MIAMI UNIVERSITY
Department of Zoology
212 Biological Sciences Building
Oxford, Ohio 45056
513 529-3100
513 529-6900 FAX

COPY FOR YOUR INFORMATION

Mr. Royce R. Huber
Refuge Manager
Ft. Niobrara - Valentine NWR Complex
HC 14, Box 67
Valentine, NE 69201-9706

March 31, 1995

Dear Mr. Huber:

My doctoral student, Mr. Michael Finkler, and I are planning to conduct three major research studies, each of which will involve, in part, work at the Valentine NWR. We are accordingly requesting special use permits for this purpose. Your Administrative Office Assistant, Ms. Mary Ayers, recently sent us the necessary information.

We have submitted a separate research study proposal for each of these three projects. The study entitled "Impact of Egg Content on ... the Common Snapping Turtle (*Chelydra serpentina*)" will involve the collection of six clutches of eggs from the Valentine NWR. This should not, however, adversely affect the snapping turtle populations inasmuch as we plan to return hatchling turtles to the site the following Spring. For the study entitled "The Effects of Grazing on ... Reptiles", we will be working entirely within the Sand Hills (including, but not restricted to sites within the Valentine NWR). This study will involve vegetation mapping and marking and trailing of reptiles and should provide some useful information about the impact of grazing practices on reptile populations. The third study, entitled "Locomotor Performance of Reptiles of the Sand Hills of Nebraska", will involve the collection of 25 specimens of various reptiles from the Valentine NWR. These animals will be returned to the Sand Hills the following Spring, so there should be no lasting impact on animal populations. I have a Nebraska scientific collecting permit (No. 95-104) for snapping turtles eggs and all identified reptiles.

We believe that all three of these projects are important, and we are looking forward to our work in the Sand Hills. I am a native Nebraskan, with some very distant relatives in the Sand Hills, so I have a special interest in this area. We hope to have the opportunity to meet you and we will plan to do so. We will be consulting with various people at the Valentine NWR and in the area in order to locate appropriate study sites.

We do not know the "Project Numbers", so this space has been left blank on all three research study proposals. If any additional information is needed please contact me by telephone (513/529-3182), FAX (513/529-6900), or e-mail (Claussen@msmail.muohio.edu). We wish to thank you and your staff for your attention to this matter.

Sincerely,

Dennis L. Claussen
Professor of Zoology

1. Title: Impact of Egg Content on Post-hatching Size, Body Composition and Performance in the Common Snapping Turtle (*Chelydra serpentina*).

2. Project Number:

3. Objectives:

   1) Determine the impact of variation in the amount of maternally invested water on the mass and body and yolk sac composition (dry mass and water content) of hatchling snapping turtles. We hypothesize that increases in the amount of water present in the egg at oviposition will correlate with increased wet and dry body mass and decreased wet and dry yolk sac mass in the hatchlings.

   2) Examine the effects of hatching size on locomotor performance (swimming speed) and predatory efficiency (successful grasps/grasps attempted, time until capture, handling time) in hatchling snapping turtles. We hypothesize that increases in hatchling size (through increases in the amount of maternally invested water) will correlate with increased locomotor performance and prey capture efficiency.

4. Justification:

   The issue of maternal investment in reptilian eggs has been a topic of much exploration in recent years with correlations between egg size and hatchling size noted in several species. The current paradigm of many studies is that eggs with greater energy reserves produce larger hatchlings with an associated increase in ecological performance (e.g increased ability to procure food, predator avoidance, etc.). Thus females which invest more energy in the eggs (pay a higher cost) produce assumedly more successful hatchlings (reap a greater benefit). This paradigm seems reasonable if one assumes that larger eggs have greater energy reserves (i.e, greater amounts of solid materials in the yolk and albumen of the egg). Yet a previous investigation of ours into the composition of snapping turtle eggs revealed that there is relatively little difference in the amount of nutrients contained in eggs of different sizes, yet considerable difference in the amount of water contained in eggs of different sizes. Moreover, several studies have indicated that the hydric conditions of the nest influence the size and performance of the hatchlings, suggesting that an increase in the amount of water available to the egg may have a significant impact on fitness of the young. In light of these findings, increased investment of water in the eggs (which is energetically less expensive to invest in the eggs that solid nutrients) may be a low cost means by which the female can increase the survival of her young. The present study will test this hypothesis by investigating the impact of variation in the amount of maternally invested water on the size and performance of the hatchlings. Moreover, predatory efficiency, a little studied measure of animal performance, will be examined thoroughly in juvenile snapping turtles.

