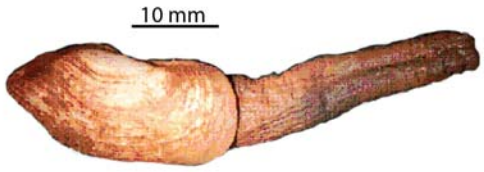
RECOVERY POTENTIAL ASSESSMENT FOR THE ATLANTIC MUD-PIDDOCK (*BARNEA TRUNCATA*)

Atlantic Mud-piddock (*Barnea truncata*)



(C. McCorry, 2008)

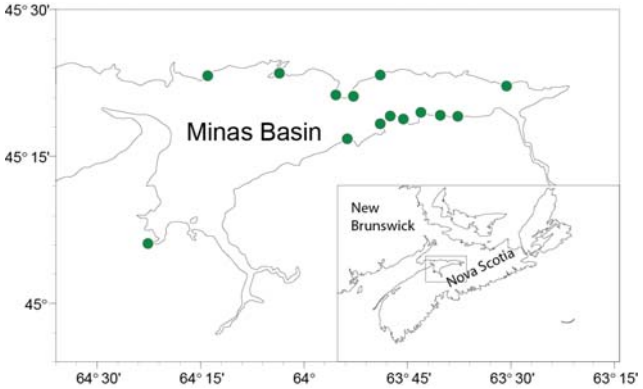


Figure 1: Present distribution of Atlantic Mud-piddock in Canada.

Context:

In November of 2009 the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the status of Atlantic Mud-piddock (Barnea truncata) as Threatened. The rationale for the designation was that in Canada the species is restricted to a single population in the Minas Basin, Nova Scotia. The Atlantic Mud-piddock is a marine intertidal bivalve that bores into hard clay and soft rock, and it is entirely dependent on the red-mudstone facies in the intertidal zone within the Minas Basin.

A species Recovery Potential Assessment (RPA) process has been developed by Fisheries and Oceans Canada (DFO) Science in order to provide the information and scientific advice required to meet the various requirements of the Species at Risk Act (SARA), such as deciding whether or not to add the Atlantic Mud-piddock to Schedule 1 under SARA, developing a Recovery Strategy if it is listed, and informing decisions on authorizations to carry out certain activities.

An additional intent of this document is to provide the information available for the development of a Recovery Strategy should one be required under SARA. It outlines the present status of Atlantic Mud-piddock, and identifies threats to the species and its habitat. This assessment offers a perspective on the recovery potential for Atlantic Mud-piddock in Canada.

SUMMARY

- The population of *Barnea truncata* in Canada is a small disjunct relic population restricted to a single type of substrate, red-mudstone, within the intertidal zone of the Minas Basin, Nova Scotia. The limited occurrence of this habitat results in an area of occupancy of less than 0.6 km^2.

- The population appears to be stable and is not expected to increase beyond current levels. There is no current estimate of abundance. Given the limited habitat available, a reasonable "recovery target" would be to maintain the current population status.

- Threats include natural (storm events) or human-induced changes in habitat quality and sediment deposition that can smother existing populations.

- Maintaining the Atlantic Mud-piddock population will be directly dependent on sustaining the exposed red-mudstone habitat within the Minas Basin.

BACKGROUND

Rationale for Assessment

The Atlantic Mud-piddock (also known as the Fallen Angelwing) is intertidal marine bivalve is restricted to a single Canadian population located in the Minas Basin, Nova Scotia. This species is adapted to boring into hard clay and soft rock and is entirely dependent on a single geological formation, the red-mudstone facies in the Minas Basin. The total available habitat for this species is less than 0.6 km^2. This species settles on and bores into the mudstone, and once settled, is immobile. Any changes in deposition of sediments can smother individuals or cover entire areas of habitat. Disturbances that change the sediment depositional regime are considered the main threat to both the species and its habitat. Most serious is the increased frequency and severity of storms, due to climate change, which have the potential to rapidly bury habitat and smother individuals. It is expected that erosion from rising sea levels (storm surges) and increased rainfall (floods), would also contribute to habitat loss by sediment deposition. Proposed development in the basin could also alter or add to sediment deposition. The Canadian population is clearly disjunct from the nearest population, 350 km south, in Maine, USA (representing its most northern distribution), and rescue is very unlikely.

