

Survey of Amphibian Breeding Habitats in Theodore Roosevelt National Park, North Dakota

A report to:

Theodore Roosevelt National Park
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January 2002

Submitted by:

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Abstract

To provide baseline information for a long-term monitoring program in Theodore Roosevelt National Park, we surveyed 68 upland wetlands and twelve 1 km sections of the Little Missouri River for presence of breeding populations of amphibians between 01 May and 29 June 2001. Future changes in occupancy by each species will be used to determine status and trends of amphibians in the park. Wetlands were searched for evidence of reproduction (i.e., embryos or larvae) using visual encounter surveys. Callings surveys were used on 2 evenings following a rainstorm to facilitate detection of vocal species. The boreal chorus frog (*Pseudacris maculata*) was the most common amphibian in the park, followed by the Woodhouse's toad (*Bufo woodhousii*), tiger salamander (*Ambystoma tigrinum*), northern leopard frog (*Rana pipiens*), and Plains spadefoot (*Spea bombifrons*). Breeding populations of the Great Plains toad (*Bufo cognatus*) have not been previously documented in Theodore Roosevelt National Park and were not found during this study. Results of this survey and of previous amphibian surveys in the park are summarized in a series of species accounts. Locality information for amphibians collected or recorded during previous surveys in the park is summarized in an appendix. Incidental observations of reptiles from the park are also included.

Background and Purpose

Status of amphibians in Theodore Roosevelt National Park and the surrounding northern Great Plains is poorly known. The most recent survey of amphibians in the park was in the late 1970s (Hansen et al. 1980 [published as Hopkins 1983]). Prior to that, Seabloom et al. (1978) studied the distribution of amphibians in southwest North Dakota, and Wheeler and Wheeler (1954) studied the distribution of amphibians in the North Dakota badlands, including Theodore Roosevelt NP. Since these previous surveys, there has been increased recognition of known and suspected declines of amphibians in many parts of North America, including losses in relatively pristine areas such as National Parks and wilderness areas (Blaustein and Wake 1990). For example, the northern leopard frog (*Rana pipiens*) is suspected to have declined throughout much of the northern Great Plains (Roberts 1981, Seburn 1992). In response to these declines, a national effort identified as the Amphibian Research and Monitoring Initiative (ARMI; <http://monitoring2.er.usgs.gov/armi/index.cfm>) was launched in 2000 to determine the status and trends of amphibian populations on Department of Interior (DOI) lands nationally and to provide information useful in determining causes of declines.

The purpose of this study was to inventory the amphibian community in Theodore Roosevelt NP and to provide baseline information for future research and monitoring efforts. Our goal was to systematically search all potential habitats for evidence of amphibian breeding. When this was not possible, we used methods that provide statistical inference to areas of the park that were not surveyed so that future changes in the proportion of sites used for breeding by each species can be used to assess population trends (Green 1997). To our knowledge, this is the most complete survey to date of

amphibian breeding habitats in the park. Through surveys of Theodore Roosevelt NP and other public lands in the northern Great Plains, we hope to gain additional information on amphibians whose distribution is uncertain and to establish whether there is a broad pattern of amphibian decline in the region.

Methods

Study Area

Theodore Roosevelt NP is a 28, 509 ha reserve in the badlands of southwest North Dakota. The park is divided into 2 units: the South Unit (18, 680 ha) located at Medora in Billings County, and the North Unit (9, 741 ha) approximately 60 km north in McKenzie County. The remaining acreage is at the 88 ha Elkhorn Ranch, which is situated between the two units on the Little Missouri River. Topographic relief varies widely within the park, but elevation of the Little Missouri River, which flows northward through both units, decreases only 7 m between the South and North units (683 m vs. 676 m). Approximately 23% of the South Unit (4253 ha) and 81% of the North Unit (7855 ha) are designated wilderness areas. The land surrounding the park is a combination of cultivated farmland and mixed-grass prairie managed by the US Forest Service Little Missouri National Grassland.

Theodore Roosevelt NP has a semi-arid continental climate, typified by long, cold winters and short, warm summers. The badlands region averages approximately 38 cm of precipitation annually, much of it coming in the form of rain from April to July (Jensen 1972). Other than the Little Missouri River, permanent water bodies are scarce. The park has increased the amount of permanent water by developing numerous springs

and wells for large mammals. A storm that lasted >48 hours from 12-14 June delivered approximately 10 cm of rain and filled many of the seasonal wetlands in the park.

Site Selection

Potential amphibian breeding habitats in the South and North units were identified with National Wetlands Inventory (NWI), US Geological Survey 7.5' topographic maps, and National Park Service maps of developed springs and wells. We found many additional wetlands that were not mapped, often by tracking down the source of calling amphibians. Wetlands found incidentally, as well as 3 wetlands (2 near the South Unit, 1 near the North Unit) on the Little Missouri National Grassland, were included in the survey. All water bodies not directly created by the Little Missouri River (hereafter referred to as "upland wetlands") were considered potential amphibian breeding habitats and treated as discrete sites. Most mapped sites that contained water were surveyed at least once, but wetlands on private in-holdings in the North Unit and a few developed wells were not surveyed.

Water bodies within the Little Missouri River floodplain were sampled differently than upland sites. We discovered that maps did not accurately represent the distribution of wetlands near the river due to the dynamic nature of its floodplain. Rather than survey the entire length of river in both park units, we divided the river into sixteen 1 km sections in the South Unit and seventeen 1 km sections in the North Unit. Eight sections were then selected randomly in each of the park units for surveys. All wetlands within the selected river sections were surveyed and the entire section was considered a single site in the analysis because, in most cases, the number and location of wetlands within the

floodplain will change over time, preventing repeat visits to the exact sites. Four of the randomly selected river sections in the North Unit were not surveyed, however, because heavy rain caused the river to rise rapidly and temporarily eliminated most riverine wetlands the week that we planned to survey the area.

A total of 35 upland wetlands and 32 riverine wetlands (in eight 1 km river sections) in the South Unit, and 33 upland wetlands and 8 riverine wetlands (in four 1 km river sections) in the North Unit were surveyed (Figures 1 & 2, Appendices 1 & 2). Thirteen and 17 upland wetlands were surveyed at least two times in the South and North units, respectively, and 5 riverine wetlands in the South Unit were surveyed twice (Appendix 1).

