

**Research Statement by Roger A. Anderson, Biology Dept, Western Washington University****The questions I ask**

Vertebrates are large creatures with complex behavior. Many are capable of remarkable feats of sensation, perception, and athletic performance in water, on land, and in air. The general questions I ask about vertebrates include:

- What are the ecological and evolutionary causes of the diverse and prodigious abilities within and among the major taxonomic groups of vertebrates?
- How have each of the major fully terrestrial vertebrate taxa (lizards-and-snakes, birds and mammals) come to be the way they are and live when and where they do?
- How do the behavioral, physiological, and morphological differences among individuals and among populations of lizards relate to the ecological challenges encountered by those individuals?

**My field of research**

My field of research is evolutionary ecology, with more of a focus on evolutionary autecology. Evolutionary autecology is the integrated analysis of the behavior, morphotype, and physiology in both ecological and evolutionary contexts in an endeavor to understand adaptation, adaptedness, and adaptability. Adaptation is the evolutionary process of becoming adapted; adaptedness is the nature of the adaptive trait which permits fitness; adaptability (phenotypic plasticity) is the flexibility of the organism to display adaptedness to differing or changing environmental conditions.

**My research paradigm**

Pursuit of an integrated analysis of animals requires some simplifying assumptions or general tenets. The most useful autecological paradigm or theoretical basis for me has been that an animal has four basic tasks that must be integrated into an adaptive complex:

- (1) acquire and utilize food,
- (2) avoid, evade, and deter predators,
- (3) acquire mates and reproduce,
- (4) cope with abiotic stresses and avoid abiotic extremes.

My major research hypothesis is that food acquisition mode (FAM) is an adaptive syndrome. An adaptive syndrome is a coordinated set of characteristics (adaptive traits) associated with an issue of overriding importance (core adaptation) to an organism. Hence, FAM is a coordinated set of behavioral, physiotypic, and morphotypic characteristics that are integrally involved in the search, detection, capture, and eating of food. The hypothesis that FAM is an adaptive syndrome has a three-part ecological assumption: the principal adaptations of food acquisition are to 1) the prey types, 2) the substratum on which those prey are sought and captured and 3) the nanohabitat (including the abiotic challenges of the medium, e.g., air, water, soil) and microhabitat in which those prey are sought and captured.

FAM may be largely responsible for the unique patterns of body forms and sizes (morphotypes), physiotypes, and behaviors we observe in a population and species, and even genus. The other three tasks may involve adaptive traits that are consequential constraints on the particular food acquisition mode rather than as coequal adaptive traits. Predators, mate competitors, and the thermal environment are obvious constraints on food acquisition behavior, and are probably important constraints on the physiotypes and morphotypes as well. Nevertheless, adaptive traits for either of the four tasks serve to uniquely define the adaptive zone of the population or species.

### **The animal systems I use in my research**

Among vertebrates, I have chosen lizards as my model research system. Lizards are an intermediate evolutionary grade among vertebrates. They are largely terrestrial, and have daily metabolism and exercise capacity exceeding amphibians. Some lizards are rather mammal-like in their peripatetic behavior; indeed, at maximum exercise some lizards achieve the metabolic rates of resting mammals and birds. In warm, arid and semi-arid ecosystems, lizards are abundant, easy to observe, easy to capture-mark-release-recapture; thus, lizards are propitious animals to study under field conditions. They also are easy to maintain in the laboratory.

### **My research methods**

My research with lizards incorporates 1) observational-descriptive studies under natural unmanipulated field conditions, 2) experiments on lizard locomotory performance in field mesocosms, and 3) experiments in the laboratory on locomotion, bite force, anti-predatory behavior, and effects of temperature on learning in lizards. My research spans organismal biology, population biology, and community ecology.

Fruitful avenues of research I have chosen focus on the relationship of food acquisition mode (FAM) to lizard ethotype (behavior), physiotype, and morphotype, that is, the ethophysiomorphotype or EPM. I compare among lizards varying in FAM, their (1) locomotor abilities, including cost of locomotion, acceleration, sprinting speed and distance, running agility, and recovery from exhaustive exercise, and (2) compressive bite force.