Species Biology and Ecology

The Atlantic Mud-piddock is an intertidal marine bivalve with a planktonic larval phase and an adult form that is adapted to boring into hard clay and soft rock where it then becomes confined within its burrow.

The sexes are separate and male and female internal organs are distinct, there is no (external) sexual dimorphism. As with many aquatic molluscs, fertilization is external. Ova and sperm are shed into the water where fertilization takes place. This process appears to be temperature mediated. In the only study of larval development, adult *B. truncata* from Virginia spawned in mid-May as well as through August and September. Individual *B. truncata* can release as many as 11 million eggs in one spawning.

After fertilization, the eggs develop through larval stages which feed on phytoplankton in well-aerated and productive shallow waters. Larval development progresses and in culture settlement takes place in about 35 days. The rate of growth is dependent on the availability of food, suggesting a limiting factor in deeper oceanic habitats (Bay of Fundy vs. Minas Basin) where particulate food may be less abundant and temperatures are lower. In the single feeding study, the author was not able to sustain growth through to settlement and start of boring, so knowledge of dietary needs of this stage is incomplete.

The larvae settle on substrates, probably at high slack tide. Many substrates are too hard or too soft and thus not suited for settlement and boring. The presence of a functional foot and a swimming appendage suggests a degree of mobility allowing for some substrate selection at

time of settlement. This is possibly significant in the Minas Basin populations, where protected horizontal habitats are limited (even where appropriate substrate is present).

Once they have settled they begin the process of boring into the substrate. In *Barnea* spp. this process is by longitudinal movements of the shell facilitated by the foot.

As the animal grows, it continues to bore along this initial axis. Because the size of the hole increases in diameter with growth of the adult, this results in a conical bore-hole. Consequently the adult animal is trapped for life inside its burrow (Figure 2).

(Photo by G. Jones)

Figure 2. Barnea truncata in conical bore-hole illustrating entrapment of adults within substrate.

There are no published data on either generation time or longevity of *B. truncata*. The only study of *Barnea* larvae spawned individuals from barrier islands off Virginia. Based on reported sizes and image provided, these individuals were probably four to five years old. Examination of valves from field studies suggests a life span of up to nine years, with sexual maturity possibly as early as two years.

Unlike bivalves that are not attached to or encased by their substrate, it is not able to tolerate any degree of rapid sediment accumulation and so is subject to smothering in acute sedimentation events or with natural migration of deposition plumes common in many estuaries.

The principal habitat constraint appears to be the requirement of a firm to semi-consolidated substrate for settlement of post-larval juveniles (spat).

The Canadian population is a relic from the last post glacial warm period (~3,000 years ago) that has survived in the warmer waters of the Minas Basin.

The entire population is associated with one specific geological structure in the Minas Basin, the red-mudstone facies found inter-bedded in Jurassic age sandstone formations in association with hard conglomerates. This substrate is limited subtidally by the presence of stable masses of sands and fine gravels. This geological formation and associated facies are absent from the balance of the Bay of Fundy and from Chignecto Bay, although they may be present, subtidally in the Minas Channel (west of Parrsboro, Cumberland County).

ASSESSMENT

Current Species Status

Globally, the Atlantic Mud-piddock has been recorded, intermittently along the west Coast of Africa from Senegal in West Africa to South Africa – ranging from 15° N latitude to 34°S latitude. In western parts of the Atlantic, it is also found sporadically. It is reported from several locations in Brazil through the Gulf of Mexico. It is then found, discontinuously, from Florida to the southern part of Maine, with a major disjunction to the only Canadian population in the Minas Basin of the Bay of Fundy – ranging from 45.4°N latitude to 24°S latitude (Figure 3).

