent over current and historical values, depending on the Basin. Temperature increases lead to a greater proportion of spring precipitation falling as rain, as opposed to snow, than was historically observed. Although summer precipitation increases between 4.5 and 11.7 percent, due to temperature increases, summer potential evapotranspiration increases between 20.7 and 22.7 percent, depending on the Basin.

Scenario 2 presents a hotter summer and wetter spring climate scenario (Table 3), where spring precipitation increases by 23 to 37 percent over historical and current values, depending on the Basin. Despite precipitation increases in the spring, summer precipitation decreases between 5.5 and 14 percent, and in combination with higher temperatures, increases summer potential evapotranspiration by between 10 and 13 percent, depending on the Basin.

Scenario 3 presents a climate scenario with a hotter summer with more frequent and intense droughts despite a wetter spring (Table 3). Spring precipitation increases by 11.9 to 31.4 percent over historical and current values, depending on Basin. Summer precipitation decreases in the Powder River Basin and the Big Horn Basin by 14.8 to 18.6 percent but increases in the Wind River Basin by 6.4 percent. Precipitation projections together with warmer temperatures increase summer potential evapotranspiration by between 23.2 and 25.6 percent, depending on the Basin.

*Assessment of future viability*

For each scenario, we evaluated the anticipated condition of each site using the same condition category table (Table 1) and methods used to assess current conditions with two exceptions: (1) we did not use the Modeled Suitability factor (Table 1) to indicate water quality because it was based on a model linking occupancy modeling and observed water quality, and thus was not applicable for assessing future condition, and (2) our assessment of spring and summer precipitation needs incorporated a qualitative description of evapotranspiration. The condition category table used to assess future conditions is below (Table 4).

Table 4. Condition category table summarizing the method for assessing future diving beetle resiliency using habitat and demographic factors.

| **Factor Type** | **Habitat Factors** | | | | **Demographic Factors** | |
|---|---|---|---|---|---|---|
| | **Habitat Quality** | **Water Quantity** | | | | |
| **Name of Factor** | **Hydrological intactness** | **Drought** | **Spring Precip** | **Summer Precip** | **Frequency of occurrence** | **Connectivity** |
| **Description of Factor** | Limited disturbance of upland around pools | Number of droughts per decade | Precipitation available in spring | Precipitation available in summer | How often diving beetles are observed | Number of known sites within 20 km |
| High condition | 0–1 disturbance | <1 per decade | Within 1 SD of historical average by Basin; evapotranspiration and spring ground water recharge not limiting water quantity | Within 1 SD of historical average by Basin; evapotranspiration not limiting water quantity | >50% observation rate | 3 or more neighbors |
| Moderate condition | 2 disturbances | 1–2 per decade | 1–2 SD of historical average by Basin; evapotranspiration limiting water quantity at times | 1–2 SD of historical average by Basin; evapotranspiration limiting water quantity at times | 25–50% observation rate | 1–2 neighbors |
| Low condition | 3+ disturbances | >2 per decade | >2 SD of historical average by Basin; evapotranspiration regularly limiting water quantity | >2 SD of historical average by Basin; evapotranspiration regularly limiting water quantity | <25% observation rate | 0 neighbors |

In all three future scenarios, the diving beetle is expected to occupy all of the 16 known sites across three Basins within one metapopulation in central Wyoming. Resiliency varies among scenarios, with a general increase in condition across sites under Scenario 1, and a general decrease in condition across sites in Scenarios 2 and 3. Specifically, in Scenario 1, we project somewhat increased resiliency with 15 sites in high condition and 1 site in moderate condition; in Scenario 2, we project 5 sites in high condition, 10 in moderate condition, and 1 in low condition; and in Scenario 3, we project no sites remaining in high condition, 5 sites in moderate and 11 sites in low condition. Although the species has sites distributed across three Basins, all known sites are within a relatively small area (an approximately 65 mi (105 km) radius). Additionally, two of those Basins have few sites, and in the event of a catastrophic event affecting the Power River Basin, which has all but three of the sites, the ability of the sites in the other two Basins to maintain the species would remain relatively low. Redundancy of this narrow endemic species is inherently low and remains low across all three scenarios, with a slight increase only under Scenario 1, supported by increases in sites' conditions. We considered severe drying and large-scale chemical spills as plausible catastrophic events that may affect the diving beetle. The distribution of the species across three different Basins within central Wyoming helps maintain future levels of redundancy, without the predicted loss or extirpation of any sites. Representation continues to be supported in part by the distribution of sites across three Basins, potentially providing a diversity of habitat conditions. Overall, diving beetles' ability to adapt to changing conditions through its life history strategy and physiological and behavioral traits will continue to support representation, with potential reductions in the flexibility of their reproductive phenology under Scenarios 2 and 3, and with a potentially reduced extent of occurrence on an annual basis and a reduced climatic niche breadth (a reduced range of climatic conditions through which the species is distributed).

