ARIZONA GAME AND FISH DEPARTMENT
HABITAT PARTNERSHIP COMMITTEE
HABITAT ENHANCEMENT AND WILDLIFE MANAGEMENT PROPOSAL

Game Branch / HPC Project Number:	15-704

PROJECT INFORMATION

Project Title: A framework for estimating elk abundance in Arizona

Region and Game Management Unit: Regions 1, 2; GMUs 1, 7E (Fig. 1; also 3C/4A/4B included in 2014 surveys; see project area below)

Local Habitat Partnership Committee (LHPC):
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Was the project presented to the LHPC?
YES[] **NO**[X]

Has this project been submitted in previous years? **YES**[X] **NO**[]
If Yes, was it funded? **YES**[] **NO**[X]→ **Funded HPC Project #(s)**:

Project Type: Research and surveys

Brief Project Summary: AZGFD is tasked with managing Arizona elk populations for the greatest benefit to the populations, their habitat, and human recreation. The Department desires to estimate elk population size as accurately as possible, but that can be very difficult when working with a wide-ranging species that inhabits a variety of habitats, especially where the ability to detect animals is also highly variable. The Department has used a variety of methods to estimate elk abundance, but the relative accuracy and precision of these methods has not been well understood. This project is evaluating the accuracy, precision, feasibility, and cost of various methods for estimating elk abundance. We are requesting funds for an additional year of surveys to increase our sample size and the robustness of our analyses.

Big Game Wildlife Species to Benefit: Primarily to benefit elk management, but may also be beneficial to management of other big game animals (e.g., mule and white-tailed deer) that the Department surveys with similar methods.

Implementation Schedule (Month/Day/Year):

Project Start Date: April 1, 2014

Project End Date: June 30, 2017

Environmental Compliance:
NEPA Completed: Yes[] No[] N/A[X]
Projected Completion Date: _____

State Historic Preservation Office - Archaeological Clearance:
Yes[] No[] N/A[X]
Projected Completion Date: _____

Arizona Game and Fish Department EA Checklist: **M14-0114023013**
To be Completed by: Is completed
Projected Completion Date: _____

PROJECT FUNDING

Special Big Game License Tag Funds Requested:	**$** 100,000
Cost Share or Matching Funds:	**$** 742,168.54
Total Project Costs:	**$ 842,168.54**

PARTICIPANT INFORMATION

Applicant (please print):	**Address**:	**E-mail**:
Larisa Harding, WMRS	Research Branch	lharding@azgfd.gov

Telephone: 623-236-7301	Arizona Game and Fish Dept. 5000 W Carefree Hwy Phoenix, AZ 85086	**Date**: 31 August 2015

AGFD Contact and Phone No. (If applicant is not AGFD personnel):

Project has been coordinated with:

- USFS personnel on Coconino and Apache-Sitgreaves National Forests;
- AZGFD staff: Game Branch: Brian Wakeling, Amber Munig and regional Game Specialists

NEED STATEMENT – PROBLEM ANALYSIS:

The Arizona Game and Fish Department ("Department") is tasked with managing the state's elk population for current and future generations. In order to make decisions regarding elk management and to set appropriate harvest limits, the Department has used a variety of approaches over the years to monitor elk populations. Recent management concerns, such as those related to browsing impacts on aspen regeneration, potential changes to elk carrying capacity following large fires, or predator-prey relationships with the reintroduction of wolves, have led the Department to conclude that is necessary to conduct an evaluation of available survey methods to identify the most robust methods for estimating elk abundance in Arizona.

Obtaining a reliable estimate of elk abundance is challenged by a number of obstacles. Population abundance estimation using mark-recapture approaches is an established method used to estimate abundance of many species. However, in the case of elk, it would require application of tracking collars on a large number of elk. This approach has not been feasible due to cost constraints, and it may not represent a feasible option for long-term population monitoring because it would require the maintenance of a substantial number of collared animals throughout areas to be surveyed. However, thanks to the last few years of increased availability of Pittman-Robertson (PR) funds, the Department has capitalized on the unique opportunity to collar a large number of elk, conduct a mark-recapture estimate, and test several other survey methods against this estimate.

