Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

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STATUS REPORT ON THE BLANDING'S TURTLE (NOVA SCOTIA POPULATION)

EMYDOIDEA BLANDINGII

IN CANADA

BY

THOMAS B. HERMAN

TERRANCE D. POWER

AND

BRIAN R. EATON

STATUS ASSIGNED IN 1993
THREATENED

REASON: LOW POPULATION (ESTIMATED AT 100-180 INDIVIDUALS) IN VERY LIMITED DISJUNCT AREA. UNEVEN RECRUITMENT (SOME AGE CLASSES MISSING), HIGH RACCOON NEST PREDATION, OCCASIONAL LOSS OF NESTS TO FLOODING MAKE IT MORE THAN VULNERABLE BUT THE LONG LIFE SPAN OF FEMALES (14 TO 18 YEARS TO 73 YEARS) AND ACTIVE MANAGEMENT IN THE NATIONAL PARK MEAN IT IS NOT ENDANGERED YET.

OCCURRENCE: NOVA SCOTIA

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CSEMDC — Un comité de représentants d'organismes fédéraux, provinciaux et privés qui attribue un statut national aux espèces menacées de disparition au Canada.

Committee
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STATUS REPORT ON THE BLANDING'S TURTLE (NOVA SCOTIA POPULATION)

EMYDOIDEA BLANDINGII

IN CANADA

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Status of Blanding's Turtle (*Emydoidea blandingii*) in Nova Scotia, Canada.

Abstract. Blanding's Turtle, *Emydoidea blandingii*, is a northern freshwater species with a distribution centered in the Great Lakes region. Numerous isolated populations exist along the periphery of the range; of these, the Nova Scotia population is the most isolated. Most individuals in the Nova Scotia population occur within Kejimkujik National Park in southwest Nova Scotia, where they are confined primarily to three centres of activity, all associated with darkly coloured waters and peaty soils. Capture-mark-recapture and radiotracking data show long-distance nesting migrations by females and exceptionally long overland movements by some males. This vagility, in combination with observations of promiscuous mating, suggests the Nova Scotia population is panmictic. Historical and recent records show that scattered individuals occur in low numbers outside the Park. The adult population within the Park is estimated to be 132 (95% confidence intervals: 99-179). Densities are substantially lower than those reported for other populations. The age structure in this population appears top-heavy; of 48 individuals aged, 31 exceeded 30 years. This suggests that longevity and reproductive lifespan are extended, but that recruitment is low. Reproductive potential is apparently compromised by: (1) the limited availability of suitable nesting areas (substrate, exposure, susceptibility to flooding); and (2) low egg and hatchling survivorship (due to raccoon predation, flooding and a short growing season). These factors, in combination with late age at maturation, underline the importance of high survivorship of breeding adults to the continued existence of this population. The recommended status of the Nova Scotia Blanding's Turtle population is threatened.

General Description. Blanding's Turtle is a relatively large North American freshwater turtle (subfamily: Emydinae). It's patchy distribution is centered in the Great Lakes region of Canada and the United States (Iverson, 1992). The high-domed, slaty-coloured carapace with variable yellow flecking, long neck, and yellow throat are characteristic (Figure 1).

Distribution. Blanding's Turtle, *Emydoidea blandingii* (Holbrook), is a northern freshwater species with a distribution centered in the Great Lakes region (Cahn 1937; Conant 1938; Lagler 1943; Breckenridge 1944; Pope 1949; Carr 1952; Bleakney 1958a, 1963; Anderson 1965; Preston and McCoy 1971; Ernst and Barbour 1972; Pritchard 1979; Gilhen 1984; (for review see McCoy 1973)). The species' main range (Figure 2) extends from extreme southwestern Quebec and southern Ontario south and west to central Nebraska including parts of Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, and South Dakota. Isolated populations occur farther east in New York, Massachussetts, New Hampshire, Maine and Nova Scotia.

Throughout its range, Blanding's Turtle is patchily distributed, especially in peripheral regions (McCoy 1973). In Ontario, recent efforts by the Ontario Herpetofaunal Summary and others yielded additional records but did not extend appreciably the known range of the species northward (Petokas and Alexander 1980; Weller and Oldham 1988). Small peripheral populations have been identified or substantiated in Maine (Graham and Doyle 1973; Graham et al. 1987) Massachussetts (Graham 1986), New York (Petokas and Alexander 1981), Minnesota (Ernst 1973; Olson 1987) and Wisconsin (Cochran and Lyons 1986). The range of Blanding's Turtle may have decreased in recent times due to loss of habitat (Cahn 1937; Jackson and Kaye 1974). In Missouri for example, it has been extirpated from several pockets in the northeast (Kofron and Schreiber 1985).

Blanding's Turtle was first described from Nova Scotia in 1953, on the basis of a large female was discovered near Kejimkujik Lake (Bleakney 1958a). Despite recent searches in peripheral areas the species' known range remains restricted to parts of the Mersey and Medway River watersheds (Powell 1965; Dobson 1971; Weller 1973*[1]; Bleakney 1976*; Drysdale 1983*; Herman et al. 1989*) (Figures 3, 4). The Nova Scotia population is the most isolated single disjunct in the entire range of the species and is considered a relict from a warmer climatic period (Bleakney 1958a).