5. Procedure:

   A. Methods and Materials.

   A total of 6 *Chelydra serpentina* clutches (>40 eggs per clutch) per year will be collected from Valentine National Wildlife Refuge, Cherry County, NE, in mid-June of 1995 to 1997. We have a Nebraska scientific collecting permit (95-104) for these eggs. Eggs in each clutch will be collected within 12 hours of oviposition, marked for identification, and

weighed to the nearest milligram. Ten randomly selected eggs from each clutch will be opened and the contents removed. The shell and egg contents will be dried separately in a drying oven to determine the masses of the dry shell and the solid constituents of the egg contents. The amount of water in each egg will be determined by subtraction [water content mass = inital egg mass - (dry shell mass + solid content mass)]. Each of these measurements will be used to form a linear regression equation to compare egg composition with variation in egg mass and to predict the amount of a component in the egg given its initial mass. The remaining eggs will be transported back to Oxford, OH in insulated containers holding a vermiculite substrate with a water potential of -300 kPa.

Upon return to the laboratory, eggs will be weighed, half buried in fresh vermiculite of -300 kPa water potential, and incubated at 29 °C. During incubation, the eggs will be weighed and candled weekly. Upon hatching, each hatchling will be washed of clinging materials, and have mass, carapace length, carapace width, head width, gape width, and limb lengths measured. Ten of the hatchlings in each clutch will be randomly selected, sacrificed by decapitation and dissected to remove the yolk sac. The yolk sacs will be weighed, and both they and the carcasses will be placed into a 60 °C drying oven and dried to a constant mass.

The remaining hatchlings from each clutch will be randomly allocated to two prey-size groups (crickets of either 5% or 10% of the mean mass of the turtles in each group) and placed into individual 250 ml containers holding 20 ml of deionized water. Animals will be housed in an environmental chamber maintained at 25 °C. An amount of commercial cat food equalling 5% of the mean mass of the turtles in each group will be offered daily up to Day 59 except on days when locomotion or prey acquisition parameters are to be measured. Size will be measured once per week as described above for the duration of the study.

Weekly, until Day 56 post-hatching, each juvenile will be placed at one end of a linear water trough 1 m long, 6 cm wide and containing 25 °C water 4 cm deep to evaluate escape velocity during predator avoidance. Light beam photocells attached to a digital timer will be interspersed along the track at 25 cm interval, each beam positioned 1.5 cm below the water line. The turtle will be stimulated to swim as quickly as possible by lightly tapping on its tail with a blunt probe. Absolute velocity (m/s) and relative velocity (# carapace lengths/s) will be calculated.

On Day 9 post-hatching and weekly therefter until Day 58, the juveniles will be placed individually into a 20 cm x 20 cm plastic container filled with 25 °C water 4 cm deep. After a 15 min. familiarization period, a live cricket of the appropriate mass for the treatment group will be placed 10 cm in front of the turtle. Prey capture will be monitored using a remote VHS observation system. The time necessary for the animal to catch the prey, the number of attempts to grasp the prey, and the amount of time required to handle the prey (time elapsed between first seizure of the prey and the first complete closure of the jaws after it has been swallowed) will be recorded.

Turtles will be removed from study on Day 60 posthatching. Juveniles remaining at the end of the study will be reared in captivity until they can be returned to the collection sites in June of the following year.

Numerous regression analyses of variance will be used to ascertain the degree of correlation among the various measures of initial egg size (e.g. egg mass, egg water content, etc.) and measures of hatchling size (including body composition). As eggs from different females may have different mass distributions, different water/solid compositions, and presumably different genetic factors that may influence performance and growth, clutch will be maintained as a blocking variable in the analyses. Repeated measures analyses of

variance will be performed to examine the effects of different sizes of prey, hatchling size, and clutch upon locomotor performance, predatory efficiency, and growth rate, with a significance level of α=0.05 will be used in all statistical tests.

