Fish Inventory at Stones River National Battlefield

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By

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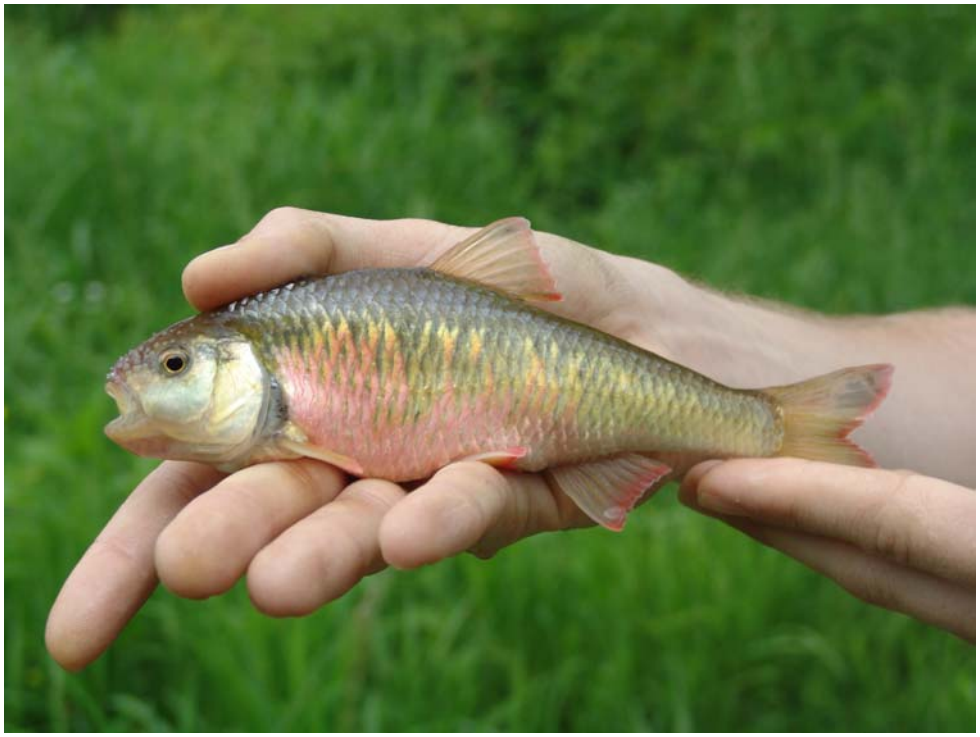

Striped Shiner (*Luxilus chrysocephalus*) – nuptial male
From Lytle Creek at Fortress Rosecrans
Photograph by D. Mullen

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Executive Summary:

The purpose of this two year survey of the fish supporting habitats on or adjacent to the Stones River National Battlefield was to document the species richness of the fish communities in those habitats. The fish communities of each of the habitats (West Fork of the Stones River at McFadden's Ford, West Fork of the Stones River at Redoubt Brannan, Lytle Creek at Fortress Rosecrans, King Pond, and an unnamed pond at Redoubt Brannan) were sampled by a combination of electrofishing, seining, and trapping, with hoop nets, once each season between October 2004 and August 2006. An Index of Biotic Integrity (IBI) based on the fish community was determined for each of the three riverine sites during August of 2005. A total of 46 species of fish (representing 73% of the species determined to potentially occur in the WFSR in this area) were documented over the course of this study and species richness estimates indicate that this survey was successful at documenting about 90% of the fish species in the area. The McFadden's Ford site had the highest richness with 41 fish species, compared to Redoubt Brannan (33 species) and Lytle Creek (31 species) which is probably a function of its larger size (compared to Lytle Creek) and greater habitat diversity (compared to both Redoubt Brannan and Lytle Creek). Both the McFadden's Ford and Lytle Creek sites were ranked as "Fair to Good" quality habitats by the IBI assessments and Redoubt Brannan was ranked as a "fair" quality habitat. All three sites scored low on the metric "Number of intolerant species," primarily due to a lack of three small benthic pollution intolerant species (slender madtom, fantail darter, and speckled darter) that are present at low densities in the WSFR system, but were not present during the IBI assessments (non-benthic pollution intolerant species bigeye shiner and rockbass were present during IBI sampling and are abundant in the system). These results are consistent with the assessment of the Tennessee Department of Environment and Conservation that this portion of the WFSR system is impaired due to excessive siltation.

Introduction:

The Stones River National Battlefield (STRI) serves as a national memorial of the Battle of the Stones River (December 31 – January 2 1863) and occupies 287 ha within or adjacent to the city of Murfreesboro, Tennessee. The entire battlefield lies within the Inner Nashville Basin Ecoregion (71i) which is characterized by flat to rolling terrain containing cedar glades, mixed hardwood forests, stands of eastern red cedar and low gradient streams flowing over large expanses of bedrock (Arnwine et al. 2000). The soils are derived from Ordovician limestone bedrock and there are many rocky outcrops. The aquatic habitat at SRNB consists of; sections of the West Fork of the Stones River (WFSR) at Redoubt Brannan and McFadden's Ford (the Artillery Monument), a section of Lytle Creek adjacent to Fortress Rosecrans and two small ponds located at the Artillery Monument (King Pond) and Redoubt Brannan (unnamed pond).

Meiman (2005) indicates that the aquatic habitat at STRI is more impacted than in any other park in the Cumberland Piedmont Network. The USEPA includes both Lytle Creek and the West Fork of the Stones River on its 303d list of impaired streams. The Tennessee Department of Environment and Conservation (TDEC) includes both the West Fork of the Stones River and Lytle Creek in its 2004 303d list of impaired streams (TDEC 2005). The WSFR adjacent to STRI is classified as "Not Supporting" of fish and aquatic life, due primarily to excessive siltation. The stretch of Lytle Creek adjacent to Fortress Rosecrans is classifies as "Not Supporting" of fish and aquatic life and "Not Supporting" recreation, primarily due to siltation and habitat alteration.

Because; no inventories of the fishes in the Stones River system in the vicinity of STRI exist, this portion of the Stones River System is currently impaired, and Rutherford County and the city of Murfreesboro are currently growing at a rapid rate, it is becoming increasingly important to document the fish community inhabiting this portion of the Stones River system. The purpose of this two year study was to inventory the ichthyofauna of the fish supporting aquatic habitat on or adjacent to the Stones River National Battlefield with the specific goals of:

(A) Identifying species richness (to a 90% level),

(B) Describing the distribution of each species within a park,

(C) Determining abundance (particularly of sensitive species),

(D) Collecting voucher photographs for all species encountered,

(E) Recording habitat variables and mapping observation coordinates,

(F) Collecting and organizing data to be compatible with existing databases,

(G) Conducting representative sampling of common habitats and comprehensive coverage of specialized habitats,

(H) Identifying non-native fish species,

(I) Reviewing Existing NPS Database Records for accuracy

Methods:

Potential fish list

Prior to sampling, a list of potential fish species for the aquatic habitats at STRI was generated from the following sources: Tennessee Wildlife Resources Agency (TWRA) – the TWRA has records form a 1997 sample taken by electrofishing during August 1997 at McFadden's Ford and a site about sixteen kilometers upstream of McFadden's Ford (unfortunately the data from both sites are combined), Tennessee Division of Natural Heritage – they provided a list of state and federally listed species known to occur in the WFSR, Etnier and Starnes (1993) – this book contains the most comprehensive data base on distribution of fishes in Tennessee, all species with known occurrences in the WFSR were included on the potential fish list, McKee (1986) – this is a M.S. thesis from Middle Tennessee State University surveying the fish communities of the entire Stones River System, all fish species that were documented for the WFSR and its tributaries were included (none of McKee's sites were near STRI) and personal records of the principle investigator.

Overall approach

The overall approach of this survey was to sample each site (using methods appropriate to the site) once per season between October 2004 and September 2006. Sampling was conducted during the months of; October (2004, 2005), January (2005, 2006), May (2005, 2006) and August (2005, 2006) (see below for site specific exceptions to this

approach). During each sampling period, all captured fish were identified to species, counted and then released. The number of each species was recorded as either the actual count (if less than five individuals were captured, and during August of 2005, when actual counts were used to generate an Index of Biotic Integrity based on the fish community) or Common (if five or more individuals were captured). A voucher digital photograph was taken of each species captured over the course of this survey .

Sampling stations

McFadden's Ford – This site on The WFSR is 170 m long (Table 1) (Fig.1) beginning in a deep pool adjacent to the north boundary between the mowed lawn and forested section of the battlefield at the Artillery Monument and moving upstream to the deep pool underneath the bridge on Thompson Lane (Hwy 268). This stretch of river contains deep pools, shallow bedrock pools (along the east margin), riffles, and shallow runs. A small spring (Battlefield Spring) empties into the WFSR at about the midpoint of this section. The west shore contains large boulders for the majority of the length and the east shore contains gravelly banks and emergent vegetation. Pool habitats and run habitats (during periods of low flow) were sampled with a 10 m bag seine and all habitats were sampled with a backpack electrofisher after seining was complete. Since none of the fish captured from Battlefield Spring were unique to the spring, they are included on the McFadden's Ford site list.

King Pond – This pond is located near the Artillery Monument and consists of shallow water with thick organic rich sediments. Emergent vegetation is abundant along the shore line and submerged vegetation was abundant during October 2004, but was lacking at other times. King pond was sampled using large hand held dip nets and hoop nets (four net nights) in October 2004 and March 2006. It was too muddy for electrofishing or bag seining.

Redoubt Brannan - This site on The WFSR is 237 m long (Table 1) (Fig 1) beginning in a shallow riffle/run habitat underneath the bridge on West College Street and moving upstream to the confluence with a small unnamed stream on the east bank of

the river adjacent to the railroad tracks. With the exception of the riffle/run underneath the bridge, the entire habitat is wide deep bedrock run with boulders and root masses along the east side. Only about one half of the sample area actually borders STRI property (all deep run habitat), but the riffle/run was included in this survey because of its uniqueness to that stretch of the WFSR and its nearness to the property. The run habitat was sampled with a 10 m bag seine and the riffle/run and east shore were sampled with a backpack electrofisher. Due to the width of the river at this point and the fact that only the east shore borders on STRI property, only the east shore was sampled. Due to high water, this site was not sampled in January of 2005 or 2006 (it is significantly deeper than the other stream sample sites) but was sampled in March of both years after water levels decreased.

Unnamed pond at Redoubt Brannan – This small pond is situated in the floodplain adjacent to the river, and just outside the STRI boundary at Redoubt Brannan (Table 1). The pond is refreshed by winter flooding of the WFSR which re-supplies it with fish and oxygen. During the fall 2004, 2005 and summer 2005, 2006 the entire pond was anoxic and devoid of fish. The pond was sampled during March and May (2005 and 2006) using hoop nets and a backpack electrofisher (the pond is shallow enough, with a bedrock bottom to allow electrofishing).

Lytle Creek – This stretch of Lytle Creek near Fortress Rosecrans is 160 m long (Table 1) (Fig. 1) beginning in deep pool habitat where the stream widens out before joining the WFSR and moving upstream to a large deep pool contained by a small concrete dam. The habitat consists of deep pools, shallow bedrock pools on one margin, shallow bedrock runs, and riffles, with root masses and bedrock beaches along the margins. The downstream pool and bedrock runs were sampled with a 10 m bag seine and all habitats were sampled with a backpack electrofisher. The wide section of Lytle Creek downstream from this reach was also sampled with hoop nets (four net nights).

Richness determination

Species richness (the total number of species within an area) was estimated for WFSR at McFadden's Ford, WFSR at Redoubt Brannan, Lytle Creek and STRI as a whole. Species richness was not estimated for King Pond (only 2 species were captured in the pond) and the unnamed pond at Redoubt Brannan (since it derives its fish from the WSFR and all species captured in the pond were added to the species list for WSFR at Redoubt Brannan for those dates). Estimates were made using SPECRICH2 (http://www.mbr-pwrc.usgs.gov/software/comdyn.html) which estimates the total number of species from species presence-absence data on multiple occasions using the jackknife estimator for model M(h) from program *CAPTURE* (Rexstad and Burnham 1991).

Index of Biotic Integrity

During August 2005, an Index of Biotic Integrity based on the fish community was calculated for each riverine site at STRI following the procedures outlined in TDEC (1997). An IBI is generated from a quantitative sample of the local fish community and is used to develop a qualitative assessment of the overall health of the stream ecosystem at that point. Streams are scored on a scale ranging from "very poor" to "excellent" (Table 2). The score for a stream is determined by adding sub-scores on 12 individual metrics (see Table 6 in the results section for a list of individual metrics). For each metric, the fish community is given a sub-score of; 1-poor, 3-intermediate, or 5-the best to be expected. The criteria for each metric sub-score are provided in TDEC (1997).

Water Quality Parameters

Water samples were taken from each location at the end of sampling and analyzed for; temperature, pH, conductivity and dissolved oxygen. Temperature, pH and conductivity were measured on site with an Oakton combination pH/conductivity meter. Dissolved oxygen was measured using the Azide modification of the Winkler method (APHA 1975). The dissolved oxygen samples were chemically fixed on site and transported to the lab at MTSU for titration. At the three riverine sites the samples were taken at the most upstream portion of the site, and at the pond sites the samples were taken from the surface in the middle of the pond.

Physical habitat descriptions

The physical characteristics of the three riverine sites (McFadden's Ford, Redoubt Brannan and Lytle Creek) were measured during September 2006. The mean width was calculated from width measurements taken every 20 m along the length of the channel. The mean depth was calculated from depth measurements taken every 1/5 of width at each width measurement point. This approach was modified at the Redoubt Brannan site because it is significantly wider than the other riverine sites (greater than 30 m throughout it's length), and the west bank is inaccessible due to thick overhanging vegetation and deep (unwadable) water at several points. Width measurements were not taken at this site and depth measurements were taken in mid channel every 20 m along the length of the channel. Discharge (m^3/sec) was determined for each site by the method described in Gore (1996). The amount (total length) of each habitat type at each site was determined by direct measurement. Habitats were classified on the basis of; depth (deep, if the maximum depth was greater than 30 cm), dominate substrate (bedrock, boulder, cobble, etc…) and flow characteristics (pool, run or riffle). These measurements were made during summer low flow conditions for the purpose of comparing habitat heterogeneity between sites, however, the relative proportions of each habitat type will vary with discharge at each site and these results only reflect low flow conditions.

Results:

The survey of available fish records for the aquatic habitats of STRI indicated that a minimum of 60 species of fish (representing 10 orders and 14 families) potentially occur in and around STRI (Table 3). Of those 60 species, six species (roseyface shiner, bedrock shiner, southern cavefish, redband darter, smallscale darter and slenderhead darter) are classified as In Need of Management by the TWRA and two species (southern cavefish and smallscale darter) are classified as Management Concern by the United States Fish ands Wildlife Service (USFW). Additionally, six species (bigeye shiner, spotted sucker, slender madtom, rockbass (> 13 cm TL), fantail darter and speckled darter) are classified as Pollution Intolerant by TDEC (1997). This may be somewhat

misleading because only of few of the fishes in this area have been assayed for pollution tolerance, and the tolerance level of many of the fishes on this list is unknown.

A total of 46 species representing eight orders and 11 families were captured during the course of this survey (Table 4). Two species (gold fish, and black bullhead) were not included in the list of potential fishes (Table 3). This survey may be the first recorded occurrence of black bullhead in the WFSR even though this species is common in Nashville Basin streams (Etnier an Starnes 1993). The single goldfish specimen captured during this study was probably released from an aquarium or entered the system from flooding of a local landscape pond. This specimen was not released back into the WFSR. The WFSR at McFadden's Ford had the highest richness of the five sites with 41 species (Table 4 and Appendix A) compared to 33 species for the WFSR at Redoubt Brannan and 31 species for Lytle Creek at Fortress Rosecrans (Appendices B and C). Only two species of fish (westerm mosquitofish and green sunfish) were captured at King pond, while 14 species were captured in the unnamed pond at Redoubt Brannan (Table 4 and Appendix D).

