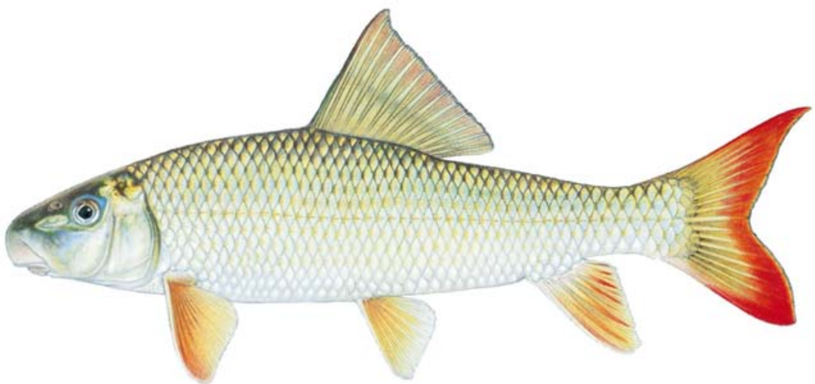
COSEWIC
Assessment and Update Status Report

on the

River Redhorse
Moxostoma carinatum

in Canada



SPECIAL CONCERN
2006

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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Previous report:

Parker, B. 1987. COSEWIC update status report on the river redhorse *Moxostoma carinatum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-12 pp.

Parker, B. and P. McKee. 1983. COSEWIC status report on the river redhorse *Moxostoma carinatum* in Canada. Committee on the Status of Endangered Wildlife in Canada.1-10 pp.

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COSEWIC
Assessment Summary

Assessment Summary – April 2006

Common name
River redhorse

Scientific name
Moxostoma carinatum

Status
Special Concern

Reason for designation
This freshwater fish species occurs in Ontario and Quebec, and although it has been collected at new locations in both provinces, sometimes in large numbers, this is thought to reflect the use of more effective sampling techniques such as boat electrofishing. It has likely disappeared historically from the Ausable, Châteauguay and Yamaska rivers, since the use of boat electrofishing has failed to collect it recently. Threats to the species include habitat degradation (pollution, siltation), stream regulation that affects water flow (dams) and habitat fragmentation (dams). The Canadian range is highly fragmented and rescue effect is improbable because of the precarious conservation status in adjoining U.S. States.

Occurrence
Ontario and Quebec

Status history
Designated Special Concern in April 1983. Status re-examined and confirmed in April 1987 and in April 2006. Last assessment based on an update status report.

COSEWIC
Executive Summary

River Redhorse
Moxostoma carinatum

Species information

The river redhorse (*Moxostoma carinatum*) is one of seven species of the genus *Moxostoma* in Canada. It is similar in appearance to the shorthead redhorse (*M. macrolepidotum*) and greater redhorse *(M. valenciennesi*). It can be distinguished from other redhorse sucker species by its moderate-sized head, entirely plicate lips, and caudal peduncle scale count.

Distribution

The river redhorse is found throughout the central and eastern Mississippi River system and the Gulf Slope from Florida to Louisiana. Several disjunct populations of river redhorse are found in southcentral Ontario and southern Quebec. Since the previous status report, river redhorse populations have been reconfirmed at some historical locations. New populations have been identified in Ontario and Quebec.

Habitat

In Canada, the river redhorse has been captured in both river and lake environments. However, its persistence is dependent on access to suitable riverine spawning habitat: moderate to swift current, riffle-run habitat and clean coarse substrates. Outside of the spawning period, reduced abundance in these habitats suggests that deeper run/pool habitats are used during other periods of the year. In the Richelieu River, young-of-the-year are found along vegetated shores where average depth is 1.5 m (maximum ≤ 3.0 m), the bank slope is shallow (≤ 20º) and the substrate is fine (silt, clay and sand).

Biology

The river redhorse is a late-maturing, long-lived species that requires large interconnected riverine habitat to fulfill the need of all life-stages. Generally, mature specimens are greater than 500 mm TL, and can exceed 700 mm TL. The maximum age reported for river redhorse in Canada is 28 years. Spawning occurs during late spring in areas with fast-flowing water and gravel or cobble substrate. Except for the few

Quebec rivers supporting copper redhorse (*M. hubbsi*), the river redhorse is the last of the *Moxostoma* species to spawn. River redhorse feed primarily on benthic invertebrates including molluscs, insect larvae and crayfishes.

Population sizes and trends

Given the lack of baseline data, population size trends cannot be addressed directly. Populations in the Mississippi River, Ottawa River, and the Richelieu River identified in the last status update are still present. In some watersheds, the species has likely disappeared (Châteauguay and Yamaska) or suffered substantial declines (St. Lawrence River). Population sizes for the Gatineau River and Mississippi River have been estimated. However, low numbers of recaptured fish and violations of model assumptions (e.g. high immigration rates) indicate that these estimates have a high degree of error. Identification of population trends would benefit from continued standardized sampling.

Limiting factors and threats

Tolerance for a narrow range of habitat characteristics and a limited amount of suitable habitat restrict the distribution of river redhorse. It is an inhabitant of medium- to large-sized rivers and intolerant of high turbidity levels, siltation, and pollution. Rivers supporting river redhorse are generally fragmented by hydroelectric, navigational and flood control dams. Dams can adversely affect populations by altering upstream and downstream habitat conditions, restricting the movements of individual fish, and limiting gene flow between populations. Due to restrictive spawning habitat (water depth and substrate) preferences, river redhorse recruitment is vulnerable to changes in the flow regime and siltation of spawning habitats.

Special significance of the species

River redhorse was historically a food source for native people and first European settlers and a species of minor commercial importance near Montreal. This fishery no longer exists. It is one of the few freshwater fishes that feed extensively on molluscs, thereby performing a unique ecological function.

Existing protection or other status designations

The river redhorse was first designated as Special Concern (Rare) by COSEWIC in 1983 and was reconfirmed as such in 1987 and 2006. In Ontario, it has been ranked as Special Concern by the OMNR. The river redhorse will be designated Vulnerable in Quebec.

COSEWIC HISTORY

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. On June 5th 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2006)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* 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. Definition of the (DD) category revised in 2006.

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.

Update
COSEWIC Status Report

on the

River Redhorse
Moxostoma carinatum

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2006

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SPECIES INFORMATION

Name and classification

Class:	Osteichthyes
Subclass:	Actinopterygii (ray-finned fishes)
Order:	Cypriniformes
Family:	Catostomidae
Scientific name:	*Moxostoma carinatum* (Cope, 1870)
English common name:	river redhorse
French common name:	chevalier de rivière

The river redhorse is a large catostomid (sucker) of the genus *Moxostoma* (Figure 1). Due to similarities in appearance among *Moxostoma* species that result in identification difficulties and previous confusion in nomenclature, this genus has been considered one of the most troublesome groups of freshwater fishes (Scott and Crossman 1973). It was formerly recognized as being in a separate genus, *Placopharynx*, due to its large molariform pharyngeal teeth and associated trophic adaptations. It has since been synonymized with *Moxostoma*, partially due to the larger pharyngeal arch and teeth observed in copper redhorse (*Moxostoma hubbsi*) (Jenkins and Burkhead 1993; Stagliano 2001). Although similar to members of the *Catostomus* genus, species of *Moxostoma* are generally larger, more laterally compressed and possess a three-chambered swim bladder (Scott and Crossman 1973; Parker 1988).

