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A Herpetological Survey of the James Bay Area of Québec and Ontario

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In May-June 2002, as part of a survey of a variety of taxa in the James Bay region of Ontario and Québec, we surveyed the poorly documented herpetofauna of this region. In Ontario we visited sites near Moosonee that FWS had previously surveyed in 1971-1972, and continued ongoing herpetological monitoring around Cochrane. In Québec we surveyed the inland James Bay Road, and roads to four settlements along the coast. American Toad (*Anaxyrus americanus*), Spring Peeper (*Pseudacris crucifer*), and Wood Frog (*Lithobates sylvaticus*) were widespread and abundant throughout. Blue-spotted Salamander (*Ambystoma laterale*) and Garter Snake (*Thamnophis sirtalis*) were widespread and common in Québec and at the study site near Cochrane. We obtained the first taped calls and voucher specimen of the Boreal Chorus Frog (*Pseudacris maculata*) from Québec, and failed to find it at the settlement and airport of Moosonee where it had been present in 1972. A significant range extension was for the Two-lined Salamander (*Eurycea bislineata*), which we found 200 km north of its previously known range in northwestern Québec. Despite extensive searches, the species was not found north of 52°05′N. The Mink Frog (*Lithobates septentrionalis*) was widespread and relatively common in Québec, but was sought but not found in Ontario. The Leopard Frog (*Lithobates pipiens*) was only found at two Québec sites, including one where it was reported in 1974, but it has not been found at any of the Ontario sites where it was found in the 1970's. We present some suggestions for the further study of the herpetofauna of the area, and review evidence for contacts between eastern and western lineages of widespread species.

En mai et juin 2002, dans le cadre d'un inventaire faunique dans la région de la baie James, en Ontario et au Québec, nous avons inventorié la faune herpétologique, laquelle est très peu documentée dans cette région. En Ontario nous avons visité des sites près de Moosonee, que l'un de nous (FWS) avait inventorié en 1971-1972, puis nous sommes allés aux environs de Cochrane. Au Québec l'inventaire s'est majoritairement fait le long de la route de la baie James et des routes d'accès aux villages. Le Crapaud d'Amérique (*Anaxyrus americanus*), la Rainette crucifère (*Pseudacris crucifer*) et la Grenouille des bois (*Lithobates sylvaticus*) sont répandus et communs sur toute l'aire d'étude. La Salamandre à points bleus (*Ambystoma laterale*) et la Couleuvre rayée (*Thamnophis sirtalis*) sont répandues et communes au Québec et près de Cochrane. Nous avons réalisé les premiers enregistrements de chants et collecté le premier spécimen de Rainette faux-grillon boréale (*Pseudacris maculata*) pour le Québec, et n'avons pu la retrouver à Moosonee et à son aéroport, où l'espèce avait été recensée en 1972. La seule extension d'aire significative a été faite pour la Salamandre à deux lignes (*Eurycea bislineata*), trouvée à 200 km au nord de son aire de répartition connue dans le nord-ouest du Québec. Malgré des recherches intensives, elle n'a pas été vue plus au nord que 52°05'N. La Grenouille du Nord (*Lithobates septentrionalis*), est répandue et relativement commune au Québec mais n'a pu être trouvée en Ontario. La Grenouille léopard (*Lithobates pipiens*) a seulement été recensée à deux endroits au Québec, incluant un site où l'espèce avait été trouvée en 1974, mais n'a pu être trouvée en Ontario dans les sites où on la retrouvait dans les années '70. Nous présentons quelques suggestions de futures études sur l'herpétofaune de cette région, et discutons des liens entre les formes de l'ouest et celles de l'est pour les espèces répandues.

Key Words: amphibians, *Ambystoma laterale*, Blue-spotted Salamander, *Eurycea bislineata*, Two-lined Salamander, *Anaxyrus americanus*, American Toad, *Pseudacris crucifer*, Spring Peeper, *Pseudacris maculata*, Boreal Chorus Frog, *Lithobates sylvaticus*, Wood Frog, *Lithobates pipiens*, Leopard Frog, *Lithobates septentrionalis*, Mink Frog, *Thamnophis sirtalis*, *Thamnophis sirtalis sirtalis*, *Thamnophis sirtalis pallidulus*, Garter Snake, distribution, range extension, first record, amphibian decline, morphometry, boreal, James Bay, Québec, Ontario.

In May-June 2002, as part of a survey of a variety of taxa in the James Bay region of Ontario and Québec, we surveyed the herpetofauna of this region in order to exploit roads that have not been previously surveyed by herpetologists, to provide data for future comparisons, and to compare current observations with previous surveys (Schueler 1973; Schueler and Karstad 1975). The logistical difficulties of travel, distance from

academic centres, and especially low species diversity, have left the herpetofauna of the James Bay area poorly documented and infrequently studied. Increased human activity in the area makes it important to determine the current status of species, and global warming makes it especially important to delimit northern range limits, in order to be able to document anticipated northward range expansions. Previous herpetological studies in the James Bay drainage of northwestern Québec and northeastern Ontario include Williams 1920; Gaige 1932; Bleakney 1959; Ashton et al. 1973; Schueler 1975; Schueler and Cook 1980, Bleakney 1954; Cook 1964; McCoy and Durden 1965; MacCulloch and Bider 1975; and Cook 1983.

Our goals in the two provinces were somewhat different. On most of the Québec route we were undertaking initial surveys, similar to those undertaken in 1971-1974 (Schueler 1973; Schueler and Karstad 1975), while in Ontario (and Lac Douay, Québec) we were re-visiting sites we had surveyed before, in some cases many times, and revisiting places where we could document the failure to find species found there in the past, and give GPS geographic co-ordinates for several sites located only verbally in those publications. We also sought other taxa such as small mammals, crayfishes, and terrestrial and freshwater molluscs (Québec results in Picard and Desroches 2003*).

Study Area and Chronology

Figure 1 shows our route and the area studied. The James Bay area contains many wetlands, oligotrophic lakes, bogs and boggy creeks. Large rivers flow into the Bay, those in Ontario mostly dammed for hydroelectric power in the 1930's, while those in Québec were impounded and diverted in the 1970's (Lacasse 1983) or planned (Hydro-Québec 2006*). The average daily annual air temperature ranges from about -2.5°C and the extremes of mean annual temperatures are about – 26°C and 21°C. The extremes of temperature are – 48°C and 36.5°C and the average annual total precipitation is 600-900 mm (Société d'énergie de la Baie James 1978; Environment Canada 2006*).

The south and west shores of James Bay are grassy tidal flats with irregular patches of shrubby willows, which we visited at the mouth of Whitetop Creek in the Moose River estuary northeast of Moosonee, and at Cabbage Willows Bay, on the west shore of Rupert Bay west of Waskaganish. This zone is very dynamic because of the combined effects of wind and ice and isostatic rebound from the weight of Wisconsinian glaciers. Around Rupert Bay the ground rises as much as 3 mm/year (Champagne 1982). Our topographic maps (based on 1955 aerial photos) plotted many of the sites where we heard Boreal Chorus Frogs at Cabbage Willows in the open water of the bay, and there have been major changes in the landscape around our camp there within living memory (Bill Jolly, personal communication). This zone of grassy and shrubby vegetation encroaches on the Bay, and is encroached on by the inland Spruce-dominated Boreal Forest. Tidal amplitude is often augmented or diminished by the strength and direction of the wind. The vegetation in these flats is a sward of grass and widely spaced shrubs (mostly *Salix* and *Alnus*). Near our Whitetop Creek camp, Ontario, there are many small ponds in depressions in the ground and in backwater channels of small creeks, while near our Cabbage Willows Bay camp, Québec, there are almost no ponds in the *Salix/Alnus* zone. On 23-30 May 2002 Larry Frazer (LF) and FWS travelled by train and boat to sites around Moosonee and on the west bank of the mouth of the Moosonee River that had been surveyed in 1971-1972 (Schueler 1973).

From 14-23 May 2002 Aleta Karstad and FWS (and FWS & LF, 30-31 May) continued monitoring around Cochrane that began with a visit in 1972 (see avian results in Schueler et al. 1974). The Ontario Clay Belt around Cochrane is rolling or flat lacustrine clays with *Populus* and *Picea* forest, extensively cleared for grass-based agriculture, with large *Sphagnum/Picea mariana* (Black Spruce) muskegs. Our Long Lake study site south of Cochrane, at the Hwy 11 Long Lake picnic area, 48°55'N, 80°58'W, is where a paved highway was left behind in smoothing a curve. Poplar woods, muskeg, and the shore of a narrow lake are in close juxtaposition to a permanent borrow pit pond and small *Typha* marsh where Wood Frogs have bred abundantly. Ruts in a 2 km clay trackway in the woods along the lake hold water in which amphibians both resort and breed. Areas along this trackway were clearcut in 1999-2000. FWS, Aleta Karstad, and others have made autumnal visits here in 1972 (Schueler et al., 1974), 1977, 1983-1987, 1989, 1990, 1992, 1993, 1995, 1997, 2000, and 2001, and spring visits in 1983 and 1997.

