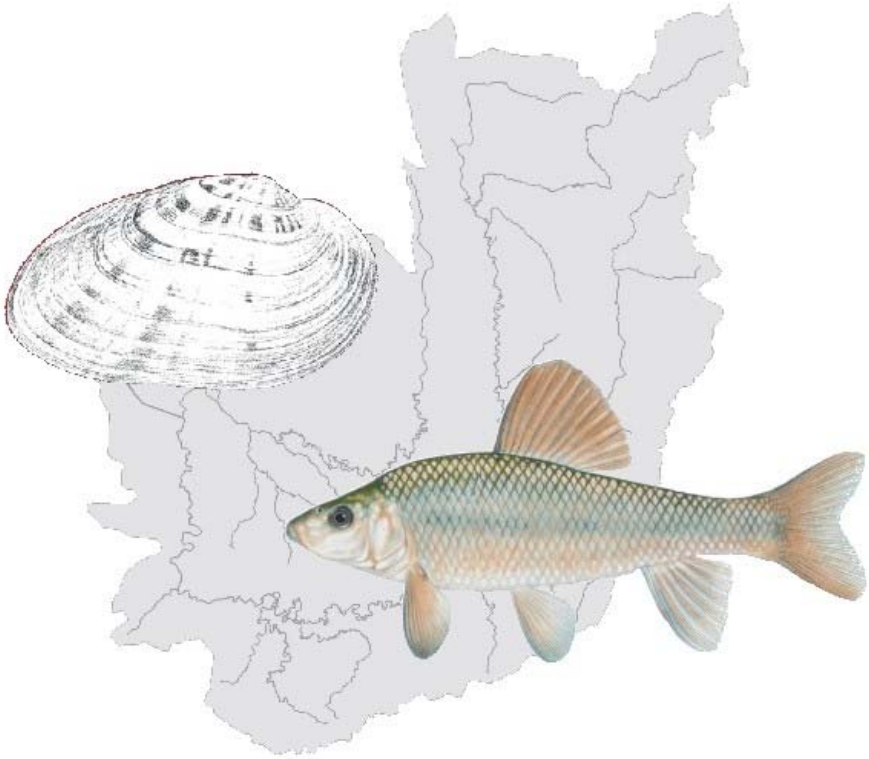
Recovery Strategy for Species at Risk in the Ausable River:

An Ecosystem Approach



2005-2010

Prepared by the
Ausable River Recovery Team

Draft 5 – June 2005

SPECIES AT RISK
AUSABLE RIVER RECOVERY

Cover Illustration:

Kidneyshell © Burch, J.B. 1973. Freshwater Unioniacean clams (Mollusca: Pelecypoda) of North America. Revised edition. Malacological Publications, Hamburg, Michigan. 204 pp. Reproduced with permission from John B. Burch.
Lake Chubsucker © Joseph R. Tomelleri

Recommended Citation

Ausable River Recovery Team. June, 2005. Recovery strategy for species at risk in the Ausable River: An ecosystem approach, 2005-2010. Draft Recovery Strategy submitted to RENEW Secretariat.

Ausable River Recovery Team

Shawn Staton (*Co-chair*)
Department of Fisheries and Oceans
Mari Veliz (*Co-chair*)
Ausable Bayfield Conservation Authority
Erin Dolmage (*previous Co-chair*)
Ausable Bayfield Conservation Authority
Alan Dextrase
Ontario Ministry of Natural Resources
Janice L. Metcalfe-Smith
Environment Canada, National Water Research Institute
Dave Zanatta
(Formerly of Environment Canada, National Water Research Institute)
Daryl McGoldrick
Environment Canada, National Water Research Institute
Harald Schraeder,
Ontario Ministry of the Environment
Dan Schaffer
Middlesex Stewardship
Tom Purdy
The Pinery Provincial Park
Steve Bowers
Huron Stewardship Council
Kim Barrett
(Formerly of Ontario Ministry of Natural Resources)
Thom Heiman
Department of Fisheries and Oceans
Dr. Nick Mandrak
Department of Fisheries and Oceans
Mike Nelson
(Formerly of Ausable Bayfield Conservation Authority)
Dr. Gerry L. Mackie
University of Guelph
Trevor Friesen
Ontario Ministry of Natural Resources
Dr. Lynda Corkum
University of Windsor
Teresa Ondrejicka
Ausable Bayfield Conservation Authority
Scott Abernethy
Ontario Ministry of the Environment
Tracy Allison
Department of Fisheries and Oceans
Dr. Todd Morris
Department of Fisheries and Oceans

Kara Vlasman
Ontario Ministry of Natural Resources

Advisors

Erling Holm
Royal Ontario Museum
Dr. Stephen Hecnar
Lakehead University
Ian Carmichael
Citizen (Odonate expert)
Colin Jones
Ontario Ministry of Natural Resources

Disclaimer

This recovery strategy has been submitted by the Ausable River Recovery Team to define recovery actions necessary to protect and recover aquatic species at risk in the Ausable River basin. It does not necessarily reflect the views of the individuals involved in the strategy's formulation or the official positions of the organizations with which the individual team members are associated. The goals, objectives, and recovery approaches identified in the strategy are based on the best existing knowledge and subject to modifications resulting from new findings. It is also recognized that implementation of this strategy will be subject to priorities and budgetary constraints imposed by participating jurisdictions and organizations.

Acknowledgements

The Ausable River Recovery Team would like to thank the many landowners and stakeholder groups who attended public meetings and provided feedback towards the development of this strategy.

Executive Summary

The Ausable River, located on the northern edge of the Carolinian Zone in southwestern Ontario, supports one of the most diverse and unique assemblages of aquatic fauna for a watershed of its size in Canada. At least 24 species of mussels, 83 species of fish and 21 reptile species have been found here. Many of these species are rare and 14 species in the Ausable River have been listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These 'species at risk', which consist of four freshwater mussels, seven fishes and three reptiles, include: (Endangered = END, Threatened = THR, Special Concern = SC): northern riffleshell (END), snuffbox (END), wavy-rayed lampmussel (END), kidneyshell (END), pugnose shiner (END), eastern sand darter (THR), lake chubsucker (THR), black redhorse (THR), river redhorse (SC), greenside darter (SC), bigmouth buffalo (SC), queen snake (THR), eastern spiny softshell (THR), and northern map turtle (SC). A number of these species are globally rare to uncommon (G1-G3) including the pugnose shiner (G3), eastern sand darter (G3), and remnant populations of the Endangered snuffbox (G3) and northern riffleshell (G2T2), which represent the only extant occurrences of these mussel species in Canada outside the Sydenham River basin. As such, the Ausable River watershed is of national significance to the survival of these and other species within Canada.

The Ausable River is approximately 'J-shaped' and drains 1142 km^2 of southwestern Ontario into Lake Huron. The watershed is located on a relatively flat till plain bounded on both sides by moraines. The river generally supports a warm water fishery; however, sand and gravel deposits in some areas discharge groundwater creating areas of cold/ cool stream habitat. Pronounced changes in land use from a predominantly forested, unsettled landscape to its current settled agricultural state occurred between 1850 and 1910, resulting in severe alteration to the drainage patterns of the basin. The lower reaches of the river were altered in the late 1800's when a channel was excavated from Port Franks to intercept the original channel to the southeast. This historic channel, now referred to as the "Old Ausable Channel" (OAC) is isolated from the rest of the river and is characterized by clear water and dense aquatic vegetation. Across the watershed, agricultural land use is now greater than 85 percent and more than 70 percent of the basin area has been tile drained with most of the wetlands now lost.

A synthesis of all available background information indicated the primary threats to populations of species at risk (SAR) in the Ausable River basin are sediment loadings causing siltation and turbidity, and nutrient enrichment. Secondary threats include channel alterations/loss, alterations to the flow regime, toxic contaminants, thermal changes and exotic species. Identified threats are widespread and chronic; however, in most cases, historical population declines of sensitive species are likely the result of cumulative impacts of many interacting anthropogenic stresses.

The Ausable River Recovery Strategy (ARRS) employs an ecosystem approach that addresses the threats faced by several SAR within the watershed and will benefit the aquatic community in general. A Conservation Priority Zone was identified based on

the past and present location of high priority species (those listed as END and THR). This zone consists of three areas: the Ausable River from its mouth to Hay Swamp, the Old Ausable Channel (OAC), and the lower reaches of the Little Ausable River. The Recovery Strategy is organized in three parts: 1) goals and approaches for overall ecosystem recovery, 2) goals and approaches for the three taxa groups (mussels, fishes and reptiles) and 3) species-specific information summaries for each of the 14 COSEWIC-listed species.

Overall Recovery of the Ausable River Ecosystem

The long-term goal of the Recovery Strategy is to sustain a healthy native aquatic community in the Ausable River through an ecosystem approach that focuses on SAR. The short-term recovery objectives to be addressed over the next five years are as follows:

I. Improve water and aquatic habitat quality through actions that mitigate identified threats to species at risk.
II. Contribute to the down-listing of species at risk and prevent their up-listing.
III. Establish a monitoring program to assess trends in the aquatic community and in the environment in order to determine change over time (enabling an adaptive management approach).
IV. Clarify and assess the relative significance of identified threats and recommend appropriate mitigation measures.
V. Increase public awareness and appreciation of species at risk in the Ausable River and their conservation needs for recovery.
VI. Develop linkages among partners, interest groups, industry, agencies and landowners interested in supporting the recovery of aquatic species at risk in the Ausable River.
VII. Integrate recovery planning with other fisheries or watershed planning processes and management efforts.

Overall strategies/approaches and specific steps required to achieve these objectives have been organized into four categories:

1. **Management Approaches**: Nine approaches are identified to assist with the protection of SAR habitat in the basin including the transfer of current relevant information to local management agencies, encouraging municipalities to upgrade wastewater treatment plants, implementing measures to reduce and/or evaluate the impact of drainage alterations, exploring different habitat preservation approaches, developing targeted sub-basin restoration plans, developing a management plan for the OAC and ensuring that SAR needs are considered during drought conditions.
2. **Stewardship/ Habitat Improvement Approaches**: Fourteen approaches are identified to improve habitat in rural areas including the implementation of stewardship initiatives (through a number of agricultural best management

practices), partnerships, the re-establishment of wetlands and through securing sustainable funding sources for such habitat improvement initiatives.

3. **Research and Monitoring Approaches**: Thirteen approaches are identified to monitor biotic and abiotic changes within the Ausable River ecosystem and address important research required for the implementation of effective recovery actions.
4. **Community Awareness and Outreach Approaches**: Six approaches are identified to increase awareness of the Ausable River watershed and the 14 species at risk. This will include the production of an overall communications strategy and associated products that will support various aspects of the Recovery Strategy.

The Ausable River Recovery Team (ARRT) recommended these four categories of approaches be implemented through the creation of two Recovery Implementation Groups (RIGs): a Management, Research and Monitoring RIG; and a Stewardship and Community Outreach RIG. The implementation groups are responsible for drafting their own Recovery Action Plans using the corresponding Overall Strategies/ Approaches to Recovery section in this document. The RIGs were formed following the finalization of the Recovery Strategy in the fall of 2004. Action plans will be drafted in 2005. The successful implementation of some strategies will require the coordinated efforts of both RIGs with overall management/coordination by the Recovery Team.

Significant progress has been made with regard to several recovery actions during the preparation of this Strategy. The ARRT has increased public awareness through the production and distribution of printed materials and provided landowners with financial support to assist them with water quality and riparian habitat improvement projects. The Recovery Team has held several meetings and workshops with landowners and other stakeholders in the watershed to gain community input into the Strategy. There have been several recent surveys and reports prepared on the status of mussels, fishes, reptiles and Odonates in the watershed and many research projects are on-going. Coordination of efforts with other ecosystem-based recovery teams including the Sydenham River and Thames River recovery teams, as well as relevant single-species recovery teams, will continue in order to share expertise and ensure effective use of available resources.

Several knowledge gaps exist surrounding the Ausable River watershed. Identified knowledge gaps include an incomplete understanding of: impacts of widespread drain closures (from open, surface drains to tiled drains), river hydrology, current land use, crayfish populations across the basin (an important reptile SAR prey item) and terrestrial SAR habitat abutting the river system. The Management, Research and Monitoring RIG will provide a forum to review these information needs and establish priorities for implementation efforts to bridge these gaps.

There are several existing management plans that are relevant to the Ausable River Recovery Strategy (e.g., conservation and natural heritage strategies, watershed management strategy, fisheries and shoreline management plans, municipal plans and

single-species recovery plans). Where necessary, implementation efforts will need to be harmonized with these plans to avoid conflicts.

Evaluation of the overall approaches to recovery will largely be accomplished through the long-term monitoring of water quality, SAR populations (abundance and distribution) and habitat quality and quantity. At the end of the Strategy's five-year period the Recovery Team will evaluate the progress made, as well as re-evaluate short-term and long-term targets, within an adaptive management planning framework.

Species-specific recovery

In this section, specific goals, objectives and associated recovery approaches are established for each of the three taxonomic groupings: mussels (four species), fishes (seven species) and reptiles (three species). Short-term objectives relate to defining and protecting habitats, determining population trends, addressing reintroduction potential, as well as addressing additional research needs. Long-term recovery goals for all mussel, fish and reptile SAR are to maintain existing populations and restore each species to areas of the river where they historically occurred. Recovery approaches identified in this section address species-specific needs that are not necessarily addressed in the 'Overall Recovery of the Ausable River Ecosystem' section of the strategy. An important component of this section is the determination of critical habitat for END and THR species, as required by SARA (for END and THR Schedule 1 species). A generalized 'schedule of studies' has been included to assist with this process and will be used for each of the 10 Endangered and Threatened mussels, fishes and reptiles.

Species-specific information summaries

This section (Appendix 1) provides a summary of relevant biological and ecological information for each of the 14 COSEWIC-listed species. These information summaries include: species description, distribution, population abundance and trends, biologically limiting factors and threats, habitat requirements and trends, knowledge gaps, and recovery potential.

Table of Contents

List of Tables

List of Figures

Figure 1. Location of the Ausable River basin in southwestern Ontario. Ten sub-basins are outlined.

Introduction

The Ausable River is located on the northern fringe of the Carolinian Zone in south-western Ontario (Fig. 1). This river supports a diverse and unique aquatic fauna. At least 24 species of freshwater mussels (Unionidae), 83 species of fishes and 21 species of reptiles have been found here, making it one of the richest watersheds of its size in Canada. Many of these species are rare; 14 of which have been designated by COSEWIC (Committee on the Status of Endangered Wildlife in Canada), including four mussels, seven fishes and three reptiles (Table 1). With regard to aquatic invertebrates, the Ontario Natural Heritage Information Centre has recently assessed species of the order Odonata (dragonflies and damselflies) and six provincially rare (S1-S3) species have been found to occur in the Ausable River. Odonates as a group have not yet been assessed by COSEWIC, however. Furthermore, a number of the mussels and fishes found in the Ausable River are globally rare to uncommon (G1-G3) and remain at only a few locations in Canada. Such species include the pugnose shiner (G3), which was recently up-listed by COSEWIC from 'Special Concern' to 'Endangered' and persists in the Old Ausable Channel (OAC). Remnant populations of the 'Endangered' snuffbox (G3) and northern riffleshell (G2) occur in the Ausable River and represent the only extant occurrence of these mussel species in Canada outside of the Sydenham River basin. As such, the Ausable River watershed is of national significance to the survival of these and other species within Canada.

To ensure the continued survival of these species at risk, the Ausable River Recovery Team (ARRT) was formed with the overall objective of developing an ecosystem-based recovery plan for this nationally significant watershed. The Sydenham River Recovery Strategy (Dextrase *et al.* 2003) figured prominently as a guideline for such an approach. The ecosystem approach is important in that it recognizes the links between species, communities and the ecosystem that supports them. Additional benefits include (Dextrase *et al.* 2003):

- Recovery actions are selected that benefit several species at risk
- Implementation is generally more cost-effective than implementing a series of single-species recovery plans
- It targets mitigation and rehabilitation of impacts and seeks to restore ecosystem health to prevent the decline of other native species in the future
- It addresses issues of scale (recognizing the inter-dependence of the river and its aquatic community on land use practices throughout the watershed)
- It requires a wider consideration of the responses of all native components of the system to actions implemented for the benefit of some species

The major criticisms of ecosystem or multi-species approach recovery strategies have been that less time and money is spent per species than with single-species approaches (Boersma et al 2001). There is a tendency for multi-species strategies to overlook details associated with species-specific threats, obstacles and biological requirements. Boersma et al (2001) emphasize the need for thorough scientific attention at the species-specific level. Such fine tuning can be incorporated into the larger, community scale strategies. The two are not necessarily mutually exclusive. The Ausable River Recovery Team recognizes the strengths of an interconnected, ecosystem approach to the recovery of aquatic species in the Ausable River basin. The Team has attempted to ensure recovery issues are identified and addressed on a species by species basis in this Strategy and in subsequent action plans (see Section II of the Strategy, Species-Specific Recovery).

The recently passed Federal Species at Risk Act requires the preparation of national recovery plans for species designated as Extirpated, Endangered or Threatened by COSEWIC. Species of Special Concern are required to be addressed through management plans, which can include multi-species or ecosystem approaches. Following the ecosystem approach, this Recovery Strategy addresses all species at risk, but places priority on those species with Endangered and Threatened status.

In order to provide the baseline information needed to develop a sound recovery strategy for the Ausable River watershed, the ARRT adopted the approach outlined by Staton *et al.* (2003). This involved the synthesis of information on land use patterns, water quality trends, the physical condition of the river, and the distributions of aquatic species at risk to gain an understanding of the overall health of the river and its major stresses. Consequently, the ARRT produced the following four background reports:

- land use (Dolmage and Nelson 2003)
- water quality (Veliz 2003)
- fluvial geomorphology (Dolmage 2003)
- species at risk (ARRT 2003)

Information from these reports was synthesized in a separate document entitled *Towards a Recovery Strategy for Species at Risk in the Ausable River: Synthesis of Background Information* (Nelson *et al.* 2003) and was used in the development of this Recovery Strategy. In addition, national status reports are available for the 14 COSEWIC-listed species and contain more, detailed species specific information.

Following Dextrase *et al.* (2003), this Recovery Strategy has been organized in three parts. The first section introduces the goals, objectives and approaches for overall ecosystem recovery; the second section describes the goals, objectives and approaches for the recovery of the three organism groups (mussels, fishes and reptiles); and the third section (Appendix 1) includes species-specific summaries for each of the 14 COSEWIC-listed species (Table 1, Appendix 3).

Table 1: COSEWIC-listed species at risk in the Ausable River (see Appendix 2 for definitions of ranks and status).

Common Name[1]	Species	COSEWIC Status (date designated)	OMNR Status	G-Rank	S-Rank
Mussels:					
northern riffleshell*	*Epioblasma torulosa rangiana*	END (1999)	END-NR[a]	G2T2	S1
snuffbox*	*Epioblasma triquetra*	END (2001)	END-NR[a]	G3	S1
wavy-rayed lampmussel*	*Lampsilis fasciola*	END (1999)	END-NR[a]	G4	S1
kidneyshell*	*Ptychobranchus fasciolaris*	END (2003)	END-NR[a]	G4/G5	S1
Fishes:					
pugnose shiner*	*Notropis anogenus*	END (2002, SC 1985)	END-R[b]	G3	S2
eastern sand darter*	*Ammocrypta pellucida*	THR (1994, revised. 2000)	THR	G3	S2
lake chubsucker*	*Erimyzon sucetta*	THR (1994, revised. 2001)	THR	G5	S2
black redhorse*	*Moxostoma duquesnei*	THR (1988)	THR	G5	S2
river redhorse	*Moxostoma carinatum*	SC (1983, revised. 1987)	SC	G4	S2
greenside darter	*Etheostoma blennioides*	SC (1990)	SC	G5	S4
bigmouth buffalo	*Ictiobus cyprinellus*	SC (1989)	SC	G5	SU
Reptiles:					
queen snake*	*Regina septemvittata*	THR (2000)	THR	G5	S2
eastern spiny softshell turtle	*Apalone spinifera spinifera*	THR (1991, revised. 2002)	THR	G5T5	S3
northern map turtle	*Graptemys geographica*	SC (2002)	SC	G5	S3

[1] The Recovery Team designated Endangered (END) and Threatened (THR) species to be of high conservation priority (indicated by an '*'). National recovery programs are directed at COSEWIC-listed Endangered and Threatened species.

[a] END-NR (Endangered, Not Regulated under the Ontario Endangered Species Act)

[b] END-R (Endangered, Regulated under the Ontario Endangered Species Act)

Background

The Ausable River drains 1142 km^2 of southwestern Ontario into the lower portion of Lake Huron. The river is approximately J-shaped, arising near Staffa and flowing south through Ailsa Craig before curving west through Arkona where the river enters a deep gorge (Figure 1). The original channel flowed northward towards Grand Bend, and then took a sharp turn to the southwest to its outlet near Port Franks. In 1873, a channelized section called the "Cut" was excavated from its current mouth in Port Franks to intercept the original channel to the southeast. A section of the historical Ausable channel still receives water from Parkhill Creek that flows parallel to the Ausable River for most of its length and now empties into Lake Huron at Grand Bend via a second excavation created in 1892. The main tributaries of the Ausable River include: Black Creek, the Little Ausable and Nairn Creek.

The Ausable River watershed is located on a relatively flat till plain bounded on both sides by moraines. Sand and gravel deposits in some areas of the watershed discharge groundwater, creating limited areas of cold or cool water stream habitat. However, the majority of the Ausable River supports a warm water fish community. Historical changes in the land use from lowland and upland forest to agriculture occurred primarily between the 1850s and 1940s. By 1983, approximately 75% of the watershed was under row cropping with forest cover reduced to only 13% of the watershed. Wetland loss and extensive agricultural drainage development have contributed to more rapid runoff and lower base flows across the basin. The Ausable River generally has poor water quality due to non-point source runoff from agricultural lands, septic systems and manure runoff, as well as point-sources such as wastewater treatment plants.

The current status of the 14 COSEWIC-listed species at risk in the Ausable River was assessed by the ARRT (ARRT 2003) and is summarized in Table 2. It should be noted that an additional COSEWIC-listed species, the spotted turtle (designated END by COSEWIC in 2004), has also been recorded from two sites in the watershed (Thedford Bog 1979 and Port Franks forested dunes and wetlands 1988, NHIC data). Although records of this species' occurrence in the riverine habitat of the Ausable River have not been found, new information from reports or surveys suggesting its presence in the River would result in its incorporation into the Recovery Strategy. Of the 14 species included in this strategy, one species was found to be expanding its range (bigmouth buffalo), three species are apparently stable (lake chubsucker, greenside darter and kidneyshell), four species are declining (pugnose shiner, northern riffleshell, wavy-rayed lampmussel and snuffbox), and two species may be extirpated from the Ausable River (eastern sand darter and river redhorse). There was insufficient data to infer general population trends for four species. These include all three species of reptiles (eastern spiny softshell turtle, queen snake and northern map turtle), which are known from only a few records, and the black redhorse, collected for the first time in 2002. For many species, additional surveys are required to confirm these assertions. For the reptiles and the black redhorse, additional surveys are required in order to clarify their present

status and distribution; however, the lack of historical data precludes the assessment of population trends over time.

To help prioritize species and locations for specific recovery actions, conservation priorities were assigned to all 14 species at risk (ARRT 2003). All species with a COSEWIC status of 'Endangered' or 'Threatened' were deemed to be of high conservation priority. These species included all four mussels, four fishes and two reptiles (see Table 1). All species with a high conservation priority are located within the 'Conservation Priority Zone' which consists of the following three major areas (Figure 2):

1. Ausable River - main channel from mouth to Hay Swamp (Hay Swamp is located predominantly in the Black Creek sub-basin)
2. Old Ausable Channel (OAC) - entirely located within the Dunes sub-basin
3. Little Ausable River (tributary) – lower reaches

In addition, nearly all distributions (present and past) of the remaining species are contained within the Conservation Priority Zone (only the widely distributed greenside darter is found at a few sites outside of this zone). Twelve of the 14 species at risk have been found in the main channel of the Ausable River between the mouth and Hay Swamp. Of the high conservation priority species, only the pugnose shiner and lake chubsucker have not been found in the main channel; these species occur only in the unique habitat provided by the OAC, with its clear waters and dense aquatic vegetation. The OAC is largely located within The Pinery Provincial Park. The Little Ausable River is the only tributary that harbours high priority species – both wavy-rayed lampmussel and black redhorse were confirmed in the lower reaches in 2002. Sub-basins supporting extant populations of the 14 species at risk have been identified in Table 2.

Table 2: Population trends and extant sites for COSEWIC-listed species at risk in the Ausable River basin.

Common Name	Population trend	Extant sites (sub-basin)
Mussels:		
northern riffleshell	Declining	Upper & Middle Ausable
snuffbox	Declining	Lower Ausable
wavy-rayed lampmussel	Declining	Upper & Little Ausable
kidneyshell	Stable?	Upper & Middle Ausable
Fishes:		
pugnose shiner	Declining?	Dunes (OAC)
eastern sand darter	Extirpated?	---
lake chubsucker	Stable?	Dunes (OAC)
black redhorse	Insufficient Data	Little Ausable
river redhorse	Extirpated?	---
greenside darter	Stable	Widespread
bigmouth buffalo	Expanding	Lower Ausable

Reptiles:		
queen snake	Insufficient Data	Lower Ausable
eastern spiny softshell	Insufficient Data	Lower Ausable
northern map turtle	Insufficient Data	Lower Ausable

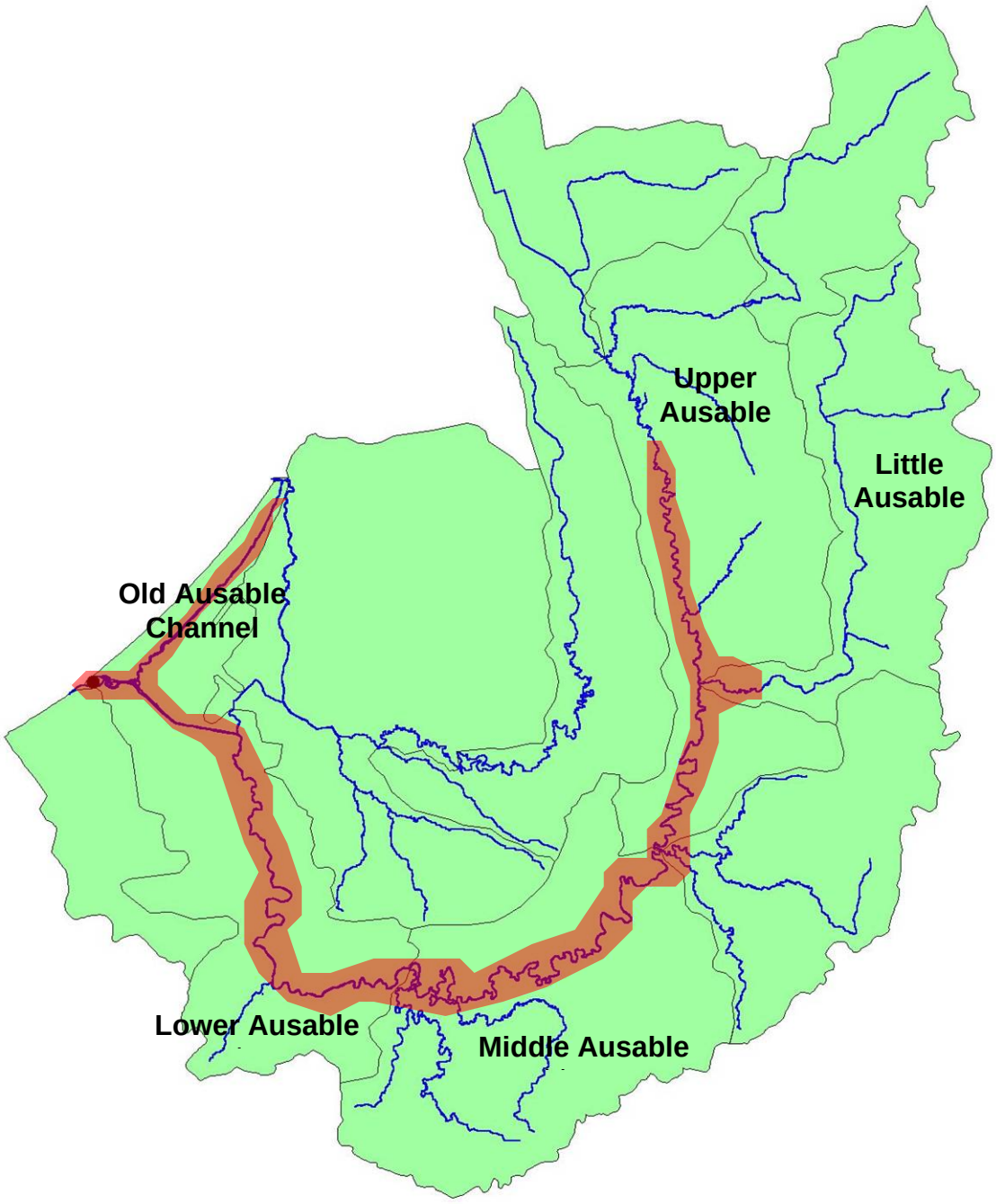


Figure 2. Map of Ausable River watershed indicating the Conservation Priority Zone in red. All known records of species at risk of high and medium conservation priority are located within this zone.

Threats

The current distribution and abundance of species at risk in the Ausable River is based largely upon natural conditions and the cumulative effect of multiple stresses on the aquatic ecosystem. Such stresses are ultimately the results of a loss of natural wetland and woodland functions and conversion to intensive landuse practices. Through a synthesis of all available background information, Nelson *et al.* (2003) determined that the primary threats to populations of species at risk in the Ausable River basin appears to be sedimentation and nutrient enrichment. Secondary threats included alterations to channels, flow regime, toxic contaminants, thermal changes, and exotic species (Table 3). While single threats may be associated with the decline of certain populations of species at risk, in most cases, population declines are likely a result of the cumulative effect of multiple widespread and chronic stresses. All identified threats are believed to be widespread and chronic in the Ausable River basin.

Table 3: Threats to species at risk in the Ausable River[1].

Threat	Relative Impact	Evaluation of Threat
Sedimentation	Predominant	Probable
Nutrient enrichment	Predominant	Probable
Channel alterations/loss	Contributing	Probable
Altered flow regime	Contributing	Speculative (limited data)
Toxic contaminants	Contributing	Speculative (limited data)
Thermal changes	Contributing	Speculative (limited data)
Exotic species	Contributing	Speculative (limited data)

[1] Additional information on specific causes of individual threats can be found in Nelson *et al.* 2003.

The most significant threat for the majority of species at risk appears to be siltation and associated turbidity caused by sedimentation. The majority of rare fish and mussel species are sensitive to siltation of their habitat (i.e., gravel and sand substrates) (Richter *et al.* 1997). High turbidity levels may affect visual behaviour of species including feeding, predator avoidance, and visual display used in reproduction (e.g., the wavy-rayed lampmussel makes use of a lure to attract its host). Suspended sediment concentrations available from eight provincial water quality monitoring stations across the watershed collected over the past 40 years indicated no significant trend over time for the watershed as a whole (Veliz 2003). Mean concentrations were highest in the main Ausable channel where the majority of species at risk occur. Mean suspended sediment concentrations (± standard error) from the Middle Ausable station between 1970 and 1993 were 117 ± 6 mg/L (n=289). Concentrations of suspended solids in this region, which is located within the known range of the northern riffleshell, were more than twice those found in the adjacent Sydenham River, which has a naturally

reproducing population of this species (Dextrase *et al.* 2003). Due to the difficulty in setting meaningful general guidelines for concentrations of suspended material, no guidelines have been developed for the protection of aquatic organisms by Canadian agencies.

The main land use, agriculture (> 85 per cent of basin area), is likely a major contributor of suspended sediments to the system. Other potential sources of suspended material include wastewater treatment plants and surface runoff from urban areas. The loss of riparian cover across the basin increases the susceptibility of the river to agricultural runoff as well as bank erosion. Riparian cover helps to maintain bank stability and withhold sediments from reaching watercourses (Vought *et al.* 1995). Livestock access can be an additional stress in localized areas. Improvements to wastewater treatments plants and implementation of agricultural best management practices would likely reduce suspended sediment loadings.

Nutrient (total phosphorus and nitrate) concentrations in the Ausable River typically exceed provincial water quality objectives and potentially pose a risk to the health of aquatic fauna. Mean concentrations for eight stations in the watershed were between 3.5 and 5.6 mg/L between 1965 and 2002. Nitrate concentrations have thus frequently exceeded the Draft Canadian Water Quality Guidelines to prevent nutrient enrichment (0.9 mg/L) and to protect aquatic life from direct toxic effects (3.0 mg/L) (Environment Canada 2003a). Total phosphorus concentrations have also been high and, since 1966, have consistently exceeded the provincial water quality objectives for the protection against enhanced nutrient enrichment (0.03 mg/L) (Ontario Ministry of Environment and Energy 1994). Nutrient sources to the Ausable River include: agricultural runoff, manure spills, wastewater treatment plant and septic system loadings. The high proportion of total phosphorus in the dissolved fraction (between 30 and 58 per cent) in the Ausable River suggests that loadings from wastewater treatment plants, livestock operations, and private septic systems may be important (Veliz 2003). Wastewater treatment plant improvements may have contributed to a decline in total phosphorus concentrations at several stations since the 1970s. In contrast, concentrations of nitrate appear to be generally increasing across the basin (Veliz 2003).