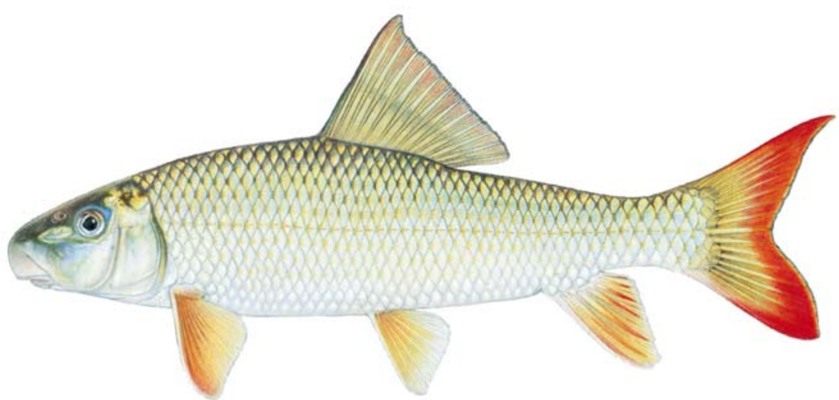

Figure 1. The river redhorse (*Moxostoma carinatum*).

The river redhorse is referred to by a variety of common names including redhorse sucker, river mullet, greater redhorse, redfin redhorse, pavement-toothed redhorse, and big-sawed sucker (Scott and Crossman 1973; Becker 1983; Stagliano 2001). Until recently, the official French name for the river redhorse was “suceur ballot”. In February 1998, this name was replaced with “chevalier de rivière” (Branchaud *et al*. 1998).

Morphological description

Parker (1988) provided a description of the river redhorse in the previous updated status report. Jenkins (1970), Scott and Crossman (1973) and Jenkins and Burkhead (1993) have also described this species in detail. The dorsum of the river redhorse is brown or olive-green, with sides brassy, yellowish-green or coppery and undersides white. Crescent-shaped dark spots are present on each dorso-lateral scale. Scale counts for the river redhorse are usually 12 around the caudal peduncle and between 42 and 47 scales along the lateral line. The caudal and dorsal fins are crimson in colour, while the lower fins are orange to reddish. The lips of the river redhorse are deeply plicate with transverse ridges and papillae (bumps) absent. The lower lip is broader than the upper lip with a virtually straight posterior margin (sometimes scallop-shaped). The dorsal fin is straight or slightly concave in shape. The caudal fin is forked, with the upper lobe usually longer and more pointed than the lower lobe.

The river redhorse is similar in external appearance to all redhorse species but particularly to the shorthead redhorse (*M. macrolepidotum*) and greater redhorse (*M. valenciennesi*). Each of these species exhibits red-tinted fins, large scales, subterminal mouth, complete lateral lines (38-48 scales), a single dorsal fin (11-17 rays), and lack buccal teeth.

The primary feature distinguishing the river redhorse from other *Moxostoma* is the heavy pharyngeal arch bearing molariform teeth (Jenkins and Burkhead 1993). The only sympatric species with a heavier pharyngeal arch and teeth is the copper redhorse while the other Canadian species (*M. anisurum*, *M. macrolepidotum*, *M. valenciennesi, M. erythrurum* and *M. duquesnei*) have a pharyngeal arch with comblike teeth (Eastman 1977, Jenkins 1970, Jenkins and Burkhead 1993, Mongeau *et al.* 1986).

Adult river redhorse are sometimes confused with the greater redhorse but can be easily distinguished by caudal peduncle scale count (greater redhorse: 15-16 scales). However, most of the misidentification occurs between the river redhorse and the shorthead redhorse. Both species have the same caudal peduncle scale counts (12). Shorthead redhorse has a thinner head, transverse ridges across the plicae (folds) of the lower lip and a falcate dorsal fin (Mongeau 1984).

Nuptial males are adorned with tubercles on the snout and anal and caudal fins (Scott and Crossman 1973; Trautman 1981; Becker 1983; Jenkins and Burkhead 1993; Reid 2003). The scales of nuptial males are thick and rough during the spawning period (Reid 2003). As well, breeding males usually exhibit a midlateral, dark stripe extending from the snout to above the anal region (Hackney *et al.* 1967; Jenkins 1970; Becker 1983). A thickening of the epidermis on the lower area of the caudal peduncle has been observed in breeding females as well as tubercle formation on the anal fin (Scott and Crossman 1973; Becker 1983). Both sexes in breeding condition exhibit intensification of body and fin colouration (Hackney *et al.* 1967; Jenkins 1970).

Genetic description

Canadian populations are found within the Great Lakes-Western St. Lawrence ecozone of the freshwater ecozone classification adopted by COSEWIC. Population structure is unknown; however, one of the authors (SR) is currently conducting an examination of the genetic structure of river redhorse in the Grand River and Trent River.

DISTRIBUTION

Global range

The river redhorse is found throughout the central and eastern Mississippi River system and the Gulf Slope from Florida to Louisiana. Its range extends north into the Great Lakes basin and St. Lawrence River (Figure 2). It is known from 24 states and from the provinces of Quebec and Ontario. The river redhorse has markedly declined throughout much of its range within the past century (Becker 1983; Trautman 1981). River redhorse populations appear concentrated in the centre of its distributional range, primarily in the states of Alabama, Arkansas, Kentucky, and Tennessee. Peripheral to this area, occurrences dramatically decrease. Trautman (1981) suggested it is likely more abundant as it is usually missed by seine hauls, and its presence is often unsuspected until revealed by accidental fish kills. Boat-electrofishing surveys have resulted in new site records in Ohio (Yoder and Beaumier 1986) and Illinois rivers (Retzer and Kowalik 2002).

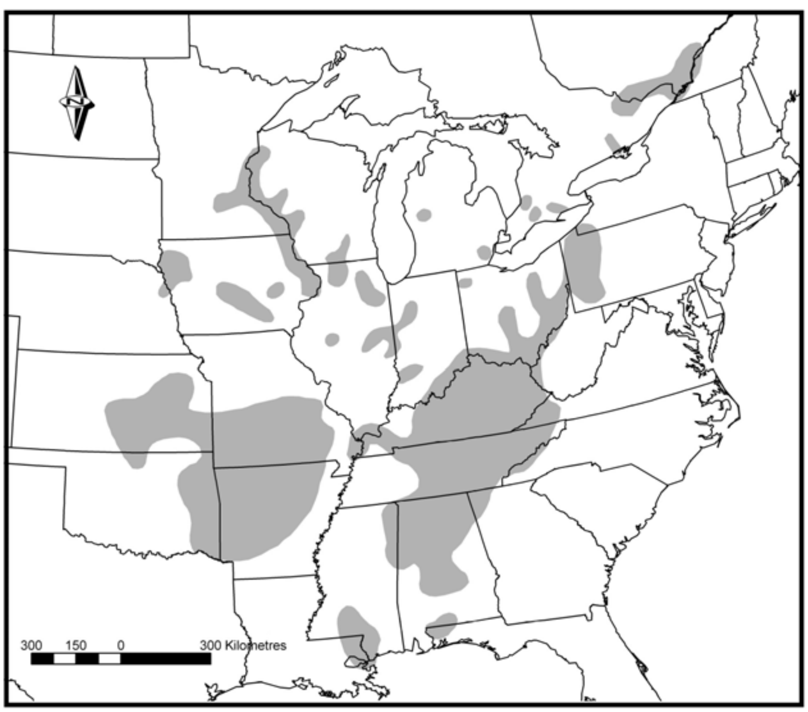

Figure 2. North American distribution of the river redhorse (*Moxostoma carinatum*).

Canadian range

Several disjunct populations of river redhorse are found in southcentral Ontario and southern Quebec (Figure 3). Parker (1988) summarized the distribution of the river redhorse in the previous status report. In Ontario, prior to 1988, specimens were collected from the Mississippi, Ausable, and Ottawa rivers. In Quebec, river redhorse were reported from the Châteauguay, Richelieu, Yamaska, and Saint-François basins and in the Ottawa and St. Lawrence rivers. Since the previous status report, river redhorse populations have been reconfirmed at most historical locations. Several new locations have also been identified in Ontario and Quebec. As in the United States, recent boat electrofishing surveys have improved distributional information.

