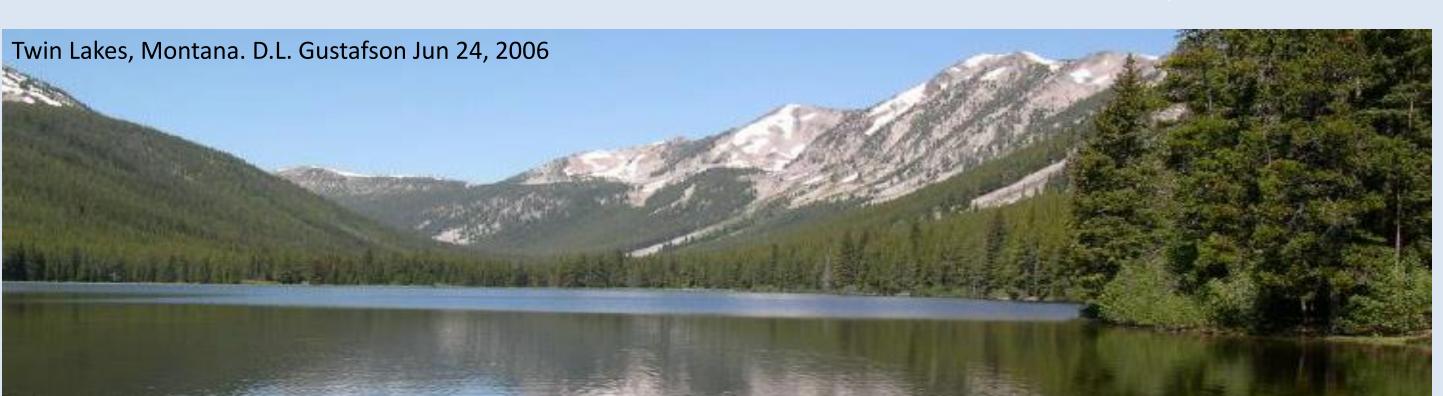
# Digitizing the Daniel L. Gustafson Aquatic Invertebrates Collection in the Montana Entomology **Collection at Montana State University**





