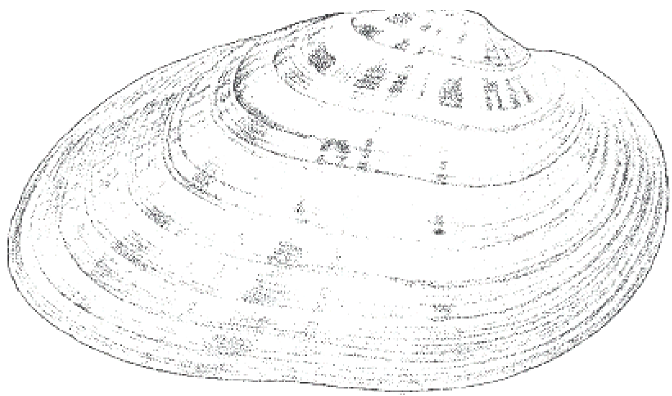
COSEWIC
Assessment and Status Report

on the

Kidneyshell
Ptychobranchus fasciolaris

in Canada



ENDANGERED
2003

COSEWIC
COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES ESPÈCES EN PÉRIL AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215
Fax: (819) 994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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COSEWIC
Assessment Summary

Assessment Summary – May 2003

Common name
Kidneyshell

Scientific name
Ptychobranchus fasciolaris

Status
Endangered

Reason for designation
This species has been lost from about 70% of its historical range in Canada due to impacts of the zebra mussel and land use practices. It is now restricted to the East Sydenham and Ausable rivers. Although both populations appear to be reproducing, there is evidence that abundance has declined in the East Sydenham River. Agricultural impacts, including siltation, have eliminated populations in the Grand and Thames Rivers and threaten the continued existence of this species in Canada.

Occurrence
Ontario

Status history
Designated Endangered in May 2003. Assessment based on a new status report.

Executive Summary

Kidneyshell
Ptychobranchus fasciolaris

Species information

The Kidneyshell, *Ptychobranchus fasciolaris* (Rafinesque 1820), is a medium to large freshwater mussel (maximum length in Canada ~120 mm) that is easily recognized by its elongate, yellow-brown shell with wide, interrupted green rays that look like squarish spots.

Distribution

The Kidneyshell historically occurred throughout the Ohio, Tennessee, and Cumberland River systems, and in Lake Erie, Lake St. Clair, and some of their tributaries. In Canada, it is known only from southern Ontario, where it has been found in the Grand, Thames, Sydenham, Ausable, Niagara and Detroit rivers, as well as Lake Erie and Lake St. Clair. The species is still found throughout its historical range in the USA; in Canada, it is extant in the Sydenham and Ausable rivers and Lake St. Clair.

Habitat

The Kidneyshell is most often found in small to medium-sized rivers and streams, where it prefers shallow areas with clear, swift-flowing water and substrates of firmly-packed coarse gravel and sand. It is rarely found in either large rivers or headwater creeks, but has been found on gravel shoals in Lake Erie and Lake St. Clair. It is often found near beds of water willow, an aquatic plant. It is usually found deeply buried in the substrate.

Biology

The Kidneyshell has separate sexes, but males and females look alike. The lifespan is not known, but is probably at least 10 years. Like other freshwater mussels, the Kidneyshell is parasitic on fish during its larval stage. The female mussel releases her larvae into the water in packets that look like fish prey items, thereby attracting nearby fish. When the fish bites into these packets, the mussel larvae are released, attach to the fish's gills, and each forms a cyst. After a period of time, the larvae transform into juveniles, which then drop off and fall to the substrate to begin life as a free-living mussel. Different mussel species have different host fishes. The most likely hosts for the Kidneyshell in Ontario are the greenside darter (*Etheostoma blennoides*), fantail darter (*E. flabellare*), and/or johnny darter (*E. nigrum*). Kidneyshells, like all freshwater mussels, feed on bacteria and algae that they filter from the water with their gills.

Population sizes and trends

Ptychobranchus fasciolaris was always rare in Lake Erie, Lake St. Clair, and the Niagara and Detroit rivers, but has now been virtually extirpated from these waters by the zebra mussel, *Dreissena polymorpha*. Only seven live animals were found during recent, extensive surveys in Lake St. Clair. The Kidneyshell is apparently extirpated from the Thames and Grand rivers. It is now restricted to two reproducing populations that occupy a 100-km reach of the East Sydenham River and a 25-km reach of the Ausable River, and there is evidence that it may be declining in abundance in the former river. Populations of *P. fasciolaris* in the United States appear stable.

Limiting factors and threats

Zebra mussels have nearly destroyed native freshwater mussel communities in the Great Lakes. Approximately 60% of sites where the Kidneyshell was found historically are now infested with zebra mussels. Populations in the Grand and Thames rivers were likely extirpated due to the combined effects of sewage pollution and agricultural impacts. The two remaining populations in Canada, located in the East Sydenham and Ausable rivers, are threatened by factors related to intensive agriculture, especially heavy loadings of silt and nutrients. Muskrats are also a potential limiting factor, since the Kidneyshell is one of the mussel species on which they prey.

Special significance of the species

There are five species in the genus *Ptychobranchus*, but only *P. fasciolaris* has a range extending into Canada. The Kidneyshell is also the only member of the genus that is considered to be stable throughout most of its North American range at the present time. Since the Kidneyshell inhabits only high-quality rivers and streams, its decline or loss is a good indication that habitat degradation is occurring.

Existing protection

The Kidneyshell is listed as endangered in Illinois and Mississippi, and special concern in Alabama and Indiana, and is therefore afforded some protection in these states. There is no protection for the Kidneyshell in Canada at the present time.

Summary of status report

Ptychobranchus fasciolaris historically occurred in 12 states and the province of Ontario. Populations in the United States appear stable. The Kidneyshell has been lost from about 70% of its historical range in Canada due to impacts of the zebra mussel and poor land use practices. It is now restricted to the East Sydenham and Ausable rivers. Although both populations appear to be reproducing, there is evidence that abundance has declined in the East Sydenham River. Agricultural impacts, particularly siltation, threaten the continued existence of the Kidneyshell in Canada.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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SPECIES INFORMATION

Name and classification

Scientific name: *Ptychobranchus fasciolaris* (Rafinesque, 1820)
English common name: Kidneyshell
French common name: Coquille de Rein

The recognized authority for the classification of aquatic molluscs in the United States and Canada is Turgeon et al. (1998). The currently accepted classification of this species is as follows:

Phylum Mollusca
Class Bivalvia
Subclass Palaeoheterodonta
Order Unionoida
Superfamily Unionacea
Family Unionidae
Subfamily Lampsilinae
Genus *Ptychobranchus*
Species *Ptychobranchus fasciolaris*

Parmalee and Bogan (1998) provide a complete synonymy for the species. The only synonym that the authors encountered during their examination of museum collections was *Ptychobranchus fasciolare*.

Description

The Kidneyshell is a medium to large freshwater mussel that is readily distinguished by its elongate, elliptical shell and yellowish-brown periostracum with wide, interrupted green rays that look like squarish spots. The type locality is the Muskingham River, Ohio. The following description of the species was adapted from Clarke (1981), Strayer and Jirka (1997) and Parmalee and Bogan (1998). The shell is solid, heavy and compressed, and may have a humped shape in old individuals. The anterior end is rounded and the posterior end is bluntly pointed. Beak sculpture is poorly developed, consisting of several fine, indistinct wavy ridges. The surface of the shell (periostracum) ranges in colour from yellowish to yellowish-green, yellowish-brown, or medium brown, with generally distributed broad, interrupted green rays; the shells of old specimens may be a dark chestnut brown and rayless. The periostracum is unsculptured except for coarse growth rests and a roughened posterior slope. The nacre is generally white or bluish white, but may be pinkish in young specimens. The hinge teeth are heavy. The left valve has two low, thick, serrated triangular pseudocardinal teeth and two lateral teeth that are short, nearly straight, and usually widely separated. The right valve has one somewhat compressed and pyramidal elevated tooth and one wide, elongated and serrated lateral tooth. The lateral teeth are almost pendulous distally, which is a good distinguishing feature. The interdentum is wide and the beak cavity is shallow. Females have a conspicuous groove on the inside of the shell that runs diagonally from the beak cavity towards the posterioventral end; this groove corresponds to the marsupium. Old, rayless Kidneyshells may be mistaken for *Elliptio dilatata* (the spike) which, however, is more elongate, has less massive lateral teeth (that are not pendulous), heavy beak sculpture, and (commonly) purple nacre.

The Kidneyshell may grow up to 150 mm long in ideal habitats, but most mature individuals do not exceed 120-130 mm in Tennessee (Parmalee and Bogan 1998) and 100 mm in New York (Strayer and Jirka 1997). It tends to remain quite small in lake environments, e.g., Ortmann (1919) reported a maximum length of 72 mm for this species in Lake Erie, and the authors recorded lengths of 53-68 mm for specimens from Lake St. Clair. According to Clarke (1981), the Kidneyshell reaches a maximum size of about 100 mm in Canada; however, the authors observed live individuals as large as 124 mm during recent surveys in Ontario rivers. Figure 1A shows the external features of the shell and internal features of the left valve (hinge teeth), and Figure 1B is a photograph of a live specimen collected from the Sydenham River near Florence, Ontario on 20 August 1997.