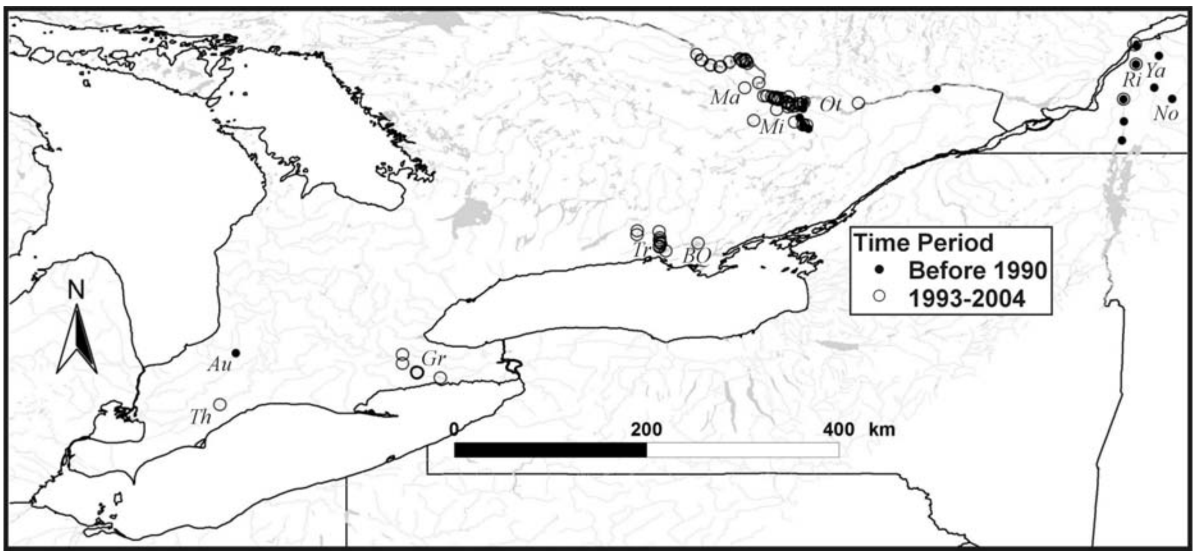

Figure 3. Canadian distribution of the river redhorse (*Moxostoma carinatum*). Abbreviations for individual waterbodies: Au: Ausable River; BQ: Bay of Quinte; Gr: Grand River; Ma: Madawaska River; Mi: Mississippi River; No: Noire River; Ot: Ottawa River; Ri: Richelieu River; Th: Thames River: Tr: Trent River; and Ya: Yamaska River.

In the Lake St. Clair drainage, two river redhorse (juvenile and adult) were collected from the lower Thames River, upstream of the Big Bend Conservation Area, in September 2003 (J. Barnucz, DFO pers. comm.). This is the first record of river redhorse in the Thames River.

In the Lake Erie watershed, river redhorse was first reported in the Grand River in 1998. Specimens were collected from the Dunnville area [ROM 70398], and from Cayuga [ROM 71654]. In 2002 and 2003, river redhorse were captured at Caledonia, Cayuga, York and Dunnville (S. Reid, unpubl. data). Archaeological excavations in northern Ohio have recovered river redhorse remains from midden and garbage pit sites (AD 750-1650), suggesting that this species has long been part of the Lake Erie basin fish community (Cavender 1989).

In the Lake Ontario watershed, river redhorse have been collected from the Bay of Quinte and the Trent River. In 1997, the first record of river redhorse in Lake Ontario was identified [ROM 71102]. Additional sampling in 1997 recovered one specimen from the Bay of Quinte area of Lake Ontario and nearshore community index netting (NSCIN) in 2001 captured two more river redhorse (Jim Hoyle, OMNR pers.comm). In 1997, river redhorse were collected for the first time in the lower Trent River, Ontario [ROM 71170]. Since 1998, river redhorse have been collected along a 50-km stretch of the Trent River from Trenton upstream to the Hagues Reach hydroelectric generating station. Suitable spawning habitat is present along the lower reaches of the Moira, Salmon, and Napanee rivers (tributaries of the Bay of Quinte); however, no spring sampling has been undertaken to evaluate its use.

Recent data suggest that river redhorse are more widely distributed in the Ottawa River watershed than previously reported (Scott and Crossman 1973; Parker 1988). Along the Ottawa River, the river redhorse is present from Sheenboro to Montebello (Chabot and Caron 1996). NSCIN of Lac des Chats (Ottawa River) in 1997 and 1998 collected 29 and 31 river redhorse, respectively (T. Haxton, pers. comm; Haxton 1999). NSCIN in Lac des Allumettes (Ottawa River) in 1997 and 1998 captured 11 and three specimens, respectively (T. Haxton, OMNR pers comm). NSCIN in 1999 captured three specimens in the Lower Allumettes (Ottawa River) (Haxton 2000a), and 13 specimens in Lac Coulonge (Ottawa River (Haxton, 2000b). One river redhorse was collected during NSCIN in the Lac du Rocher Fendu (Ottawa River) (Haxton 1998). Fall Walleye Index Netting (FWIN) performed in Holden Lake (Ottawa River) in 1998 captured 10 river redhorse. The reported captures from Holden Lake are of particular interest as this lake is situated upstream of the Rapides-des-Joachims, on the Ottawa River. It was previously presumed that no river redhorse populations were present above the rapids (Chabot and Caron 1996). Voucher specimens are required to confirm the presence of river redhorse in this stretch of the Ottawa River.

Sampling conducted from 1998 to 2002, along a 36-km stretch of the Mississippi River from downstream of Galetta to Almonte confirmed the persistence of river redhorse populations (Campbell 2001; Reid, unpubl. data). In 1992, one river redhorse specimen was collected from the Madawaska River, near Calabogie [ROM 66165]. Since this initial collection, nine were captured by OMNR in 1998 NSCIN in the locality of Arnprior downstream to the confluence with the Ottawa River. Boat-electrofishing in the fall of 2001 and 2002 resulted in the capture of seven and six river redhorse respectively (Reid, unpubl. data). Over 100 river redhorse were purportedly collected during NSCIN on Calabogie Lake in 1998. Several reports identify river redhorse in the Bonnechere River (Campbell 2001; Dextrase *et al.* 2003); however, although there are no barriers to migration between the Ottawa River and the First Chute on the Bonnechere River, this has not been confirmed (J. Cote, OMNR pers. comm.). OMNR fish community sampling captured two specimens in 1995, and five in 1998 from the Upper St. Lawrence River (Lake St. Francis).

Recent backpack and boat-electrofishing sampling has been unsuccessful in confirming the persistence of river redhorse in the Ausable River (N.E. Mandrak unpubl. data). Two river redhorse were collected from the Ausable River in 1936 at Ailsa Craig [ROM 1055CS and ROM 28250]. Sampling efforts in the vicinity of Ailsa Craig in August 2002 failed to capture any river redhorse. Parker (1988) suggested that the continued existence of this species in the Ausable River was in doubt due to a lack of suitable habitat. No other river redhorse populations have been reported in the Lake Huron drainage.

Several Ontario records of capture were not included in the previous status report. Voucher specimens are not available for the following river redhorse reports outside its known range. Additional sampling is required to confirm the existence of these populations. A single specimen was reported as collected from Lake Simcoe in 1978 during a Fall Trapnetting program conducted by the Lake Simcoe Fisheries Assessment Unit (OMNR). In 1989, a single river redhorse was reported as collected from Rice Lake, part of the Trent-Severn Waterway, during an Index Netting program (OMNR). Additional OMNR fish community sampling projects purportedly captured 24 river redhorse from Echo Lake in 1998 and over 100 in Christie Lake in 1993 (OMNR). In addition to these records, collections of larval river redhorse have been reported from several locations along the Lake Huron-Lake Erie corridor (Chenal Ecarte, Chematogan Channel, Whitebread Ditch, Dover Canal) (Leslie and Timmins 1991, 1998a) and from the western end of Lake Erie (Leslie and Timmins 1998b). However, substantial overlap in meristic variables among redhorse species and intraspecific variation in pigmentation (Bunt and Cooke 2004) prevent reliable larval identification (Kay *et al.* 1994). Therefore, larval river redhorse records are considered unconfirmed.