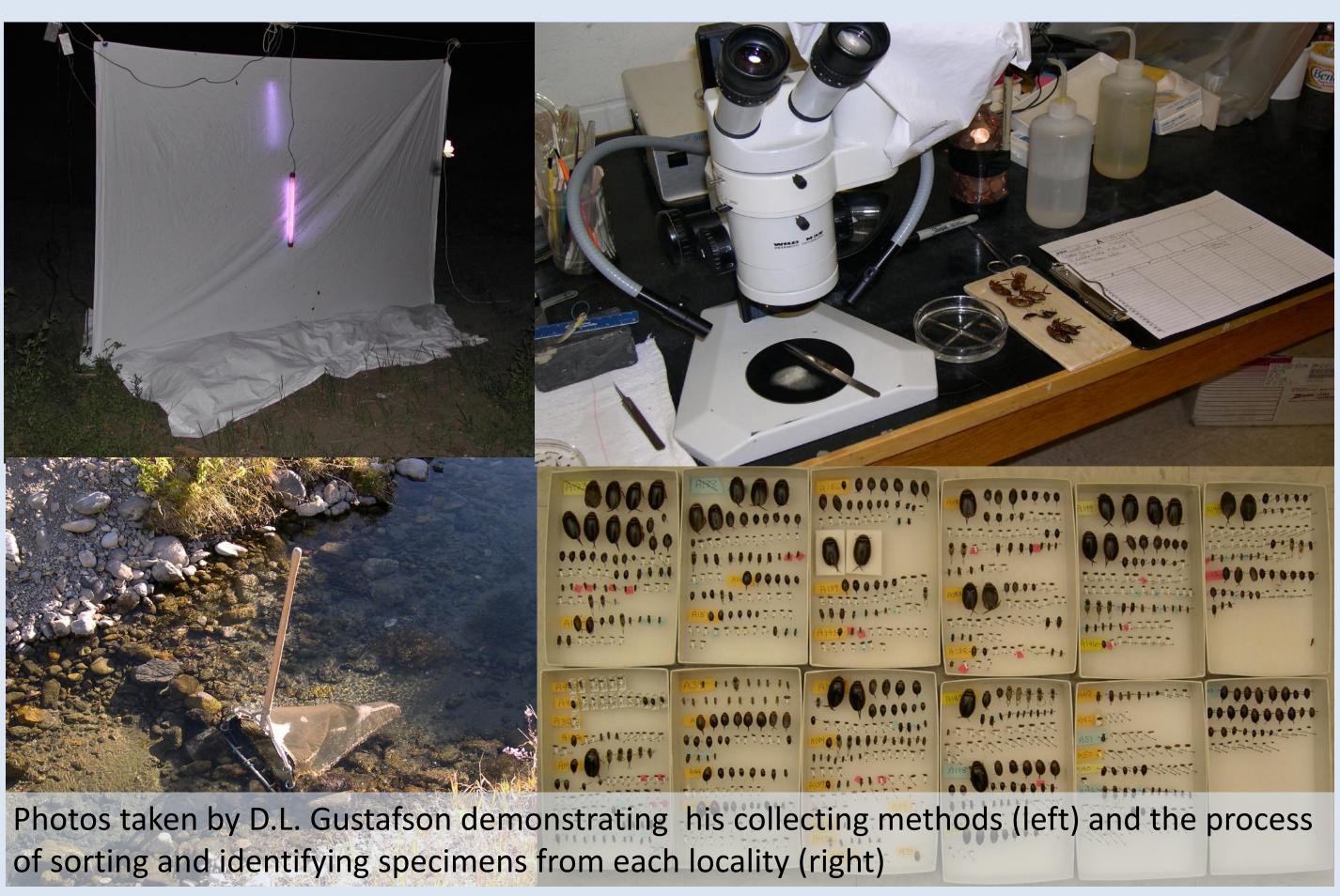






## Background

The Montana Entomology Collection (MTEC) is two years through digitizing the Daniel L. Gustafson Aquatic Invertebrates Collection (DLGAIC), which is the largest aquatic invertebrate collection housed in the MTEC. The DLGAIC contains invertebrates collected primarily from the freshwaters of Montana by Daniel L. Gustafson and his colleagues. In addition to specimens, the DLGAIC includes logbooks containing field notes, photographs of the sites taken at the time of collecting, and digital databases containing localities with coordinates and their associated logbook numbers.



# **Collecting and Recording Methods**

D.L. Gustafson used a variety of collecting techniques including, but not restricted to, hand nets, kick nets, drift nets, emergence nets, black light traps, bottle traps, pitfall traps, and Lindgren funnels. Each collecting event was assigned a unique number and field notes from the event were handwritten under this number in logbooks. Once specimens were identified, these too were written up in the logbooks.

To accompany the logbooks, D.L. Gustafson created two digital databases. One contained a list of all locality names organized by the date he visited, with latitudes, longitudes, elevations, and synonymous locality names. The other database contained a list of localities with coordinates and elevations, along with collector names and logbook numbers. Digital copies of photos taken at sites were saved with their logbook numbers as their file names.

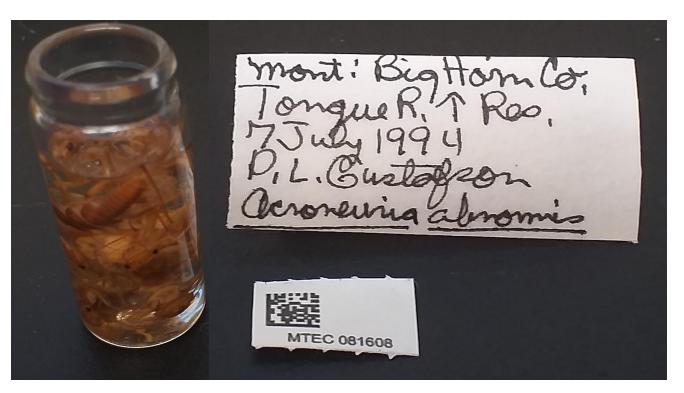
#### Chloe L. Rice, Brandon Watson, Jason A. Clark, Diane M. Debinski, and Michael A. Ivie Montana Entomology Collection, Montana State University Marsh Labs, Room 50, Bozeman, MT 59717, USA

# Digitization Workflow

Each lot was assigned a unique machine-readable barcode label, with its locality label and determination typed out in compliance with Darwin Core terminology. D.L. Gustafson's digital databases were used to find latitudes, longitudes, elevations, and logbook numbers for each lot. D.L. Gustafson was consulted regarding suspected synonymous locality names. For specimens without coordinates, Google Earth was used to georeference by locality name.