With increased PR funding the last two years, we have deployed over 90 collars on elk in two game management units (GMU), and we are using these animals to evaluate various survey approaches. As part of this evaluation, we have conducted extensive aerial surveys in the 2 units where we deployed collars to test survey method efficiencies. To date, we have surveyed a large area in GMU 7E for 2 years and a reduced survey area in 2014 and a larger portion of GMU 1 in 2015. Additionally, we took advantage of a large number of elk collared for highways research and surveyed a large area in GMU 3C/4A-B in 2014 before their collars dropped in May 2015.

While the increased PR funding has provided the framework for increased collars and has paid for surveys to date, another significant challenge to survey effectiveness is animal detection or sightability. For instance, animals that may be readily seen in pinyon-juniper vegetation may be completely hidden in mixed conifer or aspen habitats with thick canopies and therefore go undetected in regular aerial surveys. One important part of our project is to develop (and test) correction factors that may be applied to future surveys, and this requires data on a large sample of observed versus unobserved (missed) collared animals within the survey area. We have been building this sample size with the surveys flown to date, but the movement of some elk out of the survey area has reduced the planned sample size. We have determined that our analyses and evaluation of methods would be improved if we could increase this sample size with the addition of additional surveys. The collars we have deployed have a limited

lifespan. Roughly 1/4 are GPS satellite collars that will be active on animals until May 2017, at which time they are scheduled to drop, and 3/4 are VHF collars that will stay on animals until June 2020. We are proposing to conduct a third year of surveys in the fall of 2016 to make use of the full set of available collared elk.

PROJECT OBJECTIVES:

The objectives of our overall study are to:

1. Provide a literature review and evaluation of potential survey methods for estimating elk abundance in Arizona;
2. Conduct an empirical comparison of the accuracy and precision of a subset of candidate methods for estimating elk abundance in Arizona, including abundance estimates obtained from a concurrent mark-recapture survey;
3. Present recommended and alternate survey methods to estimate elk abundance in Arizona with a focus on:
    a. Resulting accuracy and precision of abundance estimates in a variety of habitat types;
    b. Resource needs (costs) to conduct and analyze survey results.

This grant proposal specifically addresses Objectives 2 and 3.

PROJECT DESCRIPTION AND STRATEGIES:

We conducted a literature review of potential estimation methods and identified six primary approaches to evaluate their utility in Arizona. Potential methods to assay elk populations include those that provide both relative and absolute estimates of population abundance. Relative estimates provide information on population trends (e.g., if the elk population is increasing or decreasing). Absolute estimates provide more detailed information, such as how many elk are present in a given area at a given time. Given the Department's need for robust estimates of elk population size, our project focuses on methods that are capable of producing absolute estimates of elk abundance.

As noted above, we are using a traditional mark-recapture method (Lincoln-Petersen mark-recapture approach) as the comparison standard, made possible by PR funding increases that allowed us to purchase GPS collars for a large number of elk. We delineated test areas in three regions, and captured and collared a large number of elk in each test area. Using these "marked" animals, we are generating a population estimate for each area using mark-resight methods. These estimates will then be compared with estimates generated using additional methods, and we will compare and quantify the accuracy, precision, and necessary resources associated with each of the following methods.

We will evaluate population abundance estimates from population models, which use demographic parameters, such as survivorship or fecundity at one time point, to estimate other parameters, like population size, at a successive time point. Several western states use a population model, and the Department currently uses it to determine trends in elk populations rather than estimating absolute numbers. We will also evaluate the simultaneous double count method, in which one observer first 'marks' and a second observer then 're-sights' animals observed on the same survey to estimate abundance. The Department has used this approach on several species, such as bighorn sheep, since 2001. A third approach we will evaluate relative to the mark-recapture is a sightability model. Sightability models are specifically designed to overcome potential detection biases in animal surveys by quantifying the probability of detecting individuals based on attributes such as group size, composition, behavior, habitat type, time of year, weather conditions, and observer experience. Moreover, sightability models provide a correction factor for population estimates by compensating for the failure to detect all animals during a survey. Once developed, sightability models are typically applied to future surveys without continued reliance on radio-collared animals under the assumption

that conditions present when the model was developed continue to be the case in future surveys. An appropriate sightability model, however, does not currently exist for elk in Arizona or the southwestern USA. A last estimation technique we will consider is a hybrid model that is a combination of double count and sightability methods. The hybrid model pulls from the strengths of each method to counter the bias inherent when each approach is used in isolation, and it is purported to provide greater sensitivity in the detection of temporal changes in population abundance.

