

THE EXPLORERS CLUB – FLAG 112 REPORT
100 MILES OF WILD: NORTH DAKOTA BADLANDS TRANSECT



Photo Courtesy EcoFlight

WHEN: APRIL 22ND – MAY 02 2013

WHERE: NORTH DAKOTA BADLANDS (Theodore Roosevelt National Park, North Unit to South Unit)

DISTANCE: 270 MILES

WEBSITE: <http://www.adventurescience.ca/100milesowild>

BLOG: <http://100milesowild.wordpress.com/>

EXECUTIVE SUMMARY

NORTH DAKOTA AND PROJECT SPECIFICS

Geography: Borders Manitoba, Saskatchewan, South Dakota, Montana, and Minnesota

Population: ~685,000 (2011 Census data)

Area: ~17,000 square miles (19th largest state)

Cattle: 1,700,000 head

Transect: Theodore Roosevelt Park North - Theodore Roosevelt Park South

Landscape: Grassland, Coulee (Badlands), River Valley, Low Mountain

Key Wildlife: Deer, Sheep, Pronghorn, Bison, Elk, Coyote, Badger, Golden Eagle

Date: Spring (April 22 - May 02) 2013

Length: 100-mile trekking transect

Other: [Flag Expedition - the explorers club, Flag 112](#)

OUTLINE

On April 22nd, 2013 (Earth Day), Adventure Science launched its eighth scientific field expedition. It was also given the honour of carrying the explorers club Flag 112 due to its uniqueness, and scientific merit. Between April 22 and May 02, three two-person teams trekked 270 miles (generally off-trail), and gained over 47,000 ft. of elevation through the rugged North Dakota Badlands to observe and document the state of wilderness, and the current effect the Bakken oil boom is having on this inspiring landscape. A general summary of findings is as follows:

OIL DEVELOPMENT

- Oil wells and related installations were generally well maintained, and displayed minimal to no leakage
- Teams did not detect any H₂S leakage.
- Scoria topped roads were common throughout most of the transect.



Measuring a channel scour in Holocene sediment, with a bison leg bone in lower centre of image

RANCHING

- Teams found a generally ubiquitous presence of ranching during the expedition.
- Since it was calving season cattle were not in pasture and therefore not often directly observed by the teams.

NATURAL/CULTURAL

- A number of key animal species were observed, including Golden Eagle and Big Horn Sheep.
- Archaeological sites were identified along the banks of several creeks.
- Numerous historic farming, ranching, or mining implements were observed.
- Fossil trees limbs and trunks of Paleocene age were abundant throughout much of the surveyed area.

SENSE OF WILDERNESS

- Wild, undisturbed areas exist, but are fragmented and generally discontinuous.
- People/Vehicle encounters are rare at this time of year.
- Occasional vehicle or airplane sounds, most often the wind is all teams heard.
- Teams commonly felt that the evidence of ranching, visibility of roads, or presence of well pads detracted from the feeling of wilderness in this region.

CONCLUSIONS

- Repeat expedition in 5 years to compare change related increased well density.
- Creation of designated roadless areas would preserve some existing wilderness areas.¹
- Centralized planning of access roads focusing would minimize the spreading web and maintaining open corridors for the natural inhabitants of the region.
- Although politically difficult to achieve, the creation of a protected wilderness corridor linking the Theodore Roosevelt National Park North and South units would be ideal.

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¹ See the document "Prairie Legacy Wilderness" (2008) by the North Dakota Wilderness Coalition for some currently proposed roadless areas. This document and other information can be found at <http://badlandsconservationalliance.org/?id=37&page=Wilderness>.

Introduction and Rational for Project:

North Dakota is a vast and wild state that is currently facing a significant land use challenge. Until recently, the State was best known for its wide-open spaces, ranching and agriculture. The wilderness of the internationally famous Badlands of North Dakota inspired a young Theodore Roosevelt, reeling from the deaths of his mother and wife. As President, Roosevelt left a legacy of conservation, establishing five national parks, creating the U.S. Forest Service, and signing into law the Antiquities Act. The state has the 4th lowest population density in the U.S., with less than 10 people per square mile. North Dakota has a long history of progressive, independent, self-sufficiency, and is the homeland of several Native American Tribes that still live there today. The *100 Miles of Wild* project has a simple aim: discover first-hand the condition of the “wilderness” that inspired Roosevelt’s effort to preserve wilderness for all Americans and the World.

Adventure Science’s project was self-funded and self-organized, to ensure that we could remain an unbiased voice as we discuss these sensitive areas.

North Dakota is in the midst of an unprecedented oil-boom that has led to a rapid increase in road-construction, drilling, pipelines, and infrastructure throughout the oil-rich Bakken Formation. The new oil boom has brought with it new technologies, and oil extraction is now accomplished by drilling lengthy horizontal wells, and then fracturing the shale formation (fracking) to release trapped oil. The rapid pace of this massive industry has caused an astonishing expansion of drilling pads and roads into the wild interior of North Dakota. Questions about the environmental impact abound. While the oil-companies adhere to the state and federal regulations on development, the growth and rapid advance of the drilling front is at a scale that is difficult for anyone to perceive and understand. This has created significant polarity amongst North Dakota residents – some opposed to the rapid growth, others in support of it, all deeply affected by it.

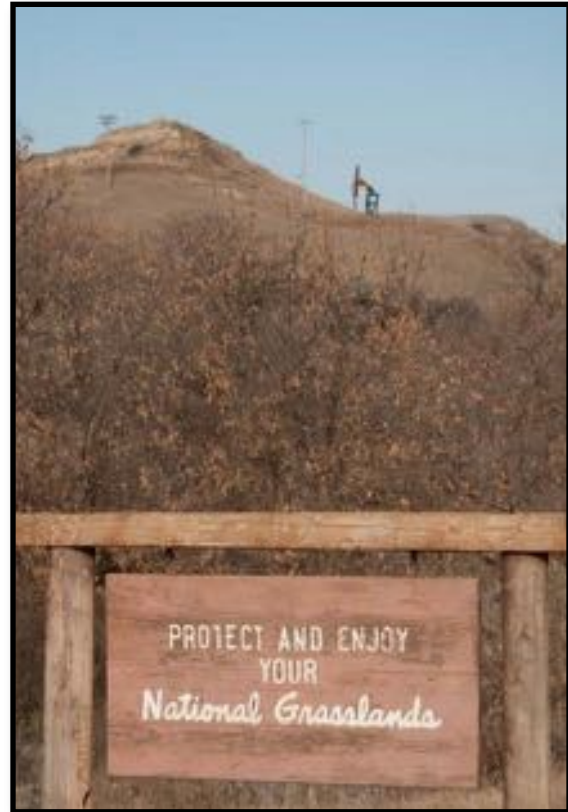


Figure 1. Pumpjack in National Grasslands

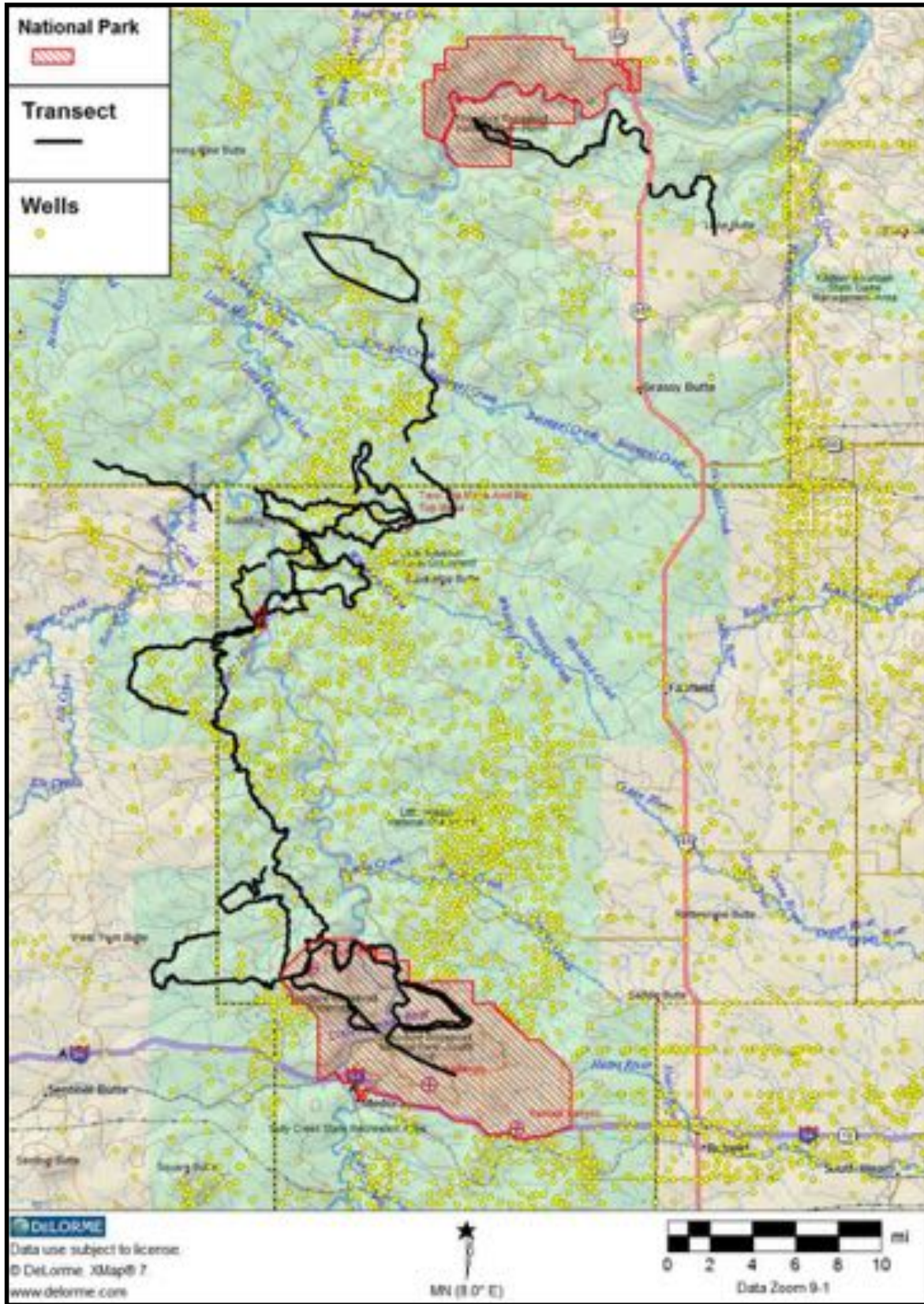


Figure 2: Project Area, transect and well pads

Team:

