Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Blanding's turtle (*Emydoidea blandingii*), Nova Scotia Population, in Canada

Blanding's turtle

2012

Canada

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Cover illustration: Adult Blanding's turtle basking © Jeffie McNeil

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« **Stratégie de rétablissement de la population néo-écossaise de tortues mouchetées (*Emydoidea blandingii*) au Canada** »

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PREFACE

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

The Minister of the Environment and the Minister responsible for the Parks Canada Agency are the competent ministers for the recovery of the Blanding's turtle, Nova Scotia population, and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Blanding's Turtle Recovery Team, Province of Nova Scotia and numerous additional individuals and agencies, academics, environmental non-government organizations, industry stakeholders, Aboriginal groups, and volunteers.

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 Environment Canada and the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Blanding's turtle, Nova Scotia population, and Canadian society as a whole.

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

ACKNOWLEDGMENTS

This strategy was prepared by Jennifer McNeil, in collaboration with the Blanding's turtle recovery team.

The recovery team has contributed to the science and communications for the recovery of the Blanding's turtle, in addition to the advice provided for this recovery strategy. We would like to acknowledge the contributions of the many volunteers, landowners, students, field assistants and interns who have helped with Blanding's turtle recovery over the years. Their field work and participation in recovery team meetings is much appreciated.

RECOMMENDATION AND APPROVAL STATEMENT

The Parks Canada Agency led the development of this federal recovery strategy, working together with the other competent minister(s) for this species under the Species at Risk Act. The Chief Executive Officer, upon recommendation of the relevant Park Superintendent(s) and Field Unit Superintendent(s), hereby approves this document indicating that Species at Risk Act requirements related to recovery strategy development (sections 37-42) have been fulfilled in accordance with the Act.

Recommended by:

Harry Delong
Superintendent, Kejimkujik National Park and National Historic Site

Recommended by:

Linda Frank
Field Unit Superintendent, Mainland Nova Scotia Field Unit

Approved by:

Alan Latourelle
Chief Executive Officer, Parks Canada Agency

All competent ministers have approved posting of this recovery strategy on the Species at Risk Public Registry.

EXECUTIVE SUMMARY

Blanding's turtles (*Emydoidea blandingii*) are typically found in shallow wetlands with abundant vegetation. During their life, they use a variety of habitats and may travel considerable distances from water, particularly for nesting. They take about 20 years to mature and can live for over 80 years. The Nova Scotia population is isolated from the species' main range and their distribution in the province appears to be limited to the southwest interior. To date, three main populations have been identified as well as two smaller concentrations. These main populations exhibit significant differences in behaviour, morphology, habitat use and fecundity. Viability analysis suggests that at least two of the populations may be at significant risk of extinction. The isolation, restricted distribution, small population size and projected decline and have resulted in the listing of the Nova Scotia population as Endangered under both the federal *Species At Risk Act* (S.C. 2002, c.29) and the *Nova Scotia Endangered Species Act* (S.N.S. 1998, c.11).

Known and potential threats identified in this recovery strategy include increased adult mortality from road kill and collection and other activities habitat loss from activities such as development, agricultural, forestry and recreational practices; increased predator populations associated with human development, and the effect of climate change. Blanding's turtles in Nova Scotia are limited in their ability to respond to threats and habitat changes by their long generation time (approx. 40 years), physiology and geographic isolation. Their slow maturation and longevity makes them especially vulnerable to increases in adult mortality. Their long generation time can also delay their ability to respond quickly to threats and can result in significant time lags in recovery. These limitations can constrain researchers' abilities to detect changes in the population until long after an event has occurred.

At the present time, recovery is considered feasible. The long term objectives are to achieve a self-sustaining population of Blanding's turtles in Nova Scotia by maintaining and/or increasing the three existing populations and two known concentrations over the current range, with a less than 5% risk of extinction in each recognized population when projected over 10 generations (400 years), and to maintain sufficient gene flow to prevent any single population from becoming genetically isolated. Intermediate objectives have also been identified; these objectives are described in Section 5 and a list of broad strategies and approaches to achieving recovery are outlined in Section 6. Research and recovery actions have been underway for many years, and the strategic approaches taken in this strategy build on these actions. While research has increased knowledge of much of the turtles' life history and habitat requirements, significant knowledge gaps remain and are identified in Section 3.5.

Critical habitat is identified for the Blanding's turtle in Nova Scotia at all five known sites. For each site, high use areas were identified by mapping turtle locations and applying the guidelines outlined in Section 7. Following this, critical habitat was identified by delineating a polygon that connects all of the high use areas. The identified critical habitat is necessary for the recovery of the species, but may not be sufficient to achieve the population and distribution objectives due to insufficient knowledge of the turtle's distribution.

One or more actions plans will be completed by December 2014.

RECOVERY FEASIBILITY SUMMARY

At this time, recovery of Blanding's turtles in Nova Scotia is considered to be feasible according to the criteria identified in the Policy on the Feasibility of Recovery (Government of Canada 2005), as outlined in Table 3.

Table 3. Feasibility of recovery criteria.

Criteria	Meets criteria?
1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance	✓
2. Sufficient habitat is available to support the species or could be made available through habitat management or restoration	✓
3. The primary threats to the species or its habitat (including threats outside of Canada) can be avoided or mitigated.	✓
4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable time frame	✓

The population contains individuals capable of reproduction, and it is believed that sufficient habitat is available to support the population. While some threats, such as vehicular mortality, are difficult to avoid, Population Viability Analysis suggests that a combination of management actions aimed at increasing recruitment and reducing threats could effectively recover these populations (Bourque at al 2006).

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1. COSEWIC SPECIES ASSESSMENT INFORMATION

Date of Assessment: May 2005

Common Name (population): Blanding's turtle (Nova Scotia population)

Scientific Name: *Emydoidea blandingii*

COSEWIC Status: Endangered

Reason for Designation: The three small subpopulations of this species found in central southwest Nova Scotia total fewer than 250 mature individuals. These three subpopulations are genetically distinct from each other and from other Blanding's turtles in Quebec, Ontario and the United States. Although the largest subpopulation occurs in a protected area, its numbers are still declining. The other subpopulations are also susceptible to increasing habitat degradation, mortality of adults and depredation on eggs and hatchlings.

Canadian Occurrence: Nova Scotia

COSEWIC Status History: Designated Threatened in April 1993. Status re-examined and designated Endangered in May 2005. Last assessment based on an update status report.

2. SPECIES STATUS INFORMATION

Globally, the current range of the species extends from extreme southern Quebec and Ontario, west to central Nebraska, and south to Illinois and Indiana (Cochran and Lyons 1986, Ernst 1973, Olson 1987). Isolated local populations occur throughout the range and the Nova Scotia population is one of the most isolated (Herman *et al.* 1995). In Canada, populations are restricted to southern Ontario, the southwestern corner of Quebec, and the interior of southwestern Nova Scotia. Approximately 20 percent of the global distribution exists in Canada and less than five percent of this exists within Nova Scotia.

Blanding's turtle has a Global Rank (G-Rank) of G4, and a National Rank (N-Rank) of N4 (Natureserv 2010). The Nova Scotia population, which is the focus of this recovery strategy, has a Sub-National Rank (S-Rank) of S1. This population is listed as Endangered under both Canada's *Species at Risk Act* (2005) and the *Nova Scotia Endangered Species Act* (2000).

3. SPECIES INFORMATION

3.1 Species Description

Figure 1 a) Adult female in the water b) Adult female basking with head up c) Newly hatched Blanding's turtle

Blanding's turtles are medium sized freshwater turtles with a semi-hinged shell. They are very long lived (80+ years) and, in Nova Scotia, slow to mature (approx. 20 years) (Congdon et *al.* 1993, Herman *et al.* 1999, McNeil 2002). One of their most distinctive features is the bright yellow chin and throat (Figure 1b). Their high-domed top shell (carapace) is grey to black with yellow flecks (Caverhill and Crowley, 2008). The flecks are typically brighter in younger turtles and most visible when the shell is wet (Figure 1a). The lower shell (plastron) is orange-yellow with irregular black patches. In juveniles, annual growth lines are visible on the lower shell (Figure 2). After turtles mature, the rings begin to wear off and the plastron eventually becomes smooth.