Additional details on each of the survey methods and analytical comparisons between them can be found in the complete study design (available on request).

Field methods

We captured most elk with Clover traps and some via aerial darting, to fit them with collars. Capture sites were identified based on their location within habitat types that elk frequent, an effort to distribute trap sites throughout the study area, available water sources, known elk feeding areas, accessibility, and historical elk location data from telemetry or GPS monitoring (Fig. 2).

Because VHF collars are less expensive than GPS collars, we primarily deployed VHF collars to maximize the number of collared animals within each of our proposed survey areas, thereby maximizing mark-recapture and re-sight opportunities and precision of the resulting abundance estimate. We collared 40^{+} elk in GMUs 1 and 7E (91 animals total), using VHF collars for large ungulates (Telonics, Inc., Mesa, AZ). We also collared a small subset of animals with GPS collars to allow us to test a key assumption of sightability models (i.e., that animals do not move significant distances between the time they are initially flown over and not observed and the time they are later relocated to document parameters affecting their detection). All VHF and GPS collars were equipped with motion sensors triggering a mortality signal if no animal movement was detected within 12 hours. VHF collars are scheduled to automatically drop off elk on June 1, 2020, whereas GPS collars will drop off on May 1, 2017, alleviating the need for recaptures.

Aerial surveys to sight and count elk have been conducted within flight blocks identified in GMUs 1, 3C and 7E (Fig. 2). Flight blocks were chosen based on inclusion of different habitat types that elk appear to favor as well as historical elk sighting locations. Prior to aerial surveys, we conduct a telemetry flight with fixed-wing aircraft at higher altitude to determine which collared elk are inside versus outside of the identified flight block areas for the upcoming survey day. We then conduct helicopter surveys to collect data for both the mark-recapture and simultaneous double counts estimations along predetermined north-south transects (Fig. 2).

Recorded data include the total number of elk observed, number of collared elk observed for mark-recapture estimates, percent visual obstruction (usually due to canopy cover or vegetation structure), vegetation type, animal behavior, group size, group composition, weather, and light conditions. Surveys are flown per Department protocol prior to the start of elk hunting season. Each survey area is flown at least once per year. Flight times are primarily in the early mornings, leaving time for the same aircraft to return to locate undetected individual elk and document covariate data along their original flight path.

At the conclusion of this project, we will present to the Department a framework for considering various survey methods. More importantly, we will be able to produce estimates of the uncertainties associated with estimates of elk abundance procured by the estimation methods investigated. In order to help the Department and other wildlife management agencies make informed decisions regarding the allocation of finite resources, we will produce a comparison in which we identify the anticipated costs

for obtaining abundance estimates and expected uncertainties given the use of different estimation methods or data collection approaches. This will help game managers decide if the increase in precision will be worth the estimated increase in cost.

PROJECT LOCATION:
The primary focal areas of this study are game management units (GMUs) 1 and 7E (Fig. 1). Townships and ranges included in our proposed work in Region 1 may cover areas in T6-8N, R28-31E and T22-25N, R6-8E in Region 2 (Fig. 2). We chose to focus on GMUs 1 and 7E because they both have historically abundant elk populations and contain a majority of representative dominant habitat types in rizona that appear to be important to elk. We also took advantage of collared elk in GMUs 3C, 4A, and 4B, where the Department's Wildlife Contracts Branch had collared approximately 75 animals for highway crossing research. Collars on these animals dropped off as scheduled in May 2015.

