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Status Report on the Narrow-Foot Diving Beetle
Hygrotus diversipes Leech

Taxon Name: *Hygrotus diversipes* Leech
Common Name: Narrow-Foot Diving Beetle
Family: Dytiscidae
Where Occurs: Wyoming, County of Natrona
Current Federal Status: Candidate Species (Category 2)
Recommended Federal Status: Not to be Listed

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INTRODUCTION / EXECUTIVE SUMMARY

This status report provides a summary of the present knowledge about the biology and distribution of the narrow footed diving beetle, *Hygrotus diversipes* Leech. The report is compiled from historic data and from field studies during the summers of 1992 and 1993.

The objectives of the 1992 and 1993 field studies were to:

1. Conduct a detection survey for *Hygrotus diversipes* Leech near the type site in Dugout Creek at its intersection with old highway 87, northwest of Midwest, Wyoming. The detection survey covered a circular area with a radius of .1 minute. All water sources within the area were sampled for *H. diversipes*. The survey also identified some topographical features useful in delineating probable habitats.
2. Conduct a distribution survey in suitable habitats within two and one half grid ticks (about 9 square miles) of the original type site to determine the beetle's presents or absence at the optimum time.. This was an effort to determine current distribution (if any) outside of the type site in Dugout Creek.

The following are the major results of field surveys, habitat analysis, and data evaluation:

* Detection surveys indicated that *Hygrotus diversipes* Leech is currently present at the original type location approximately 8.5 miles northwest of Midwest, Wyoming where Dugout Creek crosses old highway 87. The beetles are found only in highly mineralized flowing or occasionally flowing streams. *H. diversipes* has never been collected from a pond or other non-flowing body of water.

* *Hygrotus diversipes* Leech appears to be widely dispersed with confirmed collections coming from five different collection sites about eighteen miles apart. See Figure-4.

* The 1992 and 1993 surveys by PEST, Inc. and the Bureau of Land Management (BLM) expanded the known range of the species with the addition of two new locations. Of significance, the surveys found *Hygrotus diversipes* Leech in a significantly different habitat than was previously known.

* Both sexes of *Hygrotus diversipes* Leech have been found throughout the known range with the exception of Hay draw where only females were found. Finding only females here makes the identification of these specimens less positive than other identifications.

* Significant degradation of the habitat available for *Hygrotus diversipes* Leech due to changes in land use seem unlikely given the remoteness of the area and the lack of high quality water necessary for development of more intensive agriculture. The ecosystem appears to posses long term stability with little evidence of past human disturbance.

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Appendix 1

Procedures for conducting detection surveys, distribution surveys, and documentation of specimens.

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Field census methodology descriptions.

I. Species Information

1. Classification and Nomenclature

A. Species

1. Scientific Name

a. *Hygrotus diversipes* Leech

b. Bibliographic citations.

The narrow-footed diving beetle, *H. diversipes* Leech is a member *Hygrotus* group IV, which is comprised of *H. diversipes*, *H. thermanum*, *H. curvipes*, *H. pedalis*, *H. fontinalis* as classified by Leech. Leech, Hugh B. 1966. The Pedalis-Group of *Hygrotus*, With Descriptions of Two New Species and a Key to the Species (Coleoptera: Dytiscidae). Proc. of the California Academy of Sciences. (Vol. XXXIII, No. 15, pp. 481-498.). This group was revised in 1983 by Anderson, Russell D. 1983. Revision of the Nearctic Species of *Hygrotus* Groups IV, V, VI (Coleoptera: Dytiscidae). Annals of the Ent. Soc. of America. (Vol. 76, No. 2, pp. 173-196.).

Paraphrasing R. D. Anderson (1983), this group of five species are separated from other members of the genus by the aedeagus. The aedeagus, viewed laterally, is very thin and ligulate in the apical fourth. The tip of the aedeagus appears blunt when viewed ventrally. The aedeagus is tapered and pointed in all other members of this genus. The ~~pre~~ ^{profemora} ~~meso~~ ^{profemora} ~~sternite~~ and mesotibia of this group are also modified.

c. Type Specimen

H. diversipes Holotype, male, WYOMING, NATRONA COUNTY. DUGOUT CREEK, 8.5 MILES NORTHWEST OF MIDWEST, 27.VII.1964 (H. B. Leech). Deposited in the California Academy of Sciences, Entomology. Oakland, California. Allotype, female, same data as for holotype; in California Academy of Sciences, Entomology. Paratypes, eight males, ten females, all with the same data as the type. Paratypes placed in following collections: United States Museum, Canadian National Collection, F. N. Young, R. D. Anderson.

d. History of knowledge of taxon.

¹⁹⁶⁴
A *H. diversipes* was originally collected by Leech in 1966 at the type site in Natrona county, Wyoming. Since the original collection, the species has been collected by 3 separate groups. In 1985 the species was collected in 3 locations, the type site and two additional locations in Natrona county (Cloud Creek and Dead Horse Creek) in a survey conducted by the Bureau of Land Management led by Gene Dahlem. Another survey in 1988 failed to collect any *H. diversipes*. In 1992 PEST, Inc. conducted the first of two surveys, re-collecting *H. diversipes* at the type site, and at a new location (now 4 known locations) along Hay draw within Natrona county. During 1992 the Bureau of Land Management also conducted a survey finding *H. diversipes* in a second location along Cloud Creek, (now the fifth known location). In 1993 PEST, Inc. conducted the second survey, collecting *H. diversipes* in the same locations as in 1992. All known specimens of *H. diversipes* have been collected in Natrona county, Wyoming.

2. Present Legal Status

A. National

1. United States

- a. Federal classification of *H. diversipes* Leech is as a Category II species.

A Category II species is one that is proposed for listing as federally threatened or endangered. Information possessed by the U. S. Fish and Wildlife Service about Category II species suggests that listing may be appropriate, but there are not substantial data available to support a proposed rule. Additional data may support the proposed rule if the species is found only in one local or in a similar very restricted habitat. If data should show a broader distribution than previously known the species likely would be removed from the Category II list.

b. State

- ★ *Hygrotus diversipes* Leech has not been formally classified (other than Federal listing as a Category II species) by the state of Wyoming or any other entity.

3. Description

A. General nontechnical description.

Hygrotus diversipes Leech is a small diving beetle, with a length of about 4 mm. and a width of about 2 mm. These beetles are very similar to other *Hygrotus* species *H. patruellis*, and *H. nubilis* that are found in the same areas. All three beetles are similar in size, shape, and general appearance, they are all close to the same body length, yellowish brown dorsally, with various amounts of "clouding" on the head, pronotum, and elytra. Final determination of species within this group can only be made through the key written by Leech as modified by Anderson. Several characteristics observable in the field that aid in species determination. These characters include the following: Relative size of the three species - *H. diversipes* and *H. nubilis* are larger than *H. patruellis*. The shape of the lateral line of the body where the elytra and pronotum meet differs - *H. diversipes* does not form an even continuous curve where *H. patruellis* and *H. nubilis* do. Another characteristic is the coloration on the dorsal side of the head between the eyes - *H. diversipes* has an isolated dark blotch interior to each eye, *H. nubilis* has a single dark blotch on the back of the head. Last the coloration on the dorsal side of the pronotum - *H. diversipes* has a very small to moderately large central dark blotch, *H. nubilis* has no or a very small central dark blotch, and *H. patruellis* has a very large central dark blotch on the pronotum. These field characteristics were described in a letter from Dr. R. E. Roughley, The University of Manitoba, Department of Entomology. See Figures 1, 2 & 3.

B. Technical description as described by H. B. Leech

Length 4.46 MM., width 2.1 mm. Form ovate, strongly elongate. Color: head rufo-testaceous, with an elongate piceous area paralleling and slightly separated from inner margin of eye, as long as and half as wide as an eye; apical palpal segment piceous except at bases; first four antennal segments pale testaceous, next four progressively darker, last three piceous. Pronotum pale rufo-testaceous, palest laterally, with a narrow longitudinal piceous mark extending from just before middle of disk to basal three-fourths.

Elytra pale yellowish testaceous except as follows: each elytron with an oblique elongate semitransparent area just before base, from near suture to near humerus; suture narrowly piceous; a small elongate fuscous sublateral spot at basal quarter; and a large fuscous mark extending from basal third to apical sixth, one third longer than broad, well separated from suture, treidentate anteriorly, broad and a little emarginate posteriorly, bulging on its outer side at middle, and with a tiny pale inclusion behind middle. Epipleura and legs yellowish testaceous, pro- and mesofemora infusate apically. Metasternum, hind coxal plates, and abdomen rufo-piceous to black.