Although nothing is known of the history of the species in Nova Scotia, a comparison of past and present distributions of *Emydoidea blandingii* elsewhere shows a considerable change in the range of the turtle (Figure 2). Fossil specimens have been found in Kansas (Pleistocene) (Preston 1971), Nebraska (Miocene) (Hutchison 1981), Mississippi (Pleistocene) (Jackson and Kaye 1974), and Oklahoma and Missouri (late Pliocene to Pleistocene) (Preston and McCoy 1971). Archeological evidence of Blanding's exists from Ontario and Quebec (Bleakney 1958b), Maine (French 1986), Michigan (Adler 1968), Illinois, New York, Wisconsin, and Missouri (Preston and McCoy 1971). The fossil evidence, which occurs to the south and west of the present centre of distribution, suggests that the species moved from west to east in the geologic past. This movement may have resulted from habitat disappearance (Jackson and Kaye 1974), or changing climatic conditions (Preston 1971).

Archeological findings that suggest subsequent extinctions have occurred in some peripheral areas. This pattern may have resulted from the use of the Atlantic Coastal Plain as a glacial refuge, with post-glacial dispersal occurring north, east, and west from this area (Bleakney 1958a). Alternatively, the plains may have served as the glacial refuge, with post-glacial dispersal occurring along a "steppe corridor" (Schmidt 1938) to the east (Preston and McCoy 1971; Porter 1972). The present patchy distributional pattern in the

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[1] citations marked with an asterisk are unpublished documents and are listed separately following the acknowledgements and before the Literature Cited sections.

east, combined with the southwestern fossil records and the more easterly archeological evidence seem to support this latter hypothesis.

Protection. Blanding's Turtle is protected in New York (status: threatened), Michigan, and Minnesota (threatened), is considered at risk in Missouri (endangered) (Kofron and Schreiber 1985), Wisconsin (threatened) (Ross 1989), Maine (threatened), New Hampshire, Massachusetts (threatened), Iowa, and South Dakota (threatened) , has been recognized to be of special concern in Pennsylvania (Petokas 1986), Indiana, Ohio, Ontario, and Quebec, and is extirpated in Rhode Island and Connecticut (T. E. Graham, personal communication). In Canada, this species is protected (i.e. may not be collected or disturbed) in all National Parks where it occurs, including Kejmkujik National Park in Nova Scotia. At the provincial level the species has been protected since 1984 under the Game and Fish Act in Ontario, and since 1990 under the Nova Scotia Wildlife Act. Blanding's Turtle has no official status in Quebec.

Population Size. The Nova Scotia population of adult Blanding's Turtle within Kejimkujik National Park is estimated to be 132 (95% confidence intervals: 99.4 - 178.9) (Schnabel binomial estimate). This estimate was derived from a comparison of census data from three discrete marking intervals between 1969 and 1988 (1971-72, 1977-79, 1987-88). A Petersen estimate of population size, based on mark and recapture work in 1987 and 1988, was similar (125.2; 95% confidence intervals: 108.8 - 154.9). These estimates assume the population is closed. The limited recruitment of young turtles into the population and the restricted distribution of this population minimizebias in the estimate.

Historical records indicate that scattered individuals are present outside the park, almost exclusively to the east, and are associated with peaty substrates on slate bedrock. Despite local interest in and public awareness of the species in this area, reported sightings are rare. It is unlikely that this population is large.

Habitat. *Emydoidea blandingii* is believed to have originally inhabited prairie marshes (Cahn 1937; Smith 1961, in Preston and McCoy 1971); present-day macro-habitats vary, and include lakes, ponds, marshes, low fields, ditches, creeks, river sloughs and bogs (Conant 1938; Lagler 1943; Breckenridge 1944; Pope 1949; Carr 1952; Adams and Clark 1958; Preston and McCoy 1971; Ernst and Barbour 1972; Ernst 1973; Graham and Doyle 1979; Gilhen 1984; Kofron and Schreiber 1985; Ross 1989; Ross and Anderson 1990). The increased variety of habitats presently used by the species may have resulted partly from habitat destruction in its original range (Cahn 1937; Jackson and Kaye 1974), as well as from changing climatic conditions (Preston 1971).

Within these macro-habitats, the species is associated with shallow water vegetated with submergent or emergent plants (Conant 1938; Pope 1949; Carr 1952; Adams and Clark 1958; Ernst and Barbour 1972; Gilhen 1984; Kofron and Schreiber 1985; Ernst and Barbour 1989), often with deep organic sediments (Ernst and Barbour 1972; Graham and Doyle 1979; Ross 1989; Ross and Anderson 1990).

In Nova Scotia, the distribution of Blanding's Turtle closely parallels that of highly coloured acid waters and peaty soils (Power et al., in press). Mark-recapture and radio-tracking data as well as reproductive activity showed that turtles maintained three discrete centres of activity in Kejimkujik National Park (Figure 4), each associated with darkly coloured rivers and streams (Power et al., in press).

