Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Carmine Shiner (*Notropis percobromus*) in Canada

Carmine Shiner

2013

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the Species at Risk Act (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years of listing.

The Minister of Fisheries and Oceans is the competent minister for the recovery of the Carmine Shiner (*Notropis percobromus*) in Canada and has prepared this strategy, *per* section 37 of SARA. It has been prepared in cooperation with:

The Province of Manitoba - Manitoba Conservation & Water Stewardship
The Canadian Sphagnum Peat Moss Association
Manitoba Hydro
Tembec Inc.
Manitoba Live Bait Association

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the Carmine Shiner and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

This report was written by D.B. Stewart of Arctic Biological Consultants, Winnipeg, MB, who was secretary to the Recovery Team. Dana Boyter, Fisheries and Oceans Canada (DFO) revised the report into the current template which included a revised critical habitat section. Doug Watkinson of DFO in Winnipeg, MB kindly provided the photograph of the Carmine Shiner and map of its Manitoba distribution. Konrad Schmidt of the Minnesota Department of Natural Resources in St. Paul, MN, John Lyons of the Wisconsin Department of Natural Resources in Madison, WI, and Nick Mandrak of DFO in Burlington, ON, provided fish samples for the ongoing studies of Carmine Shiner morphology and genetics. Ken Stewart (deceased) of the University of Manitoba in Winnipeg, MB, was conducting the morphological analyses and Chris Wilson of the Ontario Ministry of Natural Resources in Peterborough, ON, is conducting the genetics analyses.

The Carmine Shiner Recovery Team extends its sincere appreciation to the individuals and organizations that supported the development of this recovery strategy and to the people who contributed their knowledge and hard work.

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Executive summary

This document is a revision of the Carmine Shiner Recovery Strategy initially posted on the Species at Risk Public Registry February 2008. The format has been updated to the most recent recovery strategy template and includes a revised format for the identification of critical habitat (CH).

In 2001 COSEWIC reviewed this species as Rosyface Shiner (*Notropis rubellus*) and designated the Manitoba population as “Threatened”, based on its disjunct distribution in relation to other populations of the species, its restricted range, and the species’ sensitivity to changes in water temperature and quality. Upon re-examination, the Manitoba population is now believed to be comprised of Carmine Shiner (*N. percobromus*), a species that has not been reported elsewhere in Canada. This population is still believed to be disjunct from those in northwestern Minnesota, but its known distribution has been broadened from the Whitemouth River watershed to include the Bird River and Pinawa Channel of the Winnipeg River watershed. In 2006, COSEWIC re-examined and confirmed the status of the Carmine Shiner as “Threatened” based on an updated status report (COSEWIC 2006).

Carmine Shiners are slender, elongate minnows. They are omnivorous lower to mid-level consumers and spawn in early summer. In summer, fish in Manitoba are found mostly at midwater depths of clear, brown coloured, fast flowing creeks and small rivers with clean gravel or rubble substrates, usually in or near riffles. Otherwise, little is known of their biology, life history, distribution, or abundance. Information available on the species’ physiology or ability to adapt to different conditions is insufficient to identify factors that might limit its recovery.

In 2003, the Manitoba population of Carmine Shiner was legally listed as a “threatened” species under the Species at Risk Act (SARA). SARA confers protection on the Manitoba population by prohibiting the killing, harming, harassing, capture or take of any individuals of the species or the possession, collection, or trade in the species. In addition, the general prohibitions of the Fisheries Act, including the Habitat Provisions continue to apply to the species. The species has no direct economic importance and limited importance as a forage species, but is of significant biological and scientific interest.

Threats to the species may include: overexploitation, species introductions, habitat loss/degradation, and pollution. Overexploitation probably is not a significant threat to the species as baitfish harvesters currently do not target it, and baitfishes are rarely harvested from habitats where Carmine Shiners have been found. If these fisheries became a concern in the future their impacts could be mitigated by regulation and education. The significance of the threat posed by species introductions is likely moderate in the Whitemouth River and unknown elsewhere, with a low potential for mitigating any impacts. Habitat loss and/or degradation associated with flow regulation, shoreline development, landscape changes, and climate change may occur in some reaches of the rivers inhabited by Carmine Shiners, and may pose a threat to the

species at some locations. The potential for mitigation varies with the type of threat and the affected waterbody. The threat posed to Carmine Shiners by point and non-point sources of pollution is uncertain. Examples of some pollutants that could affect the species include farm fertilizers, herbicides, and pesticides. The potential to mitigate or recover from pollution impacts is moderate to high except where long-range transport is the main source of pollutants, since these substances are ubiquitous. Scientific sampling may also pose a threat to the Carmine Shiner, but this threat is likely of low significance and can be readily mitigated.

There is no evidence that the Manitoba population has declined over time, but because of its apparently limited distribution and abundance, the species may be sensitive to future anthropogenic disturbances. Consequently, the recovery strategy focuses on the maintenance or conservation of existing populations and their habitats. Its goal is “To maintain self-sustaining populations of the Carmine Shiner by reducing or eliminating potential threats to the species and its habitat.”

The overall recovery strategy has three main objectives: 1) to maintain Carmine Shiner populations at their current abundance and within their present distribution within the Whitemouth, Birch and Winnipeg river systems; 2) to identify and protect critical habitat of the Carmine Shiner; and 3) to identify potential threats to the Carmine Shiner from human activities and ecological processes and develop plans to avoid, eliminate, or mitigate these threats. Three general approaches are proposed for helping to achieve the recovery goal and objectives: 1) research and monitoring, 2) management and regulatory actions, and 3) education and outreach. Within each of these, a number of individual strategies are outlined.

Critical habitat for the Carmine Shiner has been identified using the Bounding Box Approach (BBA). This approach requires the use of essential functions features and attributes for each life-stage of the Carmine Shiner to identify CH within the “bounding box”. The area occupied by the species becomes the “bounding box” within which the CH is found. A schedule of the studies needed to refine the species’ CH is presented.

The effects of the recovery strategy on non-target species should be positive, particularly in the Whitemouth River watershed where it may afford protection to a number of other uncommon species, including the Northern Brook Lamprey (*Ichthyomyzon fossor*), which COSEWIC has assessed as species of “Special Concern”.

An Action Plan relating to this recovery strategy will be produced within three years of the final recovery strategy being posted on the public registry.

Recovery feasibility summary

Under SARA (S.40) the competent minister must determine whether the recovery of a listed wildlife species is technically and biologically feasible. Recovery is considered technically and biologically feasible if all of the following four criteria are met:

1. ***Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance. YES***

Viable populations exist at a number of locations in Manitoba, most notably in the Whitemouth and Birch Rivers where the species has been documented for some time. Despite its apparently limited distribution there is no evidence that the distribution and/or abundance of the Carmine Shiner is declining or has declined in recent years.

2. ***The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated. YES***

Specific threats to the Carmine Shiner have been identified as moderately to highly mitigable, with the exception of species introductions, climate change, and hybridization where the potential for mitigation may be low. At present, the species introduction threat is not believed to be influencing the species' survival and the future impacts of climate change and hybridization remain speculative. While future species introductions may have the potential to disrupt populations of Carmine Shiner in Manitoba, these impacts may be avoided by applying appropriate regulatory controls and management actions to the affected water bodies. The potential impact from most of the habitat related threats may also be reduced, or eliminated, if appropriate regulatory reviews and management actions are exercised, and best management practices are applied to existing or proposed projects. Overall, the identified threats are not likely to impede the survival or recovery of the species. There are viable populations at a number of locations in Manitoba, and conservation and threat mitigation efforts targeted at these populations should be able to secure and maintain their continued viability. However, any improvement in our knowledge base for the species would improve understanding of the potential impacts of threats to it and of the efficacy of mitigation measures.

3. ***Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration. YES***

The occurrence of viable populations documented over a number of years from the Birch and Whitemouth rivers suggests that there is adequate habitat to support all life stages for the species, at least in these locations. Elsewhere, the historical development of hydroelectric projects on the Winnipeg River system may have decreased spawning habitat for the Carmine Shiner by altering depth and flow; and degraded other habitats by increasing turbidity. However, there are no definitive data to support this inference. Indeed, recent studies have found Carmine Shiners to be more widely distributed and perhaps more abundant than was previously known. While there is little or no information on the persistence of habitat from some of the more recently documented sites (i.e., Bird River and Peterson Creek), these sites do provide suitable habitat under at least some conditions. The existence of alternative habitats may help protect the species from catastrophic events. Overall, habitat is currently not believed to be a limiting factor for Manitoba populations of Carmine Shiner.

4. ***Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe. YES***

The techniques likely to be contemplated for the conservation of Carmine Shiner populations are well founded in current science and management practices. Given the relative abundance of the species within its limited distribution, the focus of recovery efforts should be on the mitigation of habitat impacts and the exclusion of unwanted species. The technical knowledge on how to deal with potential habitat impacts is well documented and applied globally. The avoidance of species introductions is best afforded through public education and management programs, both of which are entirely within the competency of the responsible jurisdictions. No impediments to the recovery of the Carmine Shiner have been identified by any of the responsible agencies.

Given the above, recovery of the Carmine Shiner is deemed to be biologically and technically **feasible**.

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1. COSEWIC species assessment information

Assessment Summary - April 2006

Common name
Carmine Shiner

Scientific name
Notropis percobromus

Status
Threatened

Reason for designation
This freshwater fish species occurs in an extremely restricted area of Manitoba. The major threat to the species is the alteration in water flow as a result of stream regulation.

Occurrence
Manitoba

Status history: Designated Special Concern in April 1994. Status re-examined and designated Threatened in November 2001 and in April 2006. Last assessment based on an update status report.

2. Species Status Information

Global Status: Carmine shiner is globally secure (G5) and only occurs in Canada and the United States. The Carmine shiner occurs in one Canadian province and has been designated at risk, S2 in Manitoba. It's status ranges from imperilled, S2 to secure, S5 in 11 U.S. States. (Table 1) (Nature Serve 2011).

Canadian Status: The Carmine Shiner (*N. percobromus*) population in Manitoba was previously identified as the Rosyface Shiner (*N. rubellus*) (Houston, 1994, 1996; COSEWIC 2001). In 2001, the Carmine Shiner, *Notropis percobromus* (Cope, 1871), was designated as a "Threatened" species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2001), and was listed as such under Schedule I of the Species at Risk Act (SARA) on 5 June 2003. Subsequent reviews of the *N. rubellus* species complex suggests that these fish are in fact Carmine Shiners (Wood et al. 2002; Stewart and Watkinson 2004; Nelson et al. 2004). Despite the change in species identification, the reason for their "Threatened" status, namely that the Manitoba population is small and disjunct within a restricted Canadian distribution, still applies. Based on an update status report, COSEWIC reaffirmed its assessment of "Threatened" for the Manitoba populations of the Carmine Shiner in 2006.

Percent of Global Distribution and Abundance in Canada: The Manitoba population is small and disjunct with a restricted Canadian distribution.

Table 1. List and description of various conservation status ranks for the Carmine Shiner (NatureServe 2011)

Rank	Jurisdiction Rank
Global (G)	**G5** (August 27, 2004)
National (N)	
Canada	**N2** (August 24, 2004)
U.S.	**N5** (August 24, 2004)
Sub-national (S)	
Canada	Manitoba (**S2**), Ontario (**SNR**)
U.S.	Arkansas (**S4**), Illinois (**S3**), Iowa (**S5**), Kansas (**S4**), Minnesota (**SNR**), Missouri (**SNR**), North Dakota (**S3**), Ohio (**S4**), Oklahoma (**S4**), South Dakota (**S2**), Wisconsin (**SNR**)

S1: Critically Imperilled; S2: Imperilled; S3: Vulnerable; S4: Apparently Secure; S5: Secure; SNR: Unranked.

3. Species information

3.1 Species description

3.1.1 Taxonomy

The Carmine Shiner is a small minnow of the genus *Notropis*, the second largest genus of freshwater fishes in North America. Many species in this genus are difficult to distinguish from one another and **phylogenetic relationships**[1] among them are largely unresolved (Dowling and Brown 1989). Recent **allozyme**[2] studies support the existence of at least five species that had hitherto been recognized only as "Rosyface Shiners", including the Rosyface Shiner, Highland Shiner (*N. micropteryx*), Rocky Shiner (*N. suttkusi*), Carmine Shiner, and a species that has not yet been described (Figure 1) (Wood et al. 2002). Stewart and Watkinson (2004) accepted the Carmine Shiner as the identity of the Manitoba population(s) on the basis of the biogeographic information in Wood et al. (2002) and in conformity with Nelson et al. (2004). COSEWIC has also officially adopted the name of Carmine Shiner to describe the Manitoba populations. Ongoing studies by Dr. Chris Wilson of the Ontario Ministry of Natural Resources (pers. comm. 2005) have confirmed that the Carmine and Rosyface shiners are separate taxa based on both mitochondrial (ATPase 6 and 8 genes) and nuclear (rRNA ITS-1) DNA sequences. These studies show that the fish in Manitoba are Carmine Shiners, like those to the south, and not Rosyface Shiners like those in eastern Canada. Consequently, all future reference in this report will be to the Carmine Shiner.

[1] **Phylogenetic relationships** describe the evolutionary history of species relative to one another.

[2] **Allozymes** are forms of an enzyme that differ in their chemistry.