C. serpentina is protected in the state of Nebraska. We anticipate the re-release of hatchlings from at least 40% of the eggs in each clutch. A recent study (Congdon et al., 1994, American Zoologist 34: 397-408) noted that predation upon the nests by mammals accounts for the loss of an average of 77% of nests per year, and only about 9% of hatchlings from successful clutches survive to the first year (Congdon et al., 1994). Our hatchlings, thus, should have a greater survival than expected in the wild.

B. Results:

Results will be presented in the form of tables and/or graphs in the final report and manuscript.

C. Interpretation:

The results and evaluation of the hypothses in this study will provide a more holistic view of how variation in the internal environment of the egg leads to variation in hatchling quality and, ultimately, the fitness of the progeny. In addition, this study should elucidate a reproductive strategy in *C. serpentina* by which female may partially offset energetic costs by increasing the efficiency with which the energy within the egg is utilized via increased water content. Such information will be an important contribution to knowledge of the reproductive biology and life history of these animals, and may aid the future management of this and other turtle species.

6. Cooperators:

Limited financial support will be provided by the Department of Zoology, Miami University, and by a grant from the Chelonian Research Foundation Linnaeus Fund.

Grant spport from The Society for the Study of Amphibians and Reptiles and the American Society of Ichthyologists and Herpetologists are pending, and we will be applying for grant support from other agencies (e.g. Sigma Xi).

7. Responsibility: Michael S. Finkler, Doctoral student, Miami University
Dennis L. Claussen, Professor of Zoology, Miami University.

8. Costs: No costs will be incurred by the Fish and Wildlife Service.

9. Schedule:

The following approximate schedule will be followed for each of the three years of the study (1995-1996, 1996-1997 and 1997-1998).

Month	Activities
June 1-20	Collect eggs at Valentine NWR: obtain egg composition data; return eggs to Oxford, Ohio; commence incubation.
June - August	Egg incubation: weekly egg mass measurements.

mid-August	Hatching period (est. 55 days post-oviposition): measure hatchling size; allocate to hatchling body composition and prey aquisition groups; obtain body composition data for hatchlings.
August - October	Performance test period (60 days): Weekly size measurements; locomotor performance, predatory performance.
October - December	Data analysis, report/manuscript preparation
March	Report/manuscript submission
June	Return hatchlings to field

10. Reports: Annual reports will be issued to the Manager of the Ft. Niobrara-Valentine NWR by April 1. of the year following each field season (1996, 1997 and 1998).

11. Publications: This study will be conducted as partial fulfilment of the requirements for the Ph.D. program at Miami University (MSF). Data will be published in refereed scientific journals (to be determined). Reprints of all published articles stemming from this study will be provided to the Manager of the Ft. Niobrara-Valentine NWR.

Submitted By: Date: 3-31-95

Endorsement: Date:

Refuge Manager Approval: Date:

Regional Office Concurrence/Approval:

Date:

1. Title: The Effects of Grazing on the Ornate Box Turtle (*Terrapene ornata*) and Other Reptiles.

2. Project Number:

3. Objectives:

1) To determine the effects of livestock grazing on the distribution and behavior of the ornate box turtle and of other terrestrial reptiles in the Sand Hills of Nebraska. We hypothesize that grazing will alter the thermoregulatory and locomotory behavior of box turtles. We further hypothesize that grazing will have beneficial effects for box turtles and for some (though not necessarily for all) other reptiles.

4. Justification:

Although it is important to keep in mind that, from one perspective, domestic livestock have merely replaced native primary consumers, such as bison and other ungulates, environmental biologists often take a very negative view of commercial grazing. The effects of grazing on native plant and arthropod communities are indeed quite apparent, with the response generally being dependent upon the intensity of the grazing pressure. Much less attention has been given to the effects of grazing on the native vertebrate fauna — especially on the herpetofauna (amphibians and reptiles). Are such effects uniformly negative, or does grazing, in certain cases, offer compensating advantages? This possibility has rarely been addressed, or even considered.

