Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Dwarf Wedgemussel (*Alasmidonta heterodon*) in Canada

Dwarf Wedgemussel

September 2007

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) outline 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. However, in the case of an extirpated species for which recovery is deemed not feasible, no further action is anticipated.

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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Recovery of this species is considered not technically or biologically feasible at this time

Recommended citation:

Department of Fisheries and Oceans. 2007. Recovery Strategy for the Dwarf Wedgemussel (*Alasmidonta heterodon*) in Canada. *Species at Risk Act* Recovery Strategy Series. Department of Fisheries and Oceans, Ottawa. vi + 9 pp.

Additional copies:

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

Cover illustration: J. Domm for Fisheries and Oceans Canada

Également disponible en français sous le titre :
« Programme de rétablissement pour l'alasmidonte naine *(Alasmidonta heterodon*) au Canada »

ISBN 978-0-662-46917-9
Catalogue no. En3-4/37-2007E-PDF

DECLARATION (RECOVERY NOT FEASIBLE)

This recovery strategy for the dwarf wedgemussel has been prepared in cooperation with the jurisdictions responsible for the species, as described in the Preface. The Department of Fisheries and Oceans (DFO) has reviewed and accepts this document as its recovery strategy for the dwarf wedgemussel as required by the *Species at Risk Act* (SARA).

The recovery of the dwarf wedgemussel in Canada has been found to be neither technically nor biologically feasible at this time. Because the population has been extirpated, recovery efforts targeted towards other species in the same geographic area or experiencing similar threats, general conservation programs in the same geographic area, and protection through SARA prohibitions protecting individuals of the species, their residences, and critical habitat will not be effective in this case. Recovery could only occur through reintroduction of the species, which is considered not feasible.

The feasibility determination will be re-evaluated as warranted in response to changing conditions and/or knowledge, in particular every five years as part of the mandatory report on implementation of the recovery strategy.

RESPONSIBLE JURISDICTIONS

Under the *Species at Risk Act*, Fisheries and Oceans Canada is the responsible jurisdiction for the dwarf wedgemussel.

AUTHORS

This document was prepared by Howard Powles (University of Ottawa), and has benefited by reviews from John Loch (Loch Consulting) and staff of Fisheries and Oceans Canada.

ACKNOWLEDGMENTS

Drs Todd Morris, DFO and Janice Smith, Environment Canada, provided valuable guidance on recent literature and contacts with experts in freshwater mussel reestablishment. Drs. Jess Jones (US Fish and Wildlife Service), David Berg (Miami University, Hamilton, Ohio) and Richard J. Neves (Virginia Tech) provided valuable information on potential for recovering extirpated populations of freshwater mussels.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

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 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.

Because the dwarf wedgemussel is extirpated and recovery is deemed to be not feasible, no further recovery action is considered appropriate at this time. Accordingly, there will be no effect of this recovery strategy on the environment.

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 protection is a SARA requirement that is separate from recovery strategy development as it relates to the general prohibitions under the Act (Section 33). To facilitate protection, 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.

In the case of an extirpated species for which the recovery strategy does not recommend its reintroduction into the wild in Canada, the prohibition pertaining to the damage or destruction of residence does not apply [SARA S33].

PREFACE

Fisheries and Oceans Canada has led development of this recovery strategy for the dwarf wedgemussel. The development of the recovery strategy has involved: (i) the preparation of a draft addressing SARA requirements for recovery strategies for extirpated species; (ii) the circulation of this draft for review and comment by the provincial government of New Brunswick; (iii) public consultations on the draft strategy; and (iv) the finalisation of the final version for posting on the SARA public registry.

The determination that recovery is not feasible, including the justification, was reviewed as part of the review and consultation process for the recovery strategy. The final decision and wording of the determination were the responsibility of the DFO and took account of the comments received.

EXECUTIVE SUMMARY

The dwarf wedgemussel (*Alasmidonta heterodonta*) was designated extirpated in Canada by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) in 2000.