General Biology

Age Structure. Age of Blanding's turtles in Nova Scotia was estimated from impressions of growth annuli on the dorsal surface of femoral and anal scutes recorded in dental registration paste (Herman et al. 1989*). Relatively clear impressions were obtained from 49 individuals (19 male, 24 female, 5 juvenile). Of these, 31 exceeded 30 years of age; one female was estimated to be 73. There were only three adults (15 years or older) under 26 years of age. The preliminary analysis of age structure in the Nova Scotia population suggests that longevity of adults is extended but that recruitment to the breeding population is low.

Aging of turtles under 30 was usually straightforward; accuracy of the aging technique, however, decreases with age. Some turtles estimated to be over 30 were impossible to age due either to excessive wear or flaking of the epidermis. In addition, some older turtles may cease growing, as suggested by Petokas (1986). Although plastral growth lines have been considered as annuli, and used widely in estimation of age in *E. blandingii* (Congdon and van Loben Sels 1991; Gibbons 1987; Graham and Doyle 1977; Petokas 1986; Ross 1989), indeterminate growth and consistent annulus formation in older adults have not been demonstrated. In *C. serpentina*, about one half of adults fail to add visible carapacial annuli in successive years (Galbraith and Brooks 1987). Cessation of growth of some adults in our sample would result in under estimation of age of these individuals; the data presented are therefore minimum ages.

Sampling bias may account for the apparent paucity of juveniles in the Nova Scotia population. Scarcity of juveniles in sampled populations of *E. blandingii* is commonly reported (Congdon et al. 1983; Gibbons 1968; Graham and Doyle 1977; Weller 1973*; Ross 1989) and often attributed to behavioural differences or differential habitat usage by juveniles (Graham and Doyle 1977; Ross 1989). However, long-term studies in Michigan (Congdon et al., 1983) found no evidence of differential habitat use by juveniles.

In Nova Scotia, the under-representation of adult age classes 16-20 and 21-25 (0% and 6.1% respectively of the population) is troubling. Individuals in these two age classes are sexually mature and should be as visible as older adults. If this apparent absence is real, an unstable age structure in this population is indicated.

Reproductive Potential. At the population level, reproductive potential of Blanding's Turtle incorporates average annual reproductive output (number and size of eggs) per adult female, as well as subsequent egg and hatchling survivourship. At the individual level, especially for such a long-lived species, clutch frequency and reproductive lifespan, as well as clutch size, are essential to any consideration of reproductive potential. Annual reproductive output at both individual and population levels may be environmentally constrained (Gibbons et al. 1982).

In some populations of Blanding's Turtle, clutch and egg size increase with adult female size (Petokas 1986; MacCulloch and Weller 1988; Congdon and van Loben Sels 1991); in others, including the Nova Scotia population, the relationship is not clear (DePari et al. 1987; Power 1989). In addition, juvenile growth rates, rather than adult growth and longevity, largely determine adult size (Congdon and van Loben Sels 1991) and are therefore an important determinant of reproductive potential. Increased growth and body size in this species have been attributed to increased habitat productivity (Graham and Doyle 1977; Petokas 1986; Ross 1989). However, even in productive habitats, growth may be constrained by competition for food, particularly where juvenile recruitment is high (Petokas 1986).

Although the environments occupied by Blanding's Turtle in Nova Scotia are relatively unproductive (Schell and Kerekes 1988*), body sizes of adults are within the range reported elsewhere (Gibbons 1968; Graham and Doyle 1979; Petokas and Alexander 1981; Congdon et al. 1983; Kofron and Schreiber 1985; Graham and Forsberg 1986; DePari et al. 1987; Rowe 1987; MacCulloch and Weller 1988; Ross 1989; Congdon and van Loben Sels 1991; Rowe 1992). As well, the mean clutch size of the species in Nova Scotia (9.4 eggs, range 1-15; Power 1989) falls within the range of mean clutch sizes (7.6-12.9 eggs) reported for other populations (Gibbons 1968; Congdon et al. 1983; Petokas 1986; DePari et al. 1987; MacCulloch and Weller 1988; Congdon and van Loben Sels 1991).

Clutch Frequency. Gibbons (1982) has suggested that since turtles are long-lived, clutch frequency is the most important parameter to measure in studies of reproduction. Blanding's Turtle produces a maximum of one clutch of eggs annually. In Michigan, only 23%-48% of females nested in a given year (Congdon et al. 1983). Although information for Nova Scotia is scant, two radio-tagged females nested in consecutive years (Power 1989). In addition, at least six of eight radio-tagged turtles nested in the same year (Power 1989). Although longer term data are required to obtain an accurate estimate of clutch frequency in Nova Scotia, indirect evidence suggests an individual may nest in at least two of three years.

Clutch Survivorship. In Nova Scotia only nine (69.2%) of thirteen nests protected from predation produced live hatchlings; the remaining four failed entirely, due to flooding in late summer (Power 1989). Among successful nests, egg failure (mean=3.1 eggs per nest) was higher than has been reported elsewhere (mean=1.2 eggs per nest; Congdon et al. 1983). Although long term data are not available for Nova Scotia, it appears that egg failure due to factors other than flooding and predation may be higher here. As well, flooding may be a major cause of nest failure in Nova Scotia in some years. This has not been reported elsewhere for Blanding's Turtle, although clutch failure in the Painted Turtle (*Chrysemys picta*) has been attributed to flooding of nests in early spring (Christens and Bider 1987).

