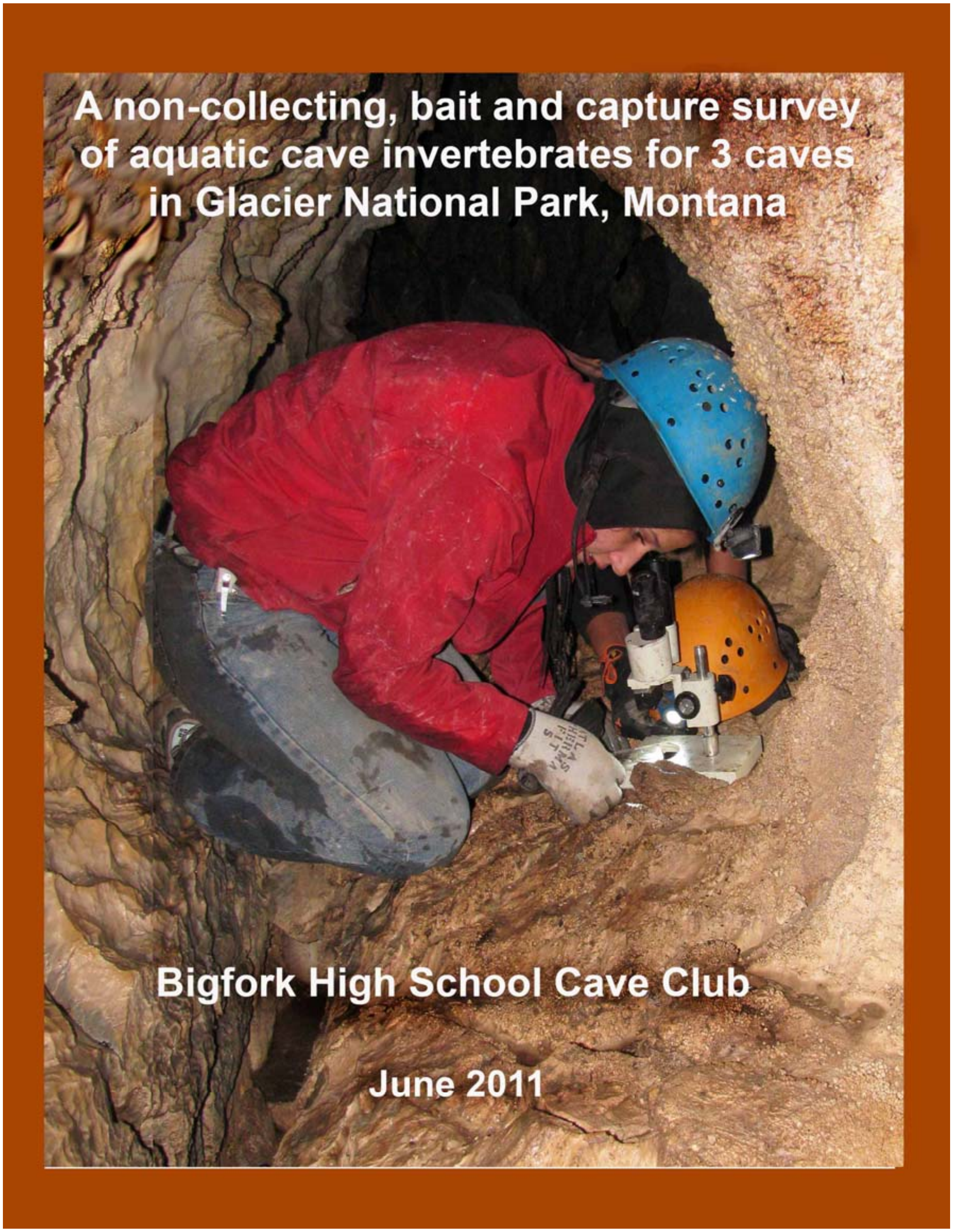

Bait Box Survey of Aquatic Cave Invertebrates for Four Caves in

Glacier National Park, Montana

by
Bigfork High School Cave Club

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Glacier National Park
US Department of Interior

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I. Acknowledgements

This project would not have been possible without the interest, enthusiasm, and logistical support of Jack Potter, now retired Chief of the Division of Science and Resource Management, and Kyle Johnson, West Lakes Wilderness Coordinator, both of Glacier National Park. The project would also not have been possible without supporting field assistance provided by NPS staff Hattie Oswald and Pete Lundberg. We are also especially grateful to Tara Carolyn, Acting Director, Crown of the Continent Research Learning Center, for her guidance in developing and acquiring our research permit, and the Glacier National Park Fund for funding travel and other expenses. We would also like to thank Paul Hendricks for his review and input on the results of our study. Last, but not least, we greatly appreciate the encouragement and initial guidance we received from J. D. Holsinger, Newell Campbell, Ron Zuber, and the late Jim Chester.

II. Executive Summary

A non collecting, bait box study of aquatic cave invertebrates was conducted in 4 caves in Glacier National Park. Bait boxes consisted of a 5cm x 5cm lidded, Tuperware container with a 0.75 cm hole drilled on the corner near the base. Bait boxes were baited with 0.5 cc of raw beef liver and set on the substrate of selected pools. Boxes were left submerged for 24 hrs, and then baited invertebrates were counted and returned to the pool. In addition to counting baited invertebrates, numbers of non baited invertebrates were estimated, pool dimensions were drawn on a map of the cave, and water temperature and chemistry was measured at each sampling site.

In Algal Cave planarians were baited and isopods numbers were estimated. Numbers of planarian and isopod increased in the cave during early spring run off and decreased in late fall. What is believed to be a caddis fly larva was the only other aquatic invertebrate observed in Algal Cave.

In Poia Lake Cave both planarians and amphipods were baited. Numbers of planarians and amphipods remained relatively constant from the fall of 2009 to the spring of 2010, but planarian numbers decreased in the fall of 2010. In addition to the decrease in planarians, the distribution of amphipods shifted closer to the entrance in the fall of 2010. Springtails and mites were also observed in the cave.

No aquatic invertebrates were observed or baited in Heavy Runner or Zoo Cave.

These speculations are made base on findings:

> 1) The number of aquatic cave invertebrate in both Algal and Poia Lake Cave most likely depends on the amount and timing of water input into the cave. Planarian, isopod, and amphipod numbers are probably greater during spring run off and less in late fall.

2) The distribution of aquatic cave invertebrate species in Algal and Poia Lake Cave is probably related to the source of ground water flowing into the cave. Planarians appear to be associated with shallow groundwater that enters the cave along a shorter path passing through soils directly over the cave. Whereas, isopods and amphipods appear to be associated with deeper groundwater that enters the cave along a longer flow path and spends more time in contact with bedrock.

3) Isopod and amphipod populations in Algal Cave may be decreasing and planarians populations increasing. In contrasting the results of this study with a similar study conducted by Paul Hendricks (2000), isopod numbers decreased by a factor of 6 or more, planarians increased by a factor of 4 or more, and amphipods disappeared from the cave.

Management recommendations are summarized below and explained at the end of the report:

1) **Test water in Algal Cave for contaminates that might affect aquatic invertebrates**

2) **Casually inspect pools in Algal Cave each fall and Poia Lake Cave each summer and fall for aquatic invertebrates**

3) **Consider another bait box study, or a more formal research project, if casual observations don't provide enough information on invertebrate population trends**

III. Background

In 1977, as part of their study of caves in Glacier National Park, Newell Campbell (then professor of geology at Yakima College) and his associates collected specimens of aquatic cave invertebrates from Algal Cave and Zoo Cave (Campbell, et. al., 1977). Prior to this, Algal Cave was thought to be biologically insignificant (Campbell, et.al. 1975 and 1976). Campbell's group recorded collecting these specimens:

<u>Algal Cave</u>
Collected in August 24 and September 6, 1977
4 isopods from 2 locations
2 amphipods collected from 2 locations
6 planarians from 1 location

<u>Zoo Cave</u>
Collected in September 1977
1 amphipod

Estimated locations of Campbell's collection sites based on Cambell's maps and descriptions are presented in Appendix A.

Specimens collected by Campbell's group were sent to experts for identification. Preserved planarians were unidentifiable. Amphipods were assigned to a new species named *Stygobromus glacialis* (Wang and Holsinger, 2001) and isopods were identified as *Samasellus sytgonothrix* which was first identified from a cave spring in Alberta (Lewis 2001). Identification of amphipods and isopods collected by Campbell's group took over 20 years to be formally published.