The dwarf wedgemussel was historically found at about 70 locations in 15 major drainages from North Carolina to New Brunswick, and has always been considered naturally uncommon or rare throughout this range. In Canada the dwarf wedgemussel was restricted to several locations in the Petitcodiac River of New Brunswick, where it was described as "common" based on a survey in 1960, but where subsequent surveys in 1984 and 1997/98 failed to locate specimens. There is a substantial range disjunction between the northern United States (US) occurrence in Vermont, and the single historic occurrence in Canada, possibly due to origin of the Canadian population in a different glacial refugium (ice-free areas that provided habitat for species during glacial periods) from US populations. If so, the Canadian population may have been genetically isolated from US populations for as long as 50,000 years and may have developed unique genetic characteristics. The species is listed as endangered in the US and now only occurs in 20 of its historical locations.

The dwarf wedgemussel has two critical early life history stages: the parasitic larval stage requiring a specific fish host, and the settlement stage where specific microhabitat conditions are required for survival. The fish host for this species is not known with certainty, but evidence suggests American shad as the probable host in the Petitcodiac system. Sand or fine gravel bottom is required for settlement and adult survival. Juveniles and adults apparently require flowing waters and are sensitive to low oxygen, siltation and chemical pollution.

The primary cause of the extirpation of dwarf wedgemussel is believed to be the elimination of the fish host due to a lack of fish passage at the Moncton-Riverview causeway constructed in 1968. Substantial changes in fish communities followed the construction of the causeway, with the disappearance of several species including the presumed host and significant reductions in others. Available information suggests that suitable habitat for the species remains in the Petitcodiac system, despite degradation in some areas. Several other freshwater mussel species, including two species from the same genus as the dwarf wedgemussel, (*A. undulata* and *A. varicosa*) have been recently collected in the system.

Recovery of the dwarf wedgemussel in Canada is considered not feasible at this time. For recovery to be feasible (1) the causeway would have to be re-engineered to permit fish passage (2) the fish host species would have to be re-established in the Petitcodiac system, either by natural processes (American shad and other coastal species are present in the upper Bay of Fundy), or by hatchery supplementation and (3) dwarf wedgemussels from another population or from captivity would have to be reintroduced in numbers adequate to permit establishment of a viable population. It is probable that several thousand adult individuals would be required in the re-established population to ensure demographic viability. Although each of these steps is possible, there are difficulties and uncertainties at each. The species is listed as endangered in the USA, which might constrain numbers of individuals available to support reintroduction.

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1. BACKGROUND[1]

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2000

Common Name:
Dwarf wedgemussel

Scientific Name:
Alasmidonta heterodon

COSEWIC Status:
Extirpated

Reason for designation:
This freshwater mussel was previously known in Canada from only one river drainage. It has disappeared subsequent to the building of a causeway across the river in 1967/68, and has not been found despite intensive systematic searches of its former habitat

Canadian Occurrence:
New Brunswick

COSEWIC Status History:
Extirpated by 1968. Designated Extirpated in April 1999. Status re-examined and confirmed in May 2000. Last assessment based on an existing status report.

1.2 Description

The dwarf wedgemussel is a small freshwater mussel that is roughly trapezoidal in shape. Clarke (1981 cited in Hanson and Locke 1999: 3-4) provided the following detailed description of the species:

> Shell up to about 45 mm long, 25 mm high, 16 mm wide, and with shell wall about 1 mm thick in the mid anterior region; more or less ovate or trapezoidal, roundly pointed posterio-basally, thin but not unduly fragile, with rounded posterior ridge, and of medium inflation. Females more inflated posteriorly than males. Sculpturing is absent except for lines of growth and beak sculpture. Periostracum is brown or yellowish-brown, and with greenish rays in young or pale-colored specimens. Nacre bluish or silvery white, and iridescent posteriorly. Beak sculpture composed of about 4 curved ridges, which are angular on the posterior slope. Hinge teeth small but distinct; pseudocardinal teeth compressed,

[1] With the exception of Part 1.1 (Species Information from COSEWIC), this Background section is based on Hanson and Locke (1999) unless other sources are cited.

1 or 2 in the right valve and 2 in the left; lateral teeth gently curved and *reversed*, that is, in most specimens, 2 in the right valve and 1 in the left.