Logbook numbers were used to link specimens to field notes. Digitization of the logbooks was outsourced to Backstage Library Works, producing PDF scans of the pages. Specimen records were linked to photographs taken by D.L. Gustafson at the collecting sites using logbook numbers .The specimen metadata, along with the PDF logbook scans and site photos which will be made publicly available online.

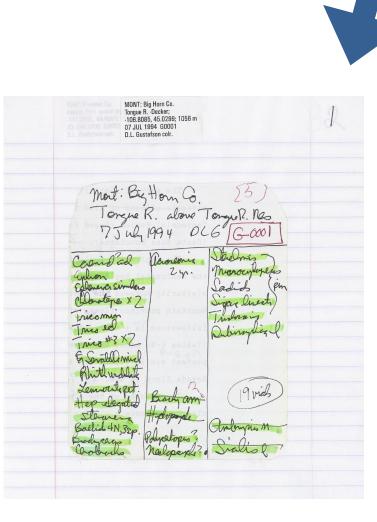
The flowchart below demonstrates, with an example specimen, the process of inputting information to create a metadata record and the digital objects which can be linked directly to the record using its logbook number.



One lot of Acroneuria abnormis (Newman, 1838) specimens with their label and barcode MTEC 081608



Darwin Core compliant metadata record in Microsoft Excel



Logbook entry for the collecting event G0001, containing field notes



Photo taken at time of collecting the lot MTEC 081608 by D.L. Gustafson at Tongue River, Bighorn Co., Montana (logbook number G0001)