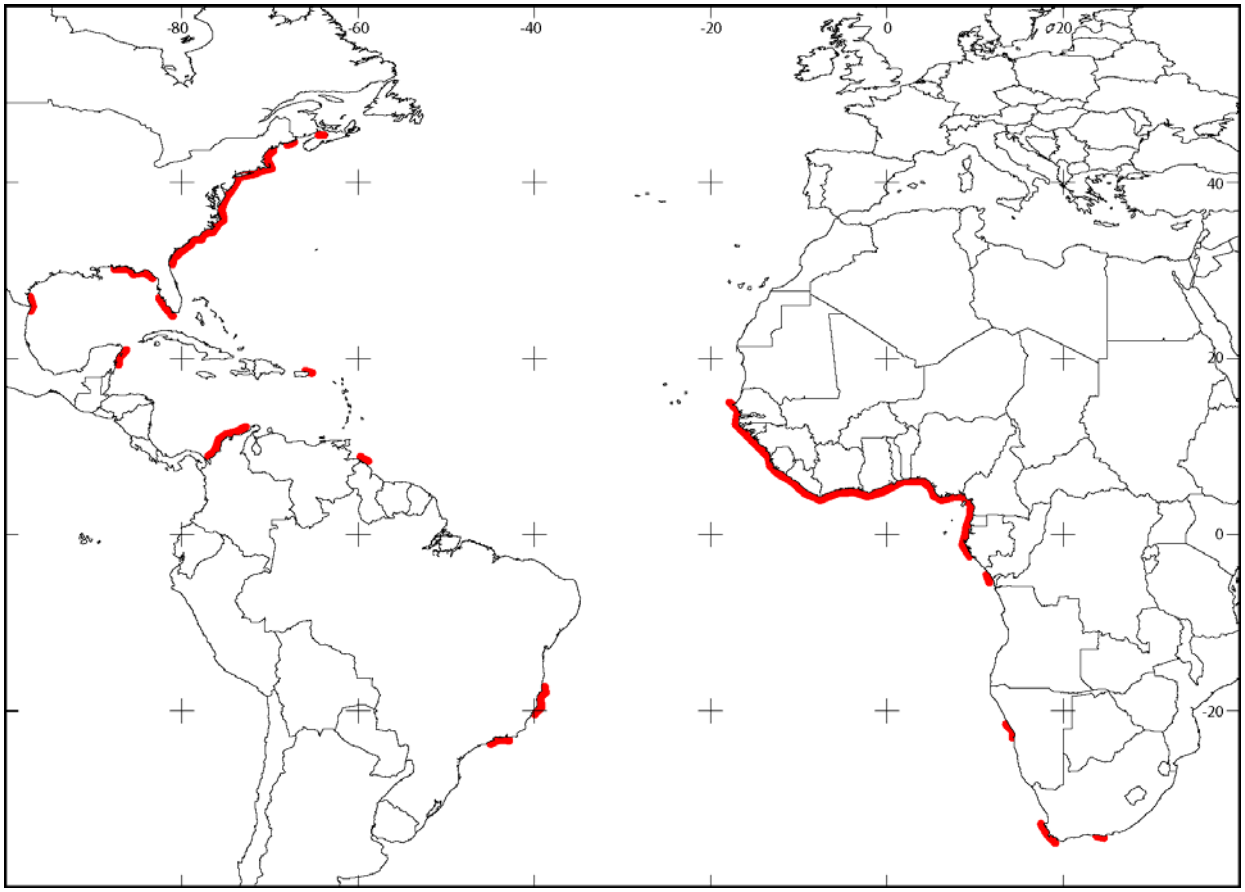


Figure 3. Global distribution of Barnea truncata (Adapted from COSEWIC 2009).

In Canadian waters the species is restricted to the Minas Basin of the Bay of Fundy, and is known to occur at 14 discrete sites (Figure 4 and Table 1 in Hebda, 2010). An extensive field

program in 2007 to 2008 and further reconnaissance in 2009 - 2010 confirmed its occurrence in only one substrate type, in intertidal portions of the Minas Basin but not in other parts of the Bay of Fundy, and based on historic surveys, it is not found in the Northumberland Strait or Atlantic coast of Nova Scotia. The presence of large bodies of sands and muds in most sub-tidal portions of the basin likely preclude its persistence in those parts of the basin. It may also be present sub-tidally where appropriate substrate exists and no sediment accumulation occurs (i.e. Minas Channel).