From 1-28 June 2002, all the authors and LF surveyed the James Bay region of northwestern Québec by road, west of 77°W, from 48°30' to nearly 54°N latitude. Most of the area in Québec is located in the Canadian Shield, with Black Spruce and moss forest grading into Black Spruce and lichen forest north of 52°N. The Black Spruce is the most abundant tree, but Balsam Fir (*Abies balsamea*) and Jack Pine (*Pinus banksiana*) are also common, and some deciduous tree species, such as the Paper Birch (*Betula papyrifera*) and the Trembling Aspen (*Populus tremuloides*) are found in sheltered and southern sites.

Methods

We sought amphibians and reptiles at previously known sites, those that looked promising, or that had been identified as promising on topographic maps. Records were obtained by 1) active searching, especially for the eggs of amphibians and the shed skins of snakes, 2) turning cover objects such as rocks, logs, artificial debris, 3) listening for calling at vehicle stops along roads (we recorded the intensity of calling as the Wisconsin Calling Index, Mossman 1990*), and 3)

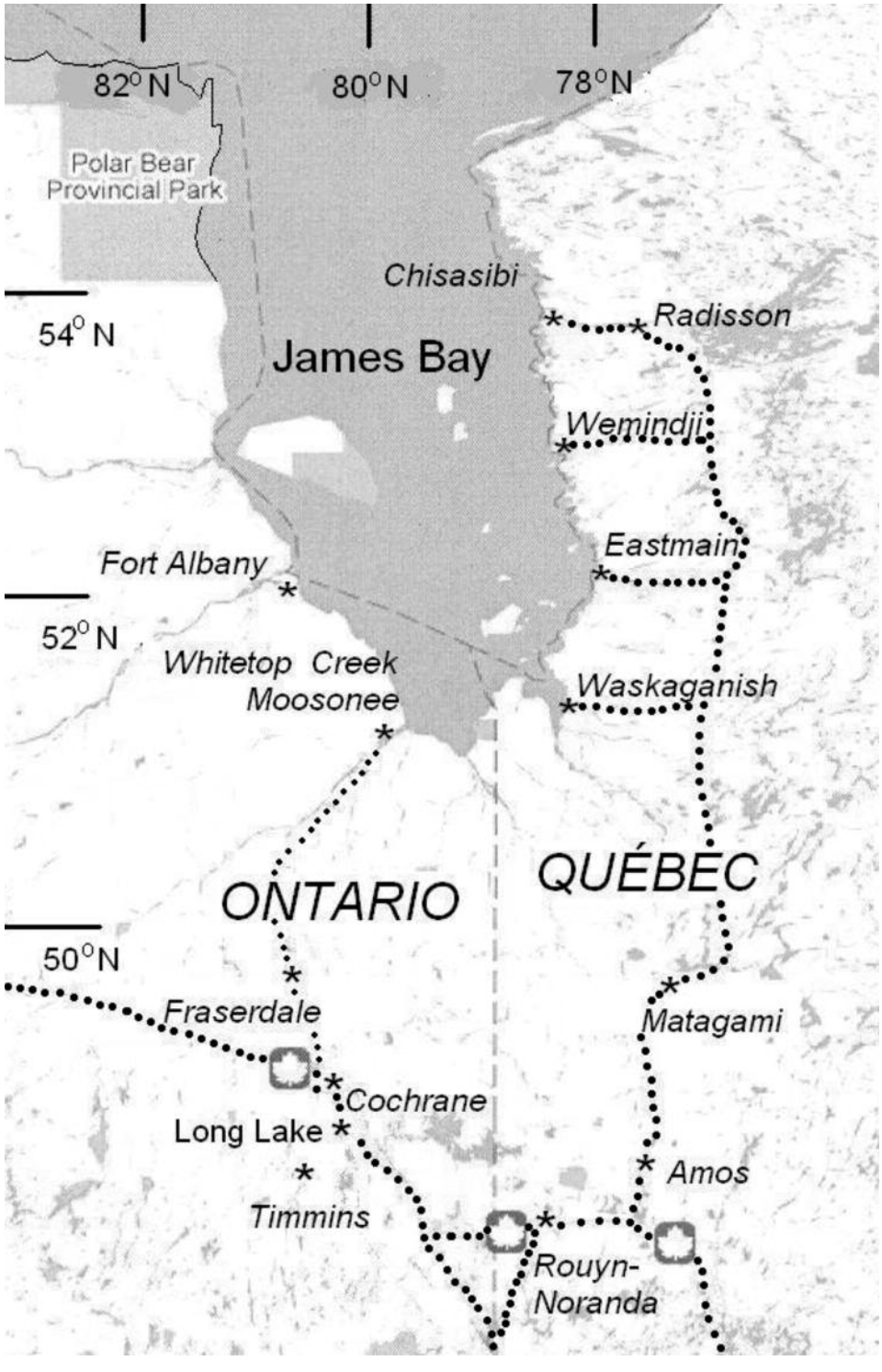

FIGURE 1. Location of the study area, and routes travelled in 2002.

road-hunting at night in areas where we anticipated that breeding amphibians would cross roads. Because we were generally not staying in camps more than overnight, permanent stations with traps and drift fences were not used, and because oviposition habitats are scattered through extensive wetlands, we did not undertake the fine-mesh dipnetting that would have been necessary to capture small larvae of some species. Because we concentrated our attention on small-scale aquatic habitats, we did not adequately survey habitats where terrestrial Redback Salamanders *(Plethodon cinereus*) might have been found. We recorded our location by GPS, and associated each observation with air temperature and other weather conditions. All specimens preserved during the 2002 survey are deposited at the Canadian Museum of Nature (CMNAR 35488-35622), and all the records are deposited in the databases of the Ontario Herpetofaunal Summary (OHS) (and subsequently the Ontario Herp Atlas) and the Québec Atlas of Amphibians and Reptiles (AARQ). All amphibian and snake measurements for Québec were taken by JFD from preserved specimens in July 2003 (except a few snakes released after measurement). Digital calipers were used for amphibian measurements and a metric tape for snakes measurements. Snout-vent length (SVL) was taken from the tip of the snout to the end of the cloacal slit in salamanders, and from the tip of the snout to the cloacal opening in anurans and snakes. In snakes, scale counts were done twice to reduce the possibility of mistake. Tadpole labial tooth row formula follows Altig (1970).

In Ontario we attempted to sample all species at the Long Lake study area. We drove roads and listened at sites near potential hibernation sites and breeding wetlands throughout the area to try to find Leopard Frogs in areas where we had found them in 1971 and 1972, and explored habitats around Cochrane for Mink Frogs. We took the Ontario Northland train to Moosonee, and travelled by boat to camp at several sites on the shores of the Moose River around and northeast of Moosonee, exploring surrounding areas on foot. From 27-29 May we camped at the mouth of South Whitetop Creek (51°22.3'N 80°26.6'W), 600m SW of our 1971-72 camp at the mouth of North Whitetop Creek (51°22.5'N 80°26.2'W, Schueler 1973; Schueler et al. 1974).

In Québec we surveyed the inland James Bay Road, and the roads to the four rivermouth Cree villages: Waskaganish (Rupert River, 51°29'N 78°45'W), Eastmain (Eastmain River, 52°15'N 78°30'W), Wemindji (Maguatua River, 53°00'N 78°48'W), and Chisasibi (La Grande River, 53°47'N 78°54'W). Potentially productive herpetological/malacological habitats were marked on a 1:50 000 topographic map, and we stopped at 5-10 of these preselected stations each day, especially targetting streams for *Eurycea* salamanders and rocky lakes for freshwater limpets. We drove roads and listened at night on the roads around some settlements. The roads reach the tidal mouths of the rivers, but only at Chisasibi is the open coast accessible by road. Cabbage Willows Bay was reached by boat, and we camped from 10-13 June at a traditional local camp on the Novide River (51°30.9'N 79°16.7'W).

We summarize calling for anuran species by latitude and date. For most species this includes only evening and nocturnal calling (20h00 – 03h00) because diurnal calling is of more inconsistent intensity.

