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Habitat Associations of Fish Species and their Assemblages in the Tonawanda and Johnson Creek Watersheds of Northwestern New York State

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Habitat Associations of Fish Species and their Assemblages in the Tonawanda and Johnson Creek Watersheds of Northwestern New York State

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By

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ABSTRACT

Stream fishes and their habitats were surveyed at 108 sampling sites to determine the status of the rare longear sunfish (*Lepomis megalotis*) and redfin shiner (*Lythrurus umbratilis*) in the Tonawanda (TCW) and Johnson Creek (JCW) watersheds of northwestern New York, May-September 2005. Of the >27,500 individuals captured and 70 fish species identified, most were cyprinids, followed by centrarchids, catostomids, and percids. Each watershed revealed cyclic patterns and substantial variation in the longitudinal profiles of habitat and fish assemblage variables, especially at sites with anthropogenic disturbances. Fish assemblages were easily delineated longitudinally in the two watersheds using detrended correspondence analysis (DCA) but associating fish species and their assemblage variables (CPUE, fish richness, Simpson's Diversity) with habitat variables was more challenging using canonical correspondence analysis (CCA: 62 associations, 27 species) and multiple linear regression (MLR: 80 associations, 47 species/33 assemblages) at 17 watershed and sub-watershed scales. In the more statistically rigorous MLR analyses, aquatic vegetation accounted for the greatest number of habitat associations (32%), followed by pool type, bank cover and substrate composition (16-17% each), suggesting that these habitat features may have been the most important to stream fishes in the study. In most cases, these finding were supported by the literature on stream fish ecology. Overall, fish species richness has remained relatively high and stable over time in both watersheds, even with ongoing localized disturbances occurring in the lower basins: NYS Barge (Erie) Canal,

Batavia Dam (TCW) and Lyndonville Dam (JCW), as well as agricultural and suburban activities. New habitat associations were suggested for seven species. Findings from this study have already assisted with restoration efforts for the longear sunfish and may support future management of lesser known stream fishes in New York State.

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BIOGRAPHICAL BACKGROUND

By Arlene H. Wells (mother)

Scott moved to Sterling, NY at age six and spent much of his childhood in the great outdoors, developing an adventurous love for fishes at age ten. Scott proceeded to catch and bring home many kinds of fish and eventually was planning our family summer camping trips to new waters in pursuit of our next angling adventure. Scott experienced the booming Lake Ontario Pacific salmon returns of the l980s and fished tirelessly whenever time permitted and wherever his bicycle would take him. Upon graduating from high school in 1988, he received the class Conservation Award and completed an AAS in Natural Resources Conservation (1990) at Finger Lakes College. Scott began a career in fisheries that summer as a seasonal technician for the USFWS and later with the NYSDEC.

Scott returned to college in 2000 after serving four honorable years in the United States Coast Guard. He eventually completed a BS in Fisheries Biology from Humboldt State University in 2004 but not before finishing another four years of USCG reserve duty (including three summers at Sodus Point, 1999-2001) and gaining more fisheries experience with the US Forest Service and HSU. Graduate studies brought Scott back to his home state to research longear sunfish at SUNY Brockport in 2004; soon after he placed second overall on the NYS civil service exam for DEC Biologist 1. In 2005, after three semesters at SUNY Brockport, Scott accepted a permanent position with the DEC in Region 4 (Stamford, NY) where he continues to serve the public in pursuit of fisheries knowledge and his next outdoor adventure.

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EXECUTIVE SUMMARY

Important findings of this study

- The majority of fish assemblages were positively associated with habitat complexity, as indicated by pool type
- The greatest habitat variation (disturbance) occurred at sites near low-head dams and the Erie Canal
- Detrended Correspondence Analysis indicated that fish assemblages were organized in a downstream to upstream direction
- Canonical Correspondence Analysis suggested that water depth was the most important habitat variable for fish species, followed by aquatic vegetation and bank cover
- Multiple Linear Regression suggested that aquatic vegetation was the most important habitat variable for fish species, followed by pool type and substrate composition
- Catch per unit effort was influenced more than fish richness and Simpson's Diversity by stream habitat characteristics such as substrate composition and aquatic vegetation
- Two-thirds (22) of the fish species examined statistically (33) were habitat generalists; 12 were associated with at least one habitat variable; nine were found in similar habitats; six were found in similar basins

- One-third (9) of the fish species with significant statistical relationships in MLR models (27) showed a marked specialization for habitat type, especially for complexity of pool types and abundance of cover
- Overall, aquatic vegetation was most important for stream fishes (greatest number of significant habitat associations), followed by pool type and substrate composition
- Most of the models with significant species-habitat associations were supported by the literature
- Previously undocumented habitat associations were suggested for seven fish species
- The rare longear sunfish was positively associated with slow, shallow water with aquatic vegetation (as expected from the literature), but only 23 were captured (all in the lower basin of the Tonawanda Creek watershed)
- The rare redfin shiner was positively associated with variable streamflow and larger substrate sizes (as expected from the literature) but also with instream wood. Fifty-seven were captured at more sites than expected in Johnson Creek but only six were captured in Tonawanda Creek
- The invasive round goby was positively associated with slower pools, near deeper water, and with bank cover. It was captured in both upstream (below Erie Canal outflows) and downstream (connected to Lake Ontario and the Niagara River in the Johnson and Tonawanda Creek watersheds, respectively), but was not found in the middle sections of the two streams

- Fish species richness has remained high in the study area: ~70% of historically recorded species were captured in this study

Sampling and management recommendations

- Examine an entire stream before choosing representative sampling locations
- Do detailed habitat assessments at many sampling locations
- Collect enough fish and habitat data for robust statistical analyses
- Sample across watersheds and habitat types
- Sample in isolated or unexplored stream reaches
- GPS mark/label habitat details at sampling sites for future GIS applications
- Sample for all fishes, not just sport fishes
- Use multiple gear types when/where applicable to detect more fish species
- Avoid psuedoreplication (e.g., sampling the same sites in time or space) and sampling biases (e.g., low sample sizes or using single gears)
- Be consistent in sampling effort through time and space
- Be adaptable in your study design to account for the many unknowns
- Identify all fishes to species and save voucher specimens for museums
- Note range of exotic fishes and potential sources of propagule pressure
- Note location and specific habitat details where any rare fish are found
- Document anthropogenic disturbances or demands in the study area
- Analyze ecological data using multiple methods on multiple spatial scales
- Quantify habitat complexity using some form of rating model

- Examine statistical associations that may have biological relevance
- Compare spatial changes in habitat using longitudinal profiling of the stream
- Examine changes in fish communities and their habitat, not just fish species
- Research the literature to compare and confirm your findings
- Manage streams for all native and sport fishes, not just the *"useful fish"*
- Collaborate often with other professionals in your field
- Share study results and interesting findings with your colleagues

INTRODUCTION

New York's inland fishes

There are about 180 freshwater fishes in NYS including exotics and hybrids (DEC Statewide Fisheries Database; Appendix I-A), and complex changes have occurred in New York‟s watersheds and fish assemblages across space and time (Carlson and Daniels 2004; Daniels 2004). In the 1800s, breakdowns in watershed integrity began to threaten stream habitats and alter the composition of native fish communities (Smith 1985; Daniels 1993; Carlson and Daniels 2004). Today over 61% of rare fishes in NYS are native stream dwellers (Carlson 2005), accounting for ten of the 19 native species protected by state law (6NYCRR Part 182b; Johnson 1987, see also Appendix I-A). The Erie-Niagara (TCW) and Ontario (JCW) drainages have two of the state‟s highest fish species richnesses, due in part to mixed origins of present day fishes in the large and diverse Laurentian Great Lakes basin (Bailey and Smith 1981; Smith 1985; Carlson and Daniels 2004; Hubbs and Lagler 2004). Fishes native to NYS are those successful at colonizing conditions following retreat of the Wisconsinan glaciers beginning some 14,000 ybp (Smith 1985; Van Diver 1985; Hubbs and Lagler 2004).

During the past 50 years many rivers and streams in North America have experienced an alarming rate of decline (Ono et al. 1983; Fausch et al. 2002) in diversity and abundance (Smith 1979; Trautman 1981; Kuehne and Barbour 1983;

Smith 1985; Tomelleri & Eberle 1990; Lever 1996; Pfleiger 1997; Lyones et al. 2000; Moyle 2002; Carlson 2005; Haslouer et al. 2005; Venter et al. 2006) or extirpation of native stream fishes (Smith 1979; Trautman 1981; Kuehne and Barbour 1983; Smith 1985; Rohde et al. 1994; Lyons et al. 2000; Moyle 2002; Carlson 2005; Venter et al. 2006). A fish species is considered rare when repeated, long-term sampling detects few individuals, and extirpated when its presence can no longer be confirmed anywhere in a state. In NYS, roughly 28% (44 spp.) of native fishes may need conservation attention (Carlson 2005; see Appendix I-A) due to various risks of local or statewide extirpation. Populations of rare fishes are presumed to exist in many NYS waters. Insufficient resources and lack of sampling effort targeting rare or lesser known fishes in NYS has allowed their decline to go mostly unnoticed until recently, and knowledge of small stream fishes in particular is limited (Moore 1927; Smith 1985; Grossman et al. 1998; Werner 2004; Carlson 2001; Carlson and Daniels 2004; Carlson 2005; NYDSEC 2008).

Declining stream fishes

Many anthropogenic activities, often acting synergistically, reduce ecological stability and species diversity in aquatic ecosystems (Gorman and Karr 1978; Smith 1979; Trautman 1981; Ono et al. 1983; Helman et al. 1997; Guy and Brown 2007). Increased siltation from urban/suburban sprawl and poor agricultural practices is a primary cause in the nationwide decline of many stream fishes (Hynes 1970; Scott and Crossman 1973; Clay 1975; Smith 1979; Trautman 1981; Kuehne and Barbour 1983; Ono et al. 1983; Smith 1985; Tomelleri & Eberle 1990; Pflieger 1997; Lyons et al. 2000; Knopf 2002; Carlson 2005). Another major environmental stressor is habitat fragmentation of drainage networks after construction of artificial impoundments (Sheldon 1988; Hansen and Ramm 1994; Eberle et al. 2002; Herbert and Gelwick 2003; Powers et al. 2003; Carlson and Daniels 2004; Closs et al. 2004; Cumming 2004; Gillette et al. 2005). Water pollution, deforestation, stream bank erosion, channelization and other land use practices also cause deleterious impacts on aquatic ecosystems (Ono et al. 1983; NYSDEC 1986; Haslam 1997; Flosi et al. 1998; Taylor and Warren 2001; Gerhard et al. 2005; Roy et al. 2005; Stewart et al. 2005; Lau et al. 2006; Quist et al. 2006; Scott 2006; Guy and Brown 2007). In contrast, canal building has homogenized ichthyofaunas by connecting drainage basins and encouraging the spread of non-native species (Sheldon 1988; Daniels 1993; Daniels 2001; Rahel 2002; Carlson and Daniels 2004; Love and Taylor 2004).

With few exceptions (cf. Smith 1979; Smith 1985; Pfleiger 1997; Moyle 2002), fisheries literature lacks information on specific habitat use or preference of freshwater fishes, especially for small stream-dwellers. Management and conservation of aquatic ecosystems requires the ability to identify species‟ historical, current and potential distributions and their habitat requirements (Argent et al. 2003).

Stream ecology

Lotic ecosystems are long ribbons of aquatic habitat that are inherently difficult to study due to many factors that affect their transfer of mass and energy across the landscape (Fausch et al. 2002). Streams of similar size tend to have similar fish communities (Heithaus and Grame 1997), although warmwater streams typically exhibit more complex hydrological patterns and have higher fish species richness than coldwater streams (Krumholtz 1981; Bain 1990; Nestler 1990). Warmwater streams are those in which the temperature becomes high enough in the summer to curtail the growth, reproduction or survival of salmonids, but allow other fishes to thrive at temperatures up to about 24º C (Krumholtz 1981; Winger 1981; Bain 1990).

Most temperate lotic systems are spatially diverse and temporally stable (Zorn et al. 2002; Love and Taylor 2004) with linear gradients of environmental conditions (Fausch et al. 2002; Herbert and Gelwick 2003; Cumming 2004; Sovan et al. 2005) that profoundly affect their biological assemblages (Angermeier and Schlosser 1989; Heithaus and Grame 1997; Beals 2006; Willis et al. 2006). Longitudinal zonation or succession is a common spatial theme in the ecology of running waters that recognizes common and distinct changes in fish communities and their habitats along a downstream (headwaters to stream mouth) gradient (Sheldon 1911; Huet 1959; Sheldon 1968; Hynes 1970; Whitton 1975; Gorman and Karr 1978; Schlosser 1982; Cvancara 1989; Rahel and Hubert 1991; Herbert and Gelwick 2003; Closs et al. 2004; Love and Taylor 2004; Sovan et al. 2005; McGarvey and Hughes 2008).

In a longitudinal profile, streams typically become larger, gradient and elevation decrease, and discharge increases downstream as tributaries enter (Cvancara 1989). The main channel widens and deepens as the stream constantly modifies its position, resulting in the formation of different stream units, such as riffles and pools, with differing current velocities and substrate particle sizes (Hynes 1970; Winger 1981; Cvancara 1989; Ebert et al. 1990; Zale et al. 1995; Sedell et al. 1990). Warmwater streams usually occur at lower elevations and have cool to warm water in summer, quiet flows, high turbidities, more pools with fewer riffles, smaller sized substrate, rooted and floating aquatic vegetation, sparse shade and cover, and more man-made modifications and exotic species that coldwater streams (Winger 1981).

Pools in streams are defined by deeper water with little if any noticeable current (Whitton 1975; Winger 1981; Platts et al. 1983; Murphy and Willis 1996; Armantrout 1998) and where surface water is calm unless disturbed by wind (Smith 1985). Pool development and depth are among the most significant habitat attributes affecting stream fishes (1964, Sheldon 1968, Evans and Noble 1979, Schlosser 1982; Platts et al. 1983; NYSDEC 1986; Heithaus and Grame1997; Grossman et al. 1998).

Pools in general support more and larger fish than runs or riffles (Whitton 1975; Winger 1981; Angermeier and Schlosser 1989; Butler and Fairchild 2005; Gillette et al. 2005; Sharma and Jackson 2007; McGarvey and Hughes 2008) but a pool‟s proximity to runs or riffles determines habitat suitability for certain stream fishes (Foltz 1990; Quist et al. 2006) by contributing to habitat heterogeneity (Hynes 1970; Gorman and Karr 1978; Schlosser 1982; Angermeier and Schlosser 1989;

Hunter 1991; Pearsons et al. 1992; Brazner and Beals 1997; Buhrnheim and Fernandes 2003; Lau et al. 2006).

Stream systems are complex, and associations between fishes and habitat features vary considerably over spatial and temporal scales (Angermeier 1987; Closs et al. 2004). Habitat complexity (e.g., heterogeneity) typically increases with downstream progression as stream order increases (Gorman and Karr 1978; Schlosser 1987; Ebert et al. 1990; Heithaus and Grame 1997; McGarvey and Hughes 2008) and as fluctuations in physicochemical conditions decrease (Whiteside and McNatt 1972). However, major disturbances in a watershed cause imbalances in the flow regime and alteration to habitat (Whitton 1975; Ono et al. 1983; Herbert and Gelwick 2003; Cumming 2004; Gillette et al. 2005; Lorentz et al 2006), disrupting the natural longitudinal profile of streams and affecting the structure of biological communities (Whitton 1975; Gorman and Karr 1978; Foltz 1990; Lorentz et al 2006).

Fish assemblage dynamics

Various features of physical stream habitat create specific environments (i.e., microhabitats) for shelter, forage, spawning, rearing, etc., which meet the life history needs of stream fishes (Gorman and Karr 1978; Platts et al 1983; NYSDEC 1986; Nestler 1990; Ross 1990; Snyder 1990; Bryan and Routherford 1995; Murphy and Willis 1996; Flosi et al. 1998; Barko et al. 2004; Rippe 2005). Physical habitat commonly influences fish assemblages in lotic systems at various spatial scales

(Whitton 1975; Gorman and Karr 1978; Winger 1981; Angermeier 1987; Angermeier and Schlosser 1989; Bart 1989; Heithaus and Grame 1997; Madejczyk et al. 1997; Pusey et al. 2000; Eros et al. 2003; Lau et al. 2006). For instance, large woody debris stabilizes sinuous streams and increases local habitat diversity (Hunter 1991; Flosi et al. 1998) and complexity (Angermeier and Karr 1994); submerged aquatic vegetation also creates local structural complexity in aquatic systems (Crowder and Cooper 1979; Brazner and Beals 1997). Fish in streams often move in search of optimal microhabitats for survival, growth and reproduction (Helfman et al. 1997).

A common generalization of riverine ecology is that fish species richness increases along a downstream gradient (Winger 1981; Sheldon 1988; Closs et al. 2004) as both stream order (Barila et al. 1981; Heithaus and Grame 1997; Zorn et al. 2002; Herbert and Gelwick 2003; Sovan et al. 2005) and cross sectional area (width x depth) increase (Whiteside and McNatt 1972; Gorman and Karr 1978; Heithaus and Grame 1997; Herbert and Gelwick 2003; Rashleigh 2004; Sovan et al. 2005). Fish species richness usually increases by the addition of new species not their replacement (Kuehne 1962; Sheldon 1968; Whiteside and McNatt 1972; Lotrich 1973; Gorman and Karr 1978; Evans and Noble 1979; Ebert et al. 1990; Rashleigh 2004; Sovan et al. 2005; Esselman et al. 2006). Typically, fish assemblages are most diverse downstream and least diverse upstream (Herbert and Gelwick 2003; McGarvey and Hughes 2008), and this longitudinal trend corresponds with downstream increases in habitat diversity and stream stability (Schlosser 1987).

Fish species diversity (richness and evenness) also changes according to habitat complexity (Whiteside and McNatt 1972; Gorman and Karr 1978, Schlosser 1982; Heithaus and Grame 1997). Fish species diversity is used as an indicator of stream quality (Talmage et al. 2002). Stream fish communities often are heavily impacted by localized hydrological disturbances along the stream continuum (Vannote et al. 1980; Van Diver 1985; Herbert and Gelwick 2003; Closs et al. 2004; Cumming 2004; Love and Taylor 2004), and reductions in fish species diversity often follow changes in stream habitat (Foltz 1990; Powers et al. 2003; Closs et al. 2004; Lorentz et al 2006).

Associating fish assemblages and habitat variables: complicating factors

Fisheries scientists are frequently charged with sampling fish populations to detect changes in the aquatic environment, especially in relation to human activities, and quantitative descriptors of the entire fish assemblage are desired for this purpose (Guy and Brown 2007). The examination of fish assemblage structure (i.e., richness, abundance, distribution) in relation to habitat variables is common in stream ecology (Strahler 1952; Whiteside and McNatt 1972; Berkman and Rabeni 1987; Pusey et al. 2000; Willis et al. 2006).

Stream studies present many challenges for researchers, and problems with sampling designs are also common in the literature. Understanding the patterns of fish assemblages in a watershed is dependent on the spatial scale of study, and coarseness of the sampling design may limit zonation analysis (McGarvey and Hughes 2008). Often only a fragment of the entire ecosystem is covered (Fausch et al. 2002) making it difficult to locate fishes with specific habitat requirements. In addition, the transport of materials and organisms down the hydraulic highway is highly temporal (Fausch et al. 2002), and spatial variation is also high (Gorman and Karr 1978). Substantial variation in habitat (e.g., depth; Powers et al. 2003) reduces the ability to detect statistical associations with fish species or assemblages (Gerhard et al. 2005; McGarvey and Hughes 2008). Biased data may result from the movement of fishes (Shaefer and Kerfoot 2004), unequal sampling effort among sites (unrarified data), and sampling sites not placed uniformly along the longitudinal profile (McGarvey and Hughes 2008). Lastly, Lima-Junior et al. (2006) warn that diversity estimates should be used cautiously to assess environmental conditions as they do not necessarily indicate better conditions of communities living in more preserved (high quality) environments.

Elucidating fish-habitat relationships has proven difficult (Beals 2006), and most comparisons are not statistically robust (Guy and Brown 2007). Many statistical procedures are used to explore and identify significant relationships in highly variable data (Koel 1997). Regression analysis is commonly used but has difficulty handling collinear variables (Beals 2006). Other multivariate methods (Koel 1997), such as ordination (Mathews and Marsh-Mathews 2000; Taylor 2000; Stewart et al. 2002; Barko et al. 2004; Rashleigh 2004; Shaefer and Kerfoot 2004; Gillette et al. 2005;

Willis et al. 2006; Guy and Brown 2007; Sharma and Jackson 2007; McGarvey and Hughes 2008), offer good alternatives for analyzing large data sets (Beals 2006).

Study objectives

This project was funded by the New York State (NYS) Department of Environmental Conservation (DEC) to determine the status of longear sunfish (*Lepomis megalotis*) and redfin shiner (*Lythrurus umbratilis*) in NYS, focusing on the Tonawanda Creek watershed (TCW) and Johnson Creek watershed (JCW) which extend through five counties in northwestern NYS (Maps 1a, 1b). Phase one of this study (Wells and Haynes 2006) dealt with longear sunfish and redfin shiner (species of concern in NYS) and their habitat associations. Phase two, this thesis, evaluates the fish and their assemblages in relation to habitats and disturbances at watershed and sub-watershed (e.g., pool type) scales. Multivariate statistics were used to explore associations with habitat variables for certain fish species and assemblage variables and to test null hypotheses that stream habitat features and fish assemblages are not related in the study streams.

Study area

The Tonawanda Creek (TCW) and Johnson Creek (JCW) watersheds are both warmwater stream systems supporting similar fish assemblages dominated by cyprinids, centrarchids, catostomids and percids. The TCW covers an area 5.6 times larger than the JCW (Table 1) across Erie, Niagara, Genesee, and Wyoming Counties, ultimately draining into the Niagara River (Maps 1b, 2a) via the western portion of the NYS Barge (Erie) Canal („canal" below); see Whitbeck (1928) and Symons (1904). The JCW borders the northeast corner of the TCW mostly in Niagara County and then flows through Orleans County into Lake Ontario (Maps 1b, 3a).

The canal creates hydrologic anomalies in both watersheds. In the TCW near river mile (RM) 11 (Map 2l), stream flow reverses course at times as locks E34 and E35 in Lockport, NY operate (Freeman and Freeman 2004). Also, when the canal is closed in winter, the lower water level results in higher current velocity in lower main stem of Tonawanda Creek above RM 11, further exposing the Pendleton Riffle (Map 2m). East of lock E34, the canal stretches across the upper JCW in Niagara and Orleans Counties (Map 3a) and drains into the watershed via discharge valves or high-water spillways (Maps 3c, 3u).

Geological discontinuities and artificial structures in each watershed (Table 1) were mapped (see Maps 1c, 1d; Series 2, 3) and used to delineate sub-basins (see Table 2). Many discontinuities and artificial structures (i.e., listed dams; Maps 1c, 1d) block the upstream passage of fish. In the TCW, the Onondaga escarpment is exposed at the 6-m high Indian Falls (Map 2mm) (Van Diver 1985; Freeman and Freeman 2002). Farther upstream in Batavia, NY a 2.4-m high dam built in 1912 (Maps 1c, 2a, 2b 2tt) persists, as do the remains of another historic dam (breached) upstream in Attica, NY (Maps 1c, 2a). A total of 108 dams are listed in the DEC"s Master Habitat

Databank (MHDB; Table 3) for the TCW; most are in small tributaries not sampled in this study (Table 1; Map 2a).

The Niagara escarpment parallels NY Route 104, creating a noticeable ridge top (Van Diver 1985) that bisects the upper JCW (Map 3c) north of the canal but does not result in a waterfall. While 18 dams existed at some time in the JCW (MHDB, Table 3), the 3.4-m high dam in Lyndonville, NY built in 1948 (Maps 1d, 3a-d, 3m) currently represents the only impassible barrier for fishes migrating up the main stem Johnson Creek from Lake Ontario. Various technical reports, publications, and websites offer additional information specific to the TCW (Hankinson 1923; Hankinson 1924; Greeley 1929; Wilkinson 1995; FBNR 2004; USACoE 2004), the JCW (Greeley 1940; Lake Plains RC&D 2000; Davenport 2007), or both watersheds (Webster 1980; Van Diver 1985; George et al. 1986; Freeman and Freeman 2002; Freeman and Freeman 2004; Hayes and Wilson 2005; Wells and Haynes 2006).

METHODS

Habitat survey protocol

Physical data on stream habitat conditions were gathered at 68 sites in the TCW and 40 sites in the JCW during the sampling season in 2005 (May-Sep) (see Appendices I-D, I-E). Each sample site included at least one pool but usually also a run or riffle. Pools were the focus of this study because of the affinity of stream-dwelling longear sunfish for pool habitat (see Introduction; Wells and Haynes 2006).

Following similar methods in Murphy and Willis (1996) and Platts et al. (1983), six physical stream habitat variables (Table 4) were assessed: pool type, maximum depth, substrate composition, instream wood, bank cover, and aquatic vegetation. These six variables were selected with regard to longear sunfish habitat preferences (see Wells and Haynes 2006) and ease of visual observation and semi-quantitative estimation in the field.

Depending on location, stream reaches were accessed by motorboat, canoe or on foot. A handheld Global Positioning System (GPS) receiver was used to record locations of sampling sites and landmarks in the study area (see Appendices I-B, I-C, I-D, I-E). Each site and landmark was assigned a river mile (RM) designation to identify the distance upstream from the terminal outlet or stream mouth. Other RM locations (e.g., bridges) were taken from overlays of United States Geological Survey (USGS) quadrangle maps provided by the NYSDEC Bureau of Fisheries (5^{th} floor, 625 Broadway, Albany, NY).

Fish survey protocol

Most of the fish sampling sites in 2005 (Appendices I-D, I-E) were randomly selected from the extensive list of sites with potentially suitable longear sunfish habitat identified in 2004 (see Wells and Haynes 2006; also Appendices I-B, I-C).

However, several new sites with habitat potentially suitable for longear sunfish discovered during fish sampling in 2005 also were sampled.

Sampling methods—. Fish surveys were conducted with guidance from the DEC‟s Centrarchid Sampling Manual (Green 1989). Most occurred during the day between May 17 to September 23, 2005 (see Appendices I-D, I-E). Site length (m) was estimated after 15 min of power-on electrofishing effort at each site. No sites overlapped to prevent pseudo-replication (Hurlbert 1984). Stream width was highly variable over the length of a site and was not recorded to reduce sampling time. Surface water temperature at mid-channel was recorded to the nearest degree Celsius and time of day was noted.

Where depth permitted, SUNY Brockport‟s 18-foot electrofishing boat (Type VI-A Pulsator, Smith-Root, Inc., Seattle, WA, 5000 W generator) was used. Other sites were sampled with a backpack electrofisher (HT-2000, Hall-Tech, Ltd., Toronto, Ontario, Canada) followed by beach seining in water <1.5 m deep. Electricity was dispensed in short bursts, generating 2-6 amperes at a constant 60 Hz pulse rate in single pass electrofishing; voltage output was adjusted regularly for best fish capturing results (range 30-250 VDC). Relatively high conductivity (not measured) in the study area (especially lower basin TCW) prohibited higher outputs. Netting crews varied from one to three people. To maximize coverage, circle runs (up one shoreline, back down the other) were common with the electrofishing boat. Diagonal patterns against stream flow were typical of backpack electrofishing.

Seining was done to improve the effectiveness of collecting small fishes less subject to capture by electrofishing. Two beach seines (13 x 7 ft and 21 x 4 ft; 1/4 in mesh, no bag) and a larger 50 x 6 ft seine (3/8 in mesh, center bag) were used immediately after backpack electrofishing. Seining was conducted parallel and perpendicular to the shoreline until the desired effort (minimum of four effective hauls or about 30 min) was achieved. An effective haul was a pass that caught fish and did not get spoiled by debris. Loose woody debris and rocks were removed from the seine path when necessary to improve sampling efficiency and reduce fish loss, corresponding with Angermeier and Schlosser (1989).

Data collection—. In the field, the objective was to sample fish assemblages at each site, with emphasis on detecting rare and lesser known species, particularly longear sunfish, its hybrids, and redfin shiner. Mostly, specimens were identified to species in the field (cf. Smith 1985; Page and Burr 1991; Knopf 2002; Nelson et al. 2004) and counted. Unknown species, young of the year fishes, and suspected hybrids were preserved in 10% formalin and returned to the laboratory for identification.

Captured fish were placed in a live well before processing. A high and low measurement of total length (TL) with caudal fin compressed was recorded (nearest mm) for each species. For large groups of small fishes, species composition and relative abundance was determined from a representative sample, and total abundance was estimated visually. Weights were only recorded (nearest 0.1 g) for rare fishes. General fish condition was observed and unusual features (e.g., lesions, external parasites) were recorded in field notes. Fish were released alive after processing, at the downstream end of a site, prior to seining after backpack electrofishing, or behind the electrofishing boat, before commencing another run upstream to prevent recapture and avoid pseudo-replication (Hurlbert 1984).

Spatial analysis

The objective of spatial analysis was to map all sites in the TCW and JCW with potentially suitable habitat for longear sunfish, as determined by watershed-wide surveys in 2004 and historical capture locations (see Wells and Haynes 2006). GPS point data collected in the field (Table 3) were downloaded into Garmin MapSource (U.S. TOPO 2000, ver. 3.02) and displayed on topographic maps. GPS coordinate data and their associated field notes were compiled at the end of each field season into a data matrix for the TCW and JCW using Microsoft (MS) Excel (see Appendices I-B, I-C, I-D, I-E). These point data were then saved as comma separated value (csv) files and converted to a readable X-Y data format (text file) for uploading as a Geographical Information System (GIS) layer. Once uploaded and displayed on screen, these point data could then be verified for spatial accuracy then saved as a separate shapefile.

ArcMap 9.1 (ESRI 2006) allowed for detailed spatial imagery of sampling sites in the study area with the assistance from the DEC‟s ArcGIS 9 MHDB (Albany, NY) and the Cornell University Geospatial Information Repository (CUGIR, Ithaca, NY). GIS layers (Table 3) were often confined within the study area and the ArcMap measuring tool was used to verify sampling site locations between known RM markers. Prominent point data layers (Table 3) include major fish barriers, 2005 fish survey sites, 2004-2005 habitat survey sites, rare fish locations for longear sunfish (historical and recent) and redfin shiner (recent), important landmarks and access locations, listed dams (some intact), USGS gauging stations (some abandoned), current DEC fish stocking points, and NYS boat launches. Common shapefiles used in mapping (Table 3) include major civil divisions and watershed boundaries, transportation systems, parks and recreational lands, and hydrologic networks. The 11-digit hydrologic unit code (HUC-11) layer delineated sub-watersheds for the larger TCW (Map 2a). Further delineation of the study area (especially for the JCW; Map 3a) on a sub-basin scale was accomplished using major fish barriers.

Data organization

Habitat and fish assemblage data were compiled into MS Excel spreadsheets for the TCW and JCW watersheds then separated into matrices at the sub-basin and pool type spatial scales (Appendices I-D, I-E) for a closer examination of relationships between variables. Raw habitat data were standardized with a scoring system (Table 4). To avoid observer bias, the author did all habitat variable scoring in the field. A habitat complexity index (HCI) was calculated as the mean of the six habitat variable scores (range 1-4) measured at each site: pool type, maximum depth, substrate size, instream wood, bank cover and aquatic vegetation. Simpson‟s diversity index (SDI, range 0-1) was calculated using the MS Excel diversity add-ins package. To reduce sample variance and promote more robust statistical conclusions, catch per unit effort (CPUE) (15 min of electricity plus minimum 4 seine hauls per site; Table 2) and species richness data, were transformed (square root) to meet assumptions of equal variance and normality.

Statistical analysis

Several important assumptions were inherent in the design of this study and analysis of these data: *1*-Random selection of most fish sampling sites also provided random physical habitat data, *2*-Intensive sampling using multiple techniques at most sites provided a representative sample of a site‟s fish assemblage, and *3*-Intra-stream movement of fishes was minimal during the hot/dry summer of 2005 due to low flows and no flooding events; low water concentrated fish in pools, increasing sampling effectiveness, and stable summer water temperatures negated thermal advantages for fish movement. Fish species comprising ≤1% abundance in a study unit (e.g., sub-basin, pool type) were generally excluded from analyses to reduce analytical complexity. Exceptions to this rule were two native rare fishes (longear sunfish, redfin shiner) and two invasive species, rudd (European exotic, *Scardinius erythrophthalmus*) and round goby (Eurasian exotic, *Neogobius melanostomus*) (see Tables 7, 10) which were examined in each analysis.

Descriptive statistics—. Scatter plots (MS Excel) were created to display watershed-wide spatial changes and overall trends in physical habitat and fish assemblage data for the TCW and the JCW. These graphs show r^2 values and 6^{th} order (maximum possible in Excel) polynomial trend lines, except for water temperature (2^{nd} order). The trend lines and r^2 values are shown for reference only and were not intended to represent statistical significance of survey data in scatter plots.

Detrended Correspondence Analysis—. DCA (PC-ORD; McCune and Mefford 1999) was used to assess fish assemblage structure for fishes with $\geq$1% abundance in the entire TCW and JCW. DCA was used initially to verify that the species data had a unimodal distribution across the environmental gradient (Croft and Fraser 2007) and to determine the best ordination method to further evaluate survey data (Sharma and Jackson 2007). Gradient length measures unimodal species responses along an ordination axis and in turn supports the use of other more detailed spatial analyses of data such as correspondence and canonical correspondence analyses (ter Braak and Smilauer 1998). This technique detrends and rescales all ordinations (species and samples simultaneously) and simplifies results to fit a single visual model geared for ecological data (Hill and Gauch 1980).

DCA results appear as biplots of axis combinations (1-2, 1-3, 2-3) and reveal spatial associations between variables. The axis with the highest cumulative species scores (usually axis 1) best displays species distributions from upstream to downstream in the watershed. Species aligned with each other vertically along horizontal axis 1 are assumed to co-occur across sampling sites in the same basin and species located at the extreme ends of vertical axes 2 or 3 are the result of small sample sizes (Stewart et al. 2002).

Canonical Correspondence Analysis—. CCA (PC-ORD; McCune and Mefford 1999) ordinates species along an environmental gradient constrained by their relationships to standardized environmental variables (e.g., habitat; ter Braak 1986; Palmer 1993) and identifies relationships between variables and species. CCA provides synthetic axes that maximally separate the niches of species (ter Braak and Verdonschot 1995) with the premise that associations with environmental variables represent optimal habitat for the species identified. CCA tends to over-emphasize rare (low sample size) species (ter Braak and Smilauer 1998).

Habitat variables appear in CCA biplots as significantly associated vectors, with their frequency and length determined somewhat by the r^2 cutoff value (set at 0.200 in this analysis). The characteristics of a vector indicate its importance as a variable in the model. Close proximity to an axis or another variable represents a greater association; however, a variable (e.g., a fish species) must be close to the end of the vector before a strong correlation between variables can be assumed. Variables close to the center of the biplot (centroid) are not significant in CCA even if they are directly on a vector. Interpretations of these kinds of ordinations thus can be easily biased by interpreter subjectivity. Axes 1 and 2 are the most interpretable; generally axis 3 should not be considered (Barko et al. 2004).

The spatial associations between individual fish species (≥1% abundance) and the six habitat variables (Table 4) were evaluated at the watershed, sub-basin and pool type scales in the TCW and JCW using CCA. Statistical significance of canonical axes was determined with the standard 1000 Monte Carlo permutations in PC-ORD.

Multiple Linear Regression (MLR)—. Best subsets (BSR) and stepwise (SWR) regressions were performed (Statistix 2003) using the same six habitat variables (Table 4) and spatial scales as in CCA. Objectives were to develop MLR models to compare with the CCA findings, possibly establishing new fish species-habitat associations, and to include evaluations of three fish assemblage variables (CPUE, Fish Richness, Simpson"s Diversity) in relation to the six habitat variables. BSR models with the lowest Mallow"s CP and the highest adjusted r^2 values (highest explanation of variance) were retained and the associated components were further analyzed using backwards SWR to determine statistical significance between the independent (habitat) and the dependent (fish species/assemblage) variables.

RESULTS AND DISCUSSION

Map Products

A total of 91 GIS maps (four introductory, 64 of the TCW, 23 of the JCW; Appendices II-A, II-B, II-C, II-D) were created to show habitat and fish sampling sites, key features in the watersheds, etc. Gaps in map coverage occurred in parts of each watershed because of sampling time constraints. The original fish sampling design for 2005 was to take a stratified random sample of stream locations with and without potentially suitable habitat for longear sunfish (identified in the summer of 2004). Typically only two or three surveys (>1 h each) could be completed each day due to the isolation of many sampling sites (see Maps 2b, 3c) and associated travel times (mostly by canoe). Consequently, the focus of sampling turned to sites (riffle-run-pool) with potentially suitable longear sunfish habitat (pools) that may not be representative of all stream habitats.

Based on natural geologic features and artificial structures (Table 1) in both the TCW (Appendix II-C) and JCW (Appendix II-D), the main stem of Tonawanda Creek was divided into three major sub-basins (lower, middle, and upper including the headwaters; Map 2a) separated by major fish barriers. The smaller main stem of Johnson Creek was divided into two sub-basins (lower and upper including the headwaters; Map 3a) separated by the Lyndonville Dam. The main stem of Tonawanda Creek is a 6^{th} order steam with the six major tributaries: Ellicott, Bull, Ransom, Mud, Murder (T1 of Ledge Creek) and Little Tonawanda Creeks are 4^{th}, 3^{rd}, 4^{th}, 3^{rd}, 5^{th} and 4^{th} order, respectively (Maps 2a, 3a). The main stem of Johnson Creek ultimately becomes a 5^{th} order steam with both the west branch and east branch (Jeddo Creek; Map 3a) attaining 4^{th} order status (Table 1).

Habitat and fish assemblage parameters across watersheds

Overview—. Scatter plots revealed some cyclic patterns and substantial variation in the longitudinal profiles of habitat and fish assemblage variables in both the TCW (Figs. 1a-j) and the JCW (Figs. 2a-j). Descriptive habitat statistics are summarized in Table 5 and all data used in graphing are listed in Appendices I-D, I-E. Overall, 70 fish species were identified (Table 6) with over 27,500 individuals recorded (Table 7) during 48 trips to 108 sampling sites in 2005 (Table 2); 64 species are considered native (two rare) and six exotic (Table 6). Both the TCW and JCW support rich ichthyofaunas dominated by cyprinids, centrarchids, catostomids, and percids (Tables 8-9). The most frequently captured fish were bluntnose minnow, *Pimephales notatus* (11.8%), fathead minnow, *Pimephales promelas* (10.0%), johnny darter, *Etheostoma nigrum* (9.7%), and striped shiner, *Luxilus chrysocephalus* (8.7%).

Tonawanda Creek watershed—. A total of 68 sites were surveyed during 29 trips covering 96 RM of main stem Tonawanda Creek in 2005 (Table 2; Appendix I-E). Sites ranged from the western most extent of the canal at its confluence with the Niagara River (Map 2f), eastward until the canal meets the original main stem of Tonawanda Creek at RM 11.1 (Map 2l), and upstream in Tonawanda Creek past several waterfalls and dams to the headwaters where the east and west forks meet at RM 94.7 (Map 2kkk). Outside of the main stem, sampling in major tributaries (T) was limited to a few locations in the lower basins of Ellicott (T1; Maps 2f-2h), Bull

(T3; Map 2i), Ransom (T6; Map 2k), Murder (T11-1; Maps 2z-2ee), and Little Tonawanda (T32; Maps 2xx-2yy) Creeks, with the farthest upstream sampling site in the east fork (T77; Maps 2kkk-2lll) at RM 96.05.

Surface water temperatures exhibited a classic dome shape over time (r^2 = 0.638; Fig. 1a), ranging from 14 to 27°C during the sampling period, June 2 to September 23, 2005. From downstream to upstream, pool type steadily increased from an average of 1 to an average of 4 (r^2 = 0.475; Fig. 1b). A type 1 pool located just above the Batavia Dam produced a small dip in the trend line at RM 63 (Map 3tt). Maximum depth increased gradually from upstream to downstream (r^2 = 0.346; Fig. 1c), rising sharply in the canal and far lower basin of the TCW up to RM 11.8 (Maps 2l-2m). Although there is much variability across sampling sites for the physical habitat and fish assemblage variables (Figs. 1b-1j), values for sampling sites in the canal (Figs. 1c, 1d, 1i) and sites near Indian Falls or Batavia Dam (Figs. 1c-1d, 1g-1h) often depart from general trends in the TCW. Artificial structures are known to act as a reset mechanism (Vannote et al. 1980) causing the overall stream continuum response to be shifted toward headwaters or seaward depending on the type of perturbation and location in the lotic system.

Several changes in habitat variables were observed, often associated with alterations in the longitudinal zonation within the TCW. Upstream from the canal confluence with Tonawanda Creek at RM 11.4 (Pendleton Riffle, Map 2m), below Indian Falls at RM 47.2 (Map 2mm), and below the Batavia Dam at RM 62.8 (Map 2tt), particle size increased due to rapidly flowing water. As indicated by dips in the substrate size score trend line (Fig. 1d), fines dominate in the lower basin between RM 20-37 (Maps 2v-2gg) and above the Batavia Dam between RM 66-72 (Maps 2vv-2aaa). In these reaches, the stream cuts through the "clay pan", causing continual high turbidity in the main stem of Tonawanda Creek regardless of flow (Freeman and Freeman 2004; Hayes and Wilson 2007). Instream wood (Fig. 1e) peaked in the lower basin at RM 27 and 33 (Maps 2x, 2y) and forested reach above the Batavia Dam at RM 72 (Map 2aaa), corresponding to areas with fine sediment deposition (Fig. 1d) and little aquatic vegetation (Fig. 1g). However, much instream wood was also present in the many logjams that could not be sampled for fish.

CPUE was mostly consistent (12.8 avg.) in the TCW but quite high (range 1.8 to 98.5) in a few places (Fig. 1h). Very high densities of fathead minnow (Appendix I-F) were found below the Batavia Dam near RM 63 (Map 2tt). The fathead minnow is used to control aquatic insects at the Batavia Municipal Wastewater Treatment Plant just upstream (J.M. Haynes, SUNY Brockport, pers. comm.; Map 2ss). CPUE was also quite high at two other sites; 1- in the middle basin at RM 52 (Map 2nn), high counts of river chub (*Nocomis micropogon*) and hornyhead chub (*Nocomis bigutattus*) reflected the distinctive pool-run-riffle habitat below the ruins of Mill Dam (now breached) at Pembroke, NY; and 2- in the east fork (T77) headwaters at RM 96 (Map 2lll) where high numbers of western blacknose dace (*Rhinichthys obtusus*) in riffles were collected along with a few adult brown trout (*Salmo trutta*) in the deeper pocket pools.

Fish richness in the TCW totaled 64 species (range 7-26, avg. 16 per site) (Fig. 1i). Richness values spiked in the lower basin below Indian Falls between RM 41-47 (Maps 2hh-2ll) amongst an intact riparian forest of mature hardwoods and clean gravel substrate in the Tonawanda Nation corridor. Schweizer and Matlack (2005) also found that fish species richness was greatest at undisturbed forested sites away from urban areas. Fish richness also spiked at one pool-run site in the upper basin at RM 90 (Fig. 1i; Map 2jjj), probably a result of a recent shoreline stabilization project (rip-rap) that was providing fish with cover. Simpson"s Diversity Index (SDI) remained relatively constant in the TCW (r^2 = 0.413, Fig. 1j) increasing sharply in the canal (RM 0-11;Map 2l) and gradually above the Batavia Dam (Map 2tt) until dropping at its lowest point in the headwaters at RM 96 (Map 2lll).

Similar to Esselman et al. (2006) longitudinal biotic zonation in the TCW was only weakly supported by these data. Conformity occurred mainly from Batavia Dam to the canal confluence (RM 11-63), where fish richness increased in a downstream direction, similar to other stream studies (Ebert et al. 1990; Heithaus and Grame 1997; Fairchild et al. 1998; Mathews and Marsh-Mathews 2000).

Cyprinidae was the most common family (23 spp.), comprising >60% of all fishes recorded in the TCW followed by centrarchids (16%, 11 spp.), percids (15%, eight spp.), and catostomids (7%, six spp.) (Table 8). These four families represented >98% of all fishes recorded during 2005 surveys (Table 6). Very few species comprised ≥9% of the total abundance over the ten spatial scales analyzed in the TCW (Table 6); 40 of 64 total species (63%) found in the TCW were uncommon and comprised <1% of the total abundance (Table 7). Due to low sample size (only seven sites), fish data from the middle basin were combined with data from the upper basin to form a middle+upper sub-basin (see Table 8).

Johnson Creek watershed—. A total of 40 sites were surveyed during 19 trips and 27.5 RM in main stem Johnson and Jeddo Creeks in 2005 (Table 2; Appendix I-E). Sites ranged from the mouth at Lake Ontario to the Erie Canal overpass. Three sites were sampled in Jeddo Creek (T9), the only major tributary in the upper basin above the village dam in Lyndonville, NY (RM 11.4, Map 3m). The most prominent disruption in the longitudinal stream profile occurs above the Lyndonville Dam, where maximum depth, substrate size score, % instream wood, % aquatic vegetation, and fish richness displayed non-continuous values in the JCW scatter plots (Figs. 2c-2e, 2g, 2i). Spikes in the far upper basin beginning with the canal spillway at 27.5 RM (Map 3u) also reflect disruptions in the normal patterns of downstream succession in maximum depth, % bank cover, and fish richness (Figs. 2c, 2f, 2i).

Surface water temperatures exhibited a classic dome shape over time (r^2 = 0.588; Fig. 2a), ranging from 12 to 28 °C from May 17 to September 21, 2005. Pool type gradually increased (r^2 =0.615; Fig. 2b) from an average of 1 to 4 but several type 1 pools located above the Lyndonville Pond resulted in a large dip in the trend line at RM 11.7 (Map 3n). Maximum depth varied from about 0.5 to 3 m (1.5 m avg.), showed very little correlation with distance upstream (r^2 = 0.187, Fig. 2c), and was greatest in the drowned river mouth near Lake Ontario (mid-channel holes >3.0

m; Maps 3e-3f), at three channelized reaches in the lower basin at RM 4.5, (Map 3h), above the Lyndonville (Johnson; Mill) Pond at RM 11.8 (Map 2n), and in the upper basin at RM 16 (Map 3p).

Substrate size score was fairly constant (range 1-4, 2.2 avg.) with very little relationship to distance upstream on the watershed scale ($r^2 = 0.113$, Fig. 2d) unlike results for the TCW (Fig. 1d). Average particle size generally increased from the main stem outlet at Lake Ontario (RM 0, Map 3e) to below the Lyndonville Dam. This section is punctuated by short, high gradient riffles with larger sized substrates, including a few large boulders that are a navigation hazard to motorboats above the NY Route 18 Bridge in Kuckville, NY (RM 1.4, Map 3f). The lowest substrate size scores were in and above the Lyndonville Pond, a result of the long-term deposition of fine sediments since the completion of the Lyndonville Dam in 1948. Not until RM 16 (Map 3p) did the upper basin streambed again showed a positive upstream trend of greater particulate sizes in conjunction with increased gradient and flow. Additional sampling sites in the headwaters (Map 3a, 3c) would have provided a more complete view of the longitudinal profile of substrate composition in the upper basin of JCW.

Instream wood, bank cover, and aquatic vegetation were absent at many sites in the JCW and showed various strengths of relationship to distance upstream: $r^2 =$ 0.297, 0.533, 0.142, respectively (Figs. 2e-2g). Instream wood averaged 9% per site, and with the exception of one site (RM 4.5, Map 3h) was less than 25% cover across the watershed. However, logjams were common along much of main stem Johnson Creek but were rarely sampled due inaccessibility. Higher values for instream wood

(Fig. 2e) at RM 4-7 (Maps 3h-3j) and above Lyndonville Pond (RM 11.8-12.4; Map 3n) were associated with low substrate size scores (Fig. 2d) representative of fines in depositional areas. Sites with >15% instream wood (Fig. 2e) were twice as common in the upper basin as in the lower basin. This trend may reflect a more extensive riparian zone in the upper basin JCW, but the increased deposition of fines in and above the Lyndonville Pond suggests excessive silt loading inconsistent with a healthy riparian zone. Also, agricultural fields with no buffer zone next to the stream occurred in some areas of the upper basin.

Bank cover, representing good overhead cover for fish, was sparse (12% avg.) in the lower basin JCW (Fig. 2f), but fluctuated above the Lyndonville Dam, peaking in the upper basin at RM 17.5 (Map 3p), 20.5 (Map r), and RM 27.5 (Map 3u). Aquatic vegetation was highly variable (0 to 70%) across the JCW (Fig. 2g), with dense patches of submerged aquatic vegetation in the lower basin above Lake Ontario (RM 1.5-1.9, Maps 3f-3g), in the upper main stem at RM 23 (Map 3s), and T1 of Jeddo Creek (RM 23.5; Map 3w). The slight positive trend in the mid portion of the JCW reflects a peak in aquatic vegetation occurring between RM 11.5-11.8 in the shallow, weed-choked Lyndonville Pond (Maps 3m-3n).

CPUE varied from 2.6-16.0, averaged 6.7, and showed a moderate positive correlation with distance upstream ($r^2 = 0.355$; Fig. 2h), especially in the upper basin. CPUE was somewhat inversely proportional to maximum depth (Fig. 2c). CPUE >12 in the JCW occurred at only one site in the lower basin (RM 2.5; Map 3g) and at four sites scattered in the upper basin at RM 17.5 (Map 3p), 20.6 (Map 3v), 24.3 (Map 3t), and 26 (Map 3u).

Fish richness in the JCW had little correlation to distance upstream (r^2 = 0.193; Fig. 2i). Fish richness totaled 47 species with a range of five to 22 species per site (average of 14). The largest number of species was recorded at RM 7.6 below T3 (Map 3j) and the fewest in the Lyndonville Pond (Map 3m).

Higher values for fish richness and CPUE at RM 27.5 below the canal spillway (Map 3u) correspond with the source for at least one new exotic fish, the round goby, in the upper basin. The construction of an overhead canal allowing main stem Johnson Creek to descend from a high gradient riffle into a concrete raceway (culvert) under the canal that empties into a plunge pool below offers unusual habitat complexity for a headwater sampling site. Overhead shelter provided by this culvert resulted in 50% bank cover (Fig. 2f) and a decrease in aquatic vegetation (Fig. 2g). Simpson‟s Diversity (SDI) remained relatively constant (r^2 = 0.163, Fig. 2j) across the JCW, increasing gradually in the downstream reaches of the lower and upper basins dropping to its lowest point at the Harris Road Bridge (RM 2.5; Map 3g).

Cyprinidae was the most common fish family (15 spp.), comprising >47% of fishes recorded in the JCW, followed by percids (21%; six spp.), centrarchids (16%; six spp.), and catostomids (11%; 4 spp.); see Table 9. These four fish families accounted for >97% of all fishes recorded during 2005 surveys (Table 6). Very few species comprised ≥9% of the total abundance over the seven spatial scales analyzed in the JCW (Table 6); 28 of 47 total species (60%) were uncommon and comprised <1% of the total abundance (Table 7).

Other interesting findings—. Longear sunfish (TCW only) and redfin shiner (TCW and JCW) were the only two rare fishes found in the study (Table 6). Several individuals of these rare species were captured at previously occupied sites, while some were found at new locations during the study (Maps 2d-2e; 3b, 3d). In addition to the 64 native fishes identified in this study (Table 6), adult *Lepomis* hybrids were identified at various sites in the study area; *cyanellus* x *gibbosus* were most common, followed by a few *cyanellus* x *macrochirus* plus one large adult specimen recorded as a longear sunfish now suspected of being a *megalotis* x *gibbosus* hybrid. This fish and most other *Lepomis* hybrids were released alive where they were captured.

Several common carp x goldfish (*Carassius auratus*) crosses displaying an unusual number of barbels (0-2 vs. 4) were the only exotic hybrid found; one of these specimens, captured in Bull Creek (Map 2i), was later identified in the laboratory as a koi, an ornamental carp (Schofield et al. 2005). Of the six exotic fishes found in the study, two were salmonines stocked annually for sport (DEC Stocking Atlas, Albany, NY); including on brown trout in the upper TCW (Maps 2a, 2jjj-2kkk) and steelhead (*Oncorhynchus mykiss*) in the lower JCW (Map 3f). The remaining four species were all invasives: round goby, goldfish, rudd, and several varieties of common carp (Schofield et al. 2005). Scaled carp were most common, but in the TCW mirror and mirror-leather carp forms were present in the lower basin below Rapids, NY (Map 2u) and abundant in the middle basin below the Batavia Dam (Maps 2rr-2tt).

Round goby were found in the far lower basin of the TCW, from the canal upstream to RM 15 (Maps 2i-2p, 2s), and in both the lower and upper basins of the JCW. By September 2005, round goby had spread from Lake Ontario upstream into the main stem of Johnson Creek to RM 4.5 (Maps 3e-h) and found their way downstream about 4 RM below the canal spillway into the west branch of Jeddo Creek (T9-1; Map 3w). A few specimens of goldfish and rudd were also caught in the TCW at sampling sites in lower reaches of Ellicott Creek (Map 2h), Bull Creek (Map 2i), and farther upstream (east) in the canal to Pendleton, NY (Map 2j).

An interesting macroinvertebrate found during daytime boat electrofishing in the canal and lower Tonawanda Creek near Pendleton, NY (Maps 2k, 2l), was the freshwater grass shrimp, *Palaemonetes paludosus* (*exilipes*) (Greeley 1940). An active swimmer, also known as freshwater prawn and ghost or glass shrimp, these native crustaceans were small (about 20-33 mm TL) and translucent with gravid females carrying a patch of conspicuous green eggs under their abdomens. They may be a locally important food source for fishes (Greeley1940).

Detrended Correspondence Analysis (DCA)

Axis 1 was most representative of the downstream to upstream (left to right) distribution of fish species in DCA biplots for the TCW and JCW (Figs. 3a-3b). The importance of axis 1 in the placement of fish species (≥9% abundance) in ordination space (Figs. 3a-3b) corresponds with other studies (Mathews and Marsh-Mathews 2000; Stewart et al. 2002; Barko et al. 2004; Shaefer and Kerfoot 2004; Sharma and Jackson 2007). Axis 2 was not associated with an environmental gradient but may reflect sample size (Stewart et al. 2002). Ordinations are typically interpreted in a relative way, so arbitrary axes units were left out (McCune and Mefford 1999).

Tonawanda Creek watershed—. In the TCW DCA model (68 sampling sites, 27 fish species) three fish assemblages were delineated with vertical bars where gaps appear between species groupings from downstream to upstream along axis 1 (Fig. 3a). Differences between lower basin and headwater species were particularly clear.

Assemblage 1 (Fig. 3a), in the extreme lower basin including the canal reach, supported the largest fish grouping (11 spp.), composed mainly of carp (Cyca) emerald shiner (Noat), spotfin shiner (Cysp), pumpkinseed (Legi), green sunfish Lecy), largemouth bass (Misa), and blackside darter (Pema). All of these fishes (Table 10) were captured in low gradient, meandering, slack water areas near some type of cover (e.g., aquatic vegetation), more characteristic of lentic systems. DCA also placed the two exotics, round goby (Neme) and rudd (Scer), plus two rare fishes, longear sunfish (Leme) and redfin shiner (Lyum), (all <9% abundance) into the lower basin fish assemblage.

Assemblage 2 (Fig. 3a), located farther upstream in the watershed and comparable in fish richness with assemblage 1 (10 spp.), was represented by river chub (Nomi), hornyhead chub (Nobi), bluntnose minnow (Pino), fathead minnow (Pipr), mimic shiner (Novo), rosyface shiner (Noru), rock bass (Amru), smallmouth bass (Mido), johnny darter (Etni), and logperch (Peca). All of these fishes (Table 10) were captured in low to moderate gradient, in slack water near current, and among some type of cover (e.g., large rocks). Habitat in the far upper section of the lower basin (e.g., Tonawanda Nation corridor) upstream into the middle basin of the TCW to Indian Falls exhibits significant gradient change. Although not shown on the biplot, adult walleye (*Sander vitreum*), northern pike (*Esox lucius*), and carp were also present (<9% abundance) in the catches. Carp, a generalist feeder and opportunistic colonizer, was the only exotic fish found in the middle basin, probably due to high propagule pressure (Lockwood et al. 2005) as a long-term invader throughout NYS (Smith 1985; Carlson and Daniels 2004; Werner 2004; Schofield et al. 2005). Very high abundance of both river chub and fathead minnow in the middle basin put them at the extreme ends of axis 2 (Fig. 3a).

Assemblage 3 (Fig. 3a) was located in the upper basin/headwaters region of the geographically diverse TCW (Table 1) and included six species (Table 10) captured in moderate to high gradient, in or near current, sometimes under bank cover (e.g., forest canopy). This habitat typically offers greater complexity (depending on flows) characterized by higher gradient, often cooler water dominated by more distinct and smaller riffle-run-pool stream units with cover such as boulders, undercut banks, or instream wood. The widely dispersed striped shiner (Luch), western blacknose dace (Rhob), creek chub (Seat), central stoneroller (Caan), white sucker

(Caco), and northern hog sucker (Hyni) comprised this assemblage. No exotic fishes were found in the upper basin aside from 36 brown trout, a species that is stocked annually between Varysburg and North Java Station (DEC Stocking Atlas, Albany, NY; Map 2a) and reproduces naturally in the high-quality stream conditions in the far upper basin of the TCW.

Johnson Creek watershed—. In the JCW DCA model (40 sampling sites, 21 fish species), three groupings of fishes were also distinguished from left to right (downstream to upstream) along DCA axis 1 (Fig. 3b), again representing the lower, middle, and headwater fish assemblages.

Assemblage 1 (Fig. 3b), located in the extreme lower basin near the outlet to Lake Ontario, included only four species: emerald shiner (Noat), common carp (Cyca), brown bullhead (Amne), and yellow perch (Pefl), which also showed the greatest spatial variation on axis 2 (due to unequal sample sizes). All of these fishes were captured in low gradient, meandering, slack water areas near shoreline cover (e.g., aquatic vegetation) more characteristic of lentic systems (Table 10). In addition to carp, round goby (<9% total abundance) was the other exotic fish found in the lower basin. High propagule pressure along the southern shoreline of Lake Ontario is the primary cause of recent round goby invasion into the lower basin of the JCW.

Assemblage 2 (Fig. 3b), located farther upstream in the watershed, was the largest fish grouping (10 spp.) composed of bluntnose minnow (Pino), spotfin shiner (Cysp), rock bass (Amru), pumpkinseed (Legi), green sunfish (Lecy), largemouth bass (Misa), smallmouth bass (Mido), and blackside darter (Pema). These fishes (Table 10) were captured in relatively low gradient, slack water areas, with aquatic vegetation or other types of cover (e.g., instream wood, bridges, rip-rap) adjacent to main channel (higher current) areas. Round goby and redfin shiner were placed in this assemblage at the extreme ends of axis 2, probably due to much lower sample sizes compared with other fishes in the grouping. Since round goby was found only in the far lower and far upper sampling sites in the JCW, DCA ordination placed the species (incorrectly) in the mid-reach of the watershed. Redfin shiner were present in both the upper and lower basins but more specimens were found in the far upper section of the lower basin and thus were placed correctly in ordination space (see Table 7).

Assemblage 3 (Fig. 3b) was located in the upper basin of the JCW, which represented a much smaller and less geographically diverse area than the upper TCW (Table 1); the assemblage included seven fishes (Table 10) captured in higher gradient areas, sometimes near current, among a mixture of larger substrates and well defined but short riffle-run-pool habitats with wood. Creek chub (Seat), central stoneroller (Caan), striped shiner (Luch), white sucker (Caco), northern hog sucker (Hyni), greenside darter (Etbl), and Johnny darter (Etni) comprise this assemblage, as do carp and round goby (not shown). Low densities of these two exotics in the upper basin below the canal indicate less than optimal habitat for carp and low propagule pressure from round goby invading eastward from Lake Erie (Michael Goehle, USFWS, Amherst, NY pers. comm.).

Overall, DCA successfully identified large-scale fish assemblage patterns along axis 1 in ordination space for each watershed (Figs. 3a-3b). Many species were common to both watersheds (Table 6). The upper reaches of the TCW and JCW had eight species with ≥9% abundance in common, five of which were found in both watersheds (63%). The lower and middle regions of the JCW resemble the lower region of the TCW with 10/13 species ≥9% abundance in common (69%).

Canonical Correspondence Analysis (CCA)

CCA modeling (PC-ORD, McCune and Mefford 1999) comparing individual fish species (≥9% abundance) and habitat variables (pool type, maximum depth, substrate size score, instream wood, bank cover, and aquatic vegetation; Table 4) produced a total of 62 spatially significant habitat associations for 27 species (25 spp. in TCW; 14 spp. in JCW) from analyses of 17 scales representing two watersheds, seven sub-basins, and four pool types (Table 11). Some associations between habitat variables and both fish species and assemblage variables were examined up to nine times as a result of analyzing the same sites across scales. Species exhibiting an affinity for one or more habitat variables were selected by their spatial orientation to habitat vectors in ordination space (Figs. 4a-4c; Appendices III, IV).

Unfavorably high total inertia and low explained variance were found in the entire basin models for the TCW and JCW, but values for total inertia decreased and explained variance increased in the smaller sub-basin and pool type models

(Appendix I-H). Variance explained more than doubled in the smaller-scale models for the JCW and more than tripled for the TCW. However, significance levels of Monte Carlo eigenvalues and species-environment (habitat variables) correlations were noticeably lower for smaller-scale models versus watershed-scale models, especially in the TCW (Appendix I-H). Statistical robustness of the smaller scale models was limited by sample size (see Table 11).

Establishing relationships between vectors (habitat variables in this case) and objects (fish species in this case) using CCA was highly subjective; so three criteria were used to infer a meaningful relationship between a species and a habitat vector: 1) A species had to be located more than half way toward the end of a vector in at least two of the three biplots (axes 1-2, 1-3, 2-3), 2) A species had to be almost touching a vector in at least one biplot, and 3) If literature was found suggesting a species was specifically associated with a habitat variable and the species was close that habitat (vector) then the association was included in the results listed in Table 11. Using three biplots and the criteria above to determine meaningful relationships was important because species‟ relationships to vectors in 3-dimensional space are not clear in single 2-dimensional biplots (see Figs. 4a-4c; Appendices III, IV).

<u>Example of CCA</u>—. Preliminary exploration of fish-habitat associations used ten models for the TCW (entire basin, five sub-basins, four pool types) and seven models for the JCW (entire basin, two sub-basins, four pool types (Table 11; Figs. 4a-4c and Appendices III, IV). The entire TCW model (68 sampling sites, 27 species) is

used below to illustrate how species-habitat associations were established by CCA (Figs. 4a-4c). The relatively large number of apparent associations also set the stage for further analysis using regression models.

For the entire TCW, species associations with the six habitat variables explain only 18.1% of the cumulative variance. Despite the low explanatory power for species associations, all three axes were significant ($P = 0.001$-0.016) with regard to species-environment correlations. Correlations of the six habitat variables with CCA axes 1-3 on the entire basin and five sub-basin models (Appendix I-H) revealed that pool type is closely correlated (inter-set, $r > 0.500$, absolute value) with at least one axis in all six models (four on axis 1, $r = 0.746$-0.962; one on axis 2, $r = 0.624$), indicating the importance of using pool type as a variable to designate habitat type and spatial scale of analysis.

In the entire TCW biplots (Figs. 4a-4c), the creek chub (Seat) was most closely associated with pool type followed by central stoneroller (Caan) and northern hog sucker (Hyni). The abundance of each species increased as pool type complexity (1-4) ascended upstream (Table 11), indicating that all of these species generally occupied pools with more complexity and nearby current in the TCW, a finding supported by the literature. Although the creek chub is a habitat generalist, persisting in both still and running waters (Cook 1959; Scarola 1973; Eddy and Underhill 1974; McClane 1974; Clay 1975; Pfliegler 1997; Schultz 2004; Knopf 2002), it is known to inhabit pools with adjacent riffles (e.g., type 4 pools) (Scott and Crossman 1973; Clay 1975; Whitworth et al. 1976; Trautman 1981; Pfliegler 1997) where it typically spawns over gravel (Cook 1959; Scott and Crossman 1973; Eddy and Underhill 1974; Whitworth et al. 1976; Phillips et al. 1982; Pfliegler 1997).

Riffle habitat is also preferred by central stoneroller (Cook 1959; Smith-Vaniz 1968; Baxter et al. 1970; McClane 1974; Clay 1975; Whitworth et al. 1976; Smith 1979; Trautman 1981; Smith 1985; Tomelleri and Eberle 1990; Page and Burr 1991; Rohde et al.1994; Pfliegler 1997; Knopf 2002; Schultz 2004; Thomas et al. 2007) and northern hog sucker (Scott and Crossman 1973; Miller and Robison 1973; Eddy and Underhill 1974; McClane 1974; Clay 1975; Smith 1979; Trautman 1981; Phillips et al. 1982; Smith 1985; Tomelleri and Eberle 1990; Page and Burr 1991; Rohde et al. 1994; Pfliegler 1997; Knopf 2002; Hubbs and Lagler 2004). Both species are fluvial specialists (Table 10) requiring running waters to persist; pools with adjacent current likely contributed to their abundance in the TCW. Also, the creek chub and central stoneroller are commonly found together in streams (Cook 1959; Baxter et al. 1970; Clay 1975; Pfliegler 1997; Schultz 2004); the creek chub is one of many species that forages on invertebrate drift flushed from sediments by actively feeding northern hog sucker (Scott and Crossman 1973; Pfliegler 1997; Werner 2004).

The largemouth bass (Misa) was most closely associated with maximum depth, followed by the common carp (Cyca) and the longear sunfish (Leme) (Figs. 4a-4c). The abundance of each species decreased as maximum depth decreased moving upstream (Table 11), indicating that these species generally occupied (i.e., may prefer) deeper waters downstream in the TCW. These results were somewhat supported in the literature. The largemouth bass is a habitat generalist; it typically inhabits slow or quiet water (Cook 1959; Sigler and Miller 1963; Scarola 1973; Miller and Robison 1973; Eddy and Underhill 1974; Whitworth et al. 1976; Smith 1979; Trautman 1981; Phillips et al. 1982; Smith 1985; Tomelleri and Eberle 1990; Rohde et al.1994; Lever 1996; Lyons et al. 2000; Hubbs and Lagler 2004; Schultz 2004; Thomas et al. 2007), is found in the deeper waters of larger streams (Miller and Robison 1973), and generally moves deeper during the day (Sigler and Miller 1963; Pfliegler 1997) and in winter (Scarola 1973). The common carp is also a habitat generalist (Cook 1959; Miller and Robison 1973; Scott and Crossman 1973; McClane 1974; Eddy and Underhill 1974; Whitworth et al. 1976; Smith 1985; Smith 1979; Trautman 1981; Rohde et al.1994; Lever 1996; Pfliegler 1997; Knopf 2002; Moyle 2002; Hubbs and Lagler 2004; Schultz 2004; Schofield et al. 2005; Thomas et al. 2007), often found in quiet, deeper habitats (Sigler and Miller 1963; Pfliegler 1997; Moyle 2002), especially after the spawning period (Cook 1959). It commonly retreats to greater depths when disturbed (Eddy and Underhill 1974). The longear sunfish is often found in larger pools (Clay 1975; Trautman 1981) of large streams or small rivers (Scott and Crossman 1973; Smith 1979; Smith 1985; Tomelleri and Eberle 1990; Page and Burr 1991; Schultz 2004; Springer 2007), often near main channel areas (Pfliegler 1997) where deepwater refugia are more accessible.

Abundance of the hornyhead chub increased with aquatic vegetation, although vegetative cover was mostly low and constant in the TCW (Table 11; Figs. 4a-4c). Hornyhead chub forage on some aquatic plants (Knopf 2002) and are often found in clear, slow moving streams with aquatic vegetation (McClane 1974; Trautman 1981;

Tomelleri and Eberle 1990; Schultz 2004), especially juveniles (Scott and Crossman 1973; Smith 1985; Pfliegler 1997). However, it prefers areas with higher gradient (Smith 1979) and currents (McClane 1974; Smith 1979; Trautman 1981; Knopf 2002; Schultz 2004) where plant growth is usually limited (Hynes 1970; Whitton 1975; Haslam 1997; Fairchild et al. 1998; Closs et al. 2004; Ray et al. 2004).

CCA summary—. Overall, CCA models provided evidence supporting water depth as the most important physical variable examined, accounting for 22% of all species associations with habitat variables across the 7 (JCW) - 10 (TCW) spatial scales explored; aquatic vegetation was a close second (21%) followed by bank cover (18%). Water depth accounted for 32% of all associations in the TCW, with aquatic vegetation and pool type tied for second (19%). However in the JCW, bank cover accounted for the most associations (28%), followed by aquatic vegetation (24%), and substrate composition (20%) (Table 11). Water depth was more variable in the TCW (68 sampling sites) than in the JCW (40 sampling sites); accordingly, depth influenced the combined basins and TCW analyses more than the JCW analysis. Aquatic vegetation was the second most important habitat variable in all of the CCA analyses and likely was the most important habitat variable in the two watersheds.

Findings from other multi-watershed studies have shown distinct differences in stream fish communities at various spatial scales (Madejczyk et al 1998; Power et al. 2003; Rashleigh 2004; Schweizer and Matlack 2005; Van Holt et al. 2006; Lau et al. 2006; Sharma and Jackson 2007), often using CCA ordination techniques

(Mathews and Marsh-Mathews 2000; Taylor 2000; Barko et al. 2004; Rashleigh 2004; Gillette et al. 2005; Willis et al. 2006; McGarvey and Hughes 2008). Many studies emphasized relationships between fish species and environmental conditions (Gorman and Karr 1978; Rabeni 1990; Capone and Kushlan 1991; Poff and Allan 1995; Fairchild et al. 1998; Mathews and Marsh-Mathews 2000; Stewart et al. 2002; Barko et al. 2004; Cumming 2004; Rashleigh 2004; Butler and Fairchild 2005; Sovan et al. 2005; Love and May 2007; Sharma and Jackson 2007), including instream or riparian habitats (Gorman and Karr 1978; Platts et al. 1983; Angermeier 1987; Freeman et al. 1988; Bart 1989; Poff and Allan 1995; Heithaus and Grame 1997; Madejczyk et al. 1997; Talmage et al. 2002; Eros et al. 2003; Power et al. 2003; Gillette et al. 2005; Lau et al. 2006; Quist et al. 2006). Considerable variation in species-habitat associations at various spatial scales reported in the literature are consistent with the findings of this study.

Multiple Linear Regression (MLR)

Preliminary best subsets regression (BSR) modeling for the JCW explored relationships between the six habitat variables (Table 4) and three fish assemblage variables (CPUE, Fish Richness, Simpson‟s Diversity), fish species ≥9% of abundance (by basin, sub-basin and pool type), and the rare (longear sunfish, redfin shiner) and exotic (round goby, rudd) fishes. Because pool type was included in 14 of the 21 (67%) significant preliminary JCW BSR models at the entire basin and sub-basin scales, and because the explanatory power of the models was low at those scales (low adj-r^2 values), survey data were explored further at the sub-basin and pool type scales in both watersheds. Except for the rare and exotic fishes noted above, only those associations in the BSR models that explained ≥20% of the variation (adj-r^2 value) in the data matrices and were statistically significant ($P \leq 0.060$) in the stepwise linear regression (SWR) models (61/135 models run) were included in the results (Table 12) and discussed below. For the TCW and JCW, respectively, 57% (77/135) and 43% (58/135) of the BSR models had adj-r^2 values ≥ 20%. Among the 61 significant SWR models for assemblage variables or species, 80 habitat variables were significantly associated with them across the seven and ten spatial scales in the JCW and TCW, respectively.

Because the analysis was exploratory, the thesis examined all SWR models with $P \leq 0.06$. If a Bonferroni adjustment for $\alpha = 0.06$ had been used in the analysis, the adjusted α (α / n) would have been much more conservative (0.00098 or ≤0.001) and would have eliminated 85% (68/80) of the potentially interesting findings suggested by the SWR models. It is often difficult to balance statistical rigor and ecological meaning, so all potentially significant associations are discussed below.

Across the 17 scales (watershed, sub-basins, pool types) examined in the two watersheds, SWR indicated 80 statistically significant associations with habitat variables, 33 with fish assemblage parameters and 47 with fish species (Table 12.) The habitat features measured for this study were determined by literature review, so it was not surprising to find many significant community/species-habitat associations.

Fish abundance/CPUE is influenced by environmental conditions in streams such as sampling area (Whiteside and McNatt 1972; Green 1989; Page and Burr 1991; Gillette et al. 2005; Van Snik Gray et al. 2005; Sharma and Jackson 2007) and type of stream unit (riffle, run, pool), which affect spatial variations in habitat characteristics (Whitton 1975; Platts et al. 1983; Freeman et al. 1988; Rashleigh 2004; Gerhard et al. 2005; Sedell et al. 1990) and alter fish assemblage dynamics (Orth and Maughan 1982; Buhrnheim and Fernandes 2003; Lau et al. 2006). Total fish abundance (catch) and CPUE (catch/time) are common metrics used to assess fish assemblage data (Gorman and Karr 1978; Angermeier and Karr 1984; Freeman et al. 1988; Green 1989; Capone and Kushlan 1991; Madejczyk et al. 1997; Heithaus and Grame 1997; Mathews and Marsh-Mathews 2000; Pusey et al. 2000; Taylor 2000; Zorn et al. 2002; Herbert and Gelwick 2003; Rashleigh 2004; Gillette et al. 2005; Roy et al. 2005; Stewart et al. 2005; Lau et al. 2006; Willis et al. 2006) as are fish species richness (RICH) (Whiteside and McNatt; Gorman and Karr 1978; Freeman et al. 1988; Capone and Kushlan 1991**;** Hansen and Ramm 1994; Heithaus and Grame 1997; Mathews and Marsh-Mathews 2000; Argent et al. 2003; Herbert and Gelwick 2003; Arrington and Winemiller 2004; Carlson and Daniels 2004; Cumming 2004; Rashleigh 2004; Love and Taylor 2004; Roy et al. 2005; Sovan et al. 2005; Lima-Junior et al. 2006; Lau et al. 2006; Willis et al. 2006; McGarvey and Hughes 2008) and Simpson"s Diversity Index (SDI) (Gorman and Karr 1978; Madejczyk et al 1998; Stewart et al. 2002; Ray et al. 2004).

Specific analyses of fish species and fish assemblage-habitat associations, like those reported in this study (Table 12), are not commonly presented in stream ecology literature. Consequently, the SWR results presented below often have no counterparts in the literature. Therefore, the text includes more general references regarding the importance of current (pool type), water depth, and cover (bank, aquatic vegetation, instream wood) for stream fishes and suggests possible influences that these habitat variables may have on fish species and their assemblages. This approach is based on the paradigm that greater habitat complexity in a given study area (see Gorman and Karr 1978; Crowder and Cooper 1979; Schlosser 1982; Hunter 1991; Hook et al. 2001; Closs et al. 2004; Van Holt et al. 2006), such as obvious changes in physical cover, contributes to and is reflective of habitat diversity (see Bussing and Lopez 1977; Gorman and Karr 1978; Platts et al. 1983; Angermeier and Schlosser 1989; Hunter 1991; Esselman et al. 2006). Such observable changes in habitat quality (see Platts et al. 1983; Rabeni 1990; Haslam 1997; MacCraken and Lebovitz 2005) may have a positive correlation with fish productivity (see Platts et al. 1983; Peterka 1989; Haslam 1997; Hook et al. 2001) and fish assemblage/community structure (see Gorman and Karr 1978; Crowder and Cooper 1979; Heithaus and Grame 1997; MacCraken and Lebovitz 2005; Esselman et al. 2006; Mathews and Marsh-Mathews 2006; Sharma and Jackson 2007). The results and discussion that follow attempt to explain the statistically significant MLR relationships for habitat variables with fish species and with fish assemblage variables found in this study (Table 12).

Catch per unit effort (CPUE)—. There were 21 significant associations between CPUE and the six habitat variables (Table 12); many of them varied according to scale. CPUE was positively associated with pool type (1-4; Table 4) in the entire TCW (r^2 = 0.398; P < 0.001) and entire JCW (r^2 = 0.217; P = 0.001). It was positively associated with maximum depth in the JCW type 3 pools (r^2 = 0. 997; P = 0.007) but was negatively associated with maximum depth in the JCW upper basin (r^2 = 0.628; P = 0.029). These results indicate that fish were generally more abundant and easier to catch in the more complex pools in both watersheds, most notably in the deeper pool-run units in the JCW but not in the shallow JCW headwaters.

Although statistically significant associations between CPUE and pool type and maximum depth were few in this study (Table 12), pool development and depth (see Introduction) are considered to be significant habitat attributes affecting stream fishes, and they are highly associated with one another (see Table 4). Fish are easier to easier to sample in shallow water (Green 1989; Murphy and Willis 1996). Also, shallow water limits access by larger fish (Butler and Fairchild 2005; Gillette et al. 2005; Mathews and Marsh-Mathews 2006; Main et al. 2007; Sharma and Jackson 2007), resulting in a potential for higher densities of smaller fish. Both factors likely caused an increase in CPUE at sites with lower maximum depths (Figs. 1c, 2c; Table 7; Appendices I-F, I-G). Finally, extensive sampling in the expansive and deeper lower basins likely missed many fishes that were too deep or widely scattered for effective electrofishing. In comparison, CPUE increased as water depth decreased upstream in the TCW (Figs. 1c, 1h) and in the JCW (Figs. 2c, 2h).

CPUE was positively associated with substrate size in the TCW middle + upper basins combined ($r^2 = 0.703$; $P = 0.029$), TCW upper basin ($r^2 = 0.686$; $P = 0.031$), TCW tributaries ($r^2 = 0.343$; $P = 0.034$), JCW upper basin ($r^2 = 0.628$; $P = 0.001$), and JCW type 4 pools ($r^2 = 0.408$; $P = 0.021$). However, it was negatively associated with substrate size in the JCW type 3 pools ($r^2 = 0.997$; $P = 0.039$) (Table 12). These results indicate that fish were generally more abundant and easier to catch over larger substrate sizes at various scales except pool-run units in the JCW.

Substrate size in general influences CPUE because it is a primary component of habitat formation and alteration in flowing waters (Hynes 1970; Whitton 1975; Platts et al. 1983; NYSDEC 1986; Freeman et al. 1988; Cvancara 1989; Hunter 1991; Castro 1998; Flosi et al. 1998; Talmage et al. 2002; Closs et al. 2004; Rashleigh et al. 2004; Gillette et al. 2005; Lau et al. 2006; Sharma and Jackson 2007) and often dictates fish assemblage structure, especially in lotic systems (Hynes 1970; Whitton 1975; Gorman and Karr 1978; Angermeier 1987; Folts 1990; Capone and Kushlan 1991; Hunter 1991; Poff and Allan 1995; Zale et al. 1995; Murphy and Willis 1996; Hook et al. 2001; Talmage et al. 2002; Gillette et al. 2005; Roy et al. 2005; Schweizer and Matlack 2005; Sovan et al. 2005; Esselman et al. 2006; Lau et al. 2006; Sharma and Jackson 2007). Substrate size can alter the effectiveness of certain gear types (Freeman et al. 1988; Greene 1989; Foltz 1990; Heithaus and Grame 1997; Talmage et al. 2002; Gillette et al. 2005; Van Snik Gray et al. 2005; Sharma and Jackson 2007) such as seining, which was only possible along shallow margins and largely ineffective among large rocks and boulders in the study area. Larger substrate size was more indicative of the shallow upper watershed sites below falls (Fig. 1d) or dams (Figs. 1d, 2d) consisting mostly of rocks/gravel favoring higher concentrations of fishes, at least when electrofishing. In many areas (Figs. 1d, 2d), suspended fines (silt-sand) were associated with greater depths (Hynes 1970; Whitton 1975; Winger 1981; Cvancara 1989; Sharma and Jackson 2007) and reduced water clarity, which limited the effectiveness of netting fish (Platts et al. 1983; Murphy and Willis 1996; Flosi et al. 1998; Green 1989) reducing the CPUE (Figs. 1h, 2h).

CPUE was positively associated with instream wood in the TCW middle + upper basins combined ($r^2 = 0.703$; $P = 0.058$), but it was negatively associated with instream wood in the entire TCW ($r^2 = 0.398$; $P = 0.052$) and JCW type 3 pools ($r^2 = 0.997$; $P < 0.001$) (Table 12). These results indicate that fish were generally less abundant and more difficult to catch among woody debris in the TCW and in pool-run units in the JCW, but not in the middle or upper basins in the TCW.

CPUE is influenced by woody debris in general (Angermeier and Karr 1984; Murphy and Willis 1996; Heithaus and Grame 1997; Madejczyk et al. 1997; Flosi et al. 1998; Talmage et al. 2002; Powers et al. 2003**;** Quist et al. 2006; Lau et al. 2006), and even though large woody debris frequently provides optimal fish cover in streams (Angermeier and Karr 1984; Hunter 1991; Murphy and Willis 1996; Flosi et al. 1998; Fischenich and Morrow 2000; Talmage et al. 2002; Wheeler and Allen 2003; MacCraken and Lebovitz 2005), especially for young fishes (Trautman 1981; Hunter 1991; Gregory and Bisson 1997; Flosi et al. 1998), it can greatly diminish the effectiveness of sampling (especially seining) (Whiteside and McNatt 1972; Murphy and Willis 1996; Flosi et al. 1998; Powers et al. 2003).

CPUE was negatively associated with bank cover in the TCW canal + adjacent (adj) tributaries (tribs) ($r^2 = 0.205$; $P = 0.059$), JCW lower basin ($r^2 = 0.172$; $P = 0.025$), and JCW type 1 pools ($r^2 = 0.589$; $P < 0.001$) (Table 12). These results indicatefish were generally less abundant and more difficult to catch among bank cover in the TCW canal + adj tribs and in the JCW lower basin and type 1 pools.

In general, CPUE is influenced by bank cover (Hynes 1970; Whitton 1975; Madejczyk et al. 1998; Butler and Fairchild 2005; Schweizer and Matlack 2005), which creates microhabitats for stream fishes (Platts et al. 1983; Capone and Kushlan 1991; Murphy and Willis 1996; Beals 2006; Talmage et al. 2002; Van Holt et al. 2006), provides terrestrial drop-in forage (Vannote et al. 1980; Platts et al. 1983; Hunter 1991; Talmage et al. 2002; Closs et al. 2004), critical rearing habitat for young stream fishes (Trautman 1981; Hunter 1991), and nearshore cover from predators (Platts et al. 1983; Hunter 1991; Murphy and Willis 1996; Rosgen 1996; Flosi et al. 1998; Talmage et al. 2002). However, bank cover can also reduce sampling effectiveness as fish hide in hard to reach places (e.g., undercut banks).

A total of six associations resulted between CPUE and aquatic vegetation (Table 12). CPUE was positively associated with aquatic vegetation in the entire TCW ($r^2 = 0.398$; $P < 0.001$), TCW middle + upper basins combined ($r^2 = 0.703$; $P < 0.001$), TCW upper basin ($r^2 = 0.686$; $P = 0.003$), and TCW type 4 pools ($r^2 = 0.409$; $P < 0.001$). However, CPUE was negatively associated with aquatic vegetation in the

JCW type 3 pools (r^2 = 0.997; P < 0.001). These results indicate that fish were generally more abundant and easier to catch among weedy cover at several scales, except pool-run units in the entire JCW.

In general, CPUE is influenced by aquatic vegetation (Whitton 1975; Platts et al. 1983; Eadie and Kearst 1984; Snyder 1990; Hunter 1991; Brazner and Beals 1997; Haslam 1997; Weaver et al. 1997; Ray et al. 2004; Van Snik Gray et al. 2005), which provides shelter or food for many aquatic organisms (Engle 1988, Jude and Pappas 1992; Murphy and Willis 1996; Rosgen 1996; Haslam 1997; Flosi et al. 1998**;** Van Snik Gray et al. 2005; Lau et al. 2006) and essential habitat for many fishes that require it for at least part of their life cycle (Whitton 1975; Snyder 1990; Haslam 1997; Van Snik Gray et al. 2005; McGarvey and Hughes 2008). However, aquatic vegetation can also reduce sampling effectiveness, resulting in low catches, especially in areas of heavy growth such as weed-choked impoundments (e.g., Lyndonville Pond, JCW), which may also impact foraging efficiency and reduce dissolved oxygen (Brazner and Beals 1997), especially at night.

Fish Richness (RICH)—. There were five significant associations between fish richness and five of the six habitat variables (Table 12). RICH was positively associated with pool type in the TCW tributaries (r^2 = 0.451; P = 0.014), maximum depth in the JCW type 4 pools (r^2 = 0.291; P = 0.050), substrate size in the JCW type 1 pools (r^2 = 0.215; P = 0.054), bank cover in the JCW upper basin (r^2 = 0.213; P = 0.041), and aquatic vegetation in the TCW canal + adj tribs (r^2 = 0.326; P = 0.019).

These results indicate that more fish species generally occupied pools with greater complexity in the TCW tributaries, pool-riffle units with deeper water in the JCW, channelized pools with larger substrate size in the JCW. There was a general affinity for bank cover in the upper basin JCW and weedy cover in the TCW canal + adj tribs.

In general, fish richness increases as stream order increases in a downstream direction by species additions (see Introduction). Lower basins (downstream) have increased stream width (Winger 1981; Foltz 1990), greater depth (Sheldon 1968; Schlosser 1987; Rahel and Hubert 1991; Poff and Allan 1995; Herbert and Gelwick 2003; McGarvey and Hughes 2008), and overall volume (Angermeier and Schlosser 1989; Poff and Allan 1995; Heithaus and Grame 1997; Cumming 2004; Butler and Fairchild 2005), all of which promote greater environmental stability. These conditions also promote more and larger individuals. (Gorman and Karr 1978; Schlosser 1987; Herbert and Gelwick 2003; Sovan et al. 2005; Lau et al. 2006; McGarvey and Hughes 2008). Greater water depth offers essential deepwater refugia to fish during high flow events (Whiteside and McNatt 1972; Gorman and Karr 1978; Angermeier 1987; Murphy and Willis 1996; Main et al. 2007), during over wintering periods (Munther 1970; Orth and Maughan 1982; Hunter 1991; Murphy and Willis 1996; Heithaus and Grame 1997; Butler and Fairchild 2005), and in the presence of piscivores (Platts et al. 1983; Zale et al. 1995; Knight and Gido 2005; Mathews and Marsh-Mathews 2006; Main et al. 2007).

Conversely, water depth is often spatially unstable (Whitton 1975; Gorman and Karr 1978; Schlosser 1982; Schlosser 1987; Capone and Kushlan 1991; Poff and

Allan 1995; Zale et al. 1995; Zorn et al. 2002; Stewart et al. 2002; Herbert and Gelwick 2003; Gillette et al. 2005; Sovan et al. 2005). Upstream pools with greater complexity (e.g., types 3-4) offer smaller but more diverse shallow water habitats (i.e., runs, riffles) where most of the substrate type-dependent (Foltz 1990; Hunter 1991; Murphy and Willis 1996; Haslam 1997) benthic macroinvertebrate productivity occurs in streams (Platts et al. 1983; Haslam 1997). The addition of lotic specialists (Table 10) in these smaller habitats, plus often severe anthropogenic degradation of downstream habitats (e.g., channelization, agriculture) likely resulted in the atypical increase in fish richness moving upstream in the TCW and JCW (see Figs. 1i, 2i).

Fish data recorded from the lower basins of the study area (Table 2) may have falsely indicated a preference for deeper water where extensive boat electrofishing was performed. The potential for oversampling in such habitats due to increased use of larger gear types can result in biased descriptions of fish assemblages (Hynes 1970; Whitton 1975; Hunter 1991; Gillette et al. 2005; Esselman et al. 2006; Lau et al. 2006; Quist et al. 2006). Although this likely occurred, deeper water also limits the effectiveness of capturing fishes.

A number of studies have found positive correlations between fish richness and substrate size (Gorman and Karr 1978; Angermeier and Karr 1984), specifically % fines in MLR models (Roy et al. 2005), and % sand and cobble at different locations suggesting certain abiotic factors are important regardless of geology (Esselman et al. 2006). Fish richness increased in the presence of cover such as undercut banks (Platts et al. 1983; Foltz 1990; Hunter 1991, NYSDEC 1986; Murphy and Willis 1996; Flosi et al. 1998; Butler and Fairchild 2005; Van Holt et al. 2006), although in the JCW upper basin the large under-canal culvert (Maps 3u) likely biased results by substantially increasing "bank cover" (see Fig. 2f). Aquatic vegetation is often limited in streams (Hynes 1970; Whitton 1975; Haslam 1997; Fairchild et al. 1998; Closs et al. 2004; Ray et al. 2004), but was abundant along the margins of the canal + adj tribs later in the 2005 sampling season.

RICH increased just below the Lyndonville Dam and matched that near the mouth at Lake Ontario (Fig. 2i). Unlimited upstream access in the lower basin of the JCW likely allowed large fauna and their young to influence sampling data (Tables 7, 9), a result also reported by Shaefer and Kerfoot (2004).

Simpson"s Diversity Index (SDI)—. There were seven significant associations between SDI and two of the six habitat variables (Table 12). SDI was positively associated with bank cover in the TCW tributaries ($r^2 = 0.285$; $P = 0.053$) and TCW type 3 pools ($r^2 = 0.384$; $P = 0.025$). SDI was also positively associated with aquatic vegetation in the JCW lower basin ($r^2 = 0.198$; $P = 0.017$) and in the JCW type 3 pools ($r^2 = 0.446$; $P = 0.042$). It was negatively associated with aquatic vegetation in the TCW middle + upper basins combined ($r^2 = 0.301$; $P = 0.009$), TCW upper basin ($r^2 = 0.507$; $P = 0.006$), and TCW type 4 pools ($r^2 = 0.223$; $P = 0.013$). These results indicate that fish diversity generally increased with bank cover in the TCW tributaries and pool-run units, and among weedy cover in the lower basin and pool-run units in the JCW, but not in the middle and upper basins or pool-riffle units in the TCW.

Fish diversity often varies with stream location (Hynes 1970; Whitton 1975; Gorman and Karr 1978; Barila et al. 1981; Sheldon 1988; Madejczyk et al. 1997; Pusey et al. 2000) and type of habitat or cover (Gorman and Karr 1978, Schlosser 1982; Brazner and Magnuson 1994, Weaver et al. 1997; Madejczyk et al. 1998; Talmage et al. 2002; Ray et al. 2004; Esselman et al. 2006; Sharma and Jackson 2007). In this study, fish diversity was explained best by small-scale (e.g., basins, pool types) models using MLR where higher pool complexity (e.g., types 3, 4) supported higher species diversity (Van Holt et al. 2006). Although shoreline habitat is an important feature of streams and influences fish diversity (Platts et al. 1983; Foltz 1990; Hunter 1991; Talmage et al. 2002; Van Holt et al. 2006), fish diversity generally increases moving downstream (Winger 1981; Foltz 1990; Heithaus and Grame 1997; Closs et al. 2004) as riparian canopy cover deceases and the stream channel widens (Vannote et al. 1980; Ebert et al. 1990), consequently increasing light penetration supporting submergent aquatic vegetation (Hynes 1970; Whitton 1975; Cvancara 1989). Ray et al. (2004) also used MLR to examine fish communities and found that submerged aquatic vegetation was the most important biological predictor of fish diversity. Similarly, Brazner and Beals (1997) reported that intermediate amounts of diverse and patchy weed cover promoted high fish diversity by attracting fish with increased habitat heterogeneity.

SDI changed little overall in the study watersheds (Figs. 1j, 2j). It increased somewhat in the tributaries and pool-run units of the TCW where bank cover provided more habitats for additional species (e.g., brown trout), especially in the forested headwaters. SDI likely increased in the lower basin and pool-run units in the JCW where excessive growth of submergent and emergent weeds was enhanced by low flows in the summer of 2005. These weeds conceal small-bodied fishes from predators (Brazner and Beals 1997), acting to increase fish diversity.

It is unclear why SDI would decrease as aquatic vegetation increased in the middle and upper basins and in the pool-riffle units of the TCW. Perhaps weedy cover impaired the effective sampling of fishes at these sampling sites or altered niche partitioning favoring more individuals of fewer species (e.g., high densities of the fathead minnow below the Batavia Dam; Table 7).

Johnny darter (Etni)—. There were seven associations between the CPUE of the johnny darter and three of the six habitat variables (Table 12). The johnny darter was positively associated with pool type in the entire JCW ($r^2 = 0.348$; $P < 0.001$), JCW lower basin ($r^2 = 0.590$; $P < 0.001$), and JCW upper basin ($r^2 = 0.328$; $P = 0.012$). It was also positively associated with instream wood in the JCW lower basin ($r^2 = 0.590$; $P = 0.014$); aquatic vegetation in the TCW type 3 pools ($r^2 = 0.406$; $P = 0.021$) and JCW lower basin ($r^2 = 0.590$; $P = 0.025$). It was negatively associated with aquatic vegetation in the TCW type 2 pools ($r^2 = 0.268$; $P = 0.049$). These results indicate that the johnny darter generally occupied pools with different levels of complexity in the JCW, with a general affinity for woody and weedy cover in the lower basin JCW and with weedy cover in pool-run units but not in slow isolated pools in the TCW.

Diverse habitat associations are typical for a habitat generalist like the johnny darter (Scott and Crossman 1973; Eddy and Underhill 1974; Trautman 1981; Phillips et al. 1982; Kuehne and Barbour 1983; Smith 1985; Rohde et al. 1994; Lyons et al. 2000). It is often found adjacent to currents (Scott and Crossman 1973; Miller and Robison 1973; Knopf 2002), occasionally in pools near current breaks (Miller and Robison 1973) or in gravel riffles (Scott and Crossman 1973) and in high gradient streams (Baxter et al. 1970; Miller and Robison 1973; Kuehne and Barbour 1983) or headwaters (Page and Burr 1991; Rohde et al 1994). It is more tolerant of slow water than other darters (Scott and Crossman 1973; Smith 1979; Trautman 1981), resulting in its wide but upstream-heavy distribution in the study streams (see Table 7).

Presence of instream wood in the JCW lower basin (Fig. 2e) had a positive effect on johnny darter CPUE because it perches on logs or near docks (Phillips et al. 1982) and spawns under sticks (Eddy and Underhill 1974) or other submerged (Baxter et al. 1970; Smith 1985; Pflieger 1997) or overhanging debris (Hubbs and Lagler 2004). Presence of aquatic vegetation in both watersheds had a positive effect on the johnny darter, a species that inhabits weedy areas (Scott and Crossman 1973; Trautman 1981). It is unclear why an increase in weedy cover would result in decreased numbers of the johnny darter in the TCW type 2 pools. Perhaps aquatic vegetation impaired the effective capture of this species at these sampling sites.

Creek chub (Seat)—. There were five associations between creek chub CPUE and four of the six habitat variables (Table 12). In the upper basin JCW, the creek chub was positively associated with pool type ($r^2 = 0.752$; $P = 0.013$) and bank cover ($r^2 = 0.752$; $P = 0.003$), but was negatively associated with maximum depth ($r^2 = 0.752$; $P = 0.015$). In the JCW type 4 pools, it was positively associated with bank cover ($r^2 = 0.678$; $P = 0.003$) and aquatic vegetation ($r^2 = 0.678$; $P = 0.015$).

The creek chub generally occupied pools with increased complexity and reduced depth with a general affinity for bank cover in the JCW upper basin and with bank and weed cover in pool-riffle units in the JCW, which are typical habitat associations for this habitat generalist (Cook 1959; Scarola 1973; Eddy and Underhill 1974; McClane 1974; Clay 1975; Pfliegler 1997; Schultz 2004; Knopf 2002). The creek chub is found in pools with adjacent riffles (Scott and Crossman 1973; Clay 1975; Whitworth et al. 1976; Trautman 1981; Pfliegler 1997) where it typically spawns over gravel (Cook 1959; Scott and Crossman 1973; Eddy and Underhill 1974; Whitworth et al. 1976; Phillips et al. 1982; Pfliegler 1997) in shallow water.

The creek chub associates with bank cutouts or tree roots (i.e., bank cover; Smith 1979, Pflieger 1997) and typically inhabits deeper pools with bank cover, especially in winter (Trautman 1981), and as solitary adults during the day (Pflieger 1997). The relatively consistent abundance of bank cover in the upper basin JCW and increased bank cover at the JCW type 4 pools both had a positive effect on creek chub CPUE (Table 12), suggesting it preferred such cover, at least upstream in the JCW.

Upstream aquatic vegetation also had a positive effect on the creek chub (Table 12), at least in the JCW type 4 pools (Map 1d). Although not found to associate directly with aquatic vegetation, it does frequent habitats with submerged aquatic vegetation such as pools (Scott and Crossman 1973; Clay 1975; Whitworth et al 1976; Smith 1979; Trautman 1981; Pflieger 1997; Schultz 2004) with clear water (Cook 1959; Miller and Robison 1973; Scott and Crossman 1973) over softer sediments (Cook 1959; Clay 1975; Whitworth et al 1976; Smith 1979; Trautman 1981; Page and Burr 1991; Rohde et al.1994; Knopf 2002), which were observed in the JCW during the summer of 2005.

Western blacknose dace (Rhob)—. There were four significant associations between the CPUE of western blacknose dace and two of the six habitat variables (Table 12). The western blacknose dace was positively associated with substrate size in the TCW middle + upper basins combined (r^2 = 0.154; P = 0.054), TCW upper basin (r^2 = 0.600; P = 0.008), and TCW tributaries (r^2 = 0.367; P = 0.029). It was also positively associated with aquatic vegetation in the TCW upper basin (r^2 = 0.600; P = 0.051). These results indicate that it generally occupied areas with larger substrate sizes at various scales in the TCW, with a generally affinity for weedy cover in the upper basin TCW.

The literature supports these results; the Western blacknose dace is found near currents over mixed sand or sand-gravel substrates (Whitworth et al. 1976; Smith 1979; Trautman 1981; Tomelleri and Eberle 1990; Rohde et al.1994). Although not often found to associate directly with aquatic vegetation, blacknose dace in general (all sub-species) tolerate stagnant conditions in summer pools (McClane 1974; Shultz 2004), which enhances aquatic vegetation growth in streams (Hynes 1970; Whitton

1975; Haslam 1997; Fairchild et al. 1998; Closs et al. 2004; Ray et al. 2004). These conditions were observed in the TCW during the warm/dry summer of 2005.

Fathead minnow (Pipr)—. There were three significant associations between the CPUE of the fathead minnow and two of the six habitat variables (Table 12). The fathead minnow was positively associated with pool type in the entire TCW (r^2 = 0.043; P = 0.049); and aquatic vegetation in the TCW middle + upper basins combined (r^2 = 0.380; P = 0.003) and in the TCW type 4 pools (r^2 = 0.382; P = 0.003) (Table 12). These results indicate that it generally occupied pools with increased complexity and had an affinity for weedy cover in pool-riffle units in the TCW, which is atypical behavior for this habitat generalist (Sigler and Miller 1963; Baxter et al. 1970; Miller and Robison 1973; Eddy and Underhill 1974; McClane 1974; Smith 1979; Trautman 1981; Phillips et al. 1982; Smith 1985; Page and Burr 1991; Pfliegler 1997; Lyons et al. 2000; Moyle 2002; Thomas et al. 2007).

The fathead minnow prefers sluggish streams (Baxter et al. 1970; Smith 1985, Smith 1979; Werner 2004) and is often found in aquatic vegetation (Baxter et al. 1970; Scott and Crossman 1973; Moyle 2002; Werner 2004). It is a pioneer species and tolerates extreme conditions (e.g., high turbidity, variable flows; Baxter et al. 1970; Scott and Crossman 1973; Eddy and Underhill 1974; Smith 1979; Trautman 1981; Phillips et al. 1982; Tomelleri and Eberle 1990; Page and burr 1991; Pfliegler 1997; Moyle 2002), which were found in various sections of the TCW. It is also a weak competitor with other minnows (e.g., bluntnose minnow) (Smith 1979;

Trautman 1981; Pflieger 1997) as shown by its low numbers throughout the TCW except for high densities in the middle basin of the TCW (Tables 7, 8; Map 3ss) near a source population in the Batavia WTP tertiary treatment ponds, which likely biased these results as a consequence of high propagule pressure.

Sampling sites immediately below the Batavia Dam (Map 3tt) corresponded well with the fathead minnow‟s association with pool-riffle units and weedy cover; both habitat features were observed there in the shallow reach. This area had an atypical spike in % of aquatic vegetation in the TCW (Fig. 1g), which likely created important cover to sustain such abnormally high numbers of fathead minnow.

Emerald shiner (Noat)—. The CPUE of the emerald shiner was negatively associated with bank cover in the JCW type 2 pools ($r^2 = 0.536$; $P = 0.037$), aquatic vegetation in the TCW canal + adj tribs ($r^2 = 0.286$; $P = 0.028$), and aquatic vegetation in the JCW lower basin ($r^2 = 0.194$; $P = 0.018$) (Table 12). These results indicate that it generally occupied isolated pools devoid of bank cover in the JCW and pools devoid of weedy cover in the lower basins of both watersheds, which is typical behavior for this normally pelagic schooling species of larger waters (Scott and Crossman 1973; Eddy and Underhill 1974; Clay 1975; Phillips et al. 1982; Smith 1985; Pfliegler 1997; Knopf 2002; Schultz 2004; Werner 2004).

However, the emerald shiner is found in nearshore waters (Lyons et al. 2000), near the mouths of streams (Cook 1959; Eddy and Underhill 1974; Smith 1979), and frequently ascends streams seasonally (Clay 1975; Smith 1979; Phillips et al. 1982;

Lyons et al. 2000; Knopf 2002) but avoids aquatic vegetation (Trautman 1981) Cvancara 1989; Closs et al. 2004). High densities of this species were observed only in the early June (2005) near the mouths of both streams (Maps 2f, 3e) when weed cover was relatively scarce.

<u>Central stoneroller (Caan)</u>—. The CPUE of the central stoneroller was negatively associated with maximum depth in the JCW upper basin (r^2 = 0.209; P = 0.043) (Table 12), indicating that it generally occupied shallow water above RM 20 where it was captured most often in the JCW (Table 7).

This species is commonly found in creeks and small rivers (Eddy and Underhill 1974; Whitworth et al. 1976; Smith 1979), moving downstream into larger waters during summer and winter (McClane 1974). It is often restricted to riffles or runs (McClane 1974; Clay 1975) where it typically spawns (Cook 1959; Baxter et al. 1970; Miller and Robison 1973; Eddy and Underhill 1974; Whitworth et al. 1976; Smith 1979; Smith 1985; Tomelleri and Eberle1990; Rohde et al.1994; Pflieger 1997; Schultz 2004). It was often abundant in the upper basin of the JCW (Table 7), but absent from most of the lower basin during the summer of 2005.

<u>White sucker (Caco)</u>—. Abundance of the white sucker was negatively associated with maximum depth in the JCW type 3 pools (r^2 = 0.401; P = 0.053) (Table 12), indicating that it generally occupied shallow pool-run units in the JCW, which is typical behavior for this very common habitat generalist (Baxter et al. 1970;

Scarola 1973; Eddy and Underhill 1974; McClane 1974; Clay 1975; Whitworth et al. 1976; Smith 1979; Trautman 1981; Phillips et al. 1982; Smith 1985; Tomelleri and Eberle 1990; Page and Burr 1991; Rohde et al. 1994; Pflieger 1997; Knopf 2002; Hubbs and Lagler 2004; Schultz 2004). Adults of this species are benthic (Scarola 1973; Phillips et al. 1982; Rohde et al. 1994; Pflieger 1997), sometimes found in currents (Scarola 1973; Clay 1975; Tomelleri and Eberle 1990; Page and Burr 1991; Rohde et al. 1994; Werner 2004), and in shallow water (Scarola 1973; Scott and Crossman 1973; Whitworth et al. 1976; Smith 1979; Page and Burr 1991).

Common carp (Cyca)—. The CPUE of the common carp was negatively associated with maximum depth in the JCW type 1 pools ($r^2 = 0.321$; $P = 0.020$) (Table 12), similar to the CCA findings in the TCW discussed above (see Table 11, Figs. 4a-4b). As a habitat generalist, the common carp has opportunistically spread across the U.S., invading most waters (Lever 1996; Schofield et al. 2005). Its absence or limited abundance in the upper basins of the TCW and the JCW during the summer of 2005 (Table 7), was likely due to low propagule pressure (i.e., dispersal blocked by fish barriers) and avoidance of shallow upstream reaches in favor of the security of deepwater refugia downstream.

Golden shiner (Nocr)—. The CPUE of the golden shiner was positively associated with aquatic vegetation in the TCW canal + adj tribs ($r^2 = 0.375$; $P = 0.012$), indicating that it has a general affinity for weed cover (Table 12), a trait typical of this species which spawns exclusively over submergent vegetation (Cook 1959; Miller and Robison 1973; Scarola 1973; Scott and Crossman 1973; Eddy and Underhill 1974; McClane 1974; Smith 1979; Smith 1985; Tomelleri and Eberle1990; Rohde et al 1994; Pflieger 1997; Moyle 2002; Werner 2004), very similar to the exotic rudd (Crossman et al. 1992; Lever 1996; Pflieger 1997; Moyle 2002). In the summer of 2005, both species were found mostly along weedy margins in the extreme lower basin of the TCW (Table 7).

Striped shiner (Luch)—. The CPUE of the striped shiner was positively associated with pool type in the TCW tributaries ($r^2 = 0.423$; $P = 0.018$; Table 12), indicating that it generally occupied pools with increased complexity. As a habitat generalist in streams (Smith 1985), it tolerates moderate flows but avoids extremes such as fast water in riffles and deep, stagnant pools with soft bottoms (Smith 1979; Smith 1985; Schultz 2004). Similar to and often found with other shiners (e.g., redfin; Table 12), it is often found next to but not in main currents, as was the case in the TCW tributaries in 2005, where it forages at all depths (Pflieger 1997).

Bluntnose minnow (Pino)—. The CPUE of the bluntnose minnow was positively associated with pool type in the JCW lower basin ($r^2 = 0.182$; $P = 0.022$), indicating that it generally occupied pools with increased complexity among the slow meandering reach below RM 11 in the JCW (Table 12).

This species is a habitat generalist (Cook 1959; Miller and Robison 1973; Eddy and Underhill 1974; McClane 1974; Smith 1979; Trautman 1981; Phillips et al. 1982; Smith 1985; Page and Burr 1991; Pflieger 1997; Lyons et al. 2000; Knopf 2002), which inhabits pools in smaller waters (Smith 1979; Tomelleri and Eberle 1990) with low to moderate (Whitworth et al. 1976) or higher gradients (Trautman 1981), suggesting use of type 3 or 4 pools upstream in a watershed. However, it is often widespread and abundant (Clay 1975; Smith 1979; Trautman 1981; Pflieger 1997). It accounted for the highest CPUE in the study (Table 7), yet only had one significant habitat association.

Yellow perch (Pefl)—. The CPUE of the yellow perch was negatively associated with bank cover in the JCW type 1 pools ($r^2 = 0.323$; $P = 0.038$), indicating that it generally occupied lower basins devoid of shoreline cover, similar to the emerald shiner (Table 12). The yellow perch is a habitat generalist (Sigler and Miller 1963; Scarola 1973; Scott and Crossman 1973; Eddy and Underhill 1974; McClane 1974; Whitworth et al. 1976; Smith 1979; Phillips et al. 1982; Smith 1985; Tomelleri and Eberle 1990; Rohde et al. 1994; Lyons et al. 2000; Knopf 2002; Hubbs and Lagler 2004; Schultz 2004), yet in streams it is usually restricted to lower gradients (Whitworth et al. 1976; Trautman 1981), preferring areas of slower flows (Sigler and Miller 1963; Scarola 1973; Whitworth et al. 1976; Tomelleri and Eberle 1990; Hubbs and Lagler 2004) or open areas of clear streams (Knopf 2002). Nearly all yellow perch were captured above the drowned river mouth near Lake Ontario in the JCW (Table 7) where bank cover is relatively scarce (Fig. 2f).

Longear sunfish (Leme)—. There were five significant associations between the CPUE of the rare longear sunfish and three of the six habitat variables, even though sample sizes were very low (Table 12). The longear sunfish was negatively associated with pool type in the entire TCW ($r^2 = 0.122$; $P = 0.007$) and maximum depth in the TCW type 2 pools ($r^2 = 0.627$; $P = 0.007$). It was positively associated with aquatic vegetation in the entire TCW ($r^2 = 0.122$; $P = 0.034$), TCW lower basin ($r^2 = 0.084$; $P = 0.025$), and TCW type 2 pools ($r^2 = 0.627$; $P = 0.060$). These results indicate that it generally occupied shallow weedy pools-run units with reduced complexity in the TCW (see Map 2d; Wells and Haynes 2006).

The longear sunfish is commonly found in quiet, sluggish pools (Miller and Robison 1973; Scott and Crossman 1973; Clay 1975; Tomelleri and Eberle1990; Werner 2004), usually at low gradient (Miller and Robison 1973; Trautman 1981; Lyons et al. 2000), and mostly in slow runs (Tomelleri and Eberle1990) and pools with moderate flows (Knopf 2002). It avoids strong current (Smith 1979; Pflieger 1997) and typically is found among aquatic vegetation (Scott and Crossman 1973; McClane 1974; Trautman 1981; Smith 1985; Page and Burr 1991; Pflieger 1997; Hubbs & Lagler 2004; Schultz 2004). Of these results, reductions in weedy cover (e.g., habitat fragmentation) along the stream margins may be an important factor in preventing the longear sunfish from colonizing the lower basin of the TCW above RM 15 (Map 2d, 2s) where none have been documented.

Redfin shiner (Lyum)—. There were five significant associations between the CPUE of the rare redfin shiner and three of the six habitat variables, even though sample sizes were very small (Table 12). The redfin shiner was positively associated with pool type in the JCW lower basin ($r^2 = 0.170$; $P = 0.026$) but was negatively associated with pool type in the JCW upper basin ($r^2 = 0.195$; $P = 0.050$). It was also negatively associated with substrate size in the entire TCW ($r^2 = 0.061$; $P = 0.024$) and TCW lower basin ($r^2 = 0.057$; $P = 0.054$); it was positively associated with instream wood in the JCW type 1 pools ($r^2 = 0.204$; $P = 0.059$). These results indicate that it generally occupied pools with variable complexity depending on scale in the JCW, with a general affinity for instream wood in slow channelized pools in the JCW and over smaller substrate sizes in the TCW (Tables 7, 12).

The redfin shiner is a habitat generalist in streams (Miller and Robison 1973; Page and Burr 1991; Pflieger 1997) occurring in a variety of gradients (Trautman 1981; Smith 1985; Pflieger 1997) from lower basins (Clay 1975; Smith 1979; Trautman 1981; Smith 1985; Werner 2004) up into headwaters (Eddy and Underhill 1974; Page and Burr 1991; Pflieger 1997; Thomas et al. 2007). It is found mostly in sluggish streams (Miller and Robison 1973; Scott and Crossman 1973; Clay 1975; Page and Burr 1991; Hubbs and Lagler 2004) and quiet, turbid pools (Page and Burr

1991). The species is most abundant in pools with some current (Smith 1979) but avoids swift currents (Miller and Robison 1973; Pflieger 1997).

The majority of redfin shiner were captured in the JCW lower basin (Table 7; Map 3d) adjacent to main channel currents (Wells and Haynes 2006) in pools that increased in complexity upstream past the mouth at Lake Ontario (Map 1d). The six individuals captured in the upper basin JCW were limited to the forested, sluggish reach above the Lyndonville Pond (Map 3n). Although the redfin shiner does not appear to associate with woody cover (i.e., no citations found), reduced flow areas in the JCW typically coincided with an intact riparian corridor and the presence of instream wood (Fig. 2e).

Only six redfin shiners were captured in the lower basin of the TCW (Table 7, Map 2e) where the presence of gravel and riprap among the more common silty banks (Fig. 1d) at two of three capture sites (Map 2v) may be biologically relevant, contrary to its general affinity for smaller substrate size (Table 12). Persistence of the redfin shiner in the lower basin TCW is likely due in part to its tolerance for silt and turbidity (Smith 1979; Trautman 1981; Page and Burr 1991; Hubbs & Lagler 2004). As in other states, the redfin shiner is uncommon and widely scattered (Lyons et al. 2000) but its affinity for gravel riffles where it spawns (Miller and Robison 1973; Trautman 1981) may be critical for locating this species, especially in turbid waters.

Round goby (Neme)—. There were five significant associations between the abundance of the exotic round goby and four of the six habitat variables, even though sample sizes were very low (Table 12). The round goby was positively associated with pool type in the JCW lower basin ($r^2 = 0.119$; $P = 0.055$) and maximum depth in the JCW type 3 pools ($r^2 = 0.848$; $P < 0.001$) but was negatively associated with instream wood in the TCW type 1 pools ($r^2 = 0.363$; $P = 0.002$). It was positively associated with bank cover in the TCW type 3 pools ($r^2 = 0.661$; $P = 0.001$) and the JCW upper basin ($r^2 = 0.259$; $P = 0.026$). These results indicate that it generally occupied deeper pools with increased complexity with a general affinity for bank cover in the JCW and the TCW but it avoided woody cover in the slow channelized pools in the TCW.

The round goby is a benthic habitat generalist (Jude et al. 1992; Lyons et al. 2000; Lever 1996; Charlesbois et al. 1997; Hubbs and Lagler 2004; Werner 2004; Sapota 2006; Savino et al. 2007; Bergstrom et al. 2008) ecologically similar to the mottled sculpin (*Cottus bairdii*) (Lever 1996; Vanderploeg et al. 2002) and well adapted for life in North America streams (no air bladder). It is often found in pools with some current (Hubbs & Lagler 2004; Werner 2004; Hensler and Jude 2007); it is more common in deeper water in large lakes (Jude et al. 1992; Vanderploeg et al. 2002; Bergstrom et al. 2008; Dopazo et al. 2008), especially during winter (Jude et al. 1992; Werner 2004). The invasion of round goby into the TCW and JCW from Lakes Erie and Ontario, respectively, (Map 1b) was undocumented before this study. The habitat associations described here may be more indicative of invasion routes than preferences for pool current and depth.

The round goby generally associates with bank cover and is found over complex bottom structure (Jude et al. 1992; Lyons et al. 2000; Vanderploeg et al. 2002; Werner 2004; Bergstrom et al. 2008), usually among nearshore debris (i.e., bank cover) (Jude et al. 1992; Charlesbois et al. 1997; Vanderploeg et al. 2002; Werner 2004; Bergstrom et al. 2008; Reid and Mandrak 2008) such as rip-rap (Cooper et al. 2007) or vertical concrete (e.g., canal) walls (Hensler and Jude 2007). The positive effect of bank cover in the upper basin JCW (Fig. 2f) is likely a consequence of sampling near the under-canal culvert (Map 3u). This site is a vector for entering streams from the overhead canal (as discussed above).

It is unclear why the CPUE of the round goby would decrease as instream wood increased in the TCW type 1 pools (Table 12). Perhaps sampling effectiveness was impaired due to increases of woody debris (Fig 1e) or the round goby had not reached sections of the stream with woody debris during the 2005 study.

Rudd (Scer)—. There were three significant associations between the CPUE of the exotic rudd and two of the six habitat variables, even though sample sizes were very small (Table 12). In the entire TCW, the rudd was negatively associated with substrate size (r^2 = 0.137; P = 0.010) but positively associated with aquatic vegetation (r^2 = 0.137; P = 0.009). It was also positively associated with aquatic vegetation in the TCW type 2 pools (r^2 = 0.503; P = 0.006). These results indicate that it generally occupied pools over smaller substrate size with a general affinity for weed cover in slow isolated pools in the TCW where it was captured only in the canal + adj tributaries (Table 7).

The literature supports these habitat associations. The rudd is commonly found in canals with muddy substrate (Schultz 2004), backwaters (Pflieger 1997; Schofield et al. 2005), and other sluggish areas (Smith 1985; Page and Burr 1991; Lever 1996) over fine sediments in lower basins (Whitton 1975; Platts et al. 1983; Smith 1985; Cvancara 1989; Castro 1998; Closs et al. 2004). Similar to the yellow perch discussed above, the rudd has an affinity for aquatic vegetation (Lever 1996; Pflieger 1997; Schultz 2004; Schofield et al. 2005) where it spawns (Pflieger 1997; Whitton 1975; Werner 2004) and forages (Schofield et al. 2005).

Regression models summary—. Among the three fish assemblage variables (CPUE, fish richness, Simpson‟s Diversity Index) across all 17 spatial scales, CPUE was most often associated with stream habitat variables (all six). CPUE accounted for 64% of the significant fish assemblage-habitat associations, followed by SDI (21%; two habitat variables) and RICH (15%; five habitat variables) (Table 12).

CPUE was significantly associated with one or more habitat variables in 21 SWR models. It was positively associated with substrate composition at five of six scales (3 in the TCW, 2 in the JCW). CPUE was positively associated with aquatic vegetation at four of five scales, all in the TCW, suggesting that weedy cover influenced CPUE more in the TCW than in the JCW. Instream wood and bank cover were negatively correlated with CPUE in five of the six models (three scales each).

Pool type and depth were positively correlated with CPUE in three of four models (two scales each) (Table 12).

Fish species richness was significantly associated with one habitat variable in each of the five significant RICH models. Depth, substrate, and bank cover were positively associated with RICH in the smaller JCW, whereas pool type and aquatic vegetation were positively associated with RICH in the larger TCW (Table 12).

Simpson"s Diversity Index (SDI) was significantly associated with bank cover (2 models) and aquatic vegetation (5 models) (Table 12). Four of the seven associations were positive: bank cover in the TCW (tributaries and type 3 pools) and aquatic vegetation in the JCW (lower basin and type 3 pools). However, SDI was negatively associated in all three models for the TCW (middle + upper basins combined, upper basin, and type 4 pools). SDI was much more variable in the TCW (Fig.1j) than in the JCW (Fig. 2j).

Sixteen fish species (10 in both the TCW and the JCW) were significantly associated with one or more habitat variables (Table 12). Across watersheds, the ubiquitous johnny darter led all species (7 models; 3 habitat variables) with 15% of the significant associations, followed by the creek chub and the round goby (4 models each), and the rare longear sunfish and rare redfin shiner (3 models each).

The longear sunfish had more significant associations (21%) than the other fishes in the TCW (Table 12); it had positive correlations with aquatic vegetation (3 models) and negative correlations with pool type and depth (1 model each). High search efforts for this species may have allowed better identification of relationships even with a small sample size (n = 23 fish). Both common and often abundant, the johnny darter and the creek chub had more significant associations (22% each) than other fishes in the JCW (Table 12). Significant habitat models for other species ranged from one to three associations for each (Table 12).

Overall, aquatic vegetation accounted for the majority of significant habitat associations (32% of all models; Table 12). These results generally agreed with CCA findings (Table 11) and the literature cited above, and they indicate that aquatic vegetation (AV) was probably the most important habitat variable for stream fishes in this study. However, these findings were not equally representative across the study area. AV was important in 47% of the significant models for the TCW but only in 17% for the JCW; this finding supports field observations that weedy cover was much more prevalent and influential in the TCW than in the JCW.

Pool type and substrate composition accounted for 16% and 17%, respectively, of the significant species-habitat associations (Table 12), with pool type more important in the JCW (21%) than in the TCW (12%) and substrate more important in the TCW (21%) than in the JCW (13%). Bank cover accounted for 16% of the significant habitat associations (Table 12) and was more important in the JCW (21%) than in the TCW (10%). Bank cover was much more variable in the JCW (Fig. 2f) than in the TCW (Fig. 1f). Fewer associations with bank cover in the larger TCW than in the JCW suggests a lesser importance as fish cover.

Maximum depth accounted for 11% of the significant associations (Table 12) and was much more important in the JCW (21%) than in the TCW (2%). Depth was more variable in the JCW, with a spike in the headwaters due to the canal influence, but displayed a gradual decrease moving downstream in the TCW (see Figs. 1c, 2c).

Lastly, instream wood accounted for the fewest significant associations among all SWR models, 8% in each watershed (Table 12). Patterns for instream wood were similar for both watersheds (see Figs. 1e, 2e) showing two small humps plus the characteristic spike in the headwaters of the JCW due to the canal influence. Instream wood (e.g., logjams) can impact sampling productivity, as discussed above, but the low amounts of instream wood at most sampling sites in the two watersheds appear not to have influenced fish assemblage variables or species to a great degree.

Similar studies using MLR also indicate high variability and scale-specific results. Effects of site volume and complexity were significant for fish abundance in pools but the nature of riffles was related more to fish richness (Angermeier and Schlosser 1989). Fish species richness has been positively correlated with water depth, substrate composition, and dominance by habitat generalists (Herbert and Gelwick 2003); richness was explained best on a large watershed scale but fish diversity was explained best in small landscape models (Van Holt et al. 2006). Associations between fish diversity and habitat complexity were significant for current and water depth but not for substrate (Gorman and Karr 1978). However, the % of fine sediment was significant for environmentally sensitive fish species in the fish richness models of Roy et al. (2005), whereas boulder configuration was positively correlated with standing crop of smallmouth bass (Rabeni 1990), suggesting it was essential habitat for that species in that stream. In contrast, Ray et al. (2004) reported that much of the variation in fish diversity was explained by submerged aquatic vegetation. Finally, Talmage et al. (2002) reported that relationships between fish communities and variation of instream habitat were positive and linear. Just as the results of this thesis study are confusing across spatial scales, so are results found in stream ecology literature.

Despite high variability in results for fish species and assemblage data (Tables 11, 12; Appendices I-D, I-E), MLR modeling confirmed much of the literature-based knowledge presented for habitat selection by stream fishes and influences on fish assemblages by the six habitat variables measured in this study. Similar to Butler and Fairchild (2005), all models were interpreted as if fish species were using the habitat they were captured in, and species-habitat correlations were assumed from fish occupying sites with such habitat. However, results in Butler and Fairchild (2005) reflect localized species-specific associations without any apparent link to the assemblage as a whole. It appears that species, not fish assemblages, associate with specific habitat variables.

Fish species, assemblages, and habitats

Further comparison of the fish species-habitat associations (CCA, MLR; Tables 11, 12) suggests a trend towards selection of habitats with greater complexity. CCA models showed significant relationships between six fish species and pool type (PT) ten times (PT avg. = 3.3; Table 11). MLR models strengthen these findings (8 species, 11 times; PT avg. = 2.7; Table 12). These results confirm that some stream fishes can be shown to occupy specific habitats and that fish assemblage composition is influenced by local habitat complexity (Gorman and Karr 1978, Schlosser 1982; Barko et al. 2004). Microhabitat specialization created through adaptive or opportunistic use of available habitats by stream fishes (Gorman and Karr 1978; Angermeier and Schlosser 1989; Stewart et al. 2002; Barko et al. 2004; Closs et al. 2004; Rippe 2005; Schweizer and Matlack 2005) is probably a key component of their success in the Tonawanda and Johnson Creek watersheds.

Across the CCA and MLR models, 29 of the 39 fish species examined were significantly associated with at least one habitat variable (Tables 11, 12). Six species (21%) were associated with the same sub-basins by both CCA and MLR (three in each watershed). Nine species (31%) were associated with the same habitat variables by both CCA and MLR, thus strengthening confidence in the associations. The nine fish species-habitat variable matches included mostly habitat generalists: common carp and longear sunfish with maximum depth; johnny darter with instream wood and aquatic vegetation; striped shiner and redfin shiner with pool type; yellow perch with bank cover; fathead minnow with aquatic vegetation; western blacknose dace with substrate; and creek chub with pool type and bank cover (Table 10). In general, the stream ecology literature supports these associations.

Habitat generalists comprised 67% of all fishes examined, including 65% in the TCW and 70% in the JCW (Tables 6, 10). Interpretation of the CCA and MLR models with regard to species-habitat guilds (Vadas and Orth 2001) was difficult and may be misleading because many generalist species are cross-classified or used as indicator species (e.g., tolerant specialists; see Hynes 1970; Orth and Maughan 1982; Heithaus and Grame 1997; Taylor and Warren 2001; Roy et al. 2005; Lau et al. 2006). The findings of this project were consistent with Poff and Allan (1995) and with the general theoretical expectation that environmentally variable lotic ecosystems contain more habitat generalists than do more stable systems (Poff and Ward 1989). However, fluvial specialists are predominately collected from unstable lotic systems (Poff and Allan 1995), and fluvial species tend to be represented by fewer individuals than generalists (Barko et al. 2004), especially in warmwater streams (Nestler 1990) and tributaries (Heithaus and Grame 1997) versus main channel areas. Therefore, it can be postulated that pool type habitats in the TCW and JCW basically are variable systems favoring habitat generalists but diverse enough to support a typically lower number of fluvial specialists (Table 10). This also implies that conditions in the study area are generally undisturbed. However, indications that the JCW fish assemblage (MLR models) may comprise almost 80% habitat generalists is troublesome and may be reflective of major disturbance due to the effects of the Lyndonville Dam (Map 3m).

The high frequency of habitat generalists in this study may also be due in part to a focus on sampling effort targeting centrarchid-friendly pool habitats for longear sunfish during the dry summer of 2005 (see Introduction; Wells and Haynes 2006). Fortunately, the relatively robust sample size (108 sites total; Appendices I-D, I-E) and relatively long sample sites (Table 5) in the study area often included both riffle and run units that acted to standardize survey data. Angermeier and Schlosser (1989) state that riffles are occupied less readily by most fish species, especially adults, as foraging opportunities (i.e., drop-ins and plants) were greater in pools. Literature findings also favor sampling in pools versus riffles to more accurately assess fish assemblage dynamics such as richness and diversity (Sheldon 1968; Schlosser 1982; Angermeier and Karr 1984; Angermeier and Schlosser 1989; Bart 1989).

The round goby is a prime example of how a new habitat generalist can successfully exploit a novel environment. Its introduction and subsequent rapid spread throughout the lower Great Lakes basin and adjacent waters is well documented (Jude et al. 1992; Lever 1996; Lyons et al. 2000; Ricciardi and MacIsaac 2000; Vanderploeg et al. 2002; Charlesbois et al. 1997; Hubbs and Lagler 2004; Werner 2004; Cooper et al. 2007; Hensler and Jude 2007; Savino et al. 2007; Bergstrom et al. 2008; Dopazo et al. 2008; Reid and Mandrak 2008) but limited information exists for the round goby in New York streams. It responded to five of the six habitat variables in the study (not substrate; Tables 11, 12), of which its negative association with bank cover in the JCW upper basin is likely a consequence of an atypical placement in the sheltered headwaters of the JCW, where it would not normally have spread without the connectivity to the canal at RM 27.5 (Map 3u). The round goby is described as being exceptionally aggressive and fecund with a great potential for negatively impacting other small-bodied benthic fishes (see references cited above). Over time, they have the potential to drive small native fishes toward local extirpation via competition for space and food.

Fish species richness is still relatively high (~70%) in the study area compared with historically described ichthyofaunas for each watershed (Hankinson 1924; Moore 1927-1940; Smith 1985; Carlson 2001; Carlson and Daniels 2004; Carlson 2005), although richness has decreased over time (Hankinson 1924; Smith 1985; Carlson and Daniels 2004; Carlson 2005), probably due to the growing list of anthropogenic disturbances that typically act synergistically to cause numerous deleterious impacts on lotic ecosystems (Gorman and Karr 1978; NYSDEC 1986; Poff and Allan 1995; Haslam 1997; Flosi et al. 1998; Taylor and Warren 2001; Eberle et al. 2002; Talmage et al. 2002; Powers et al. 2003; Closs et al. 2004; Love and Taylor 2004; Gerhard et al. 2005; Gillette et al. 2005; Stewart et al. 2005; Roy et al. 2005; Schweizer and Matlack 2005; Lau et al. 2006; Lorentz et al 2006; Quist et al. 2006). One explanation for the decrease in fish species richness in the TCW and JCW may be the general alteration of habitat (considered the number one impact; Ono et al. 1983), despite some replacement by new species, in the most disturbed lower basins.

SUMMARY

This study produced 91 GIS maps (Appendices II A-D) incorporating habitat and fish survey data from 108 sites in the study area. Analyses of these data on entire watershed, sub-basin, and pool type scales produced numerous species-habitat and fish assemblage-habitat associations, many of which have been reported in earlier studies. Consideration of pool type as a scale gave a unique perspective regarding habitat complexity in relation to fish assemblage and species associations because it contained elements of nearby stream unit types (riffle, run), stream velocity (not measured directly), and maximum depth. These local features are important to stream fishes, and watershed level management may be thwarted if finer scale components of streams are disregarded (Talmage et al. 2002).

Sampling issues

Although 2005 was a dry year with low flows, these conditions were advantageous for sampling because lesser depths and increased water clarity permitted easier measuring of habitat variables and capture of fish. Reduced water depth likely concentrated fish in pools and increased representativeness of samples.

Fish identification to species in the field was challenging. Drab-colored females, sympatric species with similar morphology, and allopatric specimens (same species, different watersheds) were challenging to identify, which increased fish handling and processing times in the field. With time field crews became better at identifying fish, which decreased both processing time and fish mortality. The importance of retaining rare and juvenile fish and fish that could not be confidently identified in the field proved invaluable during subsequent laboratory examinations that identified specimens with certainty. Because most specimens for which field identification was uncertain were kept for definitive identification in the laboratory, it is highly probable that most fish captured in this study were properly identified.

Factors influencing fish distributions

Fish assemblages were simpler (fewer species, lower numbers) above lowhead dams in both watersheds, reflecting faunal impacts caused by impounded conditions, although impacts were more dramatic in the JCW (Figs. 2b-2j) than in the TCW (Figs. 1b-1j). This may be a consequence of two factors: 1) the distance upstream to the first impassable barrier (Lyndonville Dam at RM 11.4 in the JCW; Indian Falls at RM 48 in the TCW), and 2) stream conditions below and above each barrier (Greeley 1929; Smith 1985; Wells and Haynes 2006; see also NYSDEC"s Bureau of Fisheries Database). Fewer distinct habitats that would support more fish species exist below (a short reach before entering Lake Ontario) and above (broad lentic environment) the Lyndonville Dam than is the case in the TCW below and above Indian Falls.

Indian Falls (TCW) was the only natural fish barrier examined in the study; it and had less influence on habitat and fish assemblage variables than the low-head dams in Lyndonville and Batavia. The Erie Canal had intermediate effects in both watersheds. Its stable, lentic-like features in the lower basin of the TCW has expanded fish habitat for generalists and may have reduced native specialists (e.g., bigeye chub, *Hybopsis amblops*; Greeley 1929). The interconnectivity of canals disrupts the structure and function of rivers and streams, contributing to the decline of native fishes (Herbert and Gelwick 2003), and has resulted in homogenization of fish assemblages in some NYS waters (Carlson and Daniels 2004).

Consistent catches of bluntnose minnow, fathead minnow, johnny darter, and creek chub in the study area were expected due to their wide distribution and generalist status (Table 10) in warmwater streams (Smith 1985; Page and Burr 1991; Knopf 2002). The 3:1 ratio of habitat generalists to specialists found in the TCW and JCW reflects the variable conditions in the study streams, typically reflected by a dominance of generalists (Poff and Allan 1995; Barko et al. 2004; Closs et al. 2004), especially in warmwater streams (Nestler 1990), and when sampling is focused on pools (Mathews and Marsh-Mathews 2006).

Ongoing eutrophication and allochthonous contamination were observed in both watersheds, yet fish generally appeared to be in good health except for a few common carp and brown bullhead (*Ameiurus nebulosus*) captured with raw lesions around their mouths below the Lyndonville Dam (JCW, Map 3m). The impoundment effects of the Lyndonville Pond above this dam have resulted in a sink for contaminated sediments (Lake Plains RC&D Report 1999; Johnson Pond Restoration Plan 2000). For the TCW, a list of known contaminants is provided by the Buffalo Niagara Riverkeeper (www.bnriverkeeper.org).

Modeling summary

DCA identified watershed-scale, longitudinal fish assemblage structure (Figs. 3a-3b) similar to findings in Stewart et al. 2002, Mathews and Marsh-Mathews 2000, and Shaefer and Kerfoot 2004. In contrast, initial CAA modeling results on a watershed scale were difficult to explain, mostly lacked statistical significance, and had low explanatory power. Expanding CCA modeling to include sub-basin and pool type scales greatly increased the variance explained in the data matrices (Appendix I-H) and counteracted the lack of statistical power common in CCA (Powers et al. 2003). Most findings for CCA and MLR models (Tables 11, 12) were at least partially confirmed by the literature on stream ecology, and aquatic vegetation was consistently the most significant habitat variable, followed by pool type, maximum depth, and bank cover, respectively.

CCA modeling indicated that the white sucker was associated with the most habitat variables in the TCW; the blackside darter was associated with the most habitat variables in the JCW. The johnny darter was associated with the most habitat variables among all MLR models while the rare longear sunfish had the most associations with habitat variables in the TCW, even though sample size was small and patchy. These results suggest that the persistence of the longear sunfish in the lower basin of the TCW is likely due to their generalist behavior. The abundant creek chub and johnny darter dominated all associations with habitat variables in MLR models for the JCW.

The new (i.e., no comparable information in the literature) habitat associations found for seven fish species in this study may reflect the general lack of knowledge about stream fishes, could be area specific, or altogether spurious. Literature for the often-abundant white sucker and creek chub did not support their association with instream wood or bank cover (CCA models) and aquatic vegetation (MLR models).

