Species at Risk Act
Recovery Strategy Series

Recovery Strategy for Gravel Chub (*Erimystax x-punctatus*) in Canada

Gravel Chub

February 2008

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

About the Species at Risk Act Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the Species at Risk Act and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

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Additional copies:

You can download additional copies from the SARA Public Registry (http://www.sararegistry.gc.ca/)

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DECLARATION

This recovery strategy for gravel chub has been prepared in cooperation with the jurisdictions described in the Preface. Fisheries and Oceans Canada has reviewed and accepts this document as its gravel chub recovery strategy as required by the *Species at Risk Act*. This recovery strategy also constitutes advice to other jurisdictions and organizations on the recovery goals, approaches and objectives that are recommended to protect and recover the species.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the gravel chub and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. Implementation of the strategy by other participating jurisdictions and organizations is subject to their respective policies, appropriations, priorities, and budgetary constraints.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives. The Minister of Fisheries and Oceans will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of these species. The Minister will take steps to ensure that, to the extent possible Canadians interested in, or affected, by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

Under the *Species at Risk Act*, the responsible jurisdiction for gravel chub is Fisheries and Oceans Canada. Gravel chub used to occur in Ontario, and the government of Ontario cooperated in the production of this recovery strategy.

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STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

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

This recovery strategy will clearly benefit the environment by promoting the recovery of gravel chub. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects.

RESIDENCE

SARA defines residence as: "*a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating*" **[SARA S2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

The gravel chub is a freshwater fish and was listed as Extirpated under SARA when the Act came into force in June 2003. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed Extirpated, Endangered or

Threatened species. Fisheries and Oceans Canada – Central and Arctic Region, led the development of this recovery strategy. The proposed strategy meets SARA requirements in terms of content and process (Sections 39-41). It was developed in cooperation or consultation with:

- Ontario Ministry of Natural Resources
- New York Department of Environmental Conservation

EXECUTIVE SUMMARY

The gravel chub (*Erimystax x-punctatus)* was last found in Canada in the Thames River drainage, Ontario, in 1958. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated this species as Endangered in 1985, and re-assessed it as Extirpated in 1987. This status was re-examined based on an existing status report and confirmed in 2000. The recovery of the gravel chub has been determined to be technically and biologically feasible.

The gravel chub is a slender, round-bodied minnow with an average length of 76 mm TL and a maximum length of approximately 100 mm TL. It is olive-green dorsally with silvery sides and a white belly. The scale margins on the back and sides of the gravel chub are randomly outlined in black resulting in distinct X-, Y- or W-shaped patterns. A small black spot is usually predominant on the base of the caudal fin. The snout is rounded and long, overhanging the mouth, which has small but conspicuous barbels in each corner.

In Canada, the gravel chub was only known from two locations in the Thames River drainage: at Munsee (Oneida Nation of the Thames) and in a stretch of the river in Mosa and Oxford townships, upstream of land owned by the Delaware of the Thames (Moravian Town) First Nation (or Delaware Nation Council (Moravian of the Thames). These locations are approximately 300 km from the nearest American records in Ohio.

Gravel chub inhabit clear to moderately turbid, medium to large streams, containing abundant riffle areas with silt-free sand, gravel or rock substrates.

The narrow habitat requirements of gravel chub make it vulnerable to habitat degradation and declines in water quality. Siltation and turbidity are believed to be the primary reason for the decline and eventual extirpation of gravel chub from Ontario. Nutrient loading, as a result of agricultural and urban practices (e.g. fertilizers, manure spreading, sewage treatment), may have also contributed to its extirpation.

The Gravel Chub Recovery Team consists of representatives from various Canadian and American agencies. As the gravel chub is one of 23 aquatic species found in the Recovery Strategy for the Thames River Aquatic Ecosystem, recovery approaches and actions related to Habitat Improvement and Stewardship, and Habitat Protection and Management are identified in, and will be addressed under, this watershed recovery strategy. Therefore, species-specific Research and Monitoring recovery approaches are the focus of this recovery strategy. The Recovery Team determined the long-term recovery goal of this strategy is to encourage healthy, reproducing gravel chub populations in the Thames River through habitat improvements if the species is found to be present and, if appropriate, re-introductions if the species is confirmed to be extirpated. The team also developed six short-term (5 year) recovery objectives:

i. Confirm that gravel chub is no longer present in historical areas of occurrence in the Thames River;
ii. Determine the extent and quality of gravel chub habitat in areas of former occurrence;

iii. Identify key habitat requirements in order to define critical habitat and implement strategies to protect and restore recovery habitats;
iv. Identify threats, evaluate their impacts and implement remedial actions to reduce their effects;
v. Examine the feasibility of relocations, captive-rearing and re-introductions; and,
vi. Identify responses to, and evaluate the success of, recovery measures.

The Research and Monitoring approaches identified by the Gravel Chub Recovery Team include monitoring and surveying populations and habitat, life history and critical habitat research, rearing and re-introduction techniques, and long-term monitoring.