Survey Methods

Surveys were conducted between 01 May and 29 June 2001. Amphibian occurrence was documented using visual encounter surveys (VES) and calling surveys (Heyer et al. 1994). Visual encounter surveys are widely used for amphibians and are effective in most habitats and for most lentic-breeding species. Surveys were conducted by a pair of workers slowly walking the perimeter or near-shore area of wetlands while searching for amphibians. Dip nets were used in areas with vegetation or where water clarity was poor. We recorded all life history stages (eggs, larvae, juvenile, or adult) of the taxa observed; however, detection of evidence of breeding activity (presence of eggs or larvae) was emphasized so that future surveys could use changes in the number and distribution of breeding sites for each species to assess status and trends. Data collected yields information on the presence of a species but does not establish absence, nor does it

give reliable estimates of abundance. Incidental observations of reptiles were also recorded during all surveys. Location of all sampling sites was georeferenced with a GPS using horizontal coordinate information referenced to the North American Datum of 1927.

Nighttime calling surveys were used to facilitate detection of potential breeding sites of species with less predictable breeding. The Great Plains toad (*Bufo cognatus*) and Plains spadefoot (*Spea bombifrons* [= *Scaphiopus bombifrons*]) are explosive breeders that may only be active for brief periods following warm rains. Calling surveys were conducted on the evenings of 12-13 June following a significant rainstorm. Calling stations were located at road pullouts, bridges, and mile-markers to provide a template for future surveys. We recorded data from 21 calling stations in the South Unit and 14 stations in the North Unit (Appendix 3a, 3b). Presence of calling does not provide evidence of reproduction because males may be unsuccessful at attracting mates, but it can provide information on activity patterns and general distribution. Visual encounter surveys of habitats where amphibians were heard calling was used to confirm breeding at some locations.

Research was conducted under permit THRO-2001-SCI-0005. All voucher specimens (Appendix 1) will be deposited at the National Museum of Natural History, Washington DC, in the Biological Survey vertebrate collection curated by the US Geological Survey. Cataloging will comply with all relevant National Park Service policy.

Results and Discussion

All 6 amphibians known from southwest North Dakota were found during our survey. Upland wetlands were more productive for detecting multiple species because riverine wetlands were used for breeding only by the Woodhouse's toad (*Bufo woodhousii*). Except for the Great Plains toad (*Bufo cognatus*) and Plains spadefoot (*Spea bombifrons*), all species had begun breeding by the first week in May. However, breeding phenology was highly variable within species and among wetlands. We suspect the breeding season of the tiger salamander (*Ambystoma tigrinum*), Woodhouse's toad (*Bufo woodhousii*), boreal chorus frog (*Pseudacris maculata*), and Northern leopard frog (*Rana pipiens*) began later than normal this year due to a cold weather in early April. Wheeler (1954) suggested that breeding activity in Theodore Roosevelt NP normally begins in early April, but during the first week in May we found only recently hatched larvae and embryos, and breeding had not yet occurred at most sites where we found larvae later in the spring.

Inference from our study is limited to upland wetlands and the Little Missouri River within the two units of Theodore Roosevelt NP. We did not attempt to inventory the numerous small streams in the park. We occasionally heard amphibians calling from streams or saw larvae in them, but given the often rapid changes in water flow, we were unsure whether these habitats represent viable breeding habitats or whether larvae are routinely flushed with each rainstorm. Similarly, we know some populations of *B. woodhousii* tadpoles in riverine wetlands were lost when the river level increased after the heavy rain received from 12-14 June. Surveys later in the summer would be required to determine the level of recruitment from the river and streams in the park.

Species Accounts

TIGER SALAMANDER (*AMBYSTOMA TIGRINUM MELANOSTICTUM*) - Three subspecies of tiger salamander are found in North Dakota (Wheeler and Wheeler 1966), but only the blotched tiger salamander (*Ambystoma tigrinum melanostictum*) inhabits the southwest part of the state. Previous surveys in Theodore Roosevelt NP suggest *A. tigrinum* is not abundant (Wheeler and Wheeler 1966, Hansen et al. 1980). We found evidence of reproduction by salamanders in 7 upland wetlands in the South Unit and in 3 upland wetlands in the North Unit, which are apparently the first reported breeding sites in the North Unit (Table 1). Few larvae were observed at any of the breeding sites. Four of the breeding sites in the South Unit were springs or wetlands developed by the park as a water source for large mammals. Adults were found in 4 upland wetlands, including 1 site where larvae were not found. *A. tigrinum* was never observed in a riverine wetland.

Adult *A. tigrinum* migrate to breeding ponds early in the spring and are commonly the first amphibian to breed, often while ice still covers much of the surface (Wheeler and Wheeler 1966). We estimate that salamanders had begun breeding by mid-April this year because we found several recently hatched eggs and nearly-hatched embryos during the first week of May. Of the 10 sites where we found reproduction, eggs or small larvae were found in 9 of them during the first survey in early or mid-May. Where we saw eggs, they were laid singly rather than in clusters.

We surveyed 2 sites where *A. tigrinum* larvae had previously been collected and deposited in a museum (Appendix 4). Hansen et al. (1980) collected *A. tigrinum* larvae from Lone Tree Spring in the South Unit in 1978. We surveyed this site on 03 June and

no amphibians were found (site SU-32; Appendix 1). G.C. Wheeler collected *A. tigrinum* larvae from an artificial pond in 1954 (University of North Dakota, Biology Department museum). We designated this site as SU-16, which contained *A. tigrinum* on 03 May and 02 June (Appendix 1). All other collections of *A. tigrinum* (and all other amphibians collected from the park) were of adults, usually collected from the roadside, or larvae from unidentified wetlands (Appendix 4).