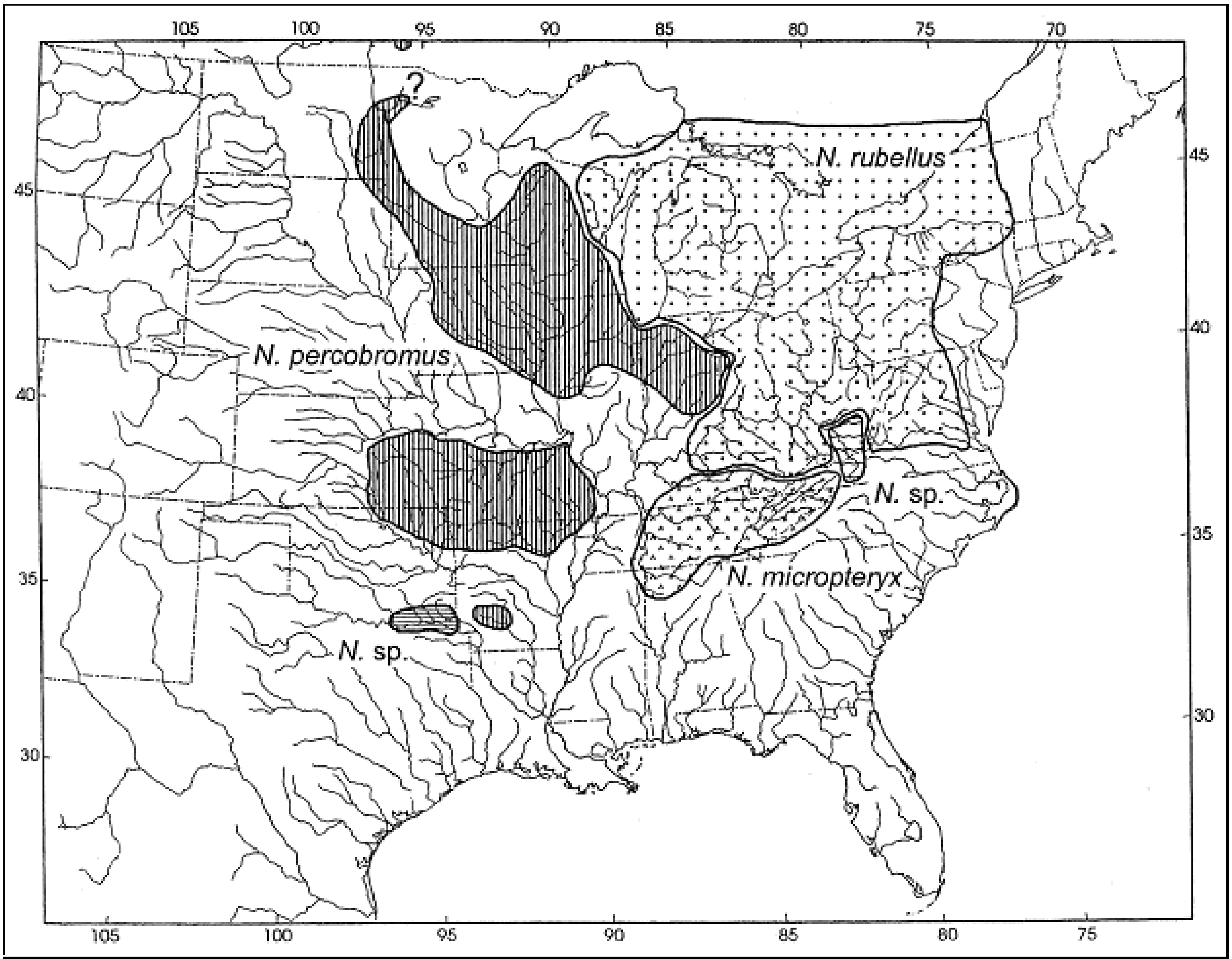

Figure 1. Hypothesized geographical distributions of species in the *Notropis rubellus* species complex based on geographical variation of allozyme products (modified from Wood et al. 2002)

The existence of various distinct forms within *N. percobromus* supported by morphological characters and phylogenetic analyses of allozyme data may eventually warrant taxonomic recognition (Wood et al. 2002). Since populations in the Whitemouth and Winnipeg rivers are apparently disjunct from those in the Red River and elsewhere, and were likely isolated there by deglaciation, they may be affected by any future taxonomic revisions.

3.1.2 Identifying features

Carmine Shiners are slender, elongate minnows that can be distinguished from other minnows in Manitoba by the following features: 1) the origin of the dorsal fin is located behind a line drawn vertically from the insertion of the pelvic fins, 2) absence of a fleshy keel on the abdomen and of a strongly decurved lateral line, 3) a narrowly conical snout that is equal in length, or nearly so, to their eye diameter, 4) 5-7 short gill rakers on the lower limb of the first gill arch, the longest being about as long as the width of its base, and 5) 4 slender, hooked, main row pharyngeal teeth (Stewart and Watkinson 2004; K.W. Stewart, Univ. of Manitoba, Winnipeg, pers. comm. 2005) (Figure 2). The last three characters distinguish the Carmine Shiner from the Emerald Shiner (*N. atherinoides*), with which it is often confused. The Emerald Shiner has a more blunt, rounded snout, usually only about 3/4 the length of the eye diameter; 8-12 gill rakers on the lower limb of the first arch, the length of longest being twice the width of its base; and four stouter, and only slightly hooked, pharyngeal teeth in the main row on each side (K.W. Stewart, pers. comm. 2005).

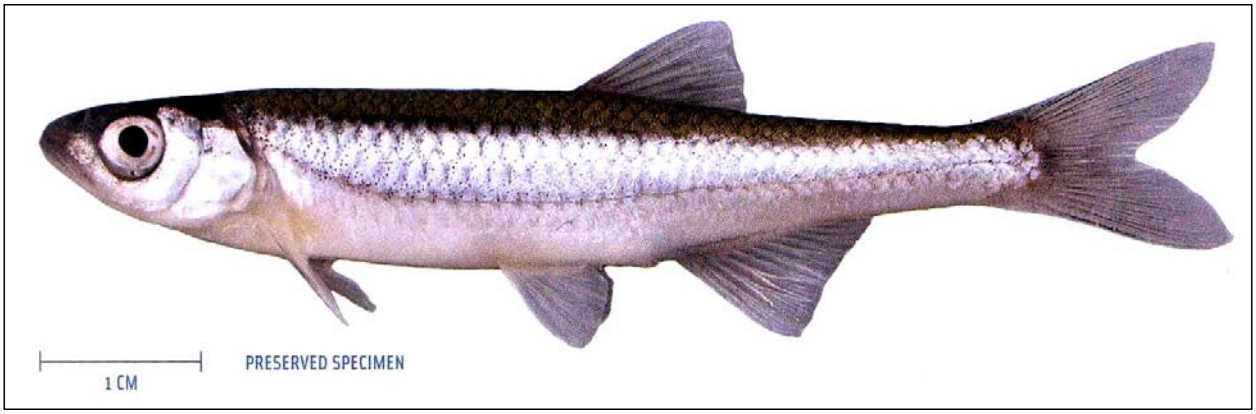

Figure 2. Carmine Shiner, *Notropis percobromus* (Photo courtesy of D. Watkinson, DFO, Winnipeg)

Outside of the breeding season Carmine Shiners are olive green dorsally, silvery on the sides and silvery white on the belly (Scott and Crossman 1973). They have black pigment outlining the scale pockets dorsally, and freshly caught adult specimens often retain pinkish or rosy pigment on the opercula and cheek, which becomes more vivid and extensive during spawning. Fins are transparent. Breeding males develop fine, sandpaper-like nuptial tubercles on the head, on some predorsal scales, and on the upper surface of the pectoral fin rays.

The spawning colours of the Carmine Shiner in Manitoba are quite vivid. Spawners turn a bright orange-red colour around their cheeks and at the base of each fin. In some fish the entire head turns this colour. In male Rosyface Shiners the entire head turns an orange-red colour, at least to the nape, and the belly a lighter red (Scott and Crossman 1973). Breeding females are usually a paler colour. Pigmentation on the sides is usually bordered below by the lateral line. Adult Carmine Shiners in the Whitemouth River grow to at least 67 mm in fork length (Watkinson, unpublished data).

3.2 Population and distribution

3.2.1 Distribution

Within Canada, the Carmine Shiner only occurs in Manitoba, where it is at the north-western limit of its range (Figure 3). The species' presence in the Winnipeg River upstream of waterfalls that were insurmountable barriers to movement (now sites of hydroelectric dams), and its apparent absence from the lower Red River and Lake Winnipeg, suggest that colonization may have been via a post-glacial connection with the headwaters of the Red Lake River in Minnesota. This dispersal track is shared with the Hornyhead Chub (*Nocomis biguttatus*) and the fluted shell mussel (*Lasmigona costata*) (K.W. Stewart, pers. comm. 2004; Clarke 1981). Alternatively the Carmine Shiner may have colonized via the Rainy River watershed from Upper Mississippi headwaters in northwest Minnesota, a dispersal track shared by a number of other fish species in southern Manitoba.

Houston (1996) reported the distribution of the Carmine Shiner only from the Whitemouth River and its tributary the Birch River (J.J. Keleher ROM 17539; Smart 1979; Houston 1996). More recent sampling has extended that range with additional specimens collected from the Whitemouth River, the Birch, and from the Winnipeg River immediately below Whitemouth Falls (Clarke 1998; Stewart and Watkinson 2004; Watkinson, unpublished data). Specimens were also collected from the Winnipeg River system in the Pinawa Channel immediately below the Old Pinawa Dam, from the Bird River at the first set of rapids upstream from Lac du Bonnet (Winnipeg River mainstem lake) and at the mouth of Peterson Creek, a Bird River tributary (Watkinson, unpublished data). All of these new reports are from reaches of the Winnipeg River system downstream of the Whitemouth River outlet. Stewart and Watkinson (2004) previously reported Carmine Shiners from Forbes Creek, a tributary of George Lake, and from Tie Creek, the outlet to George Lake, which discharges into the Winnipeg River upstream from the confluence of the Whitemouth and Winnipeg rivers, but on re-examination, these fish proved to be Emerald Shiners (K.W. Stewart, pers. comm. 2005). An historical report of Carmine Shiners farther upstream on the Winnipeg River system, in Lake of the Woods (Evermann and Goldsborough 1907), has not been verified.

Outside of Manitoba, the nearest known populations of Carmine Shiner are found in the Lost River, a tributary of the Red Lake River watershed (Red River drainage) in north-western Minnesota (Figure 4). Specimens from that river system were obtained in 2004 for morphometric study and DNA analysis (Konrad Schmidt, Minnesota Department of Natural Resources, St. Paul, MN).

Prior to its assessment by COSEWIC, the Carmine Shiner had only been reported incidentally (e.g., Smart 1979). Since then, directed samplings have extended its known range (Stewart and Watkinson 2004). The species is common but not abundant in the midcourse reach of the Whitemouth River (Smart 1979) and the Birch River (Watkinson unpublished data). The lack of information on its distribution and abundance may be an artefact of limited sampling, and of past confusion with the Emerald Shiner and Rosyface Shiner.

3.2.2 Population size and trends

Rapids and falls, now largely replaced by hydroelectric dams, have presumably partitioned fish habitat in the Winnipeg River mainstem. Falls at the mouth of the Whitemouth River are a barrier to its re-colonization from the Winnipeg River. These barriers significantly reduce any natural rescue potential for the species. In addition, the

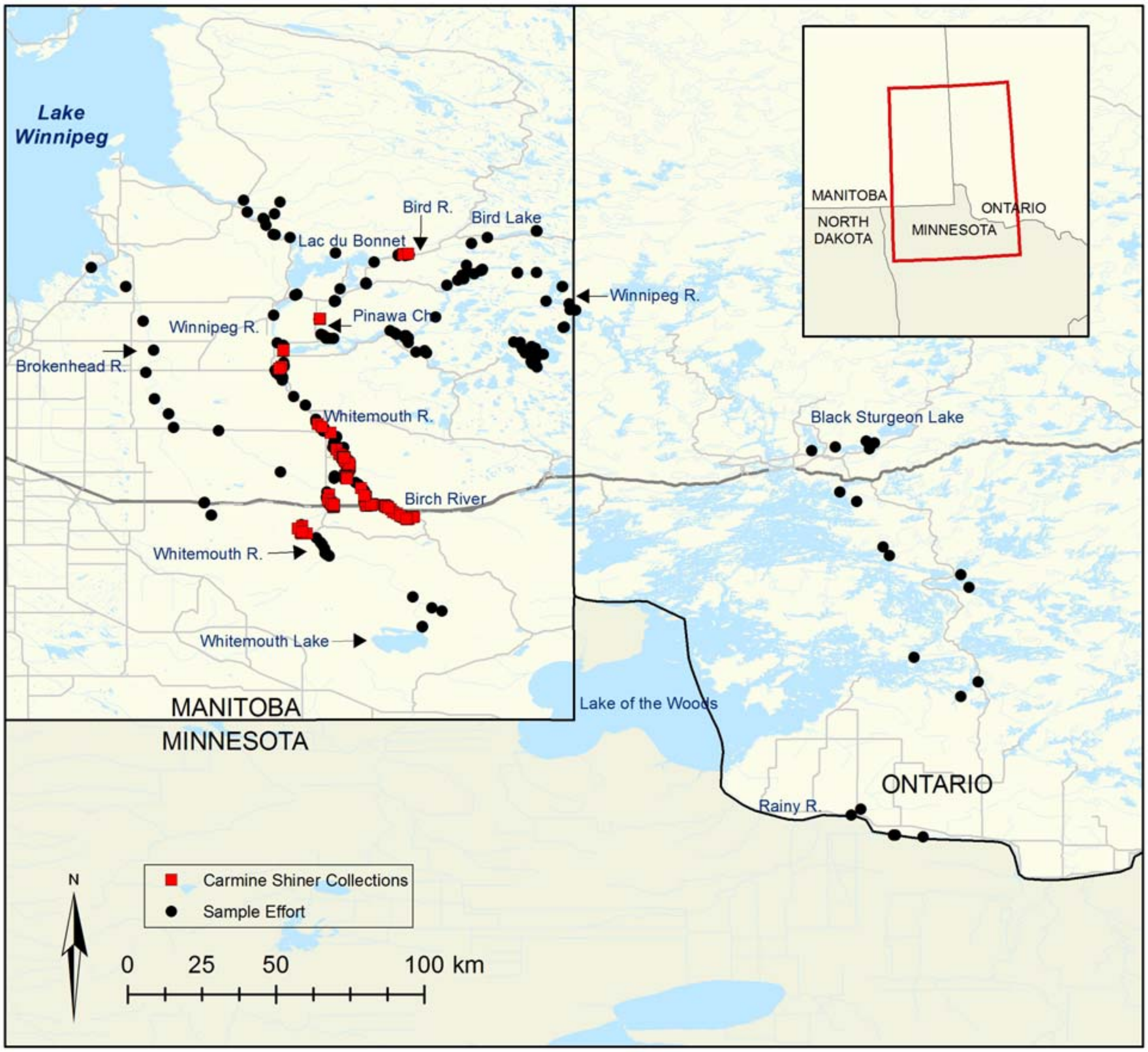

Figure 3. Distribution of the Carmine Shiner in Canada based on sampling of the Whitemouth and Winnipeg river watersheds within Manitoba and north-western Ontario in 2002 to 2006