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-107:6864, 48,4117,073 m 06 JUL 194 USYMF 0017. 10080014 41 G0966 L 006 JUL 196, 45,6006; 1219 m 06 JUL 194 JL.1 Gustafron colr. 10110201 43 G1763 Braton Lake -Unit 40; 1009010 Lake -Unit 40; 1009010 Lake -Unit 40; 1009010 Lake -Unit 40; 1009010 Lake -Unit 50; 1009010 Lake -Unit 50; 100100 Lake -Unit 50;	
Lancis Spring area; 14011 MONT: Catter Cc. 1004.1769, 45.6069; 1219 m 66 UU: 199 D. L. Gustafon colf. 10110201 43 1743 Bencion Lake -Unit 4b; 3422 MONT: Cascade Co. 10030102 41 00973 Bencion Lake -Unit 5; 3422 MONT: Cascade Co. 10030102 41 00984 Bencion Lake -Unit 6; 3432 MONT: Cascade Co. 10030102 41 00986 111.3174, 47.6545; 1218 a0 7 UU: 1994 Bencion Lake -Unit 6; 3432 MONT: Cascade Co. 10030102 41 00986 113.74, 47.6545; 1218 a0 7 UU: 1994 Bencion Lake -Unit 6; 3432 MONT: Big Morin Co. 1003012 41 00986 Cow Cr. Reservoir; 1003014 41 00900 Cow Cr. Reservoir; 1003014 41 00900 Cow Cr. Reservoir; 1003014 41 00900 Cow C. Reservoir; 1003014 41 1003014 41 100301	
-104.1769, 45.6306; 1319 m 06 JUL 199 D.L. Gustafton coil. 1011020 43 01763 m. 111.3500, 47.6800; 1321 m 07 JUL 199 J. 194521 MONT: Cascade Co. 10030102 41 00973 Benton Lake -Onit 5; 10030102 41 01974 Coil. 10030102 41 01000011 Lake -Onit 6; 1003010 41 0100001 144 01000 1107 Coil. 1003011 Lake -Drumbor 1003014 41 01000 1107 Coil. 1003014 41 0100001 4222 MONT: Faulting Co. 10030014 41 0100001 44 0100001 44 0100001 44 0100001 149 ULFW Coil. 10030014 41 0100001 4222 MONT: Faulting Co. 10030014 41 0100001 4202 MONT: Faulting Co. 10030014 41 0100001 4202 MONT: Faulting Co. 10030016 41 0100001 4202 MONT: Faulting Co. 10030016 41 0100001 41 01000010 41 0100	
Benton Lake - Unit 4b;         M432 MONT: Caesade Co.           -111.3050, 47.6600 / 1131 go 7UL 194 USTWE COL.         10000102 41           OBTION Benton Benton Benton Benton Benton Device         13422 MONT: Caesade Co.           -111.3014, 47.6897, 1131 go 7UL 194 USTWE COL.         10000102 41           OBTION Benton Benton Benton Benton Device         13422 MONT: Caesade Co.           -111.3174, 47.6845, 1131 go 7UL 194 USTWE COL.         10000102 41           OBSE         1000010 942 go 7UL 194 USTWE COL.         10000101 41           OBSE         Falst Kavier: Autorial State Formabol Col Col Keis, 48.7738; 0642 go 7UL 194 USTWE COL.         10000101 41           OLOG Col Cr. Reservoir) Col Keis, 48.0738; 0056 go 7UL 194 USTWE COL.         1000011 41           OLOG Col Cr. Reservoir) Col Keis, 48.0303; 1136 go 7UL 194 USTWE COL.         1000011 41           OLOG Col Cr. Reservoir) Col Cr. Reser	
-111.5500, 47.6800; 1121 m 07 JUL 194 USPWS colf. 1003012 41 00733 main state Julis 5; 14123 JUNIT: Cascade Co. 1003012 41 00984 Benton Lake -Onit 6; 1003012 41 00984 more state of the state o	
Bencon Lake -Unit 5;         34322 MONT: Caesade Co.           -1111.3104, 47.6597; J1311 no 7UL 1949 USTW Soil.         10000102 41           Bencon Lake -Unit 6;         34322 MONT: Caesade Co.           -111.3174, 47.6584; J131 no 7UL 1949 USTW Soil.         10000102 41           03980	
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00984         34522 MONT: Cascade Co.           -111.3174, 47.6554; J121 m 07 JUL 1994         34522 MONT: Cascade Co.           -111.3174, 47.6554; J121 m 07 JUL 1994         DSFW Colt.         100.00102 41           Bendron RSaint Kavier;         34522 MONT: Big Morn Col.         100.00102 41           -107.7466, 45.4606; 0942 m 07 JUL 1994         DL. Gustaften Colt.         100.00014 41           GL008         1004 Colt.         34522 MONT: Powder River Co.           -107.6465, 46.3738; 0465 m 07 JUL 1994         JUFWS Colt.         10080014 41           GL008         Cow Cr. Reservoir;         34522 MONT: Powder River Co.           -104.646, 45.3103; 1189 m 07 JUL 1994         D.K. Gustaffonn Colt.         10080014 41           GL008         Cow Cr. Reservoir;         34522 MONT: Revell Co.         10080012 43           Lee Metcolf MMR- Barn Slough;         34522 MONT: Revell Co.         17010205 16           -114.0523, 46.5583; 1036 m 07 JUL 1994         USFWS colt.         17010205 16           -114.0641, 45.4529; 1036 m 07 JUL 1994         USFWS colt.         17010205 16           -114.0786, 45.4569; 1036 m 07 JUL 1994         J4522 MONT: Revell Co.         101.2005 16           -114.0786, 45.4569; 1036 m 07 JUL 1994         USFWS colt.         17010205 16           -114.0798, 45.4569; 1036 m 07 JUL 1994         J4522 MONT: Revell	