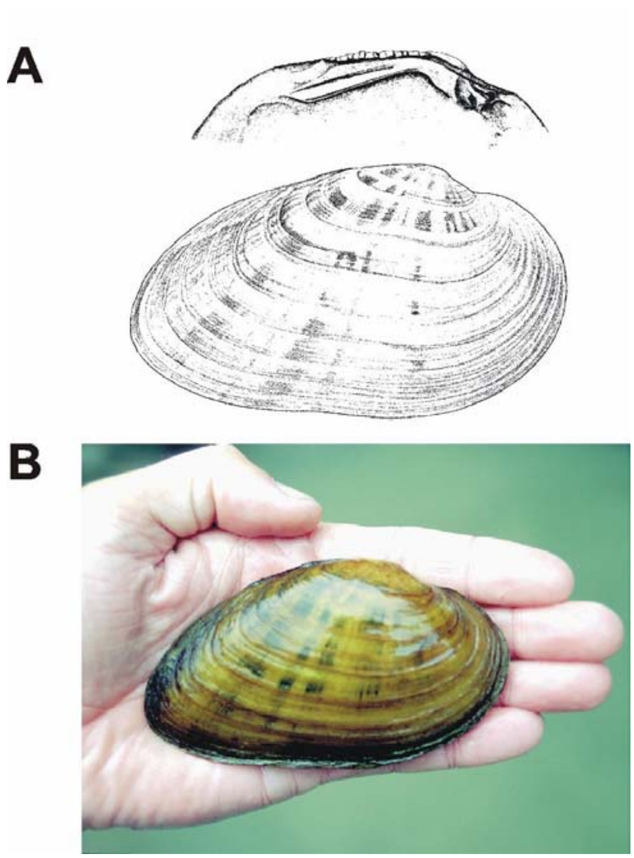

Figure 1. (A) Line drawings of the external features of the shell and internal features of the left valve (hinge teeth) of *Ptychobranchus fasciolaris*. Reproduced from Burch (1973). (B) Photograph of a live specimen from the Sydenham River Ontario. Photo credit: S.K. Staton, NWRI.

DISTRIBUTION

Global range

The Kidneyshell was once generally distributed throughout the Ohio, Tennessee, and Cumberland River systems. In the Great Lakes drainage, it was found in Lake Erie and Lake St. Clair and some of their tributaries, the Detroit River, the Niagara River and some of its tributaries, and at least one tributary to lower Lake Huron (Strayer and Jirka 1997; Parmalee and Bogan 1998; Morris and Di Maio 1998). It was historically known from Alabama, Illinois, Indiana, Kentucky, Michigan, Mississippi, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and Ontario (Figure 2).

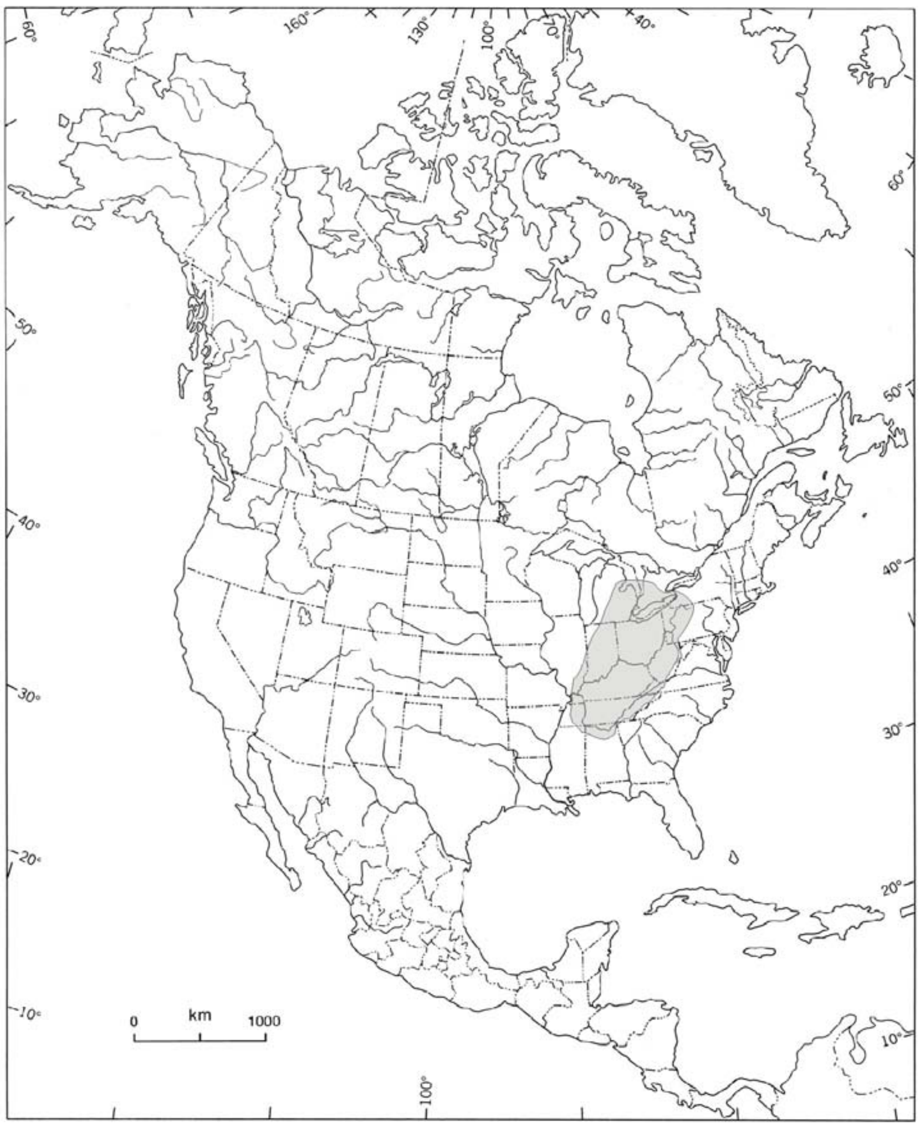

Figure 2. North American distribution of *Ptychobranchus fasciolaris* (based on information provided by jurisdictions).

Canadian range

In Canada, *P. fasciolaris* is known only from southern Ontario. The National Water Research Institute's Lower Great Lakes Unionid Database was used to identify occurrence records for *P. fasciolaris* in Ontario. At the time of writing, the database consisted of approximately 6000 records for 40 species collected from over 2000 sites in the lower Great Lakes drainage basin since 1860 (see Metcalfe-Smith et al. 1998a for a detailed description of the database and its data sources). The earliest record of the Kidneyshell in Canada is two fresh whole shells collected in 1885 from Lake Erie at Port Colborne by J. Macoun (specimens held by the Canadian Museum of Nature; cat. no. 002408). Since then, it has been reported from many other locations along the north shore of Lake Erie and in the Niagara, Detroit, Grand, Thames, Sydenham and Ausable rivers and Lake St. Clair. Figure 3 shows the historical distribution of the Kidneyshell in Ontario, based on 60 records collected between 1885 and 1990, and the current distribution, based on 42 records collected over the last decade (1991 - 2001). Only 27 of the latter records were for live animals; the remainder were for shells. The most recent live record is for a specimen collected in September 2001 from the St. Clair delta.

Lake Erie, Lake St. Clair and the Niagara and Detroit rivers are now infested with the exotic zebra mussel, *Dreissena polymorpha*, which has nearly destroyed native freshwater mussel populations in these waters - leaving only isolated pockets of surviving animals in some nearshore areas of the lakes (Zanatta et al. 2002). Approximately 60% of historical records for *P. fasciolaris* are from waters now infested with zebra mussels. The Kidneyshell has also apparently been lost from the Thames and Grand rivers (Metcalfe-Smith et al. 1999). Although there were few past records for this species from the Thames River, it had previously been found at a number of locations along a 50+ km stretch of the lower Grand River. The Kidneyshell is now restricted to a 100 km reach of the East Sydenham River and a 25 km reach of the Ausable River, with a small number of specimens still surviving in Lake St. Clair (only 7 of 2356 live mussels collected in 1999-2001 were Kidneyshells). The current extent of occurrence is approximately 2050 km^2, representing a 70% decline from the historical extent of occurrence (~6700 km^2). The current area of occupancy is 10.4 km^2.

HABITAT

Habitat requirements

Ptychobranchus fasciolaris is most commonly found in small (6-16 m wide) to medium-sized (15-20 m wide) rivers, and is rarely found in large rivers (>30-50 m wide); it also occurs in Lake Erie, Lake St. Clair and Lake Chautauqua, where it attains a much smaller size (van der Schalie 1938, Gordon and Layzer 1989, Strayer and Jirka 1997). It has also been found in shallow (<1 m) sections of impoundments that still have some moving water (Gordon and Layzer 1989, Parmalee and Bogan 1998). It is usually absent from headwater creeks less than 3 m wide (Ortmann 1919, van der Schalie