Please also refer to:

- Evolutionary ecology of lizards in the northern Great Basin desert scrub
- Lizard conservation biology in the Florida scrub

## **Evolutionary Ecology of lizards in the northern Great Basin Desert Scrub**

### **Introduction**

Students and I have been performing a multi-year study on individual growth and annual survivorship, population structure, and population density of lizards. This study site is in the Great Basin desert scrub, specifically in the Alvord Basin, at the north end of the Pueblo Valley, Harney County, OR. We are building multi-year data sets that will provide robust comparisons among-habitats and among-years for each species' population. Documenting the spatiotemporal patterns of lizards and developing an understanding of the causes of these patterns is a venerable, long-standing goal of ecological research and conservation biology.

The work is focused on a 9 hectare area so that adequate sample sizes of most lizards are obtained. We already have a detailed knowledge of the central two hectares of the study area. The substratum and perennial plants are mapped and measured, so microhabitat choices of lizards can be detailed. The three lizard species we study most intensively are the western whiptail *Aspidoscelis tigris*, the long-nosed leopard lizard *Gambelia wislizenii*, and the desert horned lizard *Phrynosoma platyrhinos*, although sagebrush lizards *Sceloporus graciosus*, and side-blotched lizards *Uta stansburiana* also occur on plot.

### **Summer Field Research Courses**

In addition to the research being accomplished on lizard ecology in the Alvord Basin, another primary goal of this work is to provide about a dozen undergraduate college students with a comprehensive field research experience over a three-week period in late June through mid-July. The research opportunity is provided via two field research courses, Ecological Methods, and Research in Reptile Ecology. A major focus of student effort for Research in Reptile Ecology is to observe lizards during their activity periods and to learn to identify and quantify spatiotemporal patterns of lizards. In Ecological Methods the students assess the proximate, ecological causes (e.g., microclimate conditions and food availability) of those lizard spatiotemporal patterns. We use a variety of methods to measure the distribution and abundance of plants, arthropods, and lizards among adjacent "habitats."

#### **Student research in the Ecological Methods course**

Five examples of recent student team research illustrate the activities for Ecological Methods. First, our census of perennial plants, wherein we precisely identify, measure, and map plants, enables us to compare plants visited by lizards v. plants available to lizards. These plants putatively are important as a source of prey, for thermoregulation, and for avoidance of predators. Second, we use a variety of methods and instruments to characterize the spatiotemporal patterns of thermal microhabitats and thermal nanohabitats. Third, our pit trapping of arthropods permits us to analyze the spatial patterns of prey availability for lizards—especially for *Aspidoscelis tigris* and *Phrynosoma platyrhinos*—among mesohabitats, microhabitats, and perennial plants. Fourth, direct counts of ant colonies on plot and our documentation of temporal patterns of ant activity near the

colonies and on annually-studied standard plots are collectively considered along with the data on ants from pit traps to enable us to document ant availability to the ant-eating specialist, *P. platyrhinos*. And fifth, our direct counts of grasshopper nymphs and adults on shrubs at annually-studied standard plots in each of three mesohabitats documents the distribution and abundance of the major prey type in summer for *G. wislizenii*. Our among-year patterns in distribution and abundance of arthropods have correlated consequences for lizard body size, body mass per unit SVL, and for lizard population structure and population density.