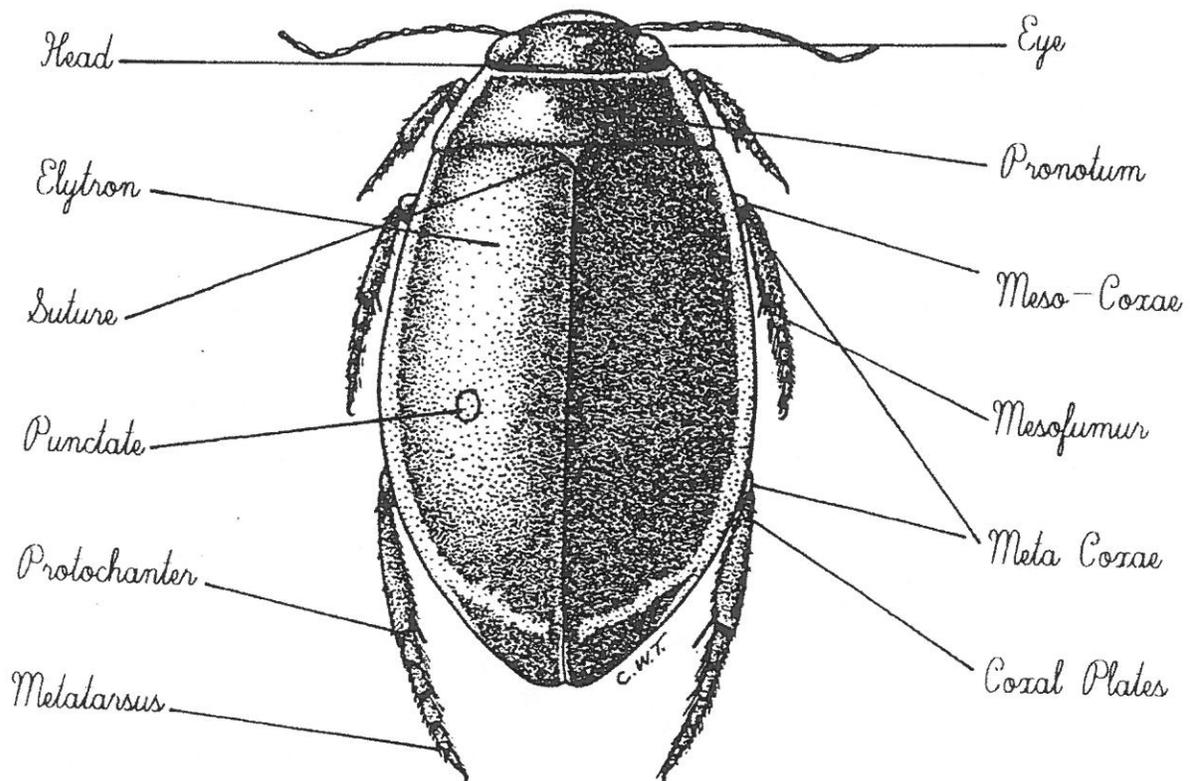
Head shining, finely punctate, punctures separated by a little more than their own diameters, except in a transverse area just before an imaginary line joining hind margins of eyes, where they are coarser, closer set, and in short series. Clypeus not margined. Pronotum shining, punctation about as on much of head, sparsest on a slightly inflated area near each side of front part of discal piceous mark. Pronotum wider at base than at apex (8 : 5.5), sides straight to near front angles, gradually converging; hind angles slightly obtuse; lateral marginal bead narrow, about as wide as a facet of eye. Elytra shining, basal half finely, densely punctate, punctures separated by about their own diameters; subsutural, discal, humeral, and sublateral longitudinal series of coarse punctures apparent, the punctures two to three times as large as fine ones between series; in addition, there are irregularly scattered coarse punctures apparent, the punctures two to three times as large as fine ones between series; in addition, there are irregularly scattered coarse punctures among fine ones on interspaces in basal half of elytra, but in apical half almost all punctures are large. Epipleura finely, densely punctate.

Metasternum coarsely punctate laterally, many of punctures behind meso-coxae confluent and longitudinally serial; posterior half of midmetasternum shining, impunctate, bordered by a linear area of fine punctures, and lateral to this with another impunctate area. Metacoxal plates coarsely, closely punctate except near posterior margin where surface is merely finely reticulose. Metacoxal lines together lyriform, intralineal area with line of coarse punctures at each side, rest with greatly elongated small punctures; median line impressed. First abdominal sternum as coarsely punctate as are metacoxal plates; second sternum nearly as coarsely punctate laterally, sparsely and more finely toward median line; following sterna progressively more finely punctate, four and five each with a few long golden hairs arising from a puncture on median line near middle. Prosternal process broadest at middle, margined, tectiform along median line, apex pointed.

Protochanter with line of golden hairs along ventral edge. Profemur broad, inflated at middle on anterior face, ventral side coming to an edge, sinuate in outer third, edge outcurved at apical third, then broadly, shallowly notched before apex, a few short golden hairs in emargination; posterior face with lower third opaque, crescentically emarginate for reception of tibia; lateral wing of apical groove in which tibia articulates, very large. Protibia as an oblique-topped elongate triangle, apical angles rounded, inner margin slightly sinuate, posterior face smooth, inflated, lower margin except near base with a compact linear brush of golden hairs. Protarsi marrow, as wide as first segment of metatarsus; claws simple, anterior one a little shorter, broader, and more curved at base than its fellow. Mesotrochanter as in protrochanter. Mesofemur broad, flat, widest at basal two-sevenths, where it is a little more than twice as wide as an epipleuron near base, lower edge slightly sinuate; lower side flat, as wide as an epipleuron, posterior edge with thin fringe of golden hairs; posterior lateral wing of apical groove large. Mesotibia simple. Metatrochanter almost one and one-half times as long as broad, not bearded, apes bluntly pointed.

Metafemur strongly narrowed at base, anterior margin broadly concave in basal third, anterior(lower) face inflated medially, lightly impressed on anterior half at apical three-fourths, sides nearly parallel in median two-thirds; surface shining, with series of short oblique impressions in basal two-thirds; thence finely reticulose; an inconspicuous longitudinal median line of setose punctures present. Metatibia gradually widening from base to apex, arcuate, with concavity outward; outer face near apex of anterior margin with a few punctures, each with a small spine. Male genitalia: aedeagus curved, strongly dorsoventrally flattened and exceedingly thin in apical three elevenths, ligulate; apex blunt, subangulate.

Allotype, female: Length 4.2 mm., width 2.1 mm. Almost exactly like the male, except sex characters; head and prothorax slightly darker than in type; elytra with rufous tinge adjacent to suture; large elytral infuscation bidentate anteriorly, the outer of the two projections larger, extending forward to level of small sublateral pot. Profemur with slight projection on lower anterior face at apical third, and small notch between that and apex; mesotibia broad, flat, lower margin distinctly sinuate. Metatibia less strongly arcuate than in male



C. Field Identifying Characteristics

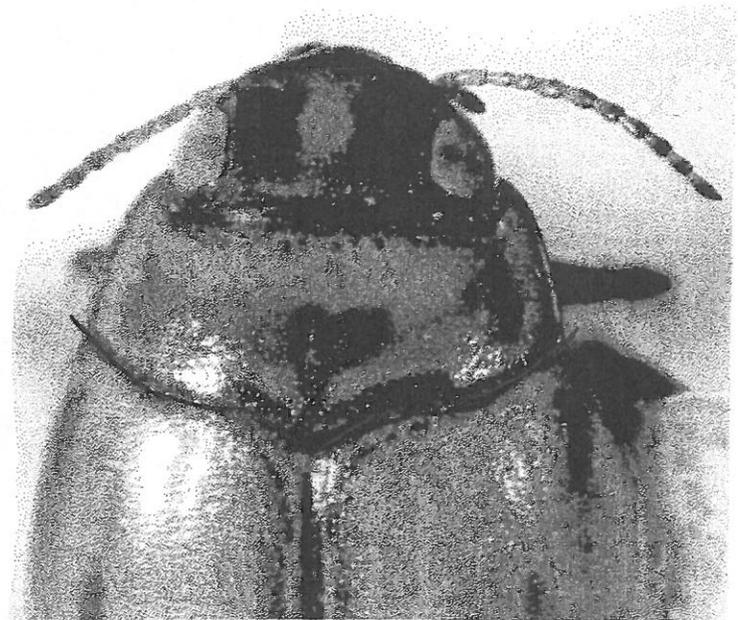
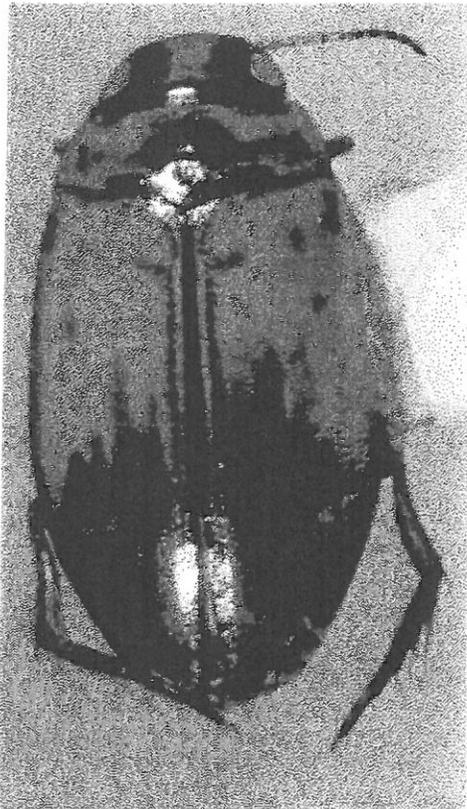


Figure 1. *Hygrotus diversipes* Leech is characterized by a couple of features (1) it is relatively larger than *H. pairuelis* in particular, (2) the lateral outline of the beetle, where the pronotum and elytra meet, is not in the form of an even continuous curve, (3) there is an isolated dark blotch interior to each eye, and (4) the pronotum has a very small up to a moderately large central dark blotch.

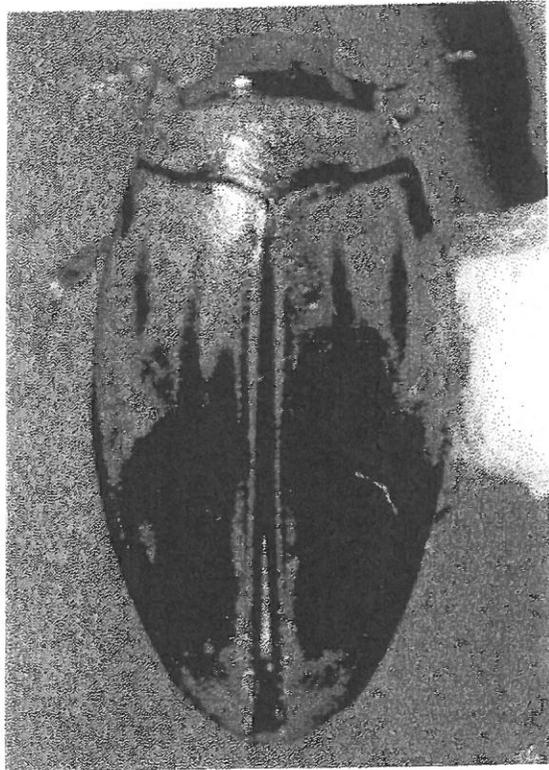


Figure 2: *Hygrotus mublisi* (LeConte) is as follows: (1) it is about the same size as *H. diversipes* and therefore relatively larger than *H. patruelis* in particular. (2) the lateral outline of the beetle, where the pronotum and elytra meet, is in the form of an even continuous curve, (3) there is not an isolated dark blotch interior to each eye (but there is a single blotch at the back of the head, and (4) the pronotum has no or a very small central dark blotch.