TABLE OF CONTENTS

1. BACKGROUND

1.1 Species Assessment Information from COSEWIC

Common Name: Gravel Chub

Scientific Name: *Erimystax x-punctatus*

COSEWIC Status: Extirpated

COSEWIC Reason for designation: Last reported in Canada in 1958, gravel chub was possibly lost due to siltation of the rivers where it had occurred.

Canadian Occurrence: No longer found in Canada.

COSEWIC Status History: Last recorded in the Thames River drainage, Ontario in 1958. Designated Endangered in April 1985 and uplisted to Extirpated in April 1987. Status re-examined and confirmed in May 2000. Last assessment based on an existing status report.

1.2 Description

The following description is from Trautman (1981) and Becker (1985). The gravel chub (Figure 1) is a slender, round-bodied minnow with an average length of 76 mm TL and a maximum length of approximately 100 mm TL. It is olive-green dorsally with silvery sides and a white belly. The scale margins on the back and sides of the gravel chub are randomly outlined in black resulting in X-, Y- or W-shaped patterns. These markings are sometimes absent in large adults, and were usually faintly evident in Ontario specimens (Scott and Crossman 1998). A small black spot is usually predominant on the base of the caudal fin (except in Ontario specimens) (Scott and Crossman 1998). Fins are transparent or silvery with no spotting. The snout is rounded and long, overhanging the mouth, which has small but conspicuous barbels in each corner.

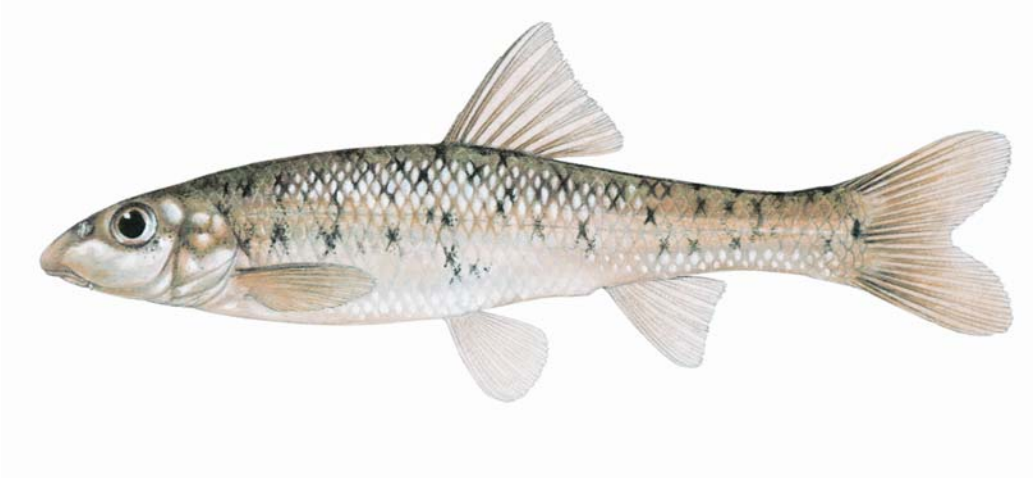

Figure 1. Gravel chub (*Erimystax x-punctatus*)

Hubbs and Crowe (1956) assigned Canadian populations of gravel chub to the subspecies *E. x. trautmani*, which is morphologically distinct from the subspecies *E. x. x-punctatus*. *E. x. trautmani* has a relatively pointed, down-curved and long muzzle compared to *E. x. x-punctatus* which has a blunter, straight, short muzzle. The snout in adult *E. x. trautmani* is typically longer than the postorbital, while the snout of *E. x. x-punctatus* is approximately as long as the postorbital. *E. x. trautmani* has a slender caudal peduncle (least depth averaging about 0.3 less than snout length), whereas the caudal peduncle of *E. x. x-punctatus* is usually deeper (least depth averaging about 0.1 less than snout length).

Genetic validation for the subspecies designation was confirmed by Simons (2004) based on the cytochrome *b* gene.

1.3 Populations and Distribution

Distribution:

Global Range (Figure 2): In the United States, the gravel chub has a discontinuous distribution from Kansas to New York, and southern Minnesota to Arkansas (NatureServe 2006). It occurs in Arkansas, Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, New York, Ohio, Oklahoma, Pennsylvania, West Virginia and Wisconsin. It is presumed extirpated in Kentucky.

The subspecies *E. x. trautmani* is limited to the Ohio River basin in Illinois, Indiana, Ohio, New York, Pennsylvania and Kentucky. In Canada, *E. x. trautmani* was present only in the Thames River, Ontario.

Figure 2. Global distribution of gravel chub (information from Page and Burr 1991).

Canadian Range (Figure 3): In Canada, the gravel chub was only known from two locations in the Thames River drainage: at Munsee (Oneida Nation of the Thames) and in a stretch of the river in Mosa and Oxford townships, upstream of land owned by the Delaware of the Thames (Moravian Town) First Nation (or Delaware Nation Council (Moravian of the Thames). These locations are approximately 300 km from the nearest American records in Ohio. This species has not been collected in Canada since 1958 (Parker *et al*. 1988).

Figure 3. Canadian distribution of gravel chub.

Percent of Global Range in Canada: Less than 5% of the species global range occurred in Canada (TRRT 2005).