Clutch Predation. Raccoons are the most important predators of eggs of Blanding's Turtle in Nova Scotia (Thexton and Mallet 1977-79*; Power 1989; Weller 1973*), although ants were suspected in at least one case (Weller 1973*). In a recent intensive investigation of nesting ecology of the species in Kejimkujik National Park, thirteen nests were protected with wire screening from predation by raccoons (Power 1989). Although no estimate of predation rate on the Nova Scotia population was possible, most protected nests showed signs of attempted predation, and it appeared that unprotected nests of all three species resident in the Park (Blanding's Turtle, Snapping Turtle (*Chelydra serpentina*), and Painted Turtle) were often destroyed on the night of oviposition (Power 1989). Outside Nova Scotia, predation rates on nests of Blanding's Turtle approached 100% in some years, with red foxes, ants (Congdon et al. 1983) and skunks (Petokas 1986) implicated, in addition to raccoons. Nesting habitat of the Nova Scotia population is distributed along edges (beaches, roadsides); predation rates in such linear habitats can be relatively high (Temple 1987).

Hatchling Survivorship. In addition to egg and clutch failure, many live hatchling Blanding's Turtles in Nova Scotia (16.1%) failed to emerge from nests by late fall (Power 1989). When nests were excavated at this time, these individuals appeared dormant. Although they probably would not have emerged had they been left undisturbed, their subsequent over-wintering success remains unknown. Over-wintering in the nest by hatchling Blanding's Turtles has not been documented, although indirect evidence (Congdon et al. 1983) suggests that it may occur rarely. Hatchling *C. picta*, which normally emerge in spring, are known to survive extended periods of subzero temperatures in the nest over winter (Storey et al. 1988; Packard et al. 1989). In some areas, however, freezing may be an important cause of mortality of *C. picta* hatchlings overwintering in nests, though deep snow effectively insulates hatchlings against freezing (Breitenbach et al. 1984). Submergence of nests of Blanding's Turtles on lakeshore beaches in late fall (Power 1989), which occurred in Nova Scotia in two consecutive years, may also protect hatchlings from freezing.

Reproductive Lifespan. Blanding's Turtle matures later and lives longer than most freshwater turtles. Sexual maturation occurs at about fourteen years in most populations (Graham and Doyle 1977; Petokas 1986; Congdon and van Loben Sels 1991), although in Wisconsin it may not occur until eighteen years (Ross 1989). Individuals frequently survive to thirty-five years in Illinois (Gibbons 1987), Nova Scotia (Herman et al. 1989*), and Michigan (Congdon and van Loben Sels 1991) and occasionally beyond seventy years (Brecke and Moriarty 1989; Herman et al. 1989*) with no evidence of reproductive senility. Based on these findings and observations of marked individual turtles nesting in Kejimkujik National Park in multiple years, the reproductive lifespan of Blanding's Turtle in Nova Scotia should commonly exceed twenty years.

Species Movement. In Nova Scotia, capture-mark-recapture and radiotracking revealed that Blanding's Turtles maintained three primary centres of activity on rivers and streams near the margin of Kejimkujik Lake (Figure 4) (Power 1989). These areas had also been generally identified during a long-term marking program in Kejimkujik National Park (1969-1982) (Weller 1973*; Bleakney 1976*; Thexton and Mallet 1977-79*; Drysdale 1983*). Although most turtles maintained a home range within one of these areas, at least three males shifted their range from one centre of activity to another, moving minimum distances of 5, 8.5, and 11.5 km overland (Herman et al. 1989*). One of these males moved a minimum of 3 km overland in less than fourteen days to establish residency in a different drainage.

In Nova Scotia, Blanding's Turtle became active in early April and generally moved downstream from overwintering areas by early May (Power 1989). Turtles on smaller streams moved to inflows of Kejimkujik Lake where most summertime activity was concentrated; on larger rivers turtles used the lake infrequently or not at all. Overwintering sites were usually located at the upstream margin of individual ranges. Onset of dormancy varied among individuals, but males generally entered hibernation later than did females.

On the basis of behavioural observations, four seasons of activity were recognized: post-emergence (early May-mid June), nesting (mid June-mid July), mating (mid July-mid November), and overwintering (mid November-late April). During post-emergence males made more long-distance (>1 km) movements than females; during nesting, females made more long-distance movements than males and travelled up to 2.9 km (straight line distance) to nest.

Home ranges of Blanding's Turtle in this population, exclusive of nesting migrations and apparent range shifts of males, frequently exceeded 1.5 km in at least one dimension (Power 1989). Nova Scotia turtles appear to be considerably more vagile (unpublished data) than has been reported elsewhere (Ross 1989; Ross and Anderson 1990; Rowe and Moll 1991). Physical barriers probably delimit both metapopulation and home range boundaries (Ross and Anderson 1990).