Figure 2. Bottom shell (plastron) of a juvenile Blanding's turtle, showing annual growth rings

In Nova Scotia, adult shell length ranges from 18 to 25 cm (Nova Scotia Blanding's turtle database 2010). Adult males are typically larger than females and can be distinguished by their concave plastron, thick tail base and solid grey upper lip. Newly emerged turtles, called hatchlings, are approximately 4cm long (the size of a toonie), and have uniform grey shells (Figure 1c).

3.2 Population and Distribution

3.2.1 Nova Scotia population: range and structure

In Nova Scotia, Blanding's turtles appear to be restricted to the southwestern interior of the province, although recent findings have expanded the extent of the range within that area (Caverhill 2006; McNeil 2002) (Figure 3). Studies of turtle movements and distribution, in concert with genetic assessment, have revealed that the Nova Scotia population complex is spatially structured, containing several distinct populations (Caverhill 2003, McNeil 2002, Mockford *et al*. 1999, Mockford *et al.* 2005, Toews 2004). To date, three genetically distinguishable populations have been documented, each separated by at least 15 km (Figure 3). These populations exhibit significant biological differences in behaviour, morphology, habitat use and fecundity (Caverhill 2006, McNeil 2002, Mockford *et al.* 2005). Even within populations, genetic structuring among concentration sites may be evident (Toews 2004)

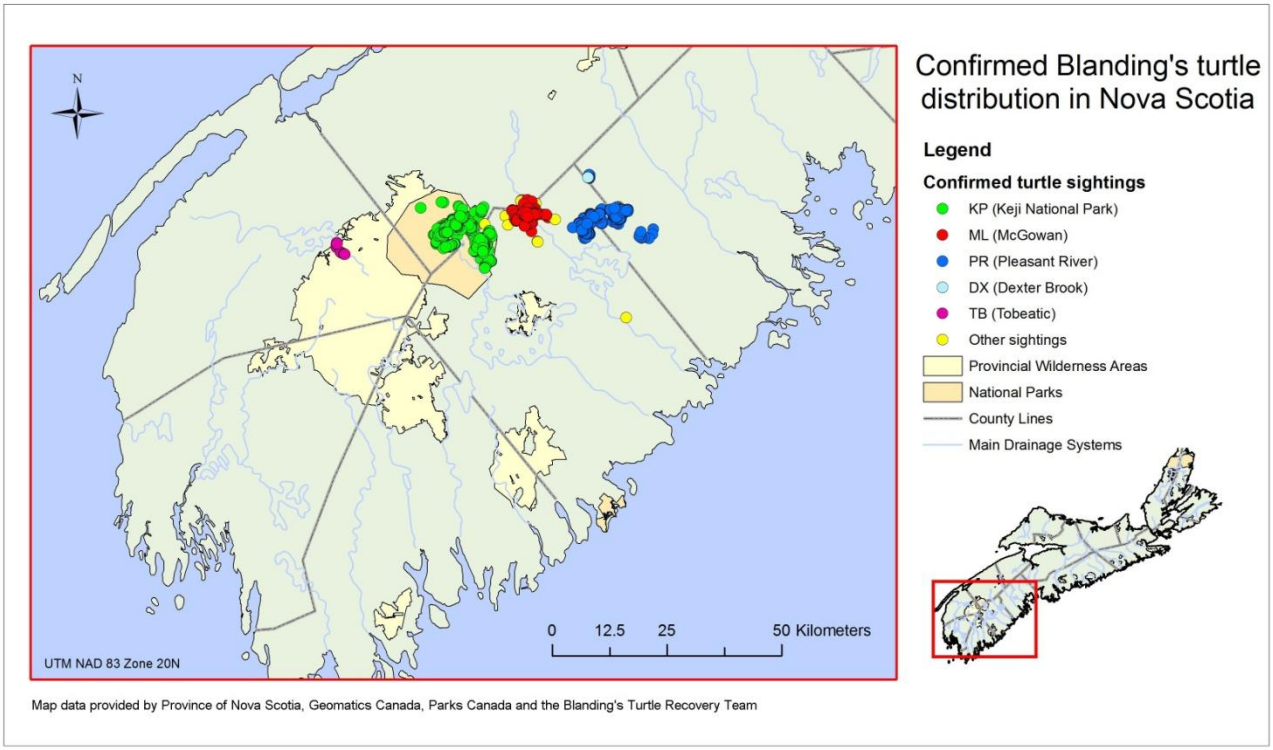

Figure 3. Confirmed distribution of Blanding`s turtles in Nova Scotia, with sightings coloured by population / concentration. Yellow dots represent confirmed sightings that have not yet been assigned to specific populations.

The Kejimkujik population occurs on the Mersey River watershed, almost entirely within the boundaries of Kejimkujik National Park and National Historic Site (Kejimkujik). The McGowan Lake and Pleasant River populations occur in working landscapes on the Medway watershed. Two smaller concentrations have also been identified within the population complex, one in the Tobeatic Wilderness Area on the Sissaboo watershed (4 turtles) and one in Dexter Brook on the Medway watershed (3 turtles). Additionally, several isolated sightings and unconfirmed reports along the Mersey, Medway and adjacent watersheds suggest that undiscovered populations may exist.

3.2.2 Population size and trends

Based on our current knowledge of the species' range, it is believed that the entire Nova Scotia Blanding's turtle population complex contains approximately 350 adults. Estimated current population size for each of the known populations is presented in Table 1. Initial population modeling of two of the three populations suggests that both may be declining (Bourque *et al.* 2006). Although little is known of the history of Blanding's turtle in Nova Scotia, based on estimates of genetic diversity, it is possible that populations were once larger and more widespread than at present (Herman *et al* 2003). Estimates of gene flow suggest that over the last few generations the McGowan Lake population has gone from a source population to a sink population, while the reverse has occurred at Pleasant River (Howes *et al* 2009).

Table 1. Estimated size for populations of Blanding's turtles in Nova Scotia

Population/ Concentration	Years of data	Population estimate/ total adults marked	Watershed	Primary Ownership
Kejimkujik	1969-2010	Population estimates: 63 -132 [1] 146 adults marked	Mersey	Federal
McGowan Lake	1996-2010	Population estimate: 79 (60-116) [2] 63 adults marked	Medway	Provincial / Private
Pleasant River	1997-2010	82 adults marked	Medway	Private / Provincial
Whitesand Stream	2007-2010	3 adults marked	Sissiboo	Provincial
Dexter Brook	2004-2005	3 adults marked	Medway	Private

[1] Kejimkujik population estimate based on two separate estimates: 1. Mean annual Jolly-Seber estimate using data from 1987- 2002 (Bourque *et al.* 2006). 2) Schnabel binomial estimate based on data census intervals 1969-1988 (Herman *et al.* 1995). Actual numbers of adults includes all adults marked from 1969-2010 and does not take into account individuals that may have died during this time period.

[2] McGowan population estimate calculated using data from 1996-2002 using the Schnabel method.

3.2.3 Significance of the NS population

Studies have shown that the degree of genetic variation in the NS population is similar to, or even higher than, that of populations in the species' main range (Mockford *et al.* 1999, Ruben *et al*. 2001). The NS population has also significantly diverged genetically from populations in the main range (Mockford *et al.* 1999, Mockford 2007, Ruben *et al*. 2001) and has been proposed as an important evolutionary unit of the species (Mockford 2007).

3.3 Mi'kmaq involvement in recovery

As a preamble to this section, there are two important considerations. First, this recovery strategy, as a requirement of SARA, adheres to the directives set out in that legislation. Second, Section 3.3 provides insight on Aboriginal perspectives on the recovery of the Blanding's Turtle as contributed by Mi'kmaw members of the recovery team, and through consultation with the Native Council.

Blanding's turtle habitat falls within Kespukwitk, one of the seven traditional districts of

Mi'kma'ki. For this reason, it is important that the involvement of the Mi'kmaq living on and sharing the land is actively sought and encouraged. It is this continuum of Mi'kmaq throughout Kespukwitk, who through their sages, talks, and walks, will begin to reveal aspects of the Blanding's turtle. Mi'kmaq can make important contributions to the recovery of turtles through traditional teachings, revealing the importance of traditional practices, and sharing an Aboriginal eco-centric world view. Mi'kmaq customary use of biodiversity embodies the Mi'kmaq principle of netukulimk; a way of harvesting resources without jeopardizing the integrity, diversity, or productivity of our natural environment (Native Council of Nova Scotia 1994). A more inclusive approach to ecosystem based management may be particularly useful for Blanding's turtle recovery and also to other rare and at risk species that are tied to similar habitats in the watersheds of southern Nova Scotia. This recovery strategy cannot hope to illustrate the total knowledge of the Mi'kmaq. Recovery planning can be revised over time as involvement with the Mi'kmaq grows.