Population Size and Status:
Global Population Size and Status: The population size of the gravel chub in the United States is unknown; however, it is believed to be at least 10 000 individuals (NatureServe 2006). This species is considered Apparently Secure (G4) globally, and Nationally Secure (N4) in the United States. The status of the gravel chub in the states where it occurs is: Arkansas (S3?), Illinois (S1S2), Indiana (S4), Iowa (S3), Kansas (S2S3), Kentucky (SX), Minnesota (S3), Missouri (SNR), New York (S1), Ohio (S3), Oklahoma (S2S3), Pennsylvania (S1), West Virginia (S1) and Wisconsin (S1S2) (NatureServe 2006).

Canadian Population Size and Status: In Canada, the gravel chub has been listed as Presumed Extirpated nationally (NX) and provincially (SX) as no specimens have been collected in Ontario since 1958 (NatureServe 2006). The population size of the historic gravel chub in the Thames River is unknown; however, specimens collected in 1923 and

housed at the University of Michigan's Museum of Zoology were of different size classes, suggesting these populations were established (B. Cudmore, DFO, pers. obs.).

Nationally Significant Populations: The Thames River populations of gravel chub were the only representation of this genus in Canada and of this species in the Great Lakes basin.

1.4 Needs of Gravel Chub

1.4.1 Habitat and Biological Needs

Historically Occupied Habitat: The 1923 Thames River gravel chub site was located between the mouth of Hogg Creek and a point on the Thames at Munsee (Holm and Crossman 1986). Habitat at this site was described as clear water, fast currents, substrates comprised of clean sand and gravel and depths up to 1.5 m (Parker *et al*. 1987). The river width at the capture location in 1923 is unknown; however, in the mid-1980's it was approximately 20-30 m (Parker *et al*. 1987). In 1958, nine gravel chub were captured while trawling from Lot 16 in Mosa Township to the eastern limit of the Moravian Indian Reserve (Holm and Crossman 1986). No habitat data are available for this capture location

In the United States, gravel chub have been collected from clear to moderately turbid streams containing abundant riffle areas with silt-free sand, gravel or rock substrates (Trautman 1981, Parker *et al*. 1987). Moore and Paden (1950) suggest that the specific microhabitat for the gravel chub may be under rocks in riffles, reducing the effects of rapid currents. When disturbed the gravel chub has been observed to hide swiftly under rocks. It avoids areas with aquatic macrophytes, aquatic mosses and larger species of algae (Trautman 1981).

In Ohio, gravel chub were found in medium to large streams, at depths of 0.3-1.2 m during the summer and at 0.6-1.8 m during the winter (Trautman 1981). In Wisconsin, specimens were collected from turbid waters, devoid of aquatic vegetation, over swift gravel riffles 0.3-0.9 m deep. Stream width at capture sites was 9-12 m (Becker 1983). No information is available concerning movement patterns or overwintering habitat requirements of adult gravel chub. Differences in habitat use by male and female gravel chub have not been reported. Habitat requirements of young-of-the-year or juvenile gravel chub are unknown.

Currently Occupied Habitat: Currently there are no known occupied habitats in the Thames River.

Habitat Trends: The habitat at the Thames River gravel chub capture sites has shifted from clear to highly turbid water. Based on Jackson Turbidity Units, the lower Thames River remains highly turbid (69.5). Since the 1970s, phosphorous levels at most sites in the watershed have shown a gradual downward trend but remain above the provincial guidelines (30 ug/L) for the protection of aquatic life. Nitrate levels at all monitoring sites in the Thames River have increased over the past 30 years (Taylor *et al*. 2004). Chloride levels have also shown a continual increase at sites across the watershed but in most cases remain below the Environment Canada level of toxicity for sensitive aquatic species (Taylor *et al*. 2004).

Habitat Protection/Ownership: The majority of land adjacent to the Thames River is privately owned and in agricultural, industrial or urban use. Gravel chub habitat is protected under the habitat provisions of the federal *Fisheries Act*. The gravel chub and/or its habitat is also protected under *Ontario's Lakes and Rivers Improvement Act*, *Environmental Protection Act*, *Environmental Assessment Act* and *Water Resources Act*. If gravel chub is reintroduced and critical habitat is then defined, the critical habitat of the gravel chub will be specifically protected under the *Species at Risk Act* (SARA) (TRRT 2005).

General Biology: Little is known regarding the biology of the gravel chub in Canada and most available information comes from populations in the United States (Parker *et al*. 1987). In the United States, gravel chub have been reported to spawn during the spring in areas of rapid current over gravel riffles (Becker 1983, Parker *et al*. 1987). In Kansas, spawning took place in April at a water temperature of 15.5°C (Becker 1983). The length of the spawning period is unknown; however, it is assumed to be limited to a brief period in early spring (Becker 1983). Non-adhesive eggs are scattered over the gravel substrate where they remain until hatching. No parental care is given (Coker *et al*. 2001). Temperature preferences of adult gravel chub are unknown. Gravel chub probably feed on epibenthic insects (Becker 1983, Scott and Crossman 1998) likely obtained from probing under rocks and crevices with its sensitive snout (Parker *et al*. 1987).