This study will focus on the ornate box turtle, *Terrapene ornata*, but will also consider other sympatric reptiles. Livestock and box turtles interact, directly or indirectly, in a number of ways. Negative interactions might include: direct injury to the turtles by trampling, destruction of nests, the collapse of burrows by trampling, disturbance and disruption of normal turtle behavior, trampling of grasses and forbs and grazing-induced changes in landscape and vegetation structure (which could decrease some potential food resources). Positive interactions might include: cattle dung (and the insects attracted thereby and appearing therein), cattle pathways, which provide open areas for turtle basking and thus more options for behavioral thermoregulation, and grazing-related reductions in above-ground litter, which markedly reduces the danger of large-scale range fires. Some reports suggest that these reptiles are more abundant in areas frequented by grazing livestock. Are we perhaps doing the box turtle no favors by promoting fenced refuges and a decrease in grazing pressure? Very possibly so; but, the evidence thus far, though intriguing, remains anecdotal. We need more specific information about the interactions between grazing cattle and ornate box turtles. We also need comparable information for other sympatric reptiles. This study will focus on the question: Does grazing significantly affect the distribution and abundance of ornate box turtles (and/or of other terrestrial reptiles)?

This study should document the effects of livestock grazing on the distribution and abundance of the ornate box turtle and of other terrestrial reptiles and amphibians within the Sand Hills community. It also should provide insights into the causal factors underlying changes in reptile abundances and behaviors. Hopefully, this study will provide a more balanced look at livestock grazing by considering both benefits and detriments from the perspective of the native ectothermic vertebrate fauna. Also, the knowledge gained about the ecology of the ornate box turtle should help us to better manage existing populations of this interesting reptile.

Aside from the marking procedures, which are standard and relatively inocuous, this study will in no way injure the box turtles or other reptiles native to the Sand Hills. The results may, in fact, prove beneficial for their future management.

5. Procedure:

A. Methods and Materials:

I. Population densities in relation to livestock grazing pressure:

Both spatial and temporal comparisons will be made in order to evaluate the relationship between livestock grazing and the population densities of box turtles and other reptiles. The Sand Hills are well suited for such studies inasmuch as most ranchers practice rotational grazing, using multiple pastures, each of which is systematically grazed for a period of time and then allowed to rest. There are also large regions, such as the Valentine National Wildlife Refuge, protected against grazing or subject only to controlled contract grazing. It should thus be relatively easy to identify several roughly comparable study plots differing only in grazing intensity and history (e.g. some plots which have been protected from grazing for a few to several years, other plots, now protected, but which have experienced grazing within the past year, and yet other plots which are currently subject to moderate to intense grazing).

The study will monitor box turtle and other reptile populations during each of three consecutive years, from early June through early July. This is a period of considerable activity by ornate box turtles in the Sand Hills, encompassing oviposition by the females.

We will establish six 12 ha rectangular (300 m x 400 m) study plots — three on land currently subject to moderate to heavy grazing, but scheduled to be protected at the end of the current cattle grazing season, and three on land protected from grazing for at least one year, but scheduled to be grazed on the following year. At least once per week, two investigators, spaced 50 m apart, will slowly and systematically walk through each plot in such a way as to traverse the short dimension four times each. The total travel path per investigator will be about 1.5 km. At least one investigator should come within 25 m of every point within the plot. Every box turtle located during these surveys will be captured, marked (if not already marked) by a filed notch in the carapace, weighed to the nearest g on a portable balance, sexed, and released at the point of capture. The right-angle distance from the transect line will be measured and the approximate location of capture will be mapped. Published methods will be used to estimate population density from the number of animals located, their mean right-angle distance from the transect line, the length of the transect line, and an empirically determined constant. Also, we will determine a separate and independent estimate of population size based on multiple marking and recapture sessions.