Richard Rothaus, Archaeologist and Historian
Andrew Reinhard, Archaeologist
Tim Puetz, Biomedical Researcher
Keith Slater, Search and Rescue
Tyler LeBlanc, Paramedic
Jane Davis, Community Health Educator
Jessica Kuepfer, Writer
Melissa Rae Stewart, Public Relations
Simon Donato, Geologist



Figure 3: Field Team, (left to right) LeBlanc, Reinhard, Puetz, Kuepfer, Davis, Slater, Rothaus, Donato

Route and Methodology:

In Spring 2013, Adventure Science undertook the *100 Miles of Wild: North Dakota Badlands Transect*, the first project of its kind across the rugged badlands. Rather than take the established Maah-Daah-Hey Trail, the team navigated primarily off-trail through areas of interest. To tie itself to the history of the region, the trek started at the North Unit of Theodore Roosevelt National Park (TRNP) headed to Theodore Roosevelt's Elkhorn Ranch, and concluded at the South Unit of TRNP in Medora. The teams travelled on foot to seldom-visited, isolated places within the Badlands, typically staying within the boundaries of the federally-administered

Little Missouri National Grassland. Three two-person teams were deployed daily and tasked with covering distances between 10 - 25 miles per transect. These teams (Team Tortoise, Speed Deer, and Mountain Kitty) were assigned routes designed to cross varied and difficult landforms, with an emphasis on travelling to places no one goes to on foot. For this project, the journey, not the destination, was important.



Figure 4: Kuepfer navigates a ridgeline

While deployed, the teams were charged with observing and recording their impressions of the native flora and fauna, as well as any anthropogenic creations. Records and documentation were collected with the goal of establishing a description and personal sense of this landscape. The data will be used to create a 'baseline' impression of the land that can be compared to this area as it was in the 19th century, as well as a record that can be used in the future to gauge the impact of the Bakken Oil Boom.



Figure 5: Sample Panorama Photo

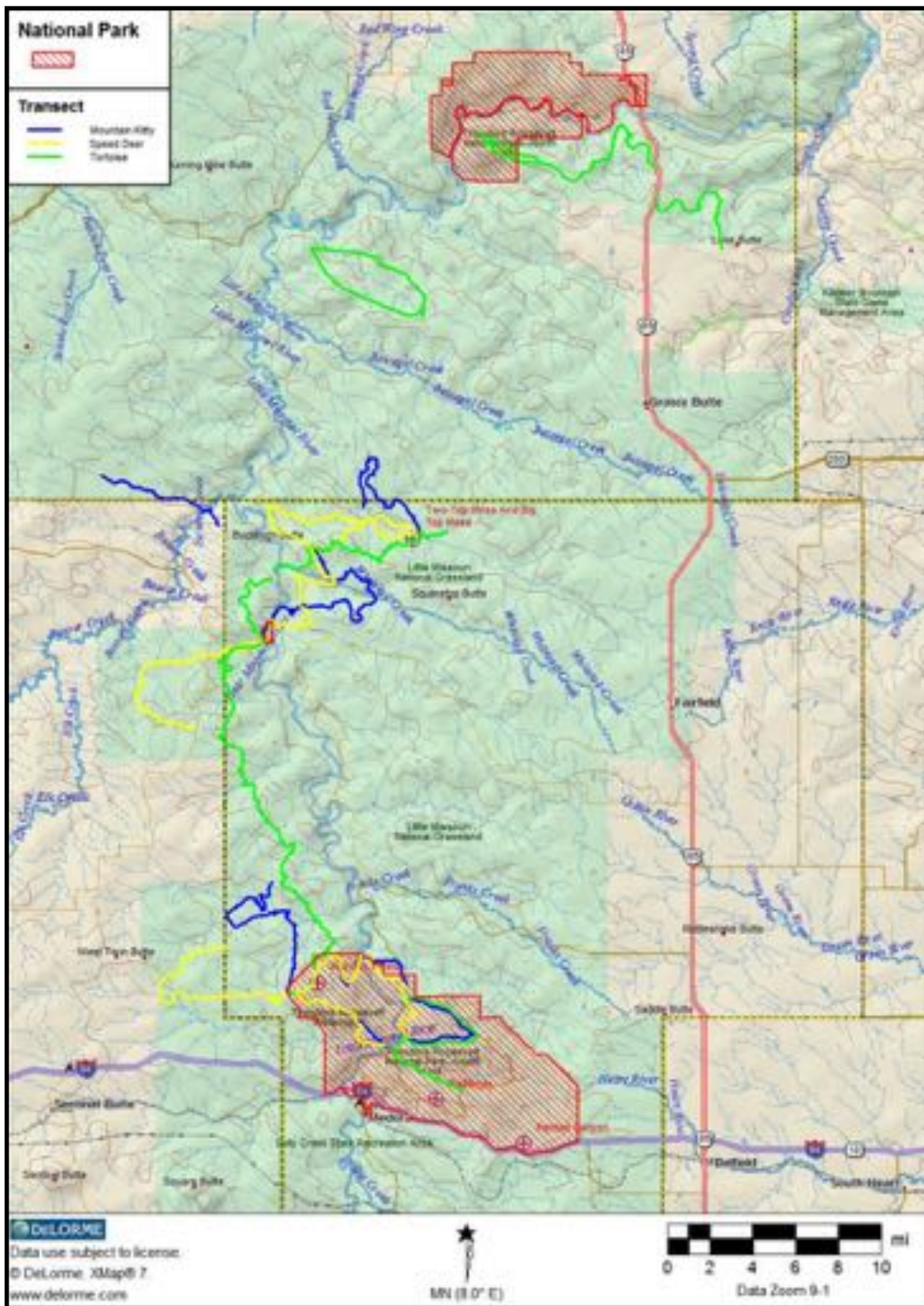


Figure 6: Transect Routes

Teams were required to stop briefly every few hours to record their experiences, the view, and the sounds they were hearing. Each of these locations was designated as a log point. At each log point team members recorded a photo and video panorama, and took notes on what they observed and felt. The route and records were carefully tracked with GPS units. Team notes at each log point included an assessment of their location and signs of ‘civilization’ they could see, the sounds and smells of the location, and perhaps most importantly the feeling of their location. This method of recordation was designed in part to overcome the inability to collect quantifiable data from a quick pedestrian transect, and in part out of recognition that the project aim was to collect the feeling of the landscape, which is inherently personal and non-quantifiable. Additionally, this data was appropriate for collection by individuals with extensive wilderness experience but lacking discrete scientific skills applicable to this landscape. Teams also recorded natural and anthropogenic features, and included a narrative of their travels between log points. At the end of each day, a debriefing was held, and each team shared what they learned about the state of this inspiring wilderness.



Figure 7: Donato completing log entry

Team Name: Speed Dept Date (D/M/Y): _____ Time (24hr): 2:54
 Team Members: Tina Jane Location (UTM NAD 83): 13T 060251B
UTM 520557B

Describe the view of where you are. What can you see? Be sure to include signs of "civilization" (roads, oil pads, cattle...)
Tim & I are currently kneeling beside a deceased golden eagle apparent death caused by electrocution from the ~~power lines~~ wires above. This sight is heart-breaking & fascinating at the same time. Below us is a ravine we chose to avoid leading to this spot.

Describe the sounds and smells of where you are. Can you hear or smell "civilization"? _____
The smell is of a freshly deceased carcass is the very pungent smell.

Describe the feel of where you are. Does it feel like you are in the wilderness (why or why not)?
Interestingly enough after traveling through a large number of pasture land & "civilized" homesteads these powerlines seem to divide the boundary between our return to the "wild".

Describe wildlife, plants and natural features you encountered in the last hour:
Since our last journal entry this poor eagle has been the only natural wild creature we have seen.

Describe cultural or fossil resources (archaeological and historic sites over 50 years old) you encountered in the last hour:
We did come across a section of mounds that had petrified stumps approximately 8.

Provide a brief narrative of the last hour of travel. Be sure to include encounters with impressive or interesting natural features, civilization, people, obstacles in your travel, and your general feelings. Did it feel like you were in the wilderness?
Our travels since last entry have continued through the mandatory erosion & poor vegetation. 2 more barbed wire fence crossings for a total 15 (RICHARD). As we left the pasture the hills have broadened & led us to Mt Eagle.

As you consider your sense of wilderness and the section you completed, remember to think of about it in the context of what you see locally, but also how it compares to your larger experiences in other places.