Age and growth of the dwarf wedgemussel are little known. Neither size nor age at maturity has been determined. Aging is difficult because shell erosion in larger animals degrades annuli. Ten-year-old animals have been recorded and ages of 12 to 18 years are theoretically possible. In the Petitcodiac, no individual dwarf wedge mussels were found in 1984, 16 years after construction of the Moncton causeway. This suggests rapid mortality and disappearance of individuals living at the time of causeway construction (thus a relatively short life span), and rapid failure of recruitment.

1.3 Populations and Distribution

The dwarf wedgemussel was historically found at about 70 locations in 15 major drainages from North Carolina to New Brunswick, and has always been considered naturally uncommon or rare throughout this range. The historical distribution (Figure 1) is more or less continuous in the USA from North Carolina to the Connecticut River in Vermont, but there is a substantial range disjunction between the northern occurrence in the USA (Vermont) and the single historic occurrence in the Petitcodiac River (New Brunswick) in Canada. In the USA the species is currently found only in 20 of the 70 historic locations and most populations are considered small or declining (Nedeau 2005). The species was listed as federally endangered under the US Endangered Species Act in 1990.

In Canada the dwarf wedgemussel was restricted to several locations in the Petitcodiac River of New Brunswick, where it was described as “common” based on a 1960 survey. Subsequent surveys in 1984 and 1997/98 did not locate specimens in the Petitcodiac. The species is not known from any other systems draining into the Bay of Fundy, nor from the state of Maine, despite suitable habitat conditions (Nedeau 2005). Because of the range disjunction with US populations, it has been suggested (Nedeau 2005) that the Petitcodiac population originated in a different glacial refugium from US populations and may thus have been genetically isolated from US populations for as long as 50,000 years. Several other mussel species show similar disjunct distributions including the yellow lampmussel (*Lampsilis cariosa*), tidewater mucket (*Ligumia ochracea*), brook floater (*Alasmidonta varicosa*) and eastern lampmussel (*Lampsilis radiata*).

1.4 Needs of the Dwarf wedgemussel

1.4.1 Habitat and biological needs

Habitat requirements of the dwarf wedgemussel have been well documented as a result of US recovery efforts. The species lives in running waters, where currents are moderate to slow, in streams from less than 5 m wide to shallow rivers more than 100 m wide. It