The remaining five species are normally fluvial specialists and their affinity for instream wood (hornyhead chub, river chub) or bank cover (greenside darter, northern hog sucker, redfin shiner) in the CCA models also lacked literature support.

Total sample size in this study was quite robust (n = 108 sites) compared with many previous one-season studies of fish assemblages reported in the literature but was often low at the sub-basin and pool type scales. Sample size relative to spatial scale is often problematic; both fish richness (Heithaus and Grame 1997; Stewart et al. 2002) and diversity (Love and Taylor 2004) are dependent on sample size. Thus, many of the results reported above had substantial limits on statistical robustness but were examined to identify potentially biologically important habitat associations for species and fish assemblages. Explaining the results of fish assemblage-habitat associations relative to literature references the most challenging part of this thesis. Overall, modeling results reported here support rejecting the null hypotheses that stream fishes were randomly distributed among pool type habitats, and that no apparent fish assemblage structure exists in the study streams.

Research and management

Freshwater fisheries science in general has been driven historically by an angler-based demand for large and abundant gamefish (Quist et al. 2006; Guy and Brown 2007). Localized focus on species-specific management has shifted to a broader eco-region scale and watershed analysis of fish assemblages is now common

(Fausch et al. 2002; Guy and Brown 2007). Small-scale, short-term studies are largely ineffective in providing managers with information and tools at the scales needed to conserve stream fish populations and communities (Fausch et al. 2002). A lack of knowledge of many stream fishes and their habitats underline the importance of studying habitat heterogeneity on larger spatial and temporal scales in these linear aquatic habitats (Fausch et al. 2002).

Stream surveys should focus much more on lesser known native fishes and include more habitat assessment. Use of a simple site rating system, like the one used in this study (Table 4), enables biologists to link fish species and assemblage variables with specific habitat variables. Such data, collected over time, can be used to make important comparisons of the ongoing spatial changes occurring in streams and may help determine why certain fishes are in need of conservation. Once management agencies have enough research data to attend to the habitat needs of rare stream fishes, they can then follow a simple management model (Fig. 5) to protect those species from extirpation.

Conclusion

Noted declines of many native fishes in NYS streams (Carlson 2001; Carlson and Daniels 2004; Carlson 2005; Wells and Haynes 2006) has increased awareness of the need for conservation efforts to maintain biodiversity (Daniels 2004) and to evaluate the current status of rare fishes in NYS. The conservation of stream fishes is an evolving science and requires assessment of entire fish assemblages on different spatial scales. Ono et al. (1983) remark that every species may be necessary to keep an ecosystem intact. Conservation efforts must encompass watersheds, not just stream reaches (Schweizer and Matlack 2005), and that is no simple task. Many stream reaches in the TCW and the JCW are nearly inaccessible and remain unexplored. The detection of rare fishes was a major objective early in this study and its findings have already assisted in restoration efforts for longear sunfish (Reynolds 2007).

Changes in expected fish assemblages can suggest sources of propagule pressure that might cause native fishes to be replaced by exotics (Mills et al. 1993; Mills 1994; Ricciardi and MacIsaac 2000; Kennard et al. 2005; Lockwood et al. 2005). The long-established common carp was the most widespread invasive found in the study area followed by the newly-established round goby. The lack of carp caught in the upper basin TCW may only reflect their avoidance of high gradients (Smith-Vaniz 1968; Eddy and Underhill 1974; McClane 1974; Clay 1975; Whitworth et al. 1976; Trautman 1981) but propagule pressure for upstream carp dispersal also is likely reduced in the TCW due to the numerous dams (Table 1). Along with increased stream aeration, barriers to exotic fish dispersal are two of the most positive impacts of lowhead dams in a watershed (Cumming 2004; Gillette et al. 2005).

Fisheries science and associated public awareness has advanced much in the 75 years since the last watershed-wide fisheries survey was conducted in the TCW (Greeley 1929) and more recently (65 years) in the JCW (Greeley 1940). Fortunately, this study can report that fish assemblages in the two watersheds (Maps 2c, 3c), although missing a few native species (e.g., bigeye chub, TCW; longear sunfish, JCW), are generally intact and remain fit for much more than just "*useful fish*" (Hankinson 1924). With ever-increasing anthropogenic demands being placed on watersheds in NYS, a comprehensive and proactive approach to stream fish management is needed now, more than ever, to help assess and protect these important aquatic habitats and prevent further extirpation of native stream fishes.

LITERATURE CITED

Angermeier, P.L. 1987. Spatiotemporal variation in habitat selection by fishes in small Illinois streams. Pages 52-60 *In* W.J. Matthews and D.C. Heins (eds.), Community and evolutionary ecology of North American stream fish. Univ. of Oklahoma Press, Norman, OK.

Angermeier, P.L., and Karr, J.R. 1984. Relationships between woody debris and fish habitat in a small warmwater stream. Trans. Am. Fish. Soc. 113: 716-726.

Angermeier, P.L., and I.J. Schlosser. 1989. Species-area relationships for stream fish. Ecol. 70: 1450-1462.

Argent, D.G., J.A. Bishop, J.R. Stauffer, Jr., R.F. Carline, and W.L. Myers. 2003. Predicting freshwater fish distributions using landscape-level variables. Fish. Res. 60: 17-32.

Armantrout, N.B. 1998. Glossary of aquatic habitat inventory terminology. Am. Fish. Soc., Bethesda, MD. 152 pp.

Arrington, D.A., and K.O. Winemiller. 2004. Organization and maintenance of fish diversity in shallow waters of tropical floodplain rivers. Pages 25-36 *In* R. Welcomme and T. Petr (eds.), Proceedings of the second Intl. Symp. on the management of large rivers for fisheries (vol. II). Regional Office for Asia and the Pacific, Bangkok, Thailand. RAP Pub. 16.

Bailey R.M., and G.R. Smith. 1981. Origin and geography of the fish fauna of the Laurentian Great Lakes basin. Can. J. Fish. Aquat. Sci. 38: 1539-1561.

Bain, M.B. (ed.) 1990. Ecology and Assessment of Warmwater Streams: Workshop Synopsis. Biol. Rept. USFWS, Alabama Coop. Fish. & Wldlf. Res. Unit, Auburn Univ., Auburn, AL. 44 pp.

Barila, T.Y., R.D. Williams, and J.R. Stauffer, Jr. 1981. The influence of stream order and selected stream bed parameters on fish diversity in Raystown Branch, Susquehanna River Drainage, Pennsylvania. J. Appl. Ecol. 18(1): 125-131.

Barko, V.A., M.W. Palmer, and D.P. Herzog. 2004. Influential environmental gradients and spatiotemporal patterns of fish assemblages in the unimpounded upper Mississippi River. Am. Midland Nat. 152(2): 369-385.

Bart, H.L., Jr. 1989. Fish-habitat association in an Ozark stream. Env. Biol. Fish. 24: 173-186.

Baxter, G. T. and J. R. Simon. 1970. Wyoming fishes. WY Game & Fish Comm. Bull. 4. 168 pp.

Beals, M. 2006. Understanding community structure: a data-driven multivariate approach. Oecologia. 150(3): 484-495.

Bergstrom M.A., Evrard L.M., and A.F. Mensinger. 2008. Distribution, abundance, and range of the round goby, *Apollina melanostoma*, in the Duluth-Superior harbor and St. Louis River estuary, 1998–2004. J. Great Lakes Res. 34(3): 535–543.

Berkman, H.E., and C.F. Rabeni. 1987. Effects of siltation on stream fishes. Env. Biol. Fish. 18:285-294.

Brazner, J.C., and J.J. Magnuson. 1994. Patterns of fish species richness and abundance in coastal marshes and other nearshore habitats in Green Bay, Lake Michigan. Verhandlungen Intl. Vereinigung Limnol. 25: 2098-2104.

Brazner, J.C., and E.W. Beals. 1997. Patterns in fish assemblages from coastal wetland and beach habitats in Green Bay, Lake Michigan: a multivariate analysis of abiotic and biotic forcing factors. Can. J. Fish. Aquat. Sci. (54): 1743-1761.

Bryan, C.B., and D.A. Rutherford. 1995. Impacts on warmwater streams. Guidelines for evaluation, 2nd ed. Warmwater streams committee, Southern Div., Amer. Fish. Soc., Bethesda, MD. 285 pp.

Buffalo Niagara Riverkeeper (formerly Friends of the Buffalo-Niagara Rivers, Inc.) 1250 Niagara Street Buffalo, NY 14213. www.bnriverkeeper.org

Bührnheim, C.M., and C.C. Fernandes. 2003. Structure of fish assemblages in Amazonian rain-forest streams: effects of habitats and locality. Copeia 2: 255-262.

Bussing, W.A., and M.I. Lopez. 1977. Distribución yaspectos ecologicos de los peces de las cuencashidrograficas de Arenal Bebedero y Tempisque, Costa Rica. Revista de Biologia Tropical. 25: 13-37.

Butler, L.H., and G.W. Fairchild. 2005. Response of fish assemblages to winter in two adjacent warmwater streams. Am. Midland Nat. 154: 152-165.

Capone, T.A., and J.A. Kushlan. 1991. Fish community structure in dry-season stream pools. Ecol. 72(3): 983-992.

Carlson, D.M. 1998. Summary of Activities Relating to Management of ETS Fishes (as listed in 1983) from 1995 to Present. NY State Dept. Env. Cons. Albany, NY. 5 pp.

Carlson, D.M. 2001. Species Accounts for the Rare Fishes of New York. NY State Dept. Env. Cons. Albany, NY. 89 pp.

Carlson, D.M. 2005. Species Accounts of the Rare Fishes of New York. NY State Dept. Env. Cons., Div. Fish Wldlf. Mar. Res. Bureau of Fisheries, Endangered Fish Project. 95 pp.

Carlson, D.M., and Daniels, R.A. 2004. Status of fishes in New York: increases, declines and homogenization of watersheds. Am. Midland Nat. (152): 104-139.

Castro, J. 1998. Understanding and managing the physical aspects of streams: a guide for land managers. Western Region Tech. Specialists, USDA Nat. Res. Con. Serv., Portland, OR. 33 pp.

Charlebois, P.M., J.E. Marsken, R.G. Goettel, R.K. Wolfe, D.J. Jude, and S. Rudnicka. 1997. The round goby, *Neogobius melanostomus* (Pallas), a review of European and North American literature. Illinois-Indiana Sea Grant Program and Illinois Natural History Survey. INHS Spec. Publ. No. 20. 76 pp.

Clay, W.M. 1975. The Fishes of Kentucky. KY Dept. Fish & Wldlf. Resources. Frankfort, KY. 416 pp.

Closs, G., B. Downes, and A. Boulton. 2004. Freshwater ecology: a scientific introduction. Wiley-Blackwell. Hoboken, NJ. 240 pp.

Cook, F.A. 1959. Freshwater fishes in Mississippi. Mississippi Game & Fish Comm. 239 pp.

Cooper, M.J., C.R. Ruetz III, D.G. Uzarski, and T.M. Burton. 2007. Distribution of round gobies in coastal areas of Lake Michigan: Are wetlands resistant to invasion? J. Great Lakes Res. 33(2): 303–313.

Croft, M.V., and P. Chow-Fraser. 2007. Use and development of the wetland macrophyte index to detect water quality impairment in fish habitat of Great Lakes coastal marshes. J. Great Lakes Res. Special Issue. 33(3): 172-197.

Crossman, E.J., E. Holm, R. Cholmondeley, and K. Tuininga. 1992. First records for Canada of the rudd, *Scardinius erythrophthalmus*, and the round goby, *Neogobius melanostomus*. Can. Field Nat. 106: 206-209.

Crowder, L.B., and W.E. Cooper. 1979. Structural complexity and fish-prey interactions in ponds: a point of view. Pages 2-10 *In* D. L. Johnson and R.A. Stein (eds.). Response of fish to habitat structure in standing water. North Central Div., Amer. Fish. Soc., Spec. Publ. 6, Bethesda, MD.

Cumming, G.S. 2004. The impact of low-head dams on fish species richness in Wisconsin, USA. Ecol. Appl. 14(15): 1495-1506.

Cvancara, A.M. 1989. At the water's edge: nature study in lakes, streams, and ponds. Wiley Nature Editions, John Wiley & Sons, Inc. New York, NY. 232 pp.

Daniels, R.A. 1993. Creation of the cosmopolitan creek: a history of change in fish assemblages. Clearwater 23(1): 20–24.

Daniels, R.A. 2001. Untested assumptions: the role of canals in the dispersal of sea lamprey, alewife and other fishes in the eastern United States. Env. Biol. Fish. 60: 309–329.

Daniels, R.A. 2004. Freshwater and estuarine fish. New York State Biodiversity Clearinghouse. NYS Biodiversity Project & Biodiversity Res. Inst. www.nybiodiversity.org

Davenport, R. 2007 (Nov.). Big kings in small waters: hidden Lake Ontario tributary treasures. New York Outdoor News, Outdoor News, Inc., Plymouth, MN. www.nyoutdoornews.com

Dopazo, S.N., L.D. Corkum, and N.E. Mandrak. 2008. Fish assemblages and environmental variables associated with gobiids in nearshore areas of the lower Great Lakes. J. Great Lakes Res. 34(3): 450–460.

Eadie, J., and A. Kearst. 1984. Resource heterogeneity and fish species diversity in lakes. Can. J. Zool. 62: 1689-1695.

Eberle, M.E., and J.R. Tomelleri. 1990. Fishes of the central United States. Univ. Press of Kansas, Lawrence, KS. 226 pp.

Ebert, D.J., S.P. Filipek, and K.M. Russell. 1990. Stream Habitat Analysis and Instream Flow Assessment: A State-Federal Effort in Arkansas. Pages 43-44 *In* M.B. Bain, Ecology and Assessment of Warmwater Streams: Workshop Synopsis. Bio. Rept. 90(5). U.S. Fish Wldlf.. Serv., Washington, DC.

Eddy, S., and J.C. Underhill. 1974. Northern fishes. Univ. of Minnesota Press. Minneapolis, MN. 414 pp.

Engle, S. 1988. The role and interactions of submerged macrophytes in a shallow Wisconsin lake. J. Freshwater Ecol. 4: 329-341.

ESRI. 2006. Environmental Systems Research Institute. Danvers, MA 01923. www.esri.com/company/boston.html#ny

Eros, T., Z. Botta-Dukát, and G.D. Grossman. 2004. Patterns of stream fish diversity across five drainages in Mississippi. Southeastern Nat. 3(4): 637-645.

Esselman, P.C., M.C. Freeman, and C.M. Pringle. 2006. Fish-assemblage variation between geologically defined regions and across a longitudinal gradient in the Monkey River Basin, Belize. J. N. Amer. Benthol. Soc. 25(1): 142-156.

Evans, J.W., and R.L. Noble. 1979. The longitudinal distribution of fishes in an east Texas stream. Am. Midland Nat. 101: 333-343.

Fairchild, G.W., R.J. Horwitz, D.A. Nieman, and M.R. Boyer. 1998. Spatial variation and historical change in fish communities of the Schuylkill River drainage, southeast Pennsylvania. Am. Midland Nat. 139: 282-295.

Fausch, K.D., C.E. Torgersen, G.V. Baxter, and H.W. Li. 2001. Landscapes to riverscapes: bridging the gap between research and conservation of stream fishes. Biosci. 52(6): 483-498.

Fischenich, J.C., and J.V. Morrow, Jr. 2000. Streambank Habitat Enhancement with Large Woody Debris. EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-13). U.S. Army Eng. Res. Dev. Ctr., Vicksburg, MS. 15 pp. www.wes.army.mil/el/emrrp

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California Salmonid Stream Restoration Manual. California Dept. Fish & Game, Inland Fish. Div., Sacramento, CA.

Foltz, J.W. 1990. Discharge versus Habitat in Steep-gradient Piedmont Streams. Pages 38-39 *In* M.B. Bain (ed.), Ecology and Assessment of Warmwater Streams: Workshop synopsis. Biol. Rept. 90(5), U.S. Fish Wldlf. Serv., Washington, DC.

Freeman, R., and S. Freeman. 2002. 200 Waterfalls in central and western New York: a finder's guide. Footprint Press, Inc., Englewood, FL. 384 pp.

Freeman, R., and S. Freeman. 2004. Take a paddle: western New York quiet water for canoes & kayaks. Footprint Press, Inc., Englewood, FL. 224 pp.

Garmin. 2002. MapSource-TOPO (ver. 3.02). Olathe, KS 66062

George, C.J., R.A. Daniels, and T.J. Sinnott. 1986. The importance of archives: fish illustrations of the 1926-39 watershed surveys in New York State. Fisheries 11: 2-11.

Gerhard, P., R. Moraes, and S. Molander. 2005. Stream fish communities and their associations to habitat variables in a rain forest reserve in southeastern Brazil. Env. Biol. Fish. 71(4): 321-340.

Gillette, D.P., J.S. Tiemann, D.R. Edds, and M.L. Wildhaber. 2005. Spatiotemporal patterns of fish assemblage structure in a river impounded by low-head dams. Copeia 3: 539–549.

Gorman, O.T., and J.R. Karr. 1978. Habitat structure and stream fish communities. Ecol. 59: 507-515.

Greeley, J.R. 1929. A biological survey of the Erie-Niagara watershed, E. Moore (ed.). Supplement to 18th annual report, State of NY Cons. Dept. Albany, NY.

Greeley, J.R. 1940. A biological survey of the Lake Ontario watershed, E. Moore (ed.). Supplement to 29th annual report. State of NY Cons. Dept. Albany, NY.

Gregory, S.V. and P.A. Bisson. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. Pg. 277-314 *In* D.J. Stouder, P.S. Bisson and R.J. Naiman. 1996. Pacific salmon and their ecosystems: status and future options. Chapman & Hall. New York, NY. 512 pp.

Green, D.M. 1989. Centrarchid Sampling Manual. NY State Dept. Env. Cons. Bureau of Fisheries, Albany, NY. 114 pp.

Grossman, G.D., R.E. Ratajczak, Jr., M. Crawford, and M. C. Freeman. 1998. Assemblage organization in stream fishes: effects of environmental variation and interspecific interactions. Ecol. Monogr. 68(3): 395-420.

Guy, C., and M.L. Brown (eds.). 2007. Analysis and interpretation of freshwater fisheries data. Amer. Fish. Soc., Bethesda, MD. 961 pp.

Hankinson, T.L. 1923. The creek fish of western New York. Copeia 1923: 29-33.

Hankinson, T.L. 1924. A preliminary report on a fish survey in western New York. Bull. Buffalo Soc. of Nat. Sci. 13(3): 57-87. www.sciencebuff.org/research/publications/bulletin/

Hansen, M.J., and C.W. Ramm. 1994. Persistence and stability of fish community structure in a southwest New York stream. Am. Midland Nat. 132(1): 52-67.

Haslam, M.A. 1997. The river scene: ecology and cultural heritage. Cambridge Univ. Press, Cambridge, UK. 344 pp.

Haslouer, S.G., M.E. Eberle, D.R. Edds, K.B. Gido, C.S. Mammoliti, J.R. Triplett, J.T. Collins, D.A. Distler, D.G. Huggins, and W.J. Stark. 2005. Current status of native fish species in Kansas. Trans. Kansas Acad. Sci. 108(1-2): 32-46.

Hayes, J., and A. Wilson. 2007. Quiet water New York: canoe and kayak guide (92nd ed.). Appalachian Mtn. Club Books. Boston, MA. 432 pp.

Heithaus, M.R., and C. Grame. 1997. Fish communities of the Vermillion River watershed: comparison of the main channel and tributaries. Ohio J. Sci. 97(5): 98-102.

Helfman, G.S., B.B. Collette, and D. E. Facey. 1997. The diversity of fishes. Blackwell Science Inc. Malden, MA. 528 pp.

Hensler, S.R., and D.J. Jude. 2007. Diel vertical migration of round goby larvae in the Great Lakes. J. Great Lakes Res. 33: 295–302.

Herbert, M.E., and F.P. Gelwick. 2003. Spatial variation of headwater fish assemblages explained by hydrologic variability and upstream effects of impoundment. Copeia 2003: 273-284.

Hill, M.O., and H.G. Gauch. 1980. Detrended correspondence analysis: an improved ordination technique. Vegetation 42: 47-58.

Hook, T.O., N.M. Eagan, and P.W. Webb. 2001. Habitat and human influences on larval fish assemblages in northern Lake Huron coastal marsh bays. Wetlands 21(2): 281-291.

Hubbs, C.L. and K.F. Lagler (rev. by G.R. Smith). 2004. Fishes of the Great Lakes region. Univ. of Michigan Press, Ann Arbor, MI. 332 pp.

Huet, M. 1959. Profiles and biology of Western European streams as related to fish management. Trans. Am. Fish. Soc. 88: 155-163.

Hunter, C.J. 1991. Better trout habitat. A guide to stream restoration and management. Montana Land Reliance and Island Press. Washington, D.C. 321 pp.

Hurlbert, S.H. 1984. Psuedoreplication and the design of ecological field experiments. Ecol. Monogr. 54: 187-211.

Hynes, H. 1970. The ecology of running waters. Univ. of Toronto Press. Toronto, Ontario, Canada. 555 pp.

Johnson, J.E. 1987. Protected Fishes of the United States and Canada. Amer. Fish. Soc. Bethesda, MD. 42 pp.

Jude, D.J., and J. Papas. 1992. Fish utilization of Great Lakes coastal wetlands. J. Great Lakes Res. 18: 651-672.

Jude, D.J., R.H. Reider and G.R. Smith. 1992. Establishment of Gobiidae in the Great Lakes Basin. Can. J. Fish. Aquat. Sci. 49: 416-421.

Kennard, M.J., A.H. Arthington, B.J. Pusey, and B.D. Harch. 2005. Are alien fish a reliable indicator of river health. Freshwater Biol. 50: 174-193.

Knight, G.L., and K.B. Gido. 2005. Habitat use and susceptibility to predation of four prairie stream fishes: implications for conservation of the endangered Topeka shiner. Copeia 2005: 38–47.

Knopf, A.A. 2002 (rev. ed.). National Audubon Society field guide to fishes of North America. Chanticleer Press, Inc., New York, NY. 608 pp.

Koel, T.M. 1997. Distribution of fishes in the Red River of the north basin on multivariate environmental gradients. Ph.D. dissertation, North Dakota State Univ., Fargo, ND. www.npwrc.usgs.gov/resource/fish/norbasin/index.htm

Krumholtz, L.A. (ed.). 1981. The Warmwater Streams Symposium. Southern Div., Amer. Fish. Soc., Bethesda, MD. 422 pp.

Kuehne, R.A., and R.W. Barbour. 1983. American darters. Univ. Press of Kentucky, Lexington, KY. 208 pp.

Lau, J.K., T.E., Lauer, and M.L. Weinman. 2006. Impacts of channelization on stream habitats and associated fish assemblages in east central Indiana. Am. Midland Nat. 156(2): 319-330.

Lever, C. 1996. Naturalized fishes of the world. Academic Press Inc., San Diego, CA. 408 pp.

Lima-Junior, S.E., I.B. Cardone, and R. Goitein. 2006. Fish assemblage structure and aquatic pollution in a Brazilian stream: some limitations of diversity indices and models for environmental impact studies. Ecol. Freshwater Fish 15(3): 284-290.

Lockwood, J.L., Cassey, P., and T. Blackburn. 2005. The role of propagule pressure in explaining species invasions. Trends Ecol. Evol. 20(5): 223-228.

Lorentz, C.N., D.T. Saalfeld, and S.T. Saalfeld. 2006. Status and changes of Ohio River fish assemblages around William H. Zimmer Power Plant, Moscow, OH. J. Kentucky Acad. Sci. 67(1): 39-46.

Love, J.W., and C. M. Taylor. 2004. Patterns of stream fish diversity across five drainages in Mississippi. Southeastern Nat. 3(4): 637-644.

Love, J.W., and E.B. May. 2007. Relationships between fish assemblage structure and selected environmental factors in Maryland's coastal bays. Northeastern Nat. 14 (2): 251–268.

Lyons, J., P.A. Cochran, and D. Fago. 2000. Wisconsin Fishes 2000: Status and Distribution. Wisconsin Sea Grant, Madison, WI. 100 pp.

MacCracken, J.G., and A.D. Lebovitz. 2005. Selection of in-stream wood structures by beaver in the Bear River, Southwest Washington. Northwest. Nat. 86: 49-58.

Madejczyk, J.C., N.D. Mundahl, and R.M. Lehtinen. 1997. Fish assemblages of natural and artificial habitats within the channel border of the upper Mississippi River. Am. Midland Nat. 139(2): 296–310.

Main, M.B., D.W. Ceilley, and P. Stansly. 2007. Freshwater fish assemblages in isolated south Florida wetlands. Southeastern Nat. 6(2): 343-350.

Mathews, W.J., and E. Marsh-Mathews. 2000. Geographic, terrestrial and aquatic factors: Which most influence the structure of stream fish assemblages in the Midwestern United States? Ecol. Freshwater Fish 9(1-2): 9-21.

Mathews, W.J., and E. Marsh-Mathews. 2006. Persistence of fish species associations in pools of a small stream of the Southern Great Plains. Copeia 2006: 696-710.

McClane, A.J. 1974. McClane's field guide to freshwater fishes of North America. Henry Holt and Company, Inc., New York, NY. 212 pp.

McCune, B., and M.J. Mefford. 1999. Multivariate analysis of ecological data. PC-ORD ver. 4.0. MJM Software. Gleneden Beach, OR.

McGarvey, D.J., and R.M. Hughes. 2008. Longitudinal zonation of Pacific Northwest (USA) fish assemblages and the species-discharge relationship. Copeia 2008: 311-321.

Miller, R.J., and H.W. Robison. 1973. The fishes of Oklahoma. OK State Univ. Press., Stillwater, OK. 246 pp.

Mills, E.L., J.H. Carlton, and C.L. Secor. 1993. Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. J. Great Lakes Res. 19: 1-54.

Mills, E.L. 1994. Exotic species and the integrity of the Great Lakes. Bioscience 44: 666-676.

Moore, E. 1927. New York State Conservation Department (NYSCD) 1927-1940 Watershed Surveys (16 volumes). NYS Dept. Env. Cons., Albany, NY 12233.

Moyle, P.B. 2002. Inland fishes of California. Univ. of California Press, Berkeley, CA. 502 pp.

Munther, G.L. 1970. Movement and distribution of smallmouth bass in the middle Snake River. Trans. Amer. Fish. Soc. 99: 44-53.

Murphy, B.R., and D.W. Willis (eds.). 1996. Fisheries techniques (2nd ed.). Amer. Fish. Soc., Bethesda, MD. 732 pp.

Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and scientific names of fishes from the United States, Canada and Mexico (6th ed.). Amer. Fish. Soc., Bethesda, MD. Special Pub. No. 29. 386 pp.

Nestler, J.M. 1990. Considerations in Applying IFIM to Warmwater Streams. Pages 34-35 *In* M.B. Bain (ed.), Ecology and Assessment of Warmwater Streams: Workshop Synopsis. Bio. Rept. 90(5). U.S. Fish Wldlf. Serv. Washington, DC.

NYSDEC. 1986. Stream corridor management: a basic reference manual. Div. of Water, Bureau of Water Quality. Albany, NY. 111 pp.

NYSDEC. 2008. Comprehensive Wildlife Conservation Strategy (CWCS) Plan. Conservation recommendations by watershed basin, southwest Lake Ontario basin. Div. Fish, Wldlf. Mar. Res., Albany, NY. www.dec.ny.gov/animals/30483.html

Ono, R.D., J.D. Williams, and A. Wagner. 1983. Vanishing fishes of North America. Stone Wall Press, Inc., Washington, D.C. 268 pp.

Orth, D.J., and O.E. Maughan. 1982. Community structure and seasonal changes in standing stocks of fish in a warmwater stream. Am. Midland Nat. 112: 369-378.

Page, L.M., and B.M. Burr. 1991. A field guide of freshwater fishes: North America north of Mexico. Peterson Field Guide Series. Houghton Mifflin Co., Boston, MA. 432 pp.

Palmer, M.W. 1993. Putting things in even better order: the advantages of canonical correspondence analysis (CCA). Ecol. 74: 2215-30.

Pearsons, T.N., H.W. Li, and G.A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Trans. Amer. Fish. Soc. 121: 427-436.

Peterka, J.J. 1989. Fishes in northern prairie wetlands. Pages 302-315 *In* A.G. van der Valk (ed.) Northern Prairie Wetlands. Iowa State Univ. Press, Ames, IA.

Pflieger, W. L. 1997. Fishes of Missouri. Missouri Dept. Cons. Jefferson City, MO. 372 pp.

Phillips, G.L., W. Schmid, and J.C. Underhill. 1982. Fishes of the Minnesota Region. Univ. of Minnesota Press, Minneapolis, MN. 258 pp.

Platts, W.S., W.F. Megham, and G.W. Minshall. 1983. Methods for evaluating stream, riparian and biotic conditions. Tech. Rept. INT-138. USDA Forest Serv., Ogden, UT. 70 pp.

Poff, N.L., and J.V. Ward. 1989. Implications of streamflow variability and predictability for lotic community structure: a regional analysis of streamflow patterns. Can. J. Fish. Aquat. Sci. 46: 1805-1818.

Poff, N.L., and J.D. Allan. 1995. Functional organization of stream fish assemblages in relation to hydrological variability. Ecol. 76: 606-627.

Powers, S.L., G.L. Jones, P. Redinger, and R.L. Mayden. 2003. Habitat associations with upland stream fish assemblages in Bankhead National Forest, Alabama. Southeastern Nat. 2(1): 85-92.

Pusey, B.J., M.J. Kennard, and A.H. Arthington. 2000. Discharge variability and the development of predictive models relating stream fish assemblage structure to habitat in northeastern Australia. Ecol. Freshwater Fish. 9(1-2): 30-50.

Quist, M.C., W.A. Hubert, and F.J. Rahel. 2006. Concurrent assessment of fish and habitat in warmwater streams in Wyoming. Fish. Mgmt. Ecol. 13: 9-20.

Rabeni, C.F. 1990. Centrarchid-Habitat Associations in Ozark streams. Pages 18-19 *In* M.B. Bain (ed.), Ecology and Assessment of Warmwater Streams: Workshop Synopsis. Bio. Rep. 90(5). U.S. Fish Wldlf. Serv., Washington, DC.

Rahel, F.J., and W.A. Hubert. 1991. Fish assemblages and habitat gradients in a Rocky Mountain-Great Plains stream: biotic zonation and additive patterns of community change. Trans. Amer. Fish. Soc. 120: 319-332.

Rahel, F.J. 2002. Homogenization of fish faunas across the United States. Science 288: 854-856.

Rashleigh, B. 2004 fish assemblage groups in the upper Tennessee River basin. Southwestern Nat. 3(4): 621-636.

Ray, H.L., A.M. Ray, and A.J. Rebertus. 2004. Rapid establishment of fish in isolated peatland beaver ponds. Wetlands 24(2): 399-405.

Reid, S.M., and N.E. Mandrak. 2008. Historical changes in the distribution of threatened channel darter (*Percina copelandi*) in Lake Erie with general observations on the beach fish assemblage. J. Great Lakes Res. 34: 324-333.

Reynolds, E.W. 2007. The New York State threatened longear sunfish, *Lepomis megalotis*: collection, rearing and recovery efforts. American Currents (Spring) 33(2): 13.

Ricciardi, A., and H.J. MacIsaac. 2000. Recent mass invasion of the North American Great Lakes by Pont-Caspian species. Tree 15(2): 62-65.

Rippe, D. 2005. Minnows, dickie-birds of the deep. Wyoming Wildlife. WY Game & Fish Dept, Cheyenne, WY. 8: 32-39.

Rohde, F.C., J.F. Parnell, D.G. Lindquist, and R.G. Arndt. 1994. Freshwater fishes of the Carolinas, Virginia, Maryland, and Delaware. Univ. of North Carolina Press, Chapel Hill, NC. 222 pp.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO. 350 pp.

Ross, S.T. 1990. Ecology of Southeastern Stream Fishes: Geographic Macro-and Micro-Habitat Considerations. Pages 11-13 *In* M.B. Bain (ed.), Ecology and Assessment of Warmwater Streams: Workshop Synopsis. Bio. Rept. Serv. 90(5). U.S. Fish Wldlf. Serv., Washington, DC.

Roy, A.H., M.C. Freeman, B.J. Freeman, S.J. Wenger, W.E. Ensign, and J.L. Meyer. 2005. Investigating hydrologic alternation as a mechanism of fish assemblage shifts in urbanizing streams. J. N. Amer. Bentho. Soc. 24(3): 656-678.

Sapota, M.R. 2006. NOBANIS – Invasive Alien Species Fact Sheet for *Neogobius melanostomus*. Online database of the North European and Baltic Network on Invasive Alien Species. www.nobanis.org

Savino, J.F., S.C. Riley, and M.J. Holuszko. 2007. Activity, aggression, and habitat use of ruffe (*Gymnocephalus cernuus*) and round goby (*Apollonia melanostoma*) under laboratory conditions. J. Great Lakes Res. 33: 326-334

Scarola, J.F. 1973. Freshwater fishes of New Hampshire. New Hampshire Fish & Game Dept., Concord, NH. 131 pp.

Schaefer, J.F., and J.R. Kerfoot. 2004. Fish assemblage dynamics in an adventitious stream: a landscape perspective. Am. Midland Nat. 151(1): 134-145.

Schofield, P.J., J.D. Williams, L.G. Nico, P. Fuller, and M.R. Thomas. 2005. Foreign Non-Indigenous Carps and Minnows (Cyprinidae) in the United States: A Guide to their Identification, Distribution, and Biology. USGS Sci. Invest. Rept. 2005-5041. 103 pp.

Schlosser, I.J. 1982. Fish community structure and function along two habitat gradients in a headwater stream. Ecol. Monogr. (52): 395-414.

Schlosser, I.J. 1987. A conceptual framework for fish communities in small warmwater streams. Pages 17-24 *In* W.J. Matthews and D.C. Heins (eds.), Community and evolutionary ecology of North American freshwater fishes. Oklahoma Univ. Press., Norman, OK.

Schultz, K. 2004. Ken Schultz's field guide to freshwater fishes. John Wiley & Sons, Inc., Hoboken, NJ. 257 pp.

Schweizer, P.E., and G.R. Matlack. 2005. Annual variation in fish assemblages of watersheds with stable and changing land use. Am. Midland Nat. 153(2): 293-308.

Scott, M.C. 2006. Winners and losers among stream fishes in relation to land use legacies and urban development in the southeastern US. Biol. Cons. 127(3): 301-309.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Res. Bd. Canada, Bull. 184, Ottawa. 966 pp.

Sedell, J.R., G.H. Reeves, F.R. Hauer, J.A. Stanford, and C.P. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. Env. Mgmt. 14(5): 711-724.

Sharma, S., and D.A. Jackson. 2007. Fish assemblages and environmental conditions in the lower reaches of northeast Lake Erie tributaries. J. Great Lakes Res. 33(1): 15–27.

Sheldon, A.L. 1968. Species diversity and longitudinal succession in streams. Ecol. 49: 193-198.

Sheldon, A.L. 1988. Conservation of stream fishes: patterns of diversity, rarity, and risk. Cons. Biol. 2(2): 149–156.

Sheldon, V.E. 1911. Ecological succession I. Stream fishes and the method of physiographic analysis. Biol. Bull. 21: 9-23.

Sigler, W.F., and R.R. Miller. 1963. Fishes of Utah. Utah State Dept. Fish & Game, Salt Lake City, UT. 203 pp.

Smith, C.L. 1985. The inland fishes of New York State. NY State Dept. Env. Conserv., Albany, NY. 522 pp.

Smith, P.W. 1979. The fishes of Illinois. Univ. Illinois Press, Champaign, IL. 314 pp.

Smith-Vaniz, W.F. 1968. Freshwater fishes of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, AL. 211 pp.

Snyder, D.E. 1990. Fish Larvae-Ecologically Distinct Organisms. Pages 20-23 *In* M.B. Bain (ed.), Ecology and Assessment of Warmwater Streams: Workshop Synopsis. Biol. Rept. 90(5). U.S. Fish Wldlf. Serv., Washington, DC.

Sovan, L., M. Scardi, P. Verdonschot, J-P. Descy, and Y-S. Park (eds.). 2005. Modeling community structure in freshwater ecosystems. Springer-Verlag, Berlin, Germany. 518 pp.

Statistix. 2000. User's Manual. Analytical Software ver. 8.0, Tallahassee, FL. www.statistix.com

Stewart, J.G., C.S. Schieble, R.C. Cashner, and V.A. Barko. 2005. Long-term trends in the Bogue Chitto River fish assemblage: a 27 year perspective. Southwestern Nat. 4(2): 261-172.

Strahler, A.N. 1952. Dynamic basis of geomorphology. Geol. Soc. of Amer. Bull. 63: 923-938.

Symons, T.W. 1904. The projected new barge canal of the State of New York. Bull. Amer. Geol. Soc. Press 36(5): 257-264.

Talmage, P.J., J.A. Perry, and R.M. Goldstein. 2002. Relation of instream habitat and physical conditions to fish communities of agricultural streams in the northern Midwest. N. Amer. J. Fish. Mgmt. 22(3): 825-833.

Taylor, C.M. 2000. A large-scale comparative analysis of riffle and pool fish communities in an upland stream system. Env. Biol. Fish. 58(1): 89-95.

Taylor, C.M., and M.L. Warren Jr. 2001. Dynamics in species composition of stream fish assemblages: environmental variability and nested subsets. Ecol. 82(8): 2320-2330.

ter Braak, C. 1986. Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. Ecol. 67(5): 1167-1179.

ter Braak, C., and P. Verdonschot. 1995. Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aquat. Sci. 57: 255–289.

ter Braak, C., and P. Smilauer. 1998. CANOCO reference manual and user's guide to CANOCO for windows: software for canonical community ordination (ver. 4). Microcomputer Power, Ithaca, NY.

Thomas, C., T.H. Bonner, and B.G. Whiteside. 2007. Freshwater fishes of Texas: a field guide. Texas A&M Univ. Press, College Station, TX. 220 pp.

Tomelleri, J.R., and M.E. Eberle 1990. Fishes of the central United States. Univ. Press of Kansas, Lawrence, KS. 230 pp.

Trautman, M.B. 1981. The fishes of Ohio. The Ohio State Univ. Press, Columbus, OH. 782 pp.

USACE—U.S. Army Corp. of Engineers. 2004. Fact sheet: Tonawanda Creek watershed flood control and environmental restoration. Buffalo, NY. fbnr.org/programs/tributary/tonawanda_river/Corps%20Tonawanda%20Waters hed%20Study.doc

Vadas, R.L., Jr., and D.J. Orth. 2001. Formulation of habitat suitability models for stream fish guilds: Do the standard methods work? Trans. Amer. Fish. Soc. 130: 217–235.

Vanderploeg, H.A., T.F. Nalepa, D.J. Jude, E.L. Mills, K.T. Holeck, J.R. Liebig, I.A. Grigorovich, and H. Ojaveer. 2002. Dispersal and emerging ecological impacts of Ponto-Capsian species in the Laurentian Great Lakes. Can. J. Fish. Aquat. Sci. 59: 1209-1228.

Van Diver, B.B. 1985. Roadside geology of New York. Mountain. Press Publ. Co., Missoula, MT. 411 pp.

Van Holt, T., D. Murphy, and L. Chapman. 2006. Local and landscape predictors of fish-assemblage characteristics in the Great Swamp, NY. Northeastern Nat. 13(3): 353–374.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Can. J. Fish. Aquat. Sci. 37: 130-137.

Van Snik Gray, E.S, R.M. Ross, and R.M. Bennett. 2005. Bioassessment of fish communities of the upper Delaware River. Northeastern Nat. 12(20): 203-216.

Venter, O., N.N. Brodeur, L. Nemiroff, B. Belland, I.J. Dolinsek, and J.W.A. Grant. 2006. Threats to endangered species in Canada. Bioscience 56(11): 903-910.

Weaver, M.J., J.J. Magnuson, and M.K. Clayton. 1997. Distribution of littoral fishes in structurally complex macrophytes. Can. J. Fish. Aquat. Sci. 54: 2277-2289.

Webster D.A. 1980. De Witt Clinton's ―Fishes of the western waters of the State of New York" reexamined. Fisheries 5(2): 5-12.

Wells, S.M., and J.M. Haynes. 2006. Status of the Longear Sunfish (*Lepomis megalotis*) in Western New York, USA. Final Rept., State Wildlife Grant Program, NY State Dept. Env. Conserv., Albany, NY. 175 pp. http://nysl.nysed.gov/Archimages/92446.PDF & www.dec.ny.gov/animals/49191.html

Werner, R.G. 2004. Freshwater fishes of the northeastern United States: a field guide. Syracuse Univ. Press, Syracuse, NY. 335 pp.

Wheeler, A.P., and M.S. Allen. 2003. Habitat and diet partitioning between Shoal Bass and Largemouth Bass in the Chipola River, FL. Trans. Amer. Fish. Soc. 132: 438-449.

Whitbeck, F. 1928. New York Barge Canal. Expectations and realizations. Econ. Geol. Clarkson Univ. Press., Canton, NY. 4(2): 196-206.

Whiteside, B.G., and R.M. McNatt. 1972. Fish species diversity in relation to stream order and physicochemical conditions in the Plum Creek drainage basin. Am. Midland Nat. 88(1): 90-101

Whitton, B.A. (ed.) 1975. Studies in ecology, vol. 2. River ecology. Univ. of California Press, Berkeley, CA. 725 pp.

Whitworth, W.R., P.L. Berrien, and W.T. Keller. 1976 (reprint). Freshwater fishes of Connecticut. State Geol. Nat. Hist. Survey of CT., Dept. Env. Protect. Bull. 101. 134 pp.

Wilkinson, M.A. Tonawanda Creek walleye spawning survey. 1995. Tech. Rept. submitted to NY State Dept. Env. Conserv., Bureau of Fisheries, Region 9, Buffalo, NY. 9 pp.

Willis, S.C., K.O. Winemiller, and H. López-Fernández. 2006. Habitat structural complexity and morphological diversity of fish assemblages in a neotropical floodplain river. Dept. Wldlf. Fish. Sci., Texas A&M Univ., College Station, TX.

Winger, P.V. 1981. Physical and Chemical Characteristics of Warmwater Streams: A Review. Pages 32-44 *In* L.A. Krumholtz (ed.), The Warmwater Streams Symposium. Southern Div, Amer. Fish. Soc., Bethesda, MD.

Zale, A.V., O.E. Maughan, D.J. Orth, and W. Layher. 1995. Withdrawls. Pages 271-280 *In* C.F. Bryan and D.A. Rutherford, Impacts on Warmwater Streams: Guidelines for Evaluation (2nd ed.). Warmwater Streams Committee. Southern Div., Amer. Fish. Soc., Bethesda, MD.

Zorn, T.G., P.W. P.W. Seelbach, and M.J. Wiley. 2002. Distributions of stream fishes and their relationship to stream size and hydrology in Michigan's lower peninsula. Trans. Amer. Fish. Soc. 131: 70-85.

Sources for additional information

Baitfish Identification in Canada (online brochure)
www.dfo-mpo.gc.ca/regions/CENTRAL/pub/baitfish-on/page14-34_e.htm

NANFA—North American Native Fishes Association
Checklist of freshwater fishes native to North America, including subspecies and undescribed forms. C. Scharpf (compiler), rev. March 2, 2005. www.nanfa.org

NOAA—National Oceanic and Atmospheric Administration
Great Lakes website: www.glerl.noaa.gov/pr/ourlakes/background.html

OSU—Oklahoma State University
Ordination methods for ecologists. http://ordination.okstate.edu

Tonawanda Creek watershed (TCW)

Habitat assessment and conservation framework
www.bnriverkeeper.org/Niagara%20Habitat/Niagara_Habitat/1%20final%20habitat%20report%20formatted2.pdf

Tonawanda Creek watershed management plan reconnaissance report
http://fbnr.org/programs/tributary/tonawanda_river/FBNR%20Ton%20Watershed%20Report%20-%20Habitat.doc

Riverwatch captain's manual
www.bnriverkeeper.org/programs/riverwatch/Riverwatch%20Captains%20Manual.pdf
www.saynotowalmart.org/html/body_watershed_in_distress.html

Genesee/Finger Lakes: regional planning council: www.gflrpc.org/

NYS Canal Corporation: www.canals.state.ny.us
http://enwikipedia.org/wiki/New_York_State_Canal_System
http://enwikipedia.org/wiki/Lockport_(city),_New_York
http://enwikipedia.org/wiki/Erie_Canal

Onondaga Escarpment
http://enwikipedia.org/wiki/Onondaga_(geological_formation)

USGS—United States Geological Survey
Real-Time Flow Data: www.waterdata.usgs.gov/ny/nwis/rt
Tonawanda Creek at Batavia, NY #04217000; and Rapids, NY #04218000

Other TCW Sources
http://enwikipedia.org/wiki/Tonawanda_Creek
http://enwikipedia.org/wiki/Ellicott_Creek
http://enwikipedia.org/wiki/Indian_Falls,_New_York
http://enwikipedia.org/wiki/Batavia,_New_York
http://history.rays-place.com/ny/batavia-ny.htm

Johnson Creek watershed (JCW)

LOCI—Lake Ontario Coastal Initiative. Ctr. for Env. Info. Rochester, NY. (Jan) 2006
www.ceinfo.org

LPRCD—Lake Plains Resource Conservation and Development. Johnson Creek Restoration Project. (Summer) 2000. Village of Lyndonville, NY 14098
www.lakeplainsrcd.org/PM_JohnsonCreekPond.htm

FLLOWPA—Finger Lakes Lake Ontario Watershed Protection Alliance.
http://www.fllowpa.org/

Other JCW Sources: http://enwikipedia.org/wiki/Johnson_Creek

Table 1. Characteristics of the Tonawanda and Johnson Creek watersheds in northwestern New York.

Feature	Tonawanda Creek watershed	Johnson Creek watershed
[1]HUC-8 Name	Erie-Niagara (River)	SW Lake Ontario
[2]NYSDEC WIN	ONT-158-12	ONT-139
HUC-11 Size	648 mi² (1678 km²), 6th order	116 mi² (300 km²), 5th order
Counties Crossed	Erie, Niagara, Genesee, Orleans, Wyoming	Orleans, Niagara
[3]Major Basins	3 - Upper, Middle, Lower	2 - Upper, Lower
Major Tributaries (Max Stream Order)	Ellicott (4); Bull (4); Ransom (4); Mud (4); Beeman (3); Murder (5); L. Tonawanda (4)	Syren (2); West Fork (4); East Fork or Jeddo,(4)
[4]Natural Fish Barriers	Indian Falls at ~RM 48	No major waterfalls
[5]Listed Dams	108, many breached	18, many breached
Main Stem Dams	Batavia Municipal Dam	Lyndonville Village Dam
Main Stem Impoundments	None, narrow channel above Batavia Dam at ~RM 63	Lyndonville Mill Pond above Village Dam, RM 11.4
Canal Influence	Entire channel from RM 11 to mouth at Niagara River	Multiple spillways & discharges in upper basin headwaters

[1]HUC—hydrologic unit code
[2]WIN—watershed index number
[3]Major basins are separated by barriers to upstream fish passage.
[4]RM—river miles from mouth.
[5]Historic dam counts obtained from the NYSDEC's ArcGIS 9 Master Habitat Databank, Albany, NY (see Table 3).

Table 2. Sampling effort (trips and sites) and fish richness and abundance by sub-basin and tributary in the Tonawanda and Johnson Creek watersheds, May-September 2005. Primary watersheds are in bold and main tributaries are in italics. Fish richness and abundance (see also Table 7) exclude hybrids, subspecies, and unidentified juveniles.

WATERSHED **Waterbody**	[1]**Day Trips**	**Sample Sites**	**Fish Richness**	[2]**Total Abundance**
ERIE-NIAGARA				
Tonawanda Creek	29	68	64	21,310
Erie Canal[3]	4	8	35	1,034
Ellicott Creek	2	3	19	108
Bull Creek	2	2	21	183
Ransom Creek	1	1	9	39
Lower Main Stem[4]	15	33	50	6,505
Murder Creek	1	2	24	679
Middle Main Stem[5]	8	7	26	7756
Upper Main Stem[6]	6	7	27	4,061
Little Tonawanda Ck	2	2	19	617
SW LAKE ONTARIO				
Johnson Creek	19	40	47	6,218
Lower Main Stem[7]	10	24	39	3,156
Upper Main Stem[7]	7	13	24	2,725
Jeddo Creek	2	3	14	682
Totals	48	108	70	27, 528

[1]Multiple sites in different waters were often sampled on the same day. Fish were collected by boat electrofishing (where accessible), backpack electrofishing, and beach seining.

[2]Total fish counts include visual estimates of individual species' abundance from large groups of small fishes and large specimens (e.g., carp) that were not the focus of the study.

[3]Surveys in the Erie (NYS Barge) Canal ranged from its confluence with the Niagara River to 11 RM upstream to its confluence with Tonawanda Creek.

[4]Main stem basins were delineated by barriers to upstream fish passage. Lower Tonawanda Creek included the reach from the confluence with the canal upstream to Indian Falls.

[5]Middle Tonawanda Creek included the reach from the Indian Falls upstream to the Batavia Dam.

[6]Upper Tonawanda Creek included the reach above the Batavia Dam into the headwaters.

[7]Upper and Lower Johnson Creek were divided by the Lyndonville Dam at RM 11.4. Jeddo Creek is also the East Branch of upper Johnson Creek.

Table 3. Mapping data used in the detailed spatial analyses of the Tonawanda and Johnson Creek watersheds (Map Series 1-3: Appendices II A-D).

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[1]**GPS** (Global Positioning System) **Point Data layers**

- Barriers to upstream fish passage
- Habitat survey sites in 2004 and 2005
- Watershed landmarks (stream access sites, downed trees, buildings, etc.)
- Historic and recent longear sunfish capture sites
- Recent redfin shiner capture sites (historic data not available)
- NYSDEC stocking points (mostly yearling trout in the spring)

GIS (Geographic Information System) Shapefile layers

[2]*Primary Source (NYSDEC –MHDB, Master Habitat Databank)*

- Major waterways: Great Lakes, Erie Canal, and major streams
- 1:24,000 statewide hydrology maps (surface waters, named streams, tributaries)
- Listed dams (completion date noted when available)
- State and federal wetlands (combined into one layer)
- NYS listed boat launch sites
- U.S. Geological Survey (USGS)-listed flow gauging stations
- NYSDEC regions (color coded background)
- Civil divisions borders (county, town, village/city)
- Public parks (state, county, municipal)
- Iroquois National Wildlife Refuge (NWR)
- NYSDEC lands; State Forests and Wildlife Management Areas (WMA)
- Canal Corporation lands along the Erie Canal
- County tax map real property (RP) polygons
- Tribal lands (Tonawanda-Seneca Nation)
- Major highways and scenic byways (e.g., Great Lakes Seaway Trail)
- Local streets/roads, railroad lines, public trails

[3]*Secondary Source (Cornell University Geospatial Information Repository, CUGIR)*

- Hydrologic Unit Codes (HUC) 8, 11 digit watershed boundaries
- Hydrology: surface waters of major watersheds
- Hydrology: streams of major drainage basins
- Urban areas and minor civil divisions
- TIGER (Topologically Integrated Geographic Encoding and Referencing) or line data: roads and railroads per county

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[1]GPS coordinates were recorded with a Garmin *etrex* Legend handheld receiver and geo-referenced using Garmin (2002) MapSource (U.S. TOPO, ver 3.02) and ArcMap 9.1 (ESRI, 2006).

[2]ArcGIS 9 Master Habitat Databank (MHDB) layers are provided to DEC staff by the Central Office GIS Dept., 625 Broadway Albany, NY 12233

[3]Cornell University Geospatial Information Repository (CUGIR), Ithaca, NY is available online at www.cugir.com.

Table 4. Physical habitat variables observed and scored at each sampling site in Tonawanda Creek and Johnson Creek, May-September 2005. Instream wood included standing or submerged timber (dead or alive) plus logjam debris and wooden docks or pilings. Bank cover (natural or artificial) included overhead riparian canopy, overhanging bank vegetation, undercut banks, riprap and boulders, bridges and culverts. Aquatic vegetation included submergent, emergent, or floating forms, excluding algae and moss.

Variable	Observation	Determination	[1]Score	[2]Range
[3]*Pool Type—PT*				
	channelized reach	lowest complexity	1	1.0-1.74
	isolated pool or run	some complexity	2	1.75-2.49
	pool with run	more complexity	3	2.50-3.24
	pool with riffle	highest complexity	4	3.25-4.0
Maximum Depth—MD				
	very shallow	0.5m or less	1	1.0-1.74
	mostly shallow	0.6m to 1.4m	2	1.75-2.49
	moderately deep	1.5m to 2.9m	3	2.50-3.24
	mostly deep	3.0m or more	4	3.25-4.0
[4]*Substrate Size Score—SS*				
	very fine particles	mostly silt	1	1.0-1.49
	larger fine particles	mostly sand	2	1.5-2.49
	smaller course particles	mostly gravel	3	2.5-3.49
	larger course particles	mostly rock	4	>3.5
% Instream Wood—IW / Bank Cover—BC / Aquatic vegetation—AV				
	absent	0%	1	0
	present	5% or less	2	>0-2.49
	moderate	6 to 25%	3	2.5-3.49
	abundant	26 to 49%	4	3.5-4.49
	dominant	50% or more	5	>4.5

[1]Codes used to estimate habitat complexity for each sampling site.
[2]Range of habitat scores indicating the habitat type at a sampling site.
[3] Type of pool was determined by the type of current (riffle or run) within or adjacent to a sampling site.
[4]Substrate size score was the mean of estimated percent cover of each size group at a sampling site.

Table 5. Descriptive statistics for some habitat and response variables at sampling sites in the Tonawanda and Johnson Creek watersheds, May-September, 2004 and May-September, 2005. See Table 4 for habitat descriptions.

Tonawanda Creek Watershed (n = 68 sites)

	[1]WT	MD	PT	%silt	%sand	%gvl	%rock	SS	%IW	%BC	%AV	HCI	SDI	SL	CPUE	AB	SR
mean	21.9	2.3	2.5	47.5	12.7	22.2	17.6	2.101	6.3	7.1	8.9	2.5	0.794	184	12.8	313	16
SE	0.418	0.134	0.153	3.4	1.9	2.2	2.0	0.078	1.0	1.1	2.0	0.039	0.014	23	2.1	47	0.477
median	22	2	2.5	42.5	5	20	15	2.05	2.5	3	1.5	2.4	0.830	100	7.8	199	16
mode	25	3	4	15	0	0	0	1.3	1	1	0	2.4	0.850	100	4.9	288	15
SD	3.5	1.1	1.3	28.3	16.0	18.4	16.5	0.647	8.3	9.2	16.1	0.325	0.117	188	17.2	389	3.9
range	13	4.3	3	90	70	65	70	2.3	50	50	60	1.6	0.577	950	96.7	1975	19
min	14	1	1	5	0	0	0	1.05	0	0	0	1.8	0.353	30	1.8	28	7
max	27	5.3	4	95	70	65	70	3.35	50	50	60	3.4	0.930	980	98.5	2003	26
95% CI	0.835	0.267	0.306	6.8	3.9	4.4	4.0	0.157	2.0	2.2	3.9	0.079	0.028	46	4.2	94	1.0

Johnson creek watershed (n = 40 sites)

	[1]WT	MD	PT	%silt	%sand	%gvl	%rock	SS	%IW	%BC	%AV	HCI	SDI	SL	CPUE	AB	SR
mean	22.5	1.5	2.4	37.6	14.0	41.0	9.0	2.2	8.7	12.0	17.0	2.5	0.810	166	6.7	155	14
SE	0.524	0.096	0.195	3.5	2.1	2.9	1.5	0.080	1.4	1.9	3.1	0.054	0.015	22	0.587	19	0.566
median	23	1.5	2	30	10	40	7.5	2.4	5	9	10	2.5	0.834	95	5.6	145	14
mode	25	1.5	1	30	10	30	0	2.6	5	10	0	2.3	0.777	75	2.6	154	14
SD	3.3	0.604	1.236	21.9	13.3	18.4	9.2	0.503	8.8	11.8	19.7	0.343	0.094	137	3.7	118	3.6
range	16	2.5	3	85	55	75	35	2.05	35	49	70	1.6	0.409	470	13.5	582	17
min	12	0.5	1	5	0	0	0	1.1	0	1	0	1.6	0.524	30	2.6	21	5
max	28	3	4	90	55	75	35	3.15	35	50	70	3.3	0.933	500	16.0	603	22
95% CI	1.06	0.193	0.395	7.0	4.2	5.9	2.9	0.161	2.8	3.8	6.3	0.110	0.030	44	1.2	38	1.1

[1]WT—water temperature; MD—maximum depth; PT—pool type; % silt, sand, gvl—gravel, and rock used to calculate SS—substrate size score; % IW—instream wood; %BC—bank cover and %AV—aquatic vegetation; SDI—Simpson's Diversity Index; SL—site length; CPUE—catch per unit effort; AB—abundance; SR—species richness.

Table 6. Fish species identified (n = 70) during sampling in the Tonawanda and Johnson Creek watersheds (TCW, JCW), May-September 2005. NYS-listed rare species are in UPPERCASE. See Appendices I-F and I-G for detailed fish survey results.

[1]Code	[2]Abbreviation	Common Name	Scientific Name	TCW	JCW
268	*Leos*	longnose gar	*Lepisosteus osseus*		X
271	*Amca*	bowfin	*Amia calva*		X
289	*Alps*	alewife	*Alosa pseudoharengus*		X
294	*Doce*	gizzard shad	*Dorosoma cepedianum*	X	
326	*Onmy*	rainbow trout	*Oncorhynchus mykiss*		X
328	*Satr*	brown trout	*Salmo trutta*	X	
335	*Osmo*	rainbow smelt	*Osmerus mordax*	X	
340	*Umli*	central mudminnow	*Umbra limi*	X	X
346	*Esav*	grass pickerel	*Esox americanus vermiculatus*	X	
347	*Eslu*	northern pike	*Esox lucius*	X	X
349	*Esni*	chain pickerel	*Esox niger*	X	
360	*Caan*	central stoneroller	*Campostoma anomalum*	X	X
361	*Caau*	goldfish	*Carassius auratus*	X	
362	*Clel*	redside dace	*Clinostomus elongatus*	X	
365	*Cyca*	common carp	*Cyprinus carpio*	X	X
375	*Nobi*	hornyhead chub	*Nocomis biguttatus*	X	X
376	*Nomi*	river chub	*Nocomis micropogon*	X	
377	*Nocr*	golden shiner	*Notemigonus crysoleucas*	X	X
381	*Noat*	emerald shiner	*Notropis atherinoides*	X	X
384	*Luch*	striped shiner	*Luxilus chrysocephalus*	X	X
[3]385	*Luco*	common shiner	*Luxilus cornutus*	X	X
[3]386	*Nodo*	bigmouth shiner	*Notropis dorsalis*	X	
390	*Nohu*	spottail shiner	*Notropis hudsonius*	X	
393	*Noru*	rosyface shiner	*Notropis rubellus*	X	X
394	*Cysp*	spotfin shiner	*Cyprinella spiloptera*	X	X
[3]395	*Nost*	sand shiner	*Notropis stramineus*	X	X
396	*Lyum*	REDFIN SHINER	*Lythrurus umbratilis*	X	X
397	*Novo*	mimic shiner	*Notropis volucellus*	X	X
400	*Pino*	bluntnose minnow	*Pimephales notatus*	X	X
401	*Pipr*	fathead minnow	*Pimephales promelas*	X	X
403	*Rhca*	longnose dace	*Rhinichthys cataractae*	X	
[4]404	*Rhob*	w. blacknose dace	*Rhinichthys obtusus*	X	X
405	*Scer*	rudd	*Scardinius erythrophthalmus*	X	
406	*Seat*	creek chub	*Semotilus atromaculatus*	X	X
407	*Seco*	fallfish	*Semotilus corporalis*	X	
419	*Caco*	white sucker	*Catostomus commersonii*	X	X
423	*Hyni*	n. hog sucker	*Hypentelium nigricans*	X	X
428	*Moan*	silver redhorse	*Moxostoma anisurum*	X	
431	*Moer*	golden redhorse	*Moxostoma erythrurum*	X	X
432	*Moma*	shorthead redhorse	*Moxostoma macrolepidotum*	X	X

433	*Mova*	greater redhorse	*Moxostoma valenciennesi*	X	
443	*Amna*	yellow bullhead	*Ameiurus natalis*		X
444	*Amne*	brown bullhead	*Ameiurus nebulosus*	X	X
445	*Icpu*	channel catfish	*Ictalurus punctatus*	X	
446	*Nofl*	stonecat	*Noturus flavus*	X	X
447	*Nogy*	tadpole madtom	*Noturus gyrinus*	X	X
449	*Nomi*	brindled madtom	*Noturus miurus*	X	X
531	*Fudia*	banded killifish	*Fundulus diaphanus*	X	
545	*Lasi*	brook silverside	*Labidesthes sicculus*	X	X
575	*Moam*	white perch	*Morone americana*		X
591	*Amru*	rock bass	*Ambloplites rupestris*	X	X
595	*Lecy*	green sunfish	*Lepomis cyanellus*	X	X
596	*Legi*	pumpkinseed	*Lepomis gibbosus*	X	X
598	*Lema*	bluegill	*Lepomis macrochirus*	X	X
599	*Leme*	LONGEAR SUNFISH	*Lepomis megalotis*	X	
600	*Mido*	smallmouth bass	*Micropterus dolomieu*	X	X
601	*Misa*	largemouth bass	*Micropterus salmoides*	X	X
602	*Poan*	white crappie	*Pomoxis annularis*	X	
603	*Poni*	black crappie	*Pomoxis nigromaculatus*	X	
606	*Etbl*	greenside darter	*Etheostoma blennioides*	X	X
607	*Etca*	rainbow darter	*Etheostoma caeruleum*	X	
609	*Etfl*	fantail dater	*Etheostoma flabellare*	X	X
613	*Etni*	johnny darter	*Etheostoma nigrum*	X	X
617	*Pefl*	yellow perch	*Perca flavescens*	X	X
618	*Peca*	logperch	*Percina caprodes*	X	X
622	*Pema*	blackside darter	*Percina maculata*	X	X
626	*Savi*	walleye	*Sander vitreum vitreum*	X	
700	*Apgr*	freshwater drum	*Aplodinotus grunniens*	X	X
792	*Neme*	round goby	*Neogobius melanostomus*	X	X
865	*Coba*	mottled sculpin	*Cottus bairdii*	X	

[1]NYSDEC reference number for fish species in New York State (Appendix I-A).
[2]Fish species are listed by common and Latin name (first two letters of genus/species) in accordance with Nelson et al. (2004).
[3]Common, bigmouth, and sand shiner were added to this roster after post-sampling inspection of voucher specimens (NYS Museum Fish Laboratory, Rensselaer, NY).
[4]Blacknose dace from these watersheds were identified as the western subspecies (D. Carlson, NYSDEC Region 6 Fisheries, pers. comm.).

Table 7. Fish abundance in the sub-basins[1] and tribuaries[1] of the Tonawanda Creek and Johnson Creek watersheds, May-September 2005. NYS-listed rare species are capitalized.

	Tonawanda Creek										Johnson Creek				
Common Name	***Entire***	**Low**	**Ecan**	**Elli**	**Bull**	**Ran**	**Mur**	**Mid**	**Upp**	**Ltc**	***Entire***	**Low**	**Upp**	**Jed**	***Totals***
longnose gar											*26*	26			*26*
bowfin											*33*	33			*33*
alewife											*24*	24			*24*
gizzard shad	*1*	1			1										*1*
rainbow trout (I)											*1*	1			*1*
brown trout (I)	*36*								36						*36*
rainbow smelt	*1*	1			1										*1*
c. mudminnow	*11*	10	1						1		*2*		2		*13*
grass pickerel	*7*	7	2				1				*1*	1			*8*
northern pike	*39*	26	13		1	2	2	8	4	2	*18*	9	9		*57*
chain pickerel	*1*	1	1												*1*
central stoneroller	*297*	15					12	9	273	22	*431*	3	428	236	*728*
goldfish (I)	*5*	7	1	4	1										*5*
redside dace	*15*								15						*15*
common carp (I)	*269*	179	32	49	7	8		90			*183*	149	34	4	*452*
hornyhead chub	*477*	58						327	92	11	*32*		32		*509*
river chub	*1146*	125						1021							*1146*
golden shiner	*150*	142	111	1	27		1	4	4	4	*28*	15	13		*178*
emerald shiner	*342*	342	167	12	78						*381*	345	44		*723*
striped shiner	*1854*	296	1				22	980	578	219	*172*	46	131	1	*2026*
common shiner	*80*								80		*5*				*85*
bigmouth shiner	*23*								23						*23*
spottail shiner	*4*	4	1												*4*
rosyface shiner	*467*	467									*12*		4		*479*

spotfin shiner	*475*	475	24		3		12				*236*	163	73		*711*
sand shiner	*134*								134						*134*
redfin shiner (SC)	*6*	6									*57*	51	6		*63*
mimic shiner	*553*	553	2					1	89	2	*59*	52	7		*612*
bluntnose minnow	*2518*	1179	127	2	4		33	979	360	100	*784*	562	196	1	*3302*
fathead minnow	*2130*	55	12	1			18	2059	16		*17*	16	1		*2147*
longnose dace	*95*								95						*95*
w. blacknose dace	*1364*	3					3		1361	14	*3*		3		*1367*
rudd (I)	*13*	13	8	3	2										*13*
creek chub	*215*	59					58	2	154	32	*541*	3	538	226	*756*
fallfish	*201*								201	1					*201*
white sucker	*665*	283	6	1	1		124	195	187	17	*304*	164	103	37	*969*
n. hog sucker	*595*	114					3	243	238	36	*346*	34	217	95	*941*
silver redhorse	*19*	19	1	2											*19*
golden redhorse	*160*	160	20	1	2	4					*54*	12	42		*214*
shorthead redhorse	*27*	27	4	3							*9*	5	4	1	*36*
greater redhorse	*14*	14	6	1	1		1								*14*
yellow bullhead											*1*	1			*1*
brown bullhead	*48*	46	30		2		3		2		*67*	64	3		*115*
channel catfish	*13*	13													*13*
stonecat	*35*	35					1				*10*	7	3		*45*
tadpole madtom	*1*	1									*3*	1	1	1	*4*
brindled madtom	*21*	21									*9*	5	4		*30*
banded killifish	*1*	1													*1*
brook silverside	*5*	5	1								*2*	2			*7*
white perch											*1*	1			*1*
rock bass	*940*	340	33	1	5	2	66	522	78	15	*297*	195	61	40	*1237*
green sunfish	*537*	458	10	1		1	31	50	29	6	*212*	136	56	5	*749*
pumpkinseed	*677*	437	186	4	19	10	5	68	172	23	*181*	117	56	1	*858*
bluegill	*189*	179	108	5	10	8	1	2	8	3	*23*	8	14	1	*212*

Longear Sunfish (T)	*23*	23	1												*23*
smallmouth bass	*430*	227	15	4	3			114	89		*120*	78	6	4	*550*
largemouth bass	*532*	176	77	10	16	3		331	25	11	*178*	147	35		*710*
white crappie	*7*	7	2												*7*
black crappie	*16*	16	3		3										*16*
greenside darter	*144*	144					6				*86*	32	38	16	*230*
rainbow darter	*108*	108					47								*108*
fantail dater	*178*	2							176	35	*34*	5	27	2	*212*
johnny darter	*2075*	1086	4		1		173	593	396	64	*820*	313	461	10	*2895*
yellow perch	*28*	28	19	3		1	1				*198*	194	3		*226*
logperch	*249*	88						158	3		*27*	23	4		*276*
blackside darter	*491*	491					55				*141*	81	51		*632*
walleye	*11*	11													*11*
freshwater drum	*2*	2									*12*	12			*14*
round goby (I)	*63*	63	5								*37*	20	15	1	*100*
mottled sculpin	*77*								77						*77*
TOTALS	***21310***	8649	1034	108	188	39	679	7756	4996	617	***6218***	*3156*	*2725*	*682*	***27528***

[1]The watersheds were divided into subunits as shown in Table 2 including Mid—Middle Basin.
[2]Fish species are listed by common name in accordance with Nelson et al. (2004) along with their status: I—introduced, SC—special concern, T—threatened (see Appendix I-A) and abundance (N) totaled per subunit (bottom) and entire study (far right).
[3]Lower (Low) Basin data include in the Ecan—Erie Canal, Elli—Ellicott Creek, Bull—Bull Creek, Ran—Ransom Creek, and Mur—Murder Creek in the TCW.
[4]Upper (Upp) Basin data include in the Ltc—Little Tonawanda Creek in the TCW, Jed—Jeddo Creek in the JCW.

Table 8. Descriptive results from fish surveys in the Tonawanda Creek watershed, May-September 2005. See Table 4 for definitions of pool types (PT) and Table 6 for species codes.

Statistic	[1]**Entire**	**Lower**	**Canal**	**Middle**	**Upper**	**Mid+Upper**	**All Tribs**	**PT 1**	**PT 2**	**PT 3**	**PT 4**
Species richness	63	57	38	21	30	32	44	49	43	44	52
Fish abundance	21,310	8,557	1,366	7,756	4,996	12,752	3,074	2,966	1,711	3,762	12,871
Cyprinid spp.	23	18	12	10	14	16	17	15	12	17	19
Catostomid spp.	6	6	5	2	2	2	6	5	6	4	6
Centrarchid spp.	11	11	9	6	6	6	7	9	9	6	9
Percid spp.	8	8	2	2	3	3	6	6	8	8	7
[2]Dom sp. 1	Pino	Pino	Noat	Pipr	Rhob	Pipr	Rhob	Pino	Pino	Luch	Pipr
(%)	(11.8)	(13.8)	(18.8)	(26.6)	(27.2)	(16.3)	(38.3)	(15.5)	(22.5)	(23.3)	(16.2)
Dom sp. 2	Pipr	Etni	Legi	Nomi	Luch	Luch	Luch	Legi	Etni	Pino	Rhob
(%)	(10.0)	(12.7)	(16.0)	(13.2)	(11.6)	(12.2)	(9.2)	(11.30	(19.6)	(15.0)	(10.2)
Dom sp. 3	Etni	Pema	Nocr	Luch	Etni	Rhob	Etni	Etni	Legi	Etni	Pino
(%)	(9.7)	(5.7)	(9.7)	(12.64)	(7.9)	(10.7)	(7.7)	(9.5)	(10.6)	(12.4)	(8.6)
Dom sp. 4	Luch	Cysp	Pino	Pino	Pino	Pino	Caco	Noat	Pema	Noru	Etni
(%)	(8.7)	(5.6)	(9.7)	(12.62)	(7.2)	(10.5)	(6.7)	(7.9)	(7.5)	(4.9)	(7.7)
Leme-T (n)	23	23	1					18			
(%)	(0.11)	(0.11)	(0.07)	0	0	0	0	(0.6)	3 (0.2)	0	2 (0.02)
Lyum-SC (n)	6	6									
(%)	(0.03)	(0.03)	0	0	0	0	0	2 (0.1)	4 (0.2)	0	0
Scer-I (n)	13	13	13					11			
(%)	(0.06)	(0.15)	(0.95)	0	0	0	5 (0.16)	(0.4)	2 (0.1)	0	0
Neme-I (n)	63	63	6								
(%)	(0.30)	(0.30)	(0.44)	0	0	0	0	8 (0.3)	5 (0.3)	5 (0.1)	45 (0.3)

[1]The watershed was divided into subunits as shown in Table 2. Lower Basin includes all sites below Indian Falls downstream to the Niagara River. Middle Basin includes all sites above Indian Falls upstream to the Batavia Dam. Upper Basin includes all sites above Batavia Falls upstream into the headwaters. Mid+Upper represent Middle and Upper Basins combined for later analysis. Canal includes sites located only in the Erie (NYS Barge) Canal and adjacent tributaries. All Tribs represent sites located in the tributaries sampled in the watershed.

[2]Dom sp. 1 is the most abundant fish in a reach, etc.

Table 9. Descriptive results from fish surveys in the Johnson Creek watershed, May-September 2005. See Table 4 for definitions of pool types (PT) and Table 6 for species codes.

Statistic	[1]Entire	Lower	Upper	PT 1	PT 2	PT 3	PT 4
Sampling sites	40	24	16	14	7	8	11
Fish richness	46	42	37	32	32	34	37
Fish abundance	6,218	3,158	3,037	907	1,115	1,764	2,432
Cyprinids	15	11	15	9	10	10	15
Catostomids	9	9	8	3	5	4	4
Centrarchids	6	6	6	6	6	6	6
Percids	6	6	6	4	5	6	6
[2]Dom spp. 1 (%)	Etni (13.2)	Pino (17.8)	Seat (17.7)	Noat (12.5)	Pino (22.2)	Etni (15.8)	Etni (16.9)
Dom spp. 2 (%)	Pino (12.6)	Noat (10.9)	Etni (16.7)	Cyca (12.5)	Noat (11.0)	Pino (12.2)	Seat (16.1)
Dom spp. 3 (%)	Seat (8.7)	Etni (9.9)	Caan (14.1)	Pefl (11.9)	Etni (10.6)	Caan (10.9)	Caan (9.8)
Dom spp. 4 (%)	Caan (6.9)	Amru (6.2)	Hyni (10.3)	Pino (8.4)	Amru (9.1)	Caco (10.3)	Pino (9.7)
Lyum-SC (n, %)	57 (0.9)	51 (1.6)	6 (0.2)	8 (0.9)	10 (0.9)	18 (1.0)	21 (0.9)
Neme-I (n, %)	37 (0.6)	20 (0.63)	17 (0.56)	0	8 (0.7)	9 (0.5)	20 (0.8)

[1]The watershed was divided into subunits as shown in Table 2. Lower Basin includes all sites below Lyndonville Dam and Upper Basin includes all sites above this dam.
[2]Dom sp. 1 is the most abundant fish in a reach, etc.

Table 10. Habitat-guild classification for 39 stream fishes included in the statistical analyses of the Tonawanda and Johnson Creek watershed survey data from May-September 2005. Generalist (G) and specialist (S) descriptors are defined by a species association with stream flow.

Abbr	[1]Common name	[2]Habitat	[2]Guild	[3]Flow preference	[4]DCA	[4]CCA	[4]MLR	[5]Main text pages
Amca	bowfin	lentic	G	slack water		x		see CCA appendices
Eslu	northern pike	both	G	slack water		x		34,
Caan	central stoneroller	lotic	S	in or near current	x	x	x	34, 36, 39-40, 62
Cyca	common carp	both	G	slack water	x	x	x	31-36,40-41,63,76,82,86
Nobi	hornyhead chub	lotic	S	near current	x	x		25, 33, 41-42, 84
Nomi	river chub	lotic	S	near current	x	x		25, 34, 84
Nocr	golden shiner	both	G	slack water		x		63-64
Noat	emerald shiner	both	G	slack water	x	x	x	33, 35, 61-62, 65
Luch	striped shiner	lotic	S	near current	x	x	x	23, 34, 36, 64, 76
Noru	rosyface shiner	lotic	S	in or near current	x	x		34
Cysp	spotfin shiner	both	G	slack water	x	x		33, 35-36
Lyum	redfin shiner	lotic	S	near current	x	x	x	10,15,17,18,31,33,36,43,64,67-68,72,76,84
Novo	mimic shiner	both	G	slack water	x	x		34
Pino	bluntnose minnow	both	G	slack water	x	x	x	23, 33, 35, 60, 64-65, 82
Pipr	fathead minnow	lentic	G	slack water	x	x		23,25,33-34,56,60-61,76,82
Rhca	longnose dace	lotic	S	in current or surf		x		see CCA appendices
Rhob	w. blacknose dace	lotic	S	in or near current	x	x		25, 34, 59-60, 76
Scer	rudd	lentic	G	slack water	x	x	x	18, 31-33, 43, 64, 70-71
Seat	creek chub	both	G	slack water	x	x	x	34-36,39-40,57-59,72-73,76,82-83
Seco	fallfish	lotic	G	in or near current		x		see CCA appendices
Caco	white sucker	both	G	slack water	x	x	x	34-36, 62-63, 83
Hyni	n. hog sucker	lotic	S	in or near current	x	x	x	34, 36, 39-40, 84
Moer	golden redhorse	lotic	G	in or near current		x		see CCA appendices
Amne	brown bullhead	lentic	G	avoids current	x	x	x	35, 82
Amru	rock bass	both	G	near current	x	x	x	33-36
Lecy	green sunfish	both	G	slack water	x	x	x	33, 35-36
Legi	pumpkinseed	lentic	G	slack water	x	x	x	33, 35-36

Lema	bluegill	lentic	G	slack water		x		see CCA appendices
Leme	longear sunfish	both	G	near current	x	x	x	10,13-18,22,31,33,40-41,43 66,72-73,76-77,83,86-87
Mido	smallmouth bass	both	G	near current	x	x	x	33-36, 74
Misa	largemouth bass	both	G	avoids current	x	x	x	33, 35-36, 40-41
Etbl	greenside darter	lotic	S	in or near current	x	x	x	36, 84
Etca	rainbow darter	lotic	S	in current		x		see CCA appendices
Etfl	fantail darter	lotic	S	in current		x		see CCA appendices
Etni	johnny darter	both	G	avoids current	x	x	x	23,33-34,36,56-57,72-73,76,82-83
Pefl	yellow perch	both	G	avoids current	x	x	x	35, 65-66, 71, 76
Peca	logperch	both	G	slacker water	x	x		34
Pema	blackside darter	lotic	S	in or near current	x	x	x	33, 35-36, 83
Neme	round goby	both	G	in or near current	x	x	x	18,30-33,35-36,43,68-70,72,78,86

[1]Species common names are in accordance with Nelson et al. 2004 and their Latin name abbreviation (abbr) includes the first two letters of the Genus and species.

[2]Habitat-guild data were found in various citations (see Literature Cited) indicating use of standing (lentic) or running (lotic) water or both by stream fishes.

[3]Flow preference describes general consensus of where species are commonly found.

[4]Indicate DCA—detrended correspondence analysis, CCA—canonical correspondence analysis, MLR—multiple linear regression tests performed.

[5] References to some fish species may only be found in the CCA biplots (Appendices III-A to IV-U).

Table 11. Canonical Correspondence Analysis results for the Tonawanda and Johnson Creek watersheds, May-September 2005, organized by species and scales. See Table 4 for descriptions of habitat variables and their codes and Table 6 for species codes. Criteria for reporting the results below were: 1) a species was more than half way out along a vector in at least two of the three biplots in an analysis; 2) a species was nearly touching a vector in at least one biplot; and 3) literature supported the species-habitat association for a species that was close to a habitat vector. See Figures 4a-c for a sample of biplots meeting all three criteria and Appendices III-A—IV-U for all remaining biplots meeting at least criteria 1 and 2 above.

[1]Scale	[2]Sites	[3]SaS	[4]N	Dep	[5]D-rel	[6]Indep	[5]I-rel	[7]Avg (SE)	[7]Avg Hab
T-EC+T	14	9	41	Amru	inc	MD	dec	3.44 (0.242)	deep
T-TR	11	8	97	Amru	inc	MD	dec	2.88 (0.227)	mod deep
J-PT3	8	3	193	Caan	inc	BC	inc	3.00 (0.577)	mod
J-PT4	11	7	238	Caan	inc	AV	inc	2.14 (0.404)	low
J-UB	16	8	428	Caan	inc	AV	dec	2.50 (0.50)	low-mod
TCW	68	18	297	Caan	inc	PT	inc	3.50 (0.825)	type 4
J-LB	24	11	164	Caco	inc	PT	inc	2.64 (0.338)	type 3
J-PT3	8	6	182	Caco	inc	AV	inc	3.33 (0.422)	mod
T-LB	49	25	283	Caco	inc	AV	dec	2.40 (0.216)	low
T-LB	49	25	283	Caco	inc	IW	inc	2.52 (0.143)	low-mod
T-PT1	22	9	92	Caco	inc	BC	inc	2.56 (0.242)	low-mod
T-TR	11	7	226	Caco	inc	AV	even	2.57 (0.369)	low-mod
J-LB	24	8	163	Cysp	inc	BC	even	2.50 (0.189)	low-mod
J-PT1	14	5	21	Cysp	dec	SS	dec	2.21 (0.185)	sand
T-EC+T	14	7	16	Eslu	inc	AV	inc	2.86 (0.633)	low-mod
JCW	40	13	95	Etbl	inc	BC	inc	3.08 (0.288)	mod
J-PT3	8	2	16	Etbl	inc	BC	inc	3.50 (0.50)	mod-high
J-PT4	11	7	56	Etbl	inc	SS	inc	2.53 (0.121)	sand-gravel
T-LB	49	10	144	Etbl	inc	PT	inc	3.7 (0.213)	type 4
J-LB	24	19	348	Etni	inc	IW	even	2.57 (0.174)	low-mod
J-PT1	14	4	11	Etni	dec	AV	dec	4.0 (0.578)	high
T-UB	12	10	396	Etni	dec	MD	dec	2.60 (0.163)	mod deep

JCW	40	13	346	Hyni	inc	PT	inc	3.31 (0.263)	type 3
J-PT4	11	7	223	Hyni	inc	BC	inc	3.00 (0.378)	mod
TCW	68	31	595	Hyni	inc	PT	inc	3.55 (0.121)	type 4
T-LB	49	15	114	Hyni	inc	PT	inc	3.47 (0.215)	type 4
T-PT2	12	8	182	Legi	even	MD	inc	3.50 (0.189)	deep
J-UB	16	10	126	Luch	inc	SS	inc	2.24 (0.18)	sand
T-LB	49	20	296	Luch	inc	PT	inc	3.10 (0.248)	PT3
J-PT1	14	8	12	Mido	dec	SS	dec	2.06 (0.156)	sand
J-PT3	8	5	34	Mido	dec	SS	dec	2.51 (0.176)	sand-gravel
T-LB	49	38	227	Mido	inc	MD	dec	3.24 (0.128)	mod deep
JCW	40	28	208	Misa	dec	AV	dec	2.86 (0.234)	low-mod
TCW	68	47	532	Misa	dec	MD	dec	3.21 (0.105)	mod deep
T-PT2	12	11	35	Misa	dec	MD	inc	3.27 (0.237)	deep
T-PT3	11	3	38	Misa	inc	BC	dec	3.67 (0.667)	mod-high
T-LB	49	24	342	Noat	dec	MD	dec	3.58 (0.119)	deep
TCW	68	14	477	Nobi	inc	AV	dec	2.71 (0.370)	low-mod
T-M+U	19	11	419	Nobi	dec	MD	dec	2.73 (0.141)	mod deep
T-UB	12	5	92	Nobi	dec	IW	dec	2.80 (0.20)	low-mod
T-PT4	23	7	971	Nomi	dec	IW	dec	2.43 (0.202)	low
T-LB	49	28	463	Novo	inc	SS	inc	2.11 (0.129)	sand
T-PT2	12	9	27	Novo	inc	AV	dec	2.33 (0.441)	low
T-PT3	11	4	98	Peca	dec	SS	even	2.59 (0.176)	sand-gravel
J-PT2	7	5	21	Pefl	even	MD	dec	2.60 (0.40)	mod deep
T-EC+T	14	6	23	Pefl	inc	BC	even	2.50 (0.342)	low-mod
J-LB	24	14	89	Pema	inc	IW	even	2.50 (0.203)	low-mod
J-PT1	14	4	5	Pema	inc	AV	dec	4.25 (0.75)	high
J-PT4	11	7	43	Pema	dec	MD	dec	2.57 (0.429)	mod deep

T-PT4	23	9	172	Pema	dec	MD	dec	2.44 (0.242)	mo shallow
T-PT2	12	5	13	Pipr	dec	AV	dec	3.00 (0.281)	mod
T-UB	12	7	95	Rhca	inc	SS	inc	2.64 (0.286)	sand-gravel
T-M+U	19	8	1361	Rhob	inc	SS	inc	2.64 (0.126)	sand-gravel
J-PT3	8	3	148	Seat	inc	BC	inc	3.33 (0.333)	mod
TCW	68	13	215	Seat	inc	PT	inc	3.69 (0.133)	type 4
T-TR	11	4	151	Seat	inc	PT	inc	3.75 (0.25)	type 4
TCW	68	11	23	Leme	dec	MD	dec	3.27 (0.237)	deep
J-LB	24	7	51	Lyum	inc	PT	inc	2.57 (0.429)	type 3
T-PT2	12	5	5	Neme	dec	AV	dec	2.60 (0.678)	low-mod
J-PT2	7	6	36	Cyca	inc	BC	inc	2.83 (0.167)	low-mod
TCW	68	37	270	Cyca	dec	MD	dec	3.24 (0.125)	mod deep
T-EC+T	14	13	96	Cyca	inc	BC	even	2.38 (0.18)	low

[1]The watershed was divided into subunits as shown in Table 2.
[2] Total number of sampling sites at a scale: (T)—Tonawanda Creek watershed, JCW (J)—Johnson Creek watershed, LB—lower basin, UB—upper basin, TR—TCW tributaries, EC+T—Erie Canal + adjacent tributaries (in TCW), M + U—middle + upper basins combined.
[3] Number of sites at a scale where the indicated species was collected.
[4]Number of individuals of a species collected at the indicated scale.
[5]Magnitude of a variable downstream to upstream: inc—increased, dec—decreased, or even (no change) for Dep—dependent variables and Indep—independent variables.
[6]Independent habitat variables: MD—mean depth, SS—substrate, AV—aquatic vegetation, BC—bank cover, IW—instream wood, and PT—pool type
[7]Quantitative (Avg/SE) and qualitative habitat scores: mo—mostly, shall—shallow, mod—moderate, and dom—dominant.

Table 12. Multiple Linear Regression results from analyses of the Tonawanda and Johnson Creek watersheds, May-September 2005. See Table 4 for definitions of habitat variables and their codes and Table 6 for species codes. CPUE—catch per unit effort, RICH—fish species richness, and SDI—Simpson's Diversity Index were also examined. Criteria for including the results below were: 1- variables in BSR models had adj-r^2 values ≥20% (plus rare/exotic species) and 2- variables in SWR models had a P-value ≤0.06.

[1]Scale	[2]Sites	[3]SWSP	[4]N	Dep	Indep	[5]Assoc	[6]m-CP	[6]adj-r^2	[7]Avg (SE)	[7]Avg Hab	[8]adj-r^2	[8]P-value
TCW	68	-	68	CPUE	PT	pos	2.7	0.398	2.51(0.153)	type 3	0.398	<0.001
JCW	40	-	40	CPUE	PT	pos	3.2	0.280	2.40(0.195)	type 2	0.217	0.001
J-PT3	8	-	8	CPUE	MD	pos	4.1	0.997	2.4(0.183)	mo shall	0.997	0.007
J-UB	16	-	16	CPUE	MD	neg	2.0	0.628	2.4(0.182)	mo shall	0.628	0.029
T-M+U	19	-	19	CPUE	SS	pos	3.5	0.753	2.4(0.125)	sand	0.703	0.029
T-UB	12	-	12	CPUE	SS	pos	0.6	0.686	2.3(0.172)	sand	0.686	0.031
T-TR	11	-	11	CPUE	SS	pos	1.4	0.714	1.9(0.172)	silt-sand	0.343	0.034
J-UB	16	-	16	CPUE	SS	pos	2.0	0.628	2.1(0.138)	sand	0.628	0.001
J-PT4	11	-	11	CPUE	SS	pos	2.5	0.693	2.4(0.118)	sand	0.408	0.021
J-PT3	8	-	8	CPUE	SS	neg	4.1	0.997	2.3(0.183)	sand	0.997	0.039
T-M+U	19	-	19	CPUE	IW	pos	3.5	0.753	2.1(0.143)	low	0.703	0.058
TCW	68	-	68	CPUE	IW	neg	2.7	0.398	2.34(0.083)	low	0.398	0.052
J-PT3	8	-	8	CPUE	IW	neg	4.1	0.997	2.5(0.189)	low-mod	0.997	<0.001
T-EC+T	14	-	14	CPUE	BC	neg	-2.2	0.205	2.4(0.169)	low	0.205	0.059
J-LB	24	-	24	CPUE	BC	neg	0.8	0.240	2.5(0.104)	low-mod	0.172	0.025
J-PT1	14	-	14	CPUE	BC	neg	0.4	0.589	2.6(0.133)	low-mod	0.589	<0.001
TCW	68	-	68	CPUE	AV	pos	2.7	0.398	2.21(0.137)	low	0.398	<0.001
T-M+U	19	-	19	CPUE	AV	pos	3.5	0.753	2.4(0.325)	low	0.703	<0.001
T-UB	12	-	12	CPUE	AV	pos	0.6	0.686	1.6(0.193)	present	0.686	0.003
T-PT4	23	-	23	CPUE	AV	pos	2.4	0.409	2.5(0.280)	low	0.409	<0.001
J-PT3	8	-	8	CPUE	AV	neg	4.1	0.997	3.1(0.441)	mod	0.997	<0.001
T-TR	11	-	11	RICH	PT	pos	1.4	0.451	2.2(0.422)	type 2	0.451	0.014
J-PT4	11	-	11	RICH	MD	pos	-0.9	0.291	2.5(0.282)	mod	0.291	0.050
J-PT1	14	-	14	RICH	SS	pos	-1.7	0.215	1.9(0.132)	silt-sand	0.215	0.054
J-UB	16	-	16	RICH	BC	pos	3.2	0.453	3.2(0.209)	mod	0.213	0.041
T-EC+T	14	-	14	RICH	AV	pos	2.4	0.465	2.4(0.359)	low	0.326	0.019
T-TR	11	-	11	SDI	BC	pos	3.1	0.400	2.7(0.237)	low-mod	0.285	0.053
T-PT3	11	-	11	SDI	BC	pos	6.0	0.736	2.7(0.273)	low-mod	0.384	0.025
J-LB	24	-	24	SDI	AV	pos	0.6	0.198	2.9(0.250)	low-mod	0.198	0.017
J-PT3	8	-	8	SDI	AV	pos	0.2	0.446	3.1(0.441)	mod	0.446	0.042
T-M+U	19	-	19	SDI	AV	neg	4.2	0.360	2.4(0.325)	low	0.301	0.009
T-UB	12	-	12	SDI	AV	neg	1.2	0.507	1.6(0.193)	present	0.507	0.006
T-PT4	23	-	23	SDI	AV	neg	0.9	0.223	2.5(0.280)	low	0.223	0.013

JCW	40	30	819	Etni	PT	pos	3.4	0.364	2.87(0.196)	type 3	0.348	<0.001
J-LB	24	19	348	Etni	PT	pos	3.5	0.590	2.37(0.232)	type 2	0.590	<0.001
J-UB	16	11	471	Etni	PT	pos	-0.7	0.308	3.73(0.141)	type 4	0.328	0.012
J-LB	24	19	348	Etni	IW	pos	3.5	0.590	2.42 (0.176)	low-mod	0.590	0.014
T-PT3	11	11	468	Etni	AV	pos	4.4	0.777	1.82(0.182)	present	0.406	0.021
J-LB	24	19	348	Etni	AV	pos	3.5	0.590	2.89(0.314)	low-mod	0.590	0.025
T-PT2	12	10	336	Etni	AV	neg	4.0	0.433	3.20(0.250)	mod	0.268	0.049
J-UB	16	11	538	Seat	PT	pos	4.8	0.752	3.73(0.141)	type 4	0.752	0.013
J-UB	16	11	538	Seat	MD	neg	4.8	0.752	2.27(0.278)	mo shall	0.752	0.015
J-UB	16	11	538	Seat	BC	pos	4.8	0.752	3.36(0.279)	mod	0.752	0.003
J-PT4	11	10	392	Seat	BC	pos	2.5	0.727	3.10(0.348)	mod	0.678	0.003
J-PT4	11	10	392	Seat	AV	pos	2.5	0.727	1.90(0.314)	present	0.678	0.015
T-M+U	19	8	1361	Rhob	SS	pos	1.1	0.231	2.64(0.126)	sand-gvl	0.154	0.054
T-UB	12	8	1361	Rhob	SS	pos	0.6	0.600	2.64(0.126)	sand-gvl	0.600	0.008
T-TR	11	3	1191	Rhob	SS	pos	1.8	0.641	2.18(0.267)	sand	0.367	0.029
T-UB	12	8	1361	Rhob	AV	pos	0.6	0.600	1.50(0.267)	present	0.600	0.051
TCW	68	25	2130	Pipr	PT	pos	1.9	0.243	2.96(0.234)	type 3	0.043	0.049
T-M+U	19	9	2075	Pipr	AV	pos	-1.3	0.380	2.22(0.547)	low	0.380	0.003
T-PT4	23	12	2089	Pipr	AV	pos	0.9	0.382	2.64(0.432)	low-mod	0.328	0.003
J-PT2	7	3	123	Noat	BC	neg	1.9	0.464	2.33(0.333)	low	0.536	0.037
T-EC+T	14	7	257	Noat	AV	neg	-0.1	0.420	1.71(0.359)	present	0.286	0.028
J-LB	24	12	350	Noat	AV	neg	3.5	0.358	2.89(0.314)	low-mod	0.194	0.018
J-UB	16	8	428	Caan	MD	neg	0.8	0.306	2.13(0.227)	mo shall	0.209	0.043
J-PT3	8	6	182	Caco	MD	neg	2.9	0.948	2.4(0.183)	mo shall	0.401	0.053
J-PT1	14	14	113	Cyca	MD	neg	0.4	0.400	2.64(0.133)	mod	0.321	0.020
T-EC+T	14	8	136	Nocr	AV	pos	0.2	0.375	2.88(0.549)	low-mod	0.375	0.012
T-TR	11	5	514	Luch	PT	pos	3.2	0.794	4.00(na)	type 4	0.423	0.018
J-LB	24	24	586	Pino	PT	pos	0.9	0.320	2.08 (0.216)	type 2	0.182	0.022
J-PT1	14	10	108	Pefl	BC	neg	0.5	0.323	2.50(0.167)	low-mod	0.253	0.038
TCW	68	11	23	Leme	PT	neg	-0.1	0.122	1.82(0.352)	type 2	0.122	0.007
T-PT2	12	3	3	Leme	MD	neg	3.0	0.691	2.33(0.333)	mo shall	0.627	0.013
TCW	68	11	23	Leme	AV	pos	-0.1	0.122	2.82(0.263)	low-mod	0.122	0.034
T-LB	49	11	23	Leme	AV	pos	-1.3	0.126	2.82(0.263)	low-mod	0.084	0.025

T-PT2	12	3	3	Leme	AV	pos	3.0	0.691	3.33(0.882)	mod	0.627	0.060
J-LB	24	7	51	Lyum	PT	pos	-0.3	0.198	2.57(0.429)	type 3	0.170	0.026
J-UB	16	2	6	Lyum	PT	neg	-0.6	0.177	1.00(na)	type 1	0.195	0.050
TCW	68	3	6	Lyum	SS	neg	-1.4	0.061	1.28 (0.073)	silt	0.061	0.024
T-LB	49	3	6	Lyum	SS	neg	-1.3	0.057	1.28(0.073)	silt	0.057	0.054
J-PT1	14	1	8	Lyum	IW	pos	-1.4	0.204	3.00 (na)	mod	0.204	0.059
J-LB	24	6	21	Neme	PT	pos	-1.8	0.119	2.83(0.307)	type 3	0.119	0.055
J-PT3	8	3	9	Neme	MD	pos	1.3	0.848	3.00(na)	mod	0.848	<0.001
T-PT1	22	7	8	Neme	IW	neg	4.0	0.500	1.71(0.184)	present	0.363	0.002
T-PT3	11	1	5	Neme	BC	pos	3.8	0.825	5.00 (na)	dom	0.661	0.001
J-UB	16	2	16	Neme	BC	pos	-0.1	0.229	4.00(1.00)	high	0.259	0.026
TCW	68	4	13	Scer	SS	neg	4.1	0.137	1.40(0.102)	silt	0.137	0.010
TCW	68	4	13	Scer	AV	pos	4.1	0.137	3.25(1.031)	mod	0.137	0.009
T-PT2	12	1	2	Scer	AV	pos	0.9	0.503	5.00(na)	dom	0.503	0.006

[1]The watersheds were divided into subunits as shown in Table 2.

[2] Total number of sampling sites in the TCW (T)—Tonawanda Creek watershed, JCW (J)—Johnson Creek watershed, LB—lower basin, UB—upper basin, TR—TCW tributaries, EC+T—Erie Canal + adjacent tributaries (TCW), M + U—middle + upper basins combined (TCW). PT—pool type (1-4).

[3] Total number of sampling sites with the same species (SWSP) collected at each scale.

[4]Total samples or fish of that species collected at each scale.

[5]Association (+/-) of dependent (Dep) and independent (Indep) variables.

[6]Results for best subsets regression (BSR): Mallow's CP score (m-CP) and adjusted r² value (adj-r²).

[7]Average (Avg) habitat scores and standard errors (SE), and qualitative meanings of the numerical scores (Avg = typical habitat).

[8]Results for backward stepwise linear regression (SWR): adj-r² values and P-values ($\alpha \leq 0.06$). Had a Bonferroni adjustment been used, only P-values ≤ 0.001) would be significant.

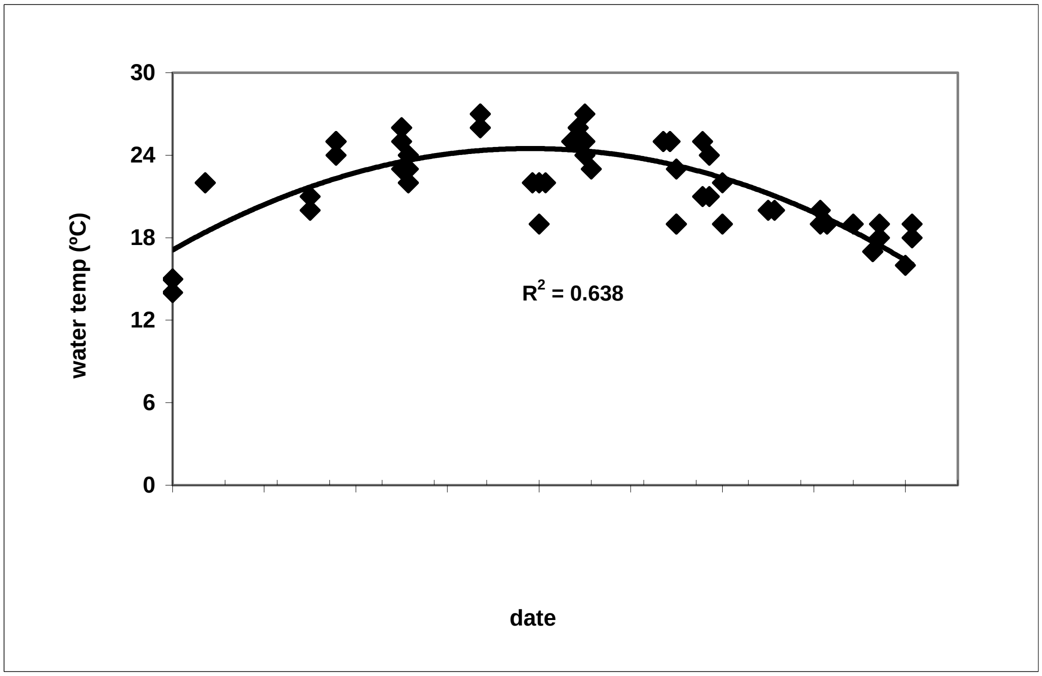

Figure 1a. Surface temperatures at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

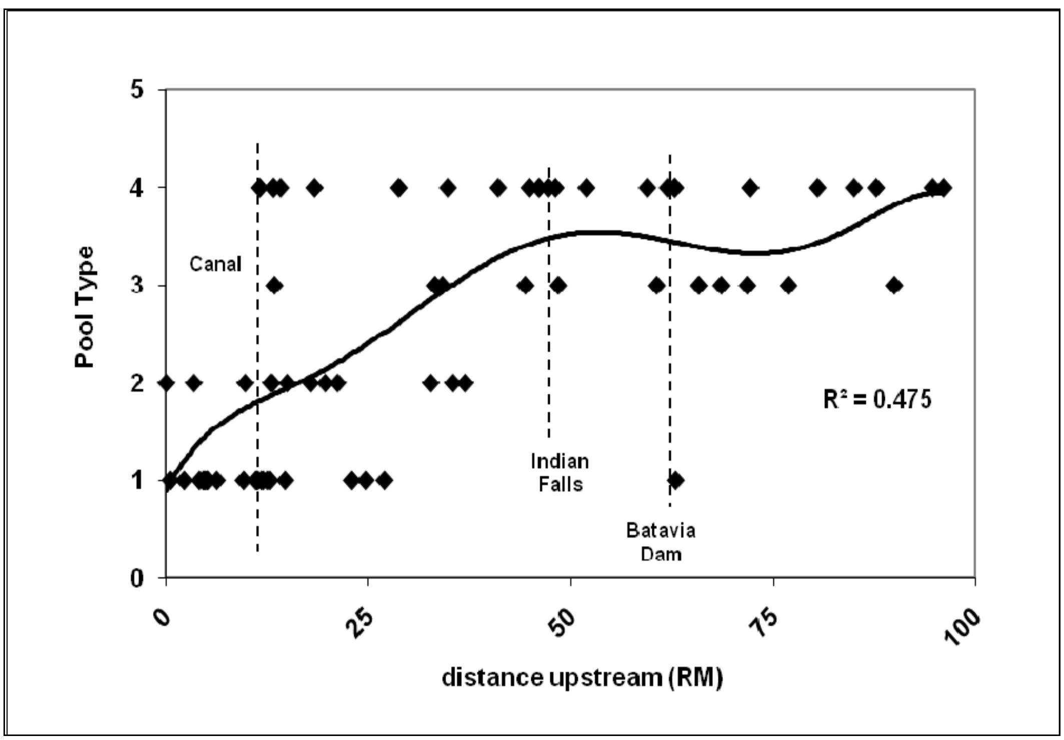

Figure 1b. Pool types at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

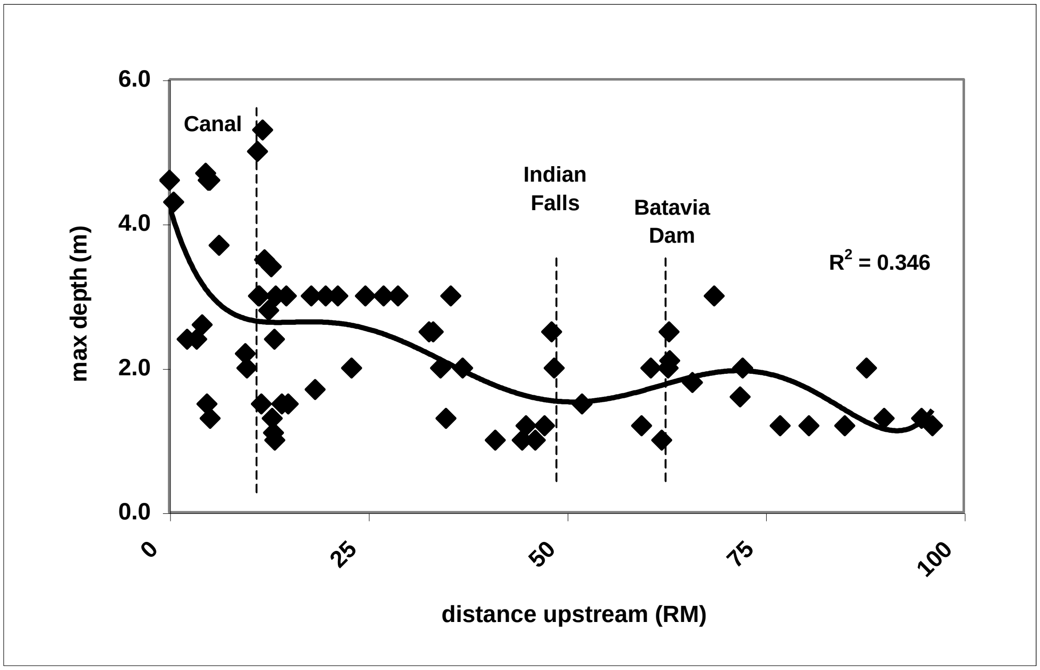

Figure 1c. Maximum depths at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

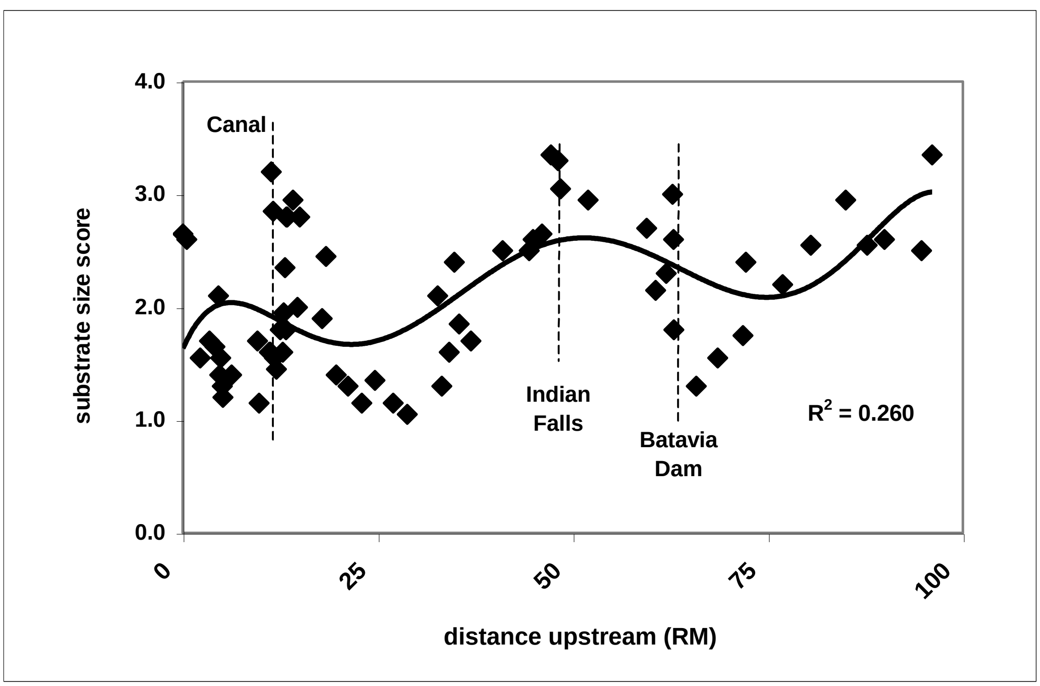

Figure 1d. Substrate particle size scores at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

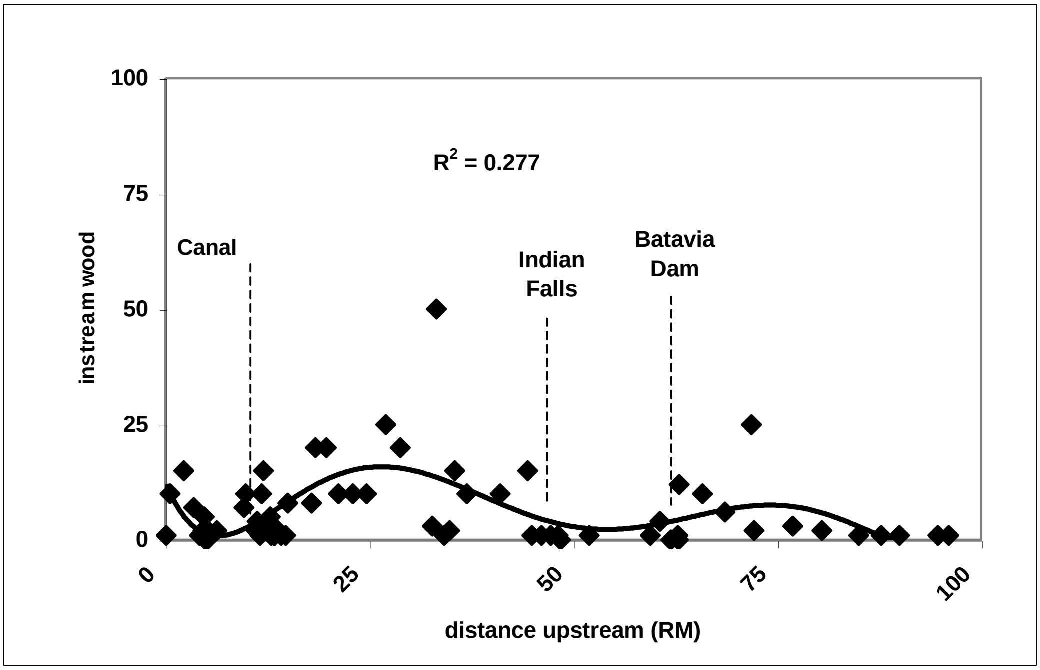

Figure 1e. Percent instream wood at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

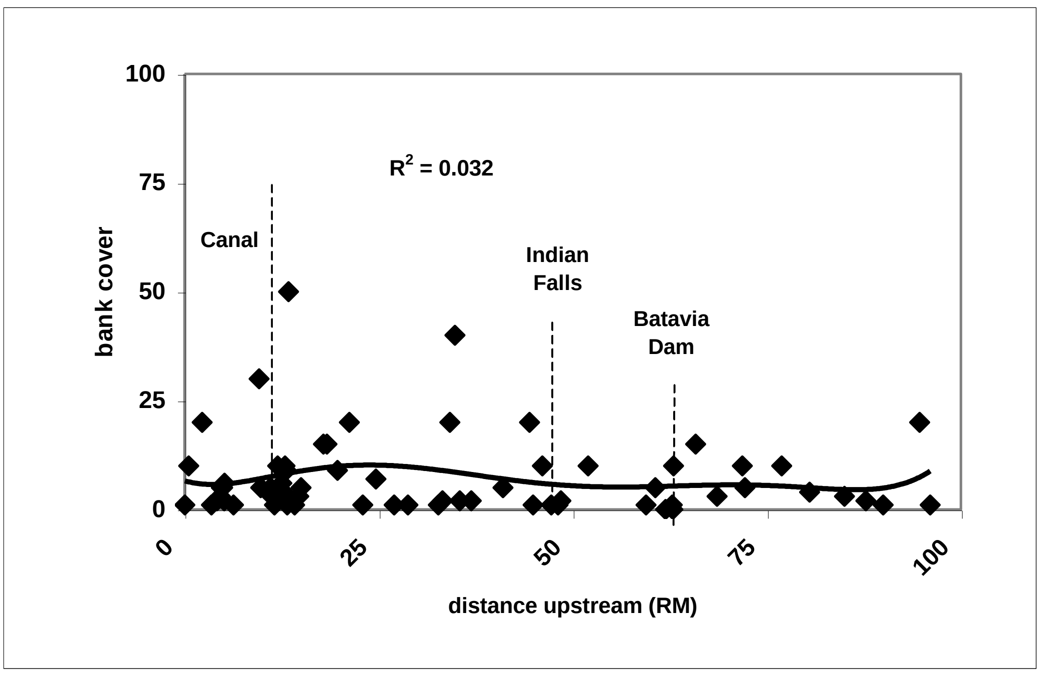

Figure 1f. Percent bank cover at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

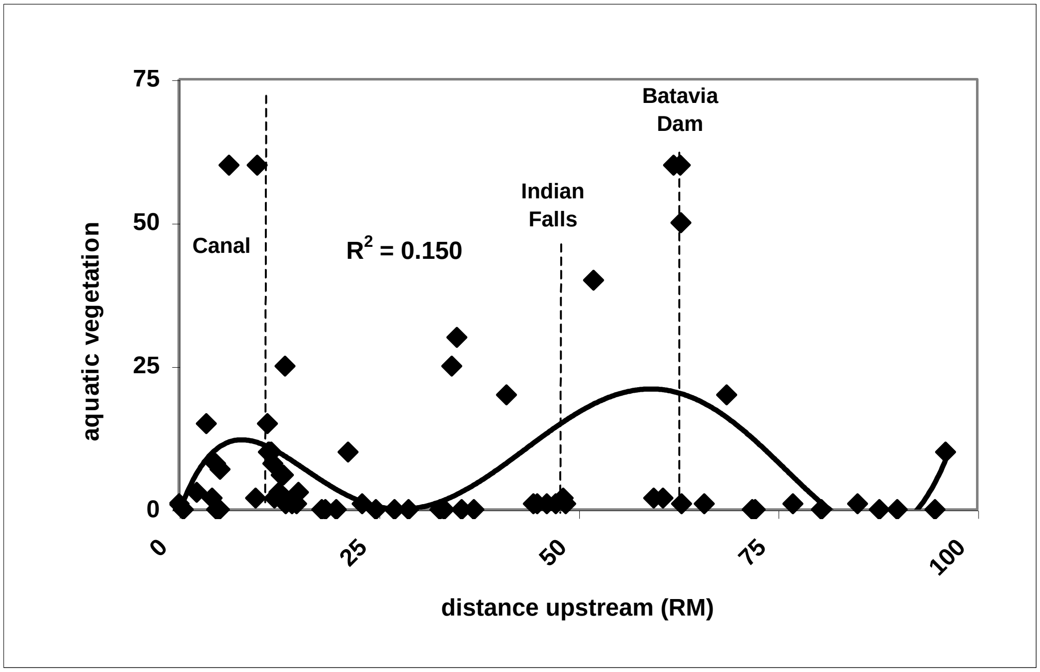

Figure 1g. Percent aquatic vegetation at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

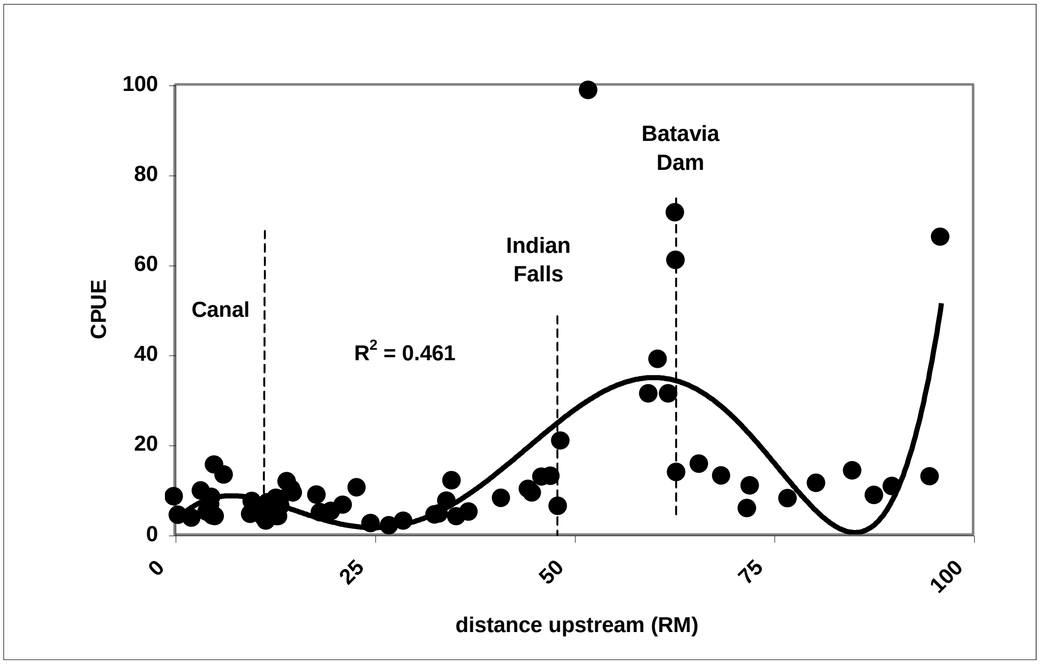

Figure 1h. Catch per unit effort (CPUE) at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

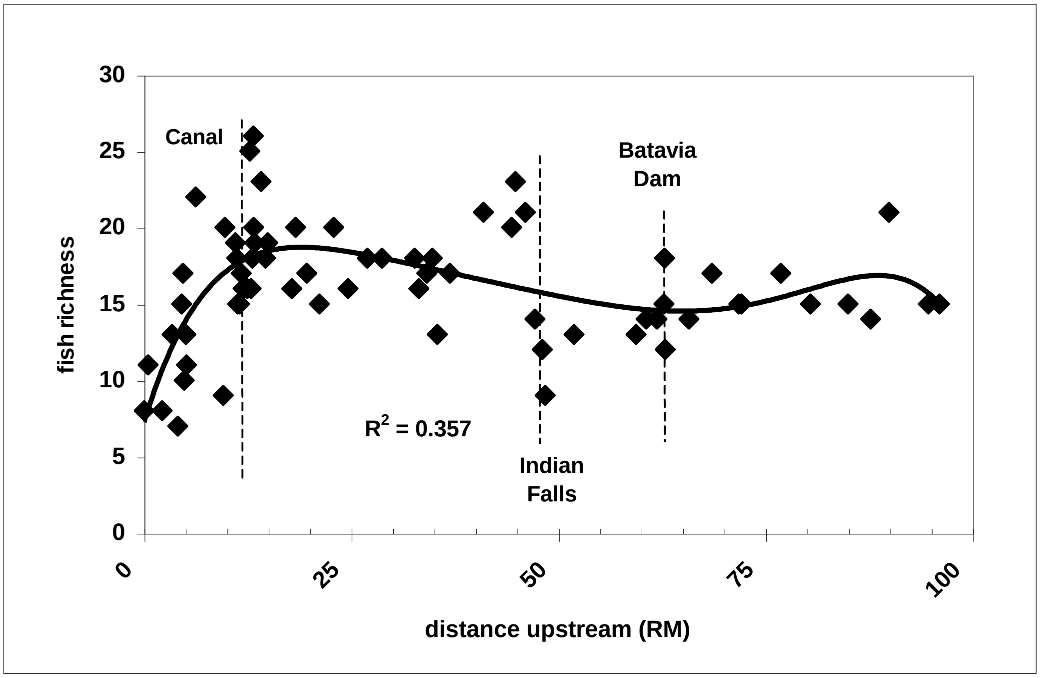

Figure 1i. Fish richness at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

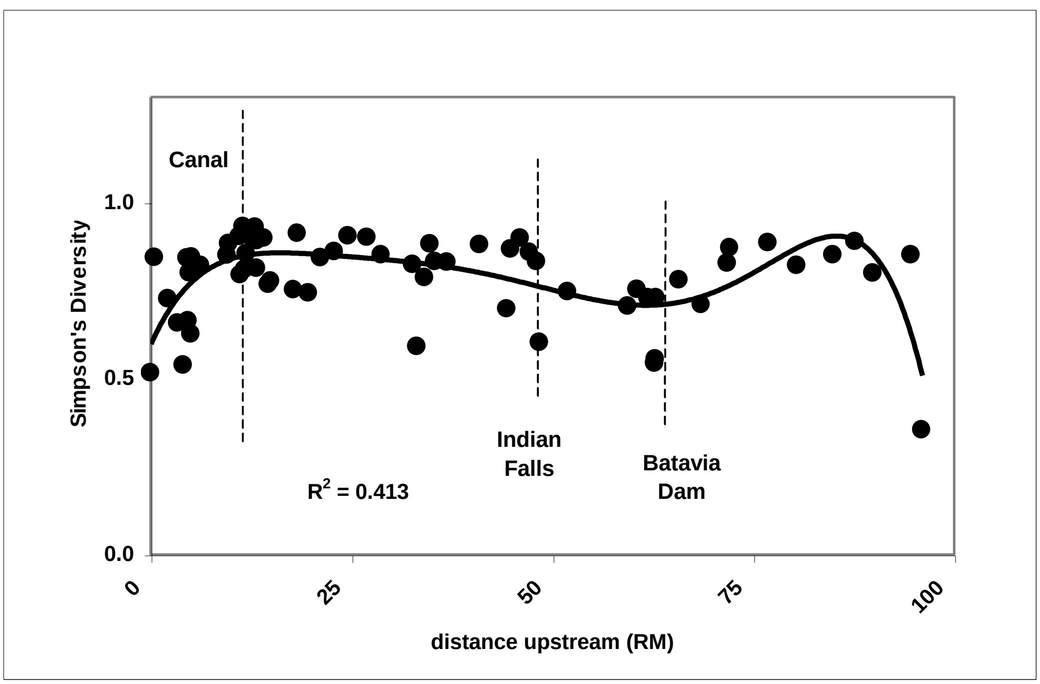

Figure 1j. Simpson's Diversity Index (SDI) at 68 sampling sites in the Tonawanda Creek watershed, June 2-September 23, 2005.

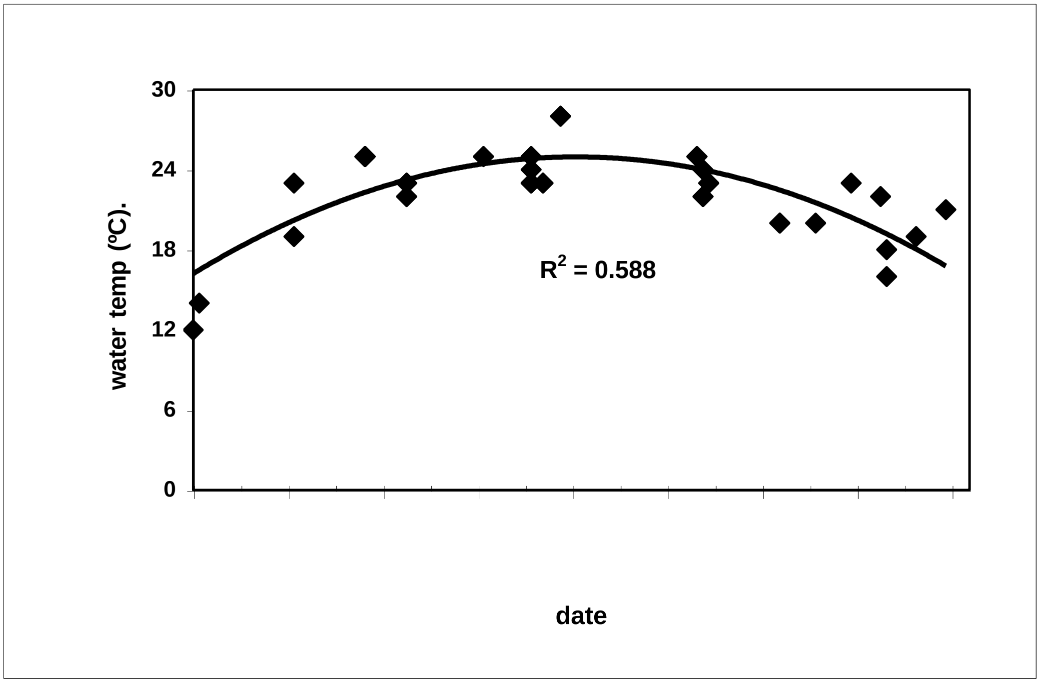

Figure 2a. Surface temperatures at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

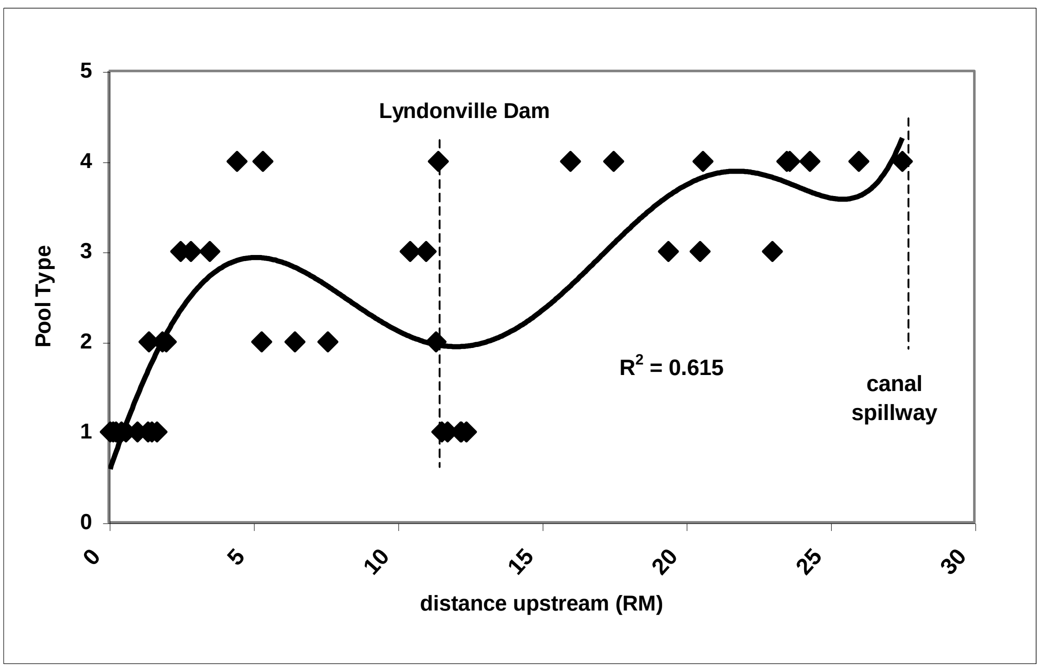

Figure 2b. Pool types at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

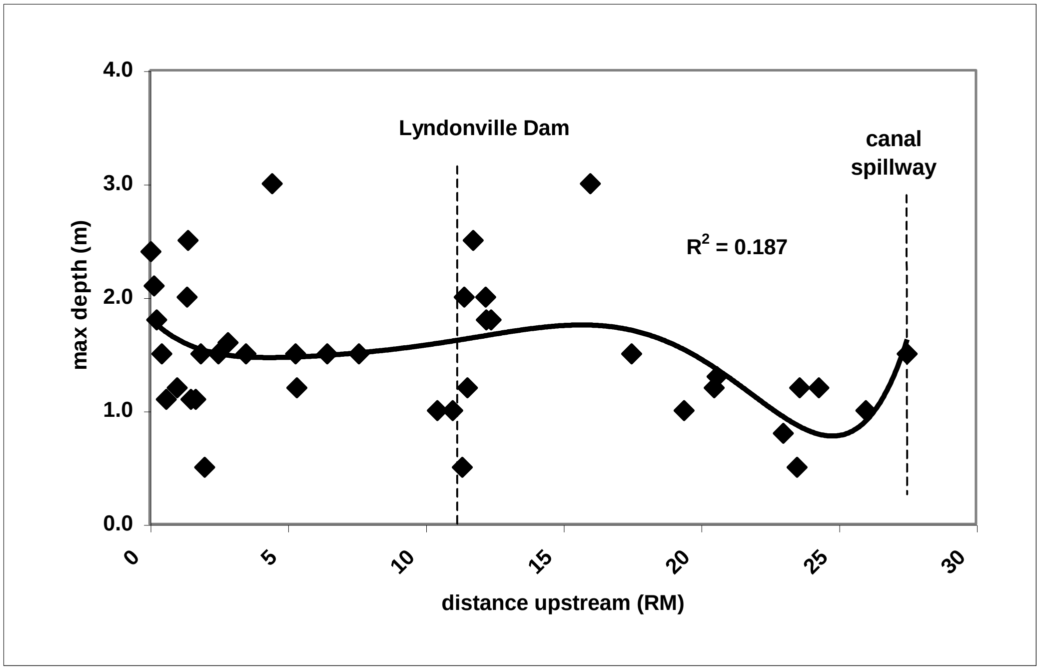

Figure 2c. Maximum depths at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

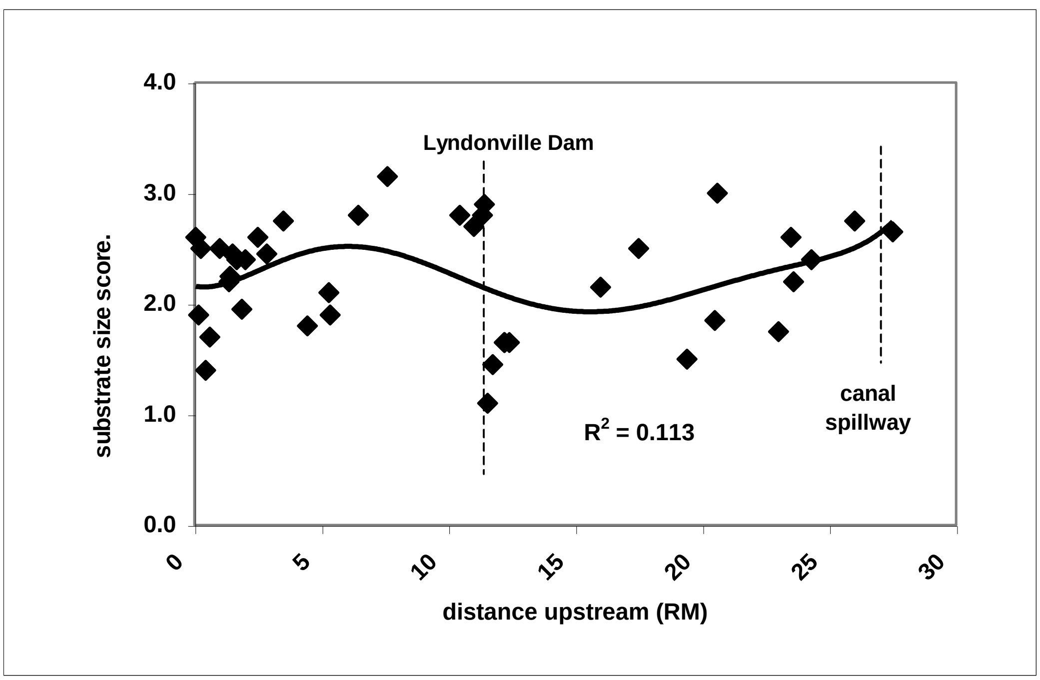

Figure 2d. Substrate particle size scores at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

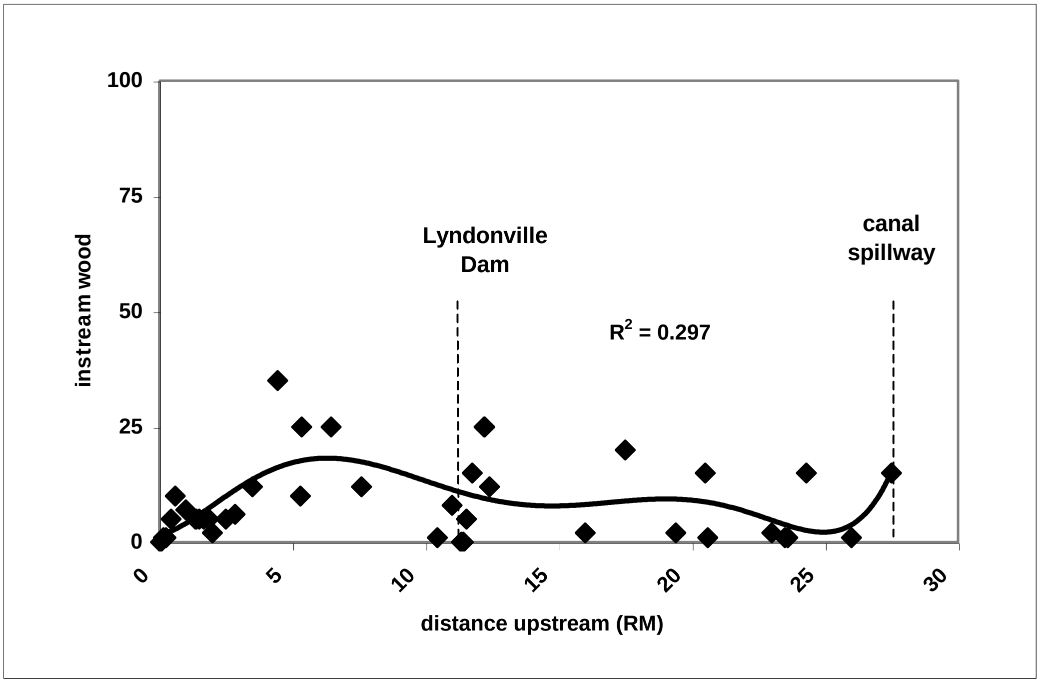

Figure 2e. Percent instream wood at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

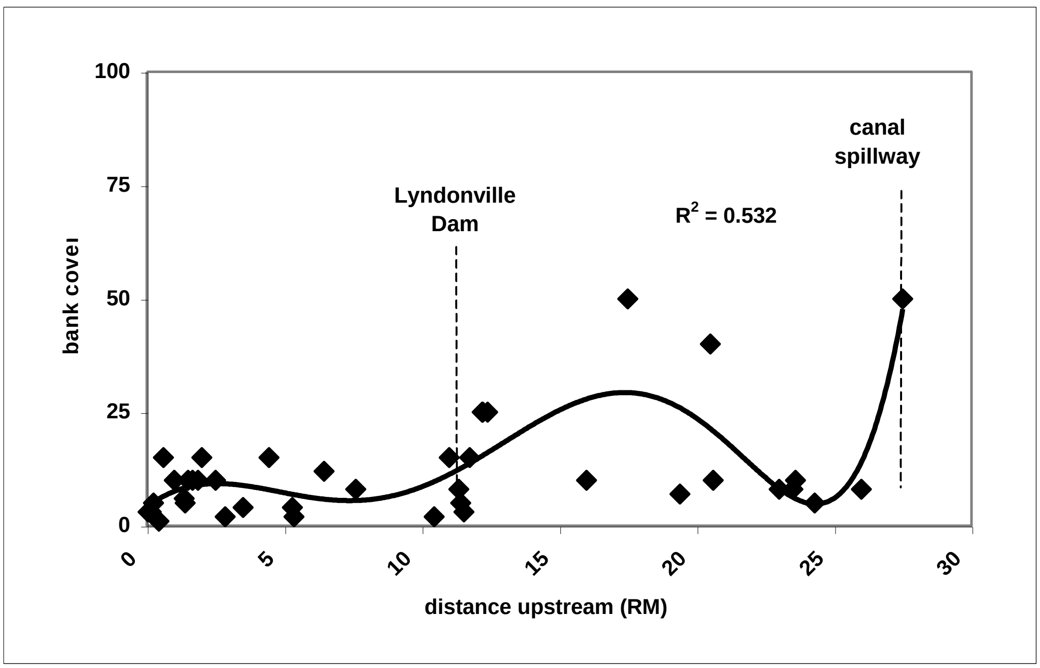

Figure 2f. Percent bank cover at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

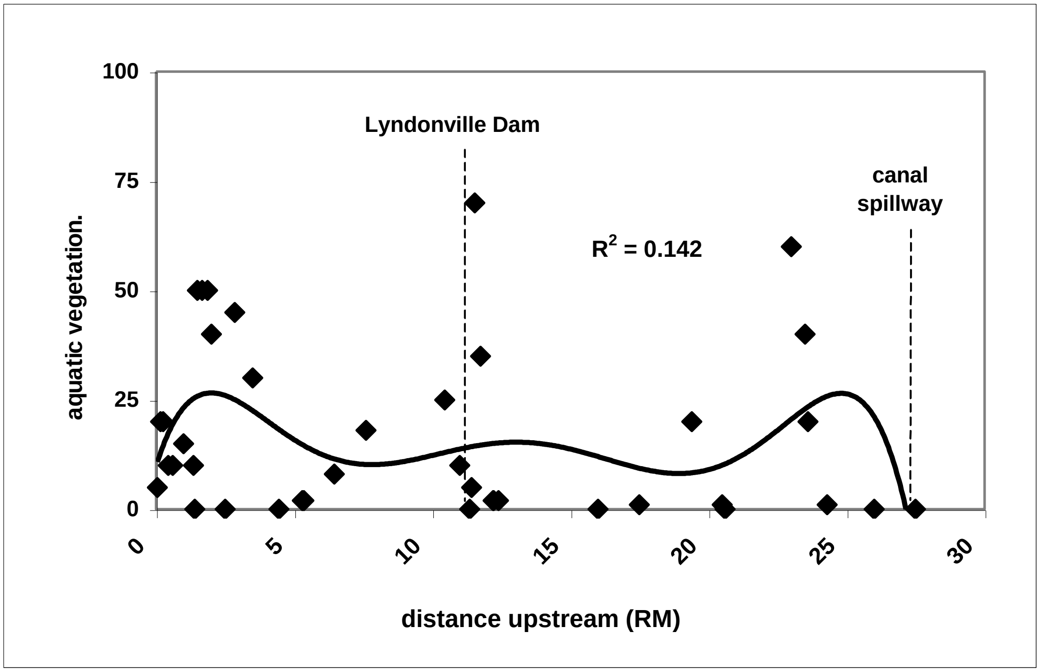

Figure 2g. Percent aquatic vegetation at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

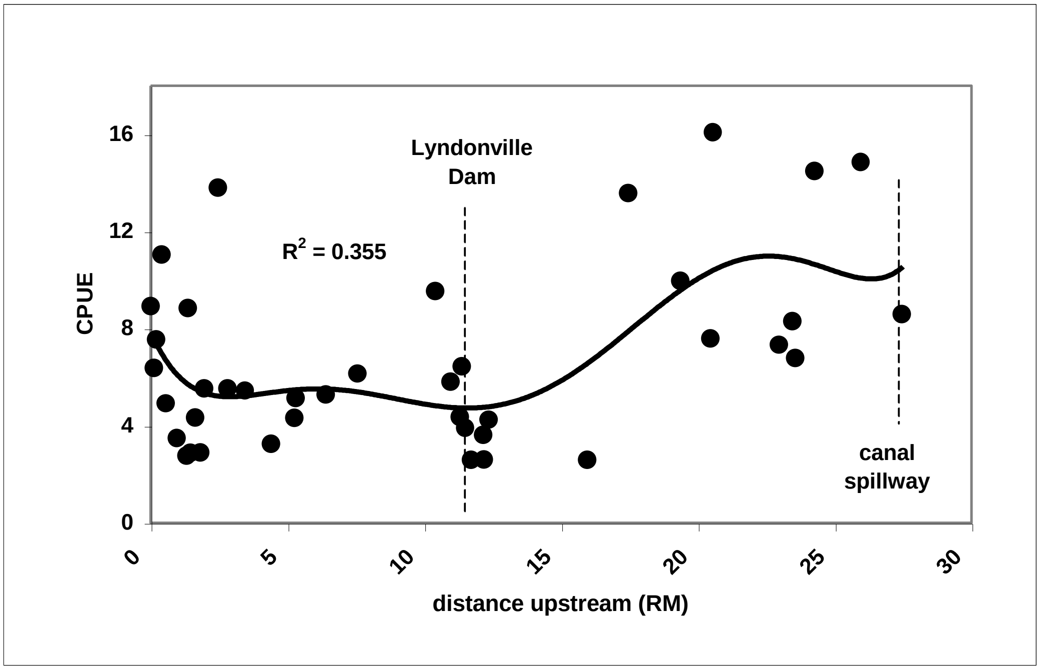

Figure 2h. Catch per unit effort (CPUE) at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

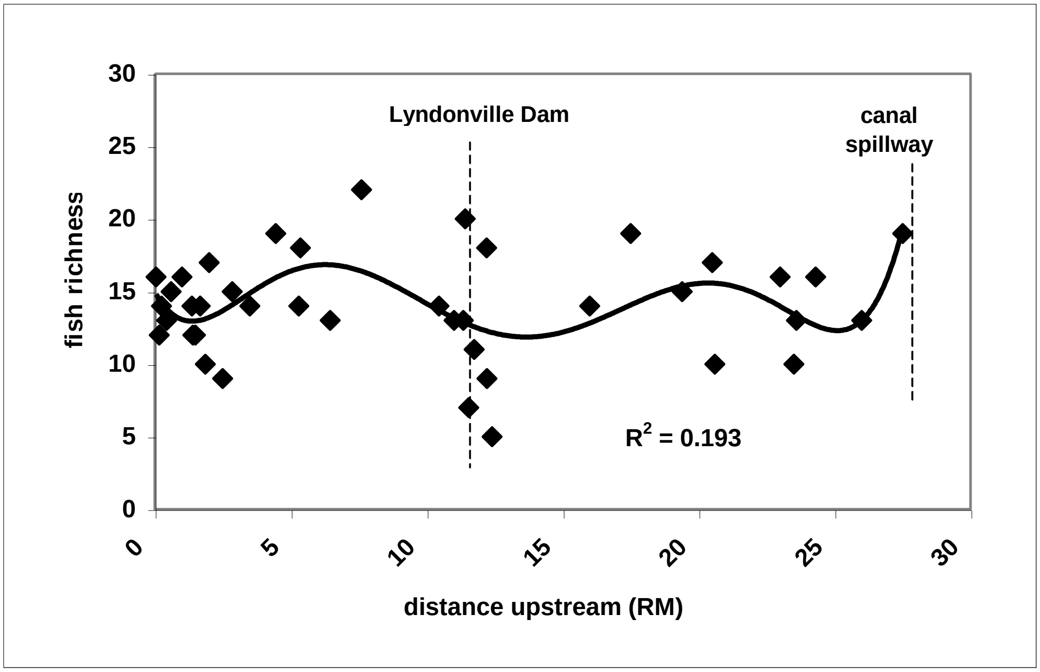

Figure 2i. Fish richness at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

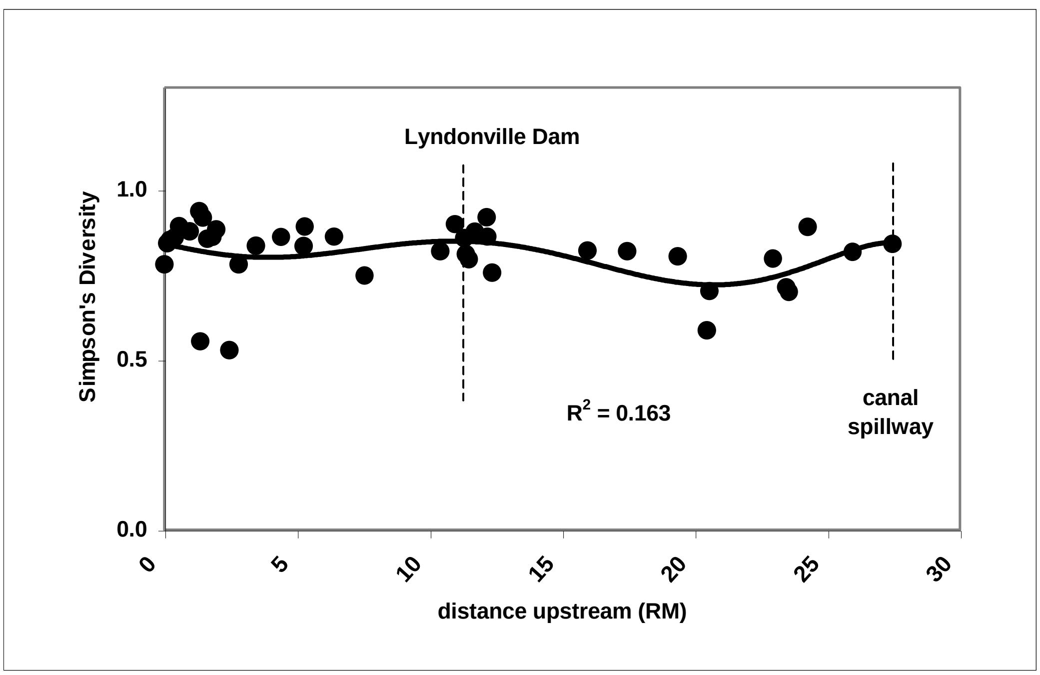

Figure 2j. Simpson's Diversity Index (SDI) at 40 sampling sites in the Johnson Creek watershed, May 17-September 21, 2005.