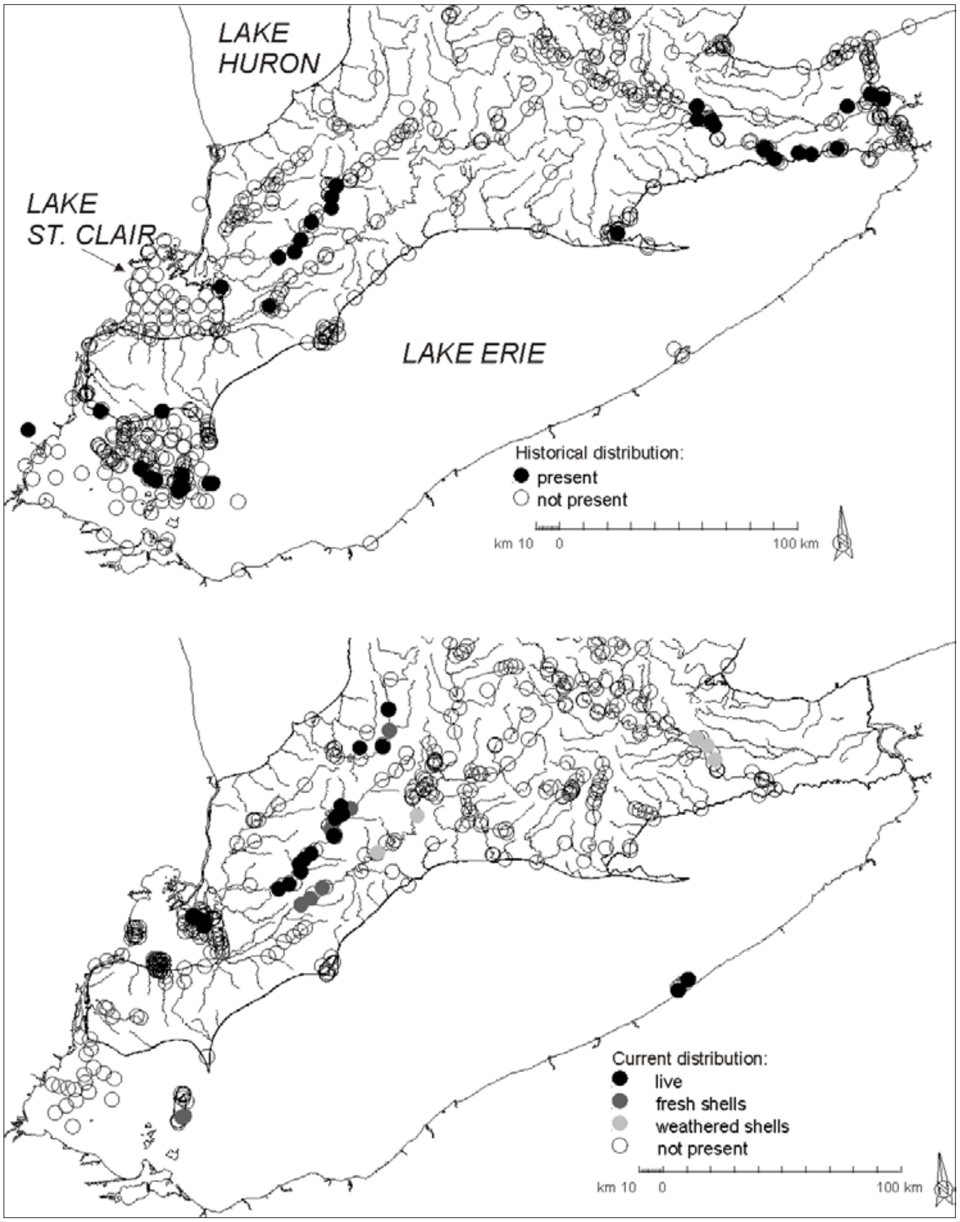

Figure 3. Historical (1885-1990) and current (1991-2001) distributions of *Ptychobranchus fasciolaris* in Ontario (based on records from the Lower Great Lakes Unionid Database).

1938). The Kidneyshell has very distinct ecological preferences, favouring riffle areas with substrates of firmly-packed coarse gravel and sand and moderate to swift flows (Ortmann 1919, Gordon and Layzer 1989), and has an aversion to ponded or backwater conditions (van der Schalie 1938). It is frequently found adjacent to beds of water willow (*Justicia americana*), an emergent aquatic plant (Ortmann 1919, Gordon and Layzer 1989). It is usually found deeply buried in stable substrates at depths of <1 m. In Lake Erie, it is (or was) found in shallow water on sandy or slightly gravelly shoals exposed to wave action (Ortmann 1919, Gordon and Layzer 1989).

The Kidneyshell has been found in most of the major river systems of southeastern Michigan, and is particularly abundant in the Clinton River - especially in the upper reaches above Pontiac. Habitat in the upper Clinton River may therefore be optimal for this species. This reach of the river is described by Strayer (1980) as "…a small, (<10 m wide), clear stream flowing across a flat outwash plain. Its course is interrupted by a number of lakes and marshy areas." The Clinton and other rivers in this region have sand and gravel substrates, steady flows, very low stream gradients, and clear water due to the high infiltration capacities of the soils (Strayer 1983). It is interesting to note that the Sydenham River in Ontario, where *P. fasciolaris* still occurs, is also a low gradient system. According to van der Schalie (1938), *P. fasciolaris* often co-occurs with *Villosa iris*, *Elliptio dilatata* and *Lampsilis fasciola*. We observed an association between *P. fasciolaris* and *E. dilatata* in the Ausable River, where the largest numbers of both species were found at the same two sites, but not in the Sydenham River where *E. dilatata* is extremely rare (Metcalfe-Smith et al. 1999). The association between *P. fasciolaris* and *L. fasciola* is noteworthy since the latter species was designated as endangered by COSEWIC in 1999 (Metcalfe-Smith et al. 2000c). We have not observed such an association, probably because both species are now so rare in Ontario.

The habitat preferences of juvenile mussels are believed to be different from those of adults, but there have been few studies on this topic (Gordon and Layzer 1989). The juvenile life stage is certainly more vulnerable than the adult stage, because juveniles have no control over the habitat into which they are released by their host and may die quickly in unsuitable habitats. The glochidial (larval) stage is the most vulnerable and specialized life stage, because the glochidia must successfully attach to an appropriate host in order to complete their metamorphosis to the juvenile stage. Since populations of *P. fasciolaris* in both the Sydenham and Ausable rivers show evidence of recruitment (see section on Population Sizes and Trends), it appears that the quality of the habitat in at least some reaches is acceptable. However, it is not known if the extent of suitable habitat is sufficient for maintaining viable populations of the species into the future.

Trends

The zebra mussel invasion of the Great Lakes, which began in the late 1980s, resulted in the near extirpation of native mussel communities from Lake Erie, Lake St. Clair, and their connecting channels by the mid-1990s. Only isolated communities of unionids, most with reduced species richness, still remain in some nearshore areas (Zanatta et al. 2002). Ptychobranchus fasciolaris was always rare in these waters, and only a few live specimens have been captured in recent years. The Kidneyshell has apparently been lost from the Thames and Grand rivers. It still occupies its historical range in the East Sydenham River, although there are indications that it may be declining in abundance in the upper reaches. It is also found in the Ausable River. A lack of historical data on mussels in this system precludes any time trend analyses. Overall, we estimate that *P. fasciolaris* has been lost from up to 70% of its historical range in Canada. Loss of habitat in the Great Lakes should be considered permanent, since zebra mussels cannot be controlled. However, loss of habitat in the Grand River may be reversible. The mussel community of the Grand River has largely recovered from the severe pollution of the 1960s; 16 species have recolonized the lower reaches over the past 25 years, reflecting significant improvements in the treatment of sewage and industrial effluent discharged to the river over the same period (Metcalfe-Smith et al. 2000b). It is not known if there is currently enough habitat available for the long-term survival of the Kidneyshell in Canada. The current level of habitat protection for this species must be considered uncertain, since most of its occupied range is privately owned. More details about changes in the distribution of the Kidneyshell in Canada, and probable causes of these changes, are presented in the sections on Distribution, and Limiting Factors and Threats.

The current distribution and abundance of the Kidneyshell in the United States remains much the same as it was historically (see Population Sizes and Trends). However, the alarming decline of many mussel species in North America is primarily the result of habitat destruction and degradation associated with anthropogenic activities (Williams et al. 1993).

Protection/ownership

Most land along the reach of the East Sydenham River where *P. fasciolaris* presently occurs is privately owned and in agricultural use. Only two small properties, the 7 ha Shetland Conservation Area and the 20 ha Mosa Township forest, are publicly owned and thus somewhat protected. It should be noted, however, that a recovery strategy has been developed for the aquatic ecosystem of the Sydenham River, and a number of landowners are participating in riparian rehabilitation projects and improved land use practices that will benefit *P. fasciolaris* and other aquatic species at risk in the Sydenham River (Sydenham River Recovery Team 2002).

Agriculture is also the primary land use in the Ausable River watershed. However, there are considerably more publicly owned lands in the Ausable basin than in the Sydenham basin. The Ausable-Bayfield Conservation Authority owns a number of properties totaling 1830 ha throughout the basin, and there are two Areas of Natural and Scientific Interest (ANSI), namely, the Ausable Gorge and Hay Swamp, that cover about 3500 hectares (ABCA 1995).

BIOLOGY

General

The basic life history of the freshwater mussel is applicable to the Kidneyshell, and is described briefly as follows (adapted from Kat 1984, Watters 1999, and Nedeau et al. 2000): during spawning, males release sperm into the water and females living downstream filter the sperm out of the water with their gills. Ova are fertilized in a specialized region of the female's gills, called a marsupium, where they are held until they reach an intermediate larval stage termed the glochidium. The female mussel then releases the glochidia, which must attach to an appropriate host and become encapsulated. The glochidia remain attached and are nourished by the host's body fluids until they metamorphose into juveniles. The juveniles then break free of the capsule and fall to the substrate to begin life as a free-living mussel. The proportion of glochidia surviving to the juvenile stage is estimated to be as low as 0.000001%. Mussels overcome the extremely high mortality associated with this life cycle by producing large numbers of glochidia.

Reproduction

The Kidneyshell, like most freshwater mussels, is considered to be dioecious, although van der Schalie (1970) reports that it may be occasionally hermaphroditic. Hermaphroditism affords benefits when population densities are low; under such conditions, females may switch to self-fertilization to ensure that recruitment continues. There are no sexual differences in the shell of *P. fasciolaris*, except that males are slightly more compressed than females (Ortmann 1919) - a feature that cannot be used with any certainty to separate the sexes. The lifespan of *P. fasciolaris* is not known, but members of the Subfamily Lampsilinae generally grow more rapidly and have shorter life spans than members of the Ambleminae, which can live for over 40 years (Stansbery 1967). For comparison, life spans of three other COSEWIC-listed lampsilines are: 10-20 years for *L. fasciola* (Metcalfe-Smith et al. 2000c), more than 15 years for *Epioblasma torulosa rangiana* (Staton et al. 2000), and up to 11 years for *V. fabalis* (Woolnough and Mackie 2002).

