

**Freshwater Mussel Surveys
for the Fishing and Gibbs Creek Watersheds**

Granville County, North Carolina

**The Catena Group, Inc.
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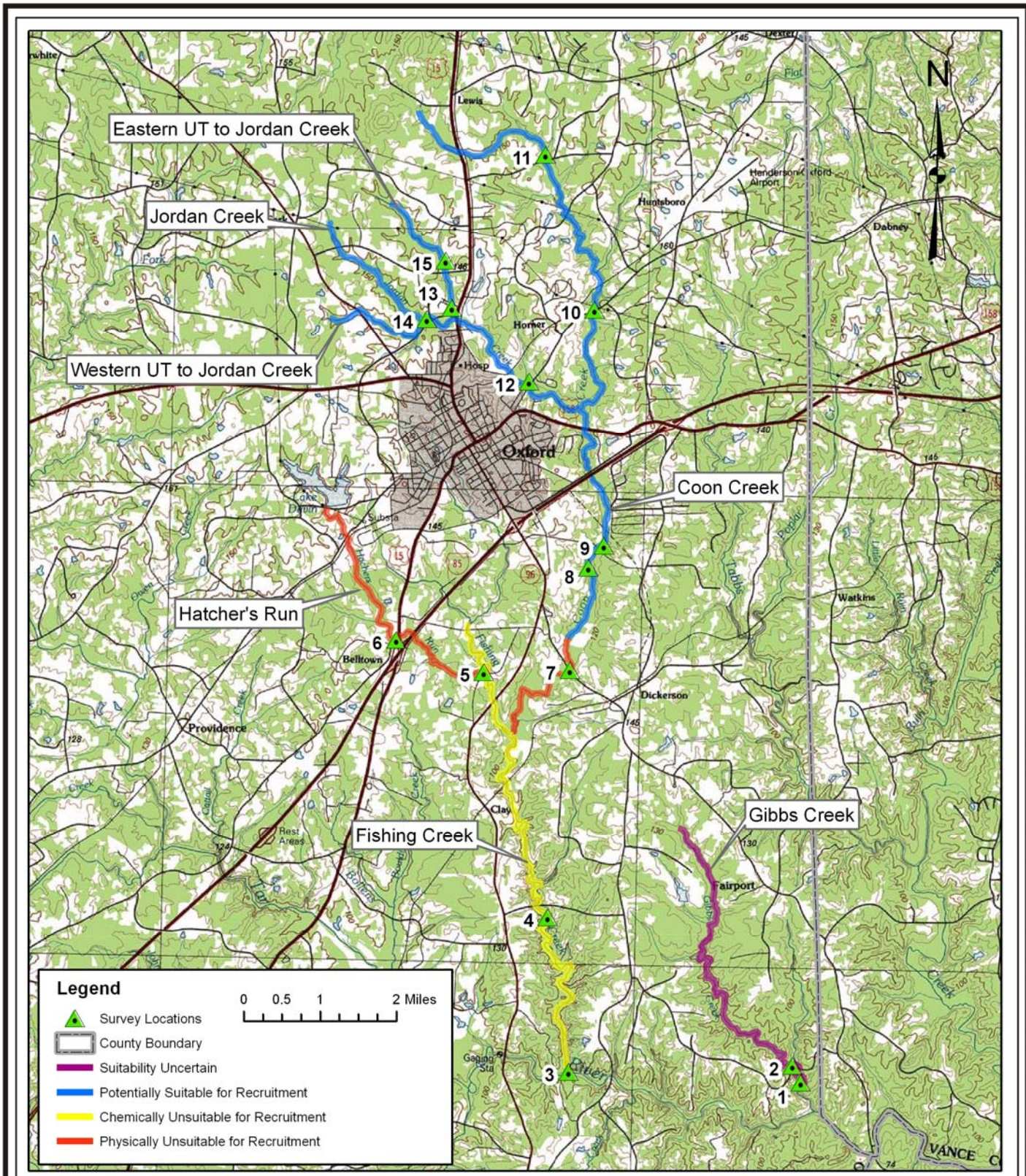
INTRODUCTION