The change in land use surrounding the Ausable River from a predominantly forested, unsettled landscape to its current agricultural, settled state over the last 200 years has been associated with severe alterations to the drainage pattern of the basin. The creation of channel diversions, major dams and water impoundments, subsurface and surface drainage, as well as the transformation of open surface drains to closed tiled drains has greatly affected the natural structure and course of the Ausable River. More than 70 per cent of the basin area was tile drained by 1983. The ecological implications of this land use are currently poorly understood. The creation of the “Cut”, ironically, has proved beneficial to some species at risk and created one of the most unique areas in the entire watershed. It effectively isolated the Old Ausable Channel from the rest of the river system, and in so doing, reduced its susceptibility to the deteriorating water quality issues affecting the rest of the system.

The transformation of low order tributaries from open, surface drains to closed, tiled drains is prevalent throughout the watershed. In one sub-basin of the Ausable River, the Nairn Creek sub-basin, approximately 14% of the river network had been enclosed between 1975 and 1999 (Veliz 2001). The enclosure of first and second order streams has potential implications for downstream nutrient recycling, water retention, and general water quality. Small headwater tributaries and associated wetlands exert critical influences on the character and quality of downstream water and comprise the majority of the river network (Meyer *et al.* 2003) - typically 50 to 80% of the river network is 1st to 2nd order streams. The physical and biological processes that occur in these systems are responsible for a wide range of invaluable benefits: they provide flood control, recharge groundwater, trap sediments and pollutants from entering the main channel, recycle nutrients and provide habitat for plants and wildlife. Although river ecosystem recovery efforts often tend to focus on the restoration of the more visible main channel (which also tends to be more directly associated with targeted species at risk habitat), *true* recovery of such ecosystems cannot occur without efforts and mitigation measures extending to these vital components.

Due to the nature of the climate, geology and soils of the Ausable River basin, flow is strongly dependent upon precipitation. It is believed that landscape changes that have occurred during the past 200 years (and associated drainage alterations) have likely intensified the natural flow variability of the Ausable River and may now pose a threat to aquatic species. In comparison with other rivers in the Great Lakes basin, the Ausable River was classified as event responsive in terms of flow responsiveness to precipitation events (Richards 1990) and as one of the most susceptible rivers in southern Ontario to experience repeated low base flow events (Scott, A., Ausable Bayfield Conservation Authority, pers. comm., July 2003). Flow variability may impact species in many ways causing effects such as substrate instability (which is a particular habitat requirement of some mussel species), increased erosion and by reducing riffle habitat availability during droughts, which can result in mussel mortalities when individuals are exposed to desiccation and predation.

Pesticide runoff (e.g., herbicides and insecticides) associated with agricultural practices and urban areas enter the Ausable River basin and could have a significant impact on species at risk. For example, tributary monitoring at the mouth of the Ausable River for currently used pesticides in 2002 indicated that both atrazine and des-ethyl atrazine were found to exceed federal guidelines for the protection of aquatic life (J. Struger, Environment Canada pers. Comm.). The extent and impact of these and other toxic contaminants (e.g., chloride) to species at risk have not been assessed and thus, the significance of their threat is unknown. It is likely that this threat is widespread as the primary source of pesticides is from agricultural land. The risks from toxic contaminants to some species may be heightened at juvenile life stages (particularly for mussels) and at times of increased stress.

Aquatic species may be impacted by thermal changes (i.e., increasing water temperatures), which are occurring to the Ausable River watercourses in three general

ways. First, the loss of riparian areas can increase the amount of solar radiation reaching the surface of the stream, leading to warming of the river's water. A quantitative assessment of riparian cover across the basin has not been completed; however in 1983 only 13.5 per cent of the watershed was forested and recent field observations have noted limited riparian vegetation, particularly in the head-water areas. Second, reservoirs and other impoundments tend to increase the surface area receptive to solar radiation. In 1991, 21 dams with greater than 0.1 hectare surface area were identified within the Ausable and Parkhill Creek basins. Third, climate change is expected to cause an increase in surface water temperatures in southern Ontario (H. Hengeveld, Environment Canada, pers. comm.). While the Ausable River generally supports a warm water aquatic community with species tolerant of warm water, any increase in stream temperatures may be an additional stress. Nairn and Black creeks support coldwater species, including brook trout (*Salvelinus fontinalis*) that would be affected by increases in stream temperatures.

Exotic species may exert negative impacts on species at risk in the Ausable River. Common carp (*Cyprinus carpio*) are widespread in the Ausable River and are a threat to species at risk due to their destructive feeding behaviour, which tends to uproot aquatic vegetation and cause elevated turbidity levels. This species may be a particular threat to the highly vegetated, clear water habitats of the OAC, which support pugnose shiner and lake chubsucker. While the round goby (*Neogobius melanostomus*) has only been found in the lower reaches of the adjacent Parkhill Creek basin, it is another potentially serious threat to benthic fishes such as sculpins and darters if it colonizes the Ausable River. Many species of darters act as hosts for mussel species at risk and mussel populations could therefore be indirectly threatened by an invasion of the round goby. In addition, round gobies are also known to readily consume mollusks and theoretically may pose a direct threat to juvenile mussels. Finally, although zebra mussels (*Dreissena polymorpha*) have not yet been found in the Ausable River basin, their impacts to native freshwater mussels are well documented (Ricciardi *et al.* 1998) and their colonization could be a future threat. Zebra mussels can establish populations assisted by the presence of suitably sized reservoirs which they require in riverine systems. Large reservoirs provide lake-like conditions that allow for the settlement of zebra mussel larvae (veligers). Without a suitably sized reservoir, veligers are flushed from the system preventing the establishment of a permanent colony. While the relatively small size and low water residence time of the Morrison Dam Reservoir (the largest reservoir along the Ausable River) suggest that the risk from zebra mussel colonization is low, a more detailed risk assessment is advised.

I. Overall Recovery of the Ausable River Ecosystem

Recovery Goal

The long-term goal of the Ausable River Ecosystem Recovery Strategy is to sustain a healthy native aquatic community in the Ausable River through an ecosystem approach that focuses on the recovery of species at risk.

Short-term Recovery Objectives

The short-term recovery objectives to be addressed over the next five years are as follows:

I. Improve water and aquatic habitat quality through actions that mitigate identified threats to species at risk.
II. Contribute to the down-listing of species at risk and prevent their up-listing.
III. Establish a monitoring program to assess trends in the aquatic community and environment to determine change over time (enabling an adaptive management approach).
IV. Clarify and assess the relative significance of identified threats and recommend appropriate mitigation measures.
V. Increase public awareness and appreciation of species at risk and the conservation needs to recover species at risk in the Ausable River.
VI. Develop linkages among partners, interest groups, industry, agencies and landowners interested in supporting the recovery of aquatic species at risk in the Ausable River.
VII. Integrate recovery planning with other fisheries or watershed planning processes and management efforts.

Overall Strategies/Approaches to Recovery

The overall strategies/approaches to recovery have been organized into the following four categories – Management, Stewardship, Research and Monitoring, and Community Awareness and Outreach. Successful implementation of these strategies will require the coordinated efforts of Recovery Implementation Groups (RIGs). A rationale is included at the end of each section when further explanation for individual approaches/strategies is warranted.

A. Management

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Urgent	V, VI, VII	A1: Information Transfer	Provide current information (including species at risk habitat mapping) to all management agencies in basin.	Will ensure that all management decisions in the basin will have appropriate information to help prevent impacts to species at risk and their habitat.
Urgent	V, VI, VII	A2: Habitat Protection/ Securement	Engage and coordinate with various organizations towards the securement of lands for conservation (including land trusts, non-government organizations and other interested groups).	Will help ensure the protection and improvement of habitat over the long term.
Urgent	IV, VI, VII	A3: Target Sub-basin Restoration Plans	Identify target sub-basins based on severity of threats and develop sub-basin restoration plans.	Will provide prioritized guidance for stewardship activities at the local sub-basin level.
Urgent	I, IV, VI, VII	A4: OAC Management Plan	Develop and implement a long-term management plan for the OAC (including reaches in and beyond The Pinery Provincial Park), based on research and monitoring, C2), to ensure the maintenance of its unique habitat for species at risk.	Will assist in the protection of the OAC to ensure the long term viability of pugnose shiner and lake chubsucker populations.

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	VI, VII	A5: Wastewater Treatment Plants	Encourage municipalities with wastewater treatment plants that are deleteriously affecting water quality (based on research and monitoring, C7) to upgrade facilities.	Will improve water quality by reducing nutrient and suspended sediment contributions from wastewater treatment plants.
Necessary	VI, VII	A6: Channel Drainage Alterations	Evaluate the impact of large-scale drainage alterations of the upper main channel to downstream species at risk.	Will provide an understanding of the potential impact of additional drainage alterations. May help protect aquatic habitat from future drainage works.
Necessary	VI, VII	A7: Drainage Alterations: Impact on Watershed	Evaluate the implications of enclosing and tiling low order watercourses at the watershed scale. Steps to curb drain enclosures may warrant consideration.	Will provide a better understanding of cumulative impact of natural first order stream loss. May help prevent further losses.
Necessary	VI, VII	A8: Drainage: Fish Surveys	Require spring fish surveys on all proposals to close and tile intermittent drains/watercourses.	Will help ensure the protection of spawning habitat and prevent cumulative impacts of drain operations in headwater regions.
Beneficial	IV	A9: Water Supply Management	Work with the low water response team to ensure the needs of species at risk (particularly riffle species) are considered in the protocol.	Will help ensure adequate baseflows are maintained for riffle species during drought conditions.

A1: Information transfer – Many management decisions have the potential to impact species at risk and their habitat. This broad approach ensures management decisions are based on the best available information pertaining to species at risk and that decision makers are aware of the potential impacts that various decisions can have upon these species. Appropriate decision-making is essential to the long-term implementation of the recovery plan. Examples of relevant decisions include: municipal and county planning (e.g., Official Plan Amendments, development proposals), drain

maintenance, project reviews and water taking permits. The provision of relevant habitat mapping (especially critical habitat) will be an integral component of this step.

A2: Habitat Protection/Securement – Options for permanent land preservation, including conservation easements, land trusts, and possibly land acquisitions need further consideration. The Recovery Team will seek to partner with various existing organizations and interests involved in habitat preservation and the wide range of land securement options that are available. Emphasis will be placed on the importance of specific habitat preservation/ protection of some important areas in the Ausable River watershed including Hay Swamp, and expanding the size of existing ESAs and ANSIs along the river corridor. Existing organizations such as the Nature Conservancy of Canada, the Federation of Ontario Naturalists and various land trusts have the desired expertise to meet this end, including expertise in communications, aspects of land acquisition, tax rebates, landowner contact, and ongoing maintenance of the property. Another option may be investigating programs where landowners can be reimbursed for the ecosystem benefits provided through the presence and management of natural areas on their properties such as the Alternate Land Use Services (ALUS) pilot program in Norfolk County. In cases where opportunities arise to preserve exceptionally significant natural habitats, land acquisition may be an important tool to help ensure the long-term goal of the Recovery Strategy. Although land stewardship has been the traditional approach on private lands, it can be relatively costly, and subject to land use and land ownership changes. Further cost-benefit analysis on these issues should be investigated in order to ensure the most efficient use of limited available resources. Such work should be done in consultation with the Stewardship RIG.

A3: Target Sub-basin Restoration Plans – This approach would first entail the identification of priority sub-basins where restoration would provide maximum benefit in terms of the reduction of identified threats. The subsequent development of sub-basin restoration plans at the local level would help identify specific improvements (such as those identified in Table B) so that resources are focused for maximum benefit to downstream habitats of species at risk. Sub-basin plans, such as the one developed for Nairn Creek, have proven to be effective in demonstrating the need for restoration and garnering support from individual landowners and community groups.

A6: Drainage – The upper watershed in particular has been altered substantially by channel alterations on larger watercourses including the main branch of the Ausable River. While such changes may not have resulted in direct habitat losses to species at risk (no historical records exist here), downstream effects would be expected, including increased sedimentation and disrupted hydrology (i.e. increased ‘flashiness’). Any downstream extensions of existing drainage works would be expected to have a compounding impact on the downstream Conservation Priority Zone. Large scale drainage extensions have been considered by the farming community in recent years; it would therefore be prudent to conduct an evaluation in advance.

A7: Drainage – First and second order headwater streams continue to be closed in underground tiles across the Ausable River watershed (Veliz 2001). This trend is of

particular concern since small headwater tributaries and associated wetlands exert critical influences on the character and quality of downstream water (Meyer *et al.* 2003). Furthermore, first and second order streams comprise 70% of the length of the entire Ausable River network (Ontario Ministry of Natural Resources 1983). These small, seemingly insignificant headwater streams are a crucial component of the river and cannot be neglected in considering the overall recovery of the Ausable River ecosystem. As such, the enclosing and tiling of headwater streams needs to be evaluated at the watershed scale. Further, recommendations should be made on how to curb this land use trend to prevent further cumulative loss.

A9: Water supply management – Low summer base flows are a recurring issue in the Ausable River basin and may be a particular threat to species at risk that depend on riffle habitats. When drought conditions occur, a 'low water response team' introduces necessary restrictions on water taking. The Recovery Team will work with the low water response team to ensure the needs of species at risk are considered in the protocol.

B. Stewardship/Habitat Improvement

Agricultural best management practices or "BMPs" not only benefit water quality and species that live in the river, but are also conducive to long-term agricultural sustainability. At the individual farm level, the Environmental Farm Management Plan (also known as the Environmental Farm Plan or EFP) is an important first step that helps farmers identify farm related environmental issues and prioritize potential solutions. The EFP presents a process for implementing BMP projects. This tool has been a great success for several years and it has recently been updated to include riparian corridor BMPs and is being promoted with increased financial rewards.

Stewardship and habitat improvement actions should be directed to improve conditions, or mitigate the impact of identified threats in regions affecting the Conservation Priority Zone. In particular, BMPs that will improve conditions for species at risk in the Conservation Priority Zone should be given the highest priority. For more information on BMPs and environmental management, please see OMAF (2005).

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Urgent	I, VI	B1: Riparian Buffers	Establish riparian buffers through naturalization and planting of native species.	Will reduce nutrient (nitrogen and phosphorus) and sediment input to receiving waters. Will provide shade and reduce water temperatures.

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Urgent	I, VI	B2: Soil Conservation	Establish grassed waterways and retire fragile lands.	Will reduce the effects of erosion by filtering sediment and nutrient contaminants and controlling overland water flow.
Urgent	I, VI	B3: Herd Management	Restrict livestock from watercourses where appropriate.	Livestock restrictions will reduce bank compaction, erosion and nutrient loadings to adjacent watercourses.
Urgent	I, VI	B4: Nutrient and Manure Management	Control barnyard runoff. Construct concrete manure storage pits. Complete septic system inspection & upgrades.	Will improve water quality by reducing nutrient (nitrogen and phosphorus) input.
Urgent	I, V	B5: Soil Conservation	Encourage the use of conservation tillage equipment.	'Low till' practices will reduce soil erosion caused by wind, water and tillage and improve soil structure.
Urgent	I, V	B6: Habitat Improvement – Wetland Reestablish-ment	Assist landowners in reestablishing wetlands in appropriate locations.	Will help to regain some wetland function across the basin that will contribute to reductions in sediment and nutrient loadings and low flow augmentation.
Urgent	I, VI,	B7: Engage Local Landowners	Pursue additional sustainable funds for landowners and local community groups.	Facilitate improvements to water quality, water quantity and aquatic habitat.
Necessary	I, V	B8: Habitat Improvement - Instream	Provide technical and financial assistance to landowners in implementing habitat improvement projects (ex. removal of dams, old crossings, etc.).	Improve instream habitat for species at risk.

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	I, V	B9: Farm Planning	Encourage the completion of Environmental Farm Plans (EFPs).	Will assist farmers in identifying farm-related environmental issues, prioritizing potential solutions, and obtaining financial support for implementation of the project
Necessary	I, V	B10: Agricultural Drainage	Install drop inlets and environmental protection valves. Encourage appropriate drainage density for tiling. Encourage the implementation of BMPs that reduce sediment and nutrient inputs to drainage infrastructure. Ensure appropriate maintenance of surface drains according to habitat conditions.	Will improve water quality, quantity and aquatic habitat by lessening the impact of agricultural drainage.
Necessary	I, VI	B11: Nutrient and Manure Management	Ensure appropriate manure (and fertilizer) application rates and timing. Encourage use of manure injectors.	Will help protect water quality by preventing nutrient loss to surface waters due to over fertilization. Nutrients placed near root zone with manure injectors may also result in enhanced plant nutrient uptake.
Necessary	I, V	B12: Soil Conservation	Encourage the establishment of windbreaks, berms, cover crops and crop rotation.	Will help protect water quality by reducing soil erosion by wind and overland water flow in cropped areas.
Necessary	I, V	B13: Nutrient and Manure Management	Encourage the creation of milkhouse washwater trenches or recycling systems.	Will help protect water quality by containing and treating runoff and by “freeing-up” space in manure storage.

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	I, V	B14: Farm Planning	Encourage the development of Nutrient Management Plans (NMP).	A NMP will identify activities that protect water from excessive nutrients and improve soil conditions to achieve optimal crop yields and reduce input costs.

(Adapted from: Monk 2002)

B1 and B10: Riparian Buffers and Tile Drainage - Sediment and nutrient loads delivered to watercourses via the tile drainage network may not benefit from filtration through the vegetated buffer strips. Further identification of this issue may be required at the farm and landscape scale.

B6: Habitat Improvement – wetland re-establishment - Wetland loss across the Ausable River watershed has been extensive. Historically, wetlands constituted approximately 20% of the basin but were reduced to only 2.5% by 1986 (Nelson *et al.* 2003). The re-establishment of wetlands in currently drained and undrained lowland regions of the watershed will help restore proper wetland function to the river system. Useful guidance for wetland projects can be taken from the recent publication "*Wetland drain restoration project 'How to Guide*' "(OMNR 2003). This guide provides comprehensive information on restoring wetlands that have been impacted by municipal drains. It should be noted that such restoration projects may require the consideration of fish passage in their design.

B7: Engage Local Landowners – The establishment of a Recovery Implementation Group ("Stewardship and Community Outreach") will be essential in coordinating existing activities related to stewardship and habitat improvement in the basin (e.g. Ausable Bayfield Conservation Authority and Ontario Stewardship). This group will develop a strategy to promote existing options for stewardship and habitat improvement, foster new partnerships (e.g. with farm organizations, corporations, provincial agencies and community groups) to streamline program delivery, leverage additional funding and expand the breadth of financially supported activities to also address non-farm residents.

B8: Habitat Improvement – Instream - Some instream projects may include: the removal of dams, establishment of riparian cover to areas of the channel that are frequently inundated, increasing the amount of large woody debris to increase cover and help maintain channel grade and sort substrates (Harald Schraeder, OMOE, pers. comm.), fish deflectors, bank fascines to stabilize eroding banks, removal/ improvement

of cattle crossings, removal of low-head dams, implementation of natural channel design principles.

B9: Farm Planning – Environmental Farm Plans (EFPs) are essential to prioritize the implementation of BMPs at the level of the individual farm. Development of these plans is overseen by the Ontario Soil and Crop Improvement Association and completion of an EFP is frequently a pre-requisite for other funding programs (i.e., Healthy Futures). Completion of an EFP gives the landowner access to a $1500 grant from Agriculture and Agri-food Canada for any worthy project identified under the plan. Although, some program delivering agencies feel that the pre-requisite EFP may prohibit the uptake of other grant monies, the EFP process represents an important first step to meet environmental objectives at the farm level.

C. Research and Monitoring

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Urgent	II, IV	C1: Research–Environmental Factors	Investigate/examine the relationships between aquatic communities and environmental variables (see below), including identified threats.	Improved understanding of the relationship between aquatic communities, environmental variables and identified threats. Improved understanding of critical habitat
Urgent	II, III, IV, VII	C2: Research–OAC	Assess the state of the current environment and assess how threats may impact the future environment of the OAC.	Improved understanding of function of, and threats to, the OAC. Improved understanding of critical habitat
Urgent	II, III, IV	C3: Water Management	Conduct studies investigating base flows, precipitation levels and water-taking and their impact on habitat for riffle-dwelling species.	Will evaluate the effects of drought and low flow events on the species at risk in the Ausable River Watershed.
Urgent	IV, VII	C4: Riparian Assessment	Detail the distribution of, and establish a monitoring program for, riparian vegetation cover.	Will provide a long-term measure of riparian vegetation cover change over time.

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Urgent	II, III	C5: Monitoring– Species at Risk	Develop a monitoring program to evaluate trends in distribution and abundance of species at risk.	Will provide trend-through-time information on range, abundance, population demographics and habitat. Will help determine population viability for species at risk and help identify critical habitat.
Urgent	II, IV	C6: Pesticides and Other Toxic Contaminants	Conduct a study on currently used pesticides within the watershed. Investigate existing water quality data sets for other potential toxic contaminants.	Will help determine the location and relative contribution of various pesticides to the basin. Will contribute to future field investigations of pesticide loadings to the watercourse. May identify additional toxic contaminants.
Urgent	II, IV	C7: Wastewater Treatment Plants	Evaluate the impacts of wastewater treatment plant outflow on the aquatic community.	Will help identify wastewater treatment plants that may be impacting species at risk and provide guidance for remedial measures.
Urgent	II, III, IV	C8: Fluvial Assessment	Conduct a general fluvial geomorphic assessment of the entire Ausable River to establish a baseline and develop a long-term monitoring program.	Will provide additional information on the functioning of, and changes to, the Ausable River as it may relate to species at risk and their habitats.
Urgent	II, IV, VI, VII	C9: Information Sharing	Develop a comprehensive database (including biotic and abiotic data, metadata) for the Recovery Team.	Will allow for improved accessibility of available data and information to all Recovery Team members (e.g., survey results, maps, status reports).

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	II, III, IV	C10: Monitoring– Water Quality and Quantity	The long-term benthic and water quality and quantity monitoring programs should continue and stations should be added in the Conservation Priority Zone.	Will continue and build upon existing programs to provide a greater understanding of changes in water quality and quantity over time.
Necessary	IV	C11: Chloride Trends	Assess i) the affect of chloride on aquatic organisms and ii) the trends over time of chloride concentrations in the Ausable River from available water quality data.	Will provide additional information on the potential threat of chloride.
Necessary	III, IV	C12: Tile Drainage	Map the spatial extent of tile drainage and evaluate the impacts to the Ausable River basin.	Will help quantify the extent of tile drainage and its impacts in the Ausable River basin and identify opportunities for implementation of best management practices.
Necessary	IV	C13: Assessment – Hay Swamp	Assess the ecological, biological and hydrological importance of Hay Swamp and evaluate the potential effects of drainage alterations to species at risk downstream.	Will determine the importance of Hay Swamp in mitigating threat factors to species at risk.
Beneficial	II, III, IV, VII	C14: Inventory - Dams	Conduct a detailed dam inventory throughout the Ausable River basin expanding on the 1991 survey by the Ausable Bayfield Conservation Authority.	Will identify any unnecessary disruptions to natural river functions and barriers to fish migration, areas in need of maintenance, and areas of restoration potential.

C1: Research: environmental factors – Many of the relationships between species at risk and their limiting factors are poorly understood. For example, while it is

acknowledged that siltation is a significant threat to many of the species at risk considered in this recovery strategy, the specific thresholds for sediment loadings that should be established for the protection of species at risk is unknown. Information pertaining to nutrients, contaminants, increased flow variability, low water levels and temperature thresholds for various species at risk should also be investigated further to provide a better understanding of the threats most likely to be limiting the distribution of species at risk.

C2: Research: OAC – The long-term health and protection of the OAC is crucial for the preservation of the lake chubsucker and pugnose shiner populations that occur there. Evaluation of current research findings (particularly pertaining to groundwater flow) and an assessment of future threats to the health of the OAC, both inside and outside of The Pinery Provincial Park, will assist in prioritizing and acting upon the main threats to the integrity of the system. This information will provide the essential knowledge required for the development of recovery actions focusing on the OAC.

C4: Riparian assessment - Riparian assessment would provide a baseline of the current status of riparian habitat quality and quantity across the basin. Protocols used should be consistent with other programs (e.g., Middlesex Natural Heritage Strategy) to allow for the development of a long-term monitoring program. The most recent tile drainage mapping should be included in the analysis to prioritize areas for restoration. Sub-surface tile drainage allows nutrients and sediment to bypass much of the riparian cover, thus reducing the effectiveness of the vegetation in lowering nutrient and sediment deposition into the watercourse. Riparian areas that do not drain tiled areas are therefore higher priority candidate sites for rehabilitation. This approach has been employed by Staton and Doolittle (2003) for the Sydenham River watershed.

C5 and C10: Monitoring programs – An integrated long-term monitoring program for tracking responses of the aquatic community and water quality and quantity to recovery efforts is essential. A species at risk monitoring program would not only focus on tracking changes in species at risk population ranges and densities over time but would also result in the collect of information on changes in the overall aquatic community including the introduction and colonization of exotic species. By monitoring the distribution and abundance of populations of species at risk over time, insights into the viability of populations will be made possible. Areas of occupation and areas of suitable habitat will also be identified as a consequence of monitoring efforts, thereby contributing to the identification of critical habitat. The species at risk and water quality monitoring program will:

- Establish index stations for fish and mussel species at risk throughout areas of recovery habitat using quantitative species-specific sampling protocols (monitor once every three to five years). Complete fish and mussel community information, including population demographics, will be collected as well as habitat parameters. Non-destructive sampling methods will be used.

- Population and habitat surveys will be conducted for the queen snake, northern map turtle and eastern spiny softshell (to be monitored once every three to five years). Since reptiles are long-lived, the collection of several sets of data will be required to clearly establish population trends. Habitat assessments will serve to determine any changes in the condition of previously known sites and record any new sites along the river.
- Continue to integrate results from provincial and federal government water quality and quantity monitoring programs. Additional stations should be added to the Conservation Priority Zone to ensure adequate representation (for example, there are no Provincial Water Quality Monitoring stations on the main branch of the Ausable River in the middle sub-watershed). The benthic invertebrate monitoring program should continue in order to complement water quality results.

C6: Pesticides and other toxic contaminants – The potential impact of pesticides and other toxic contaminants on species at risk that occur in the Ausable River is unknown but may be significant. Recent sampling by Environment Canada near the mouth of the river detected 14 different pesticides – including atrazine and des-ethyl atrazine which exceeded federal guidelines for the protection of aquatic life. It is recommended that a two-part assessment be conducted to: (1) examine existing data and design a field study based on the findings; (2) implement a field study to evaluate concentrations of various pesticides (this may include sampling animals directly if appropriate). Pesticide use data is available from the Ontario Ministry of Agriculture and Food and water quality monitoring data is available from the Ontario Ministry of Environment (OMOE) but generally has very limited information on pesticide concentrations.

C7: Wastewater Treatment Plants – Water quality monitoring data has demonstrated that wastewater treatment plants (WTPs) may have a significant impact in terms of nutrient loadings in particular. A detailed analysis of existing data held by individual WTPs would assist in a further evaluation of potential water quality issues that may be impacting species at risk (which would provide direction for A4). More specifically, the concern has been raised that WTPs may be deleterious to sensitive species by creating a biological oxygen demand (BOD). In fact, recent data suggests that the kidneyshell and wavy-rayed lampmussel have very low tolerances to low oxygen levels (Tetzloff 2001), while other species such as the three-ridge (*Amblema plicata*) exhibit more tolerance. The three-ridge is actually one of the most tolerant species to low oxygen events and is the most abundant mussel in the Ausable River watershed. Although dissolved oxygen data is available from water quality monitoring data, nightly monitoring would be required to detect BOD problems in specific locations. As such, a pilot project to monitor BOD (as well as other parameters) at a WTP outflow has been recommended by the Recovery Team.

C8: Fluvial assessment – A fluvial assessment would describe the current state and nature of the fluvial geomorphological processes of the basin. Protocols used should be consistent with other area programs to ensure consistency. It is anticipated that this assessment would contribute to the knowledge of the stability of the channel and help

identify areas of the channel which may be suitable sites for more detailed habitat and species surveys. Most importantly, however, a fluvial geomorphic assessment may help evaluate the threat of altered hydrology to species at risk and their habitats (particularly for mussels that are reliant on stable substrates).

C11: Chloride Trends – Trends in chloride concentrations across the Ausable River watershed have not yet been assessed from historical water quality monitoring data (Veliz 2003). Chloride, commonly found in road salt, has been increasing in surface waters throughout southern Ontario and found to occasionally exceed federal guidelines for the protection of aquatic life. The impact and trends over time of chloride concentrations should be investigated further from existing water quality monitoring data collected in the Ausable River watershed.

C12: Tile Drainage – Much of the Ausable basin has been tile drained. This form of artificial drainage may impact waterways by altering their natural hydrology and through the delivery of sediments and nutrients which are unmitigated by riparian vegetation. As such, the mapping of tile drainage across the basin will define the spatial extent and variation of the artificial drainage and lead to a better understanding of how this practice may be impacting the aquatic ecosystem. Tile drainage mapping will also be a useful reference in prioritizing riparian restoration efforts to maximize sediment/nutrient reduction (see C4). Research should also be initiated to quantify the impact systematic tile drainage is having on water quality, quantity and stream flow variability in the Ausable River watershed.

C13: Assessment – Hay Swamp – The Hay Swamp is an environmentally significant area and the largest wetland in the upper watershed. This wetland is immediately upstream of the Conservation Priority Zone where several species at risk presently occur. Hay Swamp has been altered somewhat by drainage in the past and may be under threat of additional drainage works in the future. The functional significance of the Hay Swamp to existing populations of species at risk needs to be assessed. The potential role of the Hay Swamp in the recovery of the watershed in general should be investigated. In addition, the potential effects of future alterations to the Swamp should be assessed.

C14: Inventory – Dams - Dams may negatively impact species at risk in the Ausable River in several ways: by trapping sediment, thereby covering essential nesting/egg-laying areas for mussels and fish; by preventing movement of native species within their normal habitat needs and by increasing the thermal gradient due to greater area of water surface exposed to sunlight. - A 1991 dam and reservoir assessment conducted by the Ausable Bayfield Conservation Authority (ABCA) identified 21 dams exceeding 0.1 hectares within the Ausable River and Parkhill Creek basins (ABCA 1991). Only one major dam, the Morrison Dam in Exeter, is located in the Ausable watershed (headwater region). This dam and eight hectare reservoir was constructed in 1955 and provides for flow augmentation and flood control. An assessment of the Morrison Dam and other smaller dam structures should be conducted to identify any unnecessary

disruptions to natural river function and barriers to fish and reptile movement, as well as areas in need of maintenance, and potential restoration sites.

Although dams can have negative impacts on wildlife, it is recognized that they also provide benefits. Dams retain water for availability during low water and dampen flood surges, trap sediment and may prevent the spread of exotic species. It is important to note that the first two beneficial functions are those that woodlands and wetlands would naturally perform in a healthy landscape.

D. Awareness

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	V, VI	D1: Communications Strategy	Develop an overall communications strategy defining approaches, information products and educational opportunities (see D1a-D1e below, which will be addressed in order of priority).	Will improve public awareness of species at risk and promote ways in which the public can help improve the Ausable River ecosystem.
Urgent	V, VI	D1a: Exotic Species	Post information about the risk of transporting exotic species by small boats and/or bait buckets at Conservation Areas and reservoir locations. Evaluate the success of this specific step.	Will reduce the potential for introductions of exotic species into basin and educate residents and visitors of the implications of exotic species introductions.
Necessary	V, VI	D1b: Awareness–Stewardship	Promote stewardship activities and initiatives.	Will improve awareness of opportunities to improve water quality and species habitat.

Priority	Objective Number	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	V	D1c: Awareness-OAC	Develop an overall awareness program specifically focusing on the OAC.	Will increase awareness of Pinery Provincial Park visitors, adjacent landowners and the local municipality of the ecological significance of the OAC.
Necessary	V, VI	D1d: Awareness–Public	Continue to develop and deliver public awareness tools such as workshops, a website and promotional materials. Put forth an SAR educational campaign 'Why SAR in the Ausable River are at risk'.	Will improve awareness of species at risk in Ausable River basin and promote ways in which the pubic can help improve the Ausable River ecosystem.
Necessary		D1e: Awareness-Addressing Landowner Concerns	Provision of clear communications addressing landowner concerns, financial compensation and landowner responsibilities under SARA.	Will address landowner concerns regarding species at risk, facilitate public interest and involvement in stewardship initiatives and the recovery of SAR.

D1: Communications Strategy – The Stewardship and Community Outreach RIG will draft an overall communications strategy to coordinate actions across the basin that will increase awareness of species at risk and the recovery program. This RIG, in consultation with partner communications staff, will identify information products and delivery mechanisms to facilitate implementation of the strategy. The communications strategy will determine "key messages" and outline specific steps to increase awareness as directed by the Ausable River Recovery Team and the other Recovery Implementation Groups through initiatives such as the development and delivery of workshops, a website, and promotional materials (e.g., brochures, posters, calendars). Individual communication actions may be implemented prior to completion of the strategy.

D1c: Awareness – Old Ausable Channel - The unique characteristics of the OAC require the development of special awareness initiatives. Although The Pinery

Provincial Park has featured terrestrial species at risk such as the Karner Blue butterfly (*Lycaeides melissa samuelis)* and the oak savanna ecosystem in its natural heritage education programs, the OAC has not figured prominently. Given that the Park hosts thousands of visitors each year, there is a unique opportunity to educate Park visitors with respect to the ecological significance of the OAC and the Ausable River Recovery program. Awareness initiatives should also be directed toward municipal officials and landowners in the section of the OAC outside of The Pinery Provincial Park boundary.

D1d: Awareness – Public – This approach will seek to promote stewardship activities (e.g. BMPs) and initiatives, while stressing the strong links between sustainable farming practices and a healthy aquatic ecosystem. This principle should be promoted to encourage uptake of already established agricultural BMPs to address threats to species at risk.