GREAT PLAINS TOAD (*BUFO COGNATUS*) - *Bufo cognatus* is distributed state wide, but previous investigators have reported few encounters with this species in Theodore Roosevelt NP. Wheeler collected 3 adults in the South Unit in the 1950s, compared to >30 of the Plains spadefoot (*Spea bombifrons*; University of North Dakota, Biology Department museum records), a species with similar activity patterns (Appendix 4). Hansen et al. (1980) encountered *B. cognatus* only once from 1978 to 1979. Prior surveys have not documented presence of breeding populations in the park.

B. cognatus is typically a late-season breeder that is active only after warm rains. Its ephemeral activity and use of small, temporary wetlands that are less likely to be mapped (and therefore surveyed) make calling surveys a potentially more efficient method for detection of presence than VES at wetlands. However, we did not detect *B. cognatus* on 2 evenings of calling surveys following a heavy rainfall (Appendix 3a, 3b). Our only detection of this species was an incidental sighting of an adult female near the mouth of Knutson Creek in the South Unit on 26 June.

We suspect *B. cognatus* is more common in the region than our survey indicates. Additional surveys in the grasslands surrounding the park may be more productive for

locating this species. Ideally, calling surveys and surveys of temporary wetlands should be conducted in June and July after rainfall events.

WOODHOUSE'S TOAD (*BUFO WOODHOUSII WOODHOUSII*) – Hansen et al. (1980) reported that *Bufo woodhousii woodhousii* was widespread and the most frequently encountered amphibian in Theodore Roosevelt NP. Our data also indicates that this species is common and widespread throughout the park. Evidence of reproduction was found at 13 of 35 upland wetlands and 6 of 8 river sections in the South Unit, and 5 of 33 upland wetlands and 3 of 4 river sections in the North Unit (Table 1). Adults were found at only 8 sites (6 upland, 2 riverine), but 12 adults were found on the road in the South Unit during nighttime calling surveys on 13 June (Appendix 3a).

We estimate breeding had begun within 1 week of our surveys in early May, when we found several egg strings with little to no elongation of the embryos. Calling by males during the first week of surveys was sparse, but by mid-May large choruses were heard that continued for many hours and numerous fresh egg strings were found, especially in riverine wetlands. By mid-June breeding activity seemed to have diminished, however, because we heard only 2 individuals during nighttime calling surveys on 13-14 June (Appendix 3a, 3b). On 16 June we returned to the waterbody (site SU-01) where we heard calling and found 6 male and 6 female *B. woodhousii*, with 2 pairs in amplexus. *B. woodhousii* eggs were present on 01 May in this site, which dried in early June and then filled again after the rainstorm of 12-14 June. The breeding season of *B. woodhousii* may extend over several months (Wheeler and Wheeler 1966), so it is likely that breeding continues into July if the area receives enough rain.

BOREAL CHORUS FROG (*PSEUDACRIS MACULATA*) – Previous researchers reported that *Pseudacris maculata* is uncommon in southwest North Dakota (Seabloom et al. 1978) and the park (Hansen et al. 1980). However, it was the species we encountered most frequently. We are not sure why previous surveys rarely encountered this species, but suggest that these different results may be due to timing and methodology of surveys. Seabloom et al. (1978) and Hansen et al. (1980) focused on multiple vertebrate species, and may not have emphasized detection of amphibian larvae.

Male *P. maculata* reportedly began breeding choruses at least 1 week prior to our survey. Because they commonly called diurnally, we were able to use their calls to locate many unmapped wetlands. We found evidence of reproduction in 10 of 35 upland wetlands in the South Unit and 18 of 33 upland wetlands in the North Unit (Table 1). Adults were found or heard calling in 22 upland wetlands in the South Unit and 26 upland wetlands in the North Unit. *P. maculata* was never found in wetlands along the river. The breeding season of *P. maculata* extended at least through mid-June, when it was heard at 7 of 21 calling stations in the South Unit and 11 of 14 calling stations in the North Unit after a rainstorm (Appendix 3a, 3b). Fresh egg masses and recently hatched tadpoles were seen in some wetlands after this storm, and like *B. woodhousii*, this species probably continues to breed after rainstorms in July.

NORTHERN LEOPARD FROG (*RANA PIPIENS*) - *Rana pipiens* is reportedly common and widespread in North Dakota (Wheeler and Wheeler 1966). Seabloom et al. (1978) found *R. pipiens* was common in southwest North Dakota wherever water was present, and

Hansen et al (1980) reported that it was distributed throughout Theodore Roosevelt NP, but usually only near permanent water bodies and wildlife watering tanks. Relative to previous studies, we encountered *R. pipiens* less frequently than expected in the park. We found evidence of breeding at 2 sites in the South Unit and at 5 sites in the North Unit (Table 1). We did not find evidence of reproduction in any riverine wetlands. Adults were found at 4 sites in the South Unit and 5 in the North Unit.

Breeding began shortly before our initial surveys during the first week in May. On 04 May, we found egg masses at 2 sites in the North Unit (NU-01 and NU-02) that had not yet hatched or were in the process of hatching. At 4 of the remaining 7 sites where we found reproduction, however, egg masses or tadpoles were not found on the first visit in early or mid-May, indicating variable timing of breeding among populations.

We suspect the small number of breeding sites found was a result of the available habitat. Most of the sites available waterbodies were either temporary wetlands or wetlands with unpredictable hydroperiods associated with the Little Missouri River; these wetlands may not be preferred breeding habitats. Supplementing our survey of Theodore Roosevelt NP with additional sites in the grasslands surrounding the park may be more productive for determining the status of *R. pipiens* in the region.

PLAINS SPADEFOOT (*SPEA BOMBIFRONS* [= *SCAPHIOPUS BOMBIFRONS*]) - In North Dakota, *Spea bombifrons* is most common in the area south and west of the Missouri River (Wheeler and Wheeler 1966). Similar to *Bufo cognatus*, it is an explosive breeder that becomes active only after warm rains. Extensive collections of *S. bombifrons* were made in the South Unit by G.C. Wheeler in the early 1950s (University of North Dakota,

Biology Department museum records; Appendix 4), but Hansen et al. (1980) recorded only one observation of this species during the summers of 1978-1979.