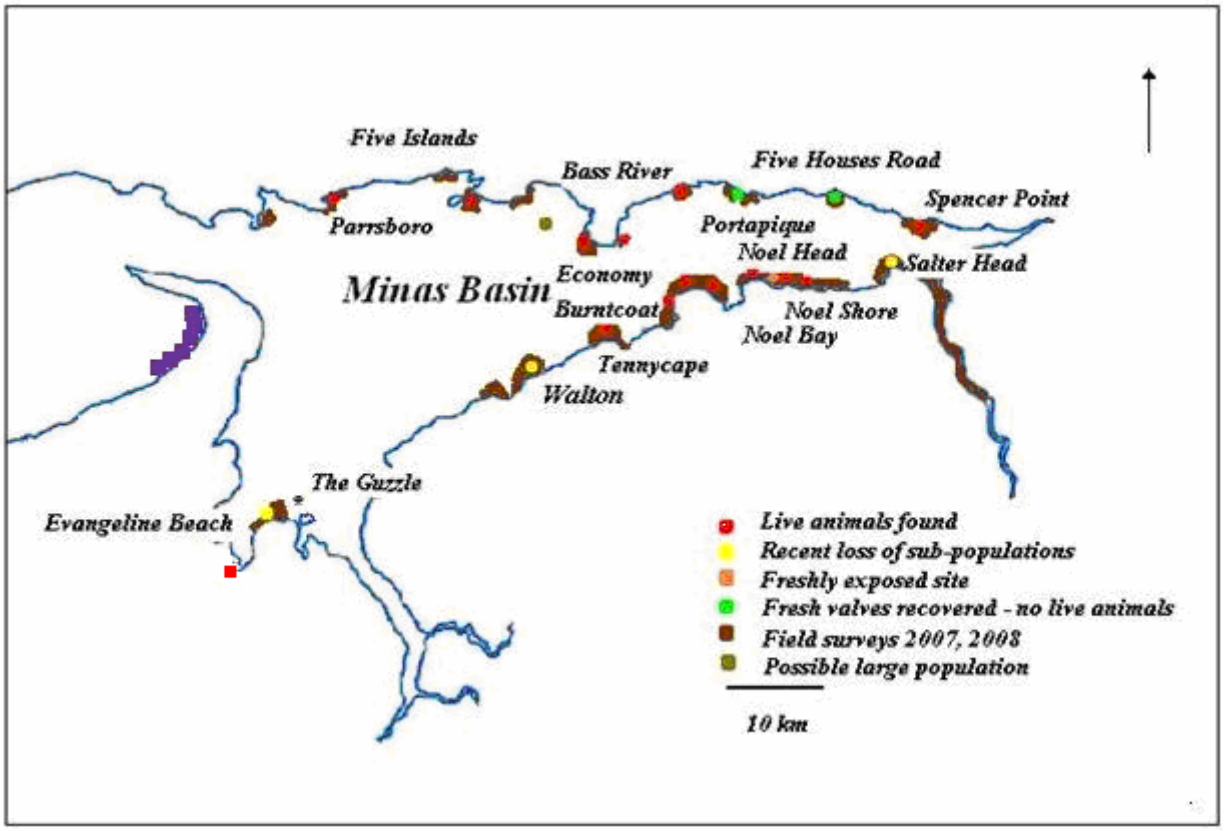


Figure 4. Current and historic distribution of Barnea truncata in the Minas Basin, Nova Scotia, including search effort in 2007-2008 and 2009, 2010. Purple colour denotes Nova Scotia Museum 2010 field survey.

Population Abundance and Trajectory

Abundance Index

The Atlantic Mud-piddock is restricted to one substrate type: red-mudstone. This substrate was found in three types of habitat settings in field investigations between 2007-2010.

1. Embedded (in burows) under a more-resistant “capstone” substrate.
2. Associated with more-resistant bedrock features such as large cobbles or other exposed rock material.
3. In exposed surfaces including rock pools where resistant rock has been eroded (probably through ice scour or movement of lithic materials during tidal exchange).