In September of 1999 Paul Hendricks (Zoologist with the Montana Natural Heritage Program) conducted a preliminary investigation of Algal Cave for aquatic invertebrates (Hendricks, 2000). At the time he was unaware of Campbell's 1977 study. However, despite this, Hendricks' investigation build on Campbell's work by verifying species collected by Campbell, developing a description of the physical environment occupied by the invertebrates, and providing a count of individuals occupying each pool in the portion of the cave inventoried. Hendricks collected additional specimens of *Stygobromus glacialis* (4 specimens) and *Samasellus sytgonothrix* (10 specimens),which were identified by Wang and Holisnger (2001), and Lewis (2001) respectively. Hendricks also collected 1 oligochaete worm and 3 planaria. The oligochaete worm was identified Dr. Mark J. Wetzel as a member of the Lumbriculidae family, but Wentzel was not able to identify the specimen below family. The preserved planarians were not identifiable. Hendricks speculated the planarians were of the genus *Polycelis* due to their similar appearance to illustrations in S.E. Nixon's report n the ecology of Deadhorse Cave (1975). Estimated locations of Hendricks' collection sites based on Campbell's maps and Hendricks' descriptions and review are presented in Appendix B.

The Bigfork High School Cave Club began surveying and establishing resource monitoring in caves in Glacier National Park in 2007. From its conception Jim Chester (who had worked with Campbell in his late 1970's study of caves in Glacier National Park) was supportive of the club and offered much advice. Yet, he was concerned club members might disturb aquatic invertebrates when moving through streams and pools. It was Chester's impression that Algal Cave had been gated to protect *Stygobromus glacialis*, which he believed is a rare species. Chester felt entry into Algal Cave should be very restricted and the club should avoid working in the cave. However, according to park officials and records Algal Cave was gated to protect visitors from flooding hazards (BHS Cave Club, 2009). Despite this, Jim maintained that the gate served a dual function. Chester cited Montana Fish Wildlife and Park's report, Animal Species of Concern (2006), which lists *Stygobromus glacialis* "at high risk because of extremely limited and/or rapidly declining numbers, range, and/or habitat, making it highly vulnerable to global extinction or extirpation in the state".

Prompted by Chester's concern for the conservation of *Stygobromus glacialis*, the Cave Club decided to undertake a noncollecting study of aquatic invertebrates in Algal and 3 other caves in the park. Chester suggested use of a "bait line" similar to what he had used to study grizzly bears for a study he conducted in the early 1980's. In adapting

Chester's suggestion "bait boxes" were developed to minimize contamination of cave waters, keep bait placed at the selected site, and temporarily capture and count aquatic invertebrates.

In July 2009 the club in partnership with the Caves of Montana Project submitted a research proposal with these objectives:

Objective 1 – Measure hydrologic factors that might affect cave invertebrates.

Objective 2 – Identify and quantify abioitic factors that might affect cave invertebrates.

Objective 3 – Identify and quantify biotic factors that might affect cave invertebrates.

Objective 4 – Estimate relative population and distribution of cave invertebrates in each studied cave without collecting.

Objective 5 – Determine seasonal variations of invertebrate population and distribution in each studied cave.

Objective 6 – Locate all data on maps of the caves and input data into GIS for presentation and analysis.

IV. Field Work and Methods

Our bait box study of aquatic cave invertebrates was conducted in Algal Cave, Heavy Runner Cave, Poia Lake Cave, and Zoo Cave. General descriptions and maps for these caves were submitted in earlier reports (BHS-OLEC, 2009, BHS-Cave Club, 2009, and Bodenhamer and Coleman 2008). Field work for the aquatic invertebrate study began in September of 2009 and ended in November of 2010. Entry dates for each cave are presented below:

Table 1 – Cave entry dates (22 total for study)

Algal Cave (12 entries)	Heavy Runner Cave (2 entries)	Poia Lake Cave (6 entries)	Zoo Cave (4 entries)
9/5 and 6/2009	6/25 and 26/2010	9/27 and 28/2009	9/27 and 28/2009
9/15 and16/2009		6/25 and 26/2010	6/25 and 26/2010
2/19 and20/2010		9/18 and19/2010	
8/4 and 5/2010			
11/10 and 11/2010			

Bait Box Sites and Characteristics – Bait box sites were chosen so that each site was in a separate pool and the sites were at least 40 feet apart. Sites locations were marked on a

1:240 plan map of the cave relative to cave walls and internal features. In Algal Cave 5 locations in pools in the passage between the entrance and the stream passage, and 1 location in the stream, were chosen as bait box sites. In Poia Lake Cave 8 locations in pools between the entrance and stream passage, and 1 location in the stream passage, were chosen as bait box sites. In Heavy Runner Cave 1 location just inside the entrance was chosen and in Zoo Cave 1 location in the small pool near the end of the cave was chosen. The location of bait box sites in each cave is marked on maps included in Appendix C and photos of bait box sites in Algal Cave and Poia Lake Caves are included on the enclosed CD.

The substrate, water depth, and surface area of the pool were recorded at each site when bait boxes were first set. These parameters did not change appreciably during the study. General characteristics for bait box sites within each cave are included in Appendix D, and presented graphically for Poia Lake and Algal Cave in Figures 1 and 2.

Hydrology – Each time bait boxes were set in Algal Cave the extent of the pool at the site was sketched on a the field map of the cave. Pools located between bait box sites were also sketched. Pool extents in Algal Cave for each sampling trip are included in Figures 3 to 8.

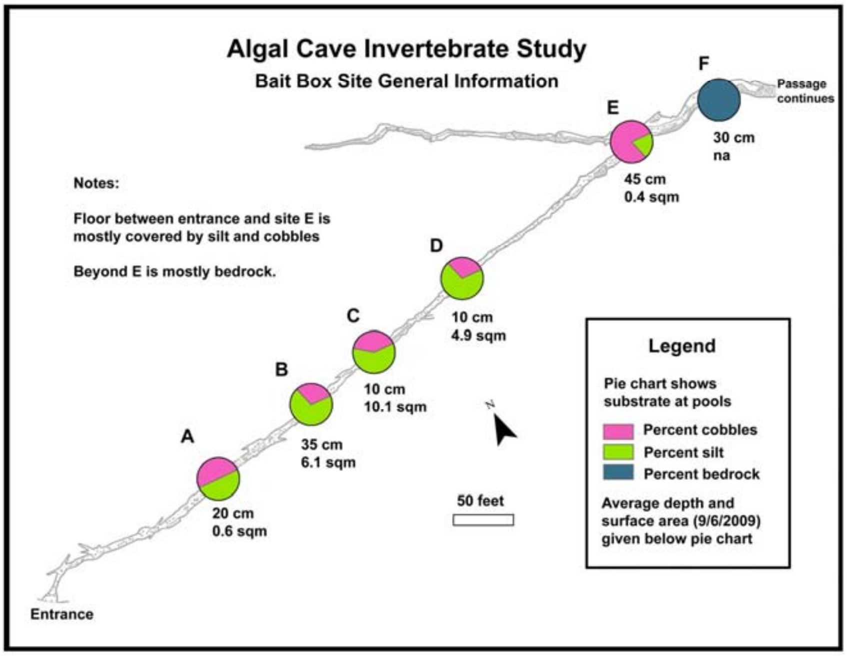
The volume flow rates of the streams in Algal Cave and Poia Lake Cave were estimated for most entry dates. In Algal Cave estimates were based on measurements taken at a point about 80 feet upstream from the junction of the stream passage and the branch passage from the entrance. In Poia Lake Cave measurements were made at two locations (1) just upstream from the climb down to where the stream is first encountered below Campbell Falls and (2) just above Campbell Falls. Measurements were taken to develop a cross section area for the stream. First the stream width was divided into 3 measured segments. Next depths were measured at both stream banks and between each segment. Areas of trapezoids between depth measurements were then calculated and added to derive an estimate of total cross section area. Next the velocity of the stream was estimated by timing a fishing bobber floating 1m downstream. The bobber was tied to a line so that it could be easily retrieved. Finally volume flow was calculated by multiplying the cross section area by the velocity. Volume flow estimates are included in Figures 3 to 11 .

Water temperature and chemistry measurements – Water temperatures were measured by setting the probe of a Taylor model 9865 digital 3cm below the water surface of the pool. The thermometer was not calibrated, but the factory reading is +/- 2 degrees F.