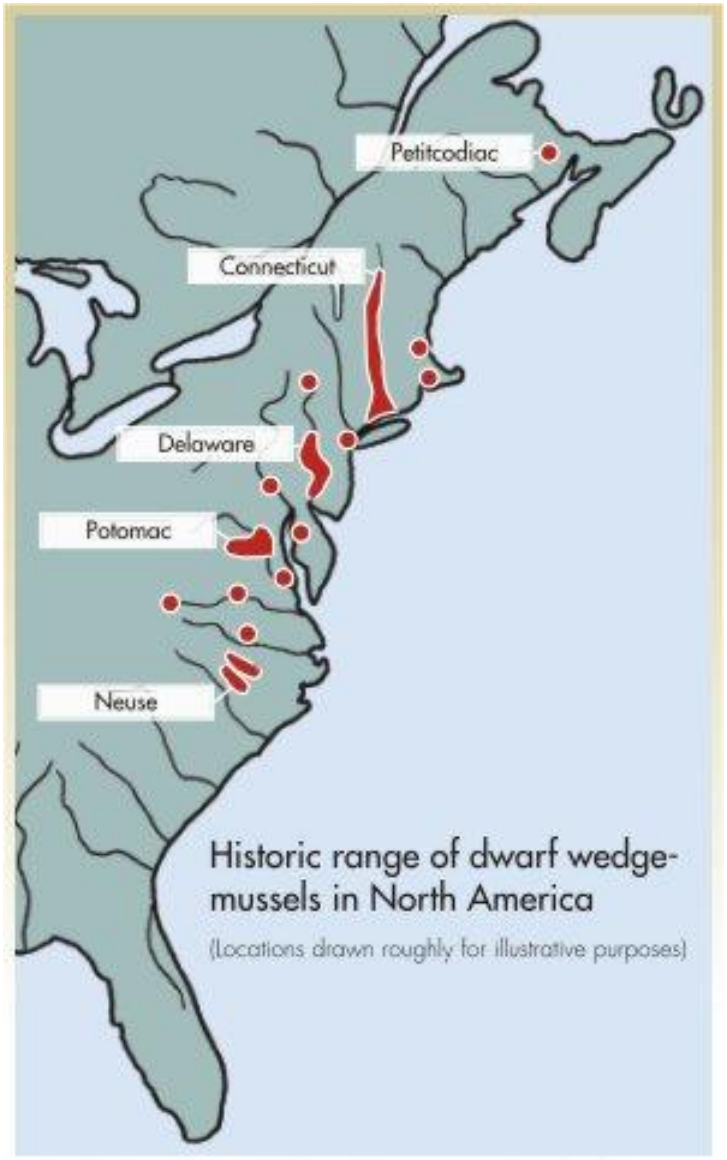

Figure 1: Historic range of the dwarf wedgemussel in North America (Nedeau 2005, based on data from the United States Fish and Wildlife dwarf wedgemussel federal recovery plan, 1993).

always occurs in patches of sand or fine gravel, often in areas of stones or cobble, and shows very low tolerance for silt or low oxygen conditions. It is often found near riverbanks under overhanging trees.

Little information on the biology of dwarf wedgemussel is available, and what is known of the species is consistent with the general biology of freshwater mussels. Eggs are

fertilized in mid-summer or autumn and the glochidia (larvae) mature within the specialized regions of the females' gills known as marsupia. Glochidia are released into the water in spring, attach to the fins and gills of fish with tiny hooks, and then encyst on the host fish. After several weeks the cyst ruptures and the juvenile mussel drops to the bottom. Successful settlement depends on the presence of suitable substrate of sand or fine gravel. Juvenile mussels bury in the sediments and feed by filtering algae and fine organic debris from the water. Following settlement mussels are essentially sedentary, with maximum movements measured in meters.

Fish hosts for wild dwarf wedgemussel are not known with certainty, although several species are capable of carrying larvae based on laboratory studies. The species is more specific in its fish host requirements than many other freshwater mussel species, and the tessellated darter (*Etheostoma olmstedi*) is believed to be the primary host in US populations (Nedeau 2005). Of species known to be capable of hosting dwarf wedgemussel, only Atlantic salmon parr (*Salmo salar*) were historically present in the Petitcodiac River. The most likely host for dwarf wedgemussel in the Petitcodiac system, however is thought to be American shad (*Alosa sapidissima*), which was present at sites where the dwarf wedgemussel was historically found and was immediately eliminated from the Petitcodiac system after construction of the causeway (Hanson and Locke 1999). Atlantic salmon are unlikely to have been the principal host, since a remnant population supplemented by stocking of parr persisted in the Petitcodiac system until the 1990s, long after the dwarf wedgemussel had disappeared.

1.4.2 Ecological role

Given its relatively low historic abundance throughout its range, the dwarf wedgemussel may not have played a large role in aquatic ecosystems. The Petitcodiac system was one of two North American locations where the species was considered historically common, but given the lack of knowledge on the species and its biology in this system, it is not possible to describe its ecological role here.

Freshwater mussels, as benthic filter feeders, play a role in transforming planktonic production to benthic biomass and ultimately to aquatic, avian and terrestrial predators. They are considered good indicators of water quality in aquatic systems because of their sensitivity to siltation, low oxygen conditions, and changes in fish communities.

1.4.3 Limiting factors

As with other freshwater mussels, the dwarf wedgemussel has two critical early life history stages: the parasitic stage requiring a specific fish host, at which dispersal can occur; and, the settlement stage where specific microhabitat conditions are required for survival. Fish host abundance and the availability of juvenile and adult habitat (sand or fine gravel) are therefore potential limiting factors.

The dwarf wedgemussel is sensitive to habitat degradation including reduced water flow, siltation, and low oxygen. Muskrats are the only known predators of adult freshwater

mussels but are not considered to have been a significant factor in the extirpation of the Canadian population.