Adaptability. Among North American freshwater turtles, *Emydoidea blandingii* has one of the most latitudinally compressed ranges. Both the northern and southern limits of the species appear to be constrained by temperature. In addition, the species has one of the lowest critical thermal maxima (CTM) of any semi-aquatic turtle (Hutchison et al. 1966). In Nova Scotia, the population is restricted to an inland plateau characterised by the highest cumulative heat units in the province (Gates 1973*), and is considered to be a relict of a warmer climatic period (Bleakney 1958a). Therefore the species appears to have a relatively narrow range of temperature tolerance. This, in addition to the fragmented distribution of existing populations, suggests that the adaptability of the species is limited.

This limited physiological tolerance, in combination with long generation time (33-35 years; Herman et al. 1989*), limits the potential adaptive responses of Blanding's Turtle to environmental change. For example, measurable climatic change may occur within the lifetime of an individual turtle. Adaptive responses to such changes would thus have to be largely behavioural rather than genetic (Herman and Scott 1992). Although turtles in general are not noted for their behavioural plasticity, Blanding's Turtle has shown that it can adapt to locally changing availability of nesting substrate. This includes the use of artifical nesting sites both in Nova Scotia (Bleakney 1963; Weller 1973*; Thexton and

Mallet 1977-79*; Drysdale 1983*; Power 1989; H. MacCormack, personal communication) and elsewhere (Graham and Doyle 1979; Petokas 1986; Breisch and Eckler 1988*; MacCulloch and Weller 1988).

Little information is available on genetic variation or structure in populations of *Emydoidea blandingii*.. Turtles in general are notably invariant, based on allozyme studies (J. P. Bogart, personal communication). Although the Nova Scotia population is genetically isolated from all other populations, it in itself is probably panmictic. Although three discrete concentrations of turtles were identified in the Park, observations of promiscuous mating and long distance movements, especially by males, indicate that genetic exchange among them is probably sufficient to prevent divergence.

Special Significance of the Nova Scotia Population. The Kejimkujik population is the most isolated of all extant Blanding's Turtle populations. Small populations may undergo relatively rapid genetic change due to isolation, leading to genetic divergence. Although a limited electrophoretic survey of fifteen loci revealed no significant differences in frequencies and no alleles fixed at alternate loci between Nova Scotia and Ontario turtles, shell shape of both males and females differed significantly between the two populations (Eaton et al., submitted). At this time we cannot confidently attribute this morphological distinctness to either environmental or genetic influences.

Cook (1987*) has stressed the need for protection of indigenous Canadian species that occur at the northern limit of their climatic tolerance. Bleakney (1958a) observed striking differences in density among such peripheral populations, and documented the presence of isolated "islands" of herpetofauna along the northern edge of species' ranges. These inherently interesting but poorly studied populations provide a unique management challenge, particularly as they become further fragmented with changing land use or climate change.

Evaluation. Based on our morphometric analysis, the Nova Scotia population of *E. blandingi* can be considered morphologically distinct. In addition, the population is geographically distinct i.e. obvious geographic barriers have prevented gene flow with other populations. This population is the sole representative of the species in the Atlantic Zone.

We recommend that the Nova Scotia population of Blanding's Turtle be assigned Threatened status for two major reasons: 1) the population occurs at the northeastern limit of the species range in a restricted area long isolated from other populations; and 2) the population is small and apparently declining: the age distribution is top-heavy i.e. unstable, and recruitment is low due partially to artificially increased predation pressure, primarily from raccoons.

Appendix 1

Management Recommendations. 1) Maintenance practices along road verges that minimize disturbance of nesting turtles (e.g. delayed lawn mowing, minimal vehicular traffic on shoulders) should be continued.

2) Closure of the trail to Heber Meadow nesting beaches should be completed.

3) Caging of nests, as carried out for the past three years, should be continued annually on a limited basis. We recommend that a minimum of one or two nests each from Mersey River and Jeremy's Bay turtles be screened against predation from raccoons and other disturbances. Because nesting populations in these areas are small, they are more prone to total nesting failure than are the larger populations at West River. Hatchlings from protected nests should be individually marked before release.

4) A systematic visual census (with standardized effort and extent) of nesting turtles at designated nesting beaches (including Glode Point/Glode Island) should be carried out in two consecutive seasons every five years. (Many females probably nest once every other year or twice every three years). Wherever possible, turtles should be

identified without disturbance, and unmarked individuals, after completion of nesting, should be notched.

5) An additional census of turtles, using large Fyke nets, should be carried out once every five years at designated locations along small streams and the Mersey River near known hibernacula. This census could take place in either spring or fall, during seasonal migration downstream or upstream. This technique has several advantages over visual censuses. It avoids observer bias and the effects of variable weather (on both visibility and seasonal timing), it is easily standardized, and requires relatively little labour (since traps need be checked only once per day). As well, the technique should be less biased toward older/larger turtles than a visual basking survey would be. This census would allow long-term tracking of sex ratio and age structure in the population. Since sex determination is temperature-dependent in this species, shifts in sex ratios could result from climatic change due to global warming.