The most significant habitat setting from the point of view of abundance is the burrow association under protective capstones (Type 1). In this setting, the mudstone substrates tend

to be riddled with boreholes. It is not possible to estimate degree of occupancy, in that the riddling can extend for substantial distance under the protective cap, possibly up to 50-100 cm. This is evidenced in ice-mediated collapse of capstones each spring, exposing some existing burrows.

The boreholes associated with rock and cobble protection (Type 2) are occupied at a slightly higher frequency than the exposed surfaces (estimated to be less than 5%). As in the rock pools noted below, occupancy of burrows is mixed, with the False Angelwing (*Petricolaria pholadiformis*) dominating. These habitats appear to comprise less than 5% of total area surveyed occupied by *B. truncata*.

The exposed surfaces (Type 3) offer the largest surface areas of burrow (bore-hole) occurence. However, less than 1% of the exposed holes are occupied by rock-boring molluscs, and a majority of these are by the False Angelwing. This is also very patchy within areas of apparently-appropriate substrate.

In order to get appropriate Atlantic Mud-piddock population estimates for the Minas Basin, it would be necessary to undertake disruptive and destructive sampling through removal of capstone protection at selected sites, then cutting cross-sections through bore-hole assemblages. In areas surveyed, capstone thickness varied up to 80 cm in depth.

Consequently there is no current estimate of abundance or densities of *B. truncata* in Canadian waters.

Trajectory

In the absence of any systematic sampling or monitoring activity since the recording of the species in Canadian waters in 1959, there are no data to use as a basis for trajectory evaluation. There was evidence that of the periodic loss and repopulation of occupied sites due to sedimentation episodes (e.g. The Guzzle, Shad Creek to Noel Head, Salter Head), some long-term reduction in substrate availability (i.e. Bass River) and some species displacement through establishment of extensive barnacle beds (i.e. Walton to Whale Cove). These suggest that the populations of *B. truncata* in the Minas Basin have been subject to suppression or elimination through large-scale events or processes in the past.

There is no evidence for successful colonization anywhere else in Canada outside of the Minas Basin.

Current information suggests that in the long term the population is stable based on habitat availability, but demonstrates substantial local variability.

Habitat Requirements and Residences

The entire Canadian population is associated with one specific geological structure in the Minas Basin, the red-mudstone facies found between the layers of Jurassic age sandstone formations in association with hard conglomerates. This substrate is limited subtidally by the presence of stable masses of sands and fine gravels. It occurs as three habitat types as noted above in the Abundance Index section.

This geological formation and associated facies are absent from the balance of the Bay of Fundy, including Chignecto Bay, although they may be present, subtidally in the Minas Channel (west of Parrsboro, Cumberland County) where appropriate substrate might exist.

Larval Habitat

The free swimming larvae settle on substrates, probably at high slack tide. Many substrates are too hard or too soft and thus not suited for settlement and boring. The presence of a functional foot and a still-functional swimming apparatus (velum) suggests a degree of mobility allowing for some substrate selection at time of settlement. Once they have settled on an appropriate substrate they begin the process of boring into the substrate.

Adult Habitat

It was noted in COSEWIC (2009) that habitat requirements for *B. truncata* were not clearly defined in the literature.

Field observations suggest that it occurs in intertidal areas with a salinity range of 19-25 ppt although it has a low salinity threshold of 5-10 ppt, considerably lower than many other estuarine molluscs. It has been suggested that toward the periphery of its range, *B. truncata* may occur in deeper waters, but this has not been confirmed and has not been shown for the peripheral Canadian population.

As a filter feeder, that is immobile within its substrate, the Atlantic Mud-piddock can only persist in areas where there is no rapid or significant accumulation of sediments. It also requires a dependable source of particulate organic matter but is tolerant of some exposure during low tidal periods. Unlike bivalves that are not attached to or encased by their substrate, it is not able to tolerate any degree of rapid sediment accumulation and so is subject to smothering in acute sedimentation events or with natural migration of deposition plumes common in many estuaries.

The principal habitat constraint appears to be the requirement of appropriate firm to semi-consolidated substrate for settlement of post-larval juveniles (spat). Although firm mud habitats are sporadically present subtidally within the Bay of Fundy and lower Gulf of Maine, there is no published evidence from fieldwork to suggest the presence of *B. truncata* in these habitats in Canadian waters.