D1e: Awareness – Addressing Landowner Concerns – An important component of the Ausable River Recovery Strategy with regard to SAR involves simplifying and interpreting the legal jargon with regard to the newly proclaimed Species at Risk Act (SARA) into understandable and meaningful terms for landowners who may be affected by this legislation. Clear definitions and communications of the terms used in the Act and regulations are essential. Landowner concerns surrounding the implications of SARA will be addressed and financial incentive and compensation opportunities will be made known to landowners who may be impacted by critical habitat designations. This will be done in an effort to improve understanding and cooperation among landowners, stewardship networks and the Recovery Team. The need for compensation will be significantly reduced by using stewardship agreements to reverse population declines of species at risk wherever possible and by ensuring the recovery strategy and action plans are developed with early and full involvement of informed and affected stakeholders. The conservation of biodiversity and the protection and recovery of species at risk is a public value shared by all Canadians.

Recovery and Survival Habitat

The identification of recovery and survival habitat is essential in the determination of critical habitat as defined by the Species at Risk Act (SARA). Generally, survival habitat has been defined as those reaches that are currently occupied, while recovery habitat has been defined as those areas currently and historically occupied by a given species. To the extent possible, recovery and survival habitat has been described for each of the 14 species at risk in the species summaries included in Appendix 1. Due to the limited information on the distribution of most species at risk in the Ausable River, habitat descriptions are restricted to general geographic accounts (all Endangered and Threatened species are included in the three 'high conservation priority' regions – refer to background section). As such, background surveys have been identified as an urgent priority to more accurately define the current range of species at risk (survival habitat) and will contribute to the identification of critical habitat for Endangered and

Threatened species. The lack of historical data for many species makes the identification of 'recovery habitat' more problematic, although extrapolations can be made for the historical ranges of some species (i.e. mussels).

While riparian areas throughout the watershed are essential to the maintenance of in-stream habitats, the Recovery Team has defined recovery and survival habitats as areas below the 'top of bank'. The 'top of bank' includes the area of active stream flow of a river in unflooded condition. It is defined by a marked change in the substrate slope from a horizontal profile to a more vertical profile and/or a visible change in floral abundance and character on vegetated slopes (OMNR 1989). The majority of species at risk in the Ausable River are entirely aquatic and occupy habitats within this zone; however, all three species of reptiles, although highly aquatic, also utilize habitats above the waterline for basking and other activities. For example, both the eastern spiny softshell and map turtle use open, sandy areas near water for nesting, and the queen snake is seldom found more than 3 meters from water. In many reaches, under normal summer flow conditions, these near shore areas would be included below the 'top of bank'. Any discrepancies that may occur in this designation (such as hibernation sites) will need to be defined once initial surveys and site-specific conditions have been assessed for the 2 Threatened reptile species (queen snake and eastern spiny softshell). The ultimate determination of critical habitat as defined by SARA will be subject to approval by the responsible federal jurisdictions (please refer to section II Species-Specific Recovery, for the approaches on determining critical habitat).

Actions Already Completed or Underway

Stewardship and Awareness Initiatives

The Government of Canada's Habitat Stewardship Program (HSP) for Species at Risk is a multi-year initiative that provides funds to protect habitat and contribute to the recovery of species at risk. In the winter of 2003, the Ausable River Recovery Team received approximately $109,000 to increase public awareness and provide grants to landowners to complete stewardship activities that will improve water quality and habitat for species at risk. The overall goal of this initiative is to improve water quality, which will assist with the recovery of species at risk in the Ausable River, by minimizing non-point source pollution, reducing sedimentation and turbidity, controlling erosion and enhancing riparian habitat. Examples of eligible projects include livestock exclusion from watercourses, farm equipment modifications and buffer strip/riparian plantings.

In order to increase public awareness of the actions of the Ausable River Recovery Team, 3000 copies of a species at risk brochure were produced in March 2003. This brochure provides species profiles on all 14 COSEWIC-listed species along with general information on the Ausable River Recovery project. Other actions implemented to support public awareness include the installation of three species at risk signs at local Conservation Areas to inform users of the species at risk in the Ausable River, the

development of a website, a species at risk education program delivered to local schools and a species at risk calendar. These and other stewardship activities (including livestock exclusion from watercourses and riparian plantings) were completed in 2004 with funding of $124,000 from the Government of Canada's HSP.

Public consultation began in April 2003 with the first meeting being held at The Pinery Provincial Park. This meeting was well attended by a variety of watershed residents who heard about the history and significance of the Ausable River and its species, the species at risk recovery planning process, and the actions to date of the Ausable River Recovery Team. In July 2003, a second public meeting was held in Exeter to gather input into the development of the Recovery Strategy. A presentation of the Synthesis Report led to public breakout groups discussing issues of importance to be addressed within the Recovery Strategy and future recovery implementation. A number of noteworthy issues from these meetings were integrated into both the Synthesis Report and the draft Recovery Strategy. The Ausable River Recovery Team presented the draft Recovery Strategy to the public in the spring of 2004 for additional input. A mailing list containing over 100 people has been generated from these meetings that will be of use for future announcements. In addition, a number of local newspaper articles have reported on these public meetings and the actions of the ARRT to watershed residents.

Coordination with other Recovery Teams

Several recovery teams are already operating adjacent to the Ausable River basin in southwestern Ontario. The Sydenham River and Thames River recovery teams are ecosystem based and present many opportunities to share expertise, experience, communications strategies and other resources for species at risk recovery actions. A public service announcement is currently being created to promote the efforts of the three basin-wide recovery teams and to highlight the importance of the three river systems (Ausable, Thames, and Sydenham). Similarly, in the spring of 2003, a recovery planning workshop was jointly held by these three recovery teams for municipal, county, and provincial planning agency representatives to discuss issues related to species at risk planning in the three watersheds. Single-species recovery teams that are relevant to the recovery efforts of species at risk in the Ausable River include those associated with the queen snake, eastern spiny softshell and the freshwater mussels that reside in the river. The continued coordination of the efforts of these and other related recovery teams will ensure cost-effective use of funds through shared expertise, approaches and communications materials.

Surveys

During the summer of 2002, researchers from the Department of Fisheries and Oceans and the National Water Research Institute of Environment Canada conducted basin-wide surveys for fish and mussel species at risk. These inventories provided important information regarding the current distribution of species at risk including first records of the bigmouth buffalo and black redhorse in the basin. During July 2003, the Natural Heritage Information Centre of the Ontario Ministry of Natural Resources conducted surveys of dragonflies, damselflies and reptiles along the Ausable River. Additional surveys for fishes, mussels, and reptiles were completed in 2004 by the ARRT to help

establish a more complete baseline on the current status of all aquatic species at risk in the basin. The 2002-04 surveys will be particularly important in the development of future monitoring strategies for species at risk.

Water Quality and Quantity Monitoring

Water quality data is collected at six stations in the Ausable watershed through a partnership between the ABCA and the Ministry of the Environment (MOE) (Provincial Water Quality Monitoring Network). In 2003, two additional stations were added which monitor phosphorus, nitrogen, suspended solids and *Escherichia coli*. The benthic invertebrate monitoring program completed its fourth field season in the autumn of 2003 and will continue to alternate the monitoring of main channel and tributary stations annually.

Through a second partnership with MOE, the ABCA has been working to establish a groundwater monitoring network throughout the Ausable watershed. Due to the drought conditions observed over the last couple of years, the Ontario Low Water Response Plan led to the establishment of the Ausable Bayfield Water Response Team. The purpose of this program is to provide information collected from existing water quantity climate monitoring stations to an advisory team to decide upon the need for varying levels of water use restrictions. While this program does not collect any additional information related to water quantity or climate variables it does provide a framework for a more timely response to potential low flow situations across the basin.

Knowledge Gaps

This section identifies important knowledge gaps not outlined in the overall strategies/approaches section. Species-specific knowledge gaps for each species, where appropriate, are included in Appendix 1.

Drain closure study

The transformation of open, surface watercourses (typically an agricultural drain) to closed, tiled systems is occurring across the southwestern Ontario landscape. For example, drain closures in the Nairn Creek sub-basin were estimated to be 14 per cent between 1975 and 1999 (Veliz 2001). Drain closures commonly occur in agricultural areas to increase the amount of arable land while reducing the inconvenience of an open watercourse. The impacts of drain closures to the aquatic habitat of species at risk and the hydrology, geomorphology and fluvial dynamics of river systems is poorly understood. Two initial steps are recommended to better understand the issue of drain closures: 1) conduct a literature review regarding the costs and benefits associated with enclosing head-water streams, and 2) determine the extent of stream enclosure that has occurred across the basin. Recommendations from these initial investigations should guide further research. Drainage studies to evaluate the environmental implications of enclosing and tiling low order watercourses at the watershed scale has

been identified as a necessary approach to recovery by the Ausable River Recovery Team (see Table A. Management).

River hydrology

A better understanding of the natural hydrological functioning of the Ausable River will be obtained through fluvial geomorphology surveys (A8), studies focusing on low flows (A8), and evaluating the relative contribution of some natural features (C13: Hay Swamp). However, the overall contribution of these, and other, interconnected changes (such as low flows) on the overall functioning of the Ausable River ecosystem must also be addressed. For example, what impact will climate change have on river flow rates, the frequency of low flows, groundwater influence, and the long-term use and availability of water in the basin? A complete description of the hydrological system is needed to help explain the links between the various functions of the Ausable River. This description would incorporate results and findings from a variety of studies including the dam and reservoir survey, tile drain survey and impact assessment, and drain closure survey and assessment. Such research may, for example, help quantify the need and location of re-establishing wetland function to restore a more natural flow regime.

Land use and land management

The most recent land use information used within this recovery planning process is from 1983. A significant gap exists on current land use changes over the past 20 years. While it is not likely that a new study similar to that of 1983 will be completed, information on land use and land management from the Census of Agriculture may be useful. Census data is reported on a 5-year cycle and includes information on land use, land management practices (including fertilizer, pesticide and manure application), conservation practices (including area of conservation tillage and planted buffer strips). Obtaining this information may assist greatly in the prioritization of areas of restoration potential and in better understanding the links between land use and species at risk distributions. This information would complement existing data and provide a snapshot of change over time.

Crayfish surveys

Crayfishes are a particularly important prey item to reptile species at risk in the Ausable River which tend to be dietary specialists. Queen snakes prey almost exclusively on crayfishes (Ontario populations likely feed predominantly on the species *Orconectes propinquus*), while they are also a major component of the diet of the eastern spiny softshell and a significant diet item for map turtles. Currently, there is little understanding of the distribution of crayfishes across the Ausable River basin. While a population of crayfish at a given location may not necessarily indicate the presence of reptile species at risk at that site, such knowledge will add to the overall understanding of their potential range and population status. Surveys may also help determine the extent and effect of non-native crayfishes in this ecosystem.

Terrestrial species at risk
According to Nelson *et al.* (2003), 20 Endangered and Threatened terrestrial species have been recorded from the Ausable watershed: 10 plants, five birds, four reptiles and one mammal. Occurrences of Endangered and Threatened terrestrial species within 100 m of watercourses throughout the Ausable basin should be identified and mapped. These maps could then be used by the recovery team, RIGs and various agencies and organizations involved with recovery initiatives and stewardship programs to ensure that aquatic recovery projects do not inadvertently negatively impact existing neighbouring terrestrial species at risk. It is also necessary to be cognizant of riparian vegetation/ cover which is indirectly associated with critical habitat for aquatic organisms, as well as the terrestrial component of the critical habitat of SAR reptiles identified in this recovery strategy, since terrestrial habitat has not been incorporated in this 'below the bank' strategy.

Recovery Implementation Groups and Recovery Action Plans

The implementation of recovery strategies requires the long-term involvement of many partners. Recovery Implementation Groups (RIGs) may be established by recovery teams to assist the team in implementing the recovery strategy. Each group is responsible for completing a Recovery Action Plan (RAP) corresponding to the appropriate strategies/approaches identified within the recovery strategy. The successful implementation of some approaches requires the synchronized efforts of more than one RIG through active communication amongst RIGs and the leadership of the recovery team.

The Ausable River Recovery Team has recommended creating two RIGs: Management, Research & Monitoring and Stewardship & Community Outreach. These two RIGs will be composed of individuals from various agencies, community groups, etc. and are intended to provide a forum for individuals to discuss and coordinate approaches to the implementation of actions identified within the Recovery Strategy. Some membership overlap with the Sydenham River Recovery Team is recommended for these two RIGs to help ensure coordination of recovery efforts where common ground exists. The implementation of recovery actions will remain the responsibility of existing groups and agencies. It is anticipated that the RIGs will be formed in early 2005; action plans will be completed within 2 years following the approval of the Recovery Strategy under SARA. The functions of the two RIGs are identified below:

Management, Research & Monitoring
This group will be responsible for the coordination of management, research and monitoring efforts within the Ausable River watershed. This will include responsibilities such as interacting with relevant management agencies concerning species at risk, sharing habitat mapping information with relevant agencies, attending to any legislative matters that may arise, and coordinating and prioritizing species at risk surveys,

monitoring, and research initiatives. This group will also be responsible for the overall evaluation of the recovery program, including establishing measures to monitor progress.

Stewardship & Community Outreach
This group will predominantly be responsible for developing and executing a broad based communications strategy as well as promoting and implementing on-the-ground stewardship activities. Actions include raising awareness amongst all watershed residents through public presentations, publications (such as brochures and calendars), a website, and public service announcements. Such actions will promote stewardship activities that will improve water quality and species at risk habitat. Additionally, this group will assist landowners by securing monies from financial grant programs (e.g., Government of Canada's Habitat Stewardship Program for Species at Risk) thereby allowing residents to undertake stewardship activities that will benefit water quality and species at risk.

Potential Management Impacts for Other Species/Ecological Processes

The ecosystem approach advocated in this recovery strategy recognizes the interconnectedness of the entire community within the basin of the Ausable River. Such an approach to improving overall watershed conditions, habitat and general environmental conditions should benefit the majority of existing populations of native species. Some common species such as common carp, (*Cyprinus carpio*), western blacknose dace (*Rhinichthys obtusus*), and white heelsplitter (*Lasmigona complanata*) are opportunistic generalists that may persist (and sometimes prosper) under degraded conditions. Although reductions in populations of these species are possible if improvements to habitat and overall watershed conditions occur, these declines should be viewed as restoration of the natural community balance. While bigmouth buffalo (*Ictiobus cyprinellus*) is tolerant of high turbidity levels, their populations will likely benefit from improvements in habitat and water quality.

Where possible, rehabilitation work in riparian areas will be conducted so that it may complement, rather than interfere with, the habitat and management of terrestrial species at risk. In most cases riparian restoration efforts will benefit terrestrial species at risk. There are opportunities to combine the efforts of this Recovery Strategy with other similar habitat improvement efforts (e.g. Tallgrass Ontario, Carolinian Canada and various land trusts). The importance of communication and coordination of restoration efforts across the Ausable basin is imperative to allow for the successful implementation of the objectives of this Recovery Strategy along with other similar projects.

Links to Existing Management Plans

The following management plans and strategies have been identified as relevant to this Recovery Strategy. Where necessary, implementation efforts will be coordinated with these plans:

- Ausable Bayfield Conservation Authority (ABCA) Conservation Strategy
- ABCA Watershed Management Strategy
- ABCA Fish Habitat Management Plan
- Cold Water Fish Habitat Management in the Nairn Creek Sub-basin
- ABCA Shoreline Management Plan
- ABCA Conservation Areas Master Plans
- The Pinery Provincial Park Resource Management Strategy
- The Pinery Provincial Park Management Plan
- Natural Heritage Strategies (i.e. Middlesex County)
- Official Plans (Perth, Huron, Middlesex and Lambton Counties, municipalities)
- Queen Snake Recovery Strategy (draft strategy, unpublished)
- Eastern Spiny Softshell Recovery Strategy (draft strategy, unpublished)
- Recovery Strategy for the Wavy-Rayed Lampmussel in Canada (draft strategy, unpublished).
- Multi-species Recovery Strategy for the round hickorynut and kidneyshell (draft strategy, unpublished)
- Sydenham River Recovery Strategy (Dextrase *et al.* 2003)
- Thames River Recovery Strategy (draft strategy, unpublished)
- Grand River Recovery Strategy (draft strategy, unpublished)

Anticipated Conflicts or Challenges

The vast majority of land in the Ausable River basin is privately owned. Many of the habitat improvements and changes in land use will therefore require the voluntary involvement of individual landowners. It is anticipated that future pressures to the agricultural community from globalized markets and ongoing uncertainty regarding legislative requirements on farmers (e.g., *Nutrient Management Act*, Species at Risk Act) may deter rural farm landowners from initiating conservation and habitat protection activities on their land if conservation initiatives are of no immediate beneficial use to the landowner. The continued presence of financial incentives to encourage landowners to undertake these actions is of critical importance, as well as the need for ongoing incentives for them (or the next owner) to maintain them. To this end, adequate funding to support private land stewardship improvements across such a large geographic area may be the single, most significant challenge affecting successful recovery of this river ecosystem. Changing land ownership can represent an additional challenge to the permanence of habitat improvements gained through a previous owner.

Population growth will be an ongoing pressure to species at risk in the Ausable River basin. This pressure emphasizes the importance of continued communication of the

best available species mapping and information to all relevant planning agencies and agencies involved in decision making with potential to impact species at risk.

Evaluation

Evaluation of the overall approaches to recovery will largely be accomplished through the long-term monitoring of water quality, species at risk populations (abundance and distribution) and habitat quality and quantity. During the five-year period that this recovery strategy covers, the Recovery Team will attempt to identify the current state of these and other related parameters, as well as establish long-term target levels and review progress on stated recovery objectives. In this way, the ARRT will evaluate the progress made in implementing the strategy while simultaneously evaluating the approaches that contributed to, and alternatively detracted from, successful implementation (specific evaluation methods for individual approaches will be determined by RIGs during action plan development. It is understood, however, that the overriding priority during this five-year period is to increase the overall knowledge of species' abundance and distribution in the Ausable River basin, particularly for Endangered and Threatened species.

II. Species-Specific Recovery

Recovery Goal

Maintain existing distributions and densities of species at risk populations and restore self-sustaining populations of each species to areas of the river where they formerly occurred.

Short-term Recovery Objectives

The short-term recovery objectives to be addressed over the next five years are as follows:

I. Define current range, abundance and population demographics for species at risk.
II. Define critical habitat for Endangered and Threatened species.
III. Develop and implement a long-term monitoring program for species at risk to assess trend through time with respect to range, abundance, and extent and quality of their habitat.
IV. Identify and evaluate threats to species at risk and, where feasible, mitigate immediate threats.
V. Investigate the feasibility of population supplementation or re-introduction for species that may be extirpated or reduced to remnant populations.
VI. Confirm the fish hosts for each mussel species at risk as well as the distribution and population strength of these hosts.
VII. Coordinate recovery efforts with other recovery teams.

Overall Strategies/Approaches to Recovery

The overall species-specific strategies/approaches to recovery for mussels, fishes and reptiles are included in the tables below. Approaches are listed in order of their relative priority and additional commentary has been included following the table where deemed necessary. Background surveys to better define the extent and health of species at risk populations is largely incomplete for most species (particularly so for reptiles) and has been assigned the highest priority action by the Recovery Team. Such information is critical to establishing a baseline, and many of the other approaches are dependent on this information, particularly for the determination of critical habitat. Most fundamentally, accurate information on species at risk populations is necessary for the development of a species at risk monitoring program upon which the adaptive management approach is based.

Determination of Critical Habitat

The identification of critical habitats of Schedule 1 Threatened and Endangered species is a requirement of the Species at Risk Act. Once identified, SARA includes provisions to protect critical habitat of these species. The identification of critical habitat is a complex process and requires solid, scientific data to support its designation. Critical habitat is defined under Section 2 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". Survival, recovery and critical habitat have been described to the extent possible in Appendix 1 for each of the ten Endangered and Threatened species at risk that occur in the Ausable River. Through the preliminary analysis of extensive data collected in 2002 and 2004, the Recovery Team has recommended the designation of significant portions of the Old Ausable Channel as critical habitat for the pugnose shiner and lake chubsucker (see species-specific summaries in Appendix 1). However, for the remaining Endangered and Threatened species, the level of detailed, defensible data required for the designation of critical habitat simply does not exist. As such, critical habitat will be determined for each of these species using technical guidance from draft guidelines currently in development (Environment Canada 2003b). Following the background and research stages of these guidelines, a generalized schedule of studies required for the identification of critical habitat is as follows:

<u>Schedule of studies for the identification of critical habitat</u>

1. Review and Document Relevant Life History and Ecology
    - Outline primary biological needs
    - Identify habitat attributes required to fulfill primary biological needs
    - Summarize species' demography
    - Identify known and/or potential rate-limiting steps for population growth
    - Characterize species' genetic population structure
    - Identify and evaluate the threats facing the species
2. Spatially Locate the Species
    - Map both current and historical distribution and abundance
3. Spatially Locate the Species Habitat
    - Locate all known occupied habitat patches
    - Identify areas of potential habitat
4. Establish Conservation Goal: Survival or Recovery
    - Determine if recovery is technically and biologically feasible
    - Set measurable objectives using best available information
    - Population viability analysis may help clarify the risks associated with objectives
5. Determine Amount & Configuration of Critical Habitat Required to Achieve Goal - Derive Proposed Critical Habitat
    - Determine if adequate information exists to identify critical habitat (with confidence)
    - Spatially explicit 'rules of thumb' or population modeling
    - Validate model

This schedule of studies for the identification of critical habitat will be used for each of the Endangered and Threatened mussels, fishes and reptiles found in the Ausable River in collaboration with the appropriate species-specific recovery teams. Note that many of the individual approaches within the species-specific sections will address some of the information requirements listed above.

Examples of activities likely to result in the destruction of critical habitat

Nonetheless, it is widely recognized that their critical habitats could be negatively affected by a variety of activities impacting the Ausable River watershed. Direct destruction of critical habitat could result from instream activities such as dredging, bridge and pipeline crossings or the construction of dams. Critical habitat could also be negatively affected by any land-based activities that affect water quality or quantity. Such activities would include (but are not limited to) the input of nutrients, sediment and toxic substances through improperly treated storm water, cultivation of riparian lands, unfettered access of livestock to the river, channelization and drainage works, water taking, aggregate extraction, and the release of improperly treated sewage. Species-specific examples of activities likely to result in the destruction of critical habitat are included for each Endangered and Threatened species in Appendix 1.

A) MUSSELS

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
MULTI-SPECIES					
URGENT	M1	VI	Research - Fish Hosts	Identify and/or confirm fish hosts for Ausable populations of mussel species at risk.	Confirmation of fish host species within the Ausable River.
	M2	VI & IV	Surveys - Host Fishes	Once the host fishes have been identified, determine their distribution and abundance.	Will help determine if host fish availability is a limiting factor for recovery of mussel species at risk.

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
URGENT	M3	II	Research – Critical Habitat Assessment	Conduct background and analytical research (and field surveys where necessary) for the identification of critical habitat.	Will enable the identification of critical habitat as per SARA.
NECESSARY	M4	V	Research - Population Supplementa-tions	Investigate the feasibility of population supplementations for the northern riffleshell, snuffbox and wavy-rayed lampmussel provided habitat conditions are not limiting.	May prevent extirpations due to small population sizes.
NECESSARY	M5	IV, V	Research – Conservation Genetics	Determine genetic variability and differentiation of mussel species at risk populations in the Ausable River and compare with genetic structure from other North American watersheds.	May help determine potential source populations for relocations and/or population augmentations.
NECESSARY	M6	IV	Research - Toxicity Testing	Conduct toxicity testing to evaluate the potential threats posed by various contaminants to early life stages of mussels.	Will help determine if toxic contaminants are a limiting factor for recovery of mussel species.
KIDNEYSHELL					
NECESSARY	M7	I, II	Background Surveys	Conduct further surveys to determine range, abundance and population demographics (particularly in the upstream reaches of the Ausable River in the vicinity of the Hay Swamp).	Will determine extent and health of existing population and contribute to the identification of critical habitat.
NORTHERN RIFFLESHELL					
URGENT	M8	IV, V	Research – Environmental Factors	Determine factors critical to the decline of the northern riffleshell in the Ausable River through comparative studies on environmental conditions in the Sydenham River where successful reproduction is occurring.	Will determine critical environmental requirements that must be met for recovery of the northern riffleshell to occur in the Ausable River.

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
URGENT	M9	I, II	Background Surveys	Conduct further surveys to determine extent and health (relict or reproducing) of existing population (e.g. reaches through the Hay Swamp and downstream of Nairn and downstream of the Arkona Gorge).	Will identify distribution, abundance and contribute to the identification of critical habitat.
SNUFFBOX					
URGENT	M10	IV, V	Research – Environmental Factors	Determine factors critical to the decline of the snuffbox in the Ausable River through comparative studies on environmental conditions in the Sydenham River where successful reproduction is occurring.	Will determine critical environmental requirements that must be met in order for recovery of the snuffbox to occur in the Ausable River.
URGENT	M11	I, II	Background Surveys	Conduct further surveys in suitable habitats downstream of the Arkona Gorge where a single live juvenile and several fresh shells were encountered in July 2003.	Will identify distribution, abundance and critical habitat of existing population in the lower river.
WAVY-RAYED LAMPMUSSEL					
URGENT	M12	I, II	Background Surveys	Conduct further surveys to determine extent and health (relict or reproducing) of existing population (e.g. areas in Hay Swamp, downstream of Nairn, and Little Ausable River).	Will identify distribution, density and contribute to the identification of critical habitat.
URGENT	M13	IV, V	Research – Environmental Factors	Determine factors critical to the decline of the wavy-rayed lampmussel in the Ausable through comparative studies on environmental conditions in watersheds with healthy populations (e.g. Grand River).	Will determine critical environmental requirements that must be met in order for recovery to occur in the Ausable River.

M1: Research - Fish Hosts - The synthesis report (Nelson *et al.* 2003) summarizes information on the fish hosts of the four mussel species at risk. Although fish hosts for the snuffbox and northern riffleshell have been identified in the nearby Sydenham River (McNichols and Mackie 2003), hosts for these same mussels may differ in the Ausable River. In fact, fish hosts of any given mussel species may be different in areas even within large drainages. As such, investigations into fish host relationships in the Ausable River are essential, but feasibility is limited for species with extremely low densities.

M3: Research: Critical Habitat Assessment – The distributions of all four Endangered mussels of the Ausable River are incompletely known. Once this information has been collected, it will be reconciled with population models and the species' biological needs to identify the critical habitat required to meet species survival and recovery. For more detailed information on this process, refer to the generalized 'Schedule of studies for the identification of critical habitat'.

M4: Research: Population Supplementations – If surveys indicate populations of wavy-rayed lampmussel, northern riffleshell and/or snuffbox are remnant populations in danger of local extirpation, the feasibility of population supplementations will be investigated. Population supplementation plans will depend on the availability of suitable habitat and knowledge of the complex host fish relationships (see M1) as well as the presence of the functional host fish. Plans will include a habitat assessment, consideration of the source populations (with respect to genetics and disease), preferred method of introduction (adult transfer versus hatchery-reared juveniles if applicable for some species) and goals and objectives for successful re-introduction and a monitoring strategy.

M5: Research - Conservation Genetics – Note: genetic investigations for several mussel species in the Ausable may not be possible due to extremely low densities.

M6: Research – Toxicity Testing - Research has shown that freshwater mussels can be particularly sensitive to some contaminants during their early life stages. Toxicity testing should be conducted to evaluate the potential threats of a suite of contaminants (e.g., metals, pesticides, chlorides, un-ionized ammonia, and nitrates).

M8, M10 and M13: Research – Environmental Factors - Research into the relationships between critical environmental factors and the decline of mussel species at risk should be investigated. Such research may be accomplished through comparative studies with nearby watersheds harboring healthier populations of identified species:

- Wavy-rayed Lampmussel: Comparative studies of environmental conditions (concentrations of suspended solids, phosphorus, etc.) between the Grand River, Maitland River (which support a relatively healthy population of the wavy-rayed lampmussel), and the Ausable River could help to determine environmental requirements of this species.

- Northern Riffleshell and Snuffbox: Determine critical factors for the decline of these species in the Ausable through comparative studies on environmental conditions in the Sydenham River where successful reproduction is occurring.

B) FISHES

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
THREATENED AND ENDANGERED FISHES					
URGENT	F1	II	Research – Critical Habitat Assessment	Conduct background and analytical research for the identification of critical habitats.	Will enable the identification of critical habitats for these species as per SARA.
URGENT	F2	IV	Research – Environmental Conditions	Investigate environmental conditions (including identified threats) potentially limiting the abundance and distribution of these species.	Will determine critical environmental requirements that must be met in order for recovery to occur in the Ausable River.
PUGNOSE SHINER AND LAKE CHUBSUCKER					
URGENT	F3	I & II	Background Surveys	Complete surveys in the Old Ausable Channel (OAC) to identify range, abundance, and population demographics.	Will determine extent and health of existing populations and contribute to the identification of critical habitat.
URGENT	F4	I,II & IV	Monitoring – OAC Fishes	Develop and implement specific sampling protocol in the OAC (inside and outside of Pinery Provincial Park).	Ongoing assessment of distribution, abundance and habitat of fishes in the OAC.
URGENT	F5	IV	Management – OAC Fish Community	Evaluate the impacts and feasibility of controlling predators and common carp in the OAC.	Will address principal threats in the OAC.
NECESSARY	F6	IV	Management – OAC Baitfishes	Evaluate the feasibility of prohibiting the use of live baitfishes in the OAC (inside and outside of Pinery Provincial Park).	Will help prevent the introduction of non-indigenous species that could negatively impact pugnose shiner and lake chubsucker.
EASTERN SAND DARTER					

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
URGENT	F7	I & II	Background Surveys	Identify potential suitable habitat patches in the main channel and sample sites using appropriate gear (seine or trawl). If eastern sand darter is found, develop and implement a monitoring program.	Will confirm presence/absence of eastern sand darter in the system.
URGENT	F8	II& III	Habitat Assessment	Evaluate the distribution, quantity and quality of sand habitats.	Will assist in the identification of critical habitat (for existing fishes or re-introduced individuals).
	F9	V	Re-introduction Plan	If suitable habitat is present and eastern sand darter is absent, develop a re-introduction plan.	Will set the stage for re-introduction of the eastern sand darter in the Ausable River.
BLACK REDHORSE					
URGENT	F10	I & II	Background Surveys	Sample fast water habitats (riffles and deeper runs) with electrofishing gear, focusing on the main branch of the Ausable and Little Ausable rivers.	Will identify species' distribution, abundance and assist in the identification of critical habitat.
	F11	II	Habitat Assessment	Evaluate the distribution, quantity and quality of fast water habitats.	Will assist in the identification of critical habitat (for existing fishes) or recovery habitat.
RIVER REDHORSE					
NECESSARY	F12	I & II	Background Surveys	Sample fast water habitats (riffles and deeper runs) with electrofishing gear. If found, develop and implement a monitoring program.	Will confirm presence/absence of river redhorse in the system and provide trend-through-time information.
BENEFICIA.	F13	V	Re-introduction Plan	If suitable habitat is present and river redhorse is absent, develop a re-introduction plan.	Will establish a reintroduction plan for river redhorse in the Ausable River.
GREENSIDE DARTER AND BIGMOUTH BUFFALO					

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
BENEFICIAL	F14	I & II	Monitoring	The range and abundance of these species should be monitored as part of routine surveys. Routine monitoring should also be used to look for additional species of *Ictiobus*.	Will provide trend-through-time information on distribution and status of populations.

F1: Research – Critical Habitat Assessment –The distributions of all four Threatened and Endangered fishes of the Ausable River are incompletely known. The best information is available for the lake chubsucker and pugnose shiner in the OAC, however, additional field work for even these species may be required. The eastern sand darter may be extirpated and the black redhorse was only recently discovered (2002). To identify critical habitat for these species in the Ausable River, it is necessary to determine current distribution and occupied and potential habitat patches via field studies. Once this information has been collected, it will be reconciled with population models and the species' biological needs to identify critical habitat required to meet species survival (maintain existing populations) and recovery (restore to historical locations). For more detailed information on this process, please refer to the generalized 'Schedule of studies for the identification of critical habitat'.

F3: Background Surveys – Surveys were conducted in the OAC within The Pinery Provincial Park by DFO in 2002 and throughout the OAC by DFO in 2004. Additional sampling may be required in some regions upstream and downstream of The Pinery Provincial Park to determine range extent and distribution in the OAC. This information will be used to define critical habitat for these species (in prep.) and form the basis of a long term monitoring program (F4).

F5: Management – Old Ausable Channel Fish Community – Fish surveys completed in 1983, 1997 and 2002 in the OAC suggest that the abundance and diversity of cyprinid species (including pugnose shiner) have decreased while the diversity and abundance of potential predators (mainly centrarchids) have increased. Further analysis and fieldwork is required to determine the impacts of predators on pugnose shiner and lake chubsucker populations in the OAC. Background surveys will assist with this assessment, and survey techniques employed in 1983 and 1997 (beach seining) should be replicated since this technique was not used in 2002. The feasibility of controlling predators will also be examined. Common carp are currently present in low abundance in the OAC and represent a threat to the clear, heavily-vegetated waters preferred by pugnose shiner and lake chubsucker. The abundance of common carp needs to be monitored and carp captured during surveys should be released downstream of the dam which maintains water levels in the OAC.

F6: Management - OAC Baitfishes – The OAC represents a unique habitat in southwestern Ontario and is home to several provincially significant species in addition to the pugnose shiner and lake chubsucker. Although much of the habitat in the OAC is protected through its presence in a Provincial Park, this ecosystem is particularly vulnerable to introductions of non-indigenous species. The use of live baitfish poses a high risk of introducing additional species.