Total dissolved solids were measured using a Milwaukee Smart pH/EC/TDS model sm802 meter. The meter was calibrated using a 1500ppm calibration solution with the zero and 1500ppm readings being calibrated, but the meter performed erratically at times, so at best the TDS readings should be considered to be relative.

Phosphate was measured using a ChemMets kit, model K-8510:0-1 and 1-10 ppm. Test procedures are outlined in the kit and are available online. Spent ampules and sampled test water were removed from the cave

Figure 1



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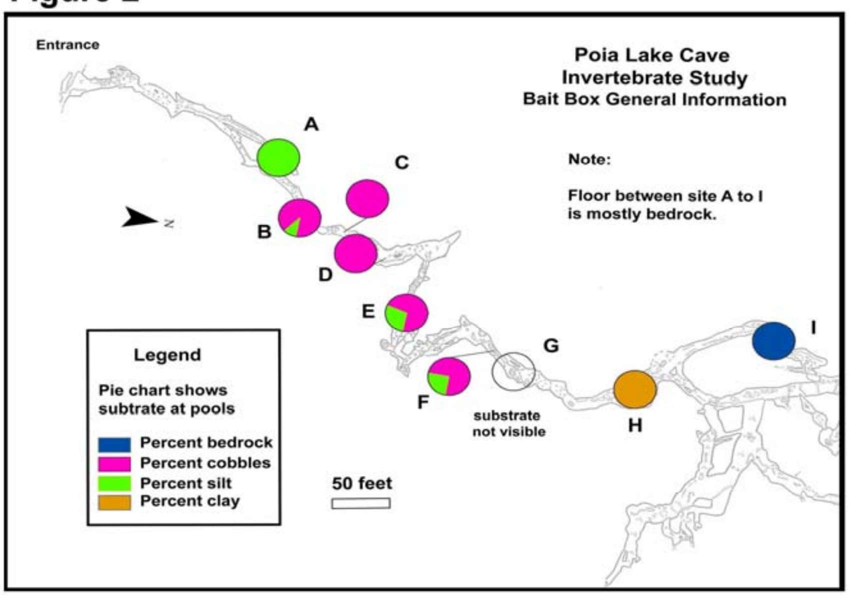

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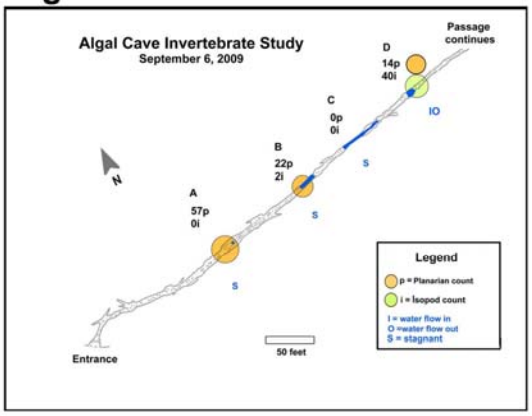

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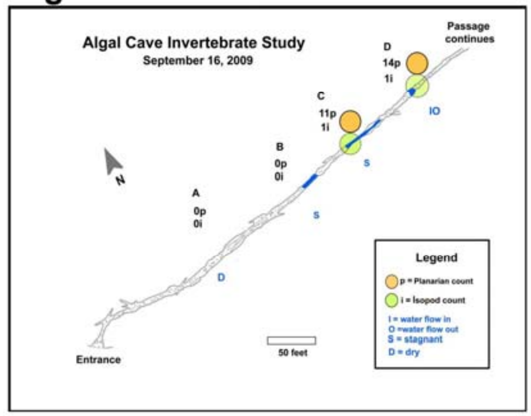

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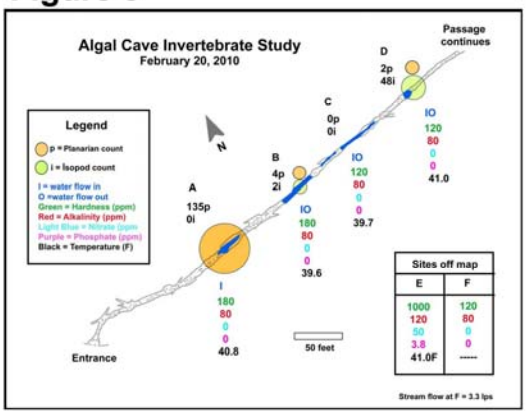

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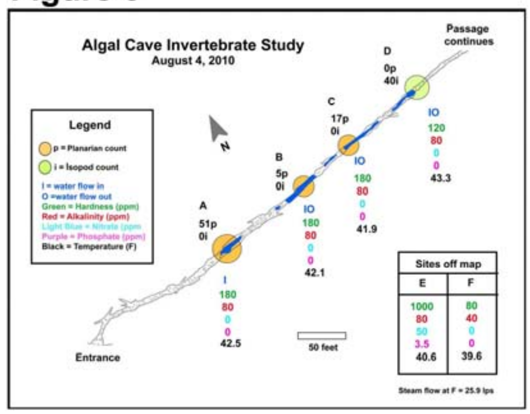

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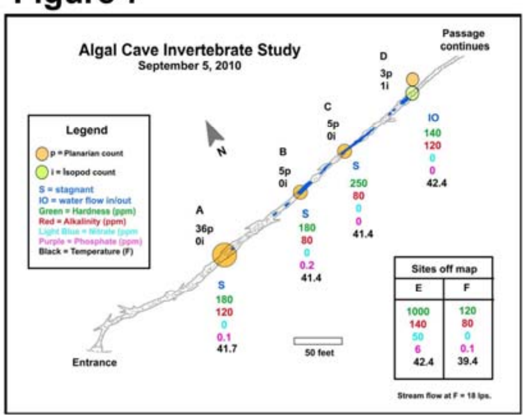
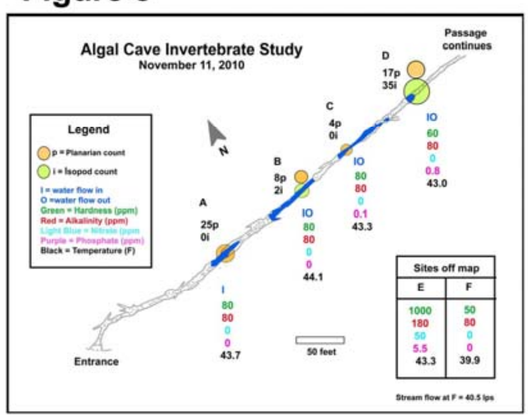


Figure 8



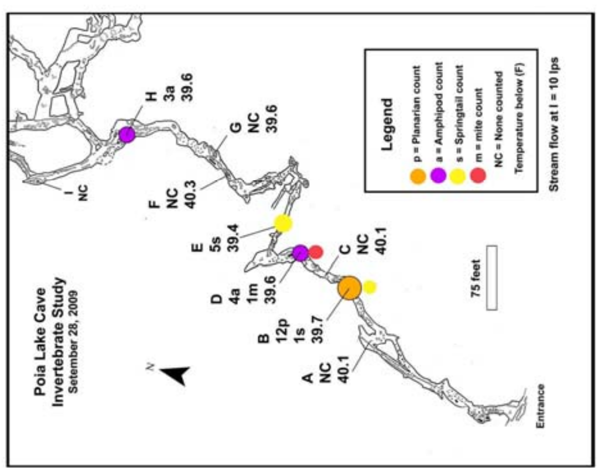


Figure 9

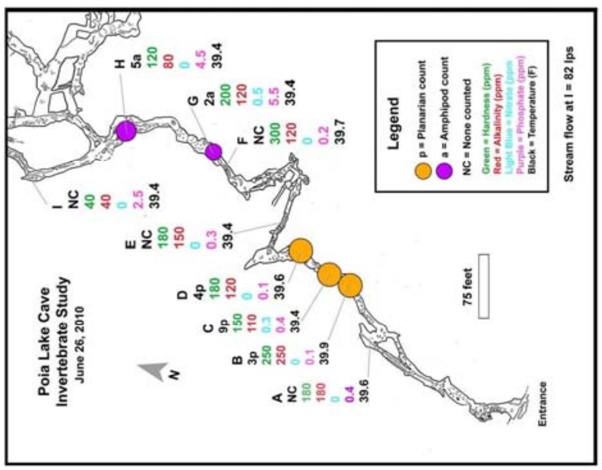


Figure 10

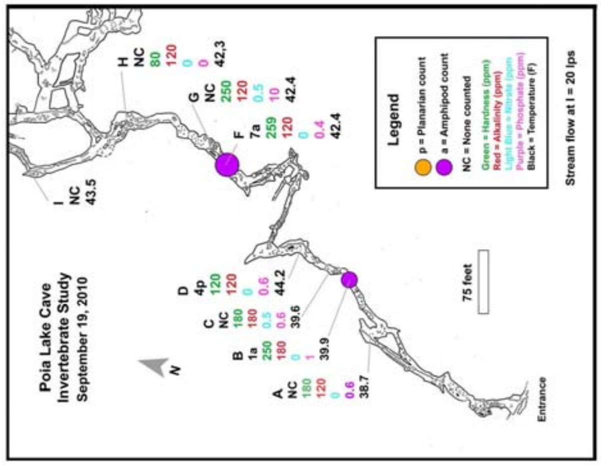


Figure 11

Nitrate, nitrite, total alkalinity, pH, and total hardness were measured using test strips purchased from Water Works at www.sensafe.com. Test strips were dipped directly into the pool. The procedures to use each type of test strip can be obtained from the company. Used test strips were removed from the cave. The range of readings (in ppm) for each type of test is given below:

