Surveys for Watercress Snail (*Fontigens nickliniana*) in and around Fort Custer Training Center

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Cover Photo: Watercress snail (*Fontigens nickliniana*) from Fort Custer Training Center. Photo by Peter Badra.

Introduction

Watercress snail (*Fontigens nickliniana*) is a species of special concern in Michigan; however, its actual status in the state is not well known and it may be more or less secure. Watercress snail occurrences within Michigan are concentrated in the southwest part of the lower peninsula, especially in the Grand Rapids and Kalamazoo area, south to the Indiana boarder. Several occurrences are scattered across other parts of the lower peninsula (MNFI Natural Heritage Database 2022, GBIF 2022). Most occurrence records for the species in the state are historical, as there has been very little documented survey effort for watercress snail in Michigan in recent decades. Prior to this survey effort, the species had only been recorded in three counties since 2000. Fort Custer Training Center (FCTC) may be one of only a few strongholds for the species in Michigan due to an abundance of relatively intact and protected watercress snail habitat on FCTC lands. The first records of watercress snail at FCTC date back to 1994 (Legge et al. 1995) and are relatively recent compared to most occurrences documented in Michigan. Surveys at FCTC in 2019 confirmed the species is still present at some locations where it was documented 20+ years ago (Bassett 2022). MNFI builds upon past survey efforts by performing targeted surveys adjacent to known occurrences and in areas with potential habitat within FCTC, as well as at historical occurrences and areas with potential habitat located outside of FCTC. This survey effort helps fill in data gaps to allow for a more accurate assessment of the species' status at FCTC as well as the state level, and to help provide information needed to guide management efforts at the local and state level before it becomes threatened or endangered.

Freshwater snails occur in rivers, lakes, springs, vernal pools, and permanent wetlands across Michigan and are important components of aquatic ecosystems throughout the state. They can dominate benthic stream communities in terms of abundance and biomass (Johnson and Brown 1997, Brown and Lydeard 2010) illustrating their significant role in aquatic food webs and nutrient cycling (Covich et al. 1999). A large proportion of aquatic snail species are endemic to small ranges, in some cases restricted to a single river basin, stream reach, lake, or spring. Declines in the status of freshwater snail species have been driven by direct habitat alteration and cumulative downstream impacts, including dams, impoundments, channelization, erosion, excessive sedimentation, ground water withdrawal, point and non-point source pollution, and invasive species (Johnson et al. 2013). Of the 742 species of freshwater snails in the U.S. and Canada, 354 (48%) are thought to be critically imperiled globally (G1) or extinct (NatureServe 2022).

Watercress snails are found in springs and spring fed headwater streams. They have a strong association with the plant watercress (*Nasturtium officinale*), which was noted at least as early as 1902 by F.C. Baker. They are often seen on the stems and leaves of watercress, and immediately adjacent at the water's edge where the plant grows. They can be found in isolated springs, springs within shaded riparian zones along the banks of larger streams and rivers and around small lakes, as well as the edges of small spring fed headwater streams (Berry 1943). At some sites outside of Michigan, watercress snails have been documented in streams within caves (Hershler et al. 1990). The watercress snail's specific habitat requirements and small size make it likely to be overlooked during surveys following typical methodologies for aquatic and terrestrial snails. For this reason, surveys targeting springs and seeps, and snails of small size are needed to efficiently detect the species. Targeted surveys throughout its range might reveal it is more common than previously documented in the past, conversely, if historically documented populations are no longer present, its conservation status may need to be adjusted to help slow the decline of the species. Identifying additional populations and planning for their conservation could help ensure this species does not become threatened or endangered in Michigan. Its global range and status are not well known due to a shortage of survey effort and coverage. Range wide survey efforts are needed to conserve this species and inform management of its groundwater dependent habitat in seeps, streams, lakes, and wetlands.

Methods

MNFI performed targeted surveys for watercress snail within and outside of FCTC. Sites upstream and downstream of previously documented occurrences in FCTC were assessed for potential habitat, including locating springs and seeps and the plant watercress with which it is strongly associated. Historical occurrences, as well as new sites with watercress growing in seeps and springs, located outside of FCTC were also surveyed to identify populations that may have potential to exchange individuals and genes with FCTC populations. Historical occurrences nearest to FCTC were prioritized for survey due to greater potential for migration to and from populations located in FCTC.