The results from the SPECRICH2 Species Richness estimates indicate that this survey was successful at identifying fish species richness at the 90% level (Table 5). Observed species richness ranged from 89 to 100% of estimated species richness (depending on site). However, those numbers decrease to 80 to 92% efficiency if the standard errors (reported in Table 5) are added to the richness estimate. The 46 species recorded in this survey represents about 73% of the species listed as potentially occurring in the WFSR at STRI (Table 3).

Analysis of habitat quality using an Index of Biotic Integrity (based on the fish community) indicates that both WFSR at McFadden's Ford and Lytle Creek are "Fair" to "Good" quality riverine habitats, while the WFSR at Redoubt Brannan is a "Fair" quality riverine habitat (Table 6). The lowest metric score for all three sites was for the number of pollution intolerant species present at the time of sampling. While the Redoubt

Brannan site also scored low for the number of sucker species present at the time of sampling.

Temperature and dissolved oxygen concentrations at the three riverine sites varied predictably with season (Table 7). Temperatures were highest during summer sampling and lowest during winter sampling while dissolved oxygen concentrations showed the opposite pattern. The unnamed pond at Redoubt Brannan was anoxic (and fishless) during summer and fall sampling but contained oxygen (and fish) during March and May sampling of both years. Dissolved Oxygen data is missing for 3/20/05 (when the D.O. bottles were broken on site) and 10/15/05 (when the water quality equipment was not available). However, on 3/20/05, fish were present and abundant in the pond (indicating presence of sufficient oxygen) and on 10/15/05 the pond was completely covered with a mat of dead duckweed (*Lemna minor*) and gave off a sulfurous odor when disturbed (indicating anaerobic conditions). King pond data are not included in Table 7 because fish sampling was limited to three occasions (only two species were found in the pond). However, dissolved oxygen concentrations and conductivity varied significantly across sampling dates. On 10/6/04 the temperature was 29^{o}C, the pH was 8.23, conductivity was 288uS and D.O. was 17.88 mg/l (the pond was full of submerged aquatic vegetation at this time and the water was supersaturated with oxygen). On 8/2/06 the temperature was 27^{o}C, the pH was 7.35, conductivity was 434uS and D.O. was 2.40mg/l (the pond was devoid of aquatic vegetation at this time and the sediments were anaerobic (emitting H_2S bubbles when disturbed).

There were nine discernable habitat types at both the McFadden's Ford and Lytle Creek sites, while there were only three at the Redoubt Brannan site during low flow conditions in September 2006 (Table 8). The McFadden's Ford site was physically more diverse with no habitat type making up more than 17 % of the site while the Redoubt Brannon site was dominated by deep bedrock run habitat (74 %) and the Lytle Creek site was dominated by shallow bedrock run habitat (41 %).

Discussion:

The 46 fish species captured over the course of this survey account for about 73 % of the species identified as potentially occurring in the fish supporting aquatic habitats in and around STRI (tables 3 and 4). In addition, two species (goldfish and black bullhead) were captured that were not on the list of potential species. Species richness estimates indicate that this survey identified about 90 % of the STRI ichthyofauna. It is likely that this survey missed some of the 16 species from the potential species list that were not encountered. Two of the large mobile species from that list (mooneye and white bass) are common in Percy Priest Reservoir and migrate into medium to large rivers to spawn during the spring (Etnier and Starnes 1993). Both of these have been captured recently in the East Fork of the Stones River below the Walter Hill dam (pers. obs) and probably move into the WFSR as well. Two other two large mobile species from that list (channel catfish and flathead catfish) are common in medium to large rivers and are common in the inner Nashville Basin (Etnier and Starnes1993). Although neither of these species were captured in the course of this survey, the head of a large catfish was observed hooked to an old set line hanging in the water from a tree at Redoubt Brannan during the August 2006 sample period. The fishes body had been eaten by scavengers (most likely turtles) making it unidentifiable to species, but it was probably one of these two species of catfish. Creek chubsuckers are common in upstream reaches of Lytle Creek (pers. obs.) and prefer headwater areas of clear streams (Page and Burr 1991), so it is not surprising that they were not found in the lower reaches of Lytle Creek and the WFSR.

It is also not surprising that southern cavefish were not captured during this study. The southern cavefish is present in a subterranean stream in the Snail Shell Cave system which is connected to the subterranean water at Rebel Yell Cave on STRI (Allen Ogden, MTSU Dept of Geosciences – pers. comm.), and therefore might occur in subterranean waters below STRI. However, this species rarely occurs in surface streams (typically, only after flooding of the subterranean streams) and, due to lack of functional eyes, probably have limited survival in those streams.

The 10 remaining species on the potential fish list (streamline chub, Tennessee shiner, rosyface shiner, bedrock shiner, mimic shiner, stonecat, brindled madtom, redband darter, smallscale darter and slenderhead darter) that were not detected in this survey may also be present in the WFSR system in the vicinity of STRI, but just not at any of the sample reaches on the sample dates. In fact, bedrock shiners were captured just upstream of the McFadden's Ford site (in a reach of the WFSR that is not on STRI property) by the MTSU Ichthyology class during fall 2004 (George Benz, MTSU Dept. of Biology – pers. comm.). Since bedrock shiner are listed as "Wildlife in Need of Management" by the TWRA, that area was seined twice during the course of this survey in an effort to document the presence of this species, however, none were found. Additionally, new species were added to the cumulative catch list of at least one of the sample sites during every sample period (including the last - the first record of speckled darters at McFadden's Ford was in August 2006 and the first record of slender madtom in the entire system was in May 2006) indicating that not all species in the area have been detected.

The WFSR at McFadden's Ford had the highest species richness of the three riverine sites (Table 4). This is probably a function of both the size of the stream and the diversity of habitats available at this site. The richness of stream fish communities is positively correlated to stream size (Angermeier and Schlosser 1989, and Angermeier and Winston 1998) and habitat diversity (Gorman and Karr 1978). Even though the Redoubt Brannan site is wider and deeper than the McFadden's Ford site (Table 1), The McFadden's Ford site has much higher habitat diversity than the Redoubt Brannan site (Table 8) which is dominated (74 %) by deep bedrock run habitat. The McFadden's Ford site is wider and deeper than the Lytle Creek site with about three times the discharge (Table 1). Even though both sites had nine identifiable habitat types during low flow (Table 8), the Lytle Creek site was dominated by shallow bedrock run habitat (41%) while the McFadden's Ford site had a more even distribution of habitat types, with no habitat type making up more than 17 % of the reach. In addition, stream fish community richness is also positively correlated with habitat complexity (Downes et al. 1998 and Willis et al. 2005). Both the Redoubt Brannan and the Lytle Creek sites were dominated by bedrock bottom habitats (total bedrock bottom habitat at Lytle Creek made up 65% of

the reach), which is structurally less complex than the mixed gravel/pebble/cobble/boulder substrates that composed 83 % of the reach at McFadden's Ford.

All three riverine sites exhibited pH and dissolved oxygen levels within the physiologically tolerable range of most warm water fishes (Table 7). The lowest dissolved oxygen concentration was 6.2 mg/l which was recorded twice from Redoubt Brannan. Dissolved Oxygen levels are typically enhanced by water cascading through riffles (causing saturation or even supersaturation) which are present at the upstream ends of both McFadden's Ford and Lytle Creek, but not at Redoubt Brannan (the one riffle/run section at Redoubt Brannan is at the downstream end of the reach, below the water quality sampling location and therefore, would not affect the dissolved oxygen levels in most of the reach). The ranges of pH, dissolved oxygen and conductivity recorded in this survey were consistent with the ranges of these parameters reported by Meiman (2005) for the same sites.

Only two fish species were detected in King Pond (Table 4). Both those species (western mosquitofish and green sunfish) are known to be tolerant of physiologically stressful environments (especially associated with low dissolved oxygen concentrations) (Etnier and Starnes 1993), which may explain their presence in this pond. The dissolved oxygen concentration of 2.4 mg/l recorded in August 2006 is consistent with the findings of Meiman (2005) for this pond during periods of low water. The presence of fish in this pond (especially during August and October sampling) indicates that the pond does not become anaerobic over the course of the summer, however these low concentrations indicate that this pond has limited capacity to support fish species that are not tolerant of low dissolved oxygen concentrations. Although these oxygen levels are above the minimum tolerable dissolved oxygen levels of bluegill sunfish, largemouth bass and channel catfish (about 1 mg/l), these species experience reduced growth and reproduction due to physiological stress at these low oxygen levels (Moss and Scott 1961).

The unnamed pond at Redoubt Brannan supported fairly rich fish communities during the March (due to winter flooding, it was not possible to sample this site in either January or February 2005 and 2006) and May sampling periods of both years (Table 4). However, the pond was devoid of fish (and oxygen) during the August and October sampling periods. The pond sits within the WFSR flood plain and is recharged with fish when the WFSR exceeds its banks (carp were observed moving between the pond and the river during one of the flood events). Because the fish appear to be trapped in the pond after the flood waters subside (the pond was wadded intensively over the course of this survey and there is no apparent subterranean connection between the pond and the river that would allow escape) and the pond becomes anaerobic during the summer months, the pond probably does not serve as an important resource for the WFSR fish community.

The Index of Biotic Integrity calculated for August 2005 for each of the riverine sites indicates that the system is moderately healthy. Both McFadden's Ford and Lytle Creek scored between the "Fair" and "Good" categories while Redoubt Brannan scored at the top of the "Fair" category (Table 6). All three sites scored lowest on the "Number of intolerant species" metric. Interestingly, all six of the species identified in Table 3 as pollution intolerant were captured over the course of this study and three of them (bigeye shiner, spotted sucker, and large rockbass) were quite common at one or more of the sites on more than one occasion (Appendices A, B, and C). Bigeye shiners were abundant at McFadden's Ford and Lytle Creek during IBI sampling and rockbass were present at McFadden's Ford and Redoubt Brannan. The other three pollution intolerant species (slender madtom, fantail darter, and speckled darter) were rare within the WFSR system. Only two slender madtoms were captured (both at Lytle Creek), only eight fantail darters were captured (seven at Redoubt Brannan and one at McFaddden's Ford) and only four speckled darters were captured (two at Redoubt Brannan, and one each at McFadden's Ford and Lytle Creek). These three species are all small benthic oriented fishes that use riffle habitats and require clean substrates for spawning (Etnier and Starnes 1993). Siltation is cited as the major factor for inclusion of the WFSR and Lytle Creek in Tennessee's 2004 303d list of impaired streams (TDEC 2005) and may help to explain the low numbers of these three species (and banded sculpin which have similar habitat

requirements). However, more fantail darters and speckled darters were captured at Redoubt Brannan than the other two riverine sites, even though that site has limited riffle habitat, and, during low flow periods, that riffle was more of a slow run habitat with heavy siltation (pers. obs.) while the other sites possessed clean riffle habitat even during the same low flow periods. The Redoubt Brannan site also scored low on the "Number of sucker species" metric. Northern hogsuckers, golden redhorse and spotted suckers were all captured on multiple occasions at Redoubt Brannan over the course of the survey (Appendix B), but not on the day of IBI sampling.

Conclusions:

The WFSR system in the vicinity of STRI appears to have a relatively rich fish community. This survey documented 46 species of fish making up about 73% of the species potentially occurring within the system, and, according to richness estimates, may have missed up to 10% of the species actually occurring in the system. Since this survey was limited to a total of about 567 meters of stream habitat (all three sites added together) and there are about 4,700 meters of stream habitat between the upstream portion of the Lytle Creek site at Fortress Rosecrans and the downstream end of the WFSR section on STRI property at the Artillery Monument, it is likely that this survey underestimates the actual richness of the WFSR system in the vicinity of STRI. Despite this richness, there are indications that the WFSR in this area is experiencing some form of environmental stress. The apparent low densities (as indicated by few captures) of benthic oriented pollution intolerant species (slender madtom, fantail darter, and speckled darter) as well as banded sculpin (which is abundant in other streams in the Nashville Basin – pers. obs.) is consistent with the TDEC (2005) assessment that this system is stressed by excessive siltation. Although STRI has little or no impact on land management practices occurring upstream of this area of the WFSR system, maintenance of the riparian zones around Lytle Creek at Fortress Rosecrans and the WFSR at McFadden's Ford and Redoubt Brannan along with efforts by the City of Murfreesboro to maintain the riparian habitat along the rest of the WFSR and Lytle Creek (in conjunction with the Stones River Greenway) should help to limit the extent of siltation occurring in this area.

Literature Cited:

Angermeier P.L. and M.R. Winston. 1998. Local vs. regional influences on local diversity in stream fish communities of Virginia. Ecology, 79(3), 911-927.

Angermeier P.L. and I.J. Schlosser. 1989. Species-area relationships in stream fishes. Ecology, 70, 1450–1462

APHA. 1975. Standard Methods for the Examination of Water and Wastewater, 14th ed. pp. 1193.

Arnwine, D.H., J.I. Broach, L.K. Cartwright, G.M. Denton. 2000. Tennessee Ecoregion Project 1994 – 1999. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Unpublished report, Nashville TN.

Downes, B.J., P.S. Lake, E.S.G. Schreiber, and A. Glaister. 1998. Habitat structure and regulation of local species diversity in a stony, upland stream. Ecological Monographs: 68 (2), 237-257.

Etnier, D.A. and W.C. Starnes. 1993. The Fishes of Tennessee. University of Tennessee Press, Knoxville. 681 pp.

Gore, J.A. 1996. Discharge measurements and streamflow analysis. In Methods in Stream Ecology. F.Hauer and G.A. Lamberti eds. Academic Press. Boston. 674 pp.

Gorman, O.T. and J. R. Karr. 1978 . Habitat Structure and Stream Fish Communities. Ecology, 59(3), 507–515.

Karr, J. R., K. D. Fausch, P. L. Angermier, P. R. Yant, and I. J. Schlosser. 1986. Assessing biological integrity in running waters, a method and its rationale. Illinois Natural History Survey. Special Publication 5. 28 pp.

McKee, D.M. 1986. Survey of the Fishes of theUpper Stones River, Tennessee. M.S. Thesis, Middle Tennessee State University. 102 pp.

Meiman, J. 2005. Cumberland Piedmont Network Water Quality Report, Stones River National Battlefield. Unpublished report, Mammoth Cave National Park, KY.

Moss, D.D. and D.C. Scott. 1961. Dissolved-oxygen requirements of three species of fish. Transactions of the American Fisheries Society, 90(4), 377-393.

Page, L. M. and B.M. Burr. 1991. A field guide to freshwater fishes: North America north of Mexico. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.

Rexstad, E., and K.P. Burnham. 1991. User's Guide for Interactive Program CAPTURE. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Fort Collins, Colorado.

Tennessee Department of Environment and Conservation. 1997. Biological Standard Operating Procedures Manual: Volume II: Fish Communities. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville TN.

Tennessee Department of Environment and Conservation. 2005. Year 2004 303(d) list. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Unpublished report, Nashville TN. (http://state.tn.us/environment/wpc/publications/2004303dListFinal.pdf).

Willis, S.C., K.O. Winemiller, and H. Lopez-Fernandez. 2005. Habitat structure and morphological diversity of fish assemblages in a neotropical floodplain river. Oecologia, 142(2), 284-295.

Table1: Location and physical characteristics (during September 2006, and only for the riverine sites) of sample sites for the STRI fish inventory.

Site	UTM Coordinates	Length (m)	Mean Depth (m)	Mean width (m)	Discharge (m^3/sec)
McFadden Ford	Zone 16 551898E 3971856N	170	0.31	13.1	0.38
King Pond	Zone 16 551809E 3971302N				
Redoubt Brannan	Zone 16 553214E 3968544N	237	0.64	> 30	0.38
Unnamed pond	Zone 16 553214E 3968435N				
Lytle Creek	Zone 16 553252E 3967912N	160	0.19	10.1	0.13

Table 2: Biotic Integrity classes used in assessing fish communities along with general descriptions of their attributes (Karr et al. 1986).

Class	Attributes	IBI Range
Excellent	Comparable to the best situations without influence of man; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with full array of age and sex classes; balanced trophic structure.	58-60
Good	Species richness somewhat below expectation, especially due to loss of most intolerant forms; some species with less than optimal abundances or size distribution; trophic structure shows some signs of stress.	48-52
Fair	Signs of additional deterioration include fewer intolerant forms, more skewed trophic structure (e.g., increasing frequency of omnivores); older age classes of top predators may be rare.	40-44
Poor	Dominated by omnivores, pollution-tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.	28-34
Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.	12-22
No fish	Repetitive sampling fails to turn up any fish.	