For *Lithobates* which seem to have declined in northeastern Ontario, we compiled tables of the number of records of the apparently declining species against the common *Lithobates sylvaticus* in FWS's observation database, and compared them with the number of records by other observers in the OHS database from Cochrane District (OHS records to entry number 264574, March 2005, from Michael Oldham (Ontario Herpetofaunal Summary 2005*)). FWS's data entry is not complete for all years, and the activities pursued and areas visited were not always the same, but in all decades most activity has been monitoring and exploration in the Clay Belt centred on the Long Lake study area. We use our data to form hypotheses of changes in relative abundance which we test as contingency tables of others' observations in the OHS data.

Our species distribution maps plot our records with OHS records and museum and literature records.

Results

Eight species of amphibians and one reptile were found during the survey; Blue-Spotted Salamander (*Ambystoma laterale*), Two-lined Salamander (*Eurycea bislineata*), American Toad (*Anaxyrus americanus*), Spring Peeper (*Pseudacris crucifer*), Boreal Chorus Frog (*Pseudacris maculata*), Wood Frog (*Lithobates sylvaticus*), Leopard Frog (*Lithobates pipiens*), Mink Frog (*Lithobates septentrionalis*) and Garter Snake (*Thamnophis sirtalis*).

Table 1 gives nocturnal air temperatures and average time of sunset at the average latitude of records for the weeks of the survey. Environment Canada (2010*) ranked this spring as "neutral" on the "El Niño Southern Oscillation" pattern of weather variation. Along our route there was little rain (we experienced rain only on 15, 16, 24, 29, and 31 May, 7, 16, 18, 20, and 21 June, usually for short periods). This lack of rainfall was not characteristic of the region in 2002, as it often rained heavily after we had left an area. We encountered falling snow on 16 to 20 and 24 May, and 2 and 5 June.

Ambystoma laterale **Blue-Spotted Salamander, Salamandre à points bleus**

The Blue-spotted Salamander was found at five different locations in Québec including all four Cree villages (Figure 2). Our northernmost record (53°47.5'N) was made at Chisasibi and is about 24 km north of the previous range limit (MacCulloch and Bider 1975). Specimens (all adults) were mostly found under objects such as woody debris. Eggs and larvae were not

TABLE 1. Weekly nocturnal air temperatures during the 2002 James Bay herpetological survey.

Mean, minimum and maximum air temperatures recorded in our databases from 22h00-24h00 for each week during the 2002 James Bay herpetological survey. Latitudinal range and number of anuran auditory records and time of sunset (EDT, from Garmin GPS software) for the average location of calling records, are also presented.

Cochrane early	(14-16 May, 48°32' – 48°55' N)	10.0°C (0-12.5°C): 22 records, 20h58
Moosonee area	(24-29 May, 51°16' – 51°22' N)	9.4°C (0-14°C): 43 records, 21h23
Cochrane late	(30-31 May, 48°55'– 49°8' N)	14.8°C (14-16°C): 19 records, 21h17
Québec Week 1:	(1-7 June, 48°13' – 51°29' N)	11.8°C (8°-13°C): 59 records, 21h20
Québec Week 2:	(8-14 June, 51°13' – 51°35' N)	4.0°C (-2.5°-12°C): 58 records, 21h32
Québec Week 3:	(15-21 June, 51°21' – 53°48' N)	12.8°C (7°-20°C): 110 records, 21h37
Québec Week 4:	(22-28 June, 46°51' – 53°58' N)	15°C (15°-15°C): 20 records, 21h38

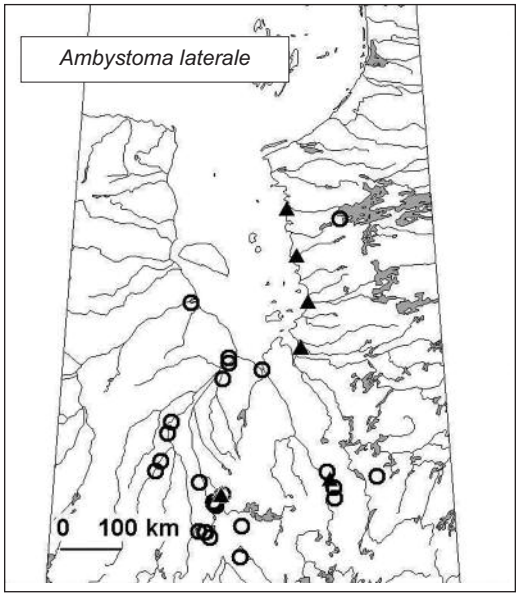

FIGURE 2. Observations of the Blue-spotted Salamander (*Ambystoma laterale*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

observed, but the failure to find larvae is doubtless due to the lack of fine-mesh dipnetting. As specimens died during transportation and were preserved in formalin, it was impossible to genetically determine if they were pure *A. laterale* or hybrids. However, measurements (SVL (average 53.8 mm; range 50.0-60.4 mm), head width (7.5 (6.9-8.1) mm) and internarial distance (2.97 mm (2.59-3.40) mm; n = 6) do not suggest that they are anything but pure *A. laterale* (Lowcock et al. 1992). The species is also known from many collections in previous years from the Long Lake study area (CMNAR specimens, OHS records) and is widespread in northeastern Ontario (MacCulloch 2002). Fifteen specimens we have previously submitted for genetic examination from Long Lake study area and elsewhere in the Ontario Clay Belt are pure *A. laterale* (LL; Jim Bogart, University of Guelph, *in litt.* 15 February 2005).

Eurycea bislineata **Two-lined Salamander, Salamandre à deux lignes** :

The Two-lined Salamander was sought in 16 different rivers and brooks (Table 2 and Figure 3) in Québec. Habitat at most of them seemed adequate for the species: clear running water, rocky shores, substrate of sand and gravel, and adjacent forest, but the species was found in only 4 stations. All were under rocks at the margin of rivers except for two larvae that were on the bottom in water. The most northern record was made at Eastmain Rd, 18.1km WNW the James Bay Road, where a rocky brown-water river runs under the road in three large culverts, 52°05'N, representing a range extension of about 200 km to the north (see distribution maps in: Cook 1984; Petranka 1998). North

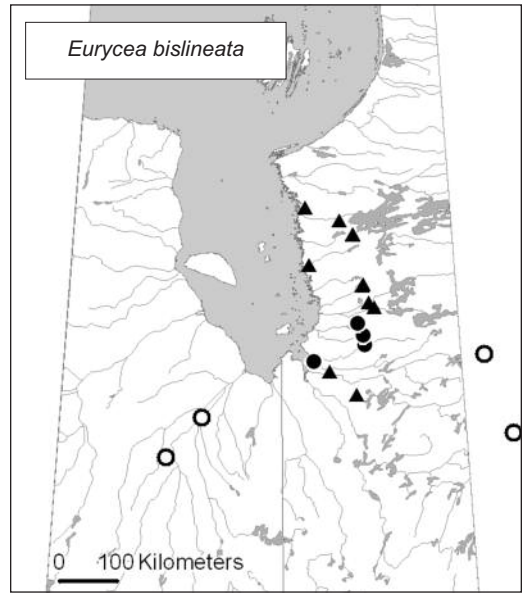

FIGURE 3. Observations of the Two-lined Salamander (*Eurycea bislineata*), around James Bay. filled circles = *Eurycea* present (June 2002), triangles = *Eurycea* not found despite search in suitable habitat (June 2002), open circles = previous records of *Eurycea.*

TABLE 2. Streams searched for the Two-lined Salamander in James Bay, Québec, in June 2002.