CHECKLIST

<input checked="" type="checkbox"/> Photo of this page (in this file)	<input checked="" type="checkbox"/> Photos that capture the vegetation coverage of your location
<input checked="" type="checkbox"/> Photo of your GPS, showing coords	<input checked="" type="checkbox"/> Photo a 360° panorama (START at north, rotate clockwise)
<input checked="" type="checkbox"/> Photos that capture the feel of your location	<input checked="" type="checkbox"/> 1 minute video of sites and sounds (video this page at start)

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Figure 8: Sample Log Entry

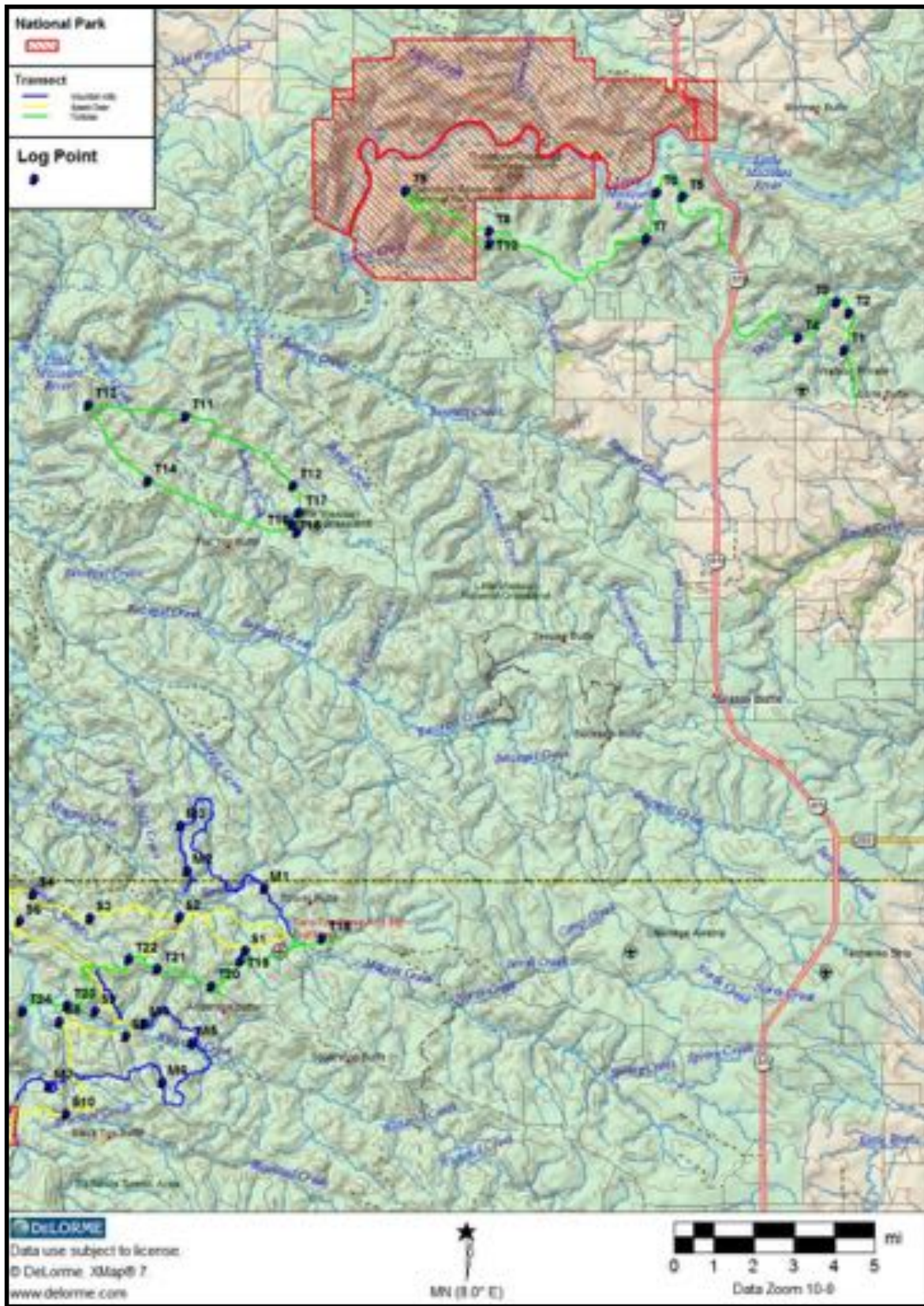


Figure 9: Log Point, north

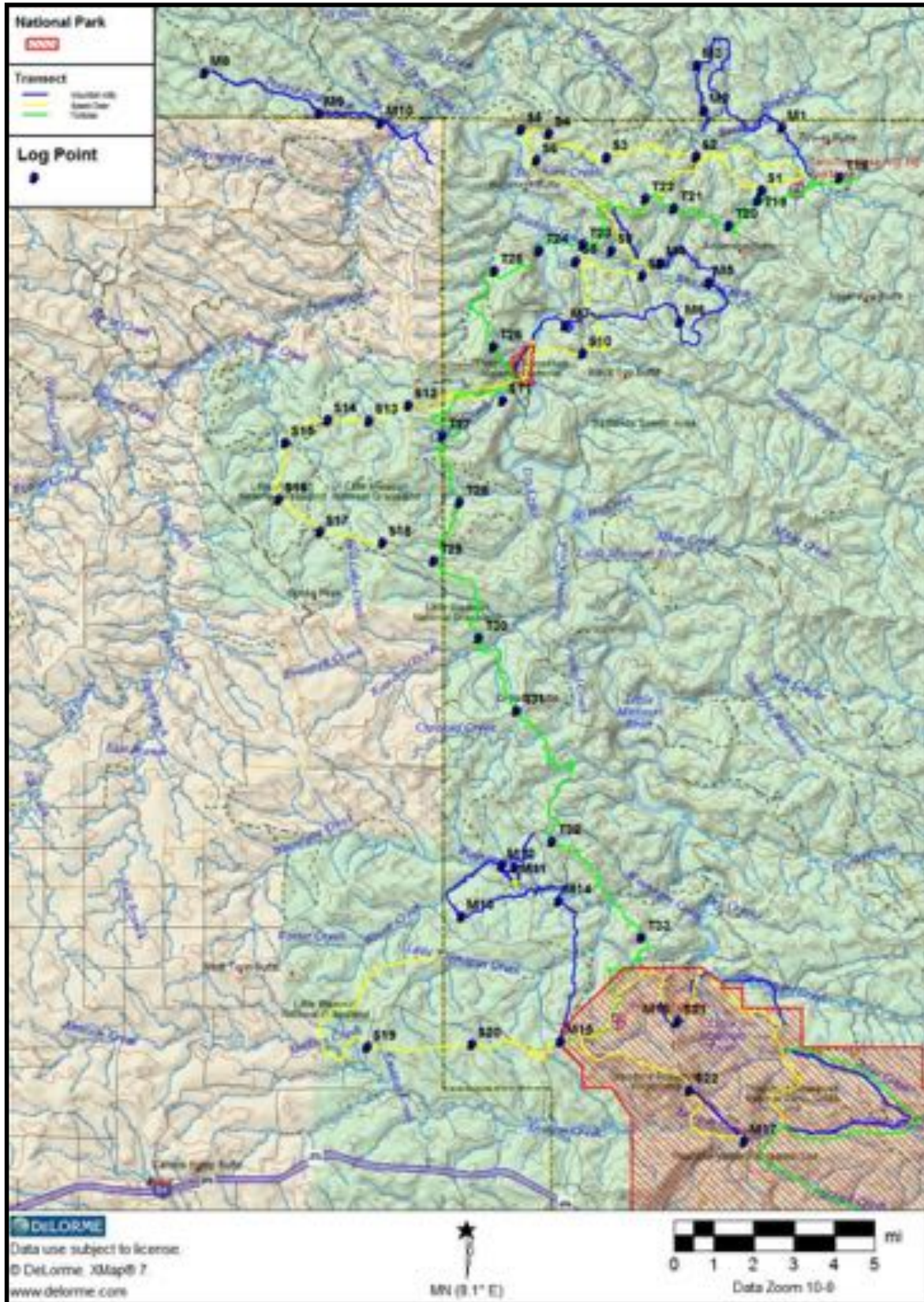


Figure 10: Log Points, south

Overview of Findings:

The 100 Miles of Wild – North Dakota Badlands project by its nature requires a prose report with ample illustrations, and this is in progress. Here we present a brief summary of the more easily described project results.