Potential habitat including streams, wetlands, and small lakes were walked with waders to locate springs and seeps with watercress. Survey effort was concentrated at sites upstream and downstream of recent records, at historical records for the species, and in areas with potential habitat where they had not been previously documented. When spring or seep habitat with watercress was found, the stems and leaves of watercress plants and the moist and shallow water areas around the plants was visually searched for snails. Live individuals and shells of small sized snails appearing to be watercress snail were placed in a labeled bottle or polyethylene bag with ethanol. Population density was estimated by counting the number of watercress snails within a small area (e.g. 0.125m^2) and extrapolating based on the area of occupied habitat. Photographs were taken of the micro-habitat and surrounding habitat where snails were found. Location of survey sites was recorded with handheld GPS units. Snails were identified to species in the lab under 7x to 63x magnification using shell characters and photographed. A visit was made to the University of Michigan Museum of Zoology Mollusk Collection to corroborate identification of watercress snails with museum specimens of this and similar species such as New Zealand mudsnail (*Potamopyrgus antipodarum*), Boreal marstonia (*Marstonia lustrica*), and Brown walker (*Pomatiopsis cincinnatiensis*).

Results

A total of 30 sites were surveyed for watercress snails at locations within and outside of FCTC (Figure 1 and Tables 1 and 2). The species was found at two sites on FCTC lands adjacent to previously documented occurrences, updating the status of those occurrences (sites 1 and 4, Figure 2). Watercress snails were found at site 1 on and around watercress plants growing in groundwater seeps between wetland and upland, and at the edges of a small unnamed creek (Figure 3). The estimated density of watercress snails at site 1 was 80 individuals per m^2 within a limited area of suitable habitat (13m^2). This occurrence expands an existing 2019 record for the species to the west. Watercress snails at site 4 were located in patches of watercress in seeps and inlet streams flowing into a small unnamed lake through the surrounding wetland habitat (Figure 4). Density of watercress snails was lower at site 4 (25/m^2) than site 1 but the area occupied was much larger (100m^2). This occurrence expands an existing 2019 record for the species to the north.

Three new populations of watercress snails were documented. The closest of these to populations in FCTC is the new occurrence at site 3 in Fort Custer State Recreation Area (Fort Custer SRA) located between Whitford Lake and Territorial Road. Watercress snails at site 3 were located in patches of watercress at the edge of wetland and upland habitats (Figure 5). Though patches of watercress were interspersed along the edge of the wetland, only three were occupied by watercress snail. Density ranged from 75 individuals per m^2 in the larger (4m^2) watercress patch down to five individuals per m^2 in the two smaller (1m^2) patches of watercress. Site 3 is located approximately 800m west of site 1 and 800m north of site 4 and is considered a new and separate occurrence due in part to the placement of Territorial Road between Site 3 in Fort Custer SRA and sites 1 and 4 within FCTC. Wetland edges in the northern half of Fort Custer SRA, in the vicinity of Yellow Trail Loop, were searched for potential watercress snail habitat but none was found (sites 8 and 9). Watercress snails were discovered at two sites in Gourdneck State Game Area that together comprise a newly documented population

approximately 26km SSW of populations in FCTC (Sites 12 and 13). Density at site 12 was estimated at 12 individuals per m^2 within a $50m^2$ area, while at site 13 it was much lower (0.2 indvs/m^2) and covered a smaller area ($15m^2$). These were found in seeps with watercress along the banks of Portage Creek (Figure 6). A new population was also found at Camp Grayling. This was by far the largest and healthiest of the newly documented occurrences with a density greater than 1000 individuals per m^2 over $20m^2$ among watercress plants in groundwater seeps on the banks of Big Canon Creek (Figure 7) and a new county record for Kalkaska County.

Watercress snails were found at three historical occurrences outside of FCTC. Closest of these to FCTC was Historical Bridge Park in southeast of Battle Creek near the I-96 crossing of the Kalamazoo River. Watercress snails were found at two of the six sites surveyed in this area (sites 18 and 22). Density ranged from 20 individuals per m^2 over an $18m^2$ area at site 22, to 10 individuals per m^2 over a $4m^2$ area at site 18. All were found on or near watercress in seeps on the banks of Dickenson Creek (Figure 8). This population was last observed in 1947 and is approximately 15km from FCTC. Watercress snails were found at a privately owned quarry (Site 27) 5.5km west from the center of Plainwell, MI at the location of a pre-1990 historical occurrence. Density was relatively low (10/m^2) and only a single patch of habitat with watercress was found in a seep along the banks of Silver Creek (Figure 9). The site is approximately 25km away from FCTC. A very dense population of watercress snails was documented in Victory Park, Albion, MI (sites 15 and 16), along the banks of the North Branch Kalamazoo River in seeps with watercress (Figure 10). Density was estimated at 400 individuals per m^2 over $20m^2$ at site 15 and at least 1000 individuals per m^2 over $40m^2$ at site 16. Maximum density was approximately 960/m^2 at site 15 and 2,420/m^2 at site 16. They were last observed at this location in 1947.