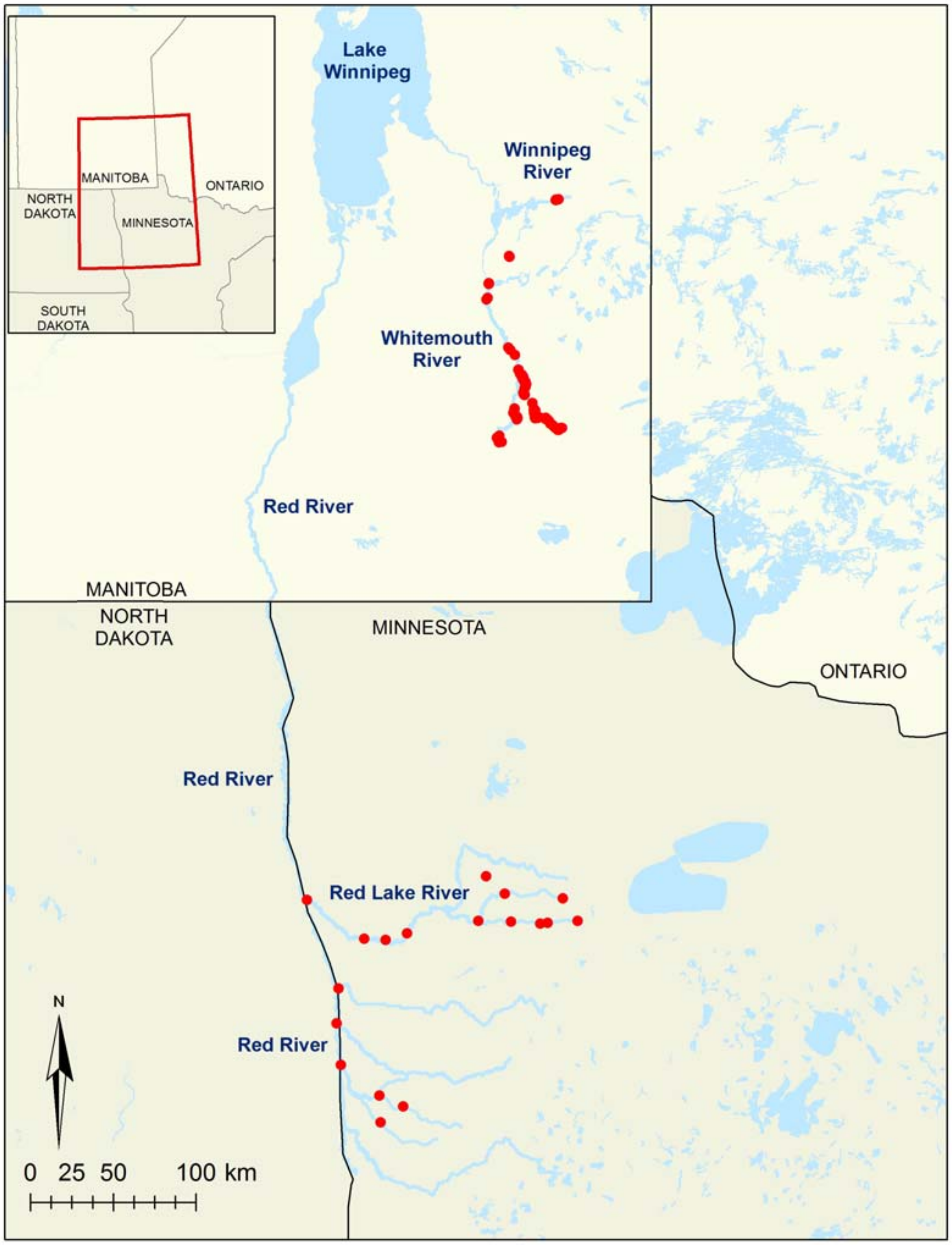

Figure 4. Locations of Carmine Shiner populations in Manitoba in relation to those in the Red Lake River of Minnesota, where the nearest known other populations of the species occur

original dispersal route, presumed to be from the Red Lakes area of Minnesota, may no longer be available. The percentage of the global range of the Carmine Shiner in

Canada remains uncertain pending additional sampling in the Winnipeg River and Lake Winnipeg watersheds and genetic studies to clarify the relationship between these fish and other members of the *Notropis rubellus* species complex.

3.2.3 Nationally significant populations

The Carmine Shiner has no direct economic importance and limited importance as a forage species, but is of significant scientific interest (Scott and Crossman 1973; Houston 1996; Stewart and Watkinson 2004). It does have intrinsic value as a contributor to Canada's biodiversity and as a potential colonizing species. Being at the periphery of the species range, populations in Manitoba may be unique and provide evidence of local adaptation to their habitat and genetic differentiation from other populations of the species (Stewart and Watkinson 2004). This may constitute a significant component of the genetic diversity of the species. Scientific studies of these populations might improve our understanding of the timing and routes of post-glacial re-colonization of Manitoba by fishes (Houston 1996). They may also provide evidence of genetic adaptation near the limit of a species' distribution.

3.3 Needs of the Carmine Shiner

3.3.1 Biology and life history

Information on the Carmine Shiner is limited and somewhat confused because many studies of the Rosyface Shiner species complex were conducted on eastern populations before the western populations were recognised as a distinct species (i.e., Carmine Shiner). The COSEWIC review by Houston (1996) included information on both species, as did Becker (1983). To avoid this problem, surrogate information from the closely related Rosyface Shiner is presented only where there is no specific information for the Carmine Shiner.

Growth

Carmine Shiners in Manitoba live to at least age 2 with spawning individuals (male and female) attaining fork lengths in the range of 55 to 67 mm (Watkinson, unpublished data). In New York State, some Rosyface Shiners live to age 3, with fewer males than females attaining that age (Pfeiffer 1955).

Reproduction

In Manitoba, Carmine Shiners in spawning condition have been caught below the Old Pinawa Dam, in the mainstem of the Whitemouth River, and in the Birch River near its confluence with the Whitemouth River (Watkinson, unpublished data). Ripe and running fish were caught between 13 June and 26 July at water temperatures of 19.3 to 22.5°C, in areas with water velocities up to 0.53 m/s, depths of 0.2 to 1.4 m, conductivities of 102.6 to 242 μS/cm and Secchi disk readings of >0.6 to at least 1.4 m. Substrates in these areas ranged from sand, to cobble and boulder, and bedrock.

Little is known of the species' spawning habits in Canada although they are probably similar to those of the Rosyface Shiner. Spawning of Carmine Shiners in the southern part of their range and of Rosyface Shiners in Great Lakes watersheds typically occurs in riffles in May and June at temperatures of 20 to 28.9ºC (Starrett 1951; Pfeiffer 1955; Reed 1957a; Miller 1964; Pflieger 1975; Baldwin 1983; Becker 1983). Cold spring weather will delay the spawning of Rosyface Shiners (Reed 1957a), and in the Des Moines River, Iowa, populations of early spawning species—including Carmine Shiners may be limited by normal high river stages in May and June (Starrett 1951). Further south, in Missouri, Carmine Shiners spawn from mid-April to early July, with the peak of activity in May and early June (Pflieger 1975). However, these observations of more southerly populations may not be directly applicable to Manitoba populations. The spawning frequency of northern populations of Carmine Shiner is currently unknown.

During spawning, schools of Rosyface Shiners break up into groups of 8 to 20 fish that spawn over depressions in the gravel (Pfeiffer 1955; Miller 1964). Often, these depressions are nests constructed by other cyprinids, such as the Hornyhead Chub and Creek Chub (*Semotilus atromaculatus*) (Miller 1964; Vives 1989), some are also occupied by the Common Shiner (*Luxilus cornutus*) (Reed 1957a; Miller 1964; Baldwin 1983; Vives 1989). Spawning by Rosyface Shiner was described by Pfeiffer (1955) and Miller (1964). Hermaphroditism has been found among Rosyface Shiners in Pennsylvania (Reed 1954), and may also occur among Carmine Shiners in Manitoba (K.W. Stewart, pers. comm. 2005).

The fecundity of Carmine Shiners (n = 20 females) sampled in Manitoba ranged from 694 to 2,806 eggs per female (Watkinson, unpublished data). Carmine Shiner mature at about age 1, and the number of eggs per female increases with size and age (Watkinson, unpublished data). Unfertilized Rosyface Shiner eggs are spherical and dull grey (Reed 1958). They are 1.2 mm in diameter within the female and expand to 1.5 mm on contact with water. Fertilized eggs turn bright yellow and become water-hardened and adhesive. At 21.1ºC they hatch in 57 to 59 hours. Newly hatched larvae take cover in the interstices of bottom gravel (Pfeiffer 1955) presumably until egg yolk absorption is complete.

Hybridization of the Carmine Shiner with other species has not been described but is likely given that the Rosyface Shiner hybridizes naturally with several species including Common Shiner (Raney 1940; Pfeiffer 1955; Miller 1964), Mimic Shiner (*Notropis volucellus*) (Bailey and Gilbert 1960), and Striped Shiner (*Luxilus chrysocephalus*) (Thoma and Rankin 1988).

Ecological Role

Carmine Shiners in Canada eat a variety of invertebrates during the summer, mostly aquatic and terrestrial insects especially dipterans (Watkinson, unpublished data). They are probably omnivorous, lower to mid-level consumers like southern populations of the species in the Ozarks (Hoover 1989) and the Rosyface Shiner in New York (Pfeiffer 1955; Reed 1957b). Aquatic insects, particularly caddisfly larvae, constituted the bulk of the diet of these fishes, but they also consumed terrestrial insects, fish eggs, algae, diatoms, and inorganic material. The young-of-the-year preferred algae and diatoms to insects. Competition for prey among minnow species in an Ozark stream led to greater dietary specialization by Carmine Shiners on midges (*Chironomidae*). The breadth of their diet decreased in the presence of Smallmouth Bass (*Micropterus dolomieui*) and increased at higher light levels, which indicates that prey are located by sight (Hoover 1989).

Little is known of the predators, parasites, and diseases of the Carmine Shiner. They are likely preyed upon mostly by larger fishes and fish-eating birds. Their eggs may be eaten by other fish species, similar to the Rosyface Shiner (Reed 1957a; Baldwin 1983).

3.3.2 Habitat

The habitat requirements and life history of Carmine Shiner are not well known, as most work on the species complex has been conducted outside the range of the Carmine Shiner in areas inhabited by the Rosyface Shiner (Pfeiffer 1955; Reed 1957a, b).

In Manitoba, during the summer, Carmine Shiners are typically found at midwater depths of clear, brown-coloured, fast-flowing creeks and small rivers with clean gravel or rubble substrates (Smart 1979; Watkinson, unpublished data). The fish are typically in or near riffles and behind the cover of boulders or fallen trees. They are not known to migrate but may move into deeper pools and eddies in winter, and are sometimes present in lakes near stream mouths. The species' apparent absence from the lower Red River, between Grand Forks and Lake Winnipeg, suggests that turbidity and fine sediment substrates may limit dispersal. These minnows may be intolerant of sustained turbidity (Trautman 1957; Becker 1983), but can tolerate pulses of turbidity in the Whitemouth River watershed associated with natural flood events (Stewart and Watkinson 2004).

Smart (1979) captured Carmine Shiners at 15 of 18 midcourse sites sampled on the Whitemouth River, and at 2 of 12 sites sampled on the lower 19 km of the Birch River. The channel of the midcourse reach of the Whitemouth River is gently winding and ranges in width from 18 to 36 m with sand, pebble, and cobble bottom substrates and numerous riffles. Carmine Shiners were not caught in the headwaters, lower course, or other tributaries of the Whitemouth River where the bottom substrate was silt and there were fewer riffles. However, more recent sampling has found them in the lower reaches of the Whitemouth River (Watkinson, unpublished data). Sampling in the Birch and Whitemouth rivers 2005 and 2006 collected them at depths of 0.12 to 2.8 m (average 0.87 m), velocities of 0.04 to 1.7 m/s (average 0.33 m/s), conductivities of 102.6 to 265 μS/cm, and water temperatures of 15.1 to 21.8°C. They were collected over substrates ranging from sand, gravel, cobble, and bedrock.