Ptychobranchus fasciolaris is a long-term brooder (bradytictic). The breeding season begins in August, and glochidia are discharged the following June to perhaps as late as August (Ortmann 1919, Clarke 1981). Gravid females have been observed in every month except July (Gordon and Layzer 1989). Glochidia are small, purse-shaped, without hooks, and measure 190 μm in height and 170 μm in length (Clarke 1981, Hoggarth 1993). The lack of hooks suggests that they are gill parasites. Some freshwater mussels have evolved structures or behaviours that increase the chances of a glochidium contacting a host. Members of the genus *Ptychobranchus* produce conglutinates, which are specialized packets of glochidia bound in a cellular or mucoidal matrix (Watters 1999). These structures are expelled intact in forms that mimic host prey items. Watters (1999) found that *P. fasciolaris* produces two types of conglutinates; the major type resembles fish fry, complete with pigmentation resembling eyes and lateral lines, and the minor type is brightly coloured and mimics insect larvae such as simuliids or chironomids. The host is infected when it bites into the conglutinate, which ruptures and releases the glochidia in close proximity to the fish's gills.

The host fish(es) for *P. fasciolaris* in the Sydenham and Ausable rivers are unknown, but Watters (1999) notes that the hosts for three other species of *Ptychobranchus* have all been identified as species of Percidae (darters) and Cottidae (sculpins). White et al. (1996) observed four darter species - *Etheostoma blennoides* (greenside darter), *E. flabellare* (fantail darter), *E. nigrum* (johnny darter), and *E. zonale* (banded darter) - habouring Kidneyshell glochidia in French Creek, Pennsylvania. All but one of these species (*E. zonale*) are native to Canada (Scott and Crossman 1973). Fantail, johnny and greenside darters have all been found in the Sydenham River, and the latter two species are widely distributed and relatively abundant in the system (S.R. de Solla and J.L. Metcalfe-Smith, unpublished data).

Movements/dispersal

In the adult form, freshwater mussels are basically sessile; movement is limited to a few metres of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations (Nedeau et al. 2000). Dispersal is likely to be a slow process for mussels like the Kidneyshell, which use resident fishes with limited home ranges as their hosts. Remaining populations of *P. fasciolaris* in Canada are isolated from one another and from populations in the United States. Thus, there is no natural means by which individuals from American populations could bolster the Canadian population or repopulate the Canadian range if the Canadian populations should disappear.

Nutrition and interspecific interactions

Kidneyshells, like all species of freshwater mussels, are filter feeders as adults. Their primary food sources are bacteria, algae, particles of organic detritus, and some protozoans (Nedeau et al. 2000). Food availability is not normally a limiting factor, although it could be in the presence of high densities of zebra mussels, which are extremely efficient filter-feeders. During the parasitic larval stage, glochidia feed on the body fluids of the host.

Behaviour/adaptability

Kidneyshells are highly specialized in terms of their habitat requirements (clear, swift-flowing water and firmly-packed gravel/sand substrates in small to medium sized rivers and streams) and their host fishes (presumably one or more species of darters and/or sculpins). There is no specific information available on their sensitivity to natural or human-induced disturbances.

Artificial propagation of freshwater mussels is in the early stages of development, and juvenile mussels have only recently been released into the wild. Long-term survival of such captive-bred animals is completely unknown at this point. To date, the only species that have been artificially reared are federally (U.S.) endangered species belonging to the *Epioblasma* and *Lampsilis* genera.

POPULATION SIZES AND TRENDS

United States

Ortmann (1919) provides an overview of the distribution and abundance of *P. fasciolaris* across its range in the United States at the turn of the century. To summarize, the species was said to be found at numerous locations all over Ohio; "practically all over the state" of Indiana in both the Ohio and Erie drainages, but absent from the Lake Michigan drainage; very abundant in the upper Tennessee region; scarce in Illinois; and "spread over practically the whole lower peninsula of Michigan". It had reached New York at Buffalo via Lake Erie, and Lake Chautauqua via the upper Allegheny River. This information indicates that *P. fasciolaris* was once widely distributed and quite common in many parts of its North American range.

Recent information suggests that the current distribution and abundance of the Kidneyshell in the U.S. remains much the same as it was historically. It is sporadic in its distribution in Ohio, but may be abundant where present (G. T. Watters, Ohio Biological Survey, pers. comm. July 2001). It is also quite abundant in the Tippicanoe and Little Blue rivers in Indiana (K. Cummings, Illinois Natural History Survey, pers. comm. August 2001). In Tennessee, it occurs throughout the Tennessee and Cumberland river systems, mostly in medium-sized rivers such as the upper Clinch and Powell, the Big South Fork, Cumberland, Emory, Nolichucky, Elk, Duck, Harpeth, and Stones (Parmalee and Bogan 1998). It is also a relatively common inhabitant of streams across Kentucky (R. Cicerello, Kentucky Department of Natural Resources, pers. comm. August 2001). In Michigan, Kidneyshells are found in many drainages in the lower peninsula of the state, and can be locally abundant (P. Badra, Michigan Natural Features Inventory, pers. comm. September 2001). In New York, the Kidneyshell is abundant in streams in the Allegheny River basin and is also found in a few places in the Lake Erie-Niagara River basins (Strayer and Jirka 1997). It is also found in the Ohio River drainage and the Allegheny and Monongahela River drainages in Pennsylvania (A. Shiels, Pennsylvania Nongame and Endangered Species Unit, pers. comm. September 2001). In West Virginia, Kidneyshells are found throughout the interior basin of the state and can be quite common at some sites (J. Clayton, West Virginia Department of Natural Resources, pers. comm. August 2001). In Virginia, the species is found at sites throughout the Clinch River (S. Carter-Lovejoy, Virginia Dept. of Conservation and Recreation, pers. comm. July 2001). In Alabama, it is very rare in the Tennessee River, but is encountered regularly in two of its tributaries, Bear Creek and Paint Rock River (J. Garner, Alabama Division of Wildlife and Freshwater Fisheries, pers. comm. October 2001). A few fresh shells were recently collected from the portion of Bear Creek that runs though Mississippi; otherwise, the species is very rare in that state (R. Jones, Mississippi Department of Wildlife, Fisheries, and Parks, pers. comm. October 2001). According to Cummings and Mayer (1997), the Kidneyshell has been lost from three of five river systems where it once occurred in eastern Illinois. It is now restricted to the Embarras and Vermilion rivers, where it is sporadic.

Although *P. fasciolaris* is widespread in distribution, it is seldom a significant component of the mussel community. Table 1 summarizes the available information on frequency of occurrence and relative abundance of this species in various locations in Alabama, Michigan, New York, Ohio, Pennsylvania and Tennessee. The Kidneyshell was generally found at fewer than one-third (range 4-40%) of sites surveyed, representing 2.5% on average (range 0.2-8.0%) of the total number of mussels collected. At individual sites where it was found, it often accounted for more than 10% of the community — which supports the description of this species as "locally abundant" (see above).

Table 1. Frequency of occurrence and relative abundance of *Ptychobranchus fasciolaris* in various locations in the United States.

			Relative abundance		
River/Lake	**State**	**Frequency of occurrence, as % of sites surveyed (# sites)**	**% of community over all sites**	**% of community at sites where found**	**Year of survey**
Clinton River	MI	13% (76)	8%	<1-30%; mean=13%	1977-78 [a]
Clinton, Huron & Raisin rivers	MI	37% (75)	-	-	1980 [b]
Lake Erie at Presque Isle	PA	20% (5)	<1%	~1%	1990-92 [c]
Tonawanda Creek	NY	5% (38)	0.4%	<1-3%	1998 [d]
Paint Rock River	AL	40% (25)	2%	<1-12%; mean=5%	1991 [e]
Elk River	TN, AL	9% (108)	0.7%	1-11%; mean=6%	1980 [f]
Duck River	TN	4% (99)	0.2%	1-14%; mean=9%	1979 [g]
Nolichucky River	TN	34% (41)	3%	2-33%; mean=11%	1980 [g]
Paint Rock River	TN	32% (28)	5%	2-18%; mean=9%	1980 [g]
Powell River	TN	28% (78)	1%	<1-14%; mean=4%	1979 [g]
upper Blanchard River	OH	36% (11)	3%	2-8%	1994-1996 [h]

[a]Strayer (1980), [b]Strayer (1983), [c]Masteller et al. (1993), [d]Marangelo and Strayer (2000), [e]Ahlstedt (1995-96), [f]Ahlstedt (1983), [g]Ahlstedt (1991), [h]Hoggarth et al. (2000).

It is exceptionally abundant in the upper Clinton River, MI, comprising 30-40% of the community (P. Marangelo, The Nature Conservancy, Michigan Chapter, pers. comm. July 2001). The only information on population densities for this species comes from the Clinch and Powell rivers in Tennessee and Virginia. Ahlstedt and Tuberville (1997) surveyed 14 sites on the Clinch River and 19 sites on the Powell River on four occasions between 1979 and 1994, and reported stable densities of about 0.15 and 0.08 Kidneyshells/m^2, respectively. There is evidence of population decline in some areas. As noted above, it has been lost from three of five previously-inhabited river systems in Illinois (Cummings and Mayer 1997). Also, the Kidneyshell was one of eight species lost between 1980 and 1998 from Copper Creek, a tributary to the Clinch River in Virginia, due to siltation from poor land management practices (Fraley and Ahlstedt 2000).