## **Student research for the Research in Reptile Ecology course**

### **Research projects using the desert horned lizard *Phrynosoma platyrhinos***

Recent student team research projects for Research in Reptile Ecology focus on the three common lizard species. Students have been integrally involved in the use of radiotransmitters on *Phrynosoma platyrhinos*. Radiotelemetry increases our frequency of encounter with these lizards, thereby permitting us to perform a landmark study of prey availability versus prey choice. Radiotelemetry combined with powder-tracking allows precise documentation of microhabitat and nanohabitat choice and visits to ant colonies by *P. platyrhinos*. The *P. platyrhinos* principally eat ants, and the diet of the lizard is discerned by collecting its fecal pellets, which are essentially just ant heads. We also have documented mesohabitat and microhabitat use of *P. platyrhinos* and we have compared its activity patterns with the spatiotemporal patterns of distribution and abundance of ants. These spatiotemporal data along with the lizards' diets provide the basis for a powerful analysis. In summer 2008 we again will use radiotelemetry and powder-tracking to study the spatiotemporal distribution of *Phrynosoma platyrhinos*; we will locate each individual with a transmitter at least 6 times daily for at least 6 days, and we will perform focal observations on individuals as they forage. In my view, our studies of prey availability to *P. platyrhinos* and prey use by *P. platyrhinos* are setting new standards for field observational research on lizards.

### **Research projects using the long-nosed leopard lizard, *Gambelia wislizenii***

Another team research project involves focal observations of *Gambelia wislizenii*; in some years we use copper models of *G. wislizenii* to predict the thermal consequences for lizards in the microhabitats they use versus the microhabitats they do not use. In 2005, for example, we had more than 900 sightings of *G. wislizenii* for which we documented microhabitat use and lizard behavior. We now know and understand enough about the effects of temperature on *G. wislizenii* activity so that we can more effectively interpret the spatiotemporal patterns of *G. wislizenii* related to the relative availability of lizards and grasshoppers, the two principal prey types eaten by *G. wislizenii*. Students also have been performing prey pursuit and predator evasion experiments with *G. wislizenii*; these projects are revealing much about the locomotory capabilities of these lizards.

### **Research projects using the western whiptail lizard, *Aspidoscelis tigris***

Students also have also documented the peripatetic movements of *Aspidoscelis tigris* and have documented its response to an ersatz predator, a pursuing human. Because *A. tigris* moves so much as it forages, it encounters two fast-moving ambush predators *G. wislizenii* and the striped whipsnake *Masticophis taeniatus*. We have had fun studying how *A. tigris* gets itself into and out of trouble. In 2007 we studied sprinting performance of the fast-running *A. tigris* with the sprinting of its major predator, *G. wislizenii*. Each lizard of both species was chased individually down a long narrow field enclosure that we call a raceway.

### **Graduate Student Research on Lizards in the Alvord Basin**

Three students who have obtained master's degrees at Western Washington University in recent years worked with lizards in the Alvord Basin. Their thesis citations are:

- Steffen, John E. 2002. The ecological correlates of habitat use for the long-nose leopard lizard, *Gambelia wislizenii*, in southeast Oregon. M.S. thesis, Western Washington University.
- Rose, Eleanor L. 2004. Foraging behavior in *Gambelia wislizenii*, the Long-nosed Leopard Lizard, in Harney County, Oregon. M.S. thesis. Western Washington University.
- Colon, Ellen W. (2006). Locomotory evasion performance and foraging activity in the Western Whiptail Lizard, *Aspidoscelis tigris*. M.S. thesis. Western Washington University.

### **Future Field Research Plans**

I am developing plans for future NSF funding. The research will be an integrated study of behavioral, physiological, and morphological features that are predicted to correlate with outcomes of natural selection. This research may be an advance in natural selection studies in the wild because it takes a comprehensive approach at relating the reproductive outcome of several major attributes of an animal instead of focusing on a single, somewhat arbitrary trait among many.

Students and I will measure the locomotory capabilities of lizards and analyze those locomotor capabilities in the context of ecological challenges these lizards face. We also will document the growth, survivorship, and reproductive success of these same lizards by a several-year capture-mark-release-recapture study of these individuals and by documenting the parents of the yearling lizards with the use of microsatellite DNA.