During periods of heavy runoff, Rosyface Shiners in Ontario will retreat to the slower-flowing edges of flooded rivers and onto the floodplain (Baldwin 1983). While it has not been observed, Carmine Shiners in Manitoba may show similar behaviour. Where they are available, flooded habitats may offer additional food resources and better feeding opportunities during periods of high turbidity, although this may also lead to stranding mortality. Steeply sloped, often near-vertical banks limit the availability of floodplain habitat along the Whitemouth River. Wintering habitats are not well known for either the Rosyface or Carmine shiners. In Ontario, Rosyface Shiners occupy deeper pools during the winter, where they are believed to remain inactive (Baldwin 1983).

In Manitoba, young-of-the-year Carmine Shiners are collected in similar habitats to the adults (Watkinson, unpublished data).

The restricted distribution of Carmine Shiners in Manitoba, and the warm-water adaptation of all species of the *N. rubellus* complex, suggests that the Carmine Shiner is a relatively recent colonizer (Houston 1996) that reached the Hudson Bay Drainage from the Upper Mississippi watershed after glacial recession. Dispersal into the headwaters of the Red River in north-western Minnesota is demonstrated by the occurrence of the species there (Koel 1997). They may also have reached Rainy River headwaters adjacent to the Upper Mississippi watershed, as there is an early report of the species from Lake of the Woods (Evermann and Goldsborough 1907). Unfortunately, the specimens no longer exist so this identification cannot be confirmed or refuted (D. Watkinson, pers. comm. 2006).

Although the effects of climate change are uncertain, a warming trend could increase the availability of suitable habitats north of the species' present limits. This could include some of the tributaries located along the east side of Lake Winnipeg. Whether the species already occurs there, or would be able to colonize these areas is unknown.

Habitat Trends and Limitations

Without specific information on the habitat requirements of the Carmine Shiner and on the importance of different habitats for its survival, protection of the entire ecosystem may be the best means of ensuring survival of the species. This may best be achieved through broad-based ecosystem initiatives and the exercise of specific regulatory actions targeting habitats in the Whitemouth and Winnipeg rivers. Elements of these approaches are already in effect to varying degrees (see Section 6.3.2, Management and regulatory action, item M3).

Relevant Legislation and Policies related to Habitat

If a critical habitat protection order made under ss.58 (4) and 58(5) (a) is in place with respect to the critical habitat of an aquatic species not found in a national park, marine protected area, migratory bird sanctuary or national wildlife area, s.58 (1) of the Species at Risk Act prohibits the destruction of the critical habitat specified in the order.

Under Manitoba's Endangered Species Act, it is an offence to damage, destroy, obstruct or remove a natural resource on which an endangered species, a threatened species or an extirpated species that has been reintroduced depends for its life and propagation. It is also an offence to destroy, disturb or interfere with the habitat of an endangered species, a threatened species or an extirpated species that has been reintroduced. However, the Carmine Shiner is not listed provincially.

Other relevant habitat-related federal statutes include s.35 of the *Fisheries Act*, which prohibits the harmful alteration, disruption or destruction of fish habitat without an authorization. Section 36(3) of the *Fisheries Act* prohibits the deposit of a deleterious substance in water frequented by fish, unless allowed under the Act. Where an environmental assessment of a project that will affect a species at risk or its critical habitat is required under the *Canadian Environmental Assessment Act* the consideration of those species at risk and their critical habitat must be taken into account in the assessment.

Provincially, a 130 ha headwater section of the Whitemouth River was designated as the Whitemouth River Ecological Reserve in 1986 to protect river-bottom forest may also provide some incidental protection for Carmine Shiner habitat by providing upstream riparian protection (Hamel 2003).

3.3.3 Limiting factors

Too little is known of the Carmine Shiner's physiology or ability to adapt to different conditions to identify factors that might limit its recovery. The species appears to occupy a relatively narrow ecological niche, which suggests limited adaptive ability. The closely related Rosyface Shiner also has a narrow range of habitat requirements and responds quickly to any changes in habitat and water quality (Smith 1979; Trautman 1981; Humphries and Cashner 1994; Houston 1996). If the Carmine Shiner's responses are similar, it may show long-term avoidance of pollutants (Cherry et al. 1977) and avoid water temperatures that exceed 27.2ºC (Stauffer et al. 1975). Rosyface Shiners in southwest Virginia avoided chlorine in water and did not acclimate to continued exposure (Cherry et al. 1977). Their response threshold varied with water temperature and pH and was correlated with the hypochlorous fraction of the residual chlorine. Some other factors that may be important include: the availability of key prey species; predation by other species; competition with other minnows for preferred habitat; diseases and parasites; and hybridization with other shiner species.

4. Threats

Carmine Shiners spawn in relatively warm, clear water and frequent shallow, flowing water with clean rocky substrates. They may be threatened by activities that alter the turbidity or flow of water. Flow impoundment, agricultural drainage that increases sediment loads, streambed gravel removal, and stream channelization are examples of activities that have been implicated in the decline or disappearance of the Rosyface Shiner within its distribution (Smith 1979; Trautman 1981; Humphries and Cashner 1994; Houston 1996). Increased bank erosion and consequent siltation probably have negative effects on eggs, fry, and food supply. Shoreline alterations associated with cottage development might adversely affect these minnows. Incidental harvests by bait fish harvesters and species introductions also may be a concern.

4.1 Threat assessment

The Carmine Shiner Recovery Team undertook a detailed threats assessment for each waterbody where the species is known to occur (see Appendix C, Table 10, 11, 12). Four categories of threat were identified:

- overexploitation,
- species introductions,
- habitat loss/degradation, and
- pollution

A brief description of the methods and assessment of threats to Carmine Shiner in each of these waterbodies is provided in Appendix C. The results are discussed below and summarized in Table 2.

4.2 Description of threats

4.2.1 Overexploitation

Carmine Shiner could potentially be exploited as a bait fish. Bait fisheries include both live and dead (frozen) bait operations. All commercial bait fishing in Manitoba is regulated and requires an annual license from Manitoba Conservation & Water Stewardship. Licensed commercial bait fishers may harvest fish for dead bait use from any Crown water within their allocated bait blocks, some of which may encompass areas where Carmine Shiners have been found. Live bait harvest, on the other hand, can only occur within specific waters approved by Manitoba Conservation & Water Stewardship. Most of the commercial bait fish harvest in southeastern Manitoba is directed at collecting live bait fishes (B. Scaife, MB Conservation & Water Stewardship, pers. comm. 2004).

Generally, live bait harvest is directed at non-shiner species, which are hardier, have a higher survival rate, and frequent different habitats from shiners. While the use of live traps allows for sorting and release, Carmine Shiners are difficult for fishermen to identify and may be easily damaged by handling. The Whitemouth, Bird, and Winnipeg rivers are not approved for live bait fish harvest and as such, Carmine Shiners are not likely to be affected by such operations.

Dead (frozen) bait harvesting is of greater potential concern as shiners are generally the targeted species. The gear used for these harvests (e.g., seines) is more likely to kill or harm the bait fish than that used for live-capture, but these methods are seldom used in the medium to small stream habitats where Carmine Shiners are most often found (K.W. Stewart, pers. comm. 2004). Although the harvest from specific waters is currently unknown, commercial bait fishermen with allocations in the Whitemouth and Bird rivers have not indicated any frozen production on their annual production report forms (B. Scaife, pers. comm. 2004). Frozen production, however, is known to occur from some areas on the Winnipeg River. Although unlikely, this could potentially include the Pinawa Channel where Carmine Shiners have recently been reported.

In addition to commercial bait fishing, licensed anglers may harvest bait fish for their own use from any Crown water including live bait where it is permitted. Live bait, however, may not be transported away from the waters in which it was caught.

The potential for incidental harvest of Carmine Shiners by bait fishing operations does exist, particularly for frozen production but this is not believed to represent a significant threat to the species at this time (Table 2). The focus of the existing fishery on live bait operations which are not permitted in areas where Carmine Shiner occur and the logistical constraints of fishing for frozen production from Carmine Shiner habitats are likely to limit the potential interaction between bait harvesters and Carmine Shiners. Although some frozen bait production may occur in the Winnipeg River, Carmine Shiner are only known to occur within the Pinawa Channel where any collection would be difficult. Notwithstanding, monitoring and research are recommended to verify this analysis and to examine measures that might further mitigate any potential effects. Public education is also necessary to ensure that commercial fishermen and anglers know where Carmine Shiners may occur, how to identify them, and how to reduce the potential for incidental harvest. In addition, further management actions could be directed as necessary at reducing any potential impacts associated with the bait fishery.

4.2.2 Species introductions

Species introductions could pose a threat to Carmine Shiner populations through predation, competition and food chain disruption. They might also carry diseases and parasites that are new to Carmine Shiner populations and could adversely affect them. The significance of this threat is likely moderate in the Whitemouth River and unknown elsewhere. The potential for mitigating the impacts of species introductions once they occur is likely low (Table 2).

Potential sources of introductions include: interbasin water transfers, possibly associated with hydrostatic pipeline testing; as live bait used by anglers; and through the stocking of game fishes. The import of live bait into Canada is illegal and requires strict enforcement by Canada Customs. Walleye (*Sander vitreus*) have been stocked in Whitemouth Lake since 1960, and Brook Trout (*Salvelinus fontinalis*) were stocked

Table 2. Carmine Shiner threats assessment summary by location

THREAT: Mechanism/ Source		**WATERBODY**					
		Whitemouth River***		**Bird River**		**Pinawa Channel**	
		Threat significance*	Mitigation potential**	Threat significance	Mitigation potential	Threat significance	Mitigation potential
OVER-EXPLOITATION:	Bait fisheries	**L**	**H**	**L**	**H**	**L**	**H**
SPECIES INTRODUCTIONS:	Predation, competition, food web disruption	**M**	**L**	**?**	**L**	**?**	**L**
HABITAT LOSS / DEGRADATION:	Flow alteration	**?**	**H**	**?**	**L**	**?**	**M**
	Shoreline/ riparian development	**M**	**M**	**?**	**M**	**?**	**M**
	Landscape changes	**?**	**M**	**?**	**M**	**?**	**M**
	Climate Change	**?**	**L**	**?**	**L**	**?**	**L**
POLLUTION:	Point Sources	**?**	**M**	**?**	**H**	**?**	**H**
	Non-Point Sources	**?**	**M**	**?**	**M**	**?**	**L**
OTHER:	Scientific Sampling	**L**	**H**	**L**	**H**	**L**	**H**
	Hybridization	**L**	**L**	**L**	**L**	**L**	**L**

*Threat Significance (High, Moderate, Low)

**Mitigation Potential (High, Moderate, Low)

*** Includes the Winnipeg River mainstem in the vicinity of the Whitemouth River outfall

? Denotes uncertainty and the need for research there in 1961-62 (D. Leroux, MB Conservation, pers. comm. 2005). The Birch River has been stocked with Rainbow Trout (*Oncorhynchus mykiss*), Brook Trout, Brown Trout (*Salmo trutta*), and Walleye, with poor survival (Clarke 1998). Brown Trout have been stocked in the Pinawa Channel. Smallmouth Bass and Rainbow Smelt (*Osmerus mordax*) have been introduced to the Winnipeg River system. The effects of these piscivores on Carmine Shiner populations are unknown, although elsewhere Smallmouth Bass and Carmine Shiners do coexist. The potential for transfer of species from the Lake of the Woods watershed via overland drainage exists but is presently unlikely given the prevalence of beaver dams and bogs that separate the respective watersheds.

4.2.3 Habitat loss/degradation

Habitat loss and/or degradation associated with flow regulation, channelization, shoreline development, landscape changes, and climate change is likely in some reaches of the rivers inhabited by Carmine Shiners, and may pose a threat to the species. The potential for mitigation varies with the type of threat and the affected waterbody (Table 2).

Flow alteration

Because Carmine Shiners frequent shallow riffles with clear water, flow alterations that affect these conditions may pose a threat to their existence. Hydroelectric development has altered flow in the Winnipeg River. Development on the river mainstem began in 1909 at Pointe du Bois, and ended in 1955 with the completion of the station at McArthur Falls. These stations are still in operation and are unlikely to be removed in the foreseeable future. Another station on the Pinawa Channel was completed in 1906. It was retired in 1951 and has been partially razed. These developments impounded reaches of the river creating forebays, flooding vegetation, and eliminating rapids. Whether these changes increased turbidity and decreased riffle habitat sufficiently to cause a decline in the abundance of Carmine Shiners in the system is unknown. Over time, the turbidity may decrease as flooded shorelines stabilize.

Other activities such as land drainage for farming, highways, and peat extraction; the installation of weirs and river crossings; and removal of nearby vegetation for forestry or agriculture may also affect drainage and thereby flow patterns. The effects of many of these activities on shorelines and runoff may be mitigated to some extent. Water removal for domestic use, for lawn or agricultural irrigation, and for watering livestock can also reduce flow, particularly during dry years. The impacts of these activities can be mitigated by restriction or control of water withdrawals from or diversions of water into, water bodies where the Carmine Shiner may occur.

In the past, water was periodically withdrawn during the winter from the Whitemouth River and other southeastern Manitoba rivers for hydrostatic testing of pipelines (COSEWIC 2006). This practice has not been allowed in the Whitemouth River since the mid-1990s but there continues to be interest in the use of water from the area for hydrostatic testing of the TransCanada Pipeline (J. Long, pers. comm. 2010). Water withdrawn for hydrostatic testing could cause dewatering and freezing of shallows; discharge of water could cause flooding that would alter ice cover, scour the stream bottom, and erode the banks.