Nitrate 0 -0.5-2-5-10-20-50

Nitrite 0-0.15-0.3-0.3-1-1.5-3-10

Total Alkalinity 0-40-80-120-180-240-720

pH 6.0-6.5-7.0-7.5-8.0-8.5-11

Total Hardness 0-40-80-120-180-250-425-1000

Water temperature and chemistry data for Algal Cave and Poia Lake Cave is included in Figures 3 to 11. Water temperature and chemistry for Heavy Runner Cave and Zoo Cave was is included in Apendix E

Bait Boxes Study – Bait boxes consisted of a 5cm x 5cm lidded, Tuperware container with a 0.75 cm hole drilled on the corner near the base. Bait boxes were baited with 0.5 cc of raw beef liver and set on the substrate so that the hole was about 5 cm below the surface of the pool at the site. Boxes were left submerged for 24 hrs, and then baited invertebrates were counted and returned to the pool. Microscopes were brought into the cave to facilitate identification of some invertebrates. Identifications were only made in general terms (ie planarian, amphipod, isopod, etc.). The bait box and liver were removed from the cave after each 24 hr sampling.

Ocular reconnaissance – Prior to setting bait boxes each pool was visually inspected for invertebrates. Two to three persons would inspect the surface and substrate of the pool where the bait box was to be set and identify the type and number of invertebrates. Great care was taken during inspection to not disturb the pool surface or substrate. If invertebrates were sparse total numbers were recorded. If invertebrates were abundant three 1x1 foot areas in the pools were inspected. The counted numbers from each square was then averaged and multiplied by the surface area of the pool for an estimate of total. If invertebrates were observed in pools that were not a bait box site, the location of the additional observation was added to the field map with estimates of type and numbers of invertebrates observed at the non baited site. (This data is included in the GIS data previously submitted to the park.)

V. GIS Input and Modeling

All data for this study was input into GIS. The map document (mxd), with all layers, and hyperlinked photos, was submitted to Glacier National Park in November 2010. Maps included in this report were created using the ArcInfo 10 and Photoshop. The procedure for inputting data into GIS is included in detail in the metadata, which accompanies the map document submitted to the park. To explain how maps for this report were created the procedure is outlined below:

For this study we used BHS-OLEC's plan map of Poia Lake Cave and Zoo Cave Algal Cave (2005) and Cave's of Montana Projects' plan map of Algal Cave (BHS Cave Club,2009) and Heavy Runner Cave (Bodenhamer and Coleman, 2008) . Each of these maps was digitally scanned at a scale of a 1:240. Next all information on the map, except for the plan view, was removed using Photoshop. Then the plan view was rotated so that north was oriented up the page. The oriented view was added as a GIS layer using georeferencing and measuring tools. Lastly, the map was classified so that cave walls and floor features show black and the background is transparent.

Bait box sites were input as a layer using the pencil tool to draw the point relative to cave floor and wall features. First a layer was created for the general characteristics of each site. Following each sampling trip new layers were created for hydrology, chemistry and invertebrate counts and observations taken during the trip.

VI. Findings

Counts of baited planarians and observed isopods for Algal Cave for each sampling trip are presented in Figures 3 to 8.   Counts of baited planarians and amphipods and observations of springtails and mites are for Poia Lake Cave are presented in Figures 9 to 11.   No aquatic invertebrates were baited or observed in Heavy Runner Cave or Zoo Cave during this study. An overview of numbers of aquatic invertebrates captured in bait boxes (baited) and observed at bait box sites (non baited) for each cave studied is presented below:

<u>Algal Cave</u>

Planarians - Baited planarians were most numerous at bait box site A, except when the pool at this site dried up in mid September 2009. Numbers baited at site A ranged from 0 (9/16/2009) to 57 (9/6/2009) to 135 (2/20/2010). Planarians were never baited or observed at sites E or F. Numbers of baited planarians at sites B, C and D ranged from 0 to ¼ to ½ of the numbers baited at A at the same time, except when the pool at site A dried up (9/16/2009). When pool A dried up planarian numbers were most numerous at site D (14 baited). Numbers of non baited planarians were not estimated. However, when water was dripping from the walls and ceiling near bait box sites (2/20/2010 and 8/4/2010), non baited planarians were observed in abundance in all pools (except pool E). When water was dripping from the ceiling and walls planarians were seen crawling on the substrate and swimming on the surface of the pool, and many were lighter in color, bloated in appearance and a few measured over 1cm in length. In contrast during drier times, non baited planarians were often not observed, even when a few were baited. During drier times (when ware was not dripping from walls and ceilings) all baited and non baited planarians were darker, thinner and shorter than those observed during wetter times. Photos of baited and non baited planarians are included in the enclosed CD.

Isopods – No isopods were bated during this study. Different baits were tried early in the study, including hamburger, dried dog food pellets, and fresh wood rat droppings, but none of these attracted isopods and all were less effective at baiting planarians.   Isopod numbers for this study are based on ocular reconnaissance. Isopods were most numerous at bait box site D when water was dripping into the cave (2/20/2010 and 8/4/2010) and also when pools and the cave stream were high (11/11/2010). The total estimated number of isopods in the pool at site "D" for each of these high water dates was about 40 and isopods were always more abundant near a rivulet that enters on the east side of this pool. Isopods were never observed at bait box sites A, E or F and were only observed in low numbers (0 to 2), at sites C and D. Isopods were never observed on pool walls or the water surface. They were always crawling on the substrate. Photos of observed isopods are included on the enclosed CD.

Other aquatic invertebrates – What is believed to be a caddis fly larva was observed in pool C during the February 20, 2010 sampling trip. A photo of the larva is included on the enclosed CD. No other aquatic invertebrates (mites, springtails, amphipods, etc.) were baited or observed in Algal Cave during this study.

<u>Poia Lake Cave</u>

Planarians – Planarians were only baited at sites B, C, and D. Numbers baited at these sites ranged from 3 (6/26/2010 at B) to 12 (9/28/2009 at B). When planarians were baited, non baited planarians were always observed in pools at the site, but always in low numbers (less than 5). Also when planarians were baited at bait box sites, non baited planarians were observed in pools between B, C, and D, but they too were in low numbers. Planarians were not observed at any other locations in the cave, and during the September 18 and 19 sampling trip no planarians were baited or observed anywhere in the cave. In general baited and non baited planarians were far less abundant in Poia Lake Cave than they were in Algal Cave.

Amphipods – Amphipods were baited and observed in pools at bait box sites and other pools during each of the sampling trips. Numbers of baited amphipods were low, ranging from 1(at B on 9/19/2010) to 7 (at F also on 9/19/2010). Numbers of non baited amphipods were also low (always less than 5). Amphipods were baited twice at site H (9/28/2009 and /19/2010), and once at sites B (9/19/2010), D (6/28/2009), F (9/19/2010), and G (6/26/2010). Amphipods were never baited at sites A, C, E, or I. At least one amphipod was observed during each of the sampling trips in a very small pool located about 10 feet south of site D. This pool measures about10cm in diameter, with a water depth of about 3cm. A photo of the pool is included on the enclosed CD.

Heavy Runner Cave – No aquatic invertebrates were observed or baited from Heavy Runner Cave during the study. The entrance room of Heavy Runner Cave floods during spring runoff and we thought aquatic invertebrates might be present during flooding. On June 26, 2010 a careful ocular reconnaissance for aquatic invertebrates was made of the flooded entrance room. None were observed, but a bait box was set. When we returned 24 hours later the bait box had been moved out of the pool and the lid had been gnawed (wood rat?). There was not time to reset this bait box. Water temperature and chemistry data for the bait box site is included in Appendix D.