1.4.2 Ecological Role

As this species has not been found in the Thames River (or Canada) for nearly 50 years, its ecological role in the watershed is unknown (TRRT 2005). The gravel chub feeds on benthic invertebrates and may be preyed upon by piscivorous species such as rock bass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieu*) found in the Thames River (McAllister *et al*. 1985).

1.4.3 Limiting Factors

Gravel chub have very specific habitat requirements that restrict populations to areas with clean sand or gravel with swift currents.

1.5 Threats

The narrow habitat requirements of the gravel chub make it vulnerable to habitat degradation and declines in water quality. Increased siltation was associated with the extirpation of the gravel chub in many parts of Ohio (Trautman 1981) and Wisconsin (Becker 1983). In Iowa and Minnesota, gravel chub populations may have been extirpated as a result of pesticides, sewage or siltation (Schmidt 2000). Impoundment of essential riffle areas is also a serious threat to the gravel chub in the United States (Becker 1983, NatureServe 2006). Dams alter upstream and downstream habitat conditions and act as barriers, fragmenting populations and limiting re-colonization. Most dams in the Thames River watershed are either in the upper watershed or tributaries to the lower and middle Thames River. The Springbank Dam, situated in northwest London, is the most downstream barrier along the mainstem of the Thames River. When stop-gates are in place from mid-May to early November, it is a barrier to fish passage and creates a small upstream run-of-the-river type impoundment (55 hectares). With the exception of filling the reservoir in mid-May and draining the reservoir in November, the dam has little effect on downstream flows. Therefore, historical habitats of gravel chub are not expected to be affected by dams in the Thames River.

Siltation and turbidity are believed to be the primary reason for the decline and eventual extirpation of the gravel chub from Ontario. Gravel chub collection sites on the Thames River were described in 1923 by D.E.S. Brown (cited in Parker *et al.* 1987) as fast flowing with clear water, and substrates of sand and gravel. In 1985, Holm and Crossman (1986) indicated a shift in habitat conditions as clay and silt were present at all sites and the water was very turbid. Nutrient loading as a result of agricultural and urban practices (e.g. fertilizers, manure spreading, sewage treatment) may have also contributed to its extirpation.

1.5.1 Threat Classification

Table 1. Threat classification for gravel chub.

1. Siltation from agricultural and urban activities		**Threat Information**		
Threat Category	Habitat Loss or Degradation	**Extent**	Widespread	
			Local	**Range-wide**
General Threat	Agricultural/ Industrial Practices	**Occurrence**	Historic /Current	
		Frequency	Continuous	
Specific Threat	Siltation	**Causal Certainty**	Medium	
		Severity	High	
Stress	Reduced population size	**Level of Concern**	High	
2. Water quality deterioration from agricultural and urban activities (fertilizers, sewage treatment etc)		**Threat Information**		
Threat Category	Pollution	**Extent**	Widespread	
			Local	**Range-wide**
General Threat	Agricultural/Urban run-off	**Occurrence**	Historic/Current	
		Frequency	Continuous	
Specific Threat	Nutrient Loading	**Causal Certainty**	Low	
		Severity	Unknown	
Stress	Toxic effects (reduced productivity, increased mortality)	**Level of Concern**	Medium	

1.5.2 Description of Threats

The following description of threats in the Thames River is adapted from the draft Recovery Strategy for the Thames River Aquatic Ecosystem (TRRT 2005).

Threat 1: Siltation from agricultural and urban activities
Elevated siltation and turbidity in the Thames River watershed are primarily a result of agricultural practices. Agriculture represents 78% of land use in the upper watershed and

88% in the lower watershed (Taylor *et al.* 2004). Overland run-off and tile drainage deposit soil directly into drains and waterways. Streamside livestock grazing and ploughing to the waters edge destroys riparian vegetation increasing both erosion rates and the input of sediments (Bailey and Yates 2003).

Areas within the Thames River ecosystem with the highest percentages of soil loss contributing to siltation and turbidity levels are the Middle Thames River (21.2%), Mud (19.9%) and Reynolds (26.4%) sub-watersheds (TRRT 2005). These sub-watersheds are all upstream of former gravel chub collection sites.

Threat 2: Water quality deterioration from agricultural and urban activities (fertilizers, sewage treatment etc)

Nutrients such as nitrogen and phosphorous enter the Thames River system through manure and fertilizer spreading, manure spills, sewage treatment effluent and faulty domestic septic systems (Taylor *et al.* 2004). High nutrient loadings in the river can often be attributed to livestock manure spreading practices (UTRCA 1998). Fifteen sewage treatment plants with varying treatment levels currently discharge wastewater into the Thames River. Bacteria levels (an indicator of manure and human waste in the water) are often well above provincial recreational standards (100 *E.coli*/100 ml). Algal blooms can result from high levels of nitrogen and phosphorous in the water. Algal bloom die-offs can reduce dissolved oxygen levels and cause fish kills. Manure spills have been the leading cause of fish kills in Ontario since 1988 (UTRCA 1998). In the Upper Thames River watershed, episodic fish kills are often reported as a result of chemical spills (most frequently oil and fuel).