Table 1. Summary of diving beetle resiliency under the three future scenarios by Basin. Colors indicate condition with green = high condition, yellow/orange = moderate condition, and pink/red = low condition.

| **Site Name** | Current | Scenario 1. | Scenario 2. | Scenario 3. |
|---|---|---|---|---|
| **Powder River Basin** | | | | |
| Dugout Creek | 2.71 | 2.83 | 2.33 | 1.67 |
| Cloud Creek at 33 Mile Road | 2.29 | 2.50 | 2.00 | 1.50 |
| Cloud Creek at Wild Horse Road | 2.71 | 2.83 | 2.33 | 1.67 |
| Dead Horse Creek | 2.57 | 2.67 | 2.33 | 1.67 |
| Hay Draw | 2.50 | 2.80 | 2.20 | 1.60 |
| Government Creek | 2.29 | 2.50 | 2.00 | 1.50 |
| Unnamed pool by Barnum | 2.00 | 2.33 | 1.83 | 1.33 |
| Flying E Creek | 2.00 | 2.20 | 1.60 | 1.40 |
| Teapot Creek | 2.33 | 2.60 | 2.00 | 1.40 |
| Sand Draw | 2.33 | 2.60 | 2.00 | 1.60 |
| Tributary to Murphy Creek | 2.50 | 2.67 | 2.17 | 1.50 |

| Site Name | Current | Scenario 1. | Scenario 2. | Scenario 3. |
|---|---|---|---|---|
| Lone Tree Creek | 2.67 | 3.00 | 2.40 | 1.80 |
| Tributary of Dead Horse Creek | 2.67 | 3.00 | 2.40 | 1.80 |
| **Wind River Basin** | | | | |
| Conant Creek | 2.14 | 2.33 | 2.00 | 1.83 |
| **Bighorn Basin** | | | | |
| East Fork Nowater Creek | 2.17 | 2.40 | 2.00 | 1.40 |
| North Fork Bud Kimball | 2.00 | 2.40 | 2.00 | 1.40 |

FINDING

Regulatory Framework

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species is an "endangered species" or a "threatened species." The Act defines an endangered species as a species that is "in danger of extinction throughout all or a significant portion of its range," and a threatened species as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether any species is an "endangered species" or a "threatened species" because of any one or a combination of the following factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;
(B) Overutilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms; or
(E) Other natural or manmade factors affecting its continued existence.

These factors represent broad categories of natural or human-caused actions or conditions that could have an effect on a species' continued existence. In evaluating these actions and conditions, we look for those that may have a negative effect on individuals of the species, as well as other actions or conditions that may ameliorate any negative effects or may have positive effects.

The Act does not define the term "foreseeable future, which appears in the statutory definition of "threatened species." Our implementing regulations at 50 CFR 424.11(d), as revised in 2019, set forth a framework for evaluating the foreseeable future on a case-by-case basis. The term "foreseeable future" extends only so far into the future as we can reasonably determine that both the future threats and the species' responses to those threats are likely. In other words, the foreseeable future is the period of time in which we can make reliable predictions. "Reliable" does not mean "certain"; it means sufficient to provide a reasonable degree of confidence in the prediction. Thus, a prediction is reliable if it is reasonable to depend on it when making decisions.

It is not always possible or necessary to define the foreseeable future as a particular number of years. Analysis of the foreseeable future uses the best scientific and commercial data available and should consider the timeframes applicable to the relevant threats and to the species' likely responses to those threats in view of its life-history characteristics. Data that are typically relevant to assessing the species' biological response include species-specific factors such as lifespan, reproductive rates or productivity, certain behaviors, and other demographic factors.