Two additional 12 ha study sites (one currently grazed and one currently protected) will be selected to study the populations of all terrestrial reptiles. Each of these sites will be sytematically traversed to search for box turtles in the same manner as above. In addition, drift fences and pitfall traps will be used to capture amphibians and reptiles. Each of six 20 liter plastic bucket traps, surrounded by three evenly spaced drift fences (of 50 cm high x 1 m long aluminum flashing), will be randomly distributed within each study site. The bucket traps will be shaded and will contain drain holes and a wet sponge (to prevent flooding or desiccation of animals). All traps will be checked at least once every two days. There is little danger of either freezing or overheating in shaded traps buried in the ground at this time of year. All captured reptiles will be toe-clipped (or scale-clipped for snakes) and released. At the end of the survey, all traps will be removed or permanently covered to prevent animal ingress.

The number of reptiles captured or visually spotted will be used (along with consideration of marked and recaptured animals) to estimate the population densities of each species during each of the three years. ANOVA will be used to analyze the data for the turtles from both a spatial (i.e. four grazed vs. four non-grazed each year) and a temporal perspective (changes in turtles after grazed plots become protected and after

protected plots become grazed). Each plot will be mapped each year with respect to vegetation structure and other landscape features, and plant cover will be determined using published methods. All plot markers will be removed at the end of a season of study except where we have obtained permission for their continued presence.

II. The effects of grazing on box turtle movements and thermoregulation:

(A). Movements:

Eight box turtles will be captured from moderately grazed areas at least 500 m distant from the nearest of the study sites identified above. Similarly, eight other turtles will be captured from protected areas. Each turtle will be weighed, sexed, and marked. A thread-trailing device, consisting of a cut-down spool containing about 500 m of white thread inside a 35 mm film canister with a hole through which the thread protrudes, will be attached with strips of duct tape to the back of the turtle. The loose end of the thread will then be fastened to some fixed object and the turtle will be released at the spot of capture. Within 48 hr, the investigators will return to the site of original capture and will map the pathway defined by the thread, using stakes, metric tapes, compasses and surveying instruments. Key landscape and vegetational features (e.g. blowouts, *Yucca glauca* plants, etc.) will be included on these maps. Special attention will be given to any apparent influences of grazing related features (e.g. cattle dung, cattle trails, etc.) and these will also be mapped.

The more accessible locations will be monitored at least twice per day, to obtain more precise estimates of daily activities. Also, at least four turtles from each group will observed (remotely, with binoculars to avoid disturbing the animals) for at least one hr, and timed (with stop watches) between specific points to determine actual speeds during routine movements.

Each pathway map will thoroughly analyzed by computation of the following parameters: Net displacement (the direct distance between the original capture site and the final position (e.g. after 48 hr) of the turtle); mean vector length (which takes into account the frequency and angle of turns, and which can range from 0.0, for uniformly dispersed turning angles, to 1.0, for perfectly directional pathways); fractal dimension (which can range from 1.0 for a smooth linear pathway to near 2.0 for a random Brownian pathway); and sinuosity of the pathway (a measure of the frequency and extent of direction changes). The pathway parameters will be evaluated statistically, using ANOVA, to determine the significance of any differences between animals from grazed versus protected areas. We will also consider differences of pathway segments within each pathway relative to landscape and vegetation features.

(B). Thermoregulation:

Grazing livestock can significantly alter the near-ground microclimate of a grassland community by physical disruption of the soil and vegetation structure. Because of the profound effects of microclimate on the physiology and ecology of ectothermic organisms, such alterations could markedly influence the behavior and performance of the resident ectothermic animals. We will evaluate the significance of grazing-induced changed by constructing and comparing microclimate "maps" of grazed versus protected study plots. Although we will monitor light intensity and humidity, we will concentrate on mapping the thermal environment.

To achieve this objective, we will monitor operative environmental temperatures (T_e) using model animals consisting of an empty turtle shell (from museum specimens) lined with copper foil and containing a Stowaway data logger. At least four such models

will be constructed, and these will serve to define the equilibrium temperatures an actual turtle would experience at any given spot within its habitat at a specified time.