Figure 1. Areas surveyed in 2021 and 2022 for watercress snail. Solid red dots mark where the species was found, circles mark survey sites where it was not found.

Ott Biological Preserve on the east side of Battle Creek has a 1937 record for watercress snail but surveys did not reveal the species and no suitable habitat was located within the northern section of the Preserve (sites 23-25). Areas that may have had seeps and watercress in the past are now dominated by cattails (*Typha*) and phragmites. Three areas outside of FCTC with no previous record of watercress snail, but with watercress plants and apparently suitable habitat, were surveyed and none were found (sites 10, 11, and 30).

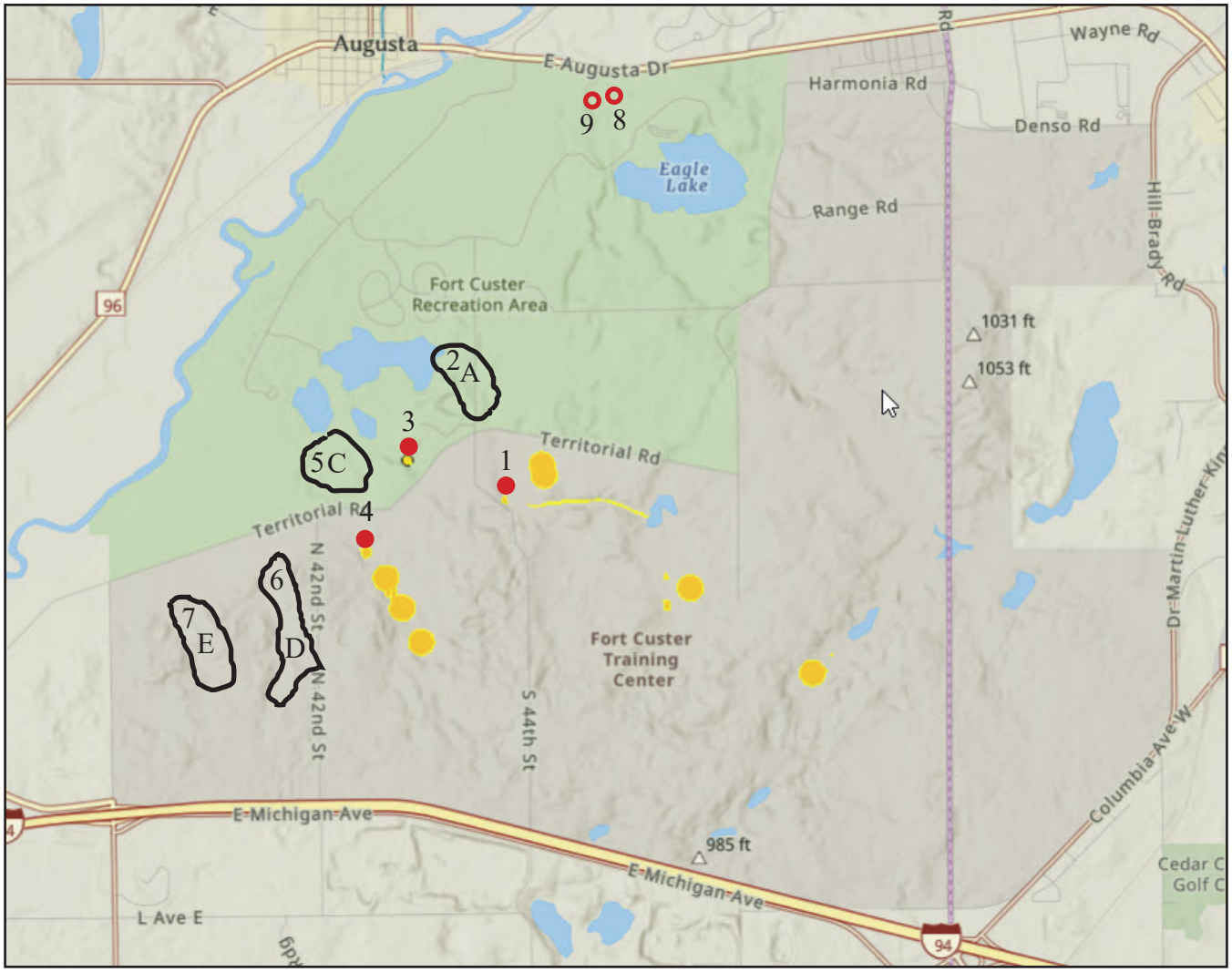

Figure 2. Watercress snail occurrences within Fort Custer Training Center and Fort Custer State Recreation Area. Red dots mark sites where the species was found and red circles mark sites where it was not found during these surveys. Orange polygons and lines mark where the species was previously documented. Black polygons mark areas searched where none was found.

Table 1. Locations of sites surveyed for watercress snail (*Fontigens nickliniana*) in summer 2021 and 2022, estimated density, and area of occupied habitat.

Site #	Site Name	Latitude	Longitude	Density Est.	Area Occupied	Waterbody
1	FCTC A	42.303734	-85.339214	80/m^2	13m^2	Wetland seeps, creek
2	FC State Rec Area A	see Figure 2.				Unnamed stream
3	FC State Rec Area B	42.306331	-85.348286	75/m^2 (5/m^2)	6m^2 (1m^2)	Whitford Lake wetland
4	FCTC C	42.300137	-85.352266	25/m^2	100m^2	Wetland seeps, creeks
5	FC State Rec Area C	see Figure 2.				Whitford Lake wetland
6	FCTC D	see Figure 2.				Unnamed stream