F9 & F13: Reintroduction Plan - The eastern sand darter and river redhorse have not been observed in the Ausable River since the 1920s and 1930s respectively. Prior to developing plans to repatriate these species, it is necessary to confirm through intensive sampling that they are no longer present. If these species are extirpated, then reintroduction plans will be developed. If these species are present, population supplementation plans should be developed. Population supplementation and reintroduction plans will depend on the availability of a sufficient quantity of suitable habitat. Plans will include a habitat assessment, consideration of source populations (with respect to genetics and disease), preferred method of introduction (adult transfer versus hatchery-reared), goals and objectives for successful reintroduction and a monitoring strategy.

F10, F11 and F12: Background Surveys and Habitat Assessment - Surveys will help define the distribution of the black redhorse, which is currently known from only two sites, and confirm the presence/absence of the river redhorse. Survey design will include the development and implementation of a black redhorse and river redhorse monitoring program as a component of the overall species at risk monitoring program (see A5, Overall Approaches).

F14: Monitoring: Routine monitoring surveys should extend to greenside darter, bigmouth buffalo (both Species of Concern) and species of the *Ictiobus* genus. In August 2002, five *Ictiobus* specimens collected in the lower end of the Ausable River near the confluence of the OAC and the Cut were tentatively identified as smallmouth buffalo (*Ictiobus bubalus*). *I. bubalus* has not been reported in Canada before. The significance of this finding is that smallmouth buffalo can be confused with black buffalo (*Ictiobus niger*) which is a species of Special Concern. Experts and DNA analysis will base confirmation on examination of specimens.

C) REPTILES

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
EASTERN SPINY SOFTSHELL TURTLE (ESSS) & QUEEN SNAKE (QUSN)					
URGENT	R1	I, II	Background Surveys	Conduct surveys throughout the Ausable River to determine current distribution, range, abundance, and population demographics.	Will determine extent and health of existing populations and contribute to the identification of critical habitat.
URGENT	R2	I, II & III	Monitoring	Conduct routine, long-term, standardized surveys in the main channel and tributaries to monitor distribution, range, abundance and population demographics.	Will determine extent and general health of existing populations, infer populations trends and contribute to the identification of critical habitat.
URGENT	R3	II	Research – Critical Habitat Assessment	Conduct background & analytical research and field surveys where necessary for the identification of critical habitat in conjunction with species-specific recovery teams.	Will enable the identification of critical habitat as per SARA and help narrow the search for other potential populations/ subpopulations.
URGENT	R4	II	Research – Environmental Conditions	Investigate environmental conditions (including identified threats) potentially limiting the abundance and distribution of these species.	Will determine critical environmental requirements that must be met in order for recovery to occur in the Ausable River.

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
URGENT	R5	I, II, III, IV, V	Mapping - Critical Habitat Features	Quantitative assessment and mapping of reptile SAR critical habitat features. Development of spatial characteristics for reptile habitats, general models and hypotheses to predict presence and absence of species, population trends and population interactions within the Watershed (to be conducted in collaboration with the two species specific recovery teams).	Will provide the knowledge necessary to plan and implement effective conservation actions.
URGENT	R6	IV	Surveys - Crayfish	Determine species abundance, demographics, and distribution.	Will help determine the health and abundance of principal prey species for eastern spiny softshell and queen snake.
NECESSARY	R7	IV	Identification & Protection - Areas of Concentration (Individuals)	Conduct field work to identify nesting and communal hibernation sites (using radio telemetry where appropriate) and communal basking sites, and ensure these areas are protected.	Will assist with census, increase recruitment rates, overwintering success and help prevent mass declines due to stochastic events in areas of concentration.
BENEFICIAL	R8	IV	Research – Crayfish Tolerance Thresholds	Determine if crayfish distribution and/or abundance appear to be limiting factors for ESSS and QUSN. If crayfishes are limiting factors for SAR, investigate factors affecting crayfishes.	Will further identify and clarify indirect threats to these SAR reptiles.

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
BENEFICIAL	R9	IV	Surveys & Awareness - Traffic Mortality	Determine if road mortality is a significant threat in the vicinity of the Ausable River. If so, increase public awareness and mitigate impacts.	Will increase awareness and reduce threats relating to the potentially decimating impacts of road mortality on these populations.
BENEFICIAL	R10	IV	Research - Disease	Work with appropriate species-specific recovery teams and wildlife health organizations to establish a protocol for disease diagnosis and monitoring through the submission of recovered carcasses.	Will increase understanding of the health and ecology of these species.
BENEFICIAL	R11	V	Research – Headstarting and Population Supplementa-tion	Investigate the feasibility of headstarting (ESSS) and supplementing (QUSN) if populations are found to be remnant populations.	Augmentation of remnant populations may prevent extirpations.
BENEFICIAL	R12	IV & V	Research – Conservation Genetics	Determine genetic variability/ relatedness of SAR reptile subpopulations/ populations in the Ausable River and compare with the genetic structure of other local watersheds.	Will identify barriers preventing genetic flow between isolated local populations. Will help determine critical habitat, population/ meta-population structure, source populations for augmentations.
NECESSARY	R13	VII	Recovery Team Coordination	Work cooperatively with the eastern spiny softshell and queen snake recovery teams to ensure their expertise is incorporated and that priority actions and research needs are addressed.	Will coordinate efforts and pool recovery team resources.
EASTERN SPINY SOFTSHELL					

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
URGENT	R14	I, II, & III	Background Surveys & Habitat Assessment	Conduct surveys to determine range, abundance, and population demographics. Surveys to be focused in and around soft-bottomed aquatic habitats with deep pools, an abundance of prey species such as crayfish, and with open sandy nesting areas. The distribution, quality and quantity of these habitat features will be evaluated.	Will determine extent and health of existing population and help identify critical habitat.
NECESSARY	R15	IV	Management – Predators	Conduct field work to identify nest locations and protect nests from predation.	Will help increase hatching success and contribute to higher population recruitment rates.
NECESSARY	R16	IV	Awareness & Enforcement – Poaching	PIT tag the commercially desirable spiny softshell.	Will allow individuals to be identified in the case of a poaching event and will assist with the enforcement of wildlife regulations while providing a deterrent.
NECESSARY	R17	IV	Research - Contaminant Analysis	Contaminant analysis of 'dead eggs' and incidental monitoring of juvenile deformities during routine field surveys.	Will help determine if contaminants are a limiting factor for reptile SAR.
QUEEN SNAKE					

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
URGENT	R18	I, II, & III	Background Surveys & Habitat Assessment	Conduct surveys to determine range, abundance, and population demographics. Surveys to be focused in and around rocky or gravel bottomed riverine habitat where crayfish are abundant and where banks with rock outcrops and/or vegetation (especially low shrubs) are present. The distribution, quality and quantity of these habitat features will be evaluated.	Will determine extent and health of existing population and help identify critical habitat.
NECESSARY	R19	II	Surveys – Travel Corridors	Conduct surveys to ensure travel corridors exist along streams where snake occurrences are concentrated.	Will help ensure critical habitat needs are met.
NECESSARY	R20	IV	Revegetation of riparian zones	R18 will determine the quality and quantity of habitat features required by the queen snake, including low riparian shrubs for basking. If this feature is found to be lacking, revegetation of riparian zones will occur.	Will help ensure critical habitat needs are met.
BENEFICIAL	R21	IV	Awareness - Public	Educate the public about the harmless nature of most snakes and their valuable role in nature (public education; especially at the elementary school level)	Will contribute to a decrease in intentional killings of all snakes and foster a sense of stewardship by promoting cultural shifts in attitudes.
NORTHERN MAP TURTLE					

Priority	Number	Objective Addressed	Broad Approach/ Strategy	Specific Steps	Anticipated Effect
BENEFICIAL	R22	I, II, & III	Background Surveys & Habitat Assessment	Conduct surveys to determine range, abundance, and population demographics. Surveys to be focused in and around slow moving riverine habitat with muddy substrate, deep areas with submerged logs or soft substrate for hibernation, abundant aquatic vegetation, and open sandy nesting and basking areas close to shore and offshore. The distribution, quality and quantity of these habitat features should be evaluated.	Will determine extent and health of existing population.
BENEFICIAL	R23	IV	Management – Predators	Conduct field work to identify nest locations and protect nests from predation.	Will help increase hatching success and contribute to higher population recruitment rates.
BENEFICIAL	R24	IV	Identification & Protection - Areas of Concentration (Individuals)	Conduct field work to identify nesting and communal hibernation sites (radio telemetry) and ensure these areas are protected.	Will increase recruitment rates and overwintering success.

R1: Background Surveys – Reported occurrences of the eastern spiny softshell turtle and queen snake in the Ausable River basin have been confined to the Lower Ausable. This is thought to be an artifact of survey effort rather than a true distribution indication. Survey work for reptiles in the southern portion of the Ausable River basin has been limited. Recently, the Natural Heritage Information Center conducted combined surveys for odonates and reptiles, but neither spiny softshells nor queen snakes were reported. A more rigorous, basin-wide survey for both of these species is required using species-specific methods. Queen snakes are cryptic animals. Surveys require searches beneath flat rocks and debris while walking the shorelines. Searching riparian vegetation close to the waters edge is also needed, primarily in small shrubs in sunny

locations where queen snakes commonly bask (K. Vlasman, pers. obs.). Spiny softshells have been successfully surveyed by canoe in navigable waterways a technique that could be used in the lower regions of the river from Port Franks up to the Arkona Gorge. Surveys for spiny softshells should be conducted during prime basking periods in May and June.

R3: Research – Critical Habitat Assessment –The distributions of the two Threatened reptile species inhabiting the Ausable River basin are incompletely known. Reported occurrences of queen snakes and eastern spiny softshells have been confined to the Lower Ausable and additional field work is required throughout the basin in areas of suitable habitat (R1). As part of a habitat assessment, quantitative analyses should be conducted in the headwaters, main channel and tributaries of the Ausable River. To identify their critical habitat, it is necessary to identify current distribution as well as potential habitat patches. This information will be reconciled with population models and species' biological needs to identify critical habitat required to meet species survival and recovery. For more detailed information on this process, please refer to the generalized 'Schedule of studies for the identification of critical habitat'.

R6: Surveys - Crayfish – Little is known about the distribution and demographics of crayfish across the Ausable River basin. This necessitates targeted surveys, as crayfish figure prominently in the diets of reptile SAR inhabiting this locality. Queen snakes are specialist feeders, with the mainstay of their diet being crayfish (98% of their diet). Crayfish are also the most common prey item of the eastern spiny softshell. Biotic and abiotic habitat features influencing their distribution and numbers should also be determined and mapped.

R7, R24: Identification and Protection – Areas of Concentration (Individuals) – Shared or communal areas are features that make small populations particularly vulnerable to stochastic events due to the sheer concentration of individuals at a given location over a given time period. Many reptiles hibernate communally, returning to the same site each year. Both softshells and queen snakes tend to hibernate in large numbers, therefore these populations are vulnerable at this time. There is currently little understanding of the constraints on overwintering success or the precise requirements for hibernation (Seburn and Seburn 2000); therefore, it is important to identify and safeguard these areas. Lack of optimal hibernation sites may limit many species. Land and water access to critical sites in which turtles are at risk of disturbance or injury should be restricted. Census may be facilitated by emergence from communal hibernacula. Map turtles are Special Concern but share this threat (R24). They bask communally and hatchlings may overwinter in the nest (CARCNET 2003).

R8: Research – Crayfish Tolerance Thresholds - Despite presumptions that crayfish are tolerant to episodic perturbations to habitat quality, a paucity of information exists on the effects of sedimentation and turbidity on crayfish in the scientific literature (Henley *et al.* 2000). It is well known, however, that there has been a general decline in crayfish numbers and that they have been eliminated from many areas due to runoff and siltation. Similarly, Wagener and LaPerriere (1985) found increased turbidity to be the

strongest determinant of declines in invertebrate density and biomass (Henley et al 2000). The Ausable River has a tendency to carry a heavy load of silt and clay due to the clay soils in the basin and intense flows associated with snow melt and summer rain events, therefore, crayfish declines may be occurring. Crayfish also accumulate mercury (Seburn and Seburn 2000), which may have an impact on their predators, particularly queen snakes. Determination of crayfish tolerance thresholds to potential limiting factors including sedimentation, nutrient enhancement, commonly used contaminants/ pesticides found in the Ausable (e.g. atrazine, des-ethyl atrazine, pesticides), thermal changes (due to loss of riparian habitat, damming), effluent from WTPs etc. may help clarify potential indirect factors limiting the distribution of these reptile SAR in the Ausable River system.

R9: Surveys & Awareness – Traffic mortality – Road/ roadside surveys during peak basking, nesting and activity times will determine the significance of this threat for populations in the Ausable basin. Such surveys offer a unique opportunity for community involvement and an added research opportunity to collect genetic information. Public awareness through signage, public education and newspaper articles run just prior to the peak in nesting and activity season are potential mitigation approaches as is the implementation of roadside barriers near nesting areas.

R10: Research – Disease – Disease has been implicated as a significant threat to both reptile and amphibian populations and is thought to be a factor contributing to reptile declines on a global scale (Gibbons *et al.* 2000; Goater and Goater 2001). Reptiles are subject to a range of diseases and parasites, including respiratory tract, circulatory, intestinal diseases, and shell diseases - the later of which has specifically been implicated in turtle declines (Gibbons *et al.* 2000). Exposure to contaminants and other environmental stressors can lead to increased disease susceptibility, emphasizing the potential of interactive or synergistic threats to reptile SAR in the Ausable River. A disease monitoring protocol, in conjunction with routine population monitoring, will track outbreaks and occurrences of diseases. Carcass submissions will link into R2 and R9.

R11: Research: Headstarting/ Population Supplementations – If background surveys indicate populations of reptile SAR are indeed remnant populations in danger of local extirpation, headstarting (for ESSS) or population supplementation (for QUSN) plans will be developed provided suitable habitat opportunities exist. Reintroductions will not occur until threats and habitat limitations have been addressed. Headstarting programs will increase turtle hatching success by reducing the number of eggs that fall prey to predators. Captive breeding of softshells is commonplace in Asia for the food trade, and the first headstarting program for the eastern spiny softshell subspecies in Canada is currently underway (S. Gillingwater, pers. comm.). Almost all queen snake headstarting attempts have ended in failure due to this species' susceptibility to skin infections, difficulty in maintaining an adequate supply of freshly molted crayfish and the difficulty in getting it to feed in captivity (S. Gillingwater, pers. comm.). Therefore, propagation of the queen snake in captivity is not a viable option and supplementation efforts as a means of population augmentation would need to be investigated.

R15: Management – Predators – There has been limited success with protecting turtle nests from predation by sweeping the soil at nesting areas after turtles have laid their eggs. Protection can be enhanced through the construction of physical barriers to predators (i.e. fencing/cages around nests). Predation of eggs can be a significant threat to a rare species. In areas of high numbers of nest predators, nesting success may be reduced to near zero. A potentially exacerbating situation in rural areas is related to the speculation that conservation no-till practices may be increasing predator populations (i.e. raccoons) to the detriment of turtle populations (predator control may be a consideration in this case).

R16: Awareness & Enforcement – Poaching – Spiny softshells should be PIT tagged. This reptile species may be particularly at risk of poaching due to both the pet trade and the expanding international trade in softshells for human consumption in Asian markets (Seburn and Seburn 2000). Due to increasing market demand, populations on the Ausable have the potential to be targeted at an unsustainable rate. This species is long-lived, takes years to reach maturity and is therefore slow to reproduce. Therefore, lack of population recruitment can go unnoticed for many years. Even the occasional removal of turtles can eliminate populations. The current threat of poaching for reptile SAR in the Ausable River is not known. The demand for map turtles is not known and the demand for queen snakes is low due to the difficulty in getting them to feed.

R17: Research – Contaminant Analysis - Pesticides are a potential threat to species at risk in the Ausable River. Female reptiles secrete many contaminants into their eggs, therefore there exists an opportunity to quantify the threat of contaminants to reptile SAR in the Ausable through recording and monitoring incidences of deformities in turtles and through contaminant analysis of ‘dead eggs’. Although non-organochloride pesticides break down quickly and cannot be analyzed from dead eggs, contaminant analysis of dead eggs is relatively reliable for metals and organochlorines such as PCBs, DDD, and dioxins.

R22: Background Surveys & Habitat Assessment - Map turtles were found at several locations in the Ausable River during the 2003 Odonata and Reptile survey (Jones 2004). Historical records for the northern map turtle are known only from the Rock Glen Conservation Area and Hungry Hollow. Both areas tend to be rocky with riffles and it is likely that additional populations occur in downstream reaches where more suitable habitats exist (deeper reaches, slower current and muddier substrate). Similarly, lower gradient regions upstream of the Arkona Gorge should be targeted for surveys.

References

Ausable River Recovery Team (ARRT). 2003. Species at risk in the Ausable River watershed. Draft report. Department of Fisheries and Oceans: Burlington, ON.

Ausable Bayfield Conservation Authority (ABCA). 1991. Dam inventory and reservoir assessment. Ausable Bayfield Conservation Authority: Exeter, ON.

Beaulieu, G. 1961. Fécondité de quelques espèces de poissons de la province de Québec. Actualités marines 5 (2): 22-27.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison. pp. 1052.

Berrill, M., L. Hollett, A. Margosian and J. Hudson. 1985. Variation in tolerance to low environmental pH by the crayfish *Orconectes rusticus, O. propinquus* and *Cambarus robustus*. Canadian Journal of Zoology 63: 2586-2589.

Boersma, P. D., P. Kareiva, W. F. Fagan, J. A. Clark, and J.M Hoekstra. 2001. How good are endangered species recovery plans? Bioscience 51: 643-649.

Branchaud, A. and A. Gendron. 1993. Artificial spawning and rearing of the copper redhorse, *Moxostoma hubbsi* (Teleostei: Catostomidae). Can. Field-Nat. 107: 279-282.

Branson, B.A. and E.C. Baker. 1974. An ecological study of the queen snake, *Regina septemvittata* (Say) in Kentucky. Tulane Studies in Zoology and Botany 18: 153-171.

Campbell, B. G. 2001. A study of the river redhorse, *Moxostoma carinatum* (Pisces; catostomidae), in the tributaries of the Ottawa River, near Canada's National Capital and in a tributary of Lake Ontario, the Grand River, near Cayuga, Ontario. M. Sc. Thesis, University of Ottawa, Ottawa, Ontario. 137 p.

Campbell, C.A. 1977. The range, ecology and status of the queen snake (*Regina septemvittata*) in Canada. Unpublished manuscript, KIZ10-6-5293 for the Canadian Wildlife Service.

Campbell, C.A. and D.W. Perrin. 1979. A survey of queen snake (*Regina septemvittata*) in southwestern Ontario. Wildlife Branch, Ontario Ministry of Natural Resources.

Canadian Amphibian and Reptile Conservation Network (CARCNET). 2003. *Graptemys geographica.* Map Turtle. Tortue géographique. www.carcnet.ca

Canadian Council of Ministers of the Environment. 2003. Summary Table of Canadian water quality guidelines for the protection of aquatic life. Available: http://www.ccme.ca/assets/pdf/e1_062.pdf [Accessed: June 03, 2005].

Clarke, A. H. 1981. The freshwater mollusks of Canada. National Museums of Canada: Ottawa, ON.

Cook, F.R. 1970. Rare or endangered Canadian amphibians and reptiles. The Canadian Field Naturalist 84: 9-16.

Cummings, K. S., and C. A. Mayer. 1992. Field Guide to Freshwater Mussels of the Midwest. Illinois Natural History Survey Manual 5.

Dalton, K.W. 1991. Status of the greenside darter, *Etheostoma blennioides*, in Canada. Canadian Field-Naturalist 105: 173-178.

Daniels, R. A. 1993. Habitat of the eastern sand darter, *Ammocrypta pellucida*. Journal of Freshwater Ecology 8(4):287-295.

Dextrase, A. J., S. K Staton, and J. L. Metcalfe-Smith. 2003. Recovery Strategy for Species at Risk in the Sydenham River: an Ecosystem Approach. National Recovery Plan No. 25. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario. 73pp.

Dolmage, E. 2003. Ausable River Recovery Strategy. Background Report: Fluvial Geomorphology. Ausable-Bayfield Conservation Authority. Exeter, ON.

Dolmage, E. and M. Nelson. 2003. Ausable River Recovery Strategy. Background Report: Land use. Ausable-Bayfield Conservation Authority. Exeter, ON.

Eberts, R.C., Jr., Santucci, V.J., Jr. and D.H. Wahl. 1998. Suitability of the lake chubsucker as prey for largemouth bass in small impoundments. North American Journal of Fisheries Management 18(2): 295-307.

Environment Canada. 2003a. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Nitrate Ion. Ecosystem Health: Science-based Solutions Report No. 1-6. National Guidelines and Standards Office, Water Policy and Coordination Directorate, Environment Canada. 130 pp.

Environment Canada. 2003b. Preliminary draft technical guidance for the identification of critical habitat under SARA. Environment Canada. Ottawa, ON.

Facey, D. E. 1998. The status of the eastern sand darter, *Ammocrypta pellucida*, in Vermont. Canadian Field-Naturalist 112:596-601.

Fletcher, M. 1996. Management of softshell turtle habitat, year 1, 1996. Upper Thames River Conservation Authority: London, ON.

Fletcher, M., M.J. Oldham and M.E. Obbard. 1997. National Recovery Plan for the Eastern Spiny Softshell Turtle (*Apalone spinifera spinifera*) in Canada. Draft recovery plan prepared for RENEW.

Froom, B. 1972. The snakes of Canada. McClelland and Stewart Ltd.: Toronto, ON

Gartshore, M.E. and P. J. Carson. 1990. Queen Snakes and Spiny Softshell Turtles on the Thames River, Aylmer District. Report for the Ontario Ministry of Natural Resources.

Gibbons, J. Whitfield**,** D. E. Scott, T. J. Ryan, *et al.* 2000. The Global Decline of Reptiles, Deja Vu Amphibians. Bioscience 50: 653-666.

Gillingwater, S.D. 2003. DRAFT National Recovery Strategy for the Queen Snake *Regina septemvittata*. Recovery of Nationally Endangered Wildlife. Draft Report.

Goater, T.M. and C.P. Goater. 2001. Ecological monitoring and assessment network protocols for measuring biodiversity: Parasites of amphibians and reptiles. EMAN. http://www.eman-rese.ca/eman/ecotools/protocols/terrestrial/herp_parasites/intro.html [Accessed March 16, 2005]

Goodchild, C. D. 1990. Status of the bigmouth buffalo, *Ictiobus cyprinellus*, in Canada. The Canadian Field-Naturalist 104: 87-97.

Gordon, M.E. and J.B. Layzer. 1989. Mussels (Bivalvia: Unionoidae) of the Cumberland River: review of life histories and ecological relationships. Biological Report 89(15). U.S. Department of the Interior, Fish and Wildlife Service: Washington, D.C.

Graham, T.E. and A.A. Graham. 1992. Metabolism and behavior of wintering common map turtles, *Graptemys geographica*, in Vermont. Canadian Field-Naturalist 106: 517-519.

Graham, T.E. and A.A. Graham. 1997. Ecology of the Eastern Spiny Softshell, Apalone spinifera spinifera, in the Lamoille River, Vermont. Chelonian Conservation and Biology 2(3): 363-369.

Hanlon, S.D. 2000. A Comparison of Reintroduction Techniques for Recovery of Freshwater Mussels. M.Sc. Thesis. Virginia Polytechnic Institute and State University. Blacksburg, Virginia

Harding, J.H. 1997. Common map turtle. Pp. 206-210 *in* Amphibians and Reptiles of the Great Lakes Region. The University of Michigan Press: Ann Arbor, MI.

Henley, W.F., M.A. Patterson, R.J. Neves and A.D. Lemly, 2000. Effects of Sedimentation and Turbidity on Lotic Food Webs: A Concise Review for Natural Resource Managers. Reviews in Fisheries Science, 8: 125-139.

Holm, E., and D. Boehm. 1998. Sampling for fishes at risk in southwestern Ontario, 1997. Unpublished report prepared by the Centre for Biodiversity and Conservation Biology, Royal Ontario Museum for the Ontario Ministry of Natural Resources Southcentral Region and Aylmer District.

Holm, E., and N. E. Mandrak. 1994. Status report on the eastern sand darter Ammocrypta pellucida in Canada. COSEWIC Status Report.

Holm, E. and N.E. Mandrak. 2002. Update COSEWIC status report on pugnose shiner *Notropis anogenus*. Update status report prepared for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Hubbs, C.L. and D.E.S. Brown. 1929. Material for a distributional study of Ontario fishes. Transactions of the Royal Canadian Institute 17.

Jacobsen, P.J., R.J. Neves, D.S. Cherry, and J.L. Farris. 1997. Sensitivity of glochidial stages of freshwater mussels (Bivalvia: Unionoidea) to copper. Environmental Toxicology and Chemistry 16: 2384-2392.

Jenkins, R. E., and N. M. Burkhead. 1993. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland. 1079 p.

Jones, C.D. 2004. NHIC Coordinates Odonata and Reptile Surveys on Sydenham and Ausable Rivers. *In* Natural Heritage Information Centre. Science and Information Newsletter. 9 (1): 10-11.

Judd, W.W. 1962. Queen Snakes on the Ausable River at Arkona, Ontario. The Cardinal Flight #41 (January 1962).

Kerr, S.J. 1995. Silt, turbidity and suspended sediments in the aquatic environment: an annotated bibliography and literature review. Ontario Ministry of Natural Resources, Southern Region Science and Technology Transfer Unit Technical Report TR-008.

Krishka, B. A., R. F. Cholmondeley, A. J. Dextrase, and P. J. Colby. 1996. Impacts of introductions and removals on Ontario percid communities. Percid Community Synthesis. Ontario Ministry of Natural Resources. Peterborough, Ontario. 111 p.

Lamond, W.G. 1994. The Reptiles and Amphibians of the Hamilton Area. *The* Hamilton Herpetofaunal Atlas. Hamilton Naturalists' Club. p. 121-124.

Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister and J.R. Stauffer, Jr. 1980. Atlas of North American freshwater fishes. North Carolina Biological Survey Publication 1980-12. North Carolina State Museum of Natural History. Chapel Hill. 867 pp.

MacCulloch, R.D. 2002. The ROM Field Guide to Amphibians and Reptiles. MacClelland and Stewart Ltd., Toronto. pp. 168.

Mandrak, N.E. and E.J. Crossman. 1996. The status of the lake chubsucker, *Erimyzon sucetta*, in Canada. Canadian Field-Naturalist 110: 478-482.

McAllister, D.E., B.J. Parker, and P.M. McKee. 1985. Rare, endangered and extinct fishes in Canada. National Museum of Natural Sciences. Syllogeus 54.

McCoy, C.J. 1982. Amphibians and reptiles in Pennsylvania. Carnegie Museum of Natural History Special Publication Number 6.

McNichols, K. and G. Mackie. 2003. ESRF 2002-2003 Final Report. Fish Host Determination of Endangered Freshwater Mussels in the Sydenham River Ontario, Canada. Department of Zoology, University of Guelph: Guelph, ON.

Metcalfe-Smith, J.L. and D.J. McGoldrick. 2003. An update on the status of the Wavy Rayed Lampmussel (*Lampsilis fasciola*) in Ontario waters. Environment Canada, National Water Research Institute, Burlington, ON. NWRI Contribution No. 03-003.

Metcalfe-Smith, J.L., D.J. McGoldrick, M. Williams, D.W. Schloesser, J. Biberhofer, G.L. Mackie, M.T. Arts, D.T. Zanatta, K. Johnson, P. Marangelo and T.D. Spencer. 2004. Status of a refuge for native freshwater mussels (Unionidae) from the impacts of the exotic zebra mussel (*Dreissena polymorpha*) in the delta area of Lake St. Clair. Environment Canada, National Water Research Institute, Burlington, Ontario. Technical Note No. AEI-TN-04-001.

Metcalfe-Smith, J.L., S.K. Staton and E.L. West. 1998. COSEWIC status report on the Wavy-Rayed Lampmussel, *Lampsilis fasciola* (Rafinesque, 1820). Prepared for the Committee on the Status of Endangered Wildlife in Canada.

Metcalfe-Smith, J.L., S.K. Staton, and E.L. West. 2000. Status of the Wavy-rayed Lampmussel, *Lampsilis fasciola* (Bivalvia: Unionidae), in Ontario and Canada. Canadian Field-Naturalist 114: 457-470.

Metcalfe-Smith, J.L. and D.T. Zanatta. 2002. COSEWIC Status Report on the Kidneyshell, *Ptychobranchus fasciolaris* (Rafinesque, 1820). Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Report.

Meyer, J.L. L.A. Kaplan, D. Newbold, D.L. Strayer, C.J. Woltemade, J.B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlitsch, M.C. Watzin, P.H. Zedler. 2003. Where Rivers Are Born: The Scientific Imperative for Defending Small Streams and Wetlands. Sierra Club Foundation, American Rivers. Available online: http://amr.convio.net/site/DocServer/WhereRiversAreBorn1.pdf?docID=182 [Accessed March 16, 2005]

Mongeau, J-R., P. Dumont., et L. Cloutier. 1992. La biologie du suceur cuivré (*Moxostoma hubbsi*) comparée à celle de quatre autres espèces de *Moxostoma* (*M. anisurum*, *M. carinatum*, *M. macrolepidotum* et *M. valenciennesi*). Canadian Journal of Zoology 70: 1354-1363.

Monk, K. 2002. Table of best management practices and incentive grants for agriculture. Ausable Bayfield Conservation Authority. Exeter, ON.

National Recovery Working Group. 2004. Recovery Handbook. February 2004. Working Draft. Recovery of Nationally Endangered Wildlife, Ottawa, Ontario. 36pp. plus appendices.

NatureServe Explorer: An online encyclopedia of life [web application]. 2003. Version 1.6. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer [Accessed March 16, 2005]

Nelson M., M. Veliz, S. Staton, E. Dolmage. 2003. Towards a Recovery Strategy for Species at Risk in the Ausable River: Synthesis of Background Information. Report prepared for the Ausable River Recovery Team. Ausable-Bayfield Conservation Authority. Exeter, ON.

Obbard, M. E. 1991. Status report on the eastern spiny softshell turtle, *Apalone spinifera*, in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Report.

Oldham, M. J. 1988. Ontario Herpetofaunal Summary 1985. World Wildlife Fund, Essex Region Conservation Authority and Ministry of Natural Resources.

Oldham, M. J. and D. A. Sutherland. 1986. Ontario Herpetofaunal Summary 1984. Essex Region Conservation Authority and World Wildlife Fund Canada.

Oldham, M. J. and W. F. Weller. 1989. Ontario Herpetofaunal Summary 1986. Ontario Field Naturalists.

Ontario Ministry of Agriculture and Food. 2005. Environmental Management. Available online at: http://www.gov.on.ca/OMAFRA/english/environment/ [Assessed June 5, 2005].

Ontario Ministry of Natural Resources (OMNR). 2003. Wetland Drain Restoration Project "How to Guide": Enhancing water storage and water quality within a watershed through wetland restoration. Available online at: http://www.conservation-ontario.on.ca/projects/watershed_reports/water_storage/WaterStorageReport2003.pdf [Accessed March 16, 2005].

Ontario Ministry of Natural Resources (OMNR). 1989. Manual of instructions: aquatic habitat inventory surveys. Fisheries Branch, Ontario Ministry of Natural Resources. Queen's Printer for Ontario, Toronto, Ontario. 248 pp.

Ontario Ministry of the Environment and Energy. 1994. Water Management – Policies, Guidelines, Provincial Water Quality Objectives o the Ministry of the Environment and Energy, July 1994. Ontario Ministry of the Environment and Energy: Toronto, ON.

Ortmann, A.E. 1919. A monograph of the naiades of Pennsylvania, Part III. Systematic account of the genera and species. Memoirs of the Carnegie Museum, Vol. VIII, No. 1. Carnegie Institute: Pittsburgh, PA.

Page, L. M., and B. M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston, MA, 432 p.

PARC Partners in Amphibian and Reptile Conservation. 2004. http://www.parcplace.org/documents/GeneralHerpInfo/reptile_decline1.htm [Accessed Jan. 2004]

Parker, B. 1989. Status of the black redhorse, *Moxostoma duquesnei*, in Canada. Canadian Field-Naturalist. 103: 175-179.

Parker, B. 1988. Updated status of the river redhorse, *Moxostoma carinatum*, in Canada. Canadian Field-Naturalist. 102: 140-146.

Parker, B., P. McKee and R.R. Campbell. 1987. Status of the pugnose shiner, *Notropis anogenus*, in Canada. Canadian Field-Naturalist 101: 203-207.

Plummer, M.V. and H.W. Shirer. 1975. Movement Patterns in a River Population of the Softshell Turtle, Trionyx muticus. Occasional Paper No. 43, Museum of Natural History, University of Kansas, Lawrence. 26 pp.

Pluto, T.G. and E.D. Bellis. 1988. Seasonal and annual movements of riverine map turtles, *Graptemys geographica*. Journal of Herpetology 22: 152-158.

Portt, C., C. Coker, and K. Barret. 2003. Recovery strategy for fish species at risk in the Grand River, Ontario. Draft report submitted to RENEW.

Raney, E.C. and R. M. Roecker. 1947. Food and growth of two species of watersnakes from western New York. Copeia 3:171-174.

Ricciardi, A., R.J. Neves and J.B. Rasmussen. 1998. Impending extinctions of North American freshwater mussels (Unionoida) following the zebra mussel (*Dreissena polymorpha*) invasion. Journal of Animal Ecology. 67: 613-619.