1.5 Threats

1.5.1 Description of threats

No detailed assessment of threats is possible since the species is extirpated in Canada and historical information is sparse. Available information suggests that the extirpation of dwarf wedgemussel was primarily caused by the elimination of the fish host due to a lack of fish passage at the Moncton-Riverview causeway constructed in 1968. Fish communities changed substantially following the construction of the causeway; populations of several species disappeared (American shad, *Alosa sapidissima*; Atlantic salmon, *Salmo salar*; Atlantic tomcod, *Microgadus tomcod*; and striped bass, *Morone saxatilis*) and others were greatly reduced (alewife, *Alosa pseudoharengus*; blueback herring, *Alosa aestivalis*; rainbow smelt, *Osmerus mordax*; and sea-run brook trout, *Salvelinus fontinalis*). Available information suggests that suitable habitat for dwarf wedgemussel remains in the Petitcodiac system despite degradation in some areas. Several other freshwater mussel species, including two from the same genus as the dwarf wedgemussel, (*Alasmidonta undulata* and *A. varicosa*) have been recently collected in the system.

2. RECOVERY FEASIBILITY

The only possible approach to recovery the dwarf wedgemussel would be the re-establishment of a viable population based on reintroduction from another population. The recovery of the dwarf wedgemussel is not considered feasible at this time, based on examination of a series of issues in the following sections.

2.1 Ability to improve population abundance

Techniques for re-establishment of extirpated freshwater mussel populations are currently in development and are showing promise. Three approaches to re-establishment are being tested: propagation of mussels in captivity to support outplanting of individuals to the wild; infecting fish hosts with larvae and releasing the fish, allowing larvae to settle in the wild; and direct translocations of adults from viable populations to areas where mussels were formerly found. All have been shown to result in successful introduction of viable individuals to the wild, and in the case of one species (the Neosho mucket, *Lampsilis rafinesqueana*) the progeny were produced in captivity using controlled propagation methods and then subsequently released to the wild to create a new population (Jess Jones, pers. comm.).

Although there are no established guidelines on numbers of individuals required to ensure a demographically viable population, realistically several thousand adult individuals would probably be required. Effective population sizes of the order of 250 (to be above

the “endangered” threshold) to 1000 (to be above the “threatened” threshold) would be required to ensure genetic viability, based on International Union for the Conservation of Nature and Natural Resources (IUCN) assessment criteria for species at risk. Effective population sizes, however, are typically a small fraction of census sizes (5-10%), therefore census sizes of several thousand would be required to ensure that these minima were met (Jess Jones, pers. comm.).

Achieving this level of abundance in a re-established dwarf wedgemussel population would require either imports of several thousand viable adults from populations in the USA, or substantial propagation work to build up seed stock of thousands of individuals from a smaller number of imported individuals. Dwarf wedgemussel juveniles have been successfully produced in captivity (Richard Neves, pers. comm.) which suggests that an approach to re-establishment based on propagated individuals could be successful.

The species is listed as endangered in the USA. Although it is relatively abundant at one US site (Nedeau 2005) it is uncertain that individuals could be made available in sufficient numbers to re-establish a viable Canadian population, given the potential impact that these removals might have on recovery efforts in the USA. Propagation in captivity based on limited numbers of spawners from the wild might be possible and would minimize impact of removals on wild populations.

It is not certain that individuals from US populations would have the same genetic characteristics as the extirpated Canadian population. In light of the significant range disjunction with US populations, the possibly different post-glacial origin and lengthy genetic separation of US and Canadian populations (Nedeau 2005), the Canadian population may have had unique genetic characteristics which would not be replaced by reintroduced US mussels.

2.2 Habitat availability and ability to restore habitat

Suitable habitat for adult and juvenile dwarf wedgemussels appears to be present in the Petitcodiac system in the Little, Petitcodiac, North, and Anagance Rivers. A portion of the former range (North River from Fawcett to the route 112 bridge) has been degraded by agricultural development (chemical runoff, bank destruction by cattle, and low oxygen conditions), and is therefore no longer suitable. This habitat could probably be restored.