The first Quebec record of the river redhorse was captured in 1941, at the confluence of the Châteauguay River and Lac Saint-Louis (Quebec) by Vladykov (1941, 1942). In Quebec, it has been found in the St. Lawrence River corridor from the Les Cèdres rapid sector upstream of Lac Saint-Louis to Saint-Nicolas, near Québec City, as well as in the Châteauguay, Richelieu, Saint-François, Des Prairies, Des Mille Iles, and Yamaska rivers (Moisan 1998; Société de la faune et des parcs du Québec unpubl. data). Archaeological excavations suggest that the species was present along the St. Lawrence River at Pointe du Buisson, upstream of Lac Saint-Louis (920-940 AD; Courtemanche 2003), Laprairie (end of the XVIIth Century and beginning of the XVIIIth); and Wirtele Inn (Old Montréal, beginning of the XIXth Century; (M. Courtemanche, Ostéothèque de Montréal, pers. comm.). Bones of river redhorse were also identified in food remains along the Richelieu River at Mandeville site (1450-1550 AD; Chapdelaine 1989), and at Fort Chambly (Richelieu River, 1665-1760; Walker and Cumbaa 1982).

Inventories of the Yamaska River and its tributary the Noire River conducted since the previous status review have not collected river redhorse (Boulet *et al.* 1995; Moisan 1998; La Violette 1999). Also, it has not been reported in the Châteauguay basin since 1963 (Couture 1972) despite extensive sampling effort (Mongeau *et al*. 1979; La Violette and Richard 1996). All three rivers were sampled intensively with boat-electrofishing units.

According to Vladykov (1942) and Cuerrier *et al*. (1946), river redhorse was relatively common in the Lac Saint-Louis, Bassin de Laprairie and Lac Saint-Pierre commercial catch in the 1940s. It was rare in the fluvial corridor between Lac Saint-Pierre and Québec City. Despite extensive fishing effort within the St. Lawrence lowlands fish survey (Mongeau *et al.* 1986) and the Réseau de suivi ichtyologique du Saint-Laurent (La Violette *et al.* 2003; Société de la faune et des parcs du Québec, unpubl. data) since the 1970s, only two river redhorse have been identified from St. Lawrence River. Individual specimens were collected at Lac Saint-Louis about 10 km downstream of Montréal in 1984 (Moisan 1998) and in April 2004 (R. Dumas, Société de la faune et des parcs du Québec, pers. comm.). There are no reports of this redhorse in the experimental weir fishery of the Aquarium du Québec (Québec City) since the beginning of its operation in 1960 (Robitaille *et al.* 1987; Y. de Lafontaine, Environment Canada, pers. comm.). Today, in Quebec, the river redhorse persists in the Richelieu River (from Chambly dam to the confluence with the St. Lawrence River) and in the Ottawa River. Additionally, spawning-ready river redhorse have been recently collected from the Gatineau River, at its confluence with the Ottawa River (Campbell 2001).

In the Richelieu River, between 1990 and 2004, more than 200 subadult and adult river redhorse were reported during ichthyological surveys and scientific studies on the spawning activities of five *Moxostoma* species (LaHaye *et al.* 1993; Boulet *et al.* 1995; Saint-Jacques 1995; Boulet *et al.* 1996; Dumont *et al.* 1997; LaHaye and Clermont 1997; Boulet and Simoneau 1999). Most were collected downstream of the Chambly and Saint-Ours dams. During the preliminary studies of the Vianney-Legendre Fish Ladder (Saint-Ours dam), 46 river redhorse were caught in the trap at the outlet of the ladder in 2002, 555 in 2003 and 104 in 2004 (Fleury and Desrochers 2003, 2004). Fall seine sampling in the Saint-Marc region of the Richelieu captured 14 young-of-year (YOY) in 1997, one in 1998, 14 in 1999 and 112 in 2001 (Vachon 1999a, 1999b, 2002). In 1998, a large reproducing population of river redhorse was identified in the Gatineau River. Fall boat-electrofishing from Alonzo-Wright bridge to the confluence with the Ottawa River (~5 km) resulted in the capture of 99 river redhorse. In the spring of 1999, over 200 river redhorse were captured (Campbell 2001).

HABITAT

Habitat requirements

While the river redhorse has been reported from both lakes and rivers within its Canadian range, the persistence of this species relies upon access to suitable riverine spawning habitat. Past studies have indicated a preference for habitats with moderate to swift current, riffle-run habitat and clean coarse substrates (Hackney *et al.* 1967; Scott and Crossman 1973; Becker 1983; Yoder and Beaumier 1986; Parker 1988; Campbell 2001; Reid 2002; 2003). Yoder and Beaumier (1986) observed densities eight times greater in locations of preferred habitat than at pooled and impoundment locations in an Ohio River. Summer trap-net sampling on the Mississippi River resulted in the capture of river redhorse in run habitat, suggesting that its habitat requirements may be more extensive than previously thought (Campbell 2001). Summer sampling of river redhorse resulted in capture in areas of abundant aquatic vegetation, fairly slow current and soft substrates (Campbell 2001). Compared to the spawning period (June), lower catch per unit effort numbers in fall sampling of fastwater habitats along the Trent River suggest that deeper run/pool habitats are used during other periods of the year (Reid 2003).

In Quebec, river redhorse occurrence has been related to the presence of the copper redhorse, showing an affinity for lowlands rivers of medium size characterized by abrupt banks and uniformely deep channels (4-7 m) flowing over a solid clay, sand or gravel bottom exposed to rather slow currents and interspersed by sections of rapids suitable for spawning (Mongeau *et al.* 1986, 1992).

Depth preference for this species has not yet been determined with accuracy. However, there is a definite trend towards shallow water (less than 2 m deep) during spawning (Campbell 2001). In addition, fish captured during spawning were consistently captured in areas within 100 m of rapids (Campbell 2001). Lac des Chats (Ottawa River) sampling in August and September of 1998 (post-spawn) captured river redhorse at depths ranging from 3-12 m and consistently at distances greater than 10 km from the nearest rapids (Campbell 2001).

In the Richelieu River, YOY are found along vegetated shores where average depth is 1.5 m (maximum ≤ 3.0 m), the slope is shallow (≤ 20º) and the substrate consists of fine sediments (silt, clay and sand). In the early spring, age 1+ specimens are also found in greater abundance in vegetated areas. An important nursery habitat has been found in the Richelieu River in the Saint-Marc region (Vachon 1999a, 1999b, 2002). Jenkins (1970) suggested that moderate-sized streams or tributaries and backwater areas provide suitable juvenile habitat. In Quebec, it is clearly associated with medium-sized and large rivers, even at the juvenile stage (Mongeau *et al.* 1986, 1992).

Trends in habitat

The distribution of the river redhorse is restricted by the availability of its specific habitats, which are vulnerable to anthropogenic activities. For example, Mississippi River populations may be at risk due to intensive agricultural activities that increase the sediment load of the river and negatively affect the availability of the benthic invertebrate prey of the river redhorse (Campbell 2001). Poor water quality (i.e. excessive nutrients) as a result of agricultural activities and urban development likely contributed to the loss of some Quebec populations, at least in the Yamaska and Châteauguay basins (La Violette and Richard 1996; Moisan 1998; La Violette 1999; Vachon 2003a). Poor water quality (turbidity, excessive nutrients and high summer water temperatures) also affects the lower Grand River where river redhorse are found. Human population growth in the Grand River basin has been projected to be 30% over the next 20 years (www.grandriver.ca). Further impairment of habitat and water quality from upstream land use changes, water utilization and sewage disposal would likely have an adverse effect on resident river redhorse. Threats to river redhorse habitat quality in southwestern Ontario may in the future be mitigated through the recovery plan actions. For example, habitat improvement goals identified for the Thames River of benefit to the river redhorse include reductions in sediment, nutrient and toxic chemical loadings (Thames River Recovery Team 2003).