Status Assessment

*Status Throughout All of Its Range*

After evaluating threats to the species and assessing the cumulative effect of the threats under the section 4(a)(1) factors, we determined that the factors affecting diving beetles and their habitat are anthropogenic disturbance and insecticide spraying (Factor A), the ongoing and future influence of climate change on water availability and flooding (Factors A and E), and the combined effects of these factors. Of these, climate change, through its associated effects on water quantity and seasonality, is the primary factor currently influencing diving beetles throughout their range. We also considered the impact of existing regulatory mechanisms (Factor D) and conservation efforts, and their effect on the identified threats and status of the species, but these were not a driving factor influencing the species' status.

We determined that the current distribution of diving beetles does not appear to have substantially changed from its known historical distribution despite past and on-going stressors, including inadequate water availability, flooding, anthropogenic disturbance, insecticide spraying, and the cumulative effect of these stressors. Diving beetles occur in moderate to high resiliency condition at all 16 known sites – 13 of which have been confirmed since 2002, with 9 of these having been confirmed since 2019 – and are anticipated to maintain a similar number of relatively robust sites in the near term. Although there is connectivity among sites, sites are spread across three main river basins and have adequate geographic separation to support redundancy across the range of the species. This spread guards against population losses due to catastrophic events, such as severe drying or heat due to weather patterns, which vary across the species range. The species' flexible traits and life history support representation and suggest that it is highly adaptable to shifts in environmental conditions, as it inhabits a dynamic system including seasonal drought, floods, and heat and it can disperse via flying or streamflow to other sites. The SSA report describes some of the uncertainties regarding the species' life history and response to threats; but, considering the best available data and observed conditions, diving beetles' current risk of extinction is low. Thus, after assessing the best available information, we conclude that diving beetles are not in danger of extinction throughout all of their range.

Therefore, we proceed with determining whether diving beetles are likely to become endangered within the foreseeable future throughout all of their range. In considering the foreseeable future as it relates to the status of diving beetles, we considered the relevant risk factors (threats) to the species and whether we could draw reliable predictions about future exposure, timing, and scale of negative effects and the species' response to these effects. We considered whether we could reliably assess the risk posed by the threats to the species, recognizing that our ability to assess risk is limited by the variable quantity and quality of available data about effects to diving beetles and their response to those effects. Based on this assessment, we considered the foreseeable future to be approximately 2050 for this species.

All currently occupied sites are expected to be maintained through 2050 in all future scenarios despite threat projections; anthropogenic disturbances and insecticide spraying may intensify in the foreseeable future and climate change is projected to reduce water availability, alter timing of water in pools, and increase temperatures, with some uncertainty in the frequency, intensity, and duration of drought and floods. The three scenarios include a wide range of projections of resiliency, from slight increases in resiliency to moderate declines in resiliency throughout the range of the species. Scenario 1 projects increased resiliency across all sites relative to current conditions; six of the sites that are currently in moderate condition are projected to increase to high condition, leaving only one site in moderate condition and the rest in high condition. Scenario 2 projects slight declines in resiliency, with 11 of the sites that are currently in high or moderate condition continuing to be in the same condition category, 4 of the sites that are currently in high condition being reduced to moderate condition, and 1 site currently in moderate condition being reduced to low condition. Scenario 3 projects moderate declines in resiliency, with all 16 sites being reduced by at least one condition category; projections show 5 sites that are currently in high condition being reduced to moderate condition, 4 sites that are currently in high condition being reduced to low condition, and all 7 sites that are currently in moderate condition are projected to be reduced to low condition. Despite the projected range of threats, diving beetles are adapted to a dynamic habitat and have a metapopulation structure with connectivity that supports resiliency among all sites throughout the entire range.

Although both increases and decreases in resiliency of sites are plausible across the range of scenarios considered, overall, we expect the species' ability to cope with relatively poor water quality and severe drying and heat will help to maintain these sites into the foreseeable future. The diving beetle is adapted to completing most of its life functions in pools in ephemeral streams, many of which dry to the point where only small pools remain in the hottest and driest parts of the summer. Severe drought events are also naturally occurring within the diving beetle's range, suggesting that the diving beetle is adapted to the historic frequency and intensity of drought events.