Residence

SARA defines a 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*". Residence is interpreted by DFO as being constructed by the organism. Under this interpretation, the Atlantic Mud-piddock's bore holes/burrows are residences, but there is a one to one correspondence between the individual and its burrow for all its post larval life. This means that the distribution of residences replicates the distribution of the post settlement population and not a sub-area of the species distribution.

Threat Assessment

At present there does not appear to be a significant demonstrated threat from any natural or human-induced mortality on the Atlantic Mud-piddock. There are, however, a number of factors that could potentially threaten *Barnea* and its habitat and thus the long term sustainability of Atlantic Mud-piddock in the Minas Basin. Table 1 lists a number of potential threats to *Barnea truncata* habitat which may or may not impact the long term stability of the Atlantic Mud-piddock in the Minas Basin. Table 1 summarizes their impact on the Atlantic Mud-piddock, the

associated current protection and management measures in place to mitigate against threats as well as those potential measures were the species to be listed under *SARA* (from DFO, Oceans, Habitat and Species at Risk Branch).

Installation of Water Control Structures or In-stream Electrical Generators

Construction of barrages or causeways have been shown to alter currents and intertidal ecosystems. Similarly, the construction of suites of "in-stream" turbines for power generation may have long term effects on sediment deposition.

Mining of Minerals in River and Basin Sediments

An experimental project to extract titanium from the sediments in the lower portions of the Shubenacadie River proved to be uneconomic, but similar activity could alter sedimentation patterns and smother existing *Barnea* habitat.

Spills from Bulk Petroleum Movement in Gulf of Maine and Bay of Fundy

Petroleum shipments pose the risk of oil spills. Spills entering the Minas Basin would be expected to have significant impacts on intertidal areas through direct mortality and habitat degradation.

Surficial Drainage from Adjoining Watersheds

The Minas Basin receives water from the Annapolis Valley and the Shubenacadie drainage basin, both productive agricultural areas with growing urban populations. There is one documented case of a fire releasing substantial volumes of pesticides into the Avon Estuary of the Minas Basin, but there are no reports of runoff waters affecting water quality in the Minas Basin. Another example is the proposal for the excavation of salt domes for liquefied natural gas storage. This project proposes to discharge approximately 400t of anhydrites a day into the Shubenacadie River for three years. The impact of this on intertidal mollusks during a falling tide has not been modeled.

Climate Change

While the effects of climate change on *B. truncata* are likely to be complex, any changes in the climate regime, including greater variability around mean temperatures or decreased winter temperatures, could have an impact on the population of Atlantic Mud-piddock in the Minas Basin. If there is a climate induced change in the volume and persistence of rafting ice in late winter-early spring, most *Barnea* populations in the Minas Basin would be negatively impacted.

More frequent and severe winter storms have been predicted for Canadian east coast waters as an effect of climate change. The resulting high tides and storm surges could result in major siltation events in the Minas Basin.

Table 1. Summary of threats, potential impacts and protection and management measures for the Atlantic Mud-piddock.