The North Carolina Department of Environment and Natural Resources's (NCDNR) Ecosystem Enhancement Program (EEP) requested a watershed analysis of Fishing Creek and Gibbs Creek in Granville County within the upper Tar-Pamlico River Basin. The goal is to determine the suitability of habitat within these watersheds for the recruitment of mussel fauna. Fishing Creek and Gibbs Creek are tributaries to the Tar-Pamlico River. The Fishing Creek watershed is approximately 11 river miles (RM) long and includes three named tributaries (Jordan Creek, Coon Creek and Hatcher's Run). Gibbs Creek is approximately 5 RM in length and is a tributary of the Tar River just east of Fishing Creek. The Fishing Creek/Gibbs Creek watershed and its tributaries are depicted in Figure 1. The Federally Endangered dwarf wedgemussel (*Alasmidonta heterodon*) is listed by the US Fish and Wildlife Service (USFWS) as occurring in Granville County, NC. Extant populations in Granville County are known to exist in the Shelton Creek watershed, as well as the main-stem of the Tar River. The dwarf wedgemussel has not been recorded within Fishing and Gibbs Creek drainage basins.

In addition to the dwarf wedgemussel, there are several other rare freshwater mussel species known to occur in the Tar-Pamlico River Basin in Granville County, NC. These include the Atlantic pigtoe (*Fusconaia masoni*), green floater (*Lasmigona subviridis*), yellow lampmussel (*Lampsilis cariosa*), yellow lance (*Elliptio lanceolata*), triangle floater (*Alasmidonta undulata*), eastern lampmussel (*Lampsilis radiata radiata*), undescribed lampmussel (*Lampsilis* sp. 2), creeper (*Strophitus undulatus*) and the notched rainbow (*Villosa constricta*). The Atlantic pigtoe, green floater, yellow lampmussel, and the yellow lance are Federal Species of Concern (FSC)¹ and are considered Endangered (E)² in North Carolina. The triangle floater, eastern lampmussel, and the creeper are considered Threatened (T) in North Carolina. The notched rainbow is considered a Special Concern (SC), while the undescribed lampmussel is considered Significantly Rare (SR) in North Carolina.

¹ **Federal Species of Concern (FSC)** are defined as a species that is under consideration for listing for which there is insufficient information to support listing. FSCs are not afforded federal protection under the Endangered Species Act and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as Threatened or Endangered. However, the status of these species is subject to change, and so should be included for consideration

² **North Carolina Endangered (E), Threatened (T), and Special Concern (SC)** species have legal protection status in North Carolina under the State Endangered Species Act administered and enforced by the North Carolina Wildlife Resources Commission. Species listed as Significantly Rare are not afforded any protection.



Freshwater Mussel Suitability Study
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Date: November 2005
 Scale: As Shown
 Job No.: 3158

Figure
1

WATERS OF INTEREST: Fishing and Gibbs Creek

Fishing Creek arises south of Oxford, North Carolina at the confluence of two unnamed tributaries. Approximately 1 RM downstream of this confluence, Hatcher's Run converges with Fishing Creek. The Coon Creek and Fishing Creek confluence is approximately 1 RM downstream of the Hatcher's Run confluence.

Habitat in Fishing Creek in the areas surveyed consists of gravel riffles and sandy runs, often with a heavy accumulation of silt and woody debris in pools. Areas of bedrock outcroppings are scattered throughout the creek course. The clay banks are fairly stable but show signs of active erosion in some areas.

One point source discharge, the City of Oxford Waste Water Treatment Plant (WWTP), is permitted within the Fishing Creek watershed. It is located approximately 1 RM upstream of the Hatcher's Run and Fishing Creek confluence.

Gibbs Creek arises approximately 5 miles southeast of Oxford, near Fairport, and flows in a general southeast direction for approximately 6 miles before converging with the Tar River. No permitted point source discharges occur in Gibbs Creek. Habitat in Gibbs Creek consists of gravel and sandy riffles and pools with sand bars being common. Areas of heavy sedimentation are evident due to soil erosion and the undercutting of banks.

Riparian areas within the Fishing Creek and Gibbs Creek watersheds are comprised of deciduous forest. Land use outside of the riparian zone generally consists of pine plantation, clear cut land, residential, and agricultural land.