Our first detections of this species were made using calling surveys on 13-14 June. We heard males calling at 11 of 21 stations in the South Unit and at 10 of 14 stations in the North Unit (Appendix 3a, 3b). This is only the second record of *S. bombifrons* in the North Unit (Tinkham 1953). We used information from the calling surveys to locate 3 breeding sites in the South Unit (Table 1). All breeding sites were temporary upland wetlands that filled from the heavy rainfall that triggered breeding, and all contained eggs but no tadpoles when they were checked on 15-16 June. *S. bombifrons* eggs hatch in approximately 48 hours and tadpoles require approximately 40 days to metamorphose (Wheeler and Wheeler 1966), so the absence of tadpoles indicates that breeding had just begun at these sites. Even though we found few breeding sites, based on the number and wide distribution of adults heard calling, *S. bombifrons* does not seem rare in either unit of Theodore Roosevelt NP.

Reptiles

Six species of reptiles were observed in Theodore Roosevelt NP during our survey. Our methods are not designed for detecting reptiles, so these observations should be considered incidental and likely do not reflect the true abundance of any species that currently occupies the park.

Western painted turtles (*Chrysemys picta bellii*) were observed in the Little Missouri River in the South Unit (river site 4f; Appendix 1) on 30 May and in Knutson Creek in the South Unit on 27 June. An eastern yellow-bellied racer (*Coluber constrictor*

flaviventris) was seen at site NU-13 on 29 June, and at least one other was seen in the North Unit in mid-May. The Plains garter snake (*Thamnophis radix*), found at 7 sites, was the reptile we encountered most frequently (Appendix 1). It was active the entire period we conducted our surveys.

The Plains western hognose snake (*Heterodon nasicus nasicus*), bullsnake (*Pituophis catenifer sayi*), and prairie rattlesnake (*Crotalus viridis viridis*) were not seen at any wetlands but were observed occasionally while hiking between sites, dead on the road, or by other incidental observations. Neither of the lizards native to the park was seen. The badlands area is the eastern limit of the range in North Dakota for both the pigmy short-horned lizard (*Phrynosoma douglasii*) and northern prairie lizard (*Sceloporus graciosus graciosus*), and they are distributed patchily throughout the area (Wheeler and Wheeler 1966, Seabloom et al. 1978). However, we are unaware of any records of *P. douglasii* from the North Unit or of *S. graciosus* from the South Unit. We suspect that we missed the peak of reptile activity, however, because on a 2-day trip to the park in September 2000, we observed more *C. constrictor*, *T. radix*, and *P. catenifer* on the roads and while hiking to wetlands than during any single week in May or June 2001. Additional searches specifically for reptiles would probably confirm that *P. douglasii* and *S. graciosus* are present in both park units.

Future Work

We plan to survey Theodore Roosevelt NP again in 2002, and hope to establish the park as an area for long-term monitoring and applied research under ARMI. Using the survey from 2001 as a baseline, we will begin monitoring breeding populations to

determine if there is a trend in the proportion of sites occupied by species. We hope to expand our work into the Little Missouri National Grasslands so that data are collected from wetlands that are more representative of the northern Great Plains. Surveys in the surrounding grasslands may increase encounters with *Ambystoma tigrinum*, *Bufo cognatus*, and *Rana pipiens*. However, it is unlikely even with a long-term monitoring program that we will be able to determine trends of *B. cognatus* or *Spea bombifrons* due to their unpredictable activity and habitat use.

We anticipate repeating surveys of more wetlands within a short time period (e.g., 2 visits per site per work week) so that we can estimate time-specific detection probabilities for each species. Collection of data in this manner will allow us to control for effects of variable breeding phenology of different species and among wetlands, and subsequently, to estimate the proportion of the area occupied by breeding populations of each species (MacKenzie et al., In Press). We also plan to begin applied research, such as investigating changes in breeding phenology associated with weather. The beginning of the field season will depend greatly upon weather, but we expect most of our work will again be conducted in May and June.

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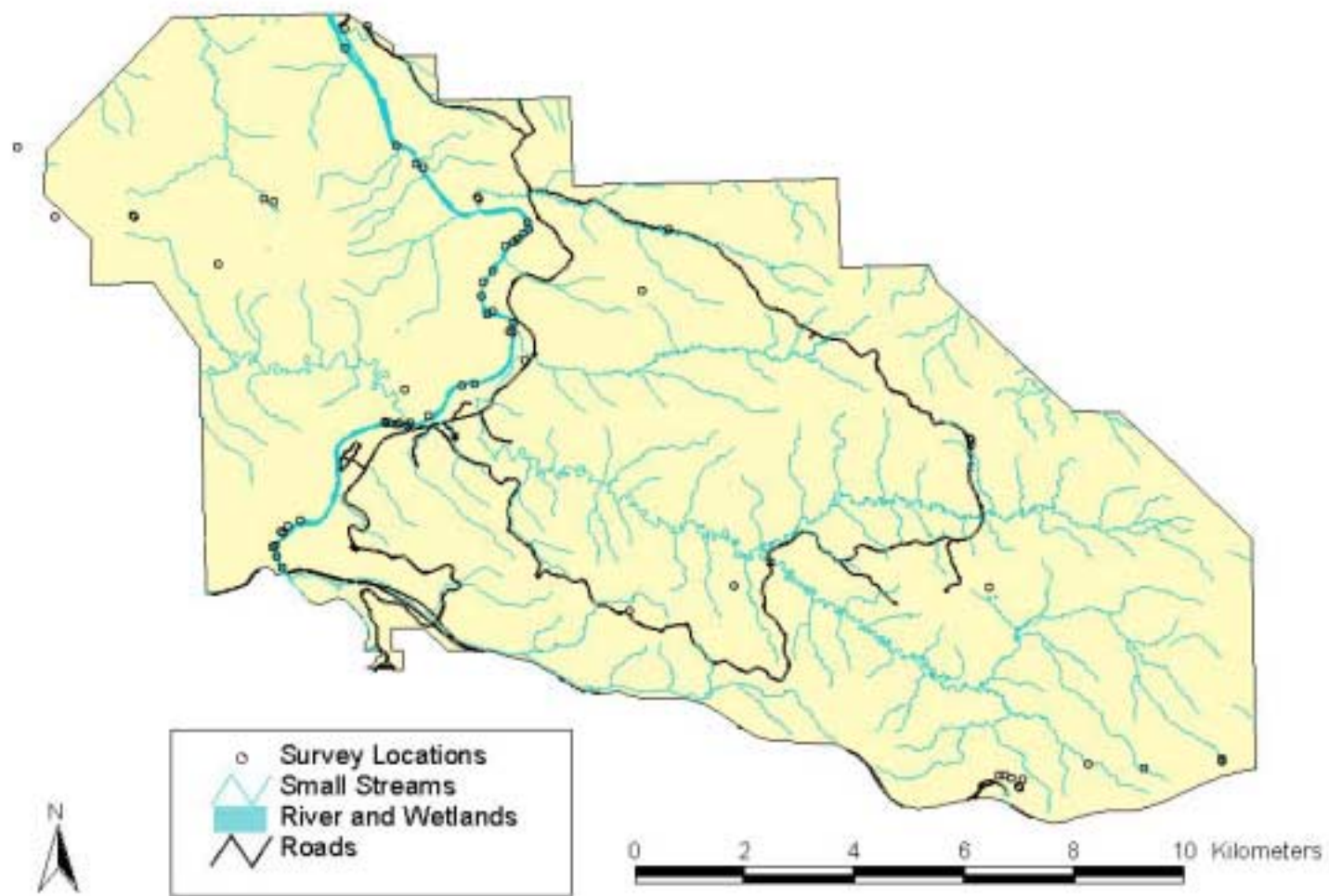