7	FCTC E	see Figure 2.				Unnamed stream
8	FC State Rec Area Yellow Trail A	42.33116	-85.32890			Pond/Tributary to Kalamazoo R.
9	FC State Rec Area Yellow Trail B	42.33118	-85.32835			Pond/Tributary to Kalamazoo R.
10	Eaton Rapids	42.510214	-84.586677			Fowler Drain
11	Big Rapids, White Pine Trail 10	43.648895	-85.441018			Byers Creek
12	Gourdneck SGA 3	42.182853	-85.633833	12/m^2	50m^2	Portage Creek
13	Gourdneck SGA 4	42.182849	-85.631334	0.2/m^2	15m^2	"
14	Gourdneck SGA A	42.192063	-85.635549			"
15	Victory Park, Albion A	42.23968	-84.74588	400/m^2	20m^2	South/North Branch Kalamazoo R.
16	Victory Park, Albion B	~10m west of site 15		1,000/m^2	40m^2	"
17	Historic Bridge Park A	42.29034	-85.11593			Dickenson Creek
18	Historic Bridge Park B	42.29057	-85.11369	10/m^2	4m^2	"
19	Historic Bridge Park C	42.29047	-85.11378			"
20	Historic Bridge Park D	42.29117	-85.11298			"
21	Historic Bridge Park E	42.29165	-85.11268			"
22	Historic Bridge Park F	42.29180	-85.11261	20/m^2	18m^2	"
23	Ott Biological Preserve A 440	42.32480	-85.11920			Wetland 260m NE of Brigham Lake
24	Ott Biological Preserve B 442	42.32319	-85.12118			Brigham Lake (North side)
25	Ott Biological Preserve C 443	42.32158	-85.12276			Stream 90m SW of Brigham Lake
26	Quary E. of Plainwell A	42.44451	-85.57278			Silver Creek
27	Quary E. of Plainwell B	42.44235	-85.57424	10/m^2	1m^2	"
28	Quary E. of Plainwell C	42.44109	-85.57416			"
29	Camp Grayling	44.53422	-85.02145	>1,000/m^2	20m^2	Big Canyon Creek
30	Lowell SGA 3	42.99786	-85.30527			Tiny tributary to Flat River

Table 2. Element occurrence (EO) information for watercress snail survey sites. (AB= excellent to good estimated viability, BC= good to fair, C?= possibly fair, CD= fair to poor, D?= possibly poor)