Zoo Cave – Because Campbell and associates had reported collecting *Stygobromus glacialis* from the cave in 1977, we made two attempts to observe and bait invertebrates. No aquatic invertebrates were observed or baited from Zoo Cave during the study. Water temperature and chemistry data for the bait box site is included in Appendix D.

VII. Discussion

The findings of our non collecting, bait box study can not be used to confidently report aquatic cave invertebrate populations, distributions, or seasonal variations. Yet we hope the study will inspire further research and be used as a preliminary guide for conservation and management of aquatic cave ecosystems in the park. With these aspirations in mind, we offer these speculations:

1) <u>The number of aquatic cave invertebrate in both Algal and Poia Lake Cave most likely depends on the amount and timing of water input into the cave. Planarian, isopod, and amphipod numbers appear to be greater during spring run off and less in late fall</u>. In Algal Cave the number of counted planarians and isopods decreased in the fall when less water is dripping into and flowing through the cave and increased during early spring runoff, which came in mid February in 2010. During the February 2010 runoff, the number of baited planarians almost doubled. Non baited isopod counts were also higher, but only increased by about 10%.

In Poia Lake Cave planarian counts were nearly the same in the fall of 2009 as those taken in the spring of 2010. However, in the fall of 2010 no planarians were baited and only one was observed. Fluctuations in planarian counts may correlate to drier than normal conditions prevailing in the fall of 2009 and wetter than normal conditions prevailing in the spring and fall of 2010. Counts of baited amphipod were about the same throughout the cave during all sampling trips, but amphipods were more numerous closer to the entrance during the fall of 2010 than in the fall of 2009 or the spring of 2010. Changes in distribution of amphipods may also be the result of drier conditions in the fall of 2009 and wetter conditions in the spring and fall of 2010.

2) <u>The distribution of aquatic cave invertebrate species in Algal and Poia Lake Cave is probably related to the source of ground water flowing into the cave. Planarians appear to be associated with shallow groundwater that enters the cave along a shorter path passing through soils directly over the cave. Whereas, isopods and amphipods appear to be associated with deeper groundwater that enters the cave along a longer flow path and spends more time in contact with bedrock</u>. Sites where planarians were abundant are generally closer to the entrance. We considered the possibility that planarians entered the cave through the entrance, but there is no watercourse that consistently runs from the entrance of either cave to any of the bait box sites. During the 2009 spring runoff, the entrance to Algal Cave was still snow bound and ice was present in the entrance. Yet, water dripping from the walls and ceiling was abundant and the greatest number of planarians baited during the study was baited at site A. Although site A is closest to the entrance planarians could not have crossed the ice to access the site and it seems likely they entered with the water dripping from the ceiling and walls. Overburden is less than

50 feet at site A and we speculate the water dripping into the site was mostly from melting snow and passing downward through soil directly over the cave.

In addition to an abundance of planarians at sites closer to the entrance, sites where isopods were observed and amphipods were observed and baited are not only further from the entrance, they are in pools that seem to have a different water supply. In Algal Cave non baited isopods were most abundant at bait box site D, and in Poia Lake Cave amphipods were baited twice at site H and only once at other sites. Both site D in Algal Cave and site H in Poia Lake Cave are over 500 feet in from the entrance where overburden is thicker than 300 feet, which would change the characteristic of water entering the cave from directly above the site. Furthermore, pools at both sites were fed in part by rivulets that continued to flow when most ceiling and wall drips had dred up. Lastly, total hardness measured at sites D and H always measured lower than sites where planarians were more abundant. All of these factors indicate that water at D and H may be from a different source which entered the cave along a deeper flow path

3) <u>Isopod and amphipod populations in Algal Cave may be decreasing and planarians populations increasing.</u> It is assumed that isopods, amphipods, and planarians observed and collected by Hendricks are the same as those we observed and baited. We did not observe or bait any amphipods and we easily observed frequently baited amphipods in Poia Lake Cave. It seems that if there had been amphipods in Algal Cave during our sampling trips, we would have observed or baited them. We speculate amphipods may have disappeared from the cave or their numbers are greatly diminished.

Our methods of estimating isopod numbers were very similar to those used by Hendricks (personal communication). Our counts indicate planarian numbers have increased dramatically (0 to 100 at site A and 10 to 40 at site B), and isopod numbers have decreased dramatically (20 to 2 at site B and 250 to 40 at site D). Tables 4 and 5 compare of Hendricks' and our counts at each site for both planarians and isopods. Based on maps and descriptions, Hendricks' site 1, 3, 5, and 6 correspond to our sites A, B, C, and D.

Table 2
Algal Cave, Comparison of planarian counts from 2000, 2009 and 2010

Hendrick's pool number	Bigfork HS bait box site	Hendrick's estimated total # of planarians in pool (9/27/1999)	Bigfork HS's estimated total # of planarians in pool (9/16/2009)	Bigfork HS's estimated total # of planarians in pool (2/20/2010)
1	A	0	100	500
2	na	8	not estimated	not estimated
3	B	10	40	4
4	na	20	not estimated	not estimated
5	C	15	0	0
6	D	3	30	2

Table 3

Algal Cave, Comparison of isopod counts in 2000, 2009, and 2010

Hendrick's pool number	Bigfork HS bait box site	Hendrick's estimated total # of isopods in pool (9/27/1999)	Bigfork HS's estimated total # of isopods in pool (9/16/2009)	Bigfork HS's estimated total # of isopods in pool (2/20/2010)
1	A	60	0	0
2	na	300	not estimated	not estimated
3	B	20	2	2
4	na	300	not estimated	not estimated
5	C	40	0	0
6	D	250	40	50

VIII. Management Recomendations

1) Test water in Algal Cave for contaminates that might affect aquatic invertebrates – If aquatic numbers have decreased in Algal Cave the most likely causes are climate change or contamination of the water from Going to the Sun Road, which passes over the cave. Testing of cave pools in the early fall when pools are diminishing would probably be the best time to test for contaminates. Waters could be tested for petroleum products or other contaminates that might be associated with road construction, maintenance, or accidental spills.

2) Casually inspect pools in Algal Cave each fall and Poia Lake cave each summer and fall for aquatic invertebrates – Developing an annual record of invertebrate observations will help determine population trends and aid in conservation of cave ecosystems. Under current park management, Poia Lake Cave will be open to recreational visitation by permit. Casual observations of invertebrates in Poia Lake Cave are likely to detect dramatic impacts to aquatic ecosystems and invertebrate populations caused by visitors. Algal Cave will only be open to research and this limited visitation seems unlikely to impact invertebrates. However, because isopod and amphipod numbers may be decreasing, invertebrate populations should be monitored to determine if decreases are actually occurring and casual observations are better than none. Casual observations in both caves could be made by park staff or volunteers with a minimum of training. Photos and maps from this report could be used to guide observers to pools and recognize and count invertebrates. A camera capable of taking macro photos could be used to substantiate observations. In Algal cave we recommend observations be made at pool A and D. In Poia Lake Cave we recommend observations be made at pools A, B, C, D, and G.

3) Consider another bait box study, or a more formal research project, if casual observations don't seem to provide enough information on invertebrate population trends – Park staff or volunteers could develop and conduct an additional bait box study if casual observations indicate invertebrate numbers are decreasing. This report can be used as a guide and experts should be consulted, however experts in the conservation of cave invertebrates are rare and additional studies may need to be initiated in by groups such as the Bigfork High School Cave Club. We recommend additional studies consider a non collecting approach and focus on developing information on the invertebrate natural history and conservation.