3.3.1 Aboriginal Traditional Knowledge

In order to integrate Aboriginal Traditional Knowledge (ATK) with other types of knowledge, it is important for recovery planners to understand how the Mi'kmaq world view may differ from other Aboriginal and scientific world views. Mi'kmaq traditional knowledge is not necessarily written, peer-reviewed, or published. ATK is a living knowledge, captured in oral language and culture, and which is highly specific to place and time – it is the *ki* of *Mi'kma'ki*. In sharing ATK, Mi'kmaq will often end by saying *tan teli kji'jitu* (as I know it to be), recognizing that the knowledge is living. In other words, the knowledge shaped from the land, e.g. about the Blanding's turtle, carried forward, and shared will differ between those experiencing that place at different times. It may change because of another action or because of another's perspective.

There are several legends and stories of *Mikjikj*, the Mi'kmaq name for turtles. These range from creation stories to legends of how the turtle got its shell. Some describe how the turtle was used by the Mi'kmaq and other stories of how and why specific turtles were named (Speck, 1923). The vast array of stories and legends signify a deep spiritual connection between the Mi'kmaq and turtles, suggesting there is much we can learn from their collective knowledge.

It is not known if Mi'kmaq people hold specific knowledge of Blanding's turtles but they likely hold knowledge of the turtle's habitat and that information has not yet been accessed. For example, ATK may be able to inform changes that have occurred in turtles' range and provide insight as to whether changes in distribution may be related to changes in habitat. In addition, the Mi'kmaw world view of planning for 7 generations into the future would be beneficial for understanding and advancing the necessity for planning for long periods that are biologically relevant to the long lived Blanding's turtle (e.g.10 generations for Blanding's turtle is 400 years).

3.3.2 Commitment to include the Mi'kmaq and consider traditional knowledge

This Recovery Strategy recognizes and incorporates Mi'kmaq knowledge in the recovery of Blanding's turtles and their habitats.

- First, by recognizing the significance that the Mi'kmaq People have shared a long history with the Blanding's turtle in Kespukwitk.

- Second, by inviting Mi'kmaq individuals and communities to sit with others, as peers, to discuss, draft, and implement recovery strategies and action plans.
- Third, by recognizing and acknowledging that it is important to gather and understand the collective knowledge of the Mi'kmaq about Blanding's turtles and their habitats.
- Fourth, by recognizing the need to include Mi'kmaw worldviews to ensure the value of netukulimk for the long term sustainability of Kespukwitk.
- Finally, by recognizing the valuable contribution of the Mi'kmaq and their traditional knowledge as an important step towards reconciling Aboriginal and scientific world views.

3.4 Needs of the Blanding's turtle

3.4.1 Habitat and biological needs

Blanding's turtles use a variety of habitats during their life cycle, and because of their longevity, individuals may have to shift these areas in response to changes in habitat over their lifetime. Limiting features of habitat are not currently known at this time. The following summary of known habitats used is presented to inform the identification of critical habitat.

Summer habitats: Blanding's turtles in Nova Scotia are found in a variety of habitats including fens, shallow lake coves, vernal ponds, and slow flowing brooks and rivers. They tend to use these habitats from April to late September. Within these habitats, Blanding's turtles tend to frequent shallow water (<2 m deep) containing abundant vegetation, often with deep, organic sediments (Ernst and Barbour 1972, Gilhen 1984, Graham and Doyle 1979, McMaster and Herman 2000, Power 1989, Ross 1989, Ross and Anderson 1990). Sites where turtles are present tend to have sweetgale (*Myrica gale*) or sedge (*Carex spp*.) overhanging the banks, few rocks (Bourque 2006), a mid range of water colour with peaty soils (Bourque 2006, Power 1989) and living sphagnum mats (McMaster and Herman 2000). Extensive beaver activity is also apparent at most known Blanding's turtle sites in NS. Juveniles typically occur in the same overall habitats as adults, although they may use different microhabitats within the larger wetland (McMaster and Herman 2000, McNeil 2002). Summer habitat for hatchlings and very young juveniles may vary. While some have been encountered in traditional turtle summer habitats, others have been radio tracked to wet areas in the woods or in small pools prior to moving to the larger wetlands (unpublished data).

Winter habitats: Blanding's turtle adults and juveniles often densely aggregate at their aquatic overwintering sites, and return to the same sites year after year (Caverhill 2006, McNeil 2002, Power 1989). They typically arrive at these sites in September and October and leave shortly after the ice melts in March and April. The characteristics and location of overwintering sites vary, including wooded pools or channels, railway trenches, and specific sections of streams or wetlands (McNeil 2002, Newton and Herman 2009, Power 1989). Sites typically have a deep organic bottom and undercut banks (Newton and Herman 2009). Temperature profile, dissolved oxygen level, water flow, water depth and vegetation composition vary considerably among sites (Newton and Herman 2009). Mating activity is often observed at overwintering sites, particularly during the fall (McNeil 2002) and basking activity occurs in nearby areas particularly in spring. Recent tracking studies of hatchlings show that their overwintering habitat is different from

adults, as they spend the winter in a variety of habitats such as vegetated water or buried in moist substrates on land (Camaclang 2007).

Nesting habitats: Blanding's turtles nest in a variety of habitats, both natural and human-influenced, including lakeshore cobble beaches, slate outcrops, gravel roadsides, borrow pits, vegetable gardens, mine tailings, and recreational tracks (Caverhill 2006, McNeil 2002, Power 1989, Standing et al. 2000). Sites must be exposed to adequate solar heat gain to allow for incubation of the eggs, and are often facing southwest (Power 1989, Standing 1997). Nest sites may be close to water or considerable distances inland. Females may nest densely in one area or singly. Many, but not all, females show high fidelity to specific nesting areas (Standing et al 2000). However, they have also demonstrated the ability to shift sites when necessary. Nesting typically occurs in evenings in June-early July and females may spend several days at or near the site prior to nesting. Females lay only one nest per year, and may not nest every year. Hatchling emergence from the nest typically occurs from late August to mid October. During emergence, hatchlings may remain in the vicinity of the nest for several days before dispersing (Camaclang 2007, McNeil *et al.* 2000, Smith 2004, Standing *et al.* 1997). In rare cases, hatchlings have been observed to overwinter in the nest cavity (Nova Scotia Blanding's turtle database 2010).

Travel routes: Blanding's turtles are capable of travelling considerable distances both overland and along waterways. They move regularly among seasonal habitats and may make occasional long distance migrations (Kydd 2010, Power 1989). Turtles travelling to and from nesting sites have been shown to use the same travel route in multiple years (Kydd 2010). Newly emerged hatchlings often make extensive treks on land as they leave their nest site and seek an appropriate overwintering location (Camaclang 2007, McNeil *et al.* 2000, Smith 2004, Standing *et al* 1997).

3.4.2 Limiting factors

Blanding's turtles in Nova Scotia are limited in their ability to respond to threats and habitat changes by their long generation time, physiology and small population size and geographic isolation from the species' main range.

As a long lived species with substantially delayed maturation (20 years), Blanding's turtles are especially vulnerable to increases in adult mortality. Even slight increases in adult mortality can drive populations to local extinction (Congdon *et al.* 1993, Heppel 1998). Because of their longevity and slow maturation, the species has a very long generation time (approx. 40 years), which can delay their ability to respond quickly to threats and result in significant time lags in recovery. These time lags also limit our ability to detect changes in the population until long after an event has occurred.

Restricted heat units and low productivity conditions significantly constrain Blanding's turtles in Nova Scotia. Sufficient heat units are required for successful incubation of eggs and emergence of hatchlings (Gutze and Packard 1987). In colder years, poor hatchling success, high rates of developmental abnormalities and lethargy in hatchlings are often apparent (Standing *et al.* 2000). Low productivity habitats may limit population density and in conjunction with short growing seasons, inhibit individual growth rates. As a result, maturation appears to be substantially delayed; in fact, Blanding's turtles in Nova Scotia have the highest age of maturity reported for the species (McNeil 2002).