Canada

Ptychobranchus fasciolaris has been reported from the Grand, Thames, Sydenham and Ausable rivers in Ontario, and from the Canadian and American waters of Lake Erie, Lake St. Clair, and the Niagara and Detroit rivers. Since the Kidneyshell is mainly a small river species that prefers swift-flowing water, it is hardly surprising that populations in the Great Lakes have always been sparse. For example, Nalepa et al. (1991) reviewed the data from six mussel surveys conducted in the western basin of Lake Erie between 1930 and 1982, and did not report any records for *P. fasciolaris*. Masteller et al. (1993) found only one live Kidneyshell among 1540 mussels of 18 species collected from Presque Isle Bay, Erie, PA, in 1990-92. They reported that the mussel fauna of the bay had remained essentially unchanged since the surveys of Ortmann (1919) in 1909-1911. The Kidneyshell was not among 18 species of mussels collected at 29 sites surveyed in Lake St. Clair on four occasions between 1986 and 1994 (Nalepa et al. (1996). Gillis and Mackie (1994) surveyed two sites in southwestern Lake St. Clair between 1990 and 1992, and reported densities of 0.01-0.06 Kidneyshells/m^2. These densities may have reflected the impacts of the zebra mussel, which eventually destroyed the mussel communities at both sites. Zanatta et al. (2002) surveyed 95 sites in nearshore areas around Lake St. Clair between 1998 and 2001 and found live mussels at 33 sites, most of which were in the St. Clair delta. Only seven (0.3%) of the 2356 live mussels collected were Kidneyshells. Schloesser et al. (1998) surveyed nine sites along the northeastern shore of the Detroit River both before (1982-83) and during (1992 and 1994) the zebra mussel invasion. Kidneyshells represented 2% (15/857) of live mussels collected in 1982-83, 4% (63/1592) in 1992 and 3% (2/58) in 1994. The Kidneyshell was one of only 13 of the original 26 species to survive up to 1994. A mussel survey was conducted in the Niagara River in the summer of 2001 for the New York Power Authority. Divers found old shells of 16 different species, but only one of the 13 study sites supported live mussels and only three species were represented. According to the consultant responsible for the survey, “There were zebra mussels everywhere” (K. Schneider, Stuyvesant Falls, NY, pers. comm. August 2001). No further details about the survey could be disclosed.

Metcalfe-Smith et al. (1998b, 1999) surveyed 65 sites on the Grand, Thames, Sydenham and Ausable rivers in 1997-98 to determine the conservation status of rare species of freshwater mussels in southwestern Ontario. They used the timed-search technique, which they have shown to be the most efficient method for detecting rare species (Metcalfe-Smith et al. 2000a), and an intensive sampling effort of 4.5 person-hours (p-h)/site. Sites that were known to support rare species (including *P. fasciolaris*) in the past were targeted. Results of these and other recent surveys were compared with the historical data to determine population trends for the Kidneyshell in these rivers.

It appears that *P. fasciolaris* is extirpated from the Grand River, and likely extirpated from the Thames River. There are just two historical records for the Kidneyshell in the Thames River (1894 and 1933), and both are from Chatham. As these records were for shells, it is possible that the animals had been living further upstream. Metcalfe-Smith et al. (1998b, 1999) surveyed 16 sites on this river in 1997-98, and found a total of two fresh shells and four weathered shells at four sites, but no live specimens. Morris (1996) surveyed 30 sites on the river in 1995, using 1 p-h of sampling effort, and found one fresh shell at one site. All of these sites were above Chatham (the river is too deep for wading at Chatham). The Kidneyshell was reported from seven sites in a 50 km stretch of the lower Grand River between Caledonia and Port Maitland (at the mouth) between 1934 and 1988. Most records are for museum specimens, so we do not know if the animals were alive at the time of collection. Nevertheless, the data show that the Kidneyshell once inhabited the river. Metcalfe-Smith et al. (2000b) reported the results of surveys conducted in 1995 and 1997-98 at 94 sites in the Grand River, including 10 sites between Caledonia and Port Maitland. Only four weathered shells were found at three of the historical sites.

The Sydenham River in the Lake St. Clair drainage, and the Ausable River in the lower Lake Huron drainage, still harbour populations of the Kidneyshell. Detweiler (1918) surveyed the Ausable River in 1916, primarily for commercially valuable species (for the pearl button industry), and did not record the presence of *P. fasciolaris*. Similarly, the species was not among those reported from a site near Hungry Hollow in the lower reaches of the river in 1950 (museum records). Morris and Di Maio (1998) surveyed six sites on the river in 1993-94 using 1 p-h sampling effort and found a total of six live Kidneyshells at two sites, representing 2% (6/266) of the overall community. Metcalfe-Smith et al. (1999) surveyed eight sites on the river in 1998 and found 27 live specimens at two sites between Brinsley and Nairn (the same sites where the species was found alive in 1993-94), as well as 16 fresh and eight weathered shells at these and two other sites in this reach. Overall, the Kidneyshell represented just 1.5% (27/1849) of the mussel community in the river, 1.5% at Nairn and 4.5% at Brinsley. The mussel community in the Ausable River is dominated by the threeridge, *Amblema plicata plicata*, which accounted for over 62% of the 1849 mussels of 18 species found in the river in 1998.

The presence of *P. fasciolaris* in the Sydenham River was first documented by H.D. Athearn at two sites near Shetland, ON in 1963 (museum records). He re-visited one of the sites in 1967 and recorded the species again. Stein and colleagues from Ohio State University reported finding live *P. fasciolaris* at sites near Florence and Alvinston in the late 1960s (museum records and personal field notes of C.B. Stein). Stein re-visited the Florence site and two other sites near Croton and Dawn Mills in 1973, and reported finding five live specimens at Dawn Mills and fresh shells at the other sites. Clarke (1973) surveyed 11 sites in the river in 1971 using an average sampling effort of 1.1 p-h/site and found 26 live species. The Kidneyshell occurred at four sites. Mackie and Topping (1988) surveyed 22 sites in the system in 1985 using a sampling effort of 1.0 p-h/site, and found only 13 species alive; they did not find any live Kidneyshells. Clarke (1992) surveyed 16 sites in 1991, using a greater sampling effort than in 1971 (mean = 2.4 p-h/site) and concentrating on the Alvinston area which had yielded rare species 20 years earlier. He found live Kidneyshells at four (25%) of the sites, representing 2% (14 of 874 animals) of the overall community in the river. Metcalfe-Smith et al. (1998b, 1999) surveyed 17 sites on the Sydenham River in 1997-98, with good coverage of the reach where *P. fasciolaris* was previously found. They found live specimens at 9 sites, or 75% of the sites in the east branch (it has never been found in the north branch). Abundance was very low; only 26 of the 2242 live mussels collected (1.1%) were *P. fasciolaris*.

To determine if *P. fasciolaris* has declined in abundance in the Sydenham River, we compared catch-per-unit-effort (CPUE) from four of the sites surveyed in 1997-98 with CPUE from earlier surveys at these sites. These are the only comparisons available to us. Sampling effort in 1997-98 was 4.5 p-h, and the search area varied from 2500 to 3800 m^2 depending on the width of the reach, the variety of habitats to be searched, and numbers of mussels being found. At a site above Alvinston, CPUE was 0.62 Kidneyshells/p-h effort in 1991 (Clarke 1992), but none were found in 4.5 p-h effort in 1997. Stein found 47 live Kidneyshells in 6.0 p-h search time at a site just below Alvinston in 1967, for a CPUE of 8 animals/p-h (C.B. Stein, personal field notes). The Kidneyshell was actually the second most abundant of 19 species found at this site. We did not find any live specimens here in 1997. At another site downstream of Alvinston, Clarke (1992) found three individuals in 5 p-h for a CPUE of 0.6/p-h, whereas we found only one animal in 4.5 p-h in 1997. Finally, Stein found five Kidneyshells in 3 p-h at a site near Dawn Mills in 1967, for a CPUE of 1.7/p-h. We found four specimens in 4.5 p-h and a total of six after 6.0 p-h in 1998, for a CPUE of ~1.0/p-h. These data suggest that the Kidneyshell may be declining in abundance in the East Sydenham River, particularly in the upper reaches.

Two good indicators of the overall health or "strength" of a mussel population are: (a) density, which can be compared with the densities of known healthy populations, and (b) size class frequencies of live animals, which provide a record of reproductive success. Density estimates for Kidneyshell populations at four sites in the East Sydenham River are available from quantitative (quadrat) sampling conducted at these sites in 1999 and 2001 (Metcalfe-Smith, Zanatta and Di Maio, unpublished data). At each site, sampling was conducted within a 400 m^2 portion of the best known habitat, i.e., the area where richness and abundance was found to be greatest during earlier timed searches. Estimated densities of 0.10, 0.17, 0.09 and 0.13 Kidneyshells/m^2 are comparable to densities of 0.15 and 0.08/m^2 in the Clinch and Powell Rivers of Tennessee and Virginia, which are among the richest rivers for mussels in the Tennessee River system (Ahlstedt 1991). Size frequency distributions for the 63 live Kidneyshells collected during timed search and quantitative surveys in the Sydenham River between 1997 and 2001, and the 27 live animals collected during timed searches in the Ausable River in 1998, are presented in Figure 4. Specimens captured in the Sydenham River measured 25-124 mm (mean = 92 mm) in shell length, and 11 size classes were represented. Such a distribution is indicative of a healthy, reproducing population. The population in the Ausable River does not appear to be as healthy, having proportionately more larger animals (mean length = 100 mm), fewer size classes represented (6 vs. 11), and a narrower size range among individuals (54-117). We must caution, however, that the species may have different growth rates in different rivers. Furthermore, data for the Sydenham River include measurements of 39 specimens collected during quadrat sampling, which involved excavation of the substrate. This technique is known to yield more juvenile mussels, which tend to burrow more deeply than adults (Vaughn et al. 1997). In fact, the mean shell length of specimens from quadrat surveys was 89 mm vs. 96 mm for specimens collected during timed searches.