Location	Habitat	Date	Presence
Along James Bay road, 50°56.73'N 77°38.82'W	Pebble and soft-mud brook	27 June 2002	No
Waskaganish access road, 51°19.53'N 78°17.47'W	Rocky dark brown water creek in burned Black Spruce forest	14 June 2002	No
Rupert River, 51°29.53'N 78°41.33'W	Large river, clear water, rocky bottom	11 June 2002	Yes (CMNAR 35488)
Pontax I River, 51°44.02'N 77°23.02'W	Clear-water river, gravel bottom, rocky shores	15 June 2002	Yes (CMNAR 35534)
Jolicoeur River, 51°52.98'N 77°25.73'W	Clear brown-water river, gravel and rocky bottom	16 June 2002	Yes (CMNAR 35535)
Eastmain access road, 52°4.92'N 77°33.63'W	Rocky brown-water river, under road in 3 large culverts	18 June 2002	Yes (CMNAR 35551)
Eastmain River, 52°19.30'N 77°06.30'W	Sandy flowing brook below low Beaver (*Castor canadensis*) dam	19 June 2002	No
Opinaca River, 52°23.60'N 77°15.10'W	Clear river, rocky bottom and shores	19 June 2002	No
Pilipas River, 52°39.82'N 77°23.45'W	Clear-water river, 5 m wide, gravel and rocky bottom	19 June 2002	No
Along James Bay road, near km 143, 52°40.83'N 77°22.25'W	Clear-water river, 5 m wide, rocky bottom, shores with alders	27 June 2002	No
Wemindji access road, 53°0.75'N 78°46.27'W	Clear-water river, 4 m wide, gravel bottom	26 June 2002	No
Along James Bay road, 53°27.93'N 77°35.08'W	Clear-water river, 5-10 m wide, gravel bottom	20 June 2002	No
Along James Bay road, at km 566, 53°28.70'N 77°36.10'W	Clear-water stream, 3 m wide, gravel and rocks on bottom	25 June 2002	No
Chisasibi access road, 53°42.58'N 77°55.98'W	Dark brown-water stream, 4 m wide, rocky bottom	24 June 2002	No
Longue-Pointe road, north of Chisasibi, 53°48.0'N 78° 39.8'W	Clayey brown-water brook/creek with rock/cobble bed	23 June 2002	No
Longue-Pointe road, north of Chisasibi, 53°55.37'N 78° 51.23'W	Clear-water river, 30 m wide, rocky bottom and shores	23 June 2002	No

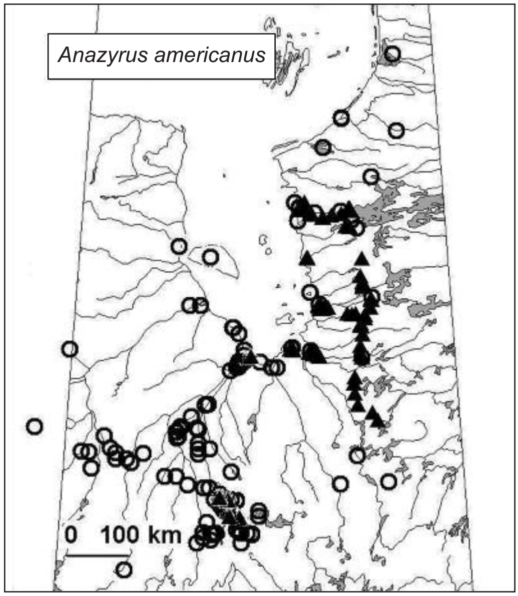

FIGURE 4. Observations of the American Toad (*Anazyrus americanus*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

of here, no specimens were found despite many searches. Our observations are the most northern in the James Bay area, but the species has been reported farther north east of our study area: 190 km farther north about 260 km east in northern Québec (Fortin 2006), and to almost 53°30'N in Labrador (Maunder 1997; Fortin 2005).

Streams in the Clay Belt are gravelly only in short stretches at riffles, and this may explain the apparent absence of this salamander in the southernmost part of our study area in Québec (as proposed by (Bider and Matte 1996) and in the Ontario Clay Belt. The only northern Ontario records are along the Abitibi River, halfway between Fraserdale and Moosonee, in the Onakawana River (Kamstra 1983), and Mowbray Creek, a tributary of the Opisatika River (8 Sept. 1990, ROM 20673, collected by G. Mornal, and S. De Forlet).

Anaxyrus americanus American Toad, Crapaud d'Amérique

The American Toad was observed or heard at 95 different locations in Québec (103 records, 69 auditions, 2 on road), and 28 in Ontario (35 records, 21 auditions, 9 on road), throughout the study area except the extreme south of our Québec route, which we visited during a cold spell. (Figure 4). When we first arrived in the Cochrane area, toads were not calling and were active on the roads, but when we were at Moosonee, and for much of the rest of the survey, the breeding season was at its peak, many index 3 choruses were heard, and we saw eggs and tadpoles in some places. Eggs were seen

TABLE 3. Calling index for American Toads, recorded in 2002 in the James Bay area. Number of evening and nocturnal (after 20h00) stations where the species was heard at index1 (few calling)/ index 2 (small chorus)/ index 3 (full chorus) at the indicated dates and latitudes (maximum index recorded for each site on each day).

Latitude/ date	14–15 May	25–30 May	1–7 June	8–14 June	15–21 June	22–28 June
53° to 54°	–	–	–	–	5/1/0	5/0/0
52° to 53°	–	–	–	–	9/8/8	none
51° to 52°	–	2/0/3	1/6/1	3/4/3	0/0/1	none
50° to 51°	–	–	1/0/1	–	–	none
48°30' to 50°	none	01/02/03	none	–	–	none

TABLE 4. Calling index for Spring Peepers, recorded in 2002 in the James Bay area. Number of evening and nocturnal (after20h00) stations where the species was heard at index1 (few calling)/ index2 (small chorus)/ index3 (full chorus) at the indicated dates and latitudes (maximum index recorded for each site on each day).

Latitude/ date	14–15 May	25–30 May	1–7 June	8–14 June	15–21 June	22–28 June
53° to 54°	–	–	–	–	2/7/5	4/1/0
52° to 53°	–	–	0/0/8	–	6/6/14	1/0/1
51° to 52°	–	1/0/11	0/4/2	5/6/5	2/0/0	0/1/0
50° to 51°	–	–	–	–	–	none
48°30' to 50°	0/1/11	0/0/5	–	–	–	1/1/0

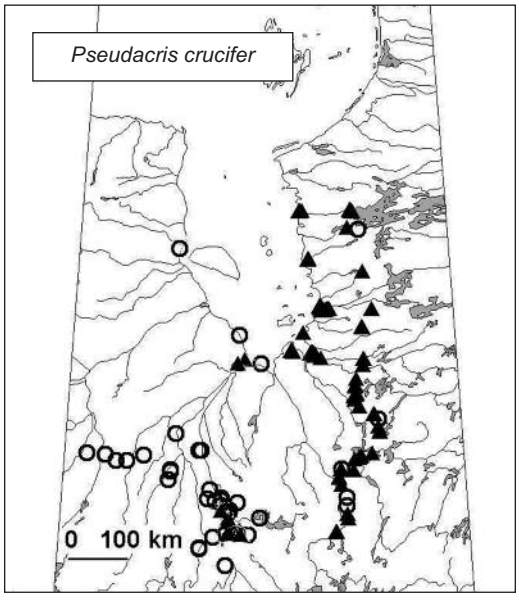

FIGURE 5. Observations of the Spring Peeper (*Pseudacris crucifer*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

in Québec side from 7 to 20 June. Table 3 presents the maximum nocturnal call index for the species, by latitude and date. Our results confirm that the American Toad is a common and widespread species in the study area. Its range goes 300 km further north in Québec (Cook 1984; Desroches and Rodrigue 2004) and it is widespread in northern Ontario (MacCulloch 2002).

Pseudacris crucifer **Spring Peeper, Rainette crucifère**

The Spring Peeper was found at 86 different locations in Québec (89 records, 83 calling), and 35 in Ontario (48 records, 45 calling), throughout the study area (Figure 5 and Table 4). This species is widespread in the southern half of the James Bay area of Ontario (MacCulloch 2002) and Québec (Desroches and Rodrigue 2004). Our northernmost record (53°48'N) at Radisson is about 36 km north of the previous range limit in Québec (MacCulloch and Bider 1975). Neither eggs nor tadpoles were observed, but fine dipnetting was not undertaken.

Pseudacris maculata **Boreal Chorus Frog, Rainette faux-grillon boréale**

In James Bay Boreal Chorus Frogs are at the eastern limit of their range, which extends narrowly around the shores of the Bay to the Moose River. Schueler (1973) speculated that this river might have been a barrier that the species had not crossed in dispersing from the west, but the calls of Boreal Chorus Frogs were reported from Cabbage Willows Bay in 1991 (Bider and Matte 1996), strongly suggesting that the range of the species extended into Québec, and inspiring our visit to the site.