SURVEY EFFORTS/HABITAT EVALUATIONS

Methodology

Mussel surveys were performed at 15 survey sites in the previously mentioned water bodies on October 18 and 19, 2005 (Figure 1). All habitat types (riffle, run, pool, slack water, etc.) contained within each site were sampled. Visual and tactile surveys were conducted using batiscoopes (glass-bottom buckets). Tom Dickinson and Chris Sheats of The Catena Group, and Daniel Ingram of W.K. Dickson performed the surveys. Habitat conditions (substrate, bank stability, etc.) were recorded at each survey site.

Upstream and downstream survey limits of each site were recorded using a hand-held Garmin e-trex vista GPS unit. A three-person survey team was used for the surveys. All habitat types were evaluated for mussels to provide full coverage of the stream bottom at each particular site. Survey efforts were then concentrated in the areas with the most suitable habitat and highest concentrations of mussels. The speed at which the team proceeded upstream depended on stream width, survey conditions (depth, clarity, etc.), habitat characteristics and the presence of mussels. Timed searches were employed at each site. The amount of time spent in each waterbody was determined by survey

conditions and appropriate habitat present. Survey distances varied between sites, as sites were chosen based on best suitable habitat for the target species and accessibility to these habitats.

Mussels were collected, identified, counted, and returned to the substrate. Catch per unit effort (CPUE) for each mussel species found were calculated for each surveyed site (Table 1 and 2). Searches were also conducted for relict shells. The presence of a shell was equated with presence of that species; however the shells found were not factored into the CPUE for each species. Measurements (total length) were taken for all species that are monitored by the North Carolina Natural Heritage Program (NCNHP).

Snails also were collected, identified, and assigned a relative abundance. Snails are mentioned in the report only for information purposes, as they are detected with the same methodology used to survey for mussels.

Pre Survey Investigation

Prior to conducting in-stream surveys, a review of previous surveys within the Fishing and Gibbs Creek watersheds was performed. Sources consulted include the NCNHP systematic inventory (database) of rare plant and animal species, the North Carolina Wildlife Resources Commission (NCWRC), and the North Carolina Division of Water Quality's (NCDWQ) Tar-Pamlico River Basinwide Water Quality Plan. The results of the review indicate that the eastern elliptio (*Elliptio complanata*) is known to occur in Fishing Creek and Coon Creek, a tributary to Fishing Creek and elliptio mussels (*Elliptio* spp.) have been recorded in Gibbs Creek and Coon Creek.

Results

Freshwater mussels were found at 9 of the 13 sites sampled in the Fishing Creek watershed (Table 1) and not found in Gibbs Creek (Table 2). Site numbers referred to have been assigned to each of the areas sampled downstream to upstream within the watershed. The introduced Asian clam (*Corbicula fluminea*) was found at all but 2 sites sampled in the two watersheds (Table 1 and 2). Two species of aquatic snails, the crested mudalia (*Leptoxis carinata*) and the pointed campeloma (*Campeloma decisum*) were found at 3 and 6 sites respectively. Both species are wide ranging and fairly common. Nature Serve (2005) lists both species as G5 (Globally secure).

Table 1. Mussels Surveys for the Gibbs Creek Watershed

Date	Site No.	Stream	Start Location (downstream)	Stop Location (upstream)	Person Hours	Species/number/CPUE
10/18/05	1	Gibbs Creek	36.1893°N, 78.5137°W	36.1903°N, 78.5131°W	1.5	<i>Corbicula fluminea</i> (C*)
10/18/05	2	Gibbs Creek	36.1925°N, 78.5156°W	36.1931°N, 78.5174°W	1	<i>Corbicula fluminea</i> (C*)

Table 2. Mussels Surveys for the Fishing Creek Watershed

Date	Site No.	Stream	Start Location (downstream)	Stop Location (upstream)	Person Hours	Species/Number/CPUE
10/19/05	3	Fishing Creek	36.1914°N, 78.5683°W	36.1932°N, 78.5687°W	0.75	<i>Corbicula fluminea</i> (C*) <i>Elliptio complanata</i> (5) - 6.7/hr
10/18/05	4	Fishing Creek	36.2210°N, 78.5729°W	36.2230°N, 78.5758°W	2.5	<i>Corbicula fluminea</i> (C*)
10/18/05	5	Hatcher's Run	36.2679°N, 78.5877°W	36.2669°N, 78.5906°W	1.5	No mussels observed
10/18/05	6	Hatcher's Run	36.2741°N, 78.6081°W	36.2748°N, 78.6096°W	0.75	No mussels observed
10/19/05	7	Coon Creek	36.2683°N, 78.5675°W	36.2698°N, 78.5671°W	1	<i>Corbicula fluminea</i> (C*) <i>Spharium</i> sp.
10/18/05	8	Coon Creek	36.2878°N, 78.5630°W	36.2889°N, 78.5627°W	2.25	<i>Corbicula fluminea</i> (C*) <i>Elliptio complanata</i> (7) - 3.11/hr <i>Pyganodon cataracta</i> (1) - 0.44/hr