Richards, R.P., 1990. Measures of flow variability and a new flow-based classification of Great Lakes tributaries. Journal of Great Lakes Research 16: 53-70.

Richter, B.D., D.P. Braun, M.A. Mendelson and L.L. Master. 1997. Threats to imperilled freshwater fauna. Conservation Biology. 11: 1081-1093.

Reid, S.M. 2003. Trent-Severn Waterway river redhorse and channel darter research (SARRF02-70), 2002 (Final Report). Prepared for the Trent-Severn Waterway.

Roche, B. 1999. Status Report on the Northern Map Turtle, *Graptemys geographica*. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Report.

Roche, B. 2002. COSEWIC status report on the northern map turtle *Graptemys geographica* in Canada, *in* COSEWIC assessment and status report on the northern map turtle *Graptemys geographica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1 – 34 pp.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184, Fisheries Research Board of Canada. 966 pages.

Seburn, D. and C. Seburn. 2000. Conservation priorities for the amphibians and reptiles of Canada. World Wildlife Fund Canada and the Canadian Amphibian and Reptile Conservation Network. Available online at: www.wwfcanada.org.

Serrouya, R., A. Ricciardi and F. Whoriskey. 1995. Predation on zebra mussels (*Dreissena polymorpha*) by captive-reared map turtles (*Graptemys geographica*). Candian Journal of Zoology 73: 2238-2243.

Smith, K. 1999. COSEWIC status report on the queen snake *Regina septemvittata* in Canada, in COSEWIC assessment and status report on the queen snake *Regina septemvittata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-28 pp.

Spurr, R.H. 1978. The queen of Hungry Hollow. Ontario Fish and Wildlife Review 17: 9-10.

Spurr, R.H. and D.C. Smith. 1979. Sightings of Queen Snakes (*Regina septemvittata*) along the Ausable River near Arkona, Ontario. Unpublished report. Privately distributed. Mimeograph. 10 p.

Stansbery, D. H., K.G. Borror, and K.E. Newman. 1982. Biological abstracts of selected species of unionid mollusks recovered from Ohio. Unpublished manuscript, prepared for the Ohio Heritage Foundation. Ohio Department of Natural Resources. 140 pp.

Staton, S.K., A. Dextrase, J.L. Metcalfe-Smith, J. Di Maio, M. Nelson, J. Parish, B. Kilgour, and E. Holm. 2003. Status and Trends of Ontario's Sydenham River Ecosystem in Relation to Aquatic Species at Risk. Ecological Monitoring and Assessment (in press).

Staton, S.K. and Doolittle, A. 2003. Sydenham River Riparian Inventory. Annual report to the Interdepartmental Recovery Fund (July 2003). Department of Fisheries and Oceans, Burlington, ON.

Staton, S.K., J.L. Metcalfe-Smith, and E.L. West. 2000. Status of the Northern Riffleshell, *Epioblamsa torulosa rangiana* (Bivalvia: Unionidae), in Ontario and Canada. Canadian Field-Naturalist 114: 224-235.

Strayer, D.L. and K.J. Jirka. 1997. The pearly mussels of New York State. Memoirs of the New York State Museum 26.

Tetzloff, J. 2001. Survival rates of unionid species following a low oxygen event. http://darbycreeks.org/Mussel%20survival%20rates.htm [Accessed March 16, 2005].

The Nature Conservancy (TNC). 2000. Element global ranking form for *Epioblasma triquetra*, January 24, 2000. Unpublished. Arlington, VA.

Trautman, M. B. 1981. The fishes of Ohio. 3rd edition. Ohio State University Press, Columbus Ohio.

United States Fish and Wildlife Service (USFWS). 1993. Endangered and Threatened wildlife and plants; Determination of endangered status for the Northern Riffleshell mussel (*Epioblasma torulosa rangiana*) and the clubshell mussel (*Pleurobema clava*). Federal Register, 22 January 1993 (50 CFR Part 17). Website: http://ecos.fws.gov/docs/frdocs/1993/93-1372.pdf [Accessed March 16, 2005].

USFWS [United States Fish and Wildlife Service]. 1994. Clubshell (*Pleurobema clava*) and Northern Riffleshell (*Epioblasma torulosa rangiana*) Recovery Plan. Hadley, MA.

van der Schalie. 1938. The naiad fauna of the Huron River, in southeastern Michigan. Miscellaneous Publication No. 40, Museum of Zoology, University of Michigan. University of Michigan Press: Ann Arbour, MI.

Veliz, M. 2003. Ausable River Water Quality Report: A background report to the Ausable River Recovery Plan. Ausable Bayfield Conservation Authority: Exeter, ON.

Veliz, M. 2001. Fish Habitat Management Plan. Ausable Bayfield Conservation Authority: Exeter, ON.

Vermeer, K. 1972. The crayfish *Orconectes virilis*, as an indicator of mercury contamination. The Canadian Field-Naturalist 86: 123-125.

Vought, L.G.-M., G. Pinay, A. Fuglsand, and C. Ruffinoni. 1995. Structure and function of buffer strips from a water quality perspective in agricultural landscapes. Landscape and Urban Planning. 31: 323-331.

Wagener, S.M. and J.D. LaPerriere. 1985. Effects of placer gold mining on primary production in subarctic streams of Alaska. Water Res. Bull., 22:91-99.

Watson, E.T., J.L. Metcalfe-Smith, and J. Di Maio. 2000. Status of the Snuffbox, *Epioblasma triquetra*, in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status report: Ottawa, ON.

Watters, G.T. 1996. Hosts for the Northern Riffleshell (Epioblasma torulosa rangiana). Triannual Unionid Report 10: 14.

White, L.R., B.A. McPheron, and J.R. Stauffer, Jr. 1996. Molecular genetic identification tools for the unionids of French Creek, Pennsylvania. Malacologia 38(1-2): 181-202.

Wood, J.T. 1949. Observations on *Natrix septemvittata* (Say) in southwestern Ohio. The American Midland Naturalist 43(1): 173-178.

Zale, A.V. and R.J. Neves. 1982. Reproductive biology of four freshwater mussel species (Mollusca: Unionoidea) in Virginia. Freshwater Invertebrate Biology 1:17-28.

Appendix 1: Species-specific Summaries.

Northern Riffleshell (*Epioblasma torulosa rangiana*)

Species Information:

Common Name: Northern Riffleshell
Scientific Name: *Epioblasma torulosa rangiana*
Assessment Summary
Status: Endangered
Reason for designation: This rare freshwater mussel has undergone a drastic range reduction and significant population decline throughout its range. In Canada, it is now restricted to short segments of two rivers where it occurs at low densities and is Threatened by siltation, highway and agricultural runoff and other pollutants in the water.
Occurrence: Ontario
Status history: Designated Endangered in April 1999.

Species Description:
The northern riffleshell is a relatively small, sexually dimorphic species. Stansbery *et al.* (1982) described the shell as small to medium-sized, subcompressed to subinflated, and solid. Males are irregularly ovate, with a wide, shallow sulcus just anterior to the posterior ridge. Females are obovate, greatly expanded post-ventrally with the expansions very broadly rounded, and transversely swollen after the third year of growth. In both sexes, the peristracum is brownish yellow to yellowish green with diffuse, fine green rays. The umbonal structure is finely douple-looped. The nacre is white, the pseudocardinal teeth are small, and the lateral teeth are short and thick. Shell lengths of mature individuals vary from 45 to 90 mm (Clarke 1981; Cummings and Mayer 1992; USFWS 1994; Staton *et al.* 2000).

Distribution:

Global Range: In the United States, significant populations of the northern riffleshell are currently found only in the Allegheny River and French Creek, Pennsylvania. This species may also still occur in Kentucky, Ohio and West Virginia but additional surveys are required to assess the status of these populations. In Canada, the northern riffleshell occurs only in southern Ontario.
Canadian Range: The range of the northern riffleshell in Canada is currently restricted to the Ausable River, Sydenham River and Lake St. Clair delta. The Sydenham River population of the northern riffleshell is nationally and globally significant. It is one of only three reproducing populations in North America.
Percent of Global Range in Canada: Approximately 25% of the species' global range is found in Canada.
Distribution Trend: In Canada, the northern riffleshell is no longer found across much of its historical range. It has been extirpated from western Lake Erie, the

Detroit River, and most of Lake St. Clair. The northern riffleshell continues to survive in the Lake St. Clair delta and the Ausable and Sydenham Rivers with only the later population showing signs of reproduction. This species has suffered declines in the United States and Canada representing a range reduction of more than 95% (USFWS 1993).

Population Abundance:

Global Range: *Epioblasma torulosa rangiana* is a rare subspecies. Although occasionally abundant, it is usually a minor component of the unionid community (Strayer and Jirka 1997). The Allegheny River and French Creek in Pennsylvania support the largest remaining populations in the United States (USFWS 1994).

Canadian Range: In Canada, a few live specimens of the northern riffleshell occur over a 55 km stretch between Rock Glen and Brinsley in the Ausable River and it occurs at low densities (2-5 live animals captured/4.5 person-hours of search effort at four of five sites surveyed in this reach in 1997) over a 40 km reach of the Sydenham River (Staton *et al.* 2000). Twenty years ago, the Sydenham River population was described as the healthiest extant population of *E. t. rangiana* in North America.

Percent of Global Abundance in Canada: Approximately 25% of the global population abundance of the northern riffleshell occurs in Canada.

Population Trend: The current Canadian distribution of the northern riffleshell is restricted to three populations. The population remaining in the St. Clair delta is known from one live specimen observed in 2000, despite surveys in this region in 2003 and 2004 (D. McGoldrick, NWRI, pers. comm.). A previously unknown population of northern riffleshell was discovered in the Ausable River in 1998 and judging from the large number of dead shells collected this population was once quite abundant and perhaps supported a larger population than did the Sydenham River. Currently there are still a few live individuals in the Ausable River but there is no evidence of reproduction. The population of northern riffleshell in the East Sydenham River is the last reproducing population in Canada. It appears that the current distribution in the East Sydenham River is essentially the same as the historical distribution; however, there is evidence to suggest that abundance has declined by as much as 90% over the past 30 years.

Biological Limiting Factors: Members of the genus *Epioblasma* are riffle/run inhabitants and cannot tolerate any substrate other than clean firmly packed gravel and sand. Members of this genus are also intolerant of low dissolved oxygen concentrations. The sex ratio of the current population in the East Sydenham River is heavily biased toward males (80%) and continued reproductive success is not certain (Staton *et al.* 2000). The glochidia of the northern riffleshell, like most freshwater mussels, are obligate parasites of fish. McNichols and Mackie (2003) conducted a study on the fish hosts of four mussel species at risk from the Sydenham River in Ontario. The blackside darter (*Percina maculata*) and logperch (*P. caprodes*) acted as host species for northern riffleshells from the Sydenham River. Despite finding only one

logperch in surveys conducted in 2002 at 25 sites throughout the Ausable River watershed, numerous blackside darters were found at over half of the sampled sites. If the northern riffleshell uses the blackside darter as a host species in the Ausable River, this would suggest that declines of this mussel species are related to factors other than fish host availability.

Threats: The historically occupied habitats in western Lake Erie, the Detroit River and most of Lake St. Clair are no longer suitable for the northern riffleshell due to the invasion of dreissenid mussels. For remaining populations, siltation is likely the most immediate threat to the northern riffleshell. Increased soil erosion and runoff can quickly cover the riffle habitats required by this species for survival. Dams and associated impoundments destroy riffle habitat and alter the thermal regime of rivers reducing the quantity of suitable habitat for the northern riffleshell. Predation by muskrats (*Ondatra zibethicus*) and raccoons (*Procyon lotor*), although a natural occurrence, could seriously impede the recovery of the northern riffleshell because of its very low abundance. Anecdotal information from local residents suggests that raccoon and muskrat populations are unnaturally high in southwestern Ontario because of a lack of natural predators and an abundance of food provided by changes in agricultural practices from conventional to conservation tillage. The limited and confined range of the northern riffleshell makes it highly susceptible to toxic spills and one catastrophic event in the Sydenham River could effectively eliminate this species from Canada.

Habitat Identification:

Critical Habitat: There is currently insufficient information available to identify critical habitat for this species in the Ausable River.

Recovery Habitat: The northern riffleshell inhabits clear, oxygen rich riffles with substrates of firmly packed sand and gravel. It also inhabited shoals in western Lake Erie and Lake St. Clair, where wave action was sufficient to produce continuously moving water. Since the glochidia of the northern riffleshell are obligate parasites of the blackside darter and logperch, these fish should be afforded some protection/management to ensure successful reproduction and recovery of this species. In the Ausable River, recovery habitat would include all habitats that meet the preceding requirements in the 55 km of the Ausable River stretching from Rock Glen to Brinsley.

Survival Habitat: In the Ausable River, survival habitat would include currently occupied reaches between Rock Glen and Brinsley.

Habitat Trend: Agricultural runoff and nutrient enrichment have caused the siltation of many riffle areas and likely reduced the dissolved oxygen content in the Ausable River. Increased ‘flashiness’ of the river may have negatively impacted substrate stability, further reducing habitat quality.

Habitat Protection: The Ontario provincial policy statement under Section 3 of the *Planning Act* provides for protection from development and site alteration in significant portions of the habitats of Threatened and Endangered species. The Ontario *Lakes and Rivers Improvement Act* prohibits the impoundment or diversion of watercourses if it would lead to siltation. The voluntary Land Stewardship II program of the Ontario Ministry of Agriculture, Food, and Rural

Affairs is designed to reduce erosion from agricultural lands. Stream side development in Ontario is managed through flood plain regulations enforced by local conservation authorities. Land ownership along the Ausable River where the northern riffleshell occurs is mainly private and in agricultural use.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Any activities that cause widespread silting to occupied riffle habitats would result in the destruction of critical habitat. Such activities would include drainage projects that do not follow proper sedimentation control protocols to downstream regions. Any proposed project that results in alteration or removal of the species' preferred stable gravel substrates (or the flows that maintain them) could result in the destruction of critical habitat (for example bridge abutments and pipeline crossings).

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife. What is the effect on the fish they parasitize?

Importance to People: Although the northern riffleshell has little economic significance, it is one of the last remaining members of a near-extinct genus. This species is only found in waters of optimal quality and is a sensitive indicator of environmental degradation. The loss of the northern riffleshell would indicate degrading water quality that could adversely affect people who use surface water for drinking, recreation or watering livestock.

Anticipated Conflicts or Challenges: The re-establishment of viable populations of this species in the Ausable River will require watershed scale recovery prior to any re-introduction. Critical improvements to riparian zones can be accomplished over the short term however these can be ephemeral solutions as they are subject to reversal with changes in land ownership.

Knowledge Gaps:

- Further research is required to assess the impacts of high turbidity and suspended solids on the survival of the northern riffleshell and other mussel species.
- The sensitivity of the northern riffleshell to environmental contaminants is not known.
- The occurrence and scale of natural predation on the northern riffleshell needs to be assessed along with the population dynamics of its predators (raccoons and muskrats).

Ecological and Technical Feasibility of Recovery:

(i) Mussels are slow growing and sedentary animals that are dependant on their host fishes for the survival and dispersal of their young. The slow rate of population growth of freshwater mussels makes the natural recovery of decimated populations extremely difficult.

(ii) Habitat in the Ausable River appears to be of low quality due to high sediment loads that fouls suitable riffle areas.
(iii) The habitat in the Ausable River could be improved significantly with proper stewardship of lands, both agricultural and urban, along the river.
(iv) Reductions in soil erosion and turbidity in the Ausable River is an achievable goal but would be challenging due to the number and intensity of the impacts.
(v) Captive-breeding of species from the genus *Epioblasma* has been recently attempted but successes have yet to be demonstrated.
(vi) The northern riffleshell is naturally rare in Canada. The level of effort required for recovery of the northern riffleshell would be high (e.g. translocation, long-term population augmentation) for the Ausable River.

Snuffbox (*Epioblasma triquetra*)

Species Information

Common Name: Snuffbox
Scientific Name: *Epioblasma triquetra*
Assessment Summary
Status: Endangered
Reason for designation: Declines in extent of occurrence, area of occupancy and number of extant locations; total population extremely fragmented, all four extant sites in one river (Sydenham); entire population could be eliminated by a single upstream catastrophic event. Habitats already exposed to high silt loading from agricultural practices and pollution from point and non-point sources.
Occurrence: Ontario
Status history: Designated Endangered in 2001

Description:

The snuffbox is a small, sexually dimorphic freshwater mussel species with a solid and thick shell that is triangular in males and somewhat elongate in females. It has a high and sharply angled posterior ridge and the sulcus is wide and covered in strong, wavy ribs. The beak is swollen and sculptured with three or four faint, double-looped ridges. The peristracum is yellowish to yellowish green marked with numerous dark green rays that are often broken into triangular spots that look like “dripping paint”. The nacre is predominantly white and the pseudocardinal teeth are ragged and sharp. The lateral teeth are short, straight, raised and notched. Shell lengths of mature individuals may reach 70 mm for males and approximately 60 mm for females.

Distribution:

Global Range: The snuffbox is the most widely distributed member of the genus *Epioblasma* and was known to occur throughout the Ohio-Mississippi River system, in Lake Erie and St. Clair, and the tributaries to Lakes Erie, St. Clair, Huron and Michigan. The snuffbox can still be found in Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. In Canada, the snuffbox only occurs in southern Ontario (TNC 2000).

Canadian Range: The snuffbox was found throughout the waters of southwestern Ontario. Until recently, the only remaining population of the snuffbox was thought to occur in the East Sydenham River, and thus this reproducing population was considered nationally significant (Watson *et al.* 2000). Although there was speculation that a historical population in the Ausable River had been extirpated, a single live juvenile was found in July 2003 by DFO in the lower reaches of the main Ausable River below the Arkona Gorge.

Percent of Global Range in Canada: Less than 5% of the species’ global distribution occurs in Canada (Watson *et al.* 2000).

Distribution Trend: The snuffbox has been lost from over 90% of its historical range in Canada. The populations from Lake Erie, Lake St. Clair, Detroit River and the Niagara River have succumbed to the impacts of dreissenid mussels (zebra and quagga mussels). Live specimens of the snuffbox have not recently been found in the Grand or Thames rivers and the species is likely extirpated from these watersheds.

Population Abundance:

Global Range: There are no abundance estimates available for the global population of the snuffbox although it has been estimated that there are fewer than 50 reproducing, extant occurrences of the snuffbox in North America (TNC 2000). The snuffbox has been extirpated from Iowa, Kansas and New York.
Canadian Range: The snuffbox is currently known to occur only in a 50 km reach of the East Sydenham River as well as a single site in the lower Ausable River. It has likely been extirpated from the Grand, Thames, Detroit and St. Clair Rivers and Lakes Erie and St. Clair.
Percent of Global Abundance in Canada: Less than 5%.
Population Trend: The rate of population change for the snuffbox is unknown but it has been lost from 60% of formerly occupied streams and in Canada has been extirpated from all previously occupied habitats with the exception of a small reach of the East Sydenham River which harbours perhaps 200 individuals (Watson *et al.* 2000) as well as a very limited area of the lower Ausable River. Data collected by NWRI indicates that the snuffbox once had a more substantial range in the Ausable River as indicated by dead shells collected in the Arkona Gorge and in areas further upstream.

Biological Limiting Factors: Members of the genus *Epioblasma* are riffle/run inhabitants and cannot tolerate substrate other than clean firmly packed gravel and sand. Members of this genus are also intolerant of low dissolved oxygen concentrations. The sex ratio of the current population in the East Sydenham River is heavily biased toward males (80%) and continued reproductive success is not certain. The glochidia of snuffbox, like most freshwater mussels, are obligate parasites of fish. McNichols and Mackie (2003) conducted a study on the fish hosts of four mussel species at risk from the Sydenham River in Ontario. Juvenile snuffbox mussels from the Sydenham River transformed on rainbow darters (*Etheostoma caeruleum*) and logperch (*Percina caprodes*). Juvenile snuffbox mussels from Davis Creek, Michigan, transformed on logperch (*Percina caprodes*) and greenside darters (*E. blennoides*). Data on rainbow darters has shown a virtual disappearance of this species from the Ausable watershed, while logperch appear exceedingly uncommon. As such, the rarity/disappearance of these fishes may be a limiting factor to the recovery of the snuffbox.

Threats: Siltation is most likely the most immediate threat to the snuffbox. Increased soil erosion and runoff can quickly cover riffle habitats required by this species for survival. Dams and associated impoundments destroy stable riffle habitat in rivers and alter the thermal regime of rivers reducing the quantity of suitable habitat for the

snuffbox. Predation by muskrats and raccoons (although a natural occurrence) could seriously impede the recovery of the snuffbox because of its very low abundance. Anecdotal information suggests that raccoon and muskrat populations are unnaturally high in southwestern Ontario because of the lack of natural predators and an abundance of food provided by changes in agricultural practices from conventional to conservation tillage. The limited and confined range of the snuffbox makes it highly susceptible to toxic spills and one catastrophic event in the Sydenham River could virtually eliminate this species from Canada.

Habitat Identification:

Critical Habitat: Critical habitat for this species in the Ausable River has yet to be determined.

Recovery Habitat: The habitat requirements for the snuffbox are highly specialized. This species requires riffle areas with clean, clear, swift flowing water with firm gravel/sand substrates that are silt free. The snuffbox also occurred on sandy wave-washed shoals of Lakes Erie and St. Clair. Since the glochidia of the snuffbox are obligate parasites of logperch and rainbow darter in Ontario, these fish species should be afforded some protection/management to ensure the successful reproduction and recovery of the snuffbox. Based on collections of fresh and weathered shells, recovery habitat for the snuffbox in the Ausable River generally overlaps that of the northern rifffleshell covering just over 55 km of river from an area downstream of the Arkona Gorge to Brinsley.

Survival Habitat: The Ausable River population is known only from a single juvenile recorded from a reach of river downstream of the Arkona Gorge in 2003. Additional surveys in this limited reach of the Ausable River are required to characterize this population.

Habitat Trend: Agricultural runoff and nutrient enrichment have caused the siltation of many riffle areas and likely reduced the dissolved oxygen content in the Ausable River. Increased 'flashiness' of the river may have negatively impacted substrate stability, further reducing habitat quality.

Habitat Protection: The Ontario provincial policy statement under Section 3 of the Planning Act provides for protection from development and site alteration in significant portions of the habitats of Threatened and Endangered species. The Ontario Lakes and Rivers Improvement Act prohibits the impoundment of diversion of watercourses if it would lead to siltation. The voluntary Land Stewardship II program of the Ontario Ministry of Agriculture, Food, and Rural Affairs is designed to reduce erosion from agricultural lands. Stream side development in Ontario is managed through flood plain regulations enforced by local conservation authorities.

Examples of Activities Likely to Result in the Destruction of Critical Habitat:

The snuffbox is probably extremely sensitive to siltation because of its specialized habitat requirements and burrowing habits. Any activities that cause widespread silting to riffle habitats would result in the destruction of critical habitat. Such activities would include drainage projects that do not follow proper sedimentation control protocols to downstream regions. Any proposed project

that results in alteration or removal of the species' preferred stable gravel substrates (or the flows that maintain them) could result in the destruction of critical habitat (for example bridge abutments and pipeline crossings).

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Importance to People: Although the snuffbox has little economic significance, it is one of the last remaining members of a near-extinct genus. This species is only found in waters of optimal quality and is a sensitive indicator of environmental degradation. The loss of the snuffbox would be indicative of declining water quality that could adversely affect people who use surface water for drinking, recreation or watering livestock.

Anticipated Conflicts or Challenges: The re-establishment of viable populations of this species in the Ausable River will require watershed scale recovery prior to any re-introduction. Critical improvements to riparian zones can be accomplished over the short term however these can be ephemeral solutions as they are subject to reversal with changes in land ownership.

Knowledge Gaps: Additional surveys are urgently required in the lower Ausable River to define the extent of the newly discovered extant occurrence.

Ecological and Technical Feasibility of Recovery:

(i) Mussels are slow growing and sedentary animals that are dependant on their host fishes for the survival and dispersal of their young. The slow rate of population growth of freshwater mussels makes the natural recovery of decimated populations extremely difficult.

(ii) The only known habitat that currently supports this species is found in a single location from the lower Ausable River. Judging from distribution declines in the Ausable River, this habitat is likely marginal, but additional surveys are required.

(iii) The habitat in the Ausable River could be improved significantly with proper stewardship of both agricultural and urban lands in the watershed.

(iv) Reductions in soil erosion and turbidity in the Ausable River are achievable goals but would be challenging due to the number and intensity of the impacts.

(v) Captive-breeding of species from the genus *Epioblasma* has been recently attempted but successes have yet to be demonstrated.

(vi) The snuffbox is naturally a rare component of the mussel community where it is found. The level of effort required for recovery of the snuffbox in the Ausable River would be moderate (e.g. habitat restoration) to high (e.g. translocation, long-term population augmentation), depending on the strength of the existing population.

Wavy-Rayed Lampmussel (*Lampsilis fasciola*)

Species Information

Common Name: Wavy-Rayed Lampmussel
Scientific Name: *Lampsilis fasciola*
Assessment Summary
Status: Endangered
Reason for designation: The wavy-rayed lampmussel has declined significantly in recent years across its historical range.
Occurrence: Ontario
Status history: Designated Endangered in 1999

Species Description:

The shell has been described as heavy and strong, moderately inflated and heavily rayed. Males are quadrate-ovate and females are ovate in shape. The wavy-rayed lampmussel is readily identified from other freshwater mussels by its yellow- yellowish green peristracum with numerous thin wavy green rays. The rays may be narrow or coalesced into wide rays but without exception they are wavy and interrupted. The posterior ridge is indistinct. The nacre is white to bluish-white. Beaks are elevated, and beak sculpture is fine, composed of about six concentric broadly curved bars which are broken in the centre or sinuous. The pseudocardinal teeth are triangular, short and thick. Lateral teeth are short, strong, straight or have only slight curvature. Shell lengths of mature individuals are usually less than 75 mm, although in Canada, shell lengths of up to 91 mm have been observed (Metcalfe-Smith et. al 2000).

Distribution

Global Range: In the United Stated, the wavy-rayed lampmussel currently occurs in Indiana, Illinois, Kentucky, Michigan, New York, Virginia, Pennsylvania, and North Carolina. In Canada, the wavy-rayed lampmussel occurs only in southern Ontario (Metcalfe-Smith *et al.* 1998).

Canadian Range: In Canada, the wavy-rayed lampmussel is only found in the waters of southwestern Ontario. This species can be found in Lake St. Clair, the upper reaches of the Grand and Thames Rivers and in limited portions of the Ausable, St. Clair and Maitland Rivers. The population in the upper Grand River, covering a 60 km reach is the healthiest known population in Canada and is therefore nationally significant (Metcalfe-Smith and McGoldrick 2003).

Percent of Global Range in Canada: Less than 5% of the species' global distribution is found in Canada.

Distribution Trend: The wavy-rayed lampmussel has been extirpated from its historical range in the western basin of Lake Erie, the majority of Lake St. Clair, Detroit River, and the Sydenham River. With the exception of the Grand River, Thames River and possibly the Maitland River, its range where it is still currently found has been significantly reduced. The three largest populations of this

species occupy a 60 km stretch of the upper Grand River, an area of approximately 12 km^2 in the Lake St. Clair Delta (Metcalfe-Smith and McGoldrick 2003) and approximately 45 km of the Maitland River from the mouth of the South Maitland River to Wingham. Live animals were also found in the lower reaches of the South and Middle Maitland Rivers but their range in these rivers has yet to be determined (D. McGoldrick, pers comm.).

Population Abundance

Global Range: The wavy-rayed lampmussel is globally secure (G4) but is an uncommon species throughout its range comprising less than 2% of the mussel community where it is found.

Canadian Range: The Lake St. Clair delta, the upper reaches of the Grand River, and the middle reaches of the Maitland River support the largest populations of this species in Canada. The wavy-rayed lampmussel also occurs in the Ausable and Thames Rivers but is represented only by large individuals and there is no evidence of successful reproduction. Live specimens were found in a recent survey at one location of the St. Clair River. Additional investigations are needed to assess the unionid populations in this river system (Metcalfe-Smith and McGoldrick 2003).

Percent of Global Abundance in Canada: Less than 1%.

Population Trend: The rate of population change for the wavy-rayed lampmussel is unknown. Apparently stable populations of this species in Canada occur in the Upper Grand, Upper Thames Rivers, and possibly the Maitland River. The Grand River population appears to have recovered from the poor water quality conditions present in the 1970's and early 1980's. Based on recent surveys, the population of the wavy-rayed lampmussel in the Lake St. Clair delta appears to be small and in decline (Metcalfe-Smith *et al.* 2004). Other Canadian populations have declined sharply to only a few individuals.

Biological Limiting Factors: The wavy-rayed lampmussel inhabits clear, hydrologically stable rivers and streams where it is typically found in sand and gravel substrates in and around riffle areas (Strayer and Jirka 1997). The larvae (glochidia) of freshwater mussels are obligate parasites and must attach to their host if development is to continue. The wavy-rayed lampmussel is a long term brooder with only two known fish hosts, the smallmouth bass (*Micropterus dolomieu*) (Zale and Neves 1982) and largemouth bass (*Micropterus salmoides*) (G.T. Watters, Ohio State University, unpublished data). Female wavy-rayed lampmussels use a modified mantle that resembles a small fish in a visual display that attracts the host fish. When the host approaches, the female ejects many glochidia which attach to the fish. It is likely that this reproductive mechanism is dependant on clear water if it is to be successful. The glochidia of the wavy-rayed lampmussel are known to be very sensitive to copper (Jacobsen *et al* 1997). Historically, copper concentrations are often in excess of federal aquatic life guidelines in watercourses that receive industrial and municipal effluents.

Threats: The wavy-rayed lampmussel is vulnerable to impoundments, loss of host fish, siltation and toxic chemicals as well as zebra mussels and muskrats in portions of its

range. Recreational canoeing has also been noted as a potential impact in the Grand River where canoe traffic can cause excessive substrate disturbances. Dreissenid mussels do not currently threaten riverine populations in Canada, however, the Grand River population would be at risk if zebra mussels became established in one or more of three large reservoirs in the upper watershed. Dreissenid mussels do co-occur with the wavy-rayed lampmussel in the St. Clair delta but it is postulated that low dreissenid densities in this area have allowed some unionids to persist. Studies are to assess the stability of the unionid population and monitor the densities and colonization rates of dreissenid mussels in the St. Clair delta are on-going. In rivers, sedimentation and pollution from urban and agricultural runoff are major threats to water and habitat quality for the wavy-rayed lampmussel. The rapid rate of human population growth projected for the Grand River watershed is expected to put further pressure on water quality. There are also concerns raised that increased fishing pressure in the Grand River could reduce smallmouth bass populations to levels that could effect the wavy-rayed lampmussel. The apparent disappearance of this species from the Ausable and Sydenham Rivers (M. Poos, University of Guelph, pers. comm.) may be attributed to poor water quality due to high turbidity levels caused by intensive agriculture. It has been speculated that the wavy-rayed lampmussel may have a critical requirement for clear water during reproduction, as the female must rely on good visibility in order to attract a sight predator such as a smallmouth bass with her lure.

Habitat Identification

Critical Habitat: Critical habitat for this species in the Ausable River has yet to be determined.

Recovery Habitat: The wavy-rayed lampmussel inhabits clear, hydrologically stable rivers and streams of a variety of sizes, where it is typically found in gravel or sand substrates in and around riffle areas. Since its larvae are obligate parasites of smallmouth bass, populations of this fish should also be afforded some protection/management to ensure the recovery of the wavy-rayed lampmussel. Recovery habitat in the Ausable River watershed would include the reach from Nairn to Exeter where shells have been previously found, as well as the lower Little Ausable River.

Survival Habitat: The survival habitat includes stretches of the Ausable River from Nairn to just downstream of the Hay Swamp where a few live animals have been encountered, and the lower reaches of the Little Ausable River just upstream of Ailsa Crag.

Habitat Trend: There is strong evidence that poor water clarity limits the distribution of the wavy-rayed lampmussel (Metcalfe-Smith and McGoldrick, 2003). High turbidity and suspended solids in the Ausable River may have rendered large portions of ideal habitat unsuitable (although water clarity appears better in the Little Ausable River). Substrate instability due to an altered flow regime in the Ausable River may also reduce habitat quality.

Habitat Protection: The Ontario provincial policy statement under Section 3 of the Planning Act provides for protection from development and site alteration in significant portions of the habitats of Threatened and Endangered species. The Ontario Lakes and Rivers Improvement Act prohibits the impoundment of

diversion of watercourses if it would lead to siltation. The voluntary Land Stewardship II program of the Ontario Ministry of Agriculture, Food, and Rural Affairs is designed to reduce erosion from agricultural lands. Stream side development in Ontario is managed through flood plain regulations enforced by local conservation authorities. Land ownership along the reaches of the Ausable River where the species was found alive is mainly private.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Any activities that cause widespread silting to occupied riffle habitats would result in the destruction of critical habitat. Such activities would include drainage projects that do not follow proper sedimentation control protocols to downstream regions. Any proposed project that results in alteration or removal of the species' preferred stable gravel substrates (or the flows that maintain them) could result in the destruction of critical habitat (for example bridge abutments and pipeline crossings). Any activities that result in increased and prolonged levels of turbidity could result in the destruction of critical habitat for this species which appears to be intolerant of turbid conditions.

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Importance to People: Although this species has no apparent economic significance, freshwater mussels are sensitive to environmental pollution and a diverse mussel community indicates a healthy ecosystem. Besides decreased biodiversity in Canada, the loss of the wavy-rayed lampmussel may indicate further environmental degradation of southern Ontario watercourses which would adversely affect those people who use surface water for drinking, recreation or watering livestock.