Potential Anthropogenic Threats	Potential Biophysical or Chemical Changes	Potential Impact on Atlantic Mud-piddock	Current Protection and Management Measures	Potential Protection and Management Measures Under *SARA*
Climate Change	-Storm events could cause serious disruption to sediments in shallow estuarine ecosystems -Change in temperature regimes -Changes to the movement of ice in mid to late winter -Rising sea level -Increased rain could increase the frequency of floods substantially altering the flow in rivers	Storms – smothering of Mud-piddock habitat -Temperature – greater oscillation of temperatures around annual means or decreased winter temperatures could harm the population -Ice – habitat could be destroyed due to substantive ice scour and the collapse of protective cap-rock under the weight of ice after water retreat at low tide -Rising sea level – likely to destroy habitat due to an increase in shore erosion and beach migration -Rainfall – a greater amount of sediment could be carried from the rivers into the Basin resulting in smothering of Mud-piddock habitat	No Current Measures	- Climate change mitigation measures are outside of DFO jurisdiction and mandate. - Periodic site surveys to monitor the distribution and status of the Atlantic Mud-piddock to be undertaken using protocols developed by the Nova Scotia Museum of Natural History.
Construction or alteration of shoreline or watercrossing structures (e.g., aboiteaus, dams causeways wharves, boat slips)	-Modification of currents -Destruction of fish habitat -smothering of habitat via sedimentation	-Changes in currents could result in the alteration of nearby intertidal fish habitat due to the movement of sediment, erosion, etc. (possibly critical alteration of substantial areas of habitat which could include Mud-piddock habitat) -Activities associated with shoreline structures could result in the destruction of Mud-piddock habitat	-Compliance with existing legislation as set out under the *Fisheries Act* (Federal), *Canadian Environmental Assessment Act* (F), Beaches Act (Provincial), etc. -DFO to continue to review development proposals under the referral process established with the Nova Scotia Department of Natural Resource (NSDNR) to determine the compliance requirements in relation to the Habitat Protection Provisions of the *Fisheries Act*.	-Certain activities under “shoreline development” fall within the “Low Risk Guidelines”. DFO does not currently receive proposals for these activities from NSDNR for review and comment. If the Atlantic Mud-piddock is listed under *SARA*, DFO would initiate discussions with the Province of Nova Scotia to ensure that protection of this species and its habitat are considered when reviewing project proposals that fall under the “Low Risk Guidelines”. -Habitat areas necessary for the Atlantic Mud-piddock's survival or recovery could be identified as the species' Critical Habitat (CH) in the recovery strategy or action plan for the species. Activities that could lead to CH destruction would be prohibited.
Exploratory or extraction activities in nearby rivers	-Disturbance of sediments (e.g., resuspension and migration of sediments)	-Smothering of Mud-piddock habitat	-Compliance with existing legislation as set out under the *Fisheries Act* (F), *Canadian Environmental Assessment Act* (F), *Crown Lands Act* (P), *Beaches Act* (P), etc.	Habitat areas necessary for the Atlantic Mud-piddock's survival or recovery could be identified as the species' Critical Habitat (CH) in the recovery strategy or action plan for the species. Activities that could lead to CH destruction would be prohibited.

Table 1 (continued). Threats, Potential Impacts and Protection and Management Measures – Atlantic Mud-piddock.

Potential Anthropogenic Threats	Potential Biophysical or Chemical Changes	Potential Impact on Atlantic Mud-piddock	Current Protection and Management Measures	Potential Protection and Management Measures Under *SARA*
Non-point source pollution, i.e. agricultural and urban runoff form the Annapolis Valley and the Schubenacadie drainage basins	-Degradation of water quality due to mitigation of soil, animal waste, pesticides, etc. into the water	-Adverse health effects on Mud-piddock related to degraded water quality	Compliance with existing legislation as set out under the *Fisheries Act* (F), *Canadian Environmental Assessment Act* (F), *Environment Act* (P), *Crown Lands Act* (P), *Beaches Act* (P), etc.	-Relevant Federal and Provincial departments to continue current management measures. - Conduct public education campaigns to raise awareness about the species and its habitat. Encourage community involvement and stewardship through funding programs such as the Habitat Stewardship Program.
Developments with potential to impact the estuary – turbines	-Alteration of tidal regimes	-Unknown	- One turbine has been deployed to date. It is the tidal in-stream energy conversion (TISEC) device and is located in the Minas Channel. The TISEC device was damaged so will be removed early. Removal is planned for October 2010. - Deployment of other experimental tidal turbines is planned to take place in the Bay of Fundy over the next several years. Dates for deployment have yet to be determined. - Any future proposals will be reviewed by DFO for compliance with the *Fisheries Act* (F) and any other relevant legislation. The Developer will be required to monitor environmental effects related to the experimental turbines. -The long term plan is to commercialize the turbines.	Environmental Effects Monitoring will be more stringent to ensure any potential effects on the Atlantic Mud-piddock are assessed.
Developments with potential to impact the estuary – underground natural gas storage project with associated release of brine into the Schubenacadie River	- Increase in the salinity level of the water over a two year period	- Unknown, likely no measurable impact in the Minas Basin due to the dilution on the brine	- This project received an environmental approval from the province of Nova Scotia. This approval outlines requirements for baseline data collection and monitoring in relation to fish and fish habitat. - The proponent is continuing to obtain any required provincial approvals\permits.- - There was no requirement for a *Fisheries Act* authorization. A Letter of Advice will be written in regards to the Habitat Protection Provisions of the *Fisheries Act*. It will provide recommendations for mitigation and monitoring. - There was no requirement for a federal environmental assessment under CEAA.	- No additional management measures required. Regulatory requirements can't be changed after a proposal has been reviewed. However, if monitoring demonstrates that federal legislation could potentially be contravened (e.g., *Species at Risk Act*, *Fisheries Act*) as a result of the project, the proponent would be requested to make changes to operating procedures
Bulk movement of petroleum by sea throughout the Gulf of Maine and Bay of Fundy to four seaports with oil refineries in Maine and New Brunswick	-Accidental oil spill – oil could enter the Basin from the lower reaches of the Fundy Basin	-Could cause significant impacts in intertidal habitats and pose considerable problems in cleanup	The *Canada Shipping Act* and associated regulations govern the transport of petroleum products by ship.	No additional management measures required. Existing legislation is considered sufficient at this time.