1.6 Actions Already Completed or Underway

Thames River Ecosystem Recovery Strategy*:* The Thames River Recovery Team (TRRT), formed in 2002, is in the process of finalizing an ecosystem-based recovery strategy for the aquatic species at risk (SAR) in the Thames River. The long-term recovery goal of the TRRT is "to use an ecosystem approach to stabilize and improve SAR populations within the Thames River ecosystem and to reduce or eliminate threats to these species and their associated habitats, so that their long-term viability in the watershed is ensured" (TRRT 2005). The gravel chub, along with 23 other COSEWIC-listed species (7 mussels, 6 reptiles, 10 fishes) that either historically inhabited or currently inhabit the Thames River watershed, are the focus of the recovery strategy. Action plans put forward by the TRRT would increase the probability of there being suitable habitat available for the gravel chub should re-introductions take place.

1.7 Knowledge Gaps

Survey Requirements: Prior to developing re-introduction plans, should this be deemed feasible, it is necessary to confirm through intensive, targeted sampling that gravel chub are no longer present. To be consistent with past sampling efforts, targeted sampling should occur during the same months and utilize seine nets and electro-fishing gear (backpack and boat). As the last specimens of gravel chub collected from the Thames River in 1958 were from trawls, the use of fine-mesh trawl nets should also be attempted.

Biological/Ecological Research Requirements: Information on the life history characteristics of the gravel chub is required to refine recovery approaches and to define residence, if appropriate, and critical habitat.

Threat Clarification Research Requirements: The threats facing the gravel chub need to be evaluated in terms of their specific impact on the species.

2. RECOVERY

2.1 Recovery Objectives

Long-term Recovery Objectives

The long-term recovery goal is to encourage healthy, reproducing gravel chub populations in the Thames River through habitat improvements if the species is found to be present and, if appropriate, re-introductions if the species is confirmed to be extirpated.

Short-term Recovery Objectives (5 year)

i. Confirm that gravel chub is no longer present in historical areas of occurrence in the Thames River. This is important as very little field work has been done in the area of the historic capture sites of gravel chub in the Thames River;
ii. Determine the extent and quality of gravel chub habitat in areas of former occurrence;
iii. Identify key habitat requirements in order to define critical habitat and implement strategies to protect and restore historically occupied habitats;
iv. Identify threats, evaluate their impacts and implement remedial actions to reduce their effects;
v. Examine the feasibility of relocations, captive rearing and re-introductions; and,
vi. Identify responses to, and evaluate the success of, recovery measures.

2.2 Feasibility of Recovery

Recovery feasibility is determined according to four criteria outlined in Government of Canada (2006):

1. *Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?*

   Yes. Gravel chub have not been collected from the Thames River since 1958 and it is considered extirpated. Gravel chub populations of the same subspecies (*E. x-punctatus trautmani*) in Ohio (S3) and Indiana (S4) are considered stable and, therefore, represent potential source populations to support re-introduction efforts if appropriate.

2. *Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?*

   Yes; however, this needs to be assessed as per Short-term Recovery Objective ii. There may be areas of clean riffles where the current is strong enough to dislodge the silt and clay. Suspended sediment may be tolerable. Across its North American range,

gravel chub is primarily found in gravel and rocky riffles where the current prevents excessive siltation. Its historic distribution in Canada was limited to a few locations along the Thames River. During the last targeted gravel chub survey, riffle habitats were present; however, habitats were affected by high levels of turbidity (Holm and Crossman 1986). No recent targeted habitat inventories have been undertaken at these sites. However, recovery approaches to improve habitat conditions and water quality are identified in the Recovery Strategy for Thames River Aquatic Ecosystem (TRRT 2005).

3. *Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?*

Yes. It is believed that habitat degradation, caused primarily by increased siltation and turbidity, was the main cause of its extirpation from Canada. The Recovery Strategy for Thames River Aquatic Ecosystem identifies recovery actions (under the Habitat Improvement and Stewardship, and Habitat Protection and Management recovery approaches) to improve aquatic habitat conditions and water quality (TRRT 2005).

4. *Do the necessary recovery techniques exist and are they demonstrated to be effective?*

Yes. Increases in the range and abundance of gravel chub have been reported since recent improvements to the water quality and habitat of Illinois and Ohio rivers (Retzer 2005, Yoder *et al*. 2005)

Captive rearing and translocations have been used in southeastern United States towards recovery of endangered benthic fish species (Shute *et al*. 2005). Captive propagation of closely related *Erimystax* species has been successfully undertaken (Conservation Fisheries Inc. 2001). An attempt to expand the range of the gravel chub (the western subspecies, *E. x-punctatus punctatus*) along the Rock River, Wisconsin was, however, unsuccessful. Survival during transfer was high, but no gravel chub were recaptured during 2 to 3 years of follow-up monitoring. Lack of success was attributed to the low number of individuals transferred, a lack of information on population limiting factors, and a lack of quantitative habitat data before the project began (John Lyons, Wisconsin Department of Natural Resources, pers. comm.).

The Thames River Recovery Team determined that gravel chub recovery to be feasible within the Thames River watershed (TRRT 2005).