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00980         34522 MONT: Big Horn Co.           107,746,45,45,4606;042 m07 JUL 1994         34522 MONT: Big Horn Co.           107,746,45,45,4606;042 m07 JUL 1994         54523 MONT: Big Horn Co.           107,746,45,45,4606;042 m07 JUL 1994         54523 MONT: Billips Co.           107,646,45,1035,1169 m 07 JUL 1994         54523 MONT: Bullips Co.           100,0645,45,3735,0695 m 07 JUL 1994         34522 MONT: Bruder River Co.           01007         114,053,46,5359,1056 m 07 JUL 1994         54522 MONT: Ravall Co.           114,052,146,5453,0056 m 07 JUL 1994         54522 MONT: Ravall Co.           114,0541,46,5429,1056 m 07 JUL 1994         10700205 16           01026         34522 MONT: Ravall Co.           114,0541,46,5429,1056 m 07 JUL 1994         USTWS colr.         17010205 16           114,0541,46,5429,1056 m 07 JUL 1994         JUSTWS colr.         17010205 16           114,0785,46,5469;1056 m 07 JUL 1994         JUSTWS colr.         17010205 16           114,0798,46,5469;1056 m 07 JUL 1994         JUSTWS colr.         17010205 16           114,0798,46,5469;1056 m 07 JUL 1994         JUSTWS colr.         17010205 16	
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-107.6665, 48.3735; 6695 m 07 JUL 199 USTWS colr. 100500141 GLOS Cov Cr. Reservoir: 34522 MONT: Rowals River Co. 0107 Lee Metcalf MRN- Barn Slough; 34522 MONT: Ravall Co. -114.0232, 46.5353 JOS 66 m 07 JUL 1994 USTWS colr. 17010205 16 GLOS Coll Control MRN- Band 3; 34522 MONT: Ravall Co. -114.0341, 46.5425; JOS 6 m 07 JUL 1994 USTWS colr. 17010205 16 GLOS Coll Control MRN- Band 3; 34522 MONT: Ravall Co. -114.0354, 46.5459; JOS 6 m 07 JUL 1994 USTWS colr. 17010205 16 GLOS Coll Control MRN- Band 3; 34522 MONT: Ravall Co. -114.0756, 46.5469; JOS 6 m 07 JUL 1994 USTWS colr. 17010205 16 -114.0756, 46.5469; JOS 6 m 07 JUL 1994 USTWS colr. 17010205 16 -114.0756, 46.5469; JOS 6 m 07 JUL 1994 USTWS colr. 17010205 16	
01008 Cut Cr. Reservoir; Cut Cut Cr. Reservoir; Cut Cut Cut Cut Cut Cut Cut Cut Cut Cut	
-106.2461, 45.3103; 1199 m 07.JUL 1994 D.L. Gustafson coll. 10090102 43 G1107 Lee Metoalf MR- Barn Slough; 34522 MONT: Ravall Co. -116.0523, 46.5539; 1036 m 07 JUL 1994 USTWS coll. 17010205 16 Lee Metoalf MR- Pond 3; 34522 MONT: Ravall Co. -114.0431, 46.5429; 1036 m 07 JUL 1994 USTWS coll. 17010205 16 G1014 Lee Metoalf MR- Pond 3; 34522 MONT: Ravall Co. -107950, 46.5469; 1036 m 07 JUL 1994 USTWS coll. 17010205 16 01020 G1020 GR State	
01107 Lee Metoolf MWR- Barn Slough; 34523 MONT: Ravalli Co. 10026 Lee Metoolf MWR- Bond J: 34523 MONT: Ravalli Co. 114,0541,465,429; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 Lee Metoolf MWR- Bond J: 34523 MONT: Ravalli Co. Lee Metoolf MWR- Bond J: 34523 MONT: Ravalli Co. 114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,465,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4559; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 1056 m O7 JUL 194 UNWTS colf. 100,0205 16 -114,0758,4569; 100,0205 m OF Colf. 100,0205 16 -114,0758,4569; 100,0205 m OF Colf. 100,0205 16 -114,0758,4569; 100,0205 m OF Colf. 100,0205 16 -114,0758,4578; 100,0205 m OF Colf. 100,0205 16 -114,0758,458; 100,0205 m OF Colf. 100,0205 16 -114,0758,458; 100,0205 m OF Colf. 100,0205 16 -114,0758,458; 100,0205	
Lee Metcalf NNR- Barn Blough; 34622 MONT: Ravalli Co. -114.0323, 46.5339; 1006 m 07 UL1994 USTWS colr. 17010205 16 01026 19 44522 MONT: Ravalli Co. -114.0541, 46.5429; 1006 m 07 UL1 1994 USTWS colr. 17010205 16 01014 20 4007 Ravalli Co. -114.0756, 46.5469; 1006 m 07 UL1 1994 USTWS colr. 1010205 16 -114.0756, 46.5469; 1006 m 07 UL1 1994 USTWS colr. 1010205 16 -114.0756, 46.5469; 1006 m 07 UL1 1994 USTWS colr. 1010205 16 -114.0756, 46.5469; 1006 m 07 UL1 1994 USTWS colr. 1010205 16 -114.0756, 46.5469; 1006 m 07 UL1 1994 USTWS colr. 1010205 16 -114.0756, 46.5469; 1006 m 07 UL1 1994 USTWS colr. 1000205 16 -114.0756, 46.5469; 1006 m 07 UL1 1994 U	
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Lee Metcalf MMR- Bond 2; 34922 MONT: Ravalli Co. -114.0491, 46.5429; JOSE mO 7 JUL 1994 USTWS colr. 17010205 16 01014 Lee Metcalf MMR- Pond 3; 34522 MONT: Ravalli Co. -01020 789, 46.5469; LOSE mO 7 JUL 1994 USTWS colr. 17010205 16 01020 Troppe RDecker; 34522 MONT: Big Morn Co.	
-114.0941, 46.5429; 1036 m 07 JUL 1994 USFWS colr. 17010205 16 GU14 Lee Metcalf MWR- Pond 3; 34522 MONT: Ravalli Co. -114.0798, 46.5469; 1036 m 07 JUL 1994 USFWS colr. 17010205 16 GU1020 Tongue RDecker; 34522 MONT: Big Horn Co.	
Lee Metcall NMR- Fond 3; 34522 MONT: Ravall2 Co. -114.0798, 46.5469; 1036 m 07 JUL 1994 USFWS colr. 17010205 16 01020 Tongue RDecker; 34522 MONT: Big Horn Co.	
-114.0798, 46.5469; 1036 m 07 JUL 1994 USFWS colr. 17010205 16 G1020 Tongue RDecker; 34522 MONT: Big Horn Co.	
Tongue RDecker; 34522 MONT: Big Horn Co.	
-106.8136, 45.0303; 1056 m 07 JUL 1994 D.L. Gustafson colr. 10090101 43	
G0001 Tongue River ResCamp: 34522 MONT: Big Horn Co.	
-106.7756, 45.1068; 1045 m 07 JUL 1994 D.L. Gustafson colr. 10090101 43	
G1764	
Benton Lake -Unit 2; 34523 MONT: Cascade Co. -111.3546, 47.6859; 1122 m 08 JUL 1994 USFWS colr. 10030102 41	