As a small, isolated population complex, Nova Scotia Blanding's turtles are vulnerable to stochastic (chance) events (COSEWIC 2005). Local disturbances such as unusually high predation, extreme weather, or disease, which would have little effect on a large population, could be devastating. The species' tendency to densely aggregate at seasonal locations, such as nesting and overwintering sites exacerbates this risk.

3.5 Knowledge gaps

Despite the long term research, knowledge gaps remain. As a result of their longevity and late maturation, accurately assessing the status of the Blanding's turtle population is a long term process. All of the research and recovery efforts listed below in section 6.1 aid in our ability to understand the population but the majority of this work has taken place in less than half of a turtle generation, which is estimated to be approximately 40 years (Herman et *al.* 2003).

Some important remaining questions include:

- What is the overall distribution in the province? Is this distribution currently shrinking, expanding and/or stable? How has it changed historically?
- Are the Kejimkujik and McGowan populations currently declining as indicated by the PVA? If so, why? What is the state of the Pleasant River population?
- What are the natural long term variations in survivorship and fecundity rates and how do they compare with elsewhere in the species range?
- How much habitat is necessary to sustain the population over the long term (allowing for shifts in habitat use)?
- What is the effective population size? Is the proportion of males successfully reproducing unusually low compared to elsewhere in the geographic range? If so, why is it low and does it reflect a recent change and/ or is it an indicator of a yet-to-be identified threat?
- What are the long term effects of [1]headstarting on fitness?
- If laboratory incubation and headstarting is to continue to be an important component of recovery, what is the most appropriate incubation temperature to produce healthy males and females?
- What will be the long term effect of climate change?
- What is the long term effect of cumulative habitat loss / alteration and disturbance?

4. THREATS

4.1 Threat Assessment

Existing and suspected threats have been identified in Table 2.

[1]Headstarting is the process by which hatchling turtles are raised in captivity for a period of up to 2 years.

Table 2. Threat Assessment Table

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Habitat loss or degradation						
Cottage and residential development	High	Widespread	Current / historic	One-time / recurrent	Moderate	High
Forestry practices (e.g. clearcutting, harvesting in riparian zone)	Medium	Widespread	Current / historic	Recurrent	High	Low
Road development	High	Widespread	Current / historic	Recurrent	High	High
Agricultural practices (e.g. Cranberry growing, tilling, crop production)	Low	Localized	Unknown	Rare	Moderate	Medium
Recreational use of nesting areas (e.g. beaches, OHV trails)	Medium	Localized	Current / historic	Seasonal	Moderate	Medium
Peat mining	Low	Localized	Unknown	Rare	Moderate	Medium
Accidental Mortality						
Mortality from on and off road vehicles and machinery	High	Widespread	Current / historic	Seasonal – rare	High	High
Motorboat use	Medium	Localized	Unknown	Seasonal – rare	High	Medium
Collection for museum specimens[4]	Low	Localized (KP)	Historic	One-time	High	High
Collection for food[4]	Low	Widespread	Unknown	Rare	High	High
Compaction or destruction of nests	Low	Localized	Unknown	Seasonal – rare	Low	Low
Changes in Ecological Dynamics or Natural Processes						
Hydroelectric dam operation	Medium	Localized	Current / historic	Continuous	Moderate	Medium
Human alteration of beaver dams	Medium	Localized	Current / historic	One-time / recurrent	Moderate	Medium
Introduction/ establishment of exotic predatory fish (small mouth bass and chain pickerel)	Medium	Widespread	Anticipated	Continuous	Unknown	Low
Changes in predator populations resulting from human activities	Medium	Localized	Current/ historic	Recurrent	Moderate	Low

Climate and natural disasters						
Climate change	Medium	Widespread	Anticipated	Continuous	Unknown	Low
Stochastic events that increase adult mortality[5]	Medium	Localized	Unknown	Unknown	High	High
Disturbance or persecution						
Collection for pets and / or relocation	Medium	Localized	Current/ historic	Unknown	High	Medium
Pollution						
Pesticide and herbicide use	Low	Localized	Unknown	One-time / recurrent	Unknown	Low
Contaminants from mine tailings	Low	Localized	Historic	Recurrent	Unknown	Low

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. (This criterion considers the assessment of all the information in the table).*

[2] *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).*

[3] *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible).*

[4] *Threats known to have occurred previously and/or do occur in other parts of the species range. These currently have a low level of concern, but there is a high causal certainty that they would significantly impact the population*

[5] *High causal certainty that this will significantly impact the population, however, currently a medium level of concern as it is not regularly occurring.*

4.2 Description of Threats

The following highlights major threats outlined in Table 2, emphasizing key points and providing additional information on the threats. Evidence suggests significant population-level impacts exists for threats with a "high" for both 'level of concern' and 'causal certainty'; other threats are identified as being potentially significant if they were to occur. While threats are listed separately, an important concern is the long-term cumulative effect of a variety of threats on the Blanding`s turtle population. As human development increases, the overall impact of activities on the habitat becomes more serious at both the small and large scale. At the landscape scale, incremental losses and multiple threats often complicate recovery efforts and confound understanding of population trends (Jensen *et al.* 1993).

Mortality, habitat loss and changes to ecological processes associated with human activities

Increased adult mortality is a potential yet very serious threat to the Blanding's turtle, as it is known to cause major declines in turtle populations (Congdon *et al.* 1983). Blanding's turtles' longevity and late maturation make their populations particularly vulnerable to even small increases in adult mortality (Congdon *et al.* 1983, Congdon *et al.* 1993). By reducing lifetime reproductive output, even these small changes can drive populations to local extinction (Heppel 1998, Congdon *et al*. 1993). Although younger life stages have higher natural mortality rates, sustained increases in mortality in these stages will also cause a population to decline (Bourque

et al 2006); the decline may be difficult to detect in the short term due to the species long generation time and the more cryptic nature of juveniles.

Human activities can affect survivorship of all life stages both directly and indirectly. In the Nova Scotia population, collection for museum specimens (historic) and vehicle collisions (on and off road) have contributed directly to mortality (Penny 2004). When first described in the early 1950's, it is known that more than a dozen turtles, most believed to be female, were removed as samples; additionally, there have been 4 known instances where vehicle mortality has occurred in adults, again all females, and several instances of vehicle mortality in hatchlings and juveniles. Indirectly, habitat destruction and fragmentation from cottage development and forestry and agricultural practices disrupt population structure by reducing the amount of habitat and impeding movements within and between populations (Hartwig 2004). This can force turtles to travel through higher risk areas; additionally, in some cases, human activities actually create habitat which attracts turtles, particularly for nesting (Congdon *et al*. 2008). Both of these put turtles at increased risk for encounters with people, machinery and pets. Additionally, nesting areas near human development may have unusually high populations of opportunistic predators such as raccoons, which could substantially increase predation on eggs and hatchlings; if sustained, this would decrease lifetime reproductive output (Hartwig 2004). In Ontario, an increase in the predation of nests by sarcophagid fly larvae has been identified as a potentially significant threat, although the cause of increase is unknown (COSWEIC 2005). In Nova Scotia only a small number of eggs have been found to contain maggots that may be from the sarcophagid fly (NS Blanding's turtle database 2010), although this may pose a future threat (Bolton *et al*, 2008).

Blanding's turtles require seasonally predictable water levels at all seasonal habitats. Hydropower generation in this region tends to accentuate variability and unpredictability in water level (Herman *et al*. 2003). Lake draw-downs in mid and late summer reduce or eliminate drought refuges and create large uninhabitable expanses; in the winter, they can potentially increase mortality by exposing overwintering turtles. Retention of water during wet summers can flood shoreline nests (NS Blanding's turtle database 2010). In contrast, impoundments controlled by beavers reduce variability and increase predictability in water level. Removal or control of beaver activity by cottage owners, farmers, foresters and highway maintenance crews potentially threatens all life stages of the turtle.