Overall, the threat posed to Carmine Shiners by flow alteration is uncertain. The mitigation potential is likely moderate to high for most activities except for conditions affected by hydroelectric development.

Shoreline development

Development of the shoreline in areas that provide spawning habitat for Carmine Shiners, or immediately upstream, could adversely affect spawning habitats by causing physical disturbances or changes in water quality. Clearing of riparian vegetation to the water's edge for cottage or agricultural development, for example, can destabilize banks and increase erosion. Allowing livestock access to the river's edge can also disturb habitats and increase silt and nutrient loading, as can ditching and drainage for local highways. Indeed, most of these effects have been documented along the lower Birch River (Clarke 1998). Fortunately, most impacts of these activities on stream habitats can be mitigated using existing technology and best management practices. Mitigation would typically include the establishment of riparian buffers, livestock fencing or otherwise restricting access, and the deployment of appropriate erosion control techniques. Shoreline development was deemed to be a moderate threat for the Whitemouth River system and uncertain elsewhere. The potential for mitigation is moderate to high in the Whitemouth River and elsewhere.

Landscape changes

Forestry, agriculture, peat extraction, and highway development all have the potential to change landscapes in ways that alter the patterns and quality of runoff entering waters that support Carmine Shiners. These changes include, in particular, the removal of vegetation, grading of overburden, drainage of wetlands, stream channelization and ditching, and the construction of physical barriers (e.g., dams, roadways, culverts). Sound project design and management, establishment of appropriate riparian buffers, and effective monitoring can mitigate many of the potential impacts of these types of activities on stream habitats. The significance of landscape changes to Carmine Shiners is uncertain, with moderate to high potential for mitigation.

Climate change

The effects of climate change on Carmine Shiners are unknown. These effects may be positive or negative depending on the direction, extent, and timing of any changes in water temperature and hydrology that affect the species' habitats. The Birch River, where low flow and low oxygen conditions already occur in summer and winter (Clarke

1998), may be the most vulnerable to any changes. The potential for mitigating threats from climate change is low as this is a global issue requiring global solutions.

4.2.4 Pollution

The threat posed to Carmine Shiners by point and non-point sources of pollution is uncertain. Examples of some pollutants that could affect the species include farm fertilizers, herbicides, and pesticides. Nutrient enrichment by runoff from barnyards or intensive livestock operations is an ongoing problem that is being addressed by the Province of Manitoba and Prairie Farm Rehabilitation Administration (PFRA). Clarke (1998) found elevated levels of phosphorus (0.2 $mg \cdot L^{-1}$ TDP) and nitrogen (0.99 $mg \cdot L^{-1}$ nitrate/nitrite) in the lower Birch River in April 1996, but not at other times of the year. These levels are probably elevated through mobilization of agricultural chemicals by spring runoff. Before leaks were repaired, the Birch River also received chlorinated water leaking from the Winnipeg Aqueduct (Clarke 1998). The potential to mitigate or recover from pollution impacts is moderate to high except where long-range transport is the main source of pollutants, since these substances are ubiquitous.

4.2.5 Other threats

Scientific sampling may also pose a threat to the Carmine Shiner. This threat is likely low and has a high potential for mitigation as it is carefully regulated through the issuance of scientific collection permits under SARA and Manitoba Conservation & Water Stewardship

Natural hybridization may occur between Carmine Shiners and other shiners in Manitoba. A substantial decline in the proportion of Carmine Shiners on the spawning grounds might lead to decreases in reproductive success or complete assimilation of the Carmine Shiner populations. The significance of this natural threat is likely low, as is the potential for mitigation should it occur (Table 2).

5. Population and distribution objectives

The population and distribution objectives for the Carmine Shiner must recognize the Manitoba population's uncertain and largely undocumented status, its potentially unique relationship with other populations to the south, and difficulties with species identification. To achieve the population and distribution objectives the recovery strategy must:

- Maintain Carmine Shiner populations at their current abundance and within their present distribution within the Whitemouth, Birch and Winnipeg river systems; and,
- Identify and protect critical habitat of the Carmine Shiner.

6. Broad strategies and general approaches to meet objectives

6.1 Recovery goal

There is no evidence to date that populations of the Carmine Shiner in Manitoba have suffered any serious decline in abundance or distribution from historical times. However, the species' abundance and distribution do appear to be very limited, which may make it sensitive to future anthropogenic disturbances. Consequently, the emphasis of the recovery goal should be to ensure the continued existence of healthy, self-sustaining populations within their current distribution. This goal would be achieved through mitigating existing or potential threats to the species and through increasing our knowledge of the species biology, ecology, and life history to improve our ability to manage and protect the species and its habitat. As species recovery is not likely required, this strategy will focus on the maintenance or conservation of existing populations and their habitats. The conservation of this species is important as it contributes to Canada's commitment to preserve its biodiversity. As such, the recovery goal for the Carmine Shiner shall be:

> "To maintain self-sustaining populations of the Carmine Shiner by reducing or eliminating potential threats to the species and its habitats"

6.2 Recovery objectives

To achieve the above goal, a number of recovery objectives are also proposed. These include both population and distribution objectives (see Section 5), and threat mitigation objectives. The objectives take into consideration the uncertainty associated with our knowledge of the species' biology, life history, abundance, and habitat requirements as well as the impact of identified threats to its survival.

6.2.1 Threat mitigation objectives

Species recovery requires the elimination or mitigation of threats that have contributed or may contribute to the species' decline or limit its future recovery or conservation efforts. In this case, where a decline in the Manitoba population has not been demonstrated, the objective will be to reduce threats that might cause the species to decline, and to take proactive measures to avoid potential threats. To achieve threat reduction or mitigation objectives for the Carmine Shiner the recovery strategy must:

- Identify potential threats to the Carmine Shiner from human activities and ecological processes and incorporate mitigation measures into the Action Plan to avoid, eliminate, or mitigate these threats.

6.3 Recovery approaches

Strategies proposed to address the identified threats, and to guide appropriate research and management activities to meet the recovery goal and objectives, are discussed under the broader approaches of:

- Research and monitoring,
- Management and regulatory actions, and
- Education and outreach.

Each strategy has been designed to assess, mitigate, or eliminate specific threats to the species; to address information deficiencies that might otherwise inhibit species recovery; or to contribute to the species recovery in general. These strategies are summarized by approach in Tables 3 to 5, which list them in order of priority and relate them to specific recovery objectives.

6.3.1 Research and monitoring

Sound scientific knowledge must form the basis of any recovery efforts for the Carmine Shiner. To address the need for scientific research and monitoring, the following strategies are recommended (Table 3):

R1 **Clarify life history requirements:** Concurrent with scientific studies of the species' life history and habitat requirements, data should be recorded on water temperature, turbidity, chemistry, flow, and bottom substrate to obtain a better sense of the species' habitat use in Manitoba, and to refine critical habitats. Observations at the Whitemouth River could be used to clarify spawning requirements, particularly related to water temperature and bottom substrate, and trophic interactions. Knowledge of these requirements might then be used to direct the search for the species in other systems. In addition to field research, preserved *N. percobromus* specimens from Manitoba should be examined for information on their age at maturity, longevity, and fecundity to learn whether they have similar reproductive potential to the more southerly populations, and whether it is reasonable to apply knowledge from the latter to management of the former.

R2 **Clarify species' distribution:** The seasonal, geographical and bathymetric distribution and abundance of Carmine Shiner populations should be determined. The species' known distribution has been expanded significantly by sampling conducted since 2001, and may increase further with more directed sampling efforts. Further discoveries could eventually contribute to species down-listing.

R3 **Identify limiting factors:** Research on factors that limit the survival of Carmine Shiners could examine the impacts of changes in physical parameters such as water quality, temperature, and flow, as well as ecosystem changes brought about by species introductions. The objective would be to improve understanding of threats from anthropogenic activities related to land use practices, water regulation, and species introductions.

R4 **Monitor population trends:** Population monitoring will be required to ensure that conservation or recovery objectives are being achieved. This requires development of indices of abundances that could be tracked over time to follow population trends. Key habitat quality parameters would be monitored in conjunction with these studies to provide trend through time data needed to understand natural variability and identify anthropogenic impacts. This work might also enable the development of population models and variability estimates that may help to refine critical habitat and develop advice on allowable harm.

R5 **Inventory habitat:** Scientific studies are needed to describe, locate, and inventory the various habitat types required by the Carmine Shiner. This work would focus initially on areas of known use, but might also include proactive sampling of other apparently suitable habitats such as the upper reaches of the Pinawa Channel. This work would enable targeting of sampling effort and identification and protection of critical habitat.

R6 **Reduce harvests:** Scientific studies should examine how existing bait fisheries might be modified to eliminate or reduce any incidental catch of Carmine Shiner, through changes in gear selection, location and depth of deployment, and timing considerations. A direct baitfish fishery for listed species cannot permitted under s.73 of SARA.

6.3.2 Management and regulatory actions

Management and regulatory actions are required to respond to a variety of threats including habitat loss or degradation, species introductions, and harvesting. To address these requirements the following strategies are recommended (Table 4):

M1 **Data conservation:** To provide continuity and future reference all samples and information (current and future) must be appropriately preserved and/or archived within known repositories. This includes any information on the species' life history and habitat such that any changes can be tracked over time, and the information can be re-visited in the event of changes to the taxonomic status of the Carmine Shiner in Manitoba. The development of a central data repository should be explored to improve access to information and the security of the data.

Table 3. Prioritization of research and monitoring strategies (R)

Priority*	Objective Number	Strategy	Specific Steps	Anticipated Effect
Urgent	2, 3	R1. Clarify life history requirements	Determine specific habitat needs for all life stages.	Better knowledge of life history parameters will help determine population targets and refine critical habitat identification.
Necessary	2	R2. Clarify species' distribution	Synoptic samplings to better define the species' distribution and to help determine total abundance/population trends.	Improve knowledge of the species habitat requirements and possibly lead to de-listing.
Necessary	3	R3. Identify limiting factors	Research the impacts of changes in water quality, temperature, and water velocity on Carmine Shiners.	Enable the assessment and mitigation of threats to the species or its habitat from anthropogenic activities.
Necessary	1,2	R4. Monitor population trends	Develop indices of abundance and use them to follow population trends, with concurrent monitoring of key habitat quality parameters at sample sites.	Provide trend through time data. Improve knowledge of natural variability and population viability. Improve ability to identify anthropogenic impacts.
Necessary	2	R5. Inventory habitat	Determine extent of suitable and critical habitats.	Enable targeting of habitat protection and restoration efforts.
Beneficial	3	R6. Reduce harvests	Research to determine the vulnerability of Carmine Shiners to various bait fishing gears.	Reduce or eliminate incidental catches by bait fisheries.

*Priority: Urgent; Necessary; Beneficial.

M2 **Revise management plans:** Where required, management plans and fisheries regulations should be revised to reflect the current status of the Carmine Shiner. The species should be excluded from allowable baitfish in the fishing regulations and brought to the attention of the affected resource users. A direct baitfish fishery for listed species cannot be permitted under s.73 of SARA. Recovery efforts should be coordinated with other agencies responsible for, or involved with, the management of Carmine Shiner, including, but not restricted to, the province of Manitoba. Land use plans associated with forestry, agriculture, highways, and other development activities should be revised to give proper consideration to the Carmine Shiner.

M3 **Protect habitats:** Habitat areas including spawning, feeding, and wintering areas must be protected to ensure the continued viability of existing populations. Protection might be afforded through ecological reserves, as in the case of the Whitemouth River Ecological Reserve that currently protects a small area of river-bottom forest on the Whitemouth River. Under the Canadian Environmental Assessment Act, 2012 (CEAA2012) the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project include, among other things, any change that might be caused to aquatic species as defined in s.2(1) of the Species at Risk Act. Under s.79 of SARA, during an environmental assessment of a project under CEAA2012, or when a federal authority must make a determination as to the significance of adverse environmental effects under s.67 of that Act, the competent minister must be notified if the project will affect a listed wildlife species or its critical habitat. If the project is carried out, measures must be taken that are consistent with applicable recovery strategies or action plans to avoid or lessen those effects (mitigation measures) and to monitor those effects.

M4 **Monitor bait harvests:** Periodic monitoring of baitfish catches should be undertaken to ensure that Carmine Shiners are not being harvested. These studies might also contribute useful data on fish community composition, species distribution, life history, and habitat use. This opportunity could also be used to improve awareness of the species among bait-fish harvesters (see also E1).

M5 **Support best management practices:** Where possible, technical advice and incentives might be provided to support practices that benefit Carmine Shiners and the quality of their habitat (e.g., erosion and sediment control, proper disposal of contaminants). This could include support for, or incentives to, the farming sector for improved livestock watering practices and management of riparian areas.

M6 **SARA permitting:** The issuance of permits for scientific collection or incidental harm under Section 73 of SARA shall be considered on a case-by-case basis, provided that the overall population and distribution objectives for the species are not compromised. Permit applications directed at Carmine Shiners must be supported by credible evidence that the activity will benefit or at least not harm species' recovery.

M7 **Rationalize stocking programs:** Any proposed stocking of waters that support Carmine Shiner should be rationalized in terms of the potential impact of the introduced species on the Carmine Shiner. Long-standing stocking programs should be re-examined to ensure that recovery objectives for the Carmine Shiner are not being compromised. New stocking programs should be avoided until their potential impacts are better understood.