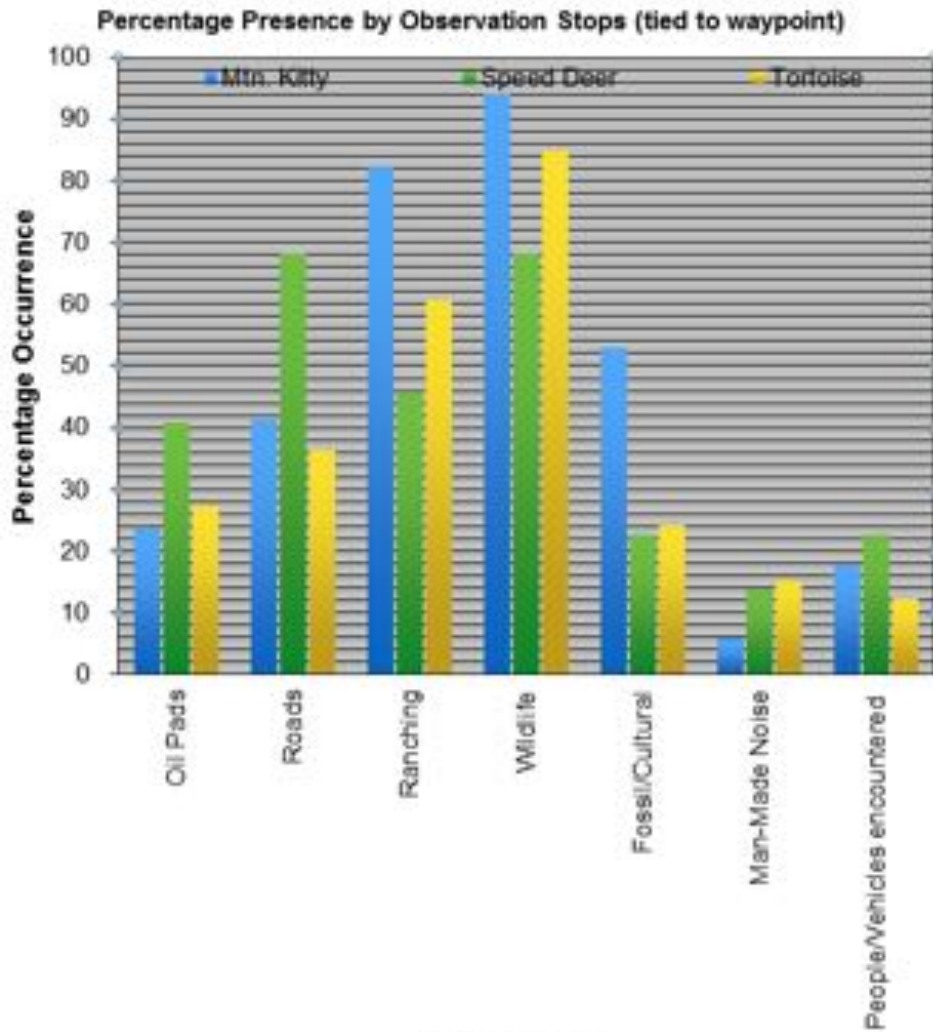


Figure 11: Observation Percentages

Percentage Presence by Observation Stops (tied to waypoint)							
Team	Pads Visible	Roads Visible	Ranching Evidence	Wildlife	Fossil/Cultural Artifacts	Man-made Noise	People/vehicles encountered
Mtn. Kitty	23.5	41.2	82.4	94.1	52.9	5.9	17.6
Speed Deer	40.9	68.2	45.5	68.2	22.7	13.6	22.7
Tortoise	27.3	36.4	60.6	84.8	24.2	15.2	12.1

Figure 12: Percentage presence/absence by log stop

Oil Development: The teams encountered numerous oil pads. The transect was conducted in the earliest days of spring when minimal drilling activity occurs. Teams carried H2S monitors and no H2S leaks were recorded during the expedition. The overall cleanliness of the well sites was better than expected, with minimal litter and no unconfined liquids observed. Within the National Grasslands, most oil pad equipment has been painted a neutral tan color that blends well with the landscape.



Figure 13: Typical Oil Pad

Roads: The team encountered an unanticipated number of roads built throughout the transects. While traffic on the roads was minimal at the time of the transects, the roads were noticeable as a substantial intrusion in the landscape. The roads are built primarily out of local ‘scoria’ (burned clay), and are built to withstand traffic from heavy trucks and equipment.



Figure 14: Typical Scoria Road



Figure 15: Water Truck



Figure 16: Scoria Roads and Pads (Photo Courtesy of EcoFlight)

Archaeology: Prehistoric archaeological sites in the Badlands (which are not numerous) can be difficult for the non-expert to identify, as they usually are expressed by small lithic scatters. Thus no definitive prehistoric archaeological sites were identified. Abundant skeletal remains of bison, horse, and other plains mammals were observed and recorded during the expedition. A possible chert scraper found in association with a bison bone bed (log point M12), suggests that this may be an archaeological site. With the exception of recent material, these sites were always identified in eroded embankments/cut-banks along numerous creeks. Such sites can be natural or related to human activity. These bone bed sites were recorded with GPS, photos, and brief descriptions.



Figure 17: Bison Bone Bed (near log point M11)

Geology/Paleontology:

Paleocene: No Cretaceous aged fossils were identified, although Paleocene marine bivalves were observed, as well as numerous fossilized tree trunks/stumps (both of the Sentinel Butte Fm.) during the survey. Fossil trees were so numerous that they are recorded in the notes but were not individually documented.



Figure 18: Kuepfer with fossilized tree trunk (between log points M4 and M5).



Figure 19: Rippled sandstone (between log points M4 and M5)

Pleistocene/Holocene: Stratified Pleistocene/Holocene deposits are common valley in-fill (alluvium). Often fining upwards from a coarse lag, these deposits record fluvial activity and tend to be highly fossiliferous, with well preserved bison material weathering out of creek banks in numerous locations visited.



Figure 20: Bison Skull from eroding creek bank (near log point M8)

Wildlife Ecology: A number of key species were observed including big horn sheep, mule deer, eagles, coyote, beaver and pronghorn. Bison, wild horse, and elk were observed in the National Parks. Evidence of other predatory animals were noted. Mountain Lion tracks were ubiquitous in any area near streams or springs. Wolf /coyote tracks were not uncommon. Bear scat was noted near the North Unit of the park.



Figure 21: Pasque Flower (one of the first flowers to bloom in spring)



Figure 22: Golden Eagle (log point S20)



Figure 23: Beaver activity (between log point S9 and S10)

Historical Sites: A number of 30-50 year old farming, ranching, and mining implements were noted during the survey. These were note recorded individually. Fences were ubiquitous.



Figure 24: Historic Farm Implement between M6 and M7



Figure 25: Active Water Tank between log points M1 and M2

Sense of Wilderness:

Defining the term “wilderness” is somewhat subjective. The Oxford dictionary defines it as “An uncultivated, uninhabited, and inhospitable region” while the Merriam-Webster dictionary defines it as: “(1): a tract or region uncultivated and uninhabited by human beings (2): an area essentially undisturbed by human activity together with its naturally developed life community”. Using either of these definitions - true wilderness areas in the lower 48 are uncommon, and often fragmented. Wilderness is a perception of individuals, and the team was carefully chosen to include only participants who had worldwide travel experience in exceptional wilderness area. Thus when the teams say something “felt like wilderness,” their point of reference is more likely to be someplace like Borneo rather than a local park.

As teams hiked a collective 270 miles of transects, it became apparent that the difficult geography of the Badlands have shielded them from large-scale development, with ranching the only extensive use of the area. The transects ran primarily through the federally-managed Little Missouri National Grasslands. The Grasslands are not a designated wilderness area, and the mandate of the U.S. Department of Agriculture is to use the lands for the public good, a use that currently includes grazing and oil development. The rugged nature of the Grasslands has, however, led to an area largely undisturbed until the current oil boom.

As the three teams moved through their transect, each made several observations daily about the “sense of wilderness”, the definition of which was largely constrained by the definitions above. Considerations of empirical factors such as presence/absence of: roads, oil pads, power transmission lines, strong gas odour, highway noise, ranching, and refuse were used to provide objective data to support the determination of wilderness vs. non-wilderness for each waypoint.

Team Tortoise, led by Andrew Reinhard, spent the most time in the badlands, travelling from Lone Butte east of the North Unit of Theodore Roosevelt National Park to the Park South Unit 105 miles in 8 days - from 04/22/2013 - 05/01/2013. Team Tortoise was charged with travelling slowly and recording their impressions with more detail than the other teams. The transect for Team Tortoise began in one of the most remote locations and slowly transitioned into a route paralleling the Mah-Da-Hey Trail. This team began during a heavy snow melt, and the route was modified and truncated in part by areas made impassable by slick mud. In the spring, when the slick clays of the Badlands are saturated, it becomes impossible to climb many slopes that would be only moderately challenging in dry conditions. Team Tortoise gained a total of 16415 ft. of elevation over the course of the transect, an indicator of the extreme ruggedness of the territory. While no single climb or peak is particularly notable, the repeated ups-and-downs equated to climbing more than 3/4th the elevation of Mt. McKinley.

Team Tortoise spent the first two days travelling through difficult territory with a strong sense of wilderness gained through absence of oil development and

ranching (T1 to T10, Figure 9 and Figure 10). At times, highway noise could be heard, although typically very faint. Days three and four saw a marked increase in the evidence of historic - active ranching, which despite the absence of oil development made those areas felt less wild. As the team made its way south from the fifth day onwards, evidence of man became more frequent, with generally ubiquitous evidence of ranching (outside of the parks), and more frequent observance of oil development/infrastructure. Finding areas with a “true” wilderness feel became far less common due greater fragmentation. Lone Butte, which has been proposed for designation as a roadless area, was perhaps the most “wild” of all the areas encountered by the teams (T1 to T4). Team Tortoise recorded 33 log points (T1-T33).



Figure 26: Reinhard traverses a ridge in Lone Butte

Team Speed Deer, led by Dr. Timothy Puetz, was a fast moving team that operated from 04/28/2013 - 05/02/2013 and covered a total of 86 miles from Magpie Creek Camp to TRNP South Unit, with 14530 ft. of elevation gain. Using the same parameters for determining wilderness as Team Tortoise, the team found “wilderness” in a very fragmentary state from log points S1 to S18 (Figures 9 and 10). Team Speed Deer found signs of the oil development common, as well as variable levels of disturbance of the eco-system through ranching. As the team neared TRNP South, the landscape did become more wild, and far less developed (log points S19-S22). Team Speed Deer recorded 22 log points (S1-S22).



Figure 27: Puetz examines stratigraphy between log points S1 and S2

Mountain Kitty was led by Dr. Simon Donato, and covered 79 miles with 16474 ft of elevation gain from 04/28/2013 - 05/02/2013. Their data also corroborates the Team Tortoise and Speed Deer findings, in that between log point M1 to M10

(Figures 9 and 10), areas of true wilderness were highly fragmented, discontinuous, and not geographically extensive. From log point M11 to M17 the landscape showed less signs of impact from ranching, oil development significantly declined, and the sense of wilderness grew. Mountain Kitty recorded 17 log points (M1-M17).

The consistent thread amongst all three teams was that wilderness areas are still present - with some areas having more of it than others. These areas however, are severely fragmented and discontinuous. Teams travelled into and out of areas of wilderness, with the transition sometimes being quite abrupt as canyons would lead to new, scoria topped roads, and active well pads.

Visibility of the Oil Industry

While North Dakotans living in the Williston area have been dealing with the serious issues of overcrowding, housing shortages, etc. as the oil boom brings workers to the province, the question of the boom's impact on the badlands landscape was raised.