Human activities can also affect availability of food such as aquatic invertebrates and amphibians. Invasive predatory fish species, such as smallmouth bass and chain pickerel, reduce populations of amphibians and small fish (Jackson 2002, Vander Zanden et al. 2004), and may also pose a direct predatory threat to hatchlings. While not yet documented at Blanding's turtle sites, the ranges of both of these species has been expanding in southwestern Nova Scotia though human introductions. Likewise, pollution and pesticides may directly affect the turtles themselves, as well as system productivity and the availability of food. This reduced productivity could affect growth of the turtles at a local scale, which may explain differences in sizes seen among populations in Nova Scotia.

Climate change and natural disasters

In the longer term, Blanding's turtles in Nova Scotia face an uncertain climatic future and it is not known if the overall effects of climate change will be positive or negative. Because of their limited physiological tolerance and long generation time (approximately 40 years), they are limited in ability to respond genetically to climatic change (Herman and Scott 1992). Substantial changes in climate may occur within the lifetime of an individual turtle; adaptive responses to such changes would have to be behavioral rather than genetic (Herman and Scott 1992). Changes to overall temperatures and seasonal water flow could affect habitat at any life stage. Additionally, climate change could alter nest temperatures which could result in skewed sex ratios or decreased fitness in the population over time. The sex of hatchlings is determined by the temperature at which they were incubated in the nest, with lower incubation temperatures producing males and higher temperatures producing females (Gutze and Packard 1987). Sub-optimal temperatures or moisture levels during incubation can result in nest failure, increased incidents of deformities, or decreased overall fitness in hatchlings (Packard 1999, Standing et al 2000).

Natural disasters that increase adult mortality can be a serious threat to this small isolated population, for reasons described above.

5. POPULATION AND DISTRIBUTION OBJECTIVES

The long term objectives are to achieve a self-sustaining population of Blanding's turtles in Nova Scotia, over the current range, (as measured by 95% probability of persistence in each recognized population when projected over 10 generations (400 years)), and to maintain sufficient gene flow to prevent any single population from becoming genetically isolated.

The long term objectives include the three currently recognized populations. The status of the two small concentrations is currently unknown, with less than 5 turtles identified at each. Further study is needed to determine if they are currently, or were historically, viable populations.
In the interim, the following short term objectives will be measured in terms of their contribution to the long term objective:

- Maintain or increase adult survivorship sufficient to sustain the three recognized populations.
- Maintain or enhance recruitment into the three recognized populations
- Maintain extent of occurrence in the province
- Maintain area of occupancy in the province
- Reduce threats facing all life stages

Current range (area of occupancy) was chosen as the benchmark as there is no information available on historic range of the species in Nova Scotia. Because our current knowledge of distribution is incomplete, loss of range is difficult to assess and requires surveys to locate

additional populations. Protecting Blanding's turtle habitat does not necessarily mean that no human activities can occur, but that necessary ecosystem processes be maintained so that survivorship, fecundity and gene flow are not negatively affected.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Currently Underway

Blanding's turtles have been described as a flagship species for conservation in Nova Scotia (Lefebvre 2009) and research and recovery actions have been underway for many years. The strategic approaches identified in this strategy are informed by both past and current research and build on the successes and knowledge gained from early recovery actions.

The Kejimkujik population was first described in Nova Scotia in 1953 and turtles have marked in this population since 1969 (Drysdale 1983, Thexton and Mallet 1977-1979, Weller 1971-1972).With help from members of the public, the populations at McGowan Lake and Pleasant River were described in 1996 and 1997 respectively (McNeil 2002, Caverhill 2003).

An extensive research, recovery and monitoring program has been underway since the mid 1990's which has increased knowledge of habitat use, threats, and age-specific survivorship necessary to inform recovery. In addition to ongoing monitoring, many research projects have been conducted to examine nesting ecology, hatchling movement, juvenile abundance and survivorship, travel routes, habitat characteristics, population genetics, and predation threats[1]. The cornerstone of the recovery approach has been based on a well established volunteer-based nest protection program which has taken place annually in Kejimkujik since 1992 (Standing *et al*. 2000) and was expanded to the other two populations in the early 2000's (Caverhill 2003, McNeil 2002). In addition to protecting nests from predation, this program provides valuable data on survivorship, fecundity, site fidelity and recruitment.

Initial efforts to bolster recruitment through headstarting in the early 1990s showed that headstarts could survive and behave like wild juveniles (Morrison 1996). Recent headstarting efforts began in 2002 to specifically address recovery at Grafton Lake, in Kejimkujik (Newbould 2003, Penny 2004). In the early 2000's, a Population Viability Analysis (PVA) was conducted on the Kejimkujik and McGowan Lake populations suggest that both are at a significant risk of decline; it predicted that a variety of recovery actions aimed at younger life stages could effectively reduce the extinction risk in both populations. Following the development of the

[1] Research project referencing: Nesting ecology (Standing 1997), hatchling movement (Standing 1997, McNeil *et al.* 2000, Smith 2004, Camaclang 2007, unpublished data), juvenile abundance and survivorship (McMaster and Herman 2000, Morrison and McNeil 2003, Arsenault in progress), travel routes (Kydd 2010), habitat characteristics (Bourque 2006), population genetics (Mockford *et al.* 2005, Howes et al 2009), and predation threats (Oickle 1997, Shallow 1998, Standing *et al.* 2000b)

PVA, the headstarting program was expanded to include the entire Kejimkujik population and McGowan Lake populations. In 2009, the current phase of this recovery experiment began, including the laboratory incubation of eggs at a variety of temperatures to determine the most appropriate to produces healthy hatchlings of both sexes (Arsenault in progress).

Efforts have also been underway to protect Blanding's turtle habitat. The known Kejimkujik population occurs mostly within the boundaries of the park, and much of this habitat has been declared as Zone 1, the highest level of protection (Kejimkujik National Park 1995). At McGowan Lake, 102ha of Blanding's turtle habitat were formally protected by Abitibi-Bowater under the company's Unique Areas Program; the Province of Nova Scotia has since acquired this land. Additionally, the province has protected over 500 ha through their Integrated Resource Management system and recently purchased an additional 12 ha of important overwintering habitat from a private landowner at McGowan Lake. Through the Nova Scotia Nature Trust, four parcels of Blanding's turtle habitat have been protected in Pleasant River.

Research and recovery actions are guided by the Blanding's Turtle Recovery Team, which each year reviews the ongoing activities and provides recommendations. The recovery program involves a variety of partners including Parks Canada, Nova Scotia Department of Natural Resources, Acadia University, Dalhousie University, Oaklawn Farm Zoo, Nova Scotia Nature Trust, Mersey Tobeatic Research Institute, Friends of Keji Cooperating Association, Abitibi-Bowater, Nova Scotia Power as well as numerous volunteers, students, and local landowners. The well established outreach program provides the opportunity for the public to be directly involved in meaningful research and recovery actions that support the strategic approaches identified in this strategy.

6.2 Strategic Direction for Recovery

To achieve the long-term and intermediate population and distribution objectives, the following broad strategies have been identified:

1. Continue to support, inform, recommend and, where possible, build on the significant public participation and partner involvement in meaningful recovery actions; engaging landowners, volunteers, Mi'kmaw communities, students, local industry, NGO's and government agencies.
2. Invite, encourage, and include Mi'kmaw involvement in the recovery process to explore opportunities for different approaches and knowledge.
3. Determine the extent of the range in Nova Scotia and identify population status, structure, habitat use and threats in known and any new concentrations.
4. Ensure conservation of currently known critical habitats and new habitats as they are identified.
5. Undertake recovery actions to increase recruitment or decrease mortality (e.g., enhance juvenile survivorship through headstarting or nest protection) in areas that have been identified and evaluate the effectiveness of these actions.

6. Examine male fecundity in the population complex to determine if there is a conservation concern and continue studies to assess and maintain the genetic variation that will sustain a viable population.
7. Conduct strategic monitoring of the population complex and continue refining and reassessing population modeling.

Recommended research and management approaches to implement these strategies are identified in Table 3.