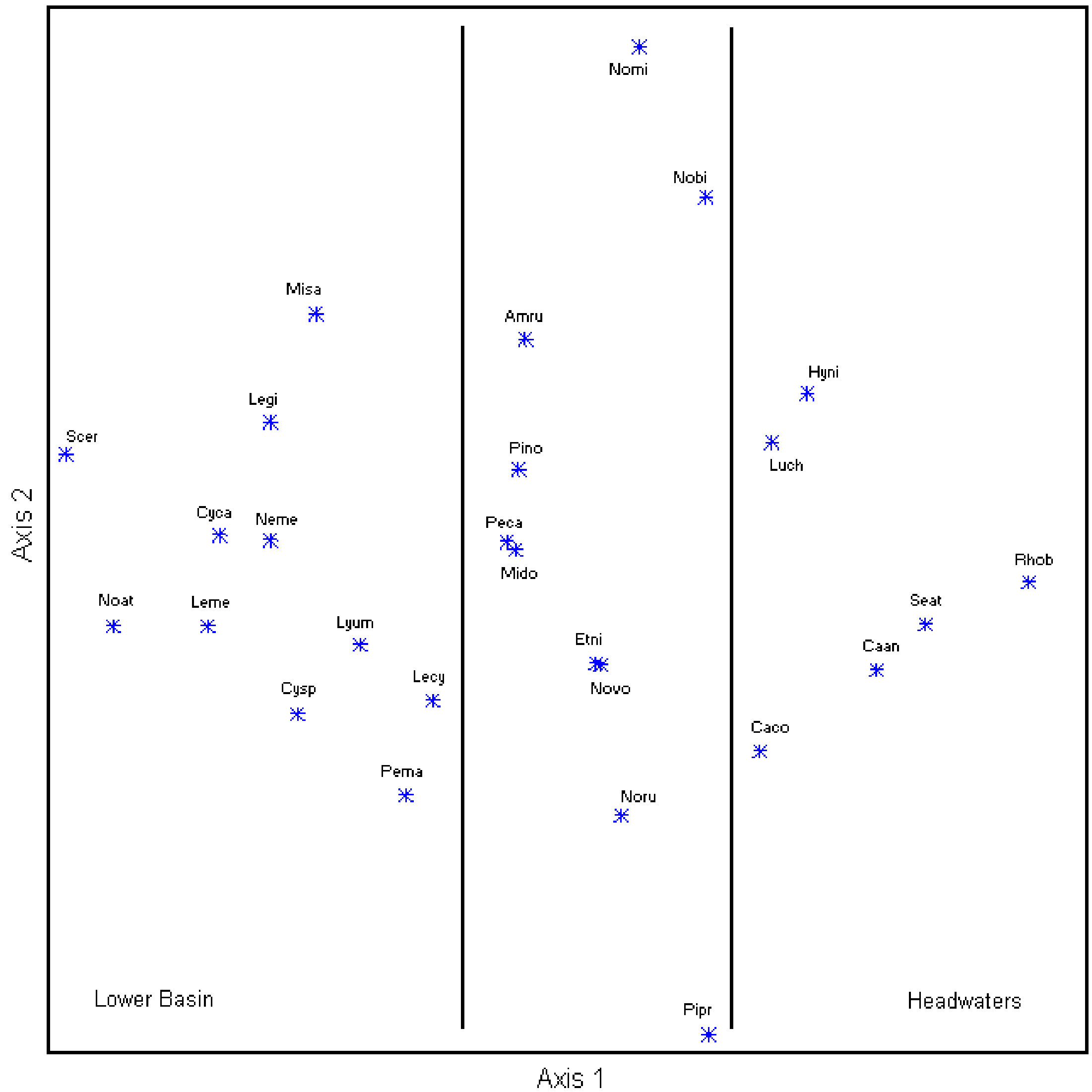

Figure 3a. Detrended Correspondence Analysis (DCA) biplot of fish species associations in relation to distance upstream (RM) in the Tonawanda Creek watershed. Vertical lines distinguish lower basin and headwater species. Fish species codes in Table 6.

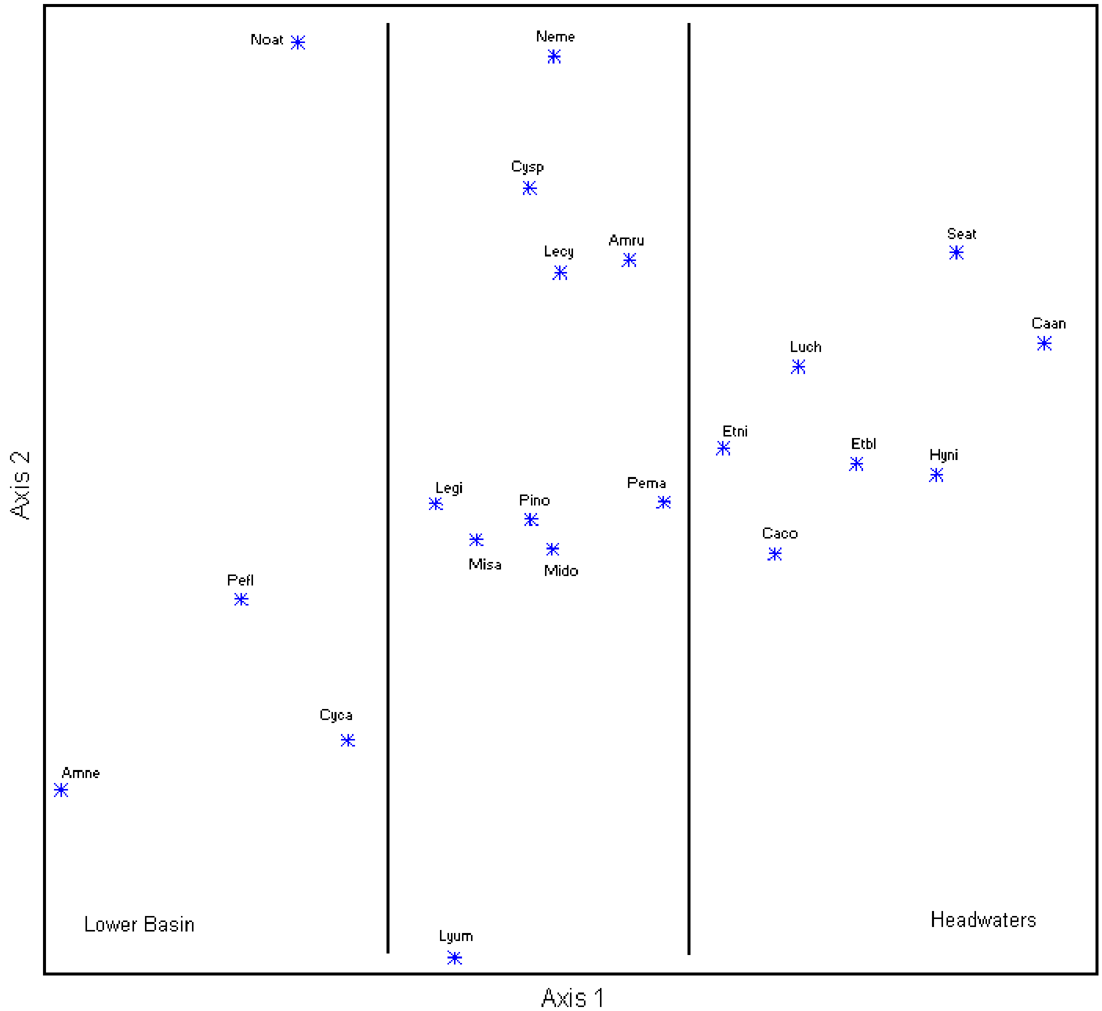

Figure 3b. Detrended Correspondence Analysis (DCA) biplot of fish species associations in relation to distance upstream (RM) in the Johnson Creek watershed. Vertical lines distinguish lower basin and headwater species. Fish species codes in Table 6.

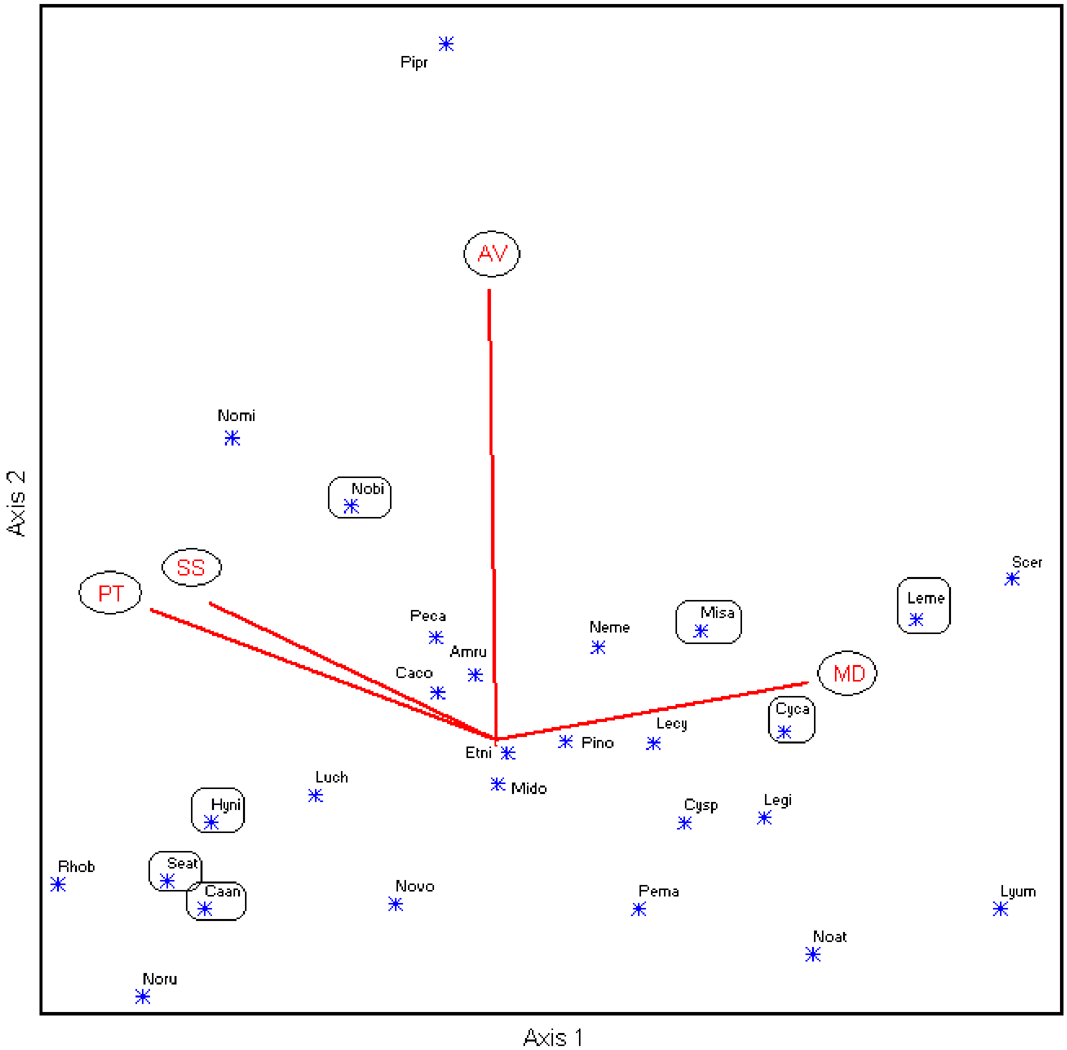

Figure 4a. Example Canonical Correspondence Analysis (CCA) biplot (axes 1-2) for the entire Tonawanda Creek watershed showing fish species (polygons) deemed to be associated with a habitat factor (vectors) according to three criteria (based on the combined results of Figures 4a-c): 1) a species was more that half way out along a vector in at least two of the three biplots (axes 1-2, 1-3, 2-3); 2) a species was nearly touching a vector in at least one biplot; and 3) literature supported the species-habitat association for a species that was close to a habitat vector.

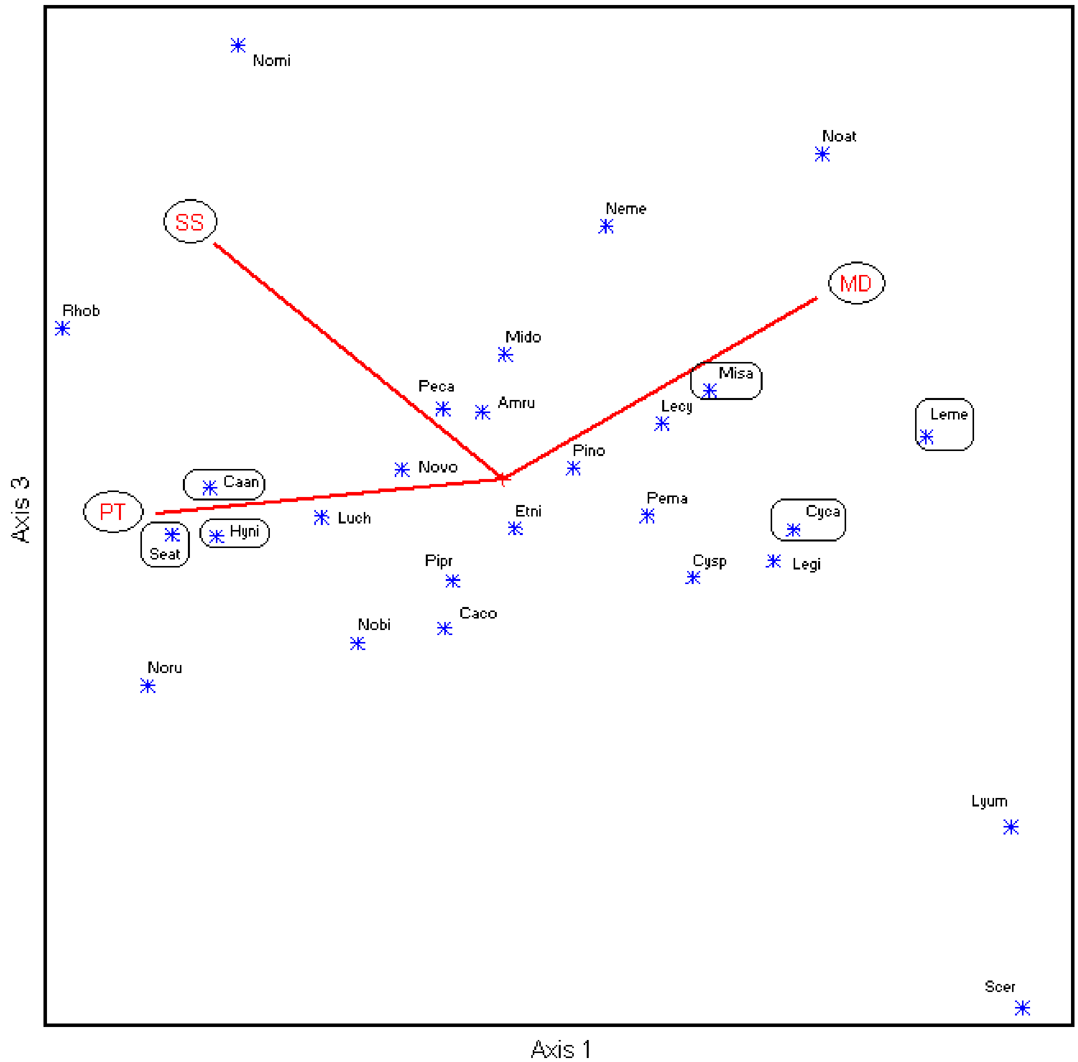

Figure 4b. Example Canonical Correspondence Analysis (CCA) biplot (axes 1-3) for the entire Tonawanda Creek watershed showing fish species (polygons) deemed to be associated with a habitat factor (vectors) according to three criteria (based on the combined results of Figures 4a-c): 1) a species was more that half way out along a vector in at least two of the three biplots (axes 1-2, 1-3, 2-3); 2) a species was nearly touching a vector in at least one biplot; and 3) literature supported the species-habitat association for a species that was close to a habitat vector.

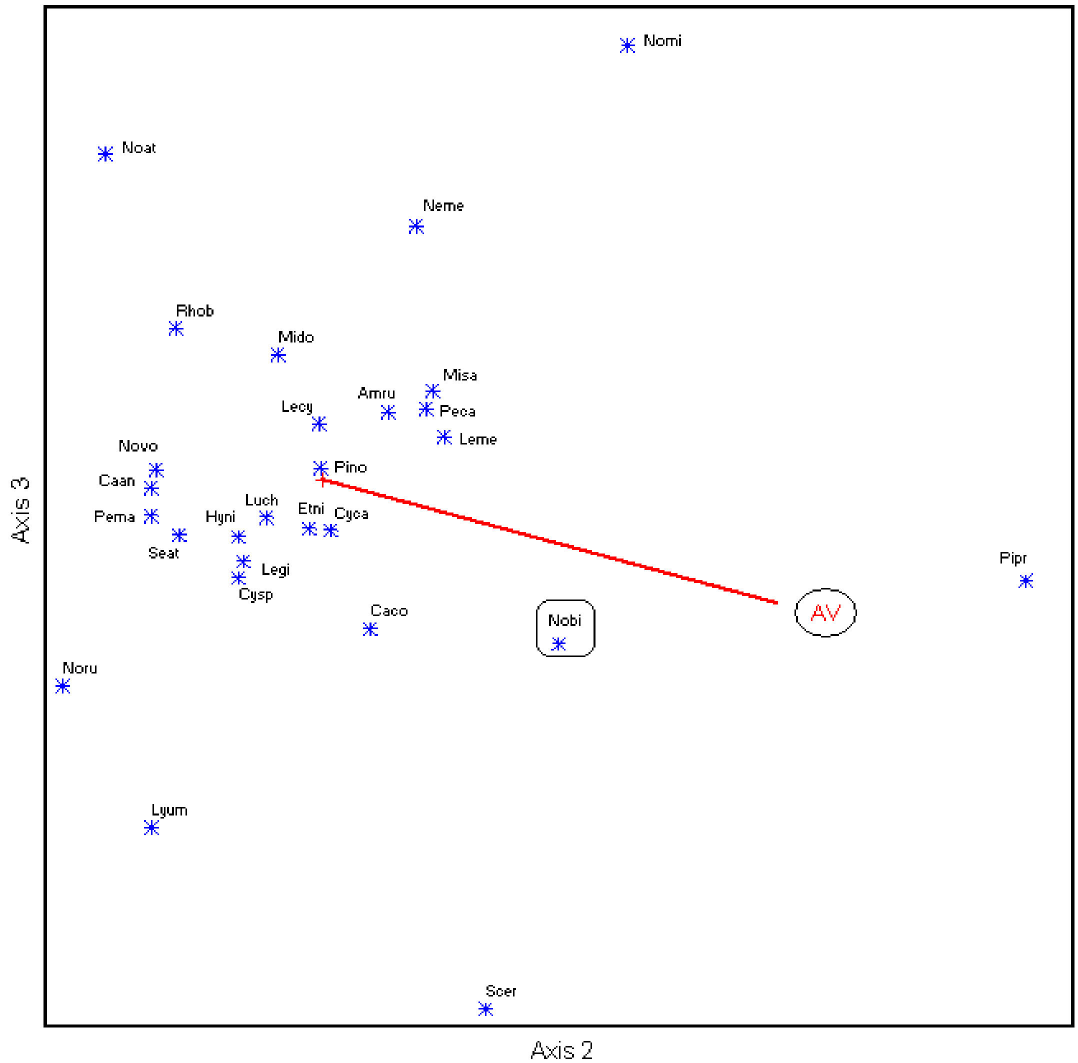

Figure 4c. Example Canonical Correspondence Analysis (CCA) biplot (axes 2-3) for the entire Tonawanda Creek watershed showing fish species (polygons) deemed to be associated with a habitat factor (vectors) according to three criteria (based on the combined results of Figures 4a-c): 1) a species was more that half way out along a vector in at least two of the three biplots (axes 1-2, 1-3, 2-3); 2) a species was nearly touching a vector in at least one biplot; and 3) literature supported the species-habitat association for a species that was close to a habitat vector.

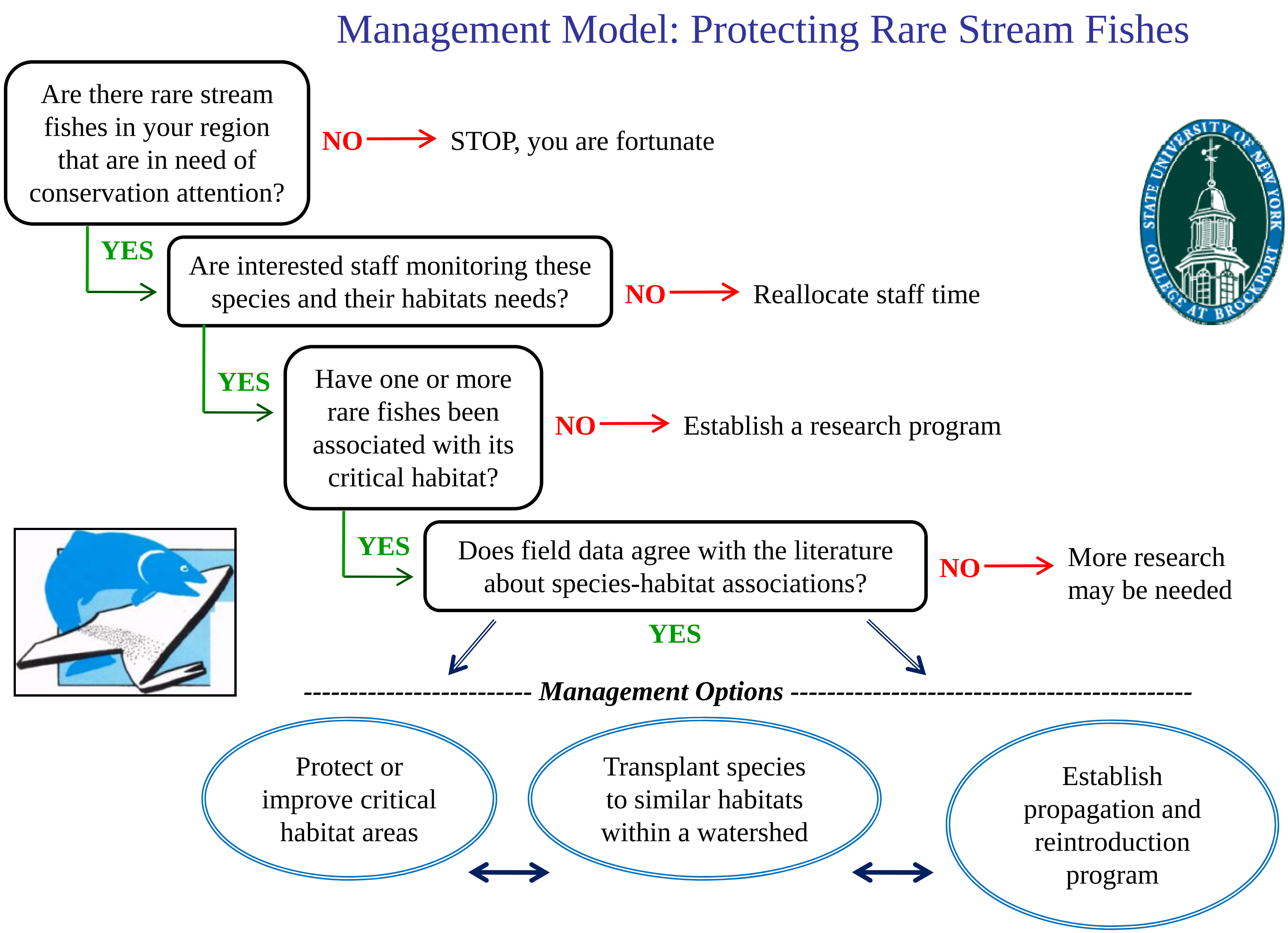

Figure 5. Decision tree for better management of rare stream fishes and their habitats.

Appendix I-A. A checklist of New York's inland fishes listed numerically by NYSDEC code in taxonomic/evolutionary order including exotics, common hybrids, and subspecies. Common and Latin names comply with Nelson et al. (2004).

[1]Code	Common Name	Scientific Name	[2]Status
2	**LAMPREYs**	**PETROMYZONTIDAE**	
201	Ohio lamprey	*Ichthyomyzon bdellium*	OC
202	chestnut lamprey	*Ichthyomyzon castaneus*	
203	northern brook lamprey	*Ichthyomyzon fossor*	OC
204	mountain brook lamprey	*Ichthyomyzon greeleyi*	SC
205	silver lamprey	*Ichthyomyzon unicuspis*	
206	American brook lamprey	*Lampetra appendix*	
207	sea lamprey	*Petromyzon marinus*	
24	**STURGEON**	**ACIPENSERIDAE**	
260	shortnose sturgeon	*Acipenser brevirostrum*	E
261	lake sturgeon	*Acipenser fulvescens*	T
262	Atlantic sturgeon	*Acipenser oxyrinchus*	
25	**PADDLEFISHES**	**POLYODONTIDAE**	
266	paddlefish	*Polyodon spathula*	X (RI)
26	**GARS**	**LEPISOSTEIDAE**	
268	longnose gar	*Lepisosteus osseus*	
27	**BOWFINS**	**AMIIDAE**	
271	bowfin	*Amia calva*	
30	**FRESHWATER EELS**	**ANGUILLIDAE**	
276	American eel	*Anguilla rostrata*	OC
40	**HERRINGS**	**CLUPEIDAE**	
285	blueback herring	*Alosa aestivalis*	
289	alewife	*Alosa pseudoharengus*	
290	American shad	*Alosa sapidissima*	
294	gizzard shad	*Dorosoma cepedianum*	
42	**MOONEYES**	**HIODONTIDAE**	
306	mooneye	*Hiodon tergisus*	T
43	**TROUTS**	**SALMONIDAE**	
311	cisco	*Coregonus artedi*	
312	lake whitefish	*Coregonus clupeaformis*	
313	bloater	*Coregonus hoyi*	X
315	kiyi	*Coregonus kiyi*	X
317	shortnose cisco	*Coregonus reighardi*	X
318	shortjaw cisco	*Coregonus zenithicus*	X
319	pink salmon	*Oncorhynchus gorbuscha*	I (sport)
320	coho salmon	*Oncorhynchus kisutch*	I (sport)
321	kokanee	*Oncorhynchus nerka*	I (sport)
322	chinook salmon	*Oncorhynchus tshawytscha*	I (sport)
324	round whitefish	*Prosopium cylindraceum*	E

326	rainbow trout	*Oncorhynchus mykiss*	I
327	Atlantic salmon	*Salmo salar*	X (RI)
328	brown trout	*Salmo trutta*	I
329	brook char	*Salvelinus fontinalis*	OC hertiage
328x9	tiger trout	*S.trutta x S.fontinalis cross*	H (sport)
330	lake char	*Salvelinus namaycush*	
332	splake	*Salvelinus hybrid*	H (sport)
44	**SMELTS**	**OSMERIDAE**	
335	rainbow smelt	*Osmerus mordax*	
48	**MUDMINNOWS**	**UMBRIDAE**	
340	central mudminnow	*Umbra limi*	
341	eastern mudminnow	*Umbra pygmaea*	
49	**PIKES**	**ESOCIDAE**	
345	redfin pickerel	*Esox americanus americanus*	subspp
346	grass pickerel	*Esox americanus vermiculatus*	subspp
347	northern pike	*Esox lucius*	
348	muskellunge	*Esox masquinongy*	
349	chain pickerel	*Esox niger*	
350	tiger musky	*Esox lucius X E. masquinongy*	H (sport)
61	**MINNOWS AND CARPS**	**CYPRINIDAE**	
359	bitterling	*Rhodeus sericeus*	I (pest)
360	central stoneroller	*Campostoma anomalum*	
361	goldfish	*Carassius auratus*	I (pest)
362	redside dace	*Clinostomus elongatus*	
363	lake chub	*Couesius plumbeus*	
364	grass carp	*Ctenopharyngodon idella*	I (pest)
365	common carp	*Cyprinus carpio*	I (pest)
361x5	hybrid carp/goldfish	*Carassius/Cyprinus cross*	hybrid (pest)
366	tonguetied minnow	*Exoglossum laurae*	
367	cutlip minnow	*Exoglossum maxillingua*	
368	brassy minnow	*Hybognathus hankinsoni*	
369	eastern silvery minnow	*Hybognathus regis*	
370	bigeye chub	*Hybopsis amblops*	OC
371	streamline chub	*Erimystax dissimilis*	SC
373	silver chub	*Macrhybopsis storeriana*	E
374	gravel chub	*Erimystax x-punctatus*	T
375	hornyhead chub	*Nocomis biguttatus*	
376	river chub	*Nocomis micropogon*	
377	golden shiner	*Notemigonus crysoleucas*	
378	comely shiner	*Notropos amoenus*	
379	satinfin shiner	*Cyprinella analostana*	
380	pugnose shiner	*Notropis anogenus*	E
381	emerald shiner	*Notropis atherinoides*	
382	bridle shiner	*Notropis bifrenatus*	
383	ironcolor shiner	*Notropis chalybaeus*	SC

384	striped shiner	*Luxilus chrysocephalus*	
385	common shiner	*Luxilus cornutus*	
386	bigmouth shiner	*Notropis dorsalis*	
388	blackchin shiner	*Notropis heterodon*	OC
389	blacknose shiner	*Notropis heterolepis*	
390	spottail shiner	*Notropis hudsonius*	
391	silver shiner	*Notropis photogenis*	
392	swallowtail shiner	*Notropis procne*	OC
393	rosyface shiner	*Notropis rubellus*	
394	spotfin shiner	*Cyprinella spiloptera*	
395	sand shiner	*Notropis stramineus*	
396	redfin shiner	*Lythrurus umbratilis*	SC
397	mimic shiner	*Notropis volucellus*	
961	unknown shiner	*Notropis spp.*	
398	n. redbelly dace	*Phoxinus eos*	
399	finescale dace	*Phoxinus neogaeus*	
400	bluntnose minnow	*Pimephales notatus*	
401	fathead minnow	*Pimephales promelas*	
402	e. blacknose dace	*Rhinichthys atratulus*	
403	longnose dace	*Rhinichthys cataractae*	
404	w. blacknose dace	*Rhinichthys obtusus*	
405	rudd	*Scardinius erythrophthalmus*	I (pest)
406	creek chub	*Semotilus atromaculatus*	
407	fallfish	*Semotilus corporalis*	
408	pearl dace	*Margariscus margarita*	
409	silverjaw minnow	*Notropis buccatus*	
410	Oriental weatherfish	*Migurnus anguillicaudatus*	I (pest)
411	tench	*Tinca tinca*	I (pest)
na	Ide	*Leuciscus idus*	I (pest)
62	**SUCKERS**	**CATOSTOMIDAE**	
416	quillback	*Carpiodes cyprinus*	
418	longnose sucker	*Catostomus catostomus*	
419	white sucker	*Catostomus commersonii*	
421	creek chubsucker	*Erimyzon oblongus*	
422	lake chubsucker	*Erimyzon sucetta*	T
423	n. hog sucker	*Hypentelium nigricans*	
424	smallmouth buffalo	*Ictiobus bubalus*	
425	bigmouth buffalo	*Ictiobus cyprinellus*	
427	spotted sucker	*Minytrema melanops*	
428	silver redhorse	*Moxostoma anisurum*	
429	river redhorse	*Moxostoma carinatum*	OC
430	black redhorse	*Moxostoma duquesnei*	SC
431	golden redhorse	*Moxostoma erythrurum*	
432	shorthead redhorse	*Moxostoma macrolepidotum*	
433	greater redhorse	*Moxostoma valenciennesi*	

432	smallmouth redhorse	*Moxostoma breviceps*	
64	**N. AMERICAN CATFISHES**	**ICTALURIDAE**	
440	white catfish	*Ameiurus catus*	
442	black bullhead	*Ameiurus melas*	
443	yellow bullhead	*Ameiurus natalis*	
444	brown bullhead	*Ameiurus nebulosus*	
445	channel catfish	*Ictalurus punctatus*	
446	stonecat	*Noturus flavus*	
447	tadpole madtom	*Noturus gyrinus*	
448	margined madton	*Noturus insignis*	
449	brindled madtom	*Noturus miurus*	
69	**PIRATE PERCHES**	**APHREDODERIDAE**	
460	e. pirate perch	*Aphredoderus sayanus sayanus*	subspp
460	w. pirate perch	*Aphredoderus sayanus gibbosus*	subspp (OC)
70	**TROUT-PERCHES**	**PERCOPSIDAE**	
461	trout-perch	*Percopsis omiscomaycus*	
79	**CODFISHES**	**GADIDAE**	
493	burbot	*Lota lota*	
496	Atlantic tomcod	*Microgadus tomcod*	
87	**TOPMINNOWS**	**FUNDULIDAE**	
531	banded killifish	*Fundulus diaphanus*	
532	mummichog	*Fundulus heteroclitus*	
89	**NEW WORLD SILVERSIDES**	**ATHERINOPSIDAE**	
545	brook silverside	*Labidesthes sicculus*	
99	**STICKLEBACKS**	**GASTEROSTEIDAE**	
560	fourspine stickleback	*Apeltes quadracus*	
561	brook stickleback	*Culaea inconstans*	
562	threespine stickleback	*Gasterosteus aculeatus*	
564	ninespine stickleback	*Pungitius pungitius*	
105	**TEMPERATE BASSES**	**MORONIDAE**	
575	white perch	*Morone americana*	
576	white bass	*Morone chrysops*	
577	striped bass	*Morone saxatilis*	
108	**SUNFISHES**	**CENTRARCHIDAE**	
590	mud sunfish	*Acantharchus pomotis*	T
591	rock bass	*Ambloplites rupestris*	
592	bluespotted sunfish	*Enneacanthus gloriosus*	
593	banded sunfish	*Enneacanthus obesus*	T
594	redbreast sunfish	*Lepomis auritus*	
595	green sunfish	*Lepomis cyanellus*	
596	pumpkinseed	*Lepomis gibbosus*	
597	warmouth	*Lepomis gulosus*	
598	bluegill	*Lepomis macrochirus*	
599	longear sunfish	*Lepomis megalotis*	T (RI)
974	hybrid sunfish	*Lepomis spp. cross*	

600 smallmouth bass	*Micropterus dolomieu*	
601 largemouth bass	*Micropterus salmoides*	
602 white crappie	*Pomoxis annularis*	
603 black crappie	*Pomoxis nigromaculatus*	
109 **PERCHES**	**PERCIDAE**	
605 eastern sand darter	*Ammocrypta pellucida*	T
606 greenside darter	*Etheostoma blennioides*	
607 rainbow darter	*Etheostoma caeruleum*	
608 Iowa darter	*Etheostoma exile*	
609 fantail dater	*Etheostoma flabellare*	
610 swamp darter	*Etheostoma fusiforme*	T
611 spotted darter	*Etheostoma maculatum*	T
613 johnny darter	*Etheostoma nigrum*	
614 tessellated darter	*Etheostoma olmstedi*	
615 variegate darter	*Etheostoma variatum*	
616 banded darter	*Etheostoma zonale*	
617 yellow perch	*Perca flavescens*	
618 logperch	*Percina caprodes*	
619 channel darter	*Percina copelandi*	
621 longhead darter	*Percina macrocephala*	T
622 blackside darter	*Percina maculata*	
623 shield darter	*Percina peltata*	
620 gilt darter	*Percina evides*	T
628 bluebreast darter	*Etheostoma camurum*	T
977 unknown darter	*Etheostoma spp.*	
625 sauger	*Sander canadensis*	
626 walleye	*Sander vitreum vitreum*	
125 **DRUM**	**SCIAENIDAE**	
700 freshwater drum	*Aplodinotus grunniens*	
159 **GOBIES**	**GOBIIDAE**	
792 round goby	*Neogobius melanostomus*	I (pest)
174 **SCULPIN**	**COTTIDAE**	
865 mottled sculpin	*Cottus bairdii*	
866 slimy sculpin	*Cottus cognatus*	
866 spoonhead sculpin	*Cottus ricei*	E
873 deepwater sculpin	*Myoxocephalus thompsonii*	E

[1]Data source from New York State Dept. of Environmental Conservation, Bureau of Fisheries Statewide Database, 625 Broadway, Albany, NY 12233.

[2]Status revised by author from Carlson (2005): X—extirpated, E—endangered, T—threatened, SC—special concern, OC—other concern, H—hybrid, I—introduced (exotic), RI—reintroduced (native), n.—northern; e.—eastern, w.—western. Note: the round goby has recently been placed in the genus *Apollonia* by some authors (e.g., Sapota 2006).

Appendix I-B. Habitat survey data from the Tonawanda Creek watershed, June-October 2004. See Table 4 for habitat descriptions.

[1]**Tonawanda Creek watershed ONT-158-12**

X	Y	[2]Site	Habitat Type	RM	MD	SS	IW	BC	AV	[3]HR	Notes
Erie Canal (Oct 12-13)											
78.73774	43.07865	4	wide channel	10.7	4.6	silt	some	some	some	3	open water blw TC conflu with rip-rap & submergents along margins
78.73974	43.07721	5	wide channel	10.5	4.6	silt	some	some	some	3	open water blw TC conflu with rip-rap & submergents along margins
Lower Basin (Jun 4-July 7)											
78.68802	43.08698	14	riffle run mix	13.9	0.3	gvl rock	none	some	some	3	some lg bldrs with patches of water lilies & arrowheads along margins
78.66858	43.08496	17	narr pool	51.4	2.4	silt rock	none	some	some	3	deep mid channel with dock on RB; water lilies along margins
78.65857	43.08514	18	narr pool	16.0	2.4	silt rock	some	none	some	3	standing wood and water lilies abundant along margins
78.64434	43.08842	19	narr pool	17.8	2.1	silt sand	some	none	none	2	narrow reach with wood on RB; depths 3 to 7 ft with some shade
78.61964	43.08756	22	long pool	20.0	3.0	na	some	some	none	2	long deep pool with wood on both banks some shade
78.61290	43.08208	23	long pool	20.5	3.0	na	some	some	none	2	long deep pool with wood-brush on sides & brush in water; some shade
78.61076	43.07695	25	long pool	21.3	3.0	na	some	some	none	2	long calm pool with wood-trees on both sides
78.60613	43.07255	26	pool run mix	22.3	3.0	na	some	some	none	2	lg pool with brush in water on RB; higher current blw with good depth
78.58624	43.07268	28	wide pool	24.2	1.5	sand gvl	some	culvert	none	3	large culvert on LB at trib mouth with brush; canoe access in high water
78.55524	43.09232	30	corner pool	29.6	3.0	na	some	some	none	2	deep corner pool with tree over RB with wood at pool tail
78.54954	43.09566	31	long pool	30.1	3.0	na	much	some	none	2	long reach with LJ on & farm field on LB
78.54539	43.09805	32	long pool	30.4	3.0	na	some	some	none	2	slow long reach with wood on RB & corner pool blw
78.54248	43.08939	33	corner pool	31.3	3.0	na	some	some	none	2	deep corner pool with shade on LB & wood at head; mod current
78.54028	43.08602	34	pool run mix	32.0	3.0	na	some	some	none	2	deep with mod current & wood on LB with shade
78.53201	43.08757	36	logjam slough	32.8	3.0	sand	much	some	none	3	massive debris jam mostly wood with split channel blw down to T11
78.51624	43.09118	38	deep pool	34.4	3.0	na	some	some	none	2	deep slow turbid main channel with wood
78.51316	43.09505	39	corner pool	34.8	3.0	silt sand	none	some	none	2	deep slow corner pool with shade on LB
78.50988	43.09804	40	corner pool	35.1	3.0	sand	some	some	none	3	deep slow corner pool with wood cover
78.50901	43.09300	41	corner pool	35.5	3.0	sand	some	some	none	3	deep slow corner pool with wood cover
78.50477	43.09008	43	corner pools	36.1	3.0	na	some	some	none	2	multiple deep slow turbid corner pools with wood cover
78.50300	43.08722	44	shallow pool	36.5	1.0	sand	some	some	none	3	shallow pool with brush-wood on banks
78.49948	43.08341	46	pool run mix	37.1	2.0	silt sand	none	bridge	none	2	poor habitat & turbid water near BR with high current
78.49003	43.08265	47	pool riffle mix	38.2	3.0	silt gvl	some	none	none	2	channelized pool with down tree & shallow gvl riffle
78.47541	43.08613	48	wooded pool	39.3	3.0	na	much	some	none	2	logjam with turtles observed on LB

78.47196	43.08417	49	wooded pool	39.8	3.0	na	some	some	none	2	down maple tree on RB stretching across creek with willow blw
78.47226	43.08156	50	wide pool	40.0	3.0	na	some	some	none	2	flat reach in deep water with overhead willow on RB
78.46403	43.08859	51	pool riffle mix	40.3	3.0	na	much	some	none	2	riffles abv/blw long pool; LJ on RB abv; backwater on RB wood on LB
78.46215	43.08804	52	pool riffle mix	40.4	3.0	na	some	some	none	2	corner pool with mod flow & maple on RB with riffle blw
78.45165	43.09050	54	riffle pool mix	40.9	3.0	silt gvl	some	some	none	3	deep slack pool with willows on LB & wood on RB; riffle blw
78.44787	43.08994	55	pool run mix	41.4	3.0	silt gvl	some	some	none	2	sm narrow pool with mod flow and feeder creek on LB; some riparian
78.43778	43.07830	56	pool riffle mix	42.7	3.0	gvl	some	some	some	4	emergents along lg pool; wood on RB; willows at tail; gvl riffle at btm
78.43732	43.07302	57	shallow pool	43.3	1.0	na	some	some	none	2	shallow slow pool in open area; some wood on LB & shade on RB
78.44183	43.06750	58	slack pool	43.9	1.5	na	some	some	none	2	lg pool with wood on RB
78.43718	43.05880	60	pool riffle mix	44.7	3.0	gvl bdrk	some	some	none	2	shallow pool with wood in center and RB with riffle blw; some brush
78.42540	43.04699	61	pool riffle mix	45.9	3.0	gvl rock	none	none	none	2	lg deep pool with slack water between riffles; no shade
Middle Basin (Jun 4-30)											
78.36702	43.02122	63	deep pool	50.6	3.0	silt gvl	some	none	none	2	lg pool with some wood cover & red canoe on LB
78.35363	43.02000	64	deep pool	51.3	3.0	silt gvl	none	some	none	2	lg open deep pool with some brush cover
78.33509	43.02038	66	pool riffle mix	52.0	1.5	na	none	some	some	3	submergents in pool blw riffle on RB; concrete wall-brush on LB abv BR
78.32630	43.01514	67	pool riffle mix	52.9	3.0	na	some	some	none	2	orner pool with some wood-brush blw riffle
78.32307	43.01291	68	deep pool	53.1	1.0	gvl	none	some	none	2	deeper area abv BR then shallow blw into slow water; rip-rap cover
78.32768	43.00964	69	slack pool	53.3	3.0	na	some	some	none	2	slack pool with brush; camp on RB & wood in center; bird houses on LB
78.31753	43.00003	70	pool riffle mix	54.4	1.0	gvl rock	some	some	none	3	slow pool at base of riffle; wood-brush on RB
78.30999	42.99929	71	shallow pool	55.2	1.0	silt rock	none	some	some	3	shallow stretch with rocks; submergent AV growth in area under BR
78.29834	42.99751	72	deep pool	55.8	3.0	gvl rock	none	some	none	2	deep under BR; little cover; slow pool blw with trees on LB
78.29173	43.00165	73	deep pool	56.3	3.0	na	some	some	none	2	slack area with wood-tree cover
78.29024	43.00207	74	deep pool	56.5	3.0	na	some	some	none	2	slack area with some wood-trees and scum debris line blw
78.28888	43.00330	75	corner pool	56.7	3.0	na	some	some	none	2	slack water area and oxbow lake along LB; tree cover
78.28767	43.00549	76	split pool	56.9	3.0	na	none	some	some	3	emergent cattails on LB & ferns on raised island in mid split channel
78.28176	43.00624	77	corner pool	57.1	3.0	na	much	some	none	2	deep wooded slack water pool
78.27885	43.00687	78	corner pool	57.4	3.0	gvl silt	none	some	none	2	turbid with gvl on inside turn; backwater blw slough on LB; brush cover
78.27271	43.00477	79	corner pool	57.9	3.0	sand	some	none	some	3	slack flow area; deep in center with wood and submergent AV
78.26767	43.00569	80	slack pool	58.3	3.0	na	some	none	some	3	slack water with some wood and submergent AV blw
78.25661	43.00154	81	corner pool	61.0	1.0	na	none	some	some	2	brush-bridge cover along margins with submergent AV
78.23138	43.00621	83	shallow pool	60.5	1.0	rock	some	some	none	2	wood-brush over stream in shallow reach
78.22330	43.00599	85	wier pool	60.9	0.5	gvl	none	some	some	3	submergent AV abv concrete block wier; good clarity and bruh cover

78.21981	43.00650	86	wide pool	61.1	1.0	sand gvl	none	some	much	3	slack water with brush; good clarity and heavy submergent AV growth
78.21536	43.00333	87	corner pool	61.4	1.0	gvl	some	some	much	4	good water clarity in lg slack area with brush; emergent/submergent AV
78.20137	43.00397	89	wide pool	60.6	1.0	sand gvl	some	some	much	4	shallow with submergent AV before corner bend and BR; some brush
78.19815	43.00094	90	shallow pool	62.3	0.5	sand gvl	none	none	much	3	good submergrent milfoil & pondweed beds but no depth
78.19752	43.00018	91	shallow pool	62.4	1.0	gvl rock	none	bridge	none	2	cover limited to BR
78.19279	42.99959	92	narr pool	62.6	3.0	gvl bdrk	none	bridge	much	3	narrow reach with some fair water clarity & submergent AV growth
78.19087	42.99889	93	pool	62.7	2.0	gvl	none	bridge	some	3	mid reach between BRs with submergent milfoil AV
Upper Basin (Jun 4-July 7-27)											
78.19149	42.99450	97	narr channel	63.2	3.0	silt	none	bridge	some	3	trib abv BR on LB with good water clarity; submergents and tree cover
78.18841	42.98985	98	narr channel	63.4	3.0	silt	some	bridge	none	2	open area; possible stream access at Law Rd BR
78.18685	42.98557	99	narr channel	63.7	3.0	silt	some	some	none	2	long deep stretch at Kibbe park; hand launch area along RB; some trees
78.18169	42.98469	100	narr channel	64.1	3.0	silt	some	some	none	2	some riparian cover abv Kibbe park blw RxR BR in deep reach
78.18081	42.98399	101	narr channel	64.2	3.0	silt	some	some	none	2	good riparian cover; sm backwater bay on LB some 100m blw RxR BR
78.18256	42.98166	102	narr channel	64.4	3.0	silt	some	none	some	3	deep in middle; submergent & emergent AV along margins; wood on LB
78.18931	42.97612	103	wooded pool	65.1	3.0	silt sand	some	some	none	2	first wood jam abv Batavia Falls; some margin shade
78.19569	42.96840	105	corner pool	66.0	3.0	silt	some	some	none	2	deep & shaded banks with trib near private camp on LB
78.19229	42.96898	106	wide pool	66.3	3.0	silt	some	some	none	2	slack water with willows shading both banks
78.19276	42.96784	107	multi-pools	66.6	3.0	silt	some	some	none	2	wide area with many pools & willow trees providing shade
78.19149	42.96633	108	narr pool	66.7	3	silt	some	bridge	none	2	straight channel with steep banks and wood blw
78.19199	42.96471	109	wooded pool	66.8	3.0	silt sand	much	some	none	3	slack water between much wood debris
78.19379	42.96125	110	narr channel	67.4	3.0	silt sand	much	some	none	3	slow & deep with steep edge with some wood; bank full abv mudline
78.19598	42.95925	111	narr channel	67.6	3.0	silt	some	some	none	2	T32 on RB with tree down over trib; high turbidity
78.20340	42.95390	112	narr channel	68.5	3.0	silt sand	much	some	none	3	deep and shaded pool between LJs; down tree on LB
78.20520	42.95277	113	narr channel	68.7	3.0	silt sand	some	some	none	3	old RxR BR ruins at dead-end road; shaded pool with trees-wood
78.20862	42.94587	114	slow pool	69.6	1.5	silt	some	some	none	2	down willow tree on RB with disgarded old tires
78.20958	42.94499	115	short pool	69.8	3.0	na	some	some	none	2	deep with down wood
78.21296	42.94214	116	deep pool	70.0	1.5	na	some	tree	none	2	semi-deep ash tree down ash tree across narrow channel
78.21645	42.94180	117	narr pool	70.2	3.0	silt sand	none	bridge	none	2	shallow reach but deep abv near RxR BR
78.22566	42.93897	118	corner pool	70.6	3.0	silt sand	none	some	none	2	deep & shaded pool
78.22556	42.93627	119	wooded pool	70.9	3.0	silt	much	some	none	2	deep pool with wood cover
78.22723	42.93370	120	split pool	71.1	3.0	silt sand	much	some	none	3	at btm of split channel with wood debris on RB and secluded LB
78.22760	42.93375	121	pool riffle mix	71.2	3.0	silt sand	some	some	none	3	deep corner & wooded with shade on RB; narrow channel & rapids blw

78.23103	42.93263	122	wooded pool	71.5	3.0	silt sand	much	some	none	3	slow & deep with LJ
78.23397	42.92018	124	corner pool	73.2	3.0	silt sand	much	none	none	2	deep with little cover
78.23628	42.91941	125	corner pool	73.5	3.0	silt sand	much	none	none	2	deep with little cover
78.23541	42.91681	126	corner pool	73.9	3.0	silt sand	much	none	none	2	sm pool with little cover and LJ blw
78.23887	42.91297	127	wooded pool	74.5	3.0	silt sand	much	some	none	3	LJ impedes navigation; deep in front with long stretch of debris
78.24971	42.90362	128	deep pool	76.6	3.0	silt sand	some	bridge	none	2	good depth abv BR
78.25079	42.90285	129	deep pool	76.7	3.0	sand rock	some	none	none	2	small but deep with wood on RB
78.25757	42.87725	131	riffle pool mix	79.0	3.0	silt sand	some	bridge	none	3	good access at BR; lg pool with shallow riffles abv; beavers obsvd
78.25735	42.87699	132	run riffle mix	79.1	1.0	silt sand	much	none	none	2	slow water abv BR then riffle into sm falls & rapids blw into LJs
78.26243	42.87763	133	wide pool	79.6	3.0	silt	some	some	none	2	lg pool with deep scouring under wood jam
78.26580	42.87458	134	riffle pool mix	79.8	1.5	silt gvl	some	some	none	3	long narrow pool between riffles; deep under wood jam; high turbidity
78.27957	42.86791	135	corner pool	80.6	3.0	silt sand	none	bridge	none	2	deep with artificial RB built in 1992; located before BR near Burger King
78.28336	42.86407	136	long pool	81.3	1.0	silt sand	none	bridge	none	2	shallow silt pool at BR; steep concrete weir blw into sm plunge pool
78.27922	42.85649	137	corner pool	82.0	3.0	gvl rock	some	none	none	2	deep with willow on RB; Attica Rodeo field on RB; shallow area blw
78.28221	42.85630	138	split pool	82.2	3.0	silt rock	some	bridge	none	2	deep pool blw long shallow pool & split channel rocky area
78.27902	42.85249	139	corner pool	82.6	1.5	sand gvl	some	some	none	3	deep with wood on LB with some brush cover
78.28222	42.84949	140	multi-pools	82.7	3.0	sand gvl	much	none	none	2	several deep wooded pools & narrow pool blw with good water clarity
78.28052	42.84540	141	multi-pools	82.9	3.0	silt sand	none	bridge	none	2	several pools abv BR with eddy then deep slow rocky & wide pool blw
78.28242	42.84168	142	multi-pools	73.3	3.0	silt gvl	some	some	none	3	wooded corner pool with willow-ash; then deep pool into shallow tail
78.28147	42.83916	143	multi-pools	83.4	2.0	gvl	much	some	none	3	clear water in slow woody pool & corner pool with wood & cottonwood
78.28493	42.83544	144	riffle pool mix	83.9	3.0	silt gvl	some	some	none	3	riffle abv with wooded scour pool into narrow corner pool blw
78.29030	42.83162	145	pool riffle mix	84.4	3.0	na	much	some	none	2	slow deep corner pool blw riffle; some trees
78.29896	42.82676	146	narr pool	84.8	1.0	sand gvl	none	bridge	none	2	private campground near white house off RT98
78.30714	42.80709	148	pool riffle mix	86.6	2.0	gvl	some	none	none	2	deep corner pools with rip-rap on RB & some shade with riffles blw
78.31091	42.80184	149	pool riffle mix	86.9	3.0	silt gvl	some	some	none	3	many deep corner pools with some shade & riffles blw with slack water
78.31338	42.80081	150	wooded pool	87.0	1.5	silt	much	some	none	2	slack water pool with some wood cover
78.31442	42.79813	151	corner pool	87.3	1.5	silt gvl	none	trees	none	2	slack water with some shade; roadway along RB
78.31848	42.79419	152	multi-pools	87.7	1.0	silt	some	some	none	2	deep turbid pool into lg shallow pool with wood & rip rap along RB
78.30564	42.74853	154	run pool mix	91.3	1.0	gvl rock	none	bridge	none	2	small water area with fast flows
78.30820	42.73755	155	riffle pool mix	93.1	1.0	gvl rock	none	bridge	none	2	scour pool blw RT98 BR between shallow riffle area; good water clarity

Mud Creek T8 (Jun 4-Aug 3)											
78.69714	43.09037	2	pool run mix	0.6	1.0	silt sand	none	bridge	none	2	shallow reach with higher current near BR area
78.68821	43.09373	3	wooded pools	1.2	1.5	na	much	some	none	2	deep with brush-wood abv small LJ; long narrow blw with LJ & shade
78.67579	43.09780	4	narr pool	2.0	3.0	na	some	some	some	3	water lilies with some trees-brush cover; light current at high water
78.66715	43.10026	5	wide pool	2.5	2.0	na	some	some	none	2	flat flooded lawn on RB with tree-brush cover; swing rope back on RB
78.65799	43.10117	6	pool riffle mix	3.0	3.0	na	some	some	none	2	deep slow pool blw riffle with shade & brush on LB in water
78.64972	43.10079	7	slack pool	3.7	3.0	na	some	some	some	3	open area with submergents along margins with willow trees-brush cover
78.64607	43.10151	8	narr pool	4.1	2.0	silt gvl	none	bridge	none	2	near BR with some brush cover
78.64653	43.10258	9	wide pool	4.2	2.0	na	some	some	much	3	abv BR & split channel; trees-brush cover plus submergent/emergents
78.64218	43.10139	10	riffle	4.5	1.5	gvl rock	some	none	none	2	private farm road crossing with down willows trees; brown house on LB
78.63935	43.10352	11	narr pool	4.8	1.5	na	some	some	some	3	submergent AV and brush filled channel area
78.63656	43.10511	12	narr pool	5.1	3.0	na	some	some	none	2	high water pool with wood-brush in flood zone & deep main channel
78.63597	43.10759	13	narr pool	5.3	2.2	silt	none	some	some	3	hand launch at BR with submergents; dark stained water, good riparian
Ledge Creek T11 (Aug 6)											
78.51950	43.08194	1	slack pool	1.3	2.0	silt sand	some	much	none	2	brush cover & slow flows
78.51831	43.08129	2	slack pool	1.4	2.0	silt sand	some	much	none	2	open area with brush & slow flows
Murder Creek T11-1 (Aug 3-6)											
78.51837	43.07873	4	corner pool	0.1	1.0	silt sand	none	bridge	none	2	small but deep pool abv BR with brush along margins
78.52170	43.07806	5	long pool	0.2	2.0	silt sand	much	none	none	2	abv split channel area with much wood in LJs
78.52091	43.07238	6	corner pool	0.4	1.0	silt sand	much	none	none	2	long narrow stretch abv-blw corner pool with carp & LJ on RB
78.52229	43.06945	7	shallow pool	1.1	0.5	silt sand	none	some	none	2	slack water abv unmapped BR; some trees
78.51783	43.06802	8	narr pool	1.4	2.0	sand gvl	some	some	some	4	carp filled pool with wood-brush & overhang trees
78.51656	43.06473	9	long pool	1.5	1.0	gvl rock	none	bridge	some	3	BR at pool tail with falls; private BR 200m blw
78.51730	43.06295	10	pool riffle mix	1.9	0.5	gvl	some	some	none	3	shallow wide pool between riffles and wood cover
78.51685	43.06122	11	narr pool	2.1	0.5	gvl rock	none	some	none	2	shallow slow pool channel with some shade
78.51971	43.05714	13	deep pool	2.4	3.0	na	some	some	some	3	farm road on RB & trees on LB and submergent AV at shallow pool tail
78.52144	43.05322	14	shallow pool	2.8	0.5	gvl	some	some	none	3	brush on banks with carp and LJ at pool tail
78.51285	43.04694	15	slack pool	3.6	1.0	gvl rock	none	bridge	none	2	blw high current area abv BR; USGS gauging station on LB blw BR
78.50898	43.04078	16	pool riffle mix	4.2	0.5	rock	none	some	none	2	sm waterfall abv walk-BR; riffle blw into rocky area with shade
78.50962	43.04124	17	narr pool	4.3	2.0	na	some	brush	some	3	shallow with LJ at tail; lg barn owl obsvd
78.50875	43.03755	18	wide pool	4.6	3.0	silt	much	some	none	2	lg pool with wood on both banks & farm field road on LB bewteen LJs
78.50948	43.03637	19	pool complex	4.8	1.5	silt gvl	some	some	some	4	floodplain split channel with brush; coontail; lg BWP blw

78.50883	43.03488	20	long pool	4.9	3.0	gvl silt	some	some	some	4	trib on RB at pool head with brush; Elodea on RB
78.50917	43.03088	21	shallow pool	5.2	1.0	sand gvl	some	none	none	2	LJ at top some wood on LB semi clear dark water shade
78.50726	43.03041	22	shallow pool	5.3	0.5	sand gvl	some	none	none	2	dark slow water willow cover LJ blw on RB center
78.50708	43.02797	23	shallow pool	5.4	0.5	silt gvl	none	bridge	none	2	slow pool at BR some 100m abv Arkron WWTP discharge pipe
78.50503	43.02224	24	shallow pool	5.9	1.5	gvl	much	some	some	4	dark water color here with tres-brush & mulitple LJs blw
78.50456	43.02061	25	shallow pool	6.0	1.0	gvl rock	none	some	some	3	good water clarity but stained with dark bottom; concrete wall on margin
Little Tonawanda Creek T32 (Sep 27)											
78.19598	42.95925	1	narr run	0.0	3.0	silt sand	some	some	none	2	high water with some wood-brush over creek channel near mouth
78.19552	42.95866	2	narr run	0.1	3.0	silt sand	none	some	none	2	flood plain filled with water past riparian brush, deep channel
78.19493	42.95771	3	narr run	0.3	1.5	silt sand	some	some	none	2	slack water with wood; flood plain on LB; down willow in main channel
78.19255	42.95643	4	narr run	0.6	3.0	silt sand	none	some	none	2	slow narrow deep pool with brush along margins
78.18776	42.95389	6	run pool mix	1.5	3.0	silt gvl	some	some	none	2	trees/brush along high water mark in mod current; shaded banks, pool blw
78.19258	42.92953	7	pool riffle mix	4.4	1.0	sand gvl	none	some	some	3	lg pool abv-under BR with high velocity riffle blw
78.19269	42.92671	8	run pool mix	4.7	1.0	sand gvl	none	culvert	some	3	high flow thru dual culverts under BR then sm slack pools blw

[1]The watershed ONT (Lake Ontario) 158-12 (watershed index no) was divided into subunits as shown in Table 2.
Only brief habitat surveys were conducted 2004 (no fish surveys) and range of sampling dates included for each basin.
[2]Each sampling site was numbered and marked by X—latitude, Y—longitude coordinates including habitat notes: narr—narrow, RM—river mile , gvl—gravel, na—data not available, Rd—road, RT—route, BR—bridge, T or trib—tributary, LB—left bank, RB—right bank, LJ—logjam, sm—small, lg—large, abv—above, blw—below, btm—bottom.
[3]Habitat rating in accordance with Wells and Haynes 2006.

Appendix I-C. Habitat survey data from the Johnson Creek watershed, June-July 2004. See Table 4 for habitat descriptions.

[1]Johnson Creek watershed ONT-139

X	Y	[2]Site	Habitat Type	RM	MD	SS	IW	BC	AV	[3]HR	Notes
Lower Basin (Jun 4-July 8)											
78.27376	43.35743	17	pool run mix	2.0	1.5	silt rocks	some	some	some	3	abv/blw old steel BR with lg wide shallow weedy sandy flats blw
78.30225	43.34571	22	corner pool	4.3	3.0	silt sand	much	some	none	3	sharp left corner pool abv T7b at water pump oil & lg logjam blw
78.30704	43.34902	24	corner pool	5.0	3.0	silt sand	some	some	none	3	deeper corner pool with some brush on banks
78.33242	43.33817	27	run pool mix	7.3	3.0	silt gvl	some	some	some	4	lg corner pool with long slow reach abv; some shade on RB and submergents
78.34856	43.33917	29	riffle pool mix	8.3	0.8	silt gvl	none	some	none	2	parking on LB at BR-out near shallow rocky reach into flats with riffle blw
78.35873	43.33410	30	run pool mix	9.0	1.0	silt sand	none	some	none	2	private road on RB no parking at BR-out near shallow channel with some shade
78.38070	43.32679	32	corner pool	10.8	3.0	gvl rock	some	some	none	3	lg down willow across creek near slack corner pool with rock gvl btm
78.37445	43.32027	35	pond 171a	1.7	3.0	silt sand	none	some	much	3	lg private pond to T5 with dam near Platten Road with much shoreline AV
78.39011	43.32124	36	pond 172	11.5	1.0	silt gvl	none	none	much	2	village boat ramp behind post office; steep bumpy slab at silt btm weedy area
78.40419	43.31379	42	slow channel	12.6	2.0	silt	some	much	some	3	narrow shaded reach with weedy shallow margins and patches of down wood
78.40295	43.31234	43	slow channel	12.8	3.0	silt	some	much	some	3	narrow shaded reach with weedy shallow margins and patches of down wood
78.40532	43.31115	44	slow channel	12.9	3.0	silt	some	much	some	3	narrow shaded reach with weedy shallow margins and patches of down wood
78.40472	43.31049	45	slow channel	13.0	3.0	silt	some	much	some	3	lg down tree impassable by boat from pond; good riparian with much wood
78.40751	43.30611	46	slow channel	13.4	3.0	silt	some	much	some	3	long deep reach between T7 and T6 with silty clay banks on both sides
78.41784	43.30642	47	slow channel	14.1	3.0	silt	some	much	none	2	long deep shaded reach with silty clay banks on both sides
78.43353	43.30238	48	slow channel	15.0	3.0	silt	some	much	none	2	deep silty reach with much bank brush and wood abv BR
78.43887	43.29890	49	corner pool	15.4	3.0	na	much	some	none	2	deep corner pool abv T7b with various logjams
78.44338	43.29637	50	corner pool	15.9	3.0	na	much	some	none	2	deep corner pool blw private farm road BR among various logjams
78.45330	43.29814	52	corner pool	16.5	3.0	na	some	some	none	2	back to back deep corner pools located abv T8a on LB
78.46561	43.29161	54	narrow pool	17.6	1.5	silt gvl	some	some	none	3	narrow reach with much shoreline brush and shallow under BR
Upper Basin (July 6-July 17)											
78.48340	43.28710	55	run pool mix	18.9	3.0	silt gvl	some	some	none	3	slack water abv/blw private farm road crossing; plunge pool blw 2 lg culverts
78.48793	43.28821	56	corner pool	19.2	3.0	na	some	some	some	3	deep corner pool blw with water lilies n blue barn on RB
78.49133	43.28534	58	run pool mix	19.6	3.0	silt sand	some	none	none	2	deep corner pool with apple farm on LB and 4 junk cars on RB
78.49236	43.28603	59	run pool mix	19.7	2.0	na	some	some	none	2	deep stretch with mod flow plus lg wt ash on LB with vines
78.50237	43.28266	60	slow pool	20.4	1.5	silt sand	some	some	none	3	slack water blw BR at mouth of T13 & brush on both banks
78.50575	43.28046	62	corner pool	20.7	3.0	na	some	some	some	3	first deep corner pool blw a long shallow reach with some shade

78.51706	43.27233	63	plunge pool	21.8	1.0	silt sand	some	some	none	3	wood choked private concrete passage 1m wide with deep plunge pool blw
78.52377	43.26008	65	plunge pool	23.2	3.0	silt sand	some	none	some	3	deep pool blw sm steel BR & waterfall blw log cabin on RB; emergent AV
78.51733	43.24349	67	run pool mix	24.7	0.5	silt	some	some	some	3	riprap work at RT104 BR with some emergents in shallow reach
78.51220	43.21622	69	riffle	26.9	0.5	silt sand	none	some	none	2	narrow reach with thick brush; short riparian corridor blw canal culvert
78.51436	43.20603	70	riffle	27.9	0.5	sand gvl	none	some	none	2	shallow gvl reach abv canal culvert was wet in 2004 but dry in 2005
Jeddo Creek T9 (Jun 7-Jun 21)											
78.45760	43.29269	1	shallow pool	0.0	1.0	sand gvl	some	some	none	3	shallow reach with undercut banks
78.45809	43.29220	2	slack pool	0.1	2.0	sand gvl	none	some	none	2	deep slack water pool
78.45584	43.27899	3	corner pool	1.3	3.0	sand gvl	none	some	none	2	deep corner pool abv small BR in back of Campgrounds
78.45398	43.27080	4	slack pool	1.9	3.0	sand gvl	some	none	none	2	deep slack water pool with some shade
78.45593	43.26868	5	corner pool	2.1	3.0	sand gvl	none	some	none	2	deep slack water pool
78.45681	43.26745	6	corner pool	2.2	3.0	sand gvl	none	some	none	2	deep slack water pool
78.45611	43.25884	7	corner pool	2.9	3.0	sand gvl	some	none	none	2	deep shaded pool with good riparian
78.45667	43.25714	8	riffle pool mix	3.0	2.0	sand gvl	none	some	none	2	pool at base of long riffle blw RT104 BR
78.43866	43.21641	10	riffle	6.8	0.5	rock gvl	none	some	none	2	small culvert blw canal at Dublin Rd
78.43557	43.21345	11	run pool mix	7.1	1.5	rock gvl	none	some	none	2	abv canal at RT31E BR west of Shelby Basin Rd
Jeddo Creek T9-1 (Jun 7-Jun 21)											
78.45633	43.25493	12	slow channel	0.0	2.0	silt sand	none	some	some	3	abv RT104 at T1 confluence; long open channel; some emergents AV
78.45355	43.24988	13	corner pool	0.5	3.0	silt	some	some	none	2	deep shaded corner pool abv confluence
78.45453	43.24929	14	slack pool	0.6	3.0	silt	some	some	none	2	deep slack water pool
78.45631	43.24859	15	corner pool	0.7	3.0	silt	some	some	none	2	deep shaded pool with good riparian
78.45876	43.24700	16	corner pool	0.9	3.0	silt	some	some	none	2	deep shaded pool with good riparian
78.46019	43.24608	17	corner pool	1.0	3.0	silt	some	some	none	2	deep shaded pool with good riparian
78.46087	43.24596	18	plunge pool	1.0	3.0	silt	some	some	none	2	scoured pool blw culvert
78.46209	43.24476	19	corner pool	1.0	2.0	silt rock	some	some	none	2	deep shaded pool with good riparian

[1]The watershed ONT (Lake Ontario) 158-12 (watershed index no) was divided into subunits as shown in Table 2. Only brief habitat surveys were conducted 2004 (no fish surveys) and range of sampling dates included for each basin.

[2]Each sampling site was numbered and marked by X—latitude, Y—longitude coordinates including habitat notes: narr—narrow, RM—river mile , gvl—gravel, na—data not available, Rd—road, RT—route, BR—bridge, T or trib—tributary, LB—left bank, RB—right bank, LJ—logjam, sm—small, lg—large, abv—above, blw—below, btm—bottom.

[3]Habitat rating in accordance with Wells and Haynes (2006).

Appendix I-D. Habitat data from the Tonawanda Creek watershed, June-September 2005. See Table 4 for habitat descriptions.

[1]Tonawanda Creek watershed

[2]Site	Map	Basin	X	Y	Survey#	RM	SO	Date	Time	Pool Type	Md	%Silt	%Sand	%Gvl	%Rock	% IW	% BC	% AV
1	2i	Erie Canal	78.82138	43.05156	905982	5.1	6	2-Jun	1000	channelized reach	4.6	90	0	0	10	0	2	0
2	2i	Erie Canal	78.82629	43.05163	905982	4.9	6	2-Jun	1130	channelized reach	4.6	80	0	5	15	0	5	0
3	3f	Erie Canal	78.88143	43.02341	905982	0.1	6	2-Jun	1330	isolated run	4.6	35	5	20	40	1	1	1
4	2k	Erie Canal	78.74638	43.06914	905982	9.8	6	27-Jun	2330	isolated pool	2.0	90	5	5	0	10	5	60
5	2l	Erie Canal	78.73393	43.08392	905982	11.1	6	27-Jun	2220	channelized reach	5.0	75	5	5	15	2	5	15
6	2i	Erie Canal	78.83127	43.05062	905982	4.6	6	7-Jul	1345	channelized reach	4.7	60	0	10	30	2	3	8
7	2h	Erie Canal	78.82430	43.03272	905982	3.5	6	7-Jul	1530	isolated pool	2.4	75	0	5	20	7	1	15
8	2j	Erie Canal	78.80694	43.06098	905982	6.3	6	8-Jul	930	channelized reach	3.7	80	10	0	10	2	1	60
9	2p	Lower Basin	78.69861	43.08655	905983	13.3	6	7-Jun	1300	pool with riffle	1.0	20	10	40	30	1	3	25
10	2s	Lower Basin	78.67995	43.08289	905983	14.7	6	7-Jun	1600	channelized reach	3.0	60	10	0	30	1	3	1
11	2p	Lower Basin	78.69927	43.08675	905983	13.3	6	23-Jun	1300	pool with riffle	2.4	60	10	20	10	3	1	2
12	2o	Lower Basin	78.70718	43.08705	905983	12.8	6	23-Jun	1600	channelized reach	3.4	70	0	30	0	5	2	6
13	2m	Lower Basin	78.72464	43.08558	905983	11.6	6	27-Jun	1700	pool with riffle	1.5	15	10	50	25	1	1	10
14	2l	Lower Basin	78.73117	43.08483	905983	11.2	6	27-Jun	1900	channelized reach	3.0	70	5	20	5	4	3	10
15	2m	Lower Basin	78.72203	43.08407	905983	11.8	6	8-Jul	1445	channelized reach	5.3	70	10	15	5	10	3	8
16	2n	Lower Basin	78.71850	43.08101	905983	12.0	6	8-Jul	1650	channelized reach	3.5	85	0	0	15	15	10	2
17	2o	Lower Basin	78.70132	43.08669	905983	13.1	6	19-Jul	1430	isolated run	1.1	45	5	20	30	3	9	6
18	2o	Lower Basin	78.70515	43.08697	905983	13.0	6	19-Jul	1600	isolated run	1.3	65	0	10	25	1	10	2
19	2n	Lower Basin	78.70931	43.08260	905983	12.5	6	19-Jul	1800	channelized reach	2.8	70	0	10	20	4	6	3
20	2m	Lower Basin	78.72923	43.08537	905983	11.4	6	19-Jul	2000	channelized reach	3.0	25	0	5	70	2	3	10
21	2mm	Lower Basin	78.40010	43.02632	805945	48.1	6	28-Jul	830	pool with riffe	2.5	15	0	25	60	1	1	2
22	2gg	Lower Basin	78.49772	43.08504	905983	37.0	6	28-Jul	1500	isolated run	2.0	45	40	15	0	10	2	0
23	2gg	Lower Basin	78.50332	43.09149	905983	35.5	6	28-Jul	1900	isolated run	3.0	25	65	10	0	15	2	0
24	2u	Lower Basin	78.63635	43.09336	905983	18.4	6	29-Jul	800	pool with riffle	1.7	35	5	40	20	20	15	0
25	2x	Lower Basin	78.57655	43.08877	905983	27.0	6	2-Aug	900	channelized reach	3.0	85	15	0	0	25	1	0
26	2w	Lower Basin	78.58266	43.07725	905983	24.7	6	2-Aug	1100	channelized reach	3.0	65	35	0	0	10	7	0
27	2y	Lower Basin	78.52743	43.09063	905983	32.7	6	3-Aug	1030	isolated run	2.5	15	70	5	10	3	1	0
28	2y	Lower Basin	78.53183	43.08728	905983	33.2	5	3-Aug	1400	pool with run	2.5	75	20	5	0	50	2	0
29	2x	Lower Basin	78.55487	43.09535	905983	28.8	6	3-Aug	1700	pool with riffle	3.0	95	5	0	0	20	1	0
30	2w	Lower Basin	78.59705	43.07206	905983	23.0	6	4-Aug	1000	channelized reach	2.0	85	15	0	0	10	1	1

31	2v	Lower Basin	78.61628	43.07505	905983	21.2	6	4-Aug	1230	isolated run	3.0	90	0	0	10	10	20	10
32	2v	Lower Basin	78.62266	43.08510	905983	19.7	6	4-Aug	1500	isolated run	3.0	80	5	10	5	20	9	0
33	2u	Lower Basin	78.64210	43.09650	905983	17.9	6	16-Aug	1400	isolated run	3.0	55	10	25	10	8	15	0
34	2s	Lower Basin	78.67726	43.08448	905983	15.0	6	16-Aug	1800	isolated run	1.5	25	10	25	40	8	5	3
35	2s	Lower Basin	78.68698	43.08395	905983	14.2	6	17-Aug	1300	pool with riffle	1.5	15	0	60	25	1	1	1
36	2p	Lower Basin	78.69669	43.08633	905983	13.4	6	17-Aug	1600	pool with run	3.0	30	5	40	30	1	50	1
37	2ll	Lower Basin	78.41456	43.03195	805945	47.2	5	18-Aug	1700	pool with riffle	1.2	15	5	10	70	1	1	1
38	2jj	Lower Basin	78.43764	43.05597	805945	44.9	5	9-Sep	930	pool with riffle	1.2	25	15	35	25	1	1	1
39	2kk	Lower Basin	78.42322	43.04530	805945	46.1	5	9-Sep	1300	pool with riffle	1.0	30	5	35	30	1	10	1
40	2jj	Lower Basin	78.44119	43.06135	805945	44.4	5	10-Sep	1000	pool with run	1.0	30	5	50	15	15	20	1
41	2hh	Lower Basin	78.45389	43.09135	805945	41.0	5	10-Sep	1400	pool with riffle	1.0	35	5	35	25	10	5	20
42	2tt	Middle Basin	78.18993	42.99842	805945	62.8	5	27-Jul	1500	pool with riffle	2.0	10	20	30	40	1	1	60
43	2tt	Middle Basin	78.18877	42.99757	805945	62.9	5	27-Jul	2000	pool with riffle	2.5	10	30	50	10	0	0	50
44	2nn	Middle Basin	78.33582	43.02056	805945	52.0	5	5-Aug	900	pool with riffle	1.5	5	20	50	25	1	10	40
45	2tt	Upper Basin	78.18843	42.99670	805945	63.0	5	22-Aug	1230	channelized reach	2.1	60	10	20	10	12	10	1
46	2vv	Upper Basin	78.19430	42.97080	805945	65.8	5	22-Aug	1500	pool with run	1.8	70	30	0	0	10	15	1
47	2mm	Middle Basin	78.39467	43.02581	805945	48.5	5	23-Aug	1400	pool with run	2.0	15	0	50	35	0	2	1
48	2ss	Middle Basin	78.20311	43.00435	805945	62.0	5	23-Aug	1630	pool with riffle	1.0	40	5	40	15	0	0	60
49	2rr	Middle Basin	78.22766	43.00536	805945	60.6	5	25-Aug	1200	pool with run	2.0	35	25	30	10	4	5	2
50	2qq	Middle Basin	78.25051	43.00341	805945	59.5	5	25-Aug	1630	pool with riffle	1.2	10	25	50	15	1	1	2
51	2ccc	Upper Basin	78.25612	42.90126	805945	76.9	5	2-Sep	1330	pool with run	1.2	10	60	30	0	3	10	1
52	2kkk	Upper Basin	78.32970	42.71160	805945	94.7	4	1-Sep	1600	pool with riffle	1.3	15	30	45	10	1	20	0
53	2iii	Upper Basin	78.31854	42.79337	905983	87.8	5	17-Sep	2000	pool with riffle	2.0	15	25	50	10	1	2	0
54	2eee	Upper Basin	78.27523	42.86959	805945	80.5	5	18-Sep	1400	pool with riffle	1.2	10	25	65	0	2	4	0
55	2jjj	Upper Basin	78.31287	42.76484	905983	90.0	5	18-Sep	1900	pool with run	1.3	25	15	35	25	1	1	0
56	2lll	Tributary 77	78.31174	42.70484	905989	96.1	4	22-Sep	1000	pool with riffle	1.2	5	5	40	50	1	1	10
57	2hhh	Upper Basin	78.29886	42.82382	905983	85.0	5	23-Sep	1300	pool with riffle	1.2	15	10	40	35	1	3	1
58	2aaa	Upper Basin	78.23436	42.92902	805945	71.8	5	23-Sep	1800	pool with run	1.6	40	50	5	5	25	10	0
59	2f	Ellicott Ck	78.87307	43.01936	905984	0.6	4	2-Jun	1500	channelized reach	4.3	40	0	20	40	10	10	0
60	2h	Ellicott Ck	78.81393	43.02292	905984	4.2	4	7-Jul	1900	channelized reach	2.6	75	0	10	15	1	2	2
61	2g	Ellicott Ck	78.84474	43.01281	905984	2.3	4	7-Jul	2030	channelized reach	2.4	80	0	5	15	15	20	3
62	2i	Bull Ck	78.83086	43.05291	905985	4.7	3	2-Jun	1730	channelized reach	1.5	85	0	5	10	5	5	0
63	2i	Bull Ck	78.83376	43.05831	905985	5.2	3	8-Jul	830	channelized reach	1.3	90	0	10	0	2	6	7
64	2k	Ransom Ck	78.74677	43.06761	905986	9.6	4	8-Jul	1100	channelized reach	2.2	70	5	10	15	7	30	2

65	2z	Murder Ck	78.51918	43.08012	905987	34.2	5	18-Aug	900	pool with run	2.0	65	10	25	0	1	20	25
66	2bb	Murder Ck	78.51773	43.06005	905987	34.8	5	18-Aug	1130	pool with riffle	1.3	35	0	55	10	2	40	30
67	2xx	L Tonawanda Ck	78.18923	42.95389	805946	68.6	4	14-Sep	1500	pool with run	3.0	70	10	15	5	6	3	20
68	2yy	L Tonawanda Ck	78.19171	42.92781	805946	72.2	4	17-Sep	1130	pool with riffle	2.0	20	35	30	15	2	5	0

[1]Tonawanda Creek watershed cont.

[2]Site	PT	MD	SS	IW	BC	AV	HCI	CPUE	RICH	AB	SDI	SL	WT	Landmark
1	1	4	1.30	1	2	1	1.72	15.23	13	198	0.625	580	15	boat ramp at West Canal Park
2	1	4	1.55	1	2	1	1.76	4.00	10	40	0.799	120	15	RT62 / Niagara Blvd BR
3	2	4	2.65	2	2	2	2.44	8.25	8	66	0.515	525	14	west end of Canal
4	2	3	1.15	3	2	5	2.69	7.20	20	144	0.882	100	25	backwater slough above T6
5	1	4	1.60	2	2	3	2.27	4.21	19	80	0.902	250	24	Canal x Tonawanda Ck confluence
6	1	4	2.10	2	2	3	2.35	6.40	15	96	0.841	100	23	Canal x Bull Ck T3 confluence
7	2	3	1.70	3	2	3	2.45	9.54	13	124	0.656	300	26	3-Mile Island / Ellicott Ck County Park
8	1	3	1.40	2	2	5	2.40	13.09	22	288	0.820	480	23	BLS Amherst Vets Canal Park
9	4	2	2.80	2	2	3	2.63	7.30	20	251	0.890	75	22	Millersport Riffle below RT78 BR
10	1	4	2.00	2	2	2	2.17	9.84	18	467	0.766	100	22	TN Valley gas pipeline crossing
11	4	3	1.80	2	2	2	2.47	7.65	26	199	0.812	30	20	Millersport Pool below RT78 BR
12	1	4	1.60	2	2	3	2.27	7.88	25	204	0.895	50	21	confluence with Mud Ck T8
13	4	3	2.85	2	2	3	2.81	2.80	15	42	0.930	100	25	above New Rd BR
14	1	4	1.60	2	2	3	2.27	3.72	18	67	0.793	150	25	above Canal confluence
15	1	4	1.55	3	2	3	2.43	6.89	17	130	0.808	320	24	above Pendleton Riffle
16	1	4	1.45	3	3	2	2.41	3.88	16	62	0.853	200	24	lg down tree above Pendleton Riffle
17	2	2	2.35	2	3	3	2.39	3.79	18	71	0.928	180	27	above Mud Creek T8
18	2	2	1.95	2	3	2	2.16	3.75	16	60	0.903	180	27	above Mud Creek T8
19	1	3	1.80	2	3	2	2.13	4.25	16	68	0.923	980	26	below Mud Creek T8
20	1	4	3.20	2	2	3	2.53	5.80	15	87	0.906	400	26	near New Rd BR
21	4	3	3.30	2	2	2	2.72	6.12	12	102	0.831	50	19	below Indian Falls
22	2	3	1.70	3	2	1	2.12	4.86	17	107	0.829	100	22	below Foot Rd BR
23	2	4	1.85	3	2	1	2.31	3.78	13	68	0.831	100	22	Brocker parcel below T12b above RT93
24	4	3	2.45	3	3	1	2.74	4.67	20	159	0.911	100	22	USGS gauge at Goodrich Rd BR
25	1	4	1.15	3	2	1	2.03	1.77	18	69	0.899	100	25	below Burdick Rd BR (below T10e)
26	1	4	1.35	3	3	1	2.23	2.29	16	69	0.904	100	25	above Rapid Rd BR (above T10)

27	2	3	2.10	2	2	1	2.02	4.22	18	143	0.823	80	25	at T11a off RT93
28	3	3	1.30	5	2	1	2.55	4.40	16	88	0.589	60	26	confluence with Ledge Ck T11
29	4	4	1.05	3	2	1	2.51	2.78	18	82	0.850	70	26	above Burdick Rd BR (above T10g)
30	1	3	1.15	3	2	2	2.03	10.19	20	374	0.859	280	24	confluence with Beeman Creek T9
31	2	4	1.30	3	3	3	2.72	6.29	15	174	0.842	150	25	S Tonawanda x Brauer Roads
32	2	4	1.40	3	3	1	2.40	5.00	17	161	0.742	100	27	off Heroy Rd dead end
33	2	4	1.90	3	3	1	2.48	8.59	16	321	0.751	100	25	below S Tonawanda Ck x Wisterman Roads
34	2	3	2.80	3	2	2	2.47	8.98	19	272	0.775	200	25	above TN Valley gas pipeline
35	4	3	2.95	2	2	2	2.66	11.56	23	475	0.897	75	25	below TN Valley gas pipeline
36	3	4	2.80	2	5	2	3.13	6.08	19	192	0.902	60	25	at RT78 BR Millersport
37	4	2	3.35	2	1	2	2.39	12.79	14	349	0.857	120	23	TIR above Indian Falls Lake Outlet T20a
38	4	2	2.60	2	1	2	2.27	9.04	23	480	0.866	80	19	TIR above Bloomingdale Rd BR above T18a
39	4	2	2.65	2	3	2	2.61	12.58	21	457	0.897	75	20	TIR above old railroad crossing
40	3	2	2.50	3	3	2	2.58	9.89	20	347	0.696	60	19	TIR below Bloomingdale Rd BR
41	4	2	2.50	3	2	3	2.75	7.85	21	316	0.879	100	19	TIR at dead end Meadville Rd
42	4	3	3.00	2	2	5	3.17	71.36	15	1566	0.542	70	22	Batavia walk BR above SPDES outlet
43	4	3	2.60	1	1	5	2.77	60.78	18	1641	0.554	100	22	below Batavia Municipal Dam
44	4	3	2.95	2	3	4	3.16	98.50	13	2003	0.745	50	23	N Pembroke Rd BR
45	1	3	1.80	3	3	2	2.30	13.65	12	337	0.728	90	21	above Batavia Municipal Dam
46	3	3	1.30	3	3	2	2.55	15.48	14	387	0.779	75	25	well above Kibbe Park Batavia
47	3	3	3.05	1	2	2	2.34	20.57	9	288	0.601	100	21	above RT77 BR (above T20c)
48	4	2	2.30	1	1	5	2.55	31.07	14	404	0.728	80	24	at River St BR off RT5 Batavia
49	3	3	2.15	2	2	2	2.36	38.77	14	968	0.752	100	19	below River St along side CR37
50	4	2	2.70	2	2	2	2.45	31.07	13	886	0.704	130	22	above Colby Rd BR along side CR37
51	3	2	2.20	2	3	2	2.37	7.84	17	319	0.885	80	20	at Railroad Ave BR Alexander
52	4	2	2.50	2	3	1	2.42	12.62	15	383	0.850	110	20	confluence with T77 at RT98 BR
53	4	3	2.55	2	2	1	2.43	8.52	14	232	0.887	150	17	at Eck Rd BR
54	4	2	2.55	2	2	1	2.26	11.19	15	347	0.820	80	19	above WWTP discharge Attica
55	3	2	2.60	2	2	1	2.10	10.52	21	404	0.798	80	18	behind Sheldon Town Park
56	4	2	3.35	2	2	3	2.73	65.86	15	1449	0.353	70	16	below Almeter Rd BR
57	4	2	2.95	2	2	2	2.49	13.95	15	387	0.850	150	19	old Steel BR on private Rd off RT98
58	3	3	1.75	3	3	1	2.46	5.63	15	135	0.826	80	18	at Peaviner Rd BR
59	1	4	2.60	3	3	1	2.43	4.09	11	45	0.843	700	15	above canal up to Freemont St BR
60	1	3	1.65	2	2	2	1.94	4.86	7	34	0.537	500	26	above RT62 BR up to diversion canal

61	1	3	1.55	3	3	2	2.26	3.5	8	28	0.725	300	25	at Colvin Blvd BR near Brighton Park
62	1	3	1.40	2	2	1	1.73	8.12	17	138	0.662	450	15	above canal confluence to RT62BR
63	1	2	1.20	2	3	3	2.03	3.83	11	46	0.844	530	22	above RT62 BR up to T3-1 confluence
64	1	3	1.70	3	4	2	2.45	4.33	9	39	0.849	700	22	lower reach upstream from canal
65	3	3	1.60	2	3	3	2.60	7.21	17	263	0.785	60	19	at Tonawanda Ck Rd BR near RT93
66	4	2	2.40	3	4	4	3.23	11.77	18	416	0.881	150	19	at Swift Mills Rd BR near RT93
67	3	3	1.55	3	2	2	2.43	12.83	17	371	0.708	75	19	at Old Creek Rd BR
68	4	3	2.40	2	2	1	2.40	10.65	15	245	0.870	100	17	at railroad BR crossing off W Bethany Rd

[1]Tonawanda Creek watershed cont.

[2]Site	Site Notes
1	some riprap on shoreline with drop off and AV along margins later in summer
2	some riprap on shoreline with drop off and AV along margins later in summer
3	outlet area into Niagara-Little River with clear blue water, moderate current below with logjam
4	shallow soft mucky bottom bay on LB off canal with good AV growth and several docks
5	riprap shoreline with drop off and AV growth along margins
6	riprap and wooded shoreline with some AV growth shallower and rocky under BR upstream T3
7	shallow soft mucky bottom backwater channel area off LB of canal
8	below BLS along RB of canal channel with high AV growth
9	shallow long wide low gradient riffle with much algae on hard SS area with sm pools
10	deep very turbid soft bottom reach with some small rip rap along shoreline devoid of trees
11	large shallow round pool at base of long riffle with soft bottom margins and rocky main stem
12	very turbid deep reach with brush along margins and a shallow silty point bar
13	first riffle in main stem with dense emergents and shallow rocky channel with boulders
14	deep narrow reach with AV growth along margins and steel pilings along RB some shade above
15	deep turbid reach above riffle with shallow wooded margins and emergents along RB
16	narrows at lg down tree with more small logs in water on RB n clay
17	shallow rocky long narrow pool below Millersport Pool with thalweg and emergents along RB
18	shallow rocky long narrow pool above T8 with thalweg and brush along RB
19	long deep narrow turbid reach with lg willow trees along RB & sm rocky shoal along LB below picnic area
20	deep turbid reach with shade from BR down to steel pilings on RB some AV along LB
21	deep rocky plunge pool below waterfall with boulders in riffle below
22	shallow narrow sandy run with rocks on RB at top of reach and wood below

23 deep wide corner pool above with narrow sandy run below
24 long narrow rocky run with wood on RB above Rapids Riffle
25 lg corner pool below channel with mod inflow on LB with wood
26 lg corner pool below narrow channel with current n wood both ends
27 shallow sandy run with lg rocks and wood plus a barn on RB
28 silty into just below massive LJ complex with current below
29 lg corner pool with house on RB narrow riffle below
30 deep clay sided with wood T9 on LB very shallow n small inflow
31 new rip rap work along the LB among a deep reach with some wood and thick clay banks
32 old dock ruins on LB near houses with much gvl and some wood plus undercut banks below
33 deep channel with shallow rocky cove and lg willows on RB with residential debris brush on LB
34 shallow rocky flat on LB with lilies below plus houses and some wood on RB
35 mod flows over shallow narrow rocky riffle across stream with intact riparian on both banks
36 deep main channel with lg rocks and rerod under BR with rip rap on both banks
37 shallow long narrow rocky riffle area with long bedrock pool above and house on LB
38 deep pool into rocky gvl run at old railroad crossing with rocky riffle below and side pool on LB
39 long shallow pool into deeper pool with roots then a shallow gvl riffle area below
40 head of split channel with shallow wooded silty pool on LB and shallow rocky gvl run along RB
41 semi open shallow run with side pools along RB with AV into wide riffle area below
42 shallow weedy sandy gvl bottom reach with no riparian and rocks at SPDES outflow
43 deep rocky plunge pool at dam into rocky riffle with pocket pools then wide weedy flats below to weir
44 site of old mill dam with wide shallow pools with soft bottom into shallow gvl riffles below
45 deep main stem silty banks with rocky shoal on RB some riparian cover and submergent AV
46 deep corner pool into shallow wooded run with soft bottom in dense riparian corridor
47 old BR abutment at small deep rocky pool with rock wall in center above shallow long rocky run
48 shallow rocky riffle under BR into weedy silty narrow run posted as city flood plain no riparian
49 slow wide pool with wood into narrow rocky run with Elodea some flow
50 deep wide pool into low gradient riffles and sm pool below some wood cover
51 shallow sandy reach with sm pool above rocky dam under BR into swift sandy run with rock wall on LB
52 shallow gvl riffles into deeper sandy pool with split channel below with gvl run riffle area some riparian
53 shallow sandy pool at T59 into gvl riffle above BR then long run rip rap on RB down to lg gvl pool below
54 shallow wide gvl riffle area with pocket pools with wood on RB into long run some riparian
55 long narrow shallow rocky run with rip rap on RB at park into wider still shallow gvl rocky pool below
56 shallow rocky reach below rip rap at BR into deeper pools above a long riffle

57	long deep pool at BR into rocky gvl run down into long wide rocky pool with riffle at bottom
58	wooded sandy run with side pools down to BR into sm LJ with steep silty banks
59	narrow channel up past 2 bridges with shoreline docks and sparse riparian rocky bottom near third BR
60	shallow soft bottom reach very stagnant with dense algal bloom and limited riparian
61	narrow deep channel with docks on LB and down wood on RB above BR
62	shallow soft bottom reach highly turbid with sparse riparian cover
63	shallow soft bottom reach highly turbid with sparse riparian and stagnant green water
64	shallow highly stagnant reach with green algal film on water with dense riparian cover
65	silty slow weedy pool near BR into beaver dam with silty wooded run below
66	small corner pool into shallow rocky riffle run at BR with deeper shaded pools below with wood
67	slow weedy deep pool near BR into beaver dam with slow silty wooded run below
68	lg deep sandy pool at T32-2 into swift rocky riffle with slow channel on RB

[1]The watershed was divided into subunits as shown in Table 2 including specific sites for each matrix: entire basin (all 68), lower basin sites (1-41,59-66), canal+adj tribs (1-8), middle+upper basin (42-58,67,68), upper basin (45,46,51-55,57,58,67,68), tributaries only (56,59-68), PT1 (1,2,5,6,8,10,14-16,19,20,25,26,30,45,59,60-64), PT2 (3,4,7,17,18,22,23,27,31-34), PT3 (28,36,40,46,47,49,51,55,58,65,67), PT4 (9,11,13,21,24,29,35,37-39,41-44,48,50,52-54,56,57,66,68).

[2]Each sampling site was numbered and marked by x—latitude, y—longitude coordinates including habitat notes: RM—river mile, SO—stream order, Gvl—gravel (see Table 4); HCI—habitat complexity index, CPUE—catch per unit effort, RICH—fish richness, and SDI—Simpson's Diversity Index, SL—site length, WT—water temperature (˚C—Celsius), ST—street, Rd—road, RT—route (county or state highway), TN—Tennessee, BR—bridge, CV—culvert, T or trib—tributary, LB—left bank, RB—right bank (with current), sm—small, lg—large, ppt—precipitation.

Appendix I-E. Habitat data from the Johnson Creek watershed, May-September 2005. See Table 4 for habitat descriptions.

[1]Johnson Creek watershed

[2]Site	Map	Basin	X	Y	Survey#	RM	SO	Date	Time	Pool Type	Md	%Silt	%Sand	%Gvl	%Rock	%IW	%BC	%AV
1	3f	Lower Basin	78.26451	43.36061	805943	1.4	5	17-May	1700	isolated run	2.5	50	0	25	25	5	5	0
2	3g	Lower Basin	78.28027	43.35443	805943	2.5	5	18-May	1600	pool with run	1.5	30	0	50	20	5	10	0
3	3m	Lower Basin	78.38756	43.32227	805943	11.4	5	3-Jun	1330	isolated run	0.5	10	10	70	10	0	8	0
4	3m	Lower Basin	78.38896	43.32191	805943	11.4	5	3-Jun	1500	pool with riffle	2.0	5	10	75	10	0	5	5
5	3g	Lower Basin	78.26942	43.35953	805943	1.7	5	15-Jun	1600	channelized reach	1.1	30	5	60	5	5	10	50
6	3f	Lower Basin	78.26584	43.36012	805943	1.5	5	15-Jun	1730	channelized reach	1.1	30	5	55	10	5	10	50
7	3f	Lower Basin	78.26416	43.36120	805943	1.4	5	15-Jun	1830	channelized reach	2.0	40	10	40	10	5	6	10
8	3e	Lower Basin	78.25821	43.36478	805943	1.0	5	15-Jun	1930	channelized reach	1.2	25	10	55	10	7	10	15
9	3e	Lower Basin	78.25768	43.37068	805943	0.6	5	15-Jun	2030	channelized reach	1.1	60	10	30	0	10	15	10
10	3e	Lower Basin	78.26745	43.37227	805943	0.1	5	22-Jun	1000	channelized reach	2.4	15	25	45	15	0	3	5
11	3e	Lower Basin	78.26562	43.37164	805943	0.2	5	22-Jun	1130	channelized reach	2.1	40	30	30	0	1	3	20
12	3e	Lower Basin	78.26397	43.37133	805943	0.3	5	22-Jun	1300	channelized reach	1.8	60	10	30	20	1	5	20
13	3e	Lower Basin	78.26009	43.37147	805943	0.4	5	22-Jun	1500	channelized reach	1.5	70	20	10	0	5	1	10
14	3g	Lower Basin	78.27470	43.35763	805943	2.0	5	5-Jul	1330	isolated run	0.5	30	0	70	0	2	15	40
15	3g	Lower Basin	78.27150	43.35761	805943	1.9	5	5-Jul	1500	isolated pool	1.5	55	0	40	5	5	10	50
16	3i	Lower Basin	78.30866	43.34536	805943	5.3	5	18-Jul	1530	isolated run	1.5	20	50	30	0	10	4	2
17	3i	Lower Basin	78.31013	43.34552	805943	5.4	5	18-Jul	1700	pool with riffle	1.2	30	50	20	0	25	2	2
18	3k	Lower Basin	78.38473	43.32587	805943	11.0	5	10-Aug	1300	pool with run	1.0	10	25	50	15	8	15	10
19	3k	Lower Basin	78.38181	43.33219	805943	10.5	5	10-Aug	1530	pool with run	1.0	15	10	55	20	1	2	25
20	3j	Lower Basin	78.33616	43.33619	805943	7.6	5	11-Aug	900	isolated pool	1.5	30	5	65	20	12	8	18
21	3j	Lower Basin	78.32358	43.34121	805943	6.5	5	11-Aug	1130	isolated pool	1.5	35	10	55	15	25	12	8
22	3h	Lower Basin	78.28472	43.35351	805943	2.9	5	11-Aug	1800	pool with run	1.6	20	20	55	5	6	2	45
23	3h	Lower Basin	78.30146	43.34737	805943	4.5	5	12-Aug	1000	pool with riffle	3.0	50	20	30	0	35	15	0
24	3h	Lower Basin	78.29147	43.35147	805943	3.5	5	12-Aug	1440	pool with run	1.5	25	15	60	10	12	4	30
25	3n	Upper Basin	78.40390	43.31560	805943	12.4	5	13-Jul	1000	channelized reach	1.8	65	5	30	0	12	25	2
26	3n	Upper Basin	78.40169	43.31794	805943	12.2	5	13-Jul	1130	channelized reach	1.8	65	5	30	0	25	25	2
27	3m	Upper Basin	78.39133	43.32195	805943	11.5	5	13-Jul	1300	channelized reach	1.2	90	10	0	0	5	3	70
28	3n	Upper Basin	78.39952	43.32032	805943	12.2	5	13-Jul	1430	channelized reach	2.0	65	5	30	0	25	25	2

29	3n	Upper Basin	78.39526	43.32210	805943	11.8	5	13-Jul	1600	channelized reach	2.5	75	5	20	0	15	15	35
30	3p	Upper Basin	78.45778	43.29288	805943	17.5	5	24-Aug	1300	pool with riffle	1.5	20	15	60	5	20	50	1
31	3p	Upper Basin	78.44550	43.29567	805943	16.0	5	24-Aug	1600	pool with riffle	3.0	40	20	25	15	2	10	0
32	3t	Upper Basin	78.52292	43.24346	905980	24.3	4	5-Sep	1030	pool with riffle	1.2	35	10	35	20	15	5	1
33	3u	Upper Basin	78.50908	43.21344	905980	27.5	3	10-Sep	1200	pool with riffle	1.5	20	10	55	15	15	50	0
34	3q	Upper Basin	78.48892	43.28753	905980	19.4	5	11-Sep	1000	pool with run	1.0	75	0	25	0	2	7	20
35	3r	Upper Basin	78.50375	43.28134	905980	20.5	5	11-Sep	1500	pool with run	1.2	30	55	15	0	15	40	1
36	3s	Upper Basin	78.52020	43.26028	905980	23.0	4	16-Sep	1730	pool with run	0.8	60	5	35	0	2	8	60
37	3u	Upper Basin	78.51980	43.22730	905980	26.0	3	21-Sep	1500	pool with riffle	1.0	15	10	60	15	1	8	0
38	3w	Jeddo	78.47392	43.22851	905981	23.5	3	15-Jul	800	pool with riffle	0.5	10	25	60	5	1	8	40
39	3w	Jeddo	78.47485	43.22765	905981	23.6	3	15-Jul	1030	pool with riffle	1.2	45	15	15	25	1	10	20
40	3v	Jeddo	78.45694	43.25540	805944	20.6	4	30-Aug	1500	pool with riffle	1.3	10	15	40	35	1	10	0

[1]**Johnson Creek watershed cont.**

[2]Site	PT	MD	SS	IW	BC	AV	HCI	CPUE	RICH	AB	SDI	SL	WT	Landmark
1	2	3	2.3	2	2	1	2.04	8.8	12	178	0.550	60	12	Kuckville BR
2	3	3	2.6	2	3	1	2.43	13.8	9	159	0.524	80	14	Harris Rd BR
3	2	1	2.8	1	3	1	1.80	4.3	13	56	0.854	80	23	below RT63 BR
4	4	3	2.9	1	2	2	2.48	6.4	20	199	0.807	50	19	above RT63 BR
5	1	2	2.4	2	3	5	2.57	4.3	14	60	0.852	340	25	above Kuckville BR
6	1	2	2.5	2	3	5	2.58	2.8	12	34	0.914	450	25	above Kuckville BR
7	1	3	2.2	2	3	3	2.37	2.7	14	38	0.933	135	25	below Kuckville BR
8	1	2	2.5	3	3	3	2.42	3.4	16	55	0.874	500	25	Lakeside SP
9	1	2	1.7	3	3	3	2.28	4.9	15	73	0.889	430	25	Syren Creek T1
10	1	3	2.6	1	2	2	1.93	8.9	16	142	0.777	160	22	Lake Ontario
11	1	3	1.9	2	2	3	2.15	6.3	12	76	0.839	105	22	below Lakeside BR
12	1	3	2.5	2	2	3	2.25	7.5	14	105	0.848	160	23	above Lakeside BR
13	1	3	1.4	2	2	3	2.07	11.0	13	154	0.856	410	23	Power Lines above BR
14	2	1	2.4	2	3	4	2.40	5.5	17	211	0.879	75	25	below Harris Rd BR
15	2	3	2.0	2	3	5	2.83	2.9	10	52	0.857	75	25	old Steel BR
16	2	3	2.1	3	2	2	2.35	4.3	14	114	0.830	50	28	Yates Carlton Townline Rd BR
17	4	2	1.9	3	2	2	2.48	5.1	18	166	0.888	75	28	Yates Carlton Townline Rd BR

18	3	2	2.7	3	3	3	2.78	5.8	13	154	0.894	30	25	Railroad crossing over weir
19	3	2	2.8	2	2	3	2.47	9.5	14	309	0.815	75	25	Private Farm Rd weir crossing
20	2	3	3.2	3	3	3	2.86	6.1	22	377	0.744	150	22	below T3
21	2	3	2.8	3	3	3	2.80	5.2	13	127	0.858	100	22	below T2
22	3	3	2.5	3	2	4	2.91	5.5	15	222	0.777	90	24	above Harris Rd BR
23	4	4	1.8	4	3	1	2.97	3.2	19	122	0.857	80	23	above Kendrick Rd bend
24	3	3	2.8	3	2	4	2.96	5.4	14	116	0.831	80	23	below Kendrick Rd bend
25	1	3	1.7	3	3	2	2.28	4.2	5	21	0.752	390	23	below navigation barrier
26	1	3	1.7	3	3	2	2.28	2.6	9	23	0.858	320	23	above split channel
27	1	2	1.1	2	2	5	2.18	3.9	7	27	0.792	380	25	Lyndonville Pond
28	1	3	1.7	3	3	2	2.28	3.6	18	68	0.915	320	24	above pond inlet
29	1	3	1.5	3	3	4	2.58	2.6	11	28	0.873	340	25	Pond inlet
30	4	3	2.5	3	5	2	3.25	13.5	19	603	0.815	100	20	Jeddo Ck mouth
31	4	4	2.2	2	3	1	2.69	2.6	14	71	0.817	75	20	below T8
32	4	2	2.4	3	2	2	2.57	14.4	16	148	0.887	75	23	Mill St BR
33	4	3	2.7	3	5	1	3.11	8.5	19	236	0.837	175	22	Erie Canal Outflow
34	3	2	1.5	2	3	3	2.42	9.9	15	311	0.800	75	16	Carmen Rd BR
35	3	2	1.9	3	3	2	2.48	7.5	17	257	0.583	150	18	Drum Rd BR
36	3	2	1.8	2	4	5	2.96	7.3	16	217	0.794	100	19	Johnson Ck Rd BR
37	4	2	2.8	2	3	1	2.46	14.8	13	227	0.813	60	21	Pearson Rd BR
38	4	1	2.6	2	3	4	2.77	8.3	10	164	0.709	80	23	T9-1 under RT271
39	4	2	2.2	2	3	3	2.70	6.7	13	179	0.696	90	23	T9-1 under RT271
40	4	2	3.0	2	3	1	2.50	16.0	10	339	0.698	70	20	T9 under RT104 BR

[1]**Johnson Creek watershed cont.**

[2]Site	Site Notes
1	shallow rocky corner run silty LB wood & weeds along RB above & riprap past BR
2	shallow gvl run above BR & silty deeper pool run under & below BR
3	below BR in shallow gravel flats with cool water from RB culvert
4	bubble curtain below dam some algae & sm gvl pools below
5	above spilt channel with dense submergents into shallow gvl flats

6 above BR with dense submergents & shallow backwater bay on RB

7 deep wide pool below BR with cattail margin along LB

8 shallow flats above split channel center island with silty bottom

9 silty bottom outside T1 cattail margins & upstream after dark

10 gvl beach with drop off on LB & artificial shore with lg willow below gravel ramp on RB

11 cattail margins with some docks below sm steel BR

12 cattails along RB docks on LB above sm steel BR

13 silty bottom reach above power lines with shoreline cottages

14 narrow shallow run with weeds & some clay on LB in shallow riffle above

15 weedy sandy flats below old steel BR above shallow rocky riffle navigation barrier

16 sandy bottom reach with wood & silty shallow BWP on RB below BR

17 sm riffle above narrow pool silty bottom some gravel & wood above BR

18 wide channel run above open concrete weir under railroad BR with SPDES site in run below on LB

19 weedy run above concrete weir road crossing with high current into tubes swift run below weir

20 shaded cool slack water area with faster current at site end

21 varied site at left bend corner pool shallow riffle at bottom many wood snags

22 weedy run eel grass & clay ledge on RB at pool tail of lg shallow pool sandy LB gvl in center channel

23 sm riffle & long deep right bend corner pool with LJ below high turbidity steep LB hard clay

24 shallow gvl riffle into run with long slow left bend pool between slow runs sandy wooded BWP

25 deep slow wooded channel below down tree navigation barrier silty weedy margins

26 narrow deep slow wooded reach below split channel silty weedy margins

27 shallow silty Lyndonville Mill Pond inlet to dam with thick weed beds

28 narrow deep wooded channel first bend split channel area above Pond silty weedy margins

29 narrow deep long channel directly above pond inlet with weedy margins

30 T9 confluence with shallow gvl riffles among sm deeper gvl pool some wood cover

31 just below T8 with fast steep riffle with lg rocks into deep wide pool at BR

32 Reg9 site 1 below abandoned BR lg pool with rocks riffles above & below down tree at pool tail

33 Reg9 site 2 headwaters of main stem at canal outflow steep gradient into culvert tube

34 Reg9 site 3 near BR at T12 with lilies on LB livestock trampling on RB very silty bottom

35 Reg9 site 4 between wood bridges with shade & IW very sandy shallow fish in poor health

36 Reg9 site 5 above below BR silty eel grass filled stretch with mod current after ppt

37 Reg9 site 6 with rip rap below BR into gvl run dry trib on LB & sm pools shallow riffle above BR

38	Reg9 site 1 in Jeddo Ck T1 below RT271 culvert small water with weeds & gvl
39	Reg9 site 2 in Jeddo Ck T1 deep rocky pool at RT271 culvert
40	Reg8 site 1 Jeddo Ck T9 wide plunge pool below concrete BR shallow rocky riffles above below

[1]The watershed was divided into subunits as shown in Table 2 including specific sites for each matrix: entire basin (all 40), lower basin sites (1-24), upper basin (26-40), PT1 (5-13, 25-29), PT2 (1,3,14-16,20,21), PT3 (2,18,19,22,24,34-36), PT4 (4,17,23,30-33,37-40).

[2]Each sampling site was numbered and marked by x—latitude, y—longitude coordinates including habitat notes: RM—river mile, SO—stream order, Gvl—gravel (see Table 4); HCI—habitat complexity index, CPUE—catch per unit effort, RICH—fish richness, and SDI—Simpson's Diversity Index, SL—site length, WT—water temperature (˚C—Celsius), ST—street, Rd—road, RT—route (county or state highway), TN—Tennessee, BR—bridge, CV—culvert, T or trib—tributary, LB—left bank, RB—right bank (with current), sm—small, lg—large, ppt—precipitation.

Appendix I-F. Fish data minus hybrids and unknowns from the Tonawanda Creek watershed, June-September 2005. See Table 6 for fish codes.

[1]Tonawanda Creek watershed

Location	Survey#	Date	[2]Site	SN	Rep	Sp	Catch	L min	L max	C/O	[3]Gear	Run	Time
Erie Canal	905982	6/2/05	1	1	1	347	1	414		O	EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	365	1	400		O	EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	377	11	125	197		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	381	115	42	65		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	390	1	70			EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	400	7	58	95		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	444	5	200	275		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	591	4	129	192		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	596	35	70	160		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	598	11	71	175		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	601	5	170	360		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	617	1	127	147		EFB	1st	900s
Erie Canal	905982	6/2/05	1	1	1	792	1	96			EFB	1st	900s
Erie Canal	905982	6/2/05	2	2	1	365	1	450		O	EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	381	4	51	60		EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	400	1	58			EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	431	1	415			EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	591	16	84	221		EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	596	4	81	112		EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	598	2	132	149		EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	600	3	123	370		EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	601	7	301	396		EFB	2nd	900s
Erie Canal	905982	6/2/05	2	2	1	792	1	66			EFB	2nd	900s
Erie Canal	905982	6/2/05	3	3	1	381	45	51	85		EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	419	1	335			EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	428	1	445			EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	431	2	395	560		EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	433	2	380	710		EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	596	3	71	111		EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	600	10	312	392		EFB	3rd	900s
Erie Canal	905982	6/2/05	3	3	1	601	2	200	275		EFB	3rd	900s
Erie Canal	905982	6/27/05	4	4	1	347	4	357	520		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	365	8	420	670		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	377	24	70	123		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	394	1	79			EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	397	2	40	55		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	401	12	45	56		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	405	2	310	320		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	419	1	444			EFB	four	900s

Erie Canal	905982	6/27/05	4	4	1	431	3	360	400	EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	432	1	360		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	433	1	500		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	444	10	250	280	EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	595	3	56	80	EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	596	31	60	120	EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	598	23	51	163	EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	599	1	100		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	601	12	167	360	EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	602	1	190		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	603	1	225		EFB	four	900s
Erie Canal	905982	6/27/05	4	4	1	617	3	85	158	EFB	four	900s
Erie Canal	905982	6/27/05	5	5	1	347	3	410	470	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	365	5	590	650	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	381	1	85		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	384	1	176		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	394	12	55	90	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	400	15	56	85	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	431	1	300		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	432	2	130	280	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	444	1	270		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	447	1	67		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	591	8	78	175	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	595	7	73	100	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	596	4	68	139	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	600	1	280		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	601	3	210	380	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	603	1	215		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	613	1	40		EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	617	12	136	190	EFB	three	900s
Erie Canal	905982	6/27/05	5	5	1	792	1	95		EFB	three	900s
Erie Canal	905982	7/7/05	6	6	1	347	1	444		EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	365	6	470	625	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	377	12	75	170	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	381	2	52	61	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	394	1	70		EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	400	8	45	60	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	419	1	240		EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	431	2	210	400	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	444	3	230	300	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	591	4	54	175	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	596	32	55	125	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	598	11	50	180	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	601	11	160	400	EFB	one	900s
Erie Canal	905982	7/7/05	6	6	1	602	1	180		EFB	one	900s

Erie Canal	905982	7/7/05	6	6	1	792	1	55		EFB	one	900s
Erie Canal	905982	7/7/05	7	7	1	361	1	605		EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	365	1	470		EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	377	2	70	122	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	400	1	69		EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	444	6	240	310	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	545	1	78		EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	596	52	45	142	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	598	51	48	150	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	601	2	200	260	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	601	1	270		EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	613	2	50	50	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	617	3	95	162	EFB	two	900s
Erie Canal	905982	7/7/05	7	7	1	792	1	65		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	340	1	86		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	346	2	185	221	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	347	4	390	700	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	349	1	230		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	365	10	400	850	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	377	62	90	163	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	394	10	50	60	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	400	95	40	70	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	405	6	310	382	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	419	3	270	425	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	431	11	380	390	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	432	1	410		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	433	3	352	530	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	444	5	283	325	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	591	1	65		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	596	25	80	130	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	598	10	91	143	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	600	1	32		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	601	34	23	360	EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	603	1	244		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	613	1	58		EFB	two	900s
Erie Canal	905982	7/8/05	8	8	1	792	1	60		EFB	two	900s
Lower Basin	905983	6/7/05	9	1	1	381	3	55	58	BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	384	12	45	125	BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	394	2	50	65	BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	397	10	50	62	BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	400	16	50	75	BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	401	1	48		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	423	11	160	280	BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	446	3	60	137	BPS	one	900s

Lower Basin	905983	6/7/05	9	1	1	591	7	70	162		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	595	6	45	90		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	600	1	305			BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	606	3	55	75		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	607	2	65	70		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	613	2	50	50		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	618	7	90	126		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	1	792	8	55	65		BPS	one	900s
Lower Basin	905983	6/7/05	9	1	2	381	1	50			BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	390	3	90	115		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	394	17	67	96		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	397	48	52	111		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	400	3	55	70		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	401	3	50	55		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	423	14	155	332		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	431	3	325	372		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	432	4	170	280		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	444	2	119	185		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	446	3	73	135		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	591	8	82	178		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	595	1	76			BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	606	3	60	81		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	607	1	80			BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	613	2	38	40		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	618	9	90	120		BPS	two	900s
Lower Basin	905983	6/7/05	9	1	2	792	32	52	82		BPS	two	900s
Lower Basin	905983	6/7/05	10	2	1	365	1	470		O	BPS	three	900s
Lower Basin	905983	6/7/05	10	2	1	400	6	53	80		BPS	three	900s
Lower Basin	905983	6/7/05	10	2	1	595	14	42	85		BPS	three	900s
Lower Basin	905983	6/7/05	10	2	1	596	2	75	106		BPS	three	900s
Lower Basin	905983	6/7/05	10	2	1	613	2	48	50		BPS	three	900s
Lower Basin	905983	6/23/05	11	3	1	347	1	475			EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	365	2	450	620		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	381	6	60	69		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	384	3	50	52		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	394	43	62	100		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	397	70	54	65		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	400	13	75	96		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	401	5	48	56		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	406	1	47			EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	423	2	174	210		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	431	23	45	470		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	432	2	60	153		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	433	1	500			EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	445	1	410			EFB	one	900s

Lower Basin	905983	6/23/05	11	3	1	449	2	65	95	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	591	2	95	96	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	595	3	48	91	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	596	1	76		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	599	1	133		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	600	1	179		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	601	2	266	290	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	603	3	210	250	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	607	1	51		EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	613	2	44	48	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	618	5	33	97	EFB	one	900s
Lower Basin	905983	6/23/05	11	3	1	626	3	312	463	EFB	one	900s
Lower Basin	905983	6/23/05	12	4	1	340	1	65		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	365	6	610	680	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	377	1	62		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	381	10	60	66	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	394	42	70	94	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	397	20	54	64	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	400	24	36	48	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	401	3	45	50	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	428	1	270		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	431	11	61	69	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	432	1	150		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	433	1	440		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	444	1	270		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	591	6	82	135	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	595	34	45	84	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	596	15	68	126	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	598	1	153		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	599	7	90	148	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	600	1	220		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	601	1	300		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	603	6	195	323	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	613	7	43	54	EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	617	1	150		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	618	1	62		EFB	two	900s
Lower Basin	905983	6/23/05	12	4	1	622	2	55	80	EFB	two	900s
Lower Basin	905983	6/27/05	13	5	1	365	5	600	760	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	394	3	76	84	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	397	2	61	65	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	400	6	50	71	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	431	5	228	384	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	449	2	64	100	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	591	4	141	195	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	598	2	150	155	EFB	one	900s

Lower Basin	905983	6/27/05	13	5	1	599	1	115		EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	600	5	200	350	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	601	3	280	361	EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	602	1	188		EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	606	1	70		EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	618	1	70		EFB	one	900s
Lower Basin	905983	6/27/05	13	5	1	700	1	275		EFB	one	900s
Lower Basin	905983	6/27/05	14	6	1	340	1	57		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	347	1	108		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	365	26	480	600	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	394	1	65		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	397	2	57	60	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	400	16	62	77	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	432	1	155		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	444	1	260		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	595	2	45	50	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	598	2	120	140	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	599	1	92		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	601	3	270	365	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	602	4	204	236	EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	613	1	54		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	617	1	154		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	622	1	70		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	700	1	310		EFB	two	900s
Lower Basin	905983	6/27/05	14	6	1	792	2	61	65	EFB	two	900s
Lower Basin	905983	7/8/05	15	7	1	365	2	400	405	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	381	1	70		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	394	47	72	83	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	397	24	46	60	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	400	20	55	67	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	428	1	444		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	432	2	75	180	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	449	1	78		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	591	6	168	185	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	595	2	75	95	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	596	6	90	140	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	598	1	180		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	599	4	88	104	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	600	6	220	290	EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	601	1	300		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	613	1	44		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	618	1	72		EFB	four	900s
Lower Basin	905983	7/8/05	15	7	1	622	4	65	78	EFB	four	900s
Lower Basin	905983	7/8/05	16	8	1	365	3	470	510	EFB	five	900s

Lower Basin	905983	7/8/05	16	8	1	381	2	55	60	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	394	1	75		EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	397	9	50	58	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	400	20	50	63	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	401	2	36	50	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	419	1	300		EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	432	1	280		EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	591	1	125		EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	596	4	70	102	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	598	9	80	170	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	599	2	78	93	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	600	3	50	372	EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	601	1	325		EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	622	1	60		EFB	five	900s
Lower Basin	905983	7/8/05	16	8	1	626	2	335	470	EFB	five	900s
Lower Basin	905983	7/19/05	17	9	1	347	1	470		EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	365	5	420	660	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	394	4	75	100	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	397	3	45	59	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	400	9	60	110	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	428	5	280	380	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	431	10	93	400	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	433	1	530		EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	444	1	290		EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	591	2	97	196	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	595	7	56	71	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	596	7	63	125	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	599	1	92		EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	600	2	50	400	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	601	1	330		EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	603	1	260		EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	613	6	45	56	EFB	one	900s
Lower Basin	905983	7/19/05	17	9	1	618	5	50	110	EFB	one	900s
Lower Basin	905983	7/19/05	18	10	1	340	1	55		EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	347	1	330		EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	397	9	45	63	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	400	12	20	50	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	419	4	35	52	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	428	2	240	315	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	431	1	395		EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	449	2	75	82	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	595	4	65	104	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	596	8	75	120	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	598	7	45	160	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	599	1	126		EFB	two	900s

Lower Basin	905983	7/19/05	18	10	1	600	3	50	70	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	601	3	165	380	EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	613	1	56		EFB	two	900s
Lower Basin	905983	7/19/05	18	10	1	622	1	42	45	EFB	two	900s
Lower Basin	905983	7/19/05	19	11	1	340	1	60		EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	347	1	350		EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	365	7	480	540	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	394	6	45	74	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	397	4	50	55	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	400	5	50	82	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	431	6	96	400	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	432	1	230		EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	595	11	60	118	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	596	7	76	102	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	598	7	65	157	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	599	2	102	111	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	600	4	64	340	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	601	3	38	275	EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	613	1	40		EFB	three	900s
Lower Basin	905983	7/19/05	19	11	1	622	2	45	70	EFB	three	900s
Lower Basin	905983	7/19/05	20	12	1	340	1	65		EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	365	6	300	520	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	394	2	73	82	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	397	6	55	79	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	400	4	63	80	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	419	1	66		EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	591	7	43	178	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	595	10	80	107	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	596	4	85	120	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	598	14	105	160	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	599	2	94	102	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	600	9	60	284	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	601	15	25	273	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	613	5	45	54	EFB	four	900s
Lower Basin	905983	7/19/05	20	12	1	618	1	105		EFB	four	900s
Lower Basin	805945	7/28/05	21	1	1	365	1	610		BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	376	22	38	180	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	384	2	40	132	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	393	1	60		BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	400	2	25	62	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	423	8	50	305	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	446	1	168		BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	591	12	131	182	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	595	5	75	115	BPS	one	900s

Lower Basin	805945	7/28/05	21	1	1	596	22	94	122	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	600	13	83	251	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	1	613	2	35	50	BPS	one	900s
Lower Basin	805945	7/28/05	21	1	2	376	2	58	110	SNE	four	
Lower Basin	805945	7/28/05	21	1	2	384	1	130		SNE	four	
Lower Basin	805945	7/28/05	21	1	2	393	1	60		SNE	four	
Lower Basin	805945	7/28/05	21	1	2	596	7	110	120	SNE	four	
Lower Basin	905983	7/28/05	22	13	1	381	1	40		BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	394	2	65	65	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	401	1	45		BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	423	2	75	180	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	431	2	85	100	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	432	1	317		BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	591	3	157	164	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	595	7	76	102	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	596	6	65	93	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	600	1	65		BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	606	2	35	65	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	607	1	54		BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	613	9	32	42	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	1	622	9	45	85	BPS	two	900s
Lower Basin	905983	7/28/05	22	13	2	393	4	50	61	SNE	four	
Lower Basin	905983	7/28/05	22	13	2	394	6	55	60	SNE	four	
Lower Basin	905983	7/28/05	22	13	2	397	5	41	52	SNE	four	
Lower Basin	905983	7/28/05	22	13	2	400	1	46		SNE	four	
Lower Basin	905983	7/28/05	22	13	2	596	3	60	90	SNE	four	
Lower Basin	905983	7/28/05	22	13	2	600	2	50	65	SNE	four	
Lower Basin	905983	7/28/05	22	13	2	613	26	41	63	SNE	four	
Lower Basin	905983	7/28/05	22	13	2	622	13	45	51	SNE	four	
Lower Basin	905983	7/28/05	23	14	1	346	1	140		BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	394	1	55		BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	428	1	350		BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	596	12	53	90	BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	600	2	58	60	BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	613	1	40		BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	622	10	32	40	BPS	three	900s
Lower Basin	905983	7/28/05	23	14	1	626	1	630		BPS	three	900s
Lower Basin	905983	7/28/05	23	14	2	384	4	38	83	SNE	four	
Lower Basin	905983	7/28/05	23	14	2	394	1	55		SNE	four	
Lower Basin	905983	7/28/05	23	14	2	397	1	48		SNE	four	
Lower Basin	905983	7/28/05	23	14	2	400	3	52	78	SNE	four	
Lower Basin	905983	7/28/05	23	14	2	423	3	50	55	SNE	four	
Lower Basin	905983	7/28/05	23	14	2	431	5	52	82	SNE	four	
Lower Basin	905983	7/28/05	23	14	2	596	12	46	75	SNE	four	
Lower Basin	905983	7/28/05	23	14	2	600	3	49	61	SNE	four	

Lower Basin	905983	7/28/05	23	14	2	613	6	32	60	SNE	four	
Lower Basin	905983	7/28/05	23	14	2	622	1	48		SNE	four	

Lower Basin	905983	7/29/05	24	15	1	384	1	30		BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	393	1	65		BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	394	14	49	73	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	400	17	21	68	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	428	1	560		BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	432	5	180	320	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	446	1	156		BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	449	1	85		BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	591	4	30	110	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	595	12	60	92	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	596	13	80	110	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	600	4	40	75	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	601	1	50		BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	606	2	45	70	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	613	9	22	50	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	618	3	64	140	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	1	622	13	43	75	BPS	one	900s
Lower Basin	905983	7/29/05	24	15	2	381	7	43	50	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	384	7	36	41	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	397	1	52		SNE	six	
Lower Basin	905983	7/29/05	24	15	2	400	15	42	76	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	431	5	103	145	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	432	1	140		SNE	six	
Lower Basin	905983	7/29/05	24	15	2	445	1	210		SNE	six	
Lower Basin	905983	7/29/05	24	15	2	449	1	25		SNE	six	
Lower Basin	905983	7/29/05	24	15	2	591	1	20		SNE	six	
Lower Basin	905983	7/29/05	24	15	2	600	3	52	64	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	613	6	30	51	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	618	5	36	100	SNE	six	
Lower Basin	905983	7/29/05	24	15	2	622	4	43	48	SNE	six	

Lower Basin	905983	8/2/05	25	16	1	365	1	530		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	381	1	33		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	394	2	50	80	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	400	5	30	65	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	401	1	45		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	419	1	58		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	431	1	41		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	449	1	90		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	591	2	30	142	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	595	2	58	100	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	596	2	48	55	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	598	1	88		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	600	2	43	49	BPS	one	900s

Lower Basin	905983	8/2/05	25	16	1	613	2	30	52	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	622	13	44	65	BPS	one	900s
Lower Basin	905983	8/2/05	25	16	1	626	1	410		BPS	one	900s
Lower Basin	905983	8/2/05	25	16	2	394	1	60		SNE	five	
Lower Basin	905983	8/2/05	25	16	2	397	4	35	55	SNE	five	
Lower Basin	905983	8/2/05	25	16	2	400	8	10	66	SNE	five	
Lower Basin	905983	8/2/05	25	16	2	401	1	25		SNE	five	
Lower Basin	905983	8/2/05	25	16	2	419	4	40	60	SNE	five	
Lower Basin	905983	8/2/05	25	16	2	545	1	50		SNE	five	
Lower Basin	905983	8/2/05	25	16	2	596	4	45	85	SNE	five	
Lower Basin	905983	8/2/05	25	16	2	600	1	50		SNE	five	
Lower Basin	905983	8/2/05	25	16	2	613	6	30	50	SNE	five	
Lower Basin	905983	8/2/05	25	16	2	622	1	42		SNE	five	
Lower Basin	905983	8/2/05	26	17	1	365	2	510	600	BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	381	1	30		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	394	7	45	66	BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	400	1	58		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	419	1	47		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	428	1	290		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	595	4	59	74	BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	596	1	48		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	600	1	40	50	BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	601	1	40		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	613	8	30	47	BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	617	1	122		BPS	two	900s
Lower Basin	905983	8/2/05	26	17	1	622	5	60	62	BPS	two	900s
Lower Basin	905983	8/2/05	26	17	2	394	2	46	50	SNE	six	
Lower Basin	905983	8/2/05	26	17	2	400	12	25	58	SNE	six	
Lower Basin	905983	8/2/05	26	17	2	419	1	50		SNE	six	
Lower Basin	905983	8/2/05	26	17	2	428	1	235		SNE	six	
Lower Basin	905983	8/2/05	26	17	2	431	3	48	50	SNE	six	
Lower Basin	905983	8/2/05	26	17	2	449	4	35	55	SNE	six	
Lower Basin	905983	8/2/05	26	17	2	591	1	27		SNE	six	
Lower Basin	905983	8/2/05	26	17	2	596	1	46		SNE	six	
Lower Basin	905983	8/2/05	26	17	2	600	1	40		SNE	six	
Lower Basin	905983	8/2/05	26	17	2	601	4	35	40	SNE	six	
Lower Basin	905983	8/2/05	26	17	2	613	4	30	50	SNE	six	
Lower Basin	905983	8/2/05	26	17	2	622	1	30		SNE	six	
Lower Basin	905983	8/3/05	27	18	1	381	2	45	55	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	394	14	59	66	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	397	2	49	52	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	419	1	56		BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	431	3	45	280	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	444	1	280		BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	591	2	142	161	BPS	one	900s

Lower Basin	905983	8/3/05	27	18	1	595	3	72	110	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	596	13	50	109	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	600	3	55	74	BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	609	1	39		BPS	one	900s
Lower Basin	905983	8/3/05	27	18	1	618	1	120		BPS	one	900s
Lower Basin	905983	8/3/05	27	18	2	381	3	25	50	SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	394	1	53		SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	400	50	16	16	SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	419	3	45	70	SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	423	1	55		SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	431	2	88	170	SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	596	4	50	65	SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	600	1	52		SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	601	1	40		SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	606	1	30		SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	613	25	35	45	SNE	seven	
Lower Basin	905983	8/3/05	27	18	2	622	5	45	45	SNE	seven	
Lower Basin	905983	8/3/05	28	19	1	365	2	400	510	BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	394	22	60	78	BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	401	1	50		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	419	1	55		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	423	2	185	190	BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	431	1	285		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	446	1	210		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	591	2	55	145	BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	600	1	68		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	613	1	37		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	618	1	105		BPS	two	900s
Lower Basin	905983	8/3/05	28	19	1	622	2	40	70	BPS	two	900s
Lower Basin	905983	8/3/05	28	19	2	381	2	48	60	SNE	four	
Lower Basin	905983	8/3/05	28	19	2	384	1	82		SNE	four	
Lower Basin	905983	8/3/05	28	19	2	394	34	45	78	SNE	four	
Lower Basin	905983	8/3/05	28	19	2	400	1	70		SNE	four	
Lower Basin	905983	8/3/05	28	19	2	431	5	90	310	SNE	four	
Lower Basin	905983	8/3/05	28	19	2	596	4	57	70	SNE	four	
Lower Basin	905983	8/3/05	28	19	2	600	3	50	60	SNE	four	
Lower Basin	905983	8/3/05	28	19	2	618	1	105		SNE	four	
Lower Basin	905983	8/3/05	29	20	1	346	1	250		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	365	1	500		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	381	1	58		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	394	12	57	64	BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	400	1	68		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	423	1	54		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	428	1	300		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	431	1	120		BPS	three	900s

Lower Basin	905983	8/3/05	29	20	1	595	2	82	92	BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	596	7	29	85	BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	600	4	66		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	613	1	50		BPS	three	900s
Lower Basin	905983	8/3/05	29	20	1	622	3	60	65	BPS	three	900s
Lower Basin	905983	8/3/05	29	20	2	381	3	25	60	SNE	six	
Lower Basin	905983	8/3/05	29	20	2	394	14	62	75	SNE	six	
Lower Basin	905983	8/3/05	29	20	2	397	2	40	55	SNE	six	
Lower Basin	905983	8/3/05	29	20	2	400	1	50		SNE	six	
Lower Basin	905983	8/3/05	29	20	2	431	1	40		SNE	six	
Lower Basin	905983	8/3/05	29	20	2	446	1	105		SNE	six	
Lower Basin	905983	8/3/05	29	20	2	449	2	10	30	SNE	six	
Lower Basin	905983	8/3/05	29	20	2	601	2	50	61	SNE	six	
Lower Basin	905983	8/3/05	29	20	2	606	1	35		SNE	six	
Lower Basin	905983	8/3/05	29	20	2	613	7	30	42	SNE	six	
Lower Basin	905983	8/3/05	29	20	2	622	12	40	70	SNE	six	
Lower Basin	905983	8/4/05	30	21	1	340	1	64		BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	377	2	50	72	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	394	3	50	62	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	400	39	20	75	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	419	5	40	335	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	428	2	285	310	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	431	3	39	285	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	591	2	90	126	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	595	33	44	85	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	596	8	45	103	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	600	7	50	280	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	609	1	25		BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	613	20	20	48	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	618	3	50		BPS	one	900s
Lower Basin	905983	8/4/05	30	21	1	622	9	32	65	BPS	one	900s
Lower Basin	905983	8/4/05	30	21	2	377	2	35	55	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	381	8	35	43	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	384	2	30	45	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	394	12	57	60	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	397	6	35	50	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	396	2	110	120	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	400	50	20	75	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	419	70	30	65	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	431	18	50	120	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	600	5	45	90	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	601	1	40		SNE	six	
Lower Basin	905983	8/4/05	30	21	2	613	40	20	50	SNE	six	
Lower Basin	905983	8/4/05	30	21	2	618	1	55		SNE	six	
Lower Basin	905983	8/4/05	30	21	2	622	19	31	55	SNE	six	

Lower Basin	905983	8/4/05	31	22	1	384	1	30		BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	400	7	32	60	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	419	2	50	110	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	591	1	180		BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	595	27	48	95	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	596	19	55	120	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	600	12	52	260	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	601	4	48	63	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	613	12	42	48	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	1	622	6	43	55	BPS	two	900s
Lower Basin	905983	8/4/05	31	22	2	346	1	135		SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	394	5	45	70	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	397	3	45	50	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	396	2	45	60	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	400	46	30	50	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	419	6	40	61	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	545	1	55		SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	595	3	65	105	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	596	2	70	105	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	600	3	45	60	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	613	6	25	40	SNE	seven	
Lower Basin	905983	8/4/05	31	22	2	622	5	40	55	SNE	seven	
Lower Basin	905983	8/4/05	32	23	1	365	1	410		BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	444	1	186		BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	595	10	57	85	BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	596	2	73	87	BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	598	1	125		BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	600	2	50	54	BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	613	7	15	40	BPS	three	900s
Lower Basin	905983	8/4/05	32	23	1	622	5	50	61	BPS	three	900s
Lower Basin	905983	8/4/05	32	23	2	381	1	30		SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	384	1	70		SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	394	1	62		SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	396	2	50	54	SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	400	63	10	64	SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	431	4	40	82	SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	591	1	133		SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	595	1	68		SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	600	4	42	62	SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	601	3	46	110	SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	613	43	20	45	SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	618	1	44		SNE	seven	
Lower Basin	905983	8/4/05	32	23	2	622	7	40	44	SNE	seven	
Lower Basin	905983	8/16/05	33	24	1	340	1	58		BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	365	1	600		BPS	one	900s

Lower Basin	905983	8/16/05	33	24	1	381	1	30		BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	431	2	120	260	BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	449	1	90		BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	591	11	42	130	BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	595	9	33	145	BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	600	1	65		BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	601	1	49		BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	613	10	40	63	BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	622	17	46	70	BPS	one	900s
Lower Basin	905983	8/16/05	33	24	1	626	2	490	680	BPS	one	900s
Lower Basin	905983	8/16/05	33	24	2	346	1	200		SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	394	5	50	60	SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	400	91	20	30	SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	449	1	30		SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	591	12	15	40	SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	595	12	10	20	SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	600	1	60		SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	613	110	15	50	SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	617	1	60		SNE	eight	
Lower Basin	905983	8/16/05	33	24	2	622	30	25	50	SNE	eight	

Lower Basin	905983	8/16/05	34	25	1	340	2	50	68	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	384	1	28		BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	400	22	25	56	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	545	2	60	60	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	591	2	42	72	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	595	22	26	105	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	598	2	78	95	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	601	3	50	90	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	613	12	20	65	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	618	4	50	64	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	622	3	47	74	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	792	2	35	76	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	1	956	5	80	105	BPS	two	900s
Lower Basin	905983	8/16/05	34	25	2	394	4	52	85	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	397	2	40	50	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	400	80	10	80	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	419	7	50	50	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	445	6	35	55	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	449	1	75		SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	591	2	40	45	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	595	3	15	95	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	596	3	100	130	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	600	1	70		SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	601	2	55	60	SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	613	60			SNE	seven	
Lower Basin	905983	8/16/05	34	25	2	622	17	28	42	SNE	seven	

Lower Basin	905983	8/16/05	34	25	2	792	2	50	70	SNE	seven	
Lower Basin	905983	8/17/05	10	2	1	394	2	50	60	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	400	34	16	50	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	401	1	55		BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	446	1	90		BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	591	1	40		BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	595	24	20	110	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	596	1	120		BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	600	7	40	84	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	601	10	40	80	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	613	40	14	50	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	618	1	50		BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	622	14	35	70	BPS	one	900s
Lower Basin	905983	8/17/05	10	2	1	974	1	50		BPS	one	900s
Lower Basin	905983	8/17/05	10	2	2	400	58	10	58	SNE	five	
Lower Basin	905983	8/17/05	10	2	2	419	1	58		SNE	five	
Lower Basin	905983	8/17/05	10	2	2	431	1	55		SNE	five	
Lower Basin	905983	8/17/05	10	2	2	445	2	40	51	SNE	five	
Lower Basin	905983	8/17/05	10	2	2	449	2	30	31	SNE	five	
Lower Basin	905983	8/17/05	10	2	2	595	73	15	20	SNE	five	
Lower Basin	905983	8/17/05	10	2	2	596	1	110		SNE	five	
Lower Basin	905983	8/17/05	10	2	2	600	1	80		SNE	five	
Lower Basin	905983	8/17/05	10	2	2	601	1	65		SNE	five	
Lower Basin	905983	8/17/05	10	2	2	613	118	25	60	SNE	five	
Lower Basin	905983	8/17/05	10	2	2	618	1	52		SNE	five	
Lower Basin	905983	8/17/05	10	2	2	622	46	35	38	SNE	five	
Lower Basin	905983	8/17/05	10	2	2	792	1	32		SNE	five	
Lower Basin	905983	8/17/05	35	26	1	381	2	50	55	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	394	20	22	80	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	397	7	40	64	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	400	26	70	72	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	419	1	68		BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	423	7	210	300	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	431	2	135	150	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	432	3	130	131	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	445	1	60		BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	446	1	135		BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	591	8	45	170	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	595	22	28	105	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	600	2	80	100	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	601	1	55		BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	606	20	50	72	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	607	1	60		BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	613	76	18	56	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	618	11	65	110	BPS	two	900s

Lower Basin	905983	8/17/05	35	26	1	622	40	68	70	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	626	1	155		BPS	two	900s
Lower Basin	905983	8/17/05	35	26	1	792	4	52	86	BPS	two	900s
Lower Basin	905983	8/17/05	35	26	2	381	24	34	55	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	384	57	35	108	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	394	32	20	75	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	397	22	24	60	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	400	37	28	70	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	401	1	45		SNE	five	
Lower Basin	905983	8/17/05	35	26	2	419	1	75		SNE	five	
Lower Basin	905983	8/17/05	35	26	2	423	1	260		SNE	five	
Lower Basin	905983	8/17/05	35	26	2	445	1	57		SNE	five	
Lower Basin	905983	8/17/05	35	26	2	591	3	110	155	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	595	12	25	30	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	600	5	70	117	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	601	1	70		SNE	five	
Lower Basin	905983	8/17/05	35	26	2	613	14	32	50	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	622	7	34	50	SNE	five	
Lower Basin	905983	8/17/05	35	26	2	792	1	88		SNE	five	
Lower Basin	905983	8/17/05	36	27	1	397	1	54		BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	400	7	40	74	BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	444	1	54		BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	446	1	111		BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	591	11	48	185	BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	595	15	60	132	BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	600	11	76	101	BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	601	1	70		BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	606	1	43		BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	618	16	60	68	BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	622	8	51		BPS	three	900s
Lower Basin	905983	8/17/05	36	27	1	792	2	90	101	BPS	three	900s
Lower Basin	905983	8/17/05	36	27	2	381	5	45	52	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	384	23	40	120	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	394	25	38	60	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	397	4	42	60	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	400	26	25	80	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	401	1	55		SNE	five	
Lower Basin	905983	8/17/05	36	27	2	419	1	80		SNE	five	
Lower Basin	905983	8/17/05	36	27	2	445	1	45		SNE	five	
Lower Basin	905983	8/17/05	36	27	2	595	4	25	103	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	600	5	70	103	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	606	1	45		SNE	five	
Lower Basin	905983	8/17/05	36	27	2	613	7	48	52	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	618	7	70	105	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	622	4	50	61	SNE	five	
Lower Basin	905983	8/17/05	36	27	2	792	3	60	102	SNE	five	

Lower Basin	805945	8/18/05	37	2	1	375	36	*50	*200	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	376	74	40	205	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	384	1	113		BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	393	10	64	75	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	397	8	52	60	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	400	7	51	80	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	423	3	82	165	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	444	1	200		BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	446	12	65	165	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	591	22	150	230	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	595	2	85	92	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	600	5	60	205	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	606	31	50	84	BPS	900s	
Lower Basin	805945	8/18/05	37	2	1	607	9	50	55	BPS	900s	
Lower Basin	805945	8/18/05	37	2	2	375	11	*50	*100	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	376	23	50	82	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	384	6	40	65	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	393	38	35	75	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	397	32	52	60	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	400	9	55	60	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	423	5	78	90	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	446	2	170	170	SNE	seven	
Lower Basin	805945	8/18/05	37	2	2	600	2	60	60	SNE	seven	
Lower Basin	805945	9/9/06	38	3	1	360	1	70		BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	365	3	350	630	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	375	1	70		BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	384	10	50	118	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	393	15	63	72	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	397	7	50	55	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	400	26	25	80	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	419	3	105	130	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	423	9	66	320	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	431	1	290		BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	446	3	55	156	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	591	18	48	180	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	595	1	35		BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	596	2	92	106	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	600	9	80	110	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	606	12	51	75	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	607	9	36	55	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	613	12	42	67	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	1	622	16	50	75	BPS	one	900s
Lower Basin	805945	9/9/06	38	3	2	347	2	560	680	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	375	2	58	60	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	376	3	44	170	SNE	seven	

Lower Basin	805945	9/9/06	38	3	2	384	74	46	125	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	393	73	15	82	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	394	1	66		SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	397	95	21	68	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	400	31	25	78	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	401	2	65	74	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	419	2	92	118	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	423	4	80	160	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	446	1	200		SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	591	2	112	130	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	595	1	35		SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	600	2	61	74	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	606	4	48	60	SNE	seven	
Lower Basin	805945	9/9/06	38	3	2	613	23	18	62	SNE	seven	
Lower Basin	805945	9/9/06	39	4	1	360	2	82	108	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	375	7	55	120	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	376	1	52		BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	384	18	52	140	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	393	20	50	73	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	397	23	50	56	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	400	45	45	80	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	419	3	88	110	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	423	19	70	260	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	446	2	75	150	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	591	22	27	185	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	595	4	84	133	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	600	7	75	410	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	606	36	52	80	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	607	21	40	60	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	613	56	42	65	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	1	622	15	31	76	BPS	two	900s
Lower Basin	805945	9/9/06	39	4	2	347	1	700		SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	375	1	85		SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	384	11	52	75	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	393	57	29	70	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	394	4	30	66	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	397	22	50	62	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	400	29	42	82	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	401	1	62		SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	419	9	80	120	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	423	4	80	320	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	431	1	133		SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	600	4	71	300	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	613	8	39	62	SNE	seven	
Lower Basin	805945	9/9/06	39	4	2	622	4	55	85	SNE	seven	

Lower Basin	805945	9/10/05	40	5	1	365	3	500	600	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	384	5	102	123	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	393	106	30	66	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	394	1	94		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	397	1	62		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	400	2	60	80	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	419	2	86	98	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	423	5	95	145	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	431	11	170	420	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	444	1	203		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	591	1	94		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	595	1	94		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	596	3	103	124	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	600	4	60	113	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	606	8	50	77	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	607	8	39	56	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	613	16	41	68	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	618	1	68		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	622	16	67	85	BPS	one	900s
Lower Basin	805945	9/10/05	40	5	1	626	1	425		BPS	one	900s
Lower Basin	805945	9/10/05	40	5	2	384	23	35	112	SNE	six	
Lower Basin	805945	9/10/05	40	5	2	393	78	36	70	SNE	six	
Lower Basin	805945	9/10/05	40	5	2	394	18	38	75	SNE	six	
Lower Basin	805945	9/10/05	40	5	2	397	3	55	63	SNE	six	
Lower Basin	805945	9/10/05	40	5	2	400	4	80	88	SNE	six	
Lower Basin	805945	9/10/05	40	5	2	419	1	100		SNE	six	
Lower Basin	805945	9/10/05	40	5	2	423	1	90		SNE	six	
Lower Basin	805945	9/10/05	40	5	2	591	1	32		SNE	six	
Lower Basin	805945	9/10/05	40	5	2	600	4	60	80	SNE	six	
Lower Basin	805945	9/10/05	40	5	2	613	18	34	45	SNE	six	
Lower Basin	805945	9/10/05	41	6	1	365	6	500	610	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	384	6	55	89	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	393	13	61	76	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	397	2	57	68	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	400	4	49	73	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	419	7	85	103	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	423	5	74	80	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	431	1	315		BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	444	1	250		BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	446	1	196		BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	591	30	45	175	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	595	6	86	128	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	600	15	88	100	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	606	9	35	87	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	607	8	43	55	BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	613	41	42	65	BPS	two	900s

Lower Basin	805945	9/10/05	41	6	1	618	1	131			BPS	two	900s
Lower Basin	805945	9/10/05	41	6	1	622	44	60	83		BPS	two	900s
Lower Basin	805945	9/10/05	41	6	2	384	3	32	87		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	393	50	41	65		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	394	2	49	87		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	397	1	50			SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	419	12	82	406		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	423	4	100	110		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	431	1	191			SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	531	1	42			SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	591	13	32	40		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	595	1	140			SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	596	2	110	110		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	600	6	80	85		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	606	3	48	53		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	613	16	47	67		SNE	seven	
Lower Basin	805945	9/10/05	41	6	2	622	1	64			SNE	seven	
Middle Basin	805945	7/27/05	42	7	1	360	5	45	155		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	365	2	500	500	O	BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	375	3	80	98		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	384	1	70	88		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	400	2	65	75		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	401	1000	44	67		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	419	100	40	155		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	591	22	50	155		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	595	32	67	112		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	596	6	76	145		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	598	2	110	175		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	600	7	32	75		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	601	2	50	85		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	613	300	28	52		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	1	618	7	105	130		BPS	one	900s
Middle Basin	805945	7/27/05	42	7	2	384	4	27	100		SNE	four	
Middle Basin	805945	7/27/05	42	7	2	400	4	41	55		SNE	four	
Middle Basin	805945	7/27/05	42	7	2	401	4	45	100		SNE	four	
Middle Basin	805945	7/27/05	42	7	2	419	50	35	60		SNE	four	
Middle Basin	805945	7/27/05	42	7	2	600	12	35	60		SNE	four	
Middle Basin	805945	7/27/05	42	7	2	613	1	45			SNE	four	
Middle Basin	805945	7/27/05	43	8	1	347	1	160			BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	360	3	48	50		BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	384	17	70	115		BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	400	300	25	75		BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	401	55	50	60		BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	419	13	55	260		BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	423	8	135	180		BPS	two	900s

Middle Basin	805945	7/27/05	43	8	1	591	6	80	95	BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	595	12	55	137	BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	596	1	112		BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	600	14	25	55	BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	613	40	30	60	BPS	two	900s
Middle Basin	805945	7/27/05	43	8	1	618	22	60	120	BPS	two	900s
Middle Basin	805945	7/27/05	43	8	2	375	2	80	85	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	377	3	40	78	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	384	100	48	96	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	397	1	52		SNE	four	
Middle Basin	805945	7/27/05	43	8	2	400	10	70	74	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	401	1000	46	72	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	406	2	75	115	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	419	10	52	34	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	423	1	88		SNE	four	
Middle Basin	805945	7/27/05	43	8	2	591	4	30	38	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	600	12	36	160	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	601	1	58		SNE	four	
Middle Basin	805945	7/27/05	43	8	2	613	2	54	55	SNE	four	
Middle Basin	805945	7/27/05	43	8	2	618	1	60		SNE	four	
Middle Basin	805945	8/5/05	44	9	1	347	2	215	700	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	375	900	80	168	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	376	100	*50	*200	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	400	125	20	30	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	423	24	225	332	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	591	400	119	202	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	595	1	85		BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	601	300	75	268	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	1	613	28	32	59	BPS	one	900s
Middle Basin	805945	8/5/05	44	9	2	375	50	80	158	SNE	six	
Middle Basin	805945	8/5/05	44	9	2	384	26	40	50	SNE	six	
Middle Basin	805945	8/5/05	44	9	2	400	22	18	68	SNE	six	
Middle Basin	805945	8/5/05	44	9	2	419	1	400		SNE	six	
Middle Basin	805945	8/5/05	44	9	2	423	1	60		SNE	six	
Middle Basin	805945	8/5/05	44	9	2	591	9	12	120	SNE	six	
Middle Basin	805945	8/5/05	44	9	2	600	5	78	82	SNE	six	
Middle Basin	805945	8/5/05	44	9	2	613	7	38	47	SNE	six	
Middle Basin	805945	8/5/05	44	9	2	618	2	58	60	SNE	six	
Middle Basin	805945	8/22/05	45	14	1	347	1	200		BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	360	1	40		BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	384	5	20	35	BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	400	2	20	45	BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	419	1	275		BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	591	10	35	175	BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	596	44	15	160	BPS	one	900s

Middle Basin	805945	8/22/05	45	14	1	598	3	152	177	BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	600	2	53	85	BPS	one	900s
Middle Basin	805945	8/22/05	45	14	1	613	11	40	55	BPS	one	900s
Middle Basin	805945	8/22/05	45	14	2	347	1	160		SNE	six	
Middle Basin	805945	8/22/05	45	14	2	375	14	43	45	SNE	six	
Middle Basin	805945	8/22/05	45	14	2	385	80	36	46	SNE	six	
Middle Basin	805945	8/22/05	45	14	2	400	25	25	52	SNE	six	
Middle Basin	805945	8/22/05	45	14	2	591	19	25	158	SNE	six	
Middle Basin	805945	8/22/05	45	14	2	595	3	35	81	SNE	six	
Middle Basin	805945	8/22/05	45	14	2	596	103	30	110	SNE	six	
Middle Basin	805945	8/22/05	45	14	2	613	12	40	56	SNE	six	
Middle Basin	805945	8/22/05	46	15	1	340	1	80		BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	375	2	25	45	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	384	75	20	30	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	400	2	30	75	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	423	1	57		BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	591	2	25	170	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	595	6	60	85	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	596	2	60	68	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	1	613	17	35	55	BPS	two	900s
Middle Basin	805945	8/22/05	46	15	2	360	1	46		SNE	six	
Middle Basin	805945	8/22/05	46	15	2	407	11	42	52	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	375	51	36	40	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	384	41	30	48	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	400	67	11	72	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	401	2	35	38	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	419	10	40	46	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	423	1	55		SNE	six	
Middle Basin	805945	8/22/05	46	15	2	613	93	35	45	SNE	six	
Middle Basin	805945	8/22/05	46	15	2	618	2	55	60	SNE	six	
Middle Basin	805945	8/23/05	47	10	1	376	135	62	230	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	1	400	5	43	50	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	1	419	4	70	85	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	1	591	14	65	70	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	1	596	2	115	120	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	1	600	35	60	210	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	1	613	20	40	50	BPS	one	900s
Middle Basin	805945	8/23/05	47	10	2	376	40	20	160	SNE	four	
Middle Basin	805945	8/23/05	47	10	2	384	27	40	60	SNE	four	
Middle Basin	805945	8/23/05	47	10	2	400	1	48		SNE	four	
Middle Basin	805945	8/23/05	47	10	2	591	1	39		SNE	four	
Middle Basin	805945	8/23/05	47	10	2	596	2	24	27	SNE	four	
Middle Basin	805945	8/23/05	47	10	2	600	1	70		SNE	four	
Middle Basin	805945	8/23/05	47	10	2	618	1	58		SNE	four	

Middle Basin	805945	8/23/05	48	11	1	347	1	200		BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	365	15	55	700	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	375	41	50	50	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	400	37	10	75	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	419	8	120	200	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	423	53	65	200	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	591	8	96	140	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	596	7	30	126	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	600	11	85	180	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	613	60	26	37	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	1	618	6	125	140	BPS	two	900s
Middle Basin	805945	8/23/05	48	11	2	360	1	59		SNE	six	
Middle Basin	805945	8/23/05	48	11	2	365	2	620	620	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	375	61	15	60	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	384	5	45	55	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	400	40	30	62	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	423	3	60	180	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	591	4	30	50	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	596	5	30	115	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	600	1	80		SNE	six	
Middle Basin	805945	8/23/05	48	11	2	601	3	300	355	SNE	six	
Middle Basin	805945	8/23/05	48	11	2	613	32	30	45	SNE	six	

Middle Basin	805945	8/25/05	49	12	1	347	1	640		BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	365	70	460	700	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	375	1	42		BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	384	200	35	55	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	400	50	32	40	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	419	4	67	460	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	423	3	300	340	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	591	42	52	195	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	595	5	41	80	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	596	36	35	110	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	601	25	100	310	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	613	40	25	55	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	1	618	51	85	135	BPS	one	900s
Middle Basin	805945	8/25/05	49	12	2	375	1	44		SNE	seven	
Middle Basin	805945	8/25/05	49	12	2	377	1	82		SNE	seven	
Middle Basin	805945	8/25/05	49	12	2	384	175	20	73	SNE	seven	
Middle Basin	805945	8/25/05	49	12	2	400	225	16	66	SNE	seven	
Middle Basin	805945	8/25/05	49	12	2	596	1	30		SNE	seven	
Middle Basin	805945	8/25/05	49	12	2	613	20	40	45	SNE	seven	
Middle Basin	805945	8/25/05	49	12	2	618	17	72	110	SNE	seven	

Middle Basin	805945	8/25/05	50	13	1	347	3	450	700	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	365	1	80		BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	375	2	50	55	BPS	two	900s

Middle Basin	805945	8/25/05	50	13	1	376	9	95	140	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	384	200	50	60	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	400	140	10	80	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	419	4	65	300	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	423	60	70	210	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	591	12	40	160	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	596	1	30		BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	600	14	80	250	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	613	42	24	60	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	1	618	43	75	155	BPS	two	900s
Middle Basin	805945	8/25/05	50	13	2	376	3	120	140	SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	384	225	45	63	SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	400	18	13	70	SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	419	1	240		SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	423	90	65	300	SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	596	7	37	45	SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	600	2	80	100	SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	613	1	50		SNE	eight	
Middle Basin	805945	8/25/05	50	13	2	618	8	75	140	SNE	eight	

Upper Basin	805945	9/2/05	51	16	1	360	6	52	55	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	375	4	46	54	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	384	3	53	120	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	397	2	42	65	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	400	11	42	72	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	401	2	50	52	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	404	1	46		BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	403	4	37	53	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	406	2	50	95	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	407	11	63	123	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	419	2	60	61	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	423	37	65	300	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	591	11	31	181	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	595	2	46	50	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	600	7	55	250	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	609	10	35	40	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	1	613	52	40	60	BPS	one	900s
Upper Basin	805945	9/2/05	51	16	2	360	1	48		SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	375	2	49	90	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	384	50	20	130	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	397	15	44	50	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	400	19	20	75	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	401	1	53		SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	403	1	45		SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	407	32	55	61	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	419	8	71	300	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	423	5	58	120	SNE	eight	

Upper Basin	805945	9/2/05	51	16	2	591	1	35		SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	600	8	58	65	SNE	eight	
Upper Basin	805945	9/2/05	51	16	2	613	9	45	50	SNE	eight	
Upper Basin	805945	9/1/05	52	28	1	328	10	64	365	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	362	6	45	90	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	384	1	68		BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	397	2	58	64	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	401	1	65		BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	404	79	35	56	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	403	40	45	77	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	406	10	41	115	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	419	8	56	190	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	423	27	35	56	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	601	7	75	105	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	609	19	38	66	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	1	865	45	27	84	BPS	one	900s
Upper Basin	805945	9/1/05	52	28	2	362	4	43	50	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	384	9	35	120	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	386	7	*40	*70	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	397	19	33	67	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	400	1	80		SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	404	39	32	67	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	403	2	42	75	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	406	5	48	76	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	419	34	32	160	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	423	4	62	67	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	601	1	104		SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	609	4	30	50	SNE	seven	
Upper Basin	805945	9/1/05	52	28	2	865	6	32	75	SNE	seven	
Upper Basin	905983	9/17/05	53	29	1	360	42	60	104	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	407	1	57		BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	384	6	32	122	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	400	21	62	85	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	404	6	44	65	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	403	7	40	60	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	406	8	60	175	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	419	5	200	320	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	423	17	43	320	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	591	3	36	44	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	595	4	32	38	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	600	3	82	95	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	609	42	44	64	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	1	613	15	42	55	BPS	two	900s
Upper Basin	905983	9/17/05	53	29	2	360	2	55	58	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	384	16	45	430	SNE	five	

Upper Basin	905983	9/17/05	53	29	2	400	9	38	63	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	404	2	40	43	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	403	1	43		SNE	five	
Upper Basin	905983	9/17/05	53	29	2	406	3	52	160	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	419	1	86		SNE	five	
Upper Basin	905983	9/17/05	53	29	2	423	3	100	180	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	591	5	30	40	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	600	8	60	88	SNE	five	
Upper Basin	905983	9/17/05	53	29	2	609	1	42		SNE	five	
Upper Basin	905983	9/17/05	53	29	2	613	1	50		SNE	five	

Upper Basin	805945	9/18/05	54	17	1	360	57	50	70	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	407	7	55	69	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	384	2	70	74	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	400	6	22	58	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	401	1	60		BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	404	1	42		BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	403	7	45	70	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	406	8	53	130	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	419	7	85	121	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	423	9	85	280	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	591	4	32	47	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	600	5	55	114	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	609	12	38	57	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	1	613	19	47	65	BPS	one	900s
Upper Basin	805945	9/18/05	54	17	2	360	13	40	79	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	407	110	60	73	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	384	35	48	123	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	397	7	49	72	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	401	2	56	61	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	404	1	46		SNE	six	
Upper Basin	805945	9/18/05	54	17	2	403	5	48	53	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	406	24	42	108	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	419	3	76	300	SNE	six	
Upper Basin	805945	9/18/05	54	17	2	600	1	54		SNE	six	
Upper Basin	805945	9/18/05	54	17	2	609	1	50		SNE	six	

Upper Basin	905983	9/18/05	55	30	1	328	1	220		BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	360	6	55	100	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	407	3	54	63	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	384	5	40	74	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	397	17	58	60	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	400	72	35	84	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	401	3	56	65	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	404	16	32	70	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	403	2	36	70	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	406	1	65		BPS	two	900s

Upper Basin	905983	9/18/05	55	30	1	419	5	81	300	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	423	4	70	180	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	444	2	60	84	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	595	8	60	64	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	596	1	110		BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	600	12	65	98	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	601	2	58	122	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	609	7	30	61	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	613	5	48	64	BPS	two	900s
Upper Basin	905983	9/18/05	55	30	1	865	1	85		BPS	two	900s
Upper Basin	905983	9/18/05	55	30	2	360	4	60	64	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	384	3	58	105	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	386	16	*40	*70	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	397	134	35	68	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	400	10	41	70	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	401	1	57		SNE	five	
Upper Basin	905983	9/18/05	55	30	2	403	1	67		SNE	five	
Upper Basin	905983	9/18/05	55	30	2	404	28	50	72	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	406	1	63		SNE	five	
Upper Basin	905983	9/18/05	55	30	2	407	4	45	55	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	419	3	133	188	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	423	3	115	132	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	600	14	62	80	SNE	five	
Upper Basin	905983	9/18/05	55	30	2	613	9	33	58	SNE	five	

Tributary 77	905989	9/22/05	56	1	1	328	24	72	378	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	360	1	115		BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	362	1	56		BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	384	16	81	125	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	404	1100	32	75	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	403	24	42	90	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	406	27	50	180	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	419	59	65	300	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	423	22	60	245	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	598	2	110	115	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	600	1	91		BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	609	29	40	68	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	1	865	25	31	98	BPS	one	900s
Tributary 77	905989	9/22/05	56	1	2	328	1	60		SNE	four	
Tributary 77	905989	9/22/05	56	1	2	362	4	56	100	SNE	four	
Tributary 77	905989	9/22/05	56	1	2	384	27	42	109	SNE	four	
Tributary 77	905989	9/22/05	56	1	2	397	3	32	68	SNE	four	
Tributary 77	905989	9/22/05	56	1	2	404	61	30	78	SNE	four	
Tributary 77	905989	9/22/05	56	1	2	406	16	48	90	SNE	four	
Tributary 77	905989	9/22/05	56	1	2	419	4	60	62	SNE	four	
Tributary 77	905989	9/22/05	56	1	2	423	1	65		SNE	four	
Tributary 77	905989	9/22/05	56	1	2	601	1	82		SNE	four	

Upper Basin	905983	9/23/05	57	31	1	360	95	55	105	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	407	1	68		BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	384	8	62	130	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	400	3	60	70	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	404	12	65	70	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	406	10	58	188	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	419	16	70	370	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	423	37	72	330	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	591	4	40	71	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	600	14	62	100	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	601	3	90	133	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	609	15	44	66	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	1	613	47	38	60	BPS	one	900s
Upper Basin	905983	9/23/05	57	31	2	360	15	52	70	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	407	1	61		SNE	five	
Upper Basin	905983	9/23/05	57	31	2	384	11	72	131	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	397	29	48	70	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	400	3	56	80	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	401	1	60		SNE	five	
Upper Basin	905983	9/23/05	57	31	2	404	1	69		SNE	five	
Upper Basin	905983	9/23/05	57	31	2	406	4	58	107	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	419	3	68	195	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	423	19	70	110	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	591	1	149		SNE	five	
Upper Basin	905983	9/23/05	57	31	2	600	13	61	95	SNE	five	
Upper Basin	905983	9/23/05	57	31	2	613	21	40	64	SNE	five	
Upper Basin	805945	9/23/05	58	18	1	360	5	50	58	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	407	11	36	60	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	375	5	42	68	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	384	11	28	73	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	400	8	33	54	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	401	1	61		BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	403	1	45		BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	406	3	42	46	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	423	9	56	153	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	591	2	38	38	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	600	1	74		BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	609	1	54		BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	613	19	38	64	BPS	two	900s
Upper Basin	805945	9/23/05	58	18	1	618	1	105		BPS	two	900s
Upper Basin	805945	9/23/05	58	18	2	360	2	60	65	SNE	four	
Upper Basin	805945	9/23/05	58	18	2	407	8	45	60	SNE	four	
Upper Basin	805945	9/23/05	58	18	2	375	3	40	108	SNE	four	
Upper Basin	805945	9/23/05	58	18	2	384	35	41	132	SNE	four	
Upper Basin	805945	9/23/05	58	18	2	400	1	30		SNE	four	

Upper Basin	805945	9/23/05	58	18	2	406	1	120		SNE	four	
Upper Basin	805945	9/23/05	58	18	2	419	1	152		SNE	four	
Upper Basin	805945	9/23/05	58	18	2	423	3	45	112	SNE	four	
Upper Basin	805945	9/23/05	58	18	2	591	1	32		SNE	four	
Upper Basin	805945	9/23/05	58	18	2	613	2	35	58	SNE	four	
Ellicott Creek	905984	6/2/05	59	1	1	365	12	400	650	EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	381	12	60	82	EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	428	2	380	390	EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	431	1	310		EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	432	1	240		EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	433	3	350	385	EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	591	1	160		EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	596	1	142		EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	600	4	224	411	EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	601	5	280	300	EFB	4th	900s
Ellicott Creek	905984	6/2/05	59	1	1	617	3	147	180	EFB	4th	900s
Ellicott Creek	905984	7/7/05	60	2	1	361	2	180	270	EFB	three	900s
Ellicott Creek	905984	7/7/05	60	2	1	365	23	360	455	EFB	three	900s
Ellicott Creek	905984	7/7/05	60	2	1	405	3	200	304.8	EFB	three	900s
Ellicott Creek	905984	7/7/05	60	2	1	419	1	305		EFB	three	900s
Ellicott Creek	905984	7/7/05	60	2	1	595	1	45		EFB	three	900s
Ellicott Creek	905984	7/7/05	60	2	1	596	1	75		EFB	three	900s
Ellicott Creek	905984	7/7/05	60	2	1	601	3	254	280	EFB	three	900s
Ellicott Creek	905984	7/7/05	61	3	1	361	2	63	65	EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	365	14	430	550	EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	377	1	113		EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	400	1	63		EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	401	1	64		EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	596	2	80	100	EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	598	5	75	112	EFB	four	900s
Ellicott Creek	905984	7/7/05	61	3	1	601	2	300	340	EFB	four	900s
Bull Creek	905985	6/2/05	62	1	1	294	1	153		EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	335	1	144		EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	347	1	520		EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	365	1	12		EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	377	12	62	205	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	381	78	62	86	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	394	3	70	80	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	400	4	50	90	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	405	2	300	310	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	431	1	355		EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	433	1	598		EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	591	4	145	205	EFB	5th	900s

Bull Creek	905985	6/2/05	62	1	1	596	8	100	170	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	598	3	43	170	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	600	3	350	365	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	601	13	220	400	EFB	5th	900s
Bull Creek	905985	6/2/05	62	1	1	603	2	210	237	EFB	5th	900s
Bull Creek	905985	7/8/05	63	2	1	365	5	430	570	EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	377	12	85	145	EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	419	1	230		EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	431	1	370		EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	444	2	255	275	EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	591	1	205		EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	596	11	80	120	EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	598	7	68	140	EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	601	3	265	320	EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	603	1	125		EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	613	1	50		EFB	one	900s
Bull Creek	905985	7/8/05	63	2	1	365	1	432		EFB	one	900s
Ransom Creek	905986	7/8/05	64	1	1	347	2	300	335	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	365	8	400	500	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	431	4	340	350	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	591	2	120	130	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	595	1	76		EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	596	10	65	135	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	598	8	45	170	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	601	3	40	350	EFB	three	900s
Ransom Creek	905986	7/8/05	64	1	1	617	1	170		EFB	three	900s
Murder Creek	905987	8/18/05	65	1	1	347	1	630		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	401	1	55		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	433	1	430		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	444	3	156	210	BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	595	16	66		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	596	5	67	110	BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	598	1	165		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	613	2	22	55	BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	617	1	126		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	1	622	3	74		BPS	one	900s
Murder Creek	905987	8/18/05	65	1	2	346	1	180		SNE	six	
Murder Creek	905987	8/18/05	65	1	2	360	1	50		SNE	six	
Murder Creek	905987	8/18/05	65	1	2	384	10	51	80	SNE	six	
Murder Creek	905987	8/18/05	65	1	2	394	2	60	85	SNE	six	
Murder Creek	905987	8/18/05	65	1	2	400	14	15	60	SNE	six	
Murder Creek	905987	8/18/05	65	1	2	401	5	52	60	SNE	six	
Murder Creek	905987	8/18/05	65	1	2	419	65	35	75	SNE	six	
Murder Creek	905987	8/18/05	65	1	2	591	2	25	30	SNE	six	

Murder Creek	905987	8/18/05	65	1	2	613	90	29	50	SNE	six	
Murder Creek	905987	8/18/05	65	1	2	622	39	45	70	SNE	six	
Murder Creek	905987	8/18/05	66	2	1	347	1	420		BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	360	2	98	100	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	400	5	62	65	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	401	2	57	63	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	406	36	100	180	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	419	27	112	280	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	446	1	128		BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	591	62	102	210	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	595	15	75	128	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	606	1	74		BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	607	37	35	70	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	613	52	40	62	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	1	622	2	40	70	BPS	two	900s
Murder Creek	905987	8/18/05	66	2	2	360	9	50	130	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	377	1	90		SNE	six	
Murder Creek	905987	8/18/05	66	2	2	384	12	70	190	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	394	10	60	87	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	400	14	50	82	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	401	10	65	75	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	404	3	70	85	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	406	22	51	195	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	419	32	45	250	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	423	3	125	170	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	591	2	60	210	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	606	5	50	72	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	607	10	38	68	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	613	29	40	65	SNE	six	
Murder Creek	905987	8/18/05	66	2	2	622	11	50	78	SNE	six	
L Tonawanda Ck	805946	9/14/05	67	1	1	347	1	178		BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	360	2	36	40	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	375	8	45	55	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	384	13	25	90	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	400	12	15	57	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	406	4	42	45	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	419	10	45	120	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	423	7	96	160	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	591	2	41	118	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	595	5	62	70	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	596	15	72	160	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	598	1	85		BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	601	6	72	130	BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	609	1	45		BPS	one	900s
L Tonawanda Ck	805946	9/14/05	67	1	1	613	34	25	58	BPS	one	900s

L Tonawanda Ck	805946	9/14/05	67	1	2	360	1	45		SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	375	3	45	64	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	377	4	62	90	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	384	175	25	115	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	400	29	15	25	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	407	1	310		SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	419	6	40	200	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	423	2	100	120	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	591	3	145	165	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	596	6	78	110	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	598	2	70	70	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	601	4	110	140	SNE	four	
L Tonawanda Ck	805946	9/14/05	67	1	2	613	14	30	60	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	1	360	15	40	90	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	384	9	37	80	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	400	42	20	80	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	404	13	28	65	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	406	22	36	158	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	419	1	310		BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	423	18	48	116	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	591	9	30	118	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	595	1	72		BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	596	1	128		BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	609	34	45	53	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	1	613	13	36	55	BPS	one	900s
L Tonawanda Ck	805946	9/17/05	68	2	2	347	1	600		SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	360	4	68	75	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	384	22	52	90	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	397	2	65	70	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	400	17	45	75	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	404	1	61		SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	406	6	40	100	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	423	9	50	145	SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	591	1	35		SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	601	1	60		SNE	four	
L Tonawanda Ck	805946	9/17/05	68	2	2	613	3	48	62	SNE	four	

[1]The watershed was divided into subunits as shown in Table 2.

[2]Each sampling site was re-numbered (SN) to correspond with a DEC fisheries database survey including notes: Rep—repetitions of effort per site, Sp—species (DEC codes, see Table 5a), Catch (C) data also includes visual observations (O) when noted. L—total fish length (Min—minimum/Max—maximum) in mm, sometimes estimated*.

[3]Gear includes EFB—electrofishing boat, BPS—backpack shocker, SNE—beach seine; and Run—effort in # of shocking passes or seine hauls.

Appendix I-G. Fish data minus hybrids and unknowns from the Johnson Creek watershed, May-September 2005. See Table 6 for fish codes.

[1]**Johnson Creek watershed**

Location	Survey#	Date	Site	SN	Rep	Sp	Catch	L min	L max	C/O	Gear	Run	Time
Lower Basin	805943	5/17/05	1	1	1	381	3	30	85		BPS	one	900s
Lower Basin	805943	5/17/05	1	1	1	591	3	62	75		BPS	one	900s
Lower Basin	805943	5/17/05	1	1	1	595	4	44	111		BPS	one	900s
Lower Basin	805943	5/17/05	1	1	1	617	1	76			BPS	one	900s
Lower Basin	805943	5/17/05	1	1	1	622	2	47	56		BPS	one	900s
Lower Basin	805943	5/17/05	1	1	2	377	1	60			BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	381	4	70	80		BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	400	1	66			BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	406	1	135			BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	591	20	64	200		BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	595	20	42	132		BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	596	2	50	75		BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	617	2	78	80		BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	618	1	126			BPS	two	900s
Lower Basin	805943	5/17/05	1	1	2	792	2	96	100		BPS	two	900s
Lower Basin	805943	5/18/05	1	1	3	377	1	68			SNE	three	
Lower Basin	805943	5/18/05	1	1	3	381	108	48	80		SNE	three	
Lower Basin	805943	5/18/05	1	1	3	613	1	40			SNE	three	
Lower Basin	805943	5/18/05	1	1	3	792	1	70			SNE	three	
Lower Basin	805943	5/18/05	2	2	1	400	2	90	91		BPS	one	900s
Lower Basin	805943	5/18/05	2	2	1	591	14	59	147		BPS	one	900s
Lower Basin	805943	5/18/05	2	2	1	595	1	42			BPS	one	900s
Lower Basin	805943	5/18/05	2	2	1	613	1	58			BPS	one	900s
Lower Basin	805943	5/18/05	2	2	1	618	2	117	128		BPS	one	900s
Lower Basin	805943	5/18/05	2	2	1	792	3	60	66		BPS	one	900s
Lower Basin	805943	5/18/05	2	2	2	400	7	52	97		BPS	two	900s
Lower Basin	805943	5/18/05	2	2	2	443	1	142			BPS	two	900s
Lower Basin	805943	5/18/05	2	2	2	591	13	68	182		BPS	two	900s
Lower Basin	805943	5/18/05	2	2	2	595	3	72	82		BPS	two	900s
Lower Basin	805943	5/18/05	2	2	2	613	2	40	55		BPS	two	900s
Lower Basin	805943	5/18/05	2	2	2	792	1	87			BPS	two	900s
Lower Basin	805943	5/18/05	2	2	3	377	1	68			SNE	four	
Lower Basin	805943	5/18/05	2	2	3	381	106	48	80		SNE	four	
Lower Basin	805943	5/18/05	2	2	3	613	1	40			SNE	four	
Lower Basin	805943	5/18/05	2	2	3	792	1	70			SNE	four	
Lower Basin	805943	6/3/05	3	3	1	326	1	30			BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	346	1	65			BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	365	2	500	600	O	BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	400	12	40	65		BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	446	5	106	190		BPS	one	900s

Lower Basin	805943	6/3/05	3	3	1	591	15	82	290		BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	595	3	85	96		BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	596	3	40	75		BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	600	1	380			BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	606	9	70	85		BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	613	1	55			BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	618	1	92			BPS	one	900s
Lower Basin	805943	6/3/05	3	3	1	622	2	80	100		BPS	one	900s

Lower Basin	805943	6/3/05	4	4	1	365	12	500	800	O	BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	377	2	100	135		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	400	3	20	132		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	419	3	160	336		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	444	2	355	355		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	446	1	156			BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	591	3	80	205		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	595	1	120			BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	596	5	60	125		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	598	1	140			BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	606	4	60	75		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	613	1	65			BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	617	8	76	126		BPS	two	900s
Lower Basin	805943	6/3/05	4	4	1	618	1	88			BPS	two	900s
Lower Basin	805943	6/3/05	4	4	2	381	1	80			SNE	four	
Lower Basin	805943	6/3/05	4	4	2	396	11	45	62		SNE	four	
Lower Basin	805943	6/3/05	4	4	2	400	75	40	65		SNE	four	
Lower Basin	805943	6/3/05	4	4	2	401	11	46	60		SNE	four	
Lower Basin	805943	6/3/05	4	4	2	406	1	60			SNE	four	
Lower Basin	805943	6/3/05	4	4	2	419	2	80	85		SNE	four	
Lower Basin	805943	6/3/05	4	4	2	431	1	120			SNE	four	
Lower Basin	805943	6/3/05	4	4	2	444	1	325			SNE	four	
Lower Basin	805943	6/3/05	4	4	2	591	1	175			SNE	four	
Lower Basin	805943	6/3/05	4	4	2	596	7	85	125		SNE	four	
Lower Basin	805943	6/3/05	4	4	2	606	1	70			SNE	four	
Lower Basin	805943	6/3/05	4	4	2	617	40	80	135		SNE	four	

Lower Basin	805943	6/15/05	5	5	1	268	3	490	700	O	EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	365	17	620	660		EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	384	1	70			EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	394	4	50	70		EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	397	5	53	64		EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	400	14	50	72		EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	431	1	148			EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	596	1	135			EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	601	1	110			EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	613	5	50	60		EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	617	3	76	78		EFB	one	900s

Lower Basin	805943	6/15/05	5	5	1	618	1	120			EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	622	1	61			EFB	one	900s
Lower Basin	805943	6/15/05	5	5	1	700	3	480	510		EFB	one	900s
Lower Basin	805943	6/15/05	6	6	1	365	6	520	650		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	381	5	60	66		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	397	3	60	70		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	400	4	66	76		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	419	1	423			EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	591	4	110	225		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	596	2	62	100		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	600	2	145	265		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	613	1	55			EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	617	4	115	170		EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	622	1	84			EFB	two	900s
Lower Basin	805943	6/15/05	6	6	1	700	1	588			EFB	two	900s
Lower Basin	805943	6/15/05	7	7	1	271	3	560	581		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	365	3	400	610		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	397	6	55	65		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	400	4	55	68		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	419	3	355	385		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	444	2	330	350		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	449	1	85			EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	591	4	73	185		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	595	2	55	100		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	596	1	138			EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	600	1	166			EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	613	3	50	60		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	617	4	85	132		EFB	three	900s
Lower Basin	805943	6/15/05	7	7	1	700	1	455			EFB	three	900s
Lower Basin	805943	6/15/05	8	8	1	268	6	700	710	O	EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	365	17	660	730	O	EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	381	1	70			EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	384	4	62	75		EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	394	4	85	120		EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	397	3	54	60		EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	400	2	55	75		EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	444	1	130			EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	591	2	150	200		EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	595	1	60			EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	596	2	82	130		EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	598	1	56			EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	600	1	240			EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	601	1	385			EFB	four	900s
Lower Basin	805943	6/15/05	8	8	1	617	6	70	130		EFB	four	900s

Lower Basin	805943	6/15/05	8	8	1	700	3	500	540	EFB	four	900s
Lower Basin	805943	6/15/05	9	9	1	347	1	720		EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	365	15	470	740	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	377	3	90	111	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	384	4	70	100	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	396	2	55	60	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	400	7	60	65	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	444	11	230	380	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	591	1	196		EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	595	2	75	90	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	596	6	73	175	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	598	1	50		EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	600	1	300		EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	601	4	295	370	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	613	2	50	62	EFB	five	900s
Lower Basin	805943	6/15/05	9	9	1	617	13	70	140	EFB	five	900s
Lower Basin	805943	6/22/05	10	10	1	268	1	60		EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	289	24	70	75	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	347	1	510		EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	365	3	580	642	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	381	60	48	80	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	394	11	55	79	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	397	1	60		EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	400	9	59	75	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	401	1	55		EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	423	1	230		EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	447	1	75		EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	591	3	55	100	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	596	6	90	130	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	600	4	250	330	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	601	4	300	390	EFB	one	900s
Lower Basin	805943	6/22/05	10	10	1	617	12	70	140	EFB	one	900s
Lower Basin	805943	6/22/05	11	11	1	271	25	530	680	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	347	3	450	620	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	365	4	560	800	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	381	12	55	60	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	394	1	75		EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	400	3	56	80	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	444	10	195	365	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	596	7	100	170	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	598	2	55	58	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	600	1	155		EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	601	5	300	410	EFB	two	900s
Lower Basin	805943	6/22/05	11	11	1	617	3	70	150	EFB	two	900s

Lower Basin	805943	6/22/05	12	12	1	268	11	20	50	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	271	2	450	620	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	347	1	560		EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	365	8	350	600	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	381	3	60	72	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	400	3	60	80	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	444	24	280	380	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	575	1	108		EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	591	1	58		EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	596	18	70	100	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	598	1	150		EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	601	3	200	380	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	617	25	75	118	EFB	three	900s
Lower Basin	805943	6/22/05	12	12	1	700	4	350	400	EFB	three	900s
Lower Basin	805943	6/22/05	13	13	1	268	1	400		EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	271	3	440	500	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	347	2	65	350	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	365	22	660	800	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	377	7	80	150	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	381	32	65	70	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	400	17	50	80	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	431	4	280	340	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	444	12	210	340	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	591	1	155		EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	596	12	96	155	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	598	1	123		EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	601	3	190	251	EFB	four	900s
Lower Basin	805943	6/22/05	13	13	1	617	37	85	190	EFB	four	900s
Lower Basin												
Lower Basin	805943	7/5/05	14	14	1	268	1	65		BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	365	4	520	600	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	397	13	55	62	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	400	7	55	70	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	401	1	50		BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	419	1	32		BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	591	8	20	132	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	595	12	55	102	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	596	1	75		BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	600	1	37		BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	601	2	47	50	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	613	7	30	66	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	617	1	95		BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	1	618	3	90	120	BPS	1st	900s
Lower Basin	805943	7/5/05	14	14	2	268	1	105		SNE	six	
Lower Basin	805943	7/5/05	14	14	2	397	2	55	62	SNE	six	

Lower Basin	805943	7/5/05	14	14	2	396	1	45		SNE	six	
Lower Basin	805943	7/5/05	14	14	2	400	37	50	66	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	401	2	50	52	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	419	8	42	55	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	591	37	20	80	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	596	3	40	70	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	600	10	35	52	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	601	13	40	55	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	613	18	33	75	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	617	1	85		SNE	six	
Lower Basin	805943	7/5/05	14	14	2	618	4	100	125	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	622	7	69	86	SNE	six	
Lower Basin	805943	7/5/05	14	14	2	792	5	63	115	SNE	six	

Lower Basin	805943	7/5/05	15	15	1	400	8	50	92	BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	449	1	85		BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	591	3	18	165	BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	595	6	55	95	BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	596	1	110		BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	600	1	40		BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	601	2	40	47	BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	613	9	56	68	BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	618	2	115	120	BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	1	622	1	68		BPS	1st	900s
Lower Basin	805943	7/5/05	15	15	2	365	1	500		SNE	six	
Lower Basin	805943	7/5/05	15	15	2	400	7	45	80	SNE	six	
Lower Basin	805943	7/5/05	15	15	2	449	1	97		SNE	six	
Lower Basin	805943	7/5/05	15	15	2	591	2	90	140	SNE	six	
Lower Basin	805943	7/5/05	15	15	2	600	4	35	43	SNE	six	
Lower Basin	805943	7/5/05	15	15	2	601	1	35		SNE	six	
Lower Basin	805943	7/5/05	15	15	2	618	1	85		SNE	six	
Lower Basin	805943	7/5/05	15	15	2	622	1	90		SNE	six	

Lower Basin	805943	7/18/05	16	16	1	268	1	180		BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	365	1	435		BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	400	2	60	70	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	419	5	50	120	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	591	2	30	36	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	595	5	68	85	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	596	3	70	75	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	600	1	55		BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	601	3	35	50	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	606	1	60		BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	613	26	32	70	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	617	2	110	140	BPS	one	900s
Lower Basin	805943	7/18/05	16	16	1	622	1	68		BPS	one	900s
Lower Basin	805943	7/18/05	16	16	2	381	6	40	50	SNE	five	

Lower Basin	805943	7/18/05	16	16	2	396	7	42	65	SNE	five	
Lower Basin	805943	7/18/05	16	16	2	400	2	52	54	SNE	five	
Lower Basin	805943	7/18/05	16	16	2	419	14	48	62	SNE	five	
Lower Basin	805943	7/18/05	16	16	2	600	2	62	65	SNE	five	
Lower Basin	805943	7/18/05	16	16	2	601	22	42	48	SNE	five	
Lower Basin	805943	7/18/05	16	16	2	613	8	25	50	SNE	five	
Lower Basin	805943	7/18/05	17	17	1	360	2	50	70	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	394	2	75	80	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	400	4	50	85	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	406	1	70		BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	419	4	51	290	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	423	2	55	240	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	432	3	135	205	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	591	6	27	165	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	595	27	52	117	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	596	5	50	100	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	600	1	50		BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	601	30	37	45	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	606	1	60		BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	613	28	40	65	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	1	617	6	90	160	BPS	two	900s
Lower Basin	805943	7/18/05	17	17	2	381	2	35	42	SNE	six	
Lower Basin	805943	7/18/05	17	17	2	394	1	75		SNE	six	
Lower Basin	805943	7/18/05	17	17	2	396	10	42	65	SNE	six	
Lower Basin	805943	7/18/05	17	17	2	397	12	40	66	SNE	six	
Lower Basin	805943	7/18/05	17	17	2	400	9	23	65	SNE	six	
Lower Basin	805943	7/18/05	17	17	2	419	3	30	280	SNE	six	
Lower Basin	805943	7/18/05	17	17	2	595	1	75		SNE	six	
Lower Basin	805943	7/18/05	17	17	2	596	2	92	150	SNE	six	
Lower Basin	805943	7/18/05	17	17	2	601	1	42		SNE	six	
Lower Basin	805943	7/18/05	17	17	2	613	1	40		SNE	six	
Lower Basin	805943	7/18/05	17	17	2	617	2	88	95	SNE	six	
Lower Basin												
Lower Basin	805943	8/10/05	18	18	1	400	5	35	60	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	419	1	80		BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	423	5	230	280	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	431	1	320		BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	591	6	45	135	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	596	2	30	116	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	600	3	55	85	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	601	12	60	80	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	613	7	35	70	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	617	5	104	107	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	618	1	80		BPS	one	900s
Lower Basin	805943	8/10/05	18	18	1	622	3	50	85	BPS	one	900s
Lower Basin	805943	8/10/05	18	18	2	384	12	45	50	SNE	five	

Lower Basin	805943	8/10/05	18	18	2	396	18	46	67		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	400	25	25	75		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	419	3	57	70		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	423	17	60	80		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	591	1	140			SNE	five	
Lower Basin	805943	8/10/05	18	18	2	600	4	60	85		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	601	4	60	69		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	613	10	50	62		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	617	4	65	120		SNE	five	
Lower Basin	805943	8/10/05	18	18	2	622	5	50	65		SNE	five	
Lower Basin	805943	8/10/05	19	19	1	365	6	84	95		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	394	1	78			BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	400	37	50	75		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	419	100	75	215		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	423	1	230			BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	444	1	230			BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	591	14	50	170		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	595	12	70	172		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	596	1	95			BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	600	12	65	100		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	601	7	55	117		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	1	613	22	40	72		BPS	one	900s
Lower Basin	805943	8/10/05	19	19	2	360	1	53			SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	394	25	51	93		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	400	10	35	64		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	419	12	75	147		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	423	2	70	80		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	591	4	42	44		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	596	1	68			SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	600	7	57	85		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	601	13	52	63		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	609	5	50	56		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	613	12	45	56		SNE	eight	
Lower Basin	805943	8/10/05	19	19	2	622	3	53	62		SNE	eight	
Lower Basin	805943	8/11/05	20	20	1	365	14	430		O	BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	394	1	80			BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	400	14	45	60		BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	449	1	140			BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	591	10	30	175		BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	595	6	100	140		BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	596	4	25	90		BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	613	6	50	70		BPS	one	900s
Lower Basin	805943	8/11/05	20	20	1	622	1	75			BPS	one	900s
Lower Basin	805943	8/11/05	20	20	2	268	1	255			SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	381	2	64	65		SNE	eight	

Lower Basin	805943	8/11/05	20	20	2	384	10	45	52		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	394	100	20	72		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	397	2	63	66		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	396	2	42	59		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	400	145	10	70		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	419	2	72	92		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	423	6	70	75		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	431	1	60			SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	596	16	32	105		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	598	1	98			SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	600	7	72	120		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	601	1	60			SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	606	9	55	62		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	613	5	36	55		SNE	eight	
Lower Basin	805943	8/11/05	20	20	2	617	10	56	100		SNE	eight	
Lower Basin	805943	8/11/05	21	21	1	365	14	425	635	O	BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	400	1	63			BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	591	2	35	175		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	595	14	70	115		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	596	2	80	102		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	600	2	100	110		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	601	5	50	108		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	613	15	35	55		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	617	3	105	150		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	1	622	12	70	90		BPS	one	900s
Lower Basin	805943	8/11/05	21	21	2	347	1	460			SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	400	12	25	60		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	432	2	62	74		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	596	2	75	86		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	600	7	78	90		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	601	4	40	52		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	606	4	45	53		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	613	22	35	44		SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	617	1	100			SNE	seven	
Lower Basin	805943	8/11/05	21	21	2	622	1	90			SNE	seven	
Lower Basin	805943	8/11/05	22	22	1	384	5	45	50		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	400	15	26	75		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	591	5	90	175		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	595	8	65	100		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	600	1	65			BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	601	2	55	63		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	613	24	29	60		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	617	1	140			BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	618	3	110	135		BPS	three	900s
Lower Basin	805943	8/11/05	22	22	1	622	8	41	95		BPS	three	900s

Lower Basin	805943	8/11/05	22	22	2	384	8	44	60	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	397	3	50	59	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	400	50	21	77	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	419	1	61		SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	431	3	45	60	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	449	1	110		SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	591	4	32	98	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	600	1	70		SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	601	1	70		SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	613	50	32	50	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	622	25	36	67	SNE	eight	
Lower Basin	805943	8/11/05	22	22	2	792	3	32	98	SNE	eight	
Lower Basin	805943	8/12/05	23	23	1	397	1	65		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	400	9	23	60	BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	401	1	55		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	431	1	87		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	446	1	135		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	591	2	37	120	BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	595	8	80	170	BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	596	1	90		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	600	1	122		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	601	1	70		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	606	1	70		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	613	13	21	65	BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	618	1	145		BPS	one	900s
Lower Basin	805943	8/12/05	23	23	1	622	4	77	90	BPS	one	900s
Lower Basin	805943	8/12/05	23	23	2	384	2	99	160	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	394	13	47	80	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	397	1	58		SNE	six	
Lower Basin	805943	8/12/05	23	23	2	400	26	25	80	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	419	1	104		SNE	six	
Lower Basin	805943	8/12/05	23	23	2	545	2	60	62	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	591	4	20	216	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	596	1	72		SNE	six	
Lower Basin	805943	8/12/05	23	23	2	600	2	65	75	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	601	2	50	62	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	606	2	38	72	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	613	12	41	66	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	618	2	116	120	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	622	3	40	78	SNE	six	
Lower Basin	805943	8/12/05	23	23	2	792	4	33	99	SNE	six	
Lower Basin	805943	8/12/05	24	24	1	365	9	580	620	BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	400	2	48	65	BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	432	2	62	125	BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	446	1	173		BPS	one	900s

Lower Basin	805943	8/12/05	24	24	1	591	1	150			BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	595	14	55	86		BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	596	5	68	80		BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	601	25	42	56		BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	613	30	49	65		BPS	one	900s
Lower Basin	805943	8/12/05	24	24	1	622	8	50	92		BPS	one	900s
Lower Basin	805943	8/12/05	24	24	2	400	5	32	70		SNE	five	
Lower Basin	805943	8/12/05	24	24	2	449	1	18			SNE	five	
Lower Basin	805943	8/12/05	24	24	2	596	3	80	80		SNE	five	
Lower Basin	805943	8/12/05	24	24	2	600	2	80	100		SNE	five	
Lower Basin	805943	8/12/05	24	24	2	601	1	60			SNE	five	
Lower Basin	805943	8/12/05	24	24	2	613	5	35	46		SNE	five	
Lower Basin	805943	8/12/05	24	24	2	617	1	165			SNE	five	
Lower Basin	805943	8/12/05	24	24	2	792	1	52			SNE	five	
Upper Basin	805943	7/13/05	25	25	1	365	3	510	740	C	EFB	one	900s
Upper Basin	805943	7/13/05	25	25	1	431	9	175	450		EFB	one	900s
Upper Basin	805943	7/13/05	25	25	1	591	5	105	245		EFB	one	900s
Upper Basin	805943	7/13/05	25	25	1	596	3	95	140		EFB	one	900s
Upper Basin	805943	7/13/05	25	25	1	600	1	35			EFB	one	900s
Upper Basin	805943	7/13/05	26	26	1	347	5	350	580		EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	365	1	650		C	EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	397	2	50	55		EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	400	1	42			EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	419	3	35	455		EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	431	1	416			EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	591	2	110	140		EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	595	1	90			EFB	two	900s
Upper Basin	805943	7/13/05	26	26	1	596	7	72	155		EFB	two	900s
Upper Basin	805943	7/13/05	27	27	1	365	10	43	73	C	EFB	three	900s
Upper Basin	805943	7/13/05	27	27	1	377	6	105	144		EFB	three	900s
Upper Basin	805943	7/13/05	27	27	1	444	1	350			EFB	three	900s
Upper Basin	805943	7/13/05	27	27	1	598	3	132	190		EFB	three	900s
Upper Basin	805943	7/13/05	27	27	1	601	5	66	400		EFB	three	900s
Upper Basin	805943	7/13/05	27	27	1	617	1	229			EFB	three	900s
Upper Basin	805943	7/13/05	27	27	1	622	1	63			EFB	three	900s
Upper Basin	805943	7/13/05	28	28	1	340	1	70			EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	365	1	112		C	EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	365	1	350		O	EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	377	7	70	98		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	384	1	68			EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	394	1	76			EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	397	3	55	62		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	396	5	32	50		EFB	four	900s

Upper Basin	805943	7/13/05	28	28	1	400	12	43	62		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	419	6	42	500		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	431	6	63	460		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	444	1	260			EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	447	1	74			EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	591	11	28	202		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	595	1	80			EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	596	3	75	121		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	598	2	152	162		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	601	3	46	50		EFB	four	900s
Upper Basin	805943	7/13/05	28	28	1	622	2	66	70		EFB	four	900s
Upper Basin	805943	7/13/05	29	29	1	347	1	700		O	EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	365	2	400	600	O	EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	384	1	63			EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	397	2	60	70		EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	396	1	60			EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	419	7	185	440		EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	444	1	253			EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	591	1	10			EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	598	6	170	255		EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	600	1	300			EFB	five	900s
Upper Basin	805943	7/13/05	29	29	1	601	5	36	400		EFB	five	900s
Upper Basin	805943	8/24/05	30	30	1	360	43	46	70		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	365	1	650		C	BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	384	5	65	80		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	394	1	90			BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	400	45	30	80		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	406	74	26	85		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	419	7	35	310		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	423	144	45	280		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	431	3	260	310		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	432	1	320			BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	446	1	180			BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	591	2	96	175		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	595	1	100			BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	596	1	78			BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	606	14	35	60		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	613	50	25	60		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	618	1	106			BPS	one	900s
Upper Basin	805943	8/24/05	30	30	1	622	6	47	70		BPS	one	900s
Upper Basin	805943	8/24/05	30	30	2	360	6	32	50		SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	400	30	35	70		SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	406	60	30	70		SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	419	12	38	42		SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	423	36	32	40		SNE	eight	

Upper Basin	805943	8/24/05	30	30	2	600	1	88			SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	606	12	37	65		SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	613	40	25	60		SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	618	1	62			SNE	eight	
Upper Basin	805943	8/24/05	30	30	2	622	5	32	65		SNE	eight	
Upper Basin	805943	8/24/05	31	31	1	400	1	82			BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	406	1	40			BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	419	1	57			BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	423	1	240			BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	431	1	300			BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	591	2	106	182		BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	595	6	50	117		BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	601	2	75	80		BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	613	26	41	68		BPS	one	900s
Upper Basin	805943	8/24/05	31	31	1	622	5	30	80		BPS	one	900s
Upper Basin	805943	8/24/05	31	31	2	347	1	430			SNE	six	
Upper Basin	805943	8/24/05	31	31	2	394	1	66			SNE	six	
Upper Basin	805943	8/24/05	31	31	2	400	1	64			SNE	six	
Upper Basin	805943	8/24/05	31	31	2	406	2	38	56		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	419	2	52	60		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	423	2	60	100		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	431	5	47	120		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	591	2	30	85		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	600	1	80			SNE	six	
Upper Basin	805943	8/24/05	31	31	2	601	3	80	92		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	613	2	30	52		SNE	six	
Upper Basin	805943	8/24/05	31	31	2	618	1	128			SNE	six	
Upper Basin	805943	8/24/05	31	31	2	622	2	45	68		SNE	six	
Upper Basin	905980	9/5/05	32	1	1	360	4	46	130		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	384	20	68	170		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	400	16	30	80		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	406	12	64	230		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	419	4	105	200		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	423	22	55	350		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	431	1	220			BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	591	4	122	170		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	595	5	80	130		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	600	2	215	255		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	601	2	84	122		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	606	1	52			BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	609	4	48	53		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	613	22	20	76		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	1	622	4	64	68		BPS	one	900s
Upper Basin	905980	9/5/05	32	1	2	61	200	30	35	O	SNE	five	
Upper Basin	905980	9/5/05	32	1	2	381	7	46	50		SNE	five	

Upper Basin	905980	9/5/05	32	1	2	384	5	30	46	SNE	five	
Upper Basin	905980	9/5/05	32	1	2	400	1	32		SNE	five	
Upper Basin	905980	9/5/05	32	1	2	406	4	35	80	SNE	five	
Upper Basin	905980	9/5/05	32	1	2	423	1	125		SNE	five	
Upper Basin	905980	9/5/05	32	1	2	591	1	200		SNE	five	
Upper Basin	905980	9/5/05	32	1	2	613	5	40	45	SNE	five	
Upper Basin	905980	9/5/05	32	1	2	622	1	75		SNE	five	
Upper Basin												
Upper Basin	905980	9/10/05	33	2	1	360	1	128		BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	375	3	55	130	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	384	27	45	132	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	394	5	42	104	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	402	3	65	72	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	406	48	50	140	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	419	4	100	270	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	446	1	171		BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	591	12	75	225	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	595	2	79	103	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	596	6	51	102	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	601	1	110		BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	606	2	58	91	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	609	3	72	81	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	617	2	116	127	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	618	1	100		BPS	one	900s
Upper Basin	905980	9/10/05	33	2	1	792	8	53	108	BPS	one	900s
Upper Basin	905980	9/10/05	33	2	2	381	29	35	62	SNE	six	
Upper Basin	905980	9/10/05	33	2	2	394	64	25	86	SNE	six	
Upper Basin	905980	9/10/05	33	2	2	591	6	102	194	SNE	six	
Upper Basin	905980	9/10/05	33	2	2	613	1	50		SNE	six	
Upper Basin	905980	9/10/05	33	2	2	792	7	48	67	SNE	six	
Upper Basin	905980	9/11/05	34	3	1	340	1	44		BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	347	1	270		BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	365	1	410		BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	400	12	52	75	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	406	6	30	90	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	419	17	58	290	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	431	2	55	111	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	591	1	130		BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	595	27	55	90	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	596	27	59	93	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	598	2	70	111	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	601	7	70	105	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	613	37	30	64	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	1	622	7	51	72	BPS	one	900s
Upper Basin	905980	9/11/05	34	3	2	384	2	45	78	SNE	five	
Upper Basin	905980	9/11/05	34	3	2	400	54	20	76	SNE	five	

Upper Basin	905980	9/11/05	34	3	2	406	2	42	49		SNE	five	
Upper Basin	905980	9/11/05	34	3	2	419	22	56	76		SNE	five	
Upper Basin	905980	9/11/05	34	3	2	431	2	120	215		SNE	five	
Upper Basin	905980	9/11/05	34	3	2	596	1	55			SNE	five	
Upper Basin	905980	9/11/05	34	3	2	601	3	70	76		SNE	five	
Upper Basin	905980	9/11/05	34	3	2	613	72	22	65		SNE	five	
Upper Basin	905980	9/11/05	34	3	2	622	5	48	54		SNE	five	
Upper Basin	905980	9/11/05	35	4	1	347	1	440			BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	365	1	500		O	BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	384	2	70	85		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	393	4	62	65		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	400	6	40	75		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	406	7	56	86		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	419	5	53	200		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	431	10	48	400		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	591	9	40	190		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	595	12	62	86		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	596	4	61	130		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	598	1	141			BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	601	1	100			BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	613	114	31	68		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	1	622	6	52	80		BPS	one	900s
Upper Basin	905980	9/11/05	35	4	2	385	3	78	85		SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	393	4	50	63		SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	394	1	56			SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	400	5	22	62		SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	406	2	50	82		SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	419	1	41			SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	431	1	180			SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	449	3	36	40		SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	596	1	105			SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	613	50	30	68		SNE	eight	
Upper Basin	905980	9/11/05	35	4	2	622	2	68	72		SNE	eight	
Upper Basin	905980	9/16/05	36	5	1	360	69	47	73		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	375	4	55	140		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	384	2	45	85		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	400	2	74	85		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	401	1	65			BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	406	52	40	205		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	419	6	53	290		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	423	1	180			BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	591	2	27	180		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	596	3	82	85		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	601	1	76			BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	606	2	42	61		BPS	one	900s

Upper Basin	905980	9/16/05	36	5	1	609	10	40	66		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	613	27	36	78		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	1	622	3	76	80		BPS	one	900s
Upper Basin	905980	9/16/05	36	5	2	360	4	41	52		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	375	3	60	120		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	384	4	65	90		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	400	2	65	80		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	406	4	82	92		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	419	1	133			SNE	four	
Upper Basin	905980	9/16/05	36	5	2	423	2	100	115		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	431	1	102			SNE	four	
Upper Basin	905980	9/16/05	36	5	2	591	1	154			SNE	four	
Upper Basin	905980	9/16/05	36	5	2	606	3	36	44		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	613	6	60	71		SNE	four	
Upper Basin	905980	9/16/05	36	5	2	622	1	78			SNE	four	
Upper Basin	905980	9/21/05	37	6	1	360	65	36	135		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	375	22	75	140		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	384	58	61	100		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	393	4	68	74		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	406	35	35	215		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	419	5	64	270		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	423	7	64	210		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	595	1	90			BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	601	2	113	135		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	606	2	36	50		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	609	9	32	72		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	613	8	30	54		BPS	one	900s
Upper Basin	905980	9/21/05	37	6	1	622	1	75			BPS	one	900s
Upper Basin	905980	9/21/05	37	6	2	406	3	40	104		SNE	four	
Upper Basin	905980	9/21/05	37	6	2	423	1	157			SNE	four	
Upper Basin	905980	9/21/05	37	6	2	606	2	68	73		SNE	four	
Upper Basin	905980	9/21/05	37	6	2	609	1	62			SNE	four	
Upper Basin	905980	9/21/05	37	6	2	613	1	47			SNE	four	
Jeddo Creek	905981	7/15/05	38	1	1	360	22	40	125		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	365	2	380	400	O	BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	406	42	36	154		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	419	13	38	154		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	423	5	195	240		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	447	1	85			BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	591	14	70	110		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	595	1	85			BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	606	3	72	82		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	1	613	5	35	85		BPS	one	900s
Jeddo Creek	905981	7/15/05	38	1	2	360	17	35	143		SNE	seven	
Jeddo Creek	905981	7/15/05	38	1	2	406	35	33	180		SNE	seven	

Jeddo Creek	905981	7/15/05	38	1	2	419	2	40	55		SNE	seven	
Jeddo Creek	905981	7/15/05	38	1	2	423	1	240			SNE	seven	
Jeddo Creek	905981	7/15/05	38	1	2	595	1	92			SNE	seven	
Jeddo Creek	905981	7/15/05	39	2	1	360	39	55	125		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	365	2	570	620	O	BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	406	42	36	180		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	419	4	45	170		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	423	3	152	290		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	591	17	22	143		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	595	3	75	78		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	596	1	80			BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	598	1	95			BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	609	1	70			BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	613	2	65	65		BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	1	792	1	80			BPS	two	900s
Jeddo Creek	905981	7/15/05	39	2	2	360	5	32	110		SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	400	1	70			SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	406	44	27	170		SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	419	7	35	160		SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	423	1	130			SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	591	2	20	145		SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	609	1	85			SNE	five	
Jeddo Creek	905981	7/15/05	39	2	2	613	2	65	70		SNE	five	
Jeddo Creek	805944	8/30/05	40	1	1	360	135	62	117		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	384	1	168			BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	406	28	47	195		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	419	10	137	325		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	423	50	72	310		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	432	1	380			BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	591	7	100	170		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	600	4	92	140		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	1	606	7	41	89		BPS	one	900s
Jeddo Creek	805944	8/30/05	40	1	2	360	18	71	116		SNE	six	
Jeddo Creek	805944	8/30/05	40	1	2	406	35	41	120		SNE	six	
Jeddo Creek	805944	8/30/05	40	1	2	419	1	54			SNE	six	
Jeddo Creek	805944	8/30/05	40	1	2	423	35	63	260		SNE	six	
Jeddo Creek	805944	8/30/05	40	1	2	606	6	54	76		SNE	six	
Jeddo Creek	805944	8/30/05	40	1	2	613	1	80			SNE	six	

[1]The watershed was divided into subunits as shown in Table 2.

[2]Each sampling site was re-numbered (SN) to correspond with a DEC fisheries database survey including notes: Rep—repetitions of effort per site, Sp—species (DEC codes, see Table 5a), Catch (C) data also includes visual observations (O) when noted. L—total fish length (Min—minimum/Max—maximum) in mm, sometimes estimated*.

[3]Gear includes EFB—electrofishing boat, BPS—backpack shocker, SNE—beach seine; and Run—effort in # of shocking passes or seine hauls.

Appendix I-H. Canonical Correspondence Analysis (CCA) results from the Tonawanda and Johnson Creek watersheds, May-September 2005. See Table 4 for habitat descriptions and Table 11 for "meaningful" species-habitat associations. See also Figures 4a-4c and Appendices III-A to IV-U for CCA biplots.

[1]Tonawanda Creek watershed

	[2]Entire (68S/27F)			**Lower (49S/27F)**			**Middle+Upper (19S/19F)**			**Upper (12S/18F)**			**Canal+Adj Tribs (14S/17F)**		
Total Inertia	2.408			1.617			1.629			1.200			0.918		
	axis 1	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**
Eigenvalue	0.249	0.126	0.059	0.276	0.099	0.063	0.321	0.190	0.119	0.425	0.209	0.115	0.226	0.105	0.067
[3]Cum Var %	10.4	15.6	**18.1**	17.1	23.2	**27.1**	19.7	31.3	**38.7**	35.4	52.8	**62.5**	24.6	36.1	**43.4**
[3]Spp-Env	0.817	0.766	0.617	0.844	0.761	0.630	0.885	0.871	0.629	0.945	0.862	0.906	0.912	0.890	0.763
Inter-Set Correlation (6 hab vars) [3]															
PT	**-0.746**	0.205	-0.044	**-0.777**	0.028	-0.104	0.110	-0.429	0.395	**-0.888**	-0.178	0.071	-0.041	**-0.624**	0.387
MD	**0.670**	0.091	0.223	**0.574**	-0.499	0.098	**-0.656**	0.048	-0.105	**0.642**	-0.254	0.341	**0.551**	0.323	-0.169
SS	**-0.619**	0.215	0.291	**-0.664**	0.036	0.209	0.070	**-0.716**	0.317	**-0.715**	0.496	-0.170	**0.519**	-0.030	-0.337
IW	0.222	-0.348	-0.293	-0.011	-0.150	-0.487	0.194	0.275	-0.278	**0.735**	-0.184	0.415	-0.400	**-0.621**	-0.237
BC	0.093	-0.153	0.052	0.082	-0.160	-0.376	0.063	-0.248	-0.499	0.398	-0.008	0.208	-0.035	-0.432	**-0.534**
AV	-0.017	**0.711**	-0.154	0.165	**0.585**	-0.085	**-0.674**	-0.130	0.333	0.001	0.381	**0.558**	**-0.763**	0.006	0.197
Monte Carlo Eigenvalue Results															
Eigenvalue	0.249	0.126	0.059	0.276	0.099	0.063	0.321	0.190	0.119	0.425	0.209	0.115	0.226	0.105	0.067
Mean	0.101	0.063	0.041	0.090	0.049	0.049	0.242	0.148	0.089	0.314	0.165	0.081	0.166	0.097	0.065
Min	0.040	0.028	0.019	0.033	0.025	0.025	0.125	0.067	0.043	0.136	0.063	0.038	0.082	0.056	0.034
Max	0.200	0.123	0.083	0.201	0.109	0.109	0.399	0.269	0.199	0.462	0.288	0.134	0.281	0.137	0.111
p-value	*0.001	*0.001	*0.045	*0.001	*0.002	*0.001	0.071	0.133	0.096	*0.036	0.171	*0.037	0.076	0.280	0.455
Monte Carlo Spp-Env Results															
Eigenvalue	0.817	0.766	0.617	0.844	0.761	0.630	0.885	0.871	0.629	0.945	0.862	0.906	0.912	0.890	0.763
Mean	0.599	0.531	0.478	0.570	0.556	0.524	0.816	0.738	0.695	0.864	0.779	0.827	0.847	0.859	0.793
Min	0.417	0.371	0.313	0.390	0.344	0.304	0.609	0.501	0.450	0.649	0.498	0.515	0.659	0.604	0.525
Max	0.797	0.698	0.676	0.765	0.758	0.723	0.966	0.918	0.965	0.994	0.978	0.990	0.988	0.983	0.966
p-value	***0.001**	***0.001**	***0.016**	***0.001**	***0.001**	0.062	0.138	***0.027**	0.766	0.123	0.164	0.209	0.119	0.365	0.685

[1]**Tonawanda Creek watershed cont.**

	TCW Tribs (11S/18F)			PT 1 (27S/18F)			PT 2 (22S/22F)			PT 3 (11S/21F)			PT 3 (11S/21F)		
Total Inertia	1.859			0.9131			0.537			0.6401			0.9761		
	axis 1	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**
Eigenvalue	0.674	0.452	0.177	0.108	0.060	0.046	0.151	0.067	0.052	0.128	0.098	0.044	0.125	0.055	0.030
[3]Cum Var %	36.3	60.6	**70.1**	11.8	18.4	**23.4**	28.1	40.6	**50.3**	20.0	35.4	**42.3**	12.8	18.5	**21.6**
[3]Spp-Env	0.986	0.994	0.973	0.776	0.640	0.706	0.952	0.799	0.812	0.951	0.703	0.914	0.771	0.636	0.755
Inter-Set Correlation (6 hab vars) [3]															
PT	**0.962**	-0.034	-0.097	-	-	-	-	-	-	-	-	-	-	-	-
MD	**-0.558**	-0.278	-0.353	0.080	-0.376	0.059	***-0.552***	0.034	**0.560**	**0.692**	0.201	-0.092	-0.236	**0.553**	-0.164
SS	**0.615**	**0.574**	0.059	0.236	0.183	-0.442	-0.326	-0.434	-0.306	-0.177	**-0.629**	-0.007	0.441	-0.389	-0.282
IW	-0.172	-0.411	-0.158	0.458	0.288	0.103	-0.118	0.169	0.106	0.237	0.269	-0.025	**-0.653**	-0.083	-0.310
BC	-0.128	**-0.526**	0.417	0.039	-0.169	-0.492	0.035	**0.642**	0.117	0.439	-0.082	**0.751**	-0.196	-0.079	-0.317
AV	0.435	-0.179	**0.683**	-0.393	0.205	0.067	**0.882**	-0.122	0.217	0.491	0.008	0.133	-0.001	-0.193	0.320
Monte Carlo Eigenvalue Results															
Eigenvalue	0.674	0.452	0.177	0.108	0.060	0.046	0.151	0.067	0.052	0.128	0.098	0.044	0.125	0.055	0.030
Mean	0.464	0.294	0.155	0.095	0.055	0.034	0.109	0.064	0.037	0.166	0.080	0.042	0.103	0.058	0.034
Min	0.209	0.122	0.076	0.041	0.026	0.015	0.059	0.022	0.014	0.071	0.035	0.021	0.046	0.025	0.013
Max	0.642	0.452	0.270	0.179	0.104	0.066	0.167	0.105	0.072	0.253	0.139	0.060	0.210	0.126	0.075
p-value	*0.001	*0.001	0.226	0.263	0.310	0.094	*0.045	0.411	0.086	0.807	0.216	0.399	0.183	0.527	0.632
Monte Carlo Spp-Env Results															
Eigenvalue	0.986	0.994	0.973	0.776	0.640	0.706	0.952	0.799	0.812	0.951	0.703	0.914	0.771	0.636	0.755
Mean	0.925	0.831	0.821	0.740	0.692	0.631	0.872	0.811	0.741	0.865	0.818	0.878	0.715	0.646	0.610
Min	0.717	0.603	0.485	0.533	0.418	0.385	0.637	0.576	0.460	0.618	0.555	0.543	0.505	0.441	0.353
Max	0.996	0.995	0.987	0.908	0.903	0.849	0.991	0.990	0.980	0.996	0.992	0.995	0.928	0.877	0.854
p-value	***0.02**	***0.002**	***0.019**	0.291	0.749	0.176	0.063	0.591	0.228	0.098	0.910	0.420	0.225	0.537	**0.056**

[1]Johnson Creek watershed

	[2]**Entire JCW (40S/21F)**			**Lower JCW (24S/21F)**			**Upper JCW (16S/20F)**		
Total Inertia	1.510			1.236			1.336		
	axis 1	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**
Eigenvalue	0.296	0.071	0.061	0.227	0.092	0.050	0.278	0.105	0.089
[3]Cum Var %	19.6	24.3	**28.3**	18.4	25.9	**29.9**	20.9	28.7	**35.3**
[3]Spp-Env	0.833	0.629	0.620	0.869	0.779	0.698	0.914	0.704	0.766
Inter-Set Correlation (6 hab vars) [3]									
PT	**0.709**	-0.120	-0.088	**-0.551**	-0.347	0.345	**0.808**	0.011	-0.276
MD	-0.306	-0.235	-0.204	0.252	-0.006	-0.029	-0.248	-0.490	0.067
SS	0.068	-0.235	-0.204	-0.327	-0.336	-0.354	**0.580**	-0.271	-0.312
IW	0.189	0.091	-0.412	-0.485	0.231	0.026	0.042	-0.426	**0.527**
BC	0.488	-0.232	0.021	-0.277	-0.032	**-0.522**	0.346	-0.348	0.320
AV	-0.108	**0.528**	0.030	-0.237	**0.616**	-0.209	-0.186	**0.575**	0.337
Monte Carlo Eigenvalue Results									
Eigenvalue	0.296	0.071	0.061	0.227	0.092	0.050	0.278	0.105	0.089
Mean	0.111	0.057	0.035	0.124	0.078	0.052	0.210	0.131	0.076
Min	0.045	0.022	0.015	0.061	0.043	0.028	0.103	0.061	0.026
Max	0.243	0.116	0.081	0.221	0.142	0.086	0.325	0.240	0.139
p-value	*0.001	0.143	*0.004	*0.001	0.154	0.577	0.320	0.777	0.194
Monte Carlo Spp-Env Results									
Eigenvalue	0.833	0.629	0.620	0.869	0.779	0.698	0.914	0.704	0.766
Mean	0.592	0.584	0.546	0.749	0.730	0.690	0.859	0.778	0.754
Min	0.411	0.329	0.298	0.572	0.504	0.442	0.657	0.553	0.435
Max	0.837	0.806	0.798	0.923	0.948	0.901	0.990	0.947	0.951
p-value	***0.002**	0.292	0.186	***0.018**	0.275	0.481	0.190	0.855	0.475

[1]**Johnson Creek watershed cont.**

	PT 1 (14S/17F)			PT 2 (7S/19F)			PT 3 (8S/21F)			PT 4 (11S/21F)		
Total Inertia	0.964			0.835			1.574			1.024		
	axis 1	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**	**axis 1**	**axis 2**	**axis 3**
Eigenvalue	0.239	0.114	0.101	0.273	0.246	0.117	0.501	0.336	0.155	0.203	0.148	0.080
[3]Cum Var %	24.8	36.6	**47.0**	32.7	62.6	**76.2**	31.8	53.2	**63.1**	19.8	34.3	**42.1**
[3]Spp-Env	0.964	0.919	0.883	0.619	0.905	0.905	0.987	0.871	0.942	0.815	0.845	0.946
Inter-Set Correlation (6 hab vars) [3]												
PT	-	-	-	-	-	-	-	-	-	-	-	-
MD	-0.093	0.042	**-0.783**	0.087	-0.357	-0.347	**0.609**	-0.219	-0.081	0.239	-0.487	0.431
SS	-0.334	**0.553**	0.098	***-0.578***	**-0.672**	0.083	0.315	-0.427	**0.725**	0.064	0.400	0.450
IW	**0.764**	-0.411	0.006	-0.331	-0.203	**-0.727**	-0.307	0.152	0.383	-0.403	**-0.587**	0.128
BC	**0.834**	0.219	0.287	**-0.786**	-0.093	0.345	-0.108	**0.727**	-0.261	***-0.504***	0.039	**0.645**
AV	0.052	-0.148	**0.782**	**-0.558**	0.255	-0.164	-0.469	-0.289	-0.299	-0.020	**0.648**	-0.203
Monte Carlo Eigenvalue Results												
Eigenvalue	0.230	0.114	0.101	0.273	0.246	0.117	0.501	0.336	0.155	0.203	0.148	0.080
Mean	0.148	0.093	0.062	0.304	0.211	0.097	0.488	0.297	0.161	0.224	0.138	0.080
Min	0.079	0.049	0.030	0.238	0.111	0.050	0.276	0.153	0.078	0.130	0.064	0.038
Max	0.237	0.138	0.101	0.352	0.246	0.127	0.578	0.469	0.214	0.326	0.227	0.155
p-value	*0.001	0.082	*0.002	0.773	*0.004	0.206	0.467	0.253	0.599	0.696	0.333	0.416
Monte Carlo Spp-Env Results												
Eigenvalue	0.964	0.919	0.883	0.899	1.000	0.955	0.987	0.871	0.942	0.815	0.845	0.946
Mean	0.868	0.862	0.808	0.964	0.948	0.916	0.962	0.878	0.903	0.894	0.832	0.811
Min	0.691	0.543	0.552	0.867	0.753	0.636	0.802	0.659	0.557	0.709	0.607	0.556
Max	0.979	0.981	0.973	1.000	1.000	1.000	1.000	1.000	1.000	0.996	0.989	0.989
p-value	***0.008**	0.203	0.155	0.960	***0.006**	0.337	0.338	0.533	0.433	0.925	0.461	***0.049**

[1]The watersheds were divided into subunits as shown in Table 2.
[2]Number of sampling sites (S) and fish species (F) are also included in Table 11.
[3]CCA output includes Cum Var—cumulative variance, Spp-Env—species environment (bold = significance), hab vars—habitat variables.

APPENDIX II-A. List of 91 ArcGIS maps created from data collected during the 2004-2005 sampling seasons in the Tonawanda and Johnson Creek watershed study area. See Table 3 for mapping data and Appendices II B-D for all maps (Series 1-3).

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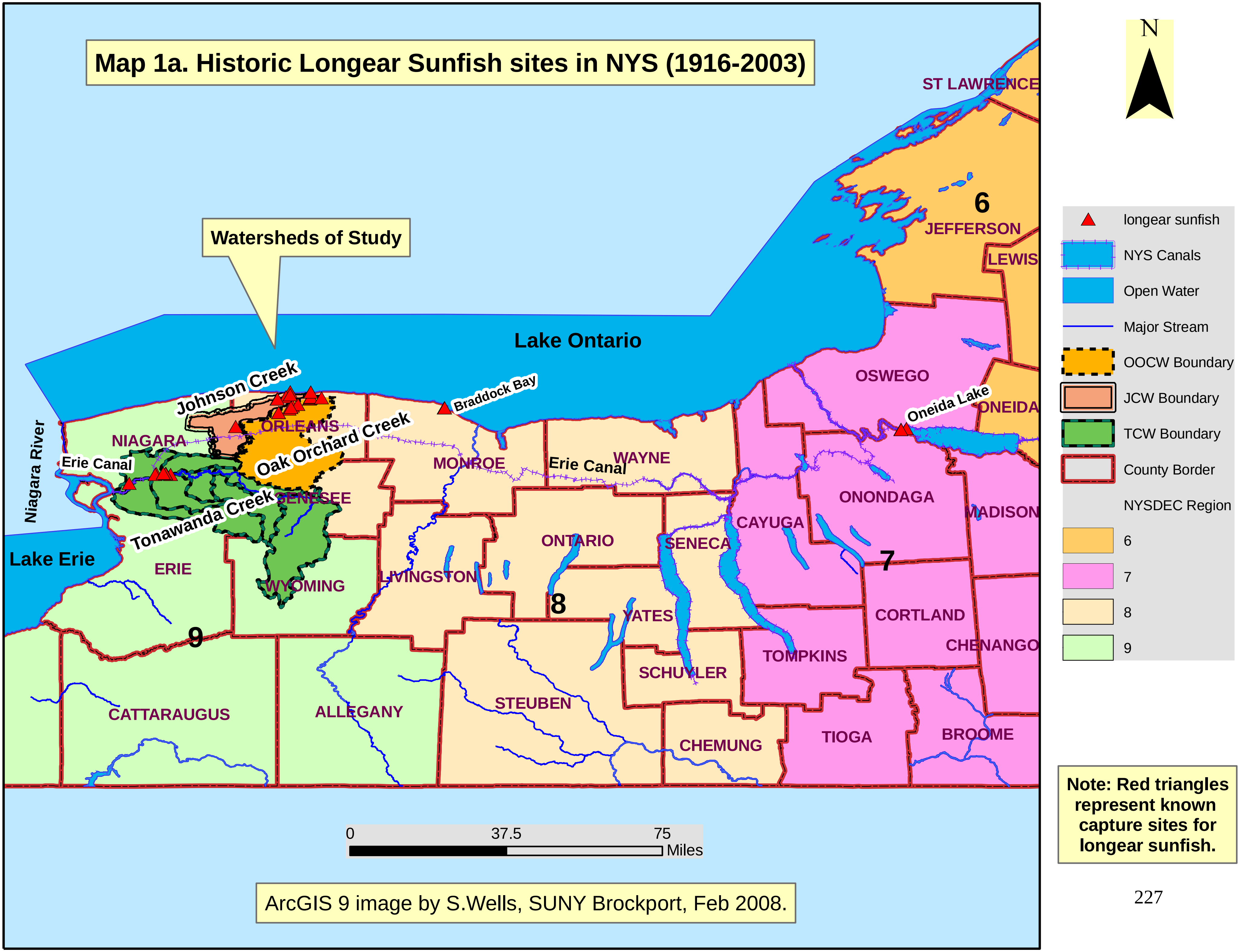
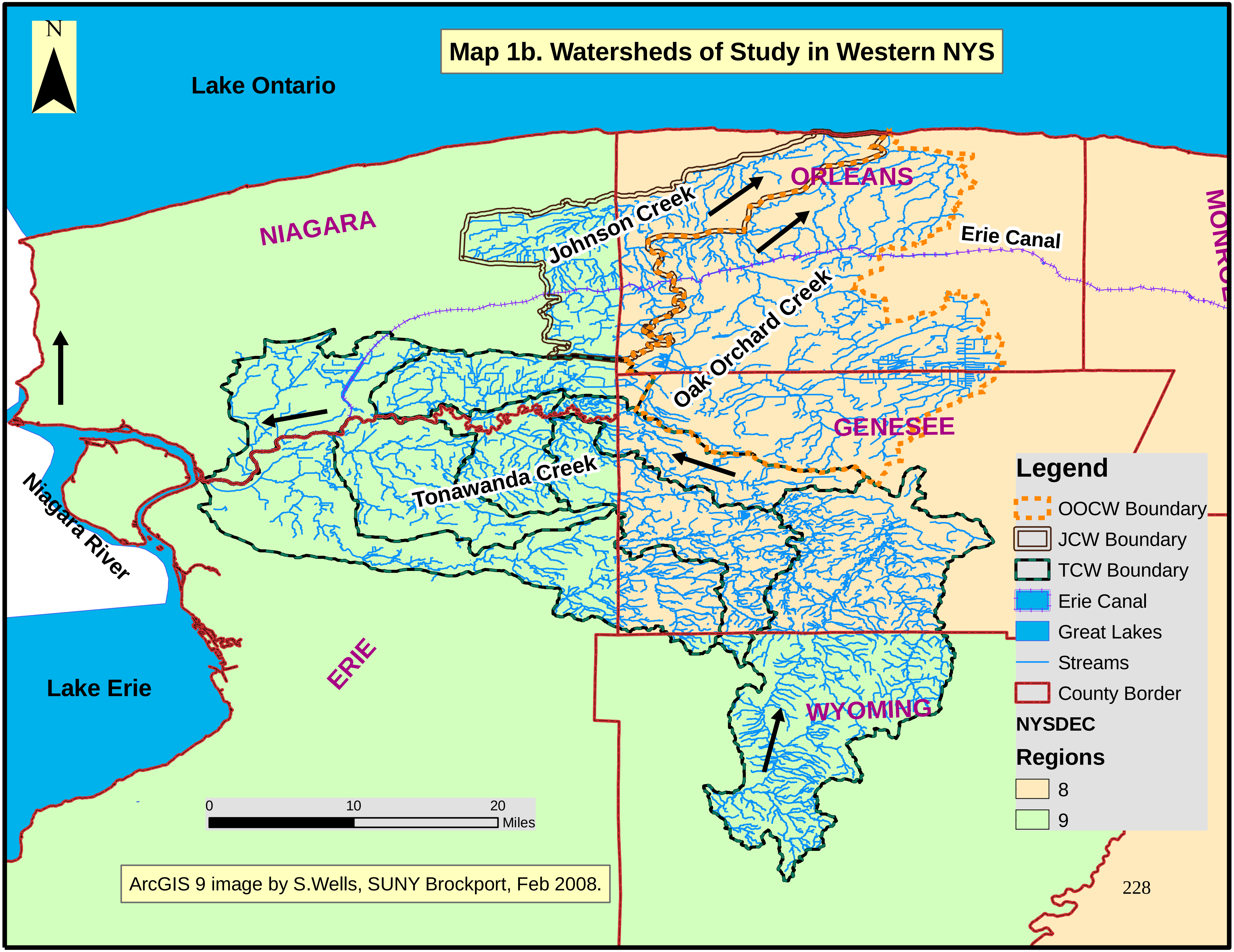
Notes: ArcGIS (ESRI 2006) maps include historic and recent observations of longear sunfish (***LES***) and recent observations of redfin shiner (***RFS***). Maps are numbered in ascending order from stream mouth to headwaters.

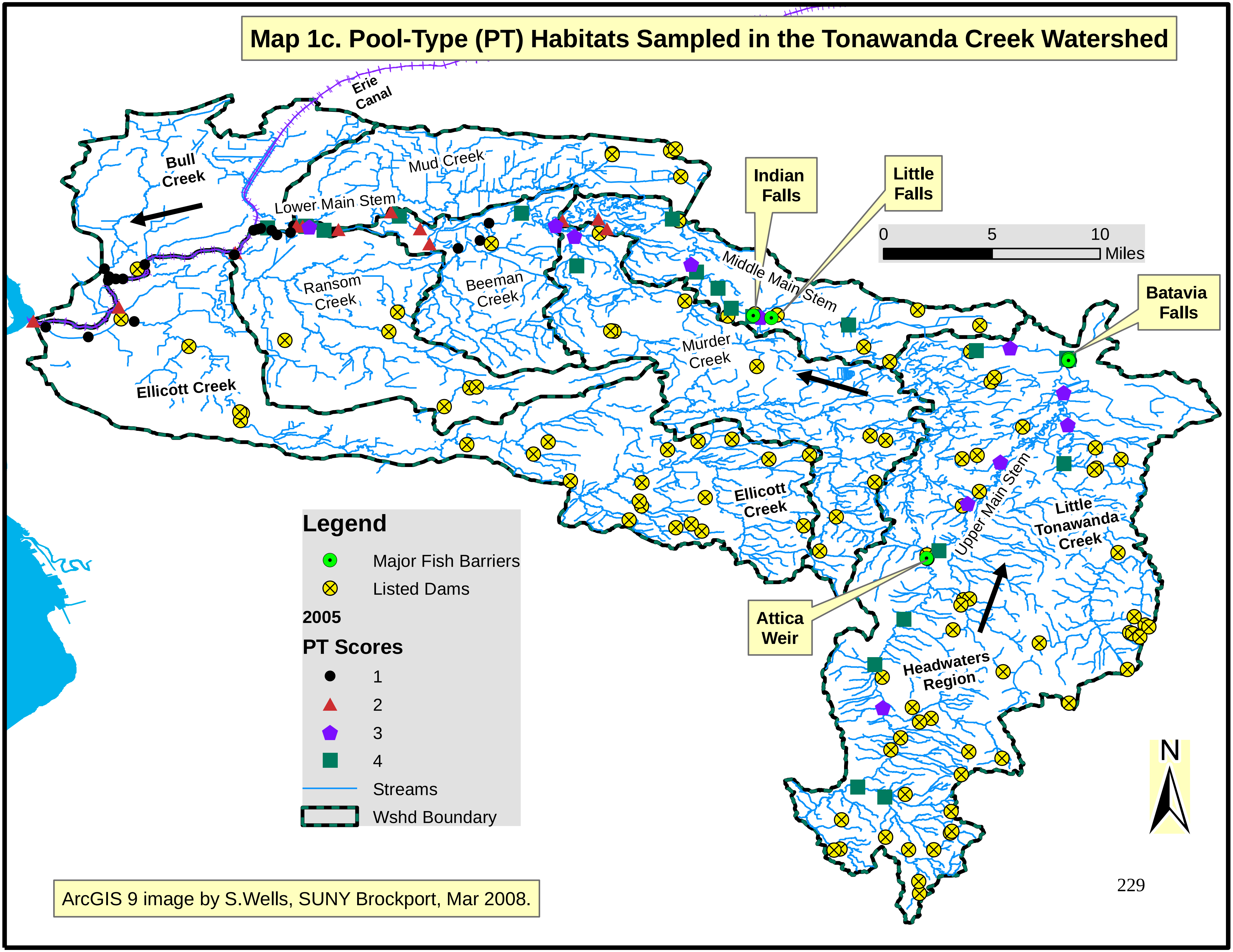
Abbreviations: BR—Bridge; RT—route (county or state highway); T—tributary associated with a WIN—watershed index number; P = pond number (including lakes and reservoirs); ONT—Lake Ontario. Stream distance sometimes estimated from the closest RM—river mile. Maps stating no fish survey may show sites with a high LES habitat suitability (score of 3 or 4) but were not selected for fish sampling (see Wells and Haynes 2006). Single black arrows indicate direction of streamflow, scale bar is set to miles in accordance to stream distance or RM marks recorded at specific landmarks (see Table 3). Each map may show data not listed in the legend to save space.

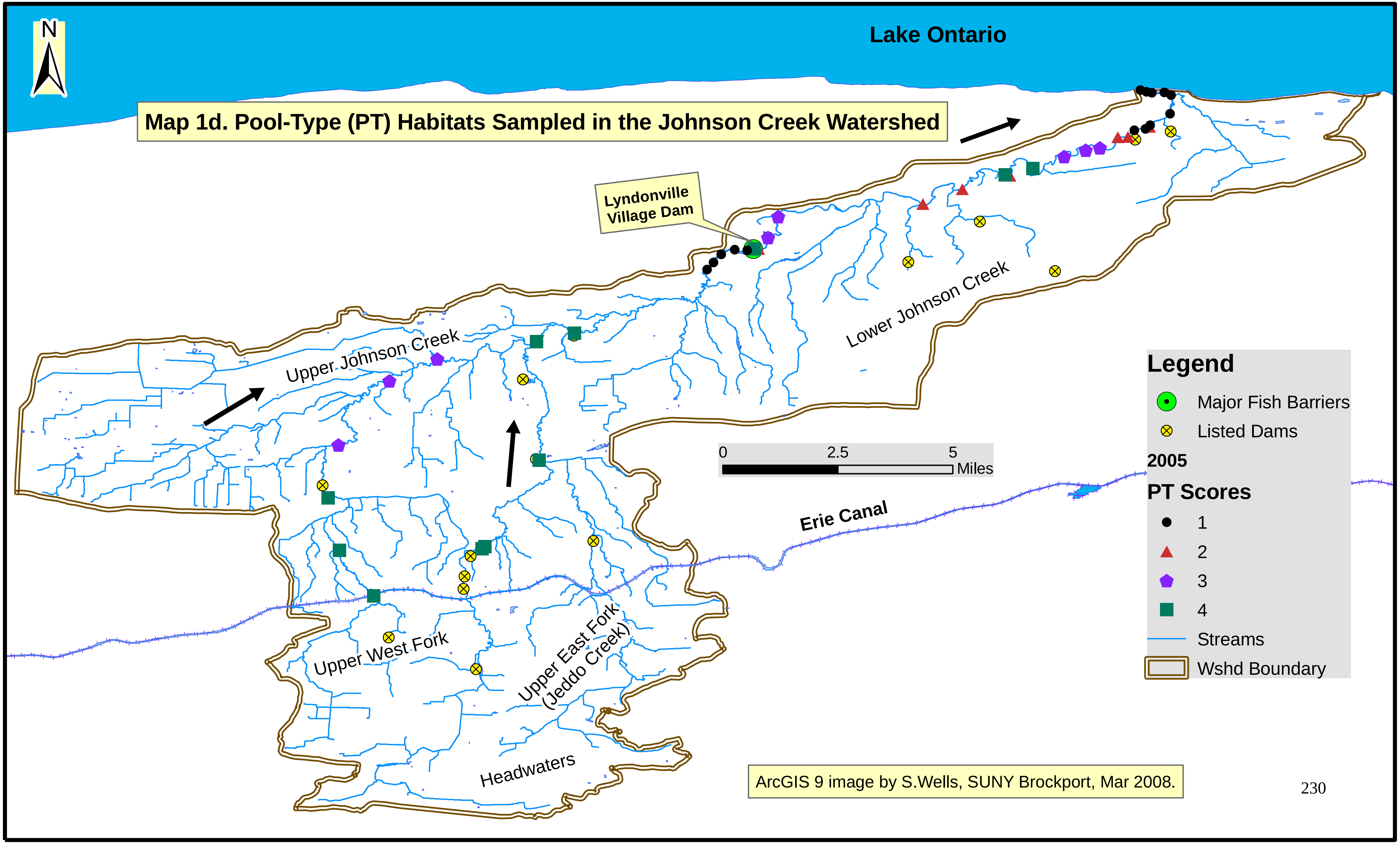


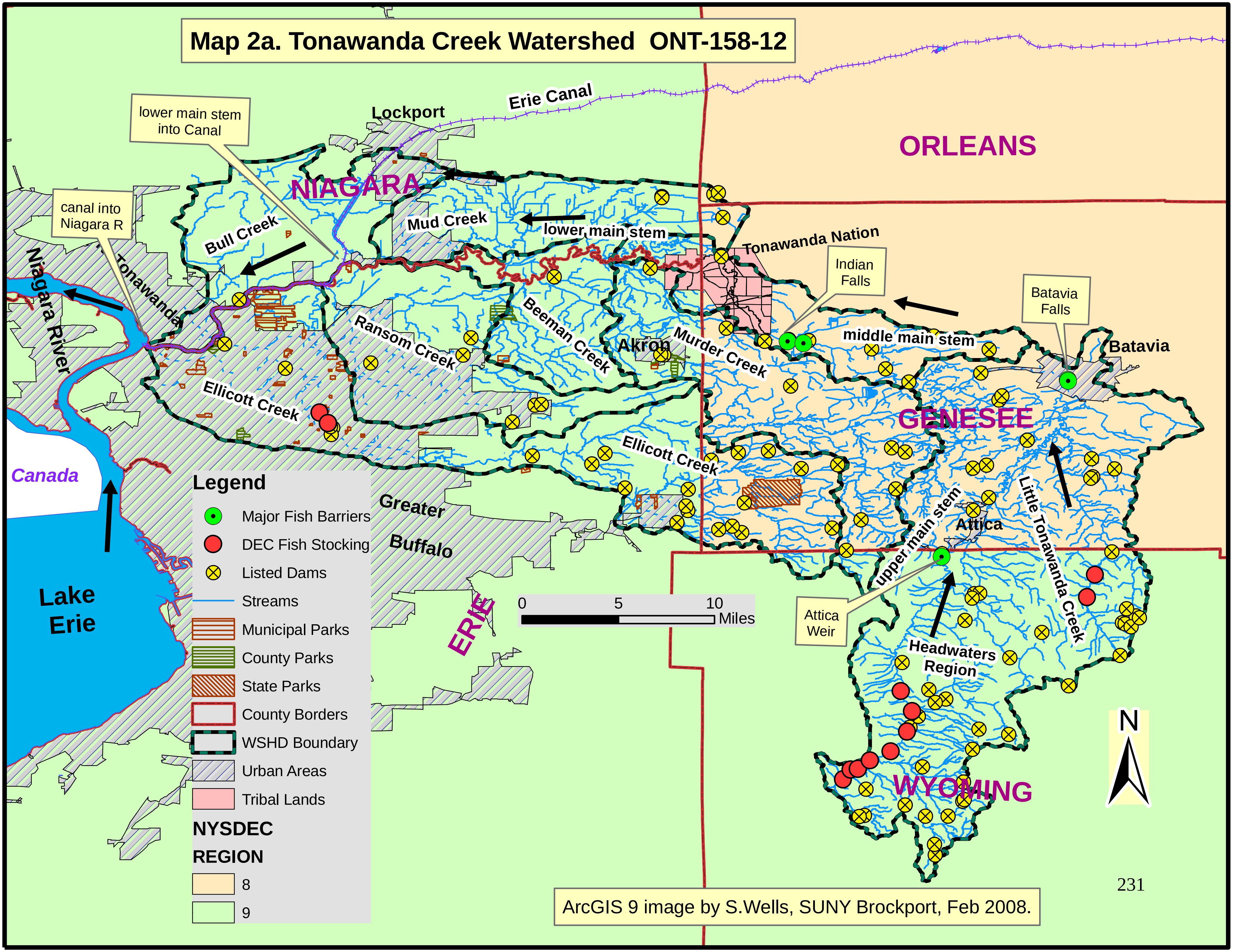
Map 1a. Historic Longear Sunfish sites in NYS (1916-2003)
Watersheds of Study
Lake Ontario
Lake Erie
Niagara River
Erie Canal
Johnson Creek
Oak Orchard Creek
Tonawanda Creek
Braddock Bay
Oneida Lake
ST LAWRENCE
JEFFERSON
LEWIS
OSWEGO
ONEIDA
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
ONONDAGA
MADISON
CAYUGA
ONTARIO
SENECA
ERIE
WYOMING
LIVINGSTON
YATES
CORTLAND
CHENANGO
TOMPKINS
SCHUYLER
CATTARAUGUS
ALLEGANY
STEUBEN
CHEMUNG
TIOGA
BROOME
6
7
8
9
0
37.5
75
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
N
longear sunfish
NYS Canals
Open Water
Major Stream
OOCW Boundary
JCW Boundary
TCW Boundary
County Border
NYSDEC Region
6
7
8
9
Note: Red triangles represent known capture sites for longear sunfish.



N
Map 1b. Watersheds of Study in Western NYS
Lake Ontario
NIAGARA
ORLEANS
MONROE
Johnson Creek
Erie Canal
Oak Orchard Creek
GENESEE
Tonawanda Creek
Niagara River
Lake Erie
ERIE
WYOMING
Legend
OOCW Boundary
JCW Boundary
TCW Boundary
Erie Canal
Great Lakes
Streams
County Border
NYSDEC
Regions
8
9
0
10
20
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

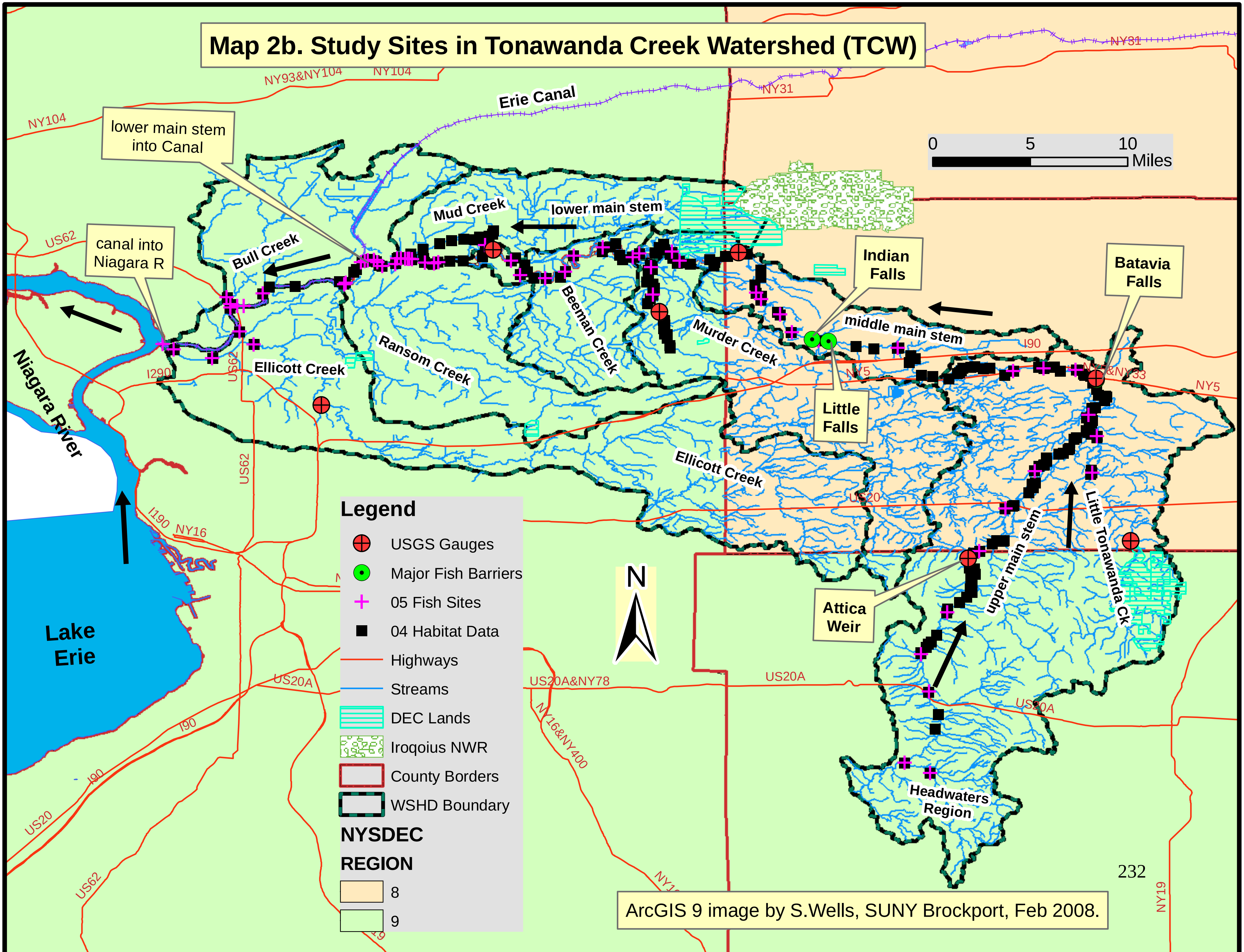

Map 1c. Pool-Type (PT) Habitats Sampled in the Tonawanda Creek Watershed
Erie Canal
Bull Creek
Mud Creek
Lower Main Stem
Ransom Creek
Beeman Creek
Ellicott Creek
Middle Main Stem
Murder Creek
Indian Falls
Little Falls
Batavia Falls
Ellicott Creek
Upper Main Stem
Little Tonawanda Creek
Attica Weir
Headwaters Region
0 5 10 Miles
N
Legend
Major Fish Barriers
Listed Dams
2005
PT Scores
1
2
3
4
Streams
Wshd Boundary
ArcGIS 9 image by S.Wells, SUNY Brockport, Mar 2008.


Map 1d. Pool-Type (PT) Habitats Sampled in the Johnson Creek Watershed
N
Lake Ontario
Lyndonville Village Dam
Upper Johnson Creek
Lower Johnson Creek
Erie Canal
Upper West Fork
Upper East Fork (Jeddo Creek)
Headwaters
0
2.5
5
Miles
Legend
Major Fish Barriers
Listed Dams
2005
PT Scores
1
2
3
4
Streams
Wshd Boundary
ArcGIS 9 image by S.Wells, SUNY Brockport, Mar 2008.

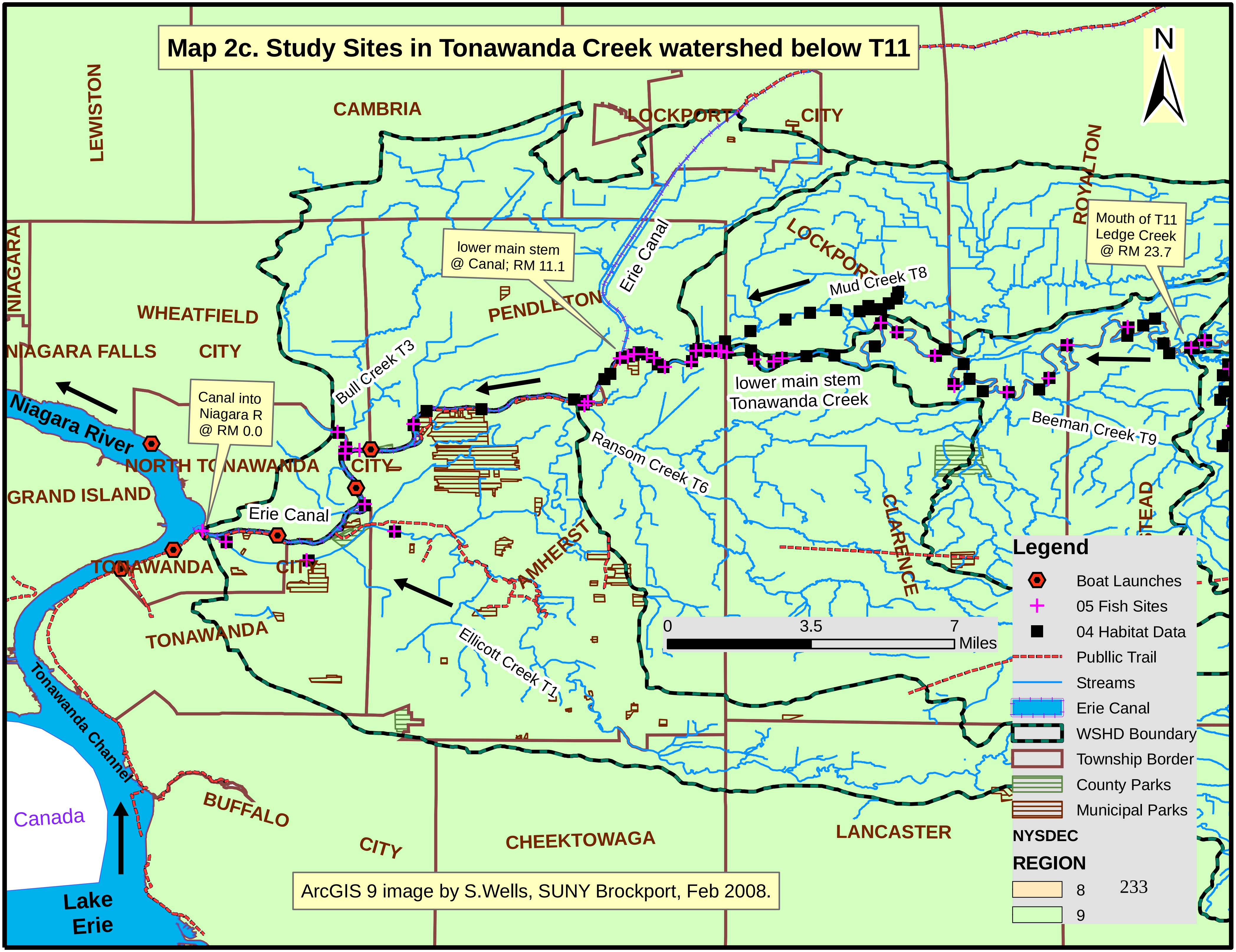


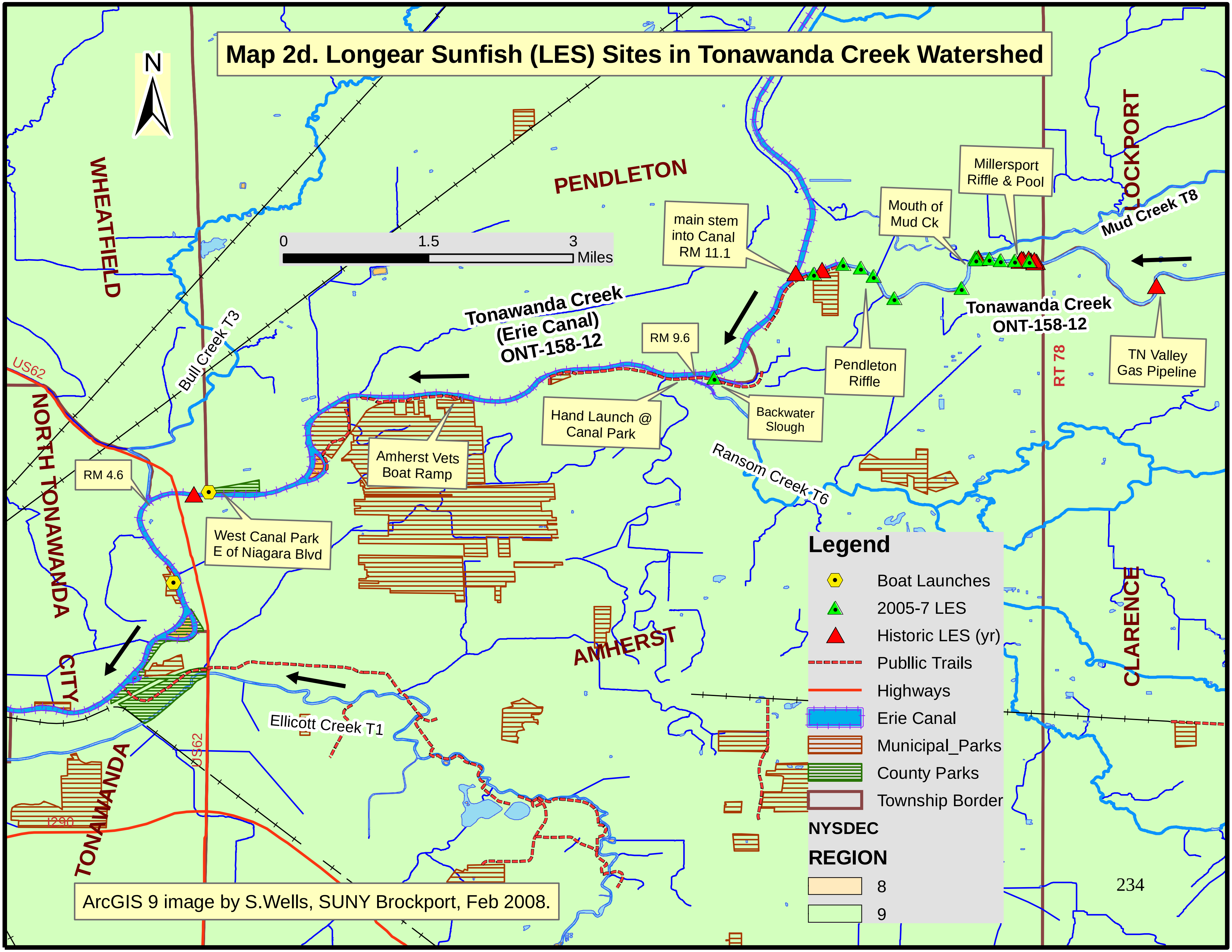
Map 2a. Tonawanda Creek Watershed ONT-158-12

ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

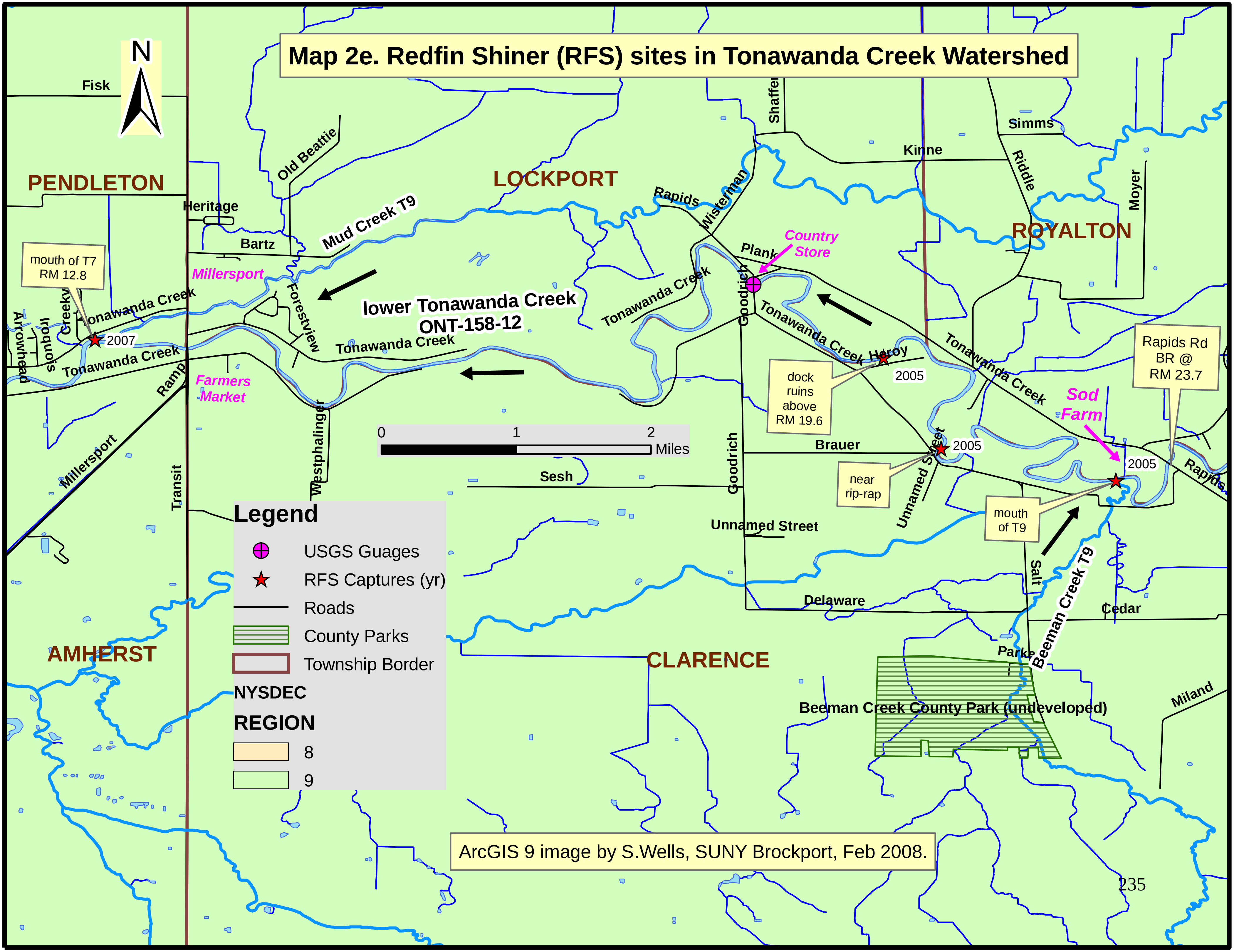


Map 2b. Study Sites in Tonawanda Creek Watershed (TCW)
NY93&NY104
NY104
Erie Canal
NY31
NY104
lower main stem into Canal
0
5
10
Miles
Mud Creek
lower main stem
US62
canal into Niagara R
Bull Creek
Indian Falls
Batavia Falls
Beeman Creek
Murder Creek
middle main stem
I90
Niagara River
Ransom Creek
Ellicott Creek
I290
US62
NY5
NY5
Little Falls
Ellicott Creek
US20
US62
I190
NY16
upper main stem
Little Tonawanda Ck
Legend
USGS Gauges
Major Fish Barriers
05 Fish Sites
04 Habitat Data
Highways
Streams
DEC Lands
Iroqoius NWR
County Borders
WSHD Boundary
NYSDEC
REGION
8
9
N
Attica Weir
Lake Erie
US20A
US20A&NY78
US20A
US20A
I90
NY16&NY400
I90
US20
US62
Headwaters Region
NY19
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

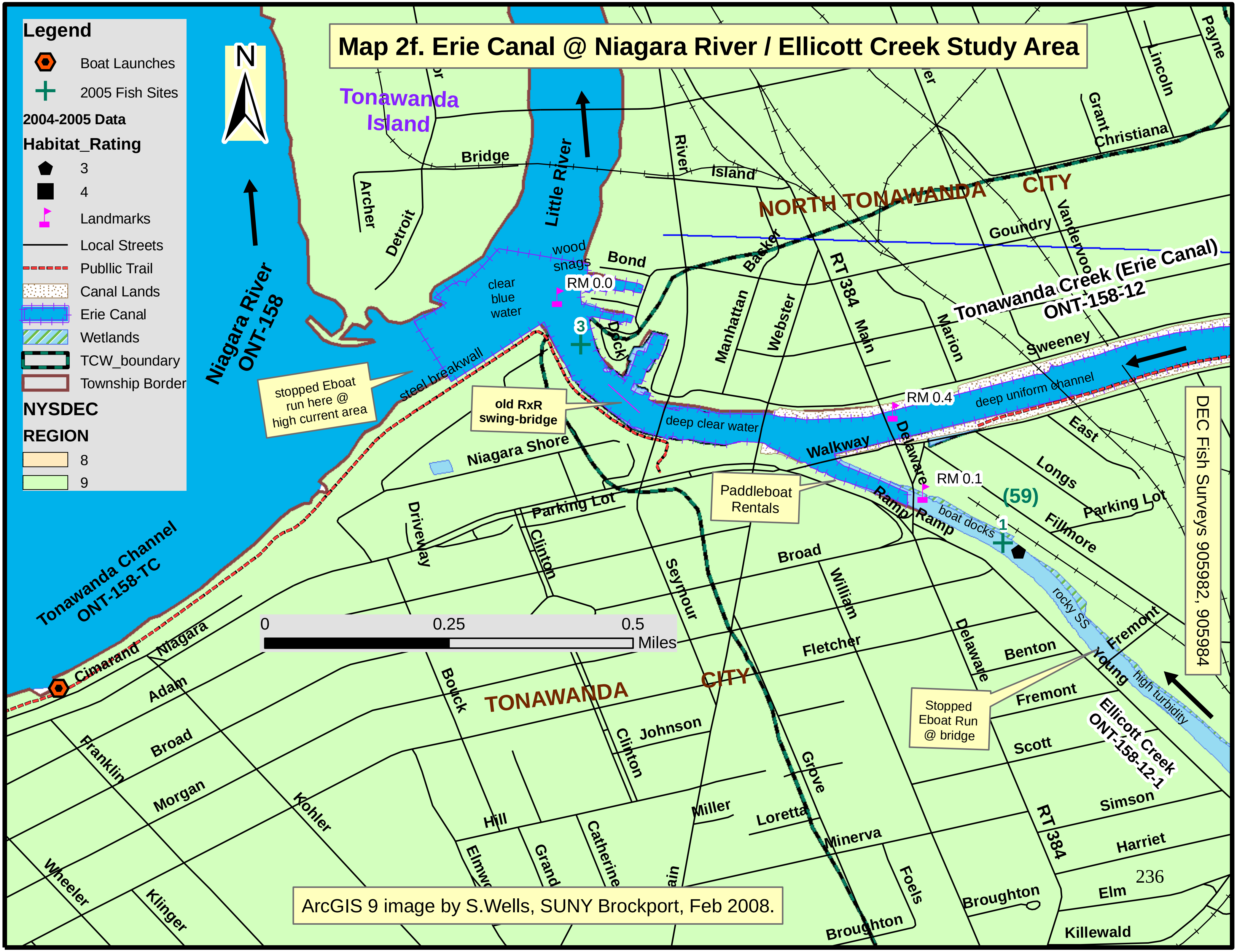

Map 2c. Study Sites in Tonawanda Creek watershed below T11
N
LEWISTON
CAMBRIA
LOCKPORT
CITY
ROYALTON
NIAGARA
WHEATFIELD
NIAGARA FALLS
CITY
PENDLETON
LOCKPORT
lower main stem
@ Canal; RM 11.1
Erie Canal
Mud Creek T8
Mouth of T11
Ledge Creek
@ RM 23.7
Bull Creek T3
lower main stem
Tonawanda Creek
Beeman Creek T9
Canal into
Niagara R
@ RM 0.0
Niagara River
NORTH TONAWANDA
CITY
Ransom Creek T6
GRAND ISLAND
Erie Canal
CLARENCE
AMHERST
TONAWANDA
CITY
TONAWANDA
Ellicott Creek T1
0
3.5
7
Miles
Legend
Boat Launches
05 Fish Sites
04 Habitat Data
Publlic Trail
Streams
Erie Canal
WSHD Boundary
Township Border
County Parks
Municipal Parks
NYSDEC
REGION
8
9
233
Tonawanda Channel
Canada
BUFFALO
CITY
CHEEKTOWAGA
LANCASTER
Lake
Erie
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



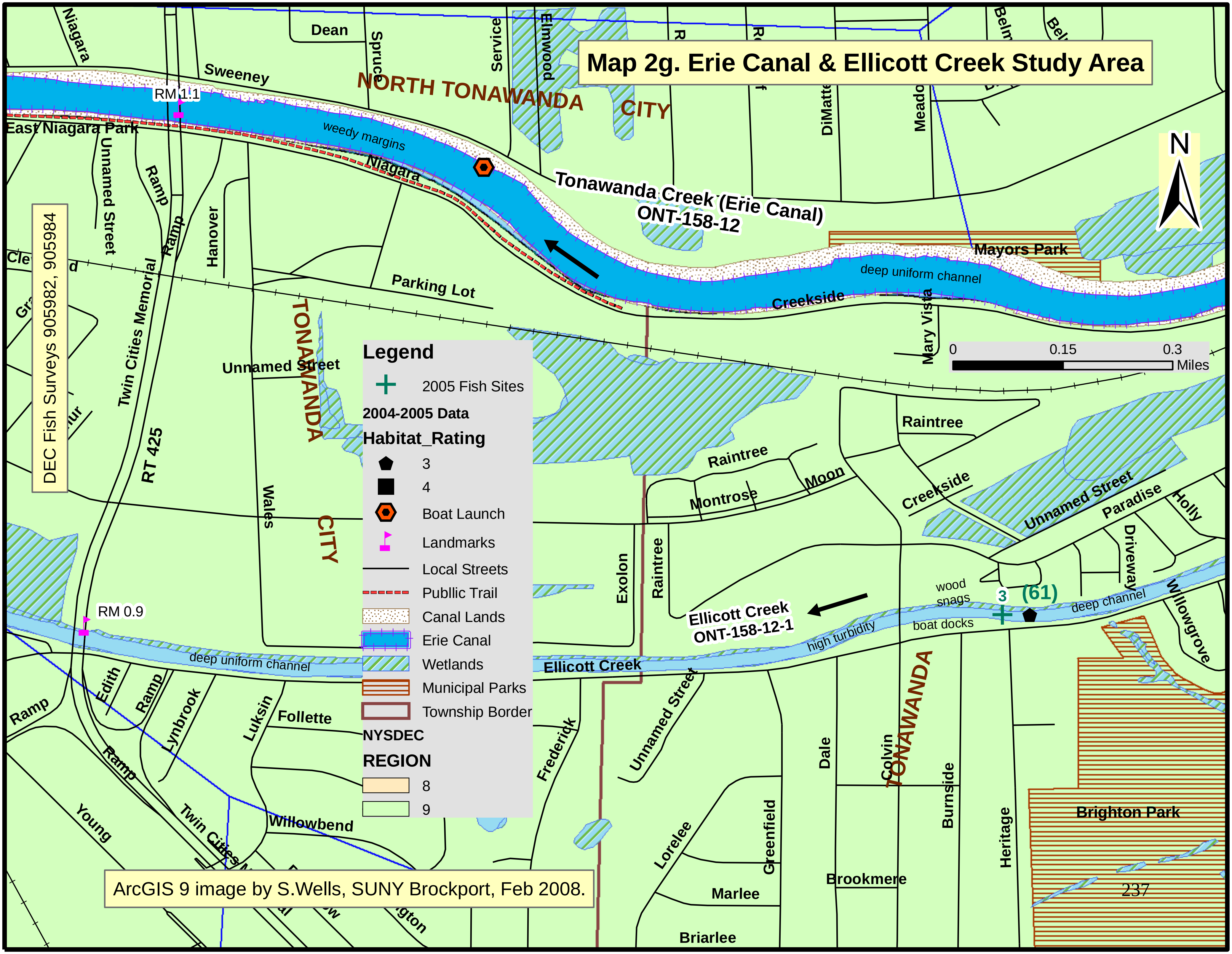
Map 2d. Longear Sunfish (LES) Sites in Tonawanda Creek Watershed
N
0
1.5
3
Miles
PENDLETON
WHEATFIELD
LOCKPORT
NORTH TONAWANDA
CITY
TONAWANDA
AMHERST
CLARENCE
US62
RT 78
I290
Bull Creek T3
Mud Creek T8
Ransom Creek T6
Ellicott Creek T1
Tonawanda Creek
(Erie Canal)
ONT-158-12
Tonawanda Creek
ONT-158-12
main stem into Canal RM 11.1
Mouth of Mud Ck
Millersport Riffle & Pool
RM 9.6
Pendleton Riffle
TN Valley Gas Pipeline
Hand Launch @ Canal Park
Backwater Slough
Amherst Vets Boat Ramp
RM 4.6
West Canal Park E of Niagara Blvd
Legend
Boat Launches
2005-7 LES
Historic LES (yr)
Publlic Trails
Highways
Erie Canal
Municipal_Parks
County Parks
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



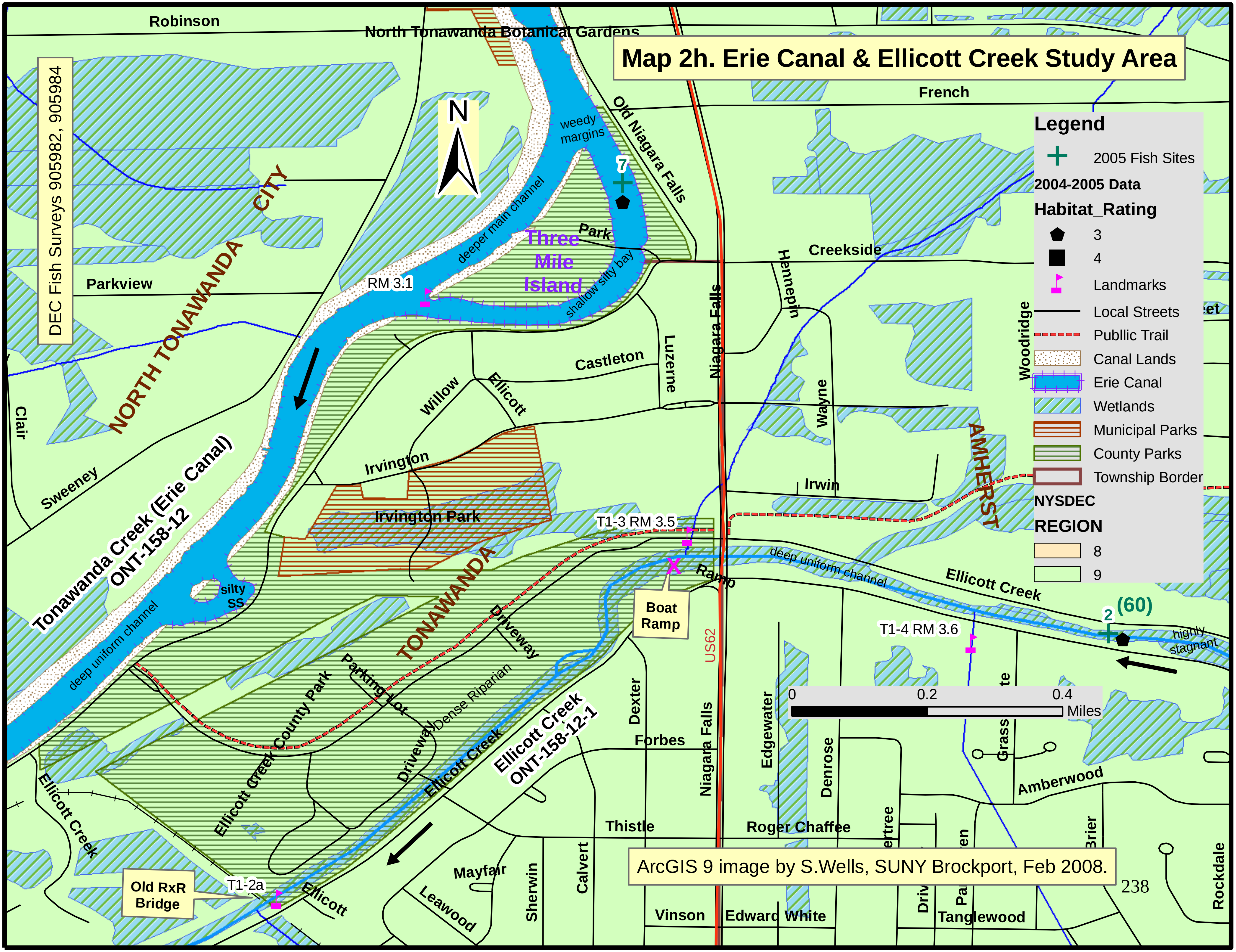
Map 2e. Redfin Shiner (RFS) sites in Tonawanda Creek Watershed
N
Fisk
PENDLETON
LOCKPORT
ROYALTON
AMHERST
CLARENCE
Old Beattie
Heritage
Bartz
Mud Creek T9
Millersport
Forestview
lower Tonawanda Creek
ONT-158-12
Tonawanda Creek
mouth of T7
RM 12.8
2007
Arrowhead
Iroquois
Ramp
Farmers Market
Westphalinger
Transit
Millersport
Sesh
Rapids
Wisterman
Shaffer
Kinne
Simms
Riddle
Moyer
Plank
Country Store
Goodrich
Heroy
2005
dock ruins above RM 19.6
Brauer
Unnamed Street
near rip-rap
Sod Farm
Rapids Rd BR @ RM 23.7
mouth of T9
Salt
Beeman Creek T9
Delaware
Cedar
Parker
Beeman Creek County Park (undeveloped)
Miland
0
1
2
Miles
Legend
USGS Guages
RFS Captures (yr)
Roads
County Parks
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



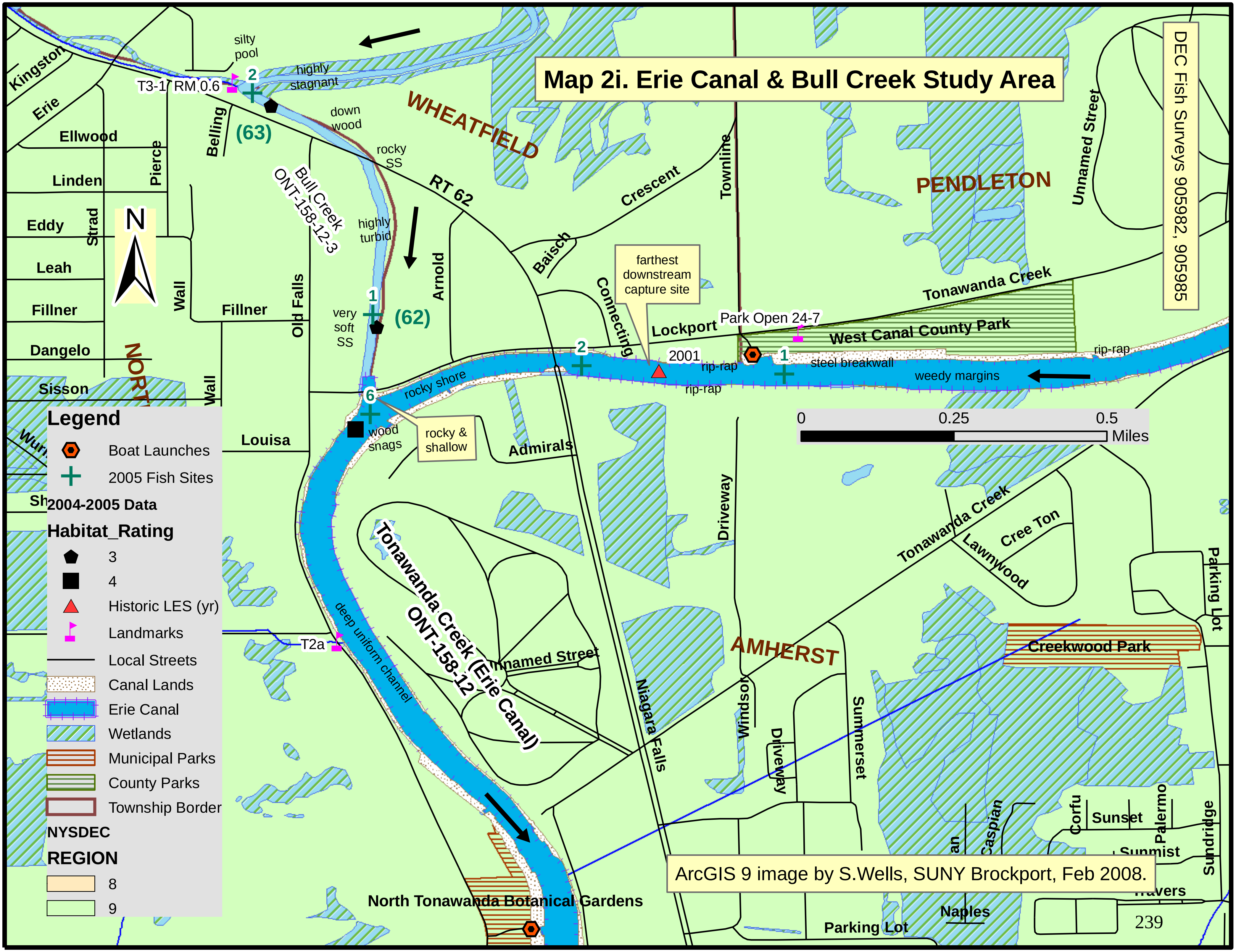
Map 2f. Erie Canal @ Niagara River / Ellicott Creek Study Area
Legend
Boat Launches
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Local Streets
Publlic Trail
Canal Lands
Erie Canal
Wetlands
TCW_boundary
Township Border
NYSDEC
REGION
8
9
N
Tonawanda Island
Niagara River ONT-158
Little River
Tonawanda Channel ONT-158-TC
NORTH TONAWANDA CITY
TONAWANDA CITY
Tonawanda Creek (Erie Canal) ONT-158-12
Ellicott Creek ONT-158-12-1
DEC Fish Surveys 905982, 905984
wood snags
clear blue water
RM 0.0
RM 0.4
RM 0.1
3
1
(59)
steel breakwall
stopped Eboat run here @ high current area
old RxR swing-bridge
deep clear water
deep uniform channel
Walkway
Paddleboat Rentals
boat docks
rocky SS
high turbidity
Stopped Eboat Run @ bridge
0
0.25
0.5
Miles
Bridge
Island
Archer
Detroit
Bond
Dock
River
Backer
Manhattan
Webster
RT 384
Main
Marion
Goundry
Vandervoort
Grant
Christiana
Lincoln
Payne
Sweeney
Niagara Shore
Parking Lot
Driveway
Clinton
Seymour
Delaware
Ramp
East
Longs
Fillmore
Fremont
Broad
William
Fletcher
Benton
Young
Scott
Simson
Harriet
Elm
Killewald
Broughton
Foels
Minerva
Loretta
Grove
Miller
Johnson
Catherine
Grand
Elmwood
Hill
Bouck
Kohler
Morgan
Franklin
Adam
Niagara
Cimarand
Wheeler
Klinger
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



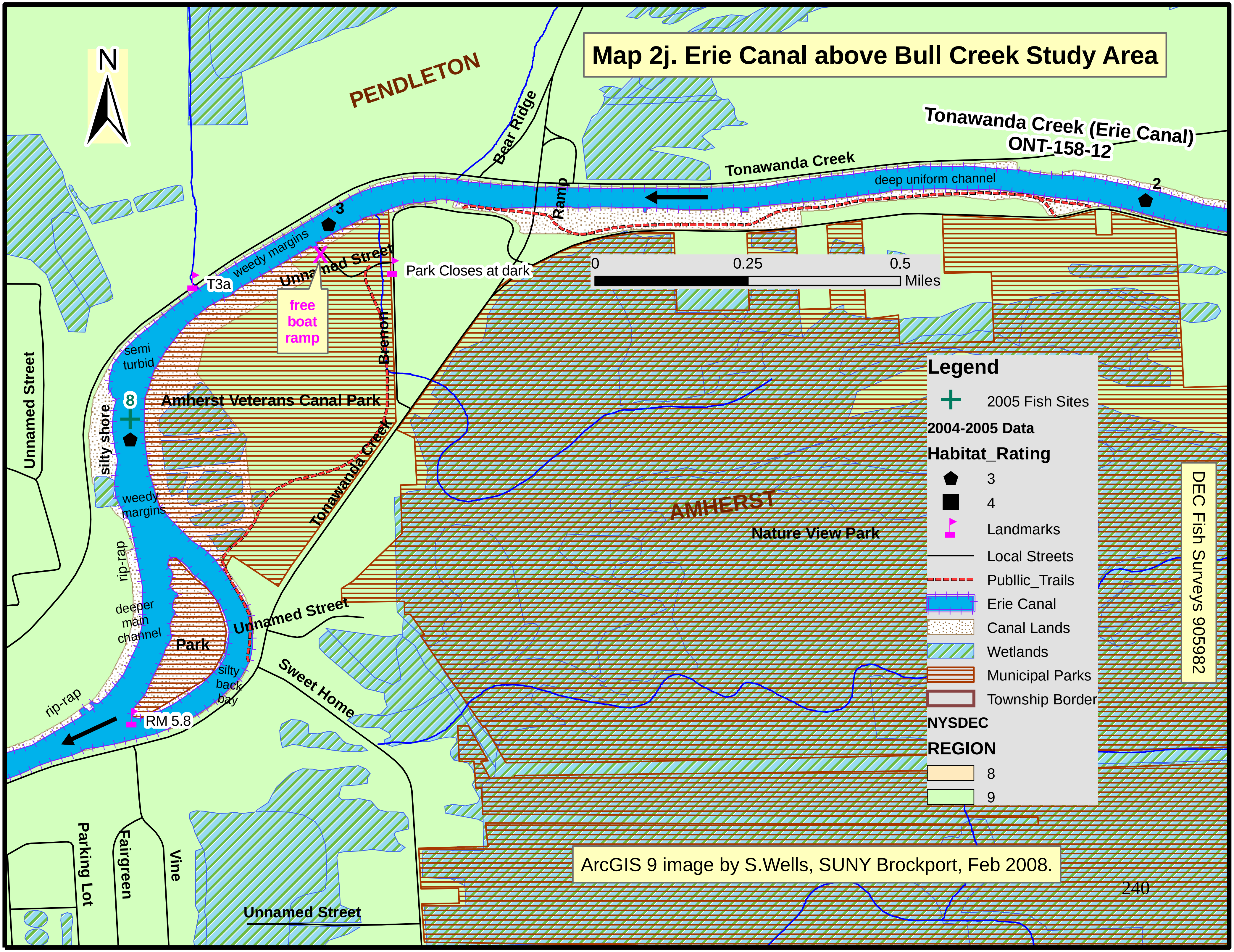
Map 2g. Erie Canal & Ellicott Creek Study Area
DEC Fish Surveys 905982, 905984
NORTH TONAWANDA CITY
TONAWANDA CITY
TONAWANDA
Tonawanda Creek (Erie Canal)
ONT-158-12
Ellicott Creek
ONT-158-12-1
RM 1.1
RM 0.9
weedy margins
deep uniform channel
wood snags
boat docks
high turbidity
deep channel
3
(61)
Mayors Park
Brighton Park
East Niagara Park
Parking Lot
N
0
0.15
0.3
Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Boat Launch
Landmarks
Local Streets
Publlic Trail
Canal Lands
Erie Canal
Wetlands
Municipal Parks
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

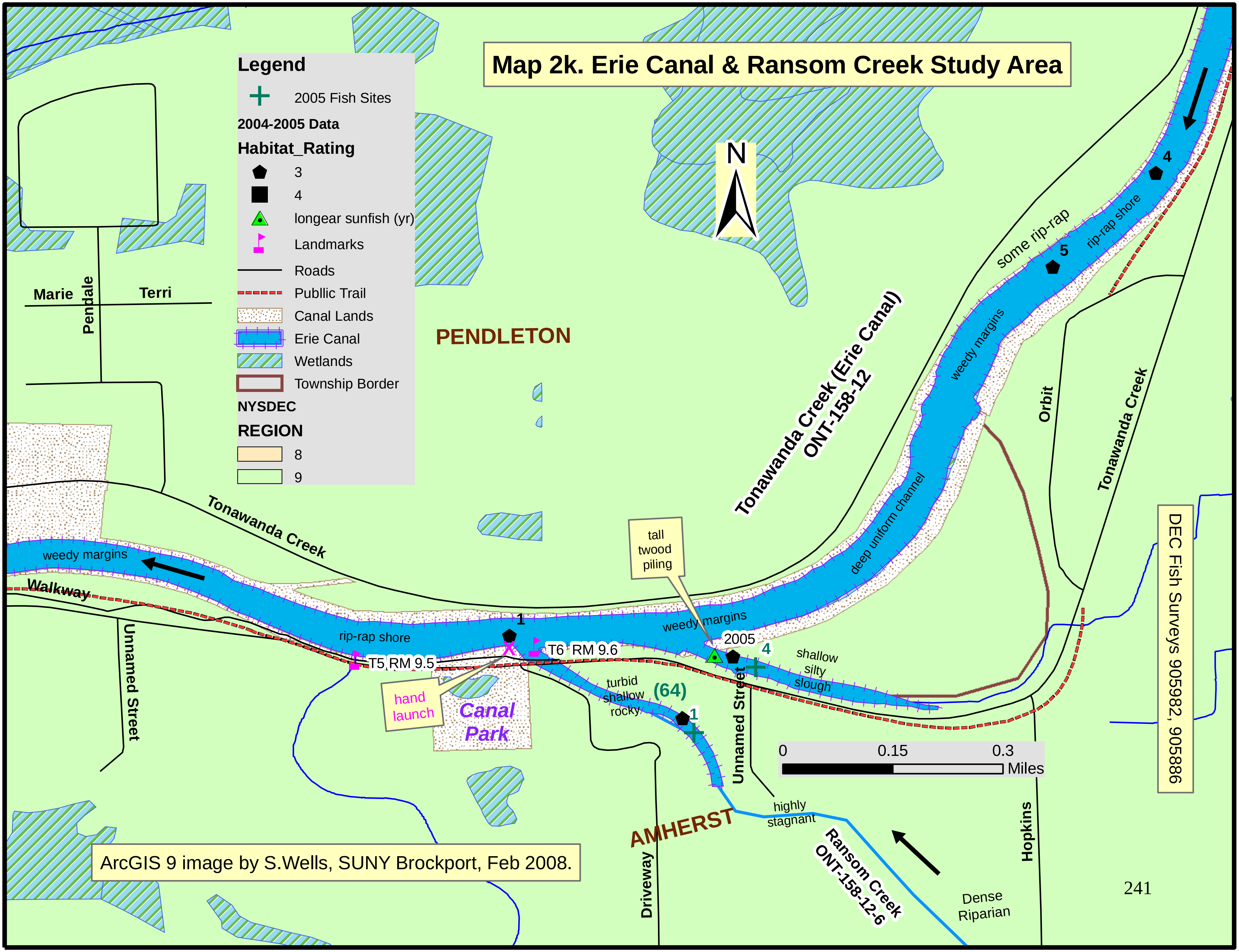


Map 2h. Erie Canal & Ellicott Creek Study Area
DEC Fish Surveys 905982, 905984
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Local Streets
Publlic Trail
Canal Lands
Erie Canal
Wetlands
Municipal Parks
County Parks
Township Border
NYSDEC
REGION
8
9
0
0.2
0.4
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Robinson
North Tonawanda Botanical Gardens
French
Old Niagara Falls
weedy margins
deeper main channel
Three Mile Island
Park
shallow silty bay
7
RM 3.1
Creekside
Hennepin
Parkview
NORTH TONAWANDA
CITY
Castleton
Luzerne
Niagara Falls
Woodridge
Wayne
Willow
Ellicott
Clair
Irvington
Irvington Park
Irwin
AMHERST
Sweeney
Tonawanda Creek (Erie Canal)
ONT-158-12
T1-3 RM 3.5
deep uniform channel
Ellicott Creek
Ramp
Boat Ramp
silty SS
TONAWANDA
Driveway
US62
(60)
2
T1-4 RM 3.6
highly stagnant
deep uniform channel
Parking Lot
Dense Riparian
Ellicott Creek County Park
Ellicott Creek
Ellicott Creek ONT-158-12-1
Dexter
Forbes
Edgewater
Denrose
Grass
Amberwood
Driveway
Ellicott Creek
Thistle
Roger Chaffee
Mayfair
Old RxR Bridge
T1-2a
Ellicott
Leawood
Sherwin
Calvert
Vinson
Edward White
Tanglewood
Rockdale
Brier

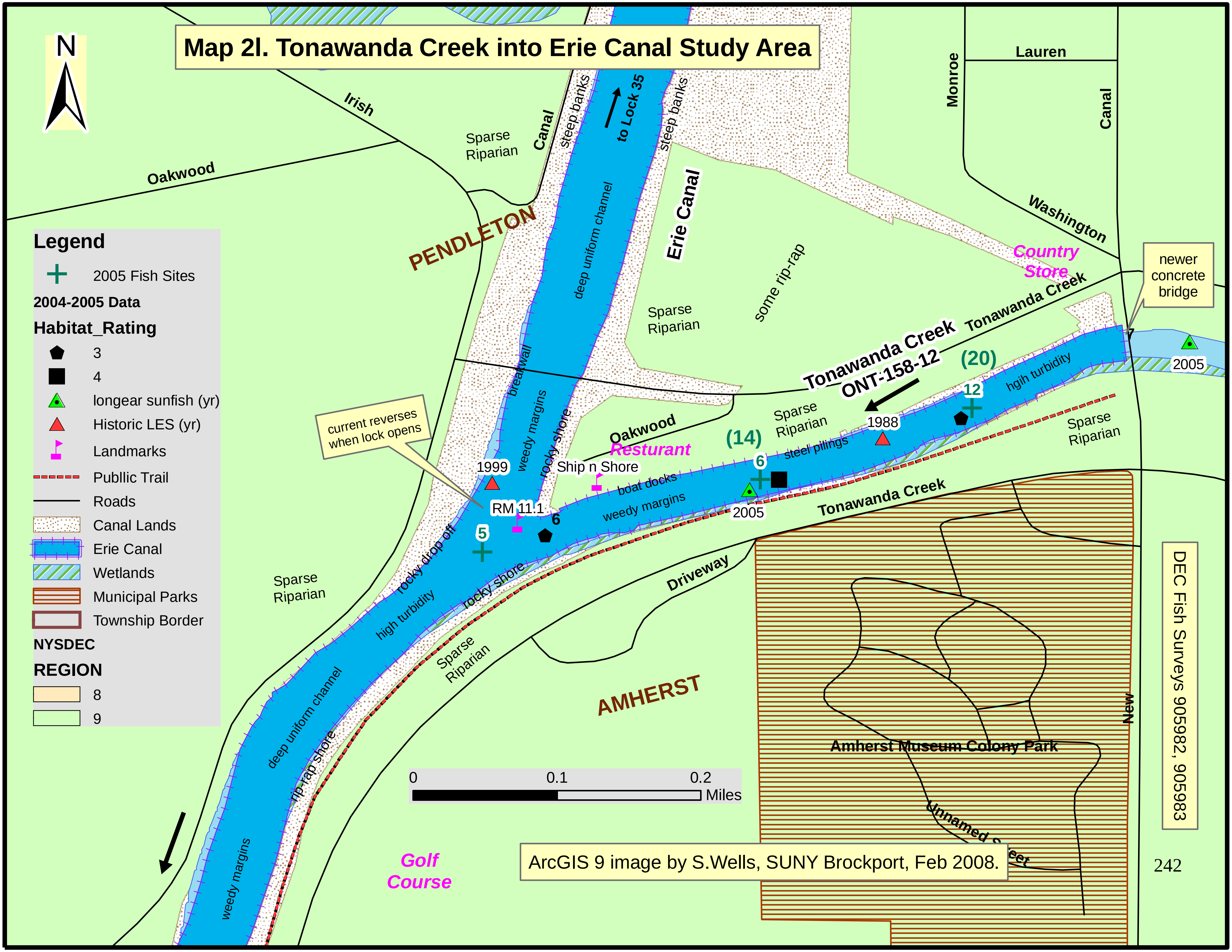


Map 2i. Erie Canal & Bull Creek Study Area
DEC Fish Surveys 905982, 905985
WHEATFIELD
PENDLETON
AMHERST
Tonawanda Creek (Erie Canal) ONT-158-12
Bull Creek ONT-158-12-3
West Canal County Park
Park Open 24-7
farthest downstream capture site
2001
rip-rap
steel breakwall
weedy margins
rocky shore
rocky & shallow
wood snags
deep uniform channel
silty pool
highly stagnant
down wood
rocky SS
highly turbid
very soft SS
T3-1 RM 0.6
T2a
(63)
(62)
Creekwood Park
North Tonawanda Botanical Gardens
RT 62
Legend
Boat Launches
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Historic LES (yr)
Landmarks
Local Streets
Canal Lands
Erie Canal
Wetlands
Municipal Parks
County Parks
Township Border
NYSDEC REGION
8
9
0
0.25
0.5
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

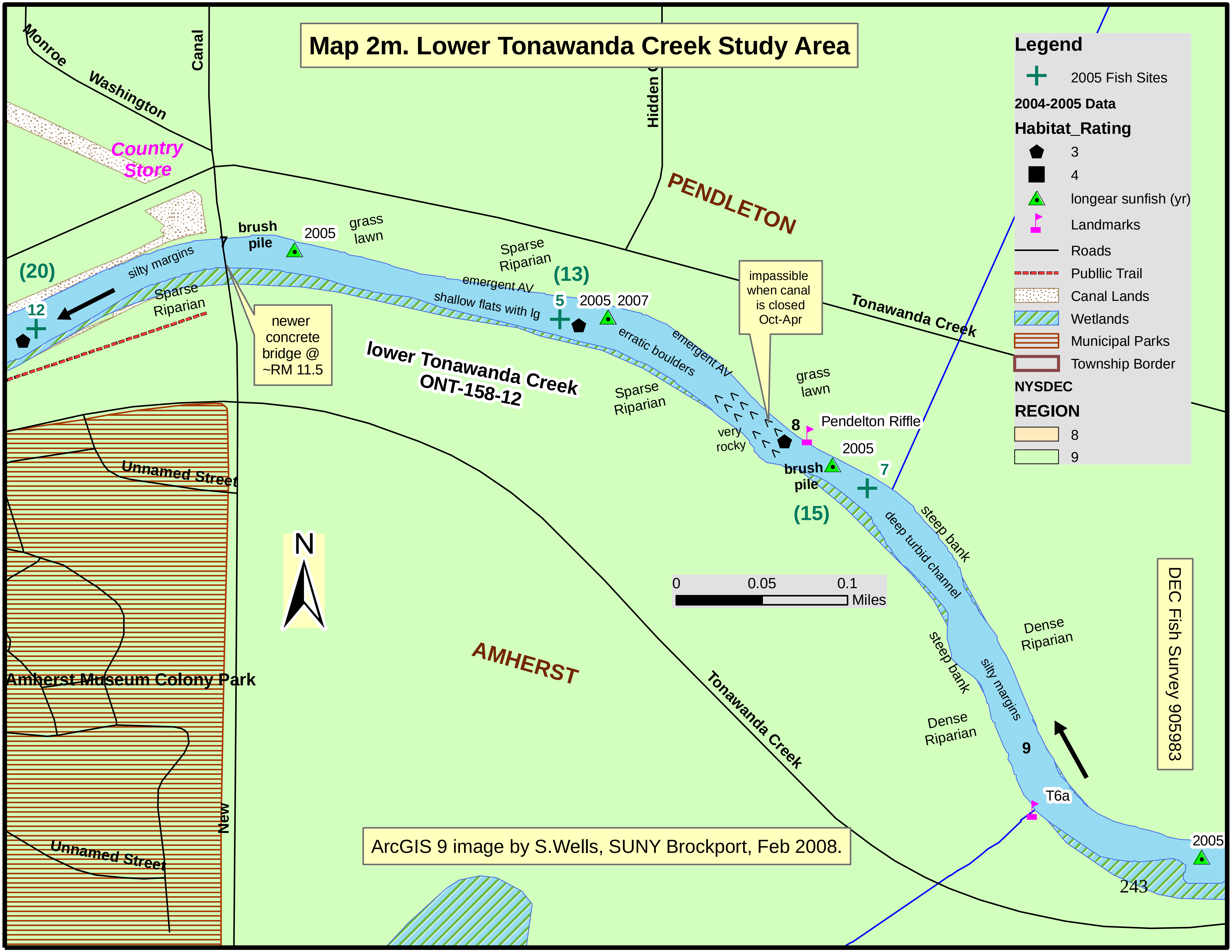

Map 2j. Erie Canal above Bull Creek Study Area
N
PENDLETON
Bear Ridge
Tonawanda Creek (Erie Canal)
ONT-158-12
Tonawanda Creek
deep uniform channel
2
3
Ramp
weedy margins
T3a
Unnamed Street
Park Closes at dark
free boat ramp
0
0.25
0.5
Miles
Brenon
semi turbid
8
Amherst Veterans Canal Park
Unnamed Street
silty shore
Tonawanda Creek
weedy margins
rip-rap
deeper main channel
Park
Unnamed Street
silty back bay
Sweet Home
rip-rap
RM 5.8
AMHERST
Nature View Park
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Local Streets
Publlic_Trails
Erie Canal
Canal Lands
Wetlands
Municipal Parks
Township Border
NYSDEC
REGION
8
9
DEC Fish Surveys 905982
Parking Lot
Fairgreen
Vine
Unnamed Street
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

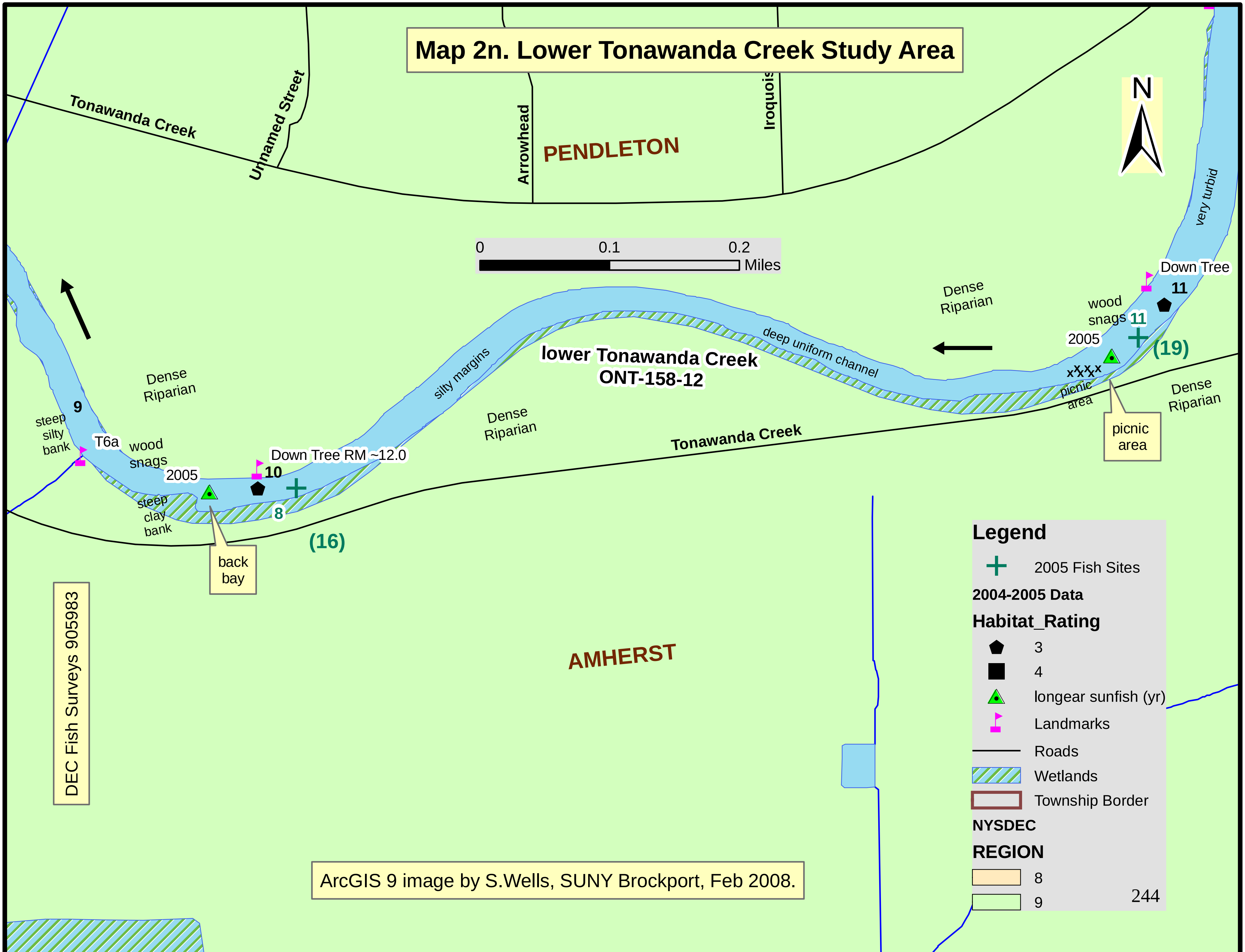


Map 2k. Erie Canal & Ransom Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
longear sunfish (yr)
Landmarks
Roads
Publlic Trail
Canal Lands
Erie Canal
Wetlands
Township Border
NYSDEC
REGION
8
9
N
PENDLETON
AMHERST
Marie
Terri
Pendale
Tonawanda Creek
Tonawanda Creek (Erie Canal)
ONT-158-12
weedy margins
Walkway
rip-rap shore
T5 RM 9.5
T6 RM 9.6
hand launch
Canal Park
turbid shallow rocky
(64)
tall twood piling
2005
shallow silty slough
deep uniform channel
some rip-rap
rip-rap shore
Orbit
Unnamed Street
Driveway
Hopkins
highly stagnant
Ransom Creek
ONT-158-12-6
Dense Riparian
0
0.15
0.3
Miles
DEC Fish Surveys 905982, 905886
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

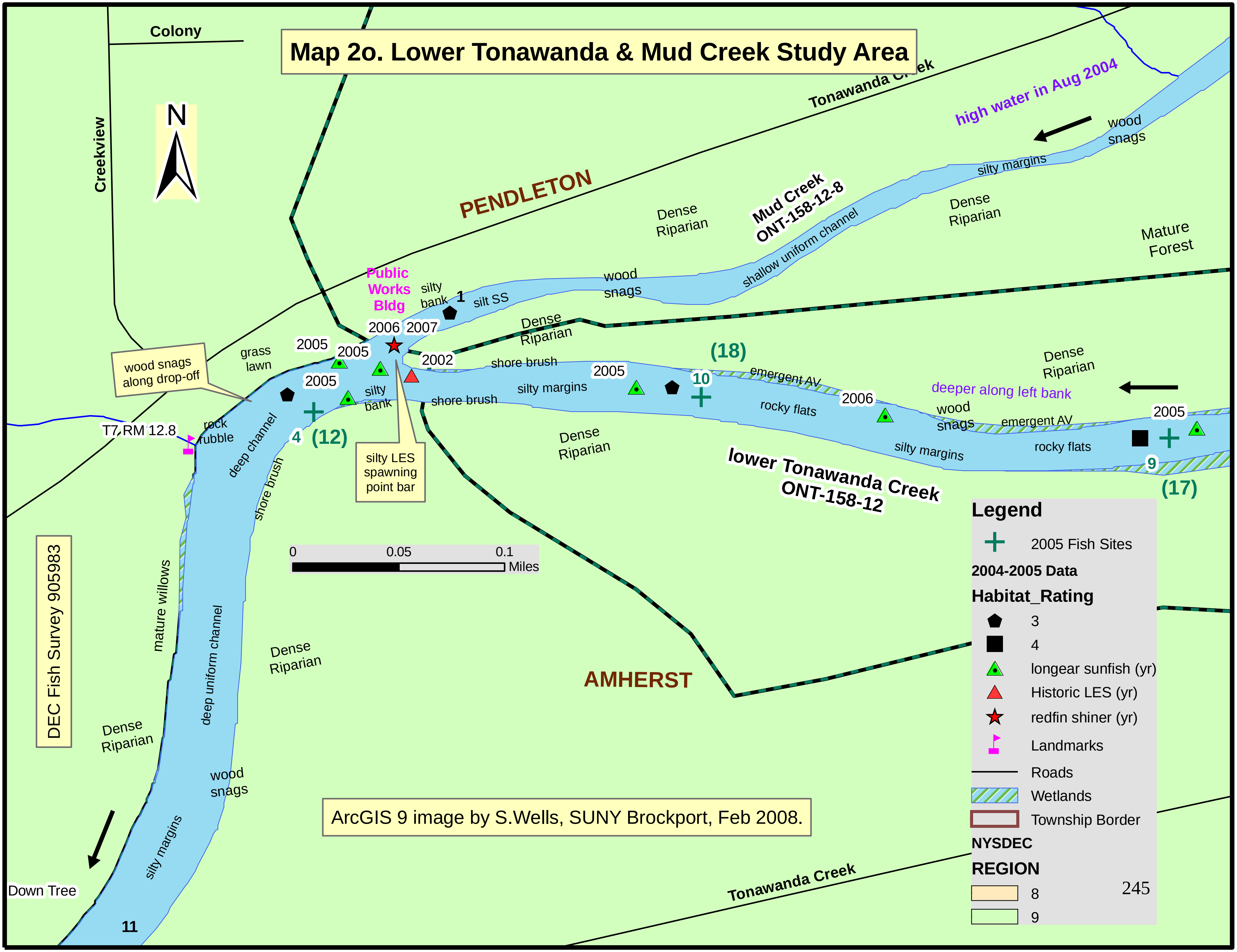


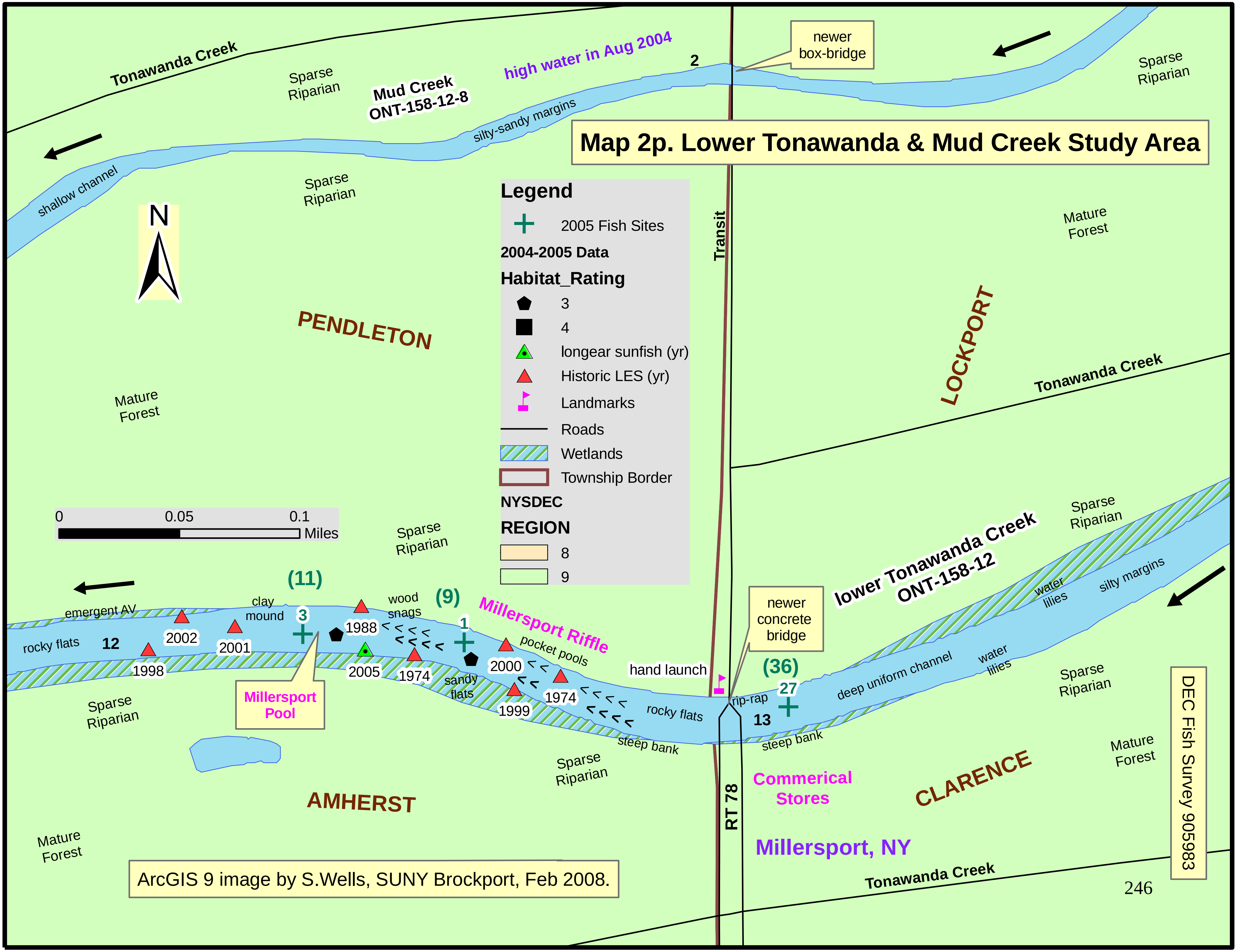
Map 2l. Tonawanda Creek into Erie Canal Study Area
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
longear sunfish (yr)
Historic LES (yr)
Landmarks
Publlic Trail
Roads
Canal Lands
Erie Canal
Wetlands
Municipal Parks
Township Border
NYSDEC
REGION
8
9
Irish
Oakwood
Canal
Sparse Riparian
steep banks
to Lock 35
deep uniform channel
Erie Canal
Monroe
Lauren
Canal
Washington
Country Store
newer concrete bridge
PENDLETON
some rip-rap
Tonawanda Creek
Tonawanda Creek ONT-158-12
(20)
hgih turbidity
2005
12
1988
(14)
steel pilings
6
Oakwood
Resturant
Ship n Shore
boat docks
weedy margins
breakwall
rocky shore
current reverses when lock opens
1999
RM 11.1
5
rocky drop off
high turbidity
rocky shore
Driveway
AMHERST
Amherst Museum Colony Park
Unnamed Street
New
DEC Fish Surveys 905982, 905983
0 0.1 0.2 Miles
Golf Course
rip-rap shore
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

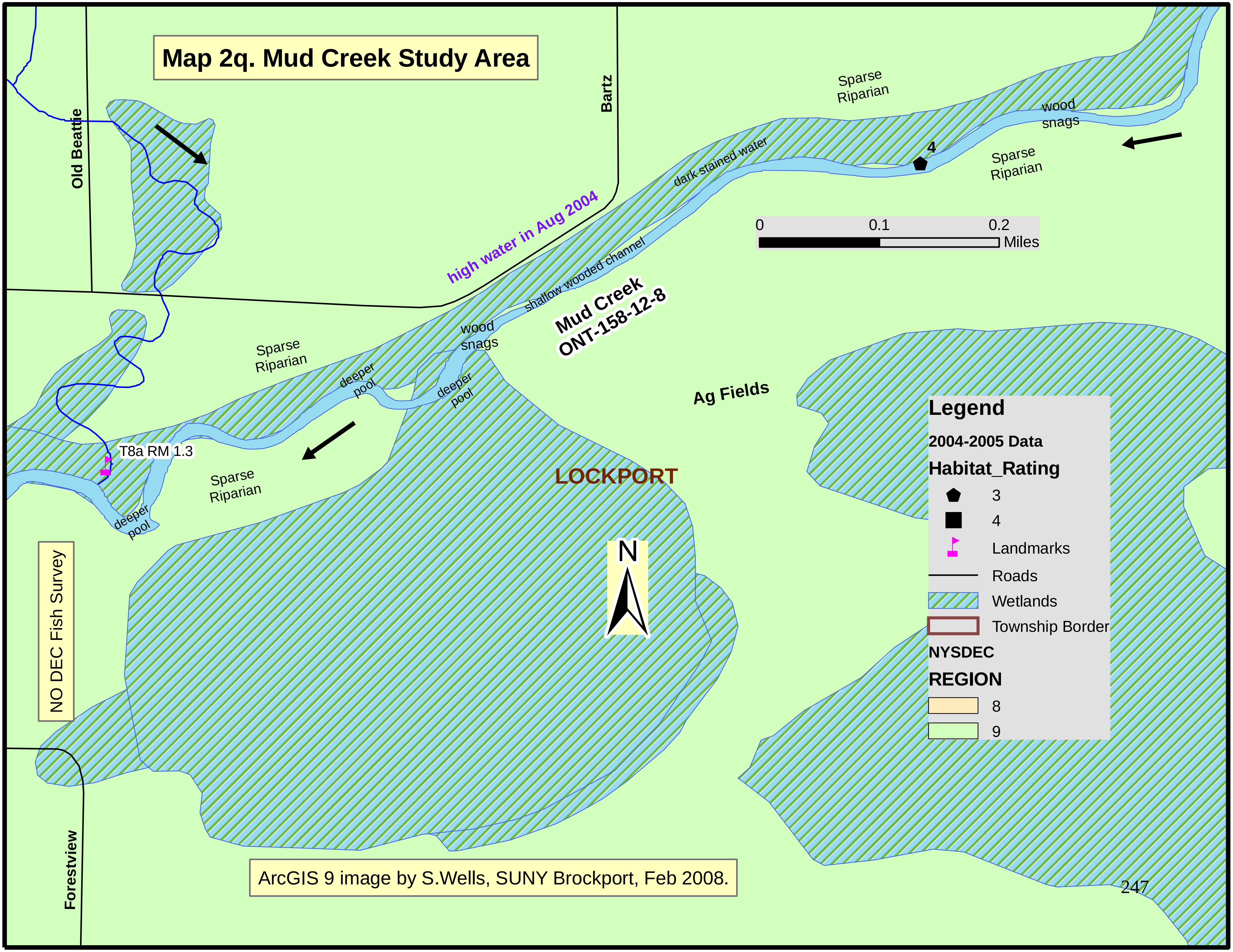

Map 2m. Lower Tonawanda Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
longear sunfish (yr)
Landmarks
Roads
Publlic Trail
Canal Lands
Wetlands
Municipal Parks
Township Border
NYSDEC
REGION
8
9
Monroe
Washington
Canal
Hidden C
Country Store
PENDLETON
AMHERST
Tonawanda Creek
lower Tonawanda Creek
ONT-158-12
(20)
12
silty margins
Sparse Riparian
brush pile
2005
grass lawn
Sparse Riparian
emergent AV
shallow flats with lg
(13)
5
2005
2007
newer concrete bridge @ ~RM 11.5
erratic boulders
emergent AV
impassible when canal is closed Oct-Apr
grass lawn
Sparse Riparian
very rocky
8
Pendelton Riffle
2005
brush pile
7
(15)
steep bank
deep turbid channel
Dense Riparian
steep bank
silty margins
Dense Riparian
9
T6a
2005
243
Unnamed Street
Amherst Museum Colony Park
Unnamed Street
New
N
0
0.05
0.1
Miles
DEC Fish Survey 905983
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



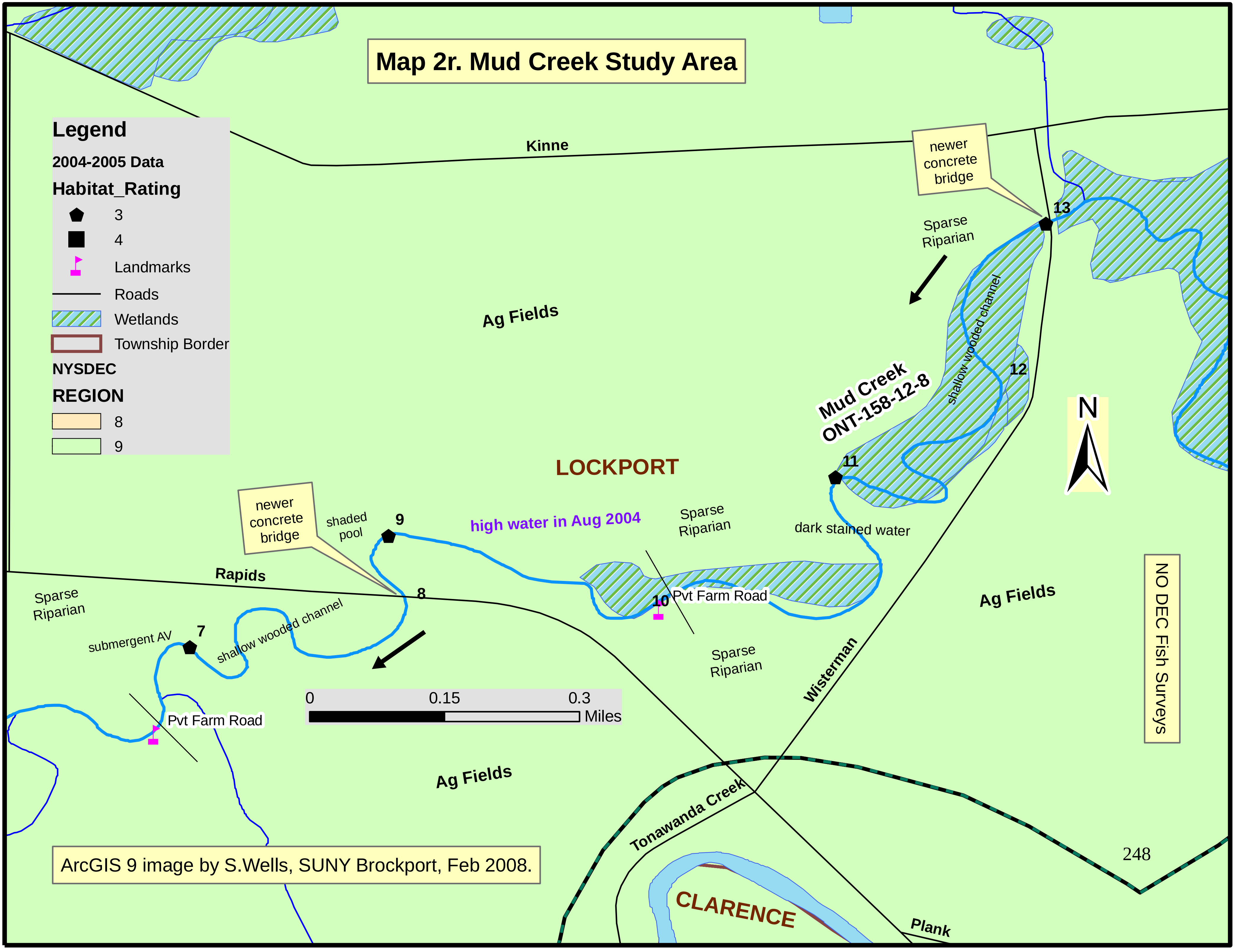
Map 2n. Lower Tonawanda Creek Study Area
PENDLETON
AMHERST
Tonawanda Creek
Unnamed Street
Arrowhead
Iroquois
N
0
0.1
0.2
Miles
lower Tonawanda Creek
ONT-158-12
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
silty margins
deep uniform channel
very turbid
Down Tree
11
wood snags
11
2005
(19)
picnic area
picnic area
steep silty bank
9
T6a
wood snags
2005
Down Tree RM ~12.0
10
steep clay bank
8
(16)
back bay
DEC Fish Surveys 905983
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
longear sunfish (yr)
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2o. Lower Tonawanda & Mud Creek Study Area
Colony
Creekview
N
PENDLETON
Tonawanda Creek
high water in Aug 2004
wood snags
silty margins
Dense Riparian
Mature Forest
Mud Creek ONT-158-12-8
shallow uniform channel
wood snags
Public Works Bldg
silty bank
1
silt SS
2006 2007
2005
2002
grass lawn
wood snags along drop-off
silty bank
silty LES spawning point bar
shore brush
silty margins
(18)
10
emergent AV
rocky flats
2006
deeper along left bank
emergent AV
rocky flats
9
(17)
lower Tonawanda Creek ONT-158-12
T7 RM 12.8
rock rubble
deep channel
shore brush
4 (12)
0 0.05 0.1 Miles
mature willows
deep uniform channel
DEC Fish Survey 905983
AMHERST
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
silty margins
Down Tree
11
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
longear sunfish (yr)
Historic LES (yr)
redfin shiner (yr)
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9

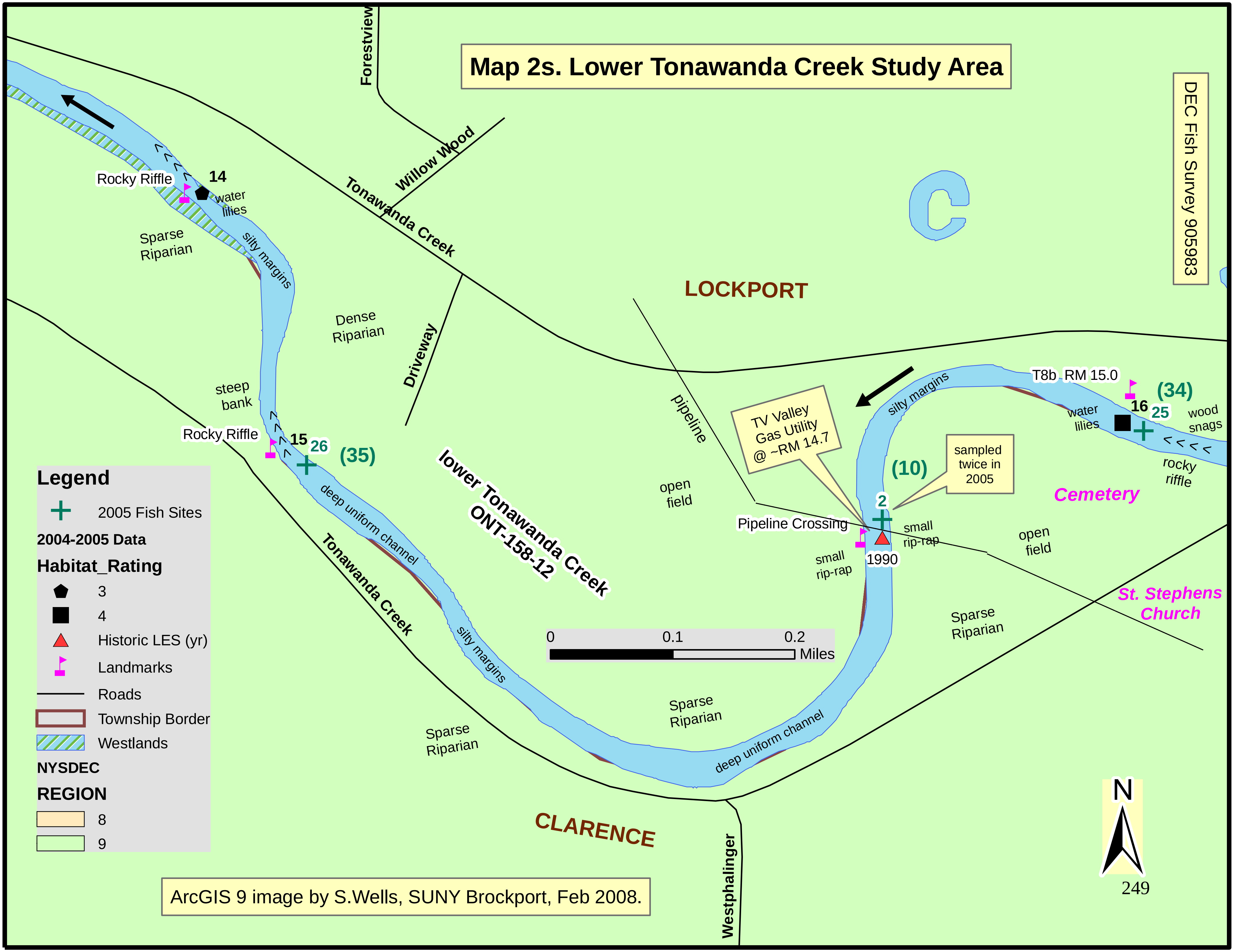

Map 2p. Lower Tonawanda & Mud Creek Study Area
Tonawanda Creek
Sparse Riparian
Mud Creek
ONT-158-12-8
high water in Aug 2004
2
newer box-bridge
silty-sandy margins
shallow channel
N
Mature Forest
PENDLETON
LOCKPORT
Transit
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
longear sunfish (yr)
Historic LES (yr)
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.05
0.1
Miles
lower Tonawanda Creek
ONT-158-12
water lilies
silty margins
(11)
(9)
(36)
emergent AV
clay mound
wood snags
rocky flats
12
3
1
27
13
2002
2001
1998
1988
2005
1974
2000
1999
Millersport Riffle
pocket pools
sandy flats
hand launch
newer concrete bridge
rip-rap
deep uniform channel
steep bank
Millersport Pool
AMHERST
CLARENCE
RT 78
Commerical Stores
Millersport, NY
DEC Fish Survey 905983
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

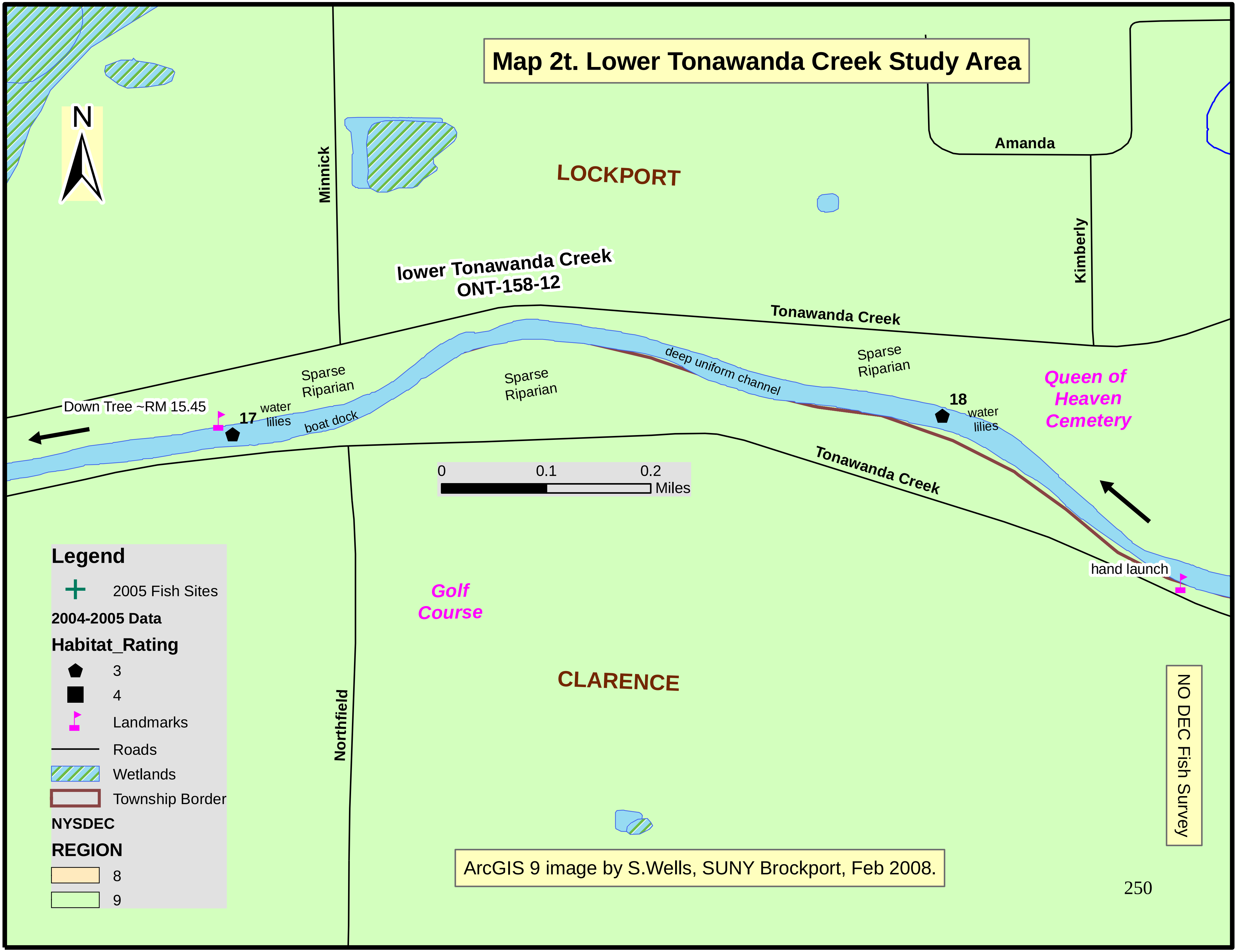


Map 2q. Mud Creek Study Area
Old Beattie
Bartz
Forestview
Sparse Riparian
wood snags
4
Sparse Riparian
dark stained water
high water in Aug 2004
shallow wooded channel
Mud Creek ONT-158-12-8
0
0.1
0.2
Miles
Sparse Riparian
wood snags
deeper pool
deeper pool
Ag Fields
T8a RM 1.3
Sparse Riparian
deeper pool
LOCKPORT
N
NO DEC Fish Survey
Legend
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

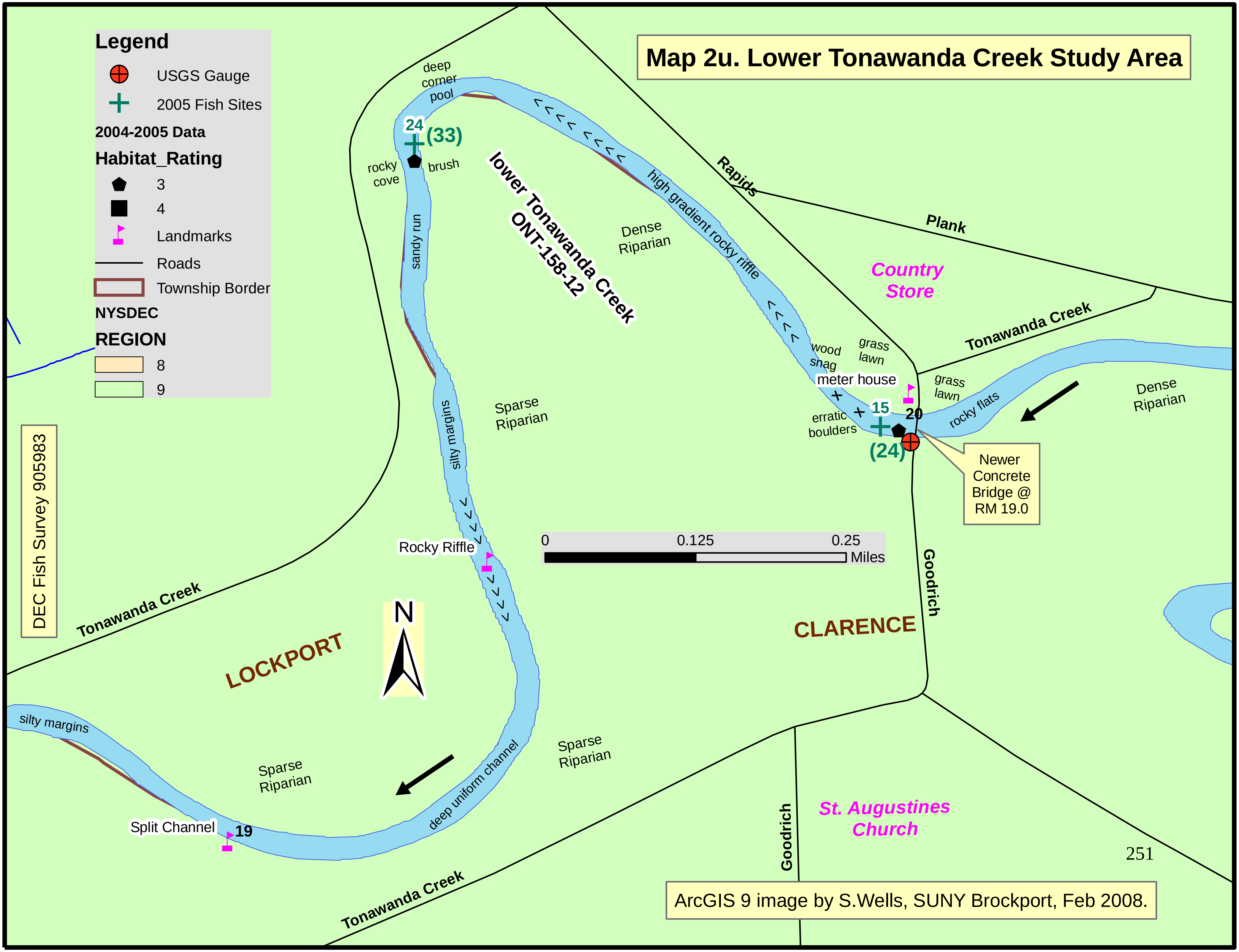


Map 2r. Mud Creek Study Area
Legend
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Kinne
newer concrete bridge
13
Sparse Riparian
Ag Fields
shallow wooded channel
12
Mud Creek ONT-158-12-8
N
LOCKPORT
11
newer concrete bridge
shaded pool
9
high water in Aug 2004
Sparse Riparian
dark stained water
Rapids
8
10
Pvt Farm Road
Ag Fields
Sparse Riparian
submergent AV
7
shallow wooded channel
Sparse Riparian
Wisterman
NO DEC Fish Surveys
0
0.15
0.3
Miles
Pvt Farm Road
Ag Fields
Tonawanda Creek
248
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
CLARENCE
Plank

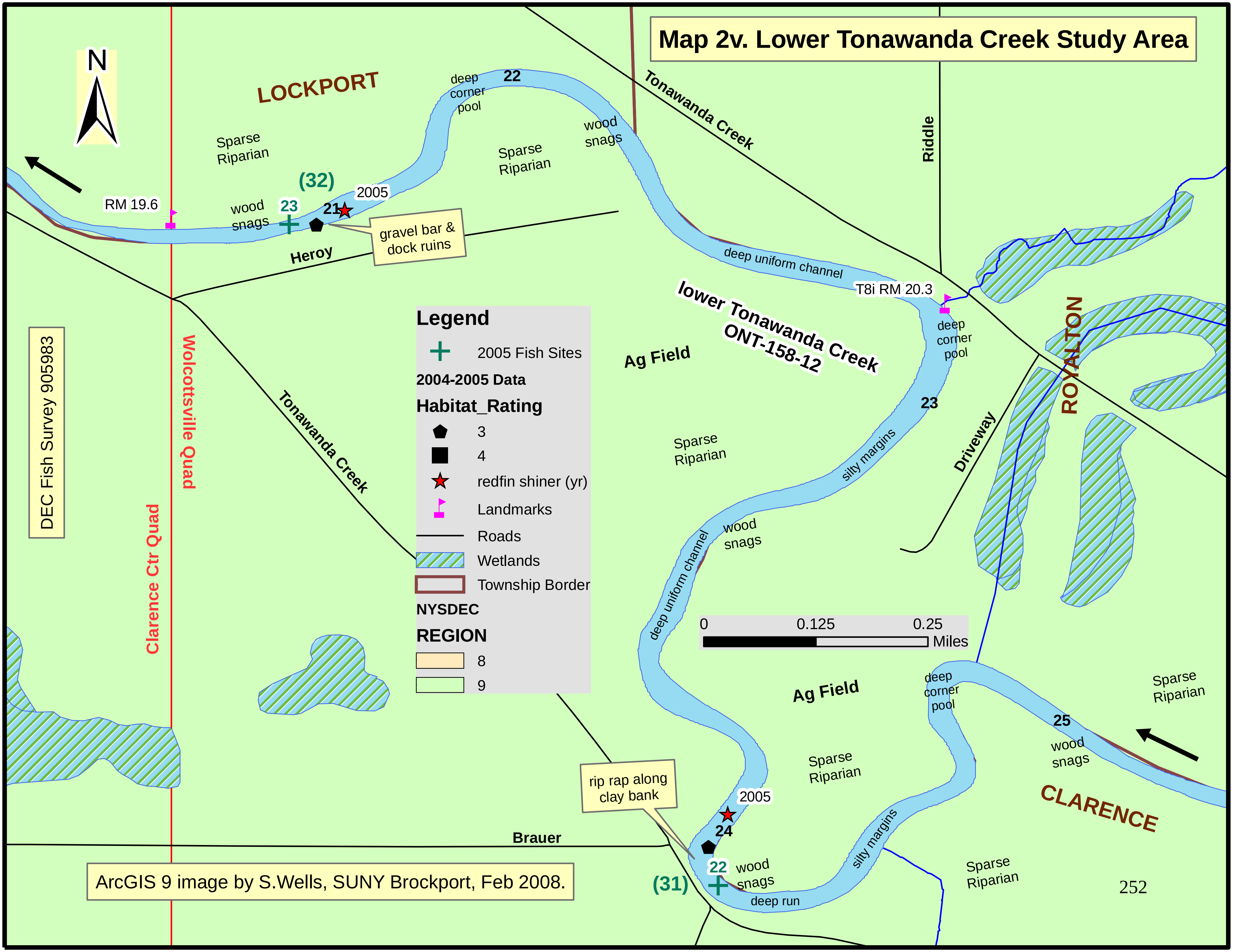

Map 2s. Lower Tonawanda Creek Study Area
DEC Fish Survey 905983
Forestview
Willow Wood
Tonawanda Creek
Rocky Riffle
14
water lilies
Sparse Riparian
silty margins
Dense Riparian
Driveway
LOCKPORT
pipeline
steep bank
Rocky Riffle
15
26
(35)
lower Tonawanda Creek
ONT-158-12
deep uniform channel
Tonawanda Creek
silty margins
TV Valley Gas Utility @ ~RM 14.7
silty margins
T8b RM 15.0
(34)
16
25
water lilies
wood snags
rocky riffle
(10)
sampled twice in 2005
Cemetery
open field
2
Pipeline Crossing
small rip-rap
small rip-rap
1990
open field
St. Stephens Church
Sparse Riparian
0
0.1
0.2
Miles
Sparse Riparian
deep uniform channel
Sparse Riparian
CLARENCE
Westphalinger
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Historic LES (yr)
Landmarks
Roads
Township Border
Westlands
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



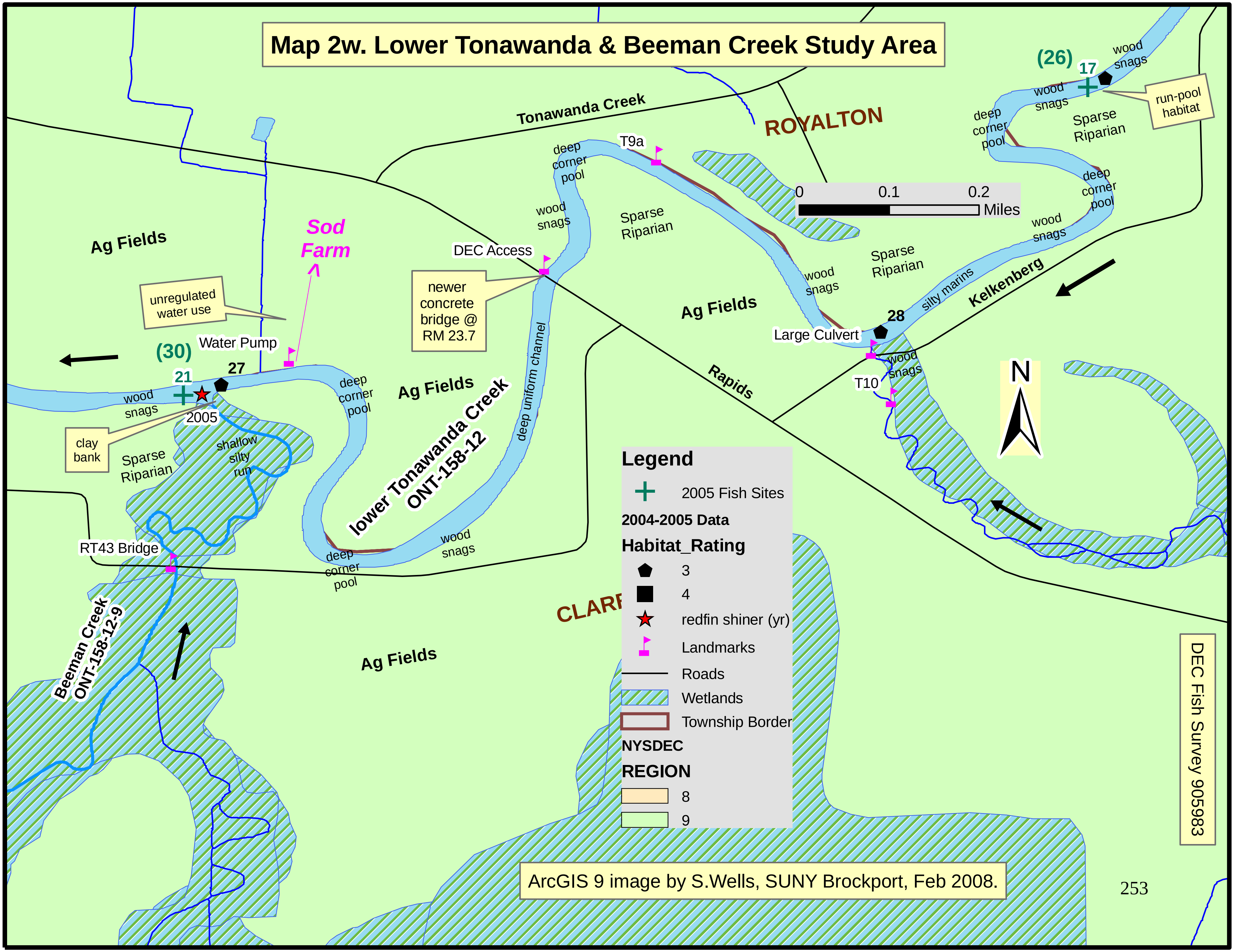
Map 2t. Lower Tonawanda Creek Study Area
N
LOCKPORT
Minnick
Amanda
Kimberly
lower Tonawanda Creek
ONT-158-12
Tonawanda Creek
deep uniform channel
Sparse Riparian
Sparse Riparian
Sparse Riparian
Queen of Heaven Cemetery
Down Tree ~RM 15.45
17
water lilies
boat dock
18
water lilies
Tonawanda Creek
0 0.1 0.2 Miles
hand launch
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Golf Course
CLARENCE
Northfield
NO DEC Fish Survey
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

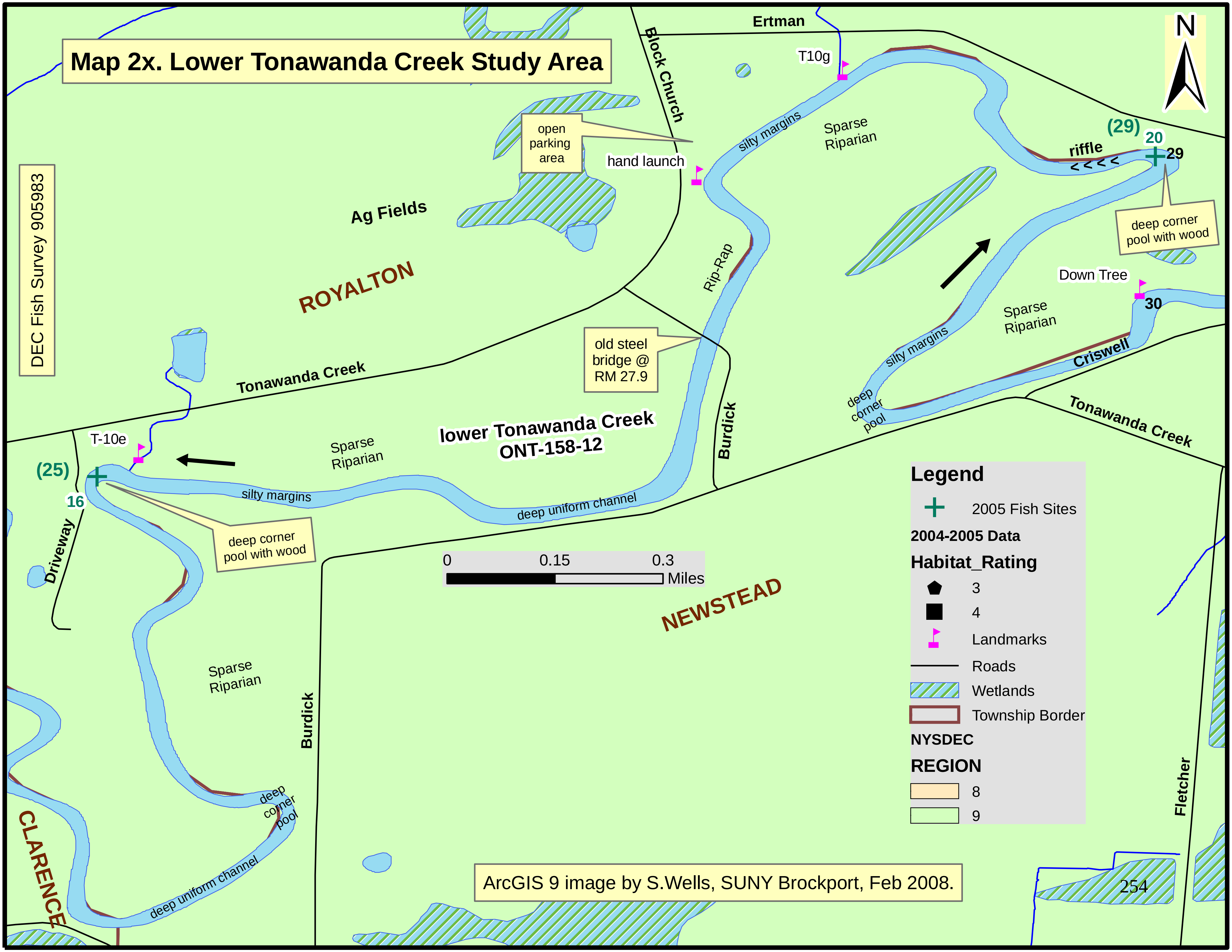


Map 2u. Lower Tonawanda Creek Study Area
Legend
USGS Gauge
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Township Border
NYSDEC
REGION
8
9
DEC Fish Survey 905983
deep corner pool
24
(33)
rocky cove
brush
sandy run
lower Tonawanda Creek
ONT-158-12
high gradient rocky riffle
Dense Riparian
Rapids
Plank
Country Store
Tonawanda Creek
wood snag
grass lawn
meter house
grass lawn
rocky flats
Dense Riparian
erratic boulders
15
(24)
20
Newer Concrete Bridge @ RM 19.0
silty margins
Sparse Riparian
Rocky Riffle
0
0.125
0.25
Miles
Goodrich
Tonawanda Creek
N
LOCKPORT
CLARENCE
silty margins
Sparse Riparian
Sparse Riparian
deep uniform channel
Split Channel
19
Tonawanda Creek
Goodrich
St. Augustines Church
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

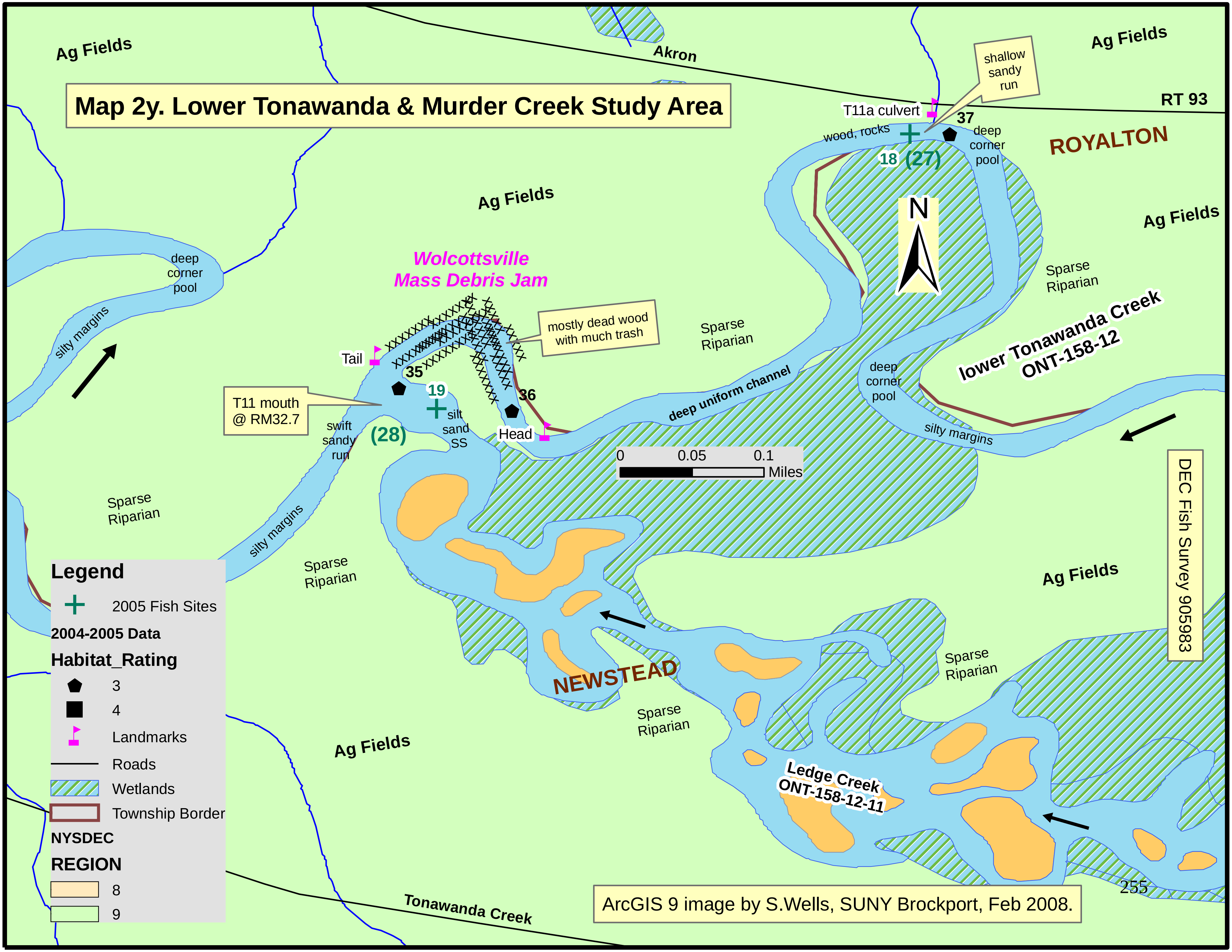


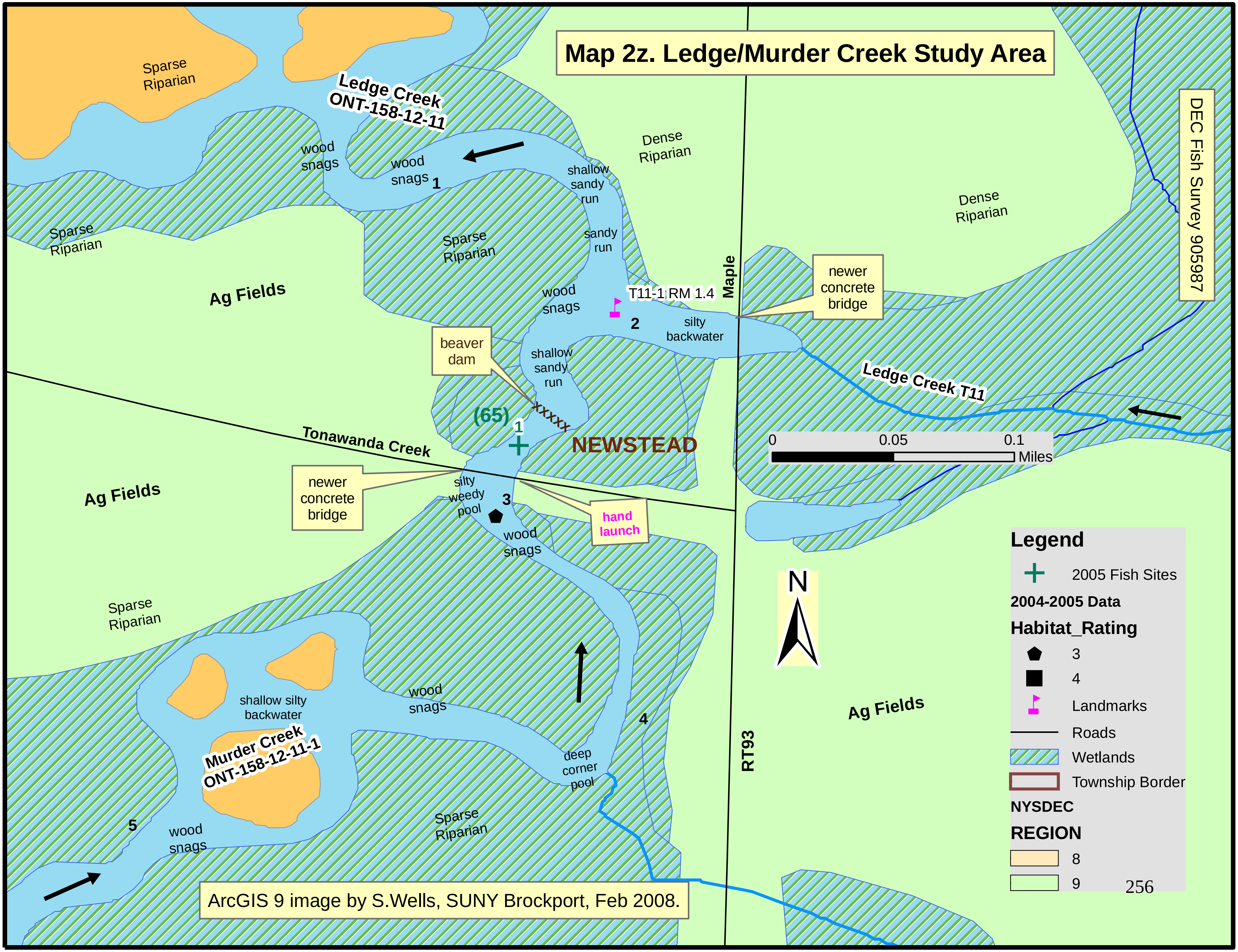
Map 2v. Lower Tonawanda Creek Study Area
N
LOCKPORT
ROYALTON
CLARENCE
DEC Fish Survey 905983
Wolcottsville Quad
Clarence Ctr Quad
Tonawanda Creek
Riddle
Heroy
Driveway
Brauer
lower Tonawanda Creek
ONT-158-12
RM 19.6
T8i RM 20.3
(32)
(31)
21
22
23
24
25
2005
deep corner pool
wood snags
Sparse Riparian
gravel bar & dock ruins
deep uniform channel
Ag Field
silty margins
rip rap along clay bank
deep run
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
redfin shiner (yr)
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.125
0.25
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

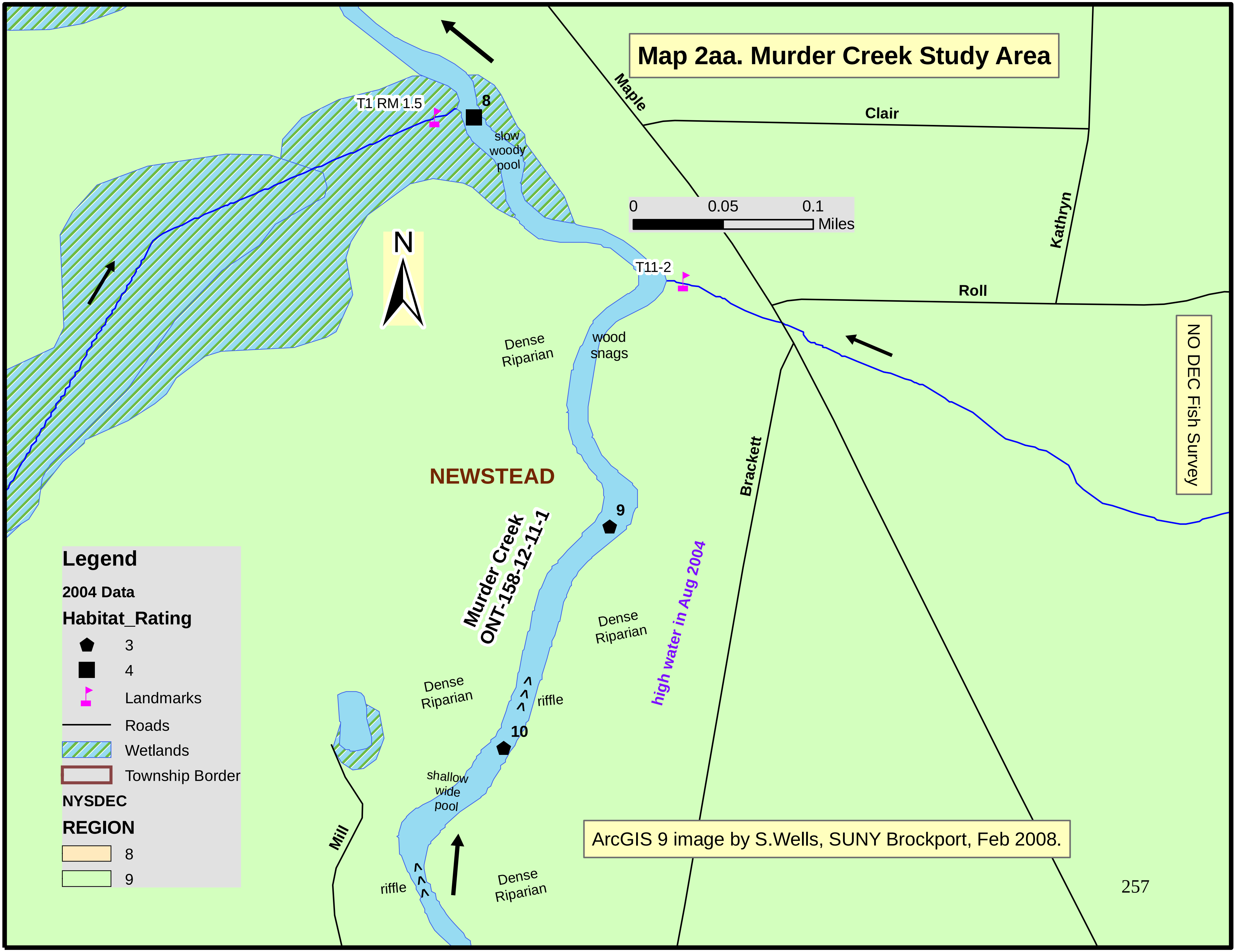

Map 2w. Lower Tonawanda & Beeman Creek Study Area
Tonawanda Creek
ROYALTON
CLARE
(26)
17
wood snags
run-pool habitat
deep corner pool
Sparse Riparian
T9a
0 0.1 0.2 Miles
Ag Fields
Sod Farm
unregulated water use
Water Pump
DEC Access
newer concrete bridge @ RM 23.7
(30)
21
27
2005
clay bank
shallow silty run
lower Tonawanda Creek ONT-158-12
deep uniform channel
Large Culvert
28
T10
silty marins
Kelkenberg
Rapids
RT43 Bridge
Beeman Creek ONT-158-12-9
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
redfin shiner (yr)
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
DEC Fish Survey 905983
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



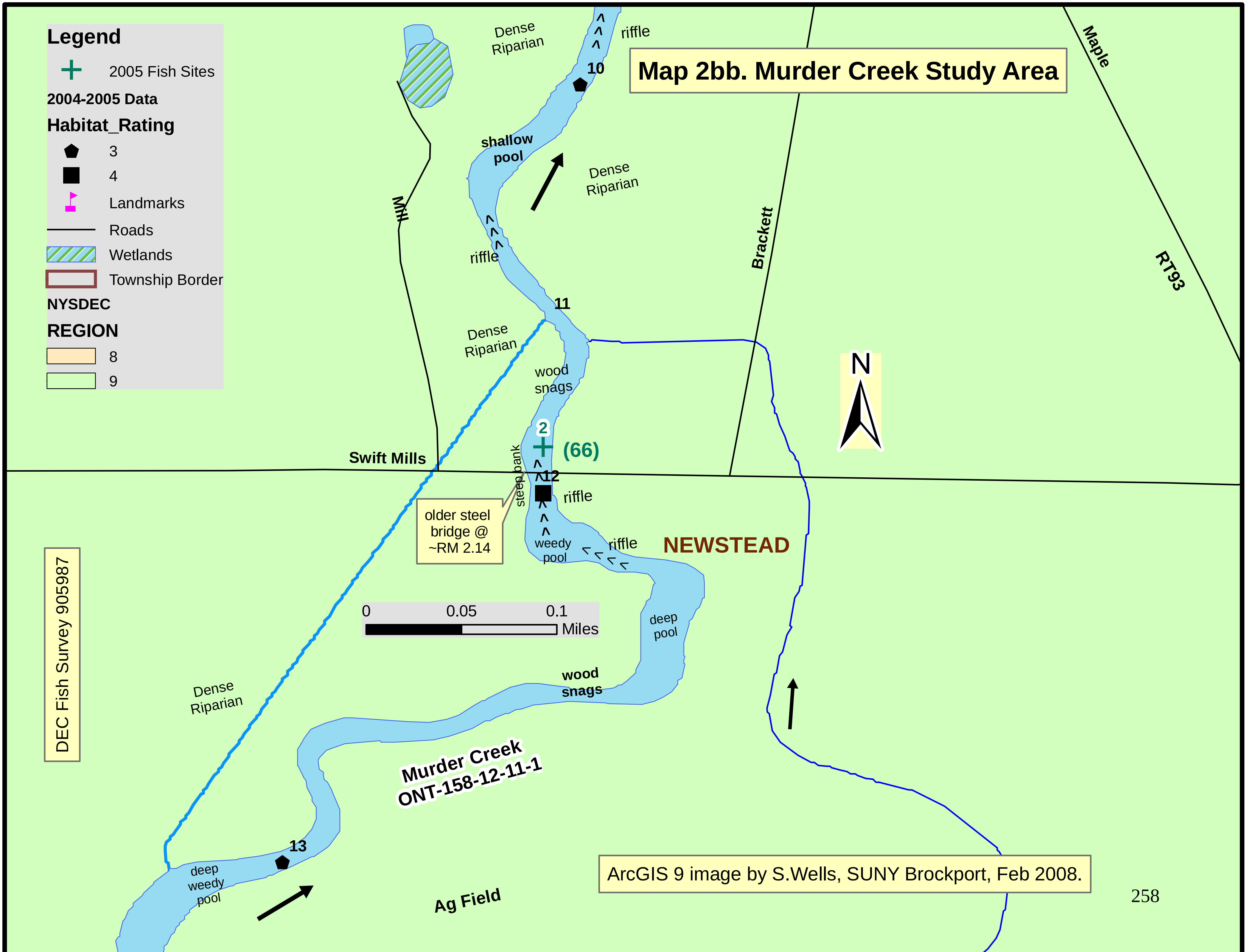
Map 2x. Lower Tonawanda Creek Study Area
DEC Fish Survey 905983
Ertman
Block Church
T10g
open parking area
hand launch
Ag Fields
ROYALTON
silty margins
Sparse Riparian
riffle
< < < <
(29)
20
29
deep corner pool with wood
Down Tree
30
Rip-Rap
old steel bridge @ RM 27.9
Tonawanda Creek
Burdick
Criswell
deep corner pool
T-10e
(25)
16
Driveway
lower Tonawanda Creek
ONT-158-12
silty margins
deep uniform channel
0
0.15
0.3
Miles
NEWSTEAD
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
CLARENCE
Fletcher
254
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2y. Lower Tonawanda & Murder Creek Study Area
Ag Fields
Akron
RT 93
ROYALTON
shallow sandy run
T11a culvert
37
deep corner pool
wood, rocks
18
(27)
N
Wolcottsville
Mass Debris Jam
mostly dead wood with much trash
Tail
35
36
19
T11 mouth @ RM32.7
swift sandy run
(28)
silt sand SS
Head
deep uniform channel
Sparse Riparian
deep corner pool
silty margins
lower Tonawanda Creek
ONT-158-12
0
0.05
0.1
Miles
DEC Fish Survey 905983
NEWSTEAD
Ledge Creek
ONT-158-12-11
Tonawanda Creek
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

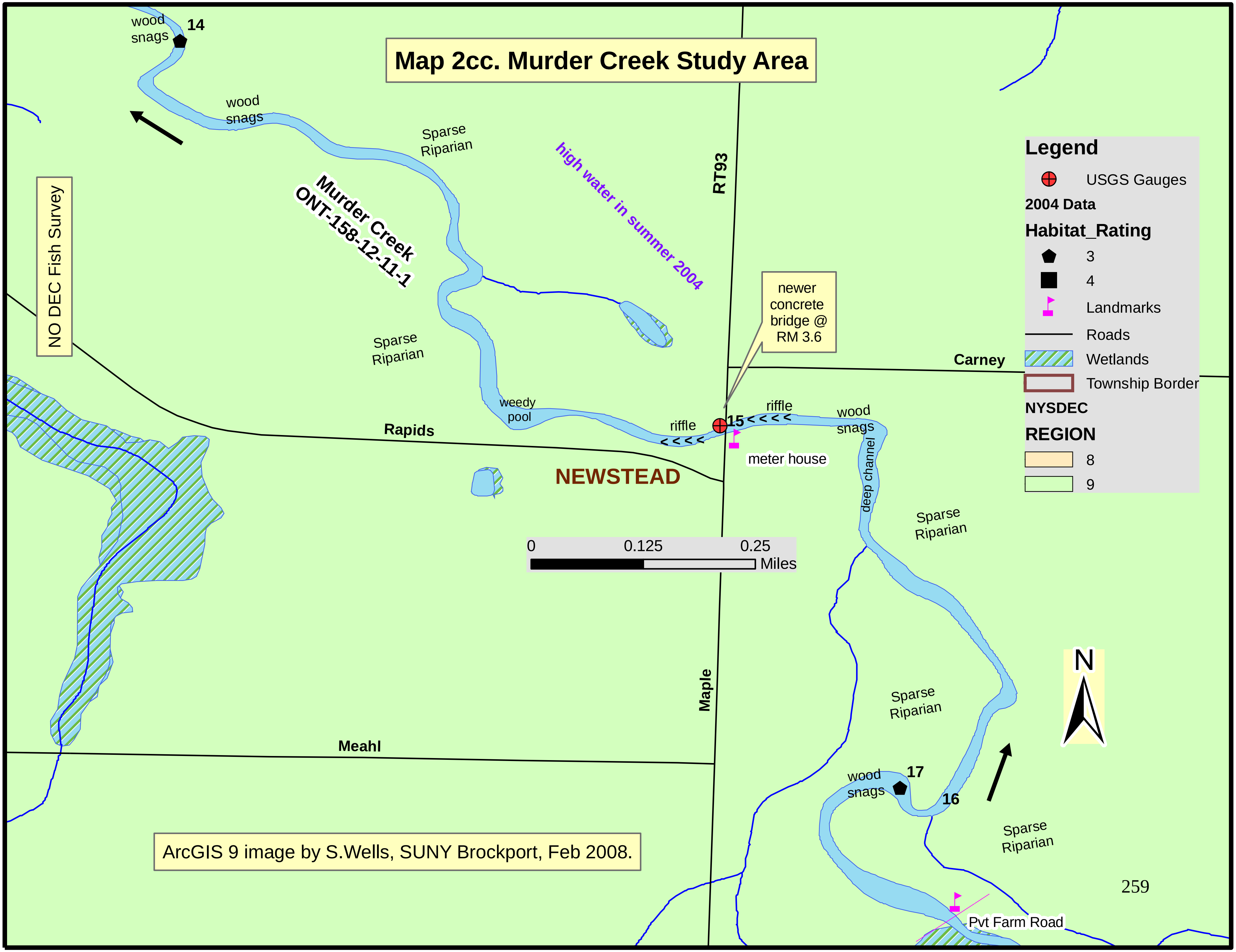

Map 2z. Ledge/Murder Creek Study Area
Ledge Creek
ONT-158-12-11
Sparse Riparian
wood snags
wood snags 1
shallow sandy run
sandy run
Dense Riparian
Dense Riparian
DEC Fish Survey 905987
Sparse Riparian
Sparse Riparian
Ag Fields
wood snags
T11-1 RM 1.4
2
silty backwater
Maple
newer concrete bridge
beaver dam
shallow sandy run
Ledge Creek T11
(65)
1
Tonawanda Creek
NEWSTEAD
0 0.05 0.1 Miles
newer concrete bridge
silty weedy pool
3
hand launch
Ag Fields
wood snags
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
N
Sparse Riparian
shallow silty backwater
wood snags
4
RT93
Ag Fields
Murder Creek
ONT-158-12-11-1
deep corner pool
5
wood snags
Sparse Riparian
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



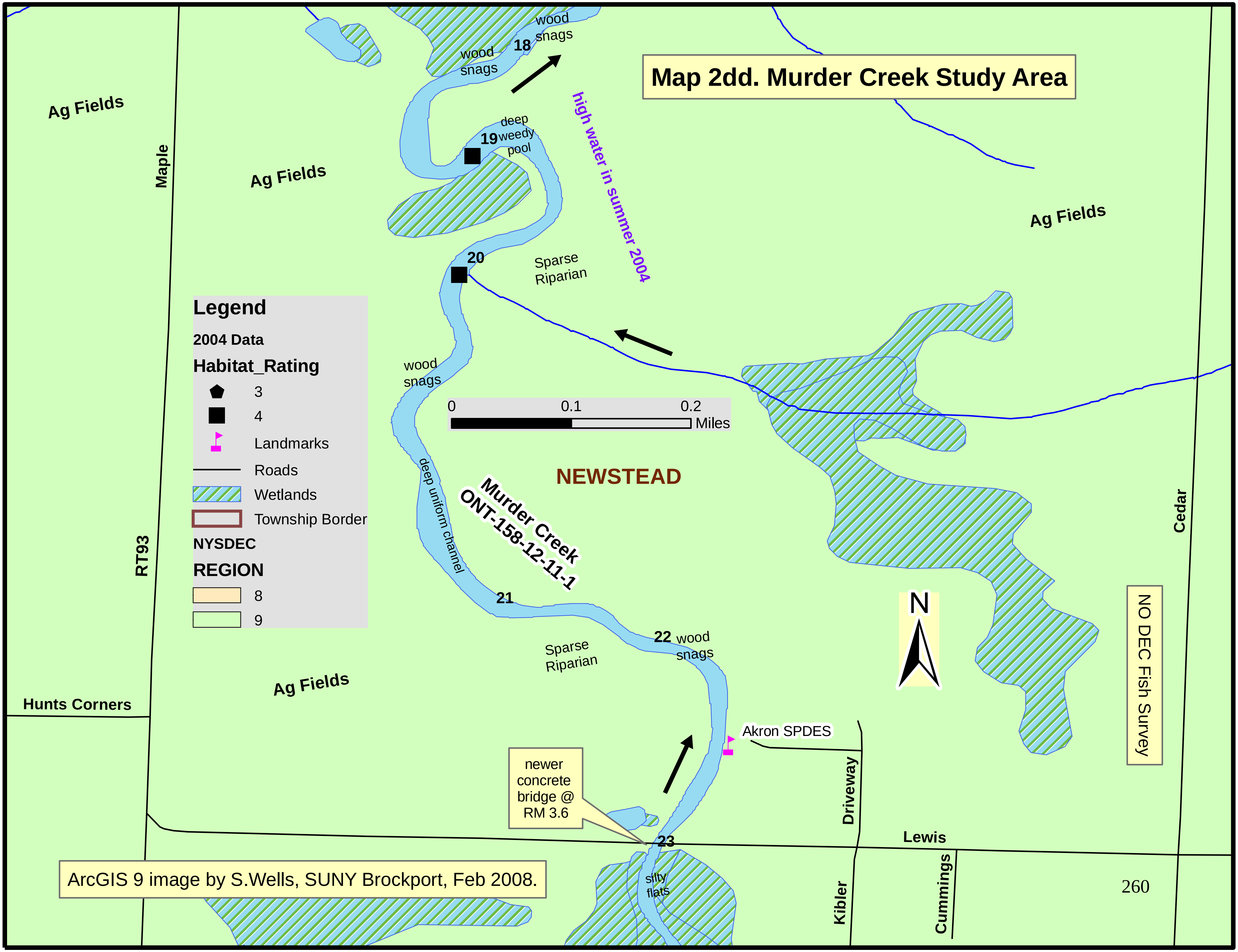
Map 2aa. Murder Creek Study Area
T1 RM 1.5
8
slow woody pool
Maple
Clair
0 0.05 0.1 Miles
Kathryn
N
T11-2
Roll
Dense Riparian
wood snags
NO DEC Fish Survey
Brackett
NEWSTEAD
9
Murder Creek ONT-158-12-11-1
high water in Aug 2004
Dense Riparian
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Dense Riparian
riffle
10
shallow wide pool
Mill
riffle
Dense Riparian
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

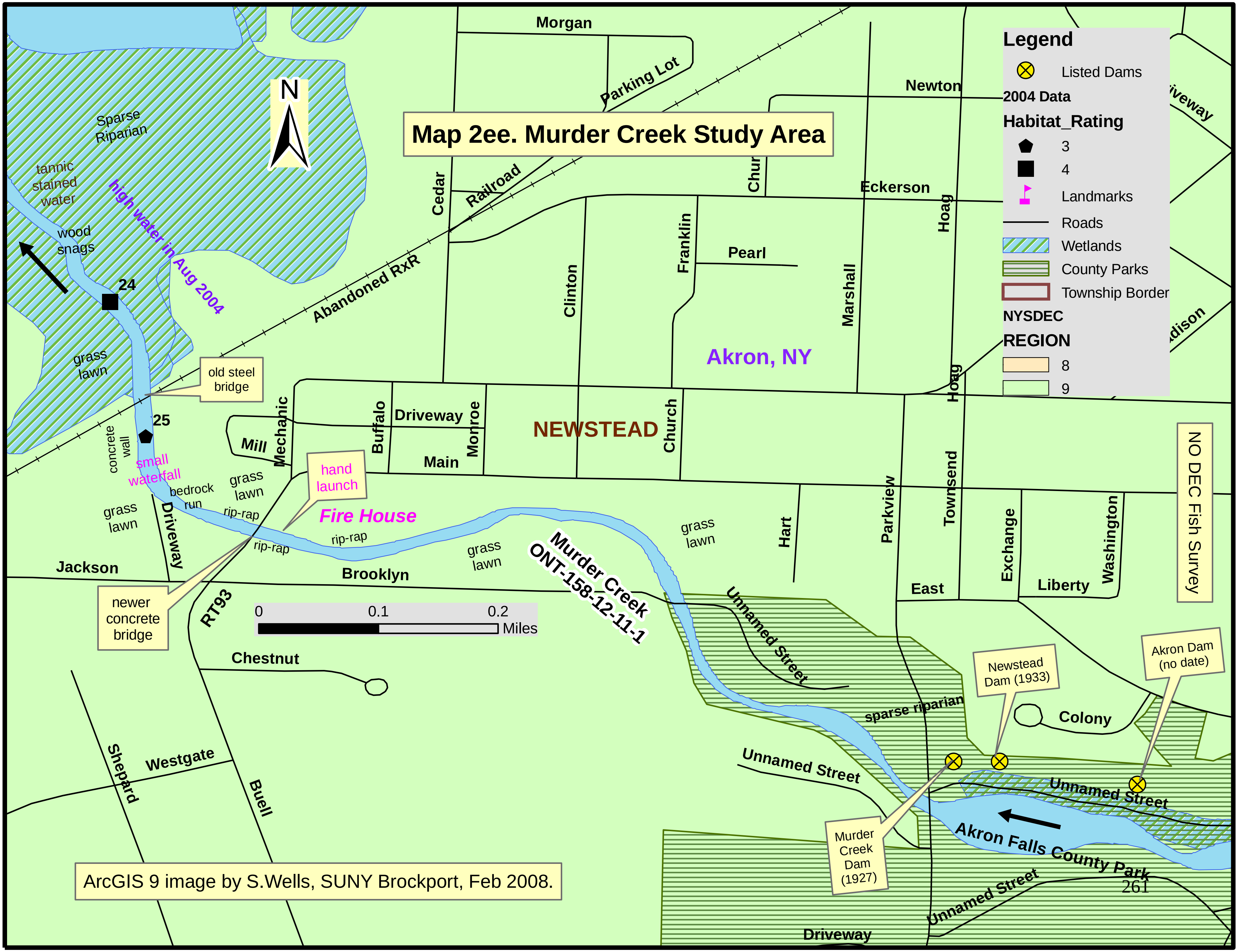


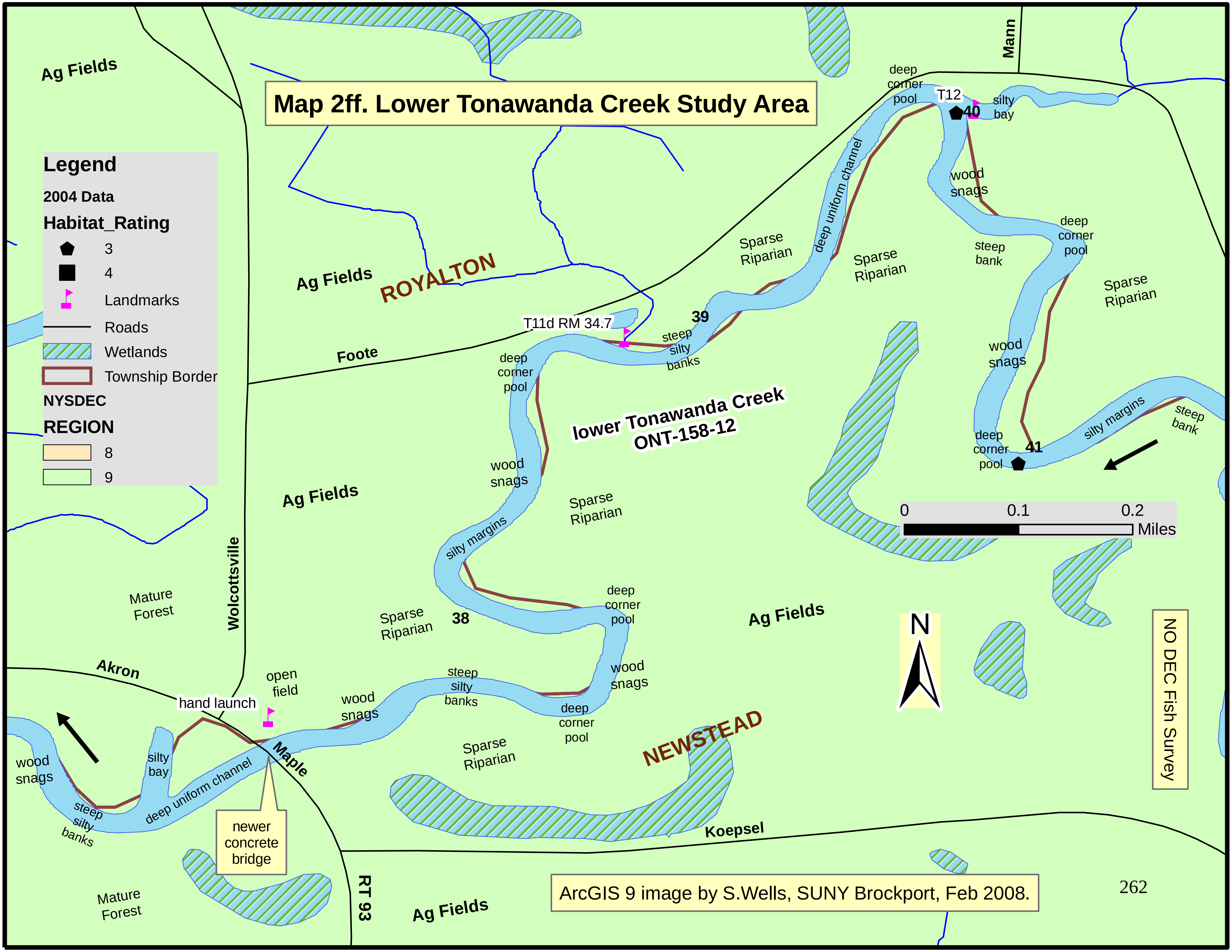
Map 2bb. Murder Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Dense Riparian
riffle
10
shallow pool
Dense Riparian
Mill
riffle
11
Brackett
Maple
RT93
Dense Riparian
wood snags
N
2
(66)
Swift Mills
steep bank
12
riffle
older steel bridge @ ~RM 2.14
weedy pool
riffle
NEWSTEAD
0
0.05
0.1
Miles
deep pool
wood snags
DEC Fish Survey 905987
Dense Riparian
Murder Creek
ONT-158-12-11-1
13
deep weedy pool
Ag Field
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



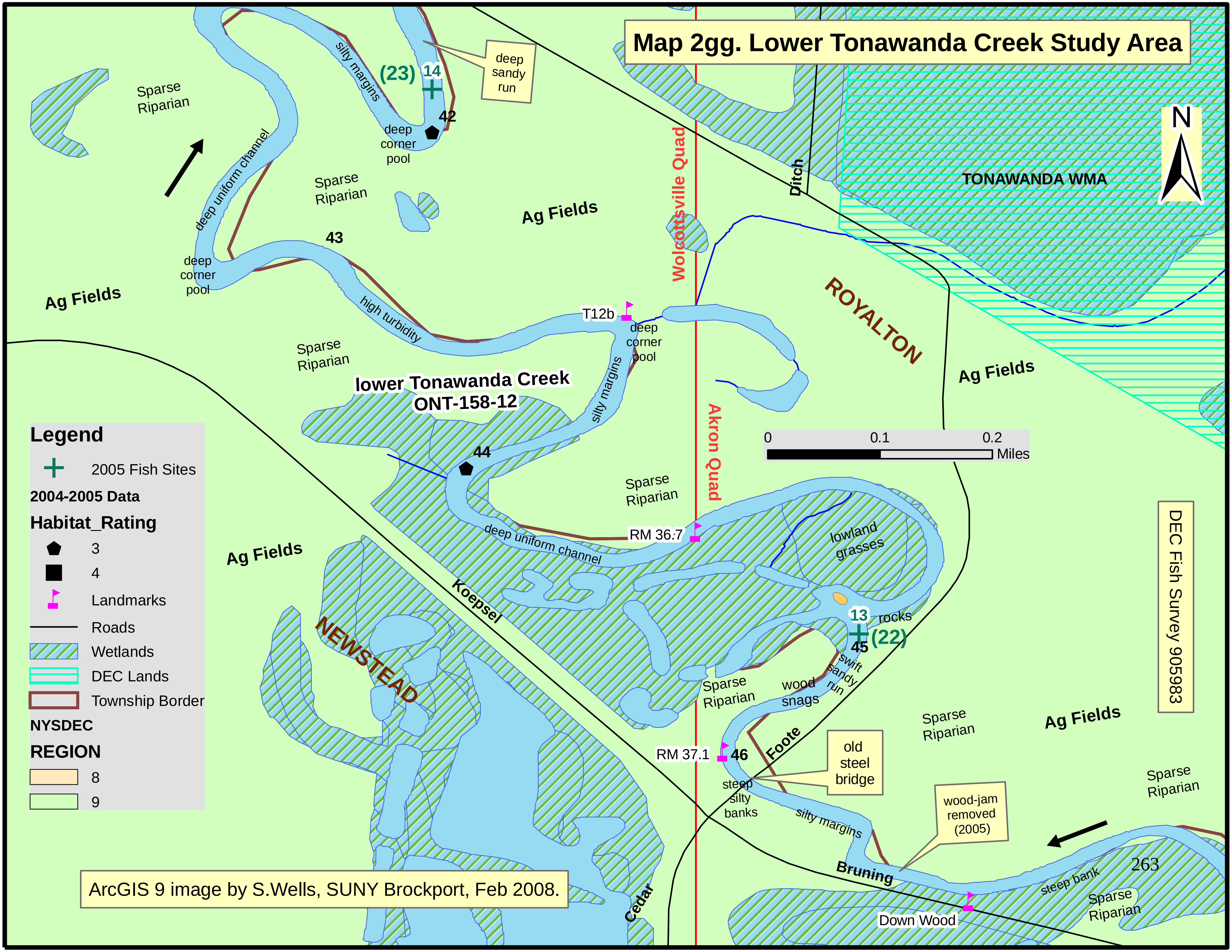
Map 2cc. Murder Creek Study Area
Legend
USGS Gauges
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
wood snags
14
wood snags
Sparse Riparian
high water in summer 2004
RT93
Murder Creek
ONT-158-12-11-1
NO DEC Fish Survey
Sparse Riparian
newer concrete bridge @ RM 3.6
Carney
weedy pool
riffle
15
riffle
wood snags
meter house
Rapids
NEWSTEAD
deep channel
Sparse Riparian
0
0.125
0.25
Miles
Maple
Sparse Riparian
N
Meahl
wood snags
17
16
Sparse Riparian
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Pvt Farm Road

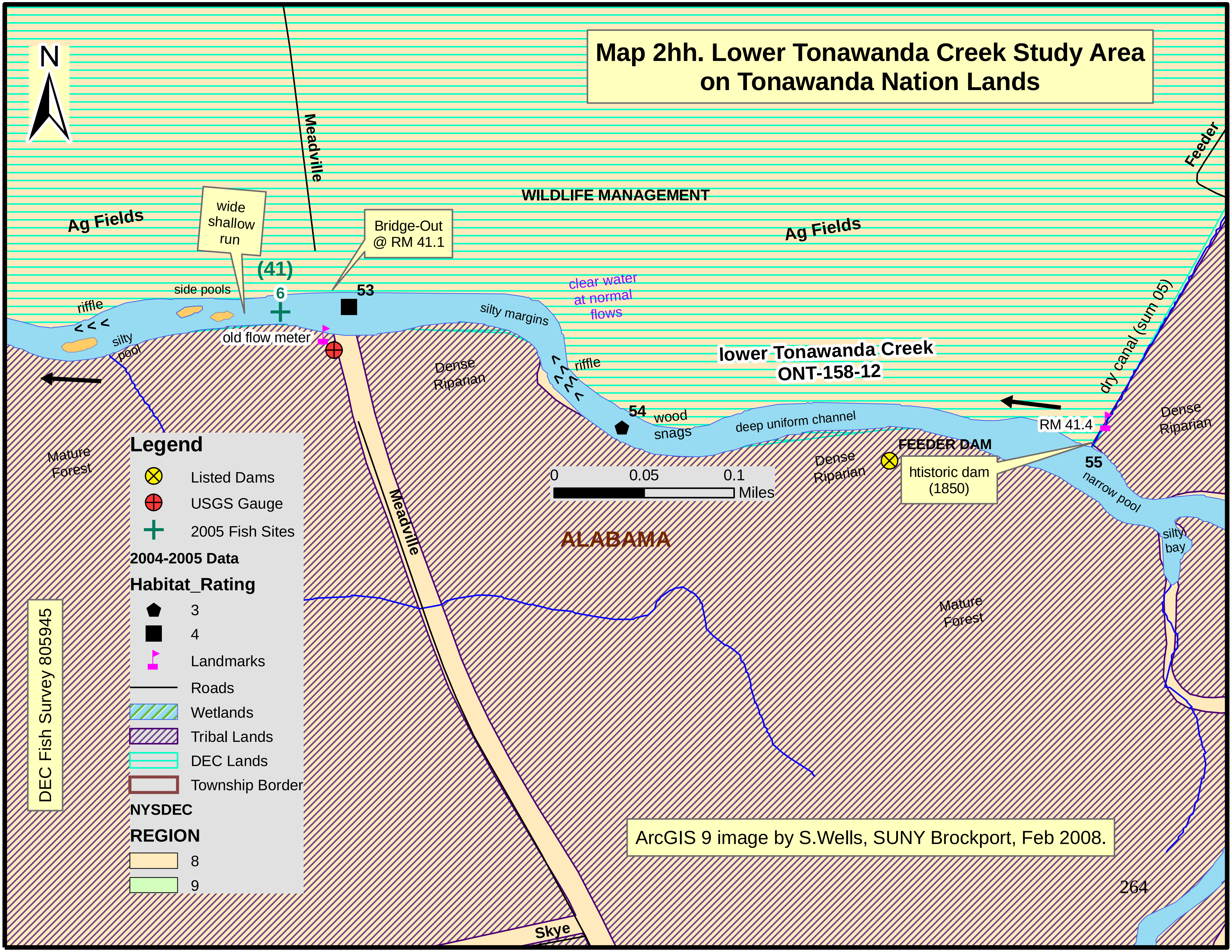

Map 2dd. Murder Creek Study Area
Ag Fields
Ag Fields
Ag Fields
Ag Fields
Maple
RT93
Hunts Corners
Cedar
Lewis
Driveway
Kibler
Cummings
wood snags
18
wood snags
19
deep weedy pool
high water in summer 2004
20
Sparse Riparian
wood snags
deep uniform channel
Murder Creek ONT-158-12-11-1
NEWSTEAD
21
22
wood snags
Sparse Riparian
Akron SPDES
newer concrete bridge @ RM 3.6
23
silty flats
0
0.1
0.2
Miles
N
NO DEC Fish Survey
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

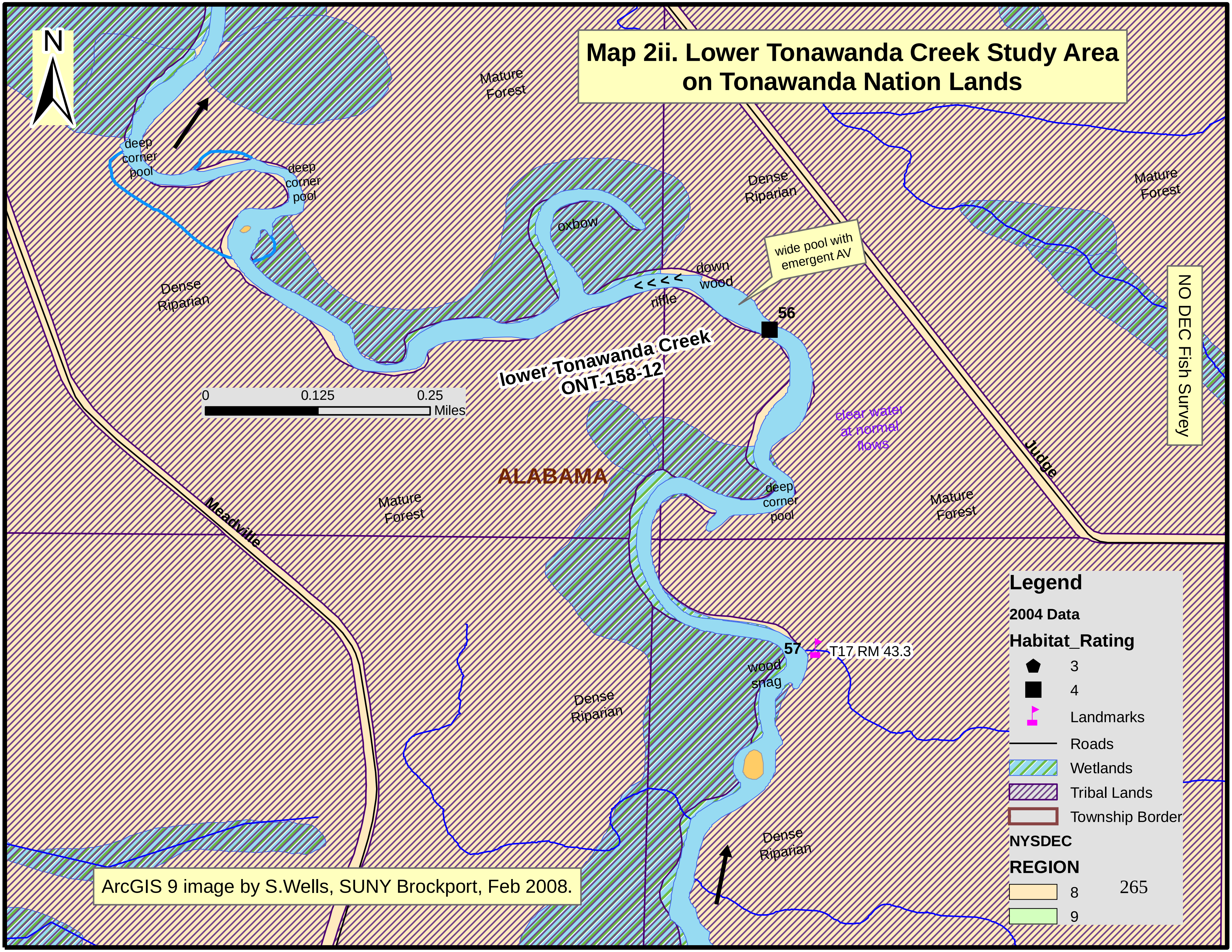

Map 2ee. Murder Creek Study Area
Legend
Listed Dams
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
County Parks
Township Border
NYSDEC
REGION
8
9
N
0
0.1
0.2
Miles
Akron, NY
NEWSTEAD
Fire House
Murder Creek
ONT-158-12-11-1
Akron Falls County Park
NO DEC Fish Survey
Sparse Riparian
tannic stained water
high water in Aug 2004
wood snags
24
grass lawn
old steel bridge
25
concrete wall
small waterfall
bedrock run
rip-rap
hand launch
newer concrete bridge
sparse riparian
Newstead Dam (1933)
Akron Dam (no date)
Murder Creek Dam (1927)
Morgan
Parking Lot
Newton
Cedar
Railroad
Abandoned RxR
Eckerson
Hoag
Clinton
Franklin
Pearl
Marshall
Mechanic
Mill
Buffalo
Driveway
Monroe
Main
Church
Parkview
Townsend
Exchange
Washington
Liberty
East
Hart
Jackson
Brooklyn
RT93
Chestnut
Colony
Unnamed Street
Shepard
Westgate
Buell
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

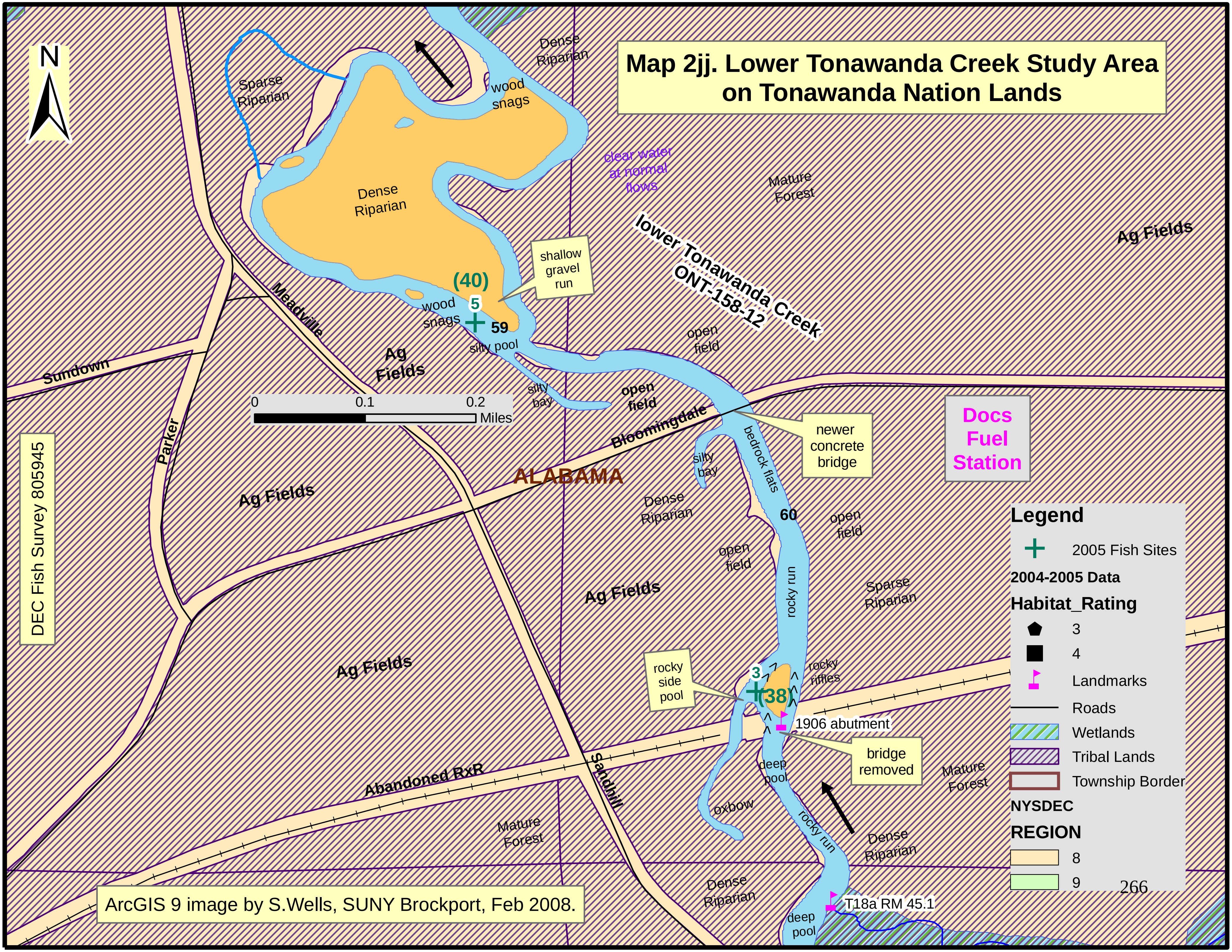


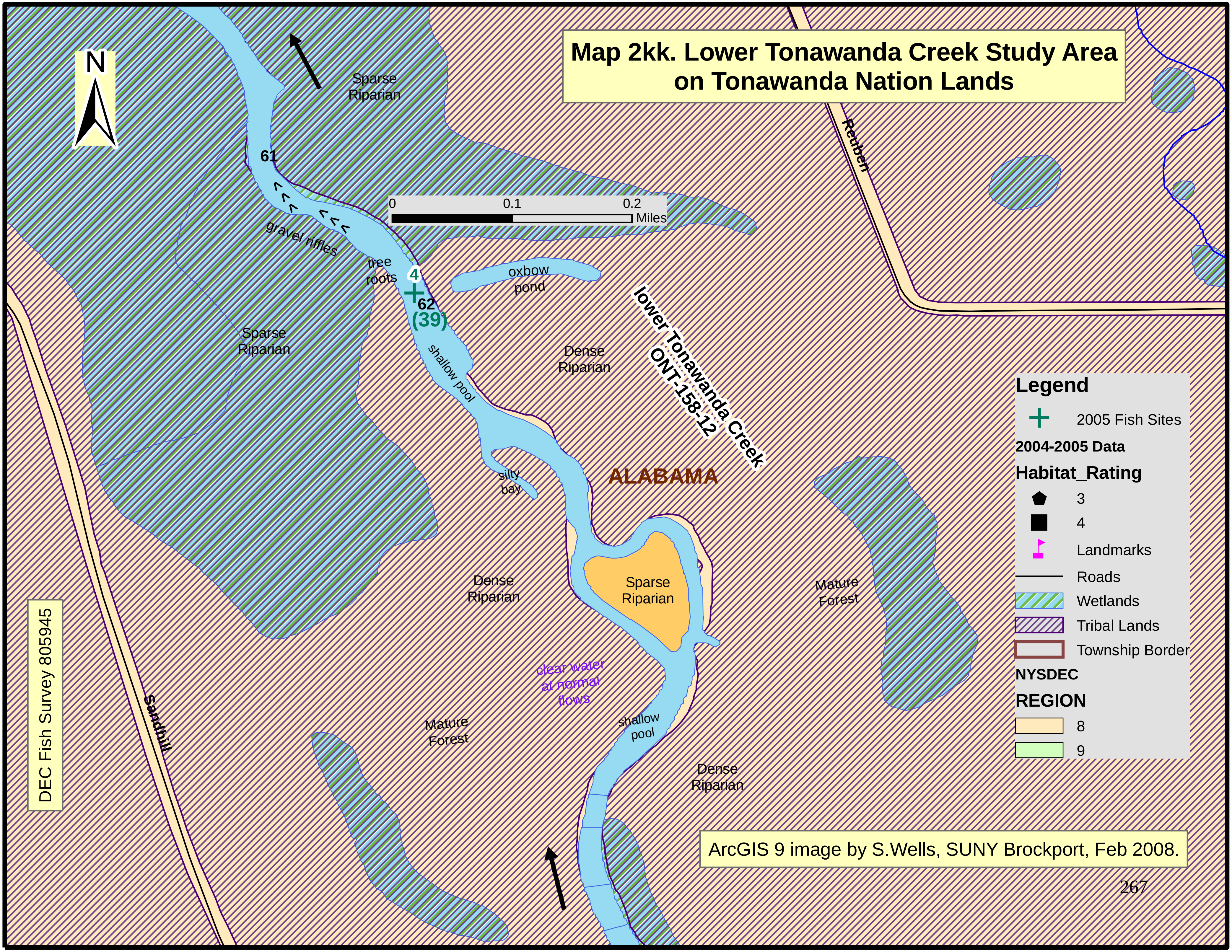
Map 2ff. Lower Tonawanda Creek Study Area
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Ag Fields
ROYALTON
NEWSTEAD
lower Tonawanda Creek
ONT-158-12
Foote
Akron
Maple
Wolcottsville
RT 93
Koepsel
Mann
T11d RM 34.7
T12
38
39
40
41
hand launch
open field
newer concrete bridge
deep corner pool
deep uniform channel
silty bay
wood snags
steep bank
steep silty banks
silty margins
Sparse Riparian
Mature Forest
0
0.1
0.2
Miles
N
NO DEC Fish Survey
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2gg. Lower Tonawanda Creek Study Area
N
TONAWANDA WMA
ROYALTON
NEWSTEAD
lower Tonawanda Creek
ONT-158-12
Wolcottsville Quad
Akron Quad
Ditch
Koepsel
Foote
Bruning
Cedar
Ag Fields
Sparse Riparian
deep sandy run
deep corner pool
deep uniform channel
silty margins
high turbidity
lowland grasses
rocks
swift sandy run
wood snags
steep silty banks
old steel bridge
wood-jam removed (2005)
steep bank
Down Wood
T12b
RM 36.7
RM 37.1
(23)
14
42
43
44
(22)
13
45
46
263
0
0.1
0.2
Miles
DEC Fish Survey 905983
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
DEC Lands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

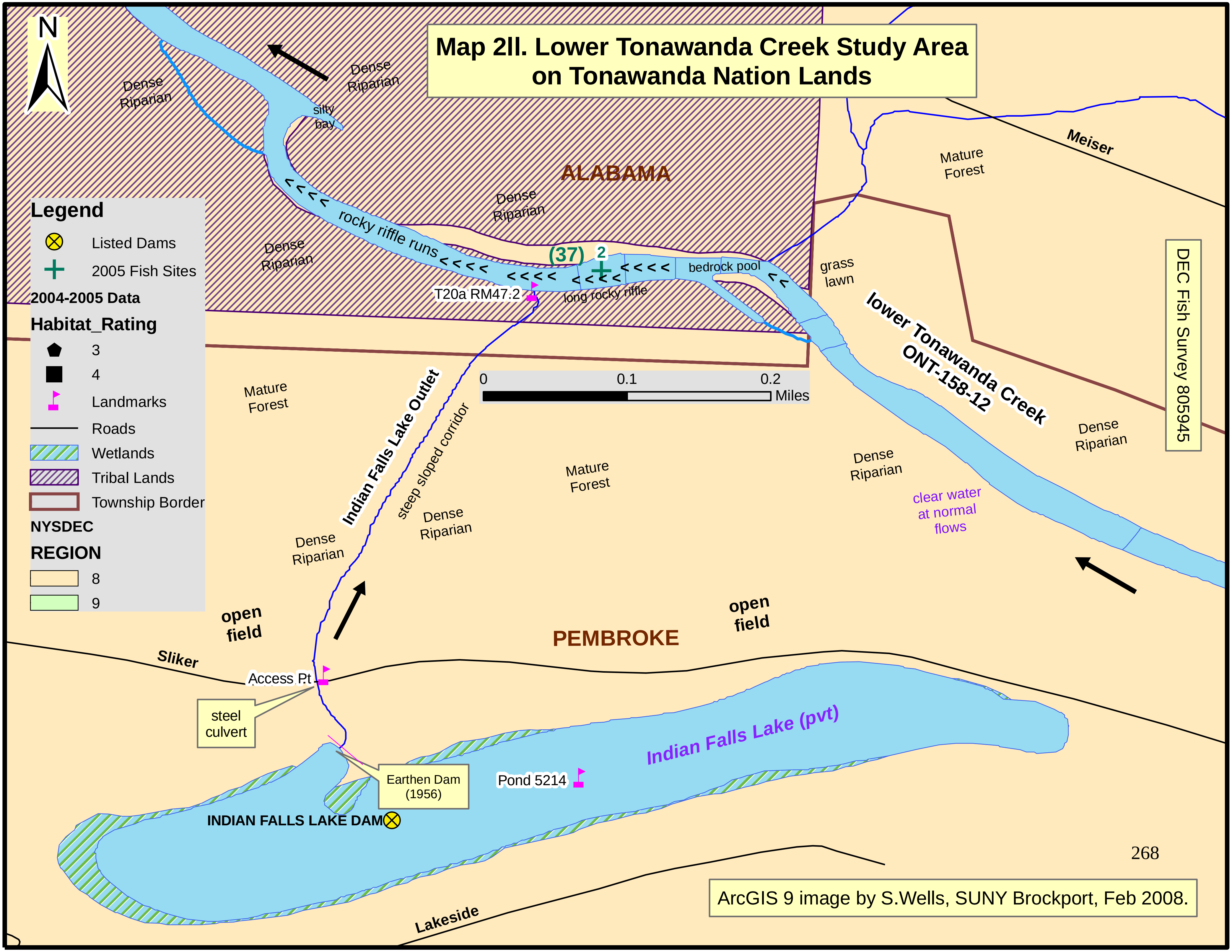

Map 2hh. Lower Tonawanda Creek Study Area
on Tonawanda Nation Lands
N
Meadville
WILDLIFE MANAGEMENT
Ag Fields
wide
shallow
run
Bridge-Out
@ RM 41.1
Ag Fields
Feeder
(41)
6
53
riffle
side pools
< < <
silty
pool
old flow meter
clear water
at normal
flows
silty margins
riffle
lower Tonawanda Creek
ONT-158-12
dry canal (sum 05)
Dense
Riparian
54
wood
snags
deep uniform channel
RM 41.4
Dense
Riparian
Mature
Forest
FEEDER DAM
Dense
Riparian
htistoric dam
(1850)
55
narrow pool
silty
bay
0
0.05
0.1
Miles
ALABAMA
Meadville
Mature
Forest
Legend
Listed Dams
USGS Gauge
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Tribal Lands
DEC Lands
Township Border
NYSDEC
REGION
8
9
DEC Fish Survey 805945
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Skye


Map 2ii. Lower Tonawanda Creek Study Area
on Tonawanda Nation Lands
N
Mature Forest
deep corner pool
deep corner pool
Dense Riparian
oxbow
down wood
riffle
wide pool with emergent AV
56
lower Tonawanda Creek
ONT-158-12
0
0.125
0.25
Miles
clear water at normal flows
ALABAMA
Meadville
Judge
NO DEC Fish Survey
Mature Forest
Dense Riparian
deep corner pool
57
T17 RM 43.3
wood snag
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Tribal Lands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

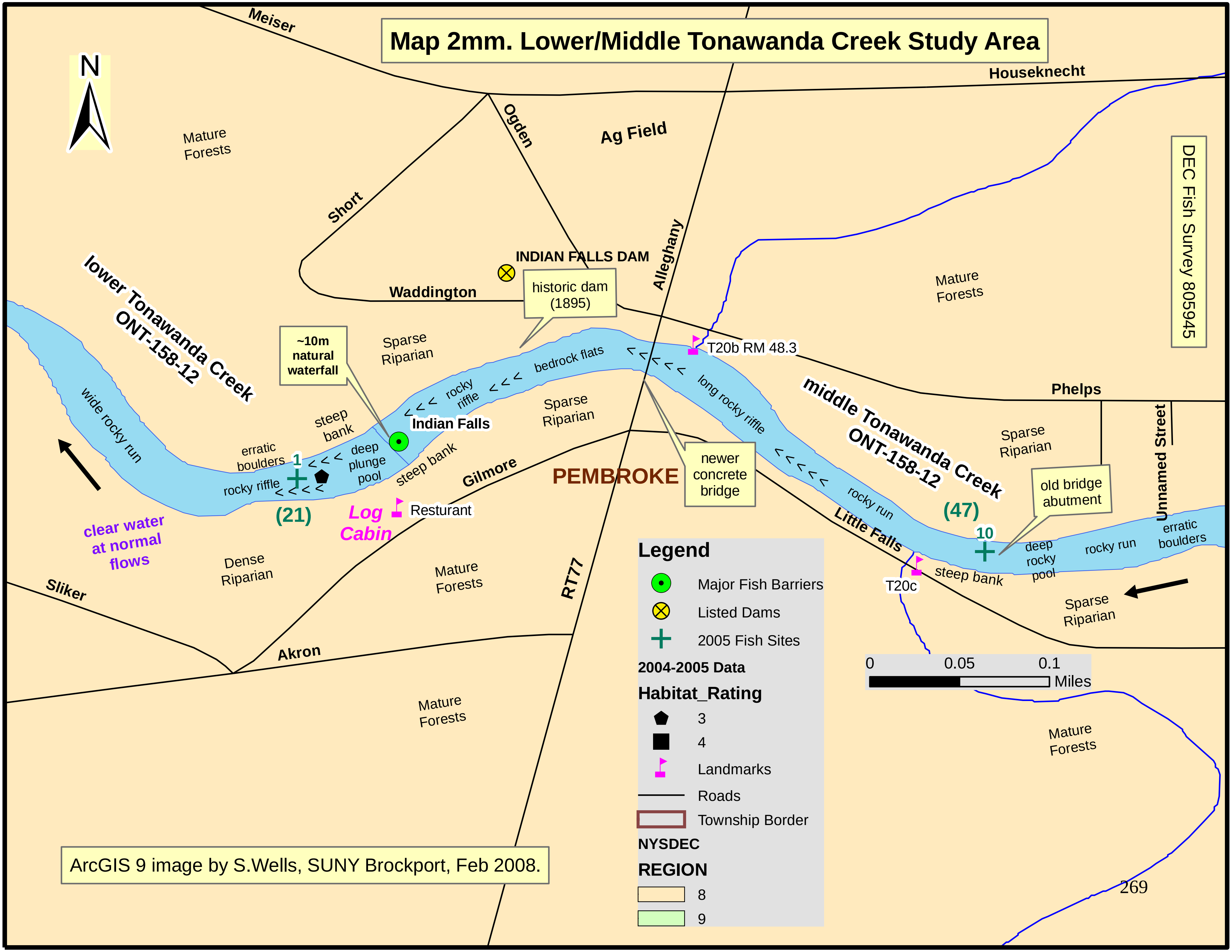

Map 2jj. Lower Tonawanda Creek Study Area
on Tonawanda Nation Lands
N
Sparse Riparian
Dense Riparian
wood snags
Dense Riparian
clear water at normal flows
Mature Forest
Ag Fields
lower Tonawanda Creek
ONT-158-12
shallow gravel run
(40)
5
59
wood snags
silty pool
Meadville
Ag Fields
open field
Sundown
silty bay
open field
0
0.1
0.2
Miles
Bloomingdale
newer concrete bridge
Docs Fuel Station
Parker
silty bay
bedrock flats
ALABAMA
Ag Fields
Dense Riparian
60
open field
open field
DEC Fish Survey 805945
rocky run
Ag Fields
Sparse Riparian
Ag Fields
rocky side pool
3
(38)
rocky riffles
1906 abutment
bridge removed
deep pool
Abandoned RxR
Sandhill
oxbow
rocky run
Mature Forest
Mature Forest
Dense Riparian
Dense Riparian
deep pool
T18a RM 45.1
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Tribal Lands
Township Border
NYSDEC
REGION
8
9



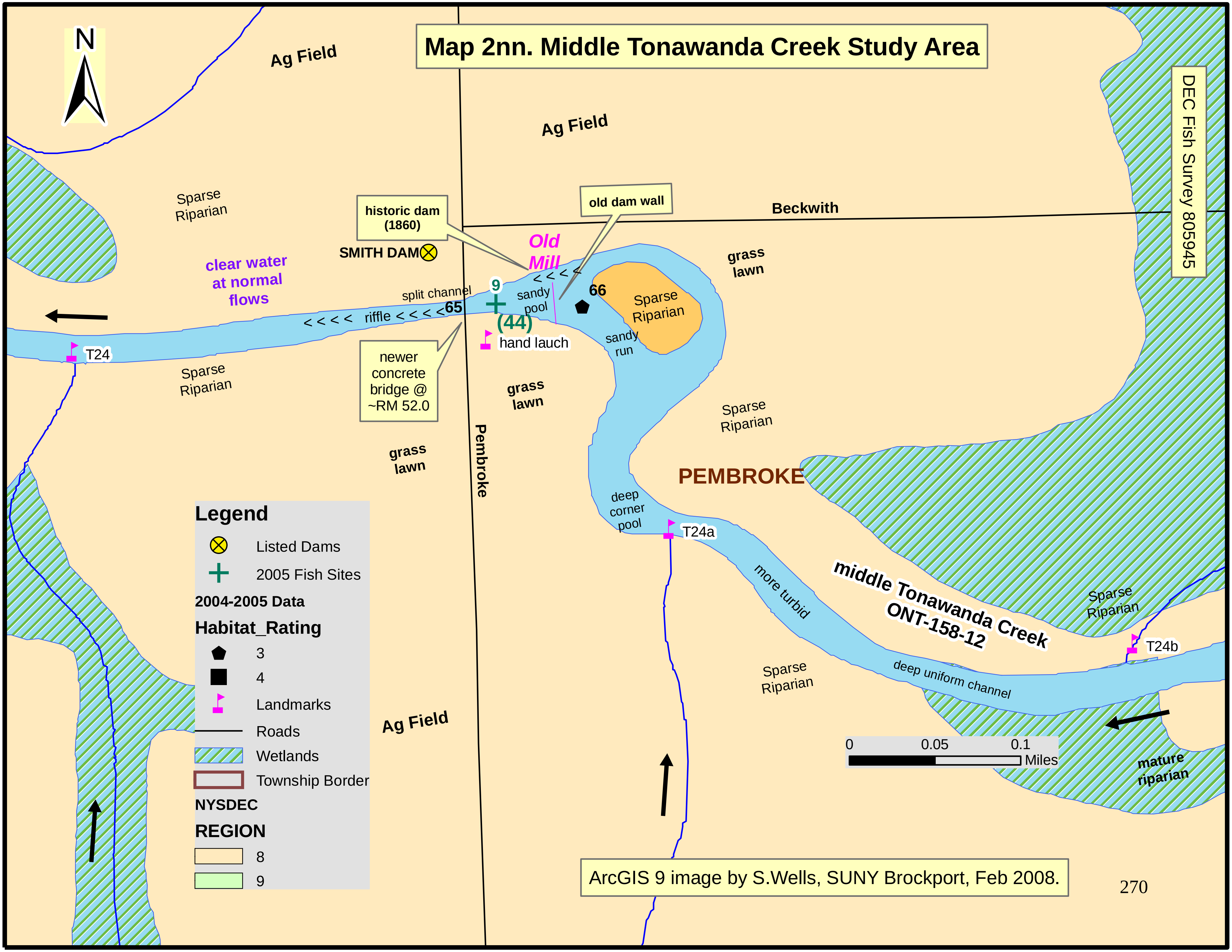
Map 2kk. Lower Tonawanda Creek Study Area
on Tonawanda Nation Lands
N
Sparse
Riparian
61
< < <
< < <
gravel riffles
0
0.1
0.2
Miles
tree
roots
4
62
(39)
oxbow
pond
Sparse
Riparian
shallow pool
Dense
Riparian
lower Tonawanda Creek
ONT-158-12
Reuben
silty
bay
ALABAMA
Dense
Riparian
Sparse
Riparian
Mature
Forest
clear water
at normal
flows
shallow
pool
Mature
Forest
Dense
Riparian
Sandhill
DEC Fish Survey 805945
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Tribal Lands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



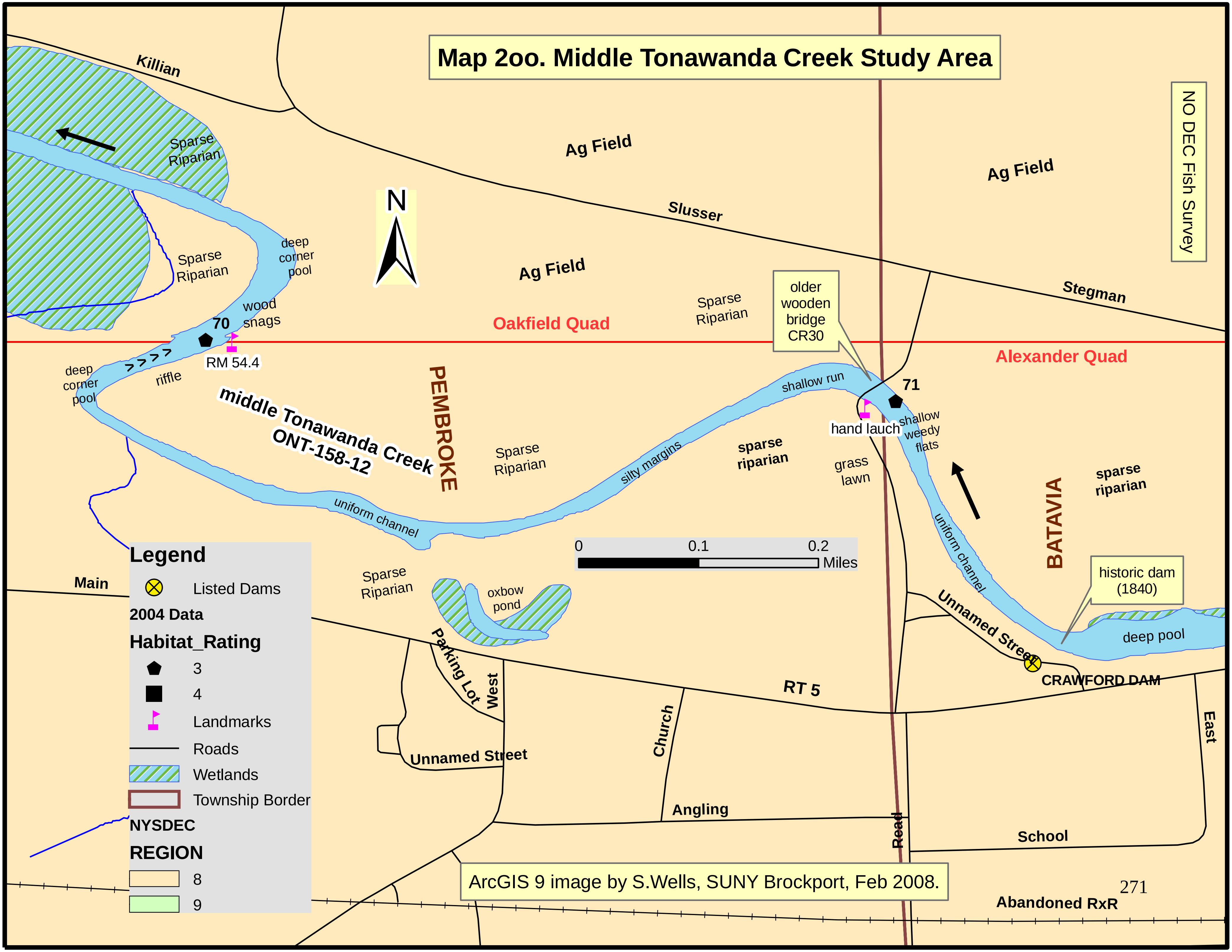
Map 2II. Lower Tonawanda Creek Study Area
on Tonawanda Nation Lands
N
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Tribal Lands
Township Border
NYSDEC
REGION
8
9
ALABAMA
PEMBROKE
Dense Riparian
silty bay
rocky riffle runs
(37) 2
long rocky riffle
bedrock pool
T20a RM47.2
grass lawn
Mature Forest
Meiser
lower Tonawanda Creek
ONT-158-12
DEC Fish Survey 805945
0
0.1
0.2
Miles
Indian Falls Lake Outlet
steep sloped corridor
clear water at normal flows
open field
Sliker
Access Pt
steel culvert
Earthen Dam (1956)
INDIAN FALLS LAKE DAM
Pond 5214
Indian Falls Lake (pvt)
Lakeside
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

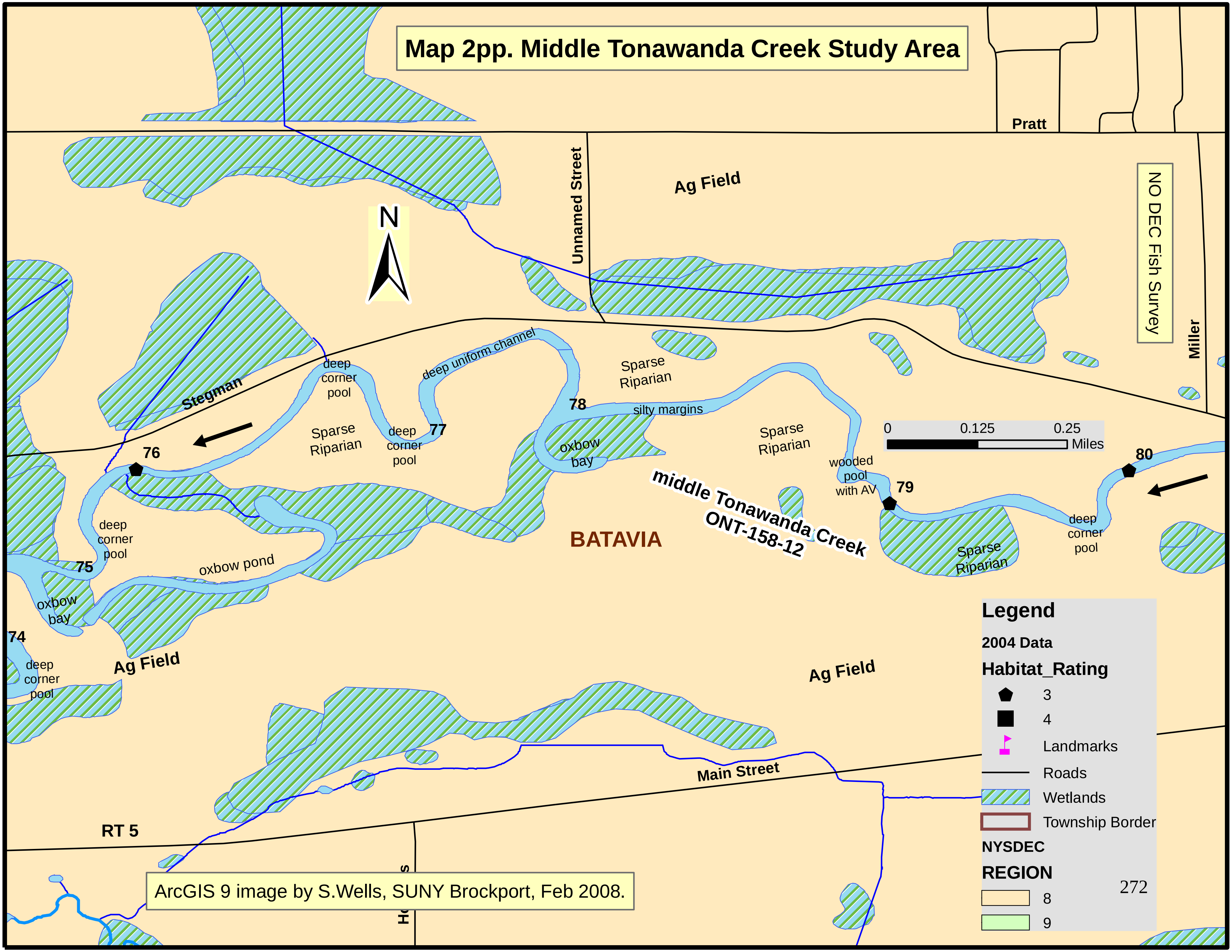


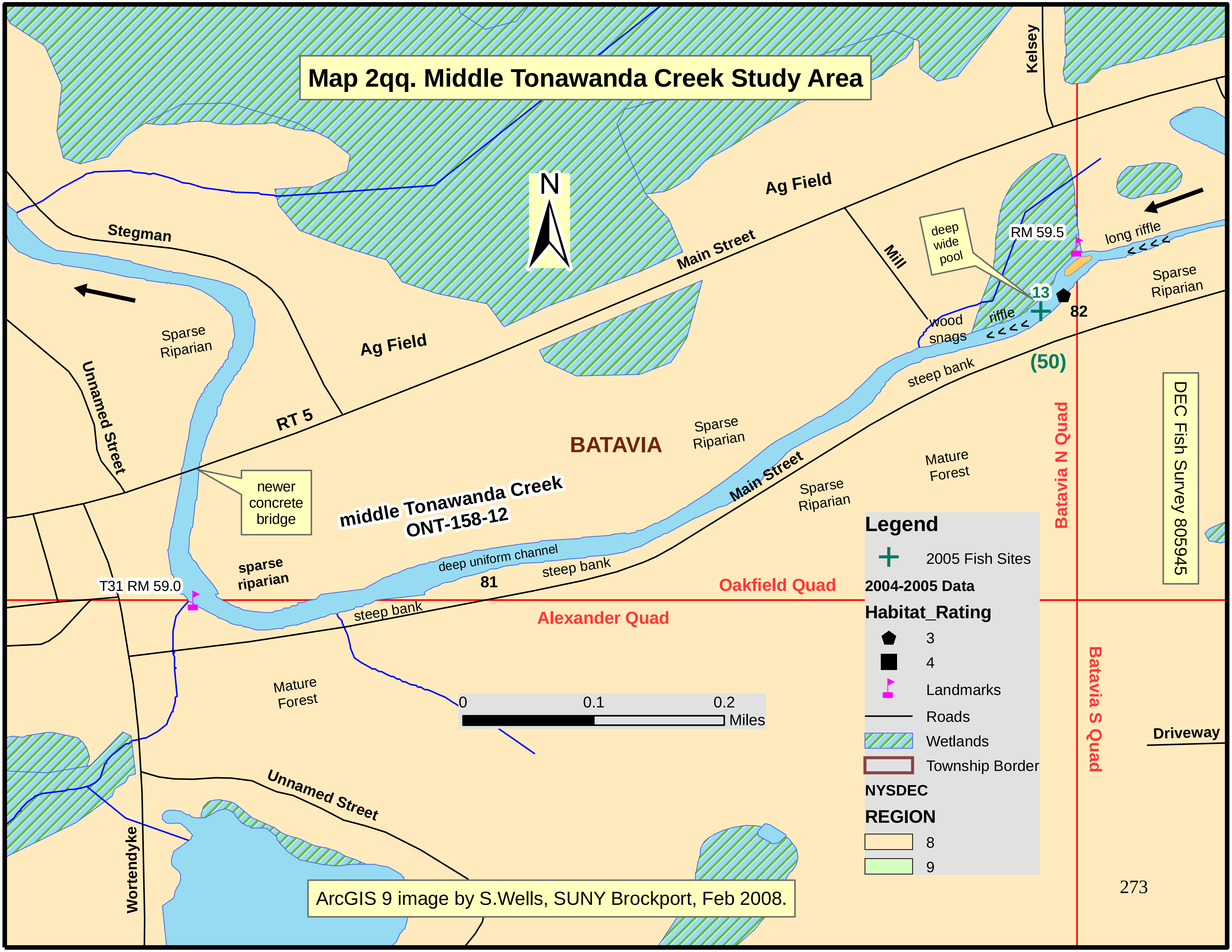
Map 2mm. Lower/Middle Tonawanda Creek Study Area
N
Meiser
Houseknecht
Ogden
Ag Field
Short
Mature Forests
INDIAN FALLS DAM
Alleghany
Waddington
historic dam (1895)
DEC Fish Survey 805945
lower Tonawanda Creek ONT-158-12
~10m natural waterfall
Sparse Riparian
bedrock flats
T20b RM 48.3
long rocky riffle
Phelps
middle Tonawanda Creek ONT-158-12
wide rocky run
rocky riffle
Indian Falls
steep bank
erratic boulders
deep plunge pool
Sparse Riparian
Unnamed Street
1
rocky riffle
(21)
Gilmore
PEMBROKE
newer concrete bridge
rocky run
(47)
old bridge abutment
10
Log Cabin
Resturant
Little Falls
deep rocky pool
rocky run
erratic boulders
clear water at normal flows
Dense Riparian
Mature Forests
RT77
T20c
steep bank
Sparse Riparian
Sliker
Akron
Mature Forests
Legend
Major Fish Barriers
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Township Border
NYSDEC
REGION
8
9
0
0.05
0.1
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



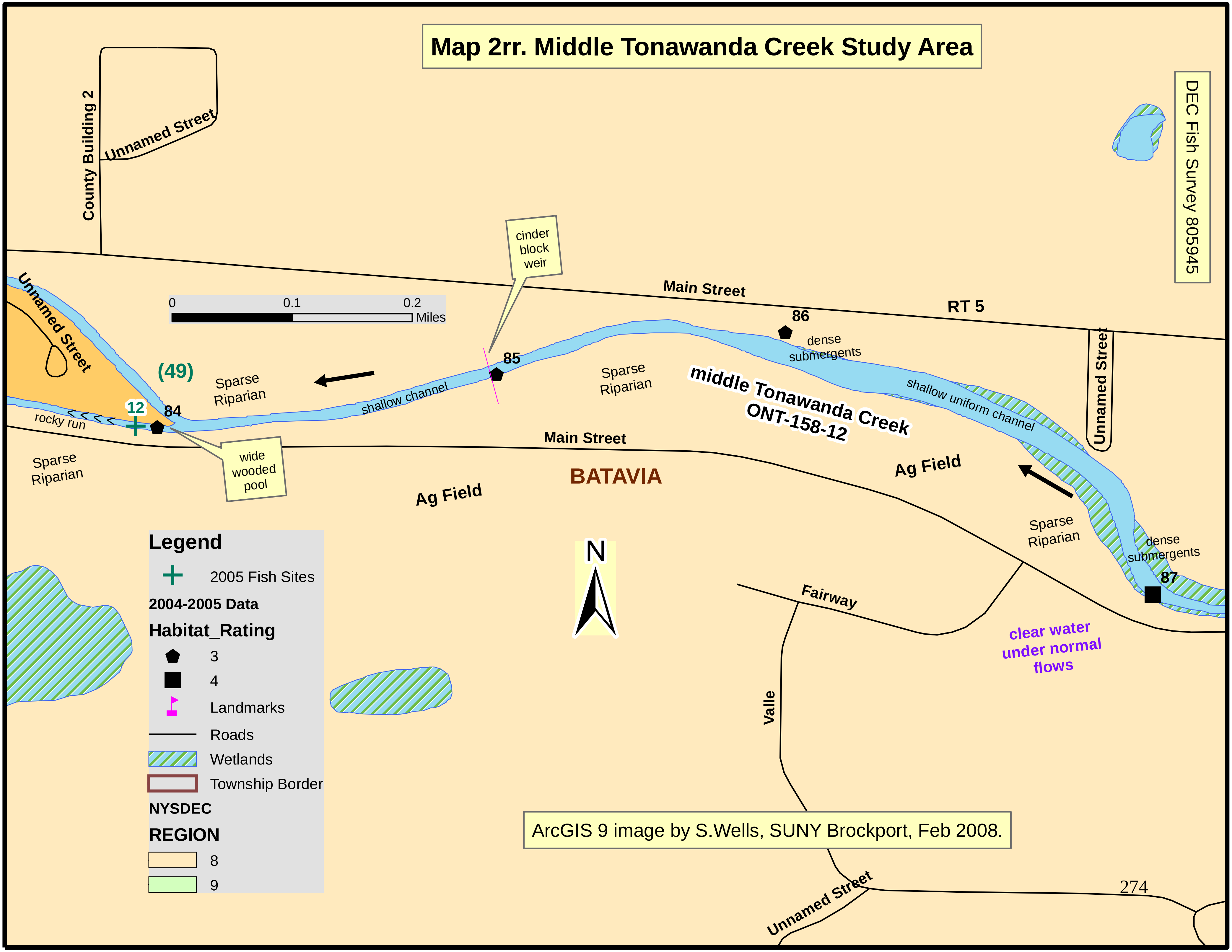
Map 2nn. Middle Tonawanda Creek Study Area
N
DEC Fish Survey 805945
Ag Field
Ag Field
Ag Field
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
historic dam (1860)
SMITH DAM
old dam wall
Beckwith
Old Mill
clear water at normal flows
split channel
< < < < riffle < < < < 65
9
(44)
sandy pool
66
hand lauch
sandy run
< < < <
T24
T24a
T24b
newer concrete bridge @ ~RM 52.0
grass lawn
grass lawn
grass lawn
Pembroke
PEMBROKE
deep corner pool
more turbid
middle Tonawanda Creek ONT-158-12
deep uniform channel
mature riparian
0 0.05 0.1 Miles
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

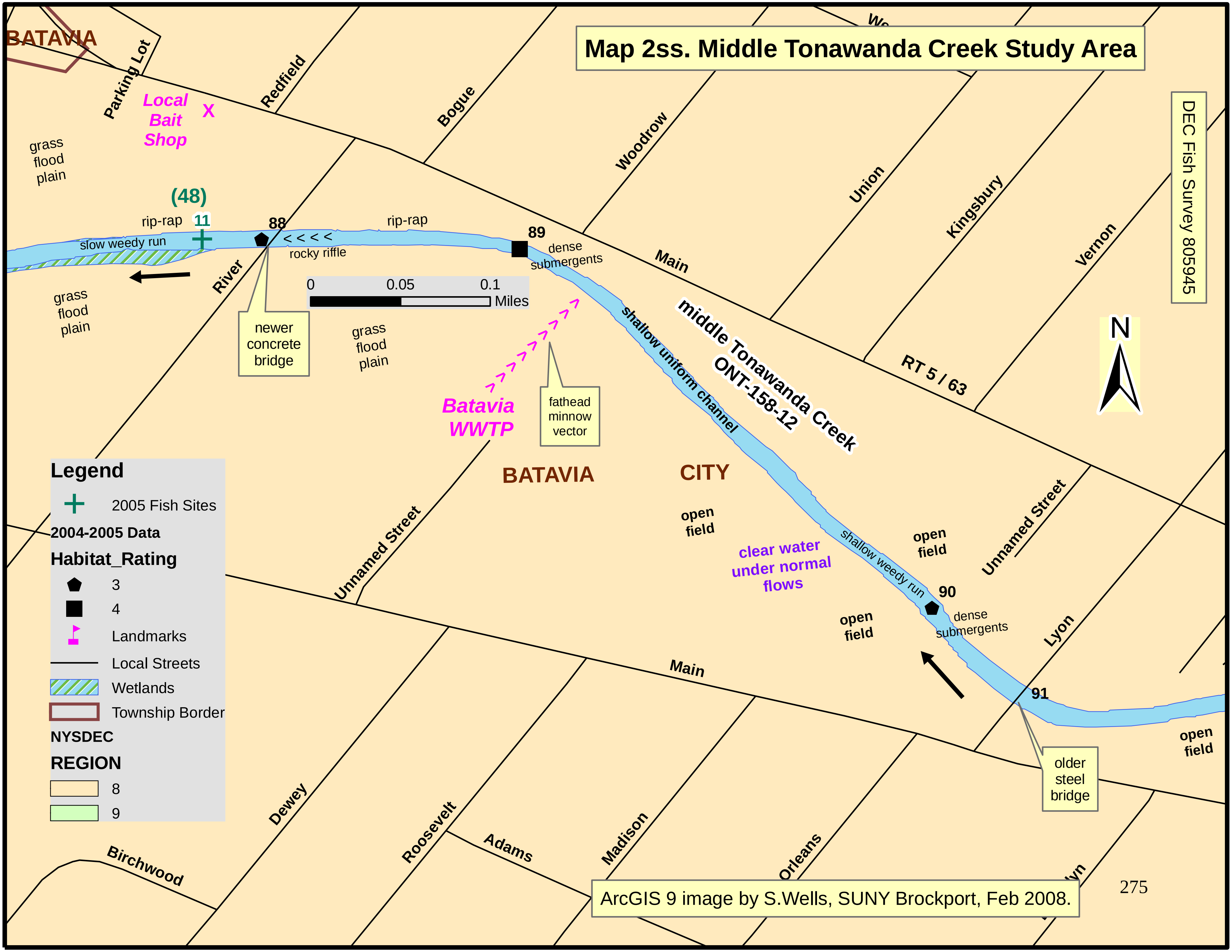

Map 2oo. Middle Tonawanda Creek Study Area
NO DEC Fish Survey
Killian
Ag Field
Ag Field
Ag Field
Slusser
Stegman
Sparse Riparian
Sparse Riparian
deep corner pool
wood snags
70
RM 54.4
N
Oakfield Quad
Alexander Quad
Sparse Riparian
older wooden bridge CR30
71
deep corner pool
riffle
middle Tonawanda Creek
ONT-158-12
PEMBROKE
Sparse Riparian
shallow run
silty margins
sparse riparian
hand lauch
shallow weedy flats
grass lawn
uniform channel
uniform channel
BATAVIA
sparse riparian
0 0.1 0.2 Miles
historic dam (1840)
deep pool
Unnamed Street
CRAWFORD DAM
Legend
Listed Dams
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Main
Sparse Riparian
oxbow pond
Parking Lot
West
RT 5
Church
Unnamed Street
Angling
Road
School
East
Abandoned RxR
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2pp. Middle Tonawanda Creek Study Area
N
Pratt
Unnamed Street
Ag Field
NO DEC Fish Survey
Miller
Stegman
deep corner pool
deep uniform channel
Sparse Riparian
deep corner pool
77
78
silty margins
oxbow bay
Sparse Riparian
wooded pool with AV
79
80
0 0.125 0.25
Miles
76
middle Tonawanda Creek
ONT-158-12
BATAVIA
deep corner pool
75
oxbow pond
oxbow bay
74
deep corner pool
Ag Field
Sparse Riparian
deep corner pool
Ag Field
Main Street
RT 5
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9

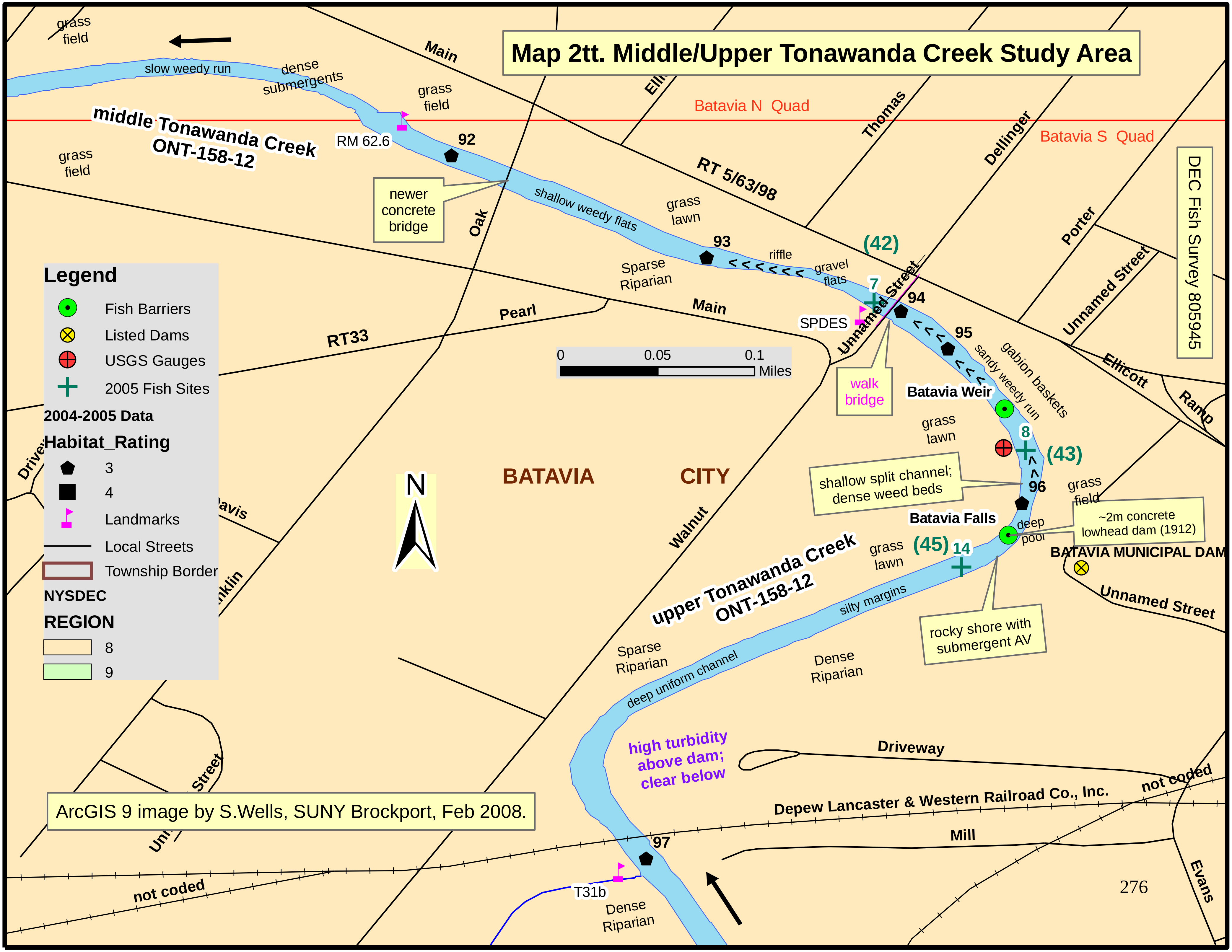


Map 2qq. Middle Tonawanda Creek Study Area
N
Kelsey
Ag Field
Main Street
Mill
deep wide pool
RM 59.5
long riffle
Sparse Riparian
13
82
riffle
wood snags
(50)
steep bank
Stegman
Sparse Riparian
Ag Field
Unnamed Street
RT 5
BATAVIA
Sparse Riparian
Main Street
Sparse Riparian
Mature Forest
Batavia N Quad
DEC Fish Survey 805945
newer concrete bridge
middle Tonawanda Creek ONT-158-12
deep uniform channel
steep bank
81
sparse riparian
T31 RM 59.0
steep bank
Oakfield Quad
Alexander Quad
Mature Forest
0
0.1
0.2
Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Batavia S Quad
Driveway
Unnamed Street
Wortendyke
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2rr. Middle Tonawanda Creek Study Area
DEC Fish Survey 805945
County Building 2
Unnamed Street
Main Street
RT 5
cinder block weir
0
0.1
0.2
Miles
Unnamed Street
(49)
Sparse Riparian
12
84
85
86
dense submergents
shallow channel
rocky run
wide wooded pool
Sparse Riparian
Sparse Riparian
middle Tonawanda Creek
ONT-158-12
shallow uniform channel
Unnamed Street
Main Street
BATAVIA
Ag Field
Ag Field
Sparse Riparian
dense submergents
87
N
Fairway
Valle
clear water under normal flows
Unnamed Street
274
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

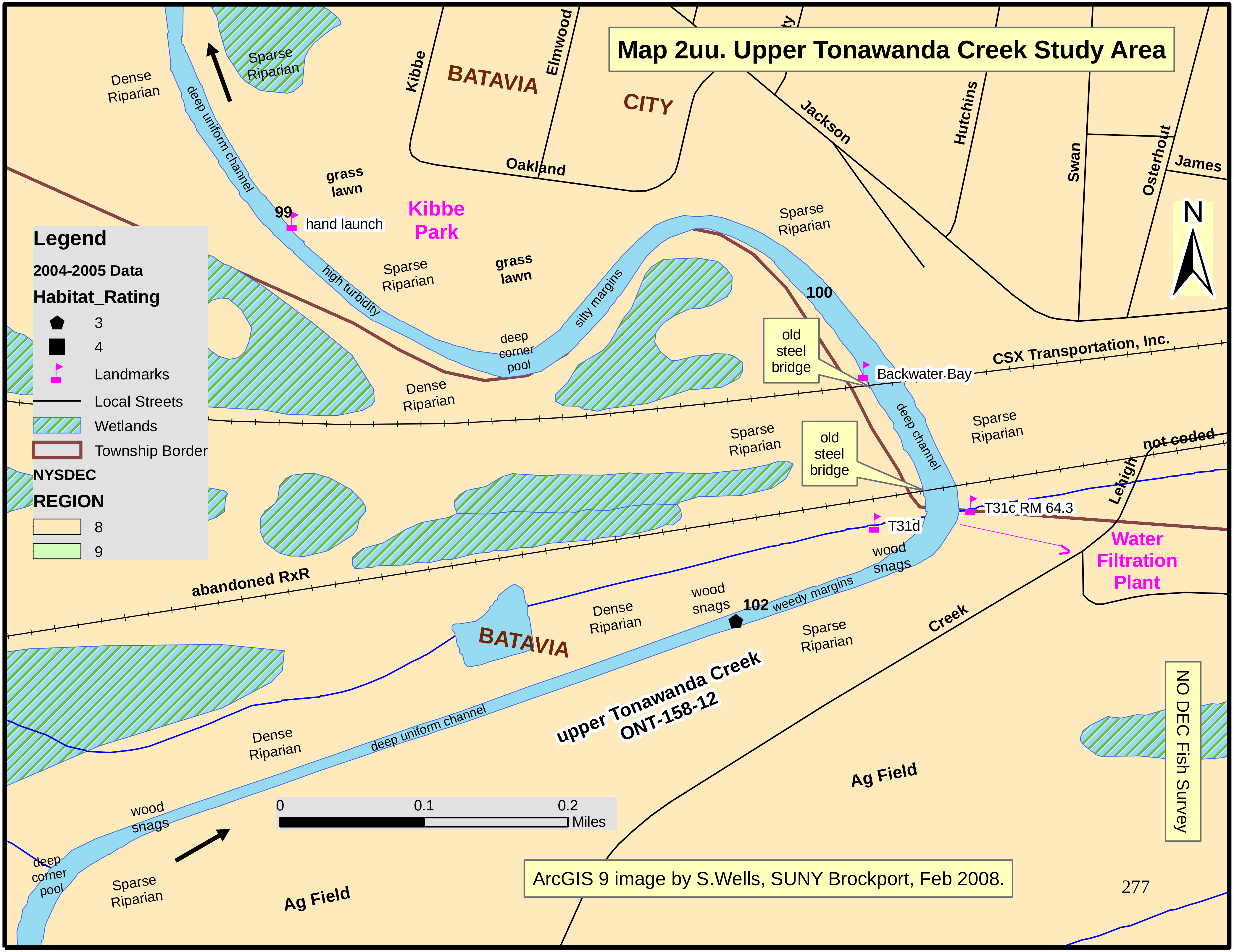


Map 2ss. Middle Tonawanda Creek Study Area
DEC Fish Survey 805945
BATAVIA
Parking Lot
Local Bait Shop
X
Redfield
Bogue
Woodrow
Union
Kingsbury
Vernon
grass flood plain
(48)
rip-rap
11
88
rip-rap
slow weedy run
< < < <
rocky riffle
89
dense submergents
Main
River
0 0.05 0.1
Miles
newer concrete bridge
grass flood plain
middle Tonawanda Creek ONT-158-12
shallow uniform channel
RT 5 / 63
N
Batavia WWTP
fathead minnow vector
BATAVIA
CITY
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Local Streets
Wetlands
Township Border
NYSDEC
REGION
8
9
Unnamed Street
open field
clear water under normal flows
shallow weedy run
open field
Unnamed Street
90
dense submergents
open field
Lyon
Main
91
older steel bridge
open field
Dewey
Roosevelt
Adams
Madison
Orleans
Birchwood
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

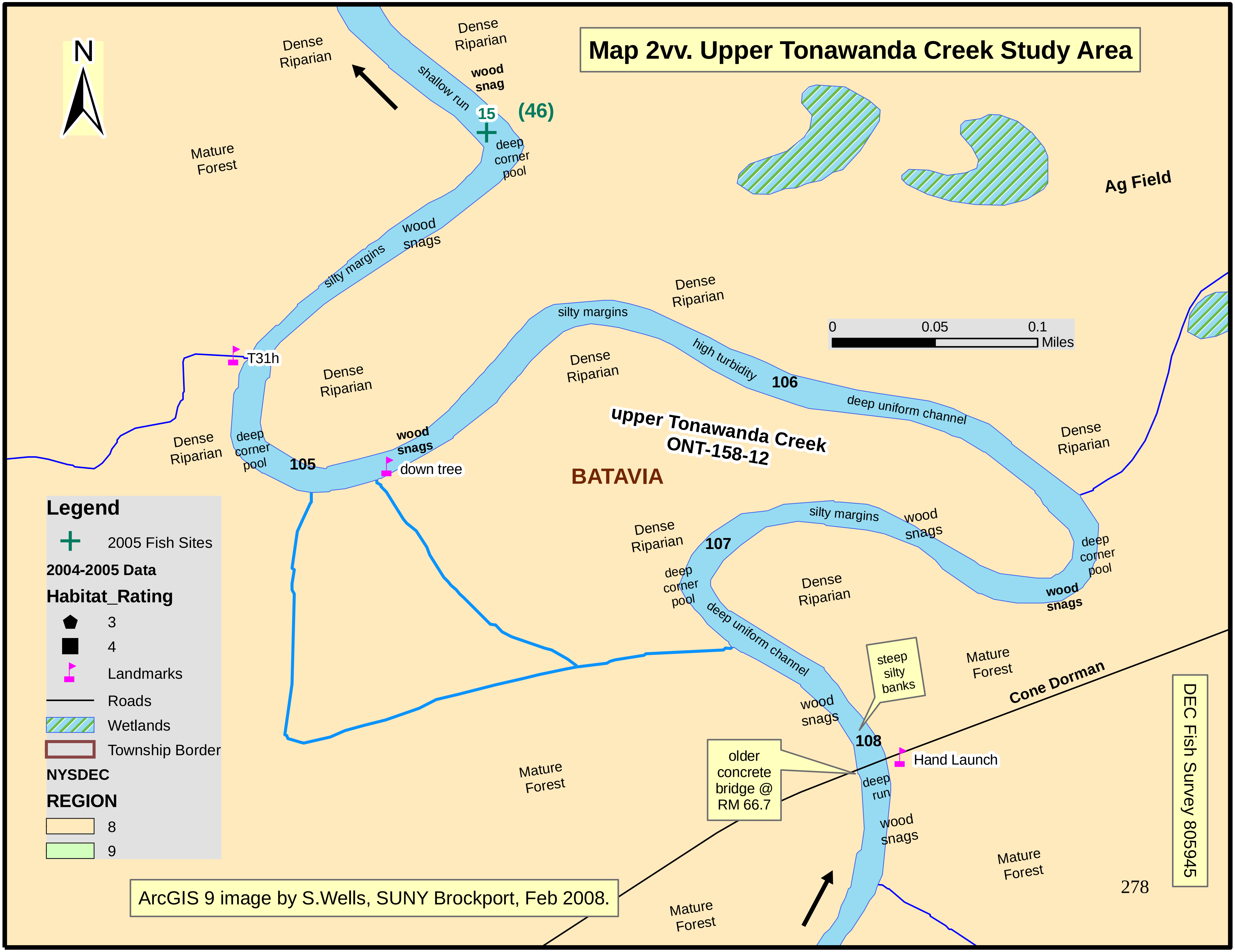


Map 2tt. Middle/Upper Tonawanda Creek Study Area

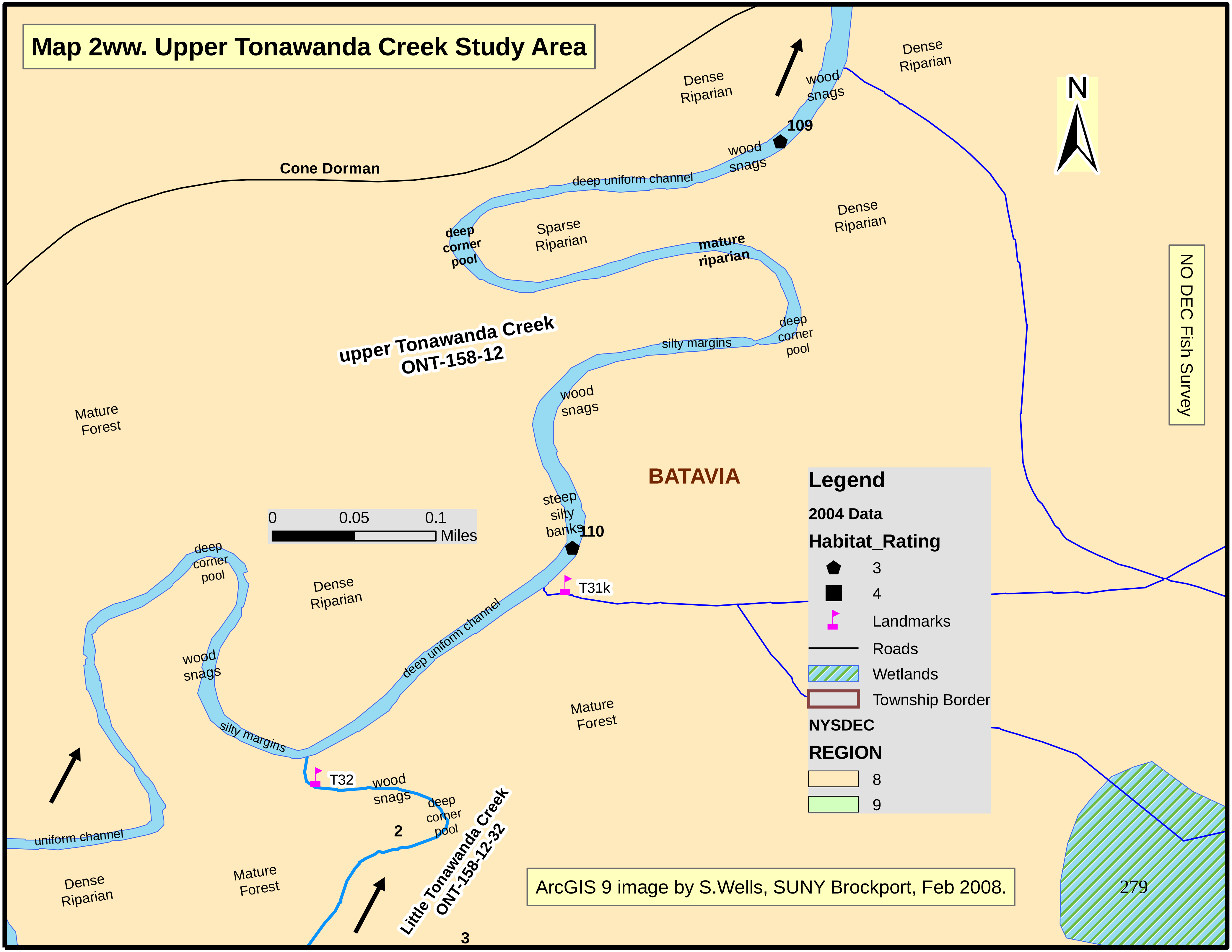
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

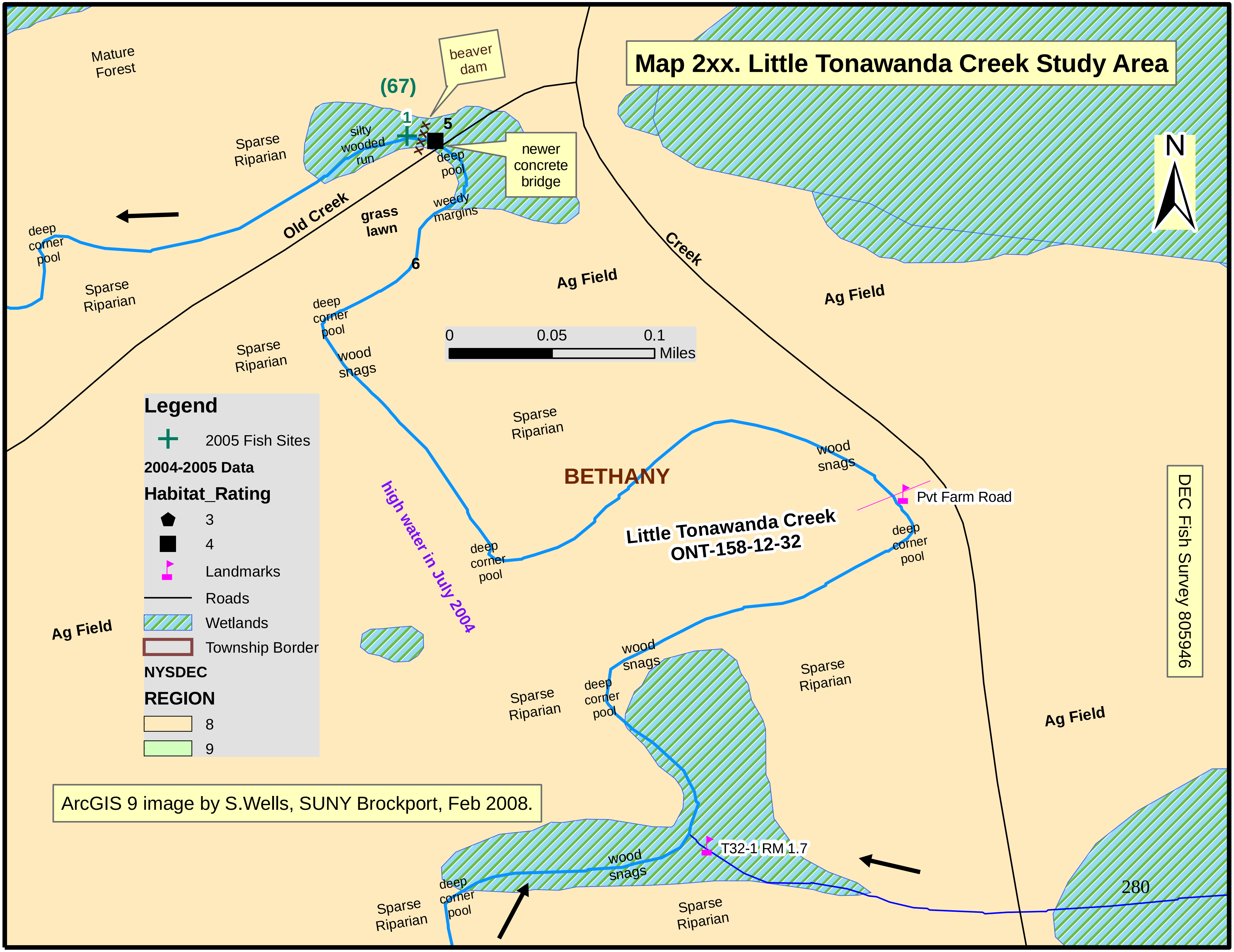


Map 2uu. Upper Tonawanda Creek Study Area
Legend
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Local Streets
Wetlands
Township Border
NYSDEC
REGION
8
9
BATAVIA
CITY
Kibbe
Elmwood
Oakland
Jackson
Hutchins
Swan
Osterhout
James
Kibbe Park
hand launch
99
100
102
grass lawn
Dense Riparian
Sparse Riparian
deep uniform channel
high turbidity
silty margins
deep corner pool
old steel bridge
Backwater Bay
CSX Transportation, Inc.
deep channel
not coded
Lehigh
T31c RM 64.3
T31d
Water Filtration Plant
wood snags
weedy margins
abandoned RxR
Creek
upper Tonawanda Creek
ONT-158-12
Ag Field
0
0.1
0.2
Miles
NO DEC Fish Survey
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

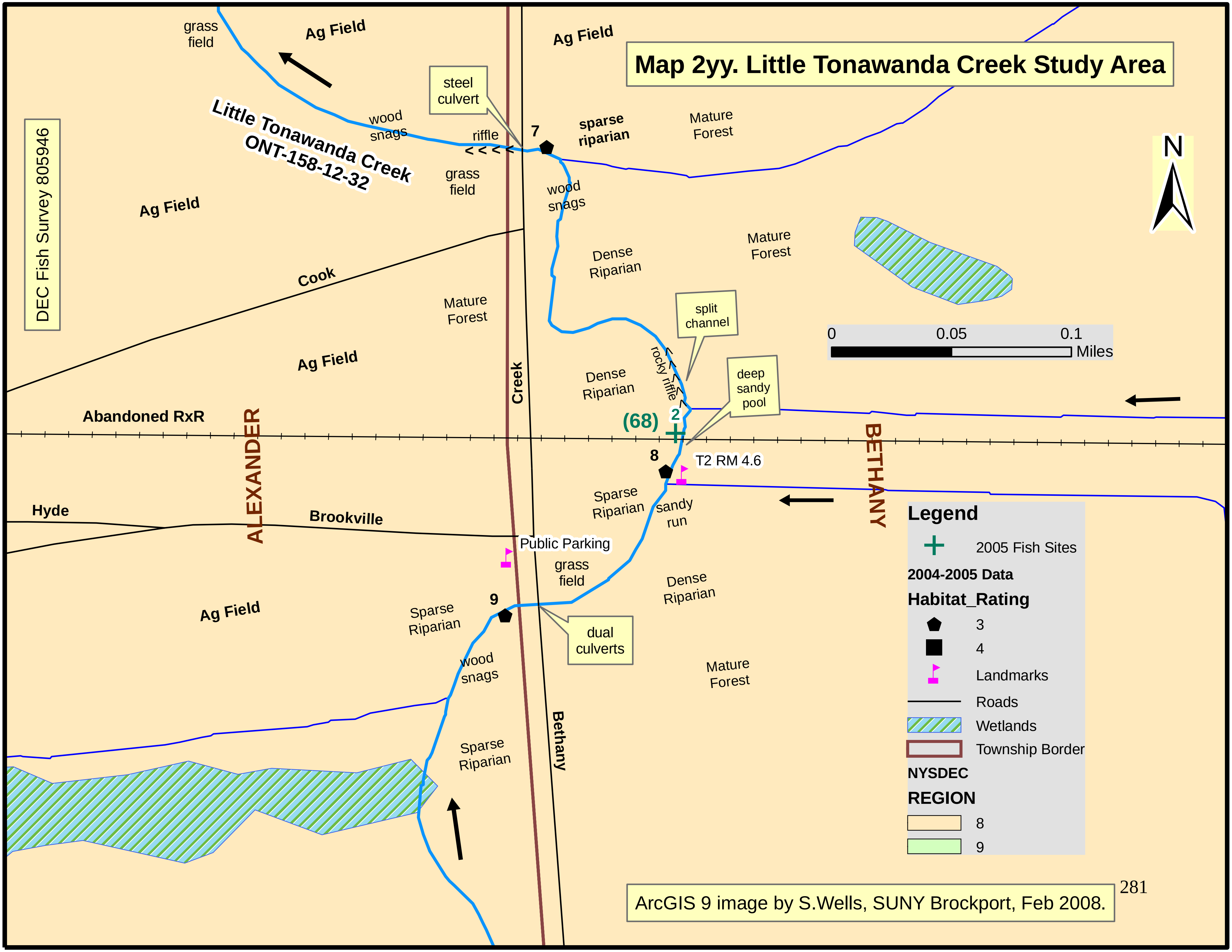


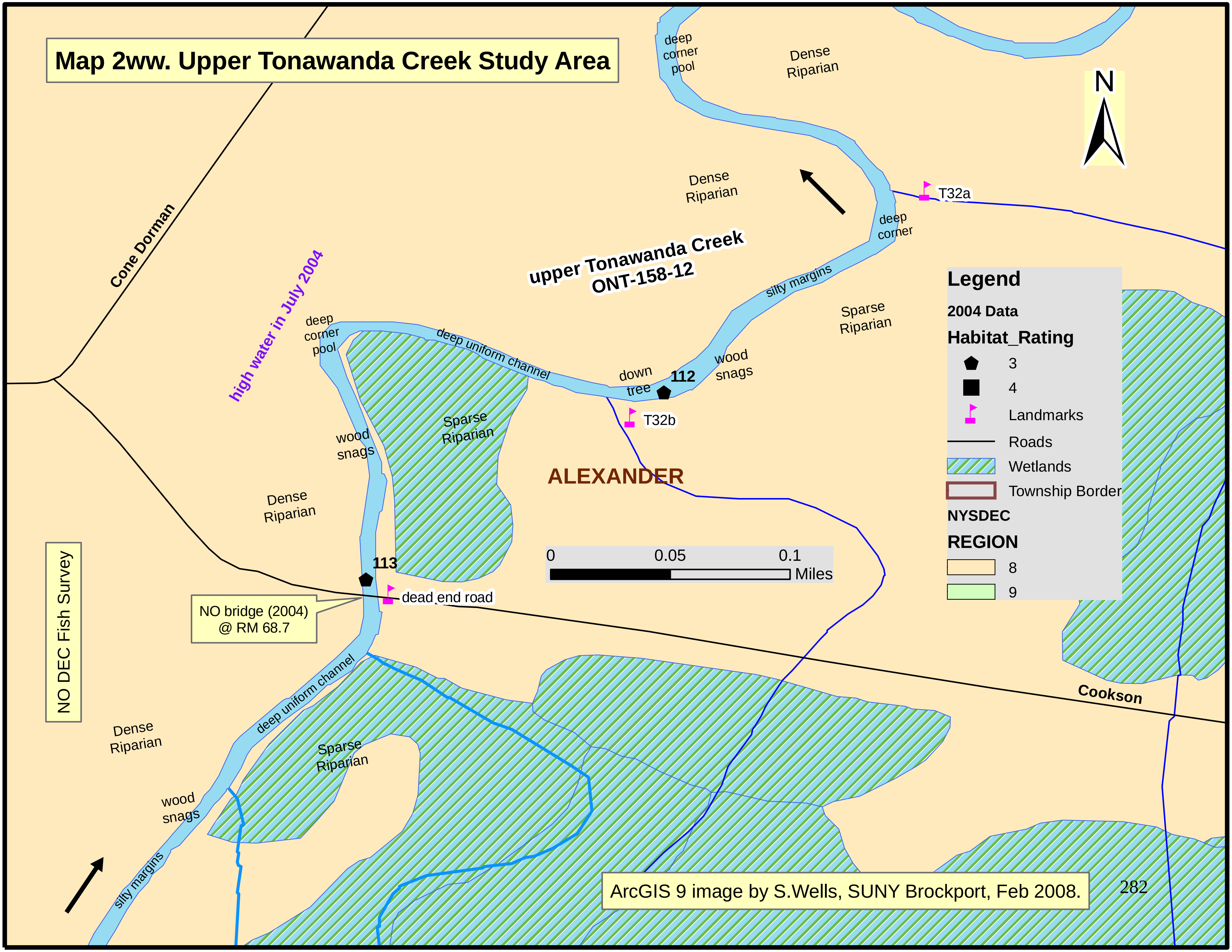
Map 2vv. Upper Tonawanda Creek Study Area
N
Dense Riparian
Dense Riparian
shallow run
wood snag
15
(46)
deep corner pool
Mature Forest
wood snags
silty margins
Ag Field
Dense Riparian
silty margins
high turbidity
106
deep uniform channel
0
0.05
0.1
Miles
T31h
Dense Riparian
Dense Riparian
upper Tonawanda Creek
ONT-158-12
Dense Riparian
deep corner pool
105
wood snags
down tree
BATAVIA
Dense Riparian
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Dense Riparian
107
silty margins
wood snags
deep corner pool
deep corner pool
Dense Riparian
wood snags
deep uniform channel
steep silty banks
Mature Forest
Cone Dorman
wood snags
108
Hand Launch
older concrete bridge @ RM 66.7
deep run
wood snags
Mature Forest
Mature Forest
DEC Fish Survey 805945
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Mature Forest

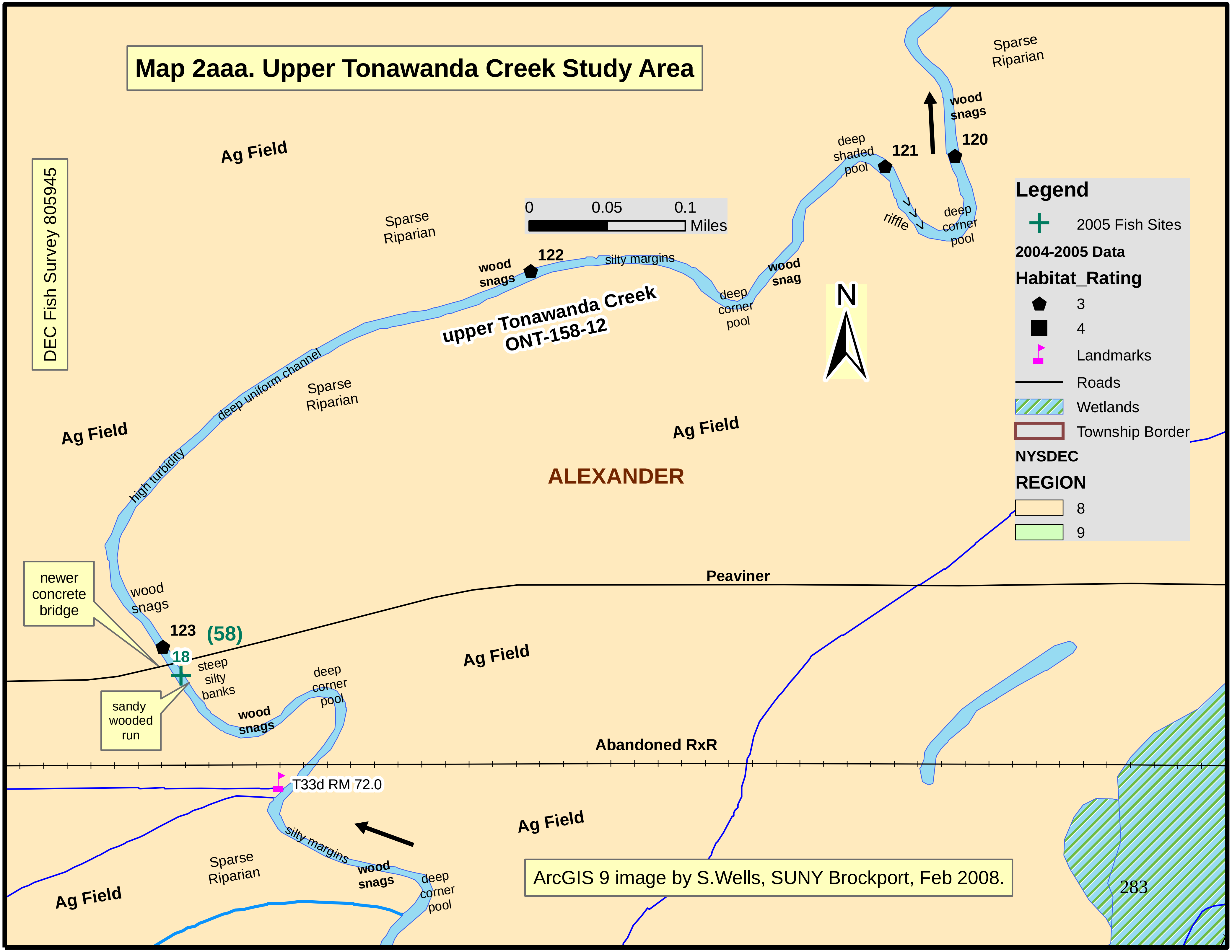

Map 2ww. Upper Tonawanda Creek Study Area
Cone Dorman
Dense Riparian
wood snags
109
wood snags
deep uniform channel
deep corner pool
Sparse Riparian
mature riparian
Dense Riparian
N
NO DEC Fish Survey
upper Tonawanda Creek ONT-158-12
silty margins
deep corner pool
wood snags
Mature Forest
BATAVIA
steep silty banks
110
T31k
0 0.05 0.1 Miles
deep corner pool
Dense Riparian
wood snags
deep uniform channel
silty margins
T32
wood snags
deep corner pool
2
Mature Forest
uniform channel
Dense Riparian
Mature Forest
Little Tonawanda Creek ONT-158-12-32
3
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
279



Map 2xx. Little Tonawanda Creek Study Area
N
Mature Forest
(67)
beaver dam
1
5
silty wooded run
newer concrete bridge
deep pool
Sparse Riparian
Old Creek
grass lawn
weedy margins
deep corner pool
Sparse Riparian
6
Ag Field
Creek
Ag Field
deep corner pool
wood snags
Sparse Riparian
0 0.05 0.1 Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Sparse Riparian
BETHANY
wood snags
Pvt Farm Road
high water in July 2004
deep corner pool
Little Tonawanda Creek ONT-158-12-32
deep corner pool
DEC Fish Survey 805946
Ag Field
wood snags
Sparse Riparian
deep corner pool
Sparse Riparian
Ag Field
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
T32-1 RM 1.7
wood snags
deep corner pool
Sparse Riparian
Sparse Riparian
280

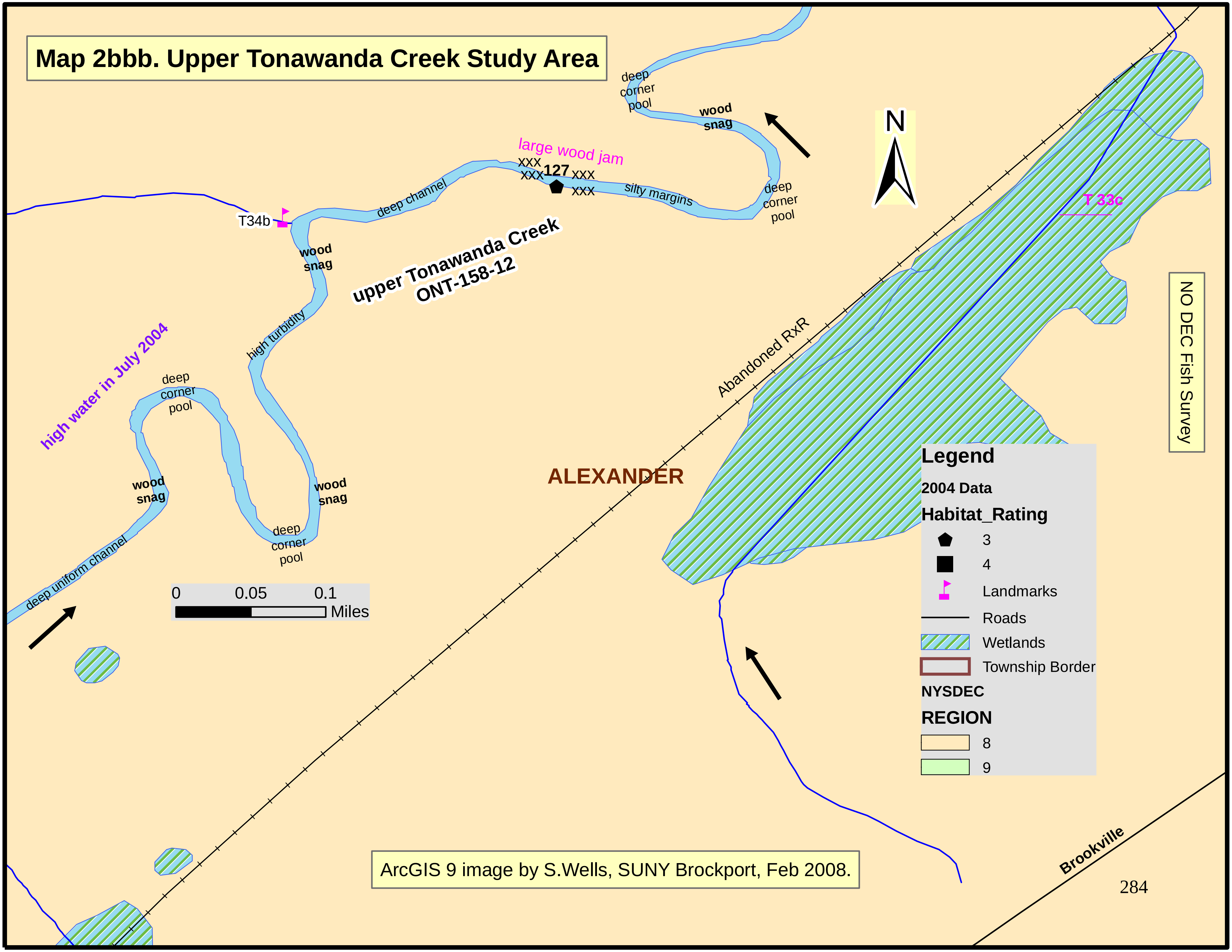

Map 2yy. Little Tonawanda Creek Study Area
DEC Fish Survey 805946
Little Tonawanda Creek
ONT-158-12-32
grass field
Ag Field
Ag Field
steel culvert
wood snags
riffle
7
sparse riparian
Mature Forest
grass field
wood snags
Ag Field
Cook
Dense Riparian
Mature Forest
Mature Forest
split channel
Ag Field
Creek
Dense Riparian
rocky riffle
deep sandy pool
0
0.05
0.1
Miles
N
Abandoned RxR
ALEXANDER
(68)
2
BETHANY
8
T2 RM 4.6
Sparse Riparian
sandy run
Hyde
Brookville
Public Parking
grass field
Dense Riparian
9
Ag Field
Sparse Riparian
dual culverts
wood snags
Mature Forest
Sparse Riparian
Bethany
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

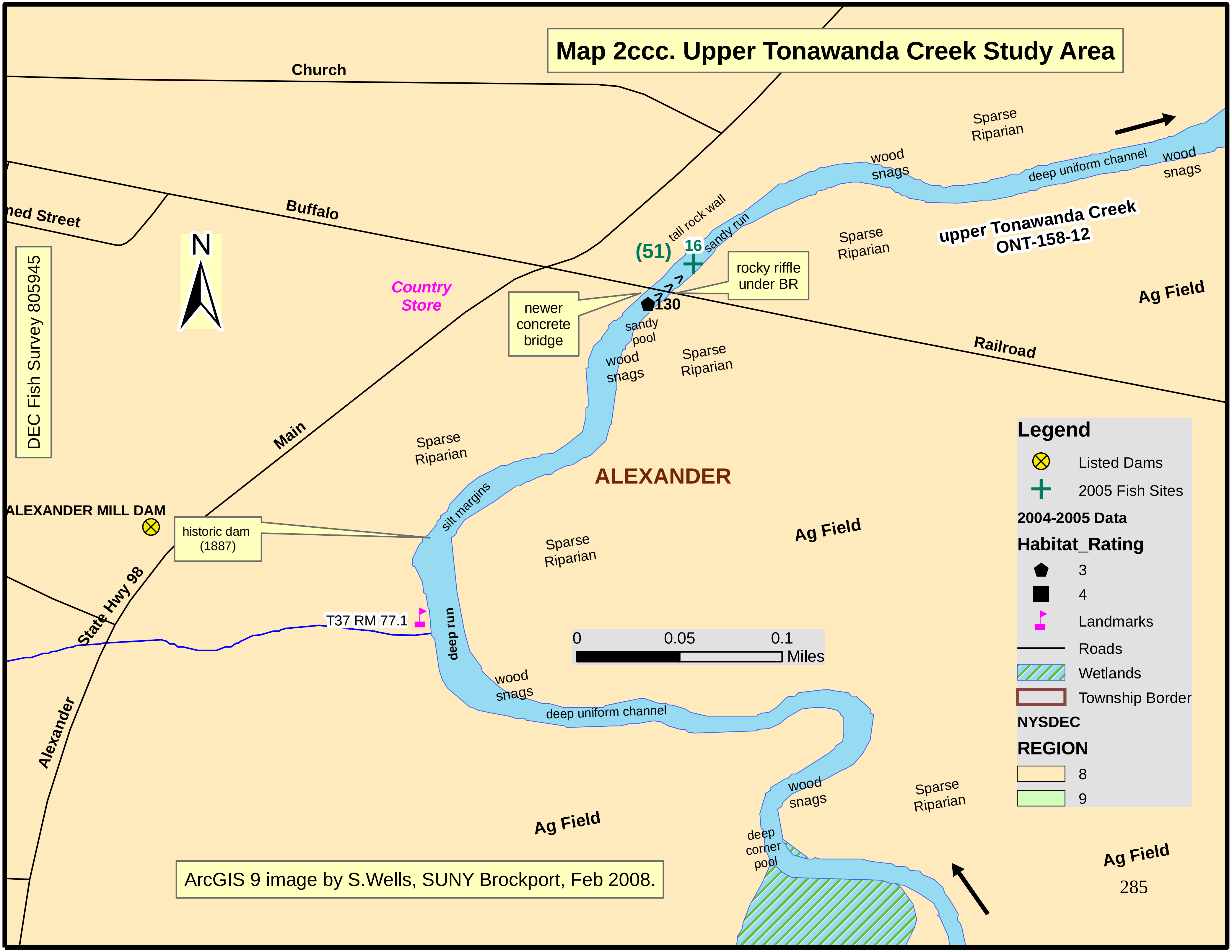

Map 2ww. Upper Tonawanda Creek Study Area
Cone Dorman
high water in July 2004
deep corner pool
deep corner pool
Dense Riparian
Dense Riparian
deep corner
silty margins
upper Tonawanda Creek ONT-158-12
Sparse Riparian
deep uniform channel
down tree
112
wood snags
T32a
T32b
Sparse Riparian
wood snags
Dense Riparian
ALEXANDER
113
dead end road
NO bridge (2004) @ RM 68.7
NO DEC Fish Survey
deep uniform channel
Dense Riparian
Sparse Riparian
wood snags
silty margins
Cookson
0
0.05
0.1
Miles
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
N
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



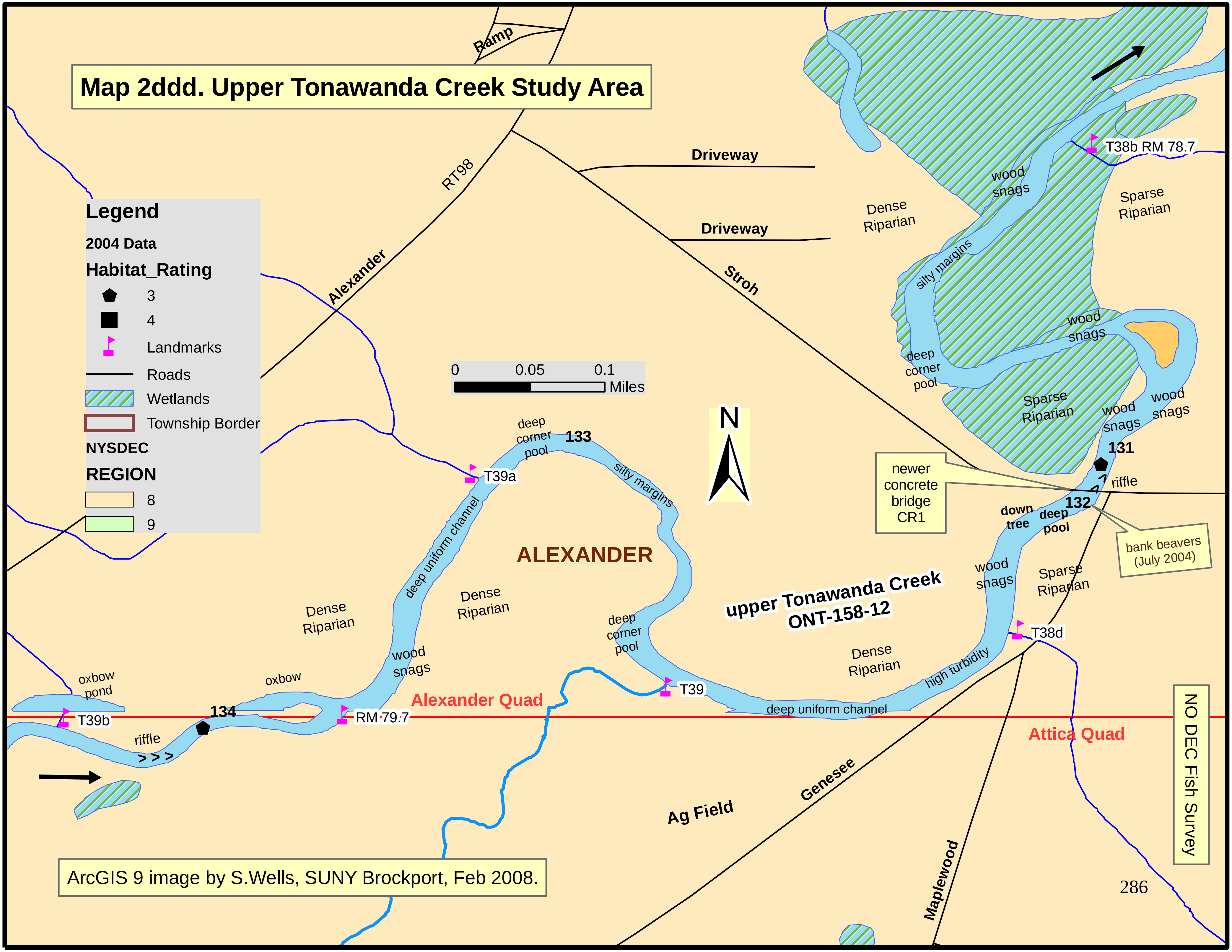
Map 2aaa. Upper Tonawanda Creek Study Area
DEC Fish Survey 805945
Ag Field
Sparse Riparian
0 0.05 0.1 Miles
wood snags
122
silty margins
wood snag
deep corner pool
deep shaded pool
121
120
wood snags
riffle
deep corner pool
upper Tonawanda Creek ONT-158-12
deep uniform channel
high turbidity
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ALEXANDER
Peaviner
newer concrete bridge
123
(58)
18
steep silty banks
sandy wooded run
deep corner pool
Abandoned RxR
T33d RM 72.0
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
283

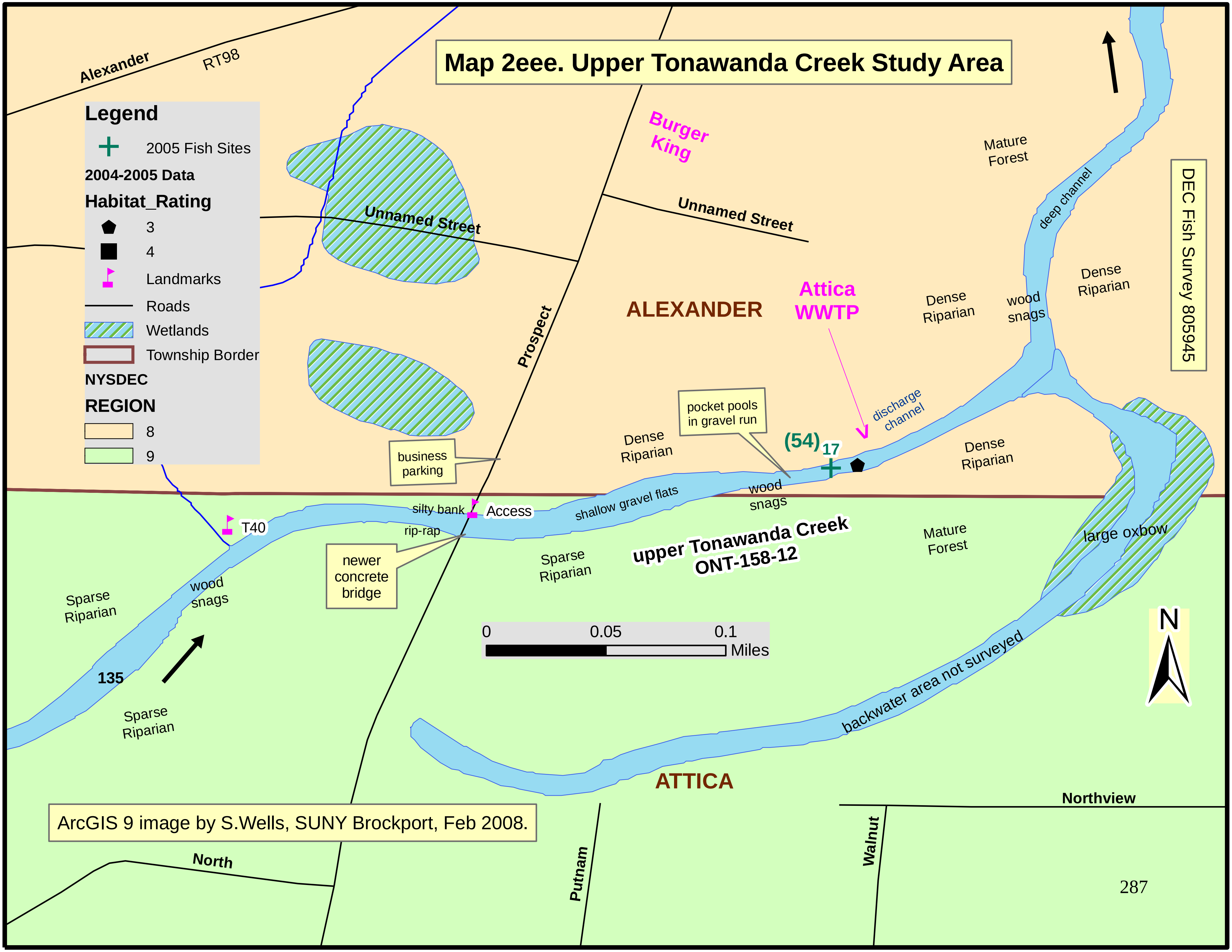
Map 2bbb. Upper Tonawanda Creek Study Area

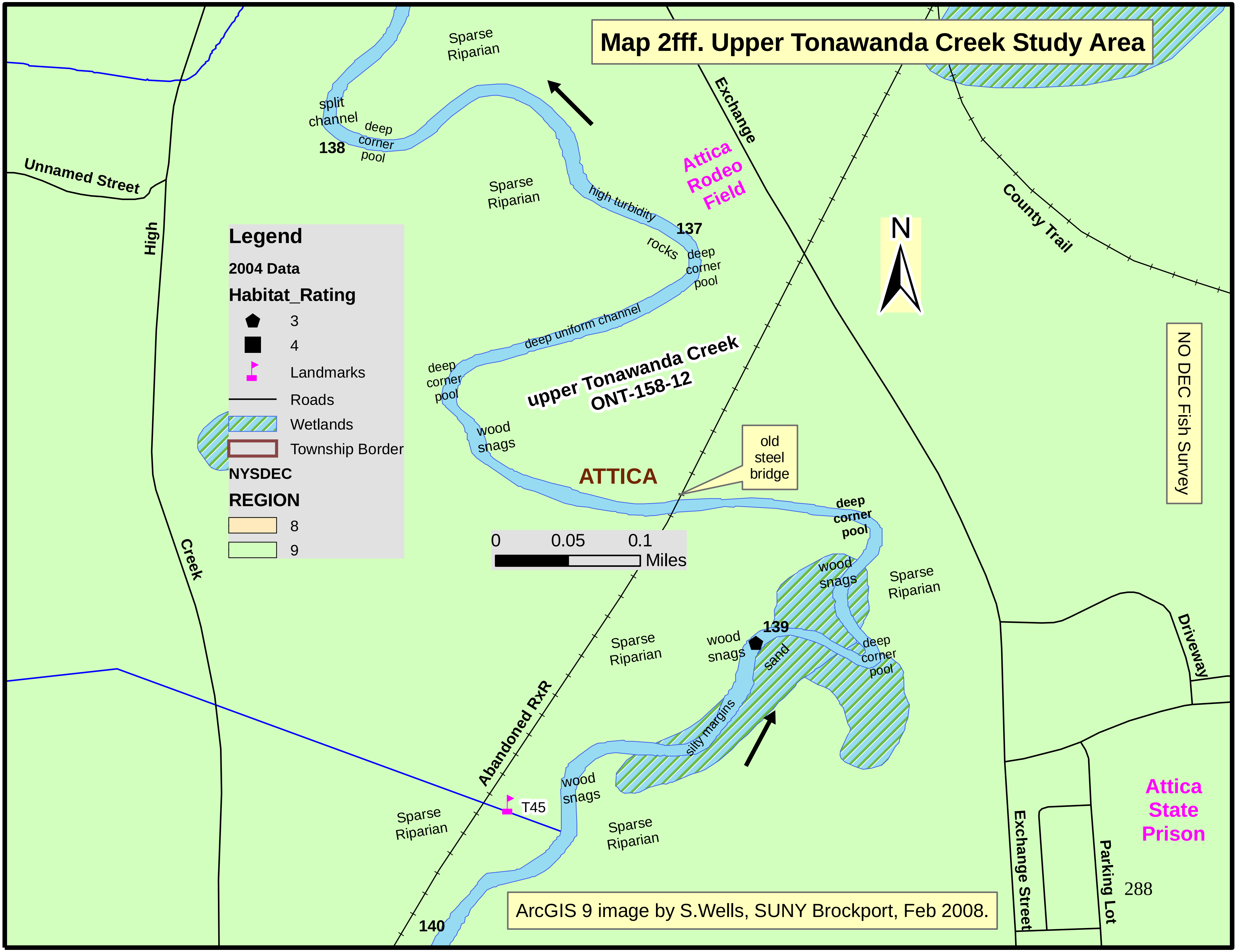




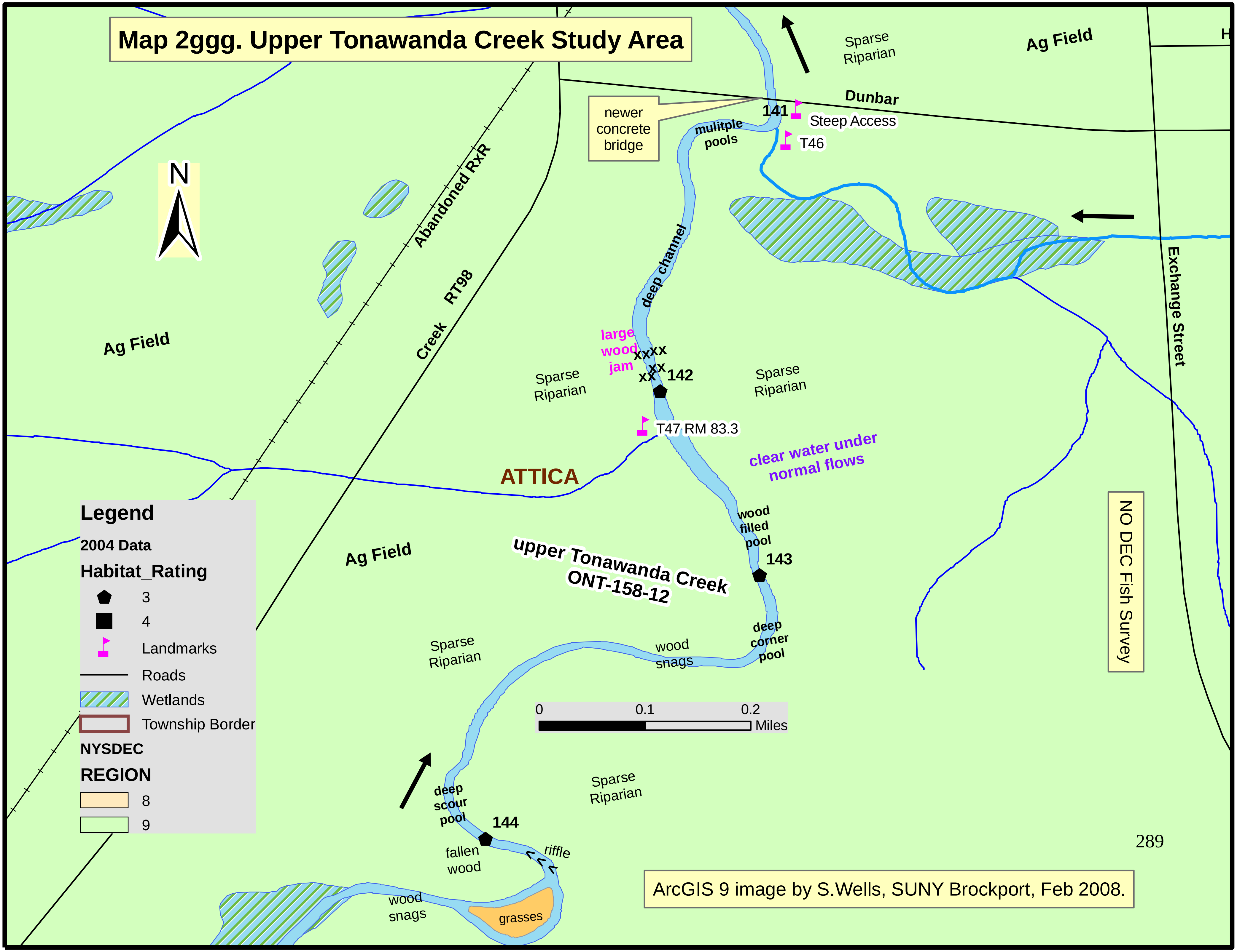
Map 2ccc. Upper Tonawanda Creek Study Area
Church
Buffalo
ned Street
Main
Railroad
State Hwy 98
Alexander
DEC Fish Survey 805945
N
Country Store
newer concrete bridge
historic dam (1887)
ALEXANDER MILL DAM
(51)
16
130
tall rock wall
sandy run
rocky riffle under BR
sandy pool
wood snags
Sparse Riparian
upper Tonawanda Creek
ONT-158-12
deep uniform channel
Ag Field
ALEXANDER
silt margins
deep run
T37 RM 77.1
deep corner pool
0
0.05
0.1
Miles
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2ddd. Upper Tonawanda Creek Study Area
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.05
0.1
Miles
N
ALEXANDER
upper Tonawanda Creek
ONT-158-12
Alexander Quad
Attica Quad
Ramp
RT98
Alexander
Driveway
Driveway
Stroh
Genesee
Maplewood
Ag Field
T38b RM 78.7
T39a
T39
T39b
RM 79.7
T38d
131
132
133
134
newer concrete bridge CR1
bank beavers (July 2004)
Dense Riparian
Sparse Riparian
wood snags
silty margins
deep corner pool
deep uniform channel
high turbidity
oxbow pond
oxbow
riffle
down tree
deep pool
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
NO DEC Fish Survey

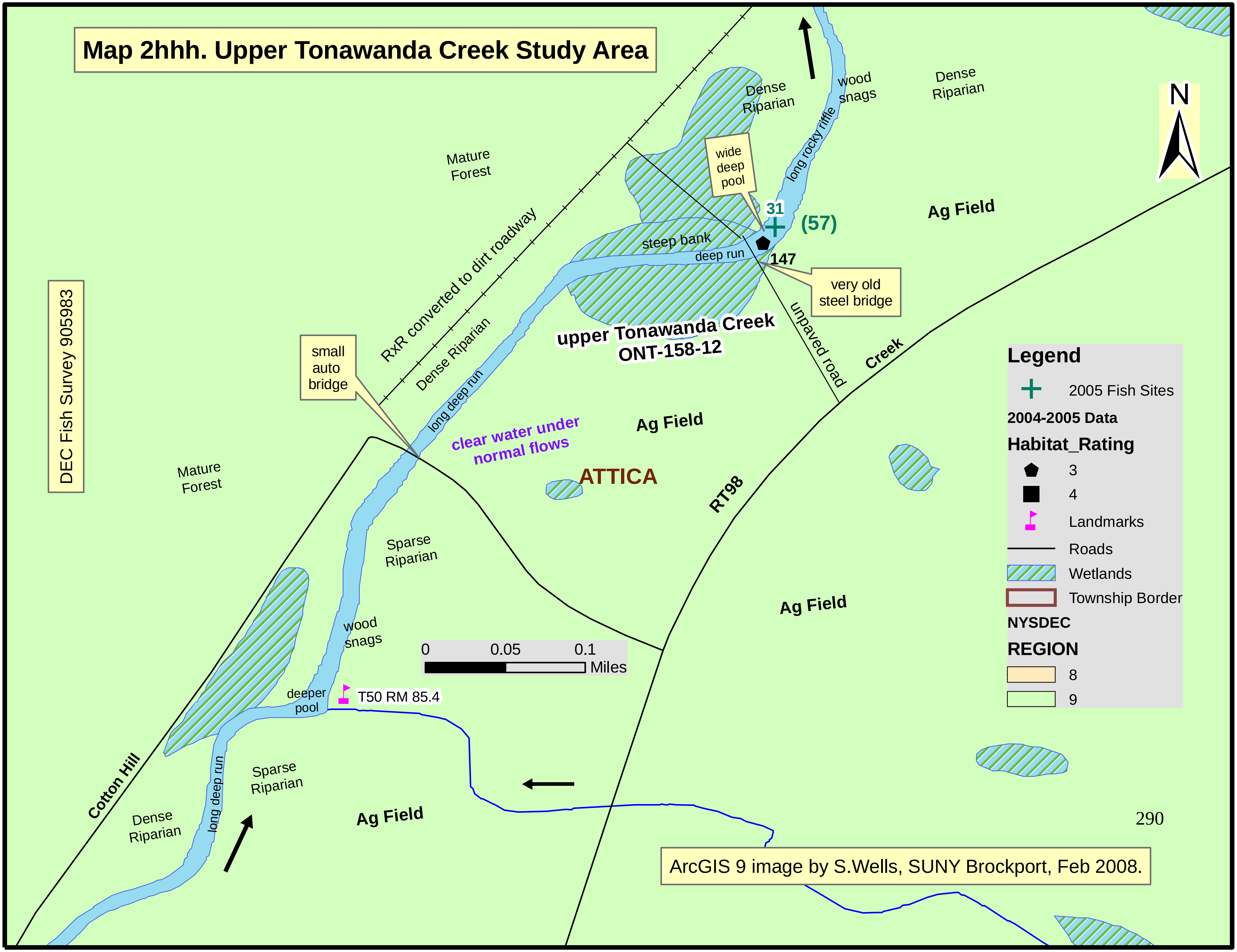

Map 2eee. Upper Tonawanda Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Alexander
RT98
Unnamed Street
Unnamed Street
Prospect
Burger King
ALEXANDER
Attica WWTP
Mature Forest
deep channel
DEC Fish Survey 805945
Dense Riparian
wood snags
Dense Riparian
Dense Riparian
pocket pools in gravel run
(54)
17
discharge channel
Dense Riparian
business parking
silty bank
Access
shallow gravel flats
wood snags
T40
rip-rap
newer concrete bridge
Sparse Riparian
upper Tonawanda Creek
ONT-158-12
Mature Forest
large oxbow
Sparse Riparian
wood snags
0
0.05
0.1
Miles
N
135
Sparse Riparian
backwater area not surveyed
ATTICA
Northview
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
North
Putnam
Walnut



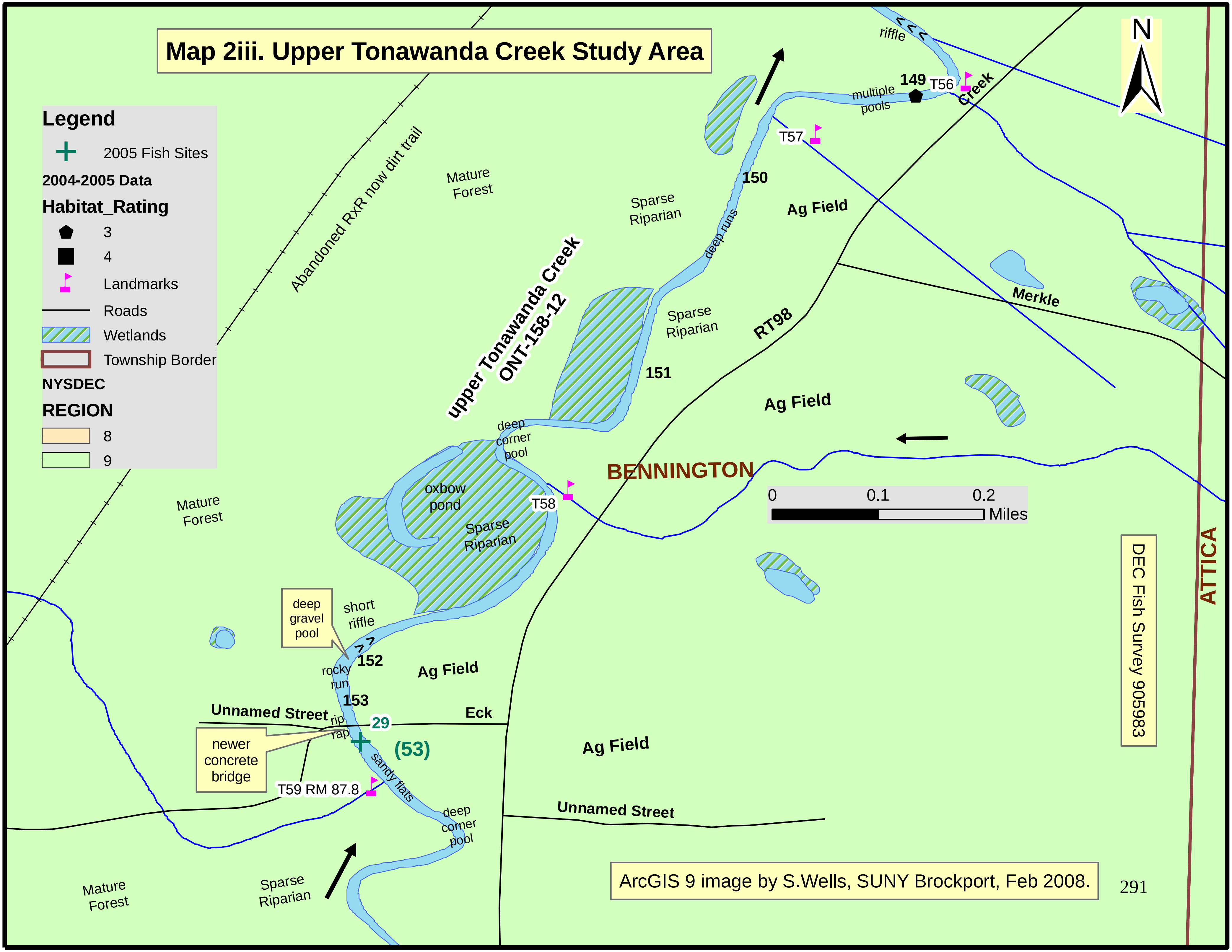
Map 2fff. Upper Tonawanda Creek Study Area
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.05
0.1
Miles
N
Sparse Riparian
split channel
deep corner pool
138
high turbidity
137
rocks
deep corner pool
Attica Rodeo Field
Exchange
County Trail
deep uniform channel
deep corner pool
upper Tonawanda Creek
ONT-158-12
wood snags
ATTICA
old steel bridge
deep corner pool
wood snags
139
wood snags
sand
deep corner pool
silty margins
wood snags
T45
Abandoned RxR
140
Unnamed Street
High
Creek
Driveway
Exchange Street
Parking Lot
288
Attica State Prison
NO DEC Fish Survey
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

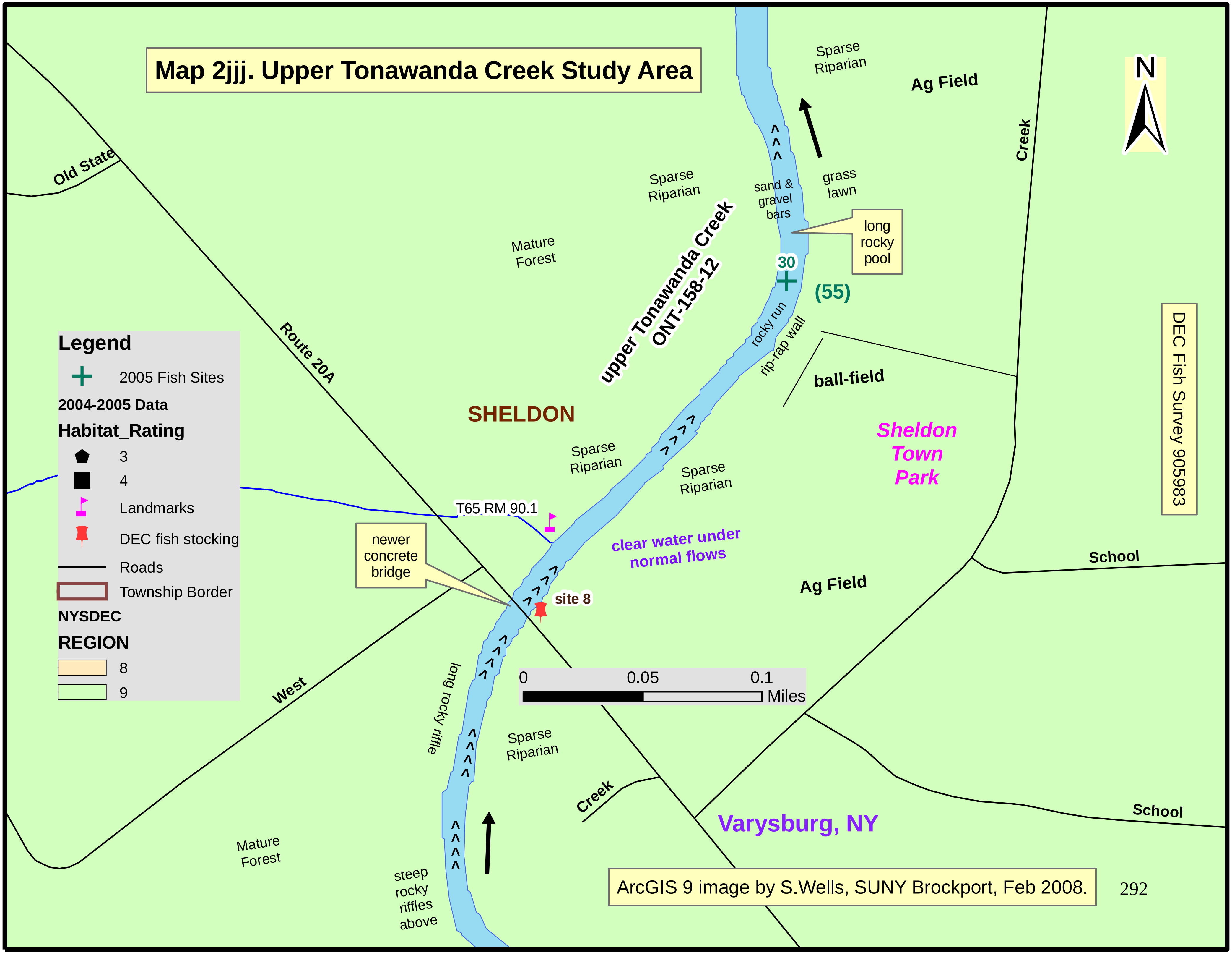


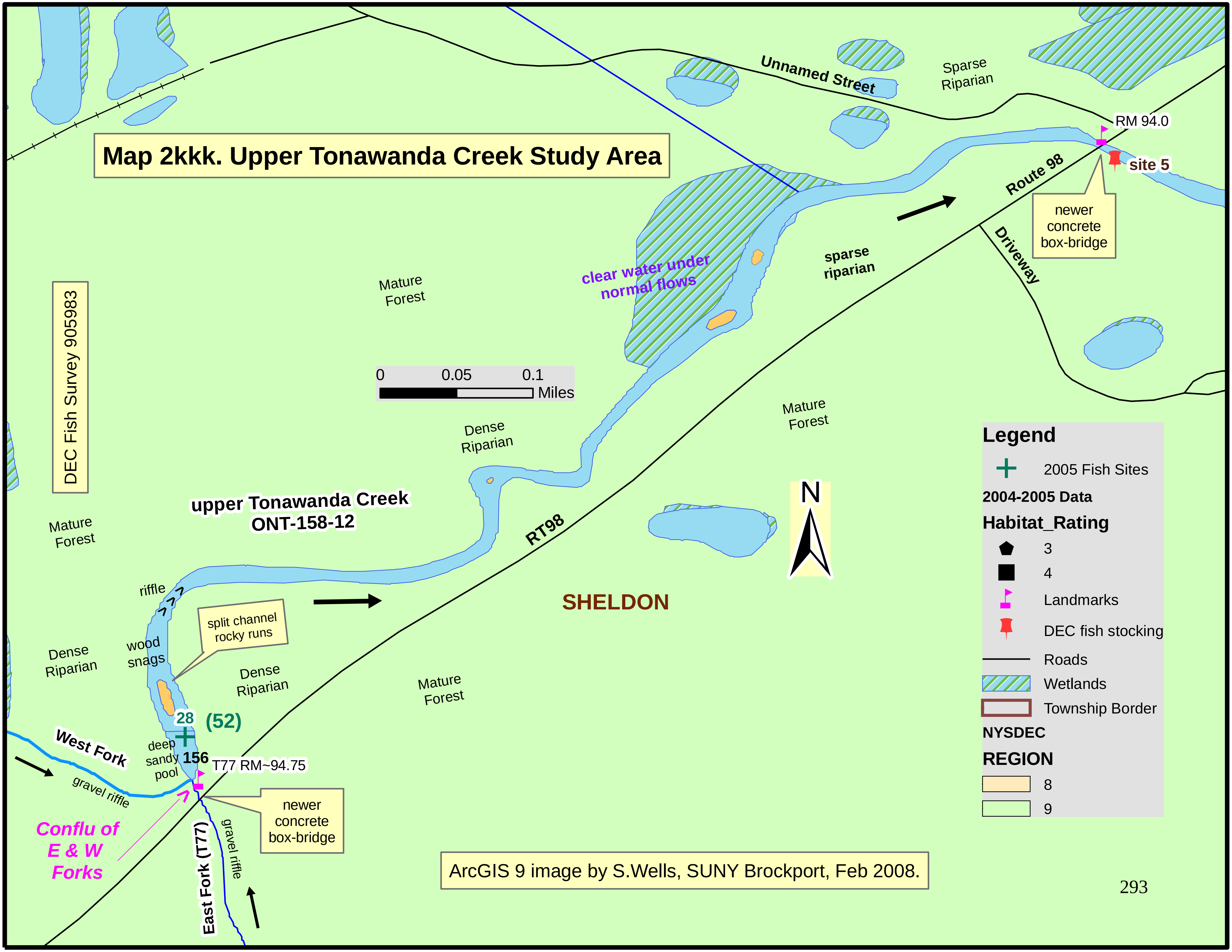
Map 2ggg. Upper Tonawanda Creek Study Area
N
Abandoned RxR
Creek RT98
Ag Field
Sparse Riparian
Dunbar
newer concrete bridge
141
Steep Access
T46
mulitple pools
deep channel
large wood jam
142
T47 RM 83.3
ATTICA
clear water under normal flows
wood filled pool
143
upper Tonawanda Creek
ONT-158-12
deep corner pool
wood snags
Exchange Street
NO DEC Fish Survey
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.1
0.2
Miles
deep scour pool
144
fallen wood
riffle
grasses
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

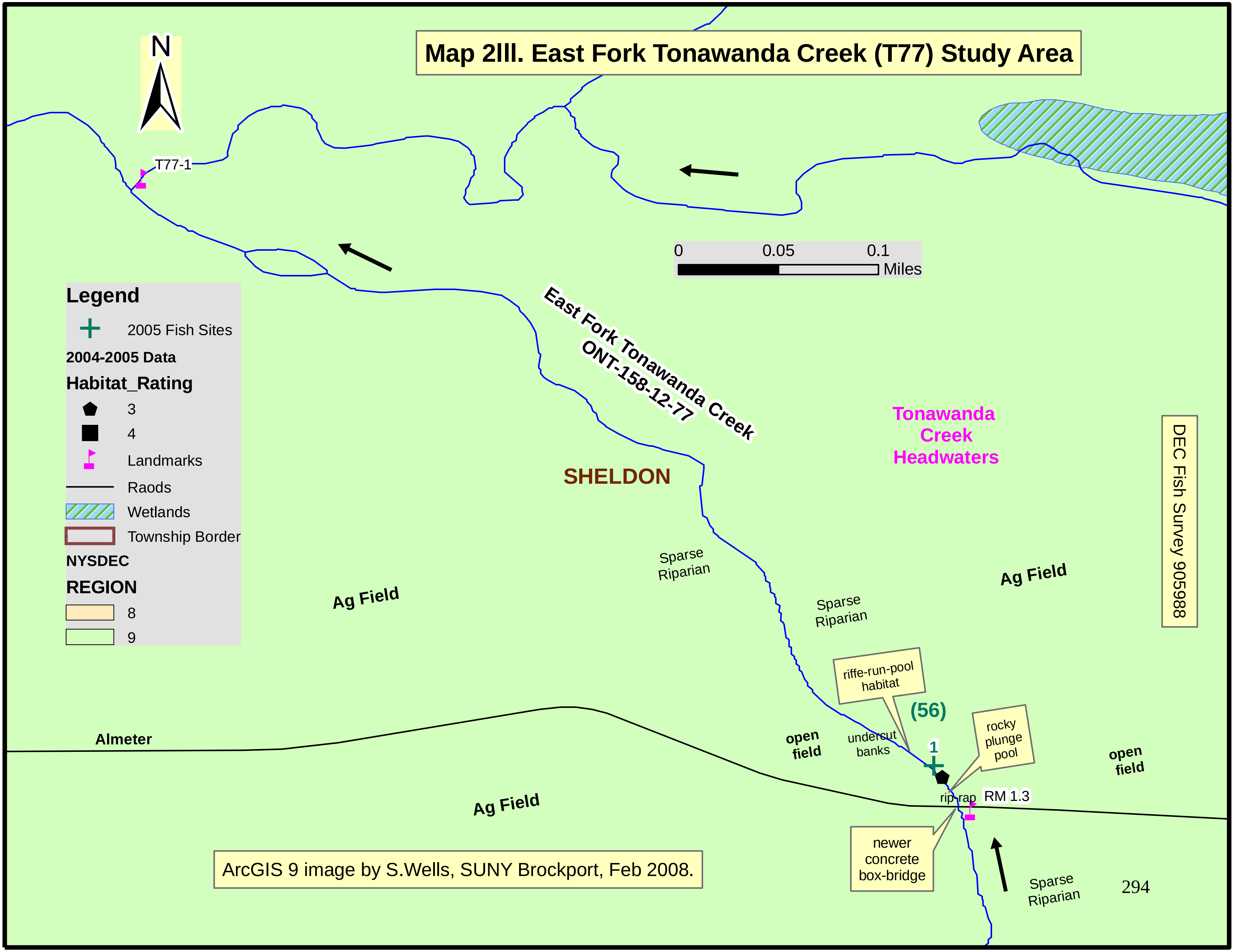


Map 2hhh. Upper Tonawanda Creek Study Area

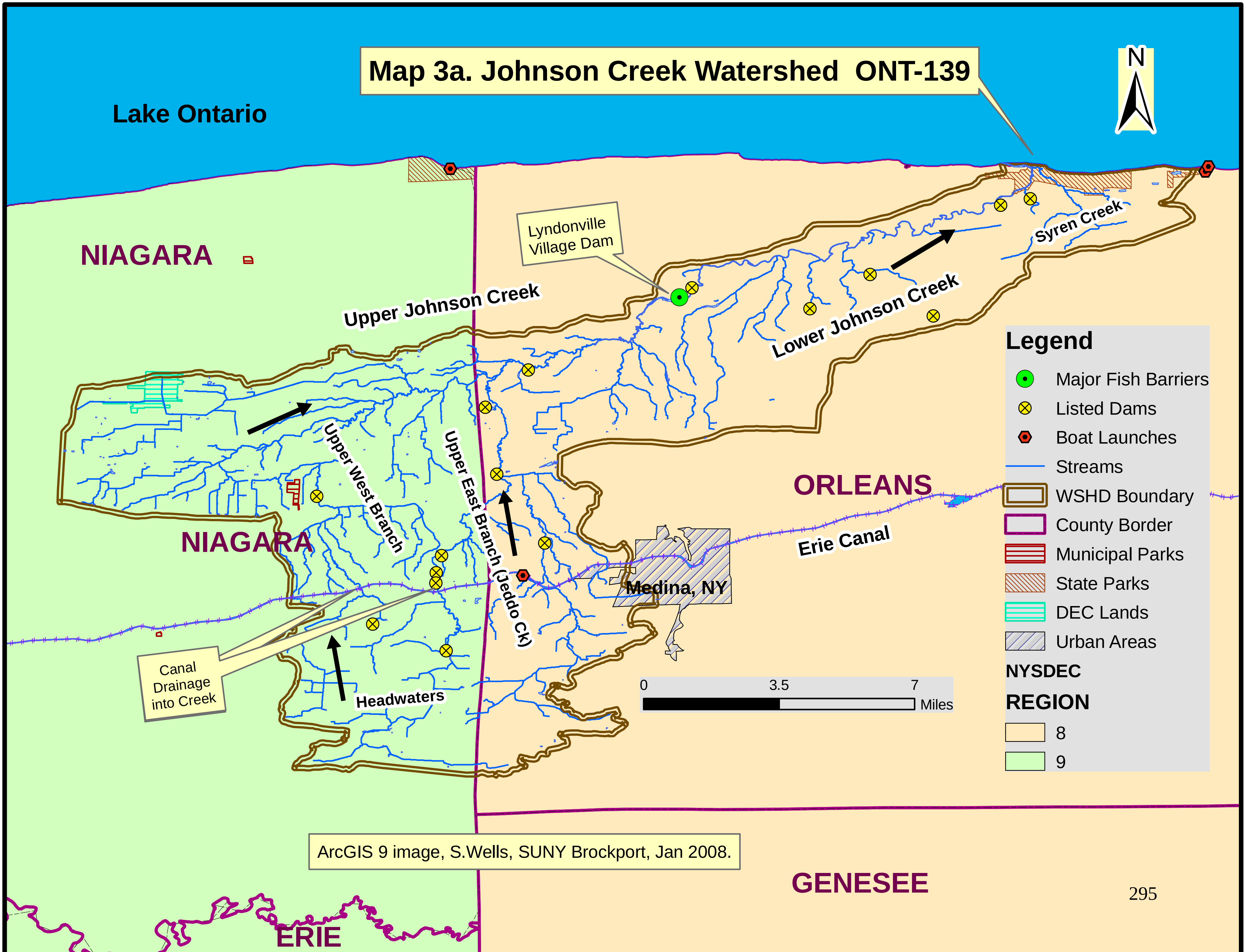

Map 2iii. Upper Tonawanda Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Abandoned RxR now dirt trail
Mature Forest
Sparse Riparian
upper Tonawanda Creek ONT-158-12
riffle
149
T56
Creek
multiple pools
T57
150
deep runs
Ag Field
Sparse Riparian
RT98
Merkle
151
Ag Field
deep corner pool
oxbow pond
Sparse Riparian
T58
BENNINGTON
0 0.1 0.2 Miles
Mature Forest
deep gravel pool
short riffle
152
rocky run
153
Ag Field
Unnamed Street
rip rap
29
Eck
newer concrete bridge
(53)
sandy flats
T59 RM 87.8
deep corner pool
Ag Field
Unnamed Street
DEC Fish Survey 905983
ATTICA
Mature Forest
Sparse Riparian
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.


Map 2jjj. Upper Tonawanda Creek Study Area
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
DEC fish stocking
Roads
Township Border
NYSDEC
REGION
8
9
Old State
Route 20A
West
Creek
School
School
Creek
upper Tonawanda Creek
ONT-158-12
SHELDON
Sheldon Town Park
Varysburg, NY
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Mature Forest
Mature Forest
Ag Field
Ag Field
grass lawn
sand & gravel bars
long rocky pool
30
(55)
rocky run
rip-rap wall
ball-field
clear water under normal flows
T65 RM 90.1
newer concrete bridge
site 8
long rocky riffle
steep rocky riffles above
0
0.05
0.1
Miles
DEC Fish Survey 905983
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.

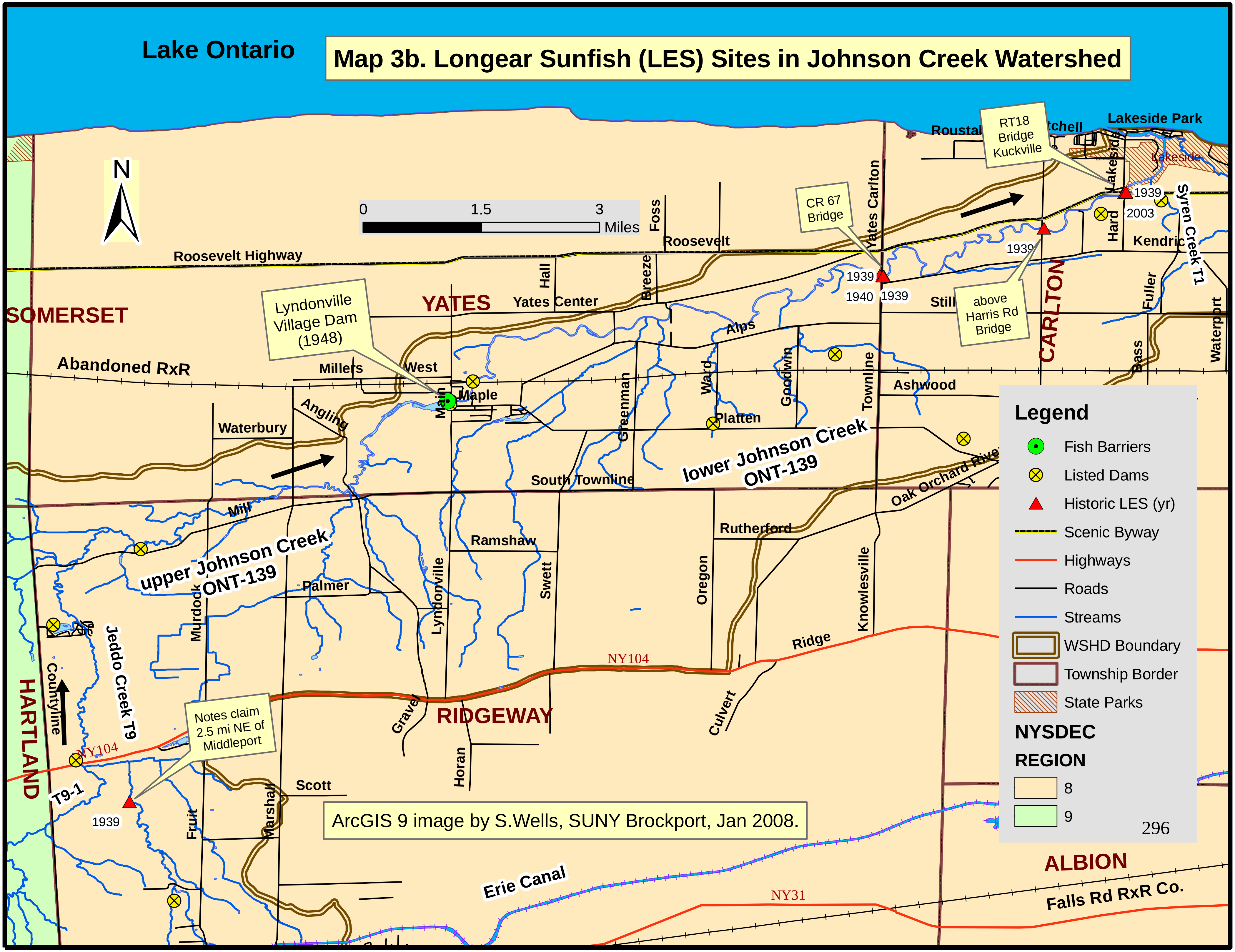

Map 2kkk. Upper Tonawanda Creek Study Area
DEC Fish Survey 905983
Unnamed Street
Sparse Riparian
RM 94.0
site 5
Route 98
newer concrete box-bridge
Driveway
clear water under normal flows
sparse riparian
Mature Forest
0 0.05 0.1 Miles
Dense Riparian
Mature Forest
upper Tonawanda Creek ONT-158-12
Mature Forest
RT98
N
SHELDON
riffle
split channel rocky runs
wood snags
Dense Riparian
Dense Riparian
Mature Forest
28 (52)
West Fork
deep sandy pool
156
T77 RM~94.75
gravel riffle
newer concrete box-bridge
Conflu of E & W Forks
East Fork (T77)
gravel riffle
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
DEC fish stocking
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9

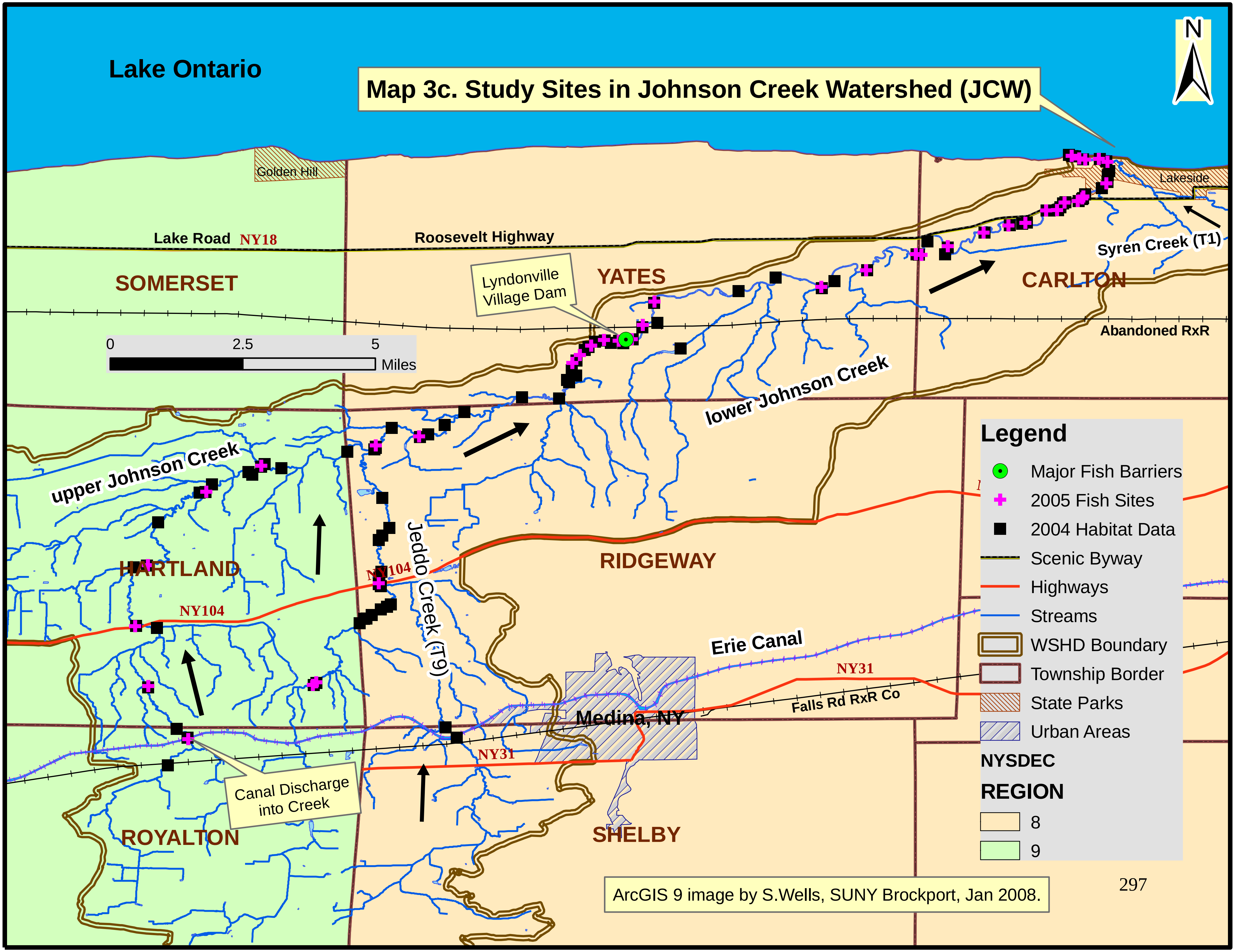


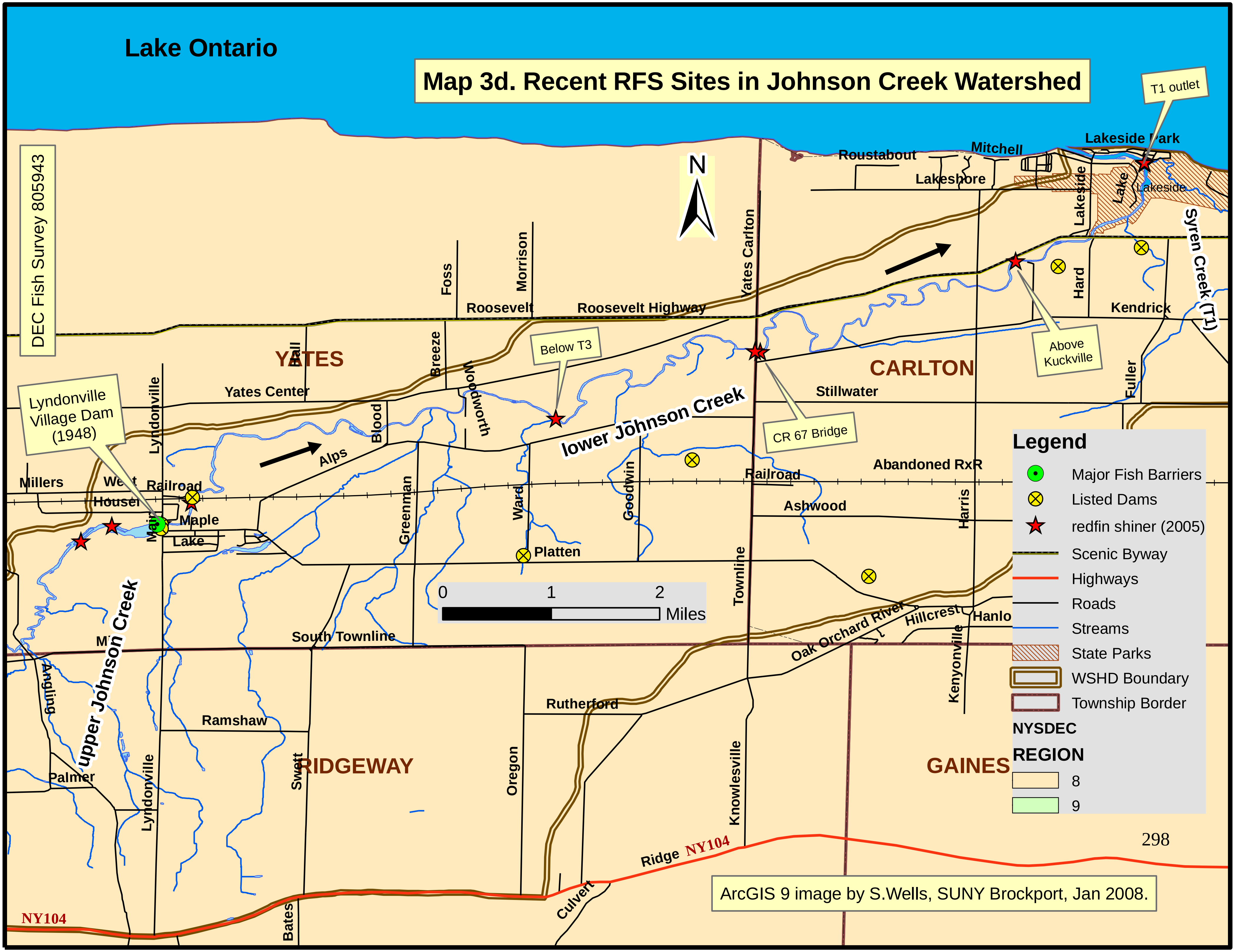
Map 2lll. East Fork Tonawanda Creek (T77) Study Area
N
T77-1
0
0.05
0.1
Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Raods
Wetlands
Township Border
NYSDEC
REGION
8
9
East Fork Tonawanda Creek
ONT-158-12-77
SHELDON
Tonawanda Creek Headwaters
DEC Fish Survey 905988
Sparse Riparian
Sparse Riparian
Ag Field
Ag Field
Ag Field
riffe-run-pool habitat
(56)
rocky plunge pool
open field
undercut banks
1
open field
Almeter
rip-rap
RM 1.3
newer concrete box-bridge
Sparse Riparian
ArcGIS 9 image by S.Wells, SUNY Brockport, Feb 2008.



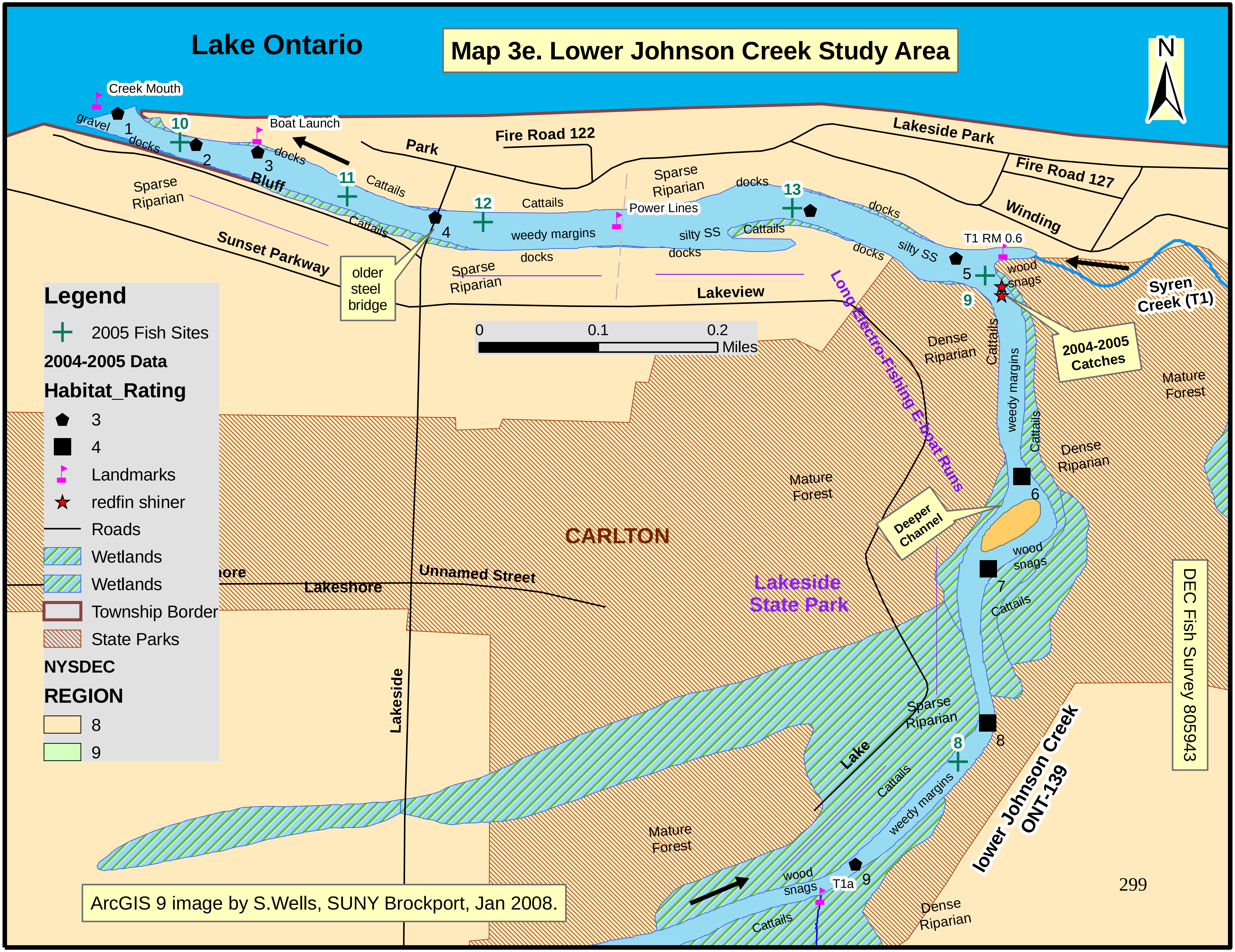
Map 3a. Johnson Creek Watershed ONT-139
N
Lake Ontario
NIAGARA
Lyndonville Village Dam
Upper Johnson Creek
Syren Creek
Lower Johnson Creek
Legend
Major Fish Barriers
Listed Dams
Boat Launches
Streams
WSHD Boundary
County Border
Municipal Parks
State Parks
DEC Lands
Urban Areas
NYSDEC
REGION
8
9
Upper West Branch
Upper East Branch (Jeddo Ck)
ORLEANS
NIAGARA
Erie Canal
Medina, NY
Canal Drainage into Creek
Headwaters
0
3.5
7
Miles
ArcGIS 9 image, S.Wells, SUNY Brockport, Jan 2008.
GENESEE
ERIE


Map 3b. Longear Sunfish (LES) Sites in Johnson Creek Watershed
Lake Ontario
N
0 1.5 3 Miles
Roosevelt Highway
Roosevelt
Abandoned RxR
SOMERSET
YATES
CARLTON
RIDGEWAY
HARTLAND
ALBION
Lyndonville Village Dam (1948)
CR 67 Bridge
RT18 Bridge Kuckville
above Harris Rd Bridge
Notes claim 2.5 mi NE of Middleport
upper Johnson Creek ONT-139
lower Johnson Creek ONT-139
Jeddo Creek T9
T9-1
Syren Creek T1
Oak Orchard River
Erie Canal
Falls Rd RxR Co.
NY104
NY31
Ridge
Lakeside Park
Lakeside
Roustal
Kendrick
Yates Carlton
Yates Center
Millers
West
Maple
Main
Angling
Waterbury
Mill
Palmer
Murdock
Countyline
Fruit
Marshall
Scott
Gravel
Horan
Lyndonville
Ramshaw
Swett
South Townline
Greenman
Ward
Goodwin
Platten
Alps
Townline
Ashwood
Still
Rutherford
Oregon
Culvert
Knowlesville
Hall
Breeze
Foss
Hard
Fuller
Bass
Waterport
1939
1940
2003
Legend
Fish Barriers
Listed Dams
Historic LES (yr)
Scenic Byway
Highways
Roads
Streams
WSHD Boundary
Township Border
State Parks
NYSDEC REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

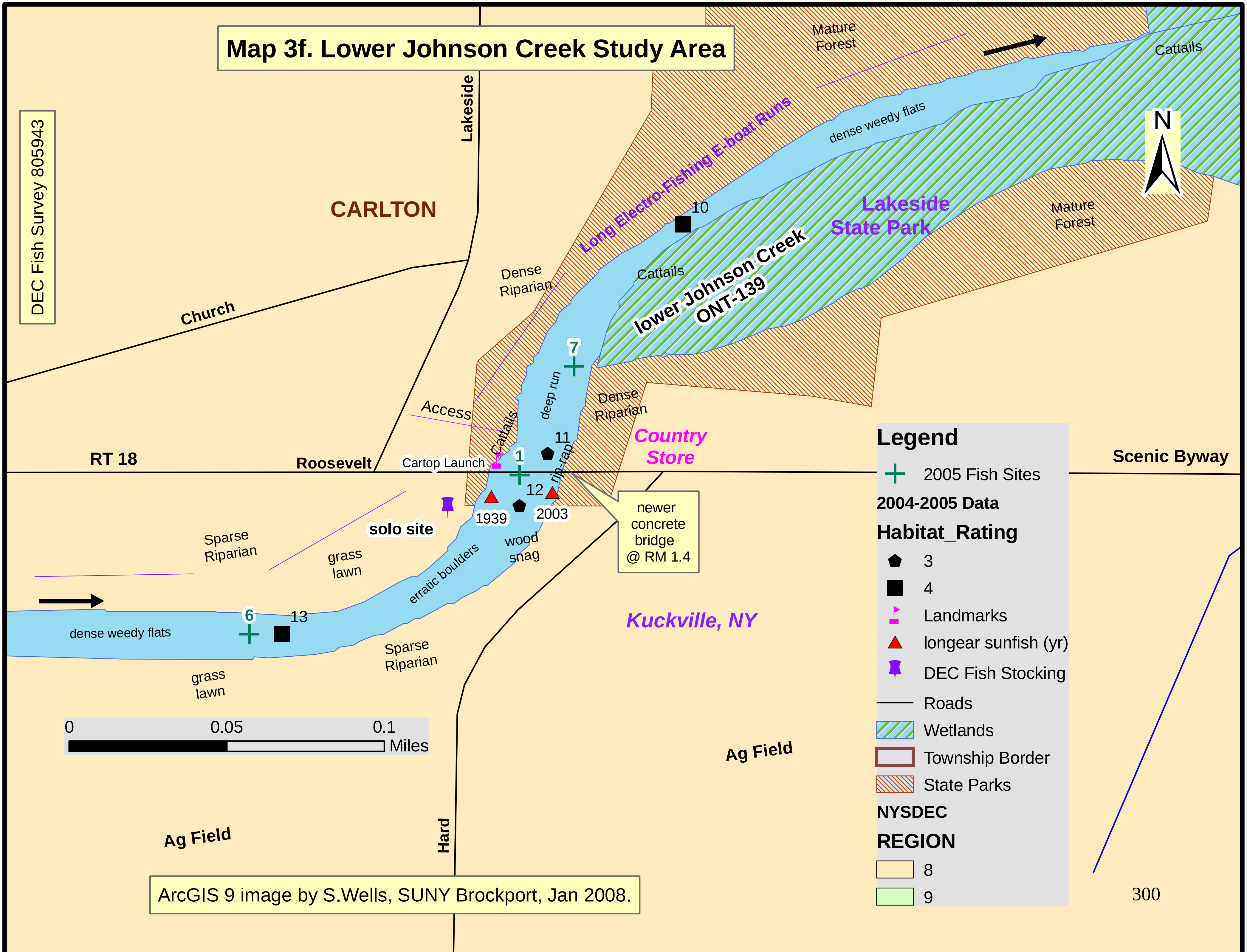

Map 3c. Study Sites in Johnson Creek Watershed (JCW)
Lake Ontario
N
Golden Hill
Lakeside
Lake Road NY18
Roosevelt Highway
SOMERSET
YATES
CARLTON
Lyndonville Village Dam
Syren Creek (T1)
Abandoned RxR
0 2.5 5 Miles
lower Johnson Creek
upper Johnson Creek
HARTLAND
RIDGEWAY
Jeddo Creek (T9)
NY104
NY104
Erie Canal
NY31
Falls Rd RxR Co
Medina, NY
NY31
Canal Discharge into Creek
ROYALTON
SHELBY
Legend
Major Fish Barriers
2005 Fish Sites
2004 Habitat Data
Scenic Byway
Highways
Streams
WSHD Boundary
Township Border
State Parks
Urban Areas
NYSDEC REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



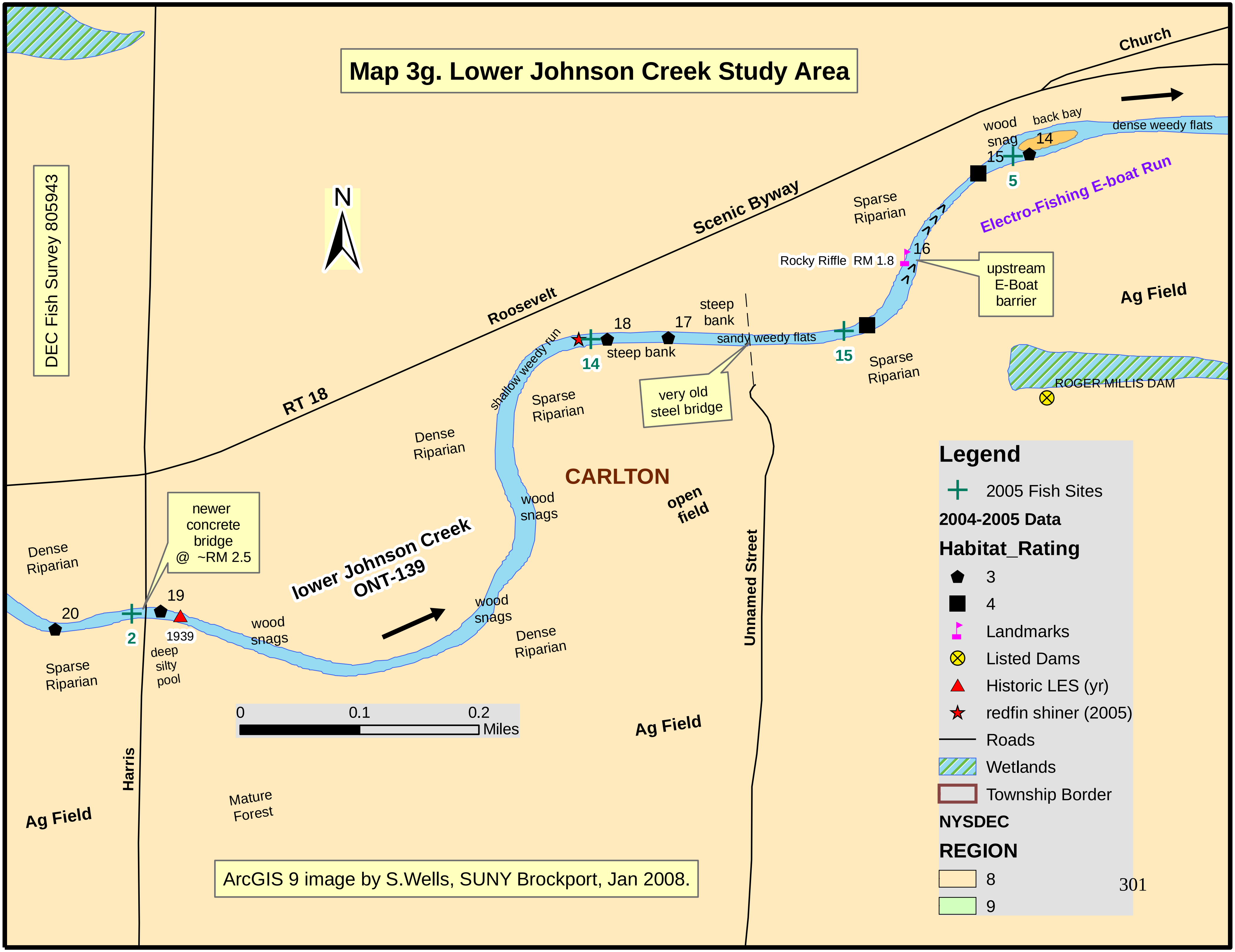
Map 3d. Recent RFS Sites in Johnson Creek Watershed
Lake Ontario
DEC Fish Survey 805943
T1 outlet
Lakeside Park
Roustabout
Mitchell
Lakeshore
Lakeside
Lake
Syren Creek (T1)
Yates Carlton
Foss
Morrison
Roosevelt
Roosevelt Highway
Hard
Kendrick
Above Kuckville
Below T3
YATES
CARLTON
Hall
Breeze
Woodworth
Yates Center
Lyndonville
Lyndonville Village Dam (1948)
Stillwater
Fuller
CR 67 Bridge
lower Johnson Creek
Alps
Blood
Millers
West
Houser
Railroad
Maple
Lake
Main
Greenman
Ward
Goodwin
Abandoned RxR
Ashwood
Harris
Platten
Townline
0 1 2 Miles
upper Johnson Creek
South Townline
Oak Orchard River
Hillcrest
Hanlo
Kenyonville
Angling
Ramshaw
Rutherford
Palmer
Swett
RIDGEWAY
Oregon
Knowlesville
GAINES
Ridge NY104
Culvert
Bates
NY104
Legend
Major Fish Barriers
Listed Dams
redfin shiner (2005)
Scenic Byway
Highways
Roads
Streams
State Parks
WSHD Boundary
Township Border
NYSDEC REGION
8
9
298
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



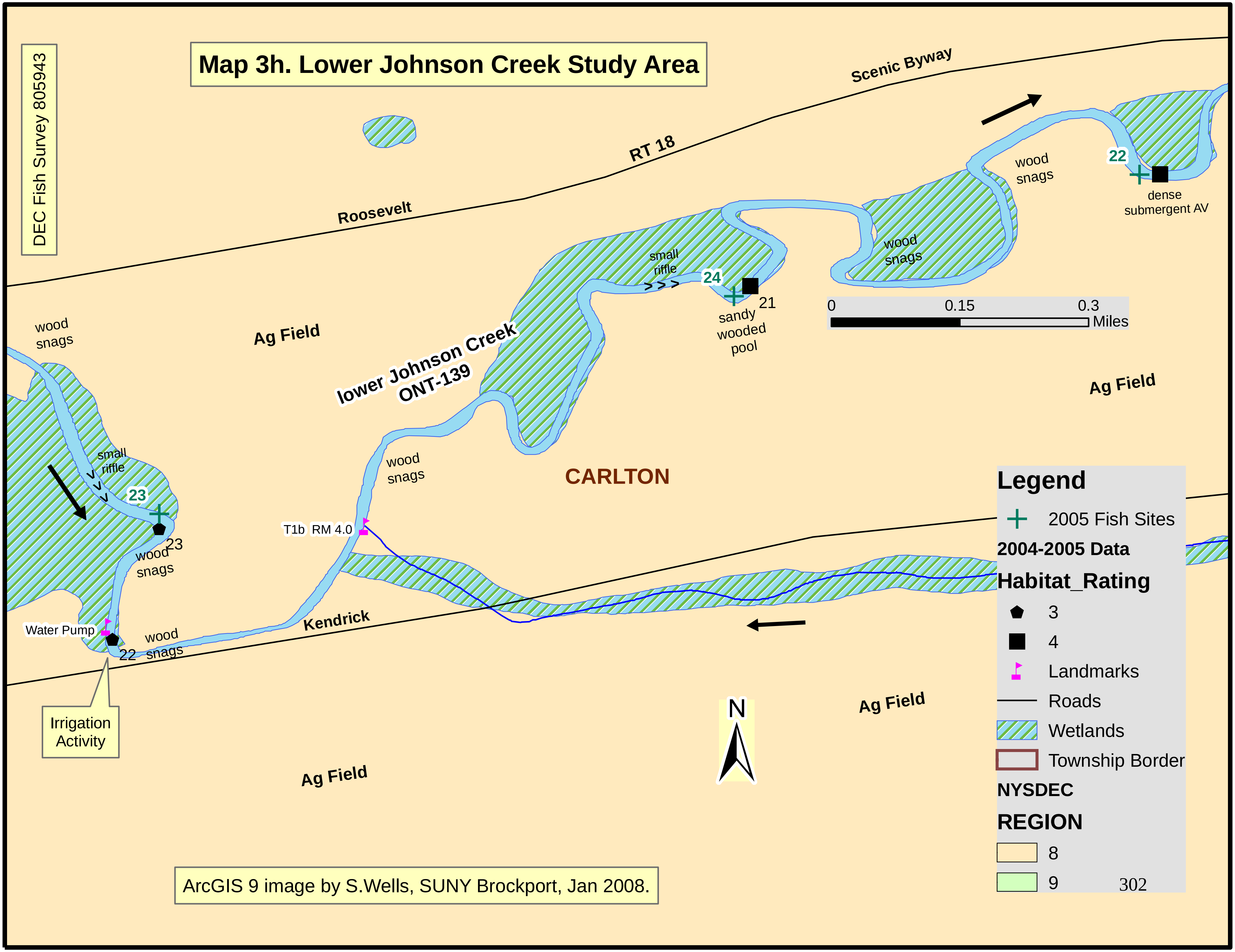
Map 3e. Lower Johnson Creek Study Area
Lake Ontario
N
Creek Mouth
Boat Launch
gravel
docks
Bluff
Sparse Riparian
Cattails
Park
Fire Road 122
Sunset Parkway
older steel bridge
weedy margins
Power Lines
silty SS
Lakeside Park
Fire Road 127
Winding
T1 RM 0.6
wood snags
Syren Creek (T1)
2004-2005 Catches
Lakeview
Long Electro-Fishing E-boat Runs
Dense Riparian
Mature Forest
weedy margins
Deeper Channel
CARLTON
Unnamed Street
Lakeshore
Lakeside State Park
Lakeside
Lake
lower Johnson Creek ONT-139
DEC Fish Survey 805943
T1a
0 0.1 0.2 Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
redfin shiner
Roads
Wetlands
Wetlands
Township Border
State Parks
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



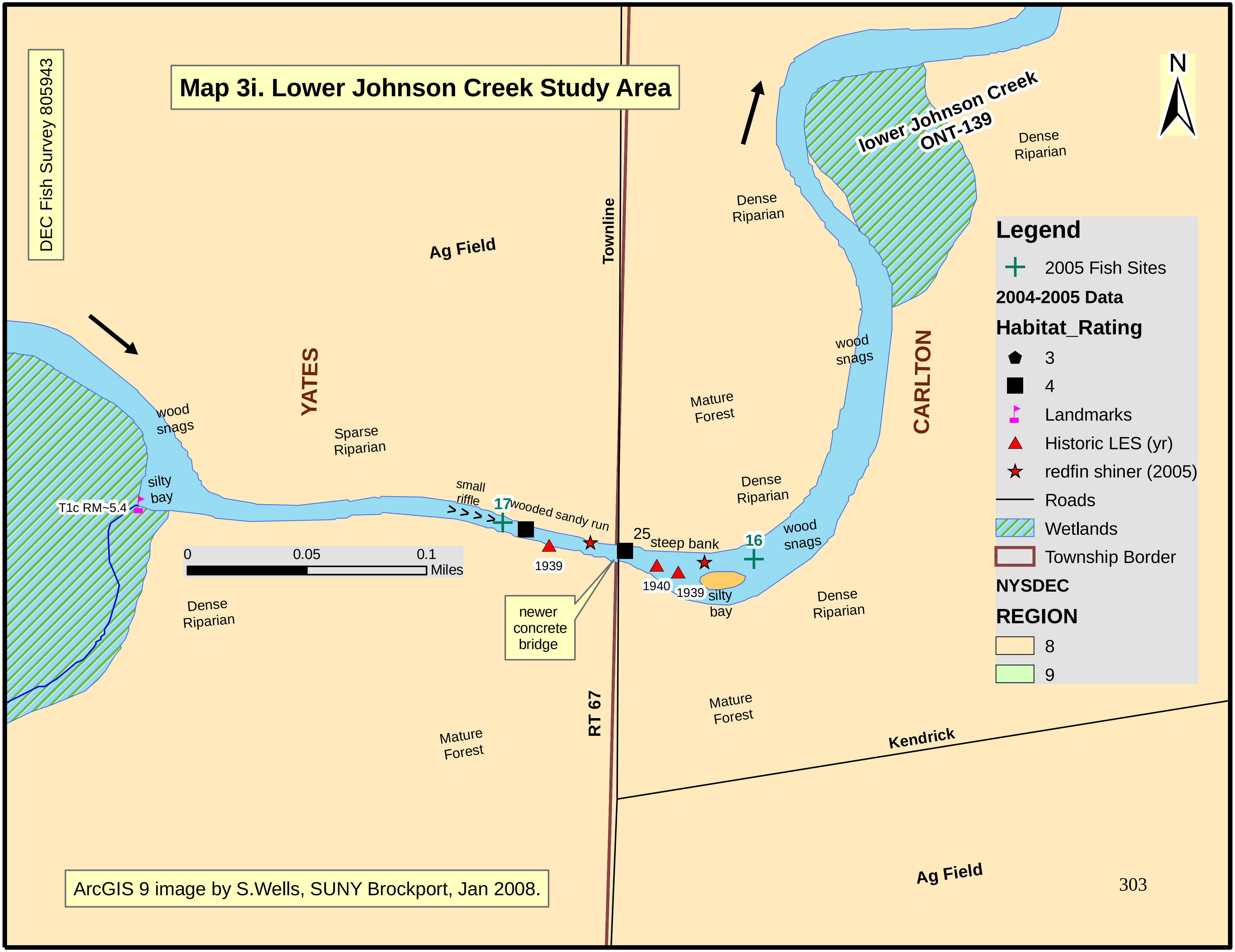
Map 3f. Lower Johnson Creek Study Area
DEC Fish Survey 805943
CARLTON
Lakeside
Church
Mature Forest
Cattails
dense weedy flats
Long Electro-Fishing E-boat Runs
10
Lakeside State Park
Mature Forest
Cattails
lower Johnson Creek
ONT-139
Dense Riparian
7
deep run
Access
Cattails
Dense Riparian
Country Store
11
rip-rap
RT 18
Roosevelt
Cartop Launch
1
12
1939
2003
Scenic Byway
newer concrete bridge @ RM 1.4
solo site
Sparse Riparian
grass lawn
erratic boulders
wood snag
6
13
dense weedy flats
Sparse Riparian
grass lawn
Kuckville, NY
0
0.05
0.1
Miles
Ag Field
Ag Field
Hard
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
longear sunfish (yr)
DEC Fish Stocking
Roads
Wetlands
Township Border
State Parks
NYSDEC
REGION
8
9
300
N

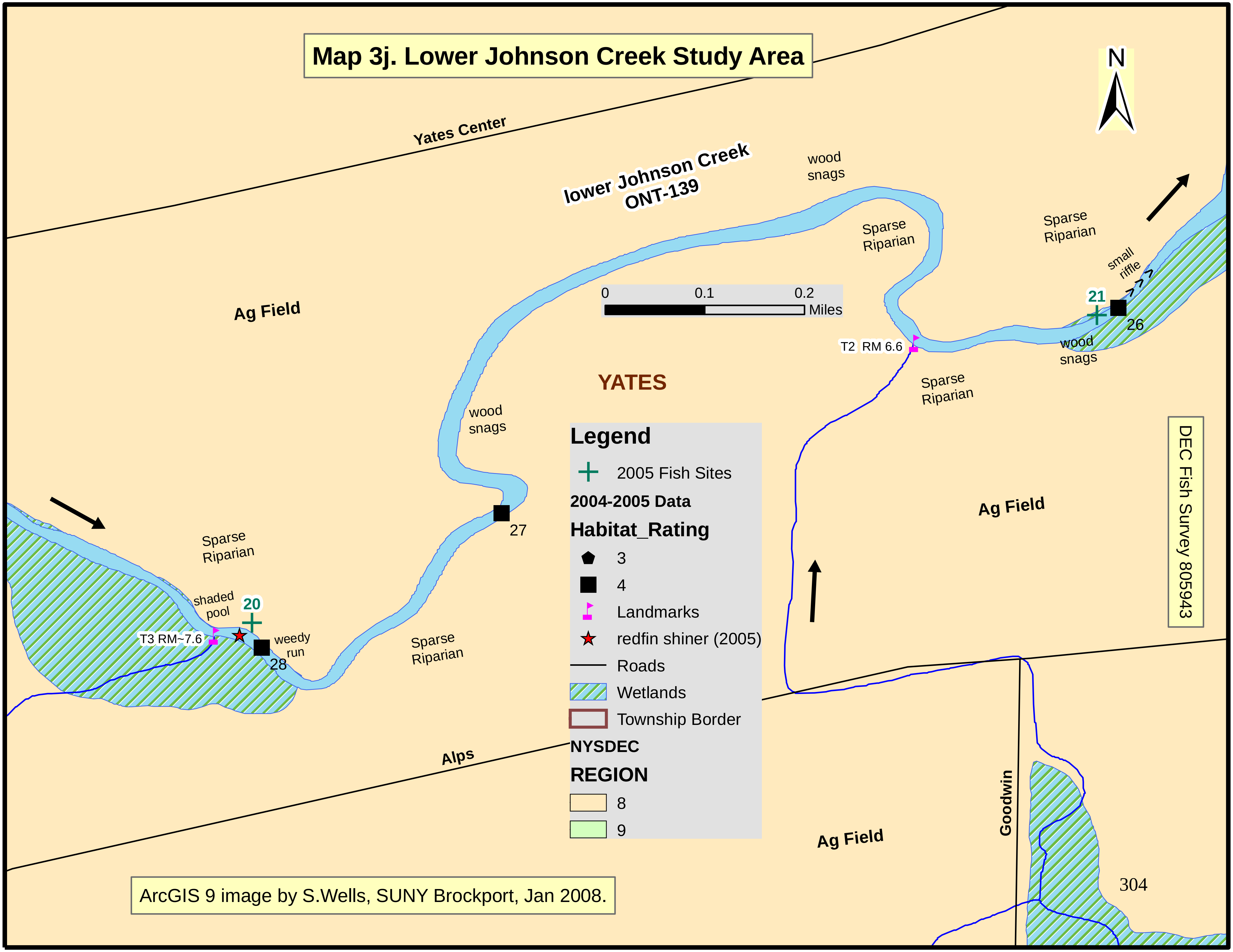


Map 3g. Lower Johnson Creek Study Area
DEC Fish Survey 805943
N
Church
Scenic Byway
Roosevelt
RT 18
wood snag
back bay
dense weedy flats
14
15
5
Electro-Fishing E-boat Run
Sparse Riparian
Rocky Riffle RM 1.8
16
upstream E-Boat barrier
Ag Field
steep bank
18
17
sandy weedy flats
shallow weedy run
14
steep bank
15
Sparse Riparian
ROGER MILLIS DAM
very old steel bridge
Sparse Riparian
Dense Riparian
CARLTON
wood snags
open field
Unnamed Street
lower Johnson Creek
ONT-139
Dense Riparian
newer concrete bridge @ ~RM 2.5
19
20
2
1939
deep silty pool
wood snags
wood snags
Dense Riparian
Sparse Riparian
0
0.1
0.2
Miles
Ag Field
Harris
Mature Forest
Ag Field
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Listed Dams
Historic LES (yr)
redfin shiner (2005)
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9

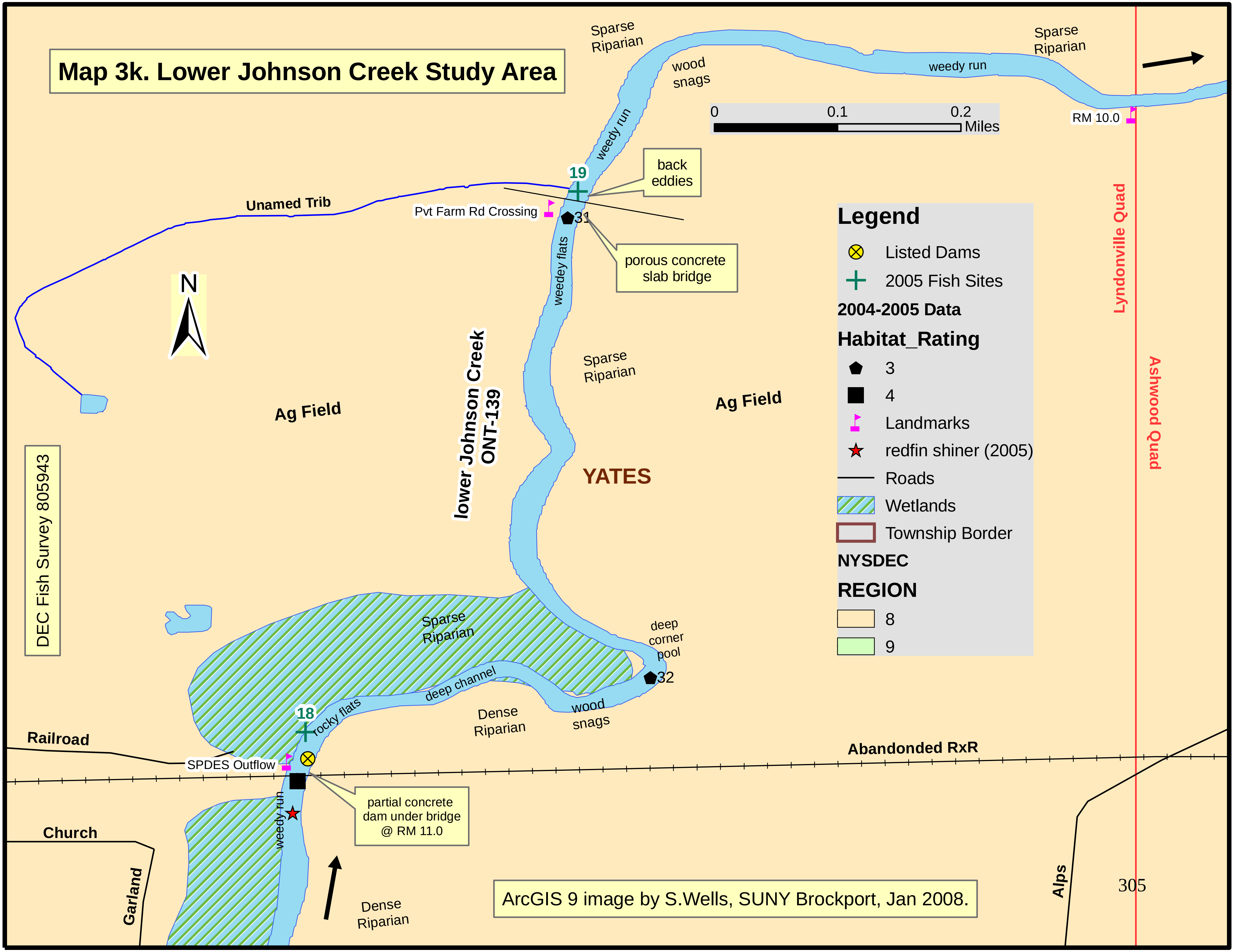


Map 3h. Lower Johnson Creek Study Area
DEC Fish Survey 805943
Scenic Byway
RT 18
Roosevelt
Ag Field
Ag Field
Ag Field
Ag Field
lower Johnson Creek
ONT-139
CARLTON
Kendrick
wood snags
wood snags
wood snags
wood snags
wood snags
wood snags
wood snags
small riffle
small riffle
sandy wooded pool
dense submergent AV
22
23
24
21
23
22
T1b RM 4.0
Water Pump
Irrigation Activity
0 0.15 0.3 Miles
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

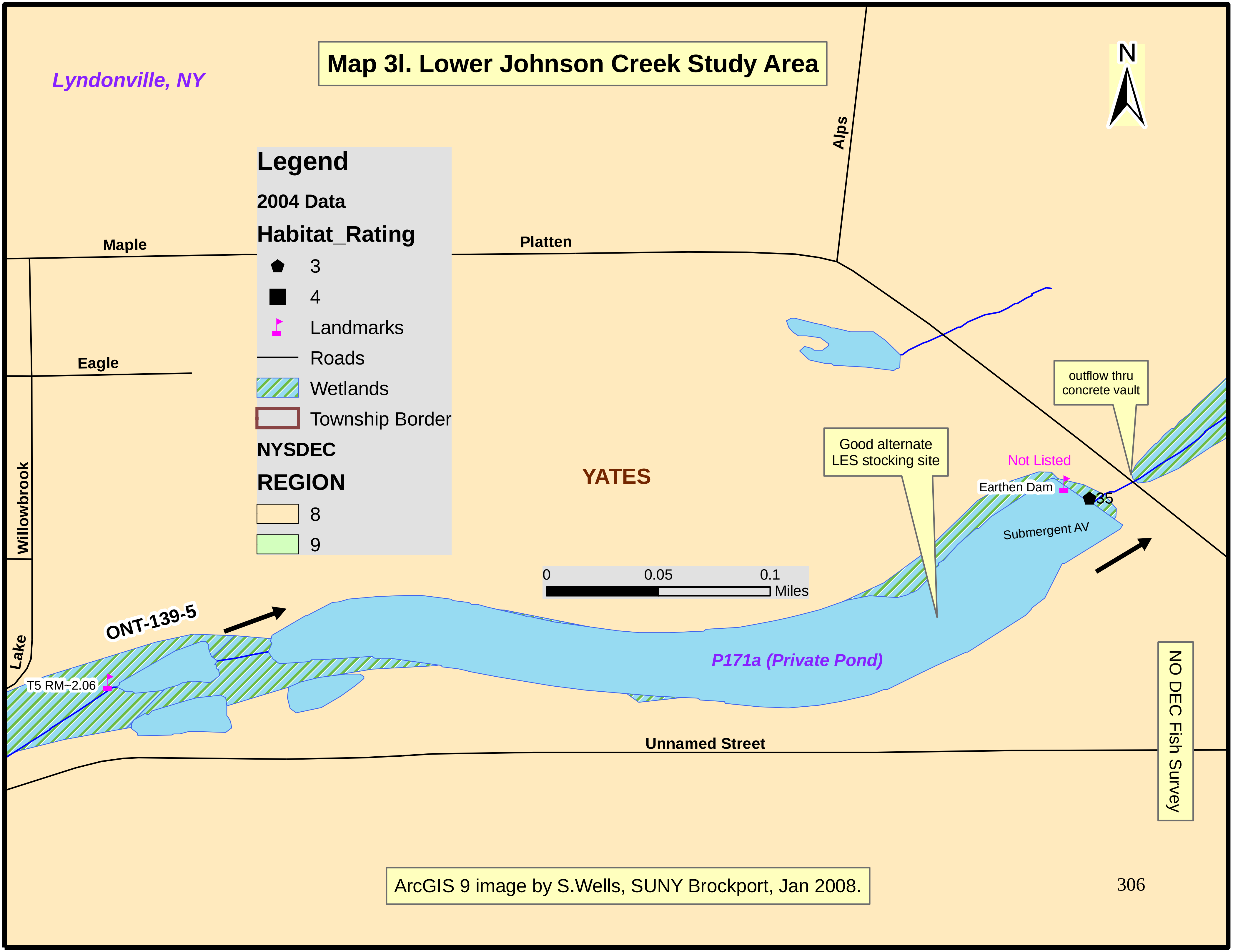

Map 3i. Lower Johnson Creek Study Area
DEC Fish Survey 805943
lower Johnson Creek
ONT-139
N
Dense Riparian
Dense Riparian
Ag Field
Townline
YATES
CARLTON
wood snags
Sparse Riparian
silty bay
T1c RM~5.4
small riffle
> > > >
17
wooded sandy run
25
steep bank
16
wood snags
Mature Forest
Dense Riparian
wood snags
1939
1940
1939
silty bay
Dense Riparian
0
0.05
0.1
Miles
newer concrete bridge
Dense Riparian
RT 67
Mature Forest
Mature Forest
Kendrick
Ag Field
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Historic LES (yr)
redfin shiner (2005)
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



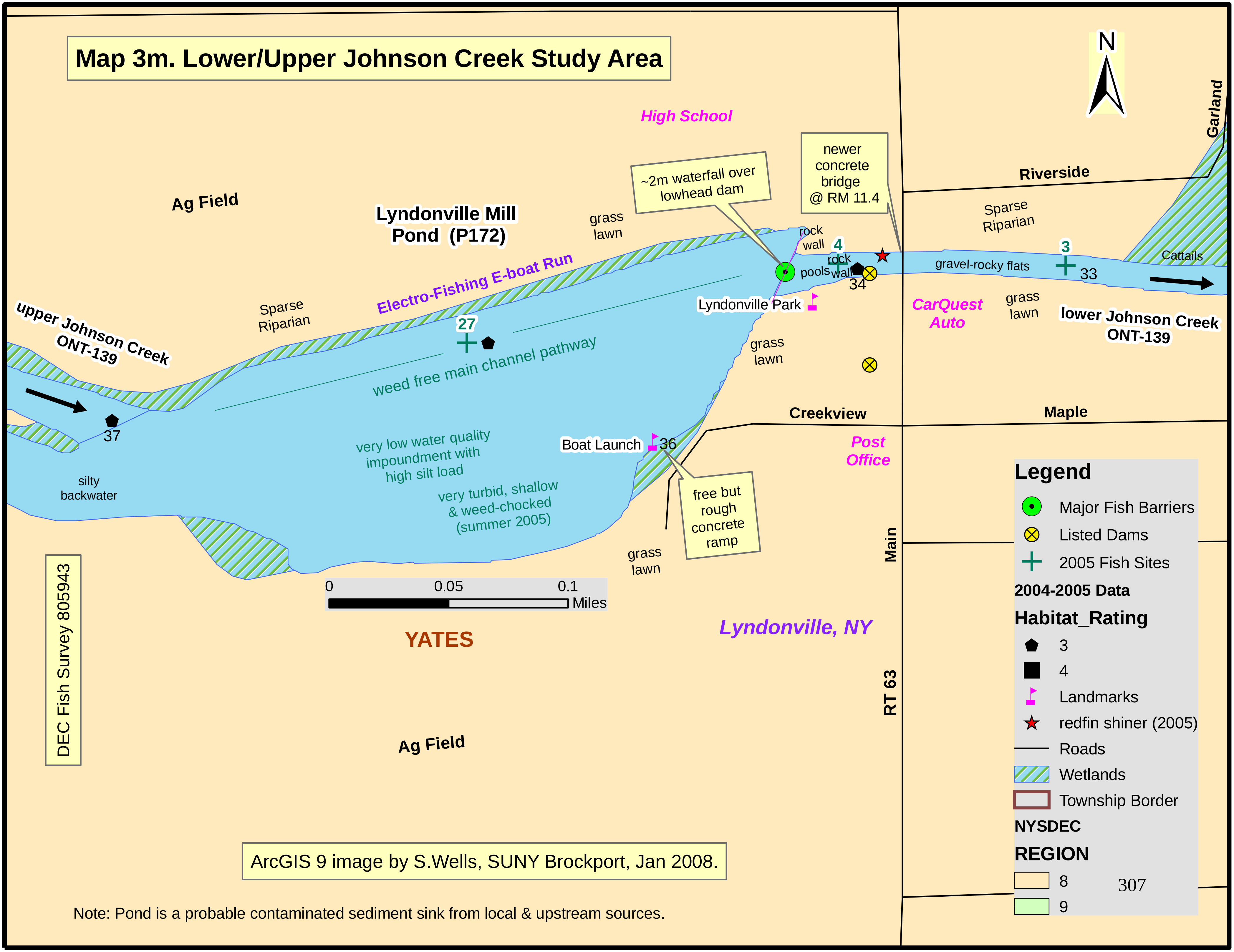
Map 3j. Lower Johnson Creek Study Area
N
Yates Center
lower Johnson Creek
ONT-139
wood snags
Sparse Riparian
Ag Field
0 0.1 0.2 Miles
small riffle
21
26
T2 RM 6.6
YATES
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
redfin shiner (2005)
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
27
20
28
shaded pool
weedy run
T3 RM~7.6
Alps
Goodwin
304
DEC Fish Survey 805943
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



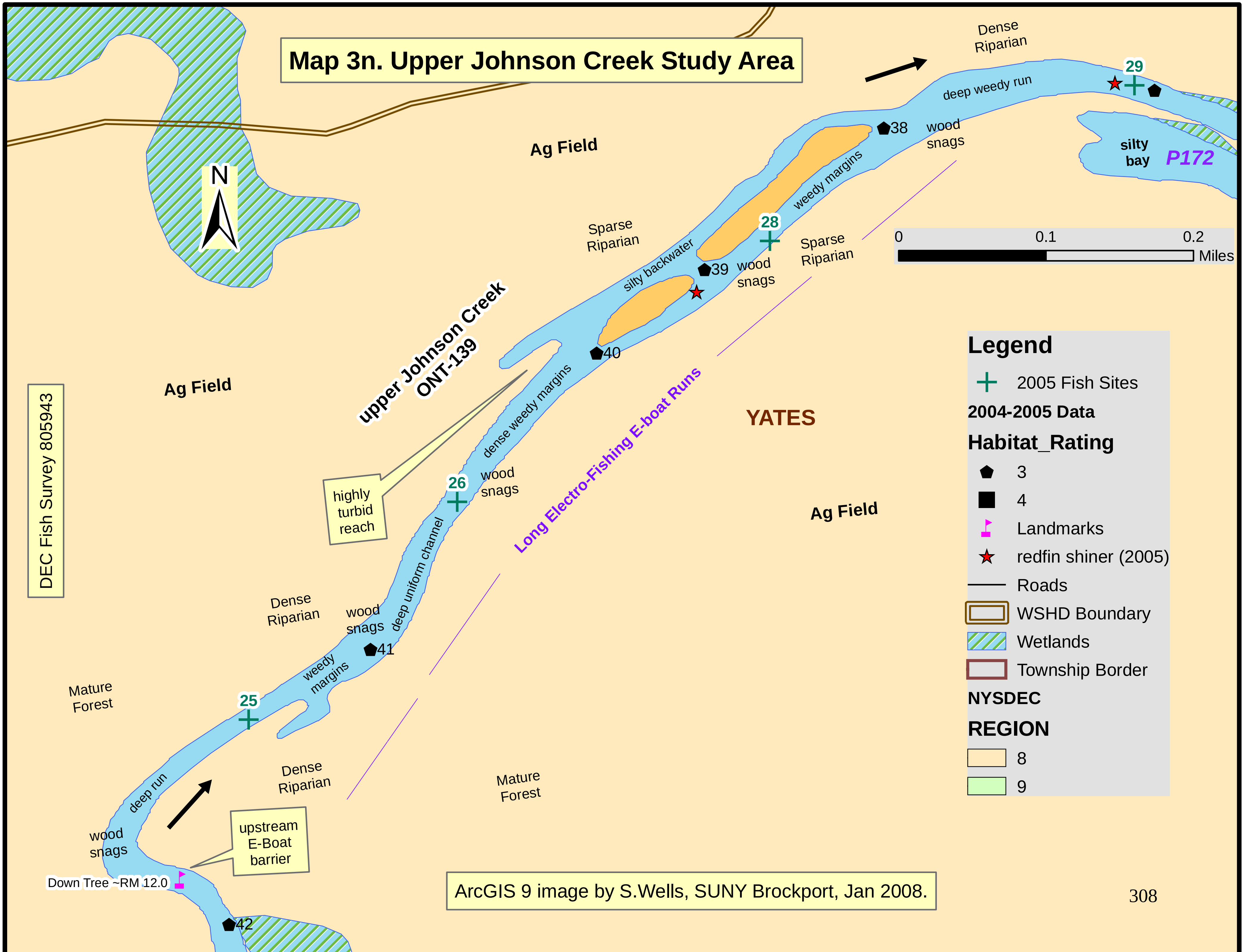
Map 3k. Lower Johnson Creek Study Area
Sparse Riparian
wood snags
weedy run
Sparse Riparian
0
0.1
0.2
Miles
RM 10.0
weedy run
19
back eddies
Unamed Trib
Pvt Farm Rd Crossing
31
porous concrete slab bridge
weedey flats
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
redfin shiner (2005)
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Lyndonville Quad
Ashwood Quad
N
lower Johnson Creek
ONT-139
Sparse Riparian
Ag Field
Ag Field
YATES
DEC Fish Survey 805943
Sparse Riparian
deep corner pool
32
deep channel
rocky flats
18
Dense Riparian
wood snags
Railroad
SPDES Outflow
Abandonded RxR
partial concrete dam under bridge @ RM 11.0
weedy run
Church
Garland
Dense Riparian
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.
Alps
305

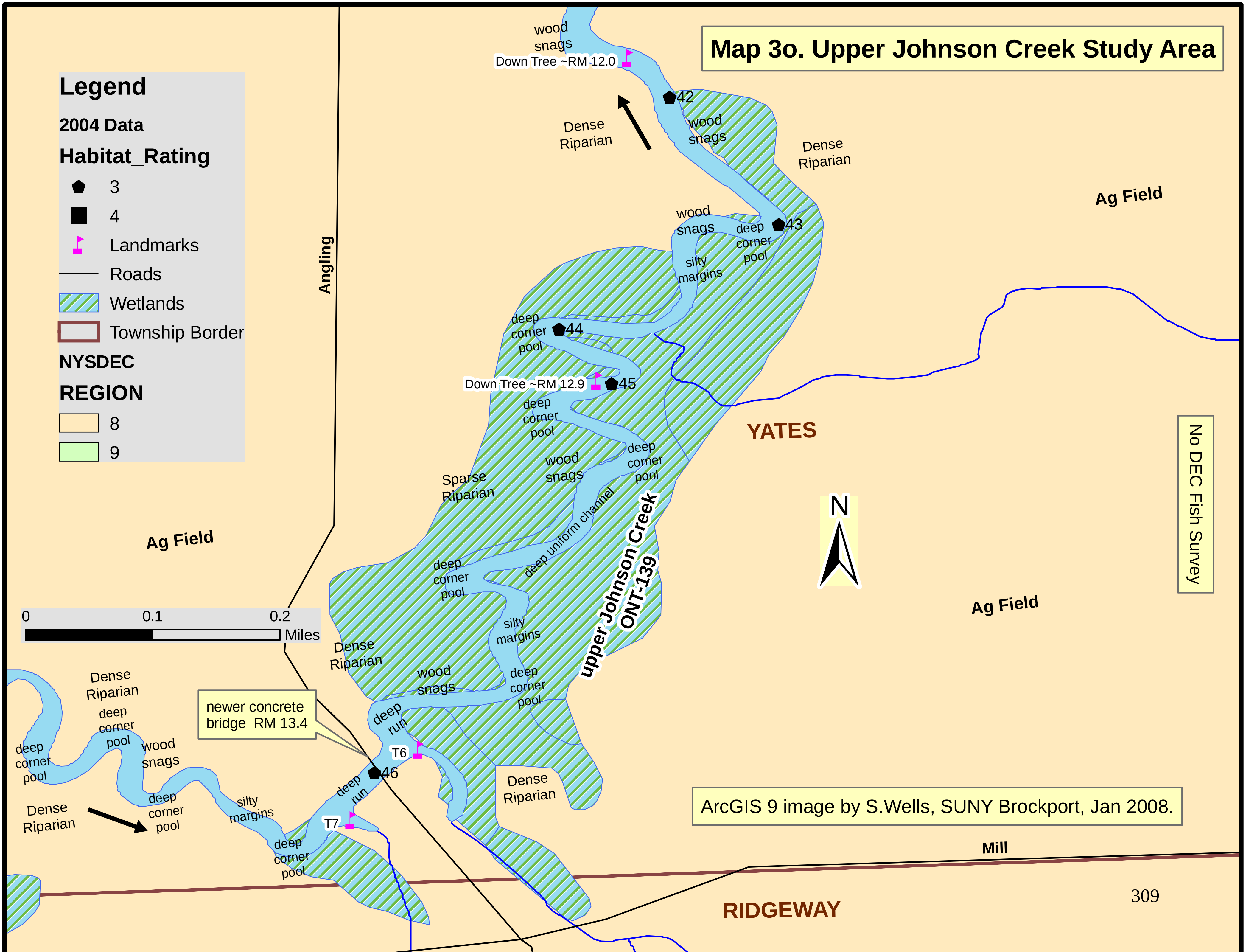


Map 3l. Lower Johnson Creek Study Area
Lyndonville, NY
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Maple
Platten
Alps
Eagle
Willowbrook
Lake
YATES
Good alternate LES stocking site
outflow thru concrete vault
Not Listed
Earthen Dam
35
Submergent AV
0
0.05
0.1
Miles
ONT-139-5
T5 RM~2.06
P171a (Private Pond)
Unnamed Street
NO DEC Fish Survey
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

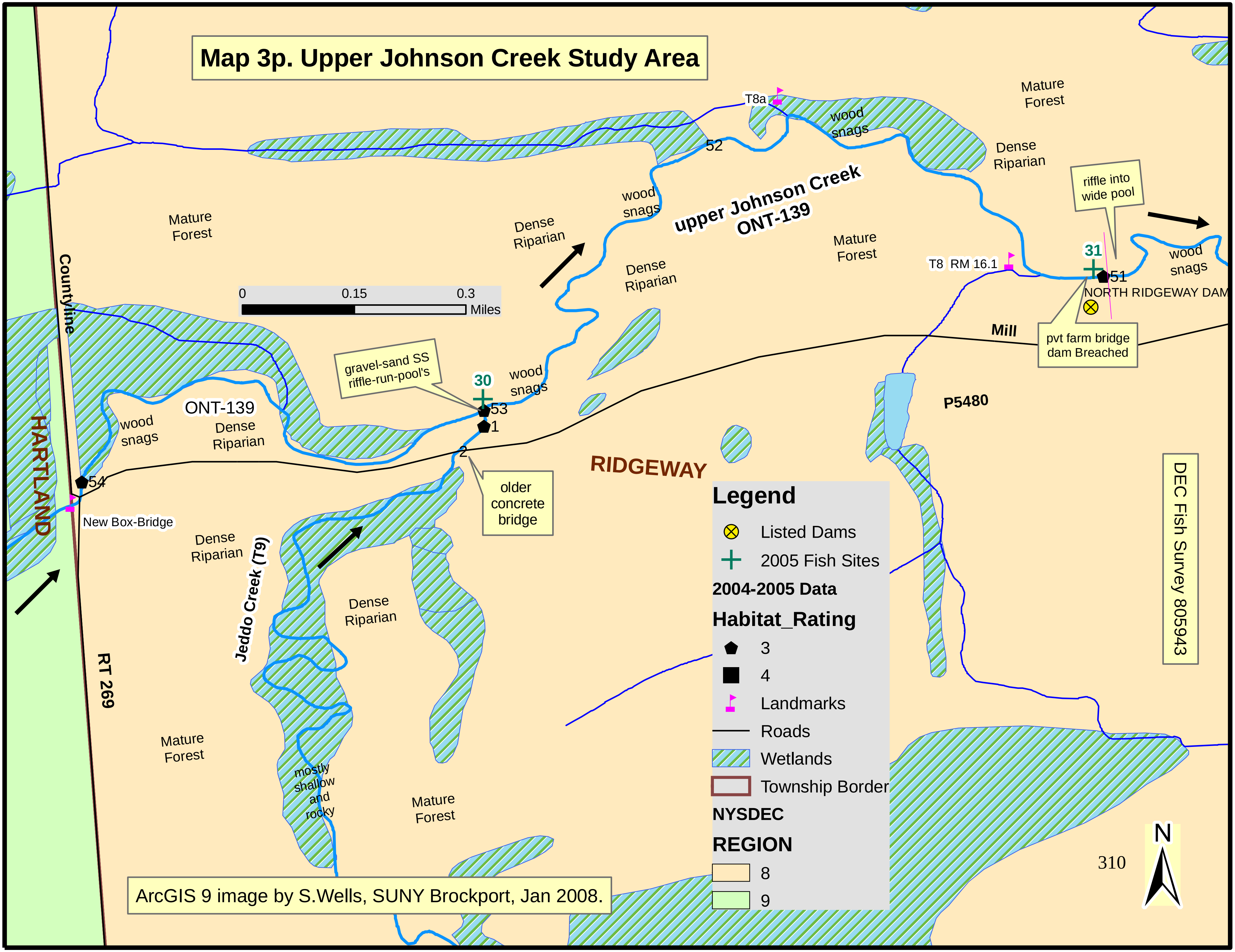


Map 3m. Lower/Upper Johnson Creek Study Area
High School
N
Garland
newer concrete bridge @ RM 11.4
~2m waterfall over lowhead dam
Riverside
Ag Field
Lyndonville Mill Pond (P172)
grass lawn
Sparse Riparian
rock wall
4
rock wall
pools
34
3
33
gravel-rocky flats
Cattails
Electro-Fishing E-boat Run
Sparse Riparian
upper Johnson Creek ONT-139
27
Lyndonville Park
CarQuest Auto
grass lawn
lower Johnson Creek ONT-139
grass lawn
weed free main channel pathway
37
Creekview
Maple
very low water quality impoundment with high silt load
Boat Launch
36
Post Office
silty backwater
very turbid, shallow & weed-chocked (summer 2005)
free but rough concrete ramp
grass lawn
Main
0
0.05
0.1
Miles
YATES
Lyndonville, NY
DEC Fish Survey 805943
RT 63
Ag Field
Legend
Major Fish Barriers
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
redfin shiner (2005)
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
307
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.
Note: Pond is a probable contaminated sediment sink from local & upstream sources.

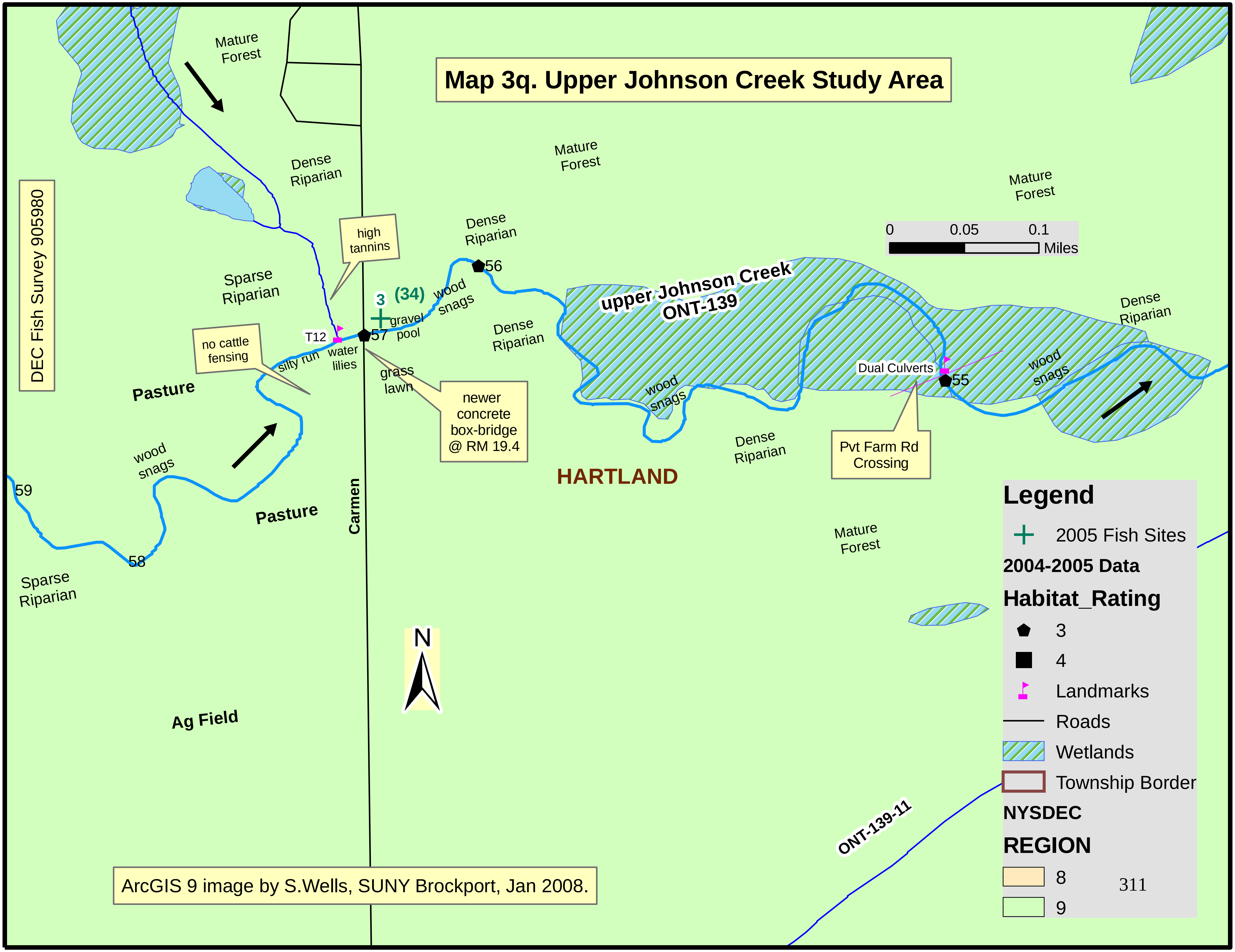

Map 3n. Upper Johnson Creek Study Area
N
Ag Field
Ag Field
Ag Field
upper Johnson Creek ONT-139
DEC Fish Survey 805943
Dense Riparian
deep weedy run
29
38
wood snags
silty bay
P172
weedy margins
28
Sparse Riparian
Sparse Riparian
silty backwater
39
wood snags
40
0
0.1
0.2
Miles
dense weedy margins
highly turbid reach
26
wood snags
Long Electro-Fishing E-boat Runs
YATES
deep uniform channel
Dense Riparian
wood snags
41
weedy margins
Mature Forest
25
Dense Riparian
Mature Forest
deep run
wood snags
upstream E-Boat barrier
Down Tree ~RM 12.0
42
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
redfin shiner (2005)
Roads
WSHD Boundary
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

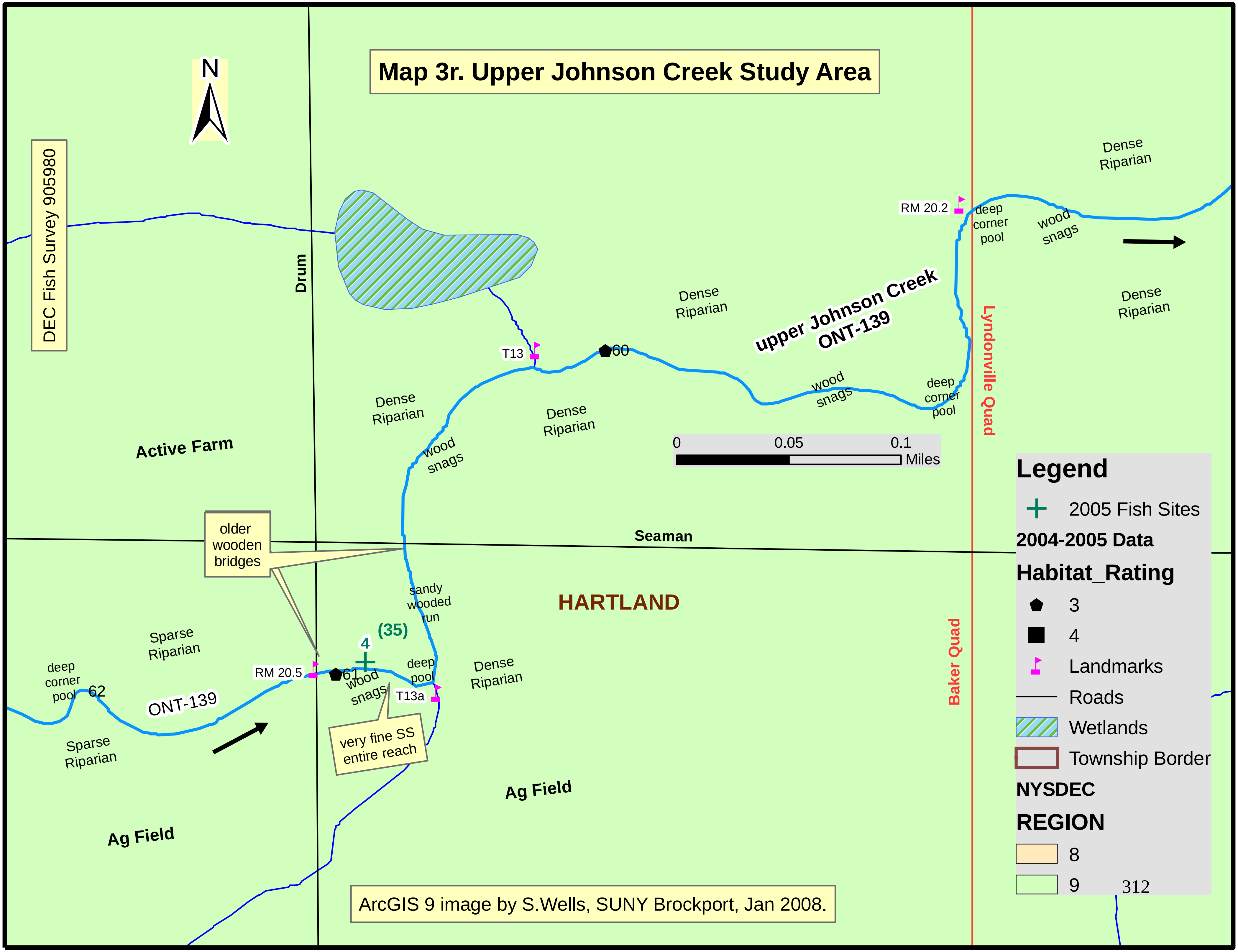


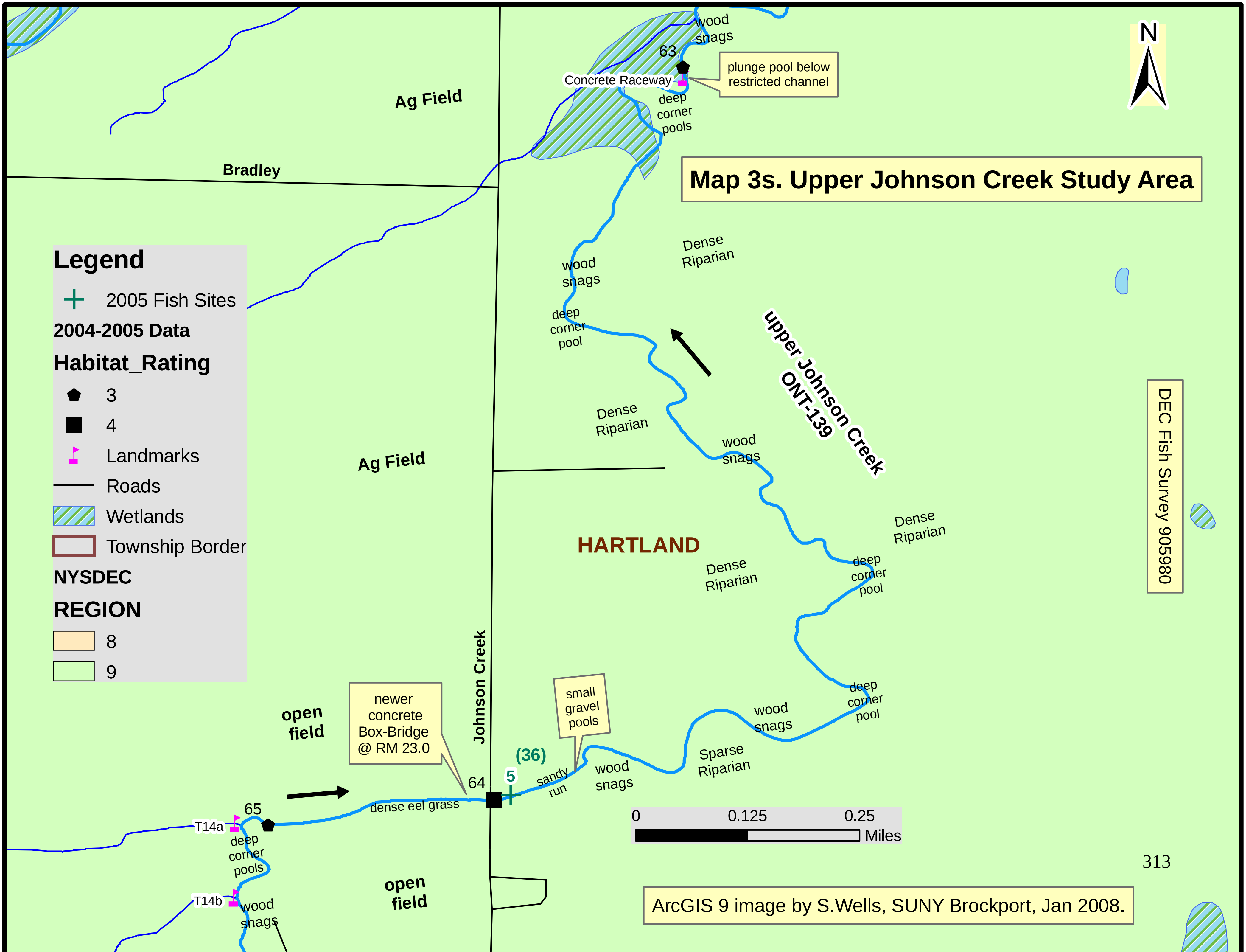
Map 3o. Upper Johnson Creek Study Area
Legend
2004 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.1
0.2
Miles
Angling
Mill
YATES
RIDGEWAY
Ag Field
Ag Field
Ag Field
N
No DEC Fish Survey
upper Johnson Creek
ONT-139
Down Tree ~RM 12.0
Down Tree ~RM 12.9
newer concrete bridge RM 13.4
42
43
44
45
46
T6
T7
wood snags
Dense Riparian
Sparse Riparian
deep corner pool
silty margins
deep uniform channel
deep run
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

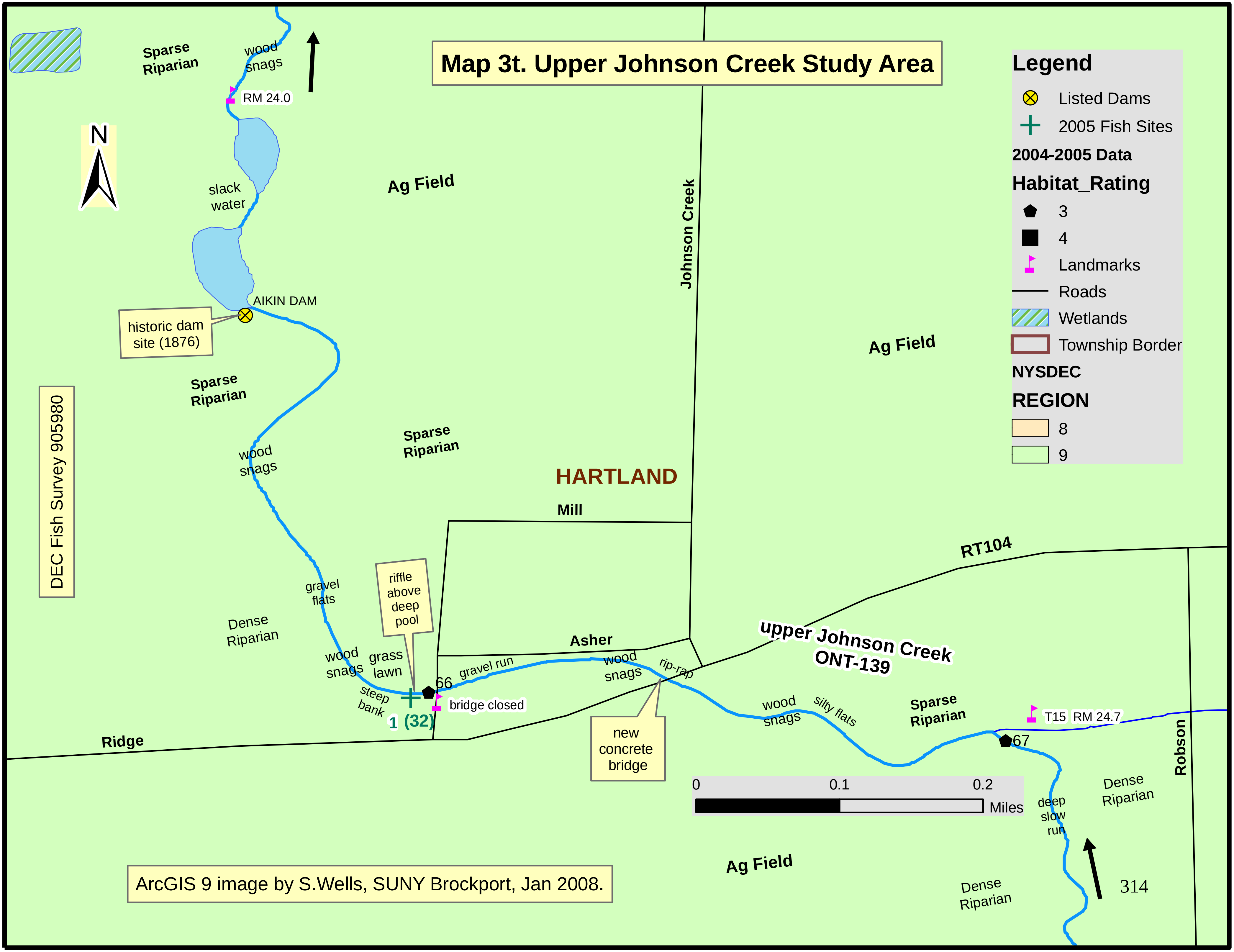


Map 3p. Upper Johnson Creek Study Area
upper Johnson Creek
ONT-139
ONT-139
Jeddo Creek (T9)
RIDGEWAY
HARTLAND
Countyline
RT 269
Mill
P5480
Mature Forest
Dense Riparian
wood snags
T8a
52
53
1
2
30
31
51
54
T8 RM 16.1
NORTH RIDGEWAY DAM
riffle into wide pool
pvt farm bridge dam Breached
gravel-sand SS riffle-run-pool's
older concrete bridge
New Box-Bridge
mostly shallow and rocky
0 0.15 0.3 Miles
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
DEC Fish Survey 805943
310
N
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

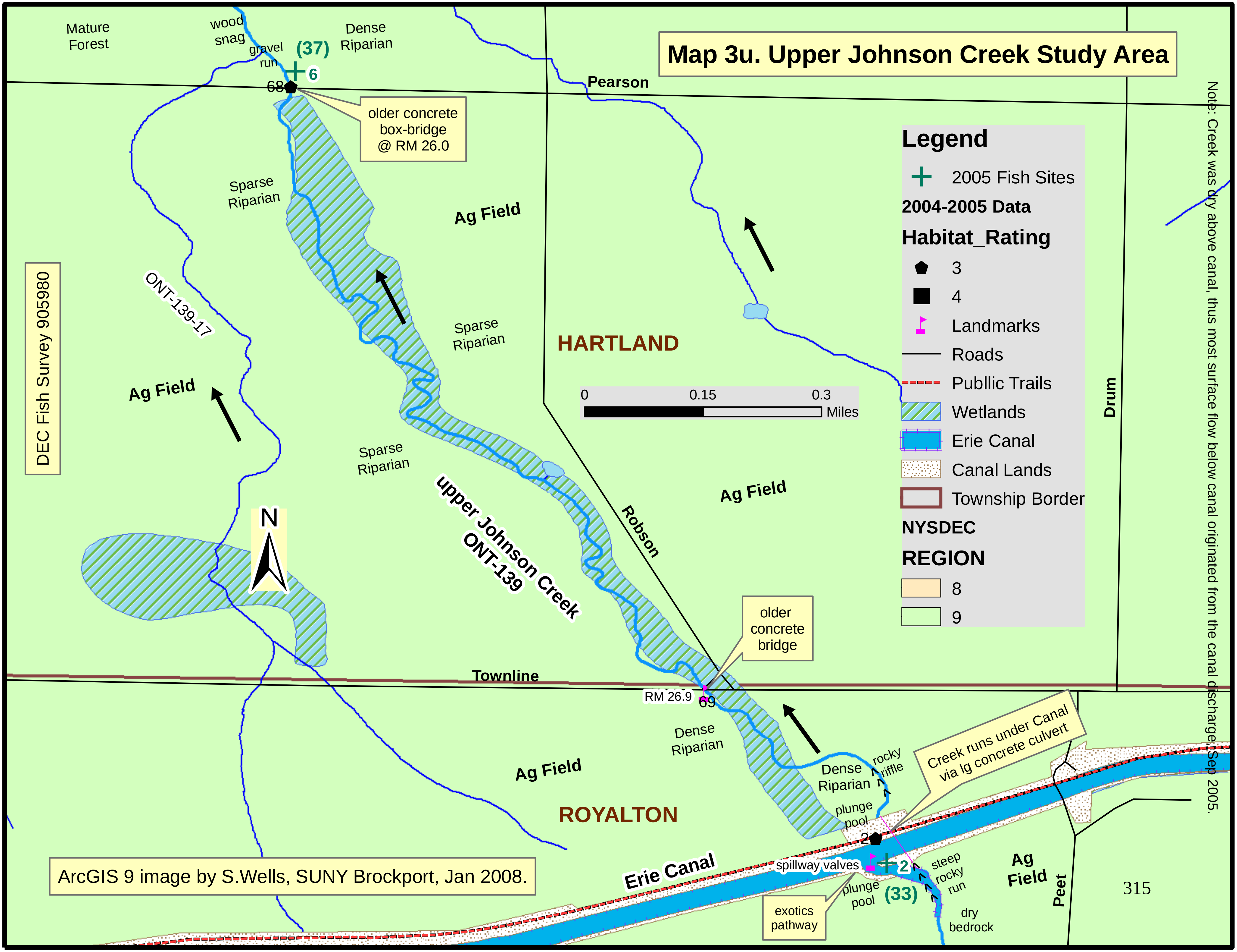

Map 3q. Upper Johnson Creek Study Area
DEC Fish Survey 905980
Mature Forest
Mature Forest
Mature Forest
Mature Forest
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Sparse Riparian
Sparse Riparian
high tannins
no cattle fensing
T12
57
56
55
58
59
3
(34)
gravel pool
wood snags
wood snags
wood snags
wood snags
silty run
water lilies
grass lawn
newer concrete box-bridge @ RM 19.4
upper Johnson Creek ONT-139
Dual Culverts
Pvt Farm Rd Crossing
Pasture
Pasture
Ag Field
Carmen
HARTLAND
ONT-139-11
N
0 0.05 0.1 Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

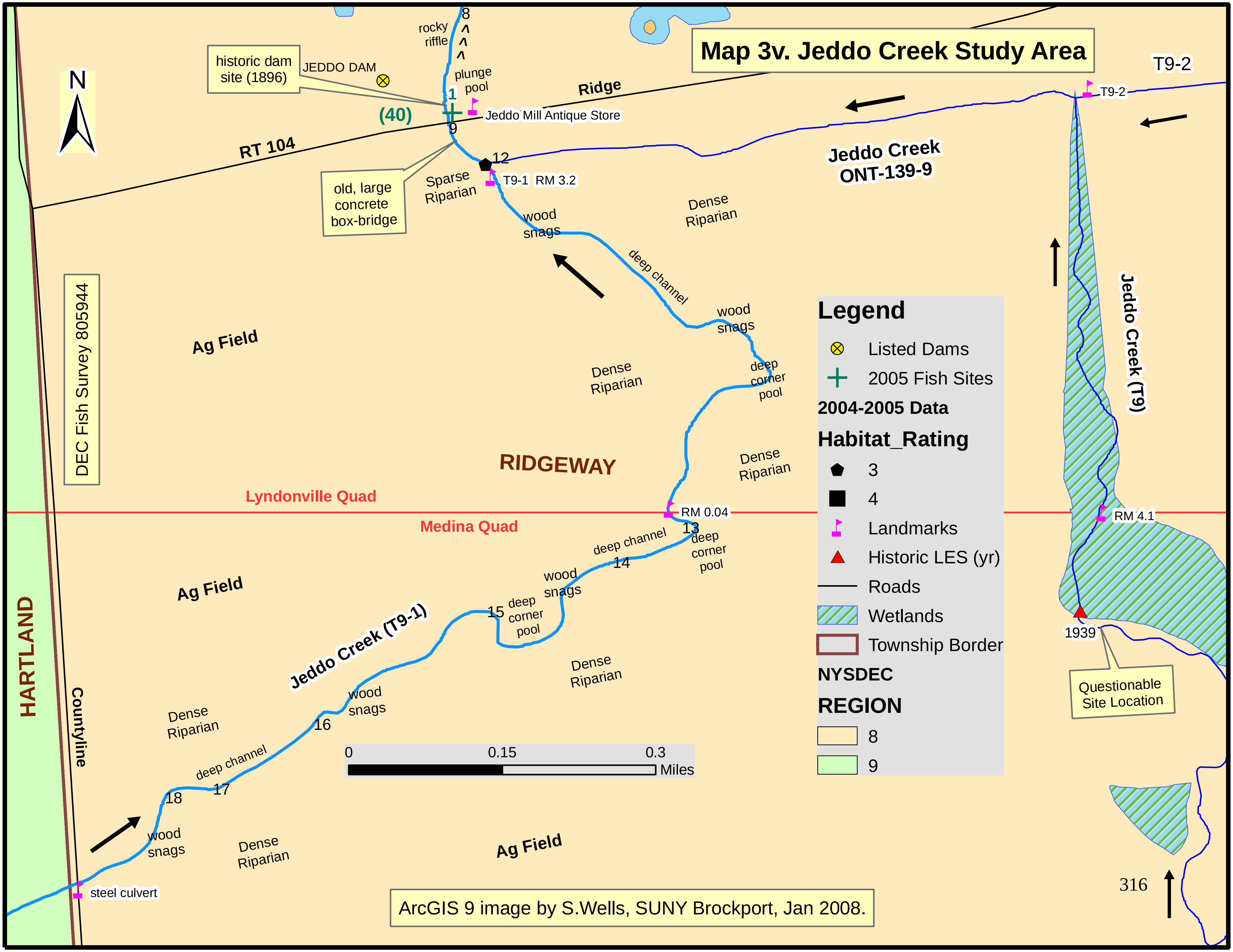

Map 3r. Upper Johnson Creek Study Area
N
DEC Fish Survey 905980
Drum
Seaman
Active Farm
HARTLAND
Ag Field
Ag Field
upper Johnson Creek
ONT-139
ONT-139
Lyndonville Quad
Baker Quad
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Dense Riparian
Sparse Riparian
Sparse Riparian
RM 20.2
RM 20.5
T13
T13a
60
61
62
4
(35)
deep corner pool
deep corner pool
deep corner pool
deep pool
wood snags
wood snags
wood snags
wood snags
sandy wooded run
older wooden bridges
very fine SS entire reach
0
0.05
0.1
Miles
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.


Map 3s. Upper Johnson Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
Ag Field
Bradley
Ag Field
wood snags
63
Concrete Raceway
plunge pool below restricted channel
deep corner pools
wood snags
Dense Riparian
deep corner pool
upper Johnson Creek
ONT-139
Dense Riparian
wood snags
HARTLAND
Dense Riparian
Dense Riparian
deep corner pool
deep corner pool
wood snags
Sparse Riparian
wood snags
small gravel pools
sandy run
(36)
5
64
Johnson Creek
newer concrete Box-Bridge @ RM 23.0
dense eel grass
open field
65
T14a
deep corner pools
T14b
wood snags
open field
DEC Fish Survey 905980
0
0.125
0.25
Miles
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

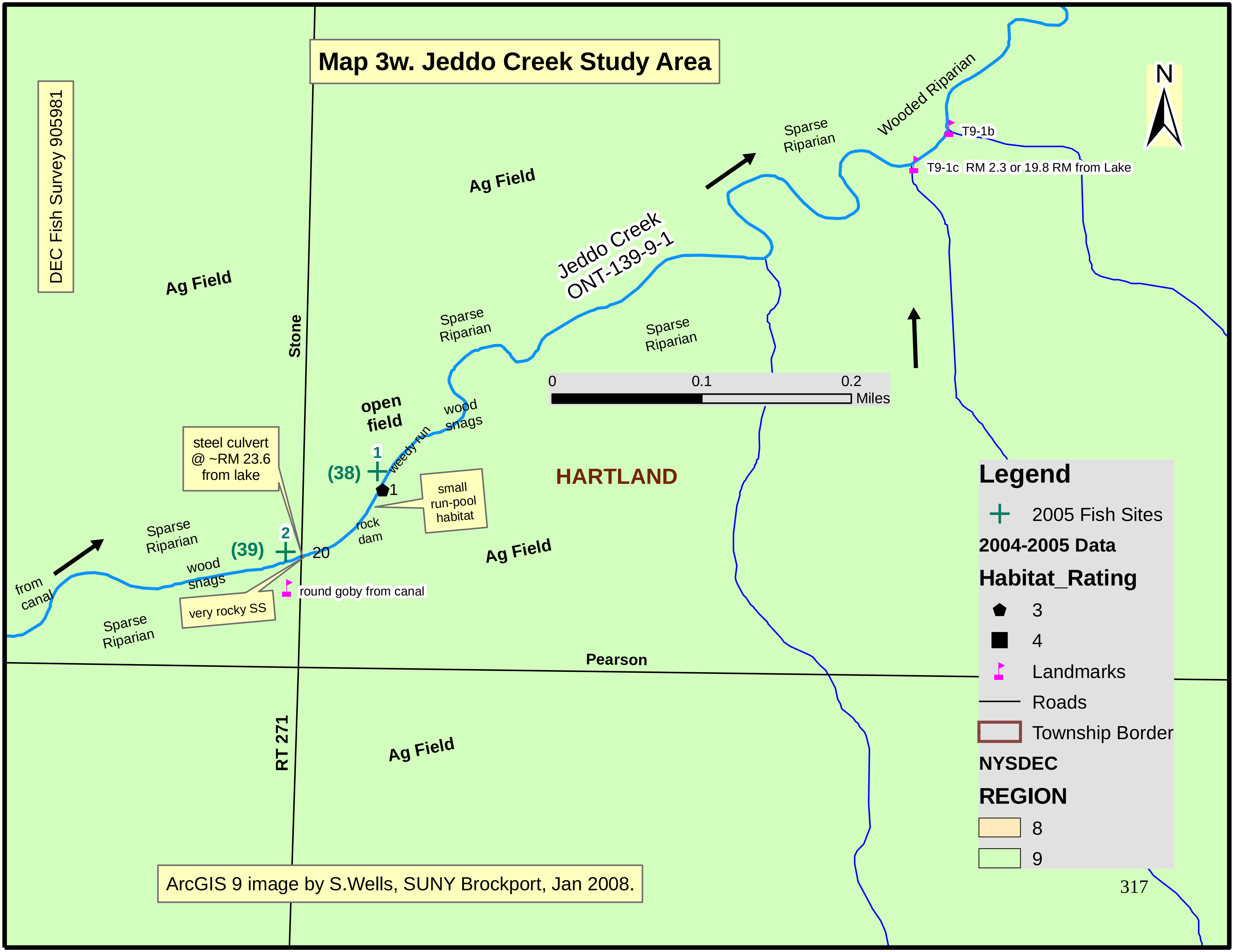


Map 3t. Upper Johnson Creek Study Area
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
N
Sparse Riparian
wood snags
RM 24.0
slack water
Ag Field
Johnson Creek
AIKIN DAM
historic dam site (1876)
Sparse Riparian
wood snags
Sparse Riparian
HARTLAND
Mill
RT104
Ag Field
DEC Fish Survey 905980
gravel flats
riffle above deep pool
Dense Riparian
wood snags
grass lawn
steep bank
66
gravel run
bridge closed
1 (32)
Asher
wood snags
rip-rap
upper Johnson Creek
ONT-139
new concrete bridge
wood snags
silty flats
Sparse Riparian
T15 RM 24.7
67
Robson
Ridge
0
0.1
0.2
Miles
deep slow run
Dense Riparian
Ag Field
Dense Riparian
314
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.

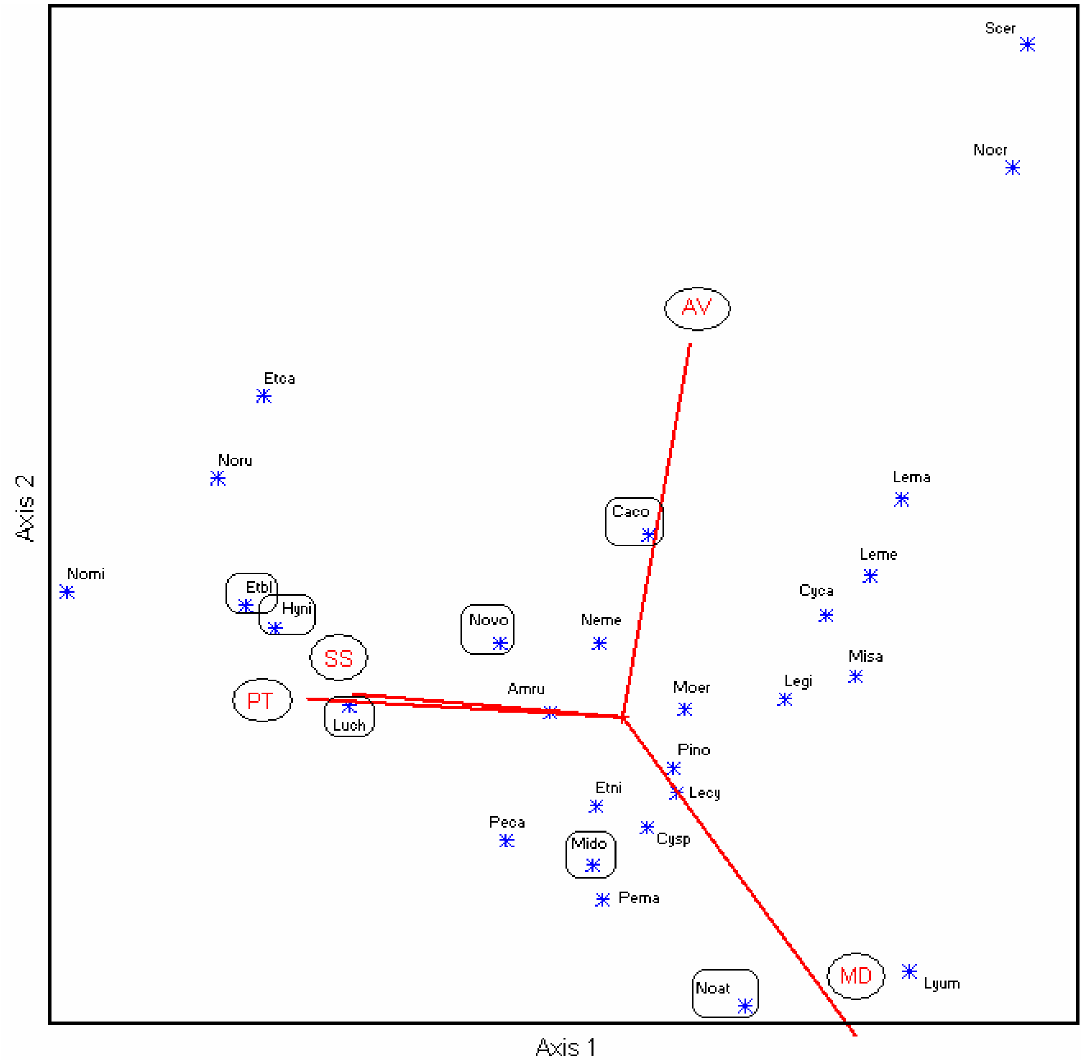

Map 3u. Upper Johnson Creek Study Area
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Publlic Trails
Wetlands
Erie Canal
Canal Lands
Township Border
NYSDEC
REGION
8
9
0
0.15
0.3
Miles
Mature Forest
wood snag
gravel run
(37)
6
68
Dense Riparian
older concrete box-bridge @ RM 26.0
Pearson
Sparse Riparian
Ag Field
Sparse Riparian
HARTLAND
DEC Fish Survey 905980
ONT-139-17
Ag Field
Sparse Riparian
upper Johnson Creek
ONT-139
Robson
Ag Field
Drum
N
older concrete bridge
Townline
RM 26.9
69
Dense Riparian
Ag Field
ROYALTON
rocky riffle
Dense Riparian
plunge pool
Creek runs under Canal via lg concrete culvert
2
spillway valves
2
steep rocky run
plunge pool
(33)
dry bedrock
Ag Field
Peet
exotics pathway
Erie Canal
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.
Note: Creek was dry above canal, thus most surface flow below canal originated from the canal discharge. Sep 2005.



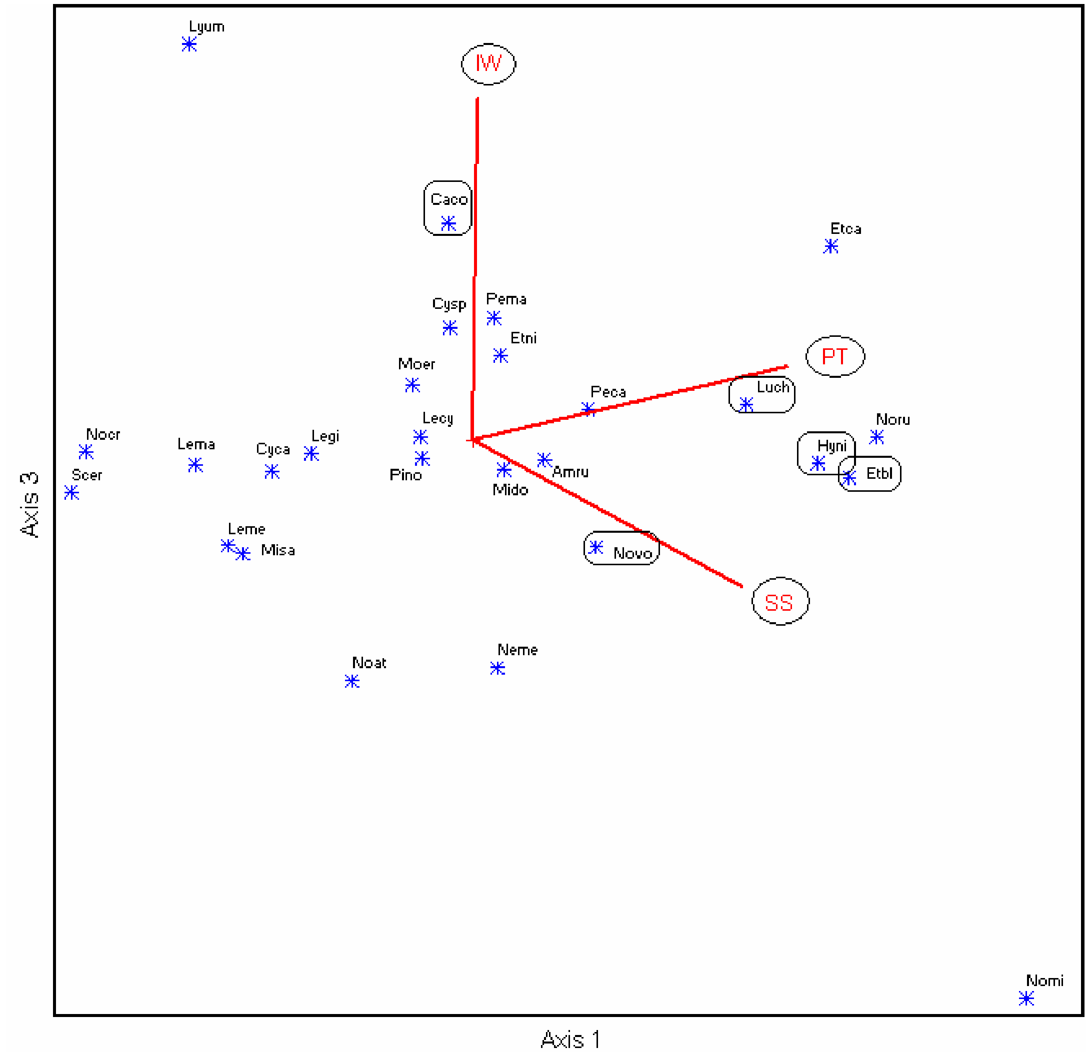
Map 3v. Jeddo Creek Study Area
N
historic dam site (1896)
JEDDO DAM
rocky riffle
8
plunge pool
1
(40)
9
Jeddo Mill Antique Store
Ridge
RT 104
old, large concrete box-bridge
Sparse Riparian
12
T9-1 RM 3.2
wood snags
Jeddo Creek ONT-139-9
T9-2
Dense Riparian
deep channel
wood snags
deep corner pool
Jeddo Creek (T9)
DEC Fish Survey 805944
Ag Field
Dense Riparian
RIDGEWAY
Lyndonville Quad
Medina Quad
RM 0.04
13
deep corner pool
deep channel
14
wood snags
15
deep corner pool
RM 4.1
1939
Questionable Site Location
Legend
Listed Dams
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Historic LES (yr)
Roads
Wetlands
Township Border
NYSDEC
REGION
8
9
0
0.15
0.3
Miles
Ag Field
Jeddo Creek (T9-1)
wood snags
16
Dense Riparian
Dense Riparian
HARTLAND
Countyline
deep channel
17
18
wood snags
Dense Riparian
Ag Field
steel culvert
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



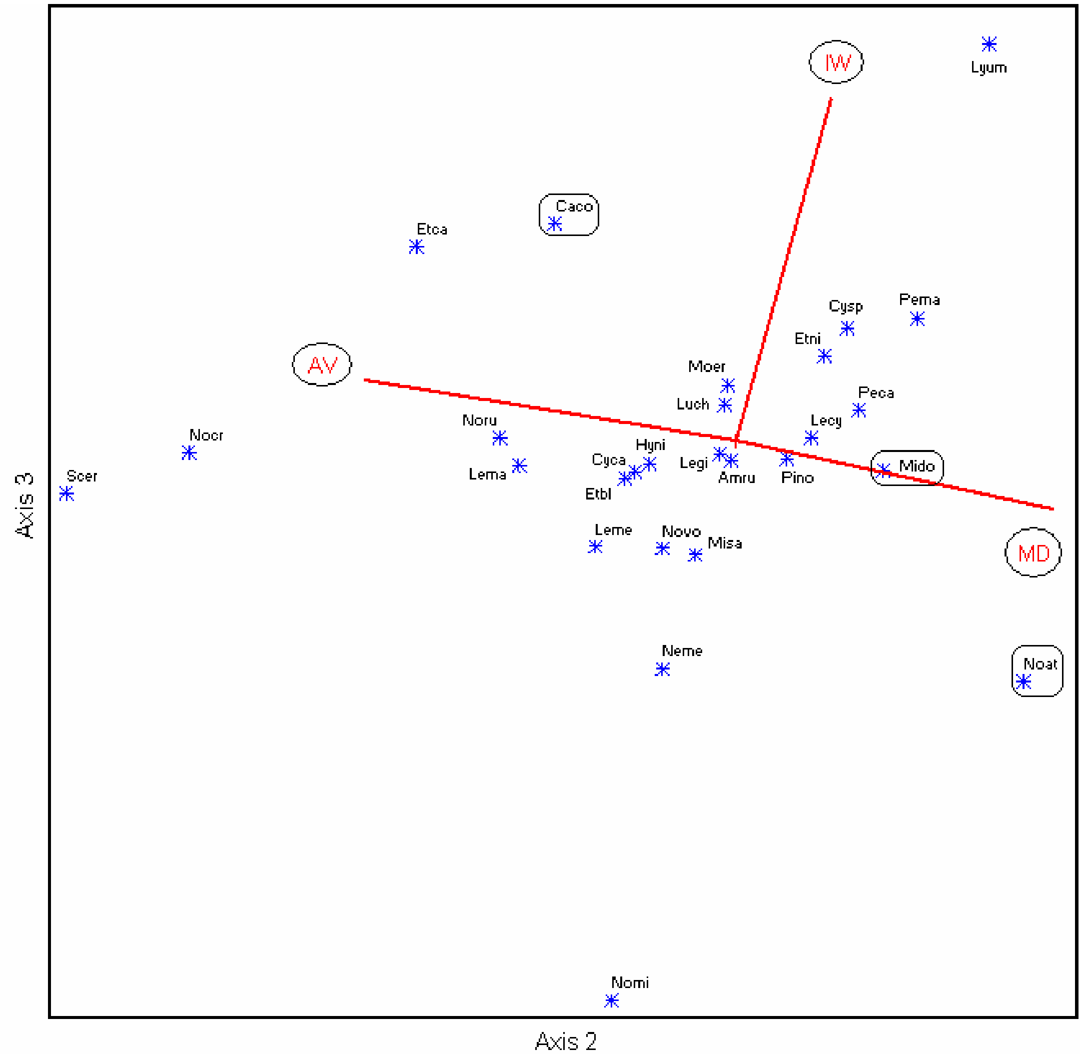
Map 3w. Jeddo Creek Study Area
DEC Fish Survey 905981
Ag Field
Ag Field
Ag Field
Ag Field
Stone
RT 271
Pearson
Jeddo Creek
ONT-139-9-1
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Sparse Riparian
Wooded Riparian
T9-1b
T9-1c RM 2.3 or 19.8 RM from Lake
open field
wood snags
weedy run
small run-pool habitat
rock dam
steel culvert @ ~RM 23.6 from lake
very rocky SS
round goby from canal
wood snags
from canal
(38)
1
(39)
2
20
HARTLAND
0
0.1
0.2
Miles
N
Legend
2005 Fish Sites
2004-2005 Data
Habitat_Rating
3
4
Landmarks
Roads
Township Border
NYSDEC
REGION
8
9
ArcGIS 9 image by S.Wells, SUNY Brockport, Jan 2008.



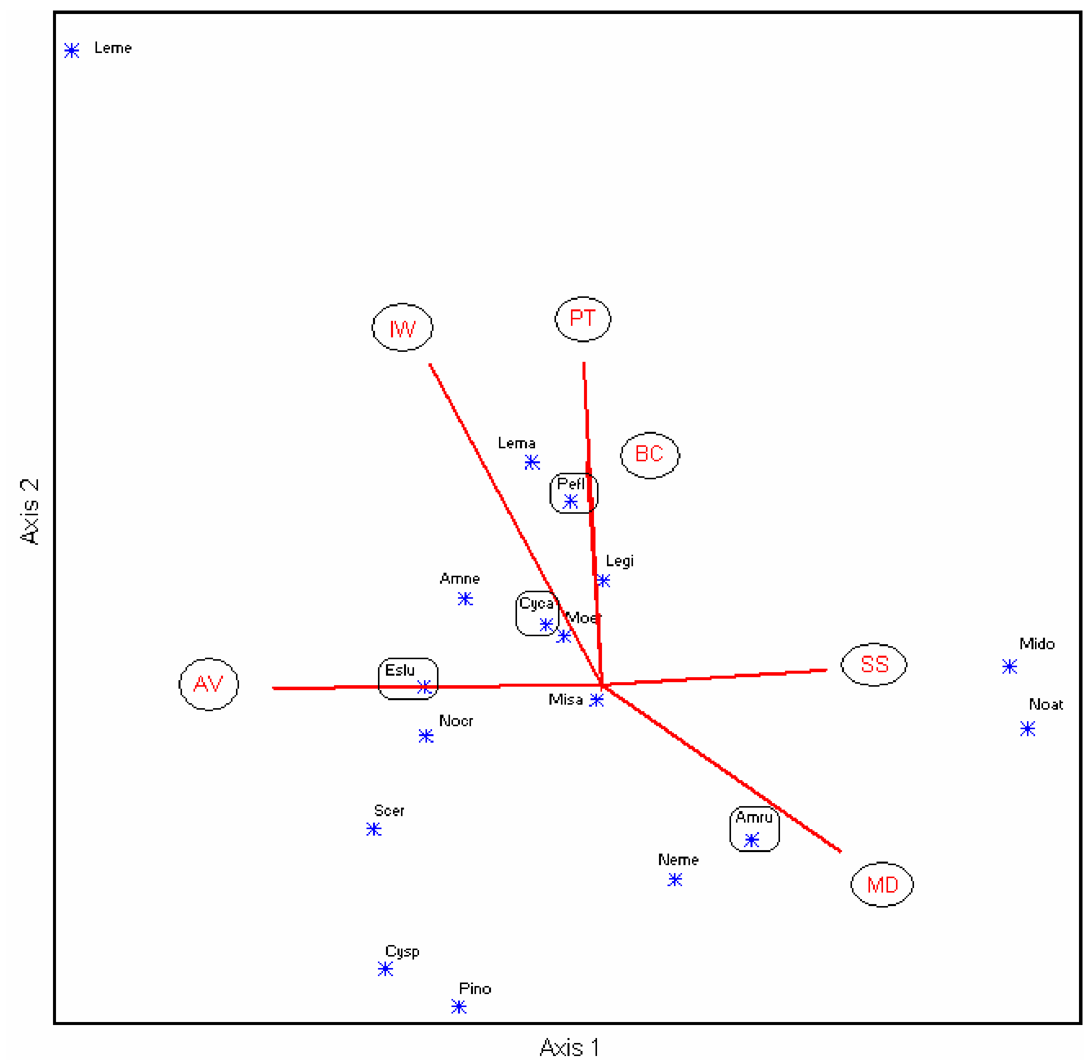
Appendix III-A. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (lower basin) June-September, 2005. See Table 11 for complete CCA results.



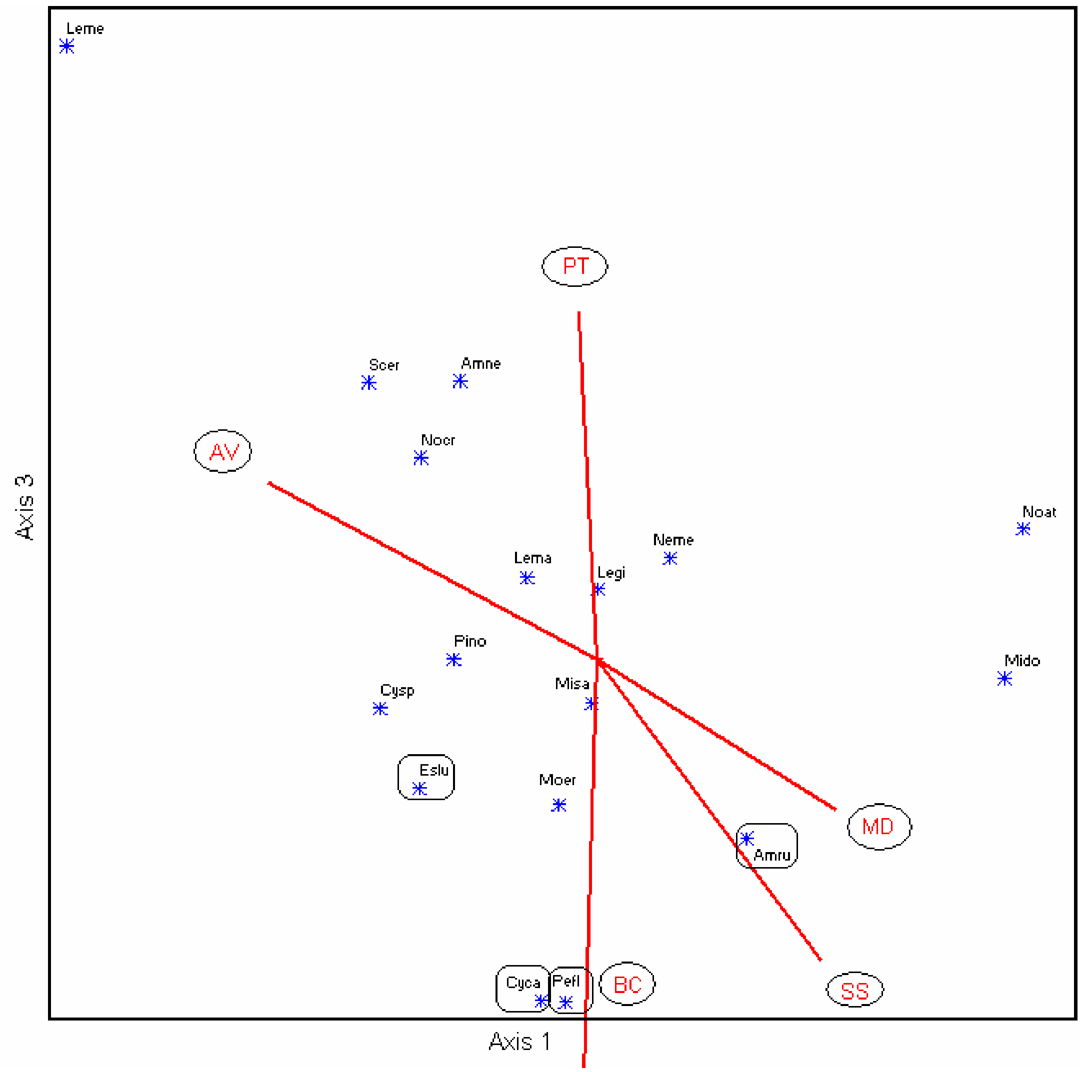
Appendix III-B. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (lower basin) June-September, 2005. See Table 11 for complete CCA results.



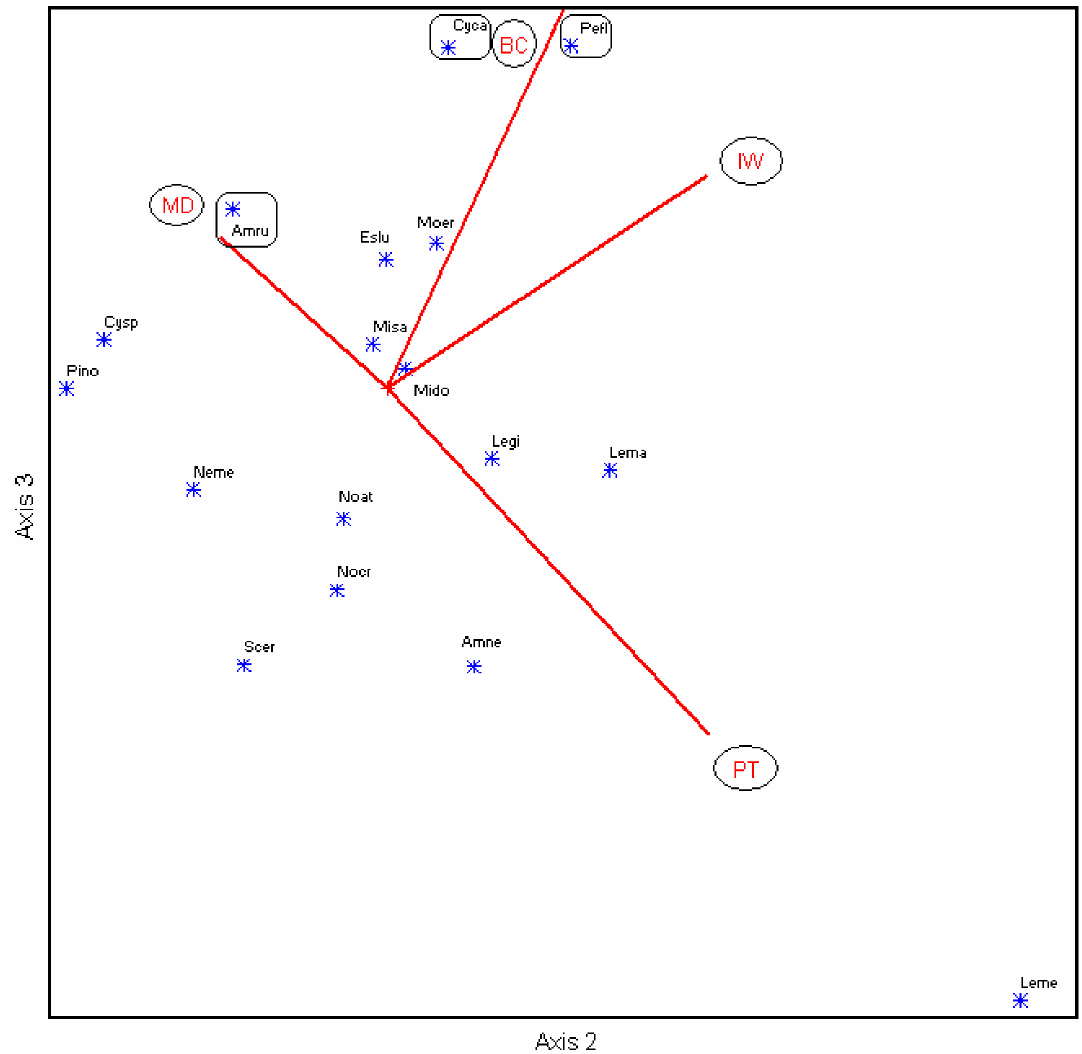
Appendix III-C. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (lower basin) June-September, 2005. See Table 11 for complete CCA results.



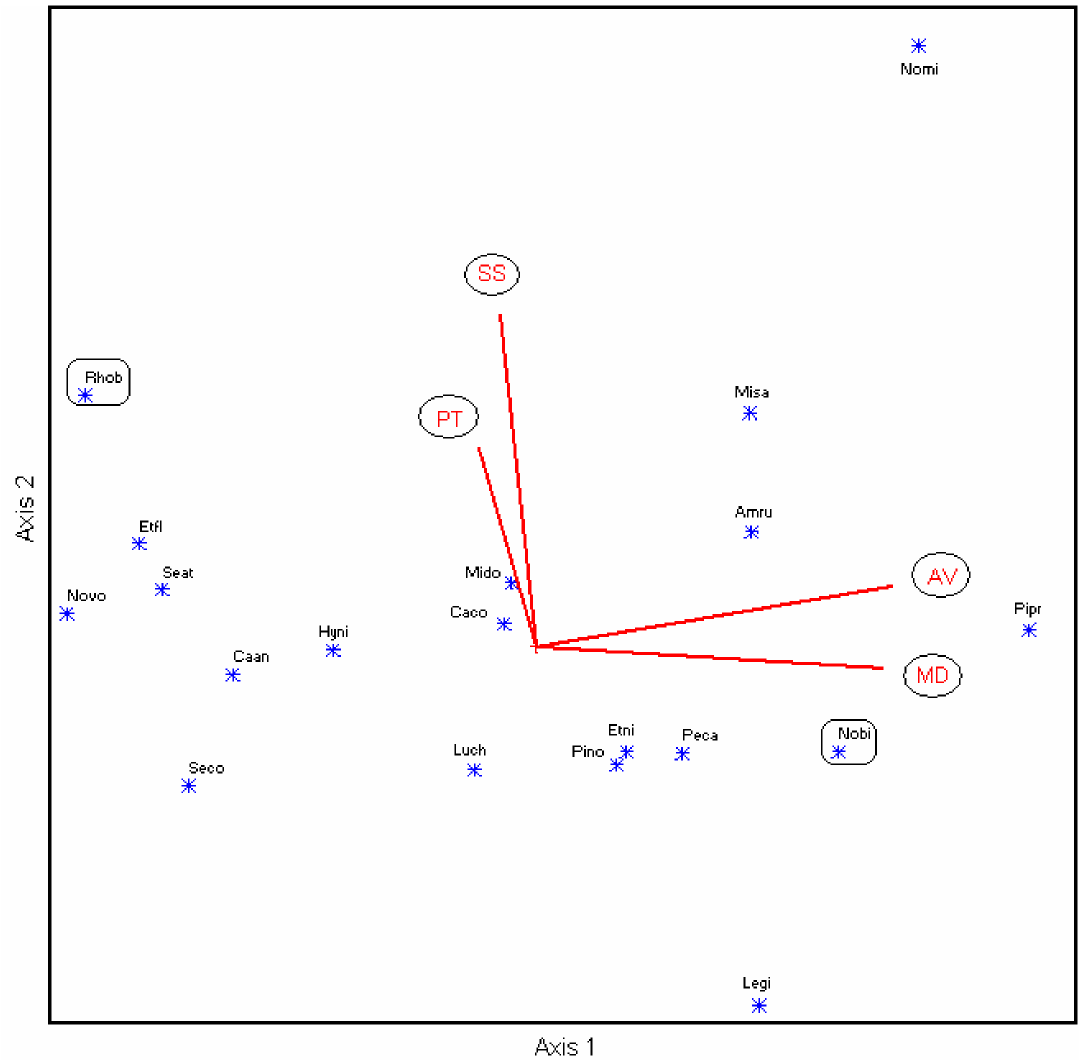
Appendix III-D. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (canal+adjacent tributaries) June-September, 2005. See Table 11 for complete CCA results.



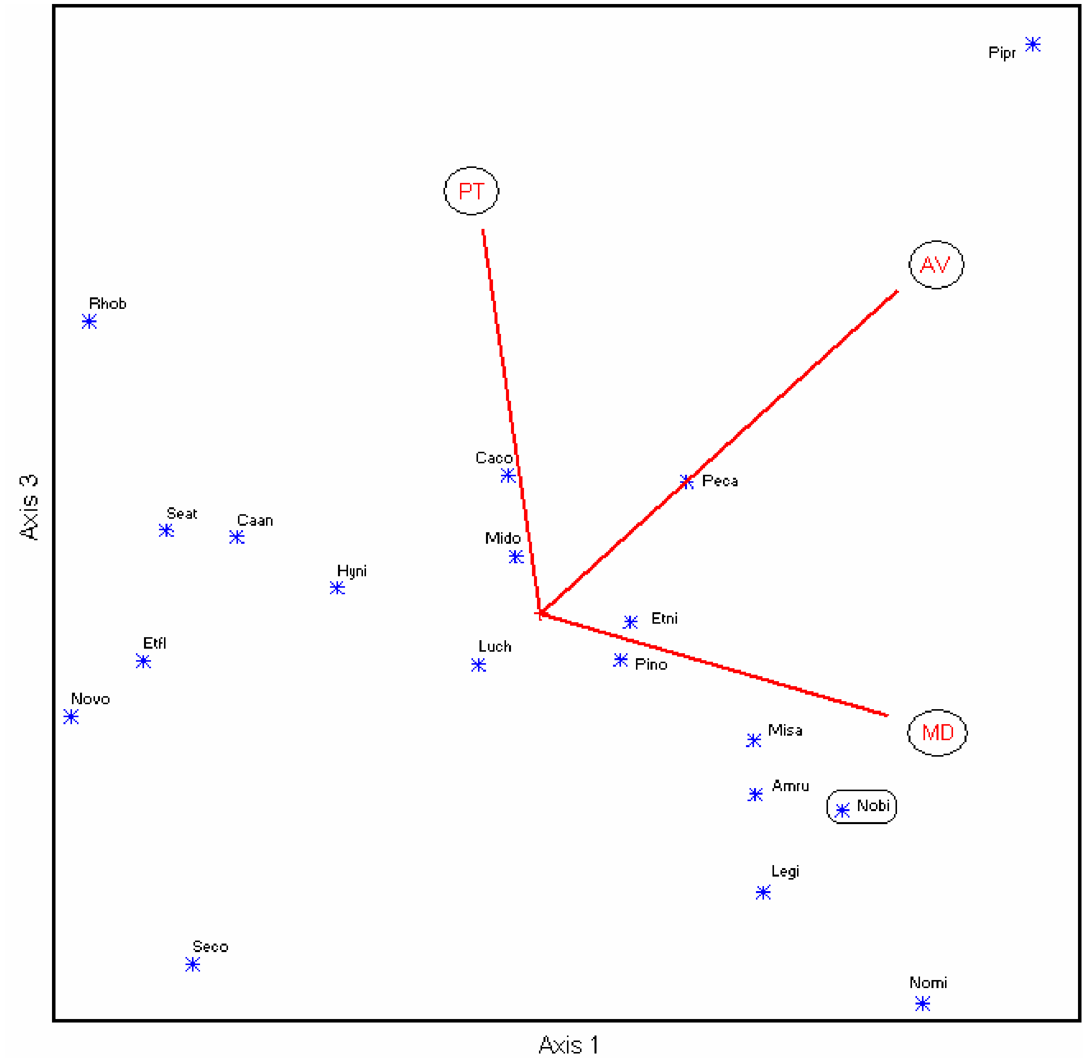
Appendix III-E. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (canal+adjacent tributaries) June-September, 2005. See Table 11 for complete CCA results.



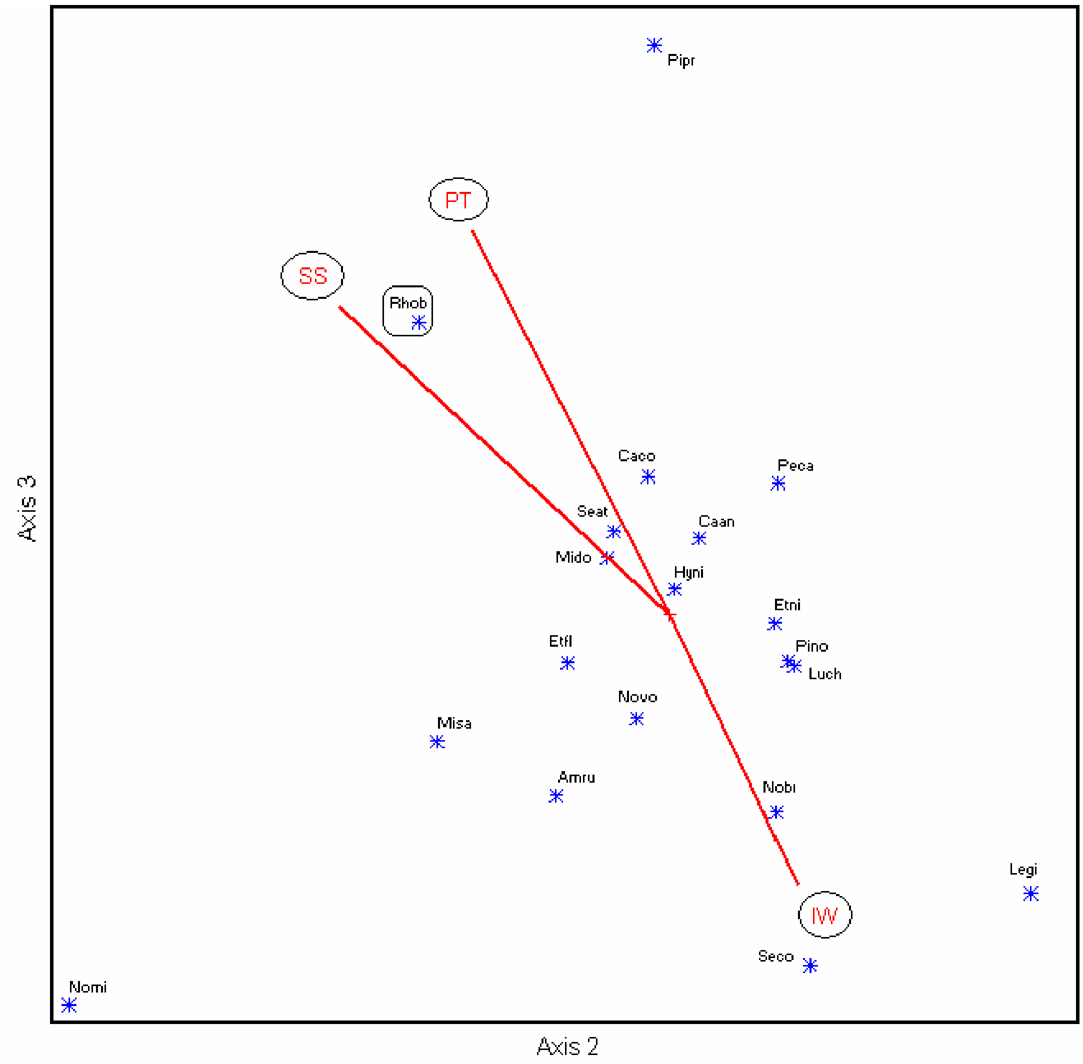
Appendix III-F. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (canal+adjacent tributaries) June-September, 2005. See Table 11 for complete CCA results.



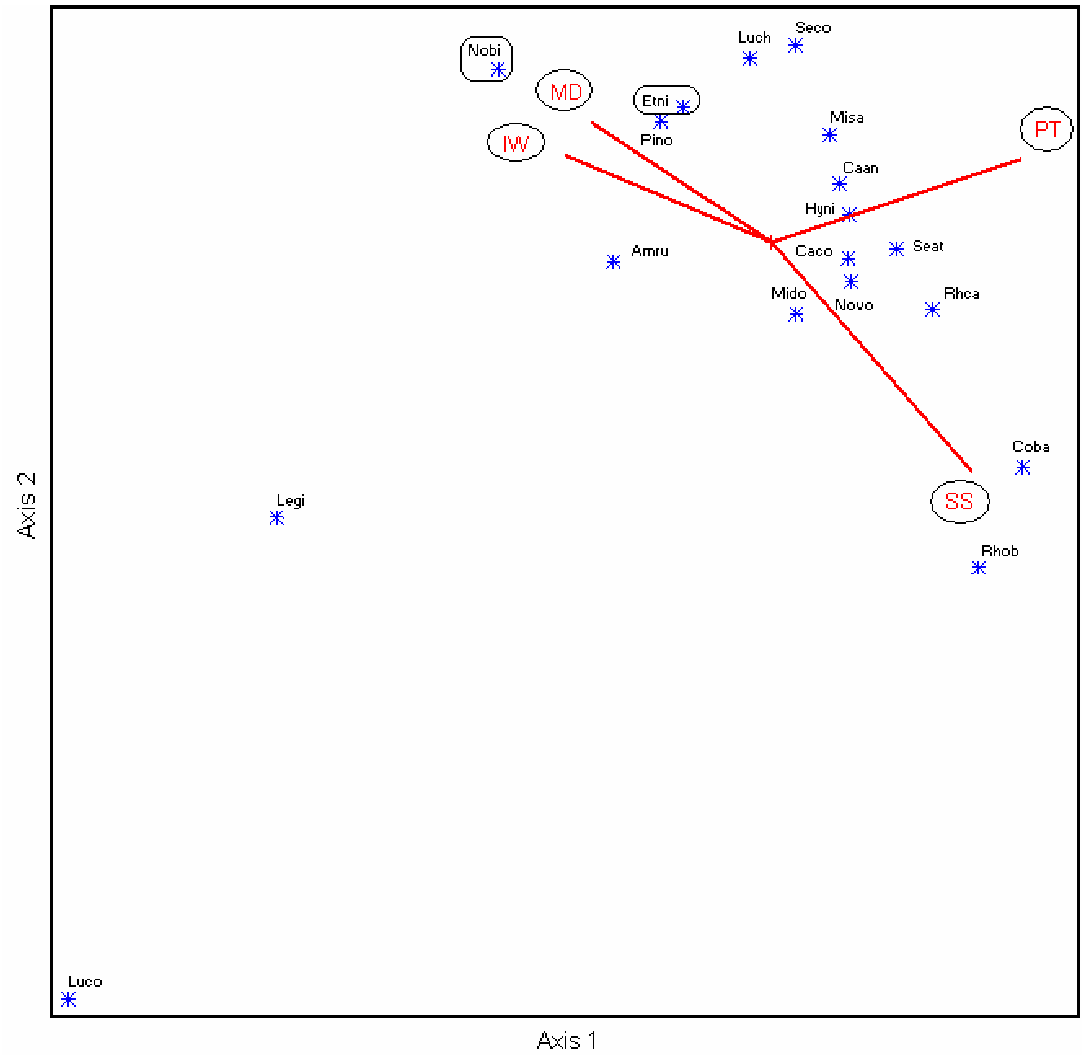
Appendix III-G. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (middle+upper basin) June-September, 2005. See Table 11 for complete CCA results.



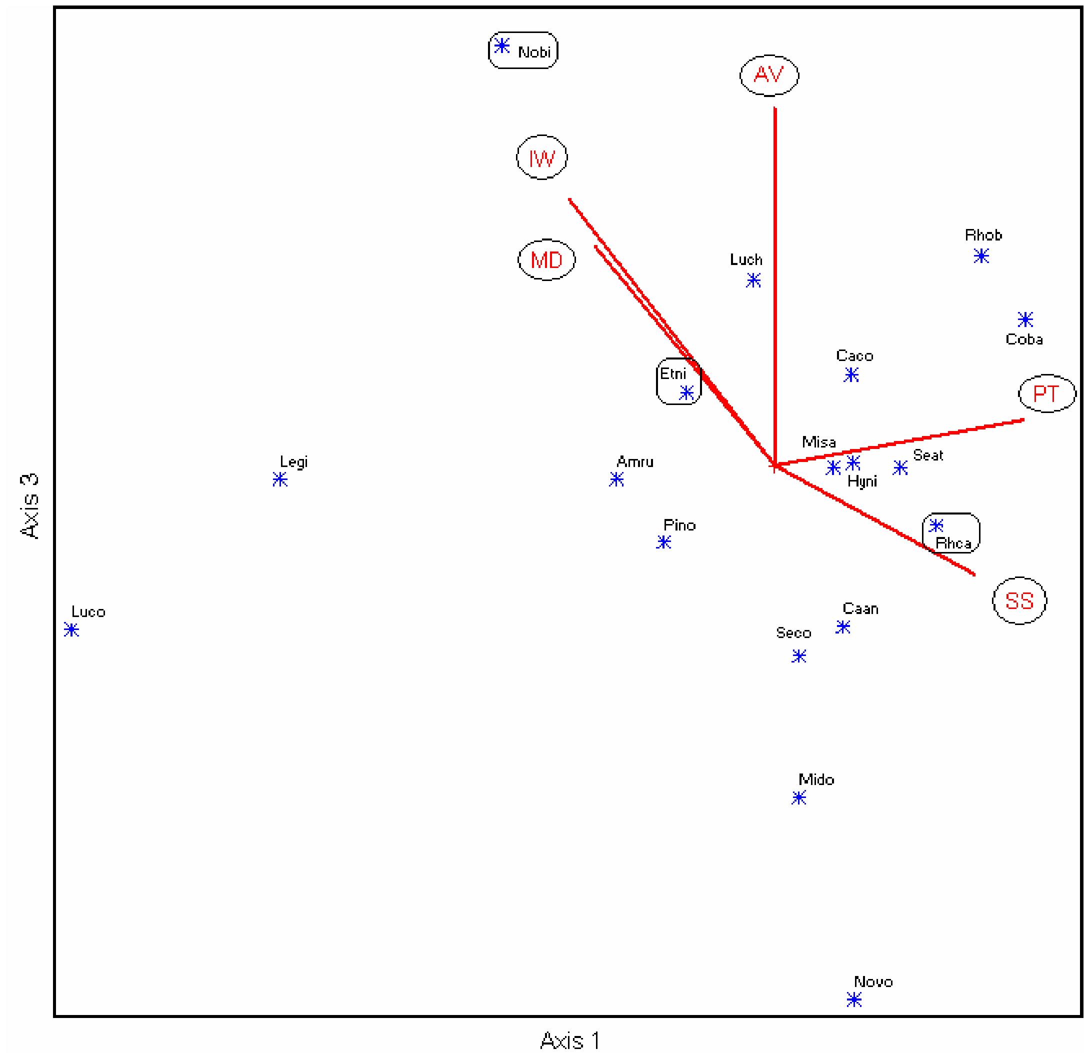
Appendix III-H. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (middle+upper basin) June-September, 2005. See Table 11 for complete CCA results.