LAND OWNERSHIP AT THE PROJECT SITE(S)*:*

- USFS public lands primarily in Coconino and Apache-Sitgreaves National Forests

IF PRIVATE PROPERTY, IS THERE A COOPERATIVE BIG GAME STEWARDSHIP or LANDOWNER AGREEMENT BETWEEN THE LANDOWNER AND THE DEPARTMENT?
YES[] NO[] N/A[X]

HABITAT DESCRIPTION:
Our study focuses primarily on the Coconino and Apache-Sitgreaves National Forests in Regions 1 and 2. In each region, elk are most commonly found between 5,500' and 10,000'+ in elevation. GMU 1 is located within Region 1. Land cover is dominated by Rocky Mountain Ponderosa Pine Woodland, Colorado Plateau Pinyon-Juniper Woodland, and Inter-Mountain Basins Semi-Desert Grassland. GMU 7E is located within Region 2, and its land cover is dominated by Colorado Plateau Pinyon-Juniper Woodland, Inter-Mountain Basins Semi-Desert Shrub Steppe, and Inter-Mountain Basins Semi-Desert Grassland. Habitats in 3C, 4A, and 4B have similar habitats to both GMU 1 and 7E.

ITEMIZED USE OF FUNDS:

Special Big Game License Tag Funds

Helicopter flight time in fall 2016	$100,000 (FY17)
Total requested funds	**$100,000**

Cost Share or Matching Funds (*for volunteer labor rates please refer to the worksheet below*)

Allocated from Pittman-Robertson Federal Aid funds, through FY2016:

Personnel (2 Wildlife Specialists, 1 Technician)	$82,710/year (FY14-16); Total (3yr): $248,130
Intern (750 hr/yr)	$10,500/yr (FY14-15); Total (2yr): $21,000
Extra personnel for capture efforts	$7,000/yr (FY14-15); Total (2yr): $14,000
24 Iridium Satellite collars, airtime, dropoff	$81,284.40 (FY14); Total $81,284.40
67 VHF Collars, drop-offs	$37,084.14 (FY14); Total $37,084.14
Capture equipment, drugs, and darts	$18,585 (FY14), $12,985 (FY15); Total $31,570
Capture bait (hay and salt)	$6,000/yr (FY14-15); Total $12,000
Extra personnel for survey efforts+travel/perdiem	$10,000/yr (FY15-16); Total $20,000
Instate travel (captures, surveys, monitoring)	$33,000 (FY 14-16); Total $33,000

Software, telemetry/computer equipment	$4,100 (FY14); Total $4,100
Helicopter surveys per research design	$120,000/yr (FY15, FY16); Total $240,000

(Helicopter survey time includes ~122 hrs of survey time per year, as well as ~20 hrs of helicopter ferry time and costs of their companion fuel truck.)

Total PR Federal Aid matching funds: $742,168.54

LIST COOPERATORS AND DESCRIBE POTENTIAL PARTICIPATION: Region 1 and 2 Game Specialists and Wildlife Managers; Game Branch personnel.

WOULD IMPLEMENTATION OF THIS PROJECT ASSIST IN PROVIDING, MAINTAINING, OR FACILITATING RECREATIONAL ACCESS?
YES[] NO[X] N/A[]

PROJECT MONITORING PLAN: We have reviewed the data collected after each survey session with the Game Program and Game Specialists in Regions 1 and 2. As feasible and appropriate, we have used data in analyses to pinpoint successes and challenges in the data so that we could improve survey techniques and data collection where possible. This project will be required to satisfy all Federal reporting requirements because Federal Aid funds will be used as well. As such, this project is included in our annual Job Statement and in our Annual Reporting to the Fish and Wildlife Service.

PROJECT COMPLETION REPORT TO BE FILED BY: Larisa Harding
WATER DEVELOPMENT PROJECTS (*please use the worksheet below***): N/A**
TREE CLEARING/REMOVAL PROJECTS (*please use the worksheet below***): N/A**