IX. References

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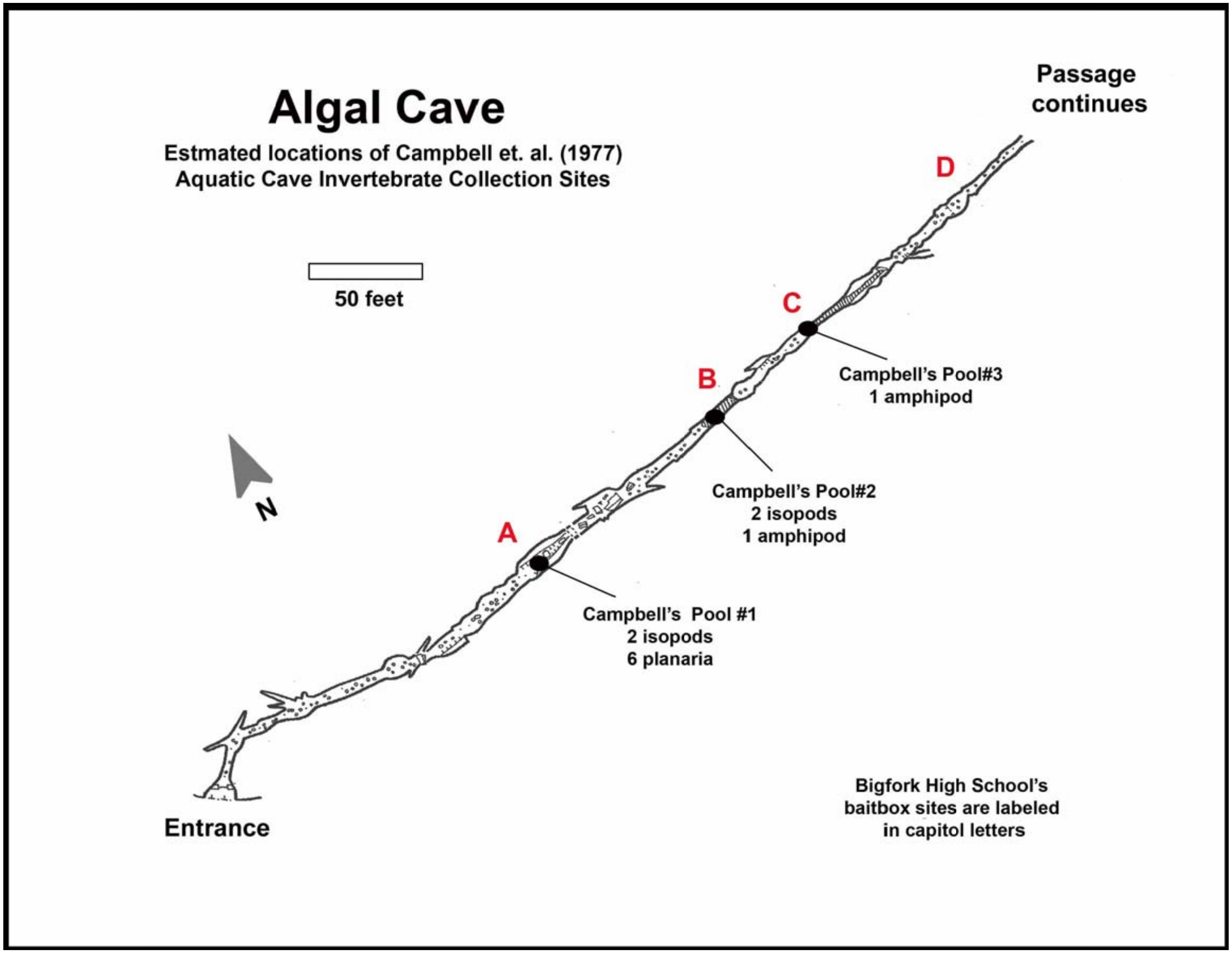
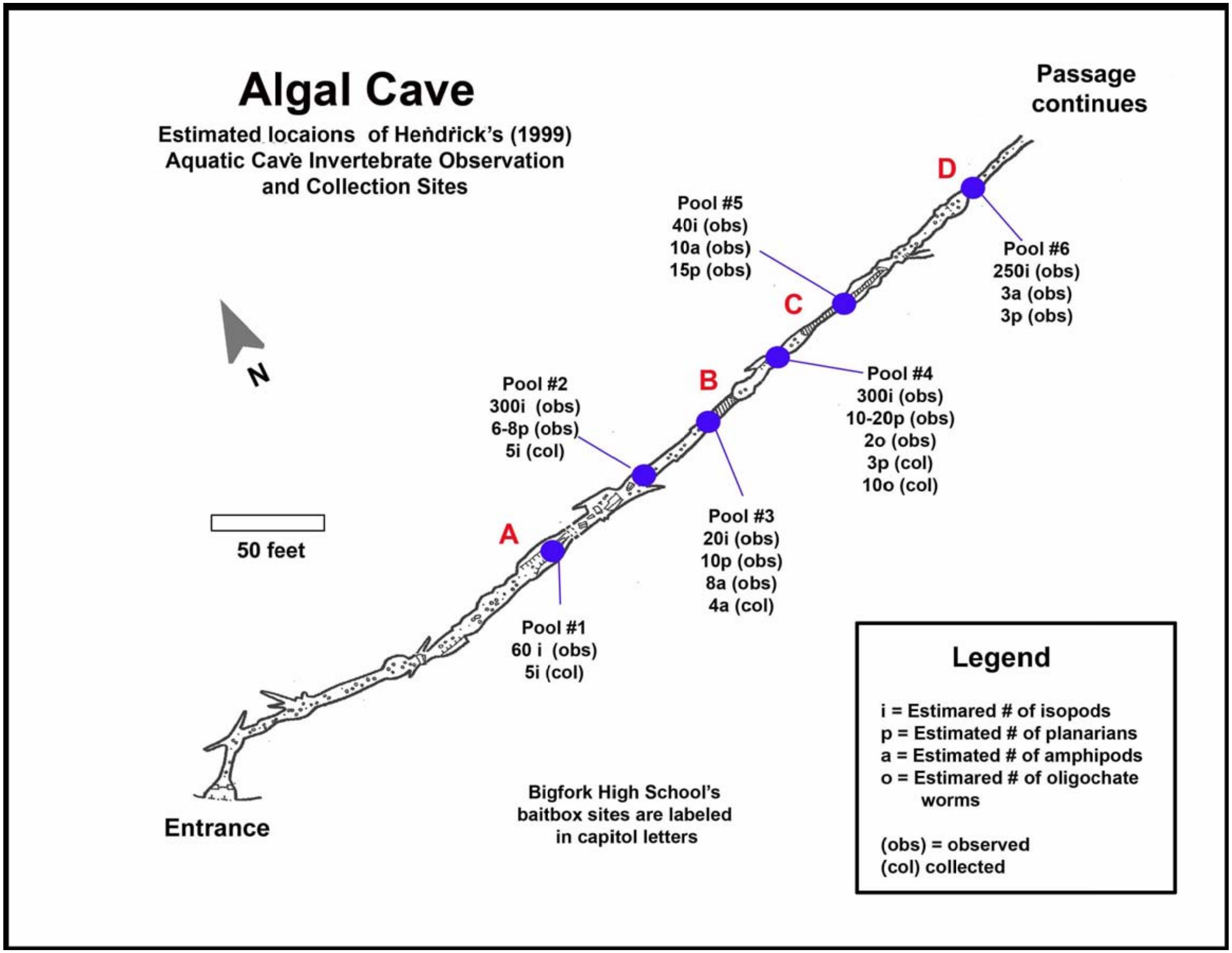
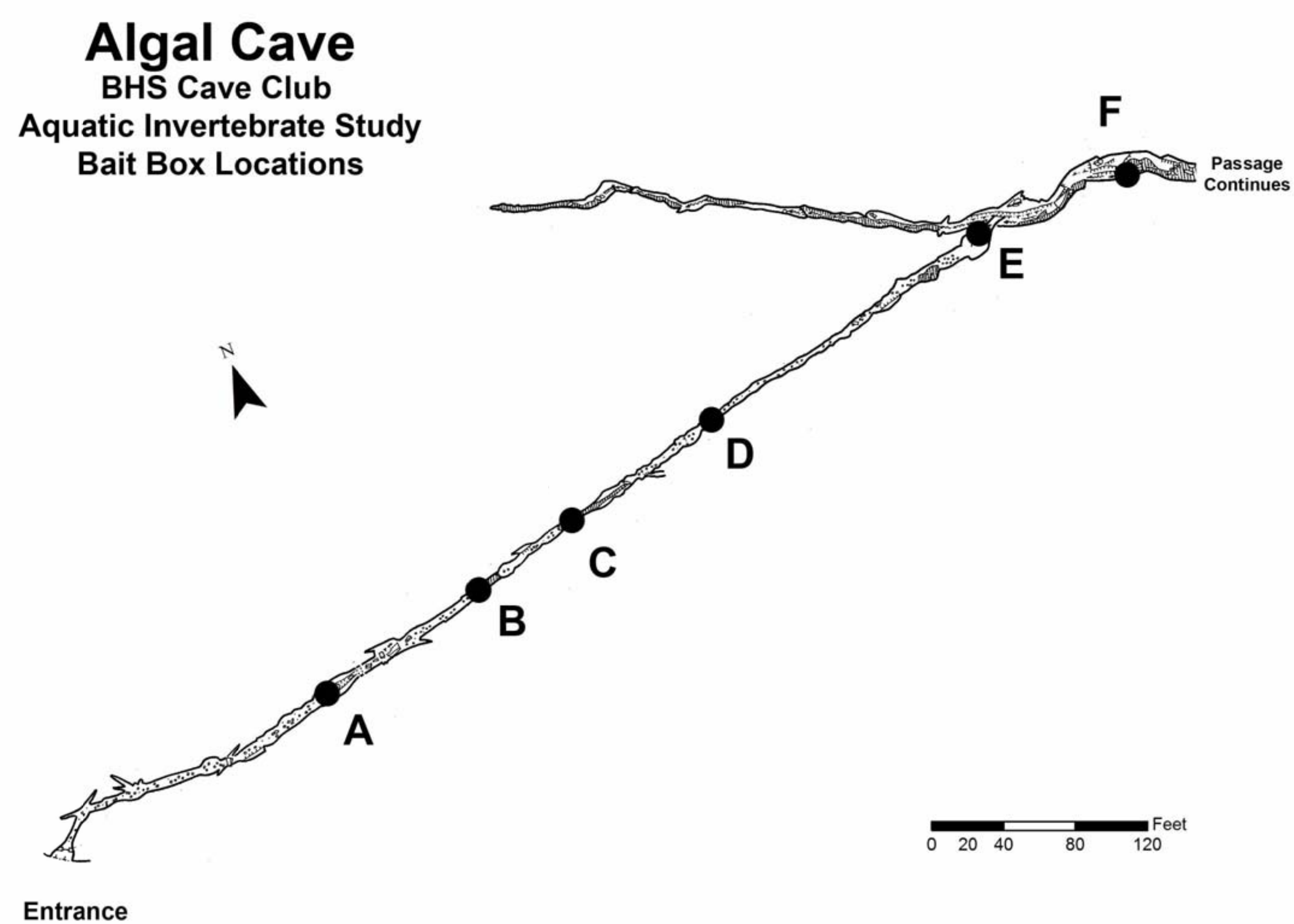
Appendix A
Algal Cave
Campbell’s Collection Sites