2.3 Approaches Recommended to Meet Recovery Objectives

Threats to historically occupied gravel chub habitat related to siltation and turbidity, nutrient loadings, and toxic compounds are addressed by actions identified in the Recovery Strategy for the Thames River Aquatic Ecosystem (TRRT 2005). Therefore, protection and improvement of historically occupied gravel chub habitat will be undertaken through the Habitat Improvement and Stewardship, and Habitat Protection and Management recovery approaches identified in the watershed recovery strategy (TRRT 2005).

Species-specific recovery actions related to 'Research and Monitoring' are detailed in the following section, along with more detailed information below the table, if required.

2.3.1 Recovery Planning

Table 2. Research and monitoring approaches for gravel chub recovery.

Priority	Number	Objective Addressed	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Urgent	i-1	i	Monitoring-Gravel Chub Survey	Undertake a targeted survey in areas of historic occurrence. This must include sampling with a trawl net, the gear that captured them in 1958.	Will provide additional evidence for absence, or confirm presence of gravel chub.
Urgent	i-2	ii	Monitoring-Habitat Surveys & Mapping	Define the habitat characteristics of the gravel chub. Evaluate and map the distribution, quantity and quality of habitats in the area of historic occurrence.	Will enable the identification and definition of critical habitat for the gravel chub as per SARA. Will assist in identifying residence if appropriate. Will assist in identifying threats to gravel chub habitat Will direct habitat recovery actions.
Urgent	i-3	iii, iv, v, vi	Research – life history characteristics of all life stages	Determine the life history characteristics of all life stages including diet, reproduction, ecological requirements. Clarify threats.	Will assist in refining necessary recovery actions and identify potential measures of success. Will assist in identifying residence if appropriate. Will identify and clarify threats. Will enable population modeling for potential re-introduction efforts.

Urgent	i-4	iii	Research – Critical Habitat	Determine the habitat needs of all life stages.	Will assist with defining critical habitat so that it can be protected under SARA. Will direct habitat recovery actions.

Table 2 (Con't). Research and monitoring approaches for gravel chub recovery.

Priority	Number	Objective Addressed	Broad Approach /Strategy	Specific Steps	Anticipated Effect
Necessary	i-5	v	Research – Captive Rearing and Re-introduction	Determine the feasibility and appropriateness of re-introductions in areas of suitable habitat. Where re-introductions are deemed appropriate for restoring populations (historical or degraded), develop a re-introduction plan.	Will assess the need for re-introductions to meet long-term recovery goals, investigate whether potential source populations exist, determine the feasibility of captive rearing, and establish/adopt a husbandry protocol if captive rearing is feasible.
Beneficial	i-6	v, vi	Monitoring – Long-term Habitat and Population Monitoring	Evaluate the quality of habitats in areas of planned re-introduction. Information from the activities suggested in i-2 should determine where re-introductions occur. Survey locations of gravel chub re-introduction, should this take place.	Will determine when habitat conditions are suitable for re-introductions. Will determine if re-introduction efforts are successful at re-establishing viable populations.

<u>i-1:</u>
Prior to developing re-introduction plans, it is necessary to confirm through intensive sampling that gravel chub are no longer present. The last targeted gravel chub survey was undertaken in 1985. To be consistent with past sampling efforts, sampling should occur during July and October and utilize a trawl, seine nets and electro-fishing gear. Backpack and boat mounted electro-fishing units have been very effective at collecting gravel chub from Ohio and Wisconsin rivers (Schimdt 2000, Yoder *et al*. 2005). As the last collections of gravel chub from the Thames River in 1958 were from trawls, the use of fine-mesh trawl nets must be attempted. Based on past records of capture in Wisconsin, late fall

(October/November) is considered to be the period of greatest likelihood of capture for gravel chub (Schimdt 1993), so sampling during these months should also occur.

i-2:
Re-introductions should not be considered until the factors for extirpation are understood and addressed. The extirpation of the gravel chub is presumed to be the result of habitat degradation (increased siltation and turbidity). In Wisconsin, water pollution (pesticides, sewage and other point source discharges) have also been identified as causes for extirpations (Schmidt 2000).

The success of a re-introduction will depend on a sufficient quantity of suitable habitat being available at the repatriation site. The failure to quantify potentially limiting habitat or water quality parameters, before translocation attempts in Wisconsin, was considered to have limited the likelihood of success (J. Lyons, pers. comm). Therefore, surveys need to be undertaken to characterize current habitat and water quality conditions and identify appropriate actions to improve degraded habitats.

i-5:
Source populations to support re-introductions need to be identified. Ideally, source populations possess a high level of genetic diversity and genetic composition developed under similar historic conditions as the repatriation site. Gravel chub populations of the same subspecies (*E. x-punctatus trautmani*) in Ohio (S3) and Indiana (S4) are considered stable and, therefore, represent potential source populations to support repatriation. Removal of individuals from source populations should not negatively affect the status of these populations.

The preferred method of introduction (e.g. adult transfer versus captive-rearing) needs to be determined. If captive propagation is the preferred option, propagation and rearing methods and an appropriate rearing facility will need to be identified. Captive propagation of closely related *Erimystax* species has been successfully undertaken (Conservation Fisheries Inc. 2001).