Date	Site No.	Stream	Start Location (downstream)	Stop Location (upstream)	Person Hours	Species/Number/CPUE
10/18/05	9	Coon Creek	36.2919°N, 78.5593°W	36.2928°N, 78.5589°W	1	<i>Corbicula fluminea</i> (C*) <i>Pyganodon cataracta</i> (1) - 1.0/hr
10/19/05	10	Coon Creek	36.3370°N, 78.5612°W	36.3393°N, 78.5609°W	1.75	<i>Corbicula fluminea</i> (C*) <i>Elliptio complanata</i> (28) - 16/hr
10/19/05	11	Upper Coon Creek	36.3666°N, 78.5726°W	36.3676°N, 78.5728°W	1.75	<i>Elliptio complanata</i> (9) - 5.14/hr
10/19/05	12	Jordan Creek	36.3233°N, 78.5767°W	36.3229°N, 78.5782°W	1.5	<i>Corbicula fluminea</i> (C*) <i>Pyganodon cataracta</i> (1) - 0.67/hr
10/19/05	13	Eastern UT to Jordan Creek	36.3375°N, 78.5944°W	36.3401°N, 78.5944°W	2.0	<i>Pyganodon cataracta</i> (1) - 0.5/hr <i>Elliptio complanata</i> (2) - 1/hr
10/19/05	14	Western UT to Jordan Creek	36.3355°N, 78.6005°W	36.3343°N, 78.6016°W	2.0	<i>Pyganodon cataracta</i> (25) - 12.5/hr
10/19/05	15	Eastern UT to Jordan Creek	36.3445°N, 78.5963°W	36.3464°N, 78.5962°W	1.0	<i>Pyganodon cataracta</i> (8) - 8/hr <i>Elliptio complanata</i> (4) - 4/hr

*-Common

Mussel Species Found

Two species of freshwater mussels, the eastern elliptio and eastern floater, and two species of freshwater clams, the Asian clam and a pea clam (*Spharium* sp.), were found during the survey efforts. The introduced Asian clam was found at most of the survey locations. Although not quantified, it appeared to be the most common bivalve species at most of the survey locations.

Elliptio complanata (eastern elliptio)-This species was described as *Mya complanata* from the Potomac River in Maryland (Lightfoot 1786). Shell characteristics are highly variable. Shell shape is typically trapezoidal to rhomboid, and compressed to inflated. The usually straight ventral margin is mostly parallel with the dorsal margin and the posterior margin is broadly rounded. Shell thickness varies from thin to solid. This species is widely distributed along the Atlantic Slope from Altamaha River Basin in Georgia north to the St. Lawrence River Basin, and west to Lake Superior and parts of the Hudson Bay Basin. It can be found in a variety of habitats from large rivers and lakes to small headwater streams. The species is widespread and common throughout its range and considered “Stable” (Williams, Warren et al. 1993).

Pyganadon cataracta (eastern floater)-Described by Say (1817) in the deep part of a milldam, presumably near Philadelphia, PA. This species is wide ranging in the Atlantic drainages from the lower St. Lawrence River Basin south to the Altamaha River Basin, Georgia, and in the Alabama-Coosa River drainage, and the Apalachicola and Coctawhatchee River Basins, Florida. The shells of this species are uniformly thin, and are lacking any hinge teeth. The shell shape is ovate, subelliptical and elongate, with an evenly rounded anterior margin and a broadly rounded ventral margin. The periostracum is light to dark green with broad green rays on the posterior slope. This species is considered common and Currently Stable throughout its range (Williams et al. 1993).

DISCUSSION

Habitat conditions and distribution of mussels at each survey site

In nearly all of the sites where mussels were found they were unevenly distributed in the stream, which is reflective of the distribution and quality of microhabitats within a particular stream segment. Brief summaries of the habitat and molluscan fauna of each stream site surveyed are provided below.