Riverine habitat in Canada is also threatened by the construction of hydroelectric dams and other barriers. Increased energy demands in Ontario and Quebec may result in the construction of new hydroelectric facilities, or the conversion of run-of-river facilities to peaking facilities. Dam construction has already heavily fragmented the Madawaska, Mississippi, Ottawa, Trent, Yamaska, Richelieu, and Châteauguay rivers and the lower reaches of the Grand River, increasing the risk of local extirpation due to limited immigration or emigration of the river redhorse population. Suitable spawning habitat is primarily limited to the tailwater areas downstream of these locks and dams. Maintenance of sufficient flows through these habitats during spawning is necessary for successful river redhorse reproduction (Reid 2002). In addition, due to the number of barriers, available habitat becomes limiting as movement between habitats and populations is restricted. Recovery of river redhorse populations after disturbances through emigration is expected to be limited by the number of dams along the rivers it inhabits (Reid 2002).

On a more positive note, recent emphasis has been placed on providing migratory fishes with access to previously unavailable habitat through the destruction of barriers, as well as through the construction of multi-species fishways. Recently, the Vianney-Legendre Fish Ladder was constructed on the Richelieu River in an effort to preserve fish biodiversity. The fish ladder enables species such as the river redhorse to reach spawning grounds and locate preferred habitat (Dumont *et al.* 1997). To determine the best operation procedures for maximizing fish passage, an experimental breaking-in period of 5 years was initiated in 2001. In 2002, 46 river redhorse (23-72 cm) were caught at the outlet between May 16 and July 4. In 2003, 555 individuals (20-70 cm) used the ladder between May 22 to June 24 (Fleury and Desrochers 2003, 2004).

Protection/ownership of habitat

The habitat of the river redhorse is protected under the habitat provisions of the federal *Fisheries Act*, particularly section 35 (1) which states that a development proposal must not cause a “harmful alteration, disruption, or destruction” of fish habitat. Habitat may also receive protection by other federal legislation, including the *Environmental Assessment Act*, *Environmental Protection Act* and *Water Act*. In Ontario, river redhorse may also receive protection under the *Lakes and Rivers Improvement Act*, *Ontario Environmental Protection Act*, *Ontario Environmental Assessment Act*, *Ontario Planning Act* and *Ontario Water Resources Act*.

Quebec legislation also provides general protection of fish habitat under the *Environment Quality Act*. The Act respecting the conservation and development of wildlife, under articles 128.1 to 128.18, controls activities that could modify biological, physical and chemical components peculiar to fish habitat. The Act respecting threatened or vulnerable species makes additional provision for the protection of the habitat of threatened or vulnerable species. Finally, the Pierre-Étienne-Fortin Wildlife Refuge, created in 2002 for the protection of the copper redhorse spawning grounds in the Chambly rapids (Richelieu River), also protects river redhorse habitat from activities that could disturb the river bed and flow characteristics. Access to the refuge sectors where the copper redhorse and river redhorse spawn is forbidden between June 20 and July 20 (Gendron and Branchaud 2001).

BIOLOGY

General

The river redhorse is a late-maturing, long-lived and large-bodied sucker that requires large interconnected riverine habitat to fulfill the need of all life stages. Generally, specimens are greater than 500 mm TL (Campbell 2001; Reid 2003). The largest river redhorse recorded to date was 812 mm TL (Jenkins *et al.* 1999). Males are usually shorter and lighter than females; however, both sexes can attain sizes in excess of 700 mm TL (Mongeau *et al.* 1992; Campbell 2001; Fleury and Desrochers 2004). The maximum weight recorded for river redhorse was a gravid female, 7,938 g (Jenkins *et al.* 1999; Campbell 2001). Maximum ages recorded for river redhorse are 27 (Trent River) and 28 years (Mississippi River) (Reid unpubl. data and Campbell 2001). Campbell (2001) characterized growth using the following the equation:

$$\text{TL (mm)} = 0.0905\,(\text{age})^3 - 5.1452(\text{age})^2 + 95.94(\text{Age}) + 0.367.$$

In the Richelieu River, backcalculated TL at age 3, 6, 9, 12, 15 and 18 are 229, 410, 533, 586, 659 and 680 mm, respectively; and corresponding weights are 223, 950, 1,833, 2,317, 3,107 and 3,360 g (Mongeau *et al.* 1986, 1992). Compared to other North American populations, growth rate in the Richelieu River is relatively high (Mongeau *et al.* 1986). In September and early October, YOY river redhorse collected from the Richelieu River averaged between 48 and 67 mm TL. These specimens were smaller than earlier spawning shorthead redhorse, silver redhorse and greater redhorse. Fall TL of age 1+ river redhorse ranged from 114 to 131.5 mm. YOY examined by Jenkins (1970) from the southern half of its distribution averaged 50 mm standard length (SL) in September with a maximum of 70 mm SL. As reported for the Richelieu River population, YOY river redhorse were smaller than other earlier spawning redhorse species (*M. erythrurum* and *M. duquesnei*).

Reproduction

Canadian river redhorse populations reach sexual maturity at an older age and a larger size than their American counterparts. In southern populations, river redhorse have been speculated to reach sexual maturity between the ages of 3 and 5 years (Tatum and Hackney 1970; Huston 1999). More northerly populations of river redhorse do not achieve sexual maturity until a relatively late age. In the Richelieu River, Mongeau *et al.* (1986, 1992) observed mature male and female near or on the spawning sites between age 10 and 20 (543-713 mm TL). Along the Trent River, males in spawning condition were 5 to 16 years old while females were 7 to 16 years old. Spawning-ready males captured from both the Trent River and Grand River were smaller than females (Trent River: ♂mean TL=603 mm; ♀mean TL= 641 mm. Grand River: ♂mean TL= 627mm; ♀mean TL= 662 mm) (S. Reid unpubl. data).

Except for Quebec rivers supporting copper redhorse, the river redhorse is the last of the *Moxostoma* species to spawn each year (Mongeau *et al.* 1992). American populations of river redhorse begin spawning in mid-April to mid-May at water temperatures between 18° and 24°C (Jenkins and Burkhead 1993). Canadian populations spawn later in the year, usually beginning in late May or early June and ending in late June (Reid 2003). In the Chambly rapids of the Richelieu River, spawning typically occurs between the second and last week of June at temperatures between 17° and 20°C. This period overlaps with the spawning period of the greater redhorse and copper redhorse (Mongeau *et al.* 1992; La Haye *et al.* 1992). Both sexes were observed in spawning condition once water temperatures reached 15.5°C (early June) in the Trent River (Reid 2003). Spawning-ready river redhorse were captured in the Grand River in late May 2002 at temperatures of 18.5°C. Similarly, the Gatineau River population began spawning at water temperatures between 17.5° and 19°C (Campbell 2001). Males have been found to be in spawning-ready condition at temperatures of 4.5°C colder than females (Campbell 2001).

It has been reported that river redhorse excavate spawning redds (Hackney *et al.* 1967). Parker (1988) observed shallow swept depressions 10-15 cm deep and 50-75 cm long at the base of shallow rapids in the Mississippi River. Similarly sized areas of cleaned spawning substrate have been observed during river redhorse spawning along the Trent River (S. Reid unpubl. data). Jenkins (1970) suggests that these apparent redds are merely an artifact of aggressive mating and not a depression dug prior to spawning. Further investigation is required to confirm if river redhorse construct redds as this has implications for spawning habitat requirements. Although redd formation is not definite, the river redhorse does exhibit ritualized spawning displays. Hackney *et al.* (1967) described this process for river redhorse in the Cahaba River, Alabama: “The female approaches the nest as the male performs a nuptial dance, darting back and forth, then a second male joins in. Once the second male is present the female swims between them. At this point the males press tightly against the female and all three vibrate across the bottom, releasing eggs and milt and burying the eggs in one sweeping pass.” Aggregations of two or three river redhorse were observed at the Trent River spawning locations (Reid 2003) supporting previous observations of Hackney *et al.* (1967) and Parker and McKee (1984).