Table 3: List of fishes potentially occurring in aquatic habitats in and around Stones River National Battlefield.

Order	Family	Scientific name	Common Name	State Status	Federal Status	Source
Lepisosteiformes	Lepisosteidae	*Lepisosteus osseus* (Linnaeus)	longnose gar			1,5
Osteoglossiformes	Hiodontidae	*Hiodon tergisus* (Lesueur)	mooneye			2
Clupeiformes	Clupeidae	*Dorosoma cepedianum* (Rafinesque)	gizzard shad			1,2,3
Cypriniformes	Cyprinidae	*Campostoma anomalum* (Rafinesque)	central stone roller			1,2,3,5
		Cyprinella galactura (Cope)	whitetail shiner			1,2,3,5
		Cyprinella spiloptera (Cope)	spotfin shiner			1,2,3
		Cyprinella whipplei (Girard)	steelcolor shiner			1
		Cyprinus carpio (Linnaeus)	carp			1,2,5
		Erimystax dissimilis (Kirtland)	Streamline chub			1
		Erimystax insignis (Hubbs and Crowe)	blotched chub			1,2
		Hybopsis amblops (Rafinesque)	bigeye chub			1
		Luxilus chrysocephalus (Rafinesque)	striped shiner			1,2,3,5
		Lythrurus ardens (Cope)	rosefin shiner			1,3,5
		Nocomis effusus (Lachner and Jenkins)	redtail chub			1,2
		Notropis boops[*] (Gilbert)	bigeye shiner			1,2,3,5
		Notropis leuciodus (Cope)	Tennessee shiner			5
		Notropis rubellus (Agassiz)	rosyface shiner	WNM		1,3
		Notropis rupestris (Page)	bedrock shiner	WNM		1,2,3,4
		Notropis volucellus (Cope)	Mimic shinner			3
		Pimephales notatus (Rafinesque)	bluntnose minnow			1,2,5
	Catastomidae	*Erimyzon oblongus* (Mitchill)	creek chubsucker			1,2
		Hypentelium nigricans (Lesueur)	northern hogsucker			1,2,3,5
		Minytrema melanops[*] (Rafinesque)	spotted sucker			1,2,3,5
		Moxostoma erythrurum (Rafinesque)	golden redhorse			1,3,5
Siluriformes	Ictaluridae	*Ameiurus natalis* (Lesueur)	yellow bullhead			3,5
		Ictalurus punctatus (Rafinesque)	channel catfish			1,3,5

Table 3: Continued

Order	Family	Scientific name	Common Name	State Status	Federal Status	Source
		Noturus exilis[*] (Nelson)	slender madtom			1
		Noturus flavus (Rafinesque)	stonecat			1,3
		Noturus miurus (Jordan)	brindled madtom			1
		Pylodictus olivaris (Rafinesque)	Flathead catfish			5
Aphredoderiformes	Amblyopsidae	*Typhlichthys subterraneus* (Girard)	southern cavefish	WNM	MC	1
Cyprinodontiformes	Cyprinodontidae	*Fundulus catenatus* (Storer)	northern studfish			1,3
		Fundulus notatus (Rafinesque)	blackstripe topminnow			1,3
	Poeciliidae	*Gambusia affinis* (Baird and Girard)	mosquitofish			1,3
Atheriniformes	Atherinidae	*Labidesthes sicculus* (Cope)	brook silverside			1,3,5
Scorpaeniformes	Cottidae	*Cottus carolinae* (Gill)	banded sculpin			1,2,3
Perciformes	Moronidae	*Morone chrysops* (Rafinesque)	white bass			3
	Centrarchidae	*Ambloplites rupestris*[*] (Rafinesque)	rock bass			1,2,3,5
		Lepomis cyanellus (Rafinesque)	green sunfish			1,2,3,5
		Lepomis gulosus (Cuvier)	warmouth			1
		Lepomis macrochirus (Rafinesque)	bluegill			1,3,5
		Lepomis megalotis (Rafinesque)	longear sunfish			1,2,3,5
		Lepomis microlophus (Guenther)	redear sunfish			1,5
		Micropterus dolomieu (Lacepede)	smallmouth bass			1,3,5
		Micropterus punctulatus (Rafinesque)	spotted bass			1,3,5
		Micropterus salmoides (Lacepede)	largemouth bass			1,3,5
		Pomoxis annularis (Rafinesque)	white crappie			3
		Pomoxis nigromaculatus (Lesueur)	black crappie			3
	Percidae	*Etheostoma blenniodes* (Rafinesque)	greenside darter			1,2,3,5
		Etheostoma caeruleum (Storer)	rainbow darter			1,2,3,5
		Etheostoma crossopterum (Braasch and Mayden)	fringed darter			1,2,3
		Etheostoma flabellare[*] (Rafinesque)	fantail darter			1,2,3,5

Table 3: Cont.

Order	Family	Scientific name	Common Name	State Status	Federal Status	Source
		Etheostoma luteovinctum (Gilbert and Swain)	redband darter	WNM		3
		Etheostoma microlepidum (Raney and Zorach)	smallscale darter	WNM	MC	1,4
		Etheostoma rufilineatum (Cope)	redline darter			1,2,3,5
		Etheostoma simoterum (Cope)	Tennessee snubnose darter			1,2,3,5
		Etheostoma stigmaeum * (Jordan)	speckled darter			1,3
		Etheostoma virgatum (Jordan)	Striped darter			1,2,3
		Percina caprodes (Rafinesque)	logperch			1,2,3,5
		Percina phoxocephala (Nelson)	Slenderhead darter	WNM		4

1 = Etnier and Starnes (1993)
2 = Unpublished personal observations
3 = Mckee (1986)
4 = Tennessee Division of Natural Heritage
5 = Tennessee Wildlife Resources Agency
WNM = Wildlife in Need of Management as designated by TWRA
MC = Management Concern as designated by USFW
* Classified as Pollution Intolerant by TDEC 1997.

Table 4: Fish species list (by site) of aquatic habitats at STRI (October 2004 – August 2006). MF = McFadden's Ford, KP = King Pond, RB = Redoubt Brannan, UP = Unnamed Pond at Redoubt Brannan, LC = Lytle Creek at Fortress Rosecrans.

Scientific name	Common Name	MF	KP	RB	UP	LC
Lepisosteus osseus	longnose gar	X		X		
Dorosoma cepedianum	gizzard shad				X	X
Campostoma anomalum	central stone roller	X		X		X
Carassius auratus	goldfish	X				
Cyprinella galactura	whitetail shiner	X		X		
Cyprinella spiloptera	spotfin shiner	X		X		
Cyprinella whipplei	steelcolor shiner	X				
Cyprinus carpio	carp	X		X	X	
Erimystax insignis	blotched chub	X				
Hybopsis amblops	bigeye chub	X		X		X
Luxilus chrysocephalus	striped shiner	X				X
Lythrurus ardens	rosefin shiner	X		X		X
Nocomis effusus	redtail chub	X				
Notropis boops	bigeye shiner	X		X		X
Pimephales notatus	bluntnose minnow	X		X	X	X
Hypentelium nigricans	northern hogsucker	X		X		X
Minytrema melanops	spotted sucker	X		X	X	X
Moxostoma erythrurum	golden redhorse	X		X	X	X
Ameiurus natalis	yellow bullhead	X				X
Ameiurus melas	Black bullhead	X				X
Noturus exilis	slender madtom					X
Fundulus catenatus	northern studfish					X
Fundulus notatus	blackstripe topminnow	X		X		
Gambusia affinis	western mosquitofish	X	X	X		X
Labidesthes sicculus	brook silverside	X		X		
Cottus carolinae	banded sculpin	X				X
Ambloplites rupestris	rock bass	X		X	X	
Lepomis cyanellus	green sunfish	X	X	X	X	X
Lepomis gulosus	warmouth	X		X	X	X
Lepomis macrochirus	bluegill	X		X	X	X
Lepomis megalotis	longear sunfish	X		X	X	X
Lepomis microlophus	redear sunfish	X		X	X	X
Micropterus dolomieu	smallmouth bass	X		X		
Micropterus punctulatus	spotted bass	X		X		X
Micropterus salmoides	largemouth bass	X		X	X	X
Pomoxis annularis	white crappie				X	
Pomoxis nigromaculatus	black crappie				X	X
Etheostoma blenniodes	greenside darter	X		X		X
Etheostoma caeruleum	rainbow darter	X		X		X
Etheostoma crossopterum	fringed darter	X		X		X

Table 4 Cont.

Scientific name	Common Name	MF	KP	RB	UP	LC
Etheostoma flabellare	fantail darter	X		X		
Etheostoma rufilineatum	redline darter	X		X		X
Etheostoma simoterum	Tennessee snubnose darter	X		X		X
Etheostoma stigmaeum	speckled darter	X		X		X
Etheostoma virgatum	Striped darter	X		X		X
Percina caprodes	logperch	X		X		
	Total number of species	41	2	33	14	31

Table 5: Fish Species Richness estimates for the 3 riverine reaches of STRI and a composite estimate for STRI as a whole.

Reach	Observed Richness (O)	Estimated Richness (E) plus 1 SE	Percentage O/E x 100
McFadden Ford	41	43 + 3.52	95 %
Redoubt Brannan	33	37 + 4.2	89%
Lytle Creek	31	31 + 2.67	100 %
STRI composite	46	51 + 2.3	90%

Table 6: Index of Biotic Integrity (IBI) scores for three stream reaches at Stones River National Battlefield during August 2005.

	Site					
	McFadden Ford		Redoubt Brannan		Lytle Creek	
Metric	Value	Score	Value	Score	Value	Score
Number of native species*	25	3	17	3	23	3
Number of darter species*	6	3	5	3	6	5
Number of sunfish species*	5	5	5	5	4	3
Number of sucker species*	2	3	0	1	2	5
Number on intolerant species*	2	1	1	1	1	1
Percentage of fish as tolerant species	2	5	<1	5	10	3
Percentage of fish as omnivores	5	5	17	3	23	3
Percentage of fish as specialized insectivores	40	3	31	3	36	3
Percentage of fish as piscivores	2	3	9	5	5.5	5
Catch rate	121	5	46	5	88	5
Percentage of fish as hybrids	0	5	0	5	0	5
Percentage of fish as with anomalies	0	5	0	5	<2	5
Total IBI Score		46		44		46
IBI Rating	Fair to Good		Fair		Fair to Good	

* Scoring criteria varies with catchment area.

Table 7: Temperature and water chemistry of four of the STRI sample sites for each sampling date

West Fork of the Stones River at the McFadden Ford								
Date	10/2/04	2/12/05	5/18/05	8/18/05	10/11/05	1/5/06	5/9/06	8/15/06
Temperature (0C)	19	9	22	28	19	10	19	27
Dissolved Oxygen (mg/l)	8.2	12.3	8.0	7.0	8.0	10.4	7.8	6.4
Specific Conductance (uS)	451	710	522	518	794	488	584	420
pH	8.05	8.07	8.00	7.50	7.74	8.27	7.94	7.68
West Fork of the Stones River at Redoubt Brannan								
Date	10/10/04	3/20/05	5/11/05	8/24/05	10/15/05*	3/19/06	5/16/06	8/29/06
Temperature (0C)	19	13	22	27	-	12	17	27
Dissolved Oxygen (mg/l)	6.2	-	6.2	6.6	-	9.6	7.8	6.6
Specific Conductance (uS)	486	832	466	636	-	616	539	412
pH	7.67	7.70	7.90	7.43	-	7.50	7.73	7.65
Unnamed Pond at Redoubt Brannan**								
Date	10/10/04	3/20/05	5/11/05	8/24/05	10/15/05*	3/19/06	5/16/06	8/29/06
Temperature (0C)	-	13	24	-	-	12	17	27
Dissolved Oxygen (mg/l)	0	-	2.8	0	0	5.4	1.0	0
Specific Conductance (uS)	-	574	574	-	-	607	600	365
pH	-	8.02	7.48	-	-	7.48	7.52	7.04
Lytle Creek at Fortress Rosecrans								
Date	10/24/04	1/22/05	5/9/05	8/16/05	10/18/05	1/11/06	5/11/06	8/1/06
Temperature (0C)	19	10	18	26	17	11	17	25
Dissolved Oxygen (mg/l)	7.8	9.8	8.4	7.0	8.0	9.6	8.2	7.6
Specific Conductance (uS)	636	712	562	873	635	494	595	594
pH	7.84	7.85	7.70	7.68	7.98	7.82	7.76	7.88

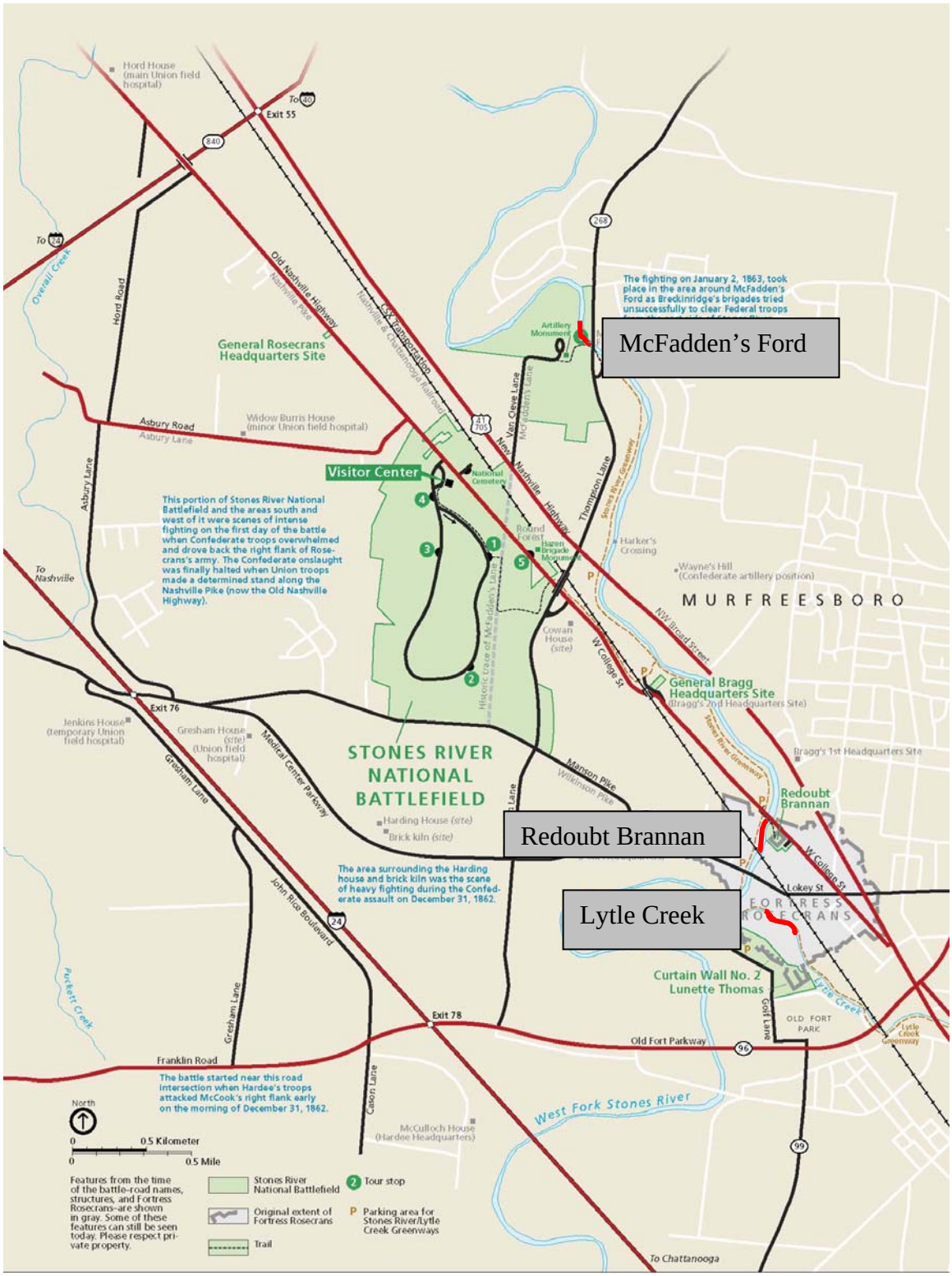
* Water quality sampling equipment was not available on this date

** pH, conductivity and temperature were only recorded on days when the pond contained oxygen and fish.

Table 8 : Total length estimates of specific habitat types at each riverine sample site. Habitats were classified as "Deep" if the maximum depth exceeded 30 cm. Since pool habitats occurring along the margin of the stream channel were included in the measurements, the total length of all habitats combined for each site may exceed the total length for each sample site recorded in Table 1.