6.3.3 Public education and outreach

Public education and outreach is a necessary strategy to ensure acceptance and compliance with the overall recovery strategy. To address these needs the following strategies are recommended (Table 5):

E1 **Improve awareness of the species:** Information and educational materials on the Carmine Shiner, its habitat and the implications of its listing under SARA should be developed and distributed to stakeholders, local communities, and agencies responsible for licensing or authorizing activities that may impact the species. To reduce the likelihood of directed or incidental harm, public awareness of the species, of threats to its survival, and of best management practices for avoiding harm to it should be promoted through the distribution of materials such as fact sheets and identification keys. Such information should accompany any permits or licences for bait fishing in areas where Carmine Shiner are likely to be encountered in Manitoba and should be considered in the development of any future baitfish guidelines.

E2 **Encourage stakeholder participation:** Stakeholder involvement in recovery efforts including research and monitoring activities should be actively encouraged. Improved awareness and involvement in recovery

Table 4. Prioritization of management and regulatory strategies (M)

Priority*	Objective Number	Strategies	Specific Steps	Anticipated Effect
Necessary	2	M1. Data conservation	Preserve and archive specimens, samples, and scientific data on the species and its habitat.	Ensure samples can be re-visited if the taxonomy is revised.
Necessary	1, 3	M2. Revise management plans	Prohibit the harvest of baitfish from critical habitats for the Carmine Shiner. Consider Carmine Shiner in land use planning.	Prevent harvesting of Carmine Shiner. Pro-active protection of Carmine Shiner habitats.
Necessary	1, 3	M3. Protect critical habitats	Coordinate recovery work with agencies involved in regulating activities that may affect Carmine Shiner recovery, including municipalities, and provincial and federal government departments.	Prevent habitat degradation and/or destruction.
Necessary	2, 3	M4. Monitor bait harvests	Determine the rate of incidental harvest of Carmine Shiners by anglers and bait harvesters.	Reduce incidental capture of Carmine Shiners.
Beneficial	3	M5. Support best management practices	Support and where possible provide technical advice on practices that benefit Carmine Shiners and the quality of their habitat (e.g., erosion and sediment control, proper disposal of contaminants).	Prevent habitat degradation and/or destruction. Reduce existing threats to Carmine Shiners.
Beneficial	3	M6. SARA permitting	Limit the number of Carmine Shiner that can be captured.	Prevent unnecessary removal and release mortality of Carmine Shiner.
Beneficial	3	M7. Rationalize stocking programs	The impacts of game fish stocking in systems that support Carmine Shiners should be assessed. New stocking programs should be avoided until their potential impacts on Carmine Shiners can be reviewed and/or studied.	Reduce unnecessary mortality of Carmine Shiners.

*Priority: Urgent; Necessary; Beneficial.

activities should help foster a stewardship attitude amongst stakeholders and generate support for species recovery initiatives. Habitat stewardship efforts should be explored, particularly those that target the management of riparian habitats. The University of Manitoba's Zoology Department, which has a long history of scientific sampling in the Whitemouth River, is a good example of how stakeholder participation could contribute to the species recovery program. Where feasible and practical, such programs should be supported and integrated into the overall recovery program.

E3 Facilitate information exchange: The exchange of information among researchers, stakeholders and fisheries agencies from Canada and the United States, with regard to research, recovery, and management activities related to the Carmine Shiner should be facilitated. A significant portion of the distribution of the Carmine Shiner is located in the United States. This presents an opportunity for collaboration and cooperation on many research, recovery, and management initiatives. Any additional information gathered on the species through these initiatives will increase our capacity to effectively manage its conservation or recovery.

E4 Discourage species introductions: The effects of species introductions are often irreversible, so prevention is often the only available option. To prevent species introductions, intentional or otherwise, education programs that heighten awareness on this issue should be supported.

Table 5. Prioritization of public education and outreach strategies (E)

Priority*	Objective Number	Strategy	Specific Steps	Anticipated Effect
Necessary	1, 2, 3	E1. Improve public awareness of the species	Develop and deliver educational materials on Carmine Shiner to stakeholders and communities, and to agencies involved in development and licensing. Include information on species identification and on the legal implications under the *Species at Risk Act* of harvesting Carmine Shiners or destroying their habitat.	Improve awareness of the Carmine Shiner and its habitat. Encourage understanding and communication with respect to the species. Reduce inadvertent harvesting and habitat destruction.
Necessary	2, 3	E2. Encourage stakeholder participation	Invite stakeholder involvement in research and monitoring studies and other species recovery initiatives.	Improve awareness of this species and its habitat and local support for species recovery initiatives.
Necessary	2, 3	E3. Facilitate information exchange	Share research and monitoring data through access to a central repository.	Improve accessibility and security of data.
Beneficial	1, 3	E4. Discourage species introductions	Increase public and government awareness of impacts of introduced species.	Reduce potential for damage to Carmine Shiner populations by introduced predators and competitors.

*Priority: Urgent; Necessary; Beneficial.

6.4 Actions already completed or currently underway

DNA and morphometric studies to confirm the identification of Carmine Shiners in Manitoba were initiated by DFO in 2002 (Dr. W. Franzin, DFO Winnipeg, pers. comm. 2005). These ongoing studies have been conducted in conjunction with field surveys to delineate the distribution and abundance of the Carmine Shiner in southeastern Manitoba and neighbouring areas of Ontario, and with morphometric studies to develop field keys. Studies directed at identifying Carmine Shiner habitat in the Whitemouth River are ongoing. Stream channel typology research is underway on the Birch River to correlate channel morphology with water chemistry and fish habitat use (Dr. J. Long, pers. comm. 2010). All of these studies address aspects of Research and Monitoring strategies R1 and R2, and are laying the groundwork for further habitat evaluations.

Ongoing studies by Dr. Chris Wilson of the Ontario Ministry of Natural Resources (pers. comm. 2005) have confirmed that the Carmine and Rosyface shiners are separate taxa, based on both mitochondrial (ATPase 6 and 8 genes) and nuclear (rRNA ITS-1) DNA sequences. Research is continuing to identify sequence differences between species that can be easily detected with restriction enzymes to enable quick (and inexpensive) screening for species identification.

Dr. K.W. Stewart, while at the University of Manitoba had collected a set of comprehensive morphometric data from representative specimens from Wisconsin, Minnesota, Ontario, and Manitoba; and from Lake Winnipeg Emerald Shiners as a closely-related, but easily distinguishable, outgroup. The data will be analyzed using various multivariate techniques to determine which characters, or combinations of characters, are useful for separating the different species in the collections. Blind samples of the same individually identified fish have been submitted for genetic analyses to provide two unbiased data sets for the final comparison of the genetic and morphometric data. It is possible to reliably distinguish Carmine Shiners from Emerald Shiners using morphological characters, but that it may not be possible to reliably distinguish Carmine Shiners from Rosyface Shiners without killing and preserving specimens for laboratory examination.

To improve awareness of the species, a fact sheet entitled “The Carmine Shiner…. A Species at Risk in the Prairie Provinces” has been prepared and is available from DFO. This publication is intended for general distribution. It describes the species’ distribution, life history and habitat requirements, and identifies potential threats to its survival.

6.5 Additional information needed about the species

The conservation or recovery of Carmine Shiner populations in Manitoba is hampered by a lack of knowledge of the species’ biology, life history and habitat requirements that prevents an accurate evaluation of potential threats. The taxonomic identity of these fish, their distribution, reproductive potential, seasonal habitat use, spawning requirements, and interactions with other species remain uncertain. Their tolerance to potentially limiting environmental factors, such as extremes of temperature, turbidity, and flow are also uncertain.

7. Critical habitat

7.1 General identification of the Carmine Shiner critical habitat

The identification of critical habitat (CH) for Threatened and Endangered species (on Schedule 1) is a requirement of SARA. Once identified, SARA includes provisions to prevent the destruction of CH. CH is defined under Section 2(1) of SARA as:

> *"…the habitat necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." [s. 2(1)]*

SARA defines habitat for aquatic species at risk as:

> *"… spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced." [s. 2(1)]*

The Species at Risk Act stipulates that a recovery strategy must include *"an identification of the species' critical habitat, to the extent possible, based on the best available information, […], and examples of activities that are likely to result in its destruction" (paragraph 41(1)(c))*. This identification is designed to facilitate the identification and protection of the critical habitat.

For the Carmine Shiner in Manitoba, CH has been identified to the extent possible, using the best information currently available. The CH identified in this recovery strategy describes the geospatial areas that contain the habitat necessary for the survival or recovery of the species. The current areas identified may be sufficient to achieve the population and distribution objectives for the species and will need to be further refined in terms of its biophysical functions, features and attributes. The schedule of studies outlines the activities required to refine the description of CH in order to support its protection.

7.2 Information and methods used to identify critical habitat

Critical habitat for Carmine Shiner was identified in the Whitemouth and Birch rivers using the Bounding Box Approach (BBA). This approach requires the use of essential functions features and attributes for each life-stage of the Carmine Shiner to identify CH within the "bounding box". The area occupied by the species becomes the "bounding box" within which the CH is found. Life stage habitat information was summarized in chart form using available data and studies referred to in Section 3.3.1 (Biology and life history), and Section 3.2.2 (Habitat). The BBA (i.e., areas where multiple adults and/or YOY have been captured) was the most appropriate, given the limited information available for the species and the lack of detailed habitat mapping for these areas. Where habitat information was available (e.g., bathymetry data), it was used to inform the identification of CH. Included in the bounding box is the area covered by the stream reach and the stream width as defined as the bankfull width. Within the bankfull width, the riparian habitat corridor plays an essential role in maintaining channel stability and offers a buffering capacity.

CH was only defined for the Whitemouth and Birch rivers as too little is known about the abundance, species' movements, and what connectivity they may require at other locations where Carmine Shiner have been collected in the Winnipeg River watershed.

Two other approaches to identifying CH were considered. The first sets a recovery target in terms of number of individuals, and then estimates the minimum habitat area required to meet this target over the long term. This approach requires knowledge of the area required by an individual adult fish as it may migrate seasonally between spawning, rearing, feeding, and overwintering areas. The Minimum Area for Population Viability (MAPV) was estimated at 3300 ha (Young and Koops 2011). This exceeds the known distribution in the Whitemouth and Birch rivers. The second approach, which is independent of the population recovery target, is more selective and considers the area of occupancy in relation to other modifiers. These modifiers can include ecological classification criteria such as depth, flow velocity, turbidity and/or substrate, and measures of habitat use such as catch per unit effort (CPUE). The information needed for this approach is not yet available but, when it is, it may be used to refine the area identified as CH.

7.2.1 Identification of critical habitat: biophysical functions, features and their attributes

To date, few studies have examined the biology, life history, or habitat requirements of the Carmine Shiner. As such, little is known of when or where spawning occurs; the location of nursery, rearing, feeding, or food supply areas; and the timing or extent of migrations, should they occur. Adults do frequent shallow riffles with clear water and clean gravel or stone bottom in the Whitemouth River, but it is not known whether, or which of, these habitats are critical to the species. Carmine Shiners have also been collected in a wider range of habitats elsewhere in the Winnipeg River system. Future efforts to refine CH need to address these information deficiencies for all life stages and seasons.

Table 6 summarizes available knowledge on the essential functions, features and attributes for each life-stage. Refer to Section 3.3.1 (Biology and life history), and Section 3.2.2 (Habitat) for full references. Areas identified as CH must support one or more of these habitat functions.

Studies to further refine knowledge on the essential functions, features and attributes for various life-stages of the Carmine Shiner are described in Section 7.3 (Schedule of studies to identify critical habitat).

Table 6. Essential functions, features and attributes of critical habitat for each life-stage of the Carmine Shiner *

Life Stage	Habitat Requirement (Function)	Feature(s)	Attribute(s)
Spawn to Larvae	• Spawning • Nursery	• Clear, brown-coloured fast flowing creeks and small rivers	• Temperature level (observation of ripe and running fish, mid-June to late July) ranging between 19 to 29°C • Substrates ranged from sand and gravel, to cobble and boulder, and bedrock
Young of Year	• Feeding • Cover	• Clear, brown-coloured fast flowing creeks and small rivers	• Sand, gravel, and cobble substrates
Juveniles	• Feeding • Cover	• Clear, brown-coloured fast flowing creeks and small rivers	• Feed on mostly aquatic and terrestrial insects especially dipterans • Gravel and cobble substrates
Adult (ages 1, {sexual maturity} to at least age 2 years old)	• Feeding • Cover	Clear, brown-coloured fast flowing creeks and small rivers	• Temperature levels ranging between 0 to 29°C • Found at depths of 0.1 to 2.8 m* • Typically in or near riffles • Substrates in the Whitemouth River include sand, gravel, cobble, and boulder with numerous riffles • Feed on mostly aquatic and terrestrial insects especially dipterans • May move into deeper pools and eddies in winter

*where known or supported by existing data

7.2.2 Identification of critical habitat: geospatial

These are areas that the Minister of Fisheries and Oceans considers necessary to support the species' survival or recovery objectives.

Critical habitat for Carmine Shiner has been identified using the Bounding Box approach. CH was only defined for the Whitemouth and Birch rivers as too little is known about the abundance, species' movements, and what connectivity they may require at other locations where Carmine Shiner have been collected in the Winnipeg River watershed. The areas delineated on the following map (Figure 5) represent the bounding box" which represents the species occupancy in the Whitemouth and Birch rivers. Critical habitat is found within the area covered by the stream reach and the stream width (bankfull channel width) in each river. Critical habitat includes all features and attributes identified to the extent possible in Table 6 and the riparian habitat contained in the bankfull channel width. Table 7 below provides the geographic coordinates that situate the boundaries within which critical habitat is found for Carmine Shiner at the locations listed above; these points are also indicated on Figure 5. Note that existing permanent anthropogenic features that may be present within the areas delineated (e.g. bridges) are specifically excluded from the CH description. Brief explanations for the areas identified as CH are provided below.