In Québec, we found this species only at Cabbage Willows Bay on the west side of Rupert Bay (Figure 6). It was heard from 10-12 June at 14 different locations on the flatlands of the Bay, which represents half of the stations where at least one anuran was heard at Cabbage Willows Bay. Other species heard with the Boreal Chorus Frogs were American Toads (up to index 3), Spring Peepers (up to index 2) and Wood Frogs (few calls). A single specimen was seen and

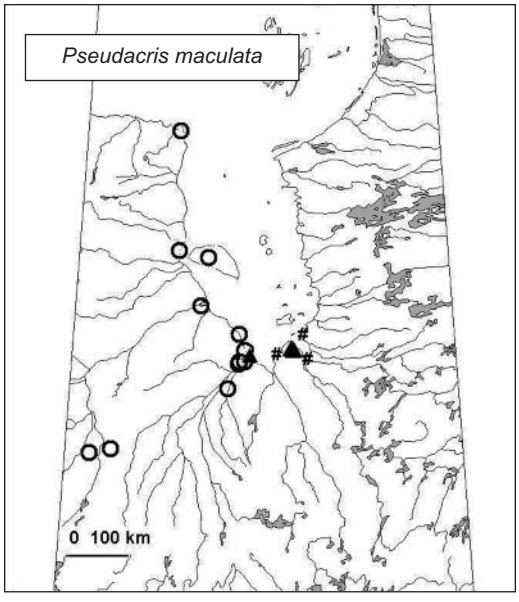

FIGURE 6. Observations of the Boreal Chorus Frog (*Pseudacris maculata*), around James Bay. triangles = our observations (June 2002), # = Fortin et al. 2003 (June 2002) and Ouellet et al. (May-June 2003), open circles = previous records.

caught, on 10 June (51°31.48'N; 79°16.31'W) CMNAR 35522, a green male, SVL 33.39 mm, tibia 14.02 mm [42% of SVL]). Most Boreal Chorus Frog calling was heard during the daylight hours, at a maximum air temperature of 15°C, but some were heard during the night at 0 and 4°C. Water temperature was 16°C in one of the ponds from which calling was heard, on 12 June 12h20, while the air was 14°C. We heard only 1-2 males calling at each station, suggesting either that the population was sparse, or that the breeding season was at its end during our visit to Cabbage Willows Bay (calling had not been intense at Whitetop Creek two weeks earlier). Very small tadpoles with external gills (CMNAR 35622), in the pond where the male Boreal Chorus Frog was caught at Cabbage Willows, may have been of this species or the more abundant Spring Peeper.

In 1971-72 FWS marked the southern range limit of Boreal Chorus Frogs at Store Creek in Moosonee (51°16.26'N 80°30.61'W, Schueler 1973). The OHS contains only one post-1970s record from Moosonee (211741, 31 May 1991 "Moosonee, 3 found, shrubs, mixed forest adj[acent] area, pond along roadside" by Steve LaForest). In 2002 Boreal Chorus Frogs were not heard from the settlement of Moosonee, nor from the grassy-boggy clearing around the airport, where they were heard in 1972 (north to 51°17.9'N 80°35.6'W). At the airport the habitat still seems adequate, but in town many of the ditches along the streets have been filled in since 1972. We both listened generally around

TABLE 5. Calling index for Boreal Chorus Frogs, recorded in 2002 in the James Bay area. Number of stations where the species was heard at index 1 (few calling)/ index 2 (small chorus)/index3 (full chorus).

Location/date	27–29 May	10–13 June
Whitetop Creek, Ontario	09/04/01	–
Cabbage Willows Bay, Québec	–	15/0/0

Moosonee during our 2002 visit, and walked the entire street grid of the settlement on the night of 26-27 May (22h30-01h45, air 8.3-3.0°C). Boreal Chorus Frogs were heard all around Whitetop Creek (southernmost audition 3.2 km SW mouth S Whitetop Creek 51°21.17'N 80°28.68'W), though the low intensity of the calling heard (Table 5) suggests that the peak of the breeding season had passed before we arrived there.

Boreal Chorus Frog habitat is restricted to grassy flat land with shrubby willows (front cover), some of it below the extreme high tide line. Plants found in the breeding pools (*Spartina* sp.) at Cabbage Willows demonstrate that water was more or less brackish. At Whitetop Creek most calling was from ponds among the *Salix* savanna well above the usual high-tide level (Figure 8), but there were almost no ponds in this zone at Cabbage Willows.

The Boreal Chorus Frog was reported from Cabbage Willows Bay in 1991 (Bider and Matte 1996) but no photos, sound recordings, or voucher specimens were taken, so our records and the sightings and auditions by others at Cabbage Willows Bay and at three sites

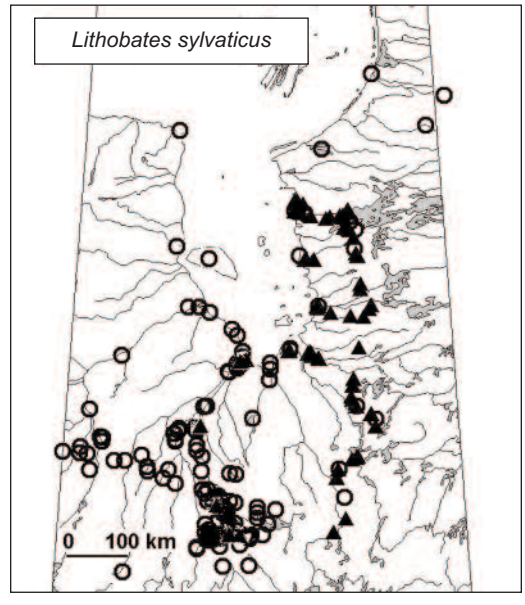

FIGURE 7. Observations of the Wood Frog (*Lithobates sylvaticus*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

FIGURE 8. Habitat of the Boreal Chorus Frog, in the *Salix/Alnus* savannah along a tributary of Whitetop Creek, Ontario (Photo by Larry Frazer).

just west, southeast and northeast of Cabbage Willows Bay, on the east coast of James Bay (Fortin et al. 2003; Ouellet et al. 2009) are the first authentic records from Québec. The restriction of the species to barely-supratidal habitats suggests that changes to the salinity of Rupert Bay by projected hydroelectric projects may imperil the species here (Picard and Desroches 2003*).

Lithobates sylvaticus **Wood Frog, Grenouille des bois**

This species is the most frequently seen amphibian in the James Bay area. In Québec we found it at 84 different sites (87 records of which 19 were calling and 18 were eggs) and in Ontario 62 records from 45 sites, of which 47 were calling records, and 10 were eggs (Figure 8 and Table 6). Most auditory records from 14-16 May around Cochrane, and at Moosonee, were index 3 choruses, but these were not actively breeding, as the frogs could not be approached, and no concentrations of egg masses were laid at those chorus sites that could be visited. Scattered egg masses were laid in the ruts along the track at Long Lake. Most of the Québec records are sightings and captures of individuals rather than auditions, reflecting the later season when we visited this area. We heard no index 3 choruses in Québec. Eggs were found at 18 sites in Québec, ranging from 1-20 masses per site, and most of the tadpoles collected were this species. Hatching was observed on 4, 5, and 6 June. Extreme temperature fluctuations in May, may have disrupted normal movement to mass oviposition sites: no eggs were laid in ponds at Long Lake where breeding usually occurs, while 18 egg-

TABLE 6. Calling index for Wood Frogs, recorded in 2002 in the James Bay area. Number of evening and nocturnal (after 20h00) stations where the species was heard at index1 (few calling)/ index2 (small chorus)/ index3 (full chorus) at the indicated dates and latitudes (maximum index recorded for each site on each day).

Latitude/ date	14–15 May	25–30 May	1–7 June	8–14 June	15–21 June	22–28 June
53° to 54°	–	–	–	–	2/0/0	none
52° to 53°	–	–	–	–	3/1/0	none
51° to 52°	–	0/5/12	5/0/0	6/0/0	none	none
50° to 51°	–	–	1/0/0	–	–	none
48°30' to 50°	0/2/7	3/0/0	3/0/0	–	–	none

masses were found at 8 sites in ruts along the track west of the lake, which averaged 6738 L in rectangular volume (length × width × depth; range: 900 – 10000 L, st.dev. = 3440 L; data in Schueler et al. 2010*). The only large clusters of egg masses noted were an estimated 30-40 masses seen from the stopped train in a shallow dark-water Grass/Carex ditch at Coral Rapids, Ontario (50°13.1'N 81°41.0'W – perhaps at the very same site where eggs were seen in 1972, Schueler 1973: 413).

The average SVL for males was 41.73 mm (36.79-47.39, n = 30) and 45.09 mm (40.46-52.17, n = 16). The ratio between the tibia length and the SVL was 0.50 for both sexes, ranging from 0.45 to 0.57 in males (n = 30) and from 0.46 to 0.56 (n = 16 for females).

The mid-dorsal pale line, or stripe, is known to be relatively frequent in northern populations of Wood Frogs from Ontario and Québec, with respective frequencies of up to 76% and 45% reported (Schueler and Cook 1980). In 2002, 58% of the Wood Frogs observed in Québec were striped. In the most recent sizeable sample from Long Lake, 14% of breeding adults from 1997 were striped (22 of 154), the same frequency reported from there in samples from August of 1971 (the site described as "along highways in the vicinity of Cochrane," Schueler and Cook 1980). No Wood Frogs were actually seen around Moosonee in 2002; historically about 55% of the frogs from there are striped (1938-1939 and 1971-1972, Schueler and Cook 1980: 1646). For comparison, about 2% in eastern Ontario and 2.5% in southwestern Québec are striped (FWS and JFD, unpublished data).