6) Efforts should be made to locate and observe hatchling and juvenile turtles within the park. Release of radiotagged headstarted hatchlings could be helpful in this regard.

7) Individual marking of turtles (from both incidental sightings and censuses), using the notch code system already in place in the park, should be continued. A working list of carapace notch codes in use and available for new turtles should be maintained by the Park Ecologist.

8) The following data should be collected at <u>all</u> turtle captures: a) notch code i.d.; b) specific location on map; c) date and time. Additional data, from turtles in census captures and, if possible, in incidental captures should include: d) sex; e) age (hatchling, juvenile, adult); f) behaviour; g) general weather conditions; h) mass; i) maximum plastron length and width. This might be facilitated by distribution of turtle capture field sheets to park personnel, as was done in 1987.

9) Serious consideration should be given to headstarting hatchlings to a larger size (Iverson 1991; Linck et al. 1989) in order to enhance recruitment. Such a program could be co-ordinated with existing nest screening practices.

10) Historical records from the Park indicate that a concentration of turtles existed in and around Grafton Lake. When the lake was dammed, natural nesting movements and hatchling movements between Grafton Lake and inflow streams and beaches along Kejimkujik Lake were apparently interrupted. As well, prime habitat along highly coloured inflow streams was probably inundated by rising water levels. This sub-population has dwindled. We recommend that the original water levels in Grafton Lake be re-established, and the dam ultimately be removed.

11) The Park should take full advantage of the unique opportunity afforded it to collect long-term data on an individually marked unexploited population of a long-lived top level predator. In the face of long-term climatic change, studies of nesting substrate choice and microclimate, in addition to regular censuses, are particularly needed.

12) Interpretation, Resource Conservation and Visitor Services personnel at Kejimkujik should continue their excellent programme of visitor education to promote awareness of this rare reptile.

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Figure Captions.

Figure 1. Past and present distribution of *Emydoidea blandingii* after McCoy (1973) (closed symbols), with updated information (open symbols). Circles represent extant populations, stars represent fossil finds, triangles represent archeological finds. Numbers refer to references for updated information as follows: extant populations: 1-Maine (Graham and Doyle 1973; Graham et al. 1987), 2-Massachussets (Graham 1986), 3-New York (Petokas and Alexander 1978, 1981), 4-Ontario (Petokas and Alexander 1980, Weller and Oldham 1988), 5-Wisconsin (Cochran and Lyons 1986), and 6-Minnesota (Ernst 1973; Olson 1987); fossil records: 7-Mississippi (Jackson and Kaye 1974), and 8-Nebraska (Hutchison 1981); archeological finds: 9-Maine (French 1986), 10-Quebec and Ontario (Bleakney 1958b; Bider et Matte 1991).

Figure 2. Distribution of *Emydoidea blandingii* in Kejimkujik National Park, Nova Scotia. Solid circles indicate sitings of different individual turtles (n=119) between 1952-91; numbers indicate the numbers of turtles observed in three areas of concentration.

Figure 3. Recorded sightings of Blanding's turtle in Nova Scotia outside Kejimkujik National Park.