Site	Habitat type	Total length	% of Site
McFadden's Ford	Deep Gravel/Pebble Pool	36.5 m	17%
	Deep Cobble/Boulder Pool	12.5 m	6%
	Shallow Bedrock Pool	19.5 m	9%
	Deep Pebble/Cobble Run	35.5 m	17%
	Deep Bedrock Run	16 m	8%
	Shallow Gravel/Pebble Run	15 m	7%
	Shallow Pebble Cobble Run	19 m	9%
	Shallow Cobble/Boulder Run	32 m	15%
	Cobble/Boulder Riffle	25 m	12%
Redoubt Brannan	Deep Bedrock Run	175 m	74%
	Deep Cobble/Boulder Run	37 m	16%
	Shallow Cobble/Boulder Run	25 m	10%
Lytle Creek	Deep Bedrock Pool	27.5 m	14%
	Shallow Bedrock Pool	15.5 m	8%
	Shallow Gravel/Pebble Pool	19 m	10%
	Deep Gravel/Pebble Pool	11.5 m	6%
	Deep Bedrock Run	4.5 m	2%
	Shallow Bedrock Run	80 m	41%
	Shallow Gravel/Pebble Run	3.5 m	2%
	Pebble/Cobble Riffle	28.5 m	15%
	Cobble/Boulder Riffle	4 m	2%

Figure 1: Map of Stones River National Battlefield showing the three riverine sample sites (in red) used in the fish survey (West Fork of the Stones River at McFadden's Ford, West Fork of the Stones River at Redoubt Brannan and Lytle Creek at Fortress Rosecrans).



Appendix A: West Fork of the Stones River at McFadden's Ford fish list. If more than 5 individuals of a species were captured, it was listed as Common (C), otherwise the actual number captured is given. On 8/18/05, all individuals captured of each species were counted. Those numbers are given.

Order	Family	Scientific name	Common Name	10/6/04	2/12/05	5/18/05	8/18/05	10/11/05	1/5/06	5/9/06	8/15/06
Lepisosteiformes	Lepisosteidae	*Lepisosteus osseus*	longnose gar			1				3	4
Cypriniformes	Cyprinidae	*Campostoma anomalum*	central stone roller	C	C	C	9	C	C	C	C
		Carassius auratus	gold fish	1							
		Cyprinella galactura	whitetail shiner	C	1	C	112	C	C	C	C
		Cyprinella spiloptera	spotfin shiner	C		C	28	C	C	C	C
		Cyprinella whipplei	steelcolor shiner				12	C			3
		Cyprinus carpio	carp			1				C	
		Erimystax insignis	blotched chub	2							
		Hybopsis amblops	bigeye chub	1		1	4	C	1	C	C
		Luxilus chrysocephalus	striped shiner	C		C	5	C	C	C	C
		Lythrurus ardens	rosefin shiner	C		1	14	C	C	C	
		Nocomis effusus	redtail chub		1						
		Notropis boops	big eye shiner	C	C	C	13	C	C	C	C
		Pimephales notatus	bluntnose minnow	C	C	C	28	C	C	C	C
	Catastomidae	*Hypentelium nigricans*	northern hogsucker	C	C		1	C	C	2	C
		Minytrema melanops	spotted sucker					1	3	1	1
		Moxostoma erythrurum	golden redhorse	C		C	3	C		C	C
Siluriformes	Ictaluridae	*Ameiurus natalis*	yellow bullhead	C	1			4		2	1
		Ameiurus melas	Black bullhead					1		1	
Cyprinodontiformes	Cyprinodontidae	*Fundulus notatus*	blackstripe topminnow						1	1	
	Poeciliidae	*Gambusia affinis*	mosquitofish	1	1		4	C	3	C	1
Atheriniformes	Atherinidae	*Labidesthes sicculus*	brook silverside			C	100	C	C	C	1
Scorpaeniformes	Cottidae	*Cottus carolinae*	banded sculpin	1					1		2
Perciformes	Centrarchidae	*Ambloplites rupestris*	rock bass	C	1	C	4	C	2	C	C

Appendix A cont:

Order	Family	Scientific name	Common Name	10/6/04	2/12/05	5/18/05	8/18/05	10/11/05	1/5/06	5/9/06	8/15/06
		Lepomis cyanellus	green sunfish	1		C	5	C	2	3	C
		Lepomis gulosus	warmouth	1		1			1	2	1
		Lepomis macrochirus	bluegill	C	C	C	4	C	C	C	C
		Lepomis megalotis	longear sunfish	C	C	C	30	C	C	C	C
		Lepomis microlophus	redear sunfish			1	4			C	C
		Micropterus dolomieu	smallmouth bass					3			
		Micropterus punctulatus	spotted bass	1	2	1	4	4		1	
		Micropterus salmoides	largemouth bass	3		1		1		2	C
	Percidae	*Etheostoma blenniodes*	greenside darter	C	C	C	31	C	C	C	C
		Etheostoma caeruleum	rainbow darter	C	2	C	1	C	C	C	C
		Etheostoma crossopterum	fringed darter	C	C	C	13	C	3	C	3
		Etheostoma flabellare	fantail darter							1	
		Etheostoma rufilineatum	redline darter	C	C	C	149	C	C	C	C
		Etheostoma simoterum	Tennessee snubnose darter	C	C	3	19	C	C	C	C
		Etheostoma stigmaeum	speckled darter								1
		Etheostoma virgatum	Striped darter	2	C	C	6	C	C	C	2
		Percina caprodes	logperch	1	2				1		
		Total number of species captured		29	19	26	25	29	26	33	30

Appendix B: West Fork of the Stones River at Redoubt Brannan fish list. If more than 5 individuals of a species were captured, it was listed as Common (C), otherwise the actual number captured is given. On 8/24/05, all individuals captured of each species were counted. Those numbers are given.

Order	Family	Scientific name	Common Name	10/10/04	3/20/05	5/11/05	8/24/05	10/25/05	3/19/06	6/16/06	8/29/06
Lepisosteiformes	Lepisosteidae	*Lepisosteus osseus*	longnose gar							1	
Cypriniformes	Cyprinidae	*Campostoma anomalum*	central stone roller					1			
		Cyprinella galactura	whitetail shiner							C	
		Cyprinella spiloptera	spotfin shiner				5	C		1	C
		Cyprinus carpio	carp	C	C						1
		Hybopsis amblops	bigeye chub	1			4	C			C
		Lythrurus ardens	rosefin shiner	1			30	C			C
		Notropis boops	big eye shiner		3			C		C	
		Pimephales notatus	bluntnose minnow	C	3		24	C	C	C	C
	Catastomidae	*Hypentelium nigricans*	northern hogsucker		2	1		2	1	2	
		Minytrema melanops	spotted sucker		4			1			
		Moxostoma erythrurum	golden redhorse			1				3	3
Cyprinodontiformes	Cyprinodontidae	*Fundulus notatus*	blackstripe topminnow					1			
	Poeciliidae	*Gambusia affinis*	mosquitofish		2			1			
Atheriniformes	Atherinidae	*Labidesthes sicculus*	brook silverside	C		3	38	C		C	C
Perciformes	Centrarchidae	*Ambloplites rupestris*	rock bass			C	1			C	1
		Lepomis cyanellus	green sunfish	C	3	C				C	
		Lepomis gulosus	warmouth	C	3	C	2	C	C	C	
		Lepomis macrochirus	bluegill	C	C		6	C	C	C	C
		Lepomis megalotis	longear sunfish	C	C	C	3	C	C	C	2
		Lepomis microlophus	redear sunfish	3	2		2	2		C	2
		Micropterus dolomieu	smallmouth bass				4				3
		Micropterus punctulatus	spotted bass	1	1		7	3		3	1
		Micropterus salmoides	largemouth bass		2						
	Percidae	*Etheostoma blenniodes*	greenside darter	C	2	2				C	1

Appendix B cont.

Order	Family	Scientific name	Common Name	10/10/04	3/20/05	5/11/05	8/24/05	10/25/05	3/19/06	6/16/06	8/29/06
		Etheostoma caeruleum	rainbow darter	C	C	C	1	C	C	C	
		Etheostoma crossopterum	fringed darter					2			
		Etheostoma flabellare	fantail darter	1		3			1	1	1
		Etheostoma rufilineatum	redline darter	C							
		Etheostoma simoterum	Tennessee snubnose darter	C	C	1	8	C	4	C	1
		Etheostoma stigmaeum	speckled darter						1	1	
		Etheostoma virgatum	Striped darter	C	1	2	1	C	3	C	1
		Percina caprodes	logperch		C	1	1		1		
		Total number of species captured		17	18	13	16	20	11	21	17

Appendix C: Lytle Creek at Fortress Rosecrans fish list. If more than 5 individuals of a species were captured, it was listed as Common (C), otherwise the actual number captured is given. On 8/16/05, all individuals captured of each species were counted. Those numbers are given.

Order	Family	Scientific name	Common Name	10/24/04	1/22/05	5/9/05	8/16/05	10/18/05	1/11/06	5/11/06	8/1/06
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	gizzard shad		C						
Cypriniformes	Cyprinidae	*Campostoma anomalum*	central stone roller	C	C	C	89	C	C	C	C
		Hybopsis amblops	bigeye chub	C	2	C	55	C	C	C	C
		Luxilus chrysocephalus	striped shiner			1	3	C	C	1	
		Lythrurus ardens	rosefin shiner	2			1	5		C	C
		Notropis boops	big eye shiner		3	1	3	C	C	C	2
		Pimephales notatus	bluntnose minnow	C	C	C	93	C	C	C	C
	Catastomidae	*Hypentelium nigricans*	northern hogsucker	C	C	1	12	C	C	C	C
		Minytrema melanops	spotted sucker			1					
		Moxostoma erythrurum	golden redhorse	1	2		1	1		2	C
Siluriformes	Ictaluridae	*Ameiurus natalis*	yellow bullhead	1			2	1		1	1
		Ameiurus melas	Black bullhead				2			1	2
		Noturus exilis	slender madtom							1	1
Cyprinodontiformes	Cyprinodontidae	*Fundulus catenatus*	northern studfish	1		1					
	Poeciliidae	*Gambusia affinis*	mosquitofish	C		C	28	C	C	C	C
Scorpaeniformes	Cottidae	*Cottus carolinae*	banded sculpin	3	1	1				2	3
Perciformes	Centrarchidae	*Lepomis cyanellus*	green sunfish	2	2	C	8	3	2	C	2
		Lepomis gulosus	warmouth		C	C	13	3	C	C	C
		Lepomis macrochirus	bluegill	C	3	C	15	C	4	C	C
		Lepomis megalotis	longear sunfish	C	C	2	43	C	C	C	C
		Lepomis microlophus	redear sunfish					2		1	
		Micropterus punctulatus	spotted bass	1			7	3			2
		Micropterus salmoides	largemouth bass	2		C	9	1		3	1
		Pomoxis nigromaculatus	black crappie		1						

Appendix C Cont.

Order	Family	Scientific name	Common Name	10/24/04	1/22/05	5/9/05	8/16/05	10/18/05	1/11/06	5/11/06	8/1/06
	Percidae	*Etheostoma blenniodes*	greenside darter	C	4	1	7	C	C	2	C
		Etheostoma caeruleum	rainbow darter	C	C	C	23	C	C	C	C
		Etheostoma crossopterum	fringed darter	2	1	C	9	C	C	C	C
		Etheostoma rufilineatum	redline darter	C	1	1	4	1		1	
		Etheostoma simoterum	Tennessee snubnose darter		C	3	7	4	C	C	C
		Etheostoma stigmaeum	speckled darter							1	
		Etheostoma virgatum	Striped darter	2	1	C	5	2	C	C	C
		Total number of species captured		20	19	21	23	23	16	26	23

Appendix D: Unnamed Pond at Redoubt Brannan Pond fish list. If more than 5 individuals of a species were captured, it was listed as Common (C), otherwise the actual number captured is given. The pond did not contain fish (due to lack of oxygen) on the other 4 sample dates.

Order	**Family**	**Scientific name**	**Common Name**	**3/20/05**	**5/11/05**	**3/19/06**	**5/16/06**
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	gizzard shad		1	2	C
Cypriniformes	Cyprinidae	*Cyprinus carpio*	carp	C		1	1
		Pimephales notatus	bluntnose minnow			C	C
	Catastomidae	*Minytrema melanops*	spotted sucker	1	1	3	3
		Moxostoma erythrurum	golden redhorse			2	
Perciformes	Centrarchidae	*Ambloplites rupestris*	rock bass		1		1
		Lepomis cyanellus	green sunfish				C
		Lepomis gulosus	warmouth		1		1
		Lepomis macrochirus	bluegill	C	C	C	C
		Lepomis megalotis	longear sunfish			1	C
		Lepomis microlophus	redear sunfish	1	C		C
		Micropterus salmoides	largemouth bass		C		
		Pomoxis annularis	white crappie	1		1	
		Pomoxis nigromaculatus	black crappie		1		
			Total number of species	5	8	8	10

APPENDIX E

Voucher photographs and ecological description of fish species captured in and around Stones River National Battlefield. Ecological information derived from NatureServe (2004[1]). Unless otherwise noted, photographs were taken by D. Mullen. When photographing small fish, live individuals were placed inside a narrow glass aquarium containing a rocky bottom (with a few exceptions). Larger fish were photographed while held by hand. Voucher photographs are not available for gold fish, blotched chub and redtail chub because the digital camera was not available on the one day that these three species were caught. The sites that each species was captured at as well as the relative abundance (Abundant – captured in high numbers on multiple occasions, Common – captured frequently but never in high numbers, Rare – captured infrequently and always at low numbers) is provided.

NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.0.
NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: September 2006).

Lepisosteus osseus - (Linnaeus, 1758)
Longnose Gar

Ecological description: Common in large weedy lakes and reservoirs, backwaters and quiet pools of medium to large rivers, stagnant ponds, sloughs, canals, brackish waters of coastal inlets, occasionally in coastal marine waters. Often near vegetation or close to submerged or overhanging objects by day. Feeds on aquatic invertebrates and fish.