The fecundity of female river redhorse collected from the Ottawa River basin was estimated to range between 9,000 and 22,000 eggs (Campbell 2001). In the Richelieu River, the fecundity of three females between 556 and 713 mm total length (TL) ranged between 14,010 and 31,050 (Mongeau *et al.* 1986, 1992). Beaulieu (1961) estimated fecundity of 28,640 to 42,630 eggs for four females from the St. Lawrence River. In these samples, the relative fecundity and gonadosomatic index are lower than those observed for the four other Quebec *Moxostoma* species. Females sacrified by Mongeau *et al.* (1986, 1992) during the 1984 spawning period had only one gonad fully developed. Similar comparatively low values of 6,078 to 23,075 eggs for individuals 450-560 mm in TL were reported by Hackney *et al.* (1967). Unfertilized eggs examined by Campbell (2001) were yellow, adhesive and ranged in diameter between 2.3 and 3.0 mm (mean diameter: 2.8 mm). However, Fuiman (1982) described eggs that are relatively large (3.7 to 4.4 mm) and non-adhesive. Fertilized river redhorse eggs hatch relatively quickly: 6 days at 24°C (Jenkins 1970) and 5 days at 18.5°C (S. Reid unpubl. data).

Survival

River redhorse in Canada are long-lived compared to more southern populations, with a maximum reported age of 28 years. However, little is known about the population demographics of the river redhorse in Canada. Information regarding population size and level of recruitment is deficient. Life-history theory predicts that large-bodied catostomids with similar reproductive tactics and biology (late age at maturity, longevity and seasonal spawn) may experience low juvenile survivorship most years, with recruitment relying on a relatively few successful spawning bouts by a given individual in its lifetime (Winemiller and Rose 1992; Healey 2002). This reproductive strategy takes advantage of seasonal and predictable changes in habitat characteristics, such as spring flooding due to snowmelt. Since year-to-year spawning success may vary depending on hydrological and climatic conditions, spawning must be unimpeded annually to take advantage of years with exceptional spawning conditions and high juvenile survivorship (Winemiller and Rose 1992; Healey 2002). Based on this type of life-history strategy, repeated unnatural perturbations to critical stream habitat may impact river redhorse recruitment (Healey 2002). A YOY redhorse survey along the Richelieu River revealed high annual variability in the river redhorse year-class strength. Relative abundance of YOY river redhorse, compared to the four other species found in this river, increased from 1998 to 2001. It was 0.35% in 1998, 3.8% in 1999 and attained 11.2% in 2001 where it was the second most abundant species (Vachon 1999b, 2002). Hydrologic conditions (spring flow) may affect reproductive success and the YOY survival of redhorse in the Richelieu River. Years with higher spring flows were associated with larger cohorts (Vachon 2002).

Physiology

Little information is available on the physiological tolerances of catostomids found in eastern North America other than the white sucker (*Catostomus commersoni)*. Walsh *et al.* (1998) reported physiological tolerances for juvenile robust redhorse (*M. robustum*), a sister taxon of the river redhorse. Critical thermal maxima were identified to be between 35 and 37^{o}C. At dissolved oxygen concentrations between 0.7 and 0.8 mgO_2L^{-1}, juvenile robust redhorse switched to aquatic surface respiration and lost equilibrium at 0.54 to 0.57 mgO_2L^{-1}. Hatching success of robust redhorse eggs has been observed to decline above 23°C along with an increase in the incidence of larval and juvenile deformities at temperatures above 25°C.

Movements/dispersal

Access to spawning habitat is essential for the continued existence of the river redhorse. During the spring, redhorse species migrate to spawning habitats (Jenkins 1970; Mongeau *et al.* 1986, 1992). Hackney *et al.* (1967) documented tagged river redhorse to travel more than 15 km upstream along the Cahaba River, Alabama to spawn. Along the Trent and Gatineau rivers, large increases in river redhorse abundance have been measured at spawning habitats during May and June (Campbell 2001; Reid 2003). In 2002, the river redhorse was present in the Vianney-Legendre fish ladder during almost the entire observation period, from May 16 to June 18 (Fleury and Desrochers 2003). In 2003, between May 22 and June 24, 555 river redhorse were observed at the outlet of the ladder, and 444 were counted during four peaks of migration, on May 26 (n=54) and 30 (n=128) and on June 5 (n=155) and 7 (n=107) (Fleury and Desrochers 2004).

Larval drift is important for the dispersion of *Moxostoma* species to suitable rearing habitats (D'Amours *et al.* 2001). For example, the nursery habitat for YOY river redhorse in the Richelieu River is 21 km downstream from the spawning site in the bassin of Chambly (Vachon 1999a).

Nutrition and interspecific interactions

The enlarged, molariform pharyngeal teeth of this species are adapted for crushing the shells of mussels, snails and crayfishes (Eastman 1977; Jenkins and Burkhead 1993). Stomach analysis performed by Hackney *et al.* (1967) of Cahaba River, Alabama specimens, found that river redhorse fed largely on bivalve molluscs. Smaller quantities of insect larvae were also taken. The adult diet of sympatric *Moxostoma* species from the Richelieu River was compared by Mongeau *et al.* (1986, 1992). Stomach contents of the river redhorse were dominated by Ephemeroptera (54%) and Trichoptera (15%) larvae. Diet ovelap was very low and gut contents varied according to the development of pharyngeal teeth. Copper redhorse had the highest preference for molluscs (99% of prey observed) while molluscs represented about 25% of the river redhorse diet and less than 15% of the diet of the greater redhorse, shorthead redhorse and silver redhorse.

Pharyngeal arch and teeth are present in YOY river redhorse (Vachon 1999a, 2003b). However, during the first growing season, young river redhorse feed mostly on microcrustaceans. The diet of 31 YOY river redhorse ($32 \leq TL \leq 63$ mm) caught from the Richelieu River was composed of chydorid cladocerans (22% in number), algae (diatoms) (21%), nematodes (15%), harpacticoid copepods (12.5%), protozoans (6%) and chironomid larvae (4%) (Vachon 1999a). In contrast to adults, there was a high degree of overlap among the diets of YOY *Moxostoma* (Vachon 1999a). McAllister *et al.* (1985) examined the gut contents of 10 Ontario specimens. River redhorse ranging between 100-150 mm TL fed primarily on chironomid larvae and pupae. Larger individuals (200-250 mm TL) consumed chironomids, crustaceans, trichopterans and coleopterans. The diet from an age 2+ specimen (TL= 140.5 mm) caught in the Richelieu River on June 10 was principally composed of chironomid larvae (57% in number) and chydorid cladocerans (26%) (Vachon 1999a). Larger river redhorse consumed molluscs, insect larvae and crayfishes.

The anatomical specialization of the river redhorse for feeding on molluscs may increase this species' susceptibility to extirpation. Over much of the North American range of this species the molluscan fauna has declined (Williams *et al.* 1993). The invasion of the Great Lakes and St. Lawrence River by zebra mussels (*Dreissena polymorpha*) has reduced the availability of the native species of molluscs and changed the bioaccumulation process of contaminants. It is not known to what extent river redhorse are consuming the large biomass of the newly established zebra mussel or its effect on growth rate. Likely the result of poor caloric value, French and Bur (1996) reported that zebra mussel-dominated diets reduced growth rate of adult freshwater drum (*Aplodinotus grunniens*) in Lake Erie.