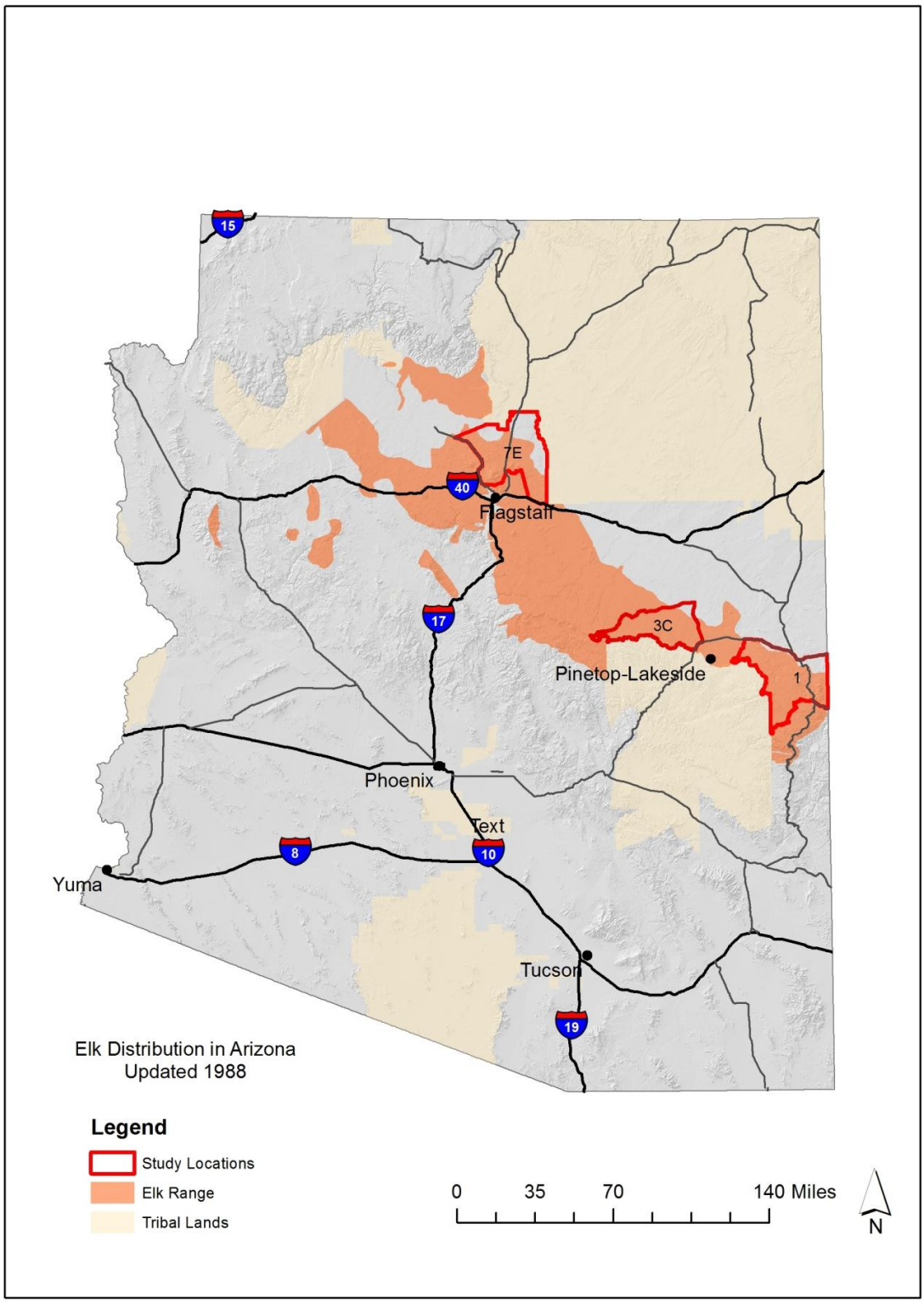
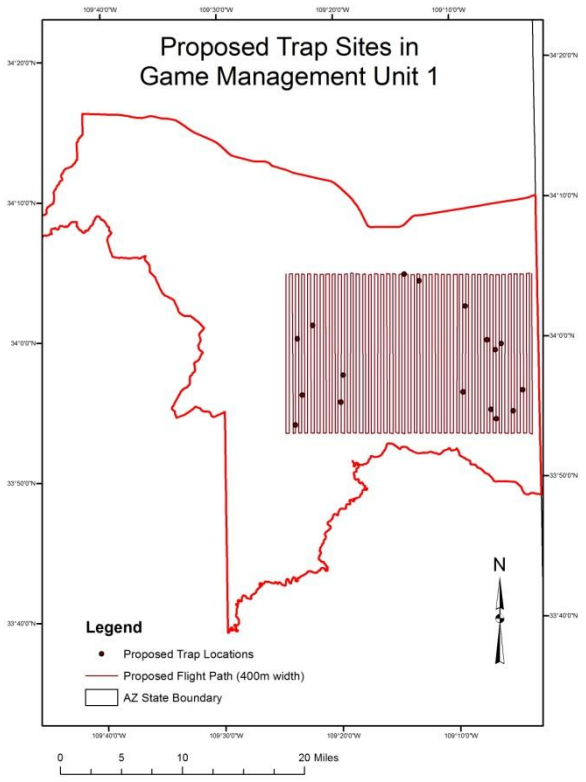
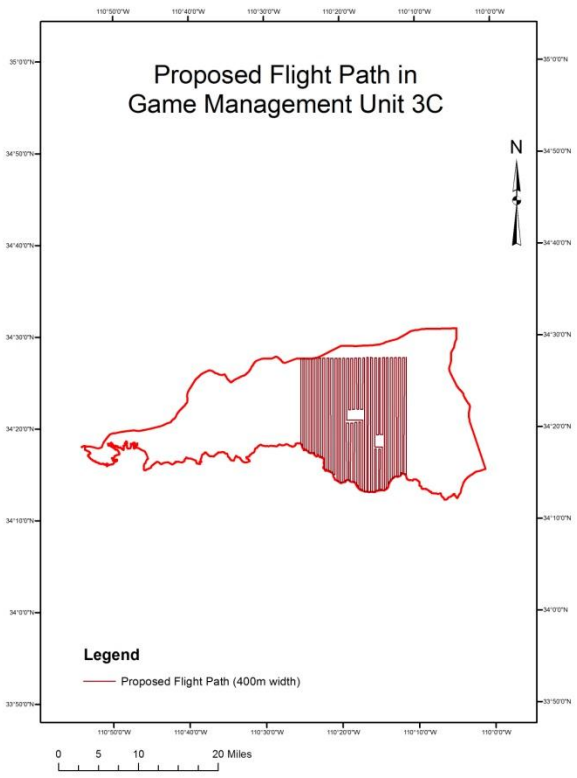