Site 1 Gibbs Creek: This reach of Gibbs Creek is located downstream from the SR 1620 (Grey Rock Road.) crossing. The survey reach for this site extended approximately 200 meters. The channel width is approximately 5-7 meters wide with banks being 1-3 meters high with shallow waters throughout. Substrate consists mostly of sand, and silt covered gravel. Prevalent sand bars due to heavy sedimentation are present. Signs of

beaver activity are present (two dams and gnawed sticks). There is evidence of erosion and undercut banks. A wide riparian buffer is present and the adjacent land use outside of the riparian is mainly timbered land. No mussel species were found, but the Asian clam was found in patches throughout this reach.

Site 2 Gibbs Creek: This reach is located upstream of the Grey Rock Road crossing and extended for approximately 200 meters. The channel width is 4-6 meters with the banks being 2-3 meters high. The substrate mainly consists of silt, sand, clay, gravel, cobble, and boulders. There is a well defined presence of boulder riffle/pool sequences with the presence of sand bars. Signs of beaver activity are present (dams and gnawed sticks). Some erosion and undercutting banks area present within this reach. The stream has a moderate to wide riparian buffer with the adjacent land use consisting mainly of natural areas. No mussel species were observed, but the Asian clam was common in this reach. The pointed campeloma was also observed within this reach.

Site 3 Fishing Creek: This reach is located at the confluence of Fishing Creek and the Tar River. The survey reach extended for approximately 250 meters. The channel is approximately 12-17 meters wide and the banks are about 3 meters high. This reach contains relatively shallow to moderate water depths with 70% being less than 2 feet deep. The substrate consists of silt, sand, clay, cobble, gravel, and bed rock with an abundance of sand bars. This reach appears to be somewhat unstable as is evidenced by undercut and eroded banks. The adjacent land use is natural areas and timbered land with the presence of a moderate to wide buffer. Six eastern elliptios were found mainly within the rocky clay banks. Asian clams were also observed.

Site 4 Fishing Creek: This reach of Fishing Creek is located downstream of the SR 1643 (Eaton Road) crossing and extended for approximately 400 meters. This reach is approximately 12-15 meters in width with bank heights being 2-3 meters high. Water depth is relatively shallow to moderate within this reach. Substrate consists of silt, sand, clay, gravel, cobble, boulder, and bedrock. The surrounding land use consists mainly of natural areas. This reach contains excellent physical habitat for mussels, however no mussel species were observed. A faint smell of chlorinated effluent was noted at this site. The Asian clam was the only bivalve species observed within this reach.

Site 5 Hatcher's Run: This reach is located just upstream of SR 1608 (Fielding Knotts Road) and the confluence with Fishing Creek. The stream width is approximately 5 meters with bank heights being 2-3 meters high. The substrate consists of silt, sand, clay, gravel, boulder, and bedrock. The majority of habitat in this section of Hatcher's Run has been degraded due to sedimentation. However, bedrock and boulder runs are present, which could provide suitable habitat for bivalves if sedimentation was less significant. The surrounding land use is mostly natural areas. No mussels were found within this reach.

Site 6 Hatcher's Run: This approximately 350 meter reach of Hatcher's Run is located upstream of the US 15 crossing. The stream channel width is approximately 3 meters wide and the banks are approximately 2 meters high. The substrate consists of silt, sand,

clay, gravel, cobble, and boulders with sand bars being common. A series of beaver dams are present throughout the reach. The stream bottom is heavily sedimented and the stream banks are highly eroded and undercut. Adjacent land use is mainly natural areas and the roadway. No mussels were found within this reach.

Site 7 Coon Creek: This 200 meter reach of Coon Creek is located upstream of the SR 1609 (Harris Road) crossing. The channel width is 7-8 meters and the bank height is 2-3 meters. The substrate consists of silt, sand, clay, gravel, cobble and bedrock with sand bars being common throughout. There is an average amount of woody debris present and there is evidence of beaver activity (gnawed sticks). The stream banks are very unstable and actively eroding within this reach. The Asian clam and a few pea clams were the only bivalves present within this reach. The pointed campeloma was also observed within this reach.