Figure 1. Locations of waterbodies surveyed for amphibians in the South Unit of Theodore Roosevelt National Park and Little Missouri National Grassland, 2001.

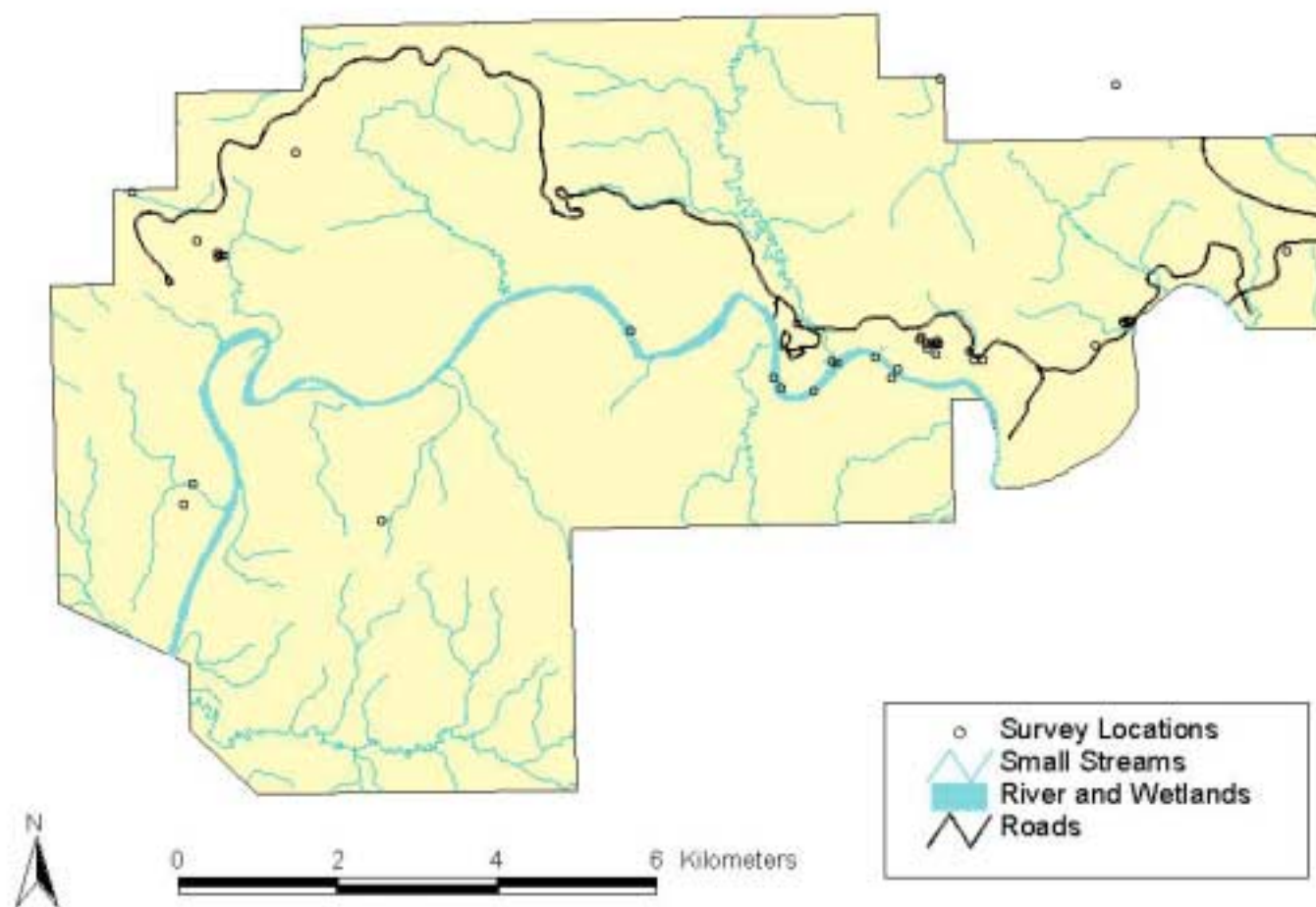


Figure 2. Locations of waterbodies surveyed for amphibians in the North Unit of Theodore Roosevelt National Park and Little Missouri National Grassland, 2001.

Table 1. Number of upland wetlands and river sections in Theodore Roosevelt National Park where each species was found using visual encounter surveys. The “larvae” columns include presence of eggs and larvae, and the “adults” columns include presence of juveniles and adults.