Anticipated Conflicts or Challenges: The re-establishment of viable populations of this species in the Ausable River will require watershed scale recovery prior to any re-introduction. Critical improvements to riparian zones can be accomplished over the short term however these can be ephemeral solutions as they are subject to reversal with changes in land ownership.

Knowledge Gaps:

- Although smallmouth bass have been confirmed as the glochidial host in the United States, there are instances of watershed based host specificity among freshwater mussels. Further research is needed to confirm that the smallmouth bass is indeed the host for the wavy-rayed lampmussel in Canada.
- Research is also needed to confirm the hypothesis that poor water clarity inhibits the reproductive success of the wavy-rayed lampmussel.

Ecological and Technical Feasibility of Recovery:

(i) Mussels are slow growing and sedentary animals that are dependant on their host fishes for the survival and dispersal of their young. The slow rate of population

growth of freshwater mussels makes the natural recovery of decimated populations extremely difficult.

(ii) Habitat in the Ausable River appears to be of low quality because of high turbidity.

(iii) The habitat in the Ausable River could be improved significantly with proper stewardship of both agricultural and urban lands.

(iv) Reductions in soil erosion and turbidity in the Ausable River watershed is an achievable goal but would be challenging due to the number and intensity of the impacts.

(v) The wavy-rayed lampmussel has been artificially propagated at Virginia Polytechnic Institute and State University (Hanlon 2000).

(vi) The wavy-rayed lampmussel is naturally a rare component of the mussel community where it is found. The level of effort required for recovery of this species would be high (e.g. translocation, long-term population augmentation) for the Ausable River.

Kidneyshell (*Ptychobranchus fasciolaris*)

Species Information

Common Name: Kidneyshell
Scientific Name: *Ptychobranchus fasciolaris*
Assessment Summary
Status: Endangered
Reason for designation: This species has been lost from about 70% of its historical range in Canada due to impacts of the zebra mussel and land use practices. It is now restricted to the East Sydenham and Ausable rivers. Although both populations appear to be reproducing, there is evidence that abundance has declined in the East Sydenham River. Agricultural impacts, including siltation, have eliminated populations in the Grand and Thames rivers and threaten the continued existence of this species in Canada.
Occurrence: Ontario
Status history: Designated Endangered in 2003.

Species Description:

The kidneyshell is a medium to large freshwater mussel. The shell is elongate, elliptical, compressed, solid and heavy. Old individuals may be hump-shaped. Males and females are morphologically similar although females have a conspicuous groove on the shell interior running diagonally from the beak cavity towards the posterioventral end. Beak sculpture is not well developed, consisting of several fine, indistinct, wavy ridges. The periostracum "is yellowish to yellowish-green, yellowish-brown, or medium brown, with generally distributed broad, interrupted green rays" resembling squarish spots. Old specimens may have dark chestnut brown and rayless shells. The periostracum is smooth except for "course growth rests and a roughened posterior slope". The nacre is white or bluish white, and may be pinkish in young specimens. The hinge teeth are heavy and complete with 'distally pendulous' lateral teeth. This species reaches a maximum shell length of 120 mm in Canada (Metcalfe-Smith and Zanatta 2002).

Distribution:

Global Range: In the United States, the kidneyshell is currently found in Ohio, Tennessee, Kentucky, Michigan, New York, Pennsylvania, West Virginia, Virginia, Alabama, Mississippi and Illinois.
Canadian Range: In Canada, the kidneyshell is found only in southwestern Ontario. Since 1997, live specimens have been reported from the Ausable River, Sydenham River, and Lake St. Clair.
Percent of Global Range in Canada: Approximately 5% of the global range of this species occurs in Canada.
Distribution Trend: Since the invasion of the Great Lakes by dreissenid mussels the Canadian geographical distribution for this species has been reduced by 70%.

Population Abundance:

Global Range: In the United States, the kidneyshell is seldom a significant component of the mussel community. It usually represents on average 2.5% (0.2- 8.0%) of the mussel community in rivers but at individual sites where it is found the kidneyshell may account for more than 10% of the community.

Canadian Range: The largest Canadian population of the kidneyshell occurs in the Ausable River where it comprises 1.5% of the overall mussel community. In the Sydenham River it occurs in an average estimated density of $0.12/m^2$ at sites where it was found alive. In the Lake St. Clair delta, kidneyshells comprised only 0.3% of the overall mussel community.

Percent of Global Abundance in Canada: Approximately 5% of the global abundance of this species occurs in Canada.

Population Trend: It is estimated that the population of kidneyshell in Canada has declined by 70% since the invasion of the Great Lakes by dreissenid mussels. This estimate is based on the number of historical records that occur in waters that now contain dreissenid mussels.

Biological Limiting Factors: The kidneyshell has specific ecological preferences, favouring riffle areas with substrates of firmly-packed coarse gravel and sand in areas with moderate to swift currents (Ortmann 1919, Gordon and Layzer 1989). This species also displays an aversion to ponded backwater conditions (van der Schalie 1938). The kidneyshell, like most freshwater mussels, is dependant on specific species of fish to act as hosts for their parasitic larvae (glochidia). The glochidial host fish(es) for the kidneyshell have not been confirmed for the Canadian populations but research in the United Stated has identified three species that are native to Canada - greenside darter, fantail darter (*Etheostoma flabellare*) and johnny darter (*Etheostoma nigrum*) as possible fish hosts (White *et al* 1996).

Threats: Although dreissenid mussels have eliminated the kidneyshell from much of its historical range in Lake Erie and Lake St. Clair, the populations in the Sydenham and Ausable River are not likely to face this threat since the East Sydenham and Ausable Rivers are not navigable by boats and there are few impoundments on these rivers. However, the destruction of suitable habitat from siltation and agricultural runoff in these rivers may also pose a threat to the continued survival of the kidneyshell.

Habitat Identification:

Critical Habitat: Critical habitat has not yet been identified for the kidneyshell in the Ausable River. Currently known occupied habitat includes reaches of the Ausable River from Huron Park to downstream of the Arkona Gorge, and all previously occupied reaches of the Thames and Lower Grand Rivers.

Recovery Habitat: The kidneyshell prefers shallow areas with clear, swift-flowing water and substrates of firmly-packed coarse gravel and sand. In the Great Lakes it was found on gravel shoals in Lake Erie and Lake St. Clair. Commonly, the kidneyshell is found near beds of water willow, an aquatic plant. Since the glochidia of the kidneyshell are obligate parasites of fish, host fish

should be afforded protection/management to ensure successful reproduction. The glochidial host(s) have yet to be confirmed in Canada. The recovery habitat for the kidneyshell in the Ausable River includes the reach from Huron Park to just downstream of the Arkona Gorge.

Survival Habitat: The survival habitat would include approximately 50 km of the Ausable River from Huron Park to just downstream of the Arkona Gorge where live animals have been recently collected from many sites. Since there are no records outside of this reach, survival and recovery habitat are equivalent.

Habitat Trend: The invasion of dreissenid mussels has rendered much of the historical habitat of kidneyshell unsuitable. The amount of suitable clean riffle habitat preferred by this species is Threatened by siltation from increased soil erosion and agricultural runoff. The kidneyshell also seems to live in association with healthy riparian vegetation – most of which has been removed from many reaches of most rivers in southwestern Ontario.

Habitat Protection: The Ontario provincial policy statement under Section 3 of the *Planning Act* provides for protection from development and site alteration in significant portions of the habitats of Threatened and Endangered species. The Ontario *Lakes and Rivers Improvement Act* prohibits the impoundment of diversion of watercourses if it would lead to siltation. The voluntary Land Stewardship II program of the Ontario Ministry of Agriculture, Food, and Rural Affairs is designed to reduce erosion from agricultural lands. Stream side development in Ontario is managed through flood plain regulations enforced by local conservation authorities. Very little of the kidneyshell's range is located in protected areas, rather, most of the land is privately owned and in agricultural use.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Any activities that cause widespread silting to occupied riffle habitats would result in the destruction of critical habitat. Such activities would include drainage projects that do not follow proper sedimentation control protocols to downstream regions. Any proposed project that results in alteration or removal of the species' preferred stable gravel substrates (or the flows that maintain them) could result in the destruction of critical habitat (for example bridge abutments and pipeline crossings).

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Importance to People: Although this species has no apparent economic significance, freshwater mussels are sensitive to environmental pollution and a diverse mussel community indicates a healthy ecosystem. Besides decreased biodiversity in Canada, the loss of the kidneyshell may indicate further environmental degradation of southern Ontario watercourses which would adversely affect those people who depend on surface water for drinking, recreation or watering livestock.

Anticipated Conflicts or Challenges: Challenges of re-establishment of viable populations of this species in the Ausable River are not the same as for other mussel species at risk identified in the Strategy because kidneyshells are well-established.

Knowledge Gaps: The glochidial fish host(s) for the kidneyshell has not been confirmed for Canadian populations.

Ecological and Technical Feasibility of Recovery:

(i) Mussels are slow growing and sedentary animals that are dependant on their host fishes for the survival and dispersal of their young. The slow rate of population growth of freshwater mussels makes the natural recovery of decimated populations extremely difficult.

(ii) Current habitat in the Ausable River is likely of moderate quality (supports a reproducing population) but may be compromised by high turbidity and intensive agricultural land use.

(iii) The habitat in the Ausable River could be improved significantly with proper stewardship of both agricultural and urban lands.

(iv) Reductions in soil erosion and turbidity in the watershed is an achievable goal but would be challenging due to the number and intensity of the impacts.

(v) Captive-breeding of the kidneyshell has never been attempted. The kidneyshell is naturally a rare component of the mussel community but can be locally abundant in prime habitat. The level of effort required for recovery of this species would be moderate (e.g. habitat restoration) for the Ausable River.

Pugnose Shiner (*Notropis anogenus*)

Species Information:

Common Name: Pugnose shiner
Scientific Name: *Notropis anogenus*
Assessment Summary – date: 2002
Status: Endangered
Reason for designation: The pugnose shiner has a limited, fragmented Canadian distribution, being found only in Ontario where it is subject to declining habitat quality. The isolated nature of its preferred habitat may prevent connectivity of fragmented populations and may prevent gene flow between existing populations and inhibit re-colonization of other suitable habitats. Two out of five localities have been lost.
Occurrence: Ontario**.**
Status History: Designated Special Concern in April 1985. Status re-examined and uplisted to Endangered in November 2002. Last assessment based on an update status report.

Description: The pugnose shiner (*Notropis anogenus*) is a small, silvery member of the minnow family (Cyprinidae) with pale yellow to olive coloured tints on the back. All fins are transparent, and there is a dark lateral band that extends from the snout through the eye to the end of the caudal peduncle, terminating in a small dark wedge-shaped caudal spot. The mouth is small, upturned and terminal (Scott and Crossman 1973). The black peritoneum distinguishes the pugnose shiner from most other *Notropis* (Holm and Mandrak 2002). Externally, the species is most similar to the blackchin shiner (*N. heterodon*), but the two species can be distinguished by the very small, sharply inclined mouth that does not extend past the nostril in the pugnose shiner (Holm and Mandrak 2002).

Distribution:

Global Range: The pugnose shiner has a patchy or discontinuous distribution that is restricted to the upper Mississippi, Red River of the North and Great Lakes basins (Holm and Mandrak 2002). The pugnose shiner was formerly found in eight states and one province.

Canadian Range: This species is restricted to southern Ontario, where it is known from Lake St. Clair, the Old Ausable Channel (OAC) , three disjunct areas of Lake Erie (Point Pelee, Rondeau Bay and Long Point Bay) and the St. Lawrence River between Eastview and Mallorytown Landing (Holm and Mandrak 2002). Recent collections have confirmed that the species is extant from the St. Lawrence River, Long Point Bay of Lake Erie, Lake St. Clair, and the OAC. The pugnose shiner was first collected from the OAC in 1982 and has been confirmed extant in the channel in 1997, 2002, and 2004.

Percentage of Global Distribution in Canada: Just under 10% of the species' global range occurs in Canada.

Distribution Trend: Three Canadian occurrences may have been lost over the last 50 years (Gananoque, Point Pelee, Rondeau).

Population Abundance:

Global Range: The pugnose shiner is globally rare (G3), and is ranked as being rare to extremely rare in each of the states and one province in which it occurs (S1-S3; NatureServe Explorer 2002). The pugnose shiner is listed as extirpated in one state (OH), Endangered in three states (IA, IL, NY), Threatened in two states (ND, WI) and Special Concern in one state (MI).

Canadian Range: There is no information available on abundance of Canadian populations, but the limited number of records indicates low abundance. The pugnose shiner was first collected from the OAC in 1982. This site was revisited in 1997 and despite the fact that more effort was expended (10 seine hauls versus 7), the number of individuals collected dropped from 110 to 21 (Holm and Boehm 1998). The authors also noted a "trend towards a predominance of sunfishes with a corresponding decrease in minnows" and predicted a continued shift towards a fish community dominated by centrarchids. A preliminary analysis (using relative abundance) of the extensive fish dataset collected by DFO in 2002 in the OAC appears to support this prediction. In this most recent survey, which employed numerous survey techniques (boat electrofishing, boat seining, minnow traps, windemere traps, and hoop nets) over a 5 km reach, a further decline was suggested in the numbers of pugnose shiners. DFO collected a total of 43 individuals of pugnose shiners over an intensive one week period; however, only seven individuals were collected in the 1000 m reach surveyed previously, suggesting an overall decline in relative abundance when compared with 1997 data. However, DFO's survey techniques did not include beach seining which was used by Holm and Boehm (1998). Additional surveys were conducted in 2004 and these data are currently being used in the identification of critical habitat.

Percent of Global Abundance in Canada: 5- 10% of the species' global abundance probably occurs in Canada.

Population Trend: The abundance of pugnose shiners has declined in Canada over the last 25 years, with the possible loss of three occurrences and an apparent decline in the OAC. There is no trend through time information available for the other extant sites.

Biologically Limiting Factors: The pugnose shiner is limited to clear, well-vegetated, slow-moving waters. The only location where this type of habitat remains in the Ausable River watershed is the OAC.

Threats: The pugnose shiner is extremely sensitive to turbidity (Scott and Crossman 1973), and this factor undoubtedly limits its distribution in the Ausable River and elsewhere in Ontario. Currently, the only records of pugnose shiner from the Ausable River watershed are in the OAC, which has much better water clarity than the main stem of the river. In the OAC, which is now protected by a dam from influxes of

suspended solids from the river, siltation is not currently a serious threat. Future development surrounding the OAC (outside The Pinery Provincial Park) near Grand Bend could have negative impacts to habitat. The lowest recorded Secchi reading from a site containing pugnose shiners was 0.3 m (Lake St. Clair, ROM 43420, cited in Holm and Mandrak 2002). High levels of siltation and turbidity may also limit plant growth, which is an important component of pugnose shiner habitat. At Point Pelee, the decline or extirpation of pugnose shiners may have also been caused by an increase in the number and diversity of predators present, and/or by an increase in interspecific competition for resources (Holm and Mandrak 2002). Apparent shifts in the fish community of the OAC from a cyprinid dominated to a centrarchid dominated community (Holm and Boehm 1998) may be currently impacting the pugnose shiner population. Common carp (C*yprinus carpio*) may also represent a potential threat to the OAC population of pugnose shiners. Although common carp were previously unknown from the OAC, three individuals were captured during extensive sampling by DFO in 2002. Although not currently numerous, a large population of common carp could have a substantial impact through their habit of uprooting aquatic vegetation important for pugnose shiners. Common carp could also increase turbidity levels through bioturbation, but considering the general sandiness of the substrate in the OAC, this seems unlikely.

Habitat Identification:

Critical Habitat: Within the Ausable River watershed, the Recovery Team recommends that critical habitat for the pugnose shiner be designated as the entire OAC upstream of the low head dam (43-14'-48"N, 81-50'-46") to its end near Grand Bend (insert coords). This region of the channel covers a distance of approximately 9.5 km, the majority of which is protected within the borders of The Pinery Provincial Park (~6.4 km). Areas of the OAC outside of the Pinery may be more susceptible to negative impacts from on-going development near Grand Bend. The preferred habitat of the pugnose shiner – clear waters with abundant aquatic vegetation, is found contiguously along this section of channel (a narrative description of the species habitat requirements is given under 'recovery habitat'). This reach of the OAC is essentially a closed system containing a relatively homogenous and possibly self sustaining population with no migration or emigration. These assertions have been supported through extensive data collected in 2002 and 2004 (Nick Mandrak, pers. Comm..) which are currently being summarized.

Recovery Habitat: In Ontario, the pugnose shiner inhabits quiet areas of large lakes, stagnant channels and large rivers with primarily sand bottoms, organic detritus and usually clear water (Holm and Mandrak 2002). It is almost always found in association with aquatic vegetation, such as stonewort (*Chara* spp.), pondweed species (*Potamogeton* spp.), water milfoil (*Myriophyllum* spp.), Canadian waterweed (*Elodea canadensis*), eel grass (*Vallisneria americana*), coontail (*Ceratophyllum demersum*), filamentous algae (especially *Spirogyra*) and bulrush (*Scirpus* spp.) (Becker 1983). In the Ausable River these habitats are limited to the OAC (in regions upstream of the low head dam), which should be considered as recovery (and survival) habitat for the pugnose shiner.

Survival Habitat: Survival habitat for the pugnose shiner is the OAC in the region upstream of the dam (equivalent to recovery habitat).
Habitat Trends: It is not known how much of the lower Ausable River provided habitat for the pugnose shiner prior to its diversion in the 1800s, but the habitat available in the OAC seems relatively unchanged. Habitat quality has declined at some of the other Canadian occurrences.
Habitat Protection: The habitat of the pugnose shiner receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). The only known occurrences of the pugnose shiner in the Ausable River watershed are within the OAC and the majority of this reach is protected within the boundaries of Pinery Provincial Park, which confers some additional protection. Floodplain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over stream side development outside of The Pinery Provincial Park. Although the bed of the channel is owned by the Crown in this area, the majority of adjacent lands outside the Park are currently residential or being developed into residential subdivisions. Designation of the OAC as 'critical habitat' would provide specific habitat protection under SARA once the pugnose shiner is added to Schedule 1.
Examples of Activities Likely to Result in the Destruction of Critical Habitat: The pugnose shiner is extremely sensitive to turbidity. Therefore any activities that result in increased and prolonged levels of turbidity would result in the destruction of critical habitat for this species. High levels of siltation and turbidity may also limit aquatic macrophyte growth, which is an important component of pugnose shiner habitat. Any activities that cause widespread silting to occupied habitats may therefore result in the destruction of critical habitat. Such activities include drainage or construction projects that do not follow proper sedimentation control protocols to downstream regions.

Ecological Role: Despite the extremely small size of its mouth (Scott and Crossman 1973), food items up to 2 mm long and twice the length of the mouth can be consumed (Becker 1983). Plants such as *Chara* and filamentous green algae were preferred over animal foods such as the cladocerans, *Daphnia* and *Chydorus* in Wisconsin (Becker 1983). In contrast, pugnose shiners from Mitchell Bay in Lake St. Clair contained mainly cladocerans (unpublished ROM data, cited in Holm and Mandrak 2002). The pugnose shiner is undoubtedly prey for a variety of piscivorous fishes.

Importance to People: Given its rarity and small size, the pugnose shiner is of little economic significance. However, it could be considered an indicator species of healthy wetlands.

Anticipated Conflicts or Challenges: The potential impacts of introduced fishes will be difficult to address.

Knowledge Gaps: Additional sampling needs to be conducted to determine the full extent of the pugnose shiner's distribution in the OAC. The sampling protocol employed in 1997 should also be replicated at the dam site for more direct comparisons to investigate the observed decline in the population of pugnose shiners. Spawning areas also need to be identified. Regions of the OAC downstream of the dam should be investigated to determine if alterations might create potential for recovery habitat. The impacts of introduced fishes (common carp, northern pike, and predatory centrarchids) on the lake pugnose shiner population in the OAC need to be assessed.

Ecological and Technical Feasibility of Species Recovery:

(i) The inherent capacity of this species to rebound demographically is unknown.
(ii) The current availability of quality habitat is probably high, but it is limited to the OAC
(iii) Habitat restoration is probably not required in the OAC (habitat protection is required) and it is unlikely that habitat restoration is feasible in the Ausable River proper.
(iv) It is feasible to mitigate threats from upstream development, but impacts of introduced predators may be difficult to address.
(v) As the pugnose shiner is extant in the system it is not necessary to consider repatriation.
(vi) The level of effort required for recovery of the Ausable River population would be low (habitat protection).

Eastern Sand Darter (*Ammocrypta pellucida*)

Species Information:

Common Name: Eastern sand darter
Scientific Name: *Ammocrypta pellucida*
Assessment Summary – date: 2000
Status: Threatened
Reason for designation: This species has a limited disjunct distribution in Canada, with fragmented, isolated populations with little chance of recolonization if extirpated. It has been in decline since the 1950s because of habitat loss and/or degradation due to siltation, impoundments and chemical pollutants.
Occurrence: Ontario and Quebec**.**
Status History: Designated Threatened in April 1994. Status re-examined and confirmed in November 2000. Last assessment based on an existing status report with an addendum.

Description: The eastern sand darter is a small member of the perch family, reaching a total length of about 8 cm. It is easily distinguished from other members of the darter sub-family in Canada by its slender, elongate, translucent body. There is a yellowish or greenish cast, especially dorsally, with a narrow metallic gold to olive-gold band passing subcutaneously along a line of lateral blotches. The back is marked with 11-19 small olive spots along the dorsal ridge, which become rows of paired spots along the base of the dorsal fins, with one row on each side of the fin. Along the lateral line is a series of 8-15 oblong, dusky-olive spots that may form a faint band posteriorly (Trautman 1981).

Distribution:

Global Range: The eastern sand darter occurs in the Ohio River, Lake Erie, and Lake St. Clair drainages as well as the Ausable River flowing into the southern tip of Lake Huron. It also has a disjunct distribution in the Lake Champlain and St. Lawrence River drainages. It is known from nine states and from the provinces of Ontario and Quebec.

Canadian Range: In Canada, the eastern sand darter is restricted to southwestern Ontario and southwestern Quebec. In Ontario, the species is extant in Lake St. Clair, Lake Erie, the Grand River, the Thames River and the Sydenham River. Populations may be extirpated from the Ausable River, Catfish Creek, Big Creek, and Big Otter Creek. In Quebec, the eastern sand darter has been collected from 10 tributaries of the St. Lawrence as well as from the St. Lawrence River, Lac des Deux-Montagnes, and Lac St. Pierre. It is thought to be extant in the Rivière Gentilly, extirpated or reduced in four rivers (Châteaugay, Yamaska, l'Assomption, St. François), and the status is unknown at the other locations. There is only one record of eastern sand darter from the Ausable River from Ailsa Craig where "a series of yearlings to breeding adults" were taken during a survey conducted in 1929 (Hubbs and Brown 1929). This species has not been reported since, and was absent from extensive

surveys of the watershed conducted in 2002, suggesting it may be extirpated from the watershed.

Percentage of Global Distribution in Canada: About 5% of the species' global range occurs in Canada.

Distribution Trend: The eastern sand darter has been lost from 45% of its Ontario occurrences and has been lost or has declined at 12 of 21 Canadian occurrences. This has been over a protracted period of about 50 years.

Population Abundance:

Global Range: The eastern sand darter is globally rare (G3) and has declined throughout much of its North American range due to siltation and deteriorating water quality (Page and Burr 1991; Holm and Mandrak 1994). In some parts of its range, these declines have been somewhat drastic. The eastern sand darter is listed as Endangered in three states (Illinois, New York, Pennsylvania), Threatened in two states (Michigan, Vermont), and of Special Concern in three states (Indiana, Kentucky, Ohio).

Canadian Range: The species was listed as Threatened in Canada by COSEWIC in 1994 (Holm and Mandrak 1994). It is listed as S2 in both Ontario and Quebec and is not considered to be abundant in any watershed.

Percent of Global Abundance in Canada: This is difficult to determine, but Canadian populations probably contain around 5% of the global population.

Population Trend: The eastern sand darter has probably disappeared from half of the Canadian watersheds that it was known from historically, and its abundance and range have been reduced in many others although there is no trend through time data to make an accurate assessment.

Biologically Limiting Factors: The eastern sand darter has a strong affinity for clean substrates of fine sand. Eastern sand darters are fossorial and will often nearly completely bury themselves in sandy substrates. Eggs are likely laid and buried in the same substrates. A well-oxygenated clean sand substrate is likely required for high egg survival and to allow for fossorial behaviour. The fecundity of the eastern sand darters is low (30–170 mature eggs per female), but is comparable to that of other darter species.

Threats: The availability of silt-free, soft sand substrates is likely the most important limiting factor for eastern sand darters in the Ausable River. Loadings of suspended solids from a variety of sources (Nelson *et al.* 2003), leading to siltation of fine sand substrates, is probably the largest threat to eastern sand darter populations. The impact of high nutrient levels, toxic chemicals and altered flow regime is unknown, but would likely represent additional threats.

Habitat Identification:

Critical Habitat: Critical habitat has yet to be identified for the eastern sand darter. As identified in the Recovery Approaches for Fishes, surveys will be conducted to assess habitat and determine if the eastern sand darter is still extant in the Ausable

River. Appropriate analysis will then be conducted to identify critical habitat for this species.

Recovery Habitat: The eastern sand darter inhabits large creeks, rivers, and lakes with sandy bottoms (Page and Burr 1991). The species is found almost exclusively on sand substrates, and, according to Daniels (1993), few temperate stream fishes are as strongly associated with a particular habitat variable as is the eastern sand darter. In rivers, these habitats tend to be patchy and are normally found on the depositional side of a bend in the river. Eastern sand darters are normally found on the downstream end of the sandbar in areas of low current (<20 cm/s) (Daniels 1993; Facey 1998). These sandy habitats are somewhat ephemeral, in that they can be created or destroyed or moved by flood events and ice action. In the Ausable River these habitats have yet to be identified.

Survival Habitat: Survival habitat is unknown at this time as the eastern sand darter may be extirpated from the Ausable River

Habitat Trends: Although the quality of eastern sand darter habitat has not been quantified, the high turbidity and nutrient levels in the Ausable River have likely resulted in degradation of habitat.

Habitat Protection: The habitat of the eastern sand darter receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). Floodplain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over stream-side development. The bed of the Ausable River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the eastern sand darter are privately owned and in agricultural use.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Any activities that cause widespread silting to occupied sand substrates would result in the destruction of critical habitat. Such activities would include drainage projects that do not follow proper sedimentation control protocols to downstream regions. Any proposed project that results in alteration or removal of the species' preferred sand habitat (or the flows that maintain them) could result in the destruction of critical habitat (for example bridge abutments and pipeline crossings).

Ecological Role: The eastern sand darter feeds on small insects (primarily midges and blackflies), crustaceans, and worms. The low abundance of the eastern sand darter suggests that it does not play an important role in food web dynamics; however, at the microhabitat level, it is one of the few Ontario fishes that exploits sand habitats and their resources. It is possible that the eastern sand darter may have been a glochidial host for one of the Endangered mussel species in the Ausable River.

Importance to People: The eastern sand darter is no longer a legal bait fish in Ontario, but it is unlikely that it has been harvested. Given its rarity and small numbers, the eastern sand darter is of little economic significance.

Anticipated Conflicts or Challenges: Efforts to reduce erosion in the watershed must recognize that natural erosion of sand banks is important to the maintenance of habitat for this species. Other challenges are as for other species.

Knowledge Gaps: Sampling needs to be conducted to determine if the eastern sand darter is extant in the Ausable River. This should be accomplished by identifying the distribution, quantity and quality of sandy habitat patches and then sampling the best sites using the appropriate gear (seine or trawl). An evaluation of the surficial geology should also be conducted to identify locations of sand sources needed to create habitat. Habitat use by early life history stages is not known, but it is unlikely that there are sufficient numbers of fish in the Ausable River to do investigations. Efforts need to be made to develop rearing methods for eastern sand darters if repatriation is warranted.

Ecological and Technical Feasibility of Species Recovery:

(i) The eastern sand darter has the ability to recover when habitat improvements are made. There is evidence from Vermont that improvements in water quality associated with a decreased silt load resulting from reforestation of stream slopes have benefited populations of eastern sand darters (Daniels 1993).

(ii) The current availability of quality habitat is probably low, although habitat assessment is required to determine the suitability of these sites.

(iii) & (iv) Restoration of habitat requires reductions in sediment input from a variety of sources (overland erosion, drainage tiles, bank, and bed). This will require a large basin-wide effort to be effective. The natural erosion of sand banks is important to maintaining habitat for this species.

(v) & (vii) It may be possible to reintroduce this species to formerly occupied upstream areas if the habitat is suitable; however, given the rarity of this species in other systems, it would be very difficult to find a source population. From a conservation perspective, it would probably be prudent to rear this species in captivity as opposed to attempting adult transfers. There are no published studies regarding the husbandry of eastern sand darters. The Approaches Section recommends that a repatriation plan be developed if suitable habitat is present and the eastern sand darter is absent. Assuming that the eastern sand darter has been extirpated from the Ausable River, the level of effort required for recovery of the Ausable River population would be high (habitat restoration and repatriation).

Lake Chubsucker (*Erimyzon sucetta*)

Species Information:

Common Name: Lake chubsucker
Scientific Name: *Erimyzon sucetta*
Assessment Summary – date: 2001
Status: Threatened
Reason for designation: Within Canada, this species occurs only in southwestern Ontario where it has been found at seven locations and has not been found at three of these since 1983. Never abundant, the species is in decline throughout its range as a result of siltation and drainage of wetlands.
Occurrence: Ontario**.**
Status History: Designated Special Concern in April 1994. Status re-examined and uplisted to Threatened in November 2001. Last assessment based on an existing status report with an addendum.

Description: The lake chubsucker is a small member of the sucker family (Catostomidae) usually less than 25 cm long. It has a blunt snout and small downward directed mouth, which is typical of suckers (ROM 2001). Robust and deep bodied, its back is deep olive to bronze, while the underside is green-yellow to yellow-white. The scales of the back and upper sides are dark-edged, creating a vague crosshatched pattern (Scott and Crossman 1973). The back is moderately deep-arched, and the lateral stripe, when present, may be either continuous (mainly in juveniles) or broken into blotched lateral bands (Mandrak and Crossman 1996). This species has no lateral line.

Distribution:

Global Range: The lake chubsucker has a disjunct distribution with a southern element in the lower coastal plain extending from Texas to Virginia, and a northern element in southern Great Lakes drainages. The species has a fragmented distribution between these two elements. The lake chubsucker is native to 22 states, 1 province, and has been introduced to Nebraska.

Canadian Range: In Canada, the lake chubsucker occurs only in southwestern Ontario. It has been found in Rondeau Harbour, Long Point Bay, several tributaries of Big Creek, Point Pelee, Jeanette's Creek (a tributary of the Thames River), Tee Creek (a Niagara River tributary), Lake Erie, Lake St. Clair, and the OAC (Mandrak and Crossman 1996). In the Ausable River, the lake chubsucker was first recorded from the OAC in 1982 and was confirmed extant in the channel in 1997, 2002, and 2004.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Distribution Trend: Although the lake chubsucker persists in several locations, it may have been lost from four Ontario occurrences (Rondeau, Long Point, Tee Creek, Jeanette's Creek), but additional sampling is required to confirm this.

Population Abundance:

Global Range: Although the lake chubsucker is globally secure (G5), declines have been reported throughout much of the northern part of its range. This species is listed as extirpated in two states (Indiana, Pennsylvania), Threatened in three states (KY, NY, OH), and as Special Concern in three states (AR, MO, WI).

Canadian Range: There is no information available on abundance of Canadian populations, but the limited number of records suggests low abundance. The lake chubsucker was recorded at four sites in the OAC in 1982 (Erling Holm, ROM, unpublished data). Seven specimens (including juveniles) were captured by seine net from two sites in the OAC in September 1997 (Holm and Boehm 1998). During a week of extensive surveys conducted by DFO in 2002 (employing a variety of survey techniques over a 5 km reach), 13 individuals were captured. By comparing pooled data from 2002 for the area within 1000 m of the dam to that collected in 1997, the relative abundance of the lake chubsucker appears unchanged and the population may currently be stable. Additional surveys were conducted in 2004 and these data are currently being used in the identification of critical habitat.

Percent of Global Abundance in Canada: Less than 5% of the species' global abundance occurs in Canada.

Population Trend: The abundance of lake chubsuckers has probably declined in Canada, but there is no trend through time data available to assess the magnitude of this trend.

Biologically Limiting Factors: The lake chubsucker is limited to clear, well-vegetated, slow-moving waters. The only location where this type of habitat remains in the Ausable River watershed is the OAC.

Threats: Lake chubsucker populations have been reduced or eliminated in some areas due to habitat alterations such as siltation (Lee *et al.* 1980) and changes to rates of flow. Drainage of wetlands and siltation of lake chubsucker habitat are the most serious threats to the species in Canada (Mandrak and Crossman 1996). In the OAC, which is now protected by a dam from influxes of suspended solids from the river, siltation is not currently a serious threat. On going development surrounding the OAC (outside The Pinery Provincial Park) near Grand Bend could have negative impacts on habitat. Other potential threats to the lake chubsucker, specific to the OAC, include shifts in the fish community to one dominated by centrarchids and negative impacts to vegetation and water clarity due to common carp (see pugnose shiner section for greater detail). Scott and Crossman (1973) note that adult lake chubsuckers would be ideal prey for basses and pikes living in the same habitats. With the apparent increase in larger predatory centrarchids and the recent discovery of northern pike in the OAC (DFO unpublished data, 2002), predation could represent an additional threat.