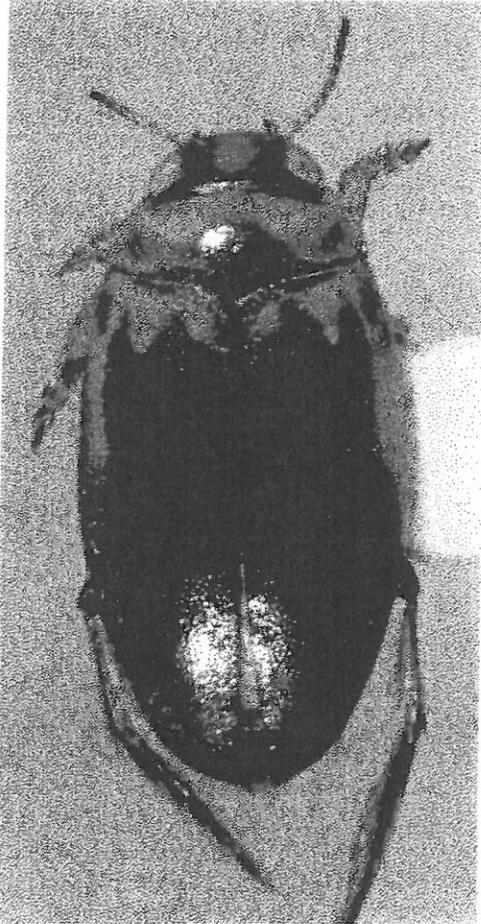


Figure 3: *Hygrotus patruelis* (LeConte) is as follows: (1) it is smaller in terms of body length than either *H. diversipes* or *H. nubilus*, (2) the lateral outline of the beetle, where the pronotum and elytra meet, is in the form of an even continuous curve, (3) there is an isolated dark blotch interior to each eye, and (4) the pronotum has a very large central dark blotch.

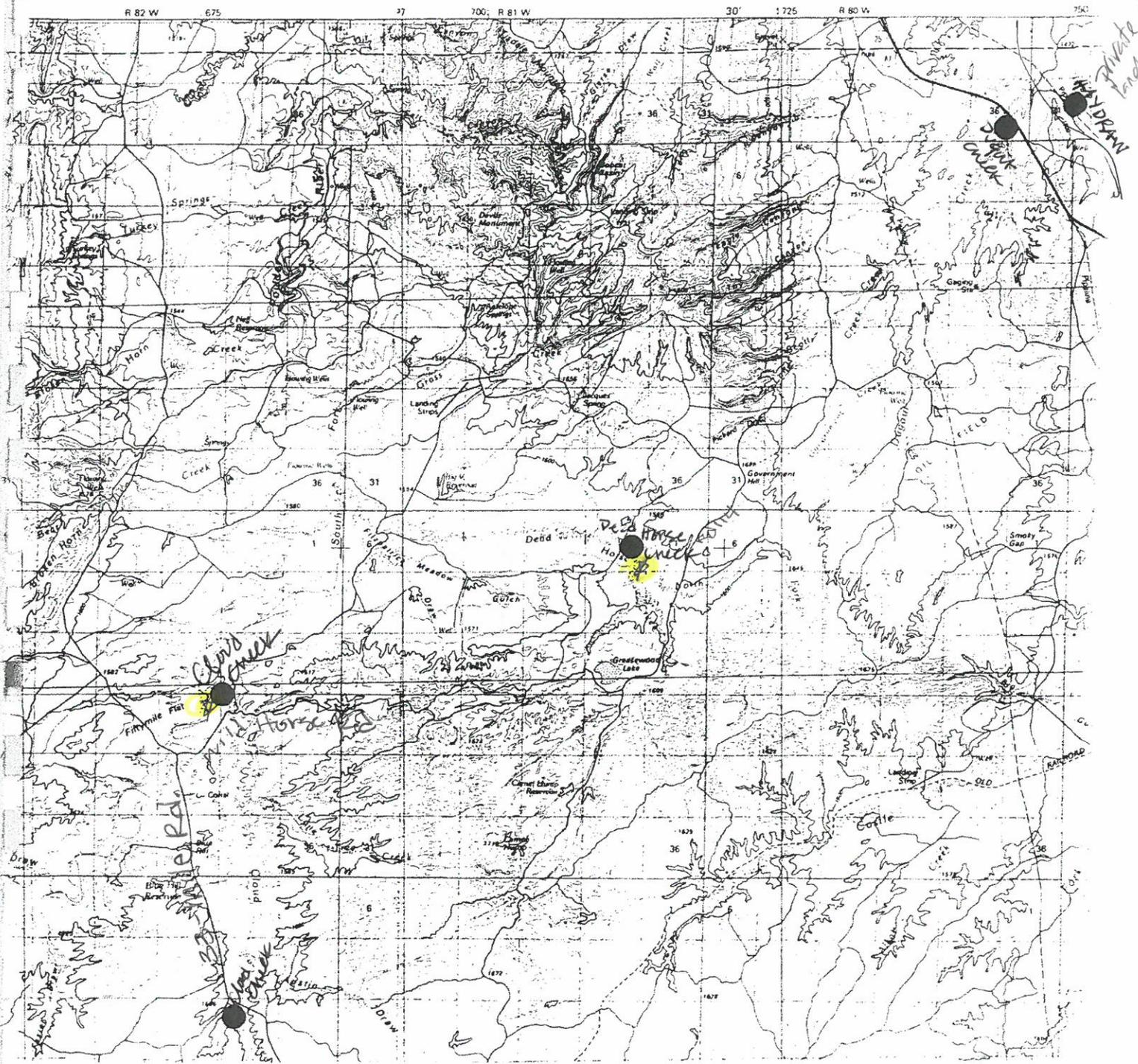


Figure 4: This figure shows all locations where *Hygrota diversipes* Leach have been collected in Natrona County, Wyoming.

* Kelsey fund *H. diversipes*

4. Significance of Taxon

A. Natural

The biological significance of the narrow-footed diving beetle is that according to R. A. Anderson, it is probably a recently evolved species of *Hygrotus*. Its somewhat limited in ecological importance by its very limited distribution. *H. diversipes* seems to be the dominant *Hygrotus* species inhabiting stream habitats, where in nearby ponds *H. patuelis* and *H. nubilis* are much more abundant.

The primary significance to humans of this species is for scientific and /or academic research into the taxonomic relationships among species found in *Hygrotus* group IV.

5. Geographical Distribution

A. Geographical range

- Currently the known range is entirely within Natrona county, Wyoming. The farthest distance between confirmed collections of *H. diversipes* is about 18.4 miles, with other specimens being collected between these locations. The known range covers two major creek drainage systems - Salt Creek, and Cloud Creek, both of which are tributaries within the Powder River system. The Powder River flows northward as part of the Missouri River system.

All known collection locations are listed in Table 1, and shown in Figure 4.

B. Precise occurrences

Table 1. Sites where (*Hygrotus diversipes* Leech) have been collected.

Location name	Legal description	# of times collected
Dugout Creek - type site	T41N,R80W,S36,SE 1/4	4
Hay Draw	T41N,R79WS31,NE 1/4	2
Cloud Creek near 33 mile road	T38N,R82W,S14,NW 1/4 of NW 1/4	2
Cloud Creek at Wild Horse Road	T39N,R82W,S23, W 1/2	1
Dead Horse Creek	T39N,R81W,S2,SW 1/4 of NE 1/4	1

1. Populations currently or recently known extant:

The first recorded specimens of *H. diversipes* were collected and later described by Hugh B. Leech, at the type location in late July 1964. The type locality is in Natrona county Wyoming (T41N, R80W, sec. 36 - N 1/2 of NW 1/4 of SE 1/4.), where Dugout Creek crosses under old highway 87.

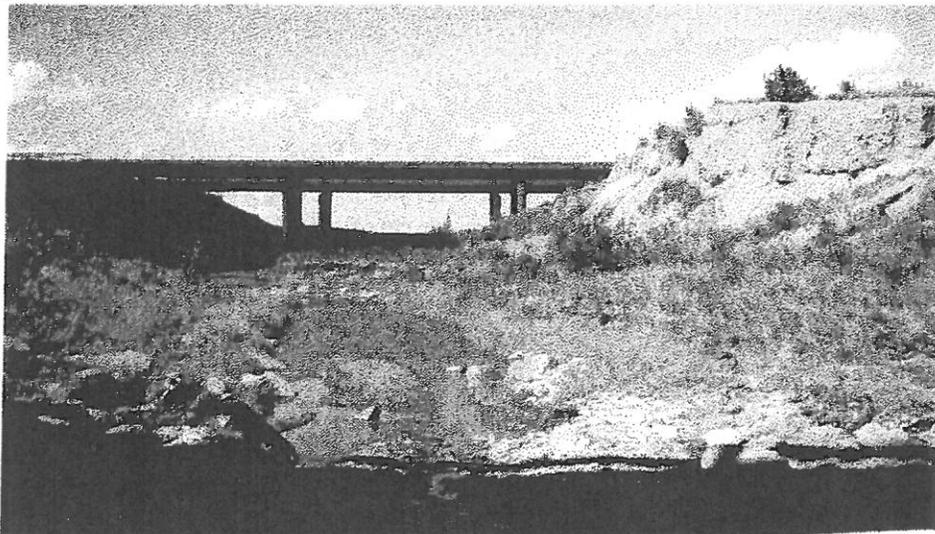


Figure 5. This figure shows the location of the first collection of *Hygrotus diversipes* (type site).