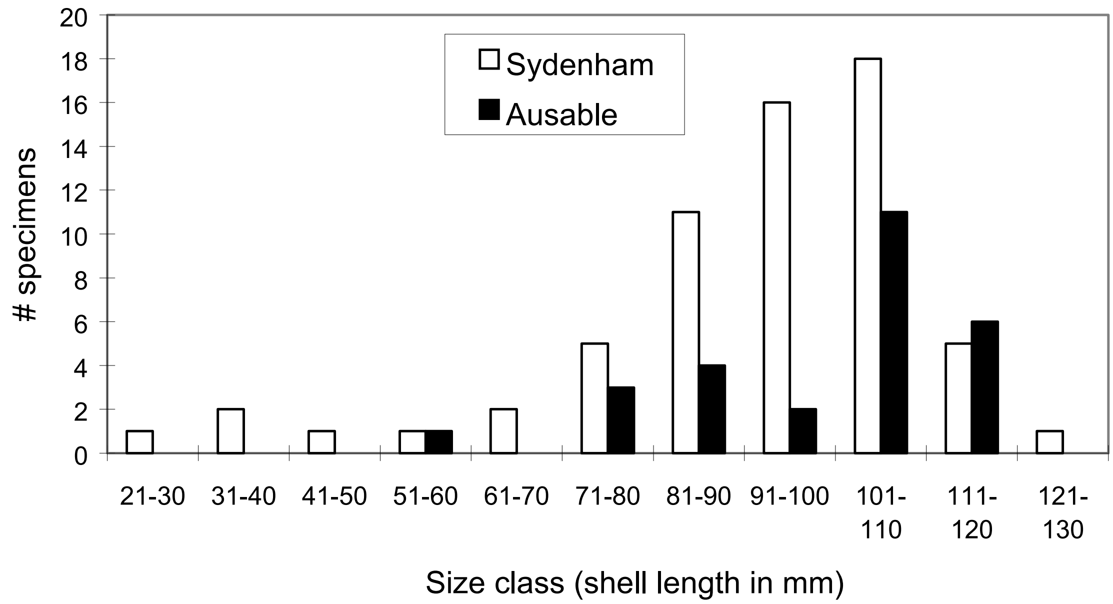

Figure 4. Size frequency distributions for live specimens of *P. fasciolaris* found in the Sydenham River (n = 63) and Ausable River (n = 27) between 1997 and 2001.

The sizes of the Sydenham River and Ausable River populations of *P. fasciolaris* were estimated to be ~30,000-50,000 and ~10,000-20,000 total animals, respectively. Population estimates were calculated by multiplying the average density of animals by the area of occupancy, as follows: The Kidneyshell was found along a ~ 100 km reach of the Sydenham River where the mean stream width was 20 m. The mean density of Kidneyshells in suitable riffle/run habitat was 0.1225/m2. Assuming that only 10-20% of the reach consists of suitable habitat, the population estimate for the Sydenham River is 30,000-50,000 specimens. The population in the Ausable River may be of slightly greater density than the population in the Sydenham River (based on comparisons of CPUE, since no density estimates are available for the Ausable River), but it occupies a much shorter reach (~25 km^2). Thus, the size of the Ausable River population is estimated to be about 10,000-20,000 animals.

LIMITING FACTORS AND THREATS

The introduction and spread of the exotic zebra mussel (*Dreissena polymorpha*) throughout the Great Lakes has destroyed native freshwater mussel populations in infested areas (Schloesser et al. 1996). Zebra mussels attach to a unionid's shell, where they interfere with activities such as feeding, respiration, excretion and locomotion — effectively starving the animal to death (Haag et al. 1993; Baker and Hornbach 1997). Approximately 60% of the sites where *P. fasciolaris* was historically collected in Ontario are in Great Lakes waters that are now heavily colonized by zebra mussels. Only a handful of live Kidneyshells have been collected from several nearshore “refuge” sites in Lake Erie and Lake St. Clair that still support significant populations of other native unionids (see Zanatta et al. 2002). The zebra mussel is unlikely to threaten the two surviving populations of *P. fasciolaris* in Ontario, since the Sydenham and Ausable rivers are not navigable by boats and have few impoundments that could support a permanent colony - although the reservoirs at Coldstream and Strathroy in the headwaters of the East Sydenham River are of some concern. However, both populations are at risk from factors related to land use practices in these watersheds.

Habitat loss and degradation due to dams, dredging, channelization, siltation, and pollution are major causes of the decline of freshwater mussels across North America during the past century (Williams et al. 1993). According to Strayer and Fetterman (1999), the main threats to mussels today are high loads of sediment, nutrients, and toxic chemicals from non-point sources, especially agriculture. Agriculture is the primary land use in the Ausable River basin, with over 50% of the area being used for row crops (corn and beans) and only 13% remaining forested (ABCA 1995). Livestock farming is also intensive, particularly in the upper reaches. Water quality is generally poor because of runoff from agricultural lands, septic system seepage, and pollution from manure. About 60% of the soils are artificially drained, and sediment loadings are high.

Land cover in the Sydenham River watershed has been dramatically transformed over the past two centuries, from 70% forest and 30% swamp prior to European settlement, to 85% agricultural land today; over 60% of the watershed is now in tile drainage (Staton et al. 2002). Only 17% of the original forest cover remains, and there are long reaches of the river with little or no riparian vegetation. Sediment loadings from overland runoff and tile drainage are high. Sediments originating from tile drainage tend to be fine-grained (Grass et al. 1979). Fine sediments are known to adversely affect mussels in many ways, e.g., they can clog the gills, thereby reducing respiration rates, feeding efficiency, and growth; they can affect their food source by reducing the amount of light available for photosynthesis; and they can affect mussels indirectly by impacting on their host fishes (see Brim-Box and Mossa 1999 for a review). Nutrient loadings are also high in the Sydenham River, and total phosphorus levels have consistently exceeded the provincial water quality objective over the past 30 years; chloride levels in the river are slowly rising due to the increased use of road salt (Staton et al. 2002). As noted earlier, *P. fasciolaris* is highly specialized in terms of its habitat requirements, preferring clear, swift-flowing water and firmly-packed gravel/sand substrates in small to medium sized rivers and streams. As such, it is likely to be very susceptible to the types of habitat disturbances occurring in the Ausable and Sydenham rivers. The Kidneyshell is among 43 species that have been lost from the main stem of the Wabash River in Illinois, although it is still found in two major tributaries - which themselves have lost approximately 30% of their mussel fauna (Cummings and Mayer 1997). Threats to mussel populations in these rivers include siltation, chemical pollution, impoundments, and instream disturbances (gravel mining, construction, dredging, channelization, etc.).

The most significant natural controls on the size and distribution of mussel populations are the distribution and abundance of their host fishes, and predation.

Unionids cannot complete their life cycle without access to their appropriate glochidial host. If host fish populations disappear, or decline in abundance to levels below that which can sustain a mussel population, recruitment will no longer occur and the mussel species may become functionally extinct (Bogan 1993). The host fish(es) for *P. fasciolaris* in Ontario are unknown. However, three species of darters shown to be hosts of *P. fasciolaris* in Pennsylvania - greenside, johnny and fantail darters - are native to Ontario and are known to occur in the Sydenham River. Determination of the host(s) of the Kidneyshell in the Sydenham and Ausable rivers is crucial to understanding its chances for survival in these systems. There have been significant advances in the methodology for laboratory identification of glochidial hosts of freshwater mussels in recent years (e.g., Hove et al. 2000), and a testing facility has now been established at the University of Guelph, Guelph, Ontario (Woolnough and Mackie 2002).

Freshwater mussels are known to be food sources for a variety of mammals and fish (Fuller 1974). Predation by muskrats (*Ondatra zibenthicus*), in particular, may be a limiting factor for some mussel species. Tyrrell and Hornbach (1998) and others have shown that muskrats are both size- and species-selective in their foraging, and can therefore significantly affect both the size structure and species composition of mussel communities. Muskrats could potentially be a threat to small populations of *P. fasciolaris*, as they tend to prey on small individuals of large species such as the Kidneyshell (Tyrrell and Hornbach 1998). The removal of smaller, younger adults would presumably have a more significant effect on the mussel population than the removal of larger, older individuals that have fewer reproductive years left. The authors observed very large female specimens of the Mucket (*Actinonaias ligamentina*) from the Thames River, Ontario that were brooding glochidia in only a small portion of their gills, whereas smaller females were full of glochidia. Neves and Odum (1989) found the shells of 16 species of mussels, including *P. fasciolaris*, in muskrat middens along the shores of the North Fork Holston River in Virginia. They estimated that muskrats consumed between 8 and 47% of the populations of ten different mussel species at their study site over an 8-year period. Among the preferred species were (in descending order): the wavy-rayed lampmussel, *L. fasciola* (47%); shiny pigtoe, *Fusconaia cor* (37%); pheasantshell, *Actinonaias pectorosa* (24%), fluted Kidneyshell, *Ptychobranchus subtentum* (20%), and Kidneyshell (20%). Although predation is a natural control on mussel populations, we must recognize that land use practices can significantly influence the distribution and density of predators. We are not aware of any studies on raccoon predation; however, we have observed raccoons feeding on mussels in the field, and there is anecdotal information from the farming community in the Sydenham River watershed that the recent adoption of conservation tillage practices has led to an explosion in the raccoon population. It is therefore possible that predation represents a significant threat to the population of *O. subrotunda* in this river.