Site 8 Coon Creek: This 200 meter reach is located downstream of SR 1606 (Orphanage Road), southeast of Oxford. This surveyed reach of Coon Creek is approximately 8-10 meters in width and approximately 150 meters in length. The banks range from 2-3 meters in height and show some evidence of erosion and undercutting. The substrate consists of silt, sand, clay, gravel, cobble, and bedrock. Overall, the channel is mostly stable with a wide vegetated buffer with the adjacent land use being forested. There was evidence of heavy sedimentation deposits within the pools. Flow variation consisting of runs, riffles, and pools was persistent throughout this reach. Approximately 95 % of the stream was less than 2 feet deep. Mussels were found mostly along clay banks, as well as within the center channel in gravel substrate. The eastern elliptio and the eastern floater were the only mussel species observed. In addition, to the mussels, the pointed campeloma and the crested mudalia were also observed within this reach. The Asian clam is common at this site.

Site 9 Coon Creek: This 150 meter reach is located upstream of Orphanage Road. The channel dimensions are about the same as the downstream reach (Coon Creek 1), with the stream width being slightly smaller at 8-9 meters wide. The substrate consists of sand, clay, gravel, cobble, and boulders. Heavier sedimentation within this reach is evident by the abundance of sand bars. There is also evidence of beaver (*Castor canadensis*) activity such as gnawed sticks. Approximately 90% of the stream is less than 2 feet deep. There is a moderate presence of buffers with the adjacent land use mainly being a roadway with surrounding natural areas. Mussels are generally scarce at this location, with the eastern floater being the only species observed. The Asian clam is common in this reach. The crested mudalia was also observed.

Site 10 Coon Creek: This reach is located upstream of the SR 1522 (Salem Road) crossing. The channel width is 2 meters wide with bank heights being 5-7 meters high. The water depth is shallow with 95% of the water being below 2 feet deep. Substrate consists of silt, sand, clay, gravel, cobble, boulder, and bedrock with sand bars being common. A moderate sized forested riparian buffer occurs adjacent to this reach. The eastern elliptio and the Asian clam were observed to be common within this reach. The pointed campeloma and the crested mudalia were also observed within this reach.

Site 11 Upper Coon Creek: This 300 meter reach is located upstream of the SR 1518 (Slaughter Pen Road.) crossing. A narrow forested riparian buffer is present, but the majority of the adjacent land has been clearcut. The stream is highly incised in this reach. The channel width is approximately 2-3 meters with the bank heights being 2-3 meters high. The water depth is relatively shallow with 90% being less than 2 feet deep. The substrate is unconsolidated and consists of silt, sand, clay, gravel, and cobble with sand bars being rare. There is a high amount of woody debris in the stream. This site could potentially be a suitable site to consider for stream restoration. Adult and juvenile eastern elliptos were the only mussel species found within this reach. The pointed campeloma was also observed within this reach.

Site 12 Jordan Creek: This 200 meter reach is located upstream of the SR 1522 (Salem Road) crossing. The bank width is 5-7 meters and the banks are 2-3 meters high. The substrate consists of silt, sand, clay, gravel, cobble, and boulder with the presence of sand bars. Signs of beaver activity are present (gnawed sticks). The riparian buffer width is narrow to moderate and the adjacent land use is a mix of natural and urban areas. There is some evidence of erosion and undercutting of the stream banks. The eastern floater was the only mussel species observed. The Asian clam was common at this site.

Site 13 Eastern UT to Jordan Creek: This 300 meter survey reach occurs within an unnamed tributary to Jordan Creek situated to the east upstream of US 15 and SR 1453. This survey reach has a lower portion and an upper portion.

In the lower portion of this reach the stream is incised to the bedrock and the banks appear to be relatively unstable. There is a narrow riparian buffer available with the surrounding land use being mainly a mix of natural and urban areas. A school is adjacent to the stream. This lower portion of the reach has the potential to be used for stream restoration and could thereafter potentially hold bivalves. No bivalves were observed in this lower portion of the stream.

The upper portion of this stream reach has a width of 2-3 meters and the banks are 2 meters high. The water depth is very shallow with a riffle/pool sequence. The substrate consists of silt, sand, gravel, cobble, and bedrock with sand bars being common. This upper portion of the reach is not as incised as the lower portion has a wider forested buffer with an accessible floodplain. The rocky riffle/pool sequence provides habitat and most mussel observed were in pools. The eastern floater and the eastern elliptio are the only mussel species observed within this upper portion of the reach.