Despite relatively low redundancy across the narrow geographic range of the diving beetle, the distribution of the species across three different Basins within central Wyoming helps support future levels of redundancy. Sites are projected to continue to be distributed across three main river basins and have adequate geographic separation to support redundancy across the range of the species, guarding against population losses due to catastrophic events. The most plausible catastrophic events for this species are prolonged, severe drying and large-scale chemical spills. Severe drying or heat due to weather patterns would be expected to vary among sites; the distances among sites within the three Basins and the variation in precipitation experienced across the three Basins may provide some protection from a catastrophic drought that would extirpate diving beetle sites from more than one Basin. A large-scale chemical spill would likely affect individual sites near a spill and potentially those downstream of the spill and thus is unlikely to pose a catastrophic risk to the entire species.

Representation is expected to continue to be supported by the species' traits and life history, which are conducive to surviving projected climate changes and other increases in evaluated stressors in the foreseeable future. After assessing the best available information, we conclude that the diving beetle is not likely to become endangered within the foreseeable future throughout all of its range.

*Status Throughout a Significant Portion of Its Range*

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so in the foreseeable future throughout all or a significant portion of its range. Having determined that the diving beetle is not in danger of extinction or likely to become so in the foreseeable future throughout all of its range, we now consider whether it may be in danger of extinction or likely to become so in the foreseeable future in a significant portion of its range—that is, whether there is any portion of the species' range for which it is true that both (1) the portion is significant; and (2) the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. Depending on the case, it might be more efficient for us to address the "significance" question or the "status" question first. We can choose to address either question first. Regardless of which question we address first, if we reach a negative answer with respect to the first question that we address, we do not need to evaluate the other question for that portion of the species' range.

In undertaking this analysis for the diving beetle, we chose to address the status question first. We began by identifying portions of the range where the biological status of the species may be different from its biological status elsewhere in its range. For this purpose, we considered information pertaining to the geographic distribution of (a) individuals of the species, (b) the threats the species faces, and (c) the resiliency condition of populations.

We evaluated the range of the diving beetle to determine if the species is in danger of extinction now or likely to become so in the foreseeable future in any portion of its range. The range of a species can theoretically be divided into portions in an infinite number of ways. We focused our analysis on portions of the species' range that may meet the definition of an endangered species or a threatened species. For the diving beetle, we considered whether the threats or their effects on the species are greater in any biologically meaningful portion of the species' range than in other portions such that the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. We examined the following threats:

- inadequate water availability, which includes the influences of unpredictable precipitation events, drought, sod-bound and compacted soils, and competition with invasive vegetation on hydrological intactness, all of which are exacerbated by climate change;
- flooding, which includes the influences of unpredictable precipitation events, drought, and sod-bound and compacted soils, all of which are exacerbated by climate change;
- anthropogenic disturbance, including the construction, use, and maintenance of roadways, pipelines, and oil and gas production as well as recreation and the presence of shiny anthropogenic objects;
- insecticide spraying; and
- the cumulative effects of these threats.

We considered any potential differences in status in portions of the range, taking into consideration that seven sites have not been confirmed within the past 20 years. Specifically, we identified areas near the periphery of the range for further consideration because the current and projected resiliency conditions of sites in these areas were generally lower than for those sites nearer to the center of the range. However, the diving beetle sites exhibit a metapopulation structure with connectivity among sites throughout the range, and moderate to high condition sites near the center of the range support the continued presence, resiliency, and biological contributions of lower condition populations near the edge of the range. Thus, even if individual sites in the periphery of the range became unoccupied temporarily, survey data collected over multiple years shows that they would eventually be recolonized due to their connectivity with sites near the center of the range: this process of localized extirpation and recolonization of subpopulations is part of the normal dynamics of a metapopulation, rather than an indication of a difference in status. Similarly, we apply metapopulation dynamics to support our assumption that sites that have not had confirmed occupancy in recent years continue to support diving beetles as a metapopulation. Additionally, threats are relatively uniform throughout the relatively narrow geographic range of the beetle currently and into the foreseeable future. Based on the metapopulation dynamics supporting resiliency throughout the range and the similarity of threats that are likely in the future, we concluded that no area has a different status than the species as a whole.

We found no portion of the diving beetle range where threats are impacting individuals differently from how they are affecting the species elsewhere in its range, or where the biological condition of the species differs from its condition elsewhere in its range such that the status of the species in that portion differs from its status in any other portion of the species' range.