Table 3. Recovery Planning Table

Threats Addressed	Priority	Broad strategy to recovery	General Description of Research and Management Approaches
All	Necessary	Continue to support, inform, recommend and, where possible, build on the significant public participation and partner involvement in meaningful recovery actions.	• Continue to invite and involve volunteers directly in meaningful recovery actions and priority research and monitoring activities and provide feedback. • Continue work with Mi'kmaw communities supporting Blanding's turtle recovery. • Facilitate landowner stewardship by building relationships and providing guidance to achieve habitat conservation and restoration and evaluate effectiveness of approaches to stewardship. • Collaborate with other recovery teams and partners to coordinate and deliver ecosystem based recovery activities and minimize overlap in landowner contact. • Work closely with local forestry, hydro electricity and tourism industries to protect and restore habitat and to foster public involvement in recovery
All	Necessary	Invite, encourage, and include Mi'kmaw involvement in the recovery process to explore opportunities for different approaches and knowledge	• Seek out and integrate Mi'kmaw knowledge and worldviews into decision making and long term planning. • Explore opportunities to establish regular communications between Mi'kmaw organizations and communities and species at risk jurisdictions, academics and volunteers • Explore opportunities for ceremony to be a regular part of recovery action.

Threats Addressed	Priority	Broad strategy to recovery	General Description of Research and Management Approaches
All	Urgent	Determine the extent of the range in Nova Scotia and identify population status, structure, habitat use and threats in known and any new concentrations found.	• Continue to solicit sighting reports from members of the public. • Continue targeted trapping and visual surveys in new areas, based on reported sightings, single confirmed sightings, aerial photographs and threats. • Assess the size and extent of known and new concentrations. • Continue to provide training for volunteers and support volunteer-led efforts that contribute to research and monitoring goals.
Habitat destruction, fragmentation and loss; human induced mortality	Urgent	Ensure conservation of currently known critical habitats and new habitats as they are identified.	• Employ a variety of approaches to conserve habitat: legal, policy and stewardship. • Coordinate recovery actions on high priority ecosystems that may contain multiple species at risk, with other recovery teams and partners. • Explore with landowners, NGO's, industry and the academic community ways to effectively use stewardship to identify and maintain critical habitat. • Facilitate recovery planning by providing updated information to partners through the Blanding's turtle database and species at risk resource website. • Monitor critical habitats to identify threats and take actions to remove or reduce any threats which arise.
Vehicular mortality; increased predation due to human influences; historic mortality; small population effects	Urgent	Undertake recovery actions to increase recruitment or decrease mortality in areas that have been identified and evaluate the effectiveness of these actions	• Continue the annual nest protection program in all known populations and conduct an initial evaluation of the program by 2015. • Assess short-term effectiveness of the incubation and headstarting program. Following the assessment, discuss optional and/or required next steps with the recovery team. • Take additional steps to reduce vehicular and boat mortality though signs, speed bumps, and public education. • Conduct research and take actions where there is imminent risk of mortality by moving vulnerable adults, hatchlings and nests. • Reduce the risk of poaching and collection for pets though public education. • Take other recovery actions that are identified as necessary by recovery experts and document all decisions, goals and evaluations of success.

Threats Addressed	Priority	Broad strategy to recovery	General Description of Research and Management Approaches
Low fecundity, Small population effects	Urgent	Examine male fecundity in the population complex to determine if there is a conservation concern and continue studies to assess and maintain genetic variation that will sustain a viable population	• Determine the effective population size by conducting an assessment of paternity within the population complex to identify the number of males successfully reproducing and the proportion of clutches with multiple sires. • Undertake studies to determine if there is a conservation concern such as male fertility, as required. • Assess genetic relationships of known and any new concentrations (when sample sizes allow) with the three known populations through DNA collection.
All	Necessary	Conduct strategic monitoring of the population complex and continue to reassess and update population models	• Develop a strategic monitoring plan and conduct standardized monitoring at a level necessary to refine assessment of survivorship, abundance and fecundity and identify new threats. • Construct initial population models for Pleasant River and refine the models for Kejimkujik and McGowan to reflect the most current demographic data, literature on models, and recovery actions underway. • Collect data necessary to assess the effectiveness of recovery actions. • Monitor the effect of human activities and habitat change on long term viability.

6.3 Narrative to Support the Recovery Planning Table

The overarching philosophy to recovery planning for Blanding's turtles is respect, for both the turtles and the many partners involved in recovery. Blanding's turtle recovery has always relied upon the integration of science, stewardship and recovery (Caverhill 2006, Herman *et al.* 1998) and on the cooperation of many partners including government, academic institutions, NGO's, aboriginal organizations, industry, volunteers and landowners. In fact, Blanding's turtles have been described as a flagship species for conservation in southwest Nova Scotia because they are well liked by the public and their recovery program presents opportunities for direct public involvement (Lefebvre 2009). This recovery strategy recognizes the importance of volunteer stewardship that directly supports the science, monitoring and recovery actions identified in Table 3. Much of the knowledge gained and recovery actions undertaken to date could not have happened without the involvement and inspiration of volunteers. Developing a strategic plan will ensure these volunteer contributions have maximum impact on recovery while minimizing disturbance to individual turtles. Engaging landowners and local communities through a variety of methods is the key to generating a local sense of ownership in recovery. Encouraging Mi'kmaq involvement in recovery may identify different types of knowledge and planning which may aid in Blanding's turtle recovery; the Mi'kmaw worldview of long-term planning (7 generations into the future) may be biologically relevant to the long lived Blanding's turtle.

Because of the long generation time of Blanding's turtles (~40 years), long term data is required to truly assess the status of the population and to assess the effectiveness of recovery actions. For example, although nest protection and headstarting efforts have been underway since the mid 1990s, this represents less than one half of one generation and several more years remain before the turtles from the earliest efforts will begin recruiting into the adult population. While intermediate assessments of success can be done in the meantime by looking at juvenile survivorship and growth, the long term data is important to truly evaluate the effect of recovery actions. If Blanding's turtles in Nova Scotia are conservation dependent, long term human intervention may be required to recover the population (NatureServ 2010).

Research activities described in Table 3 include determining the extent of the range, locating habitats, assessing male fecundity and monitoring known populations and concentrations, as well as habitats. Knowledge gained from these activities is essential to assessing population trends, identifying additional critical habitat, and recognizing threats. Identifying new areas of critical habitat is an additive process, which begins with expanding the knowledge of the species range in the province. Monitoring allows us to identify new threats and to collect important baseline data for population modeling. Appropriate monitoring frequencies will vary according to age class, location, and research question being asked. The development of a comprehensive monitoring strategy, which clearly outlines the rationale for each monitoring component, will provide appropriate frequencies to ensure all areas receive sufficient effort and avoid unnecessary sampling.

Population models, including Population Viability Analysis as well as other methods, can be useful tools to help predict the trends of a population, such as that of Blanding's turtles, for which the historical population size is unknown and for which the long generation time prevents a more direct assessment of population trends. However, those same factors which necessitate

the use of the models preclude their validation; as a result these models should be used with caution and regularly updated to ensure they reflect the most current information.

Genetic assessment has shaped the direction of the recovery program. Analysis has revealed that the Nova Scotia population is an ecologically significant unit; identifying three distinct populations (Mockford *et al.* 1999, 2005 and 2007). Continued genetic assessment will reveal whether known and any new concentrations of turtles should be treated as distinct populations, examine gene flow, and identify potential population bottlenecks. Initial analysis of male fecundity suggests that the number of males breeding is significantly lower than other populations of Blanding's turtles (Beckett 2006, Patterson 2007). Confirmed low fecundity could mean the effective population size is considerably smaller than previously thought, affecting both population projections and potential for recovery.

7. CRITICAL HABITAT

7.1 Identification of the Species' Critical Habitat

7.1.1 Rationale for critical habitat identification

Critical habitat is defined in the *Species at Risk Act* (S.C. 2002, c.29) as "…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species" (s. 2(1)).

In this recovery strategy, critical habitat is identified for the Blanding's turtle in Nova Scotia to the extent possible, using the best available information. In the province, many of the species' habitats have been determined including nesting sites, overwintering sites and summering sites used for most life stages. For many sites, multiple years of data are available, illustrating both repeated use of sites over time by the species and individual site fidelity.

Critical habitat is identified at all five known sites containing two or more identified individuals (three major populations and two smaller concentrations). Sites containing unconfirmed sightings are not included at this time. Sites containing only one identified turtle were excluded because it is possible that the turtles were moved there by the public. The two small concentrations were included in critical habitat identification at this time based on the precautionary principle; this will be reviewed as more information becomes known about these sites.