### **The focal lizard species**

The focal species for this ambitious research is the western whiptail lizard *Aspidoscelis tigris*. It forages widely across the habitat and frequently exposes itself to pursuing predators. The locomotory ability of *A. tigris* to evade predators should be related to 1) sprint acceleration and velocity, 2) how long high velocity can be maintained, 3) the ability to turn at high speed, 4) the time course of recovery from oxygen debt, and 5) the length of time after an intensive sprinting bout until maximum or near-maximum sprinting performance again can be achieved. Presumably fitness should be related to locomotory capabilities of *A. tigris*. Of course, because *Gambelia wislizenii* is a major predator on *A. tigris*, the speed and quickness of *G. wislizenii* should be related to what is required to capture its prey.

### **Integrating Behavior and Physiology**

Comparisons among individual *A. tigris* by behavioral assays for relative levels of risk-prone v. risk-averse behavior (RP v. RA) and by whole-animal physiological assays (with correlated morphotypic features) of the same individuals for abilities to sprint and recover from exercise (High Risk Capacity v. Low Risk Capacity, HRC v. LRC) will be made along with documentation of their year-to-year survivorship and reproductive success of those individuals. The reproductive success of an individual will be assessed by using microsatellite DNA to compare its genetic identity with the genetic identities of individuals that may be its offspring—juveniles and young adults in the next year.

### **Studying Natural Selection**

Individual *A. tigris* on a nine hectare site in the Alvord Basin of southeastern Oregon will be examined for an array of microsatellite DNA markers. The genotypes of each new individual will be compared with its possible parents from years previous to determine which sets of parents had the greatest reproductive success. Each year an individual is alive it will be tested for behavioral and physiological-morphological features and then characterized for relative RP v. RA and HRC v. LRC.

### **Preliminary studies are scheduled for summer 2008**

I have developed laboratory techniques for assessing RP v. RA and HRC v. LRC for lizards. I also developed tests for HRC v. LRC in *Aspidoscelis tigris* in the field during summers 2001-2004 and again in 2007, in concert with my summer field classes, Ecological Methods and Research in Reptile Ecology. In 2004 I began developing the field techniques for RP v. RA. In 2008, I will begin preliminary tests of the combined assays, along with obtaining tissue samples of individual lizards (as I have done since 2004) so that I may obtain genetic data on individuals and their parents.

## **Lizard population dynamics in a controlled landscape of Florida Scrub**

### **General Introduction**

As is the case for many ecosystems, the Florida scrub ecosystem—formerly more widespread—is being broken into small, isolated fragments. The geographic distribution of Florida Scrub now comprises a patchy array of island-like ecosystems in the higher, drier locales of Florida that are prime real estate land. Researchers and land managers have urgent questions about (1) the ability of organisms that are not especially mobile to traverse the distances between habitat fragments, and (2) the consequences of these isolated fragments for the population size and genetic diversity of these organisms.

I am interested in experimentally investigating the spatiotemporal patterns of genetic diversity and sizes of lizard populations across a managed landscape of Florida Sand Pine Scrub (FSPS). This opportunity to perform a landscape-level experiment is on the Ocala National Forest (ONF), in north-central Florida. Because the FSPS is being managed as a sand pine forest landscape rather than as the natural landscape dominated by younger regenerating scrub, the consequences for animals and plants that are endemic to young and open scrub (harboring the most endemics of any habitat-type in Florida) warrants investigation.

### **How the scrub landscape has changed on the Ocala National Forest**

The FSPS on the ONF was a fire-dominated landscape as late as 70 years ago, but after a catastrophic wildfire in 1935, control of the landscape to prevent fires became a priority. Natural fire frequency in Florida Scrub is thought to be quite variable, from 10-100 years, but a reasonable estimate for fire frequency in the Florida Scrub where sand pine is common, hence known as Florida Sand Pine Scrub, is about 20 years. Size, form, and completeness of burned areas also varied considerably. In the 1950s the increasing value of sand pines to the wood pulp industry made timber harvesting and re-planting sand pines on each stand another priority. The ONF now is administratively subdivided into numerous “stands,” with average stand size of about 35 hectares. Each stand is surrounded by about 5 other stands. The sand pines now are harvested on about a 40-45 year cycle; most stands have been logged at least once already. Thus, natural catastrophe of fire has been replaced by the scheduled anthropogenic catastrophe on “stands” created by 1) logging, 2) “spot-burning” piles of sand pine tree tops, and 3) roller-chopping to reduce oak competition with sand pines. Moreover, rapid regeneration of sand pine and dominance of sand pine on each stand is assured by the planting of sand pines at high population densities.