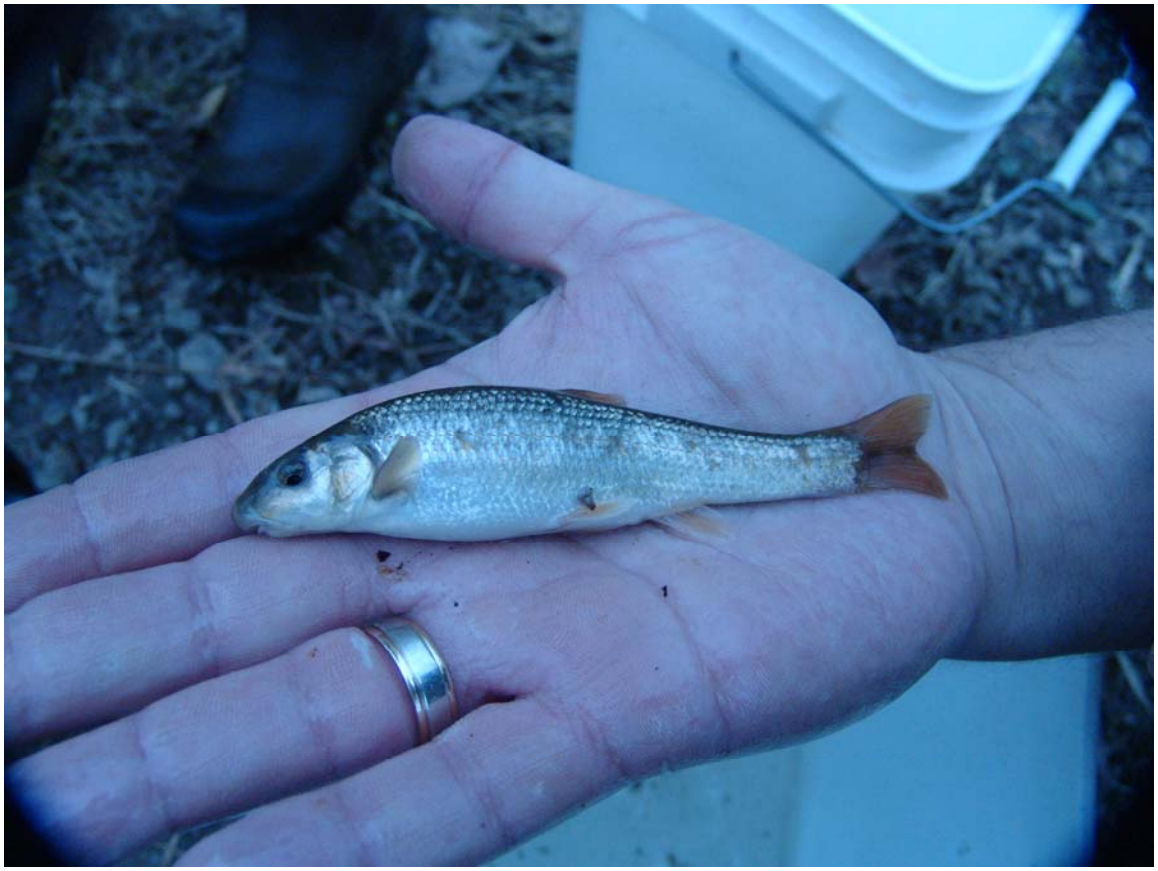
STRI Sites : McFadden’s Ford, Redoubt Brannan - Common

Dorosoma cepedianum - (Lesueur, 1818)
Gizzard Shad

Ecological description: Occurs in Medium to large rivers, reservoirs, lakes, swamps, bays, sloughs, and similar quiet open waters, from clear to very silty; an open water species; often ascends creeks and small rivers that have well-developed pools; commonly enters brackish water. Feeds on phytoplankton and zooplankton.

STRI Sites : Unnamed pond at Redoubt Brannan and Lytle Creek - Rare

Campostoma anomalum - (Rafinesque, 1820)
Central Stoneroller



Ecological description: Characteristic of small to medium rivers with cool clear water, moderate or sometimes rapid current, gravel or rubble bottom. Commonly in pools with current, riffles of small rocky streams; also in medium to large rivers, and sometimes in slow-moving, turbid water. Feeds on periphyton (attached algae).

STRI Sites : McFadden’s Ford, Redoubt Brannan and Lytle Creek - Abundant

Carassius auratus - (Linnaeus, 1758)
Goldfish

© Noel Burkhead & Virginia Dept of Game and Inland Fisheries (Fishes of Virginia)
Voucher Photograph not available

Ecological description:. Introduced species that is usually found in still water with abundant vegetation: lakes, reservoirs, ponds, rivers, quiet streams. In clear or turbid water. Feeds on aquatic vegetation and invertebrates.

STRI Sites : McFadden’s Ford – Rare (only 1 captured)

Cyprinella galactura - (Cope, 1868)
Whitetail Shiner

Ecological description: Occupies cool, usually clear, high-gradient headwaters, creeks, and small rivers, with bottom of clean gravel and rubble. Common in raceways or near riffles; frequents deep pools in association with large boulders and rocky banks. Feeds on aquatic invertebrates.

STRI Sites : McFadden’s Ford and Redoubt Brannan - Abundant

Cyprinella spiloptera - (Cope, 1867)
Spotfin Shiner

Ecological description: Most frequent in large creeks and small rivers with clear permanent flow; not typically in larger turbid rivers or intermittent creeks; usually in or near riffles or raceways over gravel in moderate to fast current. Feeds on aquatic invertebrates.

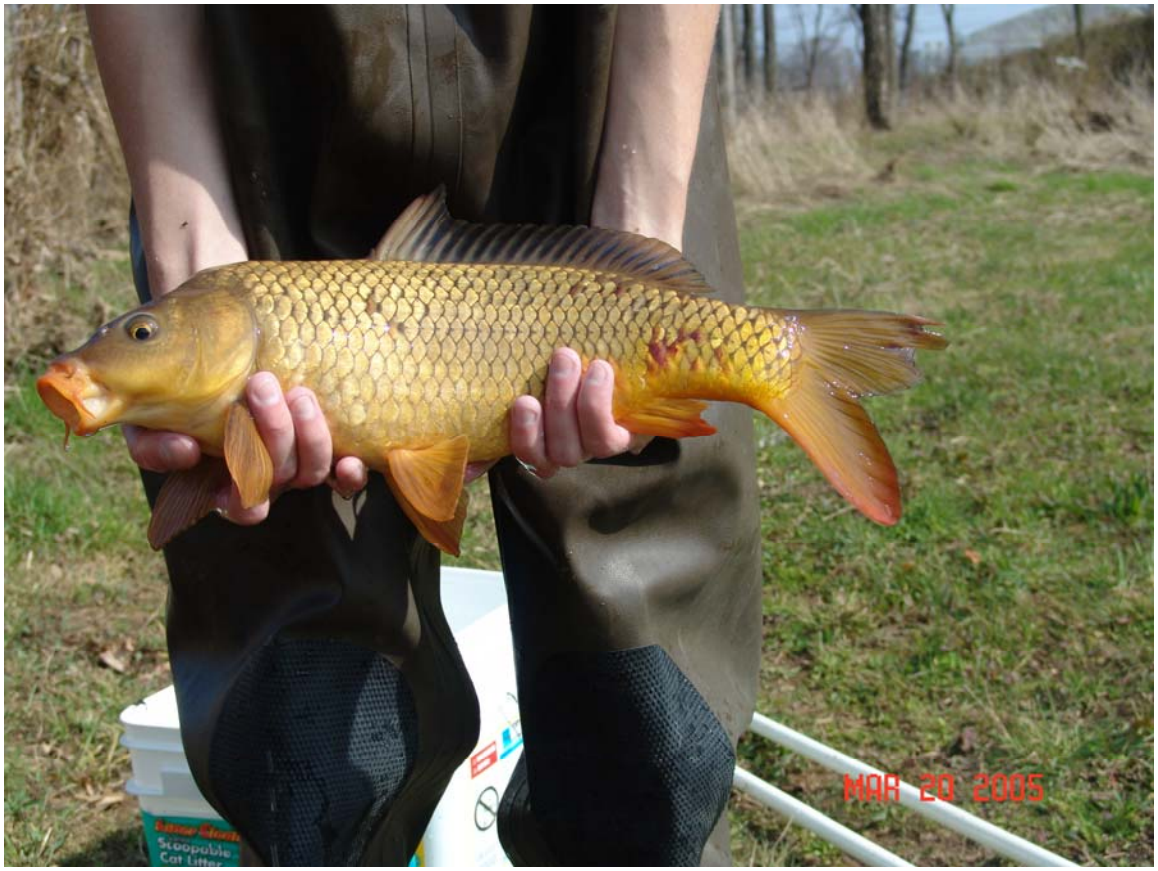
STRI Sites : McFadden’s Ford and Redoubt Brannan - Abundant

Cyprinella whipplei - Girard, 1856
Steelcolor Shiner

Ecological description: Occupies runs, pools, and backwaters of warm, moderate- to somewhat low-gradient, large creeks and medium-sized to large rivers that typically are clear; also tolerates streams that generally are turbid. Feeds on aquatic invertebrates.

STRI Sites : McFadden’s Ford - Common

Cyprinus carpio - Linnaeus, 1758
Common Carp



Ecological description: Usually occurs in rivers, lakes, ponds, reservoirs, swamps, or low-salinity estuaries; usually in shallow water with abundant vegetation and little or no current; generally does not inhabit first-order, cold streams or deep lakes with little or no littoral zone. Tolerant of wide range in oxygen, salinity, turbidity, and bottom conditions. Fry, juveniles, and adults tolerate temperatures between 5 and 35 C. Feeds on aquatic vegitation and invertebrates.

STRI Sites : McFadden's Ford, Redoubt Brannan and Unnamed pond at Redoubt Brannan - Common

Erimystax insignis - (Hubbs and Crowe, 1956)
Blotched Chub

© Noel Burkhead & Virginia Dept of Game and Inland Fisheries (Fishes of Virginia)
Voucher Photograph not available

Ecological description Typically in medium to large, clear, medium to high gradient, warm streams with clean gravel or rock bottom. Feeds on aquatic invertebrates.

STRI Sites : McFadden's Ford – Rare (only 2 captured)

Hybopsis amblops - (Rafinesque, 1820)
Bigeye Chub

Ecological description: Occurs in Small to moderate size, clear-water tributaries with sand, gravel, or rocky bottom. Usually near riffles in quiet water. Often associated with aquatic vegetation. Exceptionally intolerant of siltation.. Feeds on aquatic invertebrates.

STRI Sites: McFadden’s Ford, Redoubt Brannan and Lytle Creek - Abundant

Luxilus chrysocephalus - Rafinesque, 1820
Striped Shiner

Ecological description: Typically found in creeks and small to medium rivers having clear waters, a moderate to swift current, and alternating pools and riffles over a gravel or rubble bottom, often with some silt. Spawns over gravel in riffles, in crater-like nest made by male, or in depressions made by other species in both still and running water. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford and Lytle Creek - Abundant

Lythrurus ardens - (Cope, 1868)
Rosefin Shiner

Ecological description: Found in pools, backwaters near flowing water, and runs of warm large creeks and rivers of moderate gradient and clear to often turbid water; generally in mid- and higher depths over soft and hard bottoms. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Nocomis effusus - Lachner and Jenkins, 1967
Redtail Chub

Photo courtesy of the Kentucky Department of Fish and Wildlife Resources
Voucher photograph not available

Ecological description: Occupies Creeks and small rivers of moderate gradient, with cool to warm, usually clear water, and gravelly/rocky substrate. May have affinity for high volume spring streams. Usually in pools and slower runs. Spawns over gravel mound nest made by male.. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford – Rare (only 1 captured)

Notropis boops - Gilbert, 1884
Bigeye Shiner

Ecological description: Occupies flowing pools of moderately clear creeks and small to medium rivers with large permanent pools over bottom of clear sand, gravel, or rock. Feeds on aquatic invertebrates.

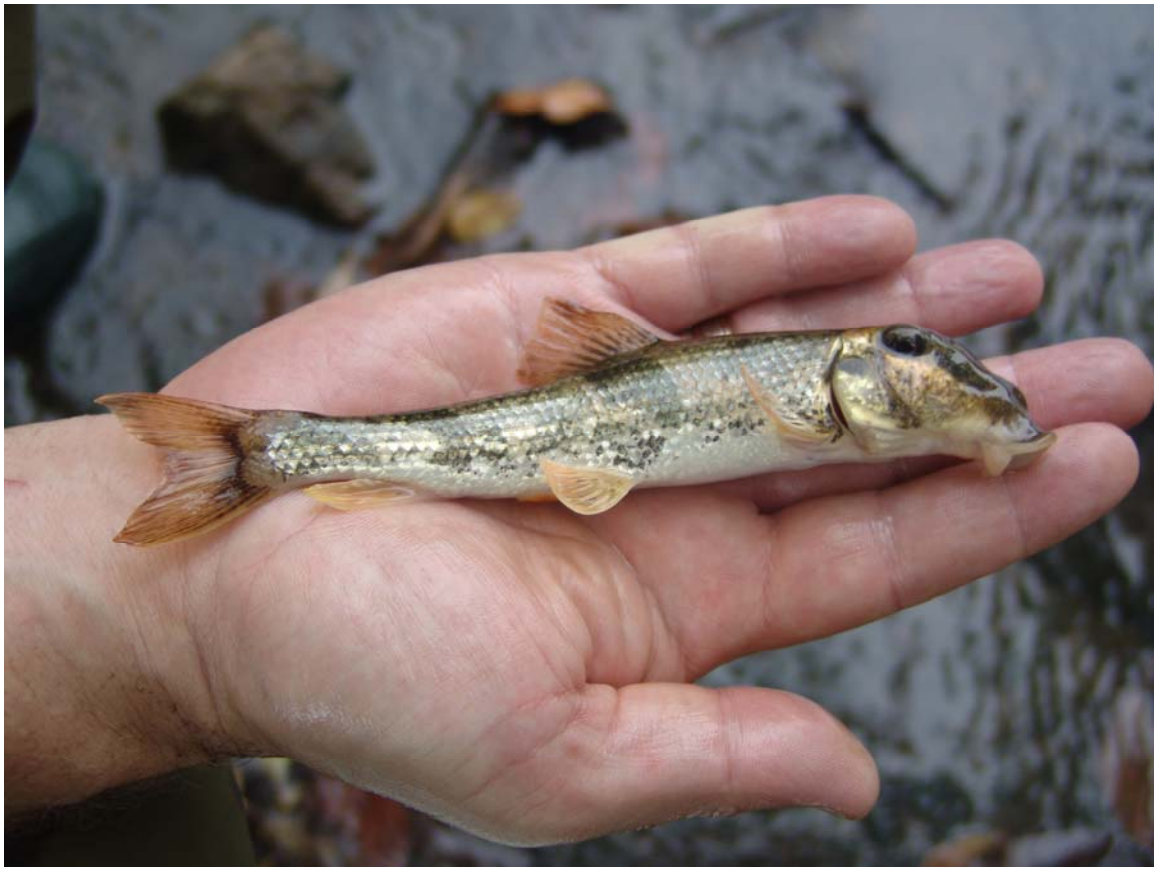
STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Pimephales notatus - (Rafinesque, 1820)
Bluntnose Minnow

Ecological description: Occupies Lakes, ponds, rivers, and creeks in a variety of habitats. Most common in clear rocky streams. Schools in midwater or near bottom. Spawns in nest made by male under object on bottom on sandy or gravelly shoals, eggs attached to underside of cover. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Abundant

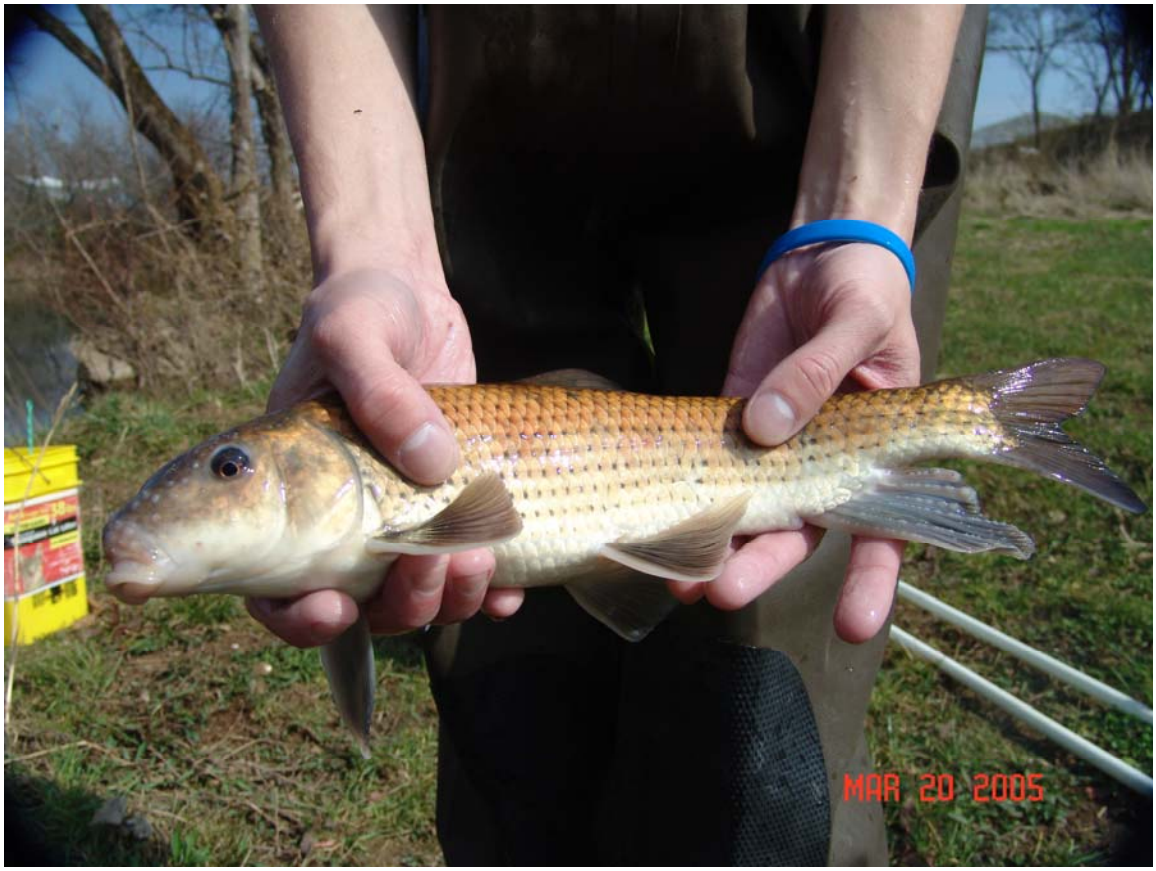
Hypentelium nigricans - (Lesueur, 1817)
Northern Hog Sucker



Ecological description: Occupies Riffles, runs, and adjacent pools of clear shallow creeks and small rivers with gravel to rubble substrates. Spawns in riffles or in shallow ends of pools over clean gravel. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan, and Lytle Creek - Abundant

Minytrema melanops - (Rafinesque, 1820)
Spotted Sucker



Ecological description: Typically found in long deep pools of clear, firm-bottomed (clay, sand, or gravel), small to medium rivers; sometimes in small turbid creeks and overflow lakes and impoundments. Intolerant of extensive siltation. Spawns in riffle areas. Feeds on aquatic invertebrates and vegetation.

STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Common

Moxostoma erythrurum - (Rafinesque, 1818)
Golden Redhorse

Ecological description: Typically found in creeks and small to large rivers with varied substrate; generally in pools, often over sand or silt. Occasionally in lakes. Spawns usually in runs and riffles in the main stream but may ascend small tributaries. Feeds on aquatic invertebrates and vegetation.

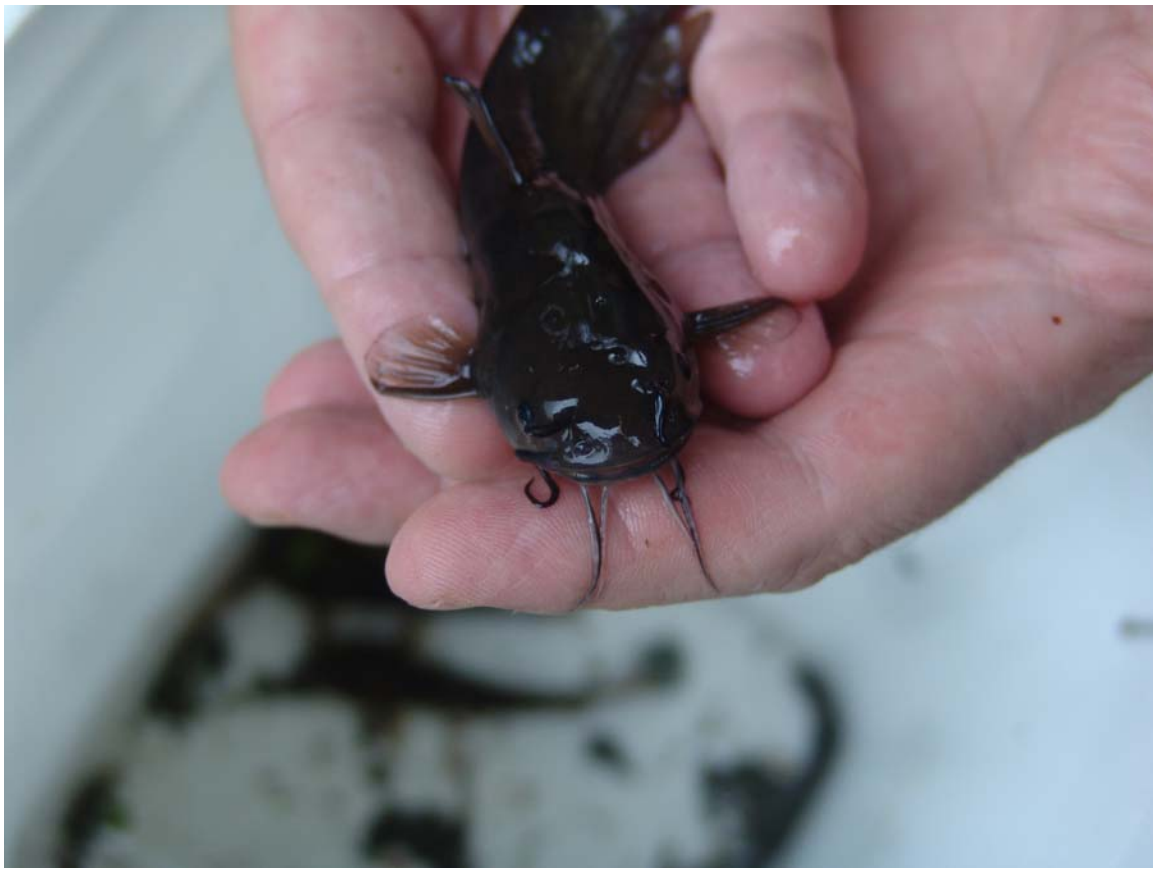
STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Abundant

Ameiurus natalis - (Lesueur, 1819)
Yellow Bullhead

Ecological description: Typically found in shallow weedy parts of clear warm lakes, ponds, or slow-moving streams or canals. More tolerant of pollution than are most other ictalurids. Eggs are laid in saucer-shaper depression beside or beneath a bank, log, or tree root, or in burrow or in or under debris on bottom. Feeds on aquatic invertebrates and fish.

STRI Sites: McFadden's Ford, and Lytle Creek - Common

Ameiurus melas - (Rafinesque, 1820)
Black Bullhead



Ecological description: Ponds, small lakes, river backwaters, swamps, impoundments, small stream pools with warm and turbid water, muddy bottoms, slow currents, and few other fish species. Adults inactive in schools in aquatic vegetation during day. Eggs are laid in shallow nest made by female on bottom in mud or sand, in secluded areas such as under logs or mats of aquatic vegetation. Feeds on aquatic invertebrates.

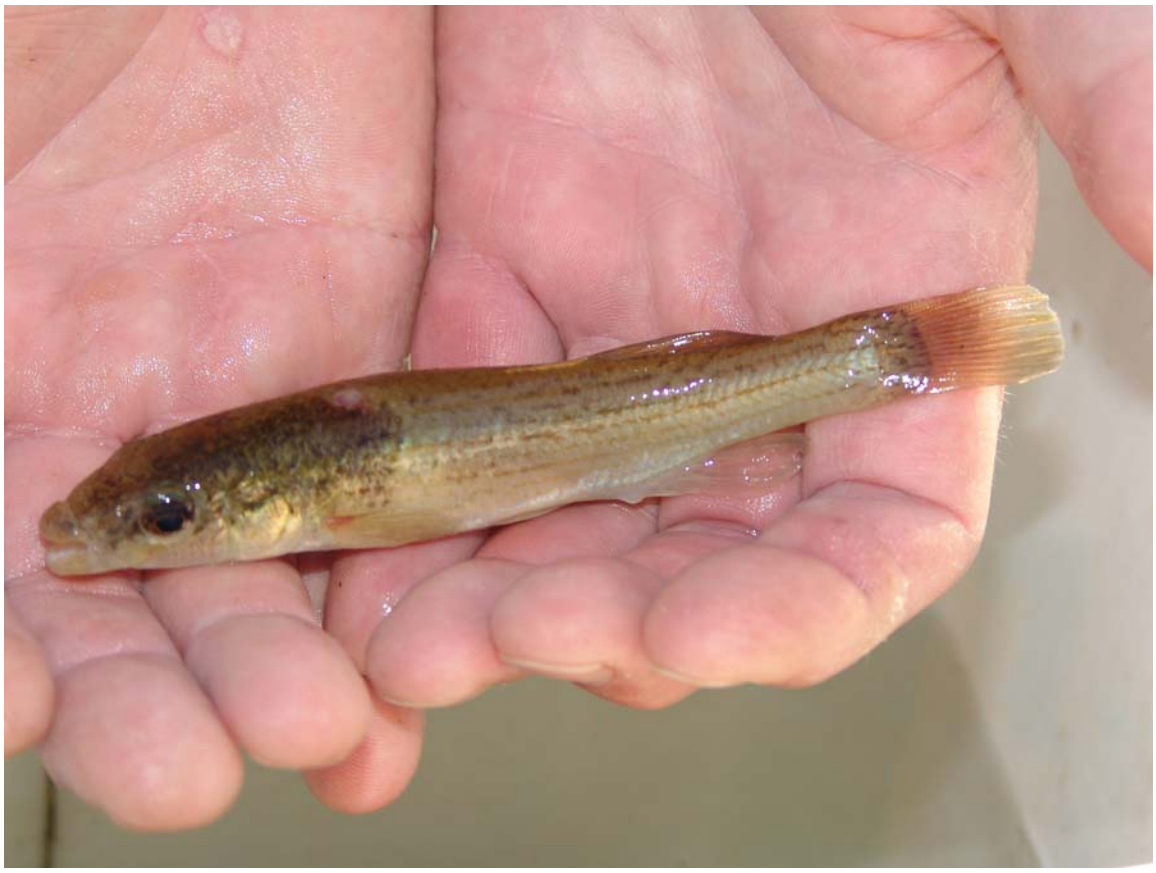
STRI Sites: McFadden's Ford, and Lytle Creek - Common

Noturus exilis - Nelson, 1876
Slender Madtom

Ecological description: Uses a wide range of depths and current velocities in various riverine macrohabitats; riffles of creeks and small rivers in moderate to fast current; also in rocky pools with current strong enough to keep bottom free of silt and in deep leaf-litter of calm pools with clear cool water. Can be numerous in aquatic vegetation. Rarely in springs and rarely along wave-swept margins of large impoundments. Feeds on aquatic invertebrates.

STRI Sites: Lytle Creek – Rare (only 2 captured)

Fundulus catenatus - (Storer, 1846)
Northern Studfish



Ecological description: Uses margins, pools, and backwaters of creeks and small rivers with moderate to high gradients, permanent flow of clear water, and bottoms usually of sand, gravel, rock, and occasionally an admixture of silt; most common in shallow sandy backwaters adjacent to clear gravelly creeks. Males establish and defend small territories in shallow quiet-water spawning areas. Feeds on aquatic invertebrates.

STRI Sites: Lytle Creek – Rare (only 2 captured)

Fundulus notatus - (Rafinesque, 1820)
Blackstripe Topminnow

Ecological description: Prefers small to large, lowland, low-gradient streams and sloughs with water of moderate to high turbidity; quiet water of creeks, rivers, lakes, swamps, drainage ditches, highwater pools of rivers, and ponds. Deeper water in winter. Common in lowlands, rare to absent in uplands. Feeds on aquatic invertebrates, typically at the water surface.

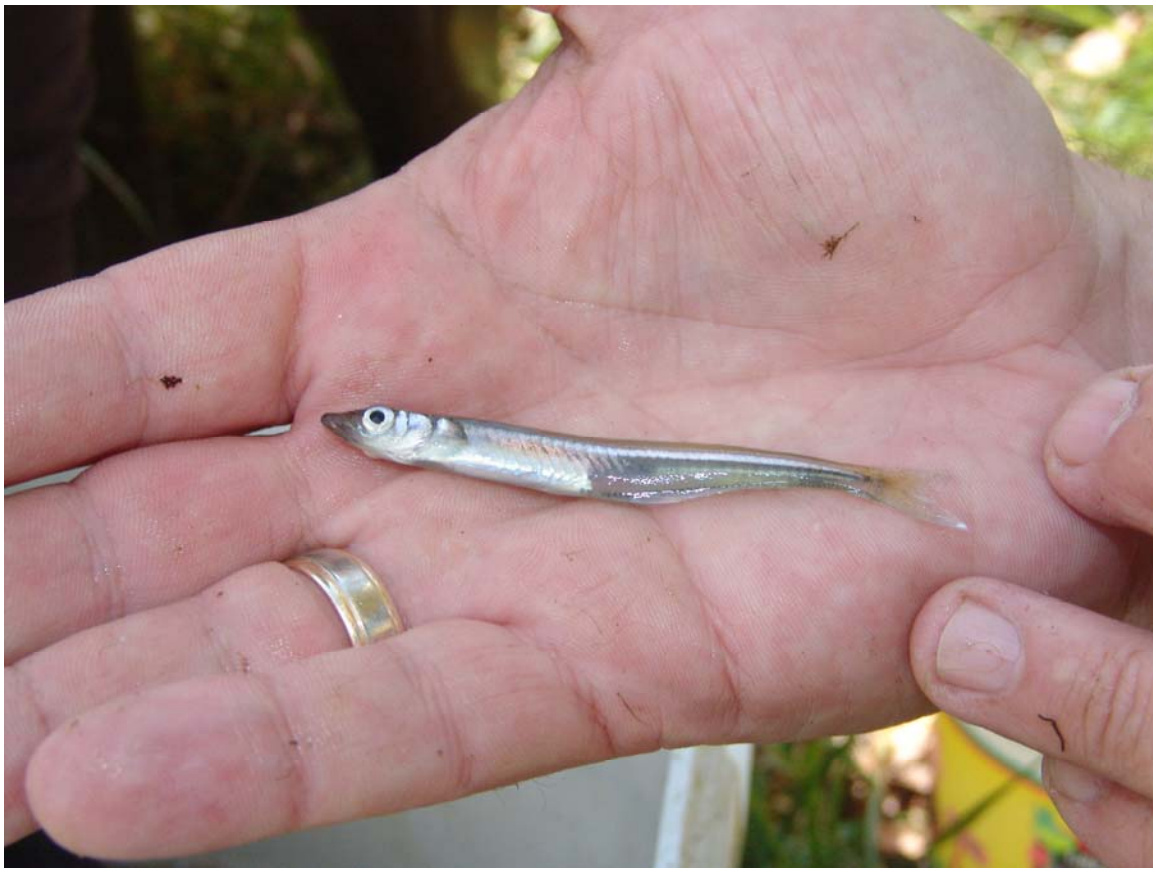
STRI Sites: McFadden's Ford and Redoubt Brannan – Rare (only 3 captured)

Gambusia affinis - (Baird and Girard, 1853)
Western Mosquitofish

Ecological description: Common in river channels, margins, backwaters; springs, marshes, and artificial habitats of all kinds. Often in shallow, often stagnant, ponds and the shallow edges of lakes and streams where predatory fishes are largely absent and temperatures are high. Most abundant in shallow water with thick vegetation. Feeds on aquatic invertebrates, typically at the water surface, and periphyton.