Tadpoles of James Bay area Wood Frogs differ from those of the same species in southern locations, in having a tooth-row formula of ⅔ (2 upper rows [anterior] and 3 lower [posterior]) instead of ¾. This was noticed in Wood Frog tadpoles from Hudson Bay by Altig (1970). All our James Bay Wood Frogs tadpoles (from Québec) have a tooth-row formula of ⅔.

The Wood Frog is a common and widespread species in the James Bay area. It ranges north of the area studied in 2002, as far as 350 km along the coast and 500 km inland in Québec (Cook 1984; Desroches and Rodrigue 2004) and is widespread all over northern Ontario (MacCulloch 2002).

Lithobates pipiens **Leopard Frog, Grenouille léopard**

The Leopard Frog was found at only two stations: Douay Lake and Opinaca River, Québec (Figure 9). The latter is about 120 km south of the northernmost record of the species in the area (MacCulloch and Bider 1975). Two or three males were heard calling at Douay Lake (49°34.8'N 78°4.6'W) at 17h50 on 3 June 2002, at an air temperature of 13°C. The Leopard Frog was reported from this lake in 1974 (Schueler and Karstad 1975). At Opinaca River (52°23.6'N 77°15.1'W), only a single juvenile was found on the shore of a bedrock river with fast current, a habitat that does not correspond to the breeding needs of the

TABLE 7. *Lithobates pipiens* taken in eastern Cochrane District, June and July 1971, May and August 1972.

Location	Habitat		Presence
Moose Twp: mouth N Whitetop Creek, 18.4 km NE Moosonee.	51°22.48'N	80°26.18'W	CMNAR 23818, 24222 **
Moosonee (in town, 1 km radius),	51°16'N	80°39'W	CMNAR 15217 15267 23893 23900 24221 24223 **
1 mile N of Fraserdale,	49°51.82'N	81°36.74'W	CMNAR 15299 #
Clute Twp: 4 miles N of Cochrane (as Lillabelle Lake dam),	49°7.54'N	81°2.27'W.	CMNAR 24246 # **
Cochrane: Commando Lake,	49°3.81'N	81°1.27'W.	CMNAR 14801 # **
Cochrane: CN railway, 1 mile W of Cochrane,	49°3.95'N	81°3.11'W	CMNAR 24252. # **
Hwy 11, 4 miles S of Cochrane,	49°0.09'N	81°1.85'W	CMNAR 24246 # **
Hwy 11, 4-11 mi S Cochrane (as Wicklow River/Hwy 11),	48°56.93'N	81°0.57'W.	CMNAR 15292, CMNAR 24253 # **
Hanna Twp: Long Lake, 12 km NW Tunis (=11 miles SE of Cochrane),	48°54.96'N	80°58.35'W.	CMNAR 24245 # **
0.5 miles W of Frederickhouse, 7 miles W of Cochrane.	49°3.41'N	81°9.56'W	CMNAR 15309, 24396 # ** @
Hwy 101/Moose Creek, 15 miles E of Timmins	48°33.18'N	81°0.47'W	CMNAR 24197 #

site searched for Leopard Frogs 1995-2001
** site searched for Leopard Frogs 2002
@ the location of this site is ambiguous – the frogs from here were actually taken by other members of the party (Schueler et al. 1974) and FWS didn't visit the site in 1972. "0.5 miles W of Frederickhouse" is 49°5.20'N 81°10.16' W – but this provides no habitat for *L. sepientrionalis,* which was also taken there, and it is 6.5 miles WNW of Cochrane. The co-ordinates given in the table are 3.3 km S of Frederickhouse, just east of Clute Lake, and could be considered half a mile west of the cluster of houses just west of the Hwy 11 Frederickhouse River bridge, but only 6 miles W of Cochrane directly along Hwy 11.

TABLE 8. Relative frequency of records of Leopard and Wood Frogs in Cochrane District by F.W. Schueler and by other observers in the Ontario Herpetofaunal Summary. The number of *L. pipiens* records are given as as a percentage of the number of *L. sylvaticus* records.

Source and years	*Lithobates pipiens* / *Lithobates sylvaticus*
FWS 1971-1977	28 / 64 – pre-decline – 44% of *Lithobates sylvaticus* records
OHS pre 1980	*41 / 89 – 46% of Lithobates sylvaticus* records
FWS 1983-1990	0 / 107 – observers unaware of decline – 0%
OHS 1981-1991	*4 / 89 – 4% of Lithobates sylvaticus* records
FWS 1992-2002	4 / 183 – aware of decline in *L. pipiens* – 2% *of L. sylvaticus* records
OHS 1992-2002	0 / 2 (data entry or submission evidently incomplete)

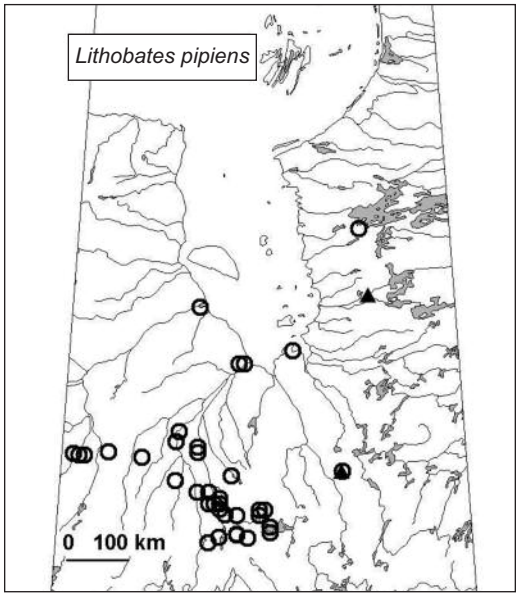

FIGURE 9. Observations of the Leopard Frog (*Lithobates pipiens*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

species. It may have come from upstream or adjacent marshy or boggy habitat.

The Leopard Frog seems uncommon on the Québec side of James Bay, though we may have visited many areas during the post-breeding period when the species isn't highly apparent. This species is associated with grassy habitats (Wright and Wright 1949; Dole 1971; Schueler 1982), though Schueler (1973) noted a greater use of aquatic habitats in the James Bay area. Adequate habitats may be scarce on the Québec side of James Bay. Douay Lake, where we heard Leopard Frogs, is bordered with grassy open habitat instead of the usual *Sphagnum* and Ericaceae shore. Several places between Lac Douay and Matagami appeared suitable for *Lithobates pipiens,* including flat mesotrophic sedgey wetlands on the outskirts of Matagami, but we were not able to visit these. The only other records of the species in James Bay region in Québec, are from Point Comfort (Logier and Toner 1961, now Cabbage Willows Bay) and from Nathalie Lake, some 120 km north of Opinaca River (MacCulloch and Bider 1975). Adult people in several of the coastal settlements we visited, and from Fort Albany, Ontario, told us that "big green frogs" were seen when they were children, while youths and children seemed not to know about such frogs; a careful assembly of oral tradition should accompany any investigation of the species status in the region.

Leopard Frogs were not heard or seen at breeding sites or on roads near potential hibernation sites near where were captured in 1971 and 1972 around Cochrane and Moosonee (Table 7), nor near sites where juveniles were found on 16 Sept 1992, south of Val Gagne on Taylor Twp Rd 4 (48°35.2'N 80°38.2'W, CMNAR 35679-35682). Since 1995 FWS has visited every place where he found Leopard Frogs in 1971-1972, in reasonable conditions for finding this species, without success. Leopard Frogs were heard calling on 14 May 2002 at one of the northernmost known Ontario populations, Casey Marsh, 12.3 km NE New Liskeard, Timiskaming District, 47°35'N 79°33'W in the upper Ottawa River drainage.

The widespread failure to find this species in northern Ontario has suggested the hypothesis that there has been a general decline throughout the Arctic drainages of Ontario (Anonymous [Schueler] 1993*; Weller and Green 1997; Seburn and Seburn 1997*; 2000). Declines have been suspected as far south as Algonquin Park in Ontario (Brooks et al. 2003).

Our data suggest a decline around 1977, and a 2×2 G test for OHS records from before and after 1978 is highly significant (Table 8, $G = 29.94249$ $p << 0.001$). The close agreement between the relative frequencies in FWS's and "others" records of the species suggests that there has been a real decline in the apparency of Leopard Frogs to herpetological observers, and that our observations are typical of those of all observers.