Young, open scrub, which is the prime habitat of many endemic animals and plants, is available in the ONF to these native organisms for only 4-6 years; then these creatures must face the challenge of dispersal to non-adjacent stands. Each stand of young regenerating Florida scrub is a veritable island in a sea of mature sand pine forest because of a combination of factors: 1) the adjacent stands are virtually closed canopies that are

unsuitable for the open scrub endemics 2) there are few nearby non-adjacent stands, 2) these stands are suitable for young scrub endemics for only a short span of time, and 3) the time intervals between harvesting of sand pines are relatively long.

### **Lizards as exemplars of Florida scrub endemics**

As the Florida Scrub is disappearing, so may be its many endemics. One well known scrub endemic is the Florida Scrub Lizard, *Sceloporus woodi*; populations of *S. woodi* are dwindling with the evanescence of the Florida Scrub. On some locations in the ONF, *S. woodi* seems to be common, and it is this putative understanding that has prevented state and federal authorities from designating the lizard as endangered or threatened. Although the last large remaining area of Florida Scrub is on the ONF, the young, open scrub on the ONF has been reduced to small temporary islands of suitable habitat, because, unlike many of the smaller patches of scrub in other parts of Florida, the sand pines on the ONF flourish and modify the open shrubby aspect of the Florida scrub rather quickly without frequent fire. Hence, even when logging and post-logging site preparation on a “stand” renders it a suitable “habitat island” for Florida scrub endemics, the habitat island becomes unsuitable in a few years. This situation may be problematic for scrub endemics that are poor dispersers. *Sceloporus woodi* has only modest vagility; these lizards are likely to have difficulty encountering new habitat islands. Hence, studying the consequences of these spatiotemporal habitat islands for population dynamics and genetic diversity of Florida Scrub Lizards on the ONF and comparing the consequences for at least two other lizard species, one with greater putative vagility, and one with lesser vagility should promote more effective management of scrub endemics on the ONF and for scrub endemics that are declining even more rapidly elsewhere (Enge et al, 1986).

### **How studying lizards will help improve biodiversity on the ONF**

We expect that this knowledge of lizard populations will improve our understanding of the effects of current timber management practices on biodiversity in the ONF and may enable us to suggest ways for timber management practices to increase biodiversity. The link of this study of lizards to conclusions about biodiversity can be seen in three ways.

#### **Rationale for Lizards, Reason One**

First, because lizards are a numerically abundant component of the increasingly threatened FSPS ecosystem, many species of vertebrate predators in the FSPS depend upon these lizards for food. Thus, these predators may be quite sensitive to changes in lizard populations. Certainly some lizard species, such as the Florida scrub lizard *Sceloporus woodi* and the six-lined racerunner *Aspidoscelis sexlineatus* are much more tractable for studies of distribution and abundance than are their predators. These lizards are day-active animals

that live in relatively open habitats so they are easy to locate and observe; moreover, these lizards are highly suitable for capture-mark-release-recapture studies.

### **Rationale for Lizards, Reason Two**

A second reason lizards are such a useful component of the Florida Scrub biota to study is related to their intermediate levels of vagility, the ability to emigrate to the suitable habitats (young regenerating stands of FSPS). The vagility of lizards may be greater than that of some of the other components of the FSPS community, particularly FSPS endemics such as nonvolant insects and annual plants. If it is clear that the vagility of these easy-to-study animals, the lizards, is inadequate to quickly generate robust populations in the young regenerating stands of FSPS under current landscape patterns, then the consequences for the harder-to-study, less vagile organisms may be even greater under those spatiotemporal conditions.