Site 14 Western UT to Jordan Creek: This 250 meter reach is located just below the confluence with the western UT to Jordan Creek. The bank width is 3-5 meters and the banks are 1-2 meters high. The substrate is composed of silt, sand, clay, gravel, cobble, and boulders with the presence of sand bars. The water depth is shallow with 90% of it being less than 2 feet deep. Habitat consists of run/riffle/pool sequences. Signs of beaver activity are present (gnawed sticks). Some erosion and undercutting of the stream banks is evident. The stream buffer is moderate in size and the adjacent land use is natural

areas and roadways. The eastern floater was the only mussel observed within this reach with most of the specimens found being of young age classes. Although uncommon, the pointed campeloma was also observed within this reach.

Site 15 Eastern UT to Jordan Creek: This 200 meter reach is located upstream of the SR 1422 (Watkins-Wilkinson Road) crossing. The bank width is 3-5 meters and the bank height is 1-2 meters high. The water depth is shallow and habitat consists of riffle/run/pool sequences. The substrate consists of silt, sand, clay, gravel, cobble, and boulders with the presence of sand bars. Signs of beaver activity are present (gnawed sticks). There is some erosion and undercutting banks. The buffer width is moderate to wide and the adjacent land use is composed of natural areas, active pastures, and roadways. The eastern floater and the eastern elliptio were observed in this reach.

CONCLUSIONS

The survey results indicate that a mussel fauna consisting of two native species, the eastern elliptio and the eastern floater, is present in the portions of the Fishing Creek watershed. In addition, two native aquatic snail species, the crested medulla and the pointed campeloma are also present within the watershed. Both snail species are somewhat tolerant of water quality degradation and should not be correlated with water quality differences between survey sites or mussel presence or potential presence.

The distribution and low numbers of mussels in the streams appears to correlate very closely with the unstable conditions of the stream banks within Coon and Jordan creeks, as mussels were rare to absent in the severely eroded stream sections, yet more abundant in the relatively stable stream sections. The stability of substrate appeared to be the most important factor determining distribution of mussels in Coon Creek and Jordan Creek.

In main-stem Fishing Creek, however, mussels were not present at site 4 (and presumably upstream to the Oxford WWTP) despite the presence of high quality physical habitat for mussels. The absence of mussels in this reach of Fishing Creek is likely the result of the presence of the Oxford WWTP. Chlorinated sewage treatment effluent is being discharged into Fishing Creek from the WWTP. As a result, this section of Fishing Creek (from the WWTP outfall #1 to Coon Creek) is currently rated as impaired waters due to poor bioclassification (DWQ 2004). Effects to mussel recruitment may extend far beyond the impaired water designation.

Currently, Fishing Creek is considered unsuitable for mussel fauna reestablishment. Sewage treatment effluent has been documented to significantly affect the diversity and abundance of mussel fauna (Goudreau et al. 1988). Goudreau et al. (1988) found that recovery of mussel populations might not occur for up to two miles below points of chlorinated sewage effluent. When the planned improved methods for treating waste water being discharged into Fishing Creek occur, further investigations may prove southern portions of the stream to be suitable for mussel recruitment.

The surveys affirmed that occupied high quality mussel habitat does occur in portions of Coon Creek and Jordan Creek, including the UT's to Jordan Creek. The occurrence of the eastern floater in Jordan Creek has not been previously recorded from the Jordan Creek drainage. In addition to the mussel species, two species of aquatic snails, the pointed campeloma and the crested mudalia, and the Asian clam occur in these creeks. Portions of Coon Creek, Jordan Creek and the UT's to Jordan Creek are considered suitable habitat locations for improved recruitment of mussel species. Further comprehensive surveys need to be conducted within Jordan Creek, the UT's to Jordan Creek, and the upper portions of Coon Creek to evaluate and identify specific reaches suitable for restoration activities.

The introduced Asian clam is common in Fishing, Coon, Jordan, and Gibbs creeks, but was not found in Hatcher's Run. The introduction of the Asian clam, an exotic species, has also been shown to pose significant threats to native freshwater mussels. The Asian clam is now established in most of the major river systems in the United States (Fuller and Powell 1973), and concern has been raised over competitive interactions for space, food and oxygen between this species and native mussels, possibly at the juvenile stages (Neves and Widlak 1987, Alderman 1997).