In June of 1985 *H. diversipes* was again collected from the type site in Natrona county Wyoming by a group with the Bureau of Land Management led by Gene Dahlem. This group also collected *H. diversipes* in two new locations. Cloud Creek at 33 Mile Road (T38N, R82W, sec. 14 - NW 1/4 of NW 1/4.); and in Dead Horse Creek (T39N, R81W, sec. 2 - SW 1/4 of NE 1/4.)

In September of 1992 scientists from the Bureau of Land Management attempted to further expand the known range of the species. This group collected *H. diversipes* in two locations. One location was very close to that sampled by Dahlem in Cloud Creek at 33 mile road (T38N, R82W, sec. - 14 NE 1/4 of NW 1/4.). The second location where the species was collected was about 5 miles away in Cloud Creek at Wild Horse Road (T39N, R82W, sec. 23 - SW 1/4 of NW 1/4 and NW 1/4 of SW 1/4.).

During the first two weeks of August 1992 and 1993 L.C. Keenan and Tim Howard of PEST, Inc. conducted a Detection Survey, and a Distribution Survey in the area surrounding the original type local. See Figures 6. During each phase of the detection survey *H. diversipes* was collected in Dugout Creek at the original type site. While conducting the distribution survey *H. diversipes* was found two consecutive summers in the same new location - Hay Draw (T41N, R79W, sec. 31 - NE 1/4.). Appendix 1 provides procedures for conducting detection and distribution surveys and documenting specimens.

GOVERNMENT CREEK QUADRANGLE
WYOMING
7.5 MINUTE SERIES (TOPOGRAPHIC)

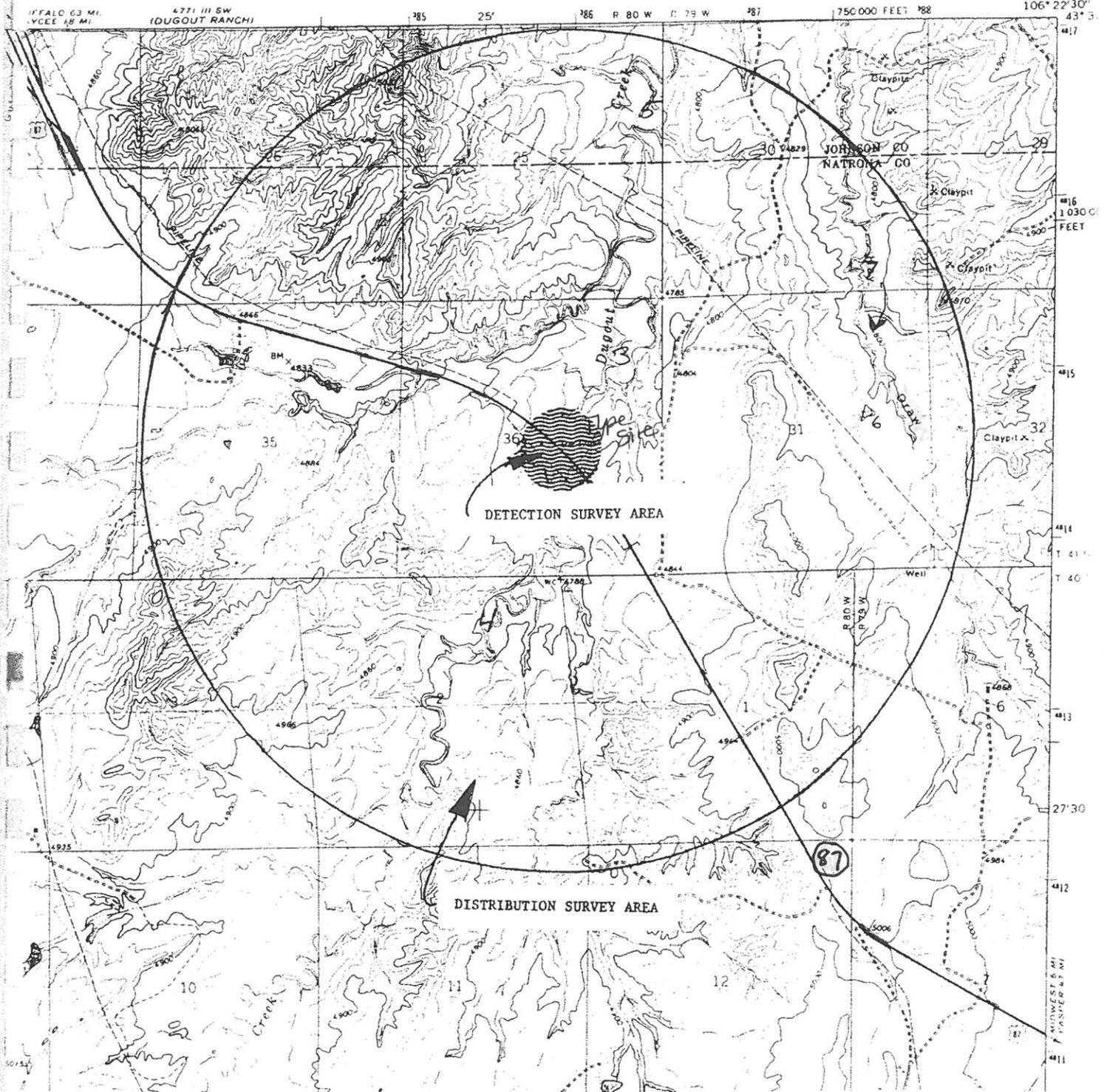


Figure 6: This figure shows the areas where the Detection and Distribution surveys were conducted by PEST is 1992-93.

C Biogeographical and Phylogenetic History

Nothing has specifically been written about the likely biogeographical or phylogenetic history of *H. diversipes* except what was previously stated. According to Dr. Anderson, *H. diversipes* is probably a recently evolved species, as evidenced by its very limited distribution. *H. diversipes* was put into a natural group by Dr. Leech on the basis similarities in the adult morphological characteristics displayed by the five species within this group. This group was retained as group IV (the *pedalis* group) by Dr. Anderson during his revisions of the groupings within *Hygrotus*.

There are only two known works regarding the phyletic relationships within the genus *Hygrotus*. These are based on larval characters. These works seem to re-align some members of the six *Hygrotus* groups. The works include: Alarie, Y., P. P. Harper, and R.E. Roughley. 1990. Descriptions of the larvae of eleven Nearctic species of *Hygrotus* Stephens (Coleoptera: Dytiscidae: Hydroporinae) with an analysis of their phyletic relationships. *Can. Entomol.*, 26: 199-210.

The only known work with a *Hygrotus* group IV beetle was done in a thesis written by Deborah Lynn Mead. 1993. Natural history of the rare curved-footed diving beetle, *Hygrotus curvipes* (Dytiscidae). San Francisco State University. *H. curvipes* (a member of *Hygrotus* group IV) is compared to the 11 species found in the paper by Alarie et. al. *Laccornis latens* (Fall) was used as an out-group comparison by Alarie et. al. and by Mead in her analysis to determine the phylogenetic position of *H. curvipes*. Of the twelve *Hygrotus* beetles for which the twenty one larval characters have been described *H. curvipes* appears to most similar to *H. falli*, *H. patruelis*, and *H. hudsonicus*. Larval characteristics have not been described for any *Hygrotus* group IV species except *H. curvipes* making comparison within the group based on larval morphology impossible.

No information is available about where *Hygrotus* group IV originated, only that all members have similar habitats, and the group is distributed widely within North America.

6. General Environmental and Habit Description

A. Concise statement of general environment and habitat.

Natrona county is in central Wyoming east of the continental divide. See Figure 7. Climate in this area can be harsh with winter temperatures occasionally reaching -35 C (about -30 F), summer temperatures occasionally reach over +40 C. (about 100 F). Average annual precipitation is around 38 centimeters (15 inches) with much of the moisture coming as fast moving thunderstorms during the summer. Wind is almost a constant feature in the area, removing soil moisture during the summer and significantly affecting snow distribution during winter months. Elevations within the area range are from 1455 to just over 1700 meters (4800 - 5700 ft.) above sea level. Vegetation varies with elevation, and slope aspect. The highest elevations within the watershed are typified by open forests of ponderosa pine (*Pinus ponderosa*) and pinon pine (*Pinus edulus*), particularly on north facing slopes. Lower elevations are a shrub steppe type vegetation. Grazing by cattle is the primary use of lands in this area.