As teams traveled through their respective traverses, they recorded the presence/absence of well pads during their observational stops. As such, they did not record every pad that they passed by, but only those that they were able to see during their stops (stops were determined by time (every ~60-120 min) and/or changing terrain). Well pads and derricks that were visible in the far distance (typically >1-2 miles) were not recorded as present at the observation point.

The results of the transect shed some interesting information on the distribution of well pads. They were typically clustered (which is normal when producing an oil field), and when a team would encounter one, they would typically encounter several within a tight radius. Wells were typically located in valley bottoms. Pad construction was generally basic, with holding tanks, derrick, several small out-buildings, and a containment berm of varying heights. Litter was generally rare at most sites visited, and most pads were free of spills, odour, and noise. In addition, Federal Grasslands regulations require derricks to be painted a matte taupe, which works well to camouflage. Overall, the transect taken by team Mtn. Kitty resulted in the lowest percentage of wells viewed at their observation stops (24%), while Speed Deer encountered the most (41%; 27% for Tortoise).



Figure 28: Random signs of development are common



Figure 29: Typical Well Pad



Figure 30: Well Pads (Photo Courtesy EcoFlight)

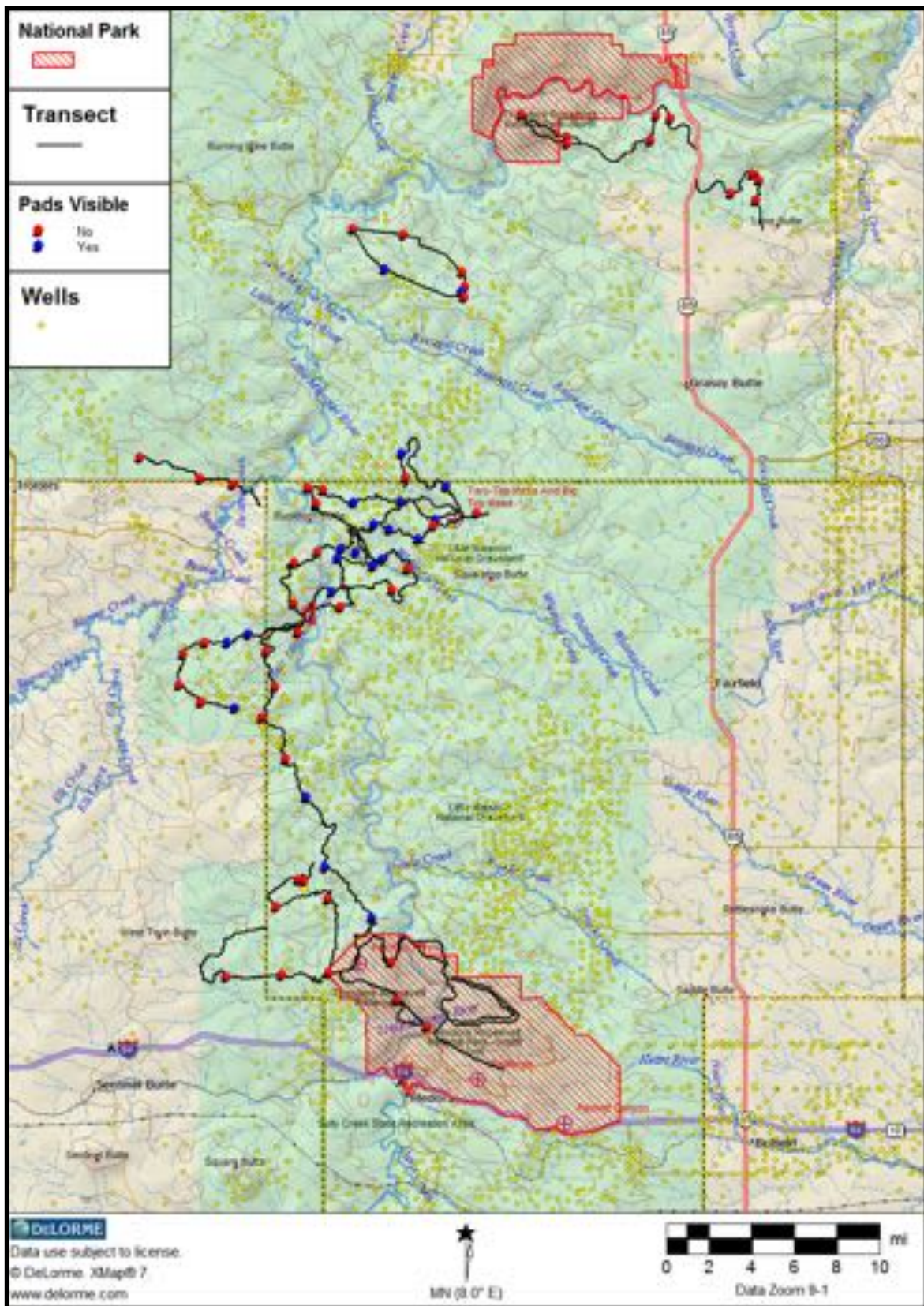


Figure 31: Well Pad Visibility

Roads

By far, the most vivid evidence of the oil industry along the transect route were the scoria topped roads. Scoria, or clinker, is a locally-available sedimentary rock that is baked *in situ* following the ignition of a proximal coal seam/bed (typically by lightning strike). The crushed red rock is visible from a distance and bisects numerous badland valleys along the transect, and undoubtedly elsewhere in the region. The presence of clinker topped roads snaking through isolated valleys directly indicated the presence of pads in the area, as the clinker helped stabilize the bentonite rich substrate, which otherwise becomes impassable during wet periods. Speed Deer observed roads (not all clinker topped though) at 68% of their observational stops, while Mtn. Kitty and Tortoise saw roads at less than 1/2 of their stops (41 and 36% respectively).



Figure 32: Scoria, (burned clay) bed

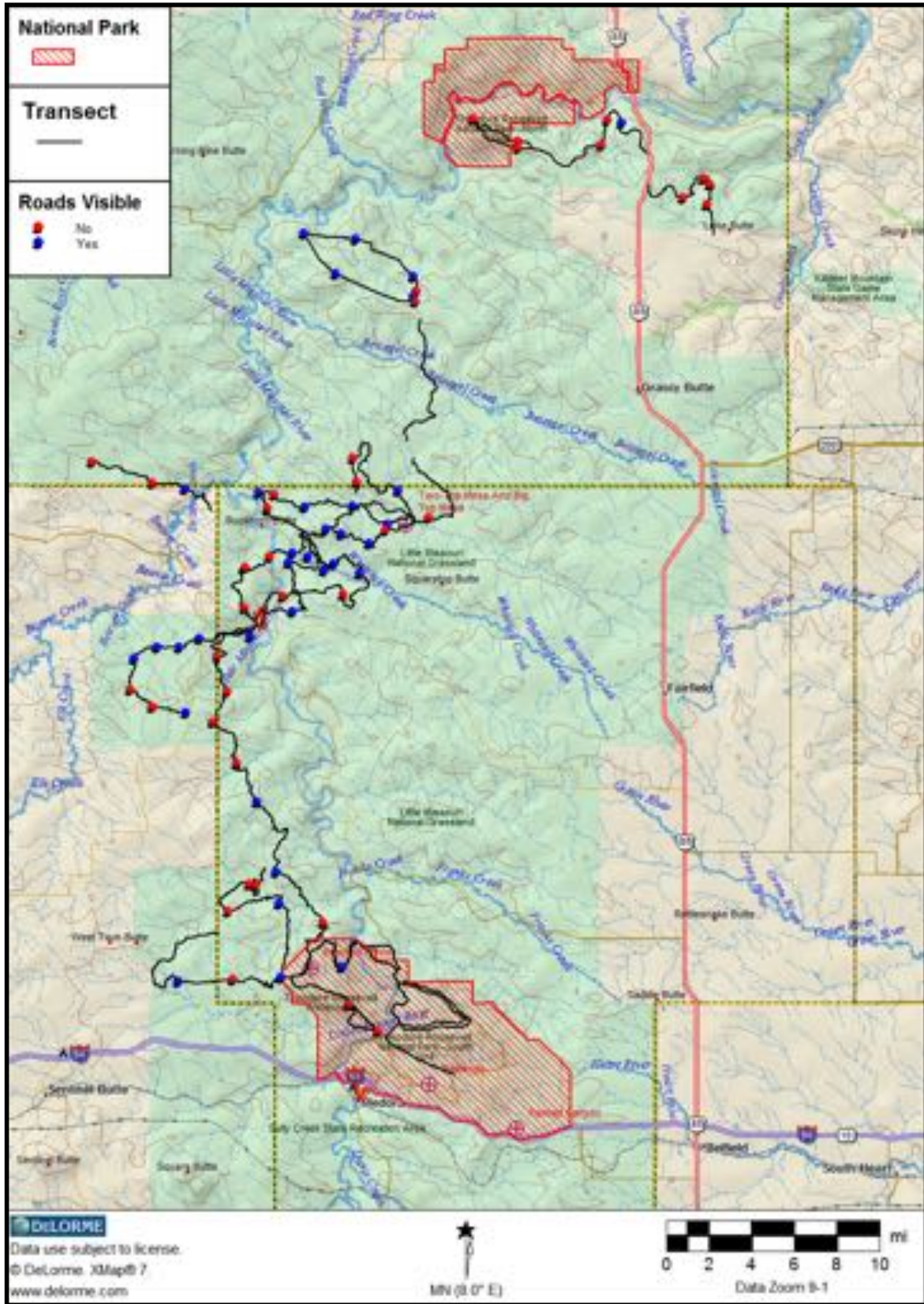


Figure 33: Roads Visible

Ranching

Ranching is synonymous with North Dakota. With a history stretching back into the 1800's, even Theodore Roosevelt was drawn to North Dakota as much for its ranching as for its wilderness. His Elkhorn ranch was, during its time, a functioning cattle ranch.