Figure 1. Proposed study area depicting elk range in Arizona.





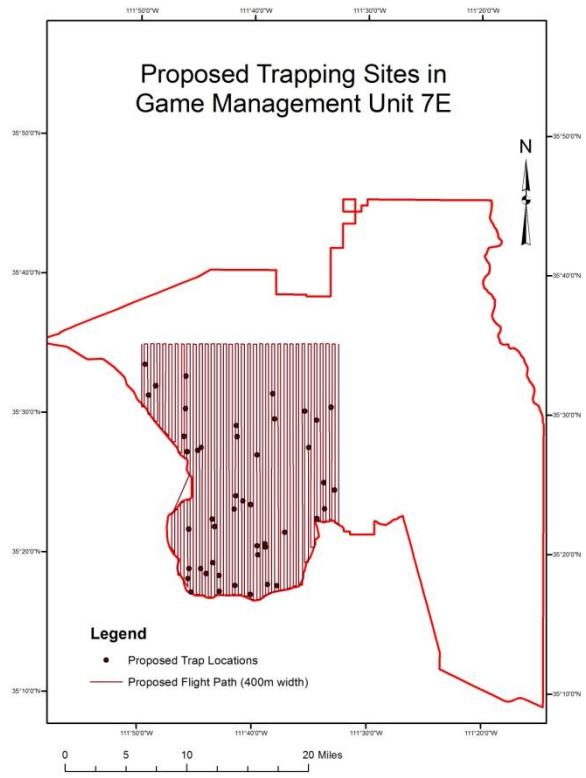


Figure 2. Proposed locations of trapping sites and study blocks where survey flights will be concentrated. White blocks inside proposed flight path in GMU 3C are towns.