D.L. Gustafson's database used to find the logbook number, latitude, longitude, and elevation. This specimen's logbook number is G0001.



# Results

### Of the 13,000 lots from the DLGAIC digitized so far: Collectors:

•75% of lots collected by D.L. Gustafson •130 collectors in total contributed specimens over a time span of

five decades

Taxonomic Scope:

- 84,000 individual specimens across 350 species.
- have been fully digitized.

Geographic Scope:

•A majority of specimens were collected from Montana, with all 56 counties represented.

•Habitats range from prairie streams in Eastern Montana to lakes in the Rocky Mountains

• A minority of specimens were collected from 28 states outside of Montana.

### **Remaining work:**

• An estimated 51,000 DLGAIC lots remain to be digitized, which are mainly coleopterans, trichopterans, gastropods and slidemounted worms

Gastropoda will be the

most specimen-rich group,

with an estimated 1,000,000 specimens.

•12,000 lots from the other aquatic invertebrate

collections at MTEC.

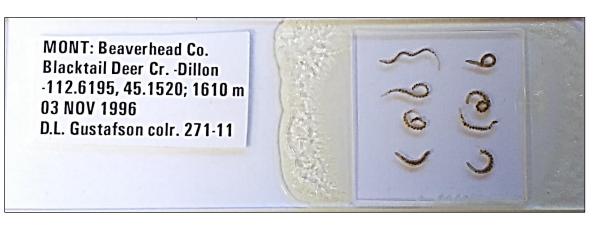
## Discussion

The long-term goal is to completely digitize the DLGAIC and the rest of the AIC. Combined, the data will represent a complex web of interspecific relationships, currently unavailable to scientists visiting the collections. This will open opportunities for scientists to conduct temporal and geographic studies on the biodiversity of Montana's freshwater systems, such as detecting changes in community composition over time and the investigating human impacts on aquatic environments. The dataset could also be used in conjunction with Montana State University's fish collections, which have recently been digitized and which share many of the same sampling sites.

### Acknowledgements

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• Astacoidea, Corixidae, Plecoptera, Ephemeroptera and Odonata



A slide with specimens collected and mounted by D.L. Gustafson