COUNTY LOCATION MAP

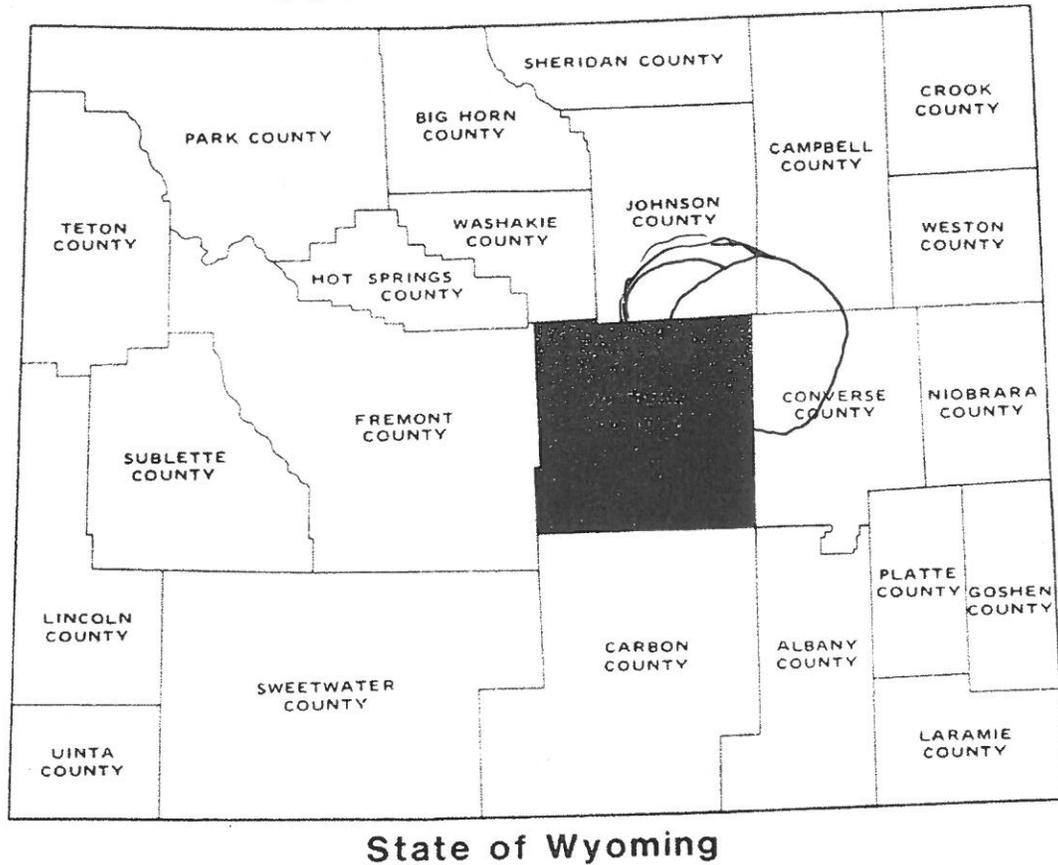


Figure 7: Location of Natrona County in the State of Wyoming.

B. Physical characteristics

Rolling hills broken by rugged winding draws with small flat "bottom" areas of variable width, and intermittently flowing streams are found throughout this region. Streams are characterized by periods of flow, drying up to form a series of pools, and steep banks up to about 1 meter high along the water's edge. Figures 8 & 9 show typical habitat in this area of Wyoming and a typical section of Dugout Creek. The bottom areas next to the water vary from non-existent to as large as 50 meters in width, as you move farther from the stream past the bottoms the sides of the draws are typically fairly steep slopes of several meters in height, rounding at the top into the gentler slopes of the rolling hills. Soil in this area is mostly clay, with some gravel but few if any apparent rocks. Water in these streams tends to be highly mineralized as evidenced by whitish mineral deposits being found along streams. Stream bottoms are variable with sections of silt, clay, shale, and gravel. Our survey was unable to detect any preference among stream bottom types for *H. diversipes*. Water depth varies, up to about 1 meter in the deeper pools. The exception to this is Hay Draw which has a very consistent bottom of mineralized silt. Water in Hay Draw is consistently 5 to 15 centimeters in depth and slowly flowing. Hay draw lacks the series of pools typical of the other locations where *H. diversipes* has been found. There is also sedge (family Cyperaceae) scattered throughout most of the stream bottom forming a marsh type habitat. See Figure 10.

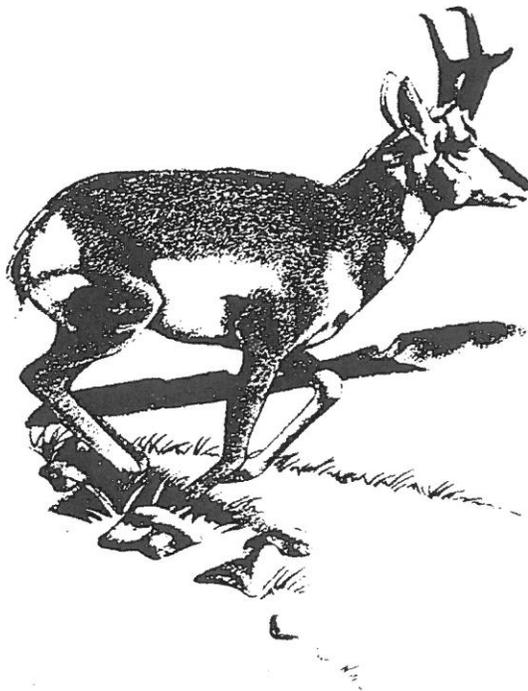




Figure 8; *Hygrotus* diving beetle habitat Natrona County , Wyoming

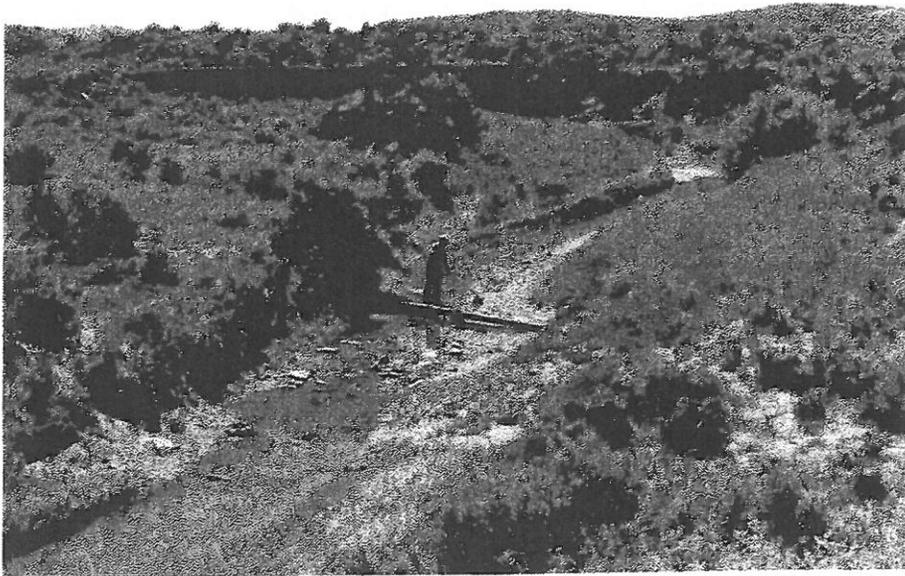


Figure 9: Typical section of Dug Out Creek (Type Site).

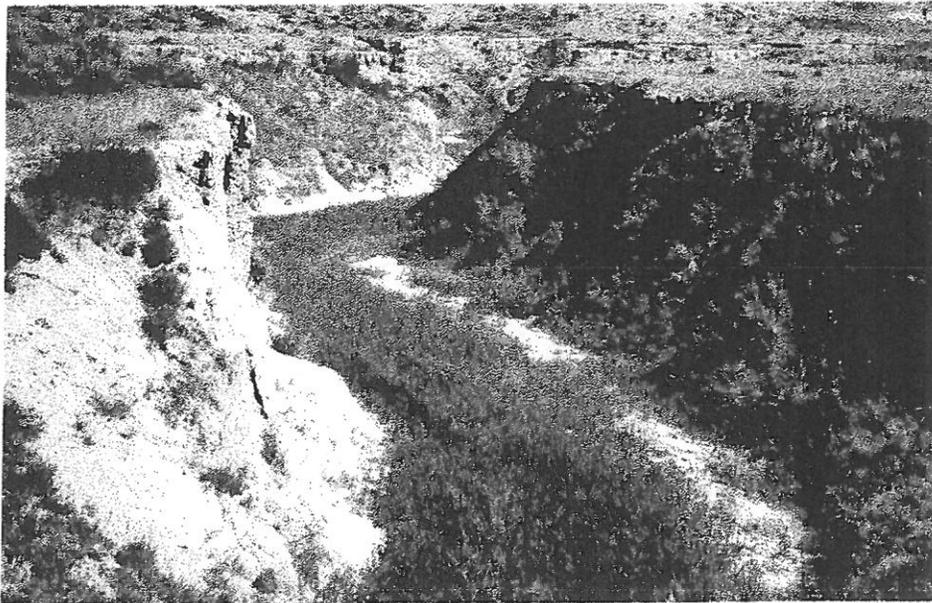


Figure 10: Typical section of Hay draw , note sedge in bottom.

C. Biological characteristics

1. Vegetation is consistent throughout the areas where *H. diversipes* has been collected. Along the hills outside of the creek bottom, greasewood (*Sarcobatus vermiculatus*), silver sage (*Artemisia cana*), big sage (*Artemisia tridentata*), prickly pear cactus (*Opuntia spp.*), blue gramma (*Butulua gracillis*), several brome grasses (*Bromus spp.*) and yellow sweet clover (*Melilotus officinalis*) are the dominant species. Inside the creek bottoms, all of the previously listed species are present, plus salt cedar (*Tamarix ramosissima*), rubber rabbitbrush (*Chrysothamnus nauseosus*), various reeds (*Juncos spp.*), sedges (*Cyperaceae spp.*), and other grasses in small quantities. In addition, halogetin (*Halogeton glomeratis*) was abundant at the site on Dead Horse Creek. At higher elevations where vegetation is significantly different, streams have formed few or no pools and typically contain water only during periods of run-off.

The ponds and streams in the area are home to a wide variety of aquatic invertebrates. PEST, Inc. collected at least nine different families of aquatic invertebrates during their 1992 survey. Small fish living in the streams include fathead chub (*Platygobio gracilis*), and killifish (*Fundulus sp.*).