While the Leopard Frog is still common in southern Québec and Ontario, it suffered widespread declines in western Canada around 1976-1980 (Koonz 1992; Seburn and Seburn 2000). These declines happened in the populations from the Prairies, from Alberta to Manitoba, which are biogeographically linked to western James Bay populations by the possession of the

TABLE 9. Relative frequency of records of Mink and Wood Frogs in Cochrane District by F.W. Schueler and by other observers in the Ontario Herpetofaunal Summary. The number of *Lithobates septentrionalis* records is given as a percentage of the number of *L. sylvaticus* records.

Source and years	*Lithobates septentrionalis* / *Lithobates sylvaticus*
FWS 1971-1987	40 / 167 – 24% of *Lithobates sylvaticus* records
OHS pre-1990	*33 / 129* – 26% of *Lithobates sylvaticus* records
FWS 1990-2002	6 / 187 – 3% of *Lithobates sylvaticus* records
OHS 1990 & after	*1 / 52* – 2% of *Lithobates sylvaticus* records

TABLE 10. Calling index for Mink Frogs, recorded in 2002 in the James Bay area of Québec. Number of evening and nocturnal (after 20h00) stations where the species was heard at index 1/ index 2/ index 3 at the indicated dates and latitudes (maximum index recorded for each site on each day).

Latitude/ date	1–7 June	8–14 June	15–21 June	22–28 June
53° to 54°	–	–	–	diurnal
52° to 53°	–	–	1/2/2	none
51° to 52°	none	none	diurnal	none
50° to 51°	none	–	–	none
48°30' to 50°	none	–	–	diurnal

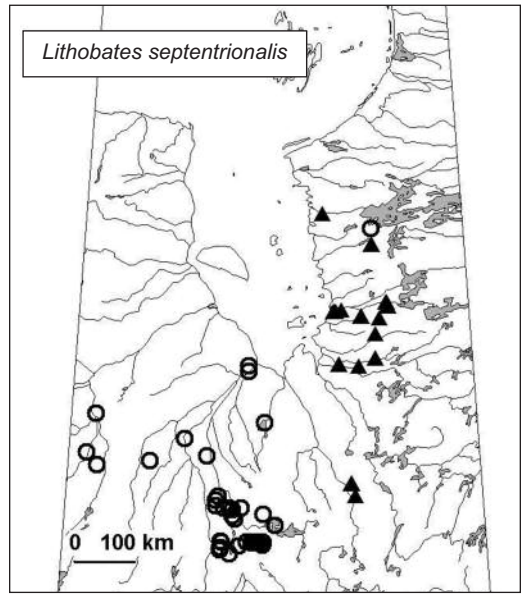

FIGURE 10. Observations of the Mink Frog (*Lithobates septentrionalis*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

western mtDNA haplotype in some frogs from Attawapiskat, though those from Moosonee had the eastern haplotype (CMNAR 1971-1972 specimens, Hoffman and Blouin 2004).

Lithobates septentrionalis **Mink Frog, Grenouille du Nord**

This frog was found at 17 different locations in Québec (20 records, 9 calling), all through the study area (Figure 10 and Table 10). Relatively few adults were seen or captured, perhaps due to the fact that this frog is highly aquatic and relatively wary. The species prefers boggy habitat (MacCulloch and Bider 1975), which are well represented on the study area, but which were not extensively entered in our survey. Overwintered tadpoles were observed at six locations; the largest number seen was about 150.

It seems that the Mink Frog is fairly common and widespread in the Québec part of the study area. The known range of this frog goes 450 km farther north than this study examined inland in Québec but not along the coasts of James Bay (see maps in Cook 1984; Desroches and Rodrigue 2004).

In Ontario, Mink Frogs, like Leopard Frogs, seem less widespread than in the 1970's. In 2002 we did not hear or encounter any in our searches and listening around Cochrane, in Moosonee, or at Whitetop Creek, where we had found them in the 1970's. FWS found Mink Frogs in a brief visit to Commando Lake in Cohrane in 1971 (CMNAR 14799), but in 2002 he searched lakes in, and south of, Cohrane's Dury Park to check Rey Brisson's suggestion (personal communication) that the lakes there are "just like" what Commando Lake was like when he was a boy, and when 'greenish frogs' were abundant there. Commando Lake now has mowed shores and domestic Mute Swams (*Cygnus olor*); searches since 1997 had not found any *Lithobates* there until one of three Mink Frogs seen was captured in May 2010 (Schueler et al. 2010*).

Our data (Table 9) suggest a decline around 1990, and counts of OHS records again closely parallel ours in frequency, with Mink Frogs much less frequent after 1990 ($G = 14.02$ $p<<0.005$; but note that 50 of the '1990 and after' OHS *L. sylvaticus* records come from 1990-1991; compare the last line of Table 8).

Bleakney (1958) was the first to report that Mink Frogs in northern Québec breed in June at the same time as the American Toad, the Spring Peeper, and the Wood Frog. He found it unusual that a frog would breed simultaneously in northern and in southern locations. The air temperature for our observations, north of 51°N when Mink Frogs were heard calling, varies

from 24.5°C to 27.5°C by day and from 13°C to 14°C by night (after 20h00). On the week of 15-21 June 2002, between 22h00 and 23h30, choruses of Mink Frogs were heard at index 3 at the same time that Toads and Peepers were calling at index 3 and Wood Frogs at index 2. A female taken on 16 June had enlarged oviducts but had not ovulated, one taken on 27 June extruded eggs as she was handled. It is not known why the breeding season of the Mink Frog is about the same in southern and northern Québec (between 45°N and 54°N), but the longer duration of days in summer in the north may result in a faster accumulation of degree-days of warmth.

The average SVL of males was 54.18 mm (45.96-61.95, n = 5) and for females it was 67.26 mm (58.38-71.32, n = 7). For females this relatively large size is consistent with other samples from Ontario and Québec, but the size of males is lower than that reported for northern males (60-64 mm snout-urostyle length; Schueler 1975). If the step cline in size described by Schueler (1975) is due to the addition of another year of growth to the life cycle (as Pace [1974] suggested for *Lithobates spenocephalus*), then mature frogs from the northern part of our area might be expected to be smaller than those from the south.

Thamnophis sirtalis **Garter Snake, Couleuvre rayée**

The Garter Snake is the only reptile found during the survey. It was found on 15 locations throughout the study area in Québec (Figure 11). Several shed skins were found and these were identified by the dorsal scale row count (always 19) and keeled scales. Many of these observations were made near metal culverts embedded in rock fill under the paved James Bay Road. Our northernmost record (53°47.7'N) at Longue-Pointe, near Chisasibi, is about 24 km north of the previous range limit (MacCulloch and Bider 1975). The species is also known from previous years from the Long Lake study area (CMNAR specimens, OHS records), and one was seen in a clearcut there on 31 May 2002.

All the 14 Garter Snakes captured and examined in Québec during the survey had a yellowish dorsal line and orange to red lateral lines. Bleakney (1959) stated that Garter Snakes from northern Ontario (Abitibi and James Bay areas) often had orange or red stripes, but without distinguishing lateral and dorsal stripes. Snakes from Long Lake are sometimes entirely yellowish with no lateral red, but sometimes are "washed with orange-ochre," "creamy colour, red only between anterior scales," "brightly white-checkered, with lateral red," "dingy olive – orangy-red between scales on anterior ⅓ of body," or "vividly red" over the head and entire anterior third of the body (FWS field notes).

Maps in the literature (see: Bleakney 1959; Cook 1984; Conant and Collins 1998) suggest that the boundary between *T. s. sirtalis* and *T. s. pallidulus* runs at or a little east of the Ontario-Québec border, associated with a west-east cline in ventral scale counts (Bleakney 1959). Our qualitative assignment to subspecies, based

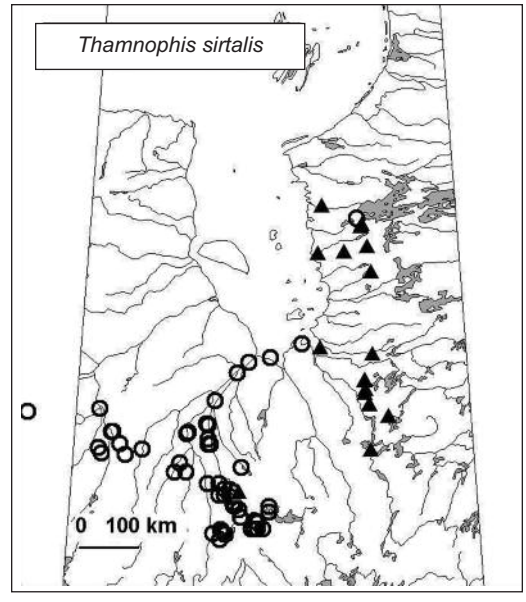

FIGURE 11. Observations of the Garter Snake (*Thamnophis sirtalis*), around James Bay. triangles = our observations in May and June 2002, open circles = previous records.

on colour pattern (striped *vs* checkered in appearance, see Cook 1984), for 11 Québec James Bay snakes, was 8 *pallidulus* and 3 *sirtalis*. Ventral and subcaudal scale counts, the quantitative characters which differ between the subspecies (Bleakney 1959), also suggests our snakes were intermediate between *T. s. sirtalis* and *T. s. pallidulus* (Figure 12). Our ventral scale counts were 151.0 ± 3.2 for males (n = 7) and 145.8 ± 3.8 (n = 5) for females; subcaudal scale counts were 73.1 ± 4.3 for males (n = 7) and 65.3 ± 5.0 for females (n = 4).