The critical habitat identified in this Recovery Strategy is necessary for the recovery of the species, but may not be sufficient to achieve the intermediate or long-term population and distribution objectives for the species due to insufficient understanding of the highly variable habitat attributes and the lack of knowledge of the species' distribution in Nova Scotia. The amount of critical habitat required to support a self-sustaining population of Blanding's turtles in Nova Scotia over the long term is currently unknown. There may be additional viable populations yet to be discovered, which are important to the long term persistence of the

population complex. Additionally, critical habitats around the periphery of the known populations may not yet be identified. Critical habitat identified here does not take into account corridors that enable movement between populations which, though infrequent, is necessary to maintain gene flow.

7.1.2 Information and methods used to identify critical habitat

Critical habitat is identified at each of the five sites using a two step process:

1) High use areas were identified by mapping turtle locations by categories based on seasonal activity and life-stage and then applying the delineation guidelines identified below.
2) The geographic limits of each of the five sites were identified by drawing a polygon that connects all of the high use areas.

Identifying high use areas

Turtle sighting locations were mapped according to seasonal activity (nesting, spring basking, summer, winter, fall travel) and life stages (male, female, juvenile). Following this, high use polygons were delineated using the following guidelines:

- When turtle location(s) were contained within wetlands, the entire wetland was included, as well as the terrestrial and aquatic area that extends 100m around the wetland, even if the turtle locations occurred only in part of the wetland.
- When turtle location(s) were contained within rivers or streams, the extent of the water channel encompassing the turtle locations and 200m upstream and downstream of the outermost extent was included, as well as the terrestrial and aquatic area that extends 100m on either side of the river or stream.
- When turtle locations(s) were contained within lakeshores, the extent of shoreline encompassing the turtle locations and 200m on either side of the outermost extent was included. The lakeshore waterside area within 100m and the terrestrial area within 50m were also included.
- When turtle location(s) were based on inland nesting areas, the entire nesting area was included, along with the surrounding terrestrial and aquatic habitat extending 100m around the site. If the nesting locations occurred along a roadway or rail bed, then the nesting area was defined as the zone encompassing the locations, plus 200m along the roadway on either side of the outermost sightings, excluding the paved surfaces.
- When the turtle location was based on an isolated sighting, a 100m radius around the sighting was included.

The terrestrial areas around identified wetlands are intended to capture additional habitats used by turtles, and include important components of the species' required habitats. This includes vernal pools, treed wetlands, small channels, seasonally flooded areas around the periphery of wetlands, and other areas that may not be identified using traditional wetland polygons. These areas also include terrestrial habitats that may be used by the turtles for travel, basking or refugia. These habitats may be particularly important to hatchling and young juveniles (unpublished data). While knowledge of turtle use of these habitats is somewhat limited in Nova Scotia, use of adjacent terrestrial habitats has been documented elsewhere in the species range. In Maine, for example, Blanding's turtles were found to frequent forested vernal pools in spring (Beaudry *et al.*2009). These areas are not buffer zones; they are fundamentally part of the critical habitat used by Blanding's turtles and their prey. The identified areas are conservative compared to others identified in the literature, where terrestrial areas of 135m to 1000m are recommended for Blanding's turtles (Bell and Stevens 2006, Hartwig 2004, Semlitch and Bodie 2003).

The lakeshore aquatic areas are identified to account for changes in seasonal water levels. Areas around nesting sites take into account female movements during nesting season and post-emergence movements of hatchlings, which can spend considerable time on land (Camaclang 2007, McNeil *et al.* 2000, Smith 2003, Standing *et al.* 2000).

Identifying extent of critical habitat in each site

Critical habitat at each site was identified by linking the outer boundaries of the high use areas together to form a polygon. With the exception of the Kejimkujik population, in places where the line would have bisected a lake, the entire lake was included. This rule was not applied to Kejimkujik Lake, due to the large size of the lake. It is believed that turtles in this population travel primarily along the shoreline rather than across open water (Kydd 2010). For Kejimkujik Lake, lakeside polygons were joined using a 100m waterside area that followed the shoreline. In the Kejimkujik population, three high use areas at the periphery of the population were identified as separate polygons because their relationship to the main population is unknown (Figure 4).

This approach allows for travel among high use areas, unidentified habitats within the population or habitats that are currently unused but may become used in future (e.g. new wetland habitat following creation of a beaver dam; new nesting areas created through disturbance).

7.1.3 Geographic location and biophysical attributes of Critical habitats

Using the above criteria, five sites were identified as critical habitat in Nova Scotia as outlined in Table 4 and illustrated in Figure 4.

Table 4. Five critical habitat sites identified in Nova Scotia. Main populations have more than 50 individuals identified and small concentrations have less than five individuals identified.

Location	Type	Watershed	Map square*
Kejimkujik	Main population	Mersey	I-11
McGowan	Main population	Medway	M-10
Pleasant River	Main population	Medway	R-10
Whitesand Stream	Small concentration	Sissiboo	B-12
Dexter Brook	Small concentration	Medway	Q-08

* *Map square refers to the accompanying map. A low resolution version of this map is presented in Figure 4.*

Biophysical attributes

Critical habitat includes all areas within the identified polygons. This encompasses seasonal habitats required for all life stages and the aquatic and terrestrial travel routes between these habitats. Biophysical attributes of habitats used varies considerably with site, season and age-class, and not all are currently identified. Typical biophysical attributes are listed below, although it should be noted that specific attributes for certain life stages (e.g., hatchings) are still unclear. Hence, section 7.2 identifies activities to help better define these attributes and determine the geographic locations of any additional critical habitat.

Biophysical attributes of aquatic habitats used during the active season typically include, but are not limited to, the following (Bourque 2006, Caverhill 2003, Gilhen 1984, McMaster and Herman 2000, Power 1989):

- Wetlands including fens, bogs, ponds, vernal pools, lake coves, streams
- Slow moving water
- Abundant aquatic vegetation
- Overhanging vegetation (e.g. sedges or sweetgale)
- Mid-range water color (100-250 TCU)
- Muddy, organic substrate, not dominated by rocks

Biophysical of overwintering habitats typically include, but are not limited to, the following (Caverhill 2006, McNeil 2002, Newton and Herman 2009, Power 1989):

- Wooded pools or channels, railway trenches, and specific sections of streams or wetlands
- Deep organic substrate
- Undercut banks

Biophysical attributes of nesting habitats include, but are not limited to, the following (Caverhill 2006, McNeil 2002, Power 1989, Standing 1997):

- Natural or human-modified sites such as lakeshore beaches, woodland outcrops, gravel pits and roadsides
- Areas exposed to sunlight
- Areas with exposed substrate such as gravel, soil or sand, in which a turtle can dig a nest

Biophysical attributes of travel routes, include but are not limited to, the following (Camaclang 2007, Kydd 2010, Lefebvre 2010, McNeil 2002, Power 1989):

- A variety of terrestrial habitats including woodland, trails, meadows
- A variety of aquatic habitats including along streams, along lake shores or across lakes, through wetlands, vernal pools