Whitemouth River: Critical habitat for the Carmine Shiner is found within the reach of the Whitemouth River from approximately Highway 505 (49.567681 N, 95.977111 W) downstream to the confluence with the Winnipeg River.

Critical habitat is found within this contiguous stream segment of the Whitemouth River including the bankfull width which ranges from approximately 25 m at the farthest upstream point to approximately 68 m at the lowest downstream point extent. This represents a stretch of river approximately 114 km long. Within this area, CH is defined as the areas that meet the habitat function, feature and attribute requirements for one or more life-stages of the Carmine Shiner (see Table 6).

Birch River: Critical habitat for the Carmine Shiner is found within the reach of the Birch River from confluence with the Boggy River (49.615958 N, 95.636806 W) downstream to the confluence with the Whitemouth River.

Critical habitat is found within this contiguous stream segment of the Birch River including the bankfull width which ranges from approximately 16 m at the farthest upstream point to approximately 30 m at the lowest downstream point extent. This represents a stretch of river approximately 52 km long. Within this area, CH is defined as the areas that meet the habitat function, feature and attribute requirements for one or more life-stages of the Carmine Shiner (see Table 6).

Table 7. Coordinates locating the boundaries within which critical habitat is found for the Carmine Shiner

	Coordinates locating areas of critical habitat	
Location	**Point 1 (SE)**	**Point 2 (NW)**
Whitemouth River *	49.567681 N 95.977111 W	50.121931 N 96.035022 W
	Point 3 (SE)	**Point 4 (NW)**
Birch River*	49.615958 N 95.636806 W	49.822425 N 95.876289 W

* Riverine habitats are delineated to the midpoint of channel of the uppermost stream segment and lower most stream segment (i.e., two points only

Figure 5. Critical habitat for the Carmine Shiner in Canada

7.3 Schedule of studies to identify critical habitat

The proposed schedule of studies in Table 8 outlines the foundation for refining the identification of CH. Many of these studies have already been highlighted in the preceding section. They include work to address gaps in knowledge of the species' biology, life history, and habitat and to describe, locate, and inventory existing habitat types. The prescribed schedule of studies is, of necessity, a long term planning document and will be revised periodically or refined on an ongoing basis as further information warrants.

The schedule of studies is designed to provide a comprehensive analysis of the CH requirements of the Carmine Shiner, but some specific elements of the species' CH may be identified earlier in the process. Such elements could include spawning and over-wintering habitats once their locations have been determined. The early and incremental identification of such habitats would help conserve the species until a more comprehensive analysis has been completed.

Activities identified in this schedule of studies will be carried out through collaboration between DFO, relevant ecosystem recovery teams, and other relevant groups and land managers. Note that many of the individual recovery approaches will address some of the information requirements listed above.

7.4 Activities likely to result in the destruction of critical habitat

Under SARA, critical habitat on federal lands must be legally protected from destruction within 180 days after it is identified. This will be accomplished through the application of the *Species at Risk Act*, including the application of subsection 58(1) which prohibits the destruction of any part of the critical habitat identified, or through another Act of Parliament.

Activities likely to result in the destruction of CH have been discussed in detail in Section 4 (Threats). Of the threats identified, flow regulation, shoreline development, and landscape changes may have the greatest potential to destroy CH. They would act by altering the flow and/or turbidity of the water. Releases of contaminants could also destroy CH by harming water quality. Climate change could modify the impact of these threats.

Permanent anthropogenic features such as road crossings that require periodic maintenance and are within the areas delineated as CH are not expected to affect the recovery of the species, provided DFO guidelines are followed.

Without appropriate mitigation, direct destruction of habitat may result from work or activities such as those identified in Table 9.

The activities described in this table are neither exhaustive nor exclusive and have been guided by the threats described in Section 4. The absence of a specific human activity does not preclude, or fetter the department's ability to regulate it pursuant to SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition since it is destruction of CH that is prohibited. Since habitat use is often temporal in nature, every activity is assessed on a case-by-case basis and site-specific mitigation is applied where it is reliable and available.

In every case, where information is available, thresholds and limits are associated with attributes to better inform management and regulatory decision-making. However, in many cases the knowledge of a species and its CH may be lacking and in particular, information associated with a species or habitats thresholds of tolerance to disturbance from human activities, is lacking and must be acquired.

Table 8. Schedule of studies to identify critical habitat

Description of Activity	Rationale	Approximate Timeline
Description of life history characteristics	Necessary to characterize the relationship between life history stages, key activities, and habitat features.	2012-2015 These studies have been initiated and are ongoing
Description of habitat use by life stage.	Such studies should include a biophysical description of habitat used by spawning, rearing, feeding, and overwintering stages.	2012-2015 These studies have been initiated and are ongoing
Identification, location and inventory of habitat	To locate areas within the range of the minnow that have similar features to those described in above studies, this will assist in determining the importance of habitat.	2012-2015 These studies have been initiated and are ongoing
Refine CH identification	Contingent on all of the above; could include population viability analysis modeling. Catch per unit effort should be examined as a surrogate abundance estimate. Potential time frame >5 years (2015-). Will aid in developing recovery targets and determining the amount of CH required by each life-stage to meet these targets.	Contingent on all of the above, potential time frame >5 years (2015-)

Table 9. Human activities likely to result in the destruction of critical habitat for Carmine Shiner

Activity	Affect- Pathway	Function Affected	Feature Affected	Attribute Affected
Shoreline Development **Habitat Loss/Degradation:** Extensive development on the shoreline and riparian areas for cottages, year-round homes, and agriculture (grazing and field crops). Also development on reaches of the Whitemouth and Birch river systems.	Damage to riparian vegetation, buffer zones, overhanging vegetation, woody structure, and near shore areas resulting in loss of vegetation, near shore and shoreline habitat diversity and bank stability.	Spawning Nursery Feeding Cover Refuge	Clear, brown-coloured fast flowing creeks and small rivers	• Increase in water temperature • Change in water velocity • Change to food web dynamics • Increased siltation and change in substrate composition • Loss of habitat structure and cover • Increase in turbidity
Pollution **Nutrient Loadings:** Over-application of fertilizer and improper nutrient management (e.g., organic debris management, wastewater management, animal waste, septic systems, and municipal sewage)	Improper nutrient management can cause nutrient loading of nearby waterbodies. Elevated nutrient levels can cause increased aquatic plant growth changing water temperatures and slowly change flow velocities and substrates. Oxygen levels in substrates can also be negatively affected.	Same as above	Same as above	• Increase in water temperature • Change to food web dynamics • Increased siltation and change in substrate composition • Increase in turbidity • Change in dissolved oxygen concentration
Landscape Activities **Siltation and Turbidity:** Altered flow regimes causing erosion and changing sediment transport (e.g., tiling of agricultural drainage systems, removal of riparian zones, etc.) Work in or around water with improper sediment and erosion control (e.g., overland runoff from ploughed fields, use of industrial equipment, cleaning or maintenance of bridges or other structures, etc.)	Improper sediment and erosion control or mitigation can cause increased turbidity levels, changing preferred substrates and their oxygen levels, potentially reducing feeding success or prey availability, impacting the growth of aquatic vegetation and possibly excluding fish from habitat due to physiological impacts of sediment in the water (e.g., gill irritation).	Same as above	Same as above	• Increase in water temperature • Change to food web dynamics • Increased siltation and change in substrate composition • Increase in turbidity
Landscape Changes **Habitat Modifications:** Dredging/ Grading/ Excavation Placement of material or structures in water (e.g., groynes, piers, infilling, partial infills, jetties, etc.) Shoreline hardening Construction of physical barriers (e.g. dams, roadways, culverts)	Changes in bathymetry and shoreline morphology can remove (or cover) preferred substrates, change water depths, flow patterns, and sediment depositional areas resulting in changes to nutrient and oxygen levels, water temperatures, aquatic plant growth and increased erosion, and turbidity. Placing material or structures in water reduces habitat availability. Hardening of shorelines can reduce organic inputs and alter water temperatures affecting optimum temp. Preference and availability of prey.	Same as above	Same as above	• Increase in water temperature • Change in water velocity and depth • Increased siltation and change in substrate composition • Loss of refuge habitat structure • Increase in turbidity

8. Measuring progress

The Carmine Shiner Recovery Team will monitor implementation of the recovery strategy and its associated action plans on an ongoing basis. The Team will be responsible for reviewing and evaluating the implementation of any action plans, and the performance of the recovery strategy in achieving its stated goal and objectives. The team will meet annually over a period of five years to evaluate the success of the strategy and to recommend any changes in direction. During the fifth year, the overall recovery strategy will be re-visited to determine whether:

- the goals and objectives are still being met;
- the goals and objectives need to be amended; or
- a fundamental change in approach to addressing the goals and objectives may be warranted.

Appropriate action, including amending or rewriting the strategy, will be considered at that time. Evaluations shall be based on the comparison of specific performance measures to the stated recovery objectives. Whenever possible, scientific studies will also be peer reviewed.

9. Statement on action plans

Implementation of the Carmine Shiner Recovery Strategy shall be effected by subsequent development of an Action Plan, which shall be completed within three years of the final recovery strategy being posted on the public registry. The current recovery team will develop the Action Plan to ensure continuity and efficiency. The Action Plan will be reviewed on a five-year basis or as needed to respond to new information.

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Appendix A: Effects on the environment and other species

Strategic environmental assessment statement

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*, the purpose of a Strategic Environmental Assessment (SEA) is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The recovery planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats.

This recovery strategy describes a number of research, management and public education approaches required for the conservation and recovery of the Carmine Shiner. Aside from the acquisition of further knowledge, the recovery strategy focuses on eliminating or mitigating threats to the species including overexploitation, species introductions, habitat loss or degradation, and pollution. In addition to generally improving environmental conditions, the reduction or elimination of these threats may benefit other co-occurring species. The recovery strategy also recommends the rationalization of existing or proposed stocking programs; potential impacts of any changes will be considered within the rationalization process. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not have significant adverse effects.

Effects on non-target species

This recovery strategy may have positive impacts on other species and their habitats, including Hornyhead Chub and Northern Brook Lamprey (*I. fossor*) in the Whitemouth River, and the Silver Lamprey (*I. unicuspis*) and Bluntnose Minnow (*Pimephales notatus*) elsewhere in the Winnipeg River system, all of which are uncommon in Manitoba (Stewart and Watkinson 2004). The strategy may also impact on bait fisheries where shiner species are included in the allowable catch. If Carmine Shiners were to become more abundant, or perhaps, expand their distribution as a result of protective measures, it would at least add to the diversity and stability of the affected aquatic communities (K.W. Stewart, pers. comm. 2004). A more diverse and abundant forage fish population might also increase the productivity of some economically important species.

This recovery strategy also recommends that the potential effects of existing and proposed stocking programs on the Carmine Shiner be examined. Most stocking programs include non-indigenous species (See 4.2.2. Species introductions), so the environmental effect of their removal would likely be positive or neutral.

Appendix B: Record of cooperation and consultation

Individuals and groups that were consulted during development of the Carmine Shiner recovery strategy included: The recovery team is deeply indebted to these people for their critical review and assessment of this strategy.

Date	Location	Meeting Type	Attendees/Issues
September 24, 2004	Winnipeg	Recovery Team Meeting	Bud Ewacha (Conserve Native Plants Society Inc., Winnipeg, MB),James Fraser (Tembec, Pine Falls, MB), Richard Pelletier (Premier Horticulture Ltd., Ste. Anne, MB), and Connie Proceviat (Sun Gro Horticulture Canada Ltd., Elma, MB), Gerry Hood (Canadian Sphagnum Peat Moss Association) - Participated in the meeting and provided the Recovery team with background information on their activities and concerns. Gerry Hood nominated to recovery team to represent Association interests.
December 12, 2004	Winnipeg	Recovery Team Meeting	Connie Proceviat (Sun Gro Horticulture Canada Ltd., Elma, MB) participated in the meeting representing peat harvester’s interests.
March 4, 2005	Winnipeg	Recovery Team Meeting	Kris Snydal (Manitoba Live Bait Association) participated in the meeting and provided the Recovery Team with background information on bait fishing operations in the region and feedback on their concerns.
May 24, 2006	Prawda, MB	Information Meeting	Northeast Agassiz Watershed Management Association. Presentation to the Association on the Species at Risk Program with specific focus on Carmine Shiner.
June 28, 2006	Whitemouth, MB	Information	Reeve and Council Rural Municipality of Reynolds. Neil Fisher described how SARA listing of Carmine Shiner might affect activities in, or around the Whitemouth River.
July 19, 2006	Whitemouth, MB	Information	Northeast Agassiz Watershed Management Association. Presentation to the Association on the Species at Risk Program and Carmine Shiner. Provided preliminary draft of recovery strategy for comments.
January 18, 2007	Dunnottar, MB	Information	Red River Basin Commission Presentation to Northern Chapter of the Commission on Species at Risk Program - included discussion of Carmine Shiner
October 24, 2007	Whitemouth, MB	Information	Reeve and Council of the Rural Municipality of Whitemouth. Presentation and discussions on the posted Recovery Strategy.