In addition to sucker and redhorse species, competition for food may occur with other native (Mongeau *et al.* 1986, 1992) and non-native fish species. Freshwater drum has pharyngeal teeth adapted for crushing mussels and snails (Jenkins and Burkhead 1993). Common carp (*Cyprinus carpio*), which was introduced into North America in 1831, also feeds on molluscs (Scott and Crossman 1973). Common carp has been associated with copper redhorse and river redhorse in the experimental catch of the 1960s and 1970s in the Yamaska-Noire system and in the Richelieu River (Mongeau *et al.* 1992). The recent introduction of tench (*Tinca tinca*) in the Upper Richelieu and its capacity to rapidly spread into the St. Lawrence River system also adds a potential competitor to the copper redhorse and river redhorse (Dumont *et al.* 2002).

The large adult size of this species and rapid growth rate of young-of-the-year reduces its vulnerability to predators (Parker 1988).

Behaviour/adaptability

River redhorse has the potential to re-establish populations in waters where they have been extirpated when other populations exist nearby (Jenkins and Burkhead 1993). However, in many of the rivers in which they reside, low population sizes and the presence of barriers to immigration (i.e. dams) reduce their ability to recover from disturbances.

POPULATION SIZES AND TRENDS

Populations appear to have been lost from the Ausable, Châteauguay, Noire and Yamaska rivers. Given the lack of baseline data, population size trends of extant populations cannot be addressed directly. Populations are still present in the following rivers identified in the previous status report to support river redhorse: Mississippi, Ottawa and Richelieu. Evidence of successful reproduction (YOY and juveniles) has been collected from the lower Grand River (S. Reid unpubl. data) and from the Richelieu River (Vachon 1999a, 1999b, 2002). Large aggregations of spawning river redhorse (50+ individuals) have been identified along the Grand River, Trent River and Gatineau River, and in the Vianney-Legendre Fish Ladder on the Richelieu River. Rather than an increase in range and population sizes, the increase in number of known rivers supporting river redhorse is interpreted to be the result of more intensive sampling of large rivers in Ontario, the use of more efficient gear (boat electrofishing units), and greater interest in the ecology of the species.

Considered common in the 1940s in the St. Lawrence River around Montréal (Vladykov 1942), river redhorse is now very rare. The decrease is likely related to reduced access to the Soulanges Rapids located between Lac Saint-François and Lac Saint-Louis. As well, from 1929 to 1961, the discharge of the St. Lawrence River was almost completely diverted to the artificial Beauharnois canal for hydroelectricity production and navigation (Morin and Leclerc 1998). A series of four dams block access to four sections of rapids.

Campbell (2001) provided the only attempt at population size estimation. Summer mark-recapture-based population estimates for the Mississippi River population ranged between 623 and 830 individuals. Mark-recapture population estimates for the Gatineau River population during the peak of spawning was 1,012 individuals (Campbell 2001). However, low numbers of recaptured fish and violations of model assumptions (e.g. high immigration rates) indicate that these estimates should be interpreted with caution. Identification of long-term population trends would benefit from continued standardized sampling. For future monitoring, it is recommended that relative abundance be measured during the spawning period (early-mid June) when large numbers of adults are aggregated in habitats effectively sampled by boat-electrofishing. Standardized nearshore fish community trap-net surveys in the Ottawa River and the Bay of Quinte, Lake Ontario during summer and fall may also provide useful data for future assessments.

LIMITING FACTORS AND THREATS

The river redhorse is at the northern limit of its distribution in Canada with low numbers and disjunct distributions. Tolerance for a narrow range of habitat characteristics, and a limited amount of suitable habitat restricts the distribution of river redhorse. It is an inhabitant of medium to large-sized rivers and intolerant of high turbidity levels, siltation and pollution (Trautman 1981; Jenkins and Burkhead 1993; Mongeau *et al.* 1986, 1992; Vachon 2003a) and likely disappeared from watersheds highly developed for intensive industrial agriculture, such as the Yamaska and Châteauguay rivers in Quebec.

Due to restrictive spawning habitat (water depth and substrate) preferences, river redhorse recruitment is vulnerable to changes in the flow regime and siltation of spawning habitats. Large increases in discharge during the spawning period have been observed to prevent the spawning of other redhorse species (Bowman 1970; Cooke and Bunt 1999). River redhorse is also a late spring spawner and as such is significantly smaller at the end of the first growing season than earlier spawning redhorse species (Vachon 1999a). As over-winter survival of YOY is size-selective (Sogard 1997), YOY river redhorse are less likely to survive than earlier spawning species. Lastly, river flows during spawning are lower compared to earlier spawning redhorse species and the river's capacity to dilute chemicals is reduced. In the Richelieu River, late spring spawning coincides with period of peak pesticide application. In the Yamaska and Richelieu rivers, Gendron and Branchaud (1997) provide evidence that the final steps of sexual maturation by copper redhorse (another late spawner) in these rivers is disrupted by exposure to agricultural, urban and industrial toxins as they congregate to spawn. In the mid-1990s, poor river redhorse gonadal condition was observed in specimens collected from this area.

In addition to adverse effects on spawning habitats, siltation can also result in decreased production of benthic macroinvertebrates and freshwater molluscs, the primary components of the river redhorse diet (Waters 1995; Vachon 2003a). French (1993) suggested that declines in mollusc populations caused by pollution and siltation of habitat will likely factor in the decline of mollusc–feeding catostomids such as the river redhorse.

Canadian populations of river redhorse are regionally isolated and locally fragmented. Rivers supporting river redhorse in Canada are generally fragmented by hydroelectric, navigational and flood control dams. Dams and impoundments have been identified as potential limiting factors for Canadian river redhorse populations (Portt *et al.* 2003). Recent evidence from the Trent River suggests that large reproducing populations of river redhorse are only found in river fragments of sufficient size with shallow fastwater habitats (Reid 2002). The decline of the river redhorse in the St. Lawrence River coincided with the beginning of works in support of hydroelectric production and shipping (Dumont *et al.* 1997). In the United States, impoundments have been shown to have a strong negative impact on the distribution of river redhorse (Etnier and Starnes 1993; Quinn and Kwak 2003). In Virginia, dams have also been implicated in preventing the re-establishment of river redhorse populations after fish kills (Jenkins and Burkhead 1993). The influence of hydroelectric energy production on downstream flow levels (i.e. peaking) may impact downstream river redhorse populations. Maintenance of sufficient flows during spawning, egg incubation and through nursery habitats is necessary for successful recruitment and population persistence of the river redhorse. Further dam construction would adversely affect river redhorse populations by altering upstream and downstream habitat conditions; restricting the movements of individual fish; and limiting gene flow between populations.

River redhorse populations may be at risk due to recreational angling activity, in particular the Grand River population where angling for redhorse is reported to occur

(Portt *et al.* 2003). During spring spawning runs, congregative behaviour likely increases the susceptibility of river redhorse to recreational angling or spearfishing. The river redhorse is not afforded protection by catch limits, minimum size restrictions, or spearfishing regulations (McAllister *et al.* 1985; Ontario Fishing Regulations 1989). Due to lack of regulation and vulnerability during the spawn, populations may be affected to a degree. Additionally, confusion with other sucker species may result in unknown harvesting and be a factor in decline of local populations (Parker and McKee 1984). This potential threat has not been quantified. In Quebec, to prevent accidental catch of the copper redhorse and river redhorse, sportfishing is prohibited for sucker species in the sectors of the Richelieu, des Mille Iles, Yamaska and Noire rivers where both species cohabit. Commercial catch of these two species is also prohibited in Quebec.

Most field biologists have difficulty correctly identifying river redhorse. Past biological studies (e.g. creel censuses, fish community inventories) in Ontario often failed to report the presence of redhorses to species due to problems with species identification and lumping of fish into the category of suckers or coarse fish (Cooke and Bunt 1999). A lack of long-term population monitoring data in conjunction with difficulties associated with correct field identification limits our ability to protect remaining populations. In Quebec, this problem was partly resolved for specimens longer than 250 mm by the production of a poster facilitating the identification of the two *Catostomus* and the five *Moxostoma* species occurring in the province (Mongeau 1984; Mongeau *et al.* 1986). This poster has been distributed to the scientists and consultants working in the St. Lawrence lowlands. Recently, genetic-based *Moxostoma* species identification tools (Branchaud *et al.* 1996; Harris *et al.* 2002; S. Reid unpubl. data) and new taxonomic keys (Holm and Boehm 1999; Vachon 2003b) have been developed.