Site #	Site Name	EOID	EO rank	Element Occurrence Note	Watercress Plant Present?
1	FCTC A	6641	BC	update to EOID 6641 and expands to the W, last observed in 2019	Y
2	FC State Rec Area A				Y
3	FC State Rec Area B	26386	C?	new EO 160m outside of FCTC	Y
4	FCTC C	4908	C?	update to EOID 4908 and expands to the NW, last observed in 2019	Y
5	FC State Rec Area C				N
6	FCTC D				N
7	FCTC E				N
8	FC State Rec Area Yellow Trail A				N
9	FC State Rec Area Yellow Trail B				N
10	Eaton Rapids				Y
11	Big Rapids, White Pine Trail 10				Y
12	Gourdneck SGA 3	26393	CD	new EO (site 12 and site 13)	Y
13	Gourdneck SGA 4	26393	CD	new EO (site 12 and site 13)	Y
14	Gourdneck SGA A				Y
15	Victory Park, Albion A	16696	BC	update to EOID 16696 and expands to the S, last observed in 1947	Y
16	Victory Park, Albion B	16696	BC	update to EOID 16696 and expands to the S, last observed in 1947	Y
17	Historic Bridge Park A				Y
18	Historic Bridge Park B	16679	D?	update to EOID 16679, last observed in 1947	Y
19	Historic Bridge Park C				N
20	Historic Bridge Park D				N
21	Historic Bridge Park E				Y
22	Historic Bridge Park F	16679	D?	update to EOID 16679, last observed in 1947	Y
23	Ott Biological Preserve A 440			not found, EOID 16678, last observed in 1936	N
24	Ott Biological Preserve B 442			not found, EOID 16678, last observed in 1936	N
25	Ott Biological Preserve C 443			not found, EOID 16678, last observed in 1936	N
26	Quary E. of Plainwell A				Y
27	Quary E. of Plainwell B	16360	D?	update to EOID 16360, last observed pre-1990	Y
28	Quary E. of Plainwell C				Y
29	Camp Grayling	26401	AB	new EO	Y
30	Lowell SGA 3				Y

Figure 3. Watercress snails and habitat with watercress at site 1, in wetland seeps, Fort Custer Training Center. Habitat photo by Eric Branch. Inset photo by Peter Badra (bar is 0.5mm in diameter).

Figure 4. Watercress snails and habitat with watercress at site 4, in wetland seeps, Fort Custer Training Center. Habitat photo by Eric Branch. Inset photo by Peter Badra (bar is 0.5mm in diameter).

Figure 5. Watercress snails and habitat with watercress at site 3, Whitford Lake wetland, Fort Custer State Recreation Area. Habitat photo by Eric Branch. Inset photo by Peter Badra.

Figure 6. Watercress snails and habitat at site 12, Portage Creek, Gourdneck State Game Area. Photos by Peter Badra (bar is 0.5mm in diameter).

Figure 7. Watercress snails and habitat with watercress at site 29, Big Canyon Creek, Camp Grayling. Photos by Peter Badra.

Figure 8. Watercress snail on watercress at site 18, Dickenson Creek, Historic Bridge Park. Photos by Peter Badra (bar is 0.5mm in diameter).

Figure 9. Watercress snails and habitat with watercress at site 27, Silver Creek, quarry east of Plainwell. Photos by Peter Badra (bar is 0.5mm in diameter).

Figure 10. Watercress snails and micro-habitat at site 15, South Branch Kalamazoo River, Victory Park. Photos by Peter Badra.

Discussion

The results of this survey expand the known range of watercress snails in and near FCTC and confirm the continued presence of historical watercress snail populations in southwest Michigan. Populations in two areas (Victory Park and Historic Bridge Park) were found to still be present after over 75 years of being last observed there (sites 15-22). Three new populations were discovered and documented, one of which is a new county record (site 29, Kalkaska County, Camp Grayling) and the largest and most intact watercress snail population documented in recent decades in Michigan. Of the four historical occurrences that were surveyed, watercress snails were found at all but one, a 1936 record at Ott Biological Preserve (Sites 23-25). Only a fraction of Ott Biological Preserve was covered in this survey. The record from 1936 did not have precise locational information about where watercress snails were found. It is only known they were found within the preserve. A small area was searched at sites 23-25 relative to the size of the preserve, and it is possible that watercress snails continue to exist there.