Species	South Unit				North Unit			
	upland wetlands		river sections		upland wetlands		river sections	
	(n = 35)		(n = 8)		(n = 33)		(n = 4)	
	larvae	adults	larvae	adults	larvae	adults	larvae	adults
<i>Ambystoma tigrinum</i>	7	2	0	0	3	2	0	0
<i>Bufo cognatus</i>	0	0	0	0	0	0	0	0
<i>Bufo woodhousii</i>	13	5	6	1	5	1	3	1
<i>Pseudacris maculata</i>	11	22	0	0	18	26	0	0
<i>Rana pipiens</i>	2	2	0	2	5	6	0	0
<i>Spea bombifrons</i>	3	0	0	0	0	0	0	0

Appendix 1.

Locations of upland and riverine wetlands surveyed in the South and North units of Theodore Roosevelt National Park, number of times each wetland was surveyed, and species found using visual encounter surveys. The number and letter of riverine wetlands refers to the river section and subsite. An “(R)” after the four-letter species code (see below for key) indicates evidence of reproduction was found, and an “*” indicates voucher specimens were collected.

Site	UTM East	UTM North	Survey Occasions	Species Detected
South Unit				
Upland				
1	617566	5204604	3	BUWO (R), PSMA, THRA
2	616866	5197664	2	AMTI (R)*, PSMA (R)
3	623958	5194452	1	PSMA
4	623930	5194462	1	0
5	624002	5194589	1	PSMA (R)
6	623679	5194659	1	PSMA (R)
7	623579	5194678	2	PSMA
8	623814	5194620	2	AMTI (R), PSMA (R)
9	625194	5194879	1	AMTI (R), PSMA (R)
10	626211	5194796	1	PSMA
11	627643	5194934	2	AMTI (R)
12	627631	5194975	2	PSMA (R)
13	611675	5208254	1	0
15	614970	5202222	2	AMTI (R), BUWO (R), PSMA
16	618769	5198129	2	AMTI (R), BUWO (R), PSMA (R)
17	614095	5205184	2	BUWO (R)
18	614122	5205164	1	BUWO (R)
23	607853	5204849	1	PSMA (R)*
24	607821	5204859	1	PSMA (R)
25	610519	5199114	2	BUWO (R), PSMA (R), THRA
26	612766	5201698	3	BUWO (R), PSMA
27	610655	5199219	4	BUWO (R)*, RAPI (R)*, THRA
28	617100	5203497	1	AMTI (R), BUWO (R)
31	612083	5208316	1	BUWO (R)
32	609366	5203975	1	0
33	610386	5205117	1	BUWO (R)
34	610204	5205162	1	BUWO (R), RAPI (R)
35	619418	5198553	1	PSMA
36	613678	5200824	2	PSMA, SPBO (R)
37	623048	5200816	1	PSMA (R)
38	623073	5200781	1	PSMA
39	623061	5200689	1	PSMA, SPBO (R)
40	623416	5198083	1	PSMA, SPBO (R)
LMNG 2	605724	5206113	1	BUWO (R)
LMNG 3	606421	5204851	1	0
Riverine				
R 0a	610364	5198831	1	0
R 0b	610576	5199082	1	BUWO (R)

Appendix 1 continued

R 0c	610884	5199312	1	BUWO (R)
R 0d	610410	5198845	1	0
R 0e	610435	5198643	1	0
R 0f	610533	5198449	1	0
R 4a	612427	5201091	1	0
R 4b	612486	5201073	1	0
R 4c	612628	5201054	1	0
R 4d	612838	5201025	1	0
R 4e	613207	5201201	1	BUWO (R)
R 4f	612886	5201082	2	BUWO (R), RAPI, CHPI, THRA
R 4g	612678	5201074	1	0
R 4h	612420	5201101	1	0
R 5a	613826	5201767	1	0
R 5b	614035	5201807	1	0
R 7a	614741	5202743	1	BUWO (R)
R 7b	614757	5202917	2	BUWO (R)
R 7c	614372	5203115	1	BUWO (R)
R 7d	614175	5203395	1	BUWO (R)
R 7e	614279	5203057	1	BUWO (R)
R 7f	614687	5202747	1	BUWO (R)
R 8a	614372	5203859	1	BUWO (R)
R 8b	614185	5203649	1	0
R 9a	614758	5204384	2	BUWO (R)
R 9b	614839	5204433	1	BUWO (R)
R 9c	615030	5204607	2	BUWO (R), RAPI
R 9d	615017	5204750	2	0
R 9e	614921	5204545	1	BUWO (R)
R 9f	614608	5204302	1	0
R 12a	612630	5206140	1	0
R 12b	612978	5205805	1	BUWO (R)
R 12c	613117	5205720	1	BUWO (R)
R 15a	611693	5207910	1	0
North Unit				
Upland				
1	617424	5270606	1	AMTI (R), BUWO (R), PSMA (R), RAPI (R)
2	617324	5270339	1	BUWO (R), PSMA (R), RAPI (R)
3	627145	5272262	2	PSMA (R)
4	626751	5272389	1	PSMA (R)
5	626719	5272365	2	PSMA (R), RAPI (R)*, THRA
6	626755	5272356	1	PSMA
7	626679	5272381	1	PSMA (R)
8	626623	5272350	1	PSMA (R), RAPI, THRA
9	626618	5272292	1	PSMA
10	626727	5272232	1	PSMA
11	627210	5272157	2	0
12	627312	5272149	2	PSMA
13	626790	5275680	2	AMTI (R), BUWO (R), PSMA (R), RAPI (R), COCO
14	631111	5273521	2	AMTI, PSMA, RAPI, THRA

Appendix 1 continued.