Microclimate mapping will concentrate on two of the representative and accessible locations used for the thread-trailing and observed behavior studies. The models will placed in a variety of microhabitats available to the turtles on the same days in both the grazed and protected sites. Using the data loggers, we we monitor each specific site over a 24 hr period with temperatures recorded every 10 min. Although we will monitor a variety of potential microhabitats, we will also place the models in specific spots as dictated by the behavior of the turtles. Box turtles characteristically construct shallow excavations called "forms" in which they remain overnight or, sometimes, for a day or several days. We will use the thread trails and behavioral observations to locate recently occupied forms and these will be monitored with the models as specific microhabitats selected by the turtles. In addition to the T_e models, we will monitor light intensity and humidity using Hobo dataloggers. These, along with the Stowaway loggers in the models, will be monitored every 10 min for 24 hr. Data from the loggers will be periodically down-loaded into a Macintosh laptop computer and we will make a back-up copy on a floppy disc.

These collective data, along with a map of landscape and vegetational features, will be used to evaluate the thermal quality of the habitat. We will attempt to document differences in thermal quality induced by grazing and to correlate, where possible, these differences with observed differences in movement patterns and other behaviors.

B. Results:

After appropriate statistical analysis as indicated above, the data will be compiled and displayed in a series of tables and figures. We will also construct vegetation maps of the study areas and we will display the trails resulting from the turtle movement studies.

C. Interpretation:

In the process of developing a scientific paper, we will evaluate our hypotheses and we will discuss these findings relative to grazing management of the refuge.

6. Cooperators:

Limited financial support for this study will be provided by the Department of Zoology, Miami University, Oxford, OH, and by a research grant from the College of Arts and Science at Miami University.

Grant support from the Explorers' Club is pending, and we will be applying for grant support from other agencies (e.g. the National Geographic Society).

7. Responsibility:

Dennis L. Claussen, Professor of Zoology, Miami University, Oxford, OH.
Michael S. Finkler, Doctoral student, Miami University, Oxford, OH

8. Costs: No costs will be incurred by the Fish and Wildlife Service.

9. Schedule: (All dates are approximate)
May 30 to June 20, 1995
May 30 to June 20, 1996
May 30 to June 20, 1997

10. Reports:

A final report will be filed with the Manager of the Ft. Niobrara-Valentine NWR by the 1st of April following each year of the study.

11. Publications: The results of this study will be published in refereed scientific journals (to be determined). Reprints of all published articles stemming from this study will be provided to the Manager of the Ft. Niobrara-Valentine NWR.

Submitted By: _____ Date: 3-31-95

Endorsement: _____ Date: _____

Refuge Manager Approval: _____ Date: _____

Regional Office Concurrence/Approval: _____

Date: _____

1. Title: Locomotor Performance of Reptiles of the Sand Hills of Nebraska

2. Project Number:

3. Objectives:

1) To determine how box turtles and lizards native to the Sand Hills are physiologically adapted for this environment. We hypothesize that these Sand Hill species will be more efficient at locomotion on both level and graded (uphill or downhill) sandy substrates than are their counterparts from other habitats.

4. Justification:

Although many studies (including several from our laboratory) have examined locomotion in reptiles, almost all of these have considered only horizontal locomotion on a firm substrate. Yet, in nature, many reptiles live in hilly or mountainous areas, and natural substrates can range from very firm (e.g. rock or compacted soil) to highly yielding (e.g. loose sand). From a locomotory perspective, animals are generally well adapted to the terrain and landscape within which they live. Our study will examine the locomotory adaptations of box turtles and lizards from the Sand Hills and compare these results with data from other reptiles. We will, for example, compare the responses of the ornate box turtle, *Terrapene ornata*, to the extensive data that we have already obtained on its woodland counterpart, the eastern box turtle, *T. carolina*. We will make similar comparisons (based on the published literature and studies in our laboratory) of Sand Hill lizards with other species from quite different habitats. These collective studies should elucidate the extent to which the reptiles of the Sand Hills are adapted, from a locomotory perspective, to their sandy and hilly habitat.