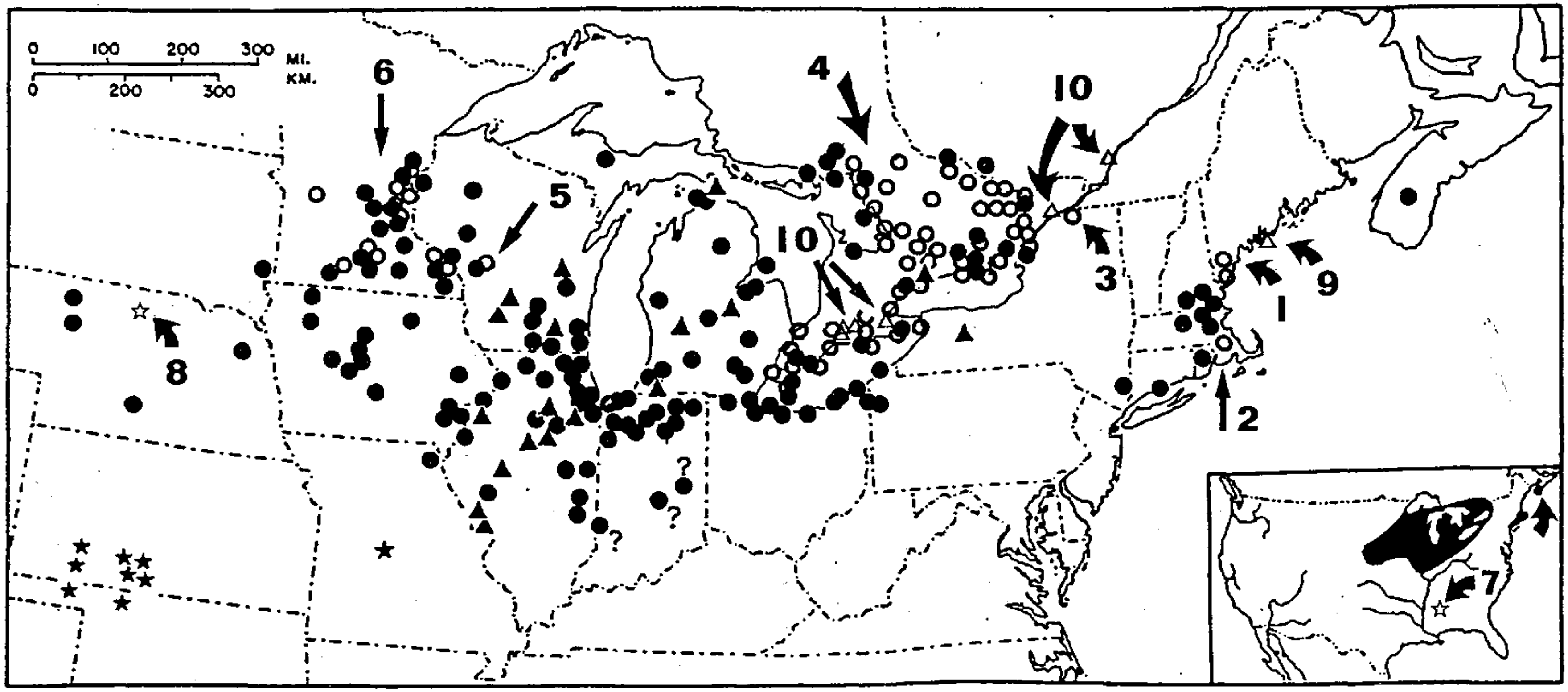
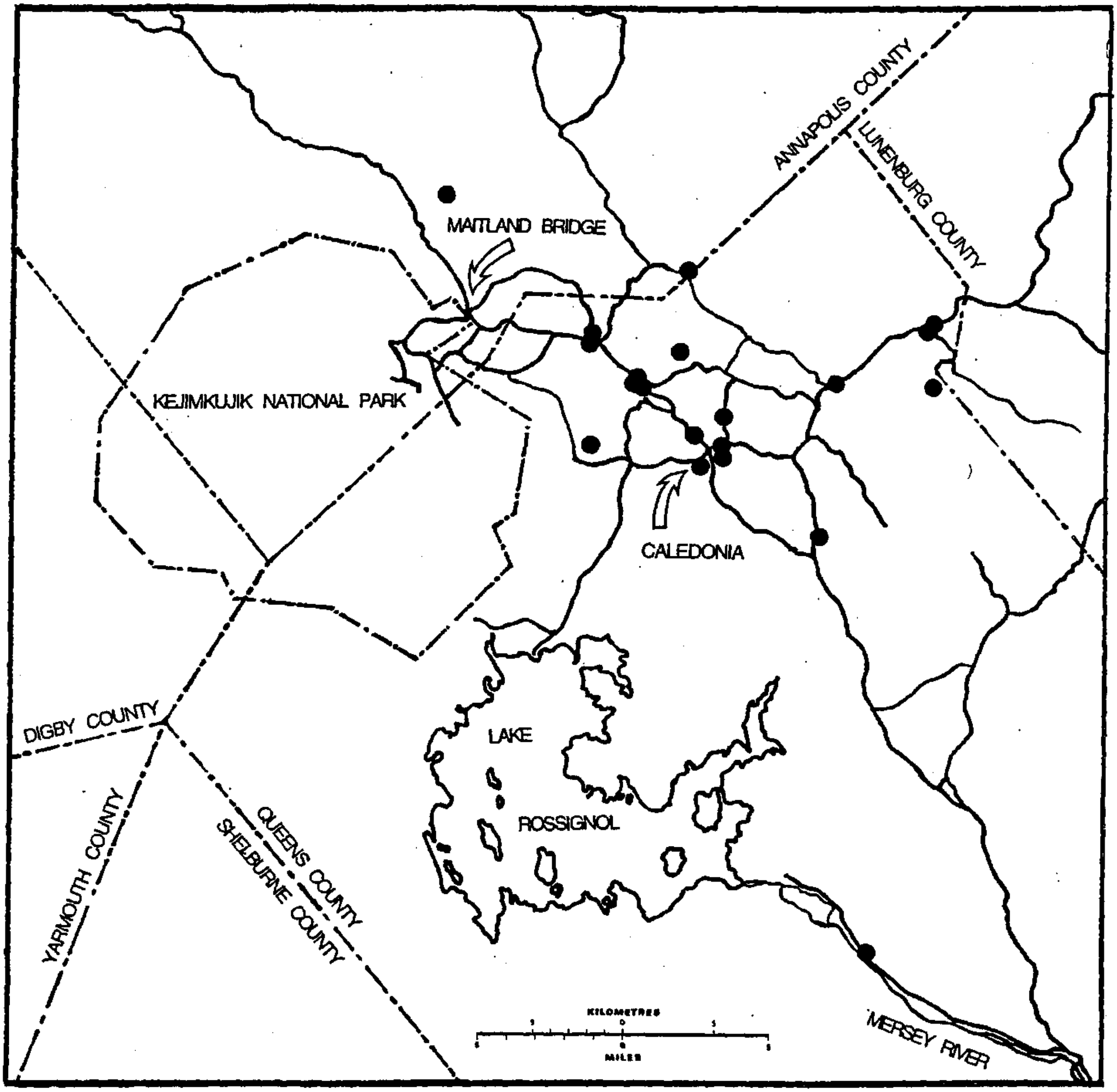