To successfully establish self-sustaining populations and preserve the genetic composition, the number of individuals to be introduced, appropriate life-stages and the frequency and duration of supplemental stockings needs to be determined. Population Viability Analysis (PVA) or other population modeling approaches may help to provide this information. Proper application of PVA tools, however, will require improved information on the life history and demographics of gravel chub.

All proposed re-introductions associated with this strategy will involve the preparation of a re-introduction plan that will address the logistic and ecological aspects discussed above. Re-introductions should follow the American Fisheries Society Guidelines for Introductions of Threatened and Endangered Fishes (Williams *et al*. 1988).

i-6:
Long-term monitoring is required should re-introductions take place to ensure that newly established gravel chub populations are viable, that the stocking rate is appropriate and habitat conditions continue to be suitable. Fall monitoring is recommended as it increases the likelihood of capture of multiple life-stages (young-of-the-year, sub-adult and adult).

2.4 Critical Habitat

2.4.1 Description

As defined by SARA, critical habitat is "*the habitat required for the survival or recovery of a listed species*". The identification of critical habitat requires a thorough knowledge of the species' environmental needs during all life stages, as well as an understanding of the distribution, quantity and quality of habitat across the species' range. At present, this information is not available for the gravel chub, although Table 3 outlines activities that would assist with obtaining the required information if gravel chub is reintroduced. These activities are not exhaustive, but outline the range and scope of actions identified by the recovery team as necessary to identify critical habitat for reintroduced gravel chub. If it is confirmed that gravel chub is extirpated from the Thames River, then defining critical habitat may require research to be undertaken in other parts of its range outside of Canada. Until critical habitat can be defined, the recovery team has identified the areas listed as historically occupied habitat as areas in need of conservation.

2.4.2 Examples of Activities Likely to Result in Destruction of Critical Habitat

Although critical habitat has not been defined, it is possible to identify activities that would negatively affect gravel chub habitat. The following list is considered useful for the assessment of activities affecting areas of former gravel chub occurrence:

- Modification or poor management of a watercourse or surrounding watershed that leads to a significant increase in turbidity or sedimentation (may be agricultural, urban, infrastructure or forestry related);
- The construction of new dams and impoundment of upstream habitats;
- Toxic materials spills;
- Excessive nutrient loading that results in a significant decrease in dissolved oxygen at substrate level; and,
- Dredging or other instream works (e.g. pipeline water crossing) that result in increased levels of turbidity and sedimentation and the disturbance of riffle habitats.

2.4.3 Schedule of Studies to Identify Critical Habitat

Table 3. Schedule of activities to identify critical habitat of gravel chub if reintroduced.

Activity	Anticipated Completion[1] (years after finalization of recovery strategy)
Map and characterize the habitat along the formerly occupied reach of the Thames River	3
Characterize habitats of populations in the subspecies range in the United States, if Thames River populations are confirmed to be extirpated	5
Characterize life-history and demographic characteristics of populations in the subspecies range in the United States, if Thames River populations are confirmed to be extirpated	5

[1]timeframes are subject to change as new priorities arise, or as a result of changing demands on resources of personnel.

2.5 Existing and Recommended Approaches to Habitat Protection

The Upper Thames River and Lower Thames Valley conservation authorities continue their efforts to provide habitat protection for all aquatic life in the Thames River watershed. This work is supported by the Thames River Recovery Team.

2.6 Performance Measures

The presence or absence of the gravel chub in the Thames River needs to be confirmed. If, after targeted sampling efforts, gravel chub are confirmed to exist in the Thames River, performance measures will include measurements of a healthy, reproducing population, such as multiple year classes. Research into the life history characteristics of the gravel chub will provide further insights into what indicators would be good measures of recovery performance.

2.7 Potential Impacts of Recovery Strategy on Other Species/Ecological Processes

The Recovery Strategy for the Thames River Aquatic Ecosystem (TRRT 2005) was developed to address the recovery needs of 23 aquatic or semi-aquatic COSEWIC-listed species (7 mussels, 6 reptiles, 10 fishes, including the gravel chub) that either historically inhabited or currently inhabit the Thames River (TRRT 2005). The gravel chub is found in the same area within the Thames River as the following fish species addressed by the Recovery Strategy for the Thames River Aquatic Ecosystem (based on Figure 14 in Taylor *et al.* 2004): bigmouth buffalo (*Ictiobus cyprinellus*), black redhorse (*Moxostoma duquesnei*), eastern sand darter (*Ammocrypta pellucida*), madtom (*Noturus stigmosus*), northern brook lamprey (*Ichthyomyzon fossor*), river redhorse (*M. carinatum*), silver shiner (*Notropis photogenis*) and spotted sucker (*Minytrema melanops*). Additionally, the following freshwater mussel SAR are also found in the same area: kidneyshell (*Ptychobranchus fasciolaris*), round hickorynut (*Obovaria subrotunda*), round pigtoe (*Pleurobema sintoxia*) and snuffbox (*Epioblasma triquetra*). The COSEWIC-listed mapleleaf mussel (*Quadrula quadrula*) is also found in this area in large numbers (T. Morris, DFO, pers. comm.).