Therefore, we find that the species is not in danger of extinction now or likely to become so in the foreseeable future in any significant portion of its range. This does not conflict with the courts' holdings in *Desert Survivors v. Department of the Interior*, 321 F. Supp. 3d 1011, 1070-74 (N.D. Cal. 2018), and *Center for Biological Diversity v. Jewell*, 248 F. Supp. 3d 946, 959 (D. Ariz. 2017) because, in reaching this conclusion, we did not apply the aspects of the Final Policy on Interpretation of the Phrase "Significant Portion of Its Range" in the Endangered Species

Act's Definitions of "Endangered Species" and "Threatened Species" (79 FR 37578; July 1, 2014), including the definition of "significant" that those court decisions held to be invalid.

*Determination of Status*
Our review of the best available scientific and commercial information indicates that the diving beetle does not meet the definition of an endangered species or a threatened species in accordance with sections 3(6) and 3(20) of the Act. Therefore, we find that listing the diving beetle is not warranted at this time.

COORDINATION WITH STATES

While conducting the SSA for the diving beetle, we closely coordinated with the Wyoming Game and Fish Department, the Wyoming Department of Agriculture, and the Wyoming Natural Diversity Database (WYNDD). As the only state within the range of this species, the state of Wyoming was given the opportunity to provide data, participate in the SSA process, and review the draft SSA report. During the process we received information from Wyoming, including survey and study results and information on land management relevant to the species.

LITERATURE CITED

Abdel-Madig, A.H., G.E. Schuman, and R.H. Hart. 1987. Soil bulk density and water infiltration as affected by grazing systems. Journal of Range Management, 40: 307–309.

Alarie, Y., P.P. Harper, and R.E. Roughley. 1990. Description of the larvae of eleven Nearctic species of Hygrotus Stephens (Coleoptera: Dytiscidae: Hydroporinae) with an analysis of their phyletic relationships. The Canadian Entomologist, 122(5):985–1035.

Anderson, R.D. 1983. Revision of the nearctic species of Hygrotus groups IC, V, and VI (Coleoptera: Dytiscidae). Annuals of the Entomological Society of America, 76:173–196.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. Merrimack Station AR-1164. EPA 841-B-99-002. 232 pp. + appendices. https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/ar/AR-1164.pdf.

Barman, E.H. 1999. A key to the mature (third instar) larvae of Georgia species of Hygrotus Stephens (Coleoptera: Dytiscidae) with notes on the biology of *H. impressopunctatus* (Schaller) and H. nubilus LeConte. Georgia Journal of Science, 57(2):109–109.

Bilton, D.T. 2014. Dispersal in Dytiscidae. Chapter 9 in Ecology, Systematics, and the Natural History of Predaceous Diving Beetles (Coleoptera: Dytiscidae), D.A. Yee (ed.). DOI 10.1007/978-94-017-9109-0_9. Springer Science+Business Media B.V. 2014. pp. 387–407.

Bofill, C.E. and D.A. Yee. 2019. An army of one: Predaceous diving beetle life history stages affect interactions with shared mosquito prey. Hydrobiologia, 827: 201–209.

Bogan, M.T. and K.S. Boersma. 2012. Aerial dispersal of aquatic invertebrates along and away from arid-land streams. Freshwater Science, 31: 1131–1144.

Boulton, A. J. 1989. Over-summering refuges of aquatic macroinvertebrates in two intermittent streams in central Victoria. Transactions of the Royal Society of South Australia, 113:23–34.

Culler, L.E., S. Ohba, and P. Crumrine. 2014. Predator-Prey Interactions of Dytiscids. Chapter 8 in Ecology, Systematics, and the Natural History of Predaceous Diving Beetles (Coleoptera: Dytiscidae) DOI 10.1007/978-94-017-9109-0_8. pp. 363–386.

Fenoglio, S., B. Tiziano, and G. Bosi. 2006. Deep Interstitial Habitat as a Refuge for *Agabus paludosus* (Fabricius) (Coleoptera: Dytiscidae) During Summer Droughts. The Coleopterists Bulletin, 60:37–41.

Garcia, R., and K. S. Hagen. 1987. Summer dormancy in adult *Agabus disintegratus* (Crotch) (Coleoptera, Dytiscidae) in dried ponds in California. Annals of the Entomological Society of America, 80:267–271.

Hanski, I. 1998. Metapopulation dynamics. Nature. 396(6706):41–49.

Hegewisch, K.C. and J.T. Abatzoglou “Future Climate Scatter” web tool. Climate Toolbox (https://climatetoolbox.org). Accessed on January 20, 2022.

Horvath, G., M. Blaho, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. Conservation Biology, 24: 1644–1653.