Ranching is still alive and well in the badlands, and all teams consistently encountered evidence of this. Fences, cow camps, cow patties, cattle tracks, and the evidence of heavy grazing (areas where the native grasses have been replaced by thistles - which are avoided by cattle) were all noted as signs of ranching. Most areas were simply grazing lands, and few structures, aside from watering stations, were observed in these areas. The difference between non-grazed and moderately - heavily grazed areas was obvious in terms of flora present. As noted, unglazed or lightly grazed areas were strongly dominated by grasses - the native flora of the non-wooded regions in the badlands. Areas where grazing pressure was high displayed a mixed-flora, with thistle plants common-dominant. Since it was calving season during our expedition, the cattle were not often observed in pasture.

All teams recorded a strong presence of ranching, with evidence in nearly all badland environs and landscapes. Mountain Kitty identified ranching evidence in 82% of their observation stops, while Tortoise observed it in 61%, and Speed Deer in only 46%.



Figure 34. Historic wagon



Figure 35: Historic Farming Equipment



Figure 36: Cattle

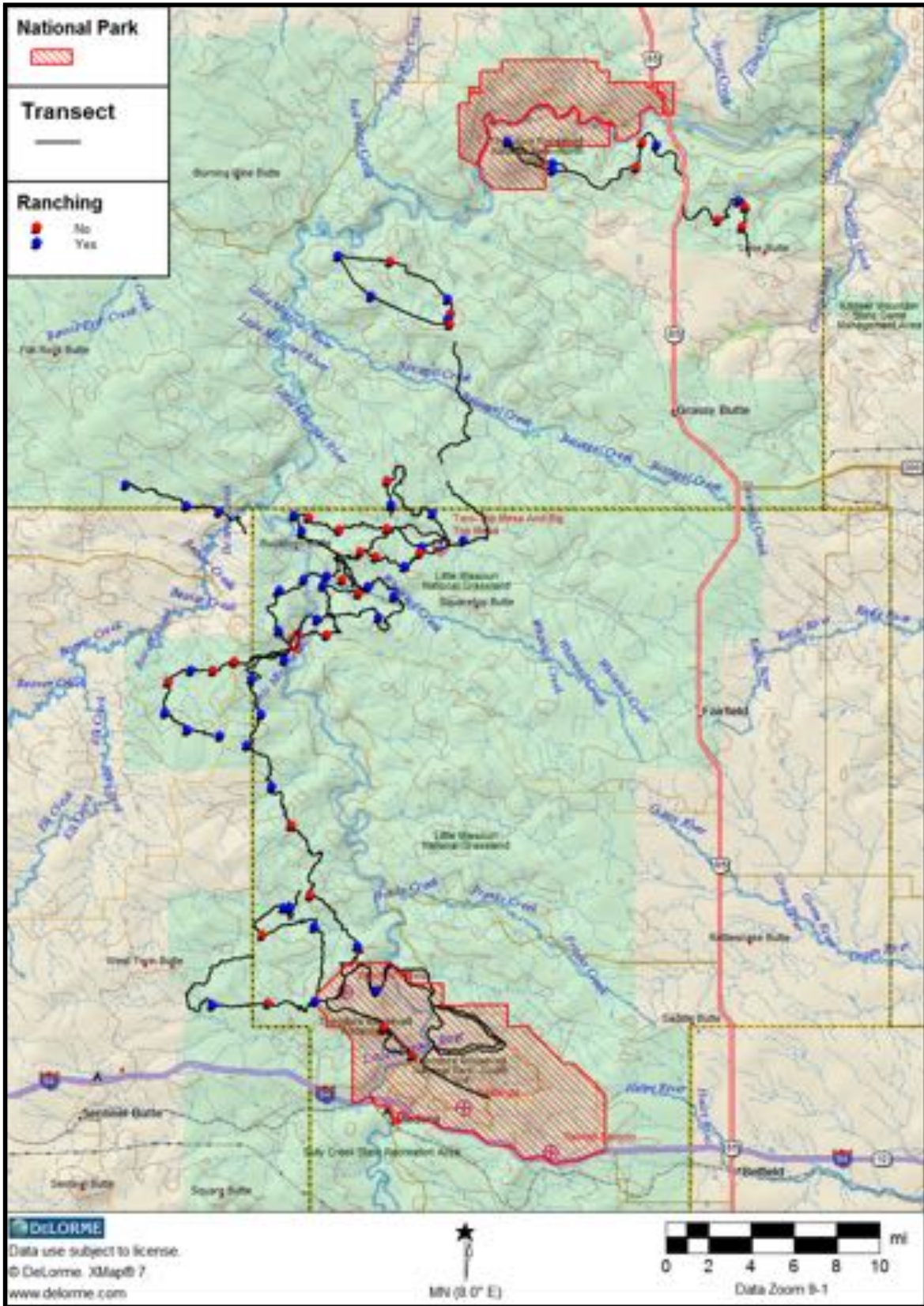


Figure 37: Ranching Visible

The Natural World

Wildlife Encountered

A pleasant surprise, teams found strong evidence of a variety of wildlife present along the transect route. A late spring limited the amount of wildlife visible, as birds were just returning to the landscape, and many mammals were still in secluded areas. Evidence for wildlife included animal and bird sightings, the observance of tracks, and the discovery of skeletal remains and numerous deer antlers (shed and with skull). Animals seen during the expedition included big horn sheep, mule deer, coyote, bison, elk, pronghorn, and rabbit. Tracks for cats (bobcat - mountain lion), and wolf/coyote were also identified. A number of bird species were observed, although not identified. Due to the time of year and cold temperatures, insects, amphibians, and reptiles were not very active, although frogs were heard. Two Golden Eagles were observed during the survey - one alive, the other recently deceased, apparently by electrocution as it was found directly under live power lines.

Teams recorded evidence of wildlife presence at most of their stops (Mtn. Kitty - 94%, Tortoise - 84%, and Speed Deer 68%). It is noteworthy to mention that wildlife was present in areas with well pad activity, although the only evidence observed of wildcats, and wolf were made in more isolated, harder to reach areas.



Figure 38: Coyote tracks



Figure 39: Donato with deer skull

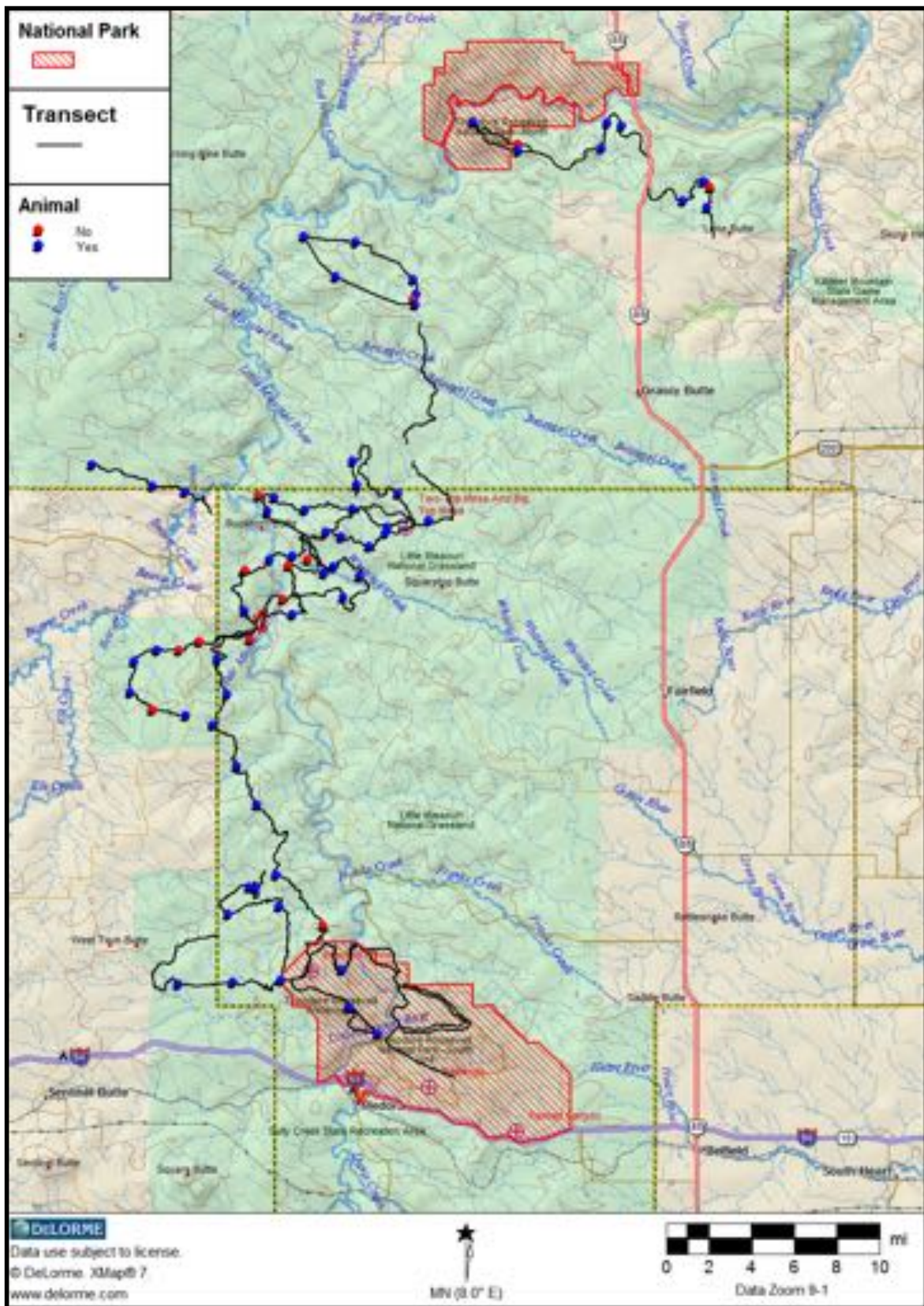


Figure 40: Wildlife Visible

Fossil and Cultural Artifacts

Subject matter experts instructed teams on how to recognize common fossils, stone artifacts/tools, historical implements, landform modifications, etc. in order to identify paleontological, archaeological, or cultural/historic sites of potential significance, or new discoveries. Despite this, it is a challenge to recognize many of these in the field, even for the experts, and especially during a rapid survey.