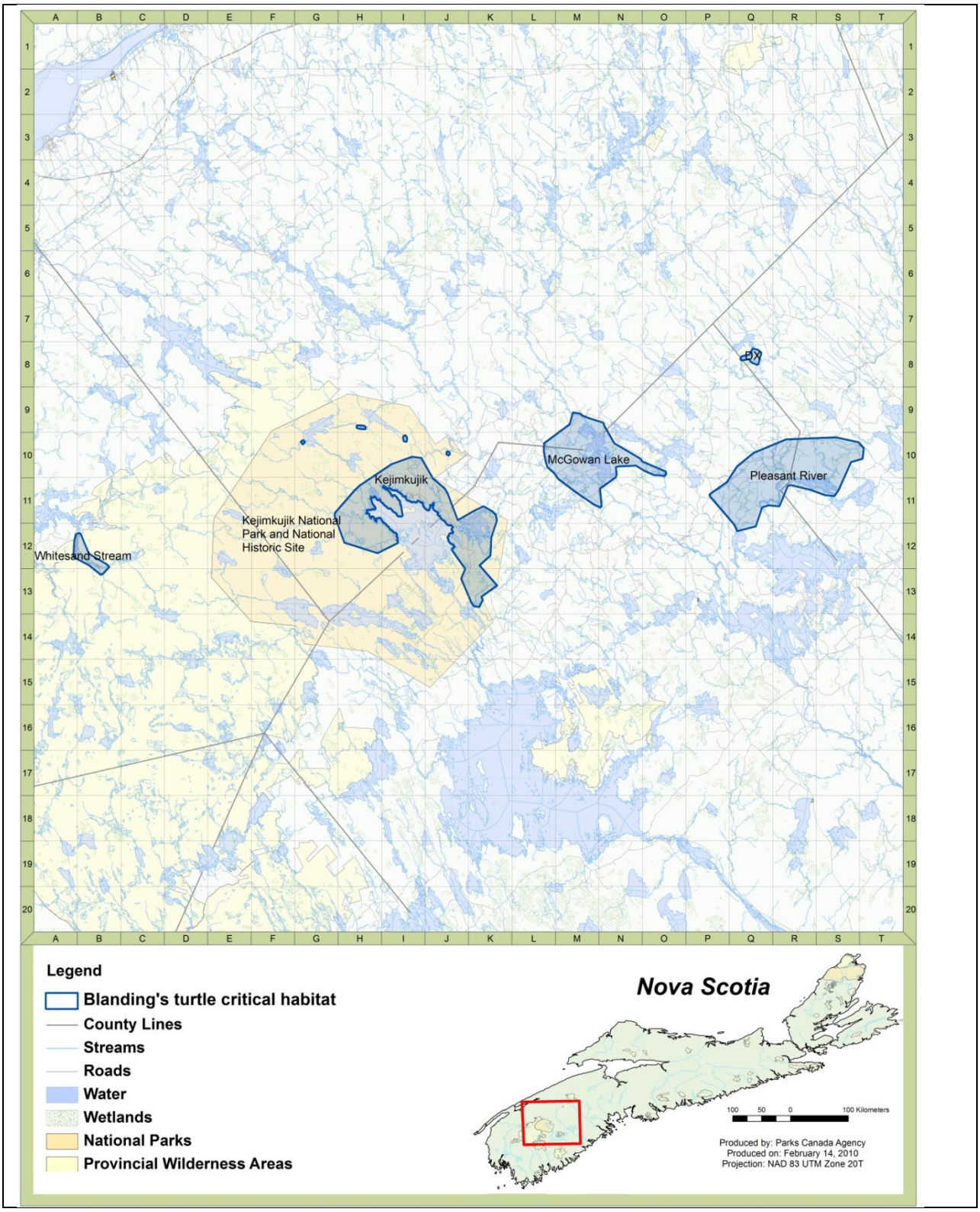

Figure 4. Location and extent of critical habitat parcels for Blanding's turtle (Nova Scotia population) in southwestern Nova Scotia. A full resolution version of this map is available on the Species at Risk Public Registry.

7.2 Schedule of Studies to Identify Critical Habitat

The critical habitat identified in this recovery strategy is necessary for the survival or recovery of the species, but may be insufficient to achieve the population and distribution objectives for the species due to insufficient understanding of the species' distribution, habitat use and the habitat's biophysical attributes in Nova Scotia.

Table 5. Schedule of Studies to identify critical habitat for Blanding's turtle, Nova Scotia population

Description of Activity	Rationale	Timeline
Investigate confirmed sightings of single individuals and unconfirmed sightings to see if populations exist	Confirm if these were single individuals or actual populations	As sightings are identified
Continue trapping potential areas in southwest Nova Scotia to locate additional populations and identify potential corridors between populations	Expand knowledge of the range in Nova Scotia. New areas of critical habitat identified, including population corridors.	2016
Conduct surveys and radio tracking studies in new areas identified, with a focus on identifying population corridors.	Refine knowledge of habitats used in new areas identified, including corridors between populations	2016
Continue radio tracking studies of hatchlings and young juveniles to better understand their seasonal movements	Increase knowledge of terrestrial habitats (biophysical attributes) used by young age classes	2015
Conduct surveys and radio tracking to better understand use of vernal pools and other terrestrial habitats used (or other wetland habitats not recognized as wetlands, seasonally flooded areas)	Refine knowledge of biophysical attributes and critical habitats allowing for refined buffer delineation	2016

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Destruction of critical habitat would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time.

Table 6. Examples of activities likely to result in the destruction of the critical habitat for the Blanding's turtle.

Examples of Activities	Example of Impact on Biophysical Attributes
Road, causeway and trail development	- fragments habitat - alters natural hydrologic regime, reduces natural vegetation, increase sediment, modifies water levels - increases risk of mortality by creating habitats that attract turtles
Off-highway vehicle use	- crushes or damages vegetation or compacts habitat - compacts nests and nesting substrate

Cottage, recreational, residential and industrial development	- fragments, degrades or eliminates habitat - alters natural hydrologic regime, reduces natural vegetation, increases sediment, modifies water levels - increases risk of mortality by creating habitats that attract turtles
Shoreline alterations, lawn development and maintenance	- degrades habitat constructs breakwaters that alter natural shorelines and natural processes
Draining and infilling of wetlands or vegetation removal	- eliminates habitat - changes natural processes
Hydroelectric dam operations	- alters water levels and natural hydrologic regime, creating unstable water levels that flood nests or drain overwintering sites and impact vegetation in wetlands and on shorelines
Crop and animal production	- decreases water quality through run off with pesticides and excessive animal waste - alters hydrologic regime through landscape modification, reducing natural vegetation, increasing sediment, and modifying water levels
Forest harvesting near waterways	- decreases water quality through erosion and sedimentation - alters hydrologic regime through changing processes and water levels - destroys overwintering sites through direct vehicle impacts
Excessive harvesting of beavers or removal of beaver dams	- alters water levels and natural hydrologic regime, creating unstable water levels that flood nests or drain overwintering sites and impact vegetation in wetlands and on shorelines - drains drought refuge sites
Peat Mining	- eliminates habitat - decreases water quality, through sedimentation and vegetation removal

8. MEASURING PROGRESS

The performance indicators presented below provide a way to define and measure progress toward achieving i) the Population and Distribution Objectives (Section 5) and ii) Strategic Direction for Recovery (Section 6.2).
Because of the turtle's longevity and slow maturation, achieving the population and distribution objectives is a long-term goal.

i) Population and Distribution Objectives Measures

- Adult survivorship maintained in all known populations.
- Management strategies implemented to mitigate identified site specific threats
- Survivorship estimates updated at least every 5 yrs to refine PVA to ensure that the goal of less than 5% extinction risk is being met

ii) Strategic Direction for Recovery Measures

- Juvenile survivorship maintained or enhanced in all known populations
- Extent of current distribution maintained or increased at all known populations
- Number of nests protected maintained or enhanced in all three populations
- Number of sites under formal habitat protection increased
- Number of landowners employing best practices to protect habitat increased
- Improved awareness of traditional knowledge of turtles and their habitat through number of stories shared
- Male fecundity in the population complex assessed
- Strategic monitoring plan developed by 2014 to enable reassessments of population models

9. STATEMENT ON ACTION PLANS

One or more action plans will be completed by December 2014.

10. REFERENCES

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APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

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 planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Overall, it is anticipated that the approaches outlined in this recovery strategy will have a beneficial impact on non-target species (other species at risk and those not at risk), ecological processes, and the environment. Management is likely to include protection of wetland habitat. This has the potential to benefit many wetland species, including some that are at risk. In Nova Scotia, the distribution and habitats of Blanding's turtles overlap considerably with that of the Threatened eastern ribbonsnake. There are also a number of Atlantic Coastal Plain Flora species at risk that occur in similar wetlands. There are examples, such as the water pennywort, where the habitats of Atlantic Coastal Plain Flora species overlap with those of Blanding's turtles. Where other species at risk coexist with Blanding's turtles, recovery and conservation initiatives outlined in this strategy will be coordinated with other recovery teams. It will ensure that actions are mutually beneficial and not detrimental to other species at risk.

Stewardship actions, educational programs and awareness initiatives with landowners, Aboriginal organizations, and the general public; all levels of government; industry; and other audiences; will lead to increased understanding, appreciation of, and concrete action towards the conservation of wetlands and the recovery of species at risk in general. The Blanding's turtle, eastern ribbonsnake and Atlantic Coastal Plain Flora recovery teams regularly collaborate on a number of outreach projects. A best practices guide for landowners with species at risk on their property has been developed to help encourage stewardship of all wetland species at risk on private lands and inform landowners of ways to minimize their impacts on these species.