16	628721	5272345	2	PSMA (R)
17	629145	5272651	2	PSMA (R)
18	629166	5272627	2	PSMA (R)
19	629063	5272639	1	0
20	629117	5272649	2	PSMA (R)
21	617735	5273444	1	PSMA (R)*
22	617751	5273494	1	PSMA (R)
23	617812	5273459	1	PSMA (R)
24	617784	5273458	1	PSMA
25	617489	5273651	1	0
26	616668	5274255	2	AMTI (R), PSMA (R), RAPI
27	618714	5274758	1	0
28	629080	5272611	1	PSMA
29	626531	5272420	2	BUWO (R), PSMA (R), RAPI (R)
30	626543	5272454	1	0
31	625434	5272130	1	BUWO (R)
32	619797	5270140	1	0
36	624999	5272621	1	PSMA
LMNG 1	628972	5275599	2	PSMA (R), RAPI
Riverine				
R 10a	622912	5272516	1	0
R 14a	624789	5271811	1	BUWO (R)
R 14b	625190	5271758	1	BUWO (R)
R 14c	625496	5272123	1	BUWO (R)
R 14d	624698	5271925	1	BUWO (R)
R 15a	626175	5271933	1	BUWO (R)
R 15b	625969	5272189	1	BUWO (R)
R 16a	626241	5272035	1	BUWO (R)

AMTI = tiger salamander (*Ambystoma tigrinum*); BUWO = Woodhouse's toad (*Bufo woodhousii*); PSMA = boreal chorus frog (*Pseudacris maculata*); RAPI = northern leopard frog (*Rana pipiens*); SPBO = Plains spadefoot toad (*Spea bombifrons*); CHPI = painted turtle (*Chrysemys picta*); COCO = racer (*Coluber constrictor*); THRA = Plains garter snake (*Thamnophis radix*)
LMNG = site on Little Missouri River National Grasslands

Appendix 2. Sections of the Little Missouri River surveyed for amphibians in the South and North units of Theodore Roosevelt National Park, 2001. Section numbers refer to distance (km) of the beginning point of the section from the upstream border (south) of the park. See Appendix 1 for locations of wetlands within each river section.

Park Unit	River Section	Start Point	End Point	Start Point	End Point
		UTM East	UTM North	UTM East	UTM North
South	R 0	610520	5198390	610880	5199310
	R 4	612410	5207090	613440	5201350
	R 5	613440	5201350	615080	5202050
	R 7	614740	5202750	614180	5203410
	R 8	614180	5203410	614560	5204190
	R 9	614560	5204190	614900	5205070
	R 12	613230	5205630	612590	5206360
	R 15	611690	5207910	611470	5208310
North	R 10	622320	5273280	622930	5272500
	R 14	624780	5272120	625540	5272220
	R 15	625540	5272220	626240	5272040
	R 16	626240	5272040	626920	5271810

Appendix 3a.

Results from a calling survey in the South Unit of Theodore Roosevelt National Park on 13 June 2001. See below the table for a key to the four-letter species codes. Weather during the survey: light rain, no wind.

Location	Time	Species Heard	Notes
~300m above campground	2230	0	
picnic area	2240	>3 SPBO, >3 PSMA	
Paddock Creek bridge	2245	>SPBO	SPBO heard at 280° angle from bridge
Jones Creek bridge	2250	>3 PSMA	2 female (1 dead), 1 male BUWO on road
Beef Corral pullout	2300	0	
Wind Canyon turnout	2310	0	
above SU-01 near mile marker 23	2322	2 SPBO	SPBO near Jule's Creek; 3 BUWO on road; 2 BUWO calling
Jule's Creek bridge	2330	>SPBO	
mile marker 22	2335	>3 SPBO	distance and direction to SPBO unknown; 3 BUWO on road
mile marker 21, near Jones Creek Trail	2340	>3 SPBO	sounds like 100's of SPBO calling from S; 3 BUWO on road
mile marker 19	2349	SPBO	SPBO calling from a distance, from N
mile marker 18	2335	PSMA	
Buck Hill overlook	0005	>3 SPBO, > 3 PSMA	SPBO calling from valley to the E
mile marker 17, near Buck Hill turn	0010	>3 PSMA	
mile marker 16	0015	SPBO	calling from a distance
mile marker 15	0020	1-2 SPBO	SPBO nearby, maybe Paddock Creek
Paddock Creek bridge	0025	1-2 PSMA	PSMA calling nearby, downstream
mile marker 13	0030	>3 SPBO	SPBO calling from W; 1 SPBO on road near mile marker 14
mile marker 12	0035	0	
mile marker 10	0040	>3 PSMA	PSMA calling from NE of road
mile marker 8	0045	0	

BUCO = Great Plains Toad (*Bufo cognatus*); BUWO = Woodhouse's toad (*Bufo woodhousii*); PSMA = boreal chorus frog (*Pseudacris maculata*); SPBO = Plains spadefoot toad (*Spea bombifrons*)

Appendix 3b.

Results from a calling survey in the North Unit of Theodore Roosevelt National Park on 14 June 2001. See below for a key to the four-letter species codes. Weather during the survey: clear, light wind, 9 °C, rain stopped at ~ 1800 after 48 hours of rain (~10cm total).

Location	Time	Species Heard	Notes
Oxbow overlook	2200	>3 SPBO, >3 PSMA	SPBO from canyon toward river, barely audible
mile marker 13	2215	>3 SPBO, >3 PSMA	SPBO from N of road in tree line; PSMA N and S of road
mile marker 12	2225	>3 SPBO, >3 PSMA	SPBO and PSMA calling from ~100m away at 230°
mile marker 10	2233	>3 SPBO, >3 PSMA	SPBO and PSMA >200m away at 266°; 1 BUCO possibly heard
mile marker 9	2243	0	
mile marker 8	2251	0	50m from river bend overlook
mile marker 7	2255	>3 PSMA	calling from ~150m at 70°; juvenile bobcat on road
mile marker 6	2303	>3 PSMA	calling in distance at 354°, perhaps from Squaw Creek
mile marker 5	2310	SPBO, >3 PSMA	SPBO and PSMA along Squaw Creek
mile marker 4	2315	>3 SPBO	SPBO towards river
mile marker 3, small pool by guard rail	2322	1 SPBO, >3 PSMA	also heard SPBO calling from area of sites NU 5-10
mile marker 2	2343	>3 SPBO, >3 PSMA	SPBO 200-300m distant at 198°; PSMA in background
mile marker 1	2350	>SPBO, >3 PSMA	SPBO calling from near river; PSMA calling from near MM 2
Ranger Station, mile marker 0	0000	>3 SPBO, >3 PSMA	SPBO calling from ~300m at 226°; PSMA calling near river

BUCO = Great Plains Toad (*Bufo cognatus*); BUWO = Woodhouse's toad (*Bufo woodhousii*); PSMA = boreal chorus frog (*Pseudacris maculata*); SPBO = Plains spadefoot toad (*Spea bombifrons*)

Appendix 4.