The feasibility of dwarf wedgemussel recovery also depends on whether there is sufficient suitable habitat available for its fish host. The dwarf wedgemussel fish host, thought to be American shad, disappeared from the Petitcodiac River following the construction of the causeway between Moncton and Riverview. Pre-conditions for ensuring adequate habitat for dwarf wedgemussel therefore include the restoration of fish passage for the fish host by removing or re-engineering the causeway, and the re-establishment of a fish host population.

The New Brunswick Government has conducted an environmental impact assessment on options for re-engineering the causeway (Government of New Brunswick 2005), which

concluded that adding a bridge section to the causeway would remove or mitigate the impacts on aquatic fauna. Specifically, such modifications would allow passage of fish species which historically were present in the upper Petitcodiac, and would remove negative environmental impacts on fishes (silting of the passage, sediment conditions in water). Although there are currently no specific plans to re-engineer the causeway, such construction could be undertaken in the future.

If the causeway were re-engineered to allow for fish passage, American shad populations might be re-established either by straying from nearby populations, or from hatchery supplementation. American shad are present in other river systems in the upper Bay of Fundy (Chaput and Bradford 2003), and individuals from all river systems of Atlantic North America mix in the upper Bay of Fundy during their at-sea residence. Existing spawning runs are known from rivers draining into the lower Saint John River system, and the Shubenacadie and Stewiacke Rivers draining into Minas Basin (Chaput and Bradford 2003). Experience in the USA has shown that hatchery supplementation can support rebuilding of American shad populations from low levels (Olney et al. 2003; Interstate Commission on the Potomac River, 2004), although this has required significant investment in hatchery production and a time period of the order of at least a decade. Experience with re-establishing populations in areas where they have been completely extirpated is not well documented, but is presumed to be potentially feasible.

Although American shad is presumed to be the primary host, this is not known with certainty. Accordingly, efforts to re-establish American shad might not be sufficient to lay the groundwork for dwarf wedgemussel re-establishment; therefore the re-establishment of the pre-extirpation fish community might be required.

In summary, while some suitable mussel habitat remains in the Petitcodiac River, considerable effort would be required to restore habitat for the fish host, and to reestablish the fish host population.

2.3 Recovery feasibility conclusion

The re-establishment of dwarf wedge mussel would require a series of steps (re-engineering the causeway, re-establishing the fish host population, re-establishing a mussel population) each with its respective difficulties and uncertainties. Based on the above evaluation, the recovery of dwarf wedgemussel is not considered technically or biologically feasible at this time, although changes in the factors leading to this determination might justify reconsideration in the future. The following conditions would have to be met to lead to a determination that recovery might be feasible:

- changes to the Petitcodiac causeway which would allow adequate fish passage to occur, and which would remove or mitigate negative environmental impacts on fish populations;
- re-establishment of populations of American shad, and possibly other fish species, either through straying from adjacent populations or through hatchery supplementation;

- availability of adequate numbers of dwarf wedgemussel, either adults from US populations, or adults from propagation programs based on US populations, to support re-establishment. Several thousand individuals would be required to ensure a demographically viable population.

The question of whether recovery efforts based on US individuals would lead to a re-established population genetically equivalent to the extirpated Canadian population remains uncertain. In the absence of clear information to the contrary, it would appear appropriate to base reintroduction on US material if the pre-conditions above were met.

3. CRITICAL HABITAT

3.1 Identification of the Species' Critical Habitat

Because the dwarf wedgemussel is extirpated in Canada and there is little information on historical ecology or habitat use, it is not possible to specifically identify critical habitat for the species. Important habitat for the species within the Petitcodiac would have been in flowing waters of high oxygen and low sediment, with areas of sand or fine gravel bottom.

4. CONSERVATION APPROACH

Further conservation action for the dwarf wedgemussel is not possible given that the population is extirpated and recovery is deemed not feasible. That said, it is still possible and important to educate Canadians about the species we have lost, including the dwarf wedgemussel.

5. REFERENCES

Unless otherwise cited, information in this Draft Recovery Strategy is based on the COSEWIC Status Report (Hanson and Locke 1999), which includes substantial original information based on an intensive survey by the authors in 1997 and 1998.

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