Figure 1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MAITLAND BRIDGE
KEJIMKUJIK NATIONAL PARK
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DIGBY COUNTY
LAKE
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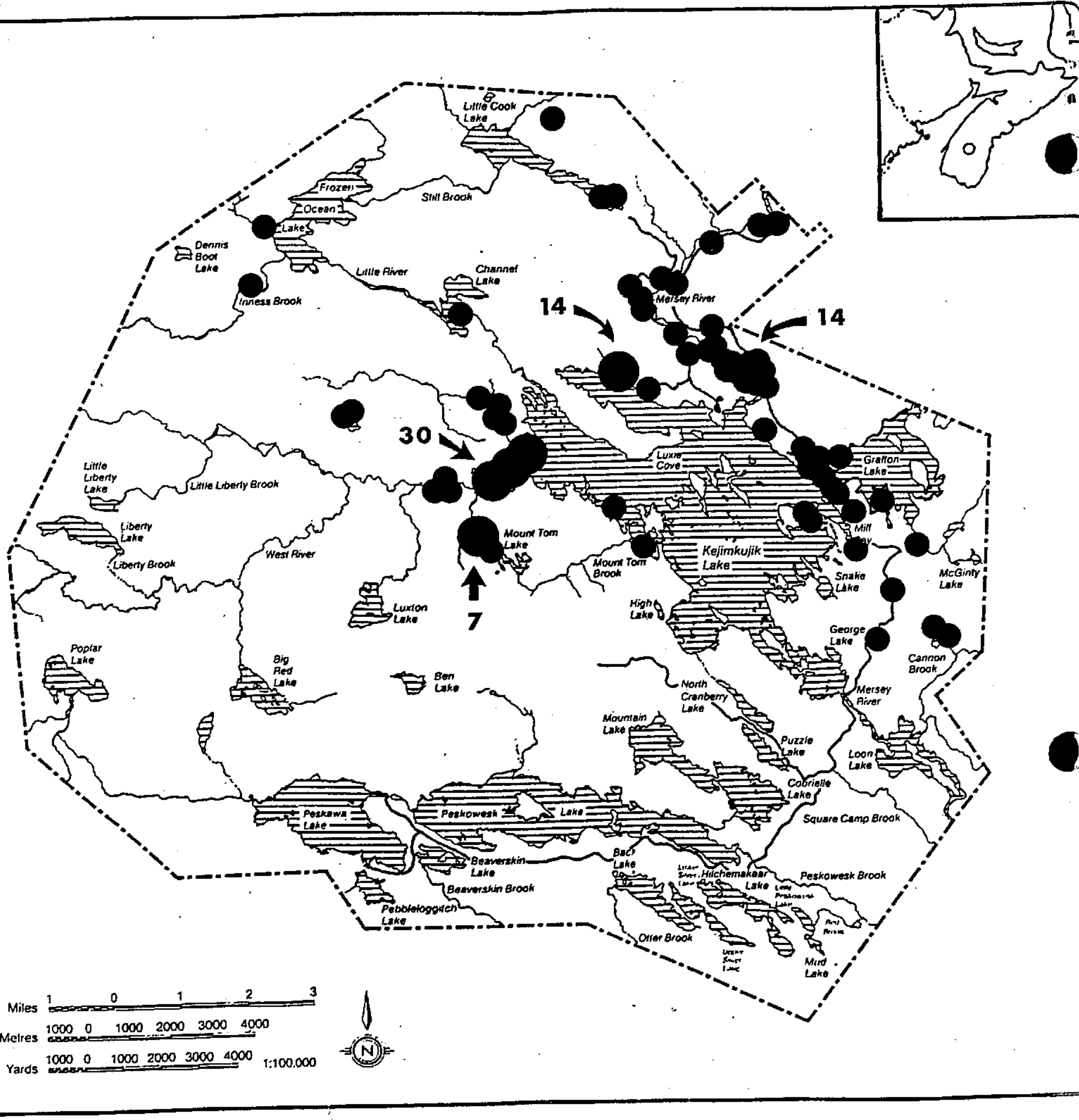
YARMOUTH COUNTY
QUEENS COUNTY
SHELBURNE COUNTY
KILOMETRES
MILES
MERSEY RIVER

Figure 2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Little River
Channel Lake
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Liberty Lake
Liberty Brook
West River
Mount Tom Lake
7
Luxie Cove
Grafton Lake
Kejimkujik Lake
Mount Tom Brook
Snake Lake
McGinty Lake
Luxton Lake
High Lake
George Lake
Cannon Brook
Poplar Lake
Big Red Lake
Ben Lake
North Cranberry Lake
Mersey River
Mountain Lake
Puzzle Lake
Loon Lake
Cobrielle Lake
Square Camp Brook
Peskawa Lake
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Beaverskin Lake
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Figure 3