5. Procedure:

A. Methods and Materials:

I. Animal collection and maintenance:

During early June, we will collect 25 specimens each of the following reptiles: ornate snapping turtles (*Terrapene ornata*), lesser earless lizards (*Holbrookia maculata*), eastern fence lizards (*Sceloporus undulatus*), and six-lined race runners (*Cnemidophorus sexlineatus*). We have a Nebraska scientific collecting permit (No. 95-104) for these animals. The turtles will be collected by hand. The lizards will be collected by noosing and/or by bucket traps associated with drift fences. The bucket traps will have drain holes, will be shaded and will contain a damp sponge to prevent desiccation. All traps will be checked daily and will be removed at the end of the collection period.

The animals will be taken to our laboratory at Miami University, where they will be housed (each species separately) in large terraria with a sand substrate. The tanks will be kept in an environmental room with controlled temperature and photoperiod. Water and food (crickets, mealworms, etc.) will be provided *ad libitum*.

After all tests (see below) are completed, the animals will be maintained (with food and water) at progressively lower temperatures through the Fall and cold temperatures (i.e. 5 °C) through the Winter (to simulate natural hibernation). After a slow and progressive warming (to simulate early Spring) the animals will be returned to the Sand Hills in late May of the following year.

II. Animal testing:

This study will examine voluntary locomotion in *T. ornata* and will compare voluntary and forced (sprint) locomotion in the lizard species. All animals will be tested individually in a custom designed 2.5 m track fitted with infrared detectors (at 0.5, 1.0, and 2.0 m from the start) wired into an electronic timer. The starting end of the track will be blocked to ensure forward movement of the animal. For the voluntary runs, the observer will leave the room to avoid disturbing the test subject. If the animal fails to complete the run within 15 min, that trial will be terminated (to be repeated later). For the forced (sprint) runs (lizards only), the observer will stimulate the animals to maximum speed with hand movements or a light touch from behind. All tests will be videotaped by means of an overhead camera wired to a Magnavox recording observation system.

For comparative purposes, all animals will be tested on both firm (wood) and sand substrates. All animals will also be tested on both up and down slopes (i.e. at track angles of 0°, ± 15°, ± 30°, ± 45°, and ± 60°).

In addition to speed, we will evaluate other parameters such as stride length and stride frequency and we will consider the effects of body mass on locomotor performance. We will use least squared mean (LSM) on statistical analysis system (SAS) on each of several measured parameters to eliminate possible effects of individual variance. We will supplement these analyses with analysis of covariance (ANCOVA) or two-way analysis of variance (ANOVA) where appropriate.

B. Results:

After appropriate statistical analysis as indicated above, the data will be compiled and displayed in a series of tables and figures. We will also compare our data with studies of other reptiles (from our laboratory and elsewhere).

C. Interpretation:

In the process of developing a scientific paper, we will evaluate our hypotheses. We will discuss these findings relative to the variable topographic and landscape features (e.g. sparse versus heavy vegetation cover, blow-outs, etc.) of the Sand Hills. These data may help to explain the distribution of these various species within the Sand Hills and thus may have implications for managing these animal populations.

6. Cooperators:

Financial support for this study will be provided by the Department of Zoology, Miami University, Oxford, OH.

7. Responsibility:

Dennis L. Claussen, Professor of Zoology, Miami University, Oxford, OH.
Michael S. Finkler, Doctoral student, Miami University, Oxford, OH

8. Costs: No costs will be incurred by the Fish and Wildlife Service.

9. Schedule: (All dates are approximate)

May 30 to June 20, 1995 - Collection of animals, return to research laboratory
June 22 to November 30, 1995 - Testing of animals
November 30, 1995 to May 30, 1996 - Animal maintenance and over-wintering
May 30, 1996 - Return of animals to the Sand Hills

10. Reports:

A final report will be filed with the Manager of the Ft. Niobrara-Valentine NWR by the 1st of April, 1996

11. Publications: The results of this study will be published in refereed scientific journals (to be determined). Reprints of all published articles stemming from this study will be provided to the Manager of the Ft. Niobrara-Valentine NWR.

Submitted By: _____ Date: 3-31-95

Endorsement: _____ Date: _____

Refuge Manager Approval: _____ Date: _____

Regional Office Concurrence/Approval: _____

Date: _____