### **Rationale for Lizards, Reason Three**

The third reason that study of lizard population dynamics is compelling is because hypotheses about the consequences for genetic diversity in lizard populations can be tested in the same research. The study should identify the spatiotemporal patterns of stands of young FSPS that are likely to generate (1) poor colonization and genetic bottlenecks, hence reduced genetic diversity, versus (2) robust colonization and no genetic bottlenecks. Again, if genetic bottlenecks are occurring in lizards, then isolation of stand populations and the genetic biodiversity consequences for less vagile organisms may be even greater.

### **Summary rationale for using lizards as exemplars**

A working assumption is that it is prudent to manage the ONF for high migration rates of lizards among young stands of FSPS. In light of the importance of lizards as (1) prey to predators such as the scrub jay, gopher frog, and snakes (eaten by the endangered indigo snake), and (2) indicators of the consequences of stand dynamics for small, low-vagility organisms, then these lizards are very useful management indicator guild for the FSPS. We first must learn about the population dynamics of lizards on the ONF.

## **The plan for future research on conservation biology of lizards on the ONF**

### **The general research plan**

I plan to track the population structure of colonizing lizards in isolated regenerating stands (“habitat islands”) of Florida sand pine scrub, to assess the reproductive success of the founders, and to measure the resulting genetic diversity of the scrub island population. The population sizes and genetic diversity of lizards will be compared among young scrub islands in the sea of mature forest. These scrub islands will vary in distance from their colonizing population sources and in numbers of corridors from those potential population sources. I will compare among three species of lizards to ensure robust analyses. These three species vary in

their ability to disperse and in their rates of reproduction, thus they are representative of an array of species of plants and animals that are restricted to open scrub habitats.

### **The lizards we will use in the study**

In each sampled island of young regenerating Florida scrub in the Ocala National Forest we will document the colonization and population growth in each of three species of lizards: *Sceloporus woodi*, *Aspidoscelis sexlineatus*, and *Eumeces egregius*. These three lizard species are prevalent reptile components of young scrub. For each species, we will also examine the genetic diversity in the colonizers and their progeny, and in the scrub island population at its peak and during its decline and dispersal period.

### **The field research methods**

The populations will be monitored from time of arrival, through the population increase associated with reproduction on site, then through the inevitable population decrease and dispersal. The lizard population patterns follow the vegetation pattern. The sparsely vegetated, sunny site first attracts colonizing lizards, then supports growth of the lizard community as the high productivity of the vegetation supports abundant arthropod prey base for the lizards. Then as the vegetation fills in to a closed canopy, about 6 years since logging, it becomes inhospitable to these three species of lizards that use predominantly young, open scrub; thus the lizards must leave and disperse down narrow sand road corridors toward other distant young scrub islands.

### **The study sites on the ONF**

We will need to compare population densities and genetic diversities of lizards in (1) young colonizable stands, (2) older declining stands as population sources for the younger stands, and (3) corridors varying in length and breadth. In general, there will be three comparison groups differing in corridor characteristics. One source group of older stands (6-9 yrs) from which lizards are expected to emigrate is connected to younger stands (0, 1, and 2 years since clearcut) via broad, very short corridors (*i.e.* stands are adjacent and across a sand road), thereby providing migration opportunities that are virtually maximal. The other comparison group is connected to younger stands via short narrow corridors (sand roads of 10-50 m). These narrow, near-contact zones provide fewer migration opportunities, but would represent short corridors and point contacts, wherein migration distance between stands is near the minimum. Thus, migration opportunities through these short, narrow corridors would be expected to be moderately high. A third comparison group of long (>100m), narrow migration corridors, the sand roads, will also be necessary to examine.

### **Sample Sizes**

Corridor comparison groups have at least three replicates each for 0, 1, and 2 year-old stands, colonizable sinks of approximately equal size. Hence, 27 total stands will be investigated. If the logistics of investigating all 27 stands is not possible, then perhaps for the long, narrow corridor comparisons we could use only stands of 0 and 1 year, resulting in 24 total stands.