SPECIAL SIGNIFICANCE OF THE SPECIES

There are five recognized species in the genus *Ptychobranchus*, with only *P. fasciolaris* having a range that extends into Canada. One of these five species, the triangular Kidneyshell (*P. greeni*), is listed as federally endangered in the United States, and another species, the fluted Kidneyshell (*P. subtentum*), is currently a “candidate taxon, ready for proposal” (U.S. Fish and Wildlife Service 2002). The American Fisheries Society (AFS) also recognizes the southern Kidneyshell (*P. jonesi*) and the Ouachita Kidneyshell (*P. occidentalis*) as threatened, i.e., likely to become endangered throughout all or a significant portion of their range (Williams et al. 1993). *Ptychobranchus fasciolaris* is the only member of the genus *Ptychobranchus* that the AFS considers to be currently stable throughout most of its range in North America. The Kidneyshell inhabits only high quality rivers and streams; therefore, its decline or loss is a good indication of habitat degradation.

EXISTING PROTECTION OR OTHER STATUS

Ptychobranchus fasciolaris is currently listed as endangered in Illinois and Mississippi and special concern in Alabama and Indiana, and is therefore afforded some protection in these states. In Illinois, for example, “it is unlawful for any person to possess, take, transport, sell, offer for sale, give or otherwise dispose of any animal or the product thereof of any animal species which occurs on the Illinois List…”. Species on the list include all species listed as endangered under the Federal Endangered Species Act, plus other species in danger of extinction in the wild in Illinois (Illinois DNR 2002). The Kidneyshell is not currently listed or proposed for listing under the U.S. Endangered Species Act, nor is it listed in the IUCN Red Book. The Nature Conservancy has assigned the Kidneyshell a global rank of G4/G5. Sub-jurisdictional (state and provincial) ranks for the species are shown in Figure 5. The Kidneyshell is ranked as S4S5 (common to very common) in both Kentucky (R. Cicerello, Kentucky Department of Natural Resources, pers. comm. August 2001) and Tennessee (Parmalee and Bogan 1998). In Virginia, it is ranked as S4 (S. Carter-Lovejoy Virginia Dept. of Conservation and Recreation, pers. comm. July 2001). Both West Virginia and Ohio rank the species as S3 (J. Clayton, West Virginia Department of Natural Resources, pers. comm. August 2001; G.T. Watters, Ohio Biological Survey, pers. comm. July 2001). It is ranked as S2 in Indiana (Cummings and Mayer 1992) and New York (D.L. Strayer, Institute of Ecosystem Studies, pers. comm. September 2001). The Kidneyshell is ranked S1 in Alabama (J. Garner, Alabama Division of Wildlife and Freshwater Fisheries, pers. comm. October 2001), Mississippi (R.L. Jones, Mississippi Department of Wildlife, Fisheries, and Parks, pers. comm. October 2001), Illinois (K. Cummings, Illinois Natural History Survey, pers. comm. August 2001) and Ontario (D.A. Sutherland, Ontario Natural Heritage Information Centre, pers. comm. September 1999). Status of this species is currently undetermined (no S-ranks exist) in Michigan (P. Badra, Michigan Natural Features Inventory, pers. comm. September 2001) and Pennsylvania (A. Shiels, Pennsylvania Nongame and Endangered Species Unit, pers. comm. September 2001).

Canada does not have federal endangered species legislation at this time, but Ontario is one of six provinces that have stand-alone endangered species acts (B.T. Fowler, Co-Chair Lepidopterans and Molluscs Specialist Subcommittee,

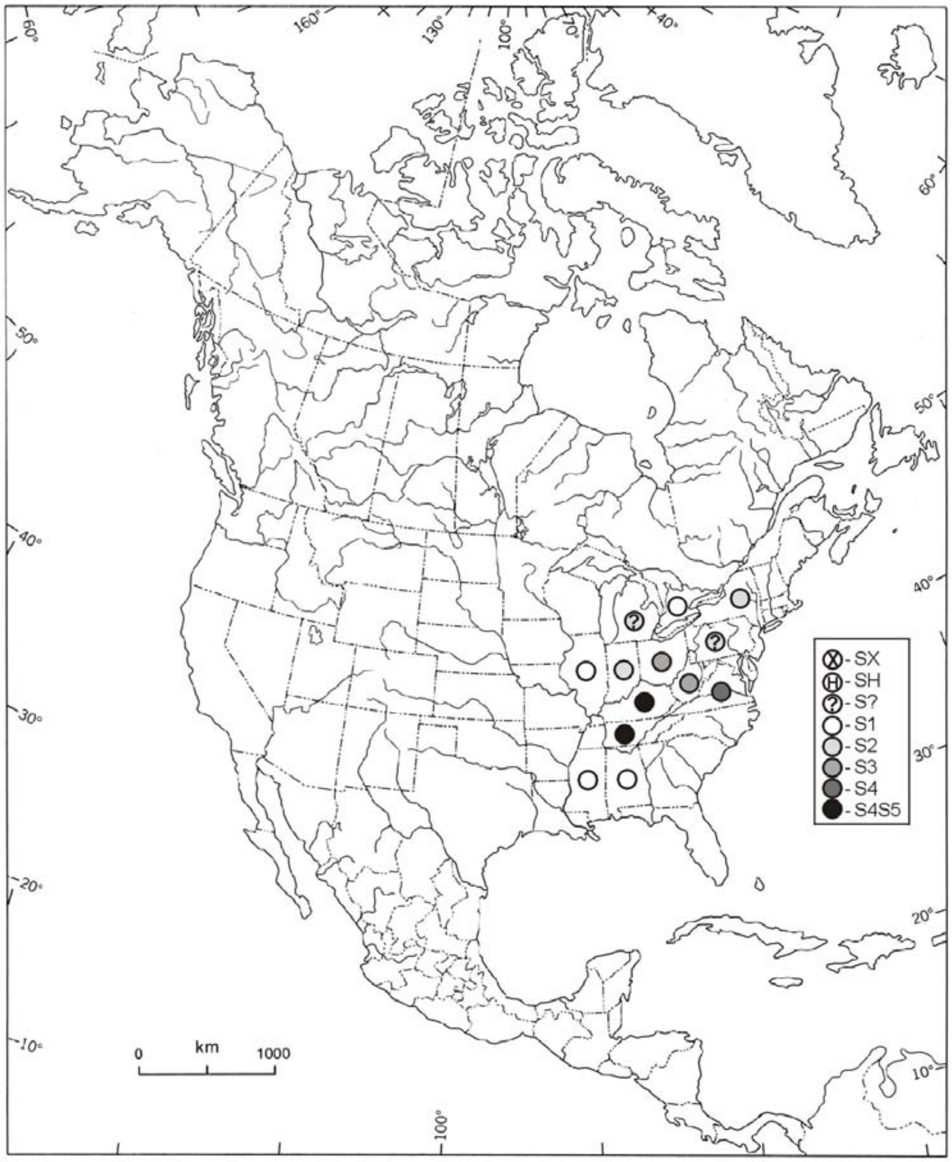

Figure 5. State and provincial conservation priority ranks (S-ranks) for *Ptychobranchus fasciolaris*.

COSEWIC, pers. comm. August 2002). Ontario's Act prohibits the willful destruction of, or interference with, a regulated endangered species or its habitat. Five species of freshwater mussels that are currently listed as endangered by COSEWIC are found only in the Province of Ontario; these species are the northern riffleshell *(Epioblasma torulosa rangiana*), rayed bean (*Villosa fabalis*), wavy-rayed lampmussel *(Lampsilis fasciola*), snuffbox (*Epioblasma triquetra*) and mudpuppy mussel (*Simpsonaias ambigua*). Since Ontario has not yet proceeded with regulating any of these species under the Act (A. Dextrase, Species at Risk Section, Ontario Parks, Ontario Ministry of Natural Resources, pers. comm. November 2001), freshwater mussels currently do not benefit from this legislation.

The Federal Fisheries Act may represent the most significant legislation protecting freshwater mussels and their habitat in Canada at the present time. Fish are broadly defined under the Act to include shellfish, although the intent was to protect marine shellfish harvested for human consumption. The protection of fish and fish habitat may indirectly protect the habitat of *P. fasciolaris* and other species of freshwater mussels. The collection of live mussels is theoretically “fishing” and would fall under the Ontario Fishery Regulations that are made under the Federal Fisheries Act. No permits have been issued for the collection of live mussels in Ontario (J. Maffei, Lake Erie Management Unit, pers. comm. May 2001). The Provincial Policy Statement under Section 3 of the Planning Act provides for protection from development and site alteration in significant portions of the habitats of threatened and endangered species. Other mechanisms for protecting mussels and their habitat in Ontario include the Ontario Lakes and Streams Improvement Act, which prohibits the impoundment or diversion of a watercourse if it would lead to siltation; and the voluntary Land Stewardship II program of the Ontario Ministry of Agriculture, Food, and Rural Affairs, which is designed to reduce erosion on agricultural lands. Stream-side development in Ontario is managed through flood plain regulations enforced by local Conservation Authorities. Very little of the Kidneyshell’s range in Ontario is in protected areas. The healthiest remaining population is located in East Sydenham River, where 85% of the land is privately owned and in agricultural use (Staton et al. 2002).