There are currently 32 occurrence records for watercress snail for Michigan in the Natural Heritage Database. Occurrences are assigned EO ranks based on the estimated viability of the population observed. The only ones with an element occurrence rank (EO rank) equal or higher than C (fair estimated population viability) are those at FCTC (BC and C), Victory Park (BC), and Camp Grayling (AB). The rest are either historical, most of which were last observed in 1947 or earlier, or have EO ranks lower than C. An EO rank of BC is defined as good to fair population viability and AB is excellent or good viability.

Although the global range of watercress snail includes the eastern half of North America, most occurrences are concentrated in Michigan and the Appalachian states of Virginia, West Virginia, Kentucky, and Tennessee. Only a scattering of records for the species exist to the north in Pennsylvania, New York, and Ontario; to the south in Alabama; and in the Midwest states of Ohio, Indiana, and Illinois (NatureServe 2022, GBIF 2022, Badra et al. 2014, Evans and Ray 2010). The status of watercress snail in New York appears to be likely extirpated. Though its state conservation rank is S1S3 (critically imperiled to vulnerable), the species was not detected in two of the most recent freshwater snail surveys in the state (Jokinen 1992, Harman and Berg 1971). Watercress snails were last documented in New York in the 1940s (New York Natural Heritage Program 2022). In Alabama it is S1, critically imperiled. In Pennsylvania it has a state rank of S2 (imperiled) and was found at only 3 out of 398 survey sites in streams and springs in a recent survey (Evans and Ray 2010). Watercress snail was one of 12 species that were found at three or fewer sites out of a total 37 freshwater snail species found. Tennessee and Virginia have the majority of recently documented occurrences outside of Michigan with state ranks of S3S4 (vulnerable to apparently secure) and S4S5 (apparently secure to secure) respectively. Watercress snail has not been assigned status ranks in the remaining five states. Though there are small numbers of occurrences in these states relative to Michigan, Virginia, and Tennessee we cannot assume that the data currently available for the five states without S-ranks provides an accurate view of its rarity due to the lack of survey effort.

In light of the results of this survey, the state rank of watercress snail in Michigan of S2S3 (imperiled to vulnerable) still seems appropriate. If future targeted surveys for watercress snail reveal more historical occurrences as still supporting viable populations, and especially if previously undocumented populations can continue to be found, its conservation status in the state may justify moving its rank to S3. Together with the Appalachian populations in Virginia and Tennessee, Michigan appears to be a global stronghold for the species.

Big Canon Creek near Grayling, MI has several ground water seeps flowing into it from both banks. Maximum density of watercress snails in the seeps was found to be greater than 1000's per m^2. This site in Big Canon Creek had gravel and pebble substrate along with sand, while sites in nearby Portage Creek (another tributary of Manistee River of similar size to Big Canon Creek) were almost 100% sand. The topography around the Portage Creek sites was mostly flat with very sandy soils. Land around the Big Canon Creek site, at least the

stream banks, was steep and cuts through glacial moraine containing gravel and pebble substrates in addition to sand. The surficial geology of Big Canon Creek may lend itself to frequent seeps and habitat for watercress and watercress snail versus that of Portage Creek. It may be worthwhile in the future to develop a habitat model based on groundwater seeps and springs and surficial geology to guide future survey efforts to find previously undocumented watercress snail populations.

The status of watercress snail in Michigan is linked to the conservation and management of its groundwater seep habitat in and around, streams, springs, lakes, and wetlands. Watercress snails depend on the particular temperature regime, water chemistry, and physical structure of microhabitats found in springs and groundwater seeps on the margins of streams and lakes where watercress plants grow. Avoiding hydrologic alterations, such as draining and filling, near occupied springs can help to maintain groundwater flow that creates this habitat type. Retaining or restoring naturally vegetated buffers around springs, streams, and lakes with watercress snail provides shade, moderate temperatures, and reduces potential for erosion. Sedimentation of fine particles and erosion along the banks of streams where watercress snails occur can be reduced by maximizing the amount of naturally vegetated landcover and minimizing impervious surfaces in the watershed. Higher proportions of impervious and non-naturally vegetated landcover types can lead to flashier stream flows and increased erosion of stream banks. Forms of pollution the species may be most susceptible to are road salt, metals (e.g. copper, mercury, and zinc), and excess nutrients from agricultural runoff (Johnson et al. 2013, Lydeard et al. 2004). One of the biggest factors limiting the conservation and management of watercress snail in Michigan is the lack of knowledge of the distribution and status of their populations. Avoiding impacts to populations once they are documented is the next step in securing and improving the species' conservation status.

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