We will use three 30 m x 30 m plots per stand to determine population densities. We infer from results of prior population density analyses (Anderson and Tiebout 1993, and 1995 cost share report) that three 30 m x 30 m plots per stand will be adequate sizes and replicates for determining lizard population densities.

We will use standardized search-capture-mark-release-recapture methods (Anderson and Tiebout 1993). Some of the more important ecological parameters of the lizard populations that will be compared among sites are: population density, size (age) and sex structure in the population, condition index (mass to body length ratio) of captured individuals, and female reproductive condition. We will examine founder effects on heterozygosity level in the populations, using microsatellite DNA.

### **When the field work will occur**

Field surveys of the sites will occur from March 1 to November 1 each year, to ensure that adult activity seasons and reproductive seasons are monitored so adult growth, reproduction, survivorship and dispersal can be documented and that juvenile growth and survivorship also can be documented. The frequent capture-mark-release-recapture efforts over a long term should be able to document individual patterns of mortality and dispersal on stands and corridors.

### **Using microsatellite DNA**

Microsatellite DNA analyses are useful and cost effective for measuring relatedness and parentage among individuals, for studying mating systems in animals, and for measuring genetic diversity in a population. If enough different primers are used (at least six), the parents of individuals can usually be identified from a fairly large pool of individuals. It is not unreasonable to expect to find approximately two dozen unique primers in lizards; each primer usually has two or more microsatellites associated with it. Statistically significant genetic variability among small populations can be documented with microsatellite DNA.

The procedure for obtaining microsatellite DNA markers for genetic studies in small populations requires (1) extraction of DNA, (2) heating DNA to cause the double helix of DNA to separate into two strands, then (3) a primer molecule (an oligonucleotide) is used to initiate DNA synthesis on a particular location in a single stranded DNA, whereupon small fragments of nuclear DNA, called "microsatellite DNA" associated with a particular primer will be copied from the DNA. Then (4) the microsatellite DNA can be "amplified," that is, increased in abundance via a polymerase chain reaction (PCR). Comparisons among individuals animals can be

made for their microsatellites associated with the primer by (5) using standard methods of electrophoresis to separate these microsatellites. The microsatellites move down a gentle electrical current through a semi-solid matrix or gel, then a stain is applied to reveal how far the microsatellite has migrated down the gel. Different microsatellites migrate different distances down the gel.

Individual lizards will have particular microsatellite DNA fragment lengths associated with the primer, and there will be variation in the population for these fragment lengths. Similarity among individuals in a population for microsatellites associated with a particular primer commonly varies from 20 to 80% sharing the same microsatellite. Thus, analyses of genetic similarities and differences among individuals in the population can be performed.

### **General comments about project logistics and outcomes**

Investigating the numerical and genetic consequences for an animal population when a temporal series of habitat islands is created in an otherwise uninhabitable landscape requires a prodigious research effort. I expect that the combined field and laboratory research for this NSF-funded project will require at least four years, with one post-doctoral associate, two technicians, and teams of students as research volunteers to accomplish the annual tasks in the field. Lab work on the genetic patterns of lizards associated with stand histories will be the focus of a post-doctoral associate and technician at Western. The results and conclusions of this work should be eagerly received by population biologists and conservation biologists, and by large governmental land management agencies, such as the USDA Forest Service, the USDI Bureau of Land Management, and the USDI National Park Service.

### **Past conservation biology research on lizards of the ONF**

In addition to preliminary studies of lizard population structure and population dynamics on small selected sets of regenerating stands by Harry Tiebout and me in the early 1990's, and two graduate students Darcie Johnson and Chris Fabry have performed their thesis research on lizard population patterns on young and maturing stands on the ONF. I spent February-May, 2005 on the ONF investigating the logging history and management plans and the efficacy of field work on a landscape level.