Most of the exposed rock, clay, and bentonite explored during the transect was devoid of vertebrate/invertebrate fossils. No vertebrate fossils of Mesozoic age were identified, but invertebrates (bivalves) were regularly observed during the trek. By far, the most abundant large fossil in this area is fossilized tree trunks, which are very common and in some areas litter the surface for several hundred square meters.

Only one prehistoric artifact was identified by the transect, a chert scraper found in association with the bison bone bed at log point M12.



Figure 41: Bison skull in situ

Several bone beds were discovered during the expedition. Teams found that by walking streams which eroded through Quaternary aged sediment (which unconformably overlies Pleistocene aged conglomeratic sediments in most instances), bones were readily spotted. Once the observer's eye was trained to identify bone fragments, it was very common to find them weathering from the unconsolidated sediment. No collection occurred (Adventure Science practices only field observation, not recovery) so unfortunately, an absolute age could not be assigned to any of the remains, however the bone beds could be relatively dated by their stratigraphic position. The oldest bone fragments were found at the boundary of the conglomerate-sandstone interface. Above this, bones were more

common, often with clusters of several bones weathering out from a certain interval. Bison bones dominated the assemblage, and lower limb bones were most prevalent. Several locations yielded intact bison skulls. The waypoints of these locations were recorded for future research purposes. As mentioned, another locality yielded a chert scraper in association with bison bone and teeth, supporting the fact that humans utilized bison populations at that period (log point M12). Overall, bone density increased upwards in the column, before vanishing abruptly in the upper meter of sediment. This abrupt disappearance is thought to coincide with the anthropogenic extermination of bison in the late 1800's.

The observance of fossil or cultural material may suffer an educational training bias, as only one team leader is a palaeontologist, and only 2 of the 3 team leaders are archaeologists. This aside, Team Mtn. Kitty saw fossil/cultural material at 53% of their stops, while Tortoise saw it at 24%, and Speed Deer 23%.



Figure 42: Possible anthropogenic markings in sandstone. Age unknown.

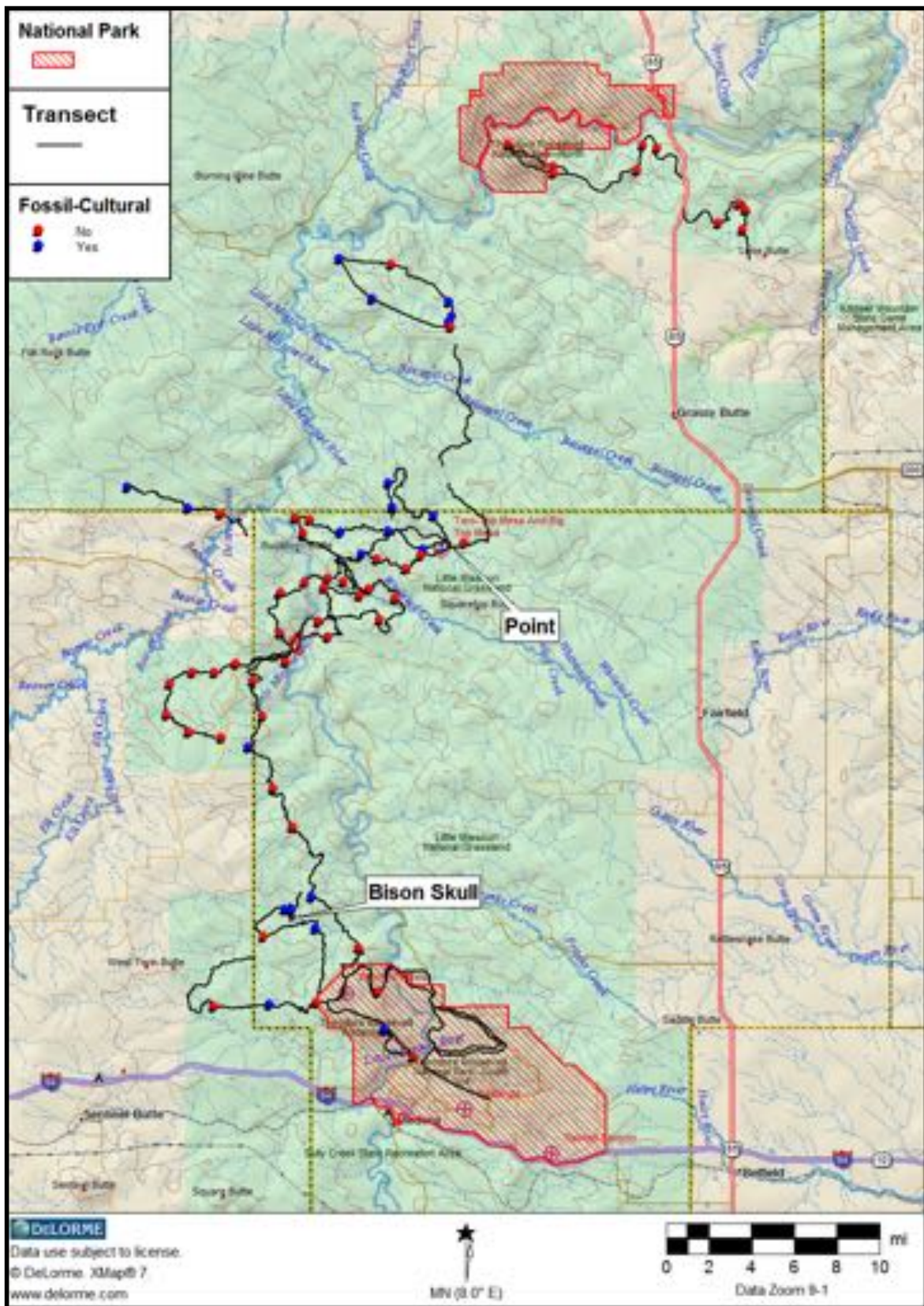


Figure 43: Fossil and Cultural Material

Geology

The geology of this region is generally well understood, and the North Dakota Geologic Survey (<https://www.dmr.nd.gov/ndgs/>) has published a significant amount of detailed information online. Briefly, the stratigraphy that outcropped in the badlands, and formed the buttes and ridges observed during the expedition were predominantly composed of Paleocene aged sandstones, silts, clays, coal, and clinker. In the valleys and ranch lands, especially near the Little Missouri River, Pleistocene to modern aged alluvial sediments dominated.



Figure 44: Imbricated pebbles and gravel in alluvial sediment

Aside from the common tree/plant fossils and occasional mollusk finds, there was a general scarcity of Paleocene fossils, and an absence of Mesozoic - older fossils in the outcrops visited. Exploring creeks proved worthwhile, as their eroded banks yielded some excellent bison dominated bone-clusters. After surveying a number of creeks, a general stratigraphic record could be gleaned for the alluvial sediment. Most creek beds had eroded to expose a gravel/cobble dominated conglomerate, often with a strongly imbricated fabric (indicating direction of flow). The sediments at this level were most likely reworked, and fluvial transported glacial sediments. Granitic cobbles and pebbles are common at this interval, and a provenance from Canadian Shield was inferred. As one moved up column, various stratigraphic features supporting a fluvial origin were observed, including rippled beds, gravel lined scours, and laminated deposits. Paleosol horizons were common higher in the section.

Sights and Sounds

The North Dakota badlands can be a very windy landscape. The predominant sound for all the teams during this project was the wind. Occasionally, vehicular traffic from a nearby highway, or a passing jet could be heard, but for the most part, wind was the only sound heard.

This landscape is generally unpopulated. Encounters with humans were rare, and they were restricted to service vehicles heading to well pads, or workers on pads. Outside of the TRNP South Unit, no other hikers/recreators were encountered.