Recovery Targets

Barnea truncata was designated as threatened due to its restricted area of occupancy and small number of locations rather than evidence of a small or declining population. At present the population appears to be stable with local variability, and is not expected to increase beyond current levels. The present limiting factor is the availability of suitable substrate (red-mudstone habitat) Due to this a reasonable recovery target would be to maintain the current status and prevent the loss of suitable habitat due to human activities in the Minas Basin.

Sources of Uncertainty

During the survey work undertaken, and subsequent review of aerial photographs, it was noted that *B. truncata* may possibly be associated with a reef structure to the south-east of Economy Mountain, west-south-west of Economy Point, as well as possibly at Brick Kiln Island. These sites would have to be surveyed. In addition, there is the possibility that *B. truncata* may exist sub-tidally where there is no sediment accumulation, even though there is little evidence in the literature that this occurs.

There are significant knowledge gaps in the life history of *Barnea truncata,* including growth rates, reproduction and recruitment. There is also nothing known about the genetics of this species and how closely related this population is genetically to other populations.

CONCLUSIONS

The population of *Barnea truncata* in Canada is a small disjunct, relic population. It is unlikely to re-establish naturally from other populations.

In Canada *Barnea truncata* is restricted to a single type of substrate, red-mudstone, within the Minas Basin, Nova Scotia.

The limited occurrence of these red-mudstone facies result in an area of occupancy (AO) of less than 0.6 km^2.

At present there are no data on current abundance or trends but the population appears to be stable and is not expected to increase beyond current levels. The species persistence would require maintaining its current population status and the prevention of suitable habitat being lost.

Barnea truncata's life history of a planktonic larval phase with the adult boring into the substrate, with the hole increasing in diameter and depth as it grows, means it is immobile and therefore highly susceptible to smothering by sediments.

SOURCES OF INFORMATION

COSEWIC. 2009. COSEWIC Status Report on Atlantic Mud-piddock *Barnea truncata* (Say, 1822), November 2009: 44 p.

Hebda, A. 2010. Recovery Potential Assessment for Atlantic Mud-piddock (*Barnea truncate*). DFO Can. Sci. Advis. Sec. Sci. Res. Doc. 2010/117.

FOR MORE INFORMATION

Contact: Dale Roddick
Population Ecology Division
Fisheries and Oceans Canada
Bedford Institute of Oceanography
PO Box 1006 Dartmouth, NS B2Y 4A2

Tel: (902) 426-6643
Fax: (902) 426-1862
E-Mail: Dale.Roddick@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Maritimes Region
Fisheries and Oceans Canada
Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2

Telephone: 902-426-7070
Fax: 902-426-5435
E-Mail: XMARMRAP@mar.dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2010. Recovery Potential Assessment for Atlantic Mud-piddock (*Barnea truncata*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/068.