SUMMARY OF STATUS REPORT

Ptychobranchus fasciolaris historically occurred in 12 states and the province of Ontario, ranging from Mississippi and Alabama in the south to Michigan and southwestern Ontario in the north, and from eastern Illinois to Virginia. Except for declines in Illinois, its distribution and abundance in the U.S. is stable. In Canada, it was historically found in Lake Erie, Lake St. Clair, and the Niagara, Detroit, Grand, Thames, Sydenham and Ausable rivers. It was always sparse in Great Lakes waters, and has now been virtually extirpated due to impacts of the zebra mussel. It has disappeared from the Grand River, where it historically occupied the lower 50 km of the main stem. It has likely been lost from the Thames River, based on limited data. It is now restricted to a 100-km reach of the East Sydenham River and a 25-km reach of the Ausable River. Both populations appear to be reproducing. The Kidneyshell may be declining in abundance in the East Sydenham River, particularly in the upper reaches. There are no historical data available for the Ausable River, but several other nationally endangered riffle-dwelling species have been extirpated, or nearly so, from this river. Overall, *P. fasciolaris* has been lost from about 70% of its historical range in Canada. Losses from Great Lakes waters should be considered permanent. Loss from the Grand River may be reversible, since many other mussel species have recolonized the lower river as a result of significant improvements in water quality over the past 25 years.

Ptychobranchus fasciolaris is listed as endangered in Illinois and Mississippi and special concern in Alabama and Indiana, and is therefore afforded some protection in these states (it is not federally listed in the U.S.). There are no protected populations in Canada, and most of its occupied range is privately owned land. The most significant threats to the continued existence of this species in Canada are zebra mussels and agricultural impacts, particularly siltation. Intensive agriculture (row-cropping) is the primary land use in both the Sydenham and Ausable river watershed, and sediment and nutrient loadings are high. The Kidneyshell was lost from a tributary to the Clinch River in Virginia due to siltation from poor land management practices. Muskrats are a potential threat to declining populations of *P. fasciolaris*, since this is one of the mussel species on which they prey.

TECHNICAL SUMMARY

Common name: *Ptychobranchus fasciolaris*
Kidneyshell (English)
French common name: Coquille de Rein
Range of occurrence in Canada: Southwestern Ontario

Extent and Area information	
• *extent of occurrence (EO)(km²)*	Ausable River, East Sydenham River, and portion of the Lake St. Clair delta ~ 2050 km^2
• *specify trend (decline, stable, increasing, unknown)*	Decline, estimate 70% (likely extirpated from the Grand, Thames, Niagara, and Detroit Rivers, Lake Erie and most of Lake St. Clair)
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	100 km reach of East Sydenham River between Napier and Dawn Mills (~2 km²), 25 km reach of Ausable River between Brinsley and Nairn (~0.4 km²), and in a portion of the Lake St. Clair delta (~8 km²). Total = 10.4 km^2.
• *specify trend (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	3 (~100 km reach of Sydenham River, ~25 km reach of Ausable River, ~8 km² in a portion of the Lake St. Clair delta)
• *specify trend in # locations (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Decline
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	Unknown (estimate 10 years)
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	Unknown (estimate 50000-100000)
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Declining
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	Unknown
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	No

• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	Yes, no mixing between populations in different watersheds
• *list each population and the number of mature individuals in each*	
• *East Sydenham River* • *Ausable River* • *Lake St. Clair*	Estimate 30000-50000 Estimate 10000-20000 Unknown (only 7 individuals found in recent surveys)
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	

- Zebra mussels (invasive species)
- Habitat loss and degradation:
  - Siltation
  - Nutrient loading
  - Loss of riparian vegetation	

- Predation by muskrats	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Yes (in the United States)
• *status of the outside population(s)?*	Largely stable
• *is immigration known or possible?*	No
• *would immigrants be adapted to survive here?*	Likely (genetic testing required)
• *is there sufficient habitat for immigrants here?*	No
Quantitative Analysis	

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BIOGRAPHICAL SUMMARY OF CONTRACTORS

Janice L. Metcalfe-Smith is an Aquatic Research Biologist with the National Water Research Institute of Environment Canada in Burlington, Ontario. She has a B.Sc. (Hons.) in Zoology from the University of Manitoba (1973), and 29 years of experience as a technologist (1973-1978) and biologist (1978-present) with the departments of Fisheries and Oceans (Winnipeg, Manitoba and St. Andrews, New Brunswick) and Environment (Burlington, Ontario). She has conducted research in several areas, including the effects of forestry practices and acid rain on Atlantic salmon, the use of benthic macroinvertebrate communities in water quality assessment, and the development of biological monitoring techniques for measuring contaminant trends in freshwater ecosystems. Since 1995, her research has focused on the assessment and conservation of freshwater mussels in Ontario. She has authored or co-authored over 60 scientific papers and reports, including 15 on biodiversity issues. She is a member of the North American Benthological Society, the Freshwater Mollusk Conservation Society, and the Mollusc Working Group of the Lepidopterans and Molluscs Specialist Subcommittee of COSEWIC. She co-authored five previous status reports on mussel species at risk for COSEWIC.

David T. Zanatta received a B.Sc. (Hons.) in Biology from Laurentian University (1998) and an M.Sc. (Zoology) from the University of Guelph (2000). His M.Sc. supervisor, Dr. Gerald L. Mackie, is currently chair of the Mollusc Species Subgroup Group of the Lepidoptera and Mollusca Subcommittee of COSEWIC. Mr. Zanatta's thesis was entitled "Biotic and abiotic factors relating to distribution of unionid mussel species in Lake St. Clair." Part of his thesis research, which documented the discovery of native mussel refuge sites in Lake St. Clair, will be published shortly in the Journal of Great Lakes Research. He has also studied Lake Trout populations in Northwestern Ontario lakes and analyzed Walleye index netting data for the Ontario Ministry of Natural Resources. He is a member of the North American Benthological Society and the Freshwater Mollusk Conservation Society. David is currently a research technologist with the National Water Research Institute of Environment Canada in Burlington, Ontario.

AUTHORITIES CONSULTED

Badra, P. September 2001. Aquatic Zoologist, Michigan Natural Features Inventory, Michigan State University Extension, Stevens T. Mason Building, PO Box 30444, Lansing, MI 48909-7944.

Carter-Lovejoy, S. July 2001. Natural Heritage Information Manager, Virginia Department of Conservation and Recreation, Division of Natural Heritage, 217 Governor Street, Richmond, VA 23219.

Cicerello, R. August 2001. Kentucky State Nature Preserves Commission, 801 Schenkel Lane, Frankfort, KY 40601.

Clayton, J. August 2001. West Virginia Division of Natural Resources, PO Box 67 Elkins, WV 26241.

Cummings, K. August 2001. Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, IL 61820.

Dextrase, A. November 2001. Ontario Parks, Species at Risk Section, Ontario Ministry of Natural Resources, Box 7000 Peterborough, ON K9J 8M5.

Fowler, B.T. August 2002. Co-chair, Lepidopterans and Molluscs Specialist Subcommittee, COSEWIC. Canadian Wildlife Service, Hull, Quebec K1A 0H3.

Garner, J. October 2001. Malacologist, Alabama Division of Wildlife and Freshwater Fisheries, 350 County Rd. 275, Florence, AL 35633.

Jones, R. October 2001. Conservation Biology Section, Museum of Natural Science, Mississippi Department of Wildlife, Fisheries, and Parks, 2418 Riverside Drive, Jackson, MS 39202-1353.

Maffei, J. May 2001. Lake Erie Management Unit, Ontario Ministry of Natural Resources.

Marangelo, P. July 2001. Planning Ecologist, The Nature Conservancy, Michigan Chapter, 2840 E. Grand River Ave. #5, East Lansing, MI 48823.

Masteller, E. September 2001. Emeritus Professor of Biology, Penn State Erie, The Behrend College, Erie, PA 16563.

Schneider, K. August 2001. Environmental consultant, P.O. Box 169, 16 Frisbee Lane, Stuyvesant Falls, NY 12174.

Shiels, A. September 2001. Pennsylvania Nongame and Endangered Species Unit, Pennsylvania Fish and Boat Commission, Bellefonte PA 16823.

Strayer, D. September 2001. Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545-0129.

Sutherland, D. September 1999. Ontario Natural Heritage Information Centre, Ministry of Natural Resources, 300 Water Street, 2nd Floor, North Tower, Peterborough, Ontario K9J 8M5.

Watters, G.T. July 2001. Curator of Molluscs, Department of Evolution, Ecology and Organismal Biology, Museum of Biological Diversity, The Ohio State University, 1315 Kinnear Road, Columbus, OH 43212.

COLLECTIONS EXAMINED

In 1996, all available historical and recent data on the occurrences of freshwater mussel species throughout the Lower Great Lakes drainage basin were compiled into a computerized, GIS-linked database referred to as the Lower Great Lakes Unionid Database. Data sources included the primary literature, natural history museums, federal, provincial, and municipal government agencies (and some American agencies), conservation authorities, Remedial Action Plans for the Great Lakes Areas of Concern, university theses, and environmental consulting firms. Mussel collections held by six natural history museums in the Great Lakes region (Canadian Museum of Nature, Ohio State University Museum of Zoology, Royal Ontario Museum, University of Michigan Museum of Zoology, Rochester Museum and Science Center, and Buffalo Museum of Science) were the primary sources of information, accounting for over two-thirds of the data acquired. The database continues to be updated and now has over 6000 records of unionids from the lower Great Lakes drainage. One of us (J.L. Metcalfe-Smith) personally examined the collections held by the Royal Ontario Museum, University of Michigan Museum of Zoology and Buffalo Museum of Science, as well as smaller collections held by the Ontario Ministry of Natural Resources.