Introgression among catostomid species due to habitat alteration has been identified as a conservation concern in western North America where hybridization between catostomid species is often common. However, hybridization is unknown or rare in most eastern suckers (Jenkins and Burkhead 1993). Of thousands of *Moxostoma* specimens examined, only two cases of hybridization have been reported (Jenkins 1970; Jenkins and Burkhead 1993). This included a single river redhorse hybrid with either a shorthead or greater redhorse. Barriers to hybridization among *Moxostoma* species include aggressive behaviour and differences in spawning time, temperature and habitat (Curry and Spacie 1984; Kwak and Skelly 1992).

SPECIAL SIGNIFICANCE OF THE SPECIES

This species was historically a food source for native people and first European settlers and a species of minor commercial importance near Montréal (Mongeau *et al.* 1986; Moisan 1998). This fishery no longer exists.

Like all sucker species, the river redhorse plays an important, yet underrated, role as a nutrient cycler in aquatic ecosystems. It transfers energy (i.e. nutrients) from the benthic food web (where it feeds) to the pelagic food web (where it is preyed upon).

Piscivorous fishes found in rivers supporting river redhorse include largemouth bass (*Micropterus salmoides*), muskellunge (*Esox masquinongy*), northern pike (*E. lucius*), smallmouth bass (*M. dolomieu*) and walleye (*Sander vitreus*). The river redhorse is also one of few freshwater fishes that feed extensively on molluscs and therefore perform a unique ecological function (Portt *et al*. 2003). French (1993) suggested that if river redhorse were found in sufficient numbers, they could possibly be used as a means of biological control of zebra mussels where their ranges and habitats overlap.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Conservation ranks determined by the Association of Biodiversity Information are summarized in Table 1.

Table 1. Global, American and Canadian federal, and state and provincial ranks assigned by NatureServe (2002)

Global	G4
USA	N4
Canada	N2
State/Provincial	Alabama (S4), Arkansas (S4), Florida (S1S2), Georgia (S2), Illinois (S2), Indiana (S3), Iowa (S?), Kansas (S1S2), Kentucky (S4), Louisiana (S1S3), Michigan (S1), Minnesota (S?), Mississippi (S3), Missouri (S?), New York (S2?), North Carolina (S2), Ohio (S3), Oklahoma (S1S2), Pennsylvania (S3), South Carolina (S1), Tennessee (S4), Virginia (S2S3), West Virginia (S3), Wisconsin (S2S3), Ontario (S2), Quebec (S2)

Canada

The river redhorse and its habitat are protected by the federal *Fisheries Act*, through the prohibition of any activity likely to adversely impact its habitat. The river redhorse was first designated as special concern (rare) by COSEWIC in 1983 (Parker and McKee 1984). This designation was reconfirmed in 1987 (Parker 1988) and in 2006. At the national level the river redhorse is ranked N2. In Ontario, it is considered very rare (S2) and has been ranked as vulnerable by the OMNR. River redhorse is addressed in the recovery strategies for species at risk in the Ausable and Grand rivers in Ontario (Dextrase *et al*. 2003, Portt *et al*. 2003).

The river redhorse is classified as a coarse fish by the OMNR and therefore is not afforded protection by catch limits, minimum size restrictions or by spearfishing regulations (McAllister *et al.* 1985). The species and/or its habitat may also be protected by the *Canadian Environmental Assessment Act*, *Canadian Environmental Protection Act*, *Federal Fisheries Act*, *Canada Water Act*, *Ontario Lakes and Rivers Improvement Act*, *Ontario Environmental Protection Act*, *Ontario Environmental Assessment Act*, *Ontario Planning Act, Ontario Water Resources Act, Quebec Environment Quality Act, Quebec Act respecting the conservation and development of* *wildlife*, and *Quebec Act respecting threatened or vulnerable species*. A wildlife refuge had been created in the Chambly Rapids to protect the spawning grounds and period of the copper and river redhorse. A fish sanctuary has also been designated along part of the Mississippi River to protect spawning river redhorse (Ontario Fishing Regulations 1989).

In Quebec, the river redhorse is on the list of species to be designated Vulnerable. Recreational harvesting of river redhorse is allowed in the St. Lawrence River, the Ottawa River and the Gatineau River but prohibited elsewhere in its distribution. Commercial harvest is prohibited in the province (Moisan 1998).

TECHNICAL SUMMARY

Moxostoma carinatum

river redhorse — chevalier de rivière

Range of occurrence in Canada: southcentral Ontario and southern Quebec

Extent and Area information	
• *extent of occurrence (EO)(km²)*	150,000
• *specify trend (decline, stable, increasing, unknown)*	Possibly stable in Ontario and decrease in Quebec
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	no
• *area of occupancy (AO) (km²)* For rivers with multiple extant sites (except Ottawa River), calculated as length of river between uppermost and lowermost sites multiplied by an average width of 0.10 km. For the Ottawa River, the average width was 1 km (pers. comm. Tim Haxton) Not determined for species from waterbodies with single site.	Grand – 5 Trent – 5 Ottawa – 150 Mississippi – 3.5 Madawaska – 5 Richelieu – 10 **Total – 178.5**
• *specify trend (decline, stable, increasing, unknown)*	Possibly stable in Ontario and decrease in Quebec
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	unknown
• *number of extant locations* Locations interpreted as discrete open circles on Fig. 3.	~25
• *specify trend in # locations (decline, stable, increasing, unknown)*	In some watersheds, the species has likely disappeared (Ausable, Châteauguay, Yamaska) or suffered a large decline (St. Lawrence River)
• *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*	Stable in Ontario Declined in Quebec
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	>5-10 years
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	Unknown
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Unknown
• *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)?*	Unknown
• *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
• *list each population and the number of mature individuals in each*	Unknown
• *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	
- habitat degradation, pollution, siltation, habitat fragmentation by dams	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	United States
• *status of the outside population(s)?*	Michigan (S1), New York (S2?), Pennsylvania (S3)
• *is immigration known or possible?*	Immigration from Michigan and New York populations to Ontario rivers improbable and from Pennsylvania possible
• *would immigrants be adapted to survive here?*	Yes
• *is there sufficient habitat for immigrants here?*	Unknown
Quantitative Analysis	Not applicable
Current Status COSEWIC: Special Concern (1987) Special Concern (2006)	

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric code**: Not Applicable

Reasons for Designation:

This freshwater fish species occurs in Ontario and Quebec, and although it has been collected at new locations in both provinces, sometimes in large numbers, this is thought to reflect the use of more effective sampling techniques such as boat electrofishing. It has likely disappeared historically from the Ausable, Châteauguay and Yamaska rivers, since the use of boat electrofishing has failed to collect it recently. Threats to the species include habitat degradation (pollution, siltation), stream regulation that affects water flow (dams) and habitat fragmentation (dams). The Canadian range is highly fragmented and rescue effect is improbable because of the precarious conservation status in adjoining U.S. states.

Applicability of Criteria

Criterion A: (Declining Total Population): Criterion thresholds not met.

Criterion B: (Small Distribution, and Decline or Fluctuation): Met criterion B2 (AO of 178.5 < 500 sq. km) and a) for severely fragmented but no continuing decline or extreme fluctuations.

Criterion C: (Small Total Population Size and Decline): Criterion thresholds not met because population sizes not known.

Criterion D: (Very Small Population or Restricted Distribution): Criterion thresholds not met because number of mature individuals not known or AO (178.5 > 20 sq. km) and no. of locations (about 25 > 5) exceed minimum thresholds.

Criterion E: (Quantitative Analysis): Not available.

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