7. Population biology

A. General summary

Data collected from the field surveys by PEST, Inc., will be supplemented with information from collection by the U. S. Bureau of Land Management to give as accurate as possible discussion of species biology. The objectives of the surveys conducted by PEST, Inc. were to determine if *H. diversipes* currently exists, the current distribution, and indicate habitat types where the species is likely to be observed. A description of field census methodology is presented in Appendix 2.

B. Demography

1. Known populations - Currently *Hygrotus diversipes* is known from five separate locations. *H. diversipes* has been collected during at least two different surveys in different years at three of these locations - the type site, Hay Draw, and one location in Cloud Creek. The only other location that was re-sampled was in Dead Horse Creek, where the beetle was not collected seven (7) years after the initial collection. This failure to collect any *H. diversipes* during the second survey of Dead Horse Creek may be due to the 1992 survey by PEST, Inc. being done during August while the 1985 survey led by Dahlem was conducted in mid June. Both sexes of *H. diversipes* have been collected in every known collection site except Hay Draw where only females have been collected. * Collections made earlier in the summer, (June and early July) by groups led by Dahlem and Nelson seem to be more efficient in terms of collecting large numbers of beetles.

* Note - Identification of isolated female specimens is less certain than other identifications.

C Population distribution

Hygrotus diversipes Leech has been found in sites more than 18 miles apart, with confirmed collections between these sites. The total known range of *H. diversipes* covers about 56 square miles within Natrona county. All known sites are within the watershed area of the Powder River, however the known sites are in two separate tributary systems - Salt Creek (the type site and Hay draw), and Cloud Creek (Dead Horse Creek and Cloud Creek sites). This indicates that *Hygrotus diversipes* is probably more widely distributed within suitable habitat in the Powder River watershed than is currently known. No known *H. diversipes* have been collected outside the Powder River watershed.

D. Habitat area

Currently all collections of *H. diversipes* have come from streams displaying the following characteristics: Small size (up to about 2 meters across), highly mineralized water, the existence of a constant water source (pools), and elevations between 1450 meters (4785 ft.) and 1800 meters (5960 ft.).

The elevational distribution may be linked to changes in vegetative community, however it is more likely a lack of suitable in stream habitat. At higher elevations the streams tend to flow only during runoff periods and lack the constant water (pools) found at lower elevations in the same streams. The species may be more widely distributed at lower elevations than is presently known. PEST, Inc. did a very limited survey (about one half mile) of Dugout Creek in Johnson county at a lower elevation than the species is currently known to exist without collecting any *H. diversipes*. The only observable change in habitat was a widening of the creek itself, with fewer of the steep sided pools, and a broadening of the stream "bottom" flats area along the creek. Plant communities and the water characteristics did not seem to change.

H. diversipes has not been recorded from a large stream, pond, or lake.

E. Life history

Nothing is known specifically about the life history of *H. diversipes*. *Hygrotus diversipes* is a member of the genus *Hygrotus* and family Dytiscidae. There are more than 2,500 described species within the family Dytiscidae, of these more than 500 occur in North America. Dytiscids mate from early spring through autumn. Members of this family grow through three larval instars, requiring several weeks to several months to mature depending upon season and food availability. All mature larvae leave the water to pupate on land near the water's edge. Adult dytiscids will readily fly, but must leave the water to take off. Dytiscids land directly in water, due to the adaptation of the legs for swimming making them useless for landing on objects. Larvae are predatory, with adults of this family either being predaceous, scavengers, or both.

Within the family Dytiscidae are several subfamilies, *H. diversipes* is in subfamily Hydroporinae. This subfamily is further divided into eight tribes in North America. *Hygrotus* is only one of seven genera currently found in the tribe Hydroporini (White, D.S., W.U. Brigham & J.T. Doyen. 1984. Aquatic Coleoptera. In: R.W. Merritt & K.W. Cummins (eds.). An introduction to the aquatic insects of North America (2nd ed.). Kendall/Hunt; Dubuque, Iowa. pp. 361-437.).

There are 43 species of nearctic *Hygrotus* species divided into six groups. *H. diversipes* is a member of group IV along with four other species as previously discussed (Section 1),

* Note - Most of the information about life history is based on information presented by Mead in her 1993 masters thesis on *Hygrotus curvipes*. *H. curvipes* is a close relative of *H. diversipes* (found in the same group) that shares similar habitat characteristics.

The life cycle for *Hygrotus* includes egg, first through third larval instars, pupation, and adult phases. There seems to be two major flight times for adults, before egg laying, and post emergence. In Mead's study there were few adult beetles for a period of several weeks between the pre-egg laying flight and the post-pupation emergent flight. During this interim there were abundant larvae in breeding sites..

In Mead's study, eggs were small (less than one mm.), whitish, oval, and were attached to vegetation of some type. It took about seven days for the eggs to hatch. The hatched larvae then took about one week to complete the first and second instar stages. The third instar lasted longer - about two weeks in the study. Larvae would stop feeding, then immediately move out of the water into holes that they would cover with a few sand grains. The length of pupation appeared variable in Mead's study from about 12 days to several weeks. After which adult beetles would emerge.

No information is available specifically on how *H. diversipes* survives the winter months, some form of hibernation as adult beetles seems likely. If *H. diversipes* does hibernate, it may be in a variety of locations, in the stream bottom, along the waters edge among vegetation, or somewhere outside the immediate creek bottom in the upland vegetation. Given the small size of the beetles Mead felt that life span is likely to be approximately one year.

Food for larvae and adult beetles seems to be somewhat different. Larvae would pursue and consume small live prey including small ostracods, disabled amphipods, or carrion. Adult beetles have not been recorded actively pursuing prey, they generally obtain the majority of their sustenance by scavenging along the bottom - moving organic debris and looking for carrion. Mead also reported that under crowded laboratory conditions, cannibalism often occurred among adult beetles.

8. Population ecology

A. General summary-

The narrow footed diving beetle has been found only in small streams in Natrona County, Wyoming. *Hygrotus patruellis*, and *Hygrotus nubilis* are the only other species of the same genus that have been collected in the same locations. *Hygrotus diversipes* is much more common in streams than either *H. patruellis* or *H. nubilis*, but has never been found in a pond or lake where populations of *H. nubilis* and *H. patruellis* are common. These related species probably are primarily prairie pot-hole species in this region that occasionally land in the stream habitat where *H. diversipes* is found.

B. Positive and neutral interactions

Since nothing is specifically known about the life history of *H. diversipes* it is impossible to accurately state what if any positive or neutral interspecific relationships may exist.

C. Negative interactions

Without a complete life history it is impossible to know if any negative relationships exist.

Competition within the species is possible, however there is no known evidence that such competition exists. The only closely related species found in the same habitat are typically much less dense than *H. diversipes* so any interspecific competition is probably insignificant. Fish (listed previously) found in the streams known to be inhabited by *H. diversipes* are too small to pose any threat as a predator to the adult beetles, however may be predacious on the larval stages of *H. diversipes*.

D. Other factors

Physical factors that impact *H. diversipes* habitat may be more significant than relationships with other species. Since *H. diversipes* has never been collected in a lake or pond, it appears the adaptations that allow *H. diversipes* to survive in the small streams somehow make them less capable of surviving in non-flowing lakes or ponds. Typical annual precipitation cycles, length of ice-cover, amount of wind or wave action in the stream pools are all variables that effect some part of the habitat conditions in which *H. diversipes* has been collected. These variables may or may not effect *H. diversipes*, the information is not available.

There simply is not enough known about *H. diversipes* to know what factors are most important to the successful completion of their life-cycle.

9. Current land ownership and management practices

A. General nature of ownership

Land ownership in the areas of Natrona County where *H. diversipes* has been collected is mostly U. S. Government land, with approximately equal amounts of Wyoming state lands and private property (see Figure 11). U. S. Government lands in the area are administered by the Bureau of Land Management (B.L.M.). Dugout Creek is found mostly on B.L.M. land, with short sections being found in private property, and Wyoming state land. The majority of Cloud Creek is on B.L.M. property, with a short section on Wyoming state property. Dead Horse Creek is mostly on B.L.M. property with short sections on private property and Wyoming state land. Hay draw is the exception, being found almost entirely on private property.