Habitat Identification:

Critical Habitat: Within the Ausable River watershed, the Recovery Team recommends that critical habitat be designated as the entire OAC upstream of the low head dam (43-14'-48"N, 81-50'-46") to its end near Grand Bend (insert coords). This region of the channel covers a distance of approximately 9.5 km, the majority of which is protected within the borders of The Pinery Provincial Park (~6.4 km). Areas of the OAC outside of the Pinery may be more susceptible to negative impacts due to on going development near Grand Bend. The preferred habitat of the lake chubsucker - clear, still, well-vegetated waters, is found contiguously along this section of channel (a narrative description of the species habitat requirements is given under 'recovery habitat'). This reach of the OAC is essentially a closed system containing a relatively homogenous and self sustaining population with no migration or emigration. These assertions are supported through extensive data collected in 2002 and 2004 (Nick Mandrak, pers. Comm..) and are currently being summarized.
Recovery Habitat: The lake chubsucker inhabits clear, still, well-vegetated waters with bottom substrates of sand or silt mixed with organic debris. These habitats are usually found in backwaters, flood plain lakes, and marshes contained within larger water bodies. Spawning usually occurs over gravel in streams or over vegetation in still water. In Ontario, lake chubsuckers have been captured primarily in heavily vegetated stagnant bays, channels, ponds and swamps with low turbidity and substrates of clay, silt, sand and organic debris (Mandrak and Crossman 1996). In the Ausable River these habitats are limited to the OAC (upstream of the low head dam) which should be considered recovery (and survival) habitat for the lake chubsucker.
Survival Habitat: Survival habitat for the lake chubsucker is limited to the OAC (equivalent to recovery habitat).
Habitat Trends: It is not known how much of the lower Ausable River provided habitat for the lake chubsucker prior to its diversion in the 1800s, but the habitat available in the OAC seems relatively unchanged. Habitat quality has declined at some of the other Canadian occurrences.
Habitat Protection: The habitat of the lake chubsucker receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). The only known occurrences of this species in the Ausable River watershed are within the OAC and the majority of this reach is protected within the boundaries of Pinery Provincial Park, which confers some additional protection. Floodplain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over stream-side development outside of The Pinery Provincial Park. Although the bed of the channel is owned by the Crown in this area, the majority of adjacent lands outside the Park are currently residential or being developed into residential subdivisions. Designation of the OAC as 'critical habitat' for the lake chubsucker would provide specific habitat protection under SARA.
Examples of Activities Likely to Result in the Destruction of Critical Habitat:

The lake chubsucker prefers clear, well vegetated waters. Therefore any activities that result in increased and prolonged levels of turbidity may result in the destruction of critical habitat for this species. High levels of siltation and turbidity may also limit aquatic macrophyte growth, which is an important component of their habitat. Any activities that cause widespread silting to occupied habitats may therefore result in the destruction of critical habitat. Such activities include drainage or construction projects that do not follow proper sedimentation control protocols to downstream regions.

Ecological Role: The lake chubsucker is a bottom feeder that consumes primarily diatoms, algae, mussels, insect larvae and occasional adult insects (Becker, 1983). Adults feed by picking mussels and aquatic insects off plants and eating filamentous algae (ROM 1999). Lake chubsuckers may be a suitable prey for largemouth bass (*Micropterus salmoides*) (Eberts et.al. 1998).

Importance to People: Given its rarity and small numbers, the lake chubsucker is of little economic significance. However, it could be considered an indicator species of healthy wetlands.

Anticipated Conflicts or Challenges: The potential impacts of introduced fishes will be difficult to address.

Knowledge Gaps: Additional sampling needs to be conducted to determine the full extent of the lake chubsucker's distribution in the OAC. Spawning areas also need to be identified. The impacts of introduced fishes (common carp, northern pike, centrarchids) on the lake chubsucker population in the OAC need to be assessed.

Ecological and Technical Feasibility of Species Recovery:

(i) The inherent capacity of this species to rebound demographically is unknown.
(ii) The current availability of quality habitat is probably high, but it is limited to the OAC
(iii) Habitat restoration is probably not required in the OAC (habitat protection is required) and it is unlikely that habitat restoration is feasible in the Ausable River proper.
(iv) It is feasible to mitigate threats from upstream development, but impacts of introduced predators may be difficult to address.
(v) As the Lake chubsucker is extant in the system it is not necessary to consider repatriation.
(vi) The level of effort required for recovery of the Ausable River population would be low (habitat protection).

Black Redhorse (*Moxostoma duquesnei*)

Species Information:

Common Name: Black redhorse
Scientific Name: *Moxostoma duquesnei*
Assessment Summary
Status: Threatened
Reason for designation: This species has a restricted range in Canada, and a declining population size. It is impacted by habitat alteration.
Occurrence: Ontario
Status history: Designated Threatened in 1988.

Species Description:
The black redhorse is one of the smaller species of redhorses, rarely more than 38 cm in length and usually 25 to 33 cm in length (Scott and Crossman 1973). It most closely resembles the larger golden redhorse (*M. erythrurum*). Although both have grey tails the black redhorse has a higher lateral line scale count of 45-48 instead of 30-44 (McAllister et al 1985). The overall colouration is olive to gray dorsally, with brassy or golden sides and orange anal and paired fins.

Distribution:

Global Range: The black redhorse occurs through much of the Mississippi River system and north into the Great Lakes Basin. It is known from 21 states and the province of Ontario. The black redhorse is globally common (G5) (NatureServe 2003). In the United States, it is listed as extremely rare (S1) in three states, very rare (S2) in three states, and vulnerable in two states. It is apparently secure or demonstrably secure (S4-S5) in the remaining states where it has been ranked (NatureServe 2003). In Canada, the black redhorse is currently listed as imperiled (S2) in Ontario and is usually a relatively minor component of the fish community.

Canadian Range: In Canada, the black redhorse has been previously reported from Catfish Creek, the Grand, Thames and Maitland Rivers (Parker 1989), as well as Spencer Creek at the western end of Lake Erie (E. Holm, Royal Ontario Museum, pers. comm.). More recently, it has been reported from the Bayfield (Veliz 2001) and the Ausable river watersheds (DFO unpublished data 2002). The Spencer Creek occurrence is based on a record from a reservoir and is likely a bait-fish introduction.

Percent of Global Range in Canada: Less than 5% of the global distribution of the black redhorse is found in Canada.

Distribution Trend: Previously, reproducing populations of black redhorse were known only from the Thames and Grand Rivers in Canada (Parker 1989). Recent sampling by DFO has confirmed their continued presence in these systems in 2002. Recent sampling in Catfish Creek by Holm and Boehm (1998) in 1997 and DFO in 2002 (J. Barnucz, DFO pers. comm.) failed to capture any

black redhorse, supporting Parker's (1989) suggestion that the species has been extirpated from the watershed. The species is still extant in the Maitland River and was captured at one site by DFO in 2002 (J. Burnucz, DFO pers. comm.). Data on black redhorse in the Ausable and Bayfield Rivers is too limited to assess trends in distribution or abundance.

Population Abundance:

Global Range: The global abundance of the black redhorse is unknown.

Canadian Range: Populations of the black redhorse have apparently been extirpated from Catfish Creek, while populations persist in the Grand, Thames, Maitland, Bayfield, and Ausable Rivers.

Percent of Global Abundance in Canada: Based on the proportion of their global range in Canada, it is likely that less than 5% of the global population abundance of the black redhorse occurs in Canada.

Population Trend: The black redhorse was first recorded from the Ausable River watershed in 2002. During a watershed-wide survey of 25 sites, a total of four individuals were captured at a single site in the lower Little Ausable River. One of the individuals captured was a juvenile (J. Burnucz, DFO pers. comm.), indicating recent reproduction. The species may have been missed in previous surveys due to limited sampling and/or difficulties with identification (few biologists can distinguish this species from other redhorses). In July 2003, a single dead adult (fresh) was found in a riffle area of the Arkona Gorge (S. Staton, DFO, pers. comm.) suggesting that the species may have a wider distribution within the main channel of the Ausable River.

Due to a general lack of comprehensive, species-specific surveys, assessing population trends in Canadian populations has been problematic. For example, in the absence of more recent collections, Scott and Crossman (1973) had suggested that the species might have been extirpated in Canada. Under consequent, more rigorous sampling, the species appears only to have disappeared from Catfish Creek. In the Grand River, more recent collections have demonstrated that the black redhorse is more widely distributed than previously thought, although it is still uncommon and generally not collected in large numbers (Portt *et al.* 2003). In the past, this species is thought to have been under-reported due to 'lumping' of redhorse species and a lack of suitable sampling gear (Portt *et al.* 2003).

Biological Limiting Factors: The black redhorse is 'intolerant of very turbid waters, and increased turbidity and siltation are usually followed by decreases in (its) population' (McAllister et al 1985).

Threats: Siltation and high turbidity is likely the most immediate threat to the black redhorse in Canada. In the Ausable River, land management practices that contribute to siltation and turbidity would be most detrimental to this species. In the Little Ausable River, where a reproducing population was located, concerns about low summer base flows have been raised (Veliz 2001). Impoundments have been implicated in population declines of the black redhorse in some regions through silting and destruction of habitat.

However, impoundments do not appear to be a threat to this species in the Ausable basin considering what is known about its current distribution. Additional survey work to better define the range of this species in the Ausable basin would greatly assist in a more thorough assessment of threats to the species.

Habitat Identification:

Critical Habitat: Critical habitat has yet to be determined for the black redhorse in the Ausable River, since available information on the distribution of this species is limited to 2 sites in the watershed.

Recovery Habitat: In Canada, the black redhorse has been reported from moderately sized rivers with sand, gravel and bedrock substrates where siltation is minimal (Parker 1989). The species is considered intolerant of siltation and an inhabitant of pools in the swifter flowing portions of rivers with clear water (Scott and Crossman 1973). Capture localities in Ontario had gravel and boulder bottoms with very little aquatic vegetation (McAllister *et al.* 1985). In the Ausable River basin, there are no historical records for the black redhorse. Thus, defining the extent of recovery habitat will require an analysis of the current population size once necessary surveys have been completed. PVA modeling may help define the region of recovery habitat.

Survival Habitat: In the Ausable River, survival habitat for the black redhorse is limited to the lower reaches of the Little Ausable River where a reproducing population appears to exist. Additional surveys, specifically targeting the black redhorse, are required throughout the basin to fully define the extent of the Ausable River population before survival habitat can be fully described.

Habitat Trend: In the Ausable River basin, little is known specifically about habitat trends for the black redhorse. However, increased levels of siltation and turbidity due primarily to agricultural landuse practices over the past 200 years have surely had a negative impact on habitat quality over time for the black redhorse. Low base flows may also be negatively impacting habitat quality. Other once abundant riffle species in the Ausable River (with similar habitat requirements), such as the northern riffleshell, have suffered drastic population declines suggesting an overall decline in the habitat quality of riffles.

Habitat Protection: The habitat of the black redhorse receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). Floodplain regulations enforced by the ABCA provide some control over stream-side development. The majority of lands throughout the Ausable basin are privately owned and in agricultural use, however, the Arkona Gorge (where the black redhorse apparently occurs) is a conservation area and protected by the ABCA. Once the critical habitat of the black redhorse has been legally designated, (and the species is added to schedule 1), it will be protected through the SARA.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Siltation and high turbidity are thought to be the most immediate threat to the black redhorse in Canada. Any activities that cause widespread silting and/or

increased levels of turbidity to occupied riffle habitats may result in the destruction of critical habitat. Such activities would include drainage projects that do not follow proper sedimentation control protocols to downstream regions. Any proposed project that results in alteration to the stream channel could result in destruction of critical habitat for this species.

Ecological Role: Black redhorse are bottom feeders that feed entirely on invertebrates.

Importance to People: Although the black redhorse has little economic significance, it may be occasionally caught by recreational fisherman.

Knowledge Gaps:

- Further research is required to assess the impacts of high turbidity and suspended solids on the survival of the black redhorse.
- The distribution of the species within the Ausable River basin is known from only two recent records. Additional surveys are required to define the population of this species as a first step in recovery planning for the species.
- There have been no comprehensive studies of the life history of the black redhorse in Canada (Parker 1989). Such information may help further refine threats and recovery needs since Canadian populations are disjunct and possibly unique (Portt *et al.* 2003).

Ecological and Technical Feasibility of Recovery:

(i) The inherent ability of the species to rebound demographically is currently unknown.

(ii) Habitat in the Ausable River proper appears to be compromised due to high sediment loads and turbidity. However, habitat conditions in the Little Ausable River appear to be more suitable and currently support reproduction. Additional survey work is required to assess available habitat for the black redhorse throughout the watershed.

(iii) The habitat in the Ausable River could be improved significantly with proper stewardship of lands, both agricultural and urban to reduce sediment inputs.

(iv) Reductions in soil erosion and turbidity from a variety of sources (overland erosion, drainage tiles, bank and bed) is achievable in the Ausable River but would require a basin wide effort.

(v) Population supplementation (from a stronger source population such as the Grand River) may be an option if required for the Ausable River population. Again, additional information on the status of the Ausable River population is required before any such considerations should be considered.

(vi) The black redhorse is naturally rare in Canada. The level of effort required for recovery of the species in the Ausable River would be moderate (e.g. habitat restoration) to high (e.g. translocation, long-term population augmentation) depending on the strength of the population which is not currently known.

River Redhorse (*Moxostoma carinatum*)

Species Information:

Common Name: River Redhorse
Scientific Name: *Moxostoma carinatum*
Assessment Summary – date: 1987
Status: Special Concern
Reason for designation: This species has restrictive habitat requirements and is impacted by siltation and pollution.
Occurrence: Ontario and Quebec**.**
Status History: Designated Special Concern in April 1983. Status re-examined and confirmed in April 1987.

Description: The river redhorse is a large member of the sucker family that is generally greater than 50 cm in total length (Campbell 2001, Reid 2003). The largest individual recorded to date measured 81.2 cm (Jenkins et al. 1999). It can be distinguished from other redhorses in Canada by its red tail (in living specimens) and large head combined with a low count of 12-13 scales around the caudal peduncle and its molariform pahryngeal teeth. The river redhorse is most similar to the greater redhorse (*Moxostoma valenciennesi*) which are both large redhorses with red tails and large heads. The greater redhorse has a higher scale count around the caudal peduncle (15-16 scales).

Distribution:

Global Range: The river redhorse occurs in small to large rivers in the southern Great Lakes and St. Lawrence drainages, throughout much of the Mississippi basin, and the Gulf Slope from Florida to Louisiana. It is known from 24 states and from the provinces of Québec and Ontario.

Canadian Range: In Canada, the river redhorse is restricted to southwestern Ontario and southwestern Quebec. In Québec, the river redhorse occurs in the St. Lawrence, Richelieu and Yamaska River basins. In Ontario, the river redhorse was historically known from the Ausable River, the Ottawa River and the Mississippi River (Parker 1988). Recently, river redhorse have been discovered in the Madawaska, Trent and Grand Rivers as well as the Bay of Quinte in Lake Ontario (E. Holm, Royal Ontario Museum, pers. comm., Campbell 2001). Recent collections have confirmed that the species is extant at all of these locations except the Ausable River. The river redhorse was collected from the Ausable River in 1936 at Ailsa Craig. Two specimens were deposited in the ROM from this collection. No river redhorse have been found in the Ausable River since this initial collection. Parker (1988) suggested that the continued existence of this species in the Ausable River was in doubt due to a lack of suitable habitat. Sampling efforts in the vicinity of Ailsa Craig in August, 2002 failed to capture any river redhorse, but a single adult greater redhorse was captured 3 km north of Ailsa Craig. Although the river redhorse has not been captured from the Ausable River since 1936, it is not possible to say with certainty

that it has been extirpated from the system. No exhaustive searches have been conducted and difficulty in distinguishing this species from other redhorses may have confounded results form previous surveys.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Distribution Trend: The river redhorse's distribution has been relatively stable in Canada with the possible exception of the Ausable River. Several new occurrences have been discovered over the last decade, but this is due to the use of new sampling gear (electrofishing boats) and better identification skills as opposed to range expansions.

Population Abundance:

Global Range: The river redhorse is globally common (G4), but declines have been reported in the northern and western parts of its range (Page and Burr 1991). There are no estimates of global abundance.

Canadian Range: The river redhorse is not abundant at any of its Canadian occurrences. Populations are normally restricted to the lower portions of major watersheds.

Percent of Global Abundance in Canada: Canadian populations probably contain less than 5% of the global population.

Population Trend: There is no trend through time information to assess population trends.

Biologically Limiting Factors: The river redhorse is apparently intolerant of pollution and turbidity (Scott and Crossman 1973) and may be less tolerant of turbidity than other species of redhorses (Jenkins and Burkhead 1993).

Threats: Land-management practices that contribute to siltation and extensive channelization may be detrimental to this species in the Ausable River. Campbell (2001) found that river redhorse abundance in the Mississippi River was highest at Secchi depths greater than 2 m and none were caught in areas where Secchi depth was less than 1 m. It is likely that turbidity levels in the Ausable River are limiting for this species.

Habitat Identification:

Recovery Habitat: The river redhorse inhabits rocky pools and swift runs of small to large rivers (Page and Burr 1991). It can also be found in natural lakes and impoundments (Jenkins and Burkhead 1993) although it prefers large rivers and the lower portions of their main tributaries (Becker 1983). The river redhorse tends to be most numerous over unsilted rock substrates in flowing water (Jenkins and Burkhead 1993). However, Campbell (2001) captured some river redhorses in the Missisippi River, Ontario in areas of high macrophyte abundance with slow current and soft substrate. Juveniles are often found in the shallow portions of pools and in backwaters. In the Ausable River these habitats have yet to be identified. The presence of this species in the Ausable River is limited to a single record from Ailsa Crag in 1936.

Survival Habitat: Survival habitat is unknown at this time as the river redhorse may be extirpated from the Ausable River.
Habitat Trends: Although the quality of river redhorse habitat has not been quantified, the high turbidity and nutrient levels in the Ausable River have likely resulted in degradation of habitat.
Habitat Protection: The habitat of the river redhorse receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). Floodplain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over stream-side development. The bed of the Ausable River is owned by the Crown, but the majority of adjacent lands are privately owned and in agricultural use.

Ecological Role: The river redhorse has enlarged, molariform pharyngeal teeth that are adapted for crushing the shells of mussels, snails and crayfish (Jenkins and Burkhead 1993). In addition to feeding on mussels, aquatic insect larvae are important in the diet of river redhorse (Scott and Crossman 1973; Becker 1983; Mongeau *et al.* 1992; Jenkins and Burkhead 1993). Aquatic insects are probably the main food for juveniles.

Importance to People: The river redhorse can be captured by angling and there are a small number of anglers in Ontario that seek this and other redhorse species. As a primary mollusk feeder, the river redhorse is one of the few native Ontario fishes that feeds on the nuisance zebra mussel.

Anticipated Conflicts or Challenges: Challenges are as for other species.

Knowledge Gaps: Sampling needs to be conducted to determine if the river redhorse is extant in the Ausable River. This should be accomplished by identifying the distribution, quantity and quality of fast water habitat patches. Sampling should be conducted at the best sites using the appropriate gear (backpack or boat electrofishing) when the likelihood of capture/detection is highest - during late May to early June when river redhorse are concentrated near spawning habitats (S. Reid, pers. comm.). Efforts need to be made to develop rearing methods for river redhorse if repatriation is warranted. River redhorse were successfully reared to the swim-up stage at the MNR Codrington Fish Hatchery from eggs and sperm collected from Trent River redhorse in spawning condition (S. Reid, pers. Comm.).

Ecological and Technical Feasibility of Species Recovery:

(i) The inherent capacity of this species to rebound demographically after a fish kill is demonstrated in Jenkins and Burkhead (1993). Fecundity of female river redhorse can range from 9,000 to almost 43,000 eggs (Campbell, 2001, Mongeau et al. 1992, Beaulieu 1961), demonstrating a good potential to rebound. Along the Trent River, males in spawning condition were 5 to 16 years old while females were 7 to 16 years old (cosewic report – get reference).

(ii) The current availability of quality habitat is probably low, although habitat assessment is required to determine the suitability of these sites.
(iii) & (iv) Restoration of habitat requires reductions in sediment input from a variety of sources (overland erosion, drainage tiles, bank, and bed). This will require a large basin-wide effort to be effective.
(v) & (vi) It may be possible to reintroduce this species to the Ausable River if the habitat is suitable. Redhorses have been successfully reared in captivity (Branchaud and Gendron 1993) and there are source populations in Ontario that could be used (Grand River, Trent River). The Approaches Section recommends that a repatriation plan be developed if suitable habitat is present and the species is absent.
(vii) Assuming that the species is extirpated, the level of effort required for recovery of the Ausable River population would be high (habitat restoration and repatriation).

Greenside Darter (*Etheostoma blennioides*)

Species Information:

Common Name: Greenside darter
Scientific Name: *Etheostoma blennioides*
Assessment Summary – date: 1990
Status: Special Concern
Reason for Designation: This species has a restricted range in Canada and appears to be declining as a result of habitat degradation.
Occurrence: Ontario**.**
Status History: Designated Special Concern in April 1990.

Description: The greenside darter is the largest member of the genus *Etheostoma* in the darter sub-family, reaching a total length of 11-14 cm. It has a rounded snout, which extends slightly beyond the mouth. The first dorsal fin, the anal fin, and the pelvic and pectoral fins are usually smaller on the females. The back and head of this fish are olive-green or olive-brown, while its sides, caudal, anal and pelvic fins are pale green, and the underparts are white. It can be distinguished from other darters occurring in Ontario by the presence of 5-8 large, green 'W's or 'U's on its side, and the fusion of the rear of the upper lip to the snout (Page and Burr 1991).

Distribution:

Global Range: The greenside darter occurs in southern Great Lakes drainages (Huron, St. Clair, Erie, and Ontario), throughout much of the Mississippi basin (there is a hiatus in its range in southern Illinois and Indiana), and along the Atlantic slope from New York to Virginia. It is known from 17 states and from the province of Ontario.

Canadian Range: In Canada, the greenside darter is known from several drainages in southwestern Ontario: Ausable River, Sydenham River, Thames River, Lake St. Clair, Big Creek, and Grand River. The species has recently spread throughout much of the upper part of the Grand River watershed after a presumed introduction about 10 years ago. The greenside darter is widespread and locally abundant in the Ausable River watershed. During a survey of 25 sites in 2002, the species was found at over half (13) of the sites surveyed with as many as 71 individuals captured at a single site.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Distribution Trend: The distribution of the greenside darter has increased in Canada after its introduction into the Grand River watershed. The species is also still present in all watersheds that it is known from historically.

Population Abundance:

Global Range: The greenside darter is globally secure (G5) and appears to be stable throughout much of its range. The species is listed as being of Special Concern in Mississippi and Kansas.
Canadian Range: There are no abundance estimates for the greenside darter in Canada, but it is locally abundant in many areas where it occurs. In Ontario it is ranked as common (S4).
Percent of Global Abundance in Canada: It is likely that Canadian populations represent less than 5 % of the greenside darter's global abundance.
Population Trend: There is no trend through time information available, but it is likely that the Canadian population has increased with the introduction of the greenside darter into the Grand River watershed.

Biologically Limiting Factors: The greenside darter lays its eggs on filamentous algae attached to rocks in fast-flowing riffle areas. These habitats may be limiting in some systems, but apparently not within its Canadian range in southwestern Ontario.

Threats: Dalton (1991) suggested that the specialized feeding and spawning areas (riffle habitats) were at risk from several anthropogenic disturbances, including impoundment, contaminants associated with industry and agriculture, siltation, and low water flows. Although the greenside darter may be limited by turbidity in the Ausable River, it appears to be maintaining its range and abundance levels throughout much of the system under current conditions. The greenside darter does not appear to be as sensitive to the common threats that are affecting other species in the system. The greenside darter is one of the few species in the Ausable River that inhabits streams classed as municipal drains and may therefore be Threatened by drain maintenance activities. However, it has persisted in these drains under existing maintenance regimes.

Habitat Identification:

Recovery Habitat: The greenside darter inhabits rocky riffles of creeks and small to medium-sized rivers and is occasionally found along the shores of large lakes (Page and Burr 1991). Greatest abundance is reached in riffles that are deep and swift with a rubble and boulder substrate (Dalton 1991). Although the greenside darter is most often found in streams of low turbidity, it exists in quite turbid habitats in the Ausable, Thames and Sydenham rivers. Juveniles and adults may be found in similar habitats. Rocks in riffles covered with filamentous algae (usually *Cladophora*) are used as spawning sites (Scott and Crossman 1973). Recovery habitat could be considered as riffles and runs in the entire Ausable River and tributaries.
Survival Habitat: It is difficult to quantify survival habitat for this species, which is widespread in the Ausable River system.
Habitat Trends: The quantity and quality of greenside darter habitat in the Ausable River have not been assessed. Given that the range and abundance of the greenside darter appear stable, trends in habitat are probably similar.
Habitat Protection: The habitat of the greenside darter receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also

received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). Floodplain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over stream-side development. The bed of the Ausable River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the greenside darter are privately owned and in agricultural use.

Ecological Role: The greenside darter feeds on small benthic invertebrates that live in riffle areas of streams. Aquatic insect larvae (primarily midges, caddisflies, and blackflies) make up the majority of the diet (Dalton 1991).

Importance to People: The greenside darter is a legal baitfish in Ontario and may be occasionally incidentally harvested for use as bait. The greenside darter is one of Canada's more beautiful freshwater fishes and may have potential as an aquarium fish, but it is currently not part of the trade.

Anticipated Conflicts or Challenges: None.

Knowledge Gaps: The range and abundance of greenside darter should be monitored as part of standard surveys.

Ecological and Technical Feasibility of Species Recovery:

(i) The maintenance of existing range and population abundance is all that is required to "recover" the greenside darter.

(ii) Given the distribution and abundance of the greenside darter in the Ausable River system, quality habitat appears to be in good supply.

(iii) & (iv) The species has thrived under existing protection measures and land use practices, and additional recovery measures will only enhance habitat and benefit the species.

(v) Captive breeding and repatriation will not be considered for this species.

(viii) The species is relatively common within its restricted Canadian range so there would be adequate source populations if repatriation was required.

(ix) The level of effort required for recovery of the Ausable River population would be low (habitat protection).

Bigmouth Buffalo (*Ictiobus cyprinellus*)

Species Information:

Common Name: Bigmouth buffalo
Scientific Name: *Ictiobus cyprinellus*
Assessment Summary – date: 1989
Status: Special Concern
Reason for Designation: The species has a limited and disjunct distribution in Canada, and occurs in low numbers. It is susceptible to parasitic infections, and may be impacted by flood control practices.
Occurrence: Saskatchewan, Manitoba, Ontario**.**
Status History: Designated Special Concern in April 1989.

Description: The bigmouth buffalo is a large member of the sucker family that reaches a length of up to 1 m. It can be distinguished from other buffalofishes by its large ovoid head and its sharply oblique, terminal mouth. The bigmouth buffalo is also superficially similar to the introduced common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*), especially in the juvenile stages.

Distribution:

Global Range: The bigmouth buffalo ranges widely in the Mississippi River basin, the southern Great Lakes, and the Nelson River basin (Hudson Bay). It is native to 21 states and three provinces and has been introduced to three states.

Canadian Range: In Canada, the bigmouth buffalo has a disjunct distribution in Saskatchewan, Manitoba, and Ontario. In Ontario, the species is known from Lake Erie and Lake St. Clair and their tributaries, as well as from Lake Ontario and Lake of the Woods (evidence suggests Lake of the Woods fish were introduced). Although the species has not been captured from Lake of the Woods since the 1970s, its distribution appears to be expanding in southern Ontario, and it has been discovered in many new drainages in the last 10 years (Welland River, Sydenham River, Ausable River, Grand River, Hamilton Harbour). The bigmouth buffalo was not reported from the Ausable River at the time its status was assessed by COSEWIC in 1989 (Goodchild 1990). In August 2002, six *Ictiobus* individuals were captured in the lower end of the river near the confluence of the OAC and the Cut. One fish was confirmed as a bigmouth buffalo and the other five have been tentatively identified as smallmouth buffalo (*Ictiobus bubalus*). This species has not been reported from Canada, and confirmation will be based on examination of specimens by experts and DNA analysis. The bigmouth buffalo can be considered a recent invader of the Ausable River as it is unlikely that a conspicuous fish like this would go undetected in previous sampling efforts.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Distribution Trend: The bigmouth buffalo appears to be expanding its range in Ontario having been found in at least five new watersheds over the last decade.

Population Abundance:

Global Range: The bigmouth buffalo is globally secure (G5) and populations appear stable throughout much of its range (Goodchild 1990). This species has been the subject of "coarse fish" removal programs in some parts of the United States (Krishka *et al.* 1996).

Canadian Range: There are no estimates of Canadian abundance for this species. In Ontario, large numbers of this species have not been collected at individual locations.

Percent of Global Abundance in Canada: Less than 5% of the species' global abundance occurs in Canada.

Population Trend: Although not quantified, the population in Ontario is increasing given the range expansion of this species.

Biologically Limiting Factors: The bigmouth buffalo requires spring flooding for successful spawning and may also be limited by cold winter temperatures.

Threats: The bigmouth buffalo is not as sensitive to human disturbance and in fact may benefit from habitat changes that are detrimental to sensitive species. Efforts to reduce erosion and nutrient loading are unlikely to limit opportunities for the bigmouth buffalo in the Ausable River.

Habitat Identification:

Recovery Habitat: Bigmouth buffalo can occupy a variety of habitats — they inhabit the main channels, pools, and backwaters of small to large rivers, as well as lakes and impoundments (Page and Burr 1991). The species has a high tolerance for turbidity and extremely low oxygen levels and exhibits a preference for warm, highly eutrophic waters (Goodchild 1990). Habitat changes resulting from anthropogenic disturbances may enhance habitat for this species. Spawning occurs in shallow bays or small tributary streams, and the fish will invade streams, ditches, and backwaters during spring flooding. Adhesive eggs are scattered over plant debris in shallow water. Recovery habitat could be considered as the lower portion of the Ausable River.

Survival Habitat: As per Recovery Habitat.

Habitat Trends: The quantity and quality of bigmouth buffalo habitat in the Ausable River have not been assessed. As a recent colonizer, it is likely that sediment and nutrient loading (perhaps coupled with increased temperatures) have enhanced habitat for this species in the Ausable River.

Habitat Protection: The habitat of the bigmouth buffalo receives general protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). Floodplain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over stream-

side development. The bed of the Ausable River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the bigmouth buffalo are privately owned and in agricultural use.

Ecological Role: The bigmouth buffalo has been described as primarily a planktivorous feeder, consuming largely crustacean zooplankton in an indiscriminate fashion. However, benthic insects, mussels, and crustaceans are also consumed (Goodchild 1990). Differing diets of the same life stages in different water bodies suggest that the bigmouth buffalo is really an opportunistic feeder with the capability of using both pelagic and benthic foraging habits (Goodchild 1990).

Importance to People: In Ontario, the bigmouth buffalo is incidentally harvested as a coarse fish in commercial fisheries and has been targeted in Saskatchewan commercial fisheries.

Anticipated Conflicts or Challenges: Recovery efforts for other species that result in improved water quality are unlikely to have a negative impact on bigmouth buffalo.

Knowledge Gaps: The range and abundance of bigmouth buffalo should be monitored as part of standard surveys.

Ecological and Technical Feasibility of Species Recovery:

(i) The bigmouth buffalo is currently expanding its range in Ontario and so has the ability to rebound demographically.
(ii) Much of the lower Ausable River system provides good habitat for the bigmouth buffalo.
(iii) & (iv) The bigmouth buffalo has prospered in the Ausable River under existing conditions. Recovery efforts for other species that result in improved water quality will likely benefit the bigmouth buffalo.
(v) Captive breeding and repatriation will not be considered for this species.
(vi) The species is expanding its range in southern Ontario.
(vii) Recovery is feasible with minimal effort.

Eastern Spiny Softshell Turtle (*Apalone spinifera spinifera*)

Species Information:

Common Name: Eastern spiny softshell turtle
Scientific Name: *Apalone spinifera spinifera*
Current status and most recent date of assessment: Threatened, May 2002
Reason for designation: The distribution of the eastern spiny softshell turtle is scattered across southern Ontario and Quebec. Declining abundance of various populations has contributed to the current Threatened status (May 2002).
Occurrence: Southern Ontario and Québec.
Status history: This turtle was designated Threatened in 1991. The Threatened status was recently re-examined and confirmed (2002).

Species Description:

Softshell turtles are olive-brown in colouration and they have extremely flat, leathery carapaces and long, tubular snouts. Softshells are sexually dimorphic with females attaining a larger carapace length (54 cm) than males (22 cm) (Ausable River Recovery Team 2003). Females can weigh as much as 11.7 kg and on average are more than 1.6 times larger than males (Harding 1997). Sex can be determined visually at hatching: spots on the carapace of males have complete black borders, whereas spots on the carapace of females have 'broken up' boarders. Female colouration becomes a mottled green-brown as the turtle ages; however males retain their colouration and distinctive spots throughout their lifetime.

Distribution:

Global Range: The eastern spiny softshell turtle is widespread throughout the central and eastern United States; however, its distribution is highly fragmented, confined to the Mississippi River-Ohio River system, the lower Great Lakes area, and Lake Champlain.

Canadian Range: This turtle is found in southern Quebec, and discontinuously in eastern and southwestern Ontario in scattered, isolated areas (Seburn and Seburn 2000). In Ontario, softshell turtles are found in Lakes Erie and St. Clair, as well as the Thames, Sydenham, Detroit and Ausable Rivers. Populations may also persist in the Grand River, Big Otter Creek, Kettle Creek, Prince Edward County (NHIC data), and the Cootes' Paradise-Hamilton Harbour area of Lake Ontario. This turtle has also been reported in the Ottawa, St. Lawrence, and Richelieu Rivers in Québec.