The only previous report of the litter size of Garter Snakes from the James Bay area was 6 embryos in a *circa* 70 cm SVL female taken on 17 July 1973 (MacCulloch and Bider 1975). This snake also contained one small egg which likely would have been aborted (F. R. Cook, personal communication). Average counts of embryos for northern locations in western Canada are 12.5 and 18.5 (Larsen et al. 1993), and 10-30 in southern Québec and Ontario (J-FD and FWS, unpublished data; Gregory and Larson 1993). Over the species' range, litter sizes average 27 (Ernst and Ernst 2003). Eight southern Quebec Garter Snakes dissected by JFD contained 12 to 25 embryos (mean = 16.8). Our three pregnant females from James Bay, Québec (taken 4-15 June) contained 35 (65cm SVL), 28 (55.6cm SVL) and 18 (60.4cm SVL) embryos. Litters born to females taken in September of previous years at the Long Lake study area averaged 31

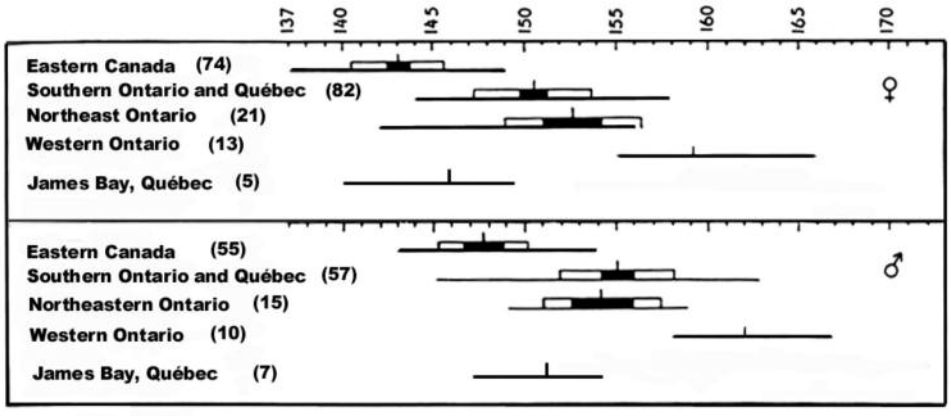

FIGURE 12. Comparison between the number of **ventral** scales for Garter Snakes in Eastern Canada (*T. s. pallidulus*), South Ontario-Québec, and northeast Ontario (*T. s. sirtalis*) [Modified after Bleakney 1959] and our James Bay specimens from Québec and Long Lake (Horizontal line: range; white boxes: standard deviation; black boxes: twice the standard error of the mean; small vertical line: mean)

young (25 [born in captivity the next June], 37 [born 14-15 Sept.], 32 [born 16-17 Sept]). There is no evidence here for a small northern litter size.

The Garter Snake seems to be widespread in the study area, both in rocky and sandy areas in Québec, and in Clay Belt areas like Long Lake and north along the Ontario Northland tracks to James Bay in Ontario. According to local people, there are populations of snakes on some islands in Rupert Bay. The species was also found on Jacob Island just north of Rupert Bay (Ouellet et al. 2009). The huge volumes of broken rock fill at the culverts where we found 70% (16/23) of our snakes (or shed skins) in Québec may provide hibernacula, but all we can say about hibernation in the Clay Belt is that snakes are found at Long Lake in both May and September.

Discussion

The herpetofauna of the area we surveyed, along about 1 200 km of roads, is remarkably uniform. We found only one significant northern range limit (Two-lined Salamander), and the Boreal Chorus Frog is the only species regionally restricted to a habitat that is not widespread in the area. Four species have their known northern range limit near the northern limit of the study area (Blue-spotted Salamander, Spring Peeper, Leopard Frog and Garter Snake).

The apparent declines of *Lithobates pipiens* and *Lithobates septentrionalis* in Ontario are troubling. These species need dedicated monitoring by local naturalists or a concerted season-long survey of all the sites where they have been found in the past (e.g., Table 7), and other sites with favourable habitat features (e.g., Schueler, 2000*).

James Bay thrusts subarctic conditions far south into central North America, so that the transition between subarctic and warm temperate conditions is perhaps as steep in the 1400 km between Moosonee and Baltimore as it is anywhere. This partial barrier, and the contrasted conditions east and west of the Bay, means that phylogenetic contacts between eastern and western stocks are expected here, imposed on the general pattern of postglacial northward dispersal from southern refugia (Cook 1983). Several species have been studied in sufficient detail to make this possible:

Ambystoma laterale seems homogeneous through the region (J. P. Bogart, *in litt.*), but hybrids with *Ambystoma jeffersonianum* (LLJ and LJ genotypes) were collected in Abitibi in 2005, just south of the area studied here (J.-F. Desroches and J. P. Bogart, personal observation). Genetic evaluation of some James Bay specimens would be needed to evaluate the status of the species in this area.

Eurycea bislineata is of Appalachian origin, and may be restricted to rocky watersheds in James Bay and absent from most of the Clay Belt.

Cook (1983) found the easternmost morphological signs of intergradation with the prairie Toad *Anaxyrus americanus hemiophrys* in samples from Whitetop Creek and Moosonee, suggesting early dispersal though grassland habitats of the dewatered Lake Agassiz basin and other post-glacial grasslands.

Austin et al. (2002) concluded that the entire Boreal Forest west to Manitoba was populated by *Pseudacris crucifer* from refugia east of the Appalachians, and that western lineages of this species had not spread very far north, perhaps because they had been held south by grassland habitats of the Prairie Peninsula and on the dewatered Lake Agassiz which provided eastward corridors for grassland species.

Pseudacris maculata, on the other hand, reached Quebec as a western incursive along the shores of Hudson and James bays, though it is also found in the interior of western Ontario (perhaps having spread through grasslands on the dewatered bed of Lake Agassiz). Moriarty and Cannatella (2004) and Moriarty

Lemmon et al. (2007) showed that Saint Lawrence and south-central Ontario populations with *P. triseriata* morphology are genetically *P. maculata*, and must have re-evolved the *triseriata* morphology from Boreal ancestors that spread through the northern grasslands now represented by the shores of James Bay (Moriarty, personnal communication).

The boundary between eastern and western populations of *Lithobates sylvaticus*, which is marked by hints of non-interbreeding and indirect evidence of morphological difference, has not been mapped north of the vicinity of Quebec City (Lee-Yaw et al. 2008). Andrée-Michelle D'Aoust-Messier is surveying this species around James Bay to map the distribution of genotypes and to see how they are associated with the tadpole tooth formula or with morphological traits of adults (see D'Aoust-Messier and Lesbarrères 2010*).

In a mtDNA study of geographic variation in *Lithobates pipiens* throughout its range, only a 1971 sample from Attawapiskat contained both eastern and western haplotype specimens (Hoffman & Blouin 2004). This western influence on the west side of James Bay was perhaps foretold by Schueler's (1973) noting colour differences between frogs from Attawapiskat and Moosonee, but Schueler (1982) found only intermediate values of the east-west variable SPOTTING, and high values of the aquatic-habitat variable GLANDS around the Bay, without enough samples west and south of the Bay to detect a stepped cline that might have reflected the ranges of the two haplotypes in Ontario.

Our study area is supposed to span the junction between *Thamnophis s. sirtalis/pallidulus*, at the south end of the Bay (Bleakney 1959; Cook 1984; Conant and Collins 1998). In New York and New England, this subspecies difference corresponds to the "eastern" and "maritime" lineages of Rye (2000). In western Ontario Rye found that the change in colour pattern (*Thamnophis s. sirtalis/parietalis*) occurred far west of the contact zone between the "eastern" and "western" genetic lineages, and that there was an eastward cline of decreasing ventral count that was not stepped or interrupted at the contact between the lineages (Rye 2000, figure 3.13).

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