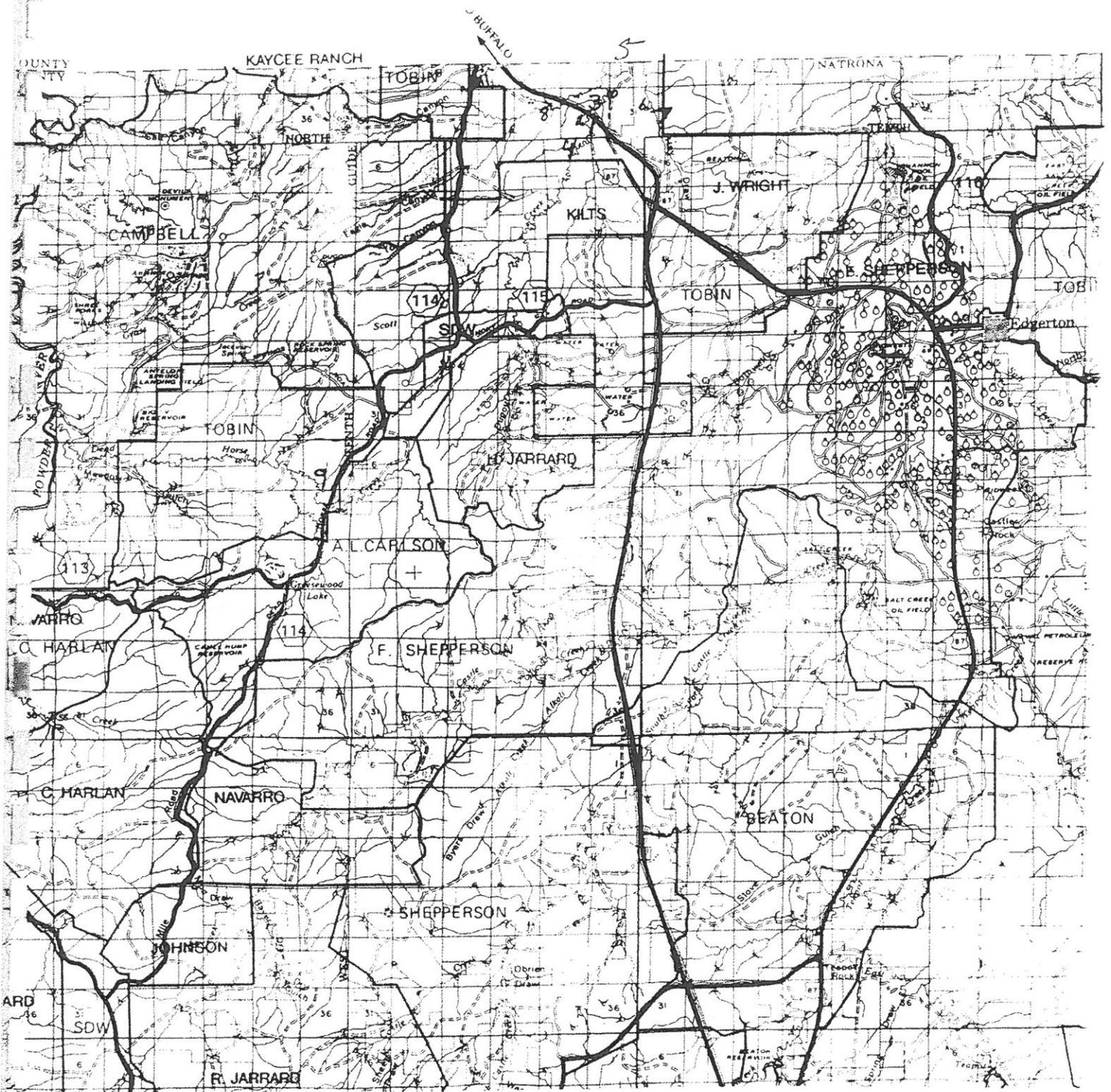


Figure 11: Land ownership map North central portion of Natrona County, Wyoming

10. Management practices and experience

A. Habitat management

1. Review of management and land-use experiences

Land in the area inhabited by *H. diversipes* is almost exclusively low intensity rangeland. Domestic cattle, pronghorns, and mule deer are the primary large ungulates in the area. The importance of these species is their possible impact on riparian areas along streams, including possible loss of vegetative diversity, increasing nutrient load in the stream, and possibly causing stream bank erosion. The area will not support a high stocking rate of cattle due to the low annual precipitation and subsequent low carrying capacity. Because of this the stocking rates in the area are low enough that there are no obvious cumulative impacts from cattle and wild ungulates despite many years of grazing in the area. Other current land uses include recreation - primarily hunting, and housing for area residents. The known range of *H. diversipes* has widely dispersed ranch homes and no towns.

2. Past management experiences

Past land use was very similar to the current use. Cattle have been grazing this area of Wyoming for many decades, and in one sense have taken the place of wild ungulates (primarily bison) that once utilized the area. Oil and gas field development has occurred in the area, but has had no observable effect on the habitat of *H. diversipes*. Roads and homes built in the past seem to have had no long term impact on *H. diversipes* as evidenced by the building of Interstate 25 a few meters from the type site. The only observable impact of these developments has been to change the pool structure of the stream at the point of development, and to shade the pool directly under the bridge. A pipeline was constructed along a portion of Dugout creek. While the pipeline is visible where it crosses the creek, there is no observable difference in the stream habitat at the pipeline except a short section of stream bank lacking any meander.

3. Likely future land use

Land uses will remain much the same as they are now in the foreseeable future. The likelihood of a significant increase in any kind of development in the area is very small because of the remoteness of the area, the harshness of the climate, and the lack of any particularly attractive feature. The lack of high quality water and soils needed for crop production presently eliminate the likelihood of intensive agricultural development. Future oil and gas field development in the area poses little threat to *H. diversipes* because of existing regulations protecting wetlands.

* Unless there is a dramatic and unexpected increase in human population or large scale changes in water use, *H. diversipes* should remain unaffected by future land uses.

B. Propagation

There have been no known attempts to raise *H. diversipes* in captivity. A self sustaining breeding population is apparently established in the surveyed area.

11. Evidence of threats to survival

A. Present or threatened destruction, modifications, or curtailment of habitat or range.

1. Past threats

Habitat inhabited by *H. diversipes* has been modified very little by human activity. As previously noted the remoteness of the area, lack of water, and harshness of the climate offer little incentive for exploitation. The occasional disturbances by hunters, cattle, etc. are infrequent and affect only very small portions of the stream systems inhabited by *H. diversipes* at any one time. Road and pipeline building appears not to have significant long term impacts as the habitat appears to be fairly resilient.

2. Other factors

Other factors such as collection for scientific purposes are not a significant threat to *H. diversipes* because of the very small areas affected by collection, and because the collections are very infrequent. There is no known commercial value for *H. diversipes* that might dramatically increase the rate of collection. No other disruptive factors on *H. diversipes* are known at this time.

II. Summary of Recommendations

12. General assessment of vigor, trends, and status.

The habitat of *Hygrotus diversipes* Leech has not been significantly altered since the species was originally described by Dr. Leech. In the last two years 1992 and 1993 *H. diversipes* has been confirmed from two new locations. *Hygrotus diversipes* has now been confirmed from five separate sites. The distance between these sites and their geographic separation into separate watersheds seems to indicate the species is well distributed in Natrona county.

The number of specimens collected by PEST, Inc. was low compared to the number collected by Leech in his original trip. This lower number is probably due to the collections being done later in the summer. PEST, Inc. collected specimens during early August while Leech collected in July. Other investigators have collected large numbers of *H. diversipes* in recent years, including 71 specimens collected in June 1985 by Gene Dahlem of the Bureau of Land Management, and 10 specimens collected by the Bureau of Land Management in August 1993. Rather than being indicative of a loss in species vigor in recent years, this low number of specimens collected is likely related to the life cycle of *H. diversipes*, with adult beetles being most numerous from mid June through mid July.

There is insufficient data to determine total populations of *H. diversipes*, but the species has been re-collected in three of the five known collection locations. These collections have been several years apart in the type site and in Cloud Creek. *H. diversipes* populations seem to be stable, with the known populations becoming more numerous as more effort is put into finding them.

13. Priority of listing or status change

A. Recommendation to U.S. Fish and Wildlife Service

On the basis of the surveys conducted by PEST, Inc. and the Bureau of Land Management we recommend to the U.S. Fish and Wildlife Service that *Hygrotus diversipes* Leech not be listed as either threatened or endangered under the provisions of the Endangered Species Act. The species is maintaining its populations and distributions as evidenced by several facts:

First the known range is constantly expanding, as more effort is put into finding this species - the more sites it is found in.

Second the species has been re-collected in known sites years after the original collections.

And third, the type site has had much more disturbance than most of the habitat will have in the foreseeable future (an Interstate highway was built over Dugout Creek, and a pipeline was built across Dugout Creek through the type site), neither of these disturbances has eliminated *H. diversipes* from the type site. We feel that this shows the relatively high level of resilience in the habitat and in the beetles themselves.

Current land management by private, state, and federal land managers does not put the species in any danger and as previously discussed, there is little likelihood of significant change in the land use or management.

14. Recommended critical habitat

We feel that given the distribution of *H. diversipes*, and the variable habitat it has been found in no habitat should be set aside as protected "critical habitat".

15. Conservation/recovery recommendations

A. General conservation recommendations

The single most important factor in maintaining *Hygrotus diversipes* Leech as a viable species is to maintain conservative land stewardship. Through conservative land stewardship the most vulnerable areas of the ecosystem - streams and riparian areas are protected, thus the habitat for *H. diversipes* is protected. The other concern is the possibility of some type of toxic spill (e.g. a pipeline break) in a stream where *H. diversipes* breeds during the early summer period when the beetle larvae are in the water. The possibility of an accidental spill is unavoidable, but rapid containment and clean up through bio-remediation would likely be the best method of protecting the larvae of *H. diversipes*.

B. Monitoring / Further Studies

We feel that *H. diversipes* is doing quite well under current conditions and no intensive monitoring is necessary. Should the land uses in the area change significantly or should there be a catastrophic event (like a toxic spill) in a stream known to have *H. diversipes* then there should be an effort to determine if the species still exists in the stream, and if conditions support reproduction.

A study should be done to identify the larval stages of *H. diversipes*. This would allow managers the additional tools of collection and transplant of a significant number of beetles should a major change in land use occur, (possibly endangering the species), or if a known indigenous population were eliminated through a temporary catastrophic event.