STRI Sites: McFadden's Ford, King Pond, Redoubt Brannan and Lytle Creek - Abundant

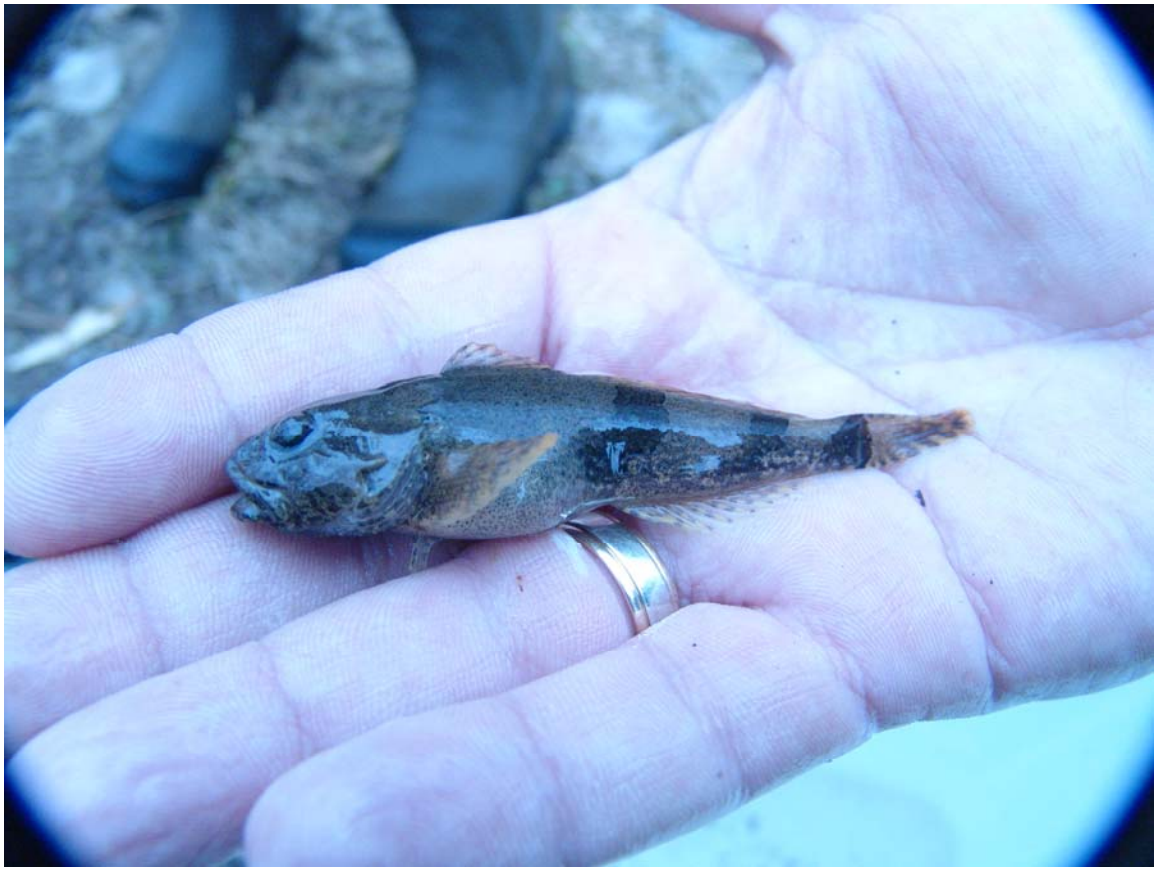
Labidesthes sicculus - (Cope, 1865)
Brook Silverside



Ecological description: Abundant near the surface of clear warm waters of rivers, creeks, lakes, and reservoirs. In other areas, occurs only in slow areas and backwaters of rivers. In streams, occupies cool and warm waters, low and moderate gradients, and areas with various substrates and differing amounts of vegetation. Apparently favors clear water in most areas. Feeds on aquatic invertebrates, typically at the water surface.

STRI Sites: McFadden's Ford and Redoubt Brannan - Abundant

Cottus carolinae - (Gill, 1861)
Banded Sculpin



Ecological description: Found in small to moderate-sized clear, cool to warm streams. Prefers gravel and rubble riffles of headwaters, creeks, and small rivers; springs and their effluents. Feeds on aquatic invertebrates, and fish.

STRI Sites: McFadden's Ford and Lytle Creek – Rare (only 14 captured)

Ambloplites rupestris - (Rafinesque, 1817)
Rock Bass

Ecological description: Most common in clear, silt-free rocky streams. Prefers small, cool, weedy lakes or littoral regions of larger lakes, and streams with typically rocky, always silt-free substrates, permanent flow, low turbidity, and extensive cover. Feeds on aquatic invertebrates, and fish.

STRI Sites: McFadden's Ford, Redoubt Brannan, and Unnamed Pond at Redoubt Brannan - Abundant

Lepomis cyanellus - Rafinesque, 1819
Green Sunfish

Ecological description: Found in sluggish warm streams, ponds, and shallow weedy margins of lakes. Usually in vicinity of weed beds. Tolerates both clear and turbid water. Characteristic of, and one the last survivors in, residual pools in intermittent streams in Great Plains region. Feeds on aquatic invertebrates, and fish.

STRI Sites: McFadden's Ford, King Pond, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Abundant

Lepomis gulosus - (Cuvier, 1829)
Warmouth

Ecological description: Found in Ponds, lakes, swamps, and streams of low gradient with mud or debris over bottom; a pool species in streams where it often is near beds of vegetation or other cover; weedy turbid areas of rivers and backwaters. Tolerant of low oxygen levels of polluted waters. Common in lowlands, uncommon in uplands. Feeds on aquatic invertebrates, and fish.

STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Abundant

Lepomis macrochirus - Rafinesque, 1819
Bluegill

Ecological description: Found in warm shallow lakes, reservoirs, ponds, swamps, sloughs, and slow-flowing rivers and streams; often associated with rooted aquatic plants and with bottoms of silt, sand, or gravel. Seldom goes much deeper than 5 m. Large individuals seek more open water than do smaller ones. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Abundant

Lepomis megalotis - (Rafinesque, 1820)
Longear Sunfish

Ecological description: Prefers clear, shallow, well-vegetated areas of low gradient streams (Sublette et al. 1990). Typically in headwaters, creeks, and small to medium rivers in uplands; generally absent from downstream lowland sections. Typically in rocky and sandy pools, usually near vegetation; avoids strong current, turbid water, and silt bottoms. Feeds on aquatic invertebrates and small fish.

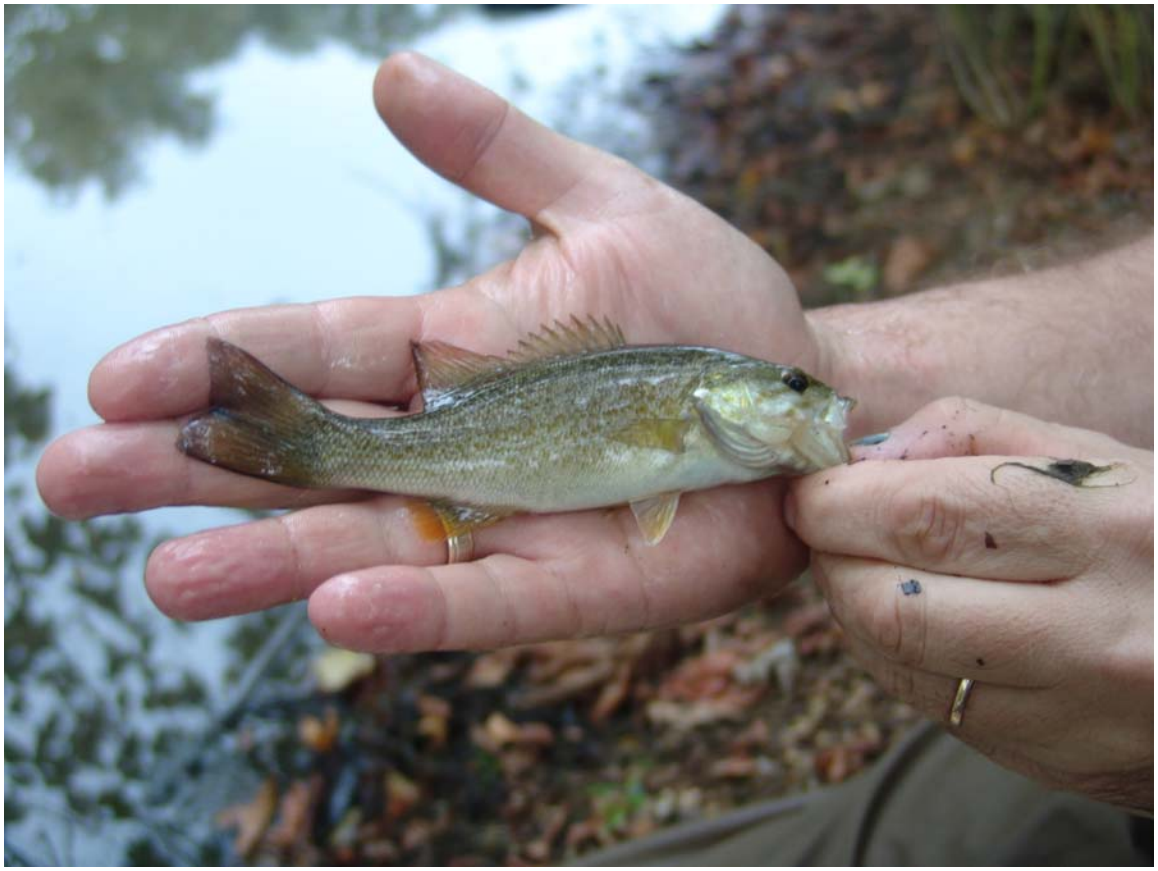
STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Abundant

Lepomis microlophus - (Gunther, 1859)
Redear Sunfish

Ecological description: Prefers deeper waters of warm quiet ponds, lakes, backwaters of small to medium rivers, reservoirs, and swamps; usually in clear water with abundant vegetation, stumps, logs, or other cover, with substrate of mud or sand. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Common

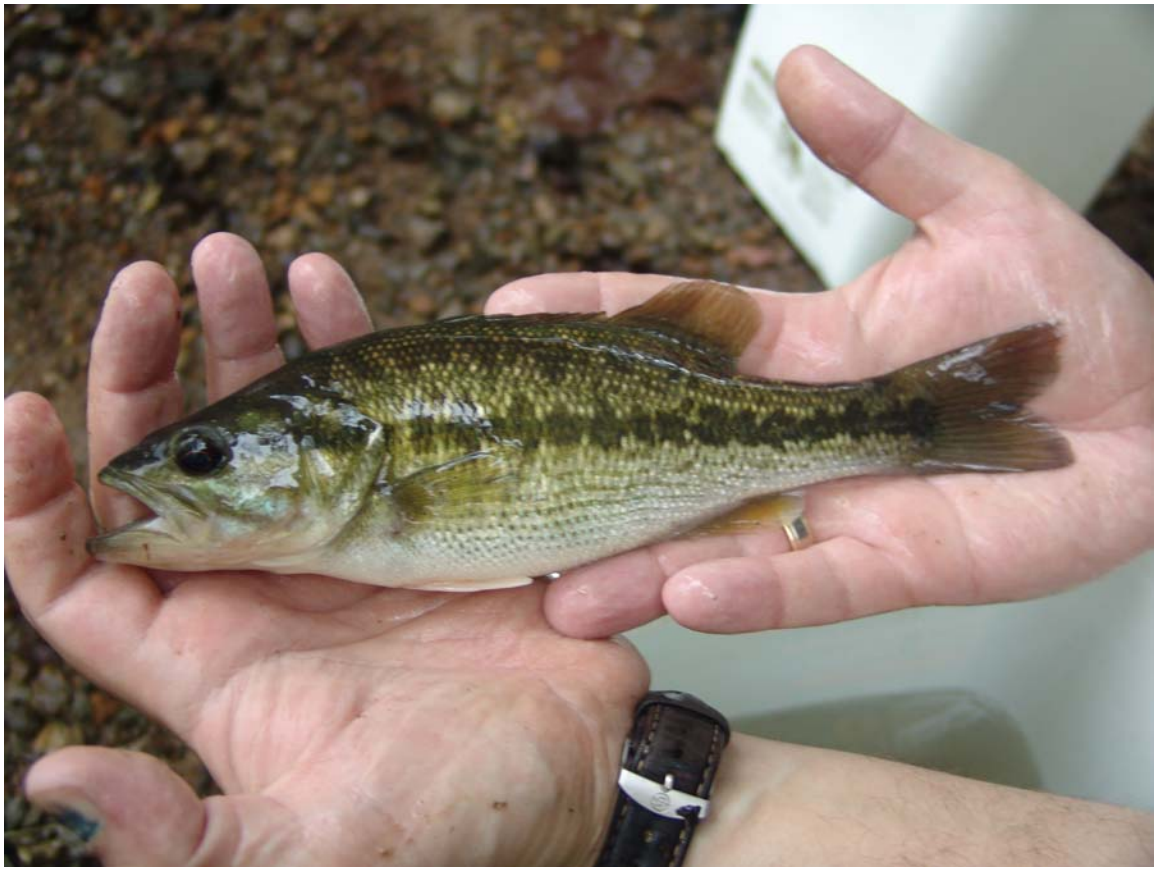
Micropterus dolomieu - Lacepede, 1802
Smallmouth Bass



Ecological description: Prefers large clear lakes (especially in north) and clear midorder streams and rivers with many large pools, abundant cover (rocks, shelves, logs, etc.), and cool (20-27 C) summer temperatures. Adults seek shelter of pools or deep water during day. Feeds on aquatic invertebrates, fish and other vertebrates.

STRI Sites: McFadden's Ford and Redoubt Brannan – Rare (only 10 captured)

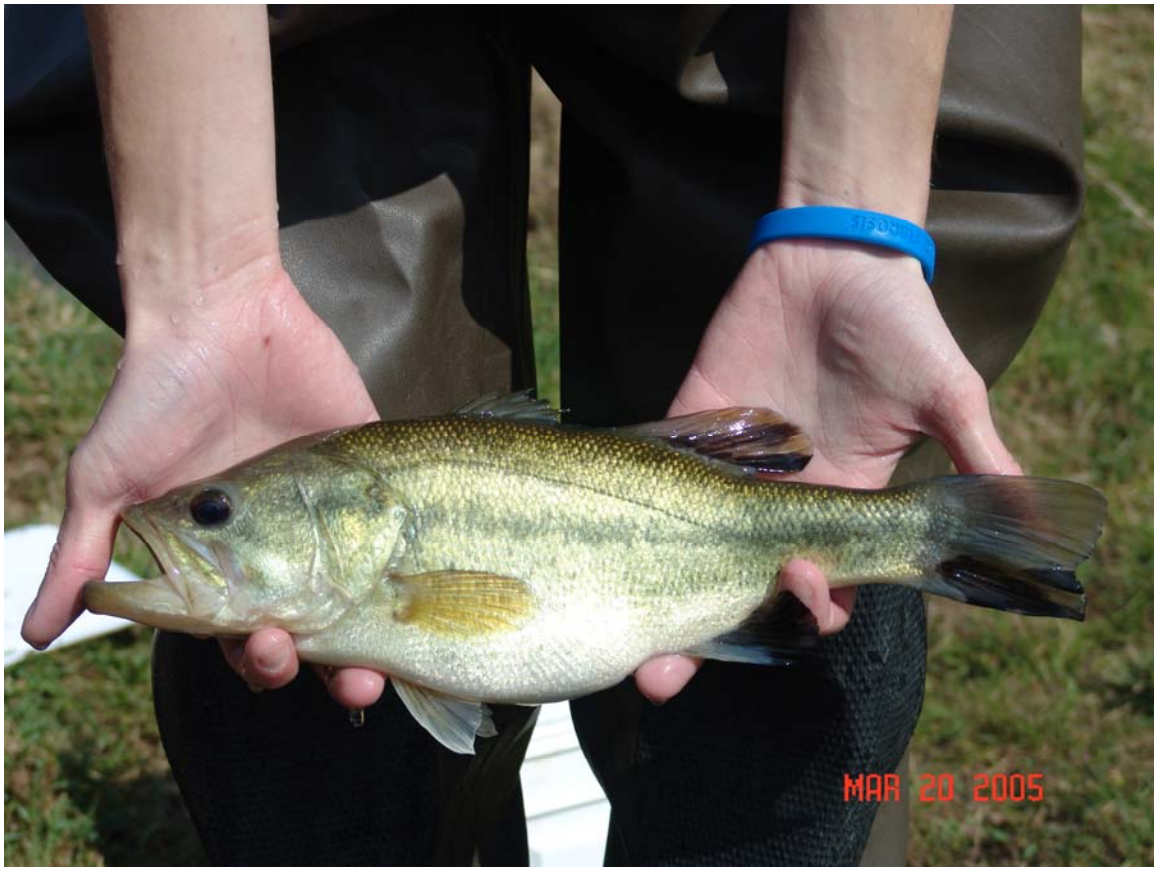
Micropterus punctulatus - (Rafinesque, 1819)
Spotted Bass