Aboriginal Organizations and First Nations:

Letters, plain language summaries of the recovery strategy and factsheets were sent to the following First Nations: Anishnaabeg of Naongashiing, Iskatewizaagegan #39 Independent First Nation, Northwest Angle No.33, Northwest Angle No.37, Shoal Lake No.40, Wabaseemoong Independent Nations, Anishinaabeg of Kabapikotawangag Resource Council, Bimose Tribal Council, Grand Council Treaty 3, Chiefs of Ontario, "Métis Nation of Ontario, Region 1", Brokenhead Ojibway Nation, Buffalo Point First Nation, Fort Alexander First Nation (Sagkeeng), Black River First Nation, Southeast Resource Development Council, Southern Chiefs Organization, Assembly of Manitoba Chiefs , Manitoba Métis Federation, "Manitoba Métis Federation, Southeast Region", Métis National Council, Assembly of First Nations and Métis Nation of Ontario. Comments were received from the Manitoba Métis Federation.

Other Jurisdictions:

The Province of Manitoba participated jointly with the DFO in the development of this recovery strategy. Comments were also received on a draft version on the strategy prior to its posting on the *SARA* Public Registry.

General:

Concurrent with posting of this recovery strategy on the SARA Public Registry, announcements were placed in local newspapers inviting public comment. In addition, information packages were forwarded to specific stakeholders with an identified interest in the recovery strategy including resource users, non-government organizations and local government inviting their comment. All comments received were considered prior to posting of the final recovery strategy.

Appendix C: Threats assessment analysis

Knowledge of the threats to a species and potential to mitigate those threats is fundamental to a species' recovery. In this assessment, the Carmine Shiner Recovery Team identified the following threats for consideration:

- **Over-exploitation**
  - Bait fisheries
- **Species introductions**
  - Predation
  - Competition
  - Food chain disruption
- **Habitat Loss/Degradation**
  - Flow alteration
  - Shoreline/riparian development
  - Landscape changes
  - Climate change
- **Pollution**
  - Point Sources
  - Non-point Sources
- **Other**
  - Scientific Sampling
  - Hybridization

Because so little is known of the species' life history and habitat requirements, the assessment of each potential threat was qualitative rather than quantitative, with each factor being rated as "low", "moderate" or "high". These assessments were based on the best professional judgement of the Recovery Team, and determined by consensus following discussions. For each potential threat at each location where the species is known to occur, the following factors were considered:

Likelihood of Occurrence – The probability of a threat occurring. Those that presently affect the species were rated "high".

Extent of Occurrence - The spatial range of each identified threat. Those that affect most or all of the area occupied by the species were rated "high".

Severity of Impact – The severity of the direct or indirect impact of a threat on the survival or recovery of the species. Impacts with the potential to extirpate the species were rated "high".

Immediacy of Impact - The immediacy of the anticipated impact from a threat. Ongoing threats that are impacting the species were rated "high".

Threat Significance – The risk of damage to a Carmine Shiner population from a particular threat, based on its likelihood and extent of occurrence and on the severity and immediacy of its impacts. Threat significance was rated “low” where severity of the impact was deemed low, and otherwise was difficult to predict given present knowledge.

Mitigation Potential - The biological and technical feasibility of mitigating a threat. Where there are no biological impediments and proven technology exists to successfully mitigate threats, the mitigation feasibility was rated “high”.

The results of these assessments are tabulated in Tables 9 to 11, summarized in Table 2, and discussed in Section 4. In the tables, questions marks (?) denote uncertainty, and the need for research. Comments provide background on each threat or its assessment.

Table 10. Assessment of potential threats* to the Carmine Shiner and its habitat in the Whitemouth River system and in the Winnipeg River near the Whitemouth River outfall, Manitoba

Identified Threat	Mechanism/ Source	Likelihood of Occurrence*	Extent of Occurrence*	Severity of Impact*	Immediacy of Impact*	Threat Significance*	Mitigation Potential*	Comments
Over-exploitation	Bait fisheries	**L**	**L**	**L**	**L**	**L**	**H**	There are commercial bait fish harvesting blocks encompassing the Whitemouth River, Whitemouth Lake, and Birch River. Minnows are not approved for harvest as live bait and are not so abundant as to support a fishery for frozen bait on these waters. Anglers may harvest some minnows for bait.
Species introductions	Predation, competition, food web disruption	**M**	**H**	**H**	**L**	**M**	**L**	Smallmouth Bass and Rainbow Smelt are present in the Winnipeg River, but Whitemouth Falls prevents their unassisted entry into the Whitemouth River. Sauger are also absent from the Whitemouth River, but Walleye have been introduced to Whitemouth Lake and trout into the Birch River. There is some limited potential for the transfer of biota from the Lake of the Woods watershed. The potential impacts of these species introductions are unknown. Smallmouth Bass and Carmine Shiner do coexist in other waters.
Habitat Loss/ Degradation	Flow alteration	**H**	**H**	**?**	**H**	**?**	**H**	The Whitemouth River is not affected by hydroelectric development. A fixed-crest weir regulates flow from Whitemouth Lake, and there is a small stone weir across the river channel at Elma. Agriculture, highways developments, and peat harvesting have altered watershed runoff patterns. There are more barriers along the river during dry years. In the past the river was dammed at Whitemouth during dry years to impound water for community use, and several old stream crossings have not been fully removed. Crossings and rock weirs have also altered flow in the Birch River (Schneider-Vieira and MacDonell 1993; Clarke 1998).
	Shoreline/ riparian development	**H**	**M**	**?**	**H**	**M**	**M**	There is extensive shoreline development along reaches of the Whitemouth River system north of Highway 1 related to communities, agriculture, and seasonal homes or cottages.
	Landscape changes	**H**	**M**	**?**	**H**	**?**	**M**	Forestry and peat moss operations are the main developments in the river basin south of Highway 1. To the north there are agricultural developments, communities, cottages, permanent homes, and a peat moss operation near the river.
	Climate Change	**?**	**?**	**?**	**?**	**?**	**L**	The potential effects of climate change are unpredictable on a local scale and cannot readily be mitigated.
Pollution	Point Sources	**H**	**M**	**?**	**H**	**?**	**M**	Peat moss extraction operations may be a point source of sediments. Agricultural feedlots, highway drainage ditches, and the Whitemouth sewage lagoon outfall may all be point sources of nutrient, sediment, or other chemical inputs. Clarke (1998) identified 12 significant point sources affecting the Birch River tributary.
	Non-Point Sources	**H**	**M**	**?**	**H**	**?**	**M**	Downstream from Highway 1, the Whitemouth River system is subject to water quality degradation through nutrient and sediment loading from modern agricultural practices. This threat is extensive and immediate, but has good potential for mitigation/restoration. Chlorinated water from the Winnipeg Aqueduct has leaked into the Birch River in the past (Clarke 1998). Some pollutants are likely deposited by long-range transport, but this problem is ubiquitous.
Other	Scientific Sampling	**H**	**H**	**L**	**H**	**L**	**H**	Small samples of Carmine Shiners have been collected from the Whitemouth River system for scientific purposes. The threat from further sampling is likely low and can be controlled.
	Hybridization	**L**	**L**	**L**	**L**	**L**	**L**	Carmine Shiners will hybridize with several other shiner species. There is no evidence of any anthropogenic influence toward hybridization in the Whitemouth River.

*H= high; M=moderate; L=low;
? Denotes uncertainty, and the need for research.

Table 11. Assessment of potential threats* to the Carmine Shiner and its habitat in the Bird River, Manitoba

Identified Threat	Mechanism/ Source	Likelihood of Occurrence*	Extent of Occurrence*	Severity of Impact*	Immediacy of Impact*	Threat Significance*	Mitigation Potential*	Comments
Over-exploitation	Bait fisheries	**L**	**L**	**L**	**L**	**L**	**H**	The Bird River is not approved for live bait harvest within the area inhabited by Carmine Shiner. The potential, however, exists for the commercial harvest of minnows for frozen bait. Anglers may also harvest minnows from the river for bait.
Species introductions	Predation, competition, food web disruption	**H**	**H**	**?**	**H**	**?**	**L**	Rainbow Smelt have been present in the Winnipeg River since the early 1990's. Their impacts on Carmine Shiner are unknown, but they do prey on the closely related Emerald Shiner. The impacts of introduced Smallmouth Bass on Carmine Shiner are likewise unknown, but the two species do coexist elsewhere.
Habitat Loss/ Degradation	Flow alteration	**H**	**H**	**?**	**H**	**?**	**L**	The lower Bird River to the first waterfalls, including known Carmine Shiner habitat, has been impounded by hydroelectric development on the Winnipeg River.
	Shoreline/ riparian development	**H**	**H**	**?**	**H**	**?**	**M**	There are extensive cottage developments on the Bird River system, particularly at Bird Lake, and a new cottage subdivision has been proposed. Forestry operations in the headwaters are proposing to harvest the riparian buffer, to limit the spread of disease from these trees to other harvestable stands of timber.
	Landscape changes	**H**	**H**	**?**	**H**	**?**	**M**	Cottage developments and forestry are the main activities with potential to effect landscape changes along the Bird River. The extent and proximity of timber harvest is controlled so its impacts on the river may not pose a significant threat. There is also potential for mining development in the watershed. http://www.gov.mb.ca/iem/mrd/geo/field/roa06pdfs/GS-19.pdf
	Climate Change	**?**	**?**	**?**	**?**	**?**	**L**	The potential effects of climate change are unpredictable on a local scale and cannot readily be mitigated.
Pollution	Point Sources	**M**	**M**	**?**	**H**	**?**	**H**	Cottages, highway crossings, and ditch drainages may be point sources of pollutants. Most cottages in the area use septic pumpout services because they lack septic fields.
	Non-Point Sources	**H**	**H**	**?**	**H**	**?**	**M**	Cottage developments upstream may increase nutrient and sediment loading. There are also forestry and mining developments upstream. Some pollutants are likely deposited by long-range transport, but this problem is ubiquitous.
Other	Scientific Sampling	**H**	**H**	**L**	**H**	**L**	**H**	Small samples of Carmine Shiners have been collected from the Bird River for scientific purposes. The threat from further sampling is likely low and can be controlled.
	Hybridization	**L**	**L**	**L**	**L**	**L**	**L**	Carmine Shiners will hybridize with several other shiner species. There is no evidence of any anthropogenic influence toward hybridization in the Bird River.

*H=high; M=moderate; L=low

? Denotes uncertainty, and the need for research.

Table 12. Assessment of potential threats* to the Carmine Shiner and its habitat in the Pinawa Channel, Manitoba

Identified Threat	Mechanism/ Source	Likelihood of Occurrence*	Extent of Occurrence*	Severity of Impact*	Immediacy of Impact*	Threat Significance*	Mitigation Potential*	Comments
Over-exploitation	Bait fisheries	L	L	L	L	L	H	The area is within an allocated commercial bait block but there is no live bait harvest. Although the potential exists for commercial harvests for frozen bait and for bait harvest by anglers.
Species introductions	Predation, competition, food web disruption	H	H	?	H	?	L	Trout have been stocked in the Pinawa Channel since the 1970's but have not established reproducing populations. Brown Trout were last stocked in 2002. There are reproducing populations of Smallmouth Bass in the Winnipeg River, and Rainbow Smelt have been present in the Winnipeg River since the early 1990's. The impacts of these introduced fishes on Carmine Shiner are unknown.
Habitat Loss/ Degradation	Flow alteration	H	H	?	H	?	M	Flow in the Pinawa Channel was altered ca. 1906 by construction of the Pinawa Hydroelectric Generating Station. This work included extensive blasting to deepen the Pinawa Channel, diking to permit impoundment upstream of the station, and a dam control structure with turbines at Old Pinawa. When the station was decommissioned in 1951, a dam was constructed across the inlet of the Pinawa Channel to divert flow to the Seven Sisters Hydrolectric Generating Station. After it was decommissioned, the dam and spillway at Old Pinawa were partially razed and still obstruct flow. The sequential effects of these alterations on Carmine Shiner habitat and populations are unknown.
	Shoreline/ riparian development	H	H	?	H	?	M	Piles of rock from channel deepening, a golf course below the inlet, dikes near the outlet with cleared agricultural fields, and a small Provincial Historical Park at the outlet are the main shoreline developments along the Pinawa Channel upstream of the Old Pinawa Dam. There are no cottages above the dam, but interest has been expressed in cottage development. There is extensive shoreline development below the dam for cottages, year-round homes, and agriculture.
	Landscape changes	H	H	?	H	?	M	Forest bordering the Pinawa Channel was logged in the early 1900's during and/or following construction of the Pinawa Generating Station and has since re-grown. The extent and proximity of modern timber harvest is controlled and impacts on the channel should not be a significant threat. There is extensive cottage and agricultural development inland from the channel below the Old Pinawa Dam.
	Climate Change	?	?	?	?	?	L	The potential effects of climate change are unpredictable on a local scale and cannot readily be mitigated.
Pollution	Point Sources	H	L	?	H	?	H	Cottages, homes, and agricultural operations may be point sources of pollution downstream from the Old Pinawa Dam.
	Non-Point Sources	H	H	?	H	?	M	There may be some nutrient enrichment and sediment loading by cottage developments and impoundments on Lake of the Woods and the Winnipeg River mainstem, upstream. Some pollutants are likely deposited by long-range transport, but this problem is ubiquitous.
Other	Scientific Sampling	H	H	L	H	L	H	Small samples of Carmine Shiners have been collected below the dam at Old Pinawa for scientific purposes. The threat from further sampling is likely low and can be controlled.
	Hybridization	L	L	L	L	L	L	Carmine Shiners will hybridize with several other shiner species. There is no evidence of any anthropogenic influence toward hybridization in the Pinawa Channel.

*H=high; M=moderate; L=low;
? Denotes uncertainty, and the need for research.