16. Interested parties

Office of Endangered Species
U.S. Fish and Wildlife Service
Washington, D.C. 20240

Wyoming Game and Fish
2800 Pheasant Drive
Casper, WY 82604

U.S. Fish and Wildlife Service
Attn: Dr. James L. Miller
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Wyoming Outback Ranch
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U.S. Fish and Wildlife Service
Region 8 Office
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Lakewood, Colorado 80228

Dr. Russell D. Anderson
Professor of Biology, Retired
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Cedar City, UT 84720

U.S. Fish and Wildlife Service
Attn: Mr. Charles Davis
State Supervisor
Fish and Wildlife Enhancement
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Dr R.E. Roughley
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U.S. Bureau of Land Management
Attn: Willie Fitzgerald
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Casper, Wyoming 82601

Professional Entomological Services Technology, Inc.
9999 Olde Wadsworth Blvd.
Broomfield, CO 80021-4028

Mr. William Mortimer
Platte River Resource Area Manager
Bureau of Land Management
P.O. Drawer 2420
Mills, Wyoming 82644

III. Information sources

17. Sources of information

A. References cited in report

- Alarie, Y., P. P. Harper, and R.E. Roughley. 1990. Descriptions of the larvae of eleven Nearctic species of *Hygrotus* Stephens (Coleoptera: Dytiscidae: Hydroporinae) with an analysis of their phyletic relationships. *Can. Entomol.*, 26: 199-210.
- Anderson, Russell D. 1983. Revision of the Nearctic Species of *Hygrotus* Groups IV, V, VI (Coleoptera: Dytiscidae). *Annals of the Ent. Soc. of America*. (Vol. 76, No. 2, pp. 173-196.).
- Brigham & J.T. Doyen. 1984. Aquatic Coleoptera. *In*: R.W. Merritt & K.W. Cummins (eds.). *An introduction to the aquatic insects of North America* (2nd ed.). Kendall/Hunt; Dubuque, Iowa. pp. 361-437.).
- Leech, Hugh B. 1966. The Pedalis-Group of *Hygrotus*, With Descriptions of Two New Species and a Key to the Species (Coleoptera: Dytiscidae). *Proc. of the California Academy of Sciences*. (Vol. XXXIII, No. 15, pp. 481-498.)
- ✦ Mead, Deborah Lynn. 1993. Thesis. Natural history of the rare curved-footed diving beetle, *Hygrotus curvipes* (Dytiscidae). San Francisco State University.
- Tracy, H.Bryn, and Wm. L. Hilsenhoff. 1985. Techniques for Collecting water beetles from Lentic Habitats. *Proceedings of the Academy of Natural Sciences of Philadelphia* 137: 8-11.

B. Museum collections consulted

Wyoming State Museum, Barrett Building, Cheyenne, Wyoming
No museum specimens of *H. diversipes* in collection.

C. Field Work

site visits by authors; (PEST, Inc. staff)

- | | |
|---------------------------|---|
| 10 through 12 August 1992 | -- General fieldwork including mapping water sources, collecting invertebrates, note taking, water sample collection, collection and identification of common plant specimens, fish collection, detailed descriptions of all collection sites, detailed information about wild and domestic animals in the area |
| 13 and 14 August 1993 | -- General fieldwork focused on collecting from the same locations (sites) where we collected in 1992, taking field notes including information about changes in water or other habitat conditions from 1992 |

D. Knowledgeable individuals

Information from the following individuals was considered and reviewed in preparation of the status report:

Dr. James L. Miller
Dr. R. D. Anderson
Dr. R. E. Roughley
Willie Fitzgerald
William Mortimer

Addresses for these individuals are listed in the "Interested Parties" section of this report.

18. Summary of materials on file.

Items on file include field notes, photo prints, 35mm slides, literature cited, collection species lists some mounted adult *H. diversipes* beetles and all related correspondence except;

Personal comments from Dr. R.E. Roughley and the thesis by Mead:

Deborah Lynn Mead. 1993. Natural history of the rare curved-footed diving beetle, *Hygrotus curvipes* (Dytiscidae). San Francisco State University.

The copy of the thesis used in preparing this report was borrowed from Dr. Roughley, and has been returned to him.

IV Authorship

19. Initial authorship

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*Lewis C. Keenan Staff Entomologist, and Timothy Howard, Staff Biologist

20. Maintenance of status report

U.S.Fish and Wildlife Service ,134 Union Blvd., Suite 130, Lakewood CO 80228

V. New information

21. Record of revisions to this status report

Will follow the guidelines outlined in "Guidelines for the preparation of status reports on rare and endangered species".

Appendix 1

Procedures for conducting detection surveys, distribution surveys, and documentation of specimens.

Detection and distribution surveys were conducted in August 1992 and August 1993 in accordance with the contract between PEST, Inc. and the U.S. Fish and Wildlife Service.

The detection survey covered a small circular area with a radius of about 660 feet around the type site where U.S. highway 87 crosses Dugout Creek. The detection survey covered only two bodies of water, Dugout Creek and a small pond north of Dugout Creek and West of highway 87.

The first body of water surveyed was the type site from the intersection where Dugout Creek crosses highway 87 upstream to the boundary of the survey area. This area was surveyed as a single sample. The entire length of the stream banks, in this section of Dugout Creek, was surveyed in the detection survey. The section of Dugout Creek downstream of highway 87 to the boundary of the detection survey area was surveyed as a separate sample. This downstream area was sampled only where there was some type of structure in the water. Salt cedar roots and branches, reeds, any type of debris, clods of soil from the creek banks, and a variety of other objects or changes in the stream bottom were considered "structure". The amount of area sampled was similar in 1992 and 1993.

The second body of water surveyed was a small pond about 12m. in length and 5m wide. Water in this pond was turbid and appeared highly mineralized during both survey years. The pond was completely surrounded by vegetation with about twenty percent of the pond margin having vegetation, primarily reeds (*Juncus* spp.) growing out into the pond. During both survey years the entire margin of the pond was sampled.

The distribution survey covered a much larger circular area with a radius of about 8500 feet. All water sources within this area were identified on a topographic map, and proofed on the ground. At least a portion of each of these water sources was sampled. Sample numbers 4 through 8 were collected within the distribution survey area. Sampling took place in areas most likely to contain beetles. Water sources sampled included Dugout Creek above the area of the detection survey, Dugout Creek below the detection survey in Johnson county, Hay draw, a small triangular pool near Hay draw, and another pond north of Dugout creek and west of I-25. The last area sampled by PEST, Inc. was outside the detection survey location in Dead Horse Creek downstream from county road 115. This area was chosen because it was in a different watershed, and was in a stream where *H. diversipes* had been found previously.

The same locations were sampled during each year of the survey except Dead Horse Creek which was sampled only in 1992. Each sample was a composite of beetles taken while sampling a pond or stream section. Samples taken from streams were from sections up to about a mile long. Samples from pond sampling sites included all beetles collected from that pond.

All beetles from a sampling site (stream section or pond) were preserved in vials containing a 70 percent ETOH solution. Immediately after finishing a certain sample site all beetles from that site were combined into one vial. A sample number was attached to each composite vial in the field. This number was correlated to a number and description of where the sample was taken in the field notes. After returning to camp these descriptions were compared to a 7.5 minute USGS quadrangle topographic map (Government Creek Quadrangle) and the legal description of the location of each sample site was recorded.

Samples collected in the field were separated out to family before being sent to Dr. Roughley of the University of Manitoba who did the final species determination. Dr. Roughley was also sent a representative sample of the aquatic invertebrates we collected in Natrona county.



Figure 12; Tim Howard, staff Biologist, "sweeping" pools for Narrow-foot diving beetles (*H. diversipes*) in Dug Out Creek, Natrona County, Wyoming

Appendix 2

Field census methodology descriptions.

Field census techniques were variations on two very basic methods. The first method was collection using a standard sweep net. Samples were taken in all available water depths, both along stream and pond sides and along stream and pond bottoms, concentrating in areas of structure like organic debris or vegetation. The second method used was to set up a black light attractant and collect beetles as they came to the light.

The sweep nets used during these collections were slight modifications of the standard D net. (See Figures 12 & 13) The handles on each net were set at the edge of the net at an angle. The angle directly below the handle was approximately a right (90 degree) angle. This allowed us to sample more efficiently along the stream banks with the net hugging both the stream bottom and the stream channel side simultaneously. The handle came off the top of the net at an angle in a direction opposite the acute angle in the net. This net shape also allowed us to sample without wading, minimizing the disturbance to the aquatic community prior to sweeping an area.

Because of the habitat typically preferred by members of the genus *Hygrotus* for various types of debris or vegetation, we attempted to use multiple sweeps through the same area in order to first dislodge then collect beetles in the net. This was often accomplished by having one person sweep an area immediately after the other, or by sweeping toward and past each other through the same habitats. These methods were similar to those suggested by Dr. R. E. Roughley (pers. comm.). Interestingly, the person following often collected a larger total number of organisms and a wider variety of organisms than the person in the lead. In areas where it was not possible to sweep one after the other we swept repeatedly in a figure eight pattern or used repeated sweeps in the same direction.

Sampling with sweep nets was done exclusively during the daytime. Sampling was done in variable weather and water conditions. The weather conditions and time of day did not seem to significantly affect the number of beetles collected. Water conditions in Dugout Creek were significantly different in 1992 and 1993. Dugout Creek was flowing in 1993 due to an unusually wet late summer. Sampling was much more difficult in the flowing stream. We collected fewer total beetles, and fewer *H. diversipes* in the higher water conditions. It was difficult to see the stream bottom, sampling could only be done in an upstream direction, and there was less vegetation (salt cedar roots and branches) in areas with little or no current. Very few organisms of any type were collected in areas where there was a significant current.

Black light sampling was attempted during 1992 using a fluorescent black light tube operated by a twelve volt battery after being converted to AC. This light was placed in the center of a white cloth near Dugout Creek and near the other small pond just north of Dugout Creek inside the detection survey area. The lights were placed below stream banks and vegetation as much out of the wind as possible. The white cloth was used so organisms flying to the light could land on the sheet and be much easier to see and collect. Organisms were collected from the white cloth and immediately preserved in a 70 percent ETOH solution as they were collected. Few specimens were collected (*no Hygrotus*) in this manner. Those that were collected were later consolidated with the samples taken previously at these sites with sweep nets.

The success of the black light attractant was limited because there was a steady wind blowing for the two hours (9 to 11 PM) that the black light attractants were in operation. Use of the black light attractants was discontinued because of equipment problems.



Figure 13: L.C. Keenan, Staff Entomologist, sorting aquatic sweep net sample in search of adult Narrow-foot diving beetles, *Hygrotus diversipes* Leech, Natrona County, Wyoming.