Figure 45: Kuepfer making observations at a log point

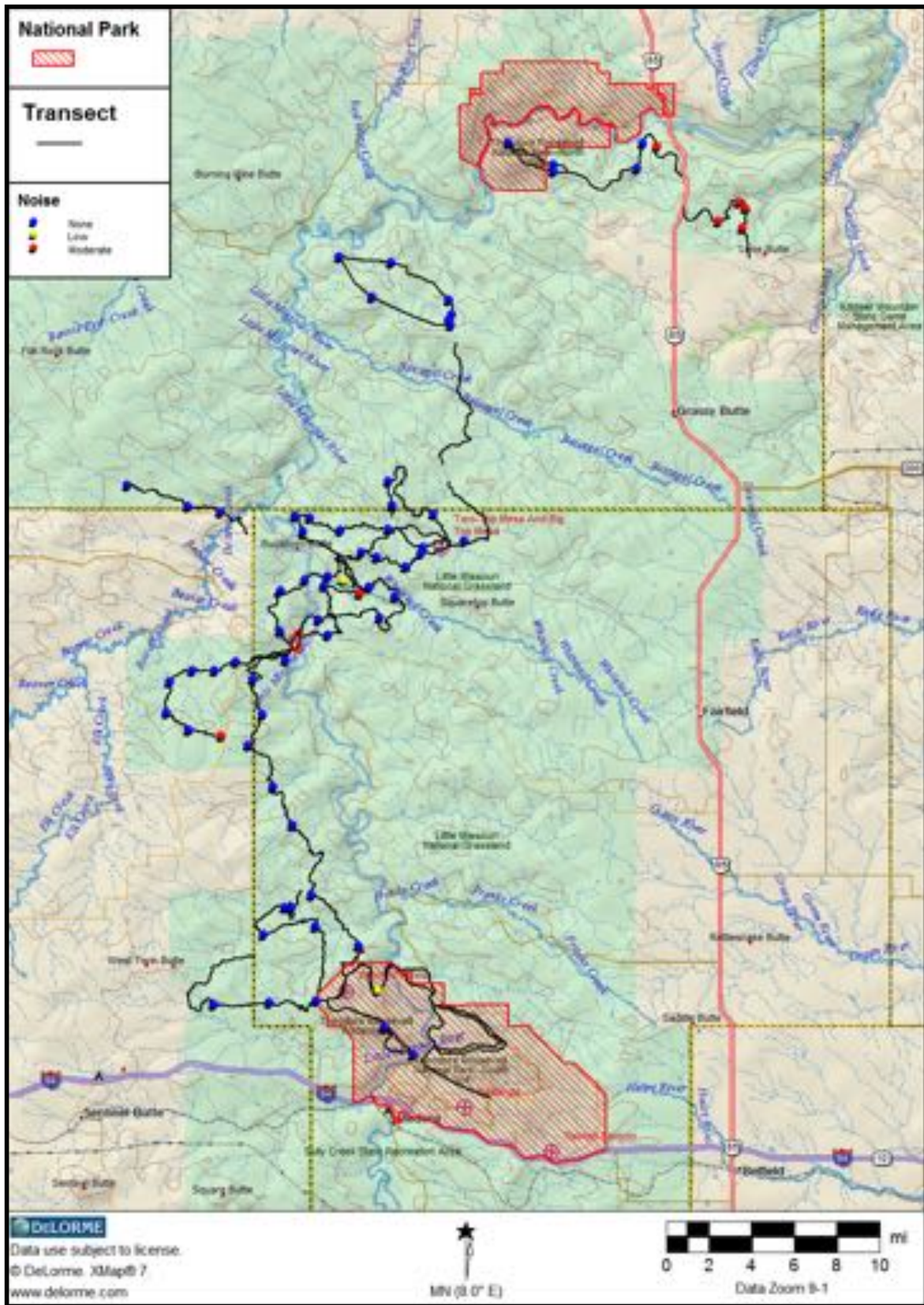


Figure 46: Noise Encountered

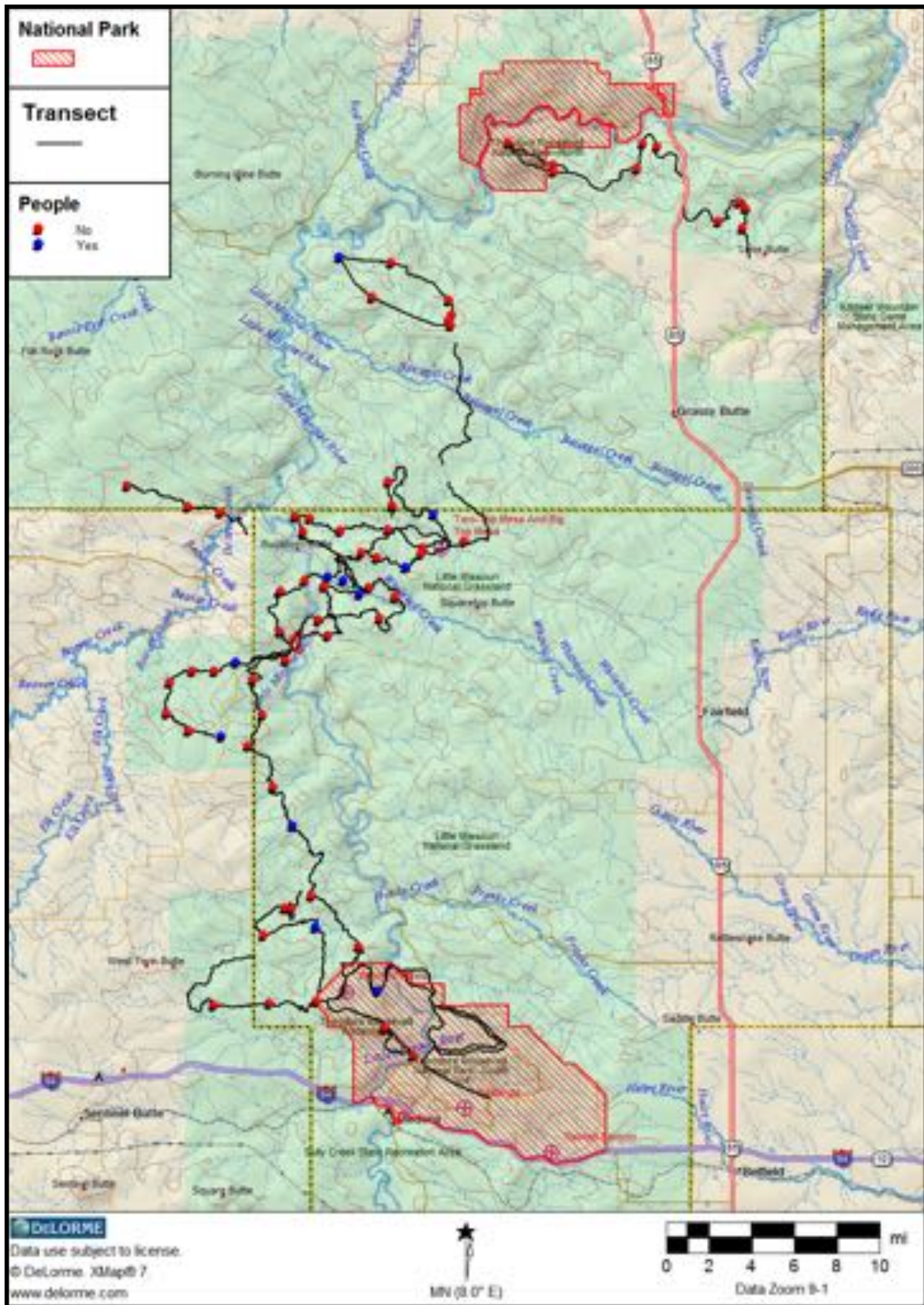


Figure 47: People Encountered

Conclusions and Recommendations:

The Badlands (referred to by General Alfred Sully as "Hell with the fires gone out") seem an unlikely place for a trip on foot, and that is precisely why the team undertook this project. While difficult, the terrain was not impossible. The main challenges faced by each team were navigating the confusing, rough terrain, and dealing with cold weather, and steep, unstable slopes. In the past, these challenges, combined with terrain unsuitable for horseback travel, and the sparse occupation of the area generally kept people out. Off-road motorized vehicle travel is prohibited in much of the Federal land, and the inhospitable remoteness of the Badlands has left the wilderness largely undocumented and unexplored. Adventure Science's self-funded and self-organized transect has given us a unique window to view these Badlands.

This expedition found that the wilderness that Theodore Roosevelt described so long ago does exist, but is highly fragmented. Ranching is as common as it was at his time, but a new threat in the form of oil resource development exists. To be frank, the well pad density observed throughout most of this expedition did not appear as a significant blight on the landscape, although it certainly did remove a sense of wilderness from the area. From the perspective of the Adventure Science team, the impact of ranching was far greater and more immediately visible than the impact of the boom. The most visually unappealing and perhaps major impact of oil development is the expansion of roads through these beautiful areas. Obviously the risk of oil spills, pipeline leaks, H₂S release, and other accidents are real, but our expedition uncovered no glaring issues. However, as oil development in this area continues, with the number of wells perhaps tripling in the coming decade, this situation could and will change significantly. We hope our results will not be used to demonstrate that the impact of the boom is minimal, but instead to indicate that this area is at a tipping point. Things are okay right now, but triple the number of wells without serious planning, and that will change. This transect provides an excellent baseline for a follow-up expedition within 5 years that will be able to analyze and document change at a level of detail previously not possible.

Adventure Science is not an activist group, and our goal was (and is) documentation, not recommendations. All participants were struck, however, by the rather shocking recent fragmentation of the areas between the North and South Units of Theodore Roosevelt National Park. While these Federal Grasslands were never intended to be wilderness, the level of fragmentation even at this relatively early stage of the boom is astonishing. The roads to oil pads and other areas have spread like a chaotic web. This fragmented state is seriously detrimental to the conservation and recreation mandates of the Grasslands, and seems unnecessarily damaging to the area. The myriad of roadways provide access for invasive species throughout the Grasslands, and during drilling season we are told they create a great deal of noise and dust. Just as the Adventure Science Team was never far from a road, it is increasingly difficult for wildlife to

navigate this area without exposure to road disturbance and hazards. For the reticent and skittish key species of the area such as Bighorn Sheep and Golden Eagles, this is most problematic.

Given that the area remains quite wild, and this wildness could be preserved with some relatively small steps, it seems obvious to act on the part of preservation. This need is amplified by the relatively small sizes of the North and South Units of Theodore Roosevelt National Park. Our work not only supports the already proposed idea for some roadless areas within the Grasslands, but suggests a most obvious need: centralized planning of access roads with an eye toward minimizing the spreading web and maintaining open corridors for the natural inhabitants of the region. Equally obvious, albeit more difficult to achieve, would be the creation of a protected wilderness corridor linking the Theodore Roosevelt National Park North and South units. While this idea might not seem politically feasible in an area in the midst of an oil boom with entrenched ranching interests, the reality remains that this could still be achieved. Such a corridor could be protected under a drilling and ranching moratorium and serve to allow wilderness to expand, and return to its natural state, as well as give wildlife a corridor to move freely, and unimpeded by fences, drilling activity, and busy roads. While we have doubts whether such a corridor will ever be created, we have little doubt that future residents will look back upon this period as a lost and last opportunity to do so.



Figure 48: Puetz with the explorers club flag (112) in TRNP South Unit