Algal Cave
Estmated locations of Campbell et. al. (1977)
Aquatic Cave Invertebrate Collection Sites
50 feet
N
Passage continues
D
C
B
A
Campbell's Pool#3
1 amphipod
Campbell's Pool#2
2 isopods
1 amphipod
Campbell's Pool #1
2 isopods
6 planaria
Entrance
Bigfork High School's baitbox sites are labeled in capitol letters

Appendix B
Algal Cave
Hendricks' Observation
and Collection Sites


Algal Cave
Estimated locaions of Hendrick's (1999)
Aquatic Cave Invertebrate Observation
and Collection Sites
N
50 feet
Entrance
Passage continues
A
B
C
D
Pool #1
60 i (obs)
5i (col)
Pool #2
300i (obs)
6-8p (obs)
5i (col)
Pool #3
20i (obs)
10p (obs)
8a (obs)
4a (col)
Pool #4
300i (obs)
10-20p (obs)
2o (obs)
3p (col)
10o (col)
Pool #5
40i (obs)
10a (obs)
15p (obs)
Pool #6
250i (obs)
3a (obs)
3p (obs)
Bigfork High School's
baitbox sites are labeled
in capitol letters
Legend
i = Estimared # of isopods
p = Estimated # of planarians
a = Estimated # of amphipods
o = Estimared # of oligochate
worms
(obs) = observed
(col) collected

Appendix C
Bait Box Sites Location Maps

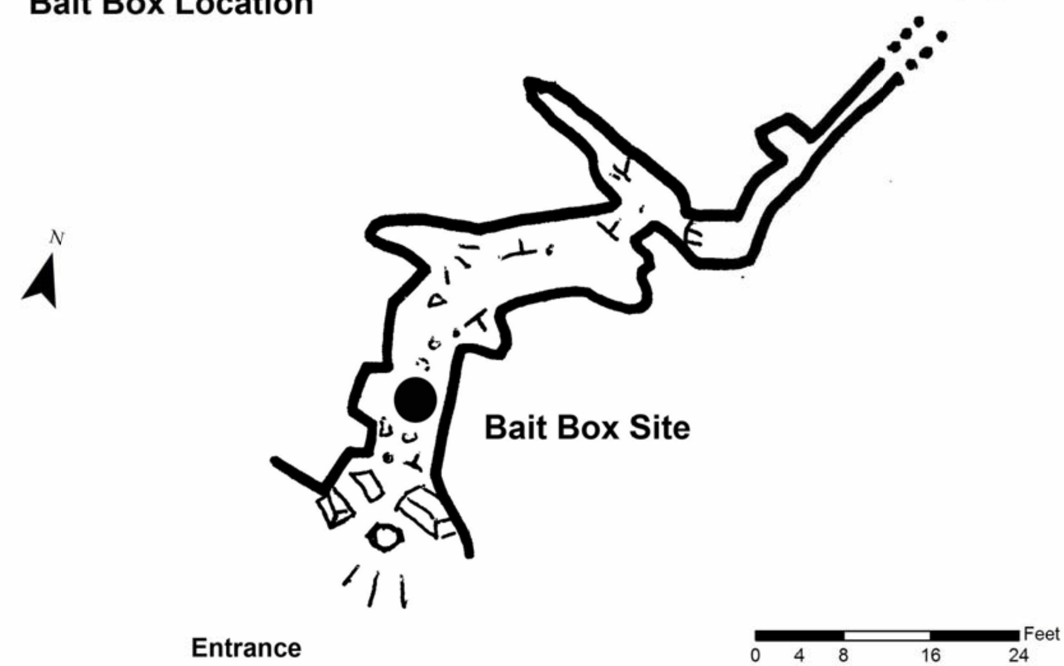

Algal Cave
BHS Cave Club
Aquatic Invertebrate Study
Bait Box Locations
N
A
B
C
D
E
F
Passage Continues
Entrance
Feet
0 20 40 80 120