Keefe, C. 2022. Personal Communication between Chris Keefe (BLM Wyoming Threatened and Endangered Species Lead) with Julie Reeves (U.S. Fish and Wildlife Service) and others of Technical Team on April 22, 2022, regarding use of insecticide to control grasshoppers in range of *H. diversipes* and willingness of BLM to dictate important diving beetle habitats to avoid.

Leech, H.B. 1966. The *Pedalis*-group of *Hygrotus*, with descriptions of two new species and a key to the species (Coleoptera: Dytiscidae). Proceedings of the California Academy of Sciences. Fourth Series Vol. XXXIII, No. 15, pp. 481–498.

Liao, W. 2021. Effects of landscape connectivity and predator-prey interactions on diving beetle assemblages in Finnish urban ponds. Dissertation; University of Helsinki. 18 pp. + appendix.

Matsushima, R. and T. Yokoi. 2020. Flight capacities of three species of diving beetles (Coleoptera: Dytiscadae) estimated in a flight mill. International Journal of Freshwater Entomology, 41:332–338.

Mead, D.L. 1993. Natural history of the rare curved-foot Hygrotus diving beetle, *Hygrotus curvipes* (Dytiscidae). Thesis submitted to San Francisco State University. 110 pp. + appendices.

Miller, K.B. 2002. Unpublished report on the diving beetle *Hygrotus diversipes* Leech (Coleoptera: Dytiscidae). Cornell University, Ithaca, NY. https://meridian.allenpress.com/jfwm/article-supplement/210494/pdf/10_3996112016-jfwm-085_s9. 4 pp. + Appendices.

Nilsson, A.N. and J. Hájek. 2022. A world catalogue of the family Dytiscidae, or the diving beetles (Coleoptera, Adephaga). Version 1. I. 2021. http://waterbeetles.eu/documents/W_CAT_Dytiscidae_2021.pdf.

Owens, M.K. and G.W. Moore. 2007. Saltcedar water use: realistic and unrealistic expectations. Rangeland Ecology and Management, 60:553–557.

Petersen, I., Z. Masters, A.G. Hildrew, and S.J. Ormerod. 2004. Dispersal of adult aquatic insects in catchments of differing land use. Journal of Applied Ecology, 41:934–950.

Printz, J.L., D. Toledo, and S.C. Botlz. 2014. Rangeland health assessment: The key to understanding and assessing rangeland soil health in the Northern Great Plains. Journal of Soil and Water Conservation, 69:73A–77A.

Rolke, D., B. Jaenicke, J. Pfaender, and U. Rothe. 2018. Drainage ditches as important habitat for species diversity and rare species of aquatic beetles in agricultural landscapes (Insecta: Coleoptera). Journal of Limnology, 77:466–482.

(Service) U.S. Fish and Wildlife Service. 2022. Species status assessment for the narrow-foot hygrotus diving beetle (*Hygrotus diversipes*), Version 1. Written by the Wyoming Ecological Services Field Office for the Mountain Prairie Region of the U.S. Fish and Wildlife Service. 79 pp. + appendices.

Shaffer, M.L. and M.A. Stein. 2000. Safeguarding our precious heritage. Pages 305–310 *in* B. Stein, L. Kutner, and J. Adams, editors. Precious Heritage. Oxford University Press; New York, New York.

Smith, D. R., N.L. Allan, C.P. McGowan, J.A. Szymanski, S.R. Oetker, and H.M. Bell. 2018. Development of a species status assessment process for decisions under the U.S. Endangered Species Act. Journal of Fish and Wildlife Management 9:302–320.

Swanson, K.M. 2012. A contribution to the predaceous diving beetles (Coleoptera: Dytiscidae) of Wyoming. M.S., Department of Ecosystem Science and Management, Chapter 1: Predicted distribution models and field surveys for *Hygrotus diversipes* Leech (Coleoptera: Dytiscidae), in Wyoming. 19 pp.

Thurman, L., B. Stein, E. Beever, W. Foden, S. Geange, N. Green, J. Gross, D. Lawrence, O. LeDee, J. Olden, L. Thompson, B. Young. 2020. Persist in place or shift in space? Evaluating the adaptive capacity of species to climate change. Frontiers in Ecology & the Environment, 18:520–528. https://doi.org/10.1002/fee.2253.