As gravel chub is considered pollution-intolerant and requires non-degraded habitats, protection or restoration of its habitats will benefit the Thames River aquatic SAR listed above through general water and aquatic habitat improvements. Gravel chub recovery approaches are consistent with the Habitat Improvement and Stewardship approaches in the Recovery Strategy for the Thames River Aquatic Ecosystem (TRRT 2005) focused on reducing sediment, nutrient and toxic loadings.

2.8 Recommended Approach for Recovery Implementation

As it is one of 23 aquatic or semi-aquatic species targeted by the Recovery Strategy for the Thames River Aquatic Ecosystem (TRRT 2005), gravel chub recovery will be implemented by the TRRT. Four First Nation communities are located within the Thames River ecosystem and gravel chub recovery habitat is located within or adjacent to First Nations land. Representatives from each First Nation sit on the TRRT.

2.9 Statement of When One of More Action Plans in Relation to the Recovery Strategy will be Completed

One or more action plans relating to this recovery strategy will be produced within 5 years of the final strategy being posted on the registry. Wherever possible, recovery action plans will be linked to the existing Thames River watershed recovery team. Partnership with this recovery team will ensure that efforts are not duplicated and will eliminate implementation of conflicting recovery efforts.

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Appendix 1

RECORD OF COOPERATION AND CONSULTATION

The Gravel Chub Recovery Strategy was prepared by the Gravel Chub Recovery Team. This recovery team was chaired by Fisheries and Oceans Canada (DFO) and has representatives from the Ontario Ministry of Natural Resources (OMNR), Royal Ontario Museum (ROM), Upper Thames River Conservation Authority (UTRCA), Lower Thames Valley Conservation Authority (LTVCA), Wisconsin Department of Natural Resources and the University of Michigan's Museum of Zoology.

The gravel chub is also included in the Thames River Aquatic Ecosystem Recovery Strategy. The Thames River Aquatic Ecosystem Recovery Strategy was prepared by The Thames River Recovery Team (TRRT). The TRRT has representatives from both the UTRCA (who co-chaired the team with DFO and the LTVCA). These Conservation Authorities share responsibility for managing the Thames River watershed where this species was historically found. Other agencies also represented on the TRRT are OMNR, Ontario Ministry of Environment, University of Western Ontario, University of Toronto, and Environment Canada (EC). Aboriginal groups were represented on the TRRT by the Delaware Nation Council (Moravian of the Thames First Nation), Chippewas of the Thames, Oneida Nation of the Thames, and Munsee-Delaware First Nation and a representative from the Southern First Nations Secretariat.

In addition to these First Nation groups, DFO has attempted to engage all potentially affected Aboriginal communities in Southern Ontario during the development of the recovery strategy for the gravel chub. Information packages were sent to the five previously mentioned groups, as well as the Chief and Council of Aamjiwnaang First Nation, Caldwell First Nation, Mississaugas of the New Credit, Six Nations of the Grand, and Walpole Island. Information packages were also sent to Metis Nation of Ontario, Metis Nation of Ontario Captain of the Hunt for Region 9, Métis National Council, Association of Iroquois and Allied Indians, Union of Ontario Indians (Anishnabek Nation), Chiefs of Ontario, and the Assembly of First Nations. Members of these communities may have traveled or harvested fish from the waters of the Thames River where this fish species was found. Follow-up telephone calls were made to each community office to ensure that packages were received and to ask if they would like to schedule a meeting to learn more about species at risk in general and proposed recovery strategies.

As a result of these letters and calls, one meeting was held with the Chief and Councilor for environmental issues of the Munsee-Delaware First Nation. Comments were received from Association of Iroquois and Allied Indians and Chippewas of Aamjiwnaang.

In addition to the above activities, DFO has established an ongoing dialogue with respect to aquatic species at risk in general with the policy advisor to the Southern First Nations Secretariat and has engaged the London Chiefs Council (an association of the 8 area First Nation governments in southwestern Ontario) on several occasions. Meetings have been held with the director of the Walpole Island Natural Heritage Centre and the Fish and Game Enforcement Officer from Walpole Island First Nation. DFO also discussed SARA issues

with a representative of the Six Nations of the Grand who works for the Six Nations EcoCentre and who also represents First Nation interests on the Grand River Fishes at Risk Management Plan, the Thames River Fish Management Plan and the St. Clair River Management Strategy.

Information packages, inviting comments, were sent to non-Aboriginal groups, environmental organizations and municipalities which may be impacted by the recovery strategy. As well, an announcement was placed in newspapers with circulation in the area where this fish was historically found to inform landowners and the general public about the strategy and to request their comments. One comment was received.

A letter was sent to the province of Ontario (OMNR) and comments received were added to the recovery strategy.

The gravel chub is only found in Canada and the United States of America. The Recovery Team has contacted representatives from resource management agencies in New York and Wisconsin where this fish also occurs. Information packages were sent to appropriate agencies in the United States within the distribution of gravel chub. No comments were received.