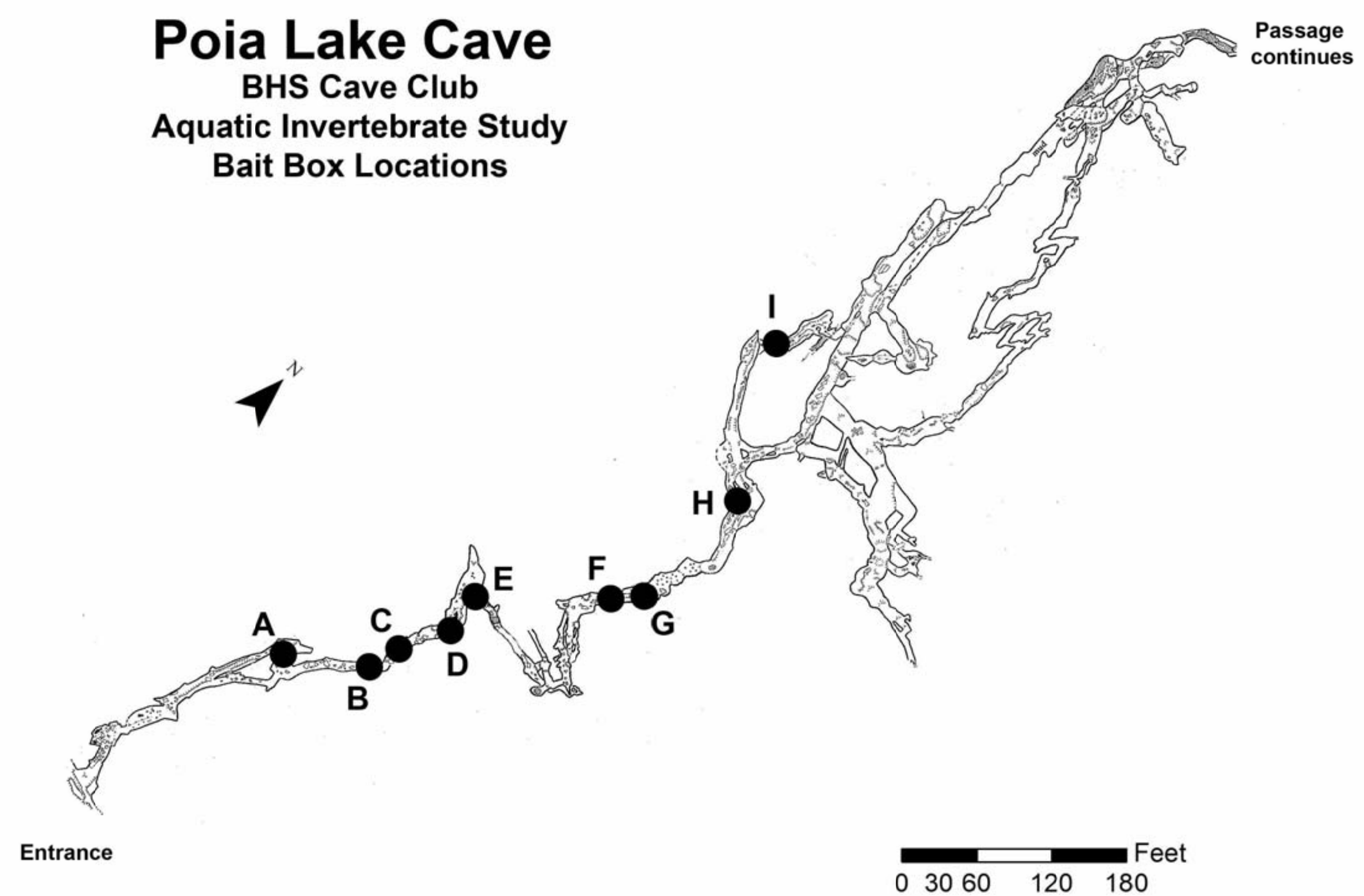
Heavy Runner Cave

BHS Cave Club

Aquati Invertebrate Study

Bait Box Location





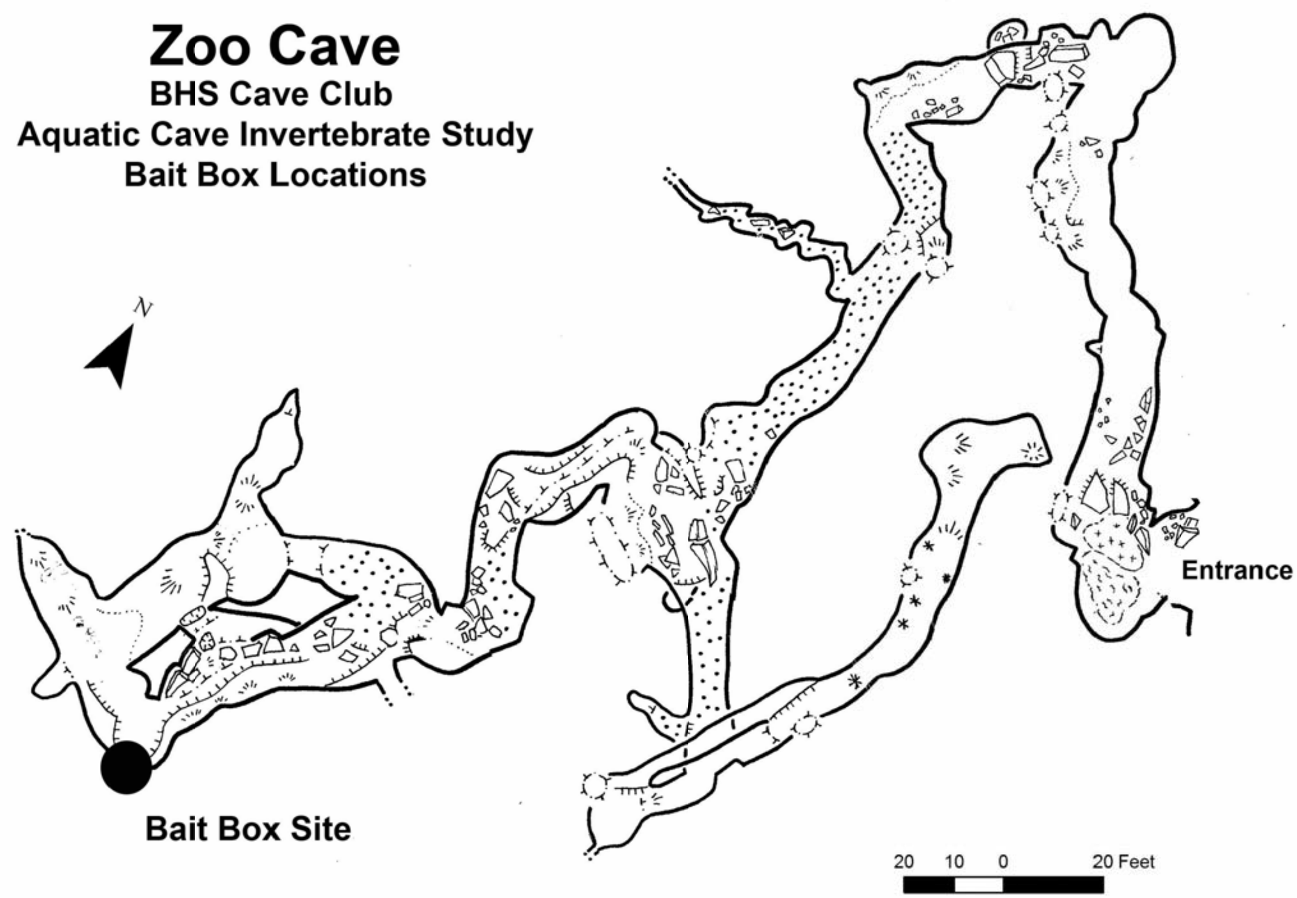
Poia Lake Cave
BHS Cave Club
Aquatic Invertebrate Study
Bait Box Locations
N
Passage continues
A
B
C
D
E
F
G
H
I
Entrance
Feet
0 30 60 120 180

Zoo Cave

BHS Cave Club

Aquatic Cave Invertebrate Study

Bait Box Locations



Appendix D
General Characteristics
of
Bait Box Sites

Algal Cave bait box site general characteristics (9/29/2009)

Bait Box Site	Substrate					Water Depth	
	Percent Cobbles	Percent Silt	Percent Clay	Percent Bedrock	% Visible Organic Debris Cover	Estimated Average (cm)	Maximum (cm)
A	50	50	0	0	5	20	25
B	30	70	0	0	5	30	60
C	40	60	0	0	5	3	5
D	30	70	0	0	2	10	20
E	80	20	0	0	2	45	45
F	0	0	0	100	0	30	60

Poia Lake Cave bait box site general characteristics (9/29/2009)

Bait Box Site	Substrate					Water Depth	
	Percent Cobbles	Percent Silt	Percent Clay	Percent Bedrock	% Visible Organic Debris Cover	Estimated Average (cm)	Maximum (cm)
A	0	95	0	0	5	3	5
B	90	10	0	0	5	5	7
C	100	0	0	0	50	3	5
D	100	0	0	0	5	3	6
E	50	0	0	0	5	5	8
F	75	0	0	0	20	15	20
G	0	0	0	0	80	15	30
H	0	0	100	0	0	5	10

Heavy Runner Cave bait box site general characteristics (6/25/2010)

Bait Box Site	Substrate					Water Depth	
	Percent Cobbles	Percent Silt	Percent Clay	Percent Bedrock	% Visible Organic Debris Cover	Estimated Average (cm)	Maximum (cm)
A	40	60	0	0	75	30	50

Zoo Cave bait box site general characteristics (9/27/2009)

Bait Box Site	Substrate					Water Depth	
	Percent Cobbles	Percent Silt	Percent Clay	Percent Bedrock	% Visible Organic Debris Cover	Estimated Average (cm)	Maximum (cm)
A	0	30	70	0	0	30	50

Appendix E
Water Temperature and Chemistry
for
Heavy Runner and Zoo Caves

Heavy Runner Cave Water Temperature and Chemistry at Bait Box Site 6/25/2010

Temp (ºF)	TDS	Phosphate	Nitrate	Nitrite	Total Alkalinity	Total Hardness	pH
37.9	80	0	0	0	80	40	7

Zoo Cave Water Temperature and Chemistry at Bait Box Site 6/25/2010

Temp (ºF)	TDS	Phosphate	Nitrate	Nitrite	Total Alkalinity	Total Hardness	pH
36.1	365	0.8	0.1	0	120	140	7