Tronstad LM, K.M. Brown, M.D. Anderson. 2018. Using species distribution models to guide field surveys for an apparently rare aquatic beetle. Journal of Fish and Wildlife Management, 9(1):330–339; e1944-687X. doi:10.3996/112016-JFWM-085

Tronstad, L.M. 2022a. Personal communication between Lusha Tronstad (WYNDD) and Julie Reeves (U.S. Fish and Wildlife Service) on March 2, 2022, regarding the current status of *H. diversipes*, its stressors, and its adaptive capacity.

Tronstad, L. 2022b. Personal Communication between Lusha Tronstad (WYNDD) and Julie Reeves (U.S. Fish and Wildlife Service) on August 25, 2022, regarding the draft of the *Hygrotus diversipes* SSA.

Tronstad, L.M. 2014. State-wide survey for *Hygrotus diversipes* in Wyoming during 2012. Report prepared for the Wyoming Game and Fish Department by the Wyoming Natural Diversity Database, University of Wyoming. 12 pp.

Tronstad, L.M. 2015. The distribution of *Hygrotus diversipes* during 2013 and 2014. Report prepared for the Wyoming Game and Fish Department by the Wyoming Natural Diversity Database, University of Wyoming.11 pp. + appendix.

Tronstad, L.M. 2017. The status of *Hygrotus diversipes* during 2015 and 2016. Report prepared for the Wyoming Game and Fish Department by the Wyoming Natural Diversity Database, University of Wyoming. 14 pp. + appendix.

Tronstad, L.M. and A. Lindsteadt. 2021. State of knowledge for the Narrow-foot Hygrotus Diving Beetle (*Hygrotus diversipes*): summary of past data and new information from recent surveys. Report prepared for the Wyoming State Office of the Bureau of Land Management by the Wyoming Natural Diversity Database, University of Wyoming. Draft. 39 pp.

Tronstad, L.M., M.D. Andersen, and K. Swanson. 2011. Statewide survey for *Hygrotus diversipes* in Wyoming. Report prepared by the Wyoming Natural Diversity Database, Laramie, Wyoming for the Wyoming Game and Fish Department, and Wyoming Governor's Office, Cheyenne, Wyoming. 14 pp. + appendices.

Villastrigo, A., I. Ribera, M. Manuel, A. Millan, and H. Fery. 2017. A new classification of the tribe Hygrotini Portevin, 1929 (Coleoptera: Dytiscidae: Hydroporinae). Zootaxa, 4317(3):499–529.

(WDEQ) Wyoming Department of Environmental Quality. 2020. Wyoming's 2020 Integrated 305(b) and 303(d) Report. Wyoming Department of Environmental Quality – Water Quality Division report published May 4, 2020, access on June 22, 2022. https://deq.wyoming.gov/water-quality/watershed-protection/water-quality-assessment/

(WDEQ) Wyoming Department of Environmental Quality. 2022. Wyoming Department of Environmental Quality spill and complaint report. https://DEQspills.wyo.gov/reports. Report generated June 16, 2022.

Williams, J. 2022. Personal Communication between Justin Williams (Wyoming Department of

Agriculture) and Julie Reeves (U.S. Fish and Wildlife Service) on April 22, 2022, and other Technical Team members, regarding use of insecticide to control grasshoppers in range of *H. diversipes* and effects of chemical once it hydrolyzes in water.

Wittkop, W. 2021. Personal communication between Wyatt Wittkop (BLM Buffalo Field Office Wildlife Biologist) to Julie Reeves (on September 22, 2021, regarding possibility of rangeland health and sod bound states of vegetation communities with regard to water infiltration and flooding of rangeland around *Hygrotus* habitats.

Wittkop, W. and L. Tronstad. 2022. Personal communication among Wyatt Wittkop (BLM Buffalo Field Office Wildlife Biologist), Lusha Tronstad (WYNDD), and Julie Reeves (U.S. Fish and Wildlife Service) on April 22, 2022, regarding beetles being attracted to shiny man-made materials, thinking they are water.

Younes, A.A. 2008. Side effects of azadirachtin fed preys on the diving predator, *Eretes sticticus* Linnaeus (Coleoptera: Dytiscidae). Egyptian Journal of Biological Pest Control, 18:347–351.

Date:

WENDI WEBER

Digitally signed by WENDI WEBER
Date: 2023.08.11 16:43:45 -04'00'

Wendi Weber,
Acting Director,
U.S. Fish and Wildlife Service

Date of annual review:
Conducted by: