Species at Risk in the
Sydenham River Watershed

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INTRODUCTION

The Sydenham River is a large river system draining a portion of southwestern Ontario into Lake St. Clair. Most of the 2900 km$^2$ watershed (78%) lies within Lambton County, with the remainder divided between Middlesex (15%) and Kent (7%) Counties. The Sydenham River has two main branches. The North Sydenham (which includes Bear Creek) begins near the village of Arkona, and winds through a narrow and shallow valley to the Town of Wallaceburg. The East Sydenham is the longer of the two branches. It arises from the Lucan moraine near Ilderton and meets the North Sydenham at Wallaceburg. About 5 km south of Wallaceburg, the main stem of the river empties into Chenal Ecarté, a channel on the low-lying shore of Lake St. Clair.

The human population within the watershed is small (74,000), with concentrations in the towns of Wallaceburg, Strathroy and Petrolia. There are also several smaller villages adjacent to the river. Forest cover in the catchment is about 12%, with most of the clearing having occurred pre-1900. Most of the land in the watershed is used for agricultural production.

The entire Sydenham drainage area is a plain of low relief resulting in low stream gradients and relatively shallow valleys. Subsurface bedrock in the watershed is dominated by the Kettle Point Formation of bituminous shale overlain with micaceous sandstone. The surface of the watershed is dominated by clay of the Brookstone Series, with the north branch flowing mainly through clay plains and the east branch flowing alternately through clay and sand plains. The clays are highly erodable and consequently there are high levels of suspended fine materials in the river.

The Sydenham River is entirely within the Carolinian Zone with a resultant high biological diversity. There are numerous rare aquatic species that reside in the river, and several of these have been listed as vulnerable, threatened or endangered species at the provincial or national levels. Although some of these species are at the northern end of their range in the Sydenham River and are more common further south, several species are globally rare or uncommon.

This report is one in a series of four background reports for the preparation of a recovery strategy for species at risk in the Sydenham River. It provides a synopsis of the distribution, life history, habitat requirements, and limiting factors for all aquatic species that are at risk (i.e., vulnerable, threatened or endangered) in the watershed. Provincialy rare species (SH, S1, S2) that are not currently listed are also considered. A spatial analysis of the distribution and trends in distribution and abundance are also presented.

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**Mussels**

The Sydenham River maintains a diverse community of freshwater mussels. Thirty-four species of mussels have been reported from the Sydenham River, 30 of these have been found alive in the river since 1997. Five species of mussels have been considered for at risk designation by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). All of these have been designated as endangered. The status, distribution, and ecology of these five mussel species are discussed below. A summary of their ecological requirements is provided in Appendix I.

Significant mussel sampling has been conducted in the Sydenham River using a variety of search methods. The largest sampling effort occurred in the 1990s when the National Water Research Institute conducted systematic surveys for rare mussels in several southern Ontario watersheds (Metcalfe-Smith et al. 1999) (Fig. 1). Earlier sampling was more sporadic, did not provide broad watershed coverage, and employed a variety of search techniques. Only one site on the Sydenham River has quantitative data over a time series (1973, 1991, 1998). Recent surveys by Metcalfe-Smith et al. (1999) have employed the timed search sampling method with a total sampling effort of 4.5 person-hours per site. This intensive sampling method increases diversity at each site sampled, and increases the probability of encountering rare mussels.

**Northern Riffleshell (*Epioblasma torulosa rangiana*) - Endangered**

The northern riffleshell is a small, colourful, sexually-dimorphic freshwater mussel. *Epioblasma t. rangiana* is a rare subspecies. Although occasionally abundant, it is usually a minor component of the unionid community. The northern riffleshell has suffered dramatic declines in North America over the past century, with the current distribution representing a range reduction of more than 95%.

*Distribution and Status* - The northern riffleshell was historically known from AL, IL, IN, KY, MI, OH, PA, TN (questionable records), WV, and Ontario (USFWS 1993). Although the subspecies has never been found in NY, it is believed to have occurred there at one time since it was found in two rivers only a few kilometres from the NY border (Strayer and Jirka 1997). It was found throughout the Ohio River drainage in rivers such as the Ohio, Allegheny, Scioto, Kanawha, Little Kanawha, Licking, Kentucky, Wabash, White, Vermilion, Mississinewa, Tippecanoe, Tennessee, Green and Salt (USFWS 1993). In the Great Lakes drainage, it was found in the Maumee River basin and tributaries to western Lake Erie such as the Huron River and the River Raison (USFWS 1993). It also occurred in southern Michigan in the Black River and Elk Creek tributaries of the St. Clair River (Hoeh and Trdan 1985). In Canada, it was historically known from western Lake Erie and the Detroit River (museum records), Lake St. Clair (LaRocque and Oughton 1937), and the Sydenham River (Clarke 1973) in southwestern Ontario. A previously unknown population was discovered in the Ausable River, a tributary to lower Lake Huron, in 1998 (Metcalfe-Smith et al. 1999).

In the United States, *E. t. rangiana* is listed as Federally Endangered and is protected under the Endangered Species Act (USFWS 1994). The northern riffleshell is also listed as endangered in five states (OH, IL, IN, KY, and MI) and Proposed Endangered in PA, and is therefore afforded...
The northern riffleshell is very rare globally (G2) and is listed as Federally Endangered in the United States.
protection in these states. The northern riffleshell is currently being considered for status designation in Ontario by the Committee On the Status of Species At Risk in Ontario (COSSARO) and, if approved, would receive provincial protection. This species was listed as endangered in Canada by COSEWIC in 1999.

The northern riffleshell was first collected from the East Sydenham River in 1963 by H.D. Athearn (Clarke 1973). Between 1965 and 1973, live specimens and/or fresh shells were collected from three sites in the East Sydenham River (C.B. Stein, personal communication, September 1997). After 1973, several surveys were conducted in the Sydenham River, but the northern riffleshell was not found alive. Metcalfe-Smith et al. (1998, 1999) surveyed 17 sites on the Sydenham River in 1997 and 1998 including four sites that were known to support this species in the past. According to the results of these surveys, the current range of *E. t. rangiana* extends over a 50 km stretch of the East Sydenham River. A total of 26 live animals numbering 2-11 individuals/site were encountered at six of seven sites surveyed within this reach. Fresh shells were found at the seventh site and at another site 5 km upstream of the reach. Five sites were also surveyed on the North Sydenham River (Bear Creek) in 1997-1998. The northern riffleshell was not found at any of these sites, nor had it been in the past. It appears that the current distribution of *E. t. rangiana* in the Sydenham River is essentially the same as the historical distribution, however, there is evidence to suggest that abundance has declined.

*Habitat* - It is widely accepted that the northern riffleshell lives mainly in highly oxygenated riffle areas of rivers (Ortmann 1919, as cited in USFWS 1993; Clarke 1981; Cummings and Mayer 1992). The preferred substrate has been described as rocky and sandy bottoms (Clarke 1981), and as firmly packed sand and fine to coarse gravel (Cummings and Mayer 1992). Recent observations in the Sydenham River confirmed these claims: all live animals encountered in 1997 and 1998 were found in stable substrates of coarse sand to fine gravel in shallow (generally <30cm), flowing waters in or near riffles. This subspecies is purported to occur in streams of various sizes, from small to medium (Ortmann 1919, as cited in USFWS 1993; Stansbery et al. 1982) and medium to large (Cummings and Mayer 1992).

*General Biology* - Although the specific biology of *E. t. rangiana* is not well known, general unionid biology is applicable. The northern riffleshell tends to live for 15 years or more (USFWS 1993). Mature individuals have been reported to vary in shell length from 45 to 76 mm. It is not known at what age reproductive maturity is reached or when it ends (USFWS 1993). Although hermaphroditic individuals have been encountered for many unionid species (Kat 1983), this condition has not been detected in *E. t. rangiana* (USFWS 1994). The northern riffleshell is a long term brooder (bradytictic), with a gravid period extending from late summer to the following spring (Ortmann 1919, as cited in USFWS 1993; Clarke 1981). Until recently, the glochidial fish hosts for *E. t. rangiana* were completely unknown. However, Watters (1996) has now identified four species of fish that serve as hosts in the United States: the bluebreast darter (*Etheostoma camurum*), banded darter (*Etheostoma zonale*), banded sculpin (*Cottus carolinae*), and brown trout (*Salmo trutta*). None of these species are native to Ontario, thus, the endemic fish host(s) for Canadian populations of the subspecies remain unknown. Brown trout were introduced into Ontario in 1913 (Scott and Crossman 1973), and may now serve as hosts. Darters and sculpins are frequently associated with *Epioblasma* species (G.T. Watters, Ohio State University, personal communication, June 1998). An analysis of ten species of darters suggests
that the johnny darter (*Etheostoma nigrum*) and blackside darter (*Percina maculata*), are the most likely hosts (Mackie et al. 2000). The eastern sand darter (*Ammocrypta pellucida*) is also a possibility.

**Limiting Factors in the Sydenham River** - Siltation is probably the most immediate threat to *E. t. rangiana* in the Sydenham River, although eutrophication and pesticide inputs may also be significant factors. Predation by muskrats, *Ondatra zibethicus*, is also a potential limiting factor. Although it is difficult to assess the impact of muskrat predation on Ontario populations of *E. t. rangiana* without further investigation, some anecdotal information exists. During her 1973 visit to the Sydenham River, C.B. Stein (personal communication, September 1997) reported finding a “…midden heap consisting mainly of fine fresh *Epioblasma torulosa rangiana* shells!” - 32 fresh whole shells in all. Regardless of whether *E. t. rangiana* is preferred by muskrats or not, it is conceivable that muskrat predation could be a contributing factor to the decline in abundance of the subspecies in the Sydenham River. At the present low densities, any level of predation could jeopardize its continued existence.

**Wavy-rayed Lampmussel (Lampsilis fasciola) - Endangered**

The wavy-rayed lampmussel, *Lampsilis fasciola*, is a medium-sized freshwater mussel. It was once widely distributed (although uncommon) throughout the Ohio and Mississippi drainages and tributaries to the lower Great Lakes, but has declined significantly in recent years.

**Distribution and Status** - The wavy-rayed lampmussel was historically known from NY (Strayer and Jirka 1997), AL, GA, IL, IN, KY, MI, NC, OH, PA, TN, VA, WV, and Ontario (Williams et al. 1993). It was found throughout the Ohio and Mississippi River drainages, as far south as the Tennessee River system (Clarke 1981). In the Great Lakes basin, it occurred in tributaries of Lake Michigan, lower Lake Huron, Lake St. Clair, and Lake Erie (Clarke 1981). According to Strayer et al. (1991) and Strayer and Jirka (1997), it also inhabited the Niagara River, tributaries to Lake Ontario, and the upper Allegheny drainage in western NY. In Canada, *L. fasciola* occurred in western Lake Erie, Lake St. Clair, and the Maitland, Sydenham, Thames, Detroit, and Grand Rivers. It was discovered in the Ausable River, a tributary to lower Lake Huron, in 1993 (Morris and Di Maio 1998).

*Lampsilis fasciola* is globally common (G4) and is not federally listed in the United States. However, it is listed as endangered in IL, threatened in MI, proposed for listing as threatened in NY, and designated as of special concern or interest in IN, OH, and NC, and is therefore afforded protection in these states. The wavy-rayed lampmussel is currently being considered for status designation in Ontario by COSSARO. This species was listed as endangered in Canada by COSEWIC in 1999.

*Lampsilis fasciola* was first recorded from the Sydenham River about 30 years ago. Four fresh whole shells were collected in the East Sydenham River in 1965 by C.B. Stein, who also collected two live animals and eight fresh whole shells in 1967 (museum records). The species was also found in the East Sydenham River in 1967 by H.D. Athearn (personal collection), but he did not indicate if the specimens were dead or alive. The first extensive survey of the Sydenham River was conducted in 1971 by Clarke (1973). He visited 11 sites and observed one
live specimen of *L. fasciola*. Mackie and Topping (1988) surveyed 20 sites in the system in 1985 and reported dead shells only at an undisclosed number of sites on the North Sydenham River. In a further investigation of 16 sites in 1991, Clarke (1992) found no trace of this species. Metcalfe-Smith et al. (1998, 1999) surveyed 17 sites on the Sydenham River in 1997-98, including the four sites where *L. fasciola* had been observed between 1963 and 1971. No live specimens were found at any site, but three fresh whole shells were found at two sites. Although the data are very limited, they suggest that the species has either been lost from the Sydenham River or its range has contracted.

**Habitat** - According to Clarke (1981) and Cummings and Mayer (1992), the wavy-rayed lampmussel lives mainly in gravel or sand bottoms of riffle areas in medium-sized streams. Strayer and Jirka (1997) reported that *L. fasciola* typically lives in and around riffles in clear, hydrologically stable (i.e., having steady flows and stable substrates) rivers and large creeks. In southeastern MI, Strayer (1983) reported this species as occurring in medium-sized and large streams on the outwash plains. Such streams are characterized by low gradients, clear water, steady flows, and substrates of sand and gravel. Dennis (1984) found that *L. fasciola* was typical of small to medium-sized streams. *Lampsilis fasciola* was found to “…commonly inhabit muddy gravel substrates in areas of moderate to slow current, and will tolerate some silt deposition during periods of low flow.” (Dennis 1984). Habitats in Ontario where *L. fasciola* were found alive in 1997-1998 were generally characterized as clean sand/gravel substrates, often stabilized with cobble or boulders, in steady currents at depths of up to 1 metre.

**General Biology** - Although the specific biology of *L. fasciola* is not well known, general unionid biology is applicable. The wavy-rayed lampmussel is a medium-sized, sexually dimorphic mussel that has been shown to live at least 10 years (Kidd 1973; Dennis 1984), but rarely more than 20 years (G.T. Watters, Ohio State University, personal communication, June 1998). *Lampsilis fasciola* is a long-term brooder (bradytictic). Spawning occurs in August, and glochidia (larvae) are released the following May through August in VA (Zale and Neves 1982) and July through August in Canada (Clarke 1981). Glochidia may also be released in the autumn of the same year that they spawn (Watters and O’Dee 1996). The only known fish hosts for *L. fasciola* are the smallmouth bass, *Micropterus dolomieu* (Zale and Neves 1982), and largemouth bass, *Micropterus salmoides* (G.T. Watters, Ohio State University, unpublished data), both of which are common in the waters of southern Ontario. As *L. fasciola* generally inhabits gravel or sand bottoms of the riffle areas of medium-sized streams, the smallmouth bass is most likely the functional host for this mussel in Ontario waters.

**Limiting Factors in the Sydenham River** - It is puzzling that the wavy-rayed lampmussel is doing poorly in the Sydenham. We speculate that *L. fasciola* may have a critical requirement for clear water during reproduction, as the female must rely on good visibility in order to attract a sight predator such as the smallmouth bass with her lure. Water clarity may become the most significant factor limiting the distribution of this species in the Sydenham River.
**Rayed Bean (**Villosa fabalis***) - Endangered

The rayed bean, *Villosa fabalis*, is a very small freshwater mussel. Although population trends are difficult to quantify due to a lack of numerical data, the species is generally recognized to have significantly declined throughout its range in recent years.

**Distribution and Status** - The rayed bean was historically known from AL, IL, IN, KY, MI, NY, OH, PA, TN, VA, WV, and Ontario. *Villosa fabalis* was once widely but discontinuously distributed throughout the Ohio and Tennessee River systems, including the Wabash, Monongahela, Elk, Allegheny, Green, Rouge, Clinch, Powell, North Fork Holston, and Duck Rivers. It also occurred in western Lake Erie and its tributaries, including the Maumee River, and in tributaries to the St. Clair River and Lake St. Clair such as the Pine River (Hoeh and Trdan 1985) and the Clinton River (Strayer 1980). A previously unknown population was recently discovered in the Belle River, MI (J.B. Layzer, U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Tech University, Cookeville, TN, personal communication, April 1999). The eastern most records for this species are those from western NY (Strayer et al. 1991). In Canada, *V. fabalis* was known from the Detroit River, the Sydenham and Thames Rivers in the Lake St. Clair drainage, and western Lake Erie (LaRocque 1953; Clarke 1981). The Sydenham River supports the only known population of *V. fabalis* remaining in Canada.

The rayed bean is extremely rare globally (G1G2) and was previously listed as a Category 2 Federal Candidate under the U.S. Endangered Species Act (Cummings and Mayer 1992), however, maintenance of this list was discontinued in 1996 (Roth 1997). Category 2 species were defined as those species for which there was some evidence for vulnerability, but not enough data for them to be listed as Endangered or Threatened (Cummings and Mayer 1992). Because state and local governments are no longer asked to take Category 2 candidates into account in their environmental planning, this change in listing procedures will significantly weaken the protection of *V. fabalis* in the United States (Roth 1997). The rayed bean is afforded state protection in AL, IN, KY, MI, and OH, where it is currently listed as endangered or of special concern. *Villosa fabalis* has also been proposed for endangered status in NY (D.L. Strayer, Institute of Ecosystem Studies, Millbrook, NY, personal communication, June 1998). The rayed bean is currently being considered for either Endangered or Threatened status by COSSARO. This species was listed as endangered in Canada by COSEWIC in 1999.

The rayed bean was first collected alive from the East Sydenham River in 1963 by H.D. Athearn (Clarke 1973). It was subsequently found alive in 1965 and (C.B. Stein, personal communication, September 1997). Athearn reported it from another site in the East Sydenham River in 1967, but did not say if it was found alive. Stein surveyed two sites in 1973, namely, her 1965 site and a new site, and found only one fresh valve at each location. Clarke (1992) sampled the river in 1991, and found a single specimen of *V. fabalis* at a site in the East Sydenham River. A few weathered valves were also collected from this site by Oldham (personal records) in 1991 and 1992. Metcalfe-Smith et al. (1998, 1999) surveyed 17 sites on the Sydenham River in 1997 and 1998 and five sites that were known to support this species in the past were targeted. Based on the presence of live specimens, the current range of *V. fabalis* in the East Sydenham River extends over a distance of approximately 45 km. A total of 15 live animals numbering 1-6 individuals/site were encountered at five of seven sites within this reach, and a few fresh shells were found at a sixth site. Several fresh shells were also taken from two sites above and one site...
below the reach. If fresh shells are taken to indicate the presence of live animals at perhaps lower densities, the range of *V. fabalis* expands to 65 km. As only one of the 12 sites surveyed for mussels on the main branch of the East Sydenham River was outside of this reach, it is possible that the species may occur further upstream. However, there is no mussel habitat in the lower portion of the East Sydenham River, where water levels fluctuate with the levels in Lake St. Clair. The current range of *V. fabalis* in the Sydenham River has changed little over time, however, there is some evidence to indicate that abundance may have declined.

**Habitat - Villosa fabalis** tends to inhabit the headwaters and smaller tributaries of river systems, where it is found in or near riffle areas (TNC 1987). Cummings and Mayer (1992) describe its habitat as “Lakes and small to large streams in sand or gravel”. It is occasionally reported from shallow water areas of lakes (TNC 1996) and large rivers. In southeastern MI, Strayer (1983) found it to be scattered in the lower courses of rivers and medium-sized streams on the outwash plains. Such streams are characterized by low gradients, clear water, steady flows, and substrates of sand and gravel. The rayed bean is usually found deeply buried in the substrate, among the roots of aquatic vegetation. As a result, this species may not be as sensitive to flow rate fluctuations in its habitat as some other mussel species (TNC 1987). Live specimens encountered in the Sydenham River during recent surveys (Metcalfe-Smith et al. 1998, 1999) were found buried in stable substrates of sand or fine gravel, generally in low flow areas along the margins of the river or the edges of small islands.

**General Biology** - Although specific information regarding the biology and ecology of *V. fabalis* is limited, general unionid biology is applicable. *Villosa fabalis* is reported to be a long term brooder (bradytictic) that holds its glochidia over winter for spring release (Ortmann 1909, as cited in TNC 1987). Only one fish host, the Tippecanoe Darter (*Etheostoma tippecanoe*), is known for *Villosa fabalis* (G.T. Watters, Ohio State University, personal communication, November 1997). As this species of fish is not found in Canada, the host fish for *V. fabalis* in this country is presently unknown. An analysis of nine species of darters suggests that the greenside darter (*Etheostoma blenniodes*), johnny darter (*Etheostoma nigrum*), and blackside darter (*Percina maculata*) are the most likely hosts in Ontario (Mackie et al. 2000).

**Limiting Factors in the Sydenham River** - Siltation is probably the most immediate threat to *V. fabalis* in the Sydenham River, but eutrophication and pesticide inputs may also be significant factors. Metcalfe-Smith et al. (1998, 1999) found that water clarity (measured as maximum depth at which the stream-bed was clearly visible) was poor in 1997-98, averaging 23 cm for all sites and 19 cm for the sites where *V. fabalis* was found alive, indicating heavy suspended sediment loadings to the system.

**Snuffbox (Epioblasma triquetra) - Endangered**

The snuffbox is a small, sexually dimorphic species of freshwater mussel that is not closely similar to any other mussel in Canada. The distribution of *E. triquetra* has been significantly reduced throughout its range, and most populations have become small and geographically isolated from one another. It is no longer found in 60% of formerly occupied streams in the United States.
Distribution and Status - The snuffbox is the most widely distributed member of the genus *Epioblasma*. Historically, it was found in AL, AR, IL, IN, IA, KS, KY, MI, MN, MS, MO, NY, OH, PA, TN, VA, WV, WI, and Ontario (TNC 2000a). It was known to occur throughout the Ohio-Mississippi River system, and in the Great Lakes system in Lake Erie, Lake St. Clair, and tributaries to lakes Erie, St. Clair, Huron, and Michigan. The snuffbox is believed to be extirpated from IA and KS (TNC 2000a), and has not been recorded from NY since 1950 (Strayer and Jirka 1997). There are 31 known historical records for *E. triquetra* from Lake Erie, Lake St. Clair, and the Ausable, Sydenham, Thames, Grand, and Niagara rivers.

*Epioblasma triquetra* is listed as endangered in IL, IN, MI, MS, OH, VA, and WI, threatened in MN, and “state-listed” (no specific status) in AL. The Nature Conservancy has assigned it a Global Rank of G3 (rare and uncommon globally), and an SRANK of S1 in ten states (TNC 2000a). The American Fisheries Society lists it as threatened in North America (Williams et al. 1993). The snuffbox was designated as endangered by COSEWIC in 2001. Until recently, *E. triquetra* was ranked SH (historical; no occurrences verified in the past 20 years) in ON by the NHIC (D.A. Sutherland, NHIC, pers. comm., December 1996). Its SRANK in Ontario has been revised to S1 based on the rediscovery of this species in the Sydenham River (TNC 2000a; D.A. Sutherland, NHIC, pers. comm., September 1999).

*Epioblasma triquetra* was first reported from the East Sydenham River by H.D. Athearn in 1963 with one live animal taken. He revisited this site in 1967 and reported another occurrence, but did not indicate if the specimen(s) were found alive or dead. Dr. C.B. Stein surveyed a site in the East Sydenham River in 1965 and found 4 live specimens and revisited the site in 1973 and found only one fresh whole shell. Mackie and Topping (1988) surveyed the same site in 1985, and found only a few weathered shells (J.L. Metcalfe-Smith, personal observation of the specimens deposited in the Canadian Museum of Nature). Stein also surveyed a downstream site in 1973, where she found one live animal. Metcalfe-Smith et al. (1998, 1999) surveyed 17 sites on the Sydenham River in 1997-1998, and made supplementary collections at several of these sites in 1998 and 1999. They visited the three sites where *E. triquetra* had been found historically, as well as 3 other sites within this reach. A total of 7 live specimens, 2 fresh whole shells, 1 fresh valve and 7 weathered valves were found at 7 different sites on the East Sydenham River. Most specimens were found in the historically occupied reach, but one live animal and one fresh shell were found further upstream. No specimens were found at the 5 sites surveyed on the north branch of the Sydenham River (Bear Creek), nor had the snuffbox been previously reported from this drainage. These findings suggest that the distribution of *E. triquetra* in the Sydenham River has not changed appreciably over time. However abundance data seems to suggest that the snuffbox has suffered a decline in abundance over time in the Sydenham River. The snuffbox is now restricted to several small populations in the Sydenham River.

Habitat - *Epioblasma triquetra* is typically found in riffle areas or shoals (runs) in small- to medium-sized rivers and streams (e.g., van der Schalie 1938, Dennis 1984). Its substrate preference has been variously described as stony and sandy bottoms (Baker 1928, Clarke 1981); gravel, cobble, and boulder (Buchanan 1980); sand and cobble (Sherman 1994); coarse sand and gravel (van der Schalie 1938); fine or coarse, closely-packed gravel (Ortmann 1919); and medium-sized gravel (Oesch 1984). It has been reported at depths of 5-60 cm (Buchanan 1980), 20-40 cm (Dennis 1984), <1 m (Gordon and Layzer 1989), and 2.5 m (Baker 1928), and is
invariably found in areas with swift currents. Many of the historical records for this species in Canada come from Lake Erie, where it probably inhabited the wave-washed shoals that were also occupied by a related species, *E. t. rangiana* (USFWS 1994).

**General Biology** - Although the specific biology of *E. triquetra* is not well known, general unionid biology is applicable. Life span and age at sexual maturity is not known for *E. triquetra*. However, Dennis (1984) collected 8-10 year olds from the Clinch River, VA, and Yeager and Saylor (1995) reported that gravid females collected from the Powell River, TN, were 5-10 years of age. *Epioblasma triquetra* is a long-term brooder (bradytictic), which means that fertilization occurs in the late summer and glochidia are held over winter for release the following spring or summer. Five species of fish have been shown to serve as hosts for *E. triquetra*, namely, the banded sculpin (*Cottus carolinae*), blackspotted topminnow (*Fundulus olivaceous*), ozark sculpin (*Cottus hypselurus*), logperch (*Percina caprodes*), and blackside darter (*Percina maculata*) (Sherman 1994, Yeager and Saylor 1995, Hillegass and Hove 1997, Barnhart 1998). Two of these species, the logperch (*Percina caprodes*) and blackside darter (*Percina maculata*), are native to Ontario.

**Limiting Factors in the Sydenham River** - According to The Nature Conservancy (2000b), *E. triquetra* is sensitive to pollution, siltation, habitat perturbation, inundation, and loss of glochidial hosts. Limiting factors at present include zebra mussels, siltation and pollution due to agricultural activities, and access to fish hosts. *Epioblasma triquetra* has several traits that suggest it may be very sensitive to zebra mussels, however, it may escape serious infestation due to its burrowing habits. The zebra mussel does not threaten existing populations of *E. triquetra* in the Sydenham River, since the river is not navigable by boats and has no significant impoundments that could support a permanent colony. *Epioblasma triquetra* is probably extremely sensitive to siltation because of its specialized habitat requirements and burrowing habitats. The decline in the overall distribution of the snuffbox suggests that it is not tolerant of poor water quality. As the remaining range of *E. triquetra* in Ontario is in an area of intensive agricultural activity, exposure to agricultural chemicals may be a factor limiting its occurrence in Canada. Mussels with few fish hosts are more sensitive to changes in the fish community than those with many hosts. Only two of the five known hosts for *E. triquetra* are native to Ontario, and there is some evidence that the most likely host, the logperch, is declining in some areas.

**Mudpuppy Mussel (Simpsonaias ambigua) - Endangered**

The mudpuppy mussel, is a small and unique freshwater mussel whose distinctive shell "cannot be confused with any other" (Clarke 1985). Although *S. ambigua* is typically overlooked during mussel surveys because of its unique habitat preference (underneath large rocks), intense searches for this species in areas where it has been reported previously indicate a decline in its range (TNC 1999).

**Distribution and Status** - Historically, *S. ambigua* was known from AR, IL, IN, IA, KY, MI, MN, MO, NY, OH, PA, TN, WV, WI, and Ontario. It was found throughout the Ohio-Mississippi drainage and the central Great Lakes drainages in the United States (Clarke 1985). *Simpsonaias ambigua* is now considered extirpated in IA (TNC 2000a), and only historical records exist for NY (Strayer and Jirka 1997). Parmalee and Bogan (1998) state that "in all
probability" it is also extirpated from TN. Until recently, *S. ambigua* was only known in Ontario from historical records in the Lake St. Clair drainage: two from the Detroit River (both in 1934) and two from the East Sydenham River (in 1965 and 1967).

*Simpsoniaias ambigua* was listed by the U.S. Fish and Wildlife Service as a "category-2 candidate" species before this designation was discontinued in December 1996. It is also listed as a species of special concern (defined as a species that is likely to become endangered or threatened by relatively minor disturbances to its habitat, and deserves careful monitoring of its abundance and distribution) by the American Fisheries Society (Williams et al. 1993).

*Simpsoniaias ambigua* has a global rank of G3 and a subnational rank of S1 in six U.S. states and S2 in four others (TNC 2000a). The mudpuppy mussel is listed as Endangered in three US states and as Threatened in three. It was recently downlisted from SH to S1 in Ontario based on its rediscovery in the Sydenham River (D. A Sutherland, Ontario Natural Heritage Information Centre, personal communication, September 1999). The mudpuppy mussel was designated as endangered by COSEWIC in 2001.

In 1965, Dr. C.B. Stein collected one fresh-dead specimen from the East Sydenham. The only historic record of a live *S. ambigua* for Ontario occurred when H.D. Athearn collected an individual from the East Sydenham River in 1967. Since then, no mudpuppy mussels had been found in the Sydenham River. Metcalfe-Smith et al. (1998, 1999) sampled 17 sites on the Sydenham River in 1997 and 1998, and revisited some of these sites in 1999. In 1997, evidence of *S. ambigua* was found at 6 sites in the Sydenham River system. Fresh-dead individuals were found at four sites on the East Sydenham River. Nineteen whole or half fresh-dead valves of a continuous size distribution (ranging from 24 to 49 mm) were found at an individual site (Metcalfe-Smith et al. 1998a). When this site was searched again in 1998 in conjunction with another study, one live *S. ambigua* was found (Metcalfe-Smith et al. 1999). One fresh-dead individual was found at another site during the 1998 survey. Metcalfe-Smith et al. (unpublished data) collected one live individual at another site in the East Sydenham River during an unrelated study in 1999. In addition, on the suggestion that a species-specific search protocol (i.e. overturning and looking under the large, flat stones under which they are known to frequent) be adopted for finding this species, Metcalfe-Smith et al. (unpublished data) surveyed sites on the Sydenham River specifically targeting *S. ambigua*. They discovered 15 live *S. ambigua*, ranging in length from 22 mm to 44 mm, under large, flat rocks at two sites. This is evidence that the population of *S. ambigua* in the Sydenham River is reproducing successfully. The discovery of a weathered shell in Bear Creek indicates that the mudpuppy mussel once lived in the North Sydenham River, however no live animals or fresh shells have been found. Based on current information, the Canadian population of *S. ambigua* is probably restricted to approximately 40 km along the East Sydenham River.

*Habitat* - *Simpsoniaias ambigua* occupies a unique habitat: it is typically found in the sand or silt substrates under flat rocks in areas of swift current (Shimek 1888, Baker 1928, Oesch 1984, Clarke 1985, Buchanan 1980, Cummings and Mayer 1992). Clarke (1981) states that it can also be found in mud or on gravel. There is a good association between this habitat and the preferred hiding place of its only known host, the mudpuppy (*Necturus maculosus*).
General Biology - Although the specific biology of *S. ambigua* is not well known, general unionid biology is applicable to some aspects of this species’ life history. Freshwater mussels are, for the most part, obligate parasites of a fish host. However, *S. ambigua* is unique among the Unionidae in that its only known host is the mudpuppy (*Necturus maculosus*), a strictly aquatic salamander (Gendron 1999). Hermaphroditism has not been recorded in *S. ambigua*. The reproductive period of *S. ambigua* is not well known, but Baker (1928) speculated it is probably bradytictic (fertilization occurring in the late summer, and the glochidia, which develop in the fall and early winter, are released the following spring or summer) like other Anodontinae.

Limiting Factors in the Sydenham River - Although it is difficult to determine the factors limiting the occurrence of this secretive and poorly known mussel, presumably the factors which have led to the dramatic reduction of mussels in general hold true for *S. ambigua*. Siltation, which is known to be a threat to most species of mussels (Williams et al. 1993), has increased over time in the Sydenham River due to an increase in agricultural activities (Mackie and Topping 1988; Clarke 1992). It is possible that *S. ambigua* could be smothered if the flat stones under which it lives become covered with heavy deposits of silt. The availability of suitable hosts is unlikely to be limiting the distribution of *S. ambigua* in Ontario. The mudpuppy is widely distributed throughout south and central Ontario, including the Sydenham River watershed (Gendron 1999). However, the mudpuppy is sensitive to siltation (Gendron 1999) and the current status of populations in the Sydenham River is not known. Since global populations of the mudpuppy mussel are declining, it is imperative that all known populations are protected to ensure the continued existence of this species.

Additional Mussel Species

In addition to the five COSEWIC mussel species discussed above, there are nine mussel species found in the Sydenham River which are provincially rare (S1, S2). All of these species are common or secure globally (G4, G5), but most of them warrant consideration for status in Canada by COSEWIC. Most occurrences are from the middle portion of the East Sydenham River, but some species also occur in the Bear Creek drainage of the North Sydenham River. Ecological requirements of these species are listed in Appendix I.

ODONATES

Six species of provincially rare dragonflies and two species of provincially rare damselflies have been found in the Sydenham drainage. Most of these sightings are in the headwaters of the East Sydenham River and are based on collections of adult specimens. Although there has been considerable sampling for benthic insects in the watershed, odonate nymphs can not be reliably identified to species. The Sydenham River has not been adequately sampled for odonates and the rare species are quite likely more widely distributed in the watershed. It would also not be unexpected that additional rare species may be found with additional survey work.

FISHES

The Sydenham River is home to a broad array diversity of fishes. At least 82 species of fish have been identified from the Sydenham River which is rivaled by perhaps only the Thames River in Canada in terms of fish diversity. Eight of these fish species have been designated as
being at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The status, distribution, and ecology of each of these species are discussed briefly below. A summary of their ecological requirements is provided in Appendix II.

Significant fish sampling has been conducted in the Sydenham River using a variety of gear types (seine net, backpack electrofisher, trap nets). The largest sampling effort occurred in the 1970s when OMNR conducted a stream survey of the entire Sydenham watershed (Figure 2). Although fish sampling in the 1980s and 1990s was less intensive, there was still broad coverage of the watershed during these years. Much of the sampling effort in the 1990s was directed specifically to collecting species at risk as opposed to general sampling in the 1970s and 1980s. Pre 1970 sampling effort was very sparse as the Ontario Department of Planning and Development did not survey the Sydenham watershed.

**Eastern Sand Darter (Ammocrypta pellucida) - Threatened**

The eastern sand darter is a small member of the perch family that grows to a length of about 8 cm. The species is easily distinguished from other members of the darter sub-family in Canada by its slender, elongate, translucent body. The eastern sand darter has declined throughout much of its limited North American range.

*Distribution and Status* – The eastern sand darter occurs in the Ohio River, Lake Erie and Lake St. Clair drainages as well as the Ausable River flowing into the southern tip of Lake Huron. It also has a disjunct distribution in the Lake Champlain and St. Lawrence River drainages. It is known from nine states and from the provinces of Ontario and Quebec. In Ontario, the species is extant in Lake St. Clair, Lake Erie, the Grand River, the Thames River and the Sydenham River. Populations may be extirpated from the Ausable River, Catfish Creek, Big Creek and Big Otter Creek.

The eastern sand darter is globally rare (G3) and has declined throughout much of its North American range due to siltation and deteriorating water quality (Page and Burr 1991, Holm and Mandrak 1994). In some parts of its range, these declines have been somewhat drastic. The eastern sand darter is listed as endangered in three states (IL, NY, PA), threatened in two states (MI, VT), and as special concern in three states (IN, KY, OH). The species was listed as threatened in Canada by COSEWIC in 1994 (Holm and Mandrak 1994).

The eastern sand darter was first collected from the upper East Sydenham River at Strathroy in 1927 and was collected downstream in 1929. Eight collections attempts in 1991 in apparently suitable habitats between these two locations failed to capture any eastern sand darters (Holm and Mandrak 1994). The species was collected further downstream in 1972 and its continued presence in this vicinity has been confirmed through repeated collections in 1989, 1991, 1997 and 1999. The eastern sand darter no longer occurs in the upper part of the East Sydenham River. Since there is no historical (pre 1972) data from the downstream area, it is not clear whether the overall range of the eastern sand darter has contracted, or if it has simply shifted downstream (Holm and Mandrak 1994).
Figure 2. Fish sampling in the Sydenham River watershed.
Habitat - The eastern sand darter inhabits large creeks, rivers and lakes with sandy bottoms (Page and Burr 1991). The species is found almost exclusively on sand substrates, and, according to Daniels (1993), few temperate stream fishes are as strongly associated with a particular habitat variable as is the eastern sand darter. In rivers, these habitats are normally found on the depositional side of a bend in the river. Eastern sand darters normally are found on the downstream side of the sand bar in areas of low current (<20 cm/sec) (Daniels 1993, Facey 1998). In Vermont rivers, Facey (1998) found eastern sand darters preferred fine, sandy substrates with very little weeds, mud, or coarse gravel. In the Sydenham River, the species has been collected from areas with silted sand bottoms (Holm and Mandrak 1994). However, land-use practices that contribute to siltation, and that change the channel structure and interfere with the deposition of sand are probably detrimental to the eastern sand darter and have probably been largely responsible for the range-wide declines reported for this species. There is evidence from Vermont that improvements in water quality associated with a decreased silt load resulting from reforestation of stream slopes have benefited populations of eastern sand darters (Daniels 1993). There is no information available to assess whether the preference of this species for sand is constant throughout its life history, although spawning does occur on the same sandy substrates on which it lives.

Eastern sand darters are fossorial and will often nearly completely bury themselves in sandy substrates. Daniels (1989) provided evidence that suggests this burying behavior serves to maintain the fish’s position in homogenous sand beds, rather than to avoid predation or to ambush prey.

Reproduction – Spawning by the eastern sand darter has not been observed in the field, but the presence of ripe and spent fish indicates that spawning occurs in the summer when the water temperature is above 20 °C. In Ontario, spawning probably occurs between late June and late July (Holm and Mandrak 1994). Well-oxygenated sandy substrates that are free of silt are probably important to the survival of eggs.

Feeding Behaviour – The eastern sand darter feeds principally on chironomid larvae, although simulid larvae, oligochaetes and small crustaceans are also eaten (Holm and Mandrak 1994). The small mouth size of this fish coupled with the unproductive sand habitats which it inhabits, probably limit the food items which it is able to consume.

Limiting Factors in the Sydenham River – Although it is not clear what factors are limiting the eastern sand darter in the Sydenham River, it is likely that the availability of silt-free, soft sand substrates is important. The species was absent from apparently suitable habitats in the upper portion of the river in 1991. If the exotic round goby (Neogobius melanostomus), which is abundant in the St. Clair River and Lake St. Clair, invades the Sydenham River, it could be detrimental to the eastern sand darter and other benthic fishes in the river.

Northern Madtom (Noturus stigmosus) – Special Concern

The northern madtom is a small member of the bullhead catfish family that grows to a size of 13 cm. It is one of five catfish of the genus Noturus found in Canada and is most similar to the brindled madtom which also occurs in the Sydenham River. The northern madtom can be
distinguished from the brindled madtom by the presence of two pale spots in front of the dorsal fin and pale margins on the dorsal and adipose fins. The species is sporadic and uncommon, and is disappearing from the edge of its range (Page and Burr 1991).

**Distribution and Status** – The northern madtom occurs sporadically in the Mississippi, western Lake Erie and Lake St. Clair drainages. It is known from nine states and the province of Ontario. In Ontario, the species is only known from the upper Detroit River, Lake St. Clair, the Thames River, and the Sydenham River. The species may be extirpated from the Sydenham River.

The northern madtom is globally rare (G3) and declines have been noted in Illinois, Michigan and Ohio. It is most common, although still rare, in the southern part of its range (MS, TN). The northern madtom is listed as endangered in three states (IL, MI, OH), threatened in one state (PA), and as special concern in one state (KY). It was listed as vulnerable in Canada by COSEWIC in 1998 (Holm and Mandrak 1998), and was listed as threatened in Ontario in 2000.

The northern madtom is known from the East Sydenham River from only one specimen collected in 1975 (E. Holm, pers. comm.). The specimen was in the Canadian Museum of Nature collection and had been misidentified as *Noturus miurus* (brindled madtom). The species has not been seen in the Sydenham River since, despite fish sampling in the vicinity of the original collection site in 1989, 1991, 1997 and 1999. However, the northern madtom is a small, secretive, nocturnal species that is difficult to capture using traditional sampling techniques. Seining at night in suitable habitats is probably the most effective means of searching for northern madtoms in the Sydenham River. An unsuccessful attempt was made to capture the northern madtom by night seining in 1999. Additional sampling is required using appropriate techniques to determine if the northern madtom is still extant in the Sydenham River.

**Habitat** - The northern madtom inhabits clear to turbid stretches of large creeks to big rivers with moderate to swift current and a variety of substrate types (Holm and Mandrak 1998). It has also been collected from sandy substrates without cover and is occasionally associated with aquatic macrophytes (Holm and Mandrak 1998). Given the extremely restricted distribution of the northern madtom, there may be very specific, but undescribed habitat characteristics. Alternatively, interactions with other species (particularly congeners) may limit the distribution of the northern madtom.

**Reproduction** – The northern madtom is a cavity spawner and the eggs are guarded by the male. Nests are made underneath large rocks as well as in a variety of anthropogenic debris (Holm and Mandrak 1998). In the Detroit River, northern madtom eggs were laid in nests during mid to late July (water temperature 23 °C in gentle current on sandy substrate surrounded by dense aquatic macrophytes (MacInnis 1998). Males guard eggs and newly hatched fry, and did not abandon nests when disturbed in MacInnis’ (1998) study.

**Feeding Behaviour** – The northern madtom appears to be an opportunistic feeder. Gut contents of Ontario specimens have typically contained a variety of benthic insects (chironomids, mayflies, and caddisflies), but small fish and small crustaceans are also consumed (Holm and Mandrak 1998). The few juveniles that have been examined also fed on benthic insects.
**Limiting Factors in the Sydenham River** – The limiting factors for the northern madtom in the Sydenham River are poorly understood. Evidence suggests that it tolerates a wide variety of habitat conditions, although it may be affected by poor water quality. Temperature is undoubtedly an important limiting factor as the Sydenham record is among the most northerly for this species. If the round goby invades the Sydenham River, it could potentially impact any remaining populations of the northern madtom.

**Spotted Gar (Lepisosteus oculatus) - Threatened**

The spotted gar is one of two members of the gar family found in Canada and it can grow to lengths of over 1 metre. It can be distinguished from the more common longnose gar (*Lepisosteus osseus*) by its relatively short, broad snout and by the presence of conspicuous spots on the head, body and all fins.

**Distribution and Status** – The spotted gar is widely distributed in the Gulf states, the Mississippi River basin and the southern Great Lakes drainages. It is known from 18 states and the province of Ontario. In Ontario, the spotted gar has been collected from Lake Erie (5 locations), Lake St. Clair, the Sydenham River, and the Bay of Quinte (presumed introduction). It is now thought to be extant only in Lake Erie (Rondeau and perhaps Long Point), although specific sampling targeting this species has not been conducted.

The spotted gar is globally secure (G5), but is extremely rare throughout the northern portion of its range. It is not clear if this rarity is the result of declines or if the spotted gar has always been rare in the north. The spotted gar is listed as endangered in Ohio. It was listed as vulnerable in Canada by COSEWIC in 1983 (Parker and McKee 1984a) and uplisted to threatened in 2000 (Campbell 1994a). The spotted gar was listed as threatened in Ontario in 2000.

In the Sydenham River, the spotted gar is only known from two individuals identified in the lower East branch in 1975. One fish was released and the identification of both specimens has been questioned (Campbell 1994a). They may have in fact been longnose gar. The spotted gar is an enigmatic creature that is rarely observed even in areas where there are established populations such as Rondeau Bay. Only 18 specimens have ever been recorded from Ontario waters. This is undoubtedly due to its rarity coupled with the difficulties in sampling its preferred wetland habitats. The species may also be incorrectly identified as the more common longnose gar and released by sampling crews. It is not clear whether the specimens collected from the Sydenham River in 1975 represented an established population, or single nomadic individuals that had originated from lake St. Clair or Lake Erie. Both specimens were captured during the summer months after the spring spawning period.

**Habitat** - The spotted gar inhabits quiet pools, backwaters and bays with an abundance of aquatic vegetation (Page and Burr 1991). Collection sites in Lake Erie typically had dense vegetative cover consisting of *Nuphar* sp., *Typha* sp., and *Elodea canadensis* (Parker and McKee 1984a). Such habitats are typically difficult to sample effectively. The spotted gar is tolerant of warm waters and low dissolved oxygen levels.
Reproduction – The spotted gar spawns in the spring in shallow, warm water with an abundance of submerged vegetation (Scott and Crossman 1973). Some populations may migrate upstream to spawn. Semi-adhesive eggs are laid over aquatic vegetation, submerged brush and debris, and hatch within 1 week. Spawning size adults are said to be greater than 55 cm in length.

Feeding Behaviour – The spotted gar is a voracious piscivore that probably will opportunistically feed on all fish species of suitable size that it encounters. Although data is very limited, Scott (1967) listed yellow perch and minnows as forming a large part of the diet in Ontario. Young spotted gar initially feed on invertebrates, but incorporate small fish into their diet at an early age.

Limiting Factors in the Sydenham River – Although almost nothing is none about this species in the Sydenham River, the availability of quiet backwater areas of dense aquatic vegetation would probably be a limiting factor. Siltation, drainage and filling have probably all contributed to the reduction of these types of habitats in the Sydenham River. There is considerable doubt as to whether this species still exists in the system.

Spotted Sucker (Minytrema melanops) – Special Concern
The spotted sucker is a medium-sized member of the sucker family that can reach a length of 50 cm, but is normally 23-28 cm in length. It can be distinguished from other suckers in Canada by the presence of 8-12 parallel rows of dark spots (at scale bases) on the back and sides. Across its range, the species is frequently encountered, but seldom in large numbers (Page and Burr 1991).

Distribution and Status – The spotted sucker occurs in smaller drainages in the southern Great Lakes, throughout much of the Mississippi basin, and along the lower coastal plain from Texas to North Carolina. It is known from 23 states and from the province of Ontario. In Ontario, the spotted sucker is known from the Sydenham River (both branches), the St. Clair River, Lake St. Clair, the Thames River, the Detroit River, and Lake Erie (west of Point Pelee). Recent collections have confirmed that the species is extant at all of these locations except Lake Erie.

The spotted sucker is globally secure (G5), but declines have been reported in the northern part of its range (Becker 1983). It is listed as a species of special concern in Pennsylvania and Kansas. The spotted sucker was listed as vulnerable by COSEWIC in 1983 (Parker and McKee 1984b) and this designation was confirmed in 1994 (Campbell 1994b). In Ontario, the spotted sucker was listed as vulnerable in 2000.

The spotted sucker was first collected from the Sydenham drainage in 1975 at two sites in the East Sydenham River. It was subsequently collected in the north Branch in Black Creek in 1982 and in Bear Creek in 1997. The continued presence of the spotted sucker in the East Sydenham River was confirmed in 1997. Very few individuals have been captured in the Sydenham River as all collections represent single individual fish (similar to other Canadian collections). Parker and Mckee (1984b) suggested that the Sydenham and Thames Rivers may provide spawning areas for a small resident population of spotted suckers in Lake St. Clair. The possibility can not be discounted that this species is a year round resident of the Sydenham River.
Habitat - The spotted sucker inhabits long, deep pools of small to medium rivers over clay, sand or gravel substrates, and is occasionally found in small creeks and impoundments (Page and Burr 1991). The spotted sucker is apparently intolerant of turbidity (Trautman 1957; Scott and Crossman 1973), but it has been taken from rivers with moderate to heavy turbidity (including the Sydenham). It has also been reported from waterbodies with dense aquatic macrophytes and organic substrates, but is generally considered to prefer firm substrates (Cross 1967).

Reproduction – The spotted sucker spawns in late spring or early summer. A pre-spawning, mature, 5-year old female was taken from the Thames River on April 1. Spawning probably occurs in clean riffle areas where semi-buoyant eggs are laid that drift downstream (Parker and McKee 1984b). Eggs develop quickly and hatch within 7-12 days.

Feeding Behaviour – Juvenile and adult spotted suckers feed on a variety of benthic organisms. Molluscs, chironomids and small crustaceans are important in the diet. Larval spotted suckers feed at the surface and at mid-water on zooplankton and diatoms.

Limiting Factors in the Sydenham River – Land-management practices that contribute to siltation may be detrimental to this species in the Sydenham River. It is also likely that temperature is important in limiting this species which is at the northern edge of its range in the Sydenham River.

Pugnose Minnow (Opsopoeodus emiliae) – Special Concern

The pugnose minnow is a small member of the minnow family with a very small, upturned mouth, that reaches a maximum size of 6.4 cm. It can be distinguished from the similar pugnose shiner (Notropis anogenus) by the presence of a cross-hatch pattern on the back and sides and in having 9 dorsal rays (versus 8). The pugnose minnow is declining in the some parts of its range (Page and Burr 1991).

Distribution and Status – The pugnose minnow is widely distributed in the Gulf states and the Mississippi River basin and is found in a few drainages of Lake Erie, Lake St. Clair and Lake Michigan. It is known from 21 states and the province of Ontario. In Ontario, the pugnose minnow occurs in Lake St. Clair and several small tributaries of the lake, the Sydenham River (both branches), the Thames River and the Detroit River.

The pugnose minnow is globally secure (G5) but is rare and may be declining in the northern part of its range (Cudmore and Holm 1999). It is listed as extirpated from Ohio, threatened in Georgia, and special concern in Missouri and West Virginia. The pugnose minnow was listed as vulnerable in Canada by COSEWIC in 1985 (Parker et al. 1987), and this status was re-confirmed (now called special concern) in 2000 (Cudmore and Holm 1999). The species was also listed as vulnerable in Ontario in 2000.

The pugnose minnow was first collected from the North Sydenham River in 1972. Subsequent collections revealed that it occurred in the lower North Sydenham River, upstream into Bear Creek. Large numbers of individuals were never encountered, and the species has not been recently collected in the North Sydenham nor in Bear Creek despite sampling efforts in 1993,
1996 (hindered by high water) and 1997. The pugnose minnow was first found in the lower East Sydenham River in 1979. In 1997 sampling efforts revealed that it is still extant in this stretch of the river, although little can be said regarding population trends.

*Habitat* - The pugnose minnow prefers clear, slow-moving waters with abundant aquatic vegetation. Although specific tolerances are not known, turbid and silty waters may only provide marginal habitat for this species (Cudmore and Holm 1999). In Ontario, the pugnose minnow has been captured at sites with a variety of water clarities, but all sites had moderate to abundant aquatic vegetation. The substrate at these sites was generally clay, silt or mud (Cudmore and Holm 1999)

*Reproduction* – Spawning by the pugnose minnow in Ontario likely occurs in late spring to early summer (Cudmore and Holm 1999). The adhesive eggs are layed on a flat surface such as the underside of a rock. Males are territorial and defend the nest and eggs from potential predators. In a laboratory study, pugnose minnow eggs hatched in 6 days at 21 °C. Cudmore and Holm (1999) suggest that turbid water may affect the elaborate courtship display of the male pugnose minnow.

*Feeding Behaviour* – The pugnose minnow feeds on a variety of small insects and crustaceans, and occasionally on larval fish and fish eggs. The upturned mouth of this species may be an adaptation to mid-water or surface feeding habit (Scott and Crossman 1973).

*Limiting Factors in the Sydenham River* – The pugnose minnow may be already limited by turbidity levels in the Sydenham River. Additional erosion and siltation may be detrimental to the remaining population. Filling and drainage of riparian wetland habitats would also further limit this species in the Sydenham drainage.

**Blackstripe Topminnow (*Fundulus notatus*) – Special Concern**

The blackstripe topminnow is a small member of the killifish family that grows to a length of 7cm. It is one of two killifishes found in Ontario and can be easily distinguished from the banded killifish (*Fundulus notatus*) by the presence of distinct, black, lateral band as opposed to horizontal stripes. The blackstripe topminnow is common in lowland areas throughout its range.

*Distribution and Status* – The blackstripe topminnow occurs in lowland areas of the southern Great Lakes, throughout much of the Mississippi basin, and along the lower coastal plain from Texas to Alabama. It is known from 16 states and from the province of Ontario. In Canada, it is only known from the Sydenham River drainage.

The blackstripe topminnow is globally secure (G5) and appears to be stable throughout its range. The species is not listed as being special concern in any state, but was listed as vulnerable in Canada by COSEWIC in 1985 (McAllister 1987). This status was re-confirmed (as special concern) by COSEWIC in 2001. It was also listed as vulnerable in Ontario in 2000.

The blackstripe topminnow was first discovered in the Sydenham River in 1972 (Gruchy et al. 1973). It is known from several sites in the north branch of the Sydenham River including Bear
Creek and several smaller tributary streams. It has recently been confirmed extant within most of its range in the North Sydenham. The blackstripe topminnow has also been collected from three sites in the lower East Sydenham River. There is no evidence of any declines in blackstripe topminnow populations in the Sydenham River.

**Habitat** - The blackstripe topminnow prefers small to large, low-gradient streams and sloughs of moderate to high turbidity (Shute 1980). Streamside and instream vegetation (emergent and floating) is important (McAllister 1987). Unlike many fishes, the blackstripe topminnow is easily observed from shore because of its surface-loving habits. In the Sydenham River McAllister (1987) notes that the blackstripe topminnow is rarely observed beyond the cover at the edge of the river. This species is apparently tolerant of a wide range in water quality (McAllister 1987).

**Reproduction** – Spawning by the blackstripe topminnow is extended in Michigan, occurring from early May to the third week of August (Carranza and Winn 1954). Mating pairs establish territories parallel to shore in dense vegetation, and 20-30 adhesive eggs are laid on submerged vegetation. The maximum age of 15 specimens from the Sydenham River examined by McAllister (1997) was 2 years.

**Feeding Behaviour** – The blackstripe topminnow feeds primarily on terrestrial insects, but larval insects, crustaceans and molluscs are also consumed. McAllister (1987) observed this species feeding just under the water surface and its upturned mouth suggests a surface feeding habit, but it appears to be a somewhat opportunistic feeder.

**Limiting Factors in the Sydenham River** – The blackstripe topminnow may be limited by stream gradient in the upper reaches of both branches of the Sydenham River as it prefers quiet and slow-moving sections. Although increases in turbidity may actually help this species, McAllister (1987) suggests that factors which may increase turbidity can also destroy instream and bank vegetation which this species requires for cover and food. He noted that in areas where edge-cover had been destroyed by livestock, the blackstripe topminnow was less numerous or absent. Wetland drainage and filling would also be detrimental to this species. Seepage from oil wells in Black Creek has also been identified as a threat for this surface-feeding species (McAllister 1987), but Holm (1997) captured several specimens from three sites in this drainage in 1996. There is also a certain amount of natural seepage in this drainage. The blackstripe topminnow is probably also limited somewhat by climate as it is at the extreme northern edge of its range in the Sydenham River.

**Greenside Darter (Etheostoma blennioides) – Special Concern**

The greenside darter is the largest member of the genus Etheostoma in the darter sub-family and reaches a size of 11 cm. It can be distinguished from other darters occurring in Ontario by the presence of 5-8 large, green ‘W’s or ‘U’s on its side, and the fusion of the rear of the upper lip to the snout. It is common and often abundant throughout much of its range (Page and Burr 1991).

**Distribution and Status** – The greenside darter occurs in southern Great Lakes drainages (Huron, St. Clair, Erie and Ontario), throughout much of the Mississippi basin (hiatus in range at
southern Illinois and Indiana), and along the Atlantic slope from New York to Virginia. It is known from 17 states and from the province of Ontario. In Canada, it is known from several drainages in southwestern Ontario: Gold Creek; Ausable River; the Sydenham River; Thames River; Nairn Creek; Lake St. Clair; Big Creek; and the Grand River. The species has recently spread throughout much of the upper part of the Grand River watershed after a presumed introduction about 10 years ago. Dalton (1991) suggests that the greenside darter appeared to be declining in Ontario, but recent collection efforts suggest that it is still extant at most of these locations and that it is sometimes locally abundant.

The greenside darter is globally secure (G5) and appears to be stable throughout much of its range. The species is listed as special concern in Mississippi and Kansas, and was listed as vulnerable in Canada by COSEWIC in 1990 (Dalton 1991). A recent review of the status of the greenside darter in Ontario concluded that it was not in any provincial risk category.

The greenside darter was first discovered in the upper East Sydenham River in 1927. Sampling efforts in the 1970s revealed that the species was also present in Bear Creek in the North Sydenham drainage. Sampling conducted in 1997 captured the greenside darter throughout much of the East Sydenham River, as well as at historical sites in Bear Creek. Substantial numbers were captured at some of the sites (e.g., 46 individuals) and the species appears to be stable in the Sydenham drainage.

**Habitat** - The greenside darter inhabits rocky riffles of creeks and small to medium rivers, and is occasionally found along the shores of large lakes (Page and Burr 1991). Greatest abundance is reached in riffles that are deep and swift with a rubble and boulder substrate (Dalton 1991). Although the greenside darter is most often found in streams of low turbidity, it exists in quite turbid habitats in the Thames and Sydenham Rivers. Juveniles and adults may be found in similar habitats.

**Reproduction** – Greenside darters mature at age 1 and may live as long as 4 or 5 years. Spawning takes place in the spring once the water temperature is above 11 °C and may be protracted over several weeks. Rocks in riffles covered with filamentous algae (usually *Cladophora*) are used as spawning sites (Scott and Crossman 1973). Adhesive eggs are laid on the algae close to the rock and hatch in about 3 weeks. Newly-hatched larvae are presumably swept downstream to quieter areas.

**Limiting Factors in the Sydenham River** – Dalton (1991) suggested that the specialized feeding and spawning areas (riffle habitats) were at risk from several anthropogenic disturbances including impoundment, contaminants associated with industry and agriculture, siltation, and low water flows. Although the greenside darter may be limited by turbidity in the Sydenham River, it appears to be maintaining its range and abundance levels throughout much of the system under current conditions.

**Bigmouth Buffalo (Ictiobus cyprinellus) – Special Concern**

The bigmouth buffalo is a large member of the sucker family that reaches a length of up to 1 m. It can be distinguished from other buffalo fishes by its large ovoid head and its sharply oblique,
terminal mouth. The bigmouth buffalo is also superficially similar to the introduced common carp (\textit{Cyprinus carpio}) and goldfish (\textit{Carassius auratus}). The bigmouth buffalo is common in much of its range and is often the target of commercial fisheries.

\textit{Distribution and Status} – The bigmouth buffalo ranges widely in the Mississippi River basin, the southern Great Lakes and the Nelson River basin (Hudson Bay). It is native to 21 states and has been introduced to three states. In Canada, it has a disjunct distribution in Saskatchewan, Manitoba and Ontario. In Ontario, the species is known from Lake Erie and Lake St. Clair and their tributaries, as well as from Lake Ontario and Lake of the Woods. Although the species has not been captured from Lake of the Woods since the 1970s, its distribution appears to be expanding in southern Ontario, and it has been discovered in many, new drainages in the last 10 years (Welland River, Sydenham River, Grand River, and Hamilton Harbour).

The bigmouth buffalo is globally secure (G5) and populations appear stable throughout much of its range (Goodchild 1990). The bigmouth buffalo was listed as vulnerable in Canada by COSEWIC in 1989 (Goodchild 1990). A recent review of the status of the bigmouth buffalo in Ontario concluded that it was not in any provincial risk category.

The bigmouth buffalo was not reported from the Sydenham River at the time its status was assessed by COSEWIC in 1989 (Goodchild 1990). In 1997, a single individual was captured in the lower East Sydenham River, and several fish were captured at two sites in the lower North Sydenham River (E. Holm, unpublished data). The bigmouth buffalo can be considered a recent invader of the Sydenham River as it is unlikely that a conspicuous fish like this would go undetected in previous sampling efforts. Fifteen small \textit{Ictiobus} sp. were also collected at a site in the North Sydenham River in 1997. It is not clear whether these fish represent hybrids or perhaps smallmouth buffalo (\textit{I. bubalus}).

\textit{Habitat} - Bigmouth buffalo can occupy a variety of habitats - they inhabit the main channels, pools, and backwaters of small to large rivers, as well as lakes and impoundments (Page and Burr 1991). The species has a high tolerance for turbidity, extremely low oxygen levels, and exhibits a preference for warm, highly eutrophic waters (Goodchild 1990). Habitat changes resulting from anthropogenic disturbances may enhance habitat for this species.

\textit{Reproduction} – Bigmouth buffalo spawn in spring at water temperatures of 15-18 °C. Spawning occurs in shallow bays or small tributary streams and the fish will invade streams, ditches and backwaters during spring flooding. Adhesive eggs are scattered over plant debris in shallow water. Eggs hatch in about 10 days. There appears to be a relationship between degree of spring flooding and reproductive success (Goodchild 1990).

\textit{Feeding Behaviour} – The bigmouth buffalo has been described as primarily a planktivorous feeder, consuming largely crustacean zooplankton in an indiscriminant fashion. However, benthic insects, molluscs and crustaceans are also consumed (Goodchild 1990). Differing diets of the same life stages in different waterbodies suggest that the bigmouth buffalo is really an opportunistic feeder with the capability of both pelagic and benthic foraging habits (Goodchild 1990).
Limiting Factors in the Sydenham River – The bigmouth buffalo is not sensitive to human disturbance and in fact may benefit from habitat changes that are detrimental to sensitive species. Important limiting factors are probably the requirement for spring flooding for successful spawning, and perhaps cold winter temperatures.

Brindled Madtom (Noturus miurus) — Not at Risk

The brindled madtom is a small member of the bullhead catfish family that grows to a size of 13 cm. It is most similar to the northern madtom, which also occurs in the Sydenham River. The brindled madtom can be distinguished from the northern madtom by the presence of a dark blotch on the first 3-5 rays at the top of the dorsal fin and a black band to the edge of the adipose fin. The species is common throughout much of its range (Page and Burr 1991).

Distribution and Status – The brindled madtom occurs in the southern Great Lakes and Mississippi River basin. It is known from 16 states and the province of Ontario. In Ontario, the species is known from Lake Erie (Long Point, Turkey Point, Wheatley Harbour) and several of its tributaries, from Lake St. Clair and from the Sydenham River (both branches). The brindled madtom appears to be extant at most of its historical sites and a few new locations have recently been discovered.

The brindled madtom is globally secure (G5) although population declines associated with siltation have been reported in Illinois and Ohio (Trautman 1981). The brindled madtom is listed as special concern in several states, and it was listed as vulnerable in Canada by COSEWIC in 1985 (Parker and McKee 1987). This status was down-listed to ‘not at risk’ in 2001 based on the discovery of new populations in Lake St. Clair and the Grand River. A recent review of the status of the brindled madtom in Ontario concluded that it was not in any provincial risk category.

The brindled madtom was first collected from the upper East Sydenham River in 1928 (Parker and McKee 1987). Sampling in the 1970s captured the brindled madtom in both the North Sydenham River and the East Sydenham River. More recent sampling efforts (1985-1997) have resulted in brindled madtom captures at in the lower East Sydenham River, and throughout much of Bear Creek of the North Sydenham River. Although this species is usually encountered in small numbers (one or two individuals), in 1997, 43 individuals were captured in two samples at a site in Bear Creek (E. Holm, unpublished data). The population in Bear Creek appears stable and the species is relatively abundant at some locations. In the East Sydenham River, collection efforts in 1991 and 1997 failed to capture brindled madtoms at the farthest upstream and downstream sites where it had been collected historically (E. Holm, unpublished data). Therefore it is possible that its range has been reduced in the East Sydenham River. Similar to the northern madtom, the brindled madtom is a secretive, nocturnal creature that is difficult to collect (Parker and McKee 1987). Seining at night may be the most efficient way of capturing this species.

Habitat - The brindled madtom inhabits riffles and pools, and runs over gravel mixed with sticks and leaves in creeks and small rivers (Page and Burr 1991). It is occasionally found in lakes and more sluggish, turbid streams (Parker and McKee 1987). The largest populations in Ohio occur
in slow-moving streams with sand and organic substrates, but minimal silt (Trautman 1981). Parker and McKee (1987) suggest that all Ontario sites have only marginal habitat for this species, and that the habitat in the lower Sydenham may no longer be suitable for brindled madtom because of the deposition of clayey silts. Collections in 1997 confirm that suitable habitat is still present in the lower stretch of the East branch.

Reproduction – The brindled madtom is a cavity spawner and the eggs are initially guarded by the male and female. The female abandons the nest after several days, but the male remains until the eggs hatch (about 2 weeks). Nests are made underneath large rocks as well as in anthropogenic debris (Parker and McKee 1987). Based on studies in Michigan and Ohio, it is likely that brindled madtoms spawn in mid to late summer in Ontario, when the water temperature is 25-27 °C.

Feeding Behaviour – The brindled madtom feeds heavily on drift invertebrates, dominated by chironomid larvae, copepods and caddisflies. It is likely that most active feeding occurs at night.

Limiting Factors in the Sydenham River – Parker and McKee (1987) suggest that the brindled madtom has a tolerance for a wide variety of habitats and that it is unlikely that habitat destruction will have a major influence on populations. Paradoxically they also suggest that habitat at most Ontario sites is marginal and that the lower Sydenham may no longer be suitable for the brindled madtom. Evidence suggests that it tolerates a wide variety of habitat conditions, although it may be negatively affected by excessive siltation. Temperature is undoubtedly an important limiting factor as the Sydenham River is close to the northern limit for this species. A recent expansion and increase in abundance of longnose gar in the Sydenham River may have a detrimental impact as this species is the only known predator of the brindled madtom. If the round goby invades the Sydenham River, it could potentially impact brindled madtom populations.

Ghost Shiner (Notropis buchanani) – Not at Risk

In addition to the COSEWIC-listed species discussed above, the provincially rare (S2) ghost shiner occurs throughout the lower halves of both branches of the Sydenham River (Holm and Houston 1993, Holm, unpublished data) (Figure 4). This species thrives in turbid waters and is abundant in some sections of the North Sydenham River (Holm and Houston 1993). The ghost shiner was evaluated by COSEWIC in 1992 and determined to be “not at risk”. The ecological requirements of the ghost shiner are summarized in Appendix II.

REPTILES

Eastern Spiny Softshell (Apalone spinifera spinifera) - Threatened

The eastern spiny softshell is the only softshell turtle that inhabits Canada. Females can reach carapace lengths of over 50 cm and weights of up to 11.7 kg, while males are normally much smaller. The eastern spiny softshell has an olive, flat, leathery shell (usually spotted or mottled) and a truncated, tubular snout which distinguish this species from all other Canadian turtles.
**Distribution and Status** – The eastern spiny softshell is one of seven subspecies of the spiny softshell turtle which is widespread in the eastern United States (west of the Appalachians). The eastern subspecies occurs in the Mississippi River-Ohio River system and the lower Great Lakes (Obbard 1991). In Canada, the eastern spiny softshell is known from the drainages of Lake St. Clair, Lake Erie, western Lake Ontario, and from the Ottawa, St. Lawrence and Richilieu Rivers.

The eastern spiny softshell is globally secure (G5T5) and apparently common throughout much of its range (Oldham and Obbard 1996). The eastern spiny softshell was listed as threatened in Canada by COSEWIC in 1991 (Obbard 1991) based on declines and the low abundance and scattered distribution of the remaining populations. It is also listed as threatened in Ontario.

Other than documented occurrences, the historical status of the eastern spiny softshell in the Sydenham River basin is unknown. A survey of the river by Fletcher and Gillingwater (1994) found 87 eastern spiny softshells in a continuous stretch of the middle portion of the East Sydenham River. No softshells were observed in the lower East Sydenham River or on Bear Creek. However, there are documented occurrences of eastern spiny softshells from the lower portion of the North Sydenham River.

**Habitat** – Eastern spiny softshells inhabit soft-bottomed water bodies with aquatic vegetation, an abundance of prey sources and an availability of nesting sites. Resting softshells bury themselves in mud and sand bottoms in shallow water to avoid predation (Obbard 1991, Oldham and Obbard 1996). These habitats are particularly important for young turtles. The availability of basking areas is also import to softshells. Eastern spiny softshells bask on river banks where vegetation does not block sunlight as well as on logs, rocks, and on some artificial structures. Bank stabilization and shoreline “improvements” such as gabion baskets can restrict access for softshell basking and nesting (Oldham and Obbard 1996). Deep pools (>1m) are important for hibernating softshells and also provide cover, food and thermoregulation opportunities during the summer. On the Sydenham River, radio telemetry has revealed that individual turtles will move as much as 30 km in a single season between nesting and hibernation sites (Fletcher 1996). Since the key features of habitat are not always in proximity, it is essential that these habitats remain connected (Oldham and Obbard 1996).

**Reproduction** – In Ontario, eastern spiny softshells lay one clutch of about 20 eggs per year from mid-June to mid-July (Obbard 1991, Oldham and Obbard 1996). Female softshells prefer to lay eggs in sandy, sunlit areas above the summer high-water level (Oldham and Obbard 1996). These habitats are normally found on the inside of a river bend downstream of eroding sandy slopes. There appears to be a shortage of these preferred nesting habitats on the Sydenham River and the majority of nests sites are in hard-packed clay soil that becomes rock-hard by late summer Fletcher (1996). Several turtles may nest in the same area. Eastern spiny softshell nests are frequently predated and survivorship from hatchling to mature adult (12 years for females?) is very low (Oldham and Obbard 1996). Eggs hatch in 62-96 days (Fletcher 1996).

**Feeding Behaviour** – Eastern spiny softshells are benthic feeders and scavengers that are primarily carnivorous (Obbard 1991). Most studies have shown that crayfish are an important food item. Aquatic insects (dragonflies and mayflies), molluscs, earthworms, fish, tadpoles and frogs are also consumed.
Limiting Factors in the Sydenham River – Habitat loss and fragmentation are the major threats to eastern spiny softshells in Ontario (Oldham and Obbard 1996). Shoreline stabilization and development are the largest contributors to habitat loss. Projects designed to control erosion should consider impacts on eastern spiny softshell habitat. On the Sydenham, nesting habitats appear to be in limited supply which may explain the long distances traveled by individual turtles. High rates of nest predation (by raccoons and striped skunks) are a serious problem for softshells in Ontario (Obbard 1991). Pollutants and contaminants affecting prey species or the reproductive potential of softshells may be a limiting factor. Other significant threats include flooding during the incubation period, illegal harvest, and vegetative overgrowth of nesting habitat (Oldham and Obbard 1996). The eastern spiny softshell has been the subject of substantive monitoring and public awareness activities in the Sydenham watershed through the efforts of the Eastern Spiny Softshell Recovery Team (Fletcher and Gillingwater 1994, Fletcher 1996, Oldham and Obbard 1996, Fletcher 1997).

Conservation Priorities

It is clear that the Sydenham River is home to a diverse array of rare species. The distribution and abundance of many of these species have undoubtedly declined over the past several decades and three of the species (wavy-rayed lamphmusel, spotted gar and northern madtom) may be extirpated from the watershed. Five species appear to be stable, and one is expanding its range (bigmouth buffalo). To help prioritize recovery actions, preliminary conservation priorities have been assigned to all of the species at risk (Table 1). These conservation priorities were assigned based on global rarity (G-rank), COSEWIC and Ontario status designations, and distribution and abundance trends within the Sydenham River watershed. It should be noted that a low conservation priority ranking does not equate to low conservation concern, it is simply a relative ranking system to help in prioritizing species- and location-specific recovery efforts.

All of the species with a high conservation priority ranking (all five mussels, eastern sand darter, northern madtom, spotted gar, and eastern spiny softshell) inhabit the middle portion of the East Sydenham River. There is only one record for a high priority species outside of this portion of the river (spotted gar in the lower East Sydenham River). The three species ranked as medium conservation priority (blackstripe topminnow, pugnose minnow and spotted sucker) inhabit the North Sydenham River and Bear Creek as well as the lower portion of the East Sydenham River (the spotted sucker has also been documented upstream in the East Sydenham River on two occasions. The species of low conservation priority are more widely distributed in both branches of the river (brindled madtom, greenside darter) or are apparently expanding their range (bigmouth buffalo).

To identify valuable habitat areas in terms of both diversity and the conservation status of the individual species present, Metcalfe-Smith et al. (unpublished data) developed a conservation scoring system which awards points for each species present based on their sub-national ranks (S1=5, S5=1). The conservation score for a particular location equals the sum of these values for all species present at the site. Conservation scores for recent mussel sampling in the Sydenham
### Table 1. Summary of status and limiting factors for species at risk in the Sydenham River.

<table>
<thead>
<tr>
<th>Species</th>
<th>G-rank</th>
<th>S-rank</th>
<th>COSEWIC</th>
<th>Ontario</th>
<th>Status in Sydenham</th>
<th>Extant sites</th>
<th>Limiting Factors</th>
<th>Conservation Priority*</th>
</tr>
</thead>
<tbody>
<tr>
<td>northern riffleshell</td>
<td>G2T2</td>
<td>S1</td>
<td>Endangered</td>
<td>under review</td>
<td>occupies historic range, but abundance may be declining</td>
<td>middle East Sydenham</td>
<td>primarily siltation, nutrient and pesticide inputs, muskrats</td>
<td>High</td>
</tr>
<tr>
<td>wavy-rayed lampmussel</td>
<td>G4</td>
<td>S1</td>
<td>Endangered</td>
<td>under review</td>
<td>may be extirpated</td>
<td>middle East Sydenham</td>
<td>water clarity</td>
<td>High</td>
</tr>
<tr>
<td>rayed bean</td>
<td>G1G2</td>
<td>S1</td>
<td>Endangered</td>
<td>under review</td>
<td>occupies historic range, but abundance may be declining</td>
<td>middle East Sydenham</td>
<td>primarily siltation, nutrient and pesticide inputs.</td>
<td>High</td>
</tr>
<tr>
<td>snuffbox</td>
<td>G3</td>
<td>S1</td>
<td>Endangered</td>
<td>under review</td>
<td>occupies historic range, but abundance may be declining</td>
<td>middle East Sydenham</td>
<td>siltation</td>
<td>High</td>
</tr>
<tr>
<td>mudpuppy mussel</td>
<td>G3</td>
<td>S1</td>
<td>Endangered</td>
<td>under review</td>
<td>stable?</td>
<td>middle East Sydenham, Bear Creek?</td>
<td>siltation</td>
<td>High</td>
</tr>
<tr>
<td>eastern sand darter</td>
<td>G3</td>
<td>S2</td>
<td>threatened</td>
<td>under review</td>
<td>reduced range</td>
<td>middle East Sydenham</td>
<td>clean, fine sand habitats</td>
<td>High</td>
</tr>
<tr>
<td>northern madtom</td>
<td>G3</td>
<td>S1S2</td>
<td>special concern</td>
<td>threatened</td>
<td>extirpated?</td>
<td>middle East Sydenham</td>
<td>?</td>
<td>High</td>
</tr>
<tr>
<td>spotted gar</td>
<td>G5</td>
<td>S2</td>
<td>threatened</td>
<td>threatened</td>
<td>extirpated?</td>
<td></td>
<td>quiet, densely vegetated waters</td>
<td>High</td>
</tr>
<tr>
<td>Species</td>
<td>G-rank</td>
<td>S-rank</td>
<td>COSEWIC</td>
<td>Ontario</td>
<td>Status in Sydenham</td>
<td>Extant sites</td>
<td>Limiting Factors</td>
<td>Conservation Priority</td>
</tr>
<tr>
<td>-------------------</td>
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<td>-------------</td>
<td>--------------------</td>
<td>---------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>spotted sucker</td>
<td>G5</td>
<td>S2</td>
<td>special concern</td>
<td>vulnerable</td>
<td>stable?</td>
<td>middle East Sydenham, Bear Creek</td>
<td>turbidity</td>
<td>Medium</td>
</tr>
<tr>
<td>pugnose minnow</td>
<td>G5</td>
<td>S2</td>
<td>special concern</td>
<td>vulnerable</td>
<td>declining in north branch?</td>
<td>lower East Sydenham</td>
<td>turbidity, densely vegetated areas</td>
<td>Medium</td>
</tr>
<tr>
<td>blackstripe topminnow</td>
<td>G5</td>
<td>S2</td>
<td>special concern</td>
<td>vulnerable</td>
<td>stable</td>
<td>North Sydenham and tributaries, middle East Sydenham</td>
<td>bank and in-stream vegetation</td>
<td>Medium</td>
</tr>
<tr>
<td>greenside darter</td>
<td>G5</td>
<td>S4</td>
<td>special concern</td>
<td>not at risk</td>
<td>stable</td>
<td>East Sydenham, Bear Creek</td>
<td>turbidity?</td>
<td>Low</td>
</tr>
<tr>
<td>brindled madtom</td>
<td>G5</td>
<td>S2</td>
<td>not at risk</td>
<td>not at risk</td>
<td>stable in Bear Cr., reduced east branch?</td>
<td>Bear Creek, middle-lower East Sydenham</td>
<td>?</td>
<td>Low</td>
</tr>
<tr>
<td>bigmouth buffalo</td>
<td>G5</td>
<td>SU</td>
<td>special concern</td>
<td>not at risk</td>
<td>expanding</td>
<td>lower North Sydenham, lower East Sydenham</td>
<td>temperature?</td>
<td>Low</td>
</tr>
<tr>
<td>eastern spiny softshell</td>
<td>G5T5</td>
<td>S3</td>
<td>threatened</td>
<td>threatened</td>
<td>stable?</td>
<td>middle East Sydenham</td>
<td>lack of nesting sites, nest predation, succession</td>
<td>High</td>
</tr>
</tbody>
</table>

* High - globally rare (G1, G2, or G3), COSEWIC or Ontario designation of endangered or threatened. Medium - globally common (G4 or G5), COSEWIC and Ontario designation of vulnerable, limited or declining distribution. Low - globally common (G4 or G5), Ontario designation of not at risk, widespread and stable or expanding distribution.
River watershed (Fig. 3) clearly demonstrates the importance of the stretch between Alvinston and Dawn Mills in the East Sydenham River (Metcalf-Smith et al., unpublished data). Conservation scores for mussels in this area were higher than in four other southwestern Ontario watersheds sampled by Metcalfe-Smith et al. (unpublished data). The highest conservation scores for fish sampling conducted in 1997 (Holm, unpublished data) were in the North Sydenham River, Bear Creek, and in the East Sydenham River at Tupperville (Fig. 3).

Rare species in the Sydenham River were grouped based on general habitat preferences to identify similarities in habitat use (Fig. 4). These groupings do not necessarily reflect specific microhabitat or seasonal requirements, nor do they imply obligatory habitat use. There is significant overlap in the habitat preferences for several of the rare species in the Sydenham River watershed and many locations are inhabited by multiple species at risk. Because of the similarities in habitat use and co-occurrence at many sites, habitat-based recovery actions will benefit multiple species. The majority of rare species (13) in the Sydenham River utilize areas with firm gravel bottoms and moderate to swift currents (Fig. 4). At least six of these species can also be found in areas with sand-dominated substrates. As previously mentioned, the eastern sand darter is strongly associated with these types of habitats. Six species prefer quieter waters with soft bottoms (mud, silt, organic matter) that are usually well-vegetated. The eastern spiny softshell uses these types of habitats as well as sandy pools.

The primary limiting factor for most of the species at risk in the Sydenham River is siltation and associated turbidity. Mussel and fish species that depend on clean gravel and sand riffles are particularly vulnerable to siltation. Increases in turbidity can also have detrimental impacts to species like the pugnose minnow that rely on dense growths of submerged macrophytes. Efforts to reduce sedimentation through improved land management practices and riparian rehabilitation will provide benefits to a large number of the species at risk. Any such efforts should recognize that “natural” erosion of sand banks is particularly important in maintaining habitats for the eastern sand darter and eastern spiny softshell and may benefit other fish and mussel species that use sand substrates in the river. Hardening of the shoreline and the establishment of vegetation on nesting sites would also result in habitat loss for the eastern spiny softshell. Four of the rare species (wabash pigtoe, ghost shiner, bigmouth buffalo, and blackstripe topminnow) are particularly tolerant of turbidity and may even thrive in high-turbidity habitats. Efforts to reduce erosion and input of fine sediments may have negative impacts on the populations of these species.
Figure 3a. Conservation score for mussel survey sites sampled 1997-1999.

Figure 3b. Conservation score for fish survey sites sampled in 1997.
Figure 4. General habitat preferences for rare species in the Sydenham River watershed (asterisk indicates species that are tolerant of turbidity).
LITERATURE CITED


4th draft, June 11, 2001


## Appendix I. Matrix of ecological requirements for rare mussels in the Sydenham River watershed.

<table>
<thead>
<tr>
<th>Mussel Species</th>
<th><em>Epioblasma torulosa rangiana</em></th>
<th><em>Epioblasma triquetra</em></th>
<th><em>Fusconaia flava</em></th>
<th><em>Lampsilis fasciola</em></th>
<th><em>Obliquaria reflexa</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Srank</strong></td>
<td>S1</td>
<td>S1</td>
<td>S2S3</td>
<td>S1</td>
<td>S1</td>
</tr>
<tr>
<td><strong>Likely/Possible Host</strong> (8)</td>
<td>Johnny darter, eastern sand darter, blackside darter</td>
<td>Logperch, blackside darter</td>
<td>Black crappie, white crappie, bluegill</td>
<td>Smallmouth bass</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Reproductive Period</strong></td>
<td>Bradytictic (4)</td>
<td>Bradytictic (3)</td>
<td>Tachytictic (3)</td>
<td>Bradytictic (2)</td>
<td>Tachytictic, Bradytictic (9)</td>
</tr>
<tr>
<td><strong>Degree of Hermaphroditism</strong></td>
<td>Dioecious (4)</td>
<td>Dioecious (10)</td>
<td>Occasionally (10)</td>
<td>Dioecious (10)</td>
<td>Dioecious (10)</td>
</tr>
<tr>
<td><strong>Waterbody</strong></td>
<td>Medium to large rivers (7)</td>
<td>Large creeks and rivers, also clear stable streams (6)</td>
<td>Running waters of all sizes (6); does well in muddy unstable streams (6)</td>
<td>Large creeks and rivers, especially clear stable streams (6)</td>
<td>Large rivers (7)</td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td>Gravel riffles (7); stable substrates (1)</td>
<td>Riffles (6)</td>
<td>General (1)</td>
<td>Riffles (6); flats (1)</td>
<td>Ubiquitous (1)</td>
</tr>
<tr>
<td><strong>Substrate</strong></td>
<td>Gravel (7); coarse sand to heterogeneous mixtures of coarser material (1)</td>
<td>Gravel (7); combinations of sand, gravel, cobble, and boulder (1);</td>
<td>Mud, sand, or gravel (7); wide variety (1); coarse sand and gravel (17)</td>
<td>Gravel (7); sand/gravel/cobble (1); mud, sand, and gravel (17)</td>
<td>Sand or gravel (7); gravel, sand, and mud (17)</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>Swift (1)</td>
<td>Moderate to swift (1)</td>
<td>0-60+ cm/s (1)</td>
<td>Slow to moderate (1)</td>
<td></td>
</tr>
<tr>
<td><strong>Water Depths</strong></td>
<td>A few cm to 2 m (1)</td>
<td>&lt; 1 m (1)</td>
<td>&lt; 1.5 m (1)</td>
<td>&lt; 1 m (17)</td>
<td>&gt; 4 m (1)</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>K: lethal @ 11 ppm 36-52 d exposure (juveniles) (13)</td>
<td>Cu: 24-h LC50 26-48 ug/L (glochidia) (16)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Appendix I (continued).

<table>
<thead>
<tr>
<th>Mussel Species</th>
<th><em>Obovaria subrotunda</em></th>
<th><em>Pleurobema sintoxia</em></th>
<th><em>Ptychobranchus fasciolaris</em></th>
<th><em>Simpsonaias ambigua</em></th>
<th><em>Toxolasma parvus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Srank</td>
<td>S1</td>
<td>S1</td>
<td>S1</td>
<td>S1</td>
<td>S1</td>
</tr>
<tr>
<td>Likely/Possible Host (8)</td>
<td>eastern sand darter</td>
<td>blunt nose minnow, northern redbelly dace, spotfin shiner</td>
<td>johnny darter; greenside darter</td>
<td>mudpuppy</td>
<td>bluegill, green sunfish, white crappie</td>
</tr>
<tr>
<td>Reproductive Period</td>
<td>bradytictic (2)</td>
<td>tachytics (3)</td>
<td>bradytictic (2)</td>
<td>bradytictic (3)</td>
<td>bradytictic (3)</td>
</tr>
<tr>
<td>Degree of Hermaphroditism</td>
<td>dioecious (10)</td>
<td>occasionally (10)</td>
<td>occasionally (10)</td>
<td>hermaphroditic (10)</td>
<td></td>
</tr>
<tr>
<td>Waterbody</td>
<td>medium sized streams (7); turbid, unstable rivers (6)</td>
<td>medium to large rivers (7); small rivers (1)</td>
<td>large creeks and small rivers (6)</td>
<td>creeks and rivers of all sizes (6)</td>
<td>low gradient creeks, rivers, and reservoirs (6)</td>
</tr>
<tr>
<td>Habitat</td>
<td>sandy riffles (6); upstream from riffles (1)</td>
<td>riffles, also sand or gravel bars (1)</td>
<td>riffles (6); near Justicia americana beds (1); flats immediately above riffles (1)</td>
<td>under flat rocks (6); mud or gravel bars (7); amongst roots of Justicia americana (1)</td>
<td>quiet waters (6); near the bank (1); associated with mud in macrophyte beds (1)</td>
</tr>
<tr>
<td>Substrate</td>
<td>sand, gravel, and cobble (7)</td>
<td>mud, sand, or gravel (7); gravel, cobble, and boulder, also mud (1)</td>
<td>gravel (7); stable sand and gravel (1)</td>
<td>mud to cobble and boulder, also sand and gravel (1)</td>
<td>mud, sand, or fine gravel (7); fine particle substrates, also gravel/cobble (1)</td>
</tr>
<tr>
<td>Current</td>
<td>moderate (1)</td>
<td>calm to swift (&gt;46 cm/s) (1)</td>
<td>moderate to swift (1)</td>
<td>calm to swift (1)</td>
<td>sluggish to no current (1)</td>
</tr>
<tr>
<td>Water Depths</td>
<td>to 2 m (1)</td>
<td>&lt; 1 m to &gt; 6 m (17)</td>
<td>to 1 m (1)</td>
<td>&lt; 1 m (1)</td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix I (continued).

<table>
<thead>
<tr>
<th>Mussel Species</th>
<th>Truncilla donaciformis</th>
<th>Utterbackia imbecillis</th>
<th>Villosa fabalis</th>
<th>Villosa iris</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Likely/Possible Host</strong> (8)</td>
<td>freshwater drum, sauger</td>
<td>bluegill, largemouth bass, creek chub, green sunfish, rock bass, yellow perch, black crappie, channel catfish</td>
<td>blackside darter, greenside darter; Johnny darter</td>
<td>largemouth bass, rock bass, smallmouth bass, greenside darter, green sunfish, rainbow darter, striped shiner, yellow perch</td>
</tr>
<tr>
<td><strong>Reproductive Period</strong></td>
<td>tachytictic (1)</td>
<td>bradytictic (3)</td>
<td>bradytictic (2)</td>
<td>bradytictic (3)</td>
</tr>
<tr>
<td><strong>Degree of Hermaphroditism</strong></td>
<td>dioecious (10)</td>
<td>hermaphroditic (3)</td>
<td>dioecious (10)</td>
<td>hermaphroditic (9)</td>
</tr>
<tr>
<td><strong>Waterbody</strong></td>
<td>large rivers (6); medium sized tributaries (1)</td>
<td>lakes, creeks, and rivers (6)</td>
<td>creeks or small rivers (6)</td>
<td>creeks and small rivers, lakes and large rivers (6)</td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td>stretches of river with current (17)</td>
<td>quiet waters (6)</td>
<td>shallow ripples (6); in water weeds and deeply buried (17)</td>
<td>in the vicinity of ripples (1); near Justicia beds (17)</td>
</tr>
<tr>
<td><strong>Substrate</strong></td>
<td>sand or gravel (7); mud, sand, and gravel mixed with cobble and boulder (1)</td>
<td>mud bottoms (7); fine particle substrates, also cobble/boulder bottoms (1)</td>
<td>sand or gravel (7)</td>
<td>coarse sand or gravel (7)</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>calm to swift (1)</td>
<td>calm, also fast-flowing (1)</td>
<td>slow to swift (1); moderate to strong (17)</td>
<td></td>
</tr>
<tr>
<td><strong>Water Depths</strong></td>
<td>&gt; 2 m (1); &lt; 1 m (3)</td>
<td>1.5 m (1)</td>
<td>&lt; 1 m (1)</td>
<td></td>
</tr>
<tr>
<td><strong>Diet</strong></td>
<td>adult: phytoplankton &amp; detritus (11)</td>
<td>adult: phytoplankton &amp; detritus (11)</td>
<td>adult: phytoplankton &amp; detritus (11)</td>
<td></td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>Cd: 96-h LC50 9 ug/L (juvenile) (14); Cr: 96-h LC50 39 ug/L (juvenile) (14); Cu: 96-h LC50 86 ug/L (juvenile) (14); Hg: 96-h LC50 35 ug/L (juvenile) (14); Ni: 96-h LC50 97 ug/L (juvenile) (14); Zn: 96-h LC50 95 ug/L (juvenile) (14)</td>
<td>Cu: 96-h LC50 83 ug/L (juvenile) (15); Cu: 30-d &gt;19 ug/L (brooded glochidia) (16); Cu: 24-h LC50 36-80 ug/L (released glochidia) (16); Cu: 20-d &gt;400 ug/L (encysted glochidia) (16)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
References:

Appendix II. Matrix of ecological requirements for rare fishes in the Sydenham River watershed.

<table>
<thead>
<tr>
<th>Fish Species</th>
<th><em>Lepisosteus oculatus</em></th>
<th><em>Notropis buchanani</em></th>
<th><em>Opsopoeodus emiliae</em></th>
<th><em>Ictiobus cyprinellus</em></th>
<th><em>Minytrema melanops</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>S-rank</td>
<td>S2</td>
<td>S2</td>
<td>S2</td>
<td>SU</td>
<td>S2</td>
</tr>
<tr>
<td>Spawning Temperature (°C)</td>
<td>15 - 17 (14)</td>
<td>19? (23)</td>
<td>15.6 - 18.3 (3)</td>
<td>12 - 19 (15)</td>
<td></td>
</tr>
<tr>
<td>Spawning Dates</td>
<td>spring (14)</td>
<td>June-August (1)</td>
<td>Mar. - Sep. (16), late spring - early summer (12)</td>
<td>April (3)</td>
<td>late spring - early summer (15)</td>
</tr>
<tr>
<td>Spawning Habitat</td>
<td>lacustrine – submerged vegetation (12)</td>
<td>riverine – sand and gravel riffles (23)</td>
<td>riv./lacustrine – under cover (16)</td>
<td>riv./lacustrine (12), submergent vegetation (3)</td>
<td>riverine - riffle over coarse limestone (15)</td>
</tr>
<tr>
<td>Nursery Habitat</td>
<td>lacustrine (12)</td>
<td>riv./lacustrine (16)</td>
<td>riv./lacustrine (12)</td>
<td>riverine (12)</td>
<td></td>
</tr>
<tr>
<td>Reproductive Guild</td>
<td>scatter (12)</td>
<td>scatter (12)</td>
<td>nest (12)</td>
<td>scatter (12)</td>
<td>scatter (12)</td>
</tr>
<tr>
<td>Trophic Guild</td>
<td>piscivore (14)</td>
<td>unknown (23)</td>
<td>insectivore (12), omnivore (16)</td>
<td>insectivore (12)</td>
<td>insectivore (15)</td>
</tr>
<tr>
<td>Oxygen (mg/L)</td>
<td>9 - 11 (14)</td>
<td>unknown (23)</td>
<td>7 (16)</td>
<td>&gt; 0.9 (3)</td>
<td>unknown (15)</td>
</tr>
<tr>
<td>Turbidity (m secchi)</td>
<td>0.3 - 3 (14)</td>
<td>0.2-0.5 (23)</td>
<td>&gt; 0.10 (16)</td>
<td>high (3)</td>
<td>0.45, intermittent (15)</td>
</tr>
<tr>
<td>Substrate</td>
<td>clays, detritus, muck (14)</td>
<td>silt, clay, sand (23)</td>
<td>Silt, muck (16)</td>
<td>mud, silt, rubble, clay, gravel (3)</td>
<td>sand, gravel, hard clay (15)</td>
</tr>
<tr>
<td>Vegetation</td>
<td><em>Nuphar sp. Typha sp. Anarchus sp., et al., possibly none (14)</em></td>
<td>sometimes present (23)</td>
<td>Aquatic macrophytes (16)</td>
<td>none - dense (3)</td>
<td>dense aquatic macrophytes (15, 19)</td>
</tr>
<tr>
<td>Waterbody Type</td>
<td>bays/backwaters of L. Erie, L. St. Clair (14)</td>
<td>sluggish rivers and creeks (23)</td>
<td>Streams, rivers, lakes (16)</td>
<td>river pools, lowland lakes, man-made reservoirs (3)</td>
<td>rivers (15), Lake Erie (12)</td>
</tr>
<tr>
<td>Current</td>
<td>~</td>
<td>none to slow (23)</td>
<td>Low gradient (avg. &lt; 0.02 m/km), sluggish (16), 0.02 m/km (9)</td>
<td>moderate to slow (3)</td>
<td>sluggish, (~1.4m3/sec) (15)</td>
</tr>
<tr>
<td>Depths (min./max)</td>
<td>prefers deeper water (14)</td>
<td>0.5-1.5 (16), &lt; 1m (18)</td>
<td>0.5 - 8.5 (3), 0-1.0 (20)</td>
<td>~0.40m (15)</td>
<td></td>
</tr>
<tr>
<td>Stream Widths (m.)</td>
<td>~</td>
<td>13-45 (23)</td>
<td>Various (16)</td>
<td>various (3)</td>
<td>various (15), prefers wide rivers (12)</td>
</tr>
</tbody>
</table>
### Appendix II (continued).

<table>
<thead>
<tr>
<th>Fish Species</th>
<th><em>Noturus miurus</em></th>
<th><em>Noturus stigmosus</em></th>
<th><em>Fundulus Notatus</em></th>
<th><em>Ammocrypta pellucida</em></th>
<th><em>Etheostoma blennioides</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S-rank</strong></td>
<td>S2</td>
<td>S1S2</td>
<td>S2</td>
<td>S2</td>
<td>S3</td>
</tr>
<tr>
<td><strong>Spawning Temperature (°C)</strong></td>
<td>25-27 (12)</td>
<td>23 (11)</td>
<td>20 - 25+ (10)</td>
<td>14.4 - 24.4 (6)</td>
<td>10.6 (12)</td>
</tr>
<tr>
<td><strong>Spawning Dates</strong></td>
<td>July-August (17), possibly spring (12)</td>
<td>July - August (12)</td>
<td>May-August (7), June-July (1)</td>
<td>May-August (6)</td>
<td>April-June (12)</td>
</tr>
<tr>
<td><strong>Spawning Habitat</strong></td>
<td>riverine – under cover</td>
<td>riverine – under cover (12)</td>
<td>riv./lacustrine – submerged vegetation (10)</td>
<td>riverine – clean sand (12)</td>
<td>riverine – filamentous algae (12)</td>
</tr>
<tr>
<td><strong>Nursery Habitat</strong></td>
<td>riverine (12)</td>
<td>riverine (12)</td>
<td>Aquatic macrophytes (10)</td>
<td>riverine (12)</td>
<td>riverine (12)</td>
</tr>
<tr>
<td><strong>Reproductive Guild</strong></td>
<td>nest (12)</td>
<td>nest (12)</td>
<td>scatter (10)</td>
<td>bury (12)</td>
<td>bury (12)</td>
</tr>
<tr>
<td><strong>Trophic Guild</strong></td>
<td>insectivore (12)</td>
<td>insectivore (12)</td>
<td>insectivore (10)</td>
<td>insectivore (12)</td>
<td>insectivore (12)</td>
</tr>
<tr>
<td><strong>Oxygen (mg/L)</strong></td>
<td>~</td>
<td>7 - 8.5 (10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turbidity (m secchi)</strong></td>
<td>slight to none (17)</td>
<td>somewhat tolerant (4)</td>
<td>&gt; 0.1m (10)</td>
<td>&gt; 15cm (6), “clear” (5)</td>
<td>Low (2). 0.5-1.2 (5)</td>
</tr>
<tr>
<td><strong>Substrate</strong></td>
<td>unsilted flat rock, gravel, occasionally detritus (17)</td>
<td>sand, rock, debris (13), logs (4)</td>
<td>Debris, silt (10)</td>
<td>sand, gravel, muddy limestone shelves (6), sand (5)</td>
<td>Rocks or gravel, covered with vegetation (2)</td>
</tr>
<tr>
<td><strong>Vegetation</strong></td>
<td>none, occasionally aquatic macrophytes (17), pond weeds (21)</td>
<td>little or none (4)</td>
<td>Aquatic macrophytes, bank cover (10)</td>
<td>absent to some submerged macrophytes (6), absent (5)</td>
<td>Filamentous algae, Cladophora, Fontinalis, Myriophyllum (2)</td>
</tr>
<tr>
<td><strong>Waterbody Type</strong></td>
<td>streams, rivers, some in lakes (17)</td>
<td>large streams, rivers, lakes (13)</td>
<td>Streams and rivers (10)</td>
<td>streams, rivers, sandy shoals in lakes (6)</td>
<td>Streams, rivers, riffles (2)</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>moderate to fast (17)</td>
<td>varied, usually moderate to swift (13)</td>
<td>Still to sluggish (avg. 1.4 m/km stream gradient) (10)</td>
<td>still to swift (6)</td>
<td>Moderate to fast (2)</td>
</tr>
<tr>
<td><strong>Depths (min./max)</strong></td>
<td>~0.3 (17), 0-0.91 (21)</td>
<td>2 (11)</td>
<td>0 - 1 (10), 0.6 (8)</td>
<td>~0 - 0.6 (18), 0.1-0.4 (5)</td>
<td>&lt; 1 (2), &lt;1.8 (5)</td>
</tr>
<tr>
<td><strong>Stream Widths (m.)</strong></td>
<td>various (17)</td>
<td>Various &lt; 4m from shore (10)</td>
<td>50 (5)</td>
<td>24 - 130 (5)</td>
<td></td>
</tr>
</tbody>
</table>
References:

7. Holm, E., Unpublished data for *Fundulus notatus* status update
12. Ontario Freshwater Fish Life History Database
19. ROM, unpublished data, Walpole Island sampling, 1999