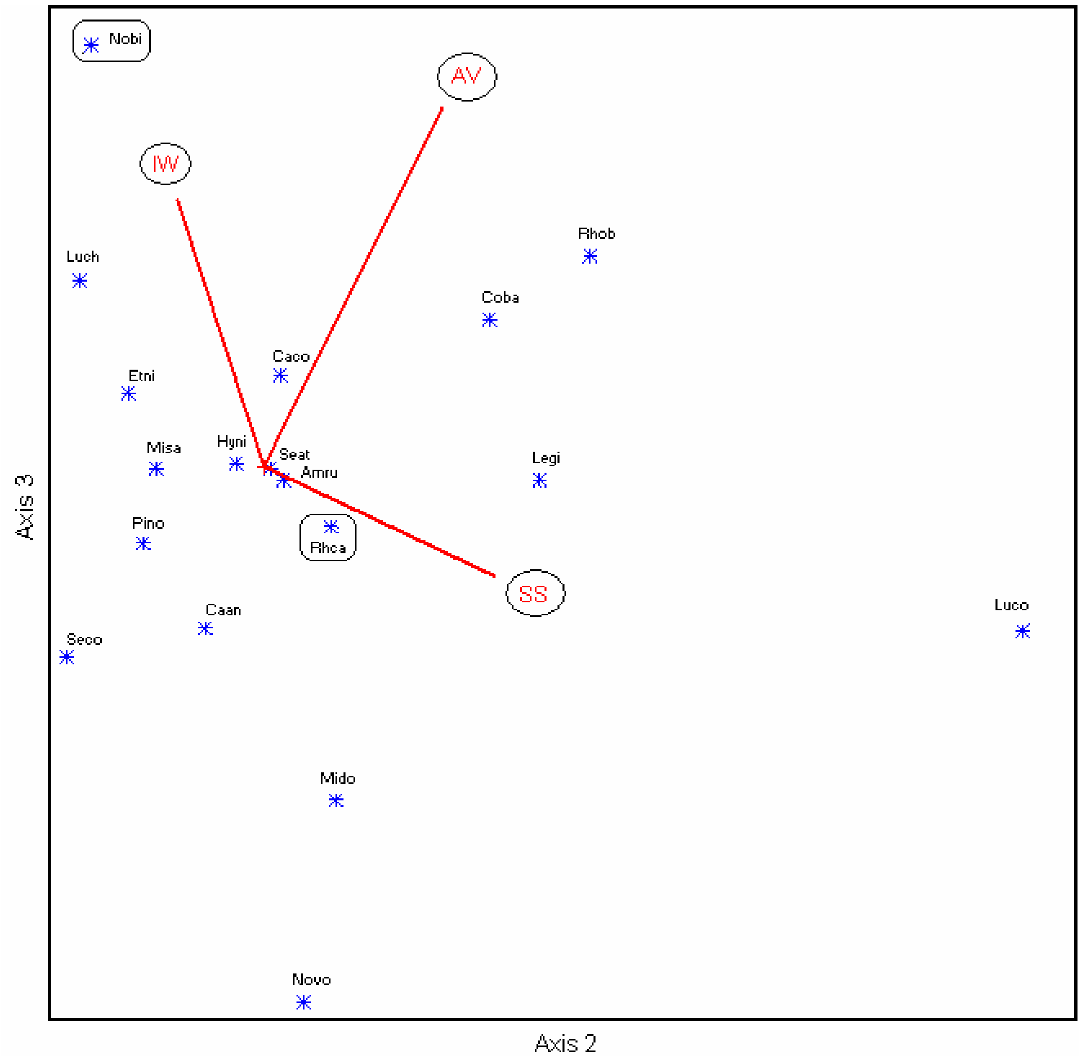
Appendix III-I. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (middle+upper basin) June-September, 2005. See Table 11 for complete CCA results.



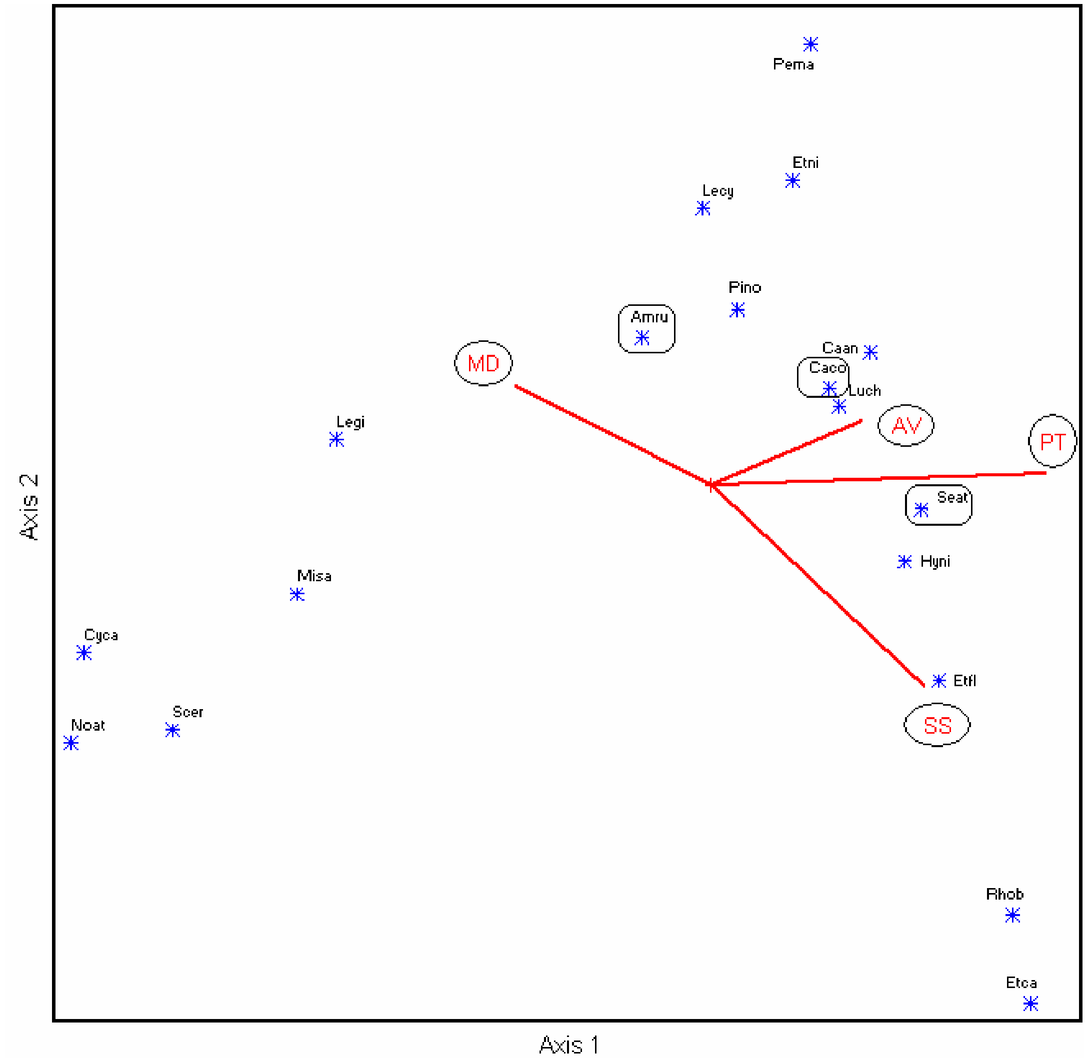
Appendix III-J. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (upper basin) June-September, 2005. See Table 11 for complete CCA results.



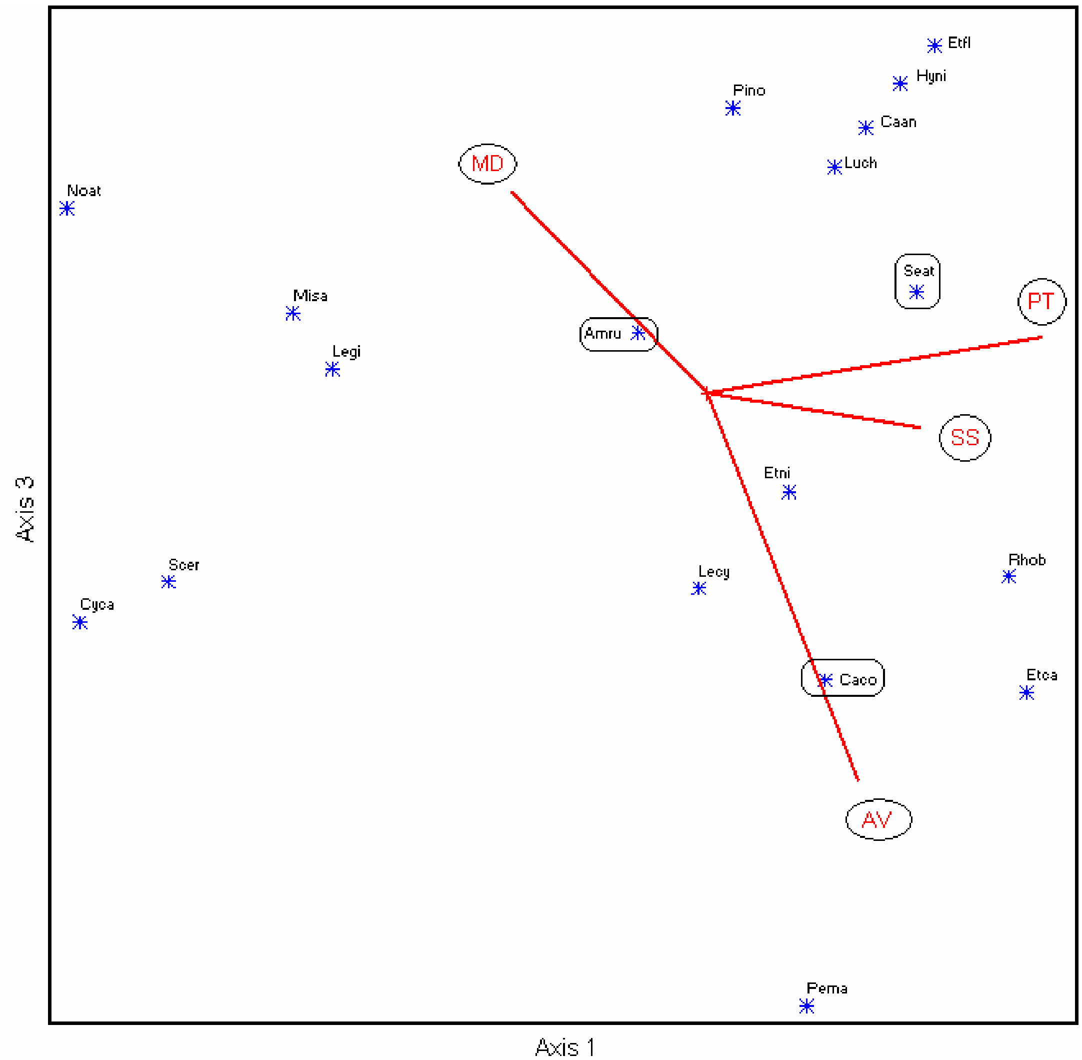
Appendix III-K. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (upper basin) June-September, 2005. See Table 11 for complete CCA results.



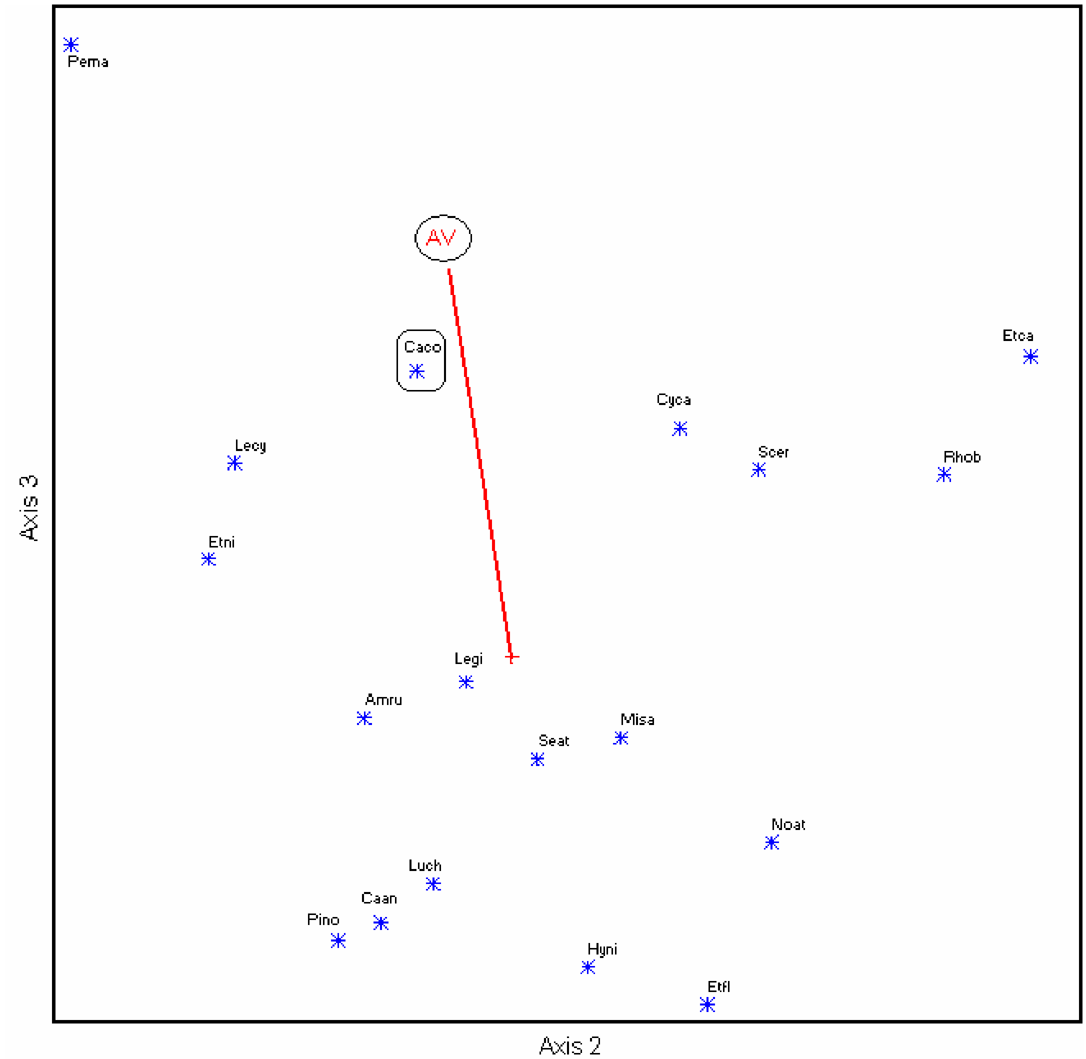
Appendix III-L. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (upper basin) June-September, 2005. See Table 11 for complete CCA results.



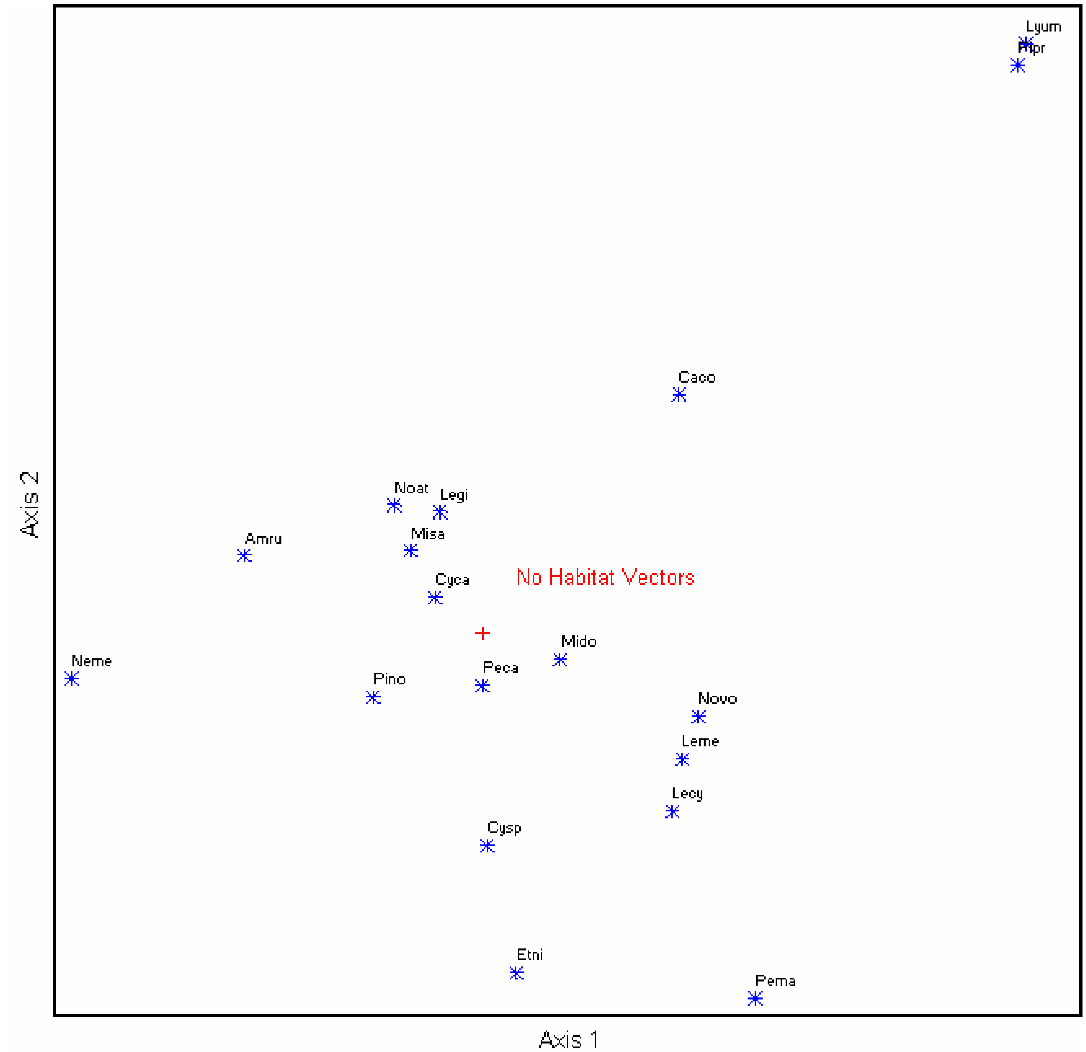
Appendix III-M. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (tributaries only) June-September, 2005. See Table 11 for complete CCA results.



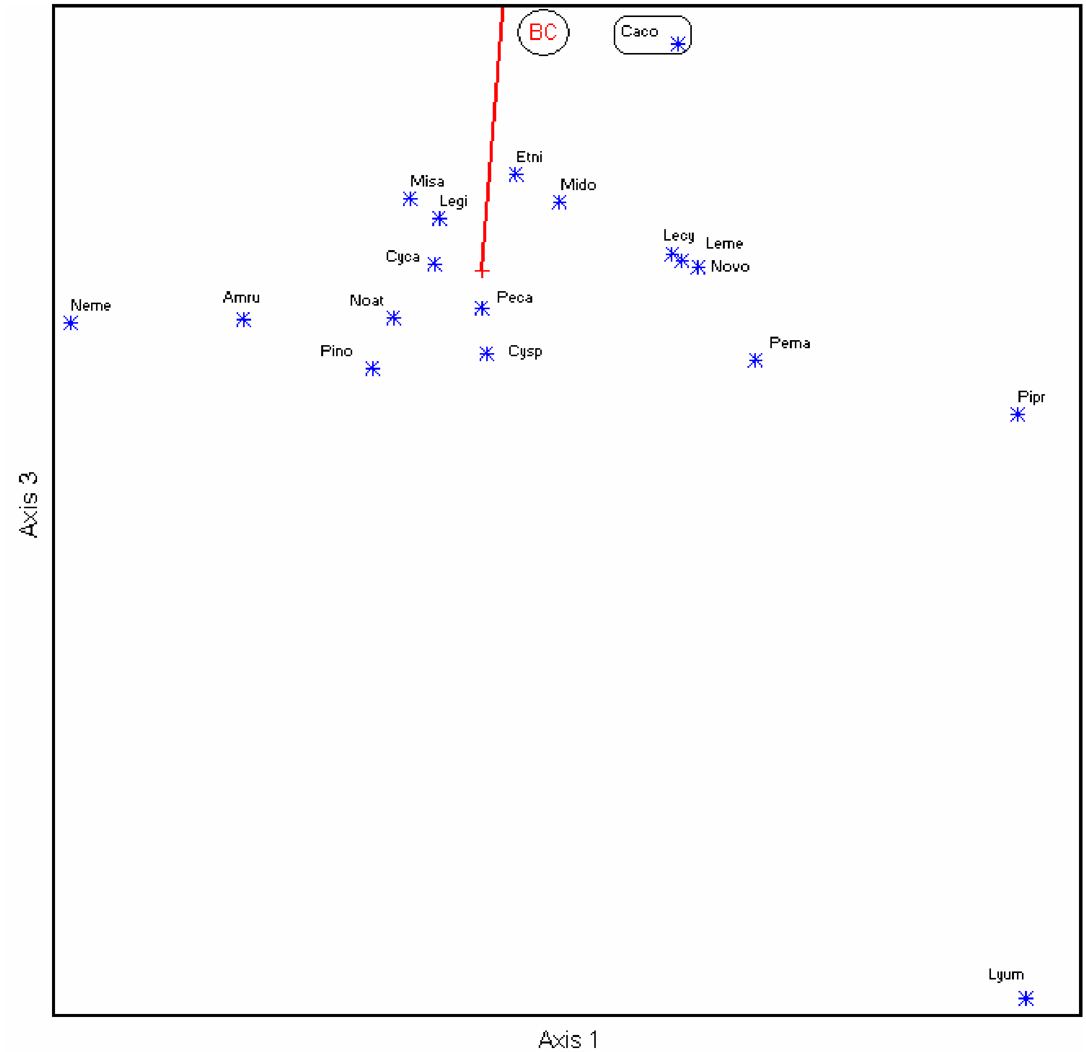
Appendix III-N. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (tributaries only) June-September, 2005. See Table 11 for complete CCA results.



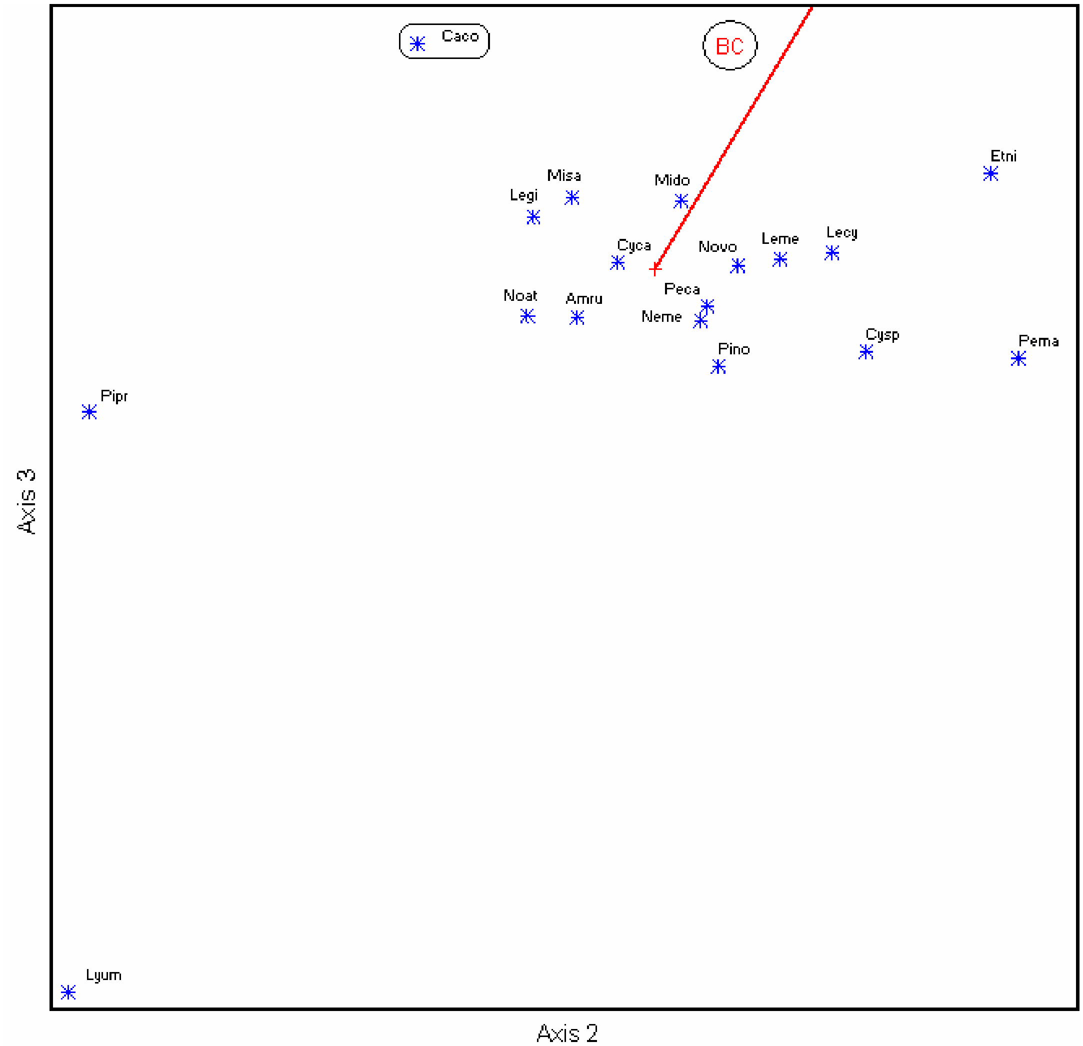
Appendix III-O. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (tributaries only) June-September, 2005. See Table 11 for complete CCA results.



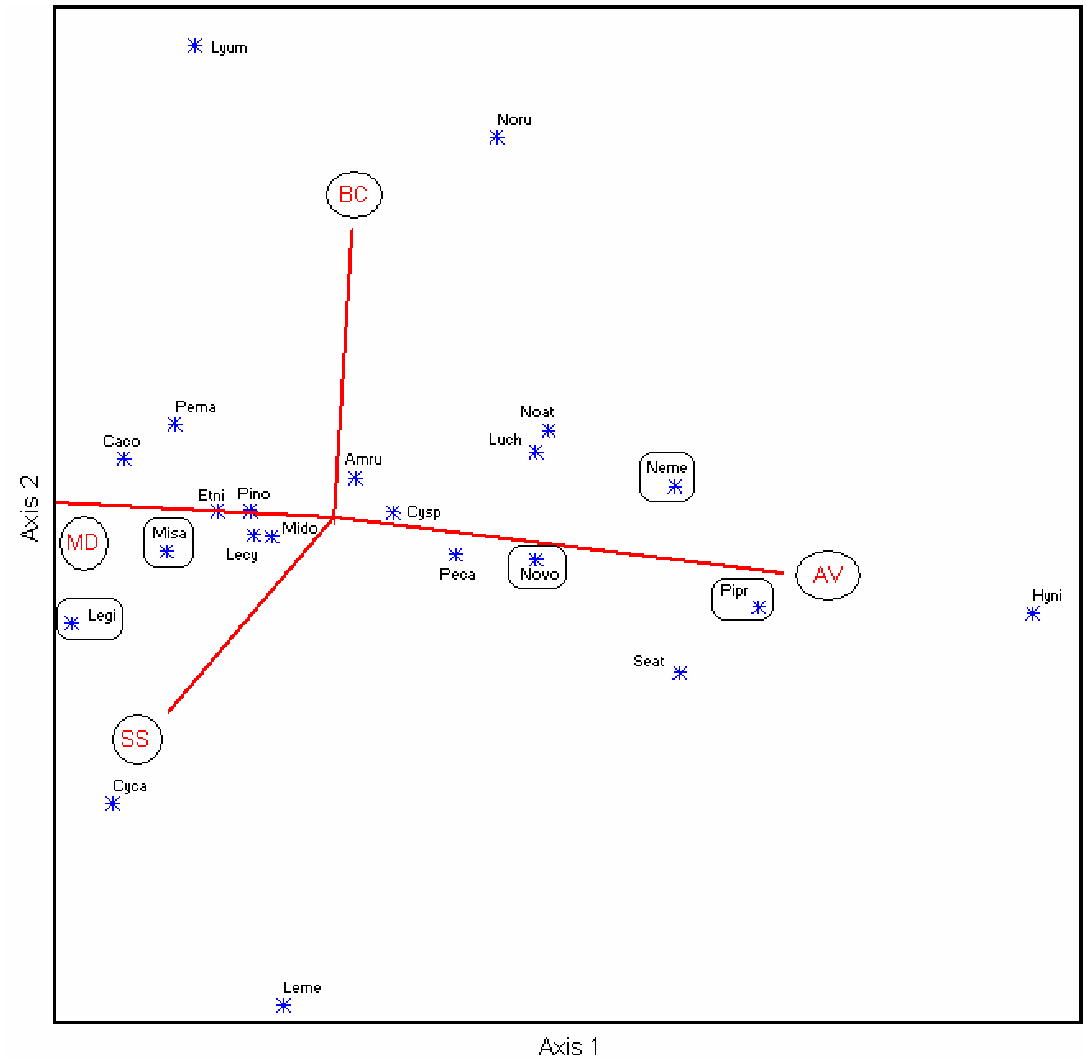
Appendix III-P. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 1 pools) June-September, 2005. See Table 11 for complete CCA results.



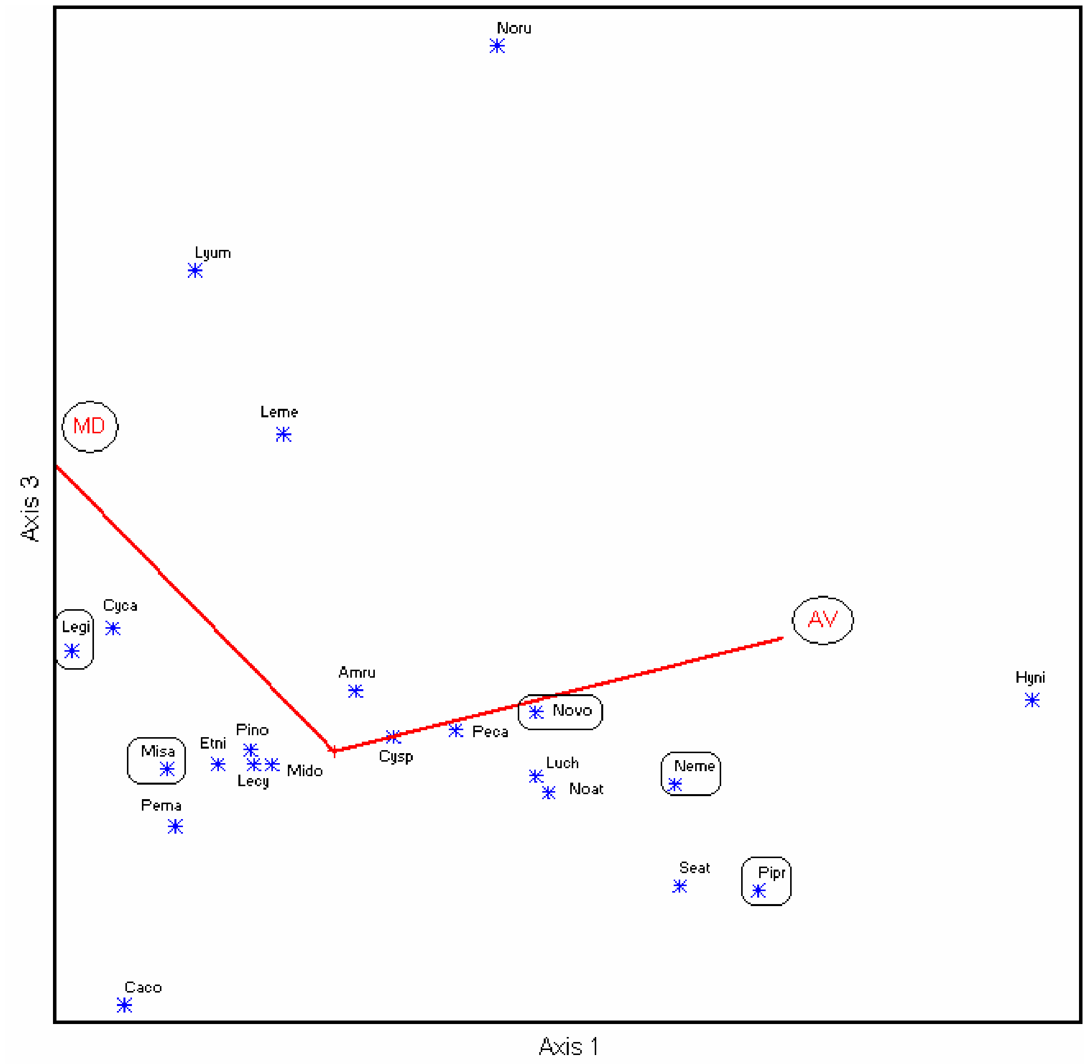
Appendix III-Q. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 1 pools) June-September, 2005. See Table 11 for complete CCA results.



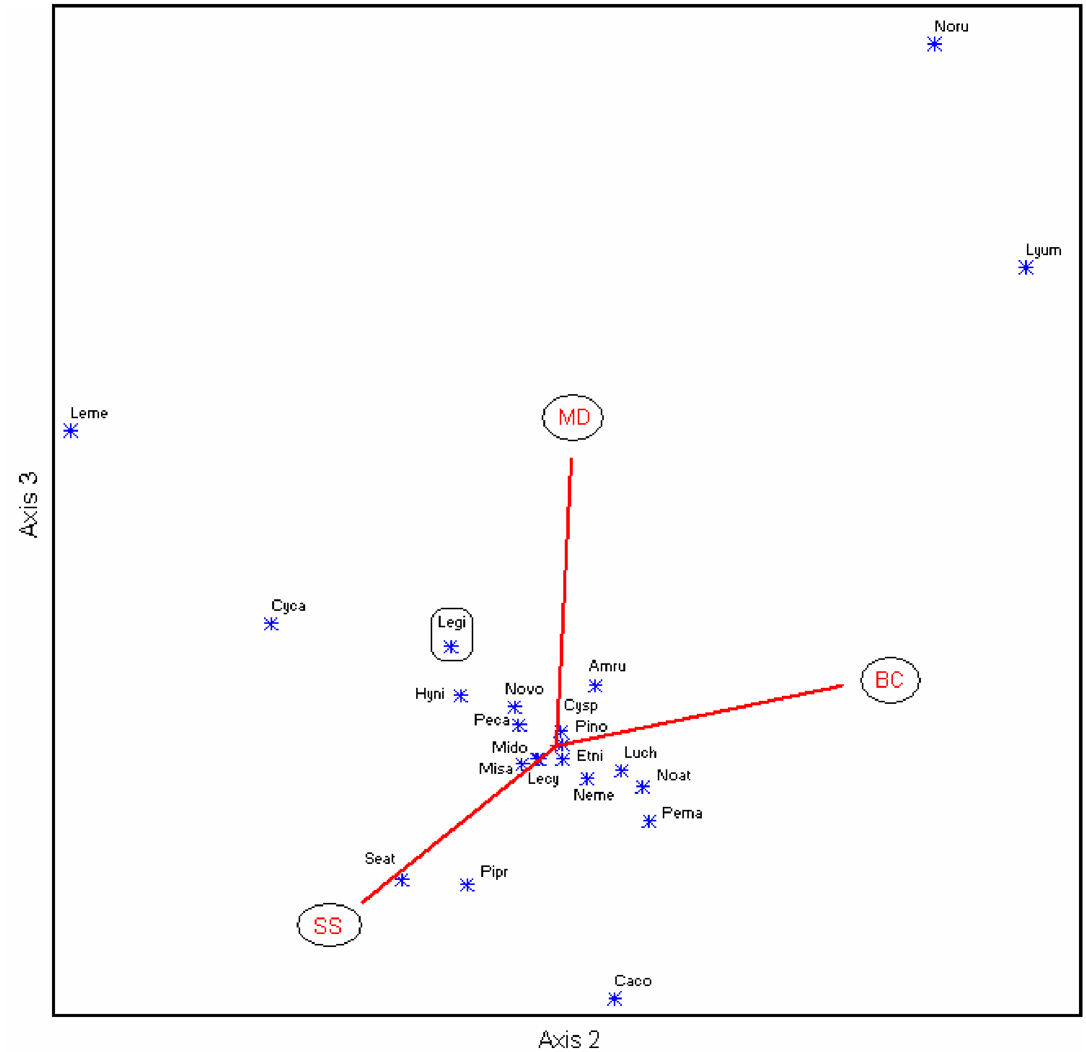
Appendix III-R. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 1 pools) June-September, 2005. See Table 11 for complete CCA results.



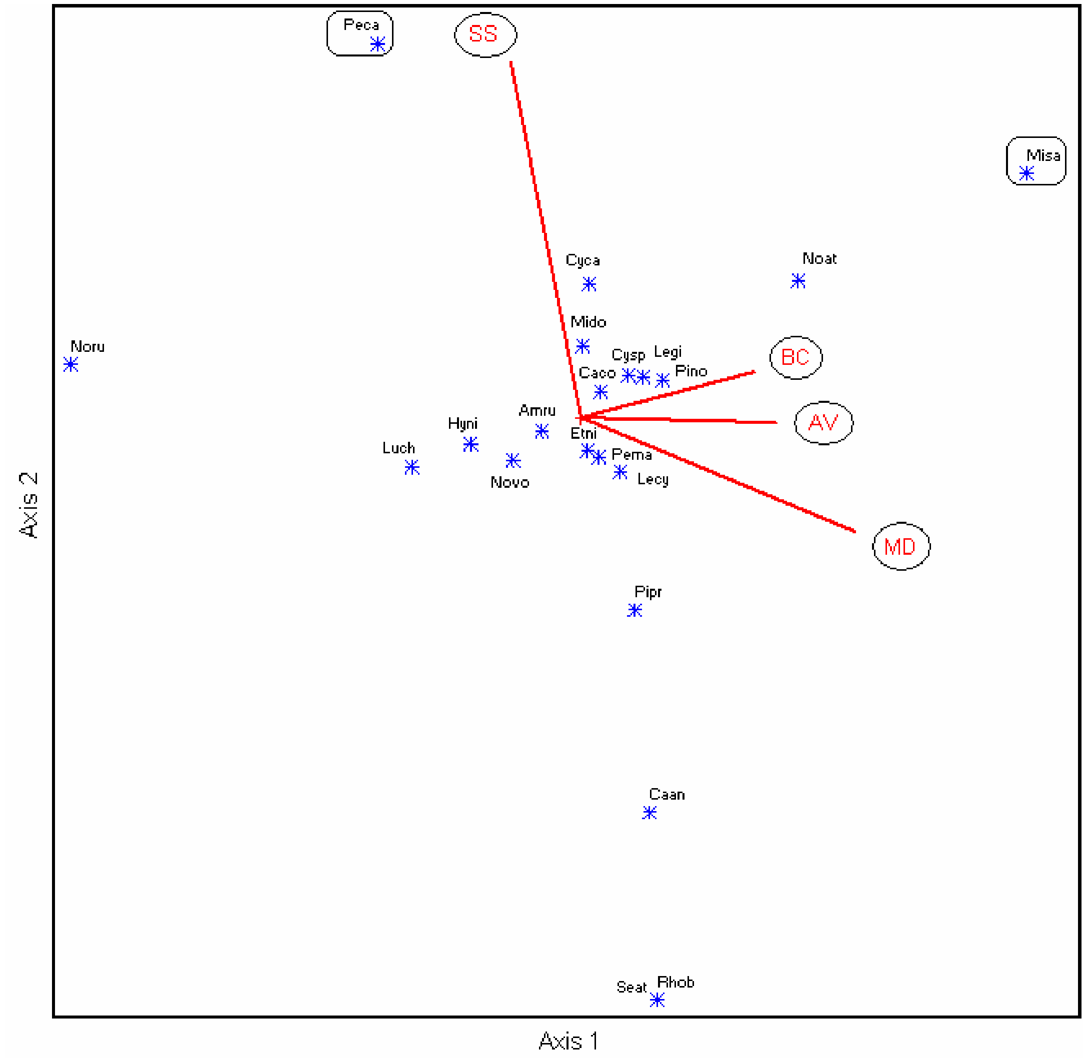
Appendix III-S. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 2 pools) June-September, 2005. See Table 11 for complete CCA results.



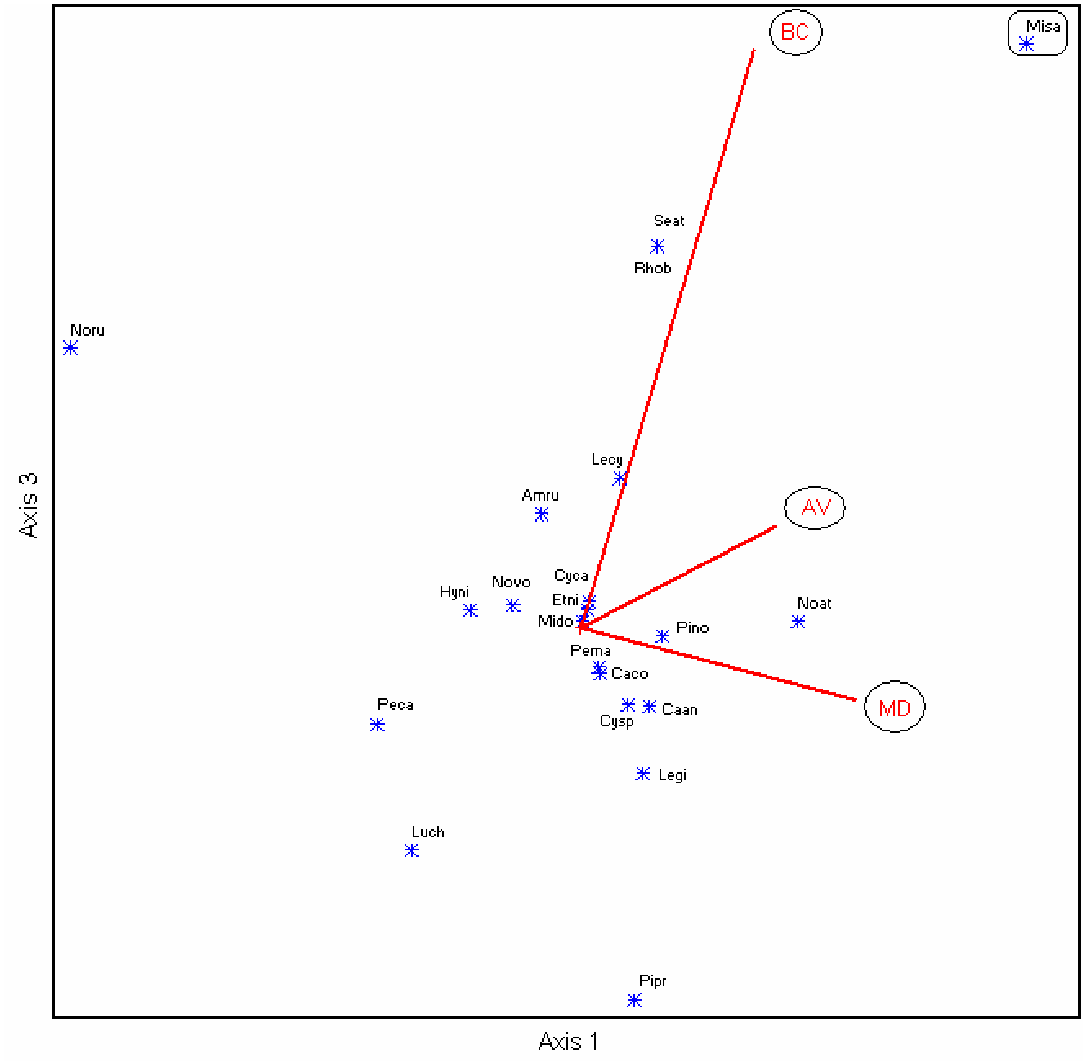
Appendix III-T. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 2 pools) June-September, 2005. See Table 11 for complete CCA results.



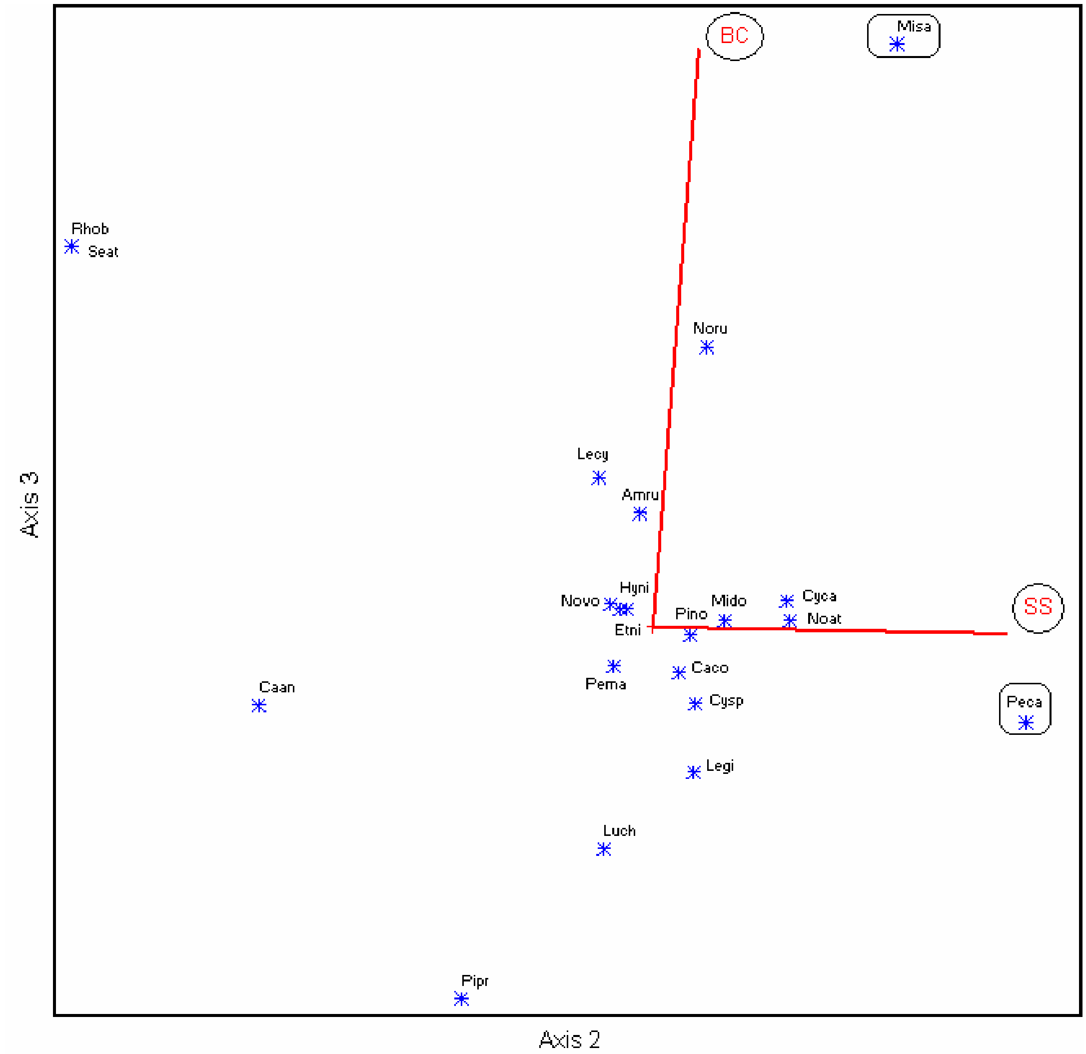
Appendix III-U. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 2 pools) June-September, 2005. See Table 11 for complete CCA results.



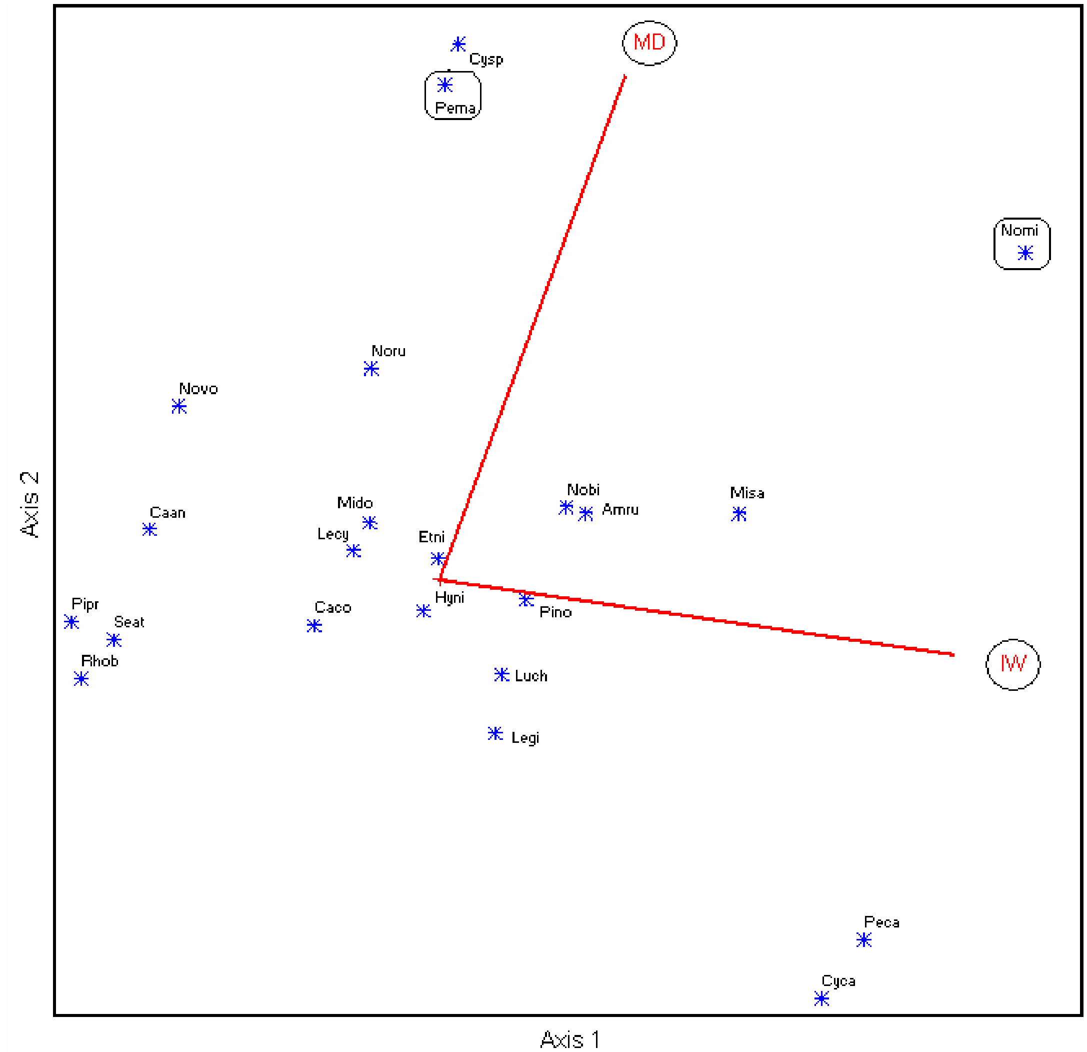
Appendix III-V. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 3 pools) June-September, 2005. See Table 11 for complete CCA results.



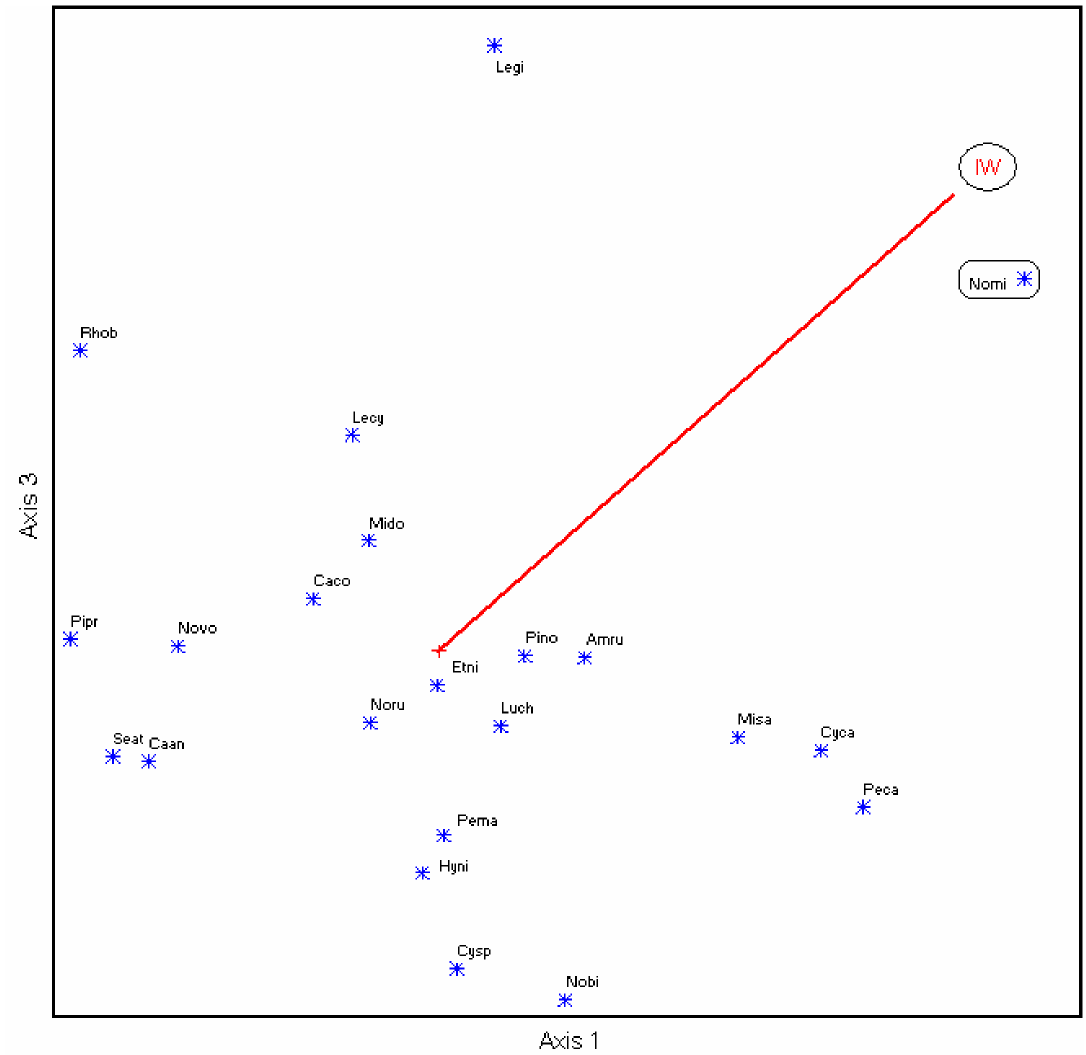
Appendix III-W. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 3 pools) June-September, 2005. See Table 11 for complete CCA results.



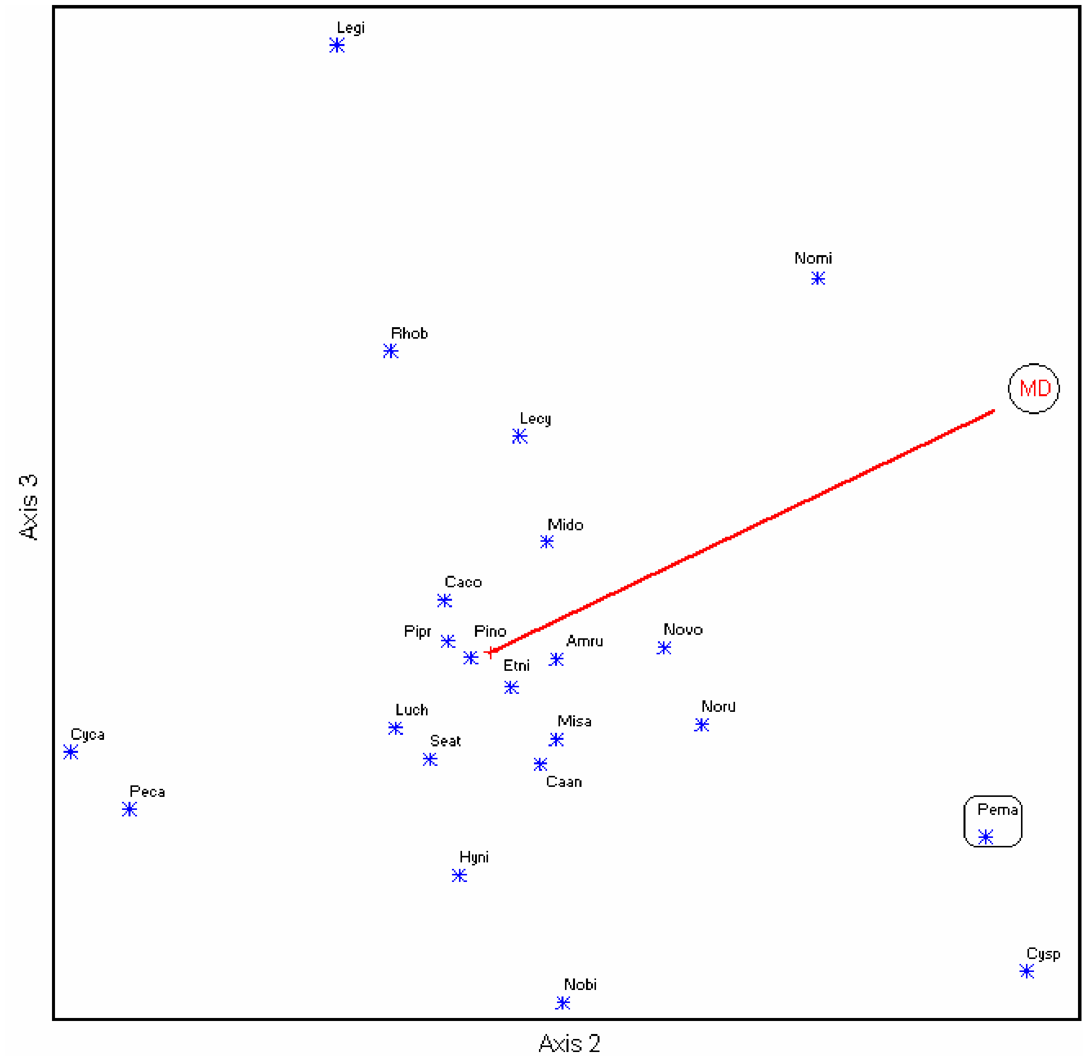
Appendix III-X. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 3 pools) June-September, 2005. See Table 11 for complete CCA results.



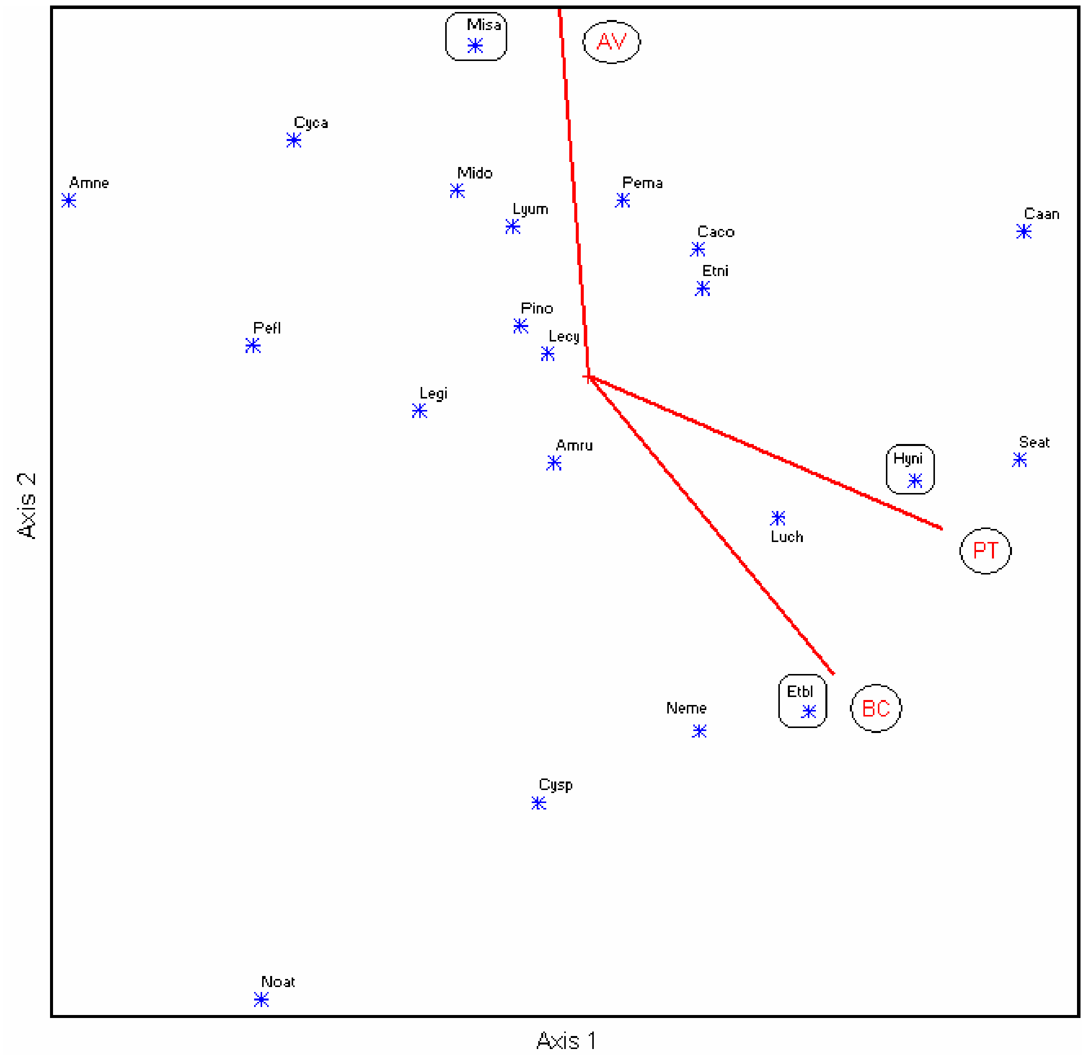
Appendix III-Y. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 4 pools) June-September, 2005. See Table 11 for complete CCA results.



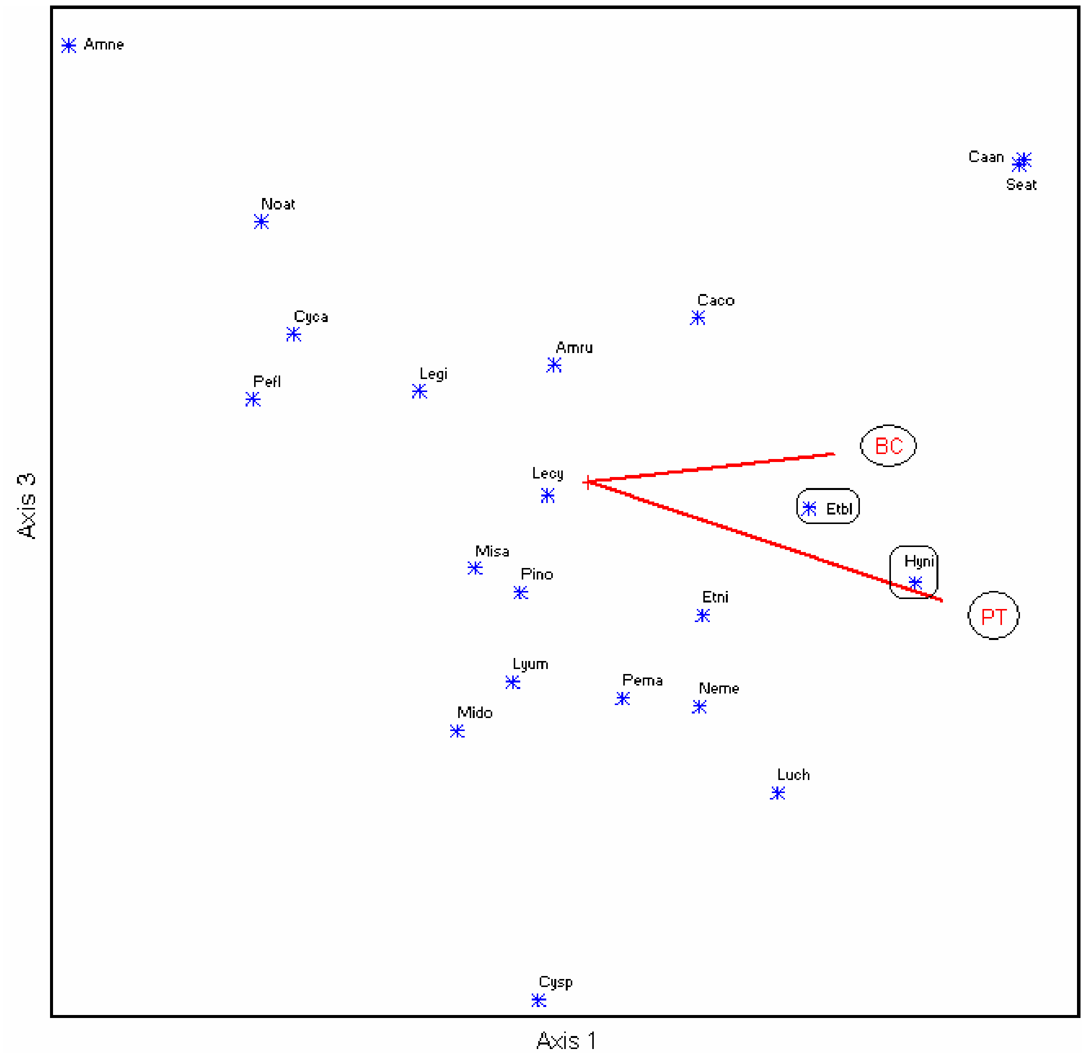
Appendix III-Z. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 4 pools) June-September, 2005. See Table 11 for complete CCA results.



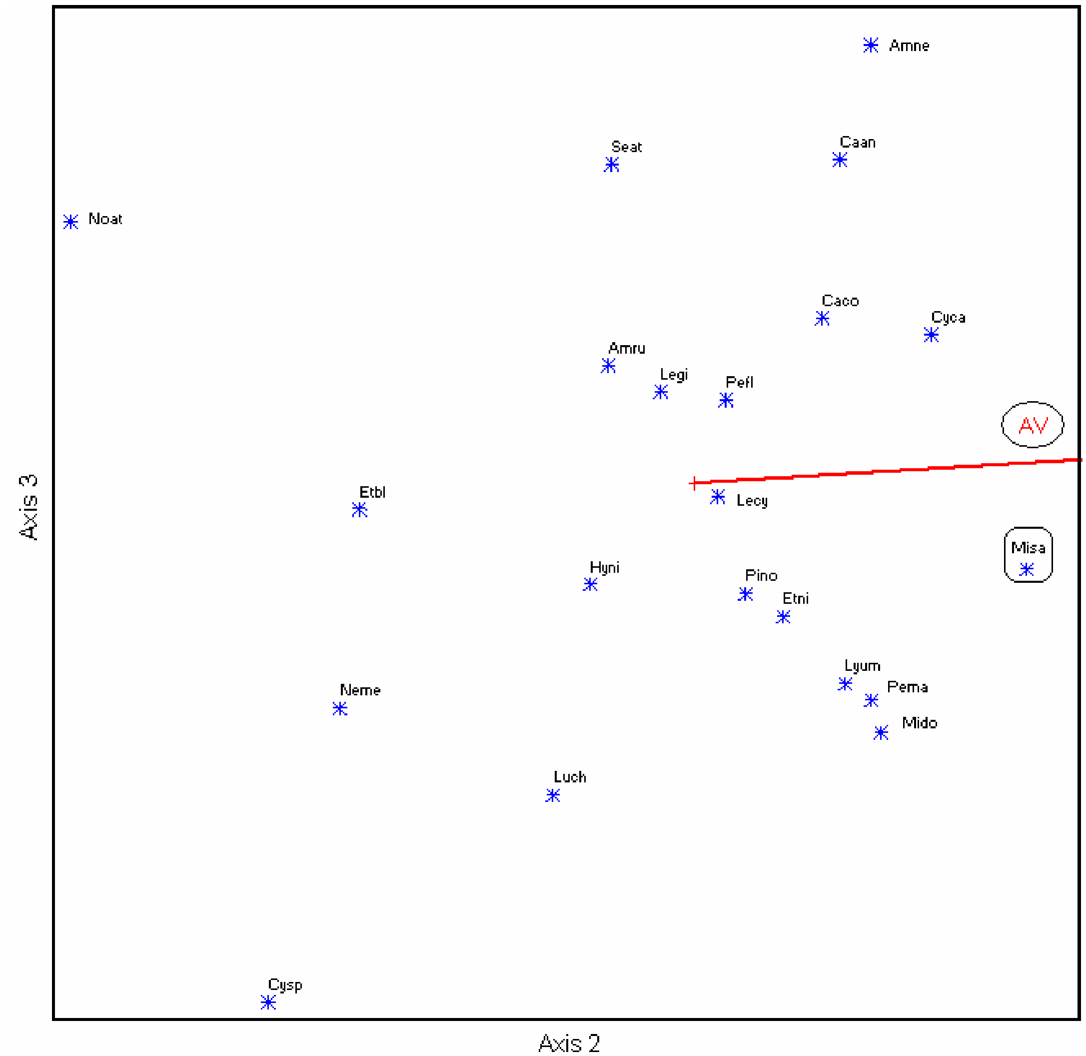
Appendix III-AA. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Tonawanda Creek watershed (type 4 pools) June-September, 2005. See Table 11 for complete CCA results.



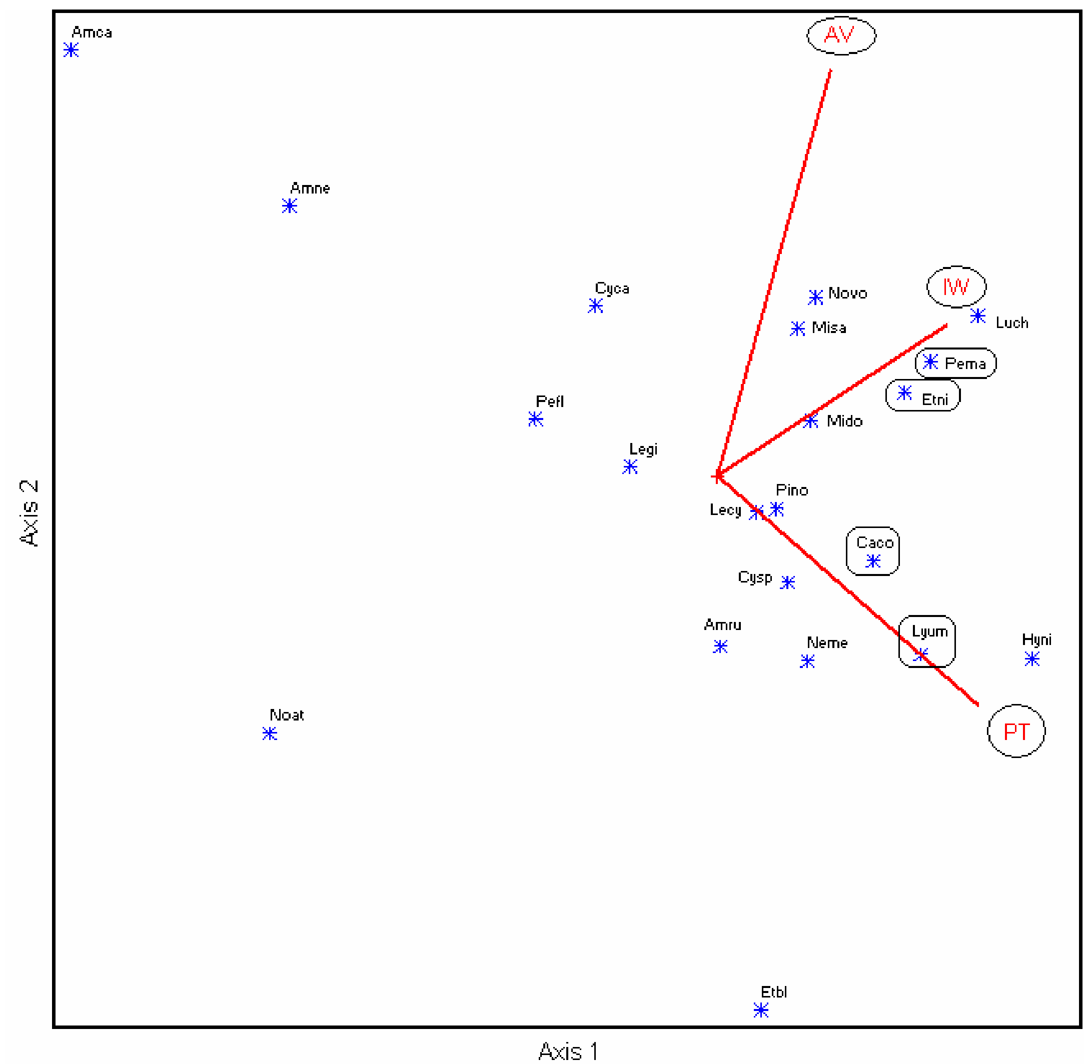
Appendix IV-A. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (entire basin) May-September, 2005. See Table 11 for complete CCA results.



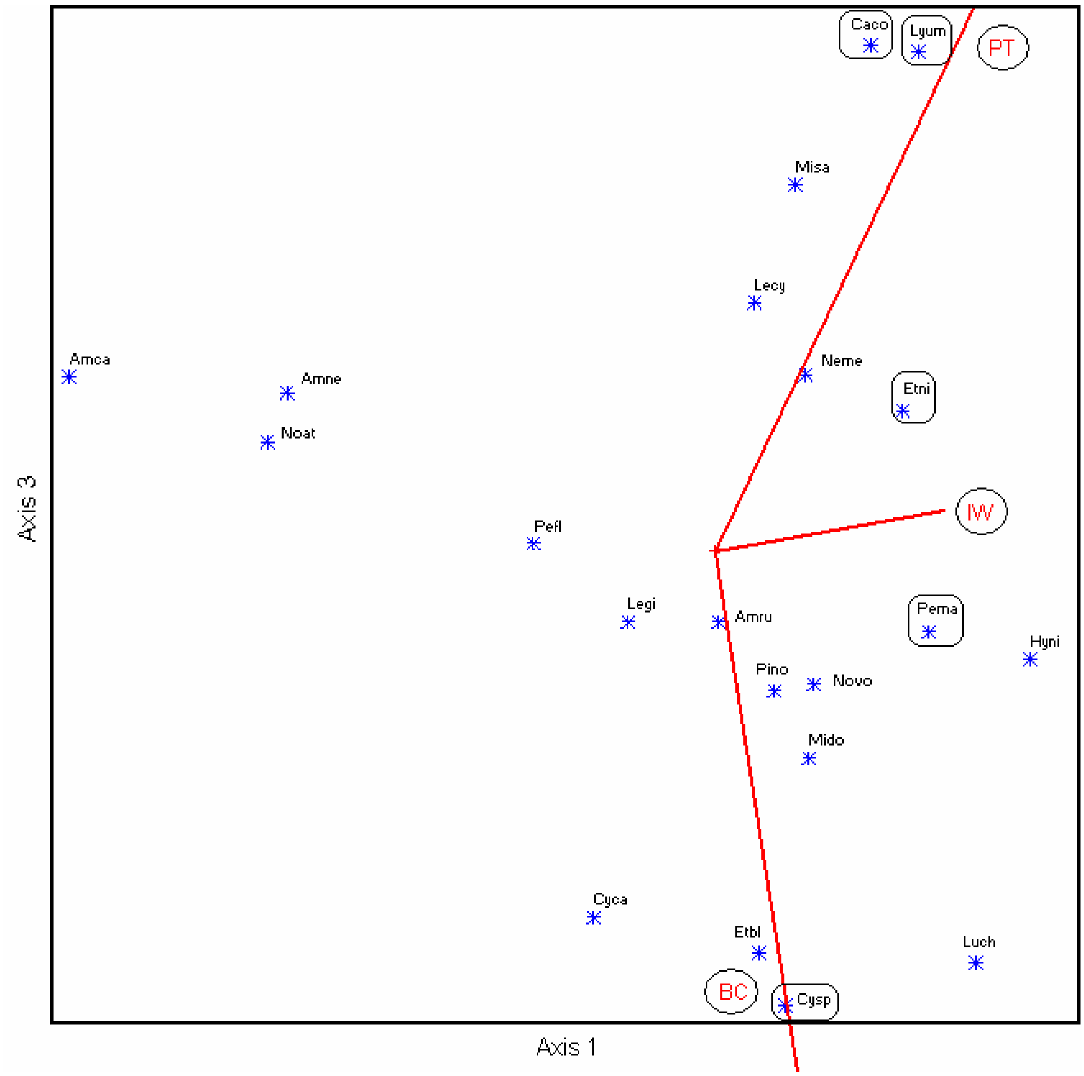
Appendix IV-B. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (entire basin) May-September, 2005. See Table 11 for complete CCA results.



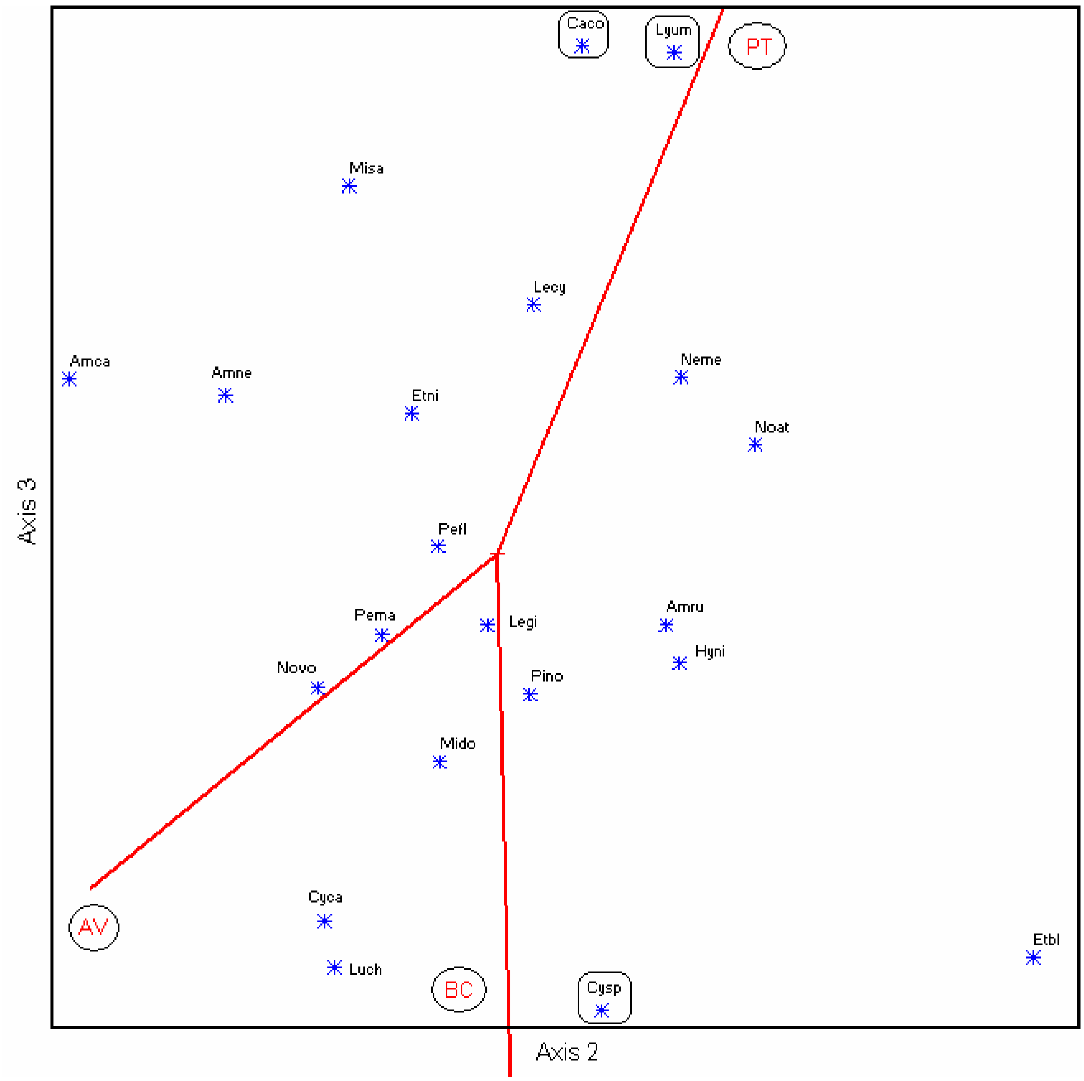
Appendix IV-C. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (entire basin) May-September, 2005. See Table 11 for complete CCA results.



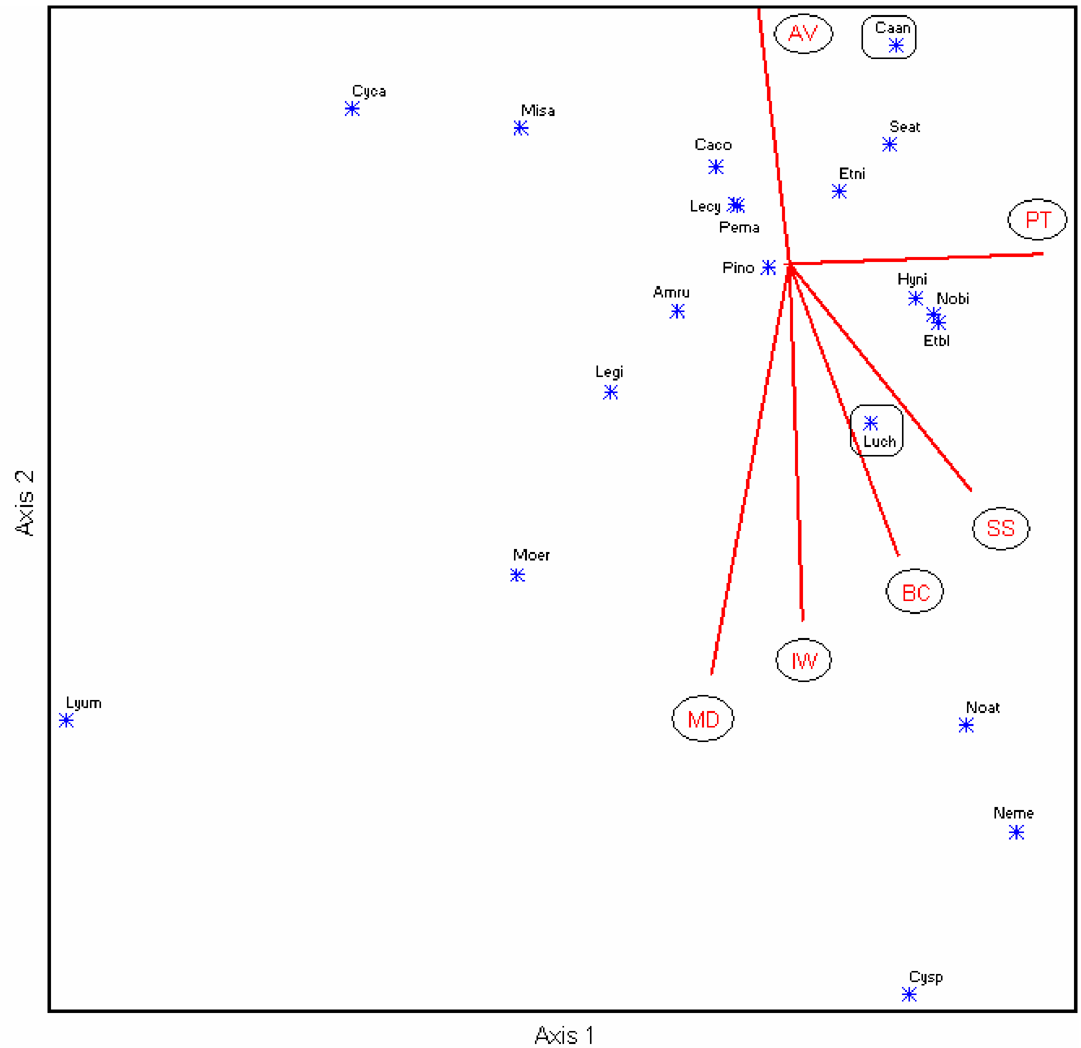
Appendix IV-D. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (lower basin) May-September, 2005. See Table 11 for complete CCA results.



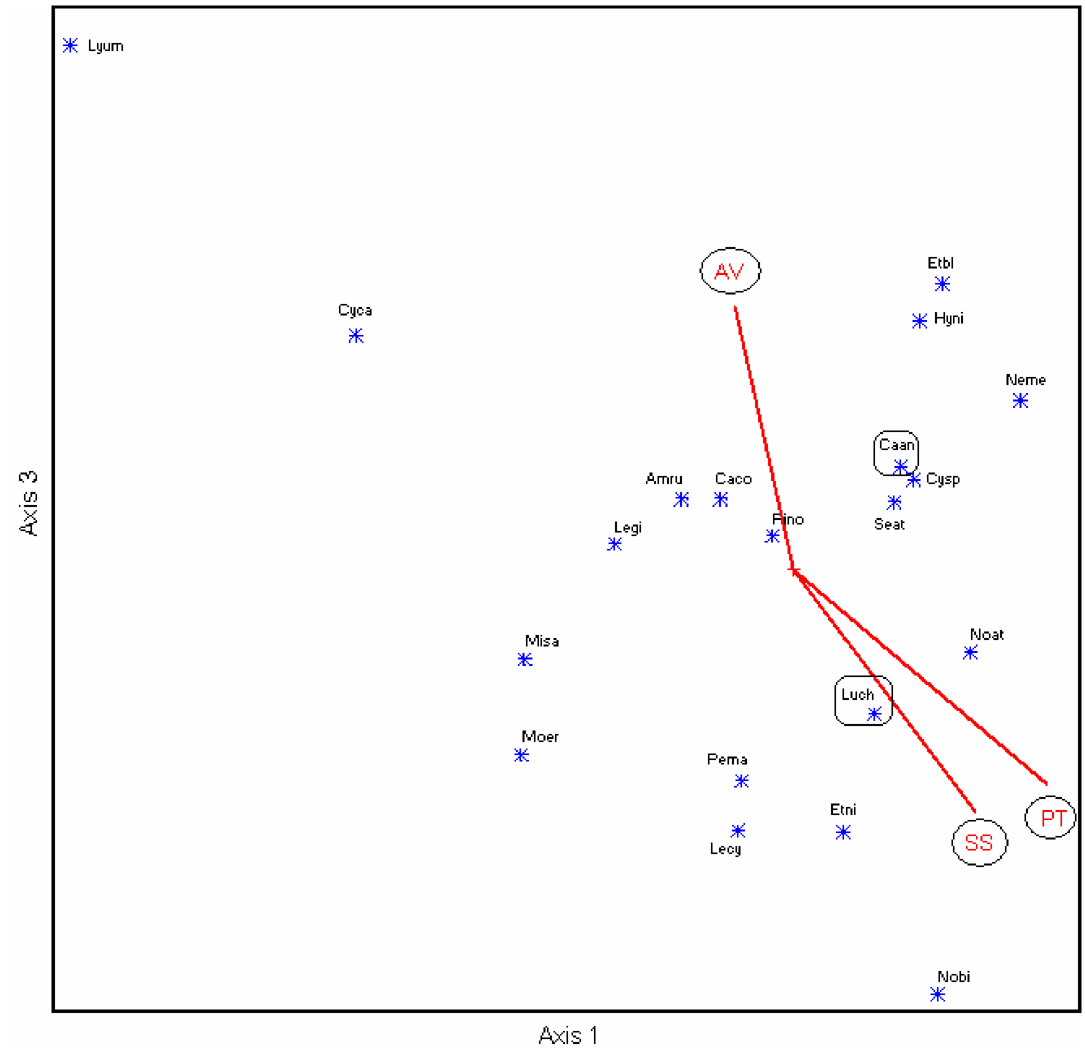
Appendix IV-E. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (lower basin) May-September, 2005. See Table 11 for complete CCA results.



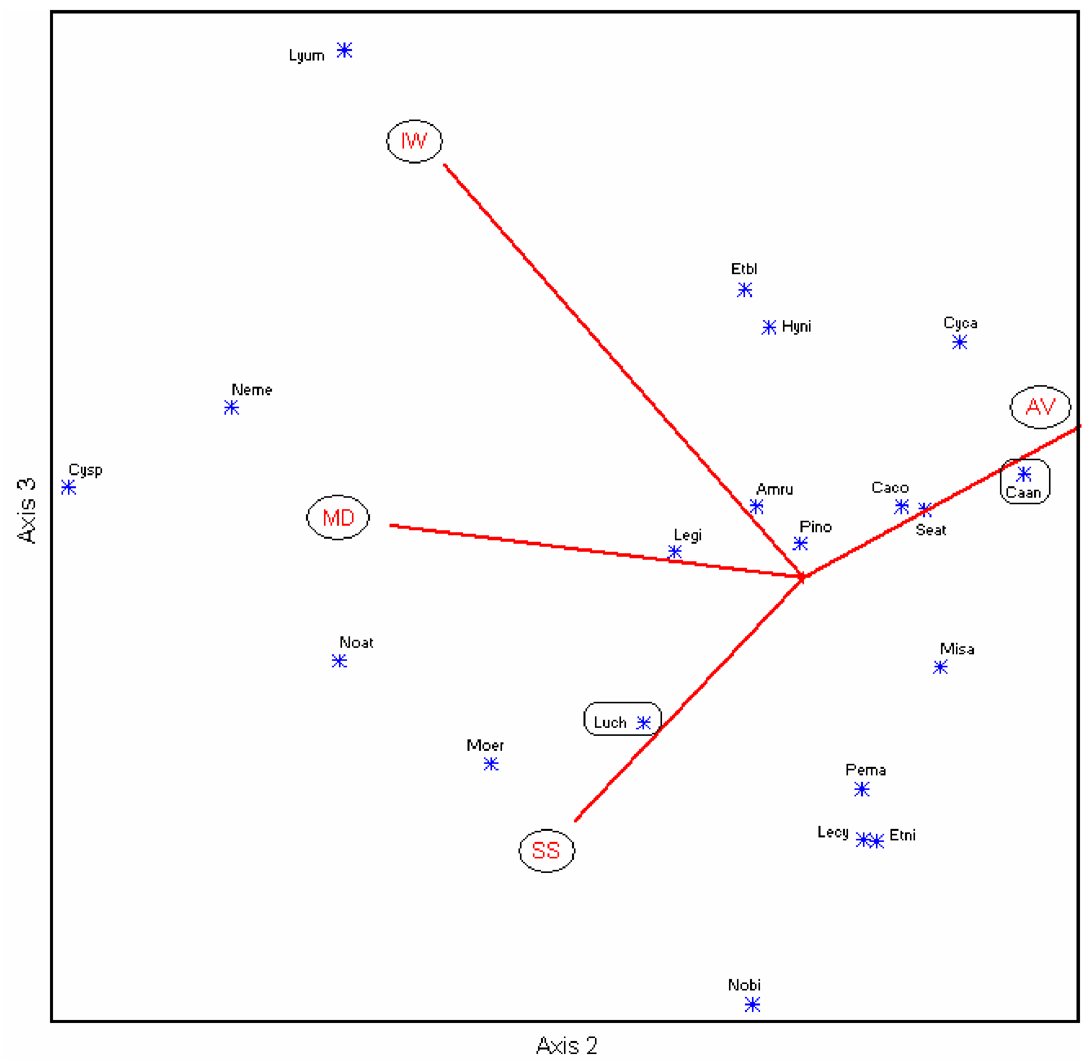
Appendix IV-F. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (lower basin) May-September, 2005. See Table 11 for complete CCA results.



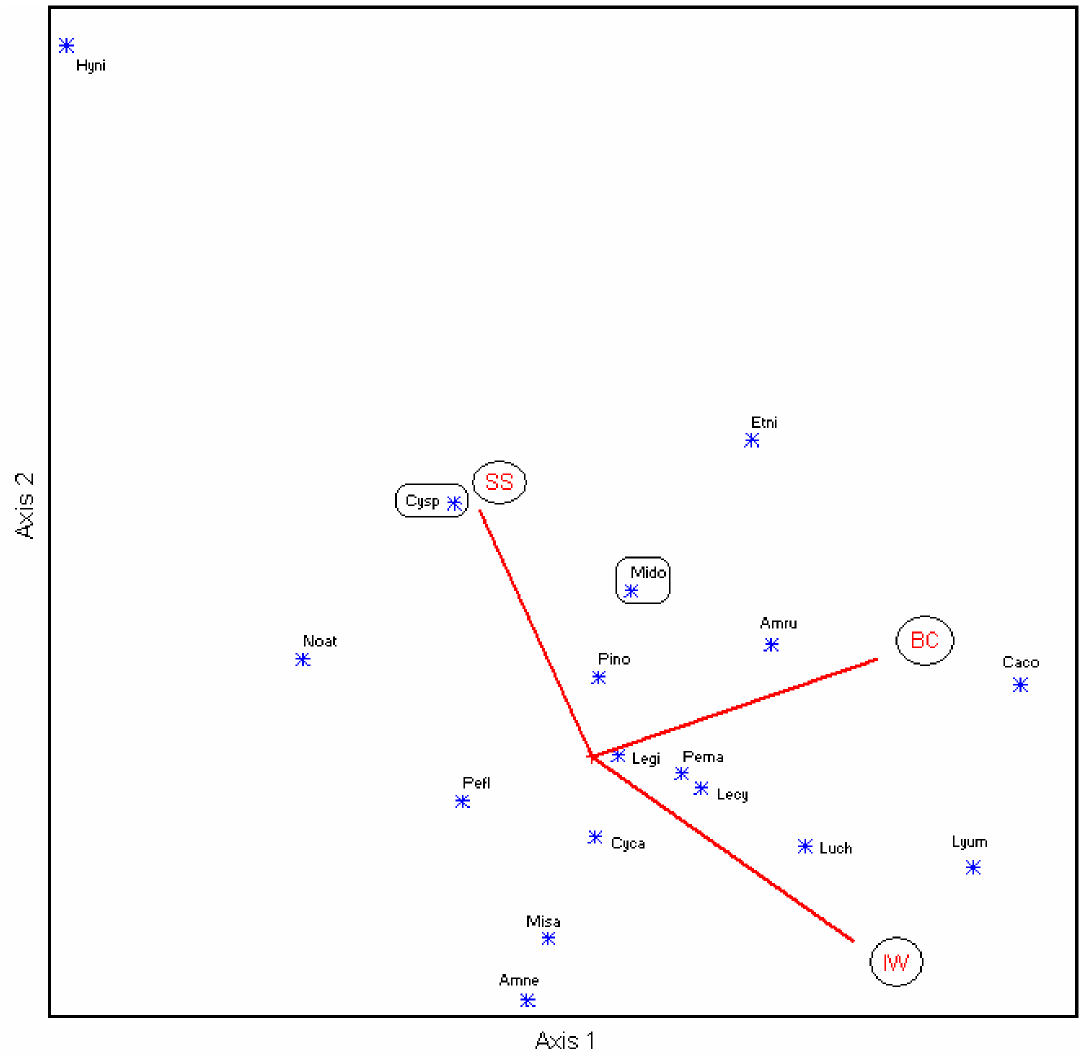
Appendix IV-G. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (upper basin) May-September, 2005. See Table 11 for complete CCA results.



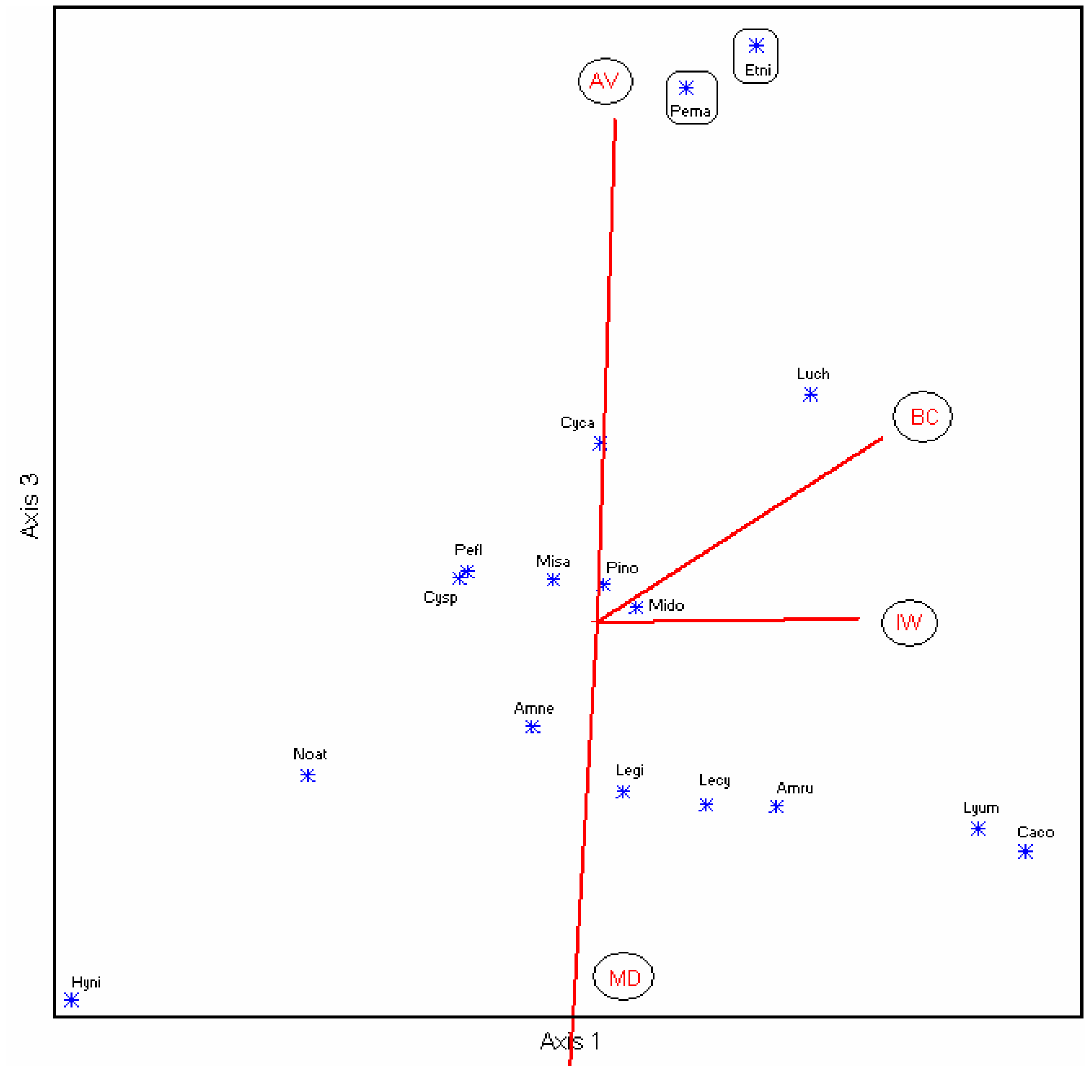
Appendix IV-H. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (upper basin) May-September, 2005. See Table 11 for complete CCA results.



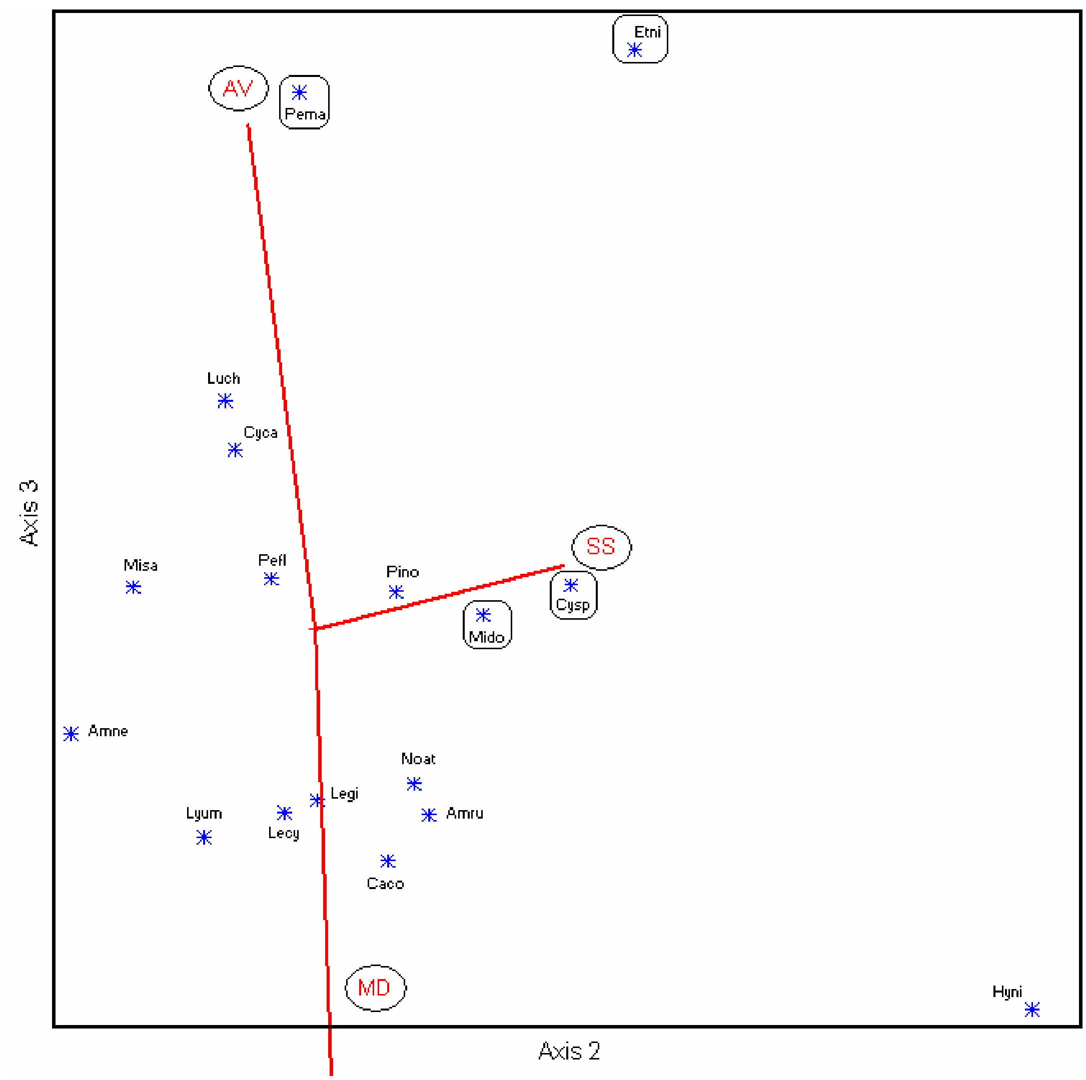
Appendix IV-I. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (upper basin) May-September, 2005. See Table 11 for complete CCA results.



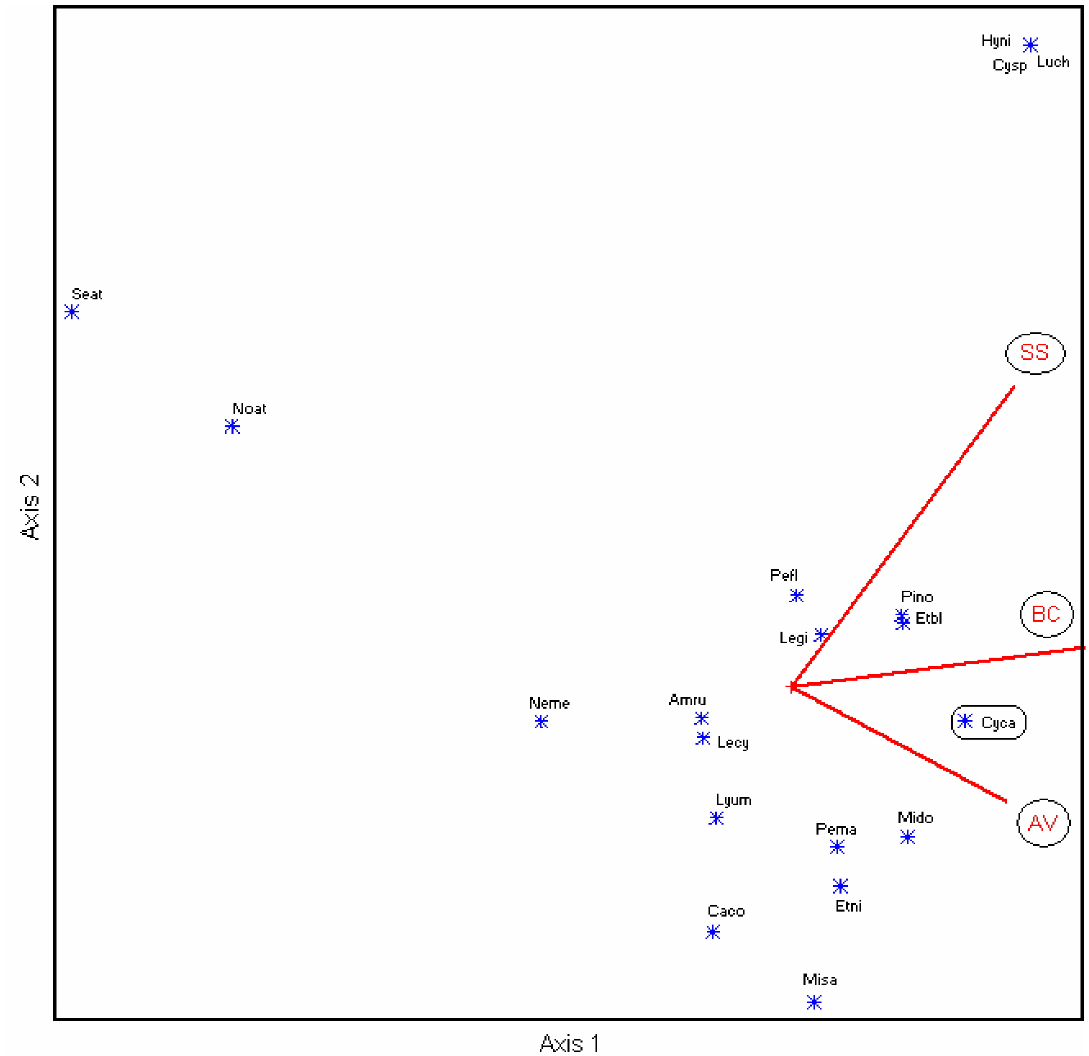
Appendix IV-J. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 1 pools) May-September, 2005. See Table 11 for complete CCA results.



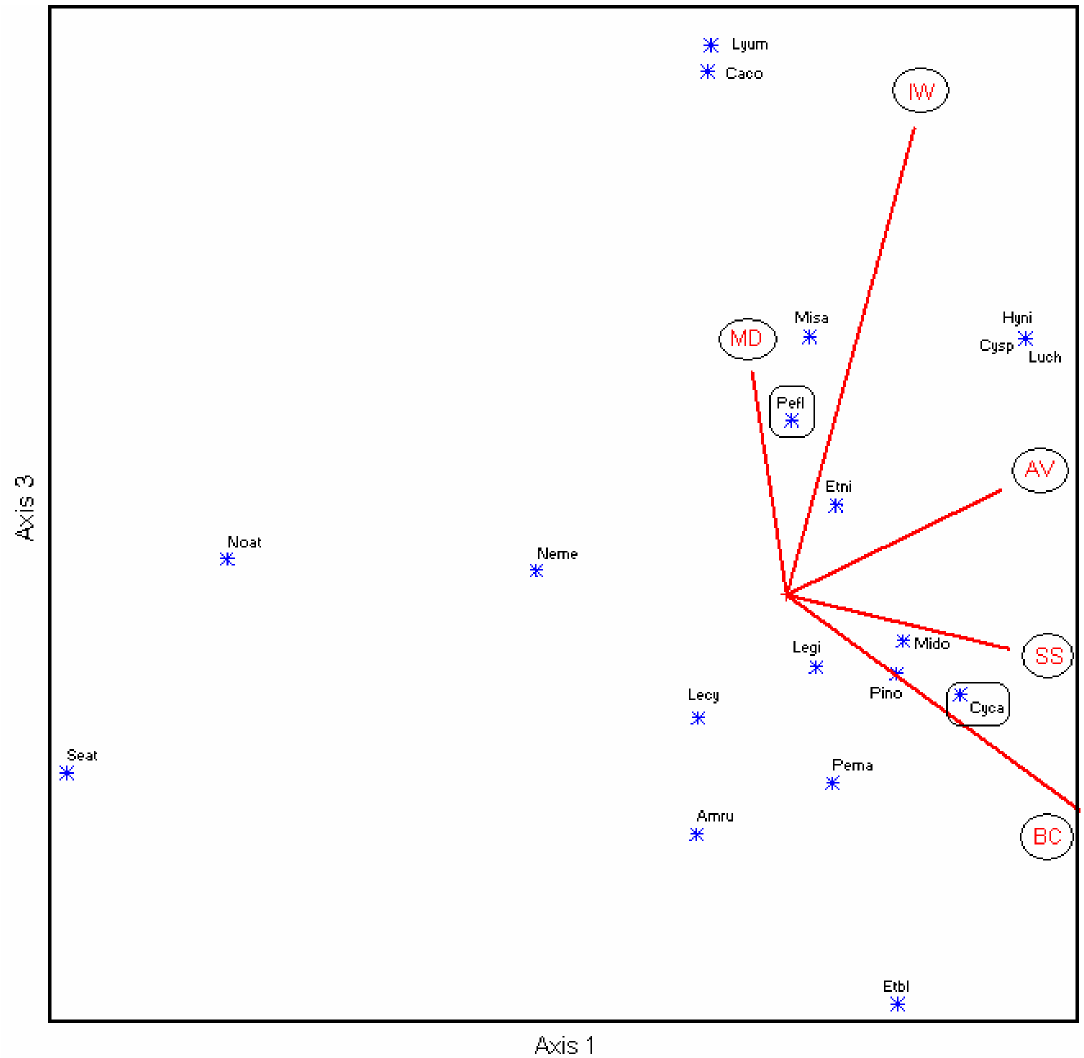
Appendix IV-K. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 1 pools) May-September, 2005. See Table 11 for complete CCA results.



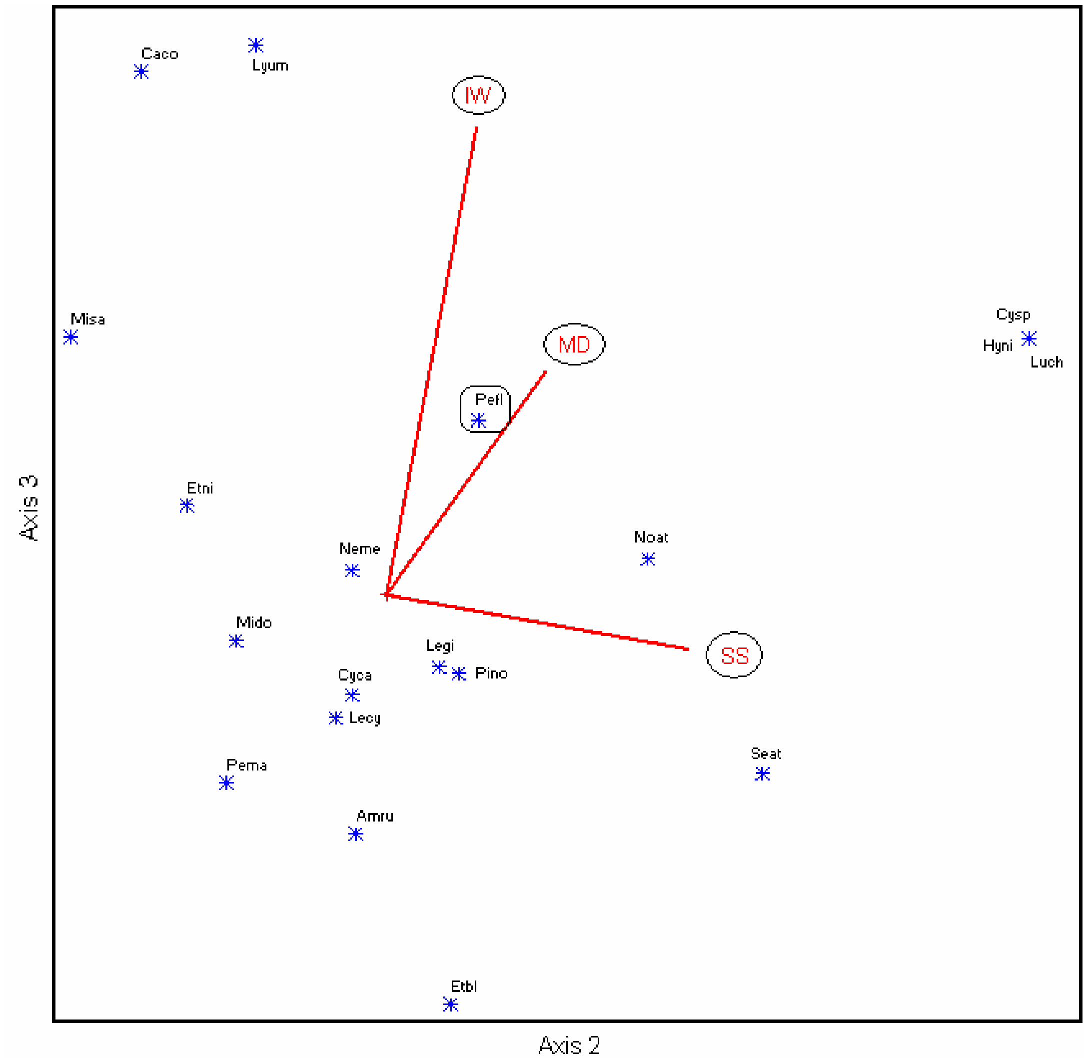
Appendix IV-L. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 1 pools) May-September, 2005. See Table 11 for complete CCA results.



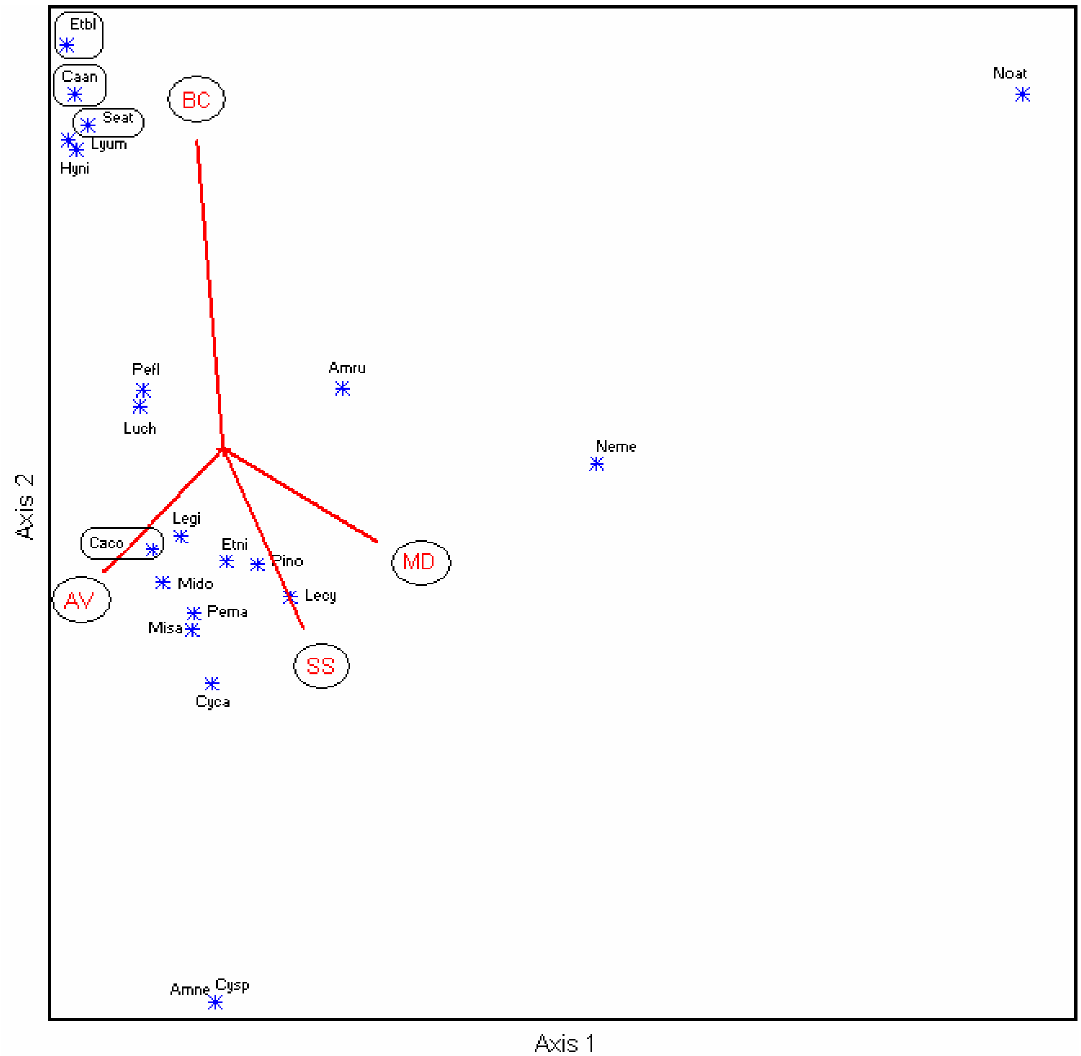
Appendix IV-M. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 2 pools) May-September, 2005. See Table 11 for complete CCA results.



Appendix IV-N. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 2 pools) May-September, 2005. See Table 11 for complete CCA results.

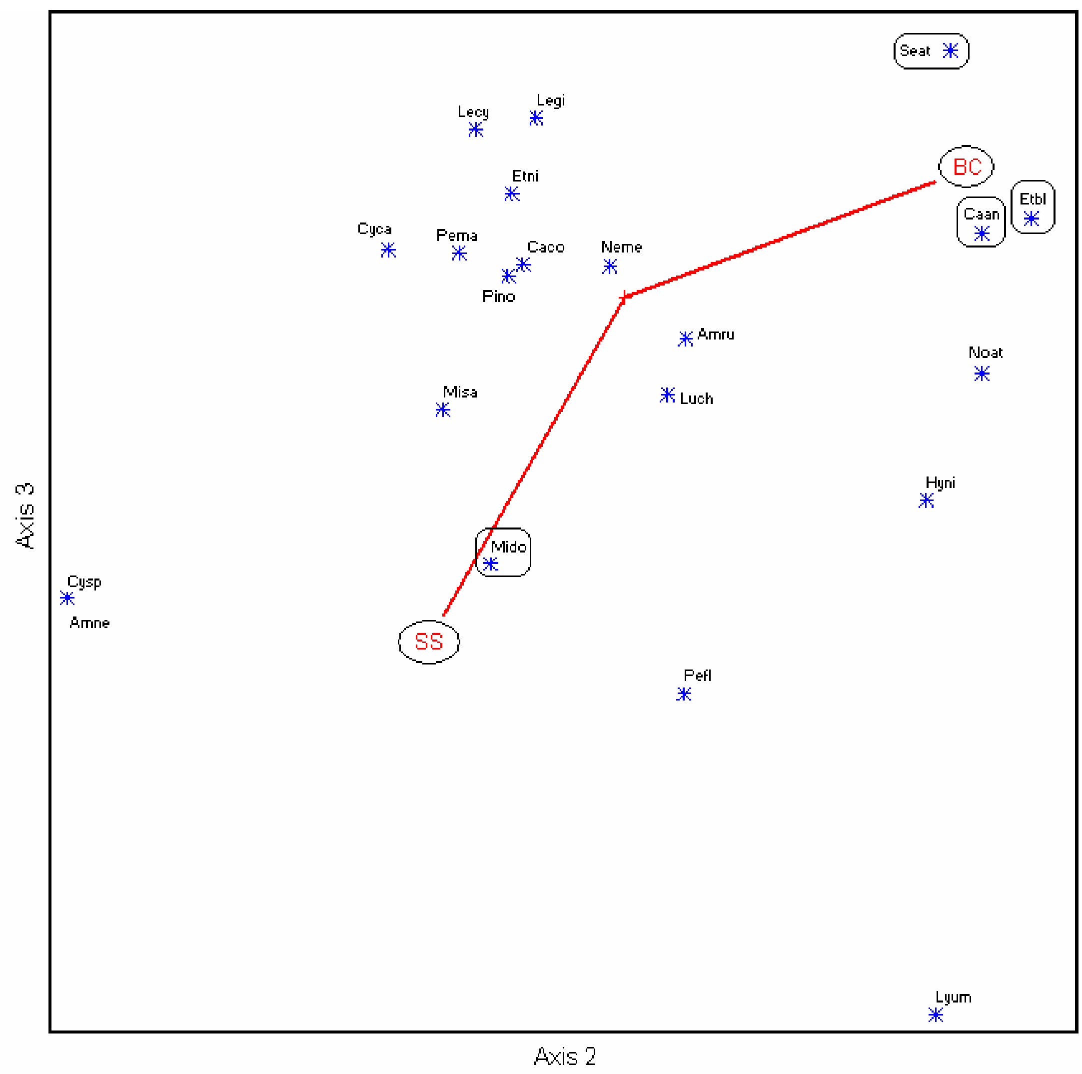


Appendix IV-O. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 2 pools) May-September, 2005. See Table 11 for complete CCA results.

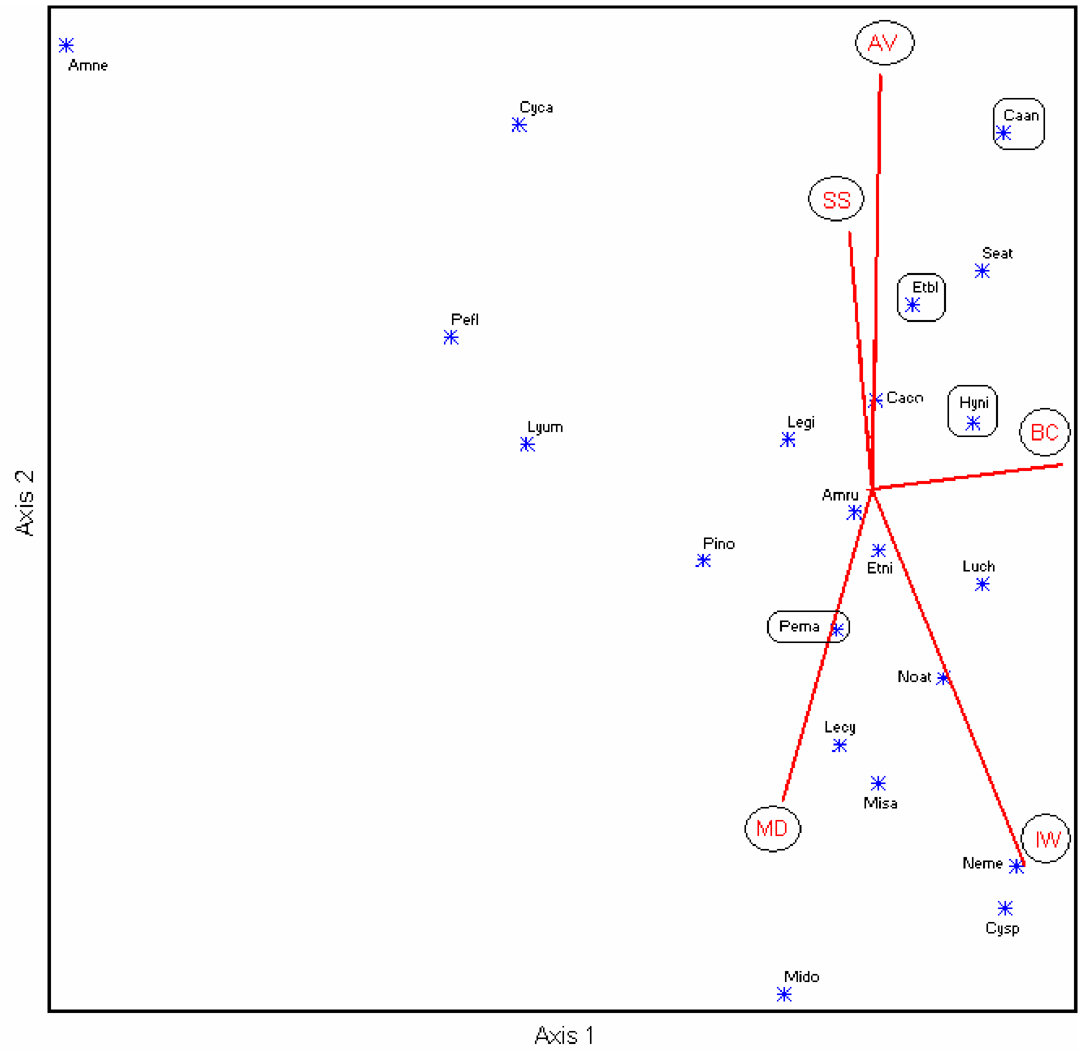


Appendix IV-P. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 3 pools) May-September, 2005. See Table 11 for complete CCA results.

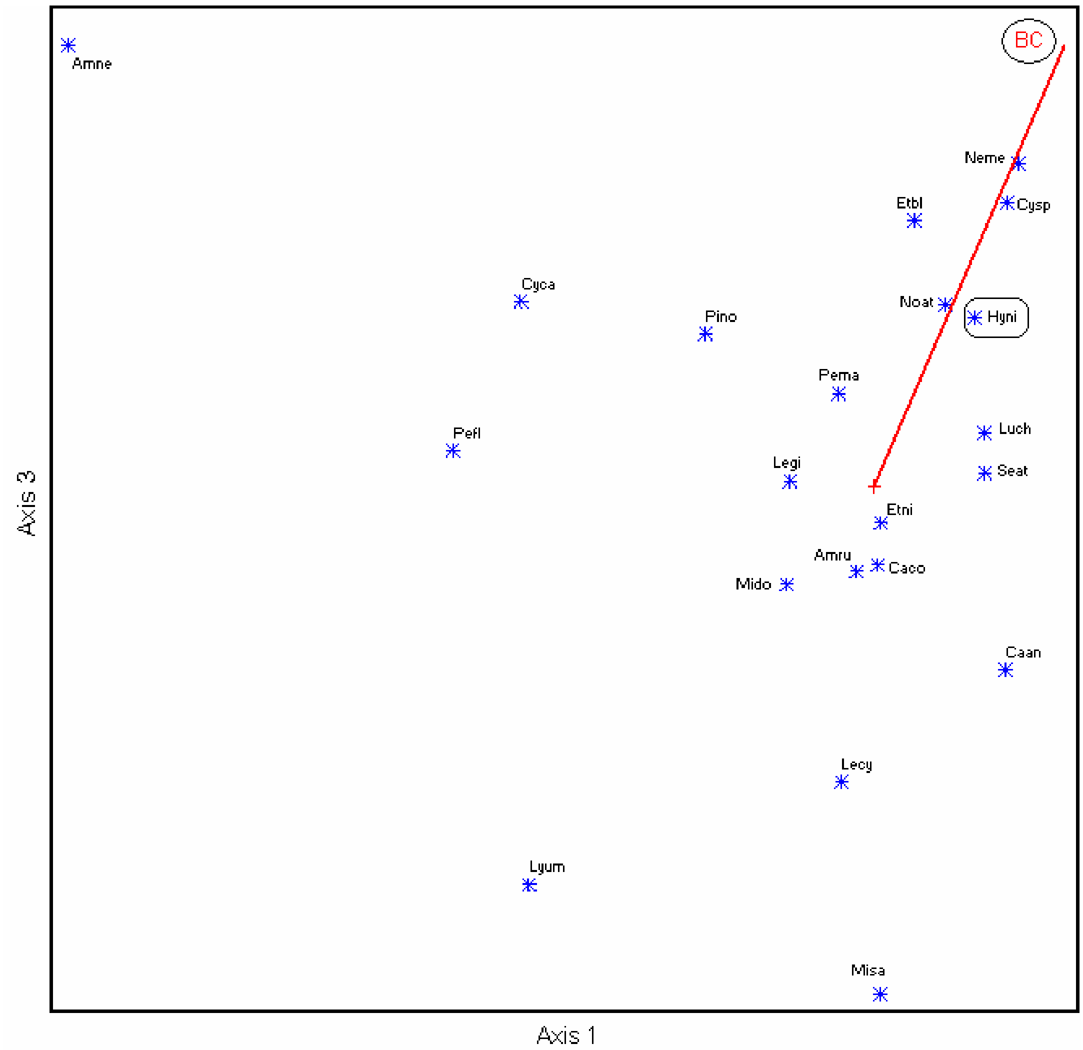
Appendix IV-Q. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 3 pools) May-September, 2005. See Table 11 for complete CCA results.



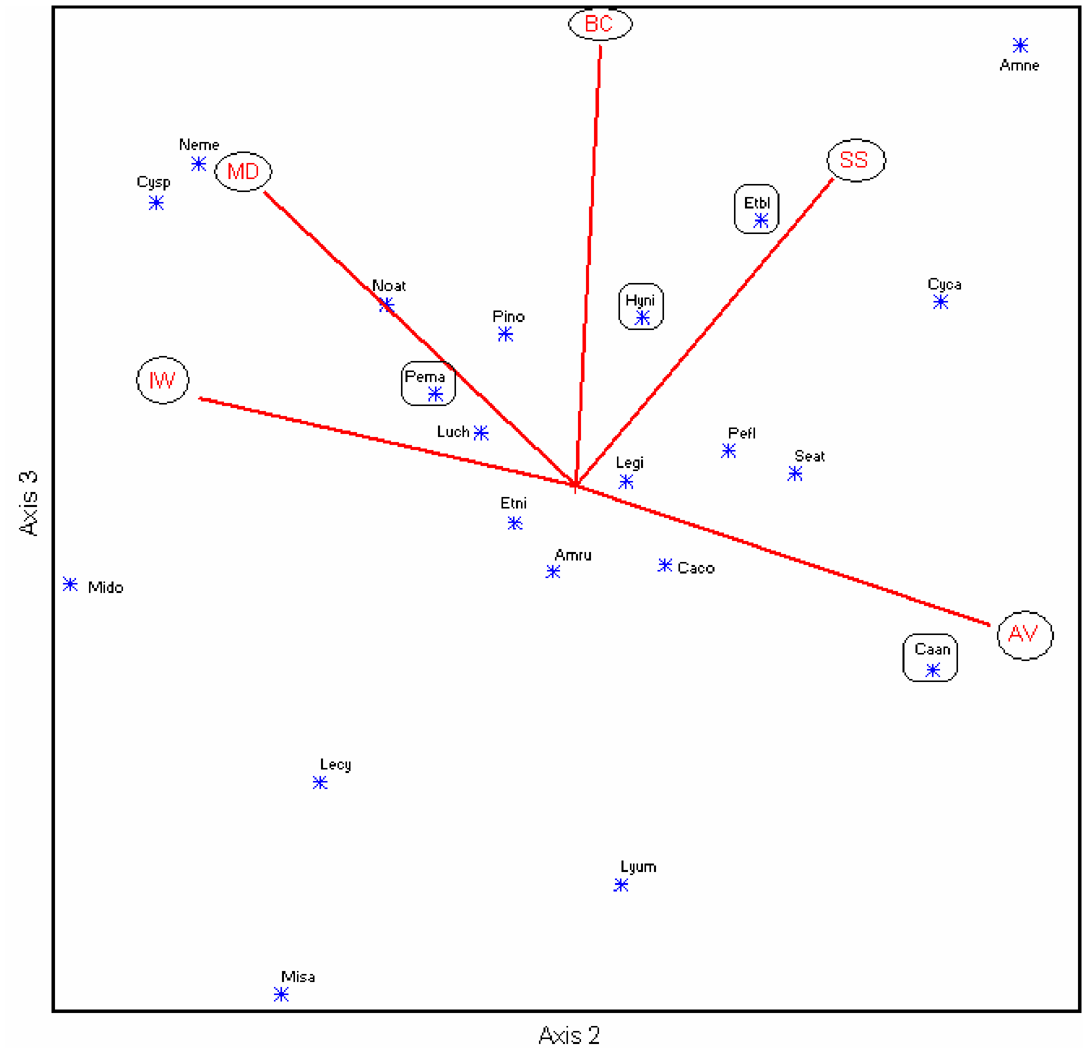
Appendix IV-R. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 3 pools) May-September, 2005. See Table 11 for complete CCA results.



Appendix IV-S. CCA biplot (axes 1-2) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 4 pools) May-September, 2005. See Table 11 for complete CCA results.



Appendix IV-T. CCA biplot (axes 1-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 4 pools) May-September, 2005. See Table 11 for complete CCA results.



Appendix IV-U. CCA biplot (axes 2-3) representing fish species (polygons, Table 6) associated with habitat (vectors, Table 4) in the Johnson Creek watershed (type 4 pools) May-September, 2005. See Table 11 for complete CCA results.