Percent of Global Distribution in Canada: Less than five per cent of the species global range is thought to occur in Canada.

Distribution Trend: Although the range of softshells throughout Canada and Ontario does not appear to have changed significantly from historic accounts, the distribution within this range has changed. Historically, softshells were found throughout the Great Lakes - St. Lawrence watershed from the Upper St.

Lawrence to lower Lake Huron. Today, populations are becoming increasingly isolated/ fragmented throughout this historic range, and it appears the rate of decline has been rapid (Fletcher *et al.* 1997). In Ontario, their range probably occupies < 3% of the province (NHIC data). The western Lake Ontario subpopulation is very small and may not be viable (NHIC data).

Population Abundance:

Global Range: The eastern spiny softshell is considered globally secure (G5T5).

Canadian Range: The overall count for Ontario is likely well under 1000 individuals and numbers from the Ottawa River/ Quebec subpopulation are unknown but are likely very low (NHIC data). The abundance of softshells in the Ausable River is largely unknown. Five hatchlings were found in a drainage ditch near the Ausable River in Port Franks in 1987 (NHIC EO 1197) and one adult was observed in the Ausable River in 1992 (Fletcher *et al.* 1997). A landowner reported a nesting female near Nairn in June 2002, however this report has not been verified (M. Veliz, ABCA pers. comm.). The eastern spiny softshell is ranked S3 (rare to uncommon) in Ontario, and S1 (extremely rare) in Quebec.

Percent of Global Abundance in Canada: Less than five per cent of the species global population abundance is thought to occur in Canada.

Population Trend: The rate of change in population abundance in Canada is not known in quantitative terms due to a lack of population data prior to the 1990s; however it is presumed that there has been an overall decline based on historic distribution, habitat loss, and current lack of ideal habitat (NHIC data). Spiny softshell populations have become increasingly isolated/ fragmented throughout their historic range, and it appears the rate of decline has been rapid (Fletcher *et al.* 1997). The historical status of this species in the Ausable River is not known, therefore, little can be said regarding population trends.

Biological Limiting Factors: Critical habitat features required for predation avoidance, hibernation, nesting, and foraging may be limited in the Ausable River. To avoid predation, young softshells utilize shallow water and bury into sand or mud substrates. Lack of suitable hibernation sites may be a limiting factor for spiny softshells. Deep pools that do not completely freeze in the winter are required for overwintering. Nest sites occur above the summer water line and consist of vegetation-free sand or gravel areas adjacent to the river. Vegetative debris and aquatic plants provide opportunities to forage on crayfish, tadpoles, minnows and aquatic insects (Fletcher *et al.* 1997). Another biologically limiting factor is related to age at maturity; this species is long-lived and is slow to reproduce. Females reach maturity at around 12 years of age. Therefore, a lack of population recruitment can go unnoticed for many years and even the occasional removal of turtles can eliminate populations. Additionally, softshell turtles tend to hibernate in large numbers; therefore, populations are vulnerable to stochastic events during this time. Another potential biological limiting factor is the requirement for large home ranges encompassing connected habitats associated with their various life history needs. In a Kansas study, individual smooth softshells were found to move 2-4 km upstream or downstream in a single day, mean short-term home

range length was 1.2 km (maximum range approximately 2.4 km) for adult females, 0.5 km (up to about 1.1 km) for males, and both sexes made long forays outside their home ranges (Plummer and Shirer 1975). In Vermont, spiny softshells migrated 3 km between riverine wintering sites and river mouth nesting sites near Lake Champlain (Graham and Graham 1997).

Threats: Limiting factors specific to softshell turtles in the Ausable River are currently unknown. General threats to this species' survival include habitat alteration, fragmentation, or destruction, contaminants affecting prey species or reproductive potential, nest predation, roads, incidental catch by fishermen, succession of nesting sites, flooding during the incubation period, illegal harvest of turtles for the pet trade or as food items, and the release of captive softshells which could potentially spread disease and/or compete with native softshells (Fletcher *et al.* 1997, Seburn and Seburn 2000). The major land use conflicts, both presently and in the future, are likely shoreline stabilization and development, agricultural use, and recreational use. These activities result in habitat loss/ degradation and fragmentation (Fletcher *et al.* 1997, Seburn and Seburn 2000). Dams alter stream flow and may reduce spring flows which historically scoured vegetation away, thus maintaining open areas. Dams may also increase water levels after nesting, potentially flooding nests. No-till agricultural conservation practices have been linked to increases in raccoons due to excess food remaining on the field, with associated increased risk of nest predation where turtle eggs are in close proximity (M. Malhiot pers. com.). Global warming may have a significant impact on this species because spiny softshells exhibit temperature-dependent sex determination. A change in sex-ratio may have profound effects on populations.

Habitat Identification:

Critical Habitat: There is currently insufficient data to identify critical habitat for the eastern spiny softshell in the Ausable River.

Recovery Habitat: Eastern spiny softshells inhabit soft-bottomed water bodies with an abundance of prey (particularly crayfish) and suitable areas for nesting (Fletcher *et al.* 1997). Several females may nest in the same area; preferring nesting areas close to the water in sandy, sunlit areas above the summer high-water level (Dextrase *et al.* 2003). Within the waterbody itself, several microhabitats are required. Deep pools that are well oxygenated with a soft substrate and will not freeze completely in winter are required for hibernation, and also help regulate body temperature during the summer (Fletcher *et al.* 1997). Resting softshells bury themselves in shallow underwater areas with a muddy or sandy substrate to avoid predation, which is particularly important for juveniles (Fletcher *et al.* 1997). The availability of basking areas where exposure to sunlight is unobstructed by vegetation is important for softshells. Softshells bask frequently during the spring and early summer, most often on riverbanks, but occasionally on logs, rocks and man-made structures such as dams and bridge supports. Gabion baskets and sheet pile walls can restrict access for basking and nesting (Dextrase *et al.* 2003) and are not suitable for basking (Fletcher *et al.* 1997). Softshells may travel considerable distances to satisfy

seasonal habitat needs (Fletcher 1996). Therefore, it is essential that these habitats remain connected (Fletcher *et al.* 1997).

Survival Habitat: Survival habitat in the Ausable River can only be inferred from the limited number of softshell sightings confined to the reaches of the river downstream of Ailsa Craig.

Habitat Trends: There is no information on trends in the quantity and quality of softshell habitat in the Ausable River.

Habitat Protection: The habitat of the eastern spiny softshell receives indirect protection under the habitat provisions of the federal *Fisheries Act*. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species). Flood-plain regulations enforced by the Ausable Bayfield Conservation Authority provides some control over streamside development. The Crown owns the bed of the Ausable River, but the majority of adjacent lands on the portion of the river inhabited by the eastern spiny softshell are privately owned.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Habitat loss and fragmentation are the major threats, with shoreline stabilization and development being the largest contributors to habitat destruction (Fletcher *et al.* 1997).

Ecological Role: Riffles, adjoining creeks, shallow inlets, shallow muddy/ sandy areas, vegetative debris and aquatic plants provide opportunities to forage on crayfish, tadpoles, minnows and aquatic insects (Fletcher *et al.* 1997). Softshells are benthic feeders and scavengers (primarily carnivorous), and crayfish are the most common prey.

Importance to People: In Ontario, the eastern spiny softshell is not subject to harvest as it is classified as Specially Protected Wildlife under the *Fish and Wildlife Conservation Act*. The distinctive features of this turtle make it an important member of the fauna for viewing opportunities in the Ausable River.

Anticipated Conflicts or Challenges: In the Sydenham River, nesting habitats were commonly found on the inside of a river bend, downstream of eroding slopes (Dextrase *et al.* 2003). Therefore, efforts to reduce erosion in the Ausable watershed must recognize that natural erosion of sand banks is important to the maintenance of habitat for this species.

Knowledge Gaps:

Survey Requirements: Surveys conducted in May and June (prime turtle basking periods) are required to determine the abundance and distribution of this turtle in the Ausable River. Important areas for basking, nesting and over-wintering should also be identified and protected.

Ecological and Technical Feasibility of Recovery:

(i) Reproductive capacity of this species to rebound demographically is ‘low’ given its long life span, late maturation and low recruitment rates.

(ii) & (iii) The lack of current information regarding this species in the Ausable River makes it difficult to assess the availability of habitat and the possibility of restoring habitat (or whether this is required).

(iv) Recruitment in most Ontario softshell populations is seriously hampered by high predation rates. It is feasible to mitigate this threat through the construction of physical barriers surrounding nest sites. Efforts to reduce erosion in the watershed must recognize that natural erosion of sand banks is important to the maintenance of habitat for this species.

(vi) Headstarting programs (artificial incubation of eggs) will increase hatching success and should be considered if deemed necessary for this population and provided the availability of required habitat is sufficient and other threats to the species have been addressed. The Thames River Conservation Authority in association with the Eastern Spiny Softshell Recovery Team have initiated the first headstarting program for this species in Canada, and will therefore provide the basis for any headstarting initiatives.

(vii) The level of effort required for recovery of the Ausable River population would likely be low (habitat protection) to moderate (habitat restoration) but this is not definitive due to lack of information. Available information indicates survival habitat extends beyond ‘areas below the top of the bank’.

Queen Snake (*Regina septemvittata*)

Species Information:

Common Name: Queen snake
Scientific Name: *Regina septemvittata*
Current status and most recent date of assessment: Threatened, May 2000
Reason for designation: This is the least reported snake in Ontario. This snake is found only in southwestern Ontario. Several populations have disappeared as a result of habitat loss. This snake is currently found in less than ten sites.
Occurrence: Ontario
Status history: This snake was designated Threatened in 2000.

Species Description:
The queen snake is grayish olive with three thin, faint black lines running the length of its back. The chin, throat and belly are yellow with four brown stripes on the underside. It is a fairly slim snake and reaches an average length of about 40 to 60 cm, although snakes approaching 1 m long have been found.

Distribution:

Global Range: The global range of the queen snake is generally east of the Mississippi River, from Ontario south as far as Florida.

Canadian Range: In Canada, the queen snake is found in southwestern Ontario, west of the Niagara escarpment and south of Georgian Bay. Populations occur in Essex, Lambton, Huron, Waterloo, Brantford, Middlesex, and Haldimand-Norfolk counties/ regional municipalities. This species was formerly known to occupy a wider range, including sites in Kent, Bruce and York counties (NHIC data). The former range extended east to Toronto, but specimens have not been found in this area since the mid-1800's (Lamond 1994). A total of 7 known occurrences are now believed to be historic or extirpated (NHIC data). A few years ago, this species was found in the St. Clair National Wildlife Area (Chatham-Kent) (A. Woodliffe pers. comm.).

Percent of Global Distribution in Canada: Less than five per cent of the species global range is thought to occur in Canada.

Distribution Trend: Consistent queen snake sightings are reported from only a few rivers: the Thames, Maitland, Grand and Ausable, as well as some of their tributaries (Smith 1999). The distribution and status of queen snakes in the Ausable River have not been systematically studied, but there are known to be concentrations of queen snakes at Rock Glen and Hungry Hollow (Judd 1962, Spurr 1978, Spurr and Smith 1979).

Population Abundance:

Global Range: The queen snake is considered globally secure (G5). The species is relatively common through the core of its U.S. range, and rare in some states at the periphery of its range.
Canadian Range: Studies estimating total queen snake abundance in Ontario have not been conducted (Smith 1999); however, this species is ranked S2 (very rare) provincially. Total numbers of Queen Snakes are difficult to estimate due to their amphibious and cryptic nature. In fact, the queen snake is the least reported snake in Ontario and thus assumed to be the least likely encountered.
Percent of Global Abundance in Canada:??
Population Trend: To date, there is no adequate standardized sampling protocol to determine abundance for this species. However, surveys conducted with a similar methodology across southwestern Ontario indicate the abundance and distribution of queen snakes has declined (Campbell and Perrin 1979, Spurr and Smith 1979, Gartshore and Carson 1990, Lamond 1994).

Biological Limiting Factors:
Queen snakes are highly aquatic and are seldom found more than 3 m from water (Campbell and Perrin 1979). Basic habitat requirements for queen snakes include a permanent water body (generally a river or creek and occasionally marshy areas (CARCNET 2003) with water temperatures remaining at or above 18.3°C throughout most of the active season, an abundance of crayfish, and rocks and/or vegetation for cover (Wood 1949). Low shrubs at the waters edge may be a limiting factor for populations inhabiting systems that have had significant riparian vegetation removal, as shrubs exposed to sunlight are commonly used for basking (K. Vlasman, pers. obs.). Queen snakes are extreme food specialists: numerous studies have found that 98% or more of their diet consists of crayfish, preferably freshly molted (Smith 1999). Therefore, the distribution and abundance of crayfish may be a limiting factor for queen snakes, as crayfish have generally been found to be declining and have been eliminated from many areas due to runoff and siltation (Seburn and Seburn 2000).

Threats: Threats specifically associated with the Ausable River are unknown; however, habitat loss or alteration is widely considered the most significant threat to queen snake populations in Ontario and elsewhere (Cook 1970, Campbell 1977, Froom 1972). Habitat loss can occur as a result of building dams (such as those on the Thames River, Whiteman's Creek and Otter Creek), bulldozing and construction activities within the riparian zone, as well as the installation of gabion baskets and storm drains along streams. Additionally, dams can render habitat unsuitable for queen snakes by causing alterations in the stream flow. Roads also present a threat for this species (Smith 1999), as their construction may effectively fragment habitat and isolate populations, as well as lead to increased mortality by means of vehicular casualties. The negative impacts of habitat loss are then further exacerbated by the habitat and dietary specificity of queen snakes.

Pollution of streams and rivers (e.g., chemical contamination, agricultural runoff and increased siltation) poses additional threats, both direct and indirect, to this species. Crayfish, the queen snakes' primary prey, are susceptible to acidification and mercury

toxicity (Vermeer 1972, Berrill *et al.* 1985), and queen snake populations have disappeared from many localities in Pennsylvania because the local crayfish populations have been extirpated (McCoy 1982). Crayfish also accumulate mercury (Seburn and Seburn 2000) and it is not know what affect this may have on the queen snake.

Habitat Identification:

Critical Habitat: There is currently insufficient data to identify critical habitat for the queen snake in the Ausable River.

Recovery Habitat: Recovery habitat is a rocky or gravel bottomed riverine habitat. Basic habitat requirements for queen snakes include a permanent area of water (generally a river or creek, occasionally a marshy area) with water temperatures remaining at or above 18°C throughout most of the active season, an abundance of crayfish and rocks and/or vegetation for cover (Wood 1949). The queen snake also requires an adequate winter hibernation location.

Survival Habitat: Sightings of queen snakes in the Lower Ausable confirm their survival habitat there. However, given the cryptic nature of this species, occupied habitat is assumed to be more far reaching than the limited number of sightings would suggest.

Habitat Trends: There is no information on trends of the quantity and quality of queen snake habitat in the Ausable River. Queen snake habitat in other rivers such as the Thames River, the Bayfield River and areas near Lake St. Clair seems to be declining due to loss of wetlands, pollution and human intervention.

Habitat Protection: The majority of queen snake habitat in Ontario is under private ownership. Although there are a few populations that occur in protected areas, the security that such areas afford may be limited to maintaining edge habitat, since the widespread decline of crayfish may affect these areas and increased human disturbance may interrupt basic life history patterns and habitat usage. In the Ausable River significant queen snake populations occur within the Rock Glen Conservation Area in Arkona (Judd 1962, Spurr and Smith 1979). Incidental protection is offered through flood plain regulations (Campbell and Perrin 1979) and through the Federal Fisheries Act. Protection from development and site alteration in significant portions of this species' habitats is also received under the Ontario Provincial Policy Statement, Section 3 of the *Planning Act* (applies to Threatened and Endangered species).

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Alteration of stream flows (Campbell 1977), loss of natural stream buffers (Seburn and Seburn 2000), loss of wetlands and human activity along river banks are activities that can have an impact on queen snake habitat (Campbell and Perrin, 1979). Stream development projects should take into account the presence of queen snakes and their habitat. Dam construction along the Grand River in 1988 is thought to be responsible for the death of most of the queen snakes inhabiting a particular site (Seburn and Seburn 2000). Pollution of watercourses that negatively impacts crayfish populations may also result in the destruction of critical habitat.

Ecological Role: The queen snake has been found to forage either among stones and detritus in swift shallow water or to remain motionless with its head exposed in calm pools (Raney and Roecker 1947, Gillingwater pers. obs.). Crayfish are the main source of prey for the queen snake (Raney and Roecker 1947, Branson and Baker 1974). Various mammals and predatory birds may eat queen snakes (Campbell and Perrin 1979) but these snakes are not likely a significant source of prey.

Importance to People: Queen snakes provide no apparent economic value in Ontario. Due to the queen snake's specialized diet of crayfish, it may be beneficial as an environmental indicator of either the decline or loss of crayfish, or as indicators of mercury contamination or suspended sediment pollution.

Anticipated Conflicts or Challenges:
Queen snakes are cryptic in nature, making sampling notoriously difficult, especially for small populations. To improve chances of finding this species it is important that survey times during the day coincide with optimal diurnal activity patterns, and that survey times during the year coincide with seasonal periods when individuals are more concentrated (breeding, gestation, nesting, birthing, emergence from hibernation etc.). Cover boards can be placed in known areas of queen snake occurrence, trapping can be conducted in hibernation areas during emergence from hibernation. Mark and recapture (use of pit tags) can be used in conjunction with the above as a method for estimating population abundance (A. Yagi pers. com.).

Knowledge Gaps:
Survey Requirements: Surveys to determine the abundance and distribution of this reptile in the Ausable River Valley are required immediately to update presence/ absence of this species.

Ecological and Technical Feasibility of Recovery:
(i) Reproductive capacity of this species to rebound demographically is 'moderate' (Seburn and Seburn 2000). Females reach maturity in 3 or more years and give birth to approximately 10 - 12 young. Reproductive females may not breed annually.
(ii) & (iii) The lack of current information regarding this species in the Ausable River makes it difficult to assess the availability of habitat and the possibility of restoring habitat (or whether this is required).
(iv) With the exception of dam removal, the restoration of known critical terrestrial habitat is possible.
(v) Propagation of the queen snake in captivity is not a viable option (Branson and Baker 1974, Campbell and Perrin 1979, Steve Marshall pers. com., Jeff Hathaway pers. com.). Supplementation from healthy northern U.S. populations may be an option. As a result of the decline of queen snake sightings throughout Ontario (Oldham 1988, Oldham and Sutherland 1986, Oldham and Weller 1989, Oldham, unpubl. Data OHS), it is unknown whether the remaining populations have sufficient numbers to remain viable over the long term. Aquatic habitat restoration would require further research and a moderate level of effort. Survival habitat may extend beyond 'areas below the top of the bank'.

Northern Map Turtle (*Graptemys geographica*)

Species Information:

Common Name: Northern map turtle
Scientific Name: *Graptemys geographica*
Current status and most recent date of assessment: Special Concern**,** May 2002
Reason for designation: There are many potential threats to this species and its habitat that suggest a significant susceptibility to population decline.
Occurrence: Ontario and Québec.
Status history: Designated Special Concern in May 2002. Assessment based on a COSWEWIC status report.

Species Description:

The northern map turtle is a fairly large, highly aquatic turtle. Northern map turtles are sexually dimorphic. Females attain a longer carapace length (25 cm) than males (14 cm). The carapace is olive-brown with a reticulate pattern that resembles contour lines on a map. This pattern fades as the turtle matures. The strongly keeled and posteriorly serrated carapace of the juvenile is also less pronounced in adults. The skin is olive-green with yellow striping and a triangular yellow spot behind each eye.

Distribution:

Global Range: The global range of the northern map turtle includes the northeastern United States, southwestern Quebec and southern Ontario.
Canadian Range: In Ontario, northern map turtles are found along the shores of Lake Ontario and Lake Erie, the Detroit River and Lake St. Clair, and the shores of Georgian Bay. They can also be found in several of the larger inland rivers, including the Thames, Ausable, Sydenham, Grand and Ottawa Rivers, in addition to some of the larger lakes along the southern edge of the Canadian Shield (Roche 1999). In Quebec this species has been found along the Ottawa River between Deep River and Montreal, in the southern end of Lac St. Francois on the St. Lawrence River, and in Baie Missisquoi of Lake Champlain (Roche 2002 and others cited therein).
Percent of Global Distribution in Canada: Approximately 10% of the species' global range is found in Canada.
Distribution Trend: The lack of short- or long- term population studies make it difficult to assess population trends. Changes in the range of this species in Canada have not been documented, although it is likely that local populations in urban areas have been extirpated (Roche 2002).

Population Abundance:

Global Range: The northern map turtle is considered globally secure (G5). The species is relatively common through the core of its U.S. range and rare in some states at the periphery of its range.

Canadian Range: This species is ranked S2 (very rare) in Quebec, and S3 (rare to uncommon) in Ontario. Population size is poorly known in Ontario, although this species is sometimes locally abundant. The level of abundance of northern map turtles in the Ausable River is currently not known. There are only seven records of this species from the Ausable River in the Ontario Herpetofaunal Summary, from the late 1970's to 1990; all are from the Hungry Hollow/ Rock Glen Conservation Area (NHIC data, K. Ramster, NHIC, pers. comm.). Records for many rare species exist from these sites, probably due to easy access to the river. Also, since these areas tend to be rocky with riffles, it may be that additional populations occur in downstream areas where presumably more suitable habitats exist (deeper, slower and muddier).

Percent of Global Abundance in Canada: Not available. There has been no ongoing monitoring of the northern map turtle in Canada (Roche 2002).

Population Trend: No trend information is available. Information in the OHS database indicates the largest and most persistent Great Lakes populations are at Long Point and Rondeau Provincial Park, and that the largest and most persistent inland river populations are along the Thames and Grand Rivers (Roche 2002). Accumulation of contaminants of this turtles' prey species such as mollusks, and general declines in molluscan numbers may be having detrimental effects on population numbers (Roche 2002).

Biological Limiting Factors: Limiting factors specific to populations in the Ausable River are unknown. The abundance and distribution of this species' mollusk prey may limit their abundance, range and distribution, particularly due to the vulnerability of some mussel species to siltation. Additional limiting factors may include lack of aquatic vegetation (turbidity is likely limiting growth of aquatic vegetation in the lower Ausable since high levels of suspended solids reduce light penetration required for aquatic plant growth). This species is long-lived and is slow to reproduce; females reach maturity at around 12 years of age. Therefore, a lack of population recruitment can go unnoticed for many years and even the occasional removal of turtles can eliminate populations. The current knowledge of this species' life history is quite limited (Roche 2002). Additionally, map turtles may be exceptionally vulnerable to a sarcophagid fly (Metasarcophaga: *Tripanurga importuna*) whose maggots kill embryos and hatchlings (Roche 2002).

Threats: Habitat alteration or destruction, nest predation and raccoon predation of all ages (Roche 2002), pet trade (resemblance to highly desirable species, COSEWIC 2002) and traffic mortality are general threats to the map turtle. Another possible limiting factor for this species may be a lack of abundant aquatic vegetation. Turbidity is likely negatively affecting the growth of aquatic vegetation in the lower Ausable. Water quality is sometimes a limiting factor for map turtles, as high water quality is required in order to support their mollusk prey base (CARCNET 2003). Shoreline development and recreational boat use may prevent turtles from using suitable nesting habitat. Dams may negatively impact this species by altering habitat and submerging nest sites (Roche 2002). Adult females are vulnerable to traffic mortality as they search for suitable nesting sites. No-till agricultural conservation practices have been linked to

increases in raccoons due to excess food remaining on the field, with associated increased risk of nest predation where turtle eggs are in close proximity (M. Malhiot pers. com.). Map turtles are habitat specialist and may be replaced by more tolerant species when changes to habitat occur (Roche 2002).

Habitat Identification:

Recovery Habitat: Map turtles prefer larger bodies of water such as lakes and rivers with a slow current. Muddy substrate, abundant aquatic vegetation and suitable basking sites are also required. Basking occurs primarily on the shore in the spring; however, preferred basking sites are further offshore on exposed rock, deadheads, etc. as the water levels drop. Gregarious basking is observed in map turtles. Open, sandy areas close to the water are required for nesting (Roche 1999). Deep sections of water with submerged logs or soft substrate (to wedge beneath) are essential for winter hibernation (Pluto and Bellis 1988, Graham and Graham 1992, Harding 1997). Suitable hibernation sites are also important for courtship and mating, as these activities occur while turtles are congregated in their winter hibernacula (Roche 1999).

Survival Habitat: Survival habitat in the Ausable River can only be inferred from the limited number of northern map turtle sightings in the Lower Ausable.

Habitat Trends: There is no information regarding the trends in the quantity and quality of map turtle habitat in the Ausable River.

Habitat Protection: Some habitat protection is indirectly provided under the federal *Fisheries Act*. Flood-plain regulations enforced by the Ausable Bayfield Conservation Authority provide some control over streamside development. The Crown owns the bed of the Ausable River, but the majority of adjacent lands are privately owned.

Examples of Activities Likely to Result in the Destruction of Critical Habitat: Habitat loss and fragmentation are the major threats, with shoreline stabilization and development and recreational use being the largest contributors to habitat loss. River clean-up projects must not remove logs upon which these turtles bask, or at minimum replace removed logs with platforms (e.g. Roche 2002).

Ecological Role: Unionid mussels are the prime food source for female northern map turtles (Roche 1999). Because of their larger size, females are able to consume mussels, clams and large snails, whereas males and juveniles eat insects, crayfish and smaller mussels (Roche 1999). Despite the recent proliferation of zebra mussels in the Great Lakes region, experimental manipulation demonstrated that captive-reared map turtles would only consume them if more profitable prey items were scarce (Serrouya *et al.* 1995). It seems unlikely that the map turtle would pose a threat to Endangered species of unionids, since most of these mussels tend to prefer riffle habitats with gravel substrates and strong currents, not preferred by map turtles.

Importance to People: The northern map turtle has little economic significance. However, the global loss of turtles is important to people. Of the 293 taxa (mainly species, but including some subspecies) known to be extant over the last few centuries, nine taxa are extinct in the wild. An additional 12 taxa are critically Endangered, 32 taxa

are Endangered and 61 taxa are vulnerable (PARC Partners in Amphibian and Reptile Conservation 2004)

Anticipated Conflicts or Challenges: General challenges are as for other species.

Knowledge Gaps:
Survey Requirements: Surveys to determine the abundance and distribution of this reptile in the Ausable River Valley are required immediately to update the presence/ absence of this species.

Ecological and Technical Feasibility of Recovery:
(i) Reproductive capacity of this species to rebound demographically is 'low' given their long life spans, late maturation and low recruitment rates.
(ii) & (iii) The lack of current information regarding this species in the Ausable River makes it difficult to assess the availability of habitat and the possibility of restoring habitat (or whether this is required)
(iv)Recruitment in most Ontario turtle populations is seriously hampered by high predation rates: map turtles are unlikely an exception. Such threats can likely be mitigated through the construction of physical barriers surrounding nests.
(v) Headstarting programs (artificial incubation of eggs) will increase hatching success and should be considered if deemed necessary and provided the availability of required habitat is sufficient.
(x) The level of effort required for recovery of the Ausable River population would likely be low (habitat protection) to moderate (habitat restoration) but this is not definitive due to lack of information. Survival habitat may extend well beyond 'areas below the top of the bank'.

Appendix 2: Species at Risk Definitions

This appendix provides the status, G-Rank and S-Rank definitions as assigned by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ontario Ministry of Natural Resources (OMNR), and The Nature Conservancy.

National Designations:

COSEWIC Status. Status assigned to species by COSEWIC. COSEWIC is the Committee on the Status of Endangered Wildlife in Canada**,** established in 1977 for the purpose of evaluating and assigning national conservation status to species at risk. This committee is an apolitical committee that includes representatives of federal, provincial and territorial governments, as well as university and museum academics and independent biologists with expertise in relevant fields. Each species receives a status designation from COSEWIC following the completion and review of a species status report. Status reports contain information on the biology, range, abundance and possible threats to the species (for more information on national status definitions see http://www.cosewic.gc.ca/index.htm).

EXT (Extinct). A species that no longer exists.

EXP (**Extirpated)**. A species no longer existing in the wild in Canada, but occurring elsewhere in the wild.

END (**Endangered)**. A species facing imminent extirpation or extinction throughout its range.

THR (**Threatened)**. A species likely to become Endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

SC (Special Concern). A species of Special Concern because of characteristics that make it particularly sensitive to human activities or natural events, but does not include an extirpated, Endangered or Threatened species.

DD (Data Deficient). A species for which there is insufficient information to support a status designation.

NAR (Not At Risk). A species that has been evaluated and found to be not at risk.

Provincial Designations:

OMNR Status
Status assigned to species by the Ontario Ministry of Natural Resources. (COSSARO). In 1996, the provinces signed the *Accord for the Protection of Species at Risk in*

Canada. As a result of this Accord, the government of Ontario was committed to assessing and reporting on the status of all native species to the province. In order to accomplish this, the province struck a committee known as the Committee on the Status of Species at Risk in Ontario (COSSARO). COSSARO is a provincial technical committee with a mandate to review status reports on species and make recommendations to the Ministry of Natural Resources (MNR) on their designation (for more information on provincial status definitions see http://www.omnr.gov.on.ca/).

EXT (Extinct). A species that no longer exists anywhere.

EXP (Extirpated). A species that no longer exists in the wild in Ontario but still occurs elsewhere.

END-R (Endangered Regulated). A species facing imminent extinction or extirpation in Ontario which has been regulated under Ontario's Endangered Species Act (ESA).

END (Endangered Not Regulated). A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's ESA.

THR (Threatened). A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.

SC (Special Concern). A species with characteristics that make it sensitive to human activities or natural events.

NAR (Not at Risk). A species that has been evaluated and found to be not at risk.

DD (Data Deficient). A species for which there is insufficient information for a provincial status recommendation.

Global Rank (G-Rank)

Global ranks are assigned by a consensus of the network of natural heritage programs (Conservation Data Centres), scientific experts, and The Nature Conservancy (www.tnc.org) to designate a rarity rank based on the range-wide status of a species, subspecies or variety. The most important factors considered in assigning global ranks are the total number of known, extant sites world-wide, and the degree to which they are potentially or actively Threatened with destruction. Other criteria include the number of known populations considered to be securely protected, the size of the various populations, and the ability of the taxon to persist at its known sites. The taxonomic distinctness of each taxon has also been considered. Hybrids, introduced species, and taxonomically dubious species, and varieties have not been included (for more information on global ranks see www.mnr.gov.on.ca/MNR/nhic/).

G1 (Extremely rare). Usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction.

G2 (Very rare). Usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction.

G3 (**Rare to uncommon)**. Usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

G4 (Common). Usually more than 100 occurrences; usually not susceptible to immediate threats.

G5 (**Very common)** and demonstrably secure under present conditions.

GU (Uncertain). Often because of low search effort or cryptic nature of the species; more data needed.

G? (**Unranked)** or, if following a ranking, rank tentatively assigned (e.g. G3?).

G A "G" (or "T") followed by a blank space means that the NHIC has not yet obtained the Global Rank from The Nature Conservancy.

Q denotes that the taxonomic status of the species, subspecies, or variety is **questionable**.

T denotes that the rank applies to a subspecies or variety.

Provincial Rank (S-Rank)

Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually. The NHIC welcomes information which will assist in assigning accurate provincial ranks. (for more information on provincial ranks see www.mnr.gov.on.ca/MNR/nhic/).

S1 (**Extremely rare)**. Usually 5 or fewer occurrences in the province or very few remaining individuals; often especially vulnerable to extirpation.

S2 (**Very rare)**. Usually between 5 and 20 occurrences in the province or with many individuals in fewer occurrences; often susceptible to extirpation.

S3 (**Rare to uncommon)**. Usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances. Most species with an S3 rank are assigned to the watch list, unless they have a relatively high global rank.

S4 (**Common)** and apparently secure in Ontario; usually with more than 100 occurrences in the province.

S5 (**Very common)** and demonstrably secure in Ontario.

SH. Historically known from Ontario, but not verified recently (typically not recorded in the province in the last 20 years); however suitable habitat is thought to be still present in the province and there is reasonable expectation that the species may be rediscovered.

SX (Extirpated). No longer exists in Ontario.

SR. **Reported** for Ontario, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.

SU (Uncertain). Often because of low search effort or cryptic nature of the species, there is insufficient information available to assign a more accurate rank; more data are needed.

Appendix 3: COSEWIC Status Reports

National status reports are available for the 14 nationally listed aquatic species from the COSEWIC Secretariat or from published reports.

Mussels:

- Northern riffleshell (Staton *et al.* 2000)
- Wavy-rayed lampmussel (Metcalfe-Smith *et al.* 2000)
- Snuffbox (Watson *et al.* 2000)
- Kidneyshell (Metcalfe-Smith and Zanatta 2002)

Fishes:

- Pugnose shiner (Parker and Campbell 1987)
- Eastern sand darter (Holm and Mandrak 1994)
- Lake chubsucker (Mandrak and Crossman 1996)
- Black redhorse (Parker 1989)
- River redhorse (Parker 1988)
- Greenside darter (Dalton 1991)
- Bigmouth buffalo (Goodchild 1990)

Reptiles:

- Eastern spiny softshell turtle (Obbard 1991)
- Queen snake (Smith 1999)
- Northern map turtle (Roche 1999)

Contact:

COSEWIC Secretariat
Canadian Wildlife Service
Environment Canada
4th Floor, Place Vincent Massey
351 St. Joseph Blvd
Hull, QC K1A 0H3
Telephone: 819-953-3215
Fax: 819-994-3684
Email: COSEWIC/COSEPAC@ec.gc.ca
Internet: www.cosewic.gc.ca