Ecological description: Found in small clear creeks with moderate to swift current and gravel to coarse sand substrate; moderate size, clear, low gradient sections of rivers with gravel substrate; and reservoirs (especially large deep oligotrophic ones). Secretive pool dweller in streams. After leaving nest, juveniles usually occur in schools in backwater or cove areas near cover. Feeds on aquatic invertebrates, and fish.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Common

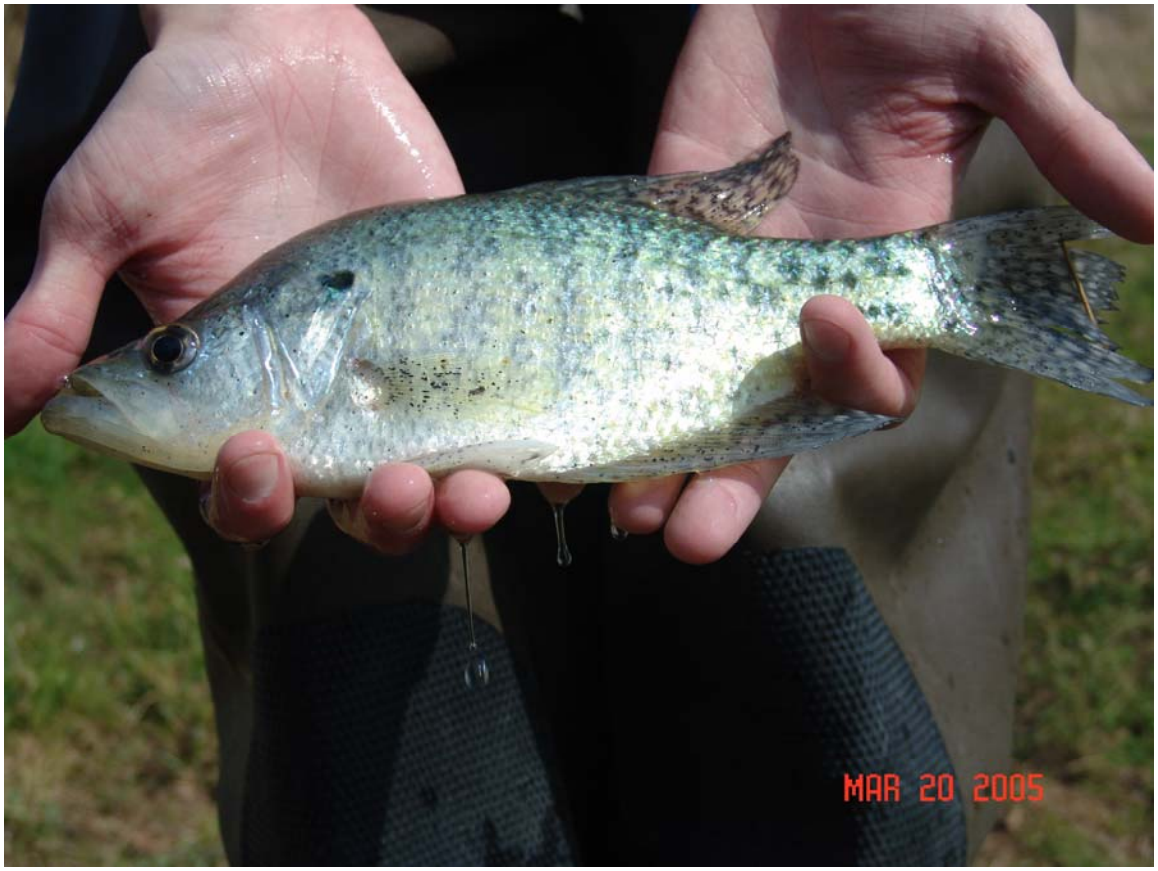
Micropterus salmoides - (Lacepede, 1802)
Largemouth Bass



Ecological description: Occupies warm quiet waters with low turbidity, soft bottom, and beds of aquatic plants; farm ponds, swamps, lakes, reservoirs, sloughs, creek pools, and river backwaters. Usually close to shore in lakes and reservoirs. Largest numbers are in mesotrophic to eutrophic lakes or reservoirs. Generally inhabits deeper water in winter. Feeds on aquatic invertebrates, fish and other vertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan, Unnamed Pond at Redoubt Brannan and Lytle Creek - Common

Pomoxis annularis - Rafinesque, 1818
White Crappie

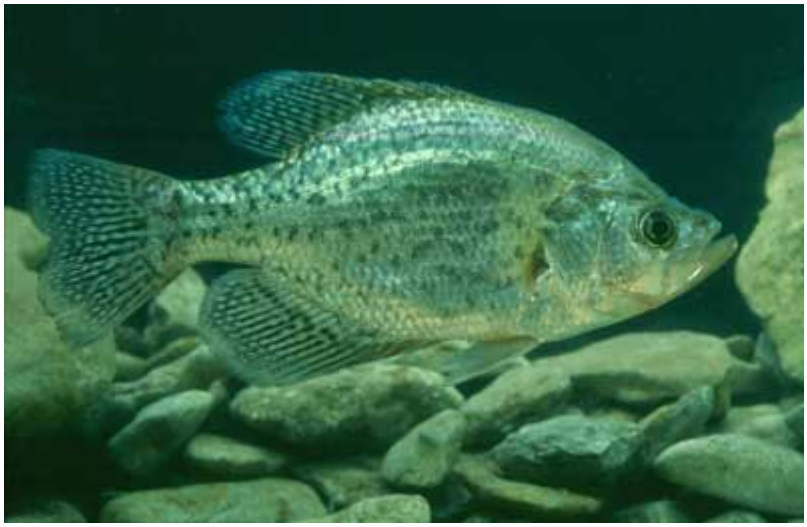


Ecological description: Most abundant in sand- and mud-bottomed pools and backwaters of warm turbid creeks, small to large rivers, lakes, and reservoirs. During day, tends to congregate around submerged logs or boulders in quiet water 2-4 m deep, or in dimly lit profundal zone of reservoir. May move into open water in evening and early morning. Shallow littoral zone is occupied by young and by foraging adults. Feeds on aquatic invertebrates and fish.

STRI Sites: Unnamed Pond at Redoubt Brannan – Rare (only 2 captured)

Pomoxis nigromaculatus - (Lesueur, 1829)
Black Crappie

Voucher Photo



Better photograph courtesy of the Kentucky Department of Fish and Wildlife Resources

Ecological description: Most abundant in large, warm, clear lakes and reservoirs and clear river backwaters; usually associated with large beds of aquatic plants and sandy to mucky bottoms. Usually in localized schools near submerged objects during day. Feeds on aquatic invertebrates and fish.

STRI Sites: Unnamed Pond at Redoubt Brannan and Lytle Creek– Rare (only 2 captured)

Etheostoma blennioides - Rafinesque, 1819
Greenside Darter

Ecological description: Often in medium-sized to large creeks and small to medium rivers with gravel- or rubble-strewn riffles. Also often in silt-free, shallow bedrock pools with steady current. Inhabits some relatively quiet lake shores. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Etheostoma caeruleum - Storer, 1845
Rainbow Darter

Ecological description: Found in creeks and small to medium rivers, over gravel and rubble. Adults in fast and deep riffles, young in quiet shallow riffles and small pools. Feeds on aquatic invertebrates.

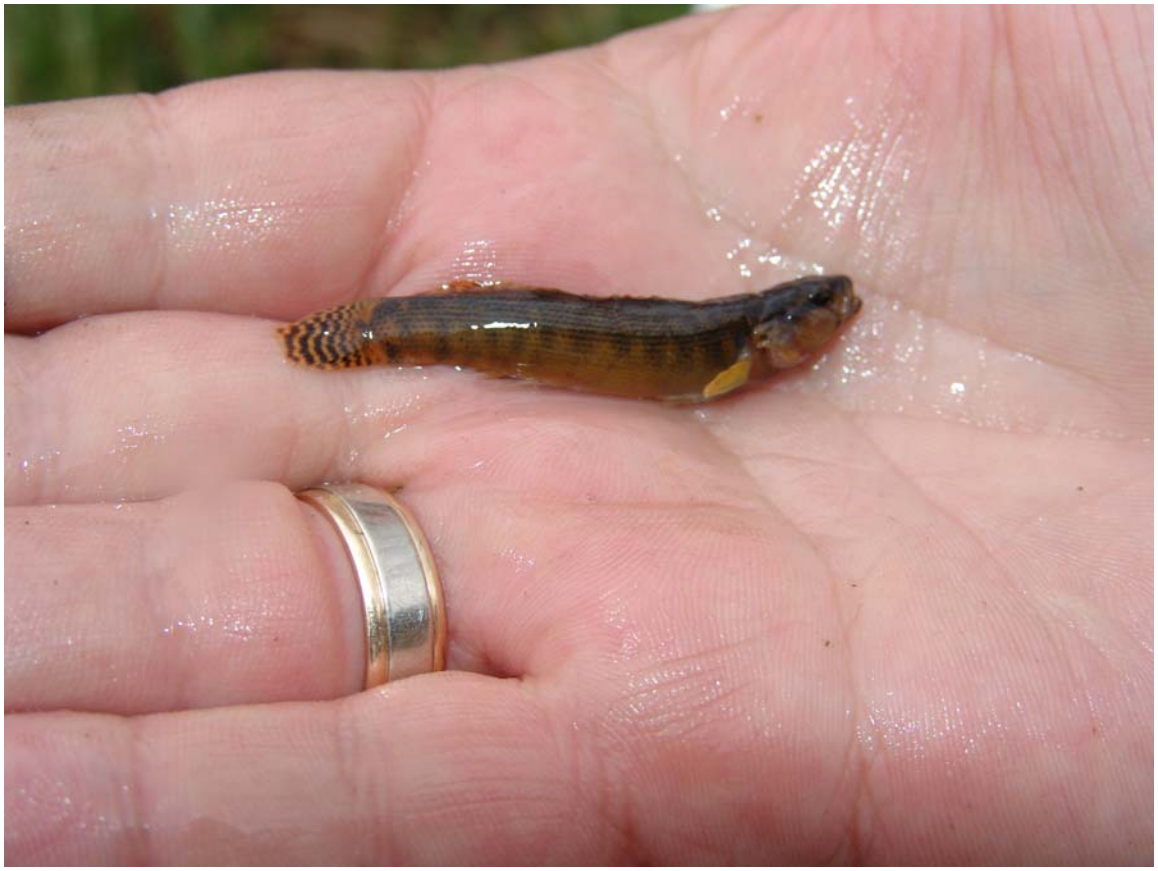
STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Etheostoma crossopterum - Braasch and Mayden, 1985
Fringed Darter

Ecological description: Prefers small quiet streams with large flat rocks or bedrock bottom; small populations occur in small gravelly streams and in larger streams along quiet margins and beneath undercut banks. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Common

Etheostoma flabellare - Rafinesque, 1819
Fantail Darter



Ecological description: Occurs in riffles with gravel or rubble substrate in streams of 1st through 8th order (creeks and small to medium rivers). In large streams, occurs in shallow areas away from main current. Occasionally occurs in lakes. Occupies deeper water in winter. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford and Redoubt Brannan – Rare (only 8 captured)

Etheostoma rufilineatum - (Cope, 1870)
Redline Darter

Ecological description: Prefers swift shallow riffles in clear streams and small rivers. Smaller individuals in areas where current less swift. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Etheostoma simoterum - (Cope, 1868)
Snubnose Darter

Ecological description: Prefers flowing rocky pools and adjacent riffles of small clear creeks with gravel bottom or bedrock strewn with rubble, and. small to medium rivers, where confined to shallow gravel-bedded portions of riffles. Rare or absent in murky water or where stream gravel impacted with silt. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Etheostoma stigmaeum - (Jordan, 1877)
Speckled Darter

Ecological description: Characteristically in pools and riffles of clear creeks and small to medium rivers with moderate gradient and fast water, occasionally in sluggish murky streams. Pools usually have bottoms of sand or sand and gravel. Feeds on aquatic invertebrates.

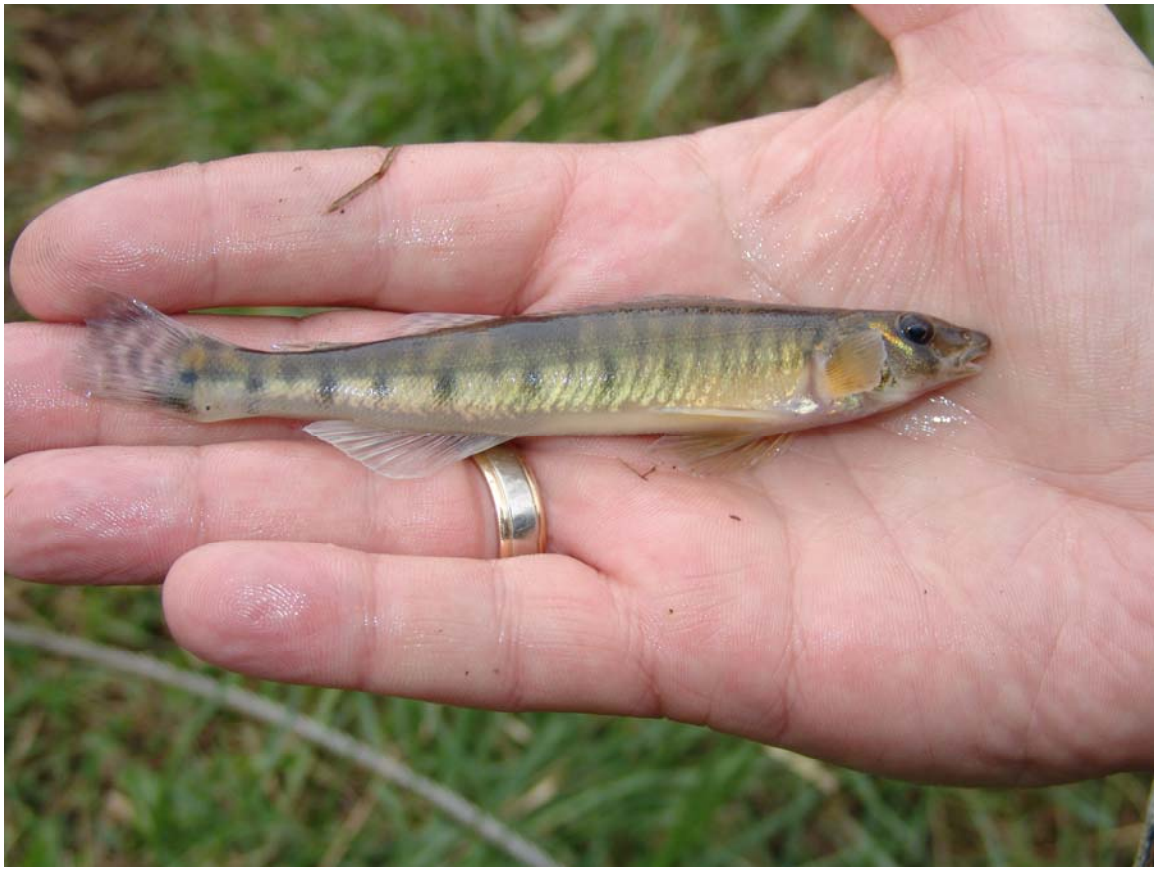
STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek – Rare (only 4 captured)

Etheostoma virgatum - (Jordan, 1880)
Striped Darter

Ecological description: Found in small bedrock creeks (under flat rocks), gravel bottom pools and gentle riffles of larger streams (small to medium rivers); in larger streams, often associated with emergent vegetation or occurs under tree roots or undercut banks; also in slower riffles and gravel pools with no cover. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford, Redoubt Brannan and Lytle Creek - Abundant

Percina caprodes - (Rafinesque, 1818)
Logperch



Ecological description: Found in small creeks to rivers, lakes, and reservoirs. Prefers clean riffles and runs over mixed sand and gravel. Often associated with bottom. Feeds on aquatic invertebrates.

STRI Sites: McFadden's Ford and Redoubt Brannan - Common