Locations of amphibians previously collected or recorded from Theodore Roosevelt National Park. Some records are for multiple specimens of a species collected from the same area. Only records that provided locality information are listed. Numerous specimens in the University of North Dakota Biology Museum (UND BM; collected by G. C. Wheeler) lacked specific locality information. Wheeler (1954) provided locality information for some observations in the North Unit. These observations are either animals that were not collected or else did not have locality information with the museum record. Hansen et al. (1980) provided a dot-distribution map of animals observed during their study. Specimens collected during that study are housed at the University of Nebraska State Museum- Division of Zoology (UNSM-DZ). Animals that were not collected but were plotted on their map are referenced as Hansen et al. 1980.

Species	Park Unit	Date	Township, Range, Section	Source
AMTI	South	11-Jun-1954	T140N, R 101W, Sec. 21	UND BM
AMTI	South	11-Jun-1954	T140N, R101W, Sec. 21	UND BM ¹
AMTI	South	14-Jun-1954	T140N, R102W, Sec. 12	UND BM
AMTI	South	14-Jun-1954	T140N, R102W, Sec. 12	UND BM
AMTI	South	1978 or 1979	T141N, R102W, Sec. 33SE	Hansen et al. 1980
AMTI	South	1978 or 1979	T141N, R102W, Sec. 36SW	UNSM-DZ ¹
BUCO	South	not available	T140N, R101W, Sec. 13	UND BM
BUWO	South	15-Jun-1954	T140N, R102W, Sec. 11	UND BM
BUWO	South	22-Jul-1954	T140N, R102W, Sec. 10	UND BM
BUWO	South	1-Aug-1955	T140N, R101W, Sec. 28	UND BM
BUWO	South	24-Jun-1956	T140N, R102W, Sec. 01	UND BM
BUWO	South	30-Jun-1957	T140N, R101W, Sec. 19	UND BM
BUWO	South	not available	T140N, R102W, Sec. 12	UND BM
BUWO	South	1978 or 1979	T141N, R101W, Sec. 34NW	UNSM-DZ
BUWO	South	1978 or 1979	T141N, R101W, Sec. 35SE	Hansen et al. 1980
BUWO	South	1978 or 1979	T140N, R101W, Sec. 04	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R101W, Sec. 10	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R102W, Sec. 01SE	Hansen et al. 1980
BUWO	South	1978 or 1979	T140N, R102W, Sec. 11E	Hansen et al. 1980
BUWO	South	1978 or 1979	T140N, R10W, Sec. 12S	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R102W, Sec. 18S	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R101W, Sec. 21SE	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R101W, Sec. 20SE	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R101W, Sec. 22	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R101W, Sec. 27	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R102W, Sec. 10SE	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R102W, Sec. 10SE	UNSM-DZ
BUWO	South	1978 or 1979	T140N, R102W, Sec. 10SE	Hansen et al. 1980
PSMA	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
PSMA	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
PSMA	South	1978 or 1979	T140N, R100W, Sec. 32N	Hansen et al. 1980
RAPI	South	1978 or 1979	T140N, R100W, Sec. 32N	Hansen et al. 1980
SPBO	South	1978 or 1979	T140N, R12W, Sec. 11E	UNSM-DZ
SPBO	South	14-Jun-1954	T140N, R102W, Sec. 12	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM

Appendix 4 continued.

SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
SPBO	South	26-Jun-1955	T140N, R102W, Sec. 10	UND BM
BUCO	North	1978 or 1979	T148N, R 100W, Sec. 28NW	Hansen et al. 1980
BUWO	North	15-Jun-1954	T148N, R99W, Sec. 35	Wheeler 1954
BUWO	North	1969	T148N, R98W, Sec. 26	UNSM-DZ ²
BUWO	North	1978 or 1979	T148N, R99W, Sec. 31S	Hansen et al. 1980
BUWO	North	1978 or 1979	T148N, R99W, Sec. 31SE	Hansen et al. 1980
BUWO	North	1978 or 1979	T148N, R99W, Sec. 31SE	Hansen et al. 1980
BUWO	North	1978 or 1979	T148N, R99W, Sec. 31N	UNSM-DZ
BUWO	North	1978 or 1979	T148N, R99W, Sec. 32SW	UNSM-DZ
PSMA	North	15-Jun-1954	T148N, R99W, Sec. 35	Wheeler 1954
PSMA	North	1978 or 1979	T148N, R100W, Sec. 21S	UNSM-DZ
PSMA	North	1978 or 1979	T147N, R100W, Sec. 03S	Hansen et al. 1980
PSMA	North	1978 or 1979	T148N, R99W, Sec. 32S	UNSM-DZ
PSMA	North	1978 or 1979	T148N, R99W, Sec. 32SE	Hansen et al. 1980
RAPI	North	15-Jun-1954	T148N, R99W, Sec. 35	Wheeler 1954
RAPI	North	1978 or 1979	T148N, R100W, Sec. 21S	UNSM-DZ
RAPI	North	1978 or 1979	T148N, R100W, Sec. 21S	Hansen et al. 1980
RAPI	North	1978 or 1979	T148N, R99W, Sec. 32SE	Hansen et al. 1980
RAPI	North	1978 or 1979	T148N, R99W, Sec. 32SW	Hansen et al. 1980
RAPI	North	1978 or 1979	T148N, R100W, Sec. 27NW	Hansen et al. 1980

AMTI = tiger salamander (*Ambystoma tigrinum*); BUWO = Woodhouse's toad (*Bufo woodhousii*);

PSMA = boreal chorus frog (*Pseudacris maculata*); RAPI = northern leopard frog (*Rana pipiens*);

SPBO = Plains spadefoot toad (*Spea bombifrons*)

1. Larvae collected from an artificial pond or developed spring

2. Collected by G. Estland