The majority of habitat observed in Hatcher's Run was degraded due to the effects of sedimentation. In locations where bedrock was high and serving as grade control, habitat degradation not as severe. This portion contained boulder and gravel runs that would be considered good physical habitat for bivalves, however, no mussels were observed in Hatcher's Run. Thus, this reach is considered unsuitable in places where heavy sedimentation is occurring. Bank stabilization and other erosion control strategies may improve habitat conditions to the point where mussel introductions may be feasible.

The observed reaches of Gibbs Creek contained evidence of heavy sedimentation and undercutting banks. There were portions with boulder riffle/pool sequences that appeared to be suitable habitat, but no mussels were observed. The Asian clam was common in some areas, but numerous fresh-dead shells were observed as well, which may be the result of recent drought conditions. One possibility for the negative survey results could be the small size and likely vulnerability to interrupted flow during extended drought in Gibbs Creek. Because of its high fecundity, short life cycle, ability to thrive in unconsolidated sediment, and broadcast method of dispersal, the Asian clam may be able to quickly colonize this stream during years of continual flow. Based on the reasons stated above, within and upstream of the survey reaches, Gibbs Creek is likely uninhabited by mussels and therefore unsuitable for recruitment goals.

The purpose of these mussel screenings is to determine mussel habitat suitability and thus aid in prioritizing the mussel suitability of the Fishing and Gibbs Creek watersheds for the recruitment of mussels. Figure 1 depicts four categories of suitability for the recruitment: suitability uncertain, potentially suitable, chemically unsuitable, and physically unsuitable. Due to the amount of and physical quality of habitat that could be restored through waste water treatment improvement at the Oxford WWTP, main-stem Fishing Creek should be considered the top priority for mussel recruitment in the study

area. The habitat available for recruitment in main-stem Fishing Creek is extensive and could support a variety of freshwater mussel species that smaller tributaries in the watershed do not typically support. Therefore, priority 1 should be the support of improved methods already underway for treating waste water at this point-source. Due to the current waste water treatment methods being used at the Oxford plant, Fishing Creek is currently considered “chemically unsuitable” for recruitment, but this is due to change as the current system of chlorine treatment is replaced with UV treatment. Additional stabilization/ habitat restoration in areas of Fishing Creek that are physically degraded will also assist in the recruitment of mussel fauna when the old WWTP is taken offline.

Priority 2 areas include survey sites where mussel presence was established, but where physical habitat appeared to be a limiting factor in the numbers located and their distribution. These areas could benefit from stabilization/ habitat restoration that would allow them to support greater numbers of mussels. Priority 2 areas include Coon Creek Site 9, Upper Coon Creek Site 11, Eastern UT to Jordan Creek Site 13, and Jordan Creek Site 12. Priority 3 areas include survey sites where mussel populations are already established and viable with relatively stable habitat conditions. Often it is the presence of bedrock in these areas that provides the necessary stability to support viable mussel populations. While areas near these survey reaches could benefit from restoration activities where localized instability, etc was occurring, they should not be considered as high a priority. Priority 3 streams include Coon Creek Site 8, Coon Creek Site 10, Eastern UT to Jordan Creek Site 15, and Western UT to Jordan Creek Site 14.

Areas categorized as physically unsuitable for mussel recruitment or suitability uncertain have physical or other unknown limitations to mussel suitability in the surveyed areas. These physical limitations include severe degradation in the case of Hatcher’s Run and Coon Creek Site 7, and small size (possibly linked to drought intolerance along with other influence from unknown factors) and heavy sedimentation in areas in the case of Gibbs Creek.

These survey efforts and analysis should serve as a beginning guide in the development plans to promote mussel recruitment in Fishing/Gibbs Creek Subbasin. Specific project goals will require additional survey and habitat investigations of greater detail. In the case of all survey areas prioritized here it is important to note that these categorizations are based on one-time surveys of relatively short reaches of these streams. While the inferences made from these surveys are accurate for the surveyed areas, it will be important to further investigate habitat conditions within, up, and downstream of these reaches before proceeding with any restoration efforts. This will allow more accurate evaluation of the mussel fauna present, the extent of habitat degradation, and the potential for recruitment in the streams in